67

# Submission to Otago Regional Council

## on

## Proposed Regional Policy Statement for Otago



**Submitter**

**Peter Foster**

61 Whites Rd
Merton
R.D. 1
Waikouaiti 9471

| | |
|---|---|
| Phone | 4657885 |
| Mobile | 0272657885 |
| Email | petefozzil@gmail.com |

I wish to be heard is support of my submission on sea level

I would consider presenting jointly, if the time allotted per submitter is the same as the time allotted for a submitter not presenting jointly.

P A Foster

20th July 2015

Attached documents.

1. The NIPCC report on sea levels for two NSW counties

2. A peer reviewed paper by Nils-Axel Morner showing Glacial Isostacy is regional.

3. PSMSL data

4. My submission to the DCC on sea levels. Ig contains additional information not given in this submission

# Re Ngai Tahu Rights

The treaty of Waitangi never ever envisaged a partnership. Maori were to be left alone to live how they liked on Maori land and Europeans could do as they liked on land purchased by the crown. That of course changed over time but any reading of the treaty and documents of the day clearly indicate that there was never and intention to have a partnership. That is political judgement only made a few decades ago.

**a)** Ngai Tahu are not the only tribe in Otago. Why are the other older tribes not included ?
Consultation with Huata Holmes might give you a better perspective on that.

**b)** I have no issue with preservation of historic Maori sites. Political influence on landscapes however is quite different and I see no justification for such rights. The landscape of Otago was bush covered, 400 years ago and the great fire that destroyed that bush was attributed, rightly or wrongly, to Maori. Ngai Tahu however are the johnny come latelies having invaded Otago in relatively recent times so they would know nothing of the original landscape.

They should therefore have no rights in that respect.

**c)** I take issue with Ngai Tahu being given any form of political priority in terms of notice or influence on the ORC.

The last pure South Island Maori died around 1900. That is 5 generations ago, at which point they were already known as the pale Maori due to a very high proportion of mixed marriages a few generations earlier.

However, a person who has one pure ancestor 5 generations ago is 1/32 Maori and has **64 ancestors**, of whom **57 are non Maori** and the remaining 6 are every fraction inbetween.
The point being that it is utterly ridiculous to give such a person, who has so little genetic connection to their Maori ancestor, the rights that were probably due to their ancestor 100 years ago.
This exercise is about political correctness and is carefully cultured by
Ngai Tahu to ensure that they, who are genetically more European than anything else, get rights above those of the ordinary citizen / ratepayer.

It is time that Maori recognised that the relationship with European has probably given them far more than they ever lost. How many of them would live now, as their Maori ancestors lived, which is what they would be doing if NZ had never been visited by peoples from other nations. The gains to them in terms of quality of life are substantially more than the losses they claim to have suffered.

It is good that Maori celebrate their cultural heritage and their history but it is clearly time we became one people politically.

**In case it is not obvious I oppose this aspect of your policy**.

I have made my point and do not wish to be heard on this issue.

I do wish to be heard with respect to the following submission on climate change.

PS re spelling. Ngai Tahu are a North Island tribe who invaded the South Island in relatively recent times and displaced the original tribes. The spelling is therefore Ngai Tahu not the southern dialect Kai Tahu.

# Climate Change issues

You have taken your advice from NIWA and others which in turn were based on the IPCC AR4 reports. In addition the IPCC reports have been strongly supported by the commissioner for the Environment Dr Jan Wright, by the PM's chief science advisor Sir Peter Gluckman. These people in turn have been advised by James Renwick formerly of NIWA now with Victoria University and David Wratt of NIWA.

With respect to sea levels I have already supplied you with my submission to the DCC on sea levels which was endorsed by Professor R Carter and with a report on sea levels prepared by the NIPCC for two Australian Counties who were going through the same exercise as the ORC is now.

**You have totally ignored these submissions**,
so lets compare the credentials of the authors, the NIPCC authors include;

**Dr Nils Axel Morner**; probably the most knowledgeable scientist on the planet on sea levels.

**Associate Professor Willem de Lange** (Waikato University) widely regarded by his peers as being one of the top scientists in his field of coastal hazards and sea levels.
**Dr David Kear** formerly head of DSIR whose speciality was historic sea levels and who was the government representative at the formation of the IPCC.
**Professor Robert Carter** marine sediments and ancient sea levels
The rest are specialists in related fields.

Now compare their research involving sea levels

| Person | number of papers on sea levels |
|---|---|
| Dr Renwick | 0 |
| Dr Wratt | 0 |
| Dr Wright | 0 |
| Professor Sir Peter Gluckman | 0 |
| | |
| Dr N A Morner | > 550 |
| Prof de Lange | > 90 |
| Prof Carter | > 25 + coauthor of NIPCC report |

I could go on but hopefully I have made my point

**Comments on your source;**
1. The sea level rise estimates were reduced significantly in AR5. If you insist on using the IPCC projections (which are wrong) then at least you should update it to use AR5 estimates.

2. The IPCC estimates are based projected warming resulting from the estimation of climate sensitivity. This value is determined by the general circulation climate models.

The climate models are based on the hypothesis that CO2 is the major driver of climate change.
(That a doubling of CO2 in the absence of feedbacks would cause a ~1.2 °C rise in temperature is not in dispute, however, whether it does cause warming or not depends on feedbacks).

***The projections of a hypothesis are not evidence, they are merely what if scenarios and if they are not supported by observation then the hypothesis is wrong.***

**The models assume;**

**a)** That the warming from an increase in CO2 would increase water vapour in the air and water being the strongest greenhouse gas, and present in the highest amount, would then cause further warming.

**b)** That the feedback from clouds is positive, that low cloud will decrease and enhance the warming effect.

**Reality**

**1.** There are no peer reviewed papers that show any link between CO2 and a known climate change

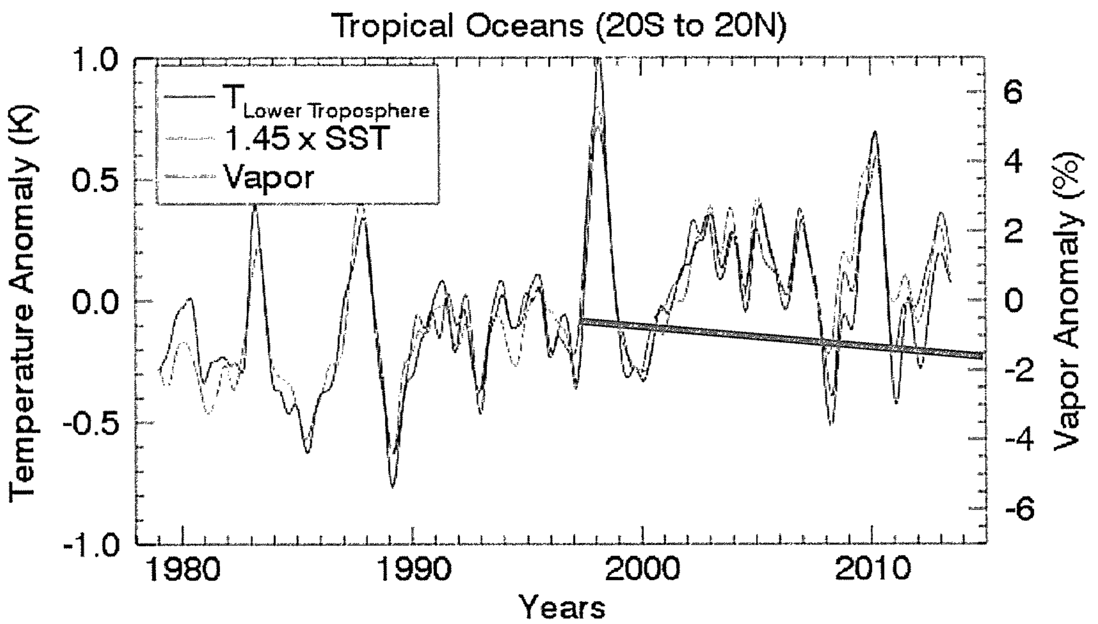
**2.** The IPCC AR5 SPM states that they know neither the sign nor the magnitude of the low cloud response. It also states that while aerosols have a negative effect the magnitude is unknown.

This being the case it is impossible to calculate climate sensitivity in the manner of the climate models.

for example **climate sensitivity = 1.1 + feedbacks**

If you do not know the value of the feedbacks then you cannot calculate Climate sensitivity.

**3.** The models require that water vapour increase with CO2. the graph below shows they do not. This graph comes from the satellite analysts Remote Sensing Systems. In my submission to the DCC I showed the same result from the analysis of van de Haar.

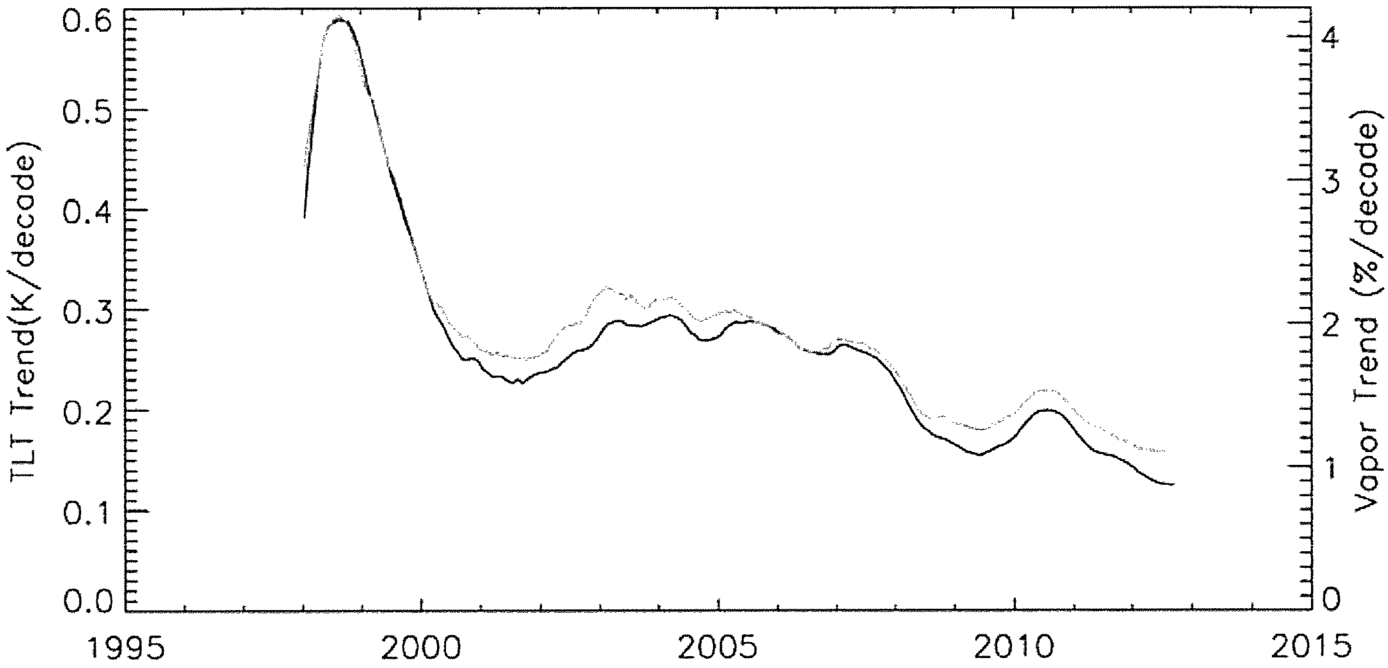



Note
Post 1997
Slope

The next graph shows trends. RSS comments as follows;

*We have compared the TPW from this product with TLT air temperature values to see if the two parameters are still strongly correlated as reported in previous papers (Mears et al, 2007). The figure below shows this agreement for the deep tropics (-20S to 20N) ocean regions only. The value of the line at each point is the linear trend, starting in January 1988, and ending at the time indicated on the x-axis. Here the TLT trend is shown in black and the TPW (vapor) trend in orange:*

(TPW = total precipitable water, TLT= temperature Lower Troposphere)




Contrary to the IPCC models, the trend since the 1998 super El Nino is downward, Total precipitable water vapour is not increasing with CO2 as the models predict.

**The models are therefore wrong**

**4.** CO2 already absorbs all radiation possible within a few metres of the Earth, increasing that would make no difference. The region where CO2 is deemed to be most effective in causing warming is the tropical upper troposphere, about 10km above the surface, where the models predict a hot spot should be present if CO2 is driving climate change.

Daily in the tropics as the sun nears midday, water temperatures rise and water evaporates. Thunderstorms develop that transport water vapour to the upper troposphere where it condenses releasing that energy. Increase CO2 then traps that energy, thereby increasing temperature.

This is fundamental to the way virtually all the models see CO2 as warming the planet. Therefore if there is no warming in the upper troposphere, then the hypothesis is wrong.

***The graphic that follows comes from the supplementary material of the IPCC AR5 WG1 (Working Group 1 is the Science report)***

The red band is the temperature profile the models predict if CO2 is driving climate change.

The blue band is the profile if CO2 is having no effect.

The white overlaid band is actual measurements from 4 sets of balloon data and 2 sets of satellite data.

The second graph is from a slightly lower region of the atmosphere but shown as a time series.
Again there is no correlation between observation and hypothesis.

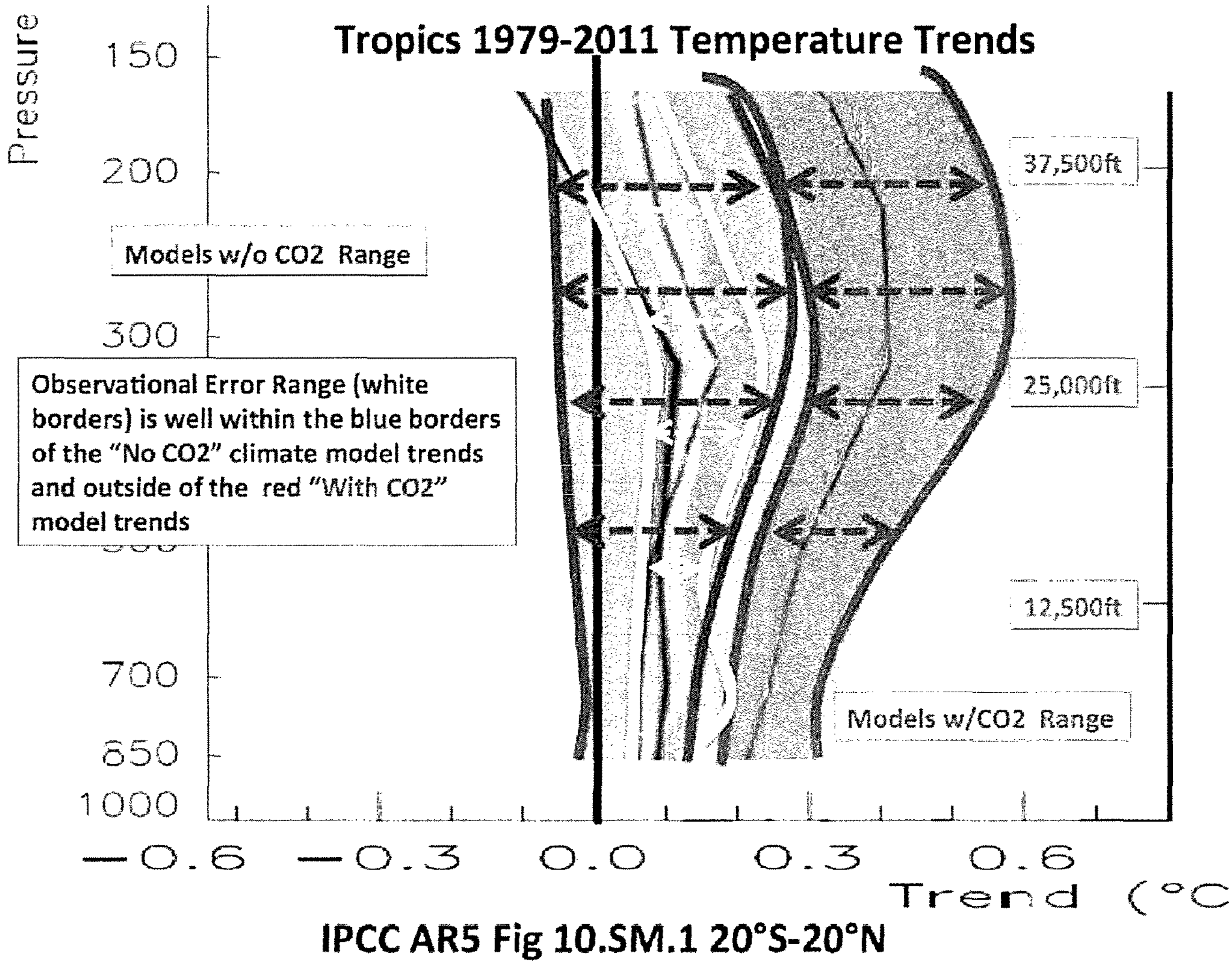
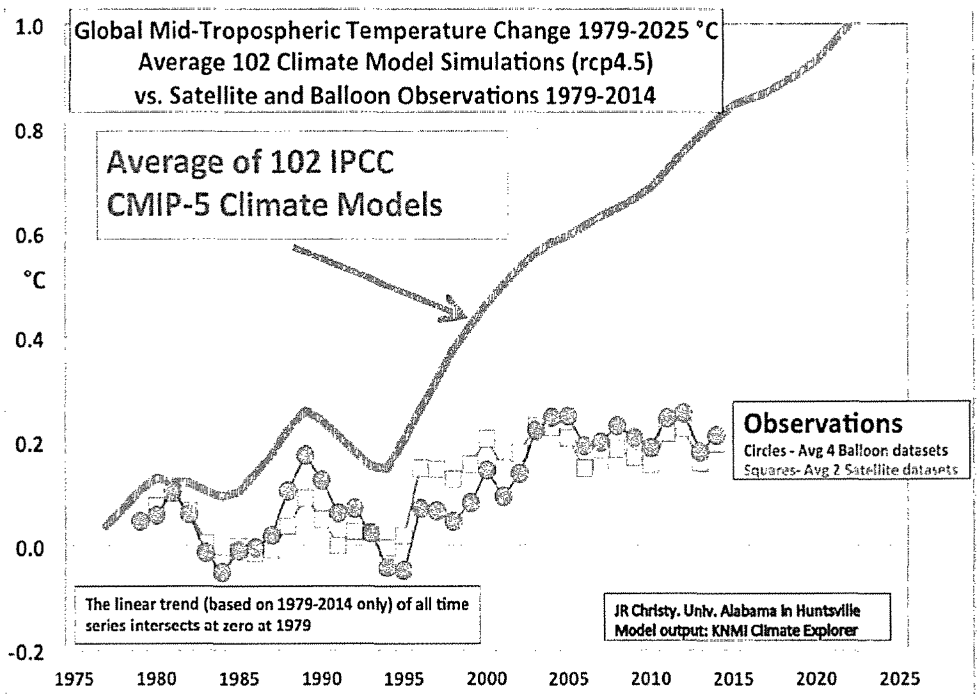



Figure 3. From Fig. 10.SM.1 (tropics) of the IPCC AR5 Supplementary Material, magnified and annotated from Fig. 2 above. The envelop of white-bordered observations falls within the blue envelop of no anthropogenic greenhouse gas increases and completely disjoint from the model runs with anthropogenic greenhouse gases.

*"No amount of experimentation can ever prove me right; a single experiment can prove me wrong."*

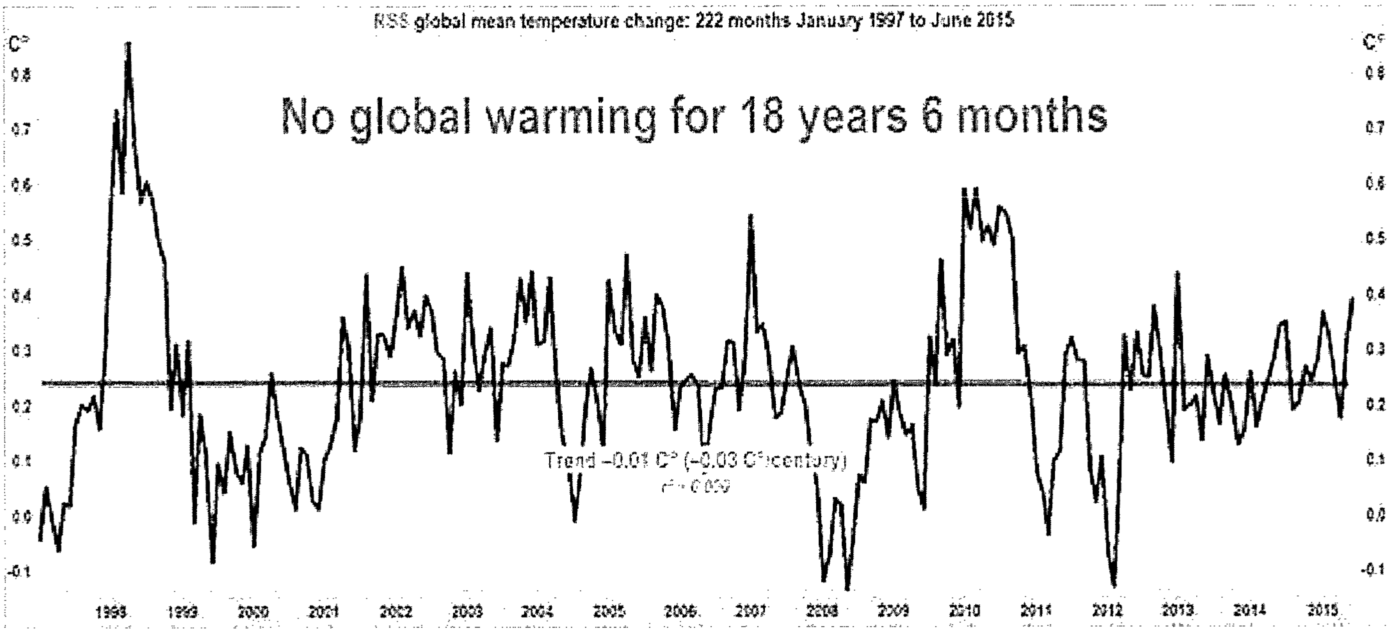
**Albert Einstein**

**These are the observations that prove the models wrong**

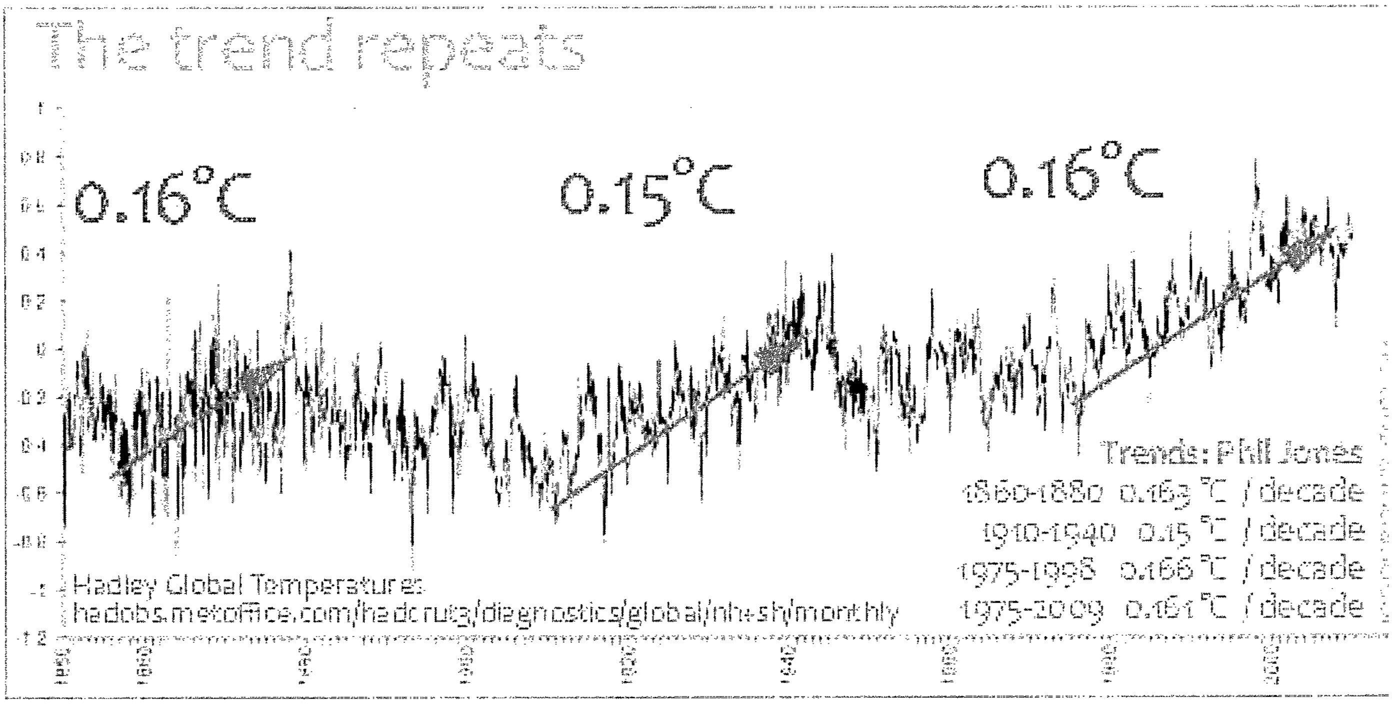


**5.** As CO2 increases global temperatures are supposed to increase but for the last 18 years and 6 months there has been no increase. Given that all the hype on global warming resulted from the 23 year natural warming phase of the 60 year cycle from 1975 to 1998 then this is a significant period of time with no warming.

Yes there will most likely be a strong El Nino this year that will warm the planet a bit but then El Nino's are not caused by CO2 and they tend to be followed by La Ninas which are cooling.




The following graph, from Hadley Climate Research Unit shows the repeating pattern of the 60 year climate cycle. It also shows that the latest warming phase 1975 to 1998 was not unusual.



**The hypothesis is wrong.**

**Therefore the basis for the sea level rise used by the ORC is wrong.**

## Sea Level Measurement

Sea level globally is a very difficult metric to measure and requires a time frame in the order of 60 years or more in order to detect cyclic patterns.

That said there are 2 ways in which eustatic sea level can be measured;

1. Tide gauges measurements from geologically stable locations with a long record

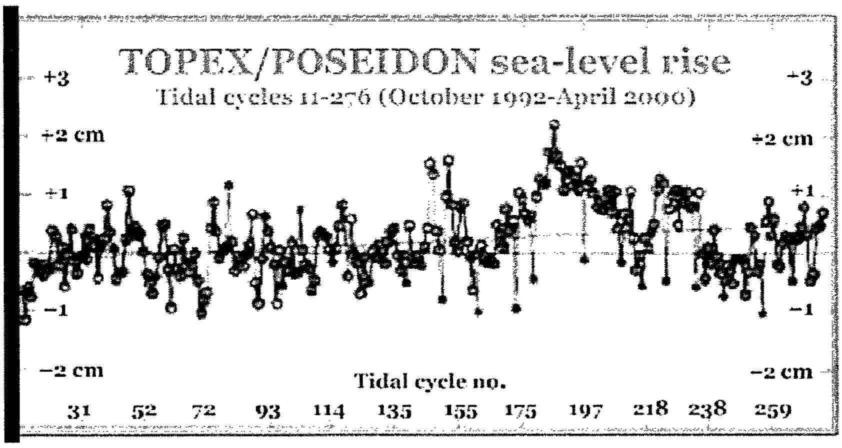
| | | |
|---|---|---|
| 2. Satellites detecting; | Altitude e.g. | NOAA satellites Topex, Jason 1 Jason 2 |
| | | EU Envirosat satellite |
| | Gravity | GRACE |

**Tide gauges measure the actual level of the sea against the land, this is the only parameter of importance for your deliberations,** however the IPCC claims an increase in eustatic sea level will impinge on this local historic rate of sea level rise.

Satellites measure a the distance between the satellite orbit and the sea surface which is then corrected for the shape of the Earth as the orbit is circular while the Earth is a geoid.

Changes in the distance over time are then averaged out to give a eustatic sea level.

The satellite raw data shows a rise in sea level consistent with tide gauge measurements



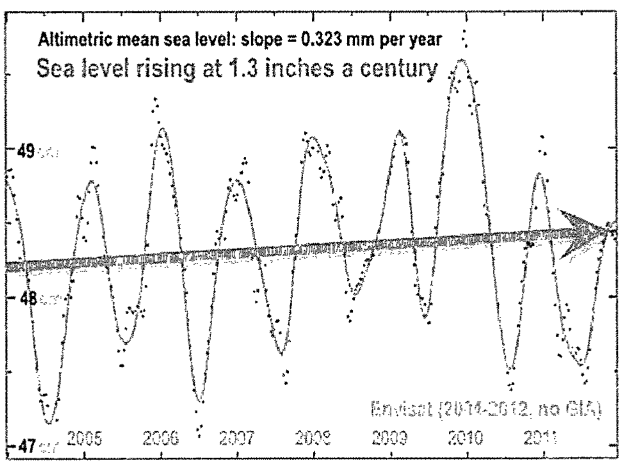

Topex / Poseidon

This gives a rise of ~5mm in 7½ years roughly 0.7 mm / year

The EU satellite Envisat, shows a rise before adjustments of just 0.32 mm/year.

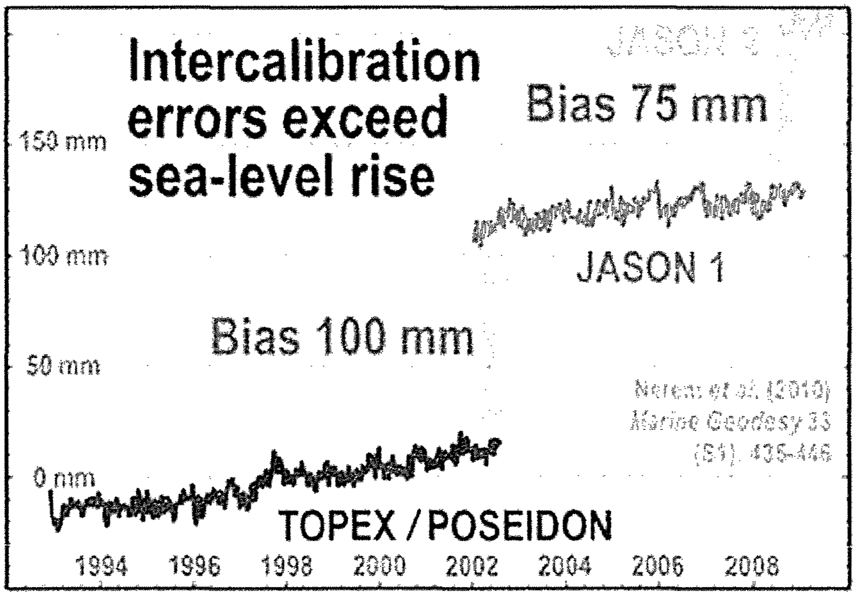
The rate differs from topex but they are not the same time periods, Topex is 1992 to 2000 while Envisat is 2004 to 2012.

The lower rate is shown by Jason 1 below



Topex was followed by Jason 1 and then Jason 2. As can be seen there is a *calibration difference between the* satellites.

Note that Jason 1 raw data trend is less than Topex shown above which is more consistent with Envisat for the same time period




Raw data from both tide gauges and satellites show a rate of sea level rise of between 0 and 200 mm per century (depending on location)

The also show no increase in the rate of sea level rise, in fact many measurements indicate a fall in the rate of rise.

The satellite sea level rate of rise is given as 3.2mm/year by the Boulder Colorado group so how is it that this rate is some 5 to 10 times that actually recorded by the satellites and double that recorded by tide gauges.

In a word - adjustments

There are two types of adjustment.
(**a**) Those for which the methodology is known and can therefore be analysed by other scientists
(**b**) Those where the rationale and methodology are secret, consequently where no independent analysis or verification can be performed.

A major adjustment of the first type is Glacial Isostatic Adjustment (GIA)

This is based on the known fact that the weight of polar ice 20,000 years ago, particularly in the Northern Hemisphere, depressed the crust in those regions thereby causing it to bulge out elsewhere. Now that the ice has gone (from NH) the crust is rebounding. This has been known and measured for centuries as sea levels in Scandinavia and northern countries fall due to the land rising, while in Netherlands and further south sea level rises due to land subsidence.

This crustal movement has been modelled and ***assumed*** to effect the **whole globe.**

Now if the sea floor sinks but the level against the land stays the same, then the sea level has effectively risen by that amount even though there would be no rise in the local tide gauge.

The GIA therefore is more about measuring ocean volume than it is about sea level as such.

The satellites and the gravity measurement both have a GIA.

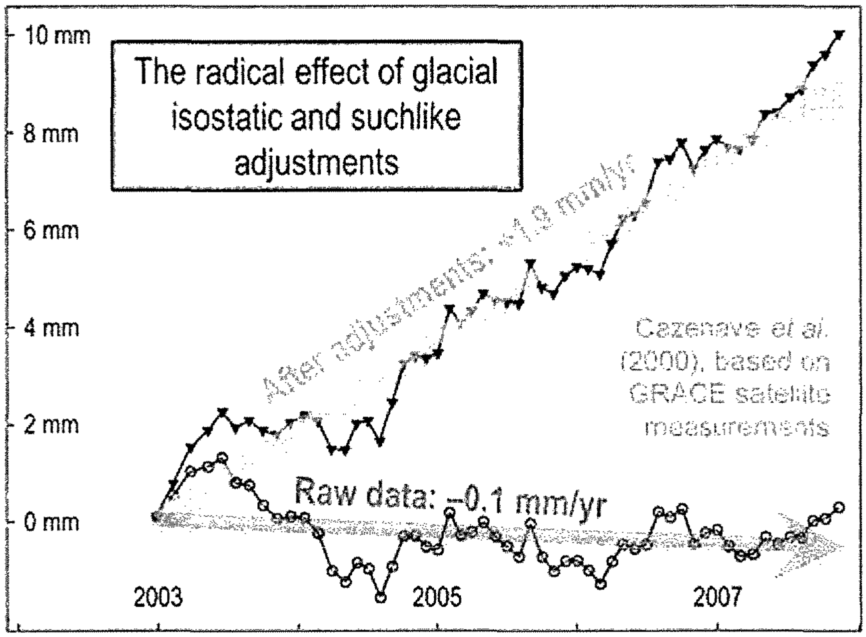
**Changes in sea level are only of importance to the ORC in as far as they affect the level of the sea against the land, changes that do not affect that are of no consequence.**

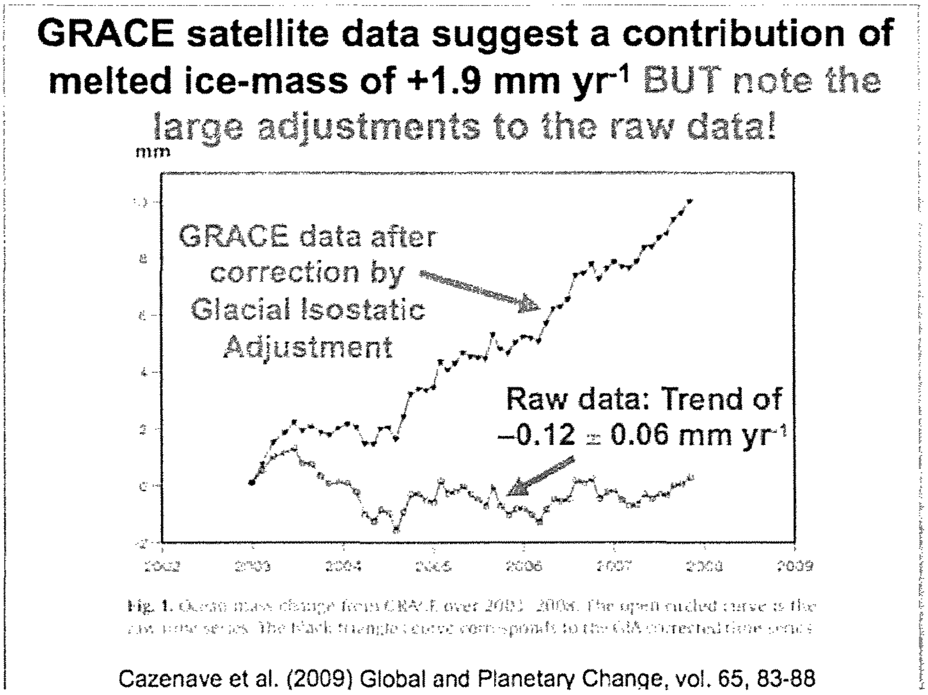
**GRACE Satellite**

Analyses sea levels from gravity comparisons. Raw data shows a fall but is adjusted upward.

These adjustments are partly GIA applied to the oceans but mostly due to GIA applied to the assumed ice loss from Antarctic and Greenland Ice Sheets.

See graph below.



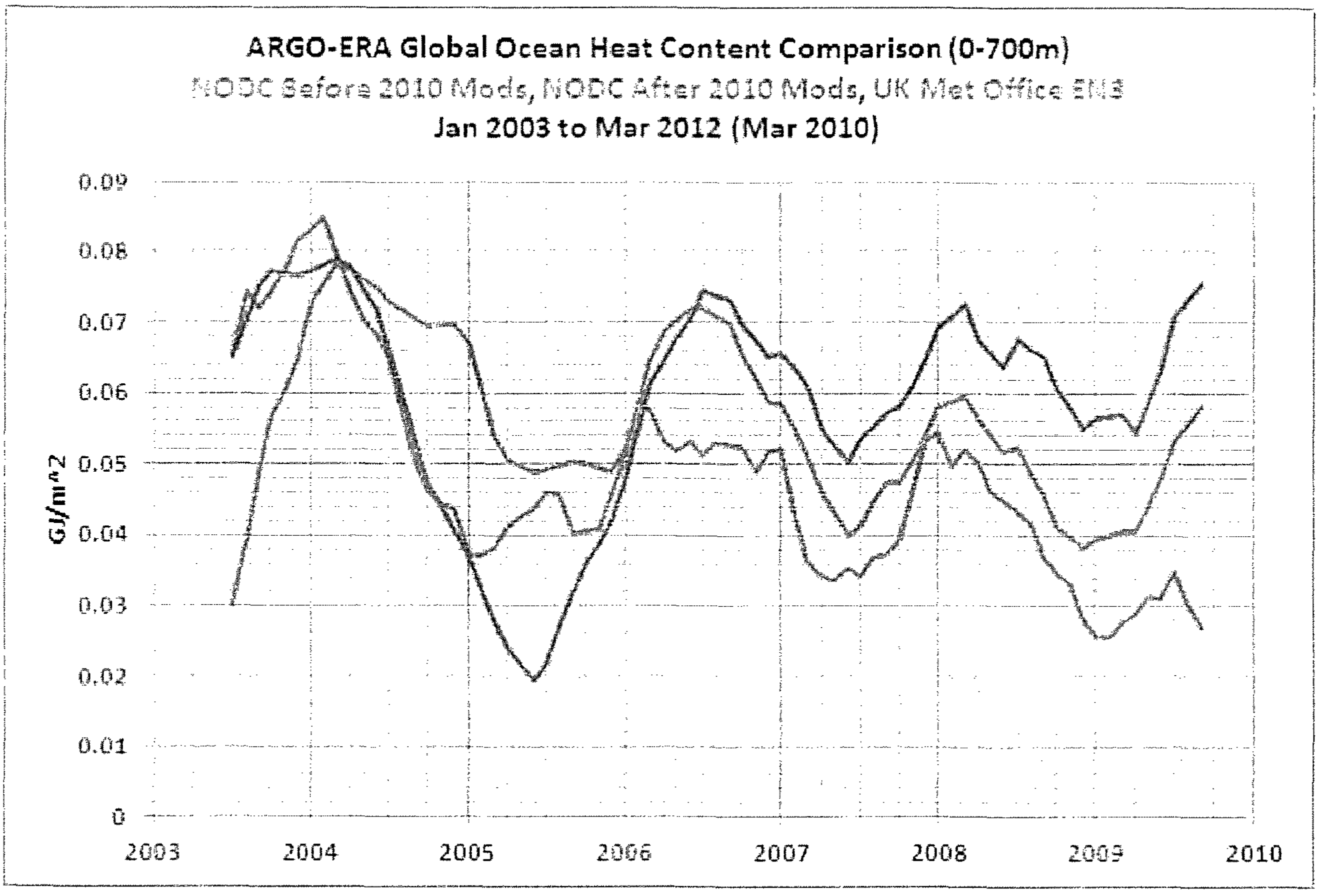

Secondly, Nils-Axel Morner, probably most well known for his work on sea levels related to isostacy in Europe/Scandinavia, has recently released a paper (attached) showing that the effect of GIA is regional not global.

**Therefore all GIA corrections to raw data are without foundation.**

Re the second type of adjustment. This is quite common in climate science, for example the Goddard Institute of Space Studies (GISS) and NOAA global temperatures are adjusted by mechanisms which are kept secret. The result is obvious but the methodology is not and the organisations concerned have refused multiple requests for raw data and/or the computer code used to homogenize and adjust the raw data.

Sea level projections are based on thermal expansion of water due to increasing temperature and to additional ice melt from Antarctica, Greenland and other glaciers.

For the first 8 years of their life the ARGO buoys showed that ocean temperatures were falling. Since 2010 that data is adjusted to show temperatures rising.
This adjustment is made to bring the ARGO data in line with calculated ocean heat content which in turn depends on assumptions on the amount of ice melt and on temperature of the ocean below 2000m (the max depth of the ARGO buoys) Several of these parameters are dependent on the GIA.




*The graph above is global heat content for the upper 700m as determined from temperature analysis from ARGO buoys.*
*Blue is from Hadley Climate Research Unit (HadCRU) and slope is downward ie oceans are cooling*
*Brown is from NODC (National Oceanographic Data Center - a part of NOAA) before adjustments, like HadCRU the slope is downward.*
*Red is from NODC after adjustments. Slope is upward, ie warming oceans*

So temperature, a prime measurement and one of the seven basic SI units, that we can measure with great accuracy, is adjusted on the basis of highly inaccurate assumptions on ice melt, sea level increase and top of the atmosphere energy imbalance.

And just coincidentally the values are now in agreement with the climate models - fancy that!

In short it is a case of adjusting data to suit the hypothesis.

Real science demands the opposite, that the hypothesis dance to observation.

**Any data which is adjusted by means that cannot be analysed or verified by other scientists has no place in scientific analysis.**

## New Zealand Sea levels.

I have attached a paper showing the sea levels from several NZ regions as held by the Permanent Service for Mean Sea Level (PSMSL)
The link to get this data for yourselves is within the paper.

Look at the rate of change from 1980 or 1990 onward. There is a distinct slope change in many records about this time to a lower rate of sea level rise. This may not mean much in the long term but certainly shows that there is no acceleration of sea level rise apparent in tide gauge data around NZ.

The thesis of Theresa Cole which I sent to you last year shows the Otago Harbour tide gauge showing no increase for 40 years. A non pressure corrected increase of 128 mm/ century and a pressure corrected rise of 122 mm/century.

From the 60 cycle of climate change shown above from HadCRU, it should be obvious that in the next 100 years there will be two cooling phases and only one warming phase. Therefore the chances of an significant increase in sea levels is quite remote.

## Summary.

- The sea level knowledge of those promoting the IPCC alarmism in NZ is nil compared to the experts whose reports I have provided you with.

- The IPCC claims are based on a hypothesis that fails the most basic requirement of science, that is that the projections of a theory agree with observation/experiment.

- Major assumptions in the models are unknown and in order to derived a value for climate sensitivity these factors are simply guessed at. And you, the ORC, are willing to make public policy based on politically inspired guesses !

- The fundamental mechanism by which $CO_2$ warms the atmosphere, the hot spot, does not exist. The models are therefore wrong

- Satellite assessment of sea levels are subject to adjustments, the basis of which have been challenged in peer reviewed research publications and do not reflect the actual rise of the sea level against the land.

- Your own tide gauge data, NZ sea level data and global tide gauge data are not showing any increase in rate of rise. Given the failings of the general climate models there is no basis for the ORC to blindly follow the IPCC alarmism.

- It is clear that the politics behind the global warming paradigm have not yet registered with the ORC.
- While the working group 1 of the IPCC analyse the science the summary for policy makers is a political perversion of that report. Do not forget that the aim of the IPCC is to show that humans cause climate change, it is not a dispassionate review of the known science, for example, most of the research on solar effects on climate are simply ignored by the IPCC.

- In working group 1 (science report) there is not one peer reviewed paper referenced that shows a link between $CO_2$ and a known change of climate.

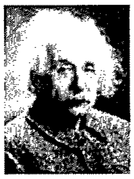
- It is all about politics and it is a measure of the naivete and gullibility of bureaucrats and councillors, that they do not understand that.

# Scientific Method

"Science, my boy, is made up of mistakes, but they are mistakes which it is useful to make, because they lead little by little to the truth."
— Jules Verne, *Journey to the Center of the Earth*

"There can be no ultimate statements science: there can be no statements in science which can not be tested, and therefore none which cannot in principle be refuted, by falsifying some of the conclusions which can be deduced from them."
- - Karl Popper

If a theory or proposed law disagrees with experiment, it's wrong. In that simple statement is the key to science. It doesn't make any difference how beautiful your guess is, it doesn't matter how smart you are who made the guess, or what his name is... If it disagrees with experiment, it's wrong. That's all there is to it."
Richard Feynman, *Cornell Physicist Lecturer*



"A model or a hypothesis cannot 'prove' anything. But data can invalidate a hypothesis or model...It takes only one experiment to prove me wrong".
- Albert Einstein

Dr. Ivar Giaever received his Nobel Prize for physics in 1973. He spoke at a Nobel forum on July 1, 2015. Among many statements he made the point that;

*"For the last hundred years, the ocean has risen 20 cm — but for the previous hundred years the ocean also has risen 20 cm and for the last 300 years, the ocean has also risen 20 cm per 100 years. So there is no unusual rise in sea level. And to be sure you understand that I will repeat it. There is no unusual rise in sea level,"* Giaever said.

The Alarmism, fostered by the IPCC only survives due to the support of scientists who put research funding ahead of integrity. It represents a failure of the scientific method.

Peter Foster
24th July 2015

POLICY **BRIEF**
NIPCC
NONGOVERNMENTAL INTERNATIONAL PANEL ON CLIMATE CHANGE

CENTER FOR THE STUDY OF CARBON DIOXIDE AND GLOBAL CHANGE
THE HEARTLAND INSTITUTE
SCIENCE AND ENVIRONMENTAL POLICY PROJECT

**September 24, 2014**

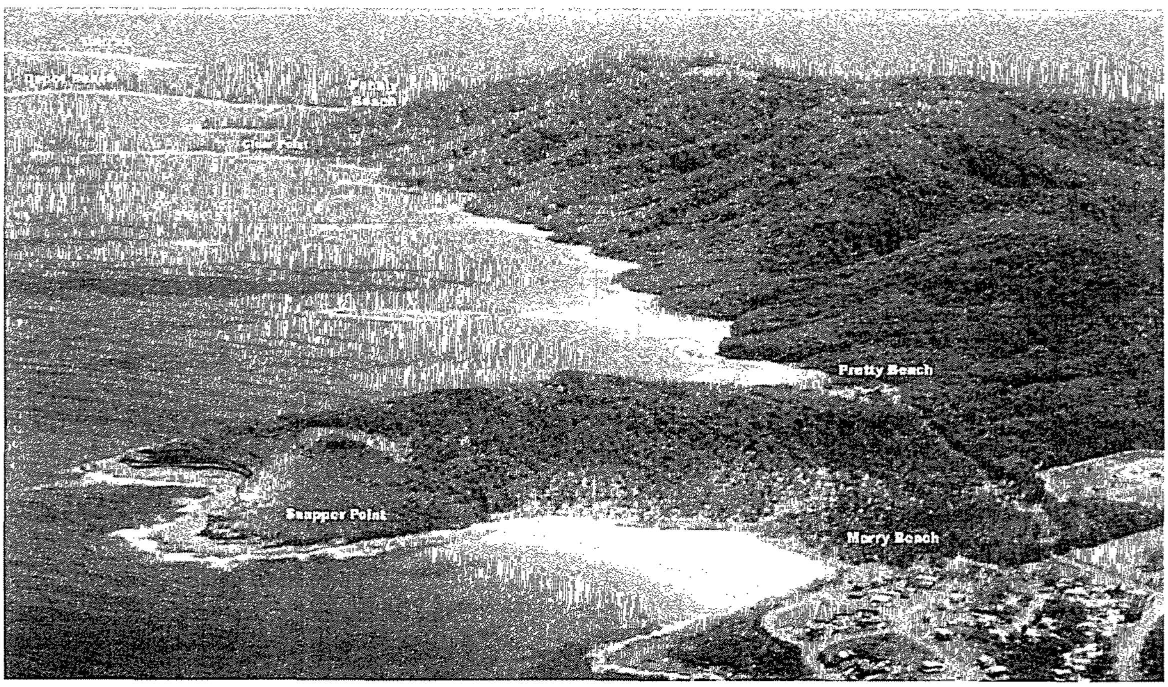
# Commentary and Analysis on the Whitehead & Associates 2014 NSW Sea-Level Report

by

Carter R.M., de Lange W., Hansen, J.M., Humlum O., Idso C.,

Kear, D., Legates, D., Mörner, N.A., Ollier C., Singer F. & Soon W.

**Reference: E13.7268**



**The Whitehead & Associates report that is the subject of this review is available at the following web address:**

*http://esc.nsw.gov.au/inside-council/project-and-exhibitions/public-exhibition/on-exhibition/south-coast-regional-sea-level-rise-planning-and-policy-response/South-Coast-Regional-Sea-Level-Rise-Policy-and-Planning-Framework.pdf*

# Summary

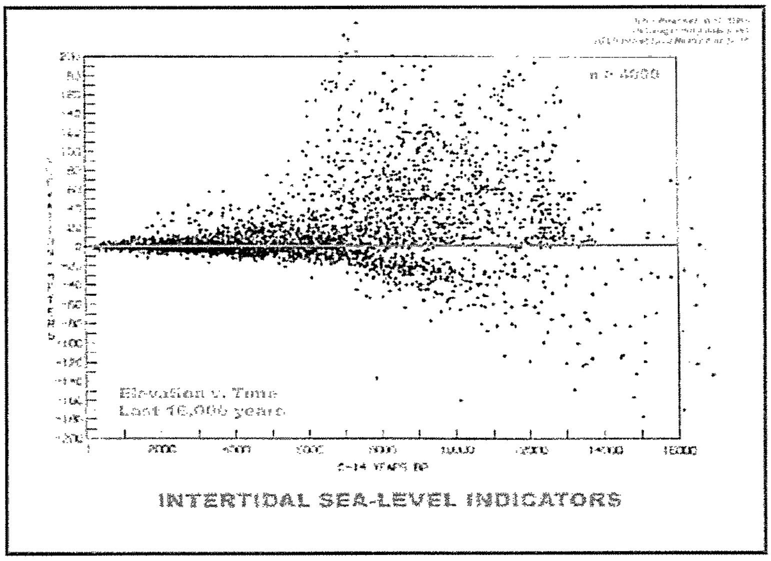
In July 2014, Whitehead & Associates Environmental Consultants, in consultation with Coastal Environment and with funding from the NSW Government, produced a report for Eurobodalla Shire Council and Shoalhaven City Council titled "South Coast Regional Sea Level Rise Policy and Planning Framework, Exhibition Draft." The conclusion of the following commentary and analysis is that this report does not provide reliable guidance to the complicated issues of measuring, forecasting, and responding to sea-level rise.

The image below presents the unmistakeable pattern of wide variations in rates of tectonic uplift (points above the red zero baseline) and subsidence (points below) in different locations around the world at particular times. In such circumstances, no effective coastal management plan can rest upon speculative computer projections regarding an idealised future *global* sea-level, such as those provided by the United Nations' Intergovernmental Panel on Climate Change (IPCC).

Coastal management must instead rest upon accurate knowledge of local geological, meteorological and oceanographical conditions, including, amongst other things, changes in *local relative sea level.*

For the central and southern New South Wales (NSW) coast of Australia, this requires basing management policies on the range of long-term rates of sea-level rise of 0.63-0.94 mm/yr that have been measured at the nearby Sydney (Fort Denison) tidal gauge.

The implied 6.3-9.4 cm of rise in the next hundred years is similar to the rise which occurred during the preceding hundred years. This did not require, nor receive, any policy formulation over and above the application of historic 20th century coastal planning regulations.




*Elevation v. age plotted for individual intertidal shoreline deposits from around the world over the last 10,000 years (Holocene) (Newman, 1986).*

# Table of Contents

# Main conclusions and recommendations

1. Given the widespread criticism of IPCC's reports and analyses, great caution needs to be applied in basing public policy on IPCC recommendations in the fashion urged by the Whitehead &Associates (W&A) report.
2. IPCC's Representative Concentration Pathway (RCP) 8.5 is an extreme and unlikely scenario of future greenhouse gas emissions. Model projections that are based upon this scenario, as are W&A's, are therefore exercises in speculation.
3. Best practice coastal management is not based on knowledge of past and present rates of global temperature change, nor on computer-based speculations of future rates of temperature or sea-level changes, but on empirical geological, oceanographical, meteorological and survey data collected at or nearby a coastal site of interest.
4. Because they represent a worldwide average, neither the tide-gauge nor the satellite estimates of ***global sea-level*** have any useful application to coastal management in specific locations. This key fact is obscured in W&A's analysis.
5. ***Local relative sea-level change*** is what counts for purposes of coastal planning, because even in tectonically stable areas such as eastern NSW, different rates of uplift and subsidence may apply in different locations.
6. The IPCC suite of CMIP5 computer models drawn on by W&A have repeatedly been shown to be wrong when tested against factual data. Since the models do not provide verifiable predictions, they cannot be relied upon as a tool for formulating coastal management policy.
7. The high sea-level rise figure of 3.3 mm/yr reported for the Fort Denision (Sydney) tide gauge by W&A does not represent the original data measurements (0.73 mm/yr) but results from computer modelling combined with the selection of a short and atypical section of the available sea-level record.
8. Much of W&A's analysis relies upon the presumed accuracy of satellite-borne sea-level measurements. Current research literature shows that this technique is not yet well enough established, and nor is the record long enough, to form an adequate basis for coastal planning.
9. In choosing to analyse the short 18-year period 1996-2013, W&A have selected an arbitrary length of record that encompasses a late-1990s, El

Niño-related regional increase in sea level rise. Thereby, they achieve a significantly higher rate of sea level rise than the true long-term trend at Fort Denison tide of about 0.73 mm/yr.

10. Considering the flooding and erosion risks already inherent in coastal locations, the likely 7.3 cm rise in local sea-level in NSW over the next 100 years is too small to justify a major planning response. Though other human impacts at the coast might require changes in coastal regulations, no imperative exists to change planning rules because of unproven sea-level hazard.

11. At the heart of the issue of good coastal management lies the need for an understanding of coastal processes in general, and the collection of accurate data regarding the history of those processes at any site of particular interest.

12. The study of Cairns Northern Beaches accomplished in the 1980s (Beach Protection Authority, 1984) provides an historic Australian "best practice" coastal management study of the type that has yet to be undertaken to inform the Eurobodalla and Shoalhaven Councils regarding the need, or not, for a revision of their local coastal planning regulations.

13. Three key guidelines for coastal planning are:

    - Abandonment of 'let's stop global sea-level rise' policies
    - Recognition of the local or regional nature of coastal hazard
    - Use of planning controls that are flexible and adaptive in nature

    These recommendations apply just as much to the NSW shoreline as they do to shorelines anywhere else in the world. Coastal councils that ignore or override such basic principles of good environmental management do so at the risk of their ratepayers' property and financial costs.

    To the degree that new planning regulations are based on experimental computer model projections (such as those reported by W&A, which are *not* validated predictions or forecasts), and cause financial damage to coastal property holders, legal culpability may apply.

# Commentary and analysis

## 1. Introduction

The issue of sea-level change, and in particular the identification of a speculative human contribution to that change, is a complex topic. Given the scientific and political controversy that surrounds the matter, the Eurobodalla and Shoalhaven Councils are to be congratulated for seeking fresh advice on the topic.

The new report by Whitehead & Associates (2014; hereafter, W&A) aims to be comprehensive and contains important new information and conclusions. It nonetheless has three systemic defects.

First, the analysis provided of the science relevant to coastal management is biased towards computer modelling of the speculative effects of sea-level rise, and largely ignores other important factors such as oceanographic and meteorological variability, and sediment supply, sources and sinks. Second, not all the scientific manipulations that were undertaken have been reported transparently, i.e. in such a way that other scientists can check and replicate the calculations. And, third, the authors of the report appear to have taken the opinions of global warming lobby groups at face value. No attempt has been made to undertake the type of critical due diligence analysis of global warming, and its putative links to sea-level change, that is required.

## 2. Over-reliance on a single authority: Inadequacies of the IPCC

The following statement occurs on p. 3 of the W&A report:

> *In addition to the planning and legislative changes, new scientific evidence is available. The NSW sea-level rise policy, now repealed, was largely based on the Intergovernmental Panel for Climate Change (IPCC) Assessment Report 4 (AR4) from 2007 (Meehl et al., 2007). The IPCC's Assessment Report 5 (AR5) is in the process of being prepared, with the first part of the report on The Physical Science Basis released online in January, 2014. That report provides an assessment of the published scientific understanding of climate change available up to 15 March, 2013. The text for the Working Group 2 report, on Impacts, Adaptation and Vulnerability was released in March, 2014. Both documents have been reviewed as part of this study.*

The United Nations' Intergovernmental Panel on Climate Change (IPCC) is a much-criticized political (not scientific) agency whose findings are known to be influenced by an overriding agenda of establishing a link between human carbon dioxide emissions and dangerous planetary warming. One manifestation of increasing carbon dioxide emissions might be, but has not yet been demonstrated to be, an increase in the rate of global sea level rise.

Regarding sea-level change specifically, IPCC's most recent conclusion (5$^{th}$ Assessment Report, Summary for Policymakers, p. SPM-13; subsequently 5AR) is that:

> *It is very likely that there is a substantial anthropogenic contribution to the global mean sea level rise since the 1970s. This is based on the high confidence in an anthropogenic influence on the two largest contributions to sea level rise, that is thermal expansion and glacier mass loss.*

No empirical evidence exists in support of this statement, and the term "high confidence" refers to no statistical tests. The references to an anthropogenic influence on sea level via thermal expansion and ice loss are assertions based only on unproven assumptions and outputs of climate models. Meyssignac *et al.* (2012) analysed sea level trends for the tropical Pacific Ocean and found no signal that could be linked to greenhouse gas forcing. Instead they attributed all the observed sea level trends to natural variability. See also NIPCC (2013, Chapter 6).

In according priority to IPCC findings, W&A have overlooked the following well understood fundamental defects of the IPCC approach to policy formulation about sea-level change:

- The assumption that the rate of *global* sea-level change can be meaningfully applied to coastal management in specific *local* areas (in some of which, modern sea-level is actually falling).
- The assumption that the rate of global sea-level change can either be measured, or projected by unvalidated, speculative computer models, with sufficient accuracy for policy recommendations to be based upon any projected rate of change.
- The assumption that the measured rate of global sea-level change is materially influenced by human carbon dioxide emissions, and that such a human influence would necessarily be a universal environmental negative.

All three assumptions are demonstrably incorrect.

In making these assumptions (and noting the report publication date of July, 2014) W&A have failed to take adequate account of the many published scientific papers that provide a different, and non-alarmist, assessment of sea-level change. Many of these have been summarised by independent expert scientists in a report that parallels that of the IPCC (Idso *et al.*, 2013a), and others were published thereafter in late 2013 or early 2014 (Fu & Haines 2013; Baker & McGowan, 2014; Beenstock *et al.* 2014; Hansen 2014; Jevrejeva et al., 2014; Mörner 2014; Parker 2014a, b). Neither have W&A considered critiques that describe inadequacies in the IPCC's 5AR (e.g., Idso et al., 2013b), nor the significant recent policy briefing statement on sea level change published by the Global Warming Policy Foundation, London (de Lange & Carter, 2014).

Councillors or other readers of the W&A report who are unfamiliar with the widely reported defects of IPCC's scientific analyses can find them discussed in prestigious international reports (Interacademy Council, 2010), popular books (Laframboise 2011, 2013) and local Australian commentary (McLean 2007a, 2007b, 2008, 2009, 2014).

**CONCLUSION 1**

**Given the widespread criticism of IPCC's reports and analyses, great caution needs to be applied in basing public policy on IPCC recommendations in the fashion urged by the Whitehead & Associates (W&A) report.**

## 3. Deficiency of adopting IPCC emissions scenario RCP 8.5 as a basis for planning

The IPCC starts by *assuming* from first principles that sea level rise is directly related to rising concentrations of atmospheric carbon dioxide. Accordingly, and for the purposes of making speculative computer model projections of future climatic states (including sea-level), the IPCC defines a number of alternative emissions scenarios (Table 1).

In their latest manifestation in 5AR, these scenarios are termed Representative Concentration Pathways (RCPs) and range from a low rate of greenhouse gas accrual (RCP2.6) to a rate that many commentators view as extreme (RCP8.5) (W&A, p. 30, Table 2).

W&A recommend that for planning purposes Councils should adopt the highest of the three calculated RCP8.5 options, which translate to low, medium and high projections of NSW local sea level rise by 2050 of 16cm, 20cm and 26cm (W&A, Table 12). Translated into reality, however, the RCP8.5 scenario not only discounts all efforts to reduce emissions, but also assumes a total greenhouse gas forcing of 8.5 W/m$^2$ by the year 2100 (Table 1, columns 2 and 4). This is equivalent to a greater than 1370 ppm atmospheric $CO_2$ concentration in 2100 (column 3), which is more than 4-times the pre-industrial level and double the more probable 2100 level of around 500-600 ppm (cf. Tans, 2009).

**Table 2 Characterisation of RCP's adopted in AR5**
**(adapted from Jubb et al. (2013))**

| RCP | Radiative Forcing end of 21st Century | Equivalent Peak $CO_2$ (ppm) | Description (from Jubb et al. (2013)) | Comparable SRES Scenario |
|---|---|---|---|---|
| RCP8.5 | 8.5 | >1370 | Very high baseline scenario. Little effort to reduce emissions and warming not curbed by 2100. | A1FI |
| RCP6.0 | 6.0 | 850 | Medium Scenario. Stabilises soon after 2100 | A1B |
| RCP4.5 | 4.5 | 650 | Medium Scenario. Stabilises after 2100 | B1 (at 2100) |
| RCP2.6 | 2.6 | 490 | Very Low "Ambitious" scenario. Emissions peak early at 3.0 W/m$^2$ then fall due to active removal of $CO_2$. Also known as RCP3PD. | Lower than all SRES scenarios considered in AR4 |

*Table 1.* Representative Concentration Pathways (RCPs) for greenhouse gas emissions, as assumed by the IPCC (5AR), After W&A (2014, their Table 2).

In addition, a high value of climate sensitivity, which leads to an overestimate of warming, underlies all previous IPCC scenario estimates (including those in Table 1), in the face of new informed research that suggests a low sensitivity of less than 2° C for a doubling of carbon dioxide (e.g., Lewis & Curry, 2014).

CONCLUSION 2

**IPCC's Representative Concentration Pathway (RCP) 8.5 is an extreme and unlikely scenario of future greenhouse gas emissions. Model projections that are based upon this scenario, as are W&A's, are therefore exercises in speculation.**

## 4. "Climate Change Science 101" (W&A, section 3.2.2)

This heading is followed in W&A by a first sentence that reads *"The Earth is warming"*; a little later in the same section we read *"Carbon dioxide is the most significant greenhouse gas"*.

Both these statements are untrue, and the first is also meaningless. That such ill-informed and misleading statements are made reveals a worrisome lack of understanding of the dynamics of the climate system that the W&A authors aim to describe for their readers - and which they presume provides the controlling framework for their speculative sea-level projections.

The following statements are all true (Figs. 1, 2):

- The long-term trend of global temperature change is one of c. 2° C *cooling* over the last 10,000 years, as revealed by high quality regional climatic datasets.
- The short-term trend of global temperature over the last 10 years, measured instrumentally, is also one of gentle *cooling*.

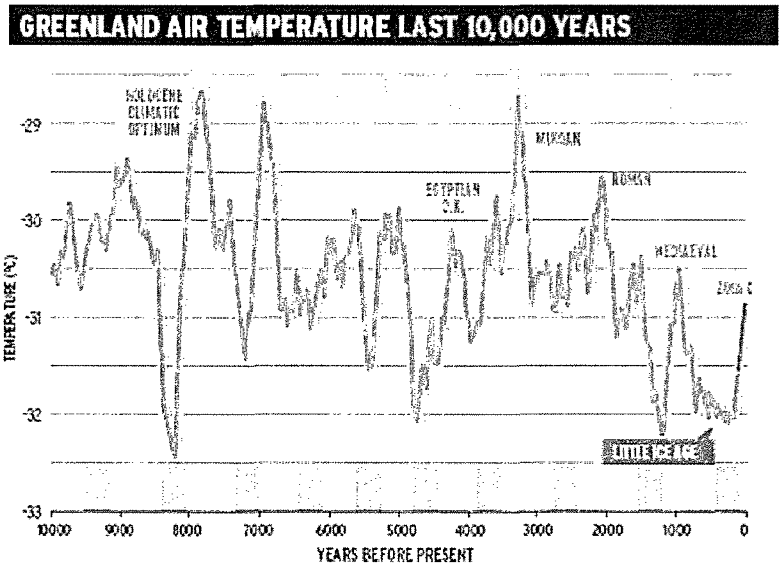
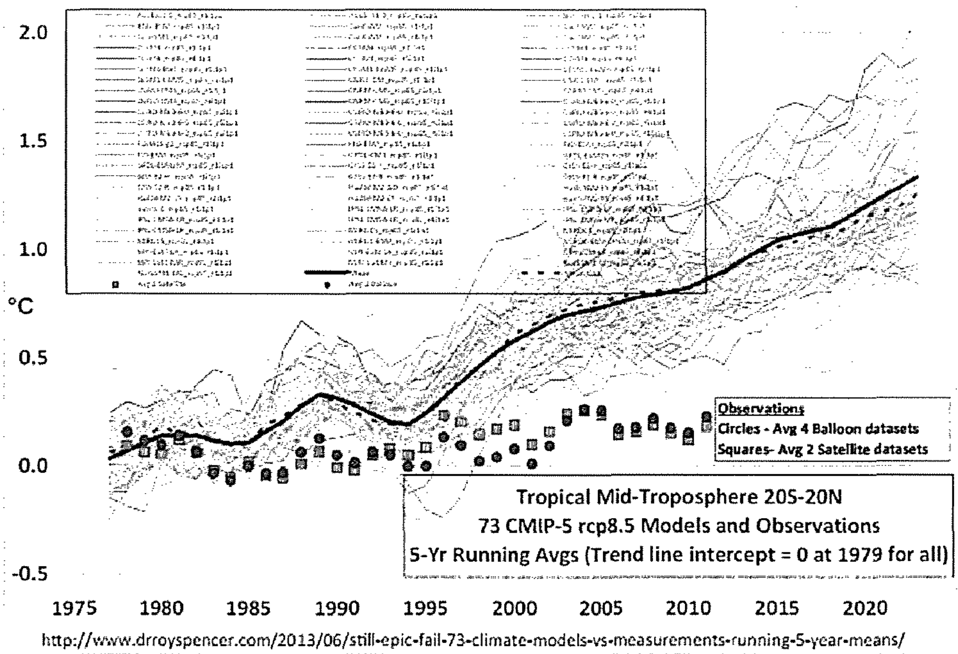



Fig. 5. Greenland surface air proxy-temperatures for the last 10,000 years (Holocene) as reflected in palaeo-temperatures derived from changes in oxygen isotope ratio in the GISP2 ice core (Alley, 2000). Short warm periods, like the Medieval Warm Period and Late 20th Century Warming, occur about every 1,000 years (pink bars, top), separated by cool periods such as the Little Ice Age (blue bars, bottom). This pattern, called the Bond Cycle and probably of solar origin, is superimposed on a cooling trend of about 0.25°C/thousand years since the Holocene Climatic Optimum (HCO). Note that the Minoan, Roman and Medieval Warm Periods, and the HCO, were all significantly warmer than the 20th century warming. Note that the short '20th C' warming plotted in red at the right side of this graph is not based upon the GISP2 isotope record, but instead represents recent global warming as measured with thermometers

Figure 1. *Temperature record for Greenland over the last 10,000 years After Carter, Spooner et al. (2013, Fig. 5).*




http://www.drroyspencer.com/2013/06/still-epic-fail-73-climate-models-vs-measurements-running-5-year-means/

Figure 2. *Comparison of measured temperatures for 1977-2013 with IPCC computer projections for 1977-2050. After Spencer (2013).*

- A phase of global *warming* occurred between 1979 and 1997 (18 years), at a rate and to a magnitude that lie well within the envelope of known earlier natural climate changes. This warming stopped in the late 20th century, there now having been no warming for 19 years (McKitrick, 2014).
- This late $20^{th}$ century phase of warming of c. $0.4^{O}$ C forms part of a longer and more general warming that since c. 1830 has accompanied the earth's passage from the inhospitable Little Ice Age (LIA) into the clement Late $20^{th}$ Century Warm Period (L20WP).
- The passage from the LIA to the L20WP represents the most recent warming limb of a quasi-regular millennial rhythm of c. $1.5^{O}$ C warming and cooling recorded in many palaeoclimatic records, and that is probably of solar origin.
- Solar cycles 23 (1996-2008) and 24 (2008-) have been of extended length and reduced solar activity, a pattern that in historic time has been followed by significant cooling in succeeding cycles; accordingly, a cooling of $1^{O}$ C or more over the next two decades is now viewed as likely by many solar scientists (e.g., Cionco & Soon 2014; Velasco Herrera *et al.* 2014).

CONCLUSION 3

**These facts notwithstanding, best practice coastal management is not based upon knowledge of past and present rates of global temperature change, nor on computer-based speculations of future rates of temperature or sea-level change, but on empirical geological, oceanographical, meteorological and survey data collected at or nearby a coastal site of interest (see Section 11).**

# 5. Global sea-level change

Global (or eustatic) sea-level change is measured relative to an idealised reference level, the geoid, which is a mathematical model of the shape of the earth's surface. Sea-level is a function of the volume of the ocean basins and the volume of water that they contain, and global changes are brought about by three main mechanisms:

- changes in ocean basin volume caused by tectonic forces
- changes in seawater density caused by variations in ocean temperature or salinity
- changes in the volume of water caused by the melting or freezing of glaciers and ice-caps

Ocean basin volume changes occur too slowly to be significant over human lifetimes and it is therefore the other two mechanisms that drive contemporary concerns about sea-level rise. It is these mechanisms that W&A are primarily concerned with in their modelling and discussion of this issue (Section 3.2.4, p. 32 *et seq.*).

Warming temperature in itself is only a minor factor contributing to global sea-level rise, because seawater has a relatively small coefficient of expansion and because, over the timescales of interest, any warming is largely confined to the upper few hundred metres of the ocean surface.

The melting of land ice – including both mountain glaciers and the ice sheets of Greenland and Antarctica – is a more significant driver of global sea-level rise. For example, during the glacial–interglacial climatic cycling over the last half-million years, glacial sea-levels were about 120 m lower than the modern shoreline (e.g., Lambeck and Nakada, 1990). Moreover, during the most recent interglacial, about 120,000 years ago, global temperature was warmer than today, and significant extra parts of the Greenland ice sheet melted. As a consequence, global sea-level was several metres higher than today (e.g., Murray Wallace and Belperio, 1991).

| **Author** | **Date of study** | **Period considered** | **Length (yr)** | **Rate of Rise (mm/yr)** | **Cumulative rise (cm) by 2100** |
|---|---|---|---|---|---|
| Douglas | 1991 | 1930-1980 | 81 | 1.8 | 18 |
| IPCC 3AR | 2001 | 1900-2000 | 101 | 1.6 | 16 |
| Church et al. | 2006 | 1950-2001 | 52 | 1.4 | 14 |
| Plag | 2006 | 1950-1998 | 48 | 1.05 | 10.5 |
| Hagedoorn et al. | 2007 | 1901-2000 | 100 | 1.46 | 14.6 |
| Holgate | 2007 | 1904-2003 | 100 | 1.45 | 14.5 |
| Wöppelmann et al. | 2009 | 1997-2006 | 10 | 1.55-1.61 | 15.5-16.1 |
| Burton | 2010 | 1807-2007 | 200 | 0.5-0.6 | 5-6 |
| Wenzel & Schröter | 2010 | 1900-2007 | 108 | 1.56 | 15.6 |
| Mörner | 2012 | 1901-2000 | 100 | 0.0-0.7 | 0-7 |
| Goddard | 2013 | 1807-2007 | 200 | 0.7 | 7 |
| Beenstock et al. | 2014 | 1807-2010 | 203 | 0.39-1.03 | 3.9-10.3 |
| Parker | 2014b | >1950-2010 | >60 | 0.40 | 4 |
| Wenzel & Schröter | 2014 | 1900-2009 | 109 | 1.65 | 16.5 |
| Menard | 2000 | 1992-2000 | 8 | 0.0*-1.0 | 0-10 |
| Cazenave et al. | 2009 | 2003-2008 | 6 | -0.12 | -1.2 |

**The asterisked value of zero results after applying a correction for an estimated ENSO effect.*

Table 2. *Recent estimates of the long-term rate of change in eustatic (global) sea-level based primarily upon selected sets of tide gauge data and (last two entries) by satellite measurement prior to applying the GIA adjustment.*

*Note that all the estimates in the upper part of the table are based upon selected (and differing) sets of tide gauge site data that various authors judge will in some way provide the best, or at least a good, representation of global sea level change.*

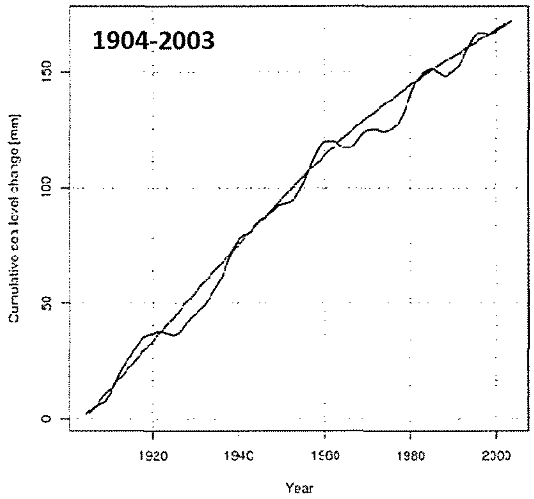



Figure 3. *Cumulative increase in mean global sea level (1904-2003) derived from nine high-quality tide gauge records from around the world. After Holgate (2007).*

Tide-gauge measurements indicate that global sea-level has been rising at rates up to about 1.8 mm/y over the 20th century (Table 2)[1], the rate decreasing somewhat over the last 50 years (Fig. 3), In contrast, the shorter satellite record indicates a higher rate of rise of 2-3 mm/y up to 2010 (Fig. 4), though also decreasing. The discrepancy between the two different rates of rise remains unexplained.

However, a reanalysis of the satellite data, using revised estimates of the respective contributions from warming and ice-melting, has indicated a rise of 1.3±0.9 mm/y for 2005–2011 (Leuliette, 2012). This result is more consistent with the tide-gauge measurements, though surprisingly this is not mentioned by W&A.

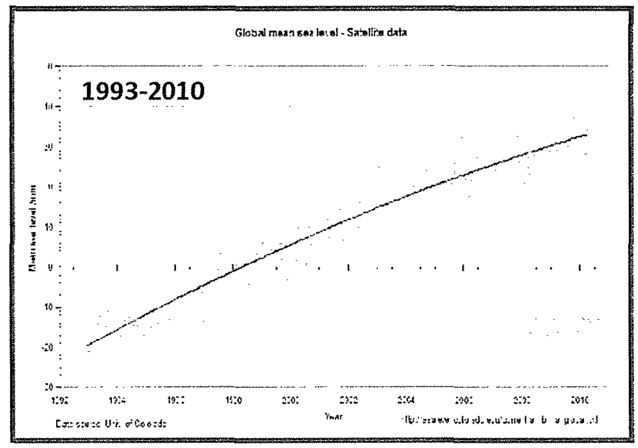



*Figure 4.* Satellite altimetry time series, 1993-2010 (data, University of Colorado). The linear trend from 1992 to end 2000 is 3.14 mm/yr, and from 2001 to 2010 it's 2.34 mm/yr. This represents a 25% reduction in the rate of sea level rise. After a diagram by Bob Dedekind.

Around the world, significant regional variations occur in the rate and direction of sea-level change; while some regions of the world's oceans are today rising, in other regions sea-level is falling. In part this is due to variations in the rate of warming and salinity changes between different regions, and proximity to discharges of meltwater. Mostly it reflects the influence of major ocean circulation systems that redistribute heat and mass through the oceans. The result is that at any location around or within the oceans, the observed sea-level behaviour can differ significantly from the smoothed global average.

Furthermore, when attempts are made to estimate global sea-level from studies at specific locations, it is found to vary through time. For example a recent study in the Kattegat Sea estimates that, after correction for local tectonic and other effects, rates of "eustatic" sea-level change since 5,000 years ago have varied through time by between -3.1 mm/y and +3.7 mm/y (Hansen, 2014). The same is true over shorter periods of time, such as the 20th century, and also for global data (Holgate, 2007; Gehrels et al., 2012; Jevrejeva et al., 2014; see Figs. 10, 3).

With regard to these matters, W&A state (p. v):

> *Given that* [local] *mean sea levels at all sites examined have adjusted quickly and in a similar manner in response to local ENSO related variability, we can find no reason why there would not be an almost equivalent adjustment to longer, underlying sea-level rise. Accordingly,* ***we expect that sea levels offshore of the study area will rise at a***

---

[1] Credible estimates of this value range between about zero up to a little less than 2.0 mm/yr. (Table 2). A widely accepted estimate in the IPCC's Third Assessment Report (2001) portrays 20th century sea-level rise occurring at a rate of 1.8 mm/yr, partitioned as 0.4 mm/yr for thermal expansion, 0.7 mm/yr for ice melt and 0.7 mm/yr for dynamic oceanographic factors.

***similar rate to the global average, and that any differences between the study area and Sydney will be minimal*** (W&A emphasis).

It may be true that tectonic conditions are mainly "stable" along the NSW coast. But that is insufficient justification for the above statement, which not only conflates ENSO and longer time-scale phenomena but also ignores the universal reality of tectonic and dynamic oceanographic variation.

**CONCLUSION 4**

**Because they represent a worldwide average, neither the tide-gauge nor the satellite estimates of GLOBAL sea-level have any useful application to coastal management in specific locations. This key fact is obscured in W&A's analysis.**

## 6. Local relative sea-level change

A proper understanding of the risks associated with sea-level change can only be attained by maintaining a clear distinction between global (or eustatic) sea-level (Section 5) and local relative sea-level (discussed here). Yet it is not until p. 38 of their report that W&A attempt to recognize this distinction, arriving at the flawed conclusion that "The projections of interest to planning represent Relative Sea-Level Rise and should include GIA and Tectonic effects". Though the first half of this sentence is correct, the second part contradicts it because adjusting for GIA and other neo-tectonic and tectonic effects is part of the process of converting a local relative sea-level signal into a eustatic estimate.

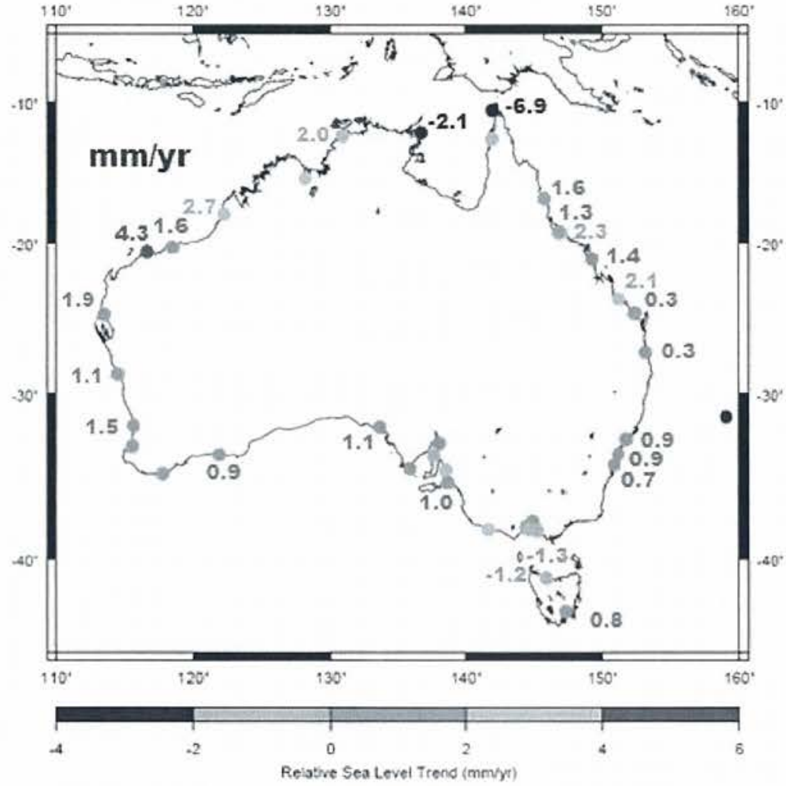



*Figure 5.* Averaged rates of local sea-level rise for locations around the Australian coastline. After Australian National Tidal Centre (2009).

Local relative sea-level is measured at specific coastal locations. The measurements are therefore affected by the local movement up or down of the land as well as by the notional eustatic sea-level. Local sea-level change can therefore occur at quite different rates and directions at different locations (see frontispiece graph).

In some locations the land is rising: for example, places that were depressed under the weight of the ice caps 20,000 years ago started to rise again as the ice melted. In consequence, in Scandinavia for example, the land is rising at rates of up to 9 mm/year, and local relative sea-level is therefore now *falling* through time despite the concurrent slow long-term *rise* in eustatic sea-level. Conversely, at locations distant from polar ice caps, such as Australia, no such glacial rebound is occurring, which results in local sea-level change in many places being similar to the eustatic rate of rise (Fig. 5; Table 2; cf. White et al., 2014).

Mörner & Parker (2013) analysed the same tide gauge stations as those in Fig. 5, concluding that "*the mean sea level rise from Australian tide gauges is to be found within the sector of rates ranging from 0.1 to 1.5 mm/year*" (yellow wedge; Fig. 6).

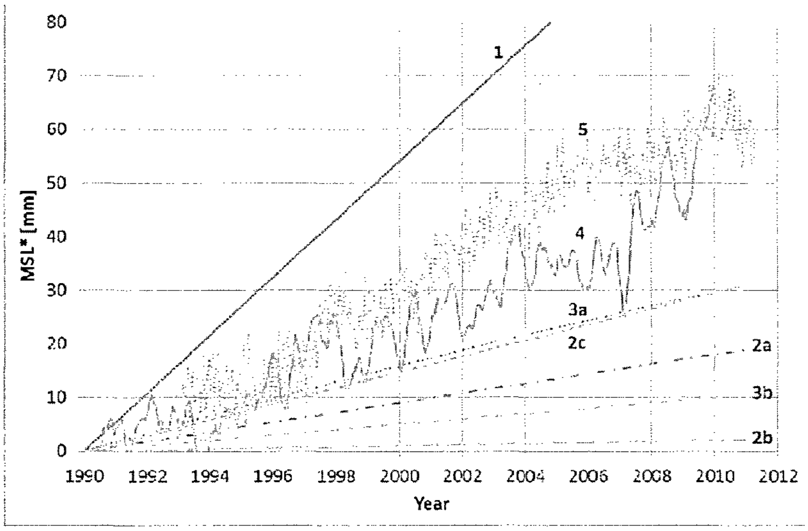



Figure 3 : Comparison among different sea level data sets: (1) the Official Australian claim (AFGCC, 2011; ABSLMP, 2011), (2a) the Australian 39 station record, (2b) the Australian 70 station record, (2c) the Australian 86 station record, (3a) the 2059 station PSMSL (2011) average, (3b) the 159 station NOAA (2011) average, (4) the reconstruction of sea level changes by Church and White (2011), and (5) the Topex/Jason satellite altimetry record (CU, 2011). All the data are shifted for a zero MSL in January 1990. The differences are far too large not to include serious errors in some of the records. The official Australian trend (1) lies far above all the other curves, indicating a strong exaggeration. The Australian (2a-c) as well as global (3a-b) curves vary between 0.1 and 1.5 mm/year. The satellite altimetry records (5) include "calibrations" previously questioned (Mörner, 2004, 2011c, 2013). The record (4) of Church and White (2011) lies between the satellite altimetry curve (5) and all the graphs representing global (3a-b) and Australian (2a-c) tide gauge records. The acceleration in curve 4 is strongly contradicted by all the other records. The same absence of acceleration is found in many other records (further discussed in the text) indicating that the concept of acceleration ought to be revised.

Figure 6. *Comparison between differing rates of sea-level rise since 1990 as indicated by Australian tidal data (yellow shaded field), the PMSL (2011) global average (blue line), satellite altimetry (green line) and by hypothetical projection of assumed Australian rates (red line). After Mörner & Parker (2013, Fig. 3).*

Alongside Mörner & Parker's (2013) estimated averages, many individual locations around the Australian coast record sea-level rises over the last century at rates between about 1 and 2 mm/y, with an absolute range between −6.9 mm/y and +4.3 mm/y (Fig. 5). Prior to this, and since the last ice age, rates of sea-level change around Australia varied in both sign and magnitude (Sloss *et al.,* 2007; Lewis *et al.,* 2012), with rates of rise perhaps greater than 10 mm/yr during sharp pulses of ice melting and shoreline advance (Larcombe *et al.,* 1995). Since the cessation of major ice-melt about 10,000 years ago, eastern Australian sea-level peaked at 1-2 m above modern sea-level about 6,000 years ago, declining thereafter due to hydro-isostatic[2] tilting (Beaman, 1994; cf. Parham *et al.,* 2014.)

A recent study by Beenstock *et al.* (2014) illustrates the variability of local relative sea-level change around the world over historic time. Using a worldwide selection of high-quality tide-gauge records from the Permanent Service for Mean Sea Level (PSMSL) for 1807 – 2010, these authors show that at 35% of locations sea levels rose at an average of 3.8mm/yr, at 61% of locations sea-level remained stable and at 4% of locations sea-levels fell on average by almost 6mm/yr.

For these and other reasons, Fu & Haines (2013, 9.1296) have recently emphasized the practical importance of local and regional sea level changes for coastal policy purposes, warning that:

> *Regional rates of sea-level change over the same (~ 20-yr) time period range from -12 to +12 mm/yr ... Due to large geographic variability in the ocean currents, the time required to accurately determine the sea level trend on a regional basis varies from a minimum of 5-100 yr ... These estimates do not include the contribution of systematic altimetric measurement errors, which may themselves induce spurious drifts that are*

---

[2] Hydro-isostasy is the effect of changing water loading due to the changing ocean volume that accompanies shoreline migration during major sea-level rises or falls. The effect is usually linked to glacio-isostasy as the changing ocean volumes are driven by changing ice volumes on land. The two terms are sometimes combined as glacio-hydro-isostasy and the term glacial isostatic adjustment (GIA) may encompass both effects (see Lambeck et al., 2003).

*geographically correlated. Because the impact of sea level change is felt locally, it is the regional nature of sea level variability that is the most important factor for future adaptation and mitigation.*

Quite so.

**CONCLUSION 5**

**Local relative sea-level change is what counts for purposes of coastal planning, because even in a largely tectonically stable area such as eastern NSW, different rates of uplift and subsidence may apply in different locations.**

# 7. Inadequacy of computer sea-level simulations using homogenized[3] data

As part of the background discussion for their NSW sea-level reconstructions, W&A (p. 36, Fig. 6; reproduced here as Fig. 7) provide a figure from IPCC 5AR which they offer as evidence that the IPCC's CMIP5 suite of computer models yield accurate projections of sea-level change. Yet at the same time, individual research publications continue to show major discrepancies between modelled and observed sea-level behaviour (e.g. Marsland *et al.,* Fig. 15).

But even should a match exist it is not necessarily evidence that the models are correct, for such correspondence can equally well result from careful and skilled curve fitting. Consider the following as an example. In 2001, IPCC 3AR authors presented a widely applauded graph that demonstrated a match between the Hadley surface temperature graph and back-predicted temperature projections from then-current computer models. Though up to 2000 the historical record and computer simulations matched (3AR), the 2007 4AR and 2013 5AR res demonstrated that subsequently a wide divergence opened up between the computer-forecast temperatures and the real-world measurements (cf. Fig. 2). This divergence relates to the cessation of warming after 1997, which falsifies the models and indicates that the pre-2000 match represented curve-fitting rather than accurate modelling.

Second, in the top panel of Fig. 7 (*Observed versus modelled sea-level height*), the indicated agreement between satellite-measured and computer-modelled sea level compares a 100-yr long simulation with an 18 yr-long set of satellite measurements. The correspondence claimed therefore rests entirely upon the baseline level chosen for the satellite measurements. What is more, and regardless of the baseline issue, the satellite data is diverging, exhibiting a higher rate of rise than present in the tide gauge data. This difference between altimetric and tide gauge-measured rates of sea-level rise, which is already widely known (e.g., Jevrejeva *et al.,* 2008; Ray & Douglas, 2011), is obscured on the middle panel of Fig. 7 (*Observed versus modelled rates of sea-level change*) by representing the altimetric curve by only a single summary point with wide error bars of unexplained origin.

[3] [3] The term homogenized "data" has come into wide circulation since government meteorological agencies replaced their former technique of reporting actual temperature measurements by publishing instead computer-generated estimates, derived from the raw data by making various corrections and modifications to it. As the W&A report demonstrates, similar techniques are now being used in the generation of sea-level "data". Though some such corrections may be justifiable, the absence of full transparency of the techniques and computer code used precludes independent checking of the homogenized "data" by disinterested third parties; as such the practice is open to subjectivity and bias, and is therefore contrary to scientific method.

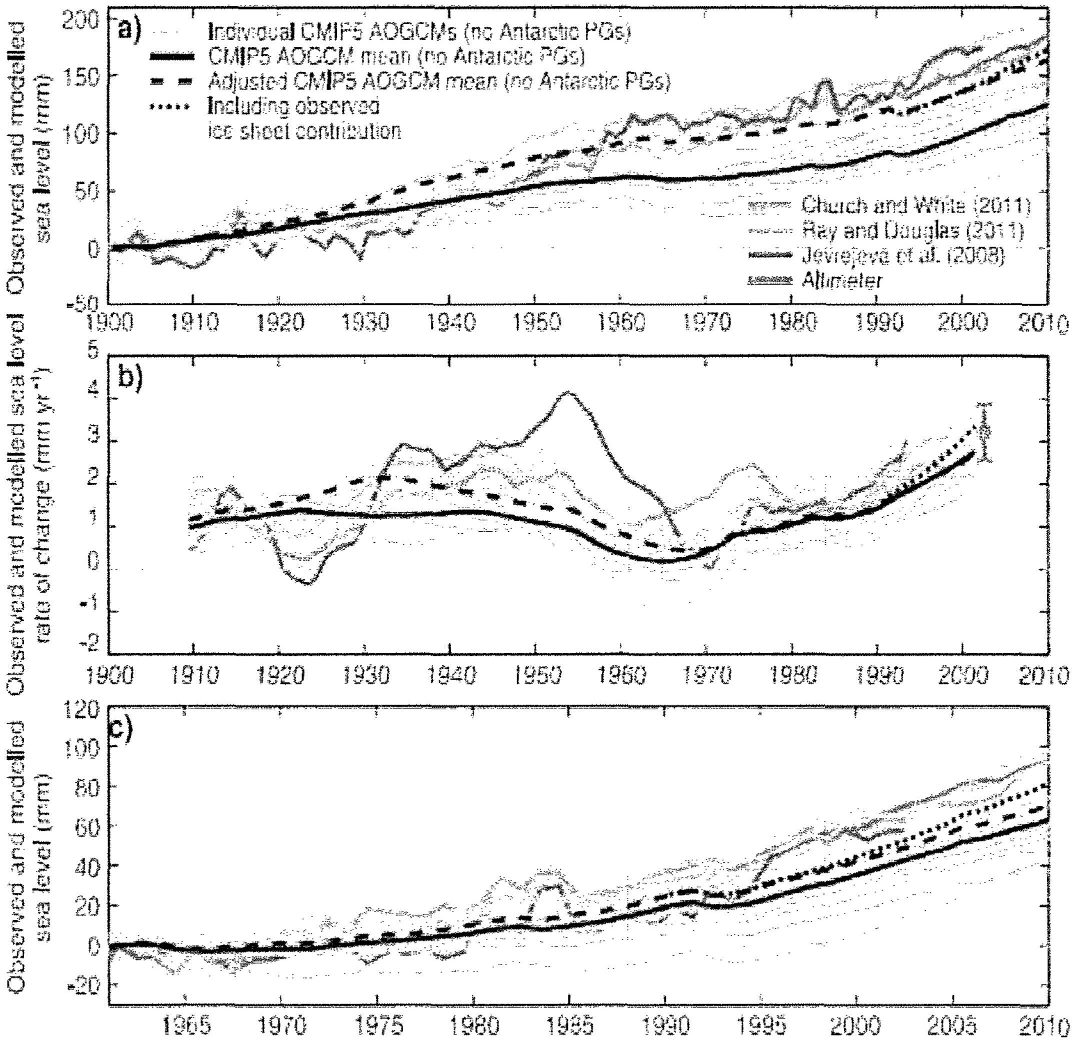



**Figure 6 Performance of CMIP5 Models against estimates of Historical Global Mean Sea Level (adopted from Figure 13.7 of IPCC (2013b)).**

(a) Observed and modelled sea level for 1900 to 2010
(b) The rates of sea level change for the same period, with satellite altimeter data shown as a red dot for the rate. Note that the rate (in mm/yr) has been greater than zero for all historical reconstructions since the 1920s. Conversely, some model simulations simulate a negative rate (falling sea level) during the 1960s.
(c) The observed and modelled sea level for 1961 to 2010.

Shading indicates the uncertainty estimates from different estimates of global mean sea level, (Jevrejava et al, 2008; Church and White, 2011; Ray and Douglas, 2011) to two standard deviations; Solid black line is mean of grey lines each of which represent different model simulation estimates of the summed sea-level rise from (i) thermal expansion, (ii) land water storage and (iii) glaciers excluding those peripheral to Antarctic ice sheet. The Dashed black line corrects the black line to include measured ice losses from glaciers instead of modelled values. The dotted black line adjusts the model results further by including ice sheet observations (from 1993 onwards). This last adjustment also includes the glaciers peripheral to the Antarctic ice sheet.

Figure 7. *After W&A (2014, p. 36, their Fig. 6).*

Third, the bottom panel of Fig. 7 (*Observed versus modelled sea-level since 1960 only*) represents the claim made later in the text that the tide gauge and altimetric data sets indicate similar rates of rise of 3-4 mm/yr over the last few decades. This quasi-match has been achieved by (i) adjusting the tide gauge data upward by means of additional glacial-melt and perhaps a geoidal correction (see also Section 8 below), followed by (ii) comparing only the rate of change of the two data sets and not their actual component data.

Fourth, and as W&A (section 5, p. 29) themselves point out:

> *In the context of climate change, projections are representative future scenarios for various climate related parameters.* ***They are not "predictions" with an associated likelihood.*** *Instead, the projections represent "what-if" scenarios that depend on pre-determined plausible scenarios of either economic development or concentrations of greenhouse gases (emphasis added).*

Quite so. They should therefore not be used as a basis for policy decisions, and especially not if they are based upon emissions scenarios as implausible as RCP 8.5 (see Section 2).

Fifth, the use of complex modelling of tide gauge data sets in order to yield sea-level information, such as that summarised by W&A, is in dispute even amongst those authors who participate in the practice. The prime reasons for this are the lack of independence between studies, and a failure to disclose the techniques used precisely and transparently so that other scientists can analyse them. As Mörner (2012) has noted, "If the 'corrections' applied are not clearly specified (and discussed and argued for), then the resulting corrected data cannot be objectively evaluated".

The matter is summarised by Woodworth *et al.* (2009, p. 778), who say:

> *A point to make concerning the various studies is that they cannot be independent as they are based on a single tide gauge data set, which has known spatial and temporal limitations. ... A second point concerns the use in some analyses, including those of CW06* [Church & White, 2006] *and J06* [Jevrejeva *et al.*, 2006]*, of short records incorporated into an analysis in ways which are not completely transparent (in spite of outlines of analysis methods having been documented) as they depend on complex minimization techniques.*

Sixth, recent modelled global sea-level projections make correction for the vertical isostatic[4] movements that occur in response to shifting loads induced on Earth's crust by the growth and decay of ice sheets, and by parallel load oscillations induced by changes in water depths across the continental shelf (caused by falling and rising sea-level in sympathy with the glacial-interglacial fluctuations). Adding an ice or water load causes isostatic subsidence (and local relative sea-level rise), whereas removing those loads causes isostatic rebound (uplift, and local relative sea-level fall). The correction, termed a Glacial Isostatic Adjustment (GIA), is the outcome of a computer model that comprises a mathematical model of the shape of the earth (the geoid) and assumptions regarding the viscosity of the upper mantle where isostatic flow occurs. Neither the geoid (NASA JPL, 2012; Tamisiea *et al.*, 2014) nor the viscosity (Jones *et al.*, 2012) is accurately known. Accordingly, several alternative geoid models exist, the deployment of which produces differing modelled estimates of sea-level change.

---

[4] *Isostasy* describes the process whereby slow adjustment flowage occurs at depth in response to the addition or removal of loads at the Earth's surface. The compensating flows occur in a hot, semi-plastic layer of the mantle (asthenosphere) at depths of 70–250 km, just below Earth's rigid outer shell (lithosphere) and at rates of subsidence or rebound (uplift) up to about 1m/century.

GIA models lack independent verification, but are informed by the best available knowledge of the Earth's actual shape, as measured from space in the form of a Terrestrial Reference Frame (TRF). Recently, NASA has indicated that current TRF errors are greater than the inferred signal of sea-level change being measured, and proposed that a new satellite be launched with the specific role of measuring the TRF accurately (NASA JPL, 2012). Clearly, estimates of sea-level change made using satellite-borne altimetric data will remain problematic until the launch of NASA's new GRASP satellite, or until the development of some other mechanism for improving the accuracy of geoid models. As Wunsch et al. (2007) have reminded us, "At best, the determination and attribution of global-mean sea-level change lies at the very edge of knowledge and technology."

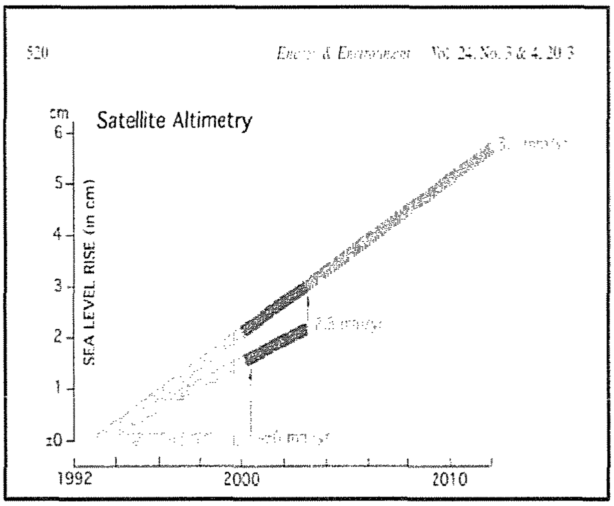



*Figure 8.* Changes, termed "corrections", in the mean rate of sea-level rise in satellite altimeter records. The 0 mm/yr trend of 1992-2000 (orange bar) was increased by 2.3 mm/yr in 2003 (blue bar) and by another 0.8 mm/yr in 2008 (purple bar), continuing to present (green bar). This implies that the satellite record is not a measured product but an arbitrarily "corrected" one (cf., Parker, 2014b). After Mörner, (2013, Fig. 9).

These problems notwithstanding, a GIA correction has been applied to all satellite altimeter measurements of sea-level since 2003, with the effect of changing a sea-level record that showed no trend or perhaps a gentle rise into one that now projects high rates of rise (Mörner 2004, 2013) (Fig. 8).

Lastly, and seventh, processing of all satellite altimetric data takes place against the background of known errors that at least match, if not exceed, the sea-level signal being sought. As Bar-Server *et al.* (2012) say:

> *... we assess that current state of the art reference frame errors are at roughly the mm/yr level, making observation of global signals of this size very difficult to detect and interpret. This level of error contaminates climatological data records, such as measurements of sea level height from altimetry missions, and was appropriately recognized as a limiting error source by the NRC Decadal Report and by GGOS.*

### Conclusion 6

**W&A (p. 33) quote George E.P. Box (1987) as saying "remember that all models are wrong; the practical question is how wrong do they have to be to not be useful". The suite of CMIP5 models drawn on by W&A have repeatedly been shown to be wrong when tested against factual data. Since the models do not provide verifiable predictions, they clearly cannot be relied upon as a tool for formulating coastal management policy.**

## 8. What is the measured rate of sea-level rise along the central NSW coast?

It is unfortunate that apparently simple questions such as the one posed in the heading can sometimes have complex answers. It is also the case that as knowledgeable readers peruse the W&A report their attention becomes sharply riveted when they come upon page 41 and Table 6. For there it is stated that the rate of recent sea-level change as measured by the Fort Denison and Port Kembla tide gauges is 3.3 and 3.6 mm/yr rise, respectively.

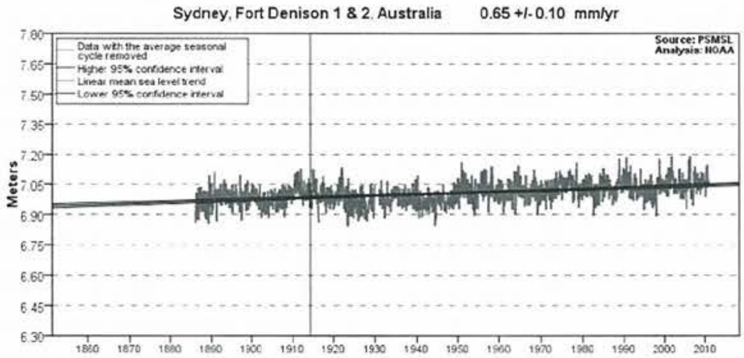



Figure 9. *Mean sea level trend for Fort Denison, Sydney for the period 1886-2010 is 0.65 millimeters/year (95% confidence interval of +/- 0.10 mm/yr). After NOAA (2014).*

How can this be? For virtually every recent official report or refereed paper on the topic has calculated rates of rise of <1 mm/yr for the long Fort Denison record (Table 3 and Fig. 9; the differing values in the table mostly representing the use of differing periods of data by different authors). Furthermore, three separate investigations have shown recently that the rate of sea-level rise on the NSW coast has been *decreasing* over the last 50 years (Watson, 2011; Boretti, 2012b; Modra & Hesse, 2011), a phenomenon that has also been noted nearby at Auckland (Hannah & Bell, 2012) and at global level by Houston & Dean (2012).

At the same time that W&A claim this almost 5-times increase in the rate of sea-level rise measured by the Fort Denison tide gauge (their Tables 6, 7), they reiterate that satellite altimeter data for the NSW coastal ocean (their Table 9, p. 47) also show rates of rise between 4.1 and 4.5 mm/yr, and assert that therefore the tide gauge and satellite records are now in agreement. Similar claims of the reconciliation of the satellite altimeter and tide gauge records have been made by Church & White (2006; 2011) and Domingues *et al.* (2008).

These assertions fly in the face of a large research literature that views the mismatch of global sea-level rise as reconstructed from tide gauges (at c. 0.0-1.8 mm/yr; Table 2) or satellite altimetry (>3 mm/yr; Fig. 6) (e.g., Munk, 2002; Houston & Dean, 2012; Houston, 2013; Jevrejeva *et al.*, 2014) as one of the biggest unsolved problems in sea-level studies (Boretti, 2012a). For example, de Lange (2010) compared the long term tide gauge record from Auckland with the nearest satellite altimeter record from the nearby Outer Hauraki Gulf (Fig. 10). His results show that the satellite data require a ~60% downscaling correction in order for them to fit with the in situ tide gauge measurements.

One reason for the mismatch is understood, though not widely taken into account. It is that the satellite measurements of sea-level yield more accurate answers when the sampling cell that they measure lies entirely within an ocean area; simplifying assumptions that are made in processing data for coastal cells, which comprise a mixture of part land and part ocean areas, introduce significant discrepancies with shoreline tide gauge measurements. A further complication, which causes a higher sea-level rise offshore than at the coast during phases of warming (as late last century), is that the amount of ocean expansion caused by warming is proportional to the depth of water below the surface measuring site, the effect thereby diminishing to zero at the shoreline (Mörner, 2013).

What then is the claim of equivalence between the tide gauge and satellite records based upon?

| **Author** | **Date of study** | **Period considered** | **Length (yr)** | **Rate of Rise (mm/yr)** | **Cumulative rise (cm) by 2114** |
|---|---|---|---|---|---|
| Hagedoorn *et al.* | 2007 | 1901-2000 | 100 | 0.86 | 8.6 |
| Australian NTC | 2009 | 1914-2010 | 106 | 0.9 | 9.0 |
| You *et al.* | 2009 | 1886-2007 | 122 | 0.63 | 6.3 |
| You *et al.* | 2009 | 1914-2007 | 93 | 0.93 | 9.3 |
| You *et al.* | 2009 | 1950-2007 | 57 | 0.58 | 5.8 |
| Manly HL | 2011 | 1986-2007 | 22 | 0.4 | 4.0 |
| Modra & Hesse | 2011 | 1914-2004 | 100 | 0.94 | 9.0 |
| Watson | 2011 | 1940-2000 | 61 | 0.68 | 6.8 |
| NOAA | 2014 | 1886-2010 | 125 | 0.65 | 6.5 |
| Whitehead & Ass. (linear fit) | 2014 | 1886-2014 | 129 | 0.70 | 7.0 |
| **NAÏVE AVERAGE** | | | | **0.73** | **7.3** |
| **SW PACIFIC only** Gehrels *et al.* | 2012 | 1950-2000 | 50 | 0.7 | 7.0 |
| **SHORT-TERM only** Whitehead & Ass. (homogenized) | 2014 | 1996-2013 | 18 | 3.3 | 33 |
| This commentary* | 2014 | 1996-2012* | 17 | 2.8 | 28 |

*Figure calculated for 1996-2012 rather than 1996-2013 because of the absence of a web-posted figure for 2013.

Table 3. *Recent estimates of the long-term rate of change in local relative sea-level at the Fort Denison tide gauge site, Sydney harbour. Note that the mean 0.73 mm/yr rise is a relative figure; when the estimated subsidence rate of -0.49 mm/yr (for 2005-2014; NASA GPL, 2014) is subtracted, the best-estimate of eustatic sea-level rise at Sydney falls to 0.24 mm/yr.*

*Note also that W&A's model-adjusted short-term estimate (penultimate line) differs dramatically from all other results. It also exceeds the observational value of 2.8 mm/yr (calculated* de novo *here) for the short period 1996-2012/13 by 0.5 mm, which amount presumably represents the additional excess produced by unspecified GIA and tectonic corrections.*

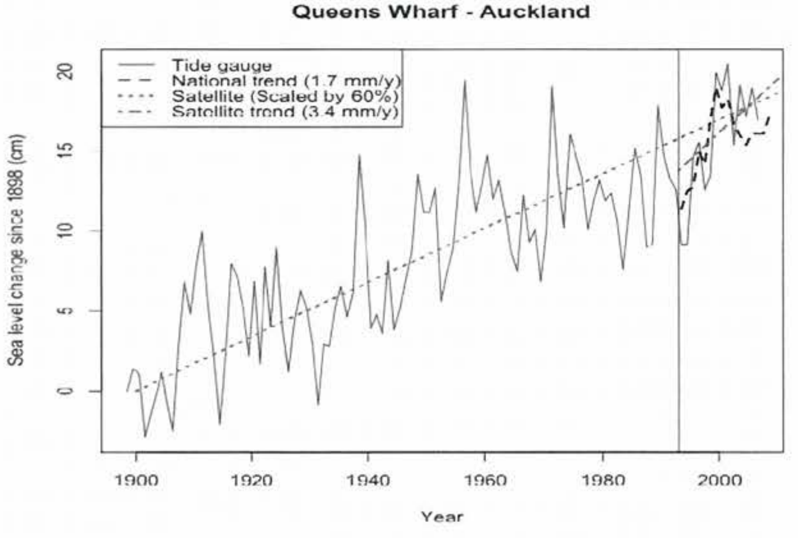



Figure 10. *Comparison of the long term Auckland sea level curve (1898-2006) and the nearest satellite altimetry observations from the outer Hauraki Gulf (1992-2009; University of Colorado). OLS regression between the tide gauge and altimetry data indicates that the altimetric data require a~60% baseline downscaling to best match the tide gauge record.*

*OLS regression trends are superimposed for tide gauge and satellite (baseline shifted by 13.8 cm to allow comparison) data at the time of analysis (2010). New Zealand-wide tide gauge average for 1992-2009 indicated as black-dashed line.*

*Note that the GIA was not applied by the University of Colorado at the time that this analysis was performed. Inclusion of a GIA adjustment would increase the deviation between the two trends shows. After de Lange (2010).*

In a 2011 study, Church & White combined measurements from discrete satellite and tide-gauge data sets into a single homogenized data set. In doing so, they noted (p. 594) that "We present results for two periods: from 1880 to 2009 and the satellite altimeter period from January 1993 to December 2009. The latter is only a partial test of the reconstruction technique because the EOFs[5] used were actually determined for this period." Exploring the matter further, Church & White (2006) acknowledged also that to represent changes in global sea-level they had included an additional spatially uniform field in their reconstruction, and that omitting this field results in a smaller rate of satellite-derived sea-level rise that is inconsistent with both individual tide gauge records, and with the various estimates of their mean; omission of the field also "results in unrealistically large regional variability in trends, because a finite number of EOFs cannot adequately represent a substantial change in mean sea-level" (Church & White, 2006).

The complexity of these unsatisfactory issues is further heightened by the practice of releasing successive sets of reprocessed (homogenized) data as the basis for "new", revised sea-level curves. In this regard, the original averaged tide gauge dataset of Church & White (2006) was supplanted by a different dataset (based on a different selection of tide gauges, and not linked to a published paper) in 2009, followed by another revised dataset in Church & White (2011). The 2006 data version shows an acceleration in the rate of sea-level rise in the late 19$^{th}$ and early 20$^{th}$ century, and a deceleration thereafter; the 2009 version shows only a deceleration in rise after 1925; and the 2011 dataset shows again a slight acceleration after 1925 (cf., Burton, 2012). How any policymaker can fashion sensible conclusions in the face of such bewildering variations in purported reality is unclear.

The key point is that a combined local tide-gauge and satellite altimetry determination of relative sea level change is based upon two incompatible sets of measurements; each of the datasets has its own

[5] Empirical orthogonal functions (EOF) represent the statistical decomposition of a data set into component functions whose weighting is determined from the data. The technique is similar to principal components analysis but identifies both time series and spatial patterns.

measurement errors and uncertainties, as well as systematic problems and errors in spatial and temporal sampling. An assertion that the two sets of measurements represent the same rate of global sea level rise is therefore a political rather than a scientific conclusion.

Deploying similar techniques to those just described, W&A arrive at their claim of matching NSW tide gauge and altimetric sea-level estimates at 3.3 mm/yr by the following route:

- Restricting the period of tide gauge data that they consider (mostly 1996-2013), and thereby discarding more than 100 years of prior data from the Fort Denison site;
- Interestingly, the selected 18 year period covers part of the time over which other authors have reported a decelerating rather than the enhanced rate of sea-level rise reported by W&A, which immediately suggests that W&A are processing the tide gauge data in a non-standard fashion; and
- Reporting the tide gauge analysis as a "Linear Fit to Annual Mean Sea Levels" (heading for Table 6, p. 42). To an innocent reader this suggests that a simple least-squares analysis has been used as the line fitting procedure, whereas discussion in the surrounding text indicates instead that the line fitted by W&A, and the rates of rise that it represents, are the outcome of a computer model.

In reporting their inflated estimate of rate of sea-level rise in NSW, W&A (p. 41) comment that for the tide gauge records analysed "erroneous data were removed, the annual average mean sea level was calculated, and that value was adjusted to Australian Height Datum", which again might suggest that simple least-squares analysis was used. However, the elevated magnitude of the rate of rise compared with all earlier estimates (Table 3) demonstrates that this result must reflect some combination of use of an inadequately short time period (1996-2013; which in itself increases the long-term rate of 0.73 to ~2.8 mm/yr; cf. Table 3) and computer adjustment (the remaining ~0.5 mm/yr, which includes the GIA correction).

Therefore, and as Dr Howard Brady has pointed out (submission to Shoalhaven Council on regional plan DCP 2014; Sept. 18, 2014), the claimed rate of sea-level rise of 3.3 mm/yr in Sydney Harbour is not based upon "the 'actual regional data' but the homogenised[6] data that calculates Fort Denison sea level rise as currently 33 cm/century (over three times the local regional rate)".

#### CONCLUSION 7

### The high sea-level rise figure of 3.3 mm/yr reported for the Fort Denison (Sydney) tide gauge by W&A does not represent the original data measurements (0.73 mm/yr) but instead results from computer modelling combined with the selection of a short and atypical section of sea-level record.

Some of the detailed steps in the data homogenization process are discussed further under the next heading. Suffice it for the moment to note that, irrespective of any modelling problem, estimates of sea-level change made using satellite-collected data remain problematic, because of the many uncertainties that exist with their collection and processing. In particular, there is inconsistency

[6] The term homogenized "data" has come into wide circulation since government meteorological agencies replaced their former technique of reporting actual temperature measurements by publishing instead computer-generated estimates, derived from the raw data by making various corrections and modifications to it. As the W&A report demonstrates, similar techniques are now being used in the generation of sea-level "data". Though some such corrections may be justifiable, the absence of full transparency of the techniques and computer code used precludes independent checking of the homogenized "data" by disinterested third parties; as such, the practice is open to subjectivity and bias, and contrary to scientific method.

between the results derived by different research groups, with all results depending upon the accuracy of complex adjustments some of which lack independent verification (Houston and Dean, 2012), plus the related problem that the signal being sought may well lie below the noise level of the data being used (Morner, 2013; Parker, 2014b).

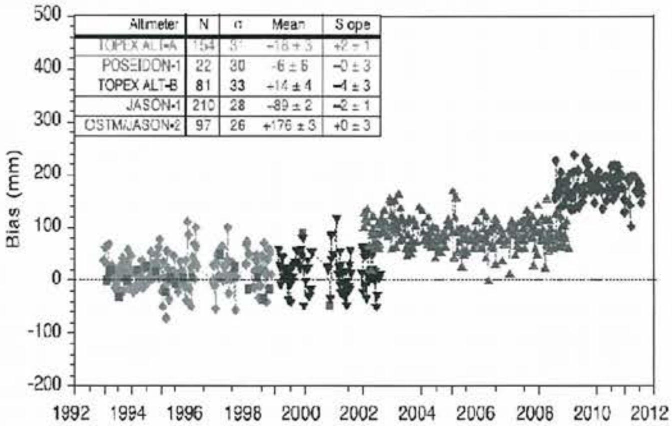



Figure 11. *Long-term sea surface height (SSH) calibration time series for three satellite altimeter missions (Topex/Poseidon), Jason-1 and Jason-2). The two latter missions measured SSH too high by +9 and +18 cm, respectively. The bias represents errors in altimeter characterization data and misattribution of the mechanical reference point for the spacecrafts' altimeter antennae. After Fu & Haines, 2014.*

One of these problems was highlighted in the recent study of the satellite altimetry data records by Fu & Haines (2013, p. 1291). These authors highlighted that:

> *[S]ignificant biases* [have] *existed for years, and must be accounted for in constructing the combined sea-level record* [their Fig. 7, re-shown here as Fig. 11]. *The sources of these biases have only been recently discovered, and relate to errors in the altimeter characterization of data as well as inconsistency in the interpretation of mechanical reference point for the altimeter antennas on the spacecraft ... .*

As concluded by Wunsch *et al.* (2007) with respect to satellite altimeter measurements of sea-level:

> *At best, the determination and attribution of global-mean sea-level change lies at the very edge of knowledge and technology...Both systematic and random errors are of concern, the former particularly, because of the changes in technology and sampling methods over the many decades, the latter from the very great spatial and temporal variability...It remains possible that the database is insufficient to compute mean sea-level trends with the accuracy necessary to discuss the impact of global warming – as disappointing as this conclusion may be. The priority has to be to make such calculations possible in the future.*

### CONCLUSION 8

**Despite these and other similar warnings and caveats, much of W&A's analysis relies upon the presumed accuracy of satellite-borne sea-level measurements. Current research literature shows that this technique is not yet well enough established, and nor is the record long enough, to form an adequate basis for coastal planning.**

# 9. Inadequacy of using an 18 year (1996-2013) baseline as a planning template

Significant sections of the W&A report are concerned with presenting results about, and discussing, sea-level change over the 18 year period 1996-2013. In a footnote to Table 6, W&A (p. 42) warn that rates calculated over this period "are unsuitable for long term estimation of sea-level rise, refer to text". They are entirely right, and therefore the policy advice that they give predicated upon analysis of 1996-2013 data should be rejected outright.

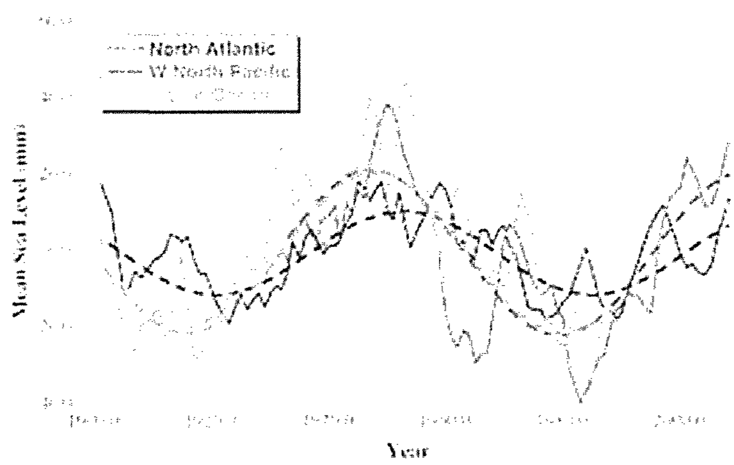



Figure 12. *60-year long, 40-cm amplitude rhythmicity associated with 20th century sea-level records from the North Atlantic, North Pacific and Indian Oceans. After Chambers et al. (2012).*

Climate-related phenomena, including changes in sea-level, change through time in a non-stationary[7] way, and exhibit repetitive (though not exactly regular) patterns of behaviour over decadal and multi-decadal periods (Fig. 12).

Changes in the rate of global sea-level are, for example, known to be influenced by a 50-60 year rhythm related to oceanic internal variability (e.g., Pacific Decadal Oscillation, PDO; Atlantic Meridional Oscillation, AMO) (Holgate, 2007; Chambers *et al.,* 2012; Marcos *et al.,* 2012; Soon & Legates, 2013). Long period tidal constituents (the 18.6 lunar nodal cycle, for example) also exert an influence on sea-level height (e.g., Pugh, 2004; Yndestad *et al.,* 2008).

It follows that sea-level records longer than 60 years, and even better longer than 120 years, are required to identify any long-term trends that might, or might not, occur in the data. On the eastern NSW seaboard, only the tide gauge record from Sydney Harbour (Fort Denison) meets these criteria (Fig. 9). This record indicates a long-term rate of rise since 1886 of just 0.73 mm/yr (Table 2). This is almost 5-times slower than the rates of rise adopted by W&A in formulating their policy advice.

W&A use 1983-2013 as their longest sea-level record and arbitrarily discard the earlier measurements, which extend back to the 19th century (cf., Fig. 13). The available tide gauge records from the Tasman Sea and Southwest Pacific Ocean that are greater than 100 years long all exhibit a similar and significant multi-decadal PDO-related sea level signal, marked by an upward step every 50-60 years with a relatively flat signal in between these steps (e.g., Auckland; Fig. 14). As W&A (p. 49) themselves note, this behaviour reflects changes in the magnitude and frequency of El Niño and La Nina events over time, in line with a changing PDO.

Note that the PDO effect does not appear strongly in *global* sea level data, because the precise timing of the oscillation differs in different parts of the ocean basins, and thereby tends to average the effect out (cf., Fig. 12).

---

[7] i.e., do not consist simply of random oscillations about a fixed long-term mean, but display steps, trends and baseline-shifting rhythmicities in their behaviour.

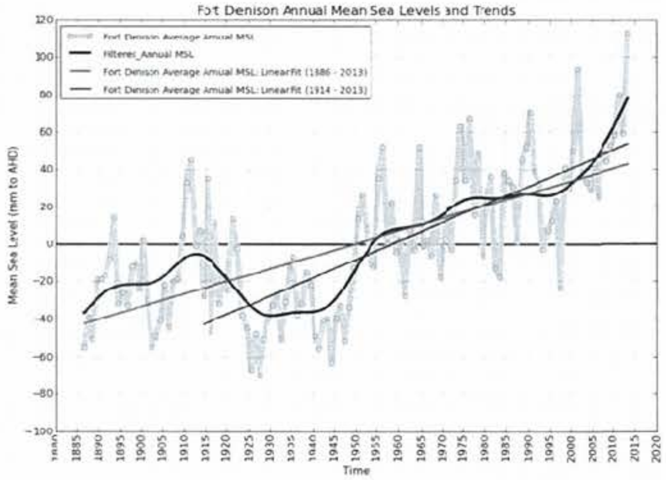
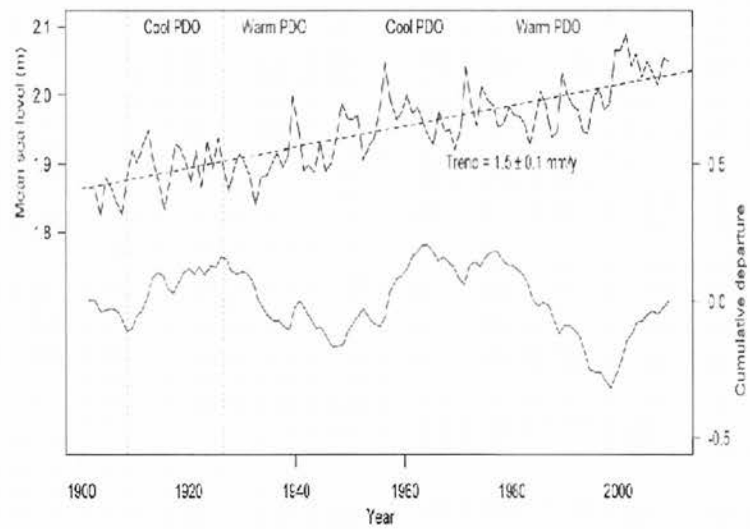



Figure 13. *Fort Denison average annual sea-level record, 1866-2013. After W&A (2014, their Fig. 13).*

Notwithstanding this, the PDO-related pattern can be coherent over *wide regions* such as the Tasman-Southwest Pacific, as can be seen by comparing the Fort Denison and Auckland tide gauge records (Figs. 12, 13; and compare W&A, Figs. 9, 10). Further analysis of the Auckland record yields long-term trend rates of sea-level rise of 1.4-1.8 mm/yr, the exact trend depending upon what time period is considered and where the analysis starts and finishes in relation to the PDO-related jumps (cf. W&A's similar alternative trend analyses of the Fort Denison record, Fig. 12).

Figure 14. *1899-2009 tide gauge record from Auckland harbour. Note the progressive long-term sea-level rise at a rate of 1.5 mm/yr, superimposed on which are irregular variations that correspond to El Nina-La Niño (ENSO) cycling and the phases of the Pacific Decadal Oscillation (PDO). Auckland gauge data (blue, above) after Hannah et al. (2010). Red line (below) is the cumulative sum of the residuals in the sea-level curve (differences between the blue dashed and solid lines). PDO phases added after* http://jisao.washington.edu/pdo/




**CONCLUSION 9**

**In choosing to analyse the short 18-year period 1993—2013 and 1996-2013, W&A have selected an arbitrary length of record that encompasses a late-1990s, El Niño-related regional jump in the rate of sea level change. Thereby, they achieve a significantly higher rate of sea level rise than the true long-term trend at Fort Denison of about 0.73 mm/yr.**

## 10. What rate of sea-level rise should be used to inform Councils' coastal planning?

Two things are clear from the previous discussion. First, and as also recommended by the NSW Chief Scientist (O'Kane, 2012), coastal Councils should use the closest available long term tide gauge measurements of local relative sea-level change to inform their policy making. Second, the current generation of deterministic computer models are flawed when measured against empirical data, and are therefore not reliable for policy setting.

Regarding the first point, the nearest long term, high-quality tide gauge to the central NSW coast is Fort Denison, Sydney harbour (Fig. 9). In which regard we agree with W&A, who say (p. 74):

> *"We advise that monitoring and analysis of the contemporary mean sea level at Fort Denison will provide results that are directly applicable to the study area"*;
>
> and (p. 53) that:
>
> *"In future, sea-level rise within the study area can be adequately assessed by examining behaviour at the Fort Denison gauge and adopting this gauge as a proxy. While Port Kembla may be equally suitable, Fort Denison has the advantage of a much longer record for teasing out longer term variability"*.

But having conceded the essential point that local long-term NSW sea-level data should be used for planning, W&A strangely then turn to providing reasons for not applying their own conclusion, saying (p. 27):

> *The following sections detail a relatively simplistic approach, applying linear fits to the available data, to determine trends over the past two decades. The values calculated by this method are not suitable for the projection of future sea levels.*

That no reason is given for the claimed lack of suitability of simple empirical projections is odd, given that such projections have informed coastal decision making for more than 100 years.

A little later (p. 35), and after extended discussion regarding the use of computer model projections, W&A add:

> *"In conclusion, we consider that the process based models and their projections are useful for planning. No model is perfect, and this needs to be considered in making policy decisions. The execution of a number of independent models as part of the CMIP5 project provides confidence that the actual sea-level rise that will be realised for a future scenario is within the ranges of projected values provided"*.

In reality, the CMIP5 intercomparison provides no such justification for model accuracy, and mostly serves to show that the model projections fail when tested against reality (Fig. 2). Furthermore, regarding the probability estimates, IPCC claim (5AR, Summary for Policy Makers, p. SPM-2):

> *"Probabilistic estimates of quantified measures of uncertainty in a finding are based on statistical analysis of observations or model results, or both, and expert judgment"*.

In other words, even the IPCC concedes that its probability estimates are NOT rigorously statistical. As Idso et al. (2013) point out:

> *"Weather forecasting methods make successful use of probabilistic ensemble averaging to provide a numerical range of uncertainties for individual forecasts. IPCC's climate models, however, are not run in this mode, and their ensemble averages are based upon a statistically inadequate and inconsistent number of runs, generally less than five. As discussed by Singer (2013), the chaoticity of modeling can only be overcome by using a large number of runs.*

Given their commitment to the usefulness of model projections, it is perhaps not surprising that W&A chose to deploy for their policy discussion NOT the long term rate of rise measured at Fort Denison (0.73 mm/yr) but instead the almost 5-times higher short-term (1996-2013) figure of 3.3 mm/yr (their Table 6). In justification of this recommendation, W&A remark (p. 35):

> *"Although the inclusion of results from many models generates uncertainty, the overall projection of an accelerating future sea-level rise is clear, even if that acceleration cannot yet be unequivocally proven based on the presently available measured record."*

Paraphrased, this says: "measurements do not show an acceleration in sea-level rise but our models do; therefore the models must be right".

The choice to use many GCM models (none empirically proven), was W&A's alone, and we agree with their statement that all it does is to introduce uncertainty; what is needed, after all, is one validated model rather than a pot-pourri of speculative ones. That all the models project acceleration in the rate of rise of sea-level is scarcely surprising, for that is what they are designed to do, and this is certainly no argument for trusting their speculative projections. We also welcome W&A's admission that no empirical evidence exists in support of their preferred model outcome.

The key issue here is the lack of any justification given by W&A for preferring to adopt a high rate of rise of 3.3 mm/yr, based on modelling homogenized data over an inadequately short period, rather than the established long term empirical trend at Fort Denison of ~0.73 mm/yr. Experienced sea-level researchers understand both that *"records under 40 years* (long) *cannot correctly represent sea level rise"* (Modra & Hess, 2011), and that *"the best prediction for sea level in the future is simply a linear projection of the [tide gauge measured] history of sea level at the same location in the past"* (Burton, 2012).

In the absence of reasons for doubting the accuracy of the long-term tide gauge record from Fort Denison, policy decisions should be formulated using the long term rates measured there, i.e. an average rate of rise of sea-level of 0.73 mm/yr (Table 2), 7.3 cm/century or 3.7 cm by 2050.

Finally, it should be noted that although the NSW coastline was subjected to a similar amount of sea-level rise as this in the 20th century, no deleterious effects are known to have resulted. This is doubtless because a change of <10 cm in a century is at least an order of magnitude less than the natural variations in local coastal sea-level caused by daily, seasonal and extreme meteorological and oceanographic events.

**CONCLUSION 10**

**Considering the flooding and erosion risks already inherent in coastal locations, the likely 7.3 cm rise in local sea-level in NSW over the next 100 years is too small to justify a major planning response. Though other human impacts at the coast might require changes in coastal regulations, no imperative exists to change planning rules because of unproven sea-level hazard.**

## 11. Good coastal management is not only about sea-level change

Societal concern about sea-level change rests upon the shoreline erosion, harbour or channel siltation and other negative coastal effects that sometimes result from a rising sea-level, but often do not. Fears of sea-level rise are easy to generate, and are often driven by two main factors. The first is the misidentification of what causes coastal flooding today, and the second is the use of the rudimentary computer models that project unrealistic estimates of future temperature and sea-level rise (Fig. 2 and Section 7, above).

The position of a shoreline and the stability of that position depend upon a number of factors besides local mean sea-level. Other important natural processes involved include subsidence or uplift of the land, rate of supply of sediment (gravel, sand, mud), tidal regime, oceanographic regime and meteorology (especially storm magnitude and periodicity, and rainfall).

As summarised by de Lange & Carter (2014, p. 17):

> *Modern coastal flooding is driven by the occurrence of rare natural events, most notably high spring tides, heavy rainfall over the interior and large storm surges, each of which can add a transitory metre or so to local sea-level height, or even 2–3 metres if combined – a height which can then be doubled for the storm surge associated with a very large hurricane. Over the last 100 years, the majority of locations (though not all) around the world's coastlines have experienced a sea-level change of between about −50 cm and +50 cm. This amount is too small to have effected noticeable changes in shorelines that are subject to daily and seasonal variations in weather and sediment supply. When, from time to time, beach erosion, river outlet clogging or cliff fall has made the media headlines, mostly the cause has been a storm event, or natural or human interference with the flow of sediment: sea-level changes that might have occurred over previous decades are rarely identifiable as a significant hazard contributor, although of course they may have slightly enhanced or diminished the precise level reached by a flood peak.*

Shorelines, then, are dynamic geographic features. The average position of a sedimentary shoreline may shift landwards or seawards by distances of metres to many tens of metres over periods between days and years, in response to variations in the amount of sediment supply, the occurrence of calms and major storms, and variations in local mean sea-level. In the past, coastal inhabitants have adapted to such changes.

CONCLUSION 11

**At the heart of the issue of good coastal management lies the need for an understanding of coastal processes in general, and the collection of accurate data regarding the history of those processes at any site of particular interest.**

The data required include measurements of coastal oceanography, historic information regarding weather variability (especially storm, hinterland rainfall, runoff and sediment discharge records), geomorphic information regarding historic changes in coastal and beach-bay landforms, stratigraphic information regarding changing pre-Recent (Holocene) sediment configurations, surveying information that includes measurement of tectonic change (i.e., land elevation or depression) and tide gauge measurements of local relative sea-level change.

CONCLUSION 12

**The study of Cairns Northern Beaches accomplished in the 1980s (Beach Protection Authority, 1984) provides an historic Australian "best practice" coastal management study of the type that has yet to be undertaken to inform the Eurobodalla and Shoalhaven Councils regarding the need, or not, for a revision of their local coastal planning regulations.**

# 12. Conclusions and recommendations

We reiterate here the policy guidelines that de Lange & Carter (2014) recommended for application by councils and other public bodies responsible for coastal hazard, including sea-level change. The three key guidelines are:

- **Abandonment of 'let's stop global sea-level rise' policies**

No justification exists for continuing to base sea-level policy and coastal management regulation upon the outcomes of speculative sea-level modelling. And even if the rate of global sea level change could be known accurately, the practice of using a notional global rate of change to manage specific coastal locations world- wide is irrational, and should be abandoned.

- **Recognition of the local or regional nature of coastal hazard**

Most coastal hazard is intrinsically local in nature. Other than periodic tsunami and exceptional storms, it is the regular and repetitive local processes of wind, waves, tides and sediment supply that fashion the location and shape of the shorelines of the world. Local relative sea-level change may be an important determinant in places, but in some localities it is rising and in others falling. Accordingly, there is no 'one size fits all' sea-level curve or policy that can be applied everywhere. Crucially, coastal hazard needs to be managed in the context of regional and local knowledge, using data gathered by site-specific tide-gauges and other relevant instrumentation.

- **Use of planning controls that are flexible and adaptive in nature**

Many planning regulations already recognize the dynamic nature of shorelines, for example by applying minimum building set back distances or heights from the tide mark. In addition, engineering solutions (groynes, breakwaters, sea-defence walls) are often used in attempts to stabilize a shoreline. To the degree that they are both effective and environmentally acceptable, such solutions should be encouraged. Nevertheless, occasional damage will continue to be imposed from time to time by large storms or other extreme - though natural - events, and that no matter how excellent the pre-existing coastal engineering and planning controls may be. In these circumstances, the appropriate policy should be one of careful preparation for, and adaptation to, hazardous events as and when they occur.

These recommendations apply just as much to the NSW shoreline as they do to shorelines anywhere else in the world. Coastal councils that ignore or override such basic principles of good environmental management do so at the risk of their ratepayers' properties and financial costs.

To the degree that new planning regulations are based on experimental computer model projections (such as those reported by W&A, which are *not* validatd predictions or forecasts), and cause financial damage to coastal property holders, legal culpability may apply.

## References

Australian National Tidal Centre (Bureau of Meteorology) 2009. Australian Mean Sea Level Survey. National Tidal Centre, Bureau of Meteorology. *www.conscious.com.au/docs/new/128.21_AustMSLsurvey2009(2).pdf*

Baker, R.G.V. & McGowan, S.A. 2014. Periodicities in mean sea-level fluctuations and climate change proxies: Lessons from the modelling for coastal management. *Ocean & Coastal Management*, 98: 187–201.

Bar-Server, Y. et al. 2012. Geodetic reference antenna in space (GRASP) – a mission to enhance space-based geodesy. Jet Propulsion Lab., Caltech, Pasadena. *ilrs.gsfc.nasa.gov/docs/GRASP_COSPAR_paper.pdf.*

Beach Protection Authority, 1984. *Mulgrave Shire Northern Beaches: a detailed study of coastal behaviour in North Queensland, Australia*. Beach Protection Authority, Brisbane, Queensland, 366 pp.

Beaman, R. J, Larcombe, P. & Carter, R.M. 1994. New evidence for the Holocene sea-level high from the inner shelf, central Great Barrier Reef, Australia. *Journal of Sedimentary Research*, 64: 881-885.

Beenstock, M., Felsenstein, D., Frank, E. & Reingewertz, Y. 2014. Tide gauge location and the measurement of global sea level rise. *Environmental & Ecological Statistics*: doi: 10.1007/s10651-014-0293-4.

Boretti, A.A. 2012a. Short term comparison of climate model predictions and satellite altimeter measurements of sea-levels. *Coastal Engineering*, 60: 319–322.

Boretti, A.A. 2012b. Is there any support in the long term tide-gauge data to the claims that parts of Sydney will be swamped by rising sea-levels? *Coastal Engineering*, 64: 161-167.

Burton, D.A. 2010. Analysis of global linear mean sea level (MSL)-trends, including distance-weighted averaging. *www.burtonsysy.com/global_msl_trend_analysis.html.*

Burton, D.A. 2012. Comments on "Assessing future risk: quantifying the effects of sea level rise on storm surge risk for the southern shores of Long Island, New York," by Shepard, C.C. et al. (Volume 60, Number 2, 727–745, DOI: 10.1007/s11069-011-0046-8). *Natural Hazards*, 63: 1219–1221 DOI 10.1007/s11069-012-0159-8.

Carter, R.M., Spooner, J. et al. 2013. *Taxing Air*. Kelpie Press. *http://www.taxingair.com/.*

Cazenave, A.K. et al. 2009. Sea level budget over 2003-2008: A re-evaluation from GRACE space gravimetry, satellite altimetry and Argo. *Global and Planetary Change*, 65: 83-88.

Chambers, D.P., Merrifield, M.A. and Nerem, R.S. 2012. Is there a 60-year oscillation in global mean sea-level? *Geophysical Research Letters*, 39(18): L18607 doi: 10.1029/2012GL052885.

Church, J.A. et al., 2006. Sea-level rise at tropical Pacific and Indian Ocean islands. *Global and Planetary Change,* 53: 155-168. doi:10.1016/j.glopacha.2006.04.001.

Church, J.A. & White, N.J. 2006. A 20th century acceleration in global sea level rise, *Geophysical Research Letters*, 33: L01602, doi:10.1029/2005GL024826.

Church, J.A. & White, N.J. 2011. Sea-level rise from the late 19th to the early 21st century. *Surveys in Geophysics*, 32:585-602, doi10.1007/s10712-011-9119-1.

Cionco, R.G. & Soon, W. 2014. A phenomenological study of the timing of solar activity minima of the last millennium through a physical modeling of the Sun-Planets Interaction. *New Astronomy*, 34: 164–171.

de Lange, W.P., 2010. Abrupt sea level changes in response to Pacific Decadal Oscillation phase shifts. *New Zealand Coastal Society Annual Conference*, 17-19 November 2010, Whitianga.

de Lange, W.P. & Carter, R.M. 2014. *Sea-level Change. Living with Uncertainty.* Global Warming Policy Foundation, London, 42 pp.

Domingues, C.M. et al. 2008. Improved estimates of upper-ocean warming and multi-decadal sea-level rise. *Nature*, 453: 1090-1093.

Douglas, B.C. 1991 Global sea-level rise. *Journal of Geophysical Research*, 96: 6981-6992.

Fu, L.-L. & Haines, B.J. 2013. The challenges in long-term altimetry calibration for addressing the problem of global sea-level change. *Advances in Space Research*, 51: 1284-1300.

Gehrels, W.R. et al. 2012. Nineteenth and twentieth century sea-level changes in Tasmania and New Zealand. *Earth & Planetary Science Letters*, 315-316: 94-102.

Goddard, S. 2013. NOAA Tide Gauges Show 0.7 mm/year Sea Level Rise. *http://stevengoddard.wordpress.com/2013/02/18/noaa-tide-gauges-show-0-7-mmyear-sea-level-rise/*.

Hagedoorn, J.M., Wolf, D. & Martinec, Z. 2007. An estimate of global mean sea-level rise inferred from tide-gauge measurements using glacial-isostatic models consistent with the relative sea-level record. *Pure & Applied Geophysics*, 164: 791-818.

Hannah, J. and Bell, R.G. 2012. Regional sea-level trends in New Zealand. *Journal of Geophysical Research*, 117: C01004-C01004.

Hannah, J., Bell, R. & Paulik, R. 2010. *Sea Level Change in the Auckland Region*. Prepared by Otago University for Auckland Regional Council. Auckland Regional Council Technical Report 2010/65, 36 pp.

Hansen, J.M. 2014. After melt down of the Scandinavian icecap sea-level change rates of the Kattegat Sea shifted many times between -3.1 and +3.7 mm $a^{-1}$. *Geophysical Research Abstracts*, 16: EGU2014-2345-1.

Holgate, S. 2007. On the decadal rates of sea level change during the twentieth century. *Geophysical Research Letters* 34: 10.1029/2006GL028492.

Houston, J.R. 2013. Global sea level projections to 2100 using methodology of the Intergovernmental Panel on Climate Change. *Journal of Waterway, Port, Coastal, and Ocean Engineering,* 139: 82–87.

Houston, J.R. & Dean, R.G. 2012. Comparisons at tide-gauge locations of glacial isostatic adjustment predictions with global positioning system measurements. *Journal of Coastal Research,* 28: 739–744.

Idso, C.D. et al. 2013a (September). *Climate Change Reconsidered II. Physical Sciences.* Chapter 6.2 Oceans, 753-796. Non-governmental International Panel on Climate Change (NIPCC), Heartland Institute, Chicago, 993 pp. *http://climatechangereconsidered.org.*

Idso, C.D. et al. 2013b (October). Scientific critique of IPCC's 2013 "Summary for Policymakers". NIPCC Policy Brief: *http://heartland.org/policy-documents/scientific-critique-ipccs-2013-summary-policymakers*.

Interacademy Council. 2010. Climate Change Assessments, Review of the Processes & Procedures of the IPCC. http://reviewipcc.interacademycouncil.net/report.html.

IPCC 2001. *Climate Change 2001: The Scientific Basis.* Third Assessment Report of the Intergovernmental Panel on Climate Change. Houghton, J.T. et al. (Eds.). Contributions of Working Group 1 to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, UK.

IPCC 2007. *Climate Change 2007: The Physical Science Basis.* Solomon, S., *et al.* (Eds.), Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, UK.

IPCC 2013. Climate Change 2013: The Physical Science Basis. IPCC Working Group I Contribution to AR5. Cambridge University Press, UK.

Jevrejeva, S., Grinsted, A., Moore, J.C. & Holgate, S., 2006. Nonlinear trends and multiyear cycles in sea level records. *Journal of Geophysical Research*, 111(C9): C09012-C09012.

Jevrejeva, S., Moore, J.C., Grinsted, A. & Woodworth, P.L. 2008. Recent global sea level acceleration started over 200 years ago? *Geophysical Research Letters*, 35(8): L08715-L08715.

Jevrejeva, S., Moore, J.C., Grinsted, A., Matthews, A.P. & Spada, G. 2014. Trends and acceleration in global and regional sea levels since 1807. *Global and Planetary Change,* 113: 11-22.

Jones, A.G., Fullea, J., Evans, R.L. & Miller, M.R. 2012. Water in cratonic lithosphere: calibrating laboratory determined models of electrical conductivity of mantle minerals using geophysical and petrological observations. *Geochemistry, Geophysics, Geosystems* (AGU) **13**: Q06010, doi: 1029/2012GC004055.

Laframboise, D. 2011 The Delinquent Teenager Who Was Mistaken for the World's Top Climate Expert. *http://nofrakkingconsensus.com/my-book/*

Laframboise, D. 2013. Into the Dustbin: Rajendra Pachauri, the Climate Report & the Nobel Peace Prize. *http://nofrakkingconsensus.com/my-book/.*

Lambeck, K. and Nakada, M. 1990. Late Pleistocene and Holocene sea-level change along the Australian coast. *Palaeogeography, Palaeoclimatology, Palaeoecology* 89: 143–176.

Lambeck, K., Purcell, A., Johnston, P., Nakada, M. & Yokoyama, Y. 2003. Water-Load Definition in the Glacio-Hydro-Isostatic Sea-Level Equation. *Quaternary Science Reviews*, 22 (2–4): 309–18. doi:10.1016/S0277-3791(02)00142-7.

Larcombe, P. et al. 1995. New evidence for episodic post-glacial sea-level rise on the central Great Barrier Reef, Australia. *Marine Geology*, 127: 1-44.

Leuliette, E. 2012. The budget of recent global sea-level rise 2005–2012. *NOAA National Environmental Satellite, Data and Information Service*. 14 pp.

Lewis, N. & Curry, J.A. 2014. The implications for climate sensitivity of AR5 forcing and heat uptake estimates. *Climate Dynamics*, 25 September 2014.

Lewis, S.E., Sloss, C.R., Murray-Wallace, C.V., Woodroffe, C.D. & Smithers, S.G., 2013. Post-glacial sea-level changes around the Australian margin: a review: *Quaternary Science Reviews,* 74: 115-138.

Manly Hydraulics Laboratory, 2011. NSW ocean and river entrance tidal levels annual summary 2010-2011. Report MHL2089, November 2011. NSW Office of Environment & Heritage, 112 pp. *mhl.nsw.gov.au/.../mhl2089_ocean_tides_annual_summary_2010-11.pdf.*

Marcos, M., Tsimplis, M.N. & Calafat, F.M. 2012. Inter-annual and decadal sea level variations in the north-western Pacific marginal seas. *Progress In Oceanography*, 105: 4–21.

Marsland, S.J. et al. 2013. Evaluation of ACCESS climate model ocean diagnostics in CMIP5 simulations. *Australian Meteorological & Oceanographic Journal*, 63: 101-119.

McKitrick, R.R. 2014. HAC-Robust Measurement of the Duration of a Trendless Subsample in a Global Climate Time Series. *Open Journal of Statistics*, 4: 527-535. doi: 10.4236/ojs.2014.47050.

McLean, J., 2007a. August/September. An Analysis of the Review of the IPCC 4AR WG I Report. Science & Public Policy Institute. *http://mclean.ch/climate/docs/IPCC_review_updated_analysis.pdf*.

McLean, J., 2007b. November. Why the IPCC should be disbanded. *http://scienceandpublicpolicy.org/originals/whytheipccshouldbedisbanded.html*.

McLean, J., 2008. Prejudiced Authors, Prejudiced Findings. Analysis of IPCC data on chapter authors and reviewers published through the Science and Public Policy Institute. Particularly pages 16-17. http://www.heartland.org/policybot/results/23573/Prejudiced_Authors_Prejudiced_Findings.html.

McLean, J., 2009. The IPCC Can't Count its 'Expert Scientists' – Author and Reviewer Numbers are Wrong, International Climate and Environmental Change Assessment Project. http://mclean.ch/climate /docs/IPCC_numbers.pdf.

McLean, J. 2014. Parsing the IPCC's piffle. *Quadrant Online*, August 19, 2014. *http://quadrant.org.au/opinion/doomed-planet/2014/08/parsing-ipccs-innumerate-piffle/*.

Menard, G. 2000. Satellite-based altimetry reveals physical ocean. *MEDIAS Newsletter*, 12: 9-17.

Meyssignac, B., Salas Y Melia, D., Becker, M., Llovel, W. & Cazenave, A. 2012. Tropical Pacific spatial trend patterns in observed sea level: internal variability and/or anthropogenic signature? *Climate of the Past*, 8: 787-802.

Modra, B. & Hesse, S. 2011. NSW Ocean Water Level. 21st NSW Coastal Conference. *http://www.coastalconference.com/papers.asp* (2011 tab).

Mörner, N-.A. 2012. Sea level is not rising. *Science & Public Policy Institute (SPPI) Report*, 26 pp.

Mörner, N-.A. 2013. Sea level changes past records and future expectations. *Energy & Environment,* 24: 509-536.

Mörner, N-.A. 2014. Deriving the eustatic sea level component in the Kattaegatt Sea. *Global Perspectives on Geography*, 2: 16–21.

Mörner, N.-A. & Parker, A. 2013. Present-to-future sea level changes: The Australian case. *Environmental Science, An Indian Journal*, 8 (2): 43-51.

Munk, W. 2002. Twentieth centjury sea level: An enigma. *Proceedings of the National Academy of Sciences*, 99: 6550-6555.

Murray Wallace, C.V. & Belperio, A.P. 1991. The last interglacial shoreline in Australia –a review. *Quaternary Science Reviews,* 10: 441–461.

NASA JPL, 2012. Satellite mission GRASP. *http://ilrs.gsfc.nasa.gov/missions/satellite_missions/future_missions/index.html.*

NASA JPL, 2014. GPS Time Series. *http://sideshow.jpl.nasa.gov/post/series.html.* [Accessed 22-09-2014).

Newman, W.S. 1986. Palaeogeodesy data bank. IGCP Project 200 Newsletter, p. 41. University of Durham.

NOAA, 2014. Tides & Currents. 680-140 Sydney, Fort Denison 1 & 2, Australia. *http://tidesandcurrents.noaa.gov/sltrends/sltrends_global_station.shtml?stnid=680-140.*

O'Kane, M. 2012. Assessment of the science behind the NSW Government's sea level rise planning benchmarks. NSW Government, Office of the Chief Scientist & Engineer, 32 pp. *http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0016/26206/CSE-Report-Sea-Level-Rise-Benchmarks_.pdf*

Parham, P.R. et al. 2014. Evidence for ca. 7-ka maximum Holocene transgression on the Peninsular Malaysia east coast. *Journal of Quaternary Science*, 29: 414-422.

Parker, A. 2014a. Present contributions to sea level rise by thermal expansion and ice melting and implication on coastal management. *Ocean & Coastal Management*, 98: 202–211. doi: 10.1016/j.ocecoaman.2014.05.026

Parker, A. 2014b. Persisting problems affecting the reliability of the satellite altimeter based Global Mean Sea Level computation. *Pattern Recognition in Physics,* 02(02): 65-74. *http://www.pattern-recognition-in-physics.com/pub/prp-2-65-2014.pdf*

Plag, H.P. 2006. Recent relative sea level trends: An attempt to quantify forcing factors. *Philosophical Transactions of the Royal Society of London,* A 364:1841-69.

Pugh, D. 2004. *Changing sea levels: Effects of tides, weather and climate*. Cambridge University Press, Cambridge, 265 pp.

Ray, R. D. & Douglas, B.C. 2011. Experiments in Reconstructing Twentieth-Century Sea Levels. *Progress in Oceanography,* 91 (4): 496–515. doi:10.1016/j.pocean.2011.07.021.

Singer, S. F. 2013. Overcoming chaotic behaviour of general circulation models (GCMS). *Energy and Environment,* 24: 397-403.

Sloss, C.R., Murray-Wallace, C.V. & Jones, B.J. 2007. Holocene sea-level change on the southeast coast of Australia: a review. *The Holocene,* 17: 999 doi: 10.1177/0959683607082415.

Soon W. & Legates D.R. 2013. Solar irradiance modulation of Equator-to-Pole (Arctic) temperature gradients: empirical evidence for climate variation on multi-decadal timescales. *Journal of Atmospheric, Solar & Terrestrial Physics*, 93: 45–56

Spencer, R.W. 2013 (June 6). Still epic fail: 73 climate models vs. measurements, running 5-year means. *http://www.drroyspencer.com/2013/06/still-epic-fail-73-climate-models-vs-measurements-running-5-year-means/.*

Tamisiea, M.E., Hughes, C.W., Williams, S.D.P. & Bingley, R.M.. 2014. Sea Level: Measuring the Bounding Surfaces of the Ocean. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 372 (2025). doi:10.1098/rsta.2013.0336.

Tans, P. 2009. An accounting of the observed increase in oceanic and atmospheric CO2 and an outlook for the future. *Oceanography,* 22: 26-35.

Velasco Herrera, V.M., Mendoza, B. & Velasco Herrera, G. 2014. Reconstruction and prediction of total solar irradiance: From the Medieval Warm Period to the 21$^{st}$ century. *New Astronomy*, 34: 221–233.

Watson, P.J. 2011. Is there evidence yet of acceleration in mean sea-level rise around mainland Australia? *Journal of Coastal Research* **27**: 368-377.

Wenzel, M. & Schröter, J. 2010. Reconstruction of regional mean sea level anomalies from tide gauges using neural networks, *Journal of .Geophysical .Research*, 115: C08013, doi:10.1029/2009JC005630.

Wenzel, M. & Schröter, J. 2014. Global and regional sea level change during the 20$^{th}$ century. *Journal of Geophysical Research: Oceans.* Doi 10.1002/2014JC009900

White, N.J. et al. 2014. Australian sea levels – trends, regional variability and influencing factors. *Earth Science Reviews*, 136: 155-174.

Whitehead & Associates 2014 (July). South Coast Regional Sea Level Rise Policy and Planning Framework, Exhibition Draft. *http://esc.nsw.gov.au/inside-council/project-and-exhibitions/public-exhibition/on-exhibition/south-coast-regional-sea-level-rise-planning-and-policy-response/South-Coast-Regional-Sea-Level-Rise-Policy-and-Planning-Framework.pdf.*

Woodworth, P.L. et al., 2009. Evidence for the accelerations of sea level on a multi-decade and century timescales. *International Journal of Climatology 29: 777-789.*

Wöppelmann, G. et al. 2009. Rates of sea-level change over the past century in a geocentric reference frame. *Geophysical Research Letters* **36**: L12607, doi: 10.1029/2009GL038720.

Wunsch, C., Ponte, R.M. & Heimbach, P. 2007. Decadal Trends in Sea-level Patterns: 1993–2004. *Journal of Climate* 20(24): 5889–5911. doi: 10.1175/2007JCLI1840.1.

Yndestad, H., Turrell, W.R. & Ozhigin, V. 2008. Lunar nodal tide effects on variability of sea level, temperature, and salinity in the Faroe-Shetland Channel and the Barents Sea. *Deep Sea Research I*, 55: 1201–1217.

You, Z.-J., Lord, D. & Watson, P. 2009. Estimation of Relative Mean Sea Level Rise From Fort Denison Tide Gauge Data. *Proceedings of the 19th Australasian Coastal and Ocean Engineering Conference*, Wellington, NZ, September 2009.

## About the Authors

***Robert M. Carter, Ph.D.***

**Carter** is a palaeontologist, stratigrapher, marine geologist and environmental scientist with more than 40 years professional experience, and holds degrees from the University of Otago (New Zealand) and the University of Cambridge (England). He has held tenured academic staff positions at the University of Otago (Dunedin), James Cook University (Townsville) - where he was Professor and Head of School of Earth Sciences between 1981 and 1999 – and a research position at the University of Adelaide (South Australia).

Dr. Carter's professional service has included acting as Chair of the Earth Sciences Discipline Panel of the Australian Research Council, Chair of the national Marine Science and Technologies Committee, Director of the Australian Office of the Ocean Drilling Program, and Co-Chief Scientist on ODP Leg 181 (Southwest Pacific Gateways). He has testified as an expert witness on climate change in the Australian, New Zealand and Swedish parliaments and the US Senate, and gave evidence in the London High Court case that ruled that Mr Al Gore's film, *An Inconvenient Truth*, contained at least 9 basic scientific errors.

Dr. Carter contributes regularly to public education and debate on scientific issues which relate to his areas of knowledge. His public commentaries draw on his knowledge of the scientific literature and a personal publication list of more than 100 papers in international science journals. His current research on climate change, sea-level change and stratigraphy is based on field studies of Cenozoic sediments (last 65 million years) from the Southwest Pacific region, especially the Great Barrier Reef and New Zealand.

***Willem de Lange, D.Phil.***

**de Lange** is a coastal oceanographer with degrees in computer and earth sciences and who specialises in prediction and mitigation of coastal hazards. He currently lectures and supervises research students in the School of Science, University of Waikato, including teaching courses in coastal management.

Dr de Lange's research, as well as his students, mostly focusses on the assessment of coastal hazards and developing tools for predicting and mitigating hazard. This included the first research in NZ linking shoreline changes and coastal processes to climatic variations associated with the El Niño-Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO), and research into the impacts of human activities on shoreline changes in the Southwest Pacific and Southeast Asia.

Dr de Lange has been involved in advising the NZ government about sea level rise as part of periodic climate change impact assessments, and has also been involved in setting legal precedents for coastal hazard management since 1984. He was involved in the IPCC second assessment report published in 1995, and more recently, the NIPCC second assessment report published in 2013.

***Jens Morten Hansen, Ph.D.***

**Hansen** was born in 1947 and took a masters degree (1975) and PhD (1983) from Copenhagen University. During 1975-1991 he worked as a researcher on a wide range of geological topics, including biostratigraphy, structural geology, sea-level change, glacio-isostasy and geological mapping in Denmark and Greenland.

After a combined scientific and administrative career as vice-managing Director for the Geological Survey of Denmark and Greenland (1991-1998), and Director General of the Danish Research Councils

(1998-2006), he reengaged as a full time researcher in a position as 'statsgeolog'. This is a public scientific position from which Hansen gives advice to Danish governmental and other public authorities on matters in the field of geology.

Hansen's present research is concentrated on sea-level changes of the North Sea and Baltic regions including analyzing the region's many long tide-gauge records, as well as studying the region's large number of palaeo-shorelines. After his reengagement in 2006 as a full-time researcher Hansen has published many scientific papers, and currently holds several research grants. Hansen participates in working out official Danish sea-level prognoses.

Hansen is currently Chairman of Danish universities' censors in geology, and Secretary of the Board of Directors for public research institutions.

***Ole Humlum, Ph.D.***

**Humlum** is a physical geographer, geomorphologist and environmental scientist with 37 years professional experience, and holds MSc and PhD degrees from the University of Copenhagen (Denmark). In 1976 he was awarded the Prize Essay Gold Medal of the University of Copenhagen. He has since held tenured academic staff positions at the University of Copenhagen (Denmark; 1976-1983 and 1986-1999), University of Oslo (Norway, since 2003), and at the University Centre in Svalbard (UNIS, Svalbard, Norway, since 1999), and has been a visiting scientist at the University of St. Andrews (Scotland) and at the Faroese Museum of Natural History (Tórshavn, Faroe Islands).

Dr. Humlum's professional service has included a position as Scientific Director at the Arctic Research Station (Qeqertarsuaq, Greenland, 1983-1986), and a position as Special Consultant at the Danish Polar Center (Copenhagen) to initiate a monitoring programme within Earth Science in NE-Greenland (Zackenberg, 1995). He has been Editor for the Greenland Home Rule Office, Pilersuiffik, Denmark, and Secretary for the INQUA Working Group on Geospatial Analysis of Glaciated Environments (GAGE, 1994-1999). He was Co-chair for the Working Group on Periglacial Processes and Environments, International Permafrost Association (IPA, 1998-2003). Dr. Humlum's own numerous research contributions have been published in many leading peer-reviewed journals.

***Craig D. Idso, Ph.D.***

**Idso** is a climatologist and agronomist, is the founder, former president, and currently chairman of the Center for the Study of Carbon Dioxide and Global Change. The Center was founded in 1998 as a non-profit public charity dedicated to discovering and disseminating scientific information pertaining to the effects of atmospheric carbon dioxide enrichment on climate and the biosphere. The Center produces a weekly online newsletter, *CO2 Science*, and maintains a massive online collection of editorials on and reviews of peer-reviewed scientific journal articles relating to global climate change. Dr. Idso has published his research contributions in many professional, peer-reviewed science journals.

Dr. Idso received a B.S. in Geography from Arizona State University, an M.S. in Agronomy from the University of Nebraska – Lincoln, and a Ph.D. in Geography from Arizona State University, where he also studied as one of a small group of University Graduate Scholars. He was a faculty researcher in the Office of Climatology at Arizona State University and has lectured in Meteorology at Arizona State University.

***David Kear, Ph.D.***

**Kear** received his training in geology and mining engineering at the University of London (Imperial College), completing a BSc (Engineering, 1st Hons) London in Mining Engineering and a BSc in Mining Geology. He also holds an Associateship of the Royal School of Mines (ARSM, Ist Hons). Kear's 1963 PhD degree, also awarded by London University, was based upon field studies of a Plio-Pleistocene succession near Auckland that contained fossil evidence for sharp climatic and sea-level changes – these studies acting to arouse a lifelong interest in climate change.

Moving permanently to New Zealand, Kear lectured at the Huntly School of Mines, and acted as Director of the New Zealand Administrative Staff College. After joining the New Zealand Geological Survey, he rose to the position of Director General of the Department of Scientific and Industrial Research (DSIR). He is a Fellow of the Royal Society of New Zealand, and served a term as Vice-President of the Society. During his active research career, Kear published more than 100 research papers on New Zealand and Pacific geology, volcanology and mineral resources, and served a term as President of the New Zealand Geological Society. Throughout his career he also acted as a member or Chairman of numerous national and international committees and working parties on matters related to geology (including sea-level change), minerals, engineering and general science policy.

**David R. Legates, Ph.D.**

**Legates** received a B.A. in Mathematics and Geography (double major) in 1982, a M.S. in Geography-Climatology in 1985, and a Ph.D. in Climatology in 1988, all from the University of Delaware. His *expertise lies in hydroclimatology/surface water hydrology, precipitation and climate change, spatial* analysis and spatial statistics, and statistical/numerical methods. Legates' dissertation was entitled "A Climatology of Global Precipitation" and focused on obtaining a better picture of global precipitation by incorporating a high-resolution precipitation gage database that was adjusted for changes in instrumentation and biases associated with the precipitation gauge measurement process. His climatology of precipitation continues to be widely used as it is still the only global climatology available that addresses the gauge measurement bias problem.

Legates became an Assistant Professor in the College of Geosciences at the University of Oklahoma, being granted tenure and promoted to Associate Professor in 1994. He became the Chief Research Scientist for the Center for Computational Geosciences at the University of Oklahoma in 1995. In 1998, Legates moved to the Louisiana State University and became an Associate Professor in the Department of Geography and Anthropology as well as a research scientist with the Southern Regional Climate Center. Legates then returned to the University of Delaware in 1999 as an Associate Professor and was promoted to Full Professor in 2010. While at Delaware, Legates has served as the Delaware State Climatologist (2005-2011), Director of the Center for Climatic Research (2001-2007), and founder and co-Director of the Delaware Environmental Observing System (2003-2011).

Legates has been invited to speak to the US Senate Committee on the Environment and Public Works on three separate occasions. He has received over $7M USD in grants over his career and has published more than 60 refereed articles. He has made more than 200 professional presentations.

***Nils-Axel Mörner, Ph.D.***

**Mörner** took his Ph.D.-thesis in 1968 in Geology at Stockholm University. In his thesis he was able to separate the isostatic and eustatic components behind the relative sea-level changes observed. His eustatic curve recorded a low-amplitude oscillating sea-level rise after the Last Ice Age – contrary to the high-amplitude curve of Fairbridge (1961) and the smooth curve of Shepard (1963). In 1976, Mörner introduced the concept of geoid changes, and by implication redefined the concept of eustasy. In 1984, he introduced the concept of Super-ENSO events and horizontal redistribution of oceanic water masses.

Mörner has published more than 200 peer-reviewed papers on sea-level change and related questions, and has direct field experience in 59 countries. He has acted as president of the INQUA Commission of Sea Level Changes and Coastal Evolution, leader of the Maldives Sea level Project and co-ordinator of the INTAS project on Geomagnetism & Climate. Mörner has also edited books like: "Earth Rheology, Isostasy and Eustasy" (Wiley, 1980), "Climate Change on a Yearly to Millennial Basis" (Kluwer, 1984), "The Tsunami Threat: research and technology (InTech, 2011).

Mörner was the head of Paleogeophysics & Geodynamics at Stockholm University between 1991 and 2005. In 2008, he was awarded "The Golden Condrite of Merits: for his irreverence and contribution to our understanding of sea level change".

***Cliff Ollier, D.Sc.***

**Ollier** is a geologist and geomorphologist who is an Emeritus Professor from the University of New England, Armidale, and currently an Honorary Research Fellow at the School of Earth and Environment, University of Western Australia, Perth.

Dr Ollier is the author of over 300 scientific papers and ten books, including *Tectonics and Landforms* which has chapters on oceans and sea level changes. He has worked on every continent, lectured at over a hundred different universities around the world, and been employed by seven. He has carried out research on coasts around Australia and on several Pacific islands, studying the practical problems associated with shoreline erosion and sea level change.

***S. Fred Singer, Ph.D.***

**Singer** is an atmospheric and space physicist, is one of the world's most respected and widely published experts on climate. Dr. Singer served as professor of environmental sciences at the University of Virginia, and is currently professor emeritus of environmental sciences at the University of Virginia. He directs the non-profit Science and Environmental Policy Project, which he founded in 1990 and incorporated in 1992.

Charlottesville, VA (1971-94); distinguished research professor at the Institute for Space Science and Technology, Gainesville, FL, where he was principal investigator for the Cosmic Dust/Orbital Debris Project (1989-94); chief scientist, U.S. Department of Transportation (1987- 89); vice chairman of the National Advisory Committee for Oceans and Atmosphere (NACOA) (1981-86); deputy assistant administrator for policy, U.S. Environmental Protection Agency (1970-71); deputy assistant secretary for water quality and research, U.S. Department of the Interior (1967- 70); founding dean of the School of Environmental and Planetary Sciences, University of Miami (1964-67); first director of the National Weather Satellite Service (1962-64); and director of the Center for Atmospheric and Space Physics, University of Maryland (1953-62).

Dr. Singer did his undergraduate work in electrical engineering at Ohio State University and holds a Ph.D. in physics from Princeton University.

***Willie H. Soon, Ph.D.***

**Soon** is an astrophysicist and geoscientist. Since 1992, Dr. Soon has been an astronomer at the Mount Wilson Observatory. He is also receiving editor in the area of solar and stellar physics for *New Astronomy*. He writes and lectures both professionally and publicly on important issues related to the sun, other stars, and the Earth, as well as general science topics in astronomy and physics.

Dr. Soon's honors include a 1989 IEEE Nuclear and Plasma Sciences Society Graduate Scholastic Award and a Rockwell Dennis Hunt Scholastic Award from the University of Southern California for "the most representative Ph.D. research thesis" of 1991. In 2003, he was invited to testify to the U.S. Senate, and in 2014 he was awarded the Courage in Defence of Science award at the 9th International Conference on Climate Change in Las Vegas.

Dr. Soon is the author of *The Maunder Minimum and the Variable Sun-Earth Connection* (World Scientific Publishing Company 2004). His research has appeared many times in peer-reviewed journals, including *Climate Research, Geophysical Research Letters, Energy & Environment, Eos,* and *Journal of Climate*.

Dr. Soon earned his bachelor's and master's degrees in science from the University of Southern California and his Ph.D. in aerospace engineering from the University of Southern California.

## About the NIPCC

The Nongovernmental International Panel on Climate Change, or NIPCC, is an international panel of scientists and scholars who came together to understand the causes and consequences of climate change. NIPCC has no formal attachment to or sponsorship from any government or governmental agency. It is wholly independent of political pressures and influences and therefore is not predisposed to produce politically motivated conclusions or policy recommendations.

NIPCC traces its beginnings to an informal meeting held in Milan, Italy in 2003 organized by Dr. S. Fred Singer and the Science & Environmental Policy Project (SEPP). The purpose was to produce an independent evaluation of the available scientific evidence for carbon dioxide-induced global warming, in anticipation of the release of the IPCC's Fourth Assessment Report (AR4). NIPCC scientists concluded the IPCC was biased with respect to making future projections of climate change, and overemphasized the human influence on current and past climatic trends.

To highlight such deficiencies in the IPCC's AR4, in 2008 SEPP partnered with The Heartland Institute to produce *Nature, Not Human Activity, Rules the Climate,* a summary of research for policymakers that has been widely distributed and translated into six languages. In 2009, the Center for the Study of Carbon Dioxide and Global Change joined the original two sponsors to help produce *Climate Change Reconsidered: The 2009 Report of the Nongovernmental International Panel on Climate Change (NIPCC),* the first comprehensive alternative to the alarmist reports of the IPCC.

In 2010, a Web site (www.nipccreport.org) was created to highlight scientific studies NIPCC scientists believed would likely be downplayed or ignored by the IPCC during preparation of its next assessment report. In 2011, the three sponsoring organizations produced *Climate Change Reconsidered: The 2011 Interim Report of the Nongovernmental International Panel on Climate Change (NIPCC),* a review and analysis of new research released since the 2009 report or overlooked by the authors of that report.

In 2013, the Information Center for Global Change Studies, a division of the Chinese Academy of Sciences, translated and published an abridged edition of the 2009 and 2011 NIPCC reports in a single volume. On June 15, the Chinese Academy of Sciences organized a NIPCC Workshop in Beijing to allow the NIPCC principal authors to present summaries of their conclusions.

In April 2014, NIPCC released *Climate Change Reconsidered II: Impacts, Adaptation, and Vulnerability,* the second of two volumes bringing the original 2009 report up to date with research from the *2011 Interim Report* plus research as current as the first quarter of 2014. In September 2013, NIPCC released *Climate Change Reconsidered II: Physical Science,* the first of these update volumes. A new Web site was created (www.ClimateChangeReconsidered.org) to feature the new report and news about its release. One more volume in the CCR-II series, subtitled *Human Welfare, Energy, and Policies*, is planned.

For more info about NIPCC, visit www.climatechangereconsidered.org or www.nipccreport.org.

**International Journal of Geosciences, 2015, 6, 577-592**
Published Online June 2015 in SciRes. http://www.scirp.org/journal/ijg
http://dx.doi.org/10.4236/ijg.2015.66045

Scientific Research Publishing

# Glacial Isostasy: Regional—Not Global

**Nils-Axel Mörner**

Paleogeophysics & Geodynamics, Stockholm, Sweden
Email: morner@pog.nu

Received 22 May 2015; accepted 15 June 2015; published 18 June 2015



## Abstract

**The load of the continental ice caps of the Ice Ages deformed the bedrock, and when the ice melted in postglacial time, land rose. This process is known as glacial isostasy. The deformations are compensated either regionally or globally. Fennoscandian data indicate a regional compensation. Global sea level data support a regional, not global, compensation. Subtracting GIA corrections from satellite altimetry records brings—for the first time—different sea level indications into harmony of a present mean global sea level rise of 0.0 to 1.0 mm/yr.**

## Keywords

**Glacial Isostasy, Fennoscandia, Postglacial Uplift, Uplift Cone, Subsidences Trough, Forebulge, Low Viscosity Channel Flow, Global Sea Level Data, Correcting Satellite Altimetry, Removing Global GIA Correction**

## 1. Introduction

Jamieson [1] [2] understood that the Earth is not rigid and that the load of an ice cap had to deform the bedrock beneath, causing down warping and uplift in response to the glacial advance and recession. He saw the Scottish and Fennoscandian uplift as evidence of this effect; *i.e.* "glacial isostasy". The full evidence and description of glacial isostasy was given by De Geer [3], however, and with this paper a new epoch begun in the study of Fennoscandian uplift [4].

When it was understood that the Earth had passed cold period known as Ice Ages with expansions of continental ice caps in the Alps [5], in North America [6] and in Fennoscandia [7], the phenomena of glacial eustasy [8] and glacial isostasy [3] followed logically. Glacial eustasy implies that water is transferred to the ice caps and global sea level by consequence falls [9], later to rise when the ice caps melt in postglacial time. Glacial isostasy implies that the load of the ice caps deforms the bedrock leading the crustal subsidence, later to transform into crustal uplift in response to the vanishing load during postglacial melting [3] [4].

The lowering of global sea level also meant that the Earth's rate of rotation increased significantly [10] and that the geoid surface was deformed affecting the crustal dynamics and local sea level [11].

How to cite this paper: Mörner, N.-A. (2015) Glacial Isostasy: Regional—Not Global. *International Journal of Geosciences*, **6**, 577-592. http://dx.doi.org/10.4236/ijg.2015.66045

The climatic alternations between Ice Ages and Interglacials [12] are linked to a spectrum of related changes of global and local terrestrial processes as illustrated in Figure 1 [13]. In this paper, however, we will confine the discussion to the process of glacial isostasy, and the question whether this is a primarily regional phenomenon or if it has global dimensions.

Bloom [14] was the first to suggest that the process of glacial isostasy might also affect the rest of the globe via the distribution of the loading effects into the asthenosphere. Walcott [15] called attention to the fact that the postglacial glacial isostatic compensation after the vanishing of the huge ice caps in Fennoscandia and North America (and elsewhere, too) would affect the crustal compensation regionally, if it took place via a low-viscosity channel flow, whilst it would generate global compensational crustal motions if the viscosity had a linear profile (*i.e.* no channel flow). The discrimination between these two concepts will be the focus of the present paper.

## 2. Regional vs Global Glacial Isostasy

Figure 2 illustrates the two alternative concepts of the spatial extension of glacial isostasy (from [16]), here termed Model A and Model B, respectively.

Model A (Figure 2(a)) is based on a linear viscosity model [17]-[20], and would imply that the glacial isostatic compensation had direct global dimensions, and hence would lack a peripheral bulge (at leas a major one) surrounding the glacially depressed region. This theory was further developed into a global standard correction model [21] [22], and has even evolved into a general correction factor for present day sea level records [23].

Model B (Figure 2(b)) implies that the glacial loading and de-loading is compensated by lateral flow in a low viscosity channel and that the glacially down warped area was surrounded by a compensational forebulge. This is the classical theory of glacial isostasy in Fennoscandian [3] [24]-[29]. All data available from Fennoscandia are in favor of a low-viscosity channel flow (Figure 2(b)). The mass in the cone of absolute postglacial uplift is

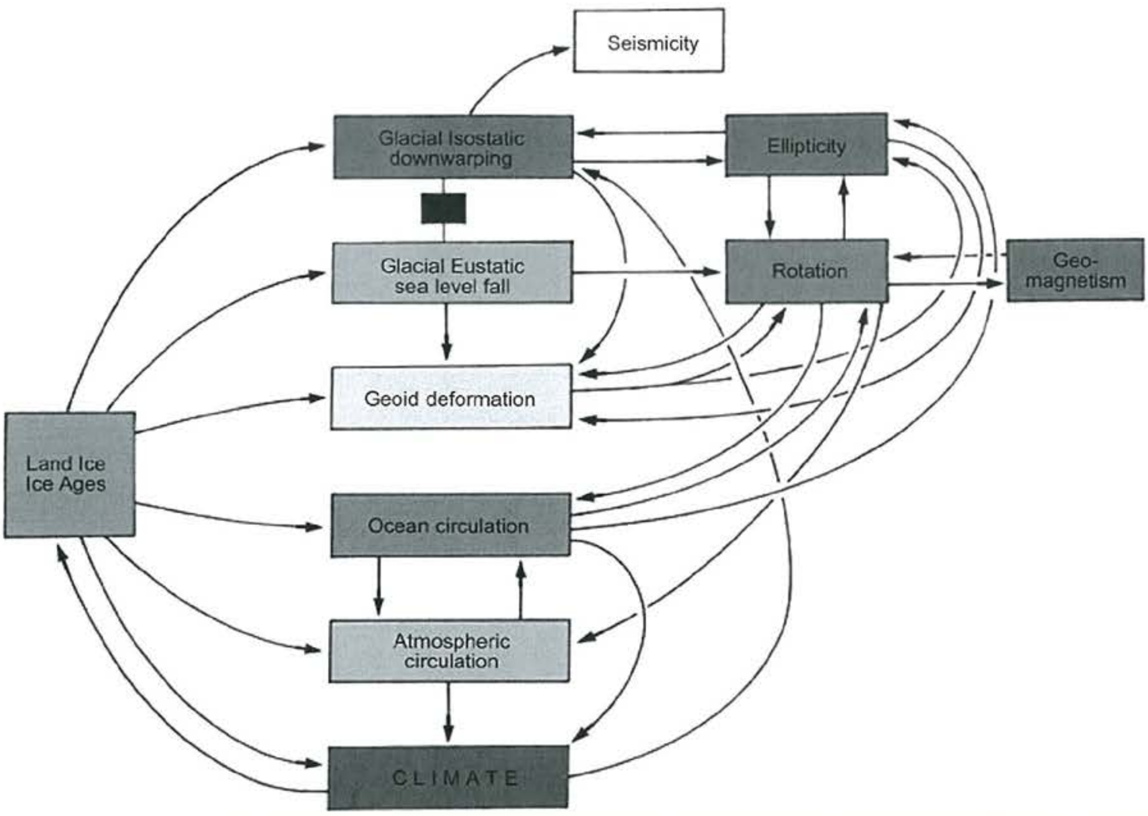



Figure 1. Interaction and feedback coupling of geodynamic processes affected by the alternations between Ice Ages and Interglacils with corresponding waxing and vanishing of continental ice caps (from [13]).

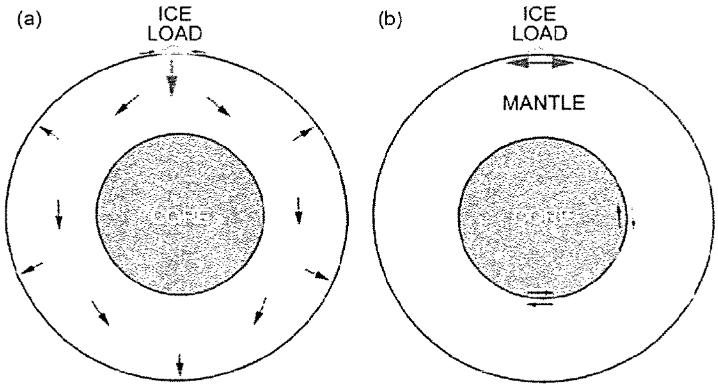



Figure 2. Global versus regional loading adjustments to glacial isostasy [16]. A: In the global loading models, the glacial loading/unloading will be transferred through the mantle and affect the coasts and sea floors all around the globe. This requires a linear viscosity in the upper mantle. B: In the regional loading model, the glacial loading/unloading is fully compensated in the region of glacial isostatic deformation via lateral mass flow in a low-viscosity upper asthenosphere channel.

the same as the mass in the surrounding peripheral subsidence trough, indicating a horizontal mass flow from the collapsing forebulge (subsidence trough) to the rising uplift cone as further discussed below (Section 3).

The determining factor for the discrimination between the two models (Figure 2) is the mode of crustal deformation in the near field [3] [27] and the mode of sea level changes in the far field [26] [30].

## 3. The Fennoscandian Ice Cap and Crustal Deformation

During the Quaternary Ice Ages large ice caps covered the Fennoscandian region [3] [4] [7] [16]. De Geer [3] was the first to show that there was clear relationship between the extension of the Fennoscandian ice cap of the Ice Age and the geometry of crustal deformation (*i.e.* postglacial uplift) of the Fennoscandian Shield with a maximum central uplift in the order of 200 m (Figure 3). Subsequent studies have, of course, sharpened the picture. Today [4] [27], we know that the absolute glacial isostatic uplift of the Fennoscandian Shield had the form of a cone with a maximum central uplift of 800 m (Figure 4), and being surrounded by a subsidence trough (*i.e.* the collapsing forebulge of the Ice Age glacial isostatic down warping of Fennoscandia). We also know that the rate of uplift right after the time of deglaciation amounted to as much as 30 - 40 cm/yr [13] [27].

### 3.1. Horizontal Mass Flow and Mode of Deformation

From the uplift profiles presented at the Stockholm symposium in 1977 [31], Mörner calculated the amount of mass disappearing from the subsidence trough and appearing in the uplift cone for every 500 year from 13,000 radiocarbon years BP to the present [4] [13] [27]. Figure 5 gives this disappearance/appearance of mass. It indicates that the entire process was a matter of horizontal mass-flow. It is interesting to note that the disappearance of mass from the subsidence trough stopped some 8000 radiocarbon years BP and that the appearance of mass in the uplift cone stopped some 4500 radiocarbon years BP.

The total mass volume of the uplift cone is $7.2 \times 10^5$ km$^3$ [27] and closely agrees with the mass in the subsidence trough (if one includes the hypothetical extension west of Norway).

Figure 6 gives an extended scheme of uplift and subsidence in the last 25 ka in a profile from the centre of uplift out across the subsidence trough [13] [28]. The down warping of the Fennoscandian Shield in response to the glacial load of the Late Weichselian ice cap generates an uplift of a forbulge. At about 16,000 BP the forebulge begun to collacse (*i.e.* mass disappears), and from 13,000 BP the Fennoscandian Shield commenced its postglacial uplift. This is 3700 years before the centre of uplift actually becomes free melted [4] [27] [28] [32].

The model of uplift is given in Figure 7 (from [4] [27]); a lithosphere of high crustal rigidity and an asthenospheric channel of low viscosity where the mass-flow occurred. The asthenospheric rigidity was calculated at $2 \times 10^{19}$ PA [27]. The crustal rigidity may be as high as $10^{25}$ Nm [33].

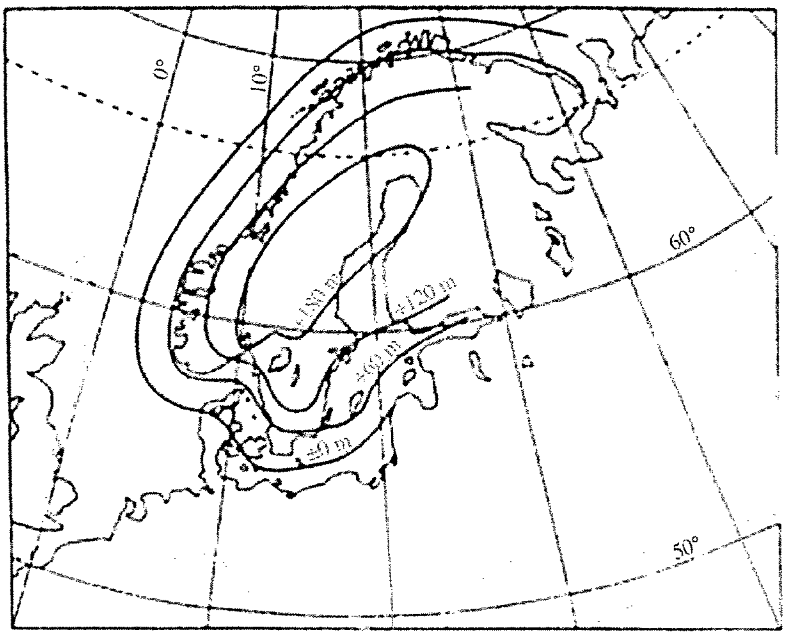



Figure 3. The isobases of postglacial uplift as recorded by the maximum sea level elevations observed (blue area) and the extension of the Ice Age glaciation (yellow line) according to De Geer [3] (with coloring [13] and later updating).

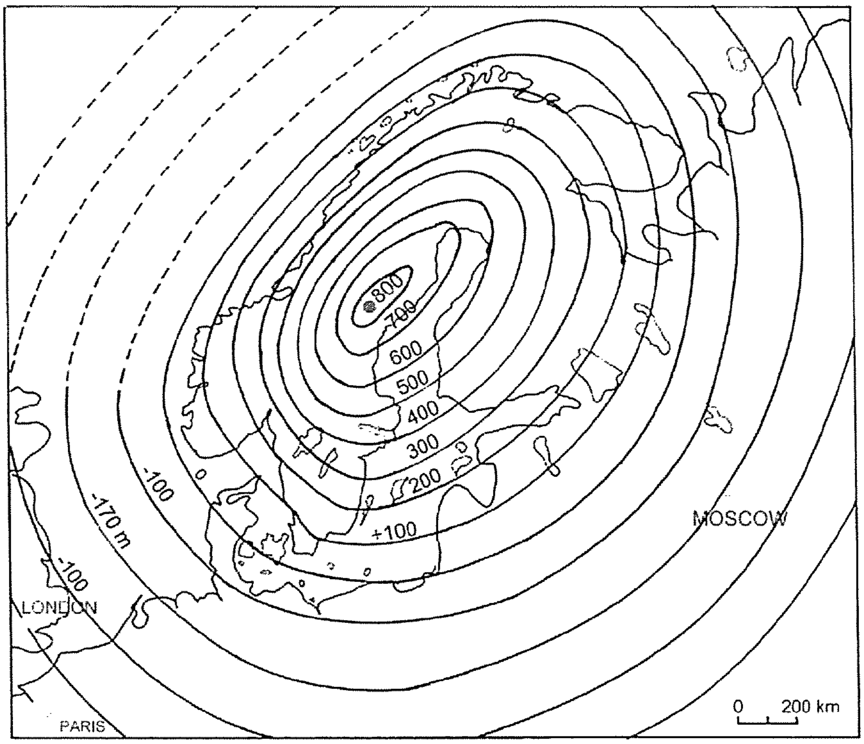



Figure 4. The amount of absolute postglacial uplift of the Fennoscandian shield (yellow), and the surrounding subsidence trough (blue); from Mörner [27] with later updating of the location of the center of uplift [13]. The mass in the uplift cone vs the mass in the subsidence trough is as 1:1 [27] [28].

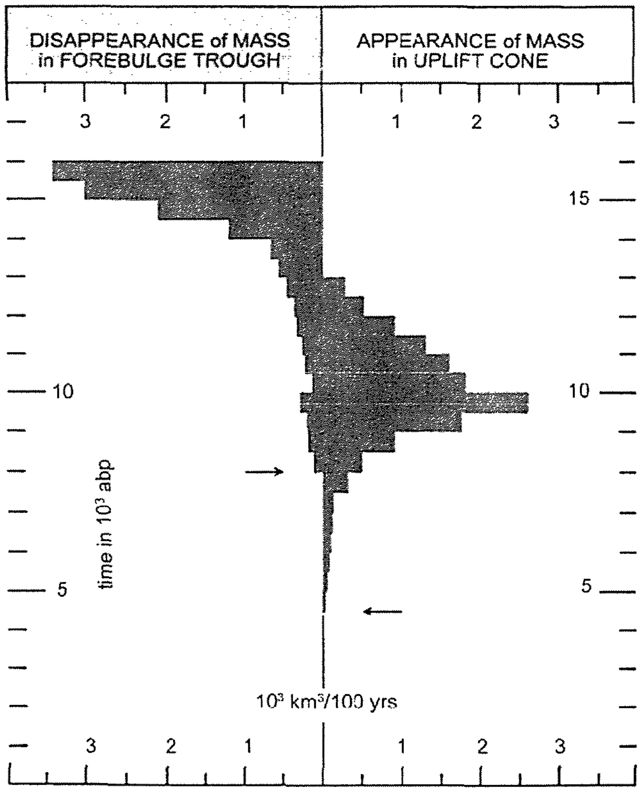



Figure 5. Mass transfer (red) from the subsidence trough to the uplift cone for every 500 years (from [4]). Arrows indicate end of mass disappearance and appearance. This diagram provides conclusive evidence of a horizontal flow of mass (*i.e.* a low viscosity channel flow) as a function of the process of glacial isostasy of NW Europe.

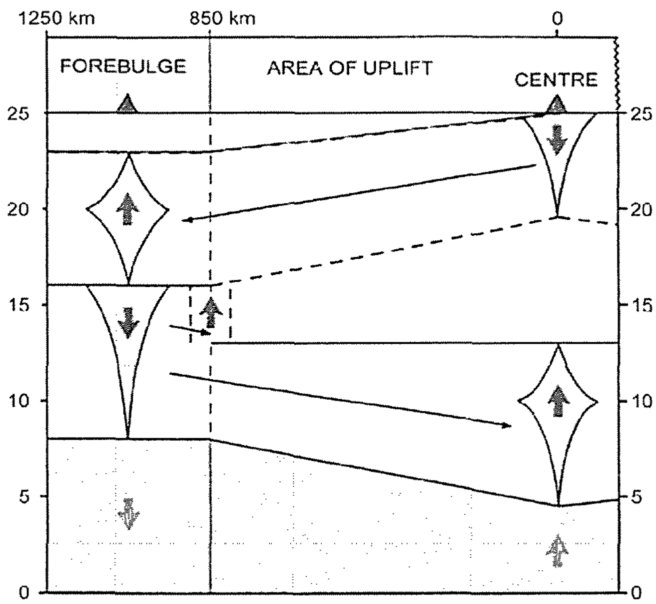



Figure 6. Uplift (yellow) and subsidence (blue), appearance/disappearance of mass (increasing/decreasing funnels) and mass transfer (thin arrow) between the area of uplift and the forebulge (from [13] [28]).

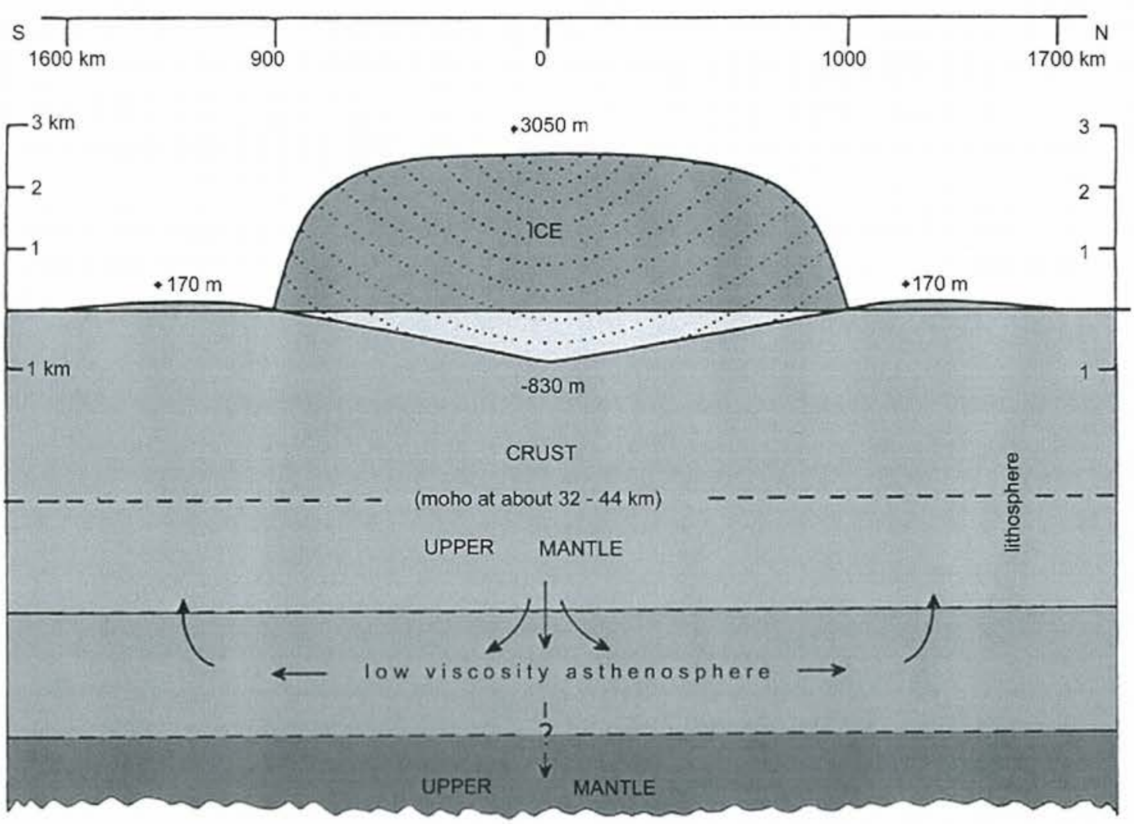



Figure 7. Model of glacial isostatic deformation [4] [27]. A 3 km thick ice cap deforms the crust. The down warping (peak value ~830 m) is compensated by horizontal mass flow in a low-viscosity asthenospheric channel. The lithospheric flexural rigidity is high (straight shorelines). The down warping (cone) is surrounded by a forebulge.

The typical glacial isostatic part of the uplift dies out with time and distance from the periphery [4] [27] [28]. Much of the uplift took part when ice still covered the land as illustrated in Figure 8. The rate of uplift reached remarkable rates at the time of free melting; estimated at 40 - 50 cm/yr at the centre of uplift [27] and later actually measured at about 30 cm/yr at a site 150 km south of the centre of uplift [13].

### 3.2. The Linear Uplift Factor

In the detailed sea level spectrum of the Swedish West coast and the Kattegatt Sea [26] it was not only possible to separate the isostatic and eustatic components [35], but also to identify the presence of two separate uplift mechanisms [34]. Converting the eustatically calibrated shorelines of the last 7000 radiocarbon years [26] into lines of rates of uplift and comparing these lines with the present rates of uplift from tide gauges and repeated levelling (Figure 9(a)), it became obvious [34] that the process of uplift, in facts, was composed of two different mechanisms; one typical glacial isostatic factor that exponentially died out with time and distance from the periphery, and one novel factor, responsible for the present uplift, that has remained linear for about 8000 years. This was later duplicated and verified for the Swedish east coast in a profile across the centre of uplift [37] as illustrated in Figure 9(b). At the centre of uplift the two factors are recorded as an exponentially decaying factor dying out 3500 - 4500 BP (A) and a linear factor commencing about 8000 BP (B) in Figure 8 [27] [28] [33].

The linear factor followed different rheological parameters with significantly higher viscosity and lower strain rates. It had a different centre of uplift, and an axis of tilting which has remained fixed in the Great Belt region for the last 8000 years [26] [34] [36]. It is likely to represent a sub-crustal phase boundary deformation [27] [28] [33] driven by pressure induced changes [33] [71] and/or the return from a strong vertical glacial isostatic overprinting back to long-term NW-SE compressional forces [59].

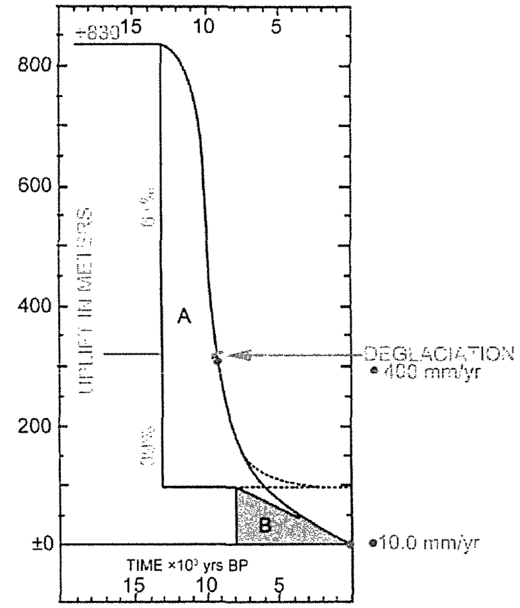



Figure 8. The glacial isostatic uplift of the Fennoscandian shield started in its central area at about 12.7-13.0 C14-ka BP [28]; not because of a thinning ice cap but because of a general change in geoid level [32]. The central area was deglaciated about 3700 years later (green mark). This implies that 61% of the uplift occurred before and only 39% after the deglaciation. The uplift is composed of two mechanisms (A and B) [4] [13] [27] [28] [33] [34].

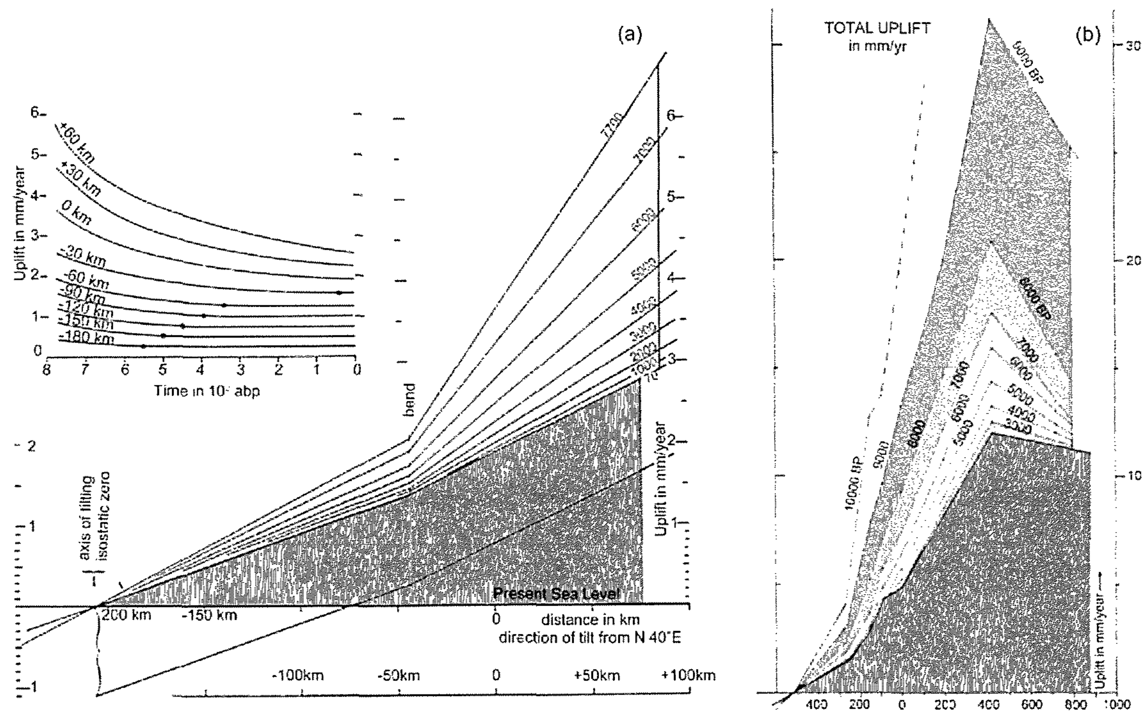



Figure 9. *A* (left): The West Coast profile [34] exhibiting an exponentially decaying uplift factor (yellow) and a linear factor (purple). The repeated levelling and tide gauge data (S-line) must be corrected by 1.1 mm/yr (= the eustatic component; E) to be compatible with the shoreline spectrum. *B* (*right*): The East Coast profile [37] exhibiting an exponentially decaying, typical glacial isostatic, factor (orange-yellow) and a strong linear factor (purple). The linear factor has kept its rate constant and the axis of tilting fixed for the last 8000 years.

### 3.3. Regional Glacial Isostasy of the Fennoscandian Ice Caps

The spectrum of elevated and tilted shorelines in Fennoscandia provides a excellent documentation of spatial and temporal mode of postglacial isostasy uplift [26] [27]. There seems to be a quite perfect balance between the uplift of the Fennoscandian uplift cone (Figure 4) and the subsidence of the surrounding subsidence trough (*i.e.* collapsing forebulge) as indicated by the horizontal mass motions documented in Figure 5, Figure 6, and developed into the model of glacial isostatic deformations of the Northwest European region (Figure 7). This implies a deformation adjusted by horizontal mass flow in a low-viscosity channel; *i.e.* a regional (not global) adjustment.

### 3.4. The Geodynamic Message from NW Europe

Consequently, the near-field observational data of a central uplift and a surrounding subsidence (Figure 7) provide records of a glacial isostatic deformation that was compensated regionally in Northwest Europe [4] [26] [27].

It was also found that 61% of the central uplift occurred subglacially before the final free melting (Figure 8). Furthermore, a second uplift mechanism commenced at around 8000 BP, and has remained lineal (*i.e.* constant) and with a fixed position of the axis of tilting for the last 8000 years [34] [37]. Uplift models not including these two additional facts [21] [22] are bound to fail.

## 4. Far Field Sea Level Changes

The global isostatic loading models [19]-[23] predict high Mid-Holocene sea levels in the Pacific and Indian Ocean. This does not concur with observational facts, either in the Indian Ocean or in the Pacific [16] [30]. The new sea level curve of the Maldives [38], exhibits a long term base-curve not above present sea level and a number of rapid oscillations caused by dynamic forces. In the Pacific, observed short and rapid fluctuations in sea level [39] [40] do not concur with the loading model but represent high-frequency dynamic sea surface changes. Grossman *et al.* [41] reconstructed the spatial distribution of Mid to Late Holocene sea level changes in the Pacific. Their reconstruction does not concur with the prediction from the global loading models, but with geoid deformation and/or changes in sea surface topography [30].

Therefore, one should be very careful in the application of model reconstruction and prediction based on proposed global loading mechanisms. This is, of course, especially true in an area like the Mediterranean dominated by tectonics and orogenic processes [16].

### Present Day Rates of Sea Level Changes

Present changes in sea level are primarily measured by coastal morphology, tide gauges, and satellite altimetry, but also by considering changes in the Earth's rate of rotation (LOD) and global gravity (GRACE).

In a few places, we know the long-term crustal component [34] [36] [42] [43], and are able to separate the absolute sea level component from the relative sea level recorded by tide gauges or other means. This is, for example the case with:

Stockholm: uplift 4.9, minus tide gauge 3.8 = eustasy 1.1 mm/yr [34] [42]

Korsör (the stable axis of tilting for 8000 years): uplift ±0.0, minus tide gauge 0.9 = eustasy 0.9 mm/yr [34] [36]

Cuxhaven: subsidence 1.4, minus tide gauge 2.5 = eustasy 1.1 mm/yr [36] [42]

Amsterdam: subsidence 0.4, minus tide gauge 1.6 = eustasy 1.2 mm/yr [34] [42] [67]

Brest: crustal component ~0.0, tide gauge 1.0 = eustasy ~1.0 mm/yr [34] [42]

Venice: subsidence 2.3, minus tide gauge 2.3 = eustasy ±0.0 mm/yr [42] [51]

Connecticut: subsidence 1.0, sea level rise 2.2 = eustasy 1.2 mm/yr [30] [43]

Figure 10 gives a histogram of the tide gage records used by University of Colorado [44] in their global sea level assessment [42]. The mean of 182 sites (excluding a few out-layers) scattered all over the globe is 1.6 mm/yr [30] [42]. Because of long-term subsidence of many river mouth sites and site-specific compaction problems [42], this value may, in fact, represent a slightly too high value. The key sites here discussed provide values of about 0.0 mm/yr, and the Kattegatt and North Sea records give firm values around 1.0 ± 0.1 mm/yr [36] [42].

This data set is in deep conflict with the high rates proposed by the IPCC [45] [46] and satellite altimetry [47]

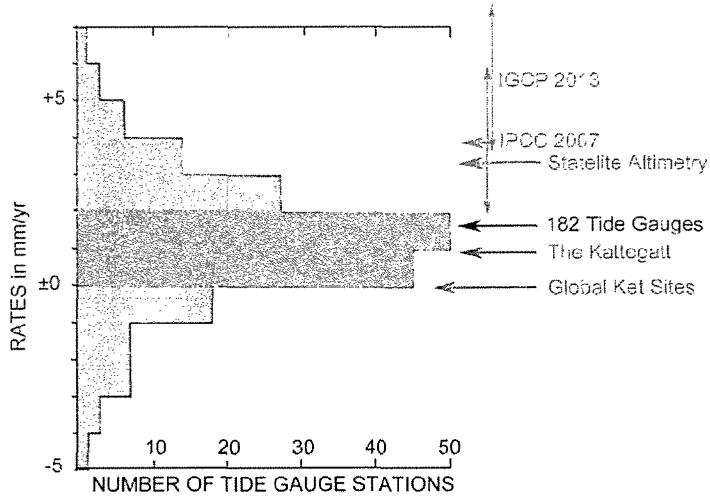



Figure 10. Spectrum of sea level rate estimates [30] [42]: observations at global key sites (±0.0), the Kattegatt (0.9), mean of 182 tide gauges (+1.6), satellite altimetry (+3.2) and IPCC model estimates. The big differences indicate errors and mistakes. The true global mean value has to be found within the zone from ±0.0 to +2.0 mm/y [42].

[48]. The differences in rates can only be understood in terms of errors and mistakes [30] [42]. The true mean global eustatic component is likely to be found in the zone ranging from +2.0 mm/yr to ±0.0 mm/yr, and most probably in the lower half of this zone; *i.e.* within 1.0 - 0.0 mm/yr [42]. The error was found to be in the satellite altimetry values for reasons of incorrect "corrections" [30].

Yes, something must be wrong (Figure 10), and we know what it is; viz. the corrections applied to the satellite altimetry records. After all my critics of these "corrections" [30] [36] [42] [49]-[55], neither specified nor backed up by established facts, the University of Colorado now for the first time admits that the record is "GIA corrected" [44] [48]; applied after 2011 and amounting only to 0.3 mm/yr, however [70].

In order to establish some harmony in the sea level records of Figure 10, we need to remove the global glacial isostatic (GIA) correction applied to the satellite records. In respect to the evidence of a regional (not global) glacial isostatic deformation of Fennoscandia and surrounding areas of northwest Europe (Figure 7), we must remove the whole idea of a global adjustment (Figure 2(a)).

Next question is which value we should subtract. This is not so easy, as this "correction" was not specified in the handling of satellite data. Peltier and Tushinghan [56] used a global GIA long-term sea level residual correction of 2.4 mm/yr, and Lambeck [22] a value of 1.8 mm/yr. Cazenave *et al.* [57] used a GIA correction of 2.0 mm/yr for their correction of the GRACE data of 2003-2008 with a pre-corrected trend of −0.12 ± 0.06 mm/yr. Hence, the different corrections range from 1.8 to 2.4 mm/yr.

A simple way of removing the "GIA" factor from the satellite altimetry records would be to subtract 1.8 to 2.4 mm/yr from the 3.3 mm/yr by University of Colorado [48] and from 2.9 mm/yr by NOAA [47]. In the first case, we obtain values ranging between 1.5 and 0.9 mm/yr. In the second case, we obtain values ranging between 1.1 and 0.5 mm/yr. This brings the satellite records down into the zone of likely global mean sea level changes of ±0.0 to +2.0 mm/yr [42], marked in dark orange in Figure 10.

The original satellite record did not exhibit any trend; just a variability around a zero value from 1992 to 2000 [50] [58]. This represents a measured sequence before corrections started to be applied; first a 2.3 mm/yr jump in 2003 and then an additional 0.8 mm/yr jump in 2008 [30]. If one would be able to identify the original, pre-correction, sequence in the present curves of NOAA [47] and University of Colorado [48], one might obtain a better holding on what value one actually need to subtract in order fully to remove the erroneous GIA corrections.

In Figure 11, I have tried to identify the pre-correction trend 1992-2000 in the satellite altimetry record of NOAA [47], and extend this trend over the entire period of recording up to 2015. I have also added the trend of GRACE [57] of −0.12 mm/yr for the period 2003-2008. It runs virtually parallel to the extended pre-correction

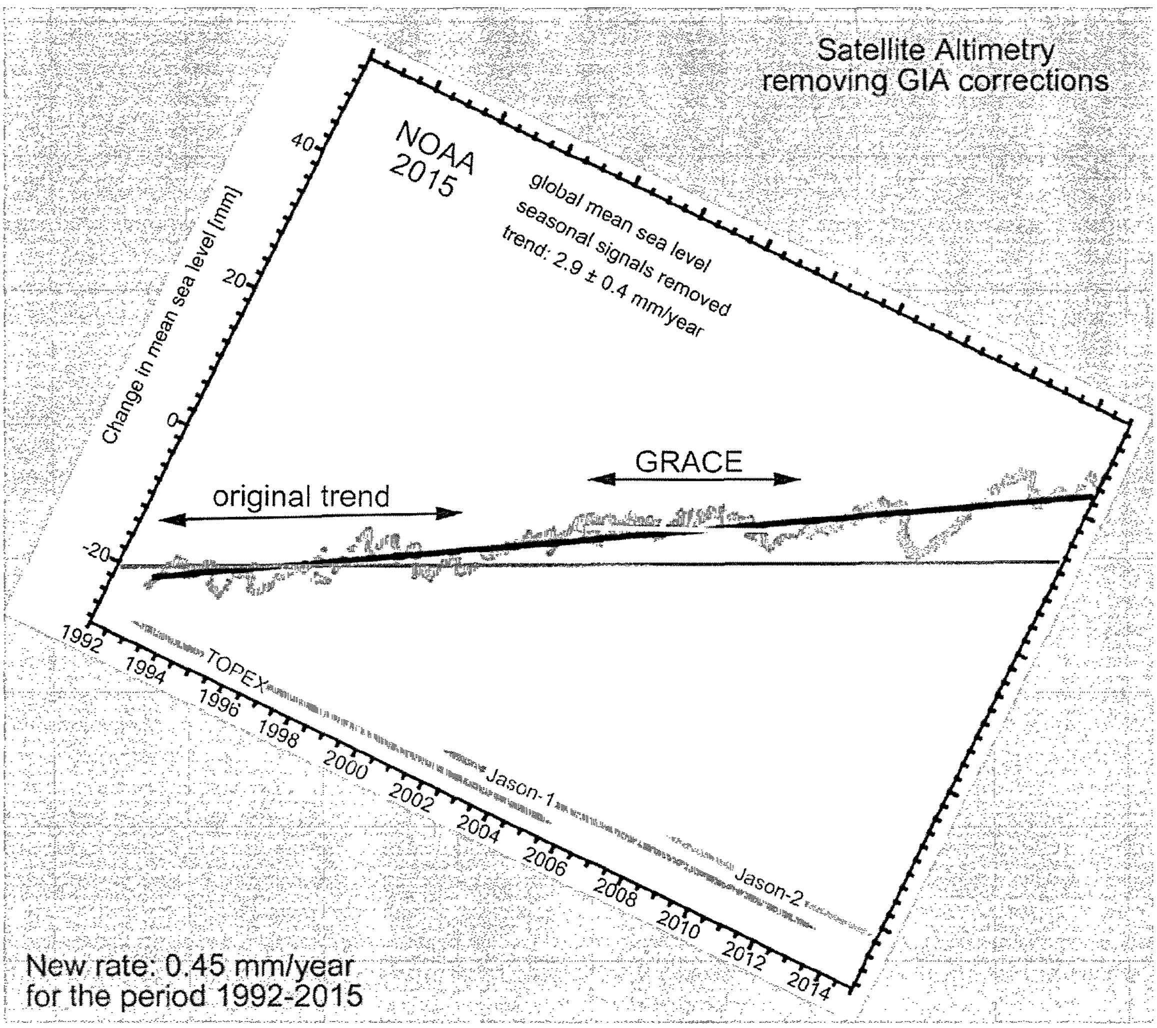



Figure 11. Removing the GIA correction from the NOAA record [47] gives a mean sea level rise of 0.45 mm/yr.

line. Then I tilted the whole graph into a horizontal position with respect to the extended pre-correction graph. I claim that this provides a good representation of the satellite altimetry record after removal of all erroneous "corrections". Now the remaining sea level trend is 0.45 mm/yr. This is in very good agreement with observational facts from tide gauges and coastal morphology from all over the globe [30] [36] [38] [42] [50] [51]. Furthermore, it is in full agreement with a previous conclusion [42] that the true global eustatic component most likely is to be found within the zone of ±0.0 to +1.0 mm/yr.

In Figure 12, the same thing has been done with the satellite altimetry record of University of Colorado [48]. When the GIA corrections are removed, the remaining curve gives a rise of 0.65 mm/yr, which implies good agreements with the Figure 10 data from tide gauges and global key sites [42].

## 5. Discussion and Conclusions

The mode of glacial isostatic deformation of the Fennoscandian shield [4] [13] [26]-[28] [33] indicates—beyond doubts—that the deformation took place via horizontal mass-flow in a low-viscosity channel. This implies a glacial isostatic deformation, which is fully compensated on the regional scale (*i.e.* model B of Figure 2). There remains no reason to advocate forces penetrating the globe and giving rise to global glacial adjustments of coasts and seafloors all around the globe (model A in Figure 2).

The relative sea level records in Sweden (*i.e.* the spectrum of dated synchronous shorelines recorded over

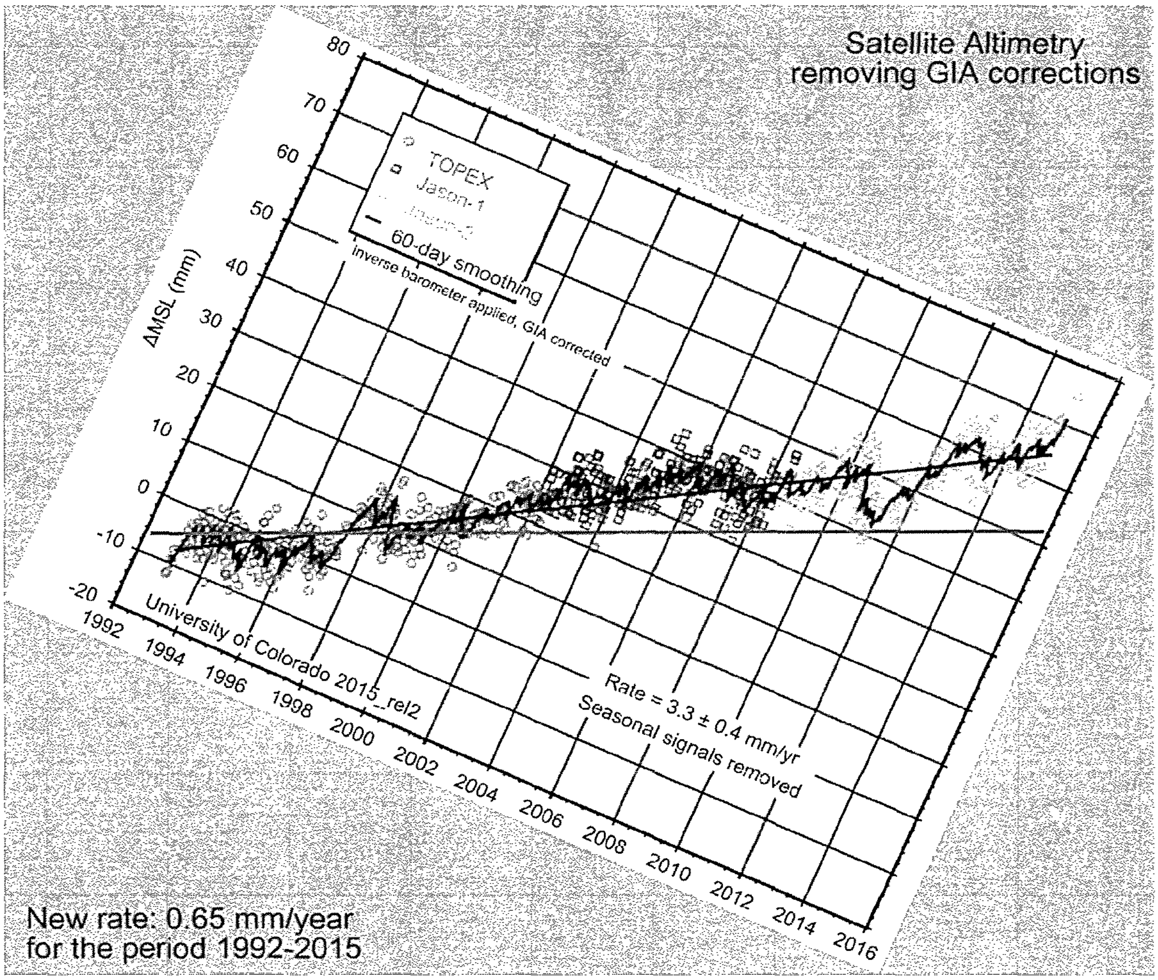



Figure 12. Removing the GIA correction from the UC record [45] gives a mean sea level rise of 0.65 mm/yr.

hundreds of kilometers and transferred in local shore level displacement curves) were successfully split up in their components of absolute glacial isostatic crustal movements and absolute eustatic sea level changes [26] [35]. The isostatic component gave fundamental information on rheological parameters [4] [27] [28] [33] and neotectonics [13] [59] [68]. The eustatic component allowed for global comparisons [26] [35] leading to the new concepts of eustasy [60] [61], the geoid theory [11], theory of differential rotation [10] [62] [63], and well-founded views on the perspectives of future sea level changes [30] [42] [50] [67].

The rheological parameters recoded as well as the global sea level data indicate that is high time to abandon the hypothesis of a global internal response to glacial loading (Figure 2(a)).

The above-mentioned relations between relative sea level observations and resulting scientific outcome is illustrated in Figure 13 from [13].

Recent investigation of the rheological character of the upper mantle record the presence of a low-viscosity zone [64] [65] is in full agreement with the Figure 7 model (*i.e.* model B of Figure 2). So, even rheological data from outside northwestern Europe are in agreement with the presence of a low-viscosity channel contradicting a linear viscosity profile as required for global transfer of glacial isostatic loading (model A of Figure 2). This supports an abandoning of the globally isostatic loading model, in favour of a regional glacial isostatic model.

The second test of the models [16] refers to the far-field sea level data (section 4, above). Observational facts in favour of a global isostatic loading model are lacking. It seems significant that Houston and Dean [66] comparing GIA predictions [23] and actual tide gauge records at 147 far-field sites found "remarkably little correlation".

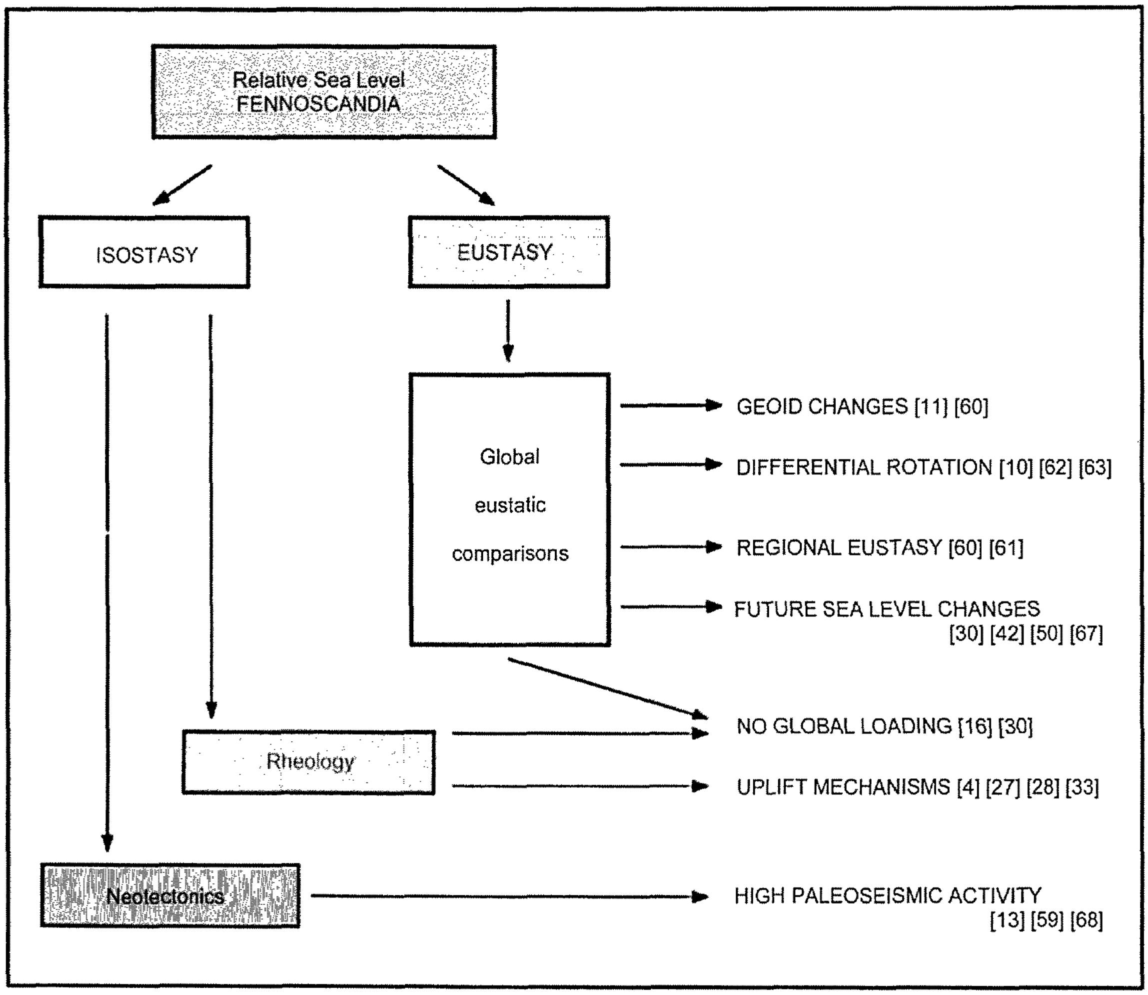



Figure 13. Separation of isostasy and eustasy from observed relative sea level changes in Fennoscandia [26] [35] and its theoretical implications for a number of fundamental questions (updated from [13]).

The satellite altimetry records [47] [48] are claimed [70] to be "a proxy for ocean water volume changes", but behind the curves are unspecified "corrections" hidden, applied by NOAA [47] and CU [48] in order to obtain the product they personally assumed to be the correct "proxy of ocean water volume changes". There is a major problem, however: their satellite altimetry records differ by 100% to 800% from observed tide gauge measurements (Figure 10).

With the removal of GIA corrections (the basic long-term residual factor of 2.3 mm/yr as well as later additional corrections) from the satellite altimetry data (Figure 11 and Figure 12), we finally obtain agreements among global tide gauge data, costal morphology data and satellite altimetry data; all agreeing on a mean global eustatic sea level factor somewhere within the zone ±0.0 to +1.0 mm/yr. This is illustrated in Figure 14. The only data set which hangs far above the others is the IPCC predictions. Those data, however, refer to assumptions and model out-puts, and are, by no means, anchored in observational facts.

The final and general conclusion of this paper is firm and says: it is high time to abandon the idea of global isostatic adjustment, and to stop all kinds of GIA corrections of records of sea level changes (*i.e.* satellite altimetry, GRACE, tide gauges, etc.).

## Acknowledgements

At the IUGG meeting in 1975 in Grenoble, France, the organization committee of the Geodynamics Project

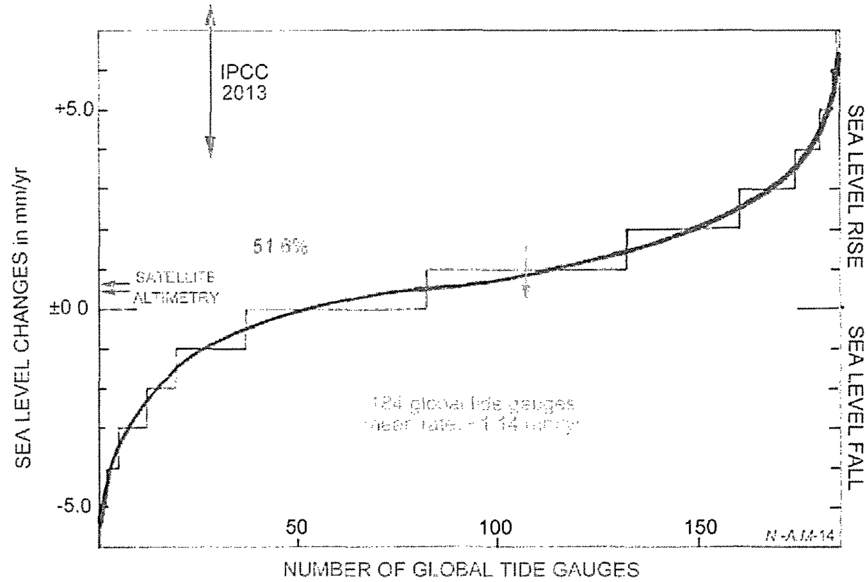



Figure 14. The new spectrum of sea level changes after removal of erroneous "corrections" applied to the satellite altimetry records [47] [48]. Yellow zone gives the peak values of recorded tide gauge rates. Blue arrow indicates that several of those sites refer to subsiding sites overestimating the eustatic factor [30] [50] [59]. Now the different records of sea level changes (*i.e.* tide gauges, coastal morphology and satellite altimetry) give a congruent picture of a mean global sea level rise within the zone ranging from ±0.0 to +1.0 mm/yr (cf. Figure 10); only the IPCC estimates hanging above "in the air".

asked me to arrange a meeting and excursion on the Fennoscandian uplift and related topics in 1977. The proceedings of this meeting became the benchmark book on "Earth Rheology, Isostasy and Eustasy" (Mörner, ed., Wiley & Sons, 1980). The work continued at the unit of Paleogeophysics & Geodynamics at Stockholm University, visited by numerous scientists and the organizer of major international excursions on uplift, neotectonics and Paleoseismicity (1999, 2008). I am indebted to two excellent reviews.

## References

[1] Jamieson, T.F. (1865) On the History of the Last Geological Changes in Scotland. *Journal of the Geological Society London*, **21**, 161-204. http://dx.doi.org/10.1144/GSL.JGS.1865.021.01-02.24

[2] Jamieson, T.F. (1882) On the Cause of the Depression and Re-Elevation of the Land during the Glacial Period. *Geological Magazine* (*Decade II*), **9**, 400-407.

[3] De Geer, G. (1888) Om Skandinaviens nivåförändringar under Quartärperioden. *Geologiska Föreningens i Stockholm Förhandlingar*, **10**, 366-379 (1888) &**12**, 61-110 (1890).

[4] Mörner, N.-A. (1979) The Fennoscandian Uplift and Late Cenozoic Geodynamics: Geological Evidence. *GeoJournal*, **3**, 287-318.

[5] de Charpentier, J. (1835) Notice sur la cause probable du transport des blocs erratiques de la Suisse. Chez Carilian-Goeury, Paris. *Annales des mines*, 3me ser.

[6] Hitchcock, E. (1841) First Anniversary Address before the Association of American Geologists. *American Journal of Science*, **41**, 232-275.

[7] Torell, O. (1872) Undersökningar öfver istiden. I & II. *Öfversigt Kongliga Svenska Vetenskapsakademiens Förhandlingar*, **10**, 25-66.

[8] Maclaren, C. (1841) The Glacial Theory of Professor Agassiz of Neuchatel. The Scotsman Office, Edinburgh. (also: *American Journal of Science*, **42**, 346-365, 1842).

[9] Daly, R.A. (1910) Pleistocene Glaciation and the coral Reef Problem. *American Journal of Science*, **30**, 297-308. http://dx.doi.org/10.2475/ajs.s4-30.179.297

[10] Mörner, N.-A. (1995) Earth Rotation, Ocean Circulation and Paleoclimate. *GeoJournal*, **37**, 419-430.

http://dx.doi.org/10.1007/BF00806932

[11] Mörner, N.-A. (1976) Eustasy and Geoid Changes. *Journal of Geology*, **84**, 123-151. http://dx.doi.org/10.1086/628184

[12] Imbrie, J. and Imbrie, K.P. (1986) Ice Ages. Solving the Mystery. Harvard University Press, Cambridge, 224 p.

[13] Mörner, N.-A. (2003) Paleoseismicity of Sweden—A Novel Paradigm. *Proceedings of the 16th International INQUA Congress*, Reno, 23-30 July 2003, 1-320.

[14] Bloom, A.L. (1967) Pleistocene Shorelines: A New Test of Isostasy. *Geological Society of America Bulletin*, **78**, 1477-1498. http://dx.doi.org/10.1130/0016-7606(1967)78[1477:PSANTO]2.0.CO;2

[15] Walcott, R.I. (1972) Past Sea Levels, Eustasy and Deformation of the Earth. *Quaternary Research*, **2**, 1-14. http://dx.doi.org/10.1016/0033-5894(72)90001-4

[16] Mörner, N.-A. (2005) Sea Level Changes and Crustal Movements with Special Reference to the East Mediterranean. *Zeitschrift für Geomorphologie*, **137**, 91-102.

[17] O'Connell, R.J. (1971) Pleistocene Glaciation and the Viscosity of the Lower Mantle. *Geophysical Journal International*, **23**, 299-327. http://dx.doi.org/10.1111/j.1365-246X.1971.tb01823.x

[18] Cathles, L.M. (1975) The Viscosity of the Earth's Mantle. Princeton University Press, Princeton, 386 p.

[19] Peltier, W.R. (1976) Glacial-Isostatic Adjustment-I. The Forward Problem. *Geophysical Journal of the Royal Astronomical Society*, **46**, 605-646. http://dx.doi.org/10.1111/j.1365-246X.1976.tb01251.x

[20] Clark, J.A. (1980) A Numerical Model of Worldwide Sea Level Changes on a Viscoelastic Earth. In: Mörner, N.-A., Ed., *Earth Rheology, Isostasy and Eustasy*, John Wiley & Sons, London, 525-534.

[21] Peltier, W.R. (1998) Postglacial Variations in the Level of the Sea: Implications for Climate Dynamics and Solid-Earth Geophysics. *Reviews of Geophysics*, **36**, 603-689. http://dx.doi.org/10.1029/98RG02638

[22] Lambeck, C. (1998) On the Choice of Timescale in Glacial Rebound Modelling: Mantle Viscosity Estimates and the Radiocarbon Timescale. *Geophysical Journal International*, **134**, 647-651. http://dx.doi.org/10.1046/j.1365-246x.1998.00597.x

[23] Peltier, W.R. (2004) Global Glacial Isostasy and the Surface of the Ice-Age Earth: The ICE-5G (VM2) Model and GRACE. *Annual Review of Earth and Planetary Sciences*, **32**, 111-149. http://dx.doi.org/10.1146/annurev.earth.32.082503.144359

[24] Nansen, F. (1928) The Earth's Crust, Its Surface Forms and Isostatic Adjustment. *Norske Videnskabs-Akademi i Oslo, Matematikk og Naturvidenskap*, **12**, 1-122.

[25] van Bemmelen, R.W. and Berlage, H.P. (1935) Versuch einer mathematischen Behandlung geotektonischer Bewegungen unter besonderer Berücksichtigung der Undattionteorie. *Gerlands Beiträge Geophysik*, **43**, 19-55.

[26] Mörner, N.-A. (1969) The Late Quaternary History of the Kattegatt Sea and the Swedish West Coast: Deglaciation, Shore-Level Displacement, Chronology, Isostasy and Eustasy. *Sveriges Geologiska Undersökning*, **C460**, 1-487.

[27] Mörner, N.-A. (1980) The Fennoscandian Uplift: Geological Data and Their Geodynamical Implication. In: Mörner, N.-A., Ed., *Earth Rheology, Isostasy and Eustasy*, John Wiley & Sons, London, 251-284.

[28] Mörner, N.-A. (1991) Course and Origin of the Fennoscandian Uplift: The Case for Two Separate Mechanisms. *Terra Nova*, **3**, 408-413. http://dx.doi.org/10.1111/j.1365-3121.1991.tb00170.x

[29] Fjeldskaar, W. and Cathles, L. (1991) The Present Rate of Uplift of Fennoscandia Implies a Low-Viscosity Asthenosphere, *Terra Nova*, **3**, 393-400. http://dx.doi.org/10.1111/j.1365-3121.1991.tb00168.x

[30] Mörner, N.-A. (2013) Sea Level Changes: Past Records and Future Expectations. *Energy & Environment*, **24**, 509-536. http://dx.doi.org/10.1260/0958-305X.24.3-4.509

[31] Mörner, N.-A. (1977) The Fennoscandian Uplift: Geological Data and Their Geodynamical Implications. *Proceedings of the Symposium on Earth Rheology and Late Cenozoic Isostatic Movements*, Stockholm, 31 July-8 August 1977, 79-92.

[32] Mörner, N.-A. (2015) Chapter 7: The Bölling/Alleröd—Younger Dryas Oscillations. In: Mörner, N.-A., Ed., *Planetary Influence on the Sun and the Earth and a Modern Book-Burning*, Noca Science Publishers, Hauppauge, 79-89.

[33] Mörner, N.-A. (1990) Glacial Isostasy and Long-Term Crustal Movements in Fennoscandia with Respect to Lithospheric and Asthenospheric Processes and Properties. *Tectonophysics*, **176**, 13-24. http://dx.doi.org/10.1016/0040-1951(90)90256-8

[34] Mörner, N.-A. (1973) Eustatic Changes during the Last 300 Years. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **13**, 1-14. http://dx.doi.org/10.1016/0031-0182(73)90046-1

[35] Mörner, N.-A. (1971) Eustatic Changes during the Last 20,000 Years and a Method of Separating the Isostatic and Eustatic Factors in an Uplifted Area. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **9**, 153-181.

http://dx.doi.org/10.1016/0031-0182(71)90030-7

[36] Mörner, N.-A. (2015) Deriving the Eustatic Sea Level Component in the Kattegatt Sea. *Global Perspectives on Geography*, **2**, 16-21.

[37] Mörner, N.-A. (1977) Past and Present Uplift in Sweden: Glacial Isostasy, Tectonism and Bedrock Influence. *Geologiska Foereningan i Stockholm. Foerhandlingar*, **99**, 48-54. http://dx.doi.org/10.1080/11035897709454988

[38] Mörner, N.-A. (2007) Sea Level Changes and Tsunamis. Environmental Stress and Migration over the Seas. *Internationales Asienforum*, **38**, 353-374.

[39] Pirazzoli, P.A., Montaggioni, L.F., Salvat, B. and Faure, G. (1988) Late Holocene Sea Level Indicators from Twelve Atolls in the Central and Eastern Tuamotus (Pacific Ocean). *Coral Reefs*, **7**, 57-68. http://dx.doi.org/10.1007/BF00301642

[40] Nunn, P. (1995) Holocene Sea-Level Changes in the South and West Pacific. *Journal of Coastal Research*, **SI17**, 311-319.

[41] Grossman, E.E., Fletcher, C.H. and Richmond, B.M. (1998) The Holocene Sea-Level Highstand in the Equatorial Pacific: Analysis of the Insular Paleosea-Level Database. *Coral Reefs*, **17**, 309-327. http://dx.doi.org/10.1007/s003380050132

[42] Mörner, N.-A. (2014) Sea Level Changes in the 19-20th and 21st Centuries. *Coordinates*, **X:10**, 15-21

[43] Mörner, N.-A. (2014) An Insult to Geology and Sea Level Research. http://joannenova.com.au/2014/10/modern-seas-unprecedented-an-insult-to-geology-and-sea-level-research/

[44] UC, University of Colorado (2013) Sea Level Research Group of University of Colorado. http://sealevel.colorado.edu/

[45] IPCC (2007) Fourth Assessment Report. The Intergovernmental Panel of Climate Change.

[46] IPCC (2013) Fifth Assessment Report. The Intergovernmental Panel of Climate Change.

[47] NOAA (2014) Laboratory for Satellite Altimetry/Sea Level Rise. http://www.star.nesdis.noaa.gov/sod/lsa/SeaLevelRise/

[48] UC, University of Colorado (2015) Sea Level Research Group of University of Colorado. http://sealevel.colorado.edu/

[49] Mörner, N.-A. (2010) There Is No Alarming Sea Level Rise. *21st Century Science & Technology*, **Winter 2010/2011**, 12-22.

[50] Mörner, N.-A. (2004) Estimating Future Sea Level Changes. *Global and Planetary Change*, **40**, 49-54. http://dx.doi.org/10.1016/S0921-8181(03)00097-3

[51] Mörner, N.-A. (2007) The Greatest Lie Ever Told. P&G-Print, Stockholm, 20 p. (2nd Edition 2009, 3rd Edition 2010)

[52] Mörner, N.-A. (2008) Comments. *Global and Planetary Change*, **62**, 219-220. http://dx.doi.org/10.1016/j.gloplacha.2008.03.002

[53] Mörner, N.-A. (2011) Chapter 6: Setting the Frames of Expected Future Sea Level Changes by Exploring Past Geological Sea Level Records. In: Easterbrook, D.J., Ed., *Evidence-Based Climate Science*, Elsevier, Amsterdam, 185-196. http://dx.doi.org/10.1016/b978-0-12-385956-3.10006-3

[54] Mörner, N.-A. (2011) Chapter 7: The Maldives as a Measure of Sea Level and Sea Level Ethics. In: Easterbrook, D.J., Ed., *Evidence-Based Climate Science*, Elsevier, Amsterdam, 197-209.

[55] Mörner, N.-A. (2012) Sea Level Is Not Rising. SPPI Reprint Series, December 6, 2012, 7-25.

[56] Peltier, W.R. and Tushinghan, A.M. (1989) Global Sea Level Rise and the Greenhouse Effect: Might There Be a Connection? *Science*, **244**, 806-810. http://dx.doi.org/10.1126/science.244.4906.806

[57] Cazenave, A., Dominh, K., Guinehut, S., Berthier, E., Llovel, W., Rammien, G., Ablain, M. and Larnicol, G. (2009) Sea Level Budget over 2003-2008: A Reevaluationfrom GRACE Space Gravimetry, Satellite Altimetry and Argo. *Global Planetary Change*, **65**, 83-88. http://dx.doi.org/10.1016/j.gloplacha.2008.10.004

[58] MEDIAS (2000) Satellite-Based Altimetry Reveals Physical Ocean. *Medias Newsletter*, **12**, 9-17.

[59] Mörner, N.-A. (1991) Intense Earthquakes and Seismotectonics as a Function of Glacial Isostasy. *Tectonophysics*, **188**, 407-410. http://dx.doi.org/10.1016/0040-1951(91)90471-4

[60] Mörner, N.-A. (1986) The Concept of Eustasy: A Redefinition. *Journal of Coastal Research*, **S1**, 49-51.

[61] Mörner, N.-A. (1980) The Northwest European "Sea-Level Laboratory" and Regional Holocene Eustasy. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **29**, 181-300.

[62] Mörner, N.-A. (1988) Terrestrial Variations within Given Energy, Mass and Momentum: Paleoclimate, Sea Level, Paleomagnetism, Differential Rotation and Geodynamics. In: Stephenson, F.R. and Wolfendale, A.W., Eds., *Secular Solar and Geomagnetic Variations in the Last* 10,000 *Years*, Kluwer Academic Publishers, Dordrecht, 455-478. http://dx.doi.org/10.1007/978-94-009-3011-7_29

[63] Mörner, N.-A. (2015) Multiple Planetary Influences on the Earth. In: Mörner, N.-A., Ed., *Planetary Influence on the Sun and the Earth, and a Modern Book-Burning*, Nova Science Publishers, Hauppauge, 39-49.

[64] Karato, S. (2012) On the Origin of the Asthenosphere. *Earth and Planetary Science Letters*, **321-322**, 95-103. http://dx.doi.org/10.1016/j.epsl.2012.01.001

[65] Naif, S., Key, K., Constable, S. and Evans, R.L. (2013) Melt-Rich Channel Observed at the Lithosphere-Asthenosphere Boundary. *Nature*, **495**, 356-359. http://dx.doi.org/10.1038/nature11939

[66] Houston, J.R. and Dean, R.G. (2012) Comparisons at Tide-Gauge Locations of Glacial Isostatic Adjustment Predictions with Global Positioning System Measurements. *Journal of Coastal Research*, **28**, 739-744. http://dx.doi.org/10.2112/JCOASTRES-D-11-00227.1

[67] Mörner, N.-A. (1996) Sea Level Variability. *Zeitschrift für Geomorphologie*, **102**, 223-232.

[68] Mörner, N.-A. (2013) Patterns in Seismology and Palaeoseismology, and Their Application in Long-Term Hazard Assessments—The Swedish Case in View of Nuclear Waste Management. *Pattern Recognition in Physics*, **1**, 75-89. http://dx.doi.org/10.5194/prp-1-75-2013

[69] Mörner, N.-A. (2010) Some Problems in the Reconstruction of Mean Sea Level and Its Changes with Time. *Quaternary International*, **221**, 3-8. http://dx.doi.org/10.1016/j.quaint.2009.10.044

[70] CU Sea Level Research Group. http://sealevel.colorado.edu/faq#n3113

[71] Broecker, W.S. (1962.) The Contribution of Pressure-Induced Phase Changes to Glacial Rebound. *Journal of Geophysical Research*, **67**, 4837-4842. http://dx.doi.org/10.1029/JZ067i012p04837

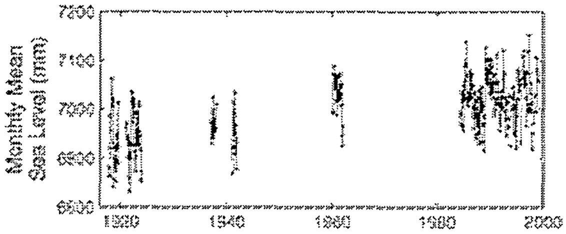
# NZCLIMATE TRUTH NEWSLETTER NO 285
# FEBRUARY 9TH 2012

## NEW ZEALAND SEA LEVEL

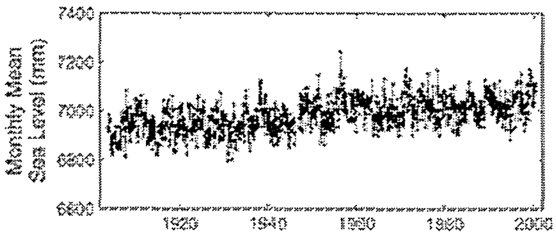
The official figures of the sea level in New Zealand are freely available from the website of the Permanent Service for Mean Sea Level (PSMSL) at

http://www.psmsl.org/data/obtaining/
These are their records for New Zealand

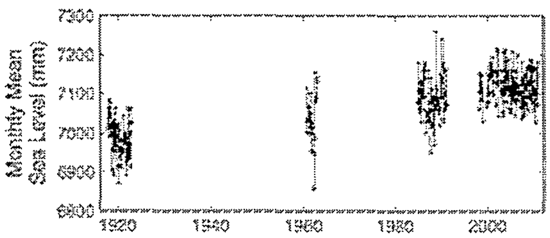
**AUCKLAND : WAITEMATA HARBOUR**



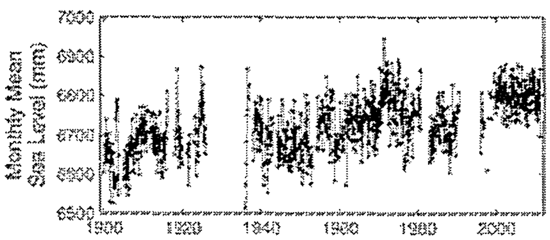

AucklandII



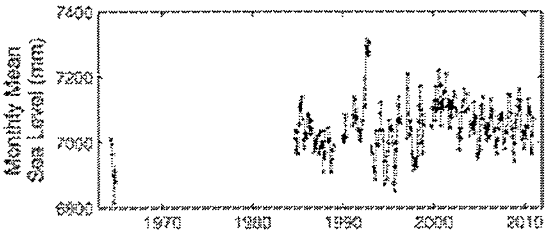

Bluff



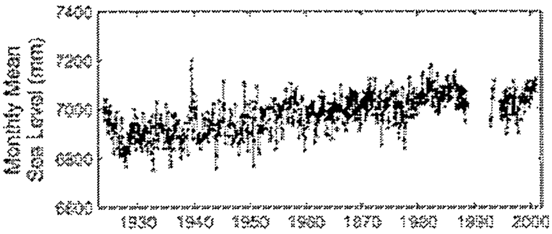

DunedinII



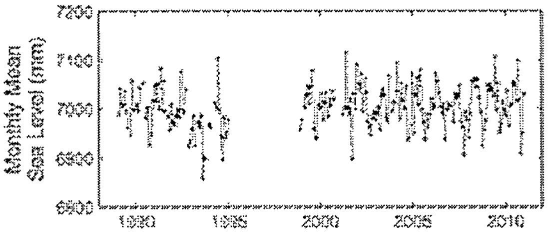

Whangerai



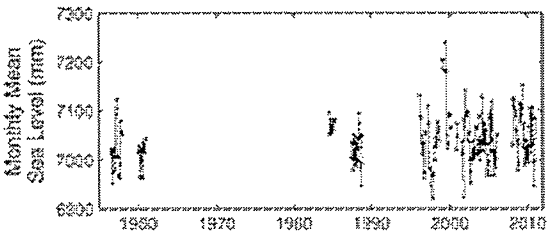

Lytteltonll



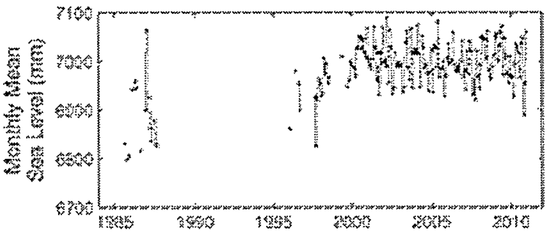

Napier



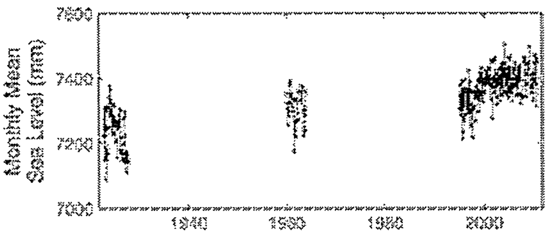

Nelson



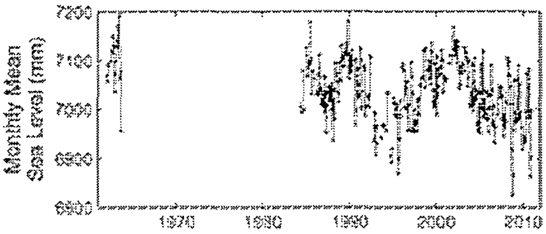

Port Chalmers



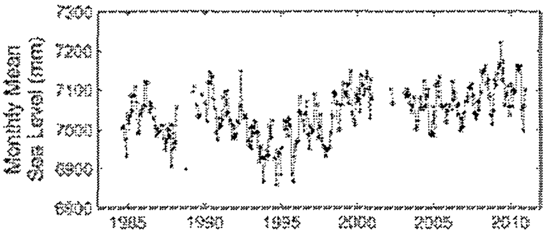

Port Lyttelton



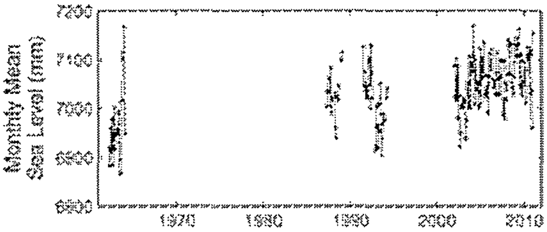

Port Taranaki



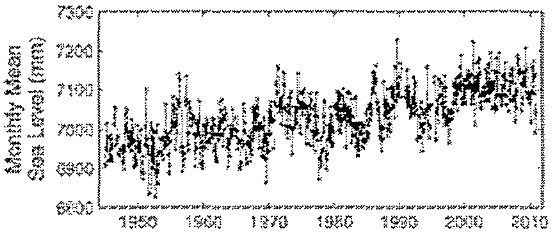

Tauranga



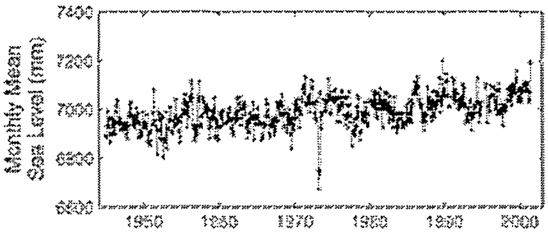

Timaru Harbour




Wellington Harbour




WellingtonII




These figures are concealed by the IPCC and by all of the official "experts" and "peer reviewed" articles in learned journals. where the results are subjected to varous mathematical tricks to try and claim that the figures support the claim by the global warming scientists that the sea level is rising. They have foisted this attitude on local authorities in New Zealand in order to persuade them to take urgent measures to prepare for their predicted disaster to their communities.

The favourite mathematical device is linear regression, a procedure that ignores variability and emophasizes the importance of the earlier, less reliable measurements. Sea level equipment is prone to damege from constant battering by the sea particularly by severe storms, which even cause false wrong low readings. Some harbourmasters take measures to increase the level within a harbour to take larger ships. All the earlier readings thus tend to have a negative bias. The use of GPS levelling equipment plus more sophisticated equipment have tended to reduce this bias, so that the most reliable readings for deciding a future trend are the most recent ones, not the earlier ones

In most cases these recent figures show no evidence of a change in sea level anywhere in New Zealand. They should be used as a guide to future b behaviour instead of reliance on untested climate models

Cheers

Vincent Gray
75 Silverstream Road
Crofton Downs
Wellington 6035
Phone/Fax 064 4 9735939
"To kill an error is as good a service
as, and sometimes better than, the
establishing of a new truth or fact"
Charles Darwin"

# Submission re DCC Hazard Plan.

by

**Peter Foster**
61 Whites Rd
Merton
R.D. 1
Waikouaiti
1st September 2014

Firstly let me say that development of a hazard plan is eminently sensible. Well done for that.

However, such a plan has to be based on actual data or projections of actual data. The sea level rises projected by the IPCC, via NIWA, Blair Fitzharris etc, are not.

This submission concerns the use of IPCC values to determine the area that might be affected by sea level rise. It shows that there is no scientific validity for any sea level projection greater than 0.2 m (plus a possible safety margin) in the next 100 years.

Councillors and Council staff need to consider how history in a few years time will look back on those that adopted a 1m+ sea level rise, reduced the value of thousands of properties, imposed needless restrictions on building in the area and wasted more money on sea level protection programmes when as with their last prediction, no significant rise actually occurs.

You will not be able to say you took best advice, you did not, you confused science with politics and based your decision on a hypothesis that had already repeatedly failed the most fundamental tenet of science - that the projections of a hypothesis must agree with observation.

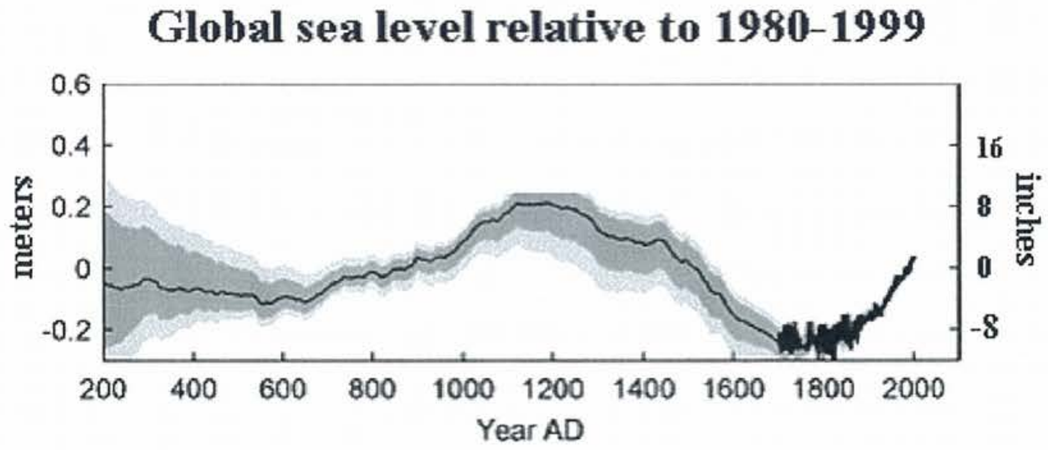
## Introduction

Projections by scientists traditionally take known data from the past and extrapolate trends or patterns of that data into the future. On over a century of data, the Otago Harbour tide gauge shows an increase in sea level of 128mm/century (MSc Thesis of Theresa Cole 2010). NZ wide, that value is 170 mm/century and globally 190mm/century.

**No research based on actual data shows any acceleration of that rate.**

* Theresa Cole MSc thesis Otago University;
* J. R. Houston and R. G. Dean (2011) Sea-Level Acceleration Based on U.S. Tide Gauges and Extensions of Previous Global-Gauge Analyses. Journal of Coastal Research: Volume 27, Issue 3: pp. 409 – 417. http://www.jcronline.org/doi/abs/10.2112/JCOASTRES-D-10-00157.1
* Cazenave et al - Nature Climate Change 4, 358–361 (2014) doi:10.1038/nclimate2159 A paper titled "The rate of sea-level rise" published in26th August 2014 Nature Climate Change on March 23 by Cazenave, et al. shows that *during the last decade the rate of sea level rise has declined by about 30% during the period 2003 through 2011 to about 2.4 mm/year from the rate of 3.4 mm/year in the period 1992 through 2002.* http://www.nature.com/nclimate/journal/v4/n5/full/nclimate2159.html

Those values would give a sea level rise of 100 to 200 mm by 2100. A rate so slow that no action need be taken for decades, if at all, and certainly no action is needed by the present council. Imposed on that historic sea level rise are the changes associated with longer term cycles of climate change, namely the 60 and 1000 year cycles. The 60 year cycle will have two cooling phases in the next 90 years. In addition it appears that the 1000 year cycle is entering a cooling phase which can be expected to cause a reduction in sea levels, as happened post 1200 AD.




Graph shows sea levels responding to the 1000 year cycle of natural climate change.
The Medieval Warm Period and the Little Ice Age clearly visible.

On the other hand the sea level rise used in the DCC Hazard report and ORC reports, comes from; Government agencies, NIWA, and the report by Blair Fitzharris. **All of these** stem from the IPCC climate models or NIWA's variations thereof.

They are NOT based on tide gauge or satellite altimetry or historic changes to sea levels but on theoretical calculations based on the hypothesis that climate change is driven by CO2. According to this hypothesis global temperature is inextricably linked to atmospheric CO2 and as that goes up so will ocean temperatures and sea levels (sea level rise comes from thermal expansion of water as it warms)
How extreme those predictions are depends on the **assumed** sensitivity of the climate to CO2.
(climate sensitivity is the temperature rise expected from a doubling of CO2)

**IPCC projections are NOT based on tide gauge or satellite altimetry.**

**They are theoretical calculations based on CO2 being the driver of climate change. They involve many unproven assumptions.**

This submission will show conclusively that;

a) the IPCC admits it has no idea whether the climate sensitivity is positive or negative
b) the IPCC states that climate is chaotic and no predictions are possible
c) The values used are based on IPCC AR4, not on the latest AR5 report.
d) the IPCC values used by the DCC are historically so extreme as to be ludicrous.
e) past and present predictions by the IPCC, based on its models, have failed
f) the IPCC is a political body, that uses climate change as a means to gain political objectives.
g) The 97% - a failure to discern fact from fiction

**For all of the above reasons the value of sea level rise used by the DCC has no scientific validity whatsoever.**

**Many fail to understand the difference between projections of a hypothesis and evidence from actual measurements collected from instruments on or above the Earth**

Many claims by bureaucrats and scientists stem from the failure to understand the difference between the projections of a hypothesis and actual measurements collected from instruments on or above the Earth. The former depends on the validity of both the hypothesis and the assumptions used in its calculation. The latter, the raw data, is a physical measurement of a particular parameter at a particular time and place. it represents a reality that the climate models do not.

Example: In a response to letters to the Editor, in the ODT. Maria Ioannou stated that sea level rise was increasing. I wrote to her asking for the evidence for this, her offsider Brendon Harper replied it was based on the NIWA/ IPCC report. In other words it is what the hypothesis predicted **should** happen **if** climate is driven by CO2, not what is actually happening. The fact that it is not happening is an example of the failure of the models and a failure by Maria and Brendon to understand the difference.

## (a) Climate sensitivity

The claims made by the IPCC for what will happen in the future, including sea level, all depend on the value of climate sensitivity, that is how much the temperature will rise with a doubling of CO2.

The value used for the NIWA / IPCC is that from the 4th Assessment Report of the IPCC, something of the order of 3.5°C/doubling while many recent models produce values between 1.5 and 2.0. Aldrin et al., 2012; Ring et al., 2012; Lewis, 2013

IPCC AR5 now says ***"The transient climate response is likely in the range of 1.0 deg. C to 2.5 deg. C ... and extremely unlikely greater than 3 deg. C"*** (SPM-12)

Significantly less than the value used to obtain the sea level rise claimed by NIWA

Most recent studies using data from observation suggest a value between 0.5 and 1.2°C/doubling.
Lindzen & Choi 2009, 2011, Spencer & Braswell 2010, 2012

The base value is < 1.2°C which is the value determined by the physics of absorption of Infrared radiation in closed system.(less than, because of the overlap in absorption spectra with water) The climate is not a closed system so this value is affected by feedback of cloud, of water vapour and many other factors.

Simplistically we could write: **Climate sensitivity = 1.2 +/− feedbacks**

One of the most significant feedbacks is how clouds respond to any CO2 induced warming.
The IPCC AR5 report, summary for policy makers states

***"No best estimate for equilibrium climate sensitivity can now be given because of a lack of agreement on values across assessed lines of evidence and studies"*** (SPM-11, fn 16).

It attributes this lack of agreement to the role of clouds. and then says

*"Uncertainty in the sign and magnitude of the cloud feedback is due primarily to continuing uncertainty in the impact of warming on low clouds"* (SPM-11)

This means that they do not know whether low cloud cover will increase negating any warming from CO2, or decrease and enhance warming.

Referring to the equation above, if they do not know the sign of the feedbacks then it is impossible to determine any value for climate sensitivity and therefore all model projections are utterly meaningless, as are the claims based on them.

**If they do not know even the sign of the cloud feedback, then it is impossible to deduce any value for climate sensitivity. i.e. All model predictions are meaningless.**

# b) the IPCC states that climate is chaotic and no predictions are possible

The WG1 report also says this of the models and the climate:

*"In climate research and modelling, we should recognise that we are dealing with a coupled non-linear chaotic system, and therefore long-term prediction of future climate states is not possible."* IPCC, TAR, Section 14.2.2.2.

What the DCC is doing by basing policy on climate predictions is precisely what the IPCC working group says is not possible to do.

**The DCC draws from the IPCC when it is convenient, but ignores contrary warnings and limitations when they conflict with the political agenda of those proposing these actions.**

# c) Extreme sea level projections used by DCC are from IPCC AR4 Not from AR5

The projections NIWA / IPCC are based on those reported in IPCC AR4. There are substantial revisions and retractions in the latest report AR5.
1. Climate sensitivity has been scaled back as detailed above.
2. Sea level projections are now given as: **"Global mean sea level rise for 2081-2100 will likely be in the ranges of 0.32 to 0.63 m mean 0.48 m** (SPM-18).

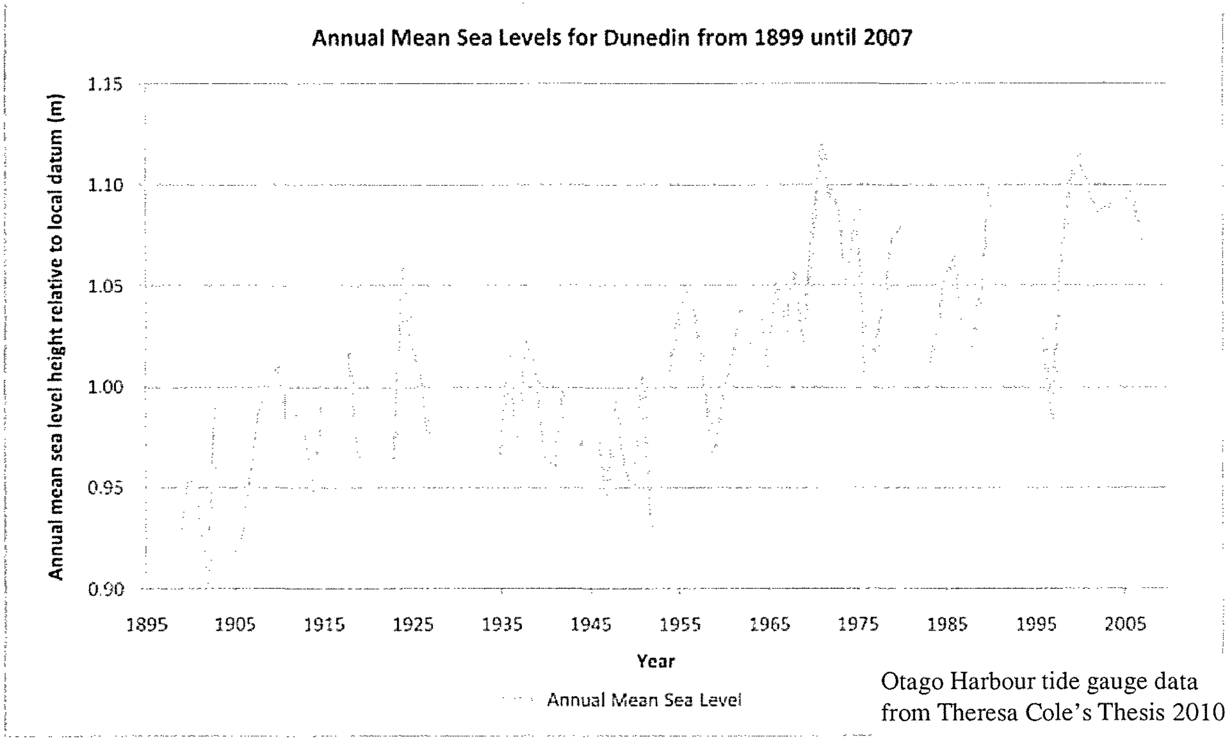
The June draft of the SPM contained the statement that *"Models do not generally reproduce the observed reduction in surface warming trend over the last 10-15 years"* (Section D-1, Draft SPM-10). This statement was removed by politicians - see political aspects to IPCC below.

So the DCC is basing its policy on sea level projections based on
(a) climate sensitivity values that have been lowered significantly in the latest report.
(b) a thesis which the proponents of admit, has not followed reality
(c) a hypothesis which the IPCC admits that they do not know the sign of one of its key assumptions

# d) Values used by the DCC are historically so extreme as to be ludicrous.

The Otago University MSc thesis of Theresa Cole is an in depth study of NZ sea levels and specifically looked for any sign of acceleration in the rate of sea level rise.

It showed for the Otago Harbour tide gauge that
1. The average rise was 128 mm/century or 1.28mm/year
2. That the raw data shows no net increase in sea level in the Harbour since early 70's




Otago Harbour tide gauge data from Theresa Cole's Thesis 2010

Figure 3.7: Original Annual Mean Sea Levels for Dunedin from 1899 until 2007

**Otago Harbour trend is ~1.3 mm/year. Rate required to reach 1 m sea level rise by 2100 is ~12 mm/year.**

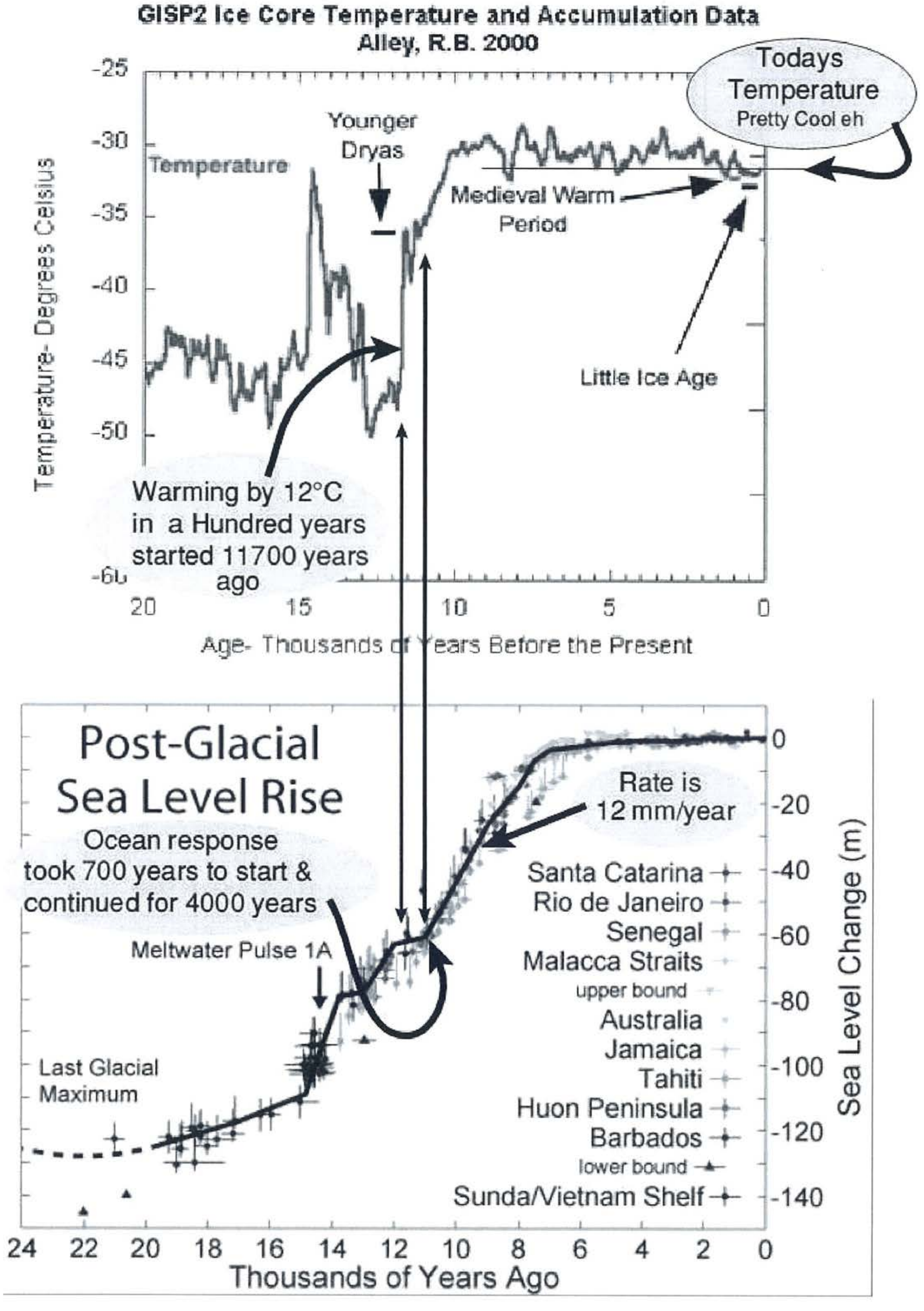
**A 10 fold increase, starting now**

The rate of sea level proposed requires an immediate acceleration of sea level rise from 1.28 mm/year to 11.75 mm/year

During the last main temperature surge at the end of the ice age, Greenland temperatures rose some 12°C in 100 years, far faster than anything the IPCC is forecasting, followed by a further 6°C over the next thousand years. At the time Canada Russia, northern China/Mongolia and northern Europe were covered by massive kilometre + thick ice sheets, .
After the temperature surge it took 700 years for sea levels rise to start and 4000 years to melt the ice and expand most of the ocean water.

**The rate of sea level rise during that 4000 year period was 12mm/year**

**This is the same rate of rise that is required to get to 1m rise by 2100**


GISP2 Ice Core Temperature and Accumulation Data
Alley, R.B. 2000
Todays Temperature
Pretty Cool eh
Younger Dryas
Temperature
Medieval Warm Period
Little Ice Age
Warming by 12°C in a Hundred years started 11700 years ago
Temperature- Degrees Celsius
-25
-30
-35
-40
-45
-50
-60
20
15
10
5
0
Age- Thousands of Years Before the Present
Post-Glacial Sea Level Rise
Ocean response took 700 years to start & continued for 4000 years
Rate is 12 mm/year
Meltwater Pulse 1A
Last Glacial Maximum
Santa Catarina
Rio de Janeiro
Senegal
Malacca Straits
upper bound
Australia
Jamaica
Tahiti
Huon Peninsula
Barbados
lower bound
Sunda/Vietnam Shelf
0
-20
-40
-60
-80
-100
-120
-140
Sea Level Change (m)
24
22
20
18
16
14
12
10
8
6
4
2
0
Thousands of Years Ago

Problems
a) IPCC / NIWA are not predicting that sort of temperature rise
b) there are no massive ice sheets at temperate latitudes to melt
c) oceans do not warm rapidly at all, global oceans are still expanding from that temperature rise that ended 10,000 years ago.

## So where is the water going to come from ?

And the DCC blindly accepts a value that is the same as the rate that happened during the most rapid temperature rise known, coupled with the melting of far more ice than is left in the world ?

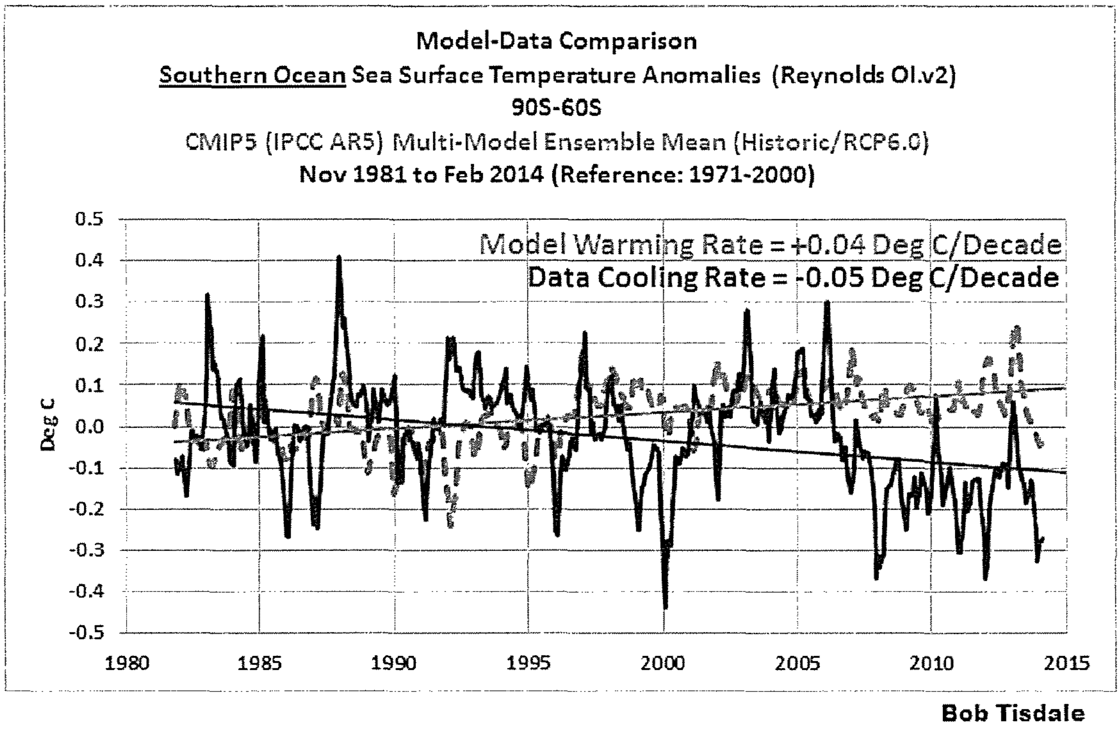
**To expect a rate of sea level rise similar to the holocene marine transgression is nothing short of ludicrous.**

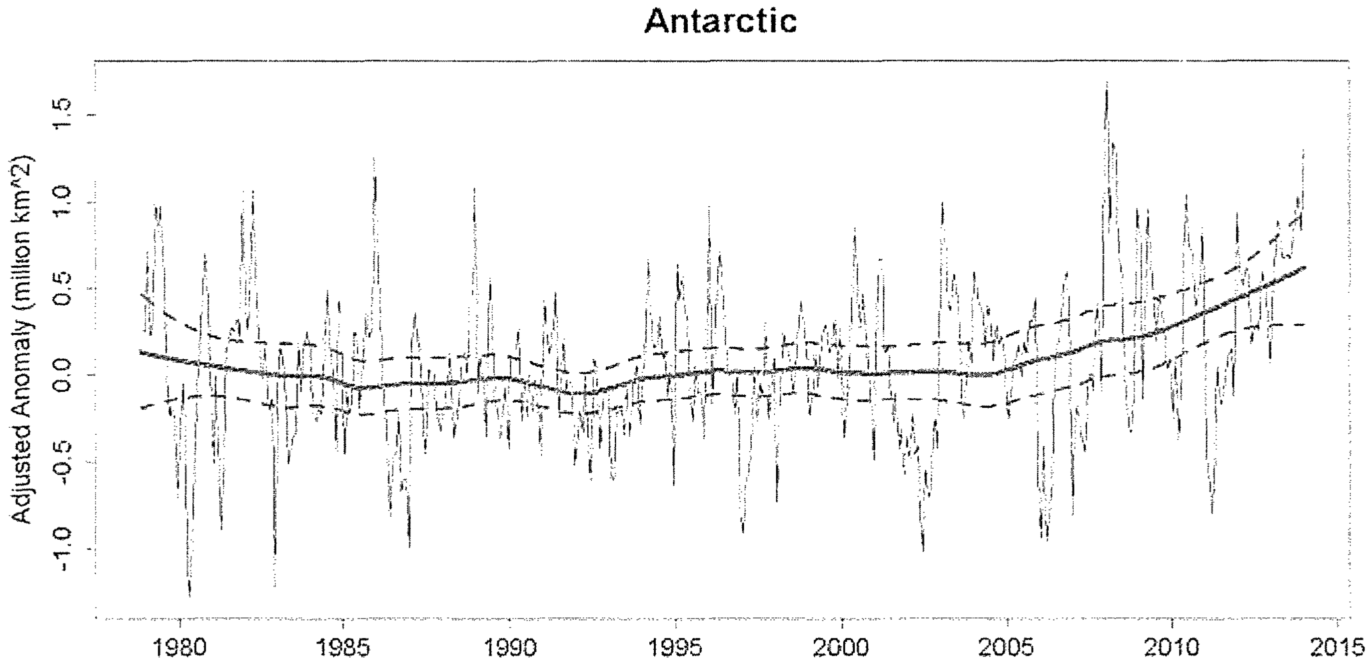
**IPCC claims are about alarmism to support political objectives.**

## Collapse of West Antarctic Ice Sheet

The ORC update report on South Dunedin ground water mentioned the possibility of ice sheet collapse. Firstly, the most recent papers to suggest this possibility, merely mentioned collapse as something that might happen in the next 200 to 900 years. A second paper calculated that this might cause additional sea level rise of 1mm/year. Hardly something the DCC needs to worry about at this point in time.
Secondly this collapse was assumed to be a a result of warming waters which the IPCC predicts should occur but in fact is not.

Reality check
1. The Antarctic glacial ice derives from falling snow, its melting point is 0°C (at atmospheric pressures)
The sea water around Antarctica has to be -1.96°C to form sea ice. Please explain how sea water at -1.96 can melt ice with a melting point of 0°C.
2. The Southern Ocean sea surface temperatures have been decreasing. Contrary to the IPCC model expectations.
3. The sea ice around Antarctica has been increasing for 30 years and the rate of increase has risen dramatically in the last 4 years.






4. The snow accumulation in East Antarctica - *The gain of almost 350 Gt from 2009 to 2011 is equivalent to a decrease in global mean sea level at a rate of 0.32 mm/yr over this three-year period."* http://onlinelibrary.wiley.com/doi/10.1029/2012GL053316/abstract

# e) Past and present predictions by the IPCC, based on its models, have failed

The hypothesis that CO2 drives climate change is still just that, a guess.
The next stage in science is for the implications of the hypothesis to be determined, this is what the IPCC projections represent. ie what **should** happen **if** the hypothesis is correct.

When projections of a hypothesis do not agree with experiment or observation then the hypothesis is wrong. As the highly esteemed physicist and Nobel prize winner Richard Feynman put it

***It does not make any difference how beautiful your guess is, it does not make any difference how smart you are, who made the guess, or what his name is—if it disagrees with experiment, it is wrong.*** " (Richard Feynman).

Below are a few of many instances where the projections of the IPCC are clearly wrong.

**This is not a matter of debating the theory of CO2 driven climate change.**
**It is a matter of recognising that to base policy decisions on a theory whose projections have repeatedly failed is just dumb.**

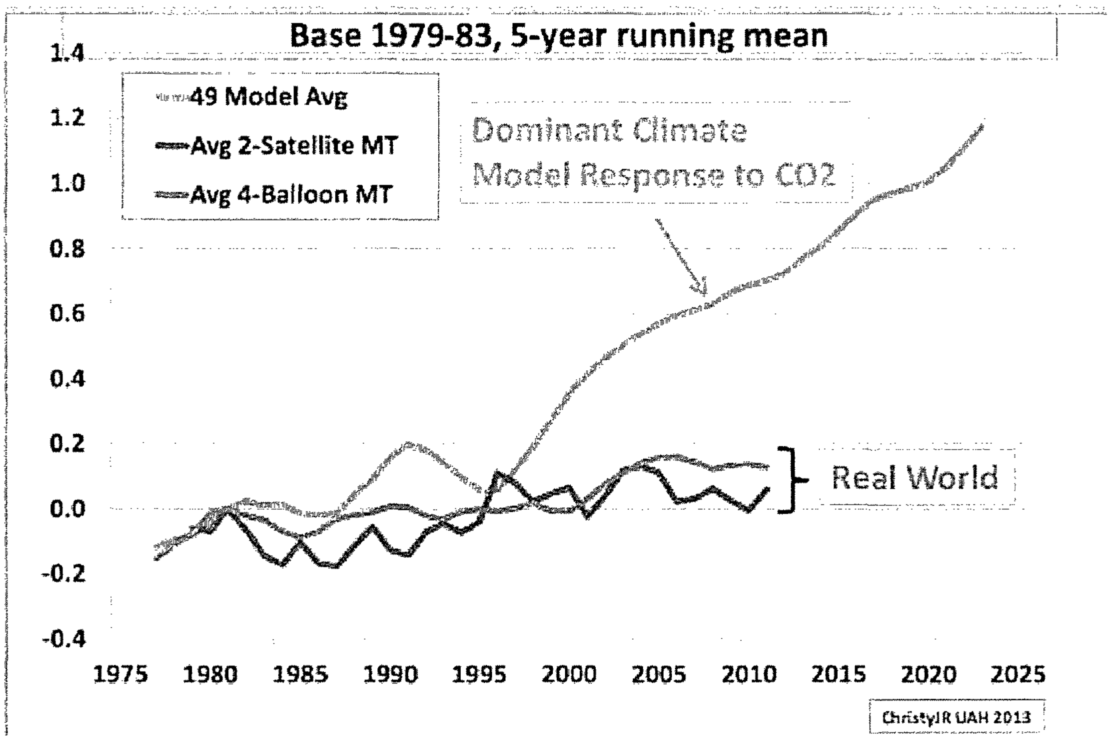
1. Based on 1985 analysis the forerunner of the IPCC in 1987 predicted sea levels around NZ would rise by 1.4m by 2025. On this forecast sea level in Dunedin should be over a metre higher now than in 1985. (David Kear, Chief Scientist DSIR and NZ representative at the formative meetings of the IPCC)

The Otago Harbour tide gauge raw data has shown no increase in sea level since 1973.

## Prediction failure

2. Global temperatures were supposed to have increased continuously at a rate determined by the climate sensitivity.
The graph below shows the model projections compared to reality.
The reality is that there has been no warming of the climate in the last 17 years and 10 months.
Reality is that climate has been cooling since 2005

## Prediction failure




3. Rate of sea level rise was supposed to increase.
As discussed above, there has been no increase in the rate and in fact it has decreased

## Prediction failure

4. The theory predicted a hot spot 10 km high in the tropics. Despite thousands of balloon radiosonde measurements plus satellite measurements, no hot spot has been detected.

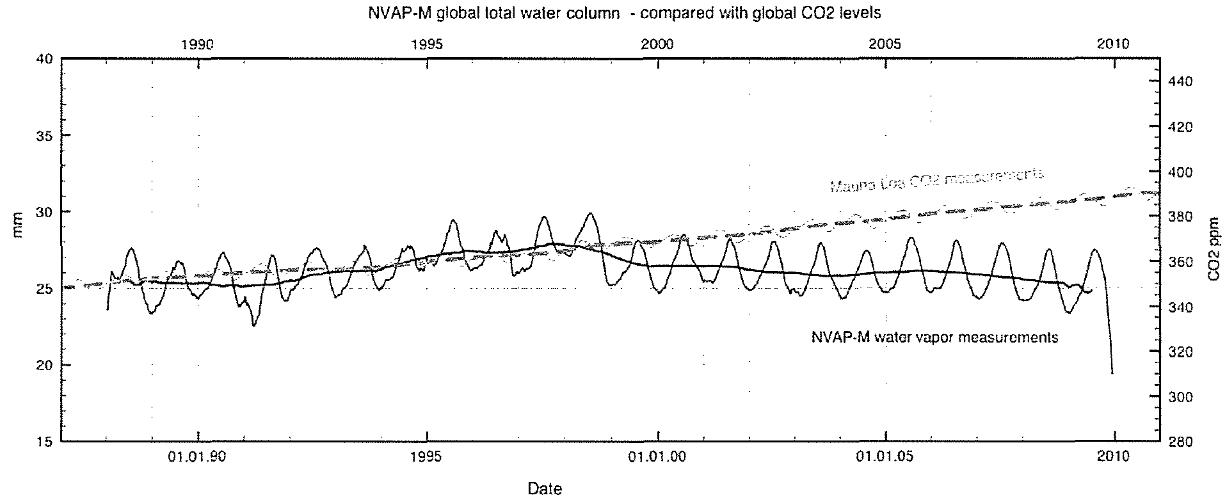
## Prediction failure

5. Antarctic sea ice should decrease and Artic ice should have disappeared by 2013.
Antarctic sea ice is increasing rapidly as shown above, and Arctic ice is rebuilding rapidly.

## Prediction failure

6. Atmospheric water vapour was predicted to increase.
Clearly it is decreasing.

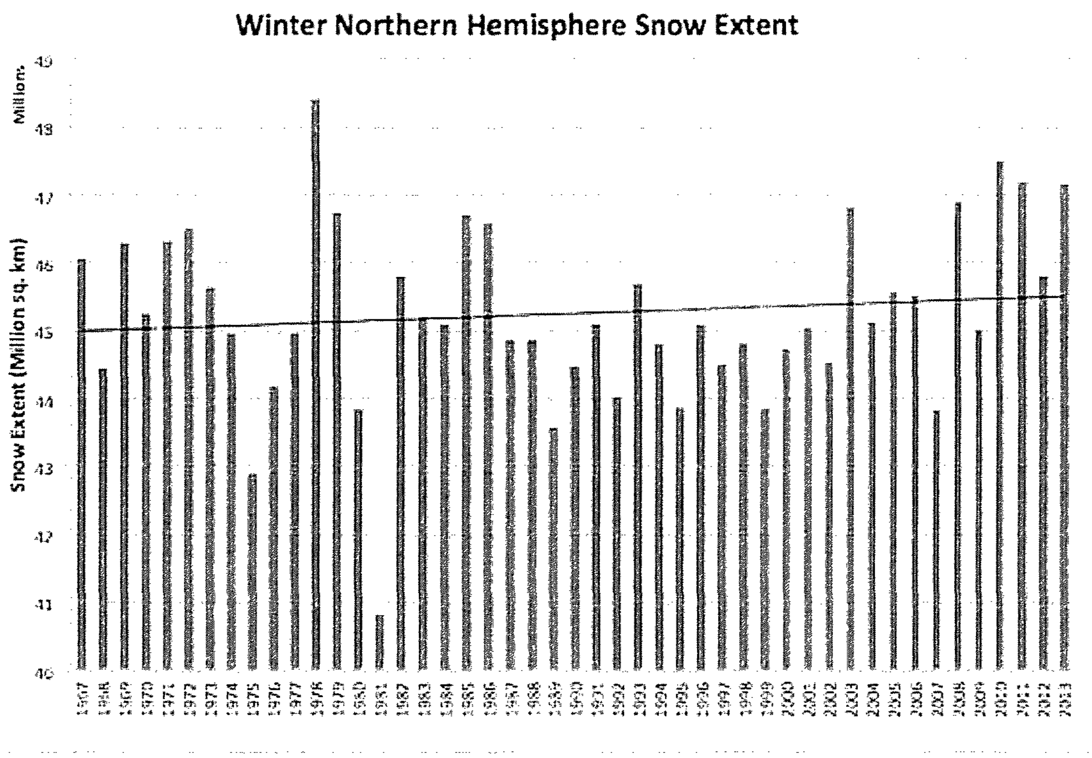
**Prediction failure**




7. Extreme weather was predicted to increase. The records show that; hurricanes, droughts, rainfall, etc have not increased at all in the last 60 years. (I could provide graphs but I hope you have the message by now.

**Prediction failure**

8.The IPCC SPM AR5 says
"The atmosphere and ocean have warmed, the **amounts of snow and ice have diminished,** sea level has risen," etc




**Prediction failure**

# f) The IPCC is a political body, that uses climate change as a means to gain political objectives.

## The IPCC Summary for Policy Makers (SPM)

Most people think that the IPCC is a body that analyses the science of climate change and presents its findings to the world via the Summary for Policy Makers. The working group reports are prepared by scholars but not the SPM.

Professor Richard Tol describes what happened in these words
*"The SPM, drafted by the scholars of the IPCC, is* **rewritten** *by delegates of the governments of the world". "Some of these delegates are scholars, others are not". "Other delegations have a political agenda too". The international climate negotiations of 2013 in Warsaw concluded that poor countries might be entitled to compensation for the impacts of climate change. It stands to reason that the IPCC would be asked to assess the size of those impacts and hence the compensation package. This led to an undignified bidding war among delegations – my country is more vulnerable than yours – that descended into farce when landlocked countries vigorously protested that they too would suffer from sea level rise.* (http://richardtol.blogspot.nl/2014/04/ipcc-again.html)

Tol withdrew his name from the SPM due to the excessive alarmism that resulted from this process. He said that;
***"many of the more worrying impacts of climate change really are symptoms of mismanagement and underdevelopment*"**.

His comments were supported in a letter of complaint to the IPCC by **Professor Robert Stavin** co-ordinating lead author of WGIII and the SPM when he said;

"***I was surprised by the degree to which governments felt free to recommend and sometimes insist on detailed changes to the SPM text on purely political, as opposed to scientific bases".***

Talking about the process he said:
*"In these contact groups, government representatives worked* ***to suppress text that might jeopardize their negotiating stances in international negotiations*** *under the United Nations Framework Convention on Climate Change (UNFCCC),* and *"nearly all delegates in the meeting demonstrated the same perspective and approach, namely that* ***any text that was considered inconsistent with their interests and positions in multilateral negotiations was treated as unacceptable****"*.

*Over the course of the two hours of the contact group deliberations, it became clear that the only way the assembled government representatives would approve text for SPM.5.2 was essentially to remove all "controversial" text (that is, text that was uncomfortable for any one individual government), which* ***meant deleting almost 75% of the text****, including nearly all explications and examples under the bolded headings.*

Prof Stavins told The Mail on Sunday that "he had been especially concerned by what happened at a special 'contact group'. He was one of only two scientists present, surrounded by '45 or 50' government officials".

http://www.robertstavinsblog.org/2014/04/25/is-the-ipcc-government-approval-process-broken-2/
and
http://www.dailymail.co.uk/news/article-2614097/Top-climate-experts-sensational-claim-government-meddling-crucial-UN-report.html

**Now imagine if the IPCC came out and said:**

- There has been no increase in any form of extreme weather over the last 60 years and low confidence that there will be any increase in the future. (which happens to be true)
- The rate of sea level rise is slowing and can be expected to drop in the next few decades.
- CO2 has caused an increase in plant productivity of over 6% and deserts have greened by 11% as higher CO2 allows plants to grow in drier places (both true).

If it had said this then:

- there would be no money for supposed effects of climate change on under developed countries.
- the IPCC bureaucracy would disintegrate,
- the funding for climate science (over 100 billion in last 30 years) would dry up,
- carbon trading /ETS/ carbon tax schemes would collapse
- The huge subsidies to wind and solar companies would cease (reducing cost of electricity)
- WWF and Greenpeace funding would take a huge hit, as would their credibility
- Politicians like Obama and the Greens would be seen to have misled the world

The consequences of the truth are politically unacceptable, **without doom & gloom the agreement to transfer funds to underdeveloped countries would never happen-**

**The SPM is about politics not science.**

The political nature of the SPM was spelled out by UN IPCC official and chairman of Working Group III (WGIII) Ottmar Edenhofer when he stated in 2010;

***" one must say clearly that we redistribute de facto the world's wealth by climate policy"***
and

***"One has to free oneself from the illusion that international climate policy is environmental policy. This has almost nothing to do with environmental policy anymore"***

The raison d'etre of the IPCC is to show that humans cause climate change, as a consequence,research highlighting warming is promoted while research on other causes of climate change is ignored. e.g. astro & cosmo climatology. For unbiased science one must go to the reports of the Nongovernmental International Panel for Climate Change.

.

## The IPCC Summary for Policy Makers is a political document representing political aspirations of member countries. It should not be used to make policy for future management of climate effects.

# g) The 97%consensus - A failure to discern the difference between fact & fiction.

This is frequently cited as a justification for believing in the IPCC but in fact is nothing more than propaganda.

There have been several "surveys" which purport to show some 97% support from scientists for the claims made by the IPCC. The majority of these rely on people and media assuming that the support is for the hypothesis that $CO_2$ drives climate change. The latest of these was an analysis of 11944 peer reviewed papers by John Cook et al.

**Cook et al paper**

If I said that rural areas were cooler than cities, then I would be part of the 97%
If I said that deforestation and agriculture cause local warming, then I would be part of the 97%

Only the first of Cook's 7 categories was in line with the IPCC statement that over 50% of the warming since 1950, it stated "(1) Explicit endorsement with quantification (explicitly states that humans are the primary cause of recent global warming)" (>50%).

Of the 11944 papers, less than one half of one percent supported this contention. I say less than as some of those papers were not on climate change at all but merely quoted the IPCC in the abstract.

**Less than 0.5% of the 11944 papers supported the IPCC contention that humans caused more than 50% of warming since 1950**

A 2008 survey of 373 actively publishing climate scientists (only 18% of those contacted responded) showed that only 8% supported the IPCC models with respect to clouds. Many other parameters had quite divergent views from contributing scientists. As shown above - if they have clouds wrong, then the output is junk.

Other surveys are falsified by the nature of the questions asked. An early 97% claimant had only 2 questions both of which even the skeptics would have responded positively to.

**There is no 97% consensus.**
**For many scientists and institutions accepting the IPCC claims means funding.**

# Conclusions

Are now self evident.

**The DCC should not use IPCC projections at all in its determination of areas likely to be affected by climate change.**

There are areas of South Dunedin that are affected to some extent by present sea levels. That is a present problem, not one related to projected climate change driven sea level rise. The present problems should be dealt with, with only the more certain possible sea level rise in mind of up to 200 mm by 2100.

To cause the reduction of property values and to place building restrictions on a very large number of homes based on ignorance and the projections of the IPCC is irresponsible.

A typical response to data such as I have presented here is to say "What if they (IPCC) are right"

If they were right then we would have seen a 1 m rise in sea level by now

If they were right then temperatures would have followed their projected curve, snow would be less, Arctic sea ice would have disappeared, etc etc etc

If they were right then we would have seen appropriate changes in $CO_2$ coinciding with known historic climate changes.

**There is not one known change of climate in the last 600 million years that has been driven by $CO_2$.**

Where there is any parallel in curves e.g interglacials and El nino events, it is always temperature that precedes $CO_2$ and in science and logic, the trailing factor cannot cause the initial factor.

**You think I am wrong**

**Prove it**

(with actual data from observation)

Peter Foster
1st September 2014

Otago Regional Council

**SUBMISSION FORM** (Print clearly on both sides)

# Proposed Regional Policy Statement for Otago

OTAGO REGIONAL COUNCIL
RECEIVED DUNEDIN
24 JUL 2015
FILE No. RA38402
DIR TO Sarah

68

Office use only

**Name of submitter:**

OSPRI

**Organisation (if applicable):**

**Postal address:**

OSPRI

PO Box 5745

DUNEDIN 9055

**Postcode:**

**Telephone:** (04) 4779527

**Email:** nikki.prime@ospri.co.nz

**I wish / do not wish** (circle preference) to be heard in support of my submission

If others make a similar submission, I will / will not consider presenting jointly with them at a hearing (circle preference)

**Signature:** [signature] **Date:** 22/7/15

(of submitter, or person authorised to sign on their behalf)

**Trade competitors declaration** (if applicable)

*I could gain through trade competition from a submission, but my submission is limited to addressing environmental effects directly impacting my business*

**Signature:**

Note that all submissions are made available for public inspection

**SUBMISSIONS MUST BE RECEIVED BY 5.00 PM, FRIDAY 24 JULY 2015**

Free

**Send to:**
Freepost ORC 497
Otago Regional Council
Private Bag 1954
Dunedin 9054

Please turn over

| 1 State what your submission relates to *and* if you support, oppose or want it amended | 2 State what decision you want the Otago Regional Council to make | 3 Give reasons for the decision you want made |
|---|---|---|
| e.g. amend provision 'y' | e.g. provision 'y' should say...<br><br>See attached. | e.g. I want provision 'y'changed because... |

Please add pages as required

Southern South Island
Level 1, 60 Tennyson Street, Dunedin
PO Box 5745, Moray Place, Dunedin 9058, New Zealand
P +64 3 477 9829

To: Otago Regional Council

**Submitter:**


| | |
|---|---|
| Name: | OSPRI New Zealand |
| Address for Service: | PO Box 5745<br>Dunedin 9058<br>Attn: Brent Rohloff / Nikki Penno |
| Email: | nikki.penno@ospri.co.nz |
| Phone: | (03) 477 9829 |


OSPRI do not wish to be heard in support of this submission.

## INTRODUCTION

OSPRI's primary role is to help protect and enhance the reputation of New Zealand's primary industries. OSPRI is the result of a merger between the Animal Health Board and NAIT, allowing the two organisations to better meet farmers' needs.

OSPRI manages the bovine tuberculosis (TB) control programme known as TBfree. Wildlife, mainly possums, are both the main carriers of bovine TB and source of the disease in cattle and deer herds. It is important that we keep their numbers low, as we work towards eradicating TB from New Zealand over the long term.

In the following paragraphs we address the provisions relevant to our operation and outline the specific concerns in respect of them.

CHAPTER 2 – OTAGO HAS HIGH QUALITY NATURAL RESOURCES AND ECOSYSTEMS

Policies 2.1.1 Managing for freshwater values
2.1.2 Managing for the values of beds of rivers and lakes, wetlands, and their margins
2.1.3 Managing for coastal water values
2.1.4 Managing for air quality values
2.1.5 Managing for soil values

**Submission**

Amend

**Reasons**

With regard to "Avoid the adverse effects of pest species…" in each policy, possums are a pest species which are already established throughout Otago, therefore their adverse effects cannot be avoided. It is unclear what the adverse effects are that are being referred to and there appears to be no method outlining how these policies are to be given effect to. If something is to be avoided there needs to be when and how the policy applies. In section 2.2, the wording is "controlling the adverse effects of pest species" however there appears to be no reason why this is different to the requirements in Section 2.1. There is a concern that "avoid" implies the requirement of prohibited rules in regional and district plans to be consistent with the PRPS.

**Decision sought**

Amend the policies to remove 'avoid' and ensure consistency with other policies which state that adverse effects need to be controlled. Clearly identify in the methods how this policy is to be given effect to.

Policies 2.1.6 Managing for ecosystem and indigenous biodiversity values

**Submission**

Amend

**Reasons**

With regard to "Avoid the adverse effects of pest species…" in each policy, possums are a pest species which are already established throughout Otago, therefore their adverse effects cannot be avoided. It is unclear what the adverse effects are that are being referred to and there appears to be no method outlining how these policies are to be given effect to. If something is to be avoided there needs to be when and how the policy applies. In section 2.2, the wording is "controlling the adverse effects of pest species" however there appears to be no reason why this is different to the requirements in Section 2.1. There is a concern that "avoid" implies the requirement of prohibited rules in regional and district plans to meet the policies in the PRPS.

**Decision sought**

Amend the policies to remove 'avoid' and ensure consistency with other policies which state that adverse effects need to be controlled. Clearly identify in the methods how provision (h) of this policy is to be given effect to.

Policies 2.2.4 Managing outstanding natural features, landscapes, and seascapes

2.2.6 Managing special amenity landscapes and highly values natural features

2.2.9 Managing the natural character of the coastal environment

2.2.13 Managing outstanding water bodies and wetlands

**Submission**

Amend

**Reasons**

It is unclear why "controlling the adverse effects of pest species..." is specified in these areas, and not areas of significant indigenous vegetation and habitat as covered by Policy 2.2.2, or other areas in general. The delivery of the provision in the methods is unclear. The need to "control" is inconsistent with the requirement to "avoid" in Section 2.1.

**Decision sought**

Amend the policies to ensure consistency with other policies relating to the "adverse effects of pest species". Clearly identify in the methods how provision of these policies is to be given effect to.

CHAPTER 3 – COMMUNITIES IN OTAGO ARE RESILIENT, SAFE AND HEALTHY

Policies 3.9.6 Encouraging use of best management practices for hazardous substance use

**Submission**

Oppose

**Reasons**

The "encourage" in this policy appears at odds with the Regional Plan: Water and Regional Plan: Air, which have rules relating to the use (discharge) of hazardous substances to the environment. The use of hazardous substances is also controlled by the HSNO Act. It is unclear in the policy whether "pesticides" are captured , and if so, "...reducing their use" as stated is of concern. This policy is redundant as HSNO requires best practice already.

**Decision sought**

Delete policy 3.9.6

Clearly identify in the methods how this policy is to be given effect to and what is meant by "reducing their use'.

CHAPTER 4 – PEOPLE ARE ABLE TO USE AND ENJOY OTAGO'S NATURAL AND BILT ENVIRONMENT

Policies 4.5.1 Avoiding objectionable discharges

**Submission**

Oppose

**Reasons**

Many discharges are potentially offensive to takata whenua and the wider public, (b) – (c) are possible inclusions, not exhaustive lists. With regard to (b), this would effectively prohibit the use of any hazardous substance, which includes pesticides (currently permitted by the Water Plan) in a number of areas. The use of pesticides in these areas is controlled by other legislation as well as a number of other organisations including Ministry of Health and the Department of Conservation. The inclusion of (b) is not needed and adds another layer of legislation that will impact on the ability to undertake work that benefits the environment.

**Decision sought**

Delete policy 4.5.1 (b).

Brent Rohloff
Programme Manager
15 July 2015

69

KiwiRail

24 July 2015



Proposed RPS
Otago Regional Council
Private Bag 1954
**DUNEDIN 9054**

**By email to**: rps@orc.govt.nz

**SUBMISSION ON PROPOSED OTAGO REGIONAL POLICY STATEMENT**

**NAME OF SUBMITTER:** KiwiRail Holdings Limited (KiwiRail)

**ADDRESS FOR SERVICE:** PO Box 593
**WELLINGTON 6140**
Attention: Rebecca Beals

**KiwiRail Submission on Proposed Otago Regional Policy Statement**

KiwiRail Holdings Limited (KiwiRail) is the State Owned Enterprise responsible for the management and operation of the national railway network. This includes managing railway infrastructure and land, as well as rail freight and passenger services within New Zealand. KiwiRail Holdings Limited is also the Requiring Authority for land designated "Railway Purposes" (or similar) in District Plans throughout New Zealand.

KiwiRail's comments on the Proposed Regional Policy Statement are set out in the attached table. Insertions we wish to make are marked in ***bold*** and ***underlined***, while recommended deletions are shown as ~~*struck out*~~ text.

KiwiRail could not gain an advantage in trade competition through this submission.

KiwiRail does not wish to speak to our submission, however are happy to provide any further detail should this be required by Council through the deliberation and consideration process in relation to the matters raised in this submission.

Regards,

Rebecca Beals
**Senior RMA Advisor**
**KiwiRail**

| Submission Number | Proposed Amendment | Support/Oppose/ Seek Amendment | Submission/Comments/Reasons | Relief Sought (as stated or similar to achieve the requested relief) |
|---|---|---|---|---|
| **Part A: Introduction** | | | | |
| | Overview | | | |
| 1. | RPS Framework | Support | KiwiRail support the Council with the four inter-related outcomes that are proposed in managing the regions resources and that these are the framework delivered through the RPS. Particularly supported by KiwiRail is the outcome in relation to safety as that is of importance to us in operating the rail network throughout the region | Retain as notified. |
| **Part B:** | | | | |
| | Chapter 2 – Otago has high quality natural resources and ecosystems | | | |
| 2. | Objective 2.1 | Support | The recognition, maintenance and enhancement of the values of the natural and physical resources within the Region, is supported by KiwiRail. | Retain as notified. |
| 3. | Policy 2.1.1(p) | Support | The maintenance of the ability for existing infrastructure of operate within their design parameters in relation to the values of freshwater, is supported.<br><br>The rail network is an existing linear network that crosses many freshwater environments, and the ability to ensure that it can continue to operate, and that as required those structures supporting the network can be maintained and upgraded, is essential. | Retain as notified. |
| 4. | Policy 2.1.2 | Support in part | Managing the values of beds of rivers and lakes, wetlands and their margins is also supported.<br><br>Specific recognition of the existence of infrastructure in these environments would also be supported, as this would also recognise practicalities around public access and natural character enhancement. In some situations moving the rail network away from a river crossing is not always practicable, and public access to the operational rail corridor is not supported for safety reasons. Ensuring that infrastructure can continue to operate as designed will address these matters. KiwiRail therefore seek a further point being added to this provision in relation to infrastructure, consistent with that provided for under Policy 2.1.1(p). | Amend Policy as follows:<br><br>…<br>***m) Maintain the ability of existing infrastructure to operate within their design parameters***. |
| 5. | Policy 2.1.3 | Support in part | Recognising and managing the values of coastal water is supported. KiwiRail have infrastructure throughout the Otago region that is adjacent to, or in, the coastal environment. Consideration of the continued ability for this to operate is supported by KiwiRail. Consistent with the submission points above, KiwiRail therefore seek that a further provision be added to this Policy to recognise existing infrastructure. | Amend Policy as follows:<br><br>…<br>***j) Maintain the ability of existing infrastructure to operate within their design parameters.*** |
| 6. | Policy 2.2.7 | Support | The landward extent of the coastal environment being defined is supported, and the use of infrastructure and built form that has modified the coastal environment to do that, is also supported. | Retain as notified. |
| | Chapter 3 – Communities in Otago are resilient, safe and healthy | | | |
| 7. | Objective 3.2 | Support | KiwiRail support Council in seeking to ensure that the risk that natural hazards pose to communities are minimised. For KiwiRail this is addressing hazards in relation to the linear rail network. | Retain as notified. |
| 8. | Policy 3.2.3(e) and (g) | Support | The assessment of natural hazard consequences through considering elements such as impacts on infrastructure and lifeline utilities is supported by KiwiRail. The ability to ensure that works are able to be undertaken as required to minimise the consequences of natural hazards, is important for KiwiRail in seeking to ensure that the rail network continues to operate. | Retain as notified. |
| 9. | Policy 3.2.6(b) | Support | For the rail network the ability to relocate is not always readily available, however recognition that avoidance of an increased risk from natural hazards through a design that facilitates recovery from natural hazard events is supported. KiwiRail seek to undertake maintenance and improvement works to the rail network that result in an asset that is able to withstand a degree of hazard event, and to be recovered quickly following an event that results in a temporary closure of the network. | Retain as notified. |
| 10. | Policy 3.2.7(d), (e) and (f) | Support | KiwiRail support these three specific provisions in relation to reducing existing natural hazard risks, particularly as they relate to a design that | Retain as notified. |

| Submission Number | Proposed Amendment | Support/Oppose/ Seek Amendment | Submission/Comments/Reasons | Relief Sought (as stated or similar to achieve the requested relief) |
|---|---|---|---|---|
| | | | facilitates recovery, relocation where practicable, and enabling development, upgrading, maintenance and operation of lifeline utilities. | |
| 11. | Policy 3.2.10 | Support | KiwiRail support that Council's preference is for soft engineering rather than hard engineering structures to manage the risk from natural hazards. KiwiRail also support the policy recognition that sometimes hard engineering structures are required. This is particularly recognised through Point (b) of the Policy where the practicalities of alternatives are required to be considered. The rail network is not easily relocatable and the range of alternatives is often reduced as a result. Council recognition of the constraints around the network at the time that consideration of the upgrade and maintenance of the asset occurs is therefore supported by KiwiRail. | Retain as notified. |
| 12. | Policy 3.2.11(b) | Support | Council seeking to enable hard mitigation measures or similar engineering interventions on public land when this relates to the functioning ability of lifeline utility is supported by KiwiRail. | Retain as notified. |
| 13. | Objective 3.4 | Support | The provision of good quality infrastructure and services that meet community needs, including recognising that this requires maintenance and upgrade of lifeline utilities to ensure that they are able to operate, is supported by KiwiRail. | Retain as notified |
| 14. | Policy 3.4.1 | Support | The integration of infrastructure with land use, and in particular the recognition of the functional need of infrastructure of regional / national importance is supported by KiwiRail. KiwiRail recognise that this requirement sits in tandem with Objective 3.8 and the supporting policies which seek to ensure that land use is integrated with infrastructure. | Retain as notified |
| 15. | Policy 3.4.2(e) and (g) | Support | Recognising the constraints that exist with the operation, upgrade and maintenance of a long linear infrastructure network such as the rail corridor, and that there are at times limited opportunities for effective mitigation to be achieved, is fundamental for KiwiRail. Therefore KiwiRail support Council seeking to protect infrastructure corridors for infrastructure purposes, and to protect the functioning ability of lifeline utilities. | Retain as notified. |
| 16. | Policy 3.4.3(a) | Support in part | Designing lifeline utilities to maintain their ability to function during and after natural hazard events, is supported. However KiwiRail wish that this be altered to design, maintain and upgrade. The rail network is not newly established, and as some of the structures reach the end of their practical life, these are replaced with new technologies and improved designs that reflect the current standards. Maintenance is also fundamental to ensure that these utilities are able to continue to operate and provide a level of resilience in relation to natural hazards. | Amend as follows:<br><br>*Policy 3.4.3*<br>*Designing lifeline utilities and facilities for essential or emergency services*<br>*Design**, upgrade and maintain** lifeline utilities, and facilities for essential or emergency services, to:*<br>*a) Maintain their ability to function to the fullest extent possible, during and after natural hazard events; and …* |
| 17. | Policy 3.4.4(a) | Support | Protecting the functioning of lifeline utilities by restricting establishment of activities that may result in reverse sensitivity effects, is supported by KiwiRail, particularly given the reverse sensitivity effects that operating a rail *network can give rise to as a result of inappropriately located or designed* developments. | Retain as notified. |
| 18. | Objective 3.5 | Support | Council seeking to ensure that regionally and nationally significant infrastructure is managed in a sustainable way, including recognition that there are in some instances constraints on where infrastructure can be physically located, and that significant adverse effects are not always able to be avoided, is supported by KiwiRail.<br><br>The rail network is nationally significant infrastructure that is not easily relocated, therefore the ability to continue to operate this and ensure that it can be maintained and upgraded as required to ensure that it continues to operate, is supported. | Retain as notified. |
| 19. | Policy 3.5.1(f) | Support | Recognising the national and regional significant significance of infrastructure, including specific reference to rail, is supported by KiwiRail. | Retain as notified. |
| 20. | Policy 3.5.2(a) and (b) | Support | Minimising the adverse effects from infrastructure, specifically through giving preference to location outside the likes of ONL's; and recognising | Retain as notified. |

| Submission Number | Proposed Amendment | Support/Oppose/ Seek Amendment | Submission/Comments/Reasons | Relief Sought (as stated or similar to achieve the requested relief) |
|---|---|---|---|---|
| | | | that where it is not possible to avoid those sites, that significant adverse effects to the values that contribute to the significant or outstanding nature of those areas are avoided, is supported.<br><br>*The rail network is a long linear network that passes through many natural* environments, and physically relocating it is not always feasible or practicable. Consideration of the ability to avoid effects, rather than simply avoid sites, when works are proposed along the existing network is therefore supported. | |
| 21. | Policy 3.5.3(a) and (e) | Support | Council seeking to protect infrastructure by – (a) restricting activities that may result in reverse sensitivity effects and (e) protect corridors for infrastructure needs, is supported by KiwiRail.<br><br>KiwiRail support the specific recognition of the potential for reverse sensitivity effects. KiwiRail acknowledges that there are instances when *development can be more suitably located, however generally KiwiRail is* not opposed to development adjoining the rail corridor and seeks that this is appropriately mitigated through setbacks and design standards, to ensure that the land use and the rail network are integrated and reverse sensitivity effects do not arise.<br><br>KiwiRail also support the recognition within the Policy that some infrastructure often does not have a choice as to location, and therefore seeking to protect these corridors for infrastructure through careful consideration of land use and development which has the potential to impede future improvement to that infrastructure, is supported. | Retain as notified. |
| | Chapter 4 – People are able to use and enjoy Otago's natural and built environment | | | |
| 22. | Policy 4.1.1(a) | | Maintaining and enhancing public access, unless restrictions are necessary to protect public health and safety, is supported by KiwiRail. The rail network includes structures over watercourses, and the provision of public access across these structures can result in health and safety risks, therefore would not be supported by KiwiRail. Recognition that in some instances restrictions on public access is appropriate, is therefore supported. | Retain as notified. |
| **Part C: Implementation** | | | | |
| | Schedule 6 – Urban Form and Design | | | |
| 23. | A Safe and Enjoyable Environment | | Support is provided for the create of a safe and enjoyable environment as part of urban form and design, in particular point (d) whereby Council seek to create safer transport networks. Safety is an important issue for KiwiRail and protecting the public from increased risk is vital for safe rail operations. | Retain as notified. |
| | Glossary | | | |
| 24. | Infrastructure | Support | KiwiRail support the definition of *Infrastructure* as proposed, specifically point (g) whereby railway structures are included within that definition. | Retain as notified. |
| 25. | Lifeline Utilities | Support | KiwiRail support the definition of *Lifeline Utilities* as proposed and the reference to this being as per Section 4 of the Civil Defence Emergency Management Act 2002. | Retain as notified |
| 26. | Reverse Sensitivity | Support | KiwiRail support the inclusion of a definition of *Reverse Sensitivity* within the Regional Policy Statement. | Retain as notified |

70

File reference Proposed Regional Policy Statement for Otago
Enquiries to Planning Unit
Email pkloosterman@waitaki.govt.nz

Waitaki
DISTRICT COUNCIL
TE KAUNIHERA Ā ROHE O WAITAKI
*Growing strong communities.*

**Phone** 03 433 0300

**Web** www.waitaki.govt.nz

**Office** 20 Thames Street
Private Bag 50058
Oamaru 9444

22 July 2015



Freepost 497
Proposed RPS
Otago Regional Council
Private Bag 1954
Dunedin 9054

Dear Sir/Madam

**Submission on Proposed Regional Policy Statement for Otago**

Please find attached Waitaki District Council's submission on the Proposed Regional Policy Statement for Otago.

Waitaki District Council wish to be heard in support of the submission. If others make a similar submission, Waitaki District Council would not be prepared to consider presenting a joint case with them at a hearing.

Yours faithfully

Peter Kloosterman
**District Planning Manager**

| **Submission Form**<br>**Proposed Regional Policy Statement for Otago**<br>**Submitter: Waitaki District Council** | | |
|---|---|---|
| **Proposed Regional Policy Statement for Otago Reference** | **Decision Requested** | **Reason for Request** |
| **Objective 1.2 Kāi Tahu values, rights and customary resources are sustained**<br>In managing our natural resources, local authorities need to recognise Kāi Tahu values and plans more effectively, and enable the exercise of customary rights. | Relief sought: that the text "*…more effectively,…*" is removed from Objective 1.2 | WDC opposes the text "…more effectively,…" this erroneously assumes local authorities are currently not recognising Kai Tahu values and plans effectively. |
| **Policy 1.1.2 Taking the principles of Te Tiriti o Waitangi into account**<br>b) Involve Kāi Tahu in resource management decision-making processes and implementation; and<br><br>f iii Provide for other areas in Otago that are recognised as significant to Kāi Tahu in a manner similar to that prescribed for statutory acknowledgement areas. | Relief sought: Amend Policy 1.1.2 b) from "*Involve Kai Tahu in…*" to "*Consult Kai Tahu in…*"<br><br>Relief sought: Delete clause f iii | Oppose: Councils have an obligation to consult and take into consideration the perspective of Tangata Whenua in their resource management decisions and implementation. Therefore this policy could be clarified by amending from *"Involve Kai Tahu in…"* to "*Consult Kai Tahu in…*"<br><br>Oppose: On 21 November 1997, the Crown and Te Rūnanga o Ngāi Tahu signed a Deed of Settlement to achieve a final settlement of Ngāi Tahu's historical claims against the Crown.<br>The Ngāi Tahu Claims Settlement Act 1998 gives effect to the Deed of Settlement.<br>Key elements of the settlement package included:<br>• making a public apology to Ngāi Tahu<br>• transferring title to Aoraki/Mount Cook to Ngāi Tahu (who gifted it back to the Crown)<br>• providing $170 million in redress<br>• enabling Ngāi Tahu to purchase properties from the Crown's "land bank"<br>• recognising Ngāi Tahu's role in environmental management<br>• providing other, non-tribal redress. |

| | | |
|---|---|---|
| | | The Settlement Act included an instrument called a Statutory Acknowledgement. Statutory Acknowledgements recognise Ngäi Tahu's mana in relation to a range of defined sites and areas. The instrument provides for this to be reflected in the management of the areas covered by Statutory Acknowledgements.<br>Provisions of the Settlement Act relating to Statutory Acknowledgements came into effect on 22 April 1999.<br>Statutory Acknowledgements impact upon specified Resource Management Act 1991 (RMA) processes concerning certain identified areas in the South Island. Local authorities in the Ngäi Tahu claim area exercising their functions as consent authorities under the RMA are obligated to observe the procedural requirements of the Statutory Acknowledgements.<br>WDC considers it is discordant to introduce the requirements of Statutory Acknowledgement Areas outside the areas defined in the Ngäi Tahu Claims Settlement Act 1998 as that act was the final settlement of Ngäi Tahu's historical claims with the Crown.<br>Unlike the Ngäi Tahu Claims Settlement Act 1998, the Proposed RPS does not define the "...other areas in Otago that are recognised as significant to Kāi Tahu" to which local government *will be obliged to provide for in a manner similar* to that prescribed for statutory acknowledgement areas. |
| **Policy 1.2.4 Enabling Kāi Tahu relationships with wāhi tupuna and associated sites**<br>Enable Kāi Tahu relationships with wāhi tupuna and associated sites by: | Relief sought: Delete: a) Facilitating Kāi Tahu access to sites of cultural significance; | Oppose: There is no obligation to facilitate access to sites of cultural significance within the Resource Management Act. Access to sites on private land is a matter of negotiation between the landowner and those seeking access. |

| | | |
|---|---|---|
| a) Facilitating Kāi Tahu access to sites of cultural significance; | | |
| **Part B Chapter 2 (Page 23) Otago has high quality natural resources and ecosystems** 2nd paragraph: It is critical to recognise the value we place on Otago's natural resources and to manage these resources accordingly. This includes identifying resources which we want to **preserve** for future generations. | Relief sought: Waitaki District Council seeks this is amended to: *It is critical to recognise the value we place on Otago's natural resources and to manage these resources accordingly. This includes identifying resources which we want to **maintain** for future generations.* | Oppose: The only requirement to preserve defined in Part 2 (The Purpose) of the Resource Management Act relates to preserving the natural character of the coastal environment. There is no generic mandate to preserve Otago's natural resources. |
| **Policy 2.1.6 Managing for ecosystem and indigenous biodiversity values** | Relief sought: Waitaki District Council seeks that: Method 7 is amended to include the requirement for the ORC develop a region wide Biodiversity Strategy. | Waitaki District Council has prepared and approved an Indigenous Biodiversity Strategy. This provides strategic guidance and informs initiatives and work programmes within the District. Following on from endorsement of the Indigenous Biodiversity Strategy Council has approved a Biodiversity Enhancement Fund and part-time employment of a Biodiversity Coordinator. Otago Regional Council has been curiously silent in regard to setting strategic direction for the management of Otago's Indigenous Biodiversity. In the absence of strategic regional direction Otagos responses to its biodiversity obligations have been highly variable. |
| **Policy 2.2.2 Managing significant indigenous vegetation and significant habitats of indigenous fauna.** | Relief sought: Waitaki District Council seeks that: Policy 2.2.2 is amended to *"Protecting significant indigenous vegetation and significant habitats of indigenous fauna."* | Council's obligation in regard to significant indigenous vegetation and significant habitats of indigenous fauna is defined in Section 6 of the resource Management Act 1991. In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and |

| | | |
|---|---|---|
| | | protection of natural and physical resources, shall recognise and provide for the following matters of national importance:<br>the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:<br>In this matter Policy 2.1.6 is inconsistent with the legislation in that it only requires management – rather than protection. |
| **Policy 2.2.4 Managing outstanding natural features, landscapes, and seascapes**<br>Protect, enhance and restore the values of outstanding natural features, landscapes and seascapes, by:<br>f) Encouraging enhancement of those areas and values | Relief sought: Waitaki District Council seeks this is amended to:<br>*Protect, the values of outstanding natural features, landscapes and seascapes, by*:<br><br>And that clause *f) Encouraging enhancement of those areas and values* is deleted. | Oppose: There is no requirement or expectation defined in the Resource Management Act 1991 that outstanding natural features and landscapes will be enhanced or restored. It becomes questionable whether the features/ landscapes warrant "outstanding" status if they require enhancement or restoration. Conversely if they have achieve outstanding status will enhancing them make them more outstanding? |
| **Policy 2.2.5 Identifying special amenity landscapes and highly valued natural features**<br>Identify areas and values of special amenity landscape or natural features which are highly valued for their contribution to the amenity or quality of the environment, but which are not outstanding, using the attributes detailed in Schedule 4.<br>**Policy 2.2.6 Managing special amenity landscapes and highly valued natural features**<br>Protect or enhance the values of special amenity landscapes and highly valued natural features, by:<br>a) Avoiding significant adverse effects on those values which contribute to the special amenity of the landscape or high value of the natural feature; and | Relief sought: Waitaki District Council seeks that Policies 2.2.5, 2.2.6 and any other reference to special amenity landscapes and highly valued natural features are deleted. | Waitaki District Council does not define special amenity landscapes and highly valued natural features within its current District Plan. There is no requirement in the Resource Management Act to recognise, protect and enhance special amenity landscapes and highly valued natural features. Therefore introducing this requirement into the RPS is ultra vires of ORC. |

| | | |
|---|---|---|
| b) Avoiding, remedying or mitigating other adverse effects on other values; and<br>c) Assessing the significance of adverse effects on those values, as detailed in Schedule 3;and<br>d) Recognising and providing for positive contributions of existing introduced species to those values; and<br>e) Controlling the adverse effects of pest species, preventing their introduction and reducing their spread; and<br>f) Encouraging enhancement of those values. | | |
| **Policy 2.2.8 Identifying areas of high and outstanding natural character in the coastal environment**<br>Identify areas and values of high and outstanding natural character in the coastal environment, using the attributes detailed in Policy 2.1.8. | Relief sought: Waitaki District Council seeks that the text "*high and outstanding*" is deleted from Policy 2.2.8 | The requirement to preserve the natural character of the coastal environment is defined in Section 6A of the Resource Management Act 1991. The Act does not introduce additional qualifiers to the natural character aspect of being high and outstanding. These embellishments effectively introduce a higher status of what needs to be defined than the Act anticipated. As such WDC considers the Policy to be erroneous and vulnerable to challenge. |
| **Policy 2.2.9 Managing the natural character of the coastal environment**<br>Preserve or enhance the natural character values of the coastal environment, by:<br>a) Avoiding adverse effects on those values which contribute to the outstanding natural character of an area; and<br>b) Avoiding significant adverse effects on those values which contribute to the high natural character values of an area; and<br>c) Assessing the significance of adverse effects on those values, as detailed in Schedule 3;and<br>d) Avoiding, remedying or mitigating other adverse effects on other values; and | Relief sought: Waitaki District Council seeks that the text *"high" and "outstanding*" is deleted from Policy 2.2.9<br><br>Relief sought: Waitaki District Council seeks that the text *"or enhance*" and clause (f) are deleted from Policy 2.2.9 | The requirement to preserve the natural character of the coastal environment is defined in Section 6A of the Resource Management Act 1991. The Act does not introduce additional qualifiers to the natural character aspect of being high and outstanding. These embellishments effectively introduce a higher status of what needs to be defined than the Act anticipated. As such WDC considers the Policy to be vulnerable to challenge. |

| | | |
|---|---|---|
| e) Recognising and providing for the contribution of existing introduced species to the natural character of the coastal environment; and<br>f) Encouraging enhancement of those values; and | | |
| **Objective 3.8 Issue**: Unplanned urban growth risks exceeding the carrying capacity of existing infrastructure and services, adversely affecting community resilience. Sometimes, unplanned growth places pressure on adjoining productive land, and risks losing connectivity with adjoining urban areas.<br><br>Need: We need well-designed and integrated urban growth, to achieve effective and affordable infrastructure, and improve resilience. We need to make the best use of our natural and physical resources and reduce the effects of unplanned growth. | Relief sought: Waitaki District Council seeks that the text *Unplanned* is amended to *Unanticipated* | Infrastructure does have a maximum carrying capacity, however in a growing urban area this can be exceeded as residential areas connect into that infrastructure. Councils provide for urban growth by zoning to facilitate growth (residential zoning) and proactively providing the necessary and suitably proportioned infrastructure to service the land. Conversely any person may apply for a Private Plan Change to rezone their particular property for intensification – the Resource Management Act 1991 provides for this. The cost of accommodating the infrastructure capacity demands from a Private Plan change are borne by the developer. Because the Act provides for "unplanned urban growth" through the Private Plan Change process Waitaki District Council considers this issue requires amendment to define the germane issue of urban growth onto highly valued soils or lack of connectivity to existing urban areas. |
| **Policy 3.8.1 Managing for urban growth**<br>Manage urban growth and creation of new urban land in a strategic and co-ordinated way, by:<br>f) Requiring the use of low or no-emission heating systems in buildings, when ambient air quality in or near the growth area is:<br>i. Below standards for human health; or<br>ii. Vulnerable to degradation given the local climatic and geographical context; and | Relief sought: Waitaki District Council seeks that ORC proactively models the potential urban areas which may be vulnerable to degradation to inform the desirability of subdivision or rezoning in the future. The modelling work by ORC needs to be specified in the methods | In order to realise this policy every green field subdivision and every residential rezone would require meteorological modelling to determine whether the land involved could be potentially vulnerable to degradation of air quality sometime in the future. This introduces costs to either the Council involved or the land developer. Waitaki District recognises that Otago Regional Council is aware of the location of its problematic airsheds. |

| | | |
|---|---|---|
| **Policy 3.8.2 Controlling growth where there are identified urban growth boundaries or future urban development areas**<br>Where urban growth boundaries, as detailed in Schedule 8, or future urban development areas, are needed to control urban expansion, control the release of land within those boundaries or areas, by | Relief sought: Waitaki District Council seeks that: Reference to Schedule 8 within Policy 3.8.2 and Schedule 8 itself are deleted from the RPS | Schedule 8 is blank and therefore provides no assistance to interpreting Policy 3.8.2. If ORC determine they wish to complete Schedule 8 at a later date it will require a variation to the Proposed RPS or a Plan Change once the RPS has been completed. Policy 3.8.2, in its proposed form, is not assisted by reference to a blank Schedule. |
| **Policy 3.8.3 Managing fragmentation of rural land**<br>Manage subdivision, use and development of rural land, to:<br>b) Have particular regard to whether the proposal will result in a loss of the productive potential of highly versatile soil, unless:<br>iii. reverse sensitivity effects on rural productive activities can be avoided; and<br>d) Avoid creating competing demand for water or other resources. | Relief sought: Waitaki District Council seeks that: Policy 3.8.3 b) iii is amended to *"reverse sensitivity effects on rural productive activities can be minimised where possible; and"*<br>Policy 3.8.3 d) is deleted | In any expansion of urban development or in establishing higher density development there will always be an edge to the zone or subdivision boundary where potentially incompatible activities will adjoin each other. A policy requiring **avoidance** of all reverse sensitivity effects on rural production activities will entail establishing extensive buffer or no build areas which is an inefficient use of land.<br>All new urban density development is reticulated into a treated potable water scheme. Similarly where new rural blocks are created through subdivision there is an expectation by purchasers that there will be a potable water supply. It is extremely unusual to have a parcel of land without a water supply as dry blocks do not sell. In this regard subdivision and development of rural land reallocates the water supplies available. It is questionable whether this is a competing demand as the new land use displaces the previous consumer.<br>Managing subdivision and development whilst avoiding demand for (all) other resources is a very fraught process. Subdivision displaces the land use which preceded it – however the market determines best use or highest return. |
| **Policy 3.9.4 Managing the use of contaminated land** | Relief sought: Waitaki District Council seeks that Policy 3.9.4 b) ii is deleted. | The management of contaminated land is defined in the National Environmental Standard for |

| | | |
|---|---|---|
| Manage the use of contaminated land, to protect people and the environment from adverse effects, by:<br>b) Where there is contamination:<br>i. Requiring an assessment of associated environmental risks; and<br>ii. Remediating land; and | | Assessing and Managing Contaminants in Soil to Protect Human Health.<br>The NES defines permitted activity status for specified activities and (effectively) all other activities on contaminated land which disturb the soil require a land use consent.<br>The User's guide to the NES defines how it is to be applied and notes<br>The applicant must decide what to do to make the land safe for the current or intended land use. There are two options:<br>1. remediate (clean up) the land to reduce the concentration of the contaminants to an acceptable level<br>2. manage the land to prevent exposure of people to the contaminants<br>There is no absolute obligation to remediate contaminated land once it is identified. It simply cannot be used for certain activities.<br>In light of the national direction, Waitaki District Council considers the text in Policy 3.9.4 b) ii to be incorrect and misleading. |
| **Objective 4.1 Public access to areas of value to the community is maintained or enhanced**<br>2nd paragraph Improving access to the natural environment or sites of cultural and historic significance can contribute to recreational, cultural, spiritual and economic wellbeing and should be maintained or enhanced unless it would be detrimental to the protection of the values of these areas, or the health and safety of the community. | Relief sought: Waitaki District Council seeks that Objective 4.1 is amended to reflect the legislative mandate by removing the reference to improving access to *"sites of cultural and historic significance"*. | The only requirement to provide access specified within the Resource Management Act 1991 is defined in Section 6d "the maintenance and enhancement of public access to and along the coastal marine area, lakes, and rivers:" There is no ability to maintain or enhance public access to areas of cultural or historic significance. |
| **Policy 4.1.1 Maintaining and enhancing public access**<br>Maintain and, where possible, enhance public access to the natural environment, including to the coast, lakes, rivers and their margins, and | Relief sought: Waitaki District Council seeks that "*…and areas of cultural or historic significance…*" is deleted from Policy 4.1.1 | The only requirement to provide access specified within the Resource Management Act 1991 is defined in Section 6d "the maintenance and enhancement of public access to and along the coastal marine area, lakes, and rivers:" There is |

| | | |
|---|---|---|
| areas of cultural or historic significance, unless restricting access is necessary to:<br>a) Protect public health and safety; or<br>b) Protect the natural heritage and ecosystem values of sensitive natural areas or habitats; or<br>c) Protect identified sites and values associated with historic heritage or cultural significance to takata whenua. | | no ability to maintain or enhance public access to areas of cultural or historic significance. |
| **Policy 4.3.2 Managing land use change in dry catchments**<br>Manage land use change in dry catchments, to avoid any significant reduction in water yield, by:<br>a) Restricting any extension of forestry activities within those catchments that would result in a significant reduction in water yield, including cumulative reductions; and<br>b) Minimising the conversion of tussock grasslands to species which are less able to capture and hold precipitation.<br>Method 2: Regional, City and District Council Relationships<br>Method 4: City and District Plans<br>Method 6: Research, Monitoring and Reporting | Relief sought: Waitaki District Council seeks that:<br>• The Dry catchments are defined in a Schedule to the RPS or a methodology is specified whereby those catchments can be identified.<br>• Method 4 to Policy 4.3.2 is amended to *"Regional Plans"* | Waitaki District Council recognises changes in land use can affect water yield. The Policy does not refer to a Schedule of Dry Catchments or a methodology for defining Dry Catchments. Method 6 states managing forestry or minimising conversion of tussock grasslands within those undefined catchments will be the responsibility of the City and the District Councils. The TLA's have no expertise in managing water quantity as that role is defined as being exclusive to Regional Councils since 1991 under Section 30 of the Resource Management Act<br>Functions of regional councils under this Act<br>**(1) Every regional council shall have the following functions for the purpose of giving effect to this Act in its region:**<br>• (a) the establishment, implementation, and review of objectives, policies, and methods to achieve integrated management of the natural and physical |

| | | |
|---|---|---|
| | | resources of the region:<br>• (b) the preparation of objectives and policies in relation to any actual or potential effects of the use, development, or protection of land which are of regional significance:<br>• **(c) the control of the use of land for the purpose of—**<br>  • (i) soil conservation:<br>  • (ii) the maintenance and enhancement of the quality of water in water bodies and coastal water:<br>  • **(iii) the maintenance of the quantity of water in water bodies and coastal water:** |

| | | |
|---|---|---|
| | | Because of the complete lack of hydrology and flow regime experience within District Councils if an application was received to afforest a dry catchment or convert tussock grasslands it would be referred to Otago Regional Council for guidance as to suitability and if so the salient conditions of consent. Therefore it is pointless delegating this particular function when Dry catchment rules within the Regional Water Plan would be more focussed and achieve the required functions of a Regional Council. |