Document 1

From: S9(2)
To: Warren Gray
Subject: Re: CC hotspots vs. observations
Date: Thursday, 10 April 2008 5:48:00 PM

A web link where you can get the pdf:
http://www.climatescience.gov/Library/sap/sap1-1/finalreport/default htm
Sam
>>> S9(2)(a) 10/04/2008 3:40 p.m. >>>
Hi Warren:

Sigh... this is somewhat related to Lindzen's (largely discredited) iris hypothesis. Not a lot of time right now, but see attached paper from Roy Spencer et al, and the detection/attribution chapter from IPCC...

S9
(2)

S9(2)(a)

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S9(2)(a)

>>>

From: Warren Gray <warren.gray@mfe.govt nz>
To:"S9(2)(a) >
CC:Vera Power <Vera.Power@mfe.govt.nz>
Date: 10/04/2008 3:04 p.m.
Subject: CC hotspots vs. observations

Hi Gents

I have been asked to follow-up on the article below
http://www nbr.co nz/home/column_article.asp?id=21153&cid=39&cname=NBR+Comment

And assess the issues!

It appears that the expected vertical signature of anthropogenic CC is not matched by the currently observed structure

See also
http://scienceandpublicpolicy.org/images/stories/papers/monckton/whatgreenhouse/monckton greenhousewarming.pdf

What do you guys think?

Rgds W

Dr Warren Gray
Senior Policy Adviser - Climate Change Science
Reporting and Communications Group
Ministry for the Environment
23 Kate Sheppard Place
P.O. Box 10362
Wellington

ph: 04 439 7731
S9(2)(a) [redacted]

New Zealand is hosting World Environment
Day on 5 June 2008.
The Ministry for the Environment is proud
to be the lead agency coordinating
this international event.
MORE INFO: Call 0800 WED 2008 or
email WED@mfe.govt nz

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Document 2

From: S9(2)(a)
To: Climate Change
Subject: ETS review Ministerial request for update due to Australian Carbon tax
Date: Monday, 1 August 2011 4:56:56 PM
Attachments: Spencer on the misdiagnosis of heat transferArticle.doc
Onthe misdiagnosis of temperature feedbacks from variations in the earths radiant energy balance.pdf

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The Hon David Caygill,

ETS review.

Given Minister Smith has kicked back the report on the ETS for updating due to the Australians introduction of a carbon tax it is also timely to update the relationship of a recently published new Paper "On the Misdiagnosis Of Surface Temperature Feedbacks From Variations In Earth's Radiant Energy Balance" By Spencer and Braswell 2011 "http://www.mdpi.com/2072-4292/3/8/1603/ to the foundation science on which the alarmist premise to introduce the ETS in New Zealand is based.

While I have read the paper in its entirety and it seems sound and reasonable in its conclusions I have attached both the abstract and the paper to this email. What is significant about this paper is that the data on which it is based NASA Terra satellite is sound. The scientific methodology appears sound and I have yet to see any technical criticism on the web that is reputable, there are comments of criticism as you would expect in this highly charged political/scientific arena but nothing scientific to refute the evidence. It is early days, accepted.

This paper is not the refutation of the GW Hypothesis it is a component that indicates caution in basing fundamental policy on computer modeling when the paramatization of those models is not at all well understood. The paper addresses these issues and they are important and they are significant in magnitude.

The Press release from UAH is set out below, I'm sure that your group will have access to scientific support to analyze the actual paper in full. The press release is the ordinary mans guide to what the paper is about.

Climate models get energy balance wrong, make too hot forecasts of global warming

HUNTSVILLE, Ala. (July 26, 2011) — Data from NASA's Terra satellite shows that when the climate warms, Earth's atmosphere is apparently more efficient at releasing energy to space than models used to forecast climate change have been programmed to "believe."

The result is climate forecasts that are warming substantially faster than the atmosphere, says Dr. Roy Spencer, a principal research scientist in the Earth System Science Center at The University of Alabama in Huntsville.

The previously unexplained differences between model-based forecasts of rapid global warming and meteorological data showing a slower rate of warming have been the source of often contentious debate and controversy for more than two decades.

In research published this week in the journal "Remote Sensing" http://www.mdpi.com/2072-4292/3/8/1603/pdf, Spencer and UA Huntsville's Dr. Danny Braswell compared what a half dozen climate models say the atmosphere should do to satellite data showing what the atmosphere actually did during the 18 months before and after warming events between 2000 and 2011.

"The satellite observations suggest there is much more energy lost to space during and after warming than the climate models show," Spencer said. "There is a huge discrepancy between the data and the forecasts that is especially big over the oceans."

Not only does the atmosphere release more energy than previously thought, it starts releasing it earlier in a warming cycle. The models forecast that the climate should continue to absorb solar energy until a warming event peaks. Instead, the satellite data shows the climate system

starting to shed energy more than three months before the typical warming event reaches its peak.

“At the peak, satellites show energy being lost while climate models show energy still being gained,” Spencer said.

This is the first time scientists have looked at radiative balances during the months before and after these transient temperature peaks.

Applied to long-term climate change, the research might indicate that the climate is less sensitive to warming due to increased carbon dioxide concentrations in the atmosphere than climate modelers have theorized. A major underpinning of global warming theory is that the slight warming caused by enhanced greenhouse gases should change cloud cover in ways that cause additional warming, which would be a positive feedback cycle.

Instead, the natural ebb and flow of clouds, solar radiation, heat rising from the oceans and a myriad of other factors added to the different time lags in which they impact the atmosphere might make it impossible to isolate or accurately identify which piece of Earth’s changing climate is feedback from manmade greenhouse gases.

“There are simply too many variables to reliably gauge the right number for that,” Spencer said. “The main finding from this research is that there is no solution to the problem of measuring atmospheric feedback, due mostly to our inability to distinguish between radiative forcing and radiative feedback in our observations.”

For this experiment, the UA Huntsville team used surface temperature data gathered by the Hadley Climate Research Unit in Great Britain. The radiant energy data was collected by the Clouds and Earth’s Radiant Energy System (CERES) instruments aboard NASA’s Terra satellite.

The six climate models were chosen from those used by the U.N.’s Intergovernmental Panel on Climate Change. The UA Huntsville team used the three models programmed using the greatest sensitivity to radiative forcing and the three that programmed in the least sensitivity.

If anything this paper indicates that the Alarmist view of AGW is at serious risk of being over stated. Our ETS was developed under an Alarmist environment that is increasingly being found to be overstated therefore it is appropriate to take a cautious approach to policy whose foundation science is underdeveloped. Policy that taxes on a false premise (partially false) is likely to be bad policy. The effects on the population and particularly of the poor and socioeconomically disadvantage will be negative.

It is getting to the stage where the entire policy should be rethought given changes in the science and the proven failure of the current ETS to effectively either change the growth in CO_2 emissions or alter the temperature of the earth now or in the future to any extent that is likely to affect the climate.

S9(2)(a) [redacted]

Document 3

From: Ted Jamieson
To: Pallavi Chhibber; Robin Brasell
Subject: something on Spencer
Date: Wednesday, 3 August 2011 4:30:34 PM
Attachments: image001.png

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http://www.desmogblog.com/roy-spencer

Whether he really worked for NASA at some time, and in what capacity, isn't clear.

Ted Jamieson – Senior Adviser, ETS Operational Policy
Ministry for the Environment – Manatu Mo Te Taiao
DDI: 04 439 7622 Mob: S9(2)(a) Website: www.mfe.govt.nz
23 Kate Sheppard Place, PO Box 10362, Wellington 6143


Please consider the environment before printing this email.

Document 4

16-M-01011

S9(2)(a)
S9(2)(a)

Dear S9(2)

Thank you for your email of 1 August 2016 regarding global temperature measurement. I am responding on behalf of Ministers English, Joyce and Bridges, as the issues you raise lie within my responsibilities as Minister for Climate Change Issues.

Thank you for passing on Dr Spencer's report, it has been noted.

Yours sincerely,

Hon Paula Bennett
Minister for Climate Change Issues

Out of scope

[redacted]

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From: S9(2)(a)
Sent: Tuesday, 6 June 2017 9:38 p.m.
To: Info at MfE
Subject: New Insights on the Physical Nature of the Atmospheric Greenhouse Effect Deduced from an Empirical Planet Model

The Chairman of the ETS review committee and members.
Headline

IPCC CO2 Hypothesis of Global Warming is wrong.

-

New Insights on the Physical Nature of the Atmospheric Greenhouse Effect Deduced from an Empirical Planetary Temperature Model by Ned Nikolov* and Karl Zeller. Full paper available here I recommend you read it as it is fundamental to your task.

This could be the most important peer reviewed and published paper on climate in the last 2 centuries. Your understanding of it and its devastating importance to current beliefs of the alarmist climate community can't be over sold. It is game changing, this is the stuff Nobel Prizes are made of.

If you have the maths and physics, a detailed read of the paper is possible, for most however it is the conclusions on Page 17 that are pertinent to a role on the ETS review. The ETS was based on the so called "settled science" of late last century, the science has moved on. A clue to the unsettled science might be that the IPCC GCM's have failed miserably to predict almost everything. Climate sensitivity has moved down to the extent that it alone takes the C out of CAGW. With CS at just over 1 and still falling it leaves the IPCC 3 to 3.5 used in models as absurd outliers producing model outputs that make the models run hot by a factor of at least 2. The hiatus in temperature, the lack of acceleration in sea level rise while CO to continues to rise, the lack of a "Hot Spot" in the tropical troposphere The lack of desertification and on the contrary the tangible greening of the earth, lack of increased hurricane intensity and number of hurricanes all goes to show that something might be wrong with the theory.

From the Papers conclusions
The planetary temperature model has several fundamental theoretical implications, i.e.

• The 'greenhouse effect' is not a radiative phenomenon driven by the atmospheric infrared optical depth as presently believed, but a pressure-induced thermal enhancement analogous to adiabatic heating and independent of atmospheric composition;

• The down-welling LW radiation is not a global driver of surface warming as hypothesized for over 100 years but a product of the near-surface air temperature controlled by solar heating and atmospheric pressure;

• The albedo of planetary bodies with tangible atmospheres is not an independent driver of climate but an intrinsic property (a by-product) of the climate system itself. This does not mean that the cloud albedo cannot be influenced by external forcing such as solar wind or galactic cosmic rays. However, the magnitude of such influences is expected to be small due to the stabilizing effect of negative feedbacks operating within the system. This understanding explains the observed remarkable stability of planetary albedos;

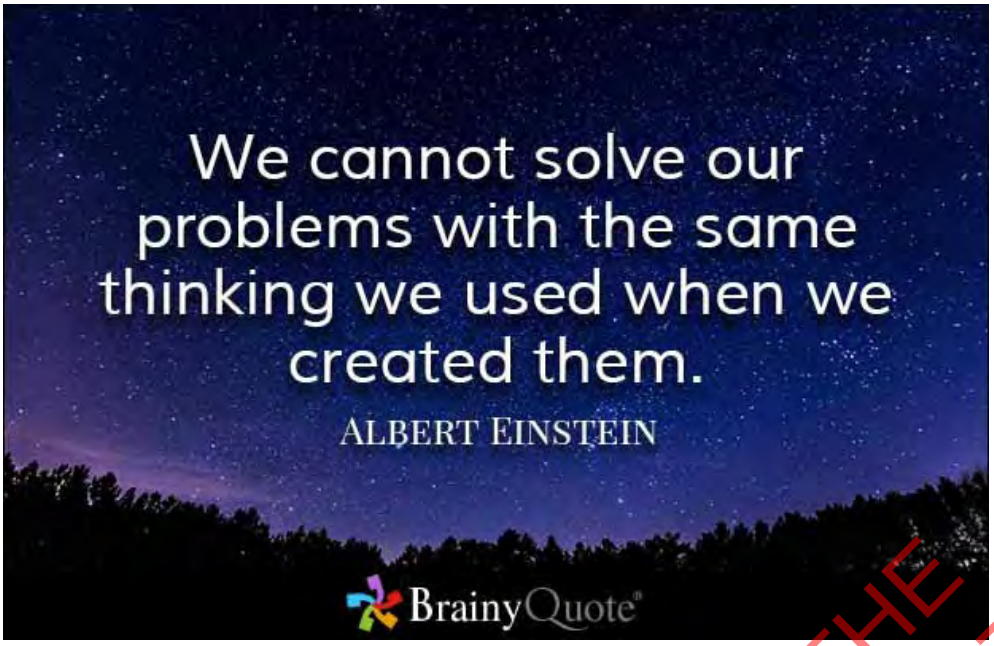
• The equilibrium surface temperature of a planet is bound to remain stable (i.e. within ± 1 K) as long as the atmospheric mass and the TOA mean solar irradiance are stationary. Hence, Earth's climate system is well buffered against sudden changes and has no tipping points;

• The proposed net positive feedback between surface temperature and the atmospheric infrared opacity controlled by water vapor appears to be a model artefact resulting from a mathematical decoupling of the radiative-convective heat transfer rather than a physical reality.

The magnitude of the needfor a paradigm shift created by Nikolov and Zeller's paper is so fundamental that it entirely destroys the scientific base on which the ETS was predicated. Policy based on wrong science has no chance of success. If such policy (ETS) continues to be implemented it can only do damage to the Economy, the Middle Class and Poor in New Zealand meanwhile having no effect on the temperature of the earth whatsoever. The unintended consequences of continuing the ETS are already becoming apparent with the cost of $1.4B/an. to the country for the next 10 years. Given Nikolov N, Zeller K (2017) it is totally unnecessary because the ETS policy is based on a false science.

The much vaunted Paris Accord will change the temperature of the earth a best by 0.05 degrees C in 2100. This amount is not measurable.
If Paris runs for an extra 70 years to 2100 it would change the temperature of the earth by 0.17degrees C only if all party's fulfil all commitments. We are off to a great start with US pulling out. You can get an idea of our share by dividing our GDP by world GDP (2015 data) and multiplying by 0.17. is 4/10,000th of a degree C. Read the full paper by Bjorn Lomborg here http://www.lomborg.com/press-release-research-reveals-negligible-impact-of-paris-climate-promises
But it all becomes futile waste of resources when we take into account Nikolov N, Zeller K (2017).

I'm sure you are thinking that this is only one paper can I refer you to Einstein 1.



Nikolov and Zeller changed the thinking big time.

Enjoy

S9(2)(a)
[redacted]

Document 6

From: Alex Pickard
To: Miranda Grimmer
Subject: FW: Climate change Important new development. Wednesday August 23 2017
Date: Monday, 11 September 2017 2:02:18 PM

Hi Miranda.
Would you be able to print for me the bottom part of this request from S9(2)(); Along with the response from this link? http://tepuna.mfe.govt.nz/otcs/cs.dll/properties/9195484

Alex

From: Georgina Beasley [mailto:xxxxxxxx.xxxxxxx@xxxxxxxxxx.xxxx.xx]
Sent: Friday, 25 August 2017 9:10 a.m.
To: Ministerials
Cc: Salote Talagi
Subject: FW: Climate change Important new development. Wednesday August 23 2017

Ministerial for us ☺

From: Helen Lahtinen
Sent: Thursday, 24 August 2017 6:22 p.m.
To: Salote Talagi; Georgina Beasley
Subject: FW: Climate change Important new development. Wednesday August 23 2017

From: Hon Paula Bennett
Sent: Thursday, 24 August 2017 5:59 p.m.
To: Helen Lahtinen <xxxxx.xxxxxxxx@xxxxxxxxxx.xxxx.xx
Subject: FW: Climate change Important new development. Wednesday August 23 2017

From: S9(2)(a)]
Sent: Wednesday, 23 August 2017 10:44 p.m.
To: Hon Paula Bennett <xxxxx.xxxxxxx@xxxxxxxxxx.xxxx.xx
Subject: Climate change Important new development. Wednesday August 23 2017

Dear Minister for Climate Change,Paula Bennett Since my last e,mails in which i have tried to expose the fact that the theory of extra Carbon Dioxide causing a runaway greenhouse effect is "Failed Science".There has been a very interesting court case. Professor Michael Mann of Pen State.{university}, one of the most important protagonists of man made global warming,has taken Dr Tim.Ball, Mark Steyn, et al.to the supreme court in Canada for defamation.Ball,Steyn,et al.had called Mann's "Hockey stick graph" of global temperature predictions,Fraudulent and Mann himself a Fraud.On the 4 July this year.The judge ruled that Mann had to disclose his data,publicly funded data,that must be free to view.Mann has failed to do as the court has ruled and is in contempt of court.He is now liable for costs and Ball can press the Fraud charges. You can find out the details.By typing in the case on youtube or google. I have alerted you to this news because the main stream media will almost certainly not publish it as it is a death blow to the AGW hoax.Mann along with ,James Hansen of NASA's Goddard institute and Gavin Schmidt are the three most influential scientists behind the theory of run away global warming ,due to extra CO2. In a letter i wrote to The Hon. Tim Groser some while ago.I alerted him to the

fact that the IPCC. NIWA.and NOAA.were bending the science.Now we know the universities are also running with" failed science" In the mean time the science that i find robust,that of the astrophysicists'[.They show how and why it is the sun not CO2 that governs climate] Their predictions are spot on.The sun spots have all but stopped.I look for them through welders helmet glass now i see none.The cooling has started.Check recent UAH satellite data.The University of Alabama At Huntsville is one beacon of honest climate science.The satellite data is made free to all to download by honest scientists Dr.John Christy and Dr.Roy Spencer.So NOAA and NASA can not bend that data and get away with it. I hope this info is of use to you.I am very frightened that if Labour get in they will take us into extremely destructive and punitive Ets.and carbon taxes.We must win this election it is more important than ever.All the best. yours faithfully S9(2)(a)
B.Sc.Agric.Wye London ps. sorry about lay out i am new to computers and self taught.

- Staff login

Zero Carbon Bill

Submission

* Company name

NA

* Given names

Kevin Maitland

Surname

Hearle

Contact person

Kevin Hearle

Thank you for the opportunity to submit on this Bill.

Short Bio

I have a BSc in Pure and Applied Mathematics with minors in Physics, Geology and Economics my career was in Education both in the Ministry (5 years) and teaching and administration ending in running BOP Polytechnic as foundation CEO from its inception in 1982 until 1994. I have served on many industry training organisations and statutory authorities including Education New Zealand in its formative stages. I had Fulbright and Churchill Fellowships. I have worked as a stockbroker so have an understanding of the financial markets. I am retired.

I'm sceptical by education and life experience, but I believe in sustainability and managing our natural environment for the benefit of humanity and the planet.

I am not affiliated to any political party nor am I paid by any entity except through a Government Pension

Reason for Submission

Through extensive reading on the topic it is abundantly clear that all is not well with the science and politics of so called "Climate Change". The result is that that the poor and middle classeses around the world, are paying dearly for the political interpretation and ideologically driven, rather than scientifically driven agendas on Climate. Humanity is suffering both in the developed western civilization as well as in the undeveloped and poor regions of the planet. Catastrophic failure of climate policy implementation in countries around the world has been to the detriment of the poor and middle classeses. In New Zealand we have serious social problems in Health, Education, Housing, Infrastructure and real threats from more important natural disaster issues such as earthquakes; all of which have a higher priority than chasing the chimera of changing the temperature of the earth by 5/10,000 C (our share of Paris Accord)100 years from now. We don t have our priorities right, and as I will show, we don't have a stable scientific foundation or more precisely have the right interpretation of the science we do have, on which to base policy.

Quote **"The theory must not contradict empirical facts."**
— Albert Einstein

Legislative Requirement

The Climate Commission should be mandated through legislation to use only empirically based science as its raison d'être.

The Commission should be independent of Government and advisory only.

The members of the commission should be chosen from a wide spectrum of the population, balanced as to ideology and politics to avoid group-think and partisanship

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Some Definitions

Global Warming- ***The hypothesis of CO2 induced global warming implies that increasing CO2 is the control knob that will raise the temperature of the earth. The signature of this hypothesis (for physical reasons) is a hot spot in the mid to upper troposphere in the tropics 20N to 20S.***

Climate Change- ***This term is what Global Warming morphed to so that Alarmists could blame every natural weather event, hot or cold, wet or dry, melting or freezing, windy or still etc on a daily basis on the "Climate Agenda" nothing could be more unscientific or misplaced.***

In this submission I will speak to Global Warming because this is the real issue.

Politics

The UNFCC IPCC is a political rather than a scientific organisation and has become the go-to organisation for Governments when formulating policy on Climate. The danger is that politics overrides science in this highly political organisation. I don't intend to address the failures of the IPCC process directly. It is however at the heart of the politics of CO2 and is failing humanity. To a large extent the failure is due to its inability to move on from the limited scientific understanding of climate of the 1980's to our much more sophisticated yet still incomplete understanding of 2018. The lock into 1980's science is designed to maintain the ideology espoused by the UN to use Climate as a surrogate to redistribute the wealth of the first world to the third world and centrally control that redistribution.

Science

It is the scientific foundation that is important in any policy formation on climate that needs to be considered, not the ideological agenda of leftist/green governments and NGO's that are driving the climate debate around the world. The Commission's first roll is to put into context the current scientific understanding of climate and the direction it is moving if we are to get good outcomes from any new policy on Climate, should it be needed. If the scientific foundation is incorrect then the policy will inevitably produce bad outcomes for society. Therefore, I urge the Government and Commission to check the state of the science first. To do this they need to look outside the incestuous and group think government funded and IPCC centric climate community that exists in our Universities, Government agencies and Ministries all of whom owe their existence to Government funding and allegiance to their funder.

Current climate policy based on outdated science around the world has failed to produce positive outcomes for its intended purpose of reducing emissions. Energy policies have been the soft target for policy makers and they have failed, in some cases catastrophically. Taxes, subsidies and subsidies on subsidies, have driven prices of energy up not down to the detriment of the poor and middle classes. In NZ the ETS has been a total failure. In Britain a massive redistribution of wealth has occurred from the middle classes to the wealthy land owners, purely due to the subsidies for Wind in particular, and Solar. In Germany the European icon of transition to so called clean energy through the 'Energiewende' policy emissions have been static for 10 years and are now rising again but 800,000 Germans are in energy poverty and can't pay their energy bills. Ironically coal and gas fired power stations are being built in Germany to keep the lights on and industry functioning without blackouts.

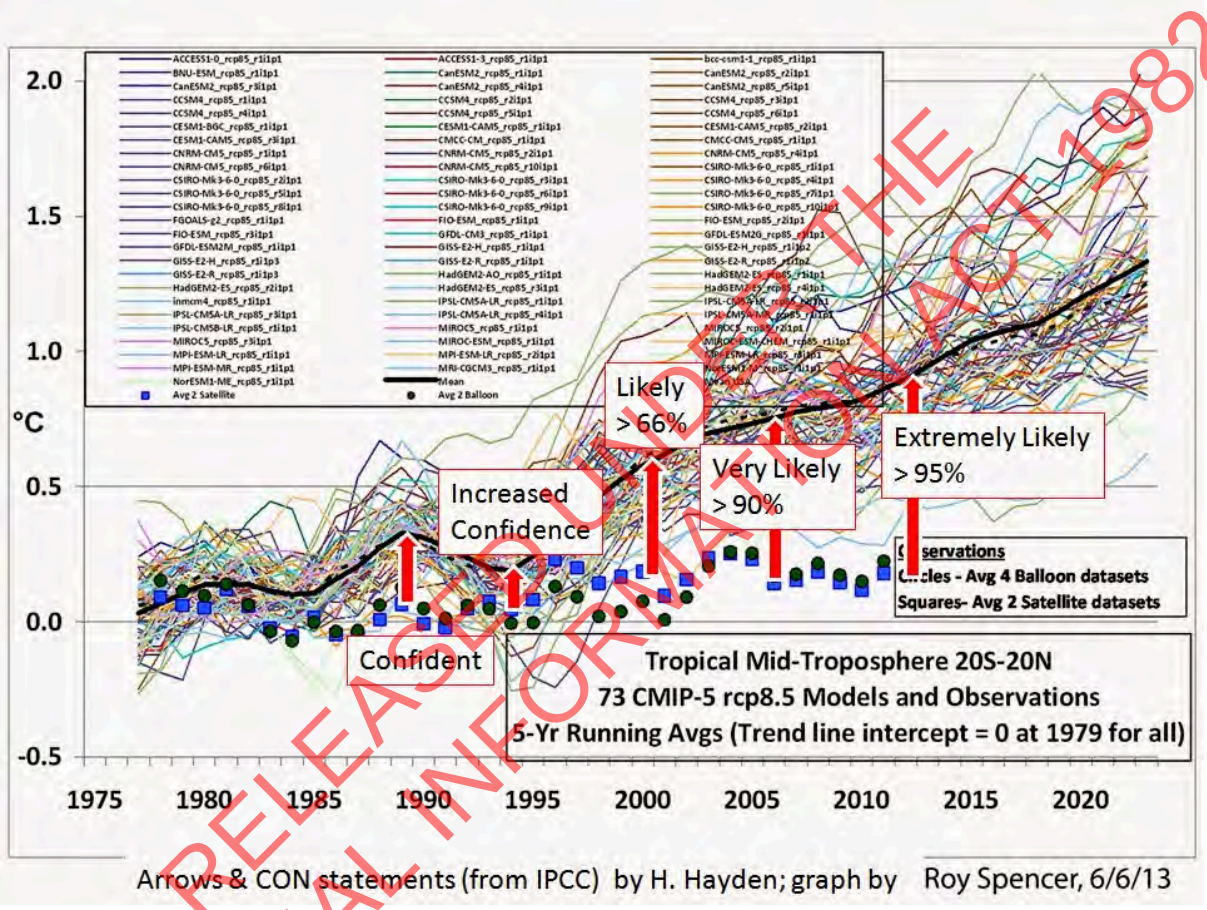
Climate Complexity, Politics and Science.

The scientific complexity and breadth of the sciences involved in understanding how our climate worked in the past and will continue to evolve in the future is beyond the understanding of most politicians and the majority of the public. This is the dilemma faced by all in discussing the issue. Here I am going to cut through the hard science and show significant outcomes of what has happened over the last 30 years and why we need to take stock before we launch into further policy initiatives that can have negative effects for humanity. I am going to try and cut through the climate catastrophe sound bite scene,

ideological dogma, and simply show what the real situation is, as the science has evolved through the decades to 2018.

Pictures speak louder than words

The Graphic below is illustrative of some of what I have eluded to above. It was presented to the US Committee on Space Science and Technology in recent hearings by Dr John Christie of UAH. (see attached U.S. House Committee on Science, Space & Technology 29 Mar 2017 Testimony of John R. Christy Professor of Atmospheric Science, Alabama State Climatologist University of Alabama in Huntsville.)



Note – the updated version of this graphic is in the testimony attached.

What this graphic shows-

Scientifically

- that the temperature of the tropical mid troposphere is not warming as predicted by the IPCC climate models on which Governments around the world have based policy. The signature of CO2 induced Global Warming, the tropical hot spot doesn't exist. The hypothesis fails. I have attached a scientific paper by Dr. John Christie of UAH and others to support this claim. *On the Existence of a "Tropical Hot Spot" & The Validity of EPA's CO2 Endangerment Finding.* (The paper is US centric but applies globally)

-Politically

- The rectangular boxes in the graphic show the IPCC's level of confidence in their models (coloured spaghetti lines with av. black thick line) at the time of each of the 5 IPCC reports thus far, as the modelled temperatures depart further from the measured temperature (blue squares and green dots)as time progresses the IPCC get increasingly confident that the models are correct. This is blatantly unscientific, and irrational on the part of the IPCC. POLICY BASED ON SUCH NONSENSE BY A GOVERNMENT WOULD BE CONSIDERED AN ACT OF SELF HARM TO THE COUNTRY.

A couple of quotes from one of the world's great physicists of the 20th century Dr Richard Feynman are in order here

> "*No government has the right to decide on the truth of scientific principles, nor to prescribe in any way the character of the questions investigated……" and*
>
> *"It doesn't make a difference how beautiful your guess is. It doesn't make a difference how smart you are, who made the guess, or what his name is. If it disagrees with experiment, it's wrong."*

What we see from the graphic then is that the guess (IPCC CO2 warming hypothesis) is wrong. The models can't mimic nature therefore the theory of Anthropogenic Global Warming (AGW) is wrong. Models are not empirical data although there is a belief (wrongly) that they represent our future climate. The models have never been validated, a requirement breached by the IPCC. Among other technical issues that bedevil the models is that they are incorrectly programmed for a level of Climate Sensitivity for a Doubling of CO2 (currently 3.4 C). The latest science finds it to be much lower (under 1.5C).

Temperature data analysis

At the heart of the climate debate is the issue of by how much has increased CO2 increased global temperature and has the current political response e.g. the EPA endangerment finding based on sound data. This has been tested, the relevant paper is "On the Existence of a "Tropical Hot Spot " & The Validity of EPA's CO2 Endangerment Finding". Dr. James P. Wallace III Dr. John R. Christy Dr. Joseph S. D'Aleo (August 2016) The abstract is below and the paper attached. While this is US centric the science on which it is based has global application.

ABSTRACT

These analysis results would appear to leave very, very little doubt but that EPA's claim of a Tropical Hot Spot (THS), caused by rising atmospheric CO2 levels, simply does not exist in the real world. Also critically important, even on an all-other-things equal basis, this analysis failed to find that the steadily rising Atmospheric CO2 Concentrations have had a statistically significant impact on any of the 13 critically important temperature time series analyzed.

Thus, the analysis results invalidate each of the Three Lines of Evidence in its CO2 Endangerment Finding. Once EPA's THS assumption is invalidated, it is obvious why the climate models they claim can be relied upon, are also invalid. And, these results clearly

demonstrate--13 times in fact--that once just the ENSO impacts on temperature data are accounted for, there is no "record setting" warming to be concerned about. In fact, there is no ENSO-Adjusted Warming at all. These natural ENSO impacts involve both changes in solar activity and the 1977 Pacific Shift.

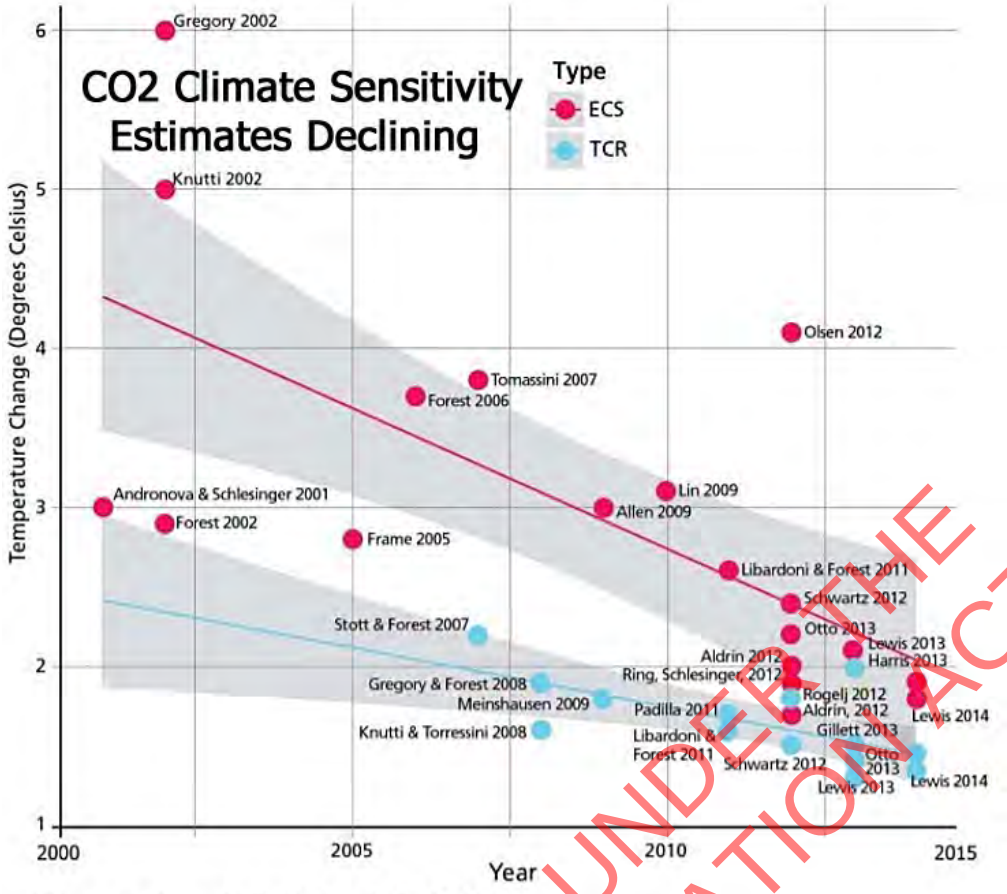
Moreover, on an all-other-things-equal basis, there is no statistically valid proof that past increases in Atmospheric CO2 Concentrations have caused the officially reported rising, even claimed record setting temperatures. To validate their claim will require mathematically credible, publicly available, simultaneous equation parameter estimation work.

The temperature data measurements that were analyzed were taken by many different entities using balloons, satellites, buoys and various land-based techniques. Needless to say, if regardless of data source, the results are the same, the analysis findings should be considered highly credible.

Equilibrium Climate Sensitivity (ECS)

ECS is at the heart of the IPCC global warming hypothesis. If the ECS is low we do not have a climate problem. To the contrary a small rise in temperature and increased CO2 can be nothing but benign and beneficial to humanity. Unfortunately for the UN, this reality destroys its agenda.

Estimates of ECS have been falling as time passes The IPCC median estimate of 3.4C (1.5-4.5) as used in its models is no longer credible.



(figure as shown in **Scafetta et al., 2017**)

Figure 7. Compilation of published transient climate response (TCR) and equilibrium climate sensitivity (ECS) values to atmospheric CO2 doubling. (Adapted from Figure 1

ECS is defined as the increase in temperature for a doubling of CO2. The latest research indicates that (ECS) is conservatively half that used in the IPCC climate models and this is material if policy is to be based on ECS and (TCR). The relevant paper is Lewis and Curry 2018 (LC2018) https://doi.org/10.1175/JCLI-D-17-0667.1 and its predecessor (LC2015). Lewis and Curry use an energy balance model for their estimate, so derived the ECS =1.5 and TCR =1.2C. This has been verified by a completely different method. This year a group headed by Lord Monkton of Brenchley discovered a fundamental mistake in the way climate scientists applied feedback theory in climate modelling. The relevant paper is best read as the evidence presented in an Amicus brief to a court case in the State of California, People of California vs BP et al. (the judge found in favour of the defendants). They find that ECS =1.2K their conclusion is "*Since the mid-range estimate of Charney sensitivity (and, equivalently, of 21st-century global warming) should not be* 3.3 *K, as had hitherto been thought, but only* 1.2 *K, and even the high-end estimate will almost certainly be less than* 1.4 *K, action to prevent global warming is no longer necessary.*"

The IPCC AR5(2013) declined to state a median climate sensitivity because they recognised the level they had used for 25 years was no longer credible. Their political solution was to stick with the range (1.5 to 4.5). In 2018 their 3.3 is even less credible as ECS estimates continue their downward slide.

Social Cost of Carbon

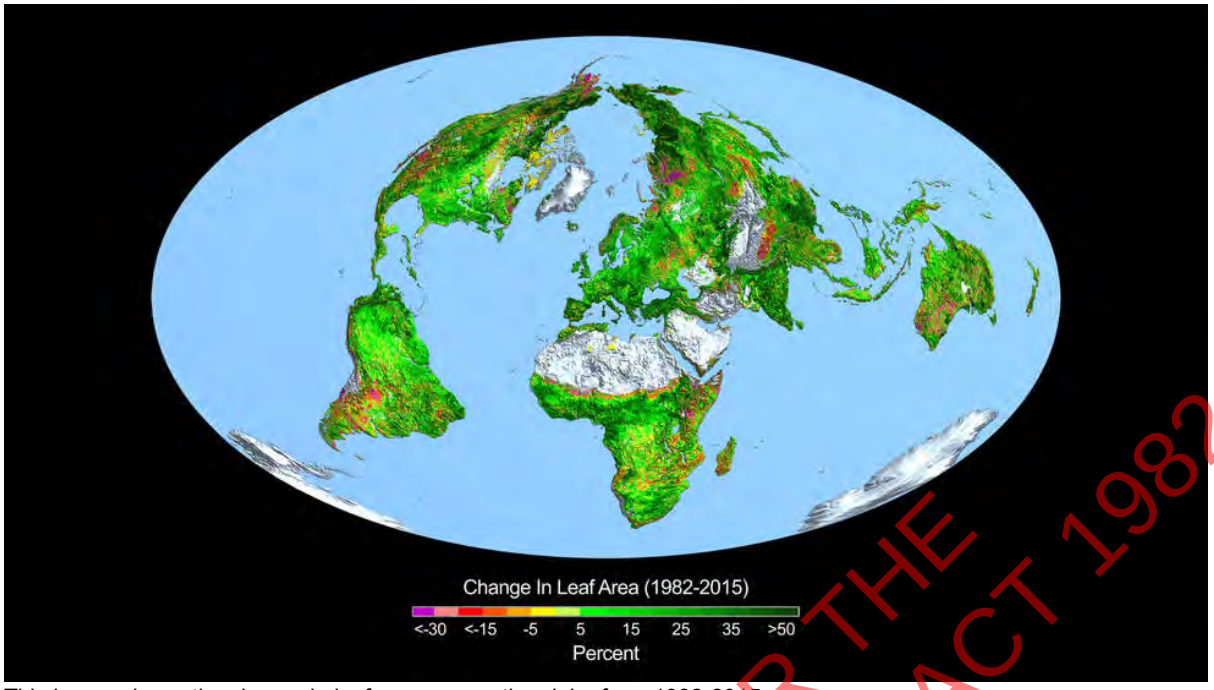
This is not the place to get into detail on Integrated Assessment Models (IAM) used to determine SCC. It suffices to show that equilibrium climate sensitivity (ECS) in the existing determination of the SCC is outdated and does not reflect multiple, independent findings in recent years, that the median ECS is materially lower, (as indicated above). The earth's equilibrium climate sensitivity is recognized as "a key input parameter" for the IAM used to determine the SCC.

Excerpt from the paper referenced below " If an empirically determined value of ECS is used in the DICE model the average SCC falls by 30-50% depending on the discount rate, while in the FUND model the average SCC falls by over 80%. The span of estimates across discount rates also shrinks considerably, implying less sensitivity to this parameter choice…Furthermore the probability of a negative SCC (implying CO2 emissions are a positive externality) jumps dramatically using an empirical ECS distribution." Note that an ECS of 1.2K would reduce the SCC more than the percentages stated above in this paragraph. A good analysis of the issue is to be found here
https://www.rossmckitrick.com/uploads/4/8/0/8/4808045/empirical_scc_cce_preprint.pdf

This paper uses the LC2015 paper and hence over estimates the SCC, an update using the latest values is required. It is beholden on the Government and Climate Commission to rigorously investigate the use of failed IPCC estimates of ECS and their effect on the SCC and hence the reliability and efficacy of any policy proposed.

Social benefits of increased CO_2

There has been a tendency to downplay or completely exclude any benefits of increasing CO2 from SCC analysis. As an example, the existing SCC calculations largely ignore the magnitude, or even the existence of the highly documented (and observed) enhancement of plant growth caused by increasing atmospheric carbon dioxide. The NASA graphic below is illustrative.



This image shows the change in leaf area across the globe from 1982-2015

Credits: Boston University/R. Myneni

Note 70% of this greening is due to CO2 the next most prevalent nitrogen at 9%

Satellite data confirm that the earth's surface is becoming greener, with the largest changes being on the margins of the world's great deser s. There is no accounting for this in the current calculation of the SCC. An explanation of the benefits of CO2 can be found here https://www.youtube.com/watch?v=27XbnyWC5WM

This is a large and material, positive externality; and one that is insufficiently modelled in the IAMs relied upon by the Government in determining the SCC. For an agriculturally based economy like NZ the positive externality of increased plant growth is material in any analysis of the effect of increased CO2 on the economy.

If we turn our attention to the Benefits of Carbon Dioxide rather than the Costs a very different picture evolves. The benefits outweigh the costs by orders of magnitude. It is beholden on the Government and Climate Commission to consider both sides of the story. Go here for a review http://www.misi-net.com/publications/CarbonBenefits-0114.pdf

A short diversion

One of the assumptions when discussing the effects of CO2 induced global warming is that the climate in 1850, the generally accepted base year, was in equilibrium and that the temperature at that time was optimal. Neither of these assumptions is true. History teaches us that humanity thrived when the temperature of the earth was higher than in 1850 (we were just exiting a mini ice age). It should not be surprising that the biosphere thrives also in higher levels of ambient CO2 and temperature. The glass house crop growers pump CO2 in at up to 1000ppm to produce the great tomatoes, beans and capsicums that we enjoy. The climate is never in equilibrium it wasn't in 1850 and it isn't now, that is the nature of nonlinear chaotic natural systems. Another assumption (wrong) is that natural variability in

the climate that had existed for 4.5B years, suddenly stopped when CO2 started to rise and according to the alarmist IPCC, became the control knob for climate. Nothing could be more absurd and scientifically wrong. Note that the ENSO produced a naturally occurring El Nino in 2015/16/17 the temperature of the earth increased then decreased about 0.55C over this event, we are now back to business as usual. If nothing else these naturally occurring events show that CO2 is not in the driver's seat in fact it shows very graphically that the power of CO2 to affect the climate is minuscule in comparison to natural variability.

In terms of policy, if as shown above the ECS is low (conservatively <1.5 C) and that this in turn gives a low or negative SCC, then the need to reduce CO2 through aggressive policy is misplaced. The inevitable detrimental effect of increased taxation such as the ETS and proposed new environmental climate taxes can not be justified. All such taxes are regressive and hit the poor and middle classes. It stands to reason that this misallocation of resources inevitably results in higher priorities listed previously unmet, for no environmental gain.

New Science redefining the baseline.

I have already shown that in the case of critical policy related variables such as ECS and SCC, we can not justify policy action because the alarmist mantra based on IPCC modelled projections, have failed the most basic scientific test. Independent scrutiny of current policy action around the world has shown negative effects on humanity for no gain to the climate.

Already mentioned above is the work of Lewis and Curry and Monkton et al.

Nikolov and Zeller (2018) took a radical approach to looking at the temperature of the earth and in the process discovered a new law for understanding the temperature of planets with similar properties to our own. They used publicly available NASA data gathered from probes and satellites to show that the temperature of the earth is determined by only 2 variables incoming solar radiation and atmospheric surface pressure. The implications of their discovery for the IPCC are to borrow a phrase, 'Catastrophic'.

Abstract Nikolov and Zeller (2018)

A recent study has revealed that the Earth's natural atmospheric greenhouse effect is around 90 K or about 2.7 times stronger than assumed for the past 40 years. A thermal enhancement of such a magnitude cannot be explained with the observed amount of outgoing infrared long-wave radiation absorbed by the atmosphere (i.e. ≈ 158 W m^{-2}), thus requiring a re-examination of the underlying Greenhouse theory. We present here a new investigation into the physical nature of the atmospheric thermal effect using a novel empirical approach toward predicting the Global Mean Annual near-surface equilibrium Temperature (GMAT) of rocky planets with diverse atmospheres. Our method utilizes Dimensional Analysis (DA) applied to a vetted set of observed data from six celestial bodies representing a broad range of physical environments in our Solar System, i.e. Venus, Earth, the Moon, Mars, Titan (a moon of Saturn), and Triton (a moon of Neptune). Twelve relationships (models) suggested by DA are explored via non-linear regression analyses that involve dimensionless products comprised of solar irradiance, greenhouse-gas partial pressure/density and total atmospheric pressure/density as forcing variables, and two temperature ratios as dependent variables. One

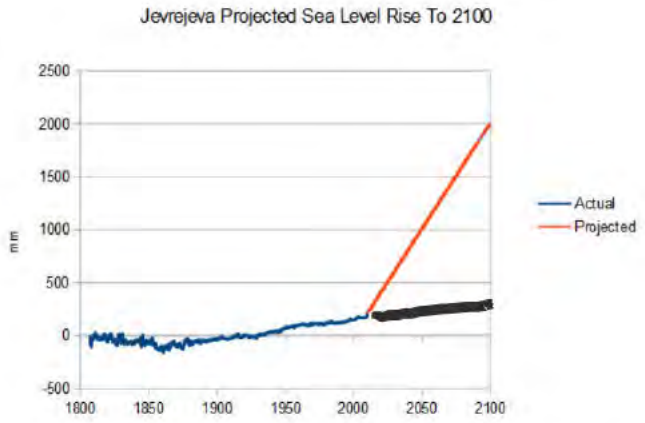
non-linear regression model is found to statistically outperform the rest by a wide margin. Our analysis revealed that GMATs of rocky planets with tangible atmospheres and a negligible geothermal surface heating can accurately be predicted over a broad range of conditions using only two forcing variables: top-of-the-atmosphere solar irradiance and total surface atmospheric pressure. The hereto discovered interplanetary pressure-temperature relationship is shown to be statistically robust while describing a smooth physical continuum without climatic tipping points. This continuum fully explains the recently discovered 90 K thermal effect of Earth's atmosphere. The new model displays characteristics of an emergent macro-level thermodynamic relationship heretofore unbeknown to science that has important theoretical implications. A key entailment from the model is that the atmospheric 'greenhouse effect' currently viewed as a radiative phenomenon is in fact an adiabatic (pressure-induced) thermal enhancement analogous to compression heating and independent of atmospheric composition. Consequently, the global down-welling long-wave flux presently assumed to drive Earth's surface warming appears to be a product of the air temperature set by solar heating and atmospheric pressure. In other words, the so-called 'greenhouse back radiation' is globally a result of the atmospheric thermal effect rather than a cause for it. Our empirical model has also fundamental implications for the role of oceans, water vapour, and planetary albedo in global climate. Since produced by a rigorous attempt to describe planetary temperatures in the context of a cosmic continuum using an objective analysis of vetted observations from across the Solar System, these findings call for a paradigm shift in our understanding of the atmospheric 'greenhouse effect' as a fundamental property of climate.

A review of the paper can be found here
https://tallbloke.wordpress.com/2017/06/01/foundations-of-greenhouse-theory-challenged-by-new-analysis-of-solar-system-observations/

Media Hype Institutional and Scientific Credibility.

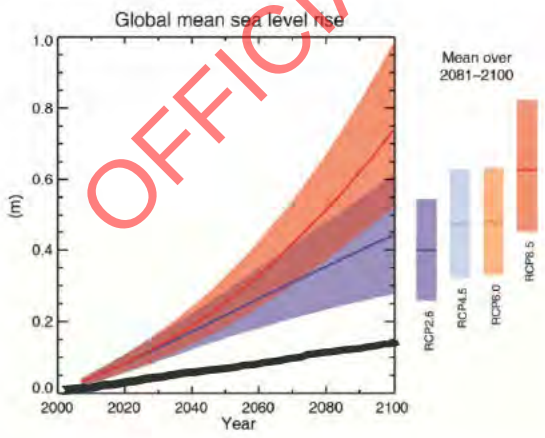
As I wrote this submission the following news report appeared. "Rising sea levels could cost the world $14 Trillion a year by 2100." July 3 2018 Institute of Physics. "*Published today in Environmental Research Letters, a study led by the UK National Oceanographic Centre (NOC) found flooding from rising sea levels could cost $14 trillion worldwide annually by 2100, if the target of holding global temperatures below 2 ºC above pre-industrial levels is missed."….*

Below is the graphic of the situation they portray



The blue line is sea level direct from the UK National Oceanic Centre same lead scientist studies on sea level 1800 until 2010 (nature) the red line is what the same scientists say is going to happen if we don't meet the UN target of 2 degrees by 2100 (1.8M rise). The black line (I added) is nature, business as usual, projected forward linearly.

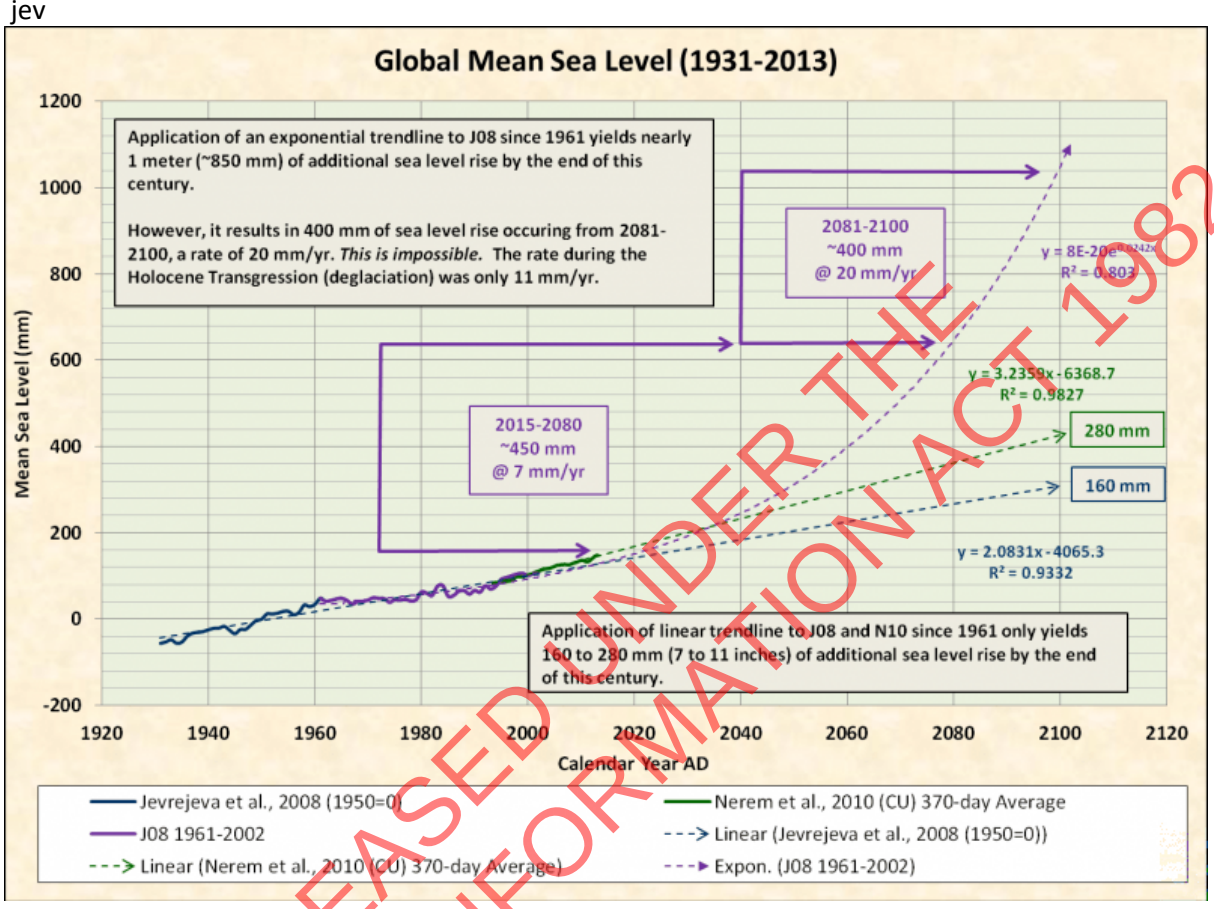
The NOC study is pseudo-science based on failed climate models and the unrealistic IPCC RCP 8.5 scenario. It is designed to be click bait for the media and to terrify the public. The scientific organisations and scientists who do this have zero credibility. Interestingly this so-called research is nothing new. It parrots the IPCC 2013 AR5 report that our PCE used in her report on sea level (page 19). Critically there is no CO2 signal in sea level data anywhere in the world. To the PCE graphic below I have added the black line (linear projection of business as usual) for NZ data. What we are now able to do is track the difference between the IPCC model projections and nature. The vertical distance on the graph between the black line and the average model IPCC projections annually, (the graphed projections all initiate at (2000,0)). After 18 years the IPCC projections are not preforming well. The longer the IPCC projections stay above the black line the harder it becomes for the 2100 projection to be attained to the extent that it will become physically impossible for the IPCC projection to be attained. The Government should not be betting our future on pseudo-science IPCC projections of future climate that are based on failed climate models using unrealistic RPC 8.5 that bear no relation to physical reality.



The black line represents a business as usual scenario, nature, 1.4mm/yr the New Zealand average rate. Need I say more.

Real scientists looked at this pseudo- scientific nonsense when it first appeared and came up with the following graphic that explains the situation well. Note the comments in the box!!!

jev



If you keep repeating the same story often enough people will believe it. However. it is still nonsense. The same scientist Jevrejeva is at NOC leading the current propaganda. This is a great example of discredited pseudo-science being regurgitated as propaganda to support a failing political agenda. The Government and Climate Commission must look past such bad science as depicted by NOC and use empirical evidence only for policy action on climate.

Ambiguity and Deep Uncertainty

Climate science is inherently mired in the effects (known and unknown) and the reliability of variables and parametrizations that go to our understanding of the climate we live in. Dr Judith Curry 'Climate Uncertainty & Risk' (Curry July 2018) Draft, is a paper helpful in understanding the issues. Her opening two paragraphs set out the problem.

"*Research scientists focus on the knowledge frontier, where doubt and uncertainty are inherent. Formal uncertainty quantification of computer models is less relevant to science than an assessment of whether the model helps us learn about how the system works.*

However in context of the science-policy interface, uncertainty matters. There is a growing need for more constructive approaches to accountability about the different dimensions of uncertainty in climate change as related to policy making– what may happen in the future and what actions might be appropriate now."

From her conclusions …… "*The root of the most significant problem at the climate science-policy interface lies not in the climate models themselves but in the way in which they are used to guide policy making. Climate scientists have helped exacerbate this problem. Both climate scientists and policy makers need to accept the limits of probabilistic methods in conditions of ambiguity and deep uncertainty that characterize climate change. Encouraging overconfidence in the realism of current climate model simulations or intentionally portraying recognized ignorance incorrectly as if it was statistical uncertainty (Knightian risk) can lead to undesirable policy outcomes".*

The full draft paper (attached) is helpful in understanding the issues to be addressed in the context of forming legislation.

It is important that politicians and bureaucrats involved in developing 'Climate Legislation' understand the real scientific, mathematical, statistical and natural environment they are attempting to legislate for. Failure to understand will inevitably produce bad legislation that will ultimately be to the detriment of the poor and middle classes for no benefit to the climate. Every policy implemented thus far around the world has produced cost increases to the poor and middle classes and no benefit to the 'Climate

This is why the proposed –

legislation for the Climate Commission must

1. **enshrine in that legislation that only research based on empirical data be used in its decision making on Climate. Model projections are not data and must be treated with caution.**
2. **Ensure that the latest research be considered impartially in the formulation of policy and legislation.**
3. **ensure the Commission is independent of Government and advisory only.**
4. **That the members of the Commission should be chosen from a wide spectrum of the population, balanced as to ideology and politics to avoid group-think and partisanship.**

This submission indicates that there has been a profound and material change in the science of Global Warming ('climate change') since the 1990's, and hence a need to update the understanding of politicians and bureaucrats as they prepare legislation on Climate. Failure to recognise the sea change in the science will inevitably produce poor legislation and

unforeseen economic and social aberrations to the detriment of the poor and middle classes for no real benefit to the climate.

Thank you for the opportunity to submit.

I am happy to be questioned on any part of this submission.

Kevin Hearle

From: Alex Pickard
To: s 9(2)(a)
Cc: Info at MfE
Subject: RE: New Insights on the Physical Nature of the Atmospheric Greenhouse Effect Deduced from an Empirical Planet Model
Date: Monday, 12 June 2017 10:51:00 AM
Attachments: image002.jpg
image004.jpg

Thank you for your emails of 6 June 2017 regarding climate change and the New Zealand Emissions Trading Scheme (NZ ETS).

The Intergovernmental Panel on Climate Change (IPCC) reports are a credible source of advice for policy. The IPCC reports represent the global expert assessment of knowledge on climate change, which the New Zealand Government accepts. The value of these scientific reports is not affected by the claims of the article you refer to in your email.

The Government considers it prudent to implement policies to reduce human-caused greenhouse gas emissions, and to prepare for the impacts of climate change, as shown by our commitment to the Paris Agreement. The NZ ETS is one of these policies.

Kind regards,

Alex – Advisor, Executive Relations Team
Ministry for the Environment – Manatu Mo Te Taiao
Email: xxxxxxxxx@xxx.xxxx.xx Website: www.mfe.govt.nz
No.3 The Terrace, PO Box 10362, Wellington 6143

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From: s 9(2)(a)
Sent: Tuesday, 6 June 2017 9:38 p.m.
To: Info at MfE
Subject: New Insights on the Physical Nature of the Atmospheric Greenhouse Effect Deduced from an Empirical Planet Model

The Chairman of the ETS review committee and members.
Headline

IPCC CO2 Hypothesis of Global Warming is wrong.

-

New Insights on the Physical Nature of the Atmospheric Greenhouse Effect Deduced from an Empirical Planetary Temperature Model by Ned Nikolov* and Karl Zeller. Full paper available here I recommend you read it as it is fundamental to your task.

This could be the most important peer reviewed and published paper on climate in the last 2 centuries. Your understanding of it and its devastating importance to current beliefs of the alarmist climate community can't be over sold. It is game changing, this is the stuff Nobel Prizes are made of.

If you have the maths and physics, a detailed read of the paper is possible, for most however it is the conclusions on Page 17 that are pertinent to a role on the ETS review. The ETS was based on the so called "settled science" of late last century, the science has moved on. A clue to the unsettled science might be that the IPCC GCM's have failed miserably to predict almost everything. Climate sensitivity has moved down to the extent that it alone takes the CO out of CAGW. With CS at just over 1 and still falling it leaves the IPCC 3 to 3.5 used in models as absurd outliers producing model outputs that make the models unfit by a factor of at least 2. The hiatus in temperature, the lack of acceleration in sea level rise while CO to continues to rise, the lack of a "Hot Spot" in the tropical troposphere The lack of desertification and on the contrary the tangible greening of the earth, lack of increased hurricane intensity and number of hurricanes all goes to show that something might be wrong with the theory.

From the Papers conclusions
The planetary temperature model has several fundamental theoretical implications, i.e.

• The greenhouse effect' is not a radiative phenomenon driven by the atmospheric infrared optical depth as presently believed, but a pressure-induced thermal enhancement analogous to adiabatic heating and independent of atmospheric composition;

• The down-welling LW radiation is not a global driver of surface warming as hypothesized for over 100 years but a product of the near-surface air temperature controlled by solar heating and atmospheric pressure;

• The albedo of planetary bodies with tangible atmospheres is not an independent driver of climate but an intrinsic property (a by-product) of the climate system itself. This does not mean that the cloud albedo cannot be influenced by external forcing such as solar wind or galactic cosmic rays. However, the magnitude of such influences is expected to be small due to the stabilizing effect of negative feedbacks operating

within the system. This understanding explains the observed remarkable stability of planetary albedos;

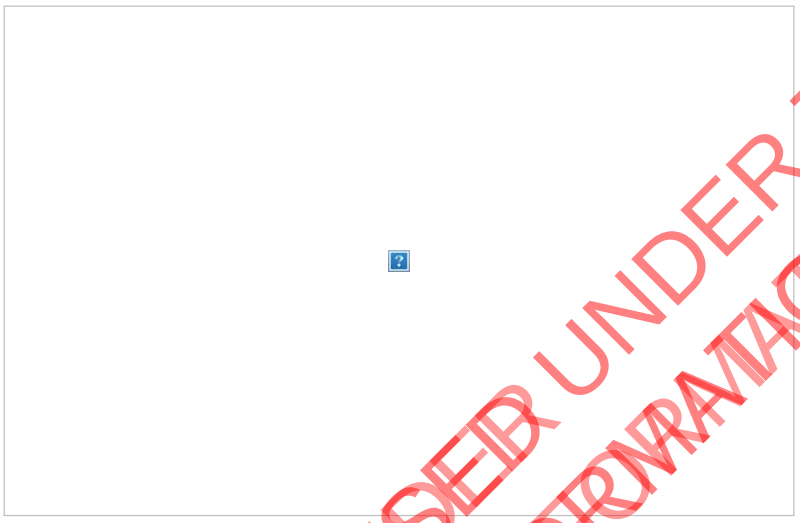
• The equilibrium surface temperature of a planet is bound to remain stable (i.e. within ± 1 K) as long as the atmospheric mass and the TOA mean solar irradiance are stationary. Hence, Earth's climate system is well buffered against sudden changes and has no tipping points;

• The proposed net positive feedback between surface temperature and the atmospheric infrared opacity controlled by water vapor appears to be a model artefact resulting from a mathematical decoupling of the radiative-convective heat transfer rather than a physical reality.

The magnitude of the needfor a paradigm shift created by Nikolov and Zeller's paper is so fundamental that it entirely destroys the scientific base on which the ETS was predicated. Policy based on wrong science has no chance of success. If such policy (ETS) continues to be implemented it can only do damage to the Economy, the Middle Class and Poor in New Zealand meanwhile having no effect on the temperature of the earth whatsoever. The unintended consequences of continuing the ETS are already becoming apparent with the cost of $1.4B/an. to the country for the next 10 years. Given Nikolov N, Zeller K (2017) it is totally unnecessary because the ETS policy is based on a false science.

The much vaunted Paris Accord will change the temperature of the earth a best by 0 05 degrees C in 2100. This amount is not measurable.
If Paris runs for an extra 70 years to 2100 it would change the temperature of the earth by 0.17degrees C only if all party's fulfil all commitments. We are off to a great start with US pulling out. You can get an idea of our share by dividing our GDP by world GDP (2015 data) and multiplying by 0.17. is 4/10,000th of a degree C. Read the full paper by Bjorn Lomborg here
http://www.lomborg.com/press-release-research-reveals-negligible-impact-of-paris-climate-promises
But it all becomes futile waste of resources when we take into account Nikolov N, Zeller K (2017).

I'm sure you are thinking that this is only one paper can I refer you to Einstein 1.



Nikolov and Zeller changed the thinking big t m

Enjoy

s 9(2)(a)
[redacted]

Document 9

Item of business :

Climate Change Response (Zero Carbon) Amendment Bill

Submission name :

Barbara McKenzie

Comments

SUBMISSION TO THE CLIMATE CHANGE RESPONSE (ZERO CARBON) AMENDMENT BILL.

There is no logic to the "Zero Carbon" bill whatsoever. It flies in the face of all serious scientific evidence - its only function appears to be to please the UN bureaucracy and the elite foundations which are affiliated with and exert considerable influence over that bureaucracy.

HUMAN GENERATED CO2 IS NOT CAUSING GLOBAL WARMING

There is no evidence that CO2 causes global warming. Ice core data indicates that CO2 levels lag warming by hundreds of years, rather than driving it. See e.g. Mudelsee (2001, attached), who found that "over the full 420,000 year Vostok history CO2 variations lag temperature by 1,300 years ± 1000".

Studies show that the warming period which began in the 1970s, and was the reason for abandoning alarmist claims of a new ice-age in favour of "global warming", eased off around 1998, and scientists are predicting a worrying cooling, even a mini-ice age.

In any case:

Of total CO2 levels human activity is responsible for 3-5% of atmospheric CO2, while New Zealand's contribution is about 0.1%. Nothing will be achieved by NZ going "zero carbon" when other bigger countries are focused on development and improving their citizens' quality of life - it is pure grandstanding. At the same time New Zealand is squandering its credibility which would be better spent drawing attention to real environmental issues.

METHANE

Undermining New Zealand's dairy industry on the back of the climate hoax is another government target. 0.00017% of atmosphere is methane. Sheahen and Allison (attached) show that methane and nitrous oxide (reputedly responsible for about half of New Zealand s emissions) are virtually irrelevant as contributors to any global warming effect.

As they point out, methane is an unstable gas which oxidises quickly in atmosphere. It occupies less than 2PPM of the atmosphere, and its absorption bands almost completely overlap with H2O. Even a very large increase in CH4 would have almost no impact on climate.

MELTING ICECAPS AND SEA LEVEL RISE.

It is claimed that the because of anthropogenic global warming, the ice caps are melting, causing a dramatic rise in sea level.

The claims of icecaps melting away are clearly nonsense: while Western Antarctic is experiencing melting due to the large number of volcanoes that have recently become active, this is more than offset by the ice accumulating in Eastern Antarctica (see eg Oct. 31, 2015, NASA Study: Mass Gains of Antarctic Ice Sheet Greater than Losses). A NZ expedition to Antarctica in the summer of 2017-18 found that the Ross Ice Shelf was freezing rather than melting.

As for the predictions of London and Manhattan disappearing under the waves: numerous studies show that the sea has been rising by one or two millimetres per year for some time, but that the rise has decelerated since the 1950s. See eg Holgate (attached):

"The rate of sea level change was found to be larger in the early part of last century (2.03 ± 0.35 mm/yr 1904 1953), in comparison with the latter part (1.45 ± 0.34 mm/yr 1954 2003)."

Australia's Bureau of Meteorology established 12 sea-level gauges on Pacific Islands from 1992. The gauges show no increased rate of sea rise, in fact no or minimal rise at all, in some cases a negative result. (See eg the BOM Pacific Country Report, Vanuatu, graph for all countries p. 9.)

The bogus claims of dramatic sea level rise are especially concerning, as councils are using them to justify changes to building codes and planning regulations. See for example the article by David Kear, former Director of the DSIR (attached). Kear observed that the Ohope Council was making decisions on the assumption that there was a landward inundation, ignoring evidence from residents and experts alike that the coastline had a net seawards movments.

ENVIRONMENTAL IMPLICATIONS

The government hopes to replace fossil fuels with "renewable" energy provided by, for example, windfarms despite the environmental impacts: the threat to birds, bats and human health, and the blighting of the rural landscape. The environmental implications of a greater use of batteries, in both production and disposal, are being ignored

Despite the fact that a large part of New Zealand is already forested, the governmment has a policy of growing planting trees a year, hoping that two thirds will be native, ie one third will be pinus radiata. Most of this will be on fertile pasture, so although dairy farming is 49% of our economy, we will be replacing dairy with pine, which is hostile to flora and fauna and renders the land infertile.

LOCAL AND NATIONAL GOVERNMENTS ARE MAKING DECISIONS ON THE BACK OF A MANIFEST FRAUD

The weakness of the climate alarmist position should be apparent by the nature of the arguments of adherents, which are based on extravagant predictions never fulfilled, fraudulent or over heated data, cherry-picking, bogus claims of consensus, and much reference to the views of teenage girls. The narrative is driven by the UN's IPCC, which from its inception has had a brief to assume anthropogenic climate change, and has consistently produced reports whose conclusions have been highly criticised even by those scientists invited to make submissions.

Since at least 2007 New Zealand's top scientists have opposed the UN's climate narrative: people like the former Director-General of the DSIR David Kear, Augie Auer (emeritus professor and former chief meteorologist with the MetService), and Dr Vincent Gray, who made a great many submissions to the IPCC. New Zealand governments have consistently ignored their advice.

The function of the climate fraud is to achieve global governance by the owners of the narrative. For decades the United Nations has produced reports, whether on environment, climate, or governance, which have urged high-density urbanisation, the elimination of private property and increased power to the corrupt UN bureaucracy, and always proposing a greater role for elite foundations such as Rockefeller, Gates etc. It is hard to believe that those politicians in the Labour and Green Parties who have made "climate" their cause are unaware of this agenda.

On the back of a manifest fraud, New Zealand politicians are hell-bent on ruining our environment, our way of life and our economy.

Recommendations

1) The government's plans to destroy the New Zealand economy, environment and way of life on the basis of pseudo-science be abandoned.

2) The government focus on genuine environmental issues, and

3) Consider how it will face the Maunder Minimum, i.e. a climatic cooling, which is predicted.

Global Warming, Reducing Emissions a Very Expensive Approach to a Non Problem : Dr Jock Allison, ONZM, FNZIPIM, October 2018

With all the present hysteria about global warming and the need to commence drastic emissions reductions within 12 years, there is still no convincing scientific evidence that atmospheric CO_2 is the cause of warming. While clearly the world has warmed a little, this has been expected, as it is coming out of a little ice age.

Emeritus Professor from MIT, Richard Lindzen a few days ago at a public meeting in the UK said "the currently popular narrative, is that the climate, a complex multifactor system, can be summarized in just one variable, the globally averaged temperature change, and is primarily controlled by the 1-2% perturbation in the energy budget due to a single variable – carbon dioxide – among many variables of comparable importance.

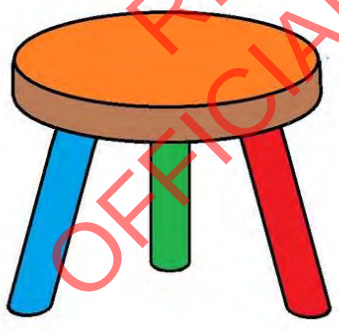
This is an extraordinary pair of claims based on reasoning that borders on magical thinking".

Three recent lines of research show global warming cannot be confidently attributed to human emissions. First, that methane and nitrous oxide are virtually irrelevant re climate change (half of New Zealand's assessed emissions).

Second, CO_2 doesn't stay in the atmosphere for very long – a half-life of 10 years, not the 200+ years asserted by the IPCC. Third, that within the "Climate Models" used by the Intergovernmental Panel on Climate Change (IPCC) and many other researchers there is a fatal error that causes them to overestimate the effect of doubling atmospheric CO_2 by three times.

Thus, the billions and billions of dollars of expenditure worldwide over the past 35 years, and the push for international unanimity to reduce the level of CO_2 in the world's atmosphere has largely been wasted.

SUMMARY: There are three legs to this stool and it is pretty hard to knock any of them over on the basis of science.



BLUE: Water vapour is the main Greenhouse Gas; methane and nitrous oxide are irrelevant, human CO_2 causes some minor warming (Allison & Sheehan 2018)

RED: Anthropogenic (human) CO_2 has a half-life of only 10 years in the atmosphere, not more than 200+ years espoused by the IPCC (Berry, 2018)

GREEN: The IPCC models, which predict 3.6 degrees C warming, + or minus 1.2 degrees (as a result of doubling atmospheric CO_2) are wrong. The correct figure is less than one third of this, 1.0 degree + or minus 0.2 degrees (Monckton et al., 2018). Monckton talks about this in a video (https://www.youtube.com/watch?v=kcxcZ8LEm2A). A lay summary is attached.

1. Allison & Sheahen 2018

Recently Tom Sheahen and I published a paper in the New Zealand Institute of Primary Industry Management Journal on the topic of the effectiveness of Greenhouse Gases (GHG), https://www.nzipim.co.nz/Folder?Action=View%20File&Folder_id=120&File=The%20Journal%20September%202018.pdf It is the first paper in the journal.

A simpler representation of the work is an article published in Dairy News, 18 September 2018: https://www.ruralnewsgroup.co.nz/dairy-news/dairy-general-news/water-blamed-as-big-planet-warmer .

The main points …

My co-author Tom Sheahen is a distinguished PhD in Physics who Chairs the United States Science and Environmental Policy Project (https://www.heartland.org/about-us/who-we-are/tom-sheahen), and we have been advised in the preparation of the paper by two distinguished Professors of Physics at American universities: Will Happer, an emeritus Professor of Physics at Princeton, who has just been appointed to the White House as a Scientific Advisor (http://www.sciencemag.org/news/2018/09/trump-adds-physicist-will-happer-climate-science-opponent-white-house-staff); Professor William van Wijngaarden of York University in Canada (http://www.physics.yorku.ca/index.php/who-we-are/all-faculty/62-wijngaarden) has also been a valuable advisor on atmospheric physics.

Our paper is most important because …

a. Water vapour is the most important GHG, and even the IPCC accepts water vapour is responsible for more than 70% of the Greenhouse Effect, (as defined in AR4 - the 4th IPCC report most estimates of the importance of water vapour estimate it at more than 90%).

c. The concentration of water vapour is very small at the poles to about 4% in the tropics. We have taken a for-example of 15,000 ppm in our paper, a conservative assumption. CO_2 is 410 ppm, methane 1.8 ppm, and nitrous oxide 0.3 ppm. (Yes, a Greenhouse Gas of only 1.8 ppm is supposedly responsible for 35%+ of New Zealand's total emissions?

d. The Global Warming Potentials (GWP, or estimated heating potential compared with CO2 = 1) estimated by the IPCC of CO_2 = 1, Methane = 28, and nitrous oxide 265 – 300. This is clearly nonsense. Tom Sheahen addresses this in "How to Deceive With Statistics : Distortions With Diminutive Denominators" see https://www.americanthinker.com/articles/2018/01/how_to_deceive_with_statistics_distortions_due_to_diminutive_denominators.html . The IPCC ignores water vapour as a participant in the competition to absorb photons of heat radiated back from the Earth. Rather, in their models they consider this is a positive feedback that amplifies the effect of the other GHGs by 2 or 3 times.

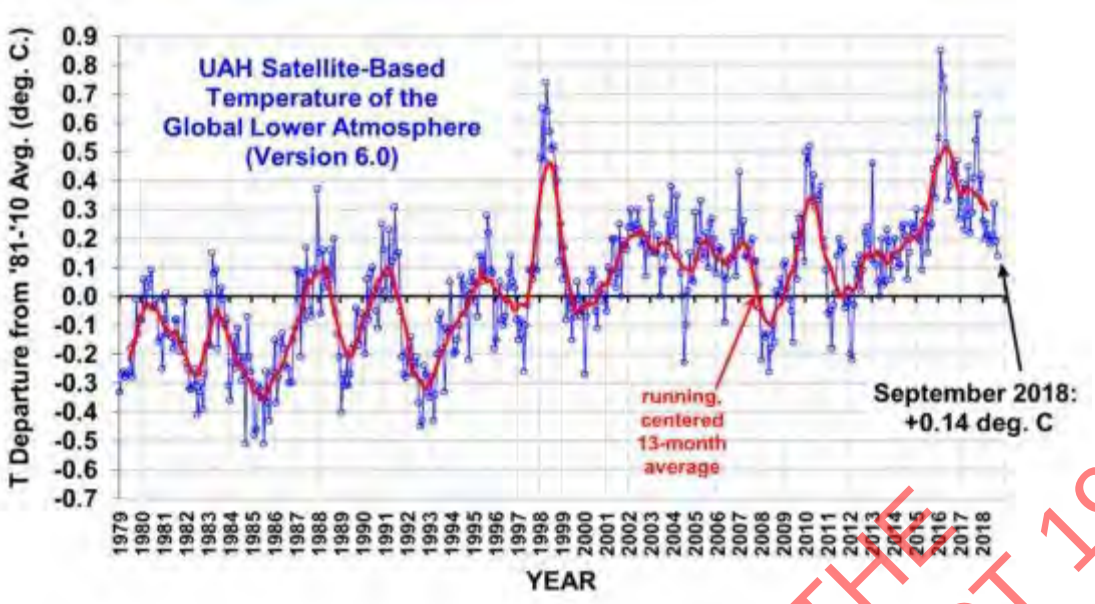
e. The Earth is not heating up. There has been some warming as we come out of the Little Ice Age. Over the past couple of decades (see https://judithcurry.com/2015/12/17/climate-models-versus-climate-reality/) this is the most accurate measure of temperature, the lower atmosphere, which unlike the surface temperature records:

i) covers almost the whole globe, unlike the land based temperature records, which cover about 25% of the globe only.

ii) doesn't have the biases of the predominantly "urban"-based temperature records that have the well-known UHI (Urban Heat Island) effects from the build-up of heat in concrete, asphalt etc., which makes nights warmer in urban areas

iii) is not subjected to continued corrections, many of which have years later been imposed in statistical treatment of surface station data that has accentuated warming trends.

The trophospheric temperature from satellites and balloons is in the figure below. Apart from two significant EL Nino spikes in 1998 and 2016, temperatures are not rising (http://www.drroyspencer.com/).



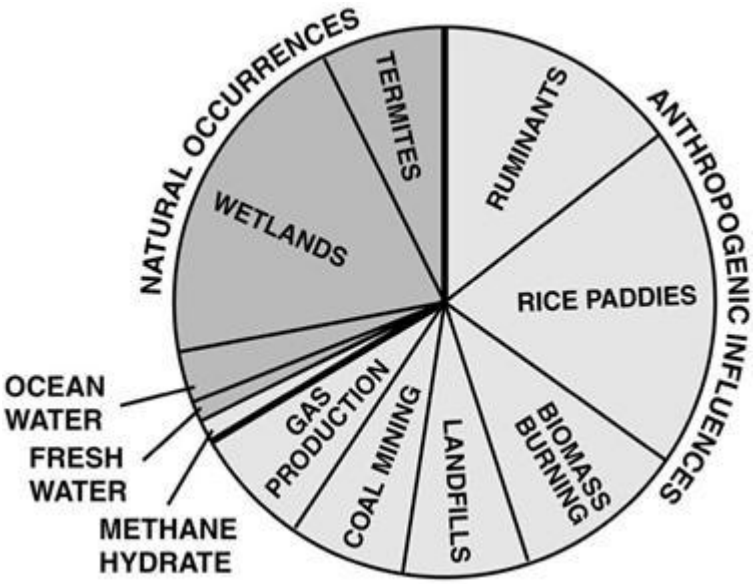
The IPCC Computer Models are clearly not working, they are running very hot. From February 2016 to September 2018, the atmospheric temperature has dropped by 0.7 degrees C.

f. Methane and nitrous oxide are able to absorb heat only in an area of the electro-magnetic spectrum where there isn't a huge amount of heat emitted from the earth, and where there is almost total saturation of water vapour (remember methane 1.8 ppm versus water vapour 15,000 ppm).

We conclude, therefore, that particularly methane and nitrous oxide (reputedly responsible for about half of New Zealand's emissions) are virtually irrelevant as contributors to any global warming effect. These gases should therefore be removed from New Zealand's GHG Inventory.

This is very important information, particularly when our politicians say they want any policy to be "evidence based", and yet they are convinced that global warming / climate change is real, and that humans cause it. Clearly this is incorrect.

New Zealand scientists Andy Reisinger and Harry Clark from the Agricultural Greenhouse Gas Research Centre at Palmerston North (AGGRC) have been publishing information contendingthat methane from livestock can be responsible for up to 20% of the world's warming. Methane from ruminants is only about 16% of all the methane going into the atmosphere – see pie chart below.



Sources of atmospheric methane. Ruminants are cattle, sheep, goats, etc. 2/3 of the total is due to human activities.
https://www.giss.nasa.gov/research/features/200409_methane/

In New Zealand we seem to be concentrating on this gas which our paper, (Allison & Sheahen, 2018) is shown to be almost irrelevant in GHG effect in the atmosphere. New Zealand concentrating on this gas and modelling and then planning the reductions that need to be made to have various effects in the future is meaningless:

a) The way the GWP value are calculated is scientifically unsound, and the derivation of the high values have been discredited a a result of faulty calculation.

b) The putative reductions required for methane from cattle in New Zealand come from only 16% of total methane emissions on the planet. If we consider that cattle make up about 85% of total world ruminant emissions, and the developed countries make up about 25% of the total numbers. With the USA removed from the numbers , because it isn't in the Paris Accord, this reduces the rest of the developed world to about 14% of the total. New Zealand has about 1% only of the world's cattle and 2.6% of the world's sheep. About 75% of the world's cattle and sheep are in undeveloped countries, which under the Paris Accord are not expected to significantly reduce emissions until after about 2030, or at such time that each country has developed sufficiently to raise the standard of living of its population to a level that would deem it to be classified as "developed".

   Many undeveloped countries will have a lower share of total ruminant emissions due to their smaller animals, than the bigger, more productive animals in developed countries. However, such recognition could bring New Zealand's total ruminant emissions up to perhaps a maximum of only 3% of world ruminant emissions. This is about 3% of 16%, or 0.48% or 1/200th of the world's methane going into the atmosphere (see above pie chart for other sources of methane).

So, making allowances for ruminant emissions in New Zealand when no such recognition of 65% to 70% or more of total world ruminant emissions is being made, let alone financially accounted for,

will likely have significant negative effects on all economic indicators in our economy. All this achieved without having any possible effect on the world's warming and or climate. This can be recognised as only "virtue signalling". Potentially, New Zealand will be paying billions of dollars or spending billions of dollars on other activities to alleviate a tiny percentage of world ruminant emissions, when most flocks and herds will not only, not be measured, but also will not be allowed for in other country commitments.

The world will be unable to reduce emissions anyway?

The effectiveness of the world in reducing CO_2 emissions since the Kyoto Protocol negotiations started, is sobering considering the heroic assumptions now being made by the IPCC with regard to what the world might achieve in GHG reductions in the future, required so temperature increases of 1.5 or 2 degrees C respectively, might be avoided.

From 1990, the baseline date for Kyoto, the world's total human emissions increased by 60% to 2013, were then pretty stable in 2014, 2015 and 2016, but increased again by 1.6% in 2017. Under the Paris 2015 Accord, "Developing Countries", which are now responsible for 62% of the world's emissions, are allowed to keep developing while they improve standards of living for their populations. China has signalled it will double emissions by 2030 (+29.5% of world emissions now), and India has signalled it will increase 3X by the same date (+13 6%). The other undeveloped countries can be expected to increase total world emissions by at least 10% by 2030. On such a scenario the world is looking at about 55% in world emissions from the presently designated undeveloped countries by 2030.

Further, with the USA out of the Paris Accord (14.5%), that leaves 23.5% of presently estimated emissions for the developed countries who are supposed to be on rigorous emissions reductions scenarios. Not to mention also they are supposed to proportionately support a $US100 billion Green Climate Fund each year from 2020. This will not happen.

Clearly the path to mostly renewable energy by 2030 or 2050 is not achievable. The world is still relying on fossil fuels which still makes up more than 80% of total world energy use. Further, the academic IPCC reports never factor in the beneficial effects of CO_2, or take note that perhaps half of the world's food is produced with the help of fossil fuel derived fertilisers.

All of this shows just how removed from reality governmental bureaucrats, politicians and scientists are when promoting the huge reductions in the world's emissions in a much shorter timeframe be it 2030, or 2050.

If we take these data on achievement above back to our very small parish here in New Zealand with supposedly only 0.17% of the world's emissions, the spending of up to $36 billion by 2030 on climate change doesn t seem to make much sense from any viewpoint.

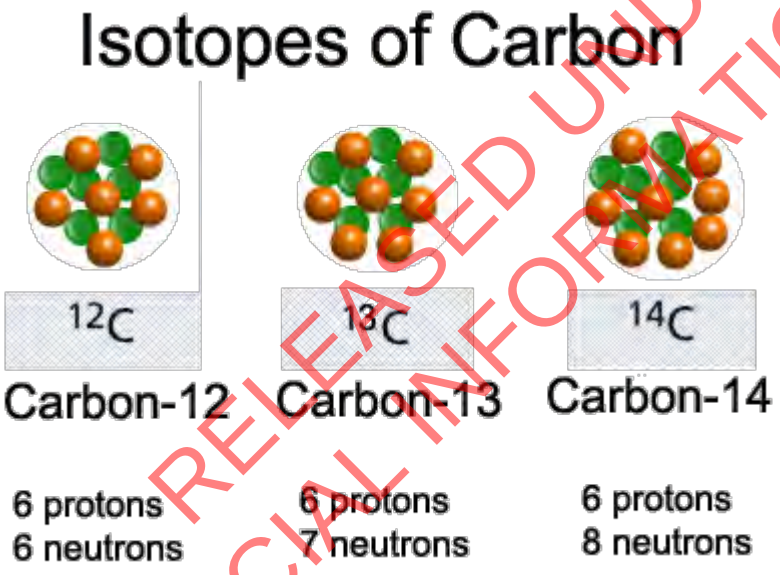
https://www.newsroom.co.nz/2017/12/07/66415/paris-agreement-could-cost-nz-36b Anything we will spend on "climate change" will be a total waste of money (which, as a country below halfway down the OECD's income / capita tables, we don't have). Further, the developed countries that are the most bullish about the need to take action about climate change – the EU, for example – are all already falling behind their ambitious GHG reduction targets.

2. The next big thing in Climate Change Research

There is a fatal flaw in Climate Change Research regarding the human effects on the percentage atmospheric CO2 and how long CO_2 stays in the atmosphere : Dr Ed Berry has had a distinguished career in climate physics see https://edberry.com/exb/dr-ed-berry/

The IPCC, the United Nations and most governments throughout the world are certain that human-produced CO_2 is the reason for the increasing levels of atmospheric CO_2, and that this is the main reason for increasing world temperature. Nothing could be further from the truth.

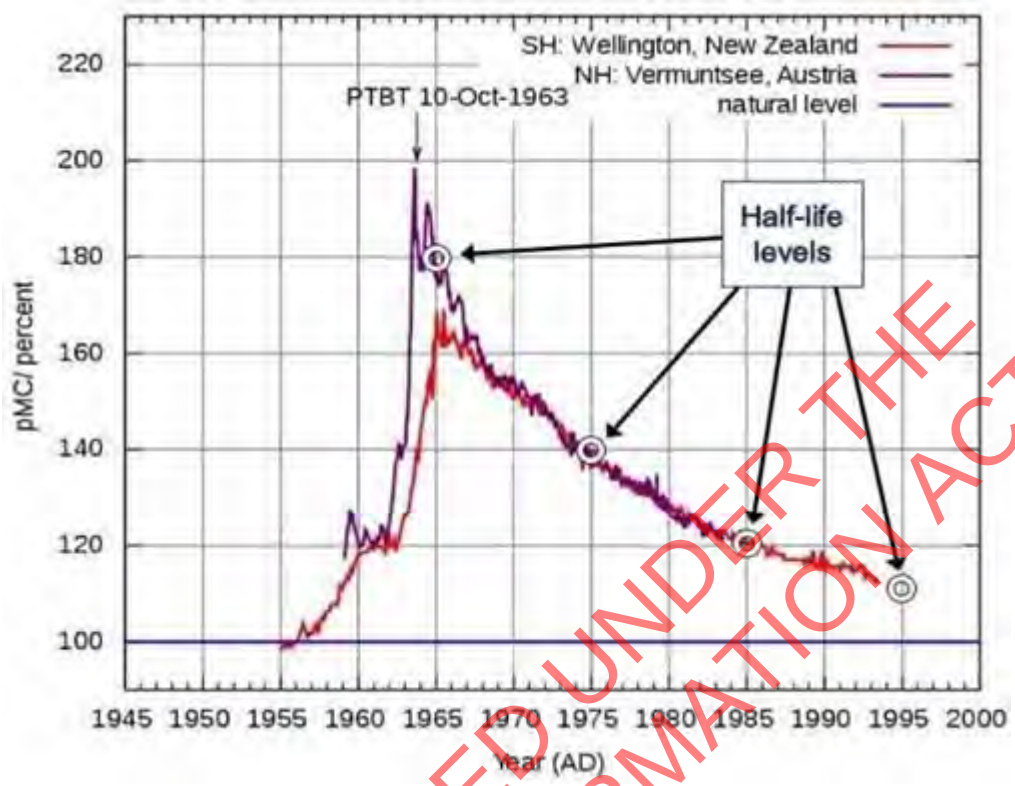
Dr Berry has developed a model for the flows of CO_2 in the atmosphere, based on the decay / disappearance rates of radioactive C14 CO_2 in the atmosphere after all the nuclear testing in the Pacific and elsewhere. These data are the only data available on real labelled CO_2 in the atmosphere. The rate of disappearance of C14 CO_2 in the atmosphere tells us something about the normal C12 CO_2 (note: carbon has a molecular weight of 12, with 6 neutrons and 6 protons in the nucleus, while C14 has 6 protons and 8 Neutrons formed as a consequence of nuclear explosions in the atmosphere. . See diagram below).



C14, in the atmosphere as C14 CO_2, will react chemically and physically in exactly the same way as the normal carbon in the atmosphere C12. Therefore, C12 CO_2 has the same half-life (rate of disappearance) from the atmosphere as the C14 CO_2. Also, there is no way to differentiate between the CO^2 from human activities, i.e. burning fossil fuels, and all other human activities (less than 5% of all the CO_2 going into the atmosphere at any time) and the 95% + of CO_2 from natural sources also going into the atmosphere.

In the years when there were a lot of nuclear tests going on, particularly in the Pacific (1946 to 1962), there was an increase in C14 in comparison with C12 (the carbon in CO_2), in the atmosphere. C14 is an isotope and has a molecular weight of 14 from the addition of two additional neutrons to the nucleus of the C atom, this being caused by the atomic explosions in the atmosphere.

(https://edberry.com/blog/climate-physics/agw-hypothesis/preprint-a-fatal-flaw-in-global-warming-science/)

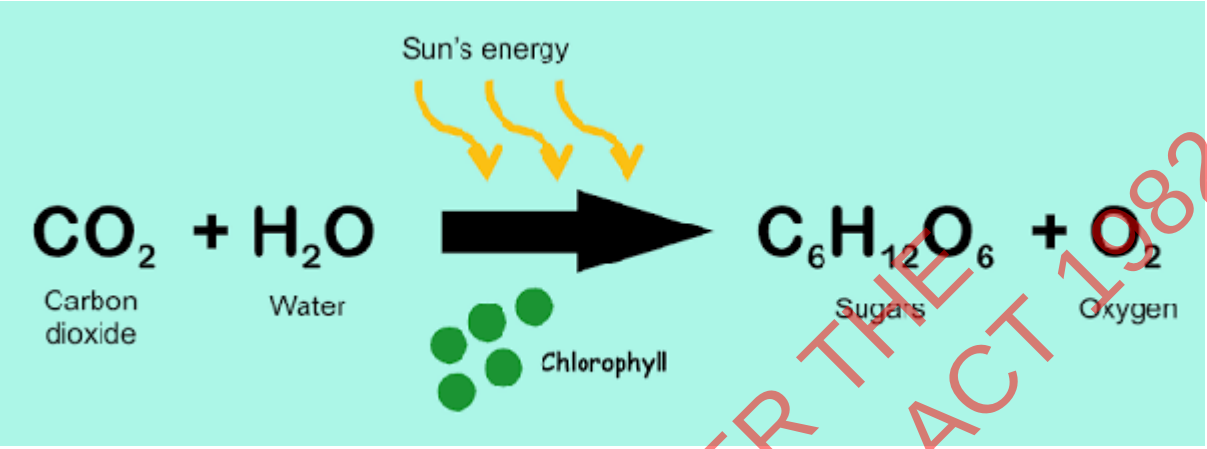


The above figure shows C14 data before and after the above-ground atomic bomb tests. The natural concentration of C14 CO_2 is defined as 100%. The pMC percent scale is "percent of modern carbon" where "modern carbon" means the level in 1950. The white circles mark the half-life times.

The graph shows that the concentration of C14 CO_2 halves every 10 years. (This is atmospheric C14 CO_2, not be confused with the radio-active half-life of C14 carbon of 5730 years). Now C14 CO_2 and C12 CO_2 (the normal stuff we have in the atmosphere) react identically chemically and physically in the atmosphere. This if C14 CO_2 is disappearing from the atmosphere at the rate illustrated in the graph, then so too will the other CO_2 in the atmosphere. Reisinger & Clark (AGGRC) have been getting a lot of publicity recently regarding the warming effect of methane in particular. They contend that CO_2 added to the atmosphere from the days when the level was about 280 ppm, (supposedly 1850, although not well defined) all comes from human activities. This is also the assumption made by the UN and the IPCC.

CO_2 is, in effect, plant food, and the higher the concentration in the atmosphere, the faster plants grow, and also with greater water use efficiency. The chemical equation is shown below:

Photosynthesis in plants which use atmospheric CO_2, water and sunlight to synthesise sugars



For most of geological time, CO_2 levels in the atmosphere have been much higher than the present day. A level of more than 150ppm is required for plants to grow at all, and as the concentration increases, plants grow faster. If the level of atmospheric CO_2 was to double, then plant growth worldwide would increase by about 30%. Significant "greening" can be observed worldwide already from space – a result of the 45% increase in atmospheric CO_2 since pre-industrial times. This is an outstanding result for the Earth, not the impending disaster of rising CO_2 widely promoted.

It is generally agreed that only 5% of CO_2 added to the atmosphere during each specified time period is from human sources (probably a bit less).

The graph of C14 CO_2 disappearing from the atmosphere shows that the concentration halves every 10 years. Under the principle of "equivalence", C14 behaves in the same way as C12 CO_2, so there is nothing to suggest that human CO_2 (which is C12 CO_2) will react or behave chemically or physically any differently from naturally occurring CO_2 does. Further, it is not possible to differentiate between human CO_2 and the other naturally occurring CO_2.

This is a very different situation from that which the IPCC claims (including New Zealand scientists advising the Government). The IPCC claims:

a) **all of the rise in atmospheric CO_2 from 280 ppm (pre-industrial, about 1850) to 410 ppm today is due to human activities**
b) **the half-life of CO_2 (i.e. C12 CO_2 which makes up about 99% of the CO_2 in the atmosphere) is 200+ years or more, often quoted to be more than 1,000 years**
c) **15% of human CO_2 will stay in the atmosphere forever**

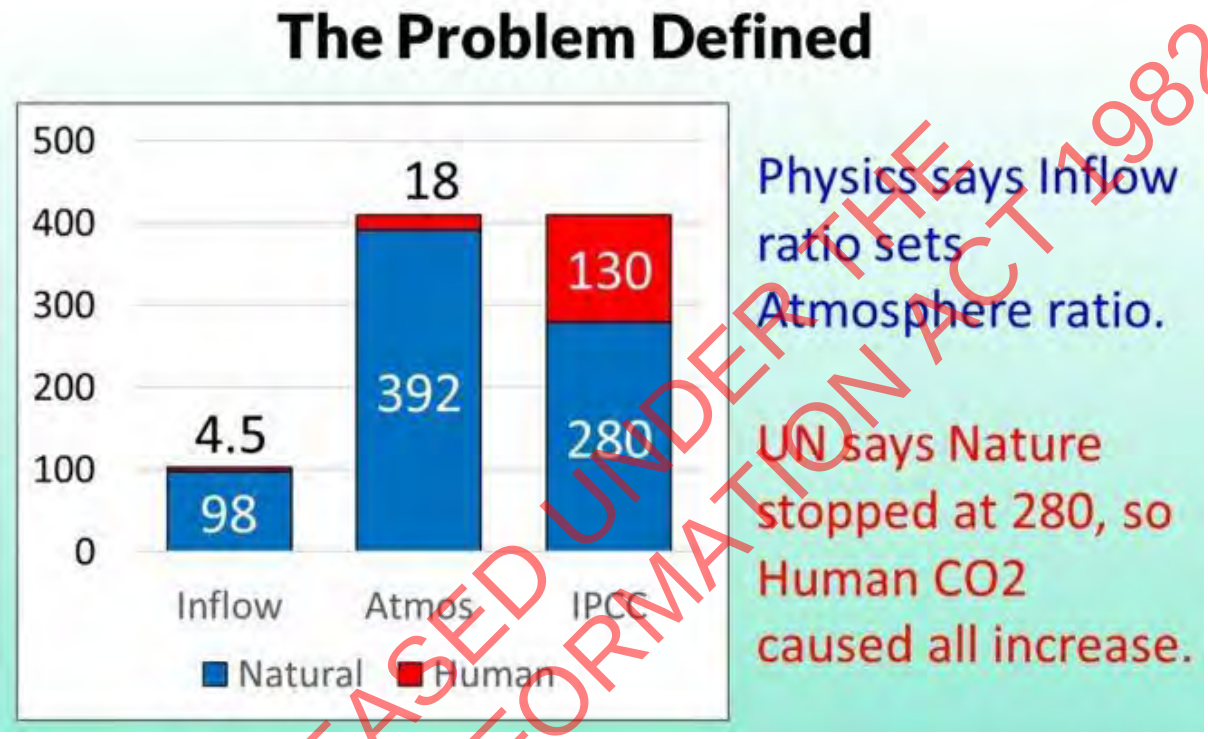
These are all wrong.

The latest science from Dr Ed Berry (https://edberry.com/wp-content/uploads/Climate/EdwinBerryPortoSep7Final.pdf) shows that as a result of applying the climate physics embodied in the C14 decay graph above, human CO_2 cannot be responsible for all of

the CO_2 increase in the atmosphere since pre-industrial times. The result of the accepted equivalent half-life of C14 CO_2 results in the calculation of only 18ppm in the atmosphere being derived from anthropogenic (human derived) CO_2.

On this basis, therefore, human CO_2 cannot possibly be the "control knob" of global warming. Any efforts to diminish atmospheric CO_2 cannot be expected to have any demonstrable effect on the climate.

The calculated levels of CO_2 from the decay rates defined from the study of the C14 after nuclear testing gives the results illustrated in the graph below:



So, the human activity-derived CO_2 in the atmosphere presently is 18ppm, not the 125ppm from human activity from 1850 as the IPCC contends. These data concerning rates of disappearance from the atmosphere are the only such data published, and show that:

a) **human-derived CO_2 emissions at only 18ppm, can make little difference to the atmosphere**
b) **reductions of the human-derived emissions will not make anything but a miniscule effect on temperature – they are a complete waste of time**
c) **so, human-derived CO_2 emissions into the atmosphere are of little significance to temperature, i.e. global warming / climate change / climate disruption**

3. IPCC Climate Models Overestimate Warming by Three Times :

The third part of this three-legged stool is work that Christopher Monckton and a few others have been doing re the "Climate Models" used by the IPCC and others to predict future temperature rises.

A lay summary of the work it attached with this paper. A more technical paper is available if required.

Lord Monckton has over several years been working on what might be wrong with these Models. He found .....

a) the IPCC estimate that Equilibrium Climate Sensitivity (from the doubling of atmospheric CO_2) is 3.6 degrees C + or minus 1.5 degrees C,

b) after allowing for the omission in the IPCC models (as Monckton put it "they forgot about the sun" - in fact the feedback to the incoming solar radiation), the ECS is only 1 degree C + or minus 0.2 degrees C. So no problem. The problem of climate change has disappeared. An increase in temperature of another one degree, most of which we have had already is really quite beneficial.

If it is accepted that the Global Warming / Climate Change / Climate Disruption scare is over then a very large number of jobs, established science institutions, governmental departments and university departments, plus the finance to run these is at stake worldwide, will be at risk, so a big kickback can be expected. Lord Monckton presented the results at an International Conference in Portugal in July 2018 and has submitted the paper for publication in a climate science journal. A more detailed Monckton et al paper can be supplied on request. .

JOCK ALLISON AND THOMAS P. SHEAHEN

GREENHOUSE GASES – A MORE REALISTIC VIEW

The contributions of water vapour (H_2O), carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) to the warming of the atmosphere are reviewed. Water vapour and clouds are responsible for 80-90% or more of the greenhouse gas (GHG) effect. CO_2 has a finite influence. However, contrary to the common assertions, the contribution of methane and N_2O to world's total emissions is negligible. We therefore conclude that expensive attempts to reduce human emissions can have negligible effects only on regional and world temperature.

Therefore, the generally accepted effects of CH_4 and N_2O as infrared-absorbing GHGs, causing about 50% of the total New Zealand emissions, must therefore be urgently reassessed, and to a lesser extent the quantitative role of CO_2. It is therefore suggested that CH_4 and N_2O be removed from New Zealand's Greenhouse Gas Inventory, and that the supporting case for such treatment be prepared for negotiation with our international partners towards eventual withdrawal from the Paris 2015 Climate Agreement.

Introduction

The rotating planet earth is warmed by incoming sunlight in the daytime and cooled by outgoing infrared radiation at night *(Figure 1A)*.

The planet never actually reaches equilibrium. The real atmosphere contains a varying percentage of water vapour (dry air is an idealised concept found only in the laboratory). The principal atmospheric gases N_2 and O_2 have no role in cooling.

The black body curves shown in *Figure 1B* are displaced in wavelength (shifted horizontally), depending on temperature. Molecules radiating from different altitudes will do so at corresponding temperatures.

The cooling process involves multiple steps: heat from the surface is radiated back, absorbed by the various GHGs (mainly water vapour), and transported upward by the convection of moist air to the upper troposphere, where clouds form. Throughout this journey from the surface molecular collisions, emission and re-absorption of radiation continues. The 'greenhouse effect' is attributed to gases that absorb and emit solar electromagnetic energy in a particular part of the electro-magnetic spectrum – ultraviolet (UV), visible, infrared light. The final cooling step (emission to space) takes place via infrared radiation leaving the upper troposphere and stratosphere.

The down-going radiation from the sun is in the UV and visible light part of the spectrum (0.1 to 1.2 microns wavelength), and here there is some interception of energy by clouds and a little by water vapour. There is virtually no effect of the GHGs, CO_2, CH_4, and N_2O at the wavelength of the incoming radiation from the sun.

All of the upgoing thermal radiation is in the 3 to 70 micron range of the spectrum, where the GHGs have some effect in absorbing the up-radiated heat from the earth's surface. This will be discussed in greater detail later.

Computer models used by the IPCC and many climate scientists attempt to account for all these mechanisms, and make future predictions about planetary conditions, especially temperature.

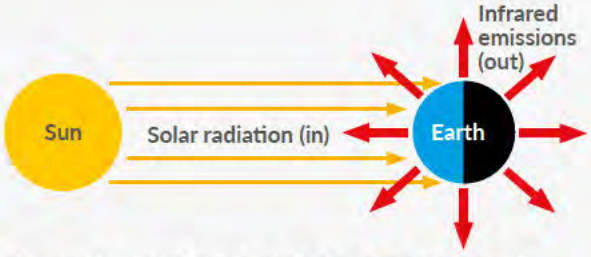


Figure 1A : Incoming solar radiation (energy) in and infrared emissions out

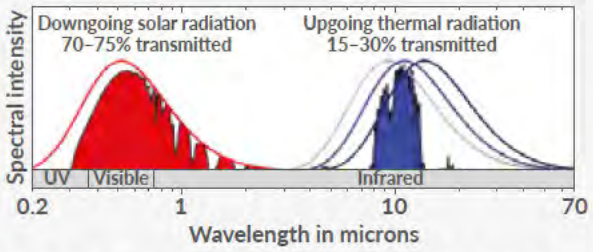


Figure 1B : Incoming solar radiation (energy) at 0.2 to 3 microns and outgoing thermal radiation at 3 to 70 microns

The IPCC concentrates mainly on anthropogenic (human) emissions, and ignores natural contributions of the GHGs from the planet and the ubiquitous water vapour, both of which also must be included in any sensible consideration of the effects on world temperature.

GHGs and their contribution to global warming (aka climate change and more recently 'climate disruption') are of national interest in view of the 2015 Paris Climate Agreement, and the commitments New Zealand has made to reduce emissions of these gases in the future. In addition to the known GHGs, ozone is recognised for its protective effect against UV radiation from space and will not be discussed further. CH_4 and N_2O make up almost half of New Zealand's assessed GHG emissions, but are insignificant in comparison with CO_2.

Mistakenly, water vapour is not included in any assessments of GHG effects by the Intergovernmental Panel on Climate Change (IPCC), a crucial omission. The IPCC concentrates mainly on anthropogenic (human) emissions, and ignores natural contributions of the GHGs from the planet and the ubiquitous water vapour, both of which also must be included in any sensible consideration of the effects on world temperature.

The potential effectiveness of GHGs in influencing temperature depends essentially on five factors:

1. The capability of individual molecules to absorb or radiate heat.
2. Their relative concentration in the atmosphere.
3. Whether each can actually absorb effectively (as heat is radiated to and from the earth) depends on both the location of their spectral bands and the energy distribution of the earth's outgoing radiation.
4. Competition for absorption by and between other gases.
5. Phase change of water, evaporation, condensation and precipitation.

These factors will be discussed in turn.

Capability of individual molecules

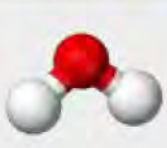
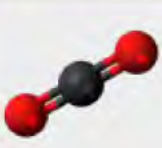
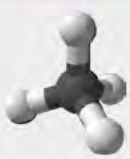
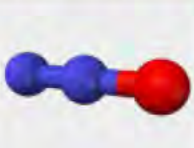
In the 1860s, John Tyndall demonstrated that some atmospheric and other gases absorbed heat from black body radiation. He reported that CH_4 and N_2O both absorbed about four times as much heat as carbonic acid, the original name for CO_2. While his observations were not truly quantitative, this estimated value is many times less than indicated by the adopted Global Warming Potential (GWP) figures from the (IPCC) – see values in *Table 1*.

GWP is a calculated ratio that the IPCC uses to estimate how much heat a GHG absorbs in the atmosphere (IPCC AR5, pp. 210-216). It compares the amount of heat trapped by a very small amount of the gas in question to the same additional very small amount of the comparator gas, CO_2 in this instance. This value for 'radiative forcing' is supposed to estimate the relative capability of a GHG molecule to have an effect on warming in comparison with one molecule of CO_2. GWP is a concept promulgated by the IPCC and is accepted (by governments) as the basis for the calculation of their country GHG inventories. More of that later.

The individual molecules of CO_2, H_2O and N_2O are similar in structure. Their relative concentrations in the atmosphere are in *Table 1* – CO_2 is now 410 ppm.

The GWP values are from the 2007 IPCC AR4 report. In 2013, the IPCC adjusted the GWP for CH_4 up to 28 and for N_2O downwards to 265. Effectively these values are almost certainly wrong because of the faulty conceptual approach embedded in the very definition of GWP. Recent reports also emphasise that the treatment of reputedly

Table 1: Atmospheric parameters of GHGs

	WATER	CARBON DIOXIDE	METHANE	NITROUS OXIDE
				
Atmospheric concentration	0.01–4%*	385 ppm	1797 ppb	322 ppb
Rate of increase	N/A	1.5 ppm/yr	7.0 ppb/yr	0.8 ppb/yr
Atmospheric lifetime	Very short 1–5 days	Variable 5–200 yr	12 yr	120 yr
Global Warming Potential (GWP)	N/A†	1	21	310

The amount of water vapor in the air varies according to temperature and density of air (usually ~1–3% of troposphere
† Water vapor levels vary strongly according to region, so rates of change and warming potential cannot be assessed

long-lived gases such as CO_2 in the same way as short-lived gases (such as CH_4, 12 years) is not environmentally credible (Allen et al., 2018). This same approach must also be considered for N_2O because the half life of this gas in the atmosphere is about half that for CO_2. Allen et al.'s (2018) approach if adopted may reduce CH_4's assessed effect by about three-quarters, or New Zealand's calculated emissions by about 30%. Quite evidently, the 'official' GWP numbers asserted by the IPCC are unreliable and controversial.

Recent calculations (Happer & van Wijngaarden, unpublished data) clearly show that the absorptive capability of individual molecules of the GHGs is not as widely different as the GWP values might suggest *(Table 2)*.

Table 2: Calculated heat absorptive capability of individual GHG molecules relative to CO_2 with a concentration change of zero to one ppb, at the tropopause (11 km) or the top of the atmosphere

CAPABILITY TO ABSORB HEAT IN COMPARISON WITH CO_2 = 1		
Gas	Top of atmosphere	Tropopause
CO2	1	1
CH4	0.19	0.22
N2O	0.54	0.66
H2O	0.084	0.14

Table 2 shows that the capability of the individual molecules to absorb heat (radiative forcing) is of the same order of magnitude. This seems reasonable since the molecular structure of the four molecules is not enormously different. Also, the absorptive value differences between the molecules is very similar to what Tyndall found in the 1860s.

This refutes the popular notion and the IPCC's claim that CH_4 and N_2O are much more powerful GHGs than CO_2. The reason for this is that the assumed radiative forcing for CO_2 is much more strongly saturated than the other gases *(Figure 2)*.

Because of this saturation additional CO_2 above 400 ppm has a miniscule effect on warming in comparison with additions to the very low unsaturated concentrations for N_2O and CH_4. However, the comparative effects of CH_4 and N_2O on warming are derived with no cognisance of any competitive effects of water vapour throughout the atmosphere, or the fact that there is very little energy transfer from the earth at the frequency on the electromagnetic spectrum at which these trace gases might have an effect. More of this later.

Relative concentration of GHGs in the atmosphere

Omitting water vapour, the major gas components of a 'dry' atmosphere are nitrogen (N_2), oxygen (O_2) and argon (Ar), at 78.1%, 20.9% and 0.92% by volume, respectively, all of which do not absorb heat. This leaves 0.1% by volume for the remaining gases. CO_2 at 400 ppm is the largest of the trace gases. CH_4 and N_2O are very small, just traces in effect, 1.7 and 0.3 ppm, respectively *(Table 1)*.

But the real atmosphere is not dry. Water vapour is widely variable: a very low percentage at the poles, but up to 4% in the tropics. For the purposes of comparisons and discussion in this article, we have assumed it is 1.5% or 15,000 ppm. Of course, any amount of atmospheric water vapour will proportionately reduce the percentage of all the other gases.

Further the amount of anthropogenic CO_2 (human induced) produced each year is less than 5% of the total CO_2 entering the atmosphere. Now, how are these gases supposed to cause all of the warming the world has experienced since the Little Ice Age (LIA)? In the teaching and scientific literature the estimates vary.

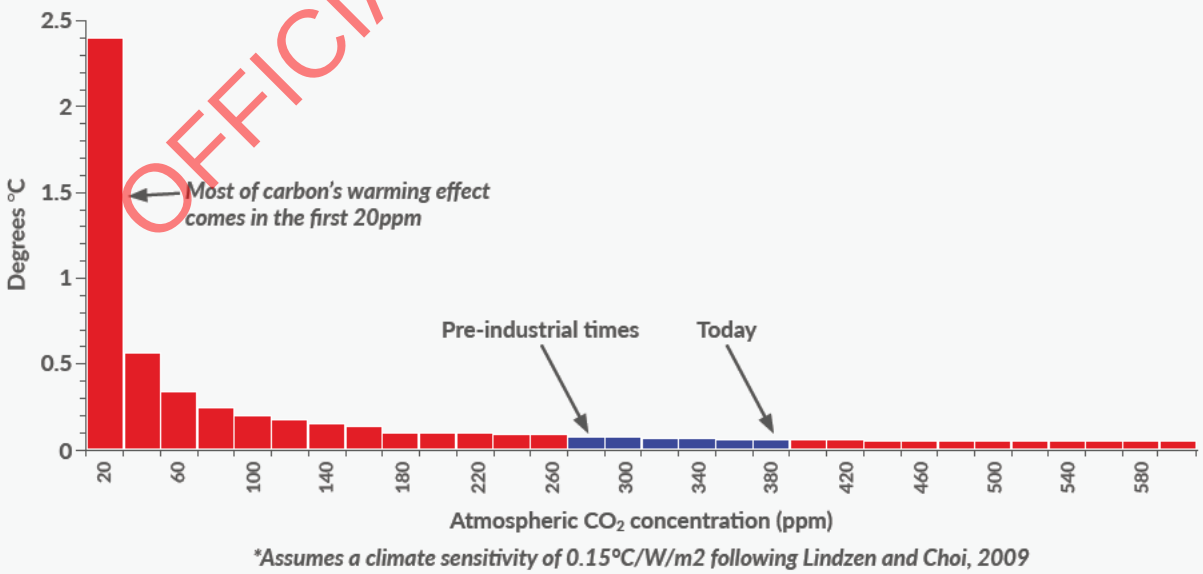


Figure 2: Increasing levels of CO_2 cause less and less warming effect
Source: Adapted from Lindzen & Choi (2009). This relationship is the basis of the MODTRAN atmospheric model, University of Chicago.

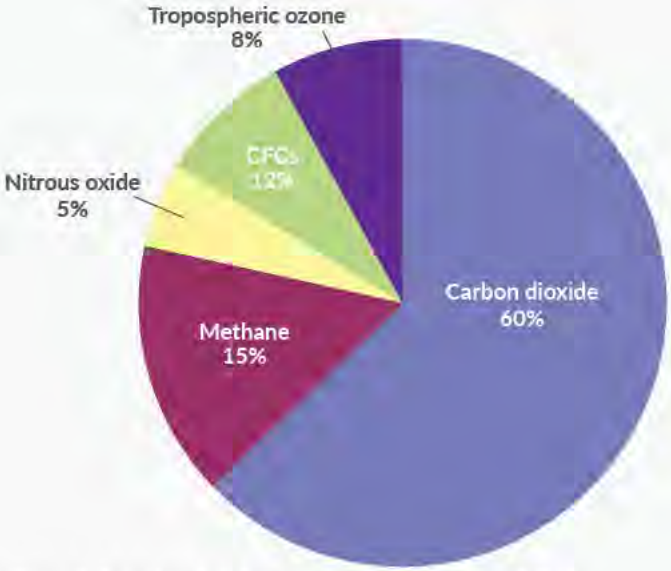


Figure 3: Putative global warming effects of selected GHGs
Source: http://eesc.columbia.edu/courses/ees/slides/climate/g_effect.gif

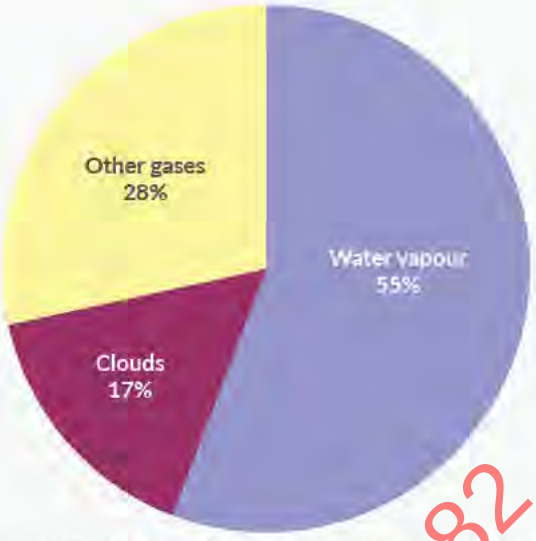


Figure 4: Breakdown of the 'natural' greenhouse effect by contributing gas. As halocarbons are industrial gases they are not represented here
Source: IPCC Report (1992)

Of all the CO_2 going into the atmosphere each year, 5% or less is anthropogenic, in comparison with CH_4, about 40% of which is from natural sources, and similarly estimates of naturally occurring N_2O are about 60%.

The estimates in *Figure 3* above suffice for the discussion. CO_2 is generally regarded as causing about 60% of the warming from GHGs, CH_4 15%, and N_2O about 5%. Clearly the 'agricultural gases', although at very minor concentrations in the atmosphere, are estimated as being major causes of the total warming effect on the world from GHGs.

A common representation of the effect of the relative effects of the GHGs is in *Figure 3*, which 'conveniently' eliminates the dominant effect of water vapour.

The 2013 IPCC Report, AR5 (Physical Science Basis, Chapter 8, p. 666) states: 'Water vapour is the primary GHG in the earth's atmosphere. The contribution of water vapour to the natural greenhouse effect relative to that of CO_2 depends on the accounting method, but can be considered to be approximately two to three times greater.' Further, the IPCC's 1992 report indicates that water vapour accounts for 55% of the total GHGs effect, and that clouds account for a further 17% *(Figure 4)*.

Many scientific assessments consider that the total effect of water vapour is more like 90%, much more than the 72% suggested by the IPCC. Even at a value of 72% for water vapour, the proportion of the GHG effect on the world temperature, which international governments are ambitiously seeking to diminish through the reduction of the GHGs going into the atmosphere, is far less than conveyed in communications to the general public through official channels or the media.

Of all the CO_2 going into the atmosphere each year, 5% or less is anthropogenic, in comparison with CH_4, about 40% of which is from natural sources, and similarly estimates of naturally occurring N_2O are about 60%. It is frequently claimed that without the anthropogenic contribution of CO_2 the amount of natural CO_2 being released into the atmosphere would equal the amount of CO_2 being absorbed each year by the biosphere, and mankind is blamed for the absence of the balance.

Governments rely heavily on the IPCC's reports and claims about GHGs causing or threatening to cause dangerous warming. As shown above, however, the IPCC's reports fail to provide the complete picture, especially about water vapour. The IPCC relies on General Circulation Models (GCMs) to predict future temperatures, and when run with and without GHGs, to estimate mankind's contribution to warming. Because water vapour added to the atmosphere is present there for only a few days it is not incorporated into the models. Instead, the assumptions in the GCMs are that water vapour operates as a 'positive feedback', which amplifies the effects of the GHGs by two to three times.

This indicates an assumption that H_2O does not operate in a direct way as do other GHG molecules in the atmosphere. This contention is made in spite of the fact that water vapour molecules are always present. All of the GHG molecules are well mixed throughout the atmosphere, albeit with water vapour at differing percentages (i.e. humidity). In this situation, all GHG molecules absorb, lose and re-absorb photons of energy. Thus, some radiant heat from the earth's surface is reflected back.

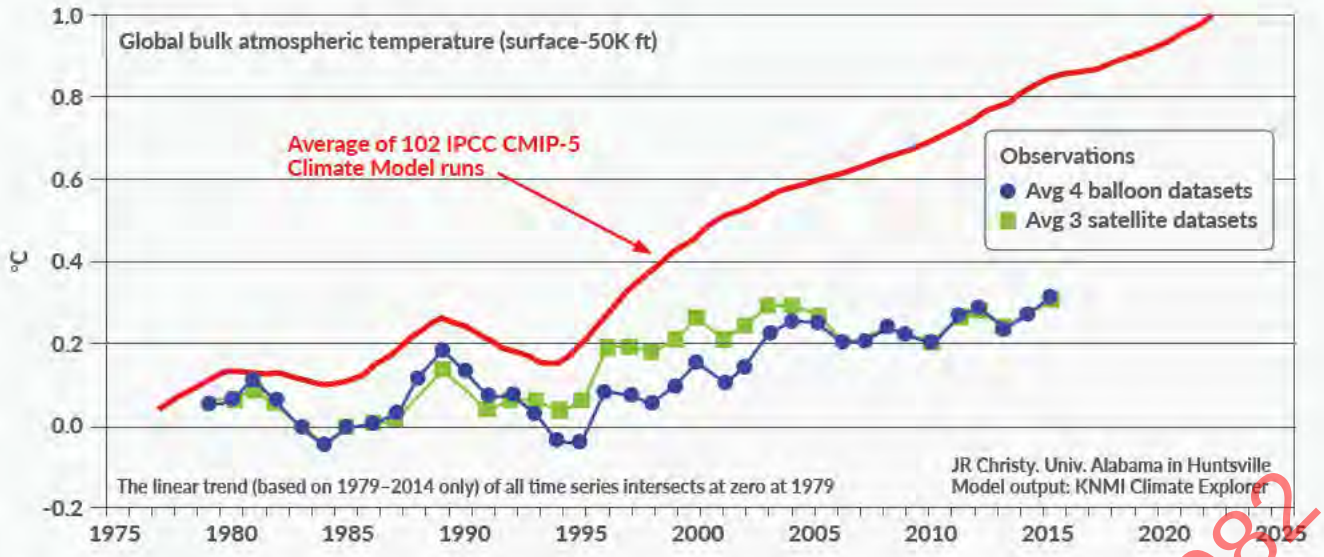


Figure 5: Climate models predicted temperature compared to actual
Source: Christy et al. (2016)

There has been no significant increase in the world's temperature in the last couple of decades, the well-known and accepted 'pause'

There is no logic for the removal of water vapour molecules from consideration in the dynamic situation where all of the GHGs participate in exchanging photons of energy radiating outward from earth. This is particularly relevant in a situation where there is such a high concentration of water vapour in comparison with the other GHGs. As noted previously, many scientific assessments specify that water vapour is the most important GHG and responsible for 80% to 90% of the greenhouse effect.

The IPCC dismisses any possible role of variations in solar output, such as the solar wind interacting with the earth's magnetic field or variations in sunspot activity.

Temperature

The fact is that the world's temperature is not increasing at anything like the rate projected from the GCMs of the IPCC. The 'feedback' from water vapour amplifying the actual temperature effect of CO_2 by two to three times, as expected in the IPCC models, is not evident at least for the last two decades. Clearly the climate models are running hot, which is shown in *Figure 5*.

The data are lower stratosphere measurements from satellites (green) and radiosondes on balloons (blue). These are the most accurate temperature data available, covering most of the world (including the oceans); not suffering from the Urban Heat Island (UHI) effects, from poor siting of climate stations in urban areas, or allowances for the heat build up, particularly at night from asphalt, shelter and other heat stores. Adjustments of past surface temperature records have also often resulted in apparent amplification of recent warming.

There has been no significant increase in the world's temperature in the last couple of decades, the well-known and accepted 'pause'. Over this short time there has been about one-third of all human GHG emissions ever, and the concentration of atmospheric CO_2 has increased more than 10%. Apart from some variation up and down, the mean temperature has not shifted much, certainly not at the rate suggested by the IPCC models. This is good evidence that CO_2 is not the main driver of the world's temperature and/or does not have a major effect on the world's temperature.

Heat absorption activity range of GHGs over the total electromagnetic spectrum

The ability of the GHGs to absorb and emit radiation has been investigated extensively. In the daytime incoming radiation from the sun spans wavelengths from 0.2 to 3 microns. CO_2 has a small absorption band centred at 2.8 microns, which can absorb some incoming radiation. At this same wavelength water vapour is 100% saturated, so its 15,000 ppm versus 400 ppm substantially diminishes any minor effect CO_2 might have on incoming heat. We conclude therefore that there is little effective absorption of incoming radiation by CO_2. Far more important is that the central stratosphere (~50 km) is warmer than the tropopause because ozone absorbs UV energy.

Water vapour does have two significant absorption peaks and some smaller ones in the 0.2 to 3 micron range of the spectrum which will be responsible for some absorption of incoming radiation. The outgoing radiation of heat from the earth is in the 4 to 70 micron range of

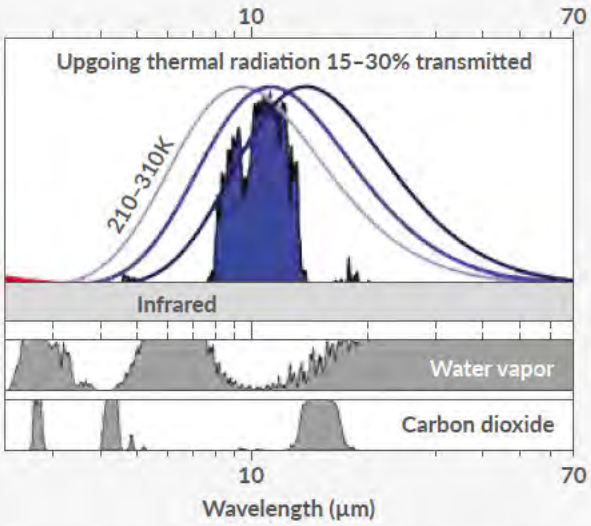


Figure 6A: Upper : Absorption of outgoing radiation from the earth's surface in the 2 to 70 micron range of the spectrum. Lower : Two panels show the absorption-saturation by H_2O and CO_2 in various spectral regions

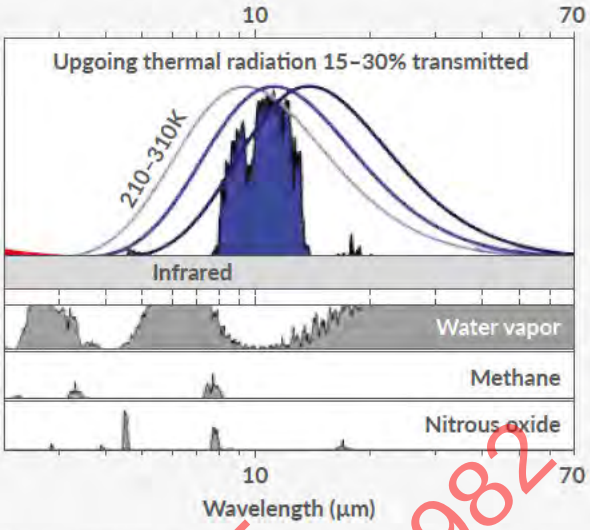


Figure 6B: Upper same as 6A. Lower bands: Absorption peaks for H_2O, CH_4 and N_2O across the infrared. The absorption bands of CH_4 and N_2O are quite narrow

the electro-magnetic spectrum (peaking around 10-15 microns), as shown in *Figures 6A* and *6B*. Absorption bands for CO_2, CH_4 and N_2O are indicated. The water vapour bands are dominant. Note that CO_2 does not compete with CH_4 and N_2O for heat radiated back from the earth, at any specific wavelength, only water vapour. Their roles are completely independent of each other.

One very important point that stands out in *Figures 6A* and *6B* is that water vapour absorbs over a very broad region of the spectrum. In contrast, CH_4 and N_2O absorb only in narrow bands. This means that H_2O captures much, much more of the radiant energy.

CO_2 has three main bands of infrared absorption: 1.8 to 2 microns, 4 to 5 microns and 12 to 18 microns. At the position of the first two bands where CO_2 is able to absorb there is hardly any energy being radiated by the earth anyway *(Figure 1A)*, and thus CO_2 is not effective as a GHG in those bands. The 12 to 18 micron band is the main place where CO_2 absorbs outgoing radiation. Absorption and emission from this band of CO_2 remains a major factor even up into the high stratosphere – above 50 km.

For CH_4 and N_2O, *Figure 6B* shows narrow absorption peaks in the 7 to 8 micron range; these are their only relevant bands. At the other minor absorption peaks for these gases there is very little energy emitted by earth into that spectral region.

In this discussion 15,000 ppm is taken for the atmospheric concentration of water vapour. This is 38 times the concentration of CO_2, and a much bigger concentration difference in comparison with those of CH_4 and N_2O. We know the individual capability of the GHG molecules is of the same order of magnitude *(Table 2)*. We also know the projected warming is not happening, *(Figure 5)* and that the GWP metrics presently used by the IPCC to classify the various GHGs as to their respective effects on warming are defective. The suggested treatment of a new way for CH_4 to get an environmentally credible metric (Allen et al., 2018) is a case in point.

Further, Sheahen (2018) has pointed out the mathematical illogicality of using the slope of a saturated gas (CO_2) as the divisor of the numerator (the top number in a fraction). If any number is divided by another number (the divisor), which is close to zero, then the quotient (the result) becomes a large number itself. This is the simple situation in the calculation of the GWP. A normal numerator (the number related to the absorption by CH_4 or N_2O) is divided by the very low number, the slope of the CO_2 absorption curve. This ridiculous situation produces a huge quotient (purported value for GWP).

CH_4 and N_2O at their tiny concentrations in the atmosphere absorb radiated heat at the earth's surface and in the trophosphere – in small, narrow bands. While this happens, water vapour (a GHG of similar absorptive capacity) is at concentrations thousands of ppm higher than these GHGs. The sequence of absorption, collisions (with N_2 and O_2), emissions and more collisions combines to carry energy away, and that process is dominated by H_2O and CO_2. That mechanism completely truncates the effectiveness of CH_4 and N_2O as GHGs.

Further, Ollila (2014) suggested that the present assessment of the effectiveness of the various GHGs was badly flawed, referring to an analysis from the Harvard-Smithsonian Centre for Astrophysics (2014), which noted that the total contributions of GHGs up to 120 km in altitude were H_2O 82.2%, CO_2 11%, O_3 5.2%, CH_4 0.8% and N_2O 0.8%. This assessment agrees with many other estimates in the scientific literature that suggest that water vapour is the main GHG,

Increasing the concentration of CO_2 in the atmosphere is not such a potential warming problem for the world as frequently promoted in the scientific literature, by governments and the media.

and 82% being higher than the IPCC's estimate of 72% mentioned above. Clearly, the main GHG is water vapour and there is not a great deal that can be done about the control of this gas.

Other energy transfer mechanisms that must be examined simultaneously

There is an important factor that is often overlooked with one of these GHGs, namely water, which has the additional ability to change phase (evaporate, condense, and precipitate) which the others cannot. These properties also act to provide cooling mechanisms for the earth.

If the planet heats up for any reason, the oceans (which are 70.9% of the earth's surface) will heat up slightly, water will evaporate, and the atmosphere will increase in humidity. Then convection carries the moist air to the cooler upper troposphere, where water changes phase back again, deposits its heat at high altitudes and forms clouds. More clouds reflect heat back to the earth. Further, in the daytime clouds will reflect back or absorb about 30% of the incoming sunlight. This is a built-in cooling effect, a 'negative' feedback. Again, this casts doubt on the IPCC contention that water vapour provides strong positive feedback that amplifies the warming effect of CO_2.

Increasing the concentration of CO_2 in the atmosphere is not such a potential warming problem for the world as frequently promoted in the scientific literature, by governments and the media. Clearly water vapour is the dominant GHG. CO_2 becomes less and less effective (at a logarithmic rate) as its atmospheric concentration increases. Thus, there is limited opportunity for additional CO_2 to cause heating, as previously illustrated in *Figure 2*.

There is agreement that increasing CO_2 in the atmosphere causes some warming; the relevant discussion is about how much? There is also general agreement that doubling the CO_2 levels in the atmosphere from 'pre-industrial' levels of about 280 ppm might increase global temperatures by up to 1°C. Just how much of the temperature rise is due to expected warming as the earth comes out of the Little Ice Age (LIA), i.e. natural variation, and how much is due to an increase in CO_2 levels is impossible to determine.

High altitude absorption

The observed temperature and GHG concentration data are pertinent close to the earth's surface and through much of the trophosphere where water is the dominant GHG. At higher altitudes water is largely frozen out and the dominant absorber becomes CO_2. At higher stratospheric altitudes water vapour is in the few ppm range, with CO_2 and CH_4 still at their lower trophospheric values. In the lower stratosphere the oxidation of CH_4 to H_2O and CO_2 begins to occur. Consequently, CH_4 always remains less than half the concentration of water vapour.

In the stratosphere the ambient temperature is below minus 30°C, and so the energy peak of outgoing radiation has shifted further out into the infrared, leaving even less energy in the 7 micron zone. Again, CH_4 has no significant role as an absorber of infrared energy. Ultimately, the cooling of the planet takes place from the stratosphere and upper troposphere as gases emit radiation into space.

CO_2 participates in this process, but CH_4 does not. CO_2 does not compete with CH_4 or N_2O to absorb radiation from the earth; CO_2 absorbs at different frequencies. Nevertheless, the effect of water vapour in the atmosphere overwhelms the role of CO_2; H_2O is known to provide about 33°C worth of greenhouse effect warming (IPCC, AR4 & AR5). That suggests that reducing atmospheric CO_2 by reducing human emissions has little potential to reduce temperature, much less to control climate. Presently, anthropogenic CO_2 is less than 5% of all the CO_2 going into the atmosphere, and as the temperature increases (as it has in the last millennium) the ocean will heat up and 'outgas' CO_2. Of course, this will also contribute to the atmospheric concentration.

Benefits of CO_2

There is a huge scientific literature about the benefits of additional CO_2 in the atmosphere; it is in fact the gas of life. The fact that many refer to this gas and the increasing levels in the atmosphere, even the adding any of it to the atmosphere, however small, as 'carbon pollution' is illustrative of a misinformed and alarmist media and a misinformed general public.

Already the increase in atmospheric CO_2 from 280 to 400+ ppm from 1850 to 2018 is responsible for probably more than a 15% increase in plant growth, and the 'greening' of the the earth is well recognised. Adding additional CO_2 to the atmosphere will increase crop, pasture and forest growth. In fact a doubling of the level of CO_2 in the atmosphere would most likely result in about 30% increase in plant growth, a result which would be a terrific boon towards food production for an increasing world population.

There is a huge scientific literature about the benefits of additional CO_2 in the atmosphere; it is in fact the gas of life. Doubling of the level of CO_2 in the atmosphere would most likely result in about 30% increase in plant growth, a result which would be a terrific boon towards food production for an increasing world population.

Are the present IPCC Estimates of GWP for the various GHGs realistic?

It is clear that the warming effect of CH_4 and N_2O is limited due to their molecular structure, their concentration in the atmosphere, and the minor amount of energy falling within their very narrow absorption bands. They are ineffective GHGs.

There are four serious discrepancies regarding our present political assessment of the effectiveness of CH_4 and N_2O as GHGs:

1. The similar molecular structure to CO_2 and H_2O, N_2O and CH_4 result in their individual capability to absorb radiating heat from the earth of a similar order of magnitude.
2. There are very tiny amounts of CH_4 and N_2O in the atmosphere.
3. The earth emits very little energy in the energy band where both CH_4 and N_2O can absorb radiation.
4. The absorption bands of CH_4 and N_2O are narrow and small, thus these molecules are unable to materially contribute to the dominant role of water vapour in the heat transfer process.

These factors drive the potential impact of these gases down to vanishingly small values. Based on the information presented we conclude that the GWP value of 25 (and rising) for CH_4, and between 265 and 310 for N_2O, is incorrect. Such an error, if followed through to financial commitment according to the United Nations Framework Convention on Climate Change (UNFCCC) and the 2015 Paris Agreement will have very serious negative effects on the New Zealand economy, not to mention all other countries. All of this would be promulgated with an indiscernible effect on temperature or climate. Thus, the generally accepted GHG effects of CH_4 and N_2O, almost 50% of the total New Zealand emissions, must be seriously questioned, and to a lesser extent the quantitative role of CO_2. Water vapour is the dominant GHG.

We assert therefore that the GWP values of both CH_4 and N_2O are vastly overstated by the IPCC, and therefore by member governments of the UNFCCC. Consequently, it is suggested that these gases be removed from New Zealand's Greenhouse Gas Inventory, and that the supporting case for such treatment be prepared for negotiation with our international partners.

Further, there is a much bigger prize at stake. CO_2 has such a small part to play in global warming/climate change, with no more than 20% of the total greenhouse (heating of the earth) effect and probably a lot less than that and the effects of CH_4 and N_2O are trivial. This means that there is an urgent need to stop all this expensive concentration on 'climate change' and be rid of the naivety of assuming that human beings can control and/or stabilise the climate.

Acknowledgements

The authors thank Will Happer, Professor of Physics at Princeton University in the USA, and William van Wijngaarden, Professor of Physics of York University in Canada, for allowing us to present their unpublished data in *Table 2*, and for their ongoing expertise and patience in improving our understanding and application of atmospheric physics during the preparation of this article.

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Further reading

For those who wish to read further on the topic of global warming we recommend a small (and free) book availabe on Google, *Why Scientists Disagree About Global Warming: The NIPCC Report on the Consensus* (2nd Edn).

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Pacific Country Report

Sea Level & Climate:
Their Present State

Vanuatu

December 2010

PACIFIC COUNTRY REPORT
ON
SEA LEVEL & CLIMATE: THEIR PRESENT STATE

VANUATU

December 2010

Executive Summary

● A SEAFRAME gauge was installed in Port Vila, Vanuatu, in January 1993. It records sea level, air and water temperature, atmospheric pressure, wind speed and direction. It is one of an array designed to monitor changes in sea level and climate in the Pacific.

● This report summarises the findings to date, and places them in a regional and historical context.

● The sea level trend to date is +5.7 mm/year but the magnitude of the trend continues to vary widely from month to month as the data set grows. Accounting for the precise levelling results and inverted barometric pressure effect, the trend is +4.9 mm/year. An older gauge at Port Vila operated from 1977-1982.

● Variations in monthly mean sea level include a moderate seasonal cycle and were affected by the 1997/1998 El Niño.

● Variations in monthly mean air and water temperature include pronounced seasonal cycles and were likewise affected by the 1997/1998 El Niño.

● A number of destructive Tropical Cyclones (TC) have passed near Vanuatu since the SEAFRAME was installed. In particular TC Prema caused damage to the SEAFRAME in March 1993.

● The SEAFRAME at Port Vila, Vanuatu has recorded 37 separate tsunami events since its installation. The largest tsunami signal of trough-to-peak height 77 cm was recorded after an earthquake of magnitude Mw7.5 that occurred near Vanuatu on 26th November 1999. Vanuatu is prone to tsunamis and two in particular have caused loss of life and damage to property in the period since installation.

Contents

1. Introduction

As part of the AusAID-sponsored South Pacific Sea Level and Climate Monitoring Project ("Pacific Project") for the FORUM region, in response to concerns raised by its member countries over the potential impacts of an enhanced Greenhouse Effect on climate and sea levels in the South Pacific region, a **SEAFRAME** (**Sea** Level **F**ine **R**esolution **A**coustic **M**easuring **E**quipment) gauge was installed in Port Vila, Vanuatu, in January, 1993. Aside from an inoperative 10-month period following damage caused by tropical cyclone Prema in March 1993, the gauge has been returning high resolution, good scientific quality data since installation.

SEAFRAME gauges not only measure sea level by two independent means, but also a number of "ancillary" variables - air and water temperatures, wind speed, wind direction and atmospheric pressure. There is an associated programme of levelling to first order, to determine shifts in the vertical of the sea level sensors due to local land movement. A Continuous Global Positioning System (CGPS) station was installed in Vanuatu in September 2002 to determine the vertical movement of the land with respect to the International Terrestrial Reference Frame.

When change in sea level is measured with a tide gauge over a number of years one cannot be sure whether the sea is rising or the land is sinking. Tide gauges measure relative sea level change, i.e., the change in sea level relative to the tide gauge, which is connected to the land. To local people, the relative sea level change is of paramount importance. Vertical movement of the land can have a number of causes, e.g. island uplift, compaction of sediment or withdrawal of ground water. From the standpoint of global change it is imperative to establish absolute sea level change, i.e. sea level referenced to the centre of the Earth, which is to say in the terrestrial reference frame. In order to accomplish this, the rate at which the land moves must be measured separately. This is the reason for the addition of CGPS near the tide gauges.

2. Regional Overview

2.1. Regional Climate and Oceanography

Variations in sea level and atmosphere are inextricably linked. For example, to understand why the sea level at Tuvalu undergoes a much larger annual fluctuation than at Samoa, we must study the seasonal shifts of the trade winds. On the other hand, the climate of the Pacific Island region is entirely ocean-dependent. When the warm waters of the western equatorial Pacific flow east during El Niño, the rainfall, in a sense, goes with them, leaving the islands in the west in drought.

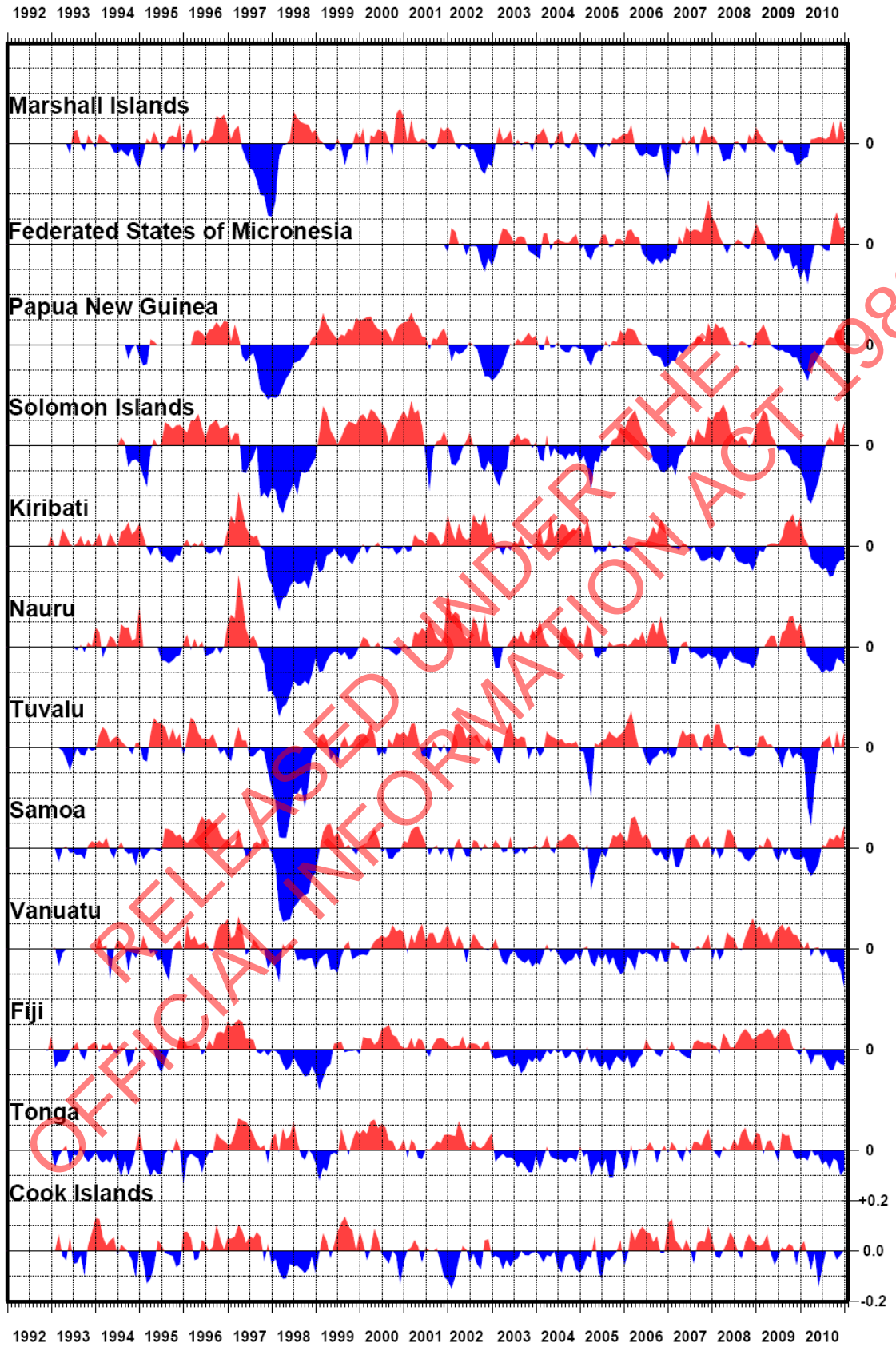
Compared to higher latitudes, air temperatures in the tropics vary little throughout the year. Of the SEAFRAME sites, those furthest from the equator naturally experience the most extreme changes – the Cook Islands (at 21°S) recorded the lowest temperature, 13.1°C, in August 1998. The Cook Islands regularly fall to 16°C while Tonga (also at 21°S) regularly falls to 18°C in winter (July/August).

Table 1. Range in air temperatures observed at SEAFRAME stations

SEAFRAME location	Minimum recorded air temperature (°C)	Mean recorded air temperature (°C)	Maximum recorded air temperature (°C)
Cook Islands	13.1	24.2	32.0
Tonga	15.3	24.2	31.4
Fiji (Lautoka)	16.6	26.0	33.9
Vanuatu	15.2	25.1	33.3
Samoa	18.7	26.6	34.3
Tuvalu	22.4	28.5	33.7
Kiribati	22.2	28.2	32.9
Nauru	19.6	28.0	33.0
Solomon Islands	20.1	26.8	34.5
Papua New Guinea	21.5	27.3	32.0
Marshall Islands	20.9	27.7	32.6
FSM	22.6	27.6	31.8

The most striking oceanic and climatic fluctuations in the equatorial region are not the seasonal, but interannual changes associated with El Niño. These affect virtually every aspect of the system, including sea level, winds, precipitation, and air and water temperature. Referring to Figure 1, we see that at most SEAFRAME sites, the lowest sea level anomalies appeared during the 1997/1998 El Niño. The most dramatic effects were observed at Marshall Islands, PNG, Solomon Islands, Nauru, Kiribati, Tuvalu and Samoa. PNG, Solomon Islands, Tuvalu and Samoa lie along a band that meteorologists refer to as the “South Pacific Convergence Zone (SPCZ)”. The SPCZ is a zone of Trade Wind convergence that extends southeastward from the equator and can sometimes be identified as a cloud band in satellite pictures.

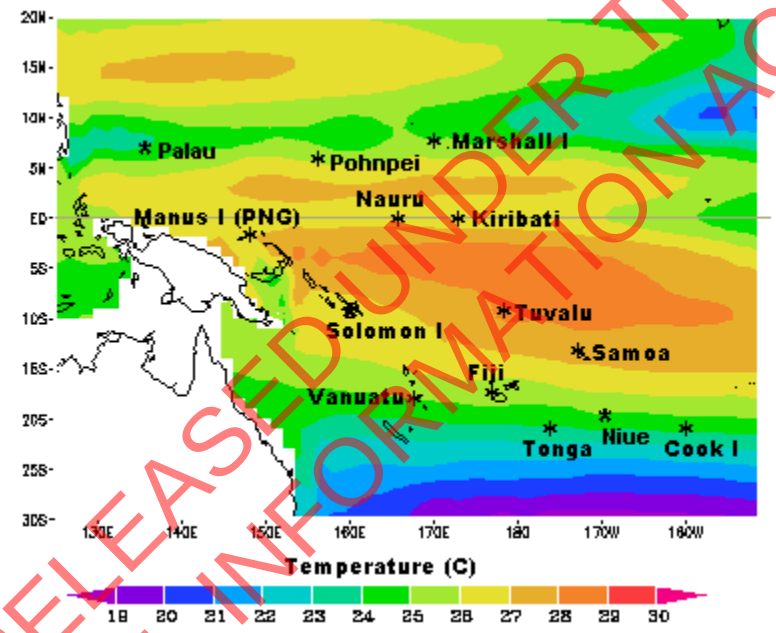
Figure 1. Sea level anomalies* at SEAFRAME sites



* Sea level "anomalies" have had tides, seasonal cycles and trend removed from the sea level observations.

Most Pacific Islanders are very aware that the sea level is controlled by many factors, some periodic (like the tides), some brief but violent (like cyclones), and some prolonged (like El Niño), because of the direct effect the changes have upon their lives. The effects vary widely across the region. Along the Melanesian archipelago, from Manus Island to Vanuatu, tides are predominantly diurnal, or once daily, while elsewhere the tide tends to have two highs and two lows each day. Cyclones, which are fuelled by heat stored in the upper ocean, tend to occur in the hottest months. They do not occur within 5° of the equator due to the weakness of the "Coriolis Force", a rather subtle effect of the earth's rotation. El Niño's impact on sea level is mostly felt along the SPCZ, because of changes in the strength and position of the Trade Winds, which have a direct bearing on sea level, and along the equator, due to related changes in ocean currents. Outside these regions, sea levels are influenced by El Niño, but to a far lesser degree.

Figure 2. Mean surface water temperature

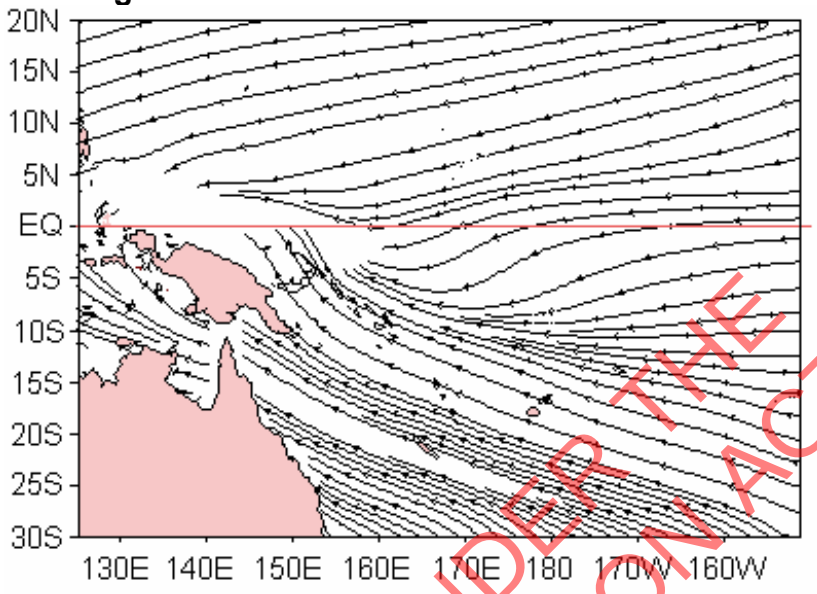


Note the warm temperatures in the SPCZ and just north of the equator.

The convergence of the Trade Winds along the SPCZ has the effect of deepening the warm upper layer of the ocean, which affects the seasonal sea level. Tuvalu, which is in the heart of the SPCZ, normally experiences higher-than-average sea levels early each year when this effect is at its peak. At Samoa, the convergence is weaker, and the seasonal variation of sea level is far less, despite the fact that the water temperature recorded by the gauge varies in a similar fashion. The interaction of wind, solar heating of the oceanic upper layer, and sea level, is quite complex and frequently leads to unexpected consequences.

The streamlines of mean surface wind (Figure 3) show how the region is dominated by easterly trade winds. In the Southern Hemisphere the Trades blow to the northwest and in the Northern Hemisphere they blow to the southwest. The streamlines converge, or crowd together, along the SPCZ.

Figure 3. Streamlines of mean surface wind



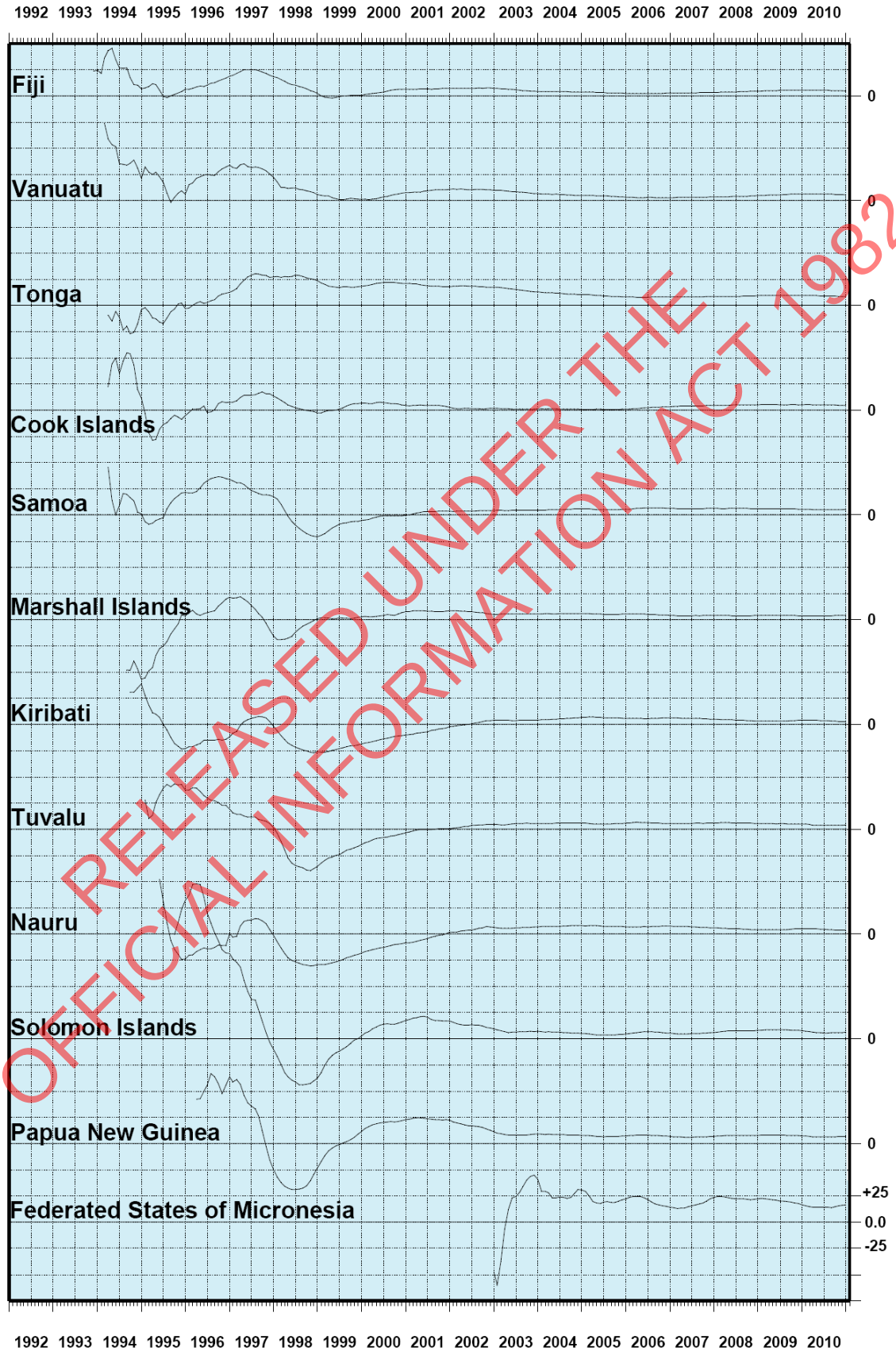
Much of the Melanesian subregion is also influenced by the Southeast Asian Monsoon. The strength and timing varies considerably, but at Manus Island (PNG), for example, the NW monsoon season (winds from the northwest) runs from November to March, while the SE monsoon brings wind (also known as the Southeast Trade Winds) from May to October. Unlike many monsoon-dominated areas, the rainfall at Manus Island is distributed evenly throughout the year (in normal years).

2.2. Sea Level Datasets from SEAFRAME stations

A key objective of the South Pacific Sea Level and Climate Monitoring Project (SPSLCMP) is to provide an accurate long-term sea level record. SEAFRAME stations were installed from 1992 onwards to provide precise relative sea level measurements. The SEAFRAME stations undergo regular calibration and maintenance and are levelled against a network of land-based benchmarks to maintain vertical datum control. The SEAFRAME observations are transmitted via satellite and are processed using specific quality control procedures.

The project's data collection program has been operating for a relatively short period with regards to long-term climate change and therefore the sea level trends are still prone to the effects of shorter-term ocean variability (such as El Niño and decadal oscillations). As the data sets increase in length the linear trend estimates will become increasingly indicative of the longer-term secular changes and less sensitive to large annual and decadal fluctuations. Figure 4 shows how the sea level trends from SEAFRAME stations have evolved from one year after installation to the present. These trends are expected to continue to stabilise, as is demonstrated by Figure 6.

Figure 4. Evolution of relative sea level trends (mm/year) at SEAFRAME stations. The trends continue to stabilise as the length of record increases.



2.2.1 Vertical datum control of SEAFRAME sensors

Precise levelling of the height of the SEAFRAME sea level sensor relative to an array of land-based benchmarks is undertaken by Geosciences Australia every eighteen months where possible. The precision to which the survey must be performed is dependent on the distance K_m (km) between the SEAFRAME sensor benchmark and the primary tide gauge benchmark (TGBM) and forms part of the project's design specifications.

The precise levelling program enables the vertical stability of the SEAFRAME stations to be monitored. Referencing the sea levels to land is especially important if the SEAFRAME needs to be replaced or relocated, or is displaced by a boat or large storm waves. The rates of vertical movement of the gauges relative to the TGBM (determined by fitting a straight line to the survey results after accounting for any adjustments to tide gauge zero) that are contributing to the observed sea level trends are listed in Table 2. Substantial subsidence of the tide gauges at Samoa and Cook Islands is occurring at rates of –0.9 mm/year and –0.7 mm/year. Subsidence is also occurring at Marshall Islands, FSM, Solomon Islands and Tonga. The tide gauges at Fiji and Nauru are rising with respect to the tide gauge benchmark at rates of +0.6 mm/yr and +0.2 mm/yr. The rates of vertical tide gauge movement are used to correct the observed rates of sea level change relative to the land-based primary tide gauge benchmark.

Table 2. Distance (km), required survey precision (mm), number of surveys and the rate of vertical movement of the SEAFRAME relative to the TGBM.

Location	K_m (km)	$\pm 2\sqrt{K_m}$ (mm)	Number of Surveys	Vertical movement (mm/year)
Cook Is	0.491	1.4	10	-0.7
FSM	0.115	0.7	4	-0.4
Fiji	0.522	1.4	11	+0.6
Kiribati	0.835	1.8	12	+0.0
Marshall Is	0.327	1.1	11	-0.5
Nauru	0.120	0.7	12	+0.2
PNG	0.474	1.4	10	-0.0
Samoa	0.519	1.4	10	-0.9
Solomon Is	0.394	1.3	6	-0.3
Tonga	0.456	1.4	11	-0.4
Tuvalu	0.592	1.5	11	-0.1
Vanuatu	1.557	2.5	10	+0.1

Continuous Geographical Positioning Systems (CGPS) stations have also been installed on all of the islands where SEAFRAME gauges are located. The purpose of the CGPS program is to close the final link in establishing vertical datum control – that is, to determine whether the island or coastal region as a whole is moving vertically with respect to the International Terrestrial Reference Frame. Early estimates of the rates of vertical movement are being calculated by Geosciences Australia but continued monitoring is necessary before long-term results emerge from the CGPS time series data. The latest CGPS information for the project is available from Geosciences Australia at http://www.ga.gov.au/geodesy/slm/spslcmp/

2.2.2. Inverted barometric pressure effect

Atmospheric pressure is another parameter that can potentially influence local measurements of relative sea level rise. Atmospheric pressure is also known as barometric pressure because it is measured by a barometer. The 'inverse barometer effect' refers to the sea level response to changes in barometric pressure, whereby a 1 hPa fall in barometric pressure that is sustained over a day or more typically causes local sea levels to rise about 1 cm (within the area beneath the low pressure system).

Scientific interest in accounting for the inverse barometer effect in sea level measurements arises because it is not directly related to global sea level rise due to global warming. Changes in barometric pressure does not cause changes in global ocean volume (because the oceans being a liquid are incompressible), but they can cause sea level to rise in some places and fall in other places due to shifting weather patterns. Global warming on the other hand does cause changes in ocean volume (and hence global sea level rise) due to the expansion of the oceans as they warm and the addition of land-based ice-melt.

Trends in barometric pressure over a period of time will cause changes in relative sea level. A 1 hPa/year decrease (increase) in barometric pressure for example would on average cause a 1cm/yr (or 10 mm/year) increase (decrease) in relative sea level. Estimates of the contribution to relative sea level trends by the inverse barometer effect at all SEAFRAME sites over the period of the project are listed in Table 3.

Table 3. Recent short-term barometric pressure trends expressed as equivalent sea level rise in mm/year based upon SEAFRAME data to December 2010.

Location	Installed	Barometric Pressure Contribution to Sea Level Trend (mm/yr)
Cook Is	19/02/1993	-0.2
FSM*	17/12/2001	-0.8
Fiji	23/10/1992	0.7
Kiribati	02/12/1992	0.3
Marshall Is	07/05/1993	0.0
Nauru	07/07/1993	0.4
PNG	28/09/1994	1.3
Samoa	26/02/1993	0.2
Solomon Is	28/07/1994	-0.3
Tonga	21/01/1993	0.4
Tuvalu	02/03/1993	0.2
Vanuatu	15/01/1993	0.9

*The trend at FSM is from a comparatively short series and therefore varies considerably.

2.2.3. Combined net rate of relative sea level trends

The effects of the vertical movement of the tide gauge platform and the inverse barometer effect are removed from the observed rates of relative sea level change and presented in Table 4 and Figure 5. The net sea level trends are positive at all sites, which indicates sea level in the region has risen over the duration of the project. The sea level rise is not geographically uniform but varies spatially in broad agreement with observations taken by satellite altimeters over a similar timeframe. The differences in the net sea level trends amongst the stations are largely due to regional oceanographic and geodynamic factors, excluding FSM where the trend is considerably large because it is derived from a shorter record than the other sites.

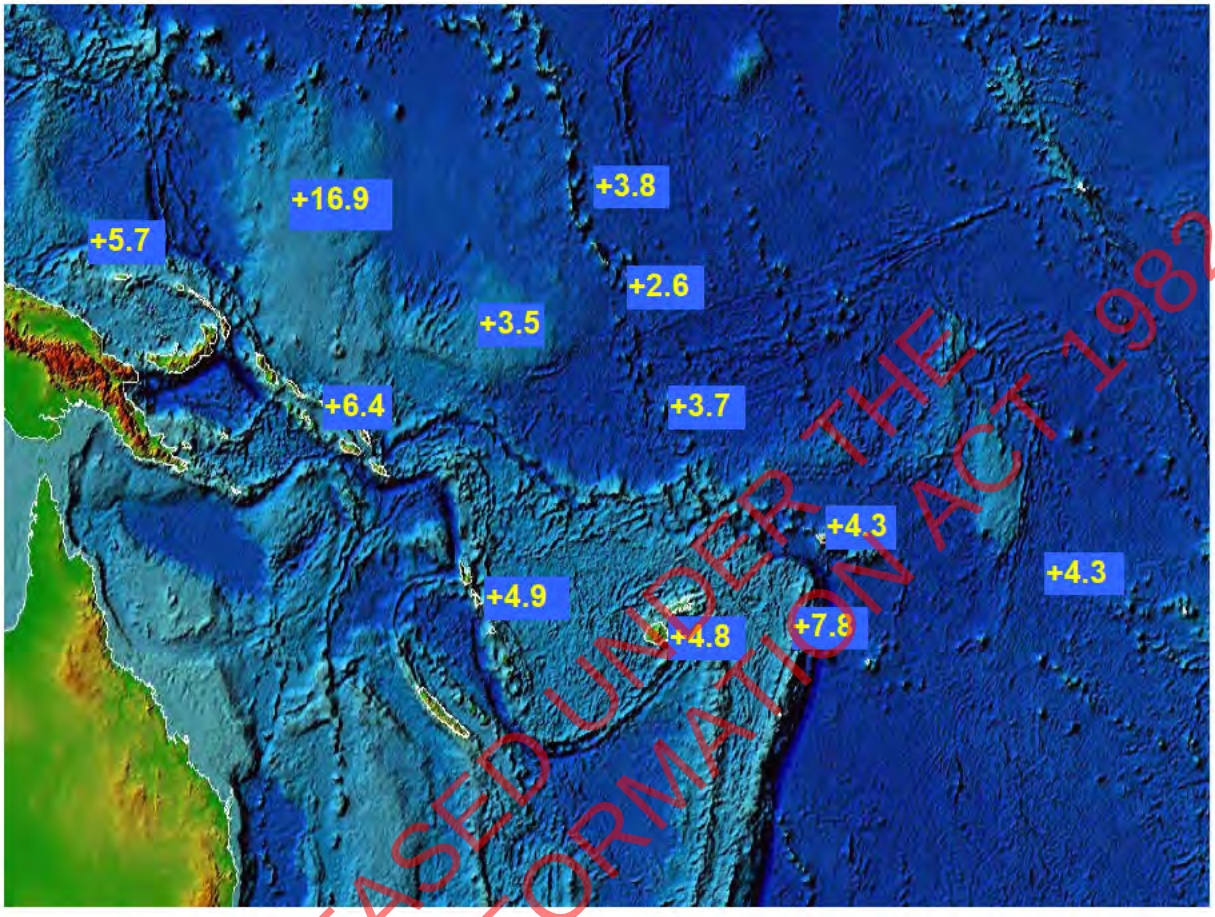
The net relative sea level trend at Tonga is larger than its neighbouring sites Fiji, Samoa and Cook Islands. Investigations that involve differencing of the sea level timeseries at Tonga from those of other stations suggest the sea level datum at Tonga is reasonably stable prior to 1996 and after 1998 but there is evidence of around 5cm of subsidence between 1996 and 1998. The impact of a tug boat occurred during this time but the precise levelling results show this collision caused less than 1cm of subsidence. Unfortunately, the CGPS station at Tonga was installed by Geosciences Australia at a later time (February 2002), and therefore it is difficult to determine whether additional subsidence is related to seismotectonic activity along the Tonga trench.

Table 4. The net relative sea level trend estimates as at December 2010 after the inverted barometric pressure effect and vertical movements in the observing platform relative to the primary tide gauge benchmark are taken into account.

Location	Installed	Sea Level Trend (mm/yr)	Barometric Pressure Contribution (mm/yr)	Vertical Tide Gauge Movement Contribution* (mm/yr)	Net Sea Level Trend (mm/yr)
Cook Is	19/02/1993	4.8	-0.2	+0.7	4.3
FSM**	17/12/2001	16.5	-0.8	+0.4	16.9
Fiji	23/10/1992	4.9	0.7	-0.6	4.8
Kiribati	02/12/1992	2.9	0.3	-0.0	2.6
Marshall Is	07/05/1993	4.3	0.0	+0.5	3.8
Nauru	07/07/1993	3.7	0.4	-0.2	3.5
PNG	28/09/1994	7.0	1.3	+0.0	5.7
Samoa	26/02/1993	5.4	0.2	+0.9	4.3
Solomon Is	28/07/1994	6.4	-0.3	+0.3	6.4
Tonga	21/01/1993	8.6	0.4	+0.4	7.8
Tuvalu	02/03/1993	4.0	0.2	+0.1	3.7
Vanuatu	15/01/1993	5.7	0.9	-0.1	4.9

*The contribution is the inverse rate of vertical tide gauge movement
** The sea level trend at FSM is derived from a comparatively short data record.

Figure 5. Map of region showing net relative sea level trends (in mm/year) after subtracting the effects of the vertical movement of the platform and the inverse barometric pressure effect, utilising all the data collected since the start of the project up to the end of December 2010.



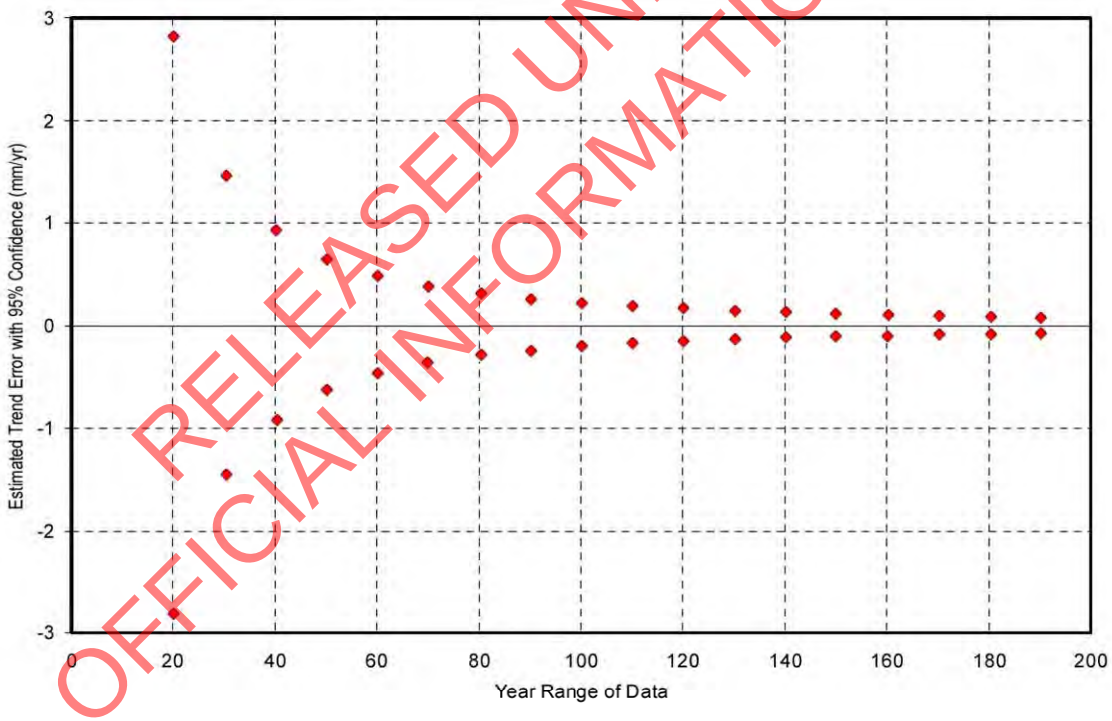
The net relative sea level measurements are important in terms of the local effects and adaptation strategies required on individual islands. Continued CGPS monitoring of the vertical motion of these islands will, in time, allow sea level trends to also be expressed in an absolute reference frame that will improve our understanding of the regional and global effects of climate change.

2.3. Sea Level Datasets from Additional Stations

Additional sea level data sets for the Pacific Forum Region are available from the Joint Archive for Sea Level (JASL). This archive was established in 1987 to supplement the University of Hawaii Sea Level Centre data holdings with contributions from other agencies. The research quality datasets available from the JASL may be accessed online at http://uhslc.soest.hawaii.edu/uhslc/jasl.html

Sea level in the Pacific Forum region undergoes large inter-annual and decadal variations due to dynamic oceanographic and climatic effects such as El Niño, and this 'noise' affects estimates of the underlying long-term trend. In general, sea level trend estimates are more precise and accurate from longer sea level records as is shown in Figure 6. Sea level records of less than 25 years are thought to be too short for obtaining reliable sea level trend estimates. A confidence interval or precision of 1 mm/year should be obtainable at most stations with 50-60 years of data on average, providing there is no acceleration in sea level change, vertical motion of the tide gauge, or abrupt shifts due to seismic events.

Figure 6. 95% Confidence Intervals for linear mean sea level trends (mm/year) plotted as a function of the year range of data. Based on NOAA tide gauges with at least 25 years of record[1].



The annual mean sea levels and relative sea level trends for the additional JASL sea level data sets are shown in Figure 7. The datasets are of different lengths covering different periods of time, and therefore different periods of climatic and sea level change. Many of the datasets are too short to provide reliable trend estimates. At some islands there are multiple sea level records, but joining them together can be problematic. They are archived separately on the Joint Archive for Sea Level

1. Zervas, C. (2001) Sea Level Variations of the United States 1854-1999. NOAA, USA.

because they either originate from different tide gauge locations or they have unrelated tide gauge datums.

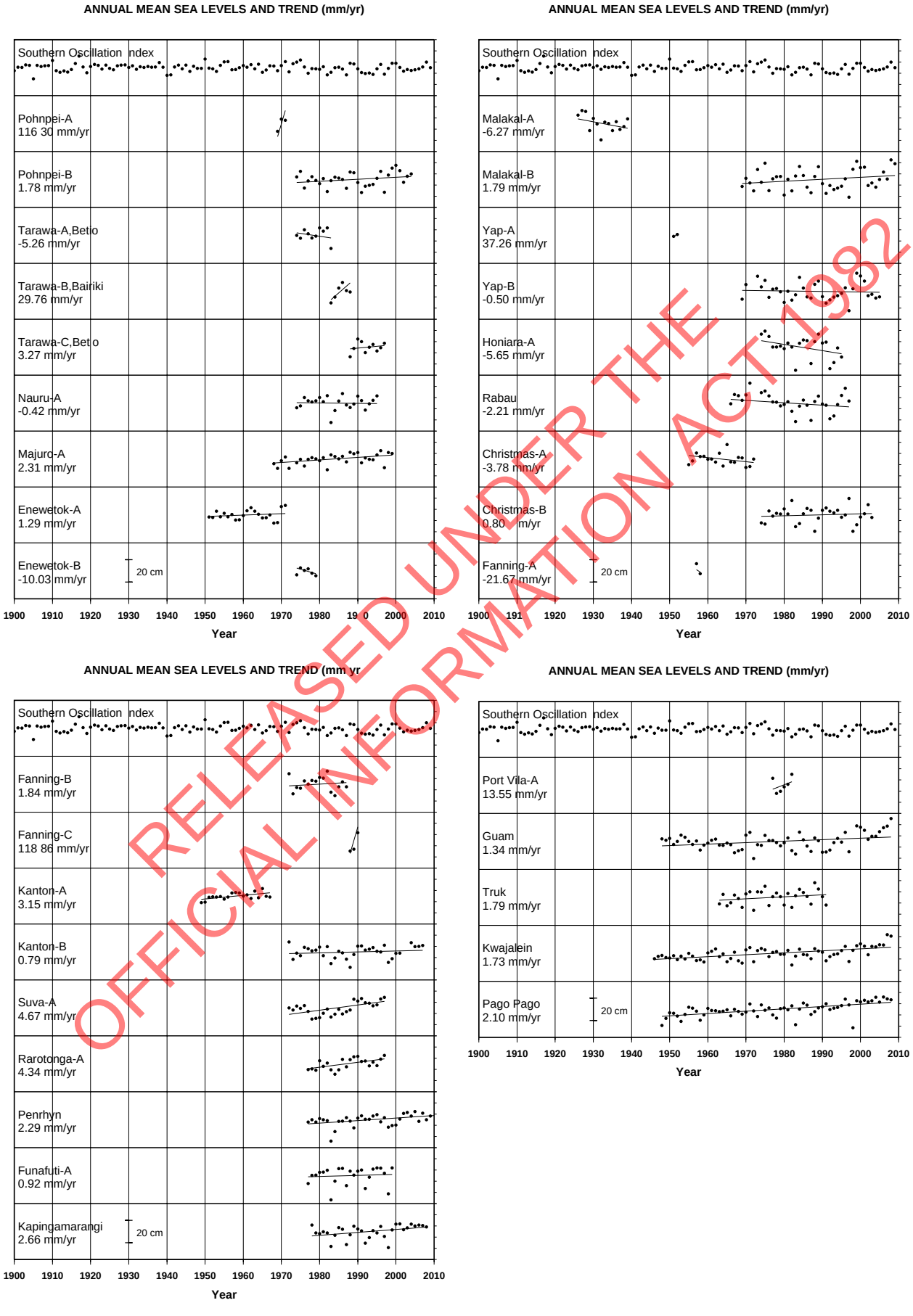
Diverse climatic and oceanographic environments are found within the Pacific Islands region. Different rates of vertical land movement are likely at different stations. Many of the historical tide gauges were designed to monitor tides and sea level variability caused by El Niño and shorter-term oceanic fluctuations rather than long-term sea level change, and therefore lack the required level of instrumental precision and vertical datum control. All of these factors potentially affect the rates of relative sea level change that are listed in Table 5. The overall mean trend from stations with more than 25 years of data is 1.3 mm/year, bearing in mind this is a very simple average that is based on datasets of different lengths that span different time periods.

Table 5. Sea level trends for additional Pacific Forum data holdings on the Joint Archive for Sea Level.

JASL	STATION	COUNTRY	START DATE	END DATE	SPAN (years)	TREND (mm/yr)
001a	Pohnpei-A	Fd St Micronesia	1-Jan-69	31-Dec-71	3	116.3
001b	**Pohnpei-B**	**Fd St Micronesia**	**1-Jan-74**	**31-Dec-04**	**1**	**1.8**
002a	Tarawa-A,Betio	Rep. of Kiribati	1-Jan-74	31-Dec-83	10	-5.3
002b	Tarawa-B,Bairiki	Rep. of Kiribati	1-Jan-83	31-Dec-88	6	29.8
002c	Tarawa-C,Betio	Rep. of Kiribati	1-Jan-88	31-Dec-97	10	3.3
004a	Nauru-A	Rep. of Nauru	1-Jan-74	31-Dec-95	22	-0.4
005a	**Majuro-A**	**Rep. Marshall I.**	**1-Jan-68**	**31-Dec-99**	**32**	**2.3**
006a	Enewetok-A	Rep. Marshall I.	1-Jan-51	31-Dec-71	21	1.3
006b	Enewetok-B	Rep. Marshall I.	1-Jan-74	31-Dec-79	6	-10.0
007a	Malakal-A	Rep. of Belau	1-Jan-26	31-Dec-39	14	-6.3
007b	**Malakal-B**	**Rep. of Belau**	**1-Jan-69**	**31-Dec-09**	**41**	**1.8**
008a	Yap-A	Fd St Micronesia	1-Jan-51	31-Dec-52	2	37.3
008b	**Yap-B**	**Fd St Micronesia**	**1-Jan-69**	**31-Dec-05**	**37**	**-0.5**
009a	Honiara-A	Solomon Islands	1-Jan-74	31-Dec-95	22	-5.7
010a	**Rabaul**	**Papua New Guinea**	**1-Jan-66**	**31-Dec-97**	**32**	**-2.2**
011a	Christmas-A	Rep. of Kiribati	1-Jan-55	31-Dec-72	18	-3.8
011b	**Christmas B**	**Rep. of Kiribati**	**1-Jan-74**	**31-Dec-03**	**30**	**0.8**
012a	Fanning-A	Rep. of Kiribati	1-Jan-57	31-Dec-58	2	-21.7
012b	Fanning B	Rep. of Kiribati	1-Jan-72	31-Dec-87	16	1.8
012c	Fanning-C	Rep. of Kiribati	1-Jan-88	31-Dec-90	3	118.9
013a	Kanton-A	Rep. of Kiribati	1-Jan-49	31-Dec-67	19	3.2
013b	**Kanton-B**	**Rep. of Kiribati**	**1-Jan-72**	**31-Dec-07**	**36**	**0.8**
018a	**Suva-A**	**Fiji**	**1-Jan-72**	**31-Dec-97**	**26**	**4.7**
023a	Rarotonga-A	Cook Islands	1-Jan-77	31-Dec-97	21	4.3
024a	**Penrhyn**	**Cook Islands**	**1-Jan-77**	**31-Dec-10**	**34**	**2.3**
025a	Funafuti-A	Tuvalu	1-Jan-77	31-Dec-99	23	0.9
029a	**Kapingamarangi**	**Fd St Micronesia**	**1-Jan-78**	**31-Dec-08**	**31**	**2.7**
046a	Port Vila-A	Vanuatu	1-Jan-77	31-Dec-82	6	13.6
053a	**Guam**	**USA Trust**	**1-Jan-48**	**31-Dec-08**	**61**	**1.3**
054a	**Truk**	**Fd St Micronesia**	**1-Jan-63**	**31-Dec-91**	**29**	**1.8**
055a	**Kwajalein**	**Rep. Marshall I.**	**1-Jan-46**	**31-Dec-08**	**63**	**1.7**
056a	**Pago Pago**	**USA Trust**	**1-Jan-48**	**31-Dec-08**	**61**	**2.1**

The mean trend for datasets that span more than 25 years (bold font) is 1.3 mm/yr.
Data from JASL as at March 2011.

Figure 7. Annual mean sea levels and linear sea level trends (mm/year) for additional stations on the Joint Archive for Sea Level.



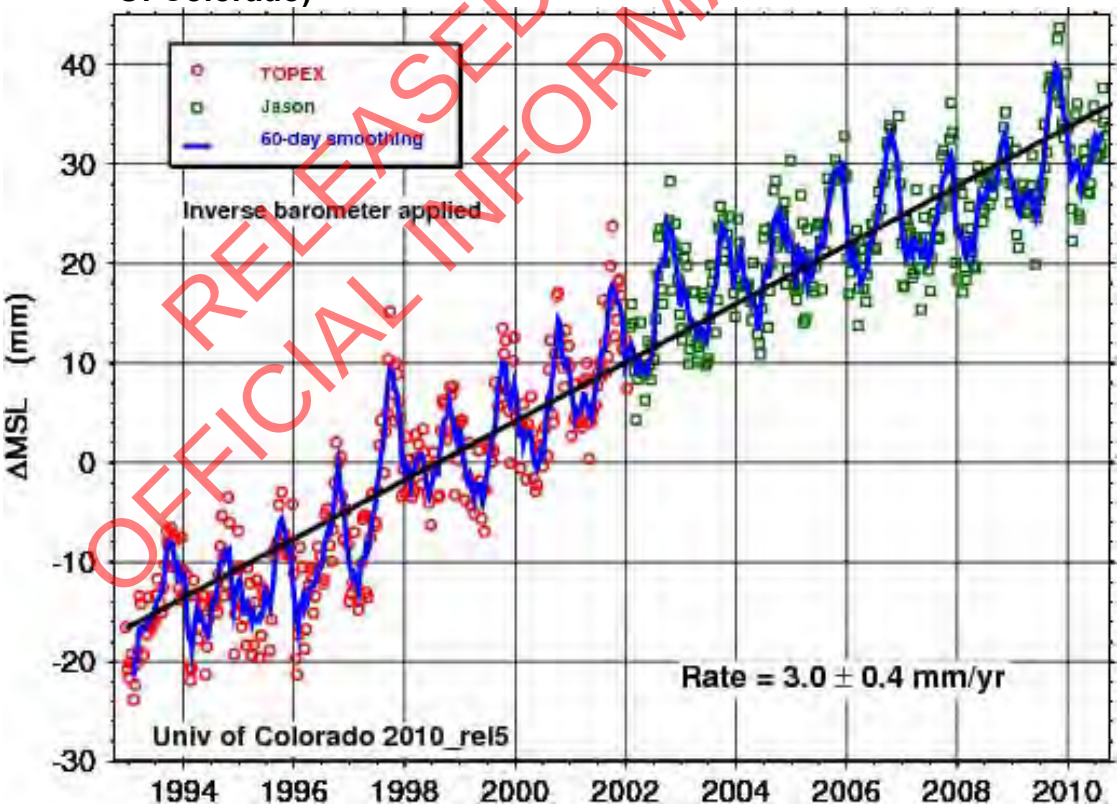
2.4. Satellite Altimetry

Satellite altimetry is technology that allows the height of the sea surface to be measured from satellites orbiting the earth. Satellite altimeters such as Topex/Poseidon and the follow-up missions Jason1 and Jason2 have provided a global record of sea level beginning in late 1992. Although the time interval between successive sea level measurements of the same position on earth is 10 days, the spatial coverage is particularly useful for mapping sea surface anomalies and monitoring development of basin scale events such as El Niño.

Satellite altimeters have an accuracy of several centimetres in the deep ocean, but they are known to be less accurate in shallow coastal regions and therefore are no replacement for in-situ tide gauges. Tide gauges are needed to calibrate the satellite altimeters and provide accurate and more frequent sea level measurements in specific locations where reliable tide predictions and real time monitoring of extreme sea levels is of prime importance.

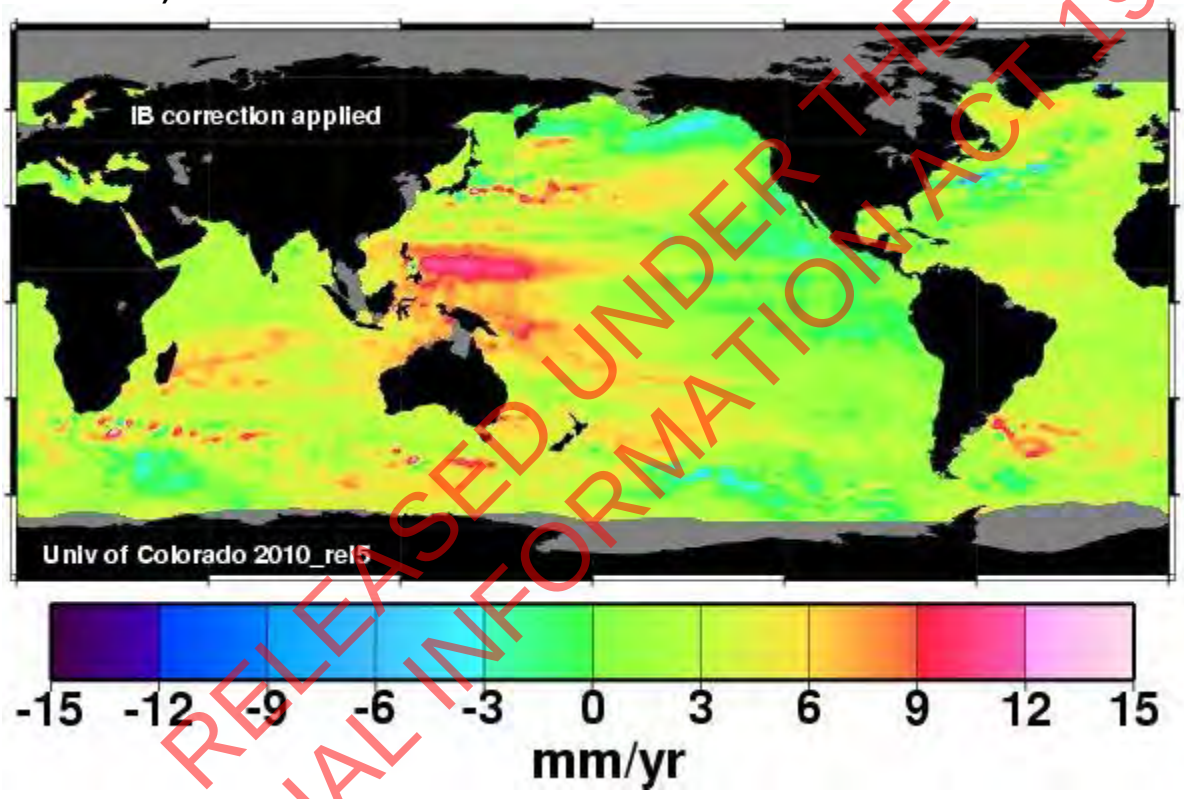
Information about global sea level change derived from satellite altimeters is available from the University of Colorado at http://sealevel.colorado.edu/. Sea level data collected by Topex/Poseidon and Jason show that global mean sea level has risen at a rate of 3.0 +/- 0.4 mm/yr since late 1992 (Figure 8).

Figure 8. Global Mean Sea Level Change Measured By Satellite Altimeters between 1992 and 2010. (Figure Courtesy Of University Of Colorado)



However, global mean sea level change during this time has not been geographically uniform (Figure 9) and continued monitoring is necessary. For example, sea level has risen at relatively high rates across the southwest Pacific but it has risen at relatively low rates across the northeast Pacific and has even fallen in some areas, illustrating basin-wide decadal variability in the Pacific Ocean. The satellite altimetry data has a similar length of record to the South Pacific Sea Level Monitoring Project SEAFRAME stations. The sea level trends from SEAFRAME stations (Table 4) are mostly higher than the global average rate, but this is consistent with higher rates in the southwest Pacific measured by satellite altimeters shown in Figure 9.

Figure 9. Regional Rates of Sea Level Change from 1992 to 2010 as measured by satellite altimeters. (Figure courtesy of University of Colorado)



This section has provided an overview of aspects of the climate and sea level of the South Pacific Sea Level and Climate Monitoring Project region as a whole. The following section provides further details of project findings to date that are relevant to Vanuatu.

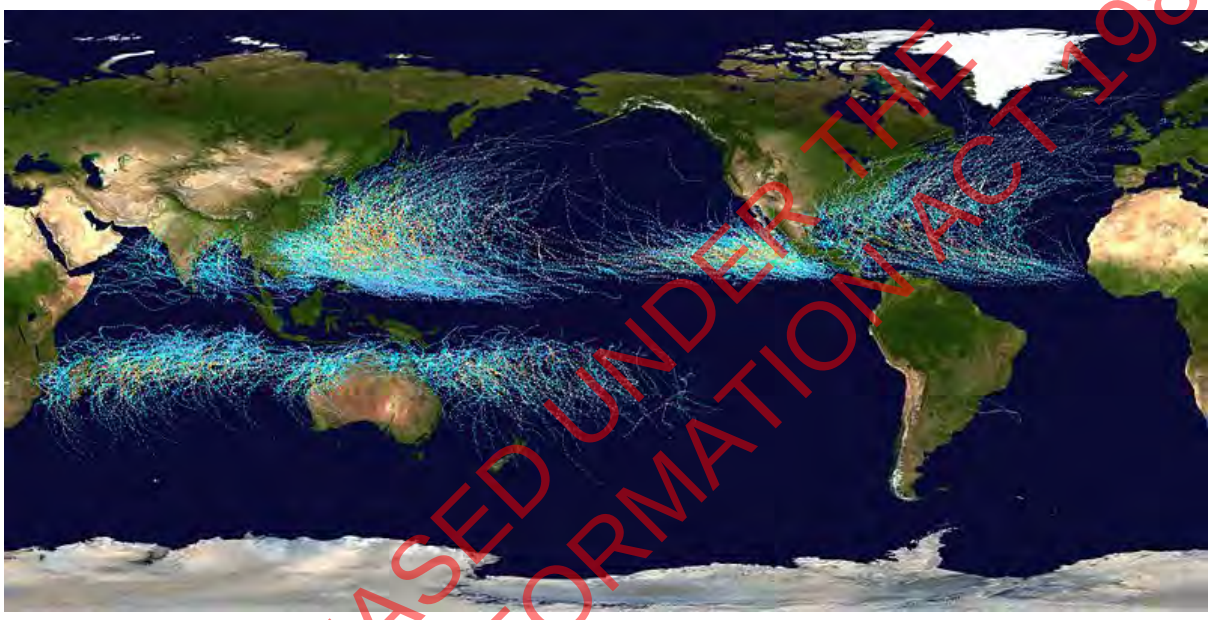
3. Project findings to date - Vanuatu

3.1 Extreme Events

3.1.1. Tropical Cyclones

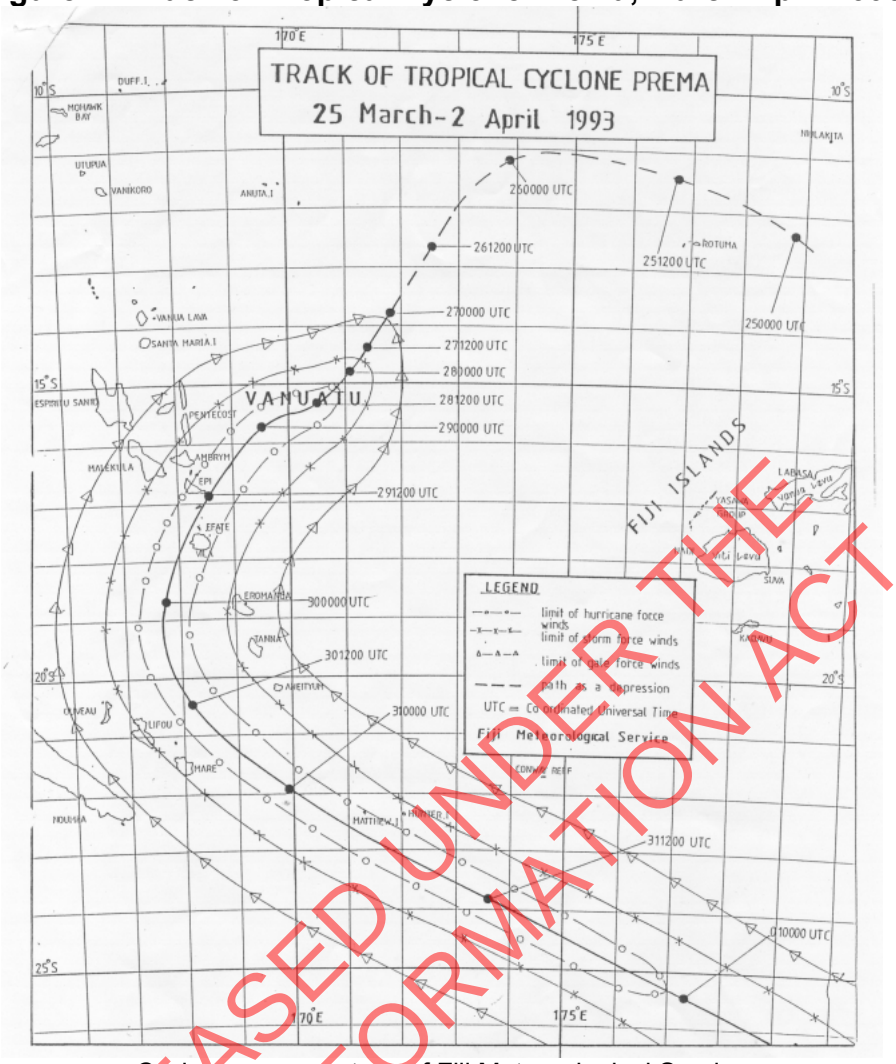
Vanuatu is situated in the southwest Pacific in an area that historically experiences tropical cyclones as shown in Figure 10.

Figure 10. Global Tropical Cyclone Tracks between 1985 and 2005 (Figure courtesy of Wikipedia)



A number of destructive tropical cyclones have passed near Vanuatu since the SEAFRAME was installed, and three in particular have come close enough to Port Vila to be recorded as very low pressures. TC Prema, on 29 March 1993, TC Paula (Category 3), on 2 March 2001 and TC Ivy (Category 4) on 26 February 2004 have all caused considerable damage. One consequence of TC Prema was that the SEAFRAME was damaged and inoperative for ten months.

Figure11. Track of Tropical Cyclone Prema, March/April 1993



Cyclone map courtesy of Fiji Meteorological Service

Figure 12. Track of Tropical Cyclone Paula, February/March 2001

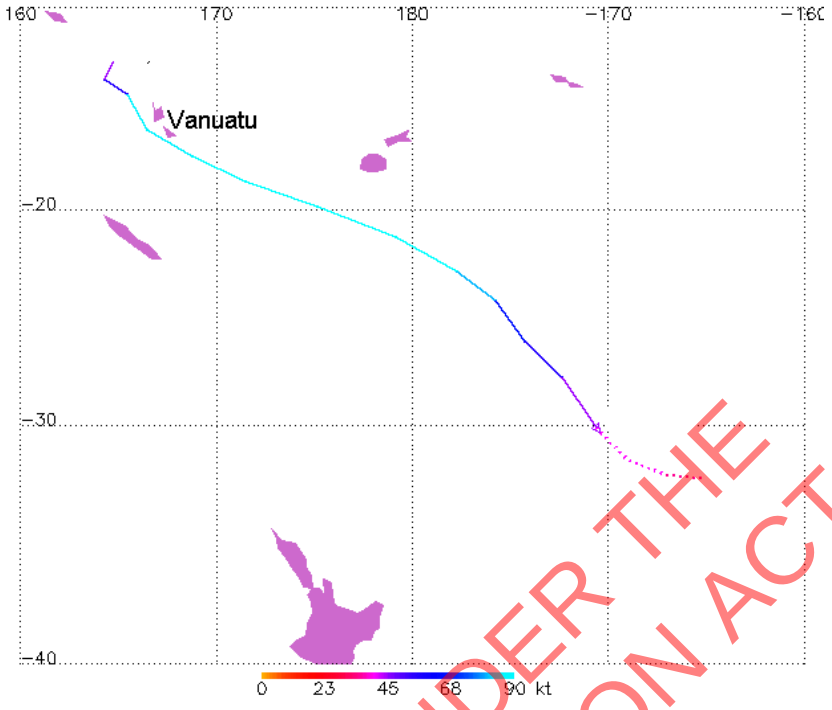
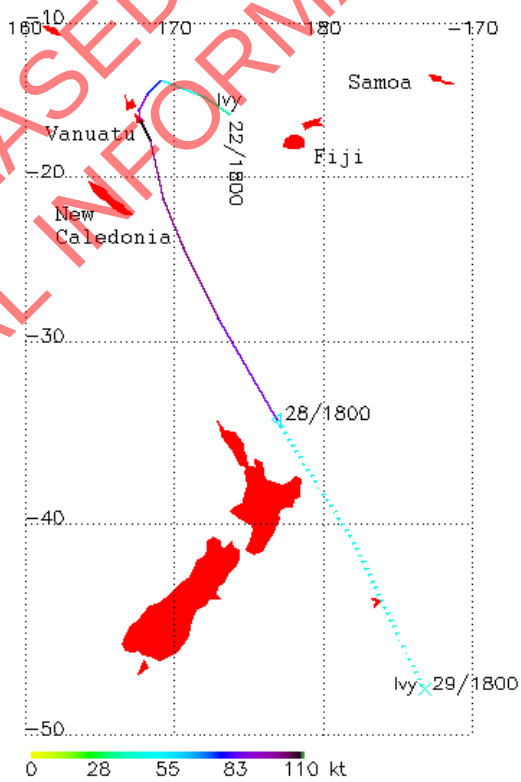


Figure 13. Track of Tropical Cyclone Ivy, February 2004

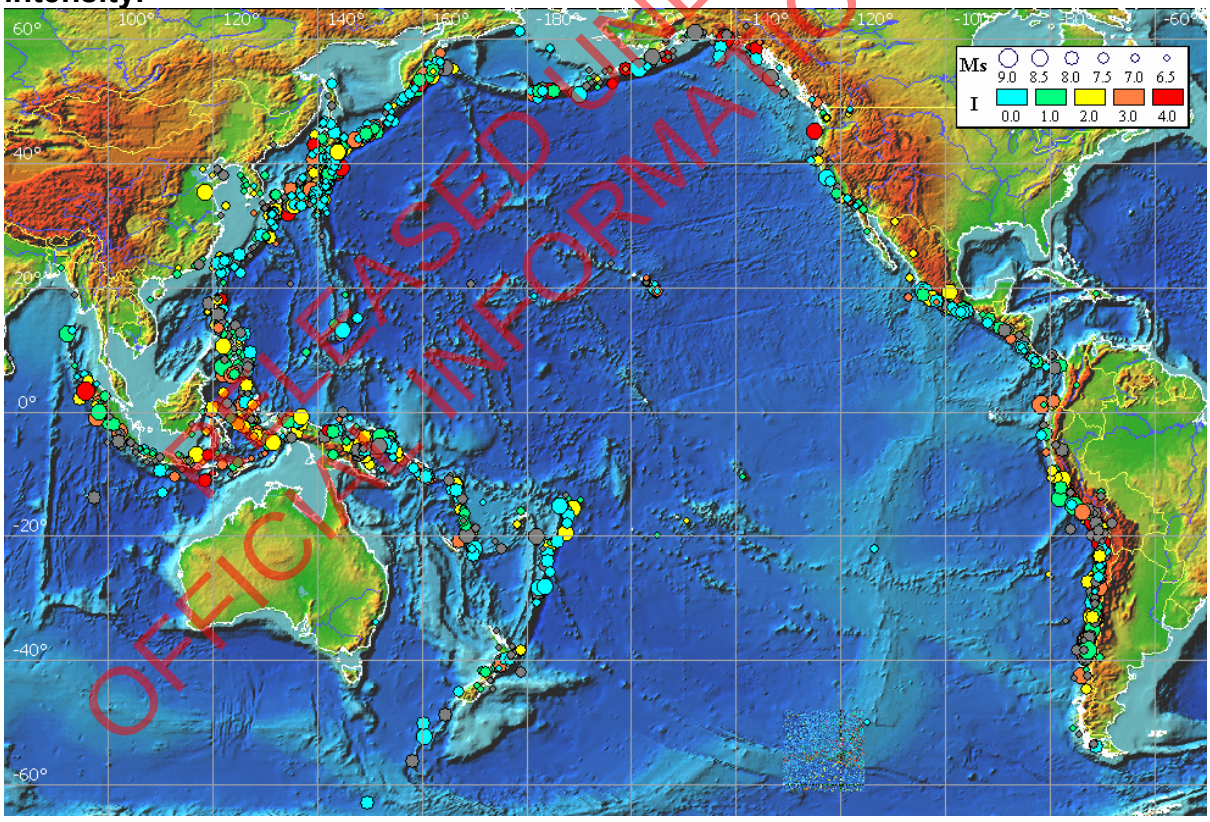


3.1.2. Tsunamis

A tsunami is a series of waves generated by an impulsive disturbance such as an undersea earthquake, coastal or submarine landslide, volcanic eruption, or asteroid impact. Tsunamis are most commonly generated along tectonic plate margins where earthquakes and volcanoes are found. Due to their association with seismic events tsunamis are also referred to as *seismic sea waves*. The term *tidal wave* is incorrect, as tsunamis have nothing to do with gravitational tide generating forces. Tsunami waves may be barely discernible in the open ocean but as they propagate into shallow coastal waters their size may increase significantly.

Figure 14 shows the sources of historical tsunami events listed in the *Integrated Tsunami Database for the Pacific and the Eastern Indian Ocean*[1]. A number of tsunamis have been generated in the South Pacific Sea Level and Climate Monitoring Project region. The SEAFRAME tide gauge network provides important real time tsunami monitoring capability in the region and contributes toward the tsunami warning system for the Pacific Ocean.

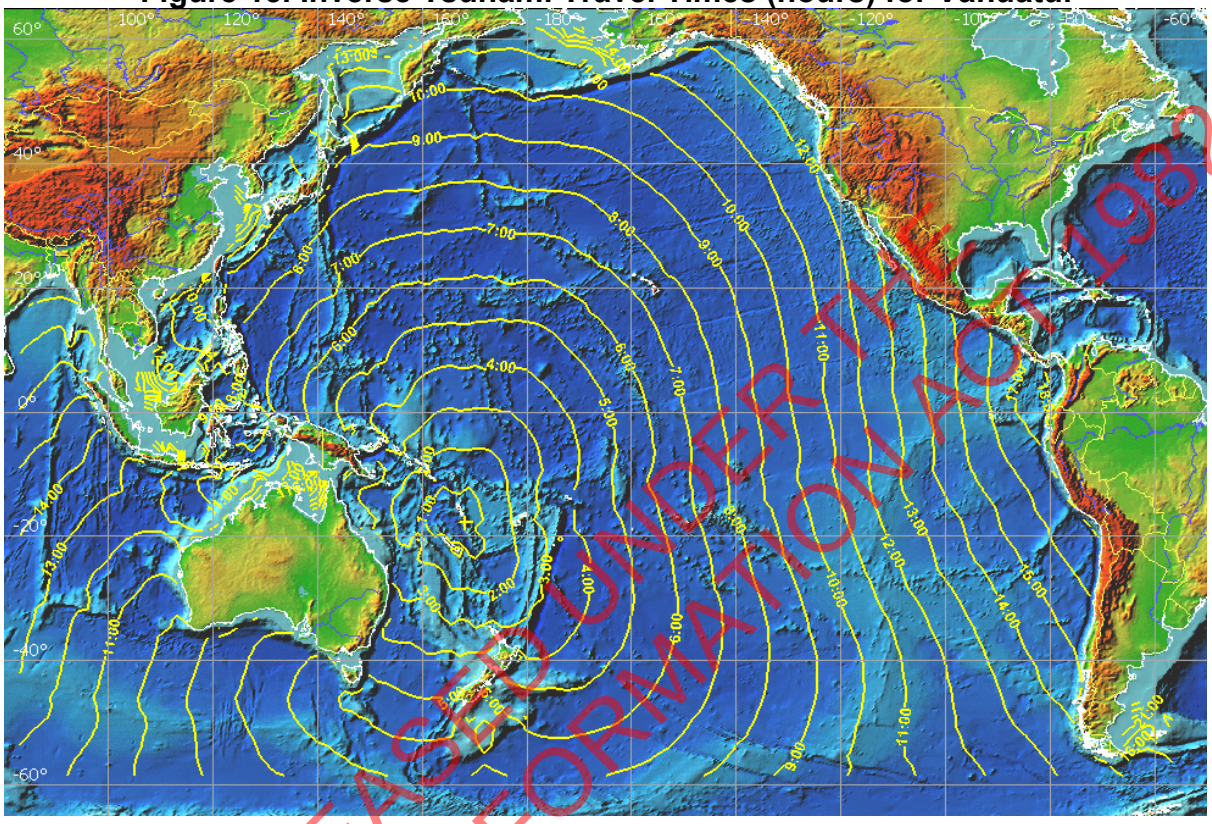
Figure 14. Historical Tsunami Events in the Pacific and Eastern Indian Ocean. Circle size indicates earthquake magnitude and colour indicates tsunami intensity.



[1] ITDB/PAC (2004) Integrated Tsunami Database for the Pacific, Version 5.12 of December 31, 2004. CD-ROM, Tsunami Laboratory, ICMMG SD RAS, Novosibirsk, Russia.

The historical record reveals that tsunamis have been observed at Vanuatu from sources including Vanuatu, Loyalty Islands, Indonesia, Chile and Peru. Figure 15 shows the inverse tsunami travel time chart for Vanuatu. This chart may be used to provide an estimate of the time taken for a tsunami to arrive at Vanuatu from any source location.

Figure 15. Inverse Tsunami Travel Times (hours) for Vanuatu.



Since its installation in 1993, the SEAFRAME tide gauge at Vanuatu has detected 37 separate tsunami events. The non-tidal sea levels (3-minute averages recorded every 6 minutes) for each of these events are presented in Figures 16a-16g. Also shown (as vertical dotted lines) are tsunami arrival times, which have been computed independent of the observations by tsunami travel time software using the earthquake location as input.

The tsunamis detected by the SEAFRAME at Vanuatu include local, regional and transoceanic tsunamis. In fact the Vanuatu SEAFRAME has recorded the most number of tsunami events and also tends to observe larger signals in comparison to other stations in the network.

A number of local tsunamigenic earthquakes have occurred in the Vanuatu region since the SEAFRAME was installed, ranging in magnitude from Mw7.1 to Mw7.7. Two of these events produced the largest tsunamis to be recorded on the SEAFRAME. The first was a magnitude Mw7.5 earthquake on 26 November 1999 that occurred 140 km to the northwest of Port Vila. A tsunami was generated which caused destruction on Pentecost Island where maximum tsunami heights reached 6m. The tsunami claimed 3 lives, although many were saved when some residents

recognised an impending tsunami as the sea began to recede and managed to warn people to seek higher ground. The peak to trough tsunami signal on the Port Vila SEAFRAME was around 0.9 m for the 1-minute sea level data, or 0.77m for the 3-minute sea level data recorded every 6 minutes. The tsunami arrival coincided with low tide, which resulted in dangerously low sea levels 23 cm below the lowest astronomical tide.

The second event was an earthquake of magnitude Mw7.2 on the 2nd of January 2002 that occurred 100 km west of Port Vila, Vanuatu. Several people were injured and there was widespread damage on the island of Efate. Access to the wharf was blocked by rockslides. The SEAFRAME tide gauge at Port Vila recorded the tsunami wave that followed, whose peak to trough height reached 80 cm for the 1-minute data, or 74cm for the 3-minute data stream.

A number of regional tsunamis have also been detected by the SEAFRAME emanating from sources including Samoa, Loyalty Islands, Tonga, Solomon Islands and Irian Jaya. Larger transoceanic tsunamis have also been observed generated from far-field earthquake sources including Kuril Islands (in the northwest Pacific), Peru, Chile, Mexico, Andreonof Islands and as far as Sumatra, Indonesia in the Indian Ocean.

Figure 16a. Tsunami signals (m) recorded by the SEAFRAME at Port Vila, Vanuatu since installation.

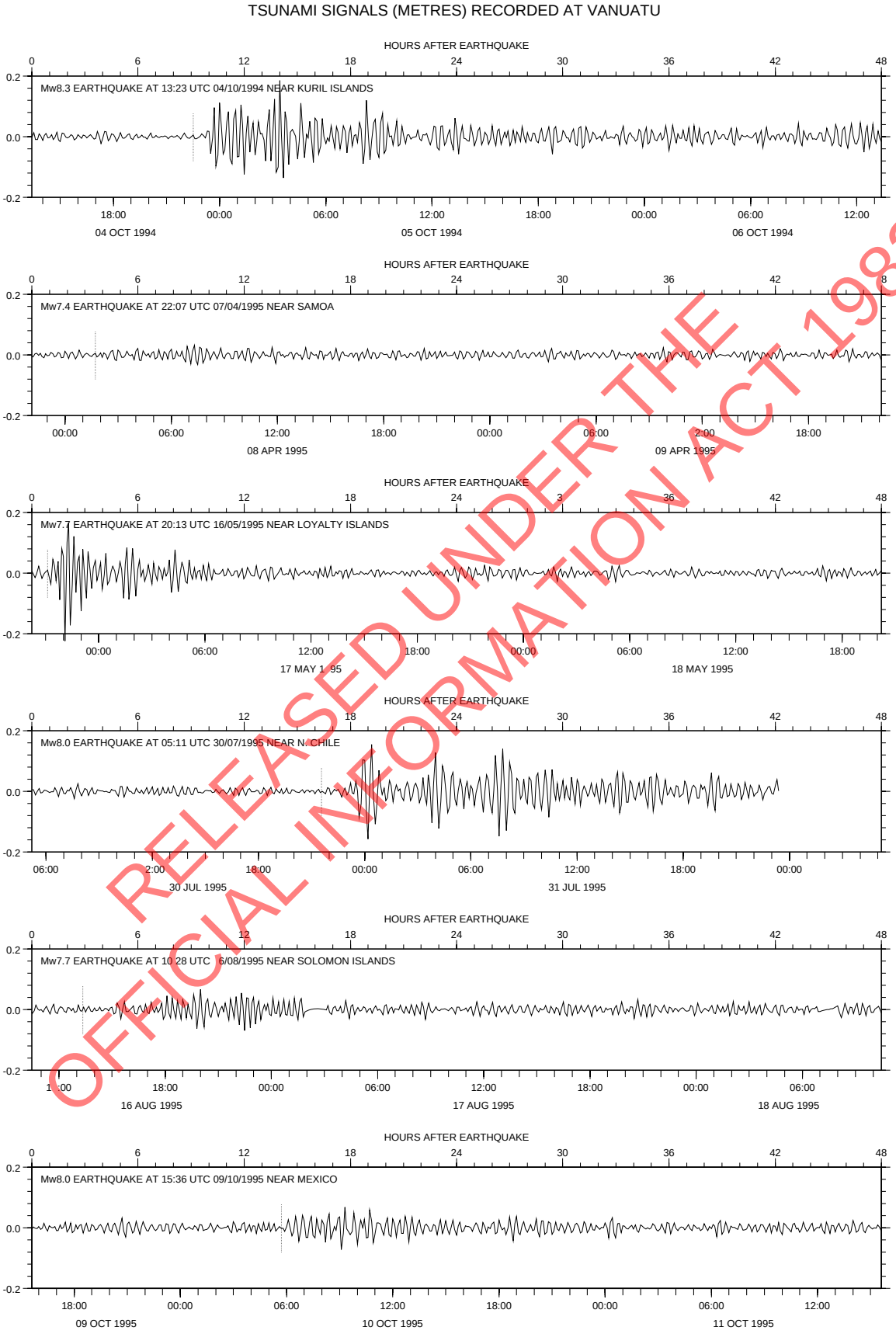


Figure 16b. Tsunami signals (m) recorded by the SEAFRAME at Port Vila, Vanuatu since installation.

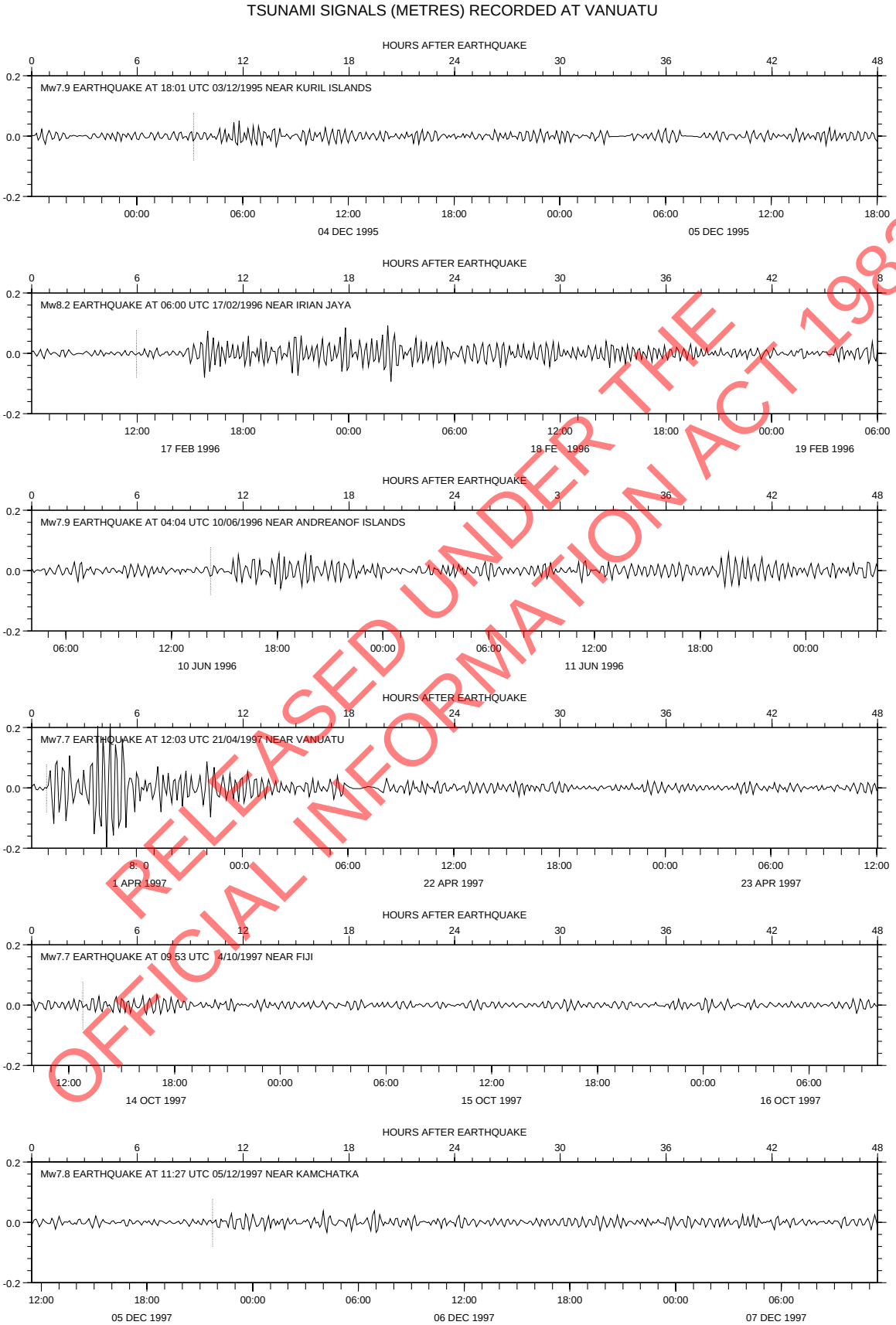


Figure 16c. Tsunami signals (m) recorded by the SEAFRAME at Port Vila, Vanuatu since installation.

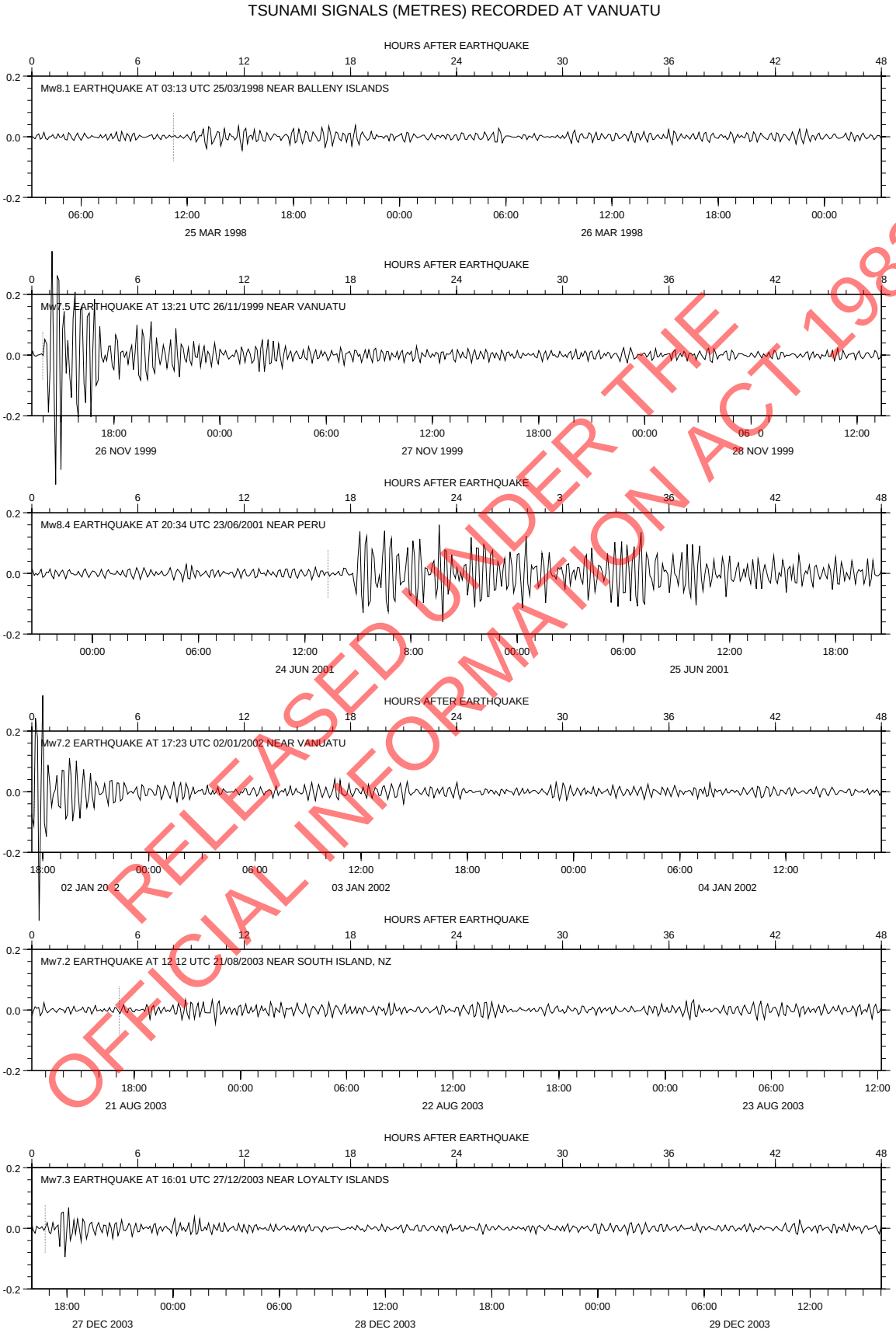


Figure 16d. Tsunami signals (m) recorded by the SEAFRAME at Port Vila, Vanuatu since installation.

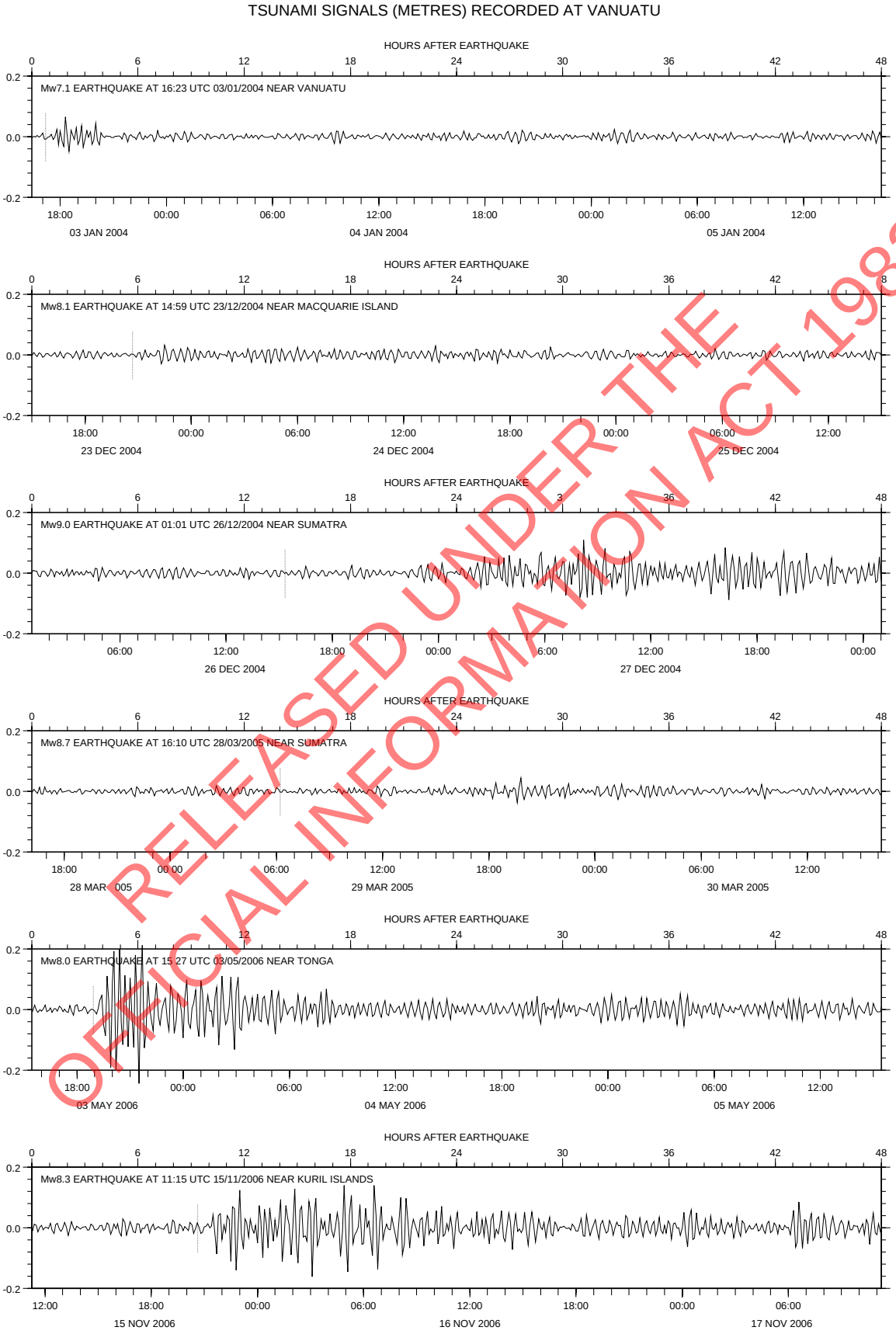


Figure 16e. Tsunami signals (m) recorded by the SEAFRAME at Port Vila, Vanuatu since installation.

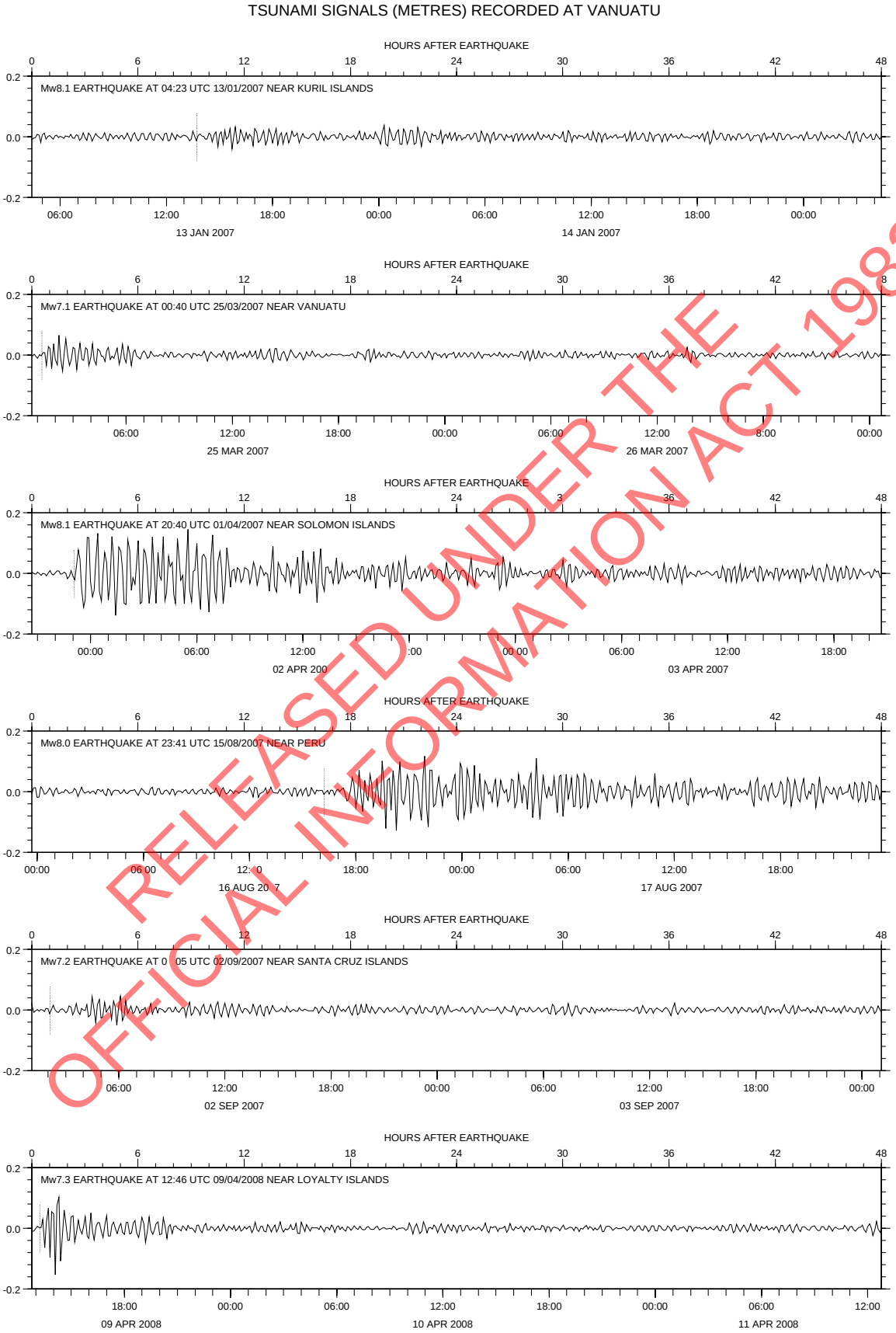


Figure 16f. Tsunami signals (m) recorded by the SEAFRAME at Port Vila, Vanuatu since installation.

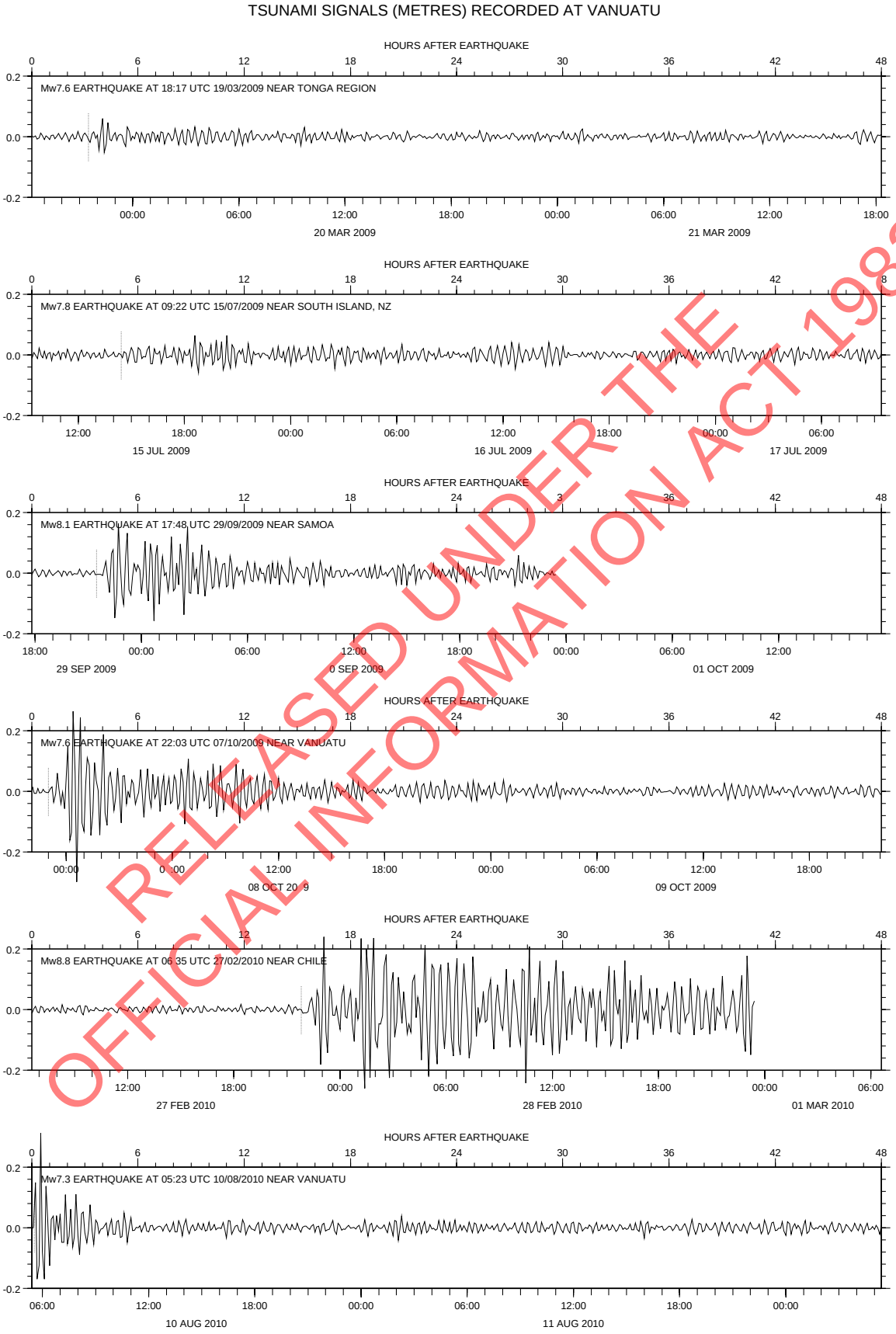


Figure 16g. Tsunami signals (m) recorded by the SEAFRAME at Port Vila, Vanuatu since installation.