We thank Anonymous Referee #2 (AR#2) for their careful and thorough review.

Both referees have done an excellent job in reviewing only the second half paper on our two-part exciting voyage of scientific discovery. We gave a comprehensive account in response to AR#1 to explain the full significance our findings (http://www.ocean-sci-discuss.net/11/C54/2014/osd-11-C54-2014-supplement.pdf; hereafter C54). However, we are baffled by the difficulty in getting our unique observational discoveries published.

Only half pair published for discussion creating serious evaluation problems

The first half, the Manx paper here reviewed (hereafter MP), was delayed by tedious questions about basic physics discoveries that were dealt with in the still unpublished companion Pacific paper (hereafter PP; Footnote 1 Title and Abstract). Questions about published North Sea cyclonic wind reversals and even the definition of a fjord estuary delayed the present public discussion. Then, Editors William Jenkins, Eric J. M. Delhez, and John M. Huthnance, abruptly withdrew the essential Pacific companion paper containing unique scientific ground truth. They also withdrew the offered fee waiver from our self-funded unbiased papers (Footnote 2). This was executed after publication of the paper under review here (MP).

It is unprecedented for unique scientific ground truth data to be blocked from publication. We explained at outset these papers represented a major paradigm shift in global warming to the almost completely unstudied ocean surface. We did not anticipate summary rejection. The work was done from a passionate research interest and publications experience of over 50 years. We have no vested interests, external funding or institutional support. These responses are by the senior author JBM who takes full responsibility for the science expressed.

Ocean Science is the modern forum for these papers

Ocean Science is the modern equivalent of the 350-year-old Royal Society discussions and publications. However, unlike the Royal Society, it is available on the Internet to all the qualified global scientific community. Experimentally verified ocean science topics can be openly discussed and refined.

We first experienced fully interactive global publishing during the tenure of an Eckert Environmental Fellowship at the prestigious IBM Watson Research Centre in New York. This pre-dates the Internet. A printable copy of a paper on a passive underwater weather station we developed for US Office of Naval Research (ONR) was published entirely from an office interactive computer terminal (Matthews and Mimken, 1974). Unfortunately, JBM's suggestion that an interactive computer be developed to connect to shipboard data loggers had to wait for the later launch of the PC. However, we were convinced of the value of interactive computing and communicating the results under an integrated computer network. Connected to one of the largest available computers, we could quickly verify the effect of multiple-length timeseries data on the precision of our Gulf of California tidal harmonic phase and amplitude derivations. We are therefore very supportive of the objectives of Ocean Science Discussions leading to refined publications in Ocean Science.

Observations: Pacific voyage of discovery

Ocean surface layer ground truth timeseries observations are the gold of scientific discovery. We are lucky to have two mother lodes. The Pacific paper discovers that the 2m-ocean surface behaves differently from common assumptions. We found that the surface layer is not well mixed to 10m (Matthews, 2013, Matthews and Matthews, 2013). We found evaporation and heat sequestration depends only on temperature and salinity: not on the commonly assumed windspeed and relative humidity (PP).

We discovered completely separate equatorial surface circulation of the south and north Pacific. Equatorial upwelling and the undercurrent (EUC) separate circulation systems to about 200m. The EUC connects the western freshwater warm pool to the eastern pool in the Gulf of Panama. The southern Pacific is hypersaline (>35.5‰) with evaporation and heat sequestration determined mainly by salinity at high temperature (>28ºC). The importance of this to ENSO, the shallow lagoons and seas, such as the Araruama Lagoon (22ºS) and Great Barrier Reef Shelf Sea, as well as Antarctic circulation and icemelt is discussed in light of these discoveries.

The north Pacific behaves as an almost land-locked stratified estuary. The discovery of a series of vertical meridional counter-rotating cells on both sides of the equator is significant for global circulation. An abrupt front between warm saline and cold fresh water is reported at 11ºN. Circulation is confined to a global system of Lagrangian wind-driven surface water. The input from the tidal Gulf of California is contrasted to the tideless Mediterranean. The significance of global tides is discussed. Also discussed is the western warm current, western sustained temperatures of ~32ºC leading to extreme typhoons, and the observed speed-over-the-ground of tropical storms in relation to heat extraction, and growth and decline of storms.

The global surface transport system, from the north Pacific estuary, of fresh nutrient rich surface waters is discussed. The only outlet is through Bering Strait. The Arctic Ocean is a strongly stratified estuary. Watermasses and heat through Bering Strait doubled since 2000. Warm fresh Pacific water, over saline Atlantic and deeper brine from freezing processes is discussed in relation to basal melting. Observations are linked to Arctic ice melt, to the release of anhydrous methane, and enhanced tidewater glacier and permafrost melting.

The Manx paper discusses the mother lode of century long surface water timeseries data from Isle of Man. It provides verification ground truth to our suggested link between tropical heating and Arctic icemelt moderated over a century by Arctic floating ice leading the present catastrophic rapid temperature rise of ocean anthropogenic warming (PP).

Our papers are based on the gold of science; verification ground truth. Scientific method demands that scientific theories, models and assumptions be verified by repeatable scientific experiments and published in peer-reviewed journals.

Many scientists appear to take unverified models and statistics in place of ground truth data. This is fools gold. Scientists refer it to as the battle between observationists and applicationists: Obs v Apps. We illustrate this pictorially.

A Picture is worth a thousand words: Apps v Obs

Figure 1 shows sea surface temperature (SST) anomalies actually observed for Niño 3.4 region (5ºN-5ºS, 120ºW-170ºW), the location of our Pacific experiment, with forecasts forward 10 months from 14 dynamical and 10 statistical models (data courtesy of http://www.cpc.ncep.noaa.gov/products/CDB/CDB_Archive_pdf/pdf_CDB_archive.shtml). The red dots representing actuality are widely divergent from forecasts even after only one month. Clearly something is wrong and repeated monthly model runs over the past four years offer no clues to the cause of the divergences. Only actual ground truth timeseries can do that.

Ground truth timeseries are extremely rare. Scripps pier daily timeseries observations of surface and 5m temperatures from 1916 are shown (Fig 2a). This clearly shows persistent temperature (and salinity, see C54) gradients. It also shows the same three phases of warming, slight cooling and warming that we found from the century-long Port Erin timeseries. Moreover, the prominent heating effect at solar maximum is also apparent during the mid-century cooling period. However, the corresponding cold water 3½ years later is not present because the Pacific has no Arctic melt waters and runoff (PP).

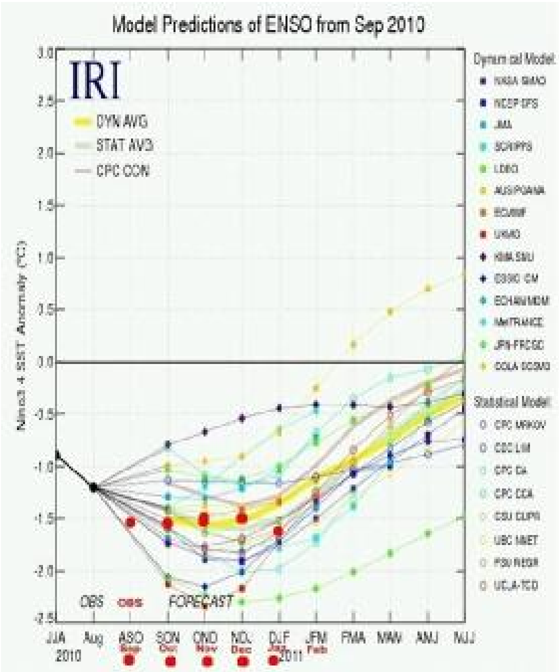

Figure 1. Sea surface temperature (SST) anomalies observed (red) and 10 months forecasts for Niño 3.4 region from 14 dynamical and 10 statistical models.

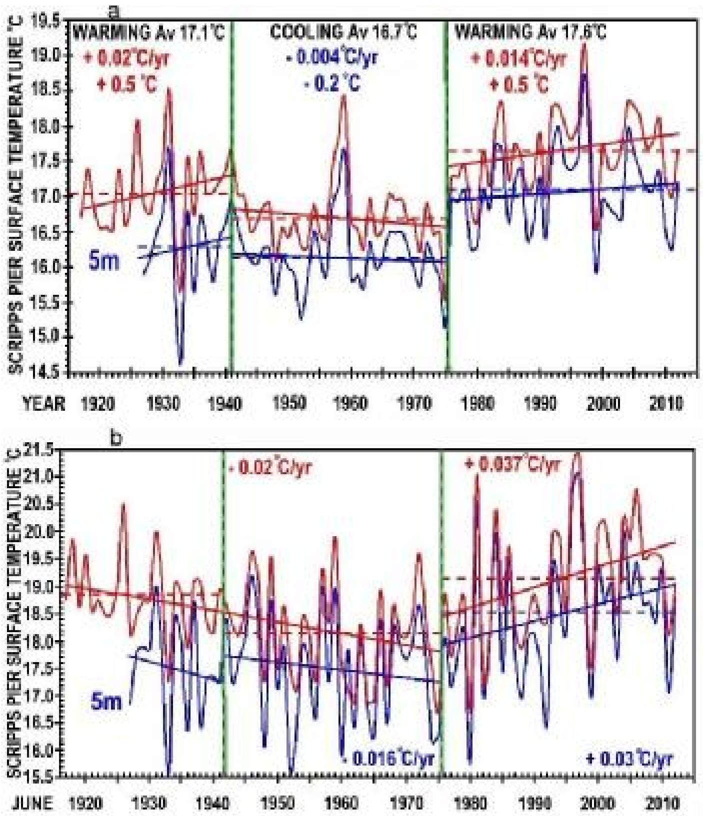

Figure 2. Scripps Pier means and trends of surface and 5m temperatures and trends 1916-2012 a) Year, and b) June month.

What is even more surprising is that warming for the month of June (Figure 2b) is identical to that at Port Erin. It is +0.037ºC yr^{-1} starting a decade earlier, 1976. This observed trend of over 1ºC in 20 years is further evidence of rapid, catastrophic and irreversible warming.

This confirms that greenhouse gas heating is the major cause of the 93% of global warming in the oceans. It now far exceeds all other variations in solar cycles including the well-known decadal sunspot cycles that drive major ocean indices including ENSO, ADO etc (PP; MP). A third picture demonstrates this (Figure 3), also given in C54.

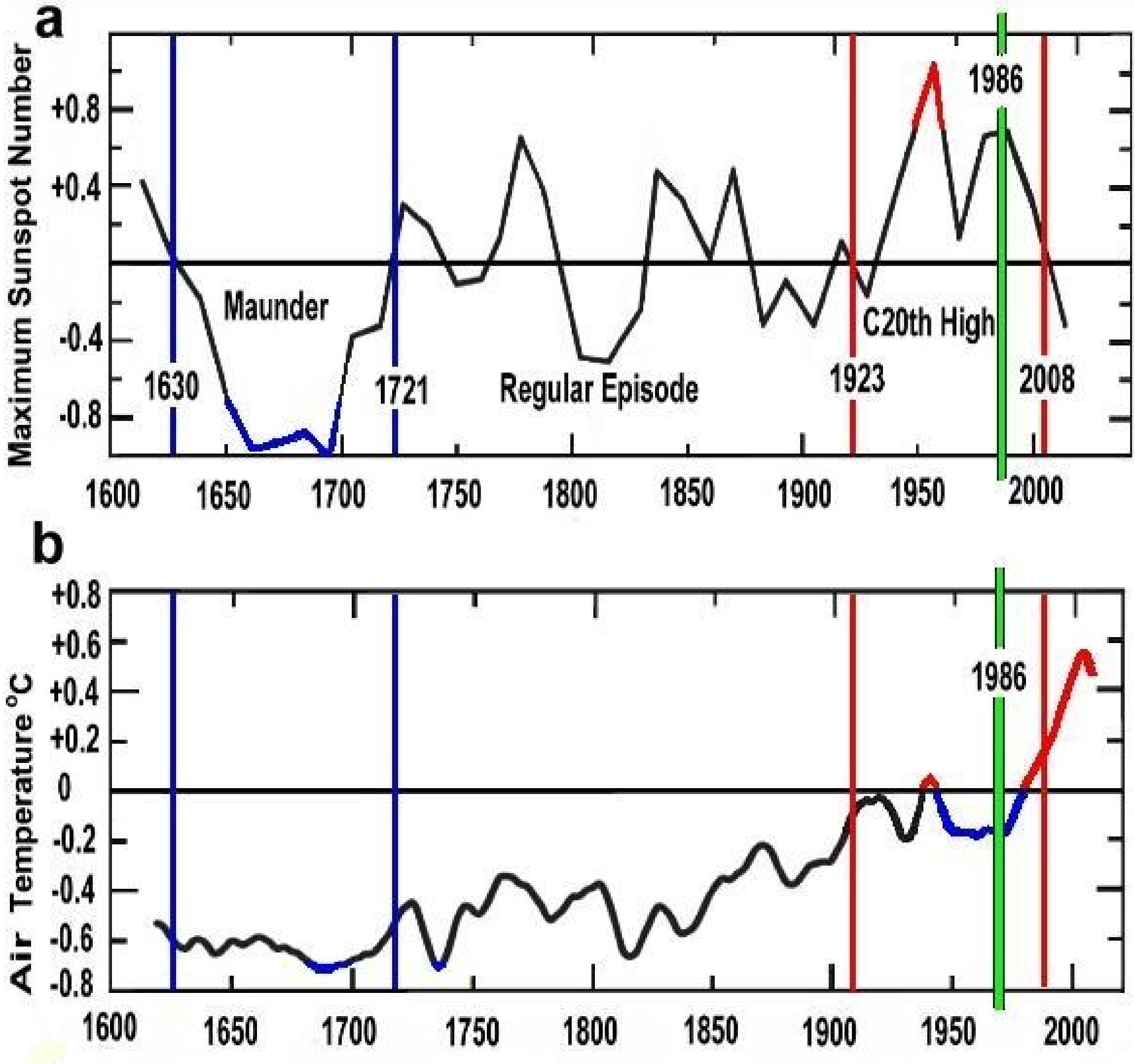

Figure 3. From 1600-2008 a) Maximum sunspot from Maunder Minimum 1630-1721 to modern 20th century high 1923-2008 (red boundaries), b) Land air temperature. 1986 (green) marks transition to rapid solar irradiance decline and rapid temperature rise. Extremes are marked high (red) and low (blue).

The steady warming in air temperatures proceeds through 400 years of the solar irradiance/sunspot cycle from Maunder Minimum through the 20th Century High (Figure 3a). The peak solar irradiance coincides with the brief 1957-59 high in both records as observed in sea surface data. However, most significantly the post-1986 rapid temperature *rise* coincides with the rapid solar irradiance *fall* (Figure 3b).

We suggest these timeseries prove beyond reasonable doubt that the rapid rise in fossil fuel greenhouse gases now completely dominates the catastrophic irreversible global warming. The IPCC (2014) confirms this trend, suggests it is in the ocean but does not know the processes.

Our two papers suggest the likely processes from two rare observational timeseries. Arctic basal ice melt has until 1986 buffered global heat imbalance. The decline in floating ice now generates rapid heating, and positive feedbacks from methane release and melting of land ice for potential rapid sea level rise.

This suggests that monitoring of the upper 10m of ocean on meridional and latitudinal transects, from moorings and manned ocean weather/oceanographic ships, is urgently needed. Science has lost its way if we abandon the gold standard of in situ scientific observations.

Rewards and penalties of monitoring the earth; How to shift paradigms

Charles Keeling (1998) changed the established paradigm in a 1960 *Tellus* paper. Established views held by key figures such as Swedish meteorologist Karl Gustav Rossby and ocean scientist Roger Revelle believed observations showed highly variable CO_2 concentration from 150 to 350ppm. Thus they argued routine monitoring was unjustified. Keeling showed the established paradigm was wrong and based on poorly calibrated instruments. Meticulously calibrated measurements showed seasonal variations on a steadily rising trend due to fossil fuel contributions. The value has risen from 350 to nearly 400ppm currently. This is based on actual continuous observation from Hawaii and the South Pole. The established paradigm was quietly dropped after publication of the 1960 paper without reference in the published literature. Roger Revelle became a keen advocate of collecting properly calibrated CO_2 timeseries to determine the full impact of fossil fuels (Rossby died in 1957).

The fossil fuel CO_2 paradigm is now well established. The impacts are acknowledged to be extremely serious. “Nobody on this planet is going to be untouched by the impacts of climate change", Rajendra Pachauri Chairman, IPCC (2014). It is "catastrophic, severe, pervasive and irreversible", US Secretary of State, John Kerry on 31 March 2014.

However, Keeling's (1998) account of the ongoing suppression of daily timeseries to establish his ground truth should be required reading. His insistence on in situ data taken by well-trained active research scientists with calibrated instruments is identical to our own for the 2m sea surface layer. Keeling used Scripps Pier data to verify his CO_2 clean air calibrations. JBM used the Scripps calibration tank for reversing thermometers in the 1960s. We believe he would be delighted in our modern use of Scripps Pier data to confirm our ocean warming processes, timescales and likely causes and consequences.

Keeling reported the use of "calibrated" peer-reviews to ensure funding was blocked (i.e. reviewers from the politically correct establishment). He revealed how routine institutional data collection was to unacceptably low standards. He noted the decline in global timeseries monitoring. Inconvenient ground truths especially those involving carbon and heat in the oceans could be ignored if they were not measured accurately or not collected in the first place. This is ostrich science. Global warming will not go away if ignored. It is already giving big unexpected surprises in extreme weather, typhoons, hurricanes, floods and droughts.

He writes, "Most shocking is that even the existing weather-observational programs have recently been seriously degraded over a wide area owing to budget cuts and unstable, indifferent, or financially distressed governments." We made similar remarks on the withdrawal of sea surface sampling in the 1980s (PP; MP). He goes on, "Also, I hope that there will always be opportunity for individual scientists to pursue scientific leads not anticipated by committees and agencies." He would be truly shocked at the extent to which the very scientists we expect to defend and pursue scientific ground truth have impeded our work (Footnote 2).

Peer review versus book publications

Keeling is not the only scientist to comment on the abuse of the peer-review process and suppression of unusual ideas contrary to politically correct establishment views. There is a demand for scientific mavericks who publish concepts beyond established norms. Professor Milton Wainwright, University of Sheffield, recently pointed out that the peer review is designed to prevent paradigm shifts (Guardian letter, 21 March 2014 http://www.theguardian.com.science/2014/mar/21/freedom-for-scientific-mavericks). He asks, "Where would Darwin have been had his famous (and unrefereed) book been peer-reviewed by the likes of arch anti-evolutionist Richard Owen?" Indeed, books tend to be the only way to get paradigm shifting ideas and data published. Work on melting tropical glaciers, global surface circulation and extension of evolution to metamorphism are controversial topics published in books (Bowen, 2005; Ebbesmeyer and Scigliano, 2009; Ryan, 2011). Indeed, Keeling's (1998) paper is an end-of-career overview publication.

It is now 6 years since we did the Pacific experiment (PP). It is 8 years since the Manx salinity timeseries was suspended (MP). It is 60 years since Don Williamson reported high-speed surface currents off the Irish Sea west coast up to the Minches in Scotland. He is still publishing exciting new ideas (Williamson, 2013). Scientific ground truth verification of our work is long overdue. However, it is unlikely to happen if our work remains unpublished.

Model as tools for ground truth experiments

Numerical models perform useful functions in finding gaps in knowledge. They have long been used for rapid but unverified forecasts for military operations. Our late friend and colleague Taivo Laevastu at US Fleet Numerical Weather Centre called them 'quick and dirty' model runs. Our late colleague Walter Hansen did the same during World War 2 using Richardson's (1922) Eulerian grid and Doodson and Proudman computational processes to predict tidal currents in the St Lawrence Seaway. All these scientists recognised their models needed repeated verification against experimental ground truth.

Taivo Laevastu developed more sophisticated verified models for advanced applications for the US Navy. He later applied his model methods for US Pacific Northwest Fisheries to create a new sustainable pollack fishery. Hansen's group at University of Hamburg, with Jürgen Sündermann, went on to cooperate with Dutch and British coastal modellers to understanding tide and storm surge processes on the North Sea coasts. Important unknown parameters (fiddle factors to modellers) in the bottom boundary layer were derived from ground truth experiments such as those of Ken Bowden, University of Liverpool, in Red Wharf Bay, Anglesey North Wales. These provided coefficients for the bottom friction. We gave observed eddy coefficients in our Pacific and fjord papers and bottom currents in the Arctic.

Model tools in Adaptive Management ecosystem process studies

Adaptive management is a process whereby many actively interacting multidisciplinary scientists use models and statistical projections systematically to guide research (PP; MP; C54;). Scientists must adapt to perceived needs to solve problems determined across many disciplines. This will not be along usual rigid disciplinary lines. Through multiple iterations they identify gaps in ground truth knowledge. The field experiments are then adapted to focus on unknowns. US NOAA OCSEAP applied this rapid cost-effective process for determining leasing conditions for Alaskan offshore oil and gas development (Matthews, 1978 (2013); PP; C4).

The lessons of the Alaska Pipeline environmental impact study had been well learnt. It studied everything that any researcher wanted. In the event the biggest unstudied impact was the release of antifreeze testwater into the permafrost tundra. No one had consulted engineers as to what building a pipeline actually involved. OCESEAP ecosystem process study using the mechanism developed from Herb Curl, Oregon State University, by Carl Walters, UBC Vancouver, Canada proved its value. It is now the bedrock of global fisheries management.

Author JBM brought this to the attention of his colleague and friend Norman Heaps, producer of the first operational tide and storm surge Thames Barrier model. Norman said it would never work in his Coastal and Tidal Institute (now Proudman Lab, Liverpool) because the other disciplines never met, were on different floors and had different teatimes! Indeed, our Coastal and Estuarine Regimes working group found it difficult to get coastal engineers and physical oceanographers to a joint conference even though, in the event, their interests and expertise overlapped and was mutually beneficial. Indeed the different obs and apps views of working group members became quite belligerent at times. The chairman had to use great tact and diplomacy to maintain order. Meetings of senior academics are notoriously difficult to run. It is ever more common to find science divided on rigid disciplinary lines. In the modern office-bound computer age, statisticians, climatologists, and most scientists never go to sea to collect verified ground truth.

The journal is broadly titled Ocean Science. Our paper has a broad focus over many disciplines not usually found in a physical oceanography paper using the ecosystem adaptive approach. Equations were omitted to help maths-shy readers.

Models show known processes but not un-modelled ones

We demonstrated the Coriolis effect in cyclonic tidal circulation in widely distributed ONR films made from the variable grid model in our *Nature* paper (Matthews and Mungall, 1970; MP). The model was applied to the Irish Sea and Cook Inlet, Alaska. It was useful for understanding the surface circulation in the western Irish Sea fjord. However, it did not show the Lagrangian surface drift reported from marine biological studies in 1954 by Don

Williamson (1956). Those surface transports were markedly different from the Eulerian tidal residual transport reported by Ken Bowden and in other models. Indeed, these fast surface processes have not been investigated further in 60 years. That is likely because they came from a completely different scientific discipline: biology versus physical oceanography.

Cook Inlet provided a similar shortcoming. The variable grid-spaced model gave details of large tidal currents in the mid-inlet Narrows. However, it had no way of showing the persistent surface frontal system carrying large tree stumps and logs with other flotsam along the freshwater/seawater boundary. Knowledge of particularly large and distinctive logs recognisable over several months could only come from personal inspection. They were well known to fishermen, coastguards, and oilfield service boats. Academic modellers were completely unaware of their existence. The front between the Susitna and other northshore rivers and seawater on the southern coast are an example of Carmack’s (2007) alpha/beta system.

The *Nature* paper (1970) also reported widely used techniques for simplifying land/sea boundary computations. The variable grid spacing allows computation and observation grids to more nearly match. Richardson (1922) suggested observations be evenly spaced over his original rectangular grid. Our variable grid could be invaluable for widely scattered ocean observation timeseries. It avoids mathematical turbulence from nested grids. However, there are few, if any, reports of its use in recent times.

Models reveal importance of freshwater to ocean warming climate change

GFDL models showed that “climate change and climate-related impacts on essential industries (e.g. fisheries, agriculture, water resources) are not strictly about temperature, but also (perhaps mainly!) about the flux, distribution and phase of freshwater components in the atmosphere and ocean” (Carmack, 2007). Indeed, this forms the basis for Eddy Carmack’s verification alpha/beta freshwater and nutrient surface distribution system from the north Pacific to north Atlantic and the global surface circulation (PP; MP). This compliments surface dynamics verified by ocean drifter experiments of Ingraham and Ebbesmeyer (PP; MP; C54 fig 2b). These ground truth verified processes, along with those of NOAA and University of Washington studies of tropical meridional vertical cells and freshwater warm pools form the background to our own papers (PP; MP; C54 Fig 2a).

Asymmetric shift in westerlies due to modern CO_2 greenhouse gases

Toggweiler and Russell (2008), from a GFDL model, showed the likely consequence of modern CO_2 greenhouse gas warming was a poleward shift of subpolar jet streams (Figure 4). It suggested strengthening of the Antarctic jet stream, but weakening of Arctic subpolar jet stream.

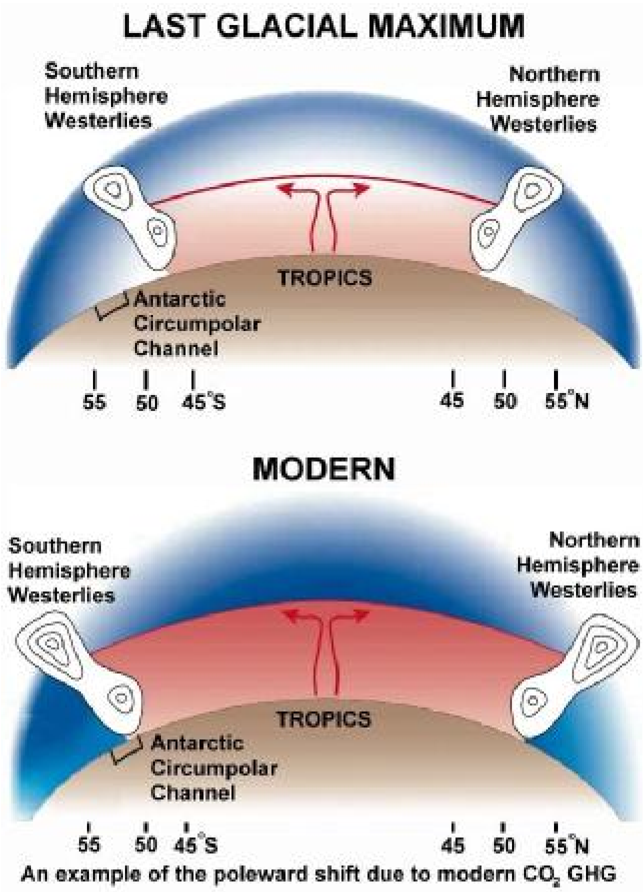

Figure 4. Stronger southern westerlies aligned with Antarctic circumpolar channel and weaker northern due to Arctic warming. Reprinted by permission from Toggweiler and Russell, *Nature,* 451, 286-8, doi: 10.1038/nature06590, (2008).

Our field ground truth papers confirm these circulation shifts and resultant changes in the ocean top 2m (PP; CP; C54). Stronger W-E jet streams from Pacific warming combine with weaker N-S components from warmer Arctic combine to give observed weather extremes. Western Pacific temperatures ~32ºC yield ~30% more evaporation and precipitation as discussed. Antarctic circumpolar jet streams and currents strengthen and coincide with the deep circumpolar channel. Typhoon winds of 300km now make landfall in the Philippines. Hurricane force winds now are observed in the Irish Sea and along the UK south coast.

Wind-driven Lagrangian and geostrophic surface currents

Surface currents dominant in the top 2m, u_z (m/s) at depth z (m), are given in terms of standard 10m winds, w_{10} (m/s) as,

$u_z = 0.03w_{10} – (u_d /0.4)ln(z_d /0.0015)$ (Pugh, 1987; PP fig 3; MP).

Practically this describes surface wind drift at 3% of windspeed at 3-4º to the right (left) of wind direction in NH (SH). Ekman wind drift currents dominate below about 2m. Verified Lagrangian logarithmic surface circulation gyres are illustrated in C54 fig 2b (from PP).

A. Bad Science - Evaporation depends on relative humidity and windspeed.

Emeritus Professor of Meteorology, Alistair Fraser, highlights the difficulty in overcoming established but wrong and unverified concepts on his Bad Science website (http://www.ems.psu.edu/~fraser/BadScience.html, last access 5 April 2014). He quotes Cardinal Wolsey (1471-1530), "Be very, very careful what you put into that head, because you will never, ever get it out". He specifically highlights the 'myth' that evaporation depends on relative humidity and windspeed. Physics shows it depends solely on temperature (http://fermi.jhuapl.edu/people/babin/vapor/index.html, last access 5 April 2014).

Good Science – Evaporation depends on surface temperature

We confirmed the governing Clausius-Clapeyron evaporation temperature dependence from verified ground truth in the mid-Pacific (PP; C54). Heat trapped in the ocean is very difficult to extract. The work of Mei et al (2012) showed the importance of sustained winds over a couple of days in cooling surface waters. The referees have not commented on these very important ground truths.

AR#2 Comment A Surely evaporation depends on windspeed

We can firmly say No! It does not for reasons given. The flux coefficients between ocean and atmosphere as used for Lorenz et al. (2010) are not verified. No ocean scientist before our work seems to have realised these basic assumptions are wrong and unverified.

Our papers support the Clausius-Clapeyron relation and but also the salinity playing a part in surface circulation in the central Pacific as detailed earlier (PP; C54 fig. 2a). The impact on freshwater warm pools is also discussed in this context (PP).

Why it was thought evaporation depends on windspeed and relative humidity

GI Taylor in his classic 1931 buoyancy paper characterised air-land turbulence from work on Salisbury Plain. Heat and mass behave differently in the boundary layer. Water does not pass through the boundary. He deduced eddy coefficients (fiddle factors) to characterise the different behaviours. Routine 10m winds and 2m Stevenson Screen meteorological data are used to determine boundary layer processes. Pan evaporation was used to verify these findings that are specific to the land-air boundary.

It was later used for evaporation at sea. However, it clearly does not apply there because water vapour crosses the air-sea boundary. The Clausius-Clapeyron water vapour logarithmic temperature relationship applies as detailed earlier. According to Taylor's biographer J Stewart Turner, Taylor had expected to work on the ocean subsurface boundary following his 1915 work off Newfoundland after the Titanic disaster (PP). However, Ekman got there first.

Taylor clearly knew Salisbury Plain conditions did not apply at sea. He was an accomplished sailor and navigator. He would know the Clausius-Clapeyron thermodynamics of evaporation. He would not apply the land-air rule to the completely different sea-air boundary.

That is not to say GI Taylor could not make mistakes. JBM pointed out to GI his book reference to bubble surface tension, as 2T/*r*, was wrong. A bubble in air has inner and outer surfaces with double surface tension 4T/*r*, where T is surface tension and *r* the radius. GI was happy to acknowledge the error and said he would correct it in later editions. One wonders if any scientists were misled by the original incorrect version.

We remarked that Taylor would have loved our simple Pacific experiment where we could obtain clear-cut verification about surface temperature measurements (PP). The first results were given in student presentation at sea! What splendid training in experimental science (Matthews, 2013; www.sea.edu). Taylor would have delighted in the bonus measurements of evaporation, heat sequestration and vertical meridional tropical cells that also came from the same experiment of hourly data over several weeks (PP).

Stuart Smith's (1988) coefficients for heat flux as a function of windspeed and temperature are routinely applied at sea. We could not reproduce this dependence, or the similar work from short timeseries of Soloviev and Lukas (2006) (PP). We analysed our hourly timeseries data and quickly found the dependence on salinity and temperature were critically important (PP). The last time meteorologists went to sea to test such relationships from ground truth were in 1926 (Matthews, 2013). We believe this proves the value of the scientific experimental verification method.

AR#2 Comment B Tropical and polar waters must cross persistent slope currents

Yes, they do cross. However we specifically referred to currents in the top 2m. Slope currents tend to follow the 200m shelf break contour as JBM found in the Labrador Current while at Bedford Institute, Nova Scotia. Subsurface currents are largely irrelevant to our surface work. For example, the Equatorial Undercurrent (EUC) was found travelling eastwards below the equatorial upwelling (PP; C54 Figure 2a). Moreover, we noted that Tully and Barber (1960) observed persistent buoyant surface freshwater with little or no seasonality in the turbulent north Pacific (PP). This is incorporated in the surface circulation schematics (PP; C54 Fig 2a,b). Oceanographic mixing data starts below 10m depths. Argo floats only recently sampled to 5m. The upper 2m behave under different dynamic and thermodynamic regimes. Therefore, findings of Souza et al (2001) are only relevant below the critical surface layer.

It is perhaps worth noting that Taylor substituted sea surface temperature for Marine Air Temperature (MAT) of the standard Stevenson Screen data in his 1915 Newfoundland Titanic paper (PP). It was thought to be more reliable than taking temperatures from the ship bridge decks with obstructions and at varying heights above sea level. Our Pacific hourly measurements show there are considerable differences between ocean surface, 3m and bridge deck air temperatures throughout any 24 hours (Matthews and Matthews, 2013; PP; C54 fig. 1). This may be significant for atmospheric studies. In any case, SST data collected for meteorological purposes are far too inaccurate for oceanographic purposes as we reported (Matthews and Matthews, 2013, PP; MP; C54 Fig 2a.). We advised extreme caution in using data collected by others, especially by unsupervised, non-scientists.

AR#2 Comment C sensitivity of evaporation to local conditions at Port Erin

AR#2 suggests local solar radiation could produce observed salinity change comparable to those in MP, Figure 5a. This is at complete variance to actual evaporation that increases at 7%ºC^{-1} given by the exponential Clausius-Clapeyron equation (PP; MP; C54). We found water at >28ºC evaporated ~7.1mm m^{-2}day^{-1} in hypersaline water >35.5‰. It evaporated ~4.5mm m^{-2}day^{-1} in brackish water <35‰ at 27-25ºC (PP). AR#2 quotes north Atlantic water as having salinity >35.2‰ at 9ºC. If we assume it behaves as hypersaline water, then 7% of 7.1mm comes out as a reduction of about -0.5mm ºC^{-1}. North Atlantic water at 9ºC is 19 degrees below 28ºC so a simple computation shows that evaporation is effectively zero at 9ºC. That is similar to the cold Humboldt Current next to the Atacama Desert (MP; PP). Therefore local effects of evaporation at Port Erin and the north Atlantic coast in winter are negligible.

The assertion that local effects can obscure any tropical or polar "signature" is not true. Moreover, it fails to recognise the fact that coherent Lagrangian water masses remain intact over great distances in the top 2m of ocean (e.g. Williamson, 1956). We noted that Ebbesmeyer et al. (2011) showed that drift bottles confirm that Gulf Stream prevents subarctic surface drifters from escaping south. They show the Gulf Stream breaks through the eastbound subpolar waters in several places on the Viking gyre (C54 fig 2b). They even describe the Gulf Stream as a 'wall' along Carmack's (2007) strong front (~10ºC) between the two water masses. We report a similar abrupt front in the north Pacific at 11ºN (PP).

AR#2 asks how do gradients persist in water as shallow as 10m?

This is a good question. We do not have any subsurface data for Port Erin. However, Scripps Pier daily data from 1916-2012 show persistent temperature gradient of 0.6±1.0ºC in the top 4.5m (Fig. 2a). The Pier is on the Pacific (32ºN) on an exposed coast (C54). We are confident that if near-surface gradient can be maintained in the exposed north Pacific, then the same processes apply on the North Atlantic coast to maintain stratification. After all, we found them in the mid-central Pacific, as did Tully and Barber (1960).

High salinity north Atlantic water in European shelf seas.

High salinity surface water observed at Port Erin in 1992-6 is not unprecedented. We stated that tropical evaporation carried by the Gulf Stream was the likely source (MP). Laane et al (1996) showed hypersaline water 50-70km offshore of the Dutch Coast and in the English Channel as well as off Cypris Station, Port Erin in long timeseries that ended in the mid 1980s (Fig. 5).

They concluded that physical, chemical, and biological processes in the different areas affect the natural variability of the Atlantic signal to such an extent that the different properties studied at the stations are not related. We noted that Smeed et al., (2014) reported water of salinity >36‰ in Gulf Stream water at 500m in Florida Strait (C54).

Laane et al. data precede the rapid warming and high salinity water observations at Port Erin. They do however, point to the Atlantic origins for water masses where one would expect surface waters from North Sea Rivers such as the Rhine, Scheldt and Thames. Tropical seawater must be the source for observed high salinity surface waters. It is an enormous loss to science that so many long timeseries were discontinued in the mid-1980s just when global warming really took off. We interpreted this as the projected regime shift from Toggweiler and Russell's model. More timeseries data are essential to verify or modify this suggestion.

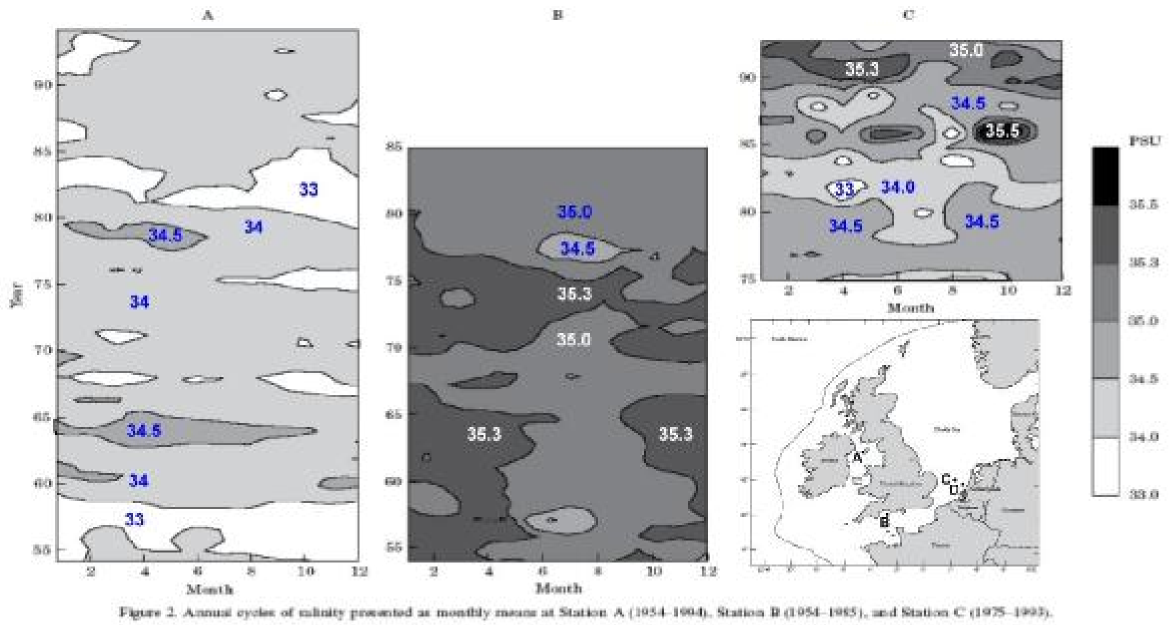

Figure 5. Monthly Mean salinities from A Cypris, off Port Erin, B off Plymouth, English Channel, and C 30-50km off Dutch North Sea coast (Laane et al., 1996).

This, we believe, answers most of the comments of AR#2. A few detailed comments are selected for further clarification

AR#2 Selected Detailed comments

Difference of Geophysics from experimental laboratory physics and models

Page 50 line 11 AR#2 asks "Correlation of what with wind speed? What range of wind speeds was tested?"

This goes to the core problem. In geophysics we cannot chose our windspeeds! That is only possible in lab experiments or models as our late friend and colleague Blair Kinsman (1957) pointed out. Ours is real ground truth data. We take what we are given. In our Pacific experiment, we looked for the traditional, but it turns out wrong, assumptions about evaporation dependence on windspeed and relative humidity (PP). We found none. However, we did find actual dependence on temperature and salinity in the top 2m as outlined above.

Our reviewer is not alone in accepting the wrong but apparently common assumptions in atmospheric physics as detailed in our paper (MP, Kinsmen 1957; Aberson, 2012). They suggest scientific method of experimental ground truth verification has not been applied for many years in atmospheric physics.

Coincidence v Correlation

Page 53 lines 20-25. Thank you for correcting the statement to read 'the fallacy is that correlation implies cause and effect'.

This goes to the heart of the problem with geophysics experiments that cannot be repeated at will in a laboratory. We only included the reference to Sharples et al on the suggestion of the Editor before publication. We had extensive pre-publications discussions on this topic. This reference is a good example of the misuse of statistics (Kinsman 1957).

We suggest correlation be re-named coincidence coefficient and give a fuller explanation in reference to mathematical correlation (C54). AR#2 states "Most people would not regard 0.8 as a weak correlation". We show, following Kinsman, that most people would be wrong. Kinsman showed that 0.95 is only a coincidence not a correlation. Mathematical correlation of seawater density can be as low as 0.4 or as high as 0.7 (C54). This is the problem with using statistics as factual evidence.

Scientists should collect and verify their own data

AR#2 Comment, "Page 60 line 8. Most papers using good data do not say so much about such factors leading to poor quality".

Office-bound scientists do not recognize the immense difficulties that highly qualified scientific observationists must overcome to take high quality data at sea with calibrated instruments (e.g. Keeling, 1998). We found that climatologists relied on sea surface data from unsupervised, voluntary observers on ships at sea for over fifty years (Matthews, 2013). These data are inherently unscientific. There is no guarantee that instructions were followed. Indeed, anyone collecting bucket samples at night in stormy conditions is extremely unlikely to follow instructions without personal scientific supervision (or a whip?). When our results were first presented to a leading office-bound climatologist, he commented only on the immense amount of work necessary to extract satellite data. He had no idea how much harder it was to extract hourly data from the remotest central Pacific! For this reason we went into detail to show that the concern about routine scientific data collection has been an important point of discussion for over 100 years. Port Erin data are exemplary examples of routine data collection at its best.

Experiments planned onshore rarely get completed as planned at sea. JBM's field staff reported that it was impossible to replace tide gauges and current meters on datum moorings on the Arctic Ocean shelf floor. They said it was not possible while wearing gloves in cold water. JBM went down and demonstrated how to do it using his SCUBA experience.

Our late friend and colleague Professor of Meteorology Louis J. Battan wasted several years on careful cloud seeding experiments as a result of faulty fieldwork. The monsoon thunderstorms occur daily over the mountains visible from the Atmospheric Physics department, University of Arizona, Tucson. Double blind experiments were conducted with planes seeding or not seeding decided by coin toss. Rain gauge data was collected from an array in the mountains. JBM was present when a canvas bag on a coat stand in the office moved as the student data collector handed in his rain gauge records. It turns out he collected rattlesnakes for herpetologists at the same time. He quickly learnt the rain gauge patterns and repeated them by hand. This allowed time for more snake collecting. It also invalidated several years' experimental data. We only found the problem by chance. JBM has always had this in mind when conducting fieldwork. We feel it is well worth mentioning along with Keeling (1998).

Scientists today are office bound and not aware of the many pitfalls in collecting good quality field data. We firmly believe that scientists should personally go to sea and collect their own data whenever possible for these reasons. It is also extremely difficult to obtain essential funding especially for remote ocean monitoring. As a society we put more into outer space than inner space studies. What goes on just below the sea surface is mostly unknown.

Lack of Access to companion paper is major problem

AR#2 page 80 Lines 12, 13, 19. Without access to Matthews and Matthews (2013; at the time of writing this) it is unclear what is meant by "1/3 (or 2/3) of ocean heat". The paper remains unpublished at the time of writing.

Other comments and corrections are appreciated and will be corrected if the opportunity arises.

Conclusions

The timeseries we report are a gift from our diligent scientific predecessors more valuable than gold. We can mine more gold. We cannot repeat past observations. That is the nature of geophysics. We archive ice cores because ice is disappearing fast. Yet at the same time long in situ records of the top 2m of ocean were abandoned. Archived modern daily climate data is twice the entire printed holdings of the Library of Congress (*Eos*, 95(13), doi: 10.1002/2014EO130003, 2014). They will be of little use if they if they do not include the all-important top 2m of oceans.

We cannot know what other discoveries remain after ours are reported. We expect the Editors and publishers to explain their part in withholding their proper analysis, verification and placement in the scientific archives.

References

Bowen, M.: Thin Ice: Unlocking the secrets of Climate in the World's Highest Mountains, ISBN-13: 978-0-8050-6443-8, Henry Hold, NY, 2005.

Ebbesmeyer, C. and Scigliano, E.: Flotsametrics and the floating world, Harper Collins Pub. Co., ISBN 978-0-06-155841-2, 2009.

IPCC, WMO statement on the status of the global climate in 2013, No. 1130, https://drive.google.com/file/d/0BwdvoC9AeWjUeEV1cnZ6QURVaEE/edit?usp=sharing Last access 3 April 2014, 2014

Keeling, C. D.: Rewards and Penalties of Monitoring the Earth, Ann Rev Energ Env, 23(1), 25-82, doi: 10.1146/annurev.energy.23.1.25, 1998.

Laane, R. W., Southward, P. M., Slinn, D. J., Allen, J., Groeneveld, G., and de Vries, A.: Changes and causes of variability in salinity and dissolved inorganic phosphate in the Irish Sea, English Channel, and Dutch coastal zone, ICES Journal of Marine Science, 53(6), 933-944, doi: 10.1006/jmsc.1996.0115, 1996.

Matthews, J. B. and Mimken, G. J.: A novel underwater weather station, Proc. OCEAN 74 IEEE Conf on Eng in Ocean Env, 1, 359-363, 1974.

Matthews, J. B. and Mungall, J. C. H.: Variable Boundary, Two Dimensional Tidal Model, Nature, 226, 835-836, doi:10.1038/226835a0, 1970.

Richardson, L. F.: Weather Prediction by numerical process, CUP, London, http://ia600302.us.archive.org/12/items/weatherpredictio00richrich/weatherpredictio00richrich.pdf, Last access 5 April 2014, 1922, Ryan, F: The mystery of metamorphosis, A scientific detective story, ISBN 978-1-60258-341-1, Chelsea Green Publishing, Vermont, USA, 2011.

Williamson, D. I.: Larvae, Lophophores and Chimeras in Classification, Cell Dev Biol 2013, 2:4, doi: 10.4172/2168-9296.1000128, 2013.

Footnote 1 PP Unpublished companion paper Title and Abstract Aug 2013.

Matthews, J. B., and Matthews, J. B. R.: In situ measurement of the tropical Pacific top metre evaporation heat trap supports alpha/beta ocean global warming through asymmetric poleward heat transport and basal icemelt, Ocean Science Discussions, Submitted August 2013

Abstract

The 7% atmospheric anthropogenic global warming derives from net heat imbalance at the troposphere/stratosphere greenhouse boundary. The 93% of ocean heat is trapped in the top 3m but timeseries are sparse. Winds, thermohaline processes and tides drive the ocean boundary layer and seawater density depends on salinity and temperature. Surface evaporation in the topics and freezing in polar regions control brine and heat sequestration. We examine hourly near-surface temperature and salinity regimes for a meridional transect 17ºS-22ºN, 140-150ºW between Tahiti and Hawaii for dynamic processes.

We show heat sequestration below 3m in the hypersaline southern hemisphere (SH) is limited to ~6MJ m^{-2}day^{-1} but evaporation is 7.3 mm m^{-2}day^{-1}, at salinity ~36.4‰ and >28ºC. In the northern hemisphere (NH) tropics the corresponding figures are ~12MJ m^{-2}day^{-1} and ~4.5 mm m^{-2}day^{-1}.

Pairs of counter-rotating meridional tropical cells (MTCs), ~300-1200km wide, ~100m deep form separate SH and NH systems with little cross-equatorial flux. Counter-rotating surface gyres transport heat polewards in seasonally and tidally moderated stratified surface waters. The zonal geostrophic balance is maintained by the Equatorial Undercurrent (EUC) with an eastbound core ~140cm/s and density ~25.0 at 50-150m.

This explains contrasting Arctic/Antarctic warming impacts on subpolar jet streams and basal icemelt. We suggest many more in situ 3m timeseries are needed to fully quantify anthropogenic global warming. This would best be conducted through a cost-efficient, global, focused, multidisciplinary, dynamic adaptive scientific management for rapid determination of mitigation and adaptation policy.

Footnote 2 Online Copernicus Editorial emails after publication of the reviewed paper (MP).

To Copernicus 11 January 2014

This paper is one of two to be published under waived fee arrangement for unfunded projects as agreed with the Topic Editor from the outset. We were informed that Ocean Science Discussions reserves 10% of the previous year’s budget for this purpose.

From Copernicus 16 Jan 2014

We have contacted the OS Executive Editors to ask for a waiver. They decided not to grant a waiver of the article processing charges in your case, as your co-author is employed with a university that should be able to pay.

To Copernicus 8 February 2014

My co-author asked me to remind the OS Editors that he is a student not an employee. He conducted the research in his own spare time completely separate from his assigned student project [*ocean acidification*]. Neither the pensioner author nor student co-author are employed or in receipt of research funds.

From Copernicus 7 March 2014

I have contacted the executive editors of Ocean Science again. They informed me that you will not be granted a discount or waiver for your publication.

Waivers are not offered solely on the basis of (lack of) financial support, but rather offered to promote access to the journal especially from developing countries or from new fields with lack of formal support. Waivers are also used to support invited submissions. After a discussion among the Executive Editors, it was decided that your manuscript did not meet these criteria. We hope that you understand this decision.

To Copernicus 17 March 2014

I certainly do not understand the Executive Editors’ decision.

We have met all the criteria from all previous iterations. We have at least as broad experience across all the disciplines as the Editors. We have experimental and mathematical background spanning 50 years in atmospheric physics, meteorology and oceanography. This includes laboratory, numerical modelling and extensive field multidisciplinary ground truth verification from the Arctic to the tropics and in shelf seas. We have practical experience in mitigating and adaptive measures such as for offshore oil and gas development, passive solar homes, wind and solar power.

1. I was invited to submit the pair of papers with fee waivers after a conversation with John Huthnance. John knew me from his student days when I was visiting professor working with Norman Heaps on coastal and estuarine regimes that led, among others, to the SCOR/IAPSO/UNESCO/ECOR working group, the first operational Thames Barrier model, and AGU monograph series. I wrote my definitive paper on Alaskan tidewater glaciers and basal icemelt at that time.

I explained that the two papers offered fundamental new insight into the defining issues of our age through the critically important, but almost totally unstudied top 2m of ocean. Salinity is an unmeasured but crucial parameter to ocean warming and acidification. It is an opportunity for Ocean Science to enter a new field.

He offered to be leading Editor and shepherd the papers through the process, and applying the fee waiver.

2. The authors are from a developing country. Manx government is part of a group of island nations that are particularly hard hit by climate change through sea level rise, over fishing, and pollution from wealthy neighbours (e.g. nuclear waste).

3. Manx residents are specifically excluded (unlike Channel Islands) from UK or EU research funds. The student author could not accept UK offers of funded PhD research but had to go to North America where no such restrictions apply. Charitable foundations can only donate to charities not individuals.

4. Study of the top 2m oceans is a completely new field with lack of formal support. Our work is based entirely on scientific verification ground truth untainted by models or statistics.

It shifts fundamentally, the focus of global warming and ocean acidification from the trivial 7% in the atmosphere, to the 93% in the almost completely unstudied top 2m over 70% of earth’s surface, of which 8.5% is shelf seas where the largest impacts strike.

5 Ocean Sciences Discussions is most appropriate to promote this fundamental shift to a new field. The online reviewer #1 appreciates this and we have clarified the reasoning for them.

6. We have funded the work from pension income, savings and loans, and are broke while others have millions for demonstrably useless repetitions of the same old unverified garbage data from unknown depth. It is difficult to present a positive case to alternative funders due to changing goalposts at this late stage.

Moreover, our case is not helped by Copernicus' use of 'anonymous' reviewers with undeclared vested interests of £1.3 million ($2.1) grant for collecting unverified garbage data contrary to our field verification. This is neither scientific method nor open frank discussions between professional scientists. We think that all reviewers should be identified so that vested interests can be discounted.

Our work surely deserves discussion even if it is subsequently proved wrong by other ground truth. Our papers are an attempt to redeem the *Economist*'s view that scientists do too much trusting and not enough verification ground truth experiments to the detriment of mankind.

Copernicus is proving a formidable opposing force unlike its namesake. "Promoting scientific work is our focus. Serving those dedicated to science is our passion!" In conclusion, we definitely do not understand the Editors decision and request reconsideration.

From Copernicus 5 April 2014

According to our records, the invoice no. OS-PUC-2014-1 from 03 Jan 2014 has not been settled and shows an outstanding balance of 2622.76 EUR. Perhaps this delay in payment is simply due to an oversight on your part. In that case, we would kindly ask you to remit the amount in question until 12 Apr 2014.