Why global warming went missing since the year 2000

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Abstract. Over the period January 2004 to present, the seas have experienced the lack of any warming, as finally properly measured in the ARGO project where a global array of more than 3,600 free-drifting profiling floats has measured the temperature of the upper 2000 m of the sea as it was not possible before. The warming of the seas has been a negligible $1.1 \cdot 10^{-3}$ °C/year on average over the layer 0 – 2000 dbar below the accuracy of the measure. Over the period January 2000 to present, the measured land and sea temperatures of the less reliable GISS, NCDC and HADCRUT4 data sets have shown a small warming of $4.2 \cdot 10^{-3}$ °C/year on average. Same period, the climate models propose for the land and sea temperatures an unrealistic warming of $20.5 \cdot 10^{-3}$ °C/year (average of CMIP3) and $18.2 \cdot 10^{-3}$ °C/year (average of the CMIP5). The “*inconvenient truth*” is that climate models are predicting a warming when there is no warming rather than simply overestimating the warming as discussed so far. The paper presents the failed validation of the climate models since their introduction and suggests the reasons of their failure in the overrated effect of the changed composition of the atmosphere and the neglected natural oscillations.

Keywords. climate change, temperature records, measurements, simulations.

1 Introduction

Over their first decades of validation, all the climate model projections have failed to predict the lack of warming [1–5]. This lack of measured warming has explanations in the natural oscillations of the climate. The natural oscillations are very clear if rather than focusing on the period 1970 to 2000 attention is also paid to what happened before 1970 [21–24] and what is happening since 2000.

The reconstructed land and sea temperatures show oscillations with many periodicities, in particular one relevant quasi-60 years (63 years to be precise), with upwards phases approx. 1910 to approx. 1940 and approx. 1970 to approx.

2000, and downward phases approx. 1940 to 1970 and approx. 2000 to present ongoing [21]. Natural oscillations of longer periodicities are certainly possible [21–24], and may explain the most part of the warming since 1910 [21–24]. These natural oscillations are not predicted by the climate models that conversely overrate the effect of the modified composition of the atmosphere [21–24].

Fyfe, Gillett and Zwiers [1] recently conceded that “*recent observed global warming is significantly less than that simulated by climate models*”. As already realised in [3], “*Global mean surface temperature over the past 20 years (1993–2012) rose at a rate of 0.14 ± 0.06 °C per decade (95% confidence interval)*” and “*this rate of warming is significantly slower than that simulated by the climate models participating in Phase 5 of the Coupled Model Intercomparison Project (CMIP5)*”. The average simulated rise in global mean surface temperature over the past 20 years is 0.30 ± 0.02 °C per decade. Over the past fifteen years (1998 – 2012), the observed trend is 0.05 ± 0.08 °C per decade more than four times smaller than the average simulated trend of 0.21 ± 0.03 °C per decade. The observed trend over the period 1998 – 2012 is commented in [1] as a temporary ‘*hiatus*’ in global warming similarly to [2–5].

The authors of [1–5] do not compare models and measurements over the last decade, where the reliability of the measurements is certainly much better, for the availability of higher quality data from recent monitoring projects as for example the ARGO programme [6], but also for the reduced upwards biasing and the smaller (but still not insignificant) corrections introduced to what was actually measured. This is possibly because the measured global warming over the decade is practically and virtually zero rather than small. Similarly, the authors of [1–5] do not try to validate the models also considering the temperatures collected prior of the last upwards phase of the quasi-60 years oscillation.

The conclusion of [1] is that the difference in between the models never to be questioned to be wrong and the measurements “*might be explained by some combination of errors in external forcing, model response and internal climate variability*”. It is shown here than rather than the “*variability*” in the climate are the neglected natural oscillations and the overrated effect of the changes in the composition of the atmosphere to produce wrong modelling results.

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Figure 1. Computed land and sea temperatures from the CMIP3 and CMIP5 models [9].

2 Models results vs. reconstructions and measurements since 2000

Land surface temperature time series are very well known to be subject to many other anthropogenic factors than the simple carbon dioxide emission, and it is an open debate how accurate global temperature reconstructions may be especially moving in the past where the number of measuring stations and the measurement techniques were very different. The accuracy of the sea surface temperature time series is even more troublesome than the land surface temperature, because before the start of the ARGO programme [6] in the early 2000s, only very few scattered measurements were available to cover more over 70% of the Earth's surface. Results of climate model predictions of land and sea temperatures, land and sea temperature reconstructions and sea temperature measurements since 2000 are shown hereafter.

2.1 Land and sea computed temperatures

It is interesting to compare the land and sea temperatures January 2000 to June 2013 measured from the GISS, NCDC and HADCRUT4 data sets and computed with the CMIP3 and CMIP5 climate models [9].

Under the World Climate Research Programme (WCRP) the Working Group on Coupled Modelling (WGCM) established the Coupled Model Intercomparison Project (CMIP) as a standard experimental protocol for studying the output of coupled atmosphere-ocean general circulation models (AOGCMs) [17]. CMIP3 included scenarios for both past and present climate forcing. This dataset provided material for the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). The current Intercomparison CMIP5 is the basis of the IPCC Fifth Assessment Report (AR5) to be published shortly.

Figure 1 presents the computed land and sea temperatures from the CMIP3 and CMIP5 models [9]. All the temperatures are shifted for a zero temperature

Figure 2. Measured land and sea temperatures from the GISS, NCDC and HADCRUT4 data sets [9].

anomaly January 2007. Linear fitting of the monthly time series of average temperatures land and sea January 2000 to June 2013 (from [9]) returns temperature gradients dT/dt of $0.0205\text{ }^{\circ}\text{C/year}$ (CMIP3 20c3m/sresa1b multi-model mean), $0.0199\text{ }^{\circ}\text{C/year}$ (CMIP5 modmean32 rcp26), $0.0195\text{ }^{\circ}\text{C/year}$ (CMIP5 modmean42 rcp45), $0.0170\text{ }^{\circ}\text{C/year}$ (CMIP5 modmean25 rcp60) and $0.0167\text{ }^{\circ}\text{C/year}$ (CMIP5 modmean39 rcp85).

2.2 Land and sea reconstructed temperatures

The combined land and sea temperatures from different data sets (HADCRUT4 [10], GISS [11] and NCDC [12]) are also not significantly warming over the period 2001 to 2013 [9], however they still produce a small warming.

HADCRUT4, GISS and NCDC use different methods to compute sea temperatures and to infill missed data for both land and sea. GISS uses NCDC ERSST.v3b sea surface temperature data [13]. NCDC merges NCDC ERSST.v3b with the GHCN-Monthly Version 3 [14] for land surface air temperatures. HADCRUT4 dataset merges CRUTEM4 [15] land-surface air temperature dataset and the HadSST3 [16] sea-surface temperature dataset. Unlike HADCRUT4 and NCDC GISS masks sea surface temperature data at the poles where seasonal sea ice exists extending land surface temperature data over the seas.

Figure 2 presents the measured land and sea temperatures from the GISS, NCDC and HADCRUT4 data sets [9]. All the temperatures are shifted for a zero temperature anomaly January 2007. Linear fitting of the monthly time series of average temperatures land and sea January 2000 to June 2013 (from [9]) returns temperature gradients dT/dt of $0.0041\text{ }^{\circ}\text{C/year}$ (HadCRUT4200 SST/T2m), $0.0027\text{ }^{\circ}\text{C/year}$ (GISS 250 T2m/SST), $0.0055\text{ }^{\circ}\text{C/year}$ (GISS 1200 T2m/SST) and $0.0047\text{ }^{\circ}\text{C/year}$ (NCDC v3 SST/T2m).

The combined land and sea temperatures are not warming significantly the first decade the sea temperatures have

Figure 3. Measured sea temperatures from the ARGO data set [6].

been properly measured and the land measurements have also been collected with a more stable procedure.

The data sets are not certainly free of upwards biasing including corrections and the influence of other well-known man made effects as change of land use or heat island formation all biasing upwards the measurements of the land component. This may explain the small warming of the reconstructed land and sea temperatures of the HADCRUT4, GISS and NCDC results vs. the measured sea temperature of the ARGO result.

Over the period January 2004 to present (June 2013) the reconstructed ERSST v3b2 Sea Surface Temperature has a slope of -0.0027 °C/year.

2.3 Sea measured temperatures

Accurate ocean measurements over water have no local contamination from heat sources or heat storage as land measurements may have. If we consider the sea temperatures as measured in the ARGO programme (prior data are absolutely not comparable in quality and more a sort of rough computation rather than a true measurement, with ARGO more than 3,600 buoys regularly sample the seas 0 to 2000 m), the only conclusion we may infer is that the sea temperatures are not warming the first decade they have been properly measured 2004 to present [7, 8]. These data are not free of upwards biasing, because a correction was introduced in 2007 after the measurements were indicating a significant cooling trend opposite to the increased heat uptake theory [8]. Nevertheless, the worldwide average (65 N to 65 S, 0 E to 360 E) surface temperature has been decreasing -0.0125 °C/year, while the 0 – 2000 m average has been increasing of 0.0012 °C/year.

The time series of the worldwide averaged ARGO temperatures show no detectable variations over the decade and the isotherms are very close each other year after year at every deep to conclude that no warming is presently occurring in our seas over the period of observation [8].

Figure 3 shows the measured sea temperatures from the ARGO data set [6]. All the temperatures are shifted for a zero temperature anomaly January 2007. Linear fitting of the monthly time series of average sea temperatures January 2004 to December 2012 (from [6]) returns temperature gradients dT/dt of -0.0088 °C/year 0 – 100 dbar, $+0.0031$ °C/year 100 – 700 dbar, $+0.0012$ °C/year 700 – 2000 dbar.

The 2004 to present (March 2013) reliable data of ARGO 0 bar Sea Surface Temperature may be fitted with a line having a slope of -0.0054 °C/year. This results may be compared with the reconstructed ERSST v3b2 Sea Surface Temperature over the period 2004 to present (June 2013) having a slope of -0.0027 °C/year.

2.4 Synthetic comparison

Table 1 summarised the temperature gradients dT/dt over the period January 2000 to June 2013 from the reconstructed and modelled land and sea temperature data sets, plus the temperature gradients dT/dt over the period January 2004 to December 2012 for the measured sea temperature data set.

From the linear fitting of a set of data $x_i, y_i, i=1, \dots, N$ where x_i is the time of the y_i computation or reconstruction, statistic only returns a linearity error estimate as the coefficient of determination R^2 . This parameter is a comparison of the estimated (from the linear fitting) and the actual (from the fitted data) y -values. Even if this parameter is commonly indicated in climate papers as “error”, the R^2 is only a measure of the linearity of a distribution that we know is not linear but mostly oscillatory, and says nothing about the reliability of the computed or reconstructed values that are different from the “true” values.

The validation of computations and reconstructions vs. reliable measurements is unfortunately a subject almost unexplored so far in the climate science, as mostly unexplored is the subject of the accuracy of the measurements and the biases these measurements may have intentionally or unintentionally. In particular, the land and sea temperatures are not true measurements, but values computed from scattered data of mostly unspecified measuring accuracy [21]. This subject is covered in details later.

The magnitude of the temperature gradient is well below any reasonable accuracy for what concerns the sea temperatures. The warming is a negligible $1.1 \cdot 10^{-3}$ °C/year on average over the layer 0 – 2000 dbar, 7 times smaller than what is claimed in [18]). The less reliable reconstruction of land and sea temperatures are warming minimally about $4.2 \cdot 10^{-3}$ °C/year (average in between the different data sets). The computational models are producing warmings of $20.5 \cdot 10^{-3}$ °C/year (CMIP3) and $18.2 \cdot 10^{-3}$ °C/year (average of the CMIP5) that are five times larger than the reconstructed values possibly already overestimated.

Table 1. Synthesis table of computed and measured temperature gradients dT/dt in $^{\circ}\text{C}/\text{year}$ since the start of this century.

Temperature gradients of average reconstructed temperatures land and sea January 2000 to June 2013 (data from [9])		
data set	dT/dt	R^2
HadCRUT4200 SST/T2m anom 0-360E -90-90N Index	0.00414	0.02039
GISS 250 T2m/SST anom 0-360E -90-90N Index	0.00273	0.01132
GISS 1200 T2m/SST anom 0-360E -90-90N Index	0.00549	0.03255
NCDC v3 SST/T2m anom 0-360E -90-90N Index	0.00467	0.02888
Temperature gradients of average computed temperatures land and sea January 2000 to June 2013 (data from [9])		
data set	dT/dt	R^2
CMIP3 20c3m/sresa1b multi-model mean tas 0-360E -90-90N Index	0.02054	0.87196
CMIP5 modmean32 rcp26 tas 0-360E -90-90N ensemble Index	0.01987	0.90109
CMIP5 modmean42 rcp45 tas 0-360E -90-90N ensemble Index	0.01954	0.93686
CMIP5 modmean25 rcp60 tas 0-360E -90-90N ensemble Index	0.01705	0.85984
CMIP5 modmean39 rcp85 tas 0-360E -60-60N ensemble Index	0.01670	0.8800
Temperature gradients of average measured and reconstructed sea surface temperatures January 2004 to June 2013 (data from [6])		
data set	dT/dt	R^2
ARGO 60S 60N 0E 360E 0 dbar (to March 2013)	-0.00541	0.00248
NCDC ERSST.v3b (to June 2013)	-0.00182	0.00416
Temperature gradients of average measured ocean layers temperatures January 2004 to December 2013 (data from [6])		
data set	dT/dt	R^2
ARGO 60S 60N 0E 360E 0-100 dbar	-0.00880	0.01030
ARGO 60S 60N 0E 360E 100-700 dbar	0.00310	0.19320
ARGO 60S 60N 0E 360E 700-2000 dbar	0.00120	0.37410

3 Models assumptions vs. reconstructions since 1880

The reason why climate models are failing so badly so quickly is not because of the “variability” in the climate, but only because of the wrong assumptions about the anthropogenic carbon dioxide emission driving the climate and the neglected natural oscillations. This “inconvenient truth” emerges clearly as soon as the reconstructed global temperatures are compared with the anthropogenic carbon dioxide emissions not only during the last upwards phase of the quasi-60 years natural oscillation affecting the climate, but also including what happened prior of 1970, as well as what is happening since 2000 [21-24].

As soon as data as the GISS land and sea temperature time series 1880 to present are all properly considered [21-24], the overrated climate sensitivity to the anthropogenic carbon dioxide emission and the neglected natural oscillations emerge clearly. The climate sensitivity to the anthropogenic carbon dioxide emission further reduces as soon as these data are corrected for the tendency to underestimate past temperatures and overestimate present tempera-

tures because of “contamination” as well as of “upwards biasing”.

The global temperature reconstructions are not “truly measured values of perfect accuracy” but the result of computations from scattered data of mostly unassessed accuracy and reliability. As an example, the GISS map has temperature values for the most part of the land and sea of Australia in 1880 of doubtful origin, with some temperatures in Western Australia prior of the start of the official Bureau of Meteorology records 30 years later, or poor accuracy, as the temperature of the just open Alice Spring station in the Northern Territory of Australia that in the year 1880 was different from the map value [21, 25]. Also to mention, the temperature records often suffer of many anthropogenic biases, from involuntary heat release and heat storage issues to the intentional corrections of the data sets incidentally all in the direction of magnifying the warming, as shown in [25] for Western Australia.

The temperatures of the reconstructions are generally lower in the past and higher for the present for “contamination”, the influence of changing heat release and heat stor-

Figure 4. GISS land and sea reconstructed temperatures 1880 to present with 63 and 250 years periods cosine fittings (from [26]).

age close to the thermometers' locations all increasing the warming, as well as of “*upwards biasing*”, the corrections, homogenization, filtering and manipulation of data incidentally all increasing the warming. While these effects have been discussed for selected locations or geographical areas (see for example [21, 25]), the warming trend analyses in the global temperature reconstructions never have cleared up the trend of these factors. A first attempt to correct the warming trends is proposed below.

3.1 Uncorrected temperature trends

Figure 4 presents the uncorrected GISS land and sea temperatures 1880 to present. Even without considering the “*contamination*” and the “*upwards biasing*” issues, a proper analysis of the full global temperature time series offers a different interpretation of the warming trend. Recent works as [21-24] have pointed out the relevance of the multi decadal natural oscillations, with particular emphasis to the 63 years periodicity, in what is called “*global warming*”.

The global temperatures have been warming during the period 1910 to 1940 and 1970 to 2000, but during the period 1940 to 1970 the temperatures have been practically flat, as practically flat have been the temperatures since 2000. The data of figure 4 are fitted with two cosines (from [26]). The first sinusoidal oscillation has a periodicity of 63 years and it is very clear in the data [21-24]. The second sinusoidal oscillation of periodicity 250 years is only a hypothesis that unfortunately the data available do not permit to confirm. The suggestion of a longer term sinusoidal oscillation is certainly not more wrong than adopting exponential fittings to the data 1970 to 2000 magnifying the upwards phase of the 63 years oscillation.

3.2 Carbon dioxide trends

Figure 5 presents the CDIAC global fossil-fuel carbon emissions. The climate models consider as the overwhelm-

ing forcing of the climate the anthropogenic carbon dioxide emission, and the sensitivity of the temperature gradients vs. the anthropogenic carbon dioxide emission gradients is set focusing on the time window 1970 to 2000. This sensitivity is overrated as it appears evident if all the data and not just the data over the carefully selected short time window are taken into account. Figures 4 and 5 do not show a particularly strong correlation.

Figure 5. CDIAC Global Fossil-Fuel Carbon Emissions (from [26]).

3.3 Corrected temperature trends

The recent works [21-24] have pointed out the relevance of the multi decadal natural oscillation of 63 years' periodicity, but they haven't provided any estimation of the “*contamination*” and “*upwards biasing*” error that however is mentioned in the works. This paper attempts a first assessment of this error.

If we do consider the temperatures truly measured in some selected location, for example Ballarat, Victoria, Australia, a small city in a less developed area not that far (114 km) from the huge urban heat island of Melbourne, Victoria, Australia, or Alice Spring, Northern Territory, Australia, where the only long term nearby station is more than 1000 km apart (1497 km to be precise), and we do compare the truly measured average temperatures with the GISS reconstructed values in the same locations, we may discover how much the values for the past are underestimated and how much the values for the present overestimated by GISS.

For Ballarat, the truly measured temperature anomalies 1908 to 2011 follow the linear trend line

$$\Delta T = 0.0014 \cdot x - 2.9.$$

Where x is the time (in years) and T is the temperature (in °C). Conversely, the GISS reconstruction returns for same latitude and longitude and same time window temperature anomalies about the linear trend

$$\Delta T = 0.0069 \cdot x - 13.40.$$

For Alice Spring, the truly measured temperature anomalies 1880 to 2013 follow the linear trend line $\Delta T = 0.0029 \cdot x - 5.68$.

While the GISS reconstruction returns for same latitude and longitude and same time window temperature anomalies about the linear trend

$$\Delta T = 0.0086 \cdot x - 16.70.$$

Therefore, the “contamination” and “upwards biasing” errors are for Ballarat and Alice Spring are respectively:

$$\Delta T = -0.0055 \cdot x + 10.61 \quad (1)$$

$$\Delta T = -0.0057 \cdot x + 11.02 \quad (2).$$

Surprisingly the two slopes and zero constants are very close values in Ballarat and Alice Spring despite the 2150 km separating the two towns, and as a very first approximation, we may try to correct the GISS result with an error given by the average of (1) and (2). Figure 6 presents the GISS reconstructed data January 1880 to June 2013 inclusive of this “contamination” and “upwards biasing” error bar.

If we assume as a more realistic global temperature distribution the GISS values corrected with half the error above, then the first cosine of period 63 years has same equation of Figure 4, while the second cosine of period 250 years has much smaller amplitude than in Figure 4. This smaller amplitude is certainly more realistic. The amplitude of the longer term oscillation further reduces if rather than half the error the GISS temperatures are corrected with the full error. This produces a global trend of very little warming 1880 to present with an overwhelming quasi-60 years natural oscillation.

The analysis of the GISS data corrected for “contamination” and “upwards biasing” returns a picture made of natural oscillations of the climate as known since ever and a further reduction of the magnitude of the anthropogenic forcing through the changed composition of the atmosphere.

The analysis of Figure 6 is also certainly questionable, but not more than assessing warming trends without accounting at all for the “contamination” and “upwards biasing”, or as previously noticed, just focusing on the upwards phase of the 63 years oscillation and neglecting everything else before and after this carefully selected time window.

4 Discussion and conclusions

The climate models are failing every possible validation during their first decade they are compared with experiments. This lack of validation is more a result of wrong assumptions, in particular the neglected natural oscillations

Figure 6. Corrected GISS land and sea reconstructed temperatures 1880 to present with 63 and 250 years periods cosine fittings.

and the exaggerated influence of the composition of the atmosphere, rather than the result of climate “uncertainty”.

The paper compared a set of experimental temperature records from the ocean and the surface versus the prediction of the models. During the last 13 years, there is a clear mismatch between the models and the data. The models predicted a warming that is not observed in the data. A novelty of the present study is to explicitly study the period from 2004 to date that also corresponds to the ARGO ocean temperature measurements that also show small temperature variation. In particular the upper level of the ocean is slightly cooling despite the models predicted a significant warming during this period.

The climate models are failing simply because they are based on the wrong correlation of temperatures and carbon dioxide emissions inferred from the analysis of a short time window of 30 years of data during an upwards phase of a quasi-60 years multi-decadal oscillation.

The idea of model as representation has led Nancy Cartwright [20] to the claim that models are “a work of fiction” In her words, “some properties ascribed to objects in the model will be genuine properties of the objects modelled, but others will be merely properties of convenience.” How much in “global warming” is based on observation and measurement of accessible phenomena and how much is based on informed judgment and convenience is certainly an open question.

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