



In reply please quote

Dear Mr Williamson

Thank you for your email of 27 May to our Director Dr Rob Vertessy requesting responses to a range of climate change questions. I have been asked to reply to you on his behalf.

Some of your questions relate to your earlier queries, which we responded to on 6 May.

Noting this, my response to the four questions in your most recent email is as follows.

1. BOM Climate Definitions Contradict BOM Report

Climate is the statistical analysis of weather over a given time period. This analysis produces many different climate variables, such as annual-mean temperature or the statistical characteristics (for example a probability density function) of rainfall over some period. Climate can be defined over weeks, months or years.

Climatology is a reference or baseline period for climate statistics. Climatology and climate are two separate terms with different meanings. A climatology is generally defined over at least 30 years in the scientific literature.

For example, annual climate anomalies are departures from normal, calculated by comparing the climate over 12 months with the climate from a climatological reference period.

2. BOM Contradicts IPCC Regarding Droughts

The Bureau of Meteorology and CSIRO report on trends in drought and rainfall in the Australian region. Trends in mean rainfall are different to trends in episodic drought. The climate record shows that Southern Australia has experienced cool season rainfall declines and climate models project rainfall to decrease, on average, over much of southern and eastern Australia through the decades ahead.

The IPCC Fifth Assessment Report states that there is low confidence in detecting changes in drought when drought is assessed at the global scale. This assessment arises in part from the difficulty in defining a global drought index. This is because the definition of drought changes from one climate zone to another.

However, the IPCC noted that there were likely changes in drought, including an increase in the frequency and duration of drought, at regional scales. The IPCC SREX report assessed that anthropogenic influence had contributed to some changes in the drought patterns observed in the second half of the Twentieth Century, with varying confidence dependent on regional scale and location. A general conclusion of climate change science, highlighted in IPCC and Bureau of Meteorology reports, is that global warming results in intensification of the hydrological cycle, meaning that we can expect more serious droughts and floods in various places at various times.

3. BOM Contradicts IPCC Regarding 15 Year Hiatus & Failure of Climate Models

There is clear evidence that the global climate system continues to warm in response to anthropogenic greenhouse gas emissions. This is borne out by a wide array of measurements performed by many agencies, including the Bureau of Meteorology.

The IPCC reference to a hiatus in recent warming relates to a slowdown in the rate of warming of global mean surface temperature trend during 1998–2012, relative to the trend observed during 1951–2012. This reduced rate of warming in this single variable is attributable in roughly equal measure to a surface cooling contribution from internal variability and a reduced trend in external forcing.

Global mean surface temperature is one of many different measures of heat in the climate system, each with their own short-term climate 'noise', or internal climate variability. By looking across multiple variables, in particular ocean heat content and sea-level rise, it is clear that the climate system has continued to accumulate heat in recent decades.

The internal variability component of reduced rates of warming in the 2000s compared with the 1990s has been linked to decadal variability in global mean surface temperature associated with the El Niño-Southern Oscillation (ENSO), which controls the exchange of heat between the atmosphere and oceans.

Climate model forcing experiments are not weather forecasts. Climate models are therefore not expected to reproduce the timing of observed internal decadal variability, but rather to reproduce the response to external forcing while simulating the statistical properties of intrinsic variability. For example, the climate models reproduce the ENSO cycle, but they do not reproduce the observed timing of El Niño events. This is not a flaw in the models *per se*, but the difference between an initial condition issue, such as numerical weather prediction, and a boundary condition issue, such as understanding the mean impact of changes in atmospheric chemistry.

4. IPCC Claims Global Warming is NOT Global & is NOT Local

Climate models do not simulate warming across every part of the climate system in response to a 40% increase in greenhouse gases. Nevertheless, observations show that the entire climate system has, on average, warmed.

There is a difference between short-term climate 'noise' and long-term climate signals. Many of the observations referenced in this question refer to short-term 'noise', or internal climate variability as outlined above, and are not especially relevant to predicted future climate change

As discussed previously, the climate model forcing experiments do not include observational data assimilation (where observed climate changes are used to constrain the model simulations). Rather, they only contain the external forcing changes, such as observed changes in greenhouse gases.

Dr Vertessy's remarks in relation to the causes of climate change (ie. anthropogenic emissions of carbon dioxide) accord with the IPCC's Fifth Scientific Assessment that emphasises the extreme likelihood (or greater than 95% probability) that the observed global warming is due to increases in carbon dioxide. The IPCC Summary for Policymakers concludes:

"Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes (see Figure SPM.6 and Table SPM.1). This evidence for human influence has grown since AR4. It is extremely likely that human

influence has been the dominant cause of the observed warming since the mid-20th century.

It is extremely likely that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together. The best estimate of the human-induced contribution to warming is similar to the observed warming over this period.

Over every continental region except Antarctica, anthropogenic forcings have likely made a substantial contribution to surface temperature increases since the mid-20th century (see Figure SPM.6). For Antarctica, large observational uncertainties result in low confidence that anthropogenic forcings have contributed to the observed warming averaged over available stations. It is likely that there has been an anthropogenic contribution to the very substantial Arctic warming since the mid-20th century.”

Finally, with regard to your suggestion of an audit of the Bureau's climate data, please note that the Bureau has already had its ACORN-SAT data and analyses independently reviewed by an expert panel less than three years ago. Their report is publicly available on the Bureau's web site, along with extensive documentation prepared by the Bureau and the raw and homogenised data. Please see <http://www.bom.gov.au/climate/change/acorn-sat/#tabs=Expert-review> and the full report can be found on the right side of that page. I note that the panel ranked the Bureau's ACORN-SAT procedures and data analysis as amongst the best in the world. I encourage you to read this material and the related journal articles published by Bureau scientists since that review (Attachment A).

Neil Plummer

Assistant Director Climate Information Services

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Additional temperature data references

Fawcett, RJB, B C Trewin, R Smalley and K Braganza (2013). On the changing nature of Australian monthly and daily temperature anomalies. In proceedings of the Australian Meteorological and Oceanographic Society, Annual Conference.

Fawcett RJB, Trewin BC, Braganza K, Smalley RJ, Jovanovic B, Jones DA (2012). On the sensitivity of Australian temperature trends and variability to analysis methods and observation networks. CAWCR Research Report 50, Bureau of Meteorology, Melbourne, 66 pp. http://www.cawcr.gov.au/publications/technicalreports/CTR_050.pdf .

Jovanovic, B., Braganza, K., Collins, D. and Jones, D.J., (2013). Climate Variations and Change evident in high-quality climate data for Australia's Antarctic and remote island weather stations. Aust. Met. Oceanogr J., Vol.62, 4, 247-261.

Trewin (2012). A daily homogenized temperature data set for Australia. International Journal of Climatology, published online 13 June 2012, doi: 10.1002/joc.3530.

Trewin (2012), Techniques involved in developing the Australian Climate Observations Reference Network - Surface Air Temperature (ACORN-SAT) dataset. CAWCR Technical Report 49. http://www.cawcr.gov.au/publications/technicalreports/CTR_049.pdf .