Minister for Climate Change and Energy Efficiency
Minister for Industry and Innovation

C12/4442

Mr Scott Morrison MP
Member for Cook
PO Box 1306
CRONULLA NSW 2230

Dear Mr Morrison Scott

Thank you for your personal representation of 29 November 2012 on behalf of Mr Laurie Cummings concerning modelling of the global hydrological cycle.

As you are aware I have already provided extensive advice to Mr Cummings on this issue. I also note that he has received responses on this topic from various other Members of Parliament and the CSIRO.

I have suggested on numerous occasions that if Mr Cummings wishes to challenge the scientific research referred to in our correspondence, that he should make a submission to a peer-reviewed journal.

It should be made very clear to Mr Cummings that posting his work on a website is not equivalent to publishing his work in a peer-reviewed journal. Science relies on continued questioning and challenging of ideas. The peer-review process provides a mechanism to quality control scientific discourse and therefore peer-reviewed papers provide a reliable and quality assured source of information on climate change science. Once an article is published in a peer-reviewed journal, its ideas can be challenged or supported by other scientists with peer-reviewed articles of their own. Eventually a consensus builds around the idea or set of ideas that explain the evidence most successfully.

Peer-review ensures that published findings are objective and conform to accepted scientific standards. Without the peer-review system, publication of research findings would be arbitrary, and possibly influenced by personal, social or political agendas. Scientists draw a sharp distinction between material in blogs or opinion pieces and peer-reviewed scientific literature.

I would note that the Intergovernmental Panel on Climate Change (IPCC) *Fifth Assessment Report* Working Group I report on the 'Physical Science Basis' will be released in September 2013 and will provide an assessment of the latest science in this field. IPCC reports assess the range of peer-reviewed literature available on climate change science, presenting a synthesised assessment. The IPCC reports are themselves subject to a robust review process involving hundreds of scientific expert and government reviewers.

In response to his latest letter, information has been prepared by the Department of Climate Change and Energy Efficiency, with input from experts. This advice is provided at Attachment A to this letter.

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I appreciate Mr Cummings interest in this topic. However, as Mr Cummings has failed to accept the extensive advice that has been provided to him previously, I will not be corresponding with him on this topic again.

Thank you for bringing Mr Cummings' concerns to my attention.

Yours sincerely

GREG COMBET

Enclosure

The following advice has been prepared in response to Mr Cummings' letter of 2 November 2012 by the Department of Climate Change and Energy Efficiency (the Department) with input from experts.

Evaporation-precipitation response in models

- In his most recent letter, Mr Cummings suggests that the Department has failed to confirm if the CSIRO have undertaken modelling of an evaporation-precipitation (E-P) response of an 8 per cent increase per degree of warming. It was explained to Mr Cumming in the letter of 22 October 2012 that the E-P response is a model output, not a model input that can be configured.

Peer-reviewed literature regarding observations of the evaporation-precipitation response

- As previously explained to Mr Cummings in the letter of 22 October 2012, it is incorrect to infer a global mean evaporation (as equal to global precipitation) rate of change from the Durack *et al* 2012 paper as it examines the regional differences in E-P. Regional patterns scale differently from the global averages as the atmosphere has many mechanisms to cause energy (both latent and dry static) to converge and diverge locally. Hence the pattern amplification of E-P over the oceans cannot help elucidate the net planetary energy budget at the surface nor at the top of the troposphere.

- Mr Cummings notes that Wentz *et al* 2007 found an evaporation response greater than that suggested by climate models. Arkin *et al* 2010 and Li *et al* 2011 found that previous estimates of global evaporation and precipitation change, including Wentz *et al* and Adler *et al* 2008, may be limited by the short record of observations and underlying sampling and algorithm errors inherent in the observations and estimates used. Arkin *et al* presents a reconstructed near-global precipitation data set for the entire 20th century to find a precipitation (and hence evaporation) response of 2.5 per cent per degree of global warming, similar to the value of 2.2 per cent obtain from the IPCC *Fourth Assessment Report* model simulations.

- O'Gorman *et al* 2011, 'Energetic Constraints on Precipitation Under Climate Change' reviewed a range of studies that considered observed changes in precipitation, including Wentz *et al*, and found that 'there is considerable sensitivity of precipitation response to the data set and time period chosen'.

- Mr Cummings dismissal of the Li *et al* 2011 paper is based primarily on a linear trend calculated therein which Mr Cummings describes as "mathematically impossible." This dismissal appears unfounded. The linear trend referred to by Mr Cummings appearing in Table 1 is based on panel B of their Figure 2. Given Mr Cummings' comments, advice was sought from the Department's Australian Climate Change Science Program (ACCSP) researchers who redigitised the data from Figure 2 panel B and computed the linear trend. This linear trend is found to be 0.9% per decade, essentially the same as reported in the paper. Therefore the Li *et al* paper is factually correct in this calculation.

- Inferring long term trends in hydrologic cycle variables using just 20 years or so of data is likely to have large uncertainty due to the strength of decadal variability in

these quantities. Advice from ACCSP researchers is that the quantities in the Li *et al* paper appear strongly influenced by decadal variability, making the estimation of long term trends based on these data prone to uncertainty.

- The main reason cited in Li *et al* for the difference between their result and that of Wentz *et al* for a trend in precipitation over what is essentially a common period is that the Li *et al* uses the recently-released GPCP-V2.1 data set (Huffman *et al* 2009) while Wentz *et al* uses the earlier GPCP-V2 data set. The GPCP-V2.1 has improvements in data analysis and quality control procedures over that of the GPCP-V2, hence is the more likely to better represent the actual behaviour during this period.

Evaporation processes and the Earth's energy balance

- As the planet warms there is more downward long wave radiation from the atmosphere, from both increasing greenhouse gases and the extra water vapour held by the atmosphere. Changes in the global mean evaporation occur as part of the internal rebalancing of surface heat that occurs as the climate warms.
  Mr Cummings' evaporative cooling argument appears to assume that the surface is decoupled from the atmosphere and that the latent heat of condensation as the evaporated water vapour condenses simply disappears from the system.

- As previously explained to Mr Cumming in the letter of 22 October 2012, it remains inappropriate to assume that surface evaporation processes in isolation are responsible for directly restoring the Earth's energy balance. What matters for the maintenance of stable temperatures on Earth is that the flow of incoming solar energy is balanced by an equal flow of heat (i.e. long wave radiation) into space at the edge of the atmosphere.

- It must be emphasised that for inferences about the surface temperature response, the global atmosphere and surface ocean must be considered as a *coupled* system. Evaporation simply moves heat from one part of this coupled system (the ocean surface) to another (the atmosphere) where it is released as latent heat of precipitation. An increase in global evaporation will thus cause equivalent warming of the atmosphere via latent heat release which then feeds back to affect the surface temperature via changes in radiative and sensible (convective) heat fluxes.

- It should be noted that the amount of water vapour in the atmosphere is not a function of the rate of evaporation as the latter is balanced by a change in precipitation. A good analogy is a lake (the atmosphere) with a river flowing in one end (evaporation) and an identical one flowing out the other (precipitation). A lake that is twice as big does not imply the rivers are twice as big – in fact does not imply anything about the size of the rivers at all. Similarly, the controlling factor on the amount of water vapour the atmosphere can hold is temperature, not the rate of evaporation.

- Advice gained by the Department from ACCSP researchers is that, to the best of their knowledge, there has been no published global climate model simulation which displays a global precipitation (hence evaporation) increase in response to increased greenhouse gas concentrations at any more than about 3.5% per degree Celsius, about half the rate required to support Mr Cumming's ideas. Atmospheric

energetics constraints such as discussed in O'Gorman *et al* 2012 and references therein place physical limits on the size of the response.

Sensitivity of the Earth's climate system

- There is significant confidence in our understanding of the Earth's climate sensitivity to a doubling of carbon dioxide. Over many years of development and increasing complexity, models have consistently projected the sensitivity of the Earth's climate to a doubling of carbon dioxide to be approximately 3 degrees Celsius.

- Knutti and Hegerl 2008 'The equilibrium sensitivity of the Earth's temperature to radiation changes' considers various methodologies, including palaeoclimate and empirical observations, for estimating sensitivity finding they are generally consistent with the range of 2 - 4.5 degrees Celsius with few methods leaving the possibility of lower values, but several unable to rule out higher values. Knutti and Hegerl's review supports the IPCC *Fourth Assessment Report* finding that climate sensitivity 'is very unlikely to be less than 1.5°C'. Mr Cummings' argument for a climate sensitivity of less than 1 degree Celsius is not supported by the results of climate models, palaeoclimate data or contemporary data.