



Australian Academy of Science

**A Submission to the
Review of the Australian Bureau of Meteorology**

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The Academy has 20 National Committees which are widely representative of its disciplines. The broad aims of the committees are to foster a designated branch or theme of natural science in Australia and to serve as a link between Australian scientists and overseas scientists in the same field. Relevant National Committees were invited to make comments for the review.

National Committee for Space Science (NCSS)

The National Committee for Space Science (NCSS) is a Committee of the Australian Academy of Science dedicated to providing leadership in the areas of space science and technology research and informed comment on matters relating to space science and its impact on society, the economy and national security. It is also responsible for international relations between scientific societies and other bodies overseas with respect to space science matters. Accordingly, the NCSS will direct its comments principally to those areas of science, scientific collaboration and science infrastructure where it believes the Bureau of Meteorology (BoM) has or should have an interest.

1) General and Review Considerations (a) and (l): The role of solar variability in global warming and climate change is a common topic of discussion, even as there is growing realization that human impacts on the lower atmosphere (below 10 km, where ordinary hydrological weather predominates) are accelerating. Multiple reasons exist for including the effects of solar/space variability and the upper atmosphere in studies and forecasting of the lower atmosphere, climate, and global warming. First, the upper and lower atmosphere are coupled but respond differently to forcings. For instance, the upper atmosphere is expected to cool as the lower atmosphere heats due to the greenhouse effect, leading to changes in the propagation and reflection of planetary waves (that originate in the lower atmosphere) and so changed energy and mechanical fluxes into the lower and upper atmospheres. Second, it appears as though climate models yield improved predictions when they are extended to include higher atmospheric layers. Third, recent ground- and space-based observations clearly show that "space weather" events associated with solar and interplanetary activity (eg solar flares and coronal mass ejections) lead to strong spatiotemporal changes in the composition, temperature, and density of the middle atmosphere and ionosphere (from ~40 to 200 km altitude). While links between space weather and meteorological weather are currently unclear, they may be enhanced by global warming. Fourth, changes in long-term solar output are of obvious importance.

Despite these connections and their importance it appears that research, modelling, and forecasting links between the Australian meteorological and space science communities could be improved. The NCSS believes strongly that improving these links will have benefits extending beyond scientific value to better managing the societal, economic and national security implications of climate change and global warming. BoM and the BoM Research Centre [BMRC] (as well as the space science community and its constituent government and academic bodies) should be encouraged to increase and expand these linkages to meet science and community objectives and to maximise the scientific and societal returns on Government funding. BoM, as a "world leading 21st century meteorological organisation" [Review Consideration (a)], is urged to consider the potential impact of anthropogenically induced change on the climate of both the middle and upper atmosphere as well as the lower atmosphere.

2) Review Considerations (d) and (h): At present Australia owns no weather satellites and has essentially free access to weather data from US, Japanese and Chinese satellites. What is BoM doing to manage the risk of Australia no longer having free access to these resources? The NCSS notes the Australian Government's position in relation to access to space and satellite services, and in particular the reliance this places on market forces to ensure that a "user pays" option is available. In the case of weather satellites, current international arrangements allow for essentially free data access. Regional volatility and issues of changing government investment

may change this perspective. As an essential element in the delivery of meteorological services, the Review should consider the consequences and risks of denial of service, unavailability of assets or any transition to an excessively high fee for service. It is an appropriate time to consider a long-term plan for a regional meteorological satellite in collaboration with regional partners.

3) The role of Research in the Review and in BoM. Only two (2) of the twelve (12) Review Considerations relate to research in meteorology, weather, and climate. This suggests to NCSS that research conducted by BoM and BMRC is perceived to have small importance to BoM, the Government, other Government entities (eg CSIRO, Defence, Environment & Heritage, Agriculture etc., and Foreign Affairs), and limited benefit to Australian corporations and people. While provision of services in an efficient manner is clearly important, it appears to NCSS as though too little attention and effort is being devoted by the Review, Government, and BoM users to the research contributions that are or could be made by BoM and BMRC. BMRC and BoM have good records of research, despite an environment of decreasing “public good” research and increasing emphasis on provision of services, and their capabilities should be strengthened. Foreign Governments and the Australian Government itself, as well as a wide cross section of people and financial/business institutions worldwide, are increasingly of the opinion that weather, climate, and global warming are of critical importance (both immediately and long term) and that addressing these areas requires increased amounts of scientific and financial resources. Thus, NCSS recommends that the Review and BoM itself should give a larger role to research on meteorology, weather and climate, especially in connection with global warming and links to Earth's space environment.

National Committee for Geography

The National Committee for Geography most strongly supports a well-resourced Bureau of Meteorology. The role of the Bureau in maintaining high quality meteorological records over a long time period and at high spatial resolution is a crucial resource for Australia, and also provides a very important international contribution because of the importance of southern hemisphere climates in global systems. In view of current concerns over drought and climate change, it is vital that policy is based on the highest quality data available. The Committee strongly endorses the importance of the Bureau and argues that its resources should be increased.

National Committee for Earth System Science

Our comments relate primarily to the following three Terms of Reference:

- a) The general vision for creating a world leading 21st century meteorological organisation.*
- c) The changing needs and expectations of users of climate and weather services in Australia, and*
- l) The capacity of the Bureau to contribute to monitoring of and preparation for climate change and related weather events.*

No leading meteorological organisation can afford not to have global climate change firmly central in its vision of its role if it is to remain relevant to society. Climate change brought about by human modification of the global atmosphere, is altering - or will soon be altering - everybody's expectation of what future weather will be like, the role and accuracy of weather forecasting, and the role of meteorological services. It is essential that the additional role of meteorological organizations to cope with this is funded commensurately with the enormity of the issue for human well-being and economies.

The work of the Bureau of Meteorology is critical to understanding, documenting, predicting and coping with by far the largest bio-geo-physical threat to socioeconomic well-being in Australia – global climate change. This submission therefore focuses on the Bureau's role in climate change and variability.

Key steps in coping with climate change involve:

- 1) Accurate, representatively sampled, long term monitoring of climatic conditions so that changes can be discerned and high quality data made available to systems for predicting future change.
- 2) Understanding of the causes of variation in climatic variables on all time scales (ie both variability and change).
- 3) Systems to predict the character of future change in Australia set in the context of global changes.
- 4) Approaches to expressing and communicating the variability and change expected, in terms that users can interpret and apply to understand impacts on them and to plan their adaptations.

With regards to representative monitoring, this is a traditional area for BoM but it is noted that public support of climatic monitoring has declined considerably in recent decades at a time when detailed documentation of change for public policy purposes has been critically needed. A significant fraction of the uncertainty in future climate prediction derives from uncertainty in what has happened in the past. Accordingly we submit that investment in accurate, spatially dense, high quality climatic monitoring is essential and requires re-ramping up. This includes continuous, well-calibrated records of air temperature, rainfall, humidity, potential evaporation via pan evaporimeters, windspeed and the various components of radiation at a standard height from the ground in representative locations. Part of an increased activity in climate monitoring would need to include an emphasis on the choice of location for, and regular inspection of monitoring sites to ensure that their data are not unduly affected by local changes to the environment which can affect the representativeness of such data. Given that the putative main cause of the observed global warming is the modification of the atmosphere's longwave radiation balance via atmospheric absorption of longwave back radiation from the surface, it is astonishing that there is no widespread systematic measurement program in place for long term monitoring of the outgoing longwave radiation from the Earth's surface as well as the incoming longwave radiation from the atmosphere. This is a demanding thing to measure accurately and needs secure new funding for the long term. A wide network of representative sites that continuously measures all terms of the energy budget at the surface (long wave and short wave, spectral, upwelling and downwelling), linked with satellite-based and radiosonde measurements at altitude, would be even better for climate change documentation and climate model improvement.

The disciplinary scope of what is needed to address the above four areas for coping with climate change usefully is broad, encompassing investigations and skills beyond the historical remit of meteorological organizations. Accordingly, the Academy of Science's National Committee for Earth System Science endorses the current movement towards the formation of a joint BoM/CSIRO climate change research facility including the multi-organisation climate modelling initiative - Australian Community Climate and Earth System Simulator (ACCESS) - that includes terrestrial, ocean and other whole Earth System feedbacks that have not yet been adequately embraced in computer modelling of the "climate system". This will bring a broader base of information to the BoM activities and foster collaborations not only with CSIRO but other organizations including the universities.

However it is disappointing that the new ACCESS venture is not beginning at a size that is commensurate with the enormity of the task at hand. The establishment of ACCESS has led to just a few percent expansion of these activities in Australian climate change research, whereas the need for advice of how climate change is and will affect various economic sectors and various regions in Australia is exploding exponentially.

We are currently on the cusp of the expanded societal needs in this area worldwide, and BoM and its partners in ACCESS will need to expand these activities in a steady manner so as to build capacity with top-rate scientists, computer scientists, economists and engineers. The needs for

expanded activity covers the full gamut of climate activity from data observation and management to model development, assimilation, and the application work of addressing the specific climate needs of various industries and regions. The type of research is physical, chemical, biological and engineering, and its end users include water authorities, councils, state and federal governments.

A glaring deficiency to date in Australia is in the overlap area between climate change science and economics. This area requires development to provide the Australian governments with properly researched advice on choosing between various policy options the aim of which is to reduce the emissions of fossil fuels and also to best mitigate and adapt to the effects of climate change on the community in an economically efficient manner. The recent Stern Report to the British government points out that the present development of economics is not yet mature enough to handle these nonlinear questions that span more than a single human generation. Hence there is a need to develop environmental economics to be able to address such long term matters.

Another area in which Australia does not contribute as it might is in climate variability research. Given the sensitivity of the Australian economy to drought, one would expect that all types of research in climate variability science would be well developed and internationally competitive in Australia. We do have many good scientists in this area, but especially with recent and pending retirements, Australia lacks theoretical scientists who lead the world in understanding and furthering the science behind El Nino and other patterns of climate variability.

In summary, the recent establishment of the coordinated ACCESS research activity is to be applauded, and we use this opportunity to affirm that this area of research needs to be significantly expanded if Australia is to have the advice it needs to develop economically in this "land of droughts and flooding rains". Additionally, the network of representative weather stations used to document climate change needs a significant boost to funding to provide a basis for guaranteed ongoing accuracy, representativeness and comprehensiveness of the climatic variables measured.