

SOUTHERN HEMISPHERE METEOROLOGY AND OCEANOGRAPHY

BY HOWARD J. DIAMOND, NEIL PLUMMER, AND KEVIN WALSH

Since 1983, and approximately every three years since, the American Meteorological Society (AMS) Committee on Meteorology and Oceanography of the Southern Hemisphere (SH) has planned and staged an international conference focusing on the unique aspects of atmospheric and oceanic science in the SH. Scientific inquiry in SH meteorology and oceanography has expanded considerably over the past 50 yr, beginning with the International Geophysical Year of 1957/58 and continuing into the International Polar Year of 2007/08. A number of factors have driven this progress: 1) increasing numbers of observations of the SH, particularly in the ocean (e.g., Argo floats, moored arrays in the Indian and Atlantic Oceans, and Southern Ocean monitoring); 2) the importance of the generally data-sparse SH to global climate and meteorological knowledge has been underscored by recent increases in ocean-observing systems coupled with recent advances in ocean modeling; 3) the increased availability of re-

THE NINTH INTERNATIONAL CONFERENCE ON SOUTHERN HEMISPHERE METEOROLOGY AND OCEANOGRAPHY

WHAT: Nearly 500 scientists and researchers from around the world gathered to focus on and discuss the weather, climate, and ocean processes of the ocean-dominated Southern Hemisphere.

WHEN: 9–13 February 2009

WHERE: Melbourne, Victoria, Australia

motely observed data by satellite; and 4) operational implementation of improved numerical weather prediction models that has resulted in better forecasts in both hemispheres. The opportunities provided by these advances have both increased understanding and appreciation of the role of the SH and elevated the importance of the International Conference on SH Meteorology and Oceanography (ICSHMO).

The ninth in the conference series (9ICSHMO), the culmination of more than two years of planning and coordination, was a joint venture by the AMS and the Australian Meteorological and Oceanographic Society (AMOS). On many levels, the conference was a great success, despite the travel difficulties and expense of getting to Australia (coupled with the global financial crisis), a record-breaking heat wave, and bushfires nearby. There were 471 registered attendees from 27 countries, which was the second greatest attendance ever for an ICSHMO conference.

Attracting both students and scientists from developing countries has always been a priority for

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ICSHMO, and the conference provided travel support to attendees from both categories. More than half of the nations represented were developing countries (including 14 delegates from Pacific Island countries), and there were 81 students in attendance.

With more than 560 abstracts submitted to the conference, the result was a comprehensive series of high-quality oral and poster presentations in areas ranging from the International Polar Year, urban climate, and monsoon systems and extremes to paleoclimate, interocean exchanges, and Earth system science. In addition, there were special sessions on SH The Observing System Research and Predictability Experiment (THORPEX) and Pacific Island

science initiatives. All short and some extended abstracts are posted on the conference Web site (www.bom.gov.au/events/9icshmo/). The theme of the conference (chosen well in advance of the meeting) was “Extremes: Climate and Water in the Southern Hemisphere,” and unfortunately this theme turned out to be all too appropriate: the weekend before the conference and less than 100 km from downtown Melbourne, Victoria, Australia, experienced its worst natural disaster on record (see the sidebar for additional information about this natural disaster).

All of the 9ICSHMO sessions were very well attended, and feedback indicated that this was an excellent forum with an extremely high level of in-

BLACK SATURDAY: AUSTRALIA'S WORST NATURAL DISASTER

The theme of the 9ICSHMO was “Extremes: Climate and Water in the Southern Hemisphere.” Merely by coincidence, it took place against the backdrop of record heat in southern Australia and the nation’s worst natural disaster on record. A total of 173 people died and about 500 were injured in what has become known as the Black Saturday bushfires, which ignited (or were burning) through the state of Victoria on 7 February. More than 3,000 structures were destroyed, several small towns were almost completely leveled, and many people were left homeless. Black Saturday occurred as a result of an extreme weather event on the heels of an extreme climate event. There were two major episodes of exceptionally high temperatures: 28–31 January and 6–8 February (National Climate Centre 2009). Many all-time records were set in Victoria on 7 February, including Melbourne, where the temperature reached 46.4°C, far exceeding its previous all-time record of 45.6°C set on Black Friday (13 January 1939). It was also a full 3.2°C above the previous February record, set in 1983; both the 1939 and 1983 events resulted in bushfires that caused significant losses of life and property. Three of Melbourne’s five hottest days occurred during the February 2009 event. The effects of the heat wave were also experienced outside of Victoria, with large bushfires burning parts of the neighboring state of New South Wales (Fig. SBI).

Karoly (2009) describes just how extreme these events were and discusses the key weather and climate influences, concluding that climate change was likely an important contributing factor in the unprecedented heat of 7 February. Very low values of relative humidity (~5%) were also a big contributor to the bushfires, as were the very strong northerly winds bringing in hot and dry air from Australia’s arid interior. Also contributing to the brushfires was the long-term drought in southern Australia that extends back to 1996 at many locations (National Climate

Centre 2008). Furthermore, Melbourne and much of Victoria received record low rainfall for the start of 2009 (National Climate Centre 2009), which, when coupled with the long-term drought, resulted in extremely low fuel moisture and unprecedentedly high values of the McArthur Forest Fire Danger index—a rating scale from 1 to 100 for fire danger in Australia, designed for use with the McArthur Mk Forest Danger Meter (see www.csiro.au/products/Mk5ForestfireDangerMeter.html).

An excursion to a winery in the affected area that was planned before the fires went ahead at the request of the owners, which allowed attendees to see the ravaged landscape. Public generosity following the bushfires was overwhelming. The Red Cross Bushfire Appeal raised more than \$230 million (U.S. dollars), and this conference raised nearly \$2,000 (U.S. dollars) for the appeal. The authors wish to express their sincere sympathies to all who have suffered through the bushfire disaster.

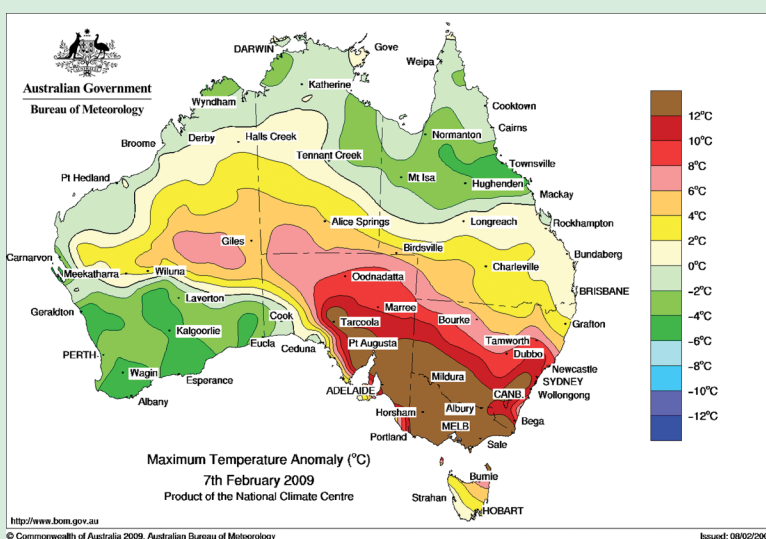


Fig. SBI. Maximum temperature anomalies for 7 Feb 2009 relative to the 1971–2000 averages. (Source: National Climate Centre, BOM.)

formation exchange. Plenty of time was set aside for the poster sessions, which provided opportunities for in-depth discussions. The conference opened with an address from the governor of the state of Victoria, Professor David de Kretser, who spoke about the importance of furthering our understanding of SH weather and climate, particularly in light of long-term concerns such as climate change and global warming as well as the short-term concerns on the minds of all attendees regarding the tragic bushfires just two days earlier.

HIGHLIGHTS OF THE CONFERENCE.

Presentations by a number of scientists emphasized work in coastal, open ocean, and polar science that constitutes critical contributions to studies of climate change, ecosystems, and boundary level interactions with the atmosphere that are unique to the SH. Particular examples, as highlighted below, were papers discussing SH THORPEX, Pacific Island science, improved weather, water, and climate predictions, and new atmospheric and oceanic observations. Despite the climate and water extremes theme, the conference was broadly structured with a multidisciplinary approach to facilitate wider interactions between oceanic and atmospheric scientists.

The nature of the conference provided a natural and very convenient opportunity for the SH THORPEX Committee (the co-chairs were Neil Gordon and Kamal Puri) to organize a special 1-day seminar spotlighting activities in its program. Among the many papers presented, Ian Simmonds of The University of Melbourne focused his paper on the polar latitudes and Antarctica. The Antarctic continent and its surroundings greatly influence the weather and climate over the midlatitudes of the SH continents. Such factors as sharp topographic and thermal contrasts, and the complexity of the interactions between the atmosphere, ocean, continental ice, and sea ice present significant challenges for the diagnosis and prediction of high-impact weather forecasts in areas where people live in the hemisphere.

Although the influence of the Madden–Julian oscillation (MJO) on tropical climate has been known for more than a decade, recent work by Matthew Wheeler from the Centre for Australian Weather and Climate Research (CAWCR) and his colleagues showed that the MJO also influences the midlatitude climate over Australia as well as extreme tropical weather in the SH. In particular, Wheeler demonstrated how an intraseasonal prediction model utilizes the MJO to produce a running multiweek tropical cyclone (TC) outlook for each of the SH's TC

basins. The outlook has shown good skill over the two most recent seasons.

Peter Webster and Carlos Hoyos from the Georgia Institute of Technology detailed a new paradigm for understanding the role of the tropics in the global heat balance equation. This dealt primarily with the tropical warm pool (TWP) serving as a physical basis to explain the evolution of sea surface temperatures (SSTs) in the tropics. Traditionally, the TWP corresponds to the area of the ocean where SSTs are greater than 28°C, whereas the dynamic warm pool (DWP) corresponds to the region of net atmospheric convective heating in the tropics. The DWP stays constant as the SST increases. The researchers expect that the concept of the DWP will create a better understanding of paleoclimate, that is, long-term interdecadal variability, allowing for an estimate of changes that may occur with the critically important tropical intraseasonal variability, including its relevance to TC activity.

Greg Holland from the National Center for Atmospheric Research (NCAR) presented calculations suggesting that the observed tropical vertical energy transport could be entirely accounted for by 80–100 tropical cyclones per year, consistent with observed records. His talk examined the effect of tropical cyclones on the global energy budget from the perspective of 1) vertical energy exchanges that maintain thermal equilibrium and the Hadley circulation; and 2) poleward energy transport in support of the maintenance of the global energy balance. Holland concluded that tropical cyclones could provide “all the vertical energy flux required to maintain the overall tropical structure, as well as contribute substantially to the poleward energy flux at 30° north and south.” (G. Holland 2009, personal communication) This result has implications for climate modeling, because tropical cyclones are typically not well resolved in coarse-resolution climate models.

A lively and well-attended Earth science session on the second-to-last day was kicked off by Kevin Trenberth from NCAR, who presented his latest work on the SH energy budget. He spoke of observations, model biases, and implications for climate sensitivity by indicating all models have too much incoming solar radiation in the southern oceans, leading to too much heating of the ocean and too little heating in the lower latitudes. That session wrapped up with a controversial presentation by Neville Nicholls of Monash University, dealing with the trends, causes, and effects of drought in southern Australia. Nicholls concluded that although decreased rainfall in southern Australia from March to August reflected increased intensity of the subtropical ridge, the drought could not be ex-

plained by the trend in either the SST around northern Australia, El Niño, or the Indian Ocean dipole. He indicated the trend could be partly explained by variations in the southern annular mode, but he noted that although there were doubts about this, the decline in rainfall could not be ascribed, in any simplistic way, to any increased frequency or intensity of the El Niño–Southern Oscillation phenomenon. His conclusions led to a vigorous debate, and the ensuing animated discussion at the conclusion of Nicholls’s paper went far beyond the posted time of the session and well into the coffee break.

Trevor McDougall from CAWCR outlined work on a new definition of seawater properties. This Thermodynamic Equation of Seawater–2010 (TEOS-10) contains the most accurate equation for density to date and also provides expressions for enthalpy, entropy, and many other thermodynamic properties. His formulation of seawater is cast in terms of a new salinity variable—absolute salinity (SA)—that requires the use of a new algorithm to move from a conductivity-based measure of salinity (practical salinity SP) to SA. The availability of enthalpy, and particularly of potential enthalpy, will enable the “heat content” of the ocean to be more accurately represented in ocean models and will more accurately quantify the climatologically important heat fluxes between the atmosphere, ocean, and ice.

Pene Lefale from the New Zealand Meteorological Service organized a session to highlight ongoing research in the Pacific Islands by scientists in both developed and developing nations across the region. Cheryl Anderson of the University of Hawaii at Manoa presented details of the Pacific Climate Information System (PaCIS), which builds on relationships established from decades of multisector collaborative work in the region to develop “end to end” climate services. Her talk focused on the PaCIS Research and Assessment working group, which recommends 11 projects be undertaken to improve climate knowledge in the islands (for details on the 11 projects, which include reanalysis research and decision making under uncertain conditions, refer to Anderson’s paper at www.bom.gov.au/events/9icshmo/manuscripts/WI100_Anderson.pdf).

John Zillman, chair of the Global Climate Observing System (GCOS) Steering Committee, provided a keynote talk for a session organized by Gary Meyers and sponsored by the Australian Integrated Marine Observing System Program. The

talk reviewed the history of GCOS as well as its recent developments. In particular, there was an emphasis on the implementation of reference observations, both at the surface and in the upper atmosphere, exemplified by the newly evolving GCOS Reference Upper-Air Network (GRUAN) effort. This project is designed to better observe upper-tropospheric and lower-stratospheric water vapor (a key climate forcing agent) to improve climate studies of the upper atmosphere that are currently limited by the use of weather radiosonde equipment.¹

Given the deep concerns over the long-term drought in Australia, a special evening session was organized by the Murray Darling Basin Authority that focused on drought and water resources in the Murray–Darling Basin, which drains one-seventh of Australia and is often termed the country’s breadbasket. Presentations from scientists at the Australian Bureau of Meteorology (BOM), Commonwealth Scientific and Industrial Research Organisation (CSIRO), and NCAR, along with ensuing discussions, explored the factors responsible for the drought, including changes in the intensity and location of the subtropical ridge, recent trends in Pacific and Indian Ocean sea surface temperatures, and climate change. Although the 13 or so years of dry conditions look unusual in the context of the historical climate record, it was clear that more time and further research are necessary to attribute the extent of the cause to either natural climate variability or human-induced climate change.

SPECIAL RECOGNITION. A major highlight of the conference was a special session honoring Professor Julia Nogues-Paegle from the University of Utah for her contributions to SH meteorology over several decades. Her publications on various aspects of South American climate variability (e.g., the South American monsoon, South Atlantic convergence zone, and Pacific South American pattern) are among the best in print and are widely cited. A paper presented by Carolina Vera focused on Dr. Nogues-Paegle’s work on South American climate variability (see www.bom.gov.au/events/9icshmo/manuscripts/TH0830_Paegle.pdf). Dr. Nogues-Paegle was a proponent of the concept of the ICSHMO and was also the very first chair of the AMS Committee on SH Meteorology and Oceanography. She was not able to travel to Melbourne but instead participated via a seamless video link to the University of Utah that

¹ Because of a scheduling conflict, this paper was presented by Howard Diamond of the National Oceanic and Atmospheric Administration’s (NOAA’s) National Climatic Data Center.

enabled her to both see and hear the speakers in the session and to address the conference attendees. This also allowed participation by a number of her students and others at the university.

SPECIAL MIDDAY SEMINAR. With much focus on the losses from the bushfires of 7 February, an impromptu lunchtime panel session involving four Australian climate experts was arranged to explore the weather and climate factors at work on that day. An account of that session is provided by Gallant (2009) and further information is included in the sidebar. During the discussion it was noted how the BOM's forecasts had assisted emergency managers and communities in providing several days advance warning of the extreme event. The Australian Broadcasting Corporation (ABC) national televised evening news show *Lateline* seized the opportunity to interview several scientists about the connection between climate change and such extreme events as the devastating bushfires.

ANOTHER COINCIDENCE. The 9ICSHMO meeting took place at the same time as (and next door to) the Evolution Festival, which was commemorating the 200th anniversary of the birth of Charles Darwin and the 150th anniversary of the publication of his landmark book, *On the Origin of Species*. On the Sunday prior to the start of both the conference and the festival, there was a public lecture entitled "Big Bang to Big Bust!—Evolution from Start to Finish" hosted by Ms. Bernie Hobbs from ABC TV. She interviewed three prominent scientists—Brian Schmidt, Steve Jones, and David Karoly—who in turn guided the audience on a journey from the origins of the universe in the Big Bang through the evolution of life on Earth into a future affected by climate change. This forum provided an excellent opportunity to interact with a large audience outside of the 9ICSHMO and to interface with other academic communities. Information about the panel experts is as follows:

- Brian Schmidt, an astronomer at the Research School of Astronomy and Astrophysics at the Australian National University, who talked about "The Big Bang and the Origins of the Universe."
- Steve Jones, a professor of genetics at the University College London, who spoke on the topic of "Evolution, Past, Present, and Future."
- David Karoly, an Australian Research Council Federation fellow from The University of Melbourne (and a key 9ICSHMO organizer), who addressed "The Challenges of Global Climate Change."

THE FUTURE. Preliminary plans for the 10th ICSHMO meeting in 2012 have been discussed, but a venue for the meeting has not been selected at this time. Possible sites include southern Africa, South America, and the Pacific Islands, and a final selection will likely be made in early 2010. Also, the chair of the AMS SH Committee has now been passed to Professor Chris Reason of the University of Cape Town.

ACKNOWLEDGMENTS. No international conference of this scope can occur without the hard work of the people who served on the Program and Local Organizing Committees (see www.bom.gov.au/events/9icshmo/committees.shtml), the many session chairs as well as the generosity of sponsors. As such, the authors would like to recognize the following organizations for providing the resources that helped facilitate the conference:

- BOM
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- CSIRO
- Meteorological Service of New Zealand, Ltd.
- Murray–Darling Basin Authority
- NOAA's National Climatic Data Center
- U.S. National Science Foundation

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