

SEASONAL DYNAMICAL PREDICTION OF CORAL BLEACHING FOR AUSTRALIA

Claire Spillman* and Oscar Alves
Centre for Australian Weather and Climate Research (CAWCR),
Bureau of Meteorology, Melbourne VIC 3001, Australia

Coral reef systems around the world are subject to increasing pressure due to anthropogenic sources and climate change (Donner et al. 2005). Coral reefs such as the Great Barrier Reef (GBR) and Ningaloo Reef, Australia, are ecosystems of enormous diversity, providing habitats for a huge variety of species, in addition to forming the basis of valuable tourism and fishing industries of great economic importance (Hoegh-Guldberg 1999; Marshall and Johnson 2007). Coral bleaching is a significant threat to the future of the world ocean's coral reefs and steps must be taken to improve management tools to protect these resources of global significance (Hughes et al. 2003).

Sea surface temperature (SST) is now recognised as the primary cause of mass coral bleaching events (Brown 1997; Lesser 2004), with coral mortality appearing to be a function of the magnitude and duration of high temperatures (Hoegh-Guldberg 1999). Major bleaching events in Southern Hemisphere reefs (Pacific and Indian) tend to occur in February-April (summer to early autumn) when SSTs are warmest (Hoegh-Guldberg 1999). Global warming studies predict that bleaching will increase in both frequency and severity, posing a serious and significant threat to the future of the GBR and the world ocean's coral reefs (Donner et al. 2005).

Seasonal forecasting models have the potential to revolutionise the way in which coral bleaching events are monitored and assessed in coral reefs such as the GBR and Ningaloo Reef. Advance warning of potential bleaching events allows for the implementation of management strategies to minimise reef damage months ahead of the event. Timely indications of bleaching sites also enables the relocation of monitoring equipment and collection of data during the prelude to bleaching, increasing current knowledge of reef response and bleaching triggers.

Seasonal SST forecasts from the Bureau of Meteorology seasonal forecast model POAMA address a current deficit in reef management tools (Spillman and Alves, 2008). POAMA (Predictive Ocean Atmosphere Model for Australia) is a global coupled ocean-atmosphere seasonal forecast system developed jointly by the Australian Bureau of Meteorology and CSIRO Division of Marine and Atmospheric Research (CMAR). This is currently the only dynamical prediction system producing SST forecasts for coral bleaching on a seasonal time-scale, incorporating data assimilation, atmospheric conditions and ocean-atmosphere coupling and with the ability to include the influence of climate change (Spillman and Alves, 2008).

Forecasts are produced operationally in real-time by the Bureau of Meteorology. Spatial maps of monthly ensemble mean SST anomalies for the GBR region are produced for up to 5 months lead-time and updated daily on the POAMA website (<http://poama.bom.gov.au>). Additionally, forecasts of the GBR Index, the areal average of monthly SST anomalies within the GBR region, are also generated. This index provides a useful summary of SST anomalies for the GBR region, and a potential indicator as to the likelihood of coral bleaching occurring. Forecasts have useful skill up to 3 months into the future though predictability studies suggest higher skill is possible (Spillman and Alves, 2008).

Additional products also include Coral HotSpots and Degree Heating Week Index (DHW). These products were originally developed as now-casts by the US National Ocean Atmosphere Administration (NOAA) using satellite data (Strong et al. 1997). The Coral Hotspots product indicates areas with temperatures that are above the maximum long term average SST value at that location. The DHW is the accumulation of HotSpot values over a period of 12 weeks, giving an indication of length of exposure to such conditions, and has been highly successful in predicting major bleaching events (Liu et al. 2003). We have reconstructed these two products using POAMA and so can now supply reef managers with forecasts of these quantities on a seasonal time-

* *Corresponding author address:* Claire Spillman,
Centre for Australian Weather and Climate Research
(CAWCR), Bureau of Meteorology, GPO Box 1289,
Melbourne VIC 3001, Australia; email:
c.spillman@bom.gov.au

scale, the most practical time frame most useful for management. Initial results appear promising.

This study is believed to be the first attempt to dynamically forecast sea surface temperatures on seasonal timescales in a reef system with the view for future application in coral bleaching management. Accurate seasonal SST forecasts for the Australian region will be an invaluable tool for the future management and conservation of our reefs.

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ADDITIONAL MATERIAL

Spillman and Alves (2008) provide further information on this study and is available online or by emailing the primary author. Real-time forecasts and model hindcast set can be accessed on the POAMA website: <http://poama.bom.gov.au>.