CLIMATE MODES AND THE INTERPRETATION OF MULTI-DECADAL CLIMATE VARIABILITY IN THE WESTERN PACIFIC SECTOR FROM ANTARCTIC ICE CORES

Goodwin, I. D.

Climate Risk CoRE and Departmen of Physical Geography, Macquarie University, 2109 NSW Australia E-mail: Ian.Goodwin@mq.edu.au

New high resolution (monthly to annual) paleoclimate time series deduced from Antarctic ice core and south-west Pacific coral chemistry, together with multi-decadal coastline evolution in NSW and south-east Queensland, Australia (Goodwin et al., 2006), indicate that the climate variability of the past 1500 years in the western Pacific sector is defined by multi-decadal to centennial behaviour of the major climate modes: the extratropical Southern Annular Mode (SAM); the Pacific-South American mode (PSA); the Interdecadal Pacific Oscillation (IPO); and the El-Nino-Southern Oscillation (ENSO). The paleoclimate time series describe the climate system response to solar and volcanic forcing, and internal dynamics. A 700 year (1300-1995 AD), winter mid-latitude MSLP and SAM time series for the Australian and New Zealand sector has been reconstructed from the sea-salt sodium (Na) ion concentration in ice cores from Law Dome (DSS), 66° 46' S, 112° 48' E, circum-Antarctic station MSLP observations, NCEP/NCAR Reanalysis (NNR) MSLP, and wind field data (Goodwin et al., 2004). More recent work has shown that the Law Dome proxy MSLP time series records the variance in the pressure and windfield anomalies in the Australian and New Zealand sector that are associated with the propagating PSA modes (South Pacific wave train from the Australian to Antarctic Peninsula regions) in addition to the SAM variability in the Australian and New Zealand sector. The Siple Dome (West Antarctic) sea-salt sodium (Na) time series (Mayewski et al., 2004) records the variance in the pressure and wind fields in the Amundsen Sea region (Kreutz et al., 2000) which is principally associated with the propagating PSA modes. Hence, the Siple Dome Na time series spanning 0 AD to 1994 AD is also used to reconstruct the propagating PSA modes, and the SAM in the south-west Pacific sector, and has been applied to reconstruct the multidecadal resolution Tasman Sea mean wind field and wave direction over the past 1500 years, following the methods in Goodwin (2005).

At a multidecadal to centennial time scale the extratropical circulation has experienced shifts in mean state. From 600 to 1000 AD the circulation was shifted towards the PSA2 +ve mode. High amplitude climate variability occurred from 1000 and 1500 AD accompanied by a shift in mean state towards the meridional PSA 1 +ve (PSA 2 –ve) and –ve SAM modes. From 1500 to 1700 AD the circulation transitioned to reduced amplitude climate variability and a shift in mean state to the opposite more zonal phases +ve SAM and PSA 1 -ve and PSA 2 +ve modes. Since 1800 the circulation returned to high amplitude climate variability towards the meridional –ve SAM and PSA 1 +ve and PSA 2 +ve circulations. This interpretation highlights the non-stationarity of the spatial teleconnection patterns and the resulting variance in the phase, coupling and synchronization of the propagating tropical climate modes together with the polar annular mode. The oscillating statistical relationship between correlated and anti-correlated Na concentration anomalies at DSS and SD can be interpreted as evidence for climate fluctuations between

synchronized to coupled circulation with phase lag on 30-40 year cycles (as hypothesized by Tsonis et al., 2007).

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