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HadCM3 Simulations of ENSO behaviour during the Mid-Pliocene Warm Period

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It has been suggested that a permanent El Niño state existed during the mid-Pliocene (ca. 3.3 – 3.0 Ma BP), with a west-to-east temperature gradient in the tropical Pacific considerably weaker than today. This is based upon a number of palaeoceanographic studies which have examined the development of the thermocline and SST gradient in the tropical Pacific over the last five million years. This state is now being referred to as El Padre in recognition of the fact that a mean state warming in EEP SSTs does not necessarily imply the presence of a permanent El Niño.

Recent results from mid-Pliocene coupled ocean-atmosphere model simulations have shown clear ENSO variability whilst maintaining the warming in the EEP. This research expands on this study, using the UK Met Office GCM (HadCM3), to examine the behaviour and characteristics of ENSO in two mid-Pliocene simulations (with an open and closed Central American Seaway, CAS) compared with a control pre-industrial run, as well as produce a detailed profile of the mean state climates.

The results shown include timescales of ENSO variability across four regions in the Pacific, as well as frequency, EOF and wavelet analysis. We have also looked at the interaction of ENSO with the annual cycle and the onset of ENSO events, and the interdecadal variability in the simulations.

The initial timeseries produced have shown a greater variability of ENSO during the closed CAS mid-Pliocene simulation where the system oscillates between events much more frequently than seen in the pre-industrial run. The EOF and wavelet analyses quantify this behaviour, showing that the variability is approximately 15% higher over the central and eastern equatorial Pacific, with a period of oscillation of 2-5 years compared with 4-8 years for the pre-industrial simulation. These results will be compared with those obtained from the second mid-Pliocene simulation (open CAS).