Evaluating mid-Holocene precipitation over Australasia and the Maritime Continent in climate models

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1: Introduction

- The Australasian INTIMATE project was undertaken to develop a consistent chronological assessment of the climate of the past 30,000 years over Australia, New Zealand and the Maritime Continent.
- Little use of this comprehensive resource for evaluating the available climate model data so far.
- Poster presents the initial assessment of model simulations of the mid-Holocene over the Australasian and Maritime Continents (from the Paleoclimate Modelling Intercomparison Project, PMIP2 and 3).
- Focus on Southern Hemisphere (SH) warm season (Oct.-Mar.).
- Two modeling studies\textsuperscript{1,2} suggest the Australian monsoon was weaker at 6 ka but only accounted for Dec.-Feb. rainfall or included PMIP1 (prescribed sea surface temperatures) simulations in the ensemble mean\textsuperscript{2}, which bias results.
- This poster takes account of the whole monsoon period (Oct.-Mar.) and only simulations with dynamical oceans (PMIP2 and 3).
- Re-evaluate the changes in precipitation, given that SH insolation was higher in the early monsoon period (Sep.-Nov.) and lower later (Jan.-Mar.)—Fig 1.

2: October to March

- Reduction in insolation by 5-10 Wm\textsuperscript{-2} over Australia and >10 Wm\textsuperscript{-2} over Borneo and Papua New Guinea (PNG) (Fig 2).
- Weak cooling (0.0-0.3 K) over each land mass with <80% model agreement (Fig 3a, white stippling).
- Weak drying over land masses (1-3% reduction in precipitation) and weak model agreement. (Fig 3b, c).
- Some evidence of more southeasterly flow over Australia, consistent with drying (Fig 3d).
- Reduced precipitation (total and convective) over Borneo and PNG where insolation is reduced (Figs 2 and 3b,c).
- Overall, weak change in precipitation implies the full monsoon season (i.e. Oct.-Mar.) similar in strength to present over northern Australia.
- Changes not as strong as those of an earlier study\textsuperscript{2}, which only focused on Dec.-Feb.
- Also evidence of weaker westerlies in the mid-latitudes to the south of Australia (Fig 3d).

3: JFM

- 0-10 Wm\textsuperscript{-2} higher insolation over Australia (Fig 4).
- Hotter land surface (Fig 5a).
- More precipitation (Fig 5b), particularly convective (Fig 5c).
- Stronger onshore flow (Fig 5d), higher moisture transport.
- Strong agreement in TS, PR and PRC (>80% models).

4: JFM

- Insolation reduced by ~20 Wm\textsuperscript{-2} (Fig 6).
- Colder surface temperatures (Fig 7a).
- Reduced total and convective precipitation (Fig 7b,c).
- Anomalous anticyclone (divergence) over Aus. (Fig 7d).
- Strong model agreement for all fields (>80% models).

5: AUS-INTIMATE assessment

- Evidence of increased coastal dune activity in northern Australia around 6 ka suggests slightly drier conditions but may be due to a sea-level maximum at this time\textsuperscript{3}.
- Weaker mid-latitude westerlies implied from drier conditions over Western Tasmania and SW Victoria\textsuperscript{4,5}.
- Speleothem records indicate reduced precipitation in the Kimberley and Borneo, although wetter in Flores\textsuperscript{6,7,8}.
- Thermal maximum of Indo-Pacific Warm Pool and offshore southern Australia\textsuperscript{9,10,11}.
- Peak in east coast and Lake Eyre Basin fluvial discharge and stabilisation of interior dunes\textsuperscript{12,13}.
- Increase in biomass burning in the N temperate zone, but decreased burning in S Australia (including Tas.)\textsuperscript{14}.

6: Conclusions

- Models suggest that monsoon rainfall was higher in OND and lower in JFM at 6 ka relative to 0 ka.
- Overall Australian monsoon precipitation (Oct.-Mar.) only slightly lower than at present in the 6 ka simulations.
- Response of simulated convection to insolation driven TS changes over land (Australia, Borneo, PNG) suggests strong direct thermal response of the land.
- Model convection too sensitive to TS? Possibly.
- Results show the importance of considering the whole monsoon season (Oct.-Mar.) and not just DJF\textsuperscript{4}.
- Model results generally supported by the proxy records; however, resolving differences in timing of peak strength of the monsoon is currently beyond the proxy capabilities.