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Climate of the Past Discussions

Interactive comment on "Using synoptic type analysis to understand New Zealand climate during the Mid-Holocene" *by* D. Ackerley et al.

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Review of Ackerley et al. Using synoptic type analysis to understand New Zealand climate during the Mid-Holocene. CPD

Reviewer: Rewi Newnham, 8/6/11

General Comments

This paper presents a way of tackling the important problem of applying low spatial resolution GCM outputs to regions with complex topography and circulation. It presents an analysis of synoptic weather patterns determined for the mid-Holocene (MH) in New Zealand from a set of 4 GCMs and compares these simulations with corresponding paleoclimate proxy data. The model-proxy comparisons demonstrate that this approach

works well for the New Zealand region, due presumably to its strong regional differentiation of climate, which is now well understood, and a reasonably coherent picture of mid-Holocene climate change reconstructed from proxy records. The results give new and useful insights into the seasonal-scale climate changes of the mid-Holocene in New Zealand and the approach will be of wider interest where similar problems with model-proxy comparisons persist. I anticipate many readers will look forward to a similar approach being applied in other regions and at other time slices.

Specific Comments (and suggestions)

1. The analysis of synoptic weather types for the MH is presented on a seasonal basis and so it would be helpful to know how the 12 synoptic 'weather types' varied seasonally in the original Kidson analysis and hence in the modern climate. Table 1 presents the seasonal frequency of occurrence of trough, zonal and blocking regimes determined from the models for both the MH and a pre-industrial (PI) control. A strong match between the PI seasonal synoptic frequency data and the seasonal frequency of synoptic weather observed in the modern climate would strengthen confidence in the models' ability to faithfully reconstruct MH patterns.

2. The detailed description of model parameters presented in Sections 2.1 to 2.4 would be more effective as a table. This would enable a more systematic and accessible comparison across the models. On a related note, there is no attempt to relate differences between model outputs to differences in these model parameters. An implicit assumption is that coherency between models implies confidence in the results. Presumably the reverse also applies as well, unless differences can be explained in terms of different model parameters such as GHG input or spatial resolution. Also, please specify what 'orbital parameters' were used in the models (in particular was regional insolation input on a seasonal basis)

3. I would like to see a stronger and more coherent argument that the principal MH-PI climate differences can be attributed to changes in synoptic weather patterns reflecting

changing atmospheric circulation (as strongly implied by paragraph 2 of the Abstract) rather than changes in seasonal insolation forcing. Beyond the Abstract, there is some ambiguity in the relative emphasis given these two factors (which may be linked of course). For example, p1317, para 2 states that "Overall, it seems likely that the seasonal insolation changes may have had a larger influence on surface air temperature than the changes in the synoptic regimes" and the next sentence suggests that the synoptic regimes were a secondary factor cf insolation changes. These statements seem at odds with the Abstract and the conclusions (in particular top of p1322) that attribute temperature changes inferred from proxy records to circulation changes alone.

Later (on p1322, para 3), it is suggested that although the model outputs show "no evidence of an overall shift to cooler temperatures" (as can be inferred from the proxy records) this might be at least in part explained by the difference in Earth's orbital parameters during the MH, in particular towards lower insolation during the growing season. But if orbital parameters were included in the models (see previous point) then why haven't the cooler overall temperatures been simulated? Previous Holocene climate reconstructions from NZ proxy data (principally by McGlone (1988; McGlone et al., 1993) have emphasised the link with precession-led changes in regional insolation which resulted in more moderate seasonality (cooler summers, warmer winters) in the early Holocene cf the late Holocene (warmer summers, cooler winters). New Zealand Holocene pollen records in particular are consistent with cooler summers in the MH (cf today) and/or a shorter growing season. It seems to me more likely that the temperature changes implied by the proxy data, if not the models (except in spring and summer), are most likely linked to seasonal insolation changes while the precipitation changes implied by proxy data and models are linked to circulation (and synoptic weather) changes. Perhaps this is what the authors think as well: if so, it is not clear in the current version.

4. P1316, para 2 states that "The higher incidence of trough events in MAM during the Mid-Holocene causes an increase in surface air temperature throughout the North

Island (particularly in the east)...". This statement needs to be reconciled with that on p1305 (para 2) that states that trough regimes are associated with below-normal temperatures (implied throughout NZ).

5. P1318, S4.2. The definitive paper on Ascarina and mid-Holocene climate reconstruction is still McGlone & Moar, 1977; The Ascarina decline and post-glacial climatic change. NZ J Bot 15: 485-9. As the MH Ascarina decline is pivotal proxy evidence in this discussion, that paper should be cited.

Technical Corrections

P1311. L21, 'representataion' P1317, L9, 'throught' P 1318, lines 20-23 concerning environmental shifts between 7.5 and 3 ka. Should clarify that the authors cited were referring to shifts from the early Holocene to this period whereas elsewhere in this paper the term shift or change is implied to mean shift or change from the present. P1319, L 24: a circulation occurred – circulation shift? P1321, L10, I would suggest patterns between the 4 GCMs are mostly coherent. P1321, L14, 'much colder SI temps in MAM'? Colder, yes, but only by up to 0.2 oC in the alpine regions or extreme south; elsewhere <= 0.1 oC. P1322, L7, With reference to point 3 above (Specific Comments) I suggest insolation changes should be added as a causal factor (if not primary) in lower temperatures.

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