Solar and volcanic forcing of the Southern Hemisphere climate over the past 1500 years

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- 2 The role of external forcings
- 3 Potential seasonal and geographical biases



### Solar and volcanic forcing over the past 1500 years



Conclusions

# Reconstructions and climate model simulations

- Hemispheric-mean temperature reconstructions (Mann et al., 2008)
  - Global network of 1209 annually- and decadally-resolved proxies
  - Decadal temperature for 300–2006 CE (NH) and 400–2006 CE (SH)
- The CSIRO Mk3L climate system model (Phipps et al., 2011, 2012)
  - Atmosphere-land-sea ice-ocean general circulation model
  - 10,000-year pre-industrial control simulation
  - Multiple transient simulations using three-member ensembles

Ensemble	Years (CE)	Forcing(s)
0	1–2000	Orbital (Berger, 1978)
OG	1-2000	O + GHGs (MacFarling Meure et al., 2006)
OGS	1-2000	OG + solar irradiance (Steinhilber et al., 2009)
OGSV	501-2000	OGS + volcanic aerosols (Gao et al., 2008)
OGSV-CEA	801-2000	OGS + volcanic aerosols (Crowley et al., 2008)









# RMS errors in model simulations (801–2000 CE)



# Distribution and composition of the proxy network



### Orbitally-driven changes in insolation



### Differences in simulated temperature: ensemble OGSV



### RMS errors in simulations: growing season/extratropics



# Conclusions

- We find evidence of solar and volcanic influences on the SH climate over the past 1500 years.
- This conclusion is robust with respect to potential seasonal and geographical biases in the response of a multi-proxy network.
- The results for the NH are more ambiguous, but suggest that orbital forcing is the dominant driver of growing season temperatures.
- We propose two future research priorities:
  - Developing better reconstructions of past climatic forcings, particularly volcanic eruptions.
  - Developing alternative approaches to palaeoclimate data-model comparison, particularly forward modelling and data assimilation.

**Reference:** Phipps, McGregor, Gergis, Gallant, Neukom, Stevenson, Ackerley, Brown, Fischer and van Ommen, Paleoclimate data-model comparison and the role of climate forcings over the past 1500 years, *Journal of Climate*, in revision.