The role of modelling in the last 2ka

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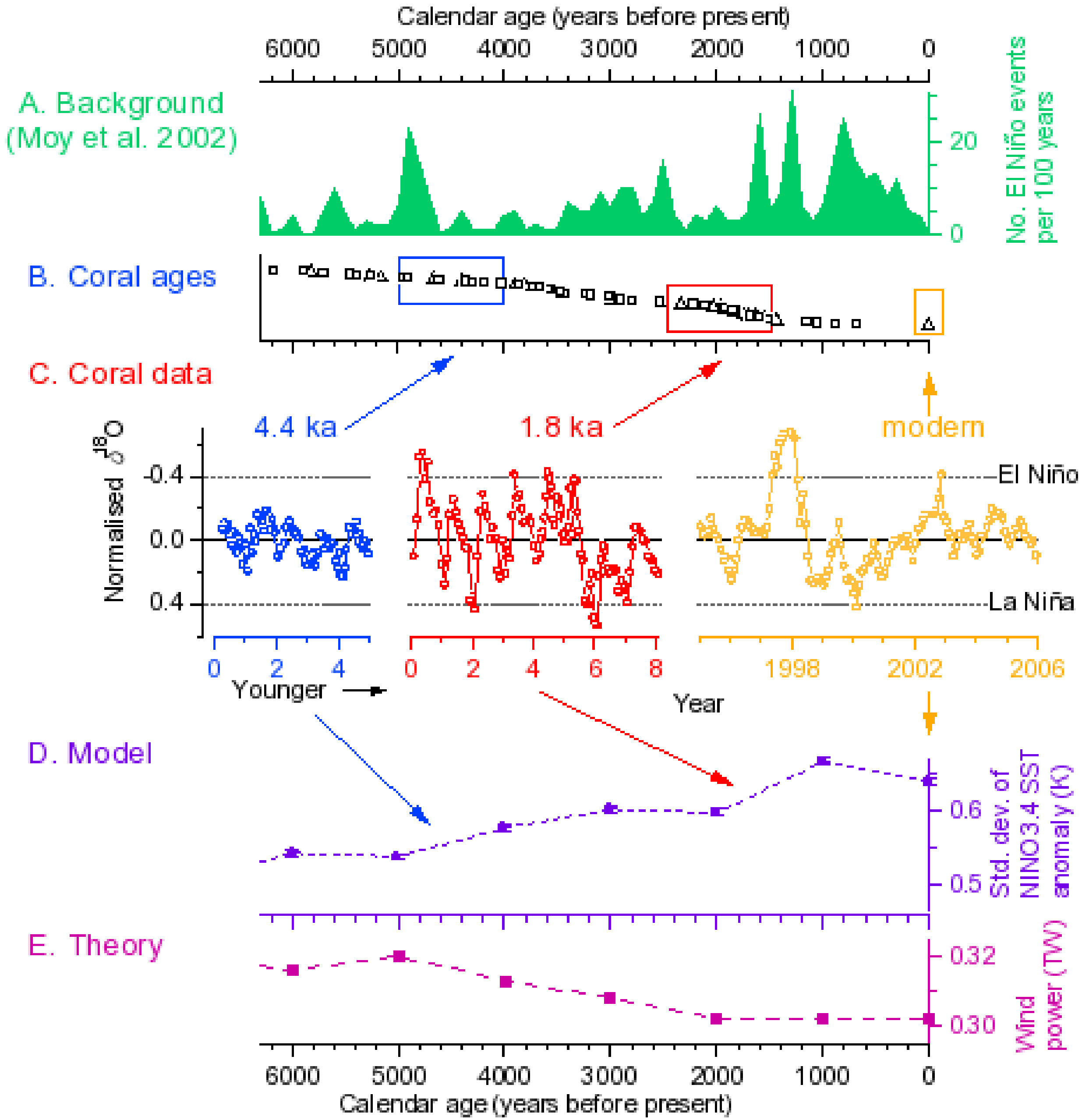
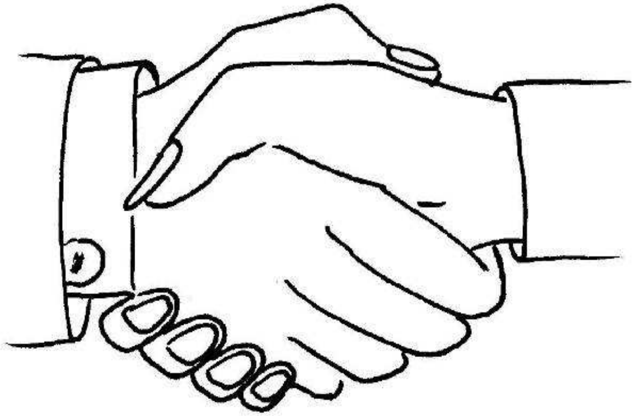
Data-model integration: a win-win situation

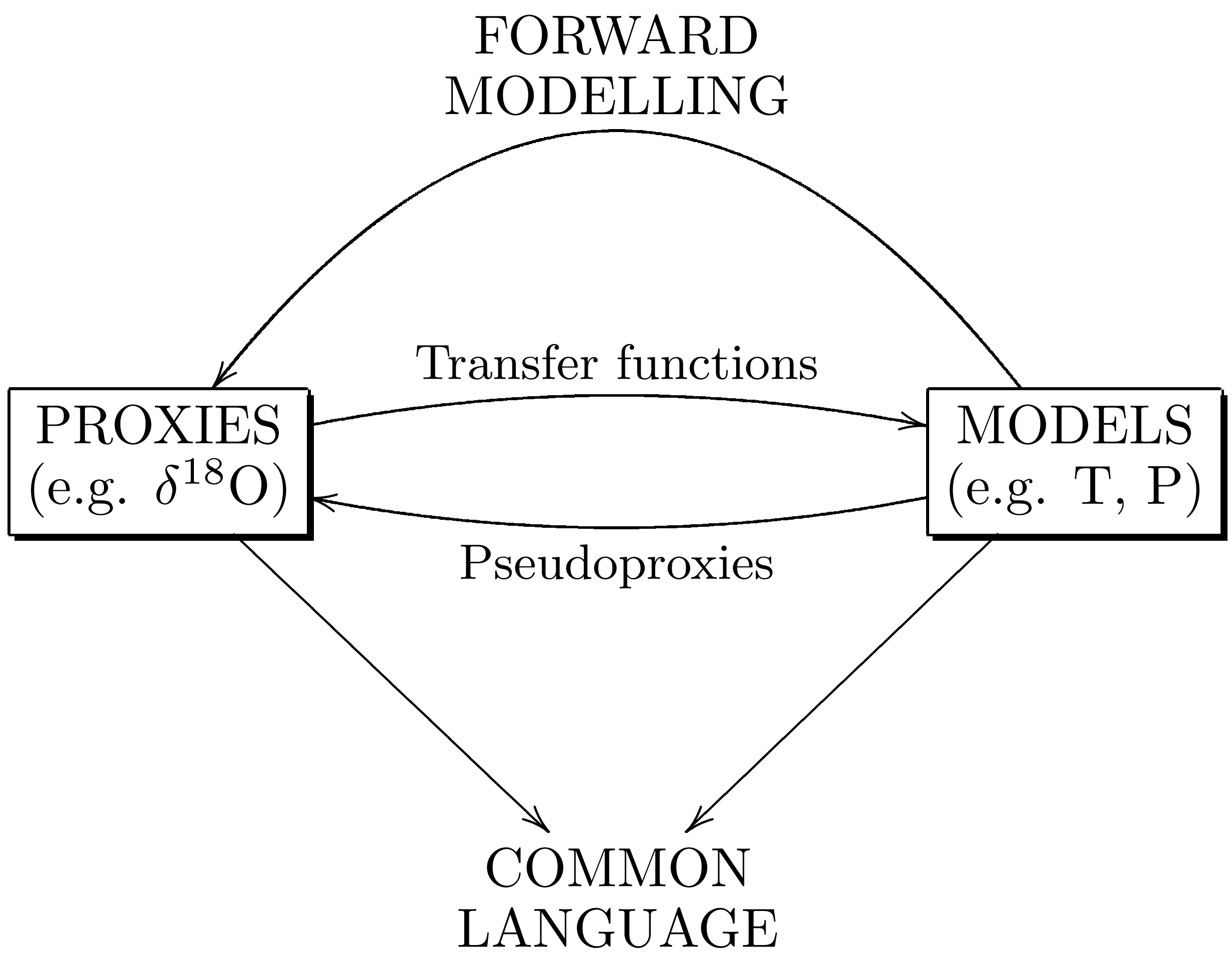


- Data-model integration is a two-way process
- The data constrains the model simulations
- The models provide a dynamical framework within which to interpret the data

The “handshake” question

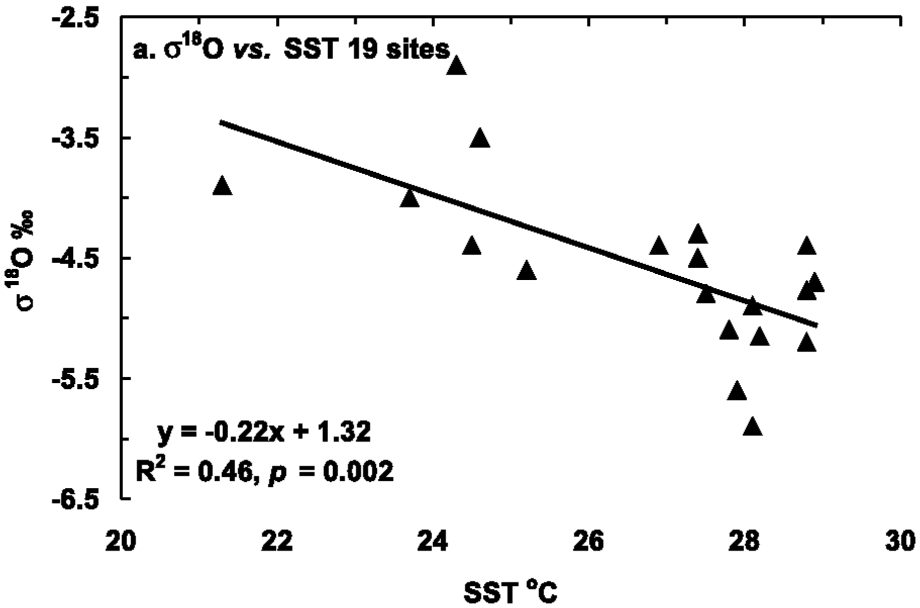


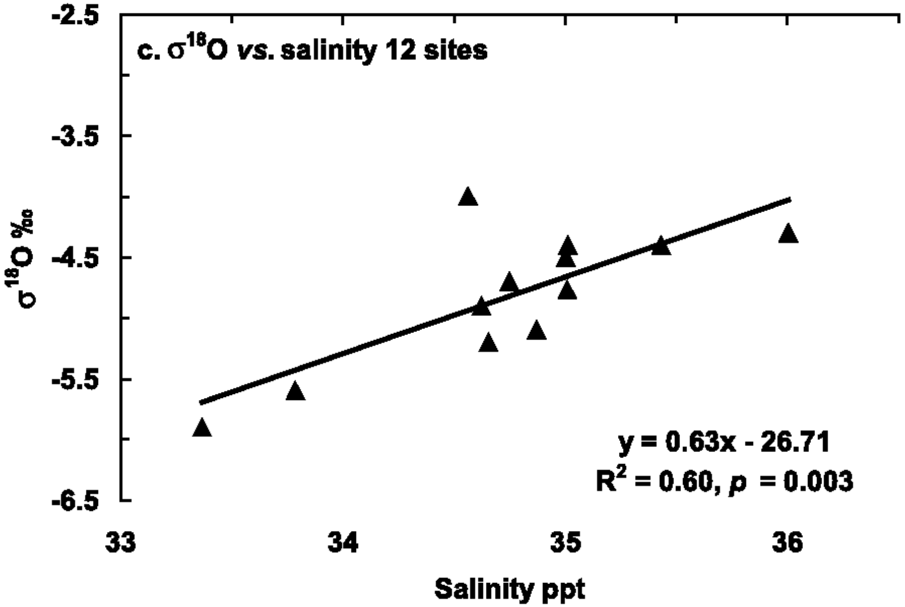
So how exactly do we shake hands *quantitatively*?



Phipps et al. (in prep.), *J. Climate*

Transfer functions and pseudoproxies



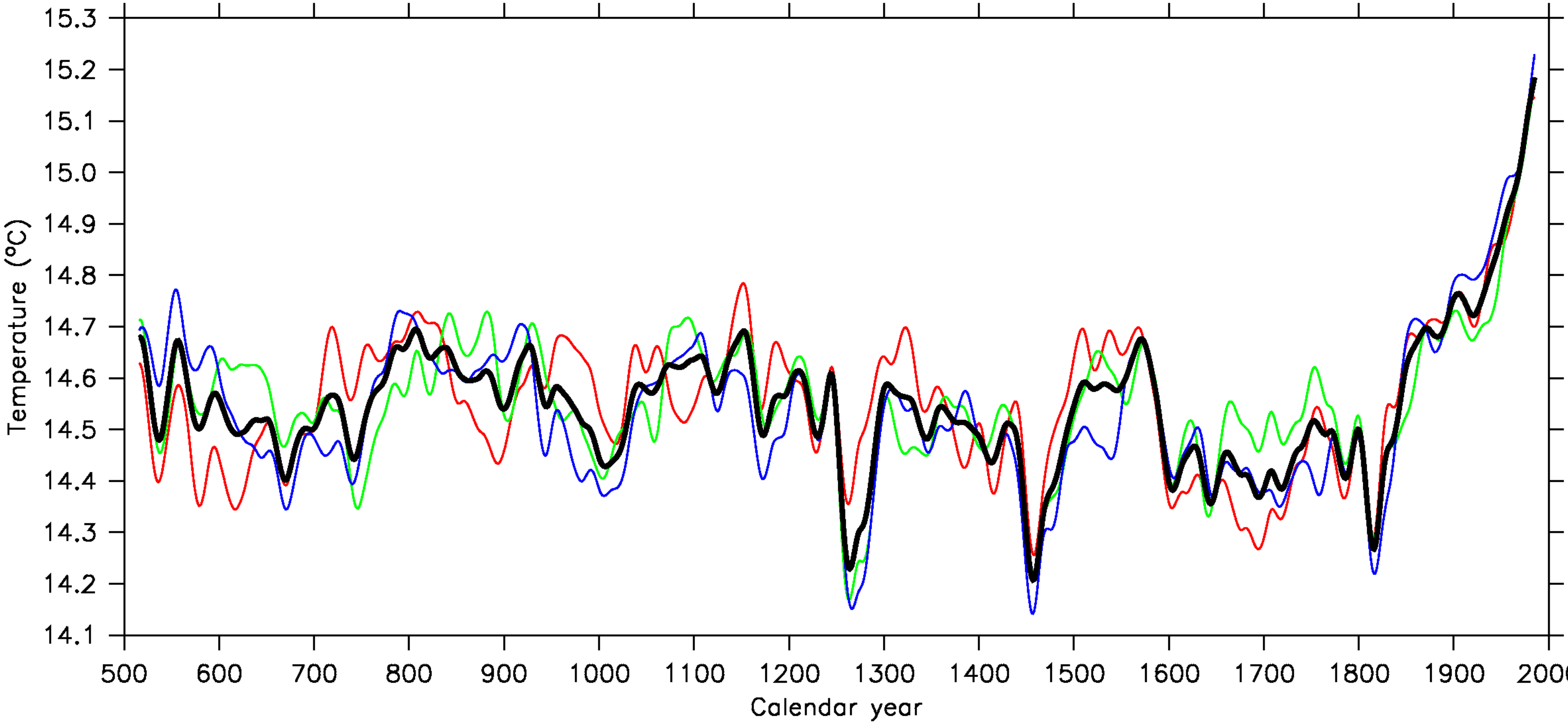


Lough (2002), *Palaeogeogr. Palaeocl.*

- Both involve some form of regression
- Arguably the best tools that we have at our disposal currently
- Mappings generally do not exist between single variables
- Involve the assumption of stationarity
- Models can be used to test this assumption

Climate model simulations of the past 1500 years

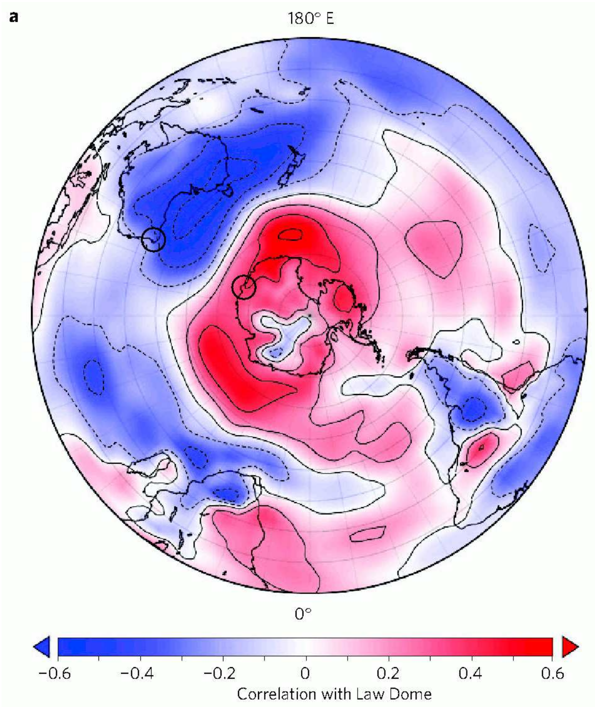
- The CSIRO Mk3L climate system model (Phipps et al., 2011)
- Three transient simulations of the past 1500 years
- Orbital, greenhouse gas, solar and volcanic forcing

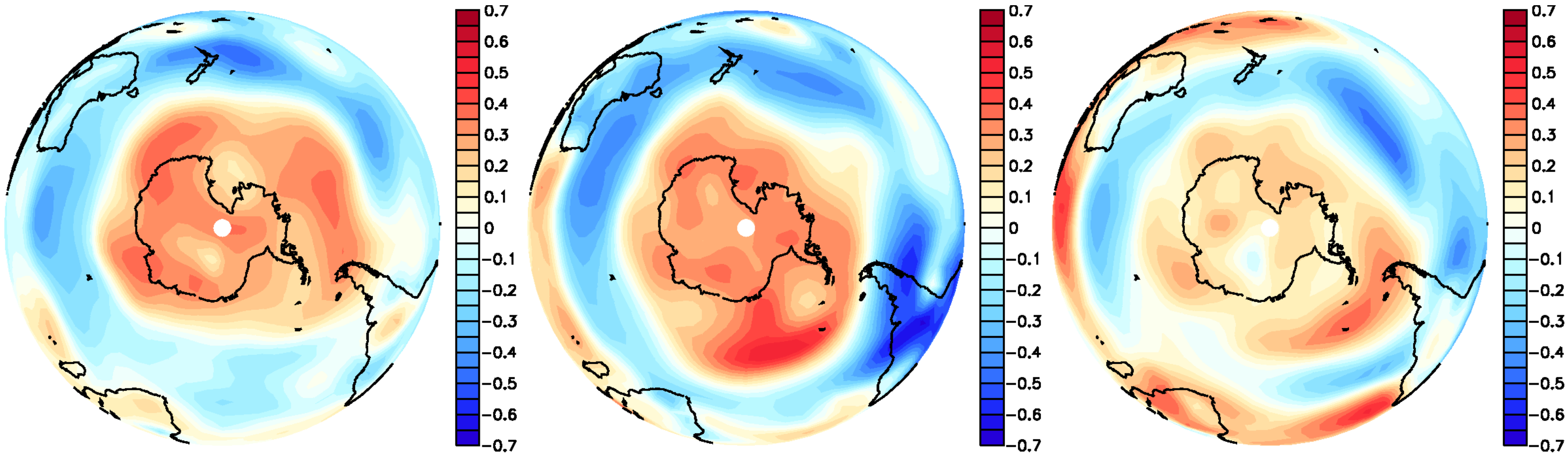


Mean Northern Hemisphere surface air temperature

Correlation of MSLP with Law Dome precipitation (1979–2004)

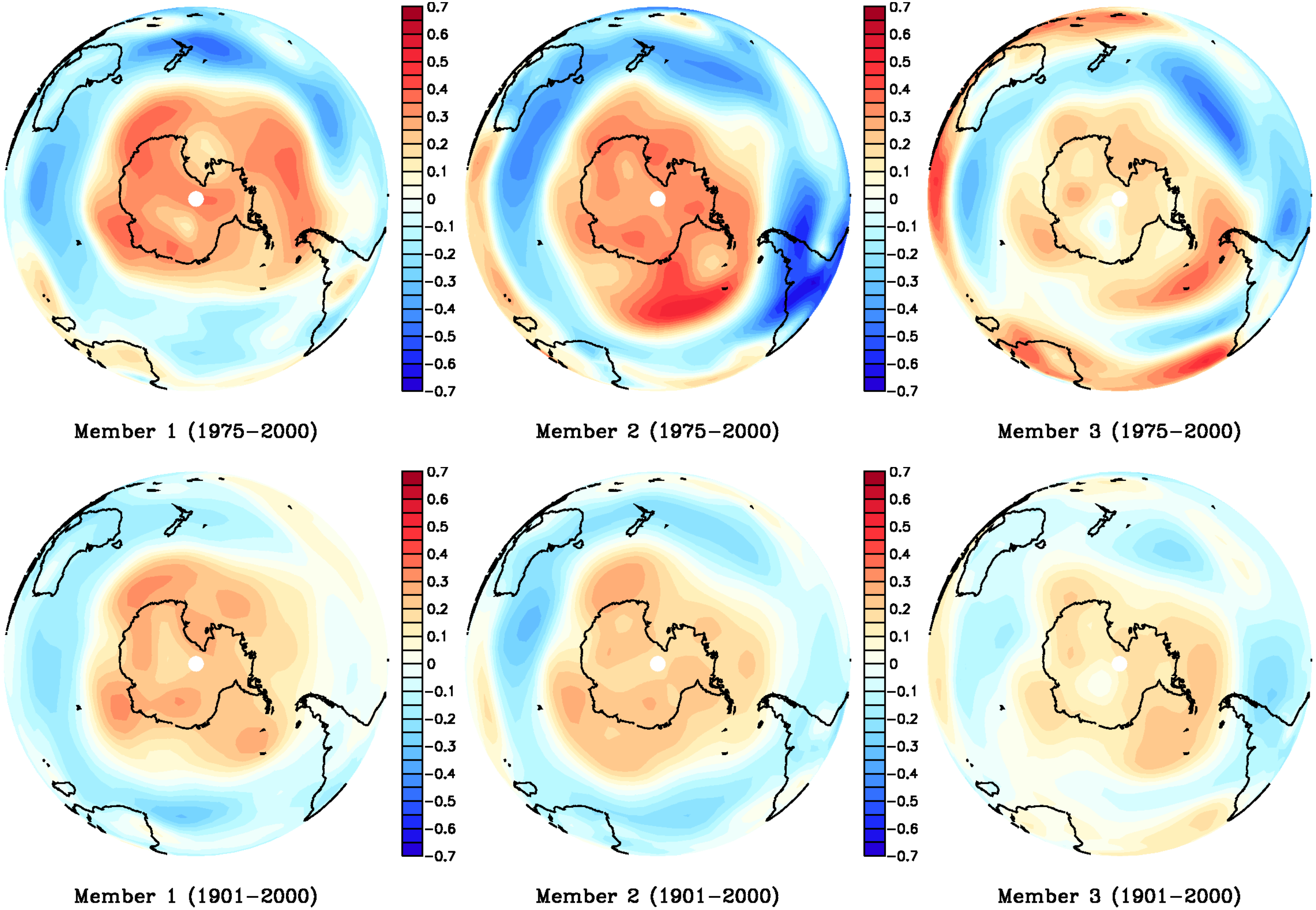
van Ommen and Morgan (2010), *Nat. Geosci.*



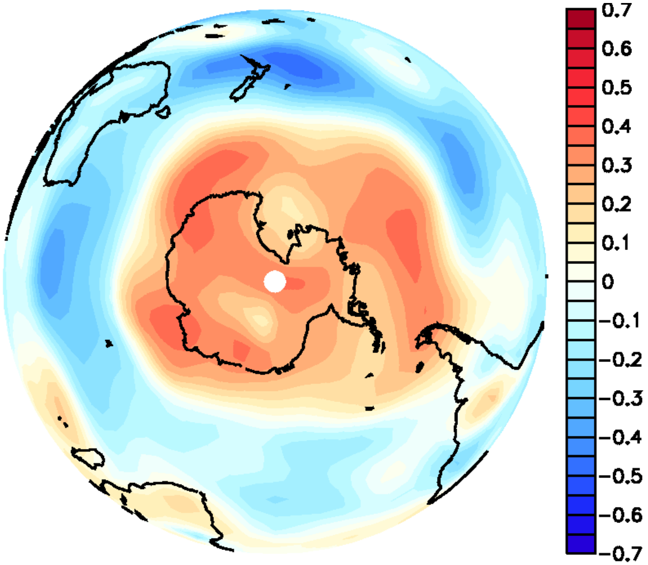


Member 1 (1975–2000) Member 2 (1975–2000) Member 3 (1975–2000)

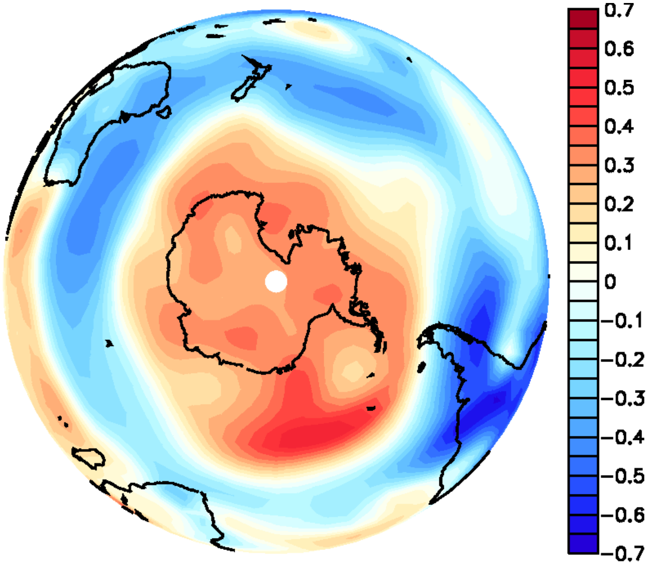
Relationship is consistent over the 20th century ...



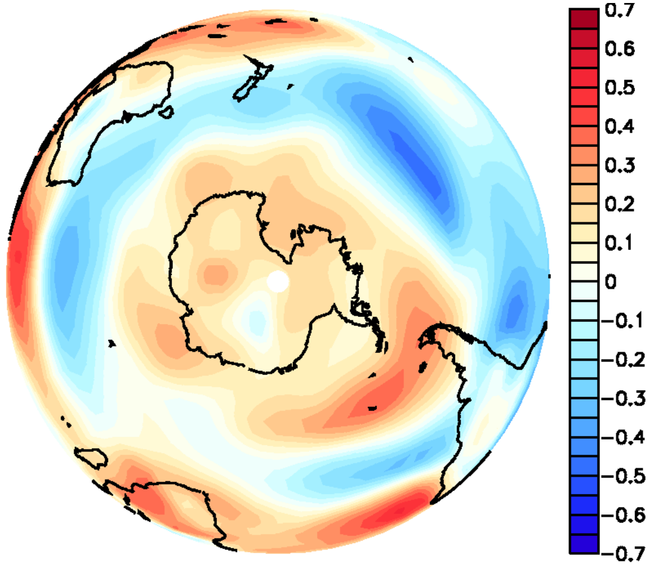
... and the full 1500 years



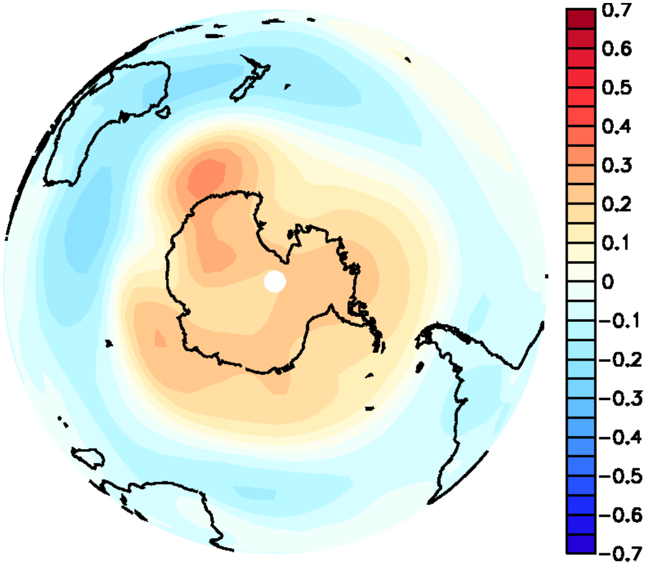
Member 1 (1975–2000)



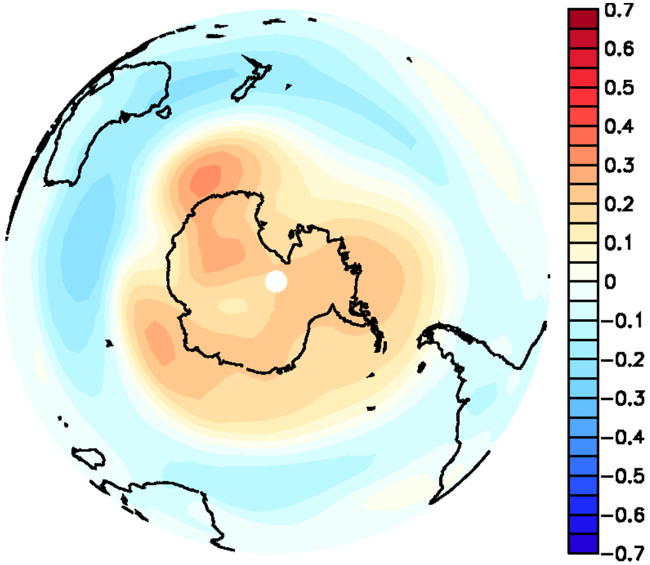
Member 2 (1975–2000)



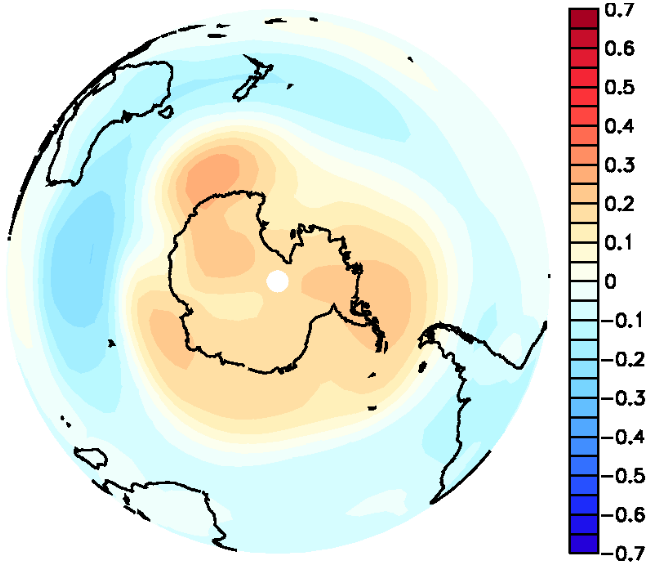
Member 3 (1975–2000)



Member 1 (501–2000)

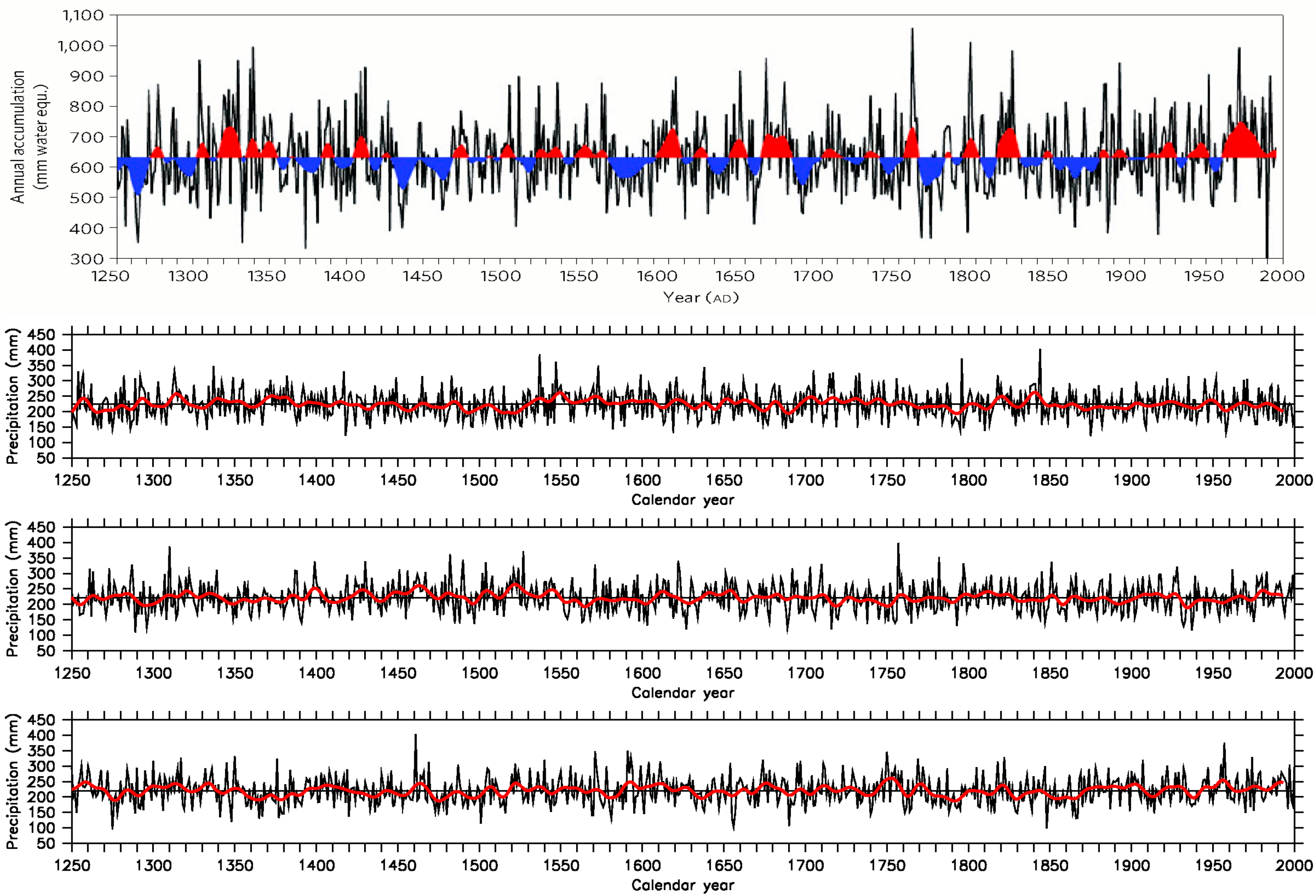


Member 2 (501–2000)



Member 3 (501–2000)

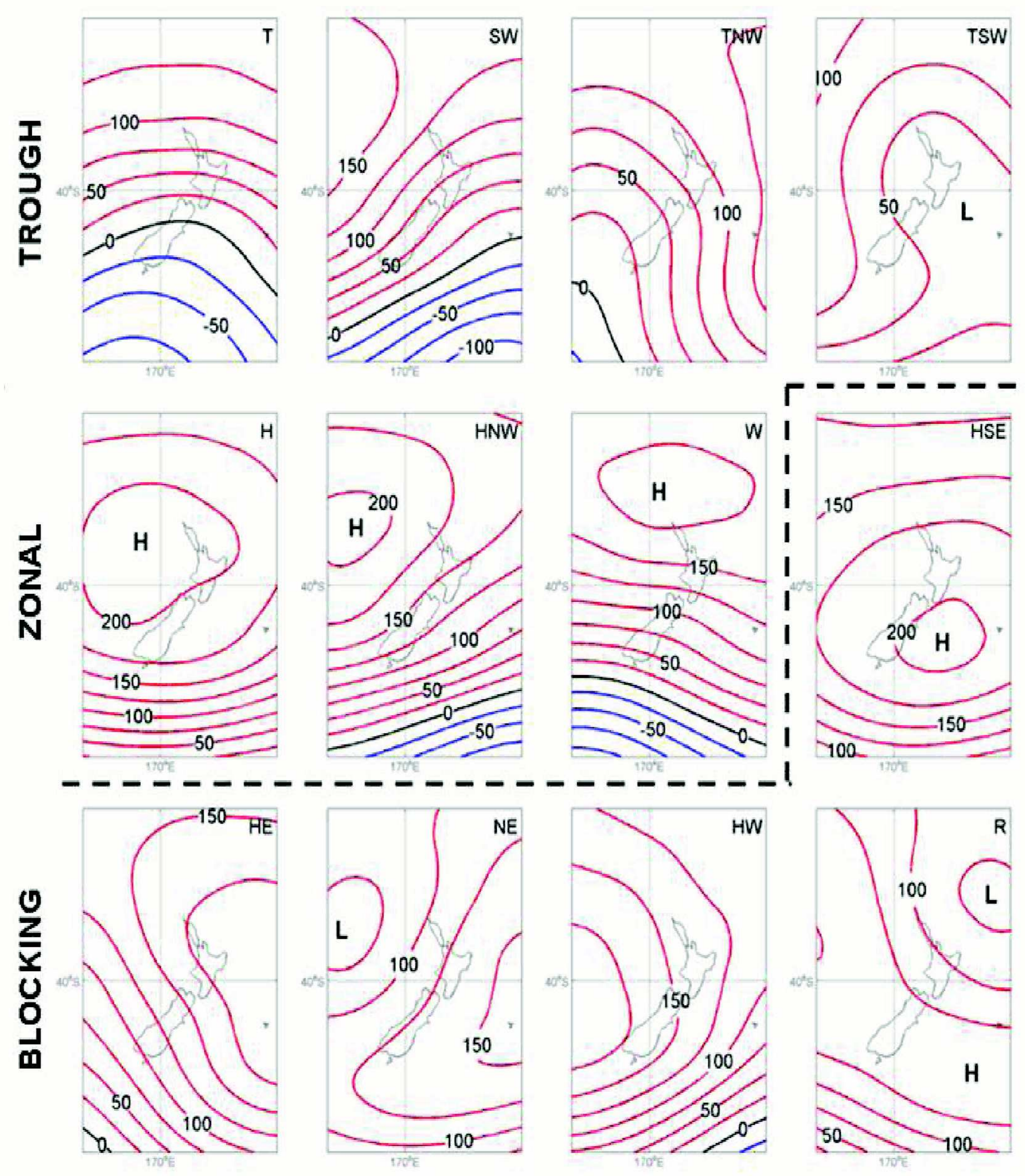
Annual precipitation at Law Dome



Common language

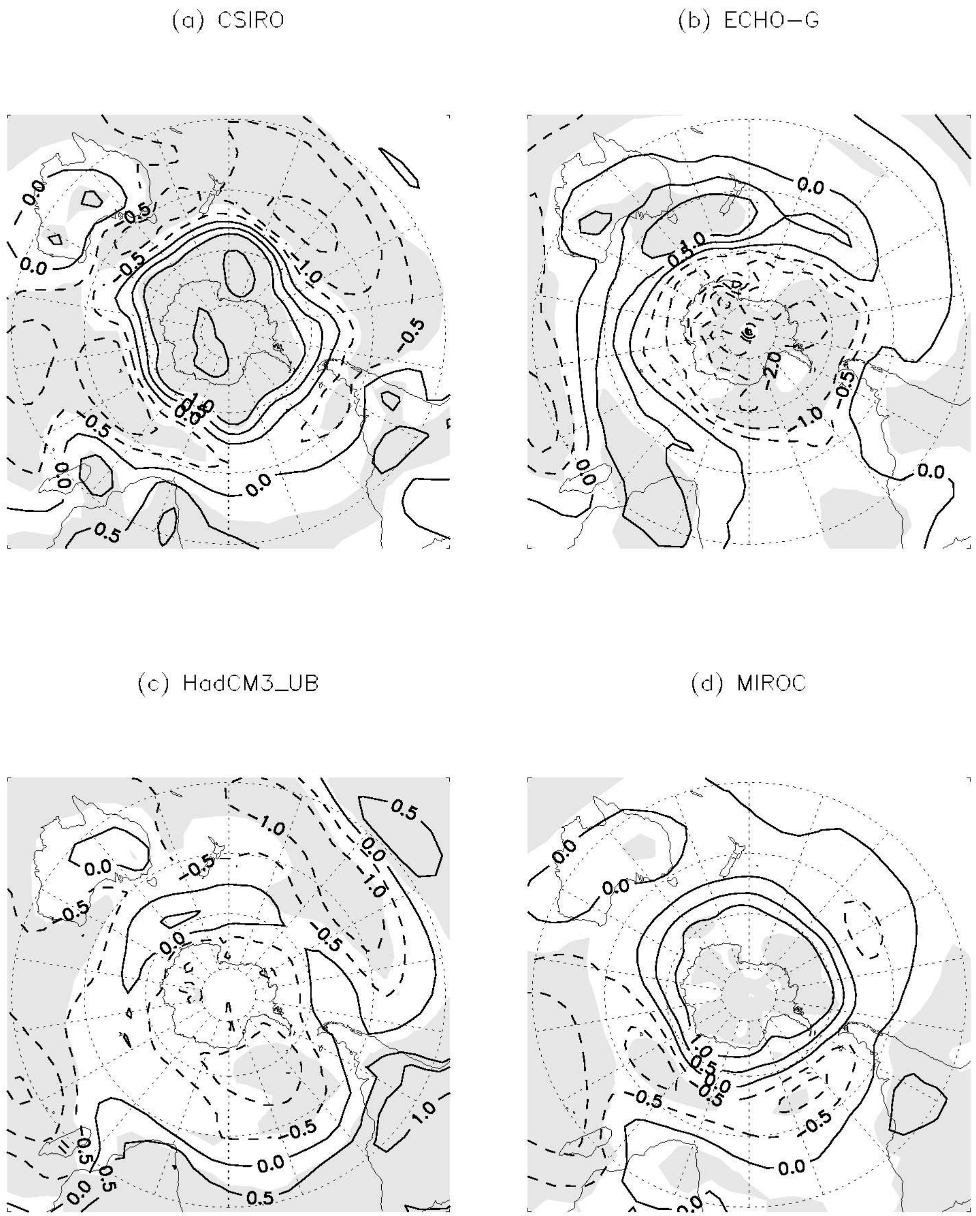
- Dynamically-based language, independent of both data and models
- Informed by understanding of climate dynamics
- Defines a dynamical vocabulary onto which data and models can be mapped
- Allows more general mappings than transfer functions/pseudoproxies
- Still involves the assumption of stationarity

Example: Kidson weather types



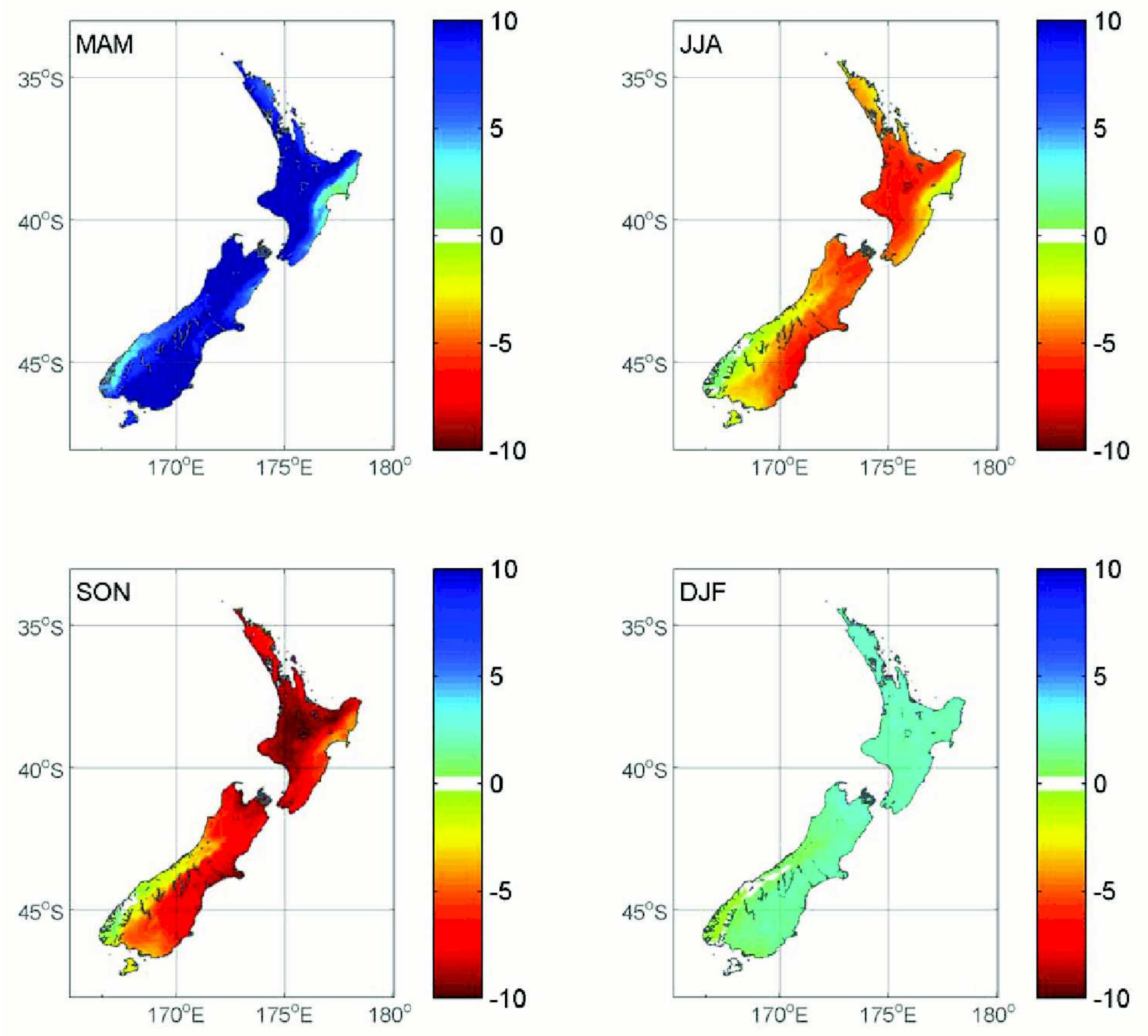
Ackerley et al. (2011), *Clim. Past Discuss.*

DJF MSLP anomalies (6 ka minus 0 ka, hPa)



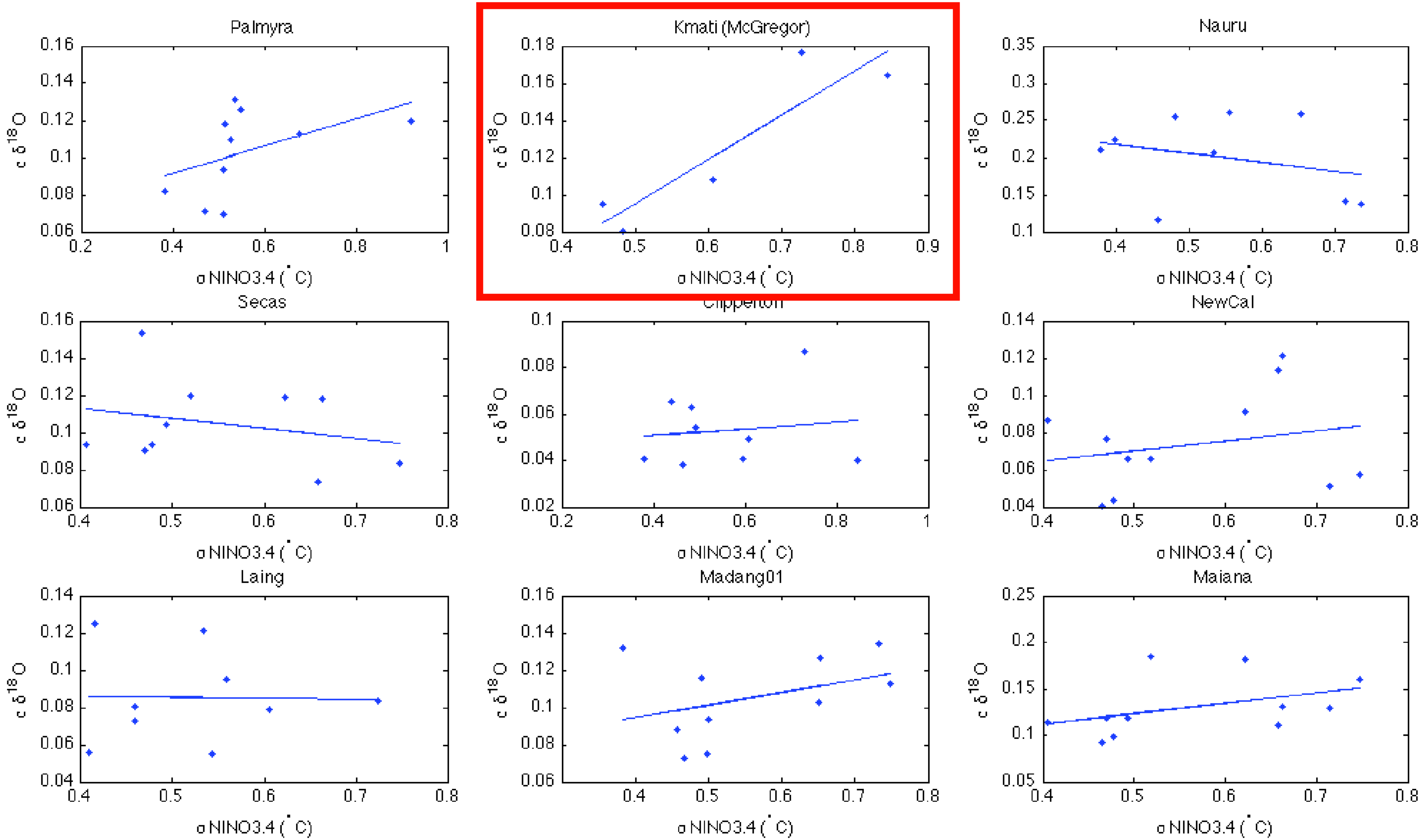
Ackerley et al. (2011), *Clim. Past Discuss.*

Mean precipitation anomaly (6 ka minus 0 ka, %)



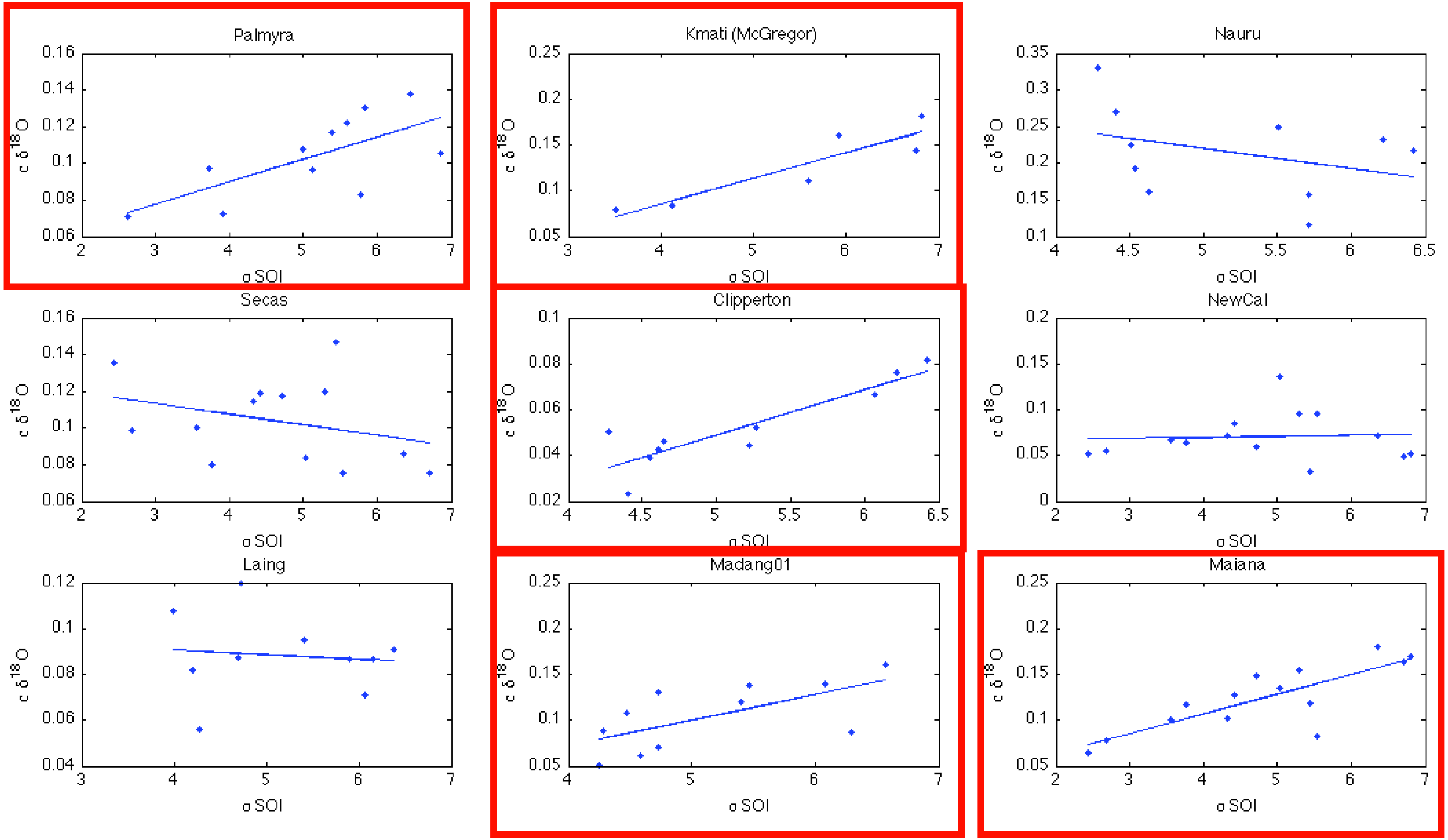
Ackerley et al. (2011), *Clim. Past Discuss.*

The search for an ENSO common language: Niño 3.4



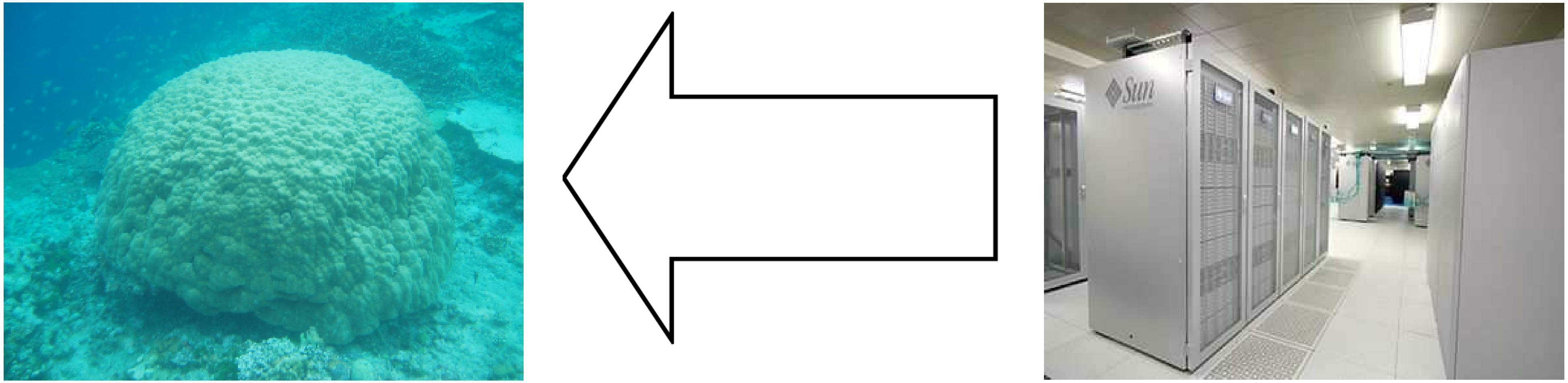
Stevenson et al. (in prep.)

The search for an ENSO common language: SOI



Stevenson et al. (in prep.)

Forward modelling



- Arguably the only approach that allows true data-model integration
- Avoids the assumption of stationarity
- Requires direct modelling of relevant physical and biological processes within a climate modelling framework
- Much, much more than just isotope-enabling climate models
- *Has* to be the future of palaeoclimate research, but a forward modelling capacity that covers all proxies is a long way off...

Opportunities

- Understand the drivers of Southern Hemisphere climate variability and change
- Understand the characteristics of natural climate variability on timescales from annual to millennial
- Understand the links between the Australasian climate and the global climate system
- Understand the modes of natural climate variability and their influence on the Australasian climate
- Characterise the response of the climate system to external forcings: sensitivity, feedbacks, signal-to-noise ratios...
- Detection and attribution of anthropogenic influences
- Better representation of physical processes within the models
- Enhanced ability to predict and adapt to future climate change

Climate modelling and Aus2k

- Dynamicists:
  - Understand the dynamics of the Australasian climate
  - Construct a common language for data-model integration
- Proxy people:
  - Characterise relationships between proxies and climate regimes
  - Construct syntheses of Australasian climate
  - Reconstruct values of key climatic indices (ENSO, SAM...)
  - Boundary conditions for models (particularly solar and volcanic)
- Modellers:
  - Dynamical interpretation of proxy data
  - Explore forcing mechanisms
  - Explore how teleconnections (transfer functions) evolve over time
- Long-term:
  - Develop a forward modelling capability