Climate modelling and OZ-INTIMATE

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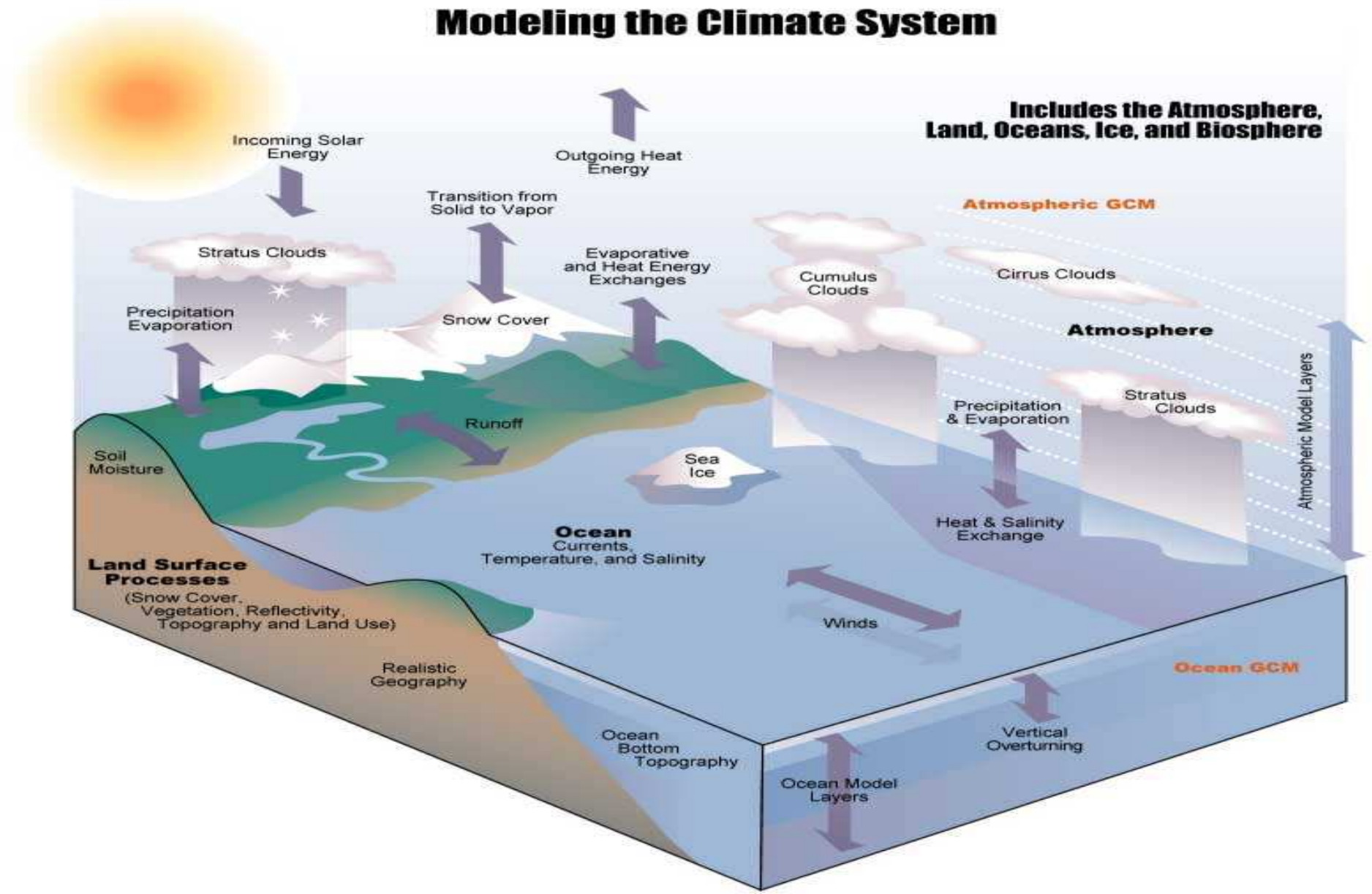
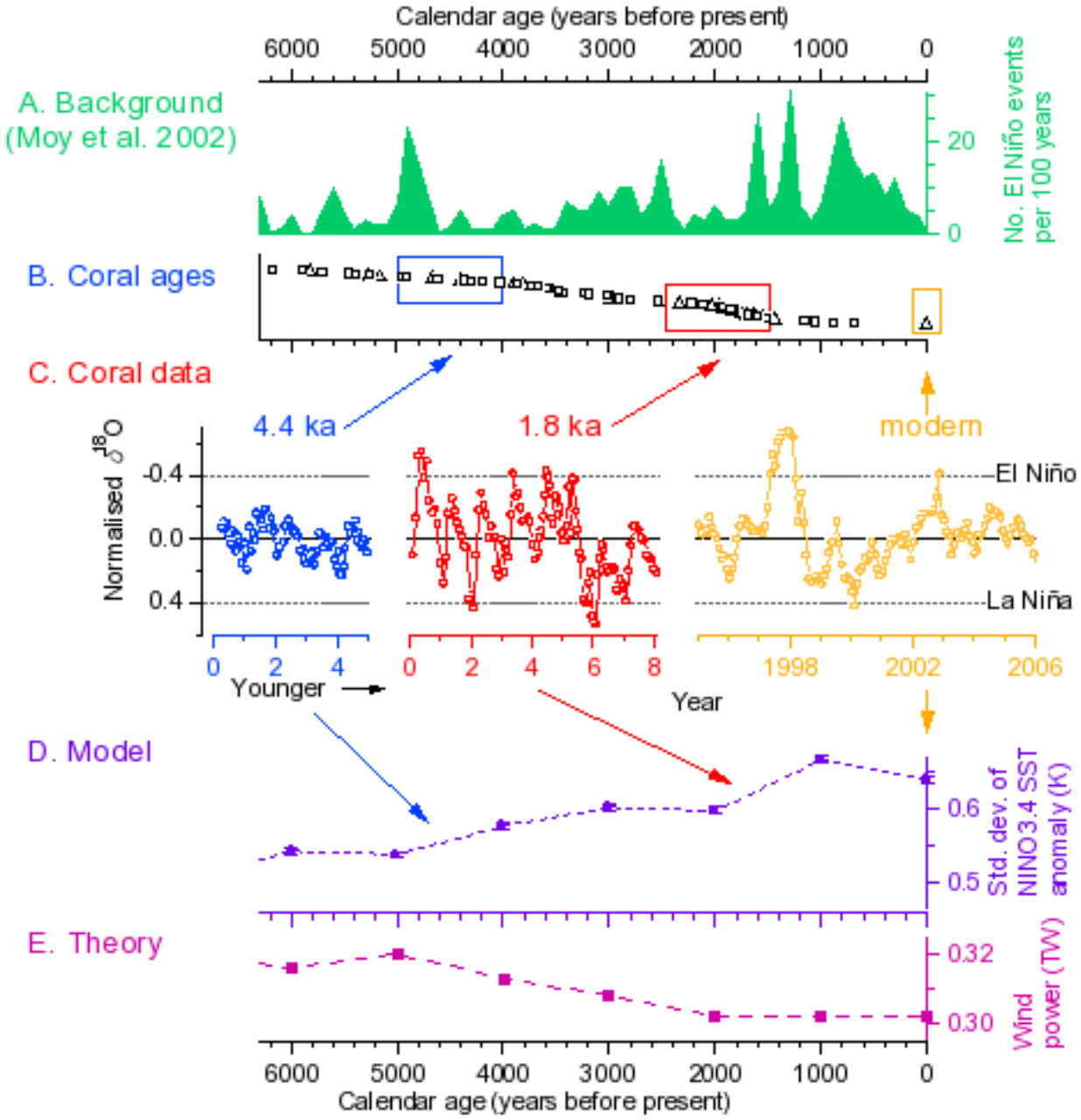
Why climate modelling?

- Data:
  - The real world
- Models:
  - Precise chronology
  - Complete spatial coverage, from bottom of ocean to top of atmosphere
  - As much temporal resolution as you need (hourly?)
  - Simulate actual physical variables (no transfer functions)
  - Just *not* the real world...

Why climate modelling?



Data-model integration: a win-win situation



- Data-model integration is a two-way process
- The data constrains the model simulations
- The models provide the dynamical interpretation of the data
- Everyone wins!

Palaeoclimate modelling: National efforts

- General circulation models (GCMs):
  - CSIRO Mk3L (UNSW, CSIRO, Macquarie University + others?)
  - CCSM (UNSW, University of Sydney)
  - FOAM (Monash University, University of Western Australia)
  - NASA GISS (ANU)
  - CSIRO Mk3.6 (CSIRO/QCCCE)
- Earth System Models of Intermediate Complexity (EMICs):
  - UVic (UNSW)
- Different timescales, different questions:
  - ENSO variability during the Holocene
  - Changes in the Australian monsoon during the last glacial cycle
  - Deep time/past warm periods
  - Process studies (abrupt changes, carbon cycle, topography...)

Palaeoclimate Modelling Intercomparison Project

- Phase 1 (1991–2001) :
  - Atmospheric GCMs
  - Primary experiments were 6 ka (mid-Holocene) and 21 ka (LGM)
  - 22 models participated
  - Contributed towards IPCC TAR
- Phase 2 (2002–2008) :
  - Atmosphere-ocean(-vegetation) GCMs
  - Primary experiments were 6 ka (mid-Holocene) and 21 ka (LGM)
  - 18 models participated
  - Contributed towards IPCC AR4

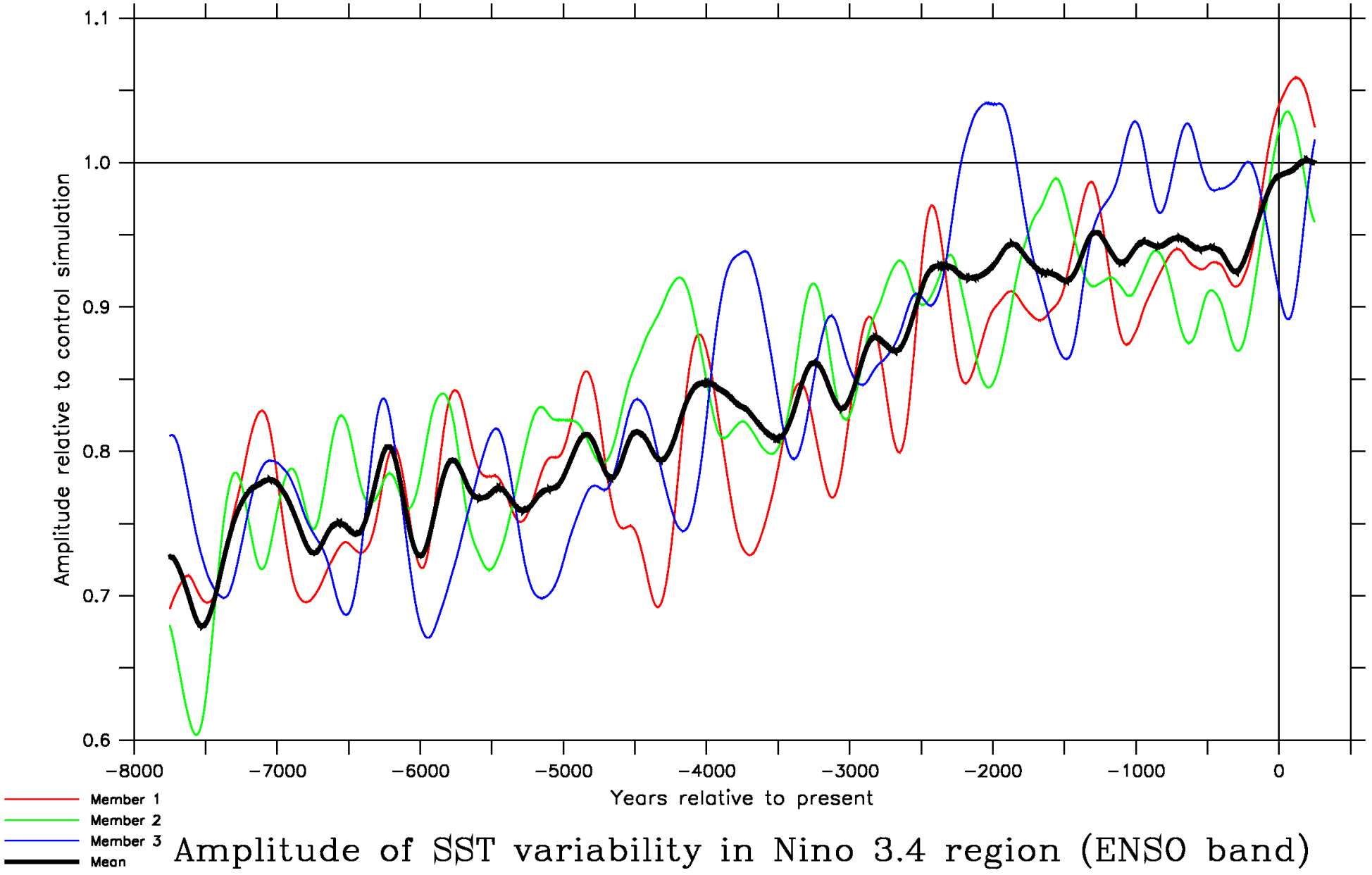
Phase 3 (2009–)

- Theme 1: Evaluation of earth system models at 6 ka and 21 ka
  - Vegetation, biogeochemical cycles, chemistry, ice sheets...
  - Use of new data syntheses for model evaluation
- Theme 2: Interglacials and warm periods
  - Last interglacial (∼130–115 ka) - snapshot and transient
  - Mid-Pliocene (∼3.3–3.0 Ma) - snapshot (PlioMIP)
- Theme 3: Abrupt climate changes
  - Transient simulations of last deglaciation, 8.2 ka event...
- Theme 4: Uncertainties: characterisation and understanding
  - Uncertainties in reconstructions, boundary conditions...
  - Weight models according to a palaeoclimate skill index?
- Will contribute towards IPCC AR5
- Two Australian models: CSIRO Mk3L and CSIRO Mk3.6

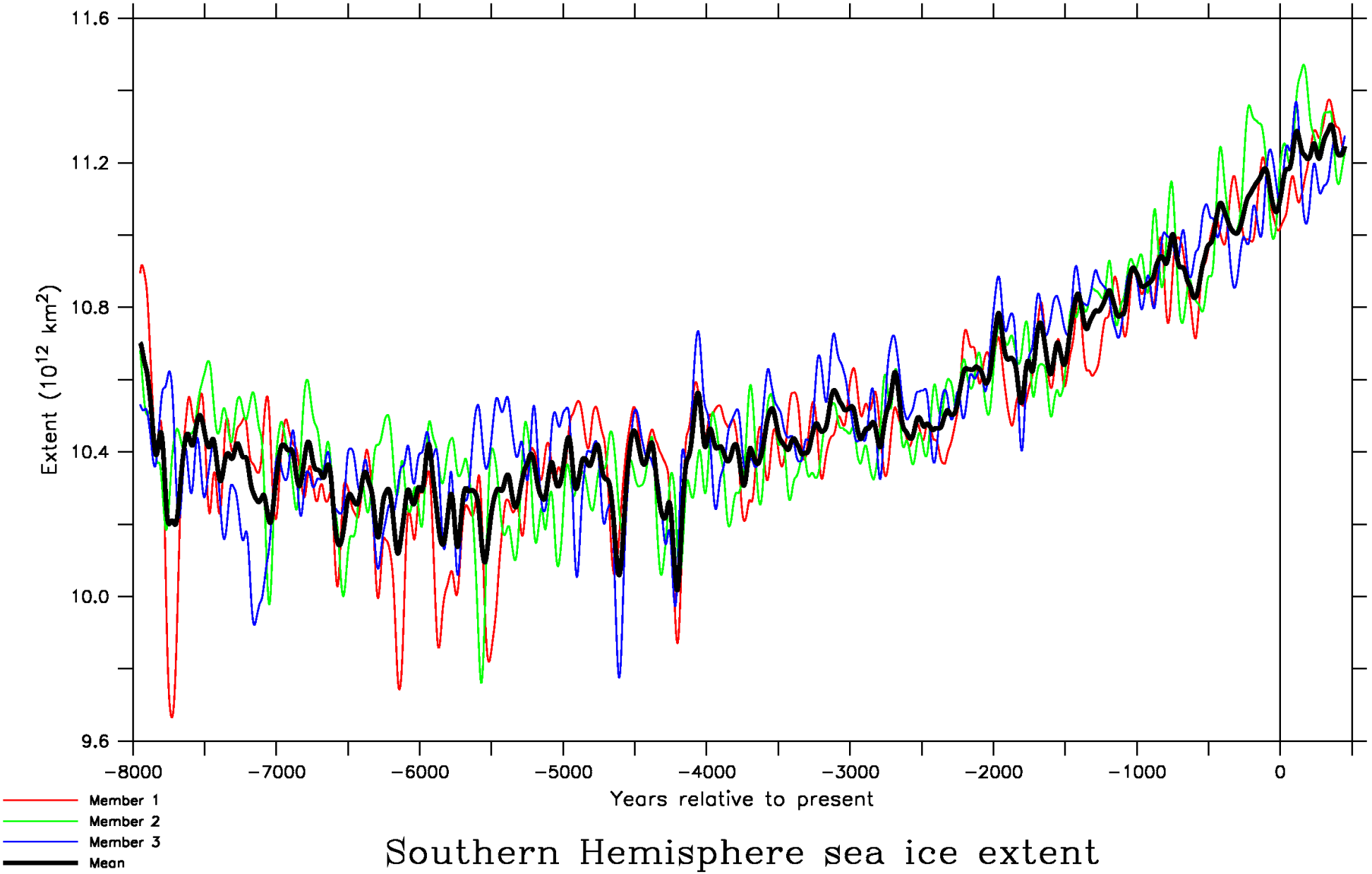
Climate modelling for OZ-INTIMATE

- CSIRO Mk3L climate system model
  - Atmosphere: $5.6^\circ \times 3.2^\circ$, 18 vertical levels
  - Ocean: $2.8^\circ \times 1.6^\circ$, 21 vertical levels
  - Sea ice: Dynamic-thermodynamic
  - Land surface: Static vegetation
- Pre-industrial control simulations (10,000 years)
- 3 x transient simulations of the past 8,000 years
  - Orbital forcing only
- 3 x 3 x transient simulations of the past 2,000 years
  - Orbital + GHGs
  - Orbital + GHGs + solar
  - Orbital + GHGs + solar + volcanic
- Transient simulation of 15–10 ka
  - Coming soon...

Simulated changes in El Niño variability



Simulated changes in SH sea ice extent



Climate modelling and OZ-INTIMATE

- How the proxy people can help the modellers:
  - Evaluation of models and model simulations
- How the modellers can help the proxy people:
  - Dynamical interpretation of data
  - Fill spatial gaps in datasets
  - Enhance temporal resolution
  - Chronology?
  - Explore how teleconnections (transfer functions) evolve over time
- The future:
  - More realistic forcings (GHGs, solar, volcanic...)
  - Data-model integration
  - Data assimilation