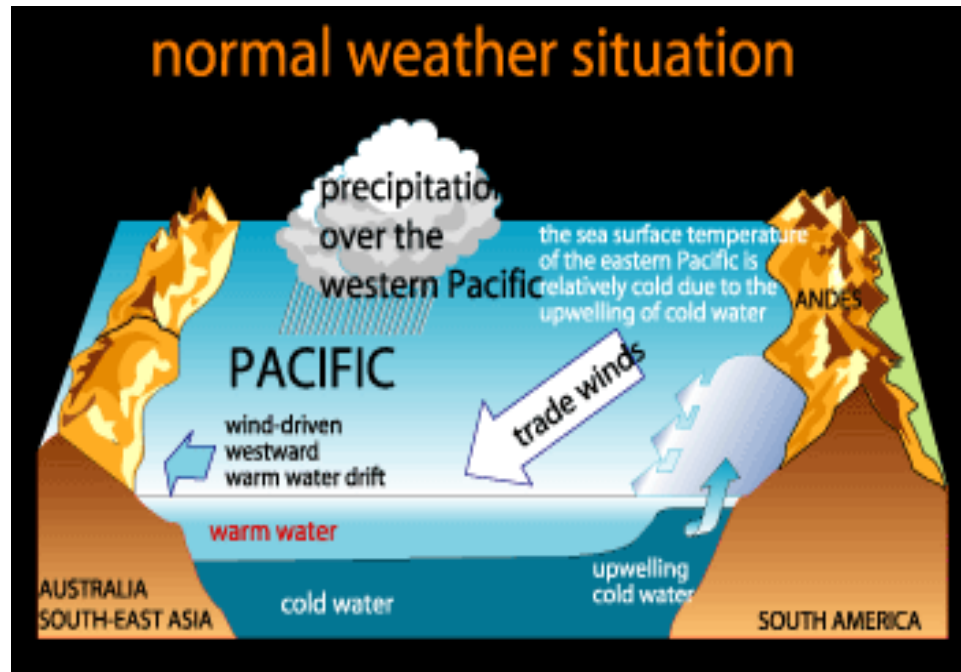
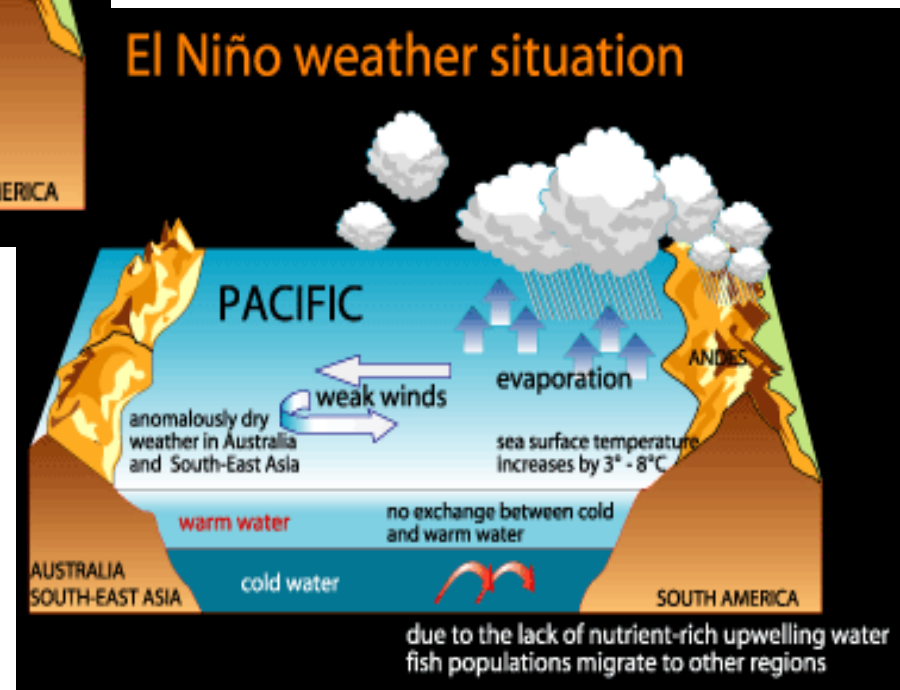


The El Niño-Southern Oscillation (ENSO) from 0-2 ka

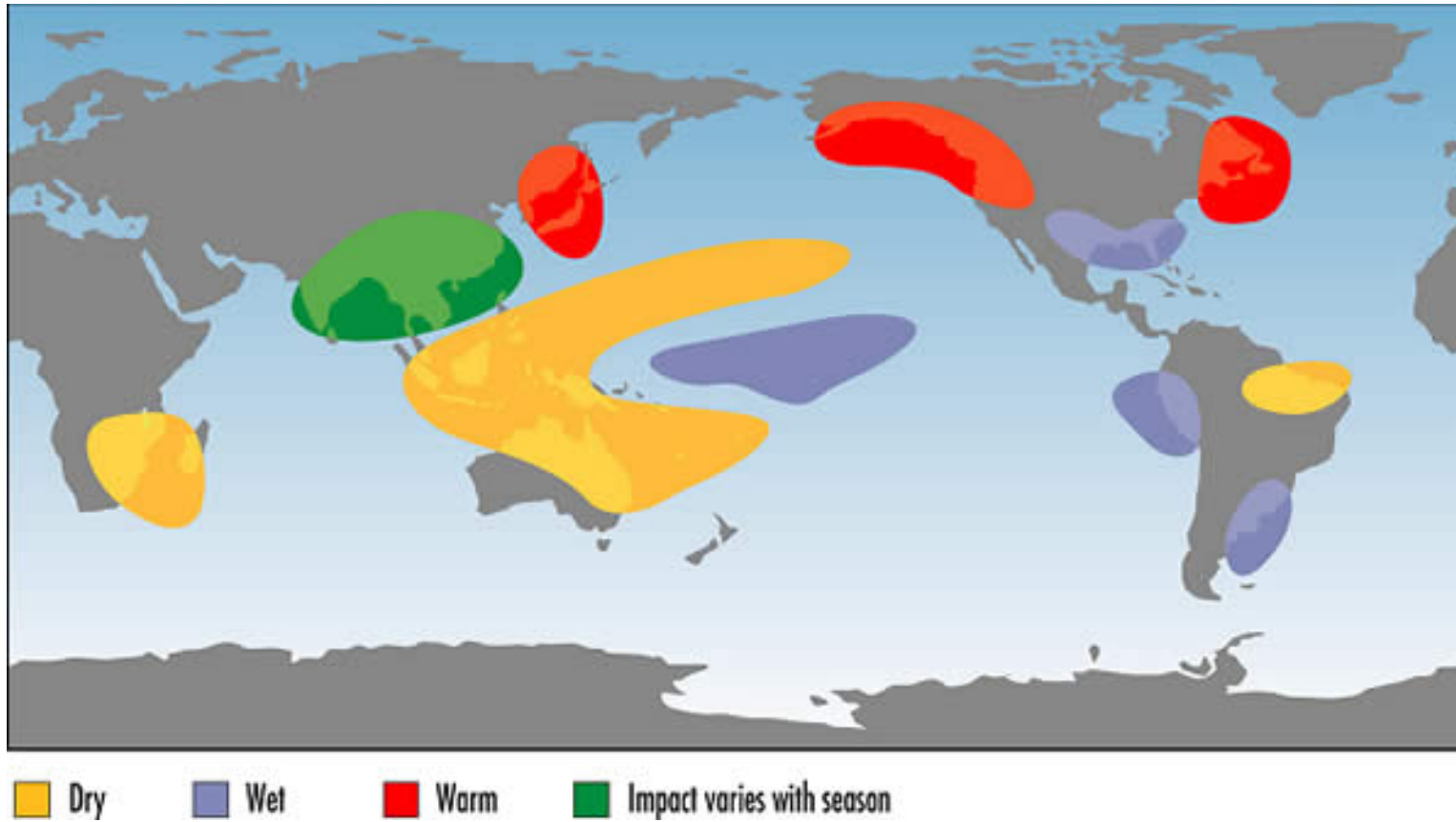
Helen McGregor, Steven Phipps,
Colin Woodroffe, Mike Gagan,
David Fink



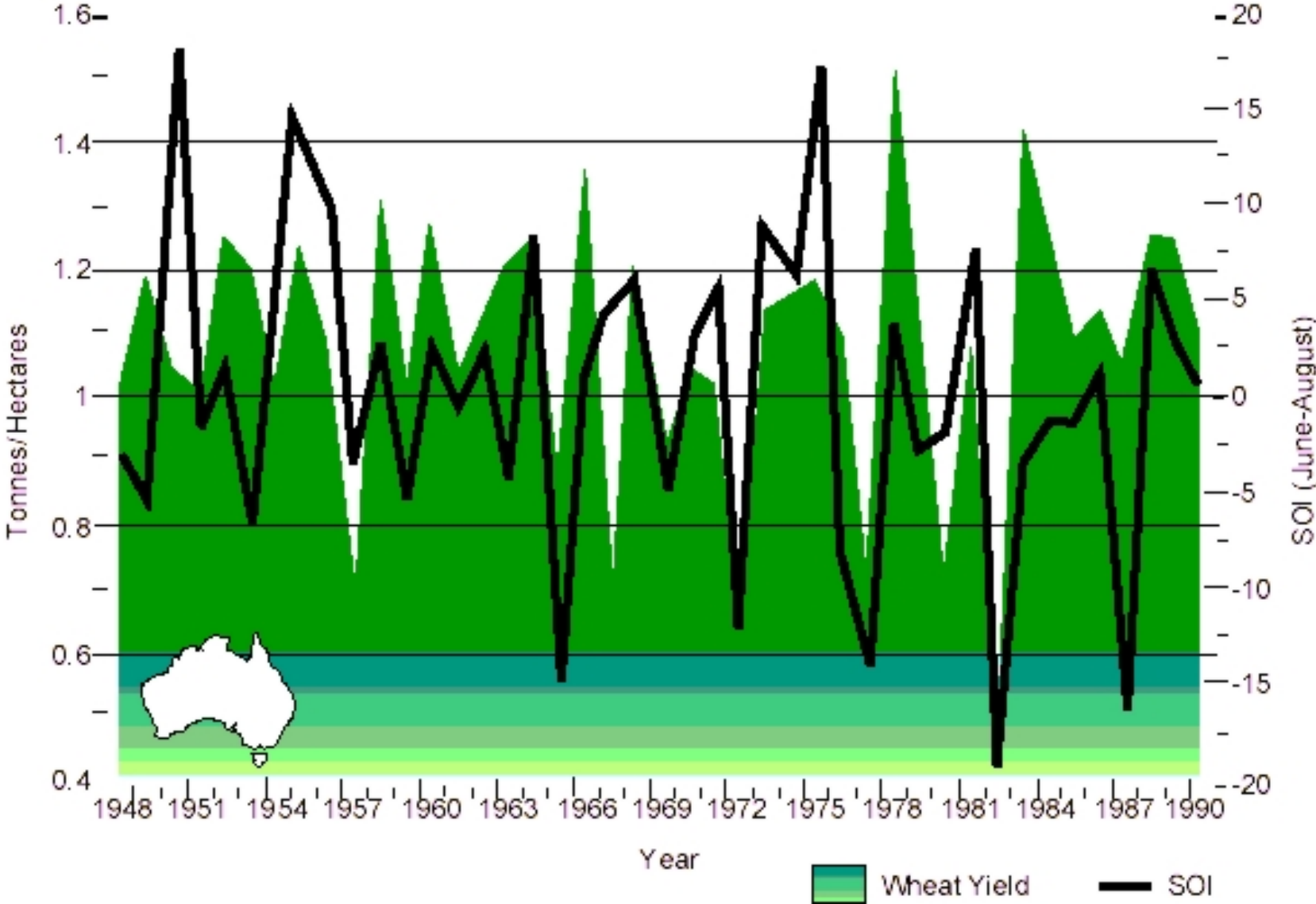
What is an El Niño event?



El Niño events are associated with reduced rainfall in eastern Australia



El Niño and Australian wheat yield



Source: ABS, BoM

Models highly variable in forecasts of future ENSO

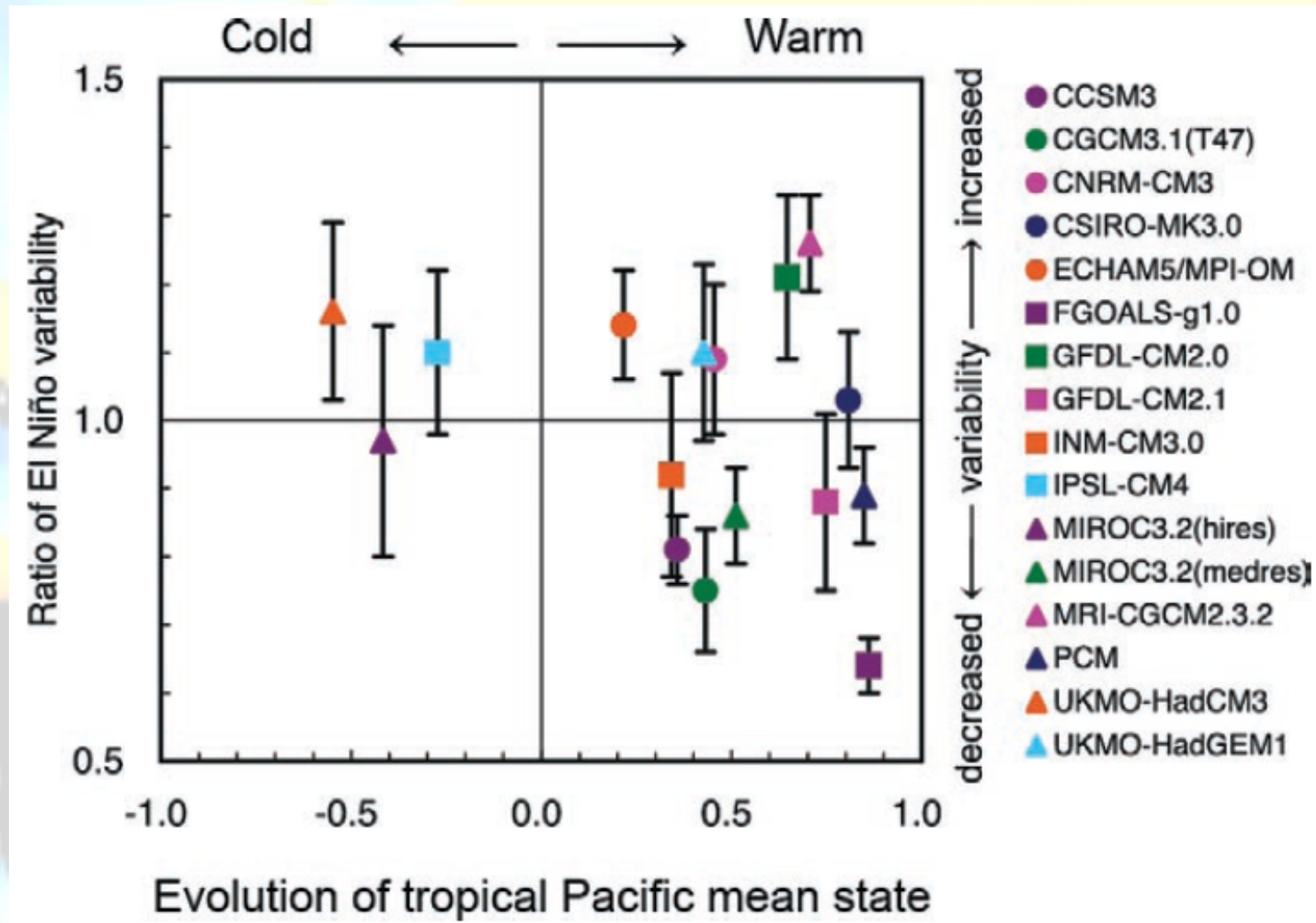
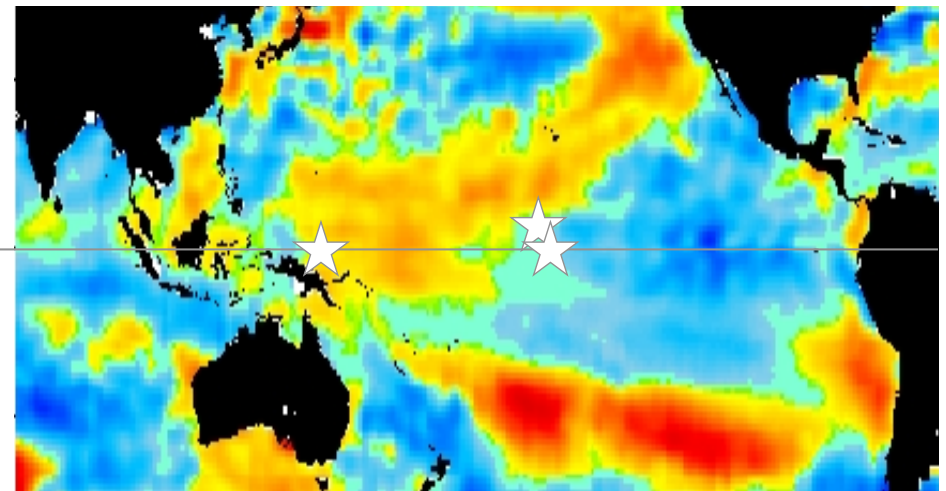
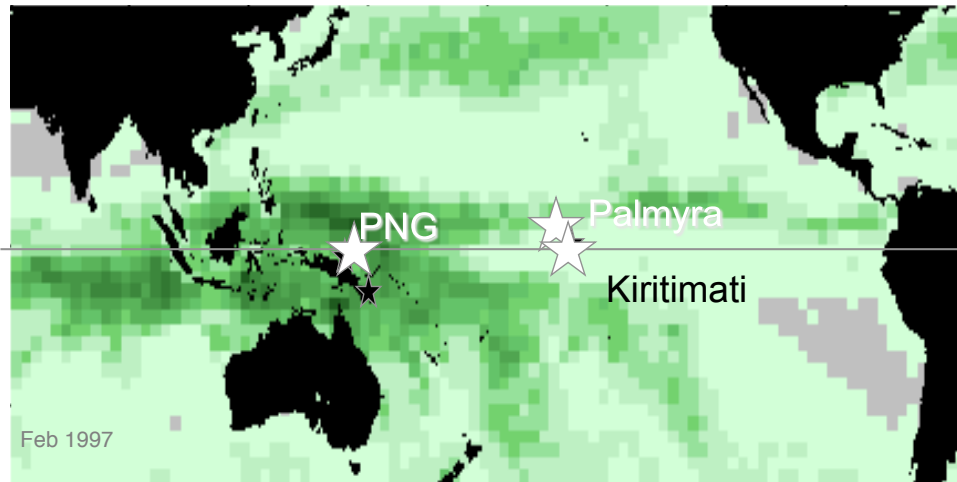


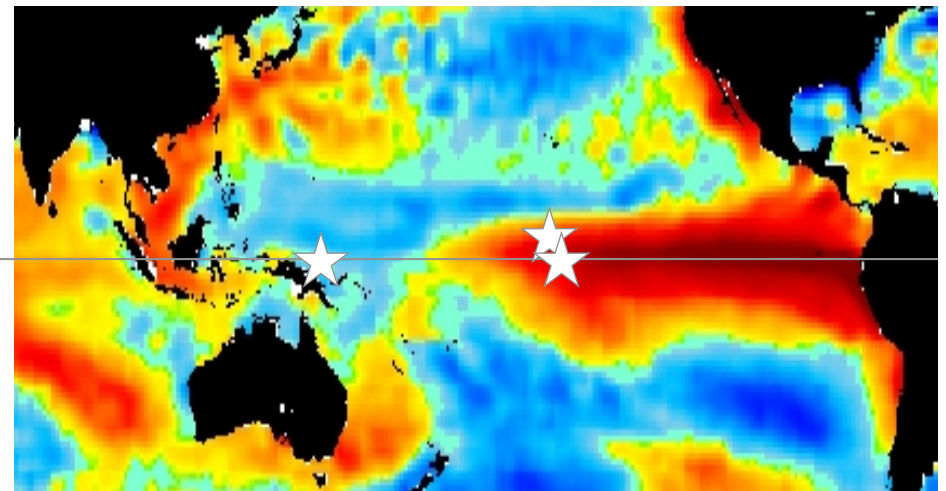
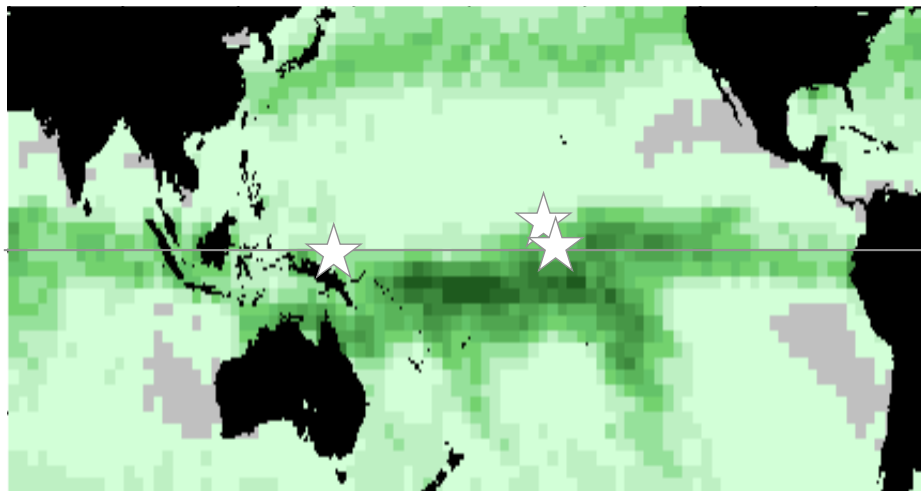
FIG. SSTA AOC state area Yam varia ENS last exce whic for v peri 60°V Error

ENSO centres of action

Normal pattern



El Niño pattern



CMAP rainfall (mm/day)



0 2 4 6 8 10 12 14 16 18 20 22

CMAP Estimated Precipitation (mm/day)

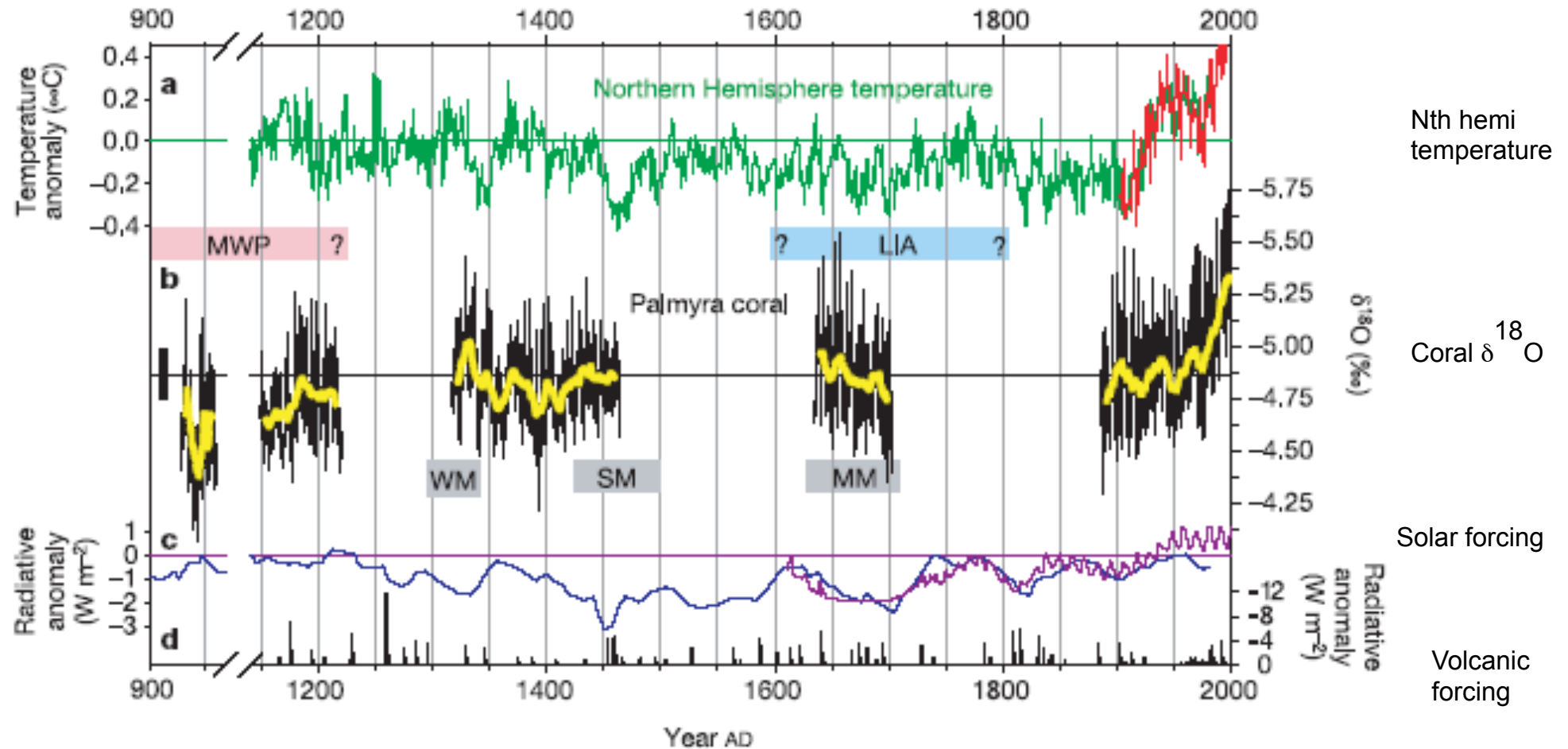
IGOSS SST anomaly (°C)



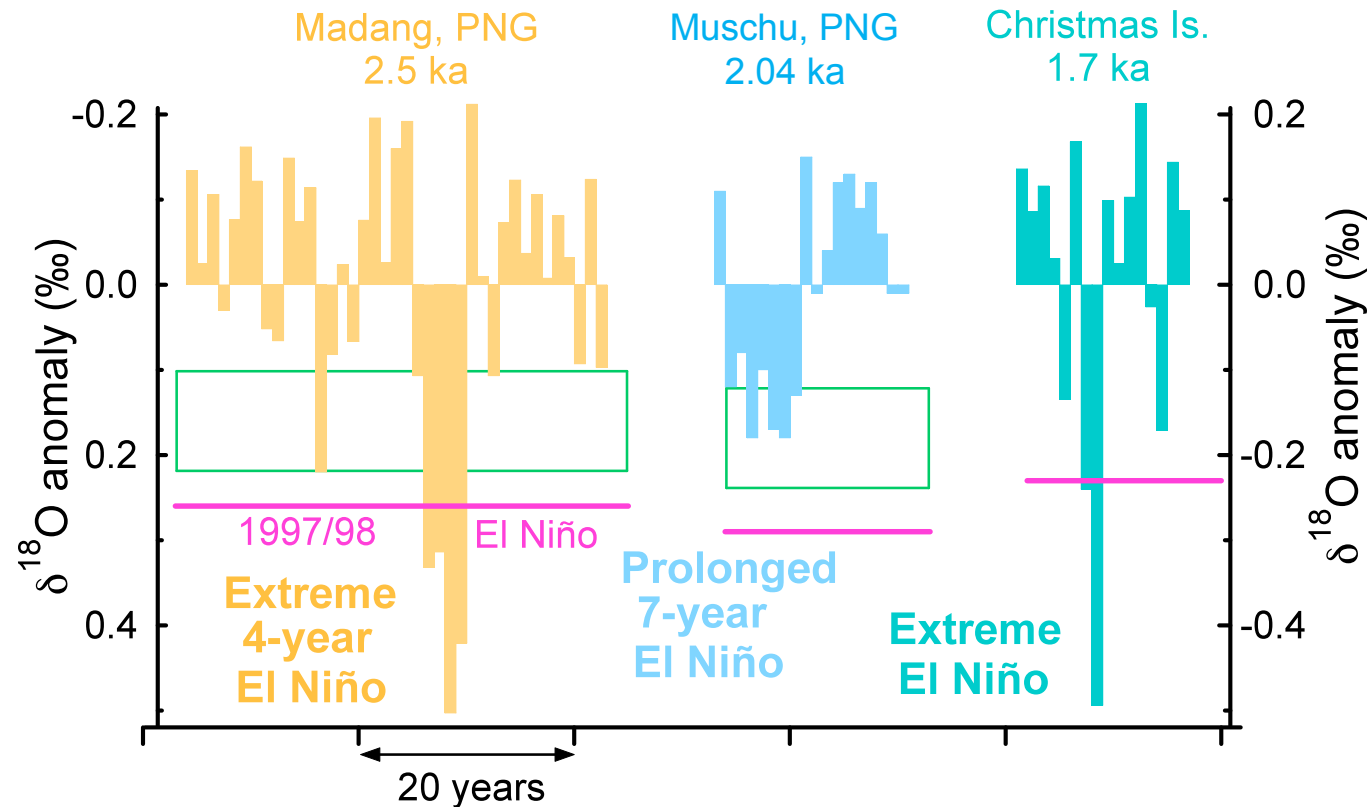
-4 -3 -2 -1 0 1 2 3 4

IGOSS SST anomaly (°C)

ENSO 0-1 ka (Palmyra Is)



ENSO ~2 ka (Kiritimati & PNG) - Severe El Niños?



Filling in the gaps: Kiritimati Microatolls

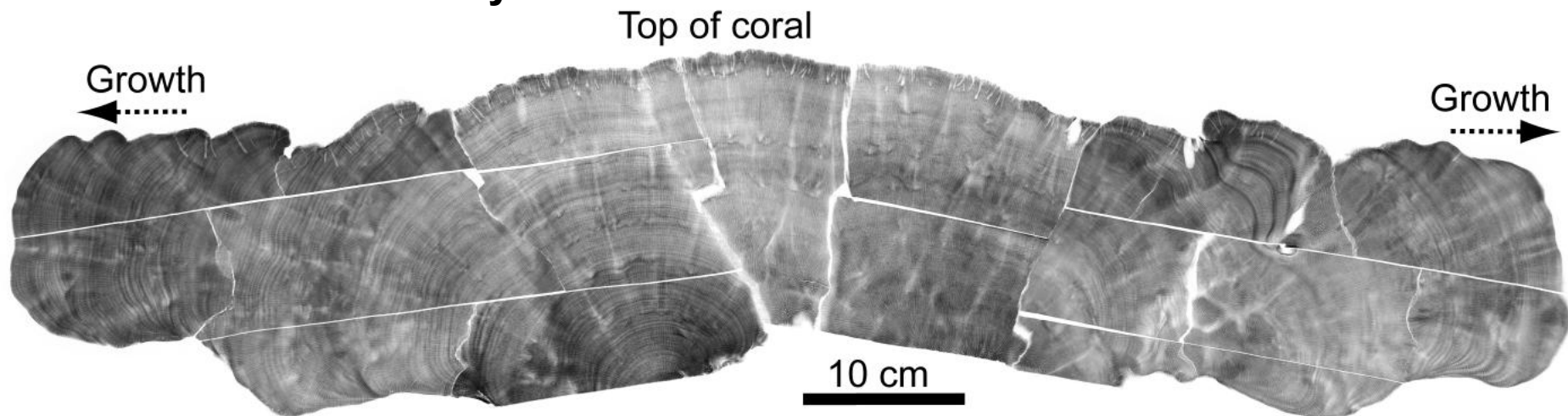
***Porites* head coral**



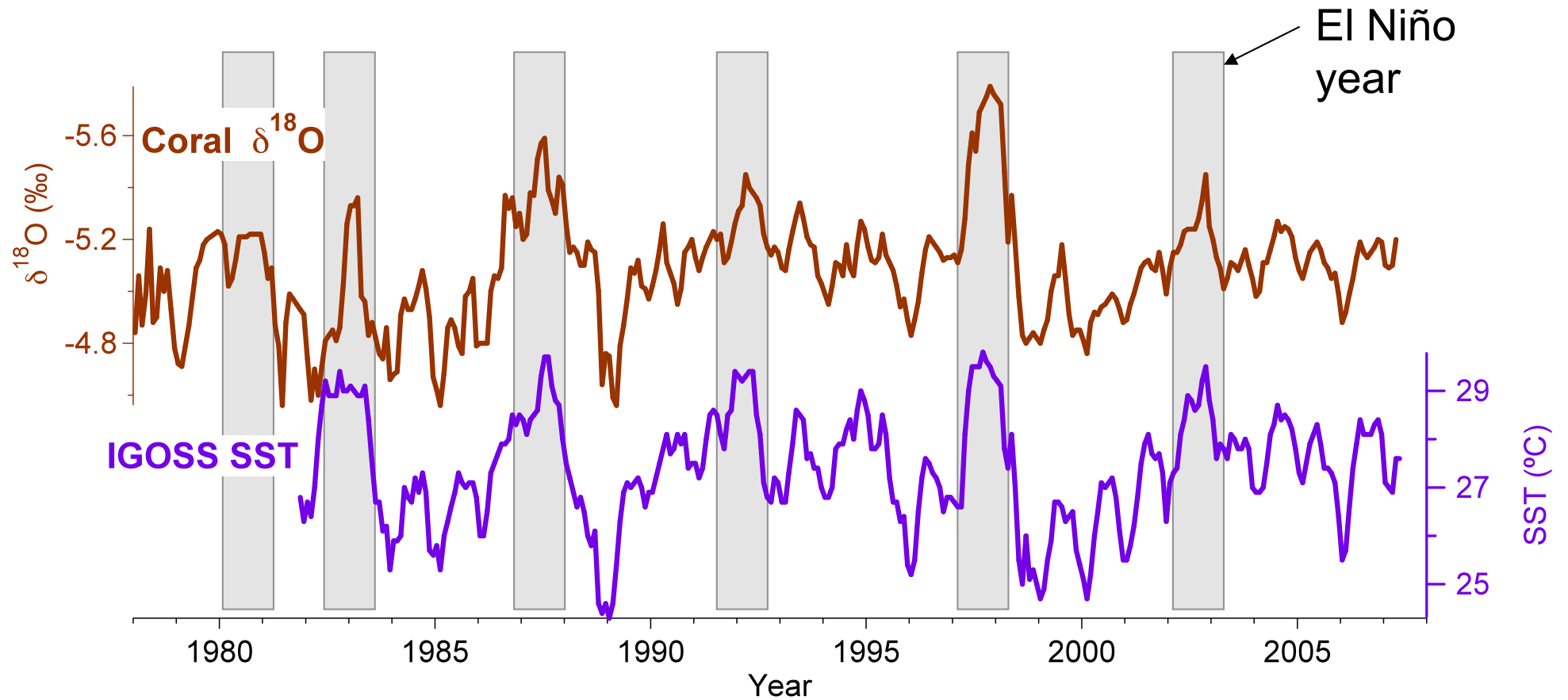
***Porites* microatoll**



***Porites* microatoll X-ray**

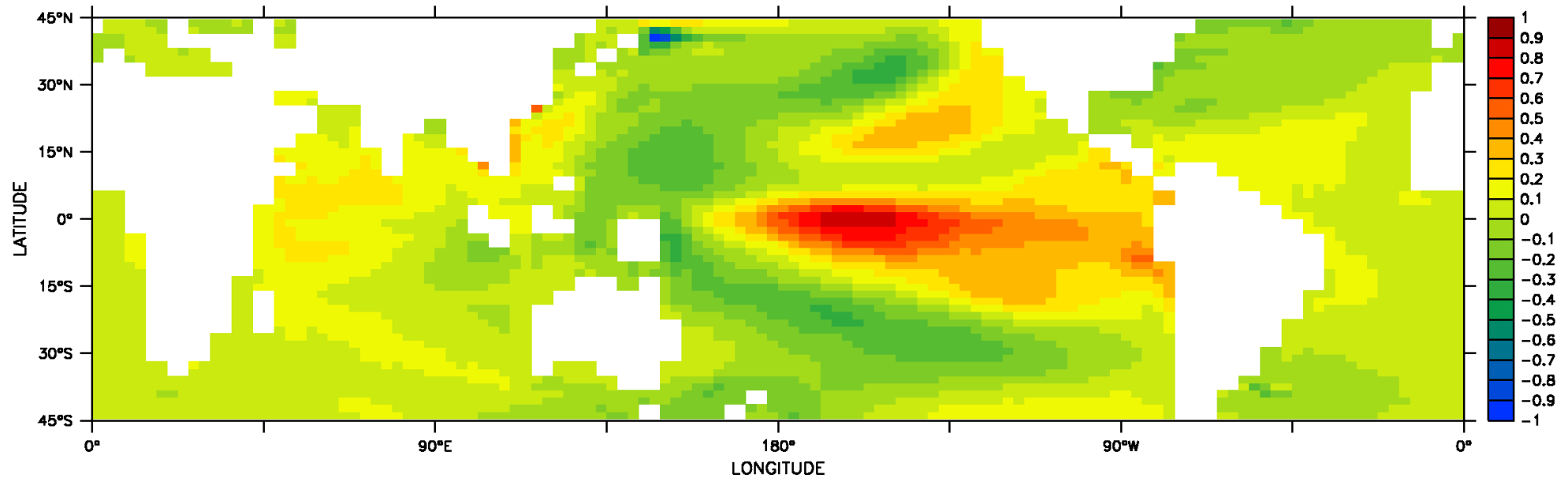


Modern coral $\delta^{18}\text{O}$ data from Kiritimati compared to satellite sea surface temperature (SST)



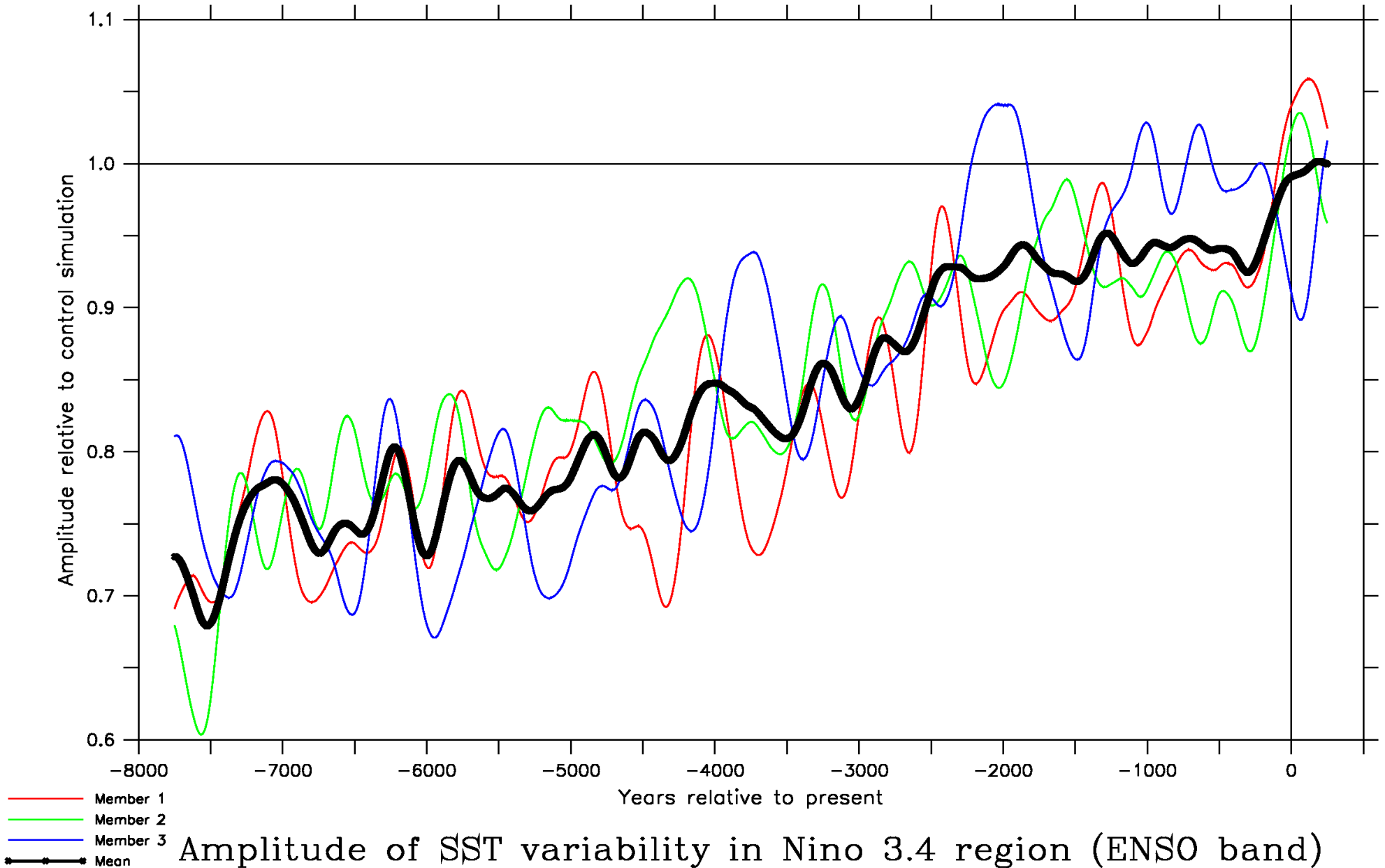
Transient climate model simulations

- CSIRO Mk3L climate system model v1.1:
 - Atmosphere: $5.6 \times 3.2^\circ$, 18 vertical levels
 - Ocean: $2.8 \times 1.6^\circ$, 21 vertical levels
 - Sea ice: Dynamic-thermodynamic
 - Land surface: Static vegetation
- 1 x 10,000-year control simulation
- 3 x transient simulations of the past 8,000 years (orbital forcing only)

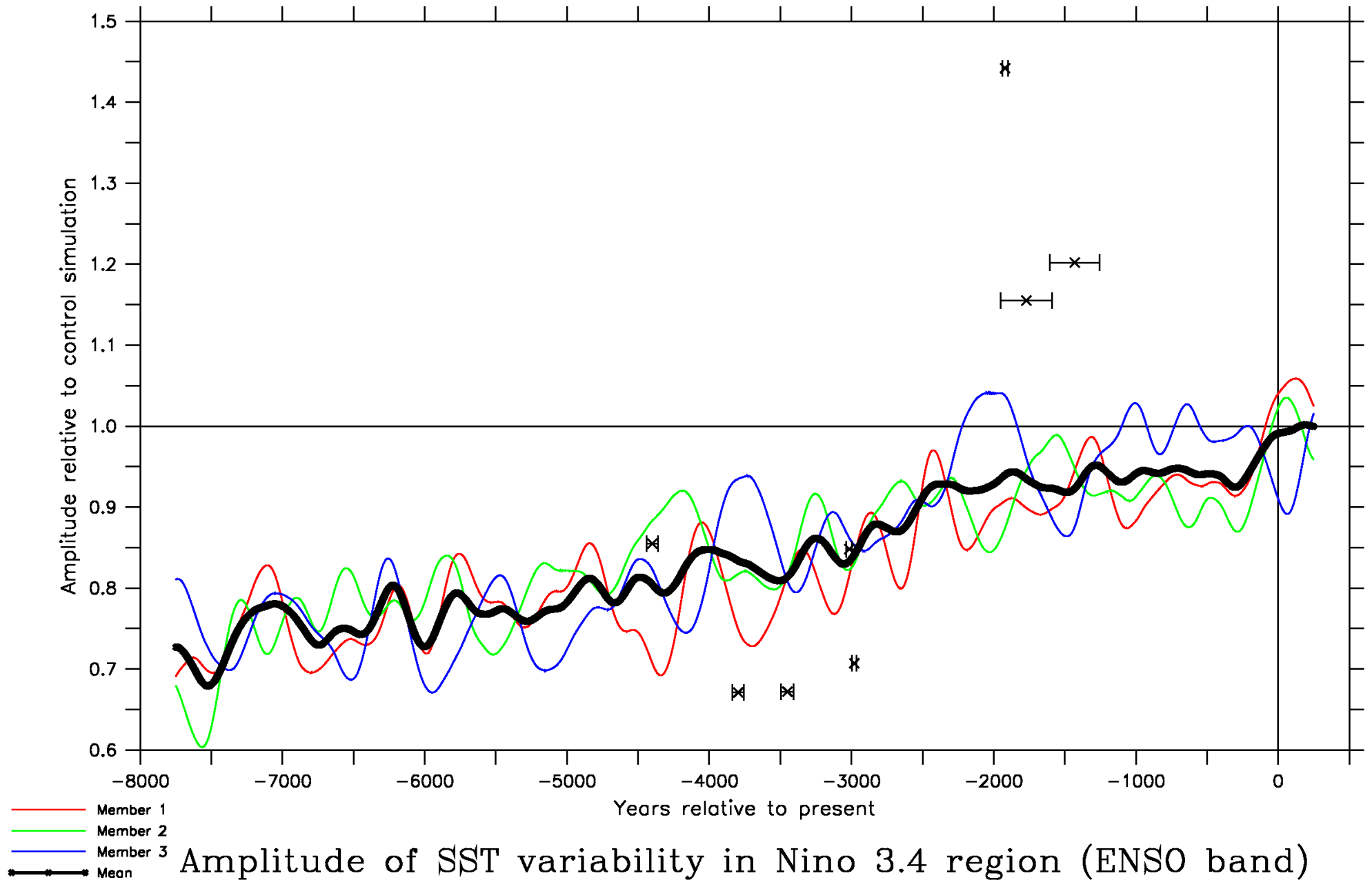


Pre-industrial control simulation: PC1 of monthly SST anomalies

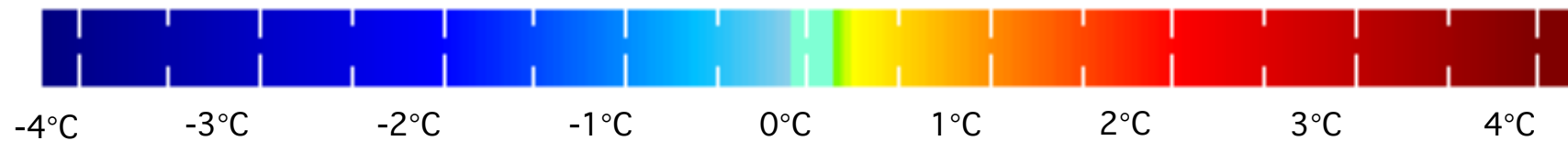
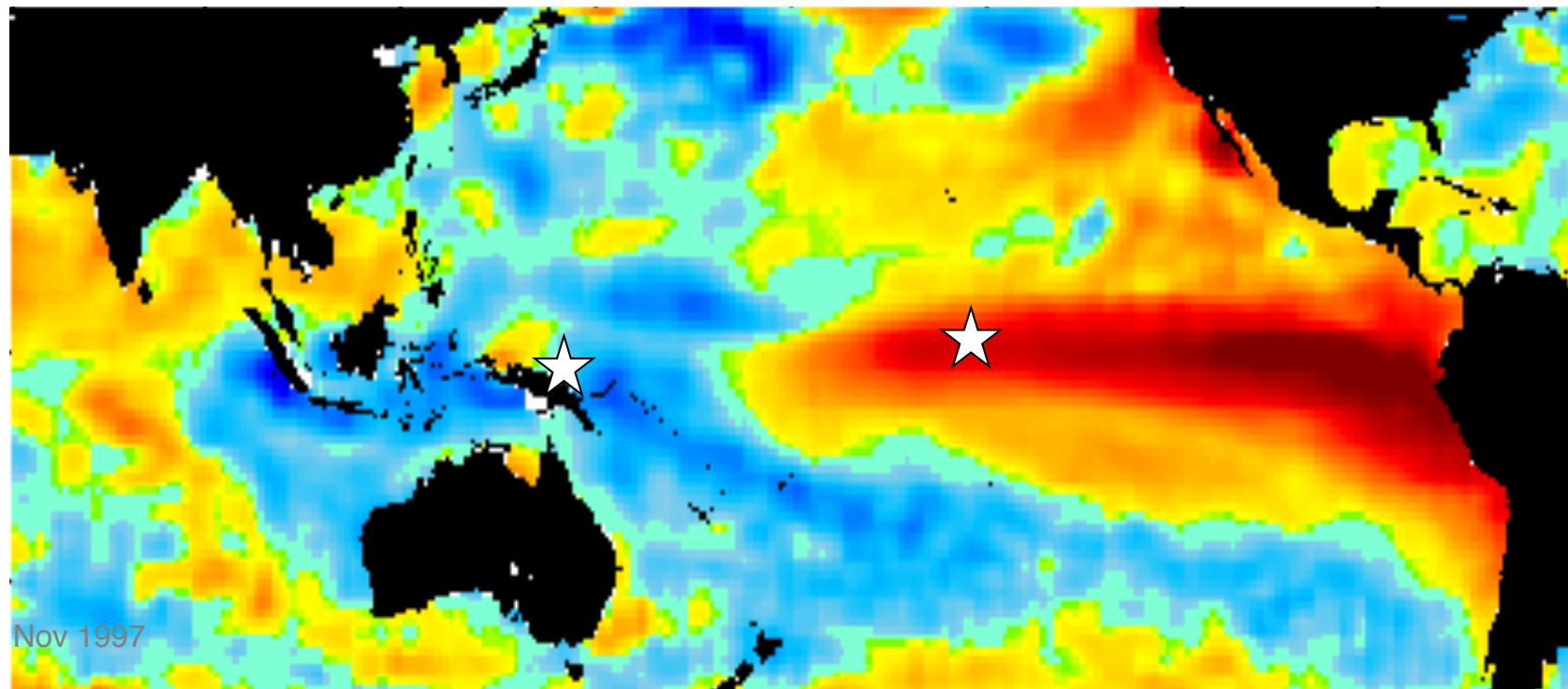
Simulated ENSO variability



Simulated ENSO variability



Target the same centuries at ~2 ka in different locations across the equatorial Pacific



El Niño SST anomalies



Photos courtesy of Javier Leon