

# Prominent precession-band variance in El Niño–Southern Oscillation Intensity over the last 300,000 years

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## Experimental design

### Fully-coupled Climate Model: NCAR CCSM3

- Atmosphere: CAM3 at T31 with 26 vertical levels
- Land: CLM3 at T31 with dynamic vegetation
- Ocean: POP at nominal 3° resolution with 25 vertical levels
- Sea-ice: CSIM5 at nominal 3° resolution, dynamic-thermodynamic model

### Realistic transient forcing:

- Orbital parameters (ORB) • Greenhouse gases (GHG) • Land ice-sheets (ICE)

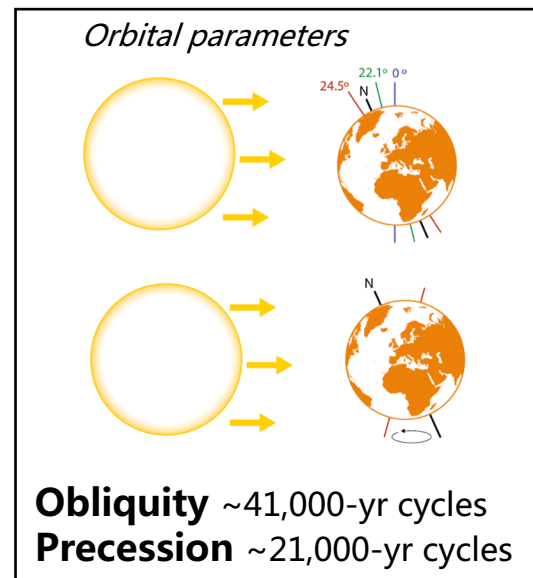
Initialization : Pre-Industrial

3 transient simulations of [300,000-yr] with 100x acceleration

→ ORB (with forcing of ORB)

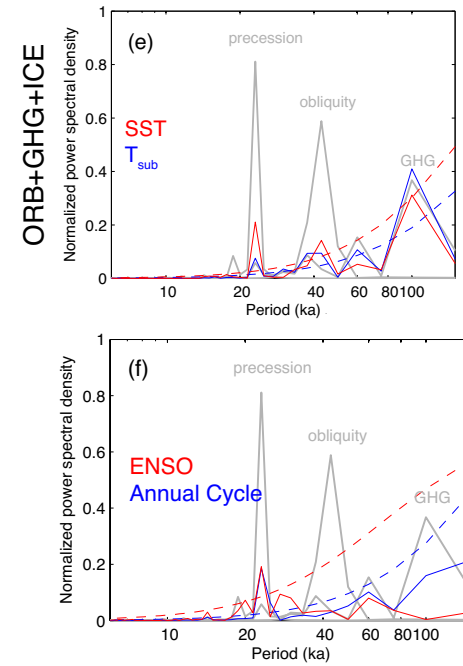
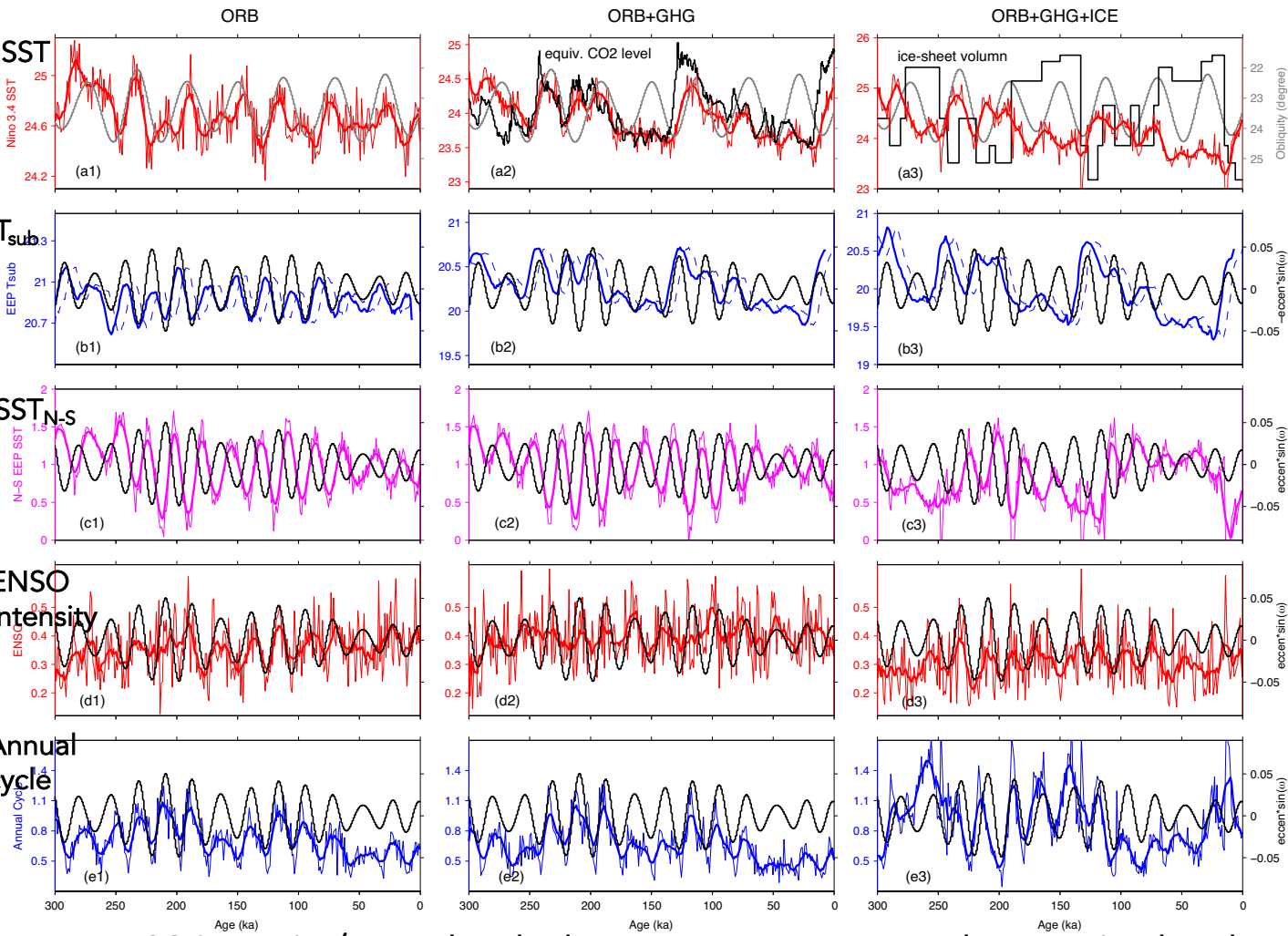
→ ORB+GHG (with forcing of ORB & GHG)

→ ORB+GHG+ICE (with forcing of ORB & GHG & ICE)



More details: Lu, Z., Liu, Z., Chen, G., & Guan, J. (2019). Prominent Precession Band Variance in ENSO Intensity Over the Last 300,000 Years. *Geophysical Research Letters*, 46(16), 9786-9795.

# ENSO and climate evolution of the last 300,000 years, and the power spectra



- ENSO intensity/Annual cycle demonstrates pronounced precession band variance;
- SST,  $T_{sub}$  show both precession and obliquity band variance

# Orbital forcing mechanisms of ENSO: BJ analysis

$$BJ = -\alpha_s - \alpha_{MA} + \mu_a \beta_u \langle -\bar{T}_x \rangle + \mu_a \beta_w \langle -\bar{T}_z \rangle + \mu_a \beta_h \langle \frac{\bar{w}}{H_1} \rangle a_h$$

1
2
3
4
5

## Bjerknes (instability) Index

- 3 Feedbacks (3,4,5)
- 2 Dampings (1,2)

1. Thermodynamic damping
2. Mean advection damping
3. Zonal advection feedback
4. Ekman upwelling feedback
5. Thermocline feedback

- The El Niño evolution is dominated by the coupled ocean-atmosphere instability (quantified by BJ index);
- Contributions from the Ekman upwelling and thermocline feedbacks

