Natural modulation of ENSO in the GFDL CM2.1 coupled GCM

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Is ENSO changing?

- Variations in amplitude & period
- Short record, changing obs system
- Disparate AR4 model projections
- Which models to trust?
- How long to evaluate/distinguish?
How would an unperturbed ENSO behave?

(prerequisite for detecting sensitivities)

GFDL CM2.1 coupled GCM
atmos: 2°x2.5°xL24 finite volume
ocean: 1°x1°xL50 MOM4 (1/3° near equator)
2hr coupling; ocean color; no flux adjustments
ENSO ranks among top 4 AR4-class models
SI forecasts; basis for AR5 models

2000-year pre-industrial control run
1860 atmospheric composition, insolation, land cover
220yr spinup from 20th-century initial conditions
substantial investment: 1 year on 60 processors
20 centuries of NINO3 SSTs
annual means & 20yr low-pass
Modulation of NINO3 SST power spectrum

20yr epochs
(e.g. satellites, TAO)

2000yr mean

98%
Given long enough runs, we can say...
CM2.1 ENSO is too strong
CM2.1 ENSO is very sensitive to some parameters
A perfect climate for ENSO?
Last Glacial Maximum (20ka)

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CM2.1 LGM (1901–2500)
CM2.1 1860 (20 centuries)
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**period (years)**

**°C²/octave**
Summary

1. Assessing & understanding intrinsic variation is key to detecting ENSO changes

2. 2000yr pre-industrial CM2.1 shows strong interdecadal & intercentennial modulation of ENSO

3. Puts large error bars on some ENSO metrics (e.g. spectra) diagnosed from short time series

4. Need long runs, large ensembles, fast computers, extended obs, multiple tests; but don't give up

5. Are other models & real world like CM2.1?
Reserve Slides
Centuries of weak or strong ENSOs
Active/inactive centuries show no robust difference in the scaled ENSO SSTA pattern.
CM2.1 mean state barely changes between active/inactive ENSO centuries
Inactive centuries have *slightly* warmer water in the west Pacific.
Are ENSO events linked to their neighbors?

bubble size = next peak NINO3 SSTA

stronger events more isolated

previous warm

next warm

previous cold

next cold

years to next peak
All warm events

5th, 50th, 95th percentiles from 245 events

gray indicates 95%-ranges for 245-sample percentiles from the climatological PDF

NINO3 SST (°C)

months since event