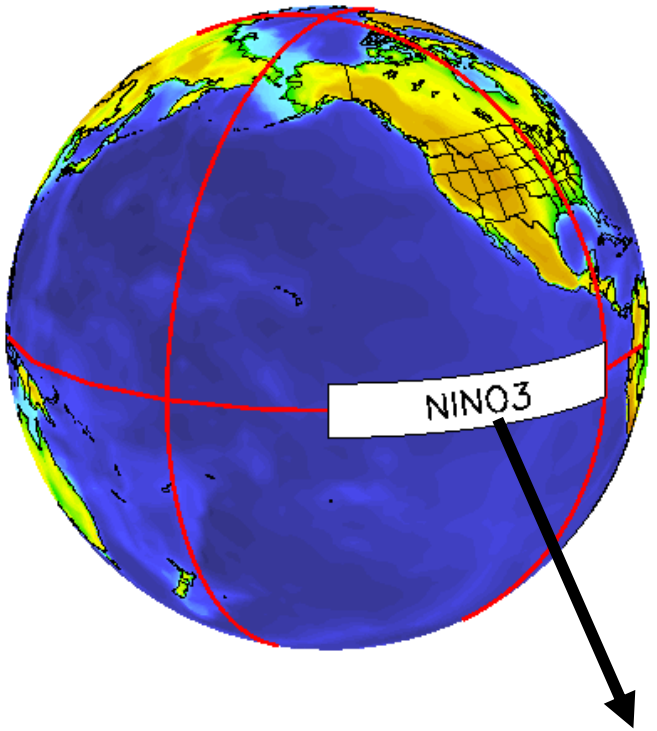
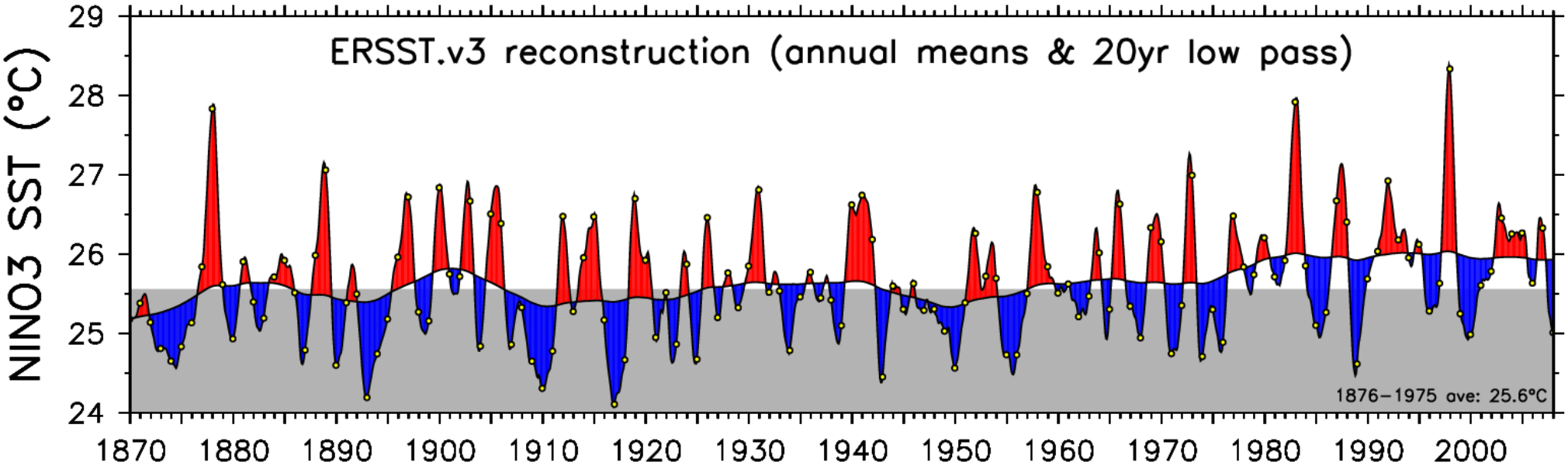
Natural modulation of ENSO in the GFDL CM2.1 coupled GCM

Andrew Wittenberg
NOAA/GFDL



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

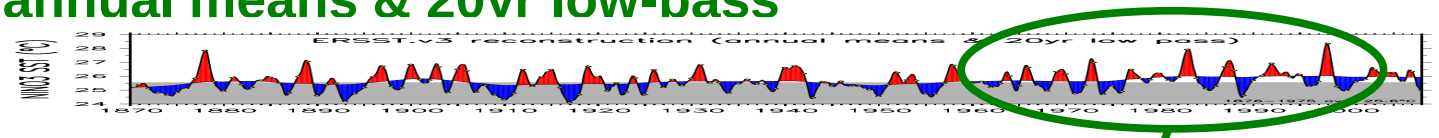
atmos: 2°x2.5°xL24 finite volume
ocean: 1°x1°xL50 MOM4 (1/3° near equator)
2hr coupling; ocean color; no flux adjustments
ENSO ranks among top 4 AR4-class models
SI forecasts; basis for AR5 models

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



1

2

3

4

5

6

7

8

9

10

ave: 24.85°C

11

12

13

14

15

16

17

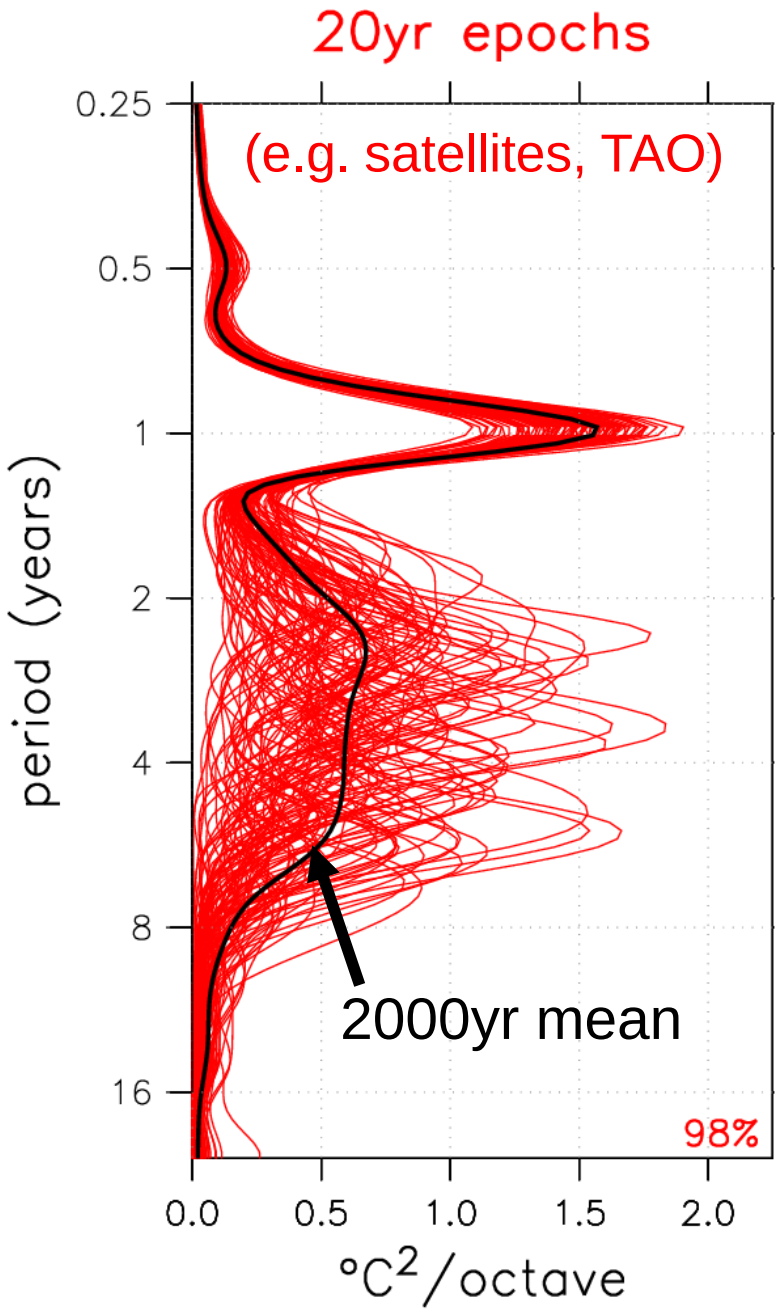
18

19

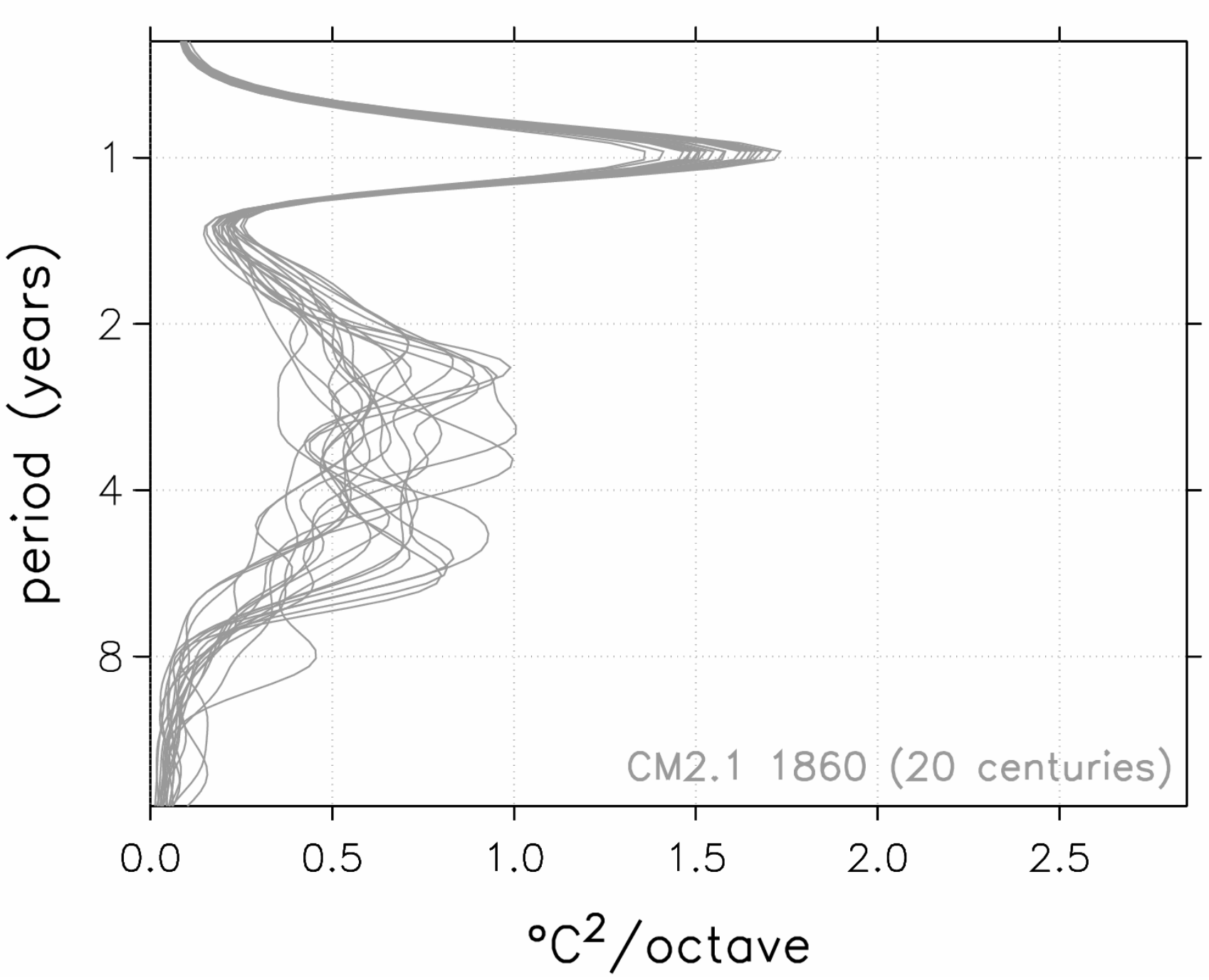
20

ave: 24.97°C

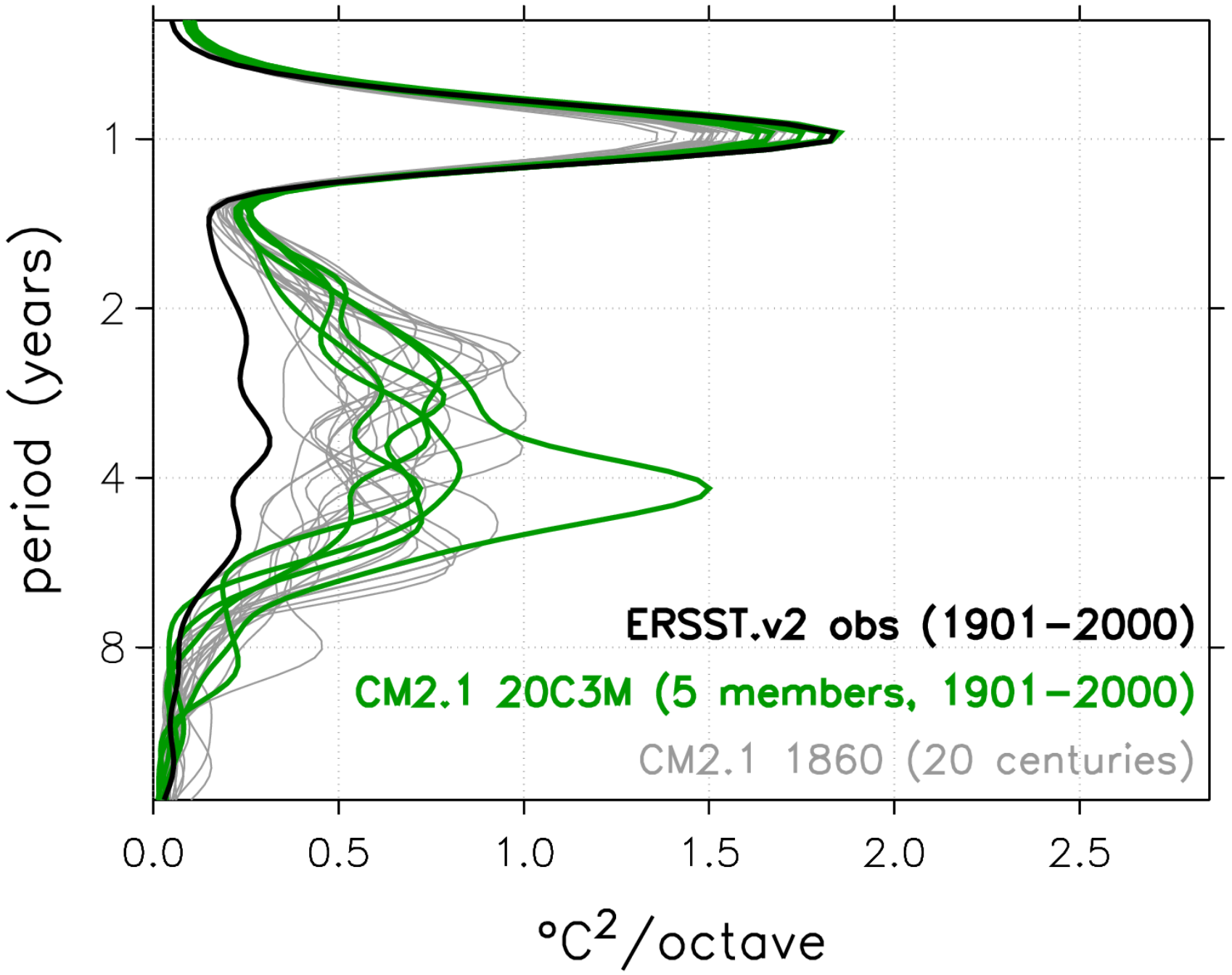
Modulation of NINO3 SST power spectrum



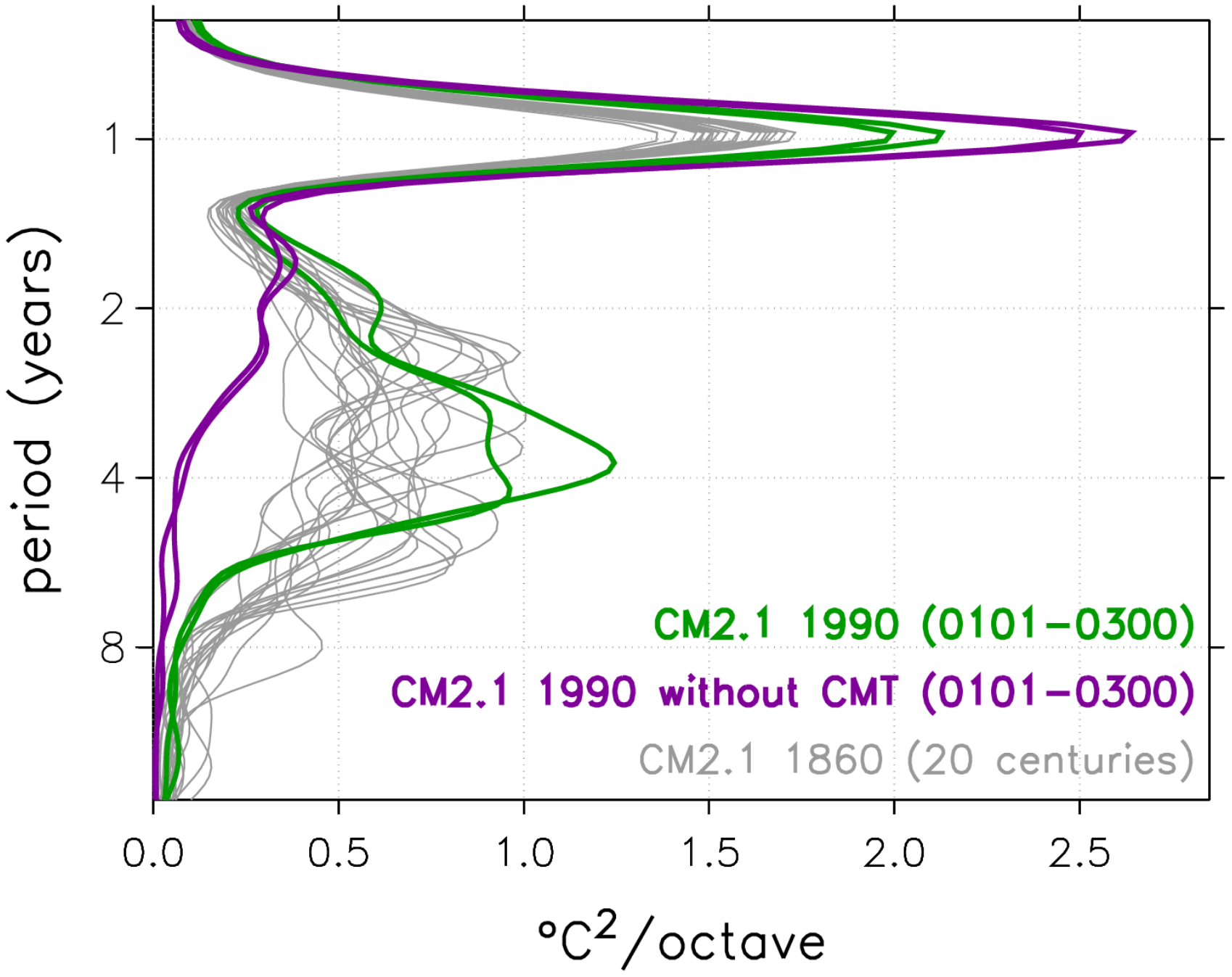
Given long enough runs, we can say...



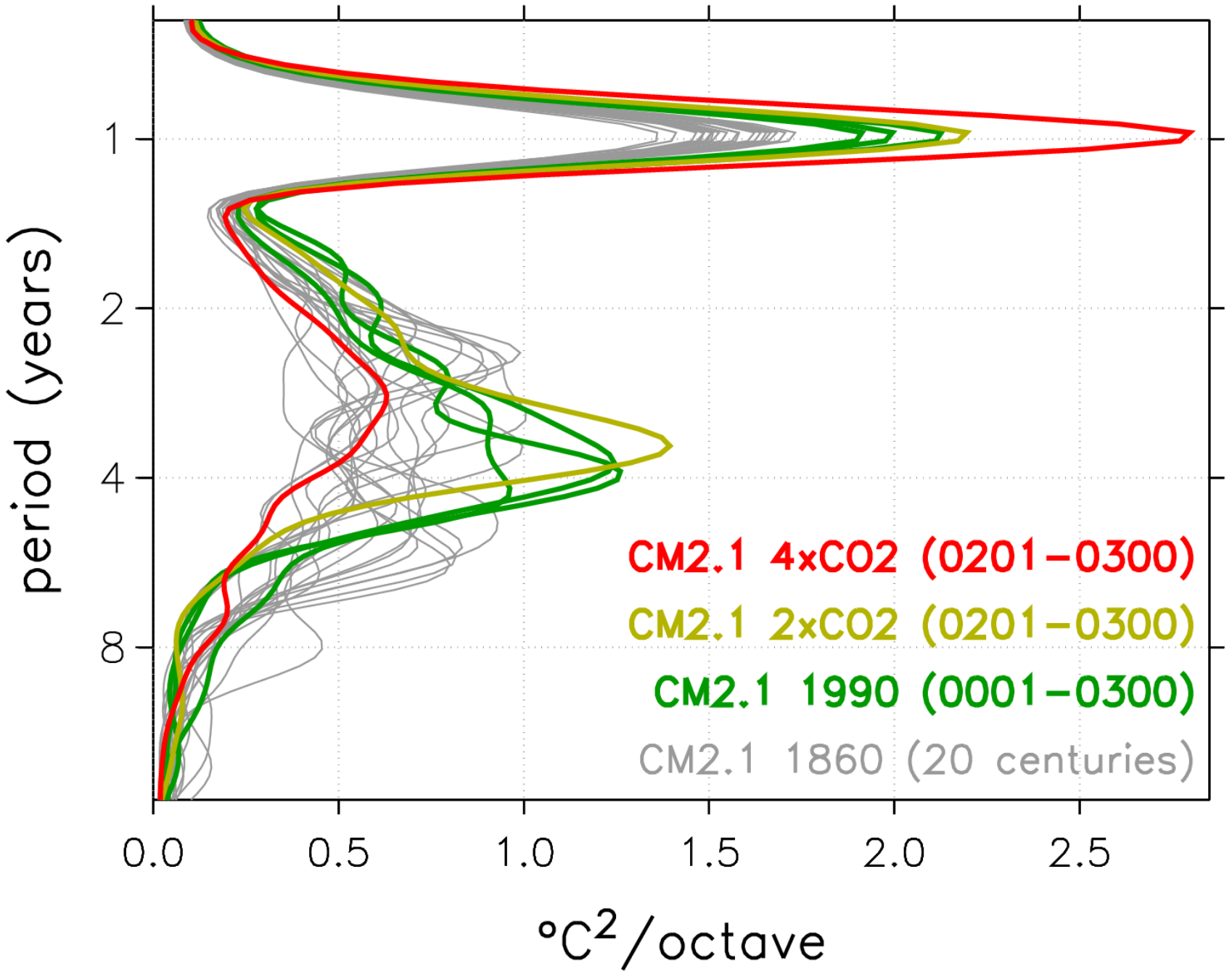
CM2.1 ENSO is too strong



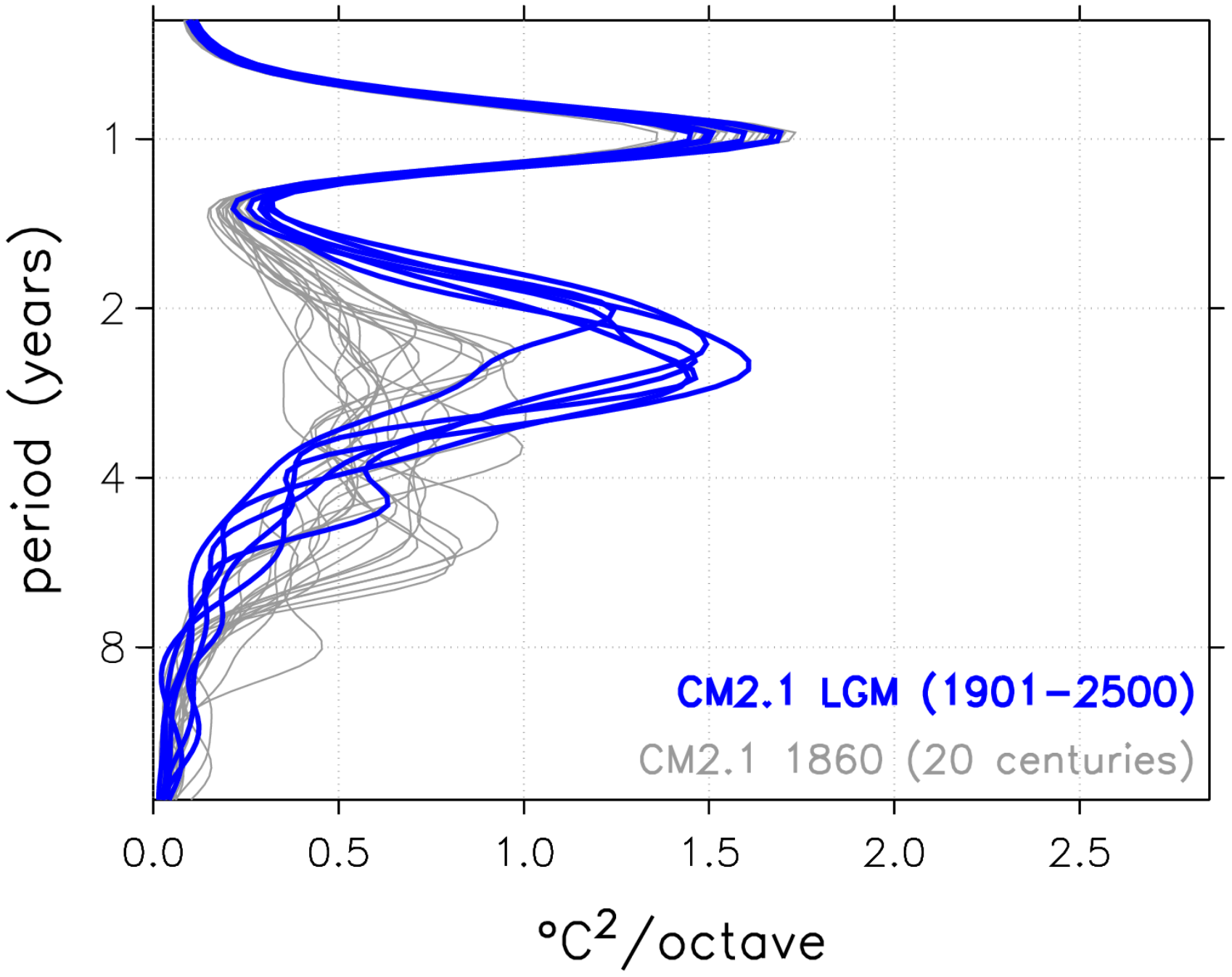
CM2.1 ENSO is very sensitive to some parameters



A perfect climate for ENSO?



Last Glacial Maximum (20ka)



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

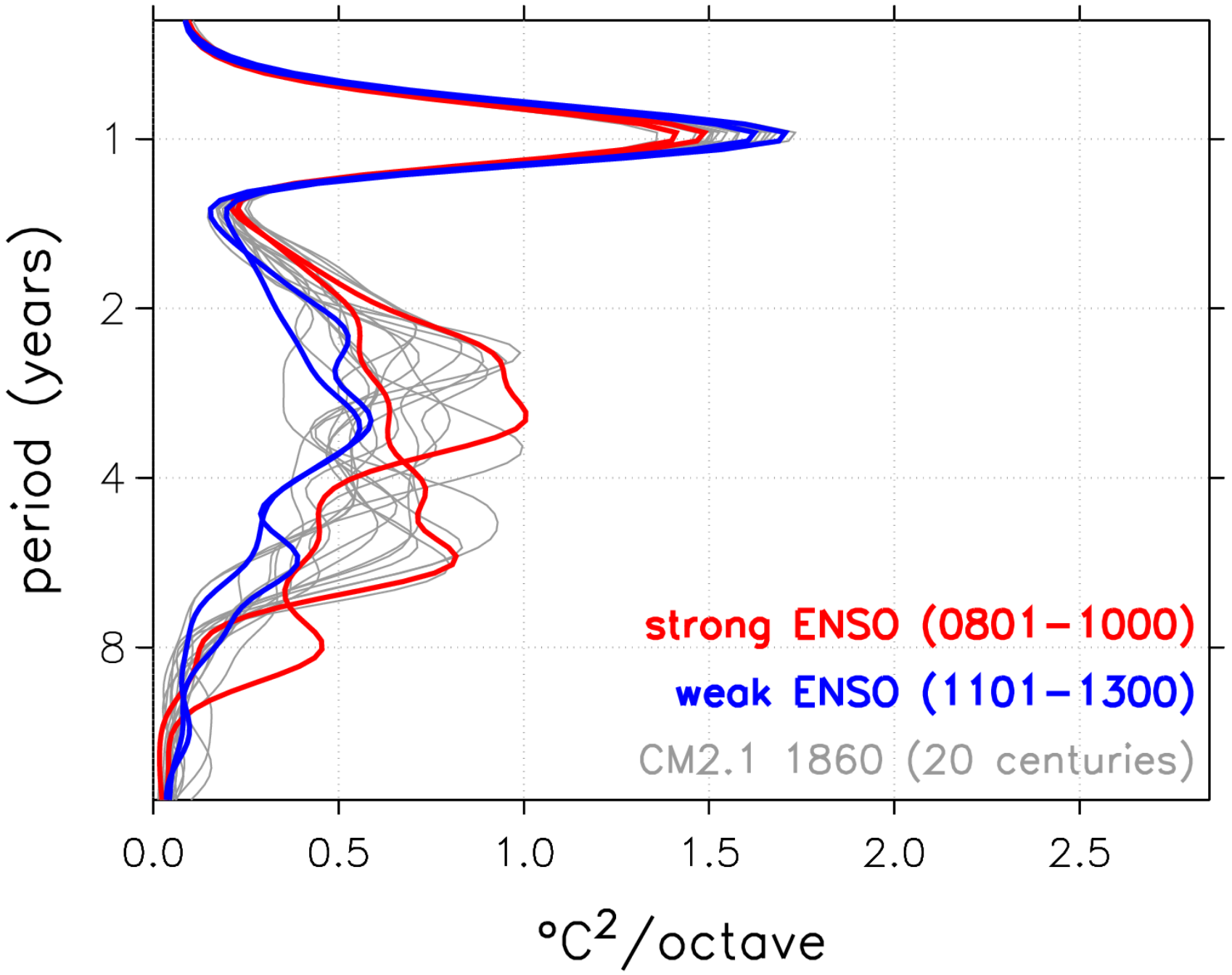
3. Puts large error bars on *some* ENSO metrics (e.g. spectra) diagnosed from short time series

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

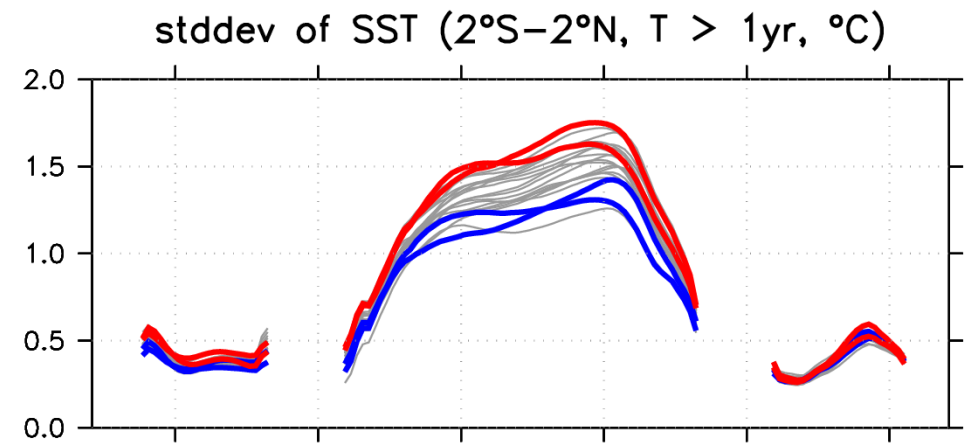
5. Are other models & real world like CM2.1?

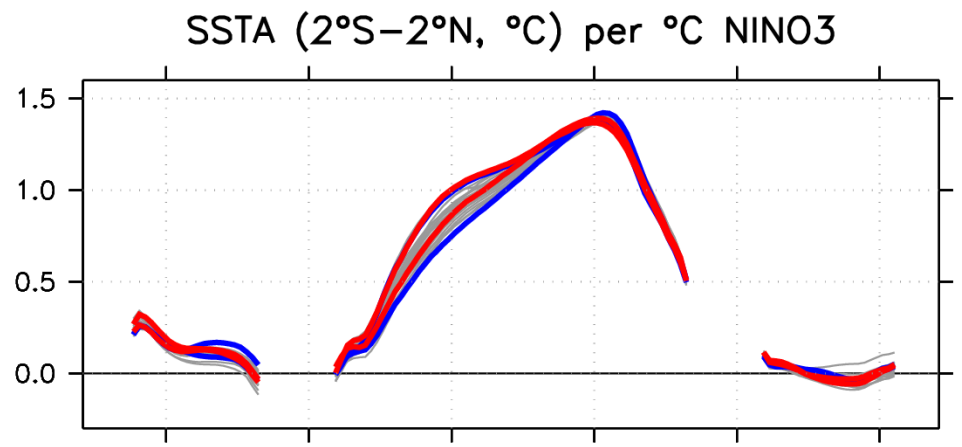
Reserve Slides

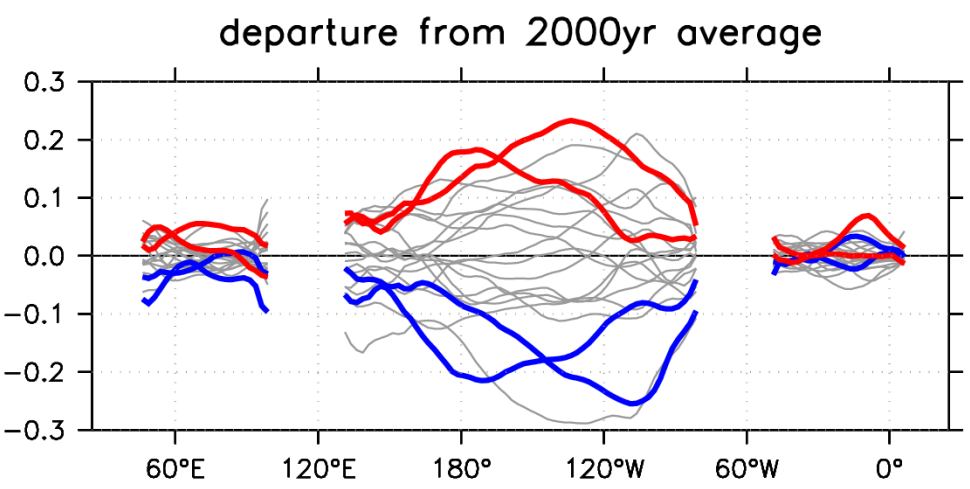
Centuries of weak or strong ENSOs

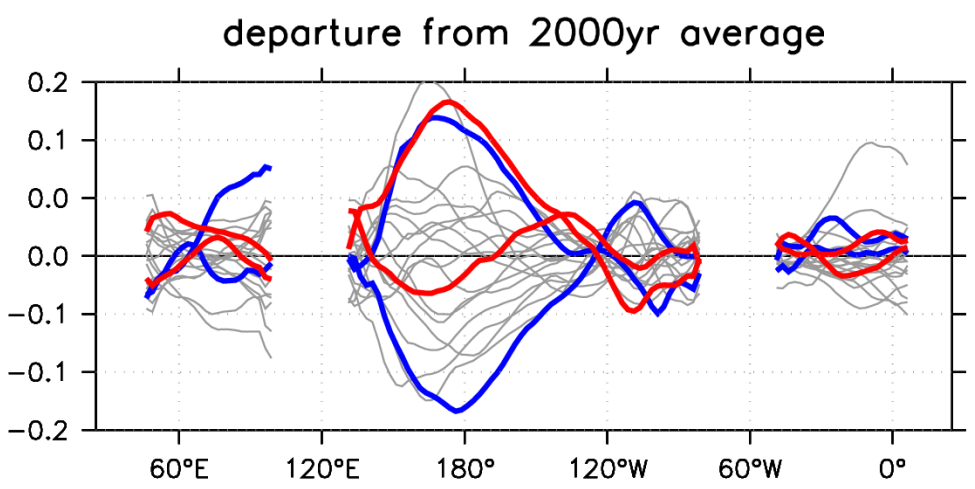


Active/inactive centuries show no *robust* difference in the scaled ENSO SSTA pattern

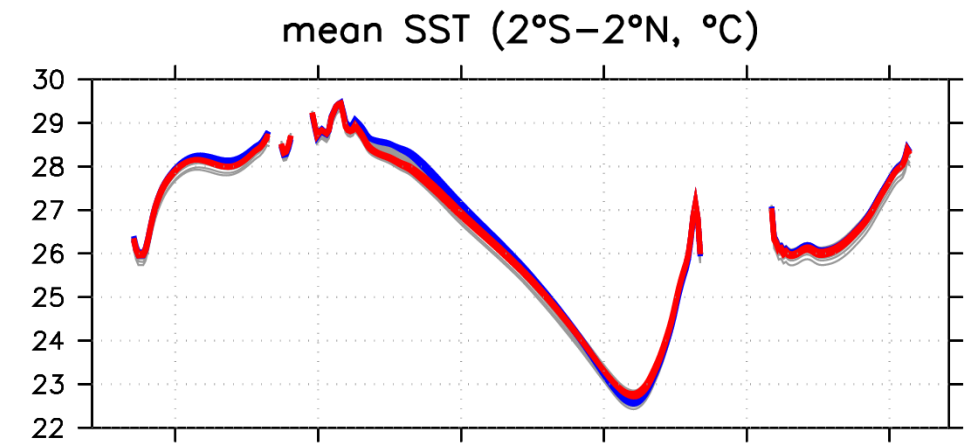


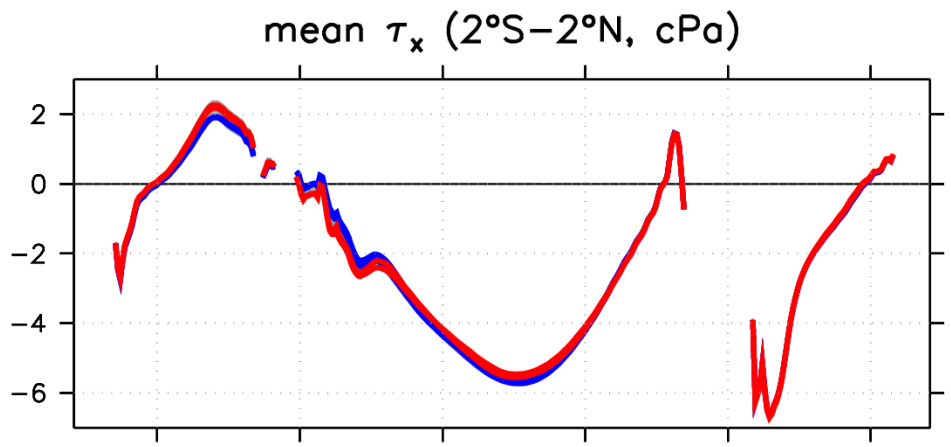


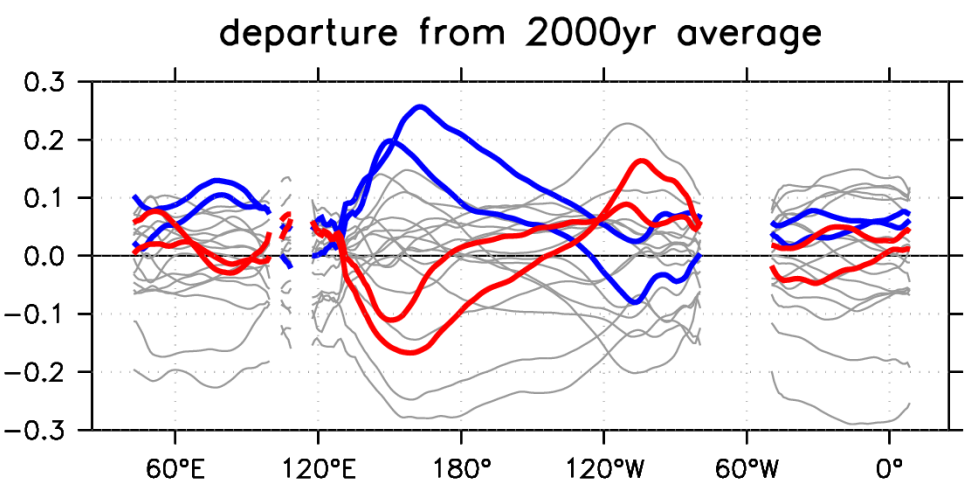


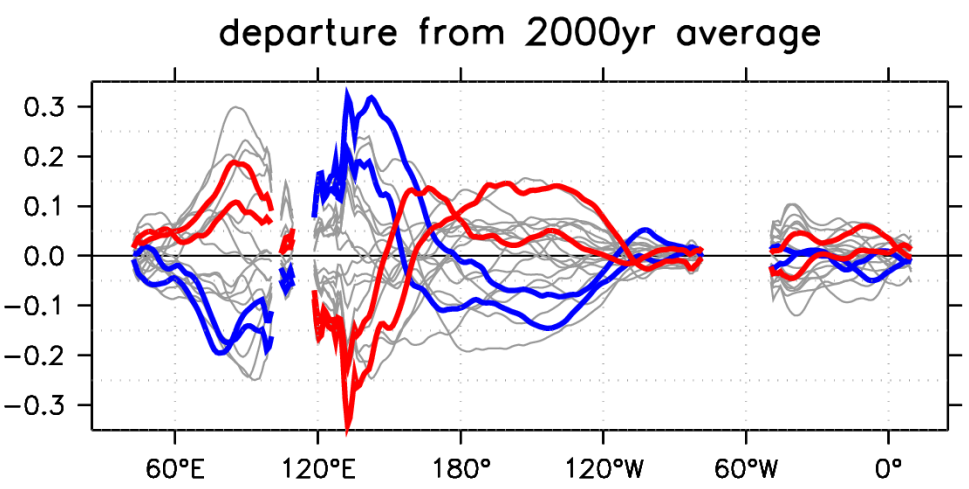


CM2.1 mean state barely changes between active/inactive ENSO centuries

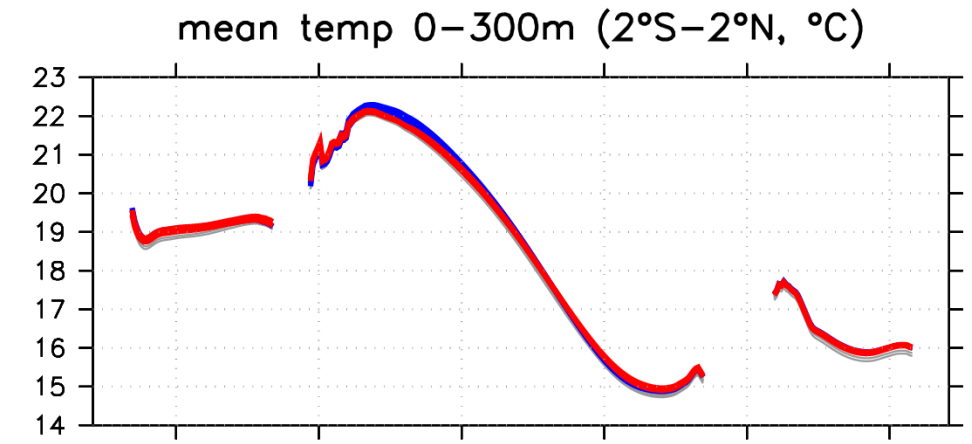


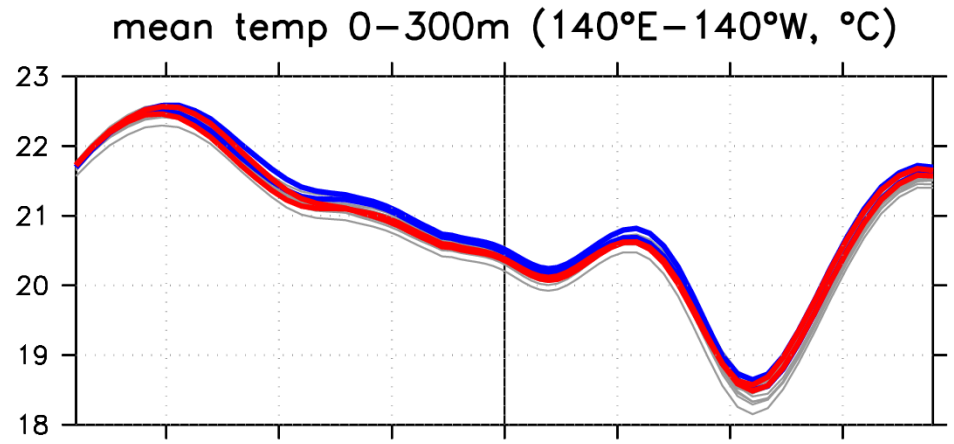


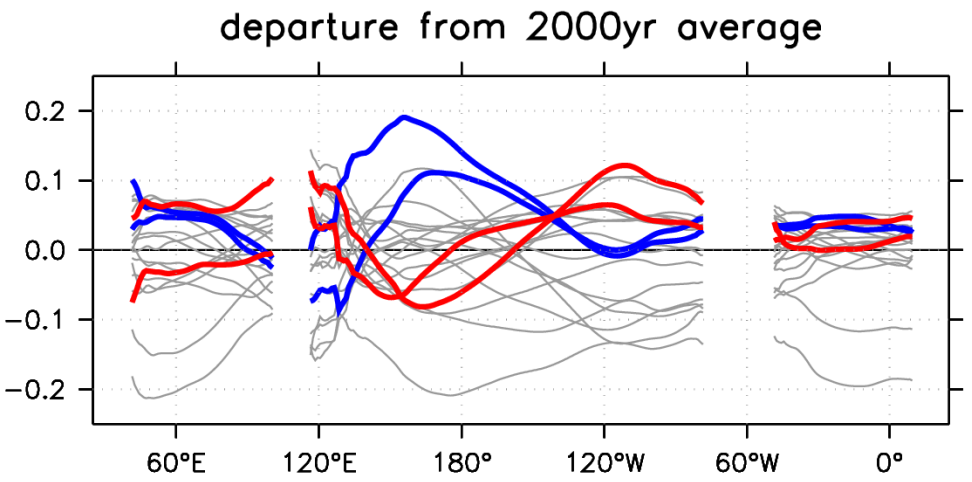


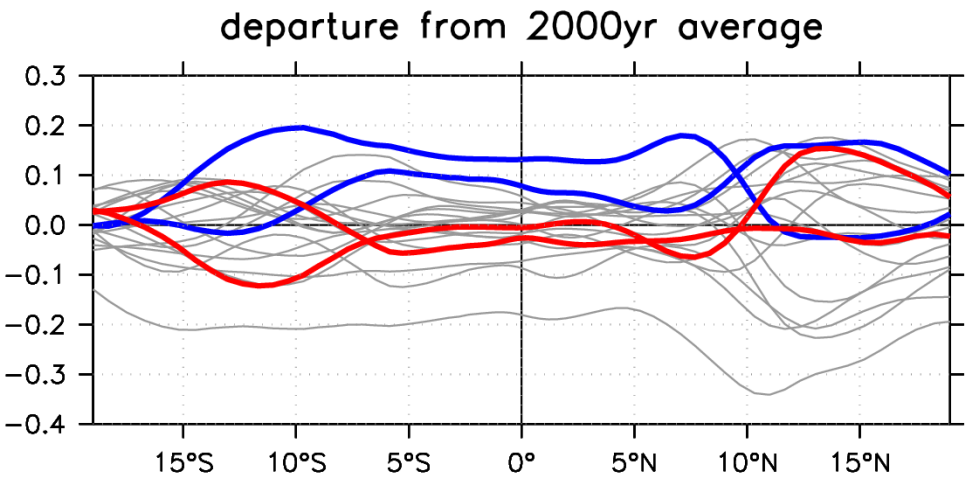


Inactive centuries have *slightly* warmer water in the west Pacific

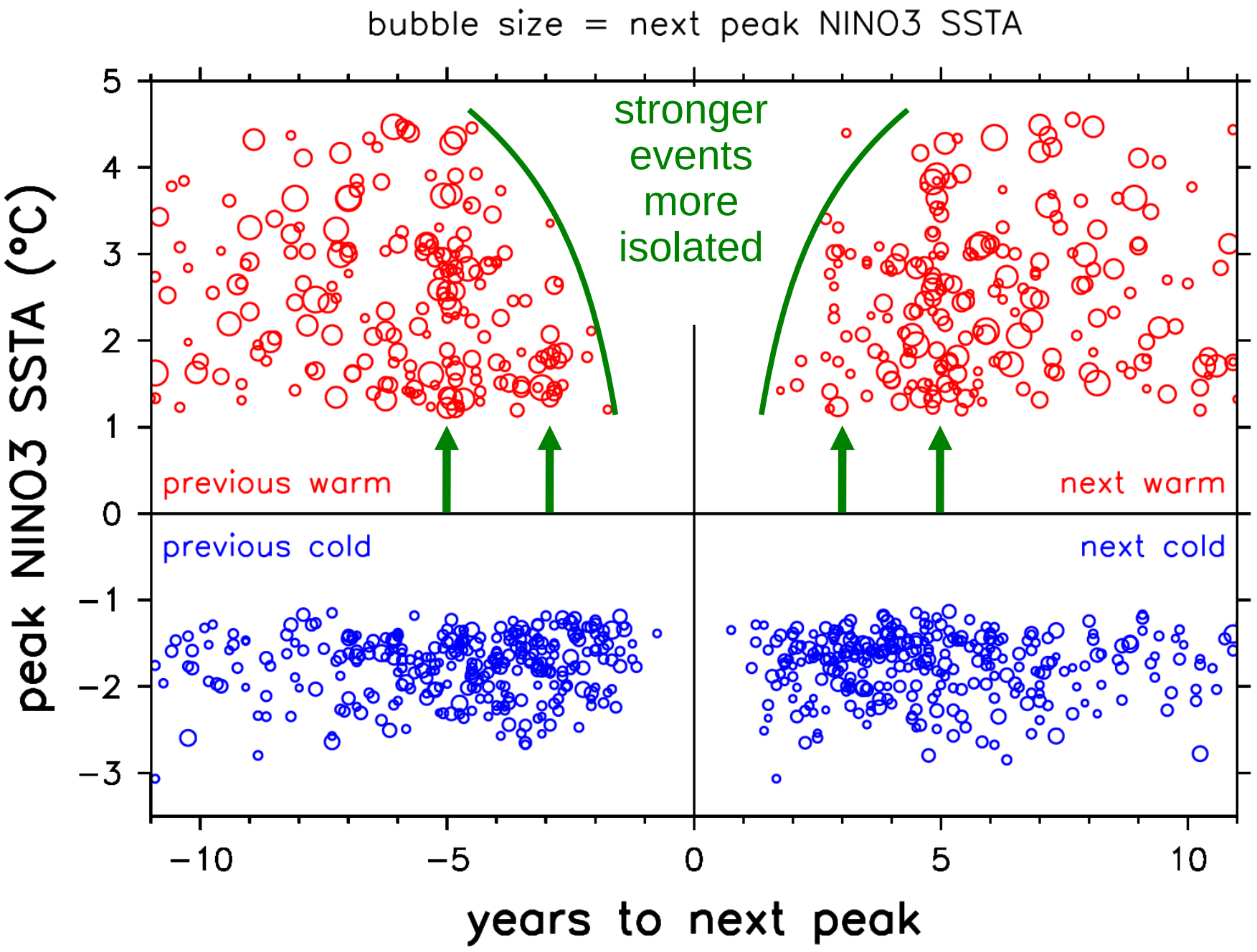


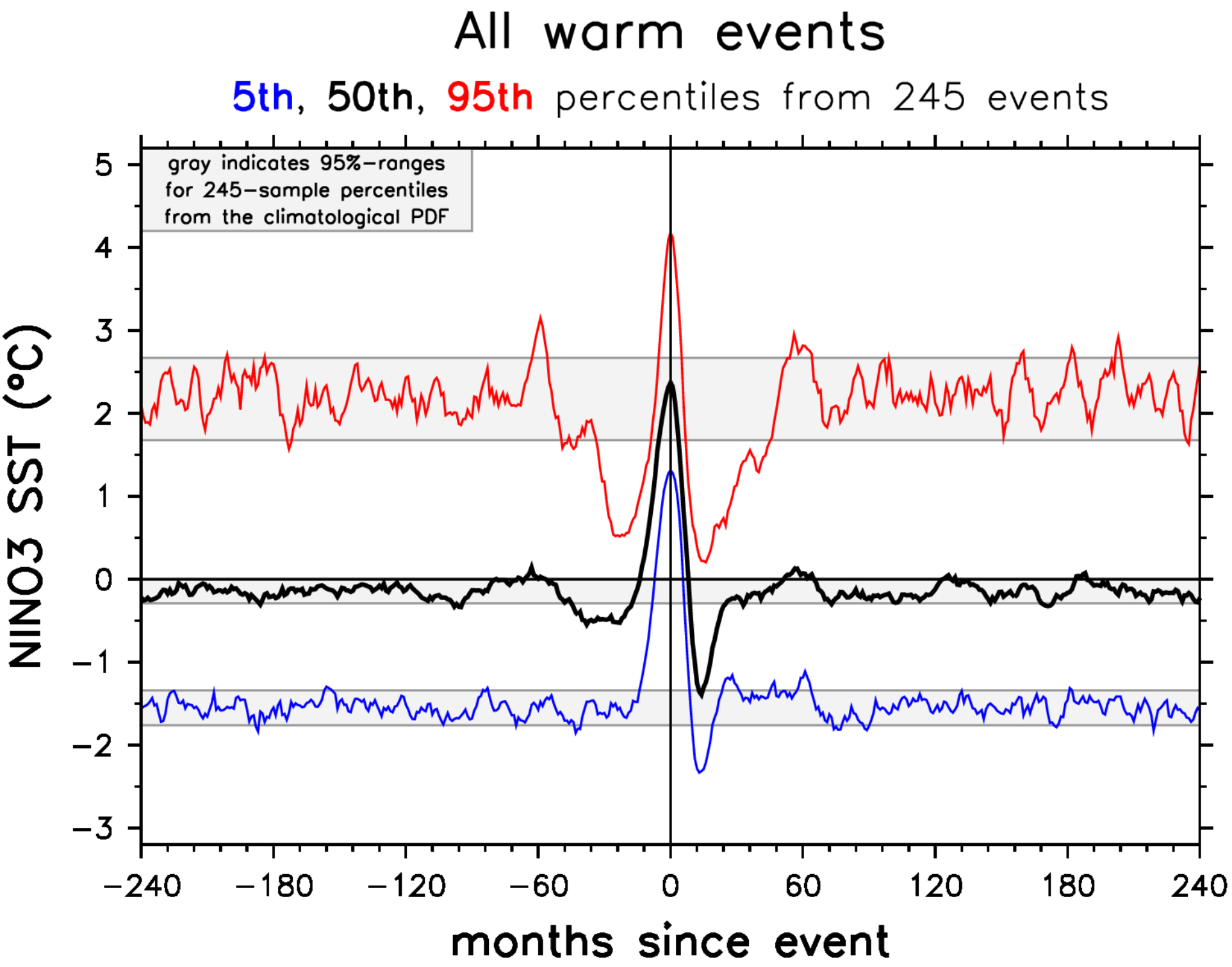






Are ENSO events linked to their neighbors?




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)
5
4
3
2
1
0
−1
−2
−3
−240
−180
−120
−60
0
60
120
180
240
months since event