

Geophysical Fluid Dynamics Laboratory Review

June 30 - July 2, 2009



Climate Change and ENSO

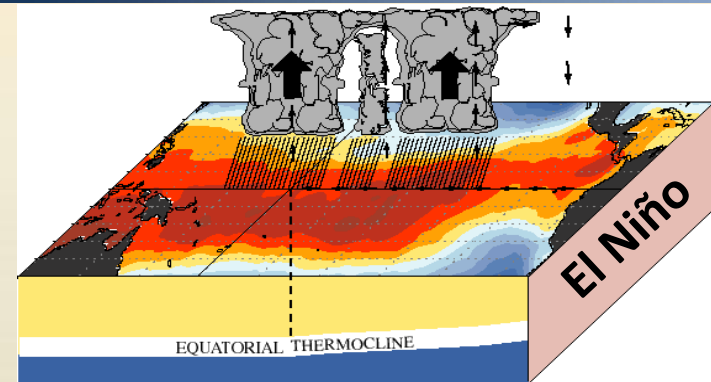
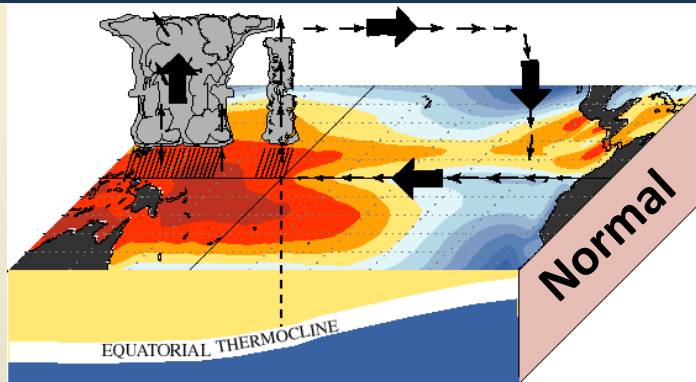
Presented by
Andrew Wittenberg

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ENSO: Earth's dominant interannual climate signal



Global impacts:

- **weather & climate**, natural disasters, **transportation**
- **ecosystems**, agriculture, **fisheries**
- **water**, food, energy, health, **commerce**

How vulnerable are we to future ENSOs?

- unresolved in AR4: **natural vs. anthropogenic risk**
- changes in **phenomenon** vs. **teleconnections** vs. **impacts**
- short, gappy, nonstationary obs system → **models crucial**
- coupling & scale interactions → **key test for models**

GFDL: Strongly positioned in the ENSO community

World-class ENSO simulations

- **Realistic** ENSO patterns, mechanisms, teleconnections
- **Rich** spectrum of ENSO behavior
- **Stable** 2000yr control run

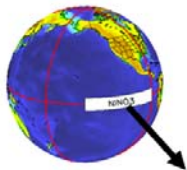
Wittenberg et al., Delworth et al., Capotondi et al., Merryfield et al., Joseph & Nigam, (all JC 2006); van Oldenborgh et al. (OS 2005); Guilyardi (CD 2006); Reichler & Kim (BAMS 2008); Wittenberg (GRL 2009)

Groundbreaking ENSO research & collaborations

- ENSO mechanisms, **modulation**, and **sensitivities**
- **Extratropical impacts**, decadal signals, drought
- **Paleoclimates** & pseudoproxies; role of volcanoes
- Community **metrics**; diagnostic submodels; visualization

Sample of external collaborations: Alexander et al. (2004), Vecchi & Harrison (JC 2006), Gebbie et al. (JAS 2007), Kim et al. (CD 2008), Zavala-Garay et al. (JC 2008), Sukharev et al. (IEEE 2009), Lengaigne & Vecchi (CD 2009)

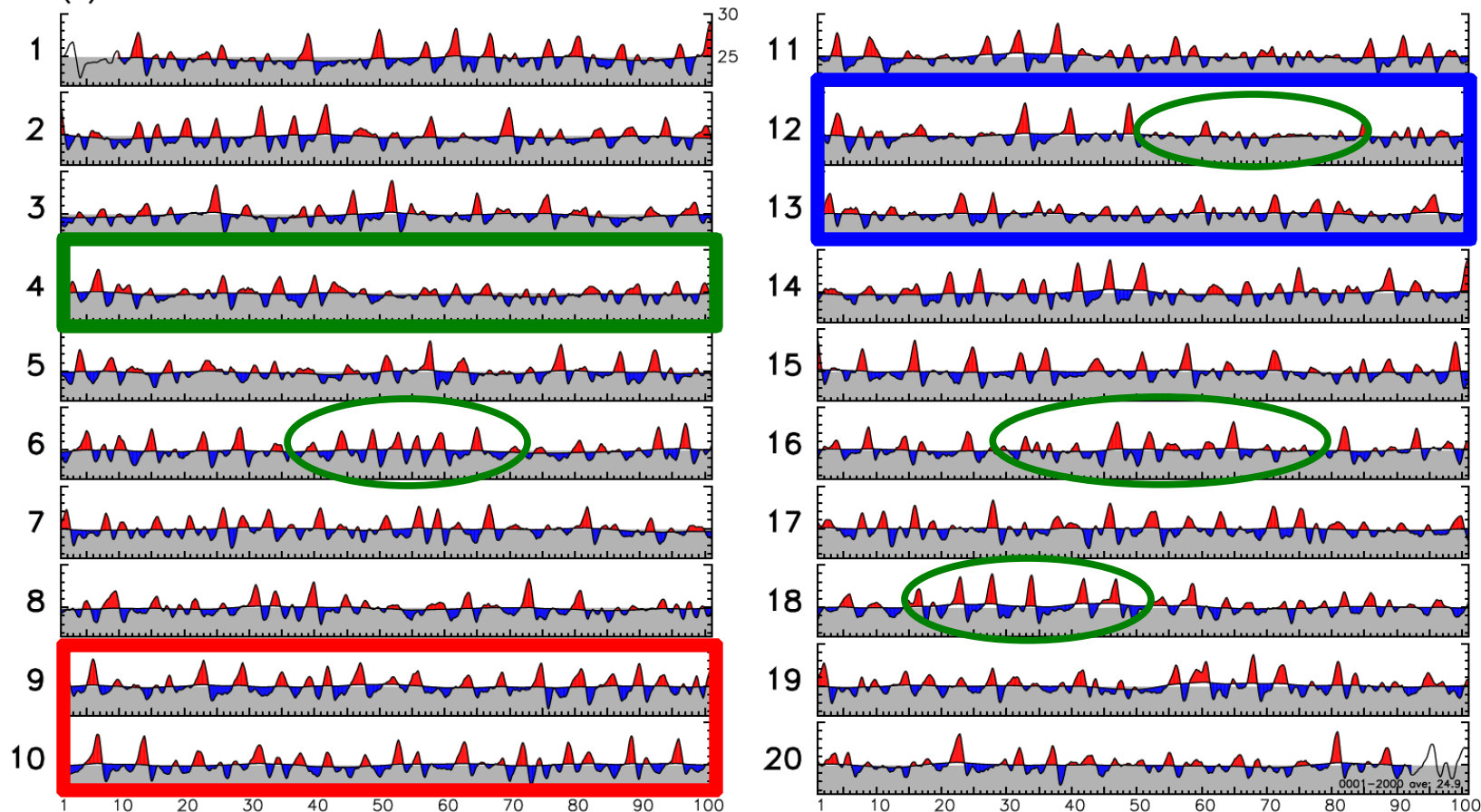
ENSO modulation implies “natural” risks



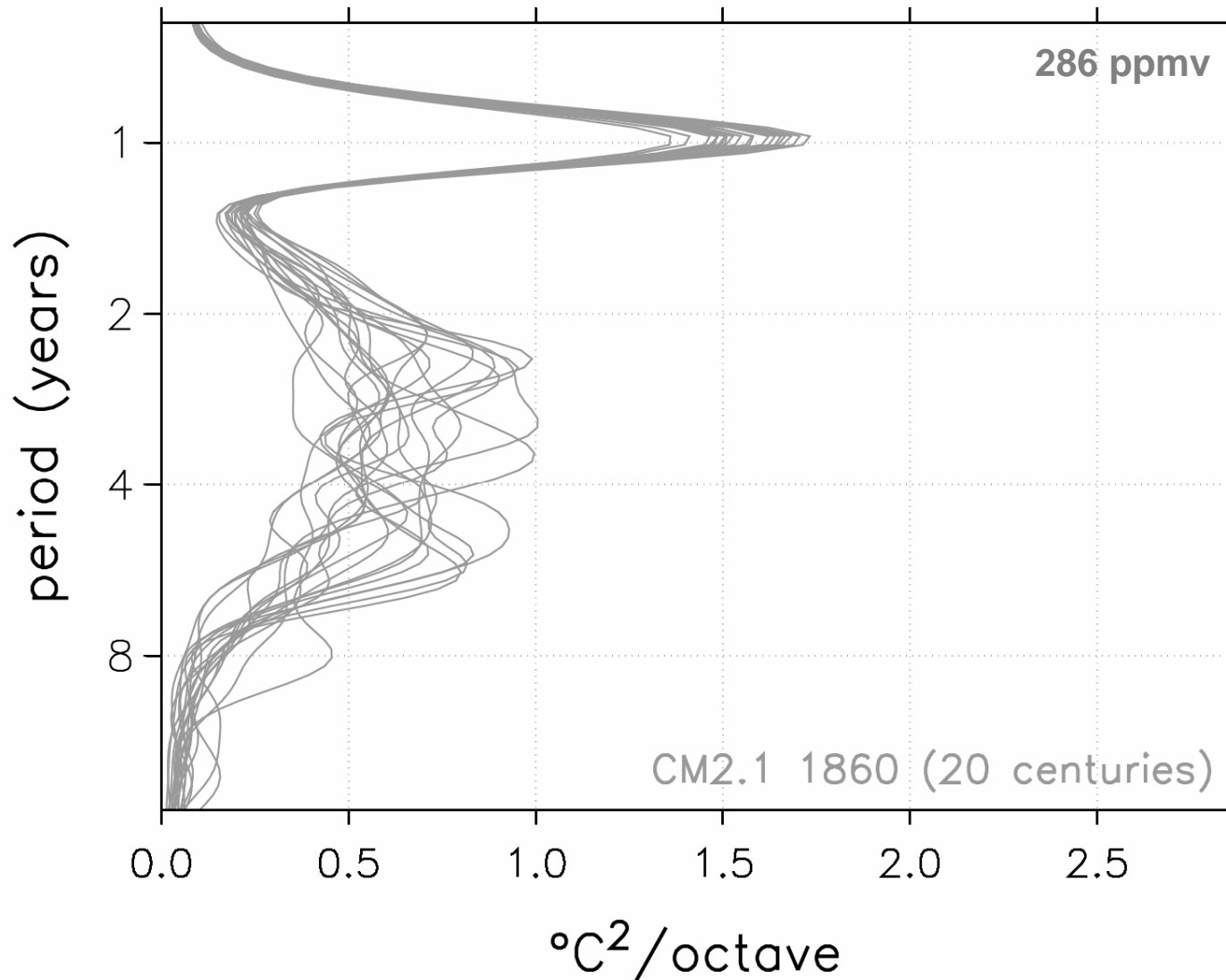
NINO3 SST, running annual mean

Wittenberg (GRL 2009)

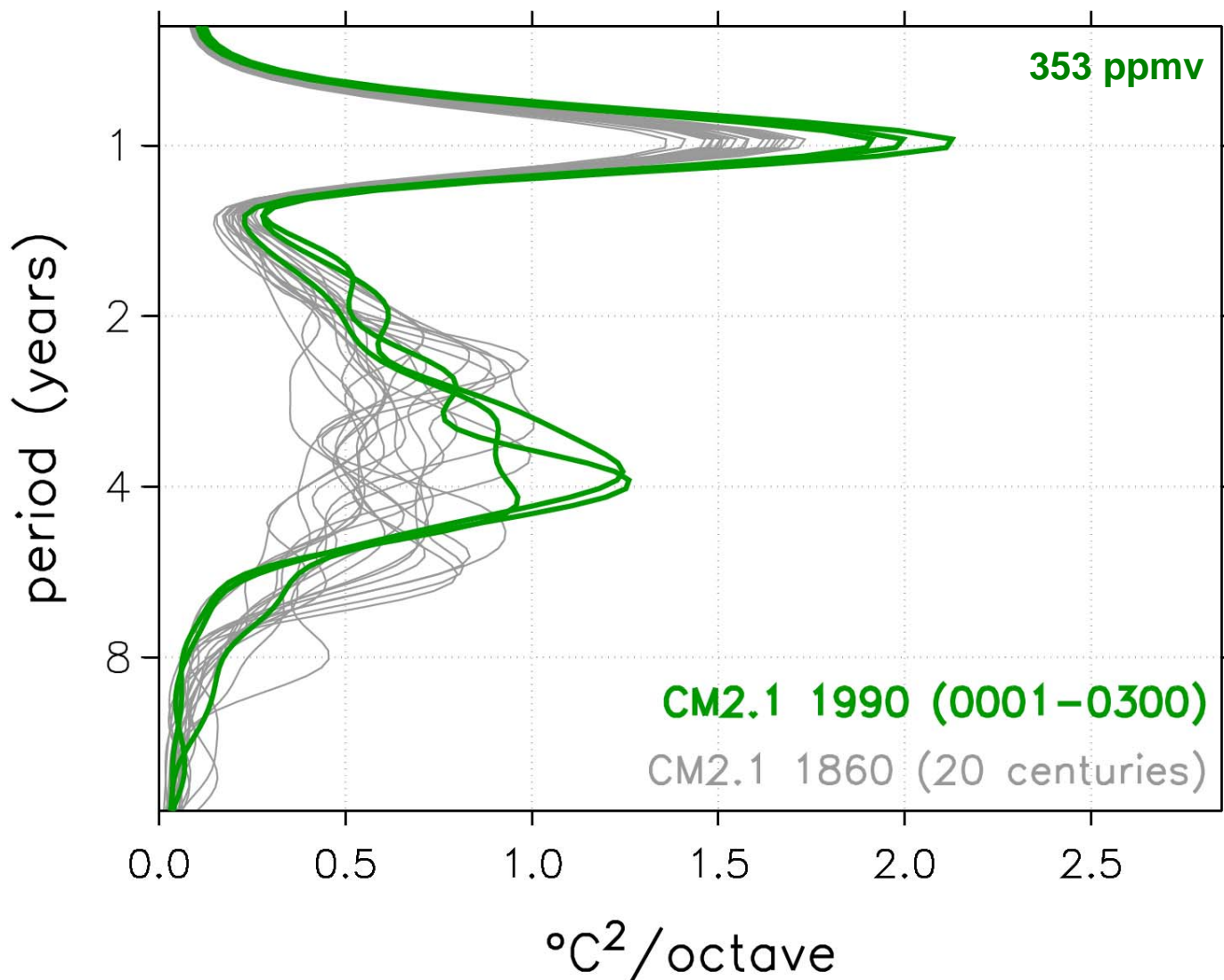
(b) CM2.1 PI control simulation



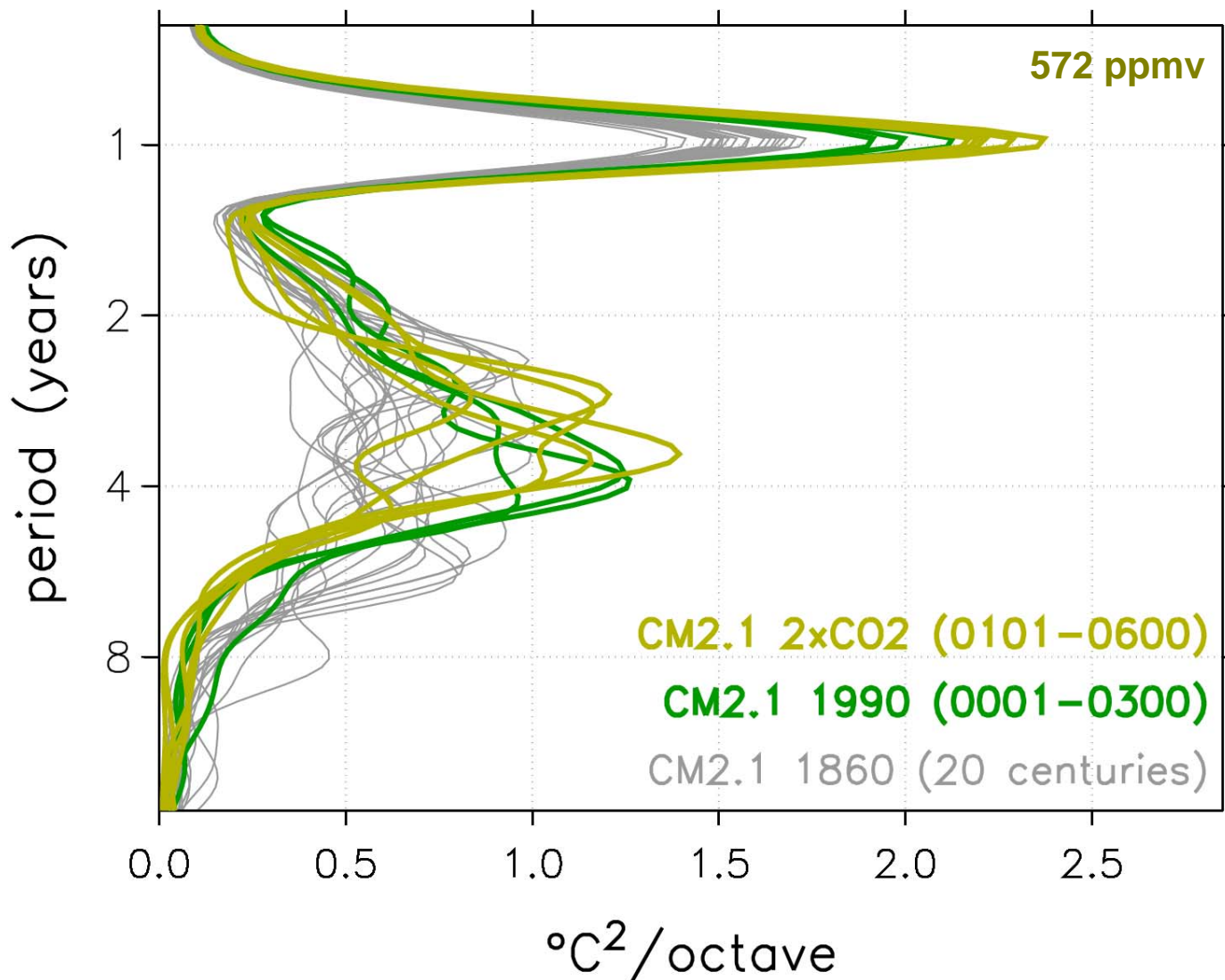
1860: Spread of 100yr NINO3 SST spectra



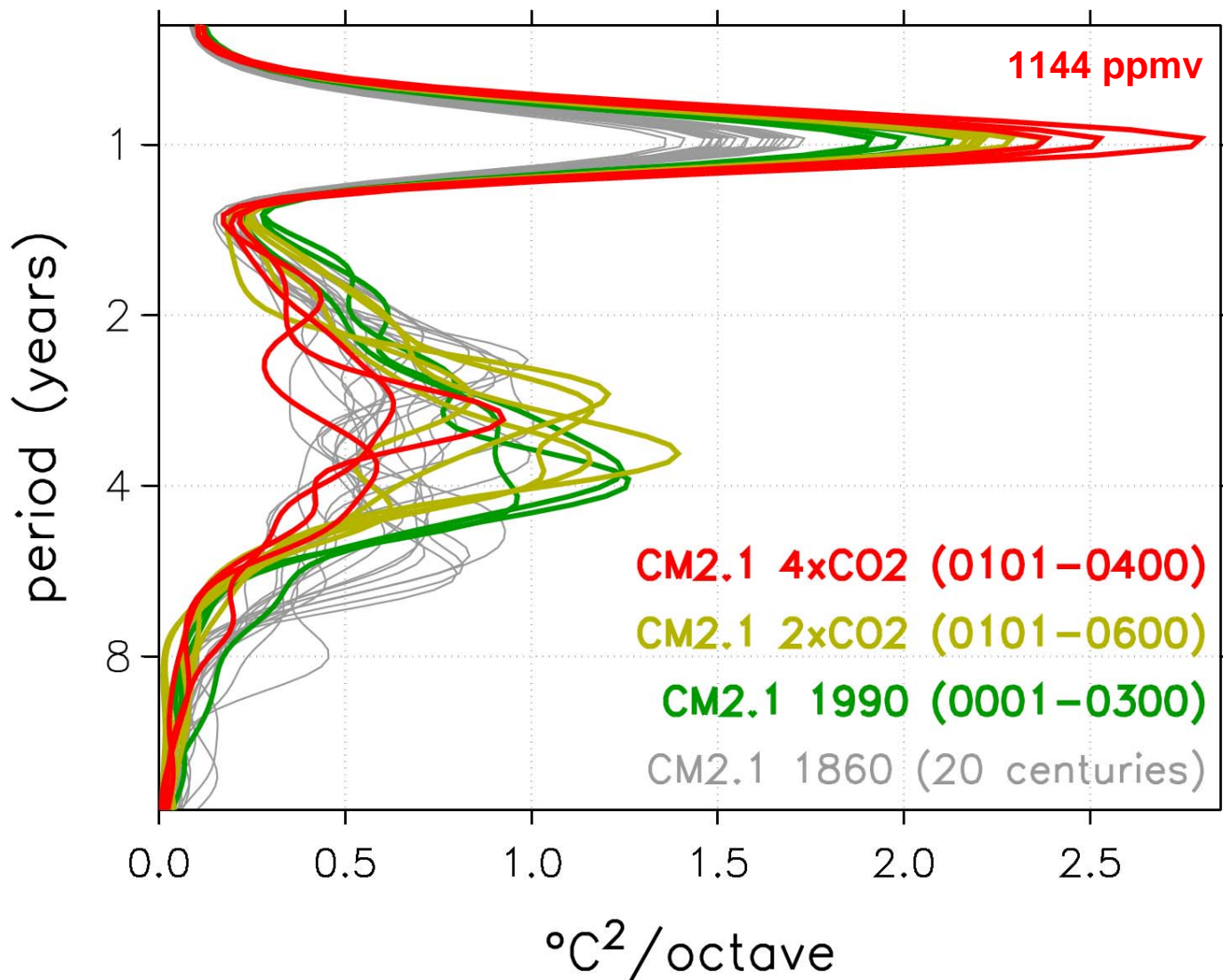
1990: Stronger annual cycle & ENSO



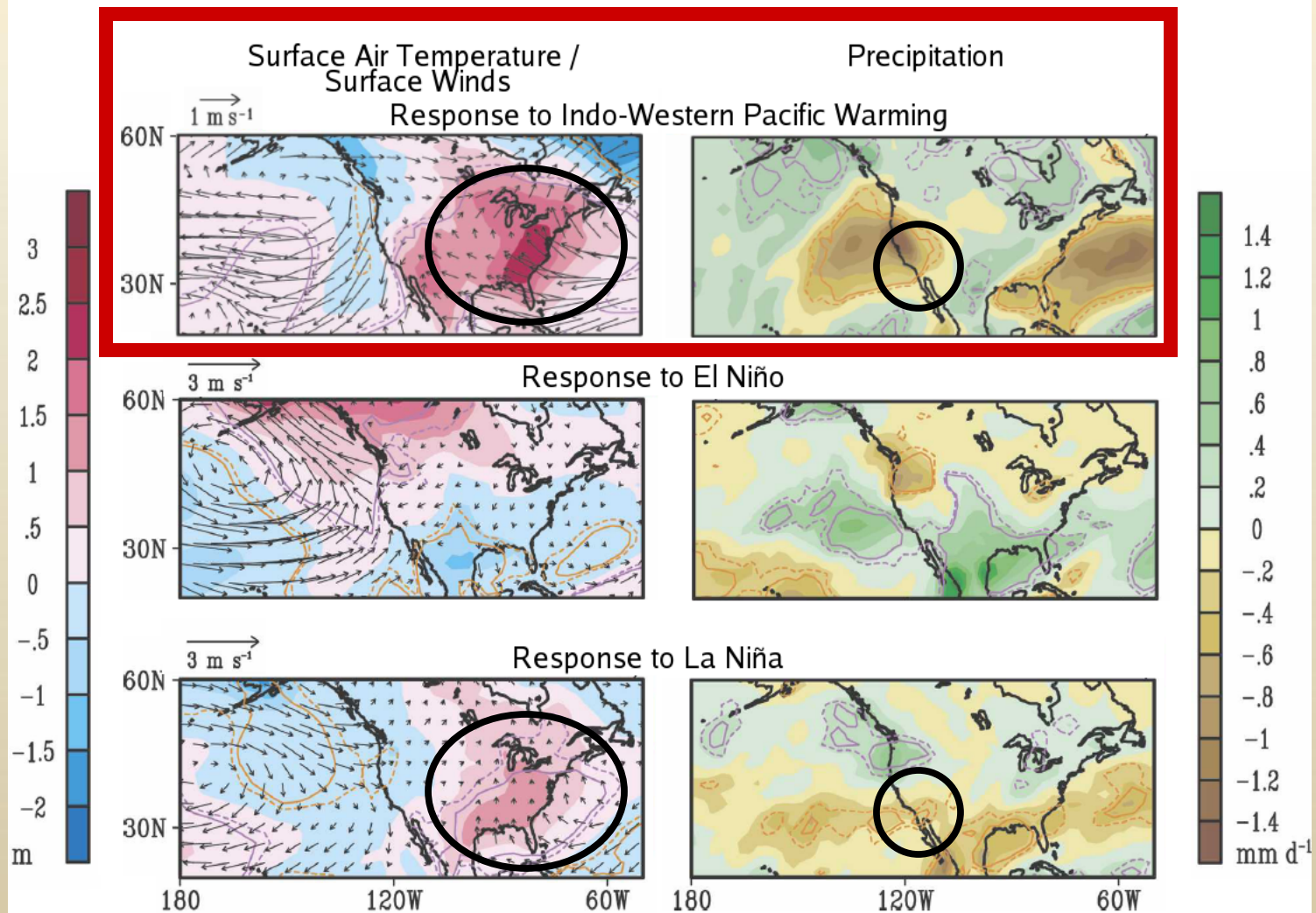
2xCO₂: A perfect climate for ENSO?



4xCO₂: Stronger annual cycle, but weaker ENSO



Anthropogenic warming alters ENSO impacts



Lau, Leetmaa and Nath (2008)

Summary

1. CM2.1 ENSO simulation is among the world's best

- Clarifying ENSO **mechanisms & sensitivities**
- GFDL **AR5 models**: new feedbacks & impacts

2. 2000yr run highlights “natural” ENSO risks

- **Modulation**: Have we observed long enough?
- Are extreme ENSO epochs **predictable**?

3. Climate change affects ENSO & its impacts

- **Optimal climate for ENSO**: which side are we on?
- Warmer warm pool: alters **U.S. vulnerability** to ENSO
- How best to extrapolate from model projections to reality?

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