Using Ocean Reanalysis to Validate CMIP5 Historical Experiments in the Tropical Pacific Ocean

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1. How well do CMIP5 coupled models simulate El Niño?

2. Does El Niño change in CMIP5 coupled models during the last century?

CMIP5 Historical Experiment

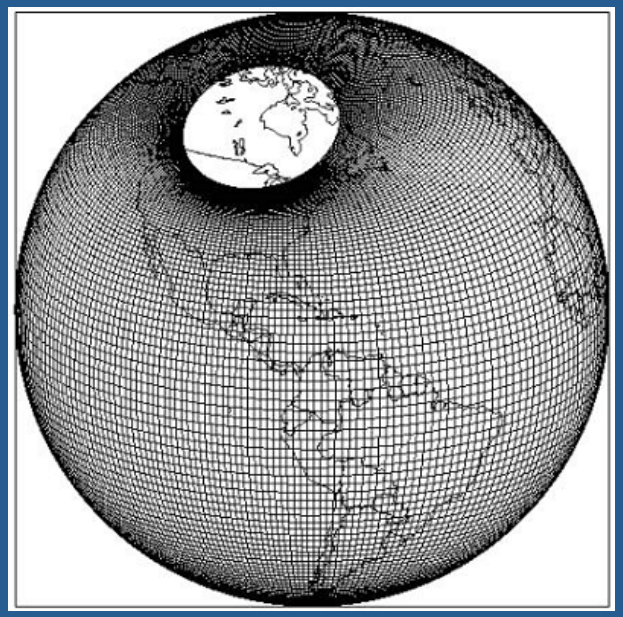
1. Most cover from 1850 to 2005, except HadCM3 covers from 1860 to 2005

2. Forcing: Observed atmospheric composition changes (Reflecting both natural and anthropogenic sources)

3. Ensemble experiments (ranging from 3 to 10 members)

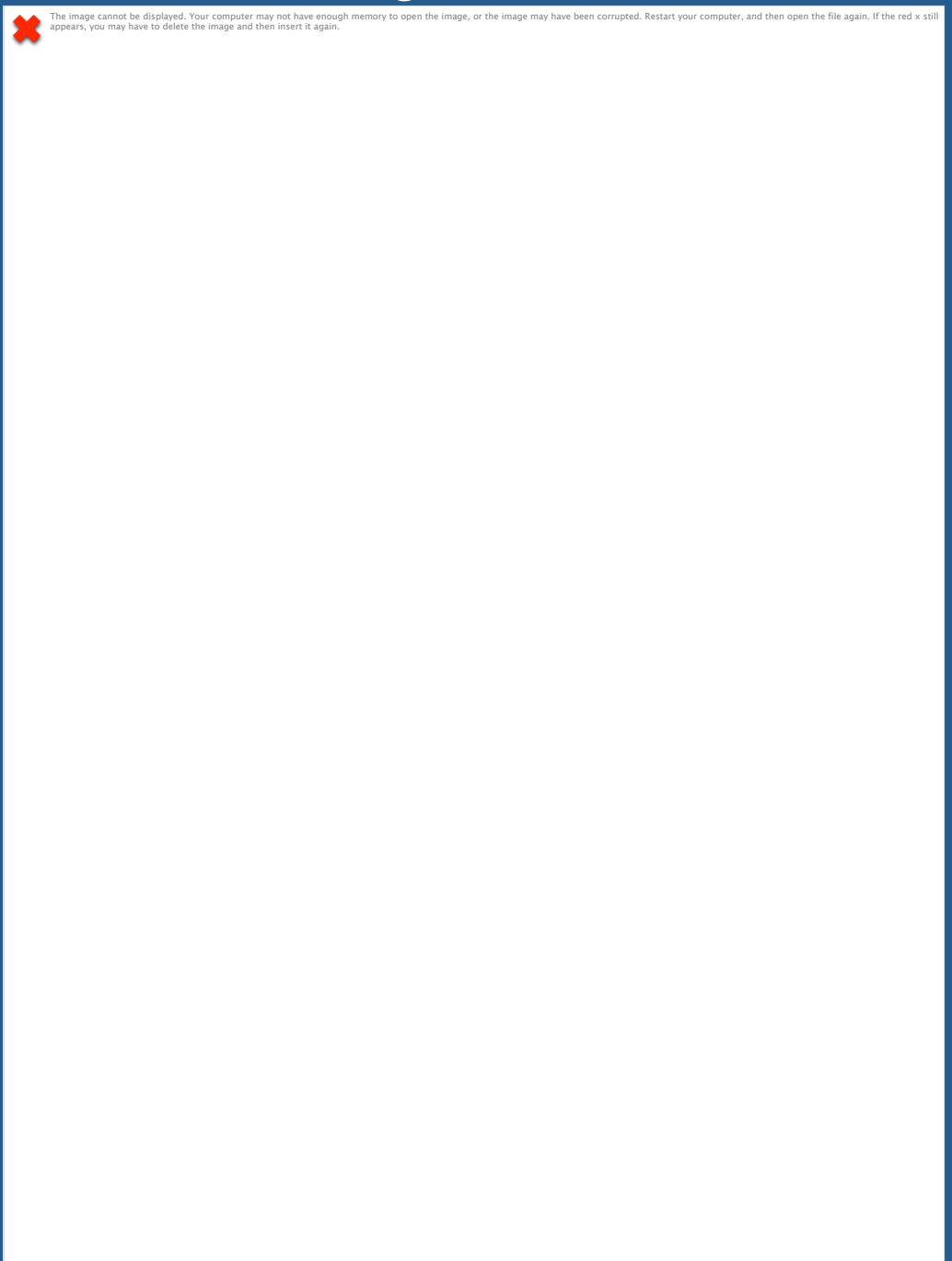
4. 10 models available at the time of this study

SODA 2.2.6



- **Eight Ensemble Members**
- **Numerics**
  - Parallel Ocean Program
- **Domain**
  - Global (including Arctic)
- **Resolution**
  - 0.4x0.25 average (~25km x 25km midlat) horizontal
  - 40 levels: 10m near surface to 450m in deep ocean
- **Winds**
  - Eight Ensemble members of 20CRv2 daily stress 1871 – 2008
- **Heat and Salt fluxes**
  - Bulk formulae using 20CRv2 daily variables
- **SODA Data Assimilation**
  - ICOADS 2.5 SST data

Averaged El Niño



SODA_2.2.6

BCC-CSM1-1

CanESM2

CNRM-CM5

CSIRO-MK3-6-0

GISS-E2-R

HadCM3

IPSL-CM5A-LR

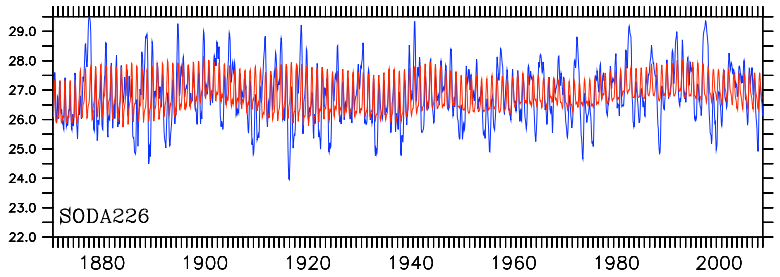
MIROC-ESM

MPI-ESM1-M

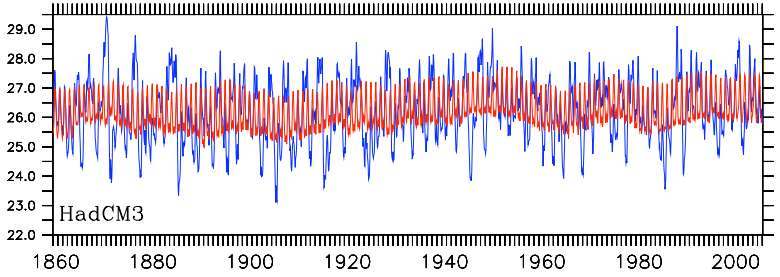
NorESM-M

Niño 3.4 SST

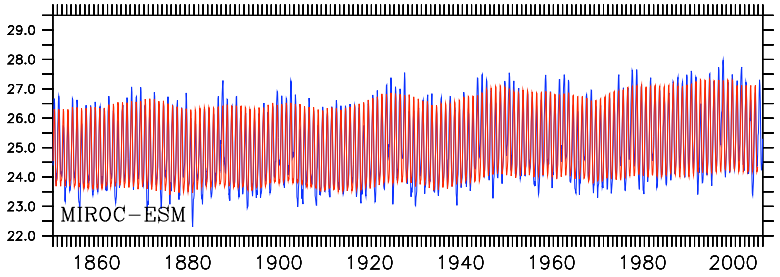
SODA_2.2.6



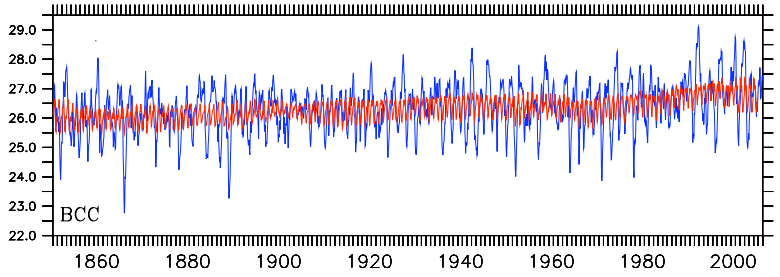
HadCM3



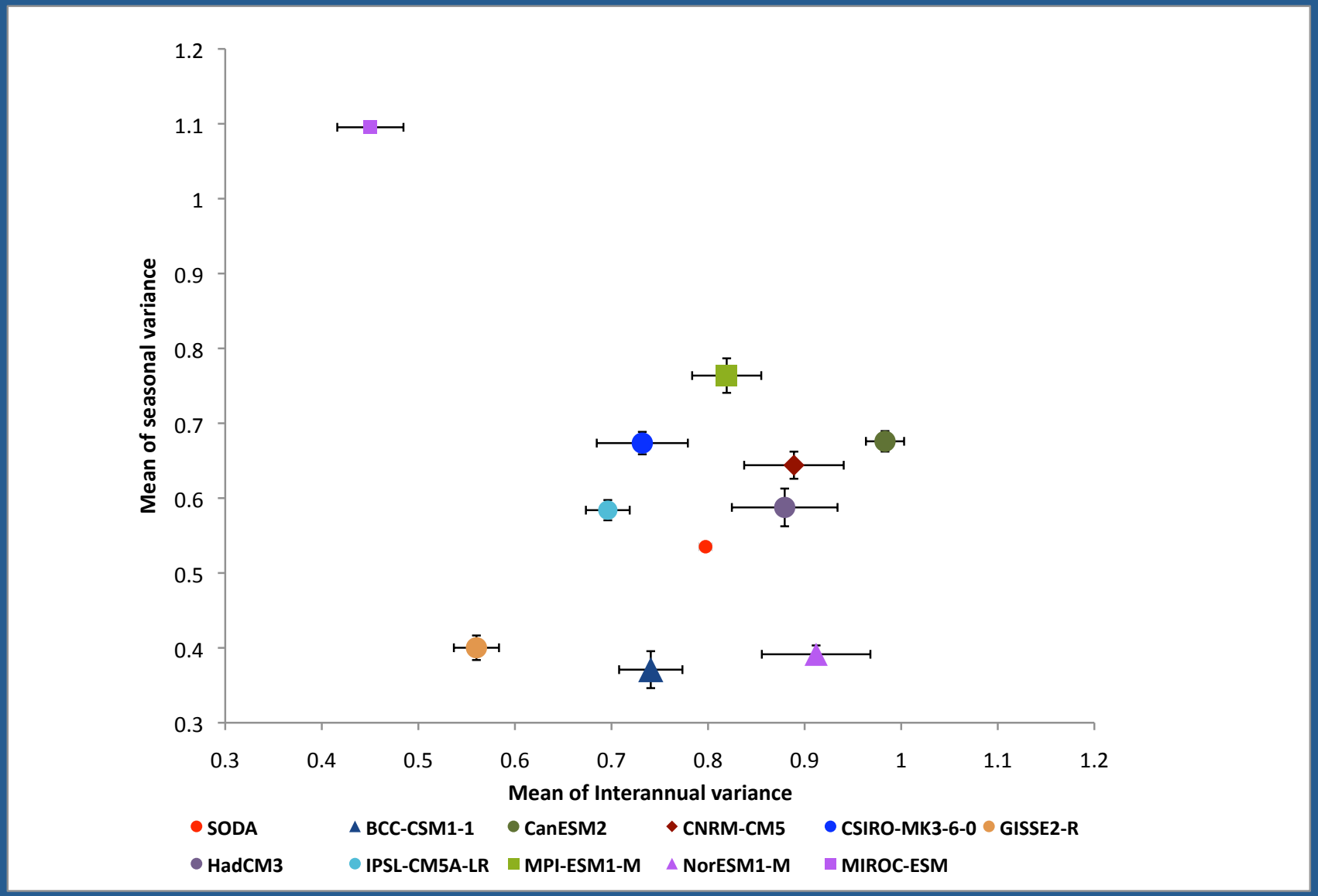
MIROC-ESM



BCC



Comparison of Niño 3.4 Seasonal and interannual variance



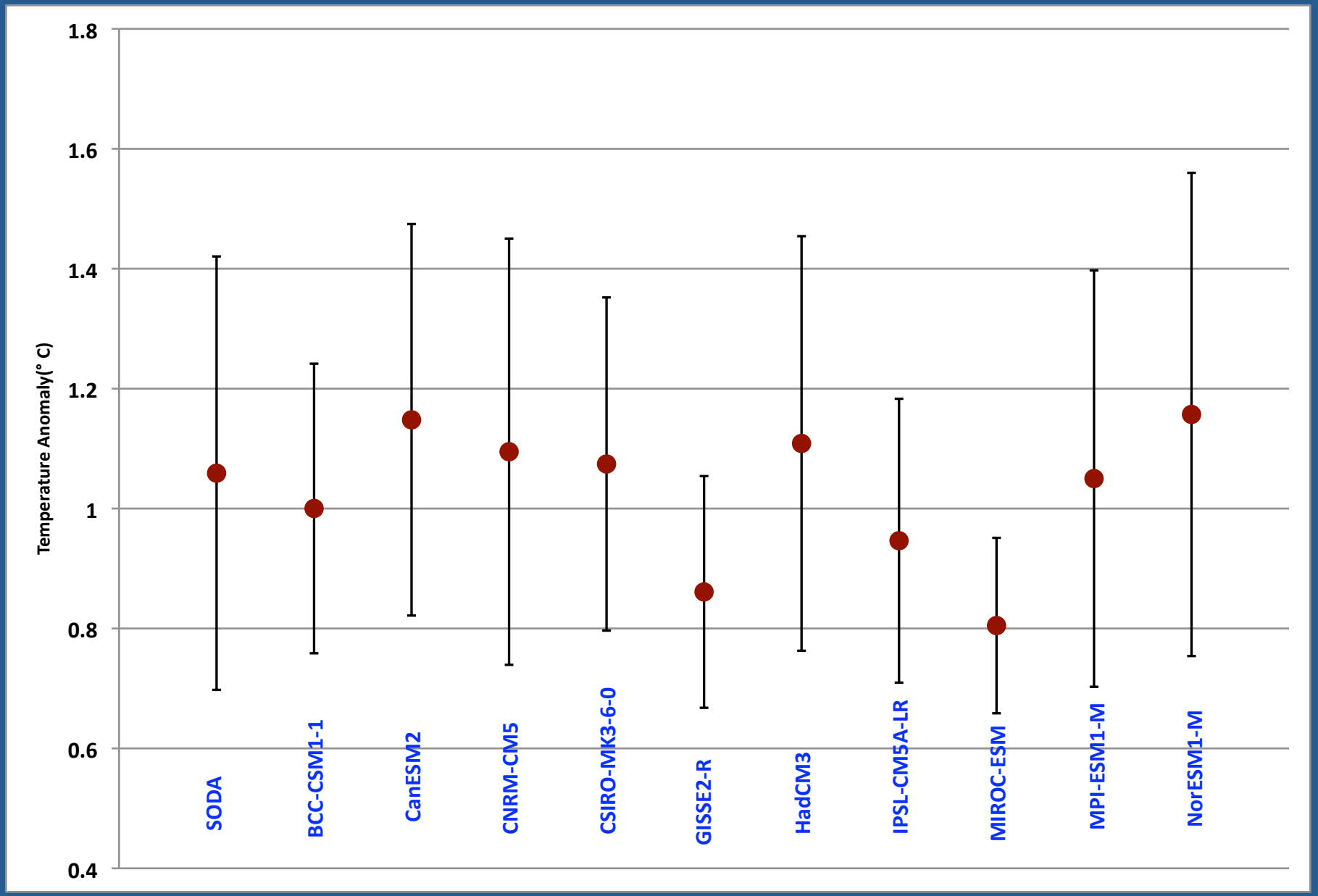
Center of Heat Index (CHI)

The first moment of SST anomaly, based on the location of SST anomalies greater than 0.5°C within a strip that spans the tropical Pacific (120°E-70°W, 5°S-5°N). The warm area has to be greater than or equal to the area of the Niño 3.4 region.

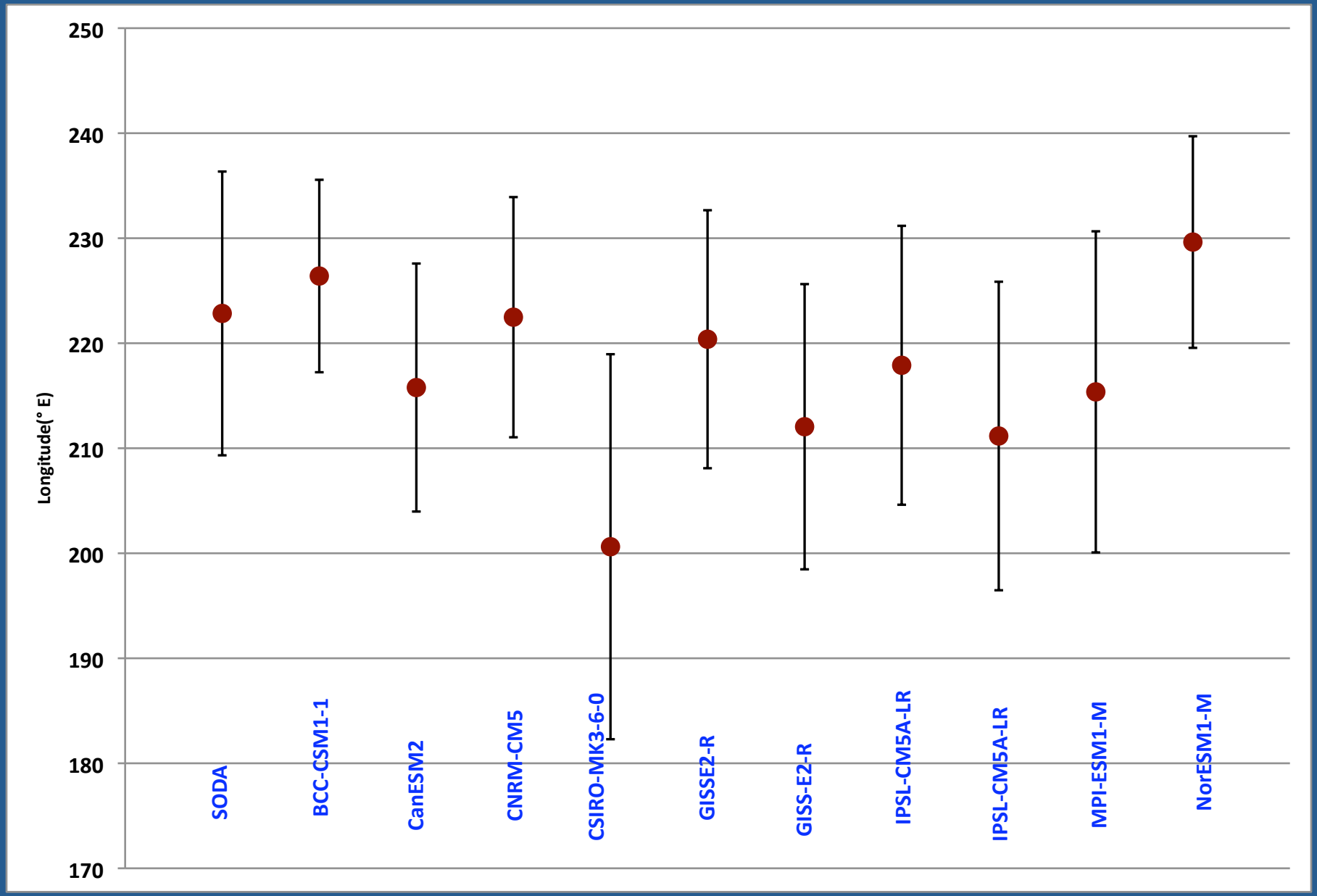
$$CHI\ amplitude = \frac{\sum sst\_anom \times area}{\sum area}$$

$$CHI\ longitude = \frac{\sum sst\_anom \times longitude}{\sum sst\_anom}$$

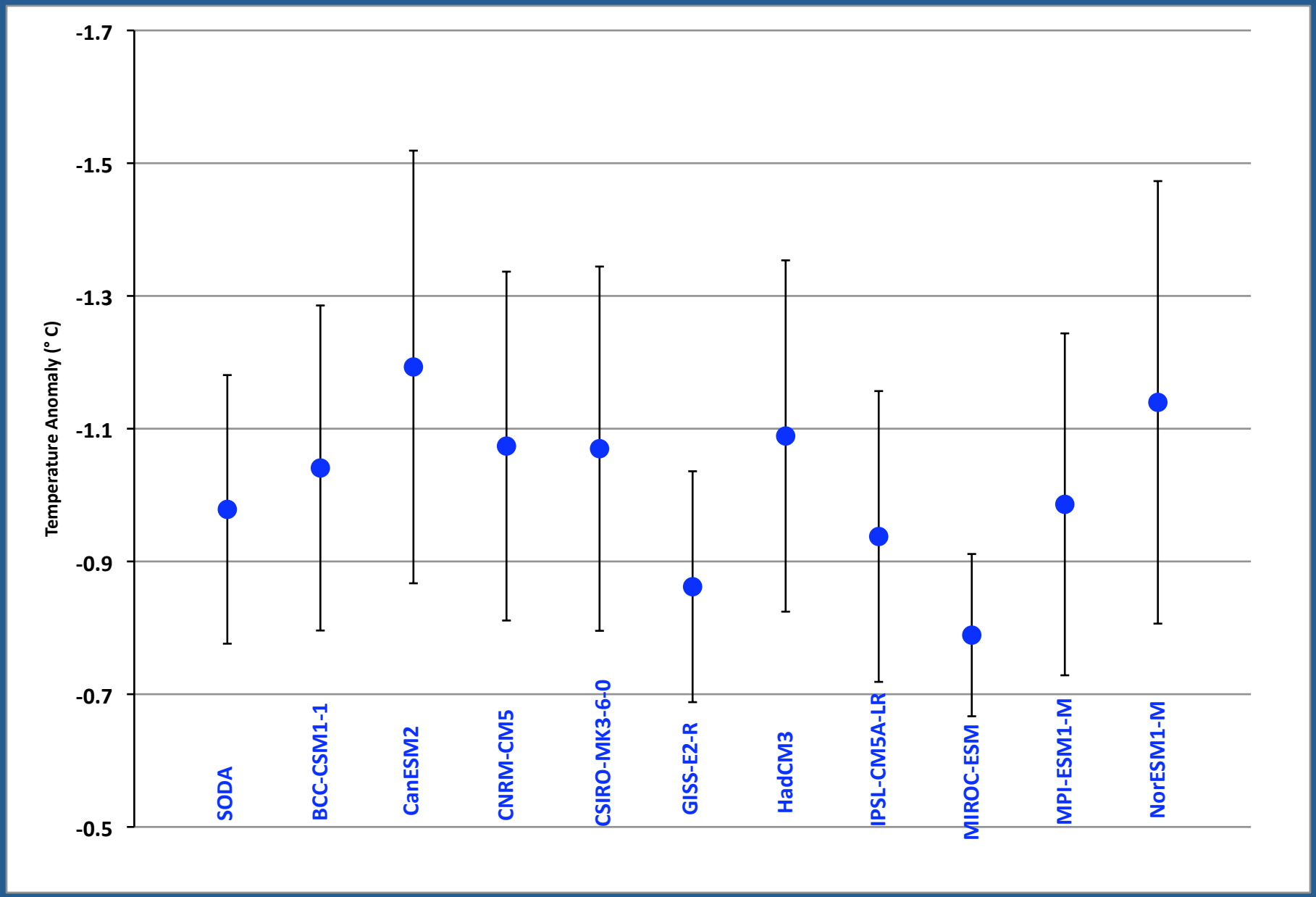
El Niño Strength



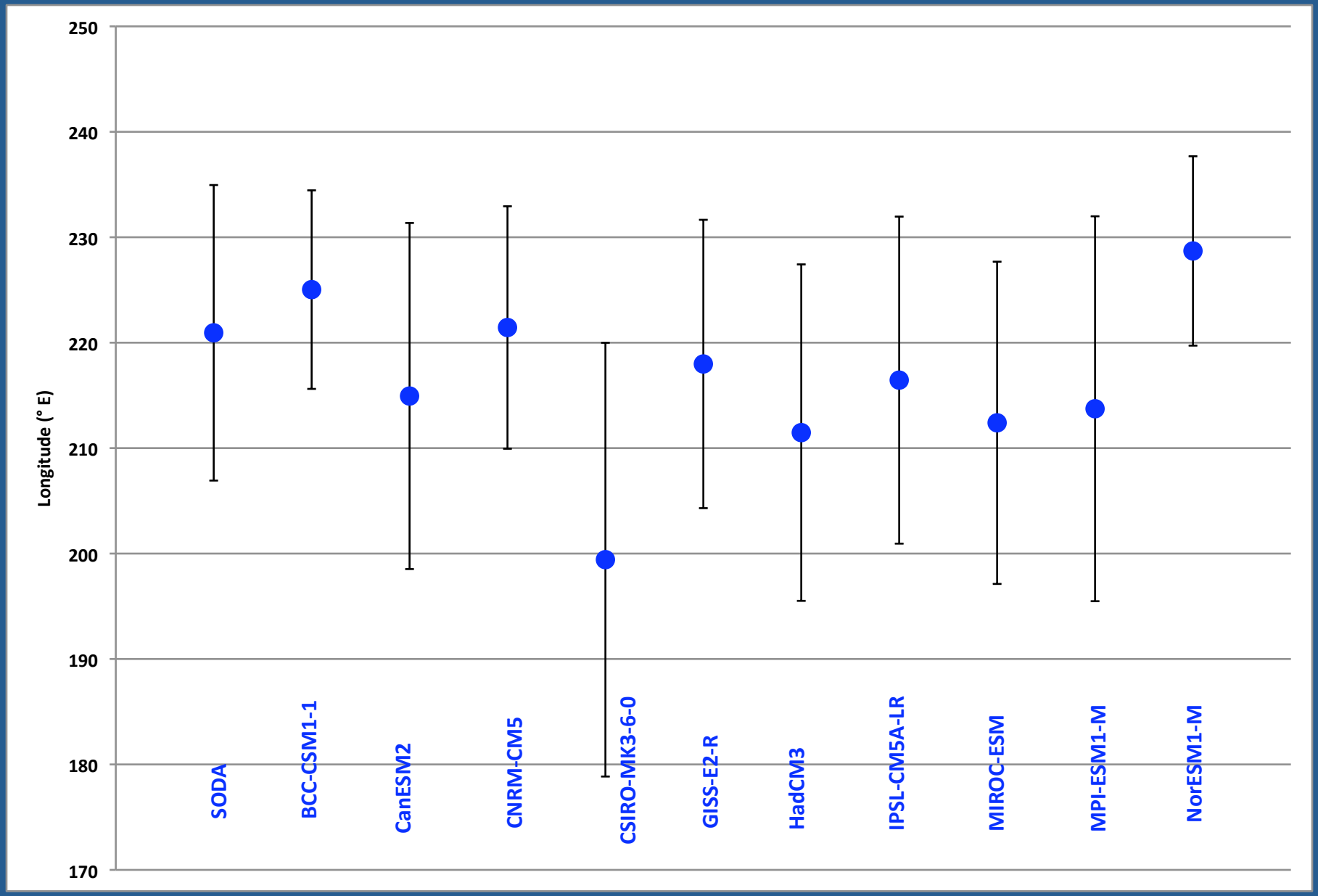
El Niño Location



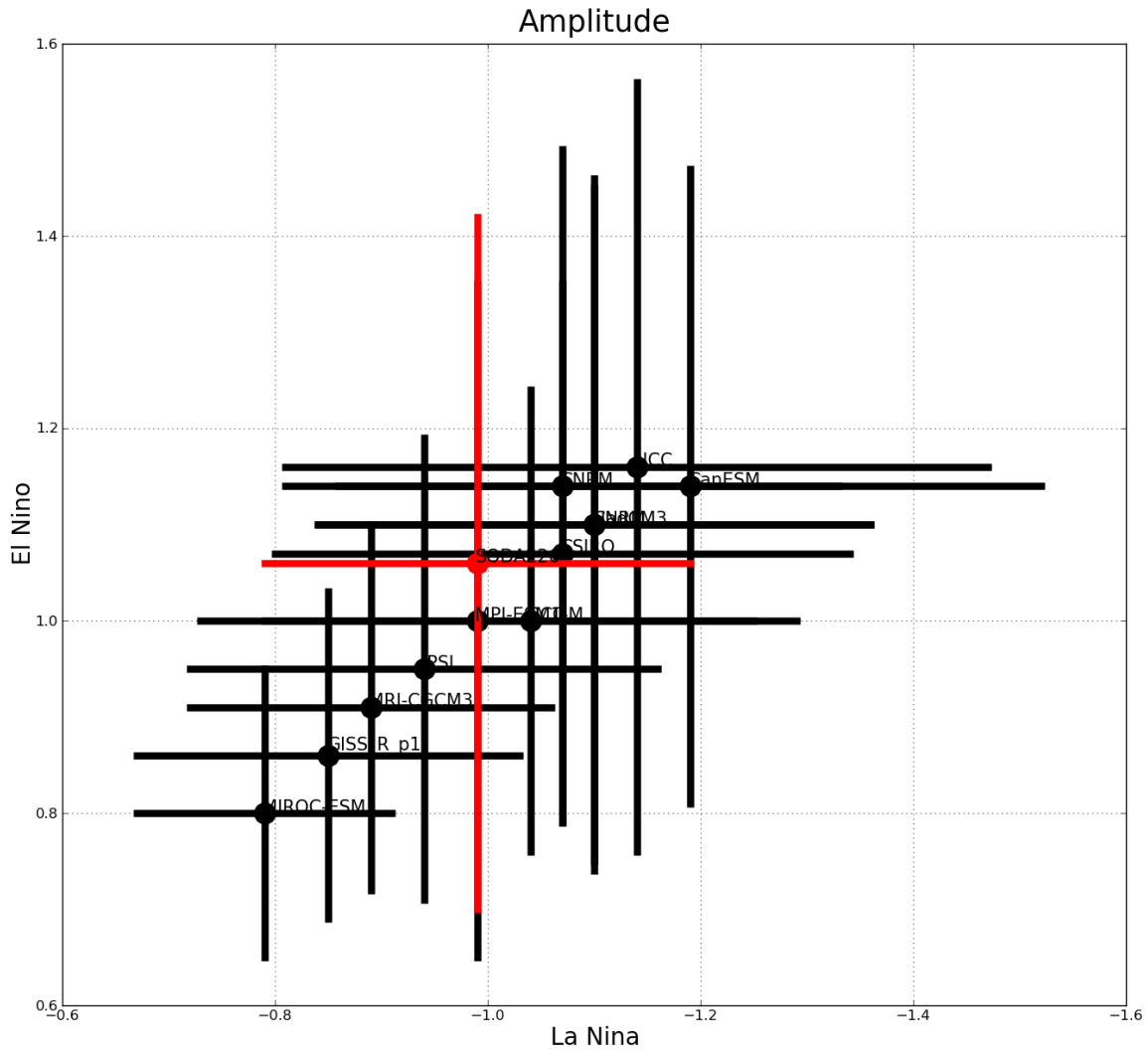
La Niña Strength



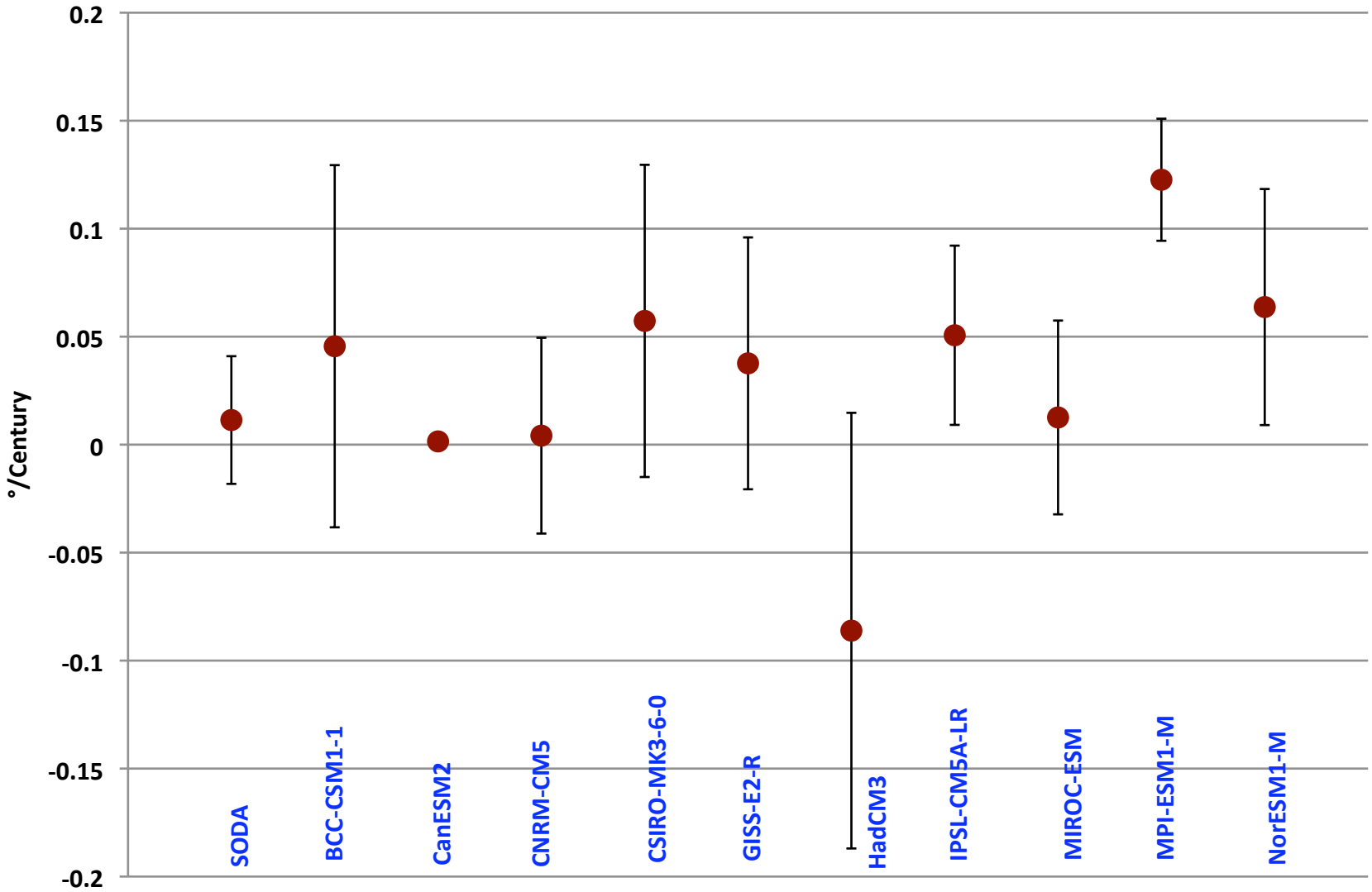
La Niña Location



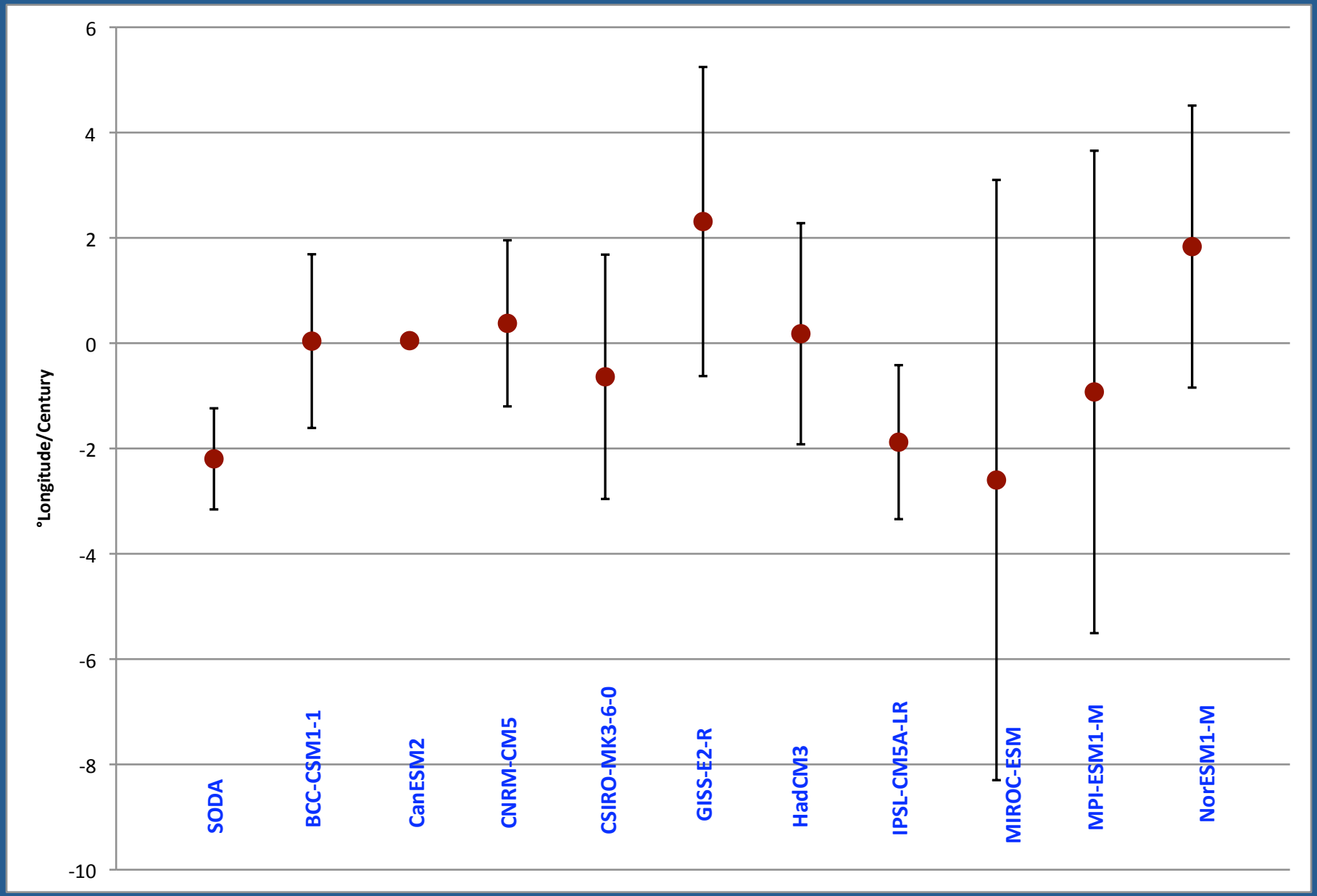
El Niño CHI Amplitude versus La Niña CHI Amplitude



Trends of El Niño Strength



Trends of El Niño Location



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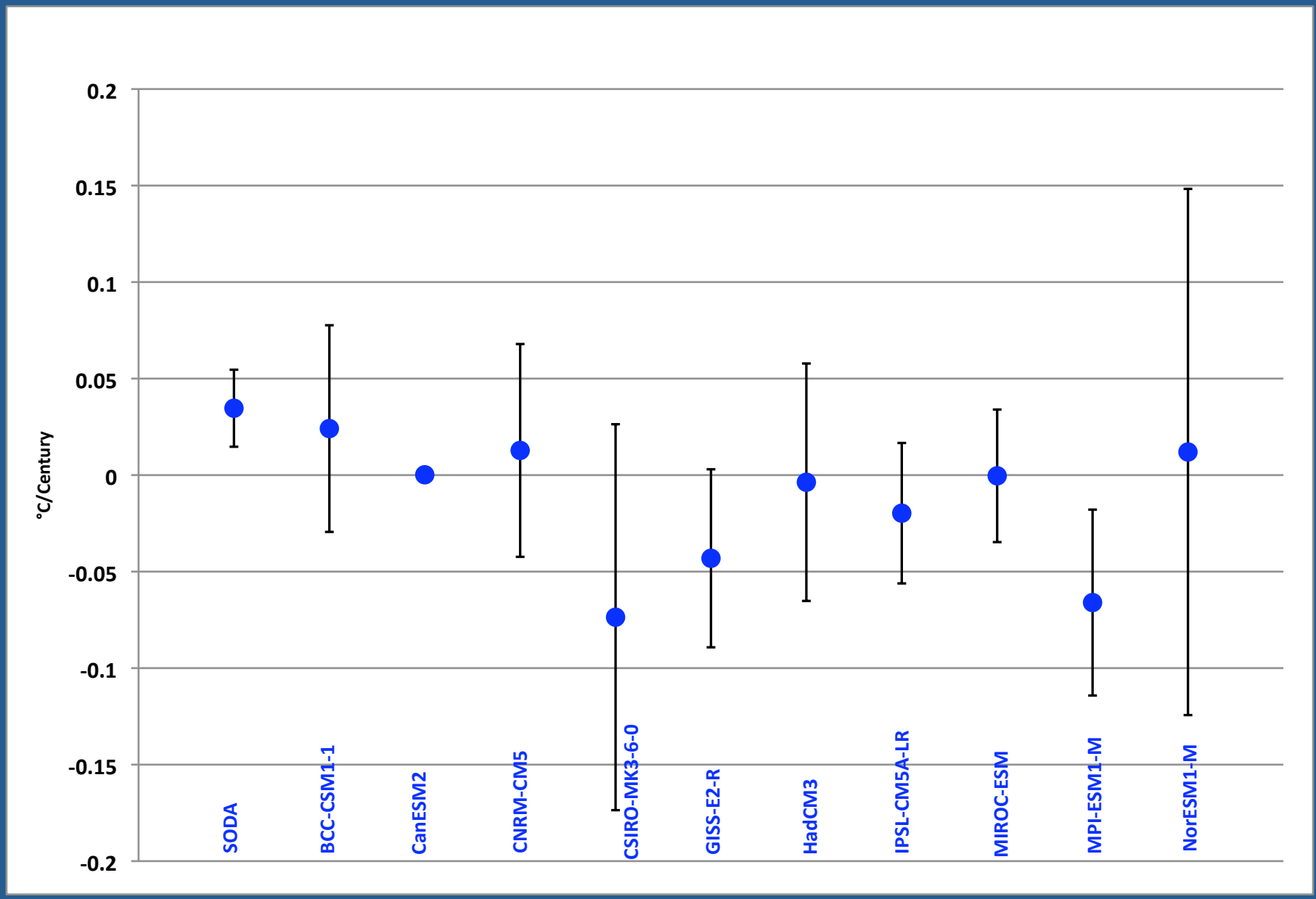
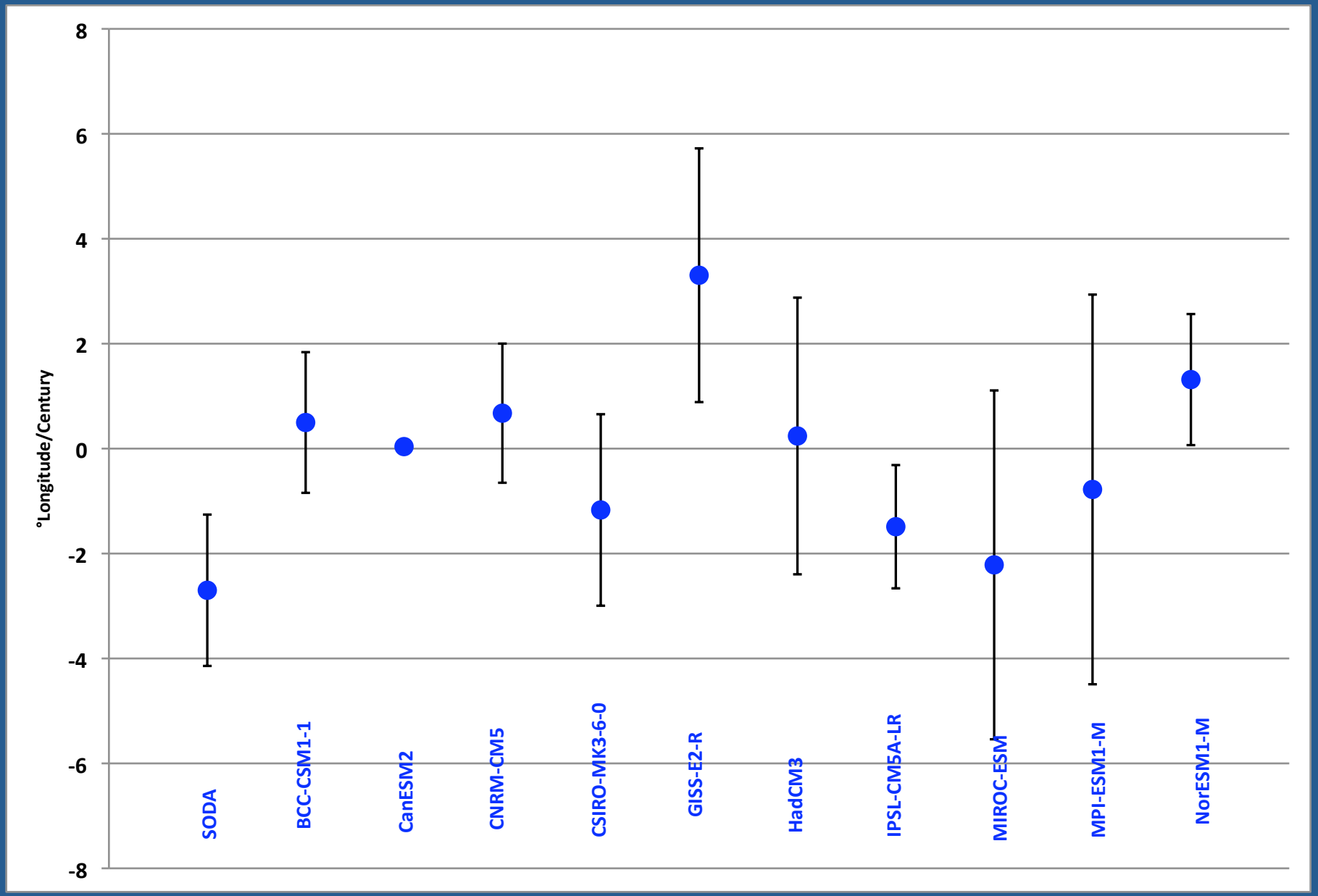


Trends of La Niña Location



Conclusions

1. Most of the CMIP5 models have realistic ENSO strength and location.

2. ENSO does not change much in the last century in SODA_2.2.6 and CMIP5 coupled models.

3. Most of the models do not capture the asymmetry between El Niño and La Niña.