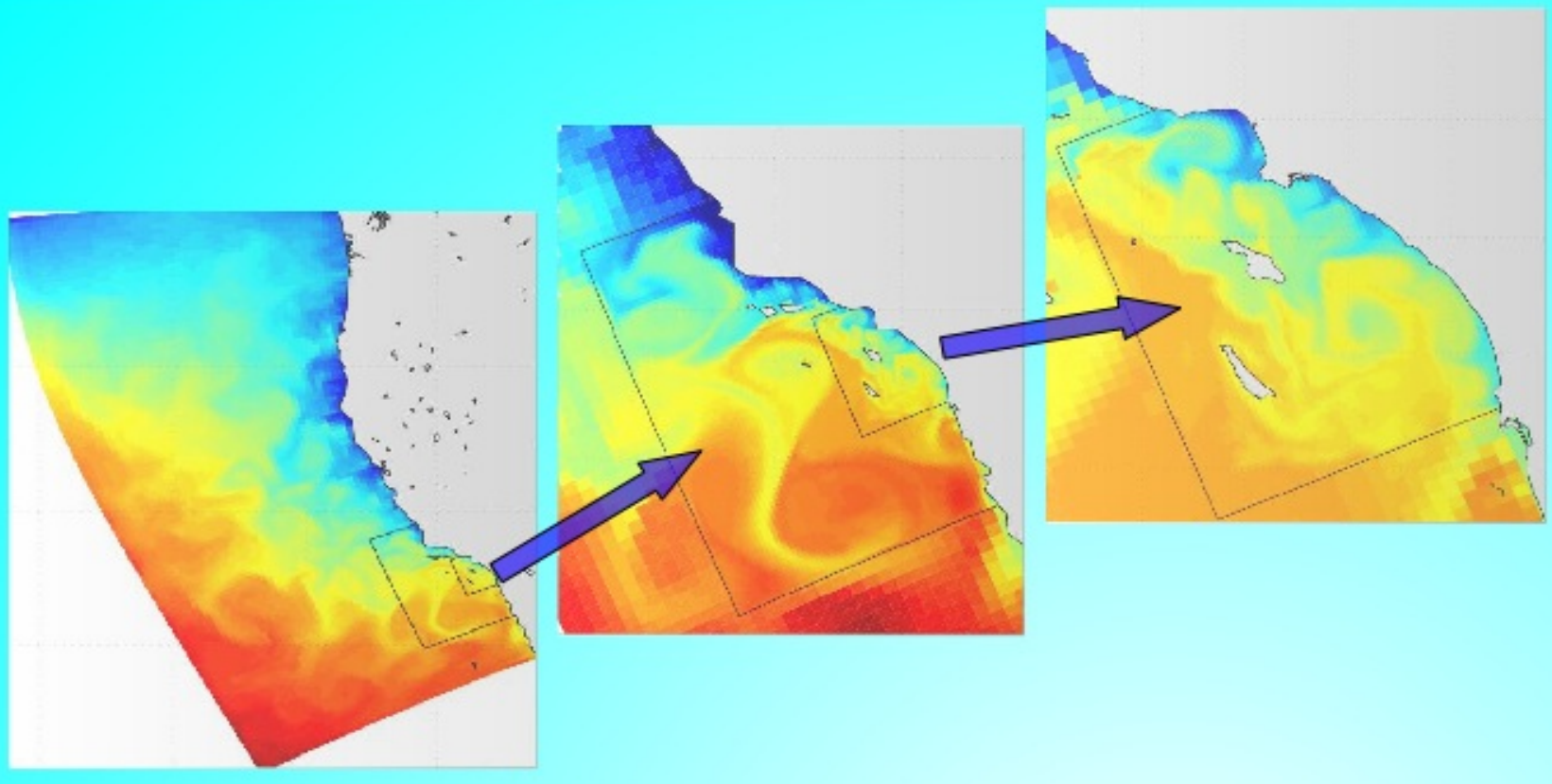

From a climate to a multi-scale Earth System Model: Technical challenges and advances

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WARNING!

Do not try this at home

Collaborators

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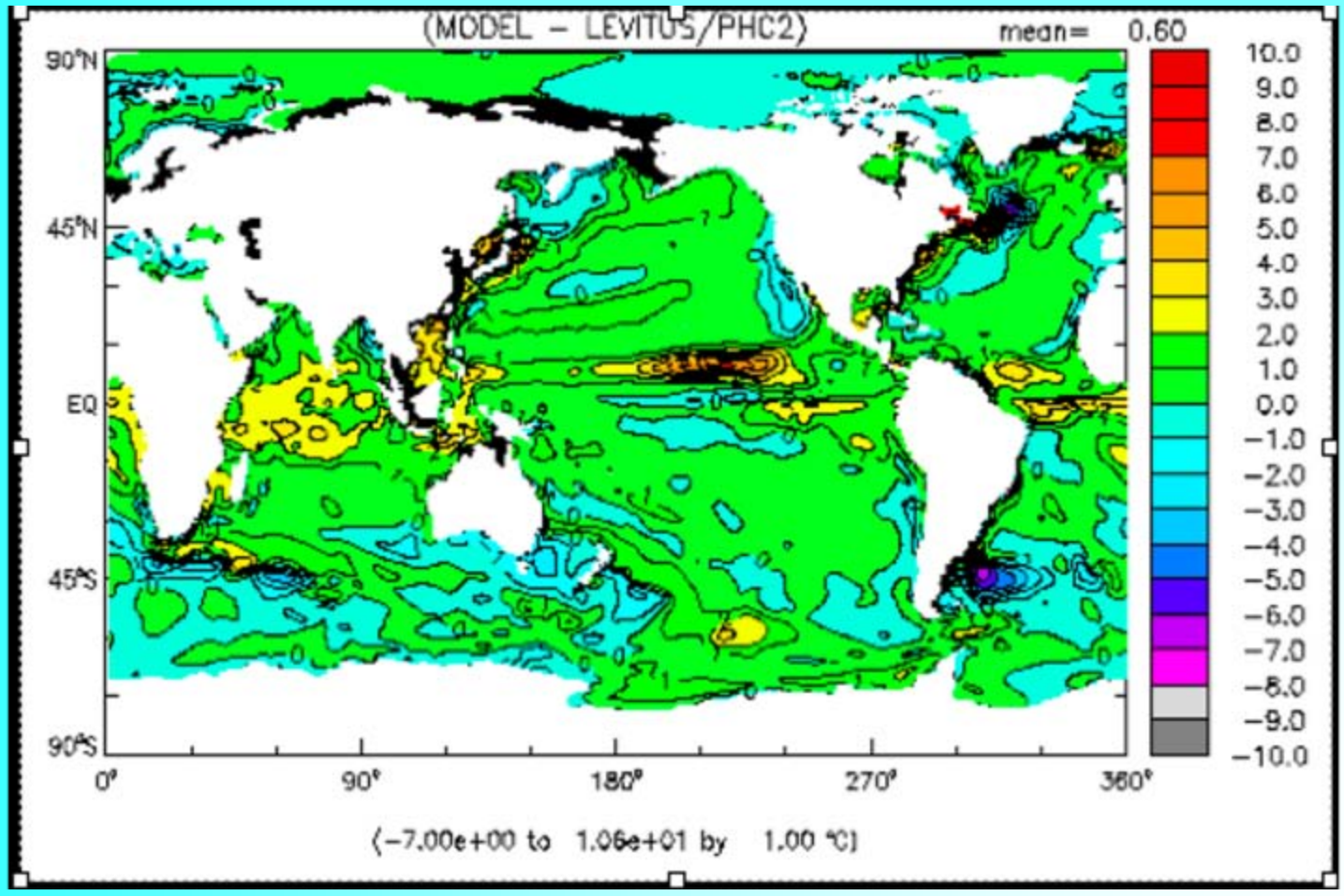
- Jon Wolfe (NCAR)
- Bill Large (NCAR)

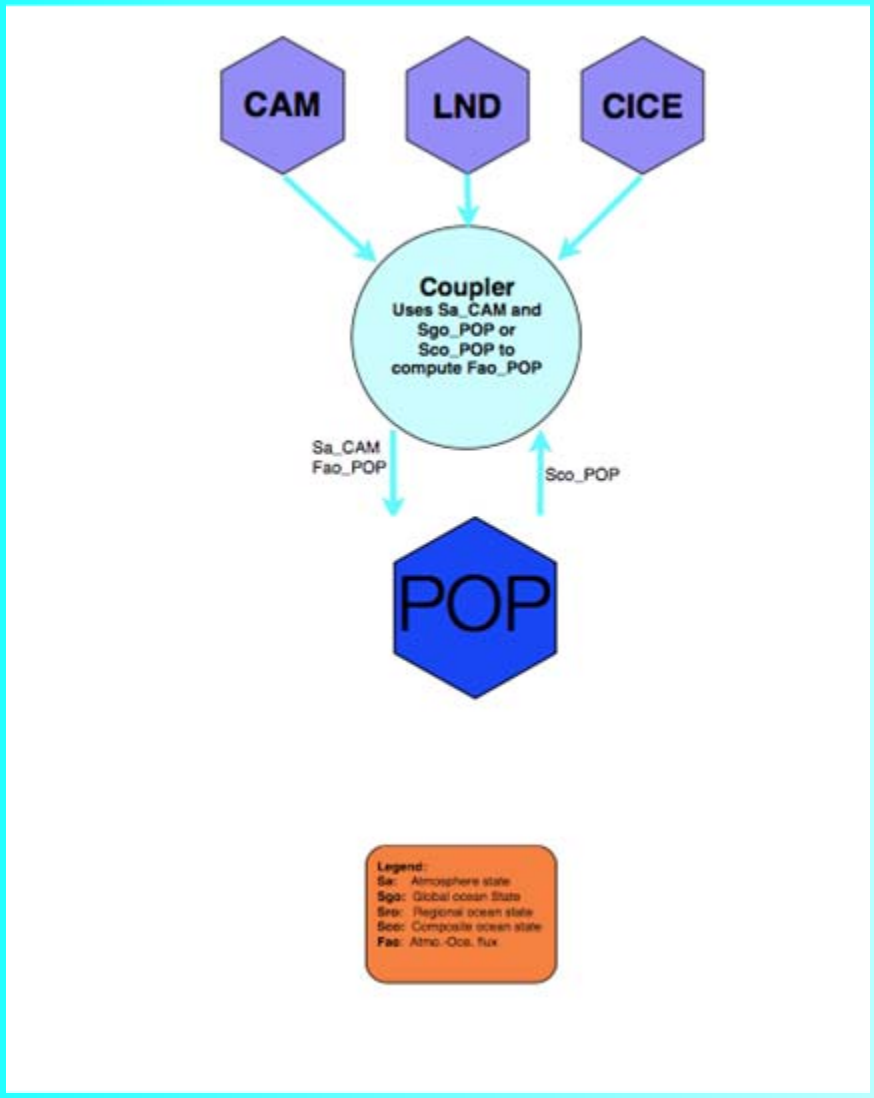
Outline

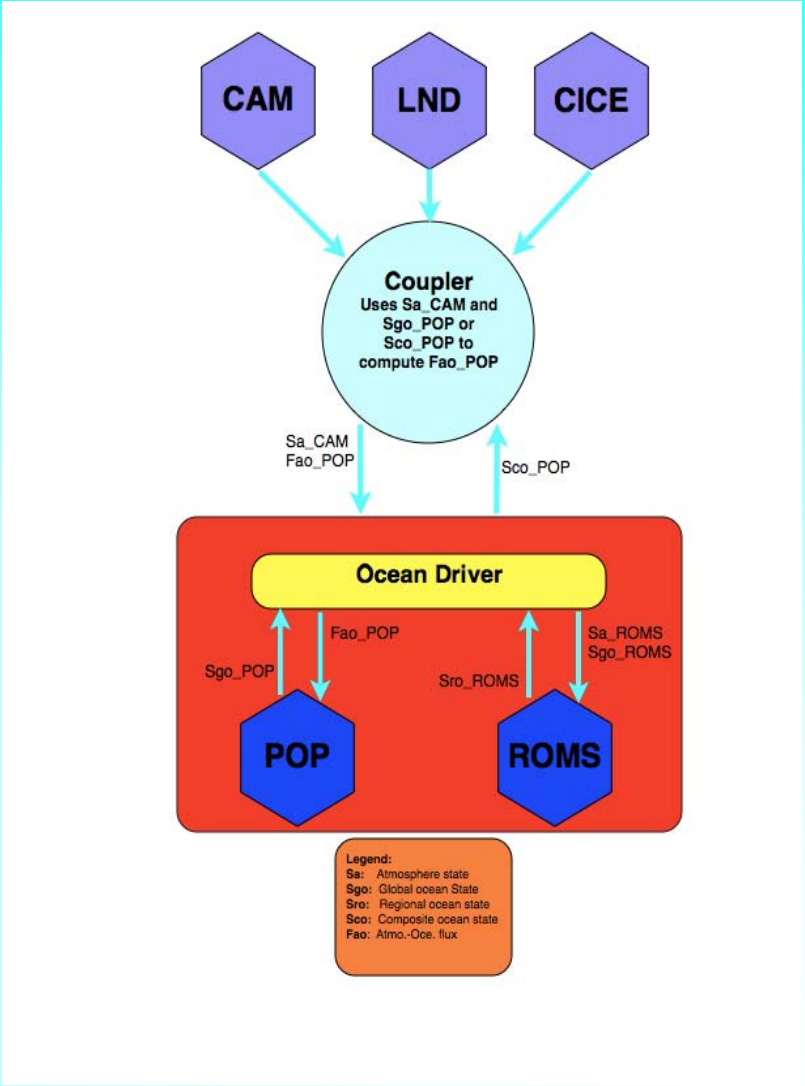
- Motivation for Nested Models
- Implementation: Re-gridding, merging and time-stepping
- (Results) – Yesterday’s talk
- Future Goals

Climate model biases



Climate model schematic

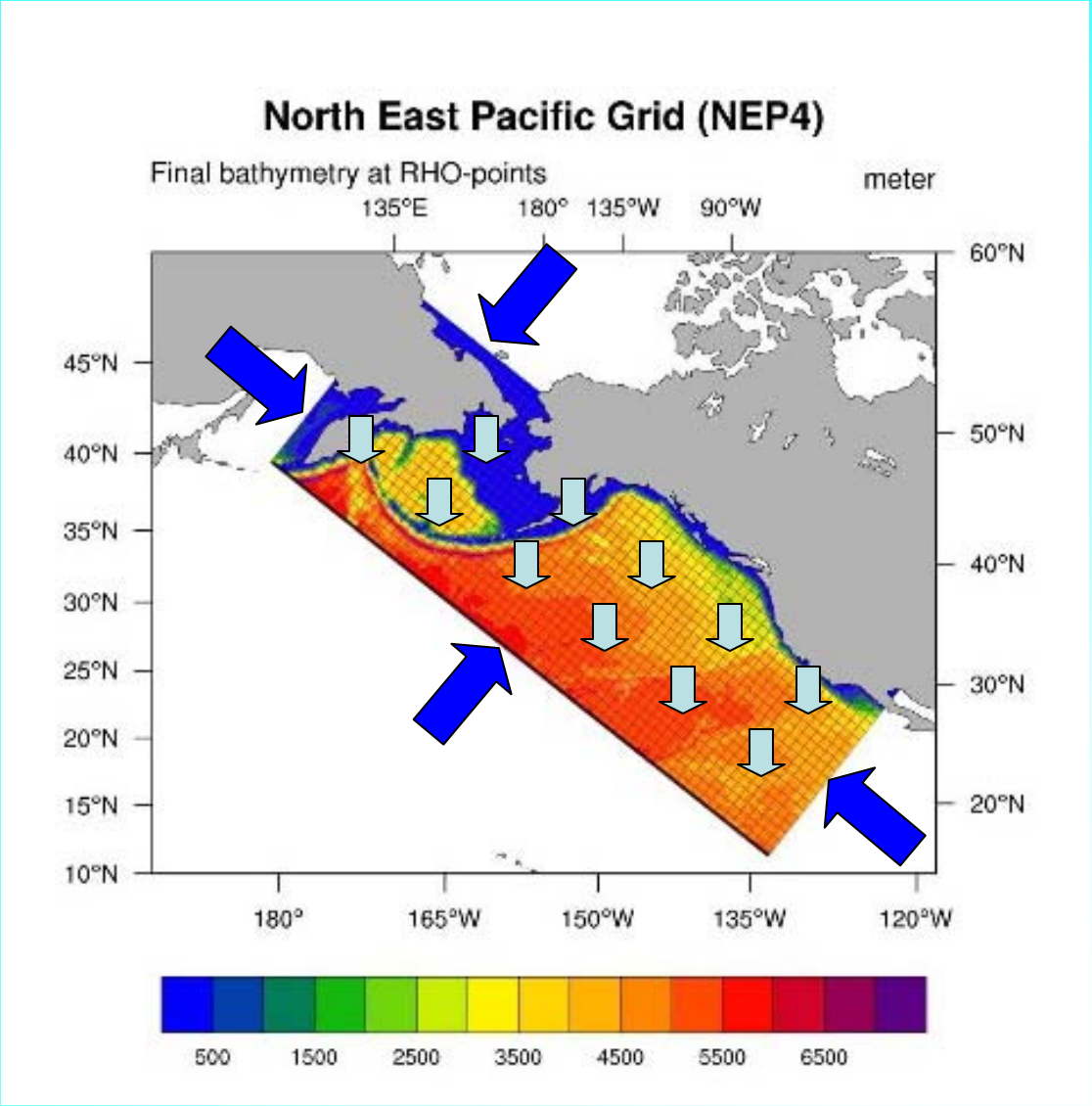




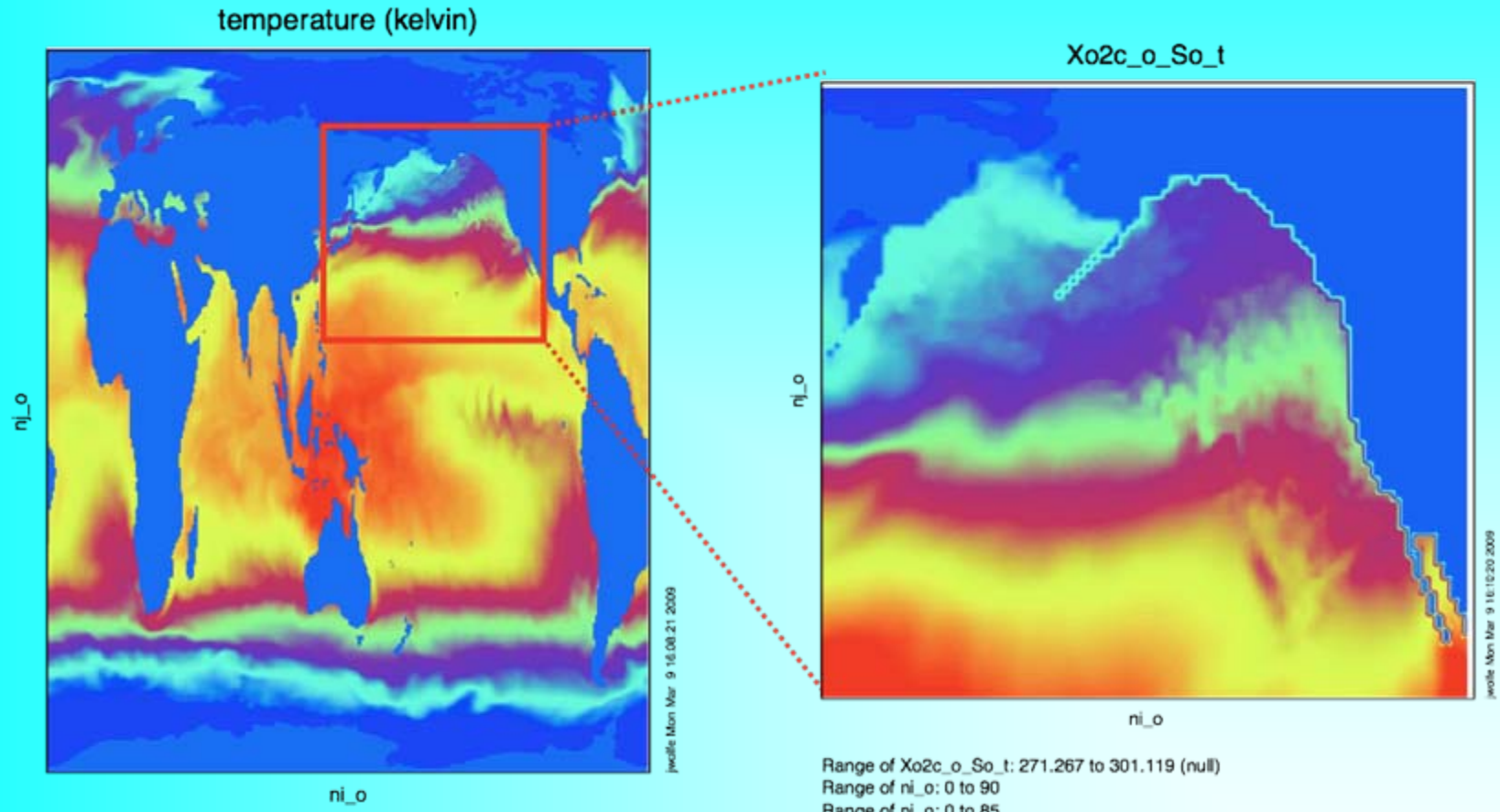
Forcing of the regional domain

Atmospheric Surface Data

Ocean Lateral Boundary Data



The new global SST

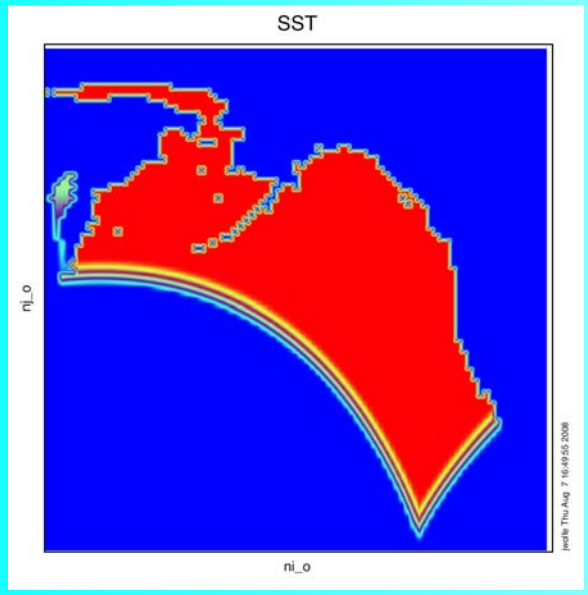


cpl6 output netCDF data file
Range of temperature: 270.948 to 304.392 kelvin
Range of ni_o: 0 to 319
Range of nj_o: 0 to 383
Current time: 2159 days since 0000-01-01 00:00:00
Frame 1 in File PR.T85_g14.C2.bluefire.composite.cpl6.hi.0005-12-01-00000.nc

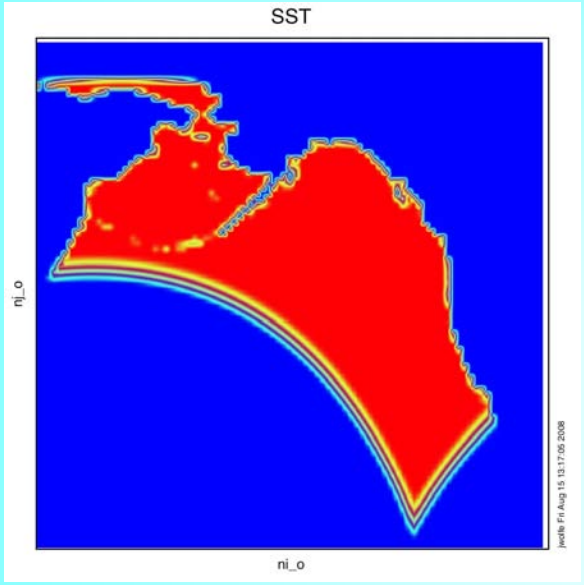
Range of Xo2c_o_So_t: 271.267 to 301.119 (null)
Range of ni_o: 0 to 90
Range of nj_o: 0 to 85
Frame 90 in File SST.T85_g14.C2.bluefire.composite.cpl6.hi.0005-12-01-00000.nc

Re-gridding From ROMS To POP

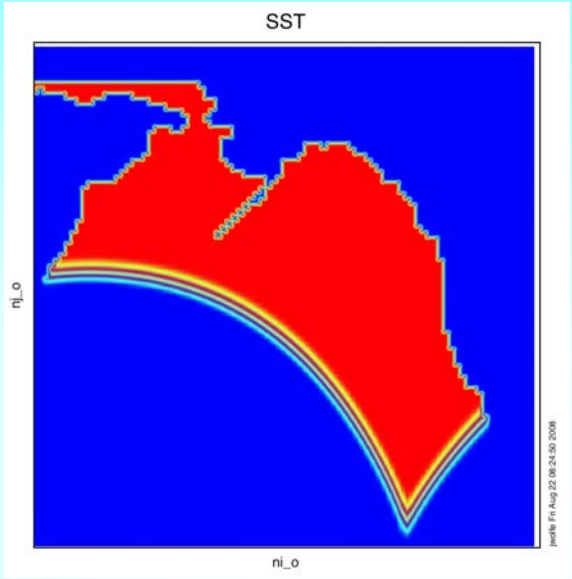
- Relative Differences in Resolution Requires Different Techniques
- Best Achieved By “Normalized” Conservative Approach -- Forces Sum of Weights to 1
- Note: Examples below use constant temperature fields for visualization



Bilinear



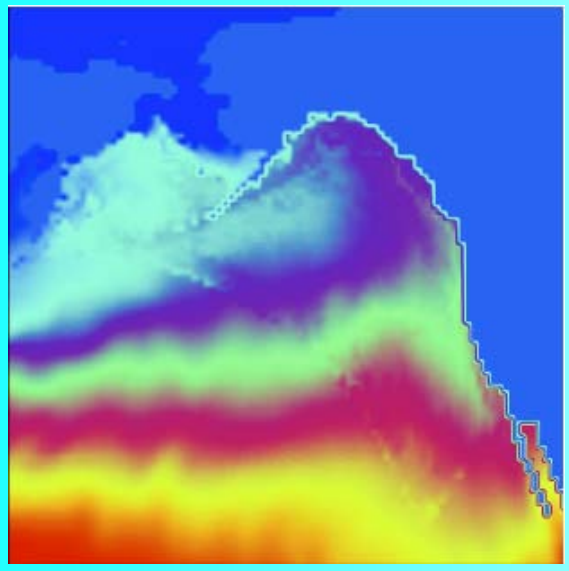
Conservative



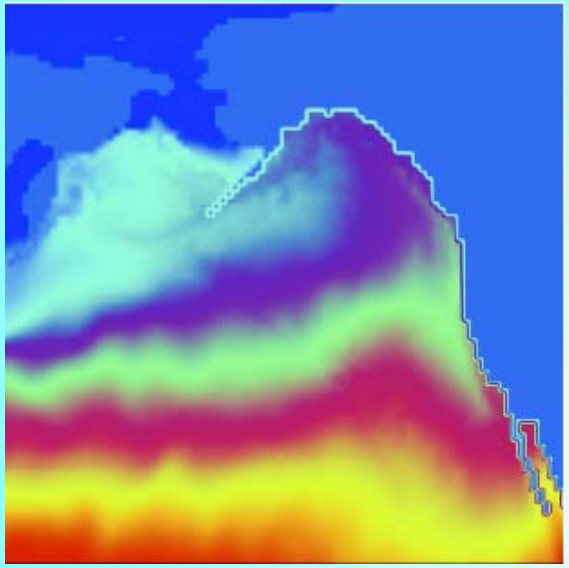
Normalized Conservative

Merging POP and ROMS SST's

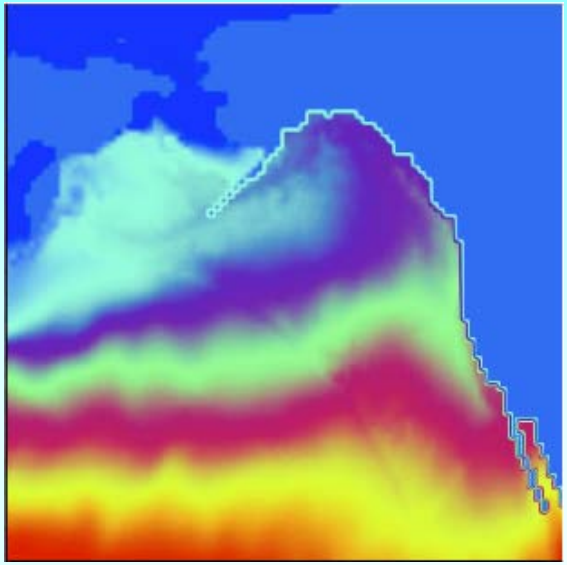
- Merging along boundaries often improved by some "blending" of results from the different models



No overlap

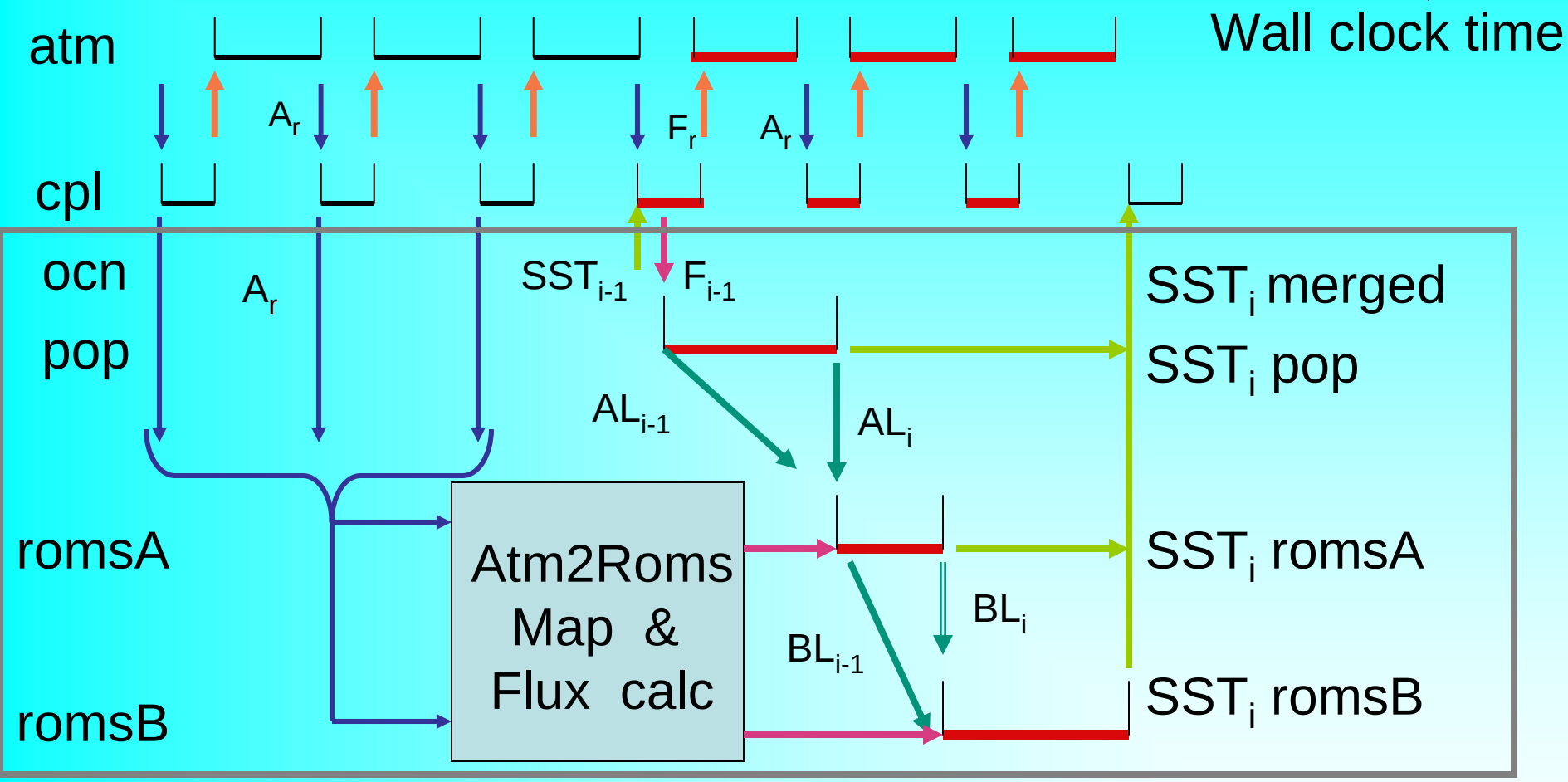


Linear



Sinusoidal

Time Flow: (ith ocn-cpl coupling interval)



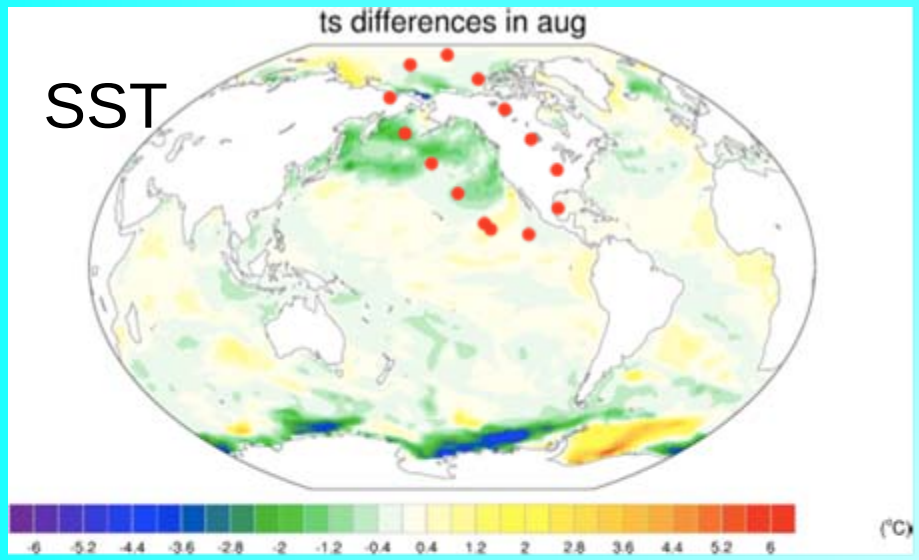
- A_r = atm state at atm radiation time
- F_r = atm/ocn flux (A_r , SST_{i-1})
- F_{i-1} = $<F_r>$ averaged over interval i−1
- $[AB]L_{i-1}$ = pop boundary conditions mapped to romsA and RomsB

Some fun facts

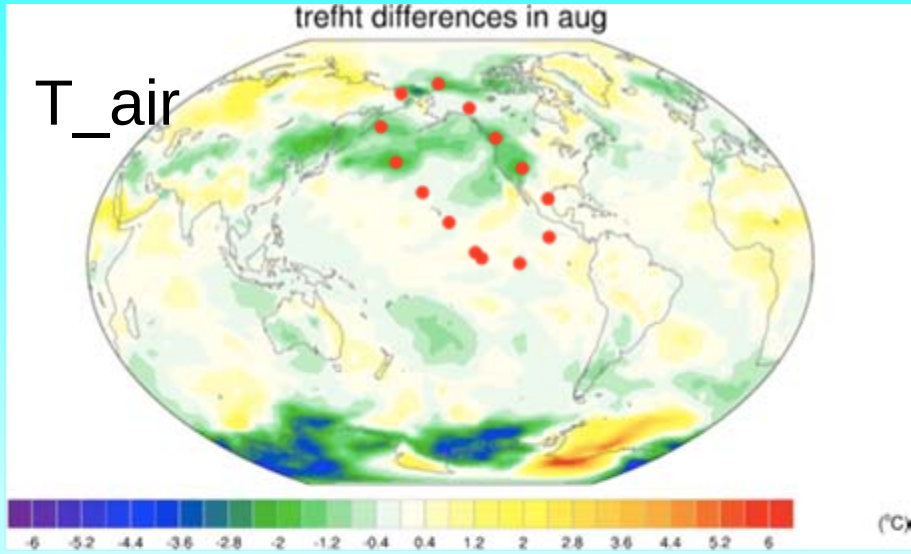
- ROMS grid is ~0.1˚ resolution, 224x640 grid cells; POP is a nominal 1˚.
- ROMS runs with a timestep of 450 s and couples with POP daily.
- Throughput is ~2 yrs/day on two bluefire nodes, compared to ~1.5 yrs/day for baseline simulation.

So what?

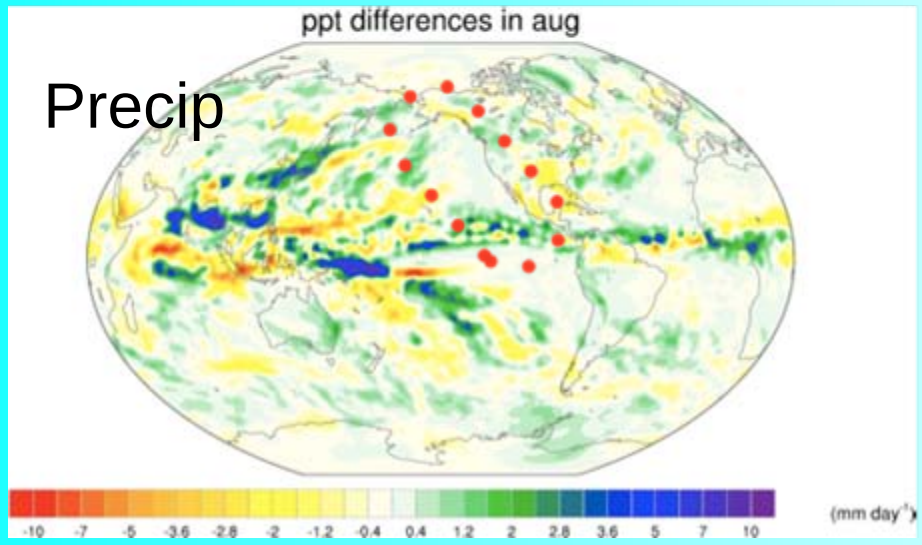
SST



T_air



Precip



SST, T_air and Precip

Final Remarks and Future Plans

- We have designed and implemented a new multi-scale ocean within a climate model.
- We are exploring the implications of both down- and up-scaling in coupled models.
- Some further work planned including multiple nested domains, ecosystem and bio-economic models.
- Some issues with downscaling biogeochemistry-- How to make two models with different currencies work communicate?
- We see this as part of an Earth System Model - Climate with ecosystems and social models.