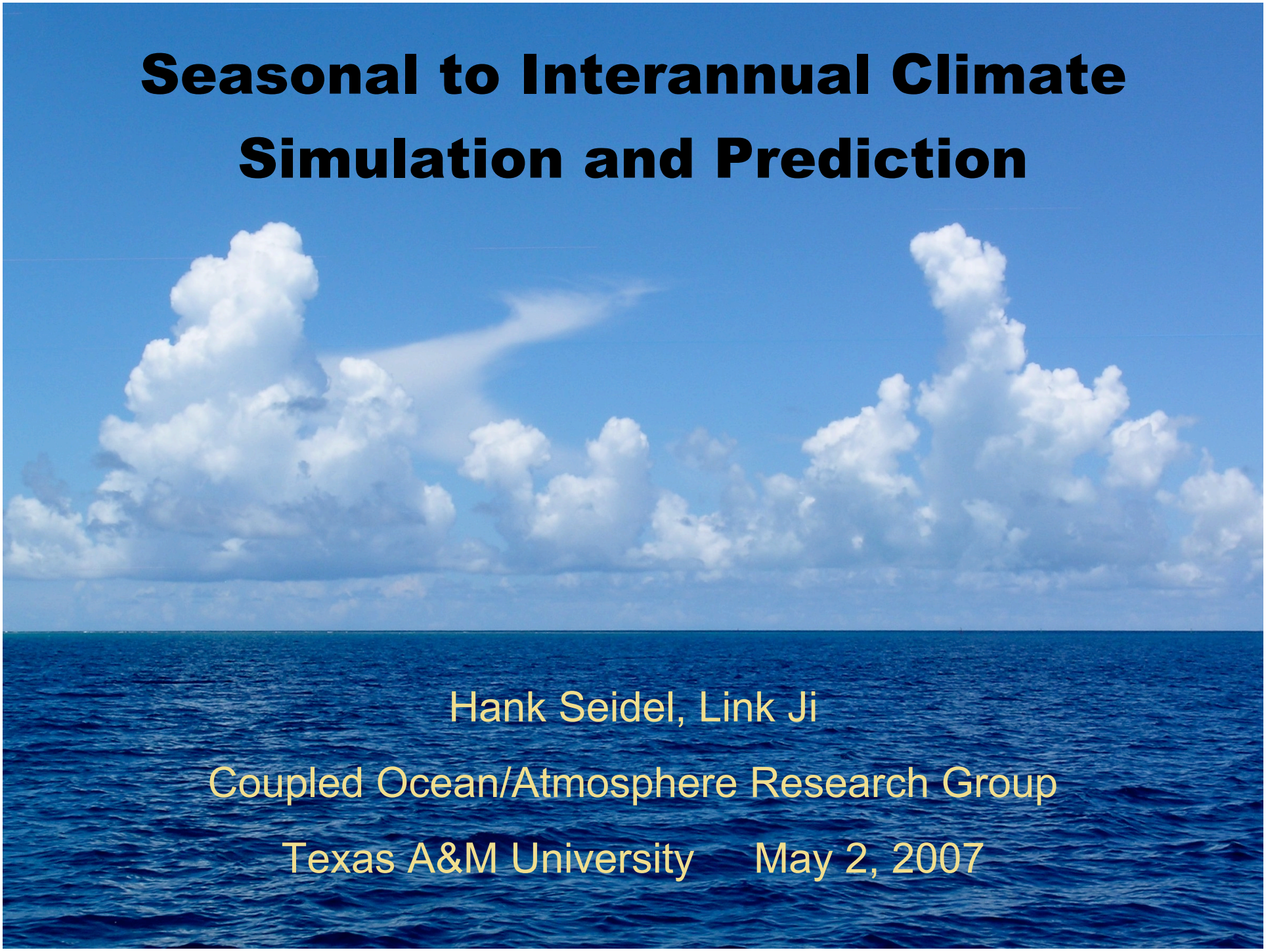
Seasonal to Interannual Climate Simulation and Prediction



Hank Seidel, Link Ji

Coupled Ocean/Atmosphere Research Group

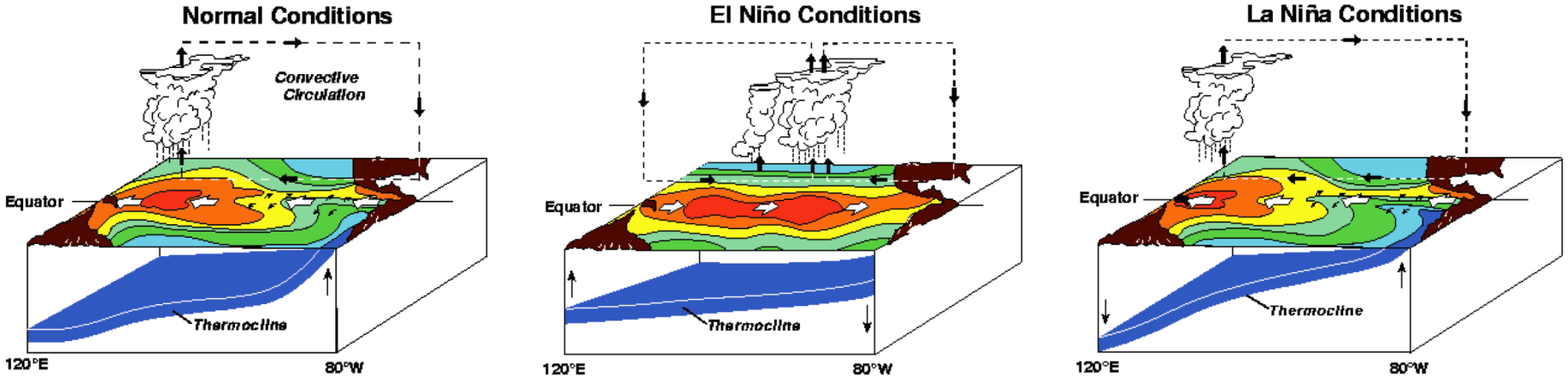
Texas A&M University May 2, 2007

- Our group currently consists of:
  - Professors Ping Chang and Saravanan
  - Three Research Scientists/Post Docs
  - Five graduate students
  - One visiting scientist
- Our research efforts:
  - Air/Sea interaction
  - Climate variability
  - Climate predictability
- Our research is conducted using:
  - Ocean Models - several types
  - Atmosphere Models - also of several types
  - Couple Ocean/Atmosphere Models - mix and match

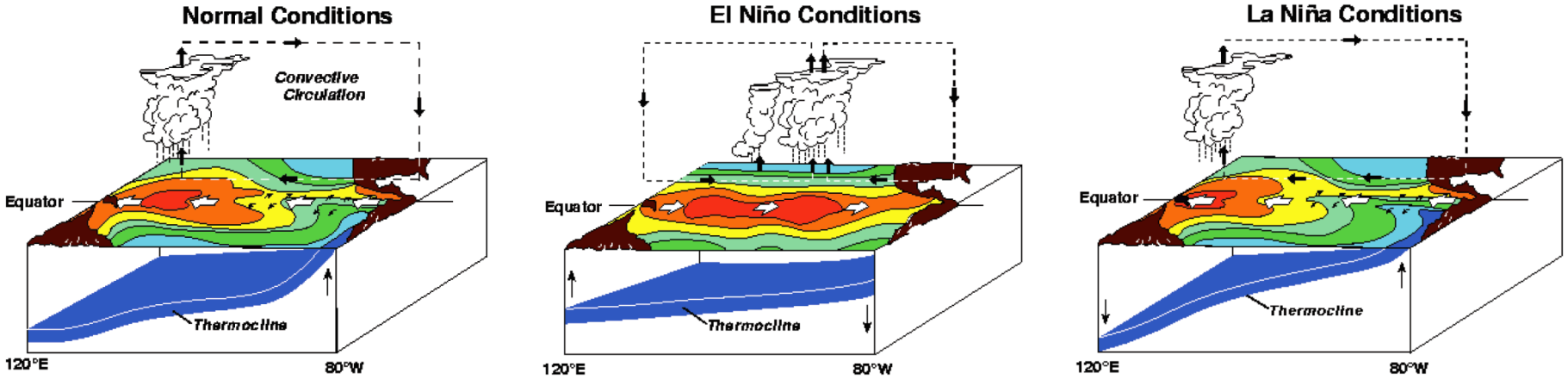
Climate Variability & Prediction

- Pacific Ocean
  - El Nino/Southern Oscillation (ENSO)
  - Coupled Ocean/Atmosphere Phenomenon
  - Impacts Climate Globally
- Atlantic Ocean:
  - Zonal Mode (Atlantic ENSO) & Meridional Mode
  - Coupled Ocean/Atmosphere Phenomena
  - Impacts Climate Regionally

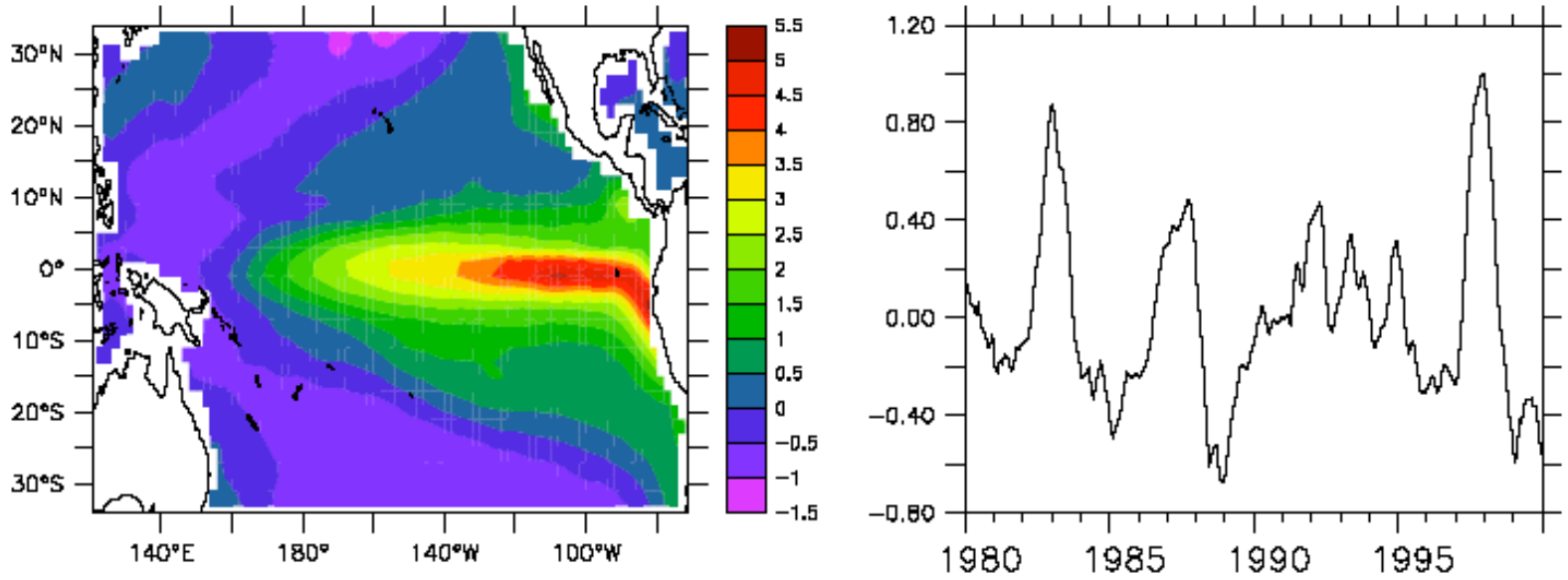
Pacific ENSO



Pacific ENSO

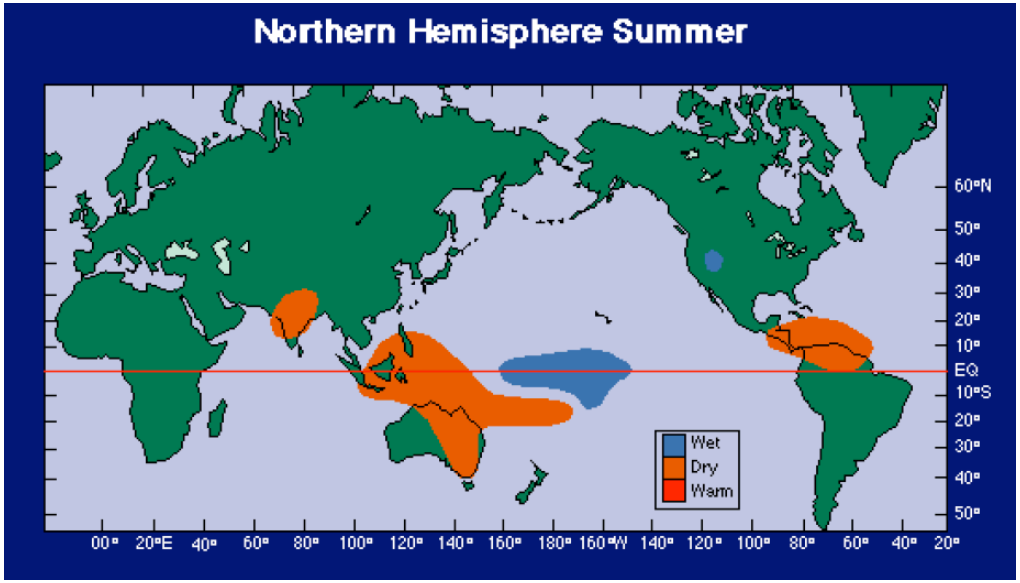


First EOF of SST



Impact of Pacific ENSO

NOAA/PMEL



Impact of Pacific ENSO

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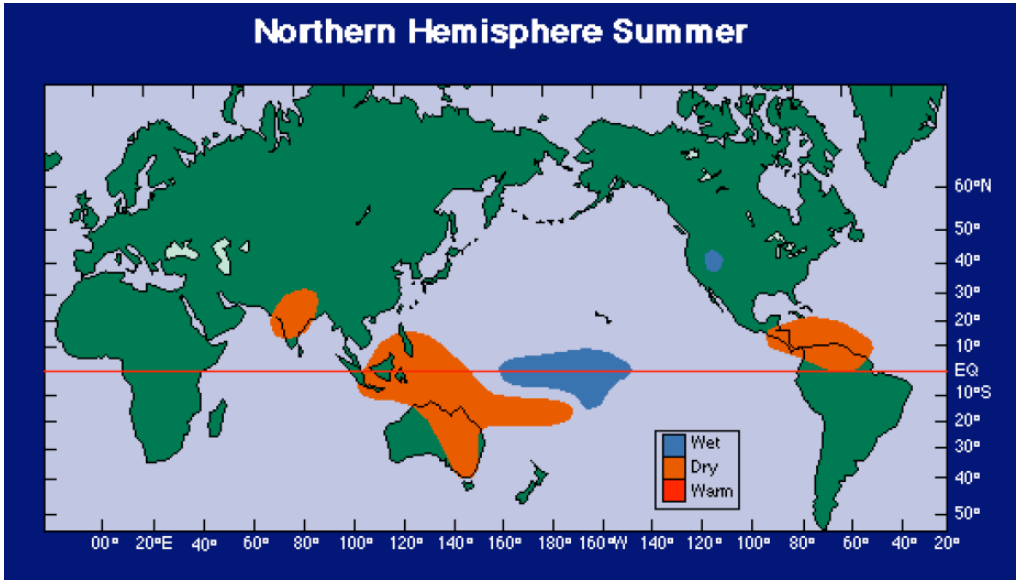
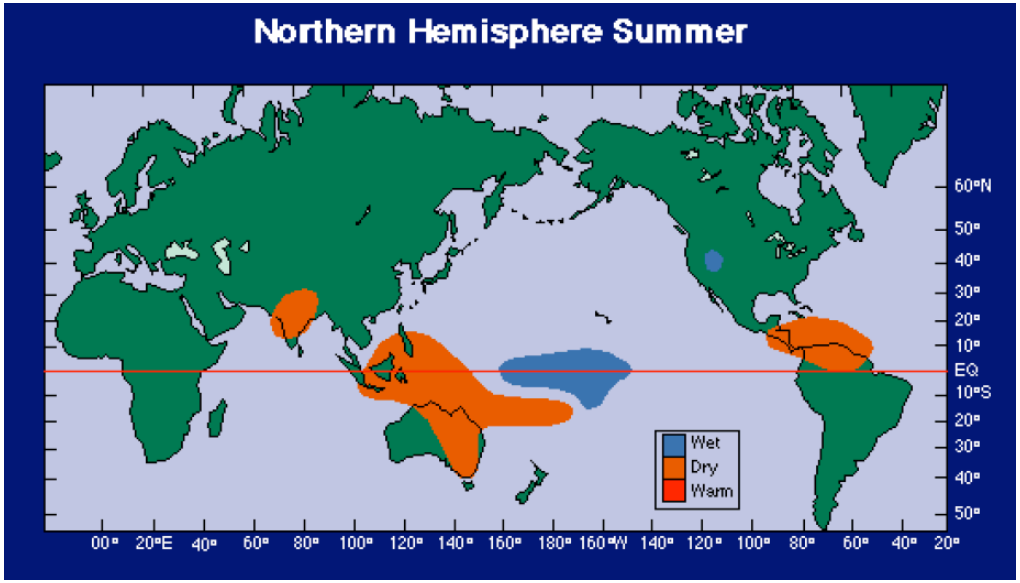


Fred Hoogervirst/Panos Picture/London

Impact of Pacific ENSO

NOAA/PMEL



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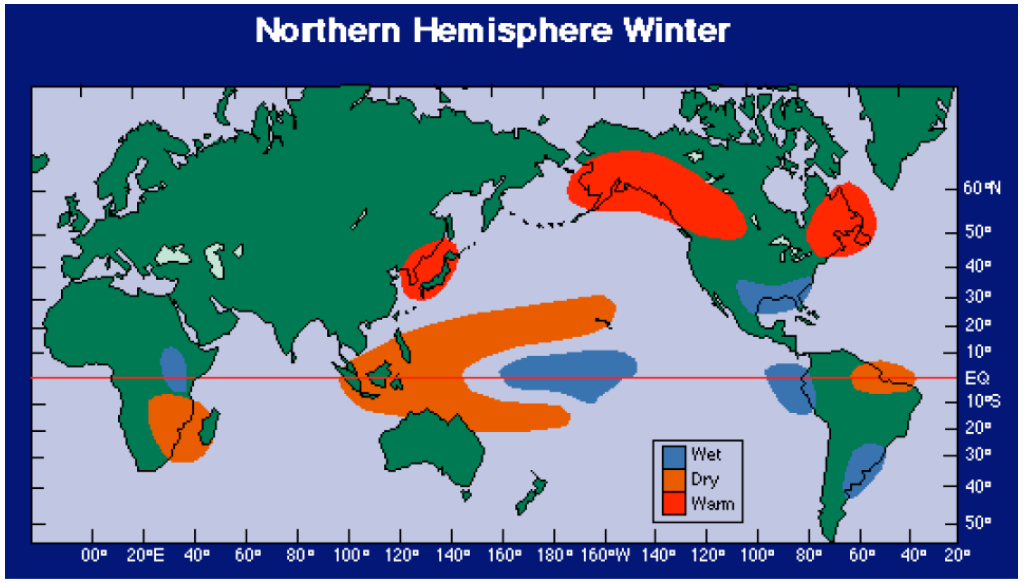
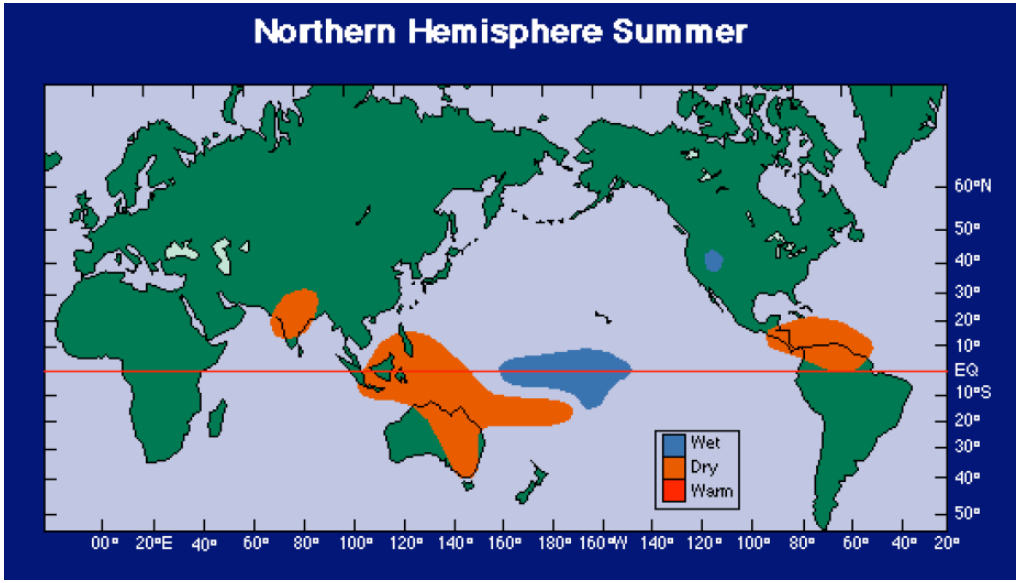


NOAA/PMEL

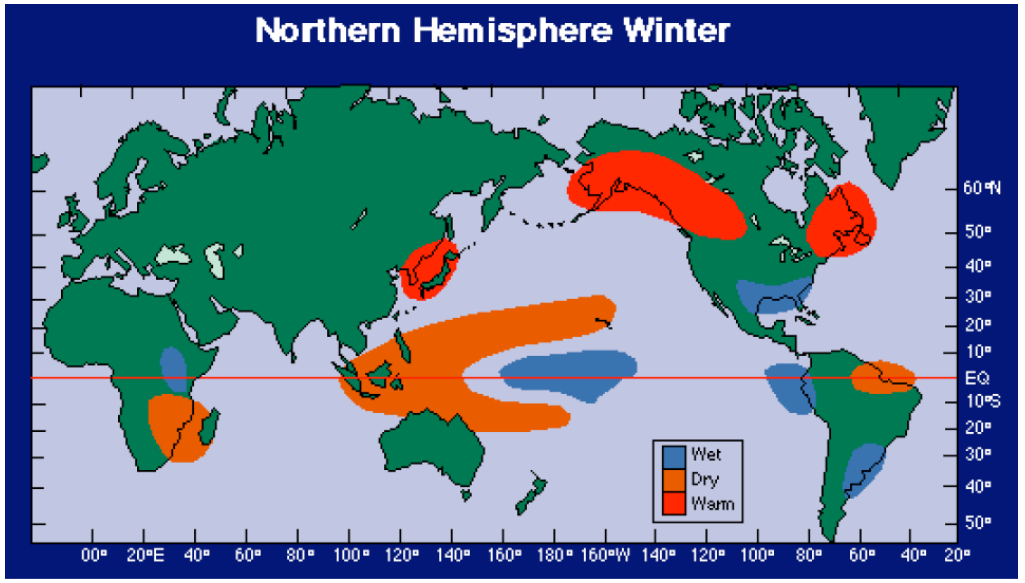
Impact of Pacific ENSO

NOAA/PMEL



Fred Hoogervirst/Panos Picture/London

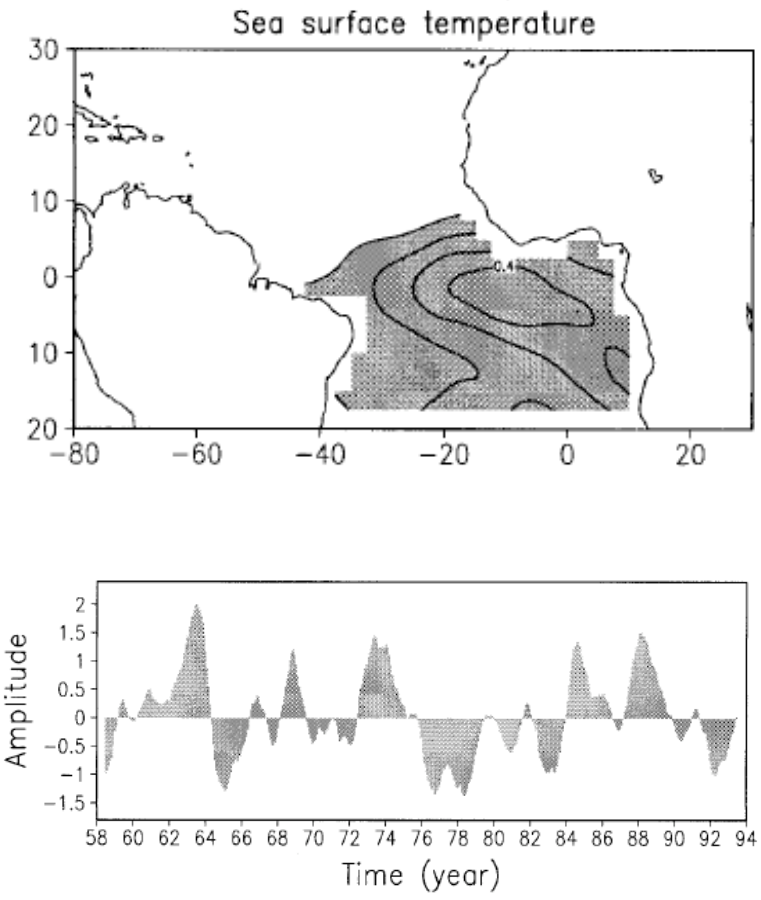
FEMA



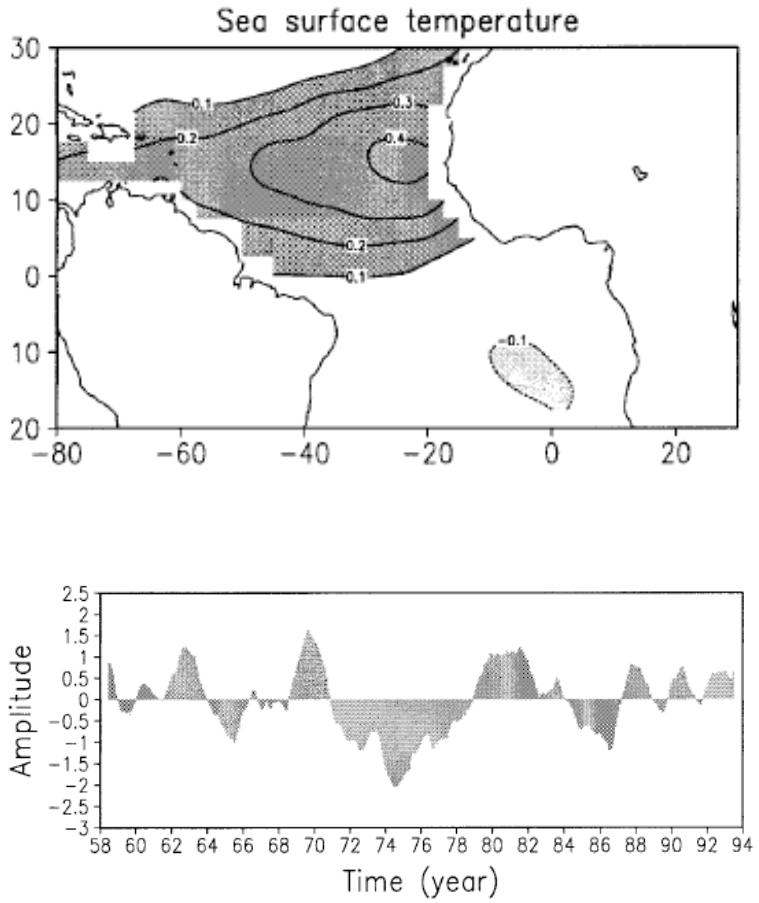
NOAA/PMEL

Modes of Variability in the Atlantic

Zonal Mode

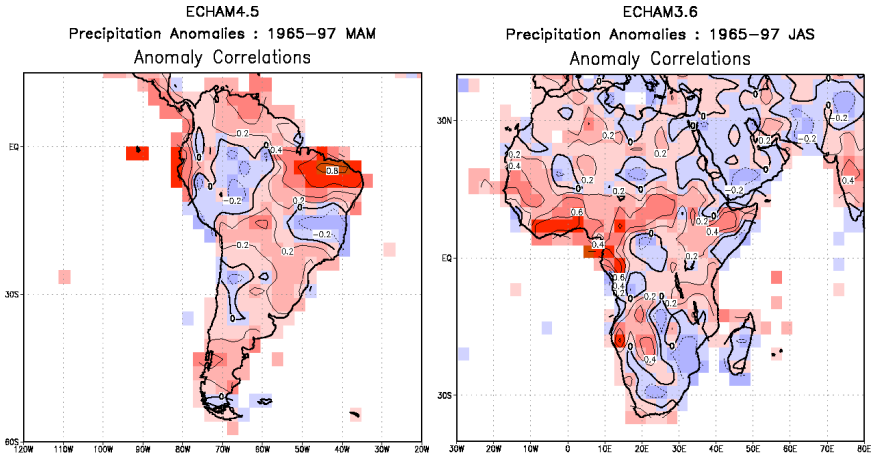


Meridional Mode



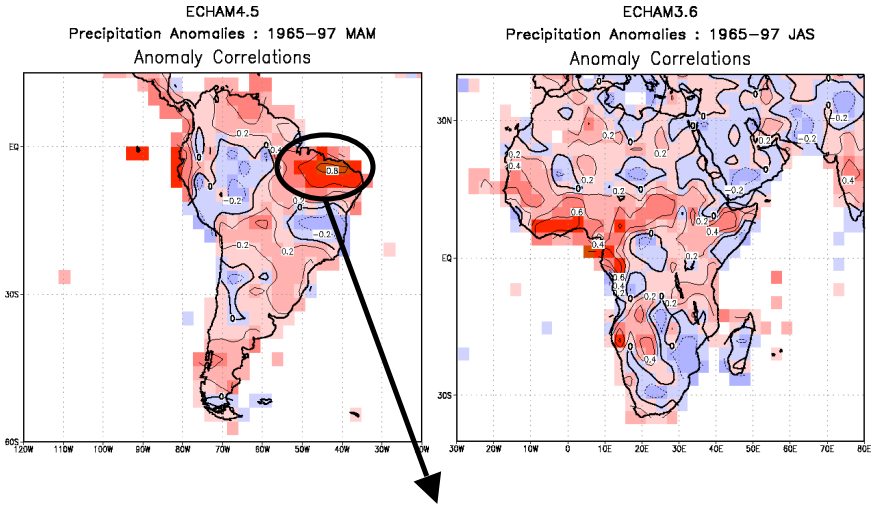
Ruiz-Barradas,1999

Impact of Variability in the Atlantic



AGCM skill in determining rainfall when SST is known Red = > 0.6 anomaly correlation.
(L. Goddard, IRI)

Impact of Variability in the Atlantic



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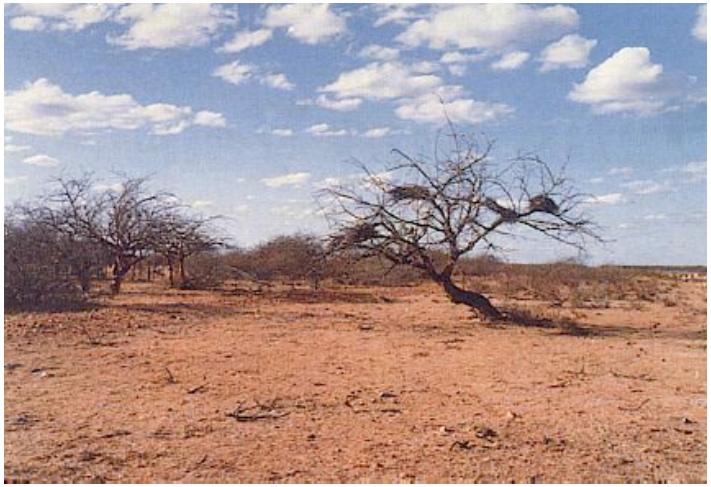
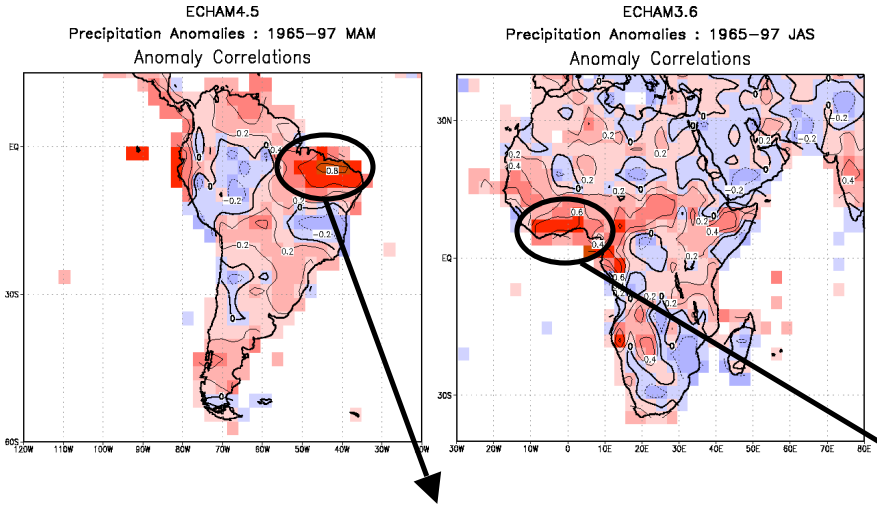


Nordeste

www.academiadovinho.com.br/brasil/br_nordeste.html

Impact of Variability in the Atlantic



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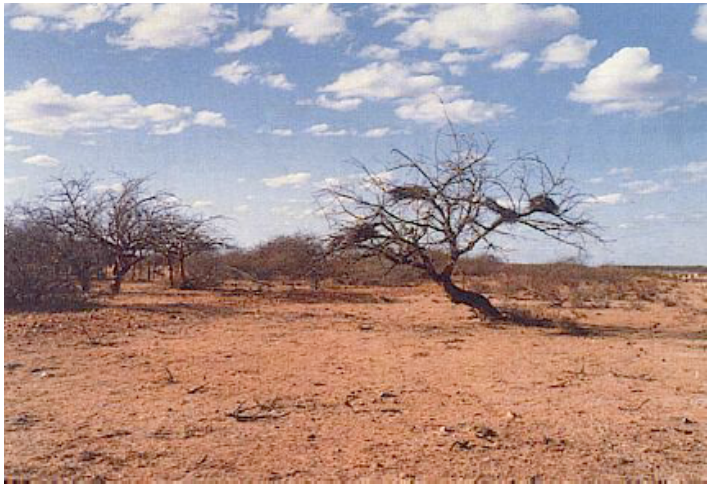
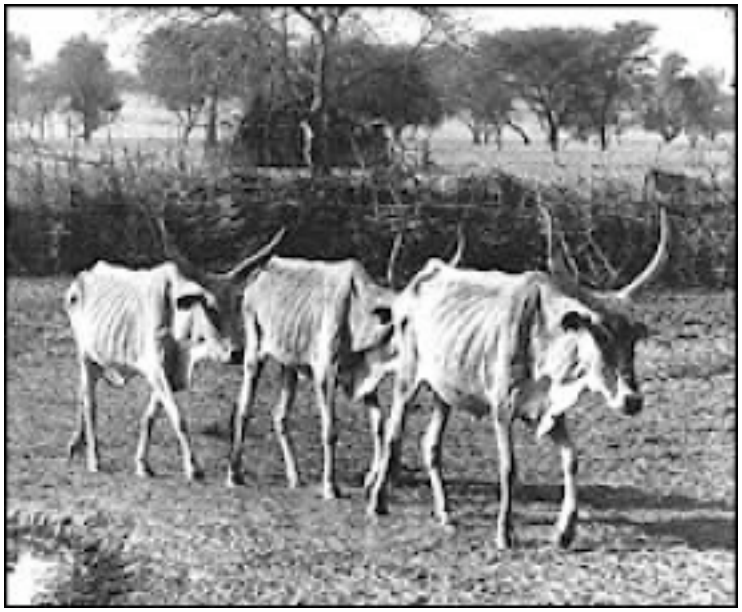


Nordeste

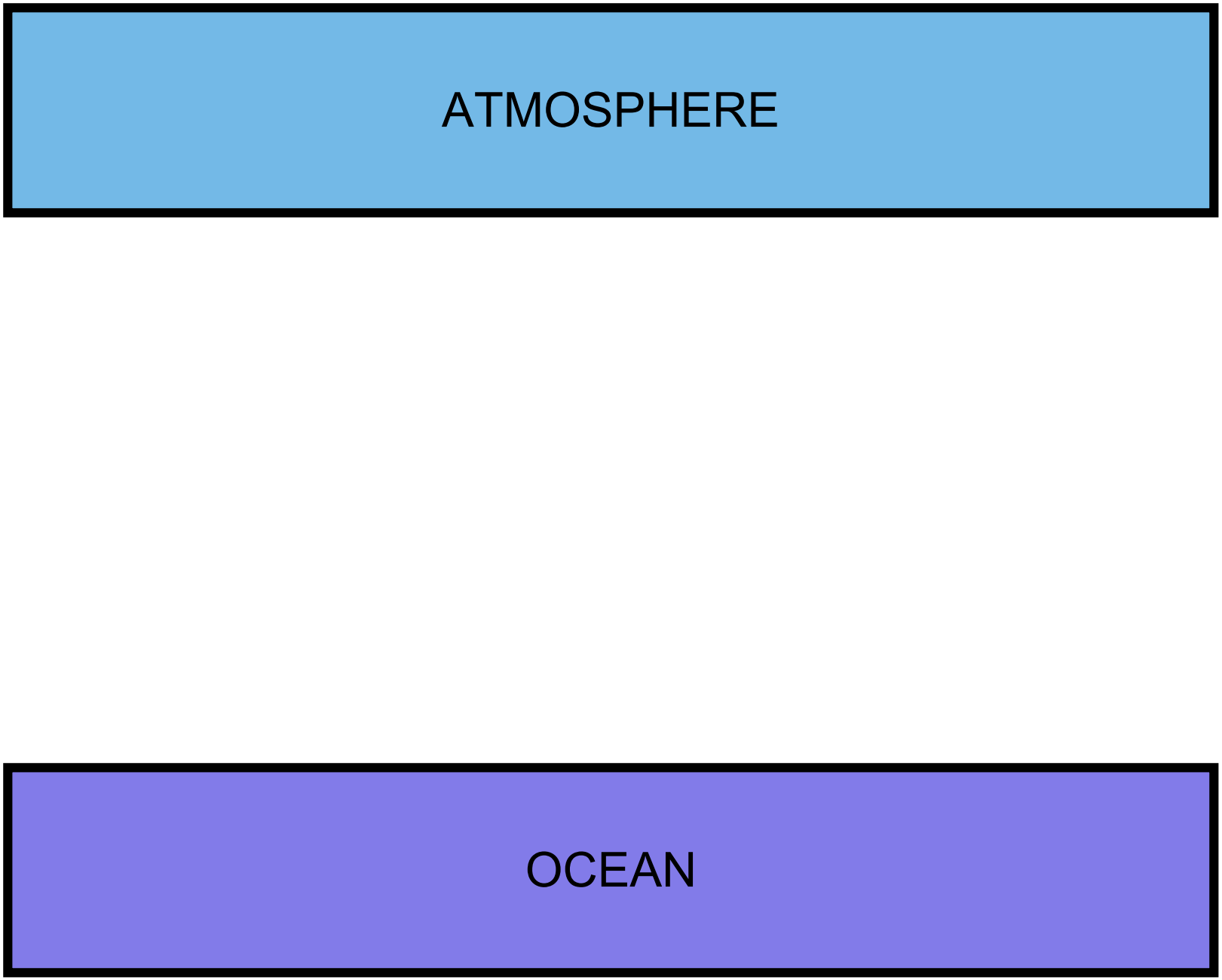
www.academiadovinho.com.br/brasil/br_nordeste.html



Sahel

Associated Press

- Ocean Models:
  - Slab Ocean - one layer, no physics, very simple, very fast
  - Reduced Gravity - 2-3 layers, limited physics, fast
  - Ocean General Circulation Model (OGCM) - 25-40 layers, extensive physics, parallel computing required
- Atmosphere Models:
  - Statistical - no physics, fast, small
  - Atmosphere General Circulation Models (AGCM) - 26-85 levels, extensive physics, parallel computing required
- Ocean and Atmosphere Domains:
  - Global - requires reduced resolution, fewer boundary issues
  - Regional - allows higher resolution - boundary issues
- What about the code?
  - All fortran
  - Source code available (“semi” public domain)
  - Support limited
  - Some has been handed down from generation to generation
  - The OGCMs and AGCMs are parallelized using MPI, OMP or both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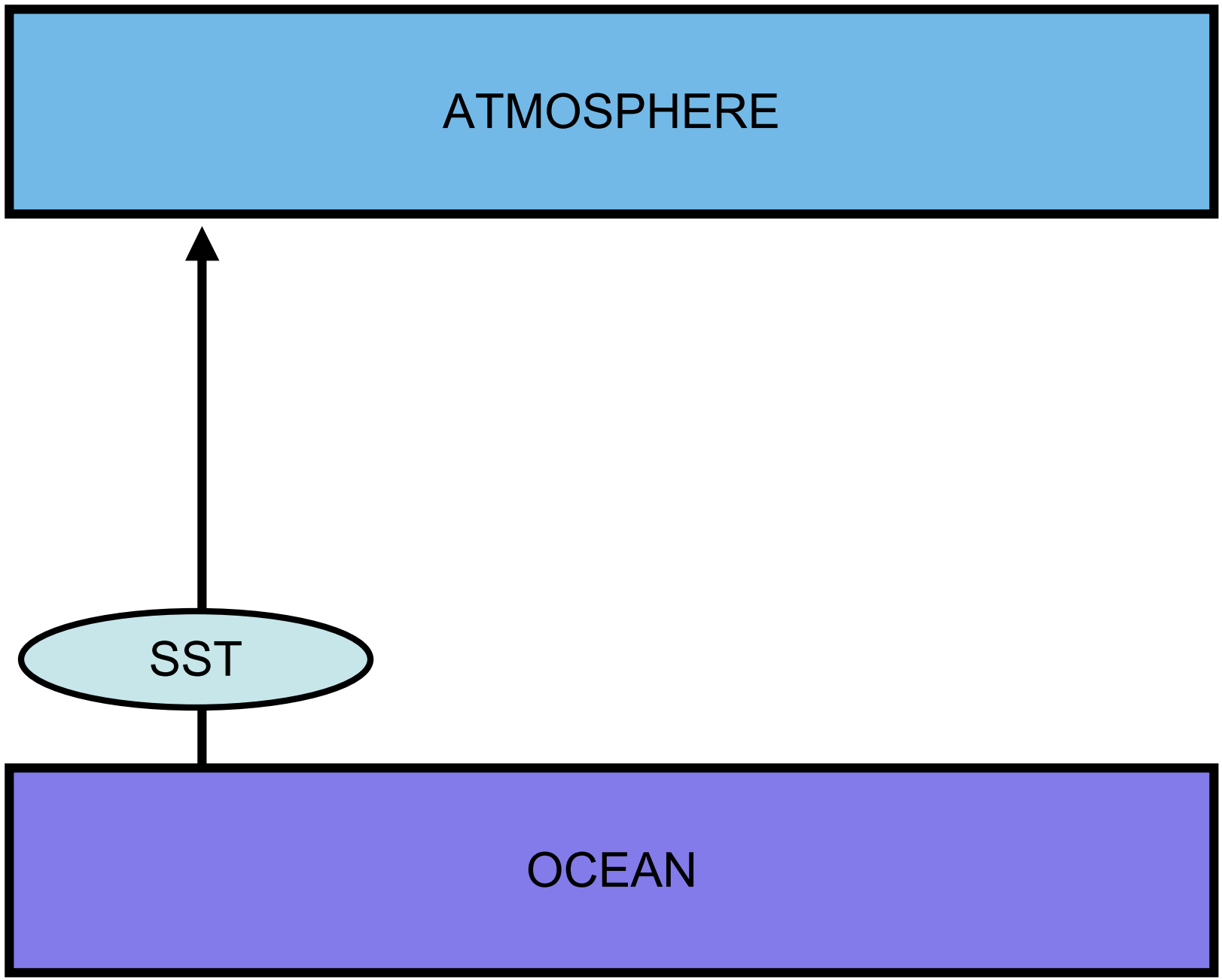
OCEAN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SST
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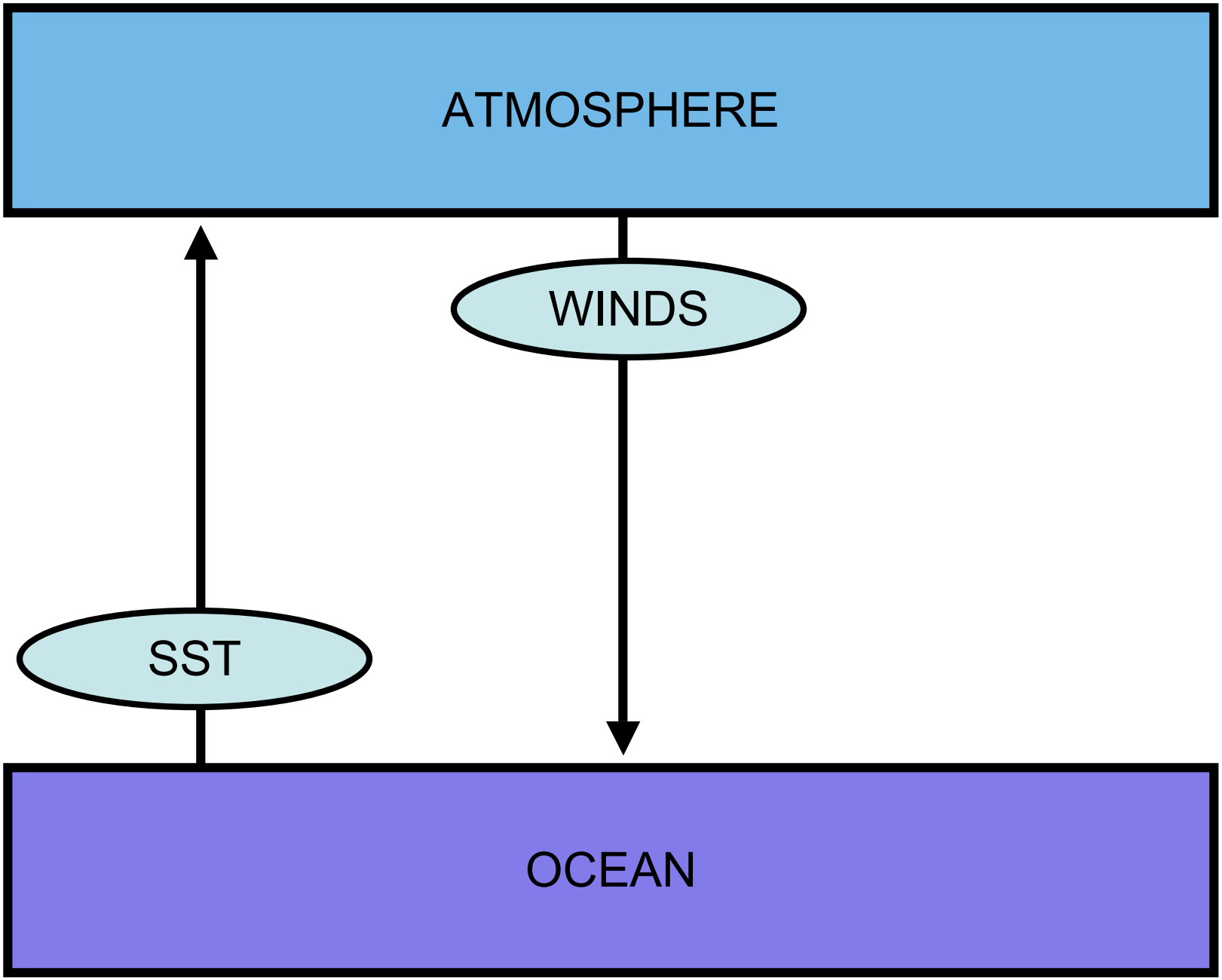
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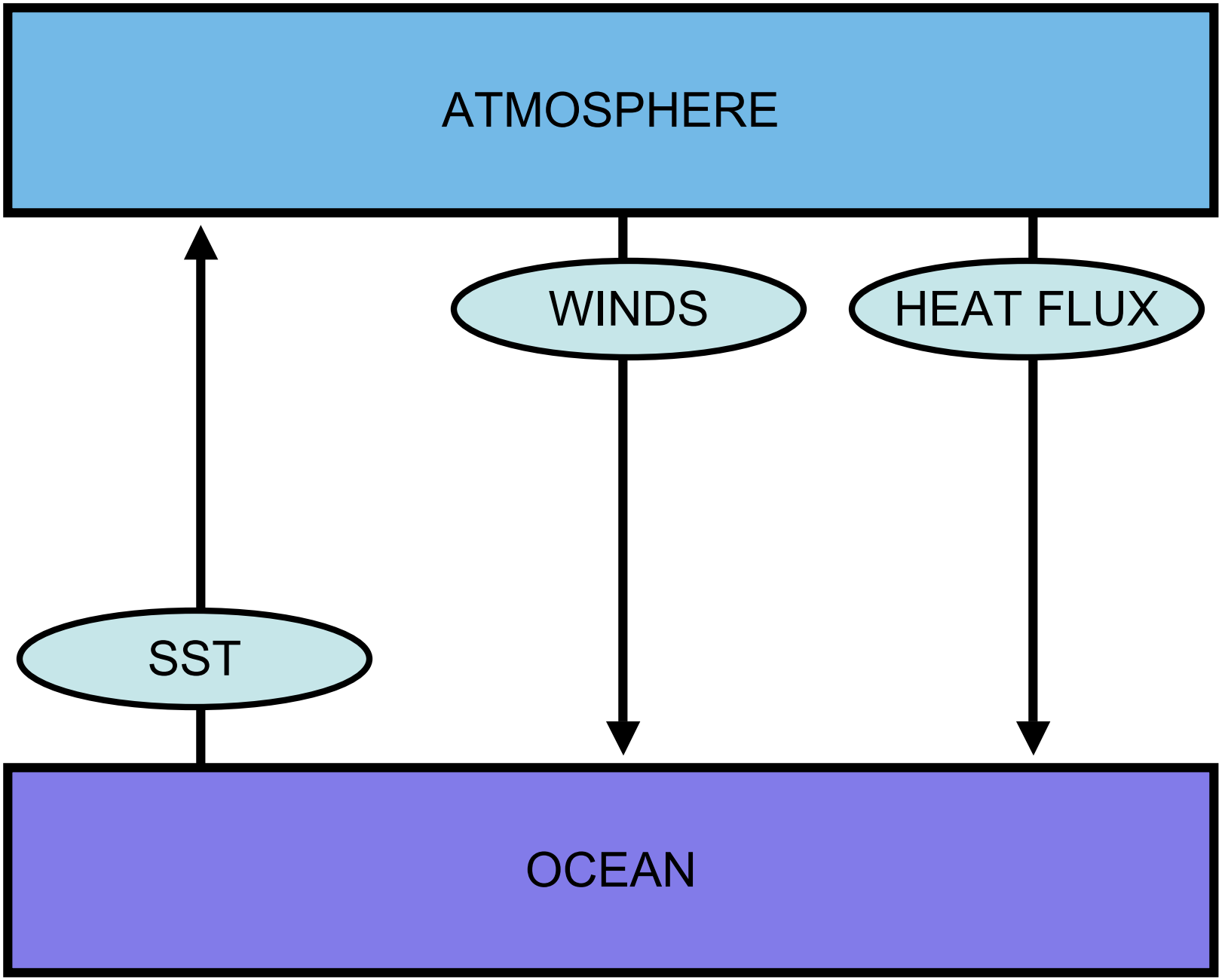
WINDS
SST
OCEAN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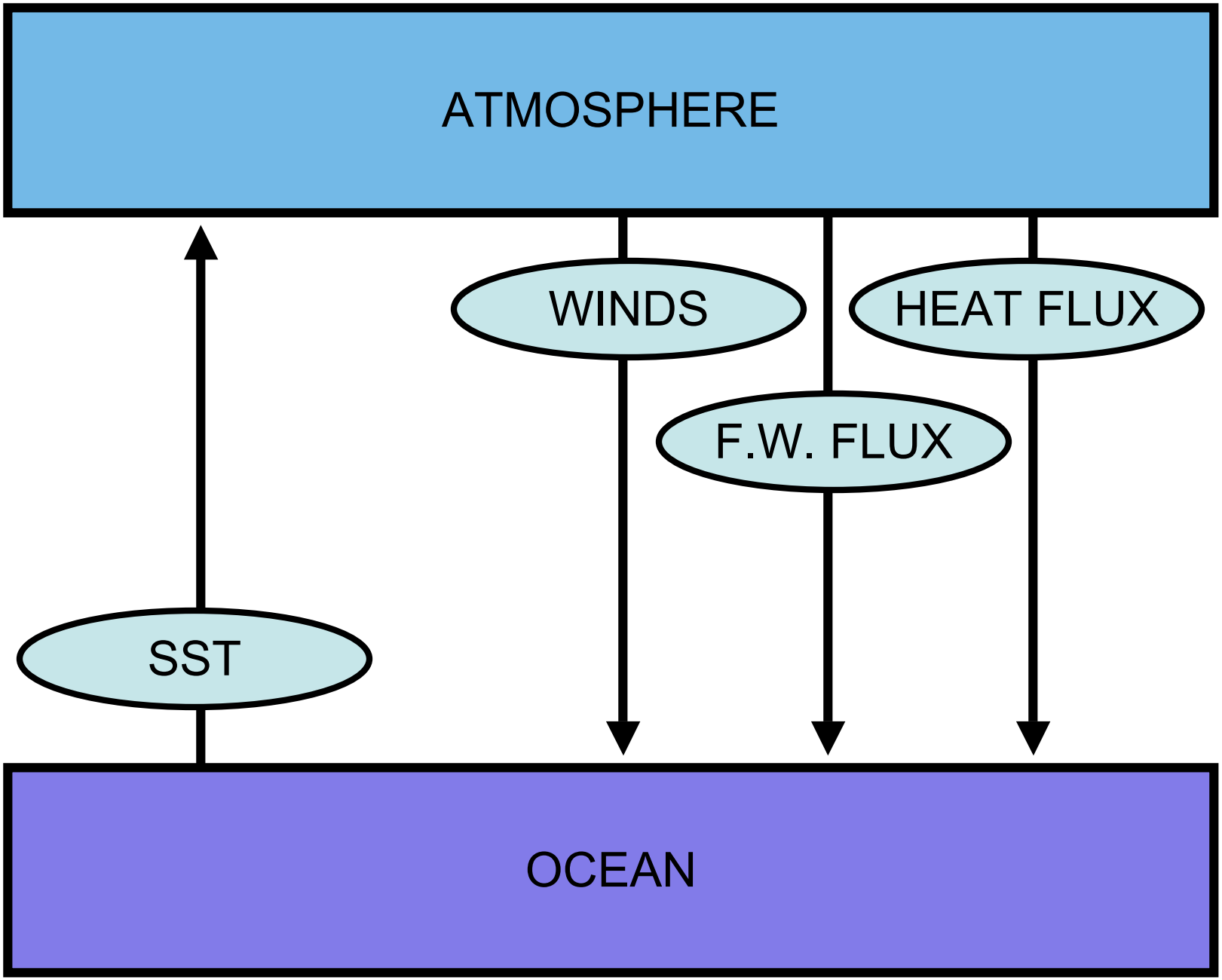
WINDS
HEAT FLUX
SST
OCEAN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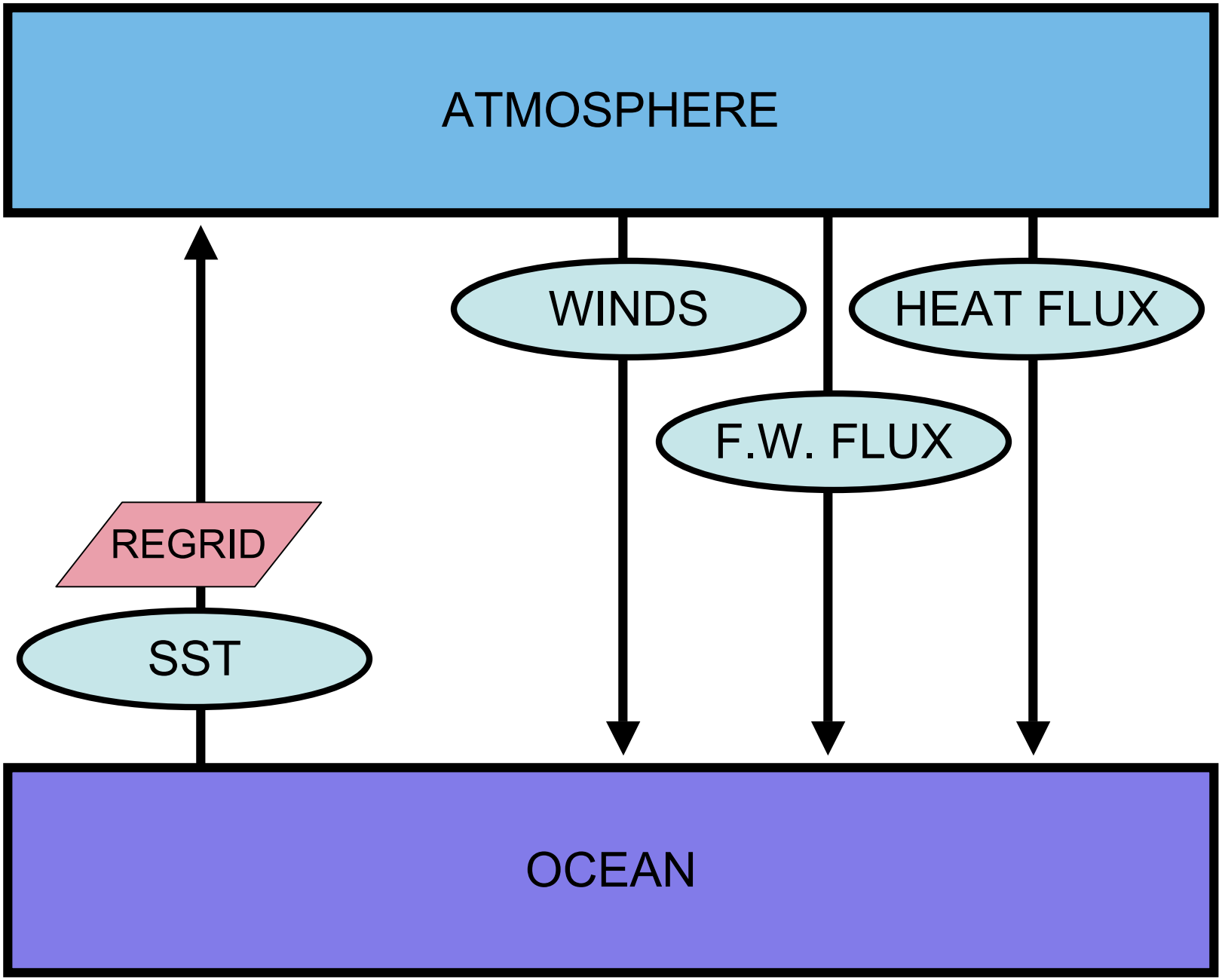
WINDS
HEAT FLUX
F.W. FLUX
SST
OCEAN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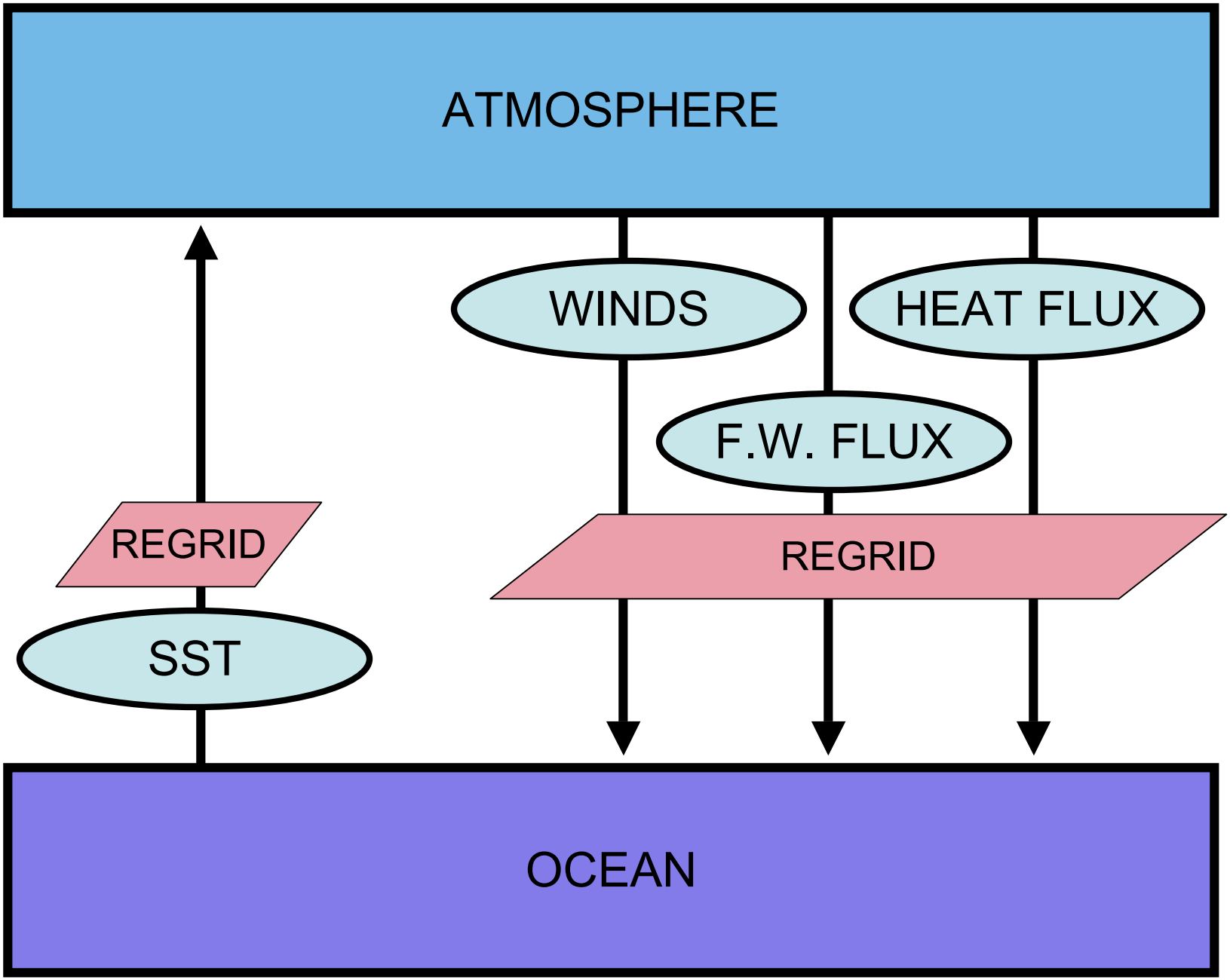
WINDS
HEAT FLUX
F.W. FLUX
REGRID
SST
OCEAN


ATMOSPHERE
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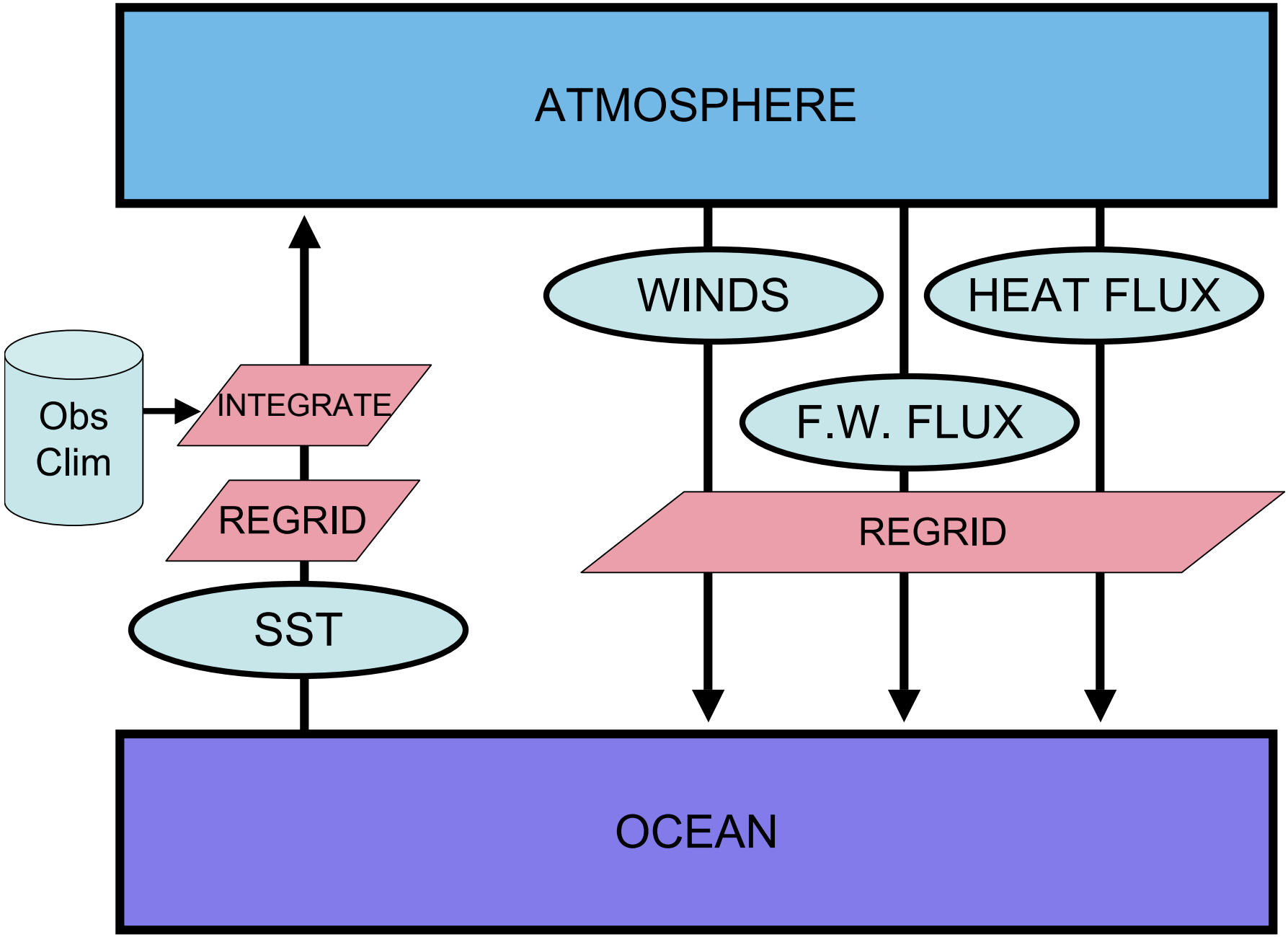
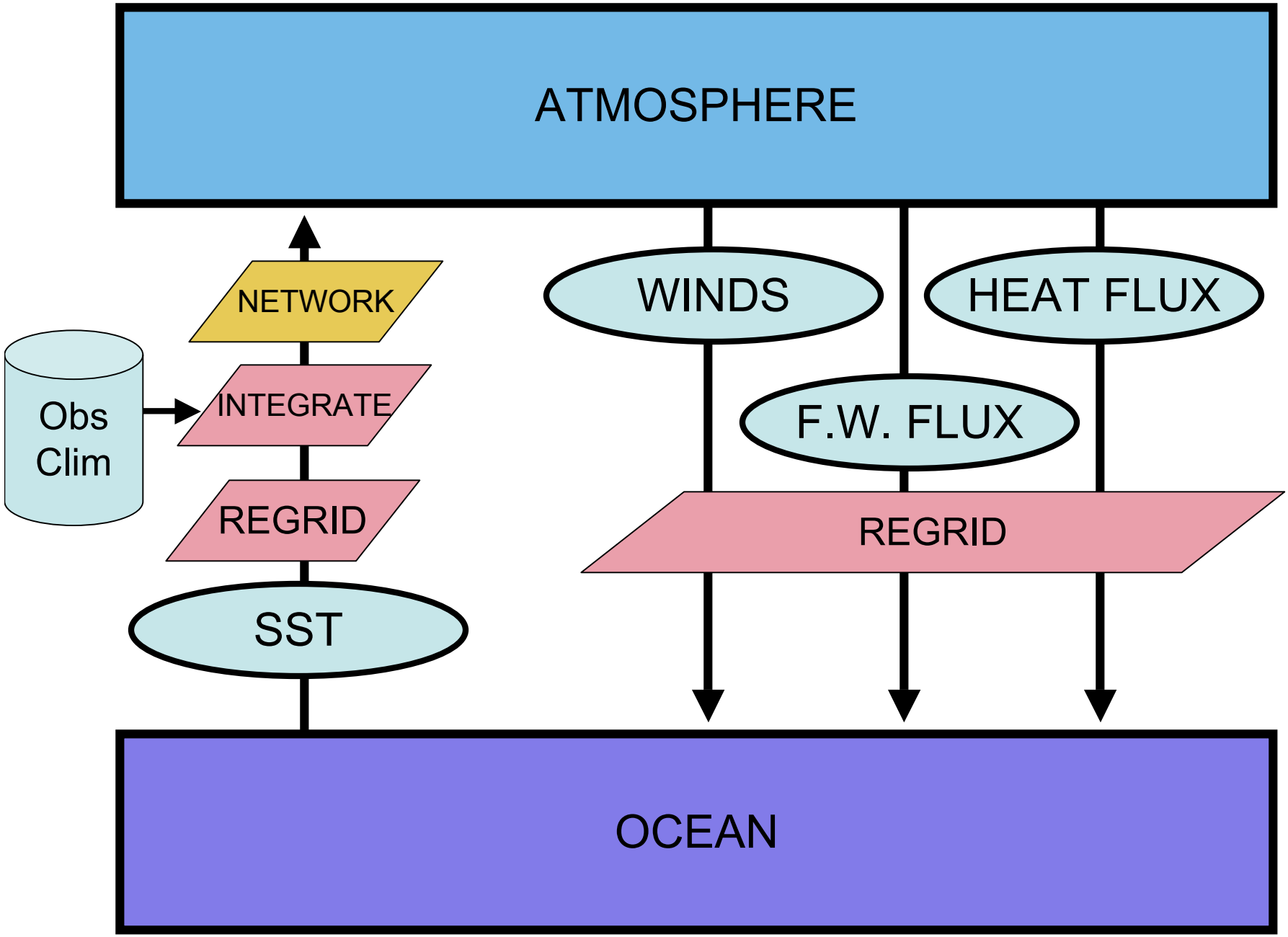
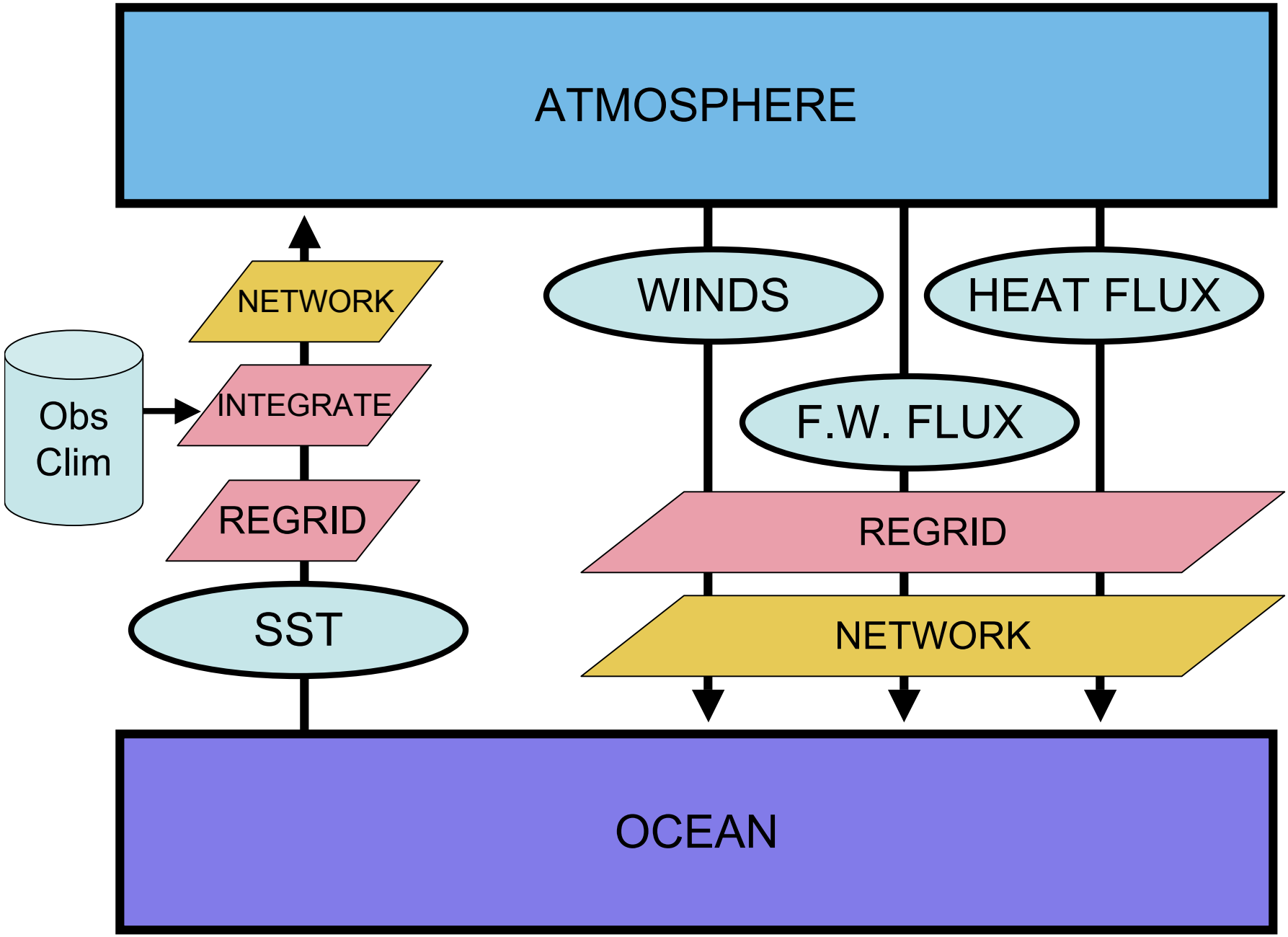
HEAT FLUX
F.W. FLUX
REGRID
REGRID
SST
OCEAN


ATMOSPHERE
WINDS
HEAT FLUX
F.W. FLUX
Obs
Clim
INTEGRATE
REGRID
REGRID
SST
OCEAN


ATMOSPHERE
NETWORK
Obs
Clim
INTEGRATE
REGRID
SST
WINDS
HEAT FLUX
F.W. FLUX
REGRID
OCEAN

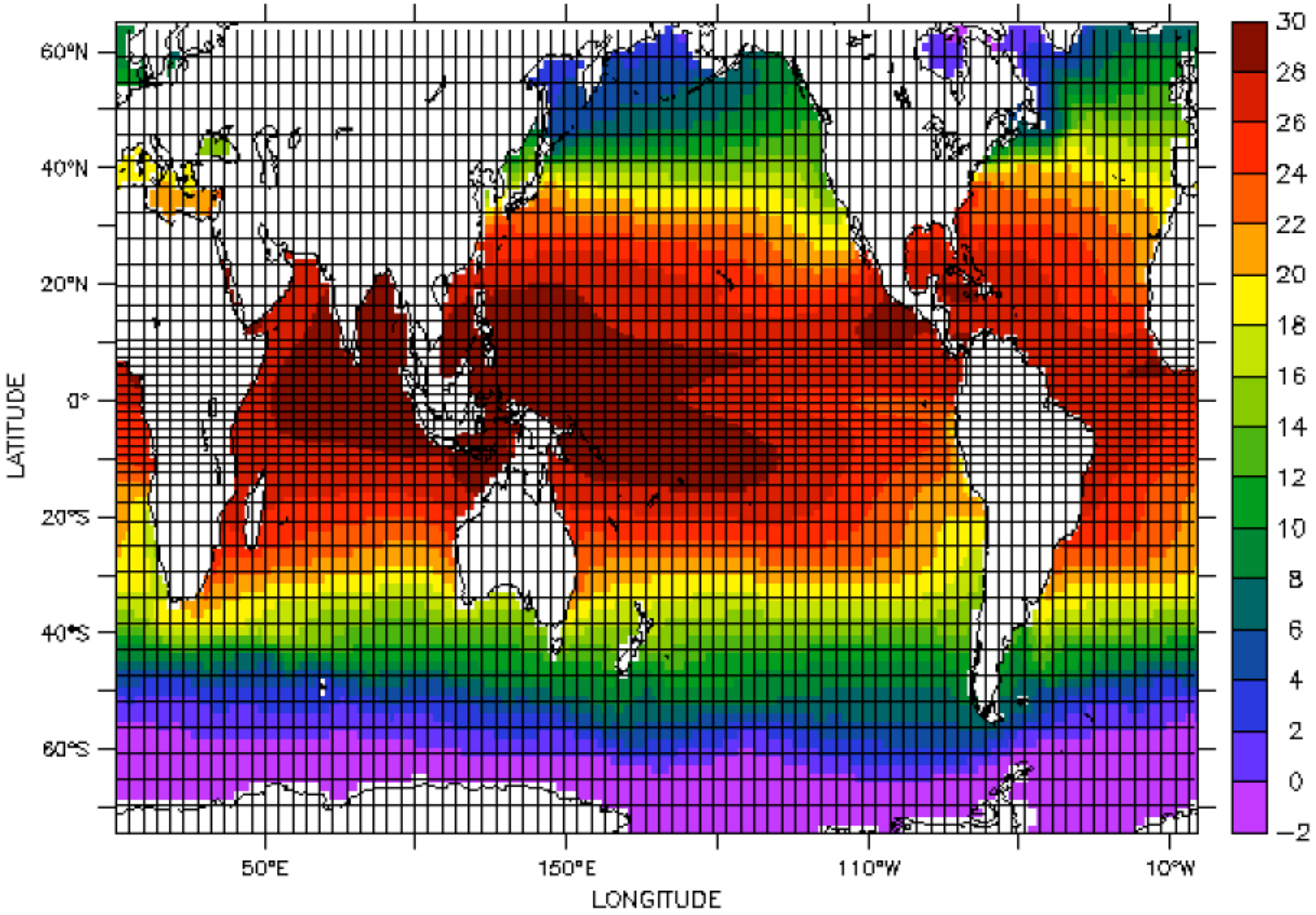

ATMOSPHERE
NETWORK
Obs
Clim
INTEGRATE
REGRID
SST
WINDS
HEAT FLUX
F.W. FLUX
REGRID
NETWORK
OCEAN

Modeling on Hydra

- Ocean Model
  - GFDL MOM3 OGCM, Finite Difference
  - Global, 240 x 134 with 25 vertical levels
  - 16 processors, MPI
- Atmosphere Model:
  - NCAR CAM3 AGCM, Spectral
  - Global T42 resolution (128 x 64) with 26 vertical levels
  - 16 processors, MPI
- Performance:
  - 3 hours per model year
  - MPI is not used for inter-model communication
  - Performance matching - Ocean spends about 5% waiting
- Current Status
  - Model development is complete
  - 50 year test run complete

MOM Ocean Model Grid

Every Third Point Plotted



MOM Ocean Model Grid

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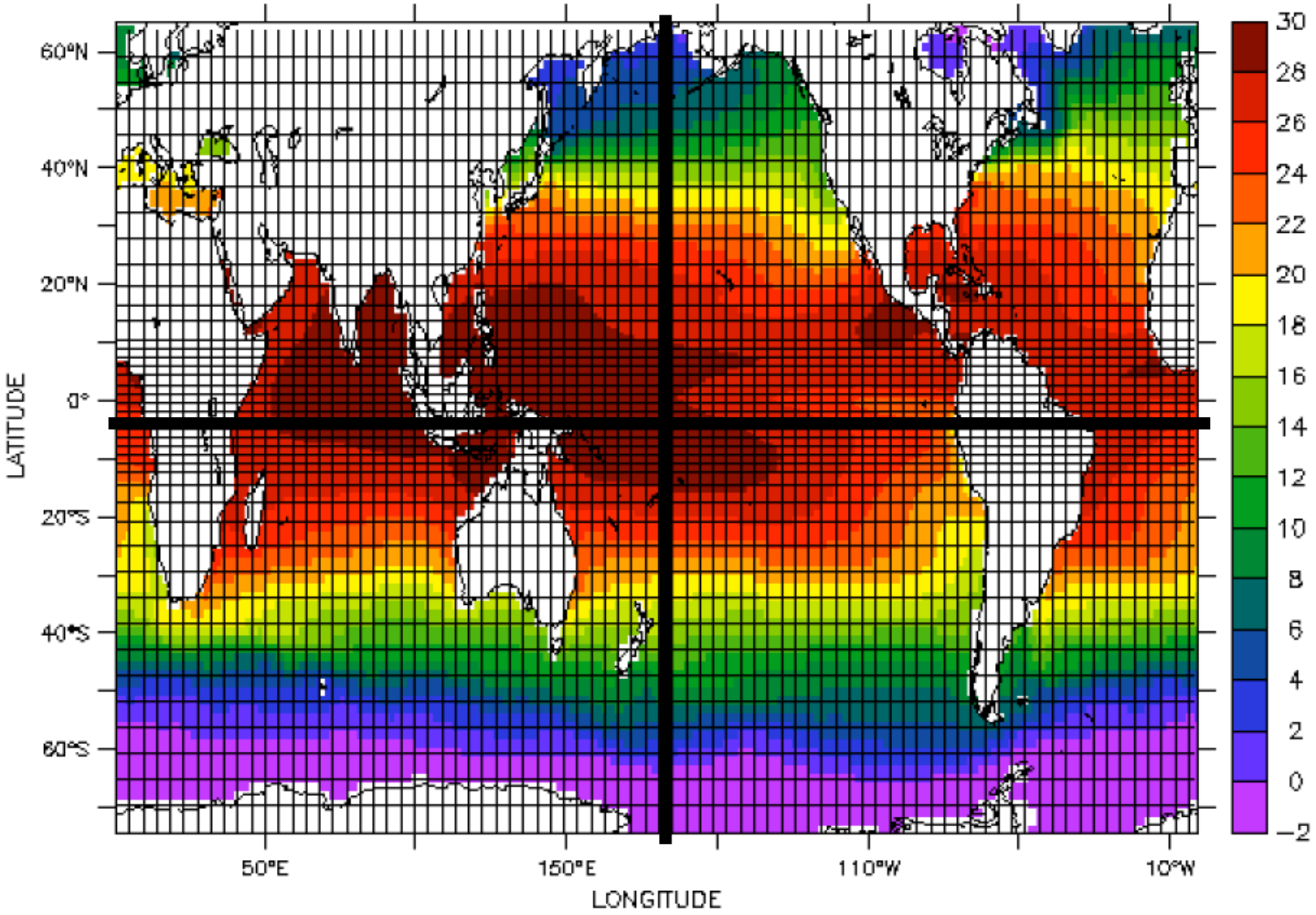
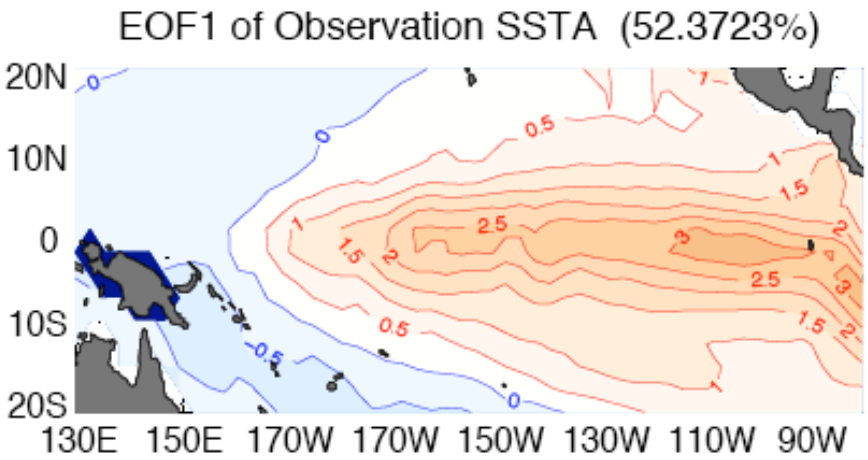
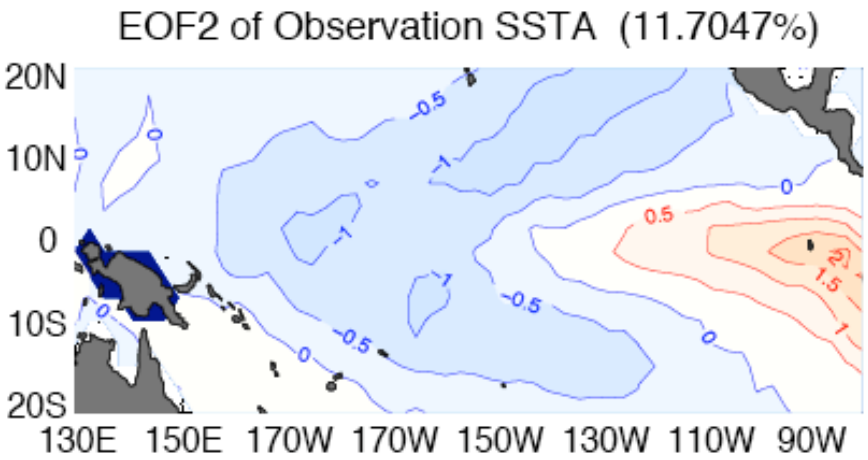
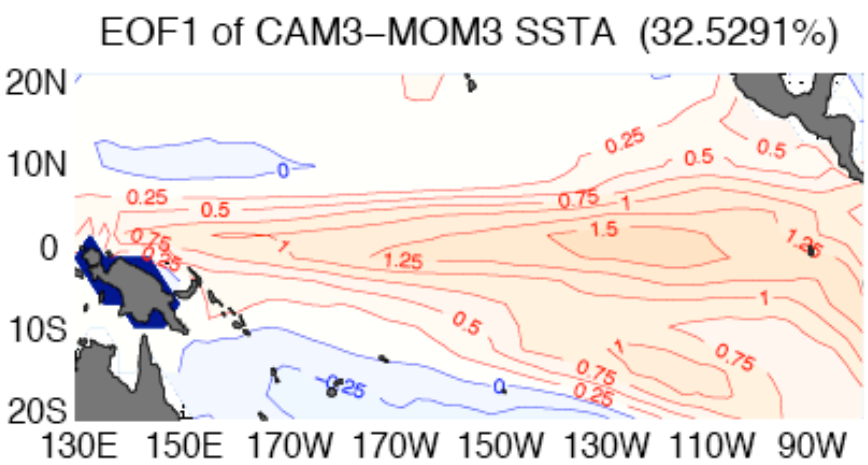
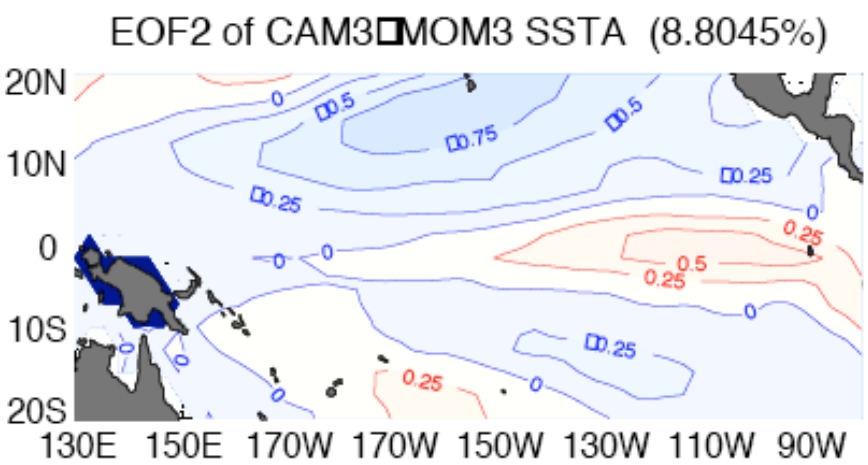


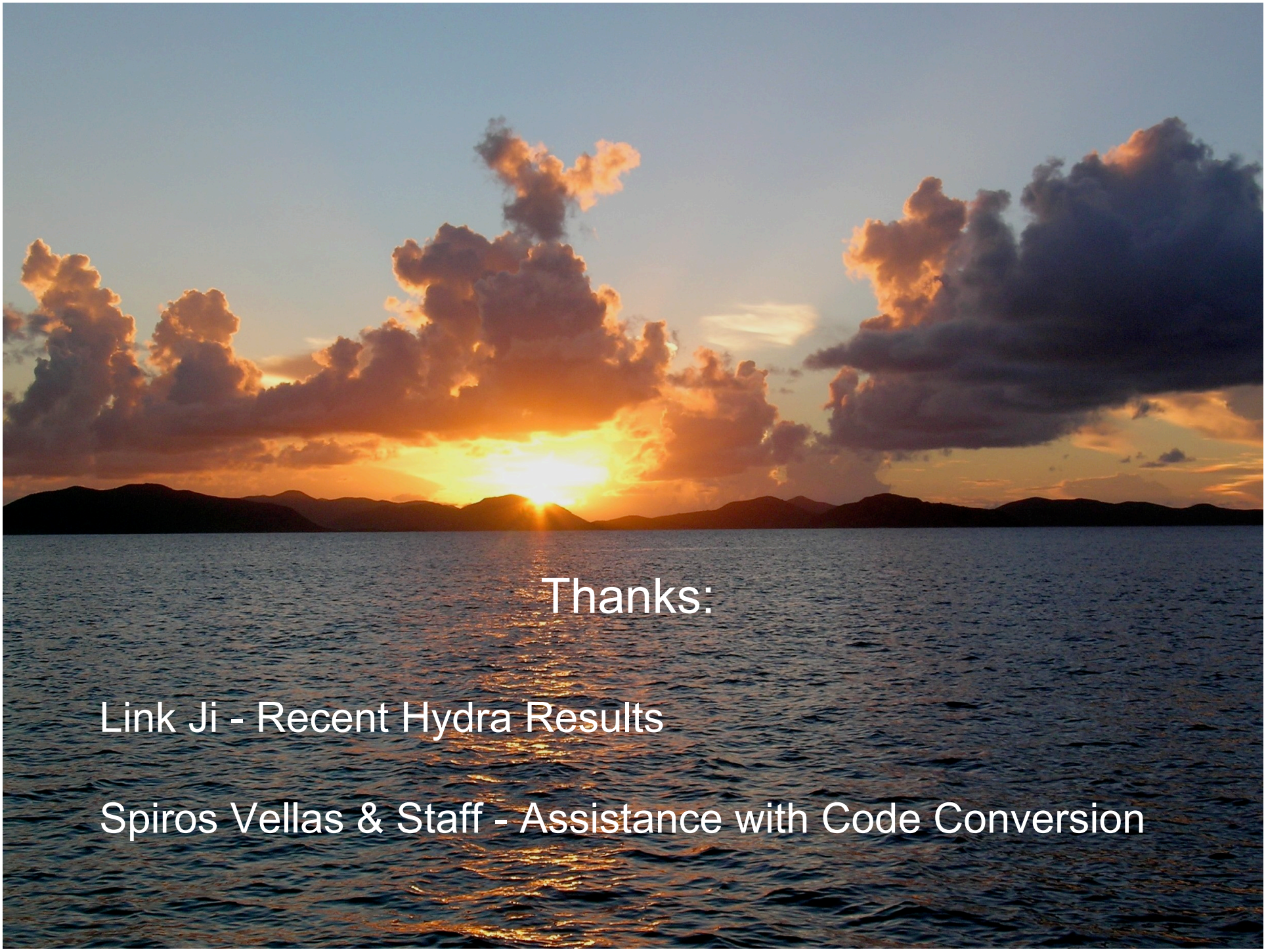
Some Preliminary Results . . .










Thanks:
Link Ji - Recent Hydra Results
Spiros Vellas & Staff - Assistance with Code Conversion