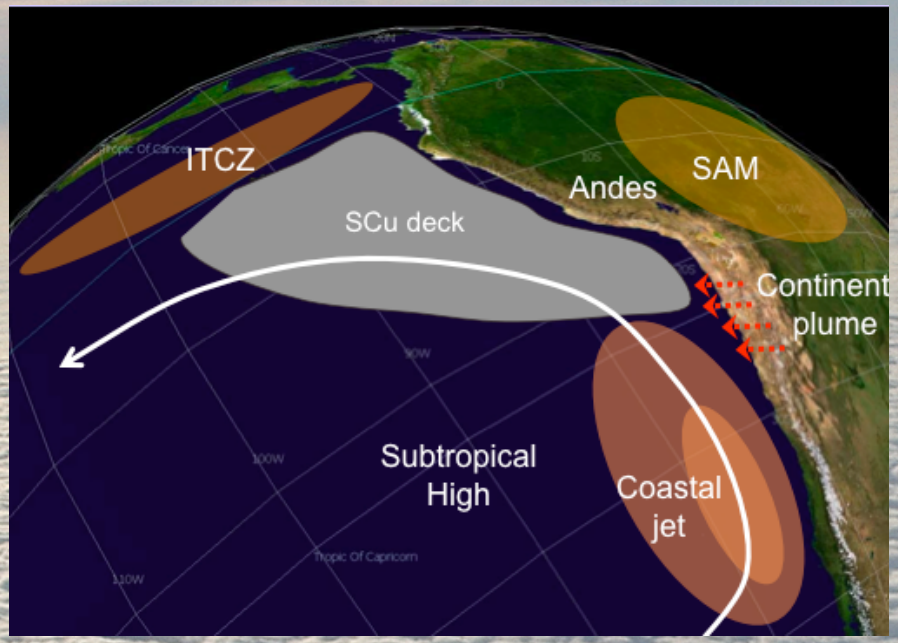
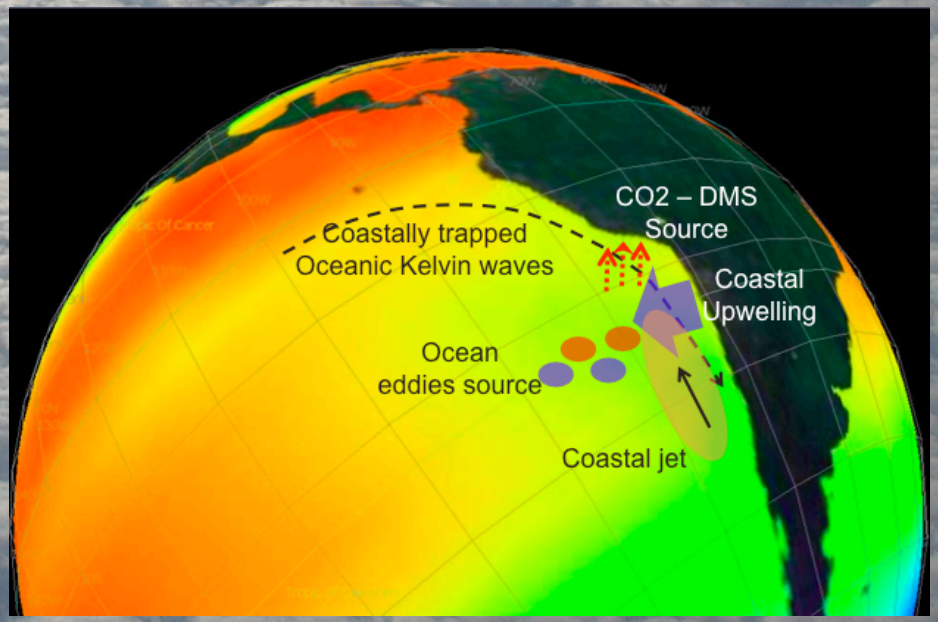
The Southeastern Pacific

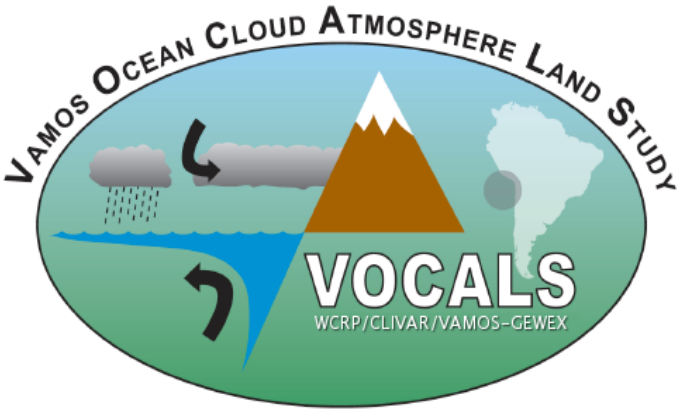


- Cold SSTs, coastal upwelling
- Coastally trapped Kelvin waves and ocean eddies
- Unresolved issues in heat and nutrient budgets
- Important links between clouds and aerosol

- Poorly simulated by atmosphere-ocean GCMs
- Cloud-topped ABLs
- Influenced by and influential on remote climates (ENSO)
- Important links between clouds and aerosol



Vocals Modeling Hypotheses



- **The Modeling Problem in the SEP**
- **Evidence for a key role of multi-scale coupled processes**
- **A methodology to address simulation and prediction in the SEP**

Systematic errors of GCMs in the Eastern Tropical Pacific

Coupled atmosphere-ocean models have difficulties in simulating stratocumulus clouds and other key elements of the PBL in the region (e.g. height, albedo)

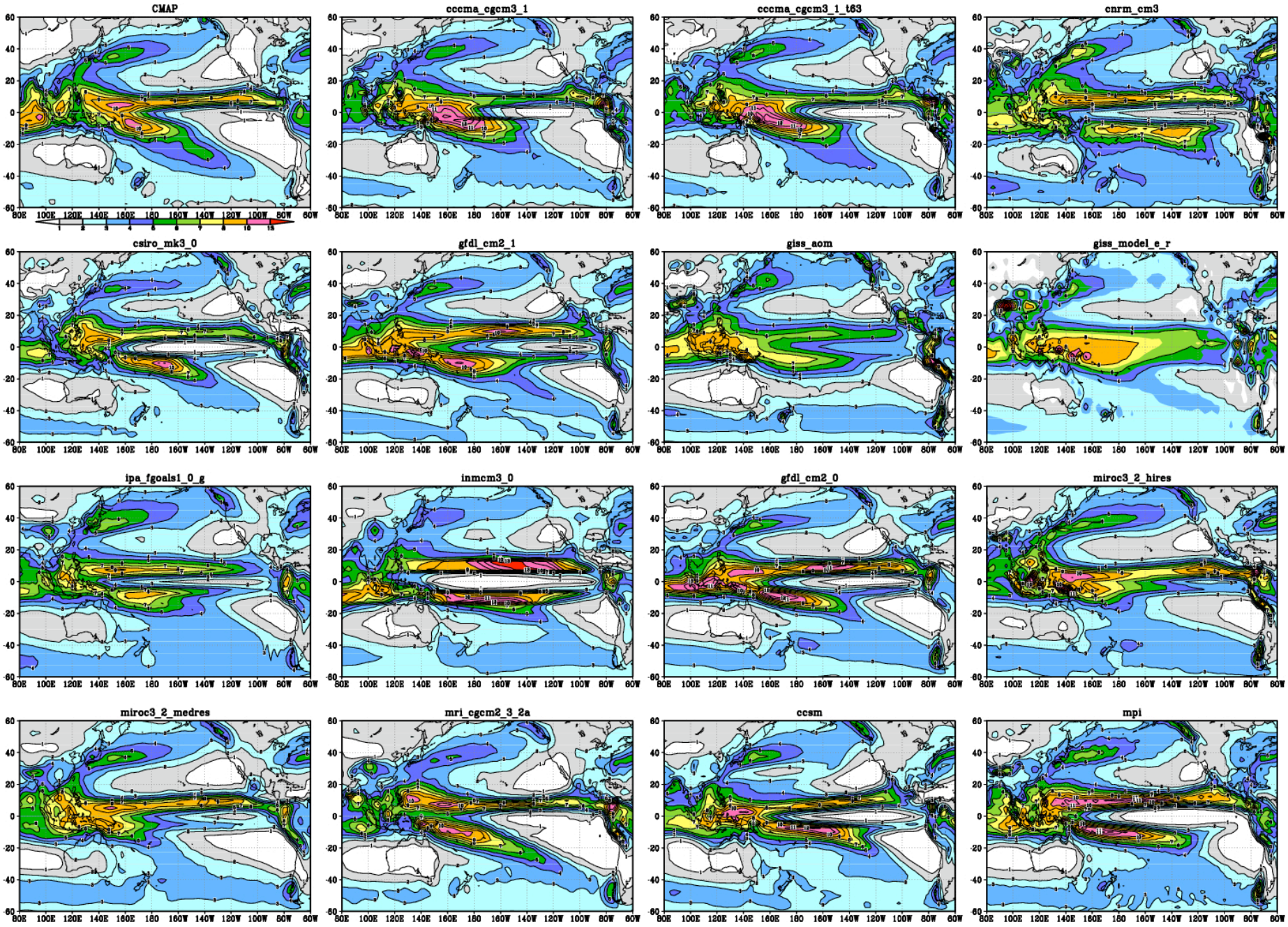
Simulated SSTs are too warm

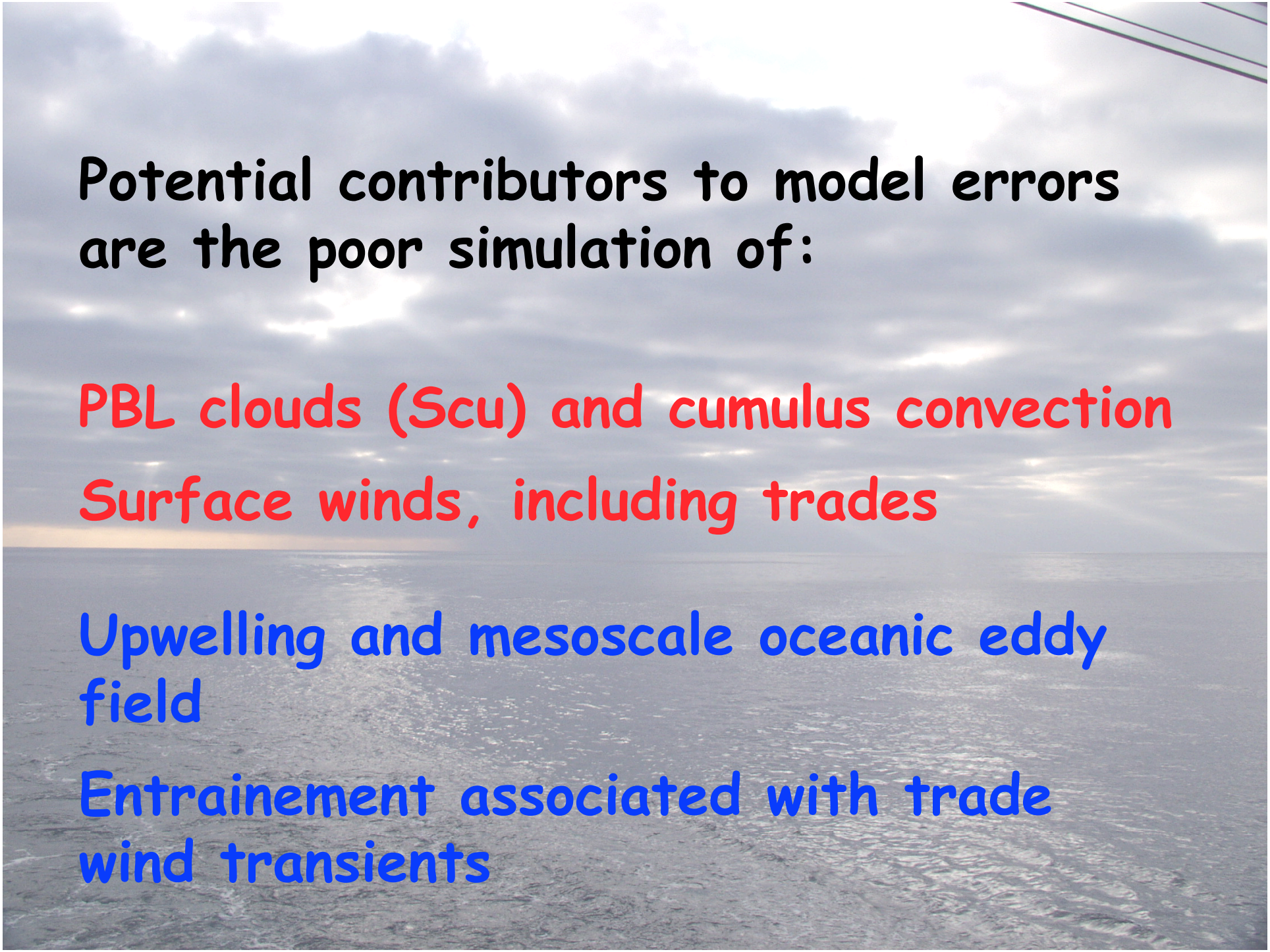
A "double ITCZ" bias develops, even if Scu are "right"

OGCMs have difficulties with the simulation of upwelling, eddy field, and associated effects

The PBL parameterizations do not consider adequately the effects of mesoscale atmospheric processes that influence the structure of Scu decks (e.g. POCs)

Annual Mean Precipitation - IPCC Models (Courtesy A. Kitoh, MRI)

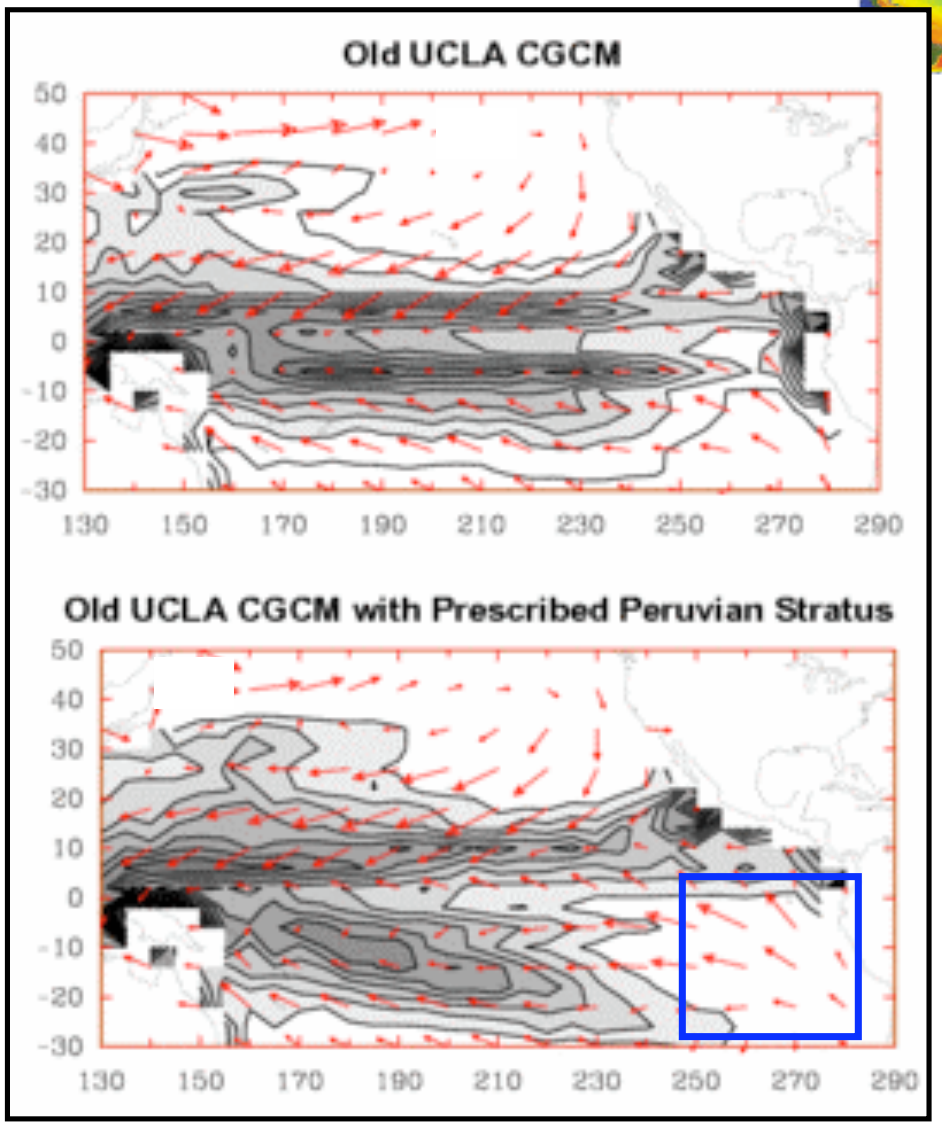



Potential contributors to model errors are the poor simulation of:
PBL clouds (Scu) and cumulus convection
Surface winds, including trades
Upwelling and mesoscale oceanic eddy field
Entrainement associated with trade wind transients

A coupled problem

- Correct prediction of stratus properties is important for the correct prediction of the climate over the tropical warm pool
  - connections with ITCZ through both ocean and atmosphere

Yu and Mechoso 2001



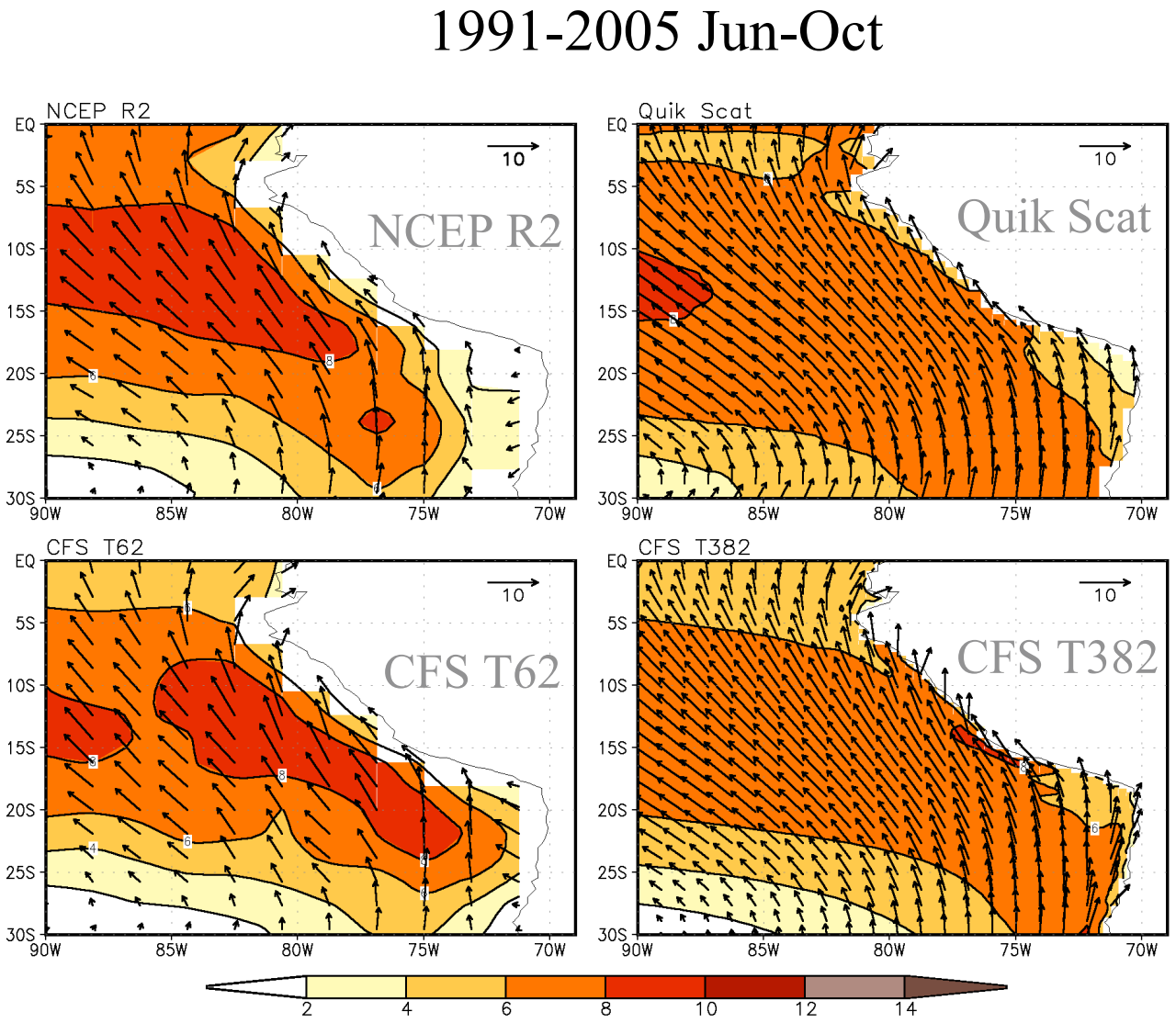
Precip [mm day^{-1}]

0 2 4 6 8 10 12 14

UCLA

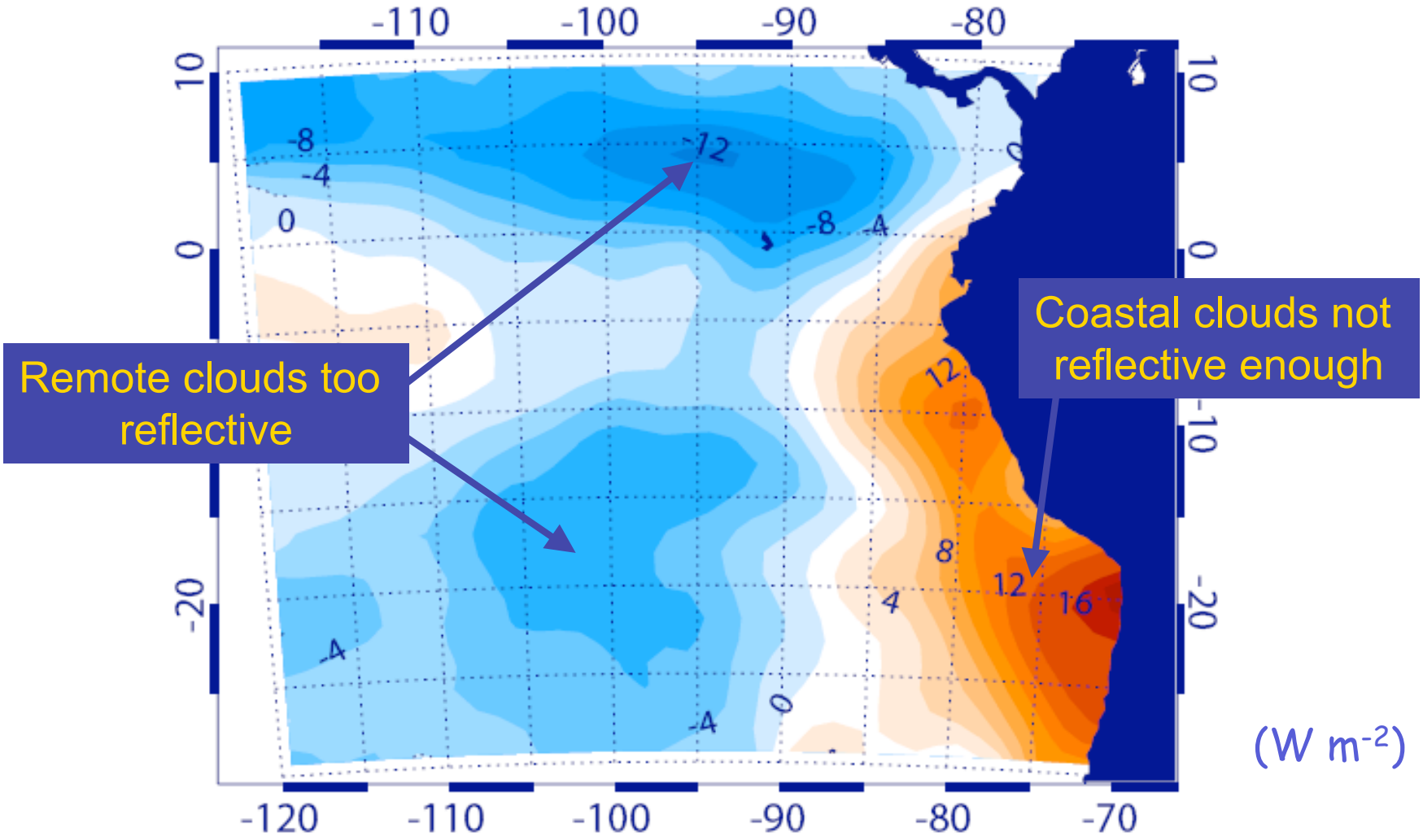
10-meter winds – high resolution model needed

- Both NCEP R2 and CFS T62 produce too weak winds near the coast
- CFS T382 is more realistic in overall magnitude, especially near the coast

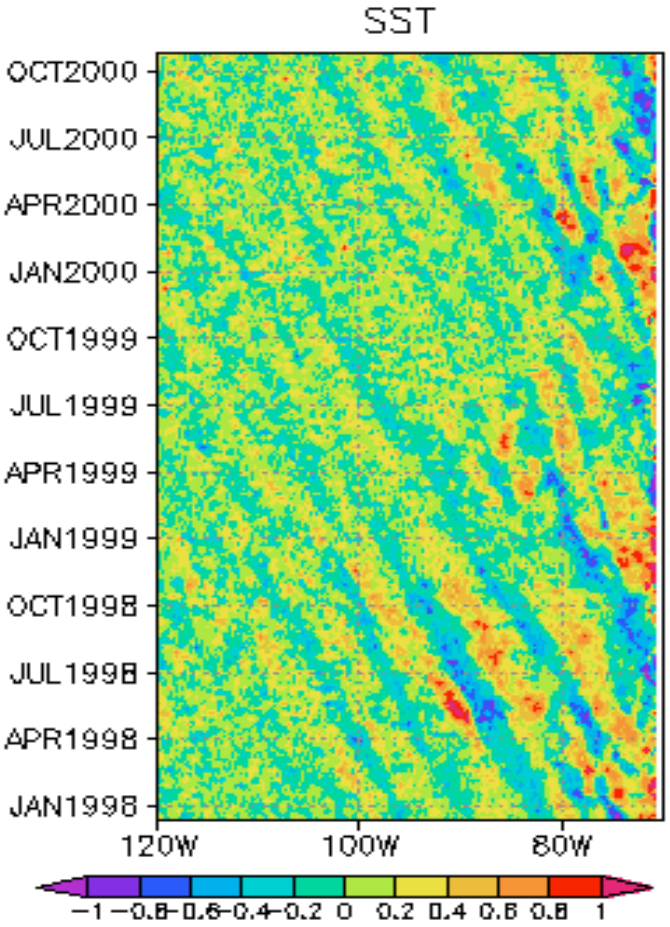


(From Wanqiu Wang)

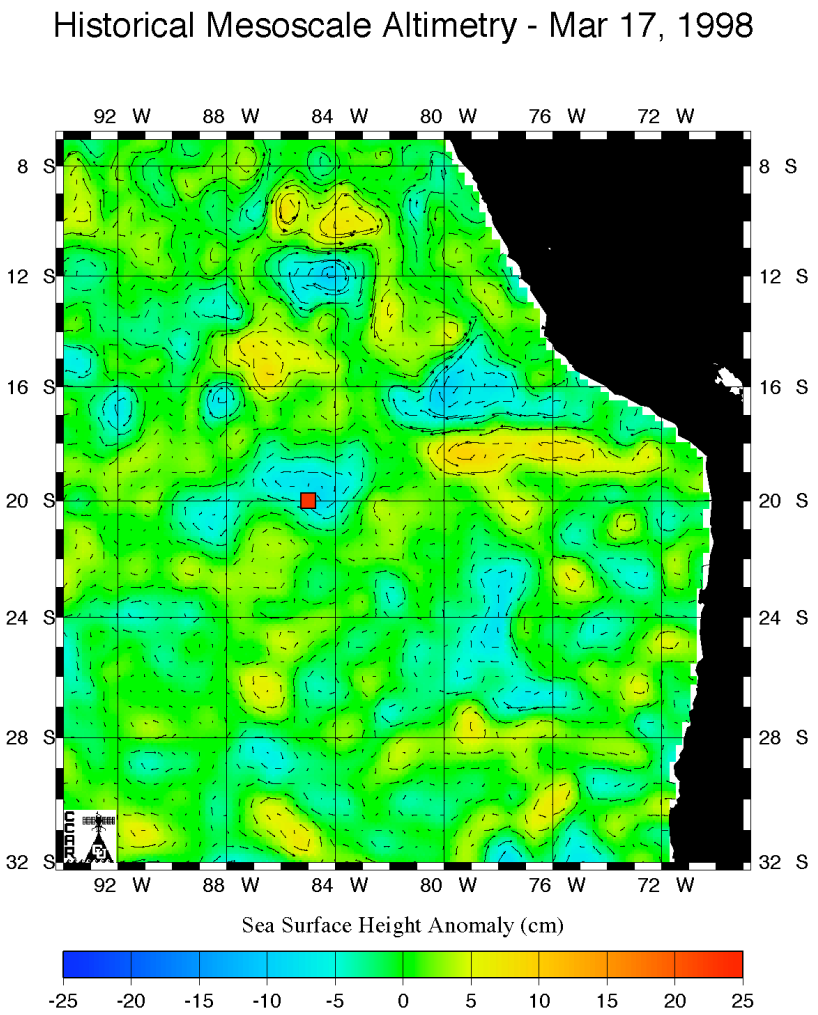
Indirect Aerosol Effects: Error in TOA net SW radiation caused by assumption of constant cloud droplet effective radius



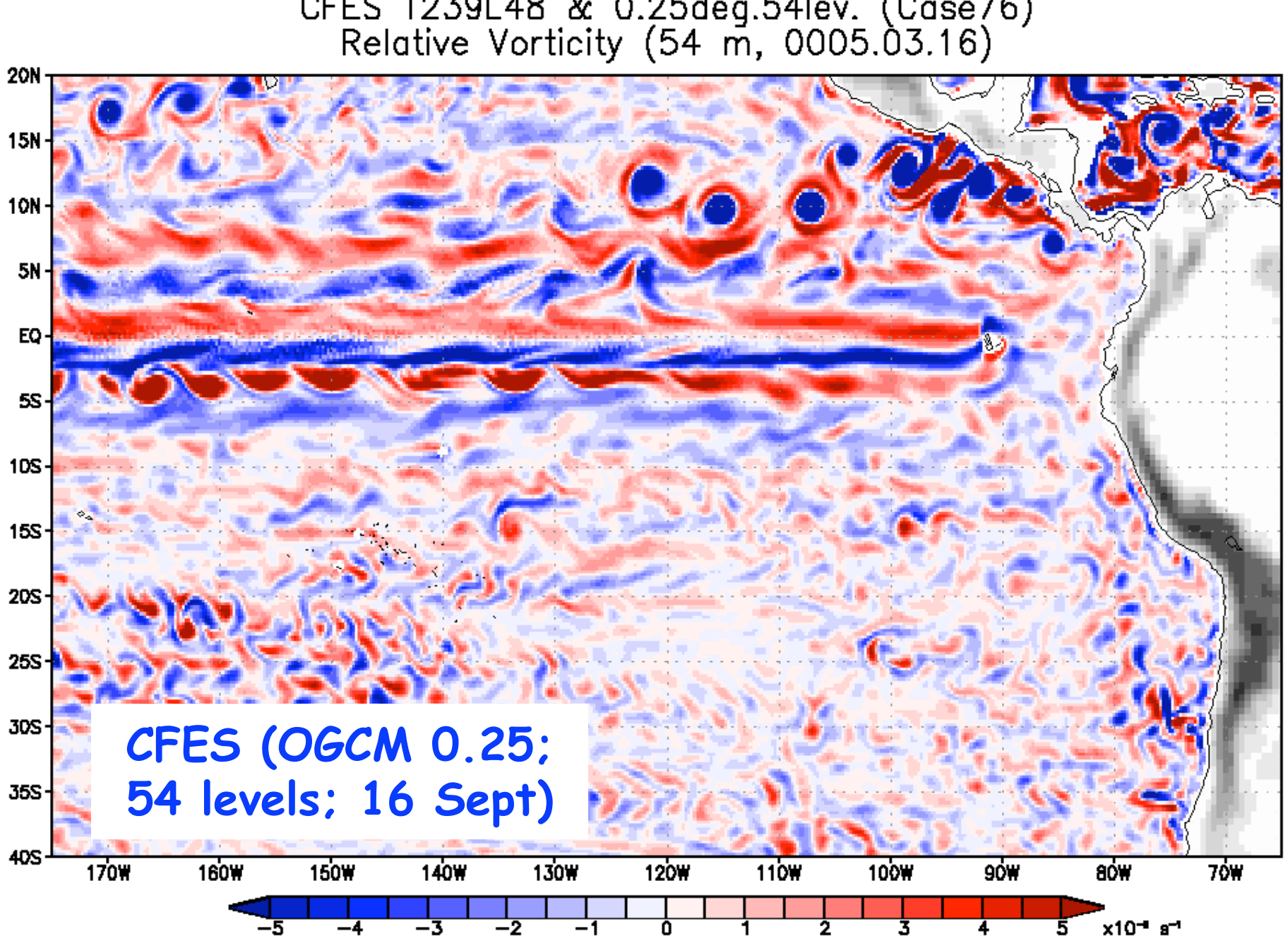
Altimetric satellites show westward propagating eddies are typical of the region.



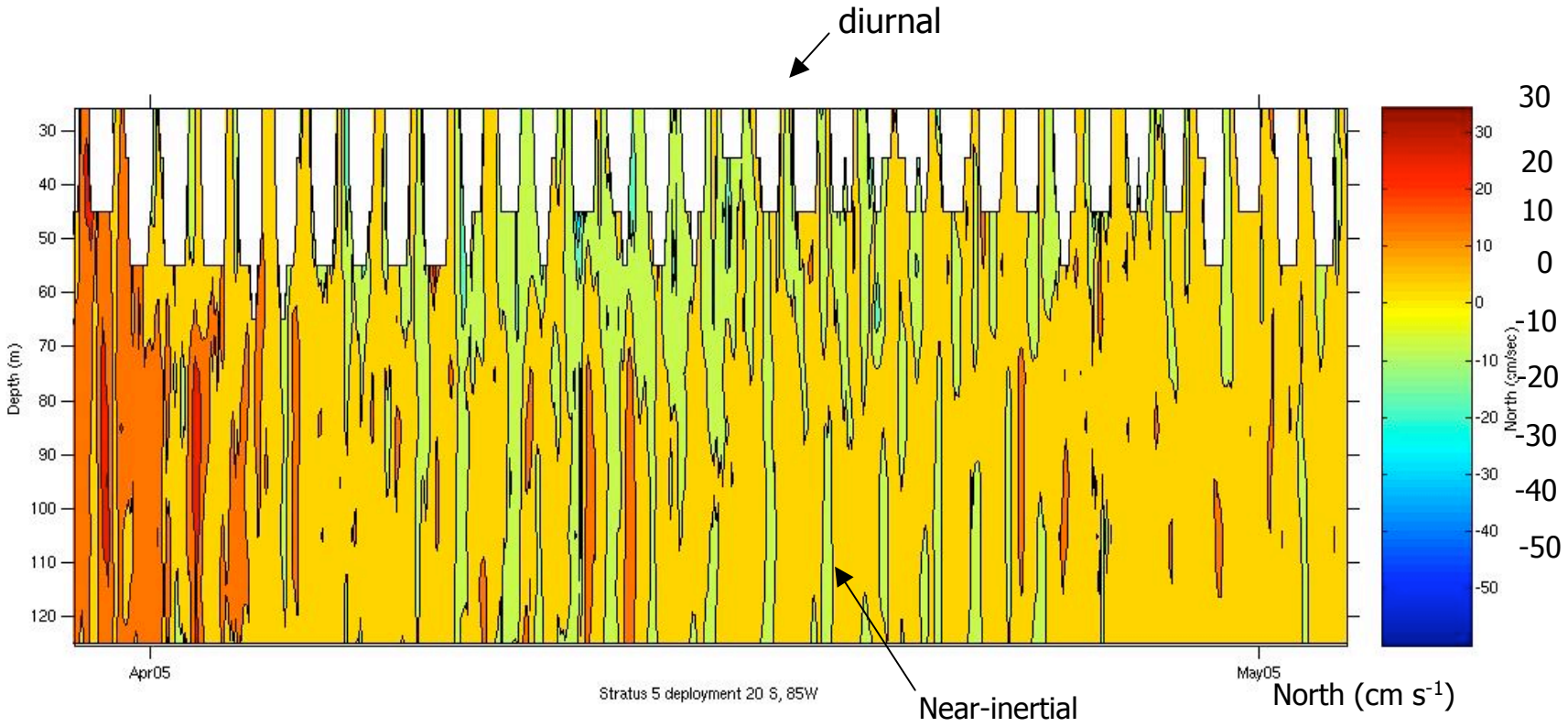
S-P Xie



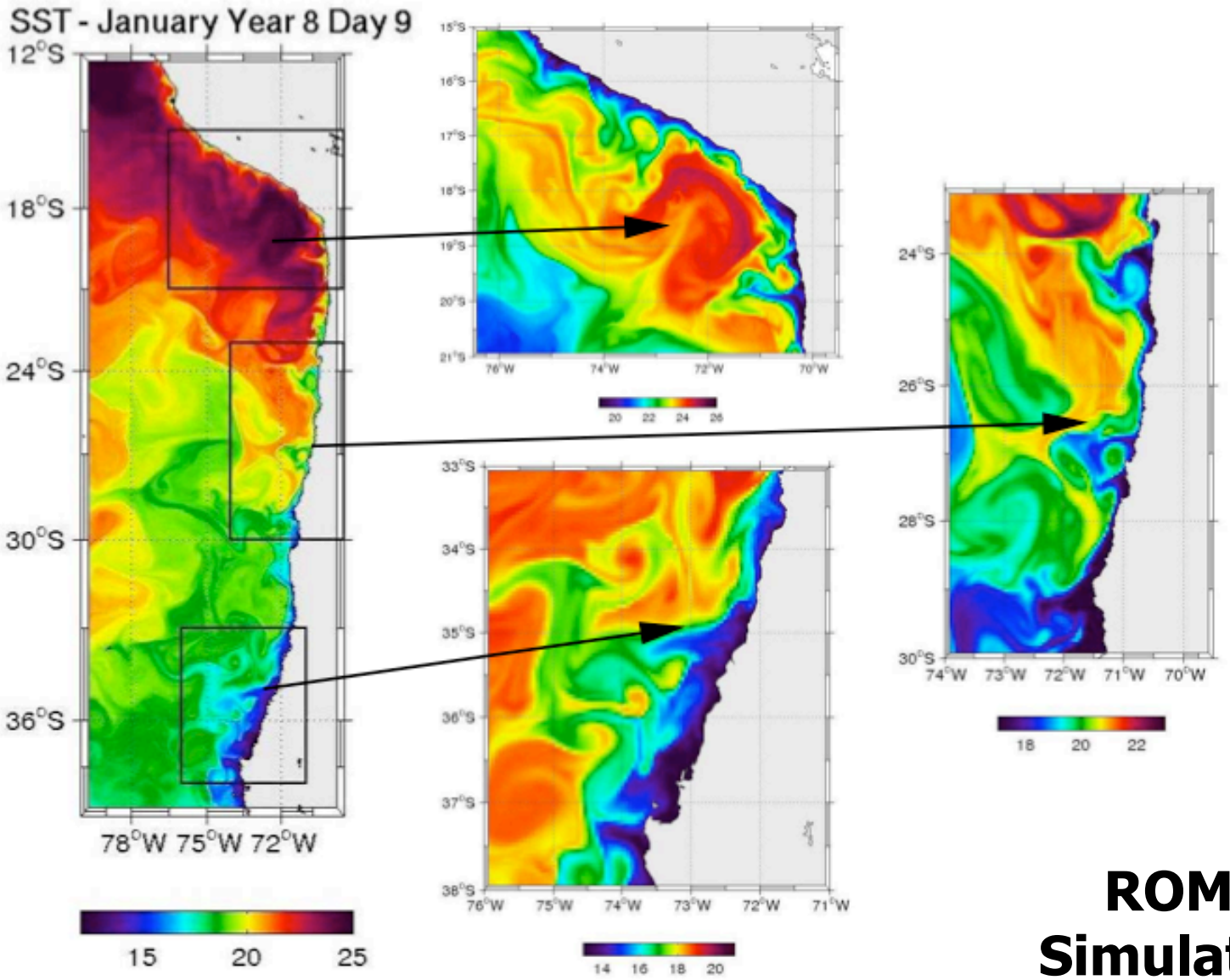
Weller


CFES T239L48 & 0.25deg.54lev. (Case76)
Relative Vorticity (54 m, 0005.03.16)
20N
15N
10N
5N
EQ
5S
10S
15S
20S
25S
30S
35S
40S
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W
70W
−5
−4
−3
−2
−1
0
1
2
3
4
5
x10⁻⁶ s⁻¹
CFES (OGCM 0.25;
54 levels; 16 Sept)

Of concern: diurnal and near-inertial ocean



One month of upper ocean velocity (15 to 125 m) data at the Stratus mooring from an acoustic Doppler velocity profiler. Note at the surface, a diurnal (24 hour) cycle in the depth of the scattering layer modulates Doppler return.
Below the surface layer, near-inertial (36 hour) oscillations are evident; these play a role in mixing. (from R. Weller)



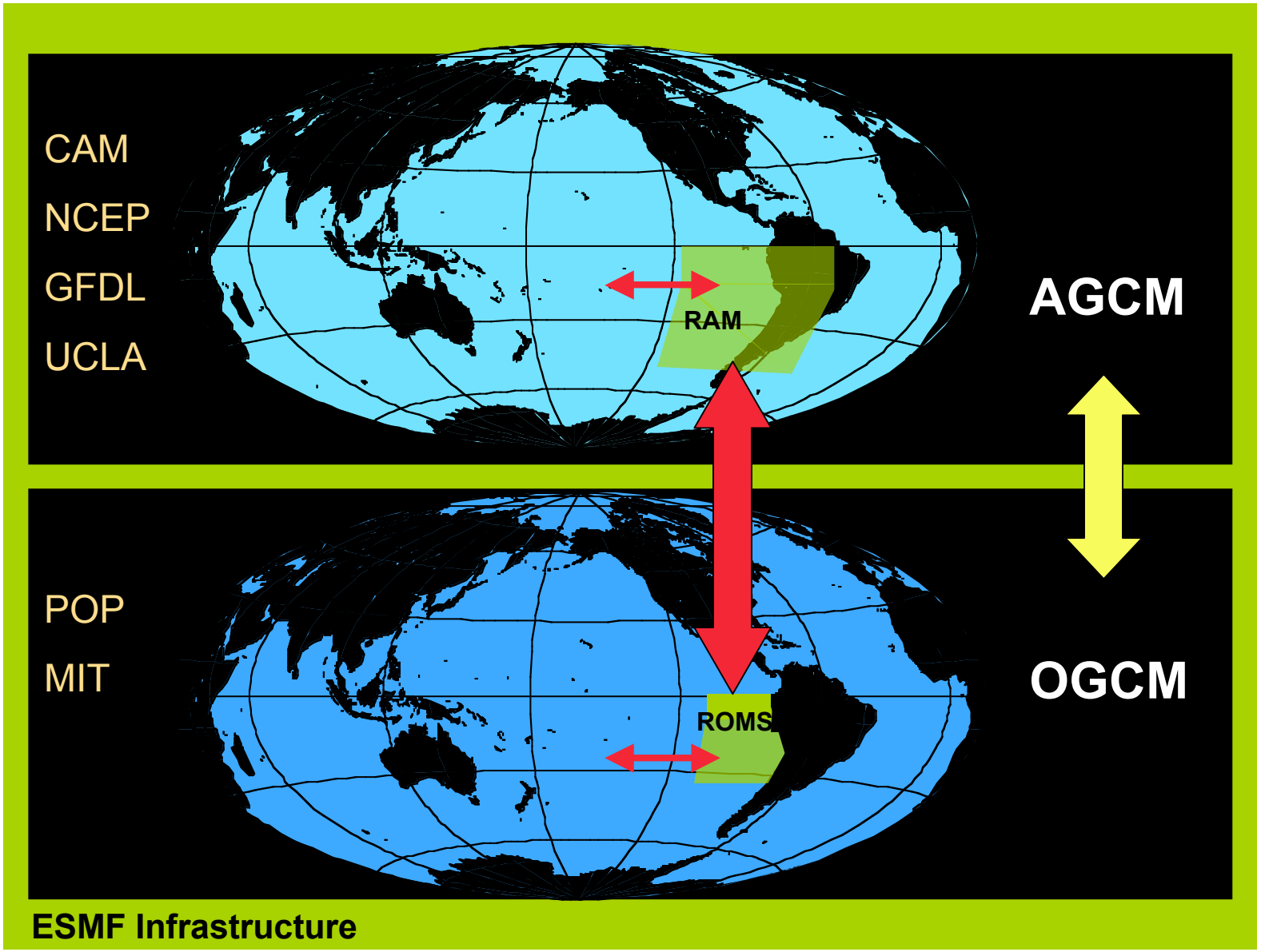
ROMS Simulation

(From J. McWilliams)

An approach, based on regional and high-resolution coastal models embedded within the seasonally and interannually varying global climate can overcome these model difficulties: MUSSIP

AGCM: Atmosphere General Circulation Model

OGCM: Ocean General Circulation Model



VOCALS Modeling Hypotheses

a. The CGCMs difficulties with the downstream effects on the SEP of a region with strong coastal upwelling and high Sc incidence are key contributors to the model errors in the SEP.

b. In the atmosphere, southeast trades from the South American coast flow from a cool and dry PBL over strong SST gradients and regions where trade cumuli form moistening the lower troposphere.

c. In the ocean, mesoscale eddies not captured by OGCMs, play a major role in the transport of heat and fresh water from coastally upwelled water to regions further offshore.

d. The highest potential for overcoming climate models difficulties in the SEP within the VOCALS timeframe is based on a multi-scale approach.

Modeling Tasks

Downscaling to the VOCALS-REx region

Modeling and analysis of stratus buoy maintenance cruises

Diagnostic studies using observed and simulated datasets.

Regional and global model development guided by Hypotheses

Development of MUSSIP

Vocals Modeling Approach

- Diagnosis of simulations of the SEP climate using both model output and observational data, including data assimilation.
- Simulation and/or prediction with different models for the austral spring, including the VOCALS-Rex season, analysis and verification of the predictions.
- Assessment of the impact of VOCALS-Rex enhanced observations on predictions through data assimilation.
- Model development for error alleviation.
- Participation in organized modeling activities that address model performance/improvement.