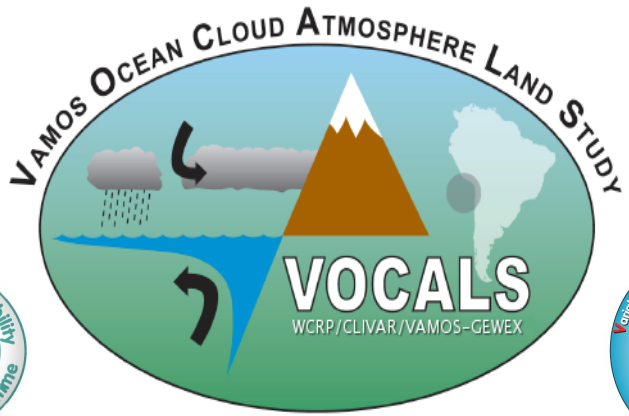
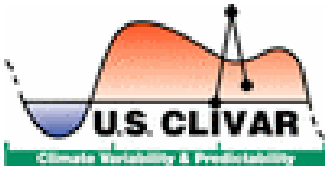




Goal: Elimination of CGCM systematic errors in the SEP, and improved model simulations of the coupled system in the region and global impacts of its variability.

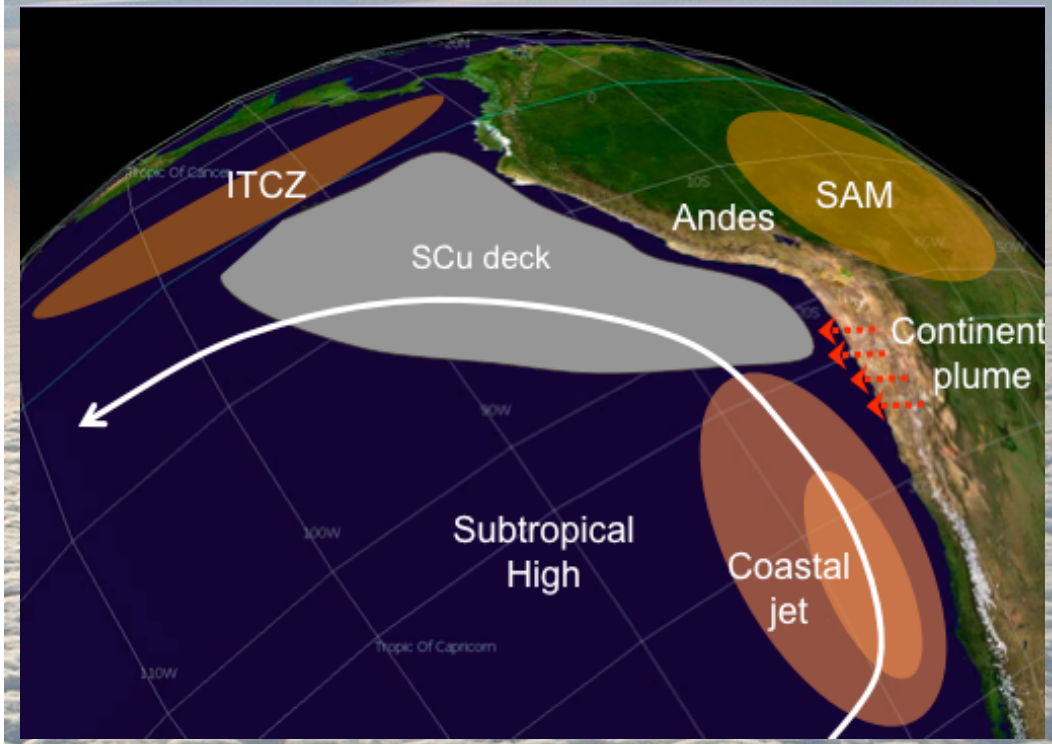
Goal: Improved understanding and regional/global model representation of aerosol indirect effects over the SEP.

www.eol.ucar.edu/projects/vocals

Modeling Status Report

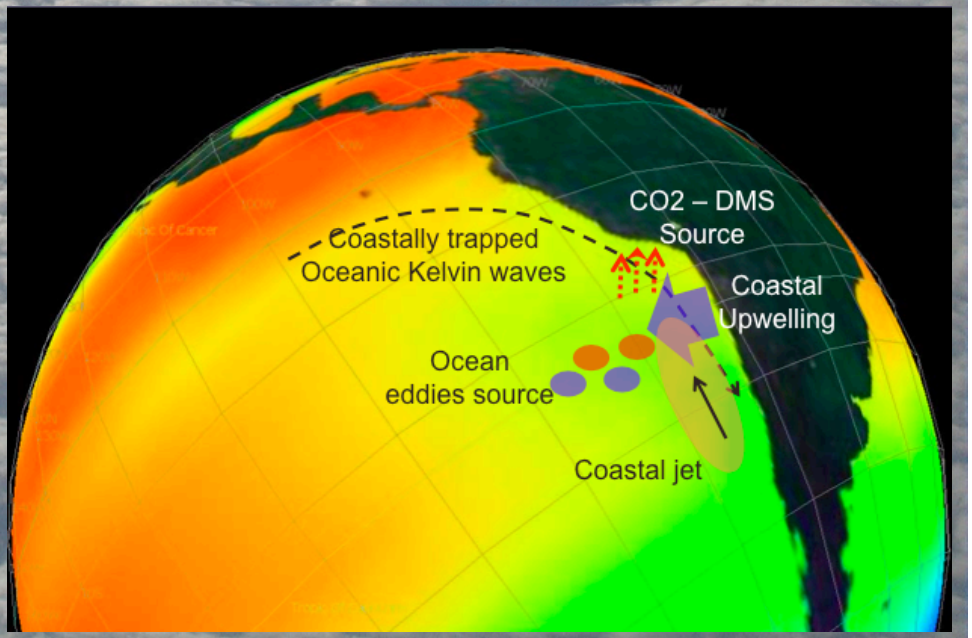
C. R. Mechoso and many others

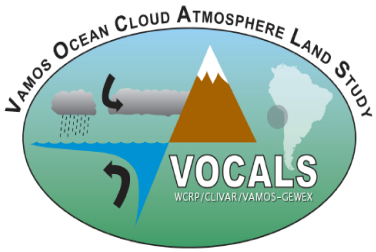
VOCALS Targets



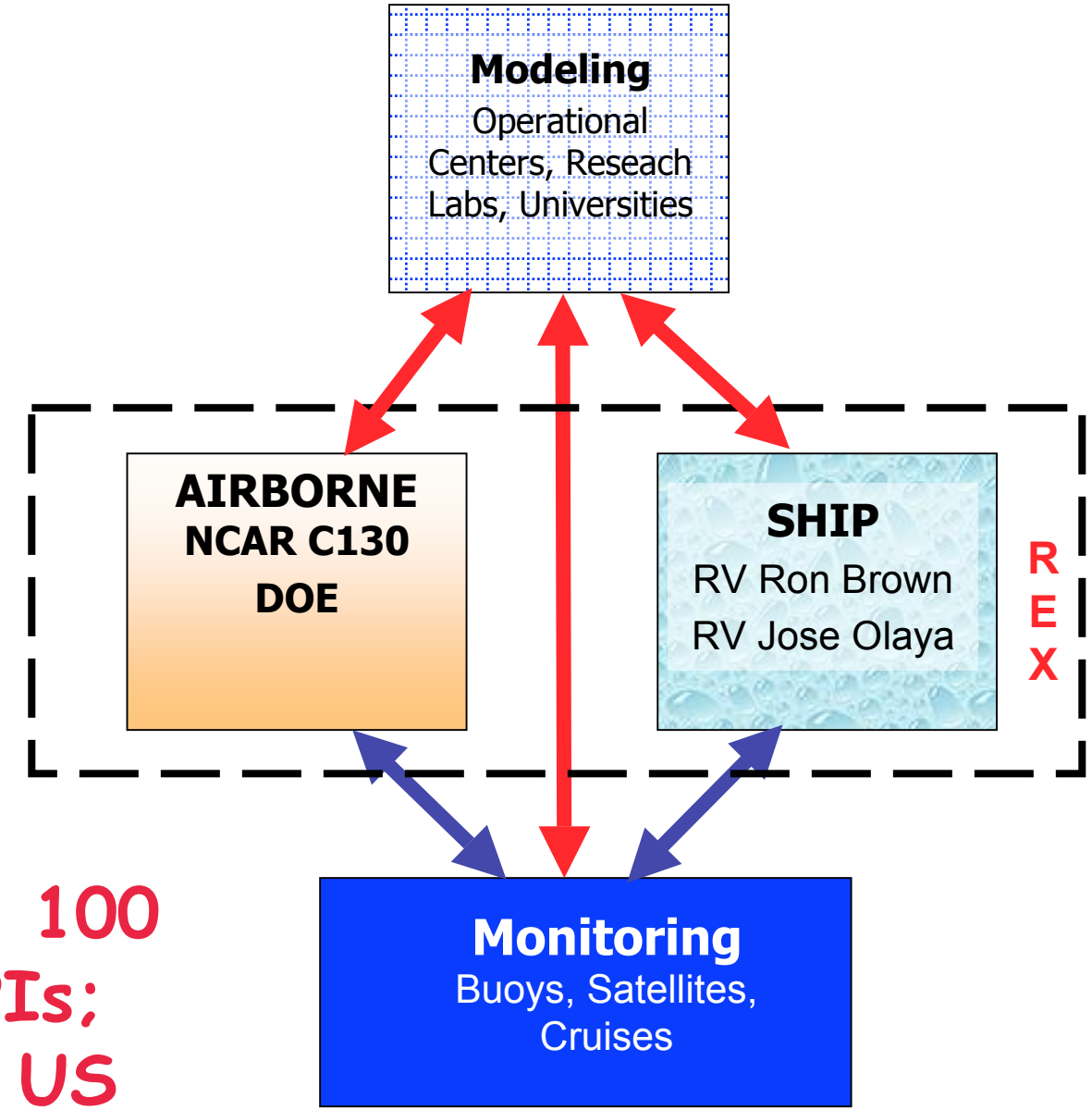
- **Clouds-aerosol interaction**
- **Heat and nutrient transports in ocean**

- **Upscale and downscale interactions with remote climates**
- **Better simulation by atmosphere-ocean GCMs**





ORGANIZATION

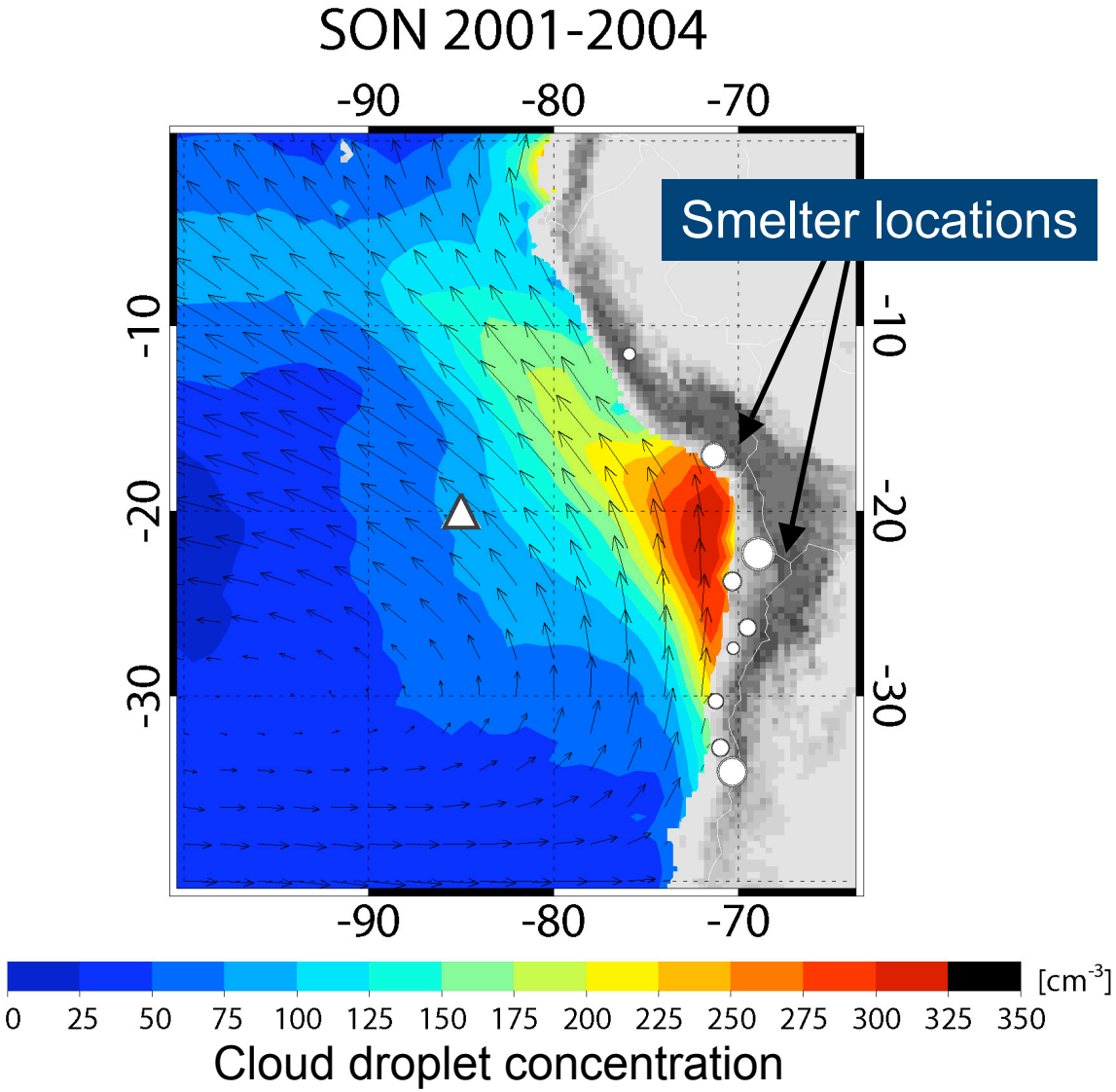


Numbers: 100
PIs-CoPIs;
~$ 25M US

VOCALS Themes

Themes	Topics
Ocean-land-atmosphere interactions	• **Simulation of Scu, winds and ocean currents** • **Role of heat transport by transient ocean eddies** • **Diurnal cycle and role of subsidence wave** • **Role of mixing associated with near-inertial oscillations in trade winds** • **Role of upwelling in aerosol properties**
Aerosol-cloud-precipitation interactions	• **Impact on drizzle formation** • **Impact on POC formation and maintenance** • **Anthropogenic vs natural generation**

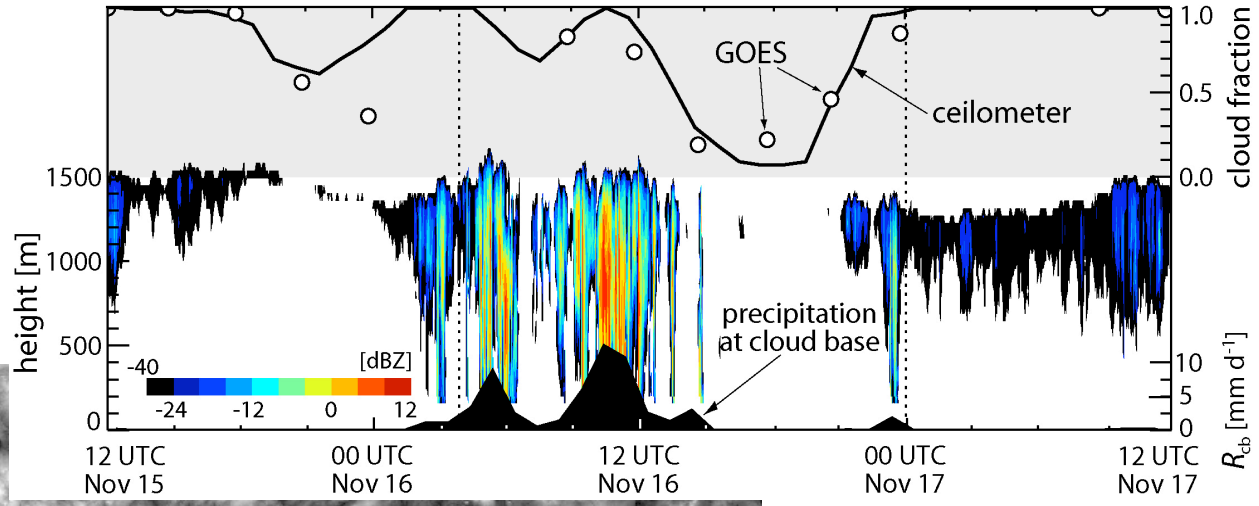
Aerosol-Cloud Interactions

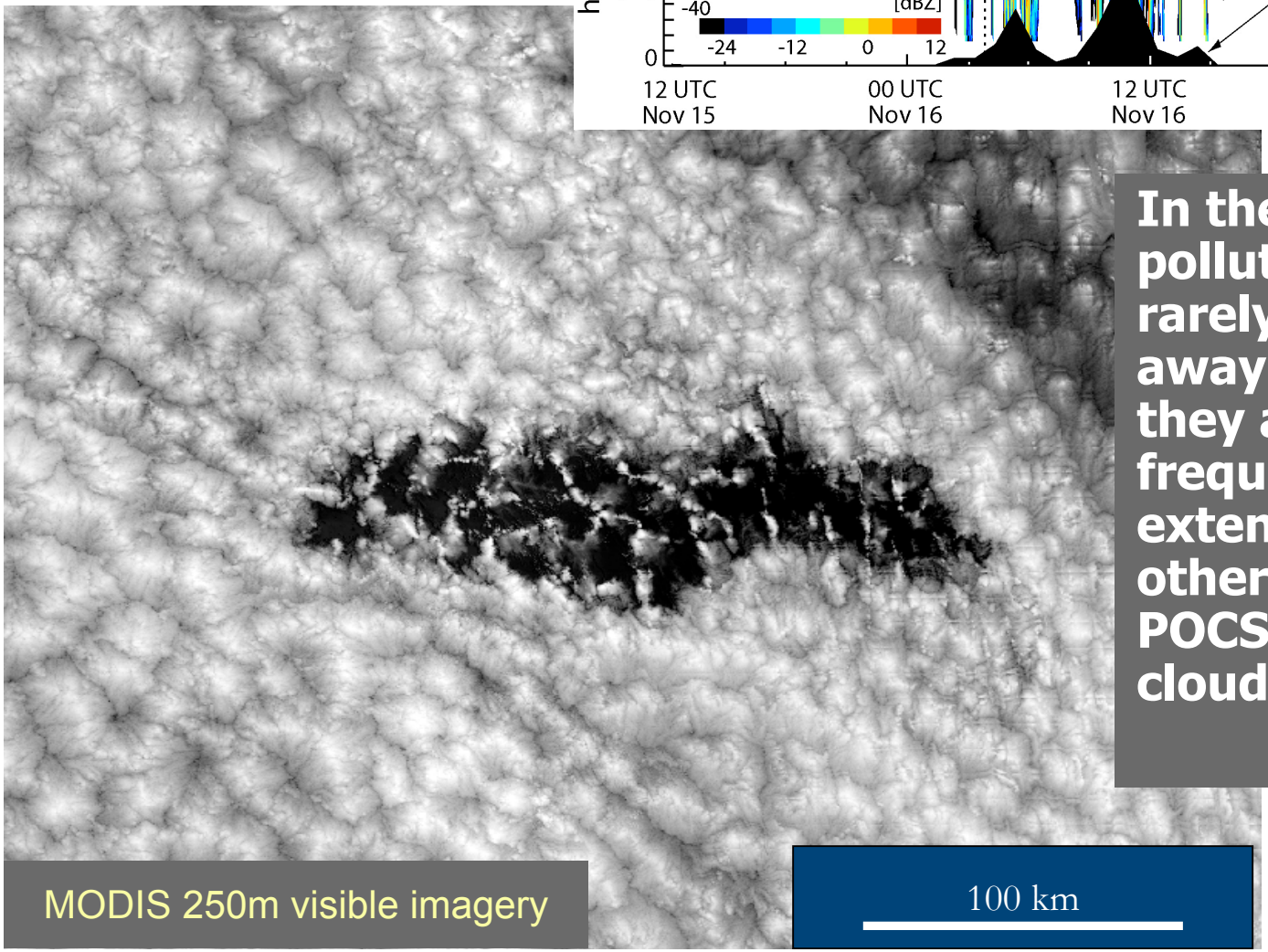


- Chile is world's largest copper producer. The associated SO_2 emissions are 1.5 TgS yr^{-1} (*)
- Andes mountains channel transports
- Neglecting aerosol lead to important errors in radiation calculation

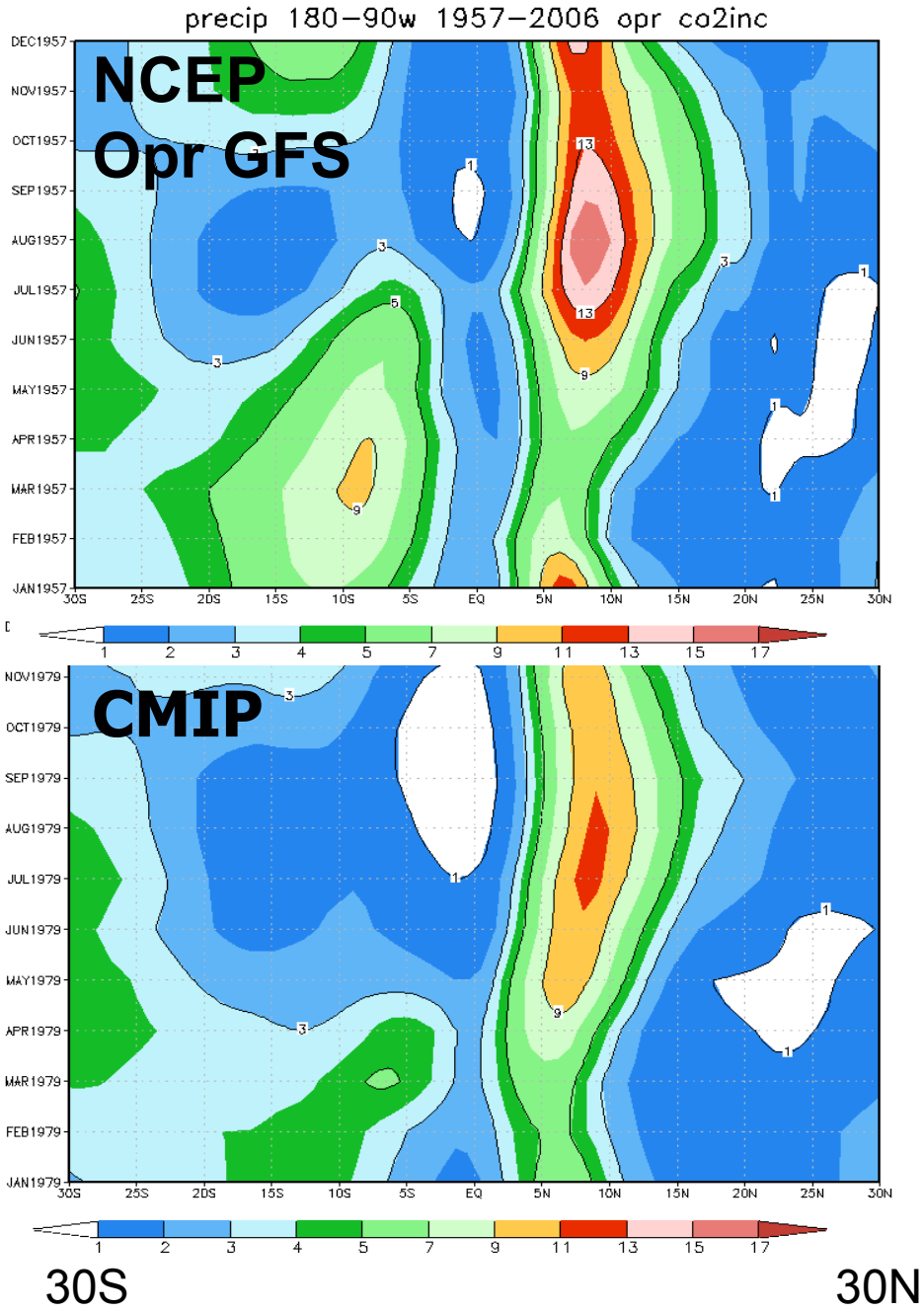
*comparable to those from Germany

Aerosol Drizzle POCs





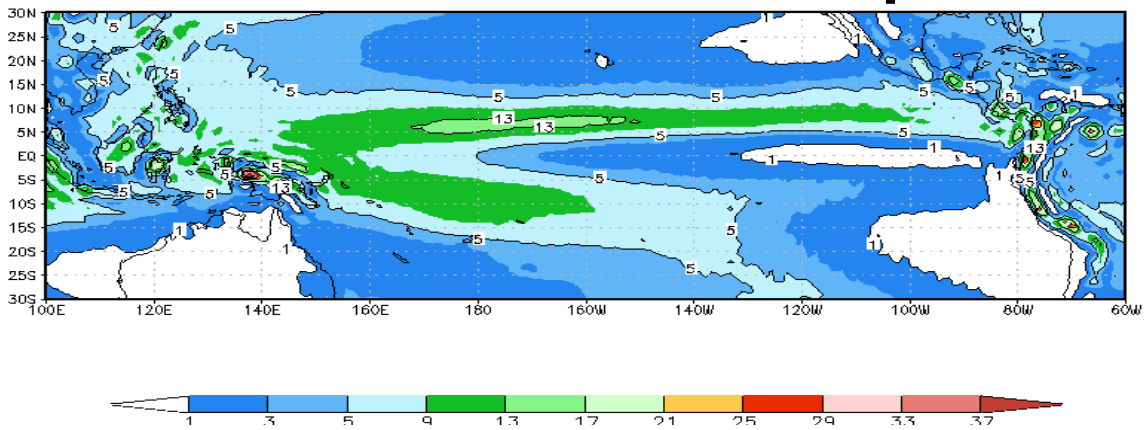
In the SEP near the polluted coast POCS rarely develop, but away from the coast they are more frequent and extended than in other Scu regions. POCS strongly affect cloud albedo.



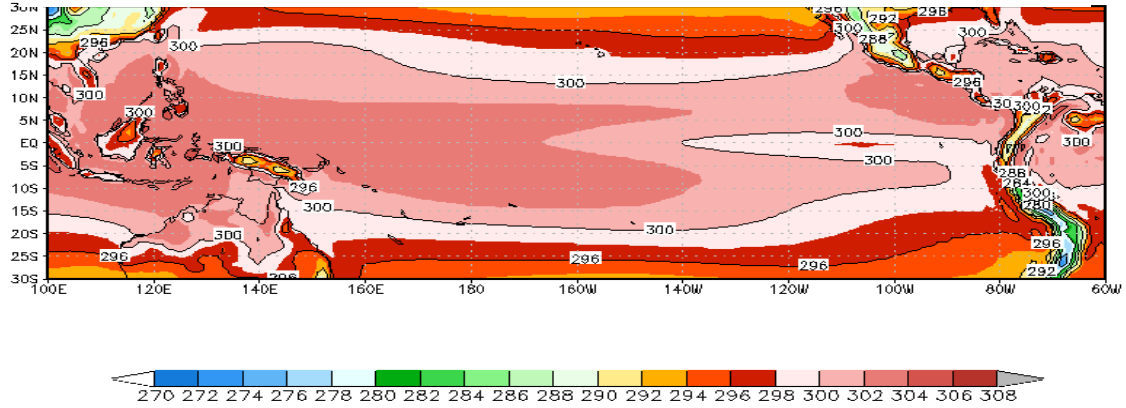
Climatological annual cycle in precipitation East Pacific

In the southeastern Pacific, most CGCMs have difficulties with the simulation of the ITCZ and SPCZ south of the equator, and /or the SST under the stratocumulus decks.

NCEP CFS Annual Mean Precipitation



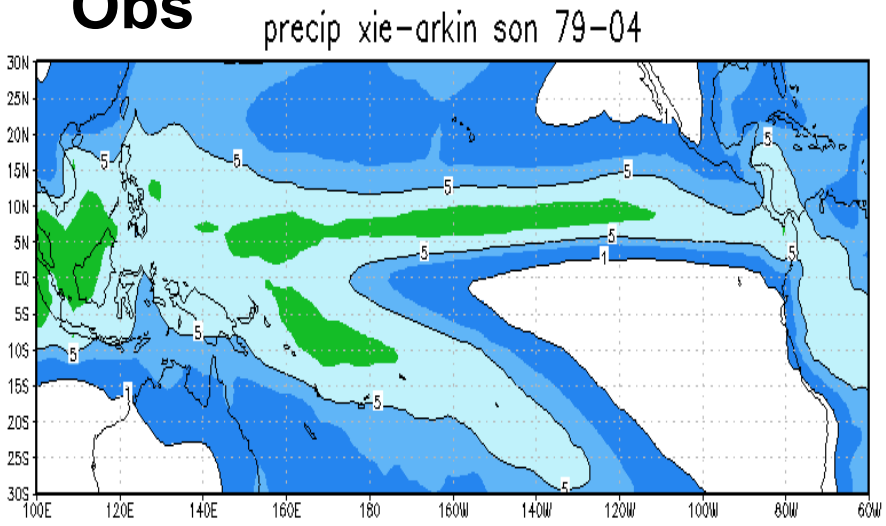
NCEP CFS Annual Mean SST

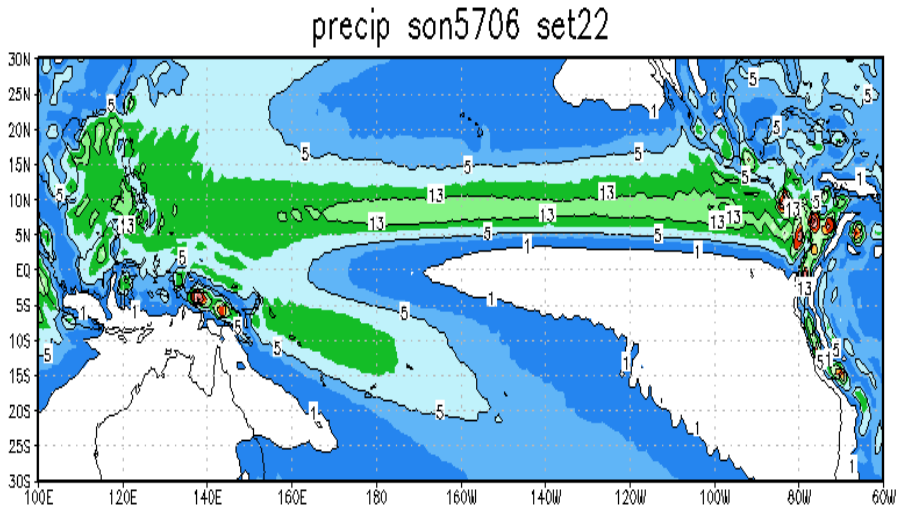


In the southeastern Pacific, most CGCMs have difficulties with the simulation of the ITCZ and SPCZ south of the equator, and /or the SST under the stratocumulus decks.

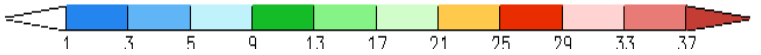
NCEP CFS Sept-Oct-Nov

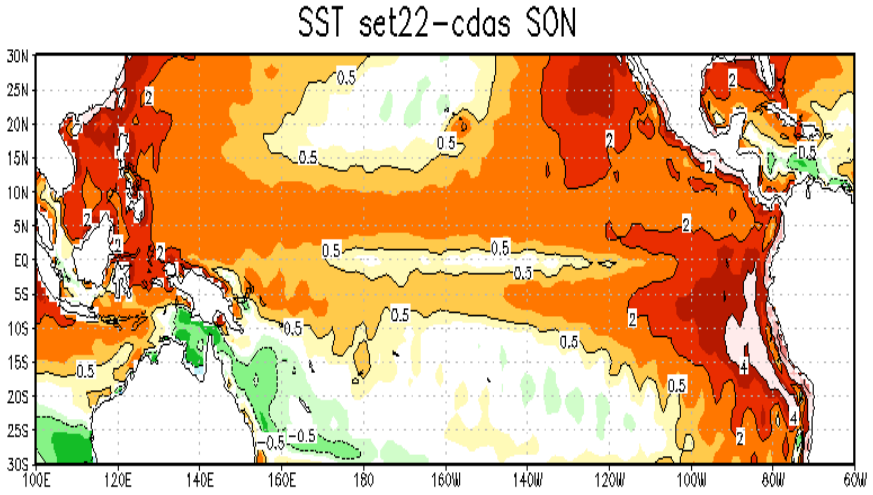
Obs

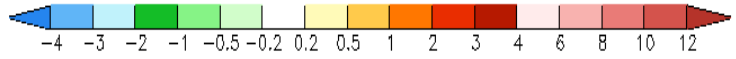


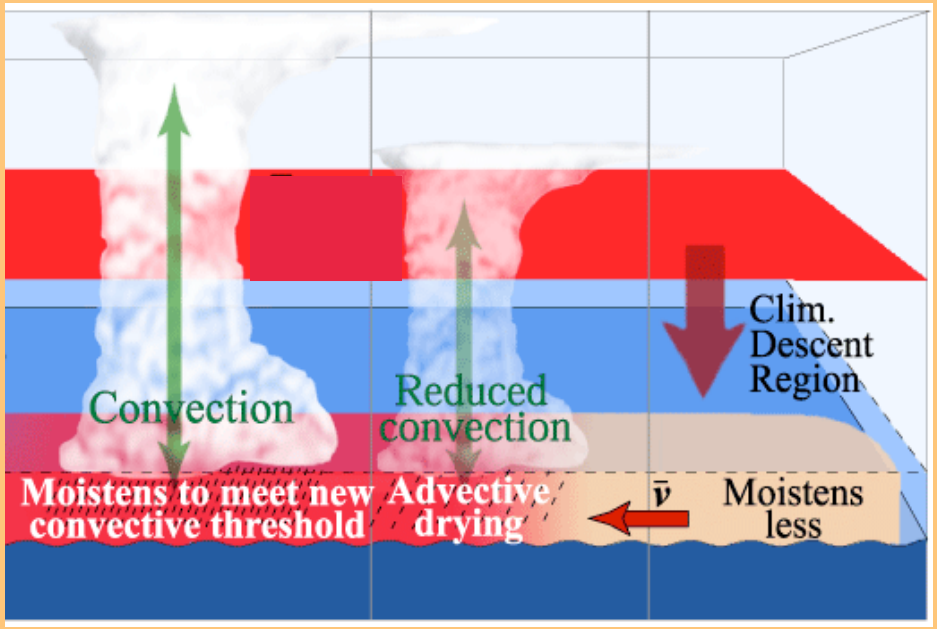


In the southern fall, the NCEP GFS correctly predicts no double ITCZ, although SSTs south of the equator are too warm and there are not enough stratocumulus in the SEP.









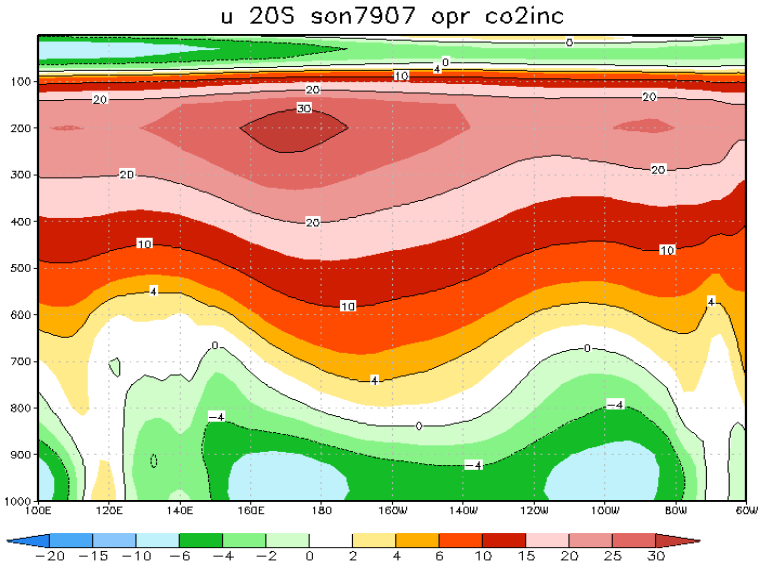
Trade winds bring into the SPCZ cool and dry air from the stratocumulus region in the Southeastern Pacific.

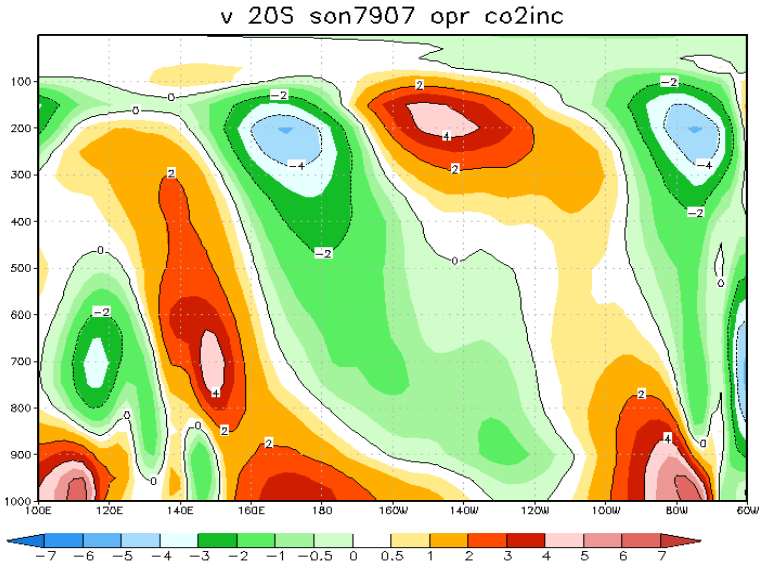
SPCZ

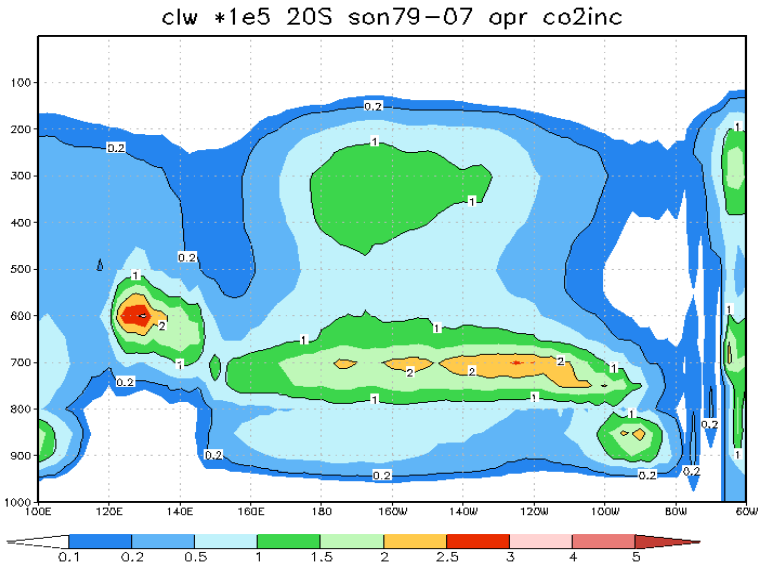
Southeastern Pacific

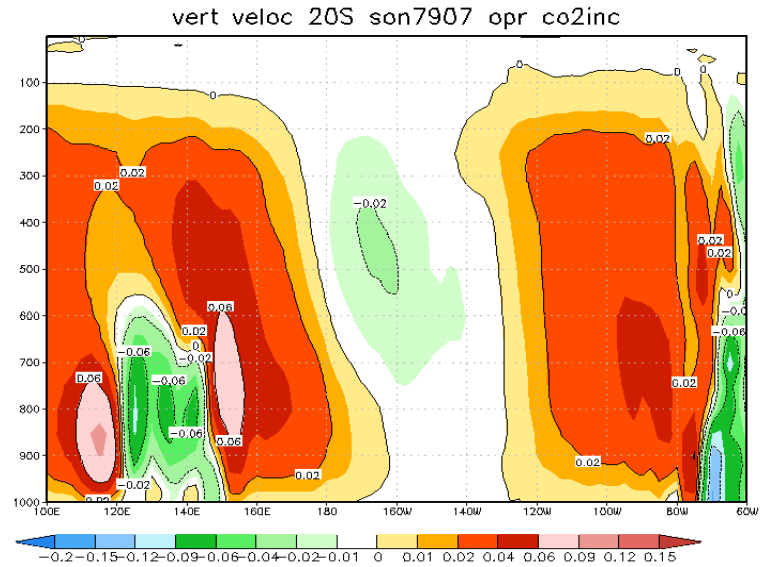
VOCALS Hypothesis: Improvement of Eastern Tropical Pacific simulation will improve IPCZ/SPCZ simulation by coupled models

NCEP Climate Forecast System CFS

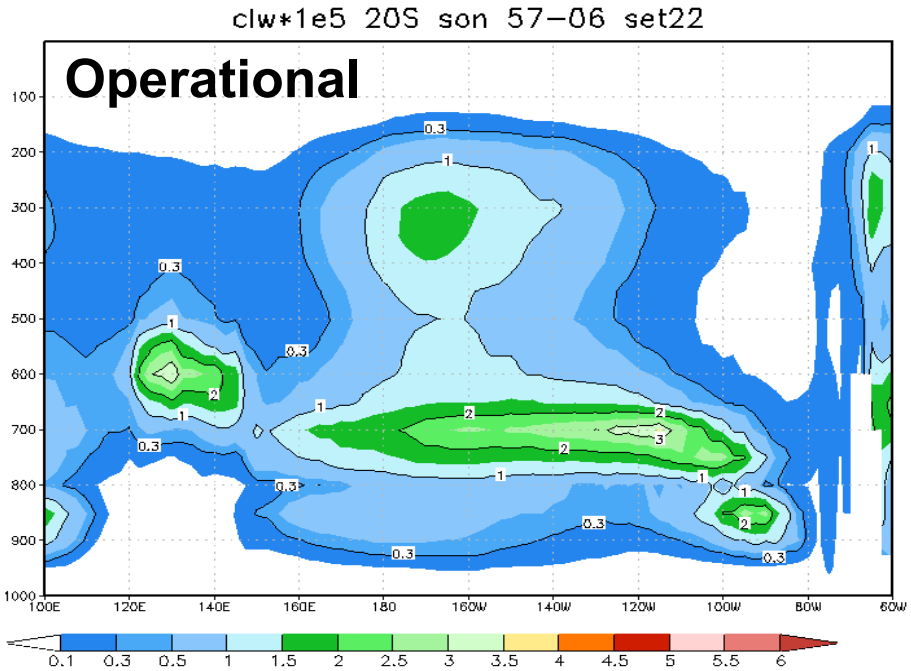


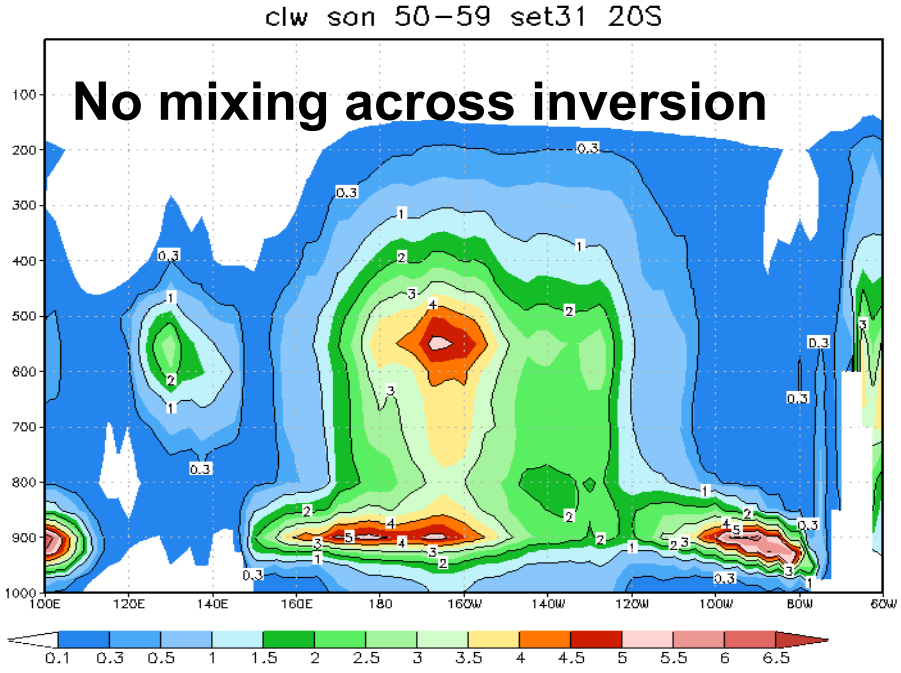


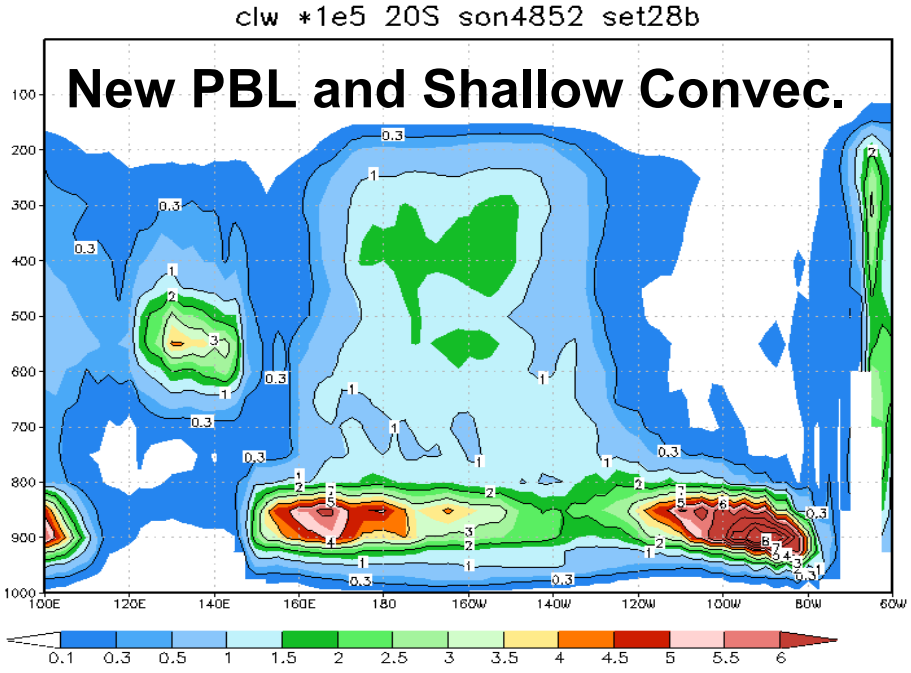




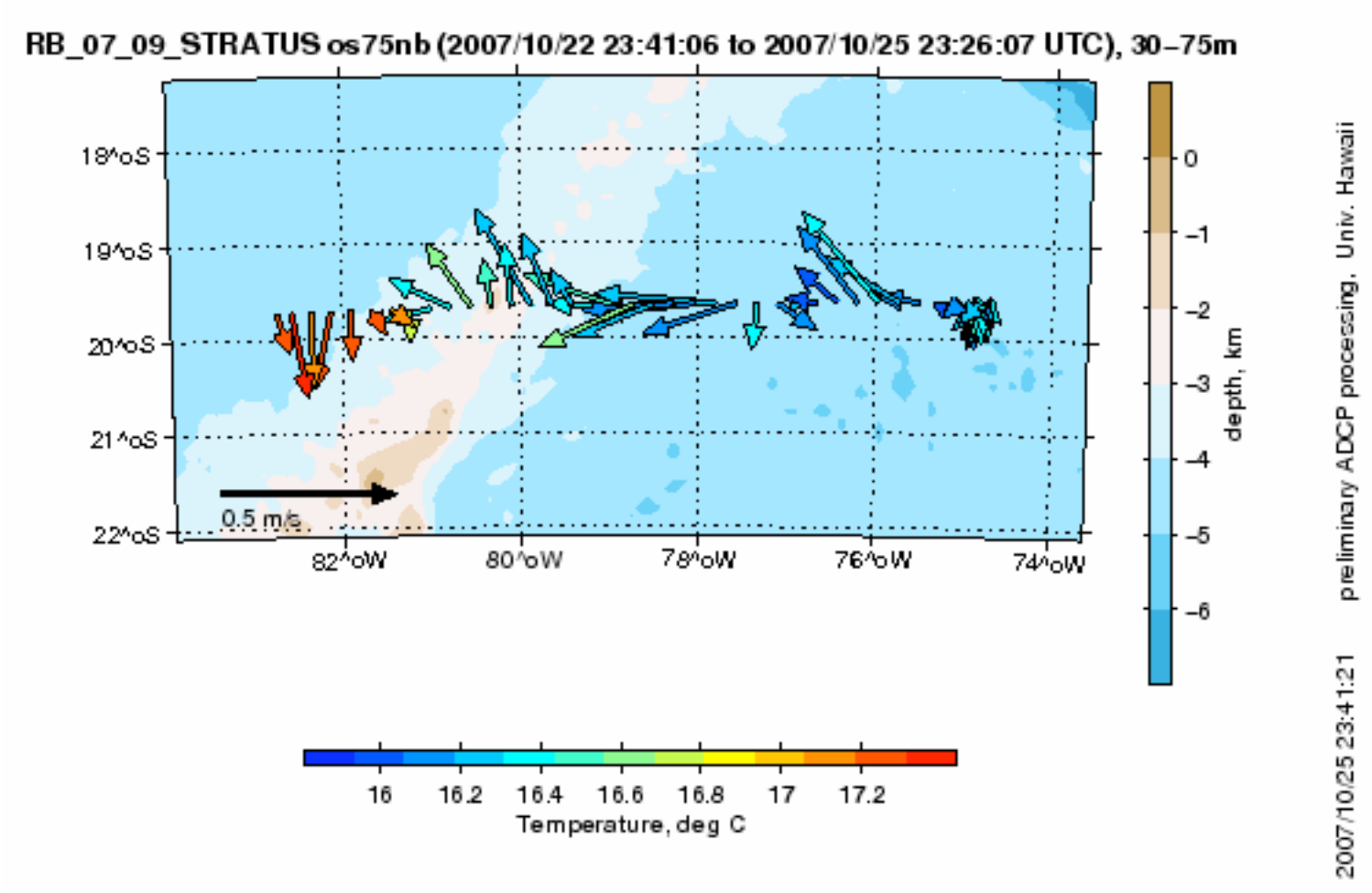
Cloud liquid water in different NCEP CFS simulations with changes in parameterizations







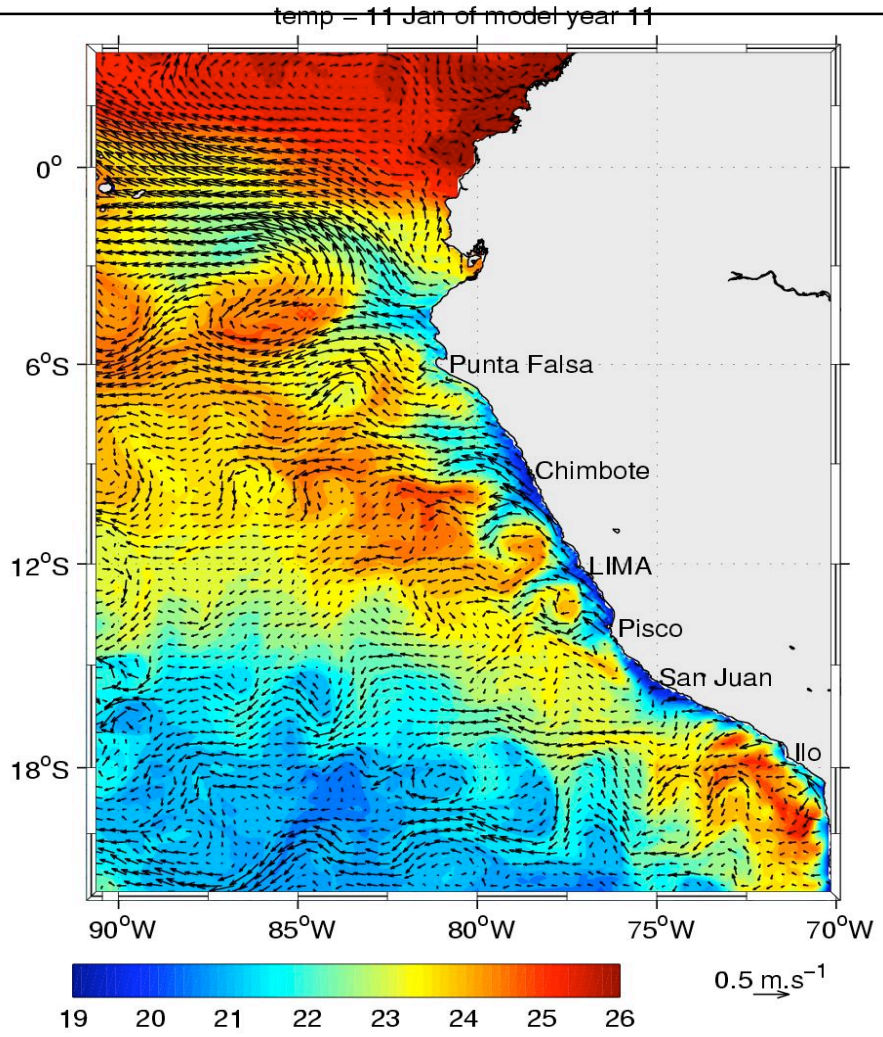
Monitoring Example: STRATUS 07 Cruise
Ocean currents averaged over 22 to 75 m



From the RV Ron Brown. B.Weller

VOCALS Hypothesis: Oceanic mesoscale circulations play a major role in the transport of heat, fresh water and nutrients from coastally upwelled water to regions further offshore

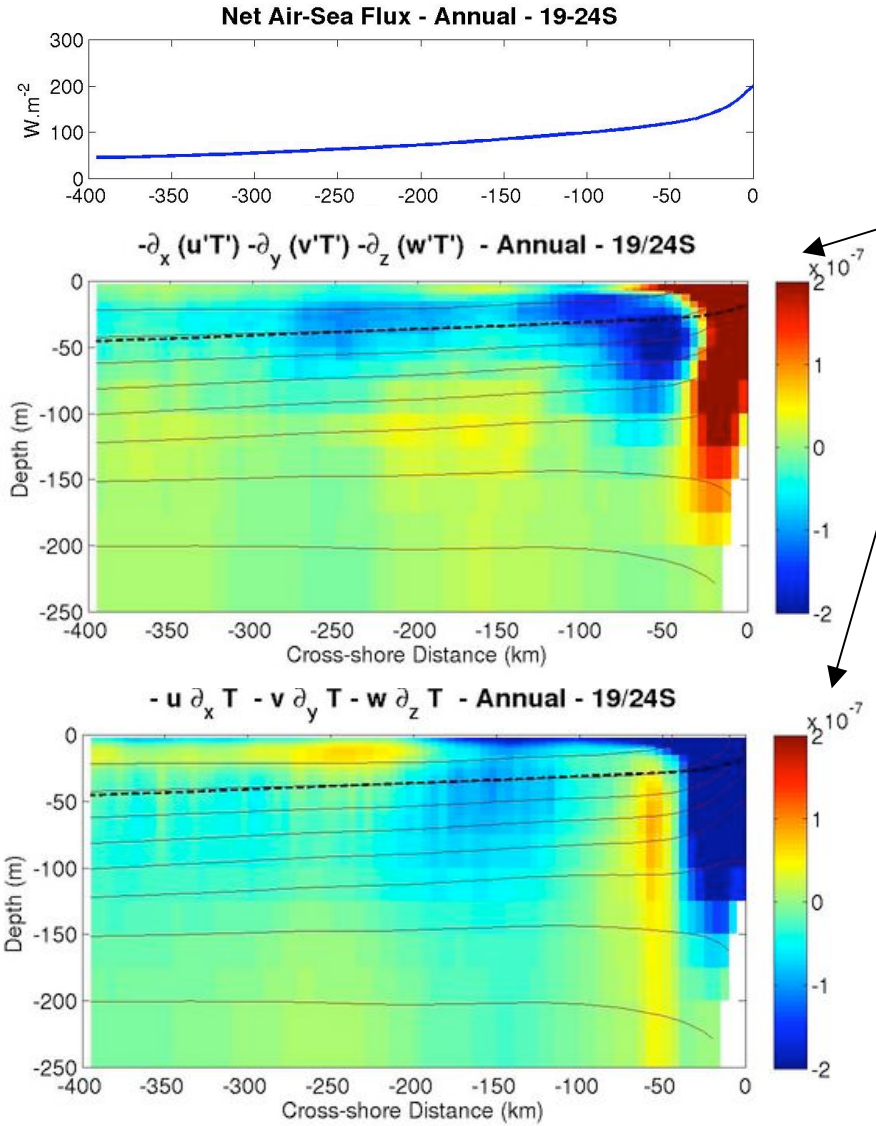
- Mesoscale ocean eddies form in coastal upwelling regions and propagate westward
- Their impact on the heat, nutrient, and freshwater budgets is poorly known
- They are not resolved in most coupled GCMs



Art Miller, Scripps

Oceanic Heat Balance in the SEP (19S-24S) by a high-resol ocean model

ROMS, 5kmx5 km, 30 sig-levels, QUIKSCAT winds, COADS F & Q



Heat Budget:

$$-adv_{mean} - adv_{eddy} - diff_{vert} = airsea$$

- Net heating by air-sea fluxes over the year
- Cooling needed to balance the airsea heating is provided by:

  Nearshore: Mean Advection (upwelling)

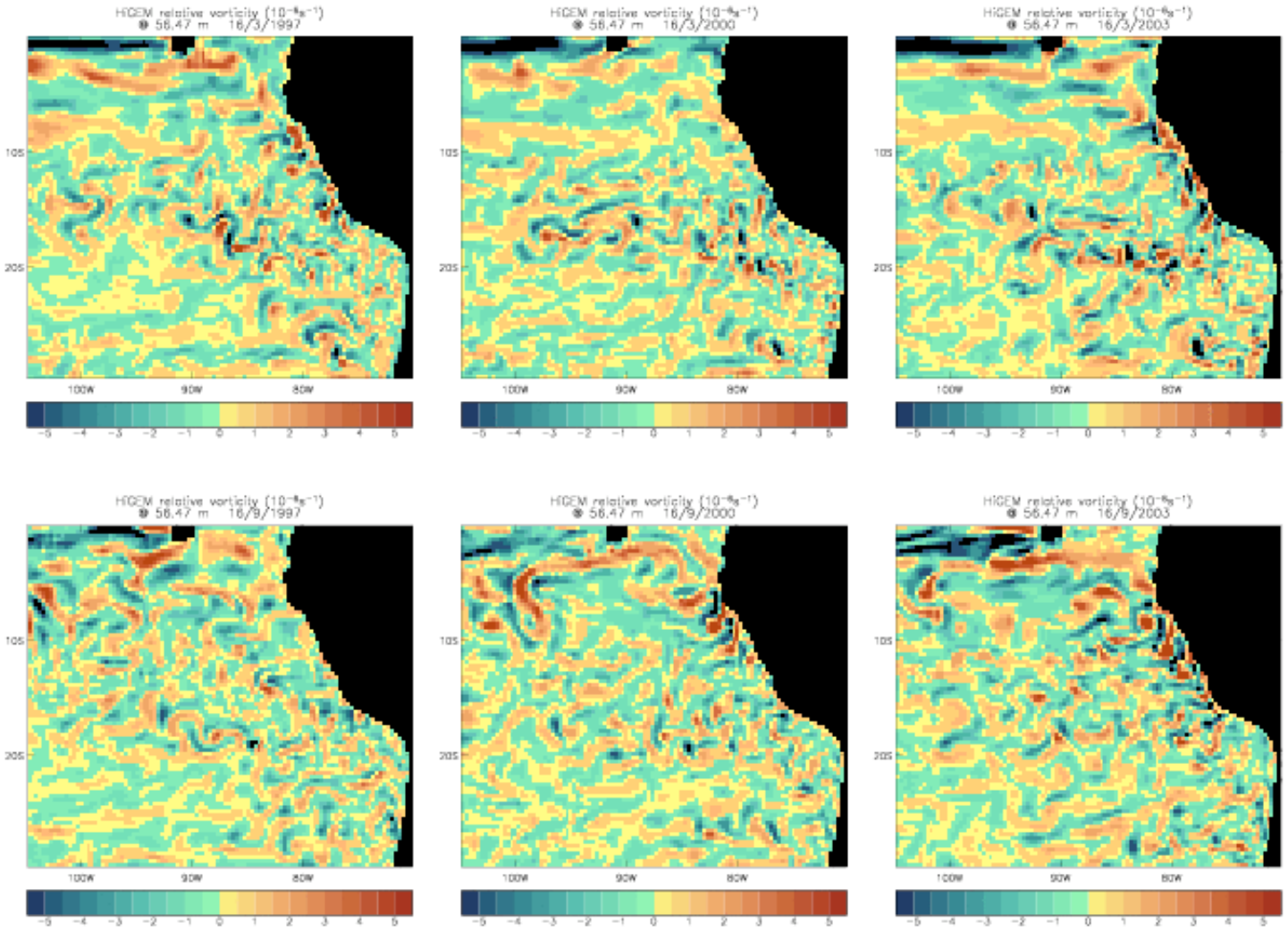
  Offshore : Eddy Advection
- Strong role played by eddies everywhere

(Colas, Capet & McWilliams, 2007)

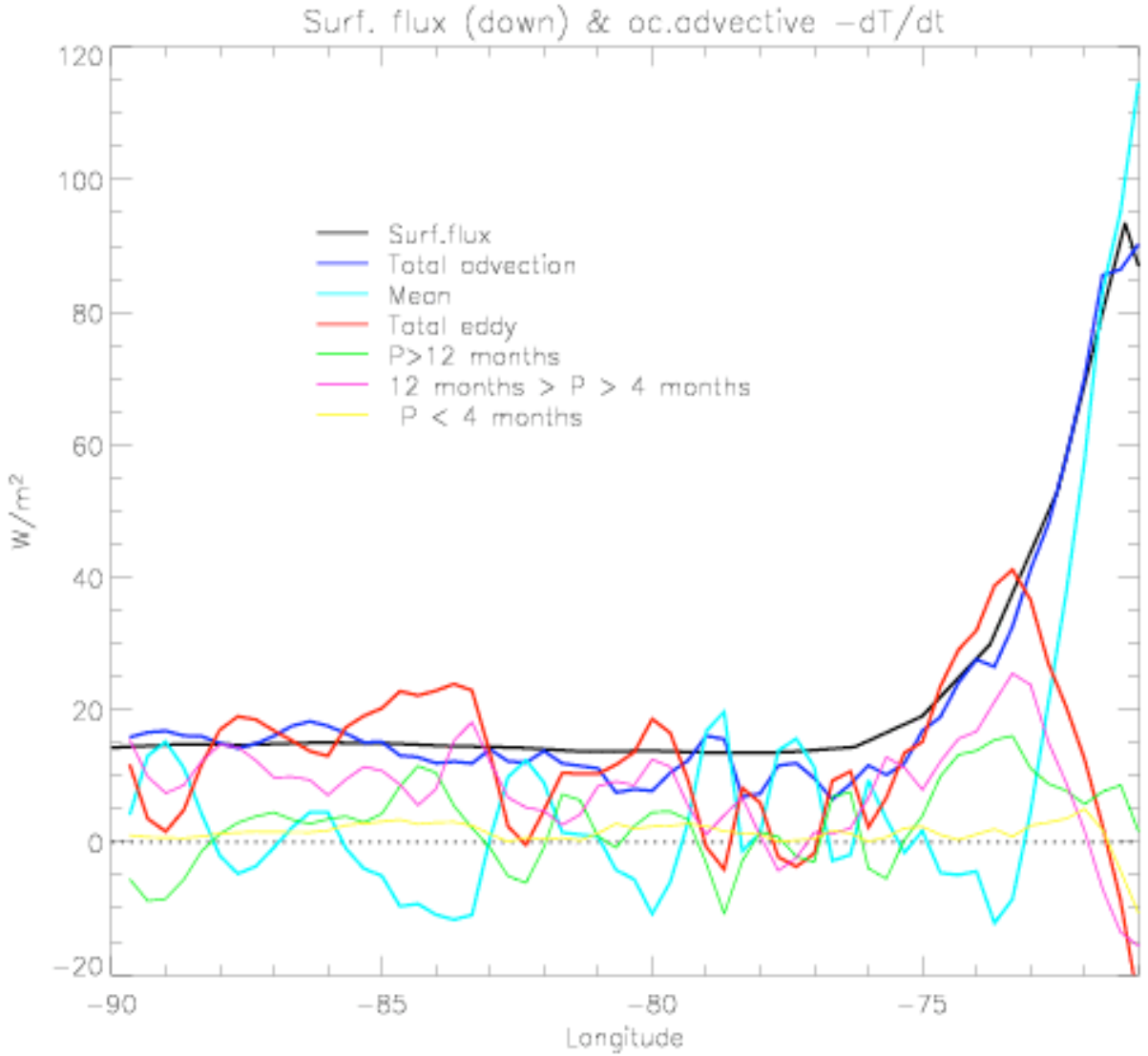
UK-VOCALS HiGEM1.2

AGCM (5/4x5/6x38L); OGCM (1/3x1/3x40L)

Vorticity at Surface



Heat Flux at 10S in HiGem



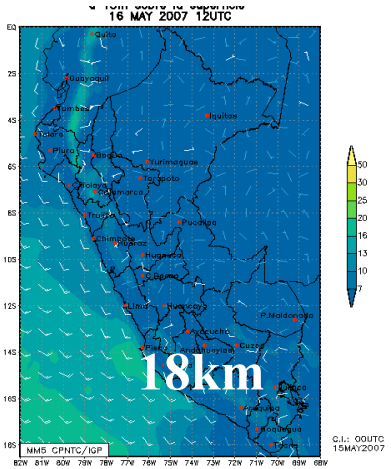
At the WHOI buoy, the heat flux by time mean flow and transient motions with frequencies between 4-12 months are comparable.

Modeling activities at IMARPE Perú

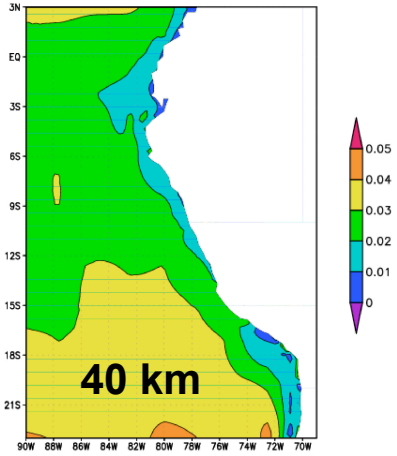
IGP IMARPE IRD Institut de recherche pour le développement LEGOS

Atmospheric models configurations

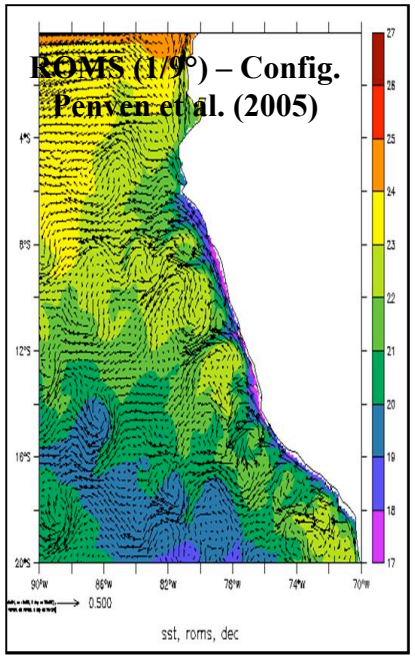
MM5 (operational)



WRF

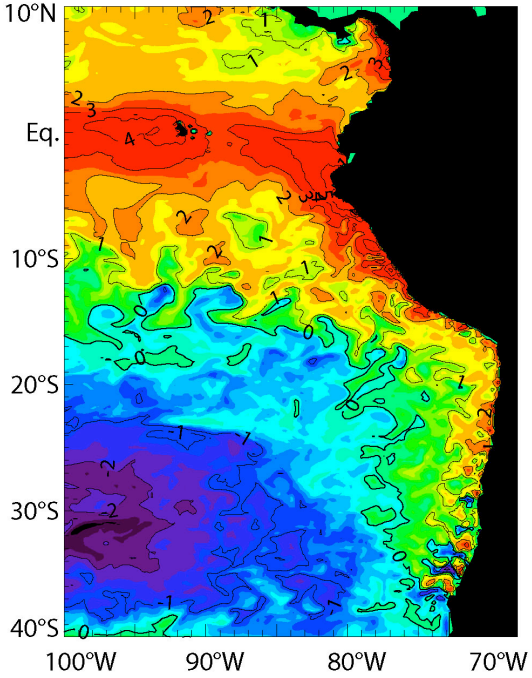


Oceanic model configurations

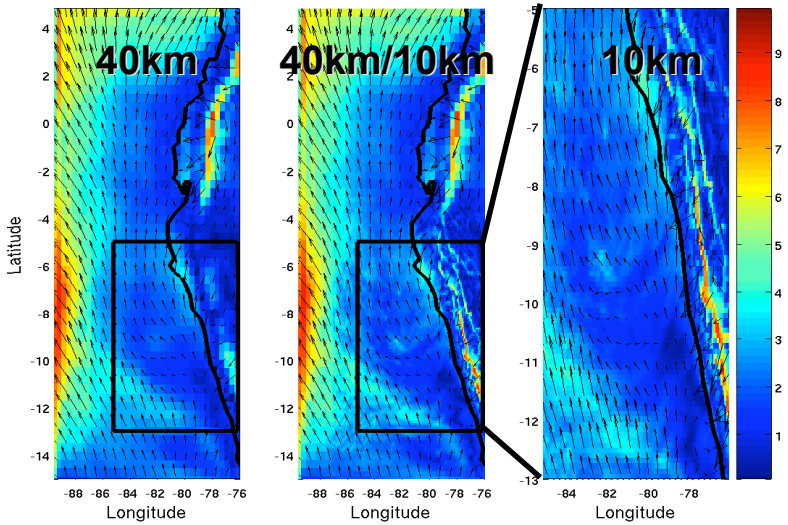


ROMS (1/6°) – PCCC project config.

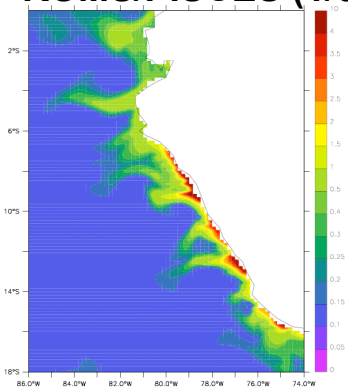
SSTA - 15th of February, 1998



Filamentos domain



ROMS/PISCES (1/6°)



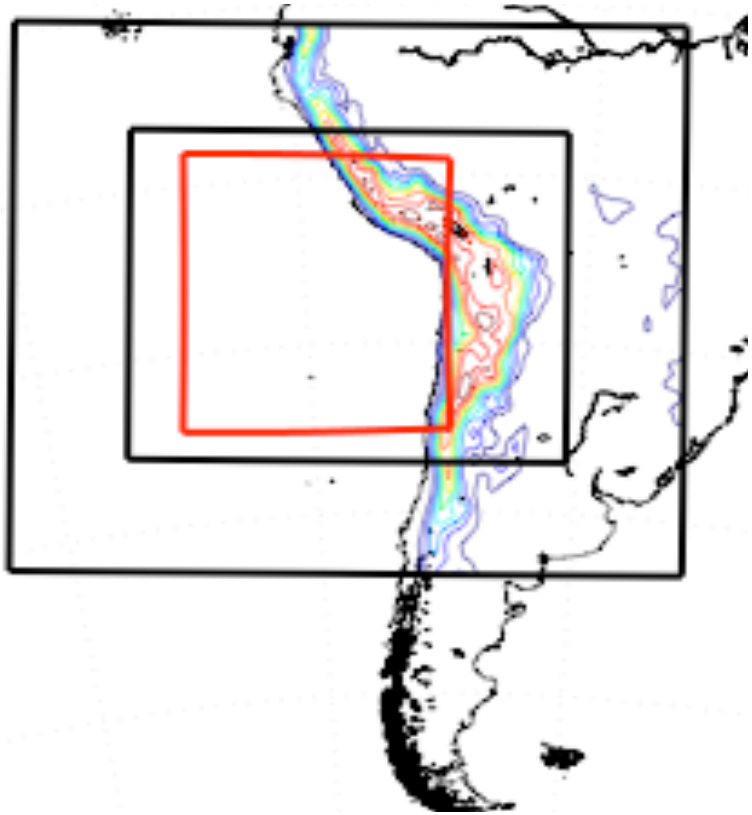
<u>Under development</u>: WRF (1/9°) – ROMS (1/27° - Chimbote and Pisco) – ROMS/PISCES (1/27°)

- Statistical downscalling of the atmospheric Reanalyses and IPCC atmospheric runs (PCCC project)

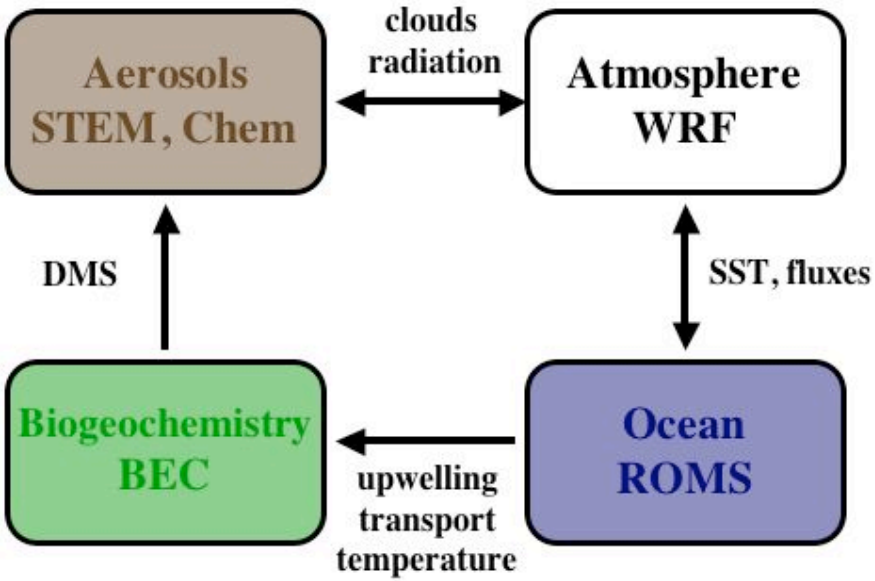
UCLA regional modeling

A. Hall, J. McWilliams,
G. Carmichael, C. Deutstch

Domains to be used for the simulations. The WRF domains (black) consist of a 12-km grid nested within a 36-km grid. The ROMS domain (red) has a resolution of 4km.



Information flows among models



PLANNED SIMULATIONS

Atmospheric forecasting during VOCALS-REx (WRF/STEM).

Retrospective VOCALS-REx simulation with full atmospheric chemistry and oceanic biogeochemistry (WRF-Chem/ROMS-BEC).

Recent interannual variability with coupled model (WRF/ROMS) and observed B.C.

Embedded coupling (WRF/ROMS) forced by global model (CCSM/UCLA).

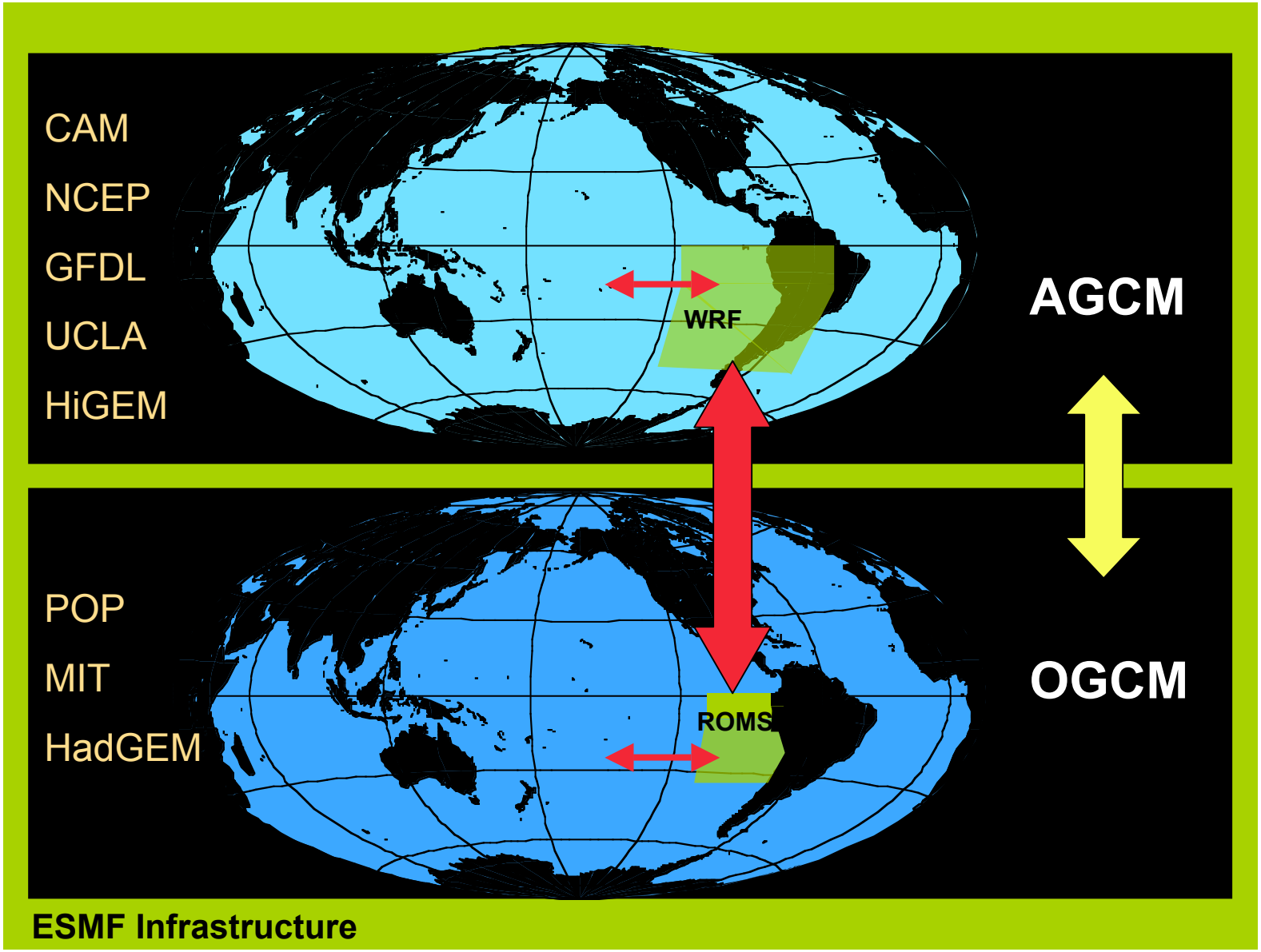
VOCALS aims to develop a multiscale hierarchy of models for interannual prediction

AGCM: Atmosphere General Circulation Model

RAM: Regional Atmospheric Model

OGCM: Ocean General Circulation Model

ROM: Regional Ocean Model

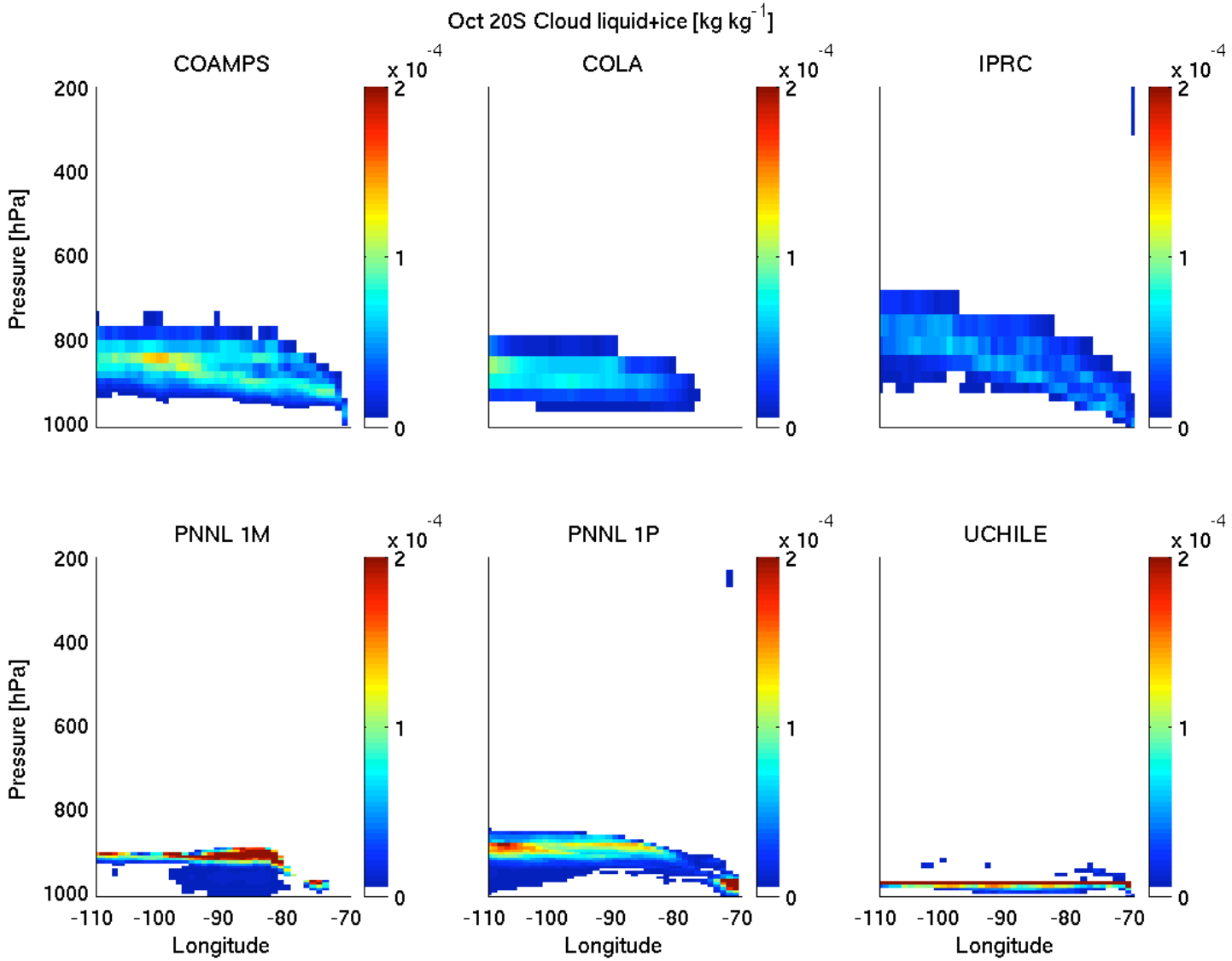


PreVOCA

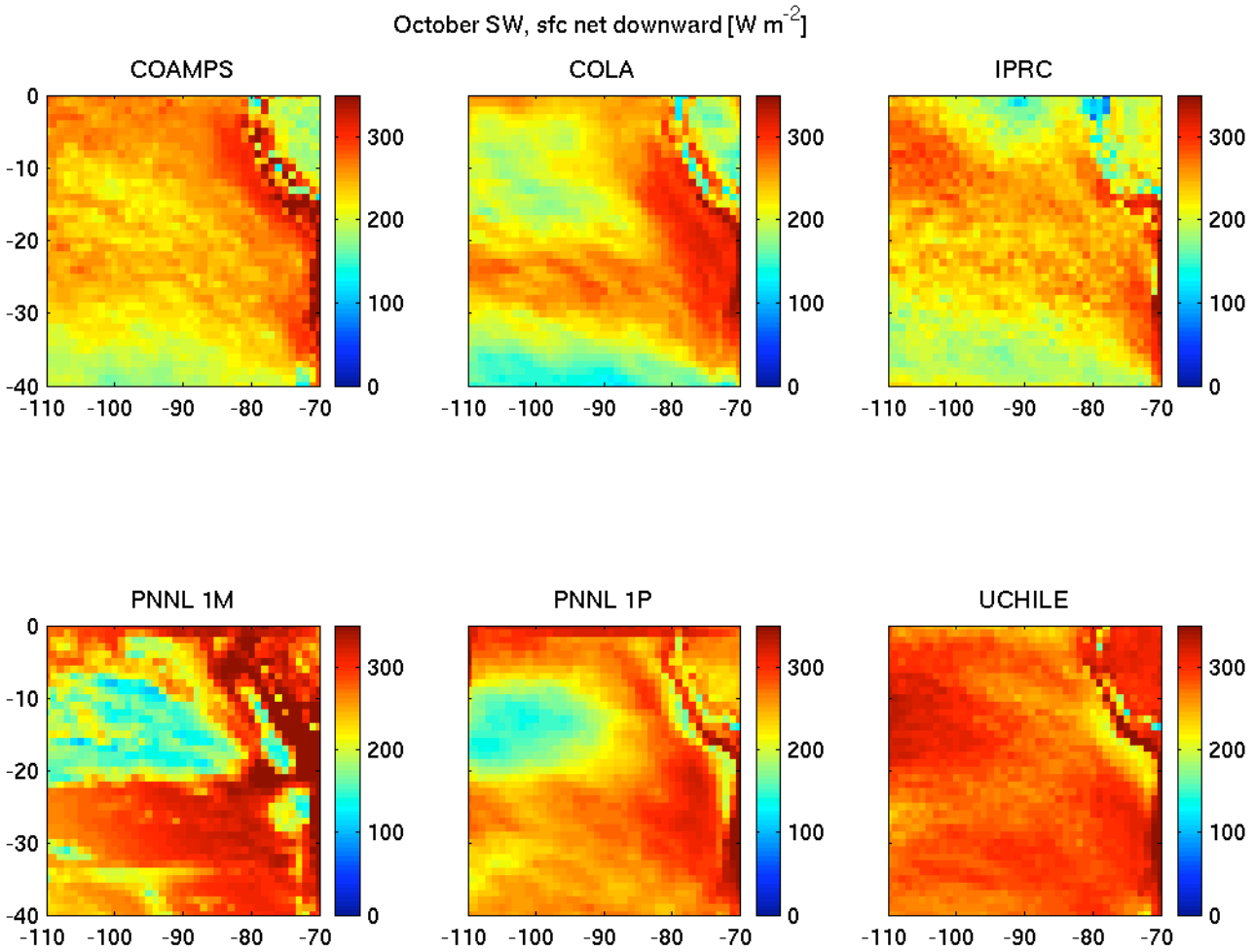
- **GOAL: To critically assess the ability of global/ regional models (atmospheric, chemical transport…) to predict/ simulate VOCALS region**
- **WHY? Learn about model forecast support for REx etc.**
- **WHAT? Hindcasts for October 2006**
- **WHEN? In progress**
- **NOT: An intercomparison; participants use their forecast/analysis**

Model	Vertical Levels	Horizontal Resolution (km)
COAMPS	42	
COLA RSM	28	50
IPRC Reg_CM (IRAM)	28	~25
PNNL (WRF-Chem)	44	45 (15 nested)
U. Chile (WRF)	43	45
ECMWF oper. 3-12h forecast	91	~25
ECMWF 5-day forecast	91	~40
ECMWF coupled fcst ensemble	62	~125
NCEP oper. 12-36h forecast	64	~38
UKMO oper. 12-36h forecast	50	
GMAO GEOS-5 DAS	72	~56
LMDZ	38	50

PreVOCA Regional Models
Cloud Liquid Water and Ice



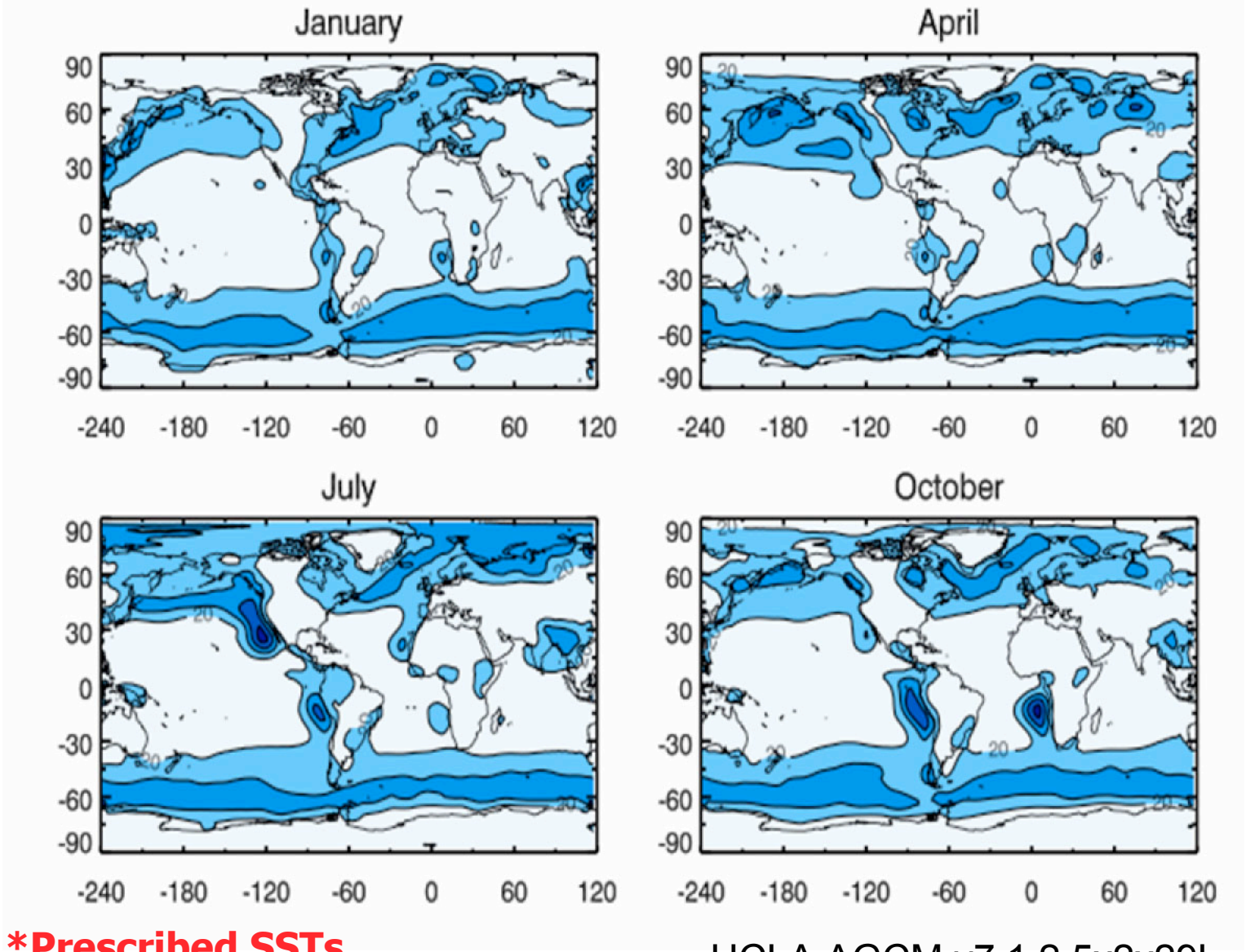
PreVOCA Regional Models
Short Wave Flux at the Surface



Summary of VOCALS Modeling Tasks

- Modeling and analysis of stratus buoy maintenance cruises
- Diagnostic studies using observed and simulated datasets (ocean eddies).
- Downscaling to the VOCALS-REx region
- Regional and global model development guided by Hypotheses (PBL, stratiform and convective clouds, etc.)
- Development of of a Multi-Scale Seasonal to Interannual Prediction System (MUSSIP)
- Model assessment prior and post Rex (PreVOCA and VOCA, respectively)

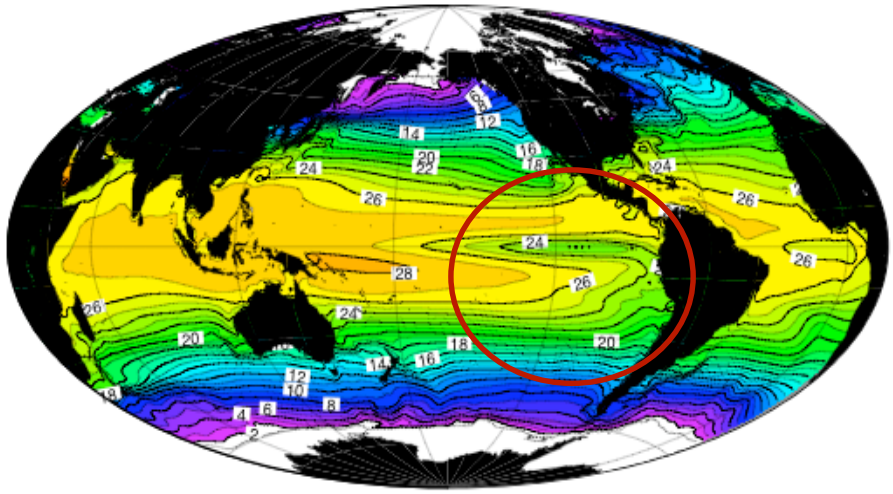
Stratocumulus Incidence by AGCMs has improved



*Prescribed SSTs

UCLA AGCM v7.1 2.5x2x29L

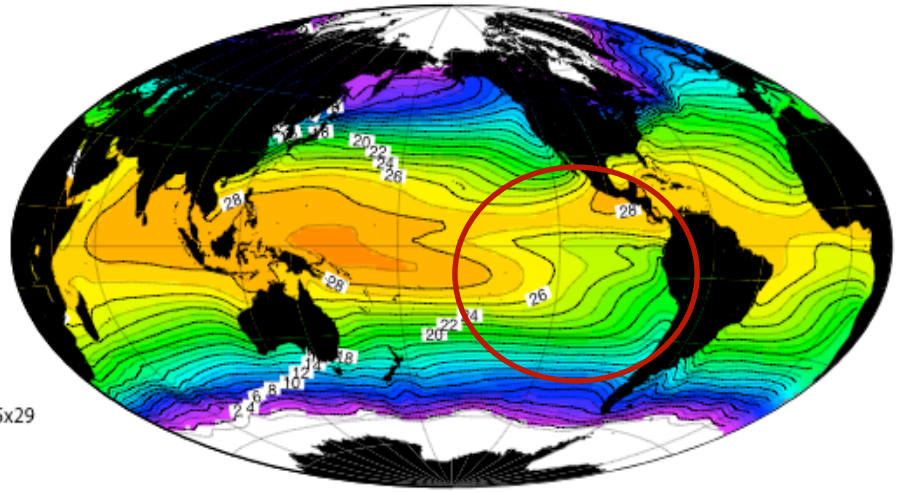
Annual Mean SST Simulation



Simulated annual mean SST

Excessive symmetry about the equator

Annual Mean SST: Reynolds analysis



Observed annual mean SST

UCLA AGCM 8.0 2x2.5x29
MIT OGCM Global

HiGEM estimates of heat balance at 20°S, 85°W, and down to 486 m

Mean and Eddy ocean advection contribute (~20 $Wm^{2)}$ to cooling at the WHOI buoy site

Toniazzo, Mechoso and Slingo, 2008