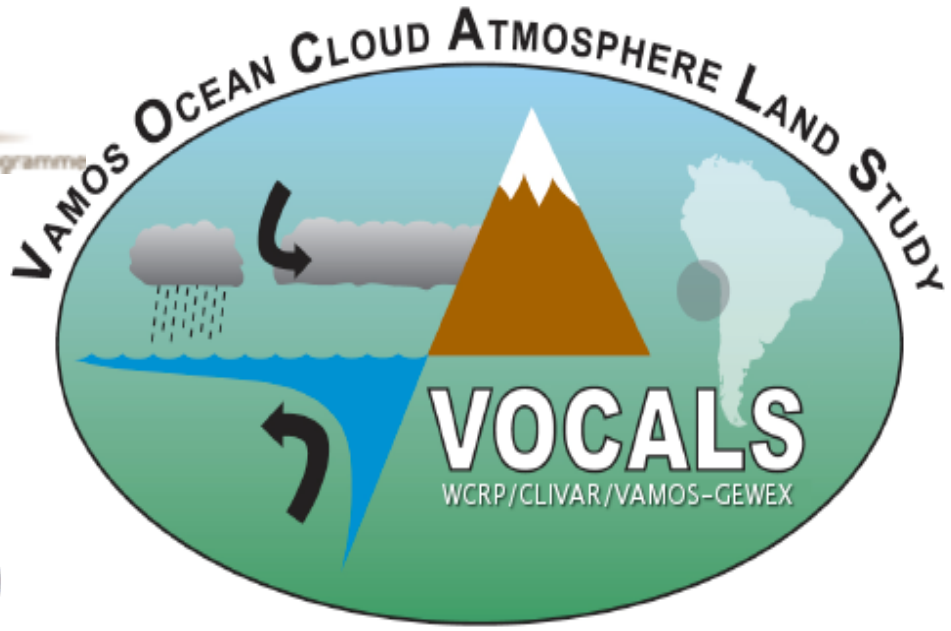


Improving understanding, model simulations, and prediction of the Southeast Pacific Climate System

C. R. Mechoso (UCLA) and R. WOOD (UW)

YOTC Implementation Planning Meeting

13-15 July 2009

GOALS of VOCALS

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.

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

www.eol.ucar.edu/projects/vocals

WCRP
World Climate Research Programme

Institutions Collaborating in VOCALS

Universities

Arizona
Arizona State
California Los Angeles
California Irvine
California San Diego
California Santa Cruz
Chile, Chile
Concepción, Chile
Colorado Boulder
Colorado State
Drexel
Hawaii
Iowa
Leeds, UK
Manchester, UK
Miami
N. Andres Bello, Chile
Naval Post. School
North Carolina State
Oregon State
Purdue
Reading, UK
Washington
Wyoming

Research Institutions

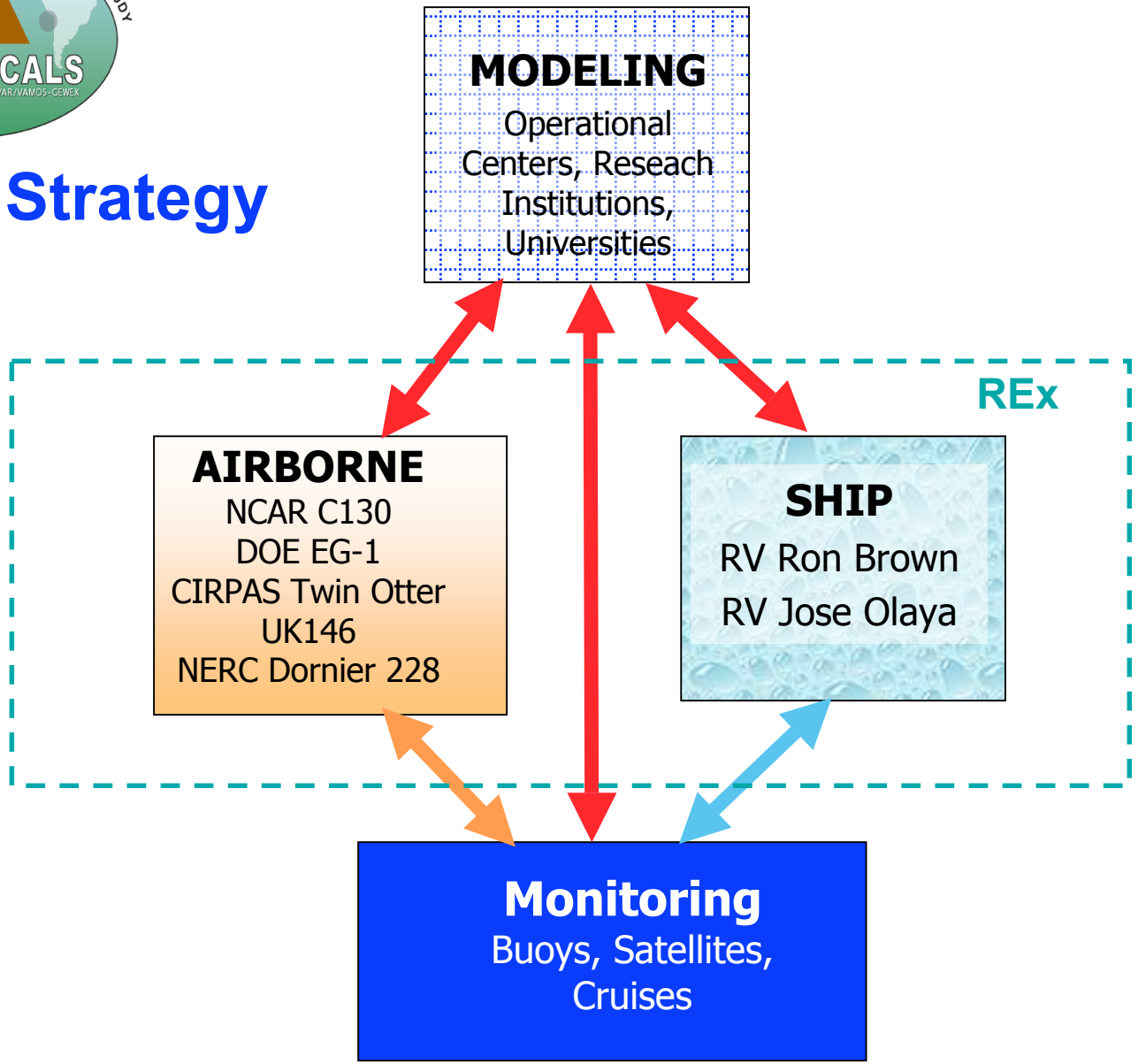
Brookhaven Nat.
COLA
CNRM/GAME France
CNRS/LMD France
IMARPE Peru
Inst. Geofísico del Peru
IPRC
JISAO
LEGOS
LOCEAN France
NASA/GSFC
NCAR
NCAS, UK
NOAA/ESRL
NOAA/GFDL
NOAA PMEL
NRL
Pacific Northwest
Scripps
Woods Hole

Logistic Support:
UCAR JOSS

Operational Centers

BMRC Australia
CPTEC Brazil
ECMWF Int.
JMA Japan
MetOffice UK
NCEP US

VOCALS Strategy

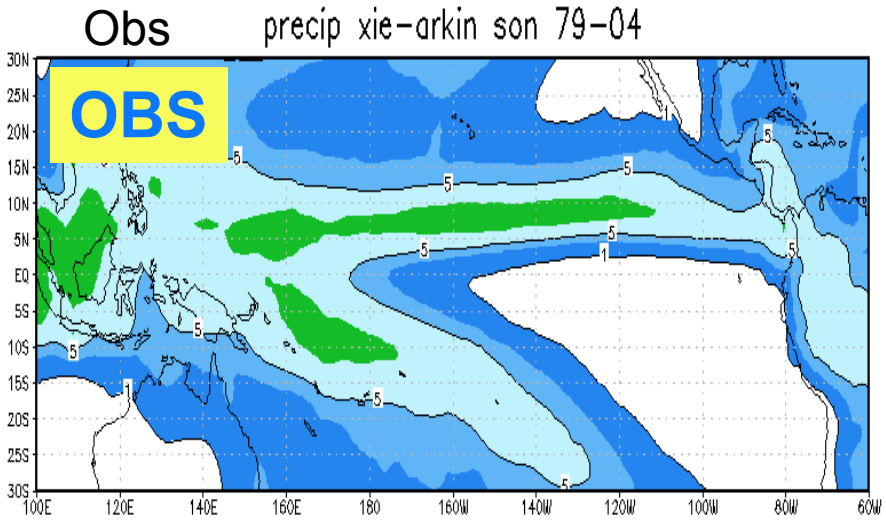


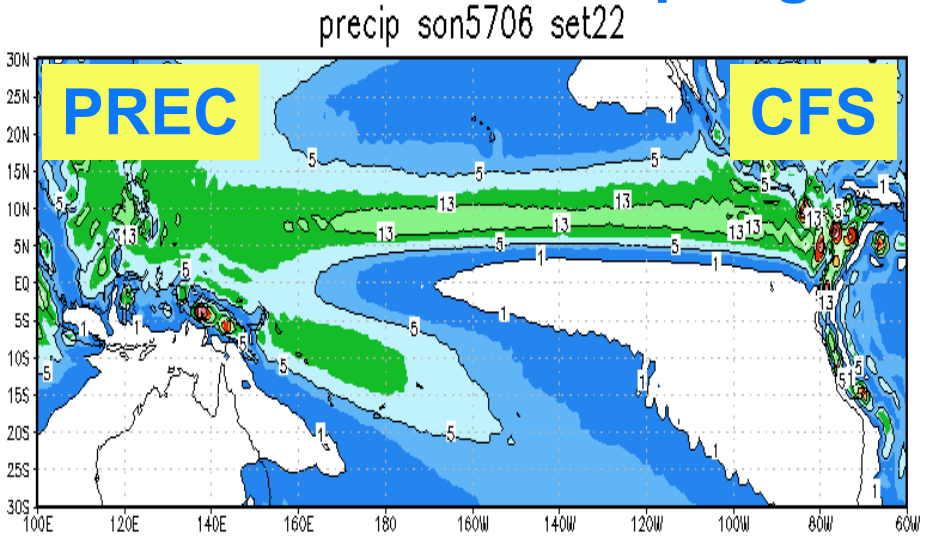
VOCALS Hypotheses

Coupled Ocean-Atmosphere-Land Hypothesis #1: Improvement of CGCMs performance in the Eastern Tropical Pacific is key to successful simulation of ITCZ/SPCZ, which will also benefit simulation of other regions.

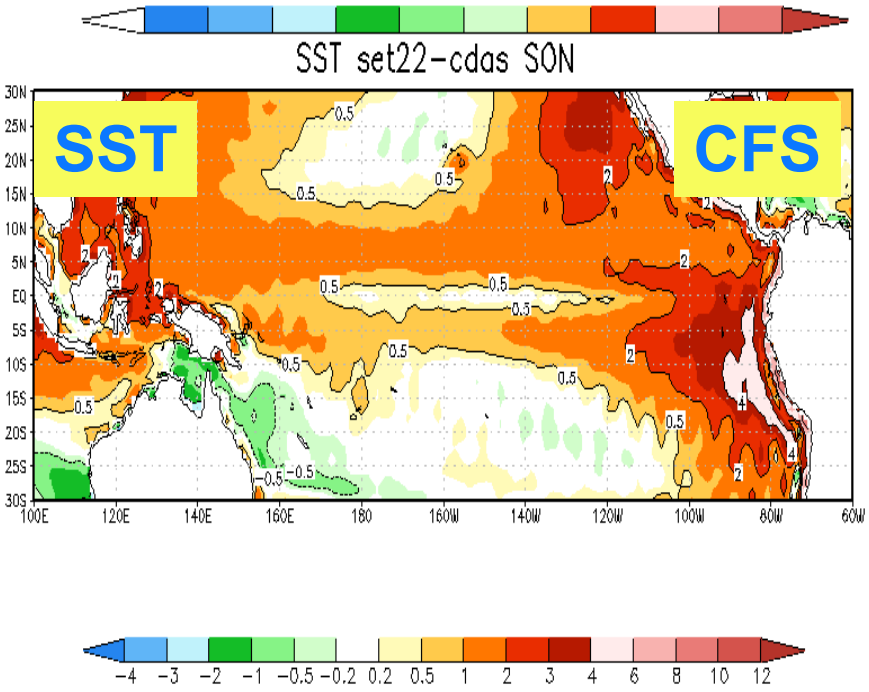
Synthesis: Major progress has been achieved in the parameterization and simulation of marine stratocumulus. However, the models still have difficulties with the ITCZ/SPCZ, transition to other cloud regimes, and SST errors in the eaastern tropical oceans.

NCEP Coupled GCM Errors in the Southern Spring





During the southern spring, NCEP's Climate Forecast System (CFS) predicts for the eastern Tropical Pacific not enough stratocumulus and too warm SSTs.

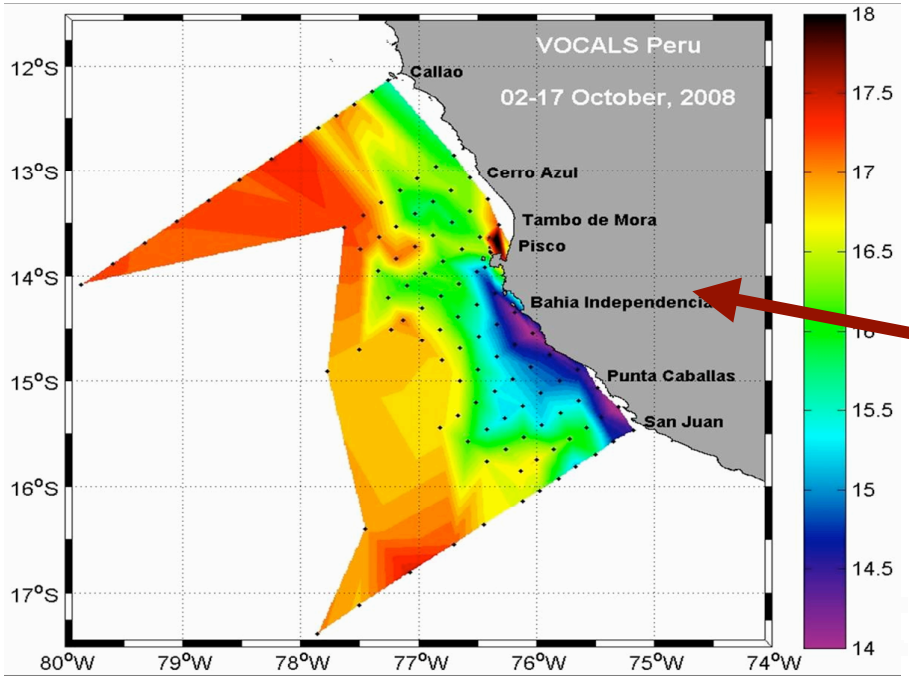


VOCALS Hypotheses

Coupled Ocean-Atmosphere-Land Hypothesis #2: Oceanic mesoscale eddies play a major role in the transport of heat and fresh water from coastally upwelled water to regions further offshore.

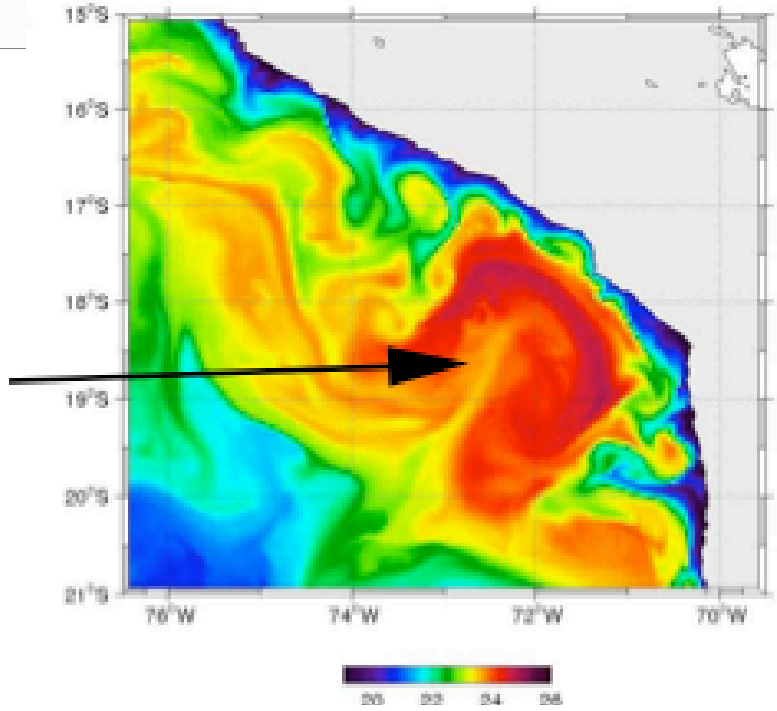
Synthesis: Oceanic mesoscale eddies were surveyed. Work with very high resolution coupled GCMs supports this hypothesis. Detailed comparisons of observations and simulations are under way.

OCEAN EDDIES



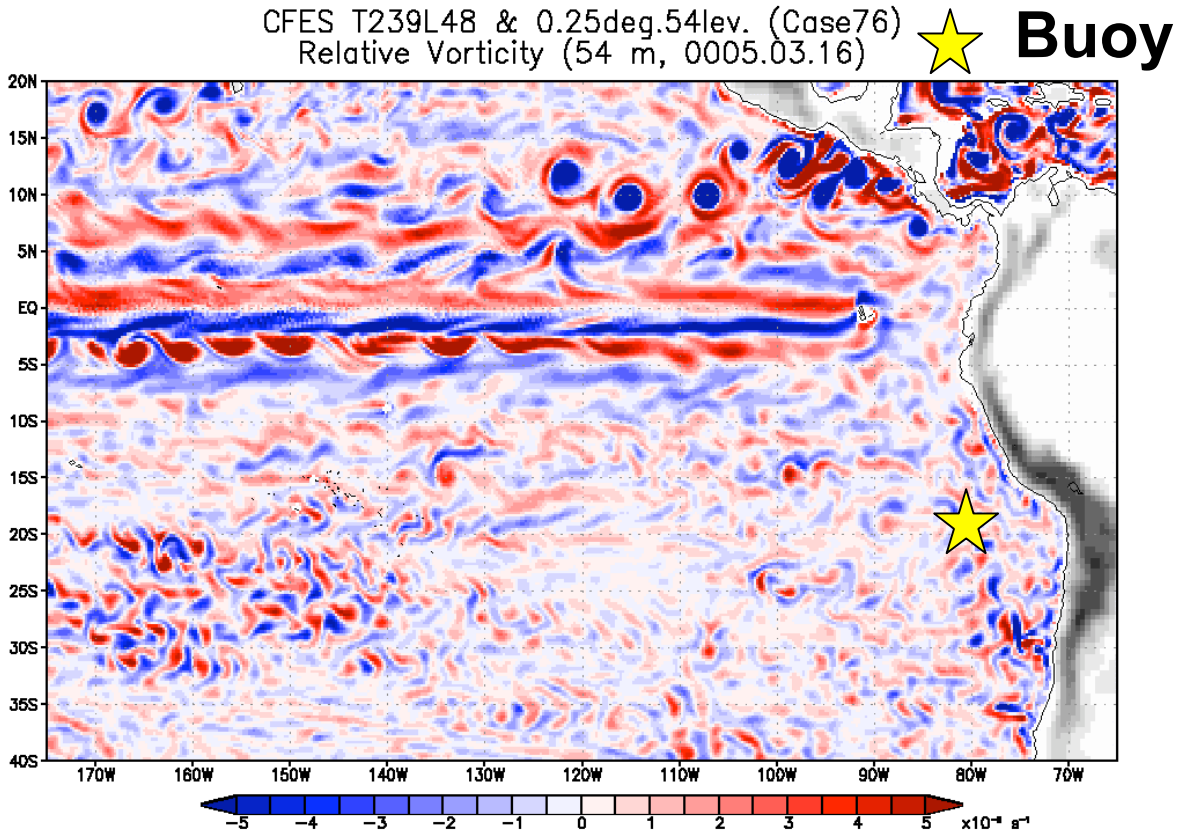
SST from oceanographic cruise October 2008
(C. Grados)

SST from very-high resolution, regional coastal ocean model (ROMS)
(McWilliams et al.)



Ocean Eddies in a high-resolution OGCM

0.25 lat x lon; 54 levels; 16 Sept



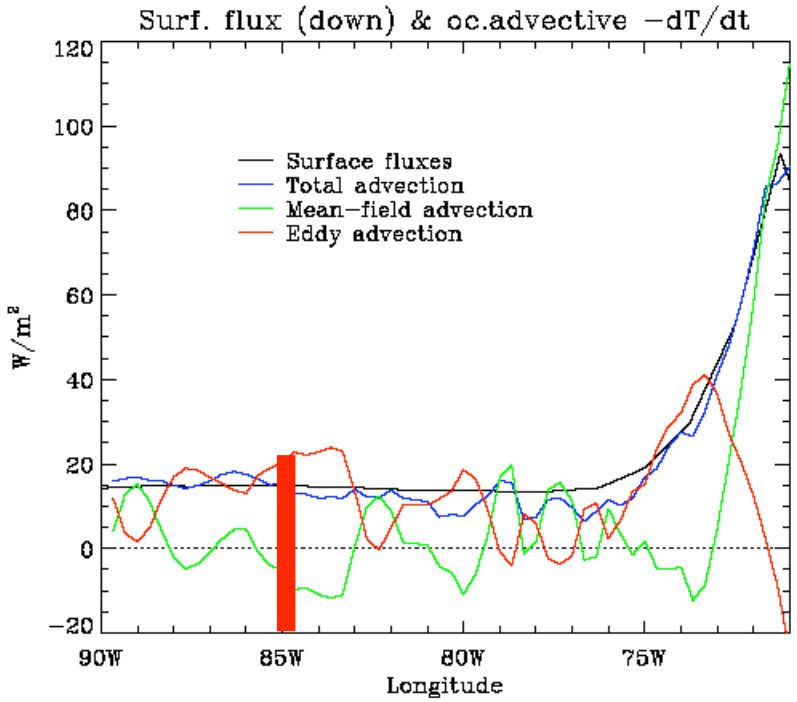
We computed heat fluxes in HiGEM Model;
AGCM: 1.25 lon, 0.83 lat, L38;
OGCM: 1/3 long, 1/3 lat, L40)

$$\mathbf{u}\cdot\nabla T = \mathbf{u}\cdot\nabla T + \mathbf{u}'\cdot\nabla T' + \mathbf{u}'\cdot\nabla T + \mathbf{u}\cdot\nabla T'$$

rectifying non-rectifying

$\mathbf{u}' = \mathbf{u}'_1 + \mathbf{u}'_2$ etc.; spatially or temporally filtered components

Toniazzo et al. (2009) found in the SEP that geostrophic transients with 4 mo < Period < 1 yr are dominant, and organised in large-scale pattern in simulation by HiGEM



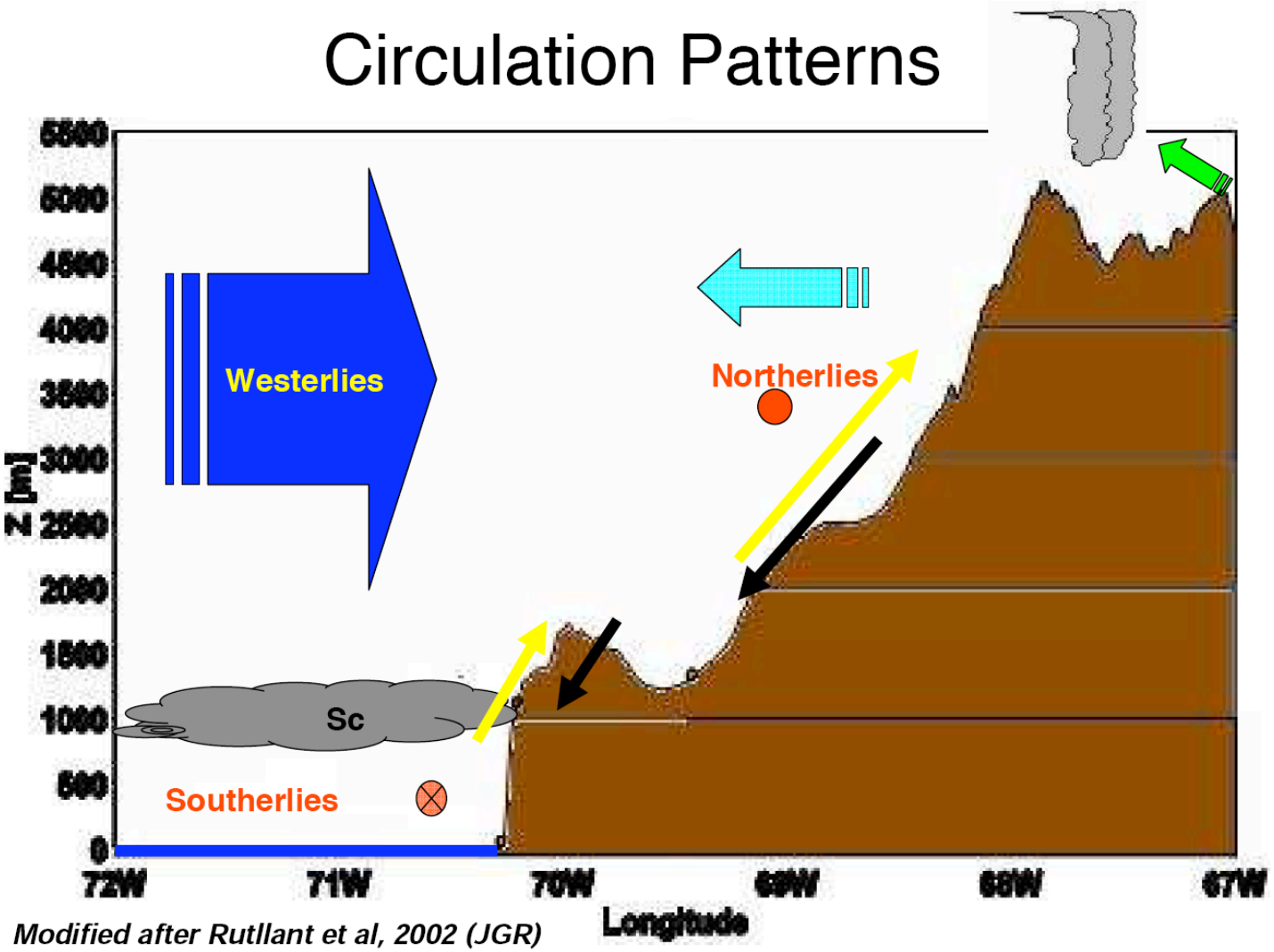
Cross-Section 20S

VOCALS Hypotheses

Coupled Ocean-Atmosphere-Land Hypothesis #3: The diurnal subsidence wave ("upsidence wave") originating in northern Chile/southern Peru has an impact upon the diurnal cycle of clouds that is well-represented in numerical models.

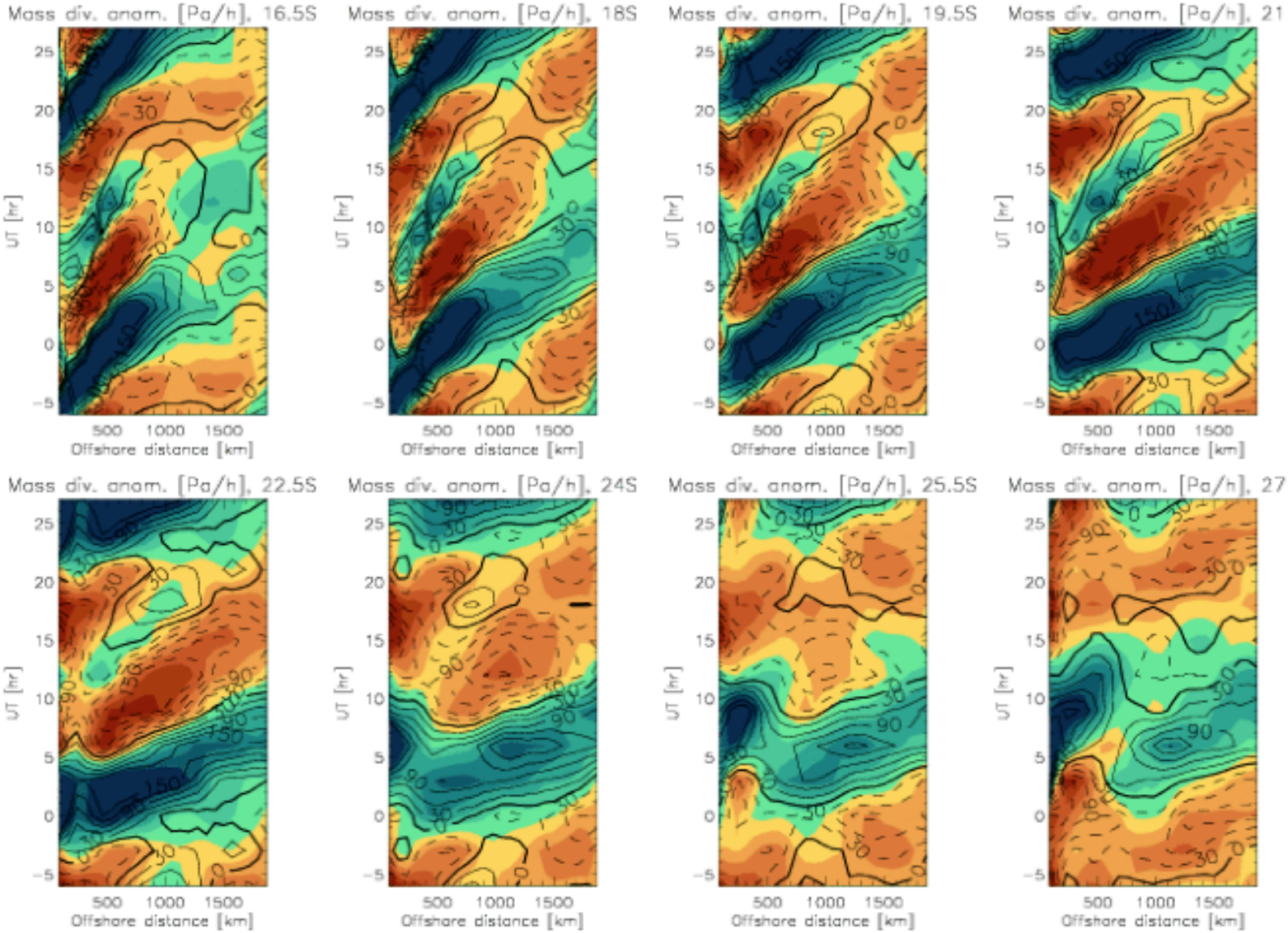
Synthesis: A preliminary examination of ship radiosondes confirms the existence of the wave. UKMO operational analysis also capture it. Current work targets the geographical variations in structure.

Circulation Patterns



Modified after Rutllant et al, 2002 (JGR)

The diurnal cycle near the coast



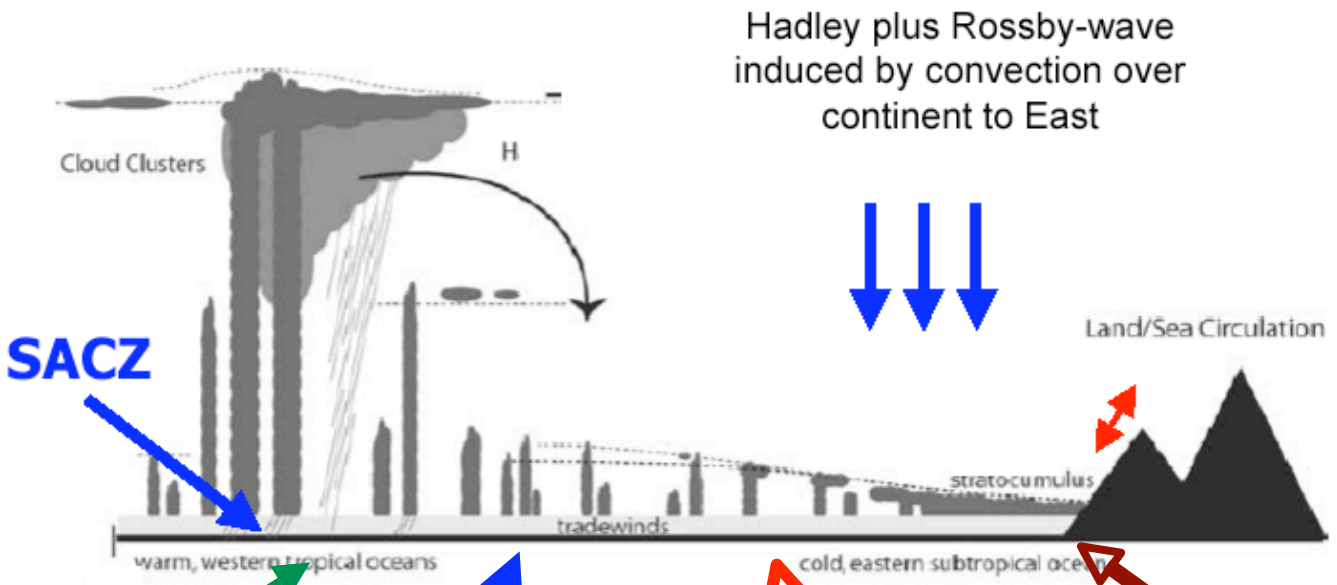
Gravity waves appear to be generated mainly over the Peruvian altiplano. They propagate offshore in a SW direction. The propagation speed (15-20 m/s) is broadly consistent with satellite cloud features. Weaker propagating signals further S.

VOCALS Hypotheses

Coupled Ocean-Atmosphere-Land Hypothesis #4: The entrainment of cool fresh intermediate water from below the surface layer during mixing associated with energetic near-inertial oscillations generated by transients in the magnitude of the trade winds is an important process to maintain heat and salt balance of the surface layer of the ocean in the SEP.

Synthesis: No progress reported so far.

The Southern Tropical Pacific (10-20S)



Transition to deep convection

Shallow convection

Transition to shallow convection

Coastal clearing Aerosol

VOCALS Paradigm C. R. Mechoso

Other **VOCALS Hypotheses**

Aerosol-Cloud-Precipitation Hypothesis #1:

Variability in the physicochemical properties of aerosols has a measurable impact upon the formation of drizzle in stratocumulus clouds over the SEP

Aerosol-Cloud-Precipitation Hypothesis #2:

Precipitation is a necessary condition for the formation and maintenance of pockets of open cells (POCs) within stratocumulus clouds.

Aerosol-Cloud-Precipitation Hypothesis #3:

The small effective radii measured from space over the SEP are **primarily controlled by anthropogenic, rather than natural**, aerosol production, and entrainment of polluted air from the lower free-troposphere is an important source of cloud condensation nuclei (CCN).

END