Cloud over EBUS
Impact and response

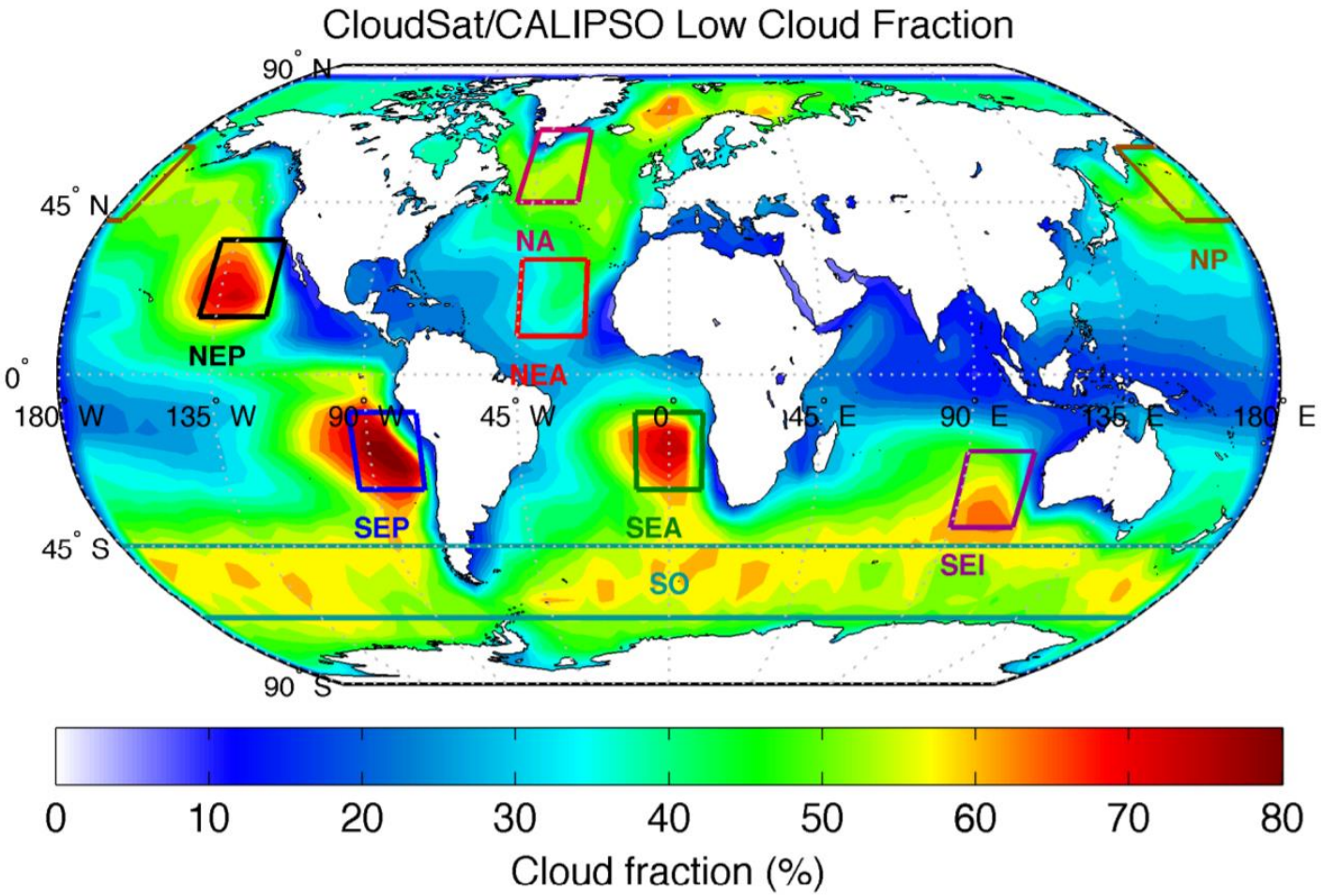
René D. Gareaud
Geophysics Department, Universidad de Chile
Center for Climate and Resilience Research

Thanks to José Rutllant[1,2], Ricardo Muñoz[1], David Rahn

Outline

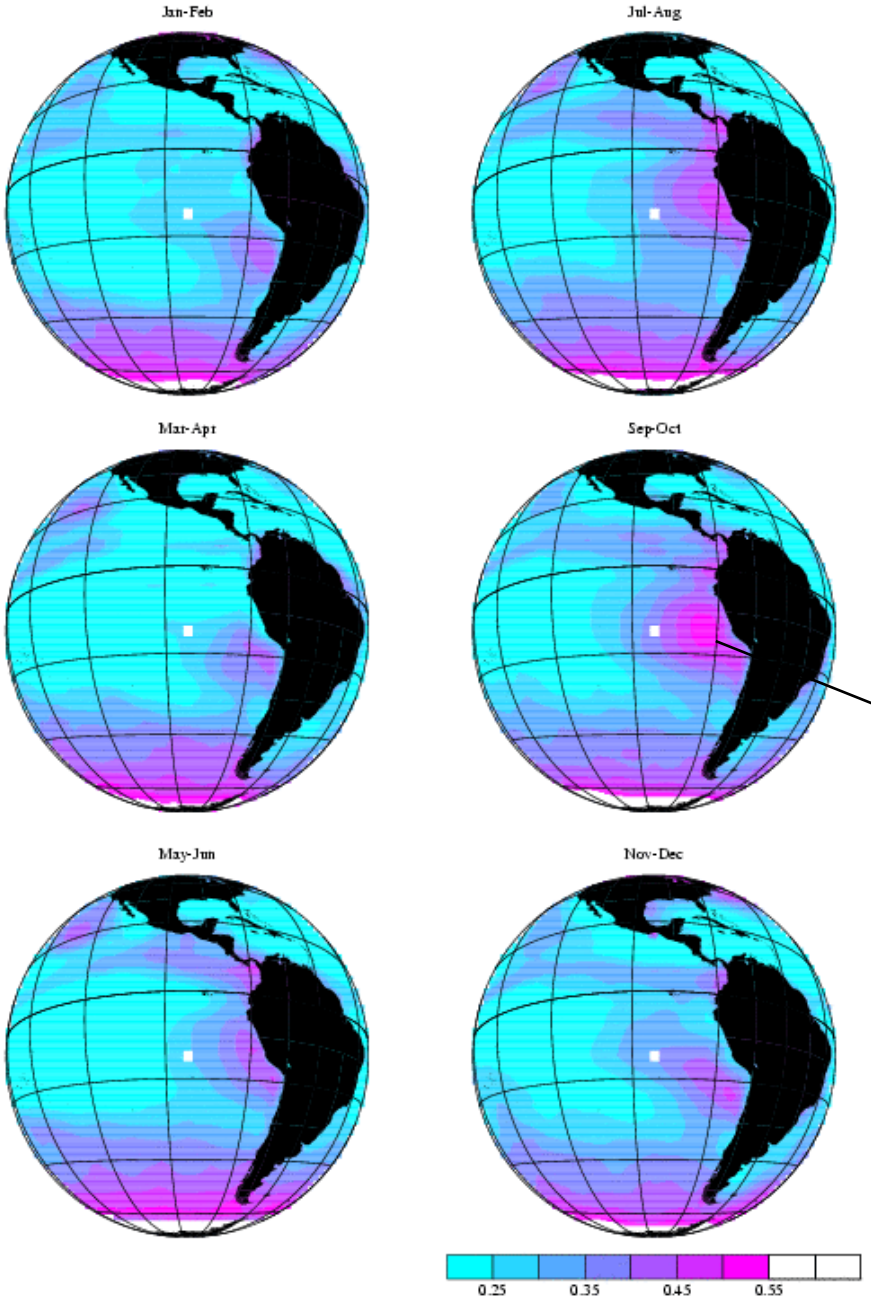
- Our cloudy EBUS…some mesoscale aspects
- Large scale impact
- Challenges

EBUS: Cold SST and Cloudy Regions



Climatology of stratocumulus cloud morphologies: microphysical properties and radiative effects

A. Muhlbauer[1], I. L. McCoy[2], and R. Wood[3]



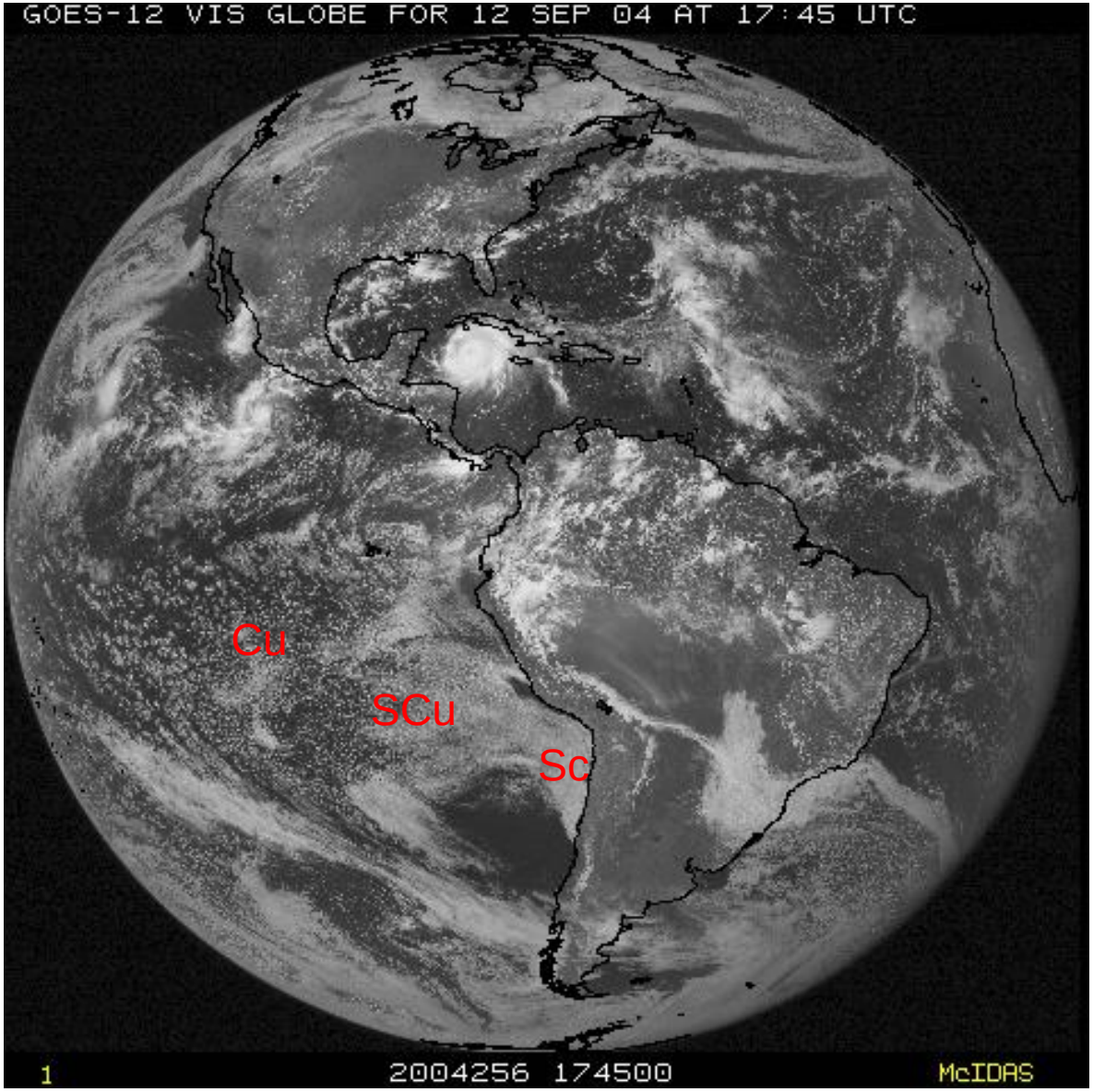
The extensive and persistent deck of SCu over the SSEP plays an important role in the regional and global climate by substancially reducing the ammount of solar radiation that reaches the sea surface

60-80%
temp. freq.

LTM bi-monthly albedo

Albedo (nubosidad)

Cloud field has significant spatial variability



CIMAR-5: A Snapshot of the Lower Troposphere over the Subtropical Southeast Pacific

René D. Garreaud,* José Rutllant,* Juan Quintana,+
Jorge Carrasco,+ and Patrick Minnis#

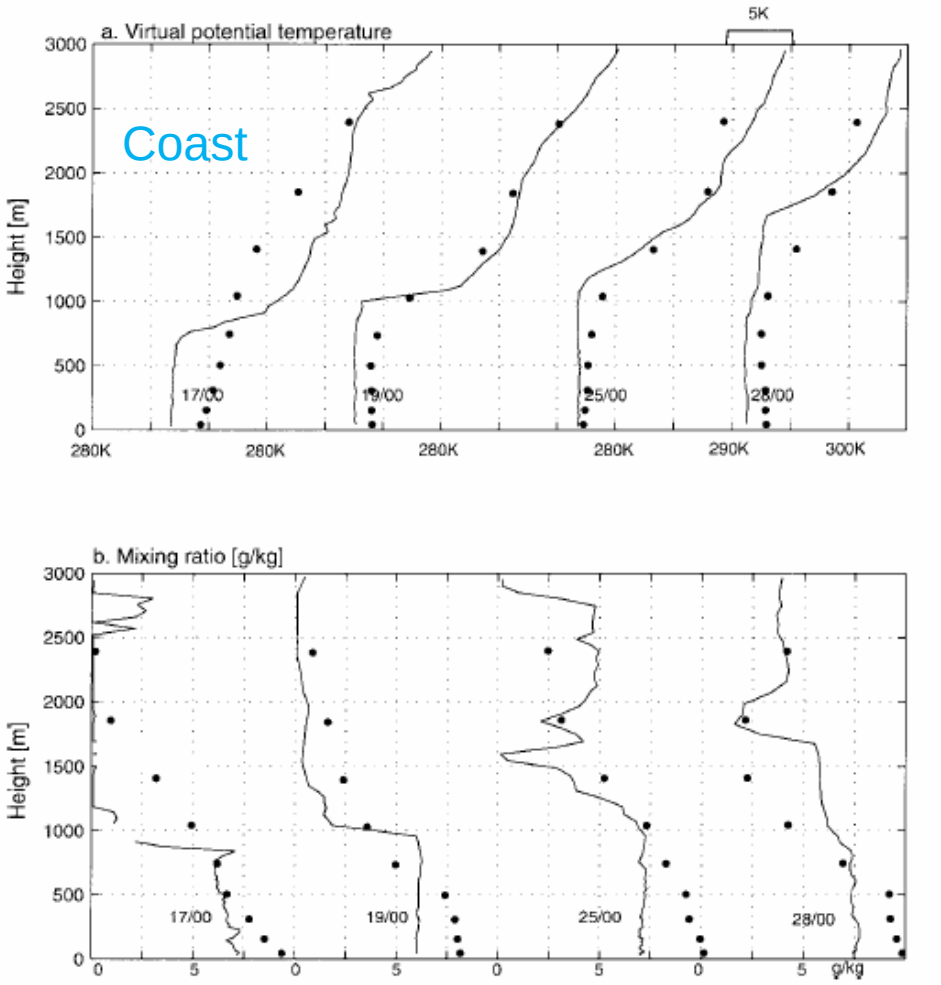
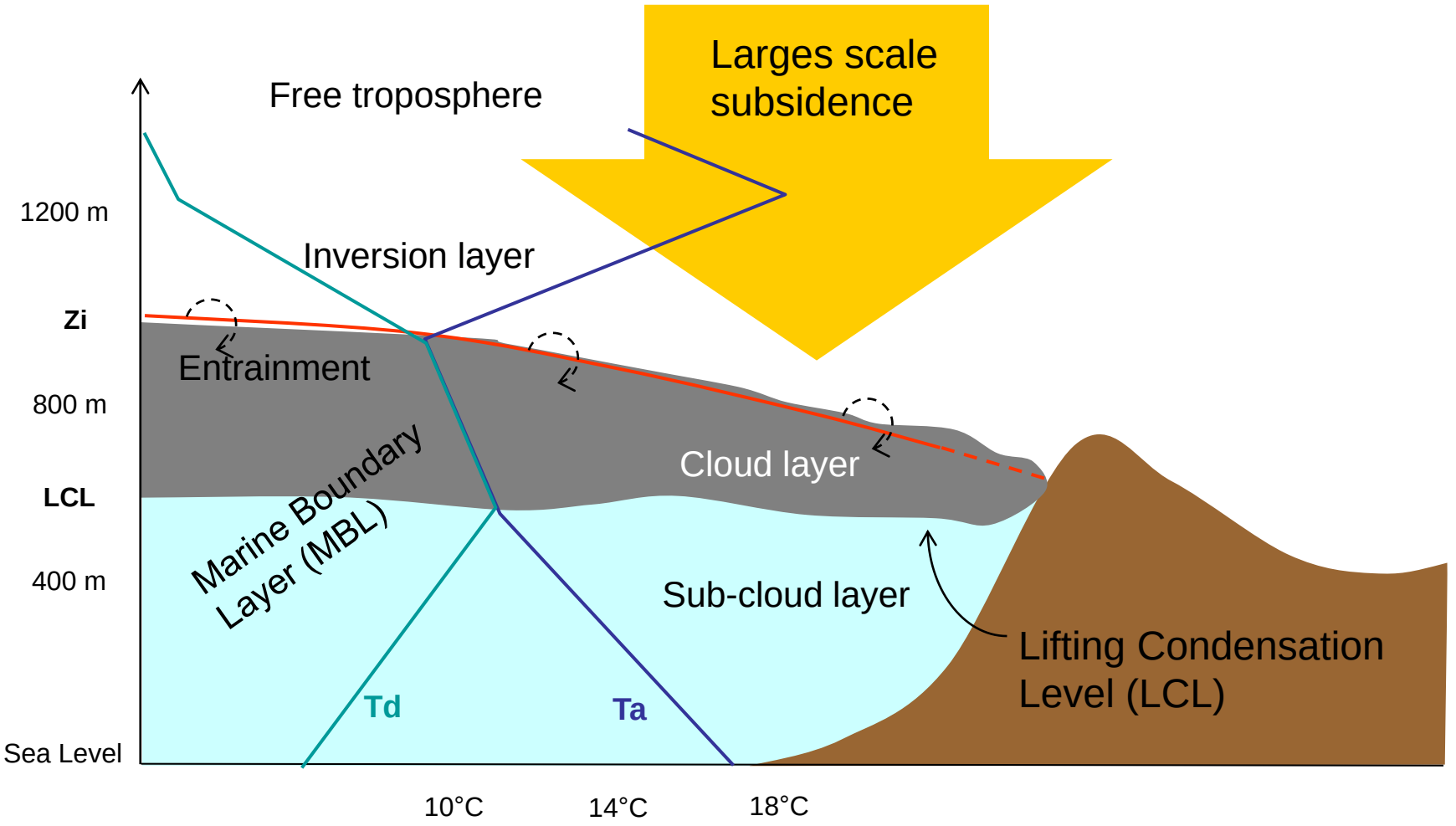


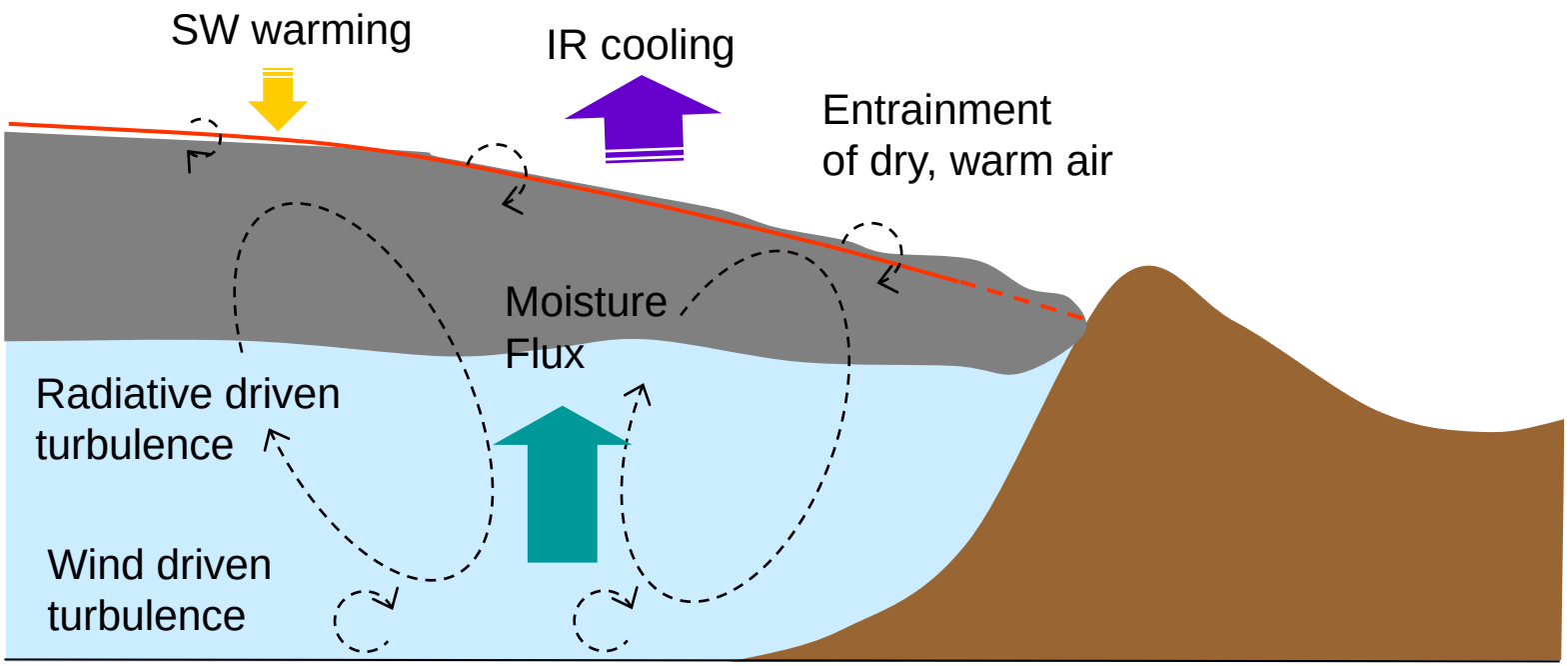
FIG. 7. (a) Vertical profiles of virtual potential temperature (θ_v) at four times during CIMAR-5. Sounding time is indicated by day (Oct)/UTC at the side of each profile. Dots are values of θ_v from the NCEP–NCAR reanalysis (original σ levels) interpolated to the ship position. (b) As in (a) but for mixing ratio.

The inversion layer is maintained by the large-scale subsidence. It caps a cool, moist, often well mixed marine boundary layer in contact with the cold waters of the SE Pacific.

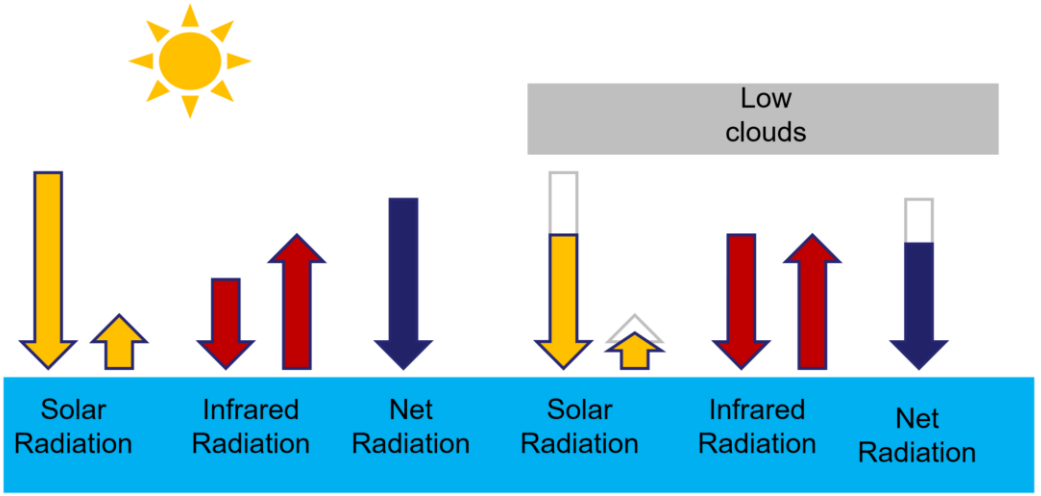


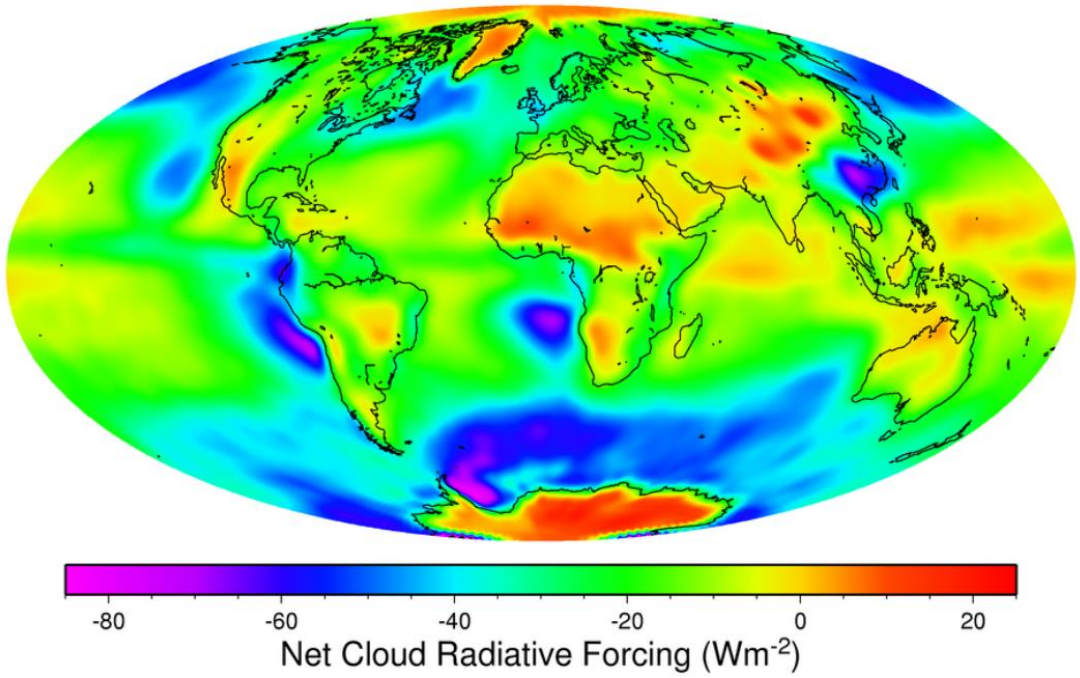
The turbulence within the MBL is largely driven by longwave cooling at the top of the cloud deck. Large eddies transport moist air upward, eventually reaching the LCL and forming the cloud. Note the feedback between cloud and turbulence.

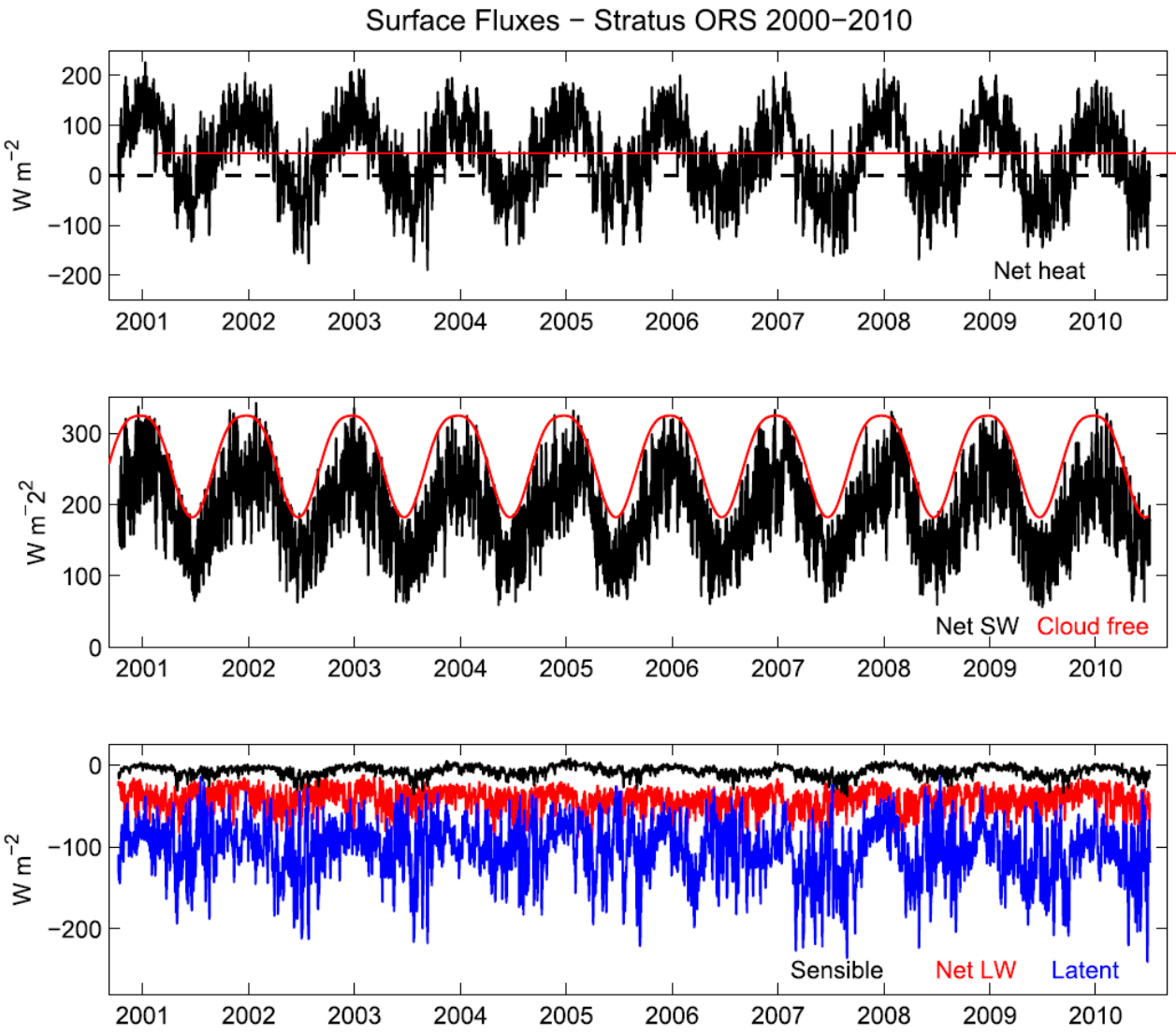
Eddies can also overshoot the MBL thus entraining dry, warm air that tend to disipate the cloud.



EBUS: Cold SST and Cloudy Regions





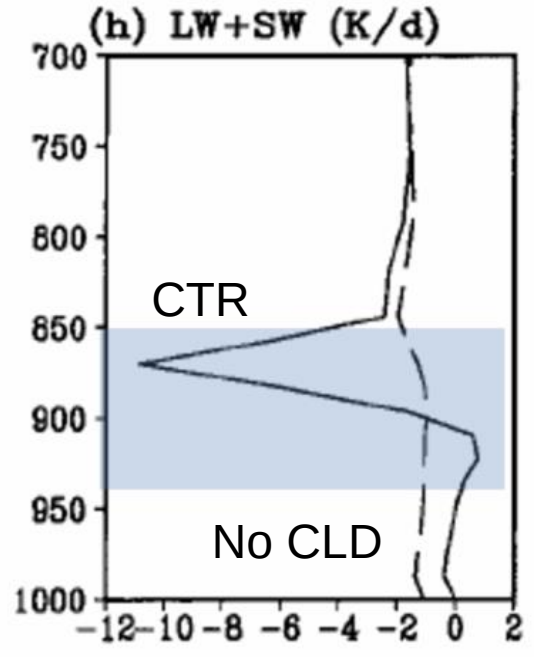


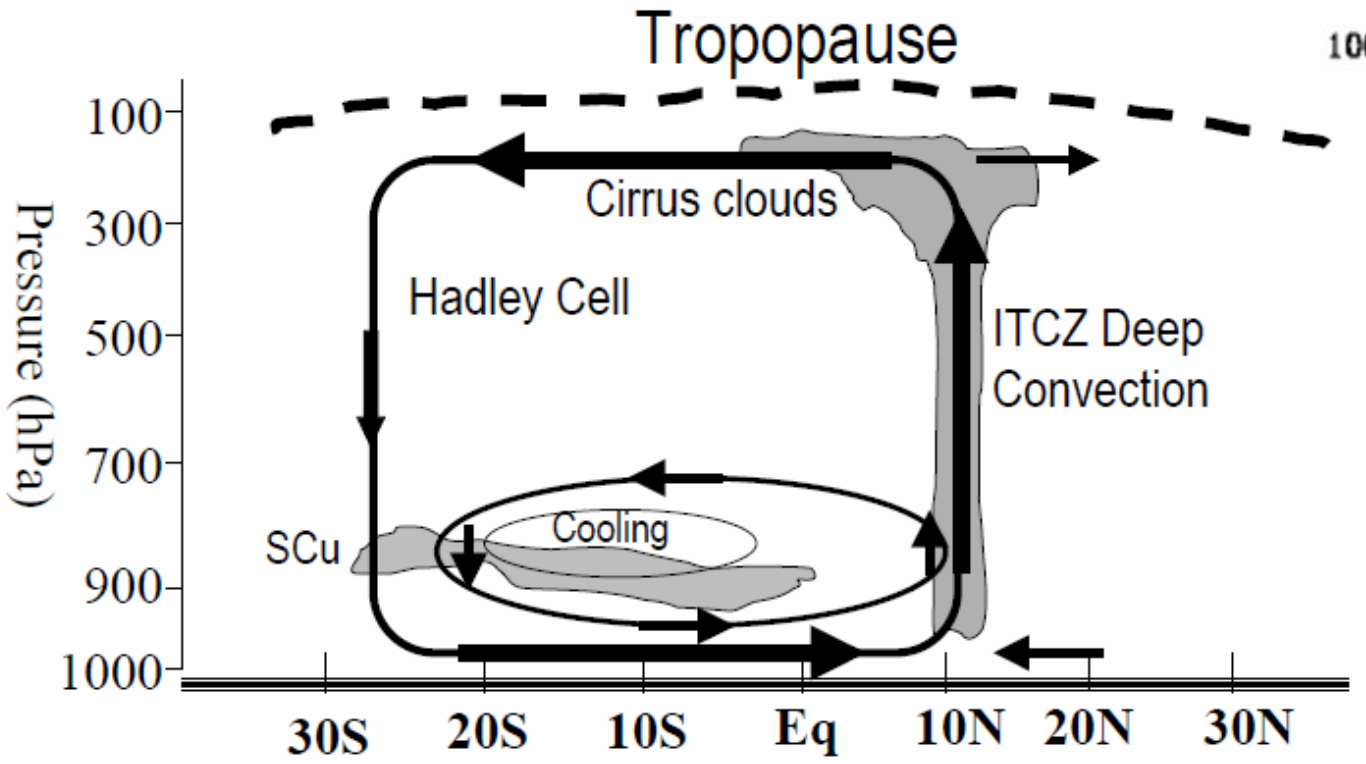
+40 W/m2

Weller 2015

Large-Scale Atmospheric Forcing by Southeast Pacific Boundary Layer Clouds: A Regional Model Study*

YUQING WANG, SHANG-PING XIE,+ BIN WANG,+ AND HAIMING XU





Wang et al. 2004

CTL – NoCLD

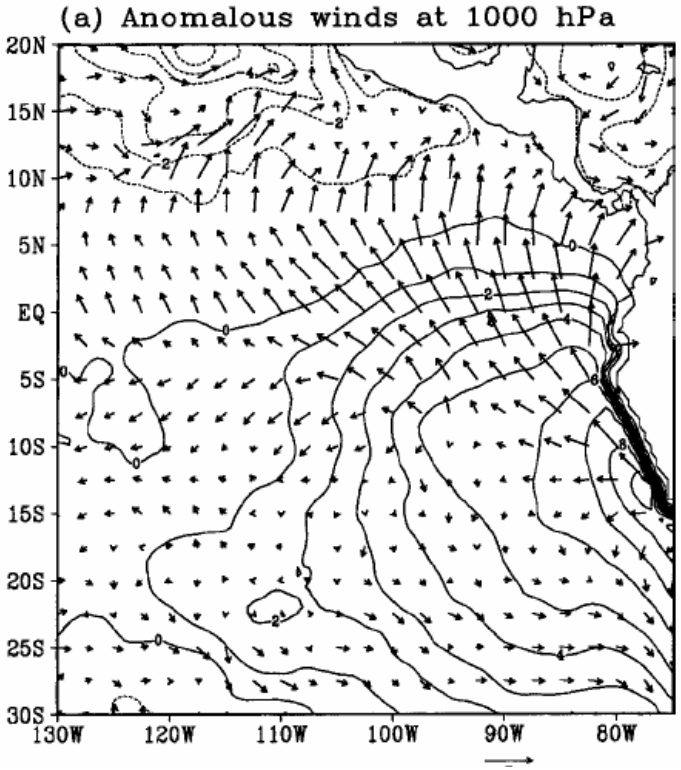
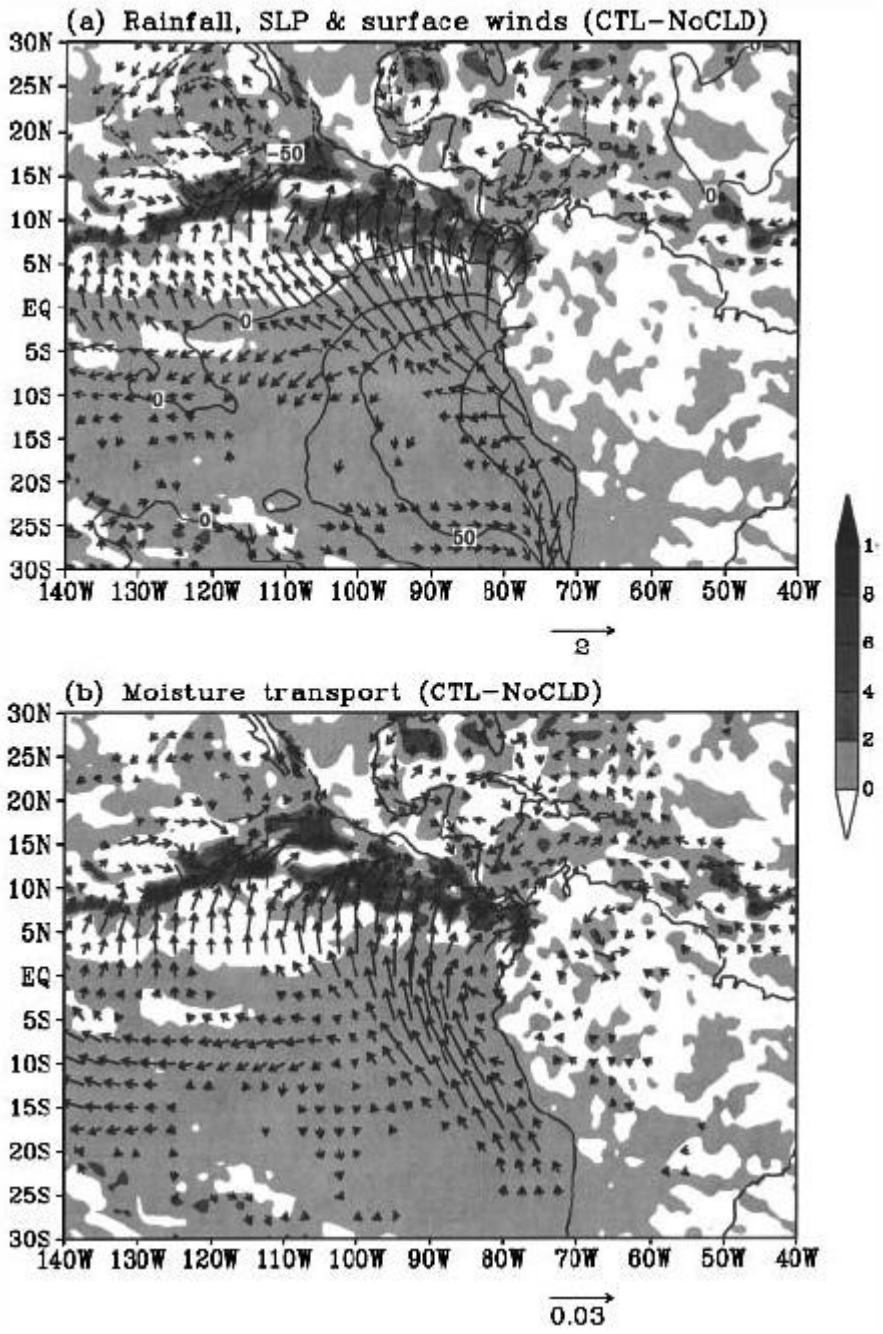
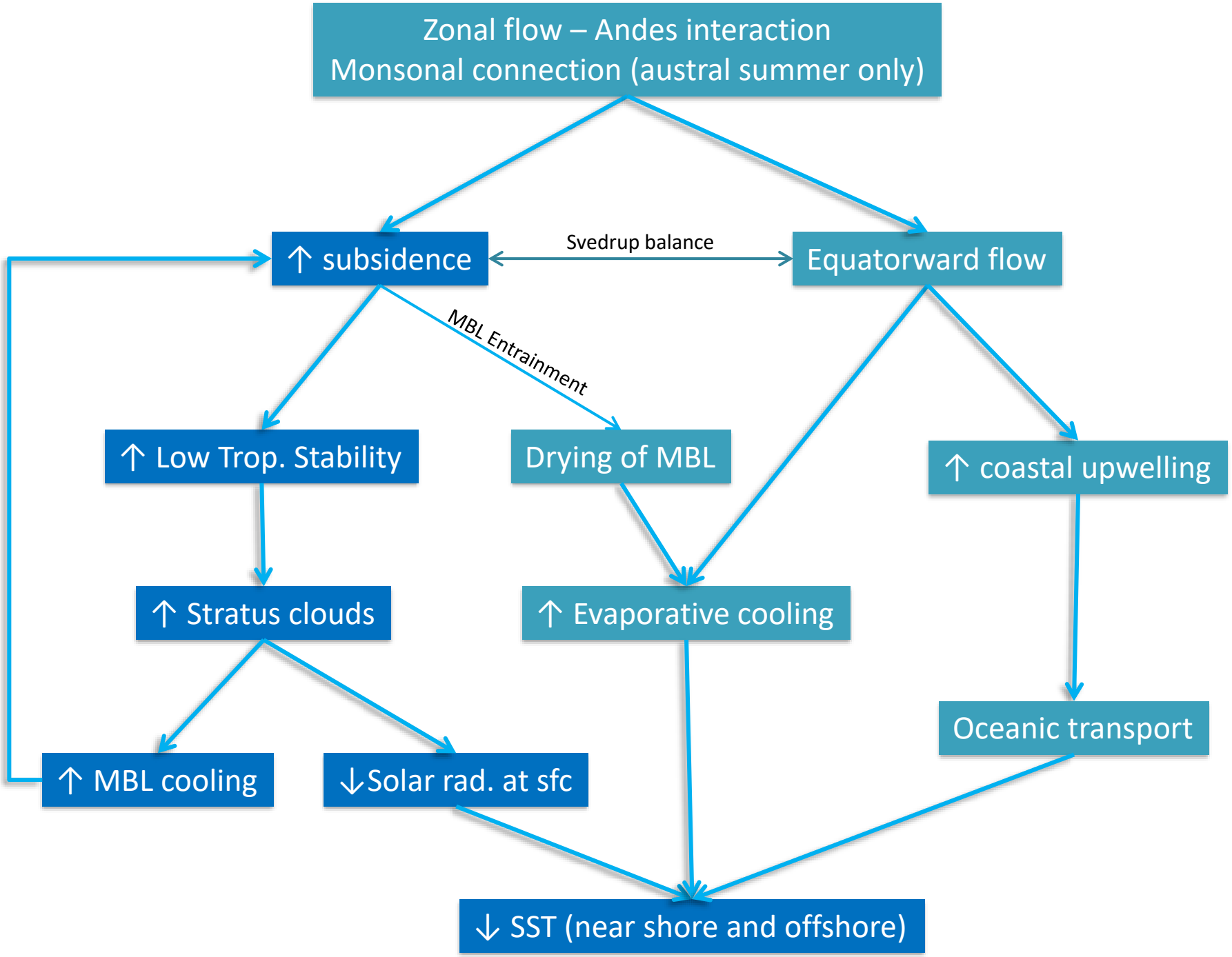


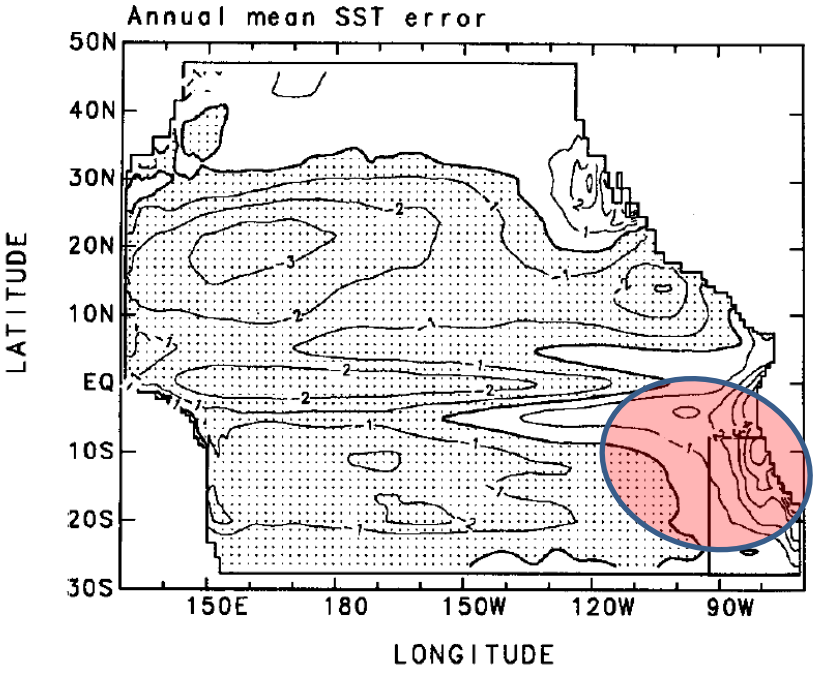
FIG. 9. (a) Differences in ASO mean daily rainfall (shaded in mm day^{-1}), sea level pressure (contours in Pa), and the 10-m-height winds (vectors with unit vector of 2 m s^{-1}) between CTL and NoCLD (CTL−NoCLD); (b) difference in column-integrated moisture transport (vectors with unit vector of 0.03 kg kg^{-1} m s^{-1}) between CTL and NoCLD superposed onto difference in rainfall as in (a).

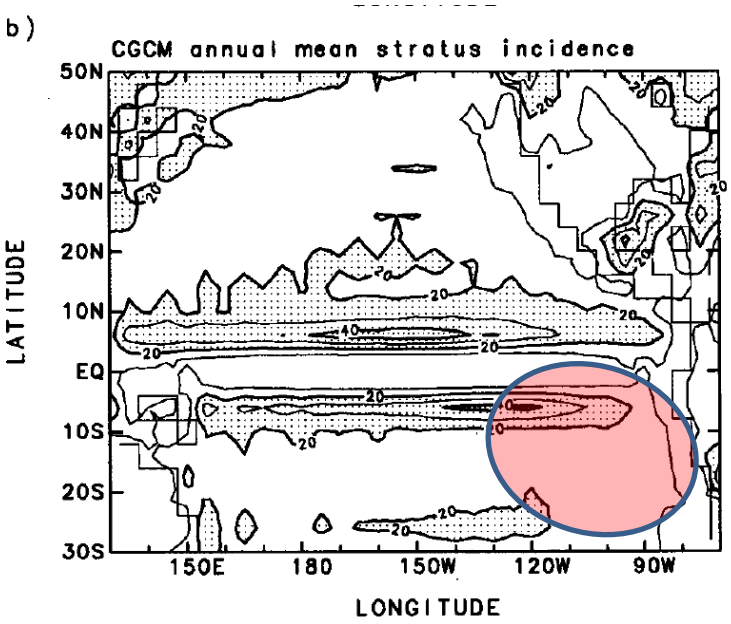



Zonal flow – Andes interaction
Monsonal connection (austral summer only)
↑ subsidence
Svedrup balance
Equatorward flow
MBL Entrainment
↑ Low Trop. Stability
Drying of MBL
↑ coastal upwelling
↑ Stratus clouds
↑ Evaporative cooling
Oceanic transport
↑ MBL cooling
↓Solar rad. at sfc
↓ SST (near shore and offshore)

Control (original) UCLA GCM simulation

few clouds, large warm bias





Peruvian Stratus Clouds and the Tropical Pacific Circulation: A Coupled Ocean–Atmosphere GCM Study

CHUNG-CHUN MA, CARLOS R. MECHOSO, ANDREW W. ROBERTSON, AND AKIO ARAKAWA

SST differences: Fixed SCu-Control

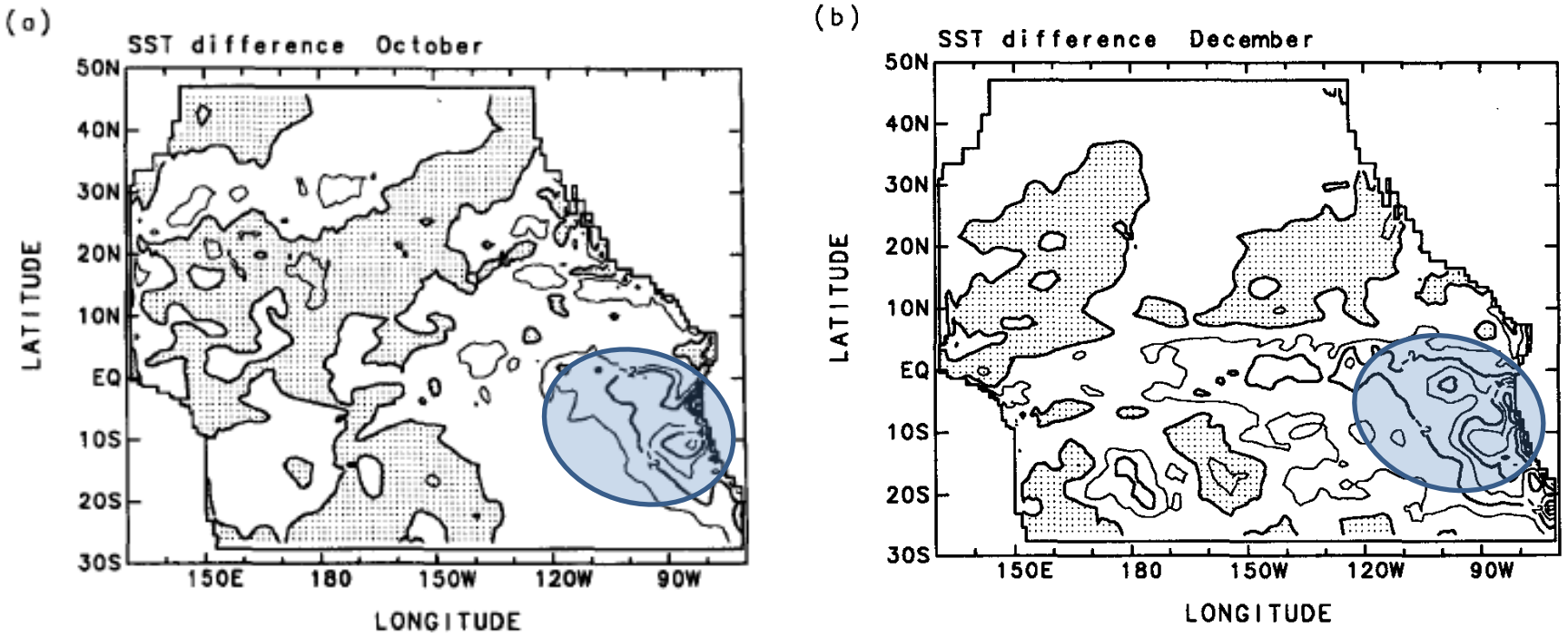


FIG. 7. Difference in simulated SST between the stratus experiment and the control simulation for (a) October and (b) December. Contour interval is 1 K; regions with positive values are stippled.

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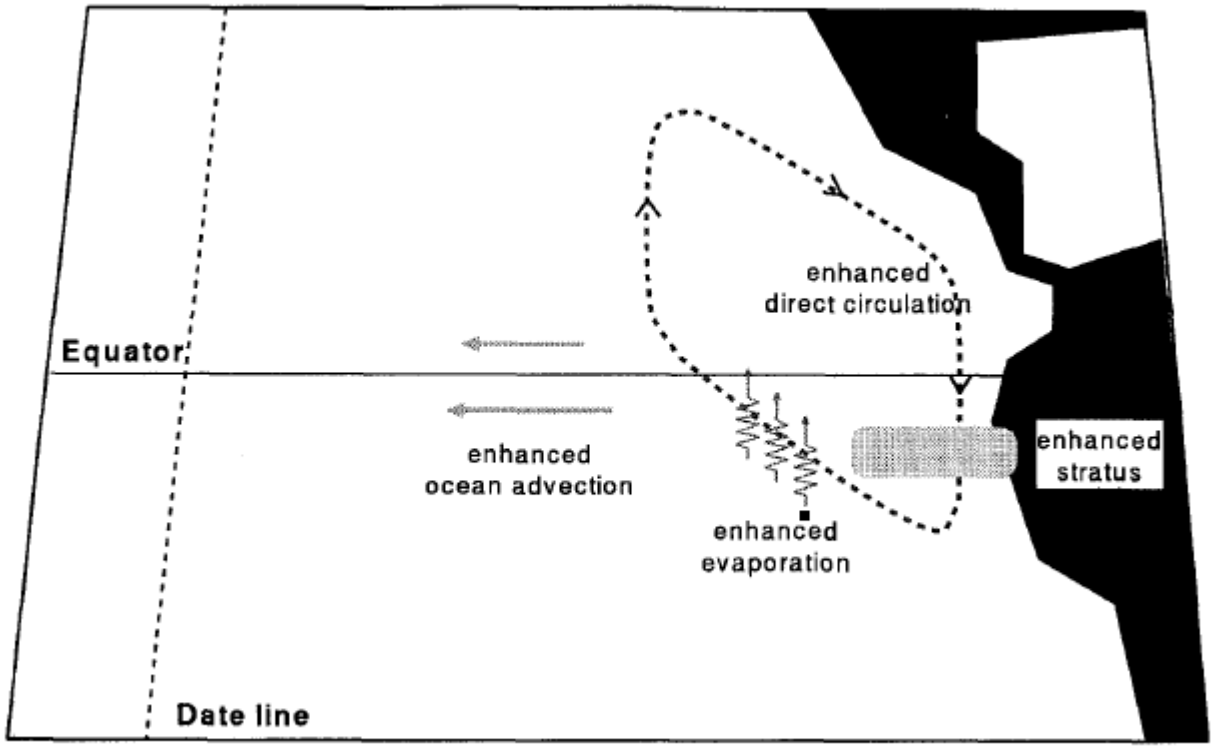
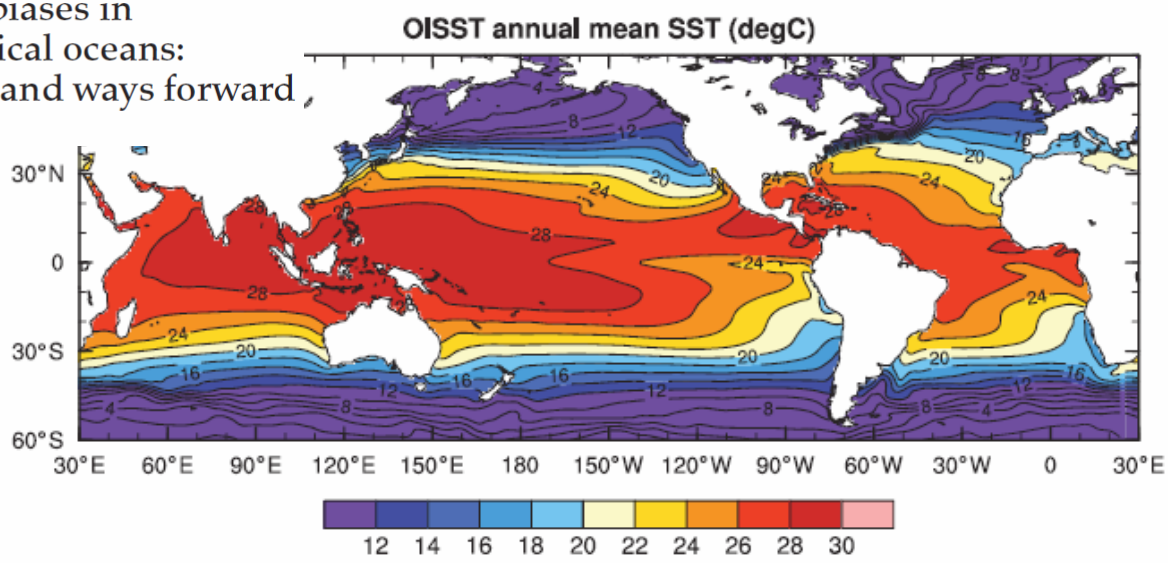


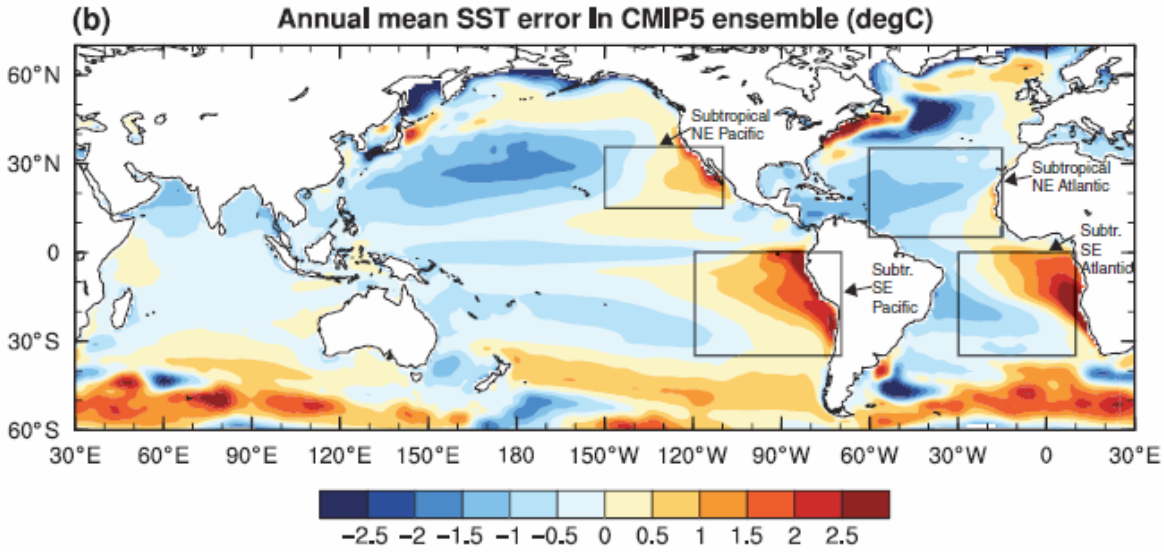
FIG. 10. A schematic illustrating the influence of Peruvian stratus on tropical atmospheric and oceanic circulations as suggested by the coupled GCM experiment.

Huston….we have a problem

Climate model biases in the eastern tropical oceans: causes, impacts and ways forward

Ingo Richter*





Cloud – SST @ EBUS

Chicken and egg problem?

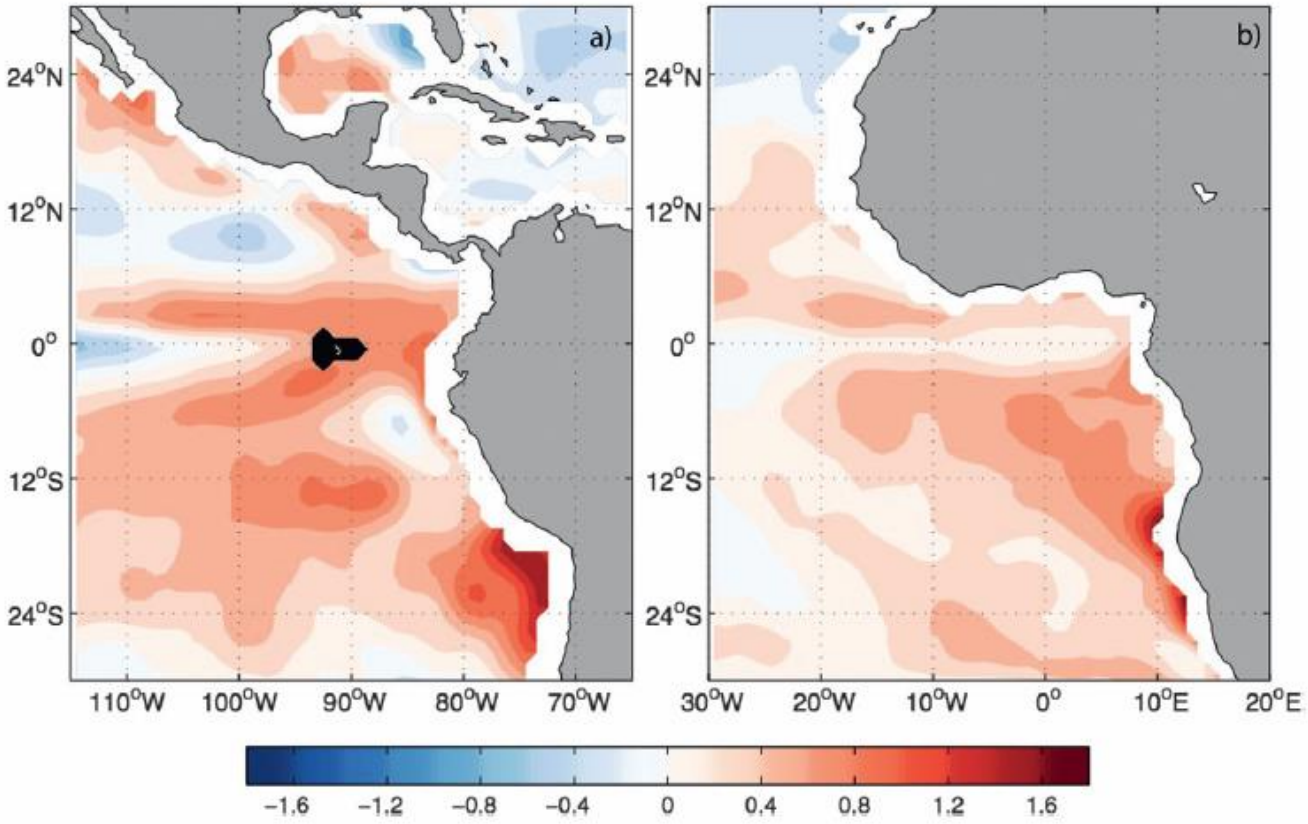


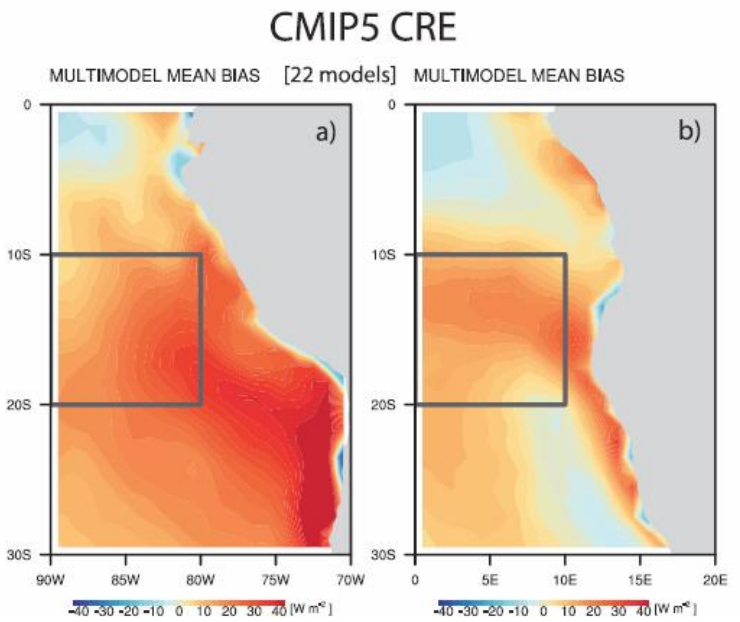
FIG. 10. Ocean simulations with fixed atmosphere forcings (termed OMIP) also produce SST biases, if less pronounced than in CMIP simulations, as shown in the 22-ensemble OMIP SST bias relative to CORE2 surface forcing for (a) the Pacific and (b) the Atlantic (Danabasoglu et al. 2014). This suggests oceanic origins also contribute to the SST biases.

Zuidema et al. 2016

Cloud – SST @ EBUS

Chicken and egg problem?

Fully coupled Ocean-Atmosphere Model: large cloud biases



Zuidema et al. 2016

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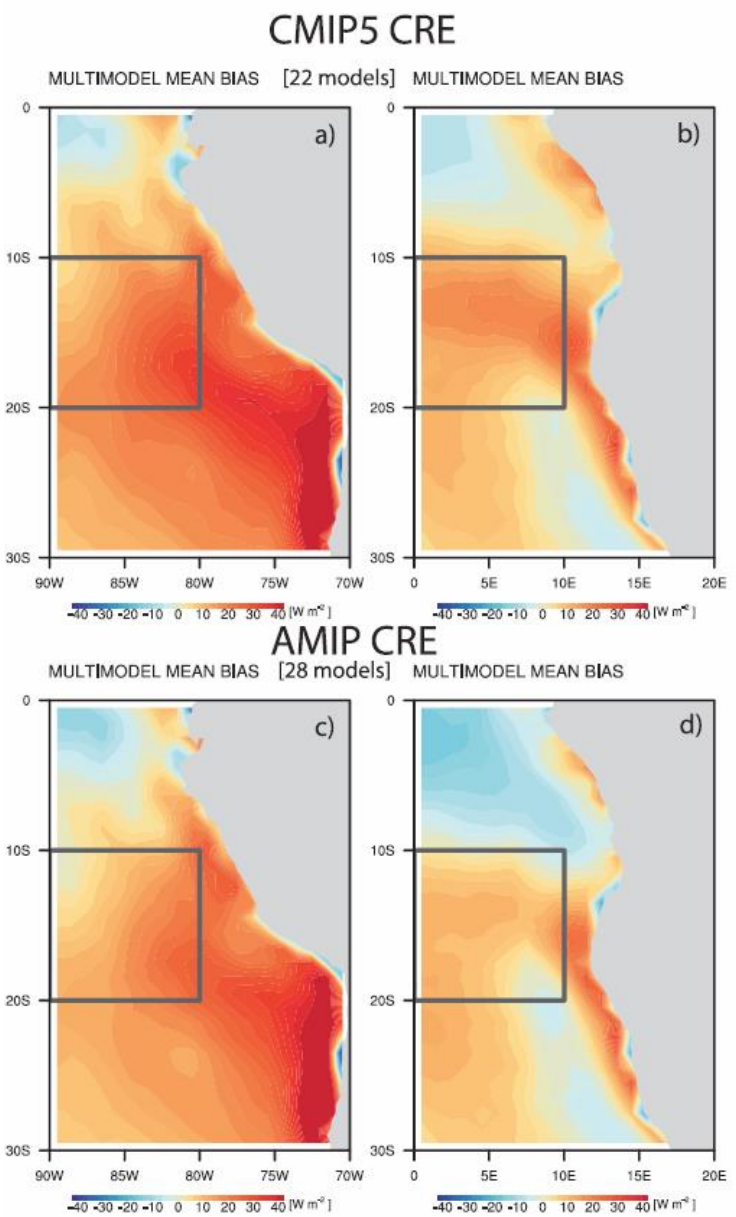
Not fully alleviated by prescribing SST. Low clouds are hard to simulate!



Zuidema et al. 2016