# Air-sea heat fluxes in the stratocumulus deck / cold tongue / ITCZ complex of the eastern tropical Pacific

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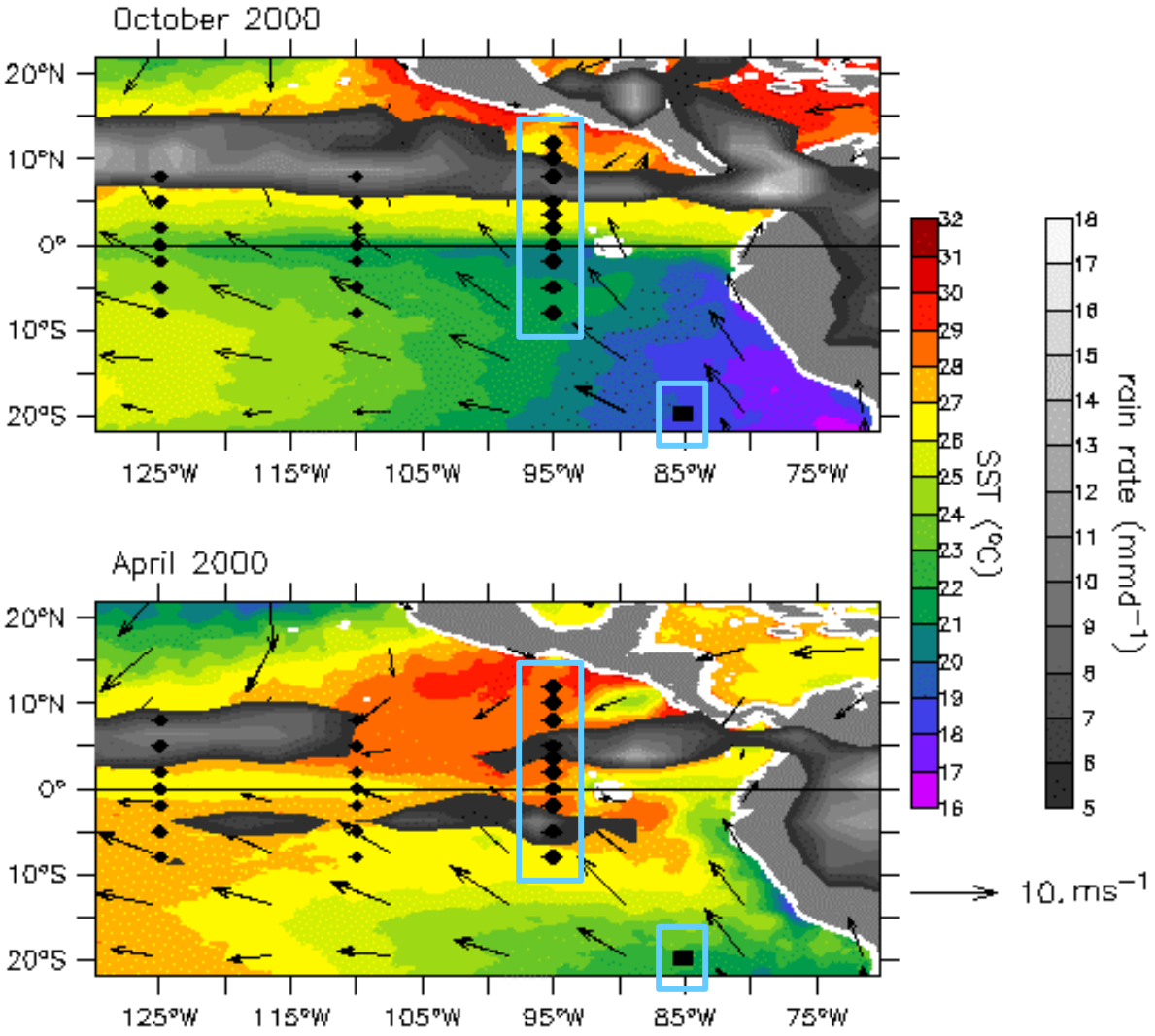
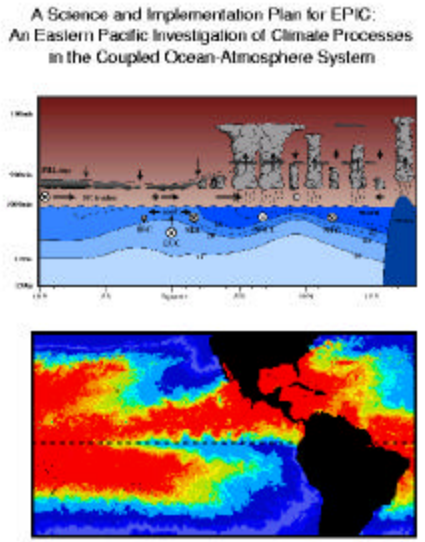
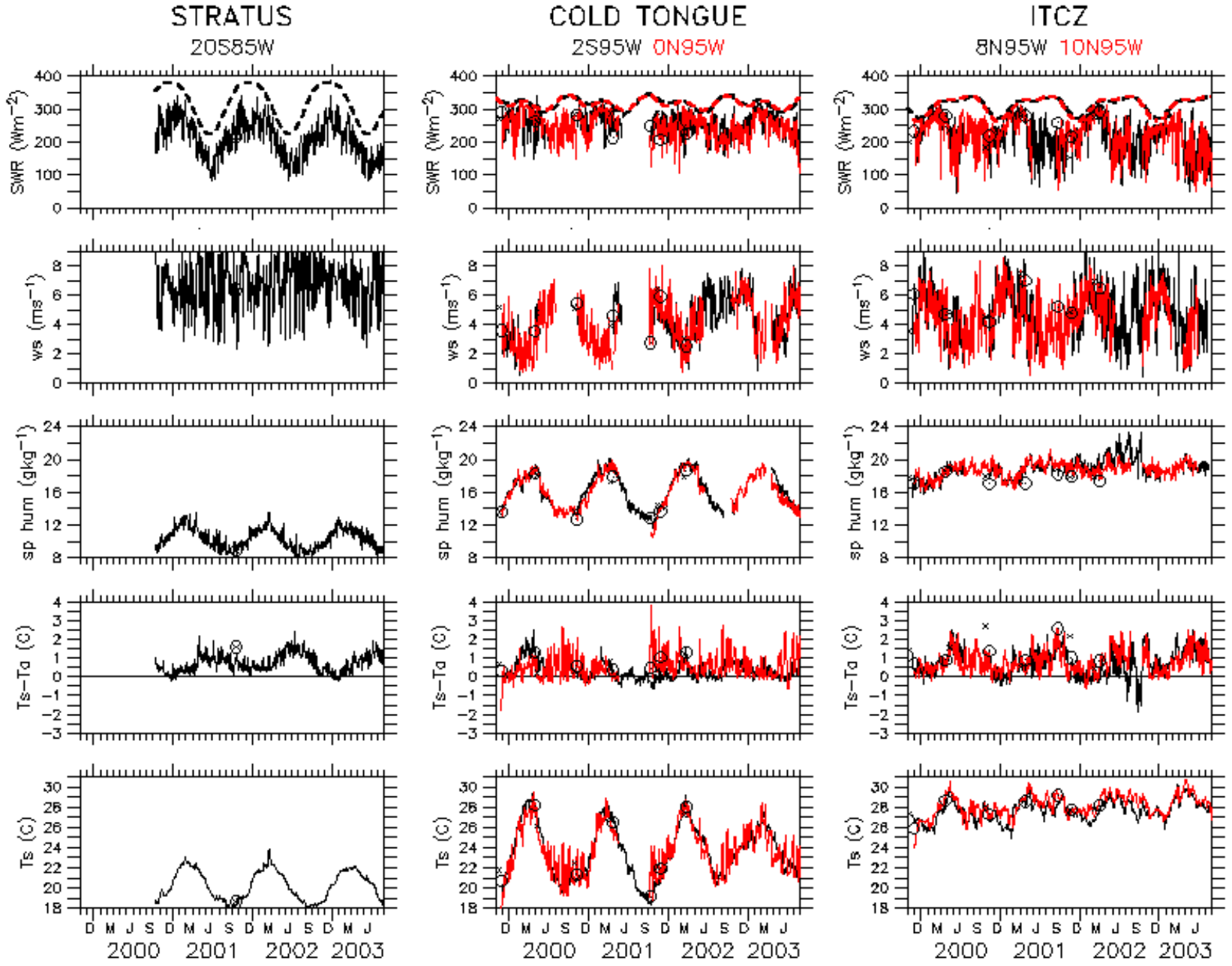
# Eastern Pacific Investigation of Climate (EPIC) experiment

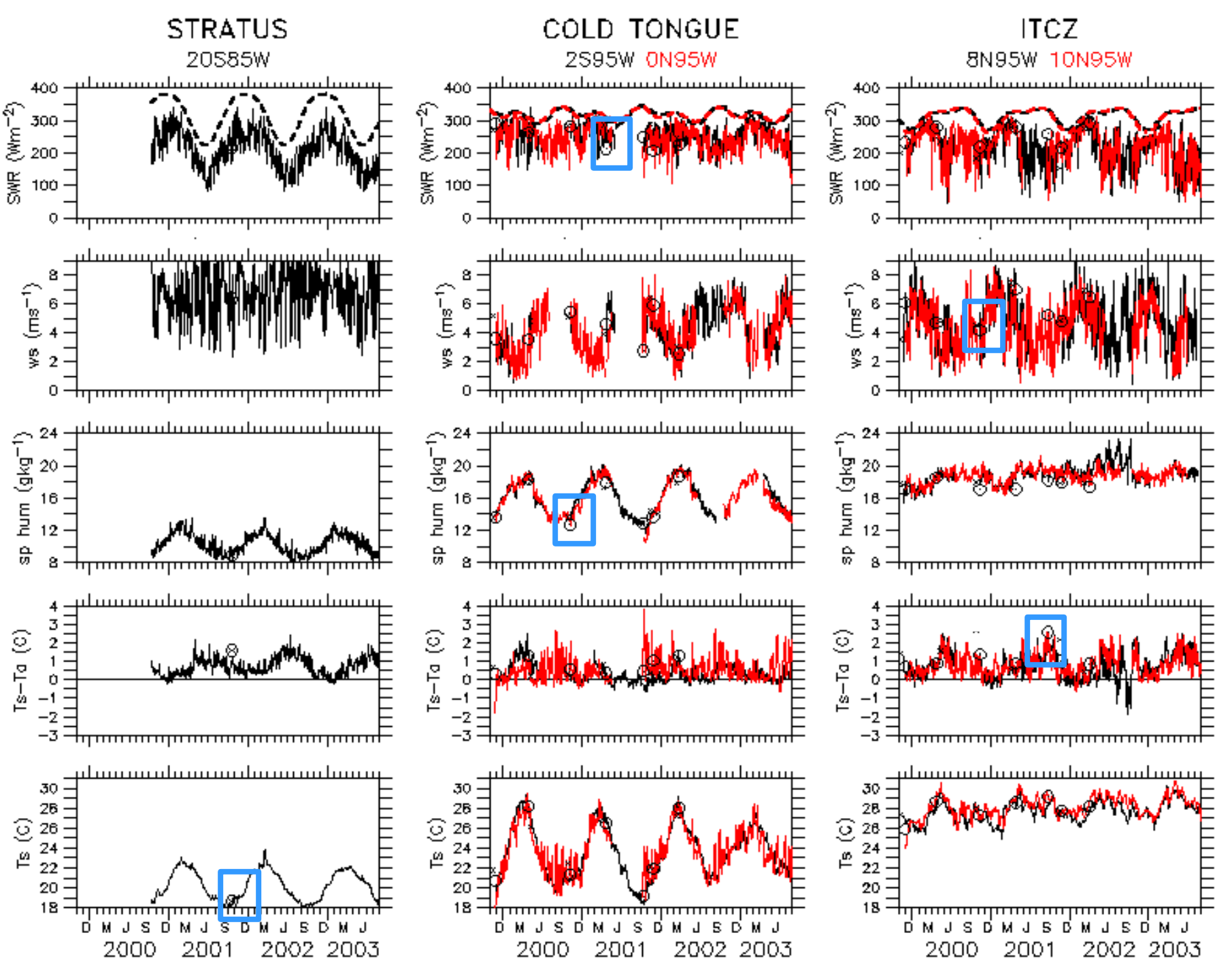



This study uses ship and buoy data along 95W and at 20S, 85W to evaluate air-sea heat fluxes in the stratus deck / cold tongue / ITCZ complex.

# Buoy and ship time series

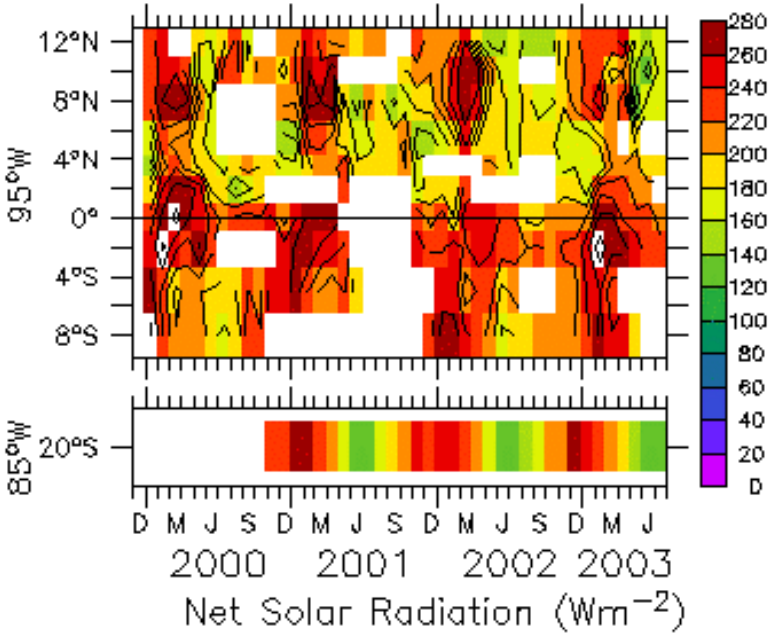



STRATUS
20S85W
COLD TONGUE
2S95W 0N95W
ITCZ
8N95W 10N95W
SWR (Wm$^{-2}$)
ws (ms$^{-1}$)
sp hum (gkg$^{-1}$)
Ts−Ta (C)
Ts (C)
D M J S D M J S D M J S D M J
2000 2001 2002 2003

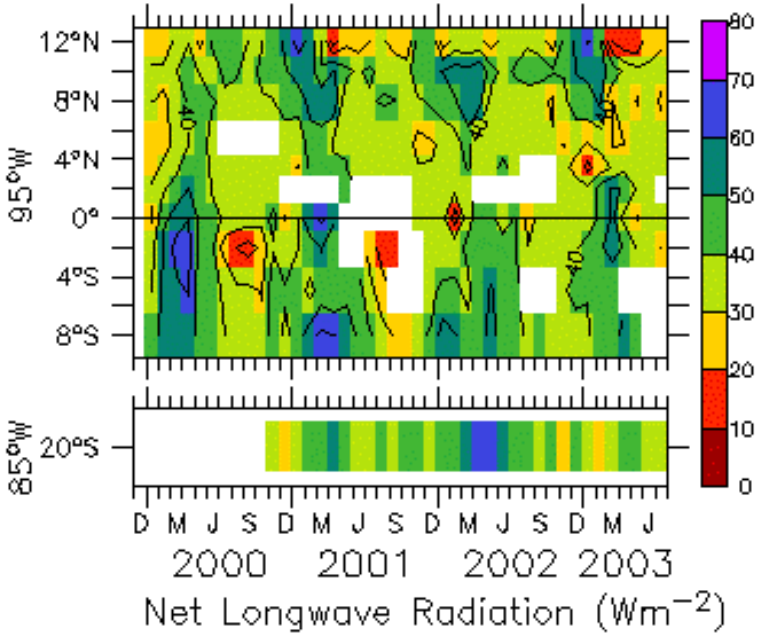
# Latent and sensible heat flux calculations from buoy data

- Used Fairall et al. (2003) v3.0a bulk flux algorithm.
- Used hourly-averaged data (fill gaps with telemetered daily-averaged data).
- Applied warm layer and cool skin corrections to extrapolate 1 m SST to surface (Tskin).
- Used winds relative to surface currents.

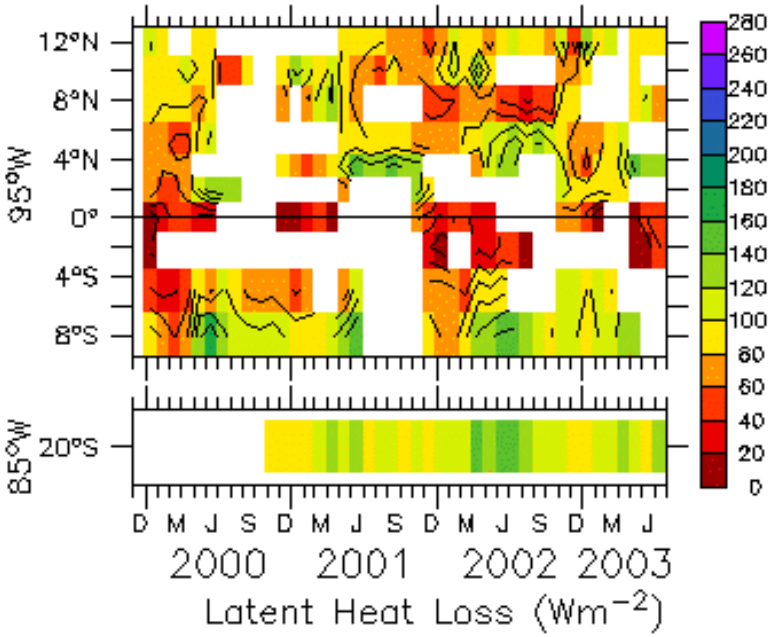
# $Q_0$ = Qsw - Qlw - Qlat - Qsen



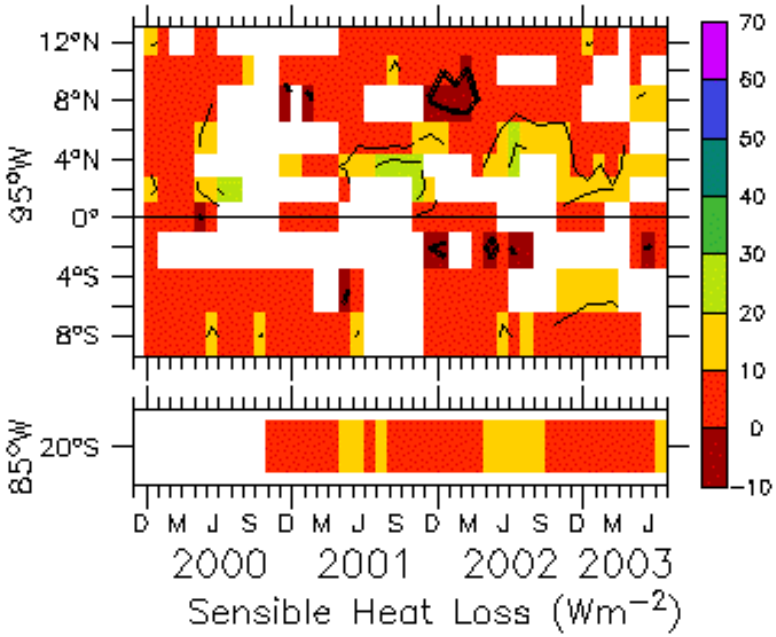
Net Solar Radiation ($Wm^{-2}$)



Net Longwave Radiation ($Wm^{-2}$)



Latent Heat Loss ($Wm^{-2}$)



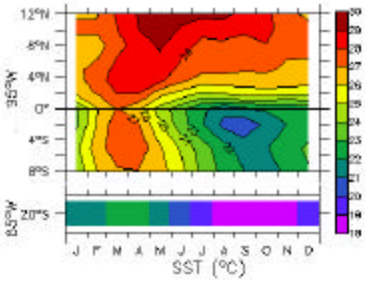
Sensible Heat Loss ($Wm^{-2}$)

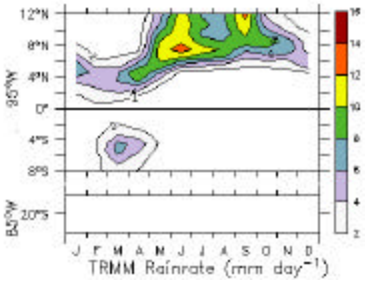
# $Q_0$ = Qsw - Qlw - Qlat - Qsen

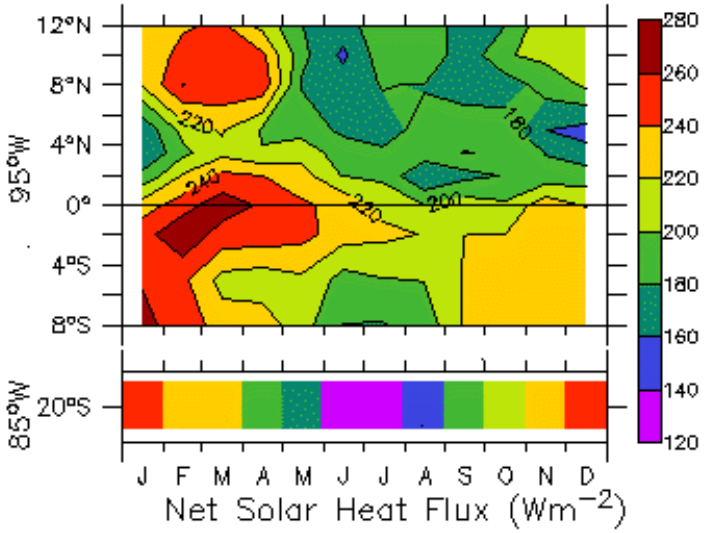
ITCZ

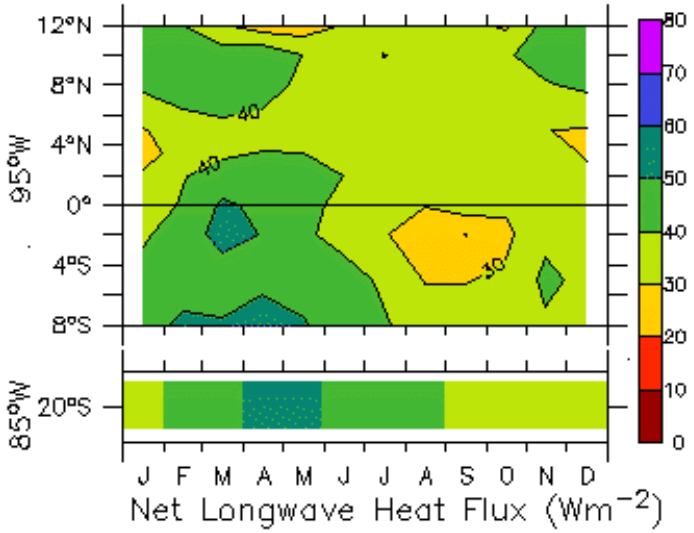
cold tongue

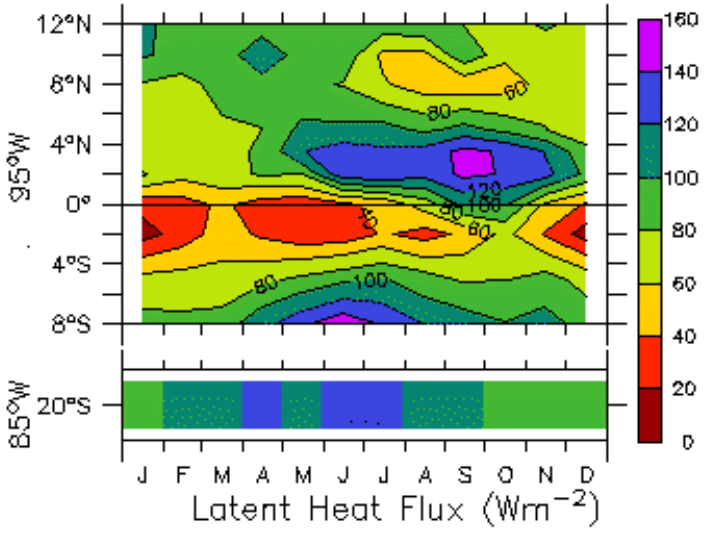
stratus deck

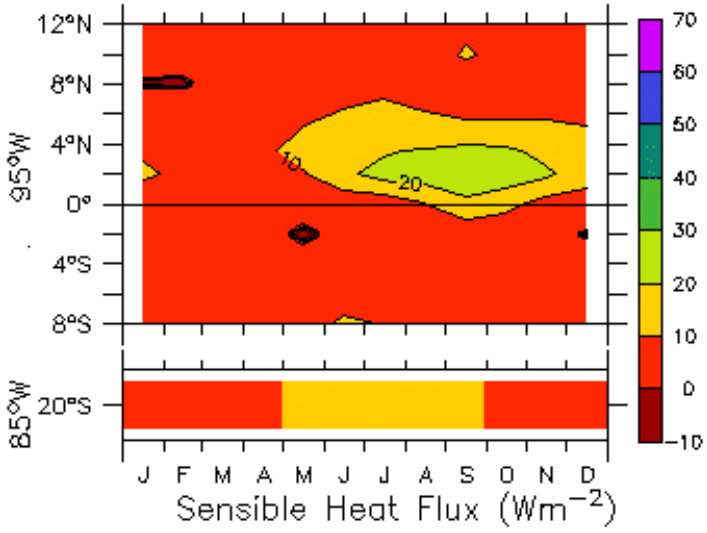


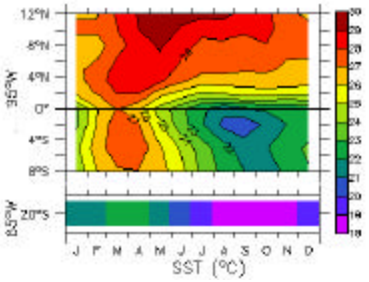

- $Q_0$ ~ Qsw - Qlat
- Qlat and Qsen max over frontal region
- Qlat near zero over cold tongue and is weakest during warm season.

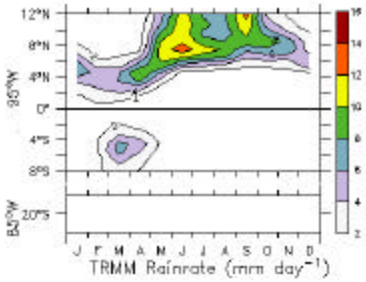
# PBL stabilized over cold tongue and destabilized over frontal region

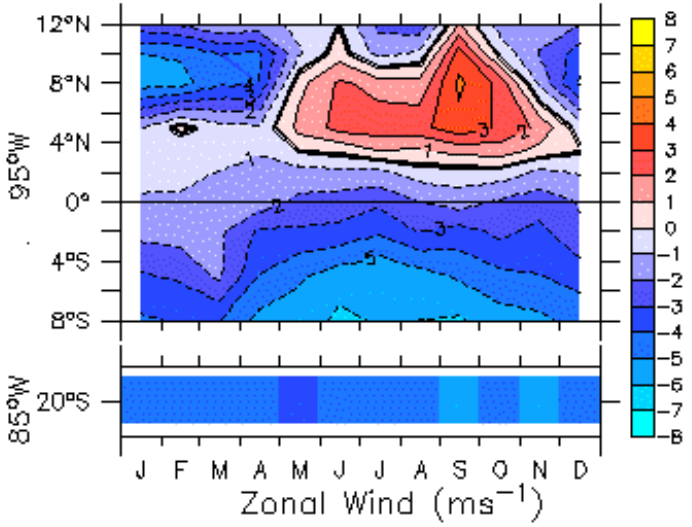
ITCZ

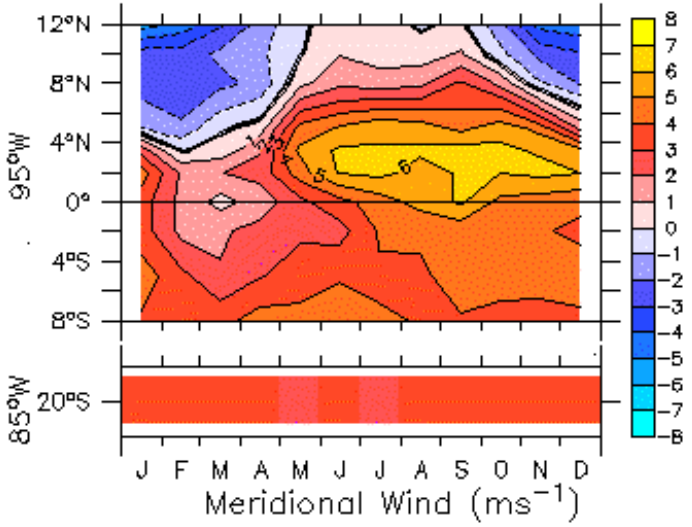
cold tongue

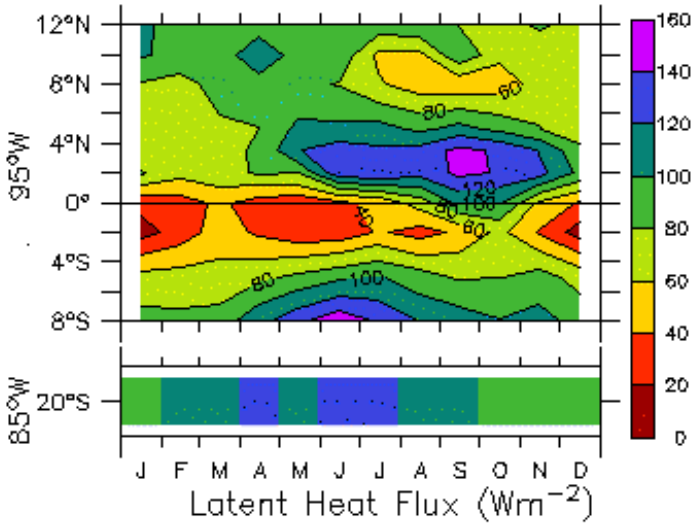
stratus deck

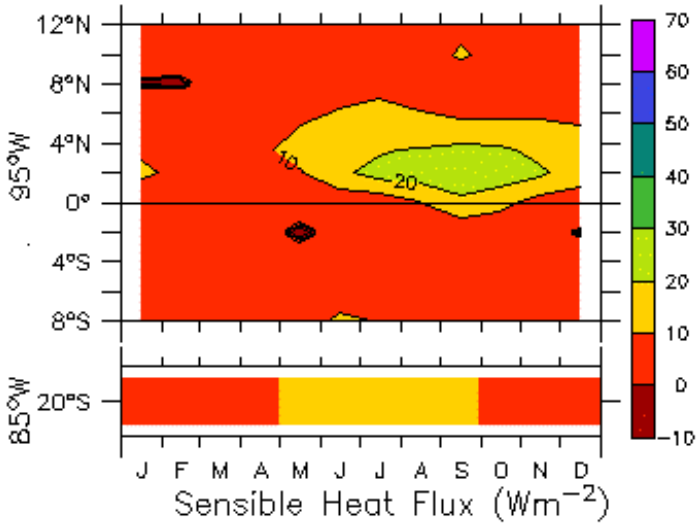


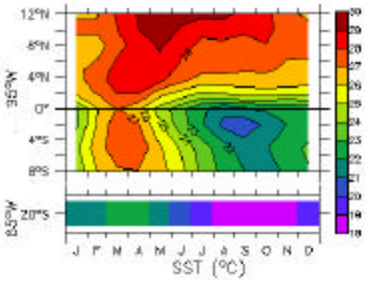

- $Q_0$ ~ Qsw - Qlat
- **Qlat and Qsen max over frontal region**
- **Qlat near zero over cold tongue and is weakest during warm season.**

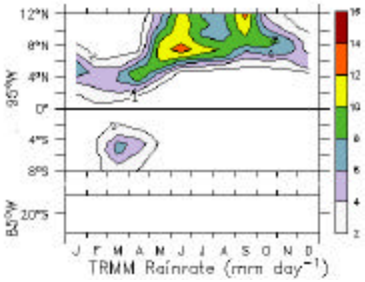
# Cloud Forcing is reduction or enhancement in surface radiation caused by clouds

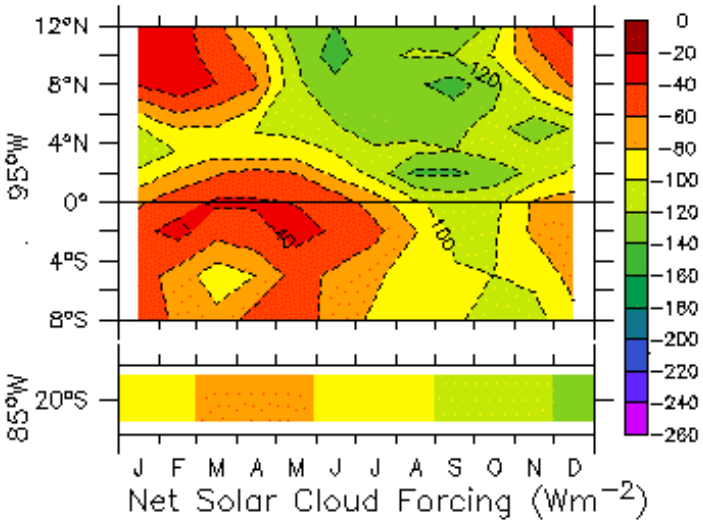
ITCZ

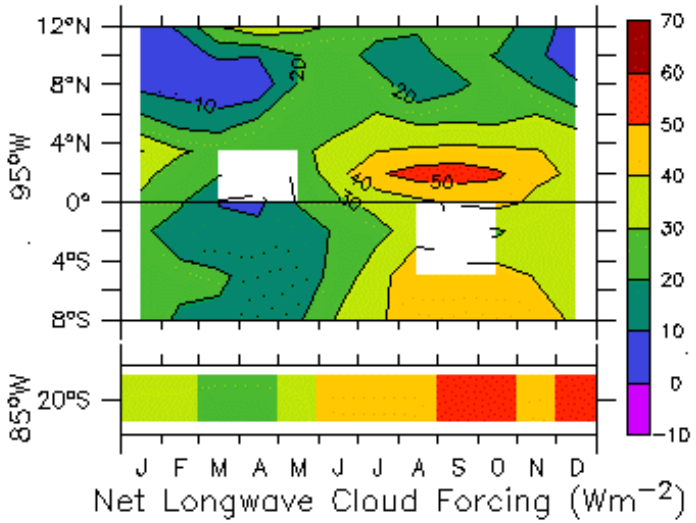
cold tongue

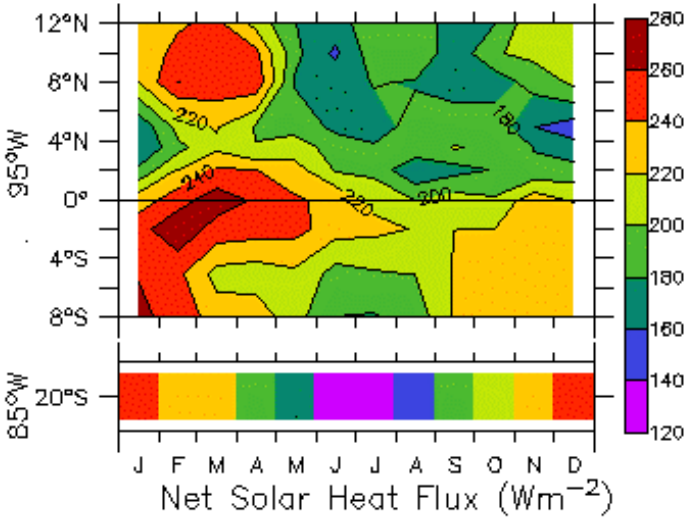
stratus deck

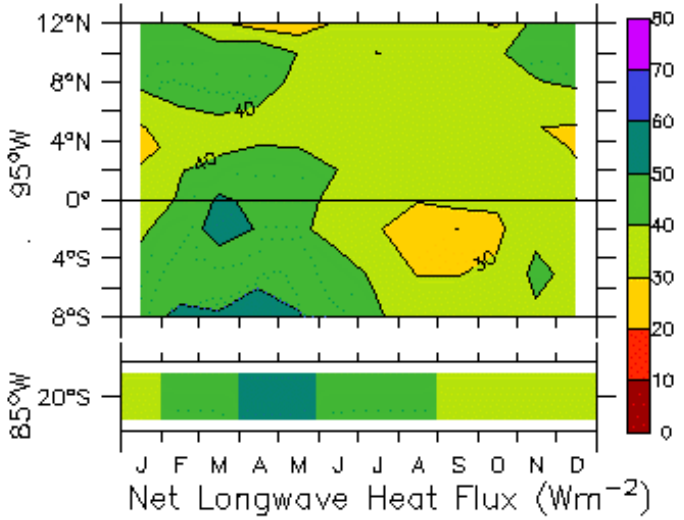



- $Q_0$ ~ Qsw - Qlat
- Qlat and Qsen max over frontal region
- Qlat near zero over cold tongue and is weakest during warm season.
- **Qsw and Qlw modulated by clouds.**

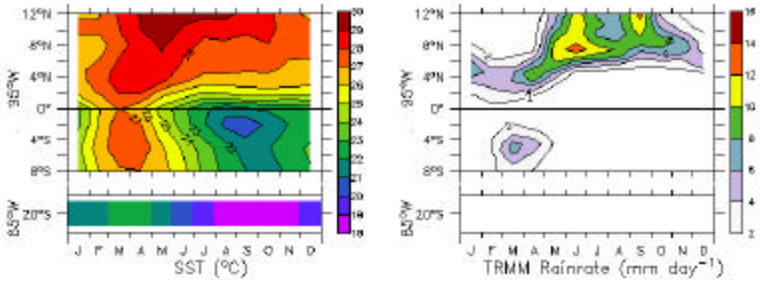
# $Q_0$' ~ Qsw - Qlat ~? d(HC)/dt

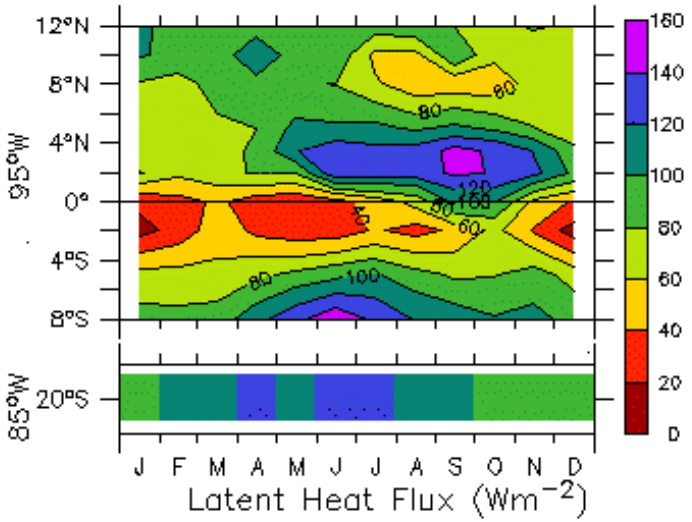
HC = 30 m Heat Content

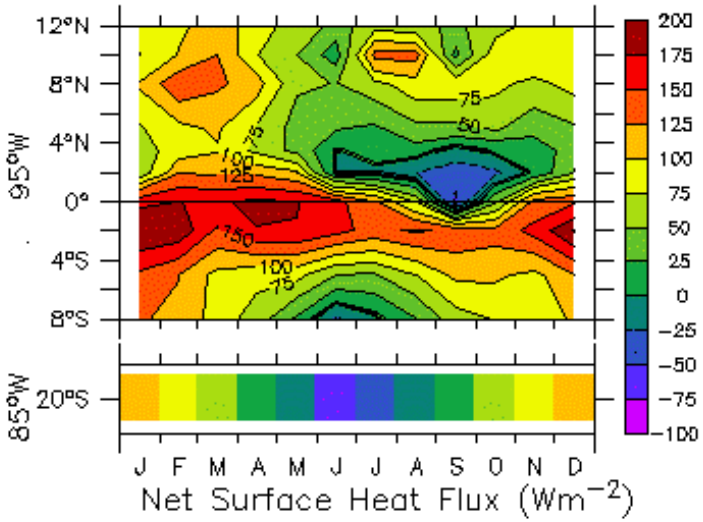
**ITCZ**

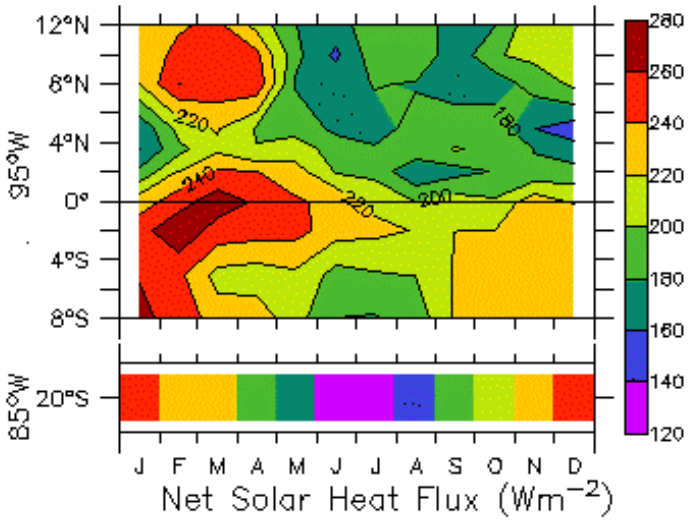
**cold tongue**

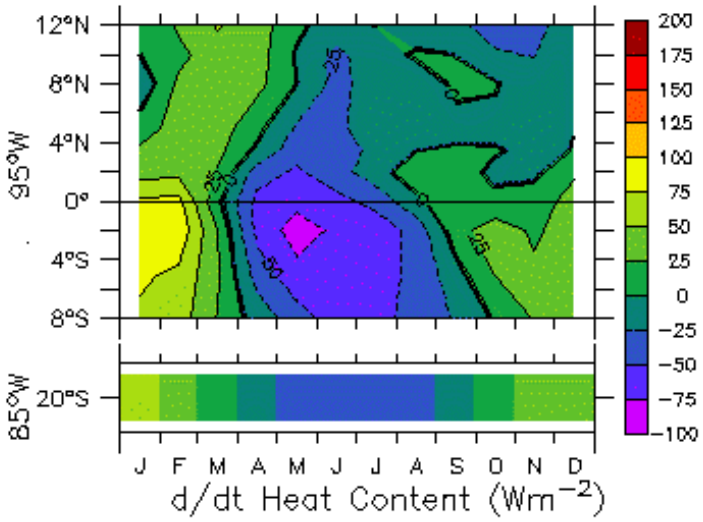
**stratus deck**



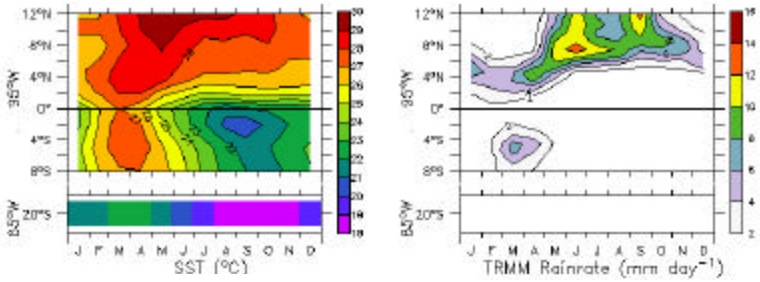

- **$Q_0$ ~ Qsw - Qlat**
- **Qlat and Qsen max over frontal region**
- **Qlat near zero over cold tongue and is weakest during warm season.**
- **Qsw and Qlw modulated by clouds.**
- **Ocean processes also important**

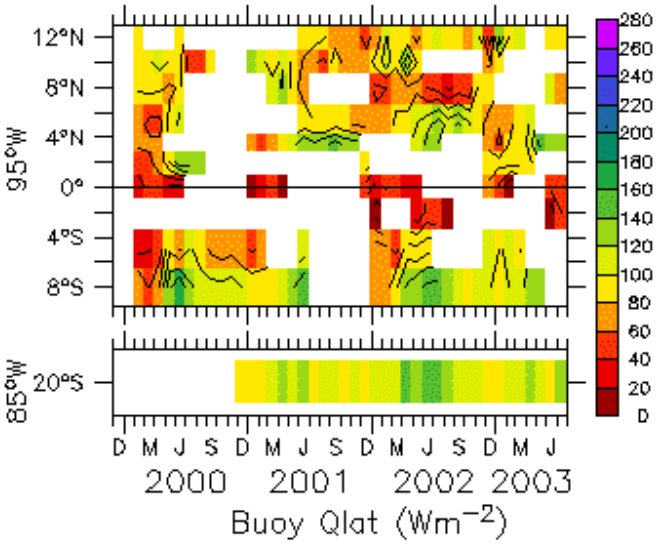
# How do NWP latent heat fluxes compare to buoy?

ITCZ

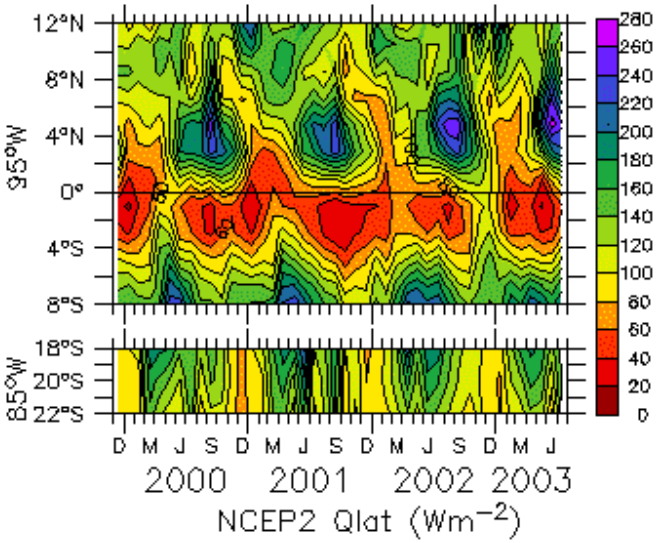
cold tongue

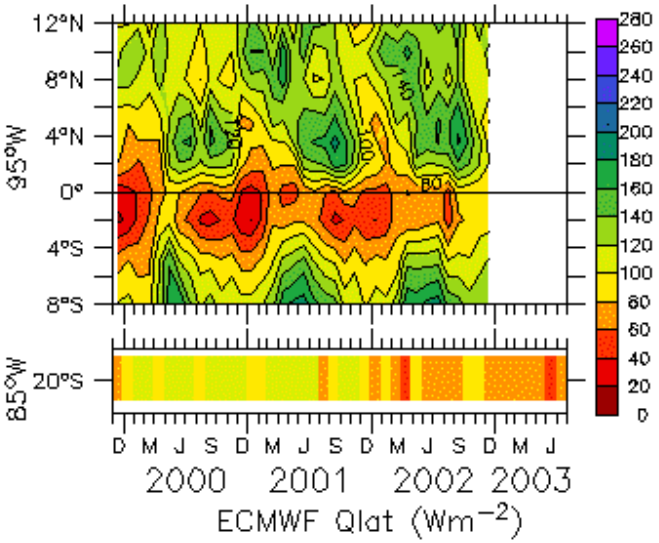
stratus deck




- NCEP2 latent heat flux is much stronger than buoy (cold bias)
- ECMWF is more realistic



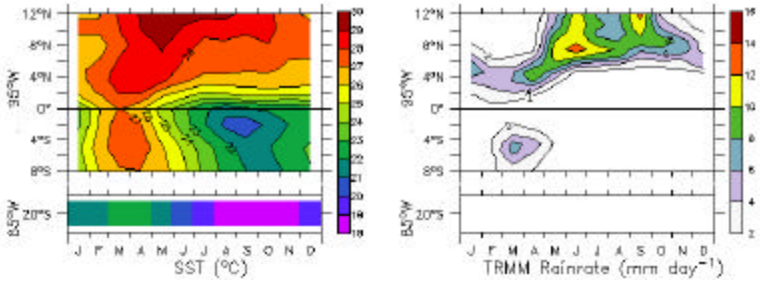



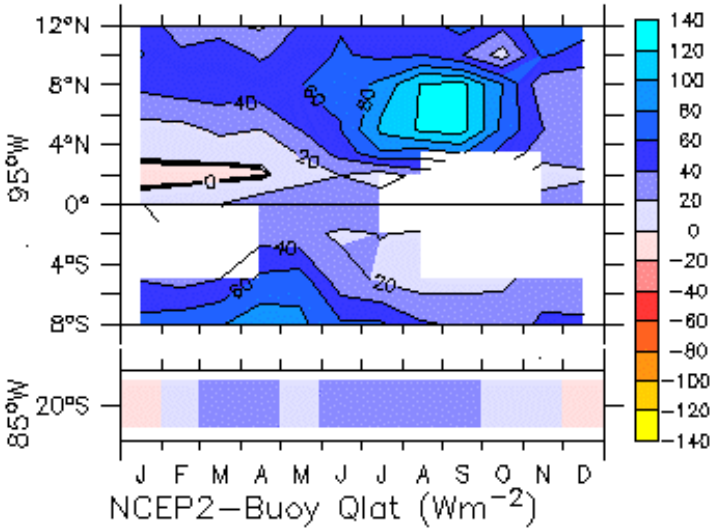
# What are SST biases associated with NWP latent heat flux “bias”?

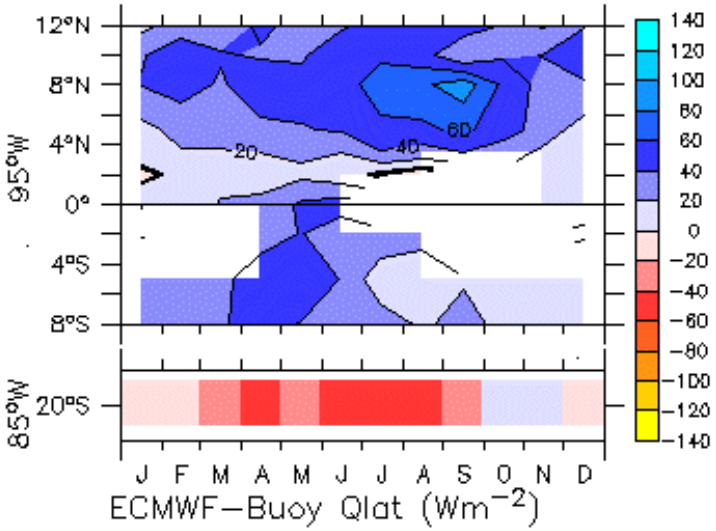
ITCZ

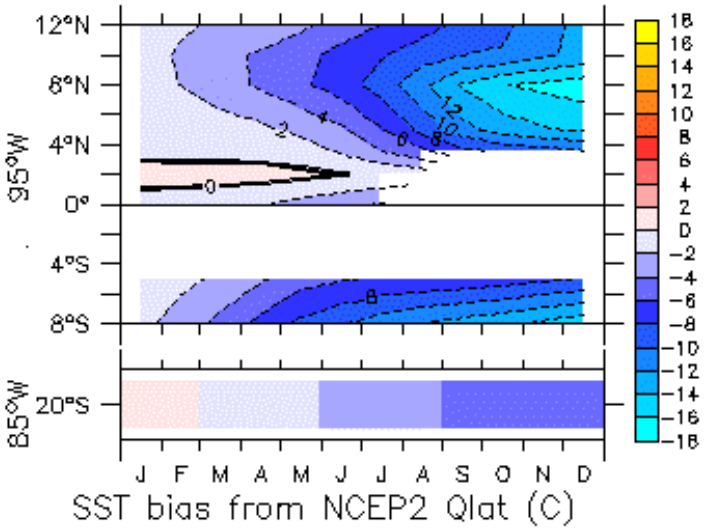
cold tongue

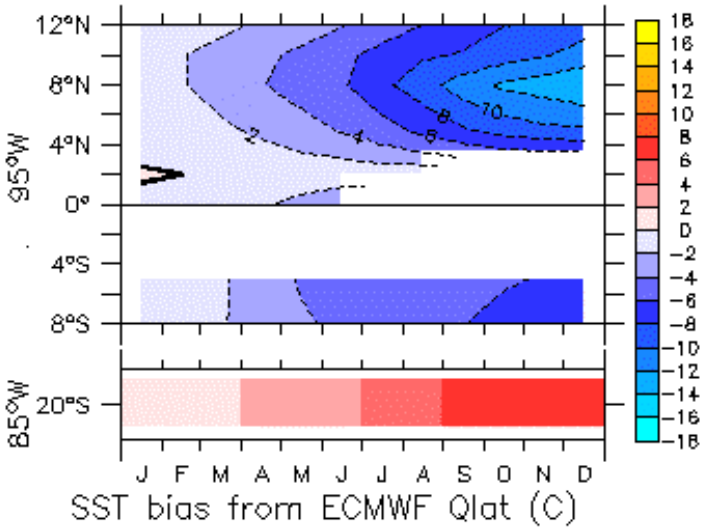
stratus deck




- **SST biases are HUGE when integrated over a year.**
- **ECMWF has a warm bias in stratus deck region and cold bias in cold tongue / ITCZ complex.**
- **NCEP2 has a cold bias everywhere.**

# Conclusions

- **Stabilized PBL causes low latent heat loss over cold tongue; and destabilized PBL causes maximum latent heat loss over frontal region.**
- **Solar radiation, latent heat loss and ocean processes control SST variability in the east Pacific stratus deck / cold tongue / ITCZ complex.**
- **ECMWF latent heat loss appears to be more realistic than NCEP2.**
- **ECMWF has a warm bias (due to latent heat flux) in stratus deck region and cold bias in cold tongue / ITCZ complex. NCEP2 has a cold bias everywhere.**
- **SST biases associated with latent heat biases are HUGE when integrated over a year.**