Upper ocean processes under stratus cloud decks in the southeast Pacific

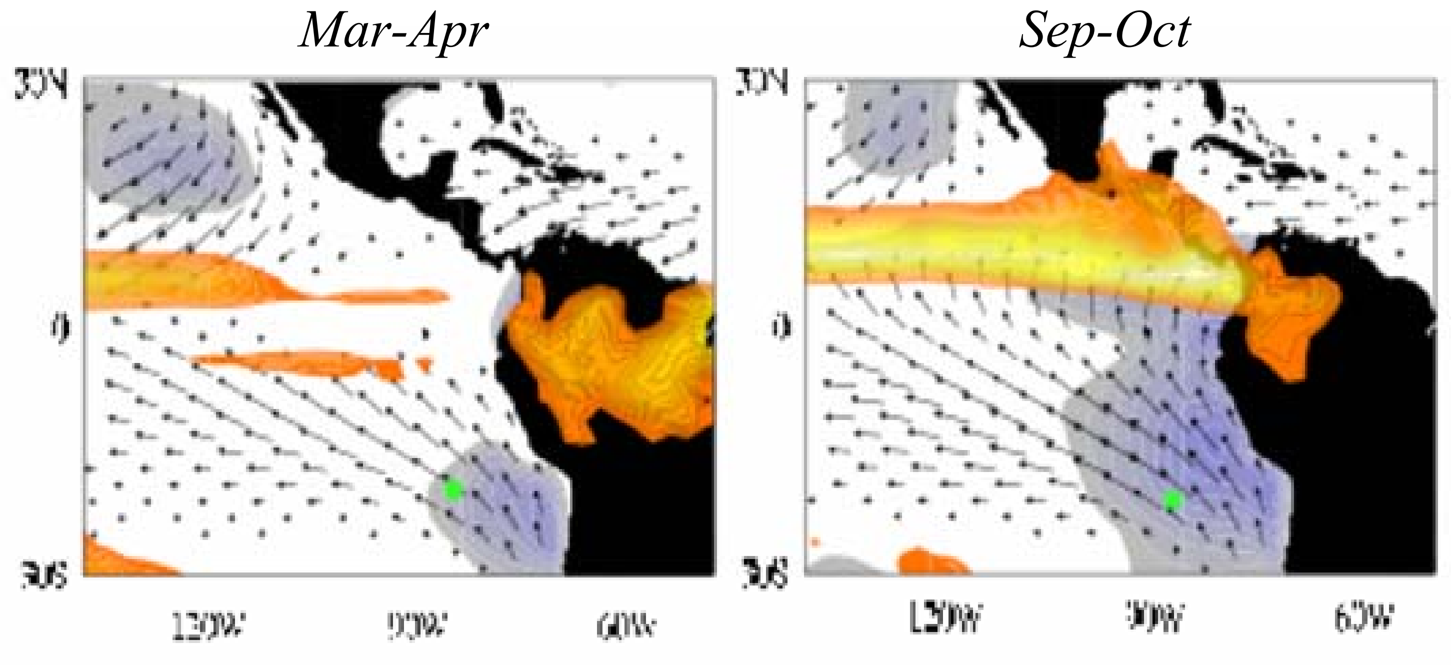
by

Toshi Shinoda

(NOAA-CIRES Earth System Research Laboratory)

1. Introduction
2. HYCOM experiments
3. Interannual variations
4. Relative importance of ocean dynamics and surface heat fluxes for the SST
5. Conclusions and ongoing study

Colbo and Weller (2007)



Stratus cloud decks ===> important role in regional and global climate

Most coupled GCMs have problems in producing realistic stratus clouds.

Upper ocean processes that control SST is crucial for simulating stratus clods

Surface mooring measurements by WHOI since October 2000

New campaign: VAMOS Ocean-Cloud-Atmosphere-Land Study (VOCALS)

Upper ocean heat balance at the buoy site (Colbo and Weller, 2007)

Term	*Estimate (W/m2)*	*Data*
Surface heat flux	*38 (±15)*	*ASIMET buoy*
Horizontal heat advection by Ekman transport	*5 (± 2)*	*QuikSCAT winds Satellite SST*
Horizontal heat advection by geostrophic transport	*-15(± 4)*	*ASIMET velocity, temperature Historical temperature*
Ekman pumping	*32(± 5)*	*QuikSCAT winds ASIMET temperature*
Eddy flux divergence	*-10(± 7)*	*Surface drifters Historical temperature*
Vertical diffusion	*-3(± 2)*	*ASIMET temperature*
Total	*47(±17)*	

Issues

Interannual variations

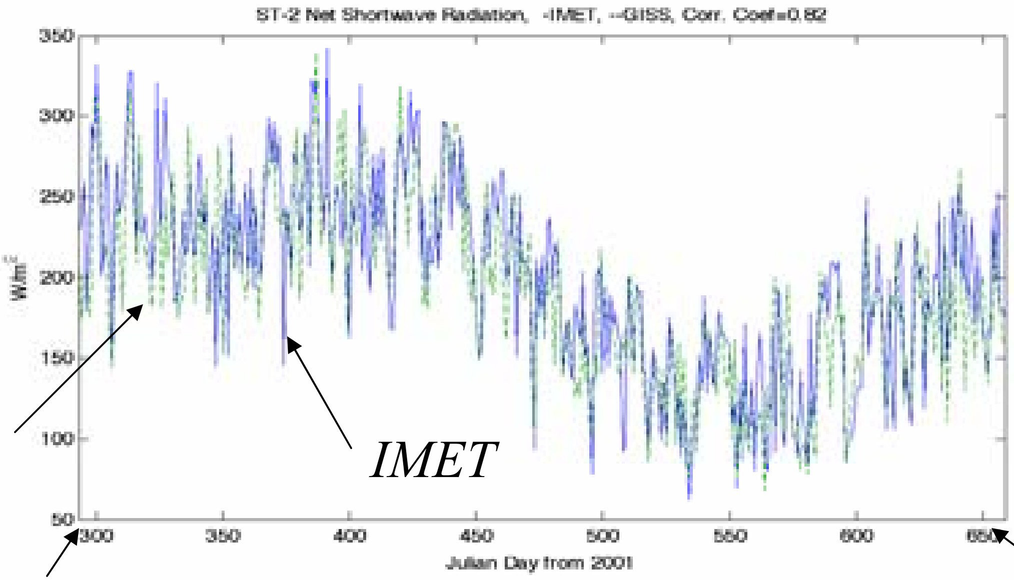
Representativeness of the mooring site for broad scale upper ocean variabiliy

OGCM experiments

Model : HYbrid Coordinate Ocean Model (HYCOM)
Domain: Tropical Indo-Pacific basin (30N-30S)
Period: 1981-2004
Daily surface fluxes
- *Shortwave and longwave radiation:*
  - *ISCCP-FD (Zhang et al. 2005)*
- *Latent and sensible heat fluxes*
  - *Winds, air temperature and humidity from the NCEP/NCAR reanalisis*

Shortwave Radiation

Corr. Coef.= 0.82

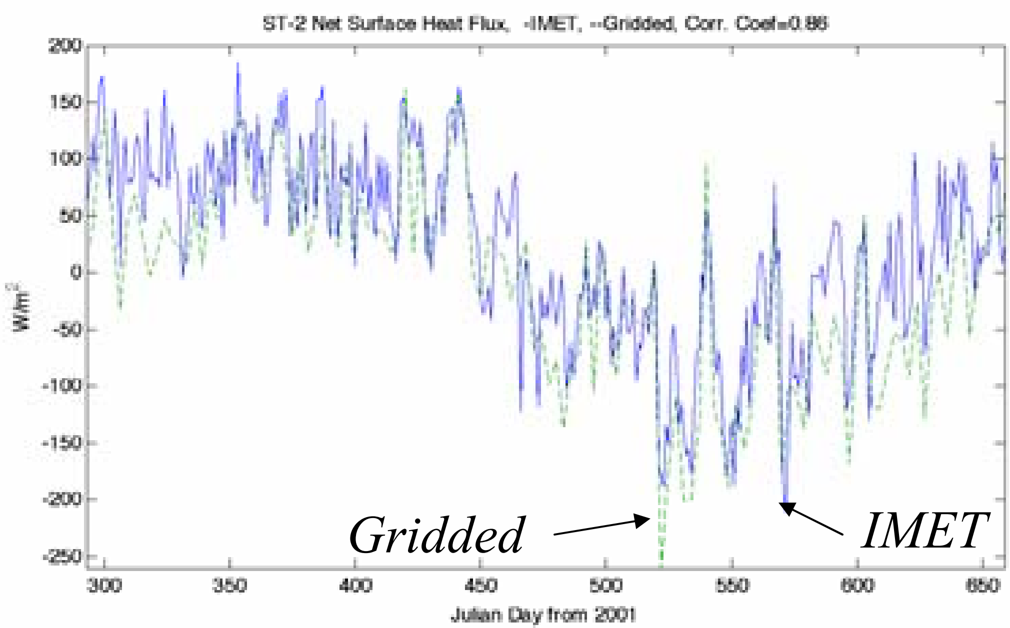


10-20-2001

10-21-2002

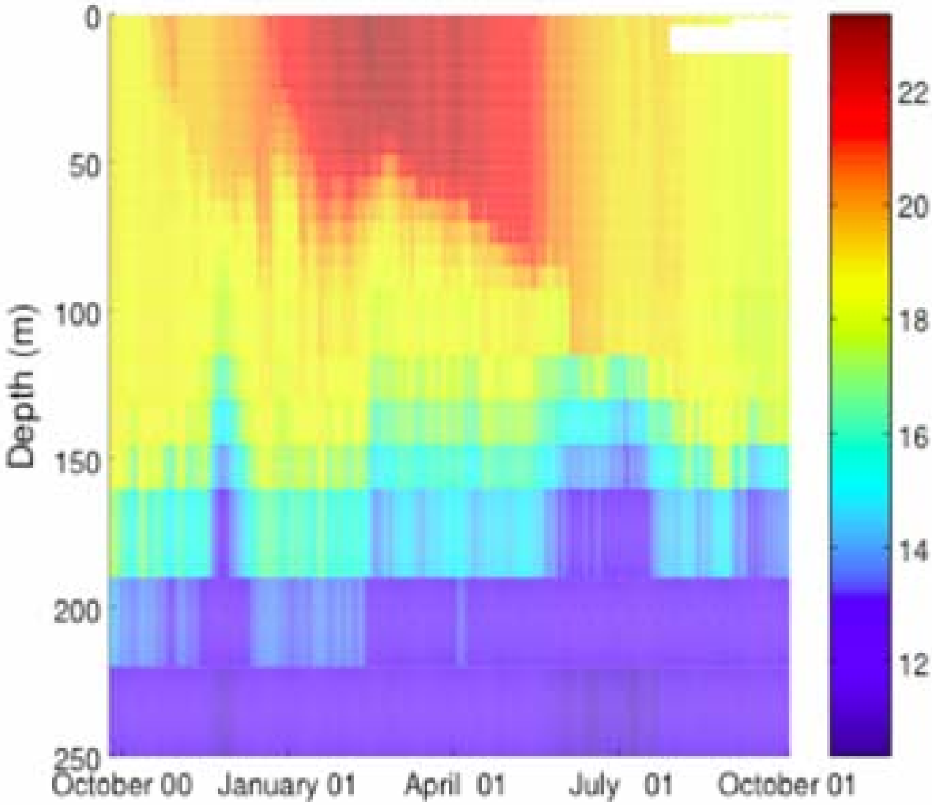
Net Surface Heat Flux

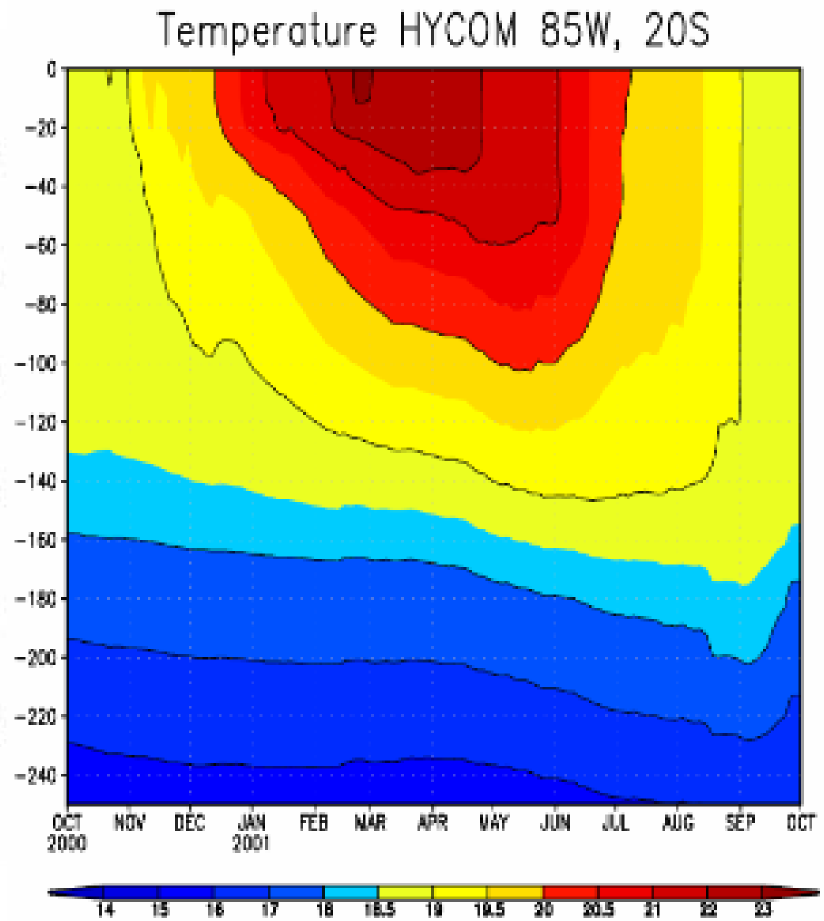
Corr. Coef. = 0.86



Upper Ocean Temperature

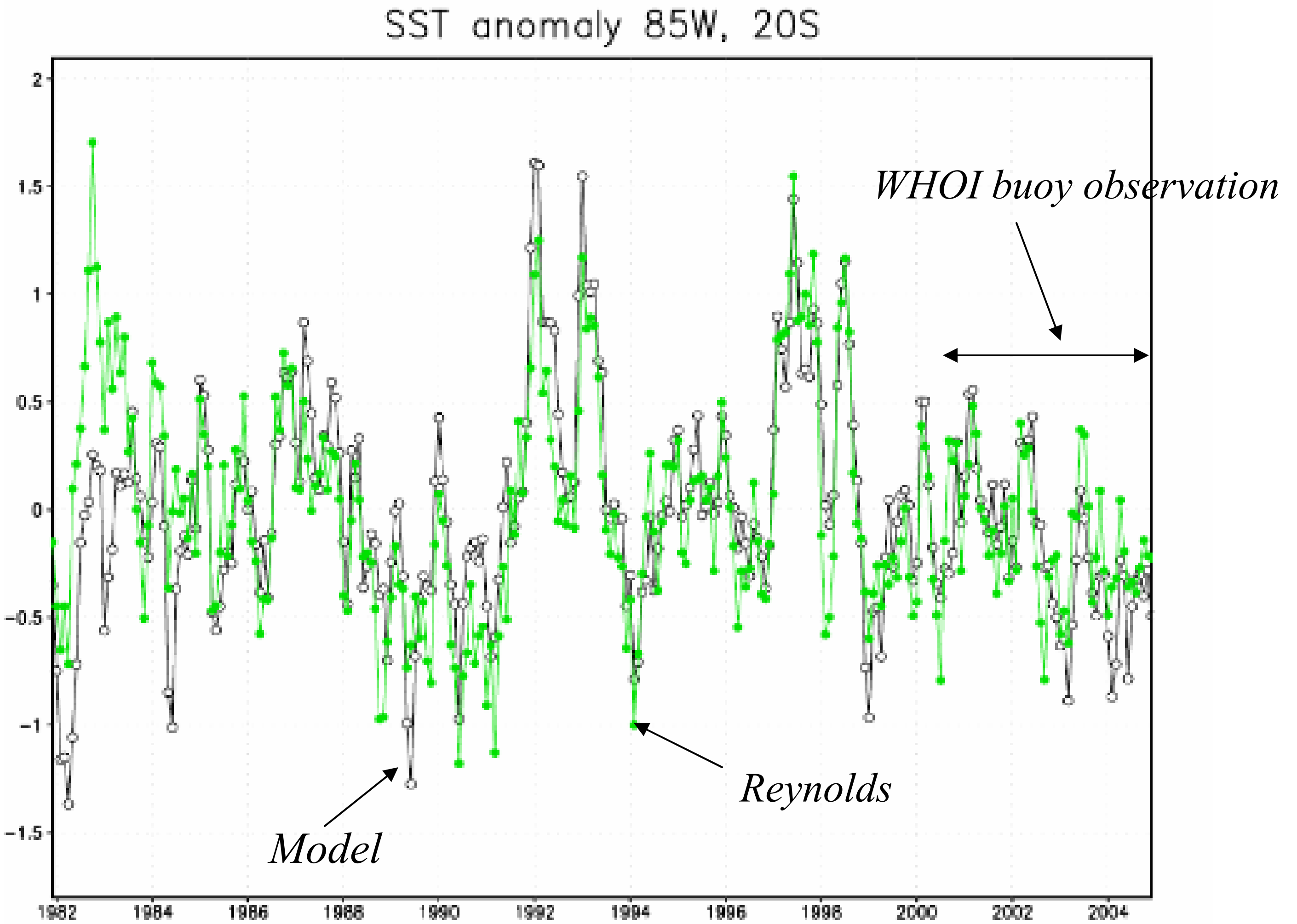
Buoy (Colbo and Weller 2007)

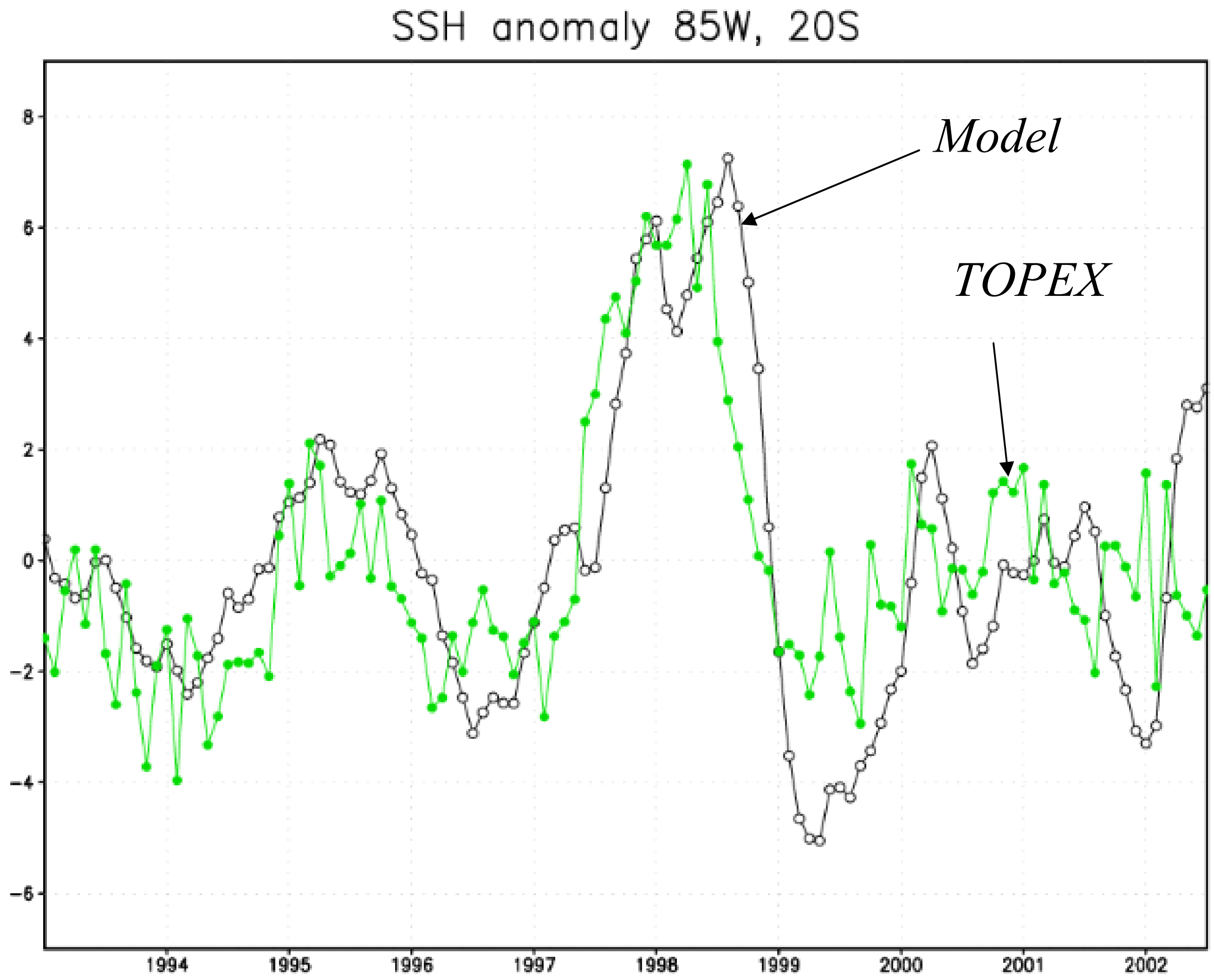




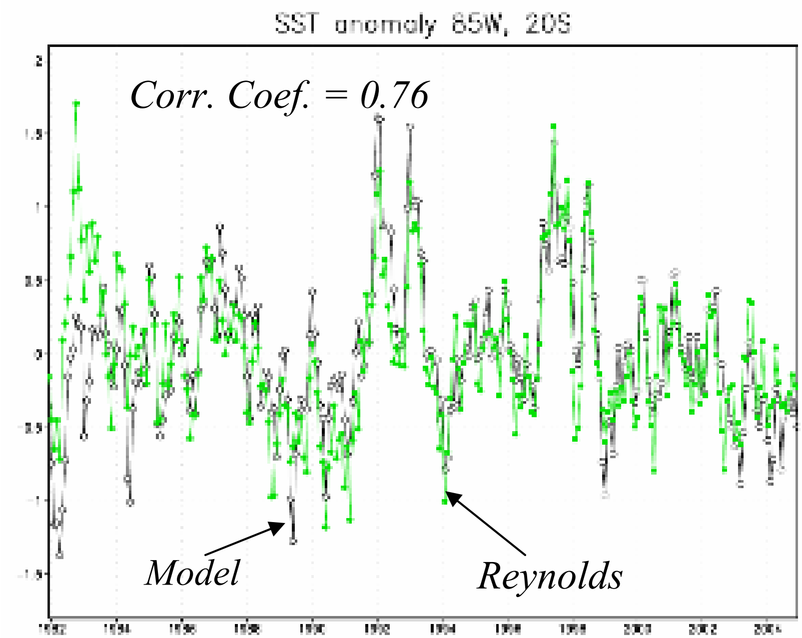
Interannual Variation

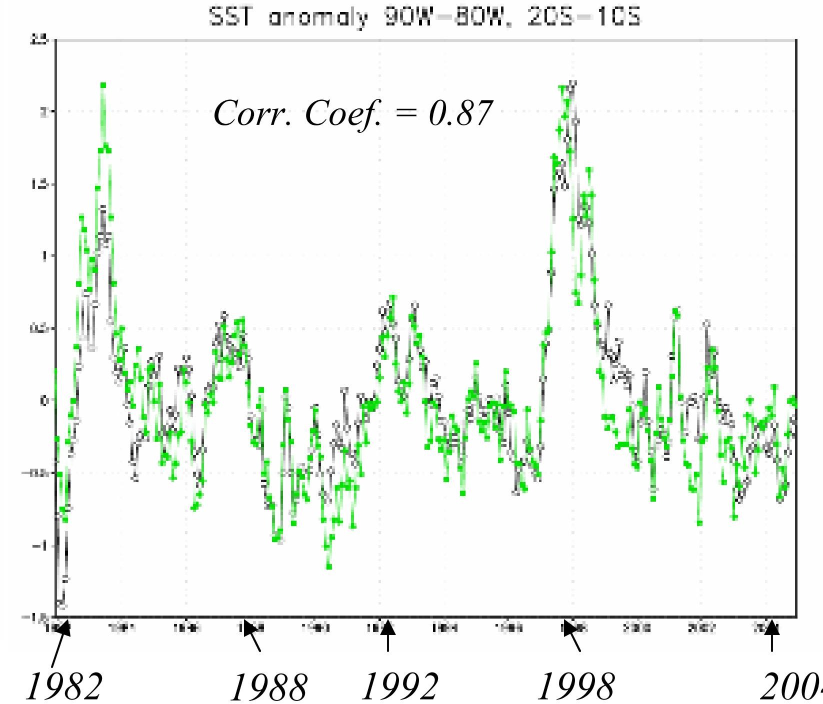
Corr. Coef.= 0.76

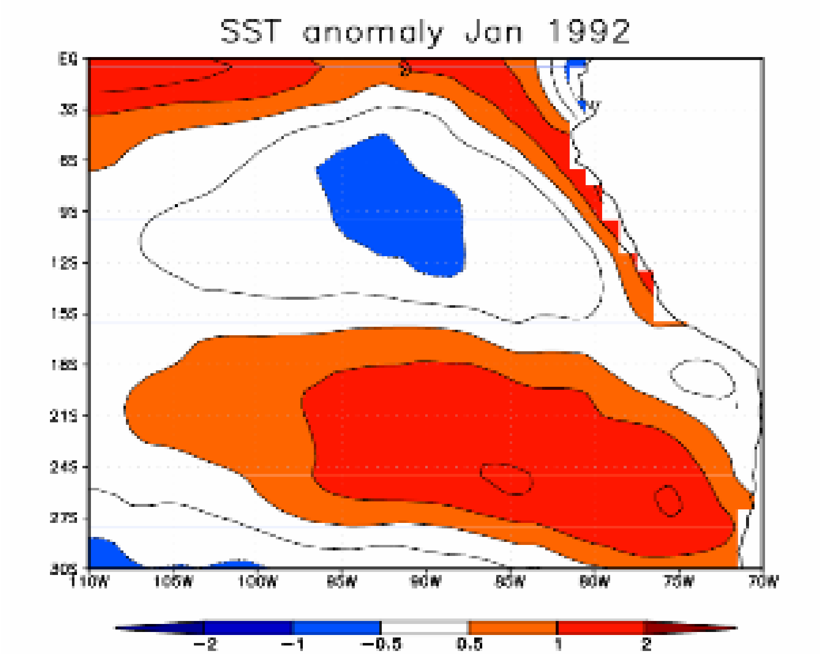


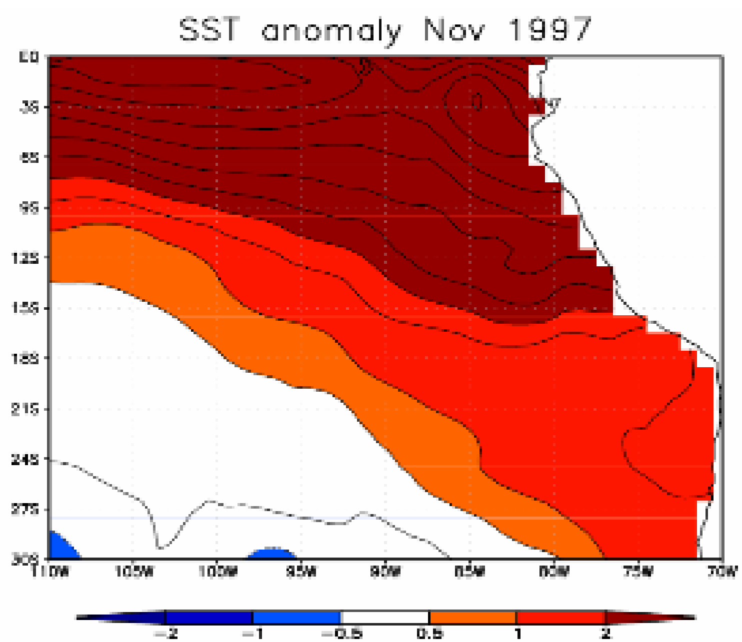


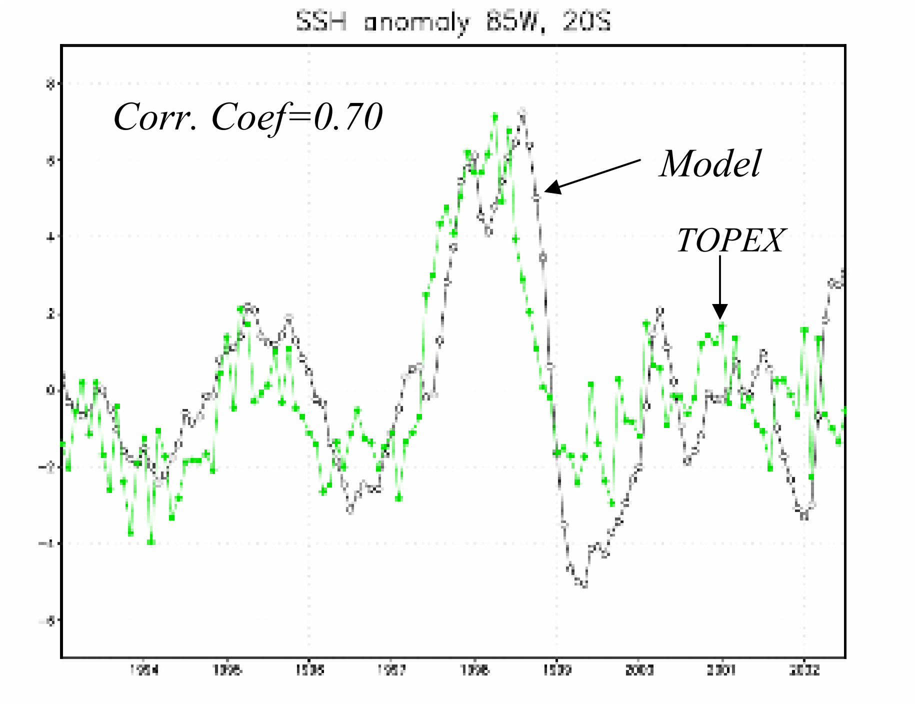
Corr. Coef=0.70

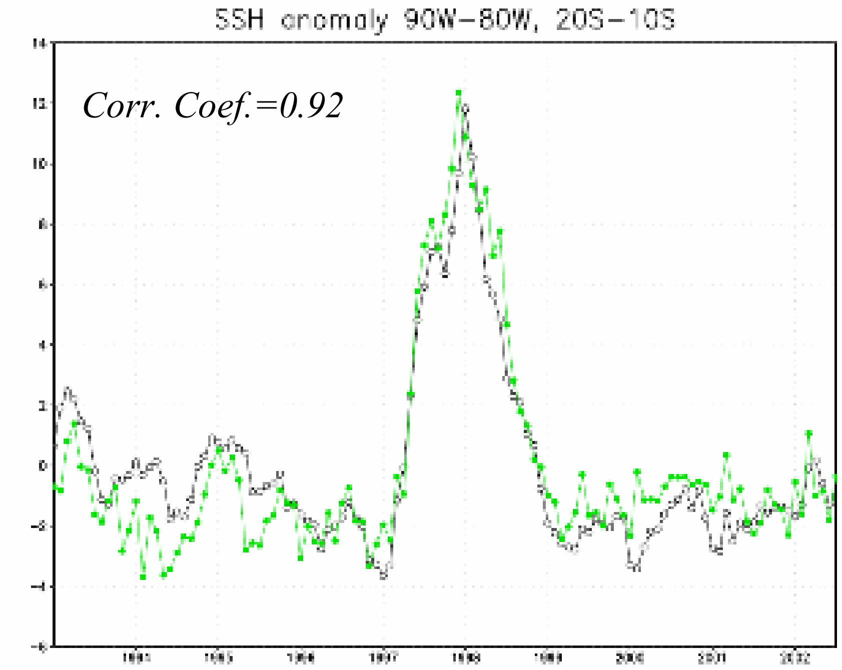

SST anomaly 85W, 20S
Corr. Coef. = 0.76
Model
Reynolds

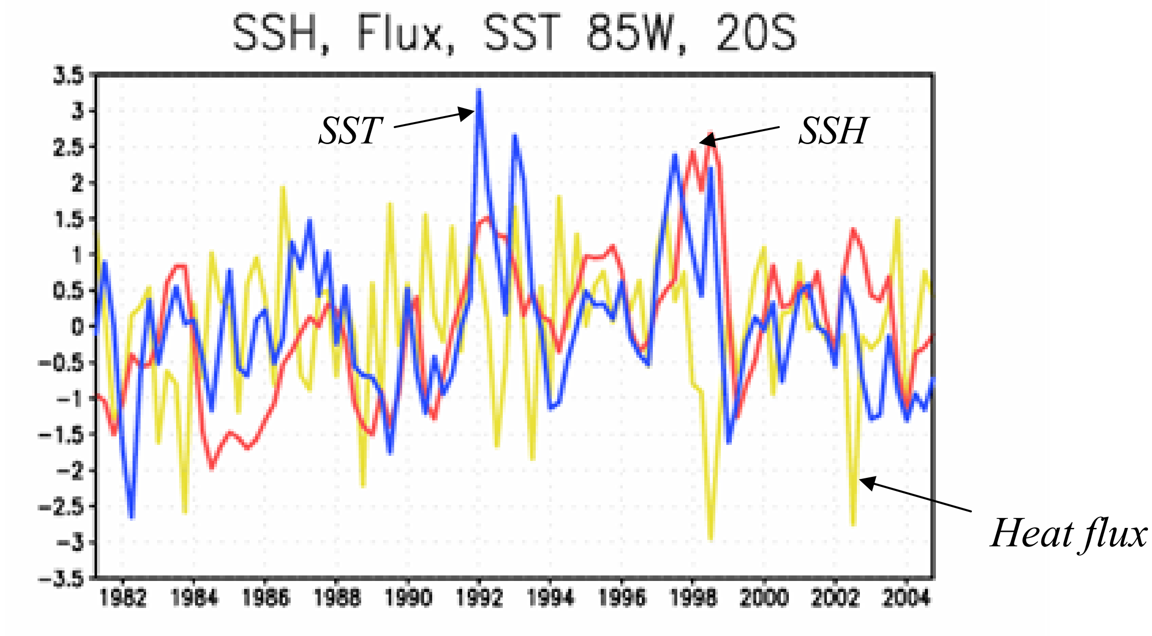

SST anomaly 90W–80W, 20S–10S
Corr. Coef. = 0.87
1982
1988
1992
1998
2004

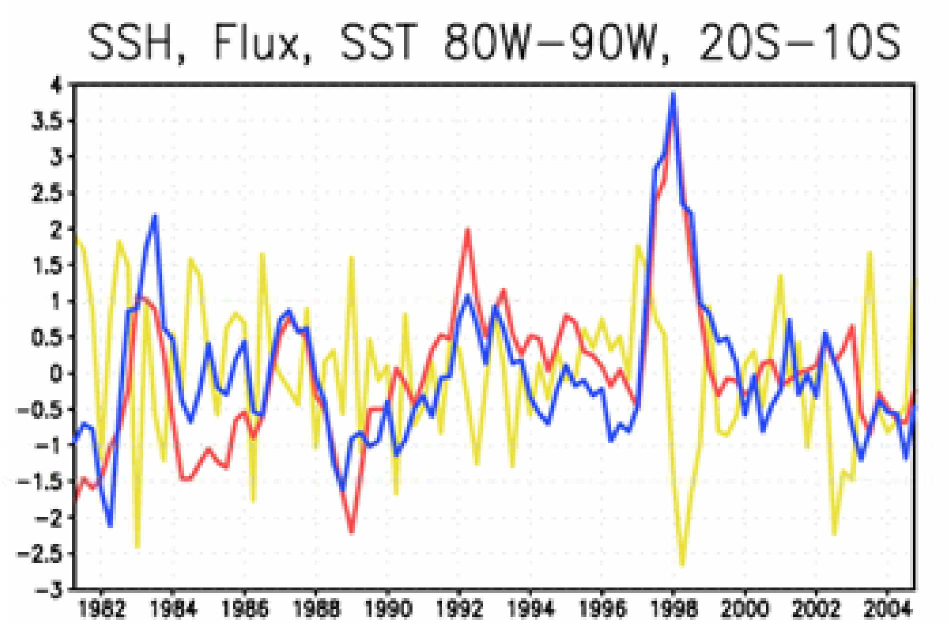

SST anomaly Jan 1992
110W
105W
100W
95W
90W
85W
80W
75W
70W
−2
−1
−0.5
0.5
1
2


SST anomaly Nov 1997
110W
105W
100W
95W
90W
85W
80W
75W
70W
−2
−1
−0.5
0.5
1
2


SSH anomaly 85W, 20S
Corr. Coef=0.70
Model
TOPEX


SSH anomaly 90W-80W, 20S-10S
Corr. Coef.=0.92


SSH, Flux, SST 85W, 20S
SST
SSH
Heat flux


SSH, Flux, SST 80W-90W, 20S-10S

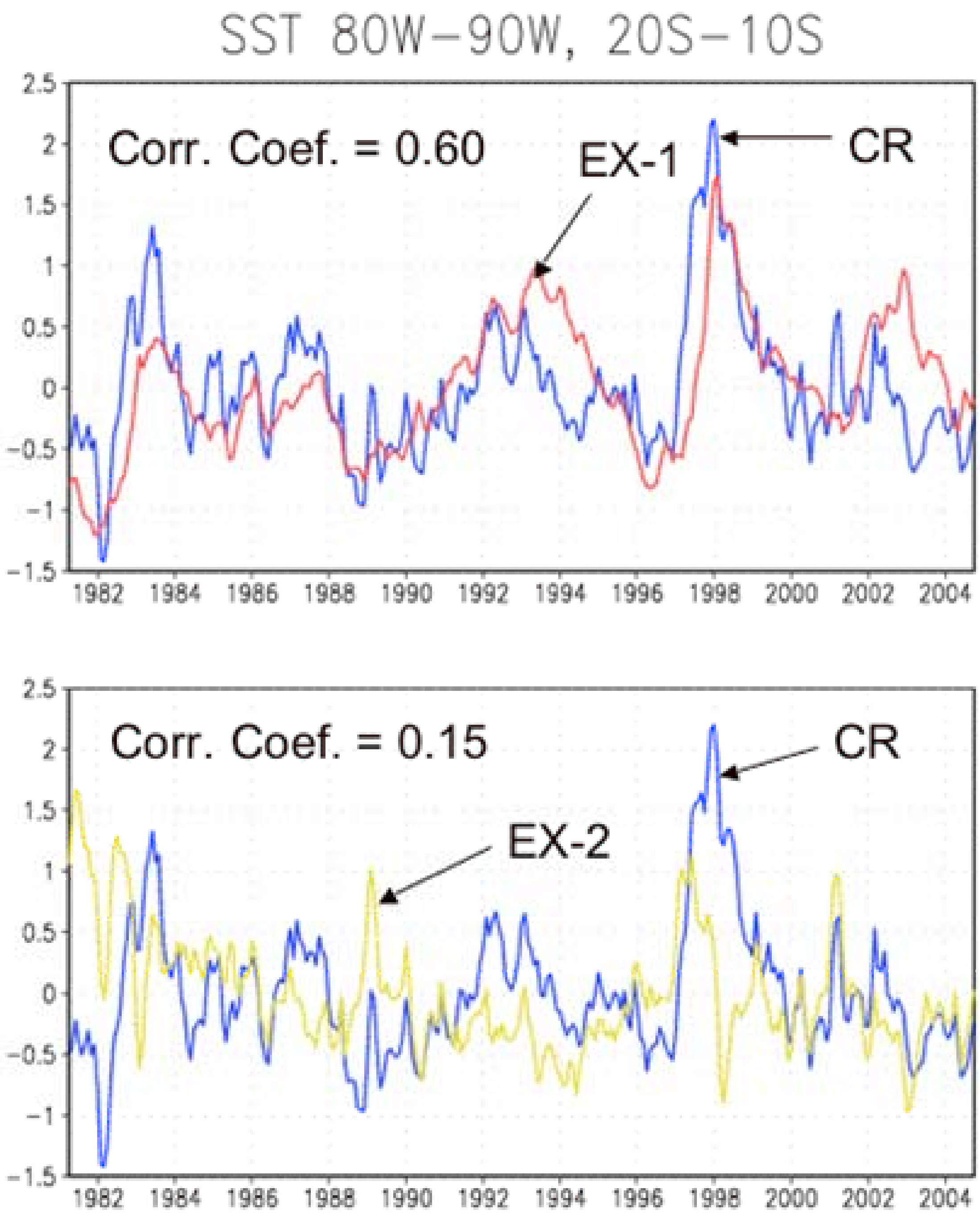
Correlation Coefficients

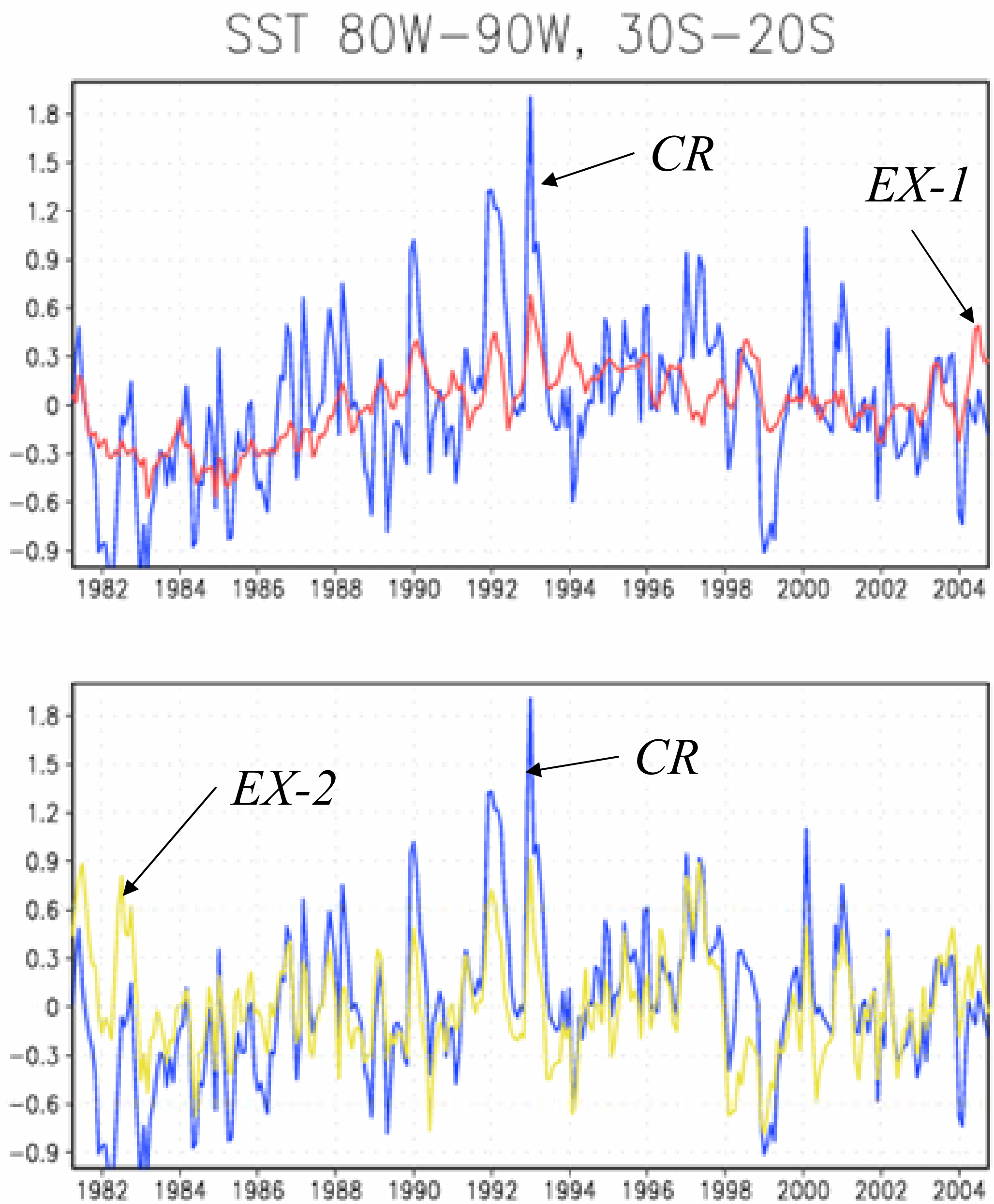
	85W, 20S	*90W-80W, 20S-10S*
SST vs. SSH	*0.59*	*0.82*
SST tendency vs. Surface heat flux	*0.61*	*0.67*

Relative importance of surface heat fluxes and ocean dynamics

EX-1: Surface heat fluxes ==> Climatological annual cycle from the control run
Wind stress ==> Daily wind stress (same as control run)

EX-2: Surface heat flux ==> Daily fluxes from the control run
Wind stress ==> Climatological annual cycle


SST 80W–90W, 20S–10S
Corr. Coef. = 0.60
EX-1
CR
Corr. Coef. = 0.15
EX-2
CR
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004


SST 80W–90W, 30S–20S
CR
EX-1
CR
EX-2
1.8
1.5
1.2
0.9
0.6
0.3
0
−0.3
−0.6
−0.9
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004

Conclusions

Large interannual SST variations near the WHOI mooring site (85W, 20S) are evident .

The WHOI buoy is located at the southern edge of ENSO influence.

North of the WHOI buoy site, 3-D ocean dynamics play a significant role in controlling interannual SST variations.