The importance of radiometric/skin SST on air-sea fluxes

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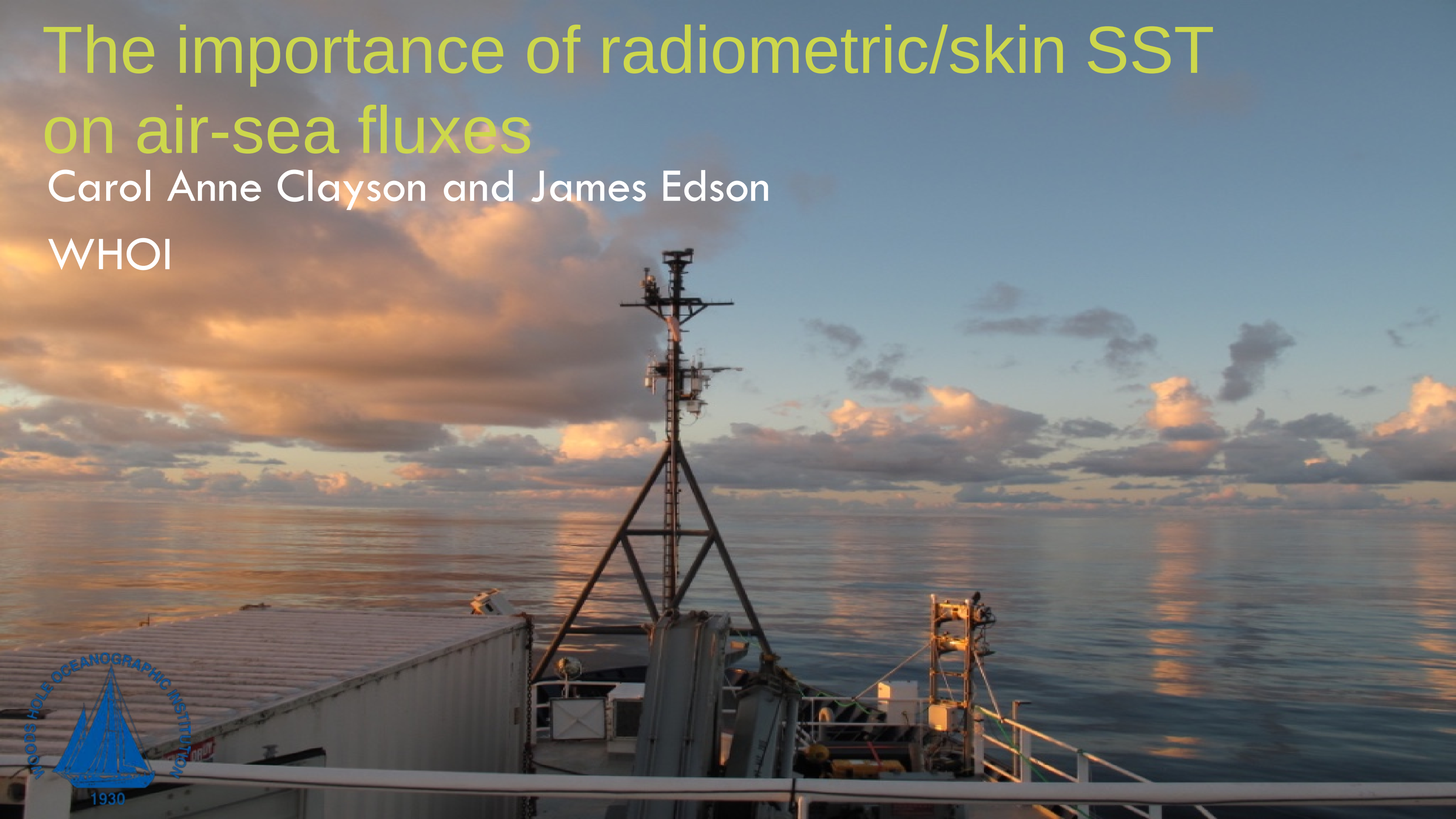
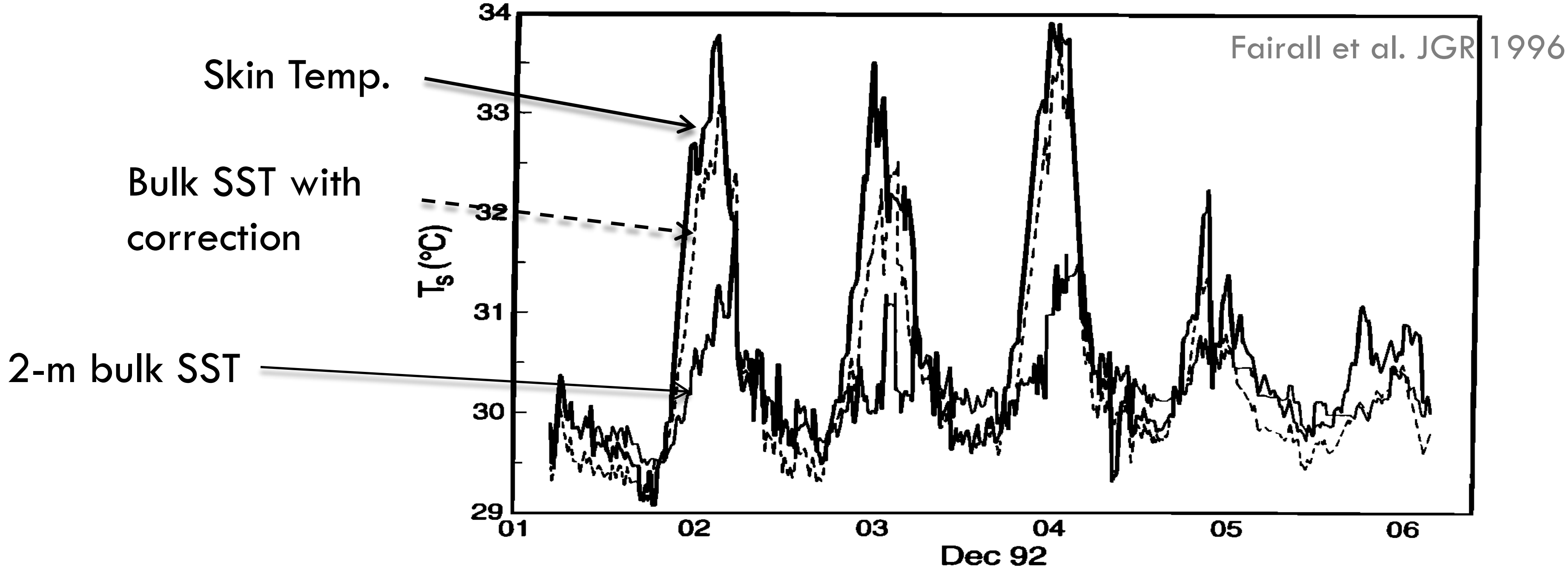
WHOI



Bulk/skin modeling and impact on fluxes



er(SST) = 1° C ➔ er(Qlat+Qsen)≈40 W/m2

Calculation of bulk fluxes

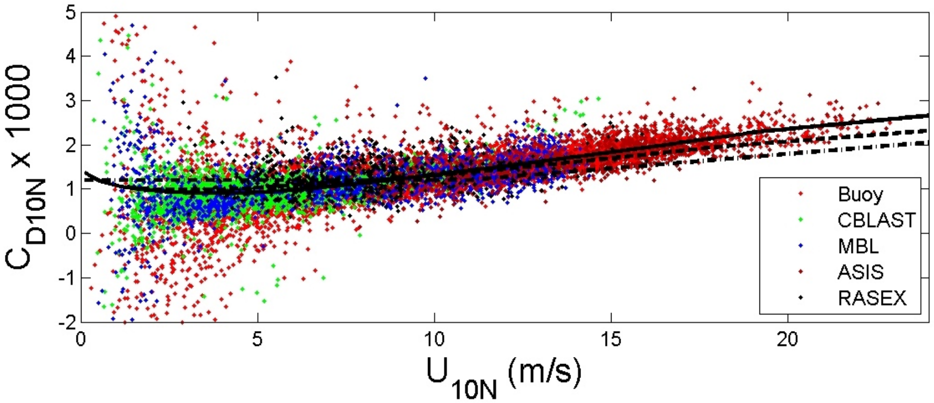
Momentum Flux: $\tau_o = \rho_a \overline{uw} = \rho_a C_D S_r \Delta U$ Drag Coefficient

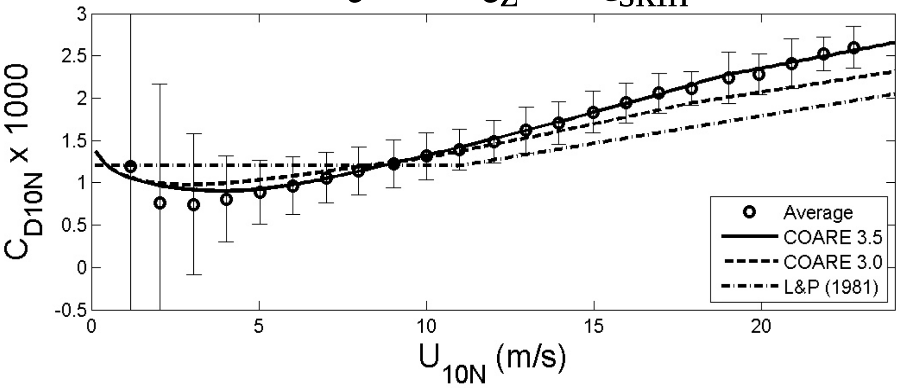
Sensible Heat Flux: $Q_H = \rho_a c_p \overline{wT} = \rho_a c_p C_H S_r \Delta\Theta$ Stanton Number

Latent Heat Flux: $Q_E = \rho_a L_v \overline{wq} = \rho_a L_v C_E S_r \Delta Q$ Dalton Number

$\Delta\Theta = \Theta_z - T_{skin}$

$\Delta Q = Q_z - Q_{skin}$

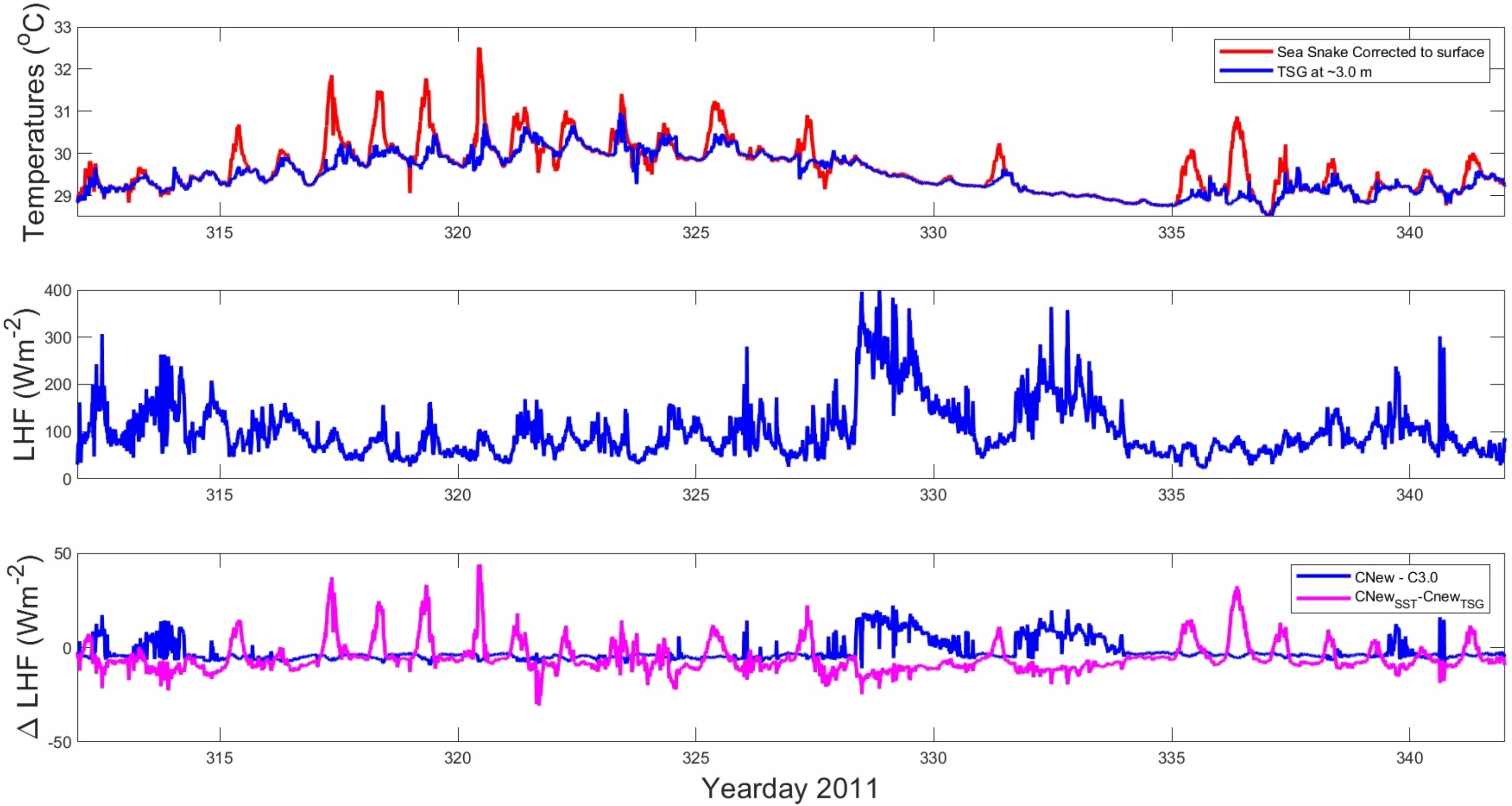




COARE 3.5

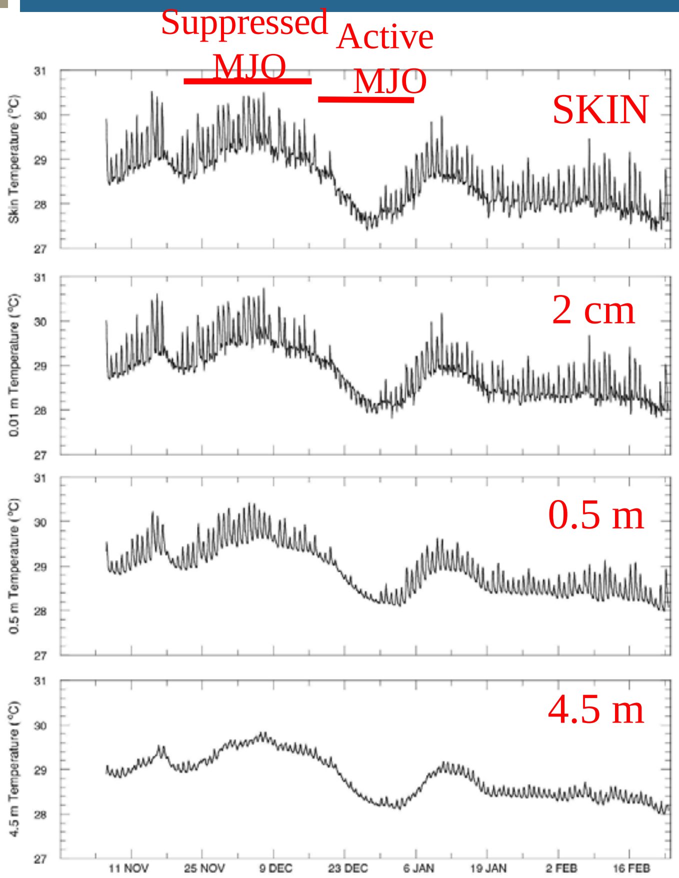
Edson et al., 2013

Bulk flux estimates and surface temperatures



Air-sea Feedbacks from Diurnal SST

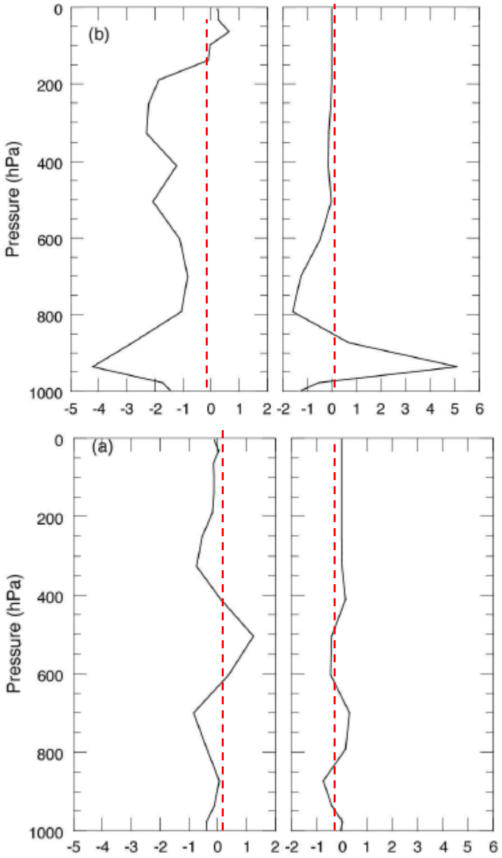
Clayson and Chen, 2002



Suppressed MJO

Active MJO

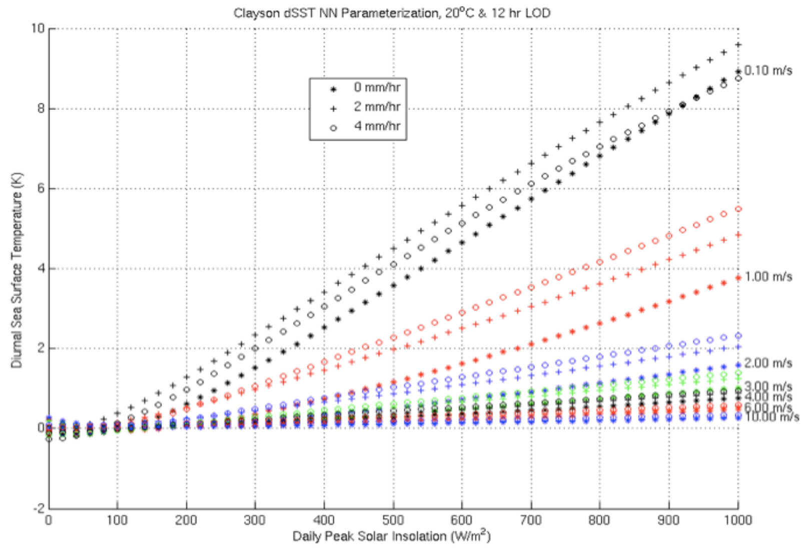
Temp Diff (K)



Hum Diff (g kg-1

SeaFlux satellite data set

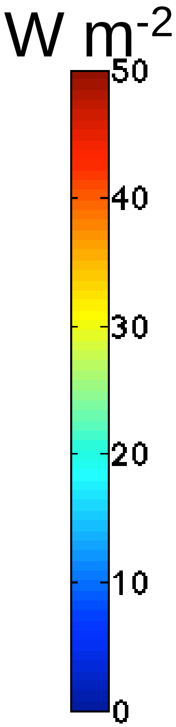
- Near-surface air temperature, winds, and humidity
  - Roberts et al. (2010) neural net technique
  - SSM/I only from CSU brightness temperatures (thus only covers 1997 - 2006)
  - 3 hourly, global oceans (uses MERRA variability)
- SST
  - Pre-dawn based on Reynolds OISST
  - Diurnal curve from new parameterization
  - Needs peak solar, precip
- Uses neural net version of COARE

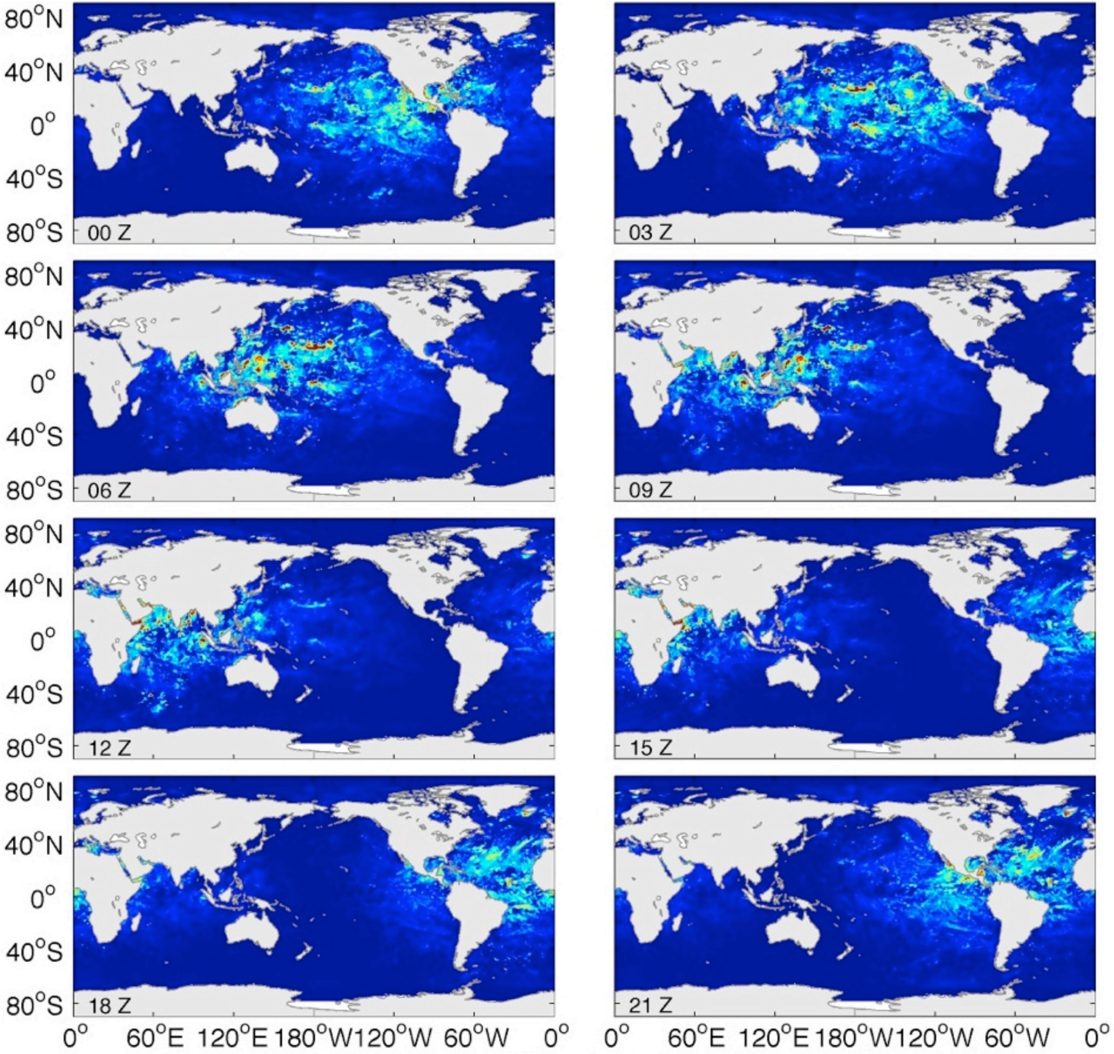


- Inputs:
  - Length of Day
  - Starting Temperature
  - Wind Speed
  - Precipitation
  - Peak Solar Radiation

Roberts et al. 2010; Clayson and Brown 2016

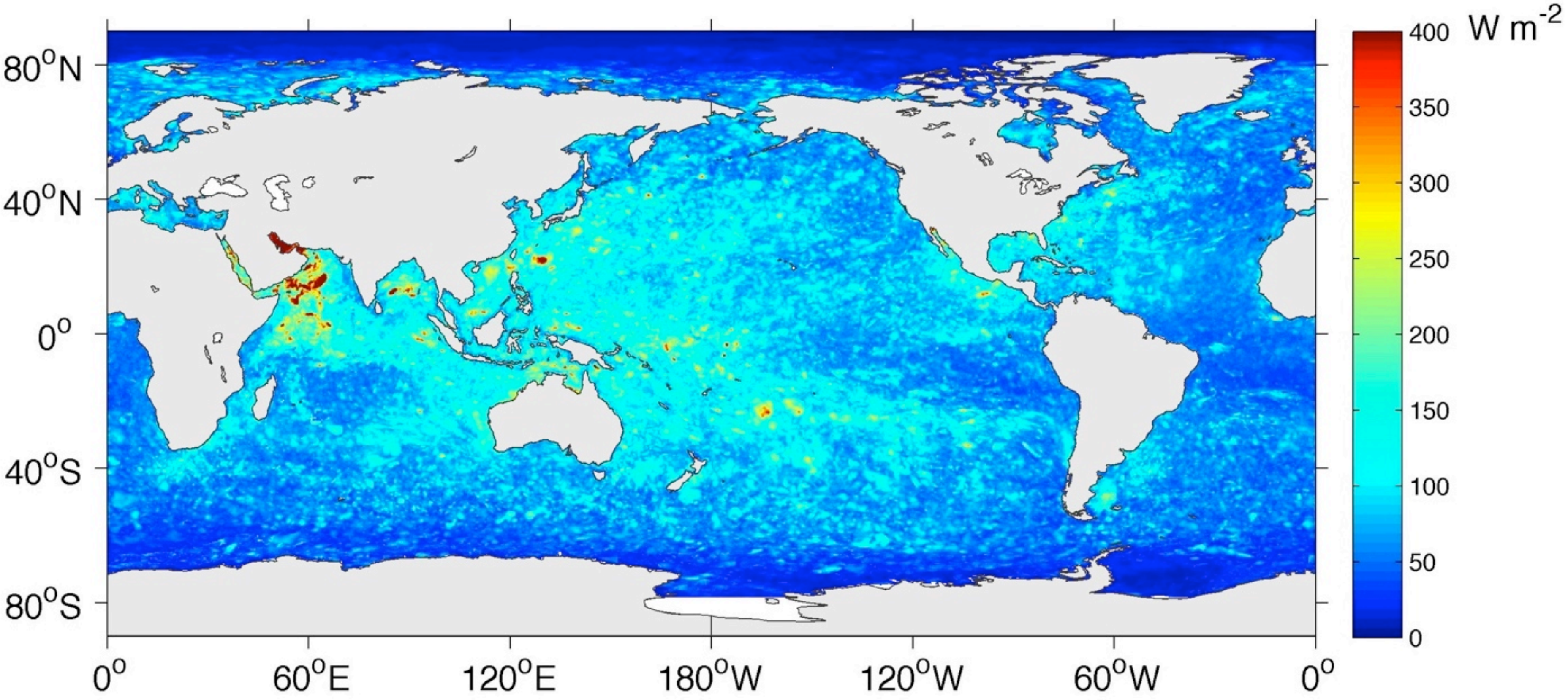
Sample daily evolution of diurnal vs. non-diurnal fluxes (LW + SH + LH)



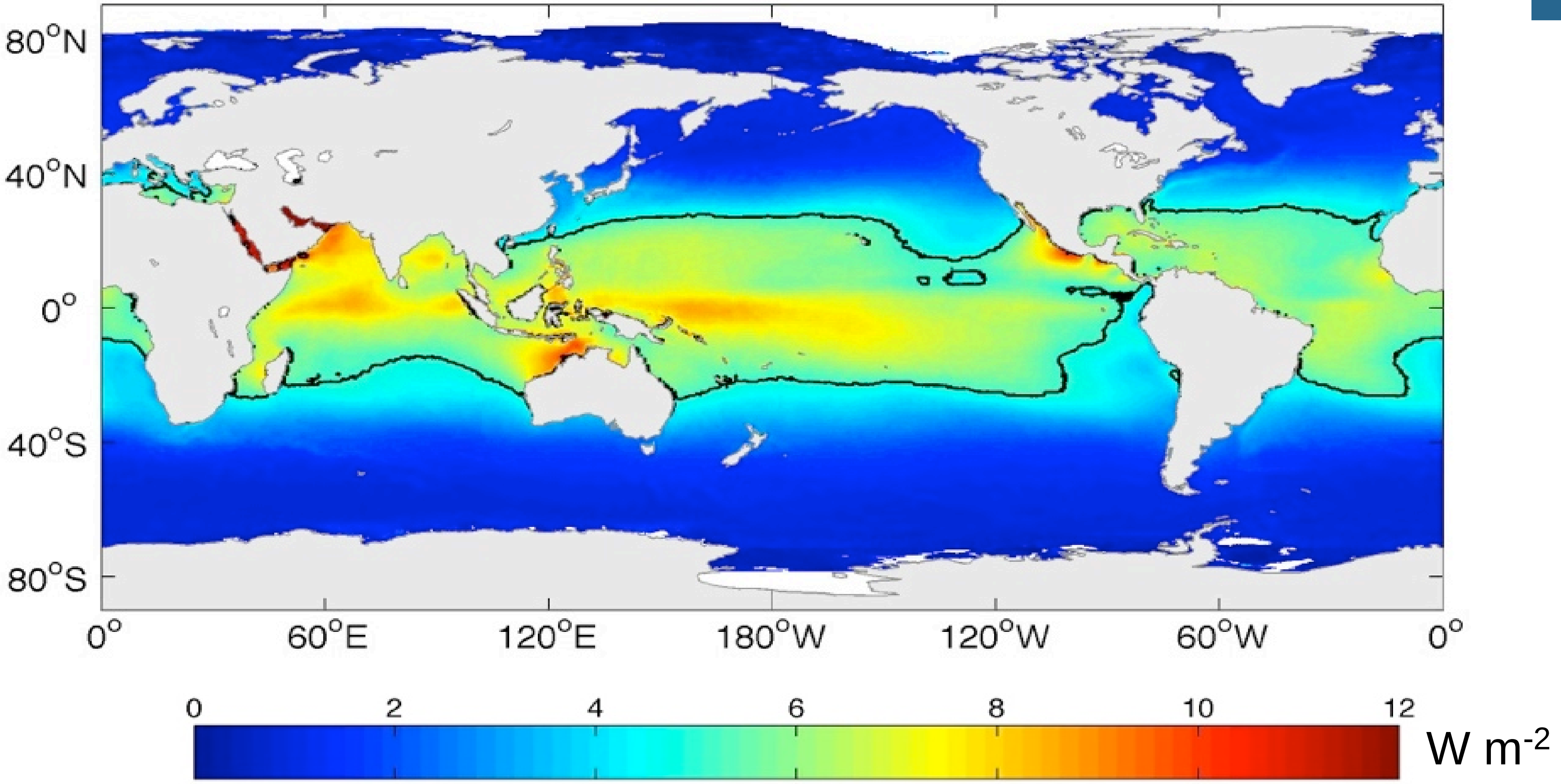


Clayson and Bogdanoff (2012)

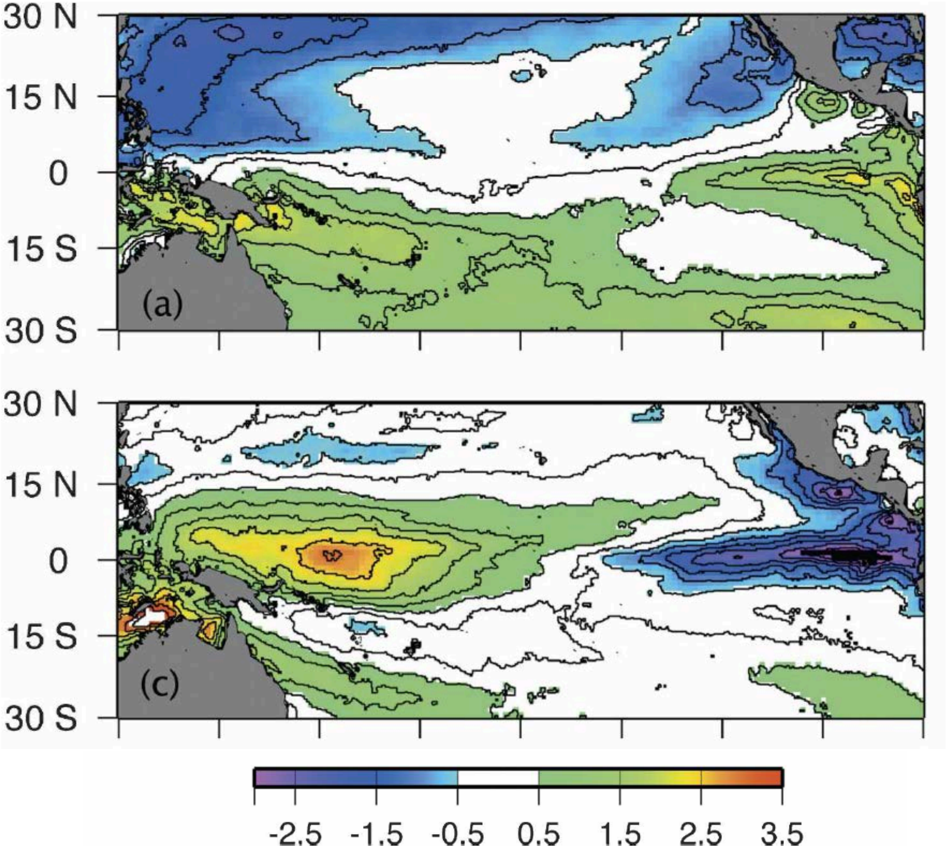
Maximum effect on fluxes (1998 – 2007)



Mean effect on fluxes (1998 – 2007)



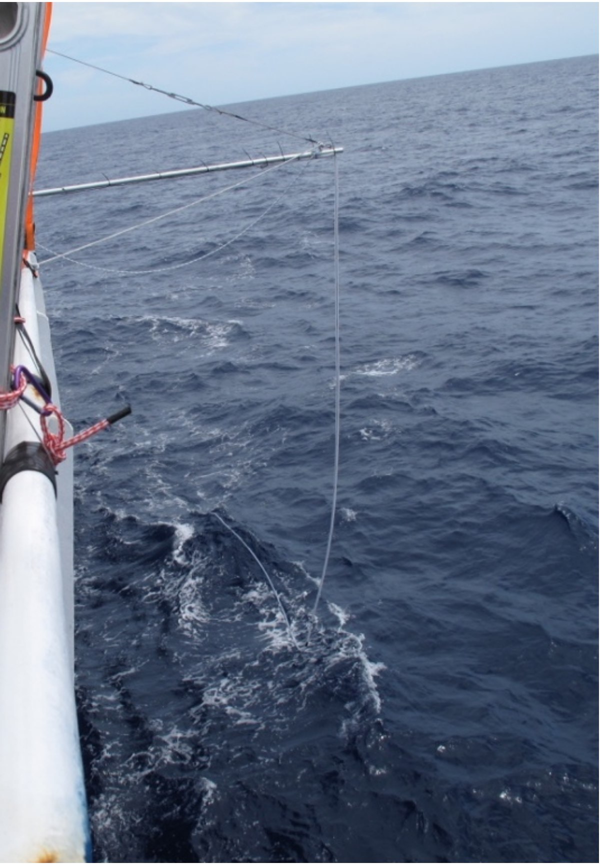
An example of dSST variability: ENSO

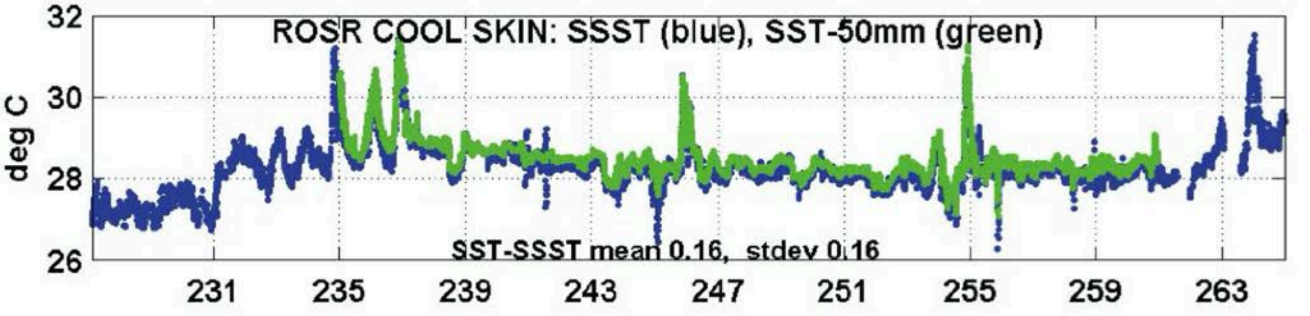


- First EOF of diurnal variability: north-south seasonal pattern
- Second EOF: east-west pattern, affected by ENSO variability
  - Pattern is opposite to mixed layer temperature variability: less diurnal warming in warmer average temperature region

Clayson and Weitlich, 2007

Bulk and skin measurements



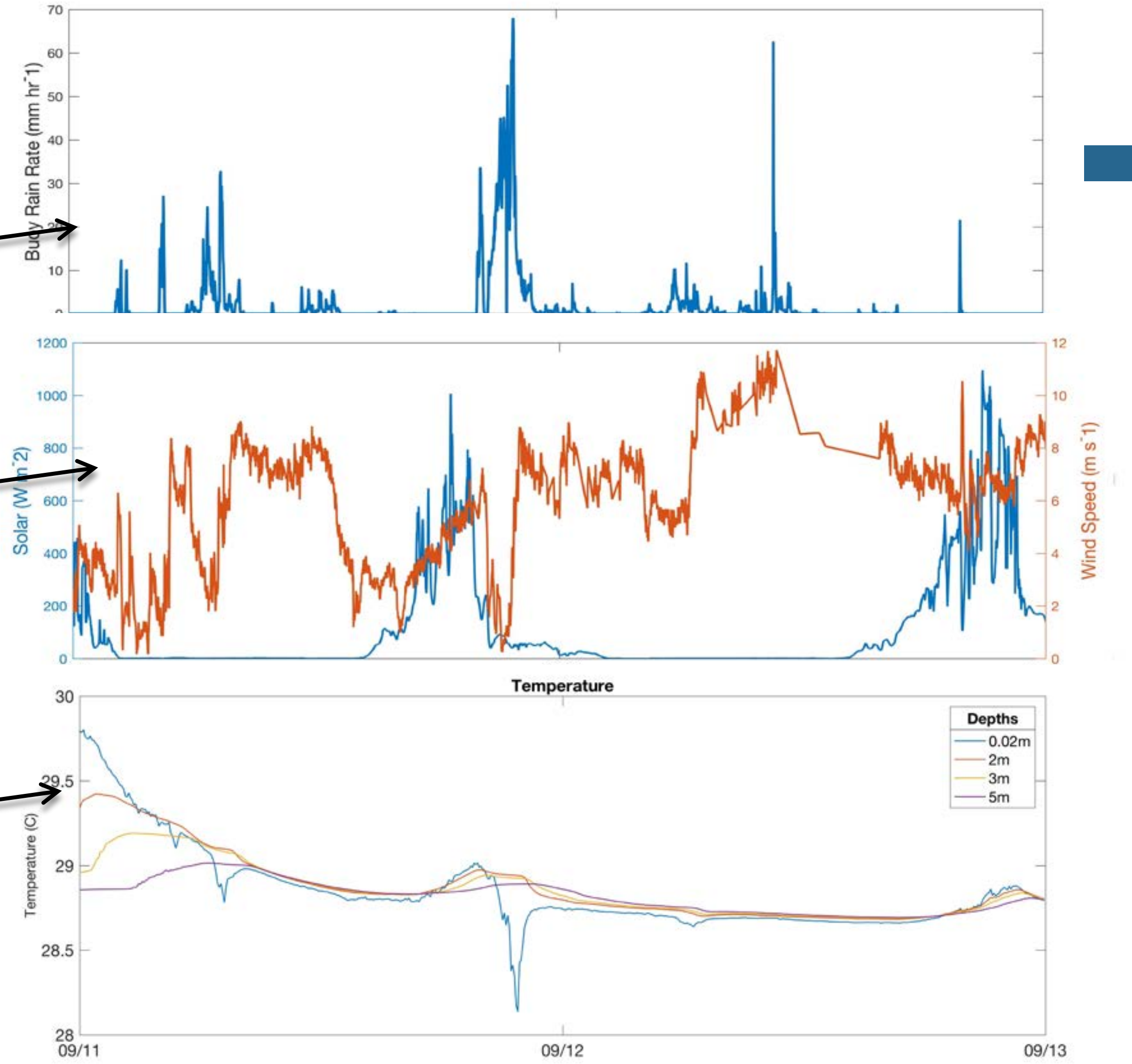


Some sample days

Rainfall

Winds and Solar

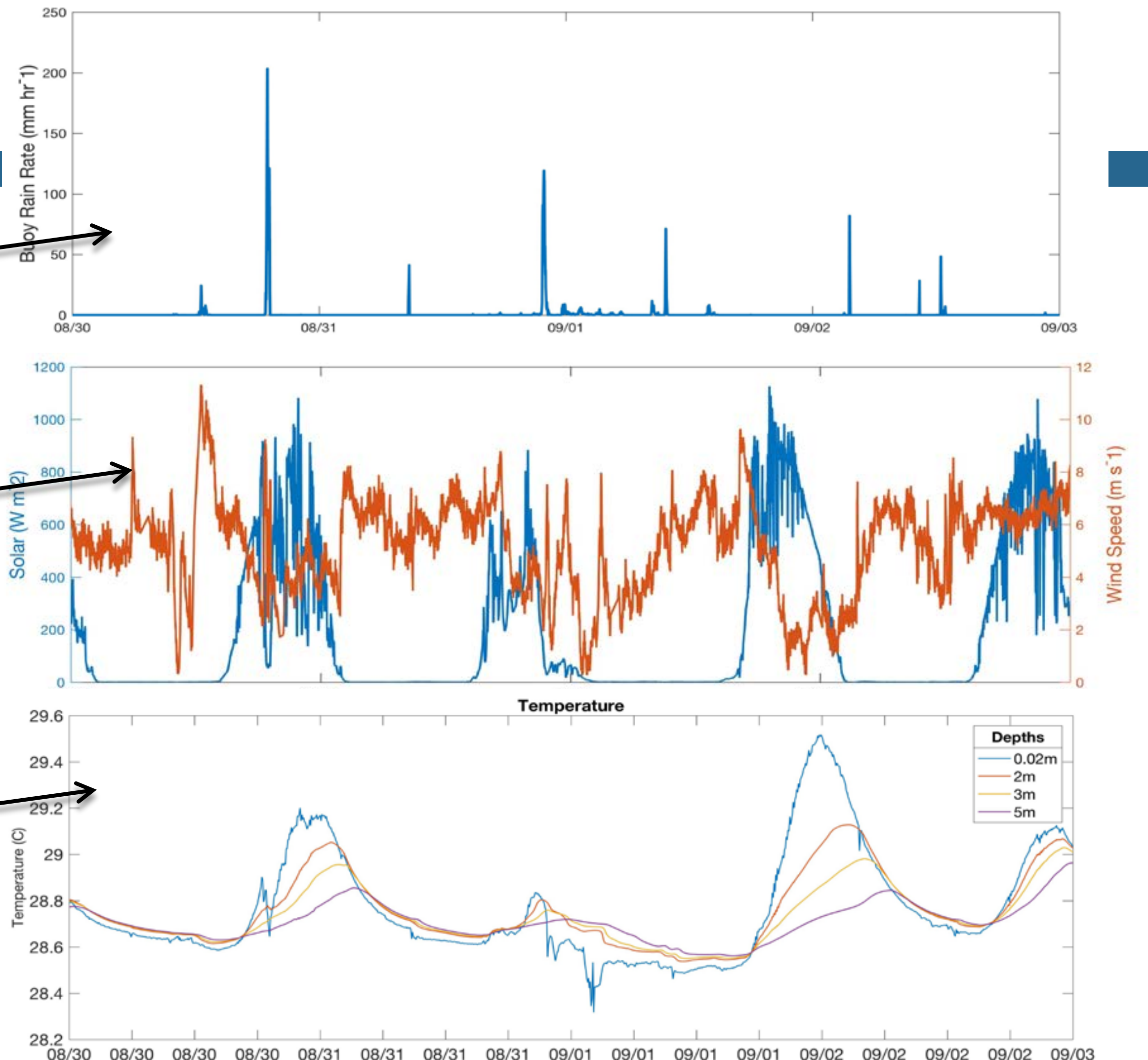
Temperatures



Rainfall

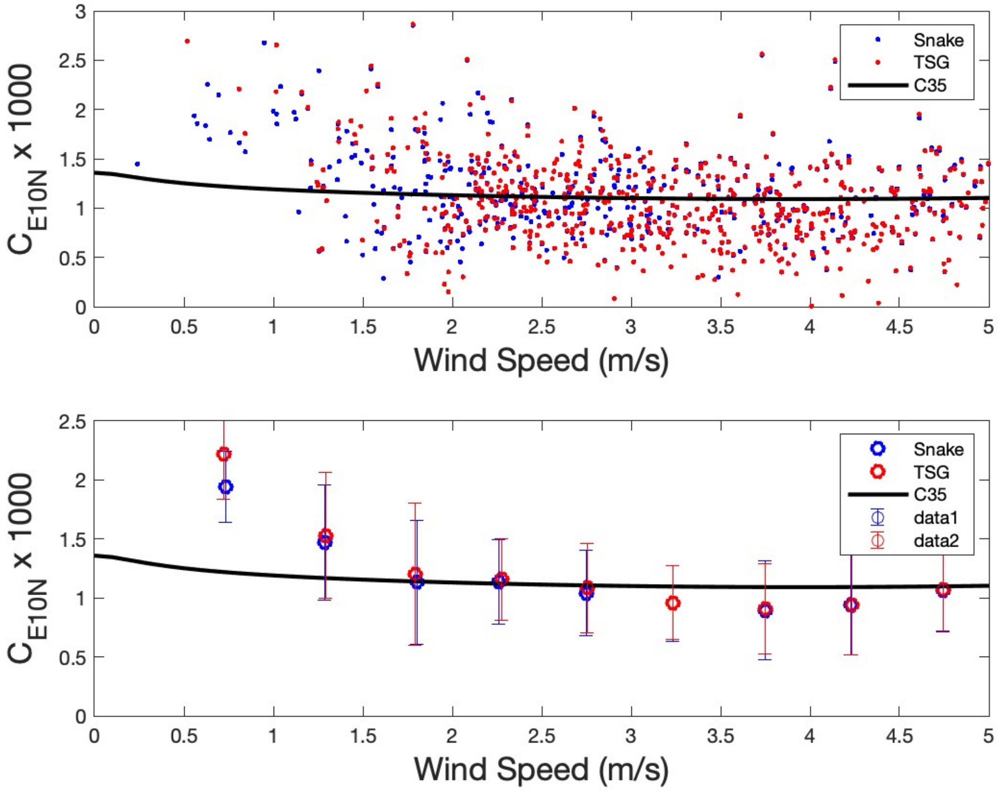
Winds and Solar

Temperatures



Determining transfer coefficients requires skin

- Few cases in SPURS cruise – diurnal warming not more than 1.5°
- At wind speeds below 3 m/s, using the skin versus the ship "SST" affects transfer coefficient by 5 – 20%
- This directly translates to a difference in fluxes of 5 - 20%

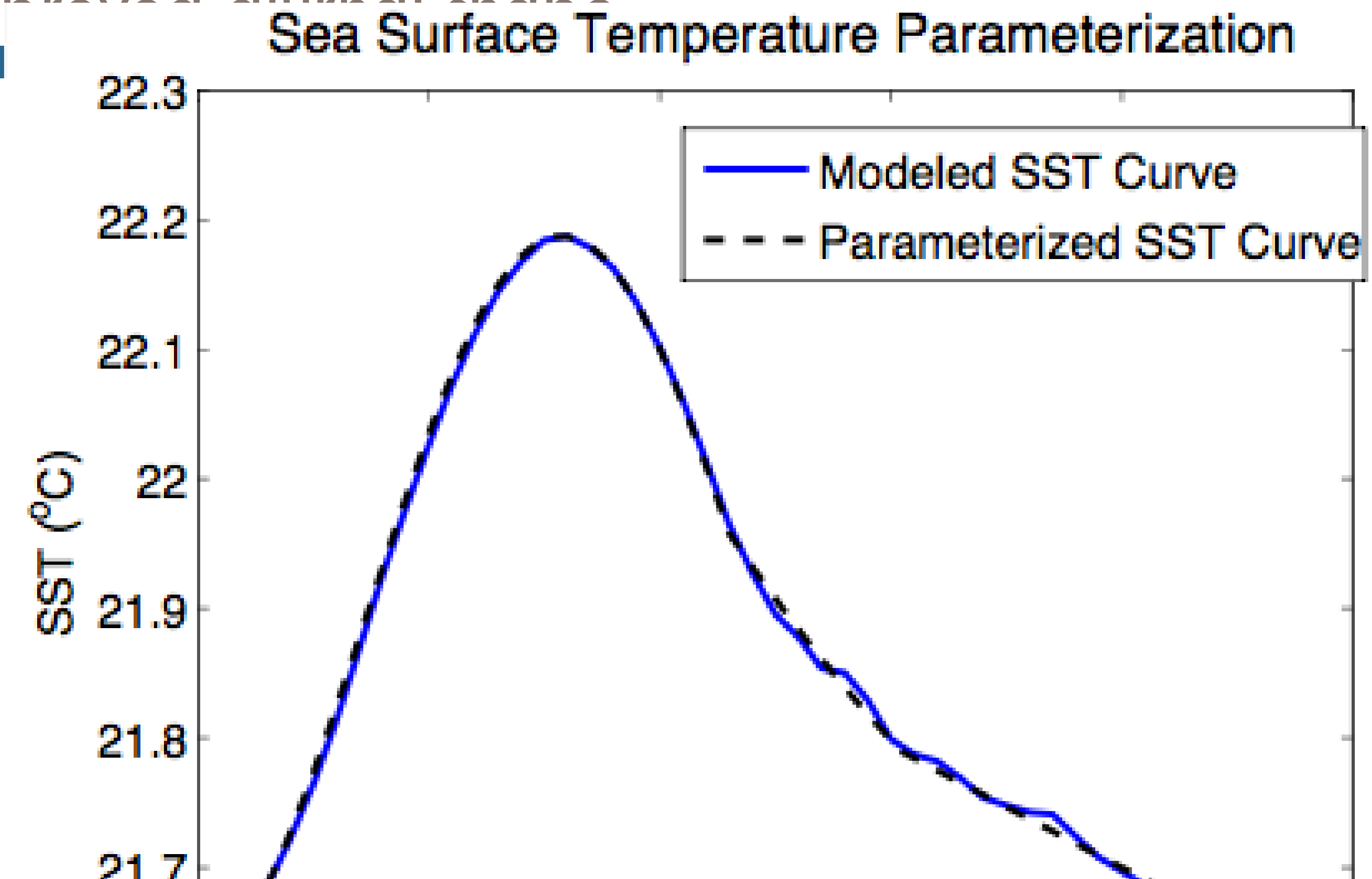


Edson et al., in prep

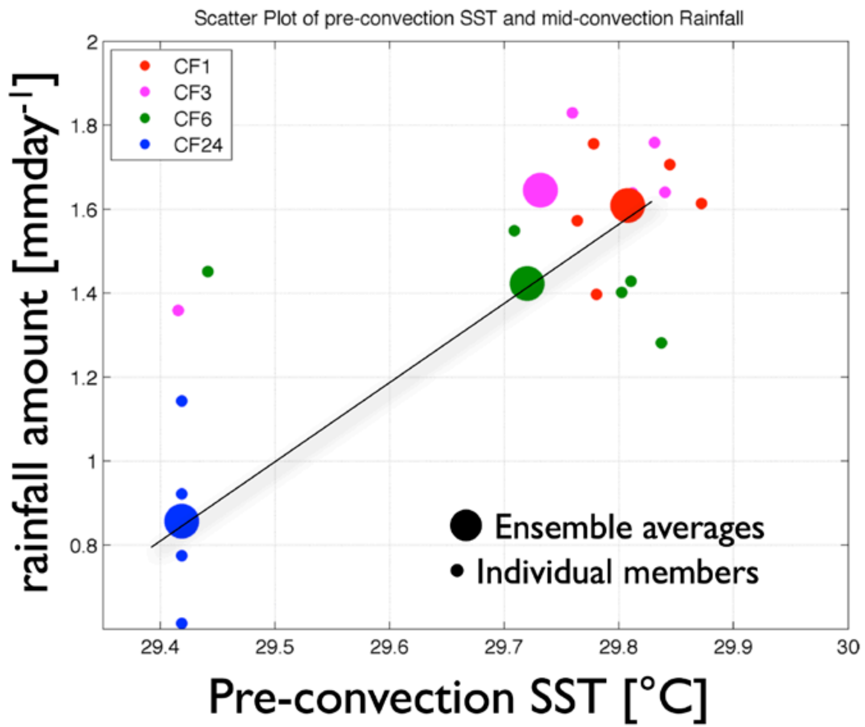
Final thoughts

- The ”skin” SST is the interfacial temperature that is what the atmosphere ”sees”
- This is the temperature that is needed for accurate calculation of the fluxes
- High-quality skin or near-skin temperatures would be great to have available from buoys with concurrent meteorology and flux measurements
- Continued and improved use of surface radiometers for improving satellite skin temperatures helpful

Questions


Sea Surface Temperature Parameterization
22.3
22.2
22.1
22
21.9
21.8
21.7
SST (°C)
Modeled SST Curve
Parameterized SST Curve

Precipitation amount ~scales with diurnal SST



- LH+SH feedback over higher SST instrumental in stronger convection intensity (Arnold et al. 2013)

- Consistent with previous studies: an improved representation of diurnally evolving SST as a potential predictability source of MJO.

Seo et al., 2014