



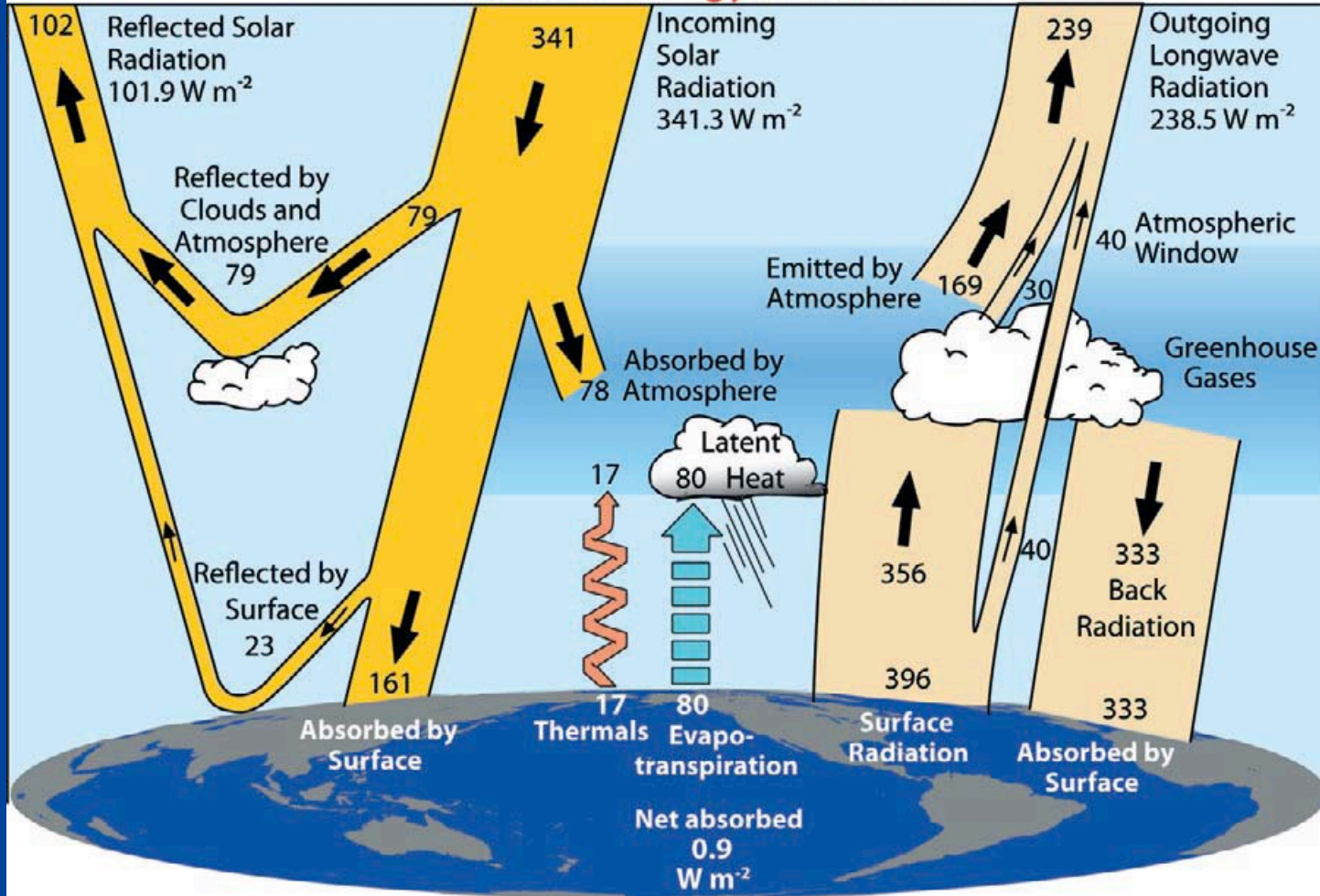
# Tropical Diurnal Cycle of TOA Radiative Fluxes within Large-Scale Circulation Regimes

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Climate Sciences Branch  
ASR Cloud Life Cycle WG Meeting  
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# Motivations



Global Energy Flows  $W m^{-2}$

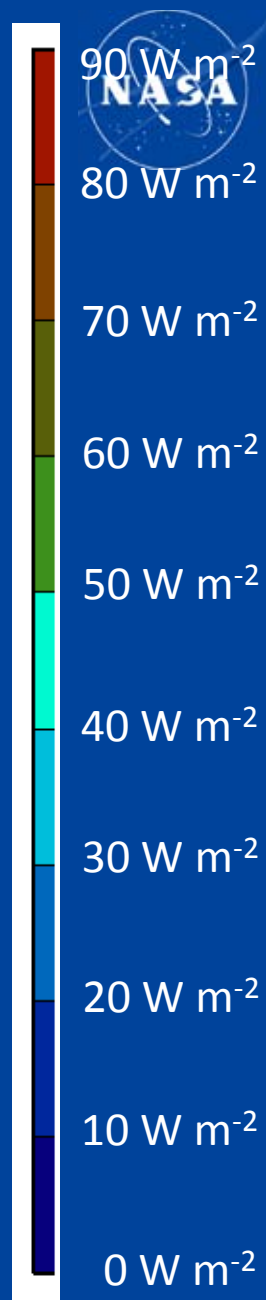
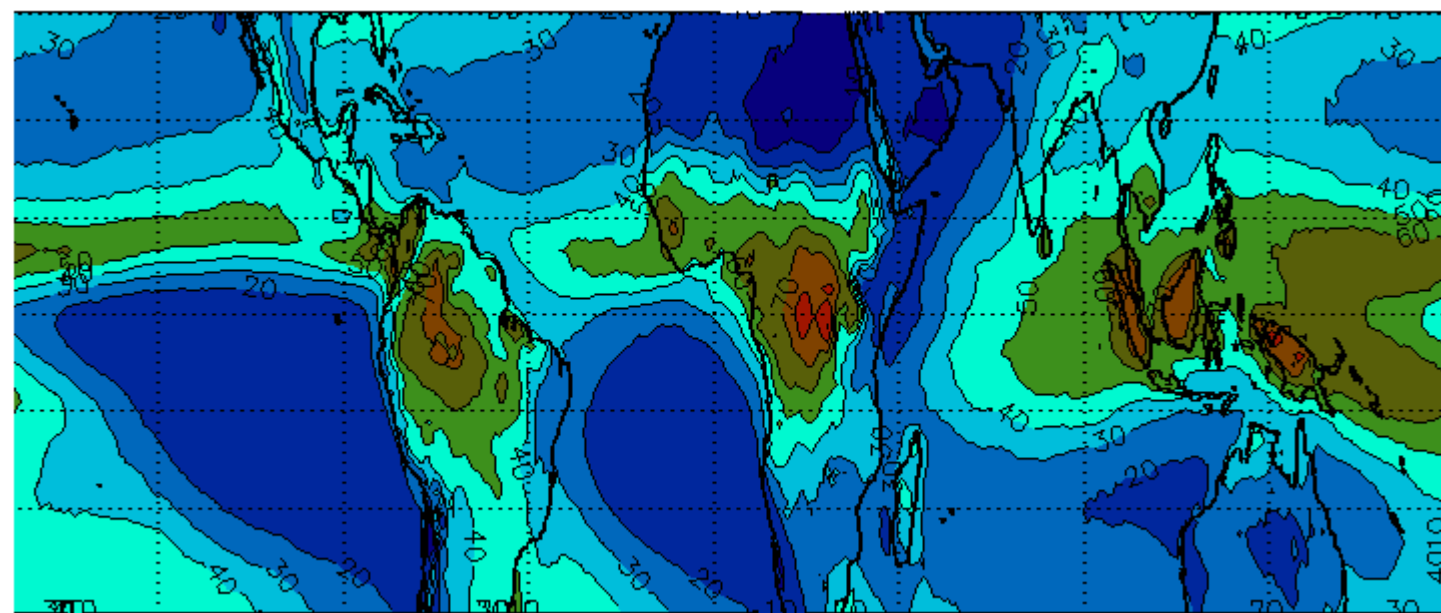
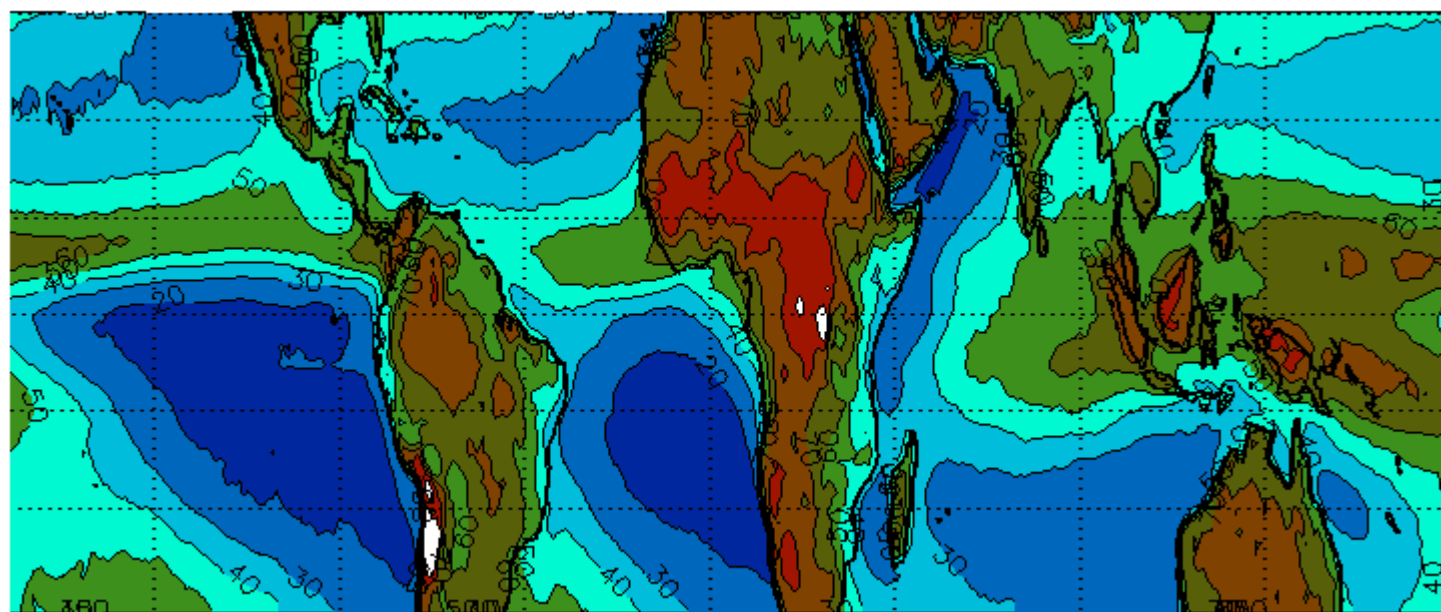


- The cloud life cycle and its variability has a large influence on the earth energy budget.

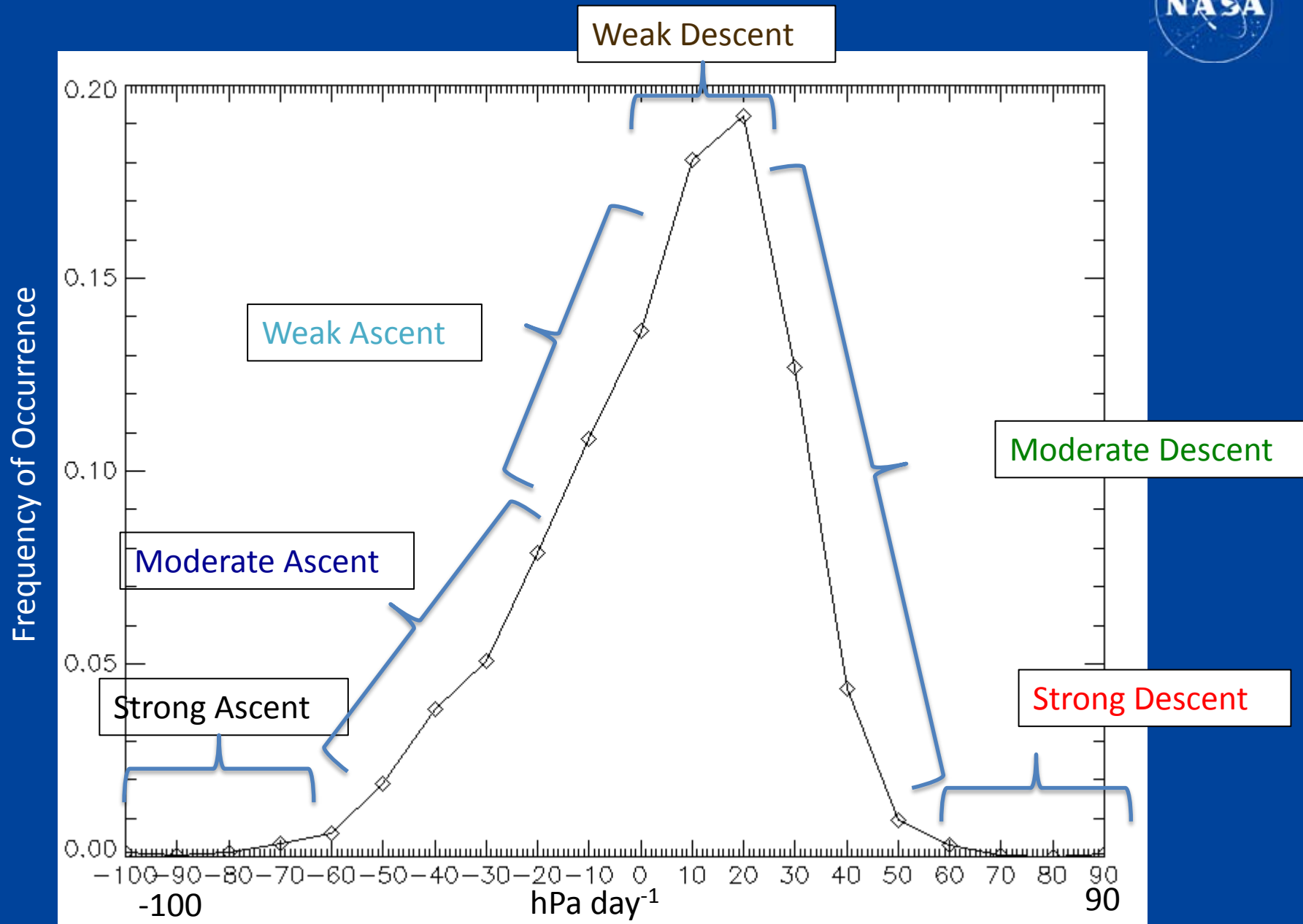
- The diurnal cycle represents an important time scale in the cloud life cycle.

- Climate models poorly represent diurnal cycle of precipitation (and therefore clouds).

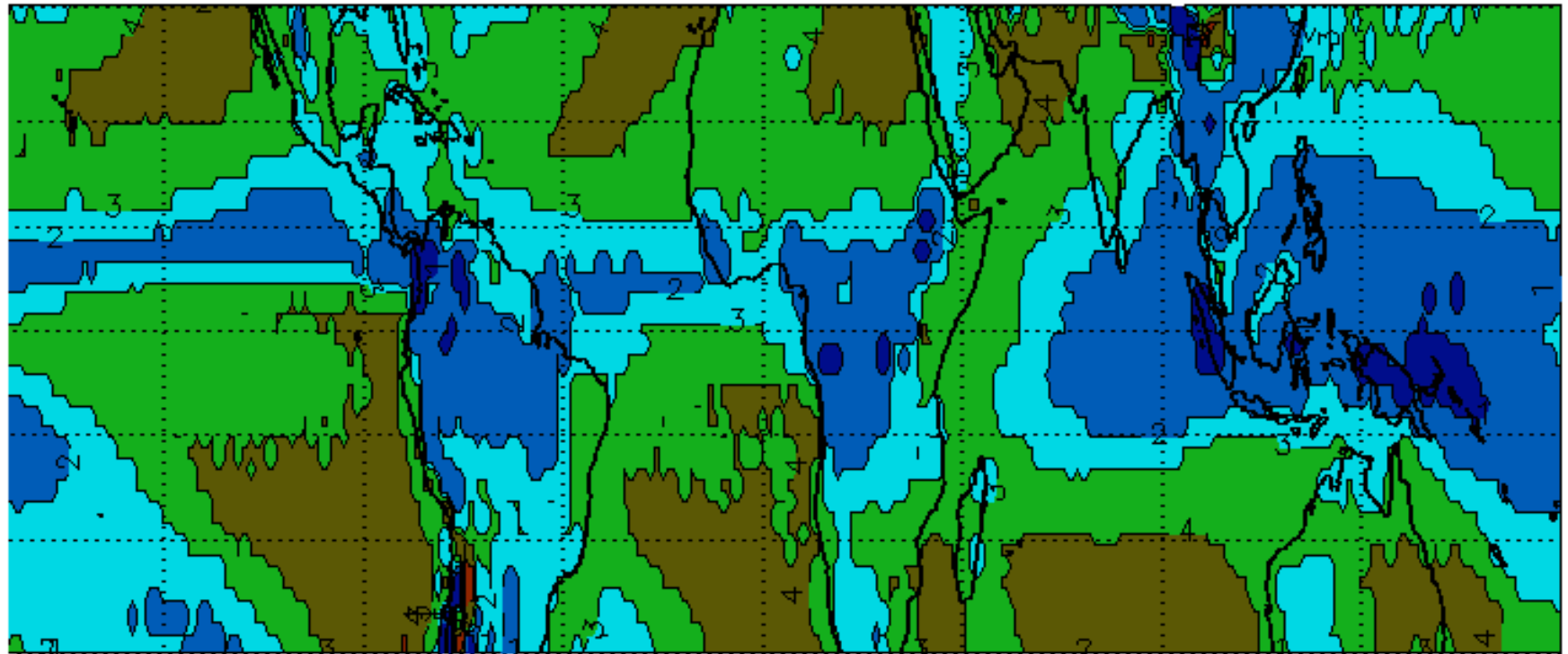
# Annual Mean Diurnal Range—OLR (top) and LW CRF (bottom)



# ERA Interim 500 hPa omega—Annual Mean



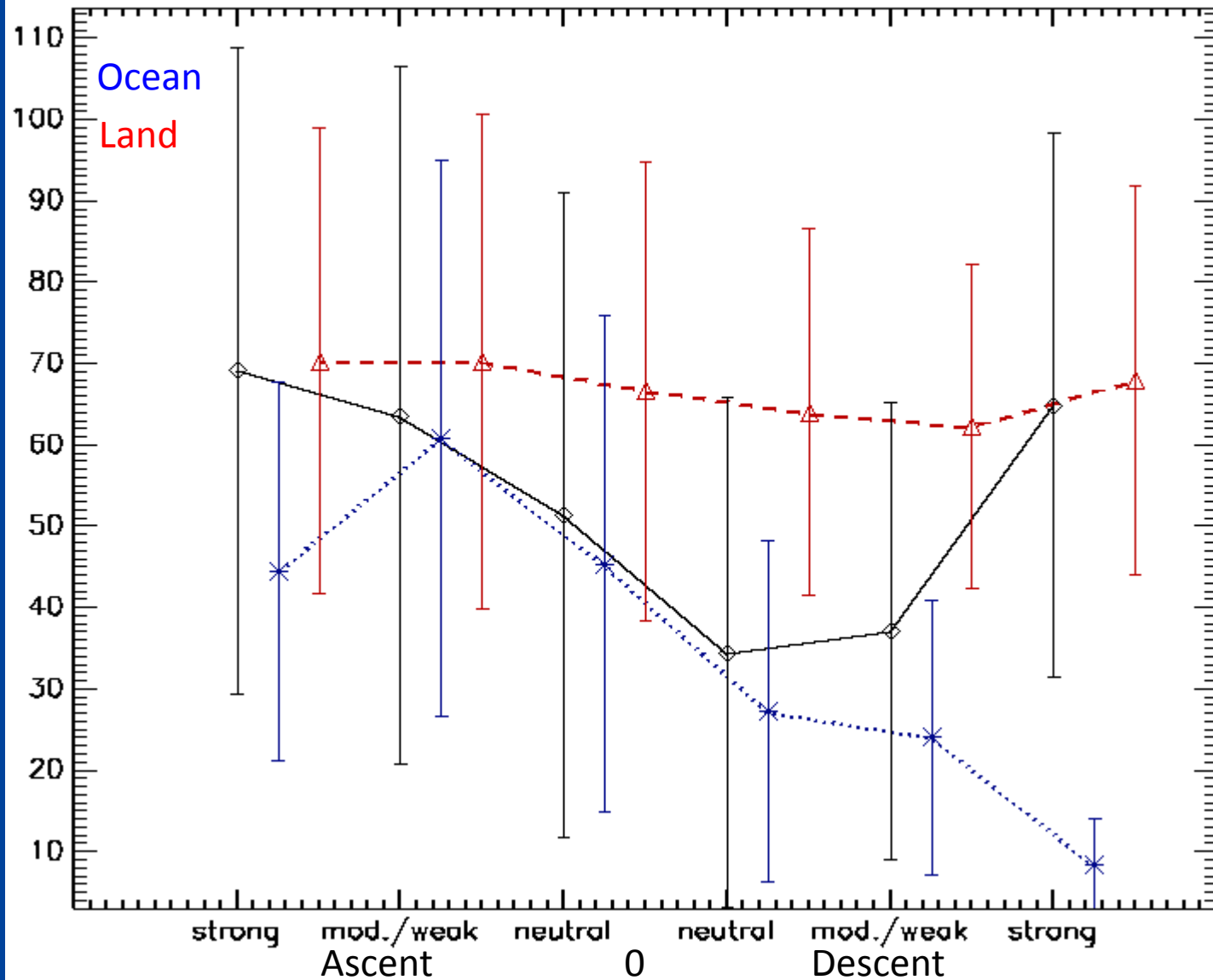
# ERA Interim 500 hPa omega—Annual Mean



# Diurnal Amplitude—OLR



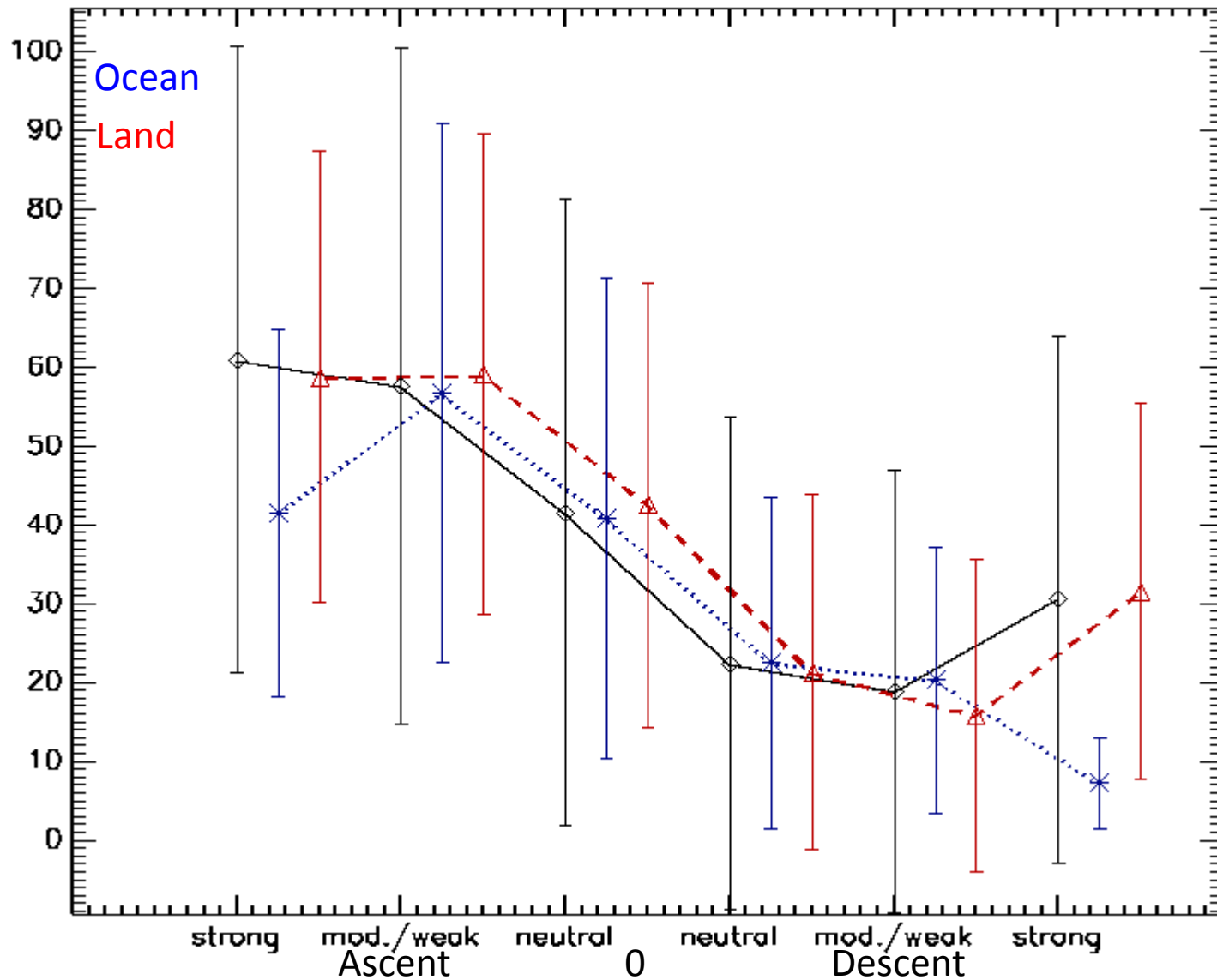
$W m^{-2}$



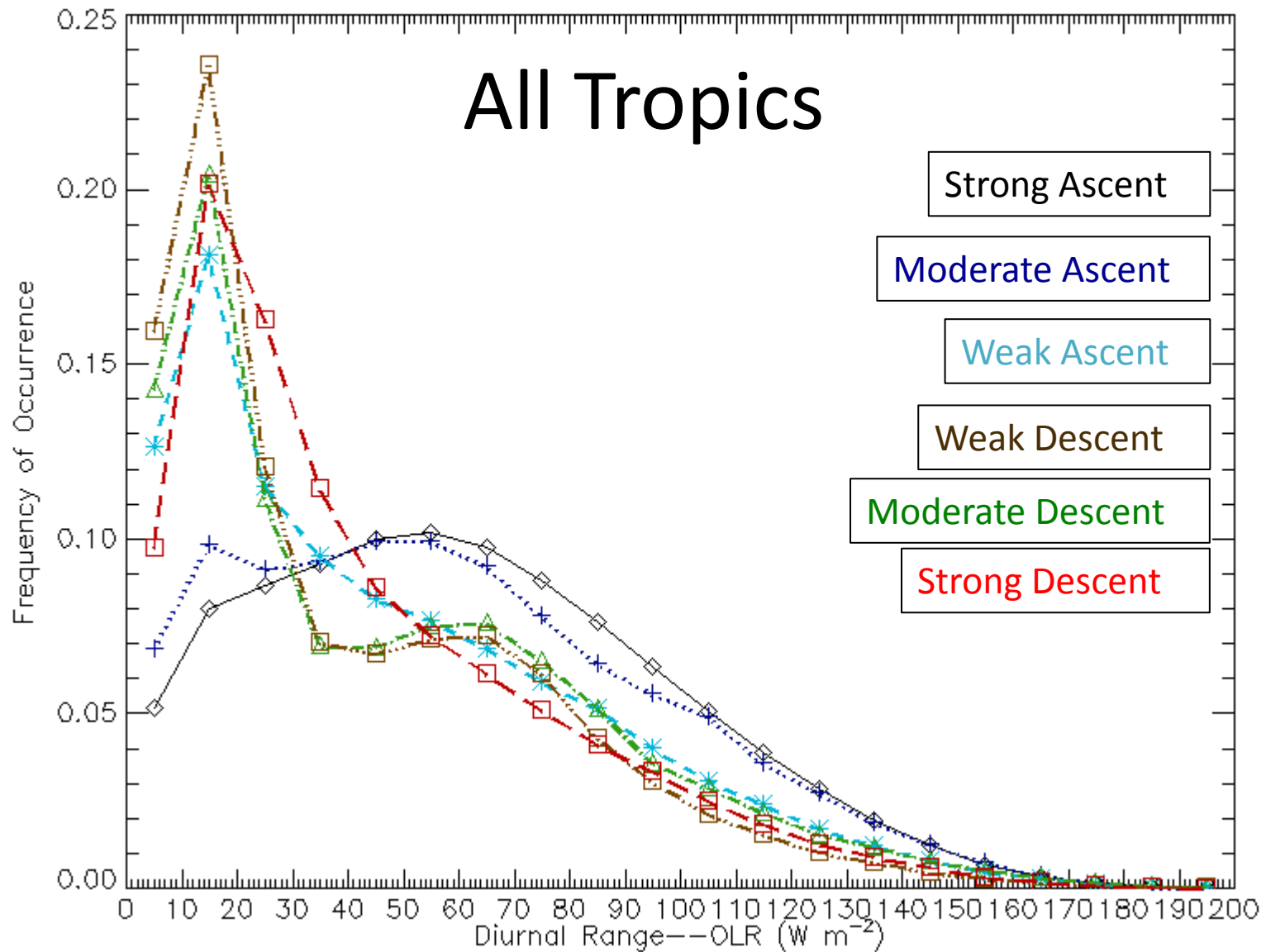
# Diurnal Amplitude—LW CRF



$W m^{-2}$

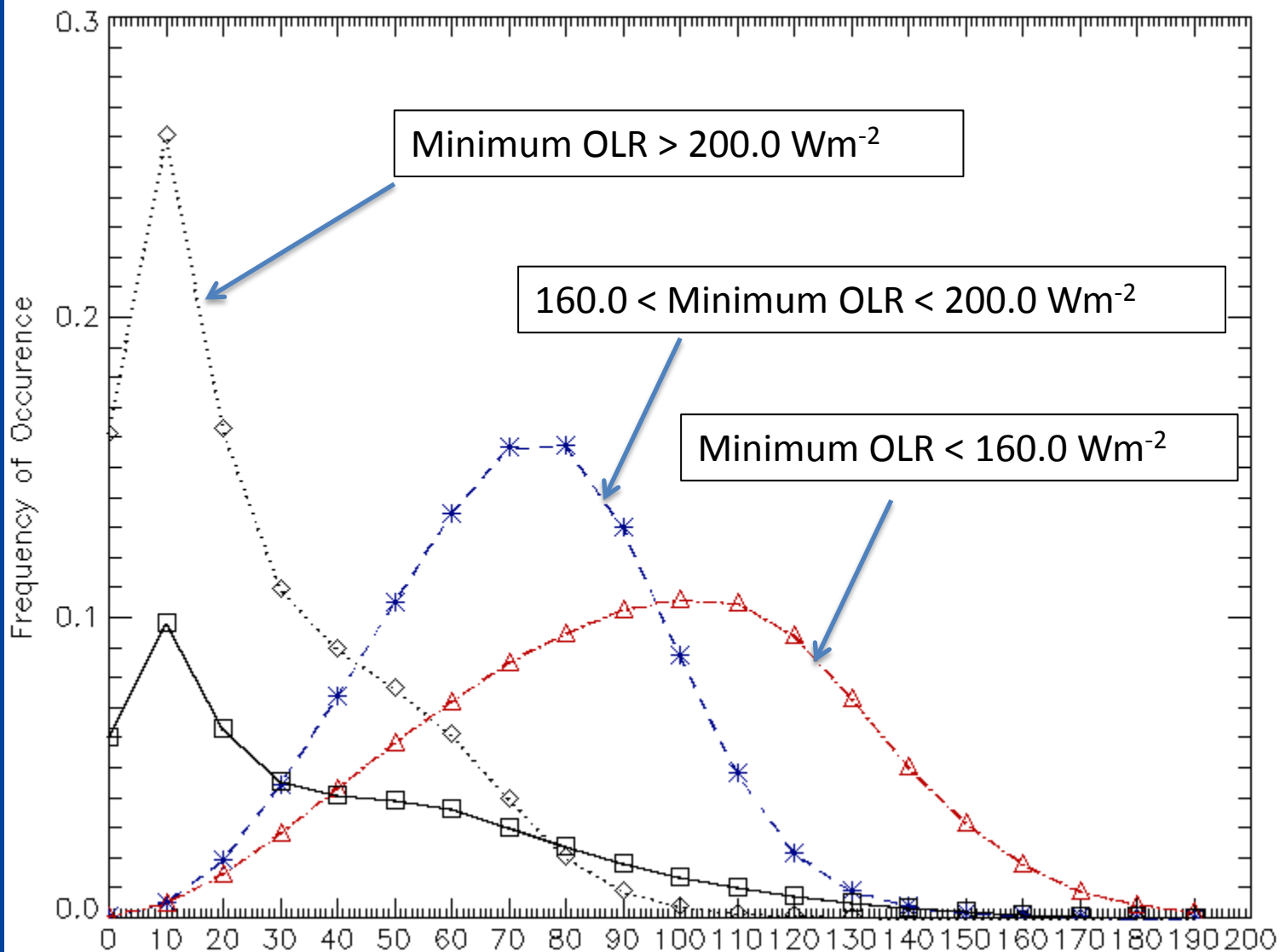


# Diurnal Amplitude—OLR

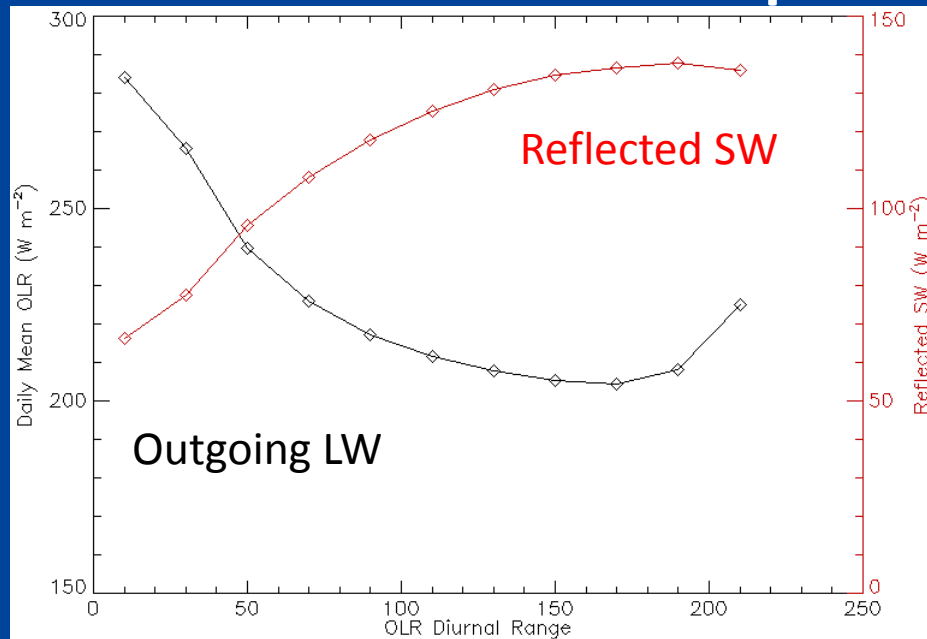




# Diurnal Amplitude—OLR

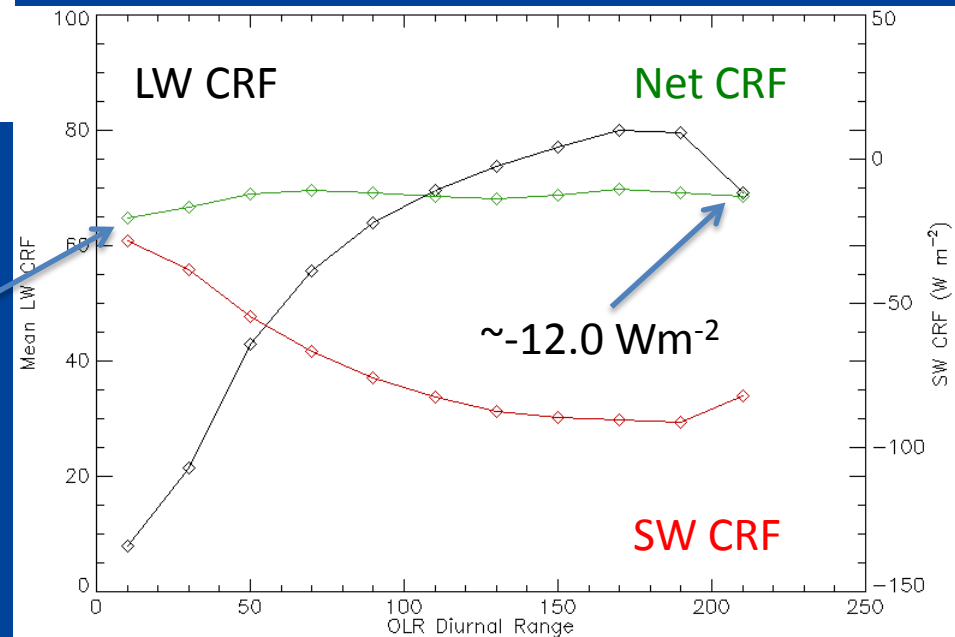


# Daily Mean TOA Fluxes: Tropical Ocean

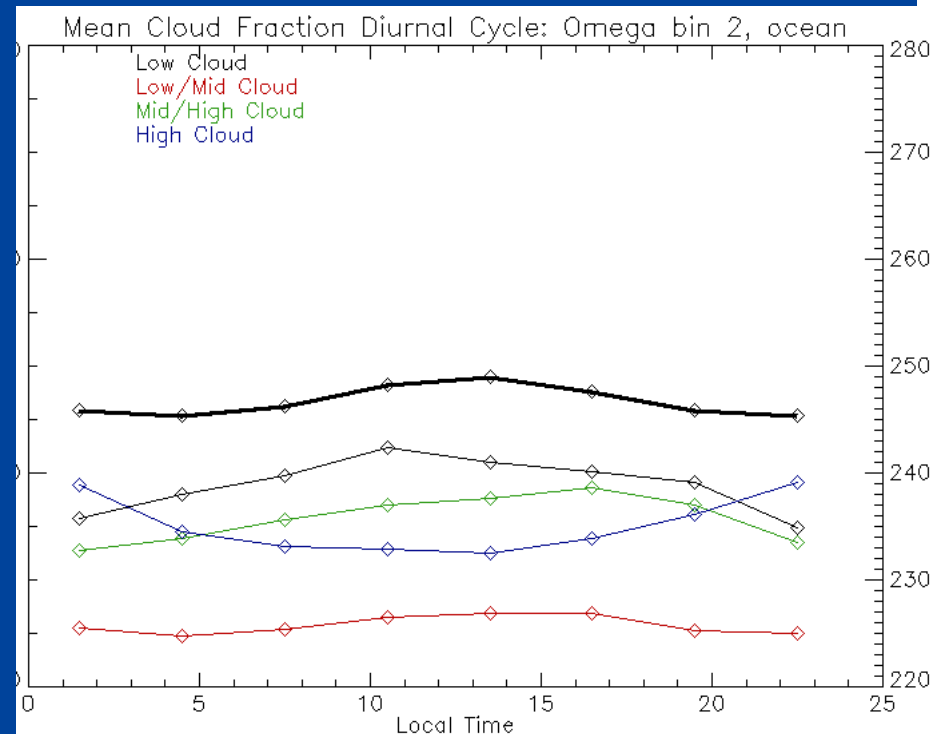
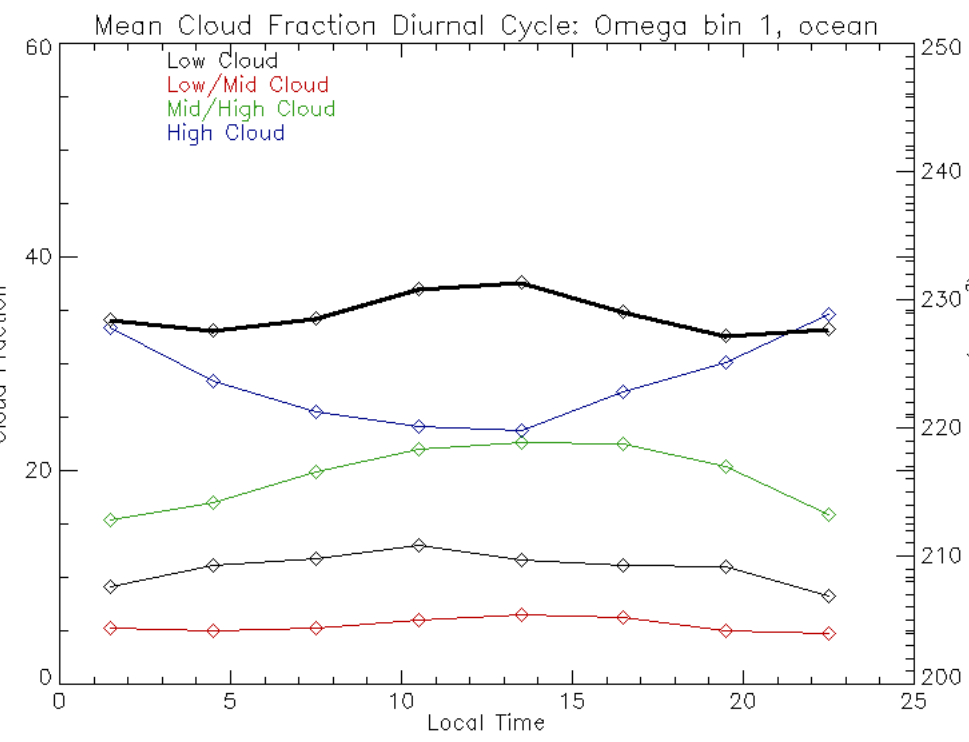
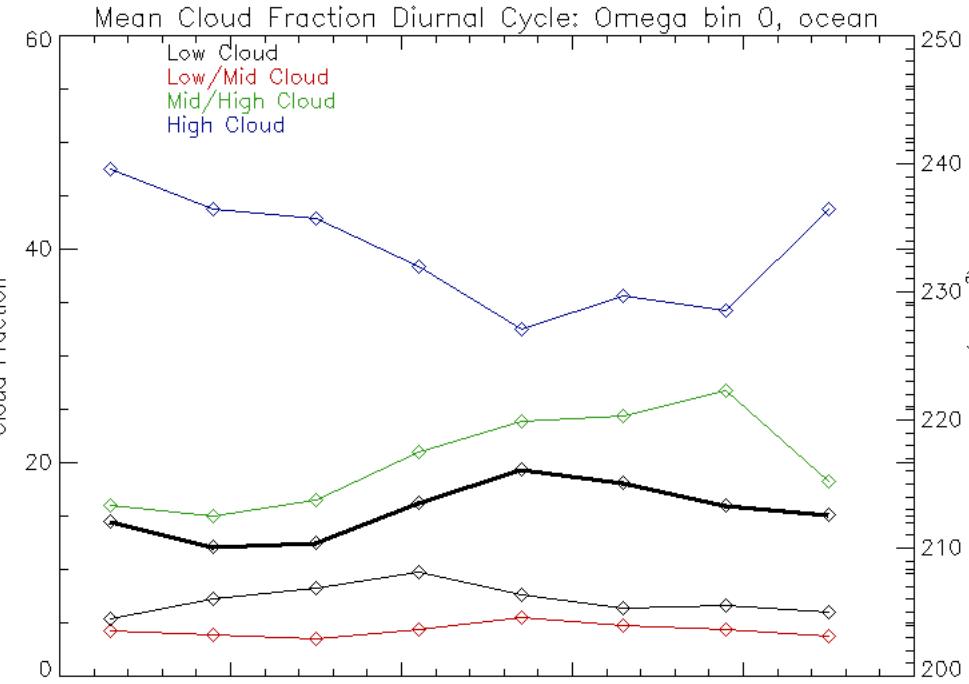


- OLR and RSW are weaker functions of OLR diurnal amplitude at larger diurnal amplitudes
- Net CRF is varies little with amplitude of OLR diurnal cycle due to compensating LW and SW cloud effects, dependent upon dynamical regime.

~ -20.0 Wm<sup>-2</sup>



# Dynamical Regime Diurnal Cycle Composites



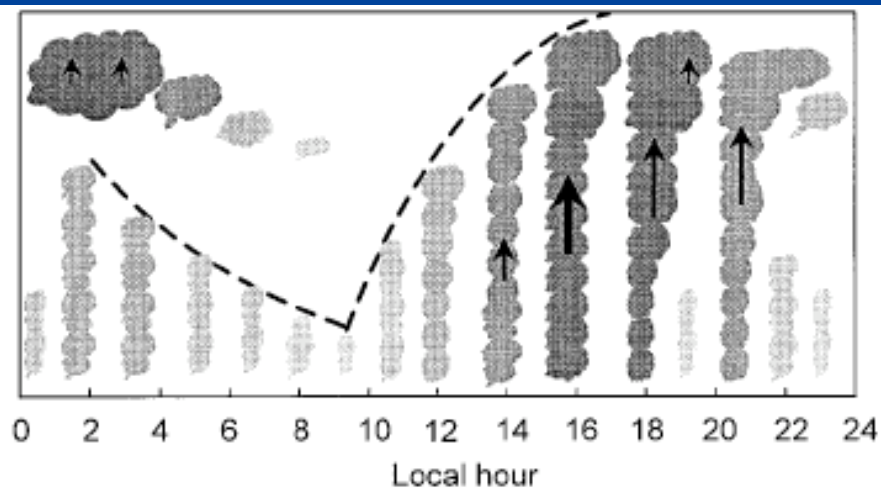
# Conclusions and Future Work



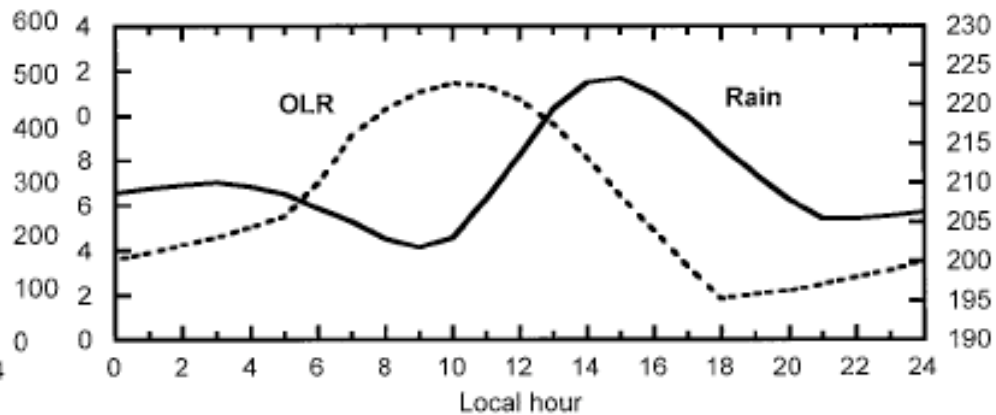
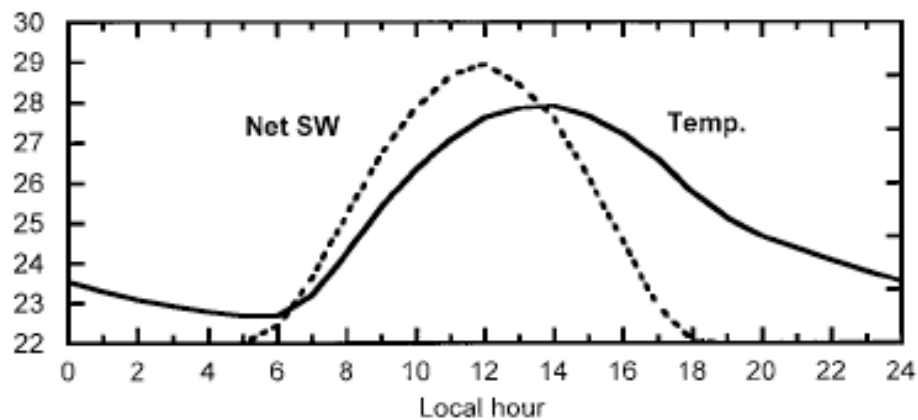
- The annual mean OLR diurnal amplitude is a function of dynamical regime over ocean and nearly independent over land.
- The annual mean LW CRF diurnal amplitude is a function of dynamic regime independent of surface type.
- The intensity and frequency of deep convection drive the distribution of OLR amplitude.
- Over ocean, large amplitude diurnal cycles have a strong CRF throughout the day.
- Use TWP ARM data to study the process-level.
- The diurnal cycle of OLR seems to be different and convective precipitation, in that the phase is generally insensitive to the strength of the convection.
- We also believe that similar analyses are a good test of GCMs.



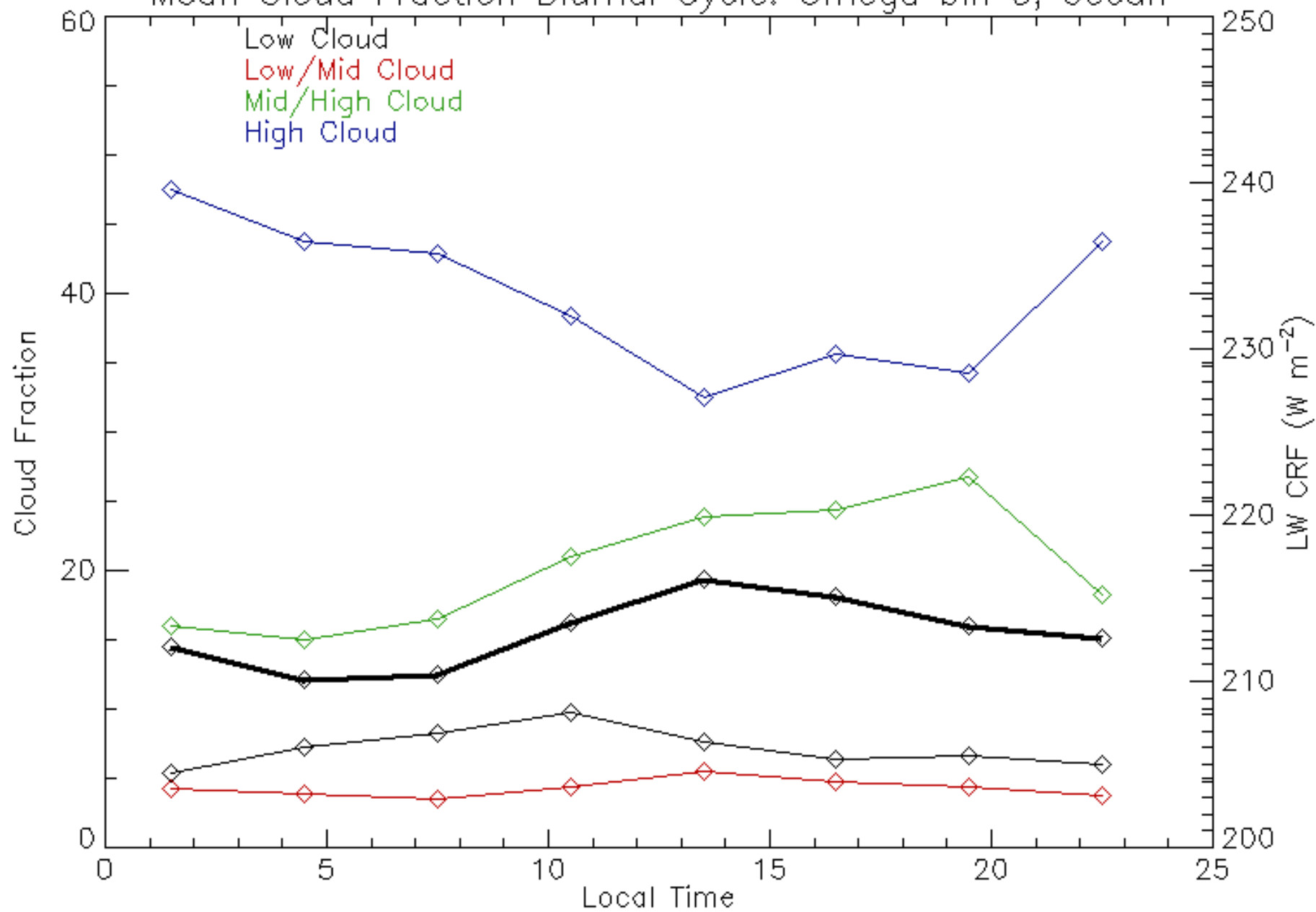
# Diurnal Cycle Schematic



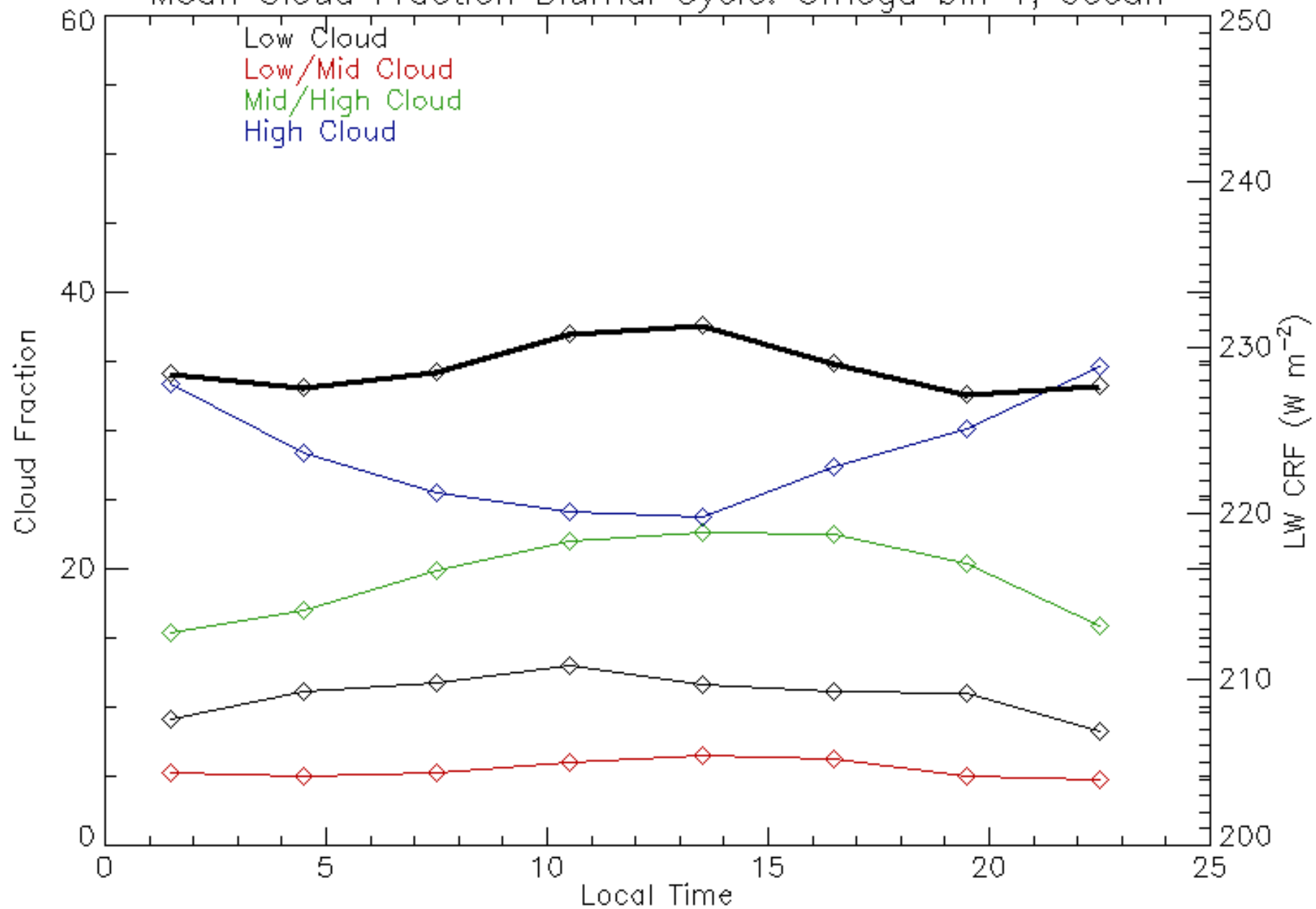
Lin et al. 2000



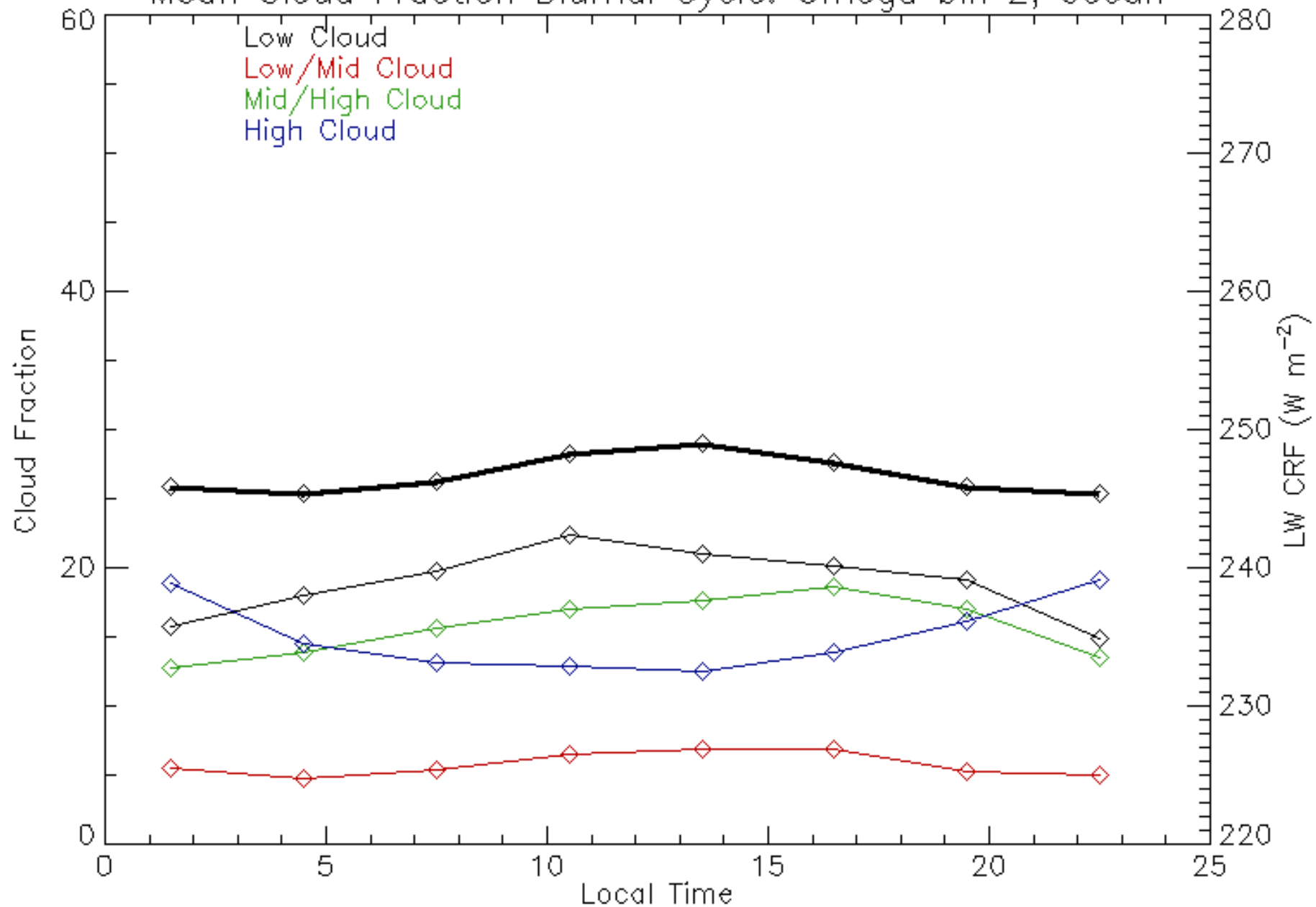
Mean Cloud Fraction Diurnal Cycle: Omega bin 0, ocean



Mean Cloud Fraction Diurnal Cycle: Omega bin 1, ocean



Mean Cloud Fraction Diurnal Cycle: Omega bin 2, ocean



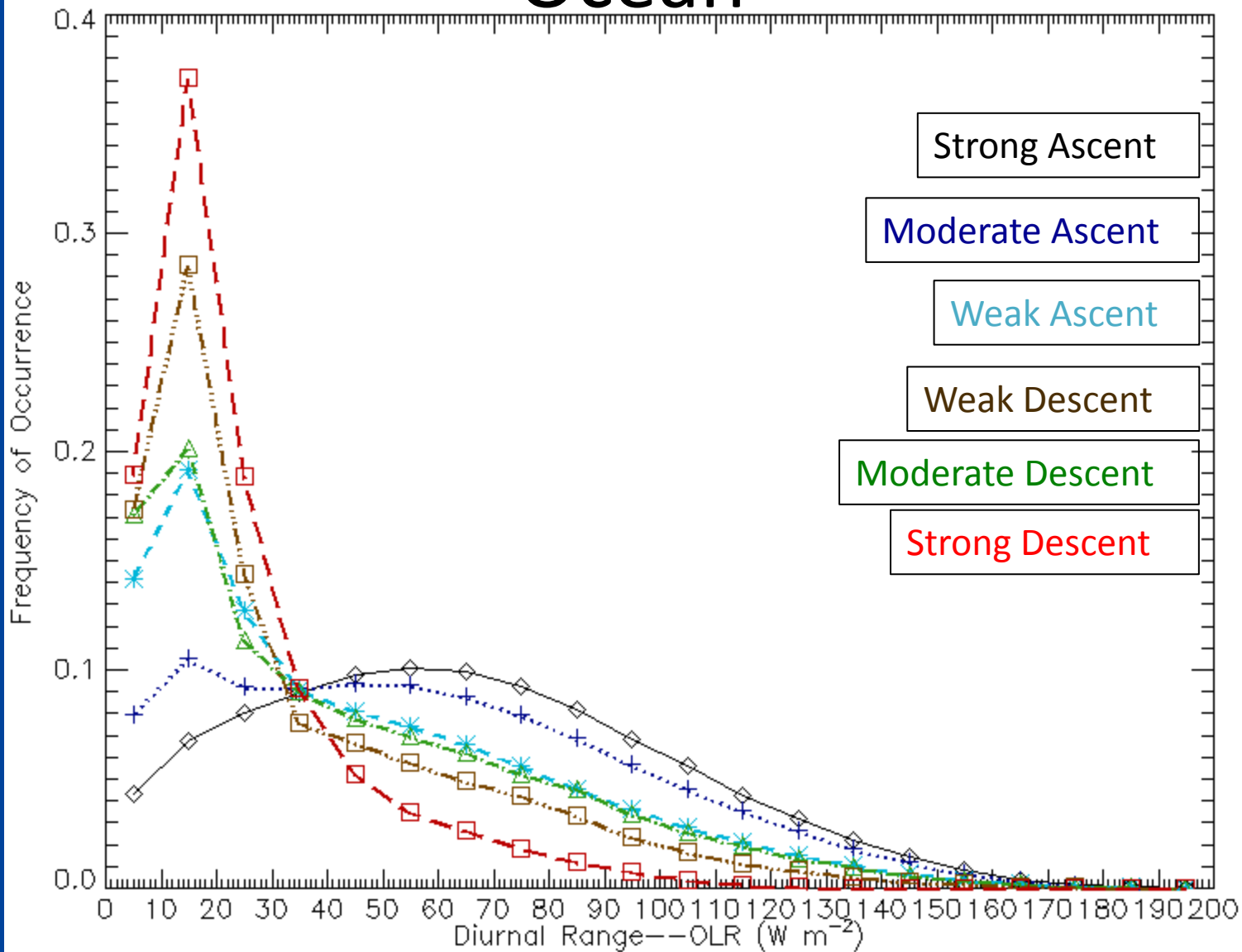


# CERES Synoptic Data Product

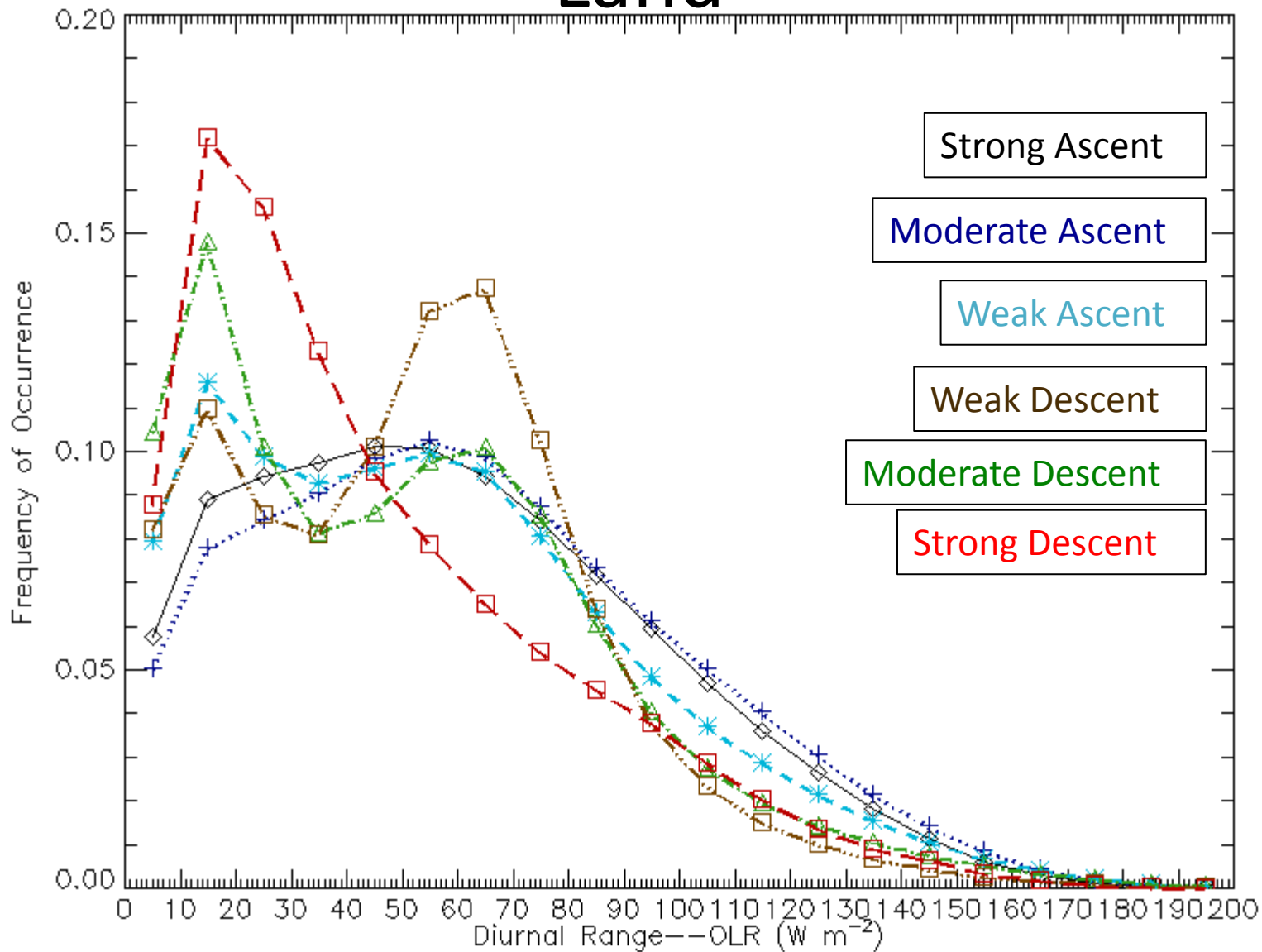


- $1^{\circ} \times 1^{\circ}$  regional 3-hourly mean fluxes
- Synergistically combines CERES and Geostationary (GEO) satellite observations to resolve the diurnal cycle.
- GEO radiances are converted to broadband fluxes and normalized to place on same scale as CERES.

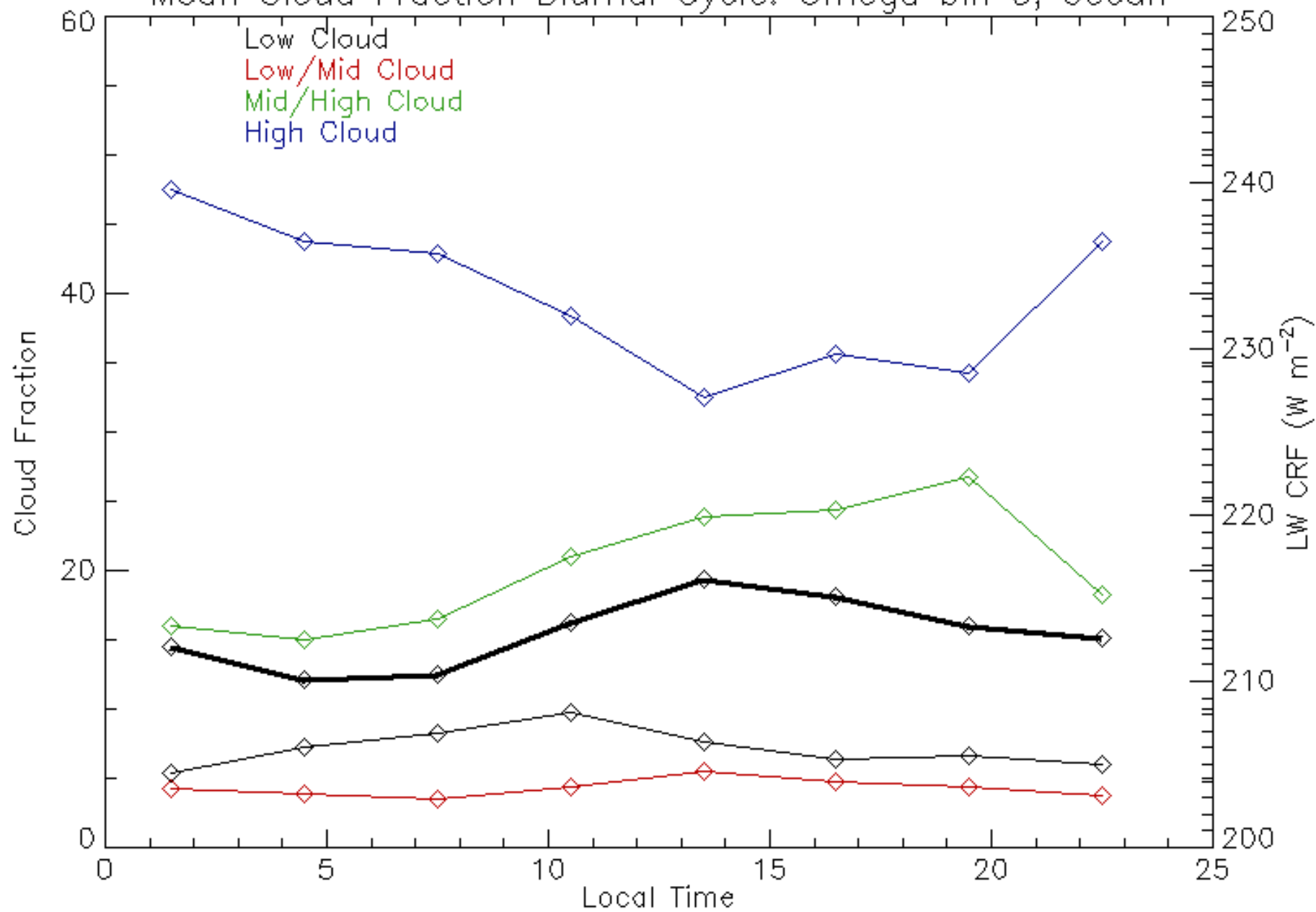
# Diurnal Amplitude—OLR Ocean



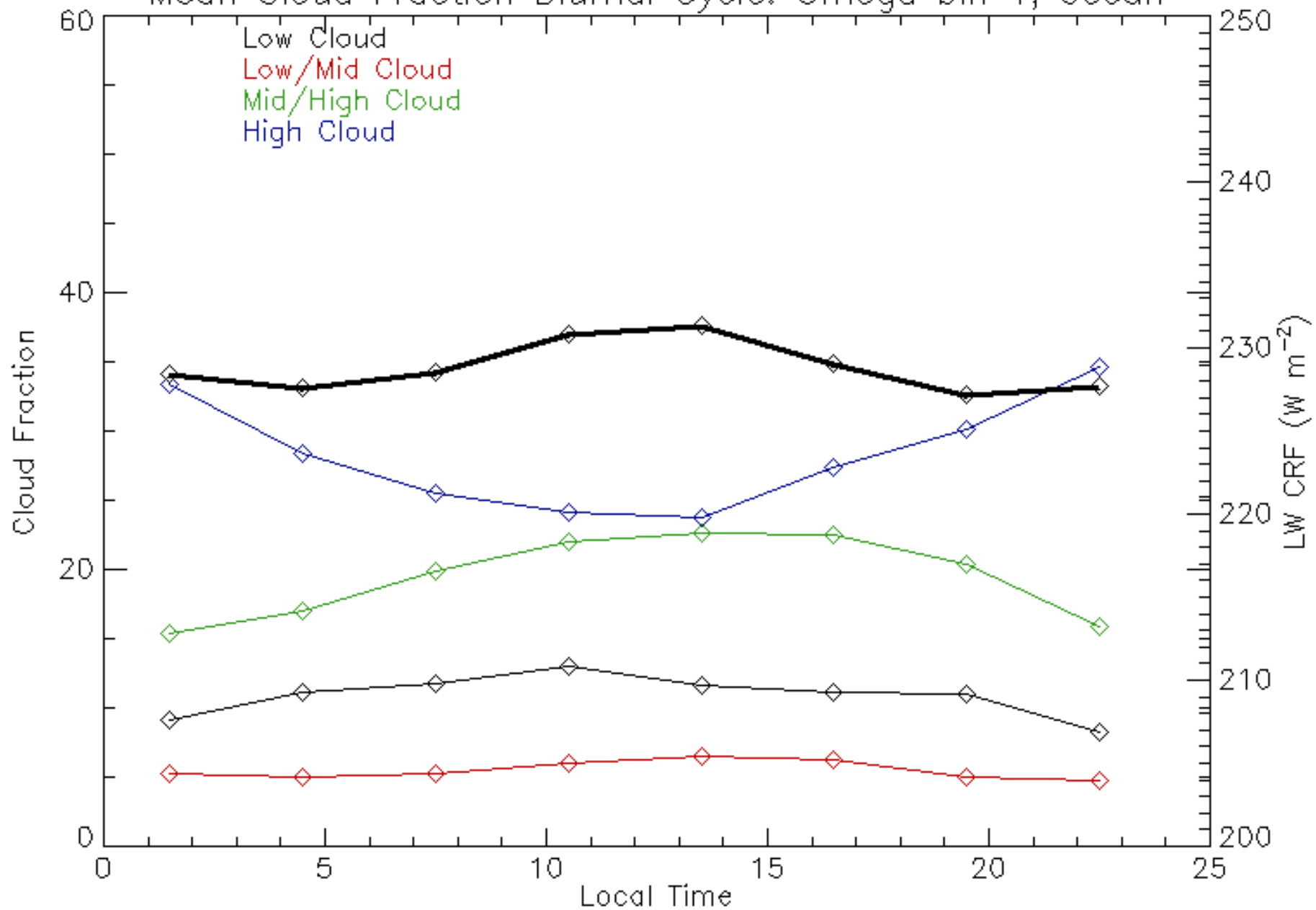
# Diurnal Amplitude—OLR Land



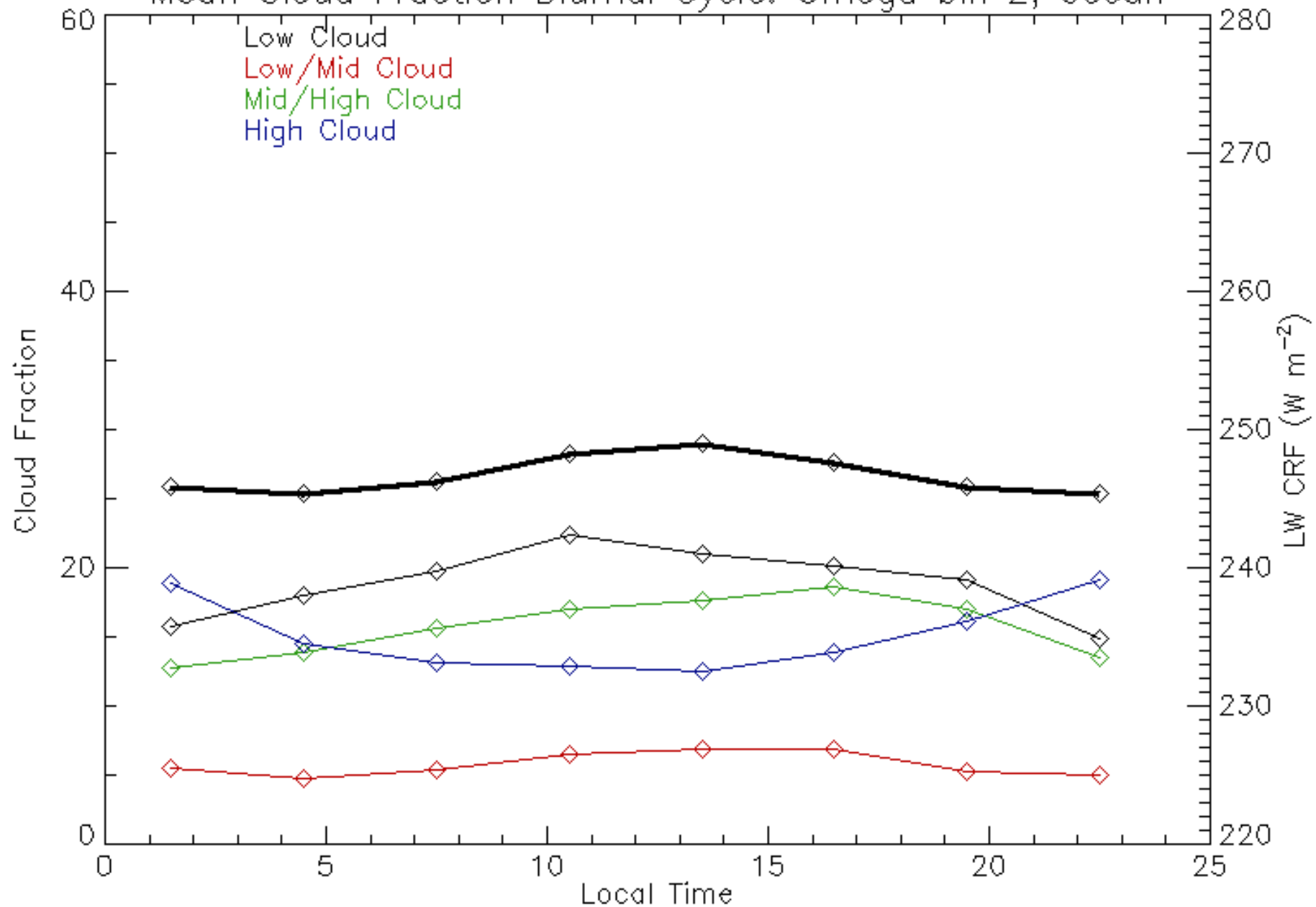
Mean Cloud Fraction Diurnal Cycle: Omega bin 0, ocean



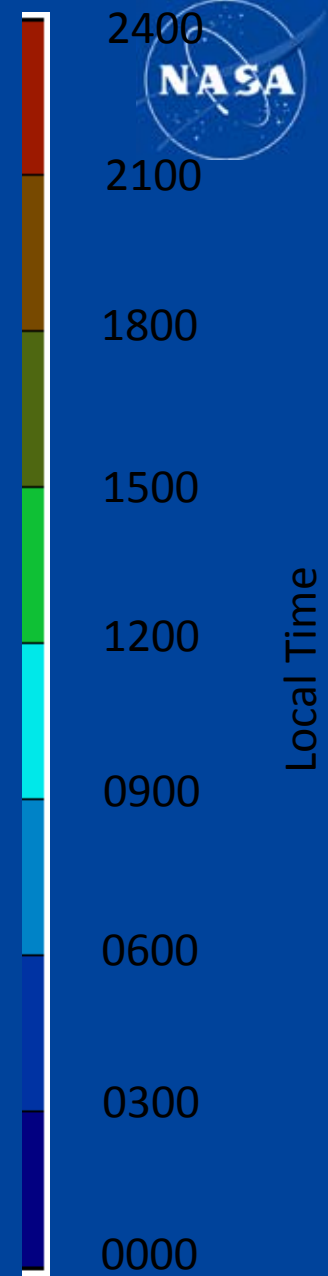
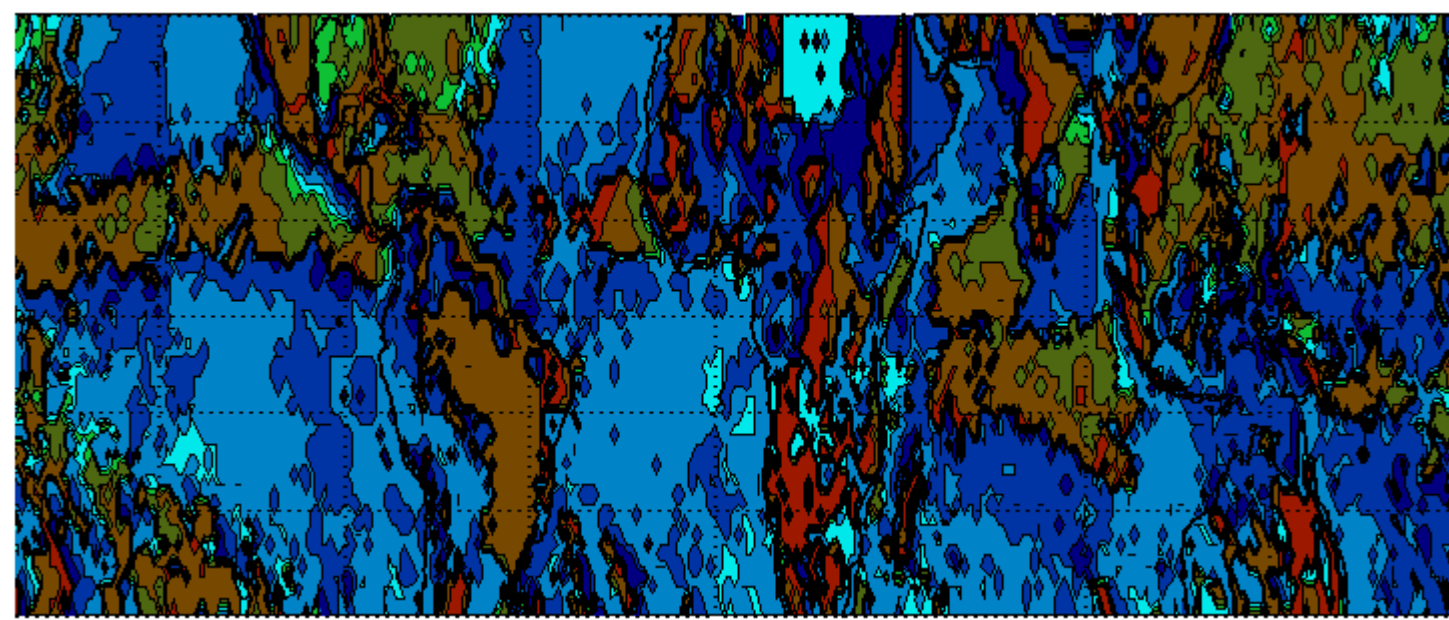
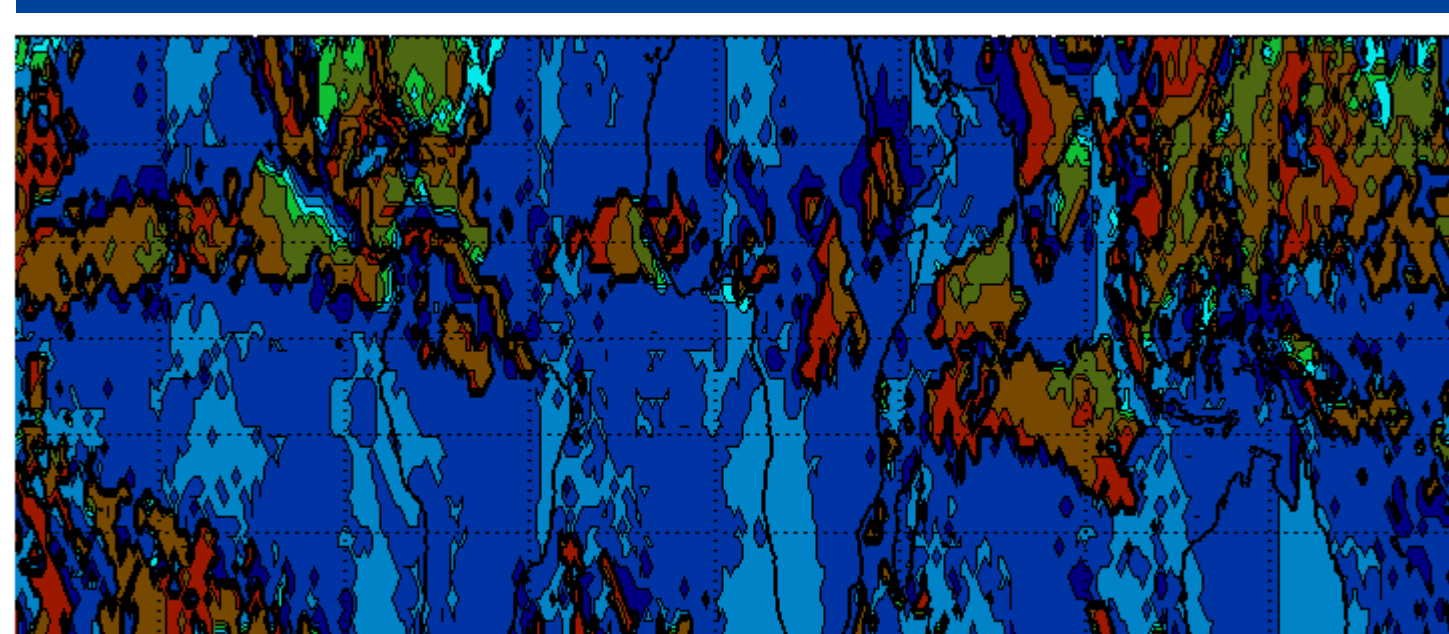
Mean Cloud Fraction Diurnal Cycle: Omega bin 1, ocean



Mean Cloud Fraction Diurnal Cycle: Omega bin 2, ocean

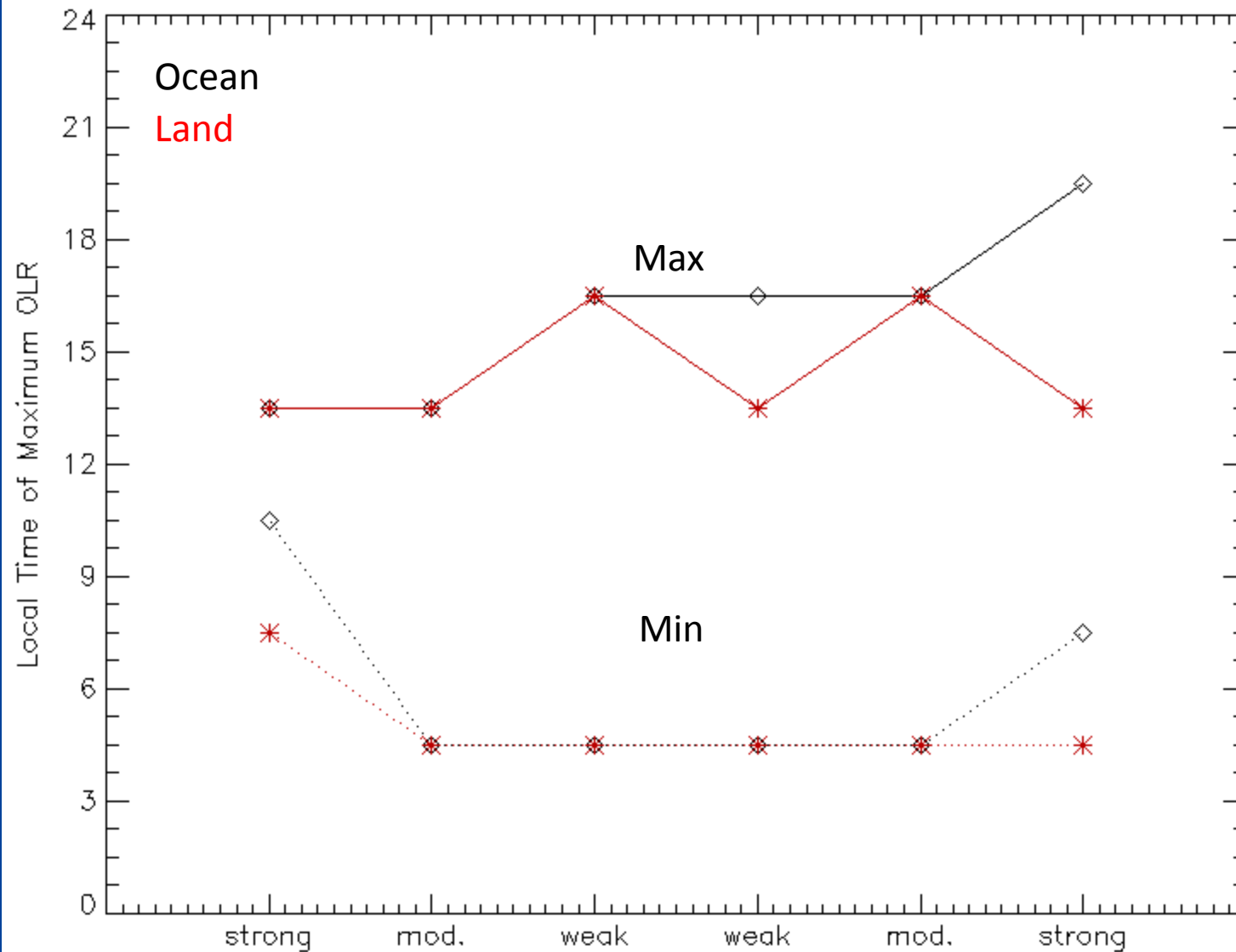


# Annual Mean Phase—OLR minimum (top) and LW CRF maximum (bottom)





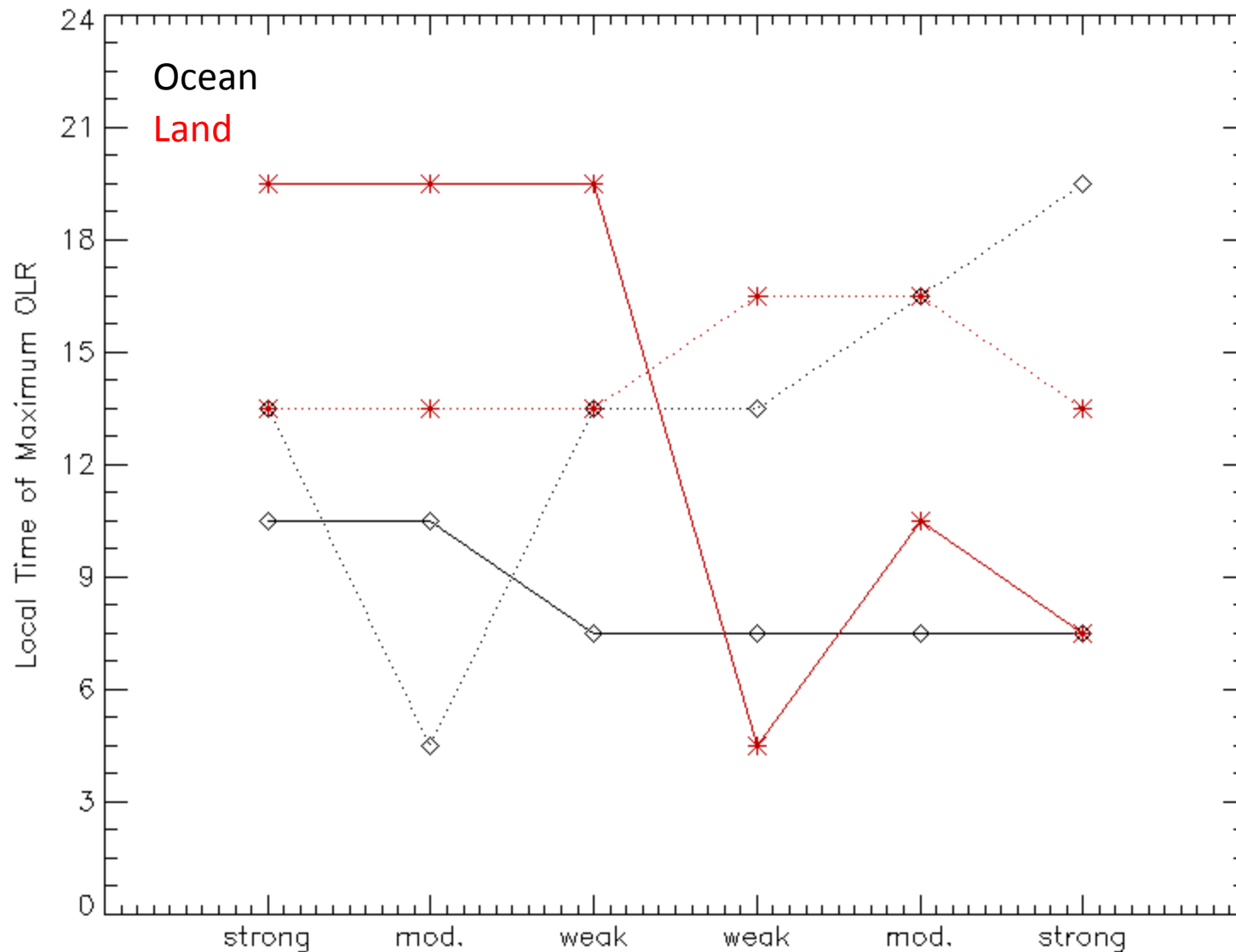
# Diurnal Phase—OLR







# Diurnal Phase—LW CRF





- What clouds are contributing to this LW CRF diurnal cycle amplitude?
  - One main point is that the percentage of high clouds drives aspects of the mean olr diurnal cycle within dynamical regimes.
- Frequency and intensity of convection drives the PDF of amplitude.
- Phase is really unanswered right now.
- How does diurnal cycle affect mean OLR?
  - Use the plots of mean olr for different size diurnal amplitudes
  - Does the mean OLR depend on local time of max or min OLR, or LW CRF.



# Approach

- Define Tropics as 30 N to 30 S
- Define dynamical regime using ERA-interim 500-hPa vertical velocity
- Analyze characteristics of the diurnal cycle within this framework.