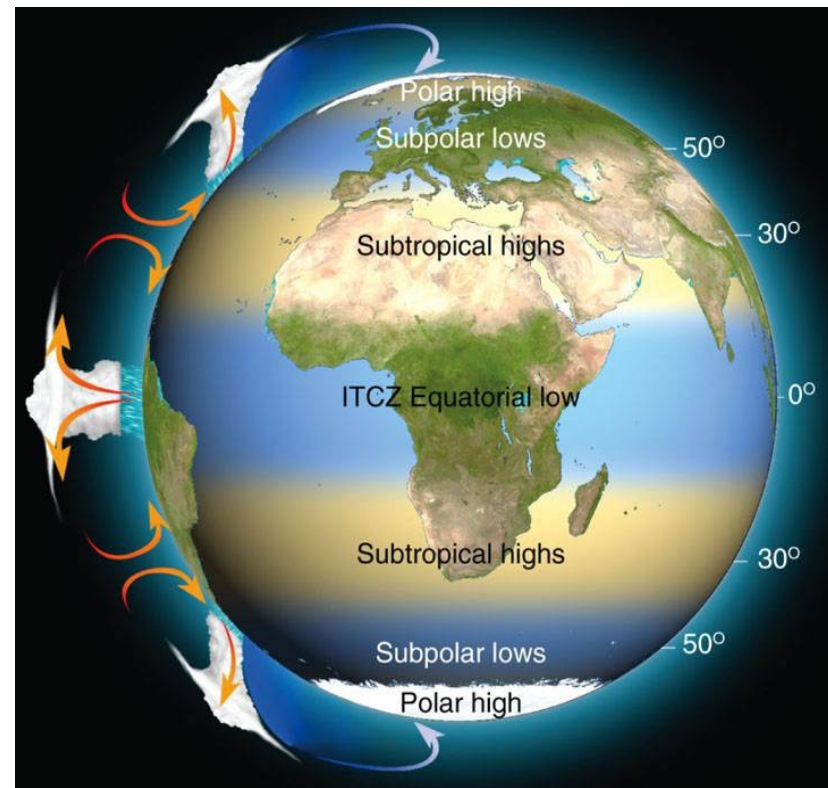
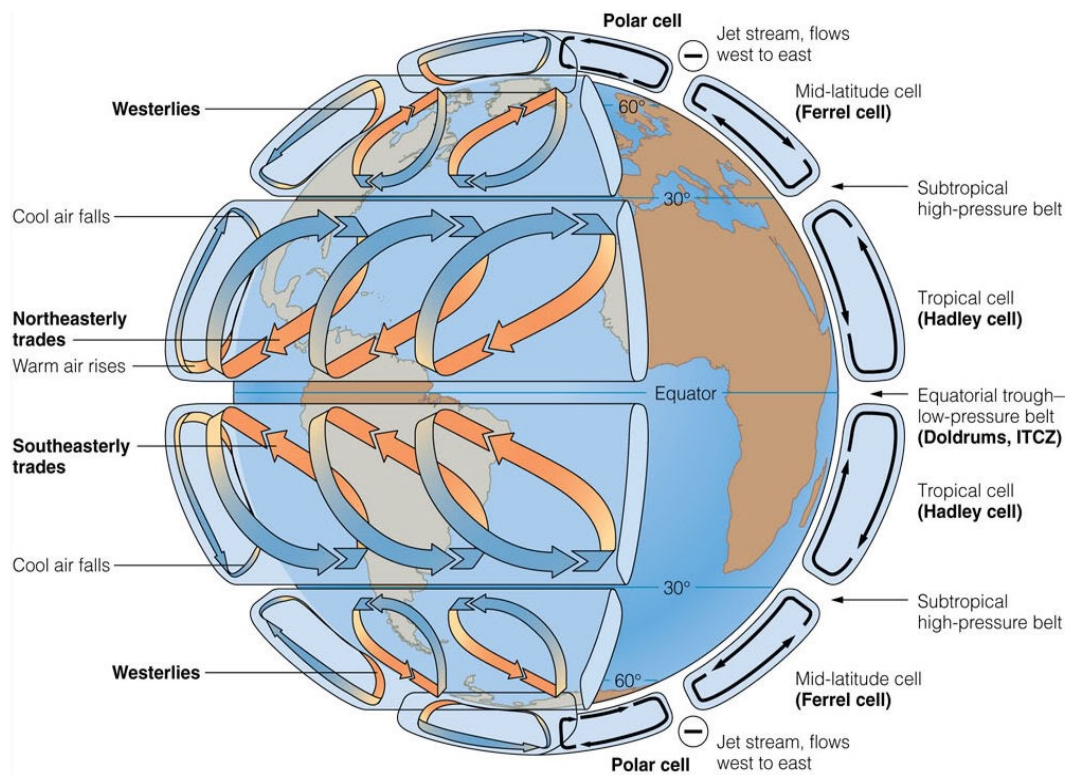


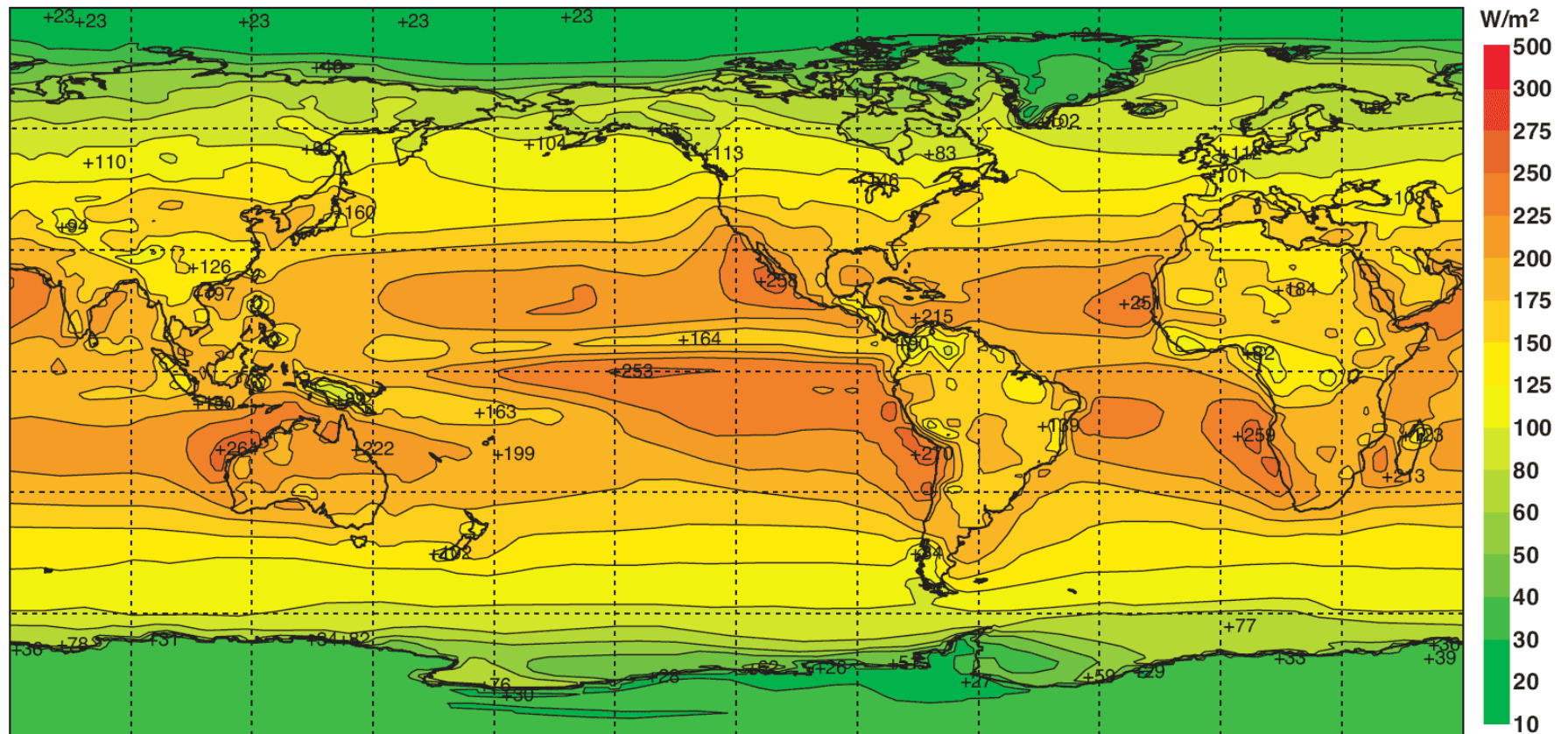
# What causes the time mean circulation pattern?



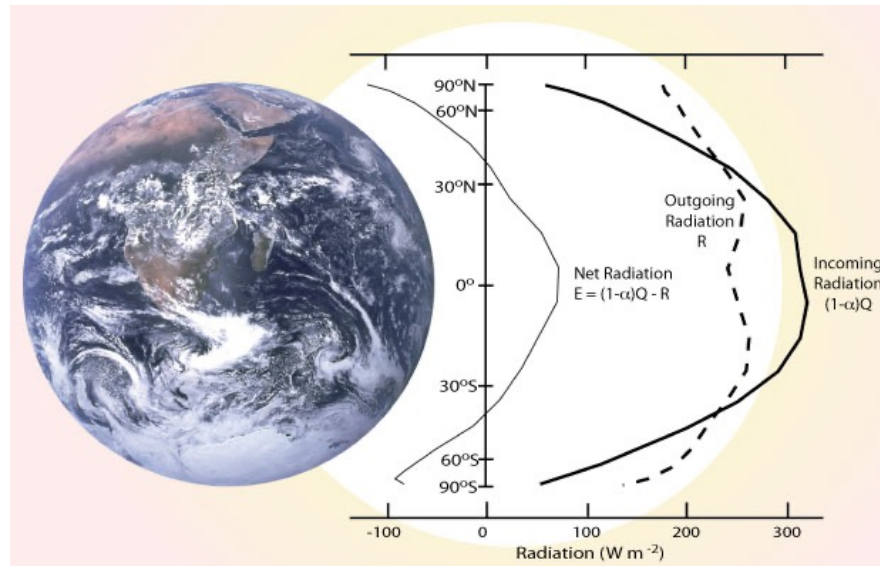
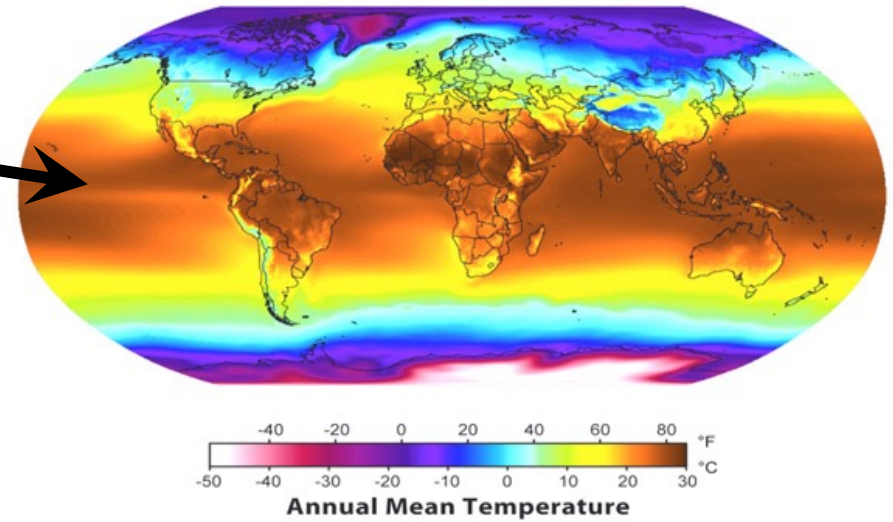
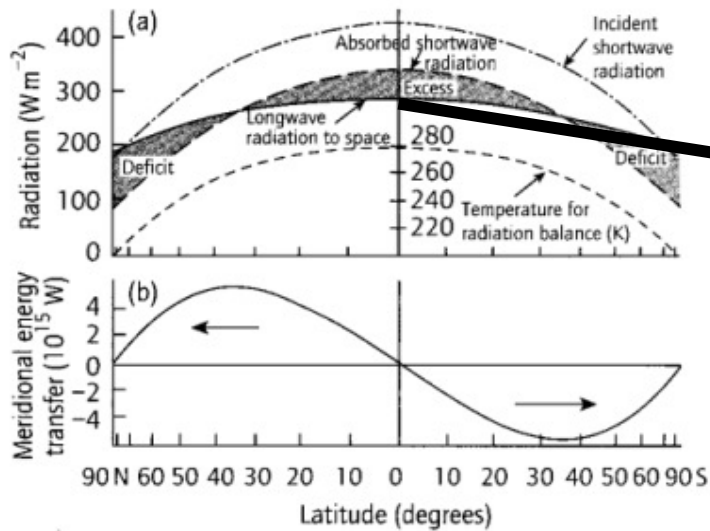
# Average annual surface solar radiation

Net surface solar radiation

Annual mean

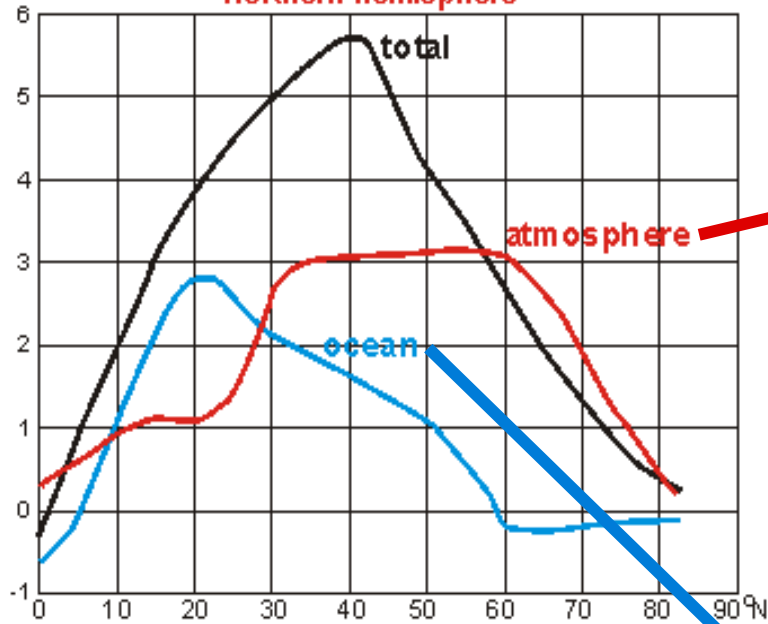


# Earth's energy balance

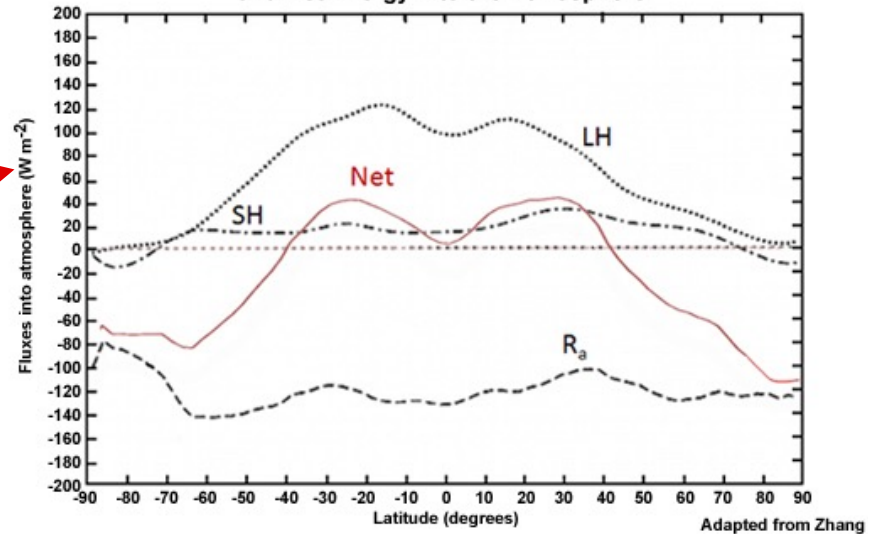


# Heat transport in the atmosphere and ocean

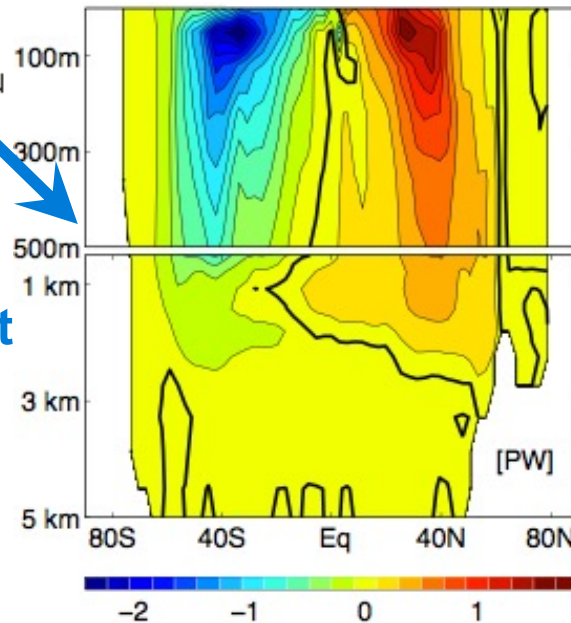
Northward heat transport in PW ( $10^{16}$  W), Northern hemisphere



Annual Mean Net Radiative Cooling, Latent Heat and Sensible Heat Fluxes, and Net Energy into the Atmosphere



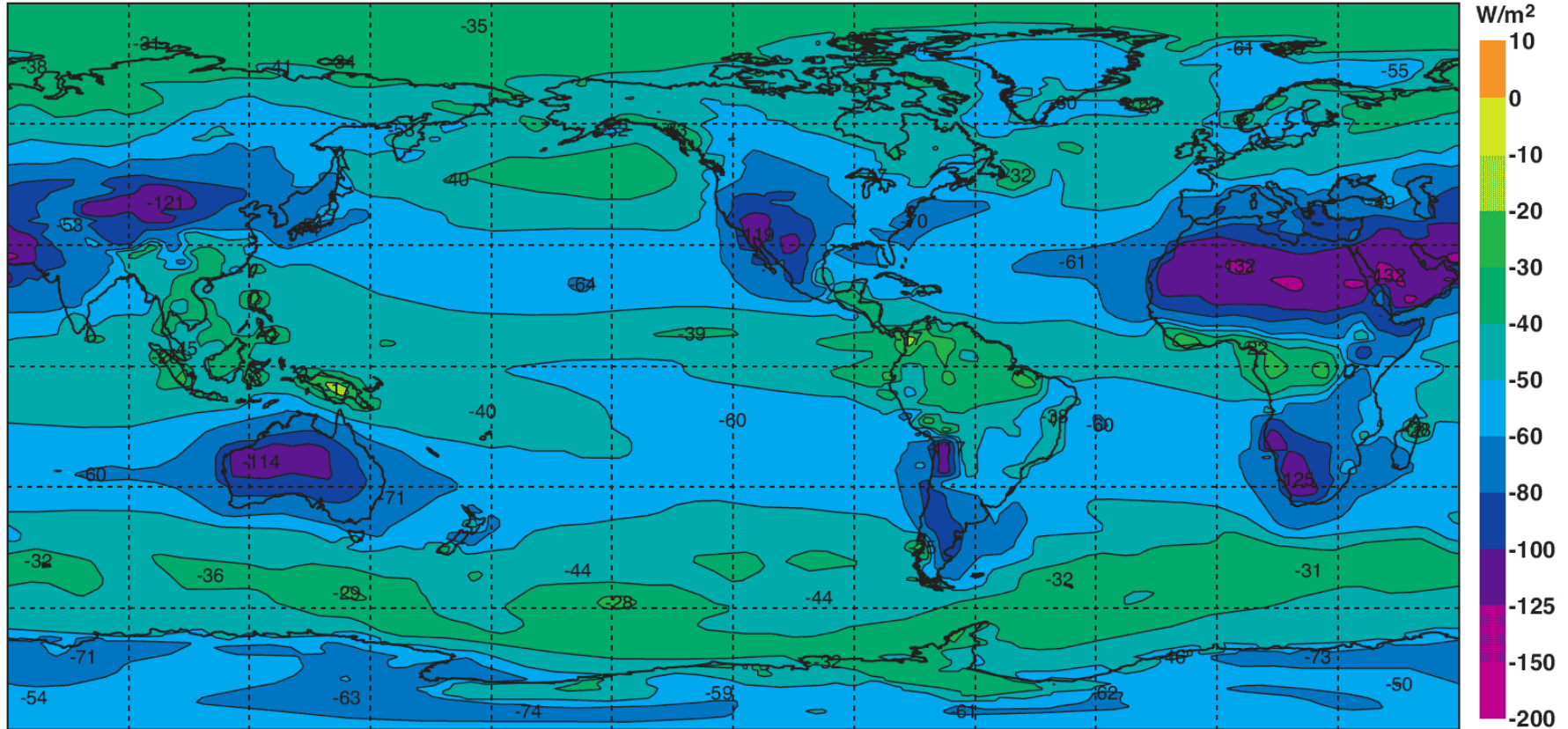
Meridional ocean heat transport



# Average sensible heat fluxes are small

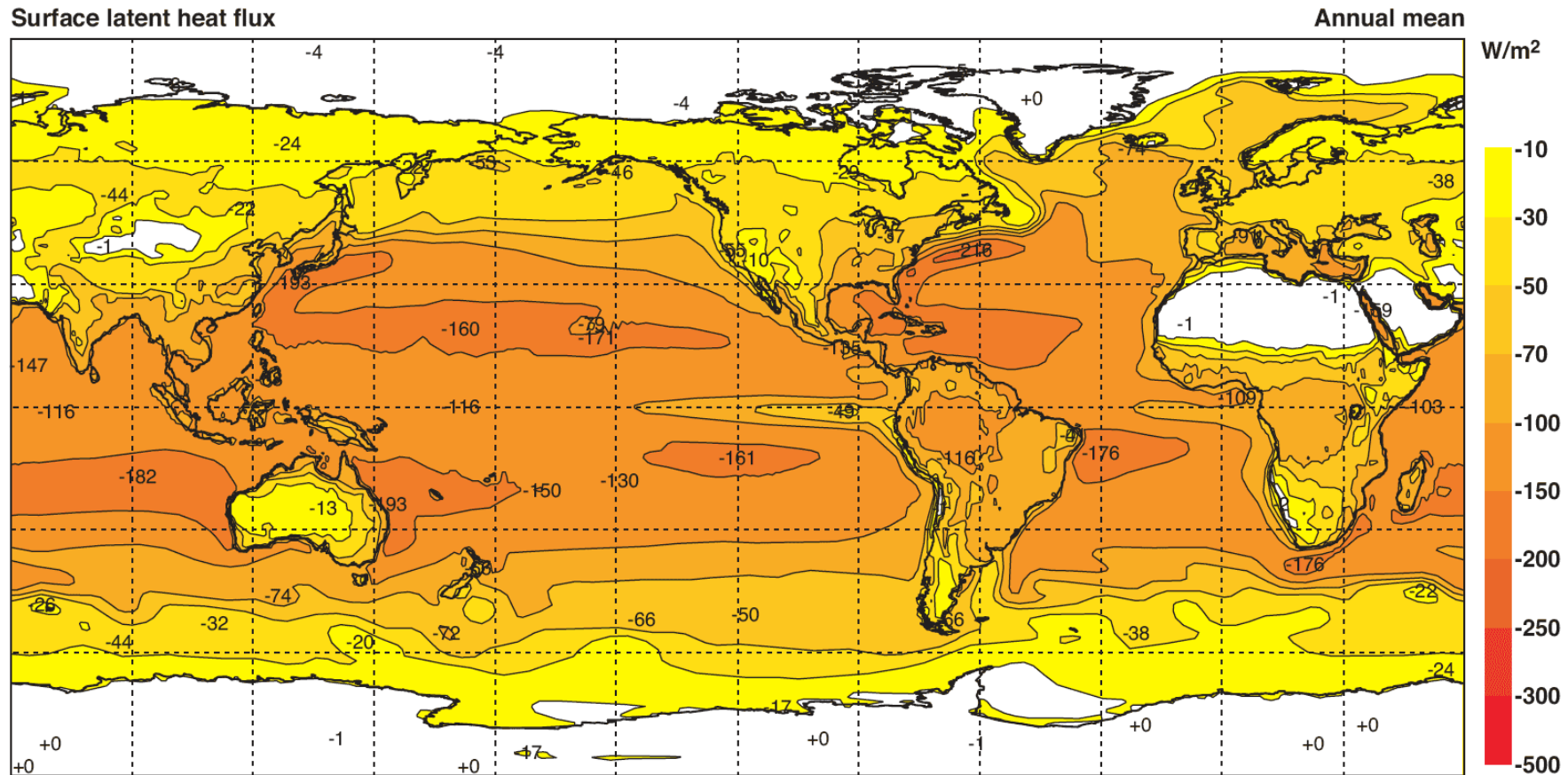
Net surface thermal radiation

Annual mean



\* Note sign change from last class because surface, as opposed to atmosphere

# Latent heat fluxes dominate the tropics

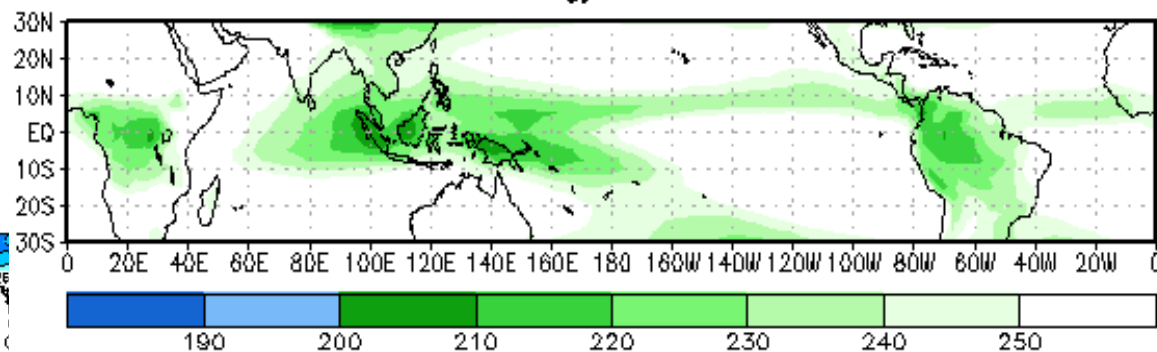
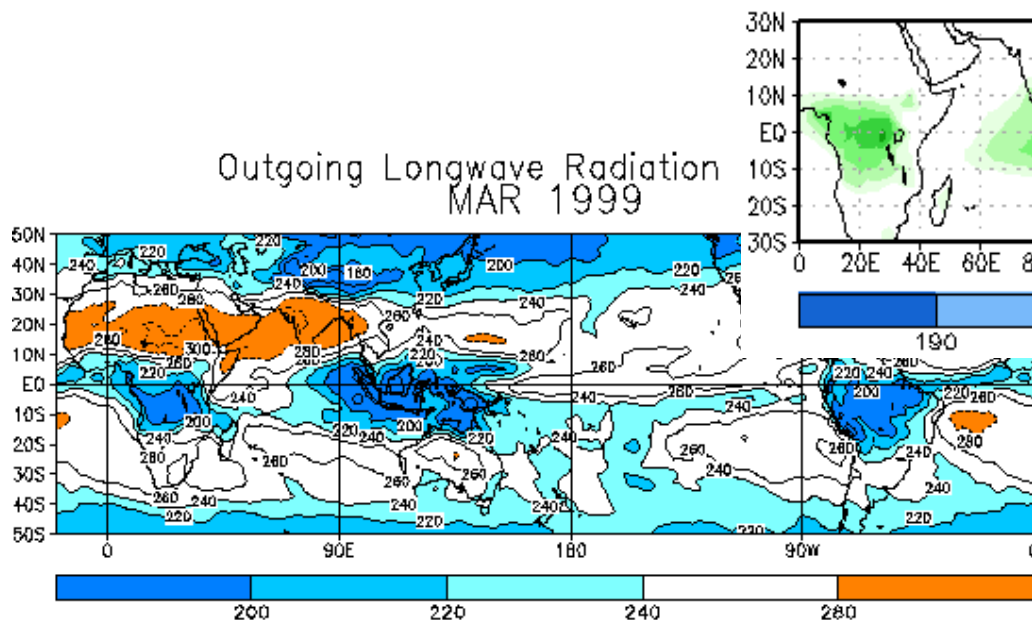


# Outgoing longwave radiation (OLR)

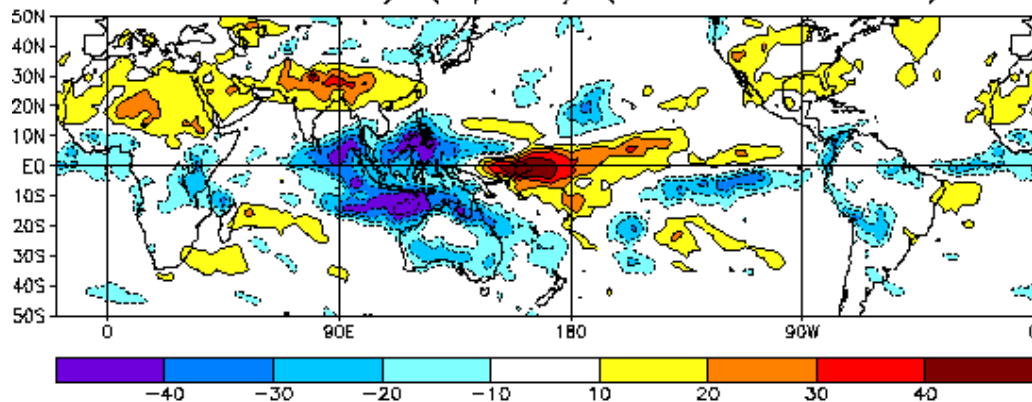
Annual Mean OLR ( $\text{W/m}^2$ )

Climatology: 1979–1995

Outgoing Longwave Radiation  
MAR 1999

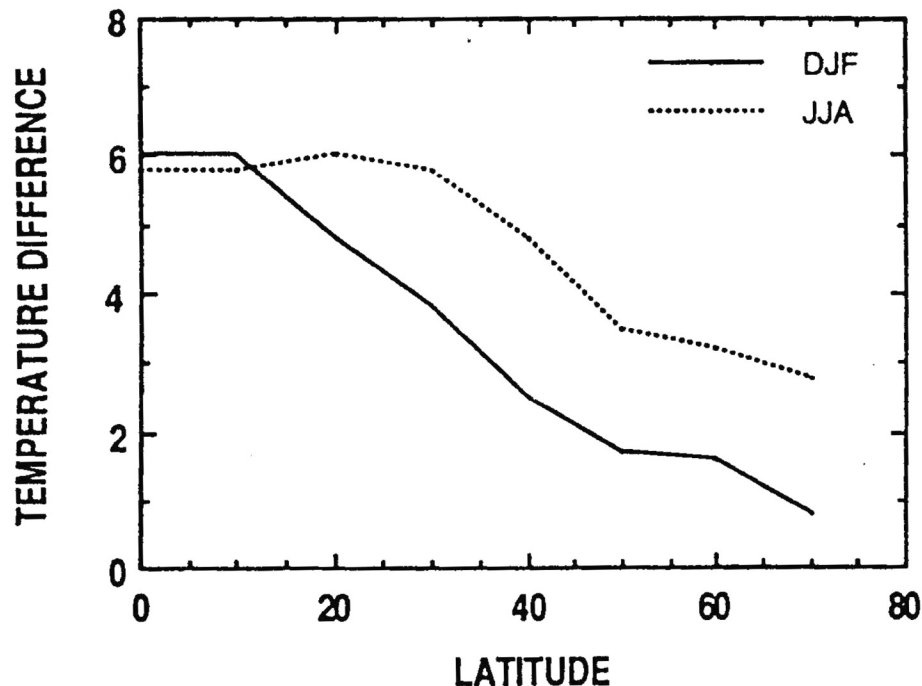


OLR Anomaly ( $\text{W/m}^2$ ) (1979–95 Climo)



# Tropical vs. midlatitude convection

TEMPERATURE DIFFERENCE BETWEEN PARCELS LIFTED  
1 KM DRY ADIABATICALLY AND MOIST ADIABATICALLY



The net increase of temperature ( $\Delta T$ ) beyond adiabatic effects for raising a parcel 1 km.  $\Delta T$  is plotted as a function of latitude for summer and winter. Note the large difference in temperature realized for the same amount of work close to the equator compared to higher latitudes. About a factor of two in  $\Delta T$  also occurs between the warm pools of the western Pacific Ocean and the colder equatorial waters further east.