**Key Concepts**

Vertical Structure: Troposphere, Stratosphere, Mesosphere, Thermosphere

Forcing: Unequal distribution of solar radiation

Hadley Circulation; ITCZ: Intratropical Convergence Zone

Jet Stream & instabilities => cyclogenesis

Surface pressure distribution

[Climate variability: Walker Circulation, Monsoons]

Surface Wind Stress: \( \tau = \rho_{\text{air}} C_d (U_{10})^2 \)

Mean distribution of wind stress on the ocean (Trades, Westerlies)

**PROBLEMS:**

1. Suppose you were riding along the winter jet stream in a high altitude balloon. How long would it take to circumnavigate the globe? Assume the stream is located at a latitude of 30° and has a mean velocity of 40 m/s. (Radius of earth = 6371 km)

2. A lake 15 km long is initially at rest with no wind blowing on it. One day, a steady wind starts to blow along the axis of the lake at a rate of \( u_{10} = 10 \) m/s. After several days, the lake comes into equilibrium with the wind stress. Calculate the wind stress. In steady state this stress is balanced by the hydrostatic pressure force of the elevated water at the downwind shoreline. What is the final difference in height of the water between the upwind and downwind end of the lake? [Density of air = 1.3 kg/m³; Drag Coefficient from Stewart fig 4.6]
Fig. 1.12 Meridional cross section of longitudinally averaged zonal wind in meters per second at the time of the solstices. Positive zonal winds denote flow from west to east. (Courtesy of R. J. Reed.)
Fig. 1.15  Annual average sea level pressure in millibars. [From Mon. Wea. Rev., 104(12) (1976).]
Jet Stream Instabilities

(a) Cold

(b) Cold

(c) Cold

(d) Cold

1800Z SURFACE ANALYSIS
ISSUED 1857Z FRD DEC 12 2005
BY HPC ANALYST, CDG
COLLABORATING CENTERS: HPC, TPC, DPC
Mean Zonal Wind Stress (units of 0.1 N/m²)