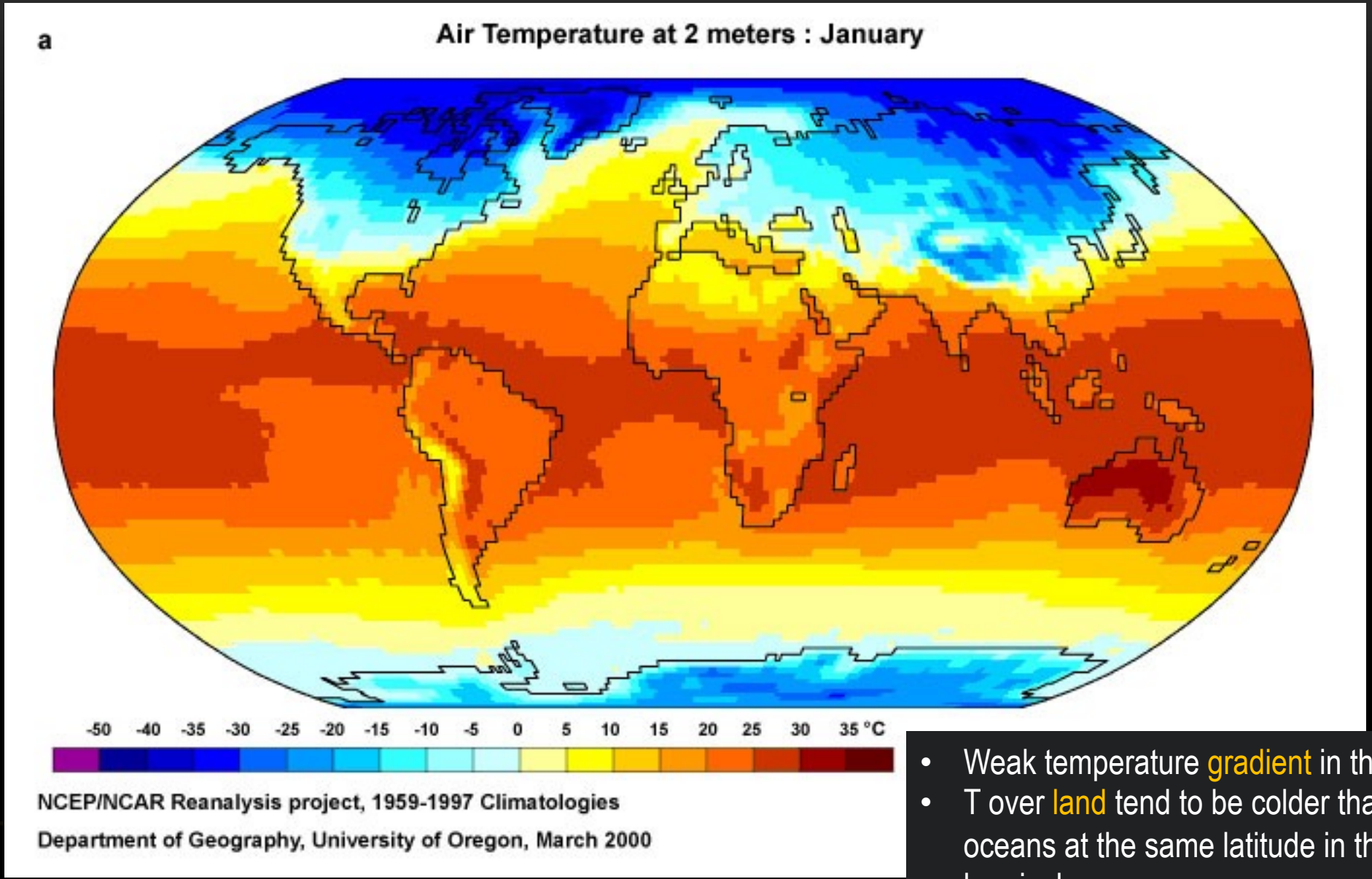
Atmospheric General Circulation: Observed Climatology and Seasonal Variations

Outline

- Temperature
- Sea-level Pressure
- Precipitation

Temperature

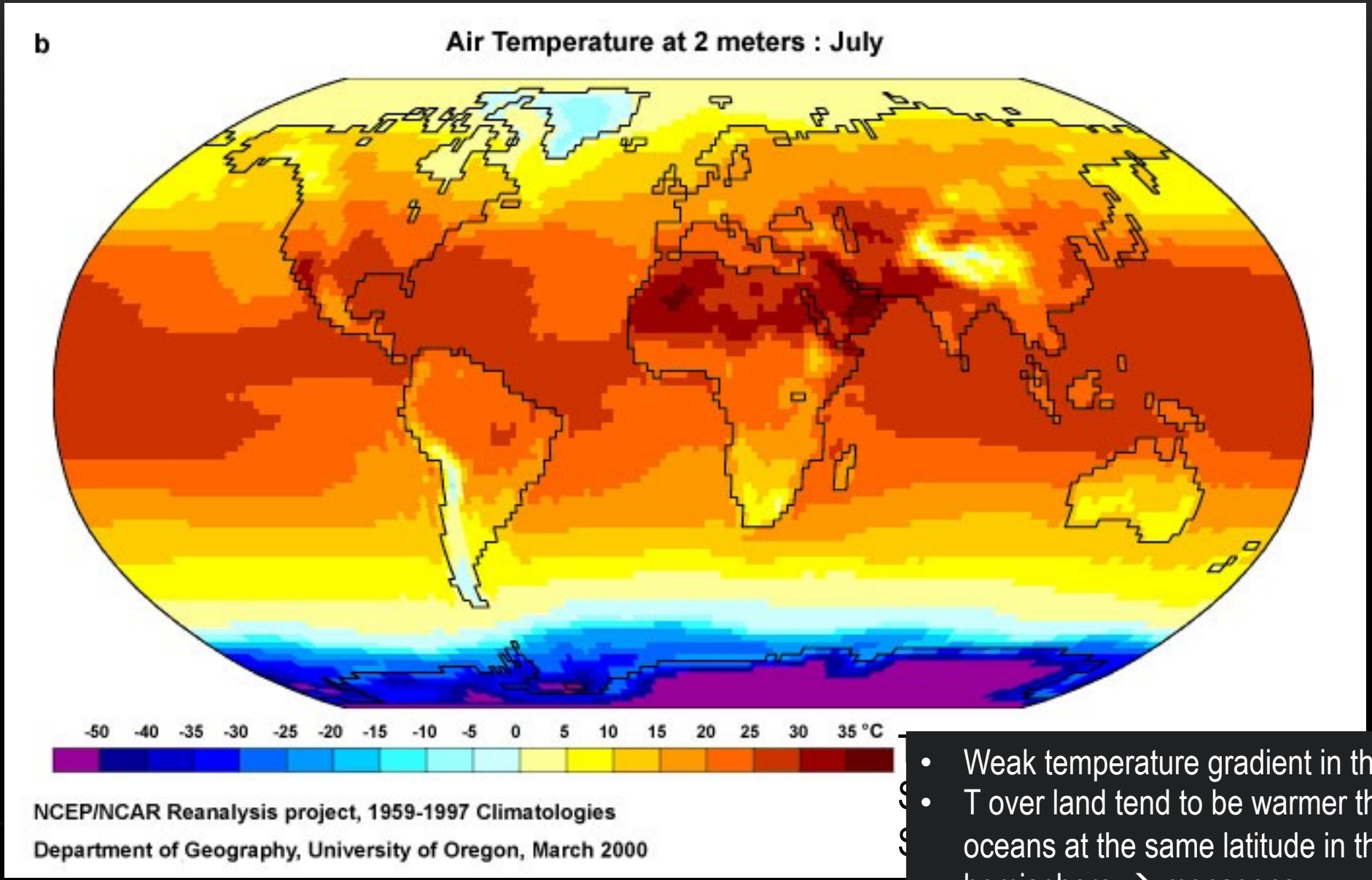
Please describe the differences in T and T gradient between the tropics and extratropics; land vs. ocean



(Figure from Introduction to Tropical Meteorology, 2nd Edition, © 2011 COMET.)

- Weak temperature gradient in the tropics
- T over land tend to be colder than over the oceans at the same latitude in the winter hemisphere
- T2m is modulated by topography

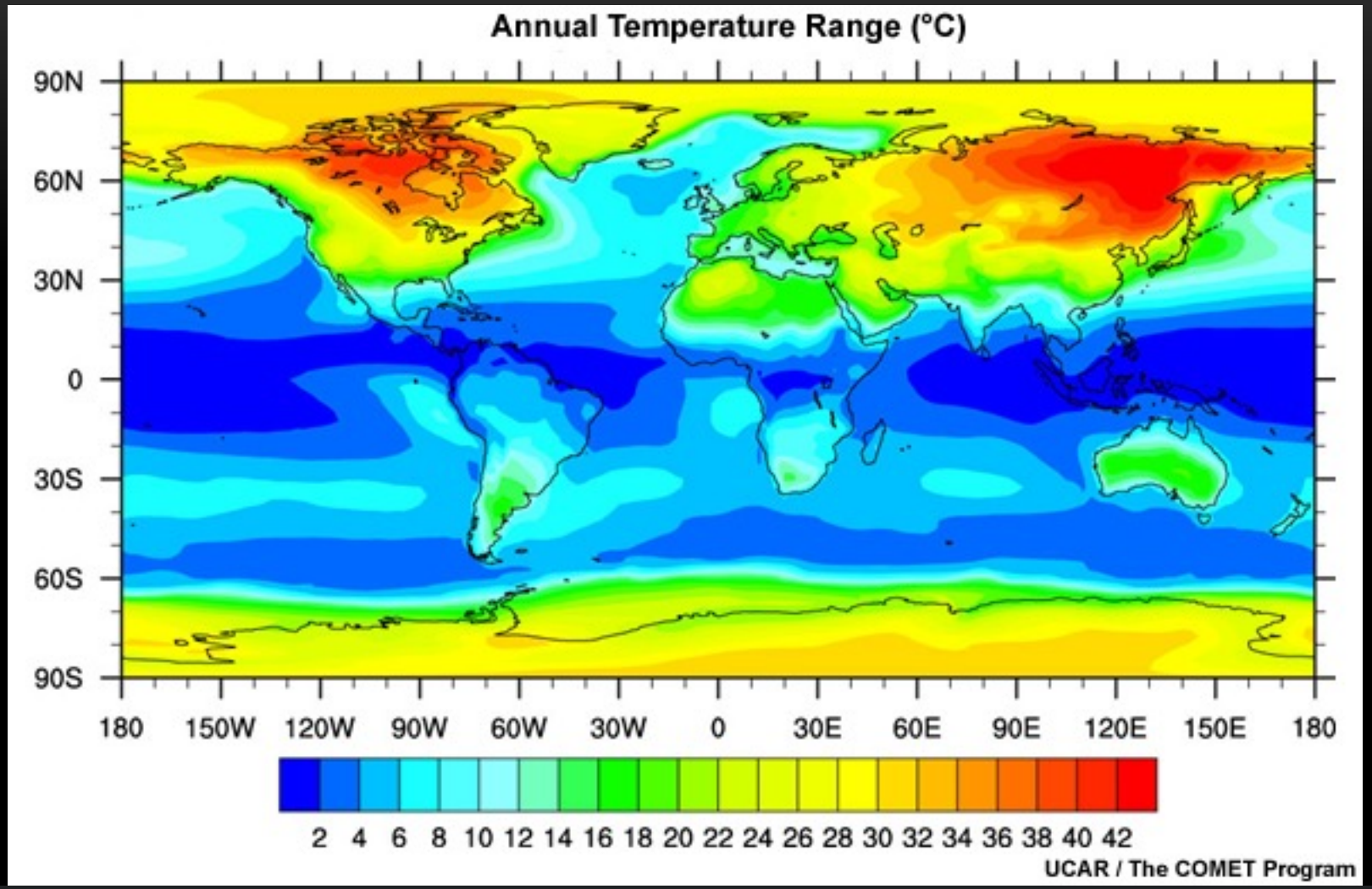
Please describe the differences in T and T gradient between the tropics and extratropics; land vs. ocean



- Weak temperature gradient in the tropics
- T over land tend to be warmer than over the oceans at the same latitude in the summer hemisphere → monsoons

(Figure from Introduction to Tropical Meteorology, 2nd Edition, © 2011 COMET.)

Where do you see strong seasonality of the surface T?



- Seasonality is larger over the continents than over the oceans, and greater at high latitudes than at low latitudes.

Latitude-height Cross Section of Air Temperature: DJF and JJA

How would you describe the variations of T with latitude and altitude? Where do you see strongest meridional T gradient?

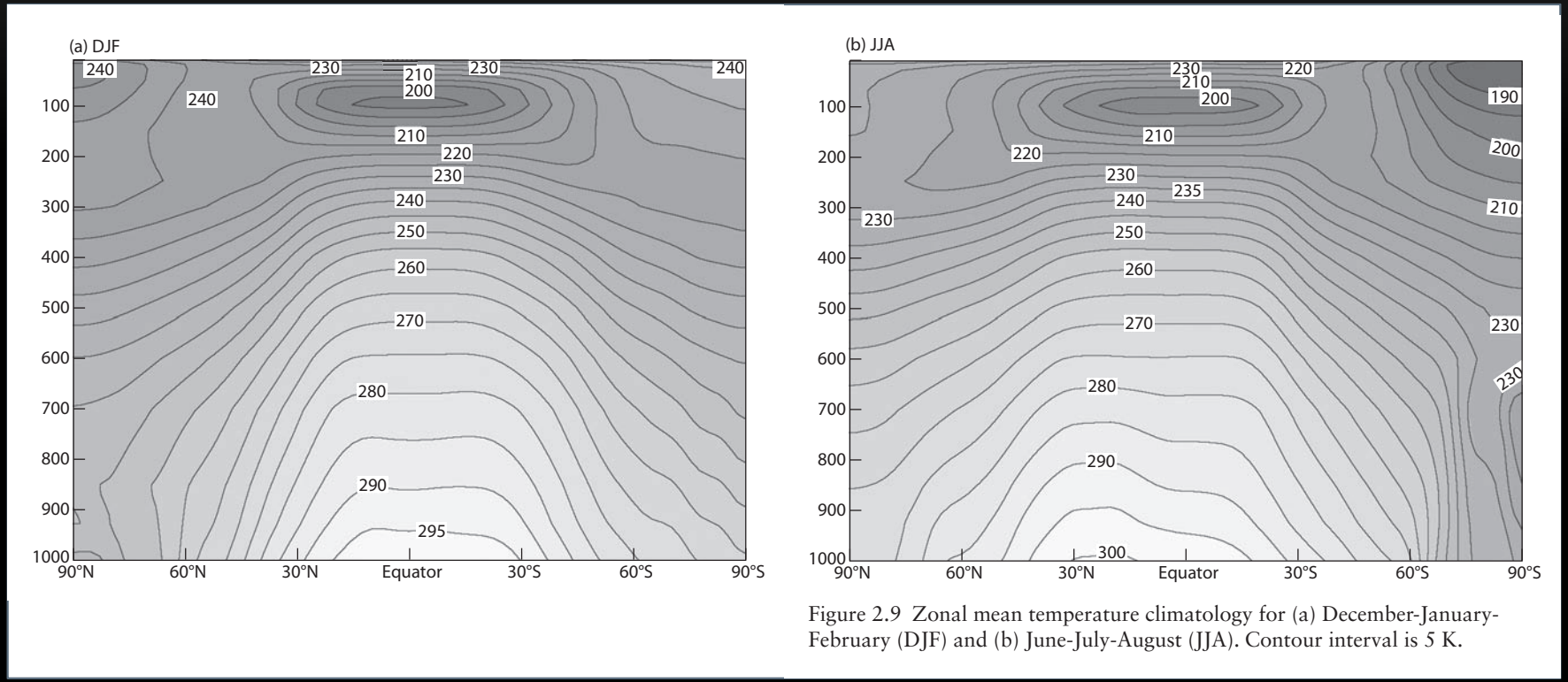


Figure 2.9 Zonal mean temperature climatology for (a) December-January-February (DJF) and (b) June-July-August (JJA). Contour interval is 5 K.

From Climate Dynamics, K. H. Cook 2013

- T decreases poleward and with height in the troposphere.
- Large T gradient occurs in midlatitudes, collocated with the westerly jets (thermal wind balance)
- The tropopause, where the lapse rate changes sign, is located near 100 hPa deep in the tropics and comes closer to the surface in higher latitudes.
- T continues to decrease with height in the lower stratosphere at very high latitudes in the winter hemisphere (due to the lack of solar radiation).

Pressure

Long-Term Mean Surface Pressure

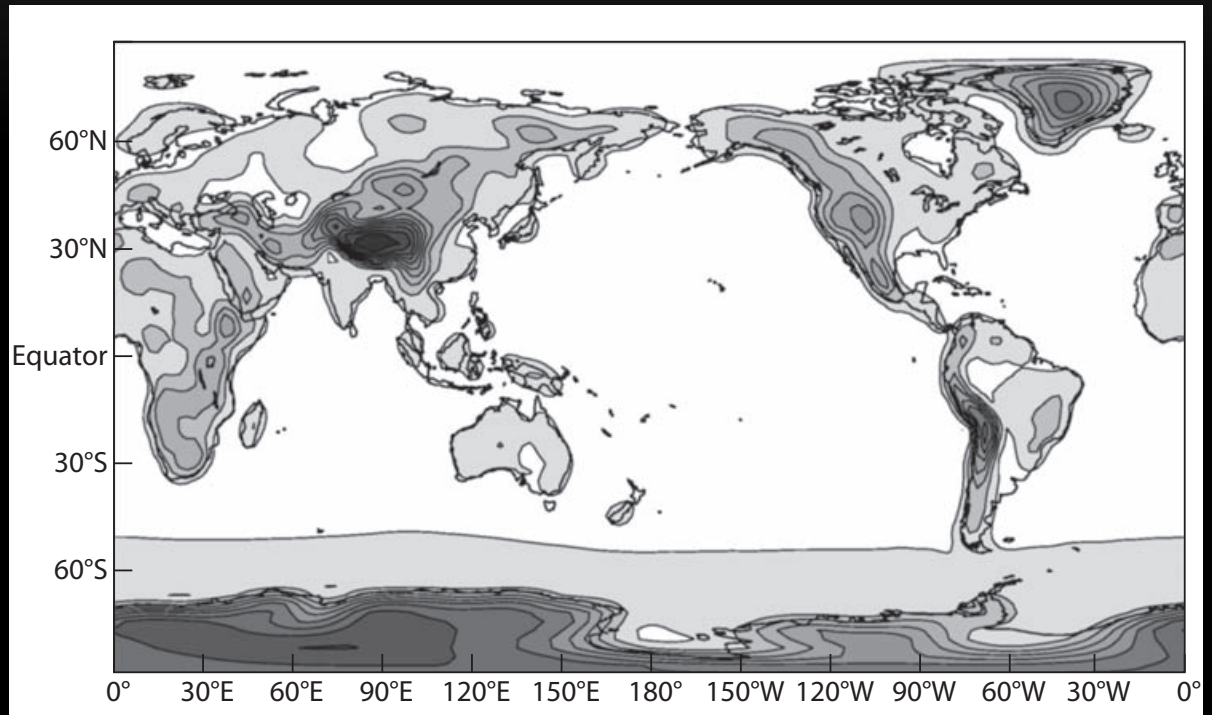
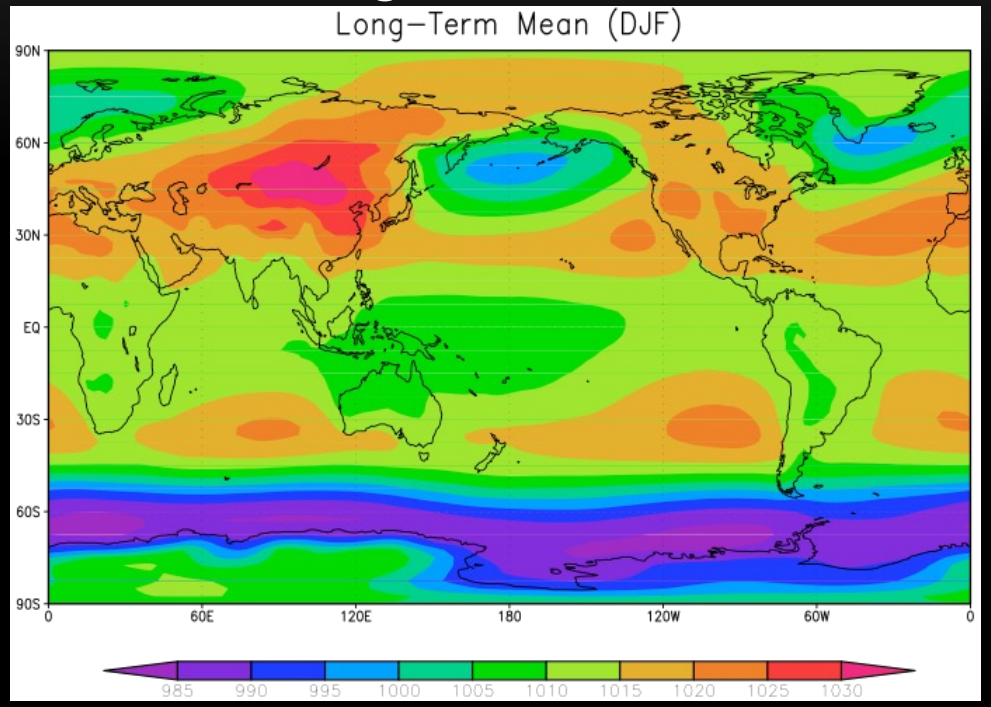


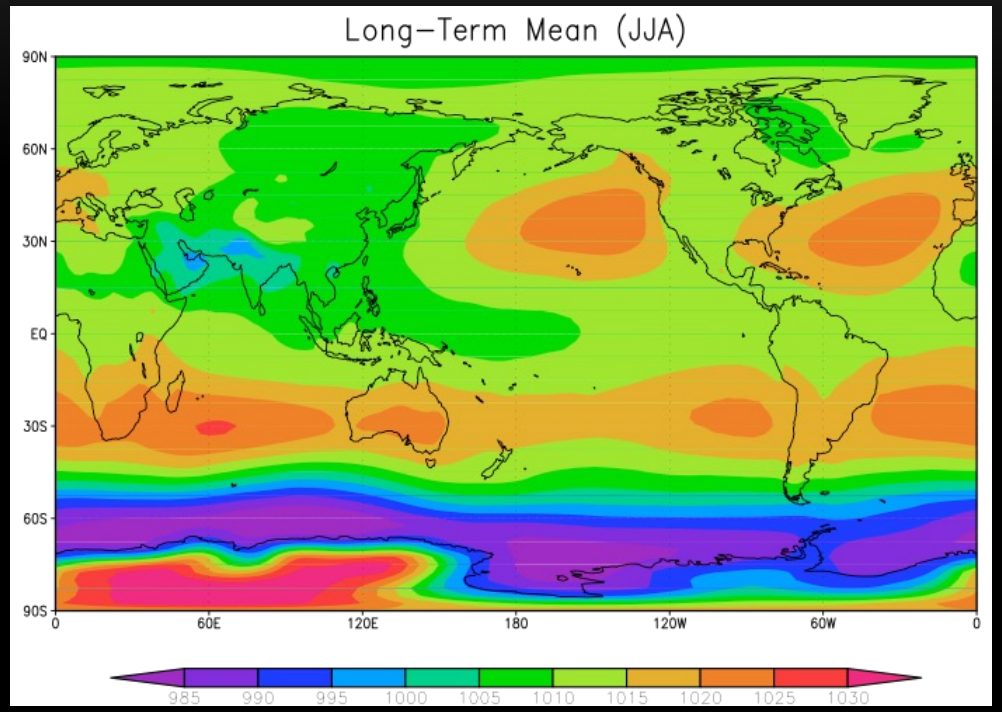
Figure 2.1 The annually averaged surface pressure climatology. Contour interval is 50 hPa.

- Surface pressure is strongly affected by topography.

From Climate Dynamics, K. H. Cook 2013

Long-Term Mean Sea Leve Pressure: DJF and JJA





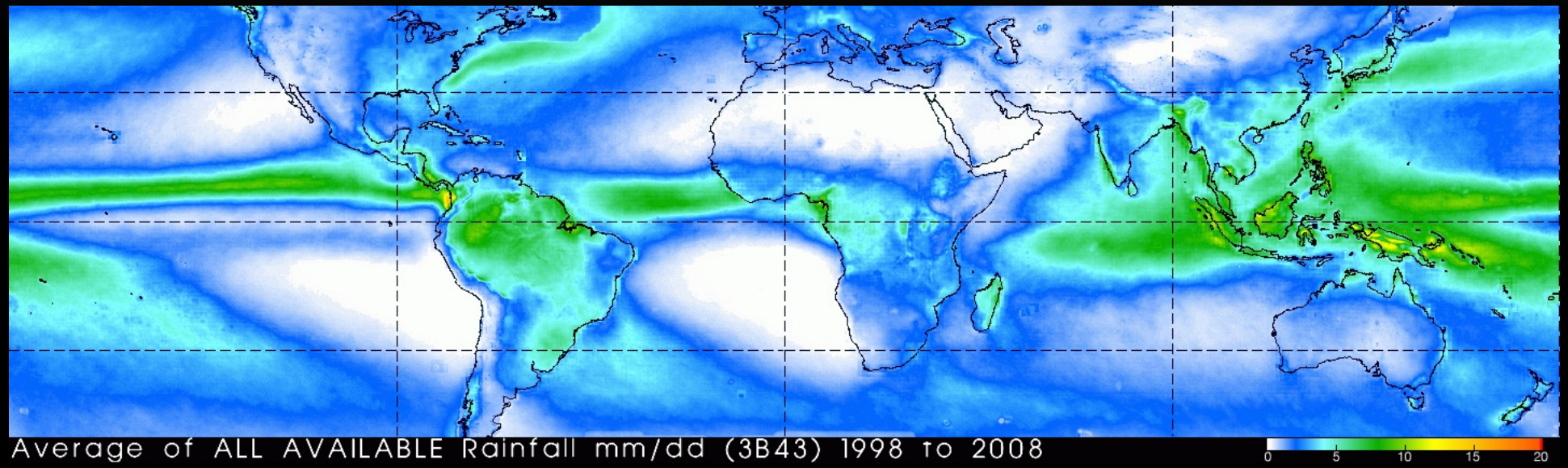
- Low SLP and weak pressure gradient in tropics
- High SLP over ocean than over land in summer and higher over land in winter. *What determines the SLP distribution?*
- Continuous high-pressure band in the winter subtropical region and isolated subtropical high centers over ocean in the summer subtropical region separated by low pressure over warm land.

Plots produced using the NCEP/NCAR reanalysis

Precipitation

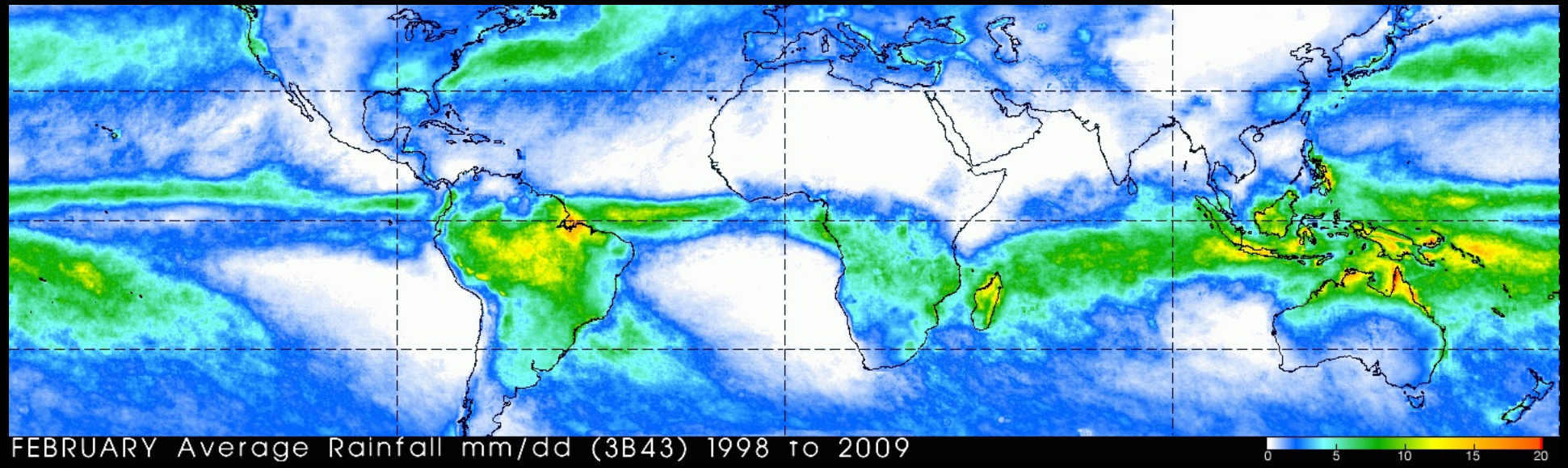
Annual Mean Precipitation (TRMM)

From http://trmm.gsfc.nasa.gov/trmm_rain/Events/trmm_climatology_3B43.html



- Heavy precipitation along the ITCZ and in monsoon regions
- Heavy precipitation in the Indonesian and Southeast Asian region (ascending branch of the Hadley cell and Walker cell).
- South Pacific Convergence Zone (SPCZ): a reverse-oriented monsoon trough characterized by low-level convergence, cloudiness and precipitation extending southeastward from tropical western Pacific
- South Atlantic convergence zone (SACZ): a counterpart of the SPCZ in the Atlantic
- Enhanced precipitation is associated with storm tracks in midlatitudes.
- Regional distribution of precipitation also affected by topography.

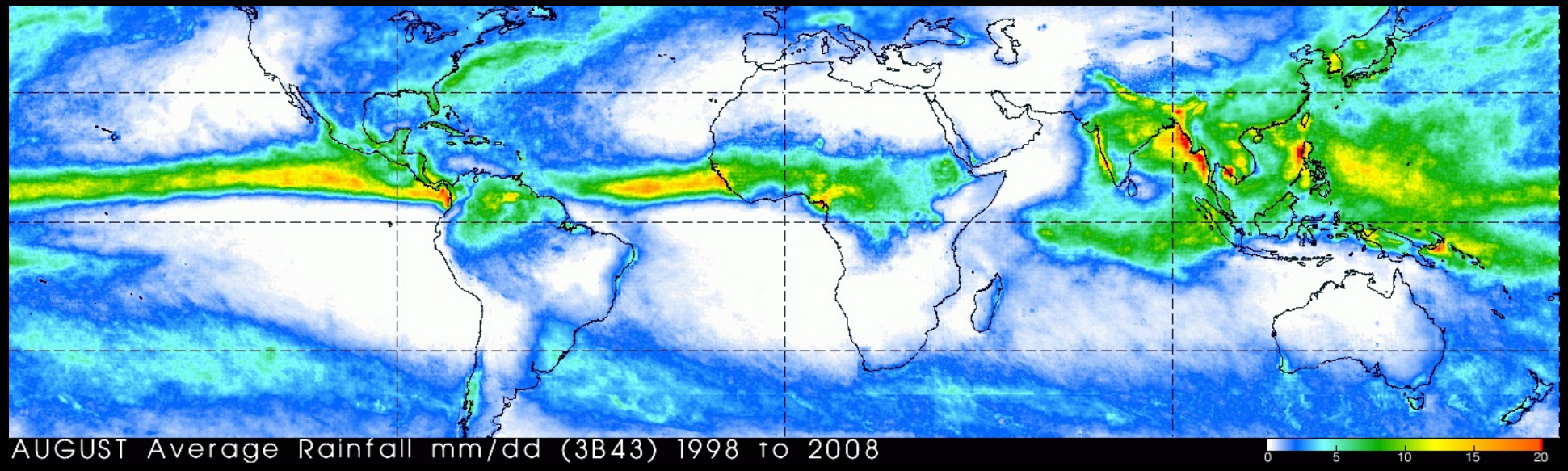
Precipitation (TRMM): Feb



- The ITCZ stays north of the equator over the eastern Pacific and the Atlantic even in boreal winter.

From http://trmm.gsfc.nasa.gov/trmm_rain/Events/trmm_climatology_3B43.html

Precipitation (TRMM): August



- Note the heavy precipitation in the South/Southeast Asian monsoon region and the African monsoon region.
- Topography plays an important role in the regional distribution of precipitation.

From http://trmm.gsfc.nasa.gov/trmm_rain/Events/trmm_climatology_3B43.html

References

- Cook, K. H., 2013: section 2.1
- COMET MetED: Introduction to Tropical Meteorology, 2nd Edition, Chapter 3: Global Circulation. Understanding Assimilation Systems: How Models Create Their Initial Conditions - version 2. The source of this material is the COMET® Website at http://meted.ucar.edu/ of the University Corporation for Atmospheric Research (UCAR), sponsored in part through cooperative agreement(s) with the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce (DOC) ©1997-2010 University Corporation for Atmospheric Research. All Rights Reserved.