

PHY392S

Physics of Climate

Lecture 21

Supplementary slides

Seasonal variations in the net flux at the TOA

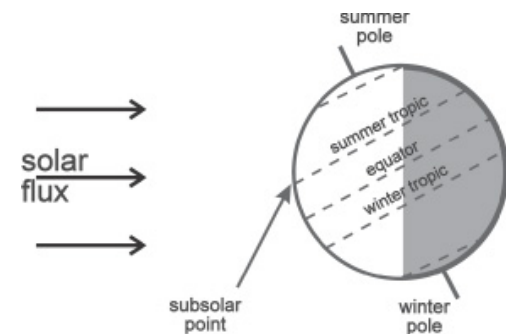
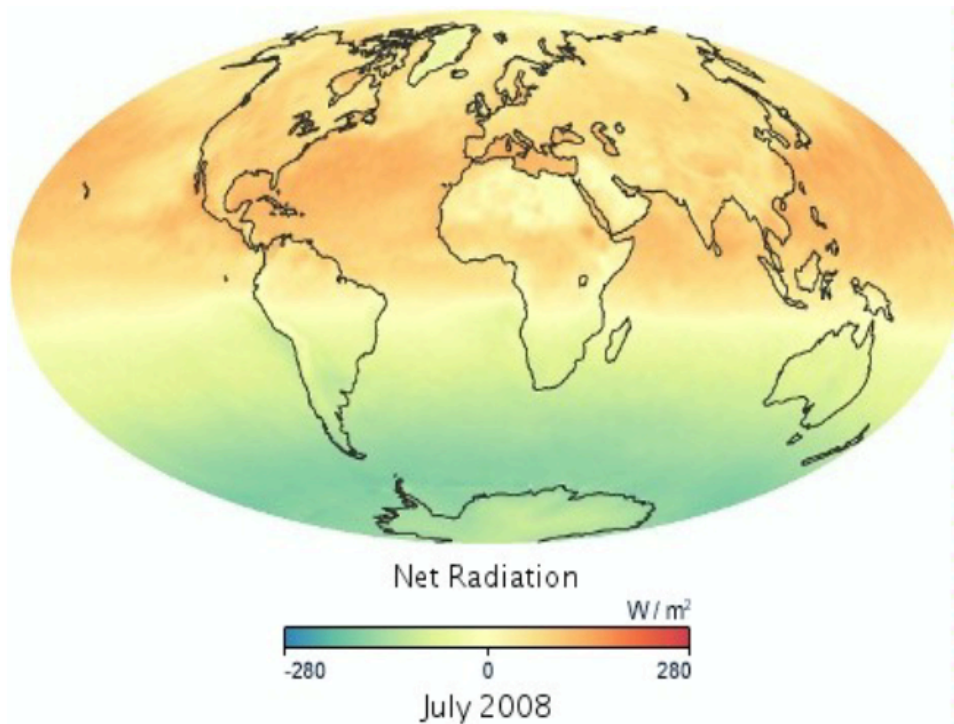


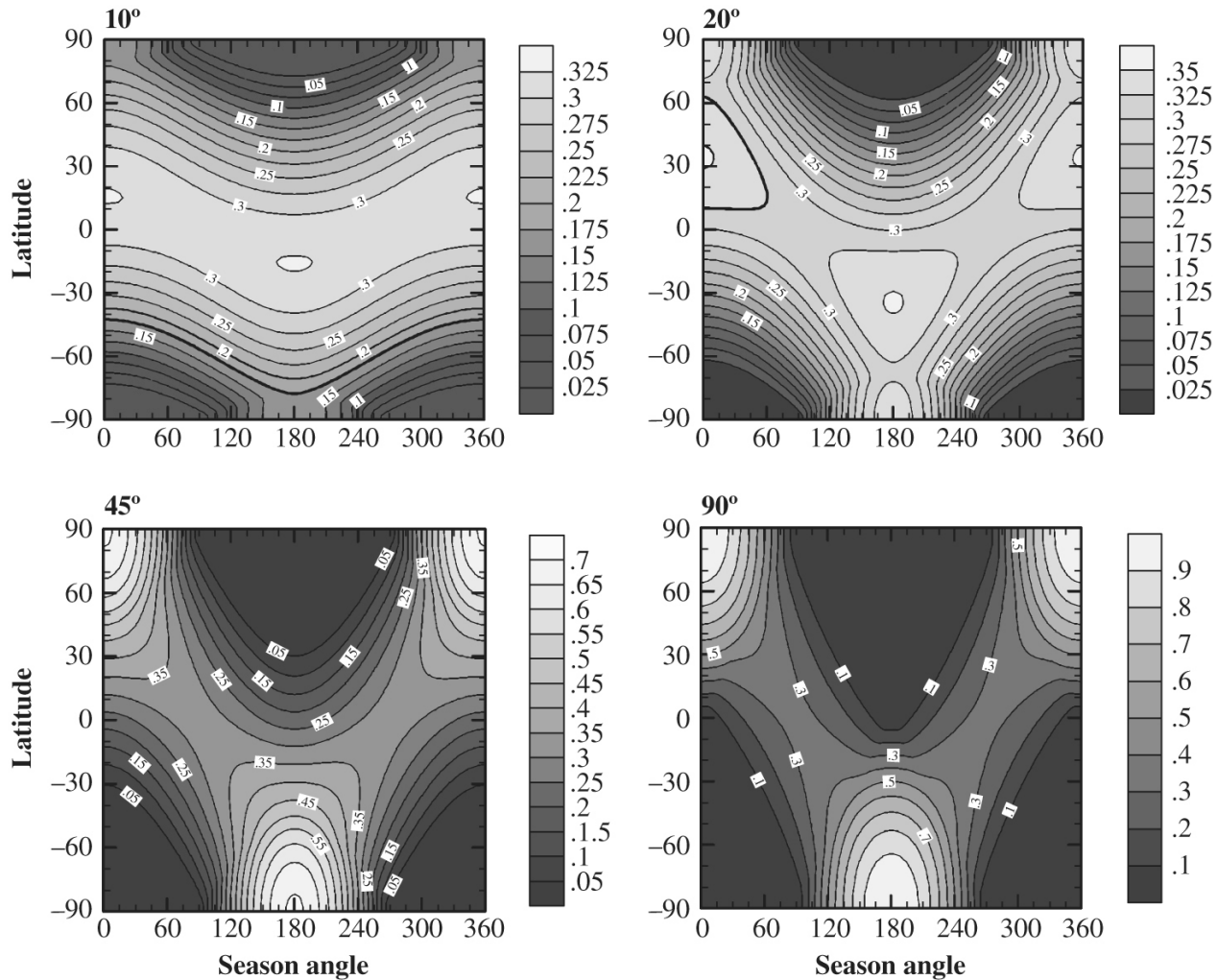
Figure 5.3: At the present time in history, the Earth's axis tilts at 23.5° and points towards the North Star. We sketch the incoming solar radiation at summer solstice when the Earth is tilted toward the Sun

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[Marshall and Plumb, 2008]

Seasonal and latitudinal variations in solar flux

Daily mean flux factor



Season angle = 0 is NH summer solstice

$$f(\phi, \delta) = \frac{1}{\pi} [\cos \phi \cos \delta \sin h_t + \sin \phi \sin(\delta) h_t]$$

[Pierrehumbert, 2010]

Energy Budget

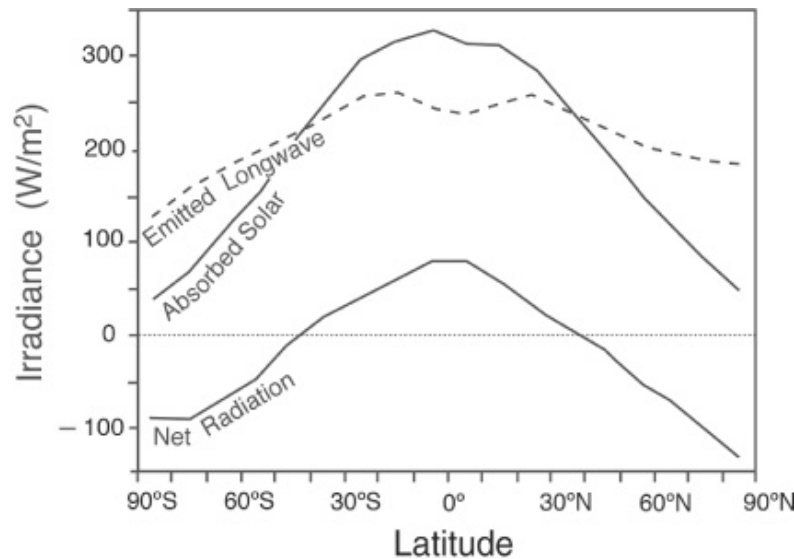


Figure 5.5: Annual mean absorbed solar radiation, emitted long-wave radiation, and net radiation, the sum of the two. The slight dip in emitted long-wave radiation at the equator is due to radiation from the (cold) tops of deep convecting clouds, as can be seen in Fig. 4.26.

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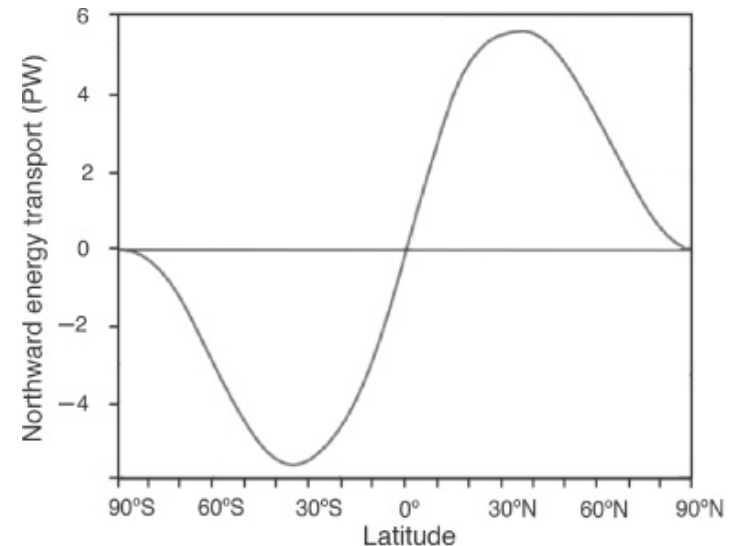
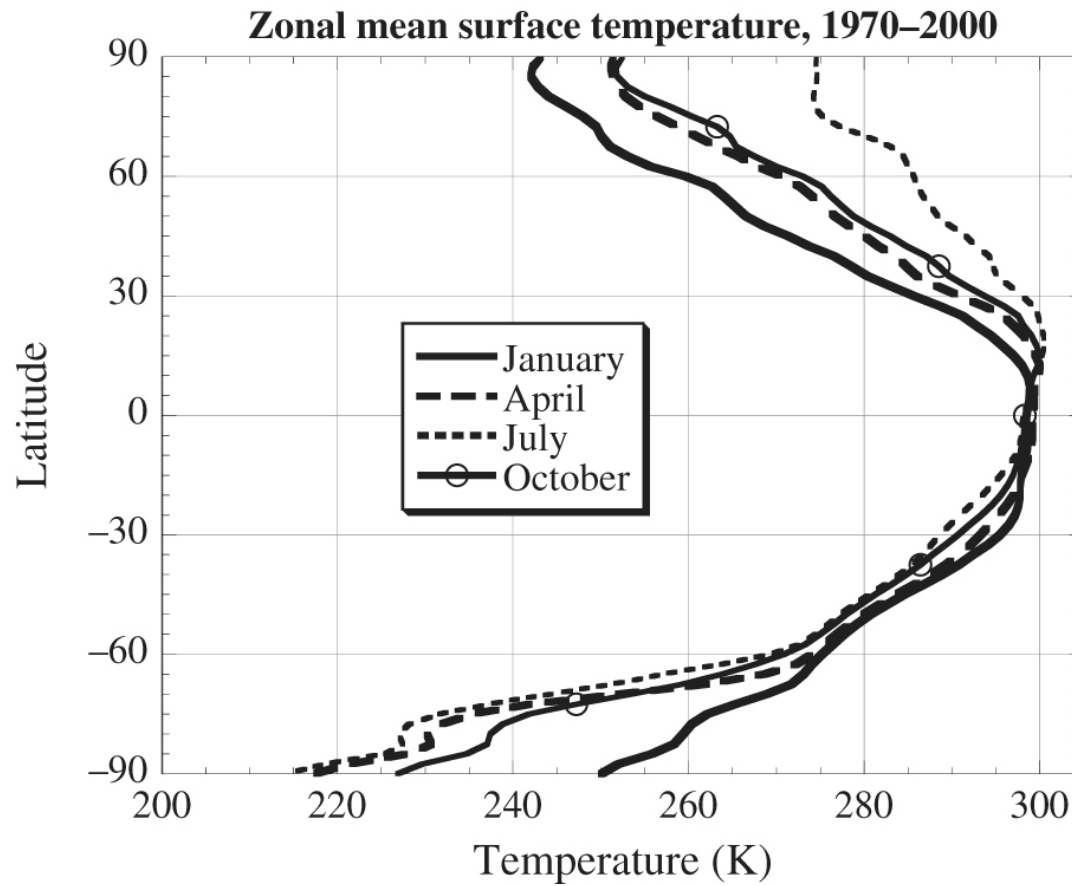


Figure 5.6: The northward energy transport deduced by top of the atmosphere measurements of incoming and outgoing solar and terrestrial radiation from the ERBE satellite. The units are in $PW = 10^{15}W$ (see Trenberth and Caron, 2001). This curve is deduced by integrating the "net radiation" plotted in Fig. 5.5 meridionally. See Chapter 11 for a more detailed discussion.

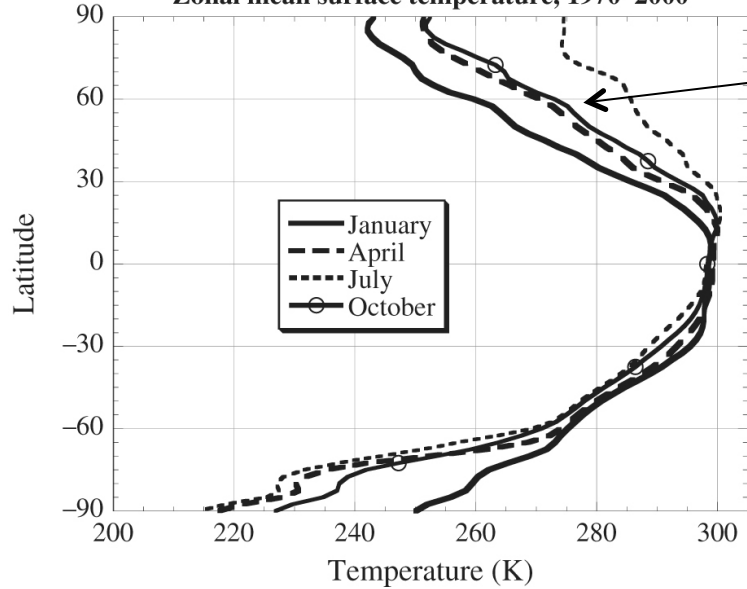
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Seasonal variations in temperature



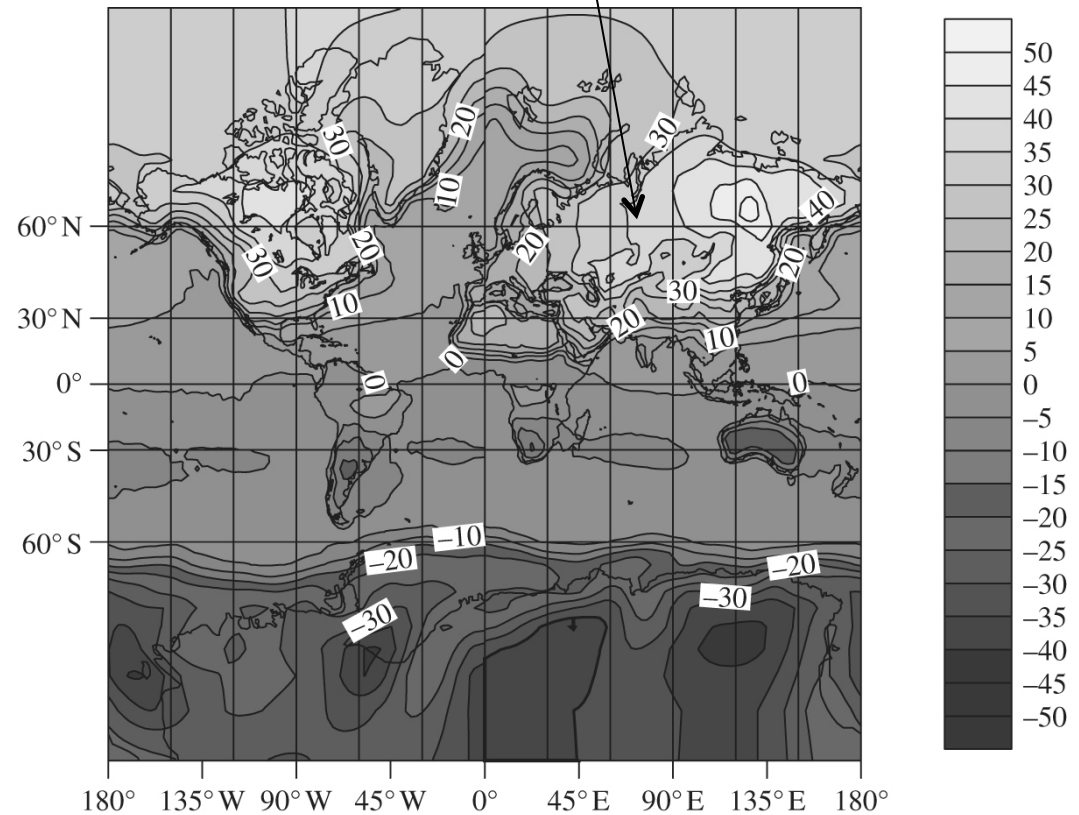
Seasonal variations in temperature

Zonal mean surface temperature, 1970–2000

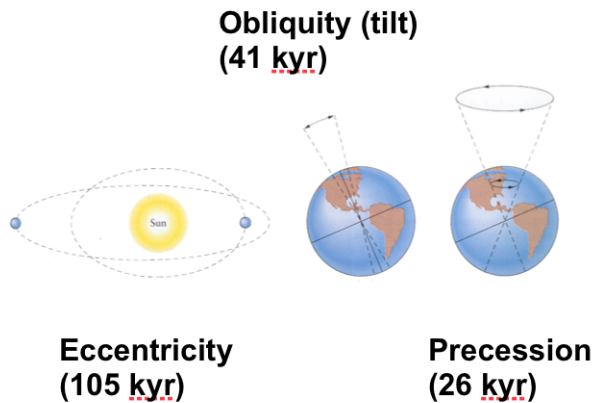
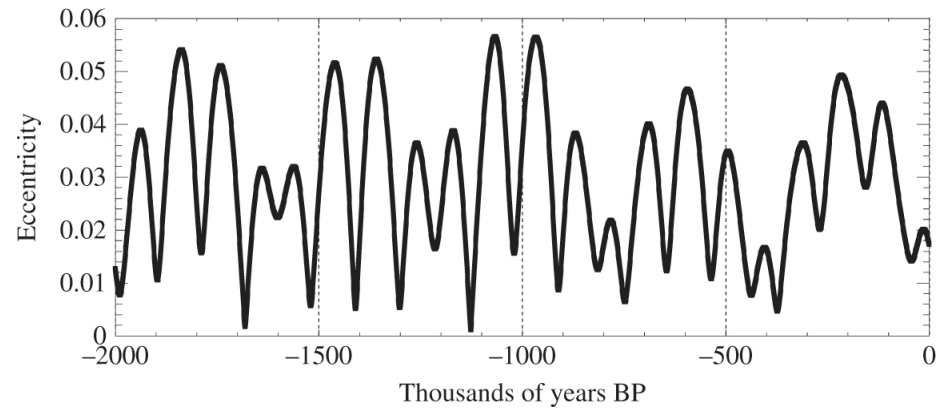
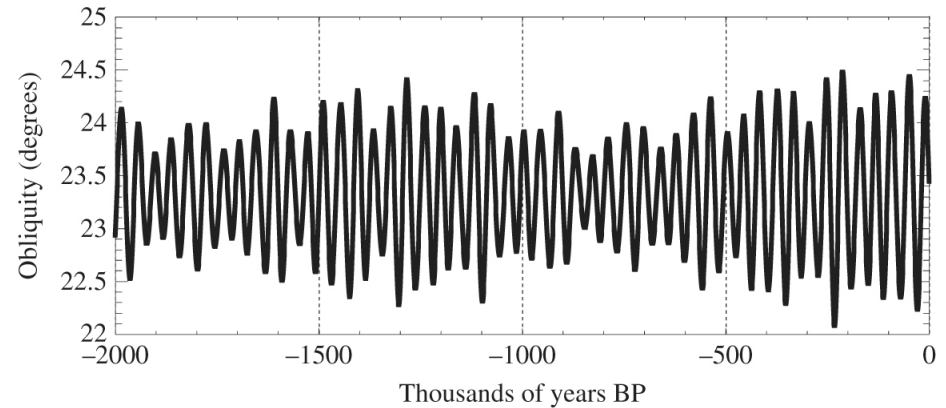
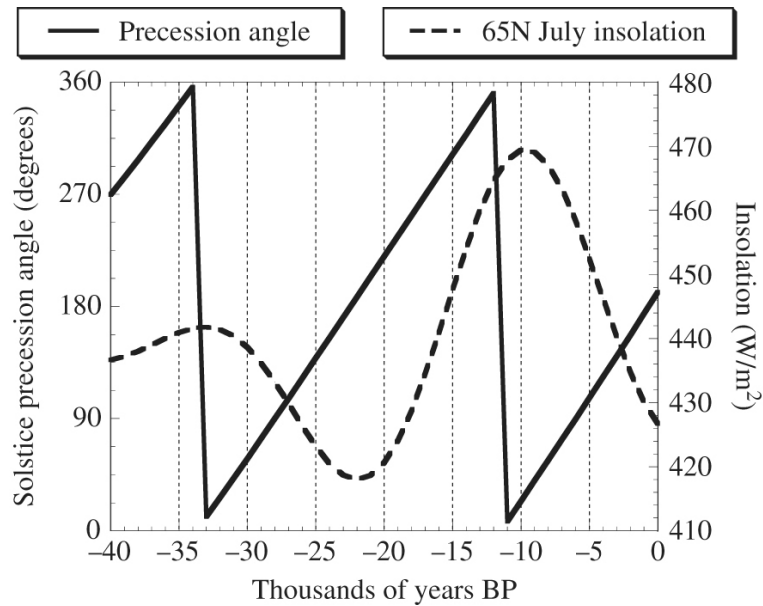


Large seasonal variations over the continents

July – January surface air temperature difference

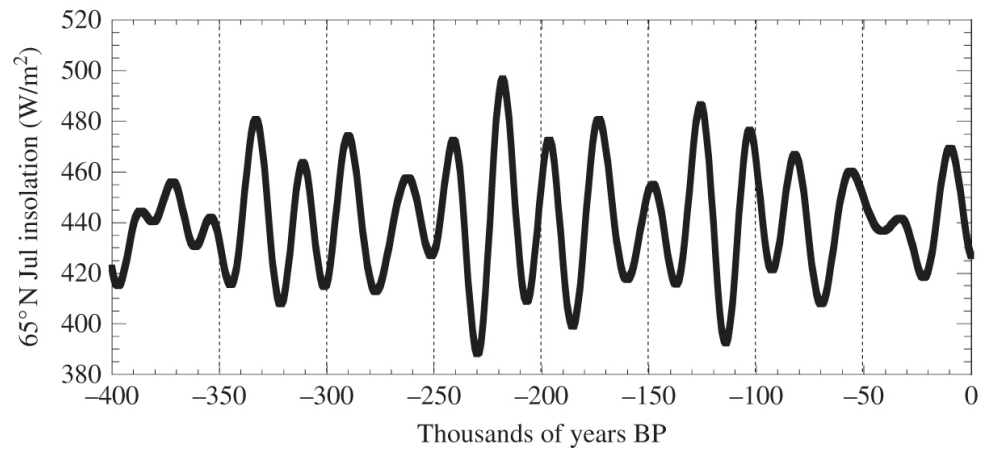
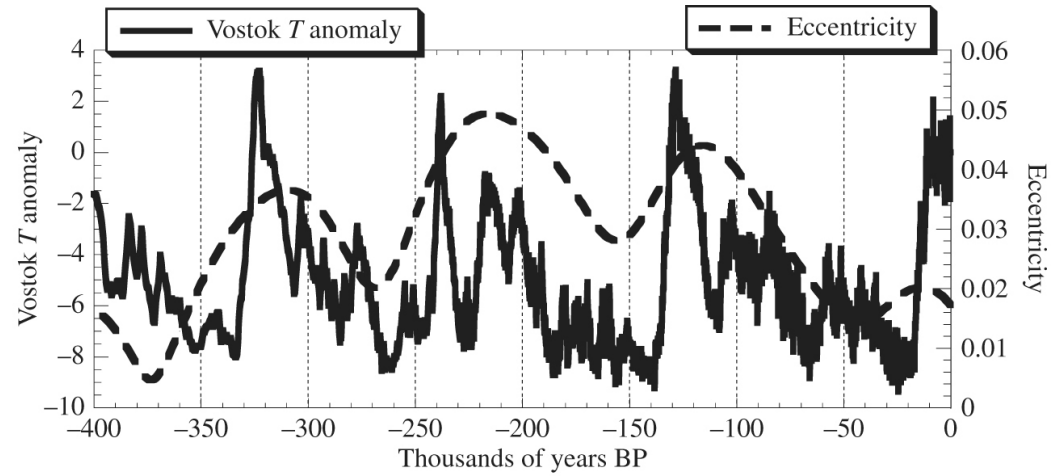
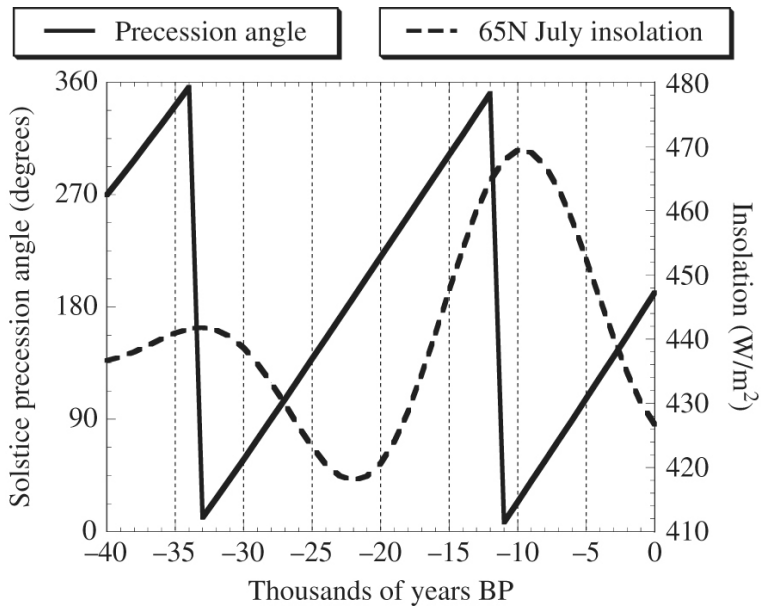


Effects of long-term orbital variation



[Pierrehumbert, 2010]

Effects of long-term orbital variation



[Pierrehumbert, 2010]

CO₂, CH₄, and Temperature During the Past 600k Years

