

Orbital Effects on Solar Radiation

1:

Lecture for Spring 2009, v0.2
Prof. Brian H. Fiedler

School of Meteorology, University of Oklahoma

Orbital Variations and the Ice Ages

2:

- The position of Earth in its elliptical orbit can be given by a longitude angle. Λ is the *longitude of perihelion*, the longitude of closest approach to the sun, relative to the *longitude of vernal equinox*.
- The *eccentricity* ϵ is a measure of the radius at aphelion r_a to the radius at perihelion r_b :

$$\frac{r_a}{r_b} = \frac{1 + \epsilon}{1 - \epsilon}$$

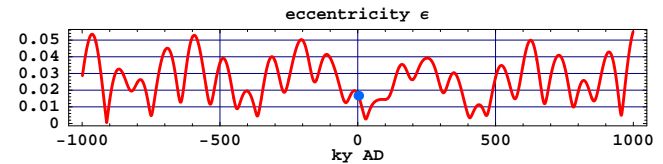
- The *obliquity* is a measure of the tilt of the axis of rotation of Earth, relative to the normal vector of the plane of the orbit.

Here is the eccentricity ϵ .

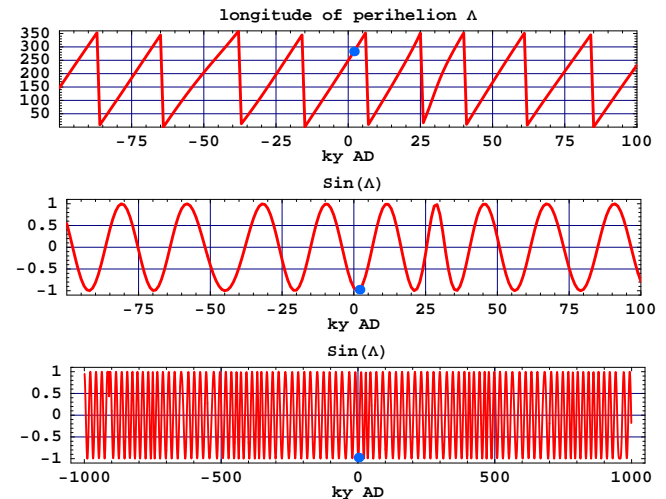
$\epsilon = 0$ would be a perfect circle.

ky is kiloyears.

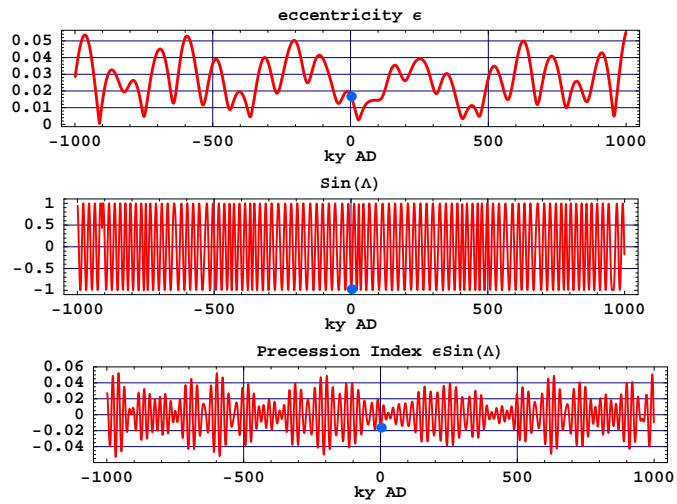
3:



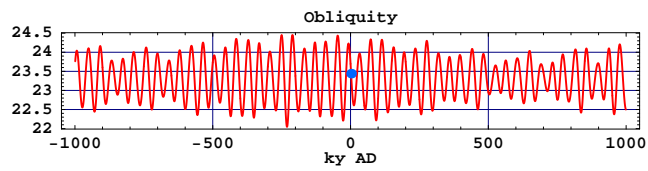
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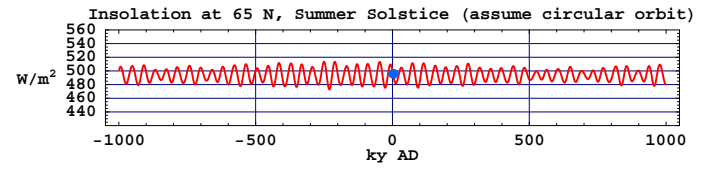
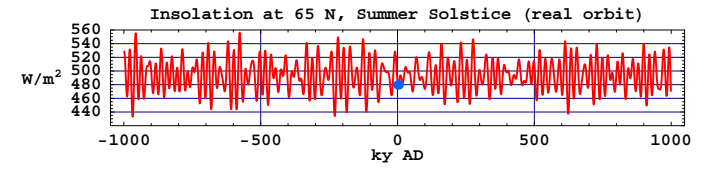
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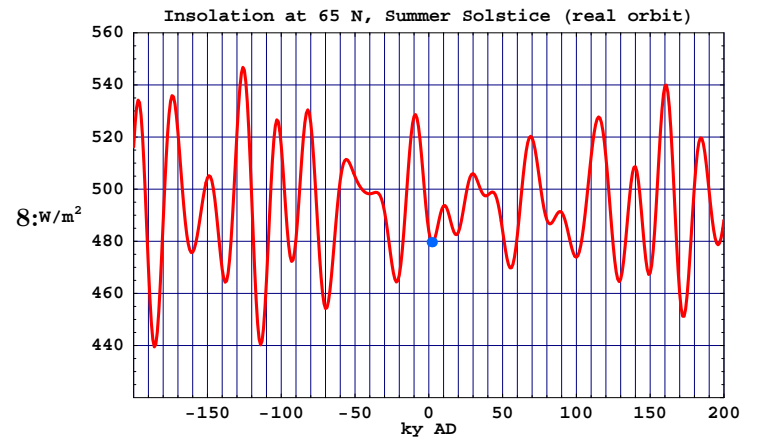
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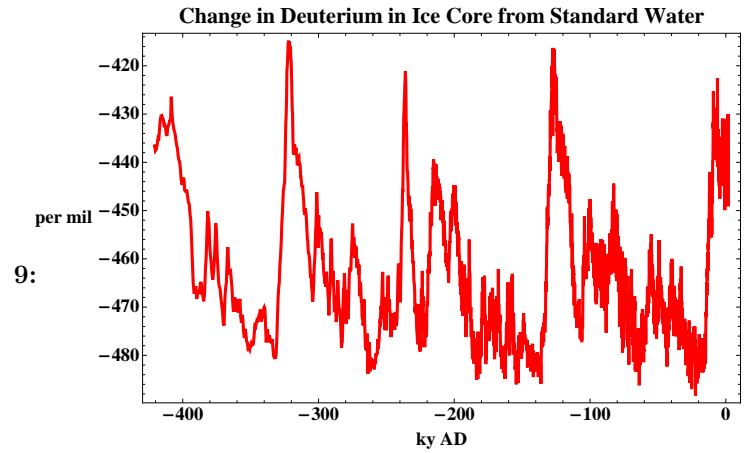


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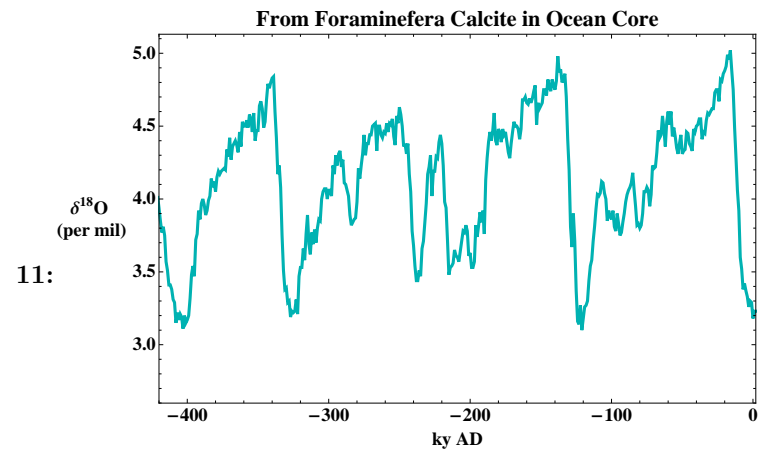


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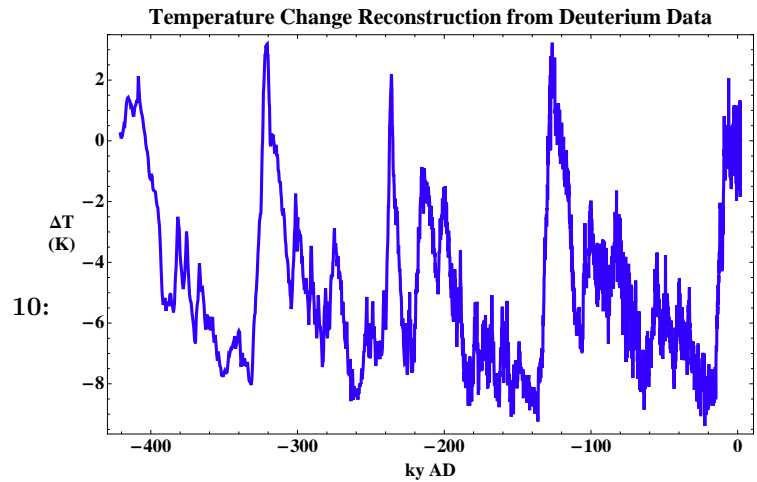




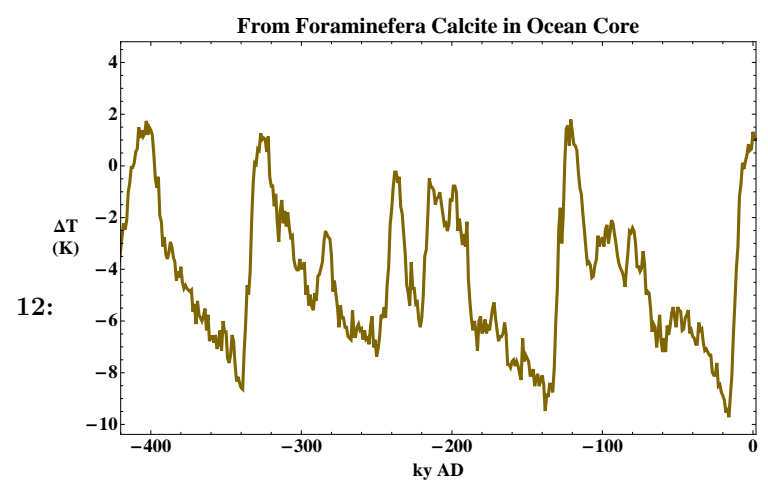
Deuterium is depleted when snow forms at colder temperatures.



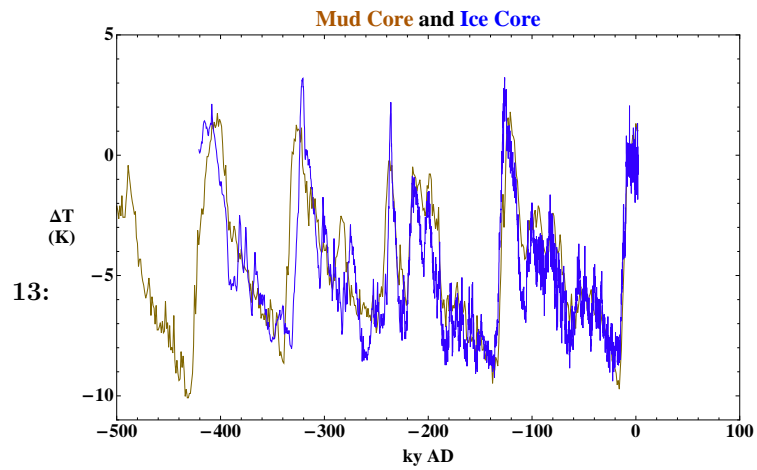
Heavy oxygen is depleted in fossil shells when sealevel is high.



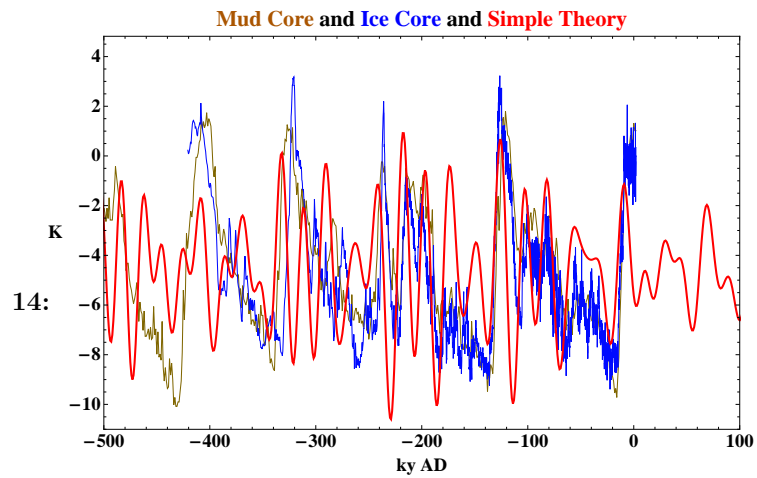
Temperature reconstruction from the deuterium depletion in the ice core.



try: $\Delta T = 6(3.4 - \delta^{18}O)$ for the temperature reconstruction from the depleted oxygen.



Touchdown! That is really good agreement in the temperature reconstruction from two different sources of data.



try: $\Delta T = (Q - 540)/10$, Q is summer solstice insolation at 65 N. The model does not completely reproduce the observations.