

## ATMO 324: Problem Set 5 (*due Nov. 15*)

### Chapters 6 & 8: Atmospheric General Circulation & History of Earth's Climate

1. (Hartmann 6.4) Calculate the zonal velocity of an air parcel at the equator, if it has conserved angular momentum while moving to the equator from 20°S, where it was initially at rest relative to the surface.
2. (Hartmann 6.5) The tropical easterlies and midlatitude westerlies occupy about the same surface area of Earth. Would you expect the surface westerly winds to be stronger, weaker, or about the same as the surface easterlies? Explain your answer with equations.
3. (Hartman 8.1) Discuss the difficulties with interpreting a curve like Fig. 8.1 or extrapolating it into the future.
4. (Hartman 8.2) One of the earliest examples of primitive humans, *Australopithecus*, lived in Africa between about 4 and 1 million years ago. Hominids began using stone tools about 2 million years ago. Place *Australopithecus* and tool use in their proper place in Fig. 8.4. For what fraction of Earth history have hominids been around?
5. (Hartman 8.6) Estimate the rate of freshwater mass production ( $\text{kg s}^{-1}$ ) by the melting of the North American ice sheet, assuming that its melting took 500 years. (Use Fig. 8.8 to obtain the mass of North American ice sheet during the last ice age.) How does this compare with the rate of deep-water formation in the North Atlantic, which is estimated to be about  $2 \times 10^{10} \text{ kg s}^{-1}$  at present?