12.812 MID-TERM EXAM

October 22, 2003

1. (15%) Long-term averages of the atmospheric circulation should conserve mass, but often don't because of observational errors and analysis errors.

   (a) Write down a mathematical expression that embodies this requirement.

   (b) Describe briefly two different techniques for adjusting the analyzed data so that this requirement is met.

2. (15%) Suppose that daily values of the wind at a particular latitude and height are available for a two-year period, and that the following statistics have been computed separately for each year. The symbols are as defined in class

	First year	Second year	
$[\overline{u}]$	10	14	ms^{-1}
$[\overline{v}]$	-1	2	ms^{-1}
$[\overline{u'v'}]$	8	16	$\mathrm{m}^2\mathrm{s}^{-2}$
$[\overline{u}^*\overline{v}^*]$	4	-2	$\mathrm{m}^2\mathrm{s}^{-2}$

Now suppose that a value for $[\overline{u}^*\overline{v}^*]$ is computed for the two-year period taken as a whole, and $[\overline{u}^*\overline{v}^*] = s$. Find the value of $[\overline{u'v'}]$ for the combined two-year period; express your answer in terms of s.

3. (15%)

   (a) Briefly *describe* two different mechanisms that act to change the angular momentum of the entire atmosphere about the earth's axis of rotation. Include in your description the variables that need to be measured in order to quantify each mechanism.

(b) For either of these mechanisms, discuss why its observed latitudinal distribution over the N.H. implies a destruction of atmospheric zonal kinetic energy for the hemisphere as a whole.

4. (15%) Describe briefly the qualitative effect that the different components of the meridional transport of angular momentum have on the zonal kinetic energy budget of the Northern Hemisphere as a whole.

5. (10%) $[\overline{T}]$ at the surface at 35°N is 17°C on an annual mean basis, 11°C in February, and 22°C in September. Estimate (roughly) how the specific humidity at the surface at 35°N in February and September differs from the annual mean specific humidity. Give your answers in terms of percentages, and be sure to specify the sign of the differences.

6. (15%) Define:
   (a) latent heat
   (b) solar constant
   (c) laminar sublayer

7. (15%)
   (a) Describe qualitatively the seasonal cycle of the Northern and Southern Hemisphere Hadley Cells.
   (b) Qualitatively, how will the meridional moisture transport by the mean meridional winds change seasonally at the equator?