ATMS 545 Winter Quarter 2013

Overview

The course begins with a brief (one lecture) historical overview of some of the major developments in general circulation research placed in the broader context of developments in the field of atmospheric dynamics. This will conclude with a discussion of the research methodologies that have tended to dominate the field.

The next section. which will occupy most of the first half of the course introduces some diagnostic schemes that can be applied to the atmosphere as a whole or to various parts of the atmosphere or Earth system in order to address fundamental questions related to basic conservation laws. The major topics covered in this section of the course are Lorenz's kinetic energy cycle and the balance requirements for angular momentum, total energy, and mass. Also included is the formalism for decomposing the general circulation into zonally symmetric and eddy components; into time mean and transient components; and into steady zonally symmetric, transient zonally symmetric, steady eddy, and transient eddy components. This section concludes with an overview of the equations governing the evolution of a geostrophically-balanced, zonally symmetric vortex (i.e., the so-called Eliassen - Kuo formulation). This concluding section provides some additional insights into the workings of the general circulation and it also serves as a concise review of the quasi-geostrophic formalism that leads to the geopotential tendency equation and the omega equation.

The remainder of the course begins with several lectures showing how the formalisms introduced in the previous section can be extended to diagnose the interactions between the eddies and the mean flow in the atmospheric circulation.Then we will consider how the zonally- varying boundary forcing of the general circulation gives rise to zonally asymmetric features in the time-mean flow such as the monsoons and the wintertime stratospheric planetary waves. The boundary forcing also gives rise to pronounced zonal variations in the structure and intensity of the transient eddies. The unforced variability of the general circulation is strongly frequency-dependent. On the day-to-day time scale it is associated with baroclinic waves that tend to be concentrated in "storm tracks" over preferred sectors of the Northern and Southern hemispheres. In contrast, on time scales of a month or longer, the variability tends to be organized in preferred spatial patterns sometimes referred to as *teleconnection patterns*.

Depending upon the interests of the students in the class we may reserve one or two of the sessions in the final week for further discussion of specific phenomena such as ENSO, the MJO, or the annular modes

Tentative Schedule (*by week*)

1. January 6 and 8. Historical overview. Concept of balance requirements. The kinetic energy cycle

2. January 13 and 15. The kinetic energy cycle (concluded). The angular momentum balance.

3. January 20 and 22. The angular momentum balance (concluded). Total energy balance.

4. January 27 and 29. Balances of total energy and]water vapor; role of the ocean

5. February 3 and 5. Dynamics of a zonally symmetric vortex. Midterm

6. February 10 and 12 Dynamics of a zonally symmetric vortex. Wave-mean flow interaction

7. February 17 and 19 the Eliassen-Palm flux, Lagrangian vs. Eulerian mean, Stokes drift, the non-interaction theorem

8. February 24 and 26 Effects of zonally-varying boundary conditions: stationary waves, storm tracks, teleconnection patterns

9. March 3 and 5 The MJO and ENSO

10. March 10 and 12 TBD