

DYM-1 Dynamic Meteorology

General Circulation of the Atmosphere and Synoptic Meteorology

François Lott

3 ECTS

Objectives: We describe and compare the general circulations of the troposphere, the stratosphere and the mesosphere. This clearly highlights the two main thermodynamical drivers of the atmosphere: in the troposphere, the absorption of the infrared radiation from the ground and oceans by the greenhouse gases and / or the convection; in the stratosphere and mesosphere, the direct absorption of solar UV radiation by ozone. The global scale circulations produced by these global thermodynamical forcings are nevertheless unstable and modulated by waves that control in good part the weather and the climate variability, and that we described with details. Although the nature of these waves vary a lot from one situation to the other, we show that their dynamics is controlled by only two restoring mechanisms, one is the force of gravity (gravity waves) the other is related to the gradient of potential vorticity (Rossby waves). We also present how these waves control the local weather and its slow variations (Rossby waves and blockings in the mid-latitude, Madden Julian Oscillation in the tropics). The course also describes the interactions between the waves and the large-scale circulation, yielding to planetary scale modes of variability like the Arctic oscillation in the midlatitudes troposphere, the blockings again, the Sudden Stratospheric Warmings in the mid-latitude stratosphere and if time permits the Quasi-Biennial Oscillation in the equatorial lower stratosphere.

The course is based on analysis of meteorological observations and global datasets covering the middle latitudes as well as the tropics, the troposphere as well as the stratosphere. In this sense its content is in good part descriptive, but the interpretations of the observations is made by using precise tools of geophysical fluid dynamics, like the Eliassen Palm fluxes, and simplified dynamical models. Some of these tools are also introduced with details, but a systematic derivation of the quasi-geostrophic dynamics, baroclinic instability or equatorial wave theory is left to more advanced geophysical fluid dynamics courses. Following such courses is not a pre-requisite of this one.

Prerequisite: Fluid Mechanics, basics in meteorology and climatology

Outlines:

- 1) Zonal mean climatologies and fundamental equations;**
- 2) General circulation of the neutral atmosphere (troposphere-stratosphere-mesosphere);**
- 3) Meridional circulations and the role of the Eddies;**
- 4) Midlatitude tropospheric synoptic variability**
- 5) The midlatitude low frequency variability of climate;**
- 6) The sudden stratospheric warming and the arctic oscillation;**
- 7) The equatorial waves and the Madden-Julian oscillation.**
- 8) Stratospheric equatorial variability**

François Lott is Directeur de Recherche CNRS at the Dynamic Meteorology Laboratory (LMD)

<http://www.lmd.jussieu.fr/~flott/homepage.html>