Influence of Gravity Waves on the Atmospheric Climate

François LOTT
Laboratoire de Météorologie Dynamique, Paris, France

Mountains influence meteorology and climate on a very large range of horizontal and time scales. At the planetary and synoptic time scales their effects can be potentially well represented in General Circulation Models (GCMs) with horizontal resolution near a degree typically. Nevertheless these models present systematic errors on the planetary scales, or do not represent well the intra-seasonal (planetary scale) variability. Some of these errors are in part due to the fact that the subgrid scale mountains significantly affect the large-scale flow. We therefore need to parameterize the subgrid scale mountains and to look at the impact these parameterizations have on the large-scale flow. The mountain gravity waves largely control the mesoscale dynamics these parameterizations try to take into account.

When we look at the middle atmosphere, the role of the gravity waves on the climate becomes much stronger than it is in the troposphere. In General Circulation models that include the middle atmosphere, the gravity waves need to be parameterized, but in this case, the parameterizations have to include the non-stationary gravity waves produced by convection, geostrophic adjustment, instabilities, and within fronts. These parameterizations are needed to produce the Temperature minimum at the polar summer mesopause, or to reduce cold temperature biases in the winter polar stratosphere. They also affect the winter stratosphere variability related to the stratospheric sudden warmings. In the tropics they drive a good part of the semi annual oscillation and of the quasi-biennal oscillation.

Lecture 1:
Dynamical impact of mountains on atmospheric flows.
A description of the influence of mountains at different horizontal scales.

Lecture 2:
Representation of mountains in General Circulation Models;
A description of how subgrid scale mountains are represented in GCMs.

Lecture 3:
Non-orographic gravity waves sources.

Lecture 4:
Impact of gravity waves on the middle atmosphere dynamics: midlatitudes and tropics.