

Dynamic Meteorology

(General Circulation of the Atmosphere and Synoptic Meteorology)

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Content :

1) Zonal mean climatologies and fundamental equations

Composition and definition of the various layers of the neutral atmosphere, zonal mean climatologies.

2) General circulation of the neutral atmosphere

Mid and high latitude jets in the troposphere and middle atmosphere.

Trade winds and monsoonal flow in the tropical troposphere.

3) Meridional circulations and the role of the eddies

Hadley and Ferrel cells (troposphere). Brewer-Dobson circulation (middle atmosphere). Relation with O_3 and H_2O

4) Midlatitudes tropospheric variability

Synoptic eddies and low frequency variability. Dominant patterns of low frequency variability: teleconnections, blockings, North Atlantic Oscillation, Pacific North American pattern, Arctic Oscillation

5) Synoptic scale variability and baroclinic instability

Eady waves and baroclinic instability; Significance of the tropopause; life-cycle of baroclinic waves.

6) Midlatitude stratospheric variabilities and sudden stratospheric warmings

Vertically propagating Rossby waves: life cycle and breaking yielding stratospheric warming

7) Tropospheric equatorial variability

The inter-annual El Nino Southern Oscillation, the intra-seasonal Madden Julian Oscillation, The convectively coupled equatorial waves.

8) Stratospheric equatorial variability

Equatorial waves and Quasi-Biennial Oscillation of the zonal mean zonal winds

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Tool box :

equations, diagnostics (dynamical and statistical) and simple (toy?) theoretical models

1) Zonal mean climatologies and fundamental equations

Static relations, hydrostatic balance, stratification, geostrophic and thermal wind balance.

Primitive equations in spherical coordinate (log-pressure and Boussinesq)

2) General circulation of the neutral atmosphere

Conservation of angular momentum.

Toy-model 1: shallow water theory for upper level jets (midlatitudes), and trade winds + monsoonal flow (tropics).

3) Meridional circulations and the role of the eddies

Eulerian and transformed Eulerian mean formalisms for waves mean-flow interactions. Eliassen Palm flux

4) Midlatitudes tropospheric variability

Level 0 statistics applied to geopotential fields: variance, co-variance, teleconnections and EOFs.

TD4: intro to toy model 5: gravity waves dynamics

5) Synoptic scale variability and baroclinic instability

Toy model 2: Quasi-geostrophic (QG) theory where 2 Eady waves interact to yield a baroclinic instability

6) Midlatitude stratospheric variabilities and sudden stratospheric warmings

Toy model 3: QG theory for Rossby wave vertical propagation and breaking

7) Tropospheric equatorial variability

Level 0 statistics applied to OLR fields, Level 1 statistics: spectra of OLR fields

Toy model 4: Equatorial wave shallow water theory adapted to a continuously stratified atmosphere

8) Stratospheric equatorial variability

Level 1 statistics: spectra of wind and Temperature fields from ERAI

Toy model 5: the quasi biennial oscillation involving two gravity waves interacting with the zonal mean wind