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Procedure of obtaining semi-analytical solutions

- Full set of atmospheric equations is linearized with respect to the mean flow and temperature stratification
- Wave equation is derived from linearized equation set
- Wave equation is usually solved numerically using periodical boundary conditions and FFT
- Iterative procedure is often used to "grow the mountain" in solutions (Laprise and Peltier, 1989)
- Usually done in z-coordinates

Excercices in SSS06 are based on pressure coordinate framework

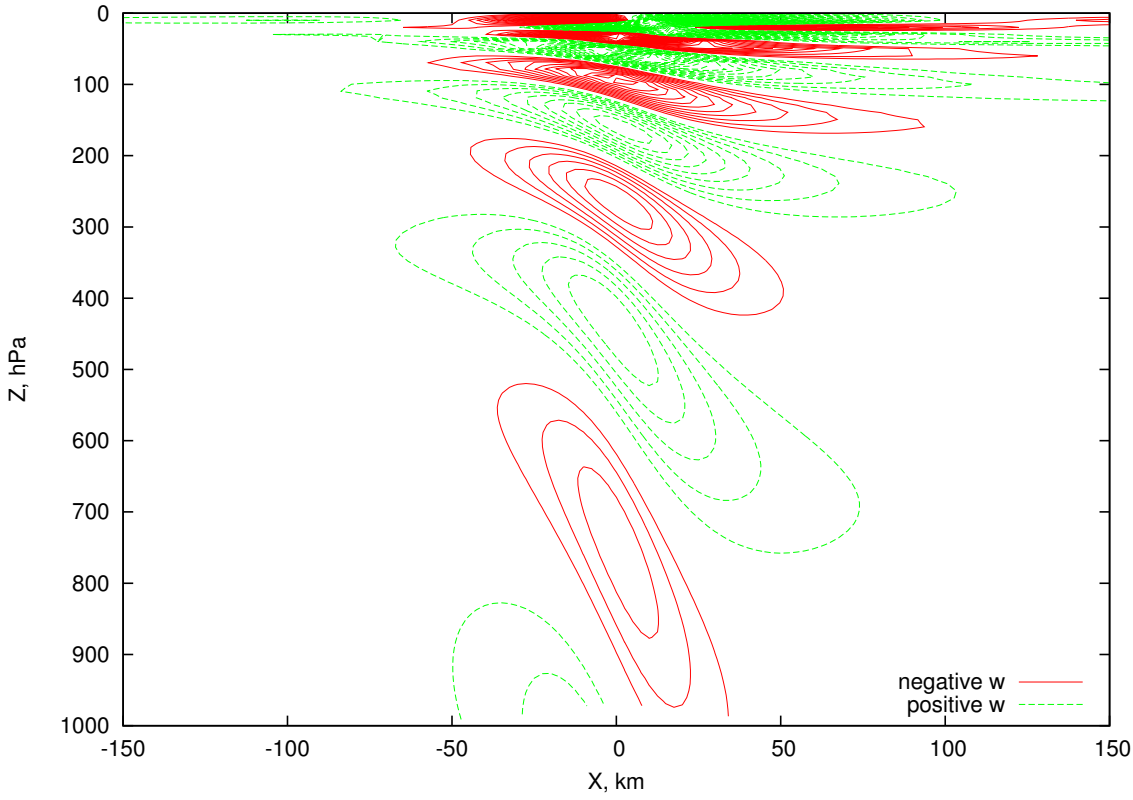
- Theory is outlined in (Rõõm and Männik, 1999)
- Solutions include full atmosphere
- Picture is somewhat "distorted" - compressed in upper levels, constant wavelength of disturbances is not clearly visible
- orography is defined as

$$h = \frac{h_0}{1 + (x - x_0)^2/a_x^2},$$

where h_0 is mountain height, a_x is mountain half-width and x_0 is the horizontal coordinate of mountain top.

- commonly used "Witch of Agnesi" is defined

$$h = \frac{h_0}{[1 + (x - x_0)^2/a_x^2]^{3/2}}$$



Common nondimensional flow characteristics

NhU parameter shows linearity of the flow. Sometimes refered as Froude number. See (Baines, 1995) for discussion.

$$\frac{Nh_0}{U} << 1, \quad \text{linear flow}$$

Nonhydrostaticity parameter, sometimes refered as Scorer parameter

$$\frac{Na_x}{U} >> 1, \quad \text{hydrostatic flow}$$

$$\frac{Na_x}{U} \sim 1, \quad \text{nonhydrostatic flow}$$

For constant reference temperature profile the Brunt-Väisäla frequency is computed

$$N = \sqrt{\frac{g^2}{c_p T_0}},$$

where $g = 9.81\ m/s^2$ is gravitational acceleration, $c_p = 1004\ J/(kg \cdot K)$ isobaric heat capacity and T_0 is temperature of the profile

References

Baines, P. G. 1995, *Topographic Effects in Stratified Flows.* Cambridge Univ. Press, 482pp.

Rõõm, R. and Männik, A. 1999. Response of different nonhydrostatic models to orographic forcing. *J. Atmos. Sci.,* **56,** 2553 – 2570

Laprise, R. and Peltier, W. R. 1989, On the structural characteristics of steady finite amplitude mountain waves over bell-shaped topography. *J. Atmos. Sci.,* **56,** 586 – 595