Mountain Wave Propagation under Transient Tropospheric Forcing

A DEEPWAVE Case Study

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Motivation and Research Questions

1. Large-scale modeling: steady-state assumption for gravity wave (GW) drag parameterization
2. DEEPWAVE campaign in New Zealand 2014 shows: Gravity wave events are highly sporadic and episodic, not permanent and appear with their own transience
3. Chen et al. (2005, 2007): dramatic differences between the momentum fluxes in the slowly varying synoptic-scale flow and those determined by steady-state theory
4. Particular, asymmetric distribution of vertical momentum flux profile with respect to the time of maximum forcing

Goals:
1. Explore the wave response to a transient tropospheric forcing
2. Characterize the different phases of the transient forcing with WRF simulations, in-situ Falcon and GV Flight Data, radio-sounding and lidar data
3. Compare to results of Chen et al. (2005, 2007)

Methods for in-situ Data Analysis

- Corrected Pressure
- Perturbations: v / (u, v, w) = (T_initial - T_final) / (T_initial)
- Energy Flux: $E_F = \tau_p \cdot v$
- Momentum Flux: $M_F = \tau_p \cdot u$
- Non-Dimensional Mountain Height: $\eta = \frac{z}{H_H}$

Accelerating Phase

1. Local small-amplitude wave excitation, especially over main mountain ridge
2. Increasing wave amplitudes
3. Local wave breaking

Decelerating Phase

1. Maximum of long wave response
2. GW breaking: wave reflection, non-linear processes
3. Waves still arrive in upper layer from previous excitation
4. Long wave response vanishes

Summary and Conclusions

- Maximum wave response at tropopause region not with maximum forcing, but decreasing forcing
- Due to lack of flight measurements can’t prove asymmetry in momentum flux like in Chen et al. (2005)
- Wave response and the strength of non-linear processes clearly transient

Characterization of IOP 9

Fig 9 a, b:

- In particular, asymmetric distribution of vertical momentum flux profile with respect to the time of maximum forcing

Fig 19:

- Perturbation Ascent Rate
- Maximum wave response at tropopause region
- Behindocclusion: small evanescent signatures of individual peaks, ceasing wave breaking in troposphere
- Long wave propagation in lower stratosphere
- Free waves continue in upper layer from previous excitation
- Waves still arrive in upper layer from previous excitation

Acknowledgements

This work was supported by the Austrian Ministry of Science BMWF as part of the UniInfrastrukturpro- gramm of the National Research Program on the University of Innsbruck. This work was also funded by the National Science Foundation, [http://data.eol.ucar.edu/]

ICAM 2015, Innsbruck