FURTHER RESULTS ON MOIST NEARLY NEUTRAL FLOW PAST A RIDGE

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Abstract: A systematic numerical study has been performed in the case of moist neutral flows past a two-dimensional ridge. The experiments considered here describe the effect of the Coriolis force and of wider mountains on the flow features.

***Keywords** – Moist flows, orography, precipitation*

1. INTRODUCTION

In a recent study (Miglietta and Rotunno, 2005), the authors performed numerical simulations of moist nearly neutral flows over a ridge using the WRF model in a regime where the Coriolis force can be neglected, with the simple Kessler (warm-rain) microphysical scheme. The numerical solution sensitivity to the mountain height revealed three basic categories of the flow (see Figure 1). Panel a) shows that if the mountain height h_m is small enough, a saturated flow can be maintained everywhere given sufficient initial cloud water. Panel b) shows that for tall mountains the atmosphere upwind of the mountain is maintained in a saturated state; transitions to an unsaturated downslope flow are observed on the lee side (which has characteristics associated with downslope windstorms). Panel c) shows that for mountains of intermediate height, solutions have the unexpected feature of an upwind-propagating disturbance which has the effect of desaturating the atmosphere above the mountain.

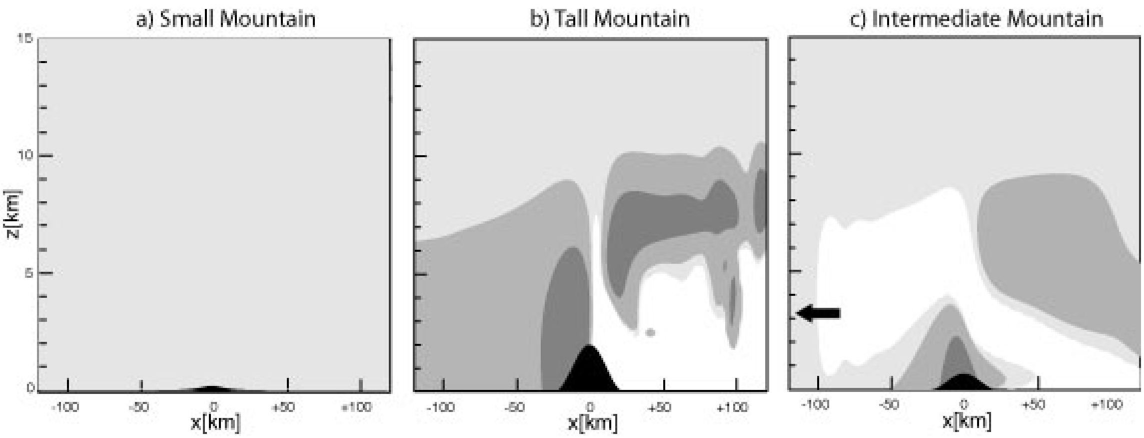

Figure 1. Cloud water mixing ratio q_c where white indicates regions of $q_c< 0.01$ g kg^{-1}; light grey, 0.01g kg^{-1} <q_c<0.1g kg^{-1}; medium gray, 0.1g kg^{-1}<q_c< 0.5g kg^{-1}; dark gray, q_c>0.5g kg^{-1}. Environmental flow is from left to right with initial q_c = 0.05 g kg^{-1}.

2. EFFECT OF THE CORIOLIS FORCE

In the present work, we discuss further numerical solutions using more general and realistic experimental conditions. In the first set of experiments, we consider how the Coriolis force modifies the solutions shown in Figure 1. Numerical solutions show that the inclusion of the Coriolis force weakens the circulation in the plane of the mountain by transferring part of the energy into the along-ridge-component. As a consequence, both the characteristic features of the simulations, the upwind propagation of the dry region and the downstream development of convective cells, appear less organized.

3. EFFECT OF A LARGER SCALE MOUNTAIN

In Miglietta and Rotunno (2005) we limited our study to the case of ridges with half-width *a*=10km. Simulations with a wider mountain (*a*=100km) have been considered here (Figure 2). An important change with *a* is apparent for h_m=2000m, since the upstream-propagating dry disturbance is present not only for h_m=700m (Fig. 2a), as for the narrower mountain, but also for the higher mountain (Fig. 2b). The effects of the inclusion of rotation observed for *a*=10km are even more evident for a wider mountain (Fig. 2c and 2d).

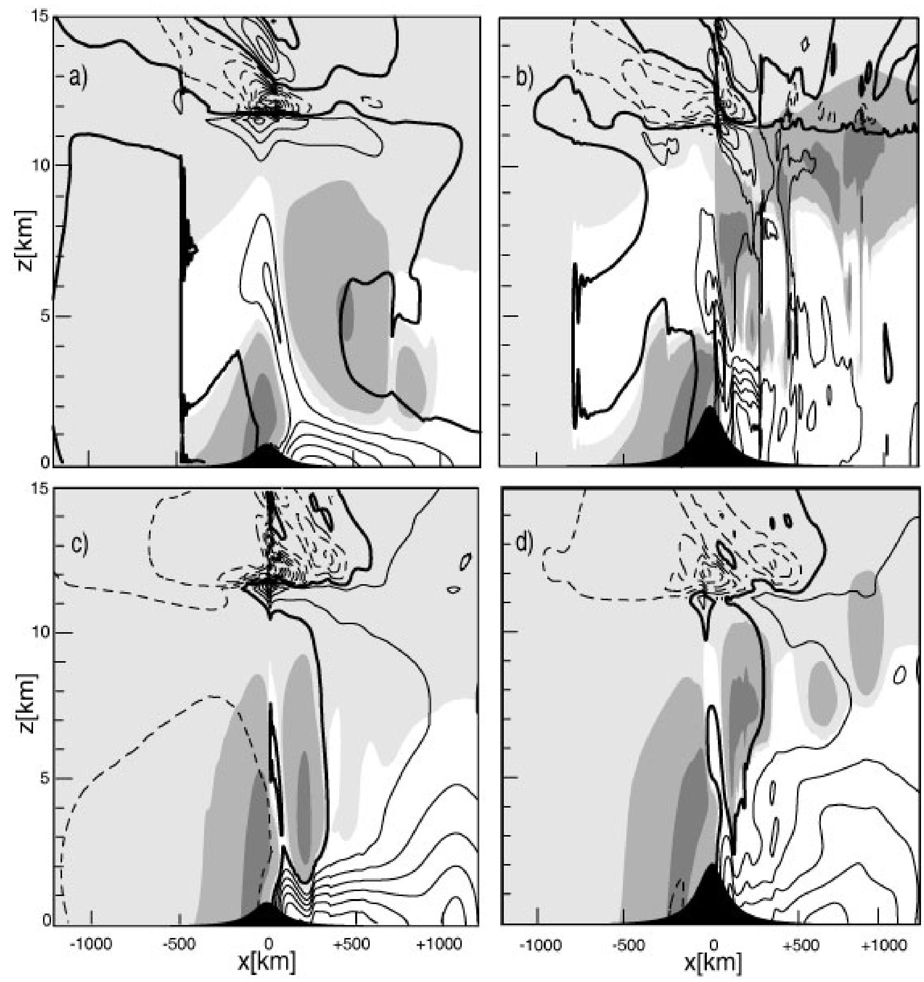

Figure 2: buoyancy and cloud water content – grey scale, where q_c < 0.01 g kg^{-1} (white), 0.01g kg^{-1} < q_c < 0.1 g kg^{-1} (light grey), 0.1 g kg^{-1} < q_c < 0.5 g kg^{-1} (dark grey) - at t = 30h for numerical simulations of moist neutral flows (N_m^2=3 10^{-6} s^{-2}, q_c =0.05 g kg^{-1}) past an obstacle with half-width *a*=100 km with the Kessler microphysical scheme: a) hm = 700m and f=0, (buoyancy lines c.i.= 0.01 m s^{-2}); b) hm = 2000m and f=0, (buoyancy lines c.i.= 0.04 m s^{-2}); c) hm = 700m and f≠0, (buoyancy lines c.i.= 0.01 m s^{-2}); d) hm = 2000m and f≠0, (buoyancy lines c.i.= 0.04 m s^{-2}). Results are shown only on a display window 0 < z < 15 km and -1200 km < x < + 1200 km.

4. CONCLUSION

In the present work, the study of the dynamics of saturated nearly neutral flow passing over a two-dimensional hill has been extended to more general and realistic conditions. In particular, the effect of the Coriolis force and of wider mountains on the numerical solutions has been reported. A sensitivity study to the microphysics is in progress.

REFERENCES

Miglietta M.M., R. Rotunno, 2005: Simulations of moist neutral flow over a ridge, *J. Atmos. Sci.*, in press.