Extreme convection in subtropical South America: TRMM observations and high-resolution modeling

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Introduction

- Observations from the Tropical Rainfall Measuring Mission (TRMM) satellite have led to the realization that intense deep convective storms just east of the Andes in subtropical South America are among the most intense anywhere in the world (Zipser et al. 2006).

- On average, South American MCC cloud shields are 60% larger than those over the United States (Velasco and Fritsch 1987), the convection is deeper (Zipser et al. 2006), and they have larger precipitation areas than those over the United States or Africa (Durkee et al. 2009).

- Despite the severity and intensity of the storms, relatively few studies have been conducted on South American convection, especially in the lee of the Andes

Background

UW methodology to separate TRMM Precipitation Radar (PR) echoes into three storm types (Houze et al. 2007): deep convective cores, wide convective cores, and broad stratiform regions

- South Asia: Houze et al. (2007), Romatschke et al. (2010a, b)
- South America: Romatschke et al. (2010), Rasmussen and Houze (2011)

Storm evolution hypothesis presented in Romatschke and Houze (2010) and Rasmussen and Houze (2011):
- Deep convective cores initiate along Andes foothills and secondary top features
- Convection grows upscale, develops wide convective cores, and moves eastward
- Decaying convective elements move further eastward and develop broad stratiform regions

South American MCSs

- Strong influence of the Andes foothills and the Sierra de Córdoba Mountains in convective initiation and maintenance of MCSs
- Storms with wide convective cores tend to be linearly organized
- Pattern of leading convective line and trailing stratiform precipitation in wide convective core storms
- Composite maps for days when TRMM observed a wide convective core show mid-level subsidence and low-level convergence in the lee of the Andes (Figure 6)

Mesoscale Organization

- Storms with wide convective cores tend to be linearly organized
- Similarity to leading-line/trailing-stratiform archetypes identified in the United States (Houze et al. 1990; adapted for South America in Fig. 7)

High-Resolution Modeling Study

- WRF simulations have produced an excellent representation of the 27 December 2003 case study from Rasmussen and Houze (2011)
- Microphysics testing indicated that the Thompson scheme captures leading-line/trailing stratiform structure

Conclusions

- Deep convection initiates near the Sierra de Córdoba Mountains and Andes foothills, grows upscale into eastward propagating MCSs, and decays into stratiform regions
- Storms with wide convective cores in subtropical South America tend to be line-organized and are similar in organization to squall lines in Oklahoma
- Lee subsidence capping low-level moisture is observed in the model results
- Choice of microphysics scheme can greatly impact the storm structure and is important for deep convection simulations

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