The effect of the Balcones Escarpment on forecasting major South Central Texas rainfall events

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Introduction

- Flooding causes extensive damage as well as loss of life and property. According to the National Oceanic and Atmospheric Administration (NOAA), the United States 2003 to 2012 average of deaths due to flooding is 76 people per year.
- Total precipitation is proportional to the rate and duration of rainfall. It is also associated with the speed of movement and the size of the system causing the event. These variables are difficult to accurately predict.
- South Central Texas is susceptible to flooding. San Antonio is located along the Balcones Escarpment, a fault that separates the hill country from the coastal plains of Texas. Moist air often flows in from the Gulf of Mexico and ascends over the escarpment. Heavy rain and flash flooding is often attributed to the terrain and urban areas.
- We seek to determine how important the Balcones Escarpment is in determining the rainfall intensity and location of heavy rain events in South Central Texas.

Methodology

- Investigated two flash flood cases with similar large-scale meteorological patterns involving the low level jet interacting with a midlevel vortex.
- Used the National Centers for Environmental Prediction (NCEP) Stage IV Analysis for the intensity and location of each rainfall event.
- Selected the North American Model (NAM) initialized Weather Research and Forecasting (WRF) run as the best forecast for 05 May 2013 event and the Weather Research and Forecasting Data Assimilation Research Testbed (WRF-DART) member as the best 09 June 2010 forecast.
- Removed the Balcones Escarpment—moved the terrain gradient to the northwest on the geogrid of WRF Preprocessing System (WPS).
- Simulated both forecasts with the modified terrain.

Topography Modification

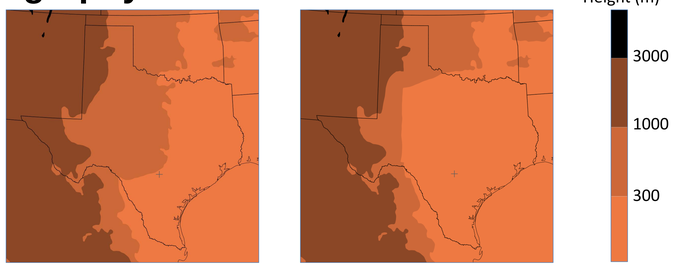
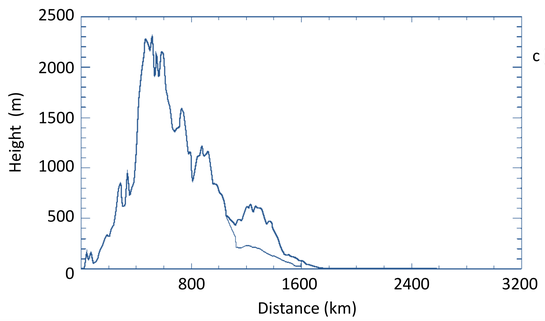


Fig. 3. a) CONTROL: Original topography b) NOBALC: Modified topography



c) West-East cross section of the Balcones Escarpment through San Antonio. The thicker line is the CONTROL. The thinner line is NOBALC.

09 June 2010

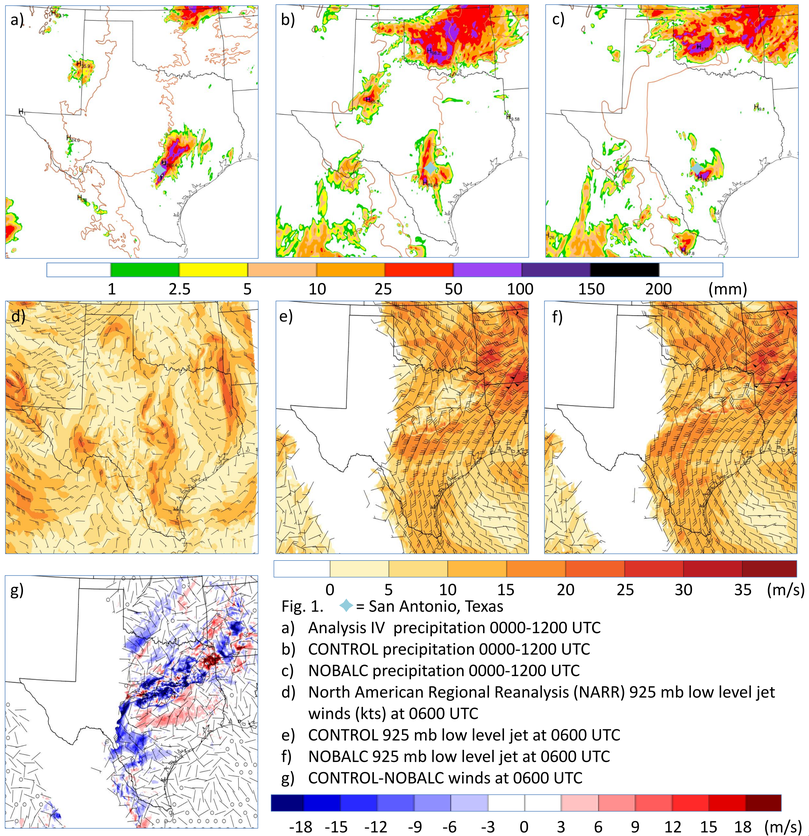


Fig. 1. ◆= San Antonio, Texas
a) Analysis IV precipitation 0000-1200 UTC
b) CONTROL precipitation 0000-1200 UTC
c) NOBALC precipitation 0000-1200 UTC
d) North American Regional Reanalysis (NARR) 925 mb low level jet winds (kts) at 0600 UTC
e) CONTROL 925 mb low level jet at 0600 UTC
f) NOBALC 925 mb low level jet at 0600 UTC
g) CONTROL-NOBALC winds at 0600 UTC

25 May 2013

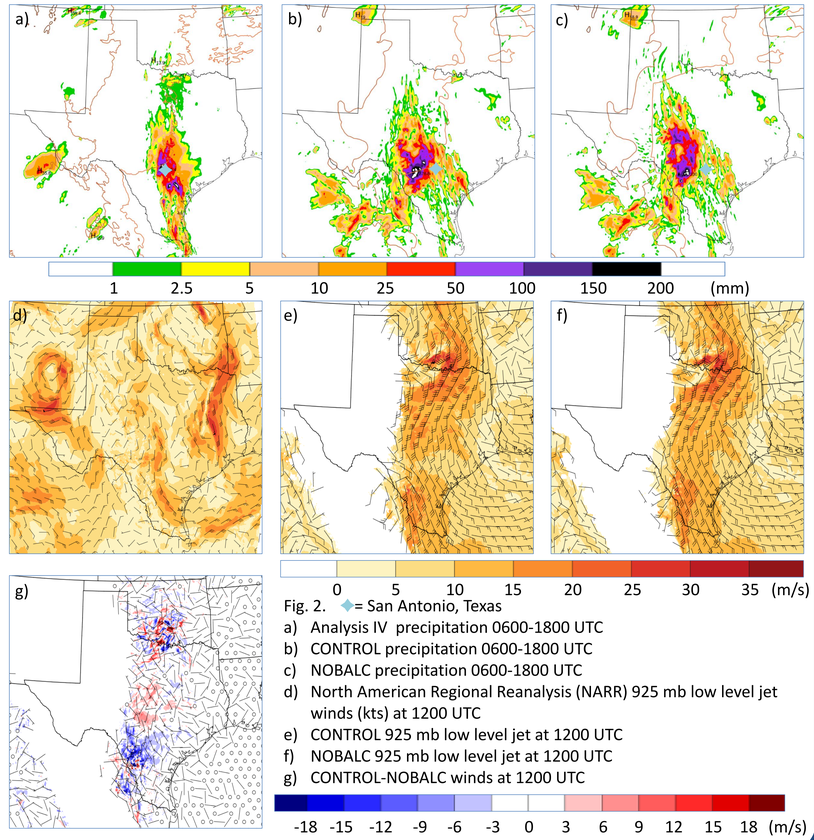


Fig. 2. ◆= San Antonio, Texas
a) Analysis IV precipitation 0600-1800 UTC
b) CONTROL precipitation 0600-1800 UTC
c) NOBALC precipitation 0600-1800 UTC
d) North American Regional Reanalysis (NARR) 925 mb low level jet winds (kts) at 1200 UTC
e) CONTROL 925 mb low level jet at 1200 UTC
f) NOBALC 925 mb low level jet at 1200 UTC
g) CONTROL-NOBALC winds at 1200 UTC

Model Configuration

- WRF Version 3.4.1
- Grid Spacing: 4 km
- Convection: Explicit
- PBL: Mellor-Yamada-Janjic scheme
- Microphysics: Morrison 2-moment scheme
- SW Radiation: RRTMG
- LW Radiation: RRTMG

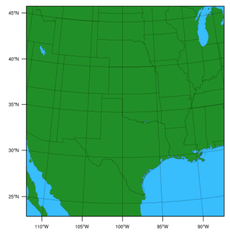


Fig. 4. WRF Preprocessing System (WPS) domain configuration

Conclusions

Surprisingly, removing the Balcones Escarpment of Texas by shifting the terrain gradient northwest causes little changes to the rainfall distribution and amount. It also caused a small change to the low level jet (LLJ). The meteorological factors, such as temperature and dew point at different pressure levels, play a larger role in the forecasting of major South Central Texas rainfall events.

Acknowledgments

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Future Work

- Simulate more South Central Texas rainfall events.
- Modify the terrain height differently.
  Shift terrain gradient southeast.
- Look into other topographic variables:
  Soil categories, land use category, annual mean deep soil temperature, monthly vegetation fraction, monthly albedo, and slope category.

References

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