Overview of Mexico City Meteorological Conditions Using Observations and Numerical Simulations

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Introduction

The Mexico City Metropolitan Area (MCMA) has over 20 million people and is situated in a basin. Hazards include high levels of air pollution and flash flooding.

Better understanding of Mexico City meteorology may aid in better prediction of forecast positions of convergence lines, which focus the hazard potential.

Another benefit would be urban planning, focusing on development that would minimize risk to life, health, and property.

In addition, results may be generalized to various cities in the Americas and Asia with similar climate and topography (Fast et al. 2000, Banta et al. 2004, Schmitz 2005).

Mexico City topography shown by color filled contours to the left, with a star denoting Mexico City locations.

Methodology

Version 2.2 of Weather Research and Forecasting (WRF) numerical weather simulation used.

Weather simulations have sources of error, such as:
- Domain and boundary conditions
- Initial and boundary conditions

Better results with VPF versus NPF boundary layers, with NPF boundary layers representing a major bias near surface of the earth (Kain et al. 1995) and high precipitation biases, as seen in simulations (Kain et al. 2003, Werners et al. 2003).

Changes in land use values from satellite (MODIS data) and little.

Domain 3 (Domain 2) shown on lower left side. The surface elevations, slope in the southern valley (blue) reduced the largest errors for the area with fewer clouds in the simulations.

Rainstorms and solid profile data used (not shown) to increase accuracy. Precipitation generally captured quite well by simulations. Errors in thermodynamics were improvements.

Satellite data from TRMM used for precipitable water and rainfall estimates. Rainfall rates from rain gauges in the region also used.

Results

WRF and TRMM accumulated precipitation (top frame in middle, bottom plot left, red dotted line) may contribute to excessive flux near surface of Earth and less surface flux for the period of numerical simulations, 21-31 March 2006.

WRF precipitation (bottom left, red dotted line) may contribute to excessive flux near surface of Earth and less surface flux for the period of numerical simulations, 21-31 March 2006. Precipitation on the WRF. TRMM (green solid line) shows less than half as much precipitation as do the rain gauges.

TRMM (dotted red) and rain gauge (solid blue) monthly precipitation averaged over 1998-2006 period for Mexico City location.

WRF and TRMM averaged monthly precipitation for each year from 1998-2006 (top right) for the same given locations. No distinct discernible trends. TRMM negative biases large, even after accounting for the subtropics (Adler et al. 2000, Bowman et al. 2003).

Ratio of rain gauge rainfall to TRMM rainfall (middle right, blue line) from 1998-2006, with median value (dashed line). Again, no obvious trends for period. Median rain gauge amount is 2.37 times that of TRMM.

Diurnal variation in TRMM precipitation. Average of December and January 1998-2008 (left two figures), 00 UTC and 15 UTC. Roughly 2-5 times as much rainfall for Mexico City area around 00 UTC than around 15 UTC.

Average of July and August 1998-2008 (right two figures), 00 UTC and 15 UTC. Roughly 20-100 times as much rainfall around 00 UTC than around 15 UTC variation that time of the year, as in Sorooshian et al. (2002).

Interannual variation in TRMM precipitation for south-central Mexico and adjacent parts of the Gulf of Mexico and Pacific.

Average annual precipitation (left).

1999 (middle) shows high values of precipitation over Eastern Mexico, Gulf of Mexico, and Central Pacific, greater than any other year from 1998-2006.

2005 (right), the driest year for Mexico and region as a whole, according to TRMM. Magnitude is a small fluctuation appreciable, though pattern is more consistent.

Conclusions

WRF overproduction of precipitation may be linked to 2-m cool and moist bias in the south-central Mexican region.

TRMM tends to underestimate precipitation, particularly in the wet season, though rainfall patterns look qualitatively good.

No clear cut trends in precipitation are evident from 1998-2006 in either rain gauge or TRMM data, though significant interannual variability exists.

TRMM clearly affirms that diurnal cycles play a role in precipitation, especially during the wet season.