Topographical Influences on a Subtropical South American Mesoscale Convective System

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Background

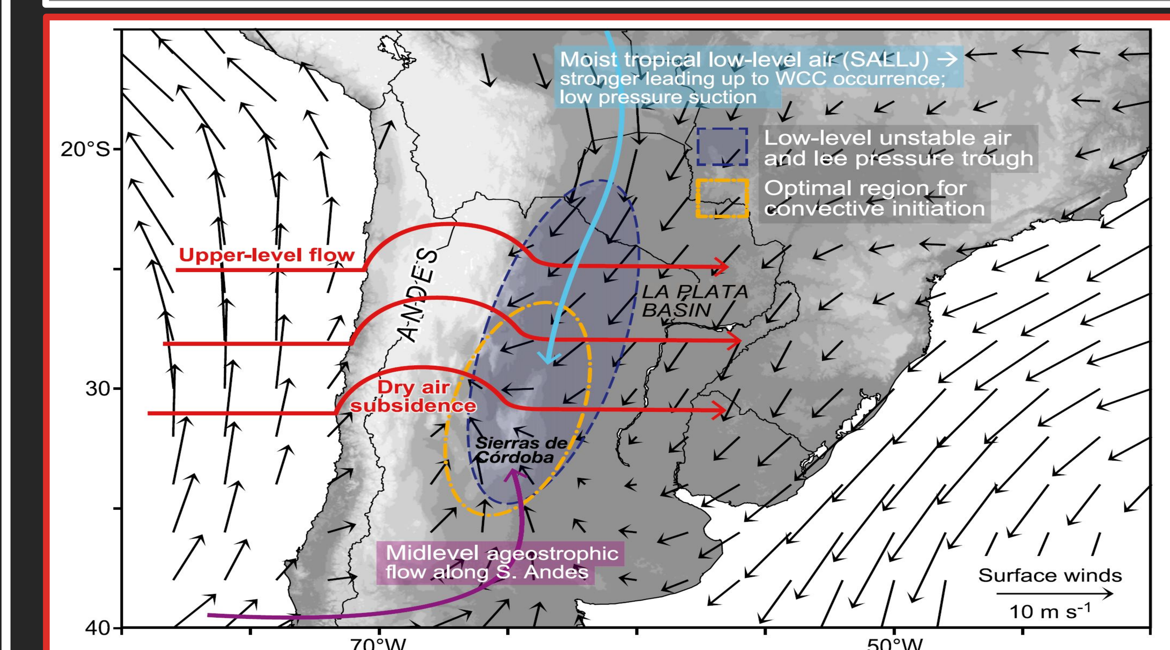

Fig. 1: Conceptual model of convective ingredients in the lee of the Andes from Rasmussen and Houze (2016).

On a global scale, South America has the deepest convection on earth. A hotspot of intense lightning and destructive hail is located over the Sierras de Cordoba (SDC), a secondary mountain range on the eastern side of the Andes.

Methods

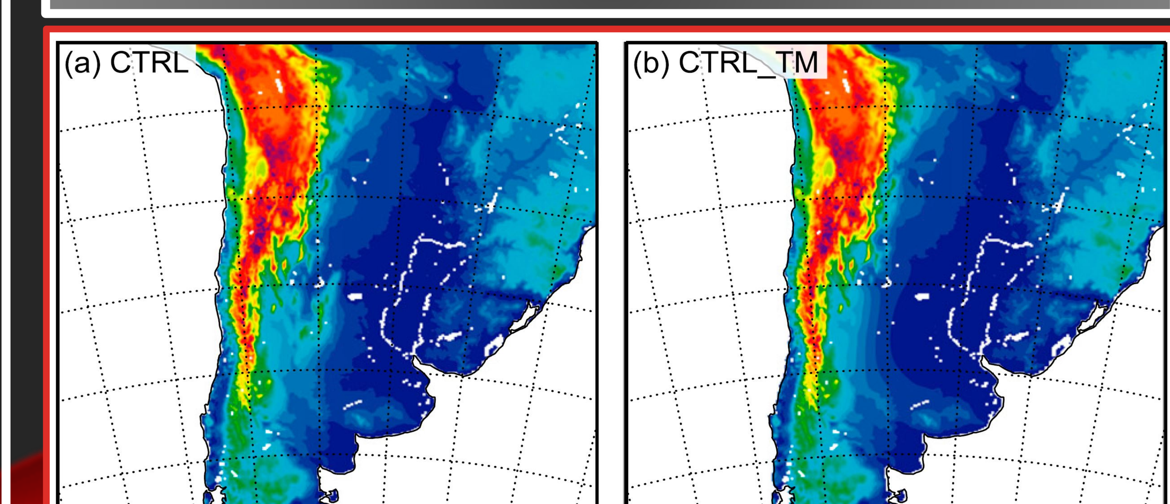

Fig. 2: Topography of the CTRL and CTRL_TM, from Rasmussen and Houze (2016).

- WRF-ARW V 3.4.1 model was initialized with GFS data on 00 UTC 26 December, 2003 and run for 48 hrs.
- Model was run with (CTRL) and without SDC (TM) to identify mesoscale differences (Fig. 2).

★The primary focus of this study is to understand interactions of the SDC and cold pools generated from a MCS.

Results

Removal of SDC results in overall weaker convection and lower cloud top heights.

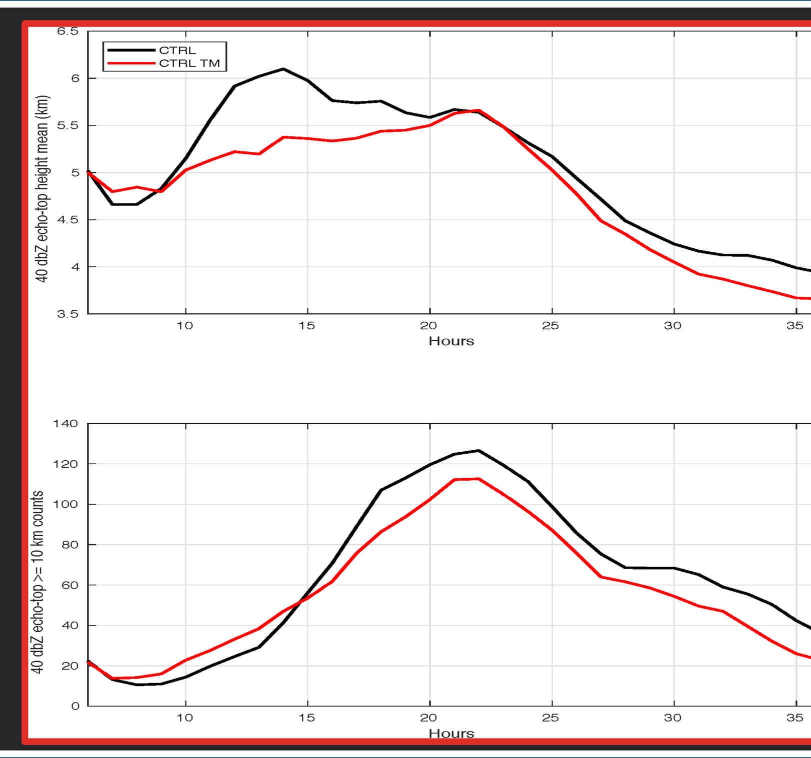

Fig. 3: 40 dbZ echo-top height mean (top) of CTRL & TM. 40 dbZ echo-top > 10 km (bottom) of CTRL & TM.

Comparison of storm reflectivity depicts TM as a more linear system, with a bowing feature. Storm motion is relatively faster without the SDC (Fig. 4).

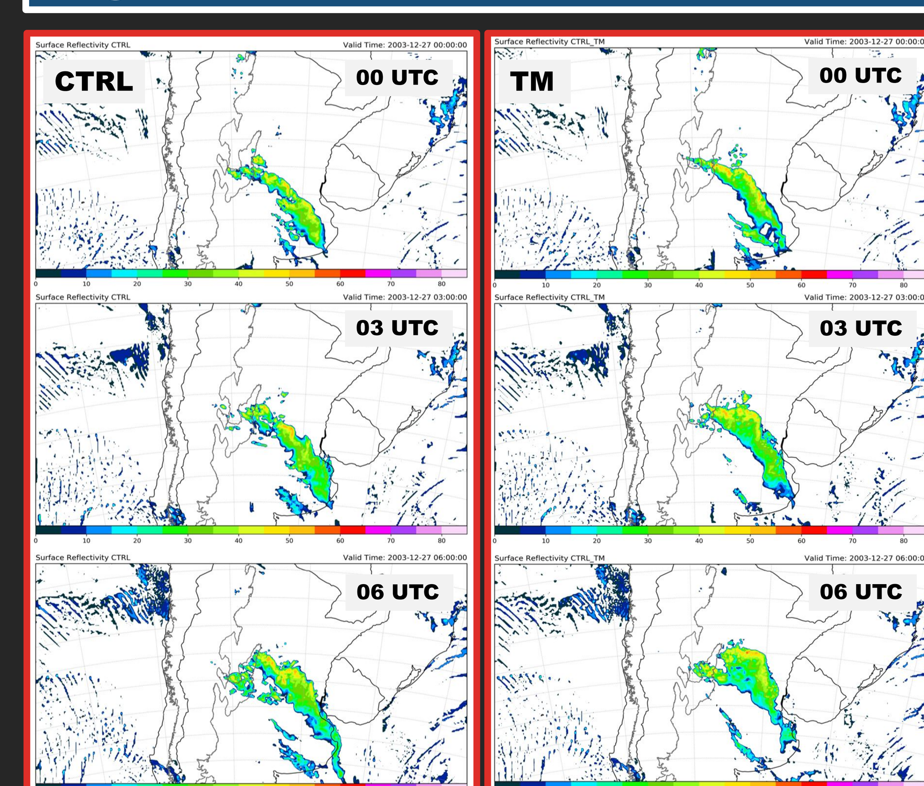

Fig. 4: Reflectivity at 00-06 UTC on 12/27.

★Eliminating a topographical feature weakens the MCS.

With the SDC, the cold pool remains tied to the terrain (Fig. 5).

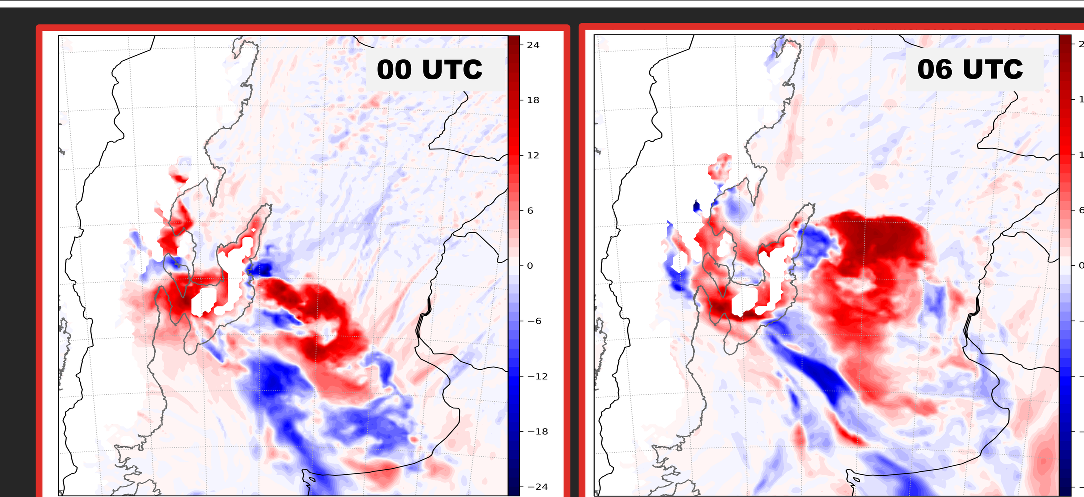

Fig. 5: 900-hPa theta-E difference between CTRL & TM at 00 UTC & 06 UTC on 12/27.

While along the SDC, mid level dry air sustains cold pool (Corfidi 2003). Mixing occurs without the SDC and cold pool shrinks (Fig. 6).

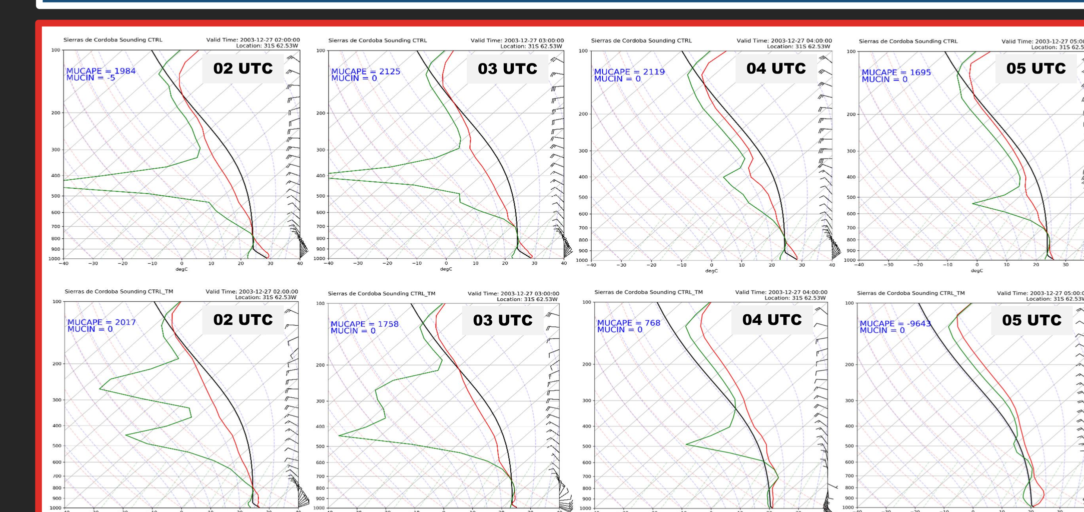

Fig. 6: CTRL (top) and TM (bottom).

The cold pool remains separated from an overnight valley inversion along the Andes in CTRL. In TM, the cold pool mixes with environment, weakening convection (Fig. 7).

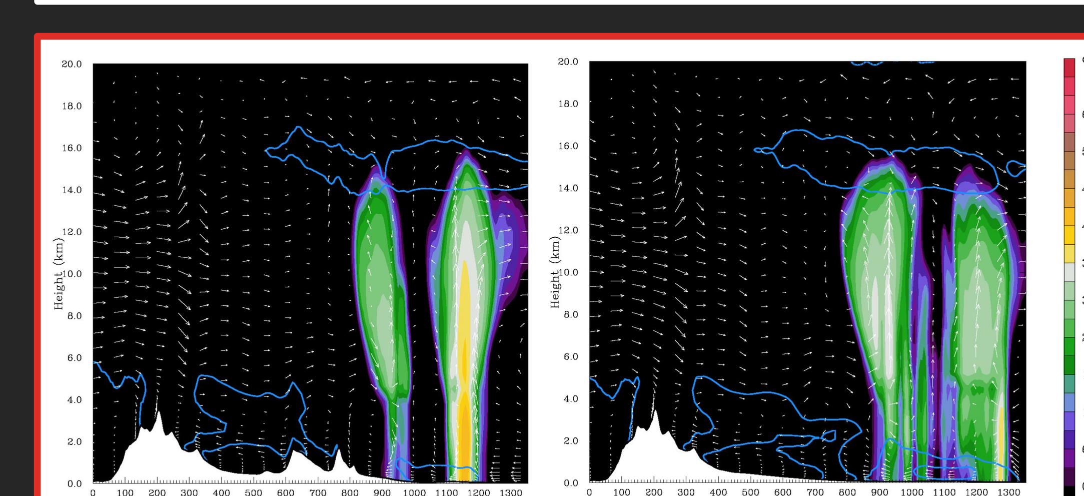

Fig. 7: Vertical cross section of reflectivity and theta-E. 12/27 at 10 UTC CTRL (left) and 09UTC TM (right).

★Cold pool dams & promotes continued convective initiation along terrain.

Conclusions

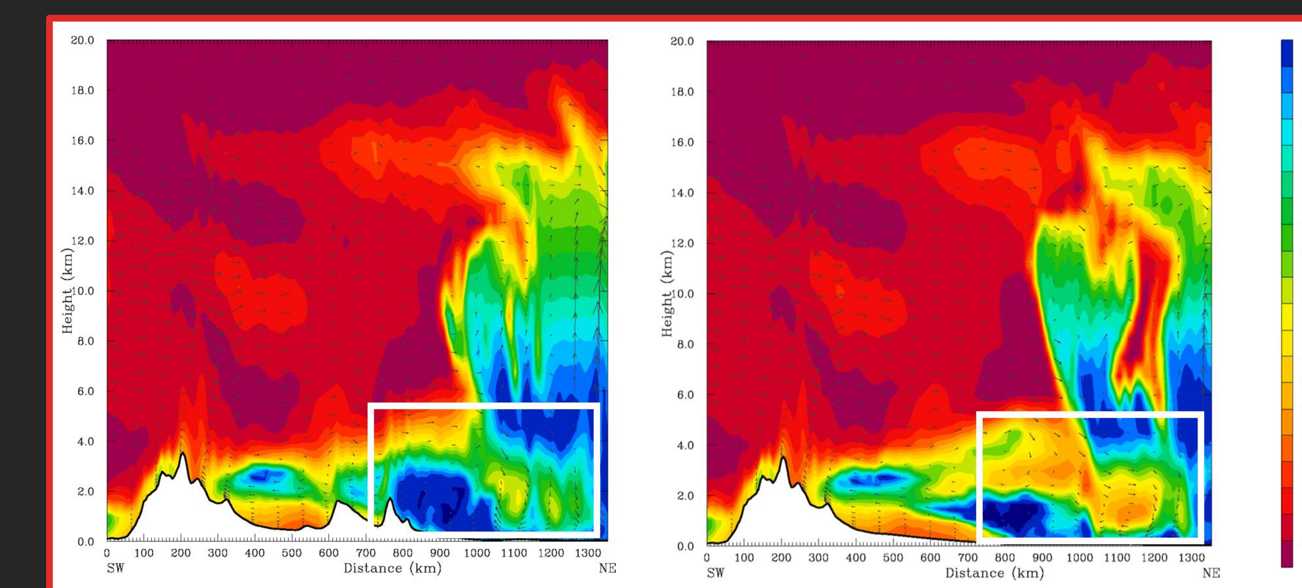

Fig. 8: Cold pool piling up along the SDC (left) and a shallower, mixed out layer without SDC (right).

- The SDC allows for enhanced evaporative cooling, deepening the cold pool by damming and retaining greater amounts of CAPE and low-level moisture.
- Continual cold pool development along the SDC support back-building and long lasting, overnight MCS events. Removing the SDC creates a broader, and weaker stratiform linear system.
- When the SDC are present, moisture and dry air are kept relatively separate. Once removed, dry air undercuts and erodes the MCS, mixing out the unstable environment, leading to less intense convection and quicker dissipation.

Future meteorological exploration at this South American location will rely upon observational data collected during the RELAMPAGO field campaign, taking place Fall 2018.

Acknowledgments

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References

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