Roles of the Brazilian Highland in the formation of SACZ
Part I: Numerical experiments using RAMS

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1. Purpose
SACZ (the South Atlantic convergence zone) is a prominent precipitation zone characterizing South American summer monsoon system (Chou and Lau 1998). SACZ extends through Brazil and extends to the Brazilian highland (BH) in its climatological position. This suggests some contribution of BH for maintaining SACZ. This study investigates the influence of BH for SACZ by numerical experiments.

Fig. 1 Climatology of OLR (January, 1975-2006): (left) and OLR in January 1990 (right)

Fig. 2 Snapshot of GOES-IR image of SACZ

2. Model and design of experiments
Model: TECO (Terrestrial Environment Research Center, Tsukuba Univ., Japan) – RAMS
Grid number: 2504×200 (30 layers)
Horizontal grid: 50 km and 25 km
Initial and Boundary condition: NCEP-NCAR reanalysis
SET: NCEP-WRF dataset
Simulated period: January 1985
Spin-up time: 100 years
Convective parameterization scheme: Arakawa-Schubert (Ninoguti et al. 1997)
Radiation scheme: Nakajima et al. (2000)

Table 1 Conditions of sensitivity experiments

<table>
<thead>
<tr>
<th>Height of BH</th>
<th>0 m</th>
<th>100 m</th>
<th>200 m</th>
<th>300 m</th>
<th>400 m</th>
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<td>Experiment</td>
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<td>Initialization</td>
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<tr>
<td>Radiation</td>
<td>0 m</td>
<td>100 m</td>
<td>200 m</td>
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<td>400 m</td>
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<td>Sensitivity</td>
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<td>Precipitation</td>
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3. Performance of Control run
Precipitation: Position of SACZ is good, but rainfall intensity is weakly simulated.
Wind: Cyclonic circulation near BH in the real atmosphere is not simulated in the lower troposphere. Bolivian High and trough of subtropical jet over the South Atlantic is poorly simulated.
Cross sections of potential vorticity and mixing ratio: Properly simulated

Fig. 3 Area of simulation (upper) and area for modifying resolution in high, low run (lower)

Fig. 4 Precipitation in CNPL (left) and in control run (right). Red lines indicate the position of cross section in Fig. 6

Fig. 5 Geopotential height (shaded) and wind at 850 hPa in NCEP-NAR reanalysis (left) and control run (right)

4. Results of sensitivity experiment
(a) BH is higher and low-level convergence and precipitation along the SACZ are stronger. The cyclonic circulation in the southwestern portion of BH is simulated at t=200 run.
(b) Precipitation along the SACZ and the low-level cyclonic circulation near BH are well simulated in high-resolution run. This indicates that expression of complex terrain of BH is important to simulate precipitation over the BH.
(c) Low-level cyclonic circulation near BH is disappeared in stop run, in which precipitation around BH is artificially stopped

Fig. 6 Cross section of potential temperature (shaded) and mixing ratio (contour)

5. Conclusion
SACZ was simulated in control run, although rainfall of SACZ was weak and the low-level cyclonic flow over BH was not simulated. In t=200 run and high-resolution run, precipitation over the BH becomes strong and cyclonic circulation over the southwestern part of BH was simulated. The cyclonic circulation was not simulated in control run. This indicates BH maintains precipitation near the BH and the precipitation generates the low-level cyclonic circulation. The circulation contributes to maintain SACZ, because it intensifies the low-level convergence of SACZ along with northerly in the western periphery of Atlantic subtropical high and South American low-level jet (SALLJ) from the eastern part of Andes.

References:

Fig. 7 Wind at 850 hPa and precipitation in each run

Fig. 8 Conceptual model of low-level circulation related to the SACZ