Improvement of rainfall simulation on the steep edge of the Tibetan Plateau

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Overestimation of precipitation over steep mountains has been a long-lasting bias in many climate models. After replacing the semi-Lagrangian method with a finite-difference approach for trace transport algorithm (the two-step shape preserving scheme, TSPAS), the modified NCAR CAM5 (M-CAM5) with high horizontal resolution results in a significant improvement of simulation in precipitation over the steep edge of the Tibetan Plateau. The M-CAM5 restrains the “overshoot” of water vapor to the high-altitude region of the windward slopes and significantly reduces the overestimation of precipitation in areas above 2000 m along the southern edge of the Tibetan Plateau. More moisture are left in the low-altitude region on the slope where used to present dry biases in CAM5. The excessive (insufficient) amount of precipitation over the higher (lower) part of the steep slope is partially caused by the multi-grid water vapor transport in CAM5, which leads to spurious accumulation of water vapor at cold and high-altitude grids. Benefited from calculation of transport grid by grid in TSPAS and detailed description of steep mountains by the high-resolution model, M-CAM5 moves water vapor and precipitation downward over windward slopes and presents a more realistic simulation. Results in this study indicate that in addition to the development of physical parameterization schemes, the dynamical process should also be reconsidered in order to improve the climate simulation over steep mountains.