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Synoptic control over orographic precipitation distributions during the Olympics Mountains Experiment (OLYMPEX)

Daniel Kirshbaum and David Purnell
McGill University, Montreal, Canada (daniel.kirshbaum@mcgill.ca)

The synoptic controls on orographic precipitation during the Olympics Mountains Experiment (OLYMPEX) are investigated using observations and numerical simulations. Precipitation retrievals for 18 observed warm-frontal (WF), warm-sector (WS), and post-cold-frontal (PF) periods indicate that heavy precipitation occurred in both WF and WS periods, but the latter saw larger orographic enhancements. Such enhancements extended well upstream of the terrain in WF periods but were focused over the windward slopes in both PF and WS periods. Quasi-idealized simulations, constrained by OLYMPEX data, reproduce the key synoptic sensitivities of Olympics precipitation and thus facilitate physical interpretation. These sensitivities are largely explained by three upstream parameters: the large-scale precipitation rate (r_{up}), the impinging horizontal moisture flux (I), and the low-level static stability. Both WF and WS events exhibit large r_{up} and I, and thus heavy orographic precipitation, which is greatly enhanced in amplitude and areal extent by the seeder-feeder process. However, the stronger low-level stability of the WF periods, particularly within the frontal inversion (even when it lies above crest level), causes their precipitation enhancement to weaken and shift upstream. In contrast, the small r_{up} and I, larger effective static stability, and absence of stratiform feeder clouds in the nominally unsaturated and convective PF events yield much lighter time- and area-averaged precipitation. Modest enhancements still occur over the windward slopes due to the local development and invigoration of shallow convective showers.