OROGRAPHIC PRECIPITATION PROCESSES

Paul J. Neiman¹, Allen B. White¹, F. Martin Ralph¹, Brooks E. Martner¹,², David E. Kingsmill²,¹, Ellen M. Sukovich²,¹, Mimi Hughes²,¹

¹NOAA ESRL Physical Sciences Division, ²University of Colorado, CIRES

Different types of rain associated with orographic precipitation

- Vertically pointing S-band radars detected a key shallow rain process without a brightband (NBB rain), as well as deep brightband (BB) rain.
- Rainrates in West Coast storms can exceed 20 mm h⁻¹ during NBB rain.
- For comparable rainrates, reflectivities were ~10 dBZ lower during NBB rain.
- NBB rain is common and hard to detect with NEXRAD due to its shallow character.
- 35% of rain in the 1997/98 winter season at CZD occurred without a brightband.
- NBB rain has also been observed by ESRL S-band profilers in the Sierra and Cascades.

Based on NNRP composite analyses for days dominated by BB rain (>75%) and NBB rain (>50%)

- The North American Regional Reanalysis (NARR) provides meteorological context for the 20 strongest vs. 20 weakest SBJ cases during the cool season at CCO (172 cases total).
- Strong SBJ cases are tied to deeper troughs located farther south than weak cases.
- BB rain is associated with stronger and deeper synoptic-scale ascent and colder (i.e., higher) cloud tops than NBB rain.
- Soundings associated with NBB rain showed warmer and moister low-level conditions than BB rain and had stronger up-slope flow.

- NBB rain is characterized by greater concentrations of small drops and smaller concentrations of large drops compared to BB rain.
- Reflectivity-rainfall rate relations for NBB rain are dramatically different than those used by operational radars, which has implications for QPE.

References:

Relationship between wind, water vapor, and orographic precipitation

- Rainrate in coastal mountains is directly correlated to up-slope flow at coast, as measured by wind profilers and collocated rain gauges over multiple winters.
- Up-slope flow at ~1 km is the best indicator of orographic rains.
- In blocked flow, near-surface winds do not provide useful rainrate information.
- GPS receivers provide measurements of integrated water vapor (IWV).
- Integrated water vapor flux (up-slope × IWV) correlates more strongly with mountain rain intensities than do either 1 km up-slope flow or IWV separately.
- Rainrate and orographic rain enhancement increases with increasing water vapor flux.

References:

Sierra barrier jet (SBJ) and its impact on precipitation distribution

- Wind profilers provided a 7-y climatology of barrier jets in CA’s northern Central Valley.
- SBJ cases are strongest, and occur most often, during the wet, cool season (Oct-Apr).
- SBJs are situated, on average, at ~1 km above ground level.
- Nearby rain gauges documented precipitation modulation by SBJs.

References: