Storm structure, freezing level height, and precipitation in the US Pacific Northwest

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Introduction

In the winter season, extratropical cyclones pass over the US west coast after developing over the Pacific Ocean. These land-falling cyclones are modified by the Coastal and Cascade mountains, yielding frequent rainfall. Some west coast orographic precipitation events can become very intense, leading to flooding and mudslides. Several recent severe flooding events in the US Pacific Northwest were associated with higher freezing level altitudes compared to long-term seasonal averages. This study examines 47 winter storms to determine the differences in the distribution of precipitation frequency along the Cascade windward slope as a function of rain layer depth.

Data

Operational Radar: The winter storm season of 2005-2006 (March-November) plus select storms from the 2006-2007 winter storm season observed by National Weather Service S-Band radar in Portland, Oregon (KRTX). Radar data were interpolated to a Cartesian coordinate system with 1km horizontal and vertical resolution.

Vertically Pointing Radar: 12 hourly sounding from Salem, Oregon (SLE).

SNOW and COOP Data: SNOWpack and Tellometry (SNOTEL) automated daily precipitation and National Weather Service Cooperative Observer Program (COOP) manual daily precipitation measurements.

Methodology

• 47 winter storms were selected that had low level winds from the South-Southwest (87% of all storms).
• The MRR Doppler velocity provided rain layer depth.
• Because of varying freezing level heights associated with frontal passages, we used storm maximum rain layer depth to categorize storms.

Deep Rain Layer: > 2.0 km
Medium: < 2.0 km and ≥ 1.5 km
Shallow Rain Layer: < 1.5 km

Contoured Frequency by Distance Diagram - CFDD

We calculated the frequency of precipitation (Z >13 dBZ) for each radar grid point of each storm and each subset of storms. At every distance from the crest, we compiled a histogram of the precipitation frequency along the Cascade windward slope as a function of rain layer depth. Several recent severe flooding events in the US Pacific Northwest were associated with higher freezing level altitudes compared to long-term seasonal averages. This study examines 47 winter storms to determine the differences in the distribution of precipitation frequency along the Cascade windward slope as a function of rain layer depth.

Conclusions

• The distribution of maximum rain layer depths for Portland winter storms is bimodal with peaks at 750 m and 2000 m MSL.
• Rain layer depth and vertically integrated water vapor from SLE sounding closest to storm onset and storm maximum rain layer depth.

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