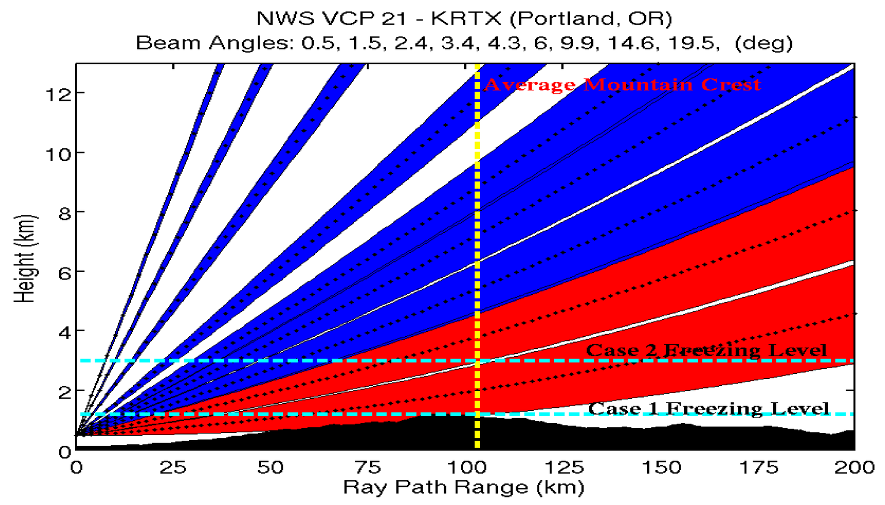

Quantitative Comparisons of 3-D Operational Radar Observations and Model Output over the Oregon Cascades

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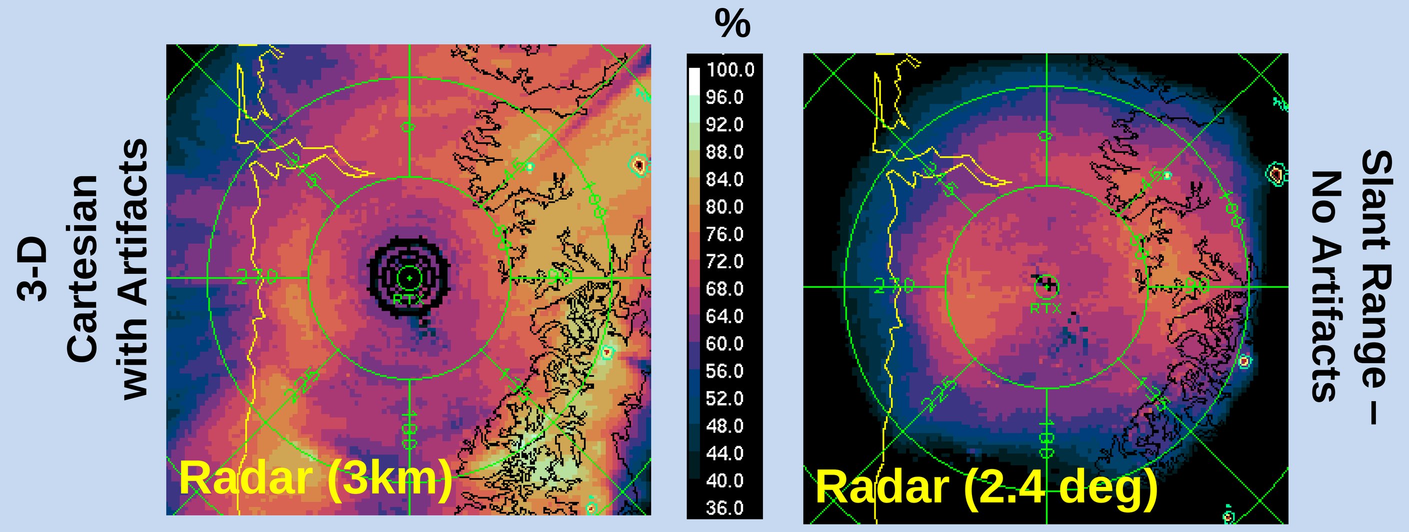
I. Introduction

Purpose

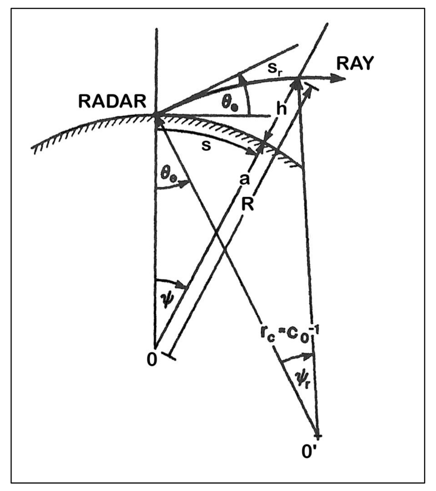
To develop an alternative to the 3-D Cartesian grid for comparing model output to radar data. Interpolating NWS radar data into a filled Cartesian grid creates too many artifacts. We have taken the alternative approach of comparing the model output to the subset of the 3-D grid along the slant-range elevation angle sweeps.

Frequency of Reflectivity >= 13 dBZ



Radar Beam Geometry

Ray Path Diagram[1]



Ray Path Height Equation[1]

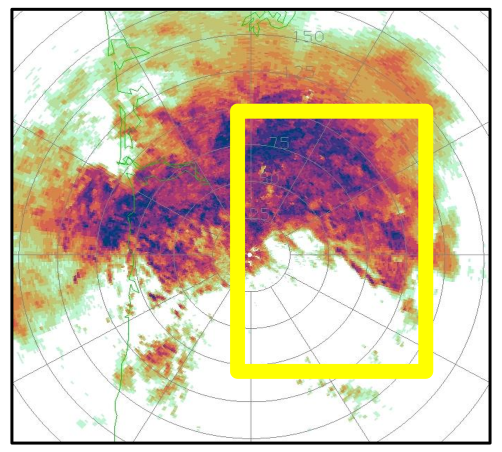
$$h = [r^2 + (k_e a)^2 + 2 r k_e a \sin\theta_e]^{1/2} - k_e a$$

Earth Path Distance Equation[1]

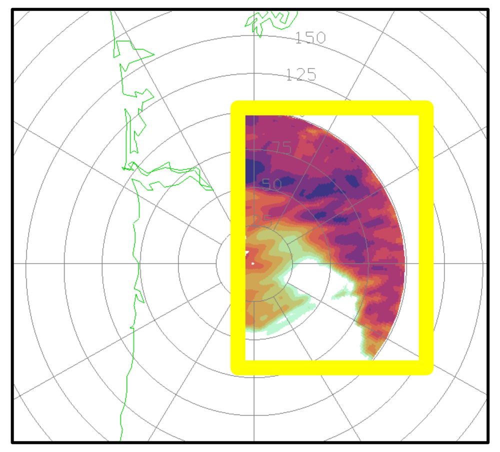
$$s = k_e a \sin^{-1}\left(\frac{r\cos\theta_e}{k_e a + h}\right)$$

r = slant range (along beam), k_e = refractive index
a = earth radius + antenna height, θ_e = elevation angle

Single Slice Example



KRTX Radar (1.5 degree elevation slice)

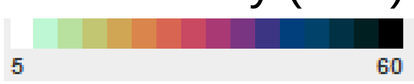


KRTX MM5 (1.5 degree elevation slice extracted)

Model Bounds

Note: Model slant range only interpolated out to 100km

Reflectivity (dBZ)



Note: Model reflectivity depicted in this poster only considers rain water mixing ratio and not ice.[2] Proper consideration of the freezing level is necessary for interpretation.

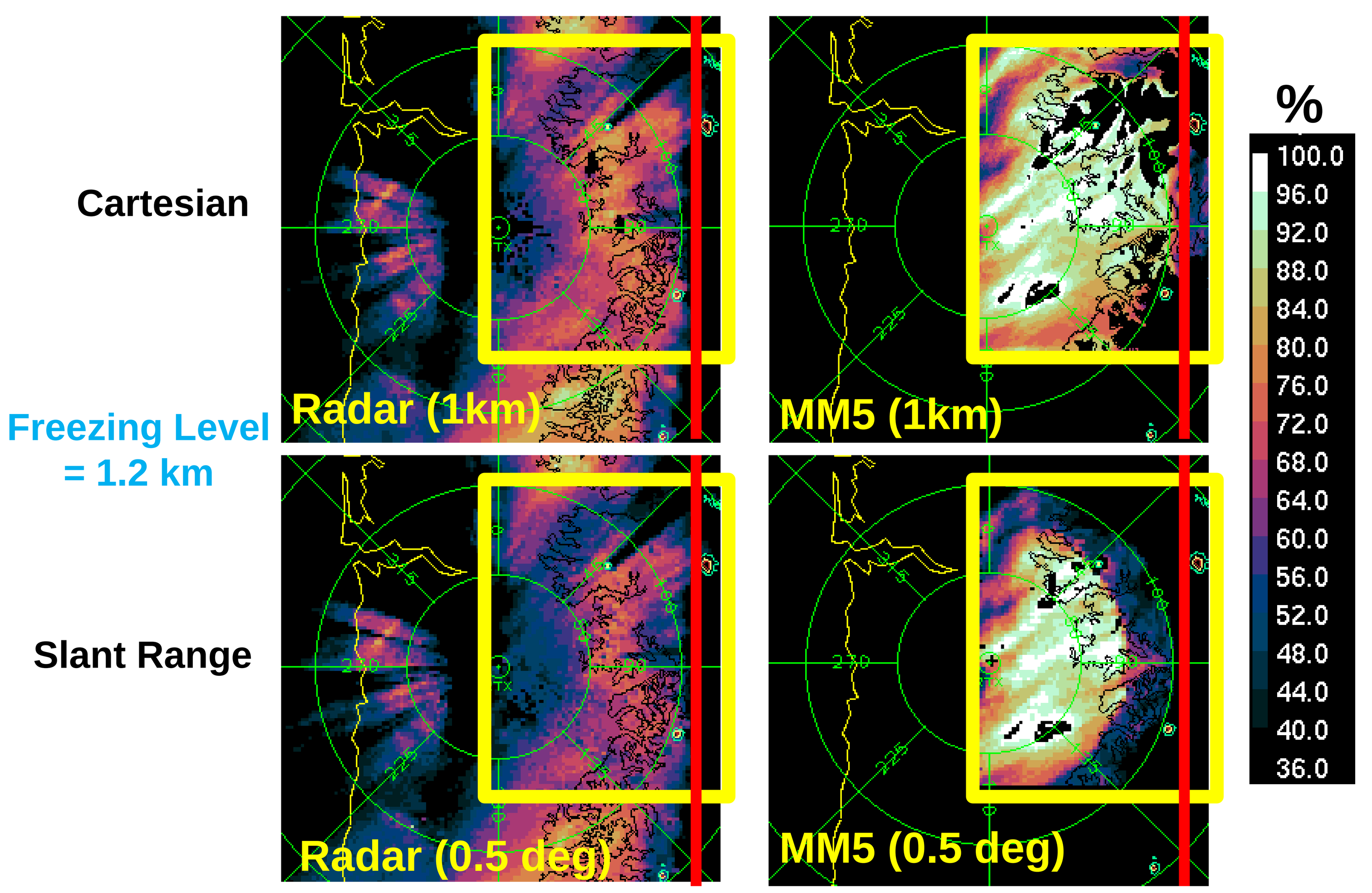
Common Polar Grid Characteristics

- Radial azimuths are aligned every degree starting with 0.5 degree
- Gate spacing is 250 meters with the first gate's center at 250 meters from the radar
- Elevations are based on NWS volume coverage pattern's lowest elevations (typically 0.5, 1.5 and 2.4 degrees)
- Radar data and model output are interpolated to the common polar grid to enable comparison in polar coordinates instead of Cartesian coordinates

II. Example Storm Composites

Case 1: 17 UTC 19 Mar 2007 to 07 UTC 20 Mar 2007

Frequency of Reflectivity >= 13 dBZ



Contour Frequency by Distance Diagram[3]

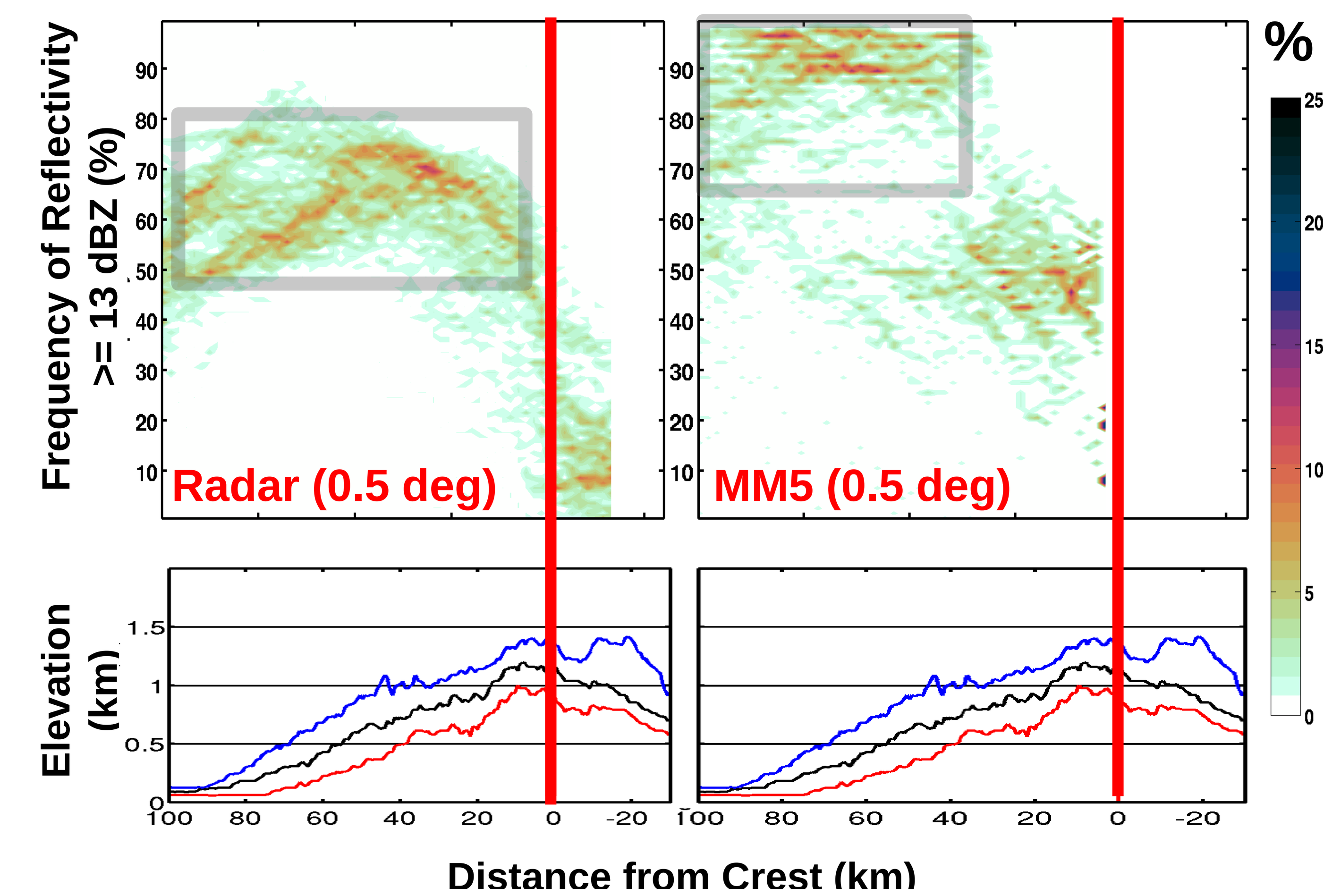
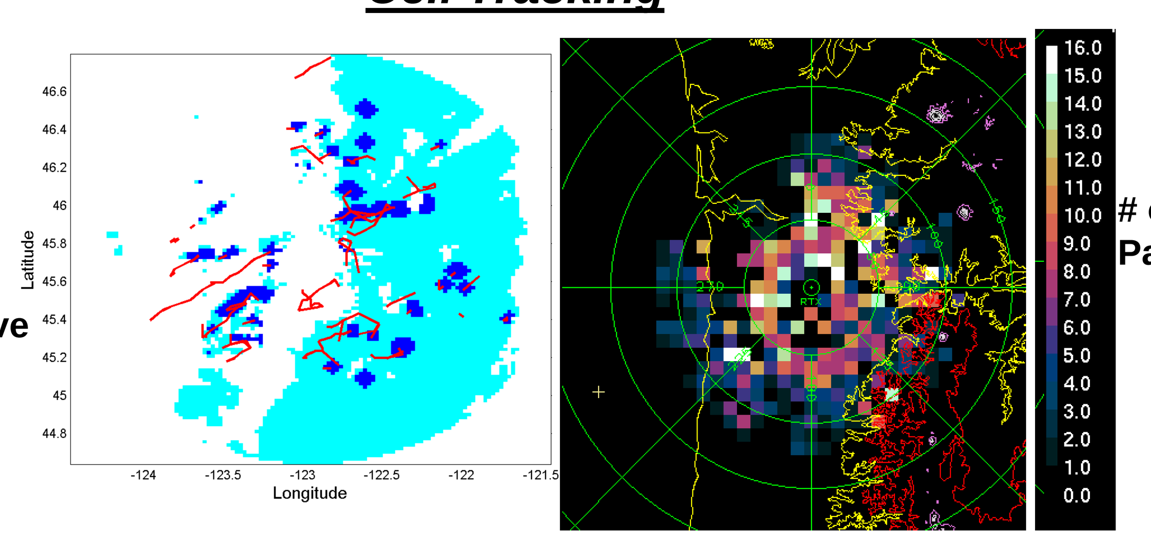


Figure Caption: Crest (red vertical line), 25th percentile (red), median (black), 75th percentile (blue) of topography for the Cascade region (46.79 N,123.36 W, 44.6 N, 121.66 W). Gray boxes indicate areas of maximum precipitation (note difference between model and radar).

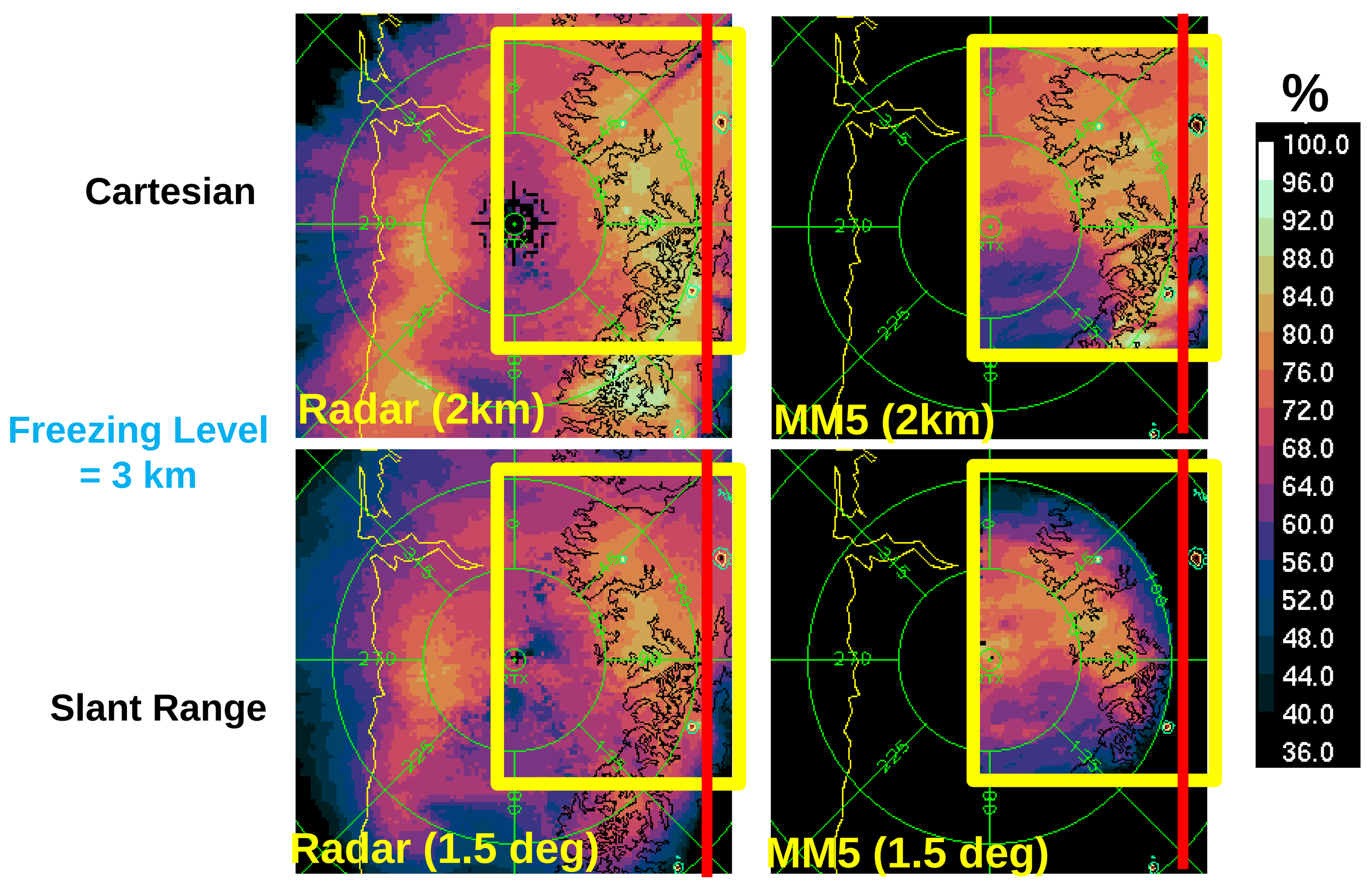
Cell Tracking

Single Instance Snapshot: (cell path – red line, stratiform precip – light blue, convective precip – dark blue)



Case 2: 00 UTC 05 Nov 2006 to 00 UTC 08 Nov 2006

Frequency of Reflectivity >= 13 dBZ



Contour Frequency by Distance Diagram[3]

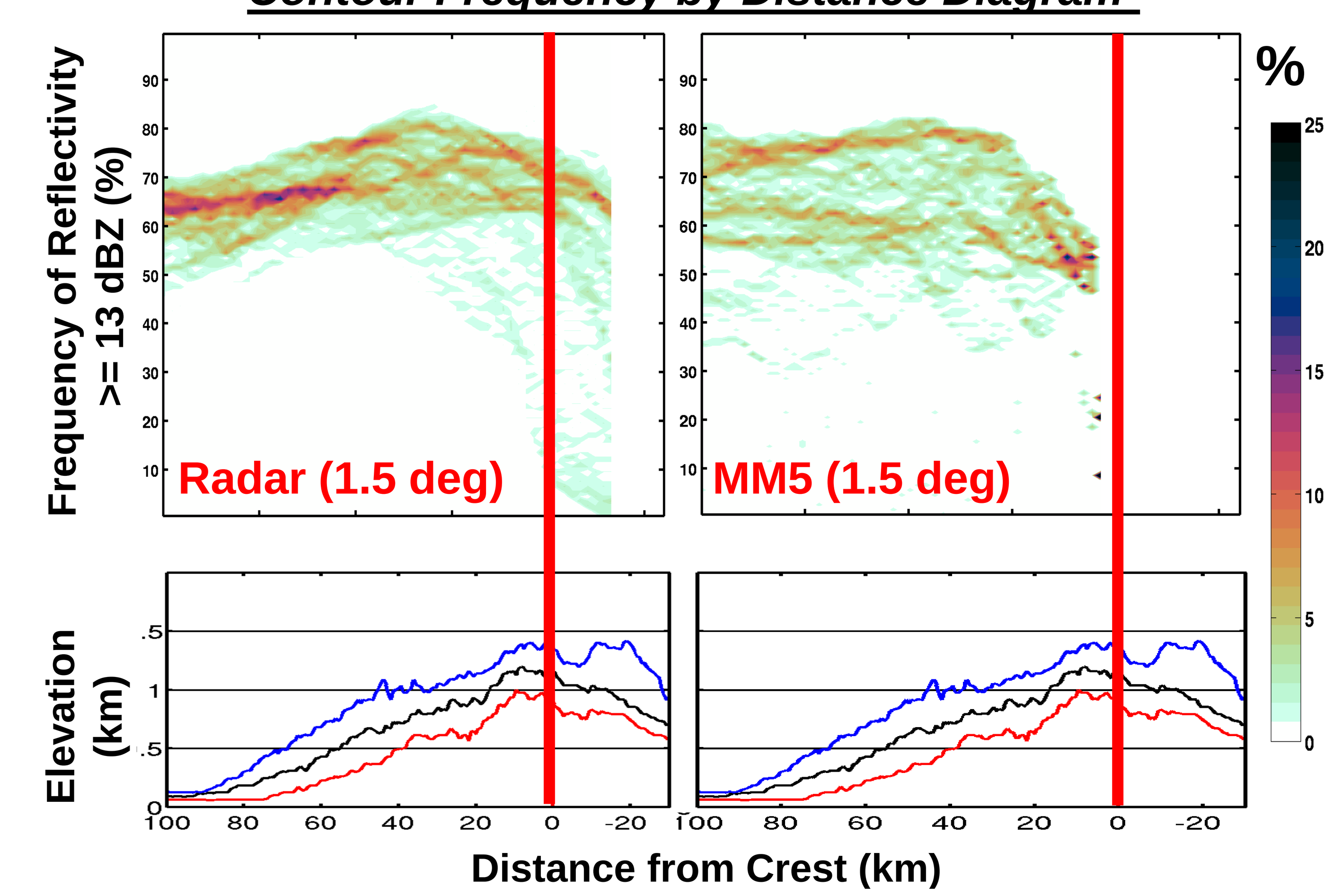


Figure Caption: Crest (red vertical line), 25th percentile (red), median (black), 75th percentile (blue) of topography for the Cascade region (46.79 N,123.36 W, 44.6 N, 121.66 W).

III. Summary

This methodology enables consistent radar-model comparisons of the orographic enhancement relative to topography. Horizontal structures within the rain layer are revealed with accumulated pixel statistics, while cell tracking makes feature-based comparisons possible. Future work will help refine model simulations of orographic precipitation.

References

1 - Doviak, R. J. and D. S. Zrnic, 1993: *Doppler Radar and Weather Observations*. 562 pp.
2 - Hagen, M. and S. E. Yuter, 2003: Relations between radar reflectivity, liquid-water content, and rainfall rate during the MAP SOP. Q.J.R. Meteorol. Soc.
3 – Guarente, et al., 2007: WRF simulations of a severe squall line: Comparison against high-resolution BAMEX observations. Presentation, 12th Conf. on Mesoscale Processes, Amer. Meteor. Soc., Waterville Valley, NH.

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