Cataloging Snow Band Vertical Structure: Insights from NASA IMPACTS and NEXRAD Data

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Motivation

Snow particles fall at ~1 m/s and usually take over an hour to traverse from near cloud top to the surface. During that time, the trajectory of a falling particle can bend and twist as it falls through layers with different wind speeds and directions and moves 10s of km horizontally. Our analysis examines the 3D structures of enhanced radar reflectivity.

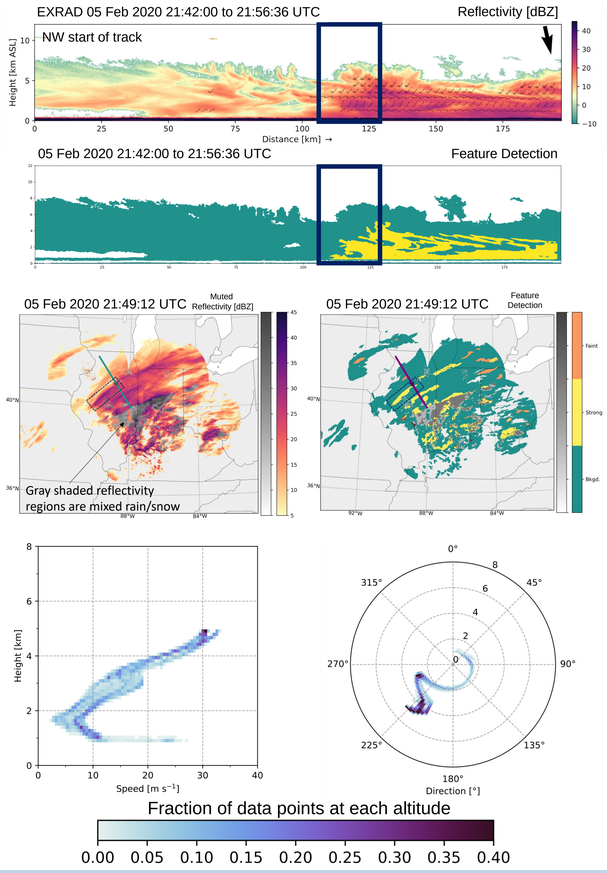
Data and Methods

We used aircraft radar data from NASA ER-2 collected during NASA IMPACTS field campaign[1] in January-February 2020, 2022, & 2023. A subset of flight legs have horizontal wind profiles derived from ER-2 EXRAD scanning radar[2]. The aircraft observations are put in the context of ground-based radar data from NWS WSR-88D NEXRAD network. We objectively identified local enhancements in radar reflectivity[3] in ER-2 flight leg cross-sections and in NEXRAD regional maps. In comparison to convective cells in warm season precipitation, enhanced Z features in winter storms are usually less distinct from the background echo and often have more fuzzy or feathered edges. The objective technique identifies both prominent, strong features and more subtle, faint features.

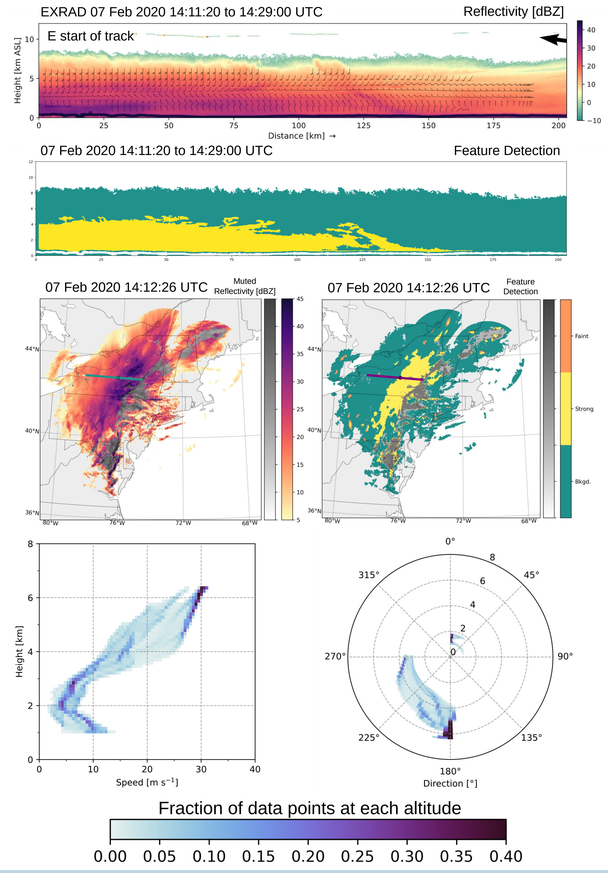
Summary and Future Work

- In general, there were few examples of ER-2 radar cross-sections that showed vertical column continuity with enhanced Z features seen in the NEXRAD regional reflectivity maps. Most examples illustrated tilting and smearing of locally enhanced Z in the vertical.
- Localized Z enhancements in vertical cross-sections usually did not have clearly associated banded features in the NEXRAD regional maps.
- Of the 73 banded features in NEXRAD regional maps that were sampled within the 45 ER-2 flight legs, just over half had a “faint” signature in the horizontal PPI rather than a “strong” signature.
- Future work will examine how spectral width (a proxy for turbulence) contributes to the observed 3D structures.

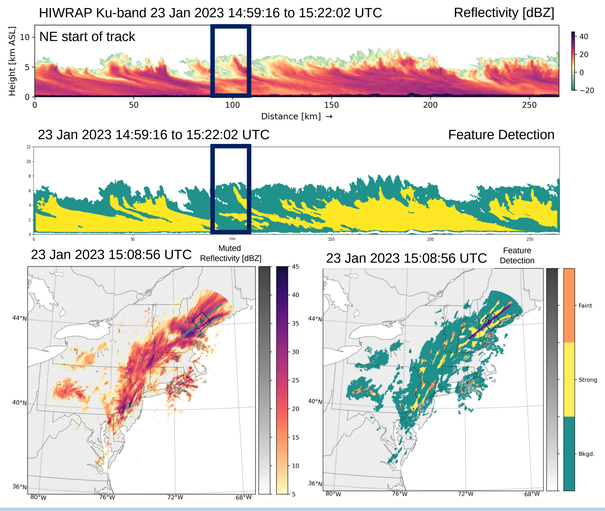
A: Across a strong band



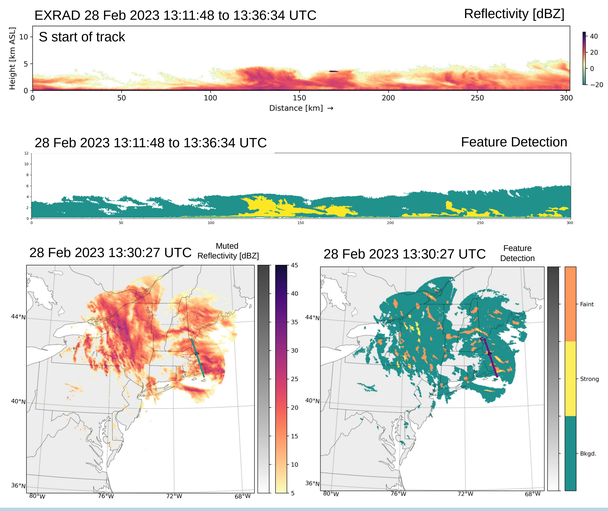
B: Across a strong feature



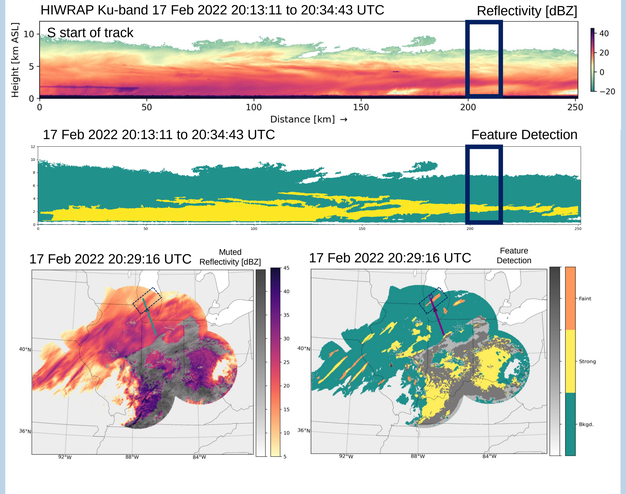
C: Along a strong band



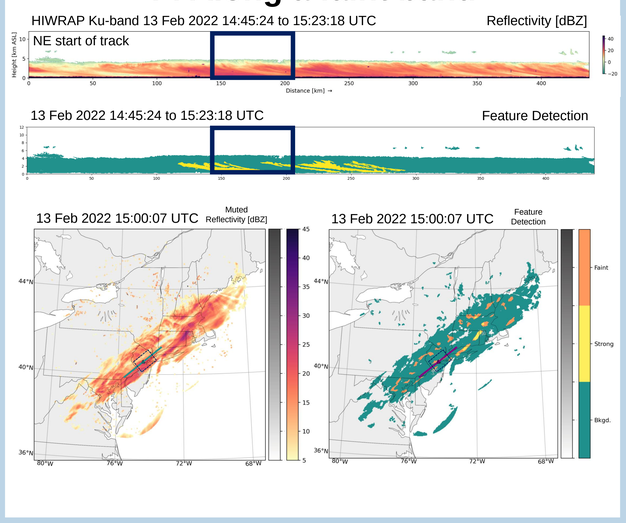
D: Across several weak features



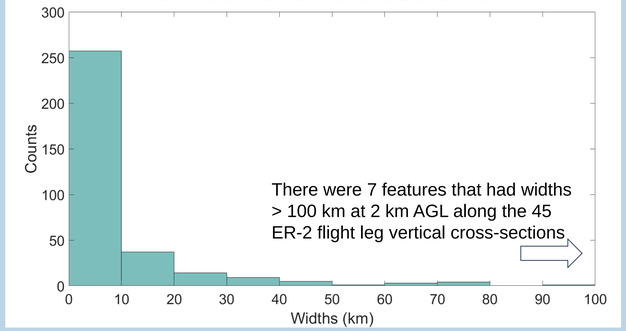
E: Across a faint band



F: Along a faint band



Along flight track widths at 2 km altitude of enhanced Z features in vertical cross-sections



References & Acknowledgements

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[1]McMurdie et al. 2021. DOI: 10.1175/BAMS-D-20-0246.1
[2]Helms et al. 2020 DOI: 10.1175/JTECH-D-20-0034.1
[3]Tomkins et al., 2024, *in review*. DOI: 10.5194/egusphere-2023-2888.