Analysis of ER-2 data to elucidate how the trajectories of ice particles are modified by horizontal air motions and wind shear

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Motivation

Snow falls at about 1 ms^{-1}, so it takes over an hour to fall 4 km in altitude. Throughout its descent, the snow will be advected by horizontal winds. Since horizontal winds generally increase in speed with increasing height, even the simplest wind profile of constant direction along the flight transect will prevent snow falling straight down. As the wind profile becomes more heterogeneous in terms of changes in wind direction and speed, the more complex the 3D path of snow falling to the surface becomes.

Methods

VAD wind profiles are derived from the EXRAD scanning beam[1]. We examine CFADs computed from the VAD wind profiles to illustrate speed and direction changes with height. Assuming the VAD profile is representative of the winds in the vicinity of the transect, we infer likely hydrometeor advection trajectories

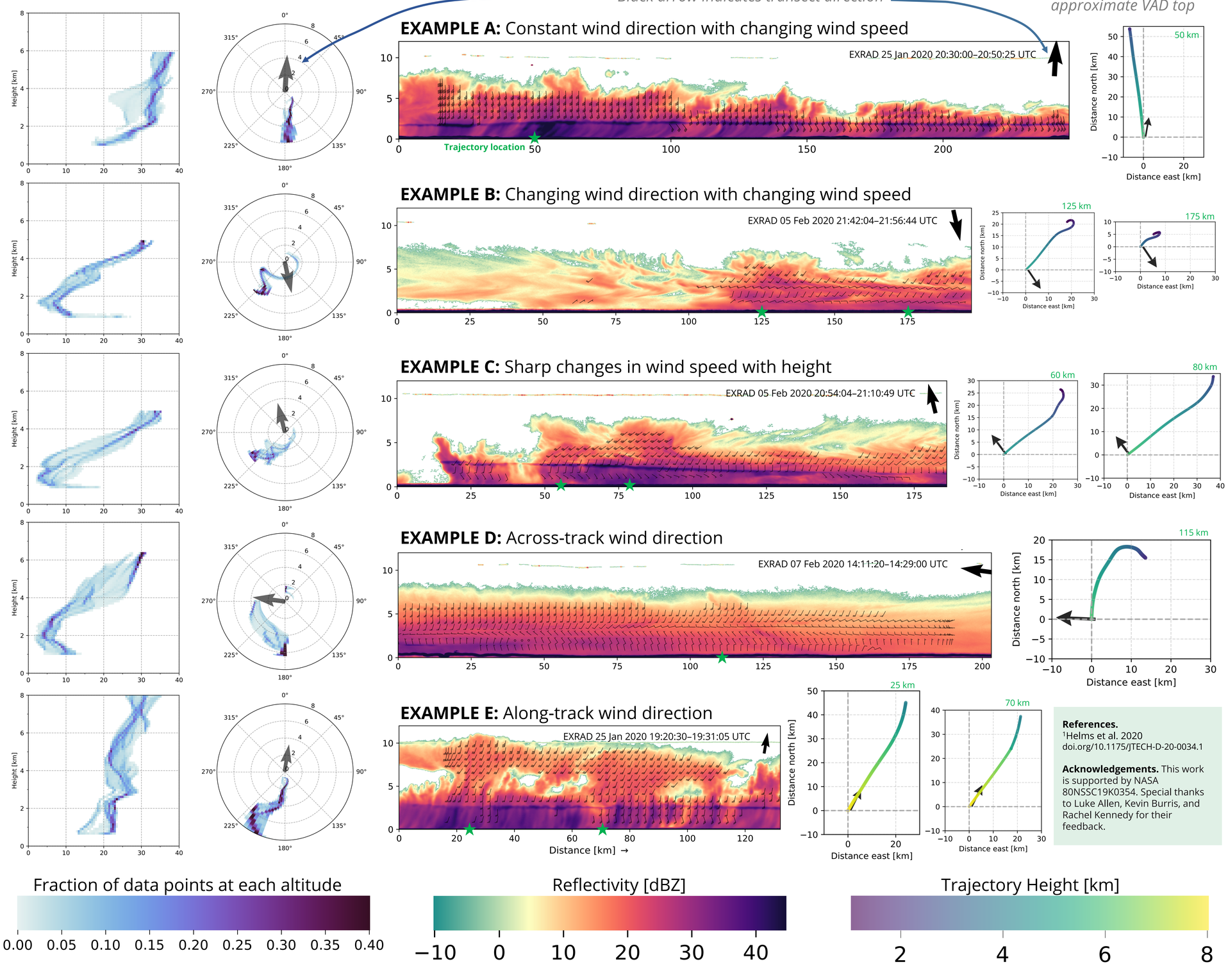
Implications

- IMPACTS 2020 included ER-2 flight legs with winds both along (ex. A, E) and across (ex. B, C, D) the transects. All other things being equal, more vertically contiguous reflectivity features are expected when winds are along the transect and more “smearing” is expected when winds are across the transect.
- For the 2023 deployment, should we prioritize flight legs oriented along the approximate wind direction in the upper portions?
- The heterogeneity of wind profiles and resulting complexity in snow particle paths to the surface yield diverse sets of hydrometeors in radar resolution volumes and knotty problems for microphysics retrievals.

Wind Speed CFAD | **Wind Direction CFAD** | **EXRAD reflectivity with VAD wind barbs** | **Particle Trajectories**

Black arrow indicates transect direction

Descending 4 km from approximate VAD top



References.
[1]Helms et al. 2020 doi.org/10.1175/JTECH-D-20-0034.1

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