A Study of the Kinematics and Dynamics Associated with Mesoscale Snowbands in a Midwest United States Snowstorm on 5 February 2020

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1. Research Goals

- Gain insight into the processes that maintain mesoscale snowbands via a detailed case study
- Examine a number of hypothesized forcing mechanisms

2. Synoptic and Mission Overview

Synoptic Setup

- Stationary front draped across southeastern US with a number of shortwave troughs extending northward into the Midwest (Fig. 1)
- Central Illinois experienced widespread light snowfall with embedded mesoscale snowbands (Fig. 2)
  - ER-2 and P3 sampled several mesoscale snowbands with paired in-situ and remote sensing observations (Fig. 2)

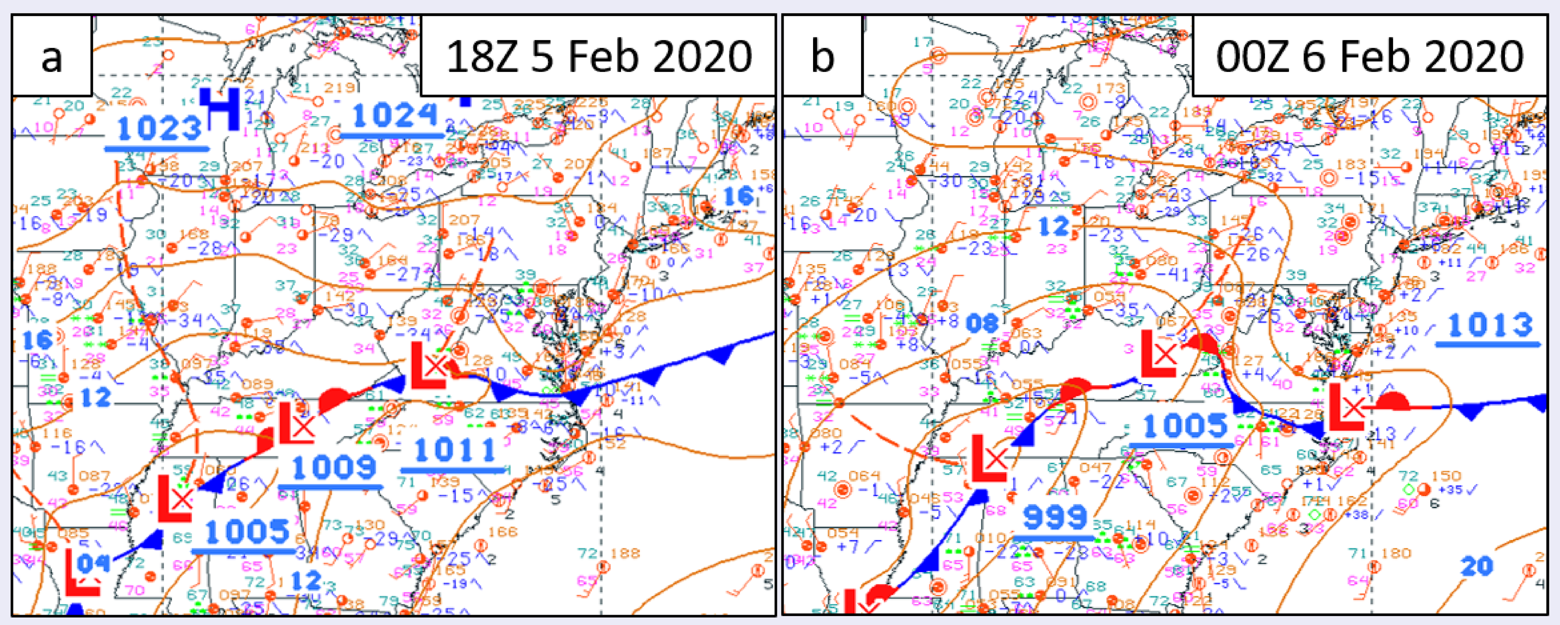

Fig. 1. NWS Surface analyses at (a) 1800 UTC 5 February 2020 and (b) 0000 UTC 6 February 2020. The flight legs of interest to this study took place between ∼2050 UTC and ∼2315 UTC 5 February 2020.

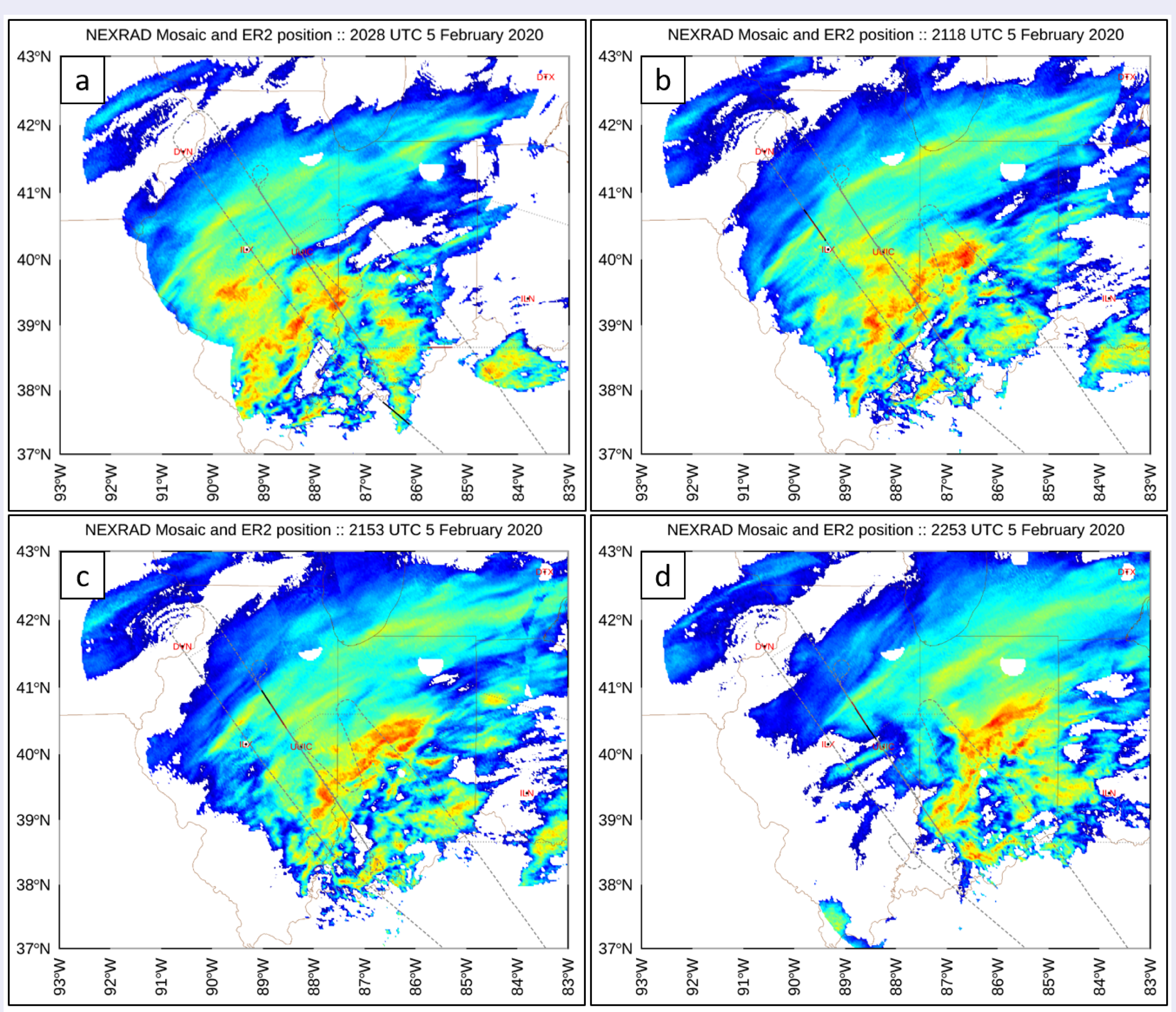

Fig. 2. NEXRAD reflectivity mosaic at 2-km altitude with ER-2 (gray dashed) and P3 (gray dotted) flight paths overlaid. ER-2 and P3 aircraft locations (±2.5 minutes) are indicated by the thick black and brown lines, respectively.

3. Three-dimensional Structure of Mesoscale Snowbands

- Distinct down-shear tilt with height: Generating cell with trailing precipitation?
- Highlights need for an along-band flight leg to capture generating cells

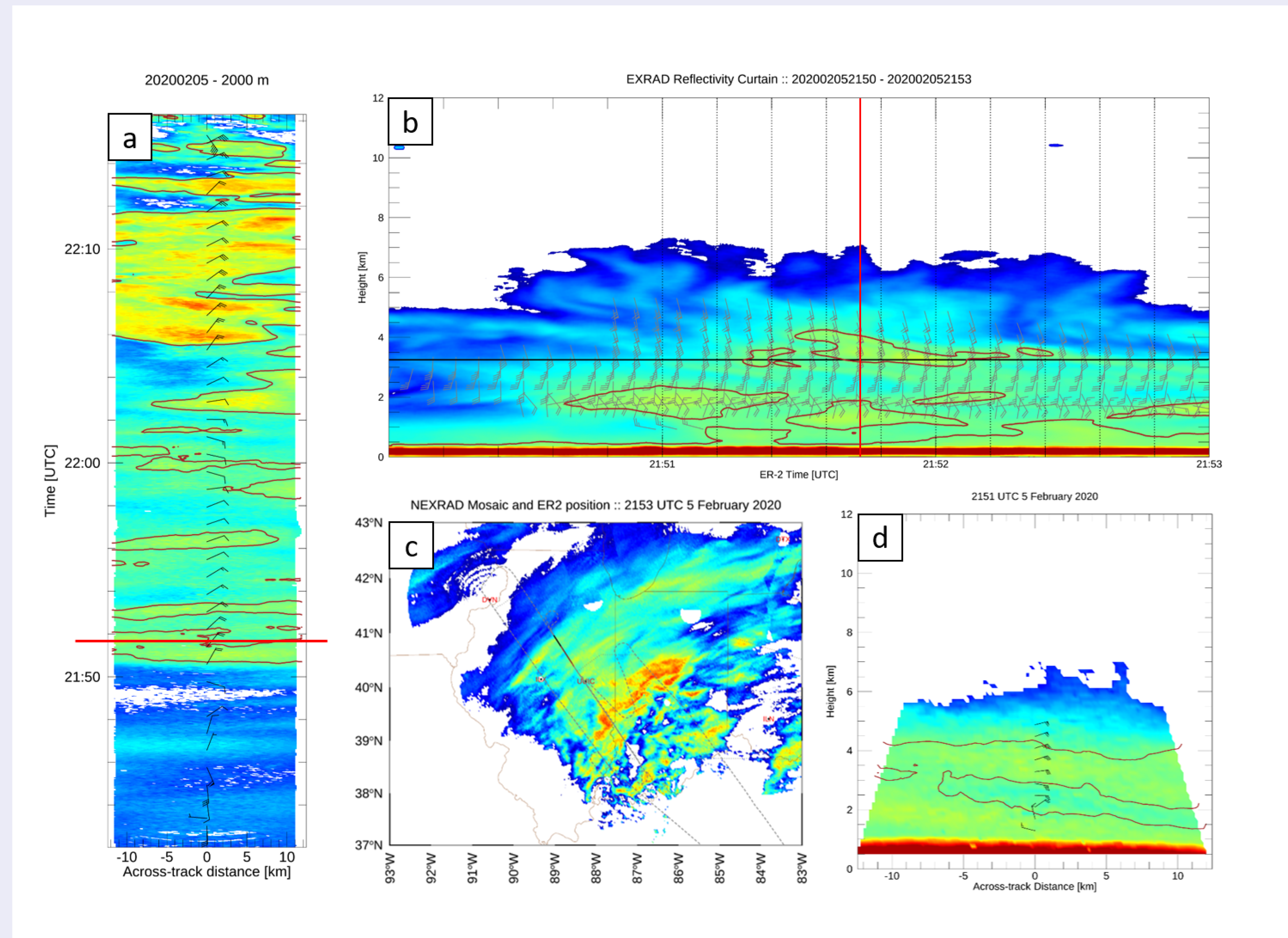

Fig. 3. Depictions of (a) EXRAD scanning-beam reflectivity at 2-km altitude, (b) EXRAD nadir-beam reflectivity, (c) NWS NEXRAD reflectivity mosaic at 2-km altitude, and (d) across-track EXRAD scanning-beam reflectivity at 21:51:44 UTC 5 February 2020. The brown contours in (a), (b), and (d) indicate the 25 dBZe isopleth and the red lines in (a) and (b) indication the location of the across-track section depicted in (d). The locations of the ER-2 and P3 near the time of the NEXRAD mosaic in (c) are indicated by the black and brown bars, respectively, with the full tracks in the dashed and dotted gray lines, respectively. Reflectivity shading is scaled to between 0 and 50 dBZe.

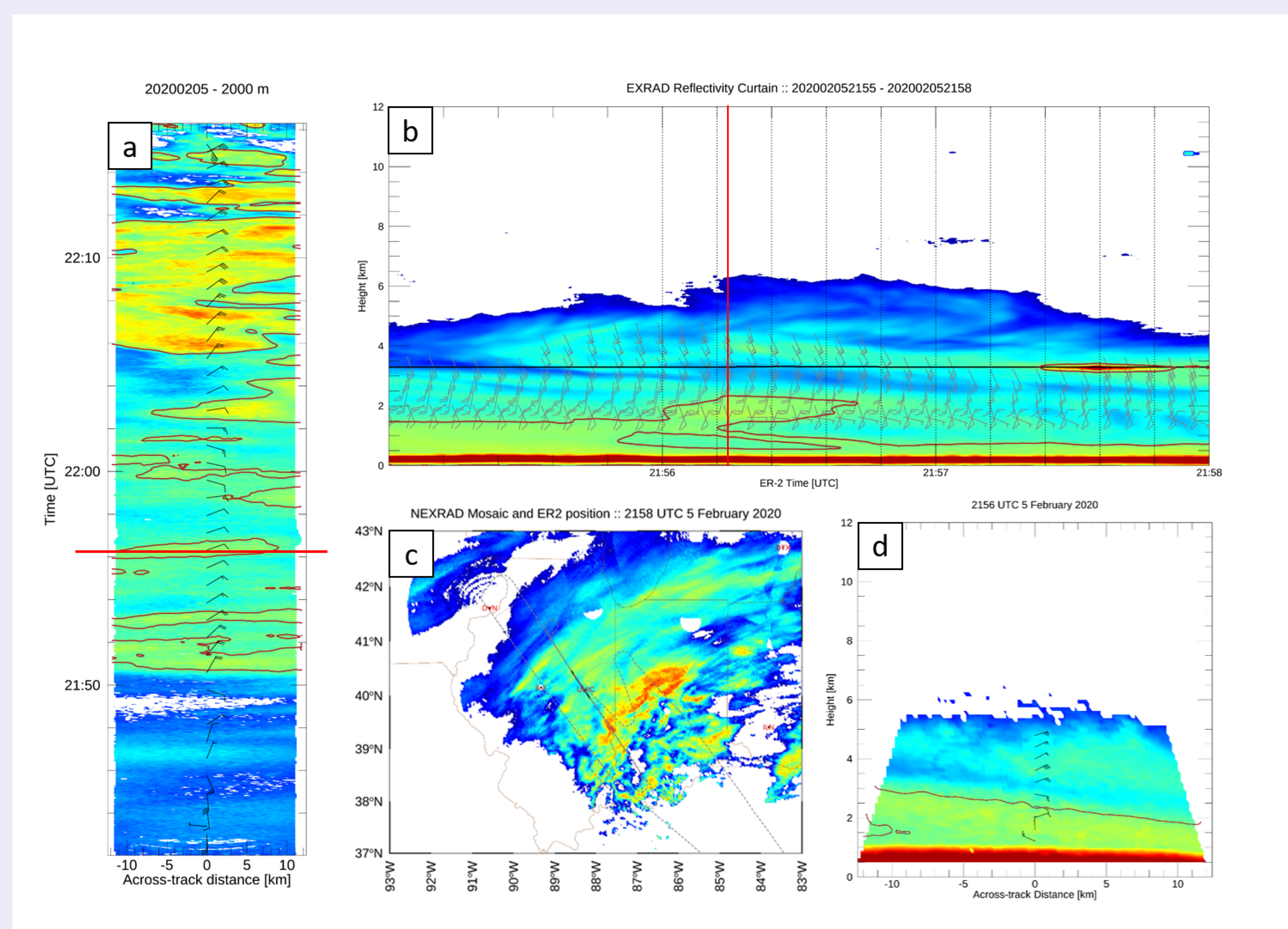

Fig. 4. As in Fig. 3, except for at a later time in the same flight leg with the across-track section occuring at 21:56:14 UTC 5 February 2020.

4. Relation to Kelvin-Helmholtz Instability

Richardson number does not support K-H instability

- No values below the critical Richardson number of 0.25
- Possible that model smooths out thermodynamic fields; additional soundings would be ideal, but would be difficult over land.

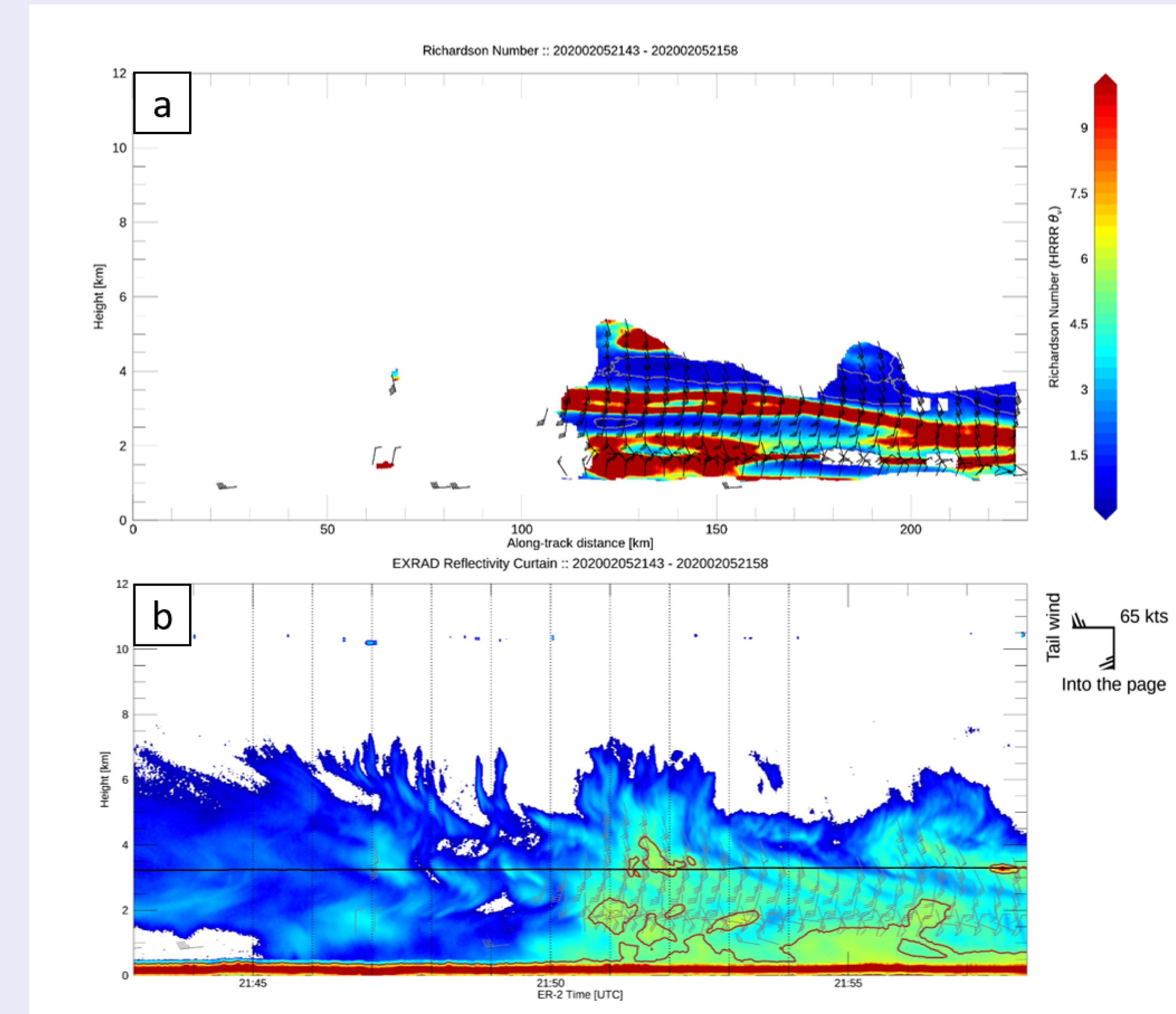

Fig. 5. (a) Bulk Richardson number, computed using the virtual potential temperature from the HRRR analysis and shear calculations from the EXRAD VAD wind retrievals, and (b) EXRAD nadir-beam reflectivity. Wind barbs are VAD track-relative winds in knots. The Richardson number in (a) is contoured at 0.25 and 1.0 with thick and thin gray lines, respectively, although no 0.25 contours appear on this plot. The horizontal black line and brown contouring in (b) indicate the P3 flight level and 25-dBZe isopleth, respectively.

5. Flight Planning

ER-2/P3 module for sampling along-band structure

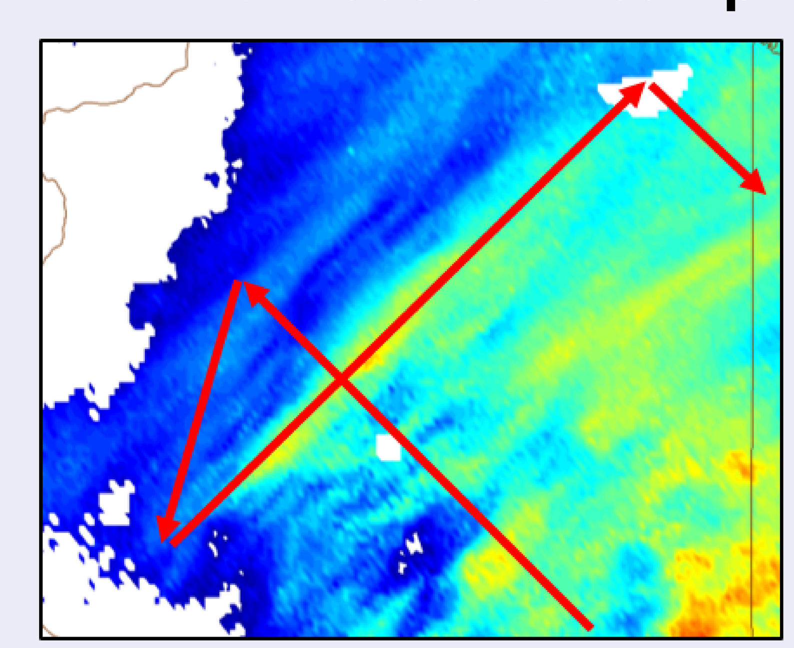

Fig. 6. Example module for sampling along-band structure.

- Would require last-minute flight plan changes based on real-time data to ensure the band is properly sampled
- Along-band leg could be repeated to enable the P3 to obtain in-situ measurements at multiple levels
- Ideally, P3 flight levels include a low-altitude leg to capture near-ground microphysics

6. Acknowledgements

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