The HIAPER Cloud Radar Performance and Observations During Winter Storm Observations of a Nor'easter

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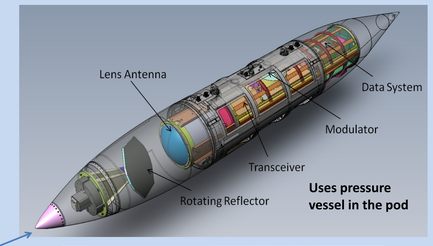
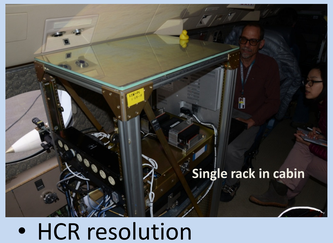
HCR System Overview

- Deployable on NCAR GV (HIAPER)
  - Pod-based (under wing)
  - Other aircraft that can support large pod
  - Staring (e.g., nadir)
  - Scanning from zenith to nadir perpendicular to aircraft
- Deployable on ground
  - Vertical pointing
  - Container houses both HCR and HSRL
- Coincident radar/lidar facilitates particle size estimates in liquid and ice
- Dual-polarization
- Time-series data recorded – enables spectral analysis
- Real-time and playback display capability





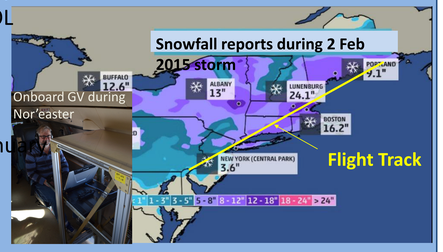
- W-band radars
  - Short wavelength
  - Small size enables airborne application
  - Sensitivity: -43 dBZ at 1 km range
  - Strong attenuation through rain, wet ice
- HCR resolution
  - Range = 20 to 150 m
  - Airborne beamwidth = 0.7 deg
  - Ground based beamwidth = 0.25 deg
  - Nominally 10 Hz data (along track resolution = 20 m @ 200 m s^{-1} ground speed)
- Measurements: Reflectivity, Radial velocity, Spectrum Width, Linear depolarization ratio

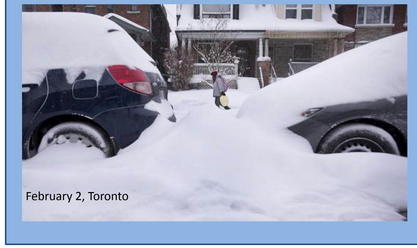
Navigation Correction

- Need to remove aircraft motion contribution to radial velocity
- Requires accurate pointing and aircraft position data
- Real-time stabilization of pointing angle
  - Keeps antenna pointing at nadir or zenith
  - Mitigates errors from non-flight level horizontal winds
- Radial velocity errors within ~ 0.1 m s^{-1}

Nor'easter: Rapid Response Project

- First scientific measurements with HCR
- First rapid-response deployment of EOL facility
- GV and HCR ready in CO
- PI's provided 5-day forecasts
- 48 hour go/no-go decision
- Flew from CO to staging area in NC Janu 31st
- IOP on February 2nd
- Big success!

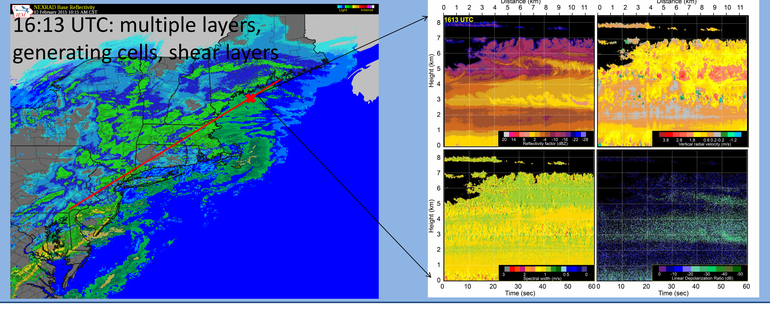




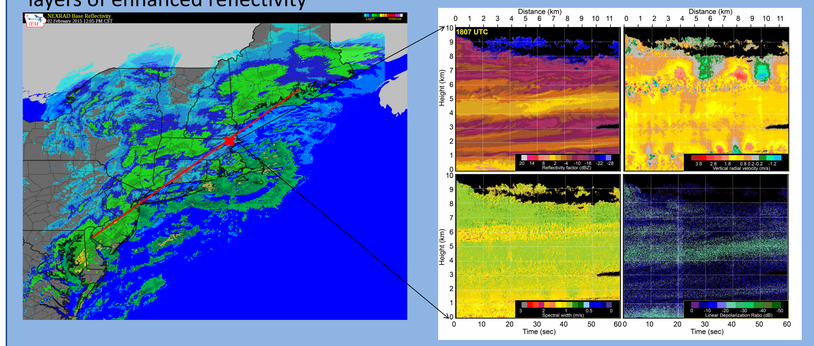
- Six transects from Washington DC to Bangor Maine over lifetime of large snow storm
- Flew at about 40 kft - above clouds
- Nadir pointing with active stabilization
- On station from about 13:00 to 20:00 UTC

Nor'easter: Data Examples

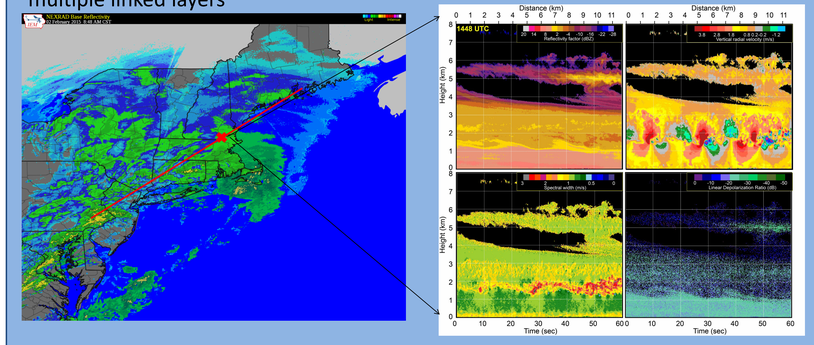
- Positive radial velocity is down, negative is up
- Particle fall speed has not been removed
- Final aircraft navigation correction has been applied



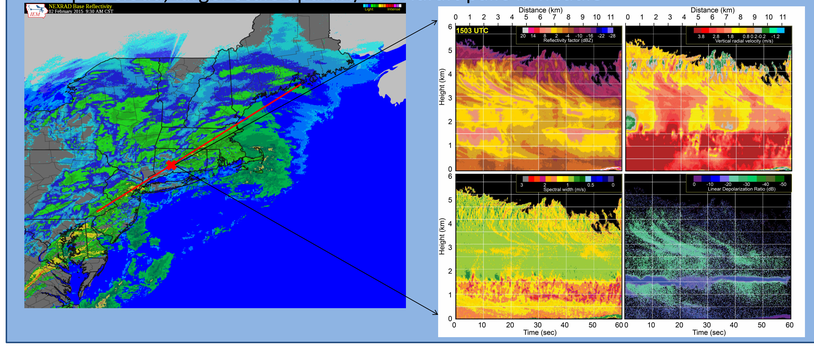
18:07 UTC: cloud top waves, shear layers, layers of enhanced reflectivity



14:48 UTC: strong waves at ~ 1.5 km, multiple linked layers



15:03 UTC: undulating melting layer, small scale updraft/downdraft pairs at top of cloud, larger scale updraft/downdraft pairs in middle



Summary and Conclusions

- HCR's first science-based deployment was successful
- EOL's first rapid-response project was successful
- Real-time stabilization of pointing angle improves nadir (and zenith) wind measurements
- The GV's endurance and flight capabilities are greatly beneficial for these types of studies
- Northeast snow storms have a lot of surprisingly complex structures as revealed by HCR on the GV