New Software Tools for Lidar and Radar "Big Data" from PECAN

Plus P3 Airborne Radar Navigation Corrections

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NOAA P3 Tail Radar Navigation Corrections

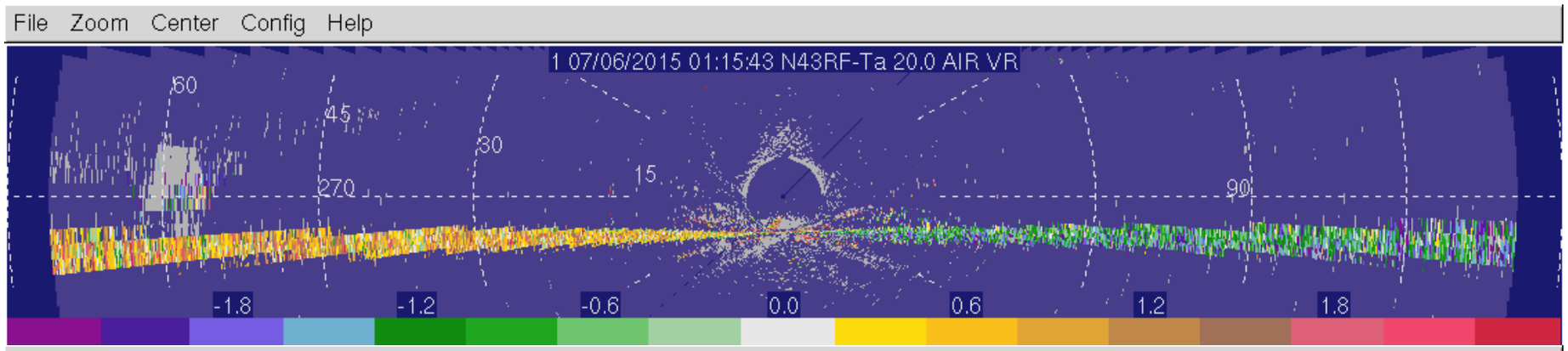
- The calculations were performed using a new generalized navigation correction method described by Cai et al. (2016).

- The calibration legs were chosen as 10-min long, straight, and level legs at the beginning of each flight.
    - 06/20: 01:30 - 01:40 UTC
    - 07/06: 01:10 - 01:20 UTC
    - 07/09: 00:50 - 01:00 UTC

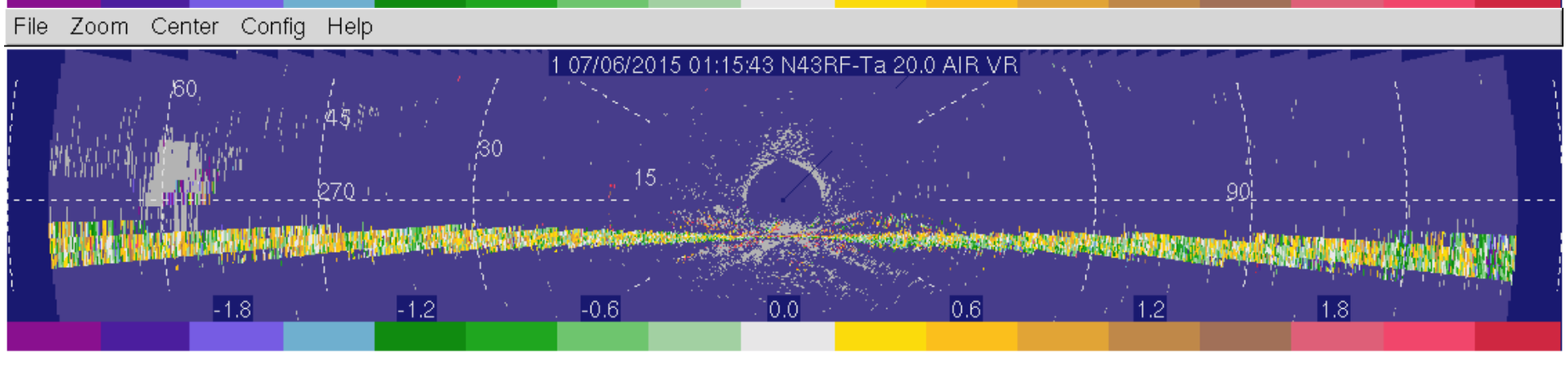
- The corrections are very consistent for all three flights, and produce corrected surface Doppler velocities that are level and have a mean of zero with ~1 m/s standard deviation. The stability across flights gives some confidence that these values are robust and stable throughout the PECAN campaign.

Illustration of Navigation Corrections 07/06/2015

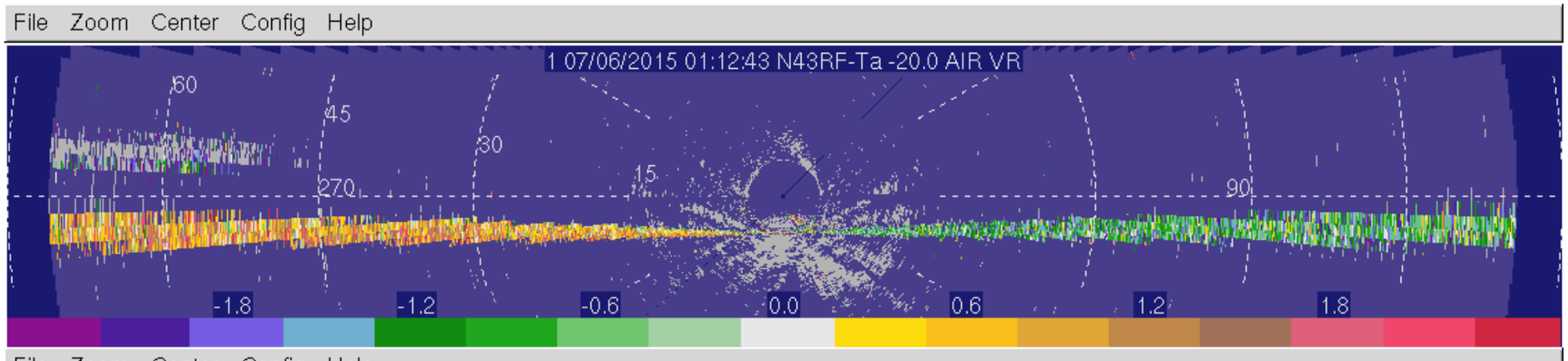
Fore Radar
Uncorrected



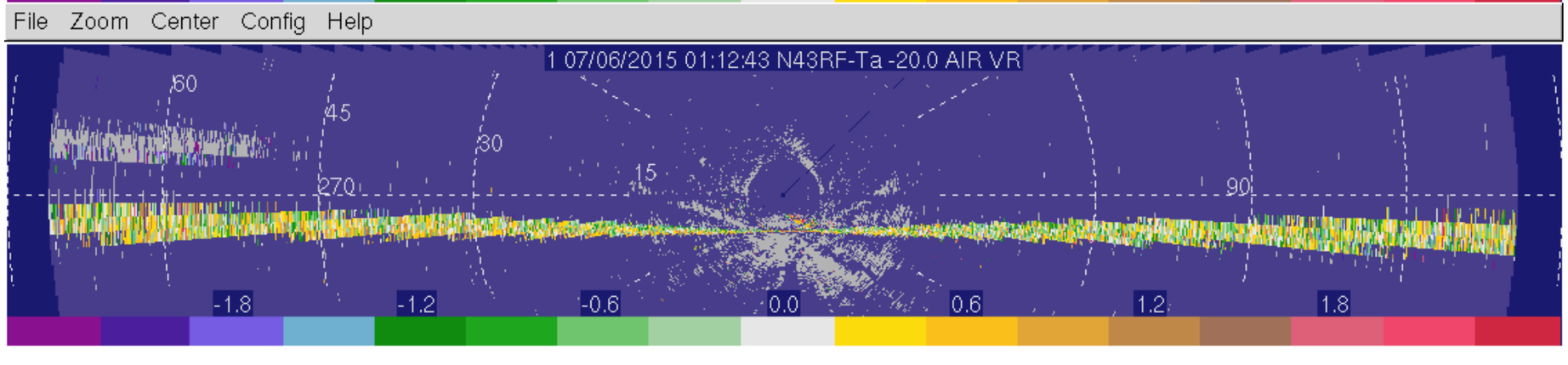
Fore Radar
Corrected



Aft Radar
Uncorrected



Aft Radar
Corrected



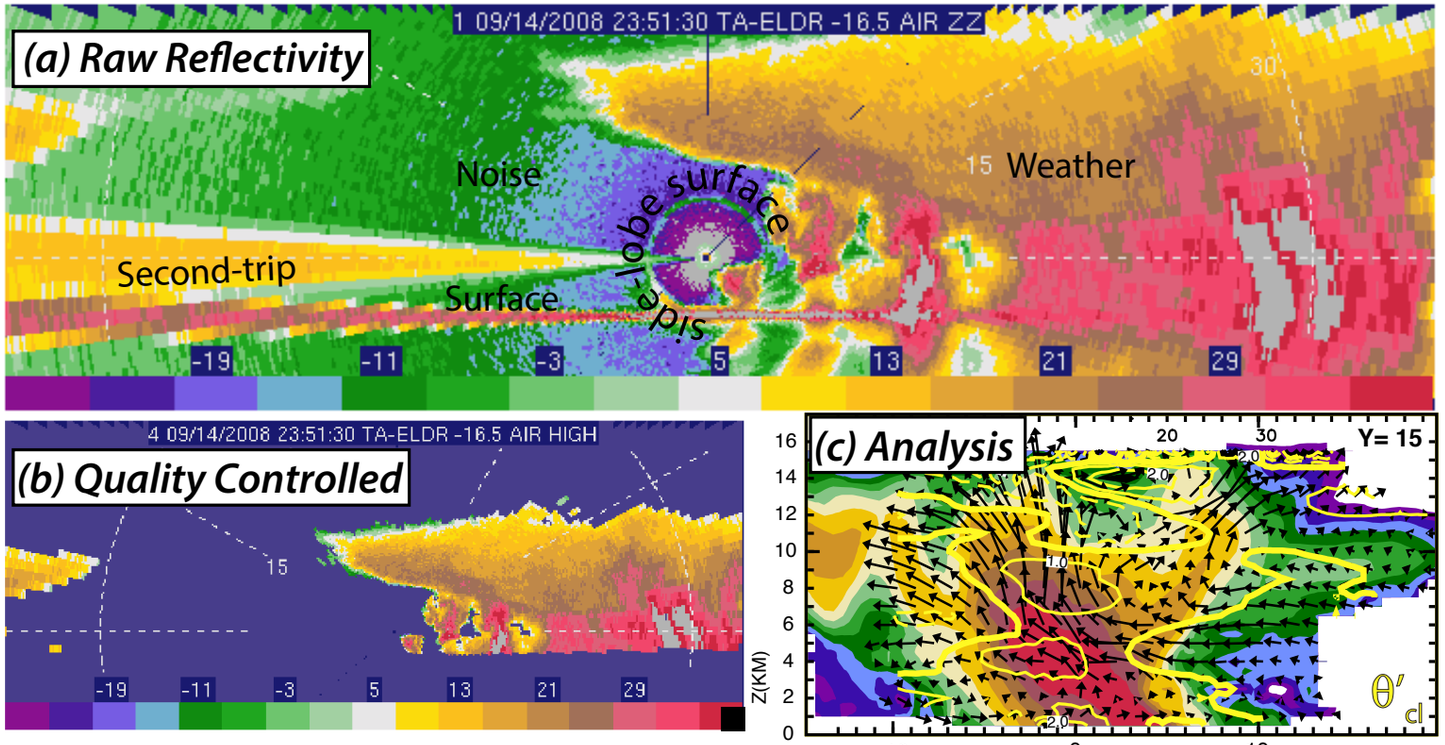
What is “Big Data”?

Big data is a broad term for data sets so ***large or complex*** that traditional data processing applications are inadequate (from Wikipedia)

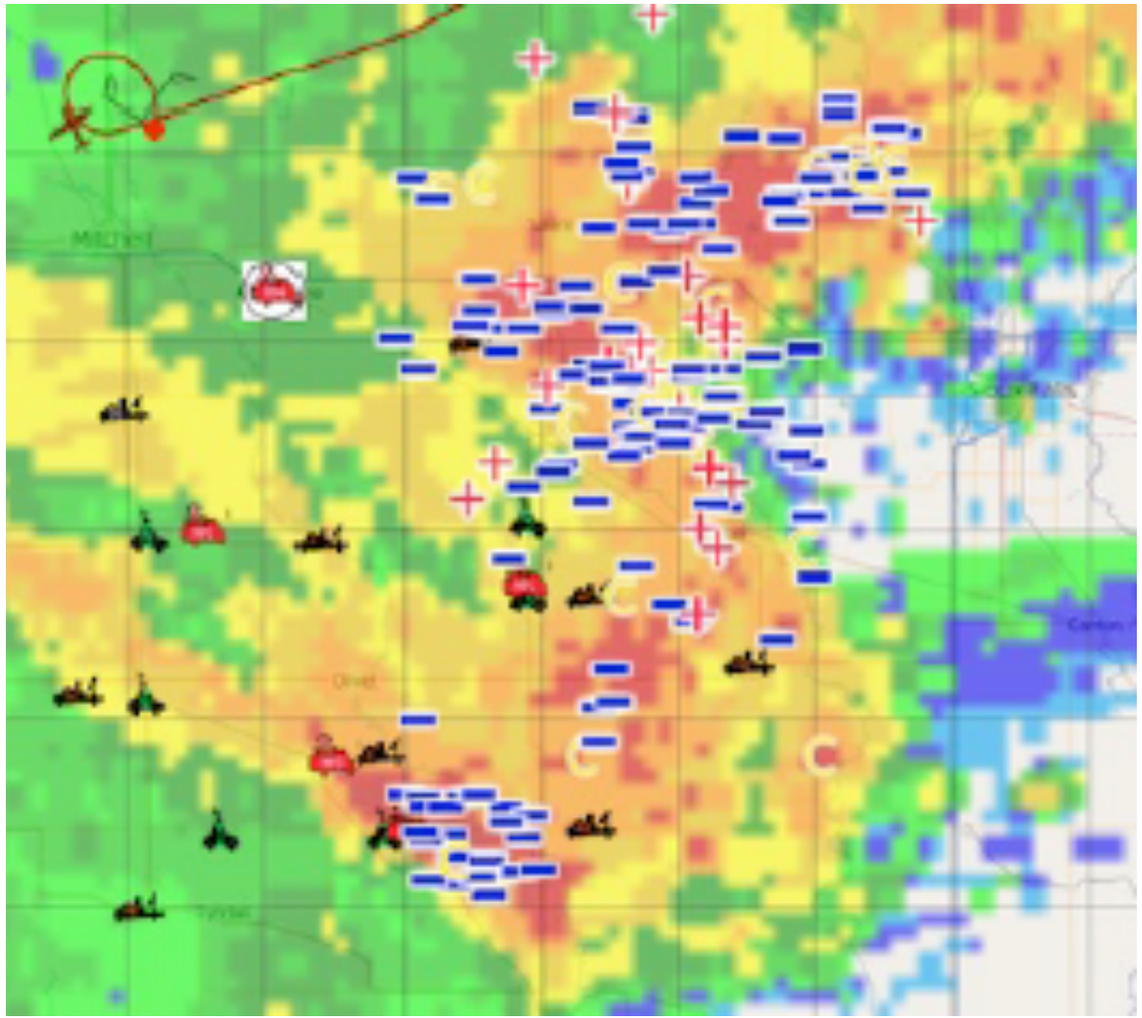
How do we study clouds using “the cloud”?

- NOAA P3 Tail radar dataset is about 75 GB
  - 6 July flight has about 4000 sweeps which require editing
  - Manual editing at 1 minute per sweep would take **over 60 hours**
  - Automatic software algorithm can reduce time significantly

- 5 minutes of PECAN radar data on 6 July 2015 from 11 radars contains over 200 sweeps and ~**40 million** individual radar observations in a 100 x 100 km domain (not including RaXpol)



Bell et al. (2013)



LROSE: Lidar-Radar Open Source Environment

- LROSE is a project to develop common software for the LIDAR, RADAR and Profiler community.
- Joint 4-year project between Colorado State University and NCAR Earth Observing Laboratory recently funded by NSF SI2-SSI
- It is based on collaborative, open source development, with algorithms and analysis tools developed and supported by the community.
- Data stored in portable data formats such as CfRadial, based on UNIDATA NetCDF, following the Climate and Forecasting (CF) conventions to facilitate data assimilation by models

https://github.com/NCAR/lrose-core

Some LROSE Tools Available Now

- Radx Tools and CfRadial data format (NCAR/EOL)
    - Format conversion to netCDF (RadxConvert), Cartesian and Polar Gridding (Radx2Grid replaces Reorder), Rainrate and PID (RadxPartRain)
- Airborne-Radar-QC - Quality control and editing tools (CSU, Bell et al. 2013, Cai et al. 2016)
- SAMURAI - Multi-Doppler synthesis (CSU, Bell et al. 2012)
- Community Partners
    - PyArt - Python ARM Radar Toolkit (DOE/ARM)
    - ARTView - Python Radar Viewer (Nick Guy and others)

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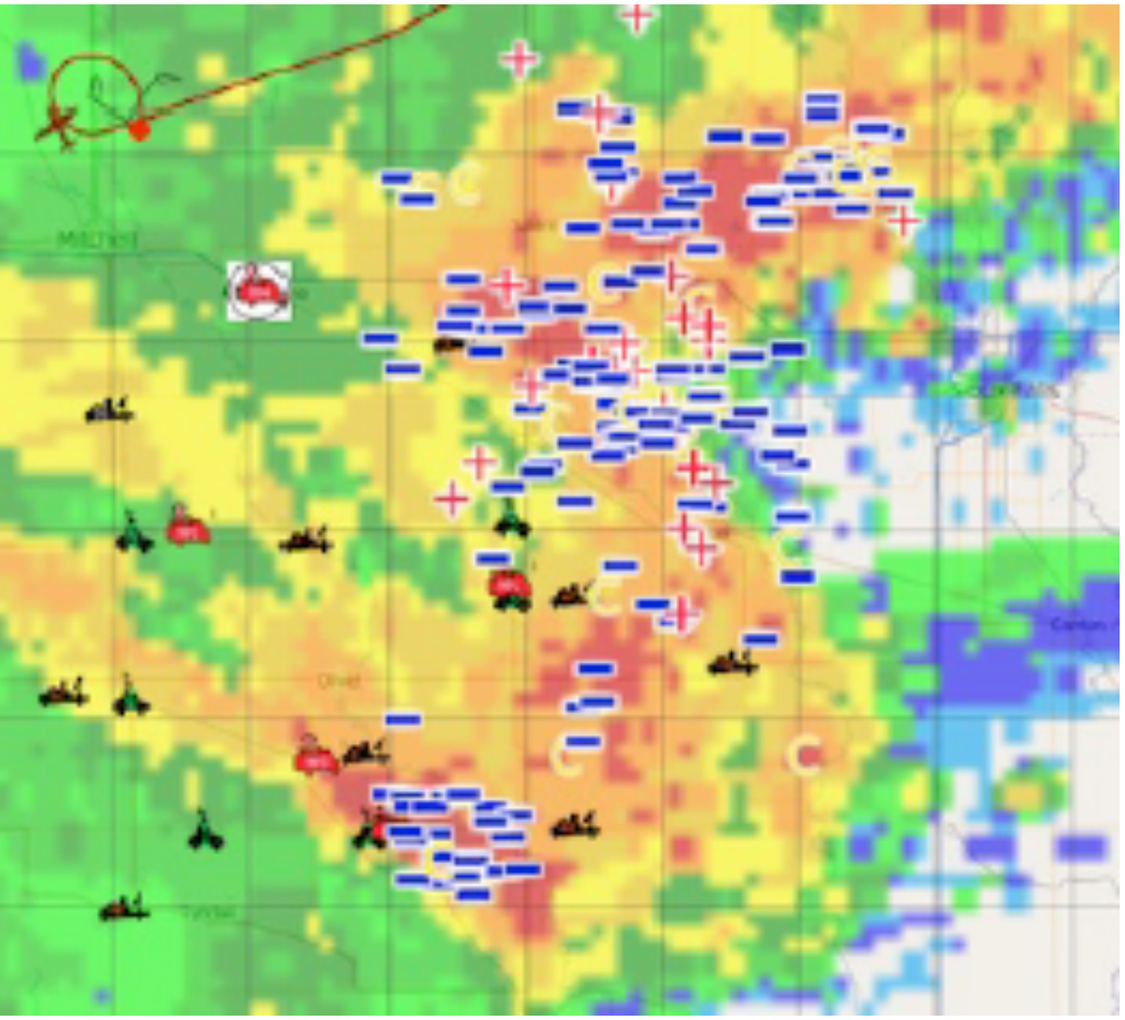
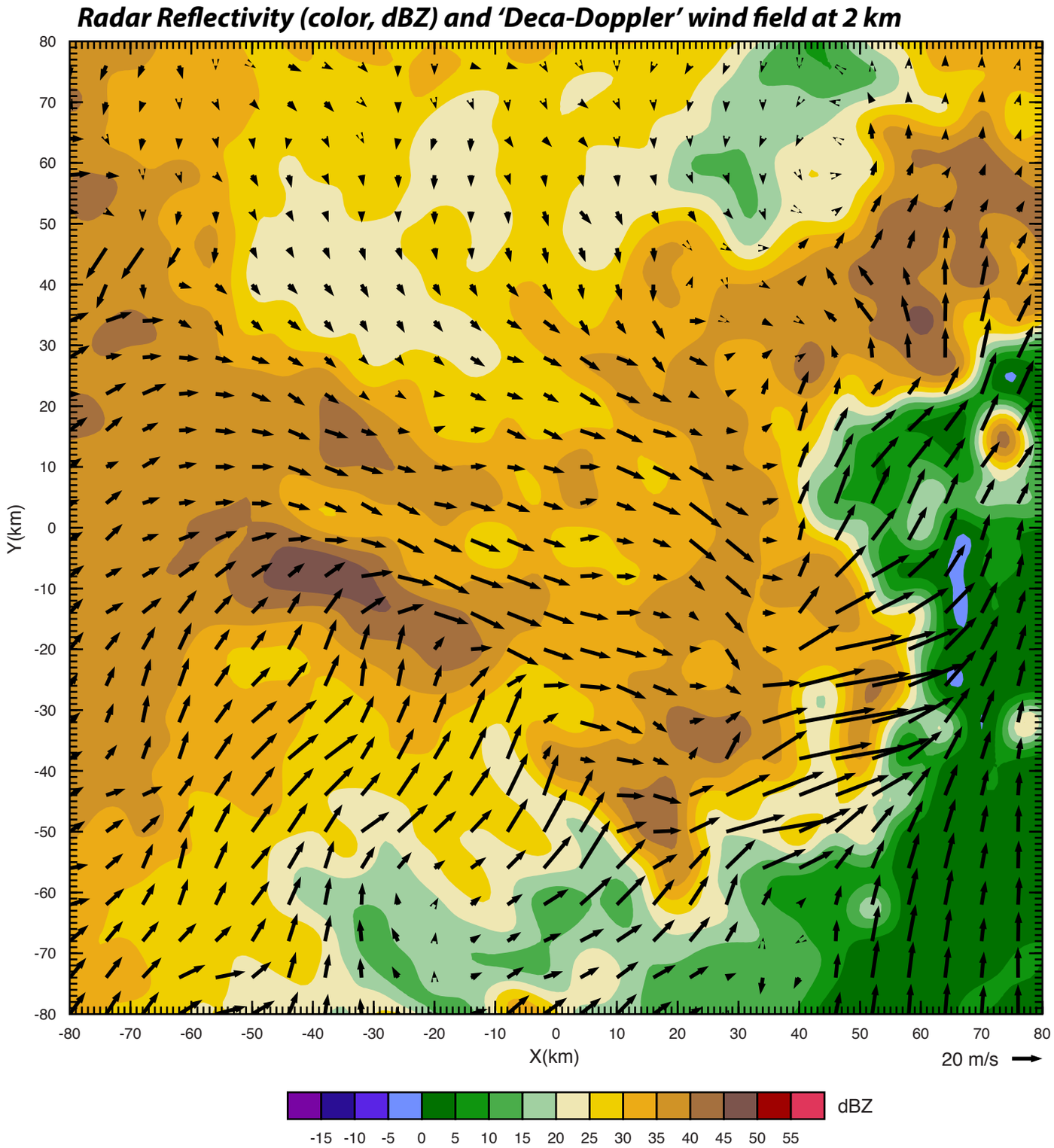
0540 - 0545 6 July



Preliminary analysis



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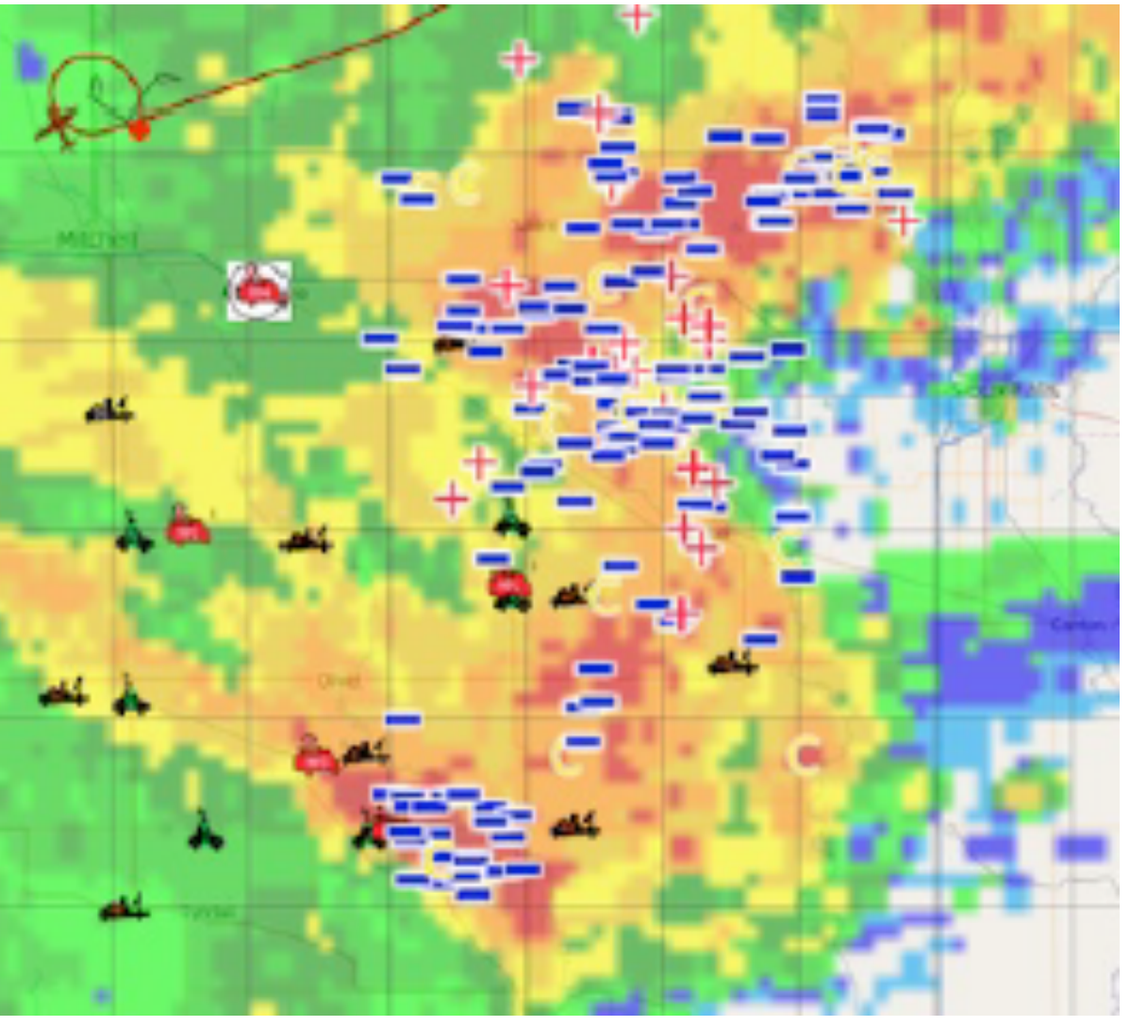

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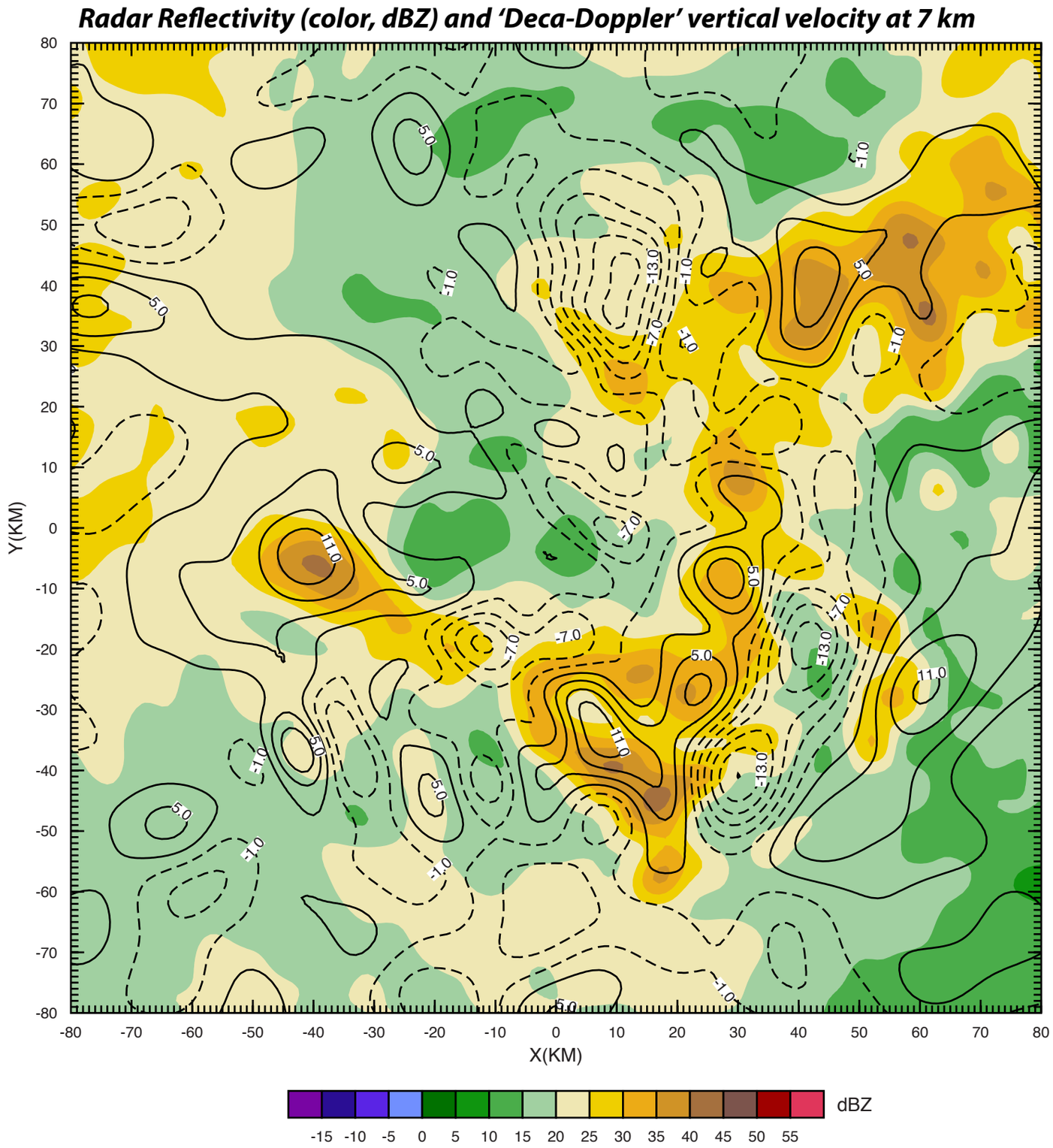

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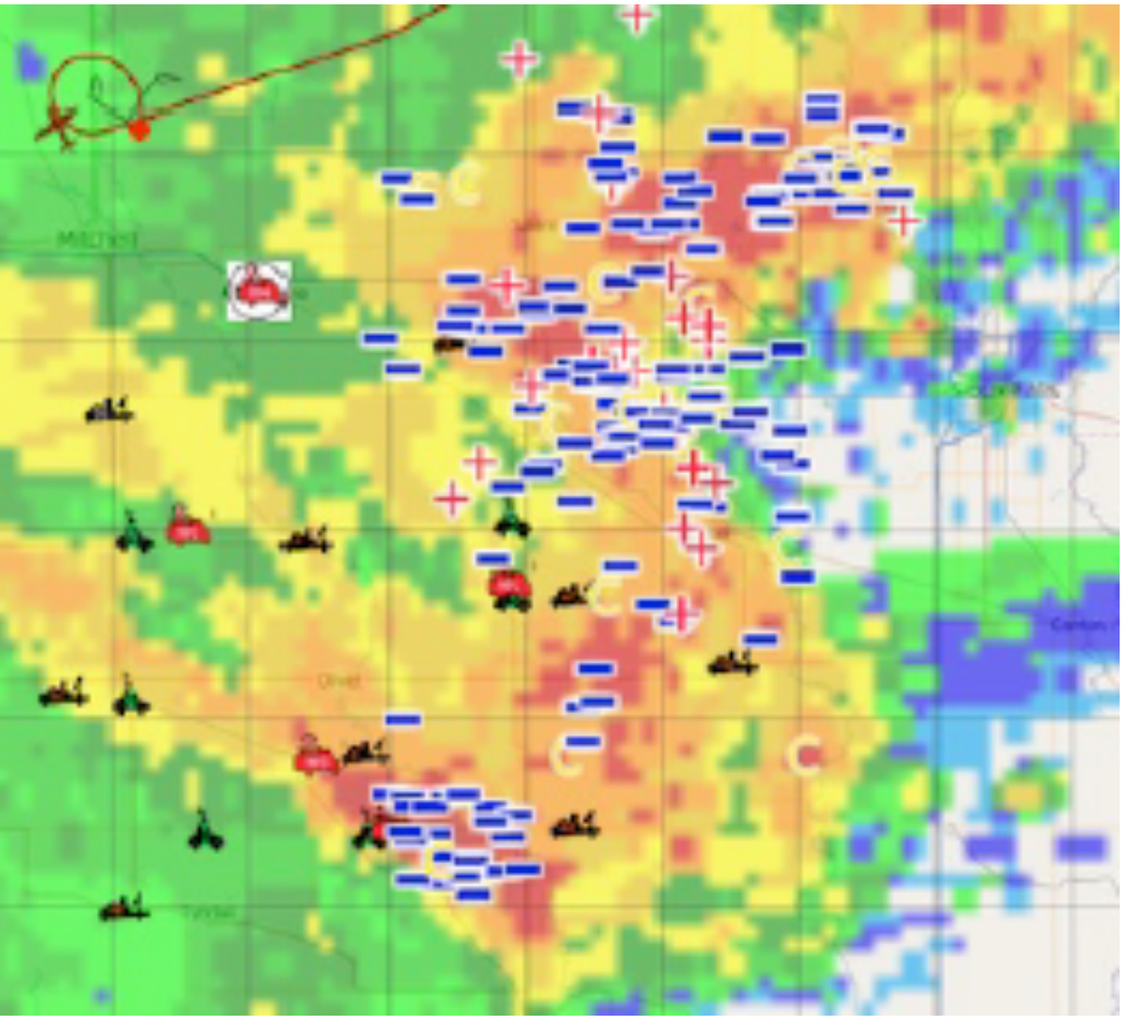
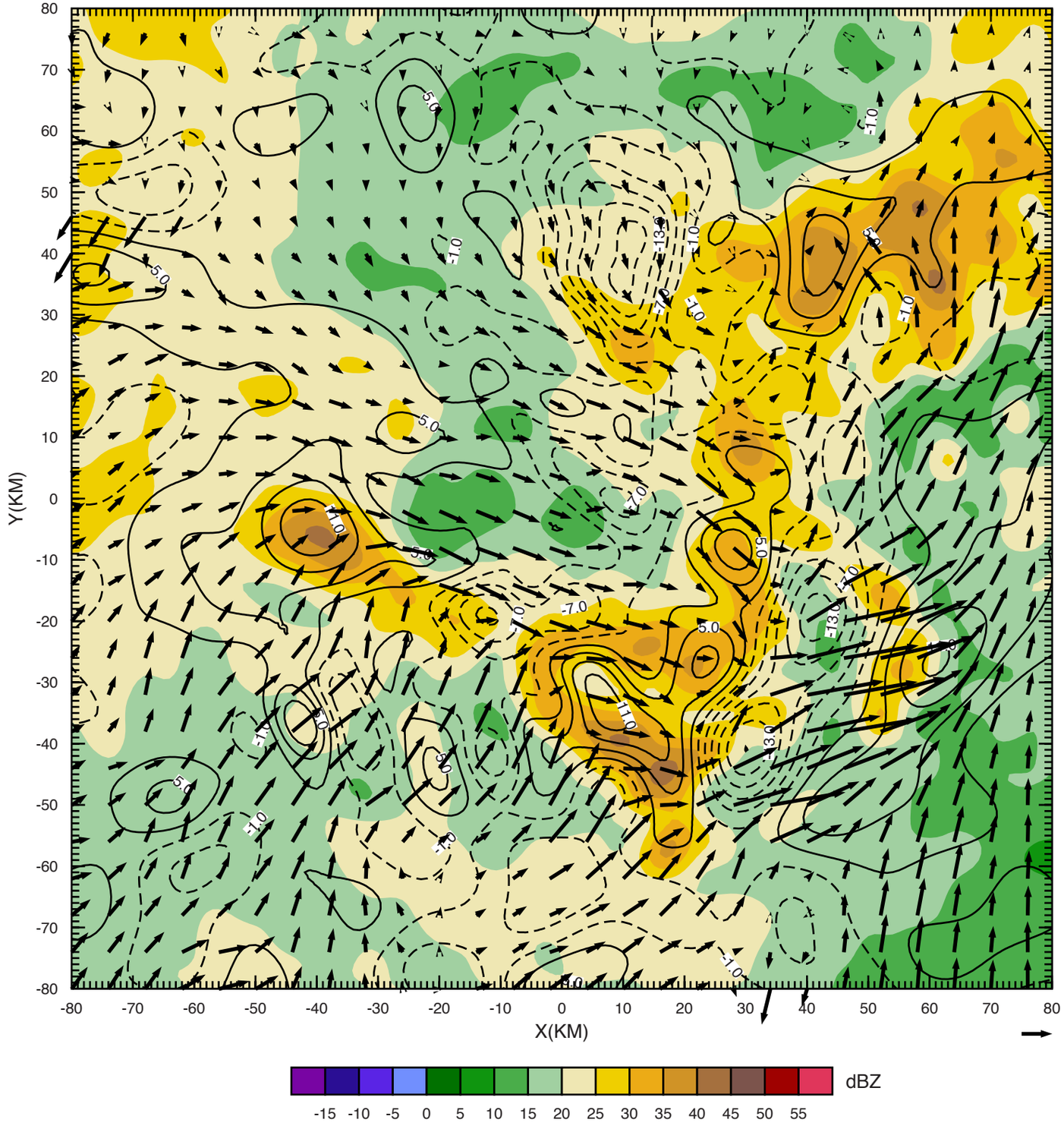


Radar Reflectivity (color, dBZ) and 'Deca-Doppler' vertical velocity at 7 km with 2 km wind vectors



Preliminary analysis

Need better diagnostic tools to assess analysis

The Future of Radar Big Data

- LROSE radar virtual toolbox
  - Low setup time, just open the box using Docker or on the cloud to get the latest tools (see Heistermann et al. 2015)
- GitHub open source collaboration (github.com/mmbell)
  - Free micro-plan for .edu users allows for private repositories
- Julia scientific computing language (julialang.org)
  - Recently developed by MIT using multiple dispatch philosophy, built-in parallelization, and can use Python, C, and FORTRAN libraries natively
- LROSE one part of larger National Strategic Computing Initiative (NSCI)
  - Integration with Big Weather Web for data assimilation
  - Cloud computing (e.g. full NEXRAD database on Amazon S3)

Radar Big Data will be conquered by the community

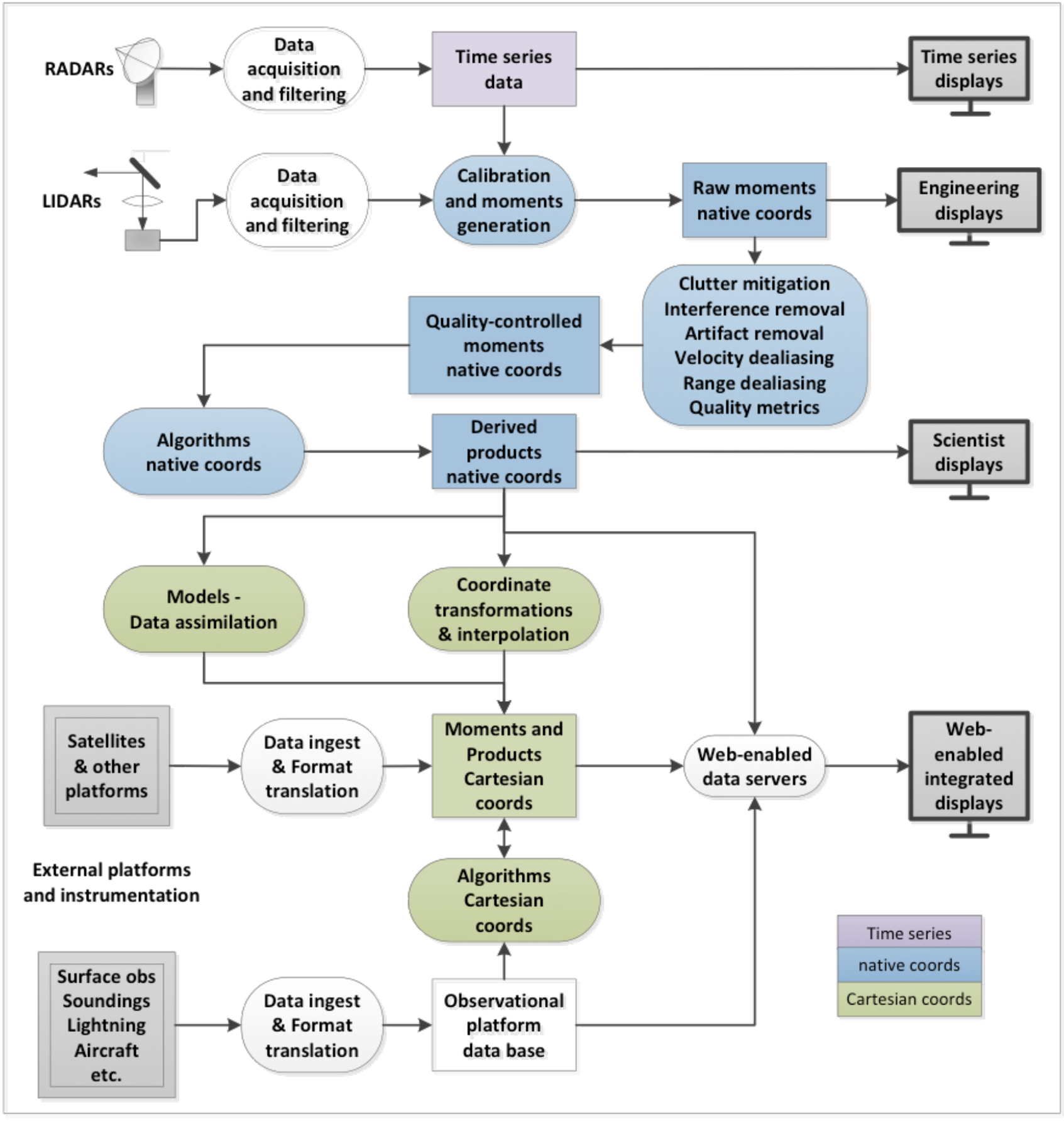
- LROSE Community Kick-off Workshop at NCAR in late March / early April 2017

- Github pages are active, LROSE webpage and mailing list coming soon

- Contact **mmbell@colostate.edu** to get involved

https://github.com/NCAR/lrose-core

https://github.com/mmbell


RADARs
Data acquisition and filtering
Time series data
Time series displays
LIDARs
Data acquisition and filtering
Calibration and moments generation
Raw moments native coords
Engineering displays
Clutter mitigation
Interference removal
Artifact removal
Velocity dealiasing
Range dealiasing
Quality metrics
Quality-controlled moments native coords
Algorithms native coords
Derived products native coords
Scientist displays
Models - Data assimilation
Coordinate transformations & interpolation
Satellites & other platforms
Data ingest & Format translation
Moments and Products Cartesian coords
Web-enabled data servers
Web-enabled integrated displays
External platforms and instrumentation
Algorithms Cartesian coords
Surface obs
Soundings
Lightning
Aircraft
etc.
Data ingest & Format translation
Observational platform data base
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native coords
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