Improved Automation and Performance of VORTRAC Intensity Guidance

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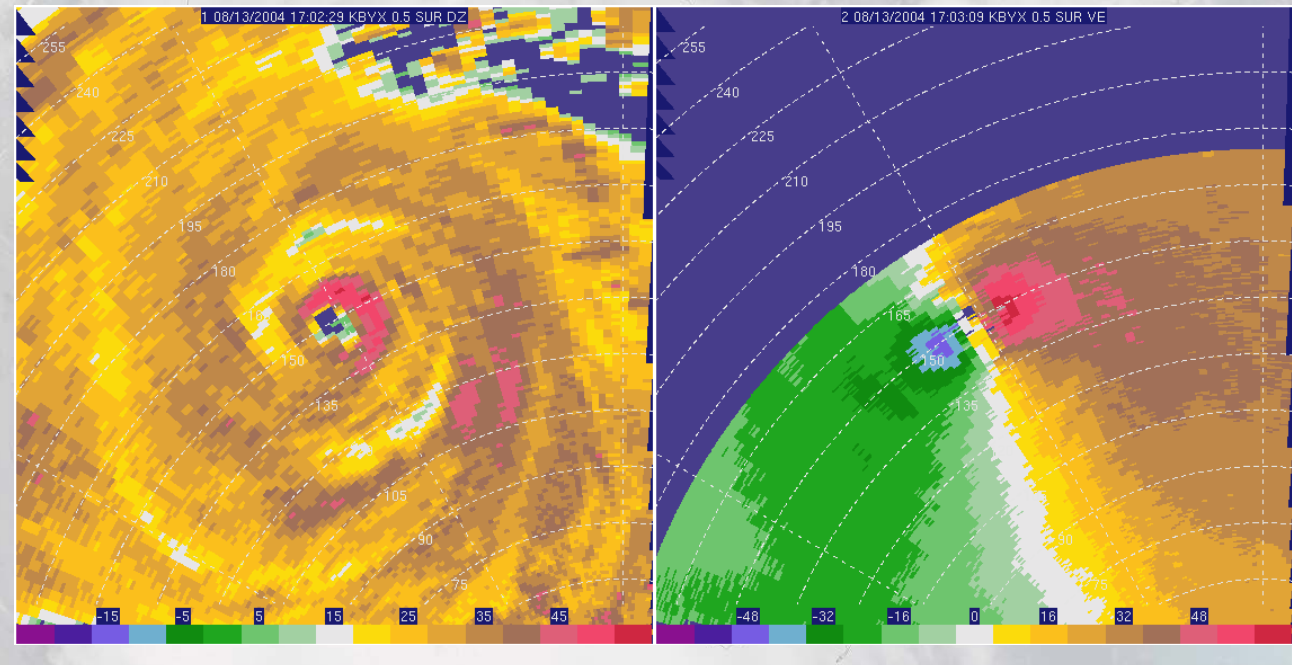
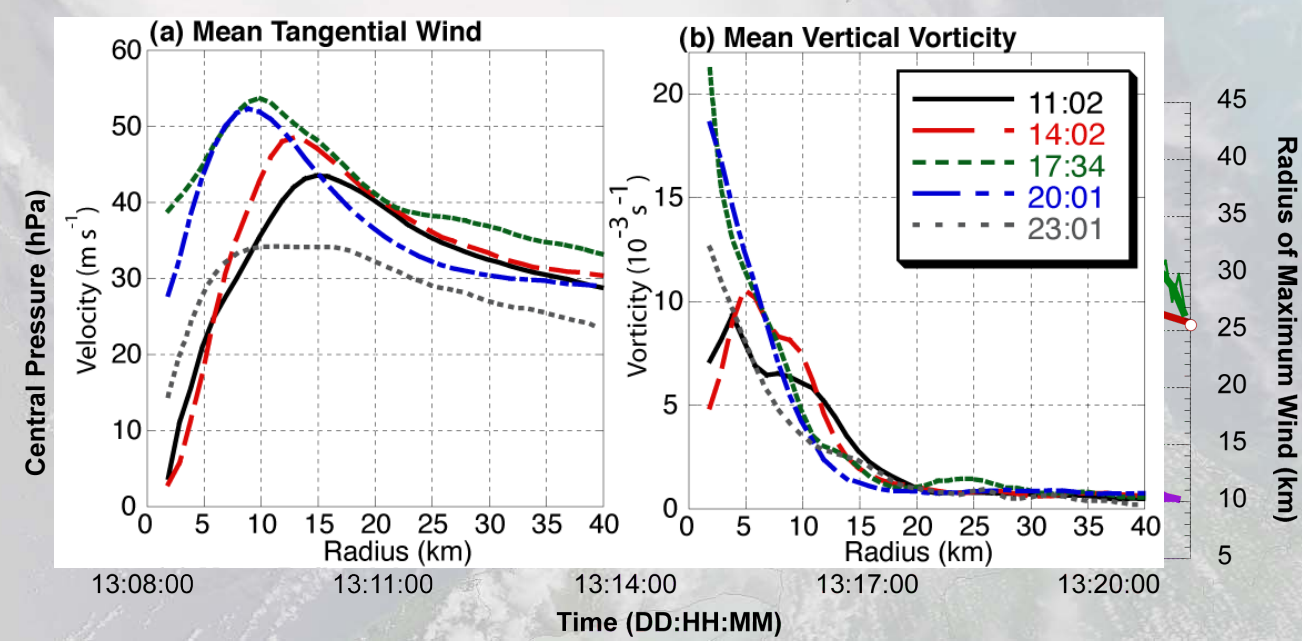
From Single Doppler Velocities to TC Central Pressure

- Basic Assumptions:
  - A single circulation center can be identified accurately
  - Primary circulation is deduced from GBVTD with HVVP environmental wind correction
  - Radial pressure gradient is deduced from the gradient wind balance
  - Central pressure is deduced from one anchor surface pressure measurement





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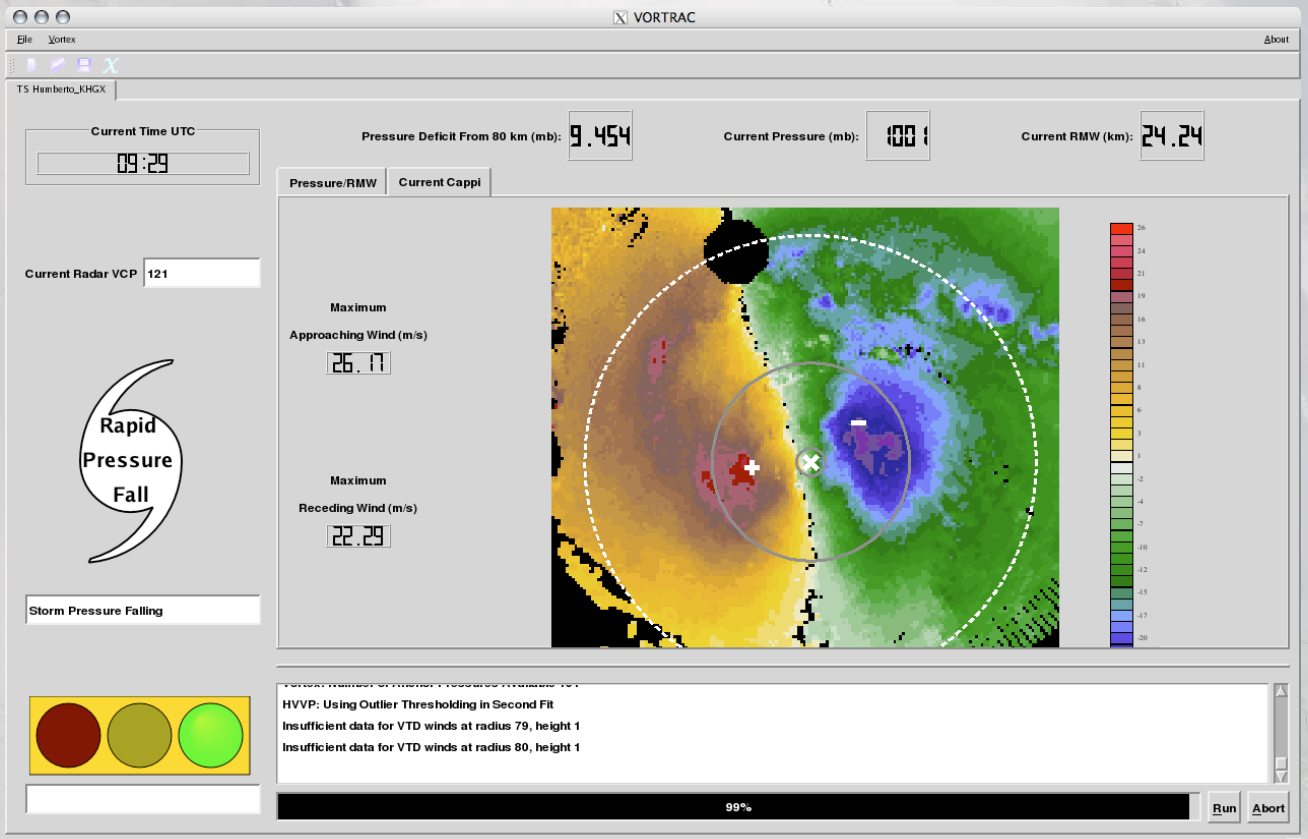
VORTRAC

Vortex Objective Radar Tracking and Circulation

- Combines single Doppler radar algorithms to find TC circulation center, compute primary circulation, derive central pressure and radius of maximum wind from real-time coastal WSR-88D data
- Automated procedures driven by a graphic user interface
- Accepted for operational implementation at NHC in 2008



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VORTRAC Challenges for Operations

- Algorithm and technical challenges
  - *Radar data QC in real time, including dealiasing*
  - *Reliable TC center tracking near the edge of Doppler range*
  - *Reliably estimate cross-beam mean wind*
  - *Inconsistency between "user-supplied" vs. "VORTRAC-derived" TC characteristics (e.g., TC center and RMW)*
  - *Difficulties in handling "ill-behaved" TCs*

- Operational challenges
  - *Program code maintenance and update (e.g., NEXRAD level II data format changed in 2008 after operational implementation)*
  - *Documentation and training for new users - Colin McAdie retired in 2010*
  - *Real-time error handling and recovery*
  - *Reject/indicate unreliable results*
  - *Infrequent landfalling hurricanes in US since 2008*

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Summary of Year 1

- 12 US landfalling hurricanes between 2005 - 2011 were identified and run through VORTRAC V1
  - Different cases with variable data quality and storm structure
- Analysis revealed areas for improvements
- Identifying the "correct" hurricane circulation center remains the most challenging component in VORTRAC, especially for ill-behaved hurricanes like Ike (2008)
- PIs tested other hurricane center finding algorithms (reflectivity and Doppler velocity based) in addition to the GBVTD-simplex algorithm to improve the confidence of hurricane center estimates

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VORTRAC Year 2 Improvements

- Improved software robustness
- Improved center finding algorithms
  - PCA center finding algorithm now fully automated
  - TCET center finding algorithm using dBZ being tested
- Improved HVVP environmental winds for GBVTD
  - Expanded use of volume scan data increases goodness of fit
  - New modified Rankine exponent estimator, asymmetry indicators, and outlier reduction technique to improve robustness
- Improved Doppler velocity Quality Control
  - New dealiasing algorithm includes expanded Bargen-Brown, azimuthal velocity derivative constraint, and multiple-PRF solver
- All input data "pulled-as-needed" from operational data streams
  - Fully automatic and lower bandwidth
  - ATCF position and RMW estimate, Level II radar, and MADIS environmental pressures

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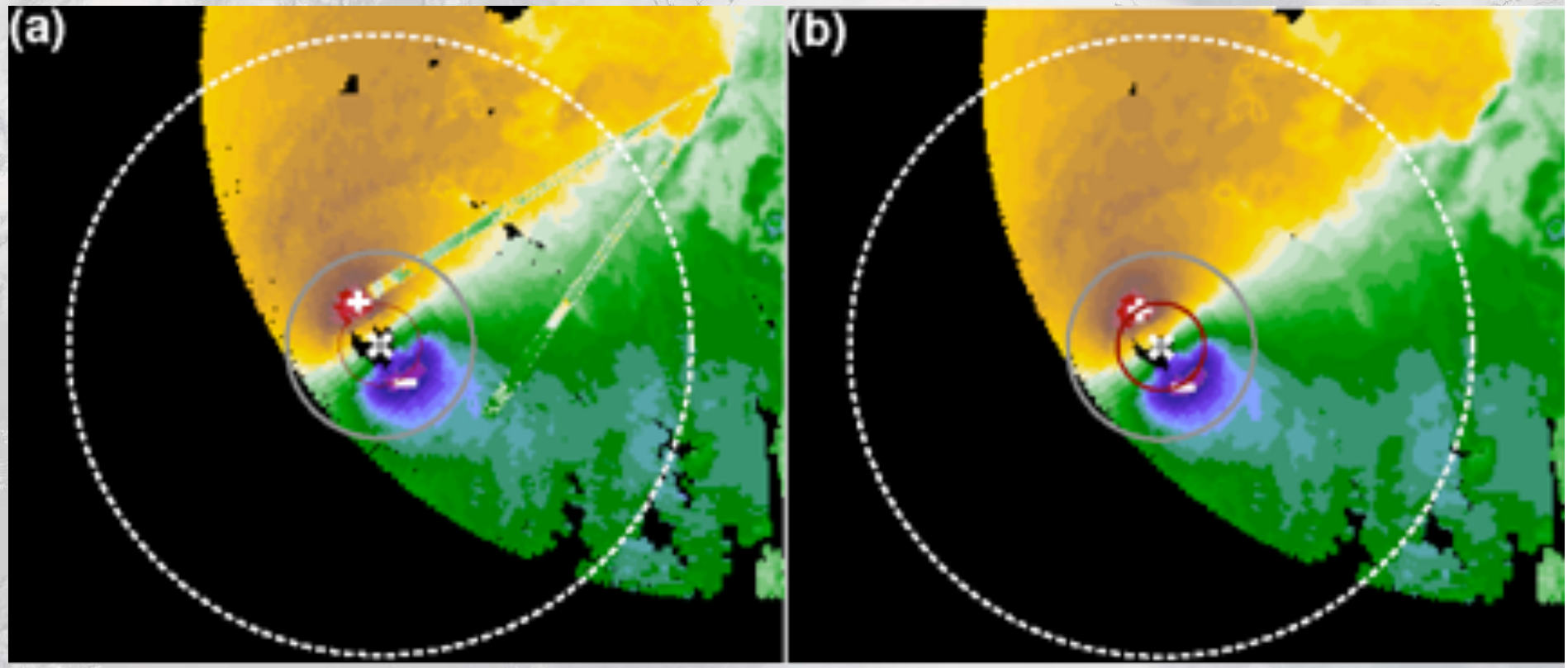
Improved Radar Quality Control



- Multiple QC algorithms are utilized to remove noise and dealias strong Doppler velocities beyond the Nyquist range

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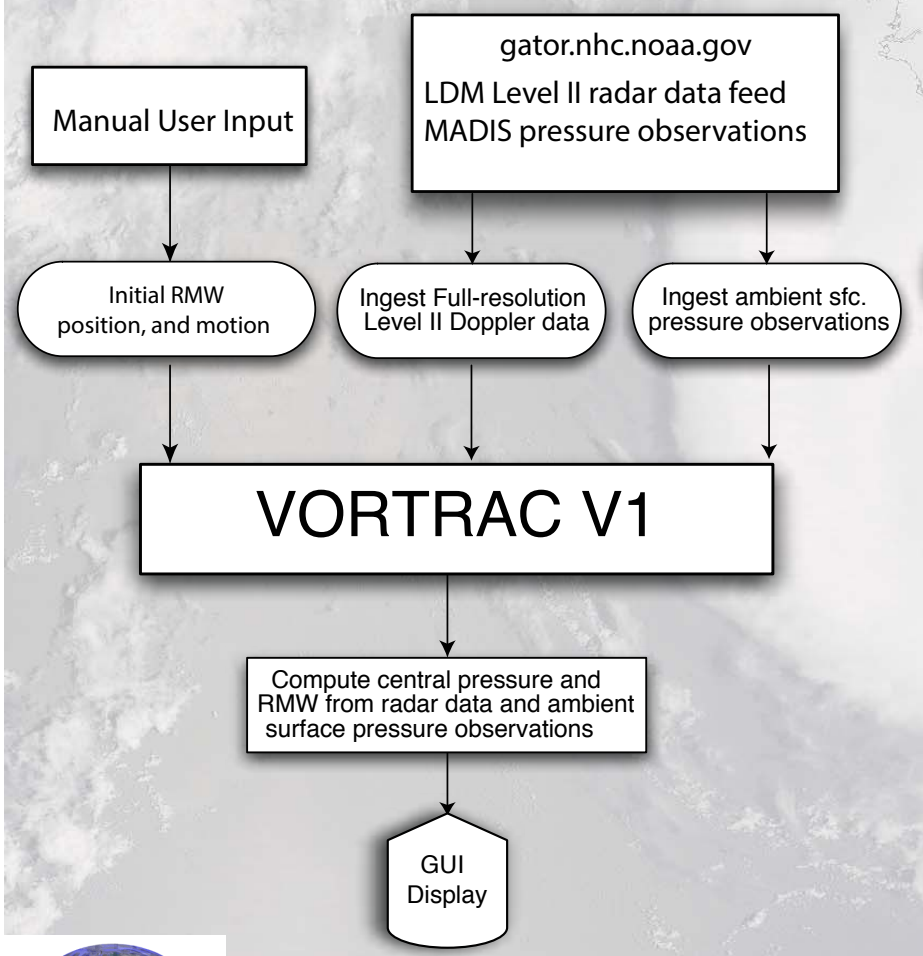
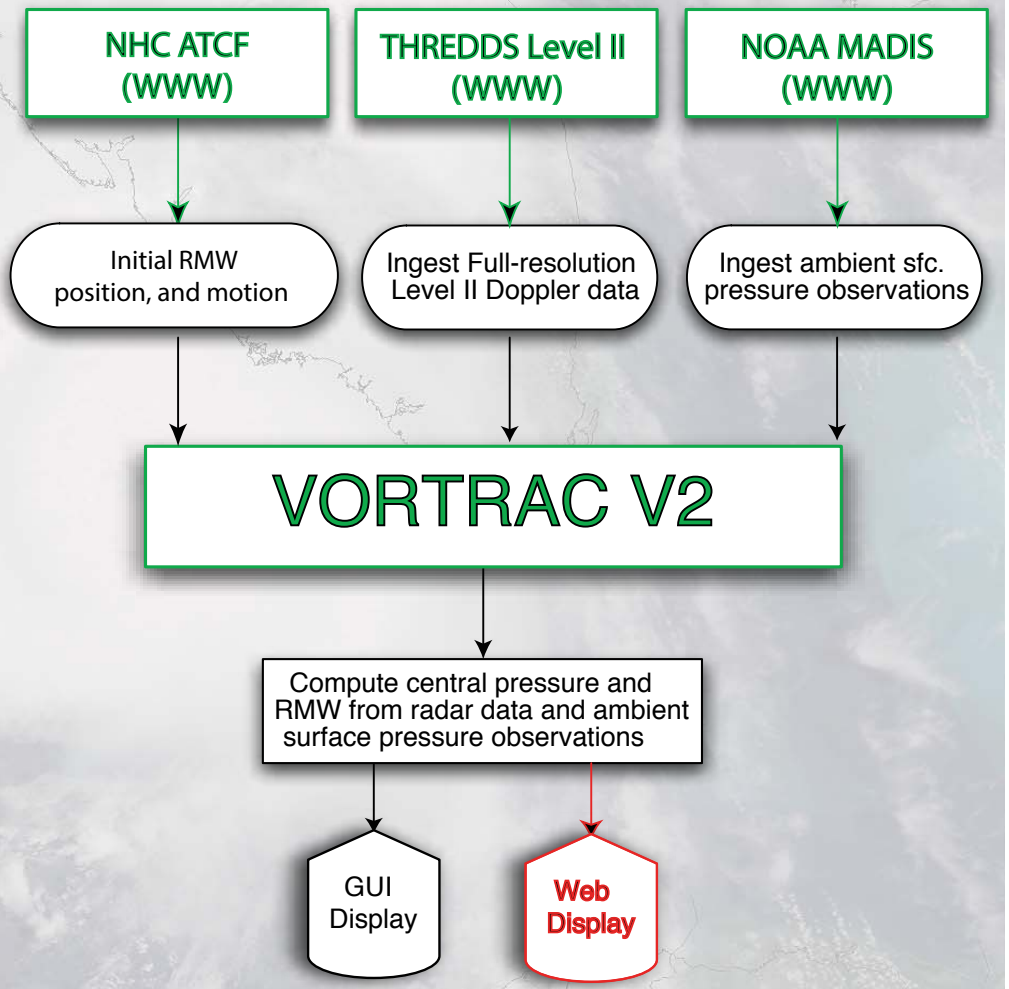
VORTRAC Year 2 Improvements





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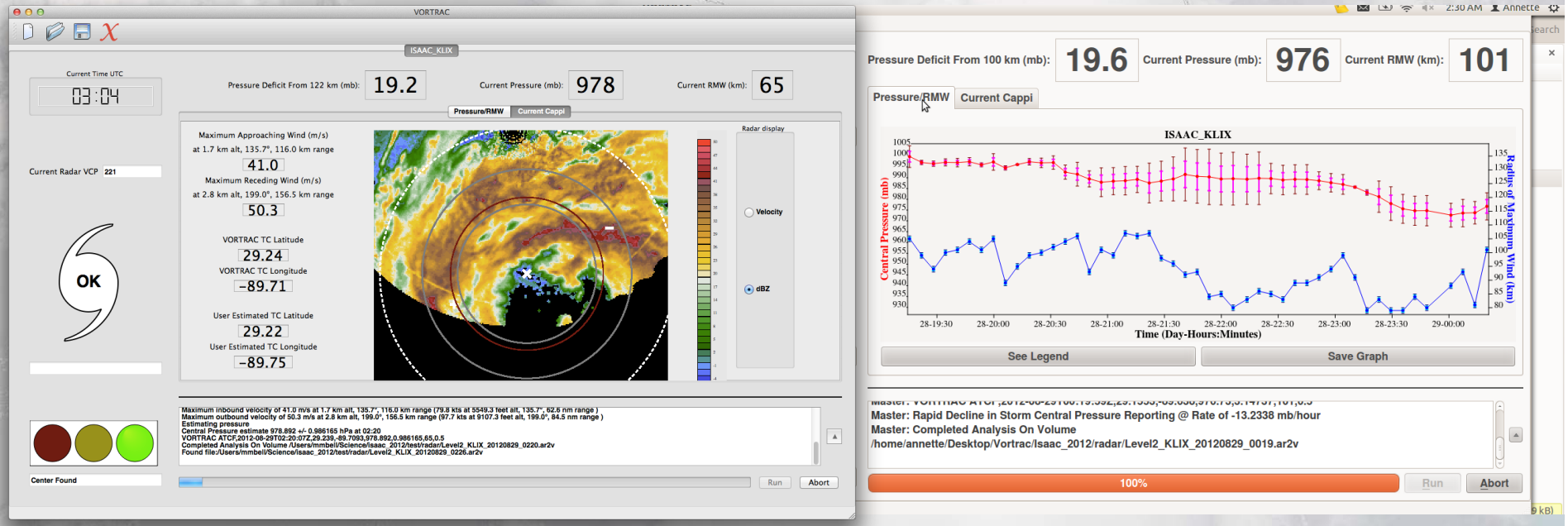
Hurricane Isaac



- VORTRAC ran successfully at NHC during Isaac's 2012 landfall

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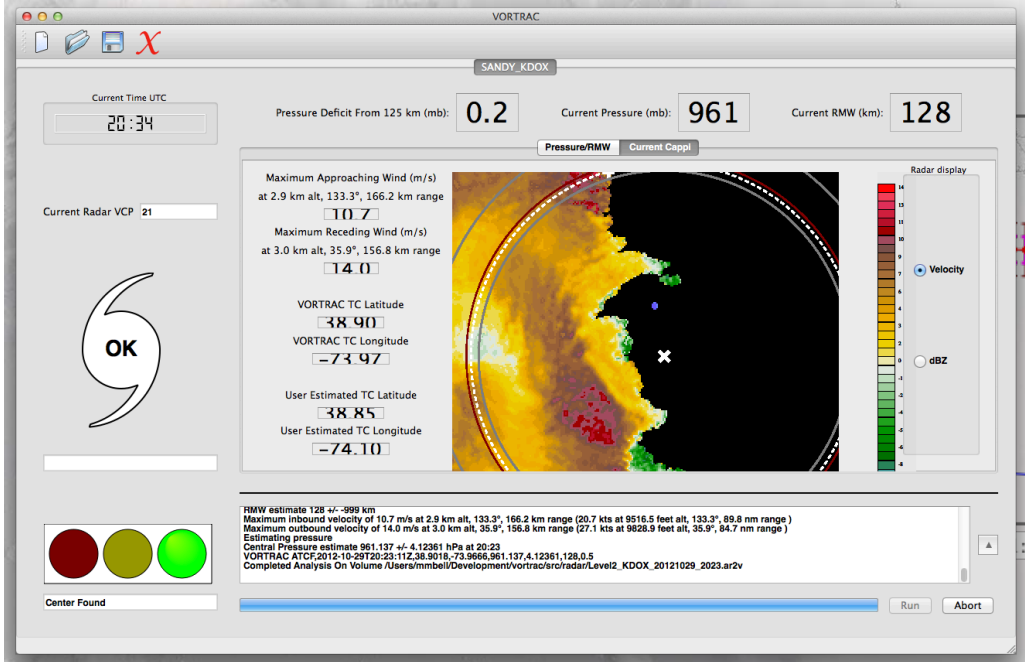
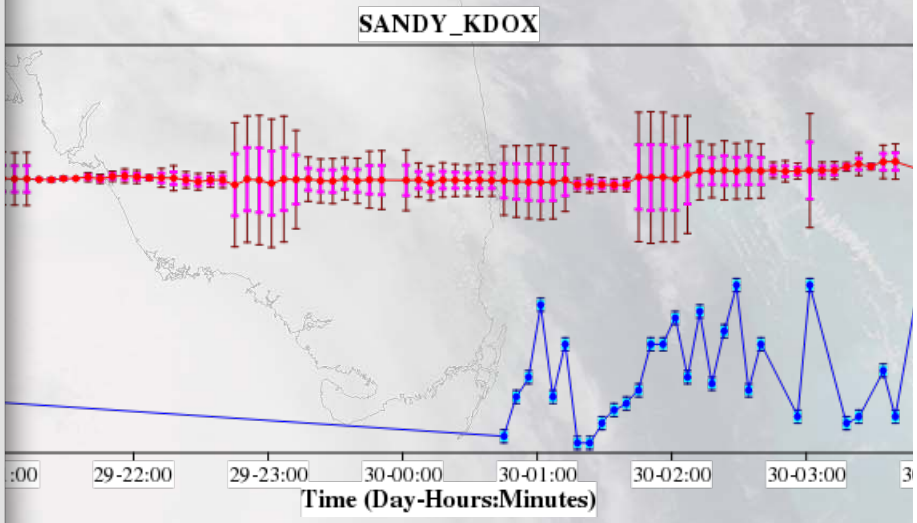
Hurricane Sandy





- VORTRAC ran at NHC during Sandy's 2012 landfall, but the storm was too large and asymmetric for the radar algorithms to perform well
- Sandy highlights the need for objective analysis quality assessment

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VORTRAC Summary

- Automatic, real-time operational mode tested well in 2012
- Continued testing with a variety of storms in the landfall dataset has improved reliability
- Very large or asymmetric storms still remain a challenge
  - PCA and TCET center finding algorithm integration in 2013
- Improved objective assessment of the analysis quality is underway for 2013 season
- Support for non-GUI “server” mode with web output is in testing, and will be available for 2013 season

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