Real-time Hurricane Wind Field Analysis

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Photo by Brad Smull

- Purpose of analysis?
  - Help diagnose wind field forecast parameters [wind radii, peak wind intensity]
  - Derived quantities for damage assessment (DHS-FEMA HAZUS)
  - Provide forcing for wave and surge models
  - Serve as a record of the event
    - peak wind related to risk
      - building design and insurance

- H*Wind = HRD Realtime Hurricane Wind Analysis System
  - NIBS, NOAA's HPCC Program supported development of H*Wind
  - Winner of Java and Tech Transfer awards at NOAATech 2000 and 2002
  - Tested at NHC during 2002, 2003
  - Analyses available on HRD web site since 1994
  - Some retrospective analyses also: Donna, Betsy, Andrew, 1935 labor day storm

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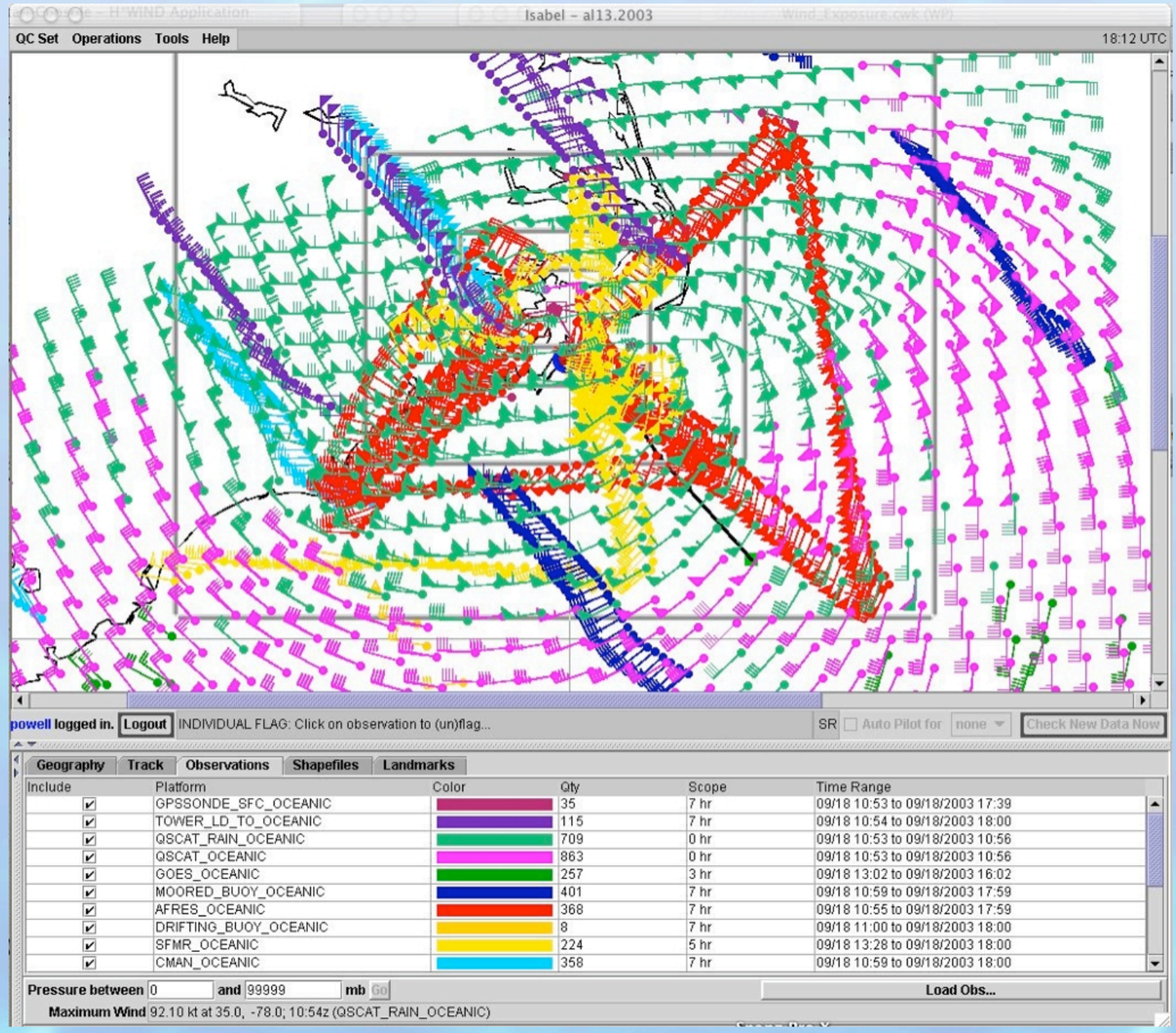
- H*Wind: A tool for graphically interacting with wind observations
- Designed for Global tropical cyclone monitoring
- Data stored in object-relational database
- QC by experienced analyst



Hurricane Isabel H*Wind Ob panel

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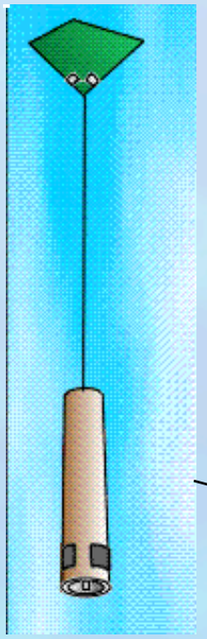
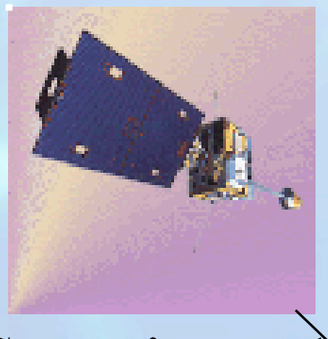
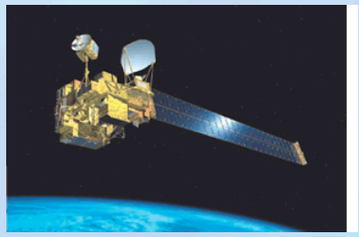
H*Wind Observing Platforms



GPS dropwindsondes



Geostationary (GOES) satellite data



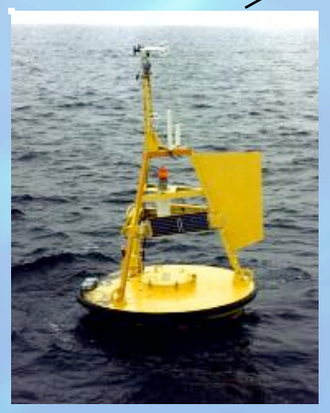
Polar Orbiting
QSCAT, TM/I, and SSM/I satellites data

Air Force and NOAA Aircraft

Stepped Frequency Microwave Radiometer (SFMR)

Database

Coastal Marine Automated Network (CMAN)



NOAA Buoys

Ship reports

Automated Surface Observing System (ASOS)

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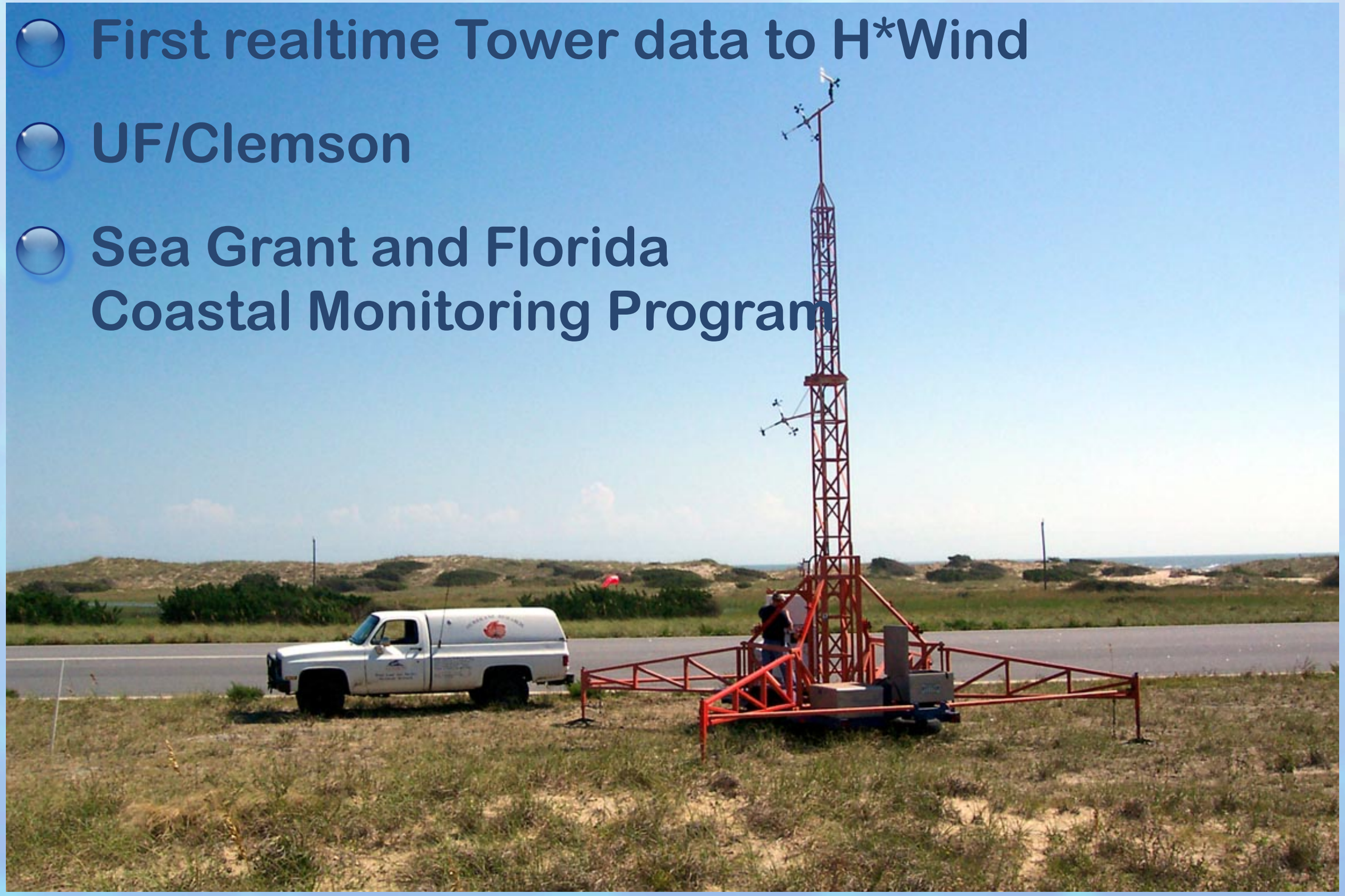
- First realtime Tower data to H*Wind
- UF/Clemson
- Sea Grant and Florida Coastal Monitoring Program



Frisco, NC (near Cape Hatteras)

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- Standard, Consistent, Framework:
  - Height: 10 m (ASTM standard D 5741-96)
  - Maximum 1 min sustained wind
  - Exposure: Open terrain (Zo ~0.03 m) or Marine

- Exposure and Height
  - Exposure documented by photographs
  - Exposure needed for roughness
  - Roughness needed to correct winds to open terrain at 10 m
  - BAMS,Powell et al June 2004

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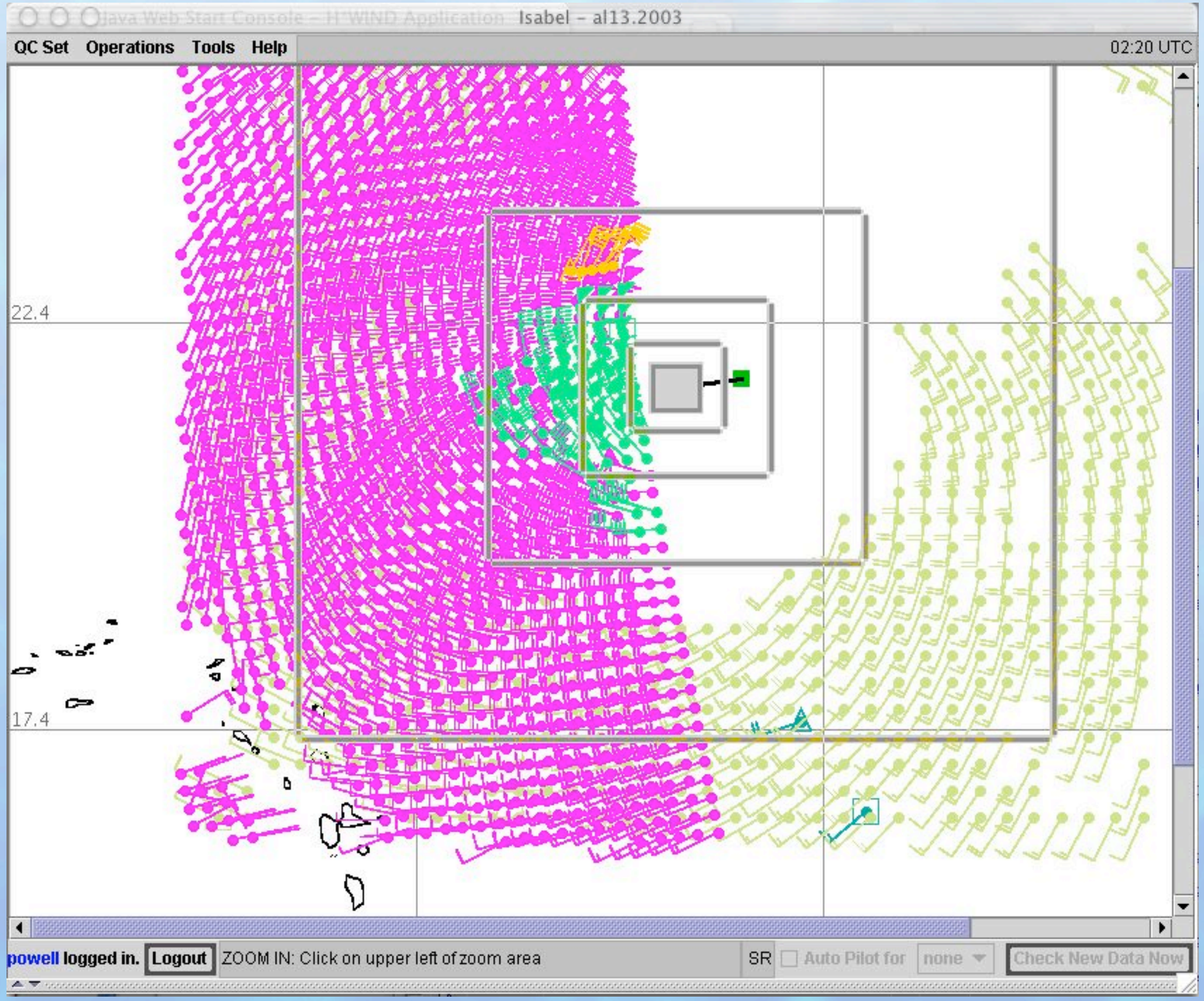
Limitations:

When storm is outside recon range

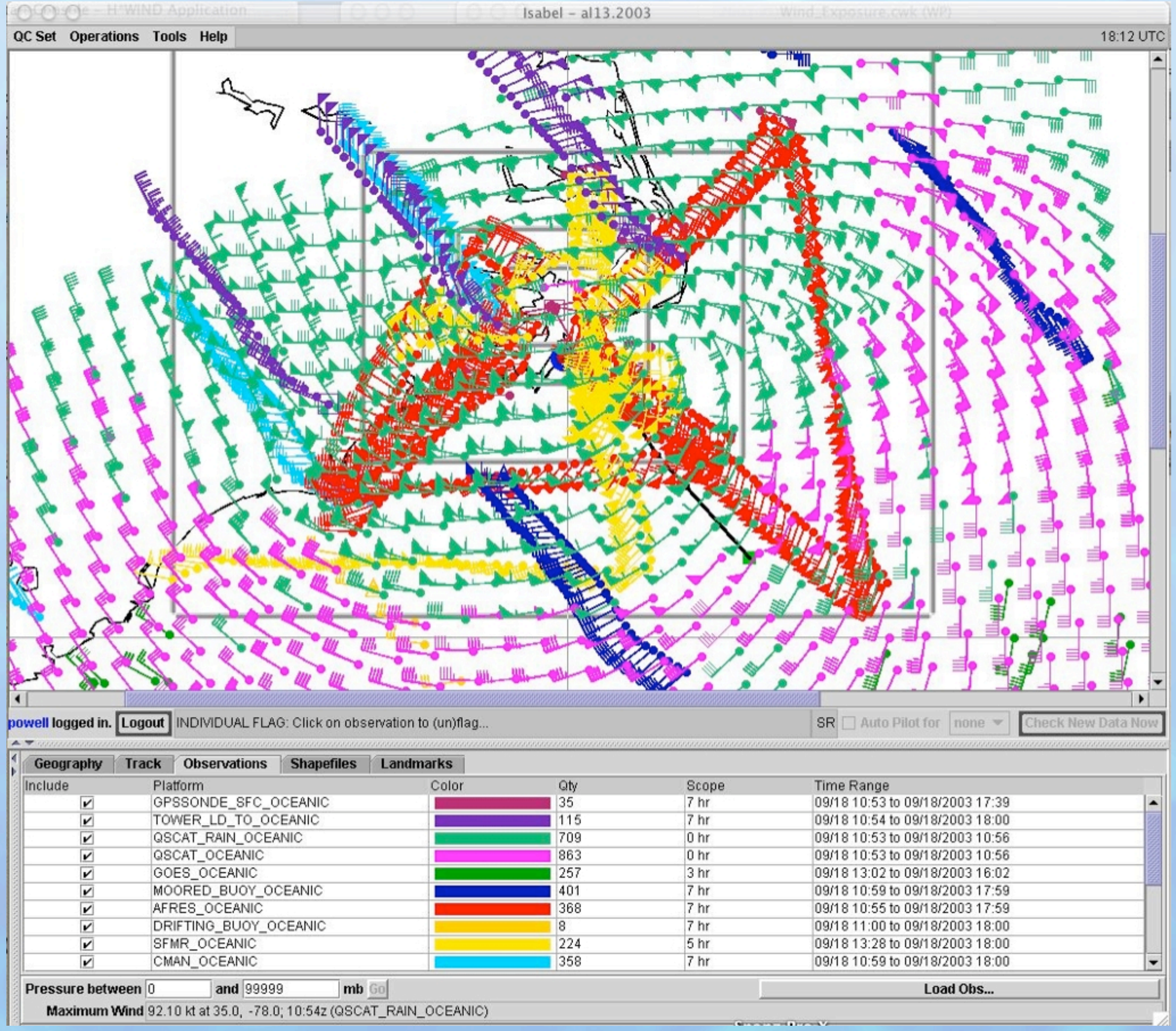
Recon is not continuous

Fill in gaps with background field from prior analysis



Isabel 06-12Z data, Sept. 12, 2003

- Graphical, interactive QC
- Nearest neighbor comparisons help eliminate poor observations
- Various tools allow interaction with observations



Hurricane Isabel

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Which platform is correct?

Platform	Max wind speed (kts)
GPS sfc	83
GPS wl-150	76
GPS sfc-mbl	84
Air Force (JF)	96
Air Force (DP)	101
Air Force PBL	91
NOAA P3 (JF)	99
NOAA P3 (DP)	93
NOAA P3 PBL	84
SFMR	89

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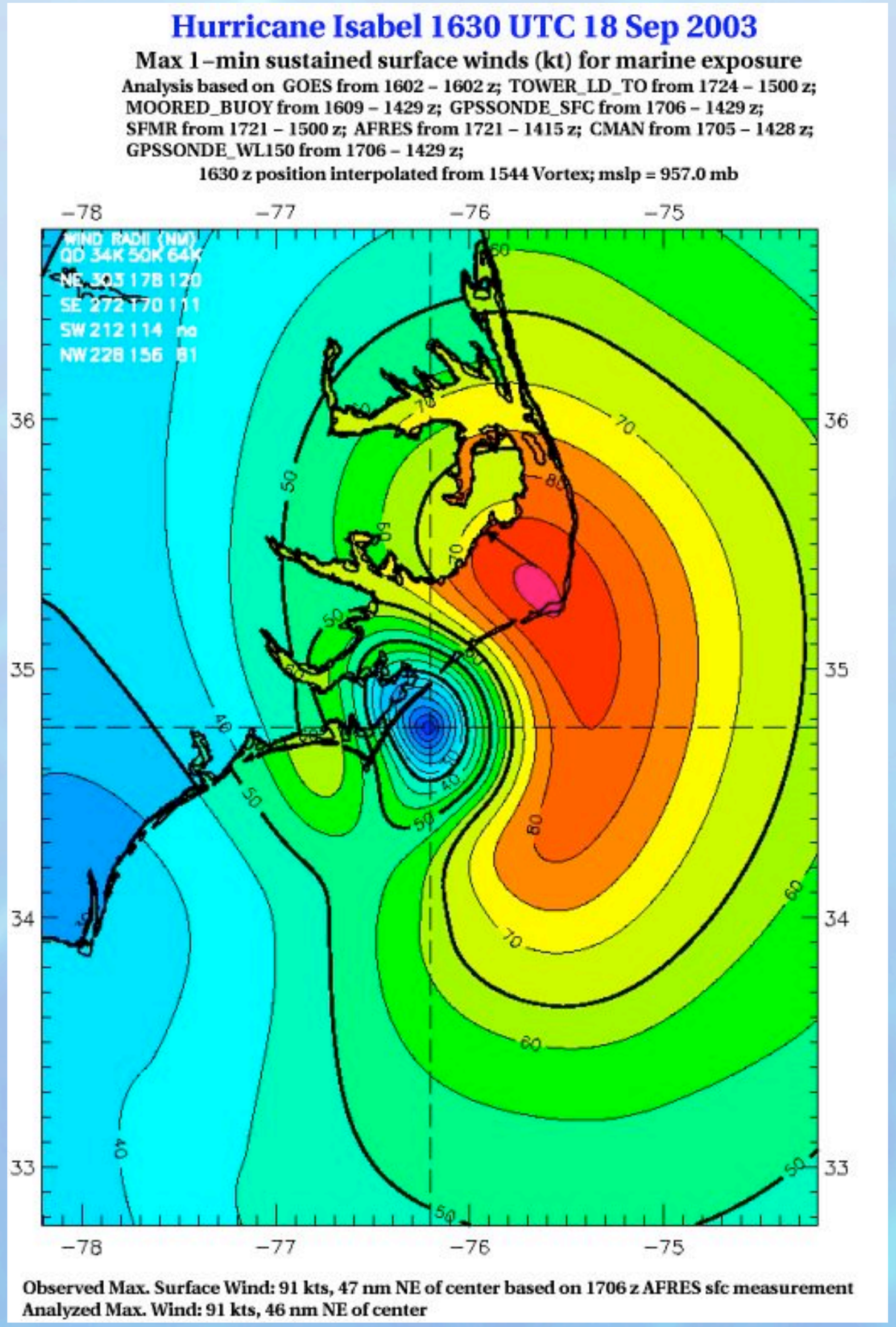
Hurricane Isabel at Landfall

- Red colors depict strongest winds
- Dark contours show 34kt, 50 kt, 64 kt winds
- Winds over land are corrected to open terrain
- Not valid for complex terrain (hills and valleys)



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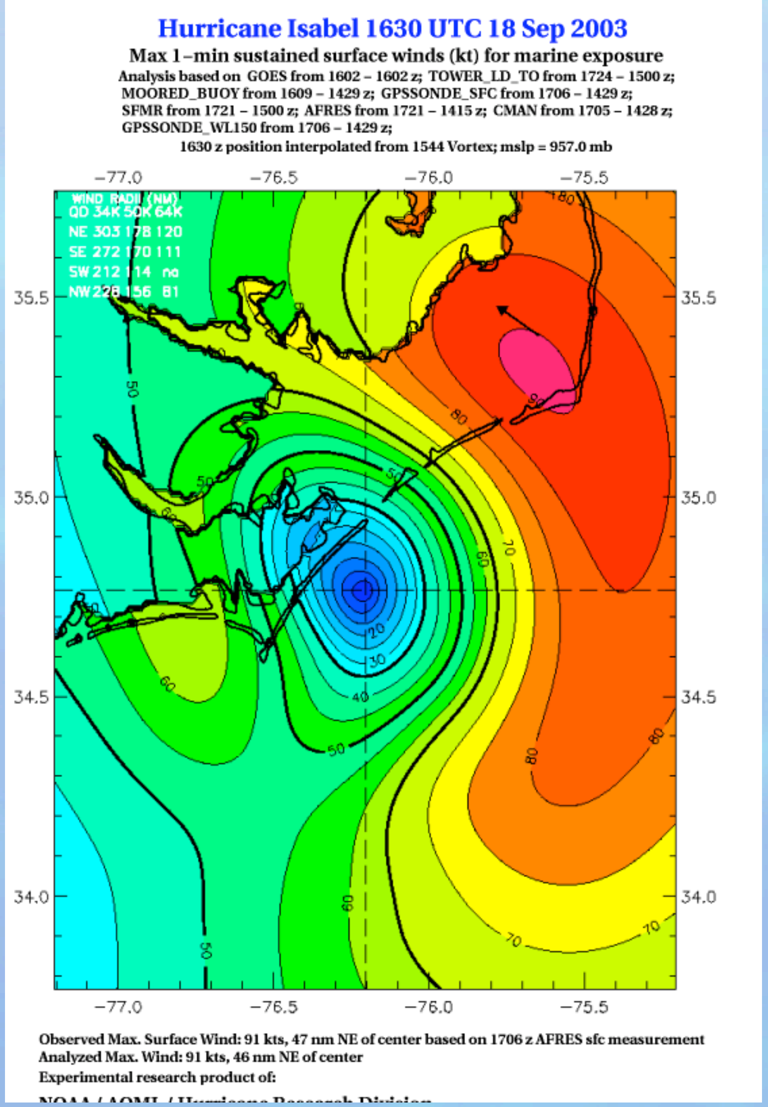
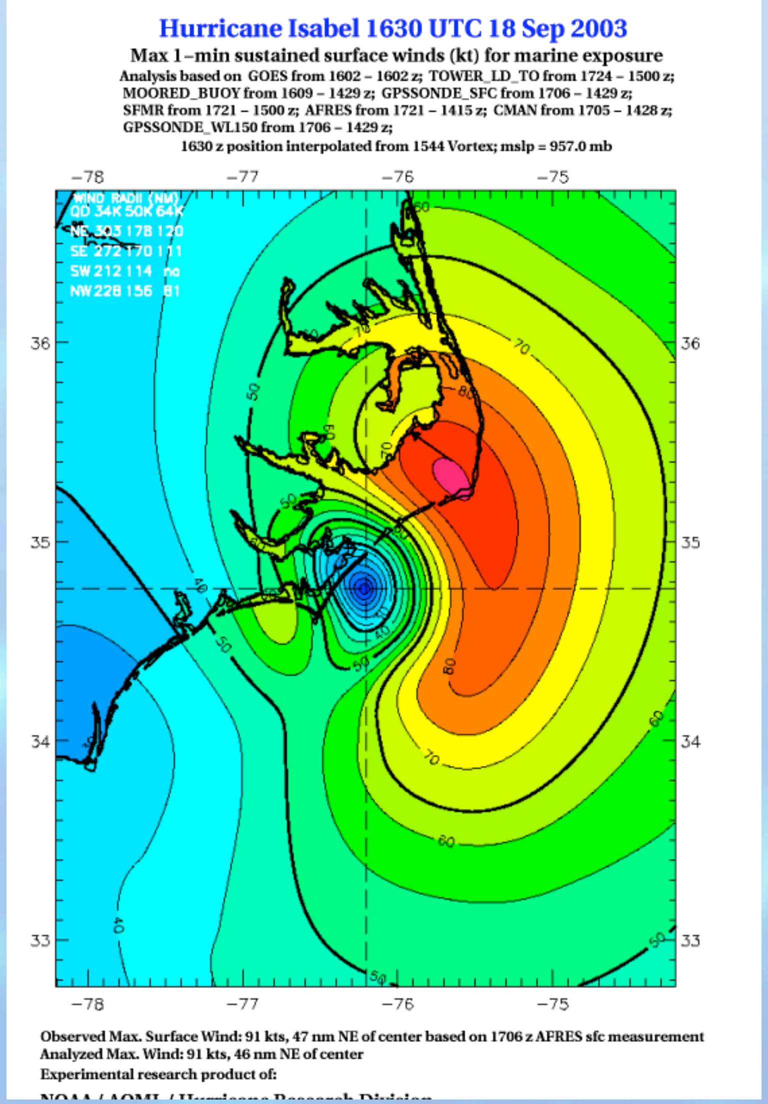
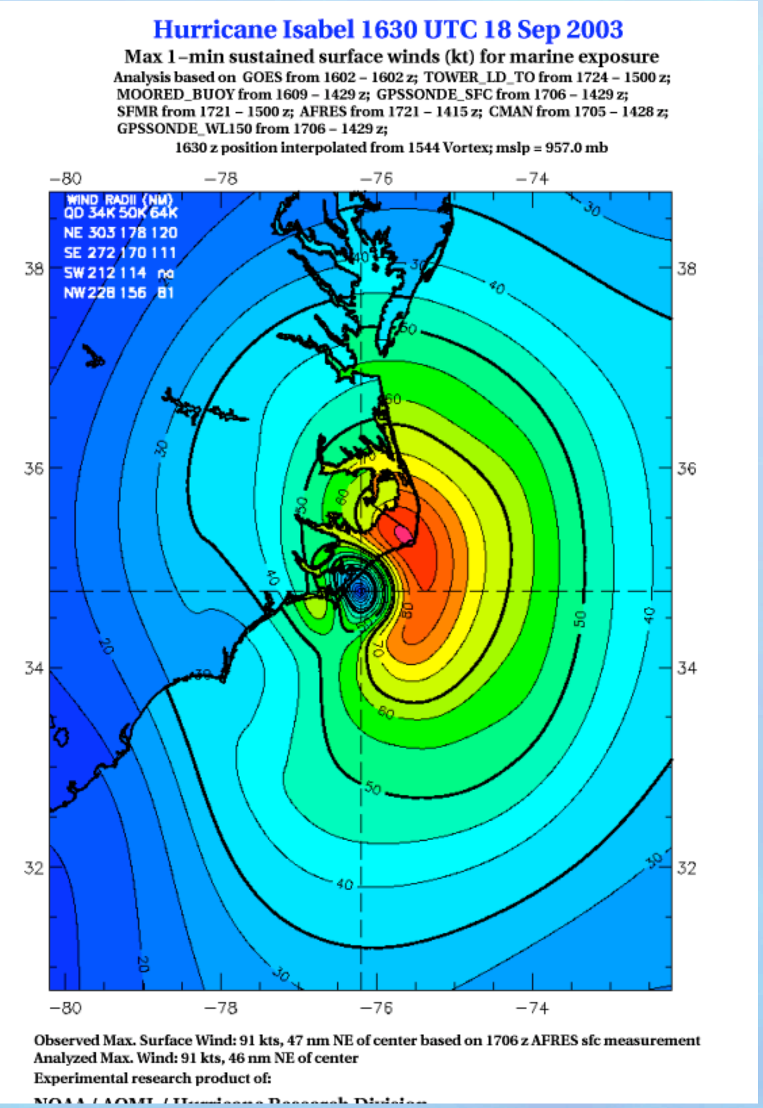
H*Wind Surface Wind Field Analyses

www.aoml.noaa.gov/hrd/data_sub/wind.html







3 levels of zoom in Hurricane Isabel

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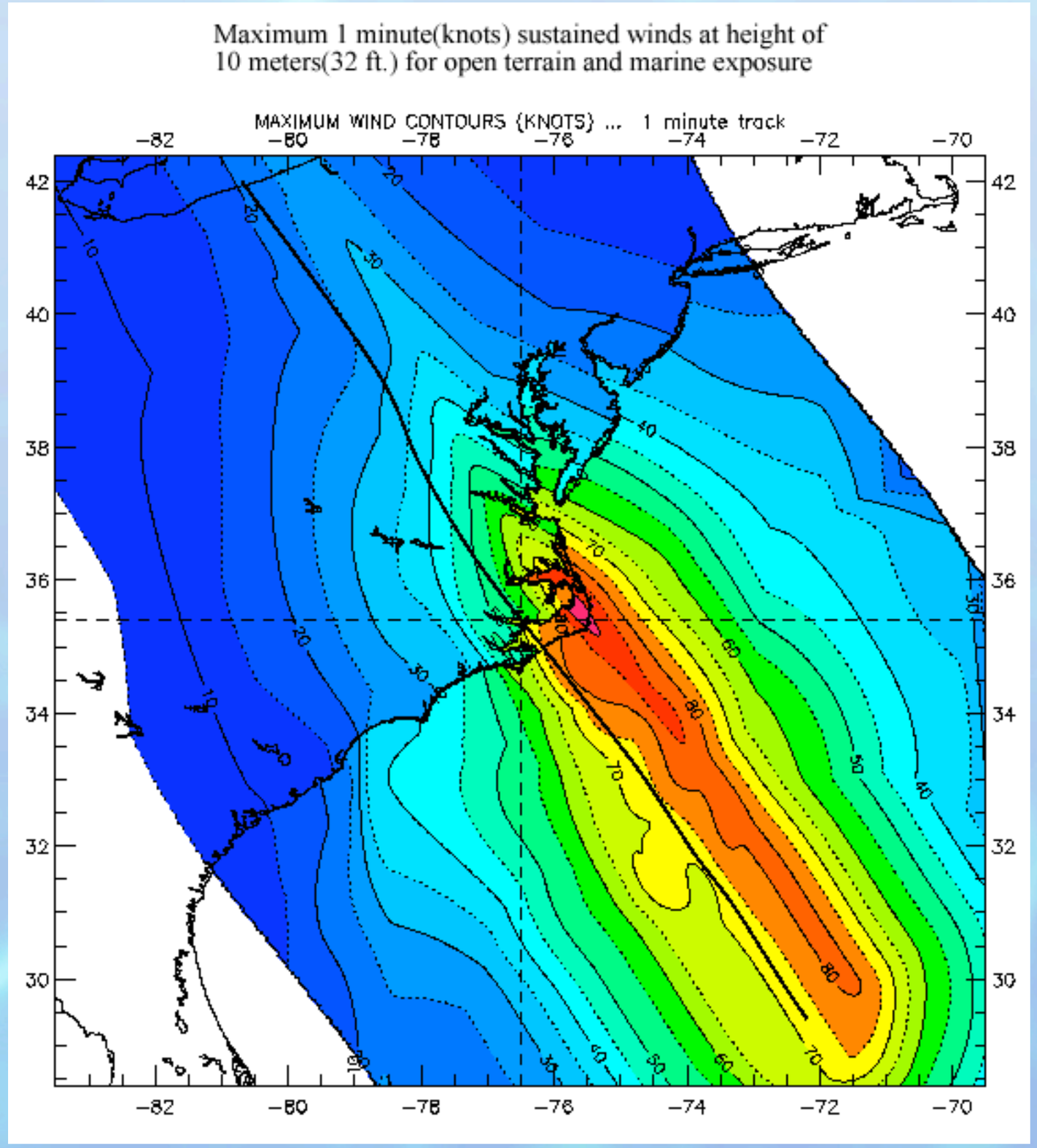
Hurricane Isabel wind swath product

- Kaplan-DeMaria inland decay applied to landfall wind field projected along official forecast track
- Funded by NESDIS for realtime input to DHS-FEMA's HAZUS model
  - Max winds at census tract locations
  - Estimate impact of event in realtime



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Provided Swath shape file product to Dominion Power to evaluate for use in recovery activities

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- **H*Wind Mechanical Interpolation:** Ooyama ‘87, Lord and Franklin ‘87
  - 2D least squares fitting algorithm combined with a derivative constraint, originally developed for GATE
  - Analyzed field represented by series of local basis functions (cubic B splines) centered at each nodal point
  - Coefficients of the splines chosen to minimize the differences between observations and analysis, subject to a constraint that acts as a low-pass filter to control resolvable scales
  - Analysis filters and homogeneous BC’s selectable for each of 5 nested meshes, subjective weights by platform
  - Analysis is continuous, twice differentiable; ideal for gridding, comparing to observations, gradients
  - Wind analysis constrained to match max ob location and magnitude; open, marine exposures merge at coast

- Existing method benefits and limitations
  - Ooyama's mechanical method works well on mature systems; weak storms are tough
    - Need to super-ob or decimate redundant data
    - Need to learn more about the performance of new observing platforms
  - Automated decisions on viable data platforms for the given situation
  - Additional Hurricane AOR candidates are rainfall distribution and surface pressure

- Critical Issues for Hurricane AOR
  - Analysis must be automated to meet hourly frequency requirement
  - An objective product may still not meet forecaster expectations: sampling myths, lack of consensus among platforms, need to change contours and peak value
  - ASOS and even C-MAN networks not designed for operation in extreme conditions; not dependable for documenting inland hurricane decay
  - SFMR must be transitioned to A/F recon, GBVTD
  - Satellite sensors susceptible to rain and cloud contamination, microwave signals can saturate at high winds
  - Retrospective difficult: aircraft reduction uncertainty, lack of station exposure details

- Bottom line…
  - With automation, H*Wind could serve as a platform for AOR in hurricanes


Thank You !!!!
Questions?
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