Hurricane Imaging Radiometer (HIRAD) operations and results from GRIP

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Chris Ruf, U Mich
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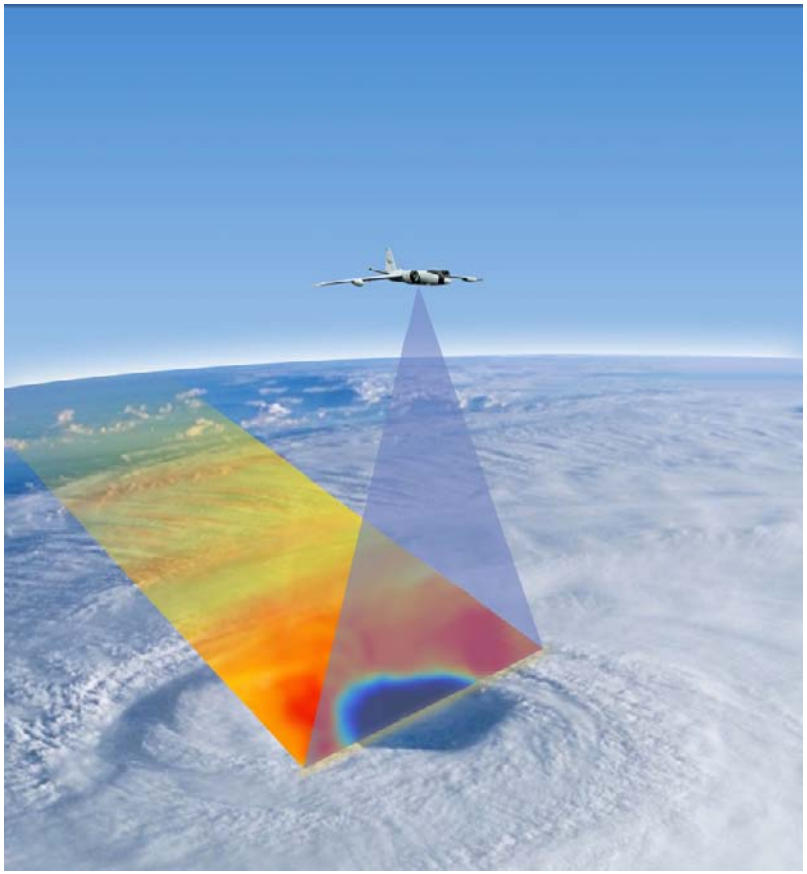
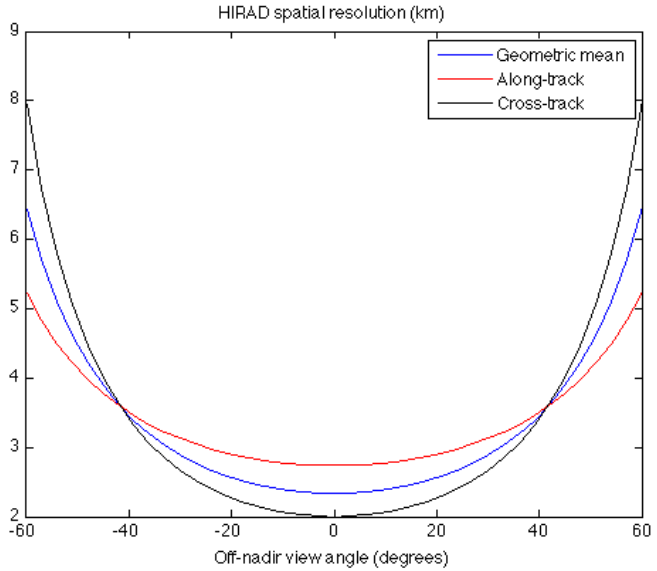


HIRAD Contributors

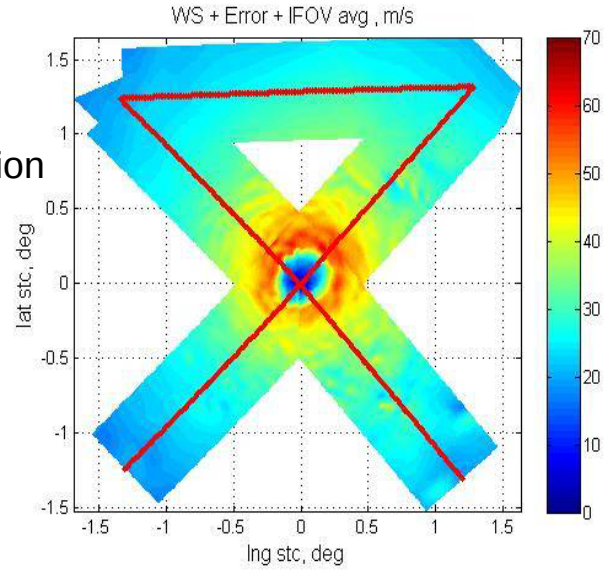
Lead Systems Engineer: Mark James, NASA/MSFC
Project Coordinator: Courtney Buckley, NASA/MSFC/USRA
Antenna design: M.C. Bailey
Systems engineering: David Simmons, UAHuntsville
RF systems engineering: Roger DeRoo, U Mich
Software engineering: William Cleveland, UAH
Project Initiator: Robbie Hood, NOAA (formerly NASA/MSFC)
Level I data analysis: Sayak Biswas, Univ. Central Florida
Mission ops: Lori Schultz (UAH), Brent Roberts (NASA/MSFC)
Radiative transfer modeling: Salem El-Nimri, Ruba Amarin (both UCF)
Presentation preparation: Cathy May, UCF
Engineering consultation: James Johnson, UCF
Science consultation: Peter Black, Robert Atlas, Cerese Albers, T. N. Krishnamurti

HIRAD Capabilities

- Passive C-band microwave radiometer (4, 5, 6, 6.6 GHz) to measure wind speed and rain rate over ocean surface
- HIRAD flew on the WB-57 during GRIP and will fly on the Global Hawk as part of HS3
- HIRAD's unique contribution: Measurement of rain rate and hurricane-strength winds, even through heavy rain
  - Wind speed ~ 5 – 85 m/s
  - Rain rate ~ 0 – 100 mm/hr
  - Swath width ~3x altitude
- Operations: NHC desires better definition of max wind speed and location
- Science Hypothesis: Short-term forecasts of intensity and structure will be improved by assimilation of HIRAD data

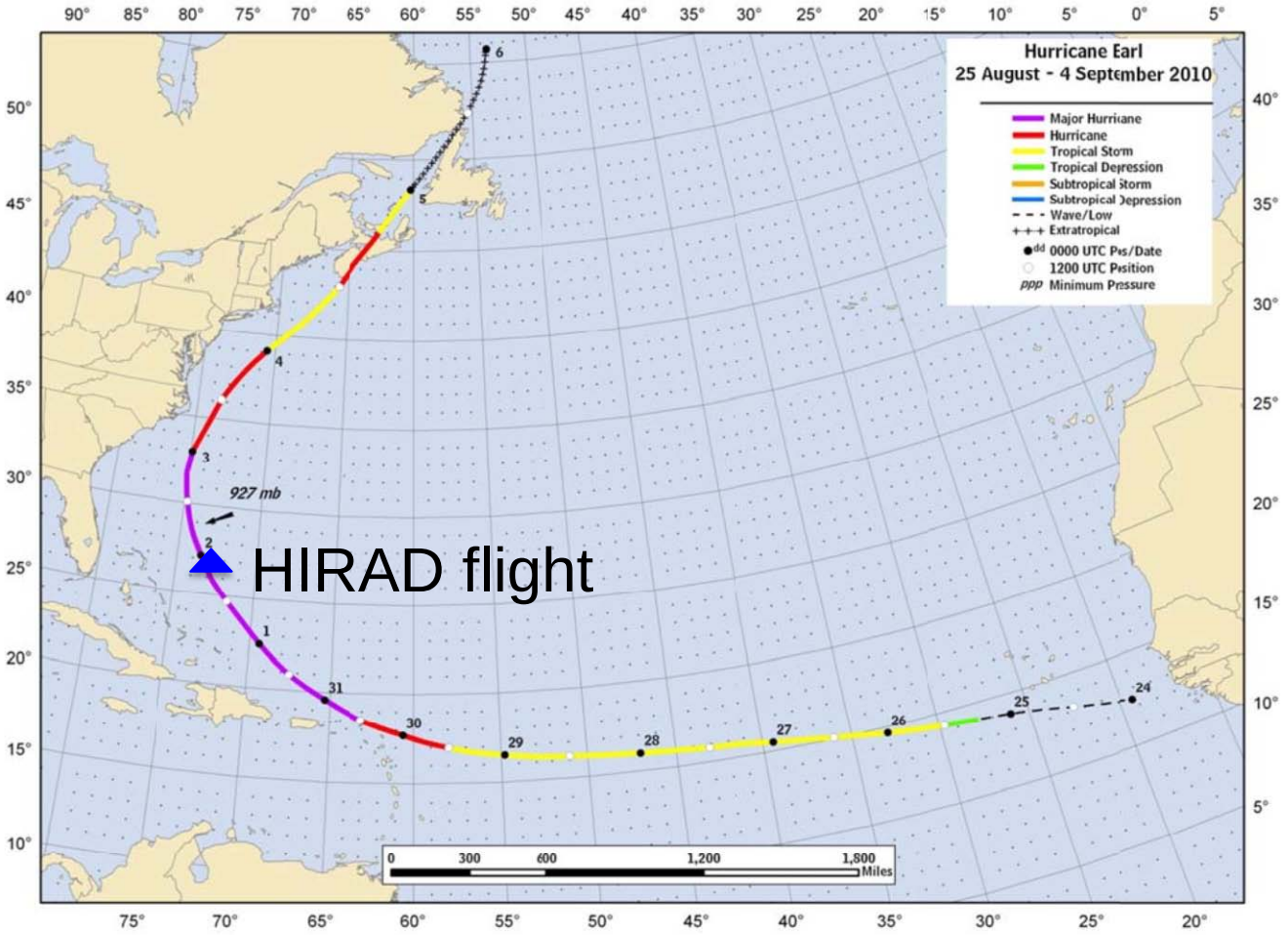


Simulation



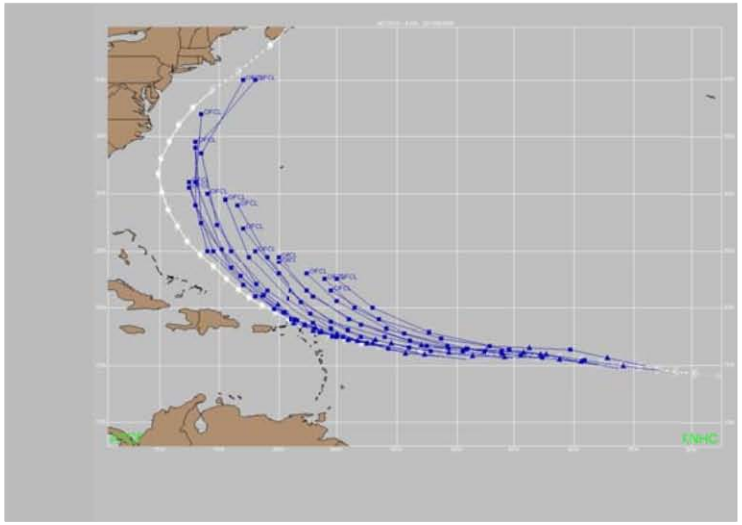
HIRAD on the NASA WB-57

Hurricane Earl Best Track

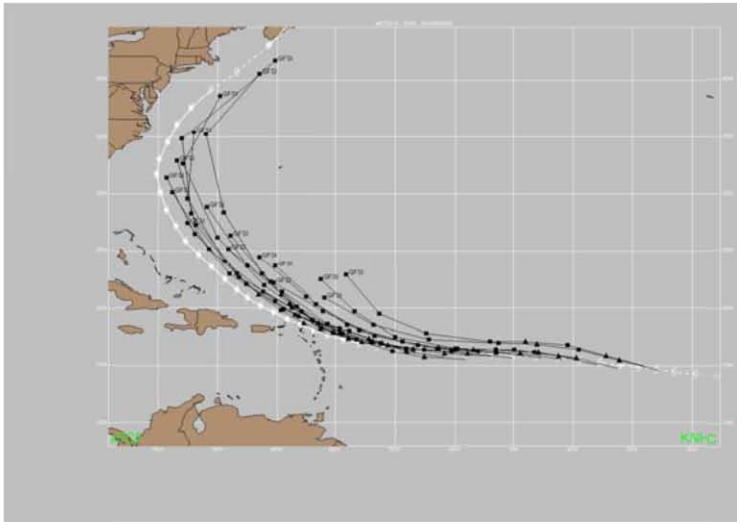


Earl's actual track was west of forecasts

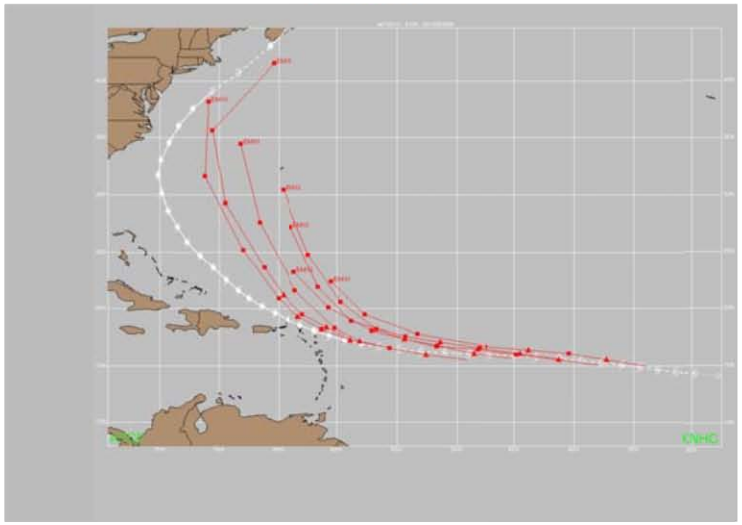
This resulted in Earl being accessible from Tampa, although planning was a challenge!



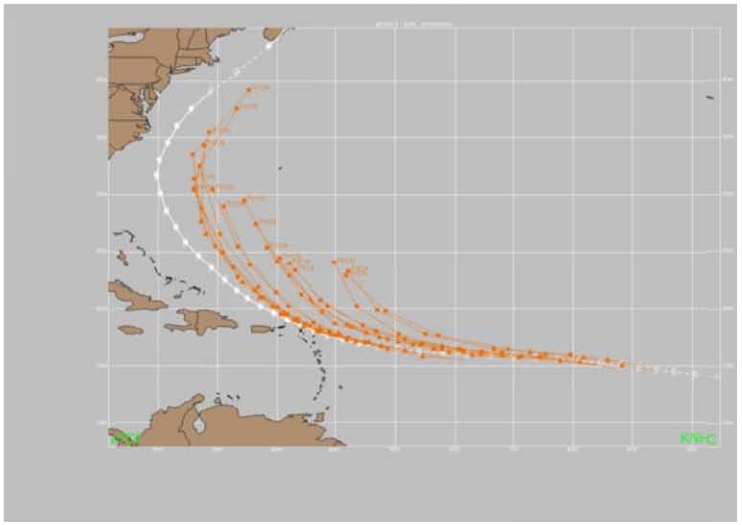
a. OFCL



b. GFSI

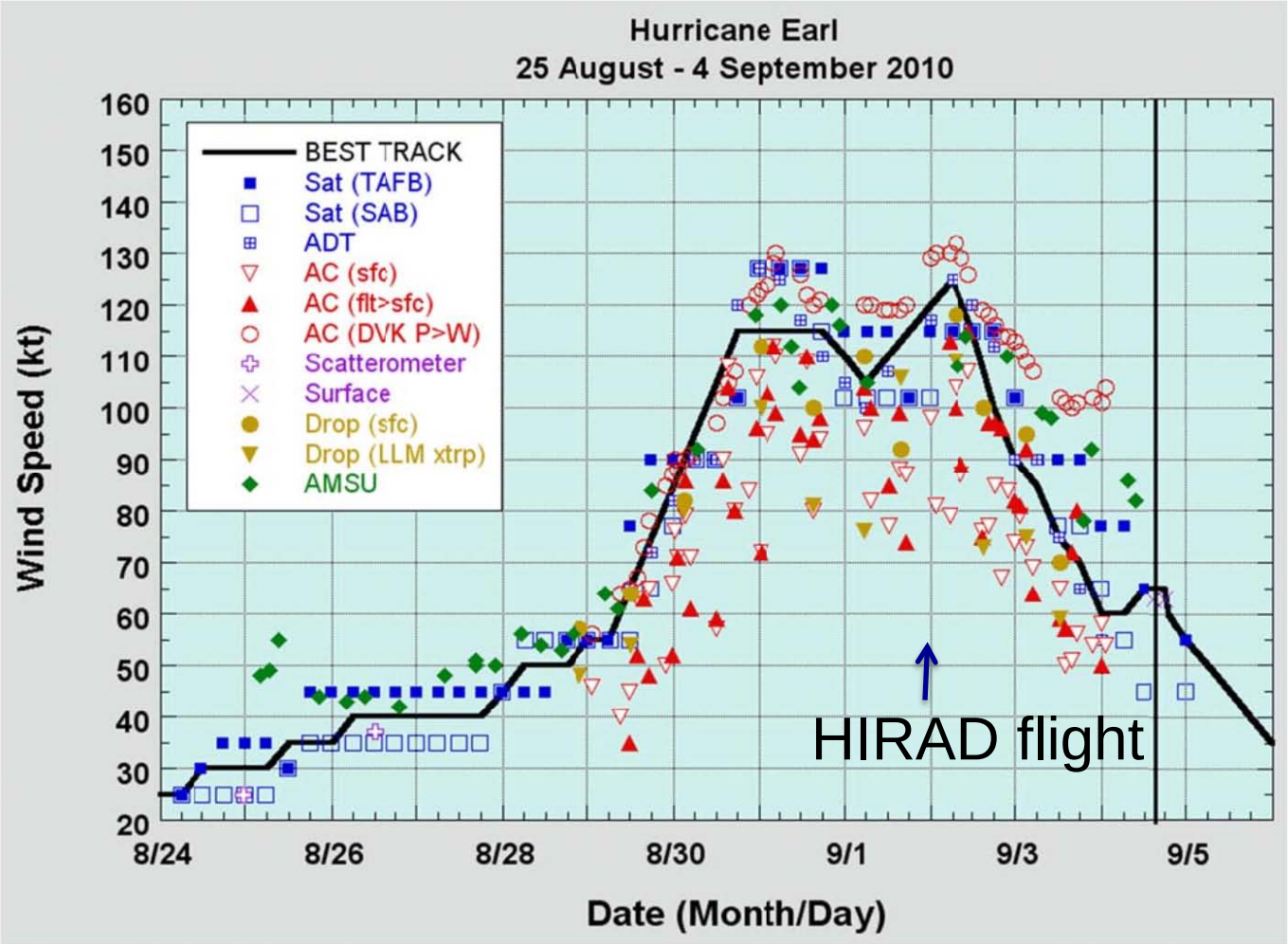


c. EMXI



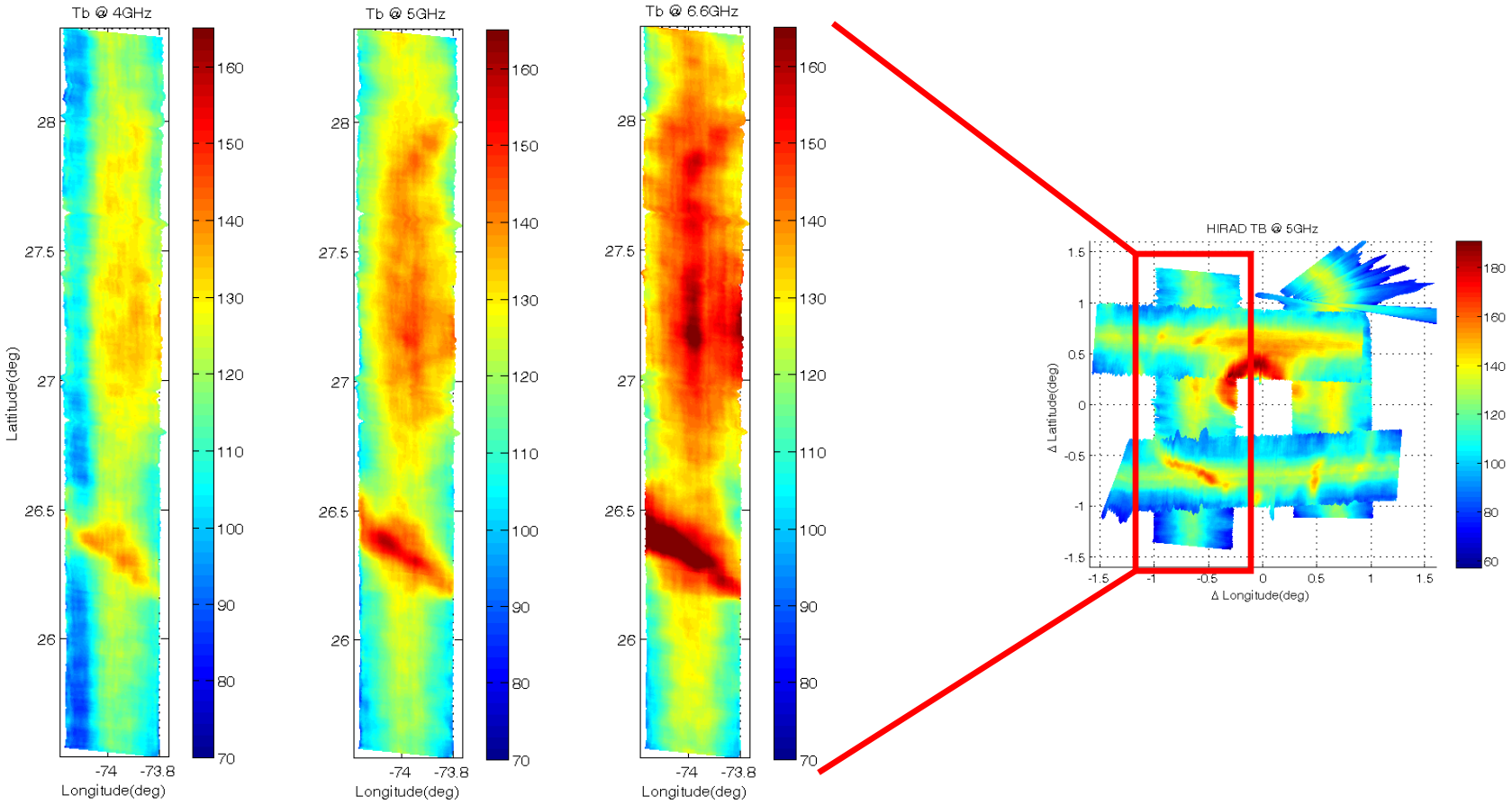
d. TVCN

Hurricane Earl Max Wind Speed



Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Earl

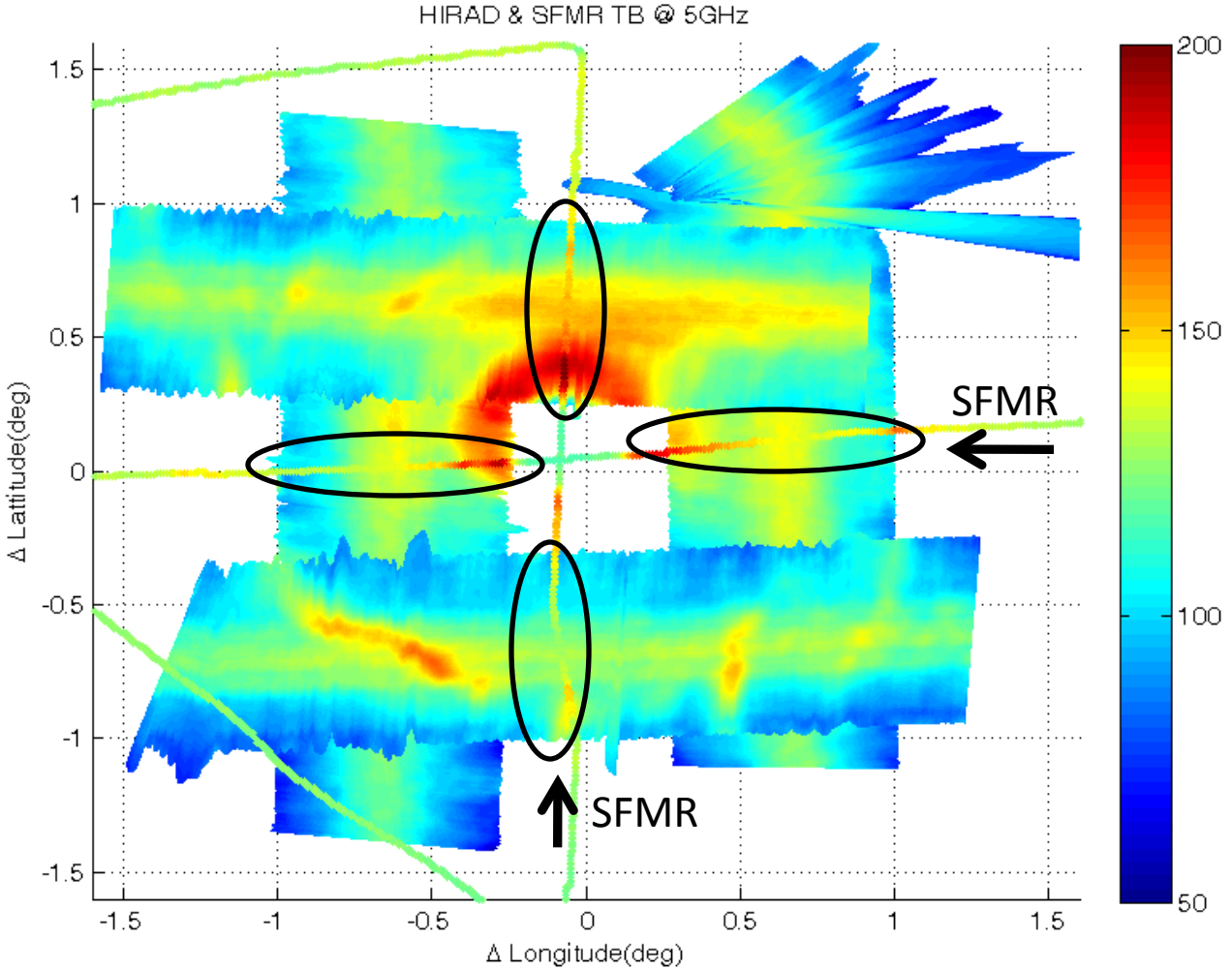
HIRAD TB Images at 4.0, 5.0 and 6.6 GHz along Northbound Earl Overpass



4.0 GHz 5.0 GHz 6.6 GHz

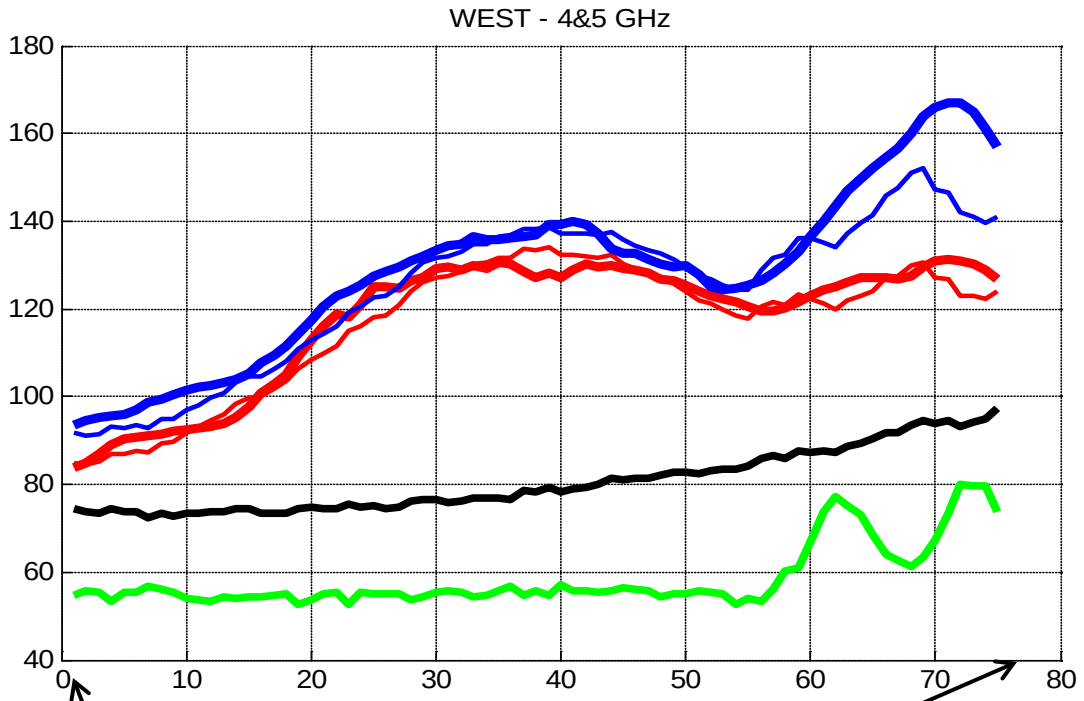
WB-57/HIRAD flight over Earl (1 Sept 2010)

Storm-centric coordinate system



SFMR is the operational NOAA instrument.
Tb is expected to agree only at the nadir point.

HIRAD/SFMR West Leg Overpass



HIRAD Tb@ 4GHz

HIRAD Tb@ 5GHz

Model Tb@ 4GHz

Model Tb@ 5GHz

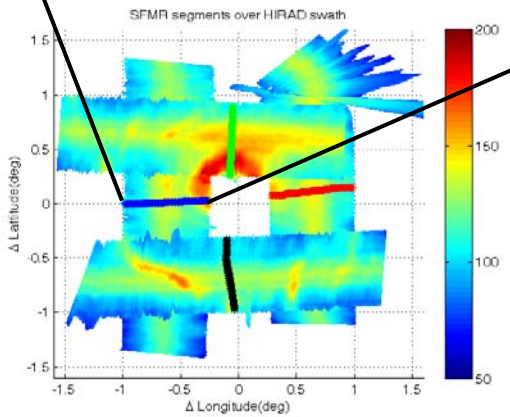
SFMR Wind +50 (m/s)

SFMR Rain +50 (mm/hr)

stop

start

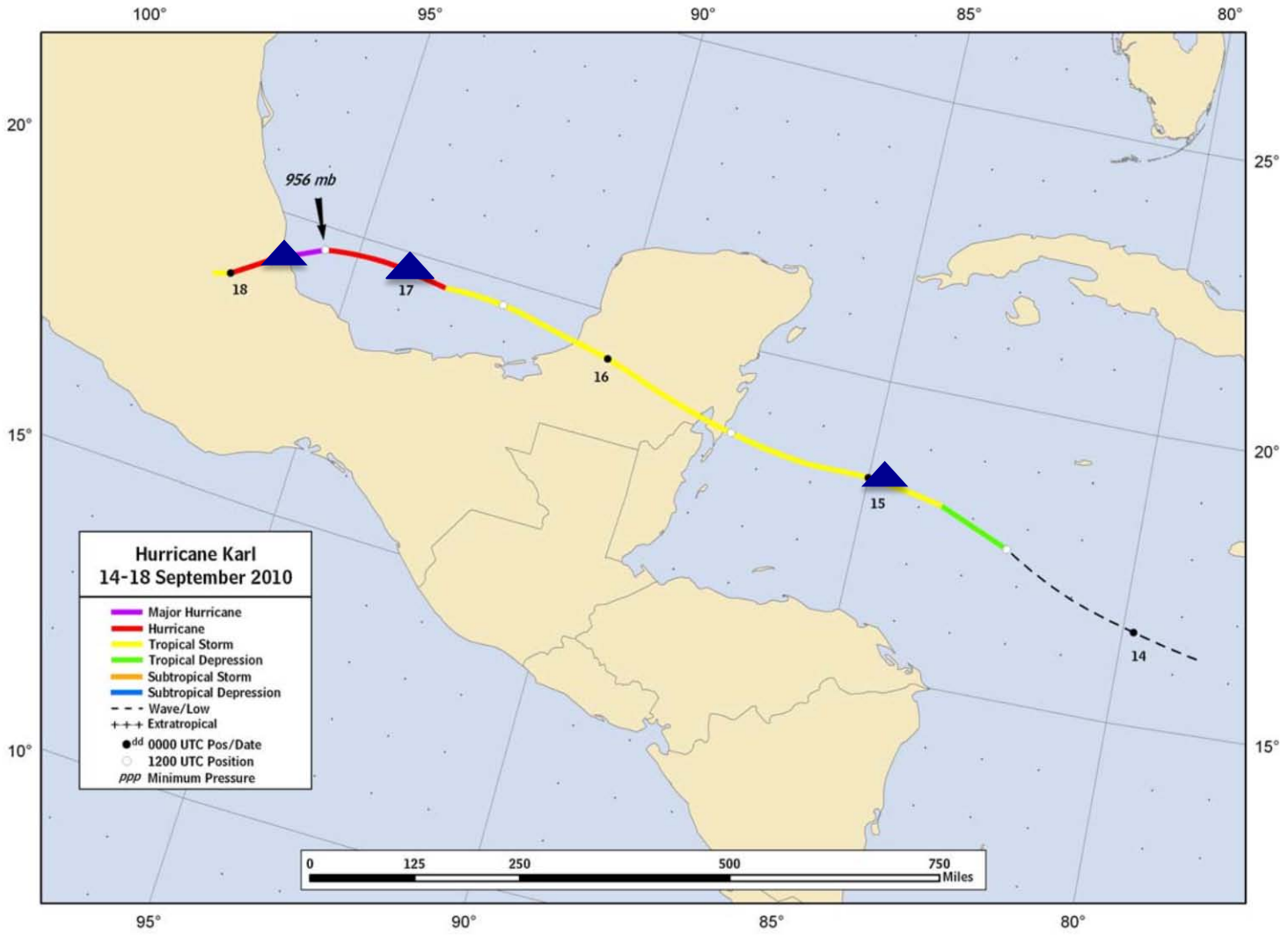
SFMR Flt Dir



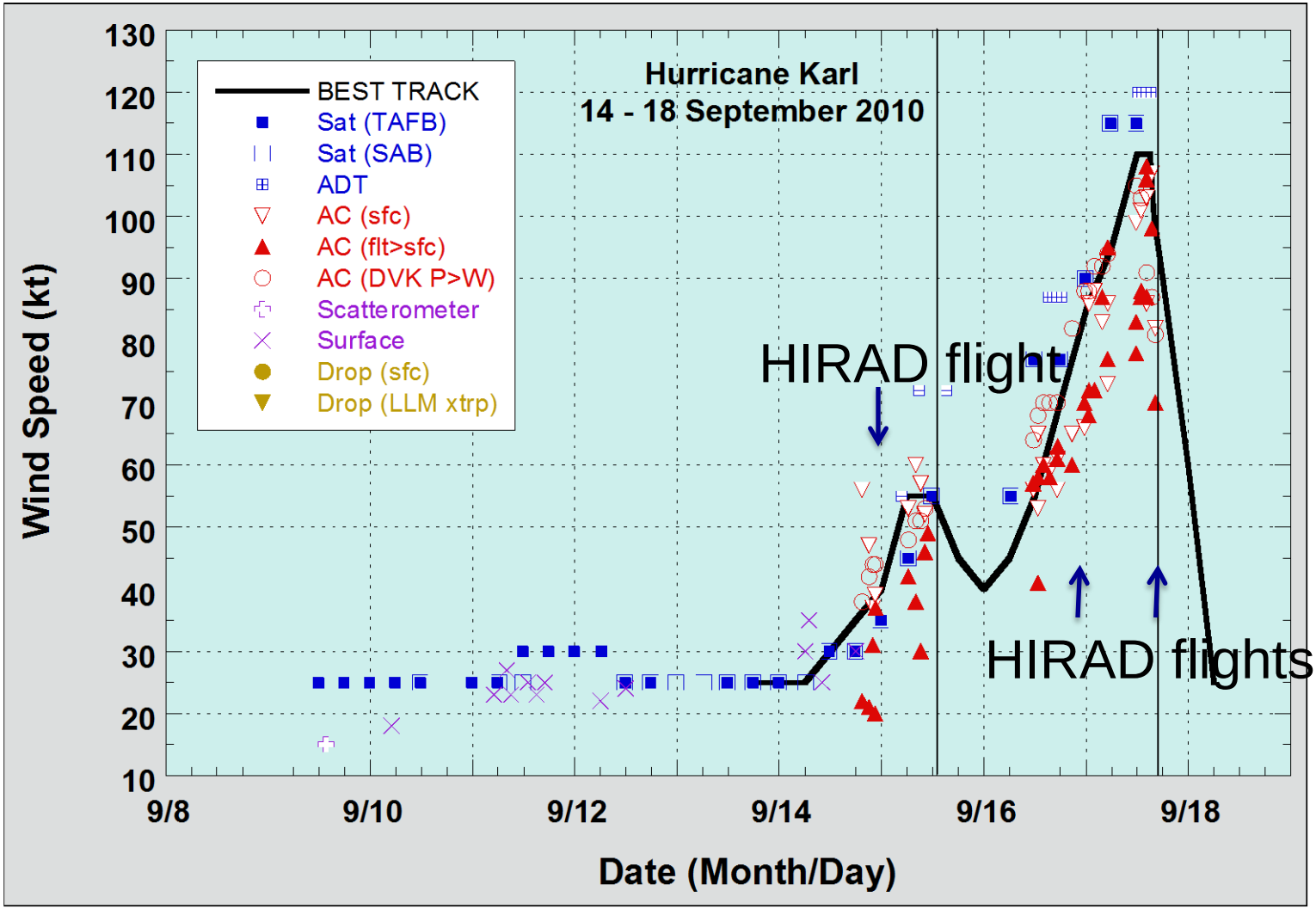
"Model" data are Tb's computed from SFMR wind & rain fields

Karl Best Track

Storm location during HIRAD flights indicated by triangles



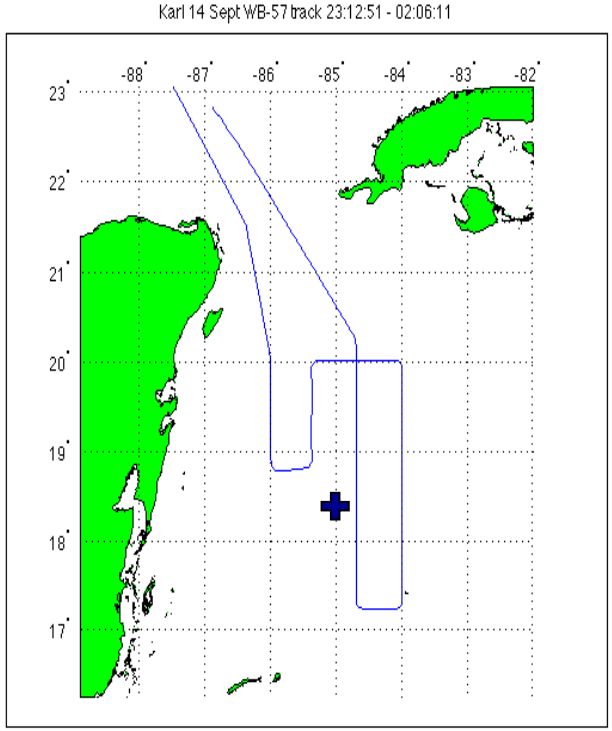
Hurricane Karl Max Wind Speeds



HIRAD flights over Karl

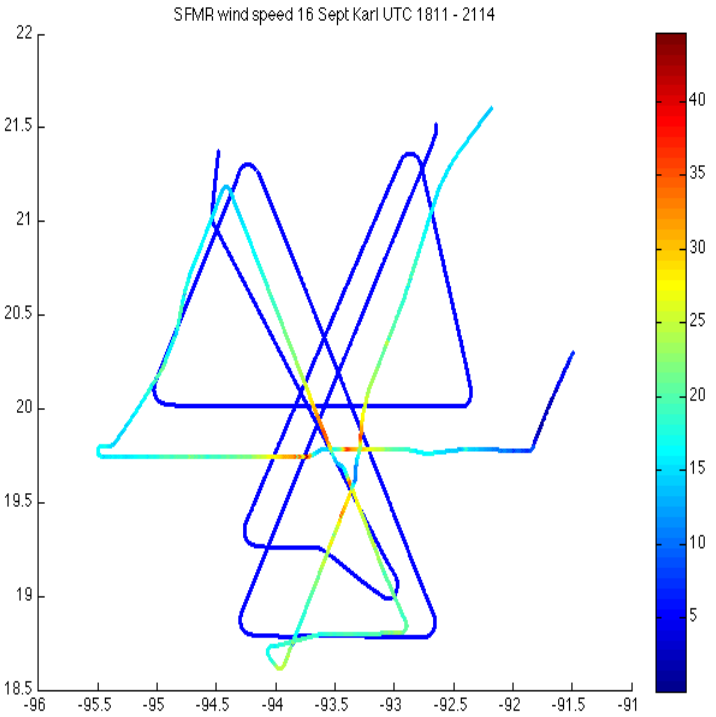
Sept 14

Storm center indicated at 00 Z



Sept 16

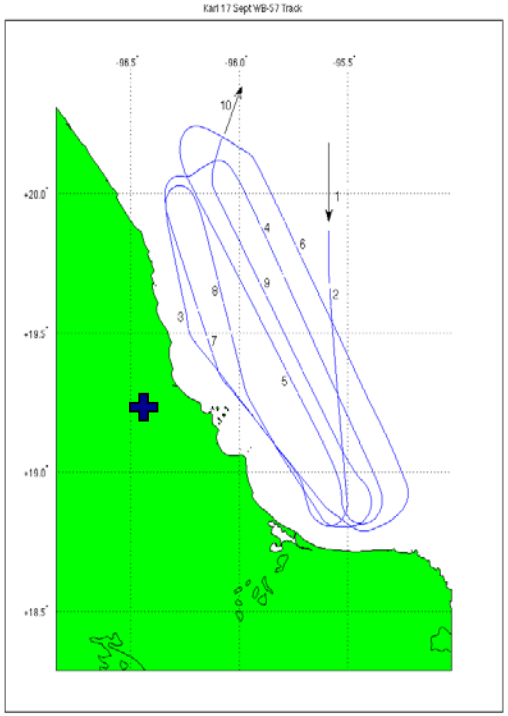
HIRAD 19:00 – 21:55



Sept 17

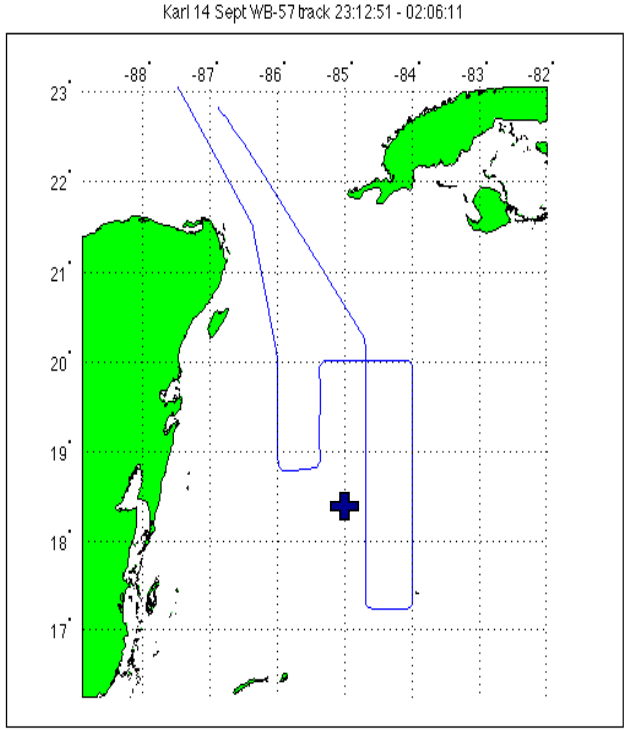
1745-2015 UTC

Storm center indicated 18 Z



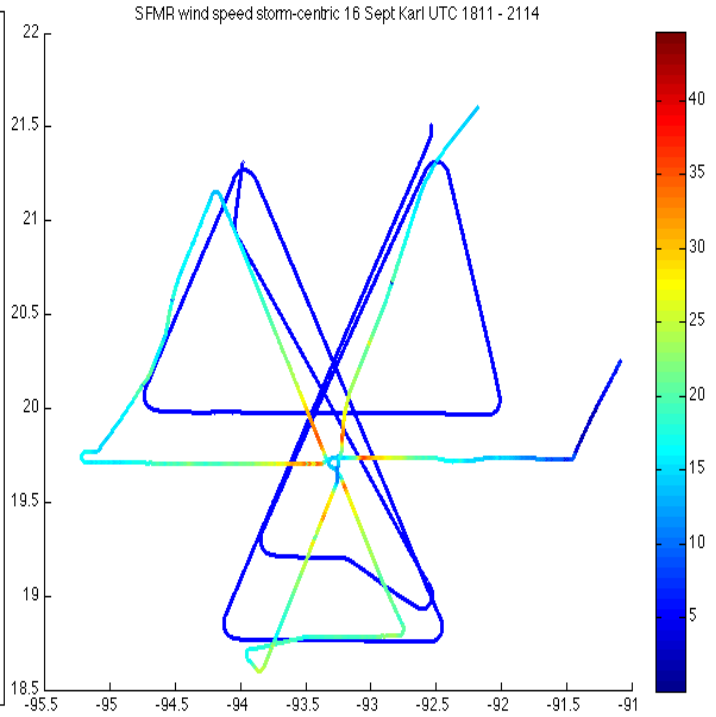
HIRAD flights over Karl

Sept 14



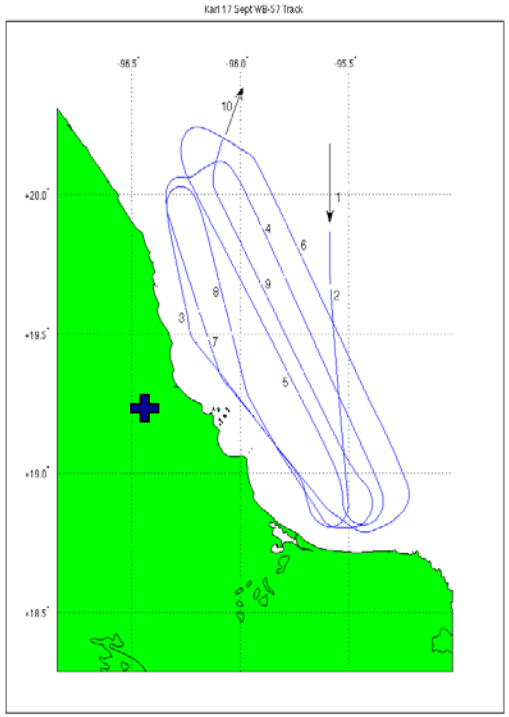
Sept 16

Adjusted for storm motion

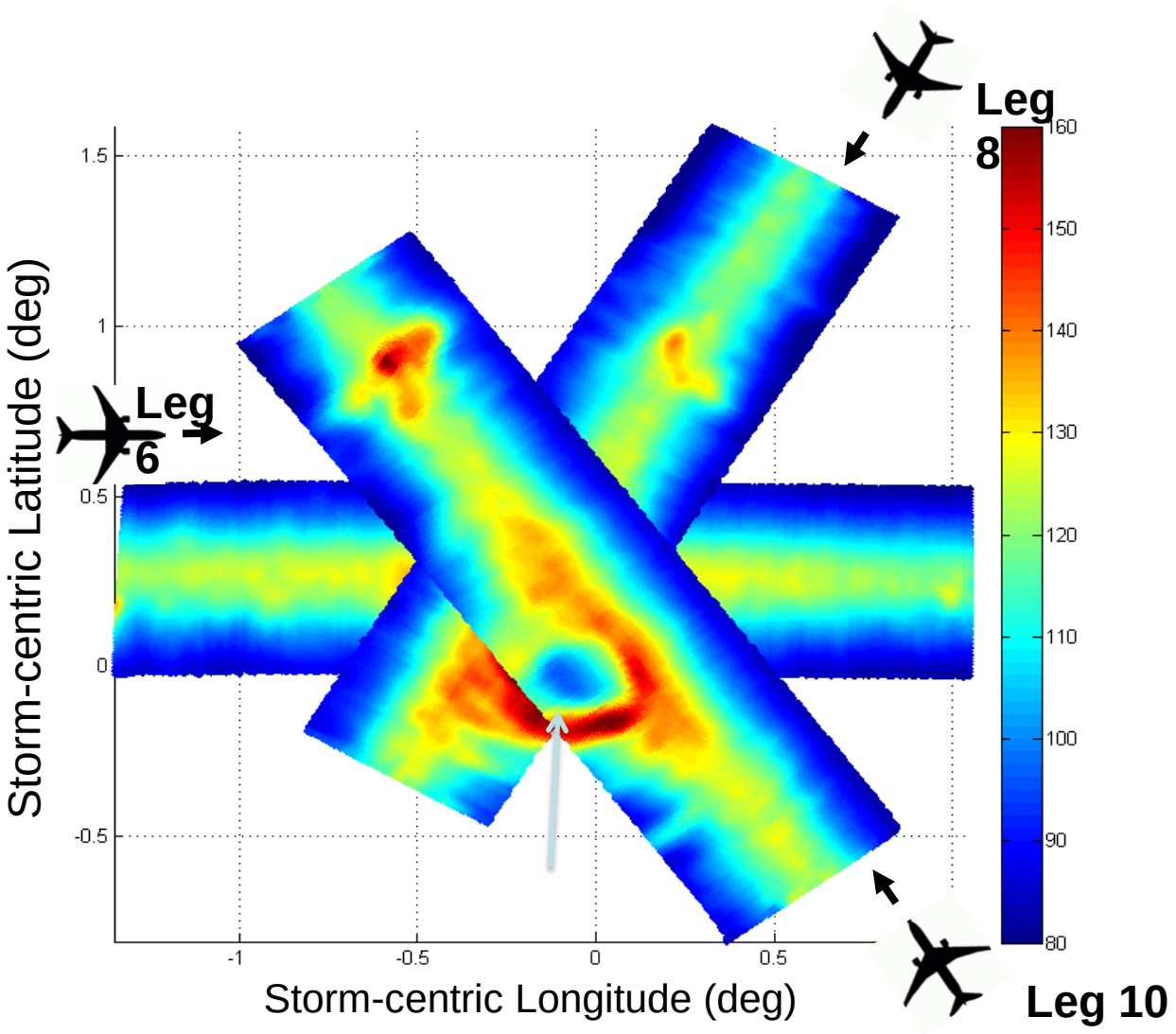


Sept 17

1745-2015 UTC

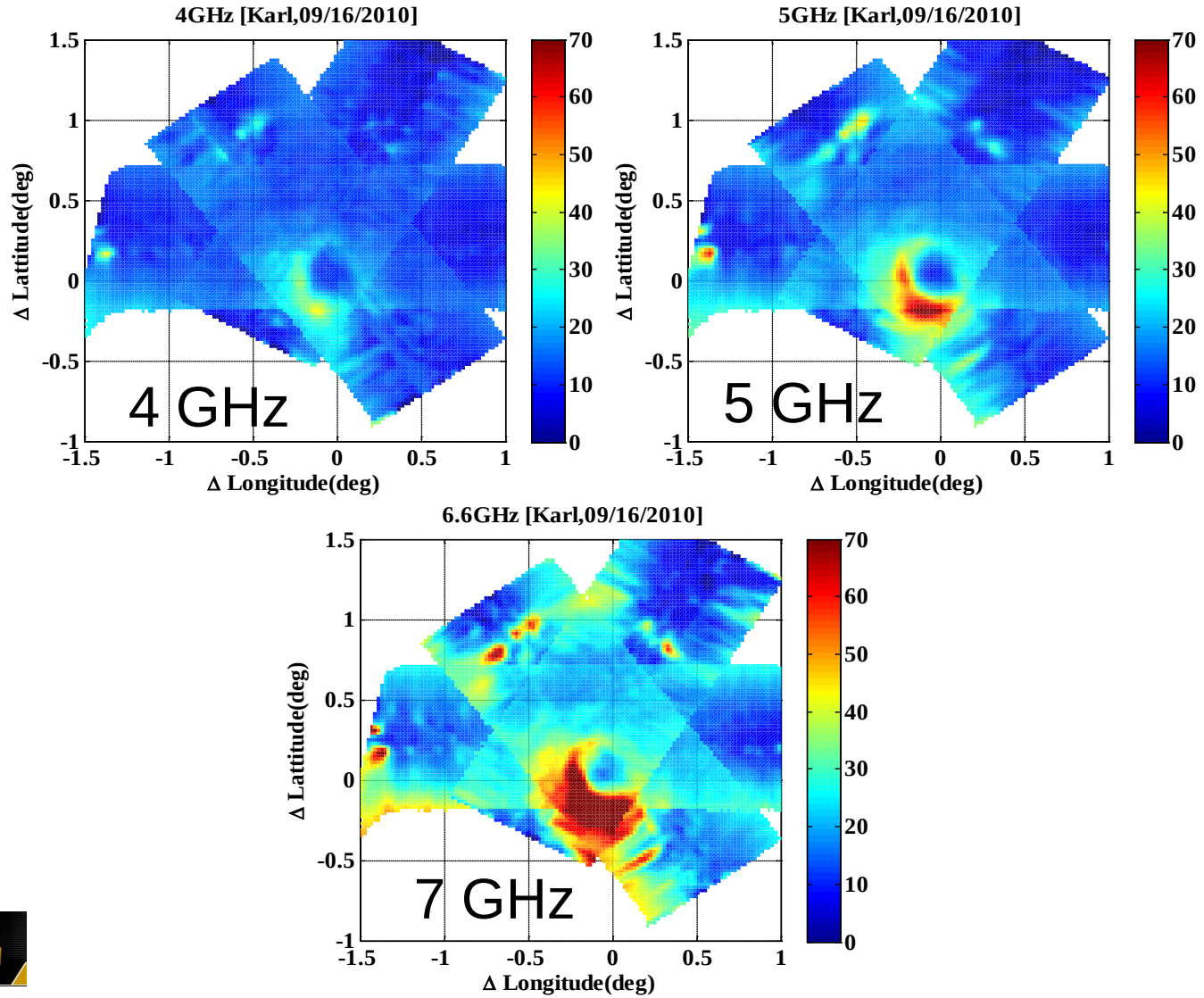


HIRAD 5 GHz Tb on Flight Tracks for Karl

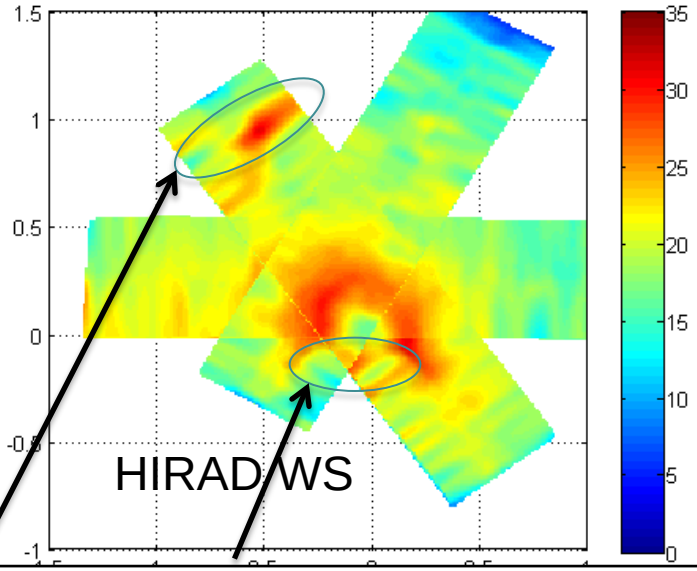


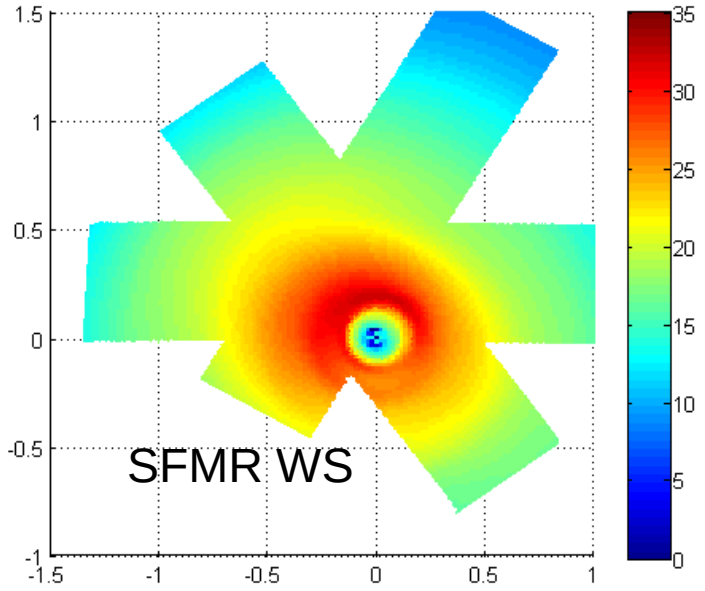
HIRAD flight over Karl on 16 Sept

- Excess Tb removes the incidence angle variation

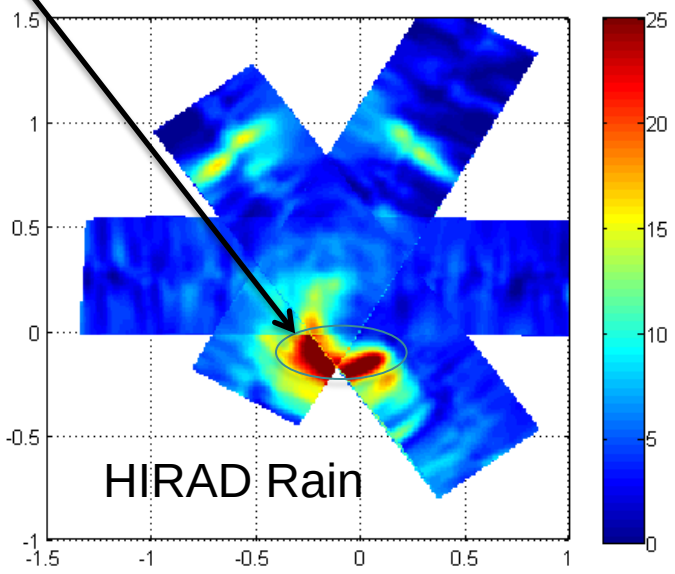


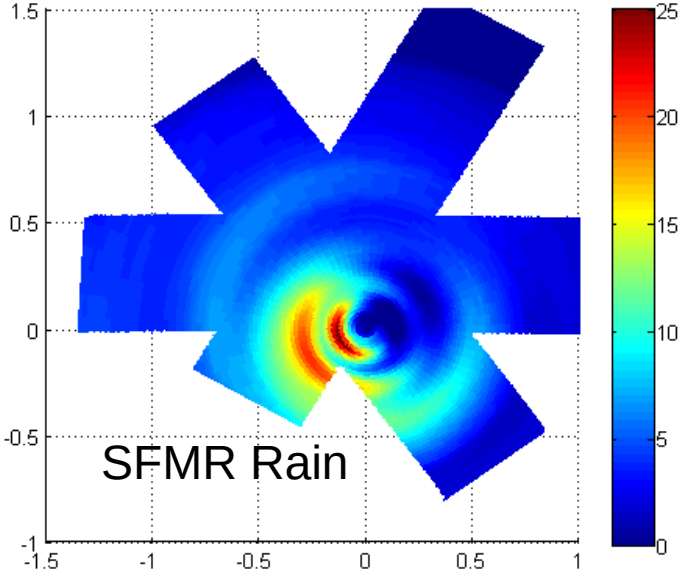
HIRAD and SFMR (analysis) Wind Speed & Rain Rate Comparisons





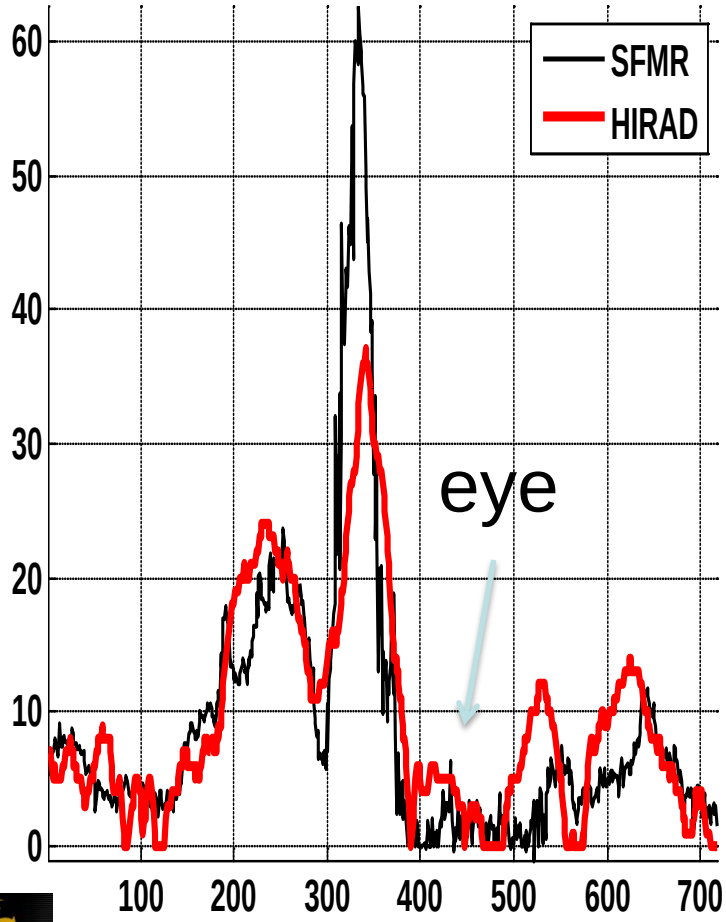
Bad retrievals, to be corrected after final Tb calibration



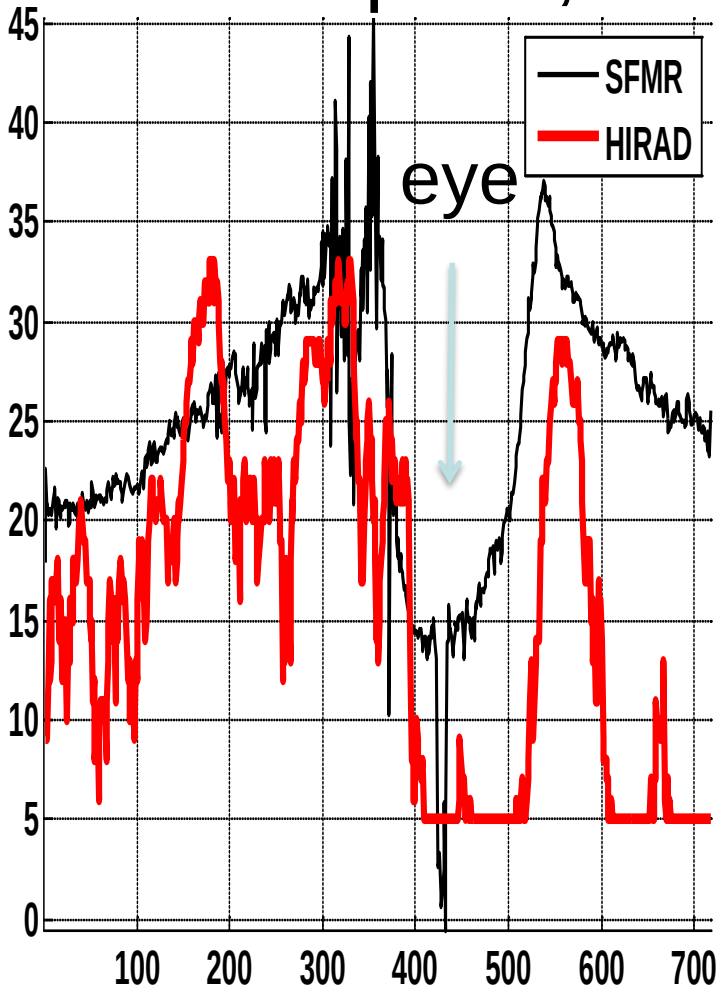


Karl Leg 6: WS & RR Time Series (HIRAD & SFMR)

Rain Rate, mm/hr



Wind Speed, m/s



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Summary

- The WB-57, with HIRAD aboard, flew once over Earl and 3 times over Karl during GRIP
- The Earl flight and the 16 Sept Karl flight look to be the most likely to provide important contributions to the GRIP mission dataset
  - These two flights have priority in data processing and analysis
  - High-res wind speed and rain rate images provide snapshot of the complete inner core in a single aircraft pass (Leg 10 of Karl, 16 Sept)
- Continuing to develop data processing methodology to establish and maintain calibration in all channels and sub-bands
  - See poster by Ruf et al.
- Meanwhile, we have developed a methodology for calibrating HIRAD Tb's against SFMR, and we are producing wind speed and rain rate retrievals that show consistency with SFMR, but with value-added details
  - See poster by Jones et al.
- Targeting release of Tb and wind/rain data for Earl and 16 Sept Karl on Aug 1