

62nd Interdepartmental Hurricane Conference

March 3-7, 2008 - Charleston, S.C.

Presentation:

Accomplishments of Our JHT SFMR Effort

Authors:

Jim Carswell, RSS

Peter Black, NRL / SAIC

Paul Chang, NOAA/NESDIS

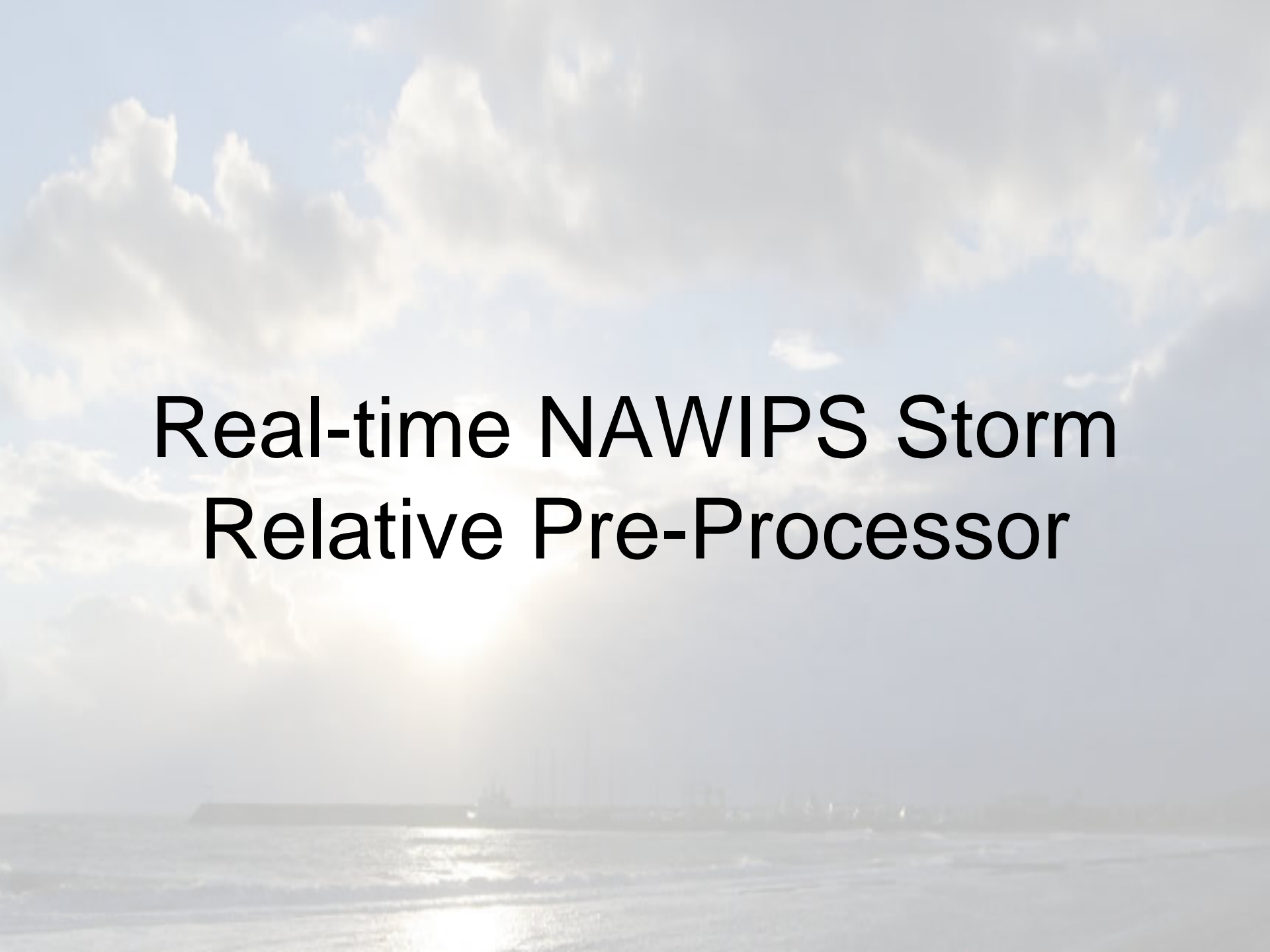
Eric Uhlhorn, NOAA HRD

Acknowledgements:

Chris Sisko, Jose Salazar and Brian Maher
Work funded through JHT.

Activities / Accomplishments

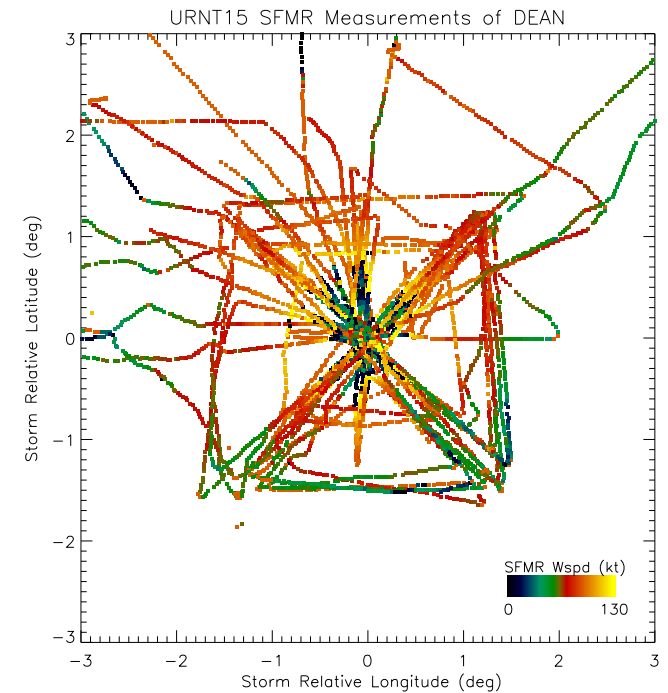
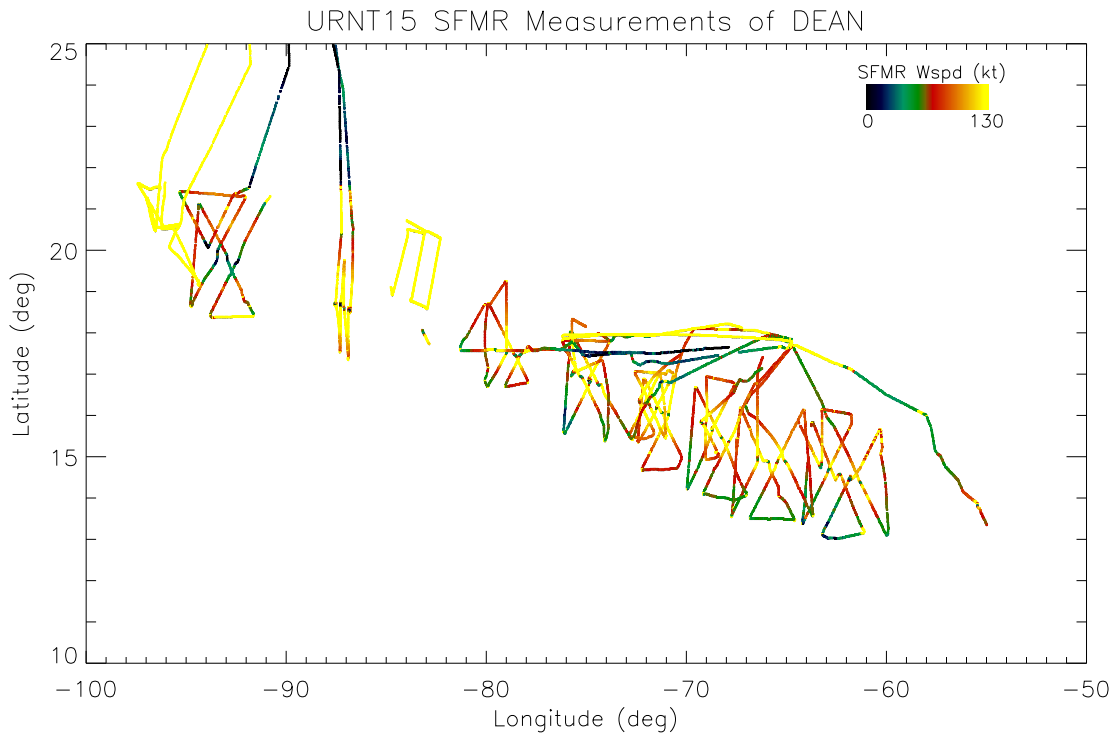
- **Developed Real-time NAWIPS Pre-Processor*:**
 - Provides SFMR Retrievals to NAWIPS environment.
 - Creates collocation SFMR-GPS dropsonde data set for real-time validation.
 - Creates a complete archive of reconnaissance data organized by storm (includes raw SFMR data files).
- **Improve SFMR wind retrievals in precipitation:**
 - New sampling approach.
 - Improved SFMR absorption model.
- **Automation of real-time display application.**
- **Developed QOS algorithm for calibration-validation (runs inside retrieval processor).**



Real-time NAWIPS Storm Relative Pre-Processor

Motivation for NAWIPS Processor

- Aircraft observations provide detailed spatial picture over time.
- Storm moves making interpretation more difficult.
- NAWIPS does not have storm relative processing capabilities.



Application Description

- Layer 1: Data Acquisition
 - Fetches REPNT3 & URNT15 files:
<http://ratfish.nhc.noaa.gov/archive/recon>
 - Fetches center fix files:
<ftp://ftp.nhc.noaa.gov/atcf/fix>
 - Fetches Air Force SFMR raw data files.
 - RSS developed application for Air Force to automatically upload SFMR data files to <ftp://dogfish.nhc.noaa.gov>.
 - Not real-time – Post mission activity.
 - Designed to be capable of fetching any data files or file system available over Internet.

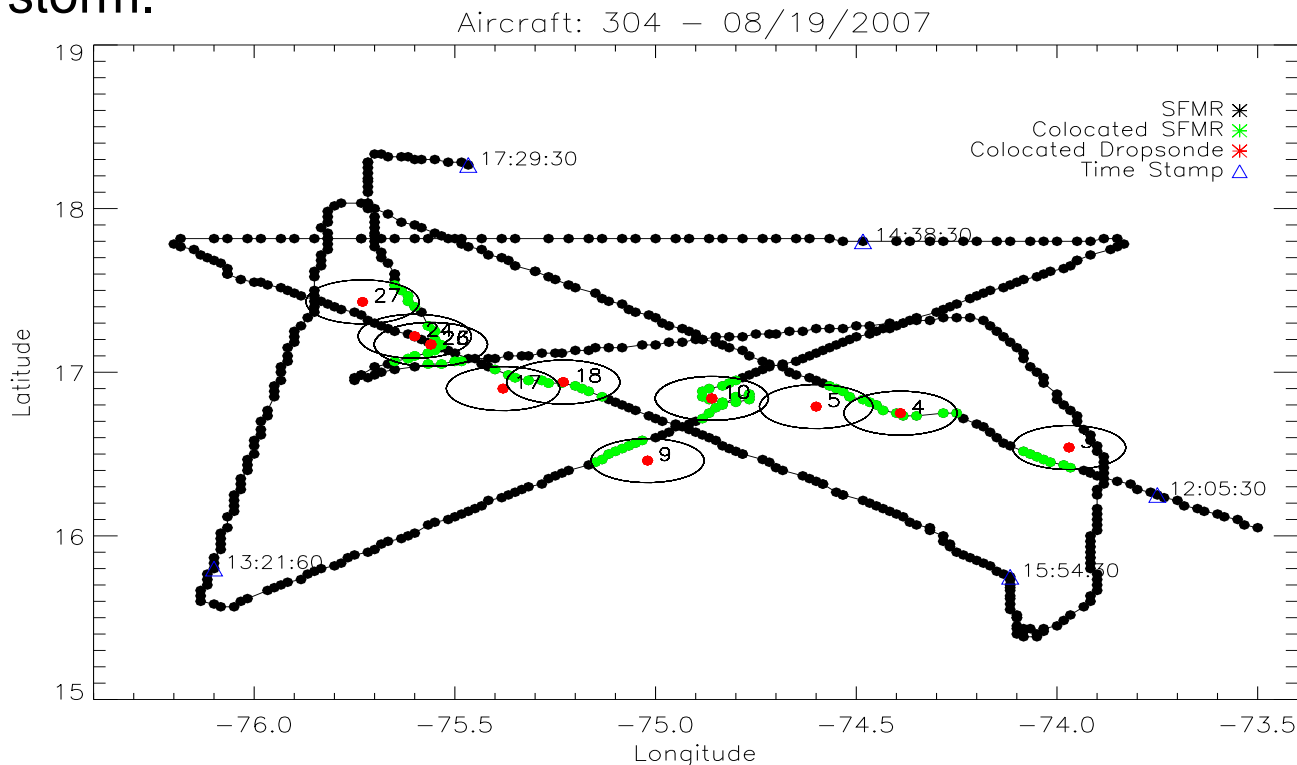
Application Description

- Layer 2: QOC, Parsing & Location Processing
 - Implements quality control (QOC) and parsing of all data fetched in Layer 1.
 - Parsed data organized by storm and outputted to NetCDF files.
 - Calculates storm relative position for each observation & appends this information to NetCDF storm data files.
 - All maintenance contained to this layer.

Application Description

- Layer 3: Collocation Processing

- Creates collocated SFMR and GPS Dropsonde data files organized by storm.



Application Description

- Layer 4: “Storm-Relative” NAWIPS File Creator
 - Maps storm relative observations to Earth coordinates at fixed center fix time intervals.
 - Outputs mapped observations to GEMPAK ship files so they can be ingested into NAWIPS.
 - Valid data window and center fix time intervals are user settable.
- Application will be tested this Spring at NHC and deployed for 2008 Hurricane Season.

Year 2 – Main Activities

- Hold March 19 Workshop at NHC.
- Deploy & test real-time NAWIPS Pre-Processor.
- Deploy & test real-time display application.
- Complete validation of new SFMR absorption GMF.
- Analyze low altitude missions, and if needed, make refinements to retrieval process.
- Execute bathymetry flight patterns and determine guidance for shallow water regions.
- Determine if storm azimuthal bias exists in SFMR wind retrievals.

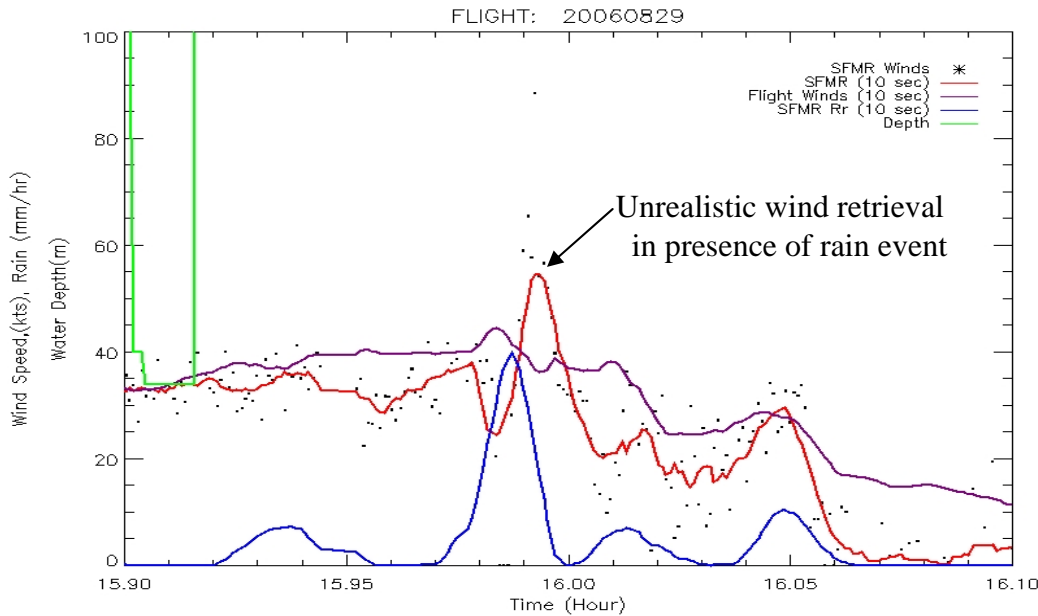


**Questions?
(And hopefully answers.)**



Impact of SFMR Sequential Sampling Approach

Motivation

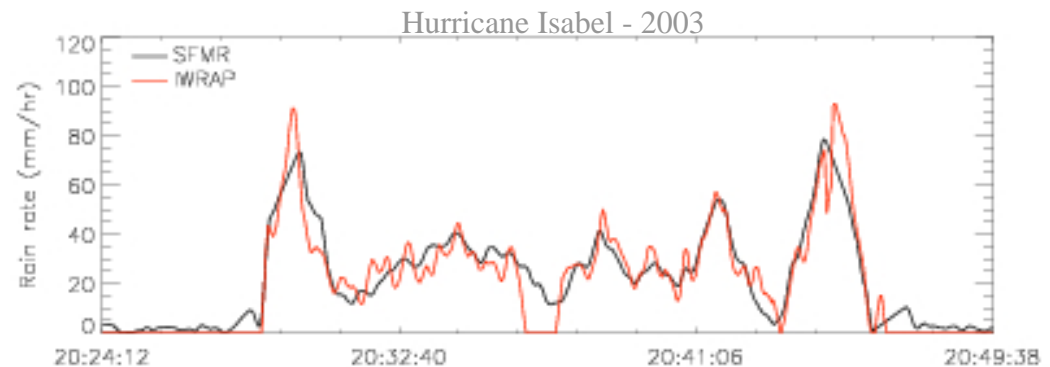


Sampling Issue:

- SFMR ocean wind speed estimates appear to oscillate in presence of rain.

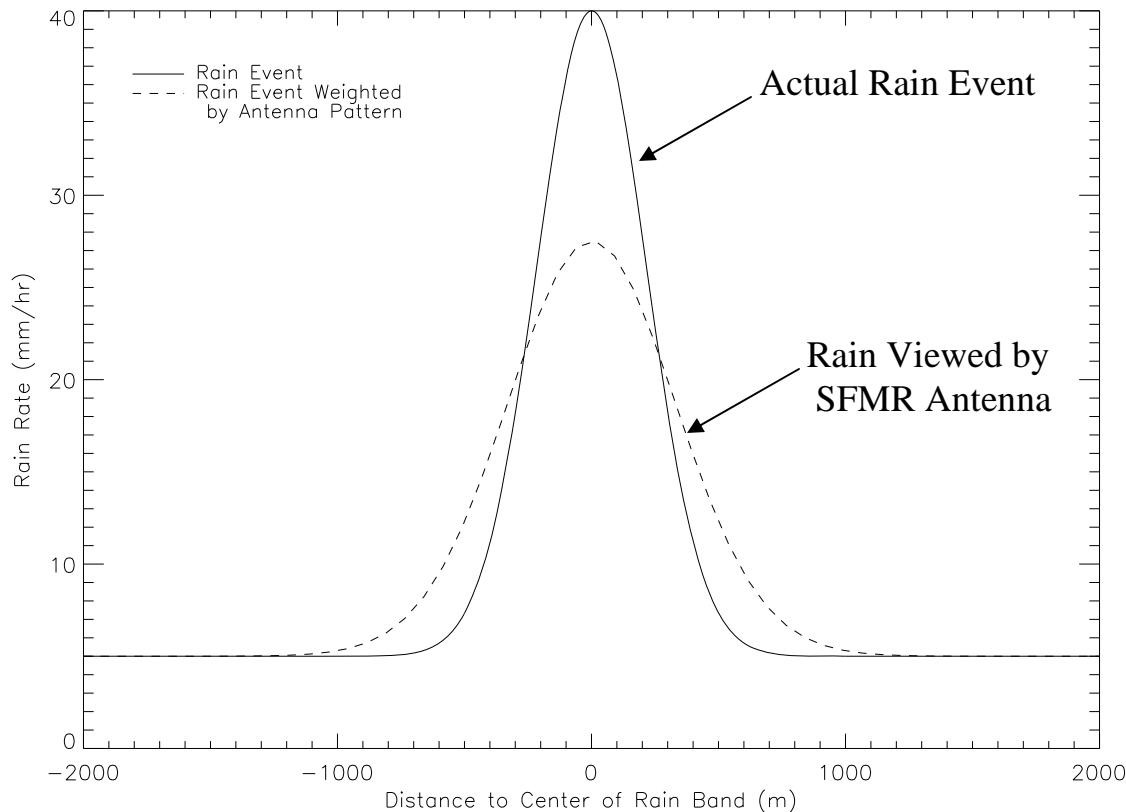
Modeling Issue:

- SFMR rain retrievals have to be scaled (factor of 2.5) and bias (5mm/hr) removed.
- **Affects wind estimates.**



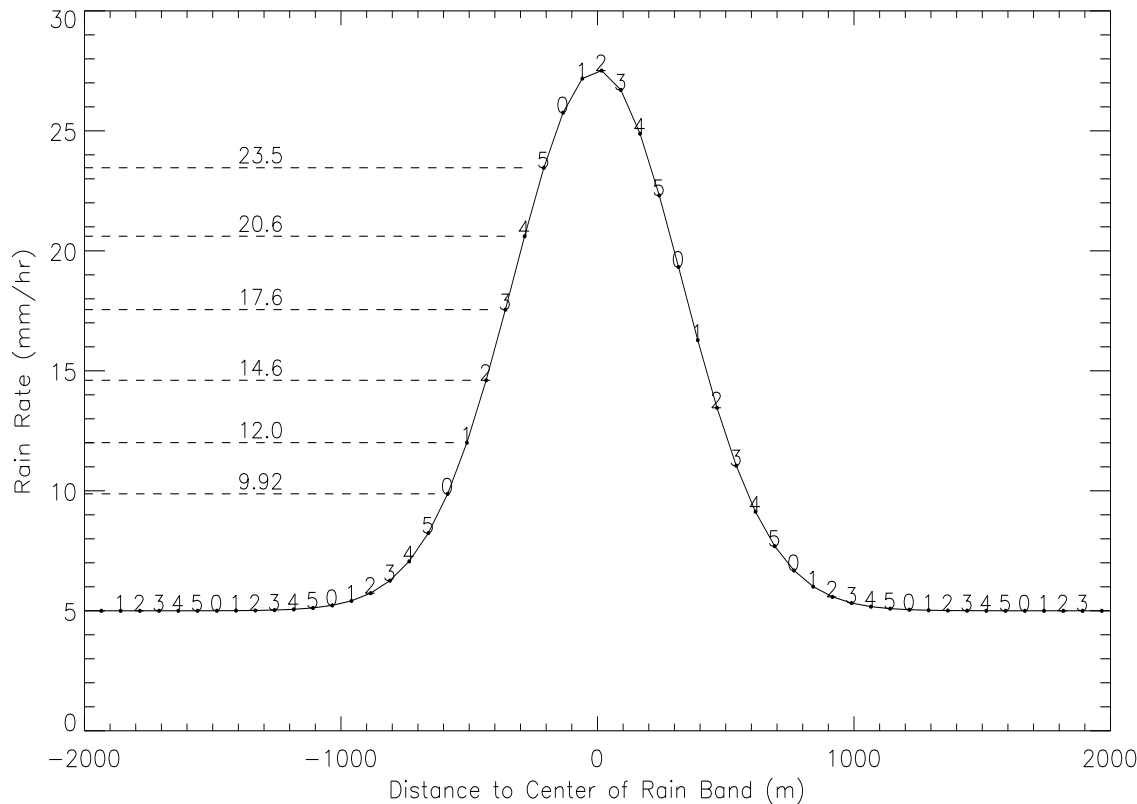
Rain Event: SFMR Viewpoint

Simulated Rain Event



- Rain Event (solid)
 - 5 to 40 mm/hr
 - Approx. 1 km along track
- SFMR Viewpoint (dashed)
 - 22 deg, 3 dB antenna pattern smoothes event
 - 5000 foot altitude

Rain Event: SFMR Sampling



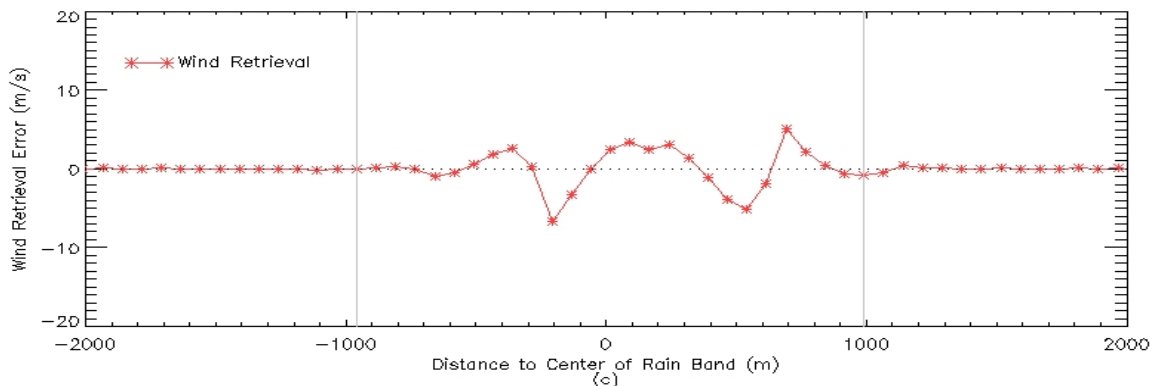
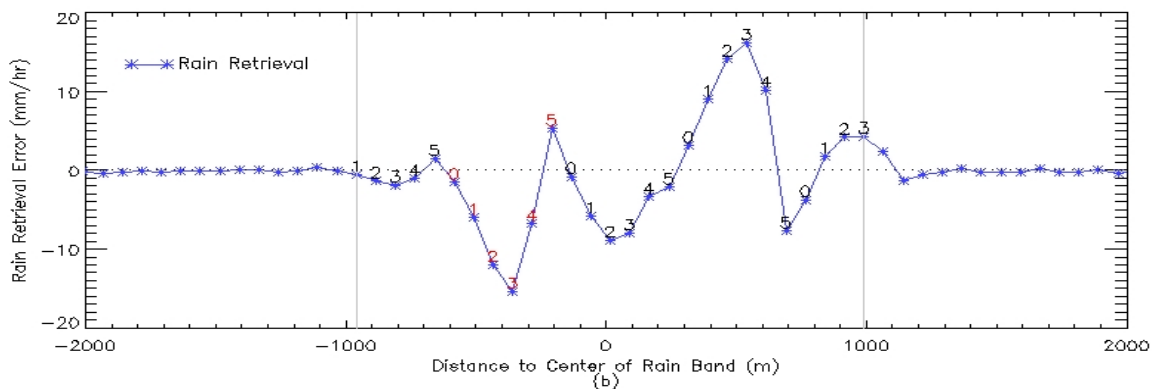
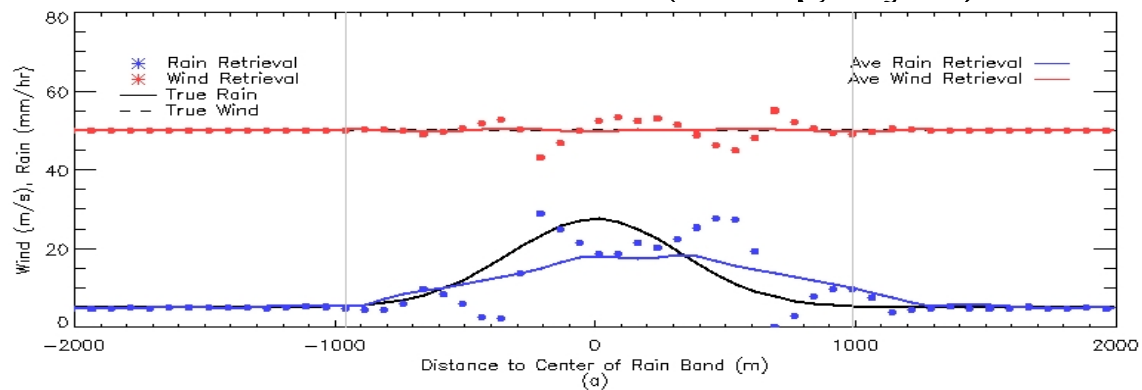
- Aircraft Speed: 120 m/s
- Altitude: 5000 ft
- SFMR Sampling
 - Channel 0: 9.92 mm/hr
 - Channel 1: 12.0 mm/hr
 - Channel 2: 14.6 mm/hr
 - Channel 3: 17.6 mm/hr
 - Channel 4: 20.6 mm/hr
 - Channel 5: 23.5 mm/hr

SFMR Sequential Sampling Effects

SFMR Rain & Wind Retrievals

- Wind (red), Rain (blue)
- Exhibit opposing & oscillating errors.
- Errors dependent on rain gradient.
- Errors depend on sampling phase.

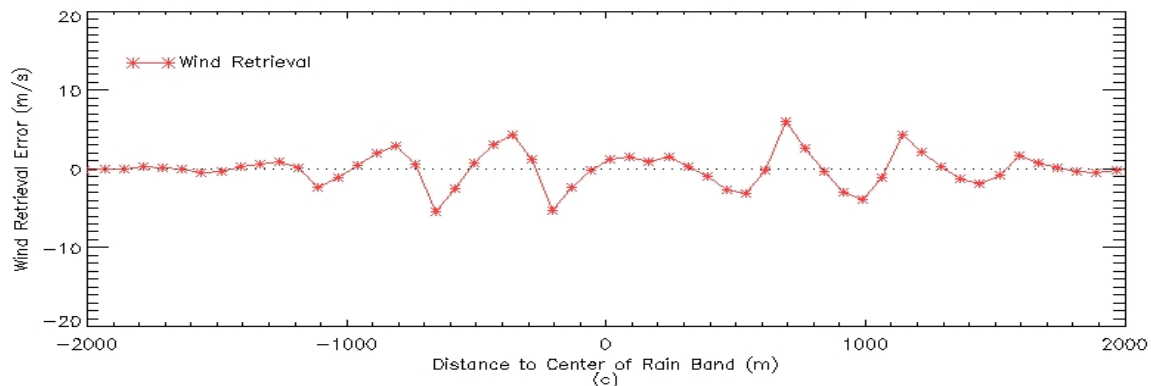
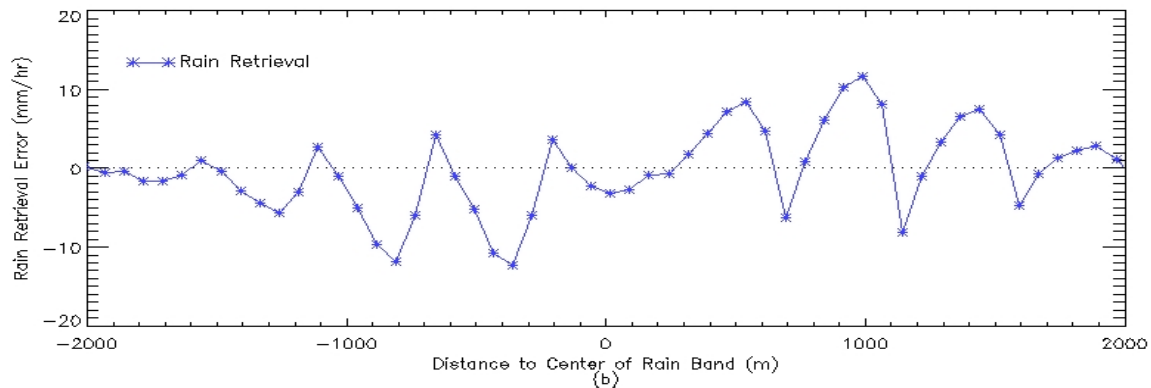
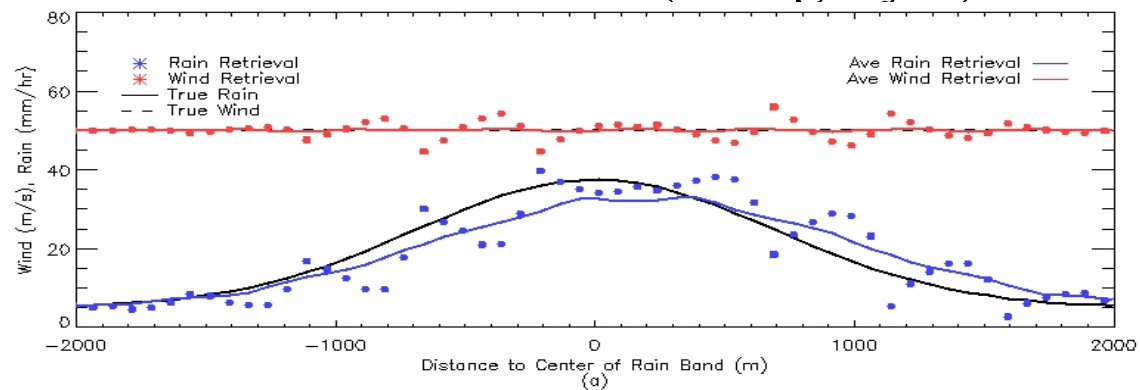
SFMR Retrievals (Category 3)



SFMR Sequential Sampling Effects

- Same as previous except rain event is twice as wide.
- Retrievals error present even at beginning of event where rain is low and changing slowly.

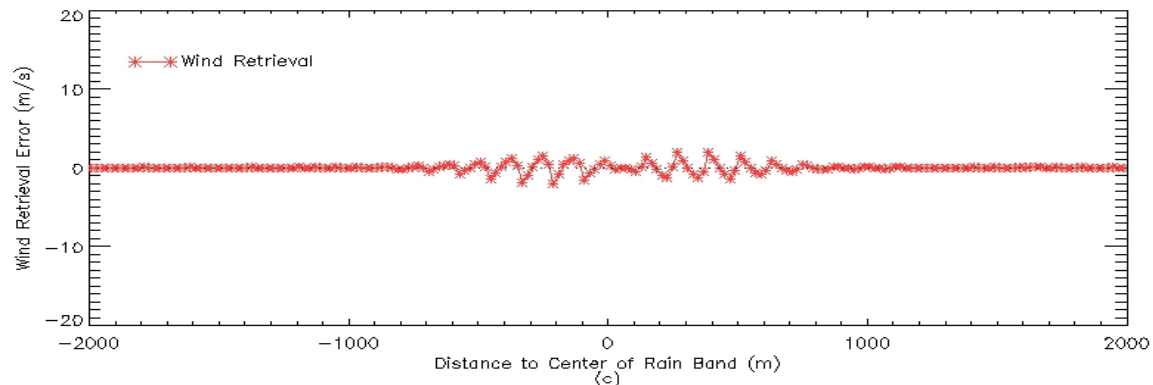
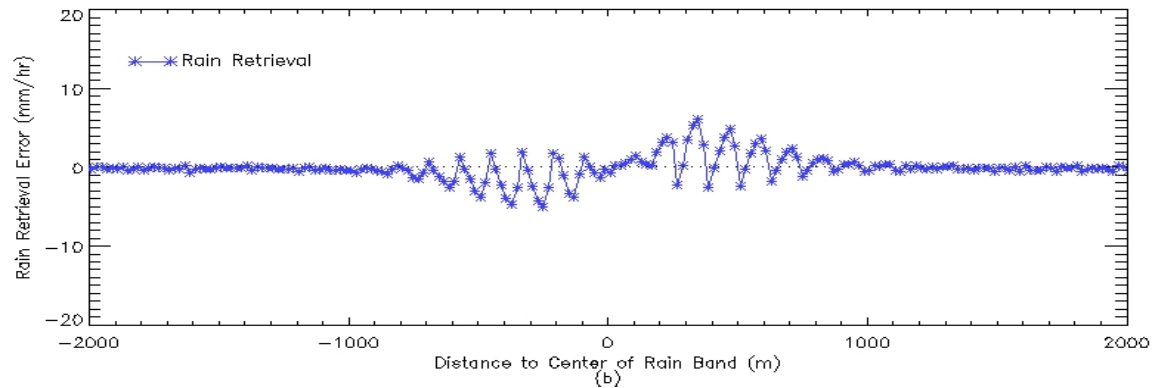
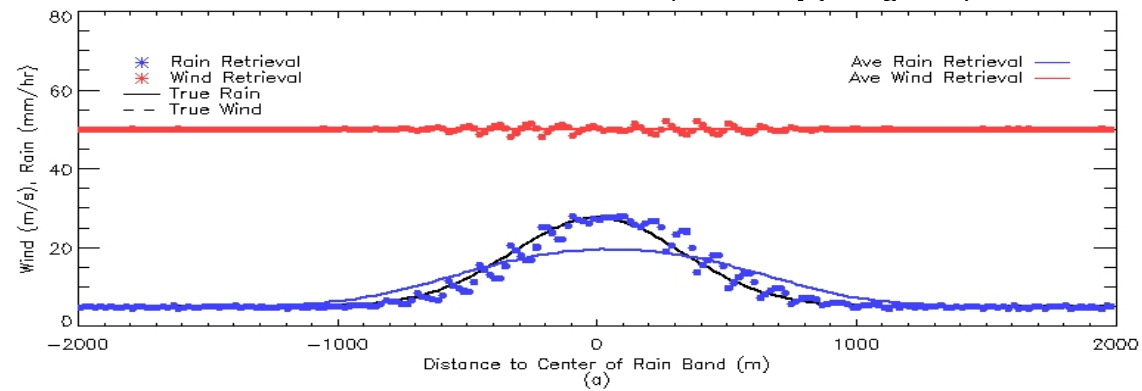
SFMR Retrievals (Category 3)

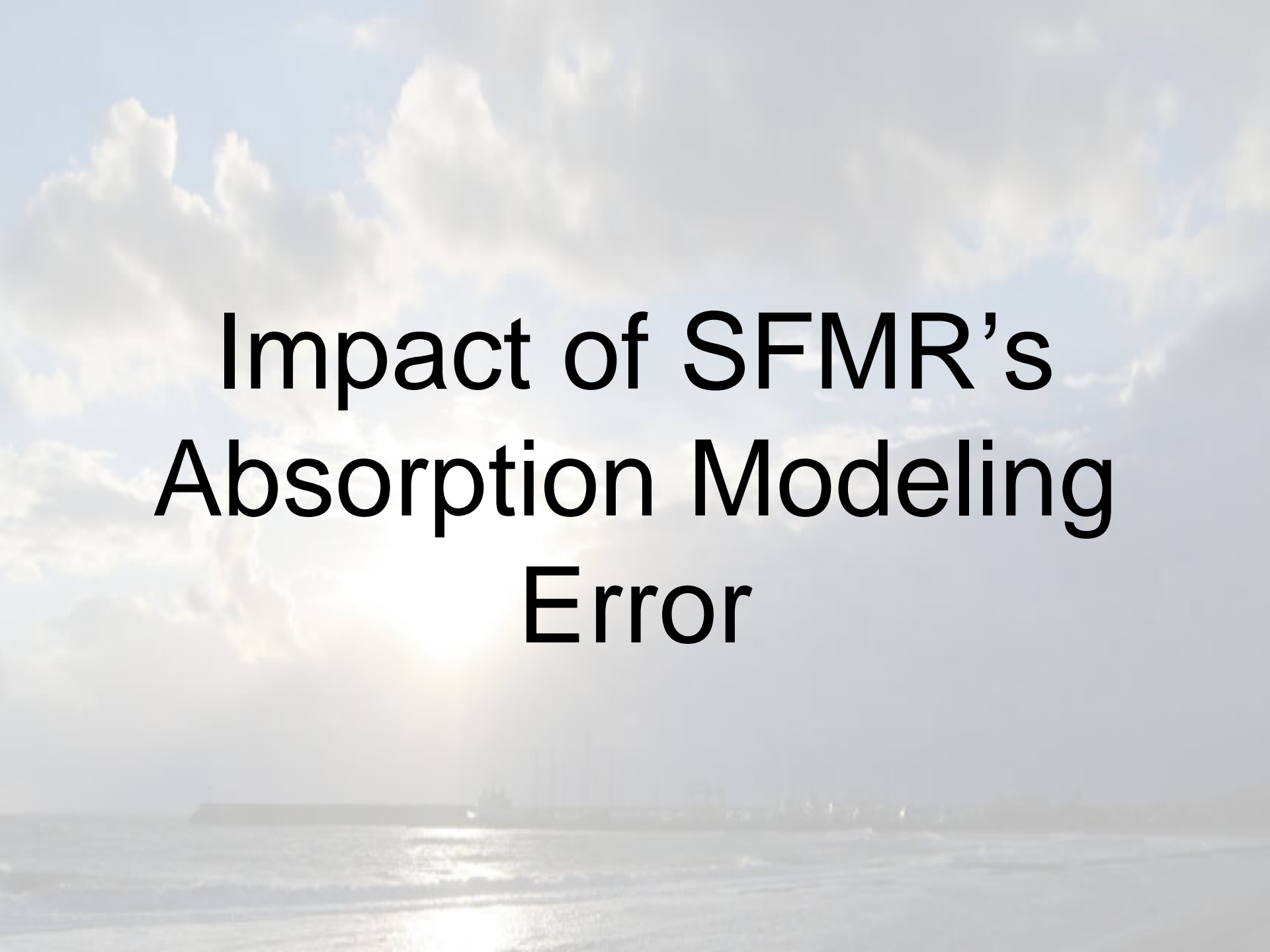


SFMR Sequential Sampling Effects

- SFMR sampling sequence performed over 1 second.
- Wind speed error reduces to < 2 m/s.
- Wind error averages out in 10 second average (not zero mean but close to zero)

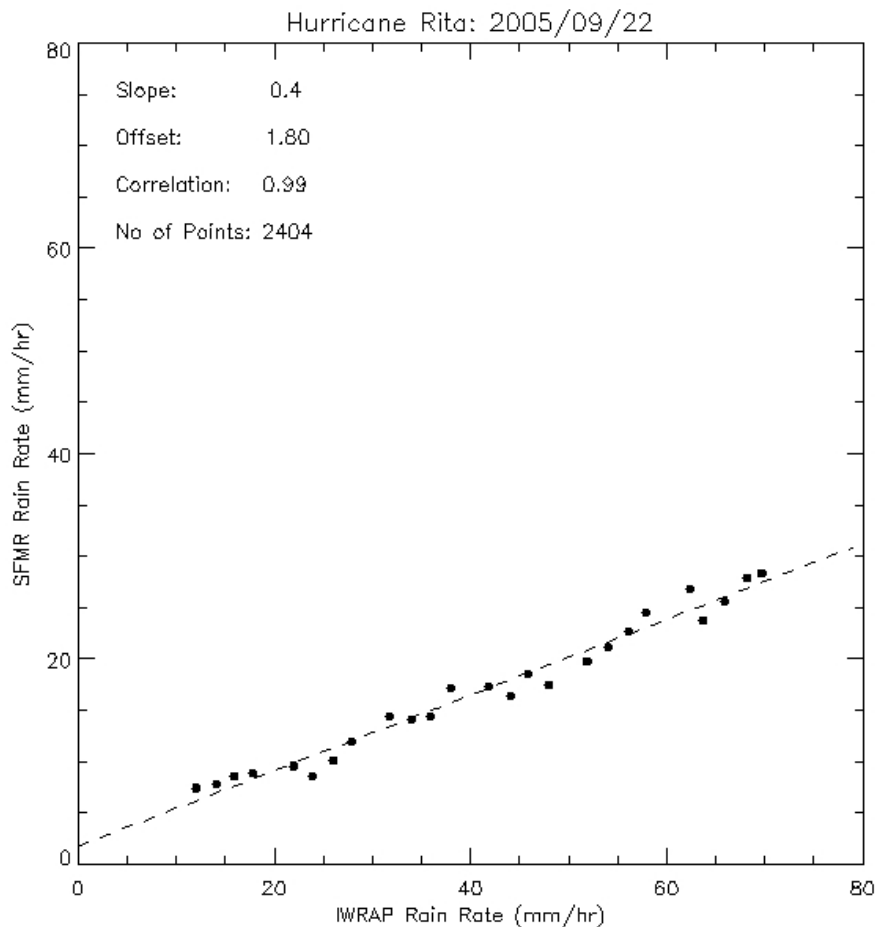
SFMR Retrievals (Category 3)





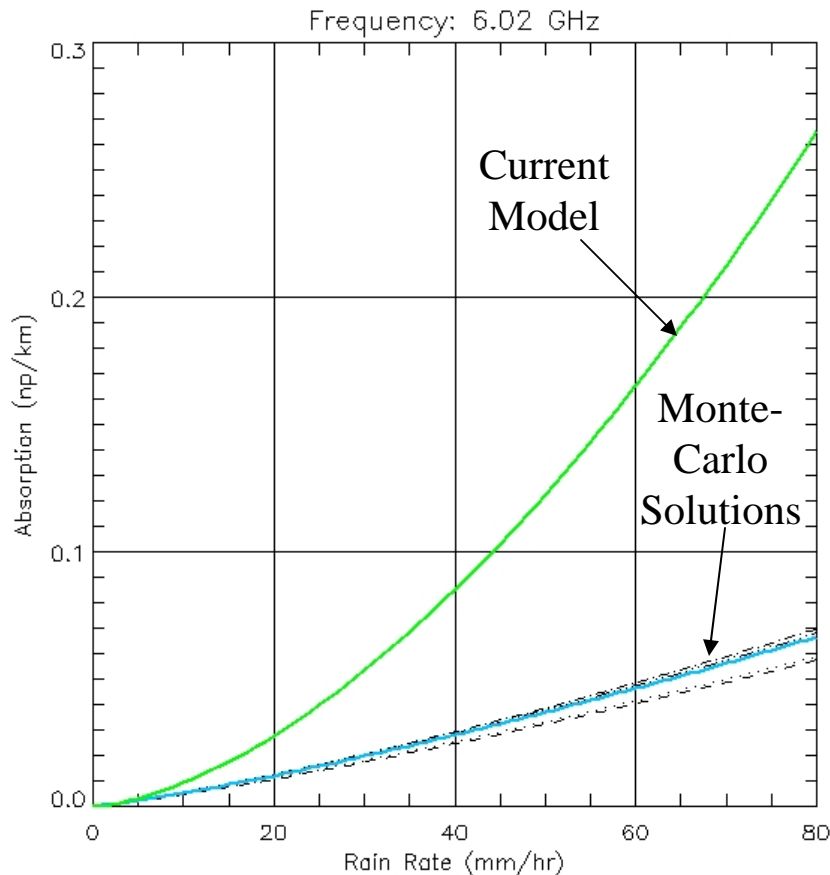
Impact of SFMR's Absorption Modeling Error

IWRAP – SFMR Comparison



- SFMR under predicts rain rate by a factor of 2.5
- SFMR rain rate estimates are biased by ~ 5 mm/hr.
- Same results observed in 2003 comparison between IWRAP and UMass SFMR.
- Comparisons with Tail and Lower Fuselage radars show 5 mm/hr bias and under estimation.

Monte-Carlo Analysis – New Absorption Model Coefficients



SFMR Absorption Model

$$K = \alpha \left(f^{R_m R_r^{F_e}} \right) \left(R_r^{R_e} \right)$$

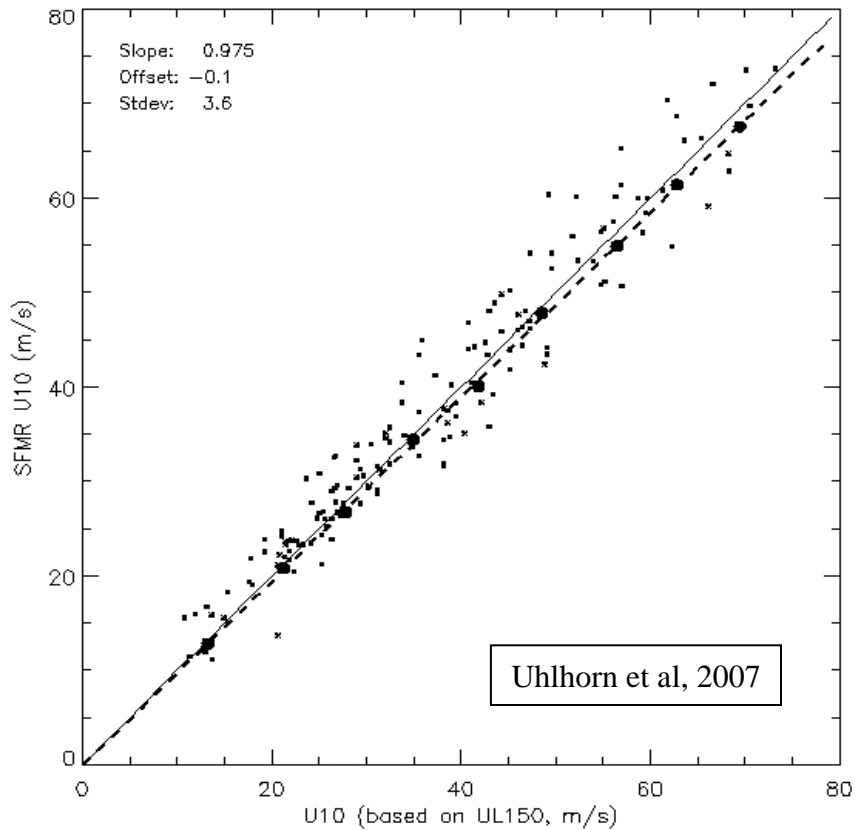
Monte-Carlo: Clustered Solutions

Re	Fe	Rm	Slope (m)	Offset (b)
0.76	0.0676	2.75	0.947	0.110
0.74	0.0696	2.75	0.950	0.138
0.74	0.0716	2.8	0.900	0.015
0.72	0.0736	2.8	0.910	-0.109
0.7	0.0756	2.8	0.915	-0.074

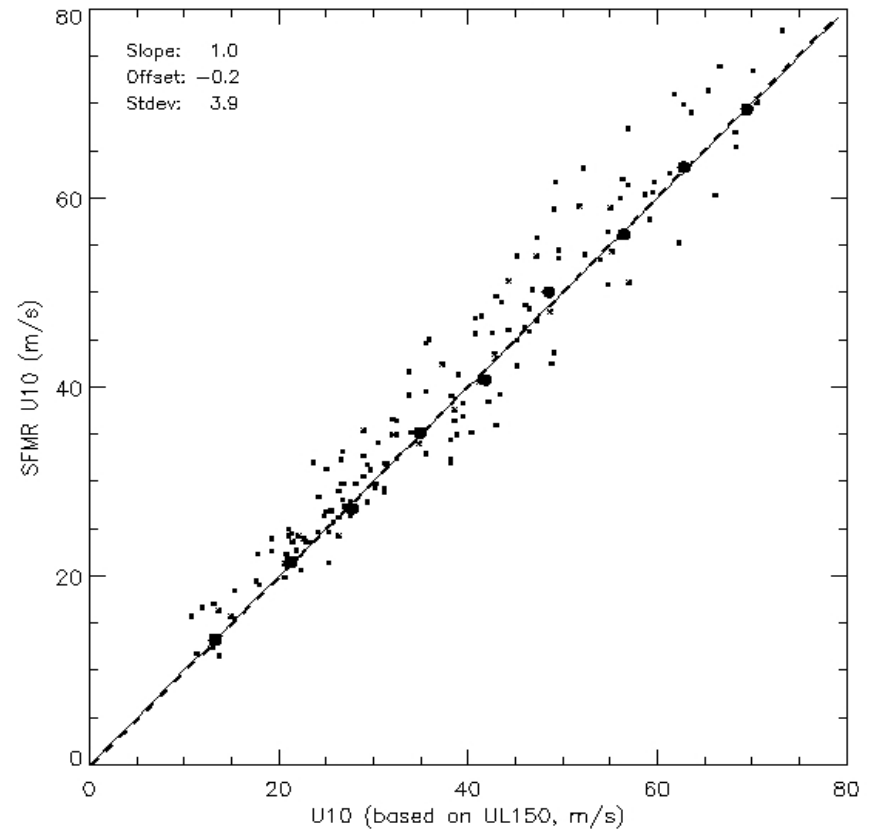
* Minimized offset and required slope > .85

Applying New Model

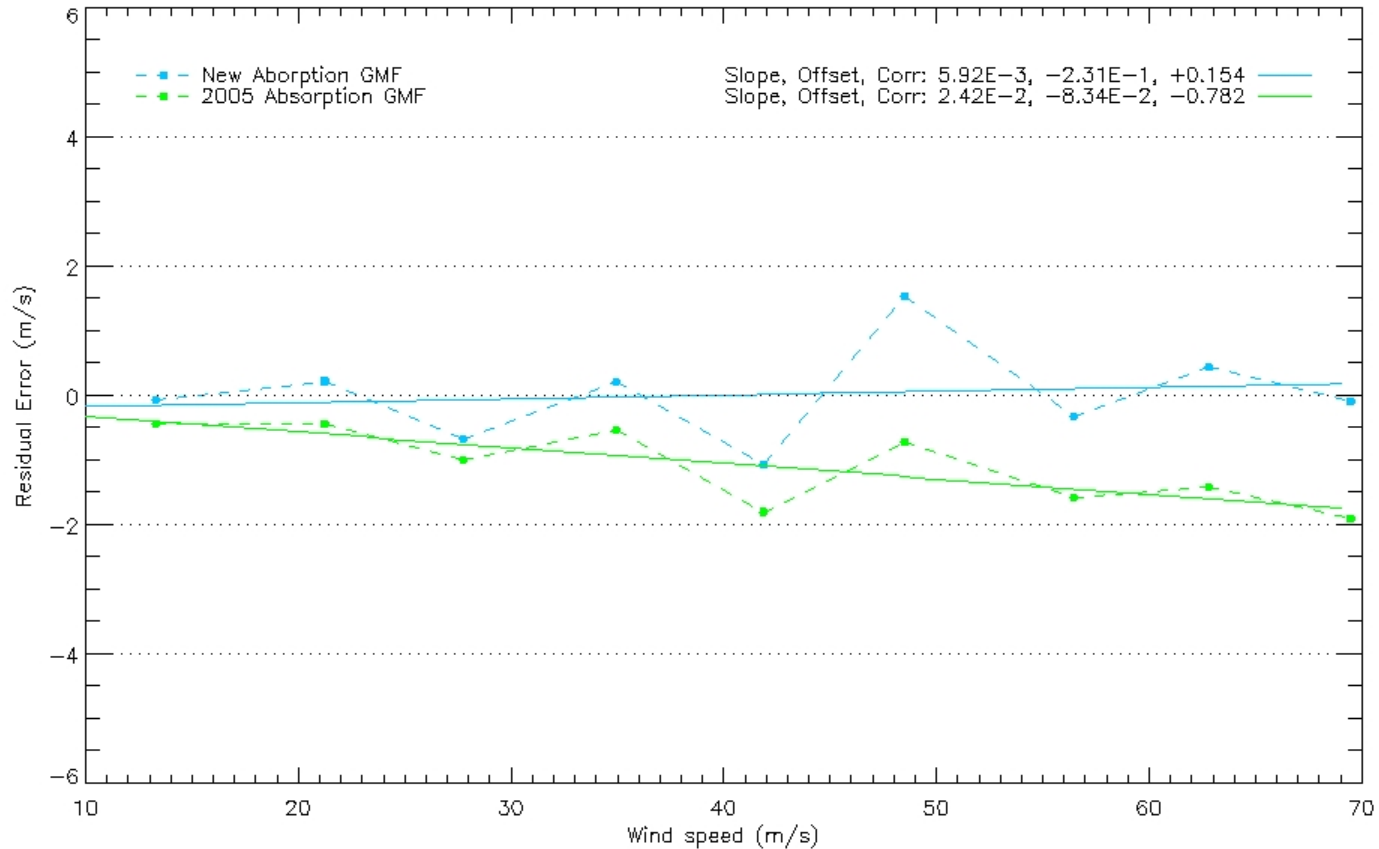
Current Absorption Model



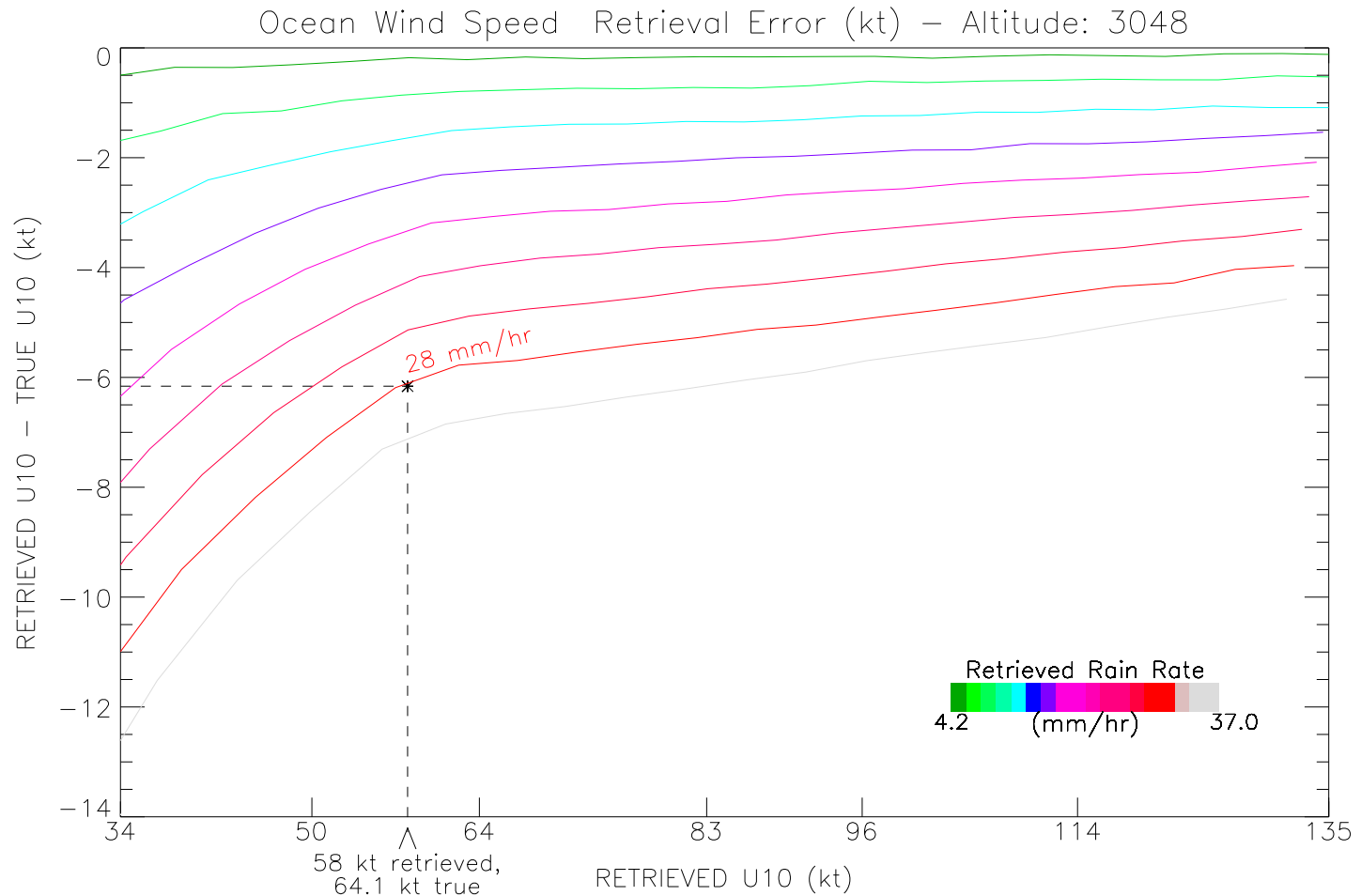
New Absorption Model



Residual Error Vs. Wind Speed



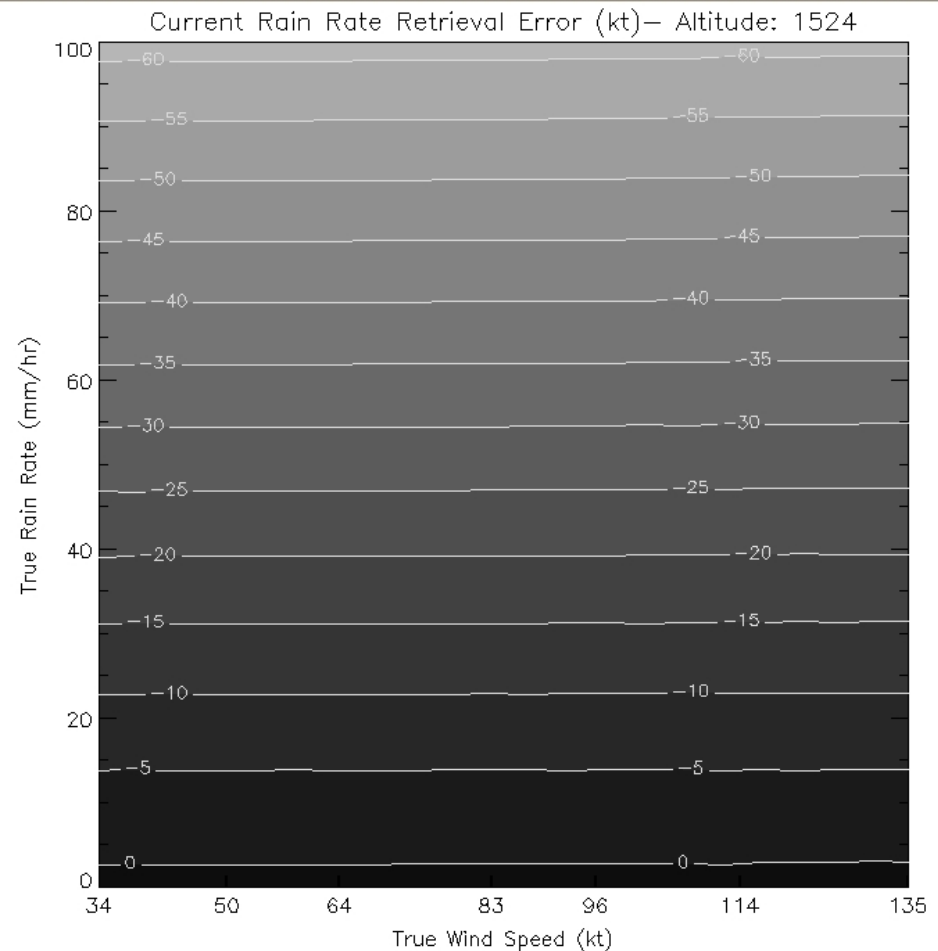
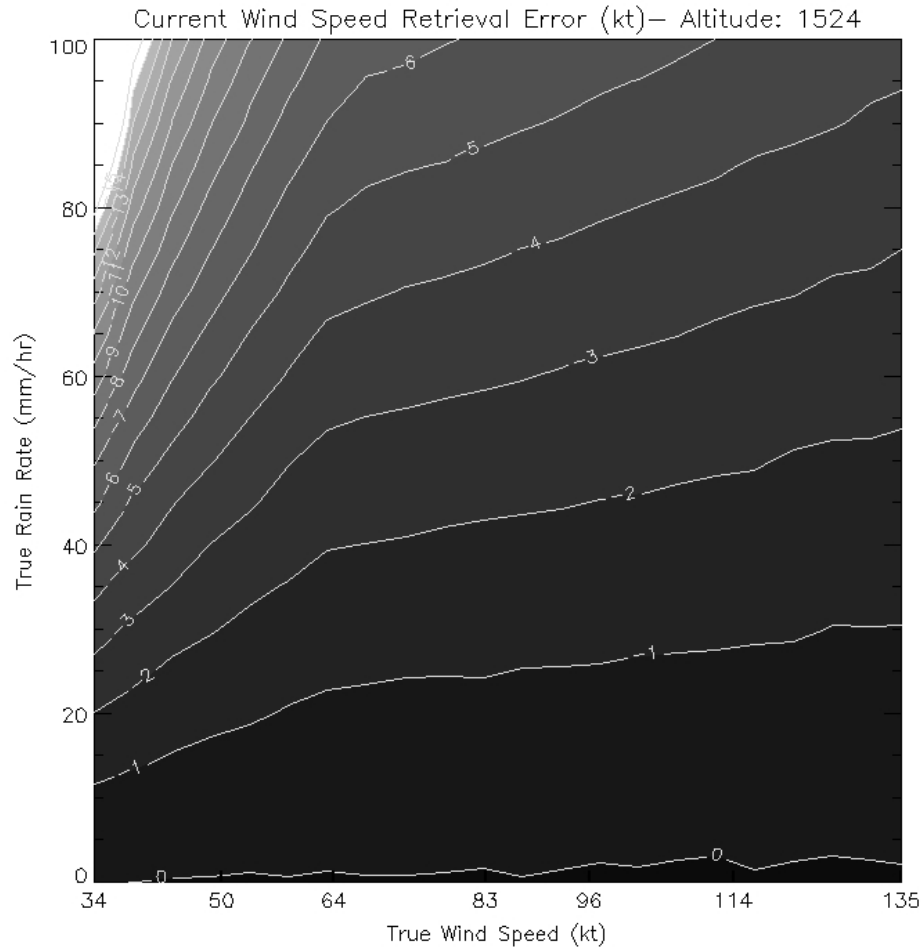
SFMR Wind Speed Error Curves (Due to Absorption Model Error)



3 - 7 March, 2008

62nd IHC – Charleston, SC

SFMR Retrieval Error Contours (Due to Absorption Model Error)



3 - 7 March, 2008

62nd IHC – Charleston, SC

Errors in Reconnaissance Files



REPNT3 - Errors

- Tropical depression (TD) number field is inconsistent and frequently invalid. Value is sometimes alpha, rather than numeric. Occasionally this field is invalid even though a storm name has been assigned. This inconsistency forces the output files to be stored by storm name rather than TD number which would be preferable. This same behavior is also noted in the URNT15 files.
- Data files for flights during Felix have incorrect month. Month is given as “08” in file names. Felix took place in September. There is no date field within the data and therefore no way to automatically check the dates of the files without knowing when specific storms occurred. Similar discrepancies in the day of month value could easily go undetected.
- Some data files for Noel have an incorrect month. Month is given as “11” when it should have been “10”. In combination with a day value of “31” this causes the additional problem of throwing date calculation exceptions since November 31 is an invalid date.
- A change in file naming conventions causes files to be listed and read in alphabetical rather than chronological order. This requires the data to be sorted by date after all files are parsed. Prior to 8/1/2007 files were named REPNT3.YYYYMMDDHHMM.txt. Following 8/1/2007 files were named REPNT3-K???. YYYYMMDDHHMM.txt causing files to be listed and read in the order of the values contained in “???”.

REPNT3 - Errors

- The octant of the globe field is consistently invalid. This value is needed for determining the sign values of latitude and longitude since they are not otherwise given. Since the octant of the globe value contained in the file is incorrect, the sign values were hard-coded so that longitude is always negative and latitude is always positive. The octant of the globe value contained in the files is consistently given as 7 when the value for these storms should usually be 0 or 1.
- The data for the Nationally Developed Codes (tag value 62626) contains unpredictable lines breaks. The data for this tag is spread over several lines in the data files. It appears that the lines break at a certain length (approximately 65 characters), without regard for the data. This causes data values and data tags to be split across multiple lines. This precludes the ability to search for a specific token or assume that a data value that follows a tag is complete. The number of lines taken by the data also varies. Therefore, the parsing code must look ahead across several lines to find the next data tag. Then it must strip off the line feeds and concatenate all of the lines that make up the data in order to ensure that all of the fields in the data are complete.
- Data files for training flights contain unpredictable patterns of incorrect, invalid, or incomplete data. There appear to be no rules regarding what can be inserted into training data files. As a result, no attempt is made to parse known training flight data files. These files are excluded by searching for storm names “TRAIN”, “TR” or “WXWXA”. The limitation on this logic is that any storm name can be inserted into these files. If future training files contain storm names other than those listed, it is likely that the script will encounter exceptions when attempting to process the file.

REPNT3 - Errors

- Files contain missing, invalid, or inconsistent data. In some cases data lines do not contain all of the fields expected. In some cases entire sections of data are missing. There are sometimes random invalid characters, such as equal signs contained within the data.
- Some files for Noel contain a storm name of “NOEL” and other have a storm name of “NOEL1”.
- Some files contain duplicated data. Generally, in these cases all of the data has been written to the file twice. The second instance of the data is ignored.
- Documentation of Nationally Developed Codes (62626) shows MBL WIND data field as “dddff” when it should be “ddfff”.

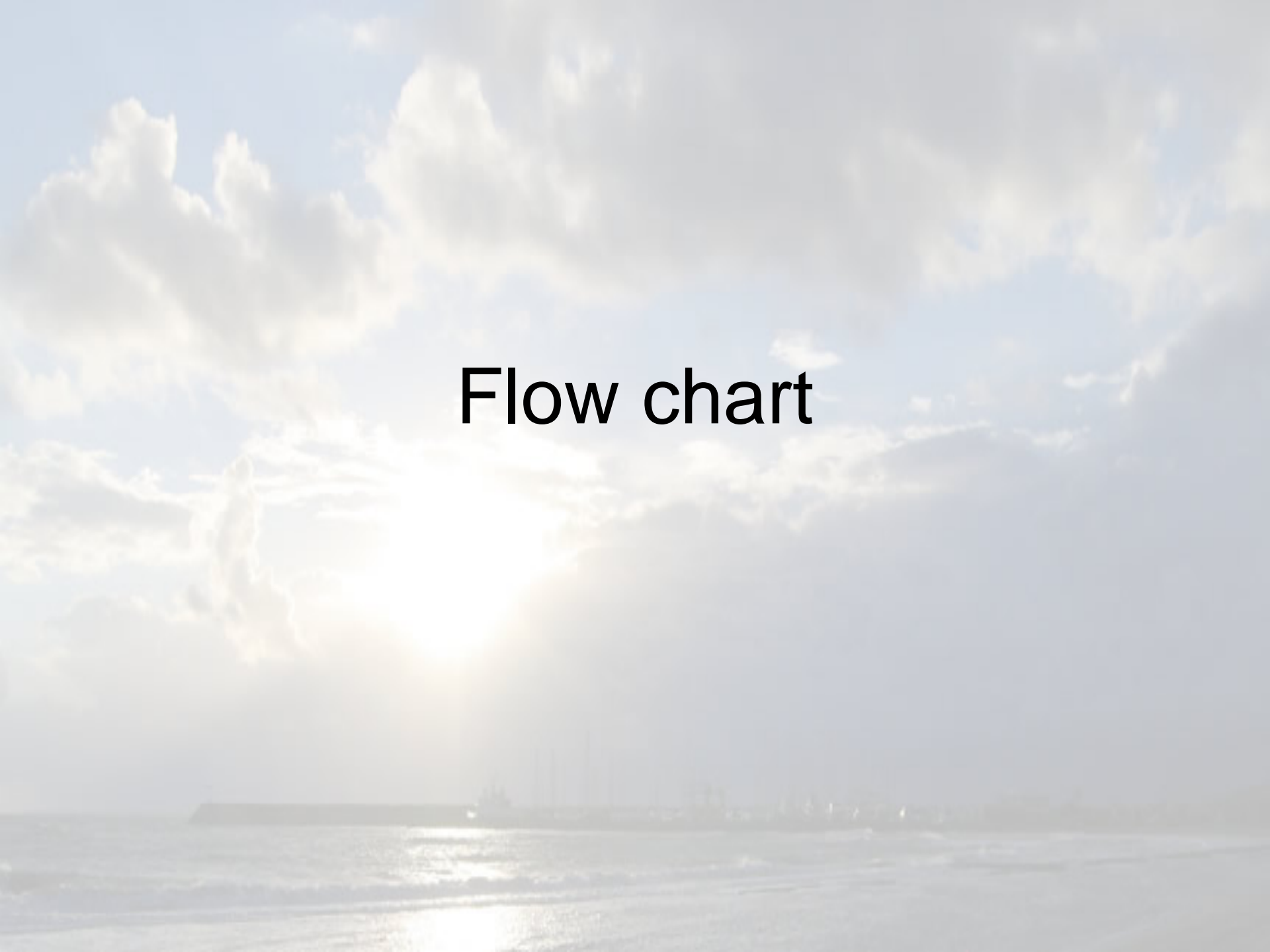
SFMR Data Files - Errors

- Data is not reported consistently at 1 Hz. Each record is time stamped with 1 second granularity. However, the time stamps do not ramp consistently in 1 second increments. There are often duplicates and/or time gaps. Many times these occur in unison. When duplicate timestamps are encountered, the parser must determine if there was a time gap before the duplicates or if one follows. If there is a time gap, followed by duplicate time stamps, the first of the duplicates is assumed to be the data that belongs in the preceding time gap. If the duplicates were not preceded by a time gap, but are followed by one, the second duplicate time stamp data is assumed to belong in the time gap. When duplicate time stamps occur without any preceding or trailing time gaps, the second set of data values overwrite the first.
- There is no identification of the storm contained in the file or the file name. This slows the collocation process with Dropsonde data because all files that match on date must be opened and searched for collocated data. This also means that there can be several SFMR files for any given storm, unlike the REPNT3 and URNT15 data which are consolidated into output files based on the storm and given file name that reflect the name of the storm, making it easier to find storm specific data.
- Some files contain large gaps of several seconds in the data without any duplicate data to extrapolate into the output file.
- The SFMR serial number provided in the Retrieved Values of Wind Speed and Rain Rate (R-record) is invalid at the beginning of the file. It takes several seconds before this value becomes valid which forces to parser to read into the file until finding a valid value.
- Some data files contain retrieval data (R-records) without matching Aux Info (A-records). Since the A-records contain information about aircraft location, the R-record information is not useful without the matching A-records.
- Data collected for Felix contains bursts of data followed by large time gaps throughout the file. Also, there are no K-records (which contain the brightness temperature information) for the entire storm.

Center Fix Files - Errors

- Some of the entries contain no latitude or longitude. In some cases the only valid data appears to be the timestamp.
- At least one file contains a TD number of 90 which appears to be invalid.
- Some files begin with data lines that contain invalid dates. For example, dates from 2006 were observed in files containing 2007 storm data.

Flow chart



Real-time NAWIPS Pre-Processor

Main Features:

- Runs unattended 24/7.
- Four separate layers (Layers 1 – 3 shown).
- Maintenance contained to parsers (layer 2).
- Organized data into storm files.
- Provides earth and storm relative coordinates.
- Provides collocated REPNT3-URNT15 Files.
- Layer 4 (not shown) maps storm-relative data to center fix positions / times & into GEMPAK data format for NAWIPS.

