SFMR Algorithm Update

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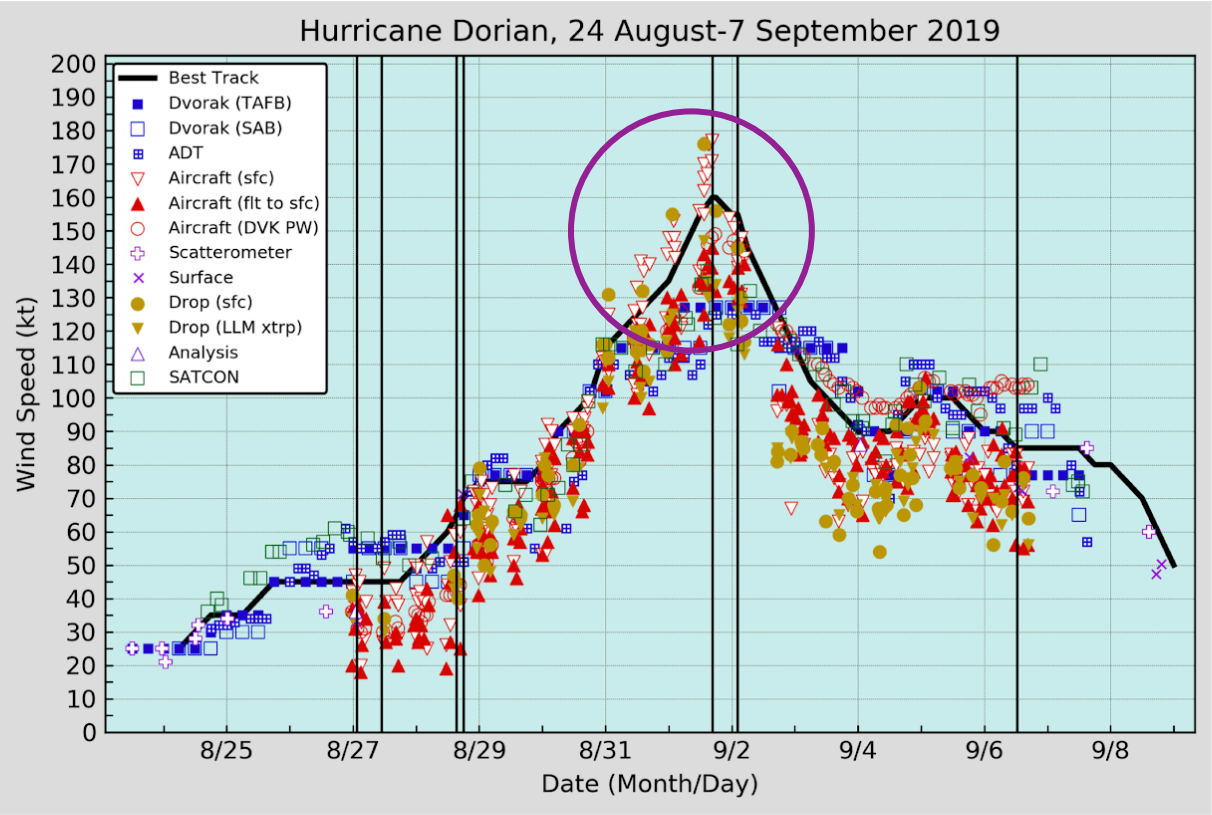
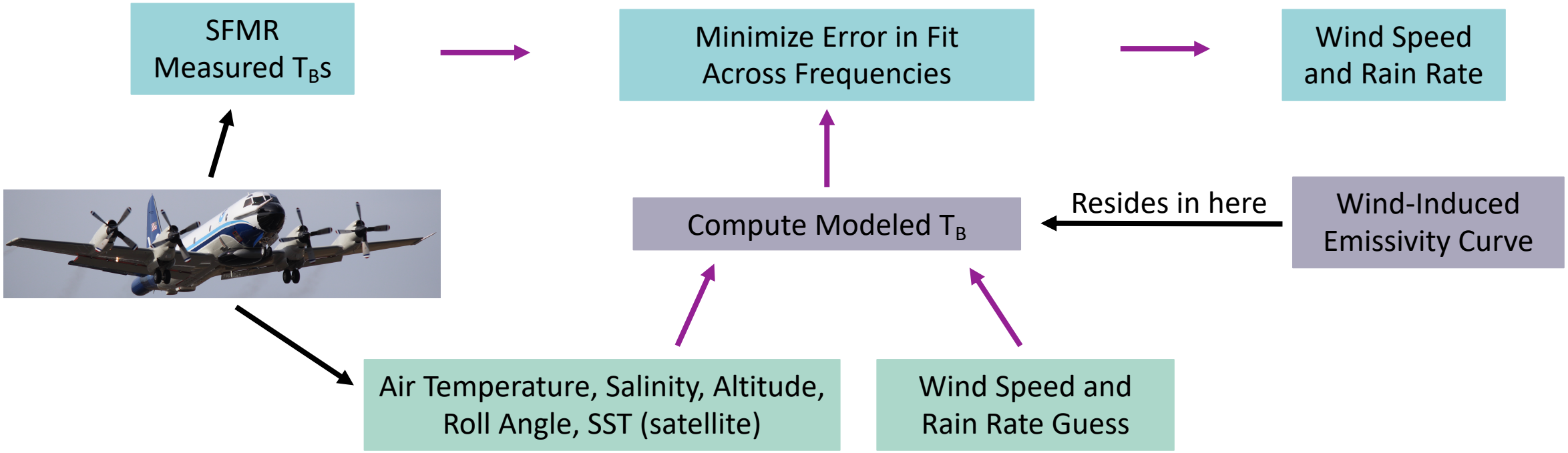
Motivation

- Inconsistencies noted between the dropsonde, SFMR, and flight-level surface wind speed estimates
  - Especially in major hurricanes



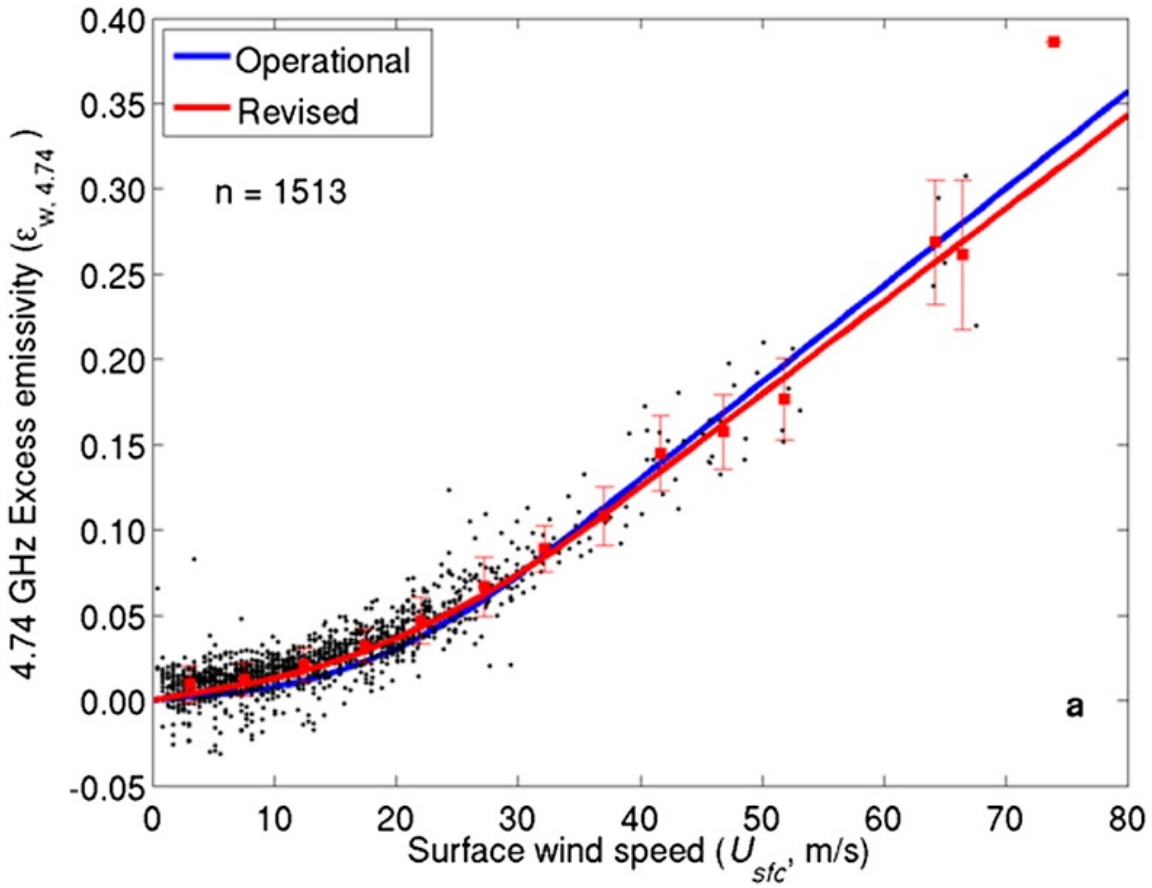
NHC time series plot of various wind speed observations in Hurricane Dorian (2019). Notice the divergence in Aircraft (sfc) or SFMR, Drop (sfc), and Aircraft (flt to sfc) in the magenta circle.

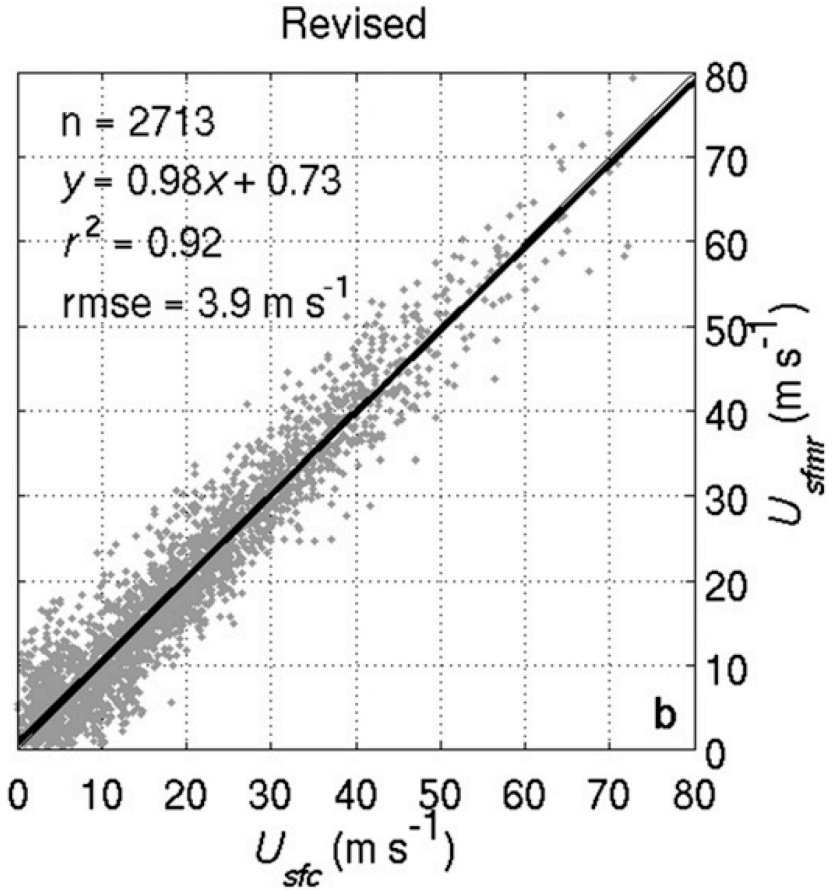
How does the SFMR algorithm work?



Prior Algorithm Updates

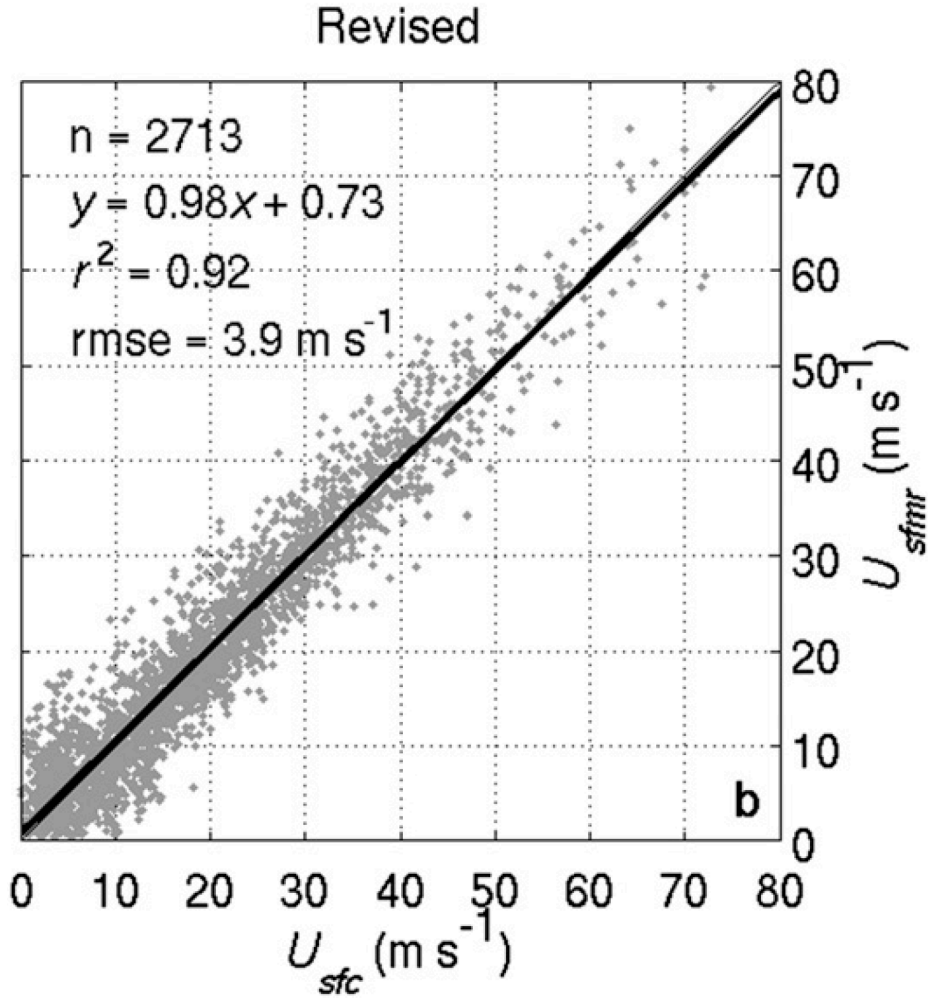
Revised = Klotz and Uhlhorn (2014) Operational = Uhlhorn et al. (2007)

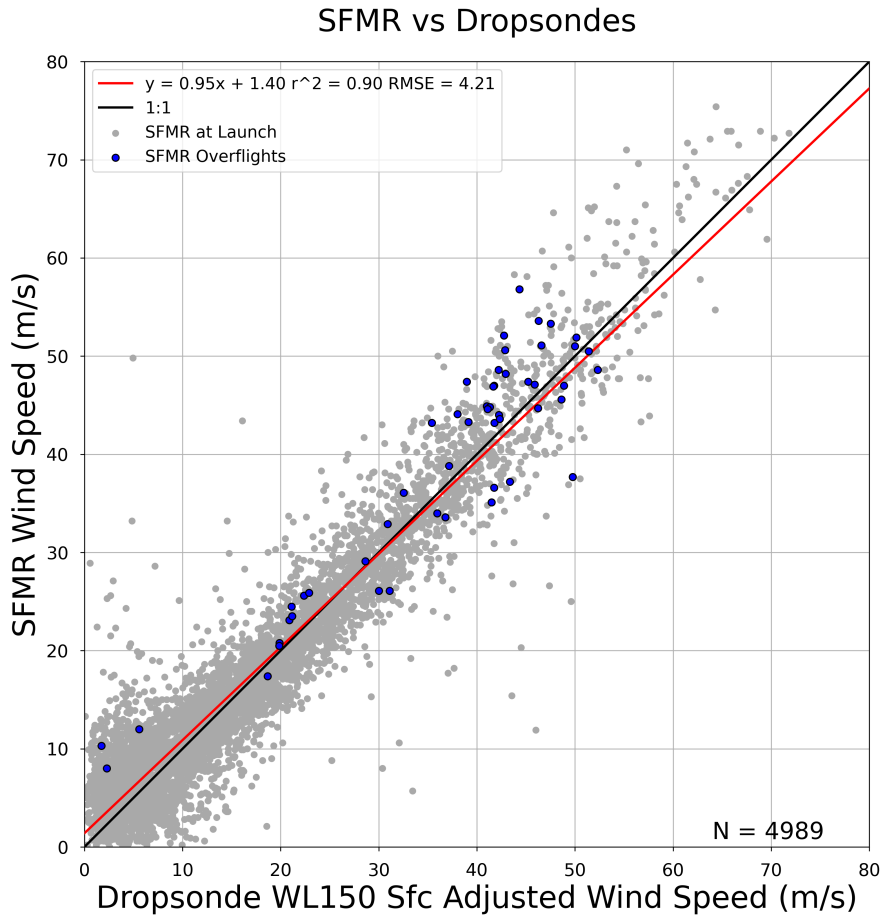




Very few data points to constrain wind-induced (excess) emissivity curve above 50 m/s in previous update

Current Wind Speed Fit

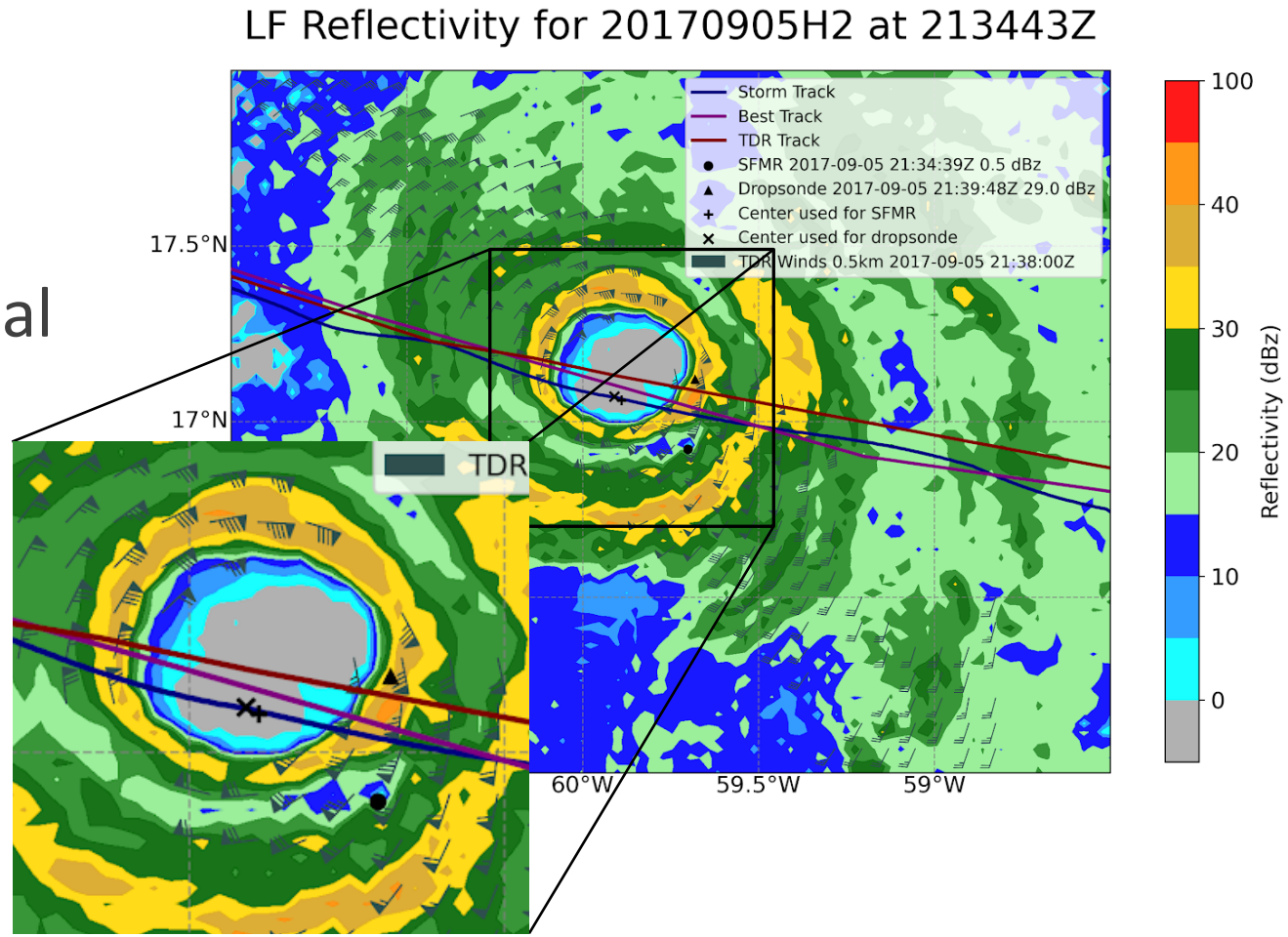




Collocated SFMR at time of dropsonde launch for 2004 to 2018 (gray) and SFMR dropsonde overflight collocations from 2019 & 2020 (blue).

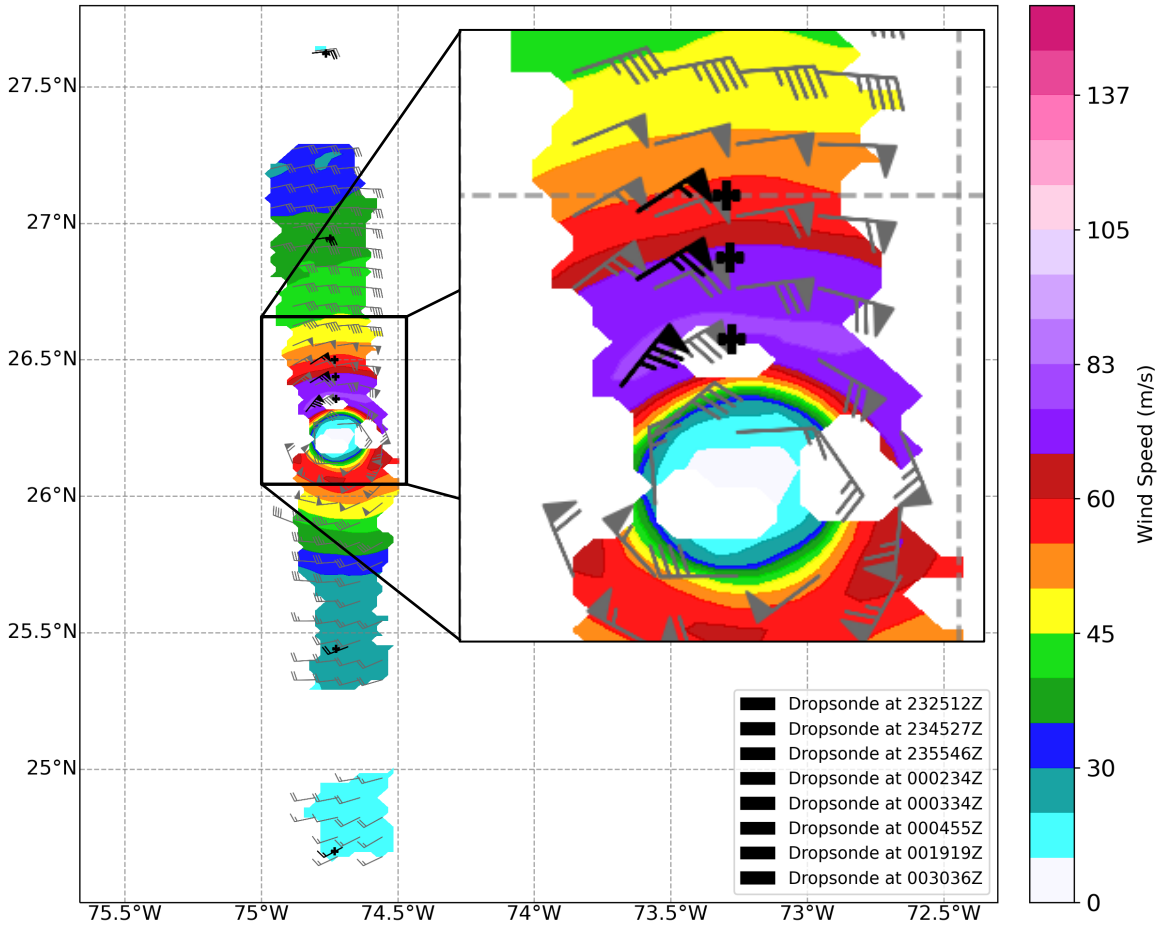
Storm-relative Collocations

- Previous algorithm updates used SFMR at time of dropsonde launch
- Assuming wind speed is azimuthally similar around a TC, using same radial position of SFMR as the dropsonde from the center should provide improved match-up
  - Very sensitive to accuracy of center, so did not provide improved comparison

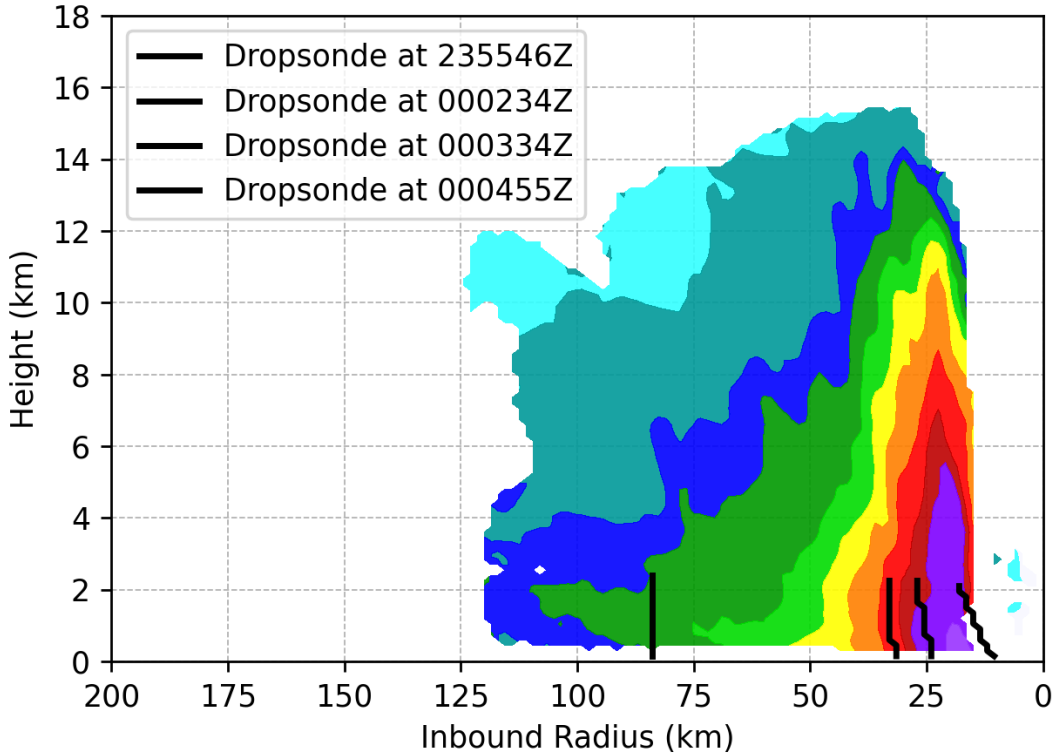


Collocation Issues in High Winds

0.5km TDR 20190831H2 at 000700Z



+ is dropsonde launch location while black wind barb is dropsonde location and wind at 0.5km



Rapid dropsonde releases across the eyewall illustrate the change in downwind translation (left) and radial translation (top) of the sondes that can advect the sondes into regions with different wind speeds.

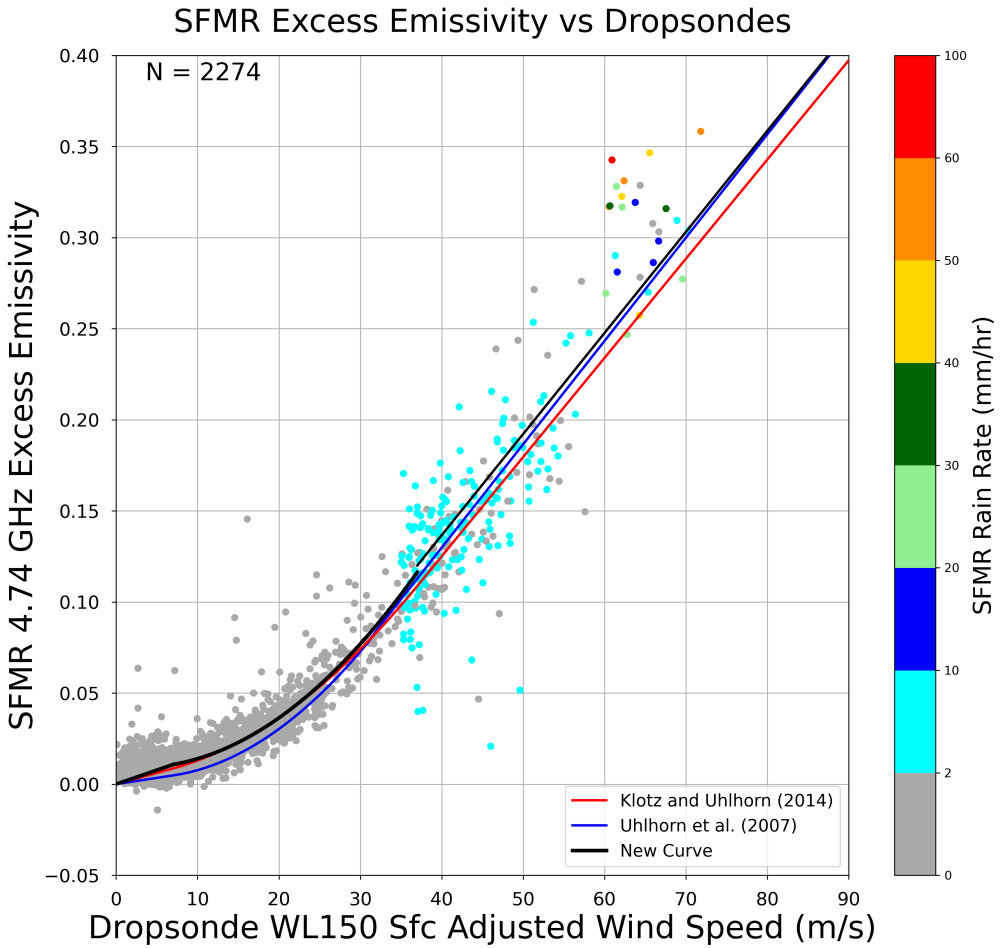
Updating Wind-Induced Emissivity Curve

- Klotz and Uhlhorn (2014) Criteria:
  - $U_{sfc} \leq 35$ m/s: RR ≤ 2 mm/hr
  - 35 m/s < $U_{sfc} \leq 60$ m/s: RR ≤ 10 mm/hr
  - $U_{sfc} > 60$ m/s: all RR
- Current Emissivity Curve:

$$\varepsilon_{w,4.74} = \begin{cases} a_1 U_{\text{sfc}} & 0 \leq U_{\text{sfc}} < w_l \\ a_2 + a_3 U_{\text{sfc}} + a_4 U_{\text{sfc}}^2 & w_l \leq U_{\text{sfc}} < w_u \\ a_5 + a_6 U_{\text{sfc}} & w_u \leq U_{\text{sfc}} \end{cases}.$$

w_l = 7.0 m/s w_u = 37.0 m/s

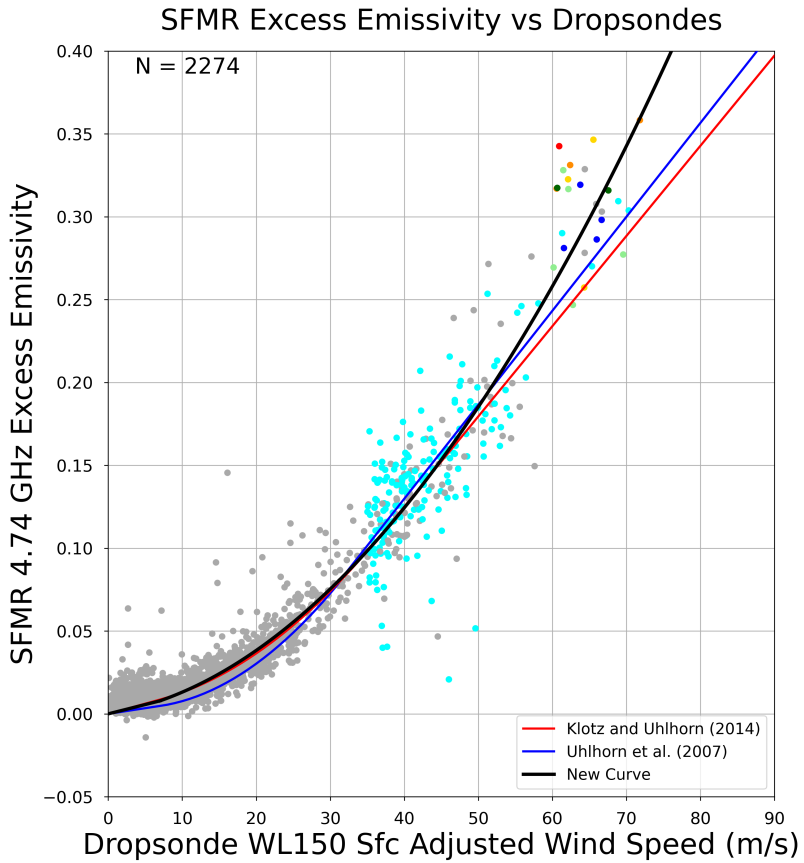
U_{sfc}: WL150 surface-adjusted wind speed
RR: SFMR rain rate



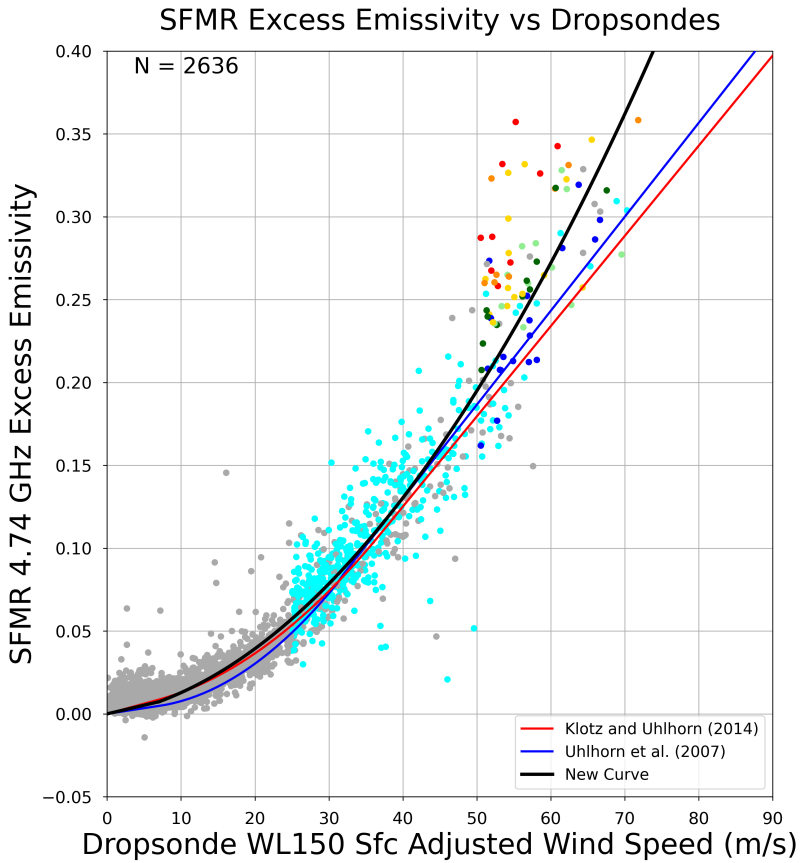
Updated SFMR and dropsonde comparison using same criteria as Klotz and Uhlhorn (2014).

Adjusting Fit Shape & Rain Rate Thresholds

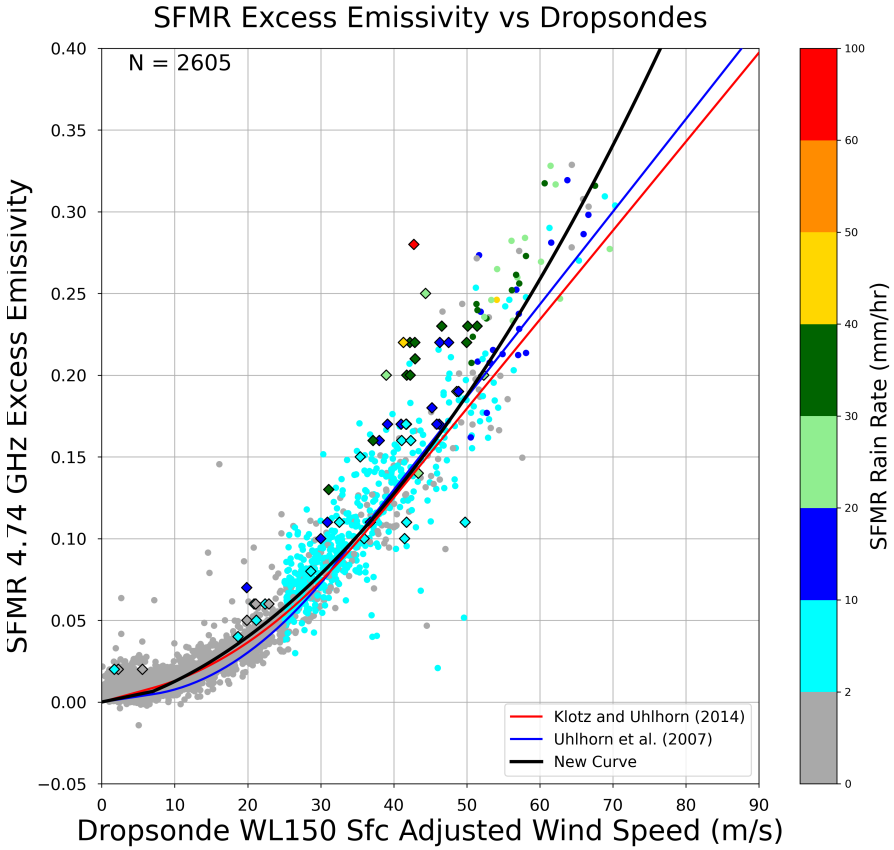
Fit with quadratic instead of linear at high end for same criteria as Klotz and Uhlhorn (2014)



Lower wind speed range for rain rate thresholds (quadratic at high end)



Lower rain rate threshold for high end given that there appears to be a trend with rain rate (all dropsonde overflights included shown as black outlined diamonds)



Next Steps

- Refine emissivity curve
  - Continue testing of rain rate thresholds
    - Determine if correction is required to rain related parameters in algorithm
    - Are we seeing impacts from sea spray that aren't being accounted for?
  - Finalize curve shape
  - Seek feedback from SFMR expert community
- Update frequency dependence for emissivity curve
- Reprocess using new curve
  - Quantify wind speed difference at high winds