SMAP Radiometer-Only Tropical Cyclone Size and Strength

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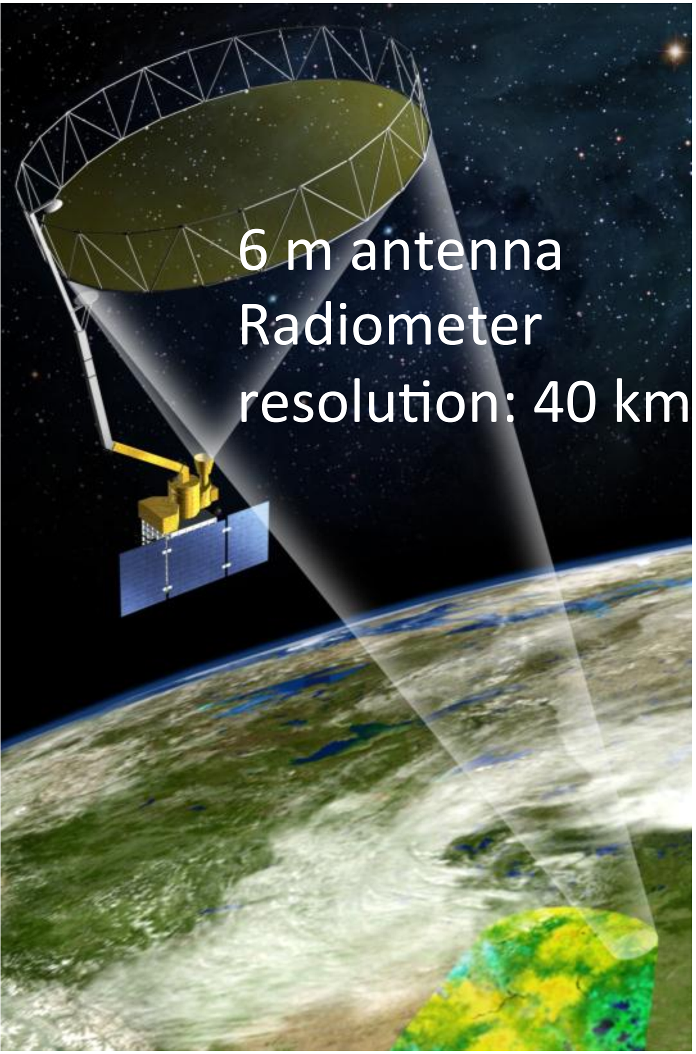
SMAP Overview



http://smap.jpl.nasa.gov/

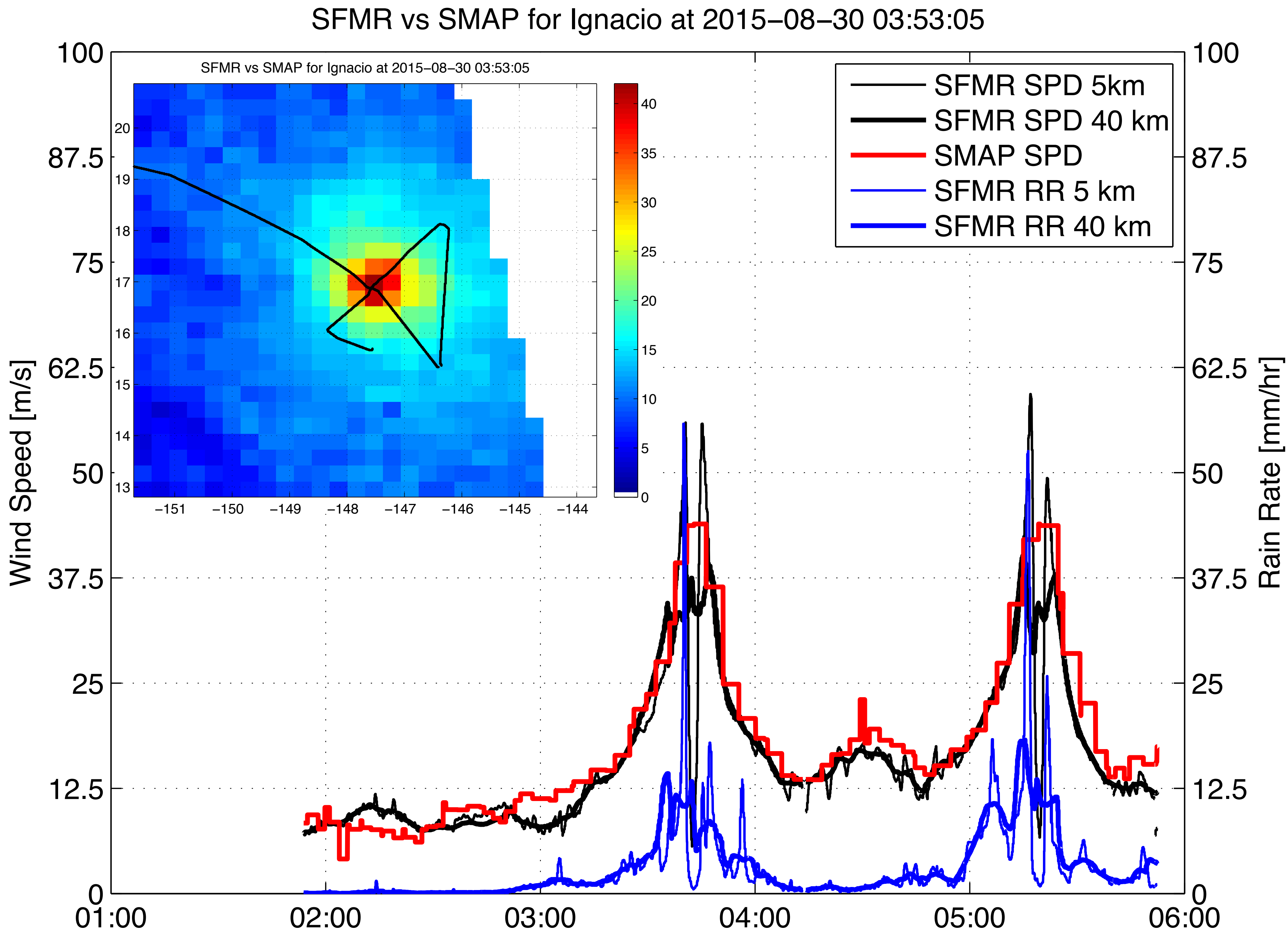
Primary Science Objectives

- Global, high-resolution mapping of soil moisture and its freeze/thaw state to
  - Link terrestrial water, energy, and carbon-cycle processes
  - Estimate global water and energy fluxes at the land surface
  - Quantify net carbon flux in boreal landscapes
  - Extend weather and climate forecast skill
  - Develop improved flood and drought prediction capability

Mission Implementation

Partners	• JPL (project & payload management, science, spacecraft, radar, mission operations, science processing) • GSFC (science, radiometer, science processing)
Launch	• January 31, 2015 on Delta 7320-10C Launch System
Orbit	• Polar Sun-synchronous; 685 km altitude
Duration	• 3 years
Payload	• L-band (non-imaging) synthetic aperture radar (JPL) • L-band radiometer (GSFC) • Shared 6-m rotating (13 to 14.6 rpm) antenna (JPL)

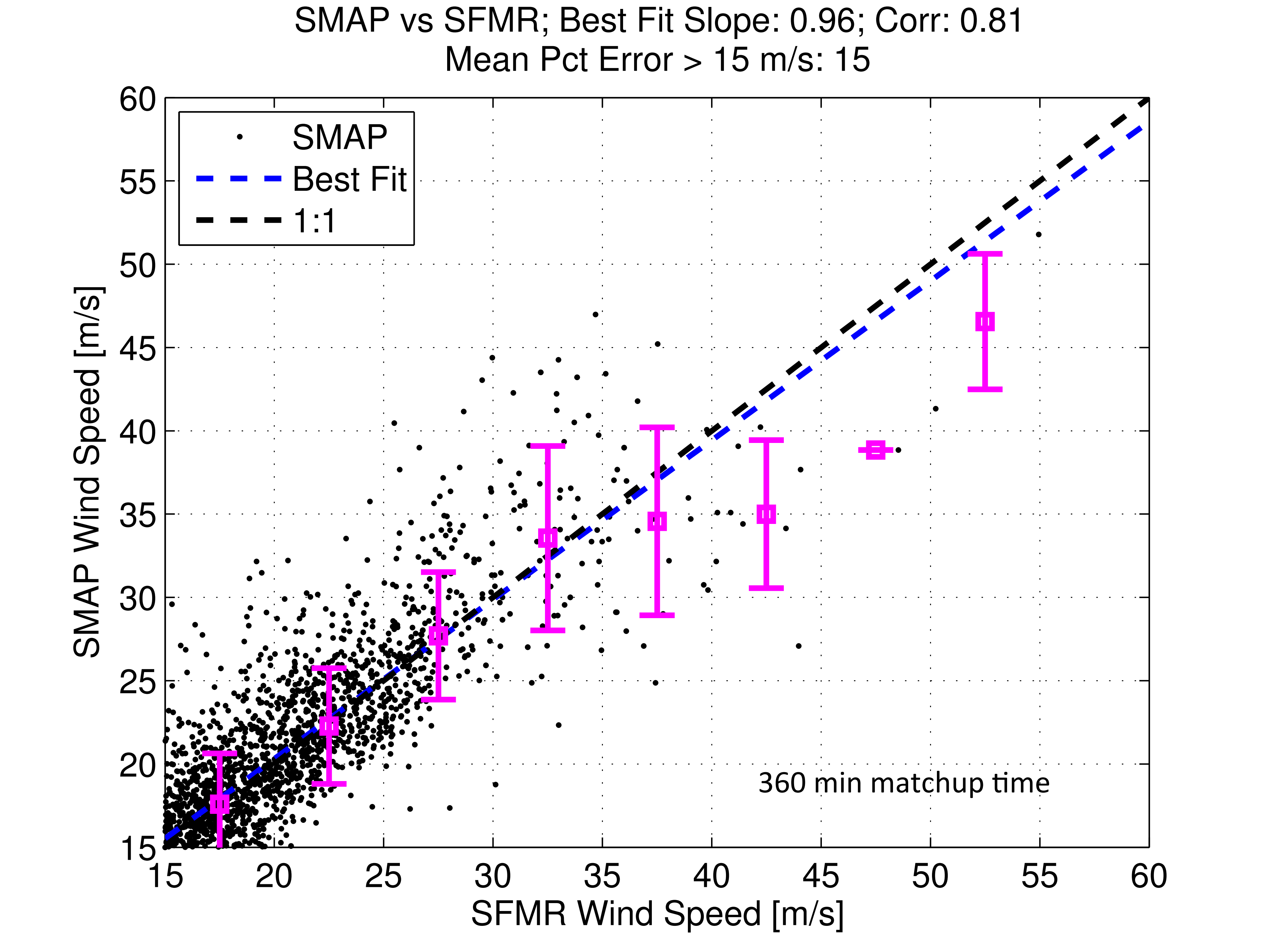
NRC Earth Science Decadal Survey (2007) recommended SMAP as a Tier 1 mission


SFMR vs SMAP for Ignacio at 2015−08−30 03:53:05
Wind Speed [m/s]
Rain Rate [mm/hr]
SFMR SPD 5km
SFMR SPD 40 km
SMAP SPD
SFMR RR 5 km
SFMR RR 40 km
0
12.5
25
37.5
50
62.5
75
87.5
100
01:00
02:00
03:00
04:00
05:00
06:00
SFMR vs SMAP for Ignacio at 2015−08−30 03:53:05
−151
−150
−149
−148
−147
−146
−145
−144
13
14
15
16
17
18
19
20
0
5
10
15
20
25
30
35
40

SFMR Matchups for 2015-2017

	SFMR > 20 m/s				SFMR > 25 m/s			
DTime	Counts	Bias	STD	Corr	Counts	Bias	STD	Corr
15	43	0.88	3.10	0.85	18	0.66	3.82	0.85
30	79	1.61	3.54	0.81	38	1.69	3.99	0.77
45	116	1.51	3.54	0.80	58	1.59	4.05	0.73
90	261	1.15	3.15	0.84	102	1.90	3.80	0.73
180	523	1.21	3.23	0.81	196	1.93	3.97	0.69
240	632	0.90	3.33	0.79	245	1.31	4.23	0.63
300	791	0.58	3.66	0.74	316	0.52	4.66	0.58
360	954	0.20	3.96	0.73	363	0.38	4.63	0.60

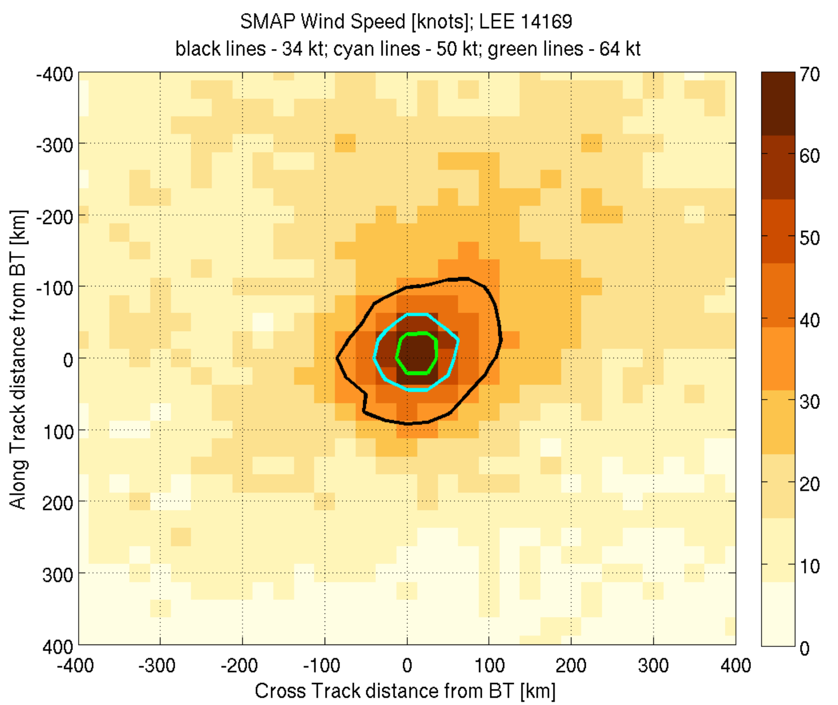
- Average SFMR along-track to 60 km, pick point of nearest approach to SMAP cell.
- Use best-track to shift SFMR tracks to SMAP observation time.

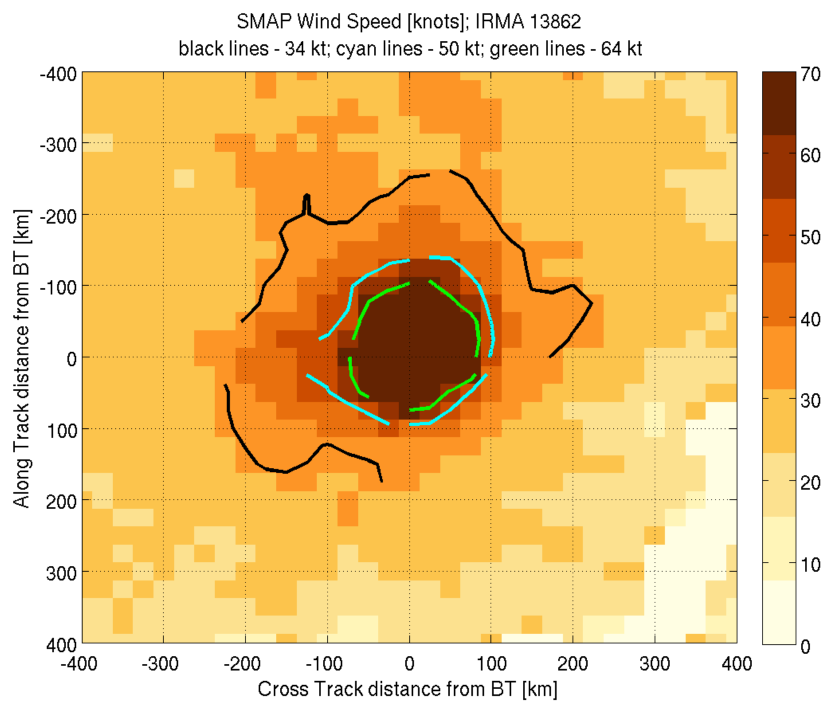


SMAP vs SFMR; Best Fit Slope: 0.96; Corr: 0.81
Mean Pct Error > 15 m/s: 15
SMAP
Best Fit
1:1
360 min matchup time
SMAP Wind Speed [m/s]
SFMR Wind Speed [m/s]
15
20
25
30
35
40
45
50
55
60

SMAP Wind Radii

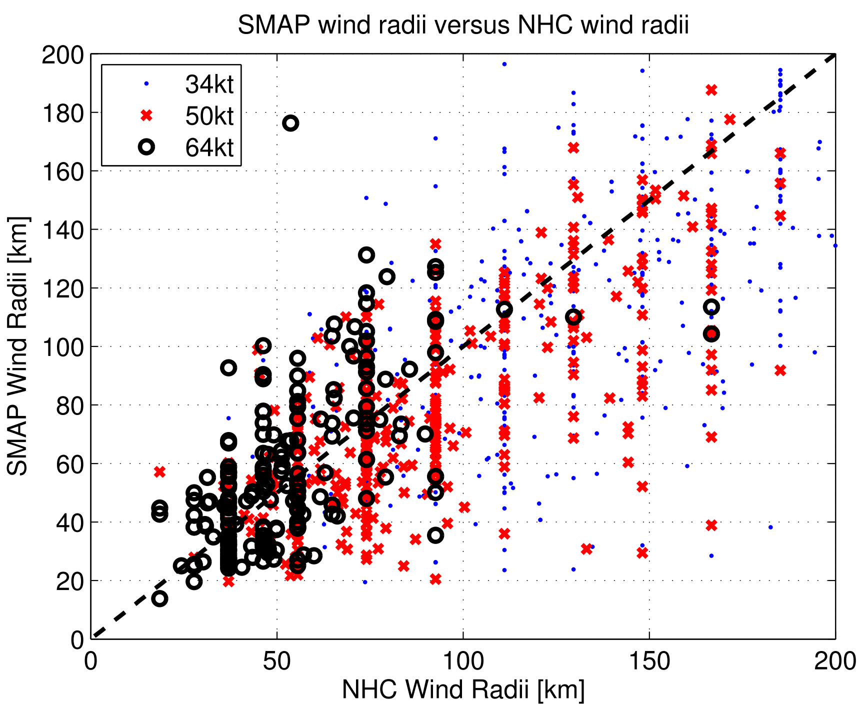
- We validate against the ATCF B-deck datasets.
- For each SMAP cyclone hit:
  - Compute contours at (34, 50, 64) knot wind thresholds.
  - Extract longest contour in each compass quadrant and compute the 90% threshold value.

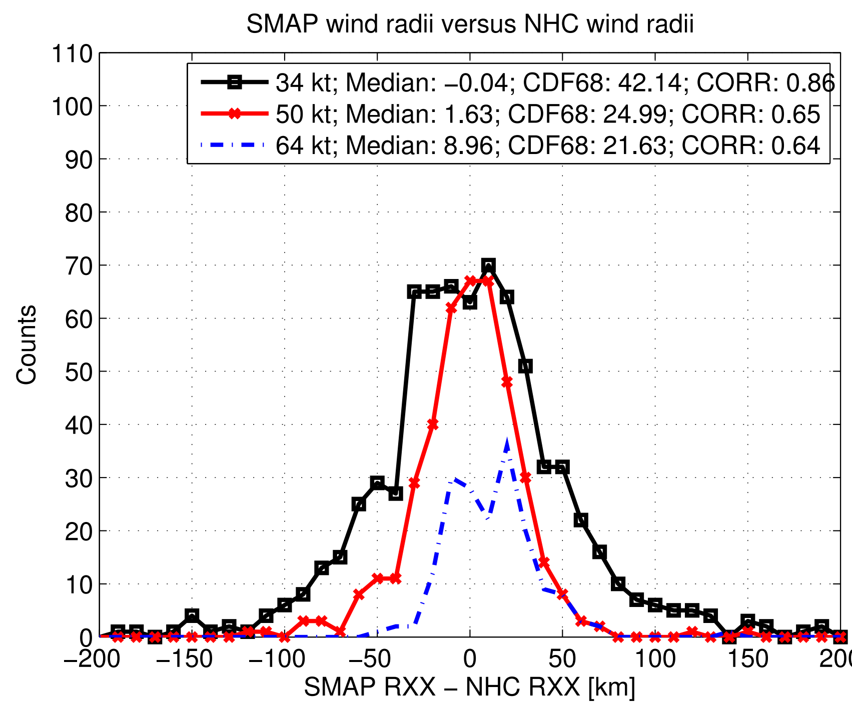




Wind Radii Results

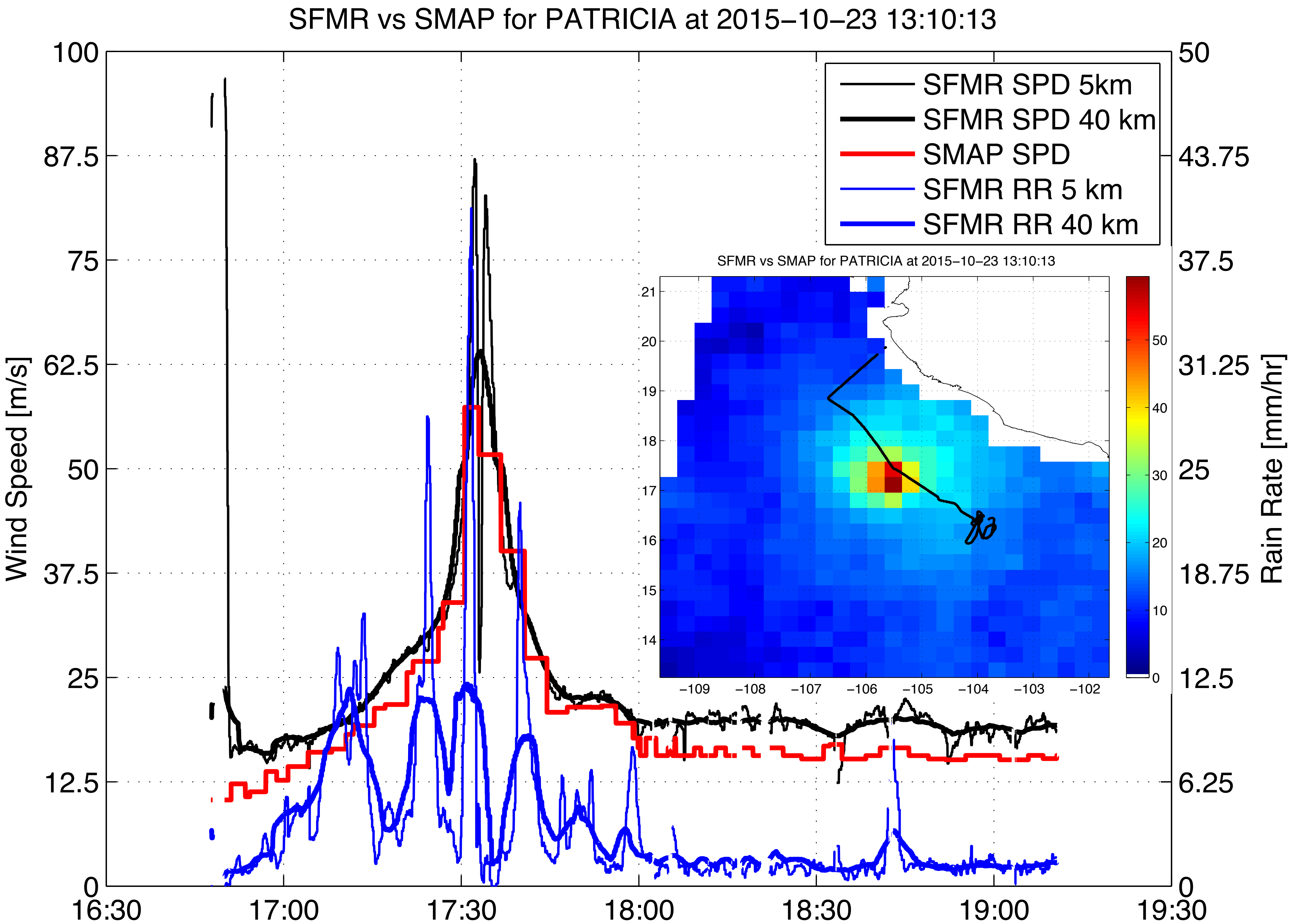
- SMAP wind radii are in reasonable agreement with ATCF B-deck radii:
  - ATCF wind radii estimates have ~ 20-40% error.
  - Good correlation to ATCF radii.
  - SMAP relatively unbiased.





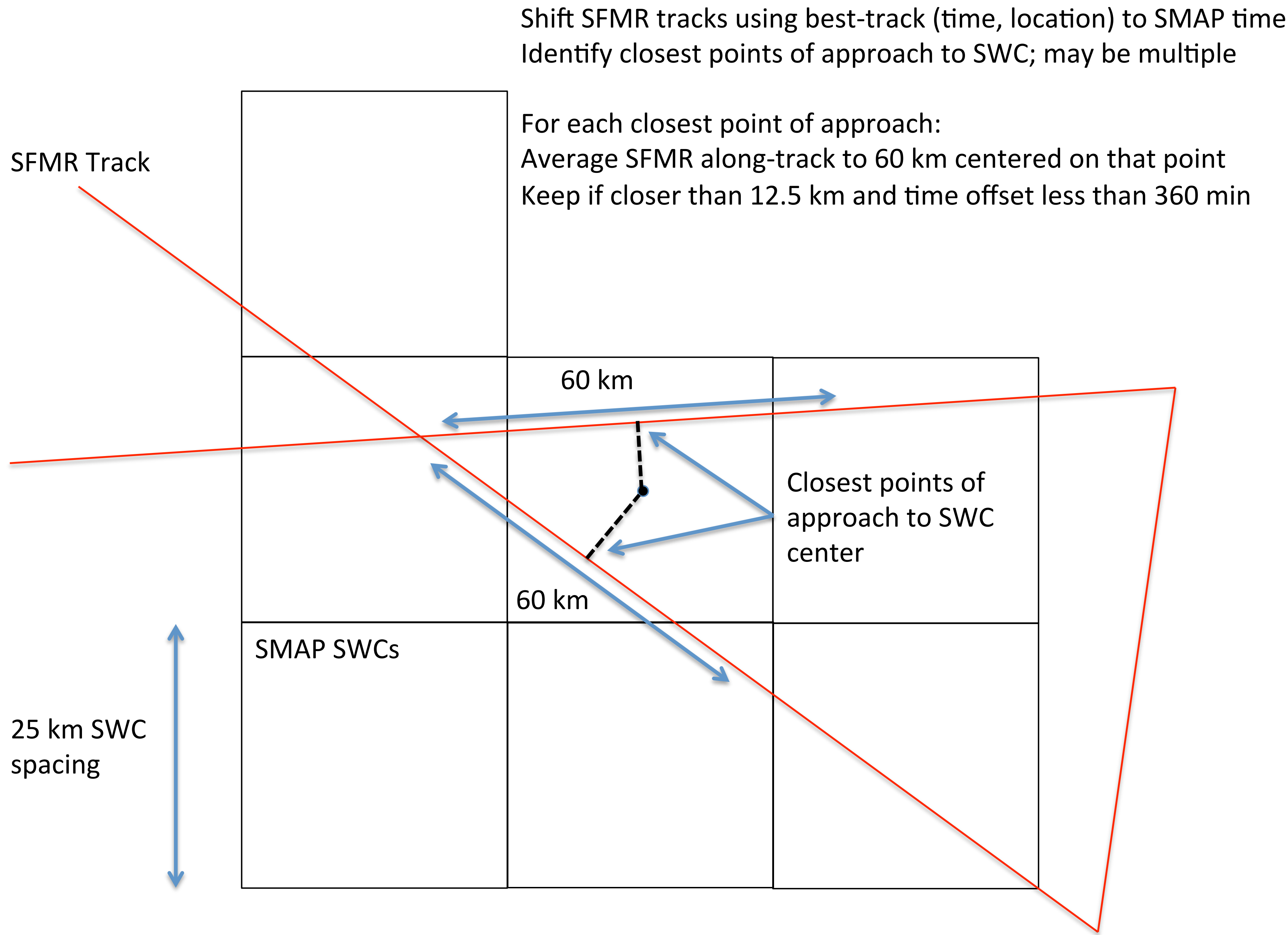
Summary

- Using SFMR we find good agreement to about 40 ms^{-1}
  - Positive bias between 30-40 ms^{-1} no larger than 3 ms^{-1}
  - Overall STD as compared to SFMR is on the order of 4 ms^{-1} for wind speeds larger than 25 ms^{-1}
- Comparisons to ATCF B-deck datasets shows SMAP provides reasonably unbiased size estimates with good correlation to ATCF values.
- Overall, SMAP can provide valuable information on Tropical Cyclone size and *averaged* intensity.
- Peer-reviewed publications:
  - S. H. Yueh et al., "SMAP L-Band Passive Microwave Observations of Ocean Surface Wind During Severe Storms," in IEEE Transactions on Geoscience and Remote Sensing, vol. 54, no. 12, pp. 7339-7350, Dec. 2016.
  - A. G. Fore, et al., "Combined Active/Passive Retrievals of Ocean Vector Wind and Sea Surface Salinity With SMAP," in IEEE Transactions on Geoscience and Remote Sensing, vol. 54, no. 12, pp. 7396-7404, Dec. 2016.
  - N. Reul, et al., "A new generate of Tropical Cyclone Size measurements from space," in BAMS, Early release (online). 10.1175/BAMS-D-15-00291.1


SFMR vs SMAP for PATRICIA at 2015−10−23 13:10:13
Wind Speed [m/s]
Rain Rate [mm/hr]
SFMR SPD 5km
SFMR SPD 40 km
SMAP SPD
SFMR RR 5 km
SFMR RR 40 km
100
87.5
75
62.5
50
37.5
25
12.5
0
43.75
37.5
31.25
25
18.75
12.5
6.25
0
16:30
17:00
17:30
18:00
18:30
19:00
19:30
SFMR vs SMAP for PATRICIA at 2015−10−23 13:10:13
21
20
19
18
17
16
15
14
−109
−108
−107
−106
−105
−104
−103
−102
50
40
30
20
10
0

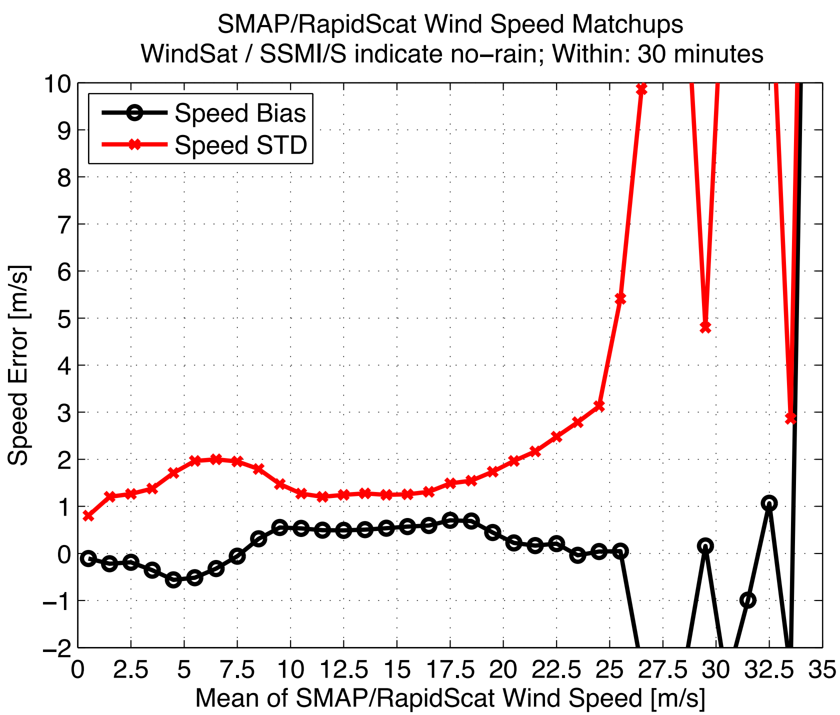
From SFMR stat plot 360 minutes / 60 km avg SFMR

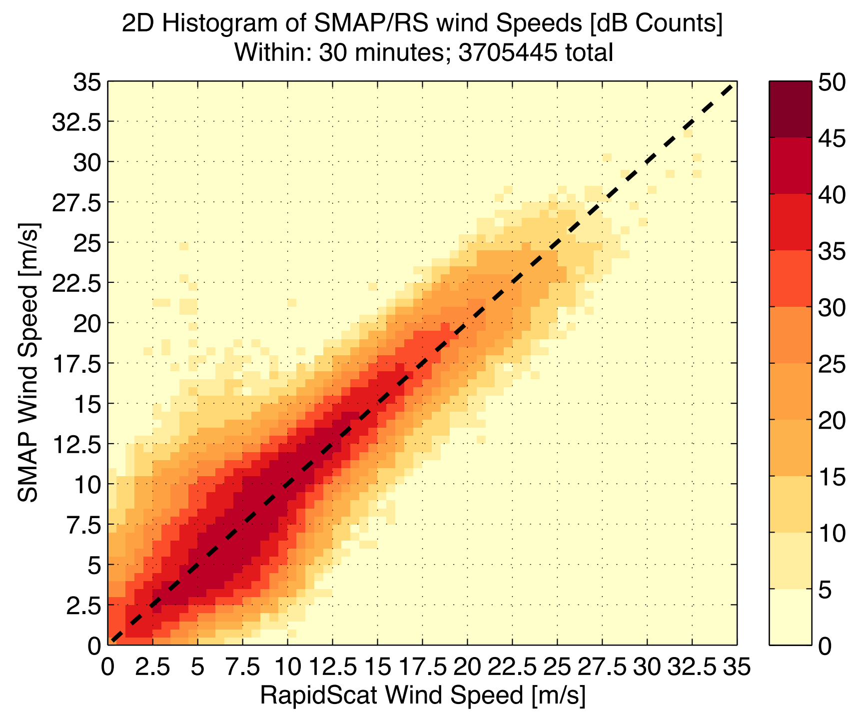
Wind Speed Bin	Bias	STD	Counts
15-20	0.09	3.05	985
20-25	-0.22	3.47	591
25-30	0.19	3.82	253
30-35	1.05	5.54	73
35-40	-2.93	5.64	25
40-45	-7.51	4.44	9
45-50	-8.66	n/a	1
50-55	-5.94	4.06	2


Shift SFMR tracks using best-track (time, location) to SMAP time
Identify closest points of approach to SWC; may be multiple
For each closest point of approach:
Average SFMR along-track to 60 km centered on that point
Keep if closer than 12.5 km and time offset less than 360 min
SFMR Track
60 km
Closest points of approach to SWC center
60 km
SMAP SWCs
25 km SWC spacing

SMAP / RapidScat / WindSat collocations (30m)

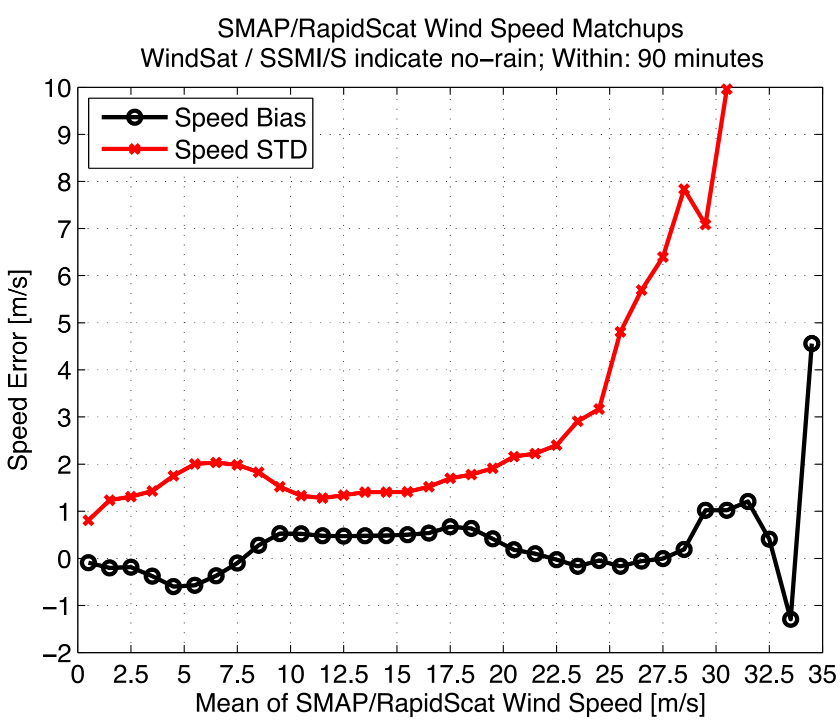
- Only extract joint collocations within 30 minutes of SMAP.
  - 3.7 million matchups.
- Use WindSat to remove rainy observations.
- Find nearly zero speed bias up to 26 m/s, not enough data past that.
- 2d histogram does not show any trend of increasing SMAP speed bias as compared to RapidScat

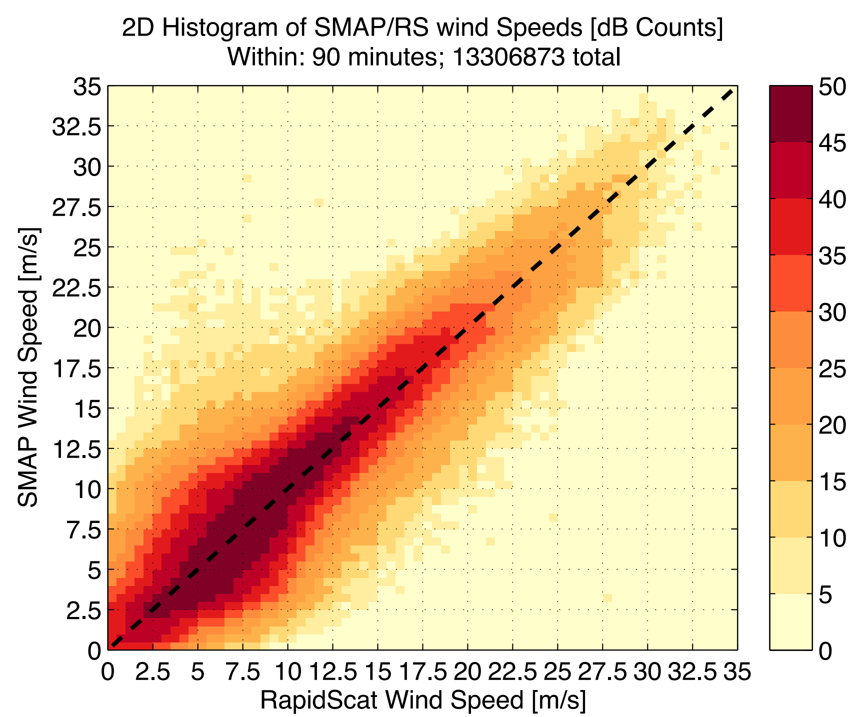


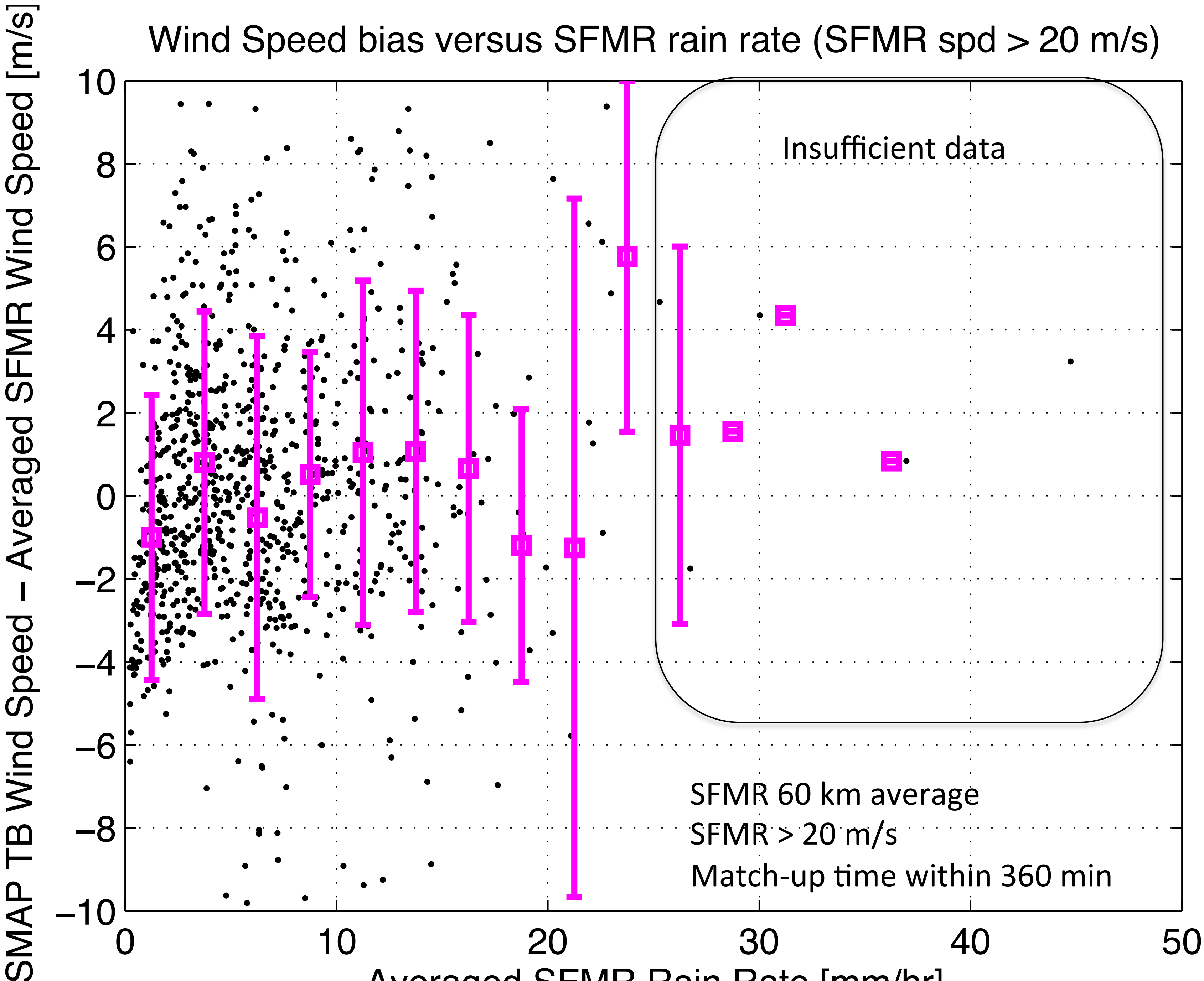


SMAP / RapidScat / WindSat collocations (90m)

- Same as previous with 90 minute collocation time.
  - 13 million matchups.
- Find very small speed bias up to 30 m/s (order 1 m/s).
- 2d histogram show data distributed near 1:1 line, no evidence of large positive SMAP bias near 30 m/s as compared to RapidScat.







Wind Speed bias versus SFMR rain rate (SFMR spd > 20 m/s)
SMAP TB Wind Speed – Averaged SFMR Wind Speed [m/s]
Averaged SFMR Rain Rate [mm/hr]
10
8
6
4
2
0
−2
−4
−6
−8
−10
0
10
20
30
40
50
Insufficient data
SFMR 60 km average
SFMR > 20 m/s
Match-up time within 360 min

L2A Gridding