Radiometer RFI Algorithm and Parameter Tuning

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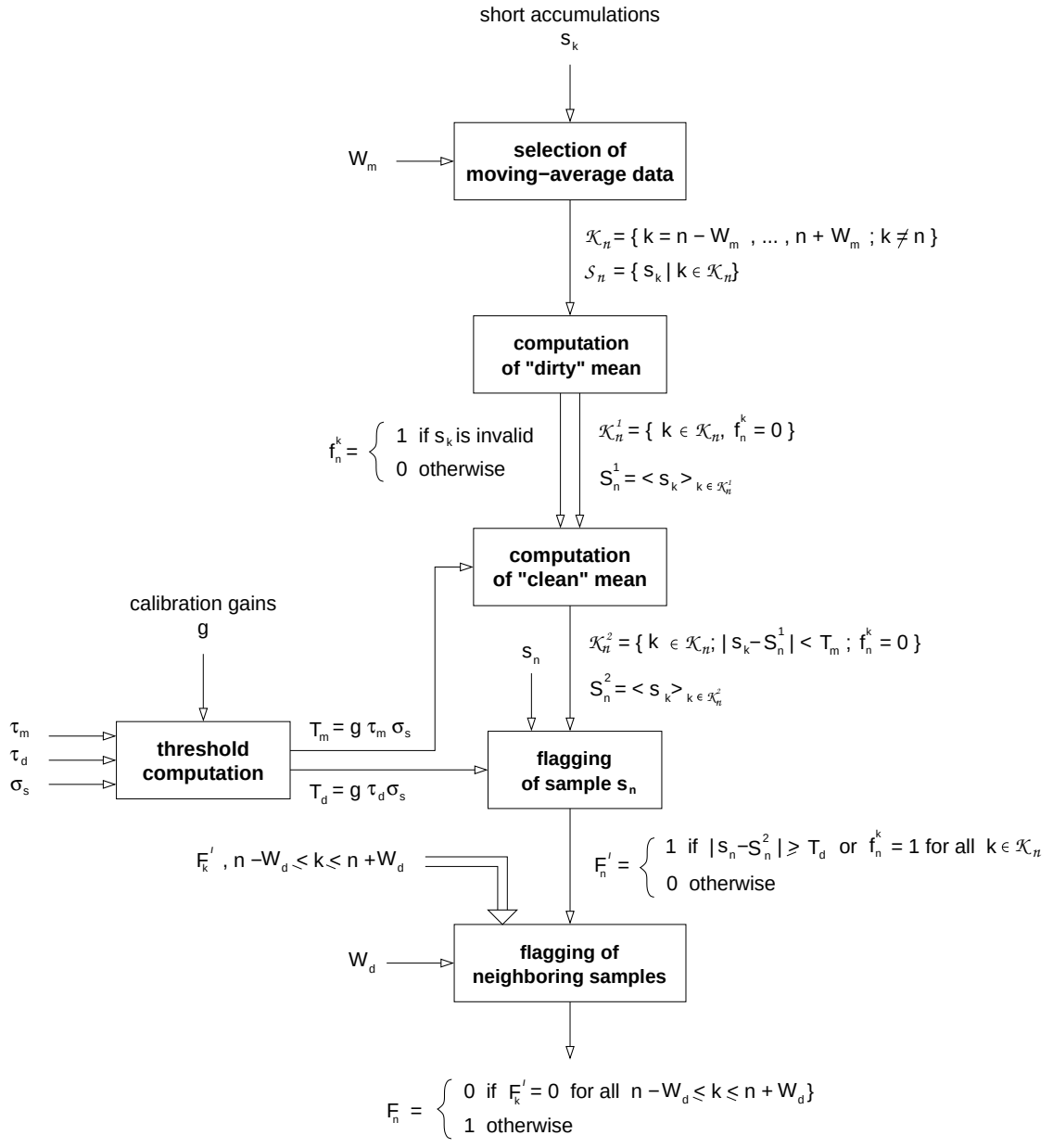
RFI Detection Algorithm

W_m	20
W_d	5
σ_s	~ 0.5
g	0.8-1.6
τ_m	1.5
τ_d	4.0



RFI Detection Algorithm Thresholds

- Two thresholds:
  - $T_m = g\,\sigma_s\,\tau_m(\text{lat}, \text{lon})$ for removing outliers
  - $T_d = g\,\sigma_s\,\tau_d(\text{lat}, \text{lon})$ for RFI flag decision
- Other two parameters:
  - W_m = width of RFI detection averaging window
  - W_d = width of RFI-by-association window
- $g = g(\text{beam}, \text{pol})$ is the gain used in the conversion from short accumulations to antenna temperatures
- τ_m, τ_d, W_m and W_d tunable by geographical location (ocean, land, etc.)
- σ_s corresponds to the standard deviation of the measured antenna temperature

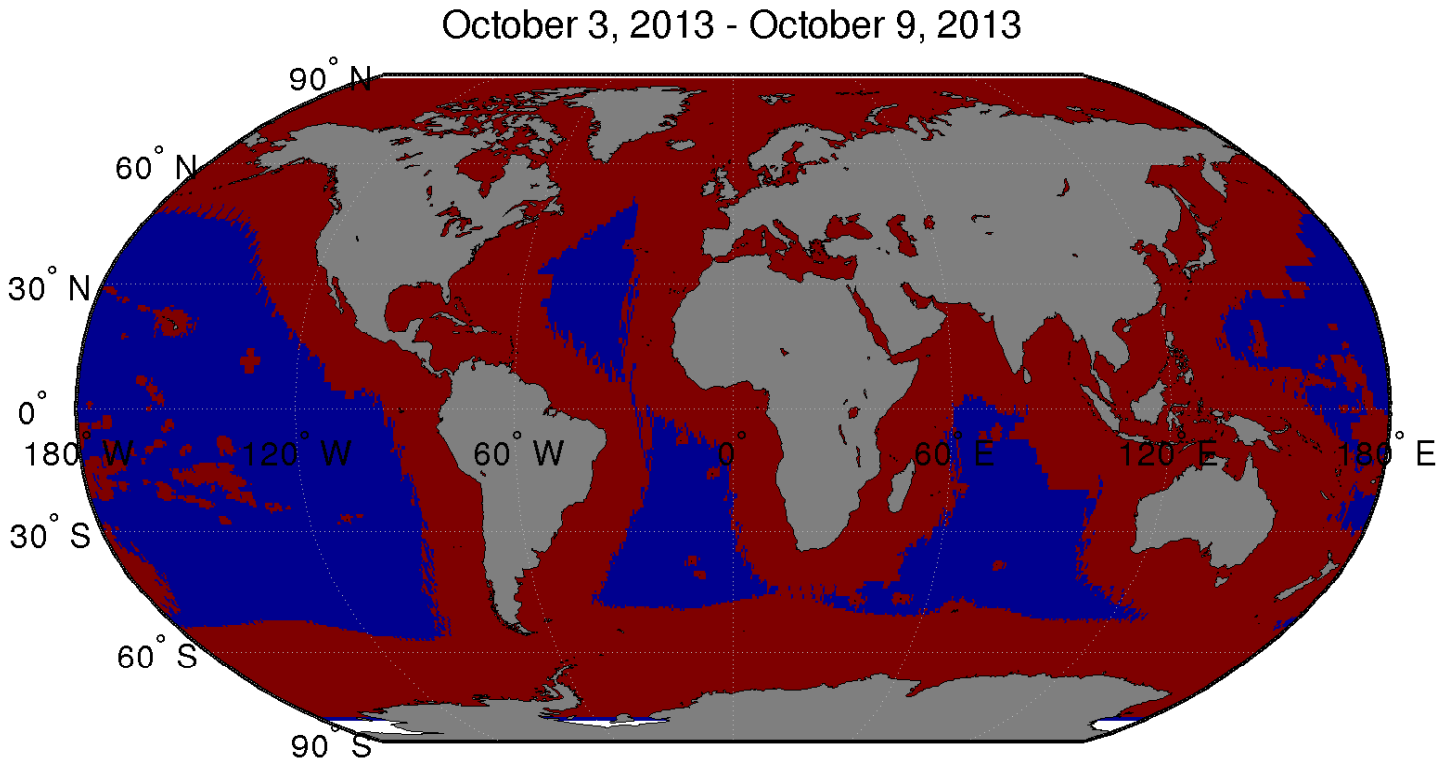
Outline

- Analysis of τ_m, τ_d, W_m and W_d influence on RFI detection and retrieved salinity
- Proposed approach for parameter tuning
- Discussion
- Additional issues

Characterization of RFI

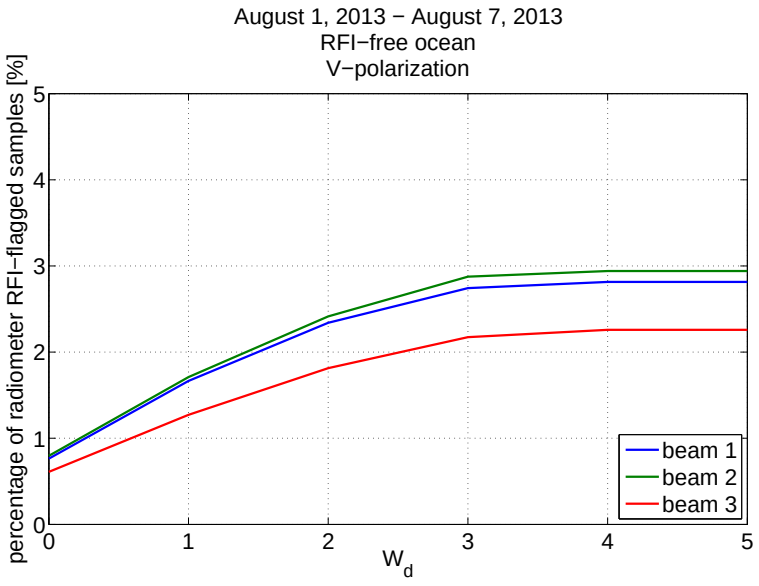
- Need for several different regions for parameter tuning:
  - RFI-free ocean
  - ocean with low RFI
  - ocean/land/ice regions
  - RFI-free land
  - land with low RFI
  - strong RFI regions
  - sea ice

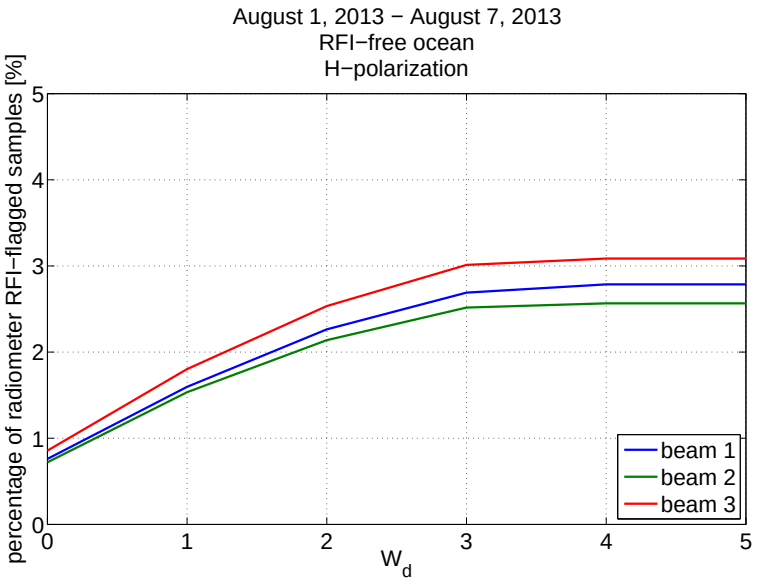
Selection of RFI-free Ocean

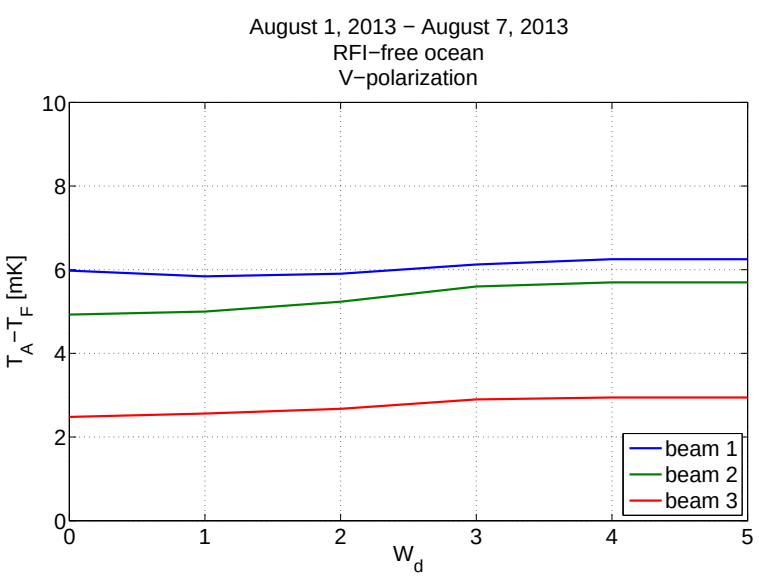


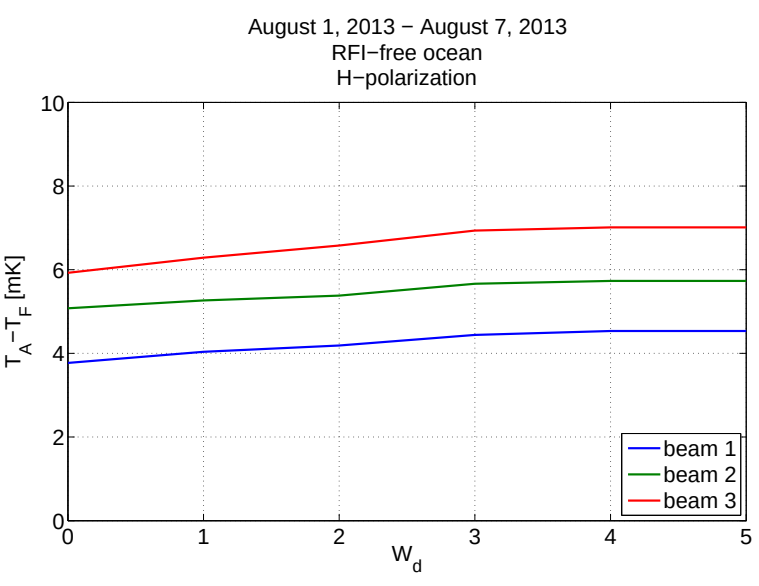
- Blue corresponds to RFI-free ocean
- Criteria for RFI-free ocean
  - water fraction greater than 99.99%
  - ascending/descending difference regions excluded
  - standard deviation of T_A smaller than 1.5

Variation of FAR and $T_A - T_F$ vs. W_d (currently $W_d = 5$)

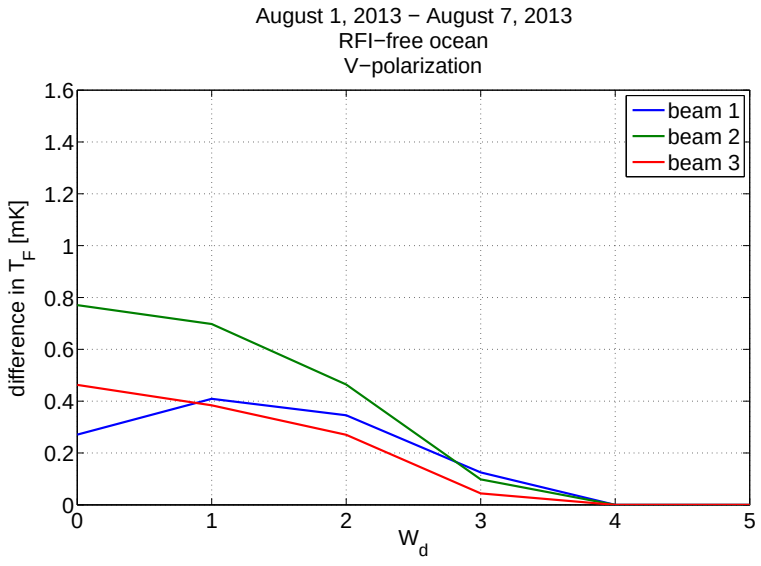


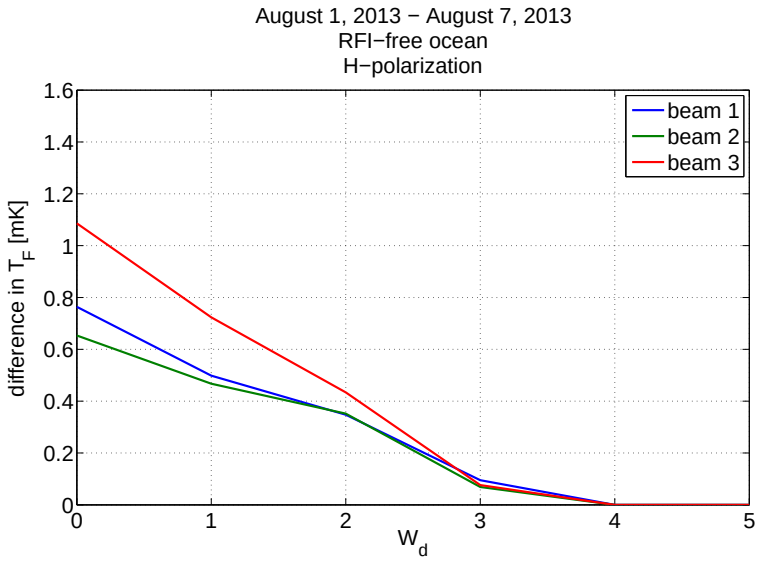


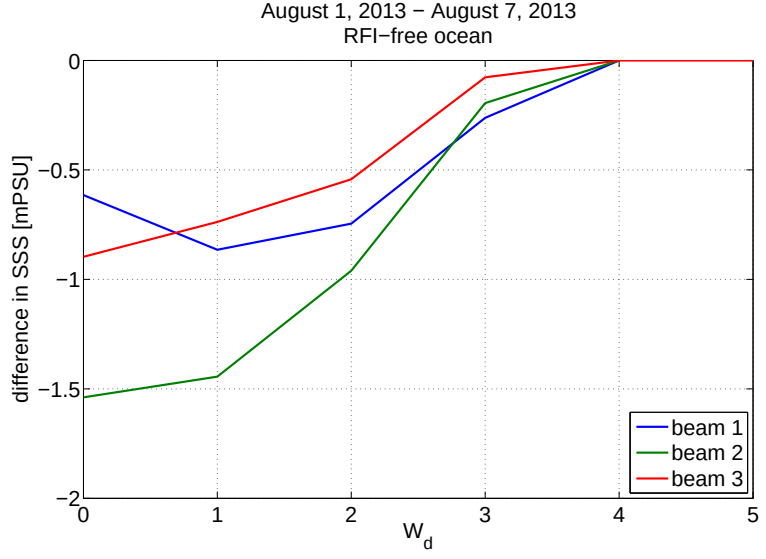




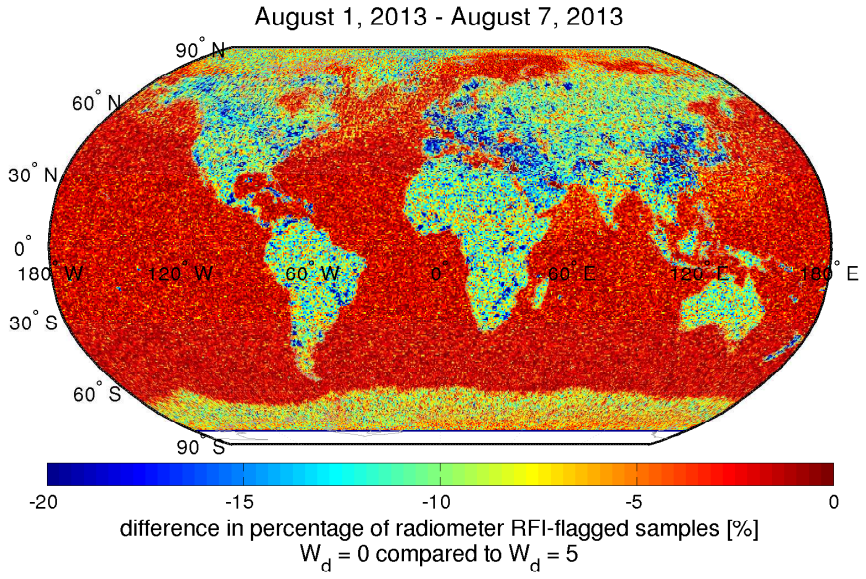
Variation of T_F and SSS vs. W_d (currently $W_d = 5$)

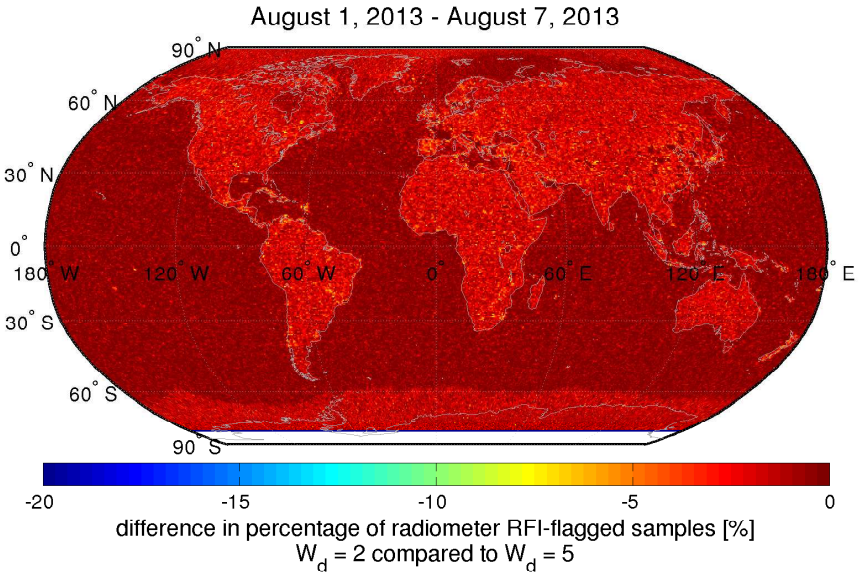


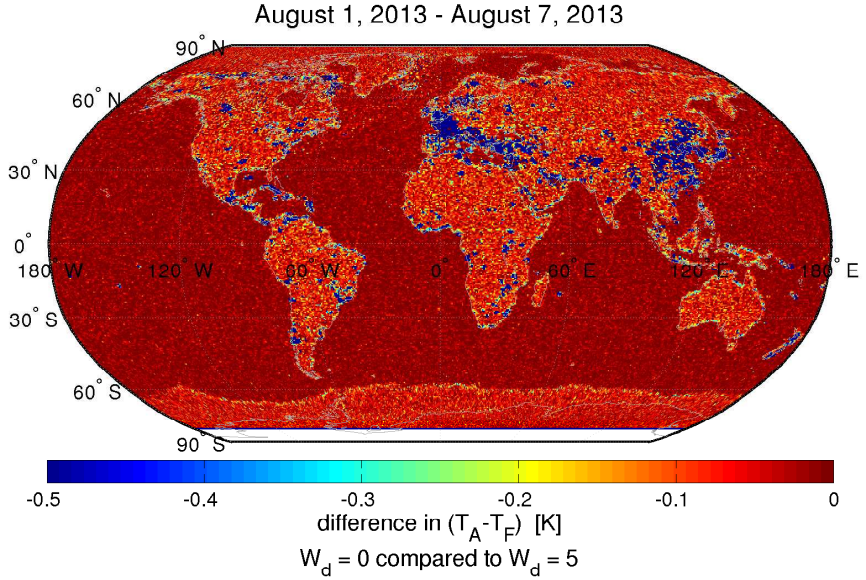


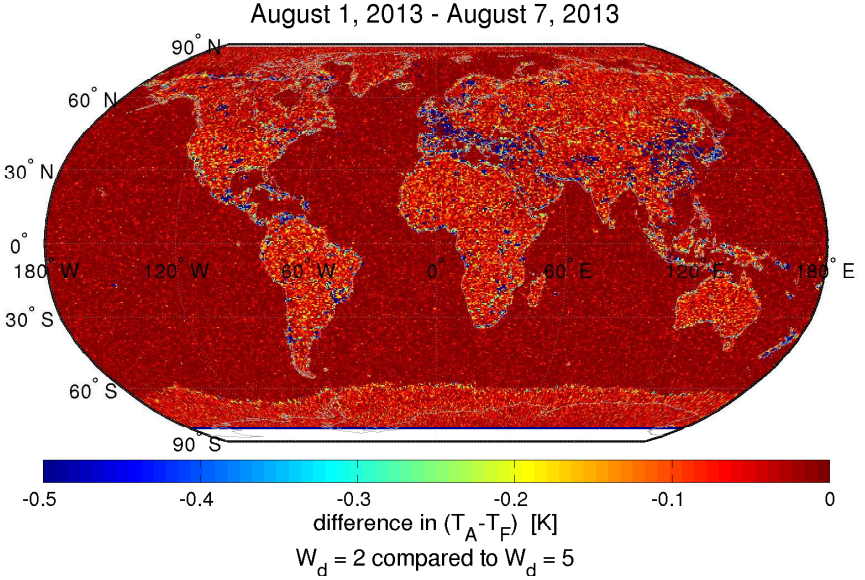


W_d Parameter Analysis, Effect on FAR and $T_A - T_F$

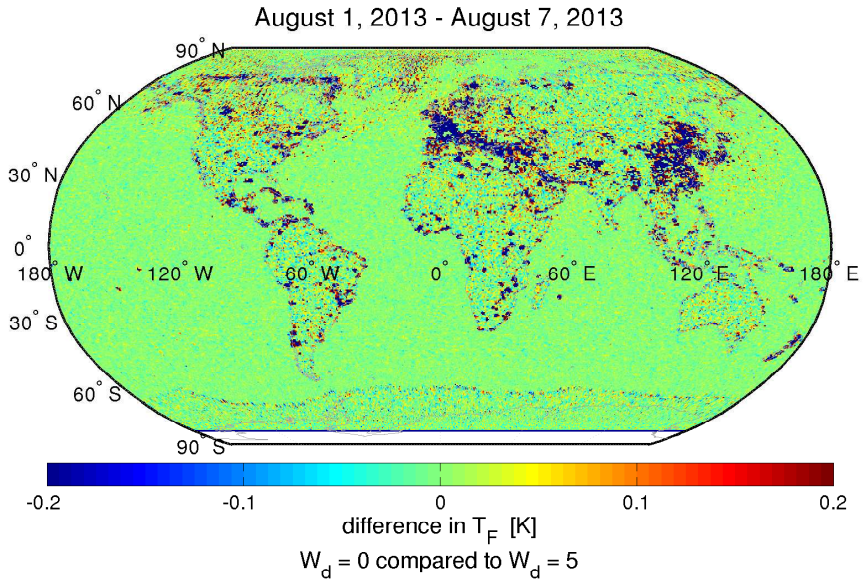


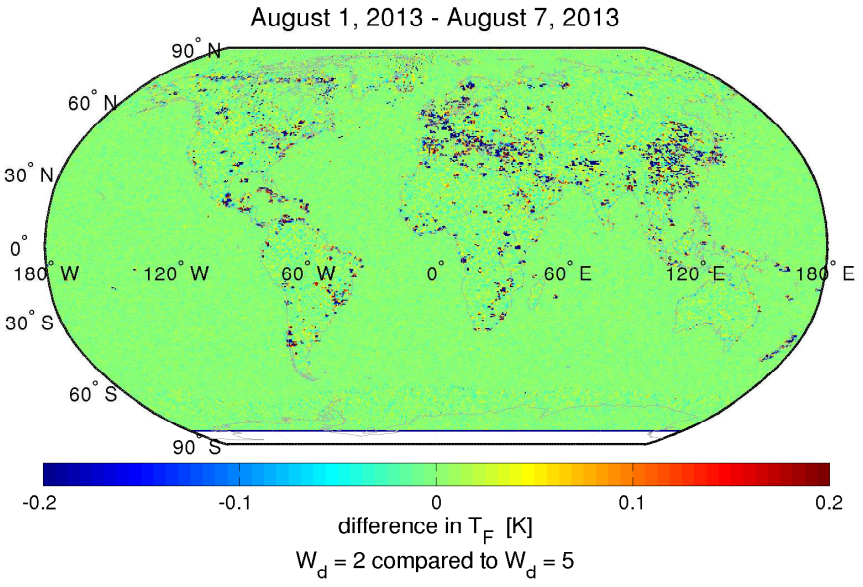


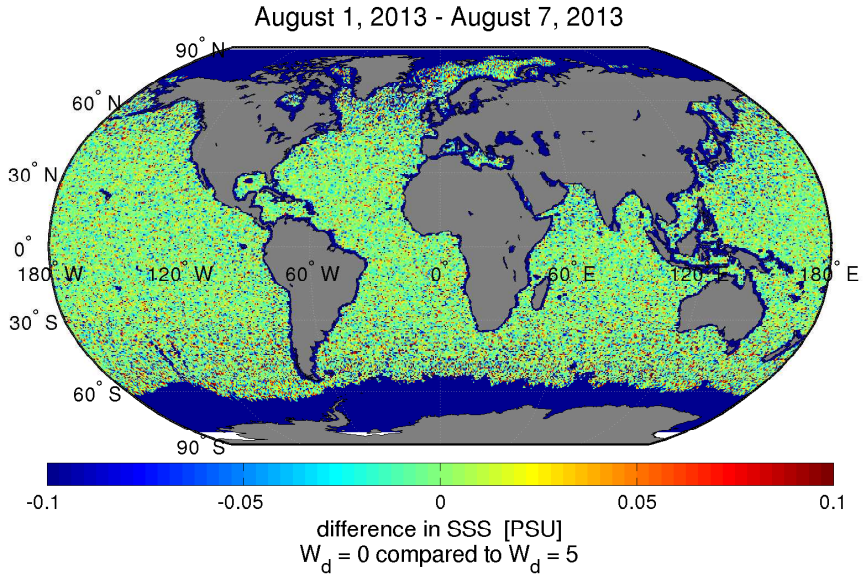


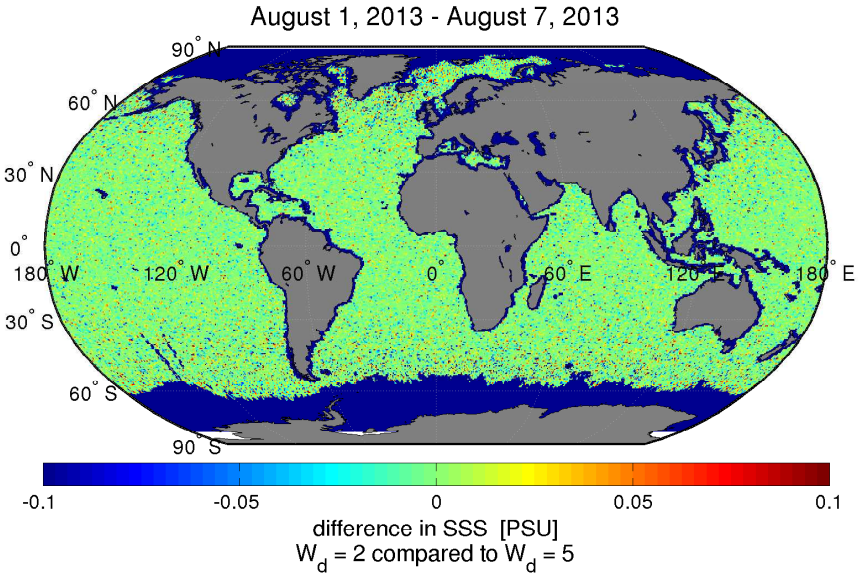


W_d Parameter Analysis, Effect on T_F and SSS



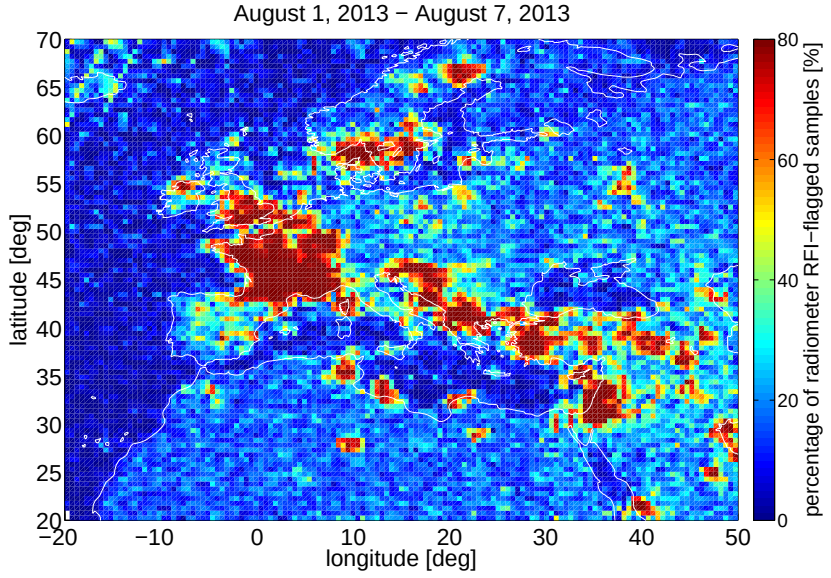


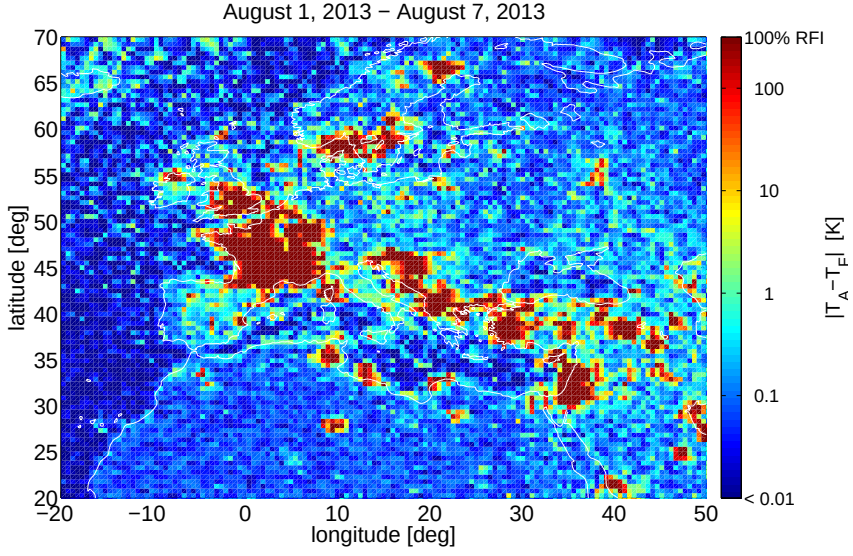




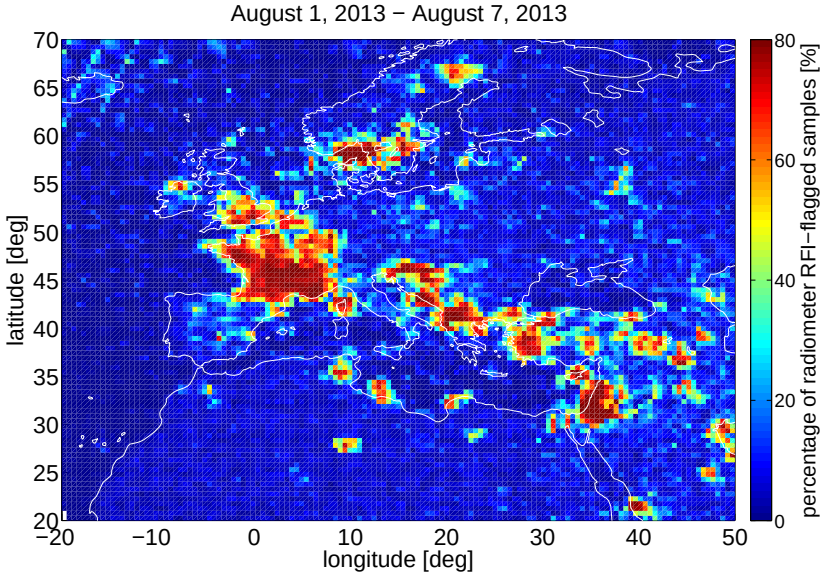
W_d Parameter Analysis in Strong RFI Regions

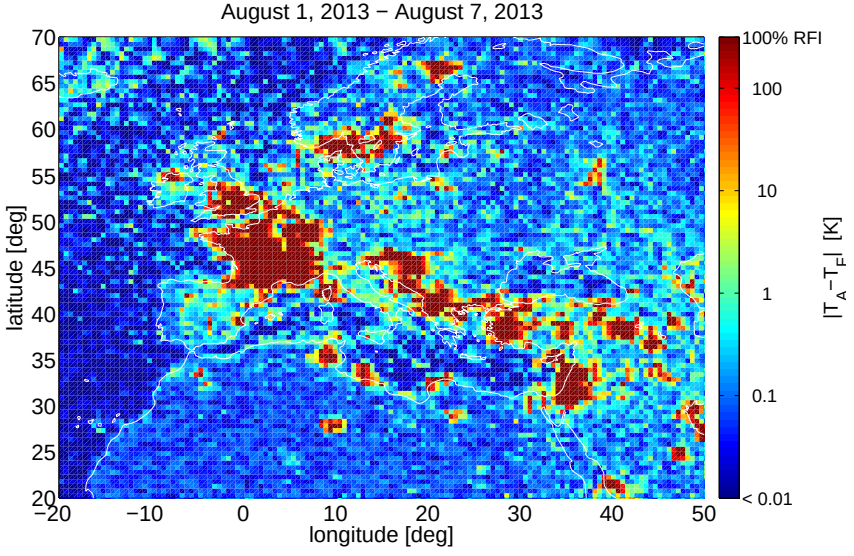
$W_d = 5$





$W_d = 0$

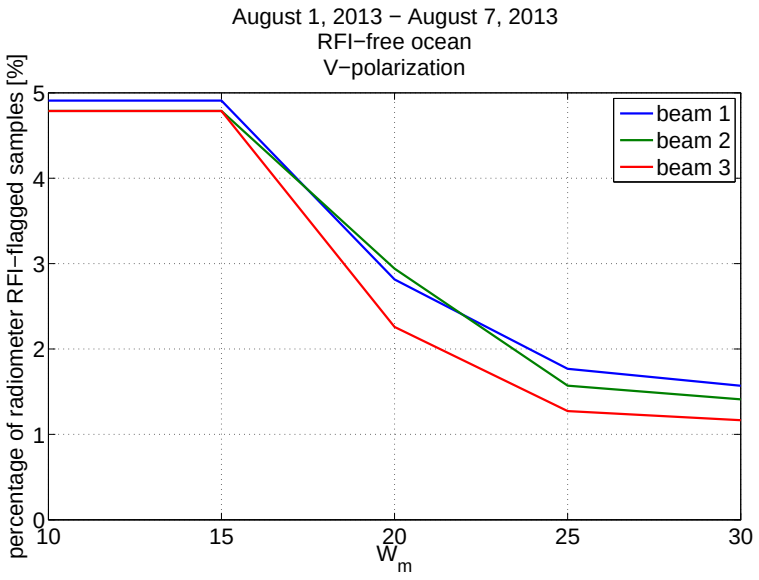


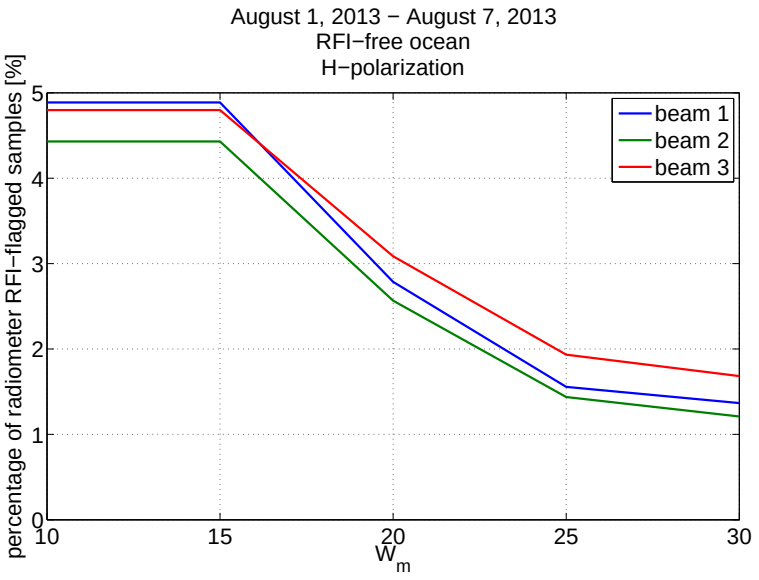


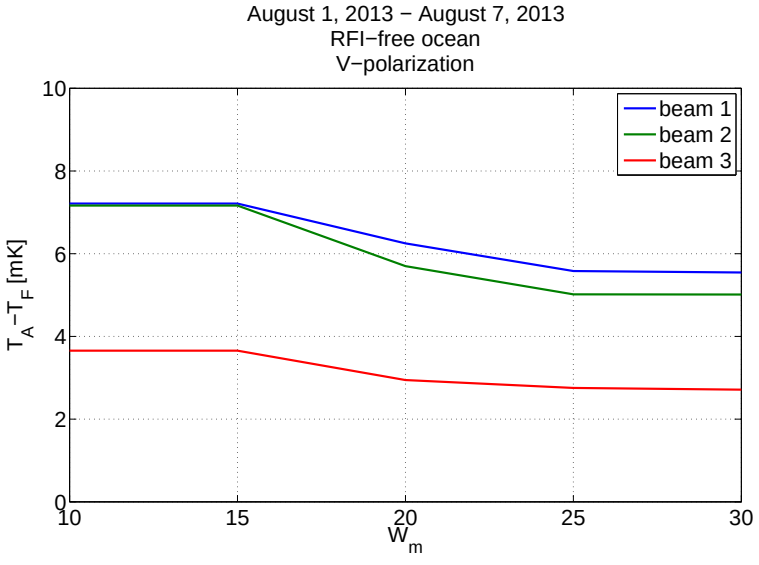
W_d Parameter Analysis, Summary

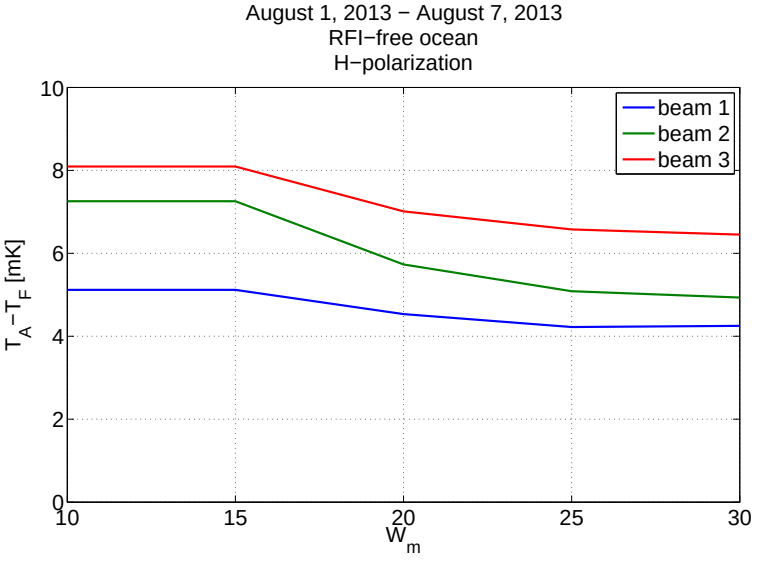
- Using $W_d = 5$ increases the FAR over RFI-free ocean
- A small bias of up to 1 mK in T_F is related to the FAR over RFI-free ocean, most likely due to the small asymmetry of the statistical distribution of the measurement values
- The bias in T_F translates into a very small bias in the salinity
- Reducing the FAR would reduce these biases
- A value of $W_d = 2$ is proposed for RFI-free ocean

Variation of FAR and $T_A - T_F$ vs. W_m

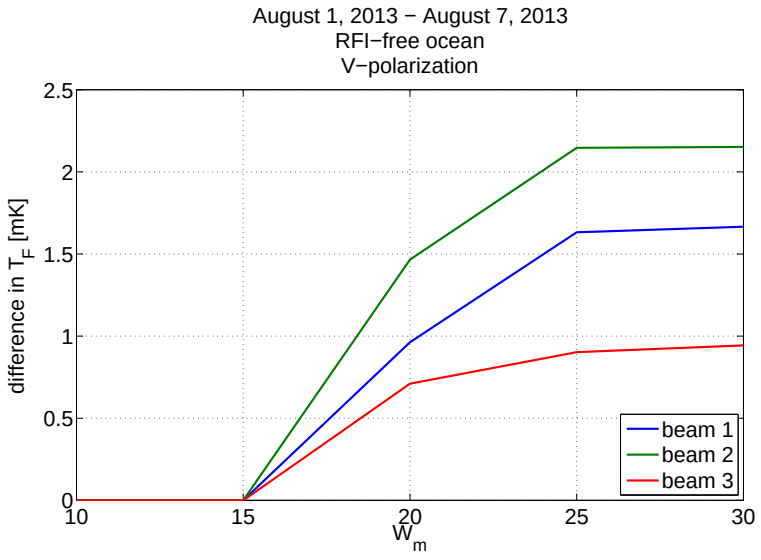


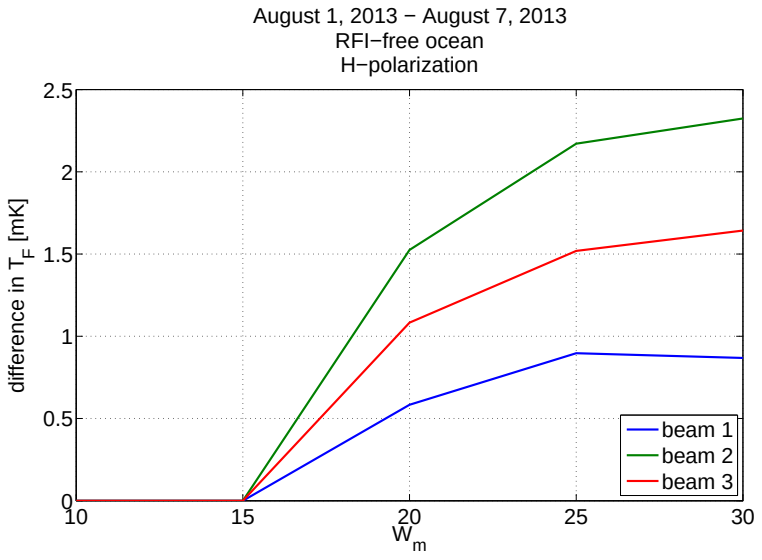


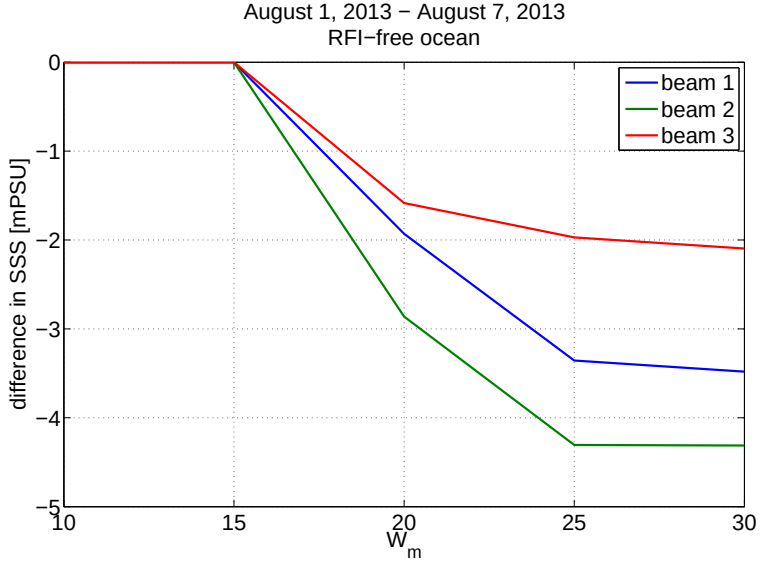




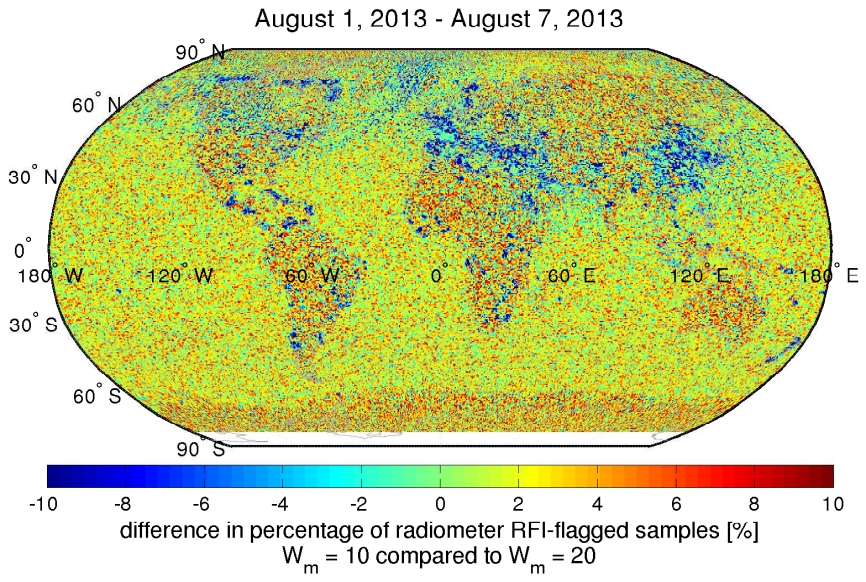
Variation of T_F and SSS vs. W_m

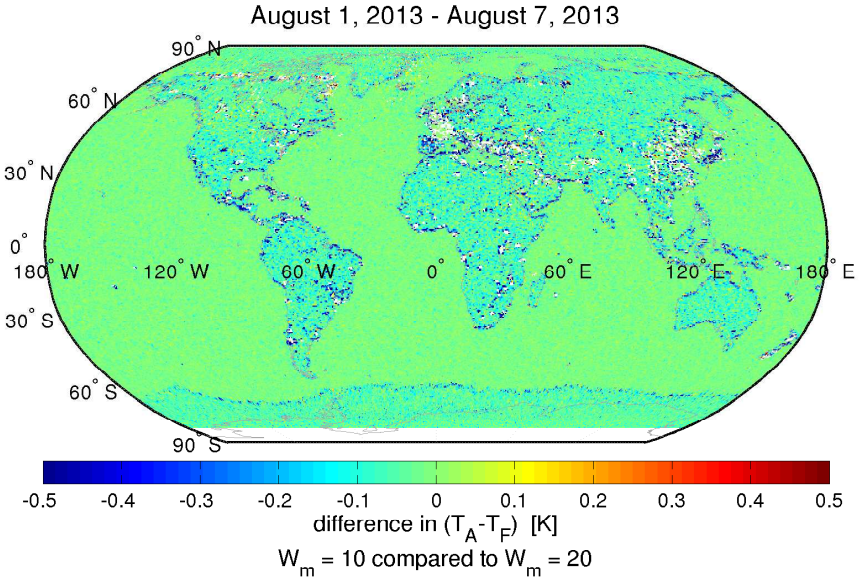


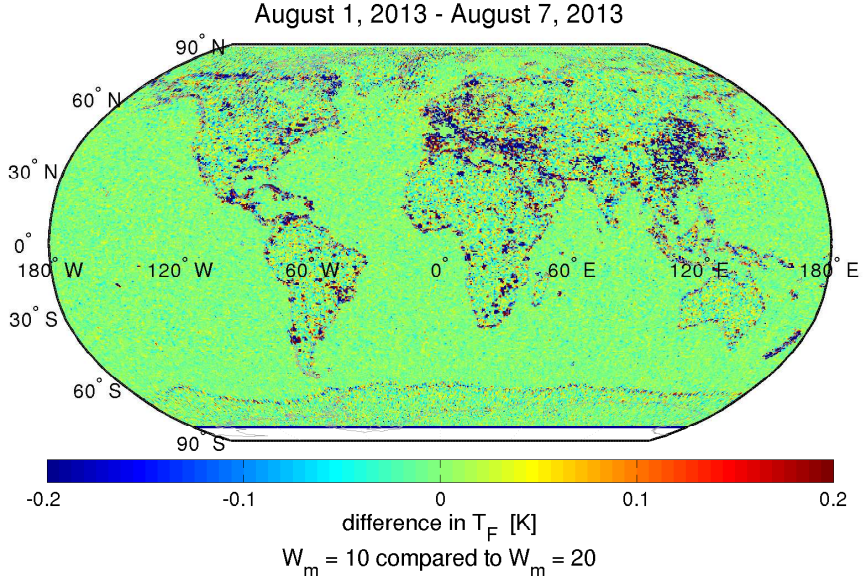


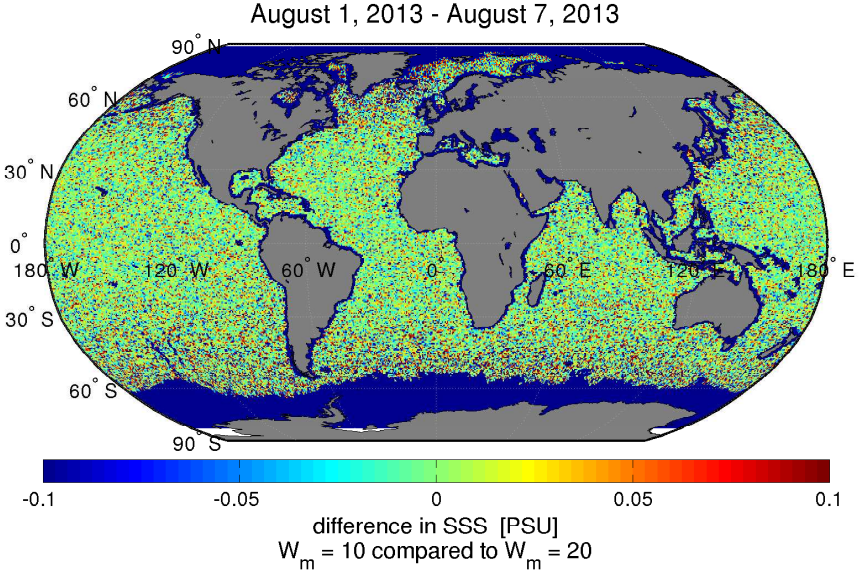


W_m Parameter Analysis, Smaller W_m

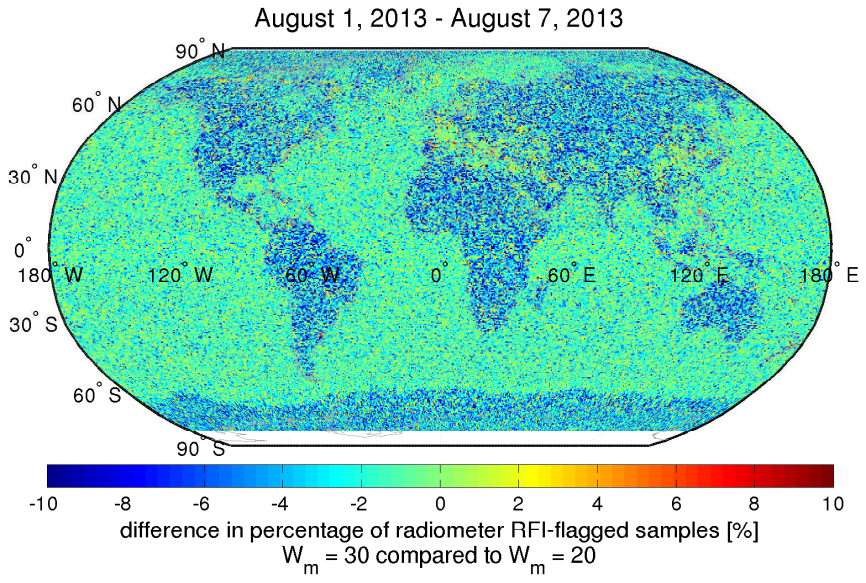


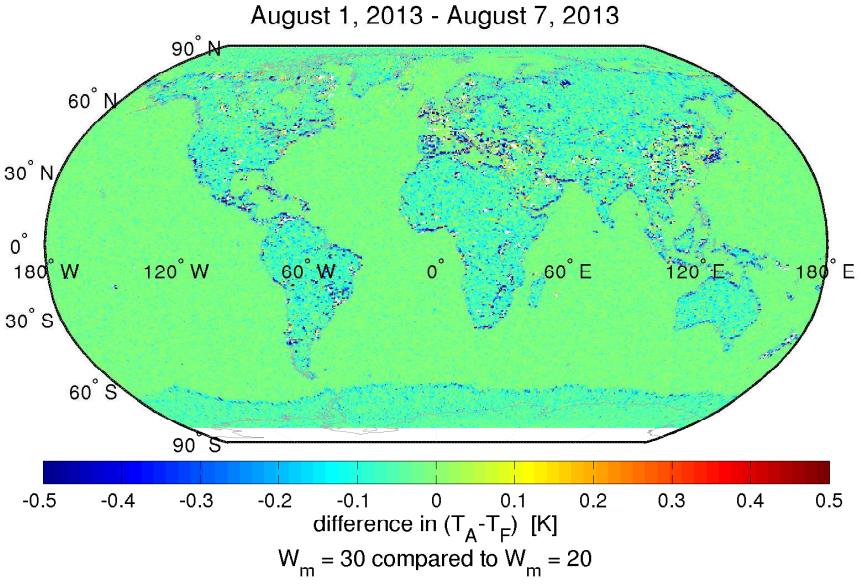


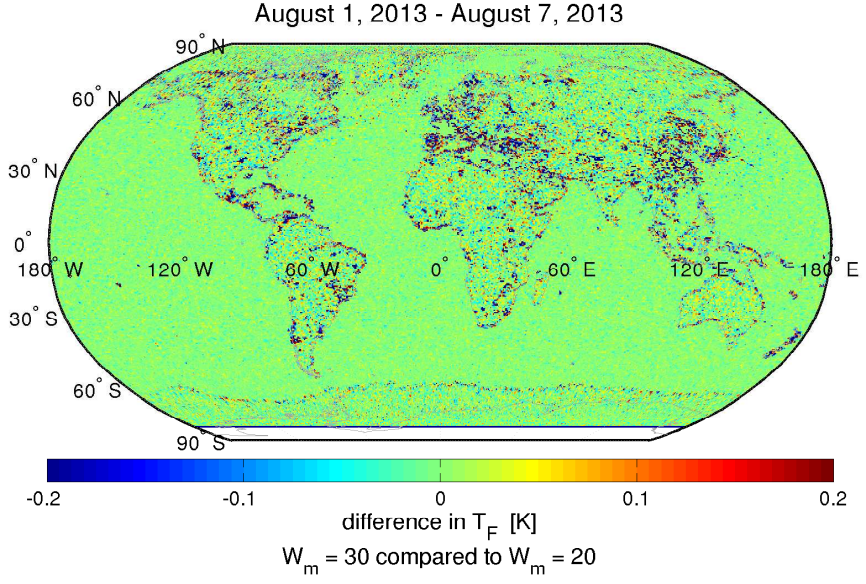


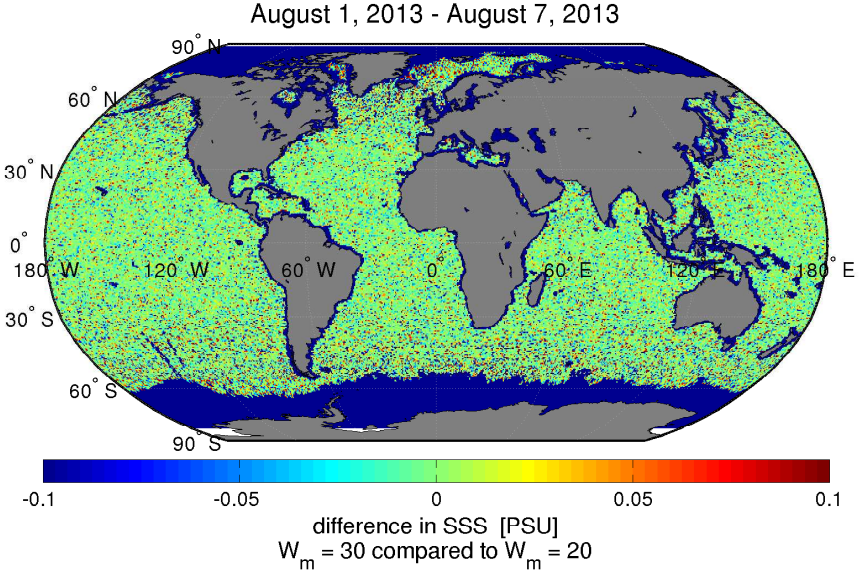


W_m Parameter Analysis, Larger W_m

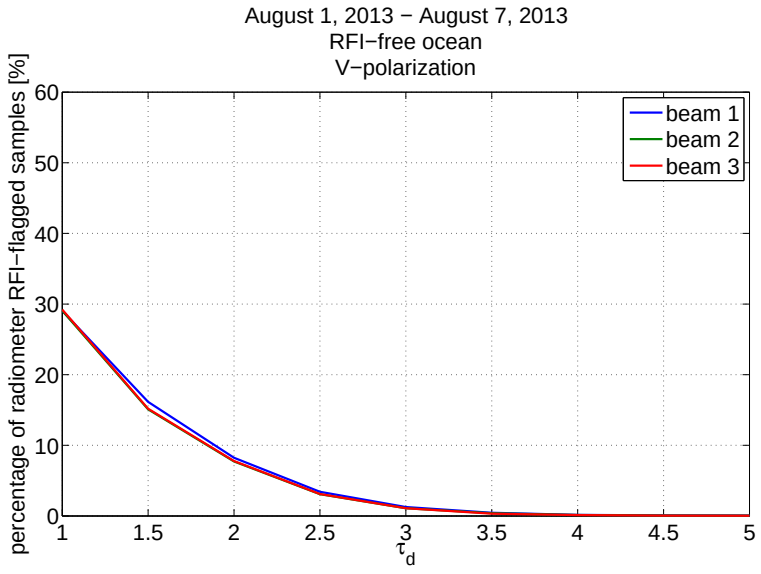


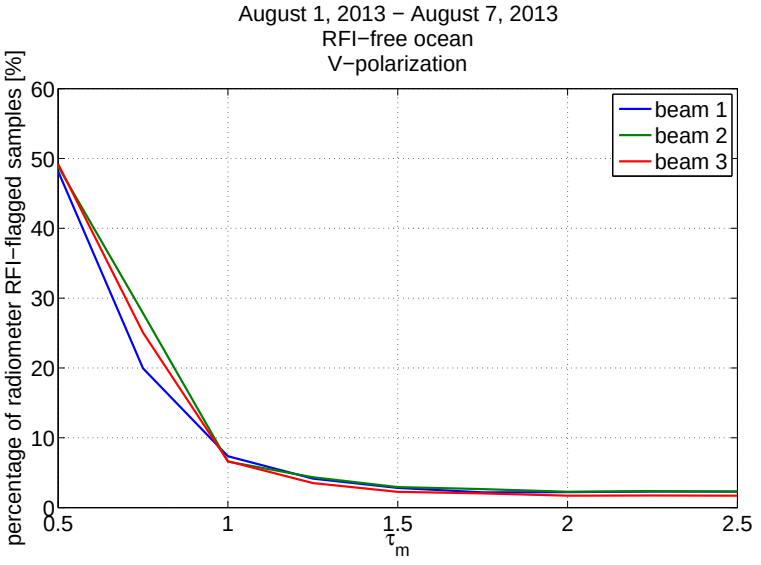


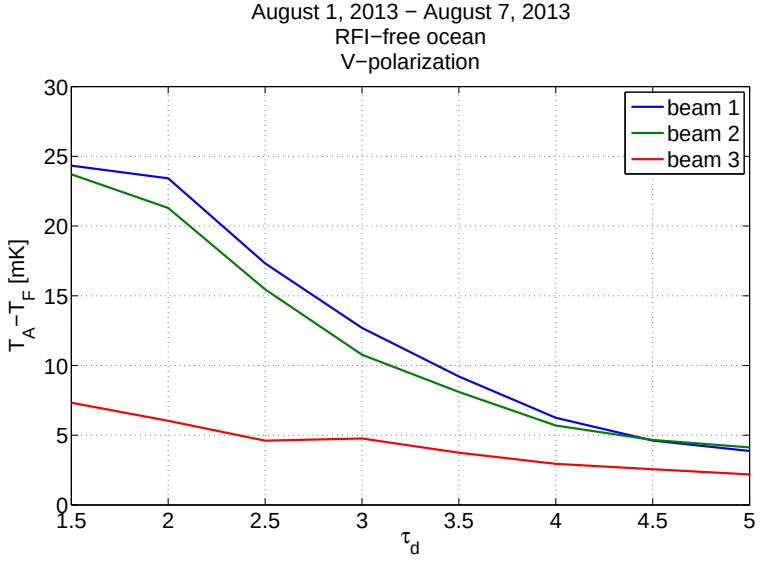


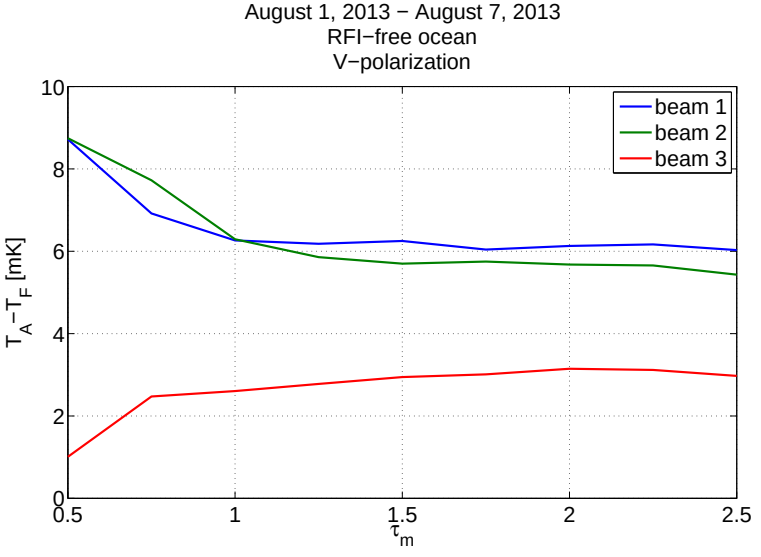


Variation of FAR and $T_A - T_F$ vs. τ_d and τ_m

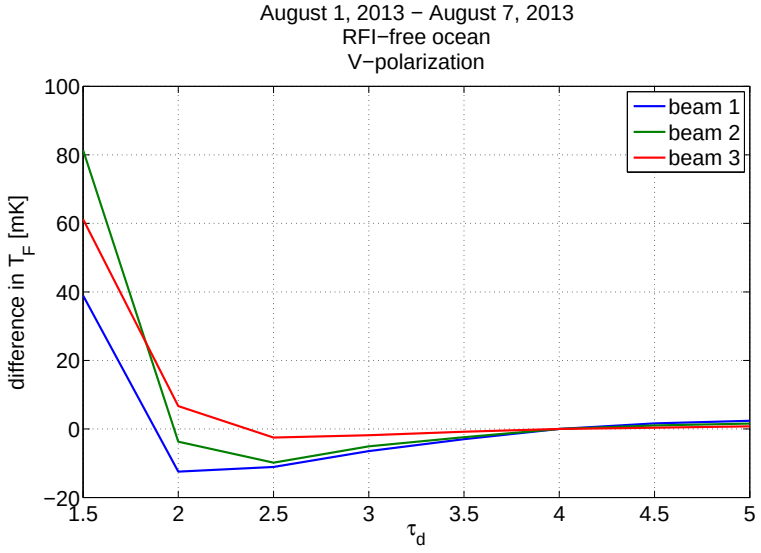


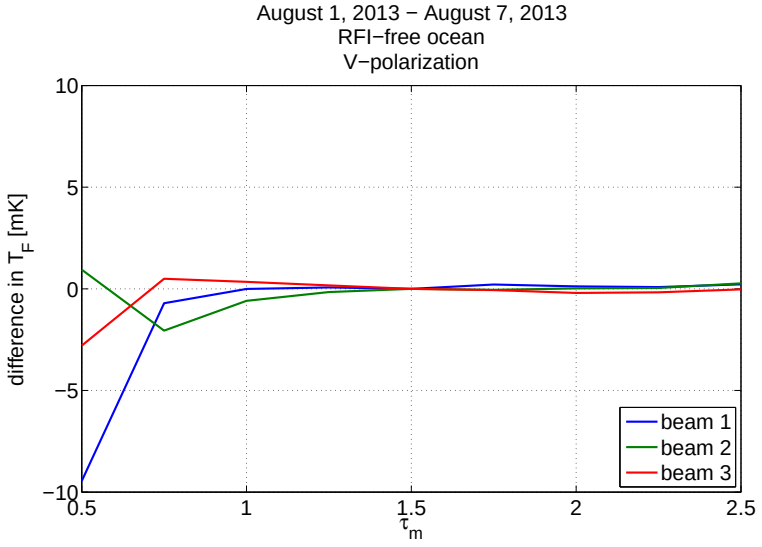


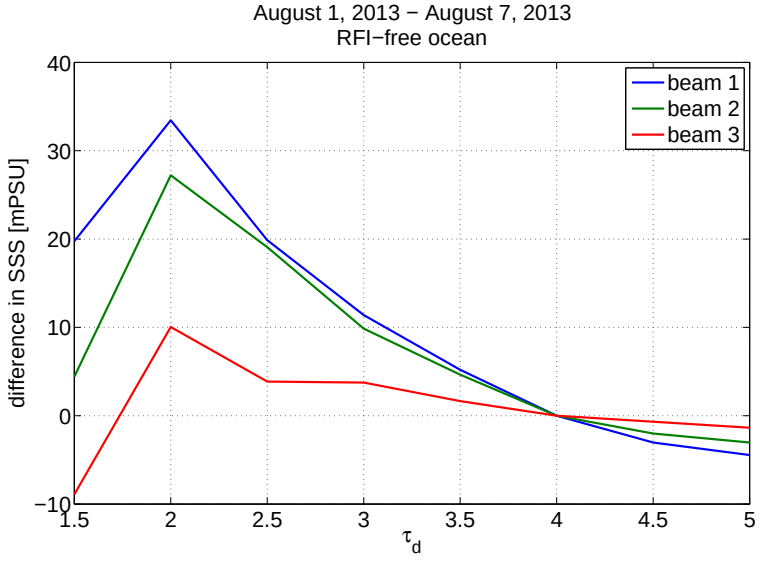


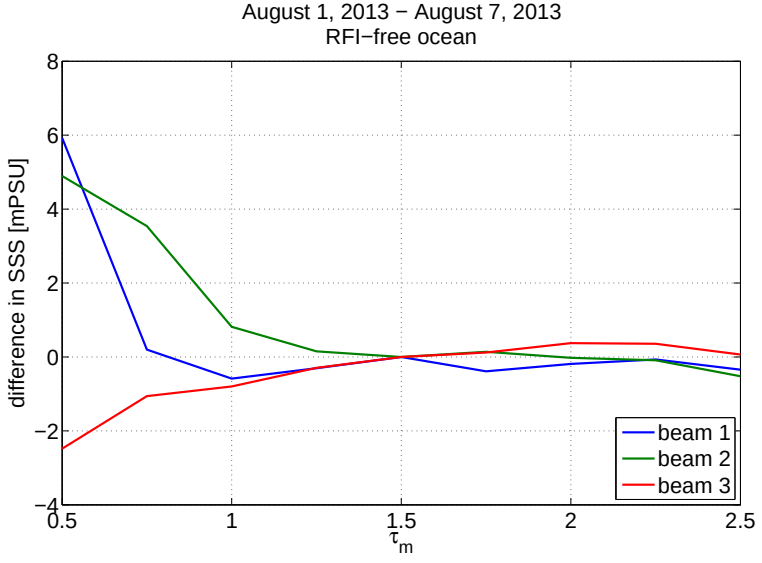


Variation of T_F and SSS vs. τ_d and τ_m









W_m, τ_d and τ_m Parameter Analysis, Summary

- Increasing W_m can be beneficial to decrease the FAR in homogeneous areas such as RFI-free ocean
- Threshold τ_m has minor influence but should not be too small (at least equal to 1, currently 1.5)
- τ_d is the most critical parameter for RFI detection

Re-evaluation of σ_s Parameters

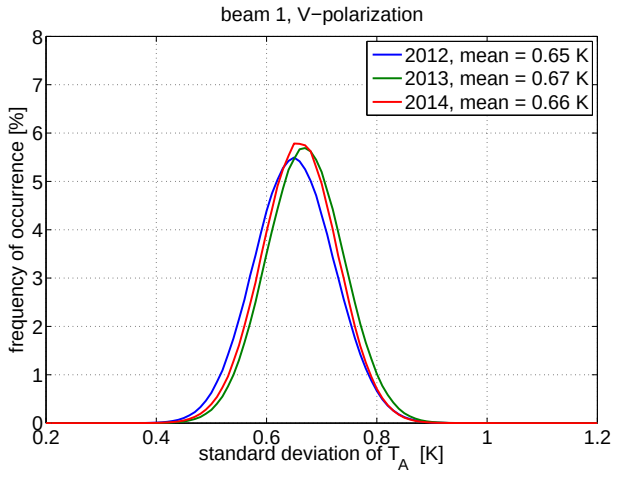
- values of σ_s are chosen to yield a FAR over RFI-free ocean uniform across all beams and polarization channels:

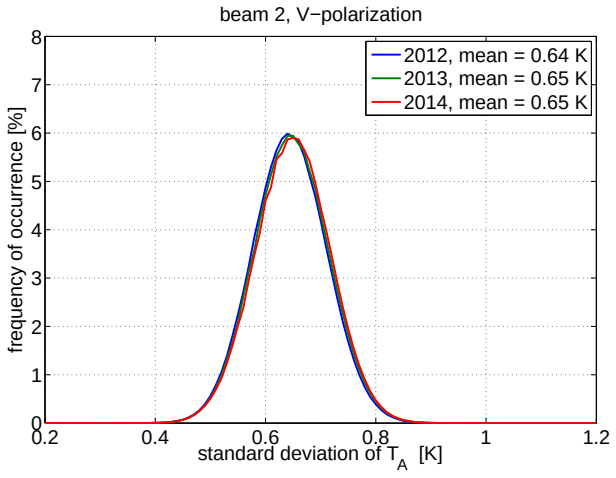
	V	V+H	V-H	H
Beam 1	0.558	0.551	0.540	0.532
Beam 2	0.543	0.562	0.548	0.538
Beam 3	0.552	0.548	0.554	0.546

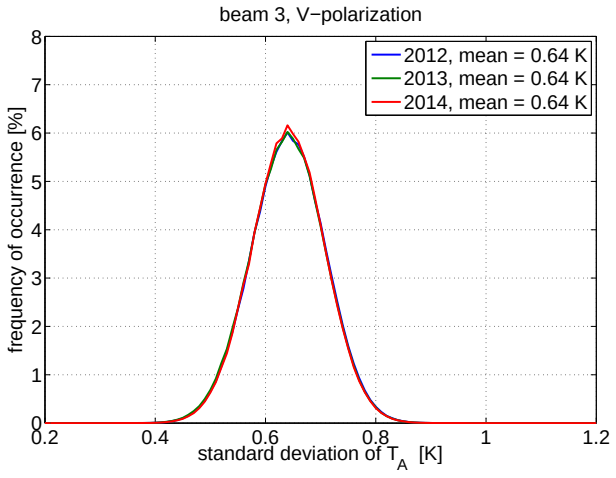
- this choice is based on $W_d = 5$, and, if W_d is modified, the FAR will change
- better choose σ_s independently of W_d, then tune τ_d to obtain the desired FAR
- values of σ_s can be chosen equal to standard deviation of 1.44 s T_A averages:

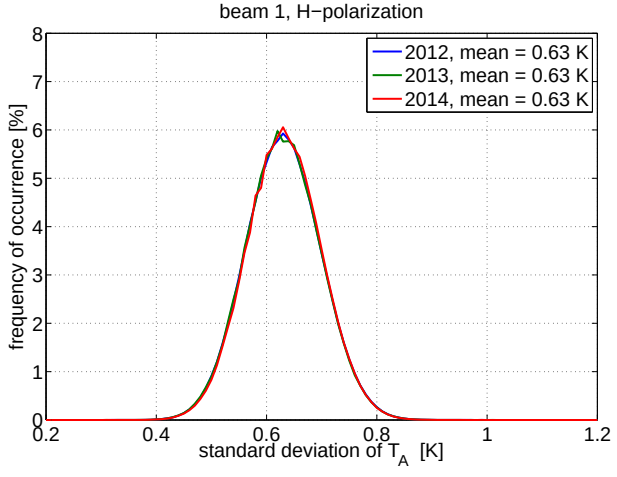
	V	V+H	V-H	H
Beam 1	0.668	0.679	0.664	0.638
Beam 2	0.657	0.699	0.680	0.651
Beam 3	0.656	0.717	0.695	0.673

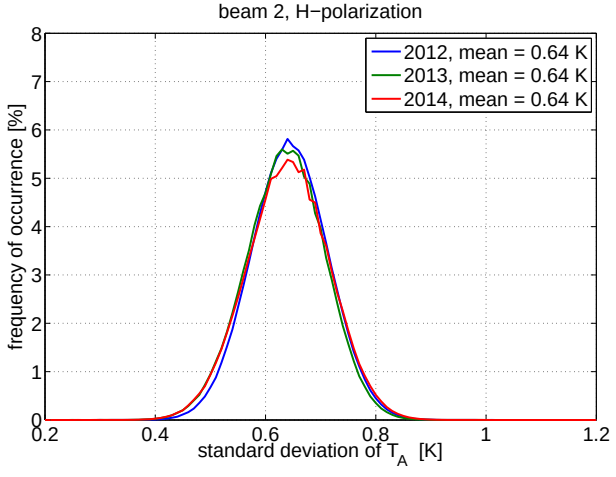
Standard Deviation of T_A

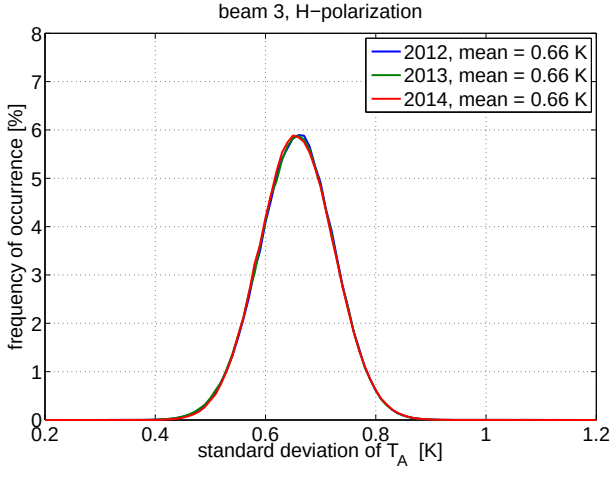




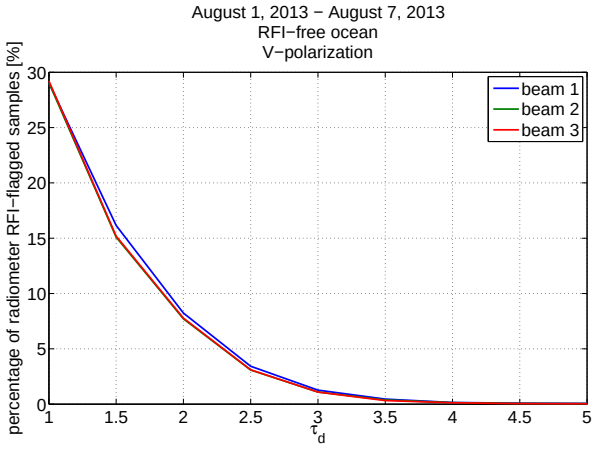


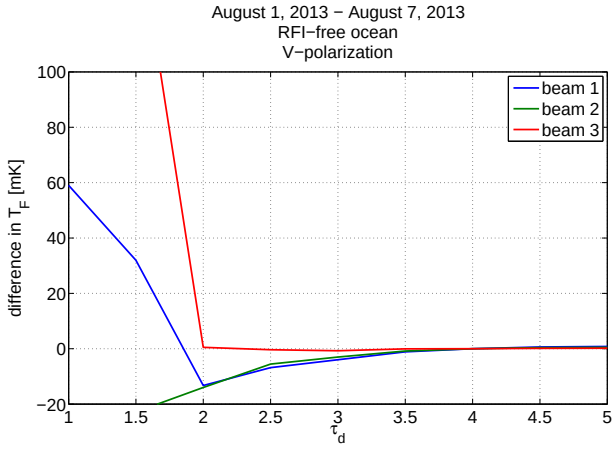


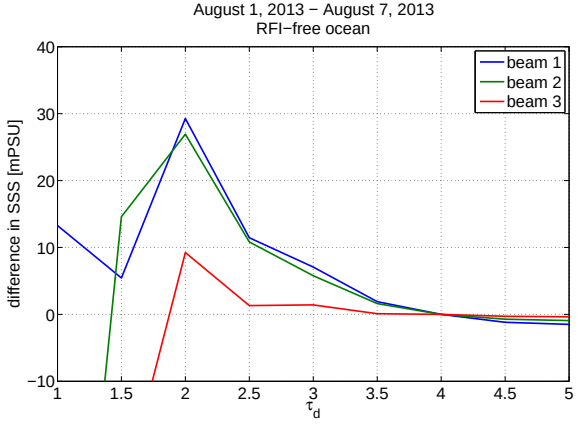




Tuning of vs. τ_d over RFI-free Ocean







- ~ 4 % FAR (one mis-flagged sample) for $W_d = 5$ corresponds to ~ 0.8 % FAR for $W_d = 0$
- ~ 0.8 % FAR is chosen for $W_d = 0$, τ_d would be tuned to ~ 3 (currently $\tau_d = 4$)
- effect of T_f and salinity is minimal

Tuning Procedure over RFI-free Ocean

1. Set $W_d = 2$
2. Set σ_s equal to the value of the T_A standard deviation (over 1.44 s)
3. $\tau_m = 1.5$ remains unchanged
4. Simulate RFI response for different values of threshold τ_d
5. Select value of τ_d that yields desired FAR
6. Set $W_d = 25$?
7. Analyze changes in T_F and SSS (sample data set)

Tuning Procedure over Ocean with Low RFI

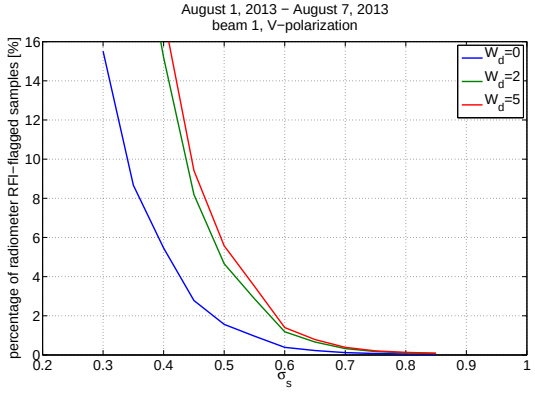
1. Set $W_d = 5$
2. Set σ_s equal to the value of the T_A standard deviation (over 1.44 s)
3. $\tau_m = 1.5$ and $W_d = 20$ remain unchanged
4. Simulate RFI response for different values of threshold τ_d for two weeks in 2013 and 2014
5. Compare results in North Atlantic RFI regions from 2013 (RFI present) and 2014 (no RFI present)

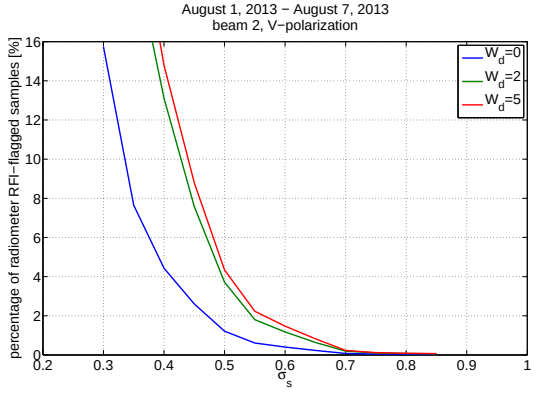
Other Issues

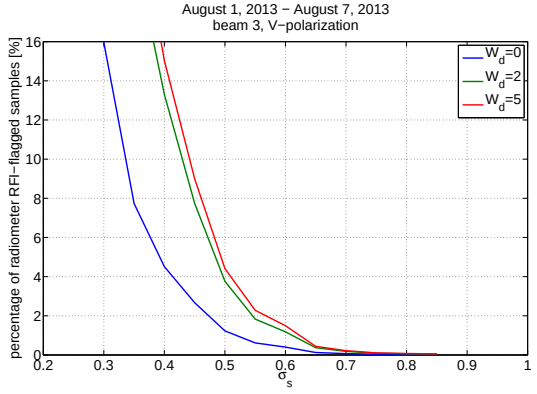
1. Chris Ruf and David Chen algorithm to determine τ_d
2. RFI detection for isolated cases with non-impulsive RFI (e.g., Japan, France)

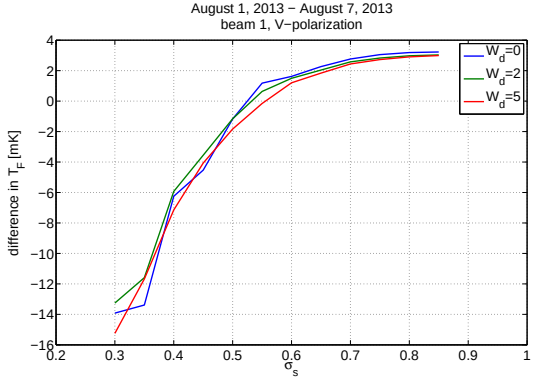
Extra Slides

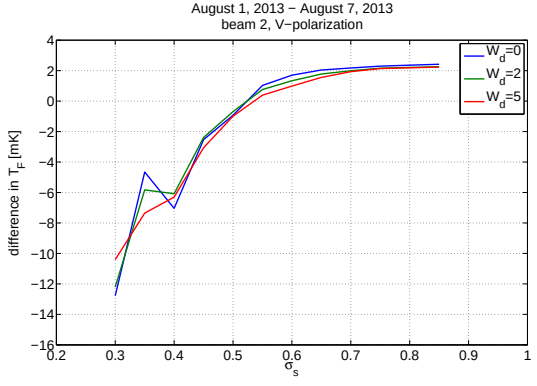
Variation vs. σ_s

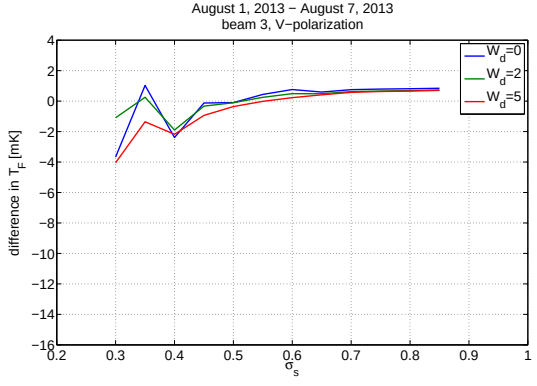


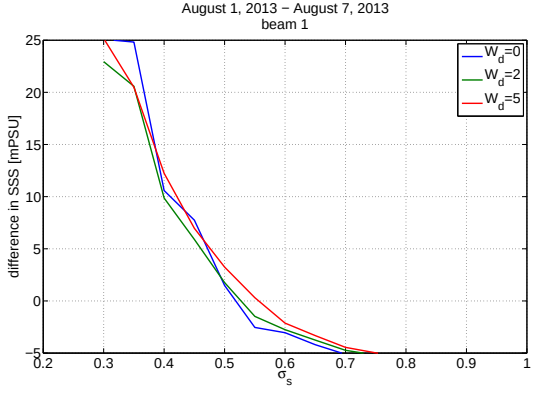


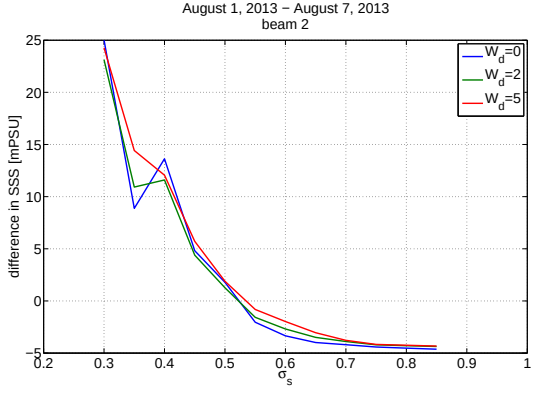


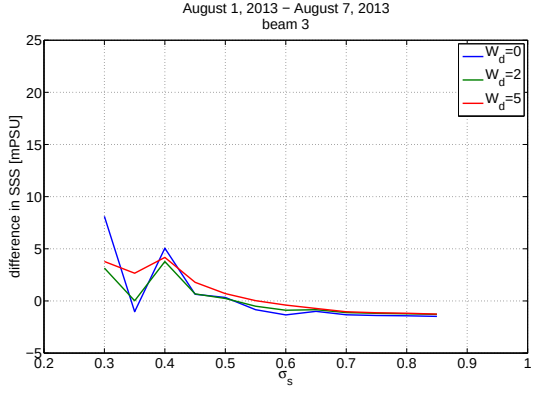












Variation vs. σ_s