Texas A&M X-CAL Activities

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Overview

The X-CAL activities of the Texas A&M "team" (of one) have been wide ranging as have the activities of the X- CAL working group; TAMU has made contributions in all areas. We have compared two years of Windsat data separated by 5 ½ years with TMI to estimate the calibration drift of TMI (if any). TAMU computed the drifts two different ways and combined the working group's results into a coherent whole. The TMI-SSS/I(beta version) offsets have been computed two different ways. Recently two very important data sets have become available, AMSR-2 and SAPHIR. In a an accelerated effort, both data sets have been analyzed for data quality and offset. The two methods of comparing data sets have been discussed in detail in "Comparing Calibrations Of Similar Conically-Scanning Window-Channel Microwave Radiometers" by Thomas T. Wilheit to be published in *TGRS*

SSMI/TMI Matchups X-CAL year

Fitting Algorithm All Data

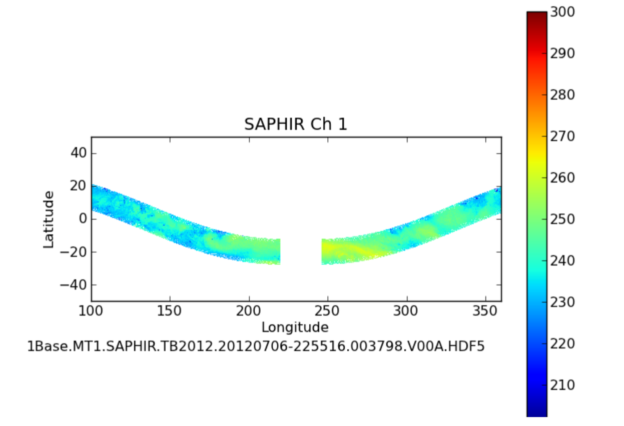
19V	19H	22V	37V	37H	85V	85H
F13						
0.66	-0.12	1.75	-1.35	0.28	0.67	1.34K
F14						
0.87	-0.54	1.66	-1.07	0.02	1.10	1.52K
F15						
0.17	-0.41	1.29	-1.08	0.09	0.53	1.11K

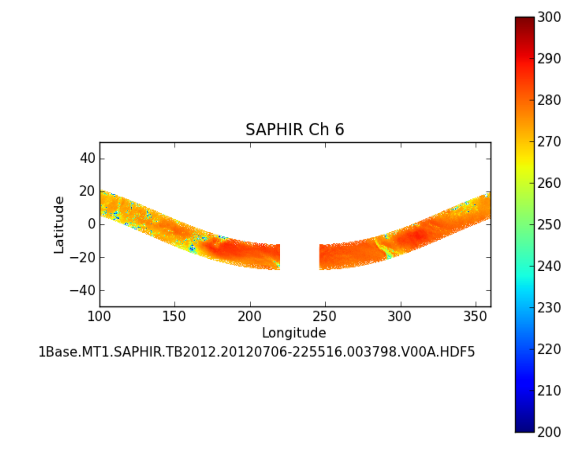
GDAS Algorithm All Data

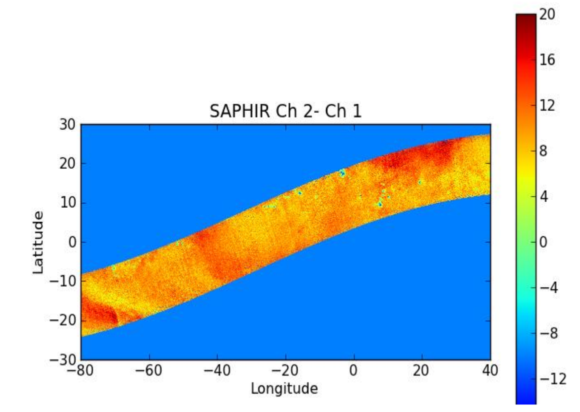
F13						
0.67	-0.13	1.73	-1.34	0.26	0.69	1.33K
F14						
0.87	-0.55	1.62	-1.06	0.01	1.12	1.50K
F153						
0.18	-0.43	1.26	-1.07	0.08	0.55	1.09K
@ 195	128	222	212	149	256	219K

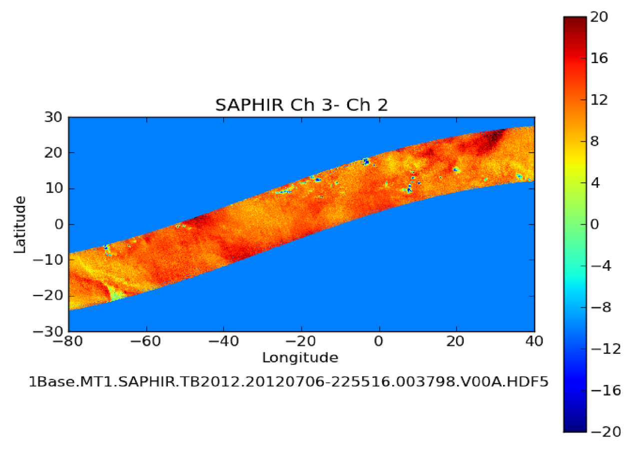
Using the Beta version of the CSU Fundamental Climate Data Record and matchups generated by UCF, we have run analyses of the SSM/I differences from TMI. These results are preliminary, however the final version has recently been released so we are in a position to generate at-launch values almost immediately

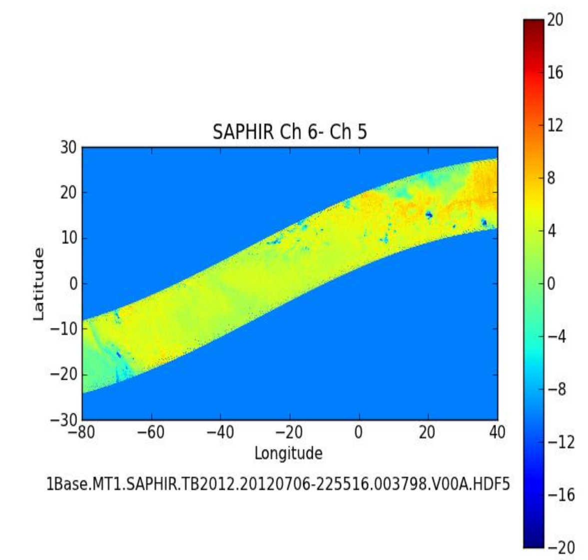
SAPHIR Imagery











In raw imagery, cold features suggest convection. Most convection should show up in channel 6 (the lowest altitude sounding channel) and only the most intense should show up in channel 1(the highest sounding channel. By going to difference images, the detection of convection becomes much clearer, Negative values of the differences can only be generated by scattering of radiation by ice. All convection will show up in the channel 5-6 differences and only the most intense in the channel 1-2 difference.

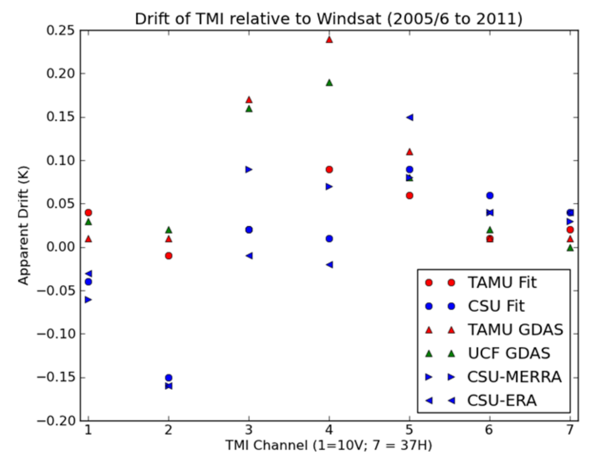
TMI Drift (NOT!)

More than 15 years since launch of TRMM
>11 Years Since boost
Likely more to come

Very long self-consistent data set to investigate climate changes

Subsets have already been used to look at oceanic rain trends

How "self-consistent" is it?



OK, what do we believe?

First: What do we have to work with?

TMI Freq (GHz)	TMI EIA	Windsat Freq	Windsat EIA	
10.65	53.34°	10.66	50.41°	(0 GHz/2.93°)
19.35		18.7	55.91°	(0.65GHz/ 2.57°)
21.3		23.8	53.54°	(2.5GHz/0.20°)
37		37	53.53°	(0GHz/0.19°)

37H corrections < 0.1K (angle only)
19H as large as 10K (angle and frequency)

OK, what do we believe?

(continued)

Put together a preliminary scoring system with 4 factors:

- Statistical Uncertainty
- Variability of Correction Method-to-Method
- Variability of Correction Matchup-to-Matchup
- Variability of Results Method-to-Method

Renormalize each so best channel is 1 and worst is 0 and add

Channel	Credibility Score	Apparent Drift
37H	2.8	0.02K
37V	2.6	0.03K
10V	2.1	-0.01K
10H	1.7	-0.07K
21V	1.1	0.10K
19V	0.6	0.10K
19H	0.6	0.12K

Suggests that drift is of the order 0.02K ± *ca*. 0.05K or less over 5 ½ years. (Consistent with no change)

Additional Points

These results must be considered preliminary

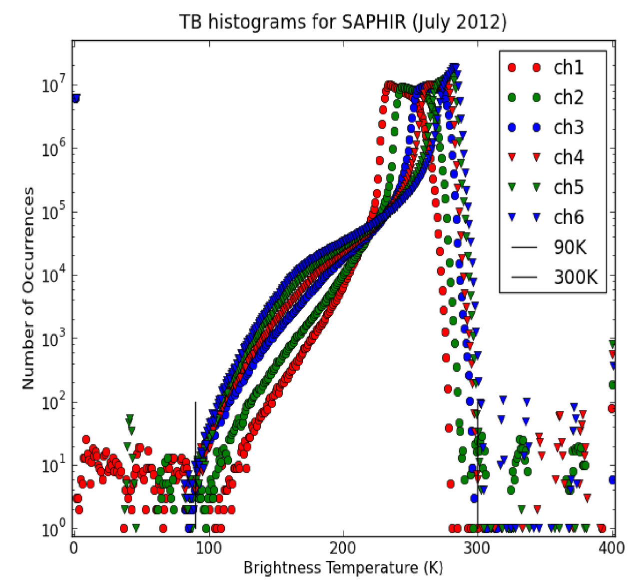
Longer Time Series would Help (Windsat Launch was Jan 2003)
10 + Year Series Possible

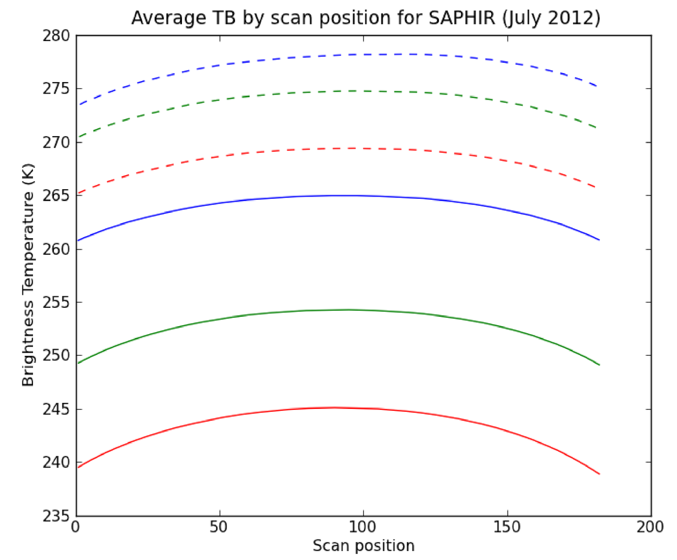
Planned Calibration Maneuver at TRMM End-of-life is very important.

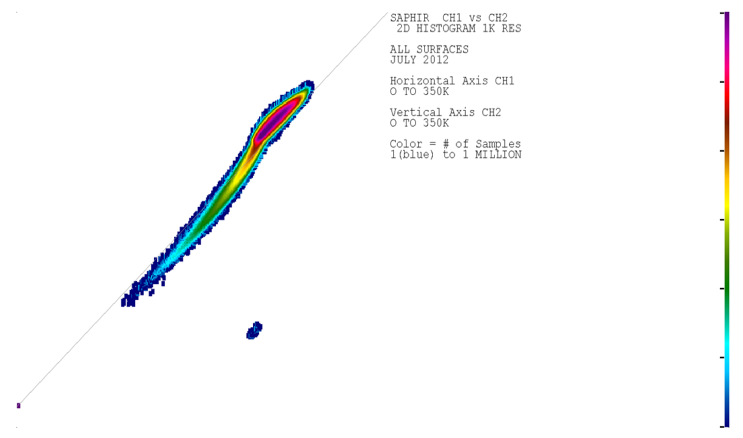
Likewise GPM soon after launch

Underscored X-CAL strategy of using multiple approaches
Fitting and Analysis Techniques have different problems.

SAPHIR Data







AMSR 2 TMI Intercomparisons

INTERCALIBRATION WITH TMI

Got 4 months of Matchups from UCF (thanks)

Ran fit based and GDAS based algorithms

Did Fits with both 7 (1-37GHz) and All 9 TMI Channels

Ran with both TMI Version 7 and TMI CC_1.1

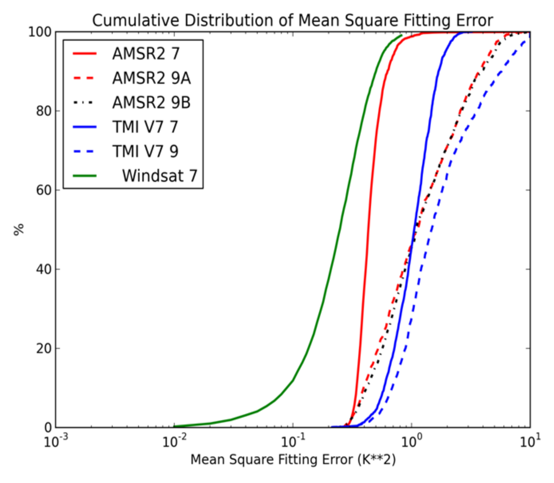
400 samples/month—heavily filtered.

Looked at AMSR-2 Model Consistency

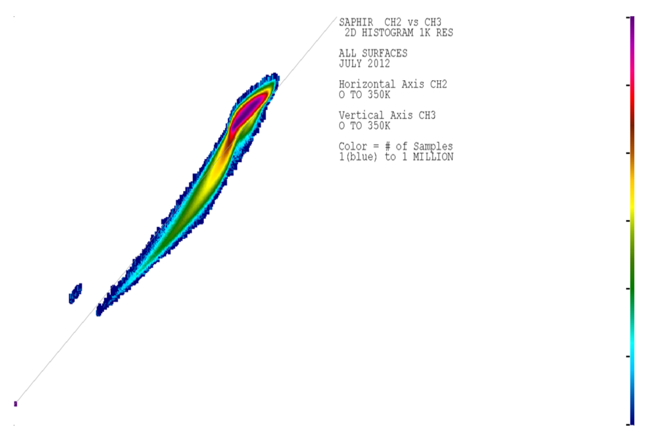
Intercalibration of AMSR2 and TMI V7

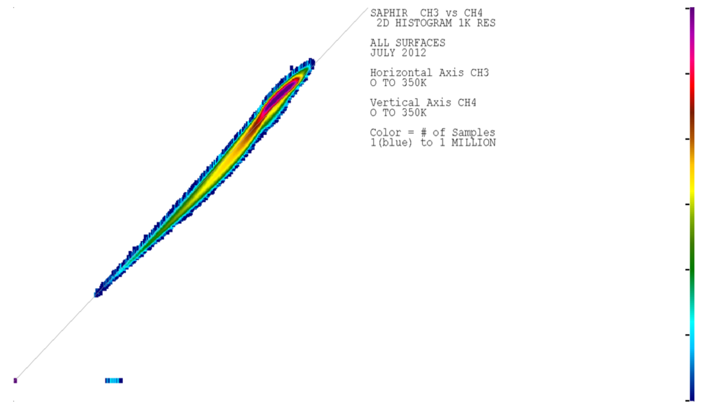
AMSR2 Channel	7ch	9ch	GDAS	JAXA Prelim
10V	4.1	4.1	4.1	4.3
10H	5.2	5.1	5.2	5.0
18V	4.1	4.1	4.0	3.5
18H	2.9	2.7	2.7	2.7
23V	4.1	4.1	4.2	5.5
23H *	5.8	6.0	6.7	
36V	4.3	4.4	4.3	3.9
36H	5.2	5.3	5.2	4.5
89AV	2.5	2.5	2.7	1.9
89AH	3.3	3.3	3.6	2.8
89BV	2.8	2.8	3.1	1.9
89BH	3.2	3.2	3.5	2.3

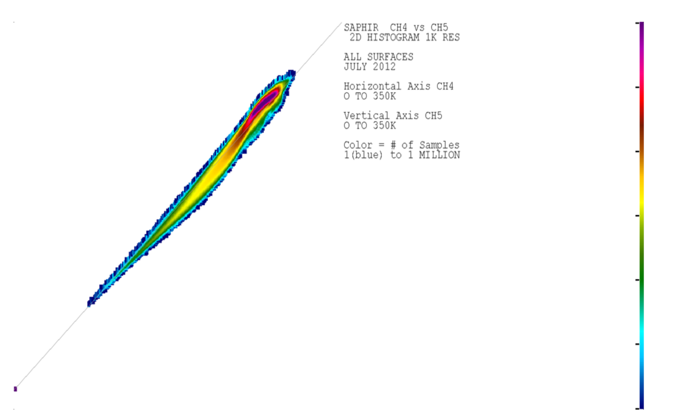
*23H Very Uncertain.

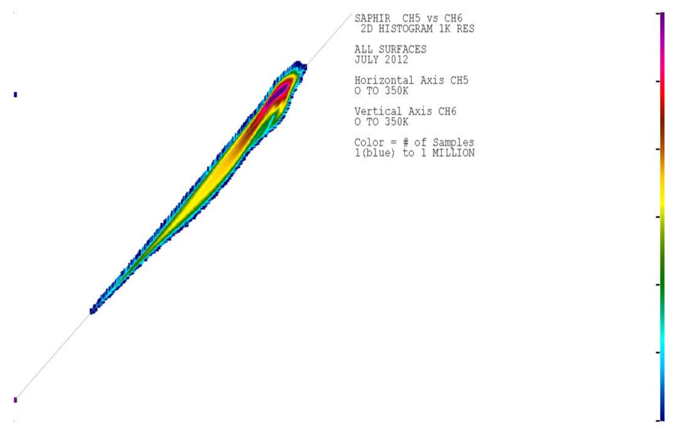


At the TRMM 15th "Birthday-Party" in Tokyo, I met with Keiji Imaoka and other personnel from JAXA and Melco. They show preliminary calibration results for AMSR 2. The warm bias was unexpected particularly at 10 GHz. He asked if the X-CAL team could corroborate the preliminary results. The TAMU results do, in fact , corroborate the JAXA results.

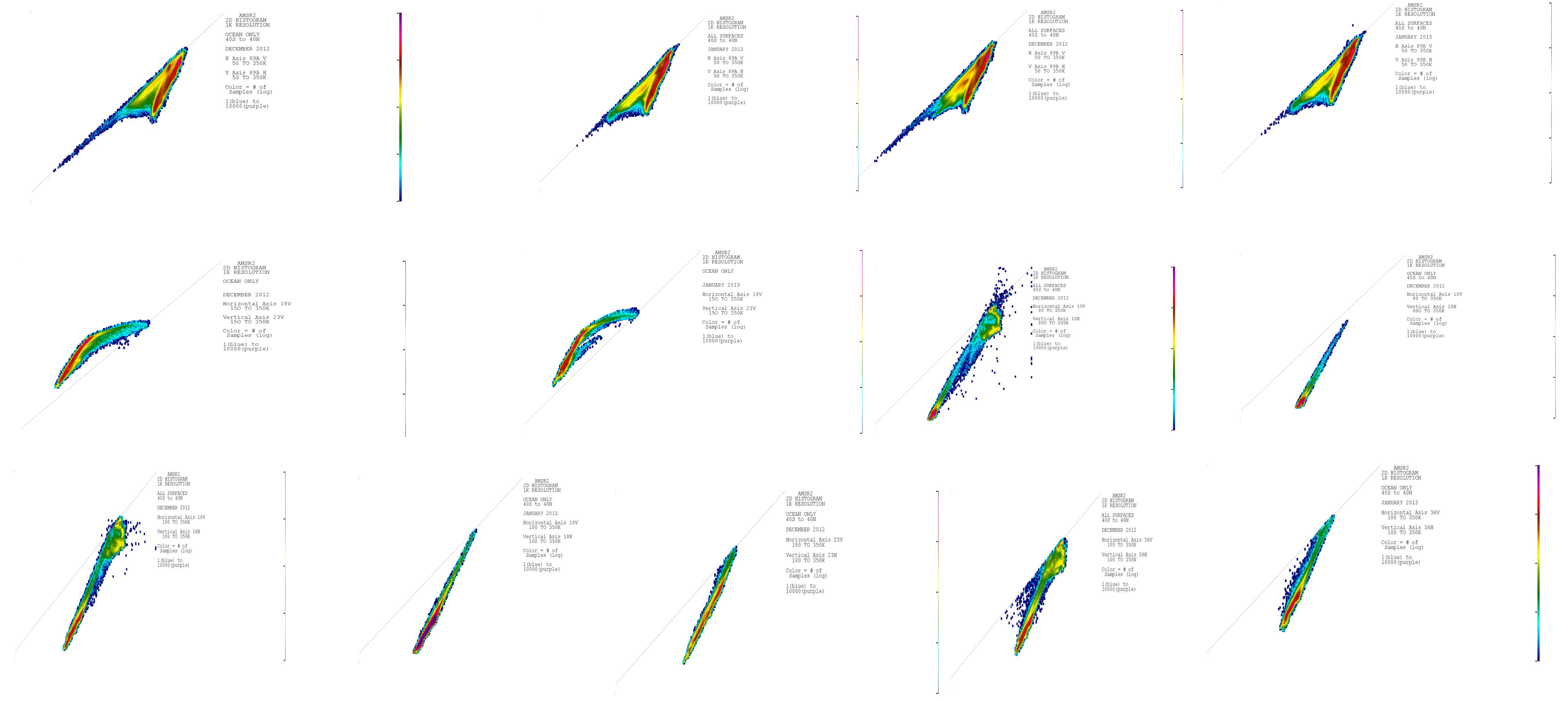


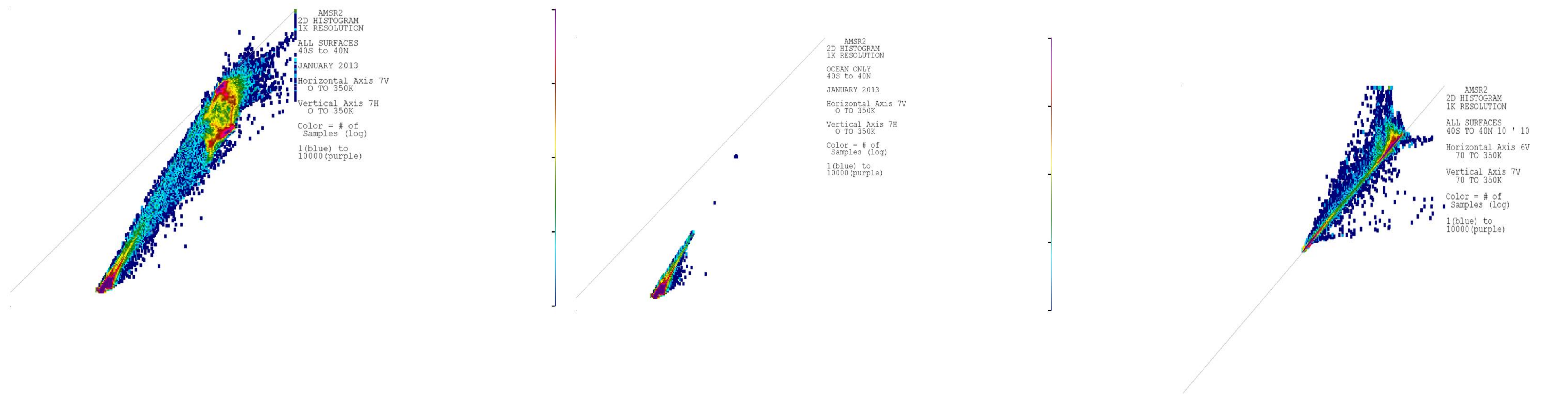






AMSR 2 Scatter Plots





The AMSR-2 scatter plots (2D Histograms @ 1K resolution) were produced quickly after the data became available. The top row shows scatter plots for the 89A and B channels. These data are extraordinarily clean. In the 4 panels only one questionable point (out of approximately 5 Billion) is observed. The 18V 23V plots on the second row are similarly well behaved. When overlaid with computed contours these points fall into a rain-rate/freezing level space. The 10 GHz plot (all surfaces) shows a great deal of scatter, but the data become quite clean when restricted to ocean only. The plots for 23 and 37 GHz are also quite clean. AMSR2 included both 6 and 7 GHz channels for Radio Frequency Interference (RFI) detection. If the two frequencies differ by any substantial amount, the signal is narrow band *i.e.* RFI. One can see that the RFI is extremely bad over land but much less so over ocean.

SAPHIR Retrieval-Based Algorithm

Conventional Temperature Weighting Function

$$Tb_{\uparrow} = \int_0^{\infty} K(\nu, h) T(h) dh$$

Would be nice if….

$$Tb_{\uparrow} = \int_0^{\infty} G(h) \gamma(h) dh$$

Unfortunately….

However

$$\Delta Tb_{\uparrow} = \int_0^{\infty} G(h, \gamma(h), T(h)) \Delta\gamma(h) dh$$

Can actually generate such a sensitivity function

$$G(h, \gamma(h), T(h)) = e^{-\tau(h,\infty)} (T(h) - Tb_{\uparrow}(h)) +$$

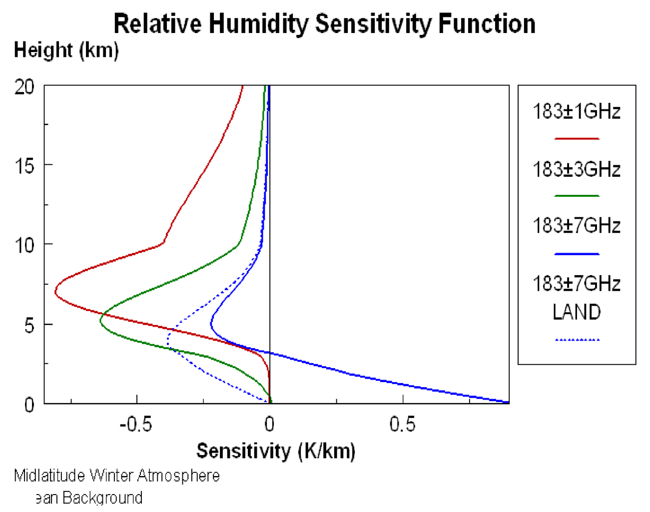
$$\mathrm{R} e^{-\tau(0,\infty)} e^{-\tau(0,h)} (T(h) - Tb_{\downarrow}(h))$$

Water Vapor Sensitivity Function

$$G_{\rho} = G \frac{\partial \gamma}{\partial \rho}$$

Relative Humidity Sensitivity Function

$$G(h)_{RH} = G(h)_{\rho} \rho_{sat}(T(h))$$



Use Matchup Data Set provided by Saswati Datta (UCF)
(60,558 matchups)

For Now use Placeholder Atmosphere

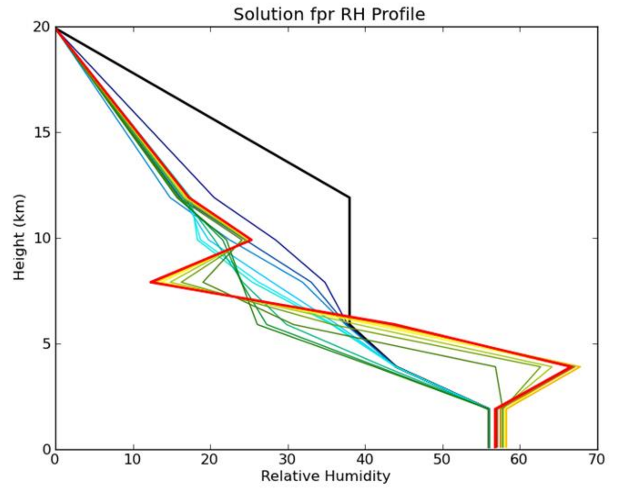
For Each Matchup Retrieve WV Profile from SAPHIR obs.
Iteratively minimize ΔTbs and Δ from a Statistical Constraint (first guess)
Handles liquid clouds

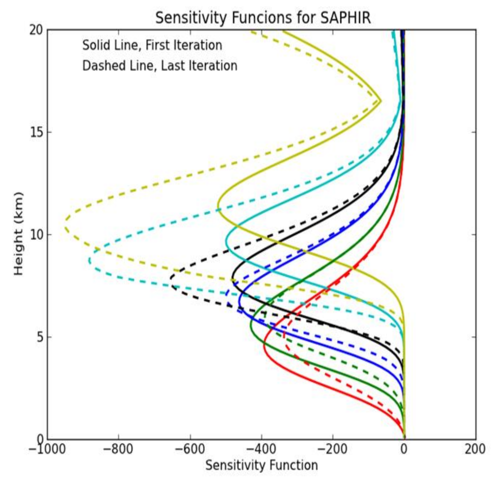
Start with one channel (highest peaking)
after 3 iterations add second channel…
6th channel added at 16th interation
stop at 25 iterations

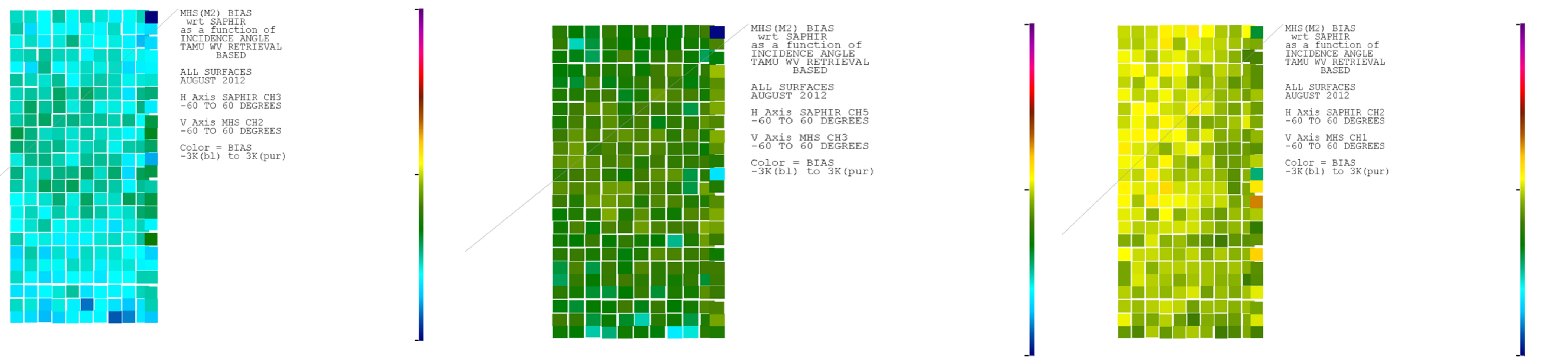
Compute MHS TBs

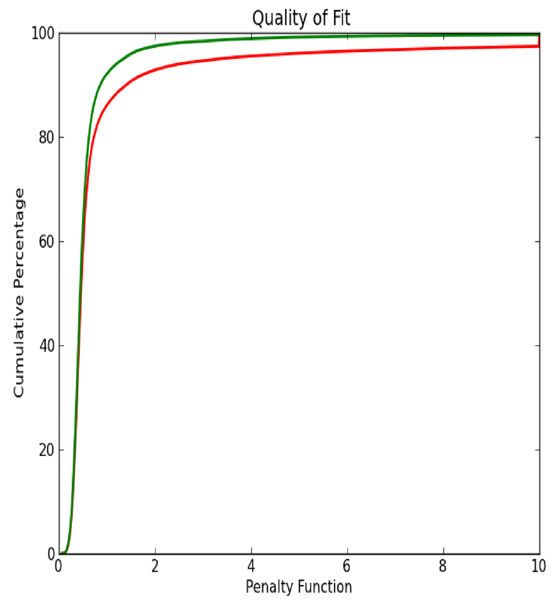
Use all incidence angles

½ hour to run all 60,558 cases.









The retrieval-based intercomparison algorithm is analogous the fitting algorithm used for imagers by TAMU and CSU. However, it only adjusts the humidity profile and retains the temperature profile furnished by the analysis. It can also insert a cloud if the brightness temperatures require it. The key to the retrieval is a closed-form Jacobian to relate changes in the humidity profile to changes in the brightness temperatures. The algorithm begins with a first guess profile (Black). It first adjusts the profile based only on SAPHIR channel 1 for 3 iterations, and then adds the remaining SAPHIR channels (top down) one at a time. It quits after 25 iterations. The present version is very preliminary. However, it indicates that wide Earth incidence angle differences can be accommodated by the algorithm and that the EIA dependence of the differences between SAPHIR and MHS is reasonably small.