RFI Detection and Correction on Cold Target of FY-3D/MWRI

Shengli Wu@NSMC

28th CALCON
Logan, Utah, USA
2019.06.19

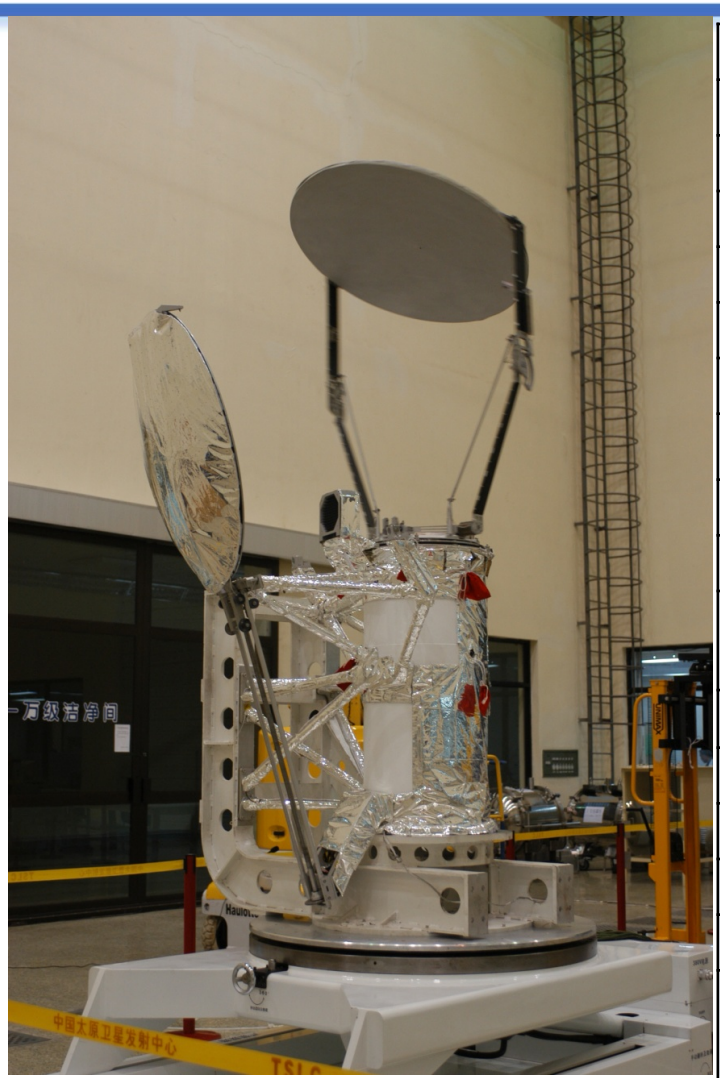
calcon
www.calcon.sdl.usu.edu

CMA NSMC NSMC

Outline

- Introduction of FY-3D/MWRI
- Motivation
- RFI Detection and Correction on Cold Target
- Conclusion

Introduction of FY-3D/MWRI



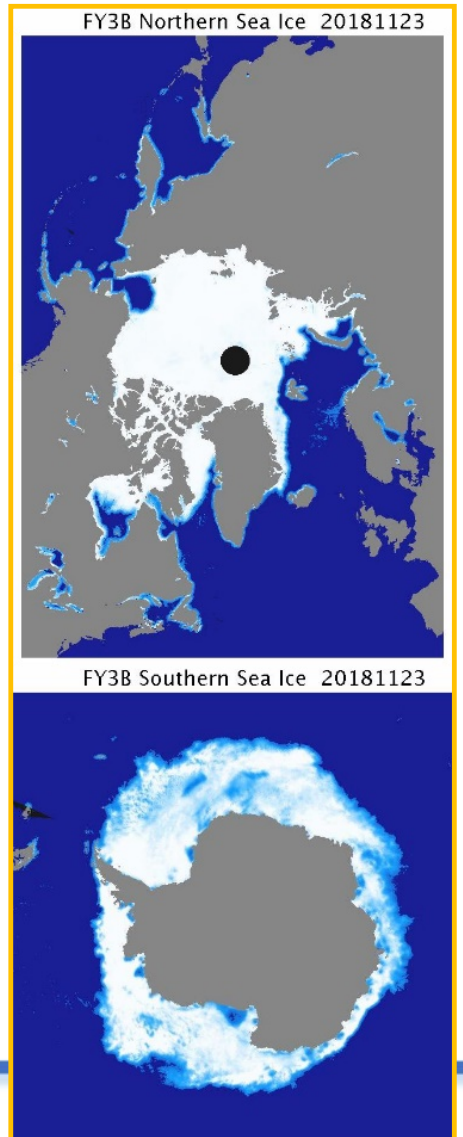
Frequency(GHz)	10.65	18.7	23.8	36.5	89
Polarization	V.H	V.H	V.H	V.H	V.H
Band Width(MHz)	180	200	400	900	2×2300
NeDT(k)	0.5	0.5	0.5	0.5	0.8
Accurancy(k)	2.0	2.0	2.0	2.0	2.0
BT Range(k)	3～340				
Scan Points	266(1.8s)				
Black Body Stability	0.3K				
Nonlinear	<1K				
Main Beam	≥90%				
Resolution ≤(km×km)	51×85	30×50	27×45	18×30	9×15
Beam of different Channel	<0.07°				
Scan	Conic				
Orbit Width(Km)	≥1400				
Antenna angle(°)	45				
Scan Period(s)	1.8±0.1				
Scan Period Stability(ms)	≤0.36ms*（2 Scan lines）				
	≤1ms(30 minutes)				

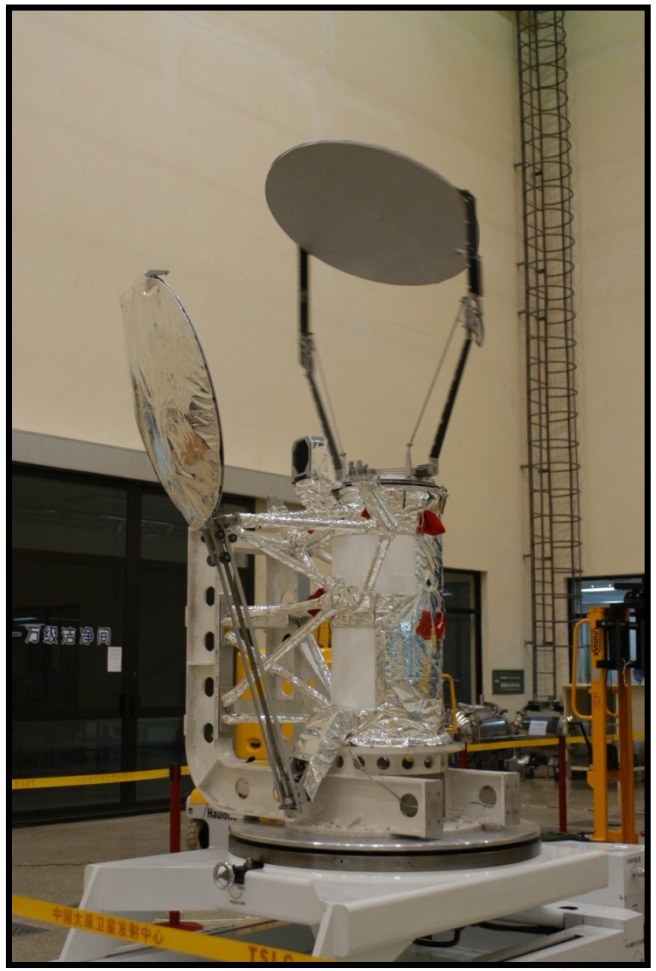
FY-3/MWRI launch schedule

- Shut down:
  - 2008:FY-3A(10-89GHz, Dul-p, Morning Orbit);
- Operational：
  - 2010:FY-3B(10-89GHz, Dul-p, Afternoon Orbit);
  - 2013:FY-3C(10-89GHz, Dul-p, Morning Orbit);
  - 2017:FY-3D(10-89GHz, Dul-p, Afternoon Orbit);
- Schedule (10-89, 50, 118, 183GHz)：
  - 2020:FY-3F(Morning Orbit, **Reflector increased to 1.8m**);
  - 2021:FY-3P(**Precipitation Satellite, Lower orbit, Reflector increased to 1.6m**);
  - 2022:FY-3G(Afternoon Orbit, **Reflector increased to 1.8m**);
  - **The emissivity of reflector will be much improved for these 3 sensors.**

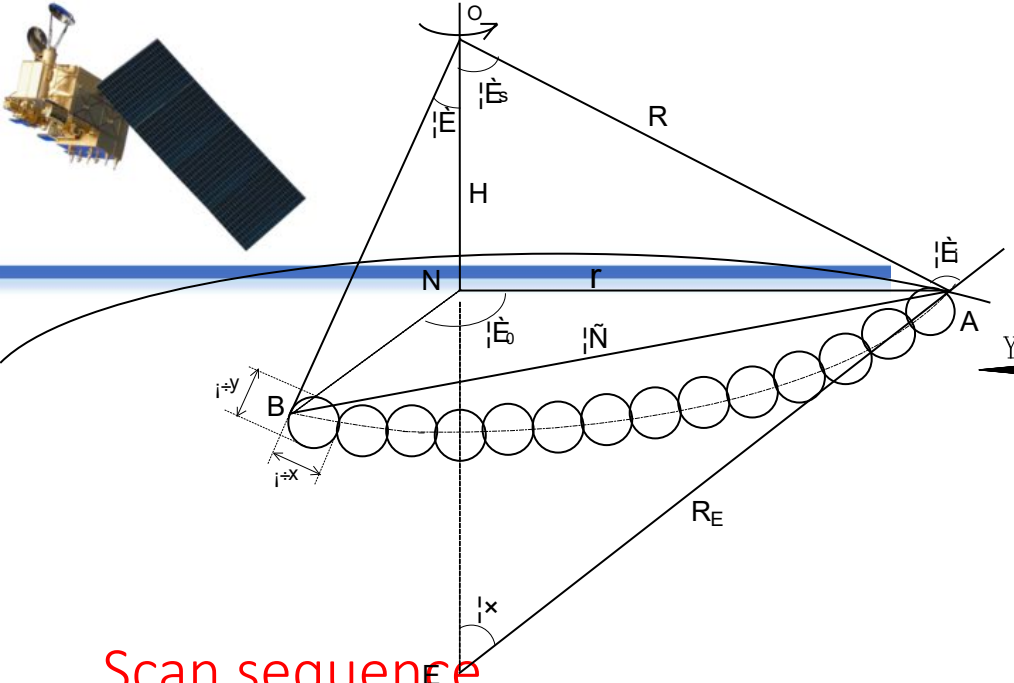
Time Series Data Record

- FY-3B：
- 2010-2019

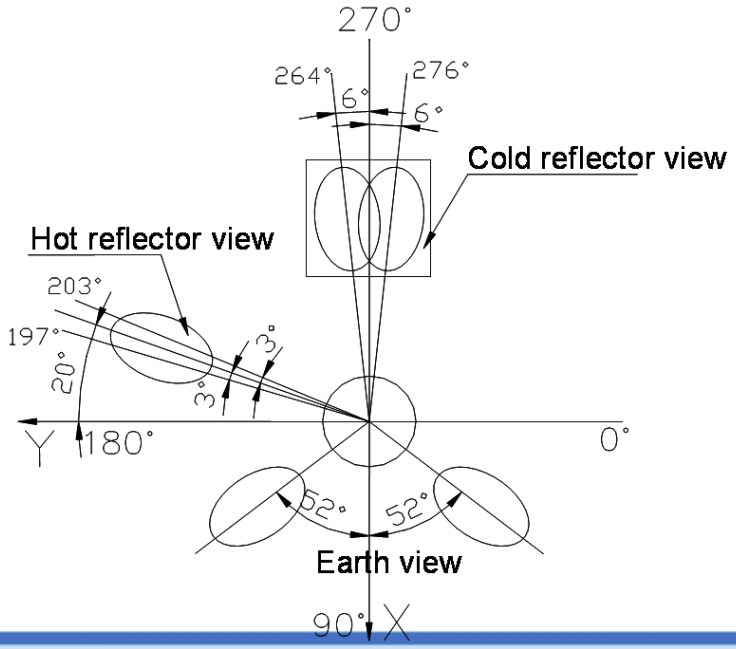




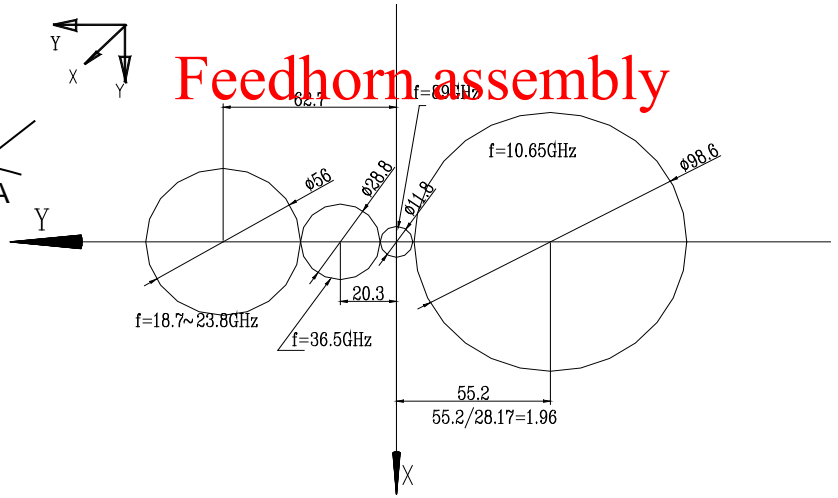
CMA NSMC NSMC



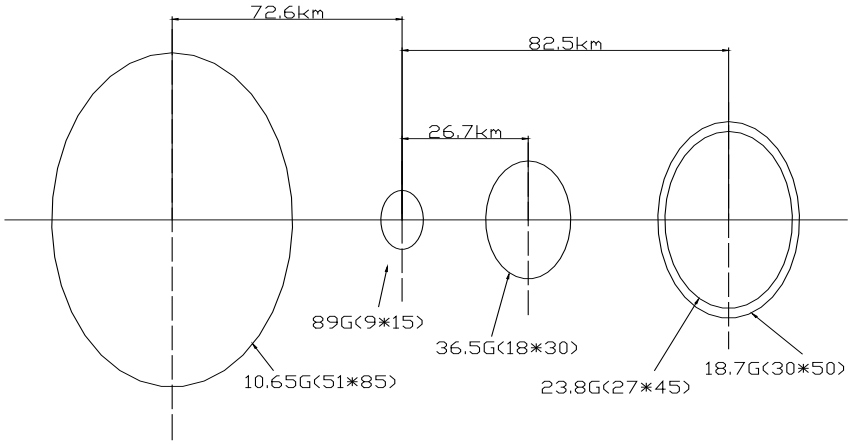
Scan sequence



Feedhorn assembly

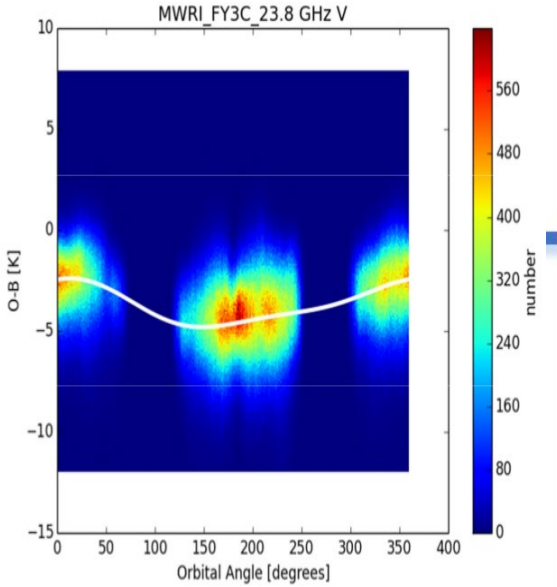


Antenna Pattern
Ground footprint



MWRI (FY-3C)

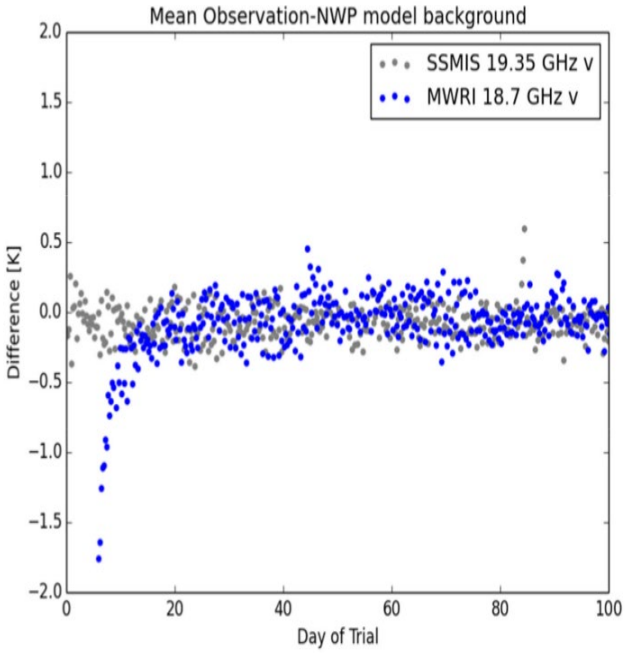
MWRI 23 GHz V-pol O-B from the Met Office over clear sky ocean w.r.t the orbital angle, May 2017. Fourier series fit (white).



A bias correction scheme similar to that of SSMIS was developed for MWRI FY-3C:

- A Fourier series with N=1 component (2 predictors + 1 constant) is used to fit MWRI bias.
- After correction O-B differences against the NWP model are similar to those found with existing microwave imagers, such as GMI.

MWRI FY-3C radiances from 18-37 GHz channels will be assimilating from May 2019.



Mean residual bias after correction in a Met Office assimilation trial for MWRI 18.7 and SSMIS 19.35 GHz V-pol channels.

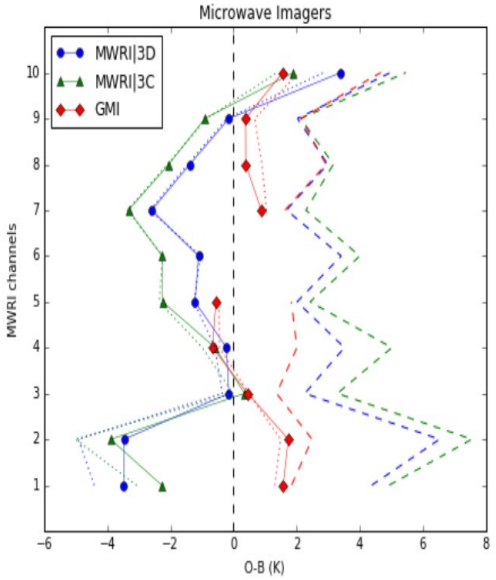
FROM Met Office

Carminati et al., 2018 https://link.springer.com/article/10.1007/s00376-018-7266-8
Candy et al., 2019 - in prep

CMA NSMC

MWRI (FY-3D)

FY-3D MWRI (blue), FY-3C MWRI (green), and GPM GMI (red) O-B mean (solid), mode (dotted), and standard deviation (dashed), June 09, 2018, over clear sky ocean.



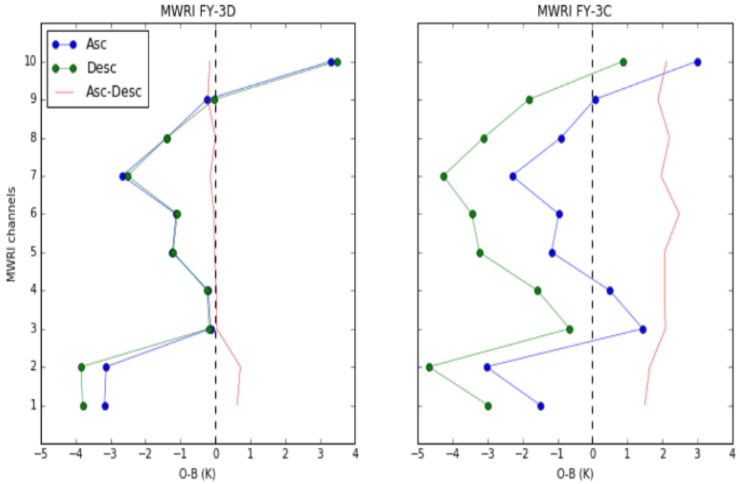
A preliminary study has been conducted on 24h of MWRI FY-3D observations. It suggests:

- A reduction of global mean O-B and standard deviation compared to the FY-3C version.
- Close agreement with GMI at 18, 23, and 89 GHz.
- The OA bias reduced to less than 0.2 K on FY-3D.

Those findings are consistent with the bias correction developed by CMA aimed at reducing the noise in the warm target used for the calibration and an emissivity correction for the warm and cold reflectors.

It is planned to further evaluate MWRI FY-3D for a possible assimilation late 2019.

FROM Met Office



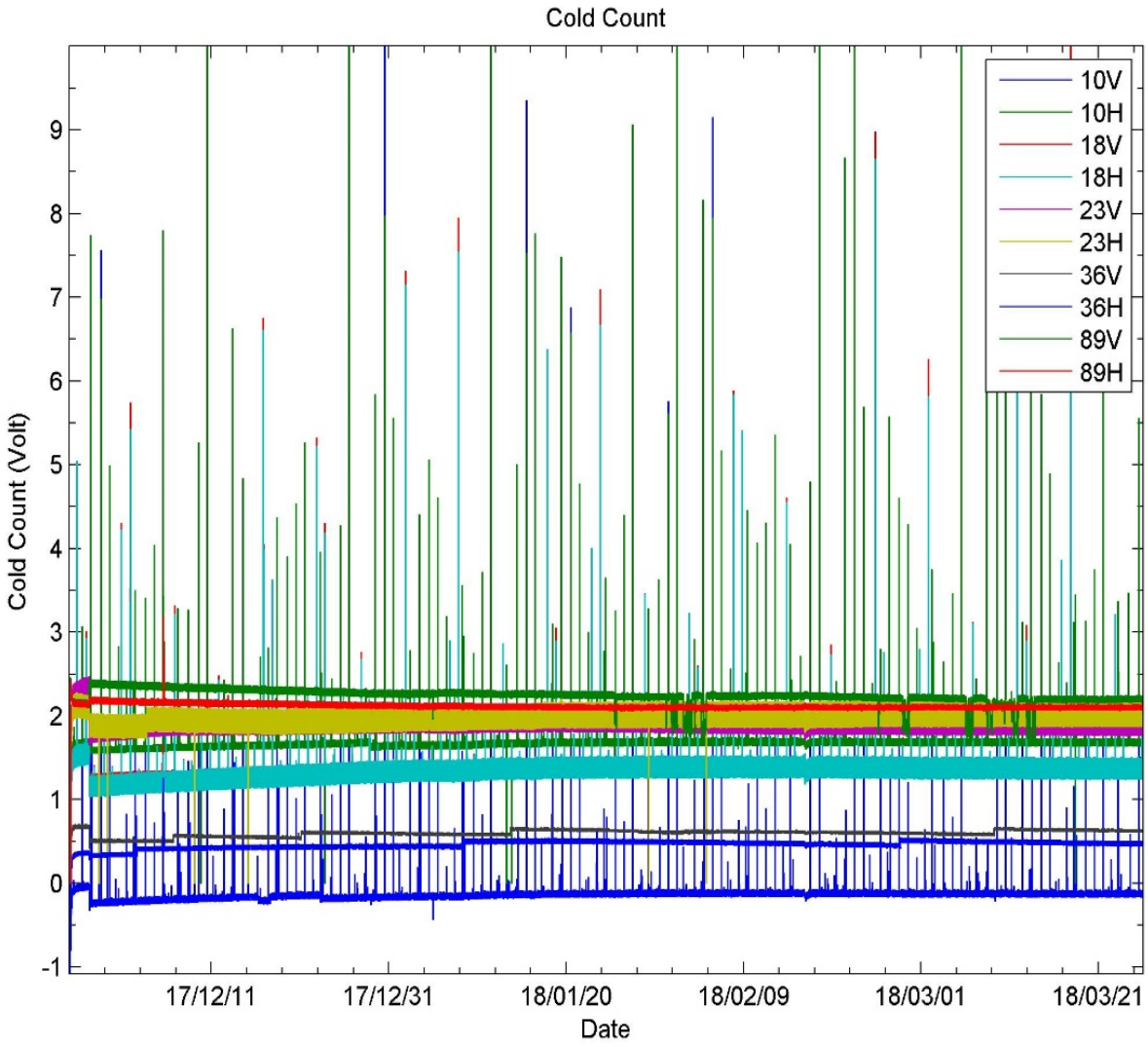
FY-3D MWRI (left) and FY-3C MWRI (right) O-B from the ascending nodes (blue), descending nodes (green), and their difference (red), June 09, 2018, over clear sky ocean.

Xie et al., 2018 https://ieeexplore.ieee.org/abstract/document/8566165

Carminati et al., 2019 https://www.metoffice.gov.uk/binaries/content/assets/mohippo/pdf/library/weather-science-technical-reports/frtr_634_2019p.pdf

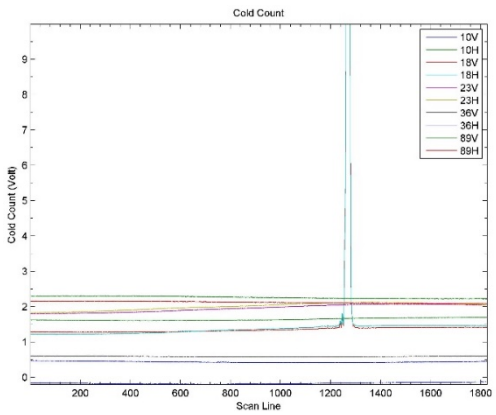
CMA NSMC NSMC

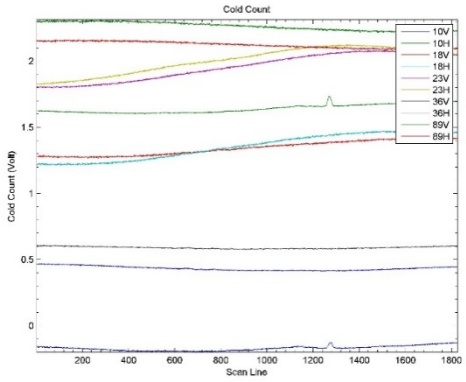
Motivation

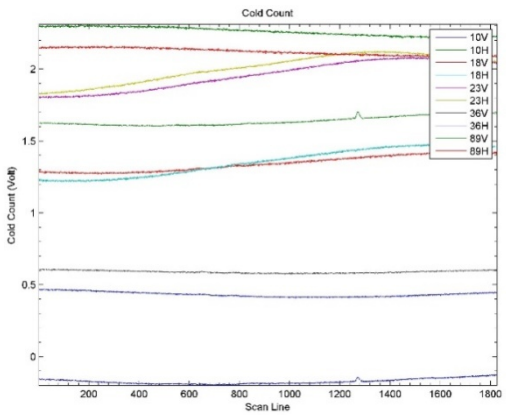

Cold Count
Cold Count (Volt)
Date
10V
10H
18V
18H
23V
23H
36V
36H
89V
89H
9
8
7
6
5
4
3
2
1
0
-1
17/12/11
17/12/31
18/01/20
18/02/09
18/03/01
18/03/21

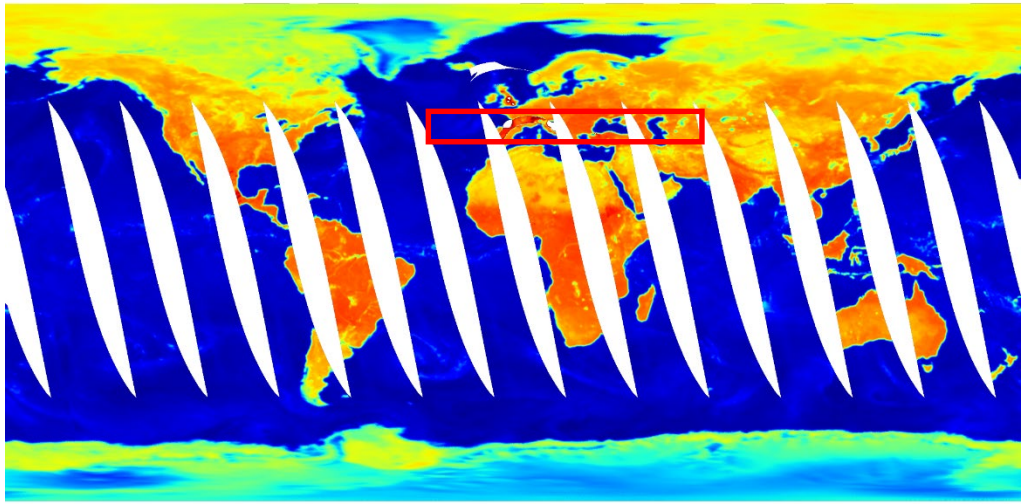
For 10GHz always in EU area

Strength decreasing in 3 orbits

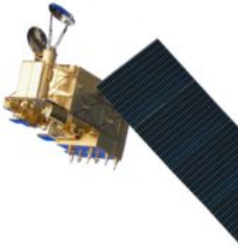


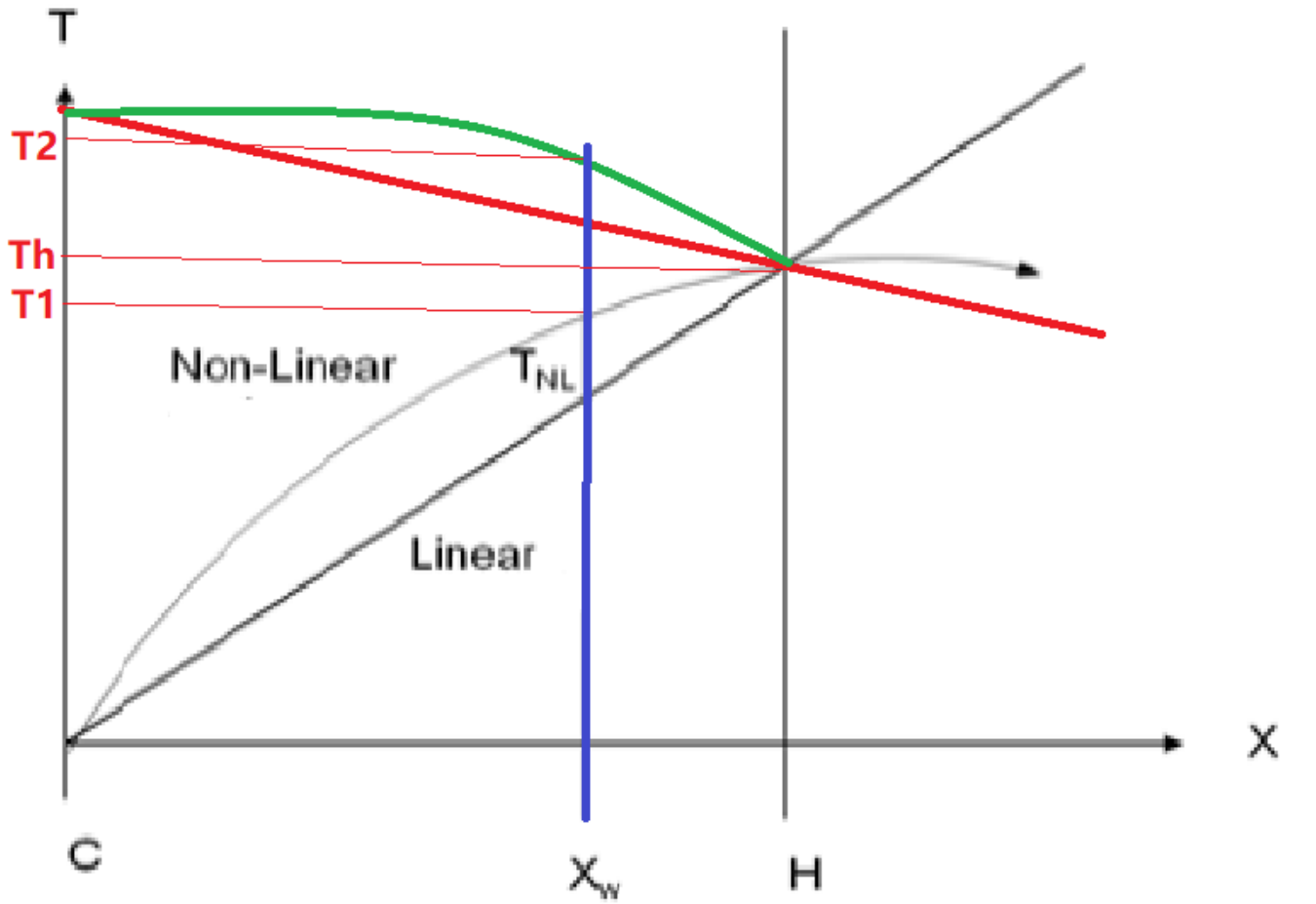


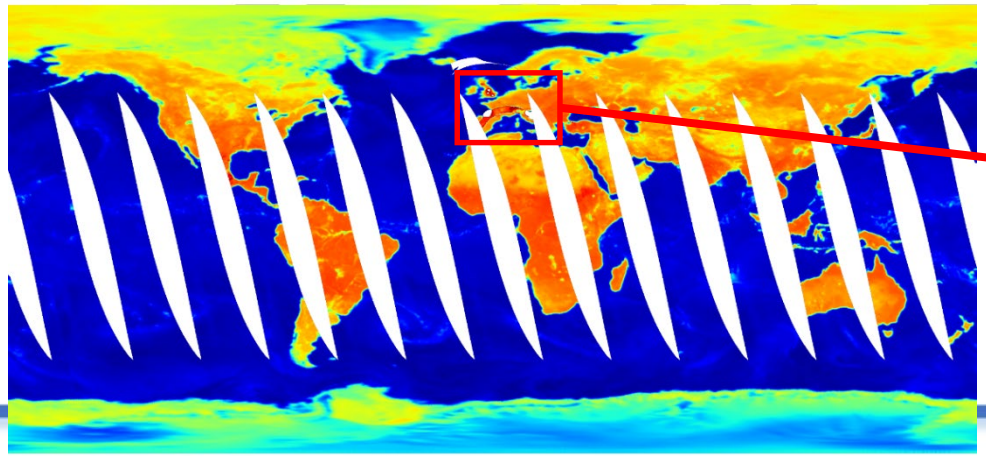


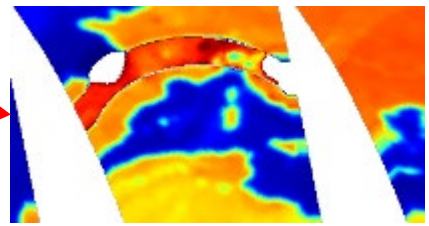


CMA NSMC NSMC



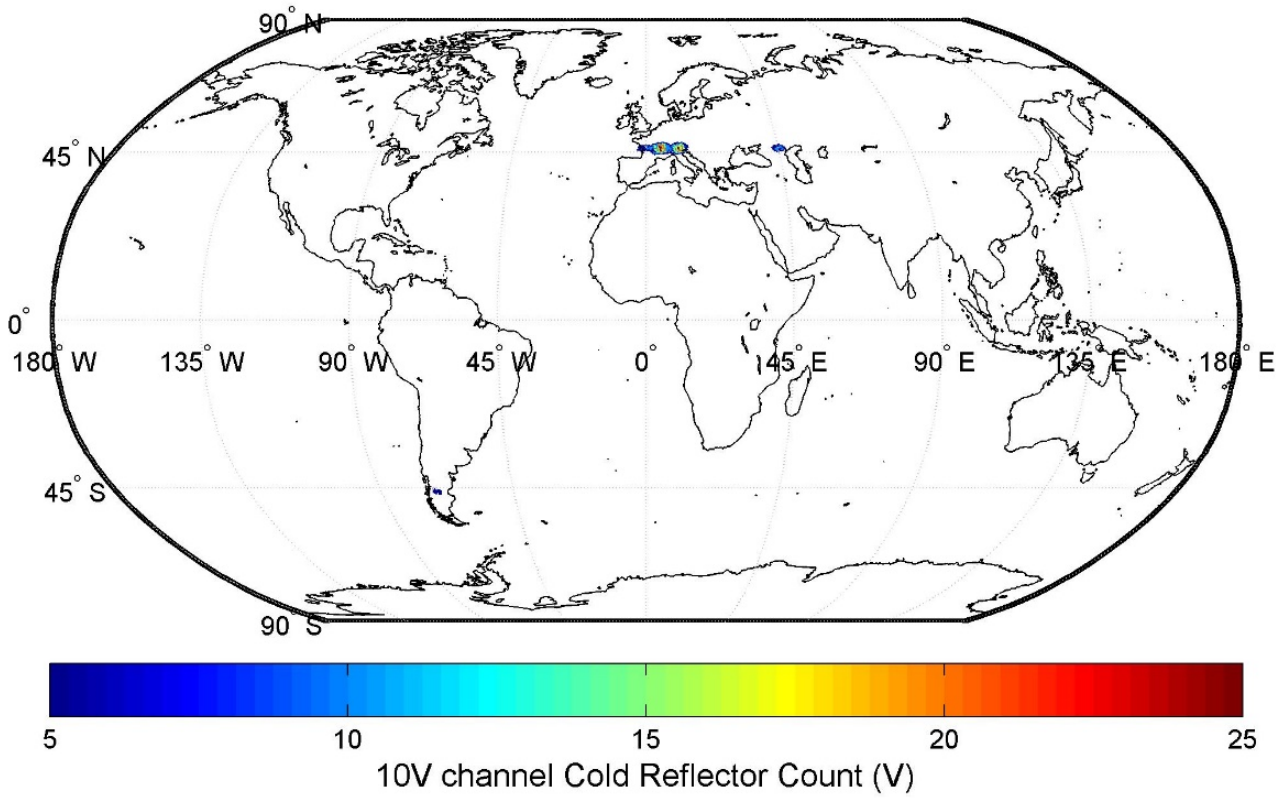


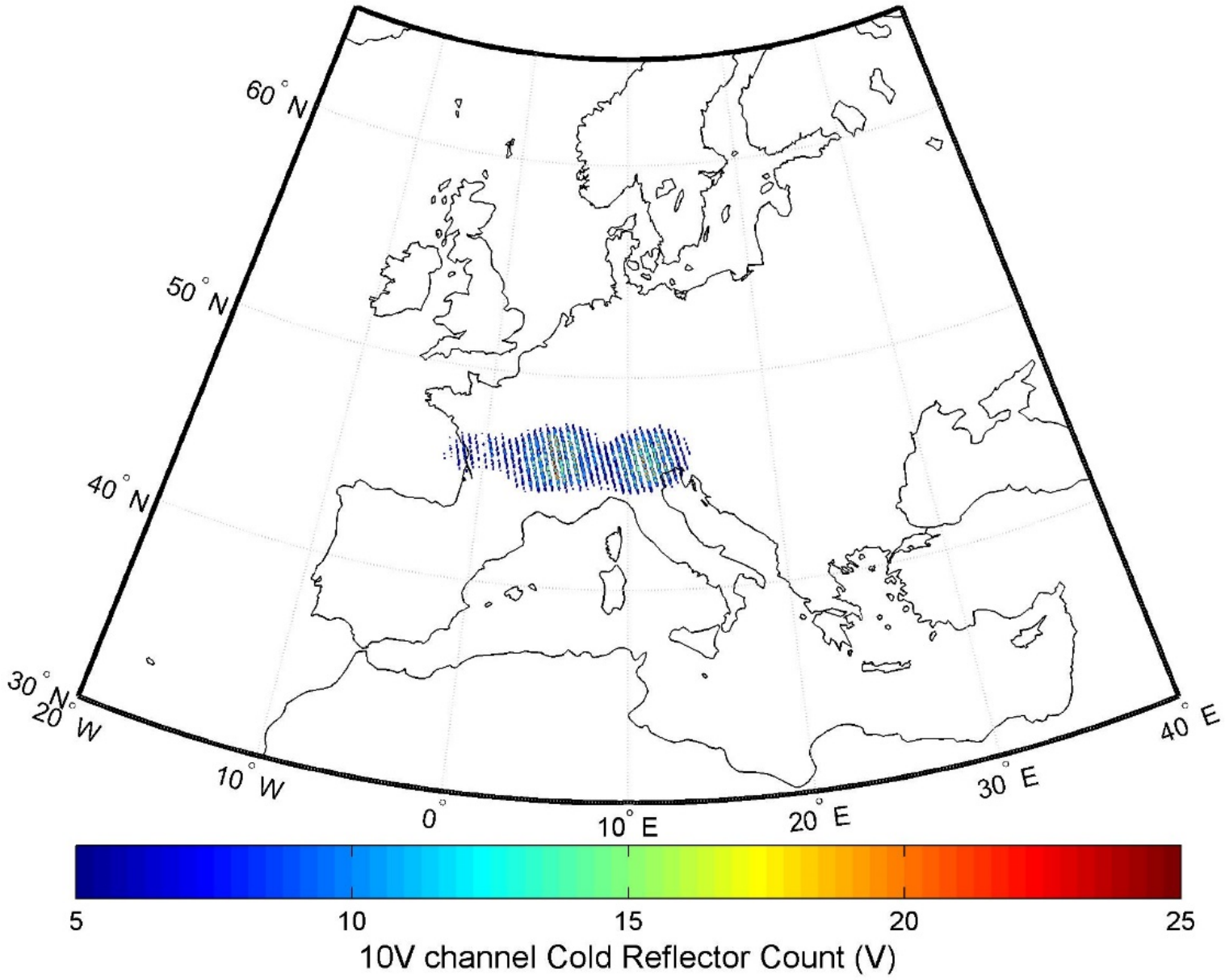




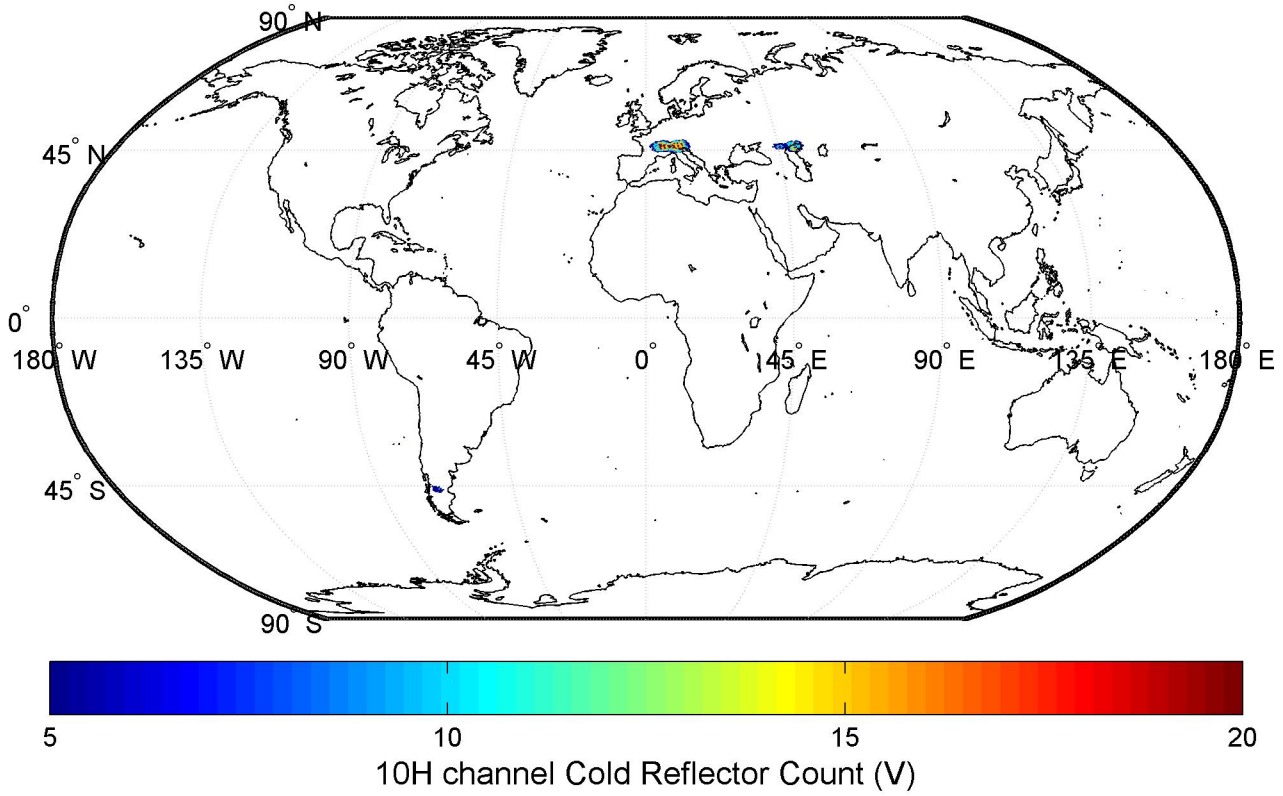
CMA NSMC NSMC

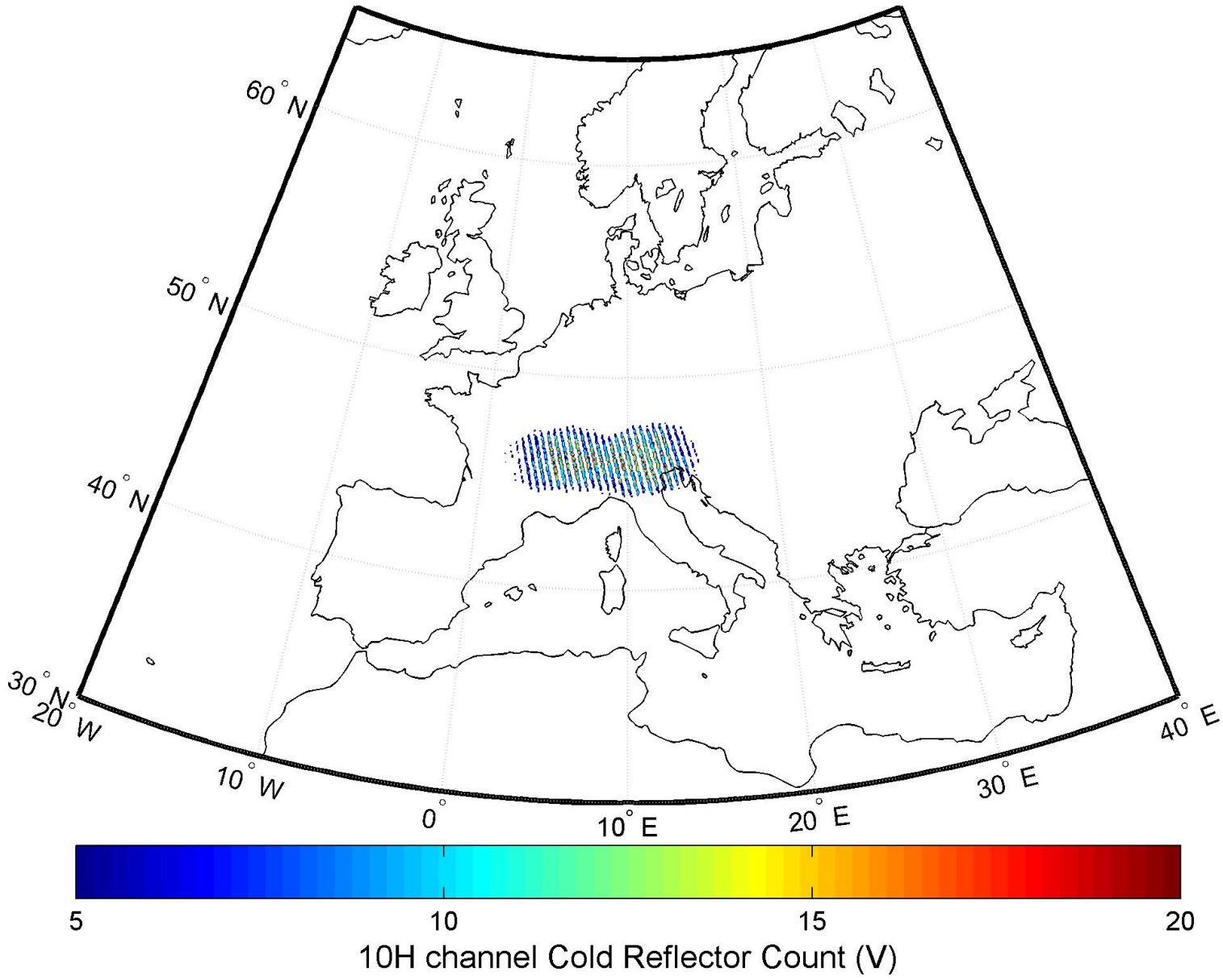
Cold Count Jump Area of 10V



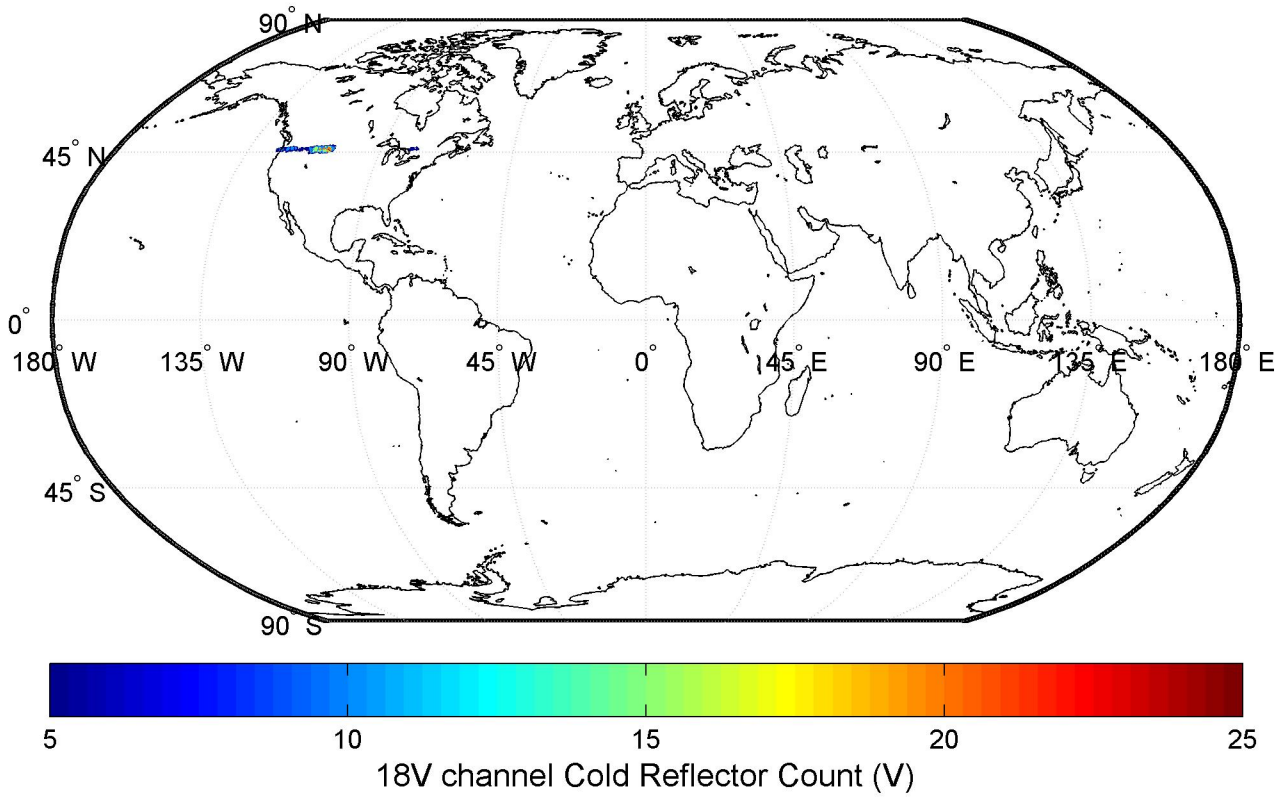

60° N
50° N
40° N
30° N
20° W
10° W
0°
10° E
20° E
30° E
40° E
5
10
15
20
25
10V channel Cold Reflector Count (V)

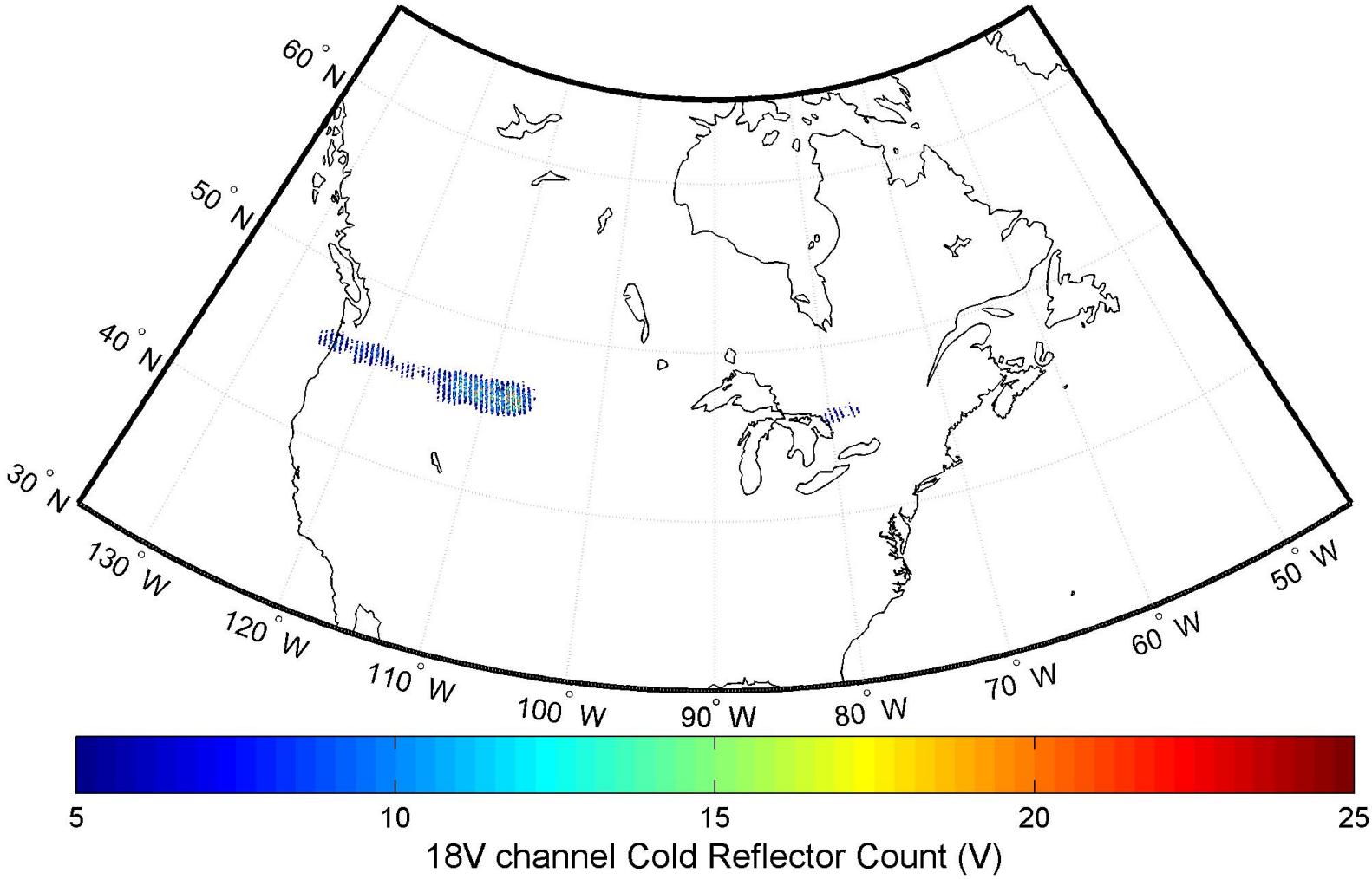
Cold Count Jump Area of 10H



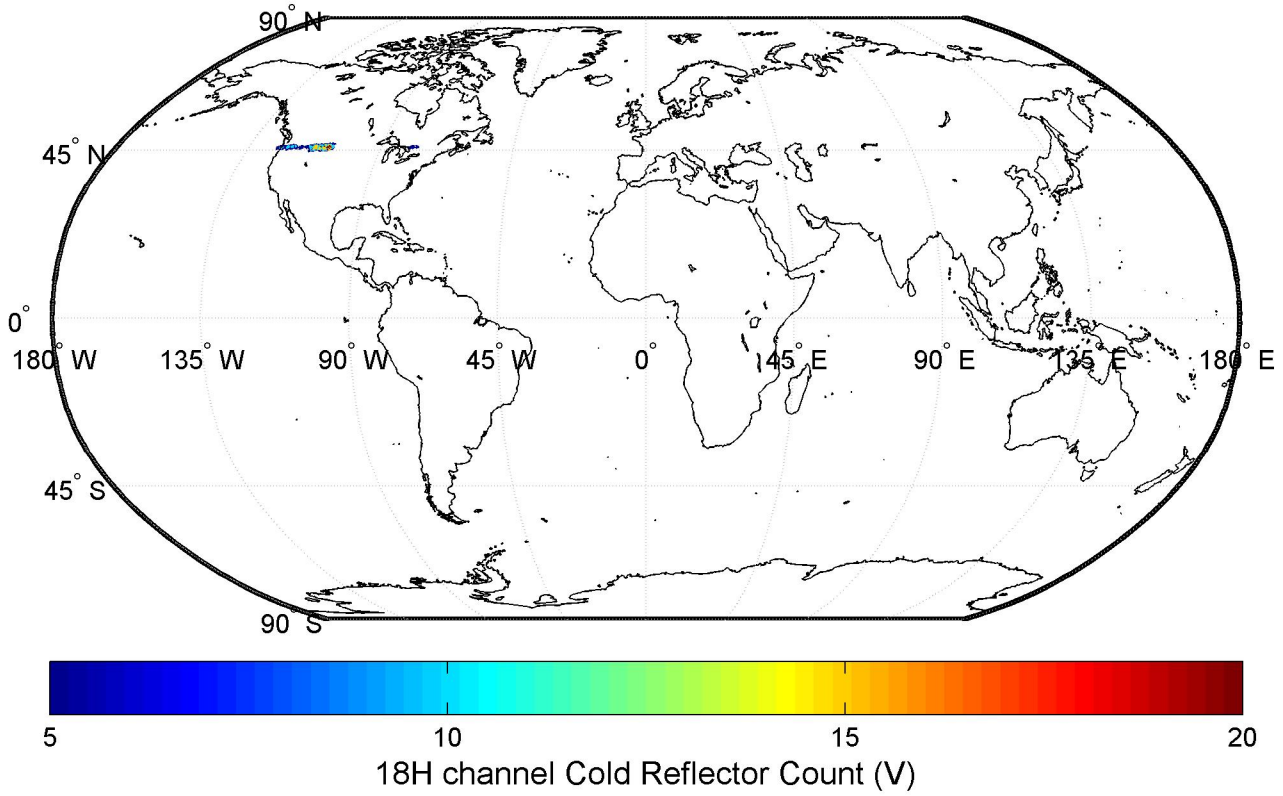

60° N
50° N
40° N
30° N
20° W
10° W
0°
10° E
20° E
30° E
40° E
5
10
15
20
10H channel Cold Reflector Count (V)

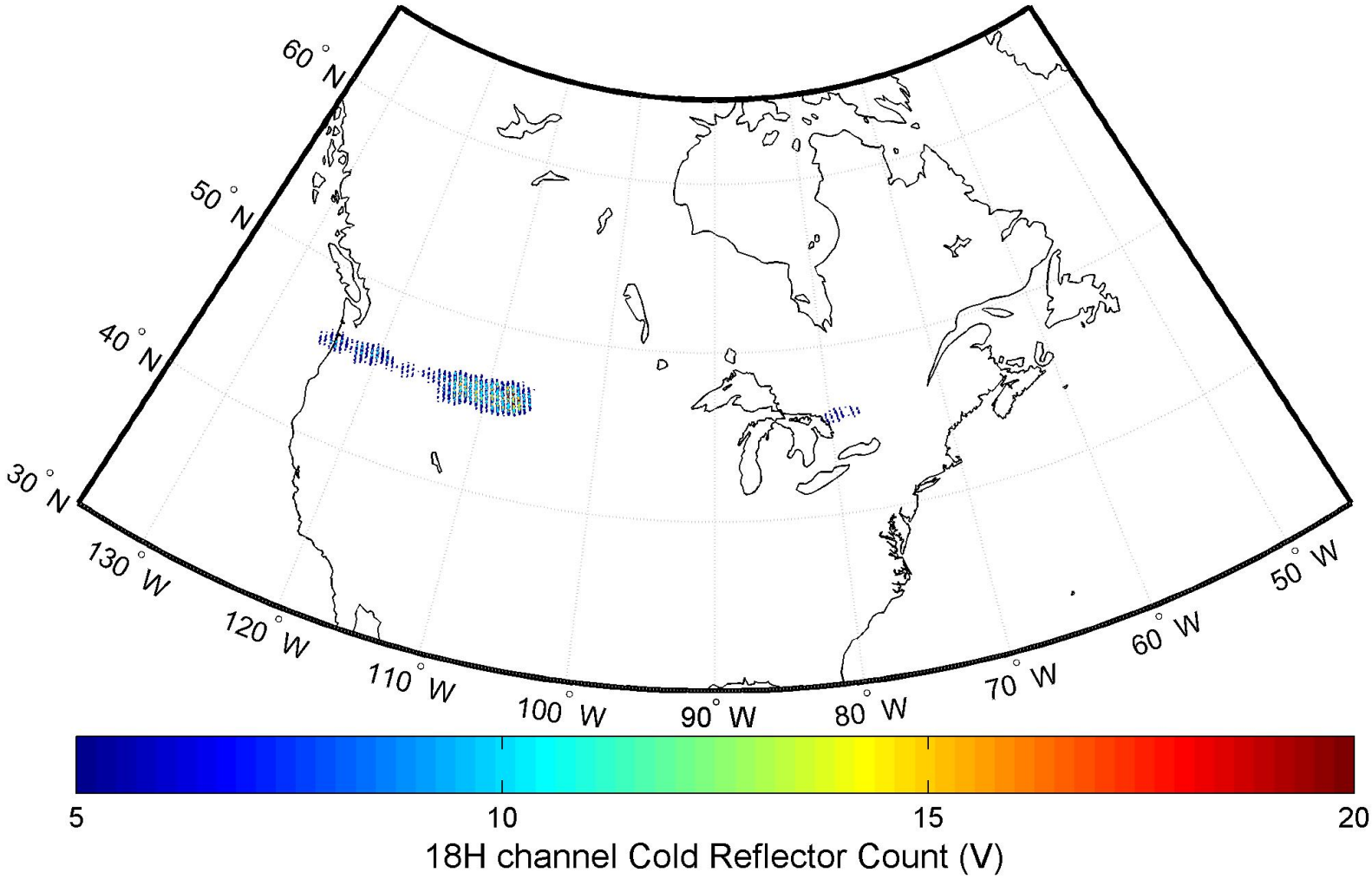
Cold Count Jump Area of 18V



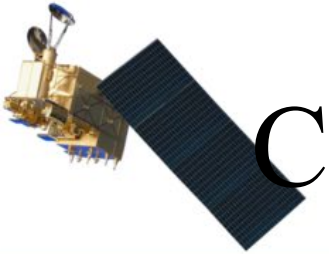

60 ° N
50 ° N
40 ° N
30 ° N
130 ° W
120 ° W
110 ° W
100 ° W
90 ° W
80 ° W
70 ° W
60 ° W
50 ° W
5
10
15
20
25
18V channel Cold Reflector Count (V)

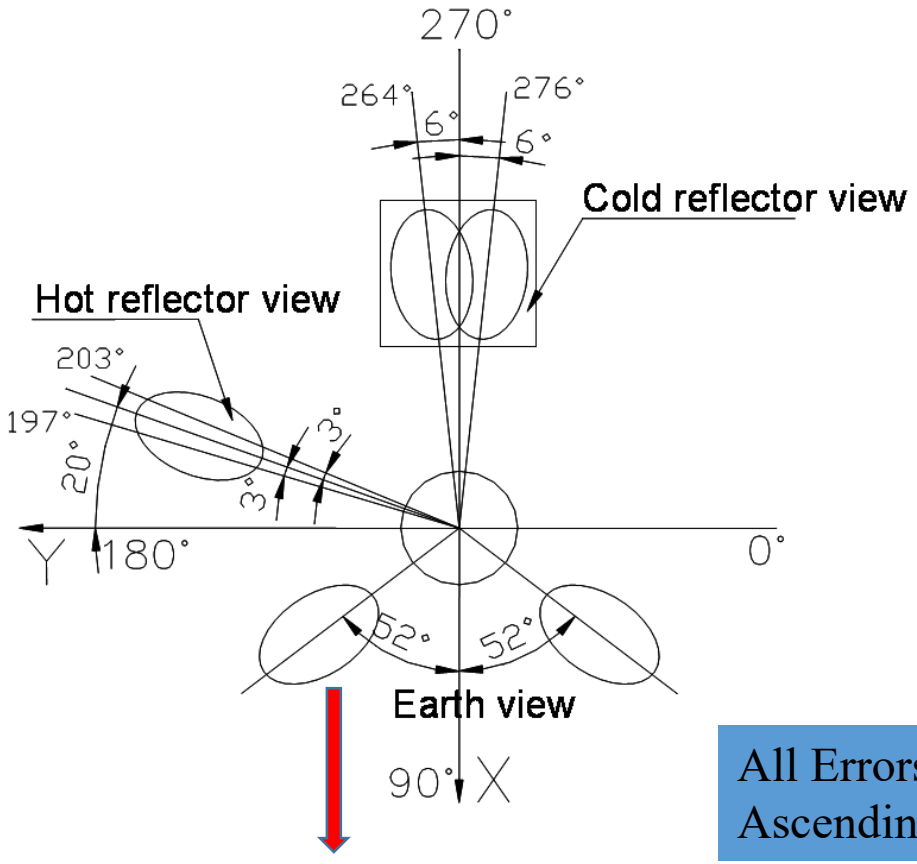
Cold Count Jump Area of 18H



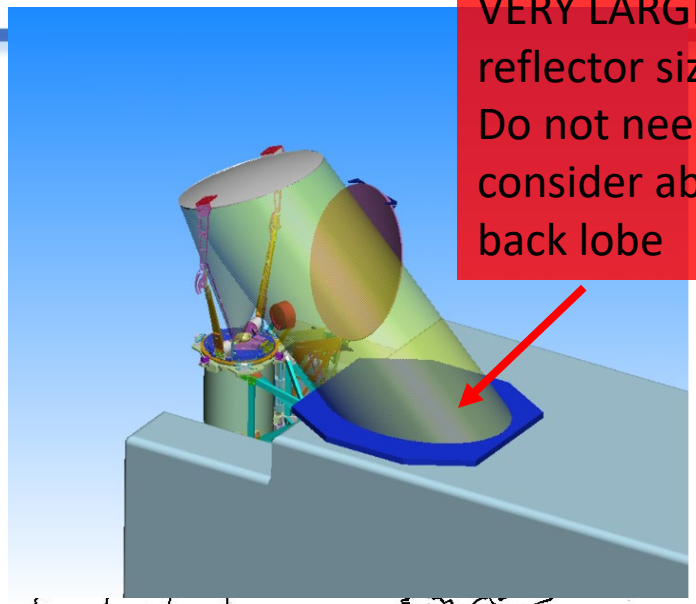

60 ° N
50 ° N
40 ° N
30 ° N
130 ° W
120 ° W
110 ° W
100 ° W
90 ° W
80 ° W
70 ° W
60 ° W
50 ° W
5
10
15
20
18H channel Cold Reflector Count (V)

Cold Calibration Error Source

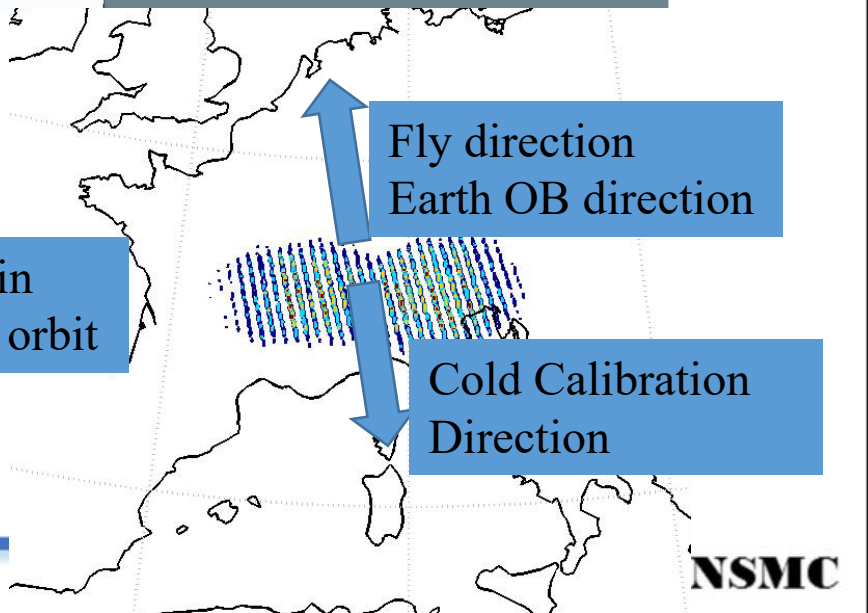




Fly direction
Earth OB direction



VERY LARGE reflector size (>1m)
Do not need to consider about the back lobe



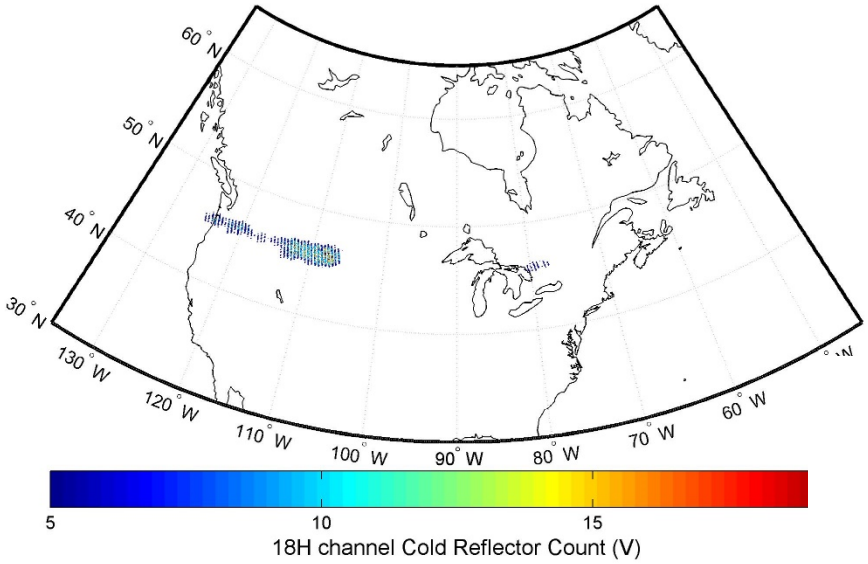
All Errors in Ascending orbit

Fly direction
Earth OB direction

Cold Calibration Direction

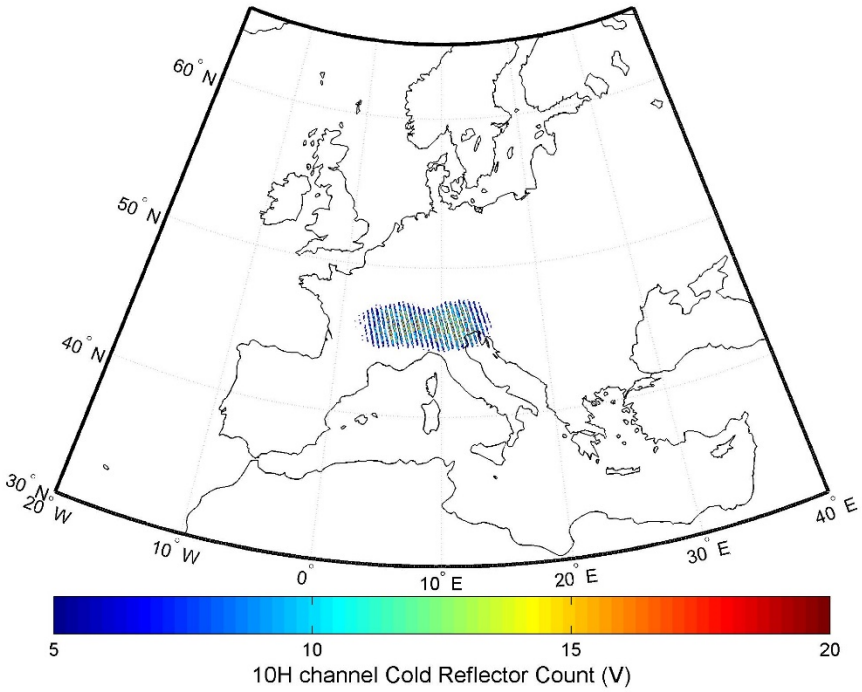
NSMC

All of the Polluted Area near N 45



The signal comes from much higher orbit of 0 degree latitude.

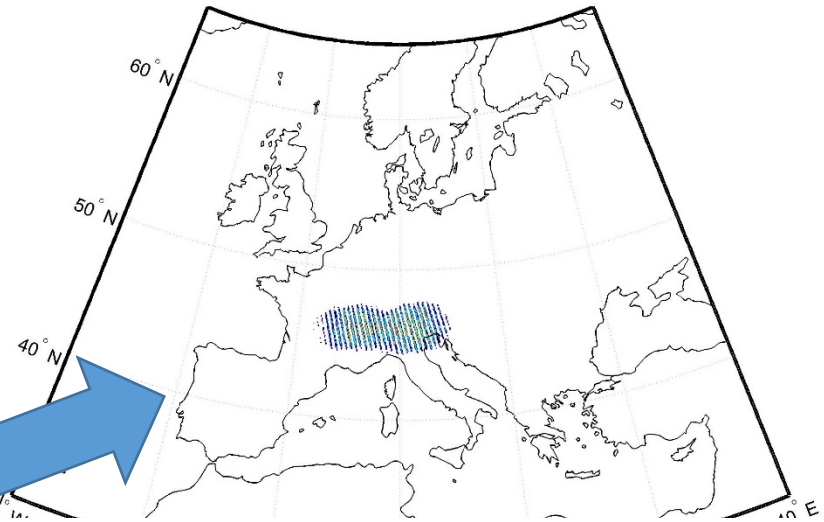
Geostationary Satellite.

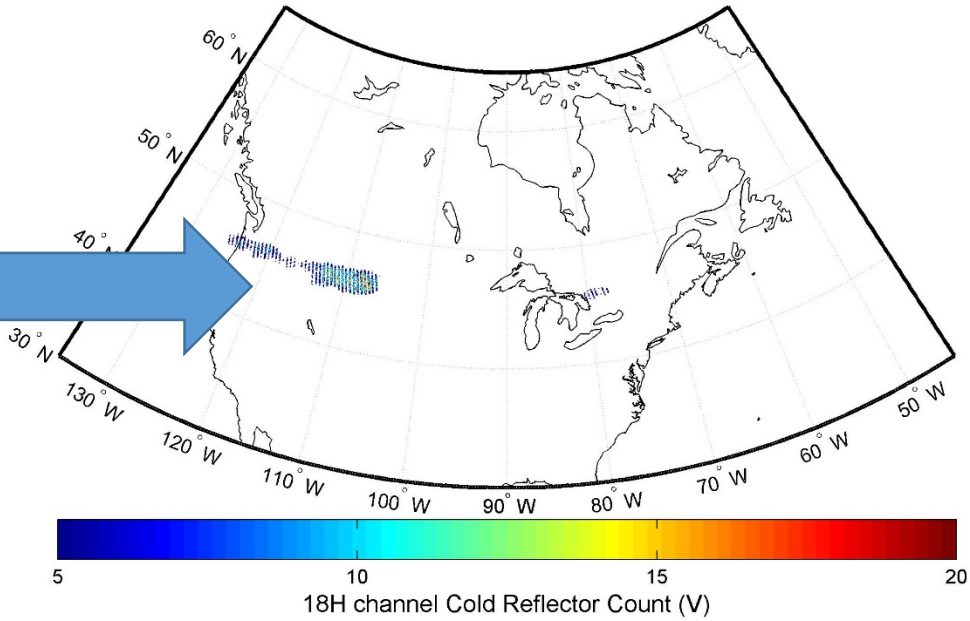


45deg is the Main Antenna Looking Angle of MWRI.
Also consider about the stable of location.

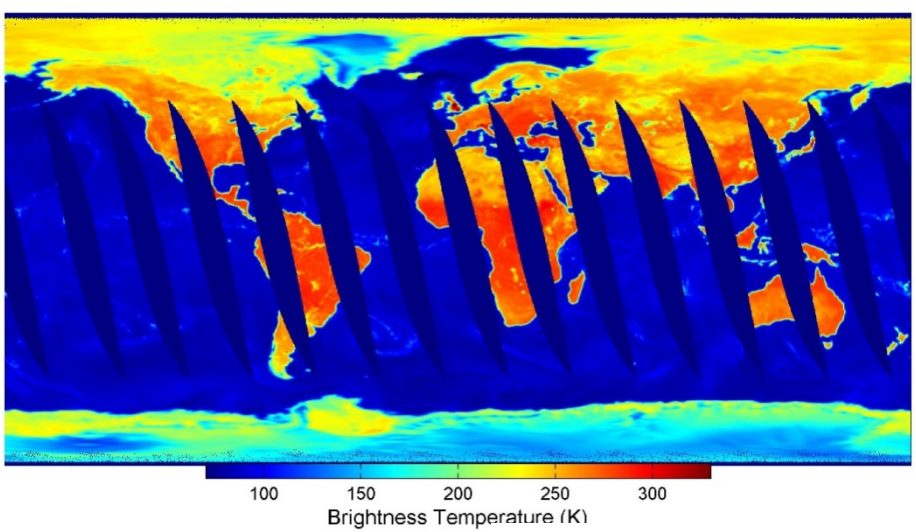
Geostationary

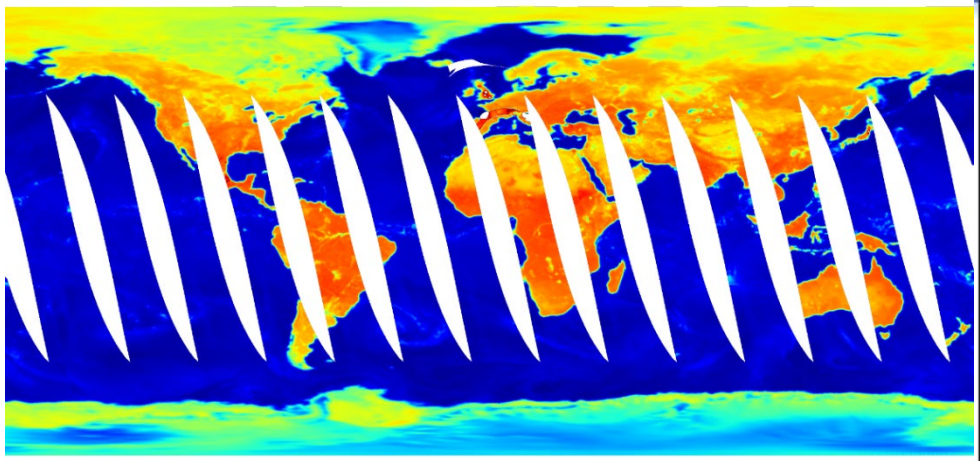
Satellite	Location	F
Telstar 12	15.0 W	11.5
Hotbird	13.0 E	11.6
AnikF1R	107.3 W	12.2
DirectTV10	103.0 W	19.1
DirectTV11	99.0 W	
SpacewayF1	102.8 W	18.3-19

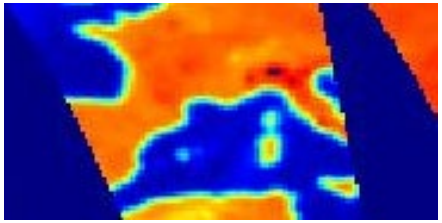


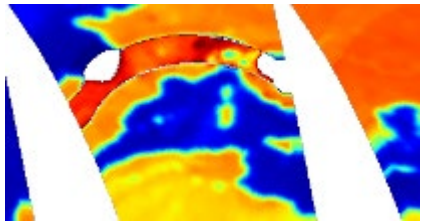


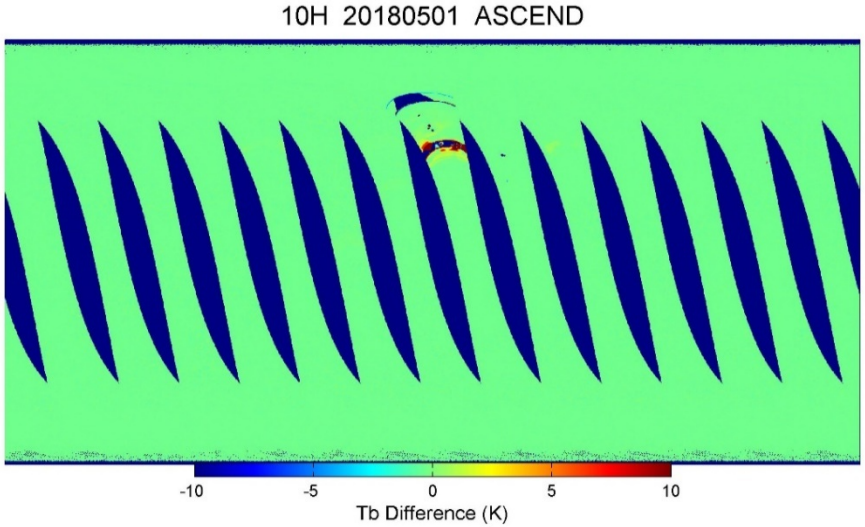
RFI Filter











CMA NSMC NSMC

Conclusion

- RFI was found for 10Ghz and 18GHz of MWRI and very stable for both location and direction;
- Analysis of MWRI structure shows that the source of 10/18GHz RFI comes from higher orbit, location and direction shows and EU and US Geostationary TV Satellites are “Suspects”;
- After the Cold Target correction, stability of MWRI’s 4 channels are significant improved.

Thank You
for your attention!