



Improved Calibration through SMAP RFI Change Detection

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Outline



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- SMAP Error Budget
- How SMAP RFI Detection and Filtering Works
- Error Performance in Lab Environment
- Motivation
- Control Charting for Process Monitoring
- RFI Statistics
- Case #1: Kerrville, TX
- Case #2: Europe
- What's next?

Radiometer Hardware and Algorithm Have Error Budget (Margin When RFI Mitigation Succeeds)



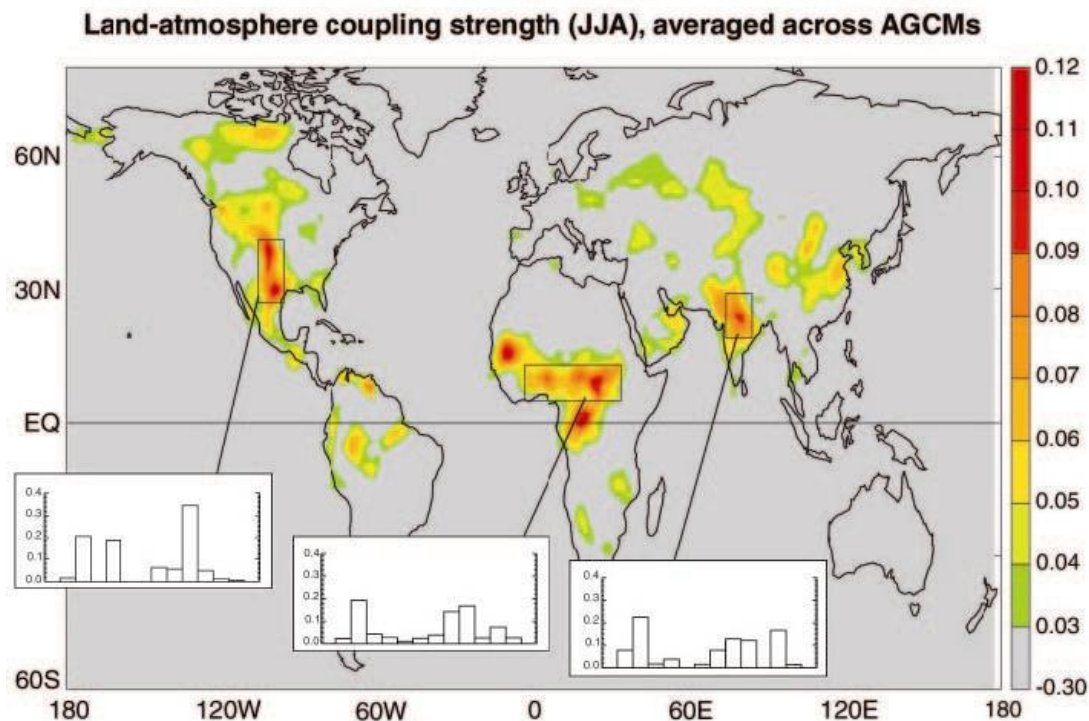
Error Term	Current Best Estimate
Multi-look averaged TB	
Antenna Pattern Correction – Instrument component	0.40 K
Antenna Pattern Correction – Algorithm component	0.40 K
NEΔT	0.45 K
Antenna Temperature Calibration	0.44 K
RFI	0.23 K
Long Term Drift	0.2 K
Atmospheric Correction	0.04 K
RSS Total	0.90 K
Requirement	1.3 K
Margin (Unencumbered RSS)	0.93 K
Margin (Unencumbered Linear)	0.40 K

Single-look TB Performance
Assessed by Cal/Val Team for the Level 1B_TB product

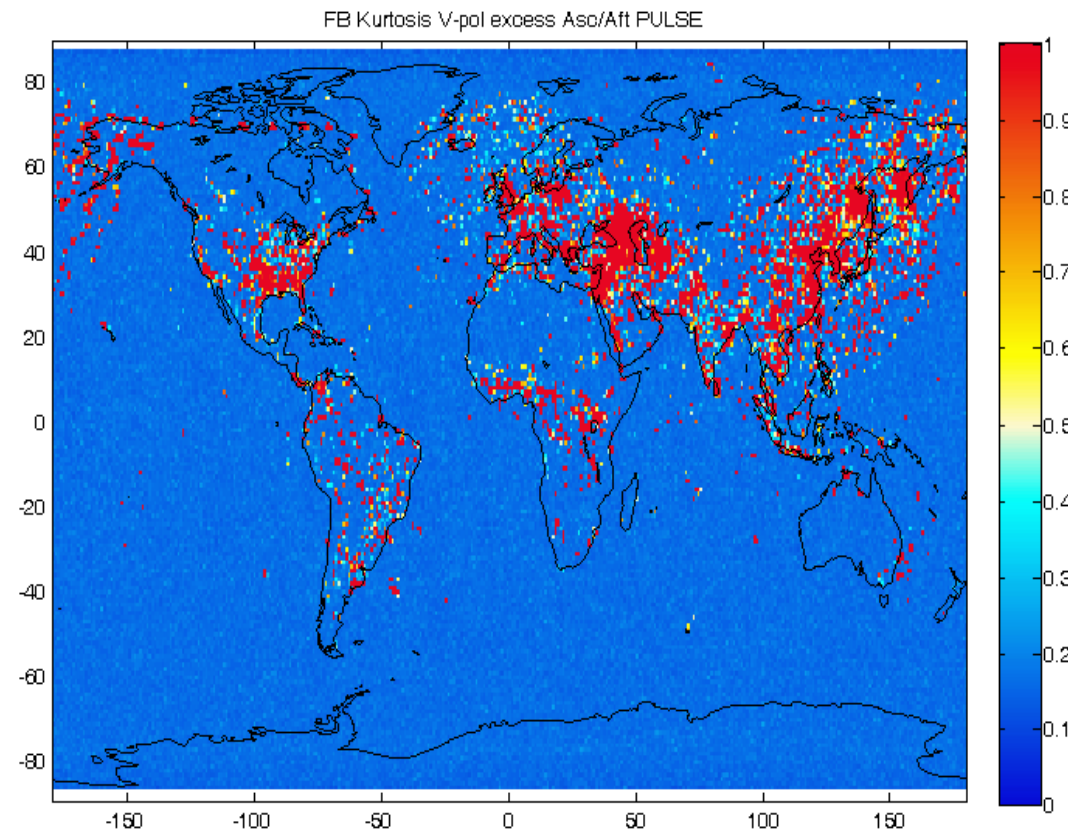
Metric	Allocation	Measured
Ocean Model RMSD (incl. NEDT)	1.4 K	1.2 K
NEDT (land)	1.6 K	1.2 K
NEDT (ocean)	1.1 K	0.9 K
Monthly Drift	0.4 K	+0.1/-0.25



Relevance



Locations where soil moisture has the greatest influence on precipitation. (Fig.17 from *SMAP Decadal Survey Workshop Report* from Koster et al. (2004) *Science*)

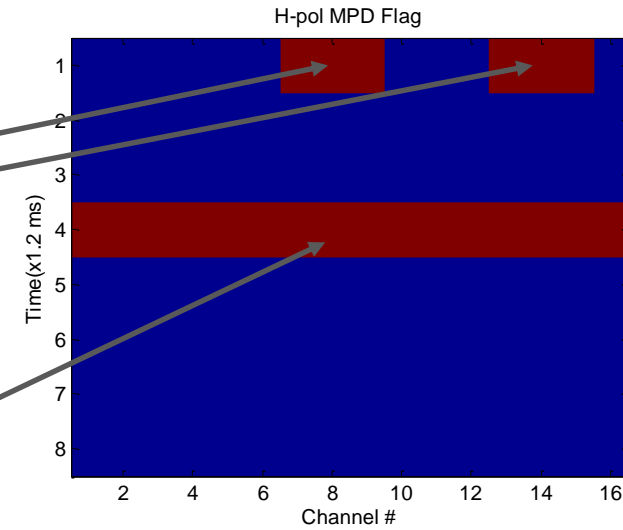
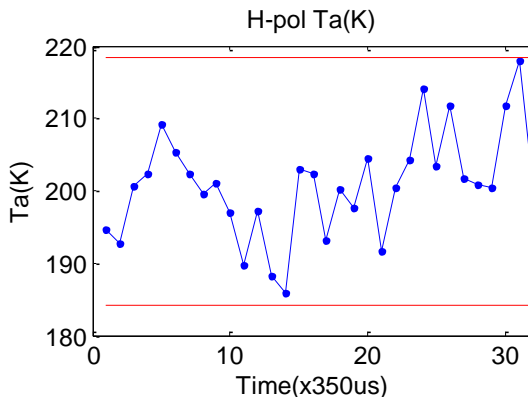
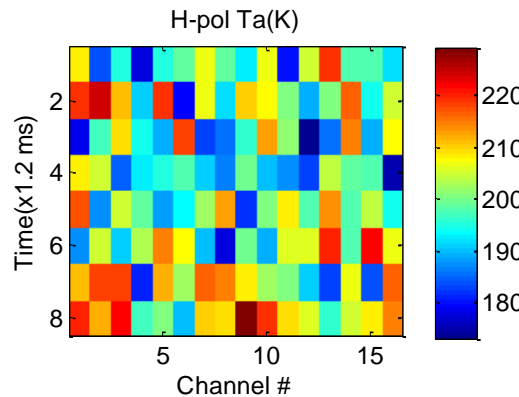
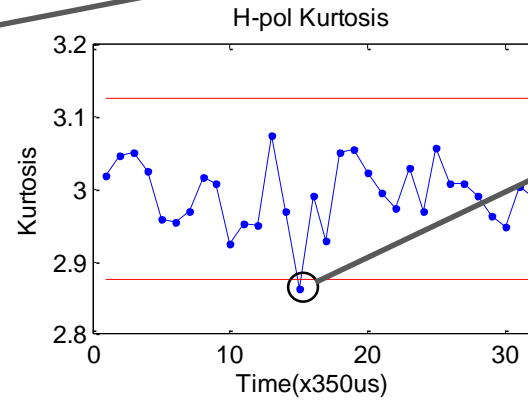
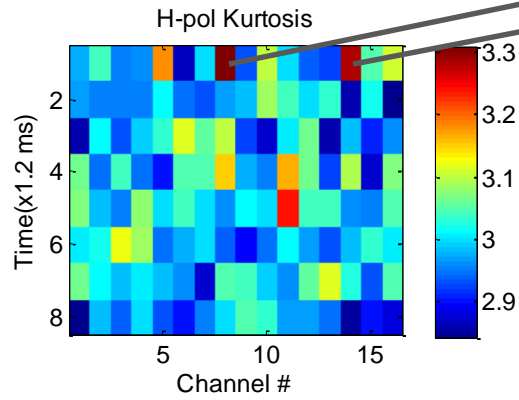


Presence of ground radar RFI indicated by kurtosis measurements.

How SMAP RFI Detection and Filtering Works



Subband detection algorithms detect and flag RFI; also flag adjacent channels



Time domain detectors detect and flag RFI; MPD flags corresponding time slice in subband data

Drop all flagged data and average remaining clean pixels of subband data to get RFI free footprint, T_A

Error Performance in Lab Environment



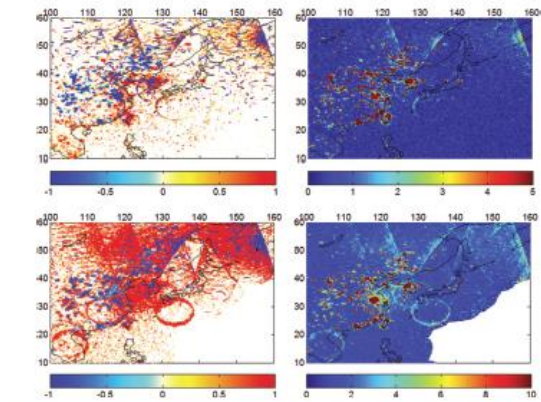
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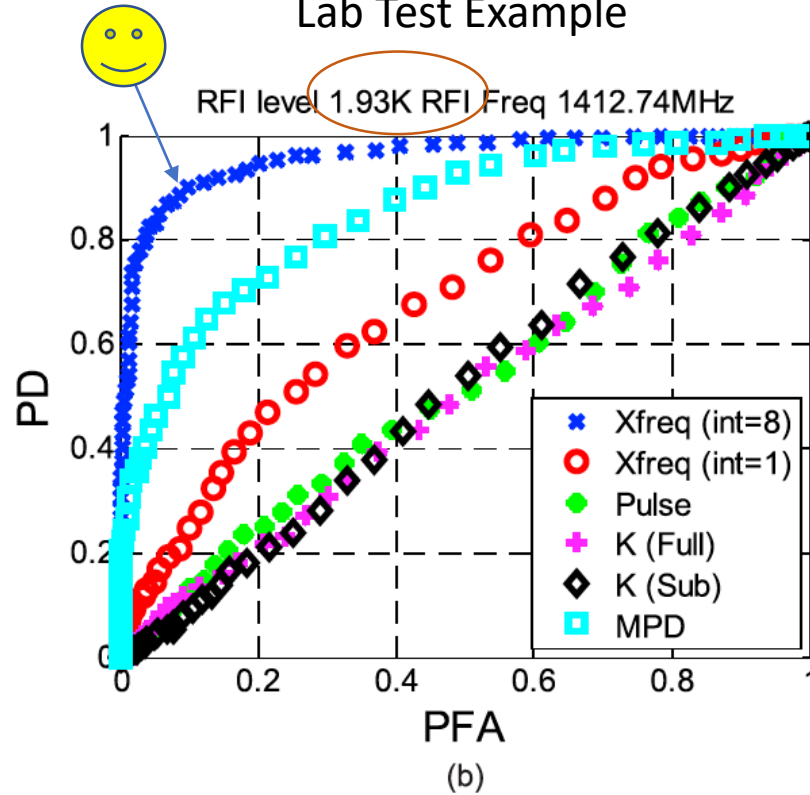


These bar plots show the measured RFI detection rates in East Asia and Japan, as measured by the SMAP mission 1400–1427 MHz radiometer for the period June 3, 2015 to June 9, 2015. The top two figures are coarse bar plots (left) and bar plots (right) over East Asia derived from the high-resolution data stream. The bottom two figures show similar information obtained from the classified data stream.

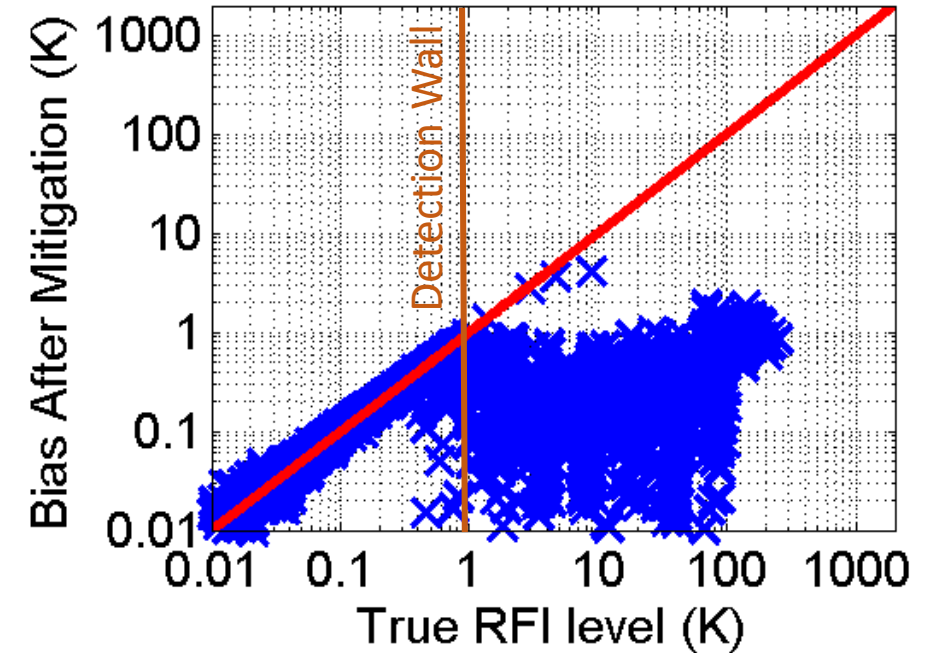


Mohammed, et al.

Low-amplitude
Narrowband RFI
Lab Test Example



0.23-K mean bias
From J. Johnson
TVAC assessment report

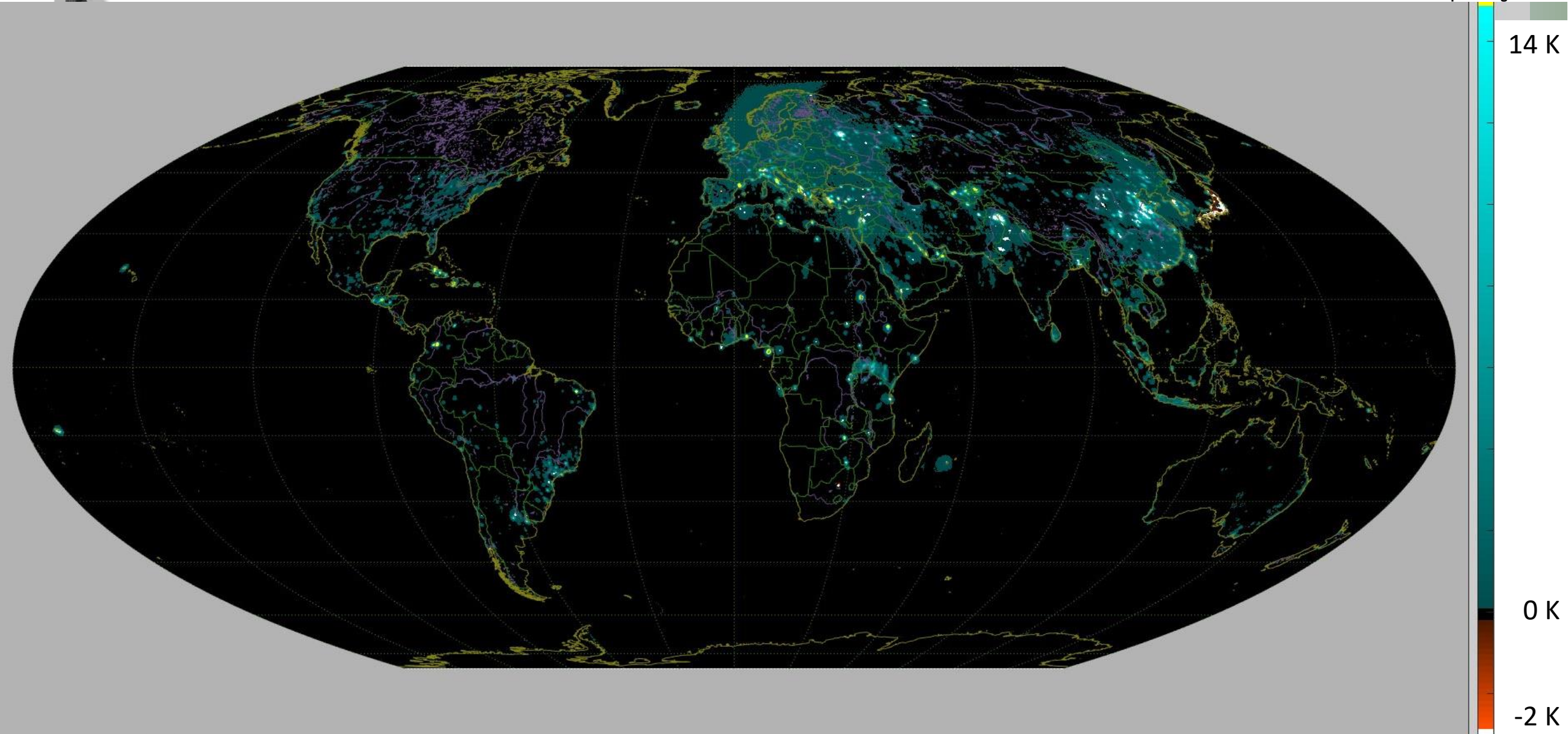




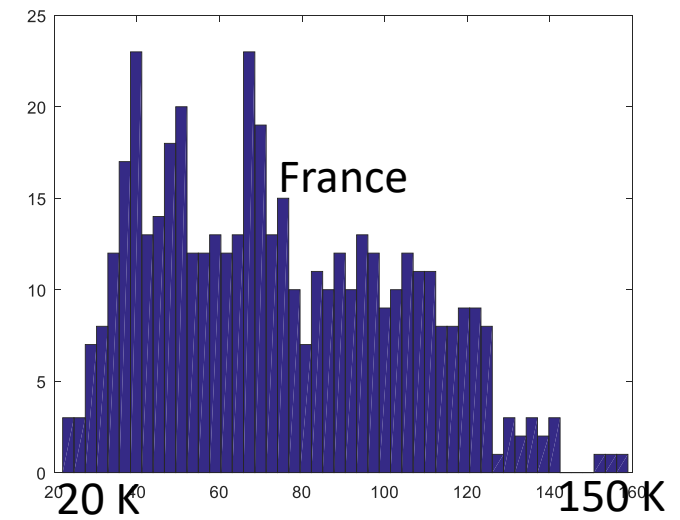
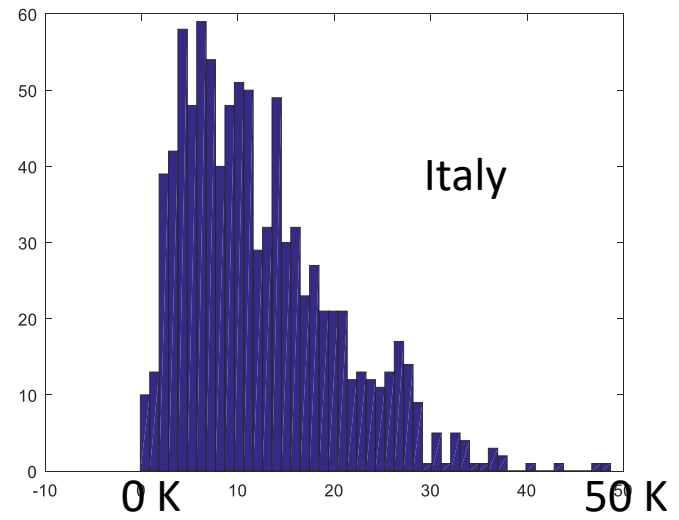
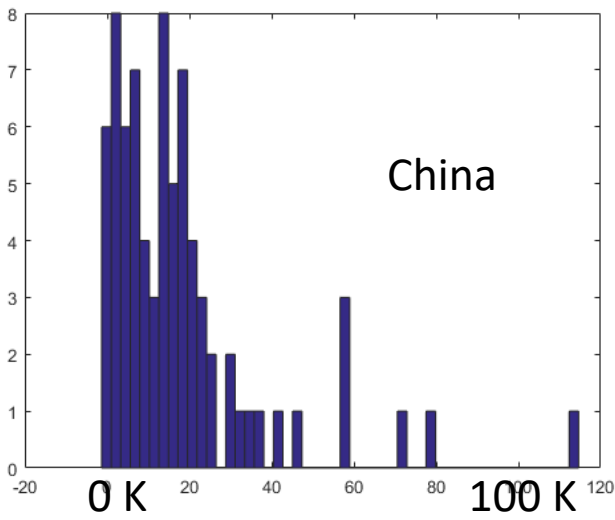
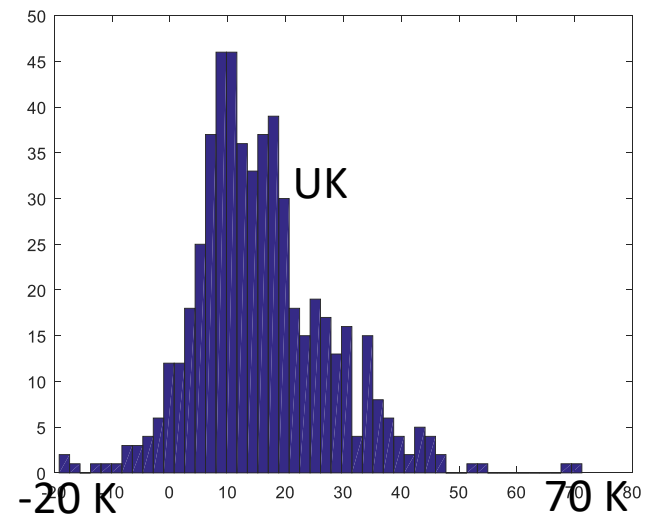
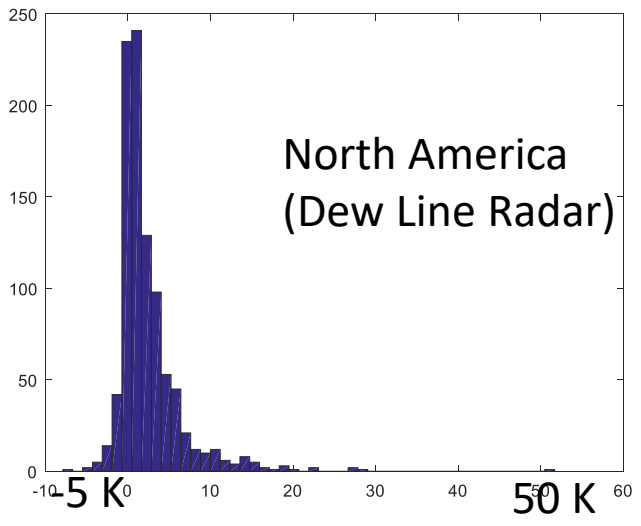
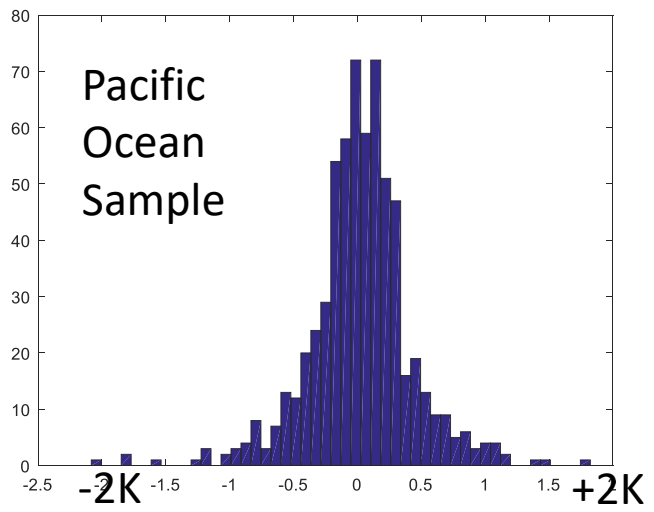
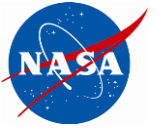
Global Time-Averaged RFI

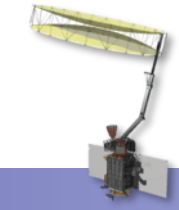


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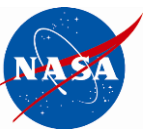


Average RFI Intensity Time Series Distributions

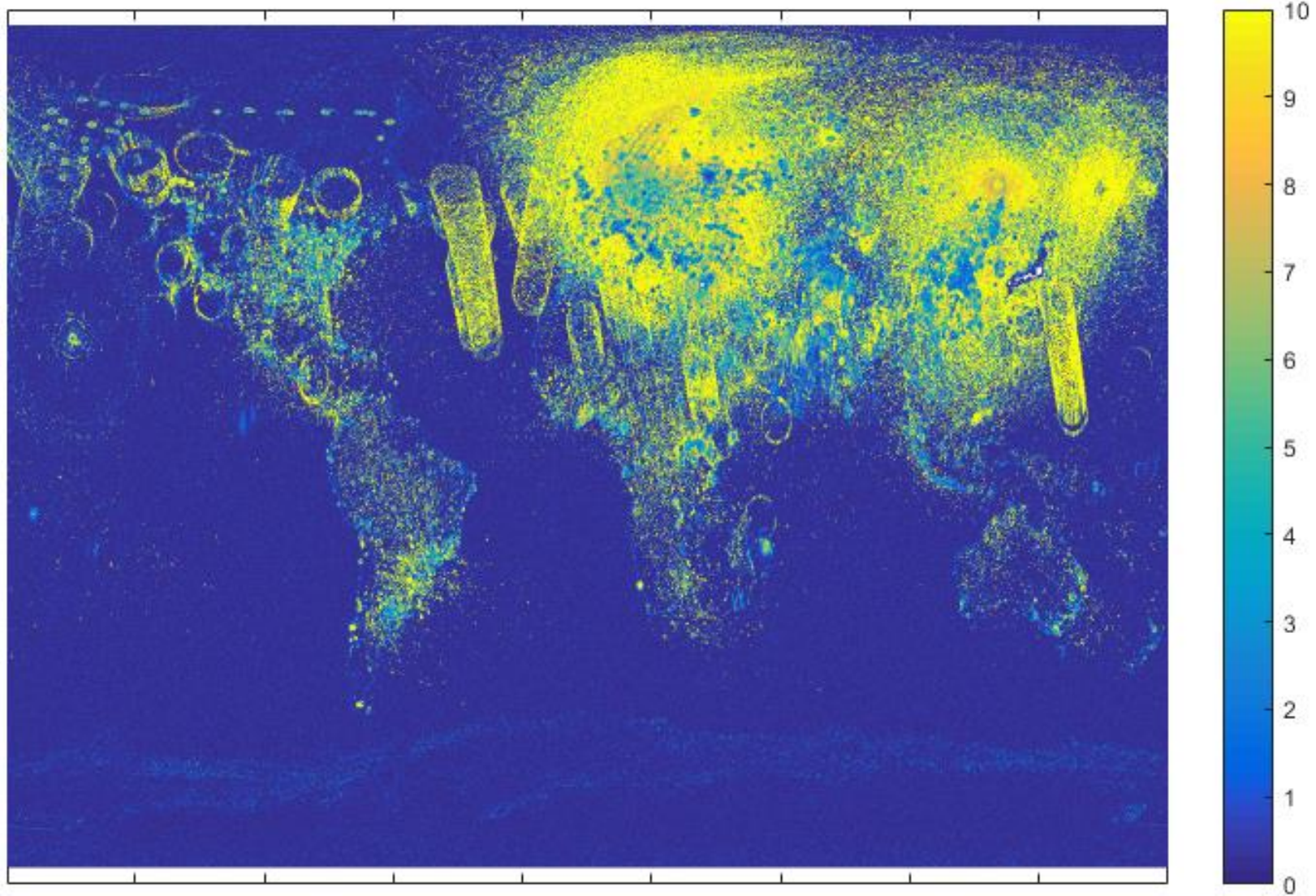




Time Series Skewness



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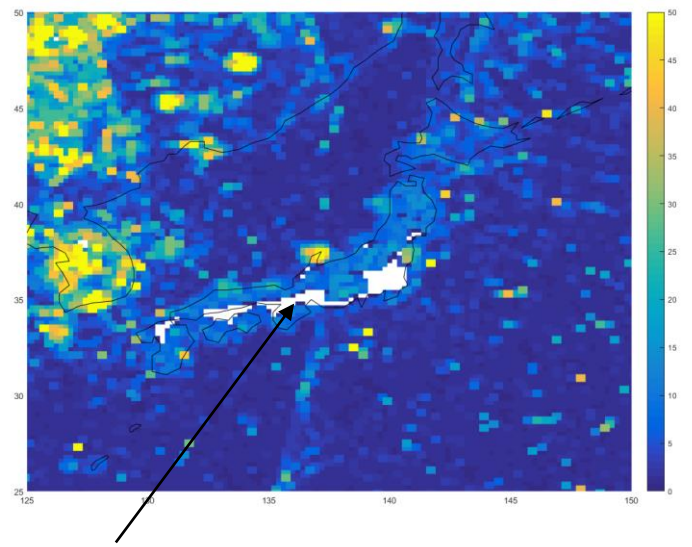




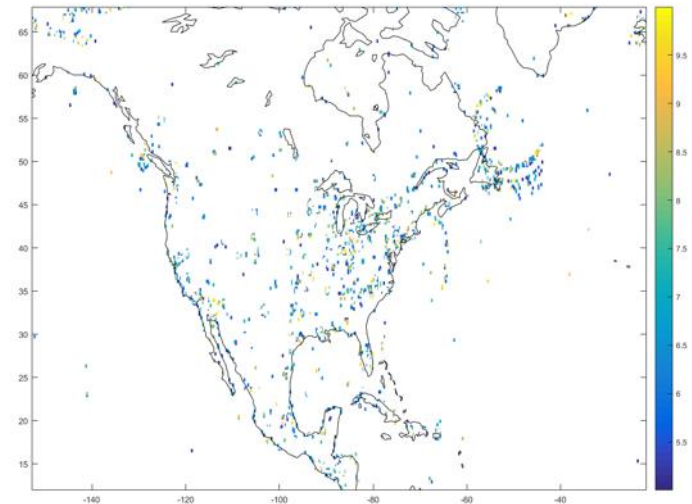
Sticky RFI: Choose Your Flavor



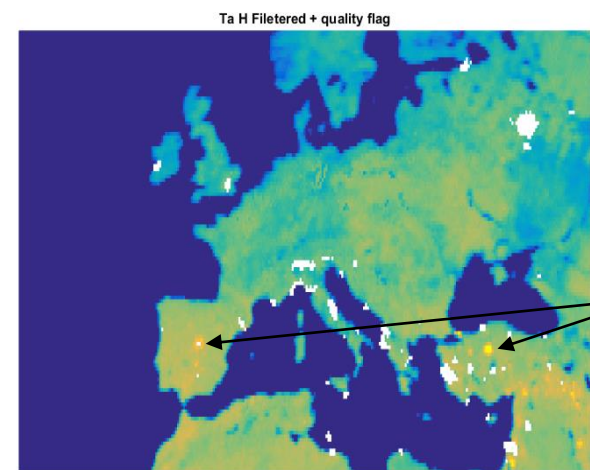
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Results in DoS

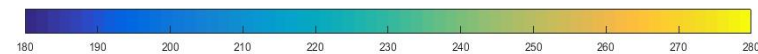


Low level



Residual
Courtesy A. Bringer, OSU

SUSMAF



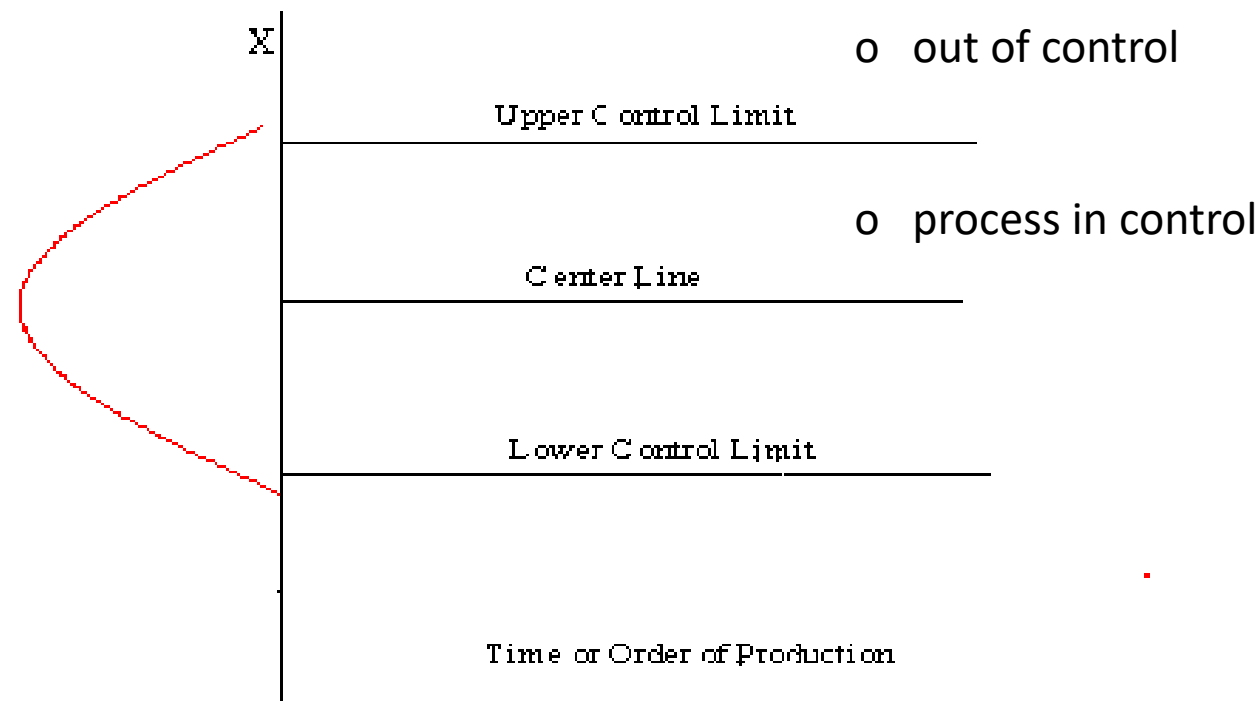


Control Charting for Process Monitoring



- Hypothesis: time series monitoring can reveal new sources or problematic sources that are not detected by current processes
- Borrow the classical “Shewhart *X-bar* and *s* Control Chart”
- +3/-1 standard deviations

Theoretical Basis for a Control Chart



NIST/SEMATECH e-Handbook of Statistical Methods,
<http://www.itl.nist.gov/div898/handbook/pmc/pmc.htm>,
retrieved 9/20/17.

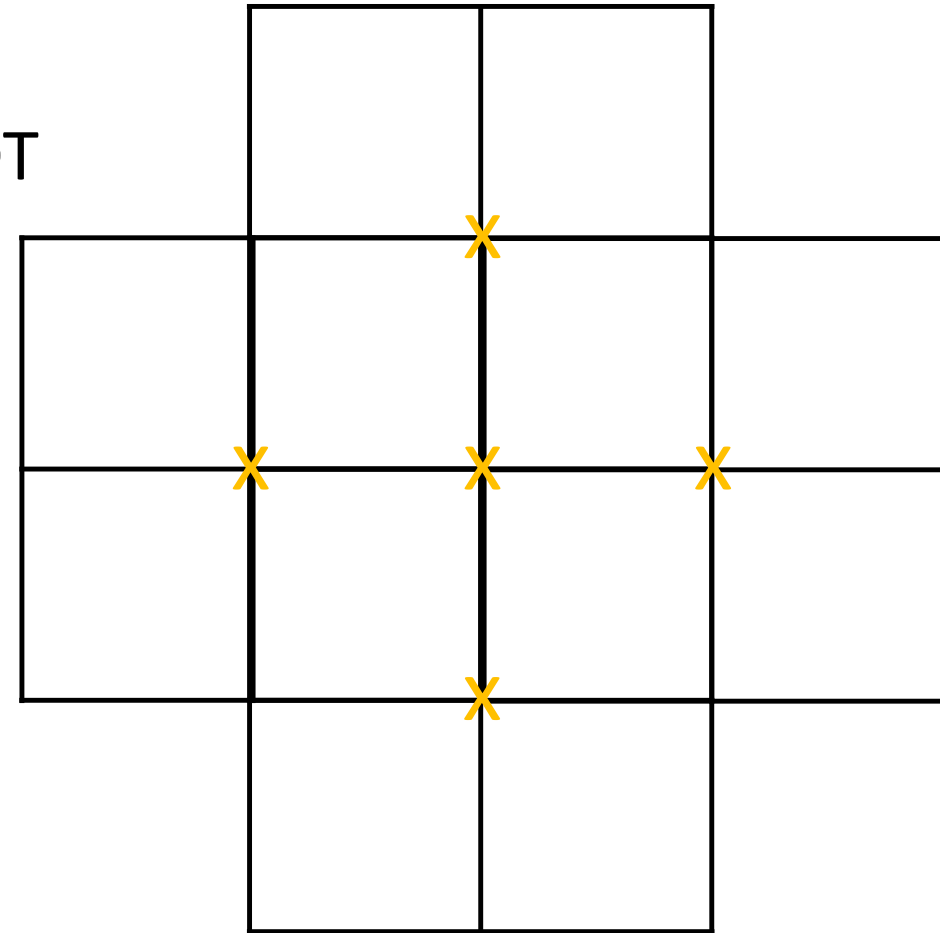


Data Preparation



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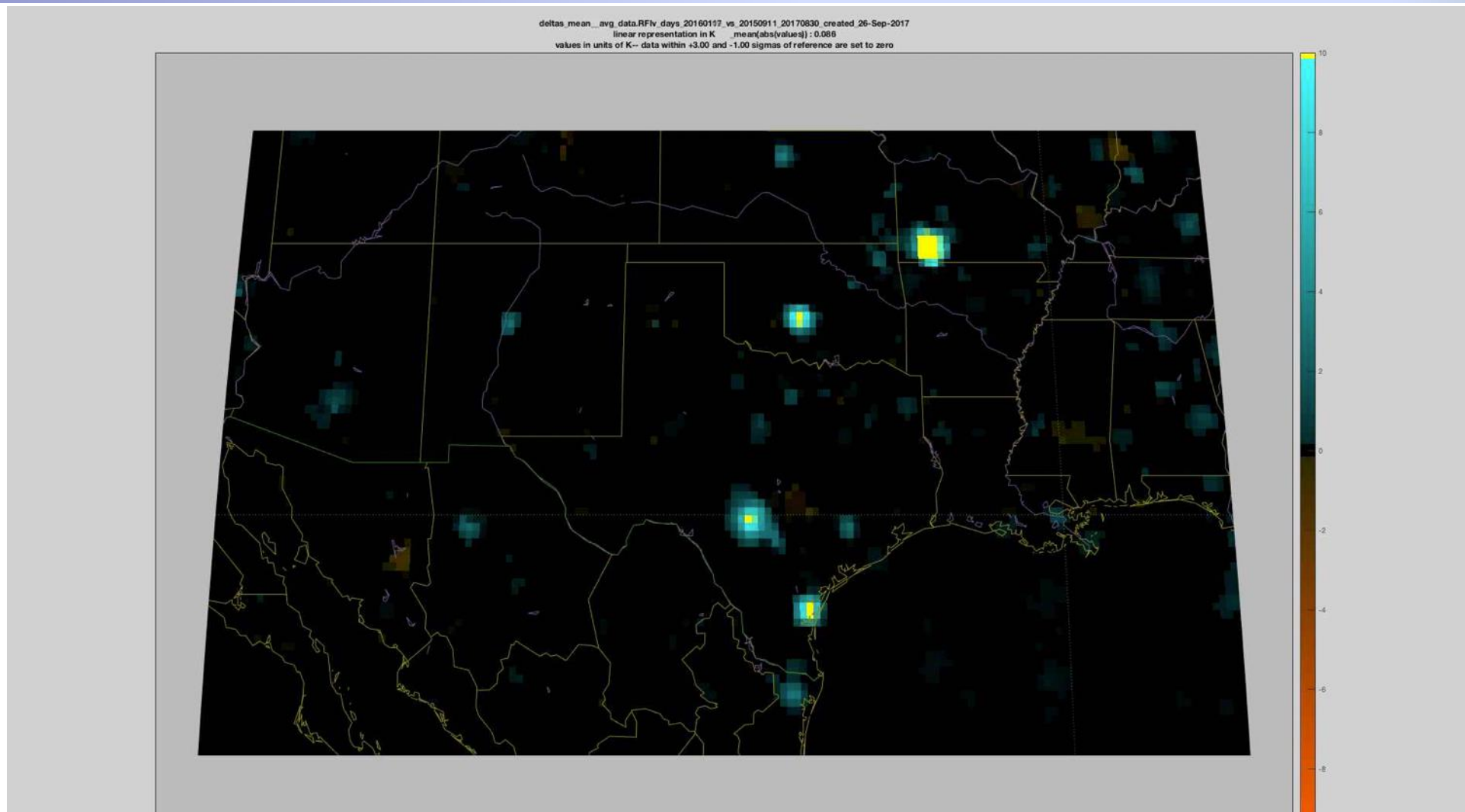
- 0.4-degree bins posted on 0.2 degree grid
- 8-day orbit cycle statistics computed in bin
- Mean, std, min, max of T_A , RFI intensity, NEDT
- September 2015 to August 2017



- Create geographic “control charts”

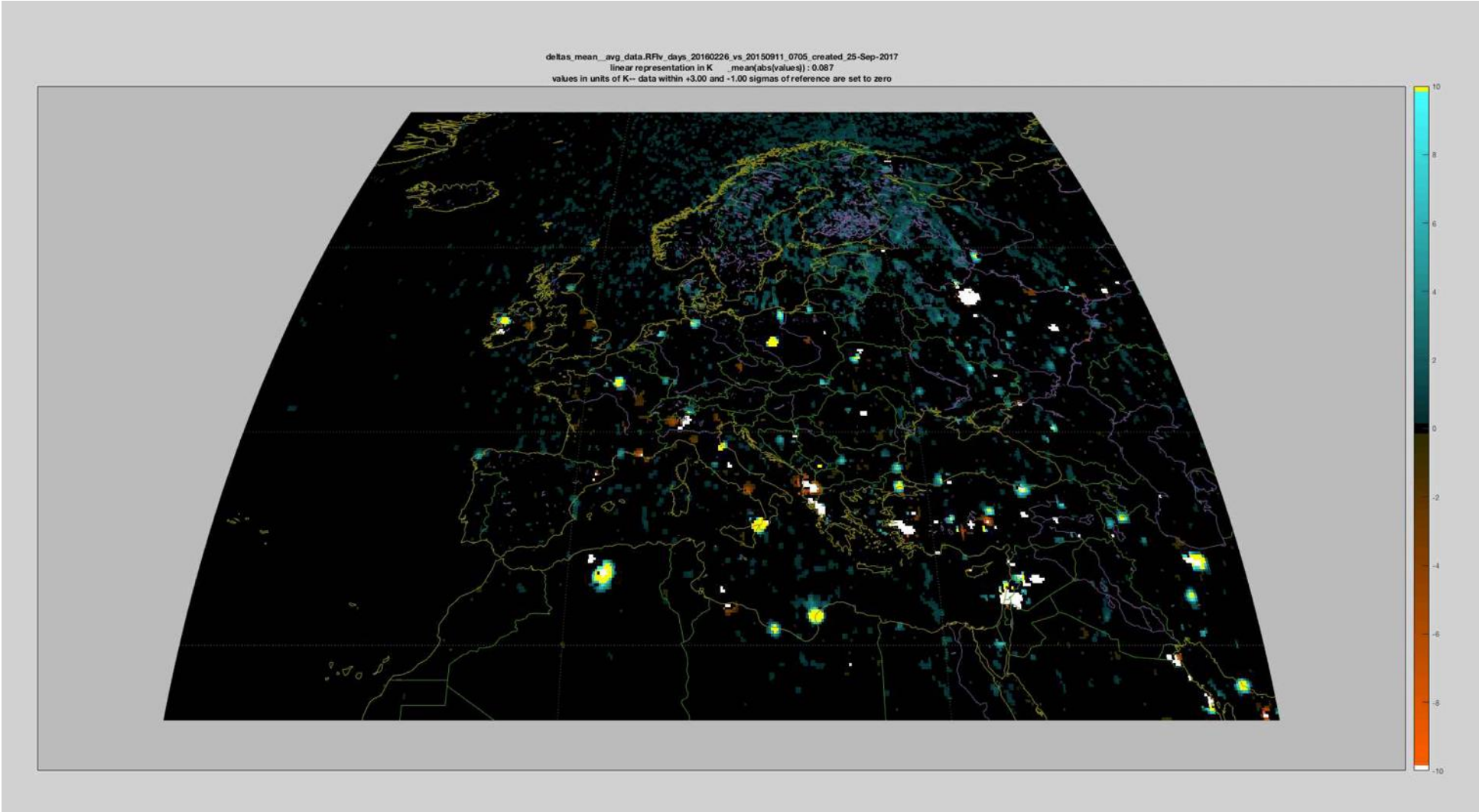


Case #1: Kerrville, TX





Case #2: Europe





What's next?



- Current state:
 - Project/ST automate monitoring and geolocation tool
- SUSMAP Plan
 - Target low-level RFI: push the wall to the left
 - Binning of RFICAL file data
 - Kurtosis, spectrograms, detection flags
 - Data prior to application of filtering algorithms
 - Research feature vector composition
 - Research utility of classification using feature vectors
 - Test change detection using different norms
- What's most important for SMAP L2/3 users?