Goddard Space Flight Center

Improved Calibration through SMAP RFI Change Detection

Jeffrey Piepmeier (GSFC)
Giovanni De Amici (GSFC)
Priscilla Mohammed (GSFC/Morgan State)
Jinzheng Peng (GSFC/USRA)

Outline

Goddard Space Flight Center

- 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)

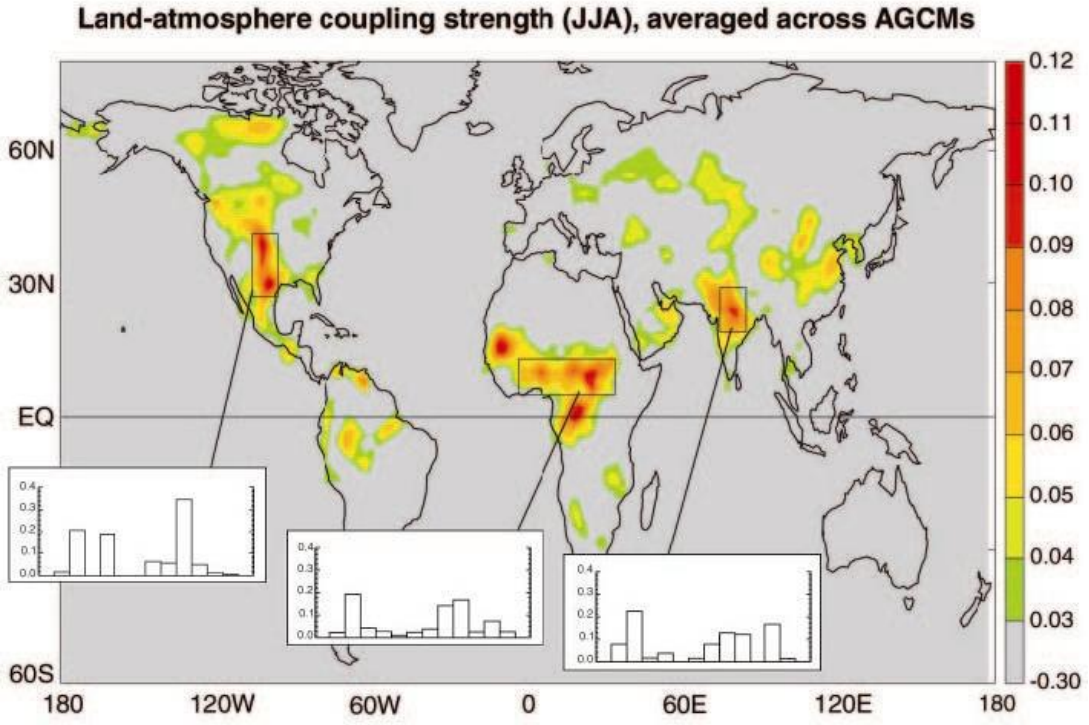
Goddard Space Flight Center

Error Term Multi-look averaged TB	**Current Best Estimate**
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

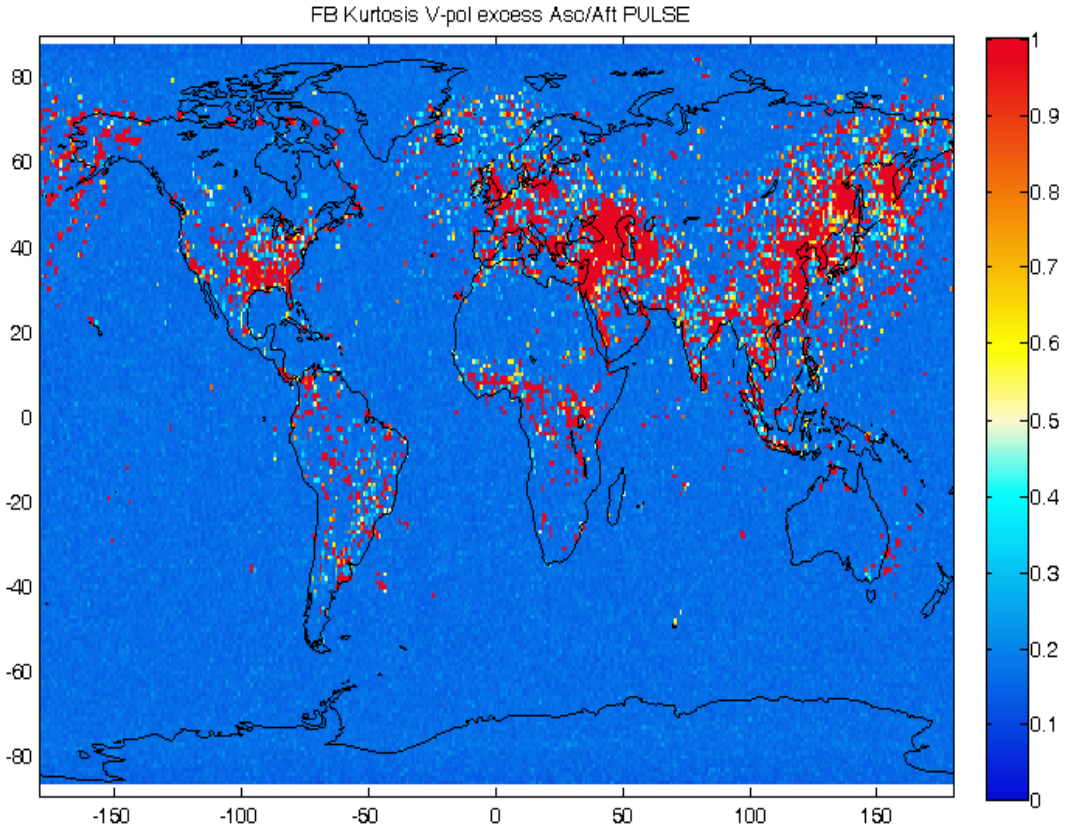
Single-look TB Performance
Assessed by Cal/Val Team for the Level 1B_TB product

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*)

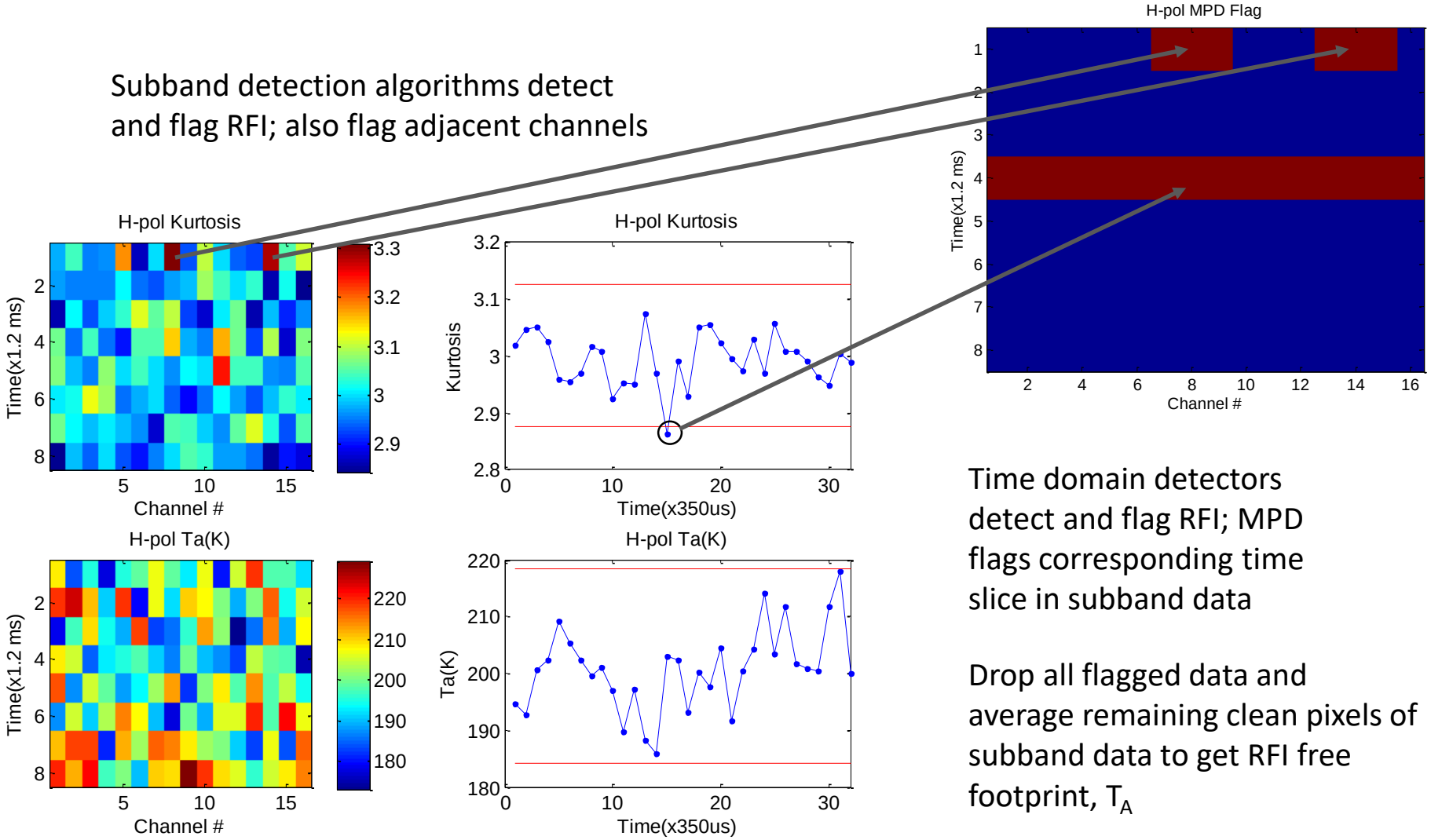


Presence of ground radar RFI indicated by kurtosis measurements.

How SMAP RFI Detection and Filtering Works

Goddard Space Flight Center

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

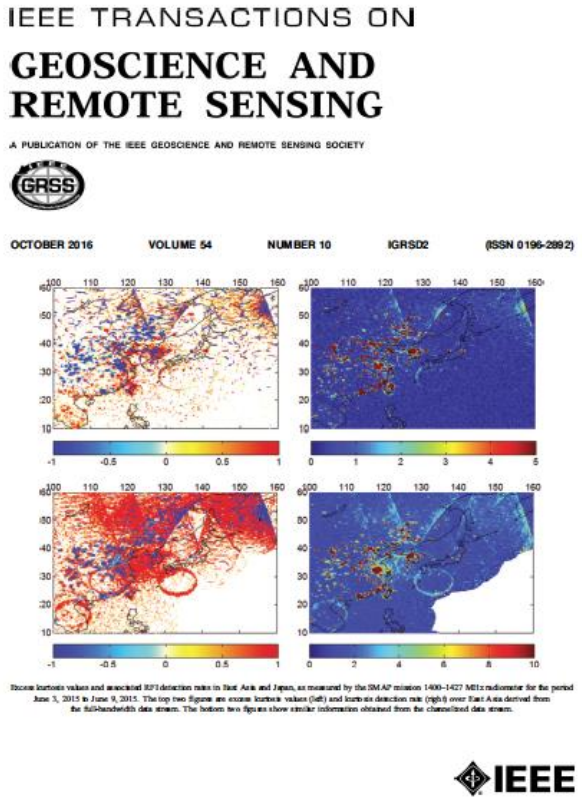


Time domain detectors detect and flag RFI; MPD flags corresponding time slice in subband data

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

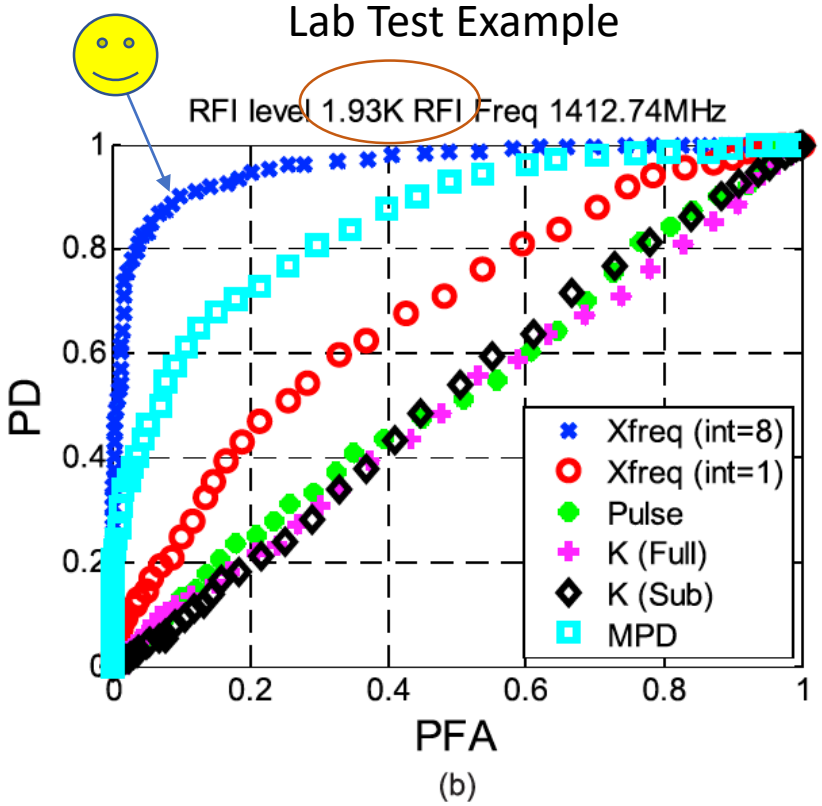
Error Performance in Lab Environment

Goddard Space Flight Center

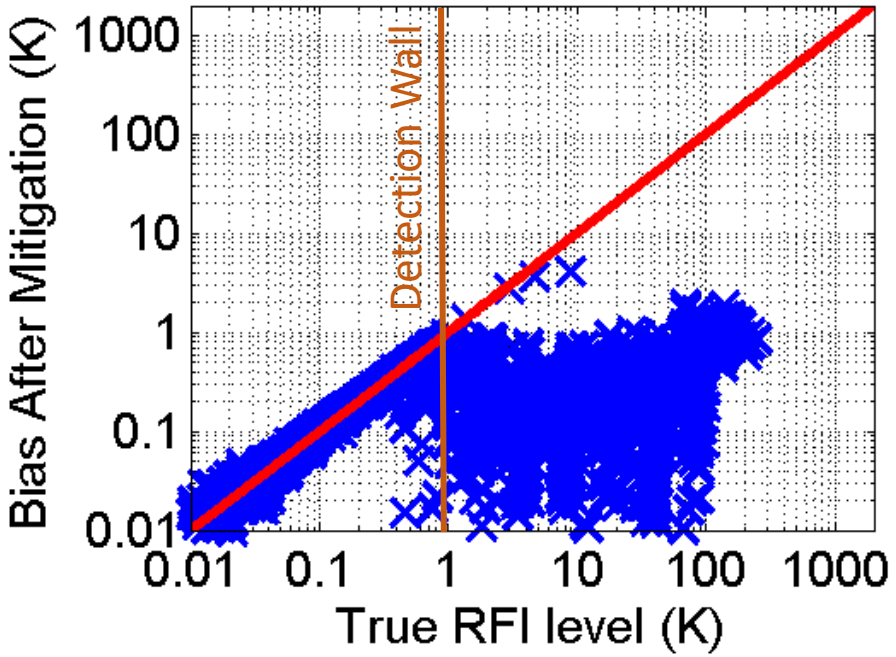


Mohammed, et al.

Low-amplitude
Narrowband RFI
Lab Test Example

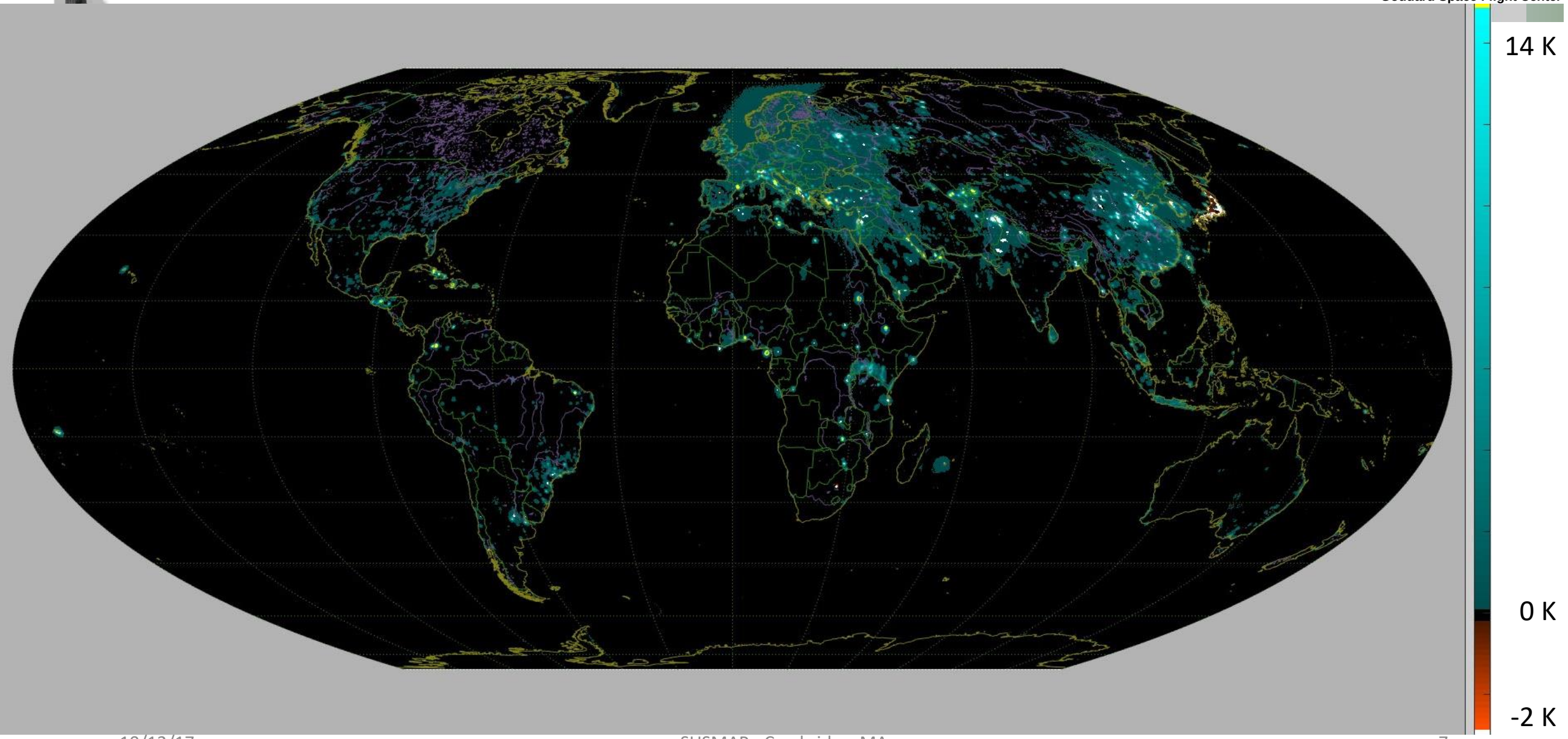


0.23-K mean bias
From J. Johnson
TVAC assessment report



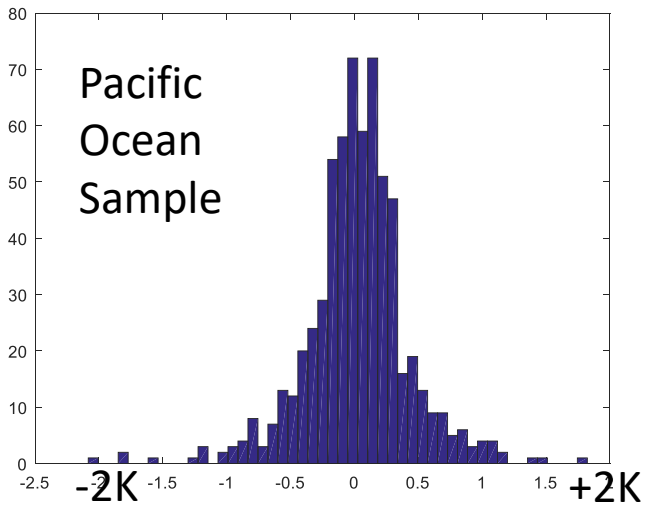
Global Time-Averaged RFI

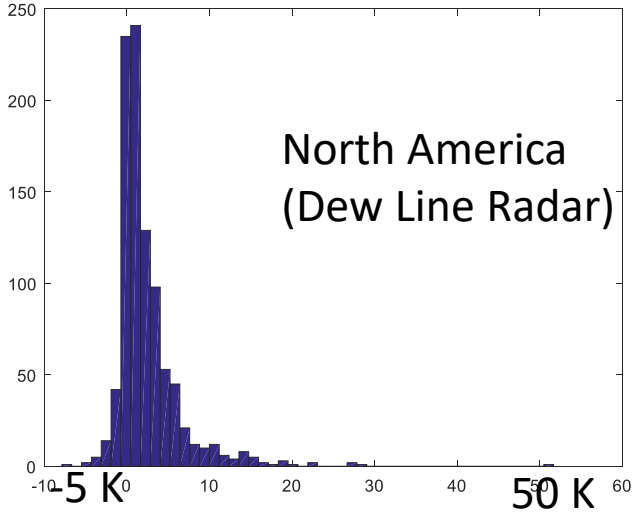
Goddard Space Flight Center

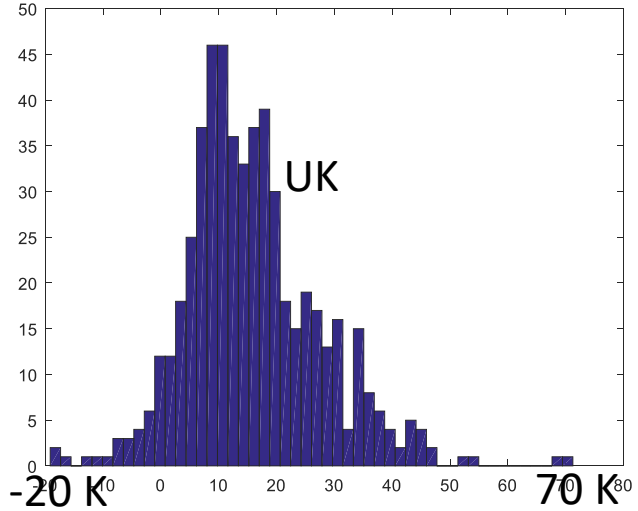


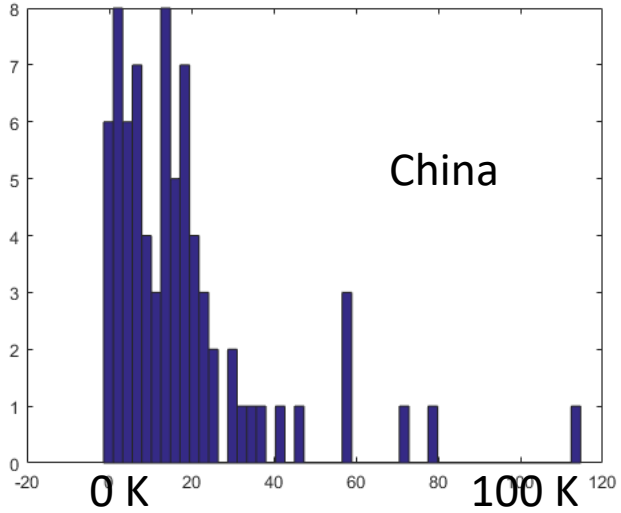
Average RFI Intensity Time Series Distributions

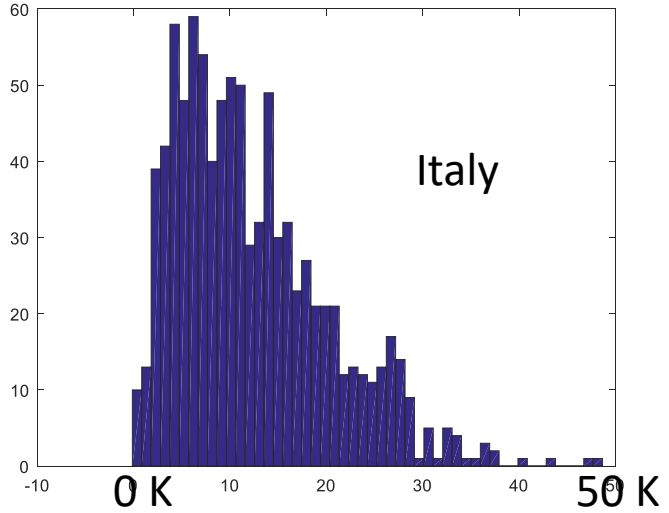
Goddard Space Flight Center

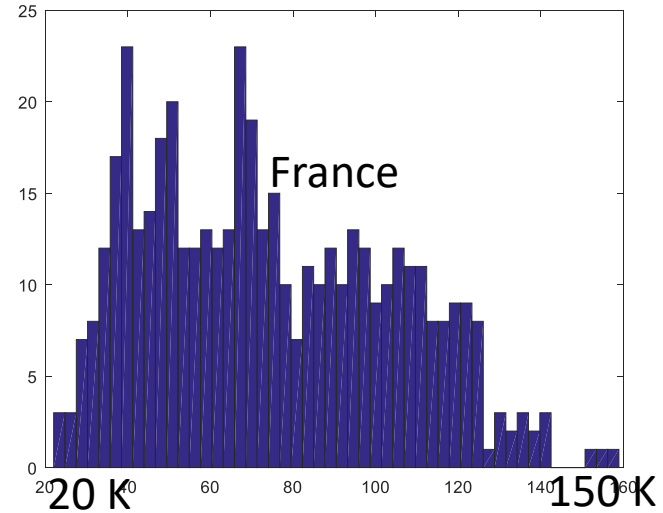






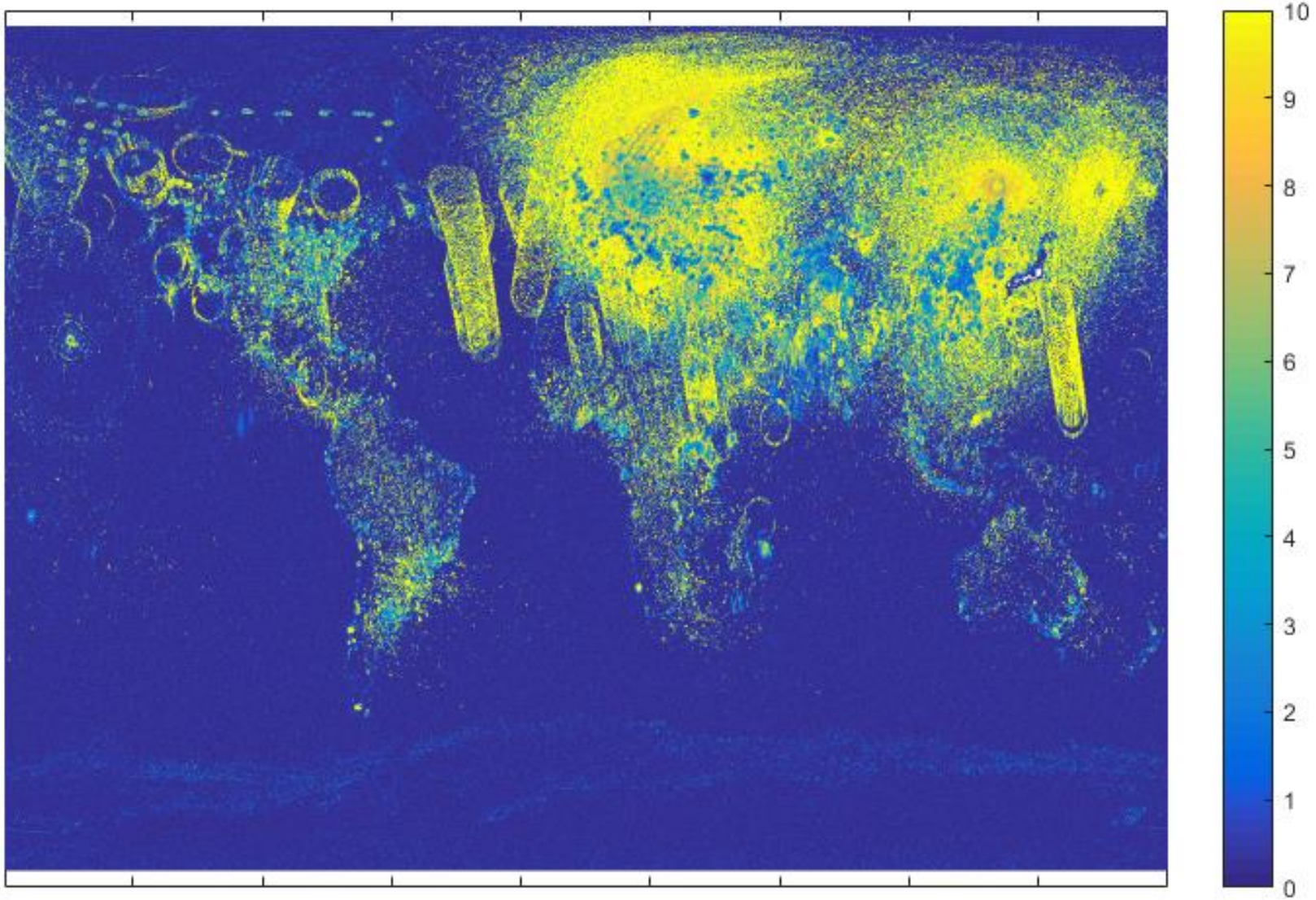




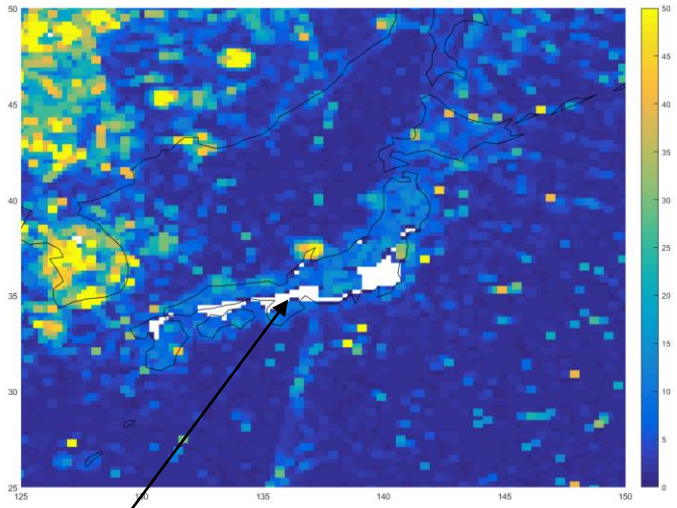


Time Series Skewness

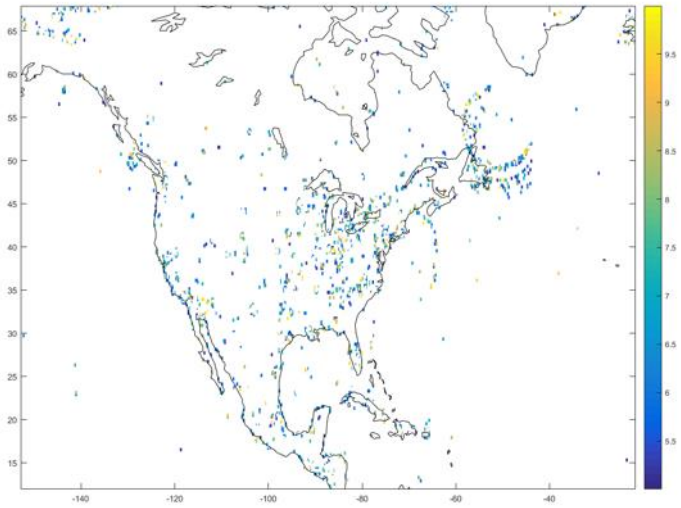
Goddard Space Flight Center



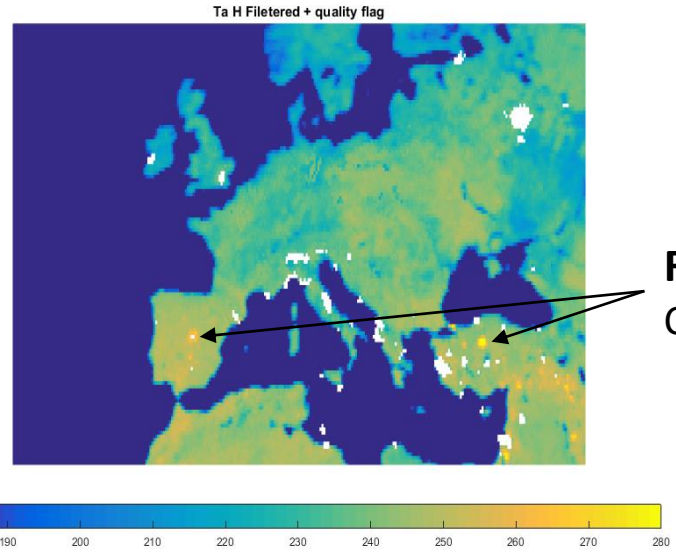
Sticky RFI: Choose Your Flavor



Results in DoS



Low level



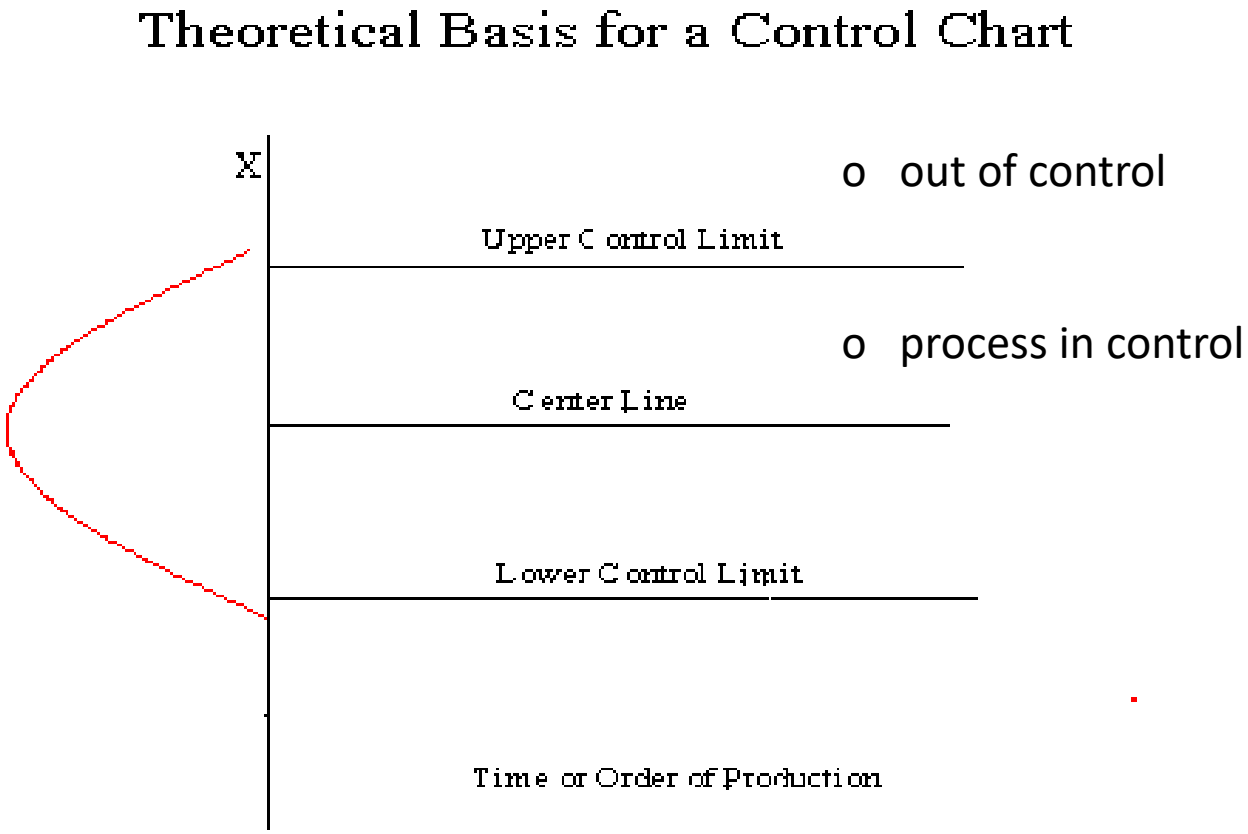
Residual

Courtesy A. Bringer, OSU

Control Charting for Process Monitoring

Goddard Space Flight Center

- 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

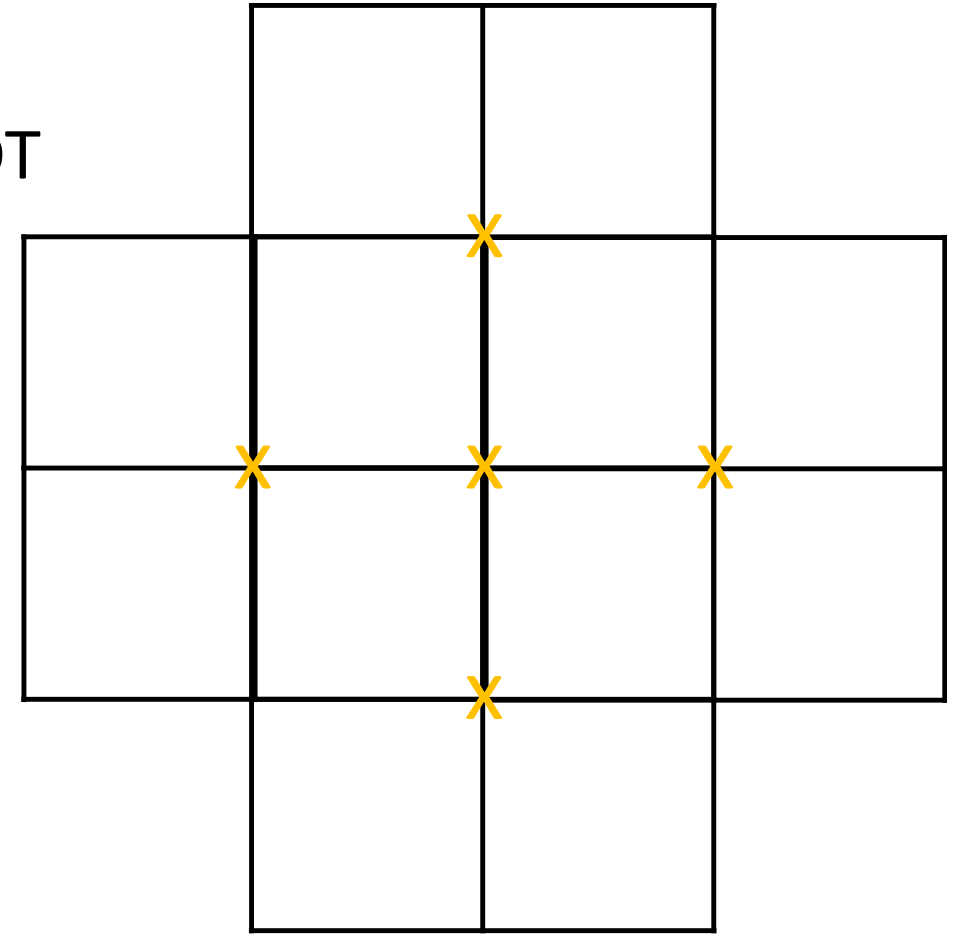


NIST/SEMATECH e-Handbook of Statistical Methods, http://www.itl.nist.gov/div898/handbook/pmc/pmc.htm, retrieved 9/20/17.

Data Preparation

Goddard Space Flight Center

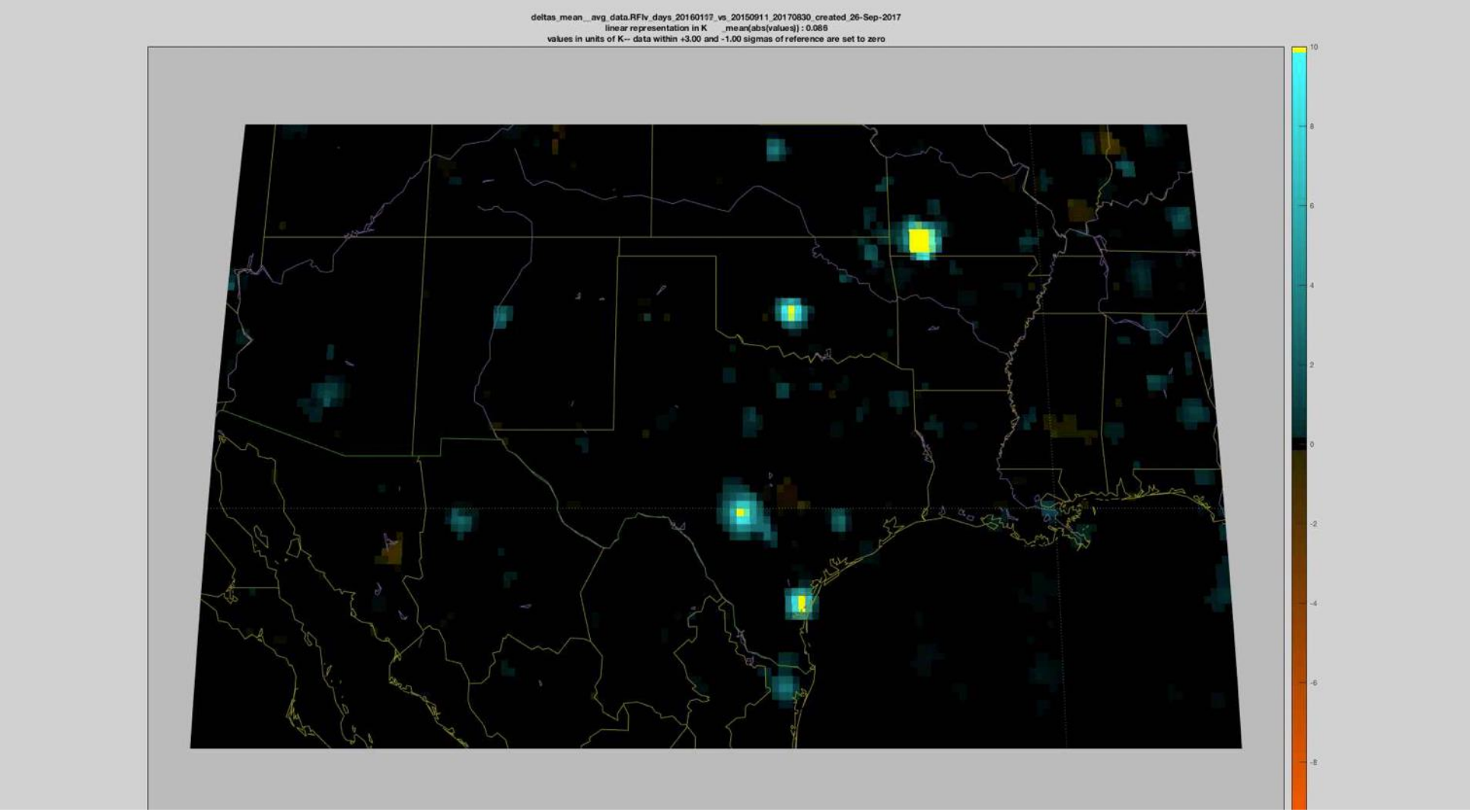
- 0.4-degree bins posted on 0.2 degree grid
- 8-day orbit cycle statistics computed in bin
- Mean, std, min, max of T_A, RFI intensity, NEDT
- September 2015 to August 2017



- Create geographic “control charts”

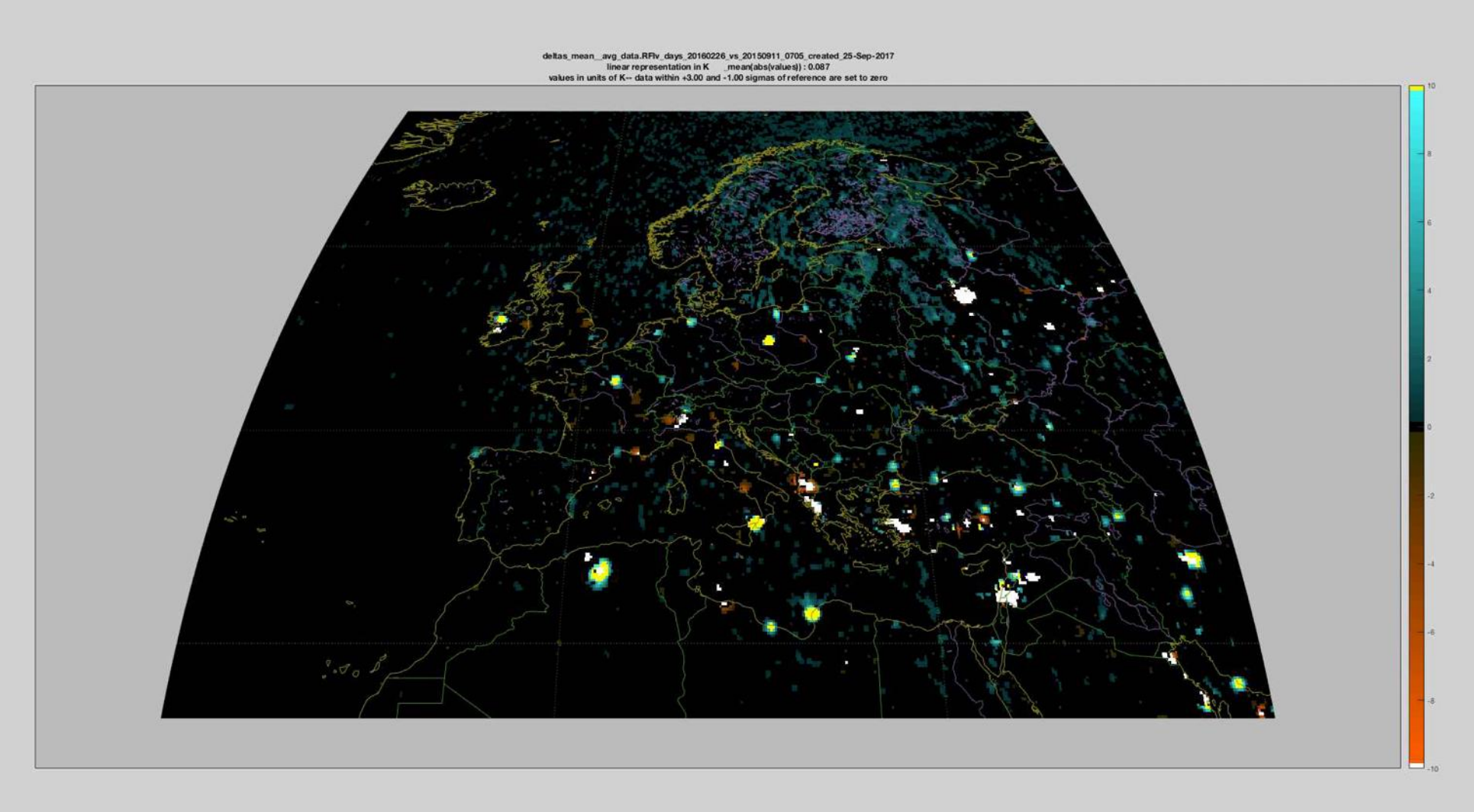
Case #1: Kerrville, TX

Goddard Space Flight Center



Case #2: Europe

Goddard Space Flight Center



What's next?

Goddard Space Flight Center

- 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?