# L-band RFI in NWP

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RFI 2022 Workshop, 17th February 2022

ECMWF

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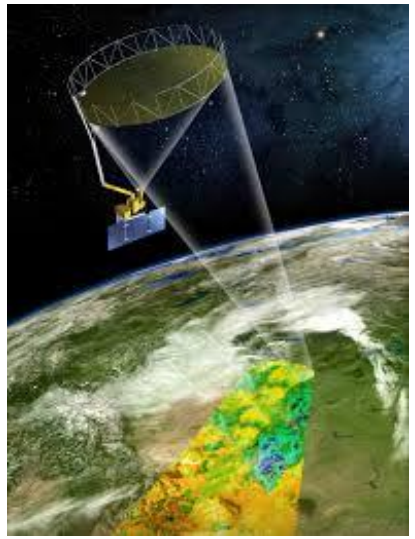
- Introduction
- GRDS SMOS results
- SMAP
- Conclusions and future work

## SMOS

- SMOS is the soil moisture and ocean salinity mission
- ESA Earth Explorer satellite launched in 2009
- Operated well beyond it’s originally planned lifespan

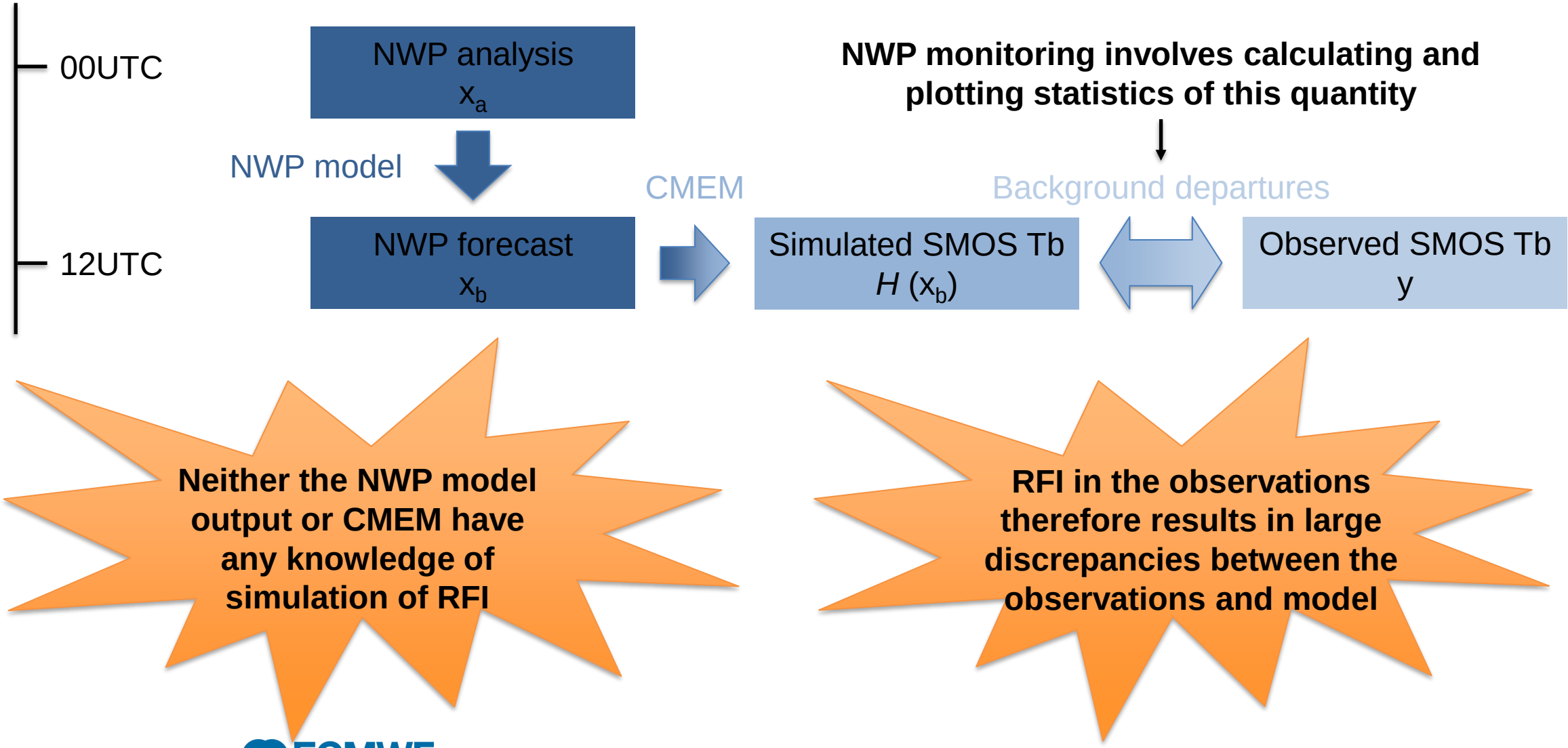
## SMAP

- SMAP is the Soil Moisture Active-Passive mission
- NASA research satellite launched in 2015
- Active radar failed soon after launch but passive radiometer still operating

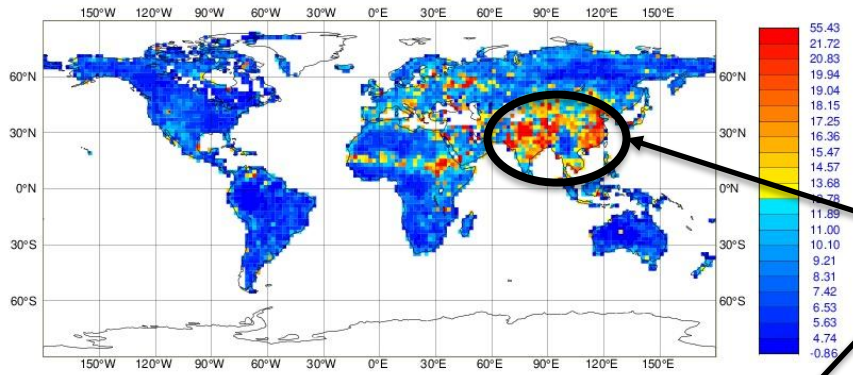


- Both are passive microwave instruments measuring L-band (1.4 GHz) brightness temperatures
  - Sensitive to ocean salinity and surface wind speed over ocean
  - Sensitive to soil moisture over land
  - **Heavily affected by RFI e.g. military radar, wireless security cameras, satellite TV etc.**

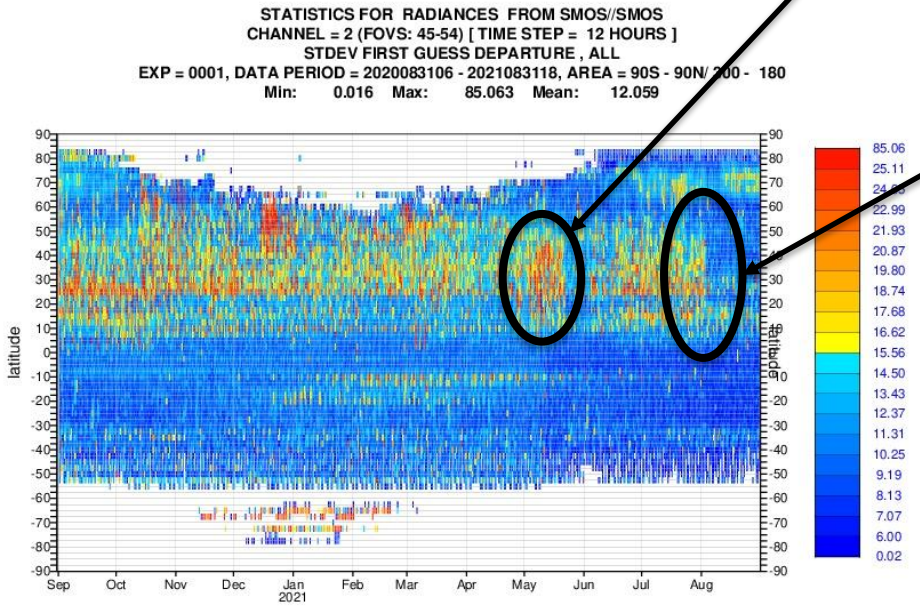
# NWP monitoring introduction



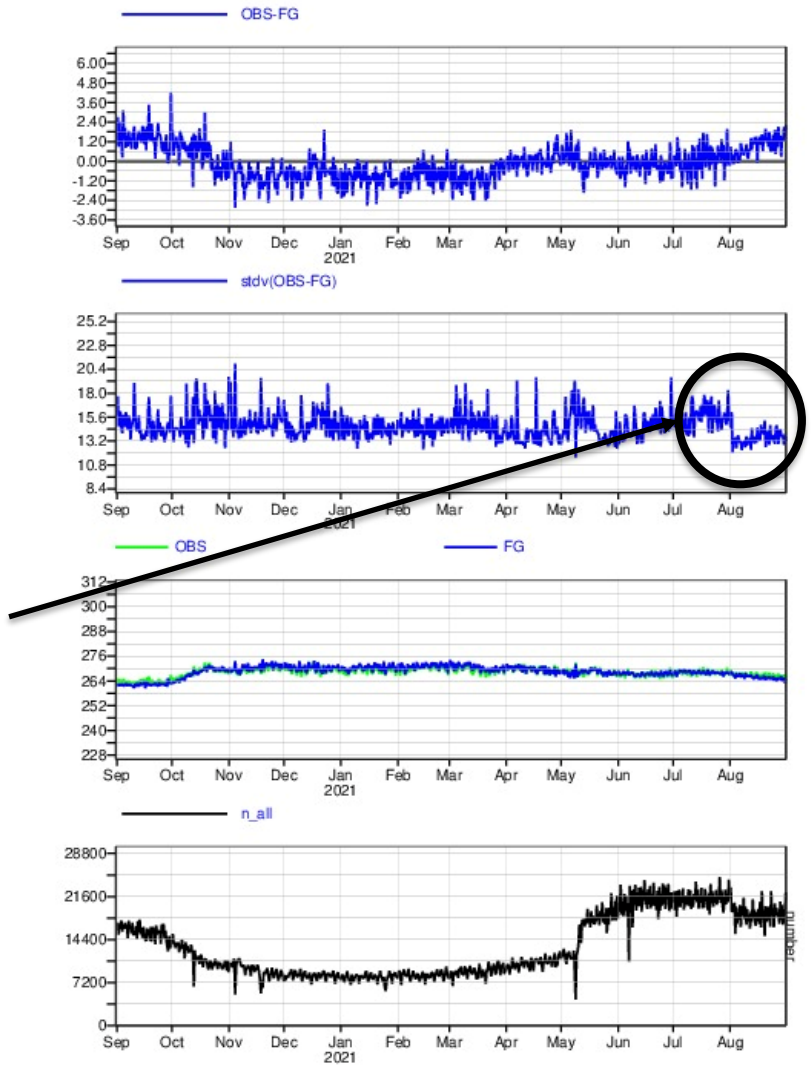
# Examples of NWP monitoring plots




Despite existing RFI screening we still see RFI signatures

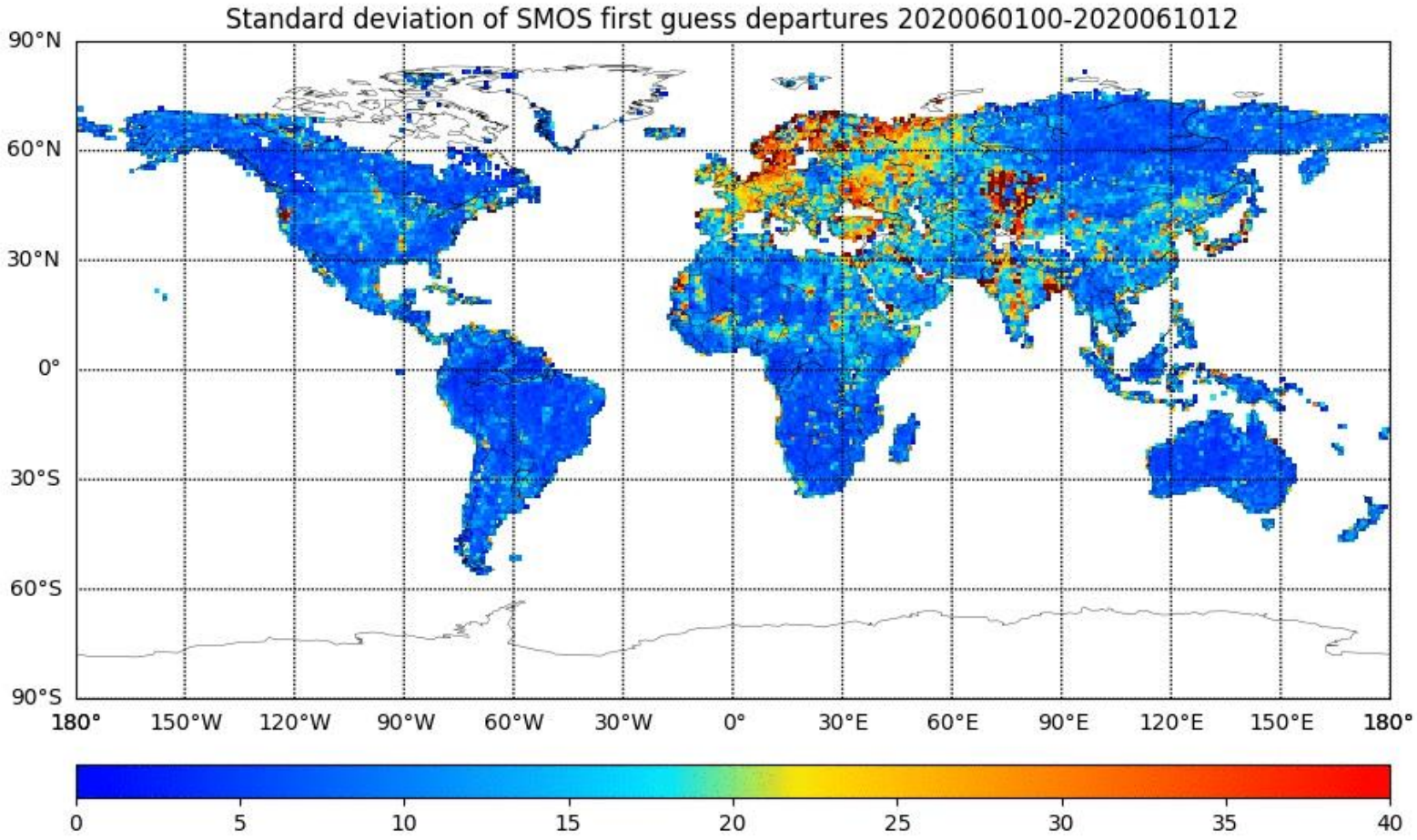



Recent improvements to SMOS RFI screening visible in statistics



# RFI

- L-band RFI sources are highly variable in strength, source location and time



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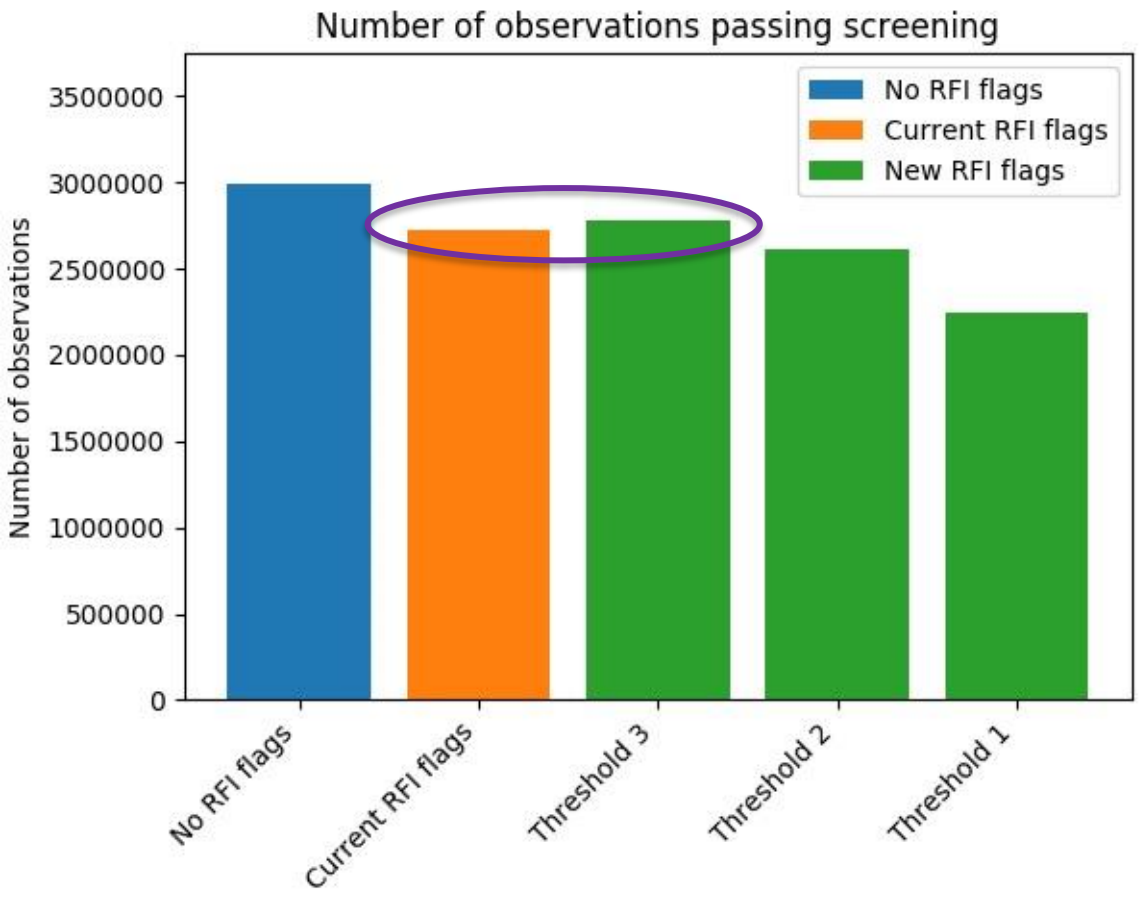
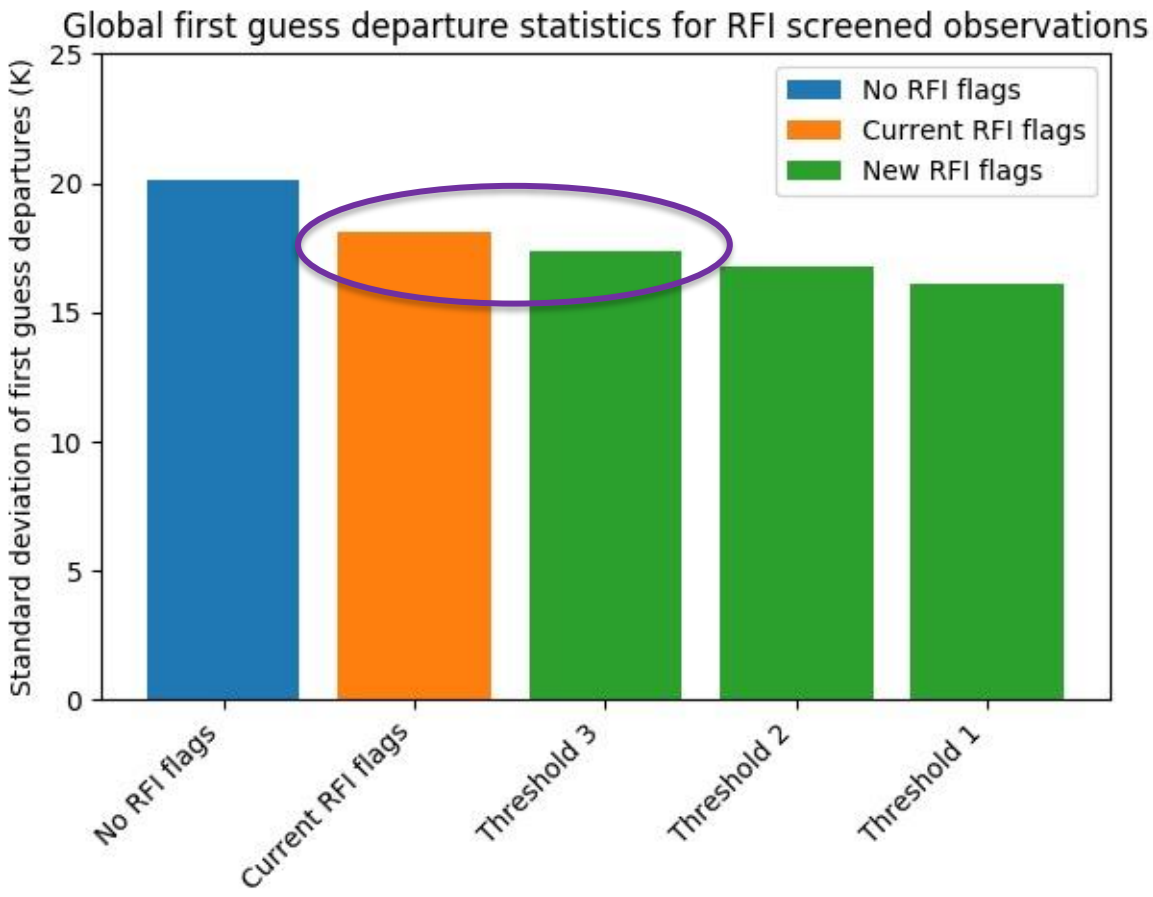
# GRDS results

- GRDS (Ground RFI Detection System) is an independent software package designed to better detect low level RFI from any passive Earth observation data – see previous presentation (Onrubia et al) for details
- The final version of the GRDS was used to generate one month (July 2019) of SMOS data
- New flags were provided and 3 different thresholds used within the algorithms:
  - GRDS threshold 1: Most aggressive screening
  - GRDS threshold 2: Intermediate screening
  - GRDS threshold 3: Least aggressive screening
- The performance of the GRDS was assessed against:
  - Baseline: No RFI screening
  - Control: SMOS v620 (current at the time of the analysis) RFI screening
- Various analyses were carried out including global statistics, gridded maps, histograms of departure distributions

# Bar charts

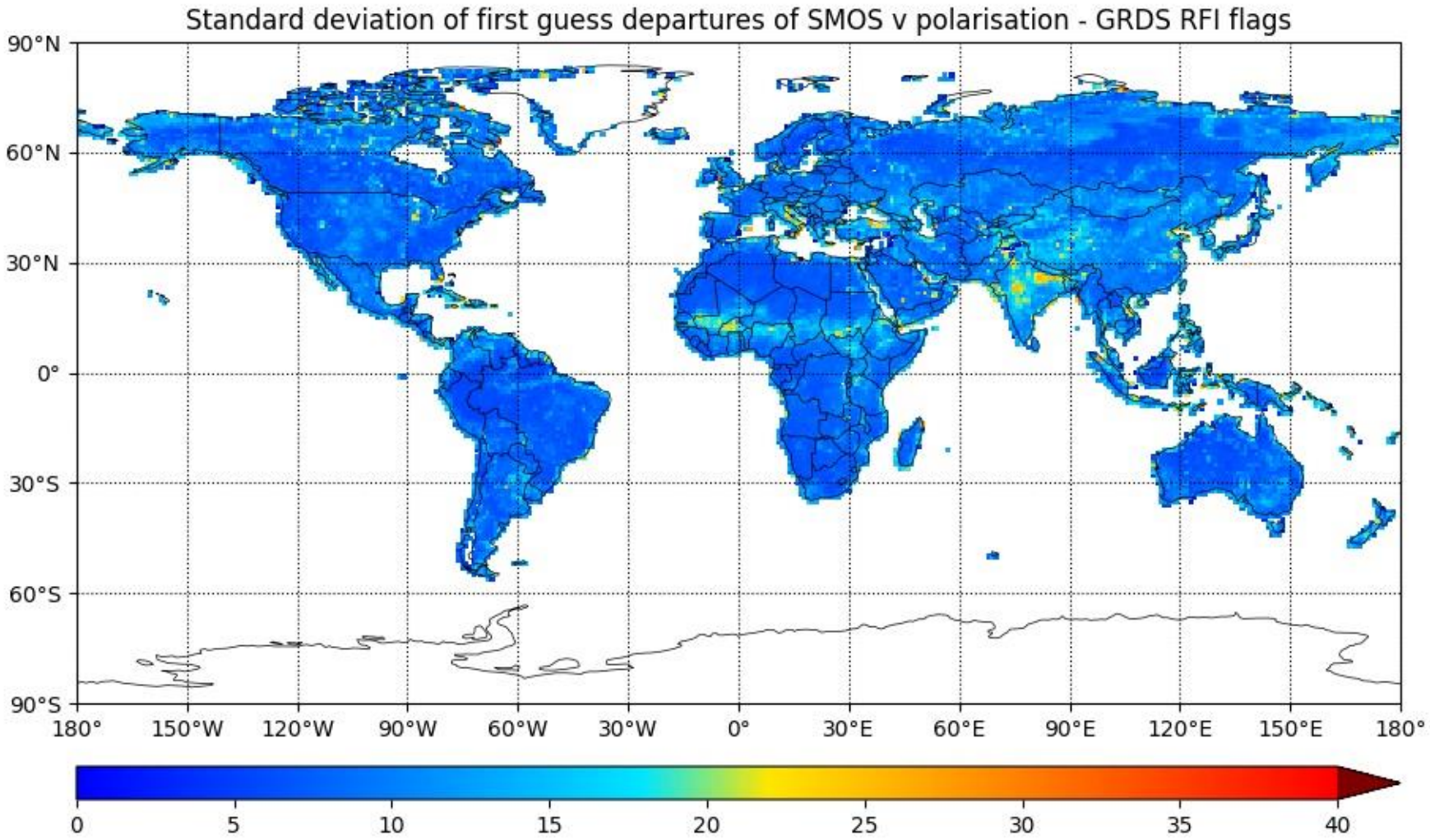
- Threshold 3 screens fewer observations but reduces departures more than current screening
- Thresholds 2 & 1 screen more observations and further reduce departures



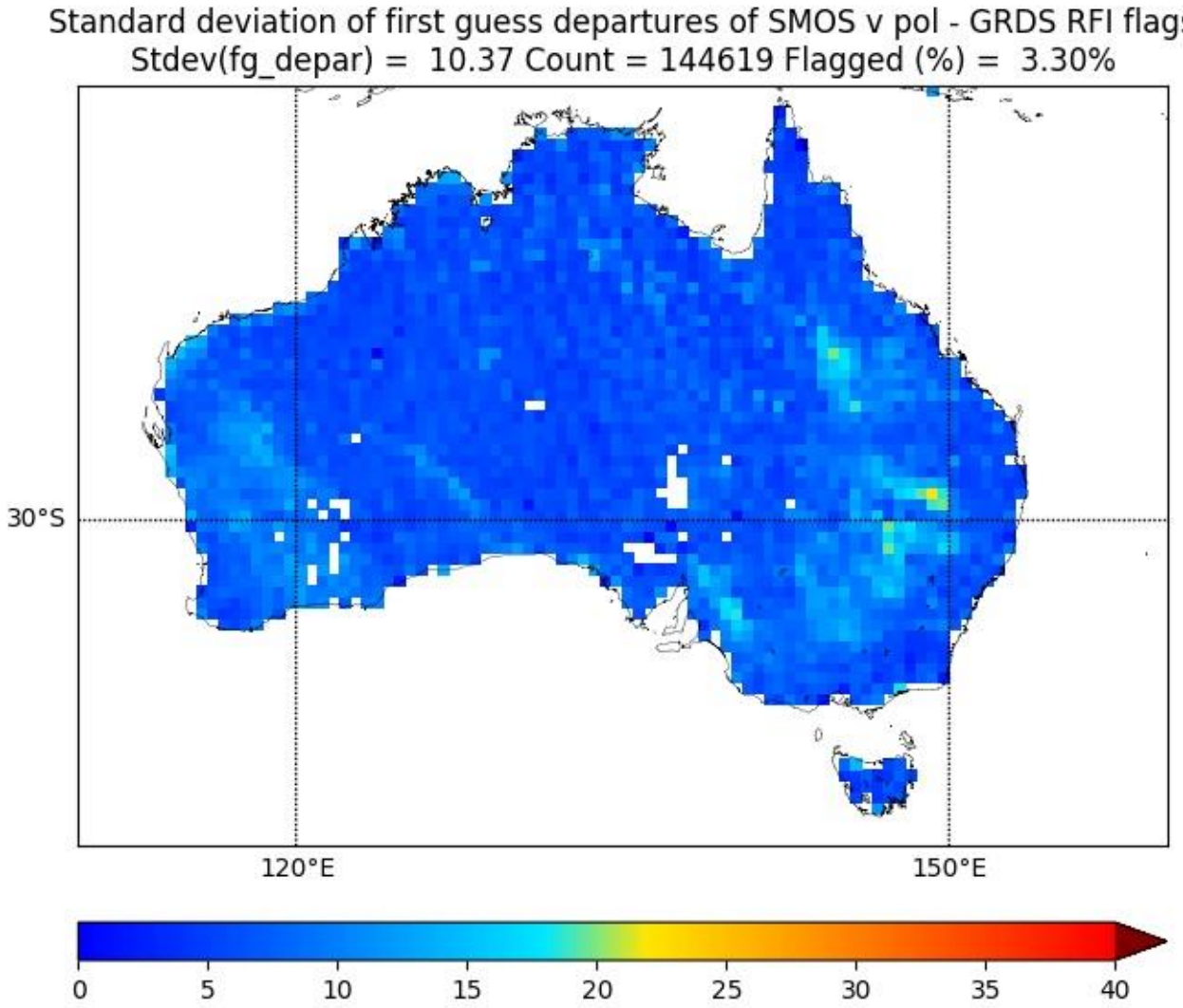
# Gridded maps – V-pol

- No screening
- Current screening
- GRDS threshold 3
- GRDS threshold 2
- GRDS threshold 1



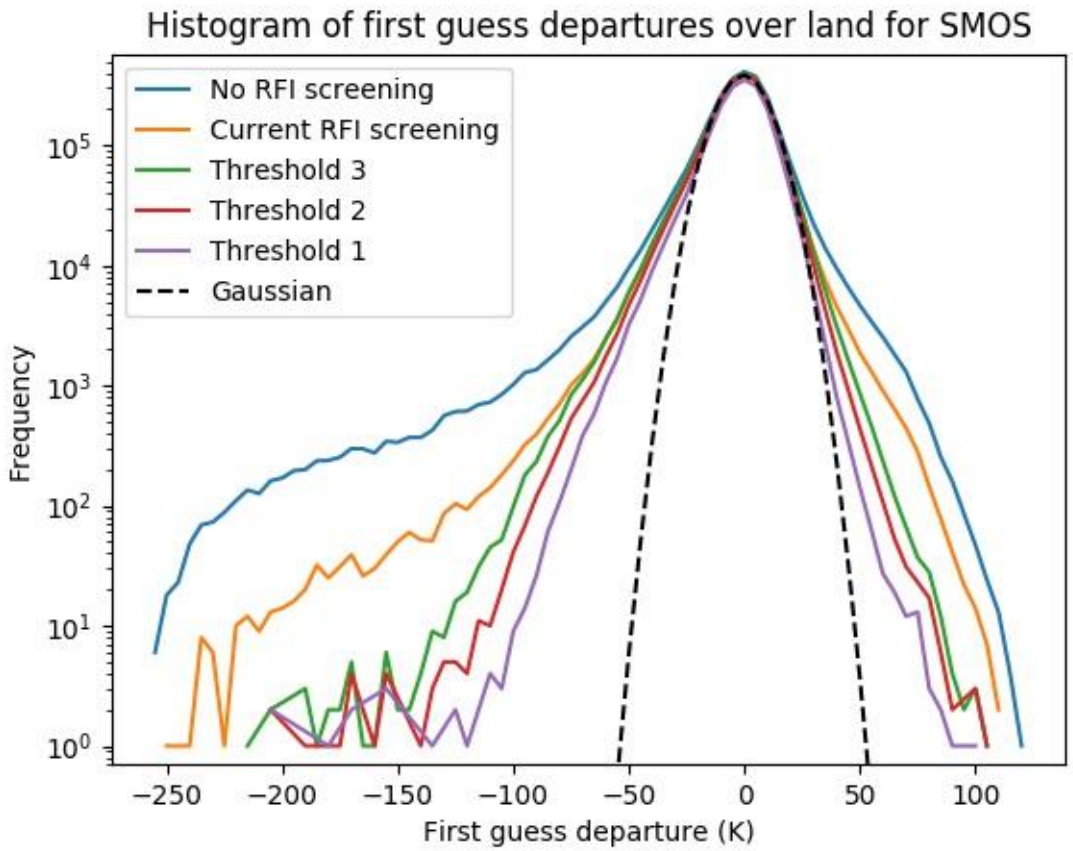
# Gridded maps – Australia – V-pol (proxy for false alarm rate)

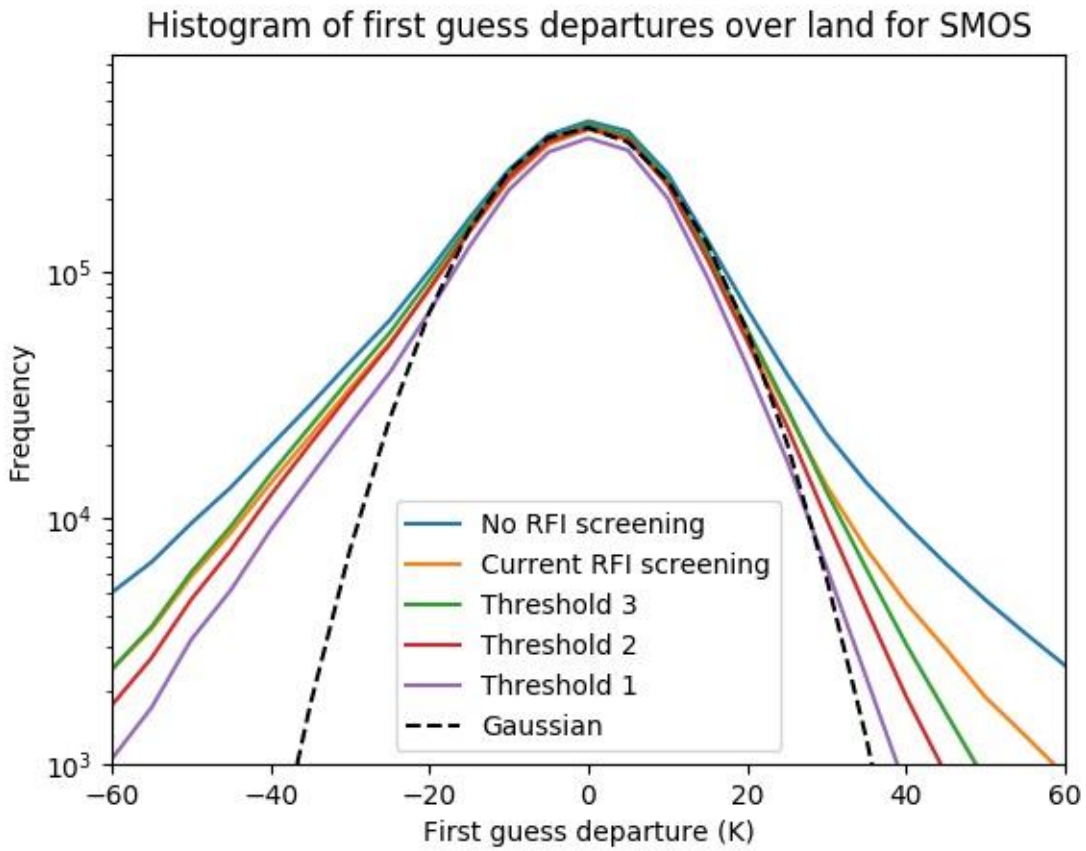
- No screening (0%)
- Current screening (0%)
- GRDS threshold 3 (0.18%)
- GRDS threshold 2 (0.74%)
- GRDS threshold 1 (3.3%)



# Histograms

- GRDS significantly reduces the tails and makes departure distribution more Gaussian and symmetric
- Threshold 1 also reduces the peak:
  - Could be a sign of false alarms or could be weakly RFI-affected observations



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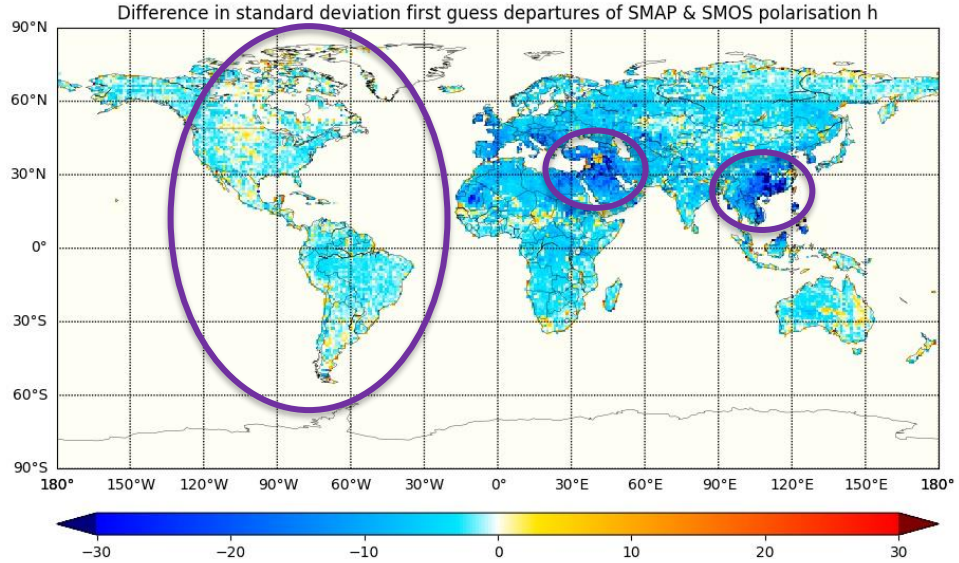
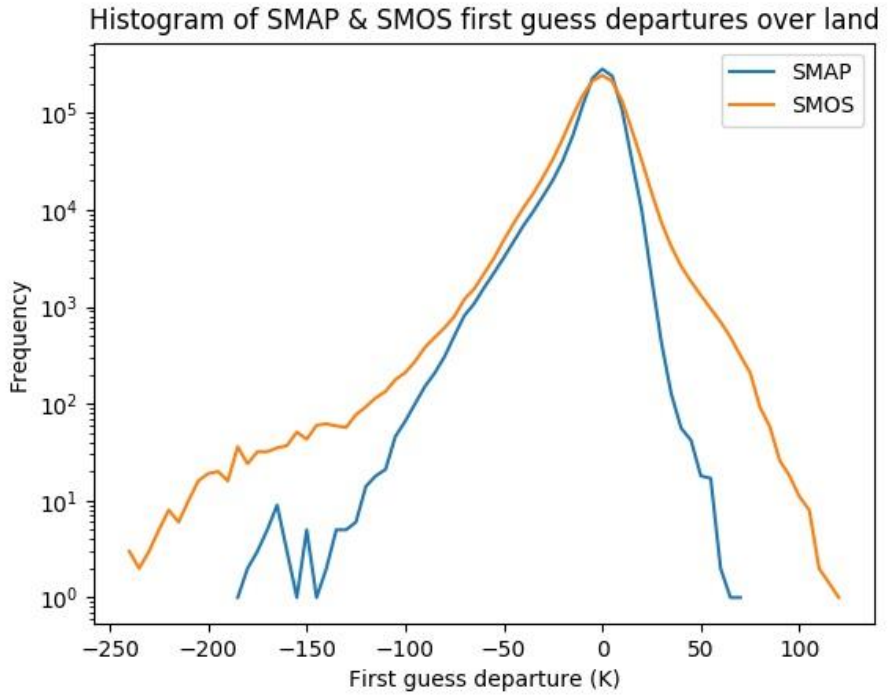
# SMOS v SMAP

- SMOS and SMAP measure at the same frequency but:
  - They have different instrument designs
  - **Several automated algorithms are applied to the SMAP data to screen for RFI**
- SMAP has smaller standard deviations of background departures:
  - Differences are largest in areas of known RFI sources
  - Smaller differences over RFI-free areas
- SMAP background departure distribution also has reduced tails than corresponding SMOS distribution
- Indicates that SMAP ‘onboard’ RFI screening is effective



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# Conclusions and future work

- The GRDS provides significant improvements over the currently operational RFI screening information available for SMOS:
  - Reduction/removal of hot spots and extreme departure values
  - Improvements in global statistics
  - Low false alarm rates
- The ‘onboard’ screening for SMAP minimises the effects of RFI on the data
- **However, using the GRDS or SMAP screening still means we are losing valuable Earth observation data. The best solution is to remove RFI at source, but this is challenging!**

Future work

- Apply to more instruments (e.g. GMI, AMSU-A, ATMS) and higher frequencies (e.g. 5G at 24GHz)
- Adapt the GRDS for operational use (e.g. as part of the SMOS ground segment?)
- Develop NWP-based RFI monitoring and screening (use pre-5G deployment ‘climatology’ as baseline to compare against)