

# ERS/Envisat MWR Recalibration and Water Vapour FCDR Generation (EMiR)



## EMiR - Objectives

- ERS-1,ERS-2, Envisat MWR provides long-term observations of total column water vapour (TCWV) and cloud liquid water content.
- Time series will be continued with Sentinel-3
- Objective of project is to provide a Climate Data Record of intercalibrated MWR Tbs and retrieved TCWV product.
- Ideally, product will be integrated in ongoing GEWEX Water Vapor Assessment (GEWEX-GVap).

## Progress since January 2015 1/3

- Full dataset provided by CLS on January 7, 2015 (as agreed upon at last PM)
- Have performed bias analysis on full dataset using two independent RT models (RTTOV and SOI)
- Have performed sensitivity studies of bias w.r.t. ERA water vapor and liquid water
- Have integrated FAME-C to allow for identification of cloud-free areas and assess cloud-free biases

## Progress since January 2015 2/3

- Have drafted calibration report based on those results
- Have drafted and updated ATBD to reflect actual model choices
- Have developed and started to document procedure for intercalibration/bias correction
- Have initially applied intercalibration procedure to entire satellite dataset

## Progress since January 2015 3/3

- Have re-run TCWV retrievals with and without bias correction
- Have performed initial assessment of TCWV time series

## Outline

- Calibration Assessment
- Intercalibration
- First TCWV results
- Open issues

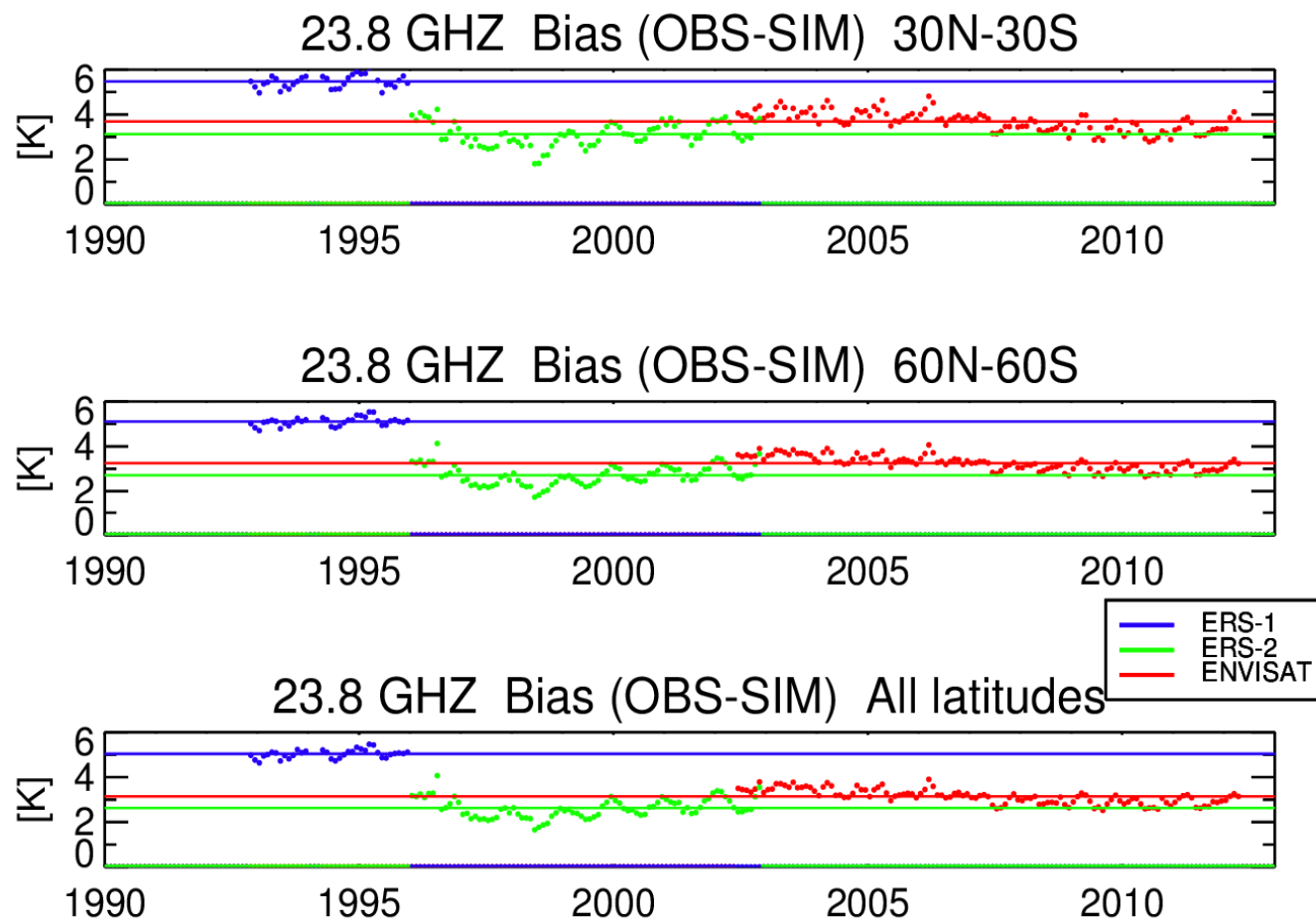
## Calibration Assessment

- Performed assessment against two independent models (RTTOV/FASTEM-2 and SOI/FASTEM-5).  
Results for time series:

	23 GHz Bias [K]	36 GHz Bias [K]	23 GHz Stdv. [K]	36 GHz Stdv. [K]
Envisat	3.3 (6.2)	6.2 (9.4)	9.4 (8.6)	10.3 (10.2)
ERS-1	5.1 (8.1)	8.4 (11.6)	9.5 (8.8)	10.8 (10.7)
ERS-2	2.7 (5.7)	5.8 (9.0)	9.4 (8.7)	10.8 (10.7)

- Numbers in brackets: SOI)\

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## All-sky versus cloud-free biases

- Cloud-Free (FAME-C cloud-cleared):

	23 GHz Bias [K]	36 GHz Bias [K]	23 GHz Stdv. [K]	36 GHz Stdv. [K]
All-sky	6.2	9.4	8.6	10.3
Clear-sky	2.8	6.7	4.4	2.4

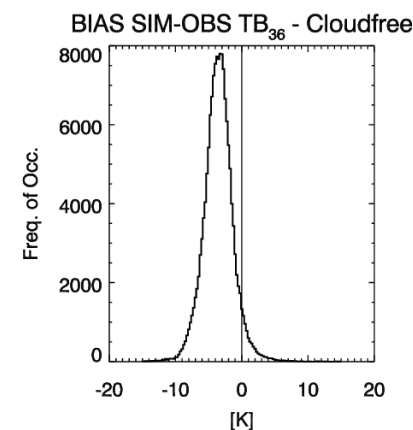
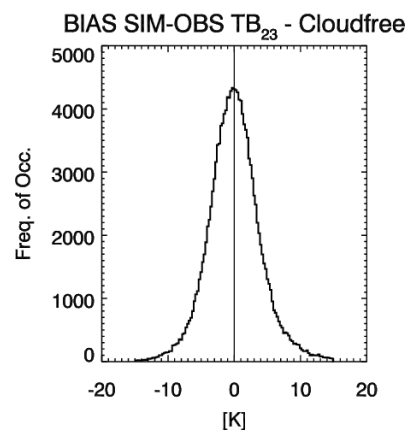
- Large part of bias caused by representativeness of ERA LWP

## Calibration assessment

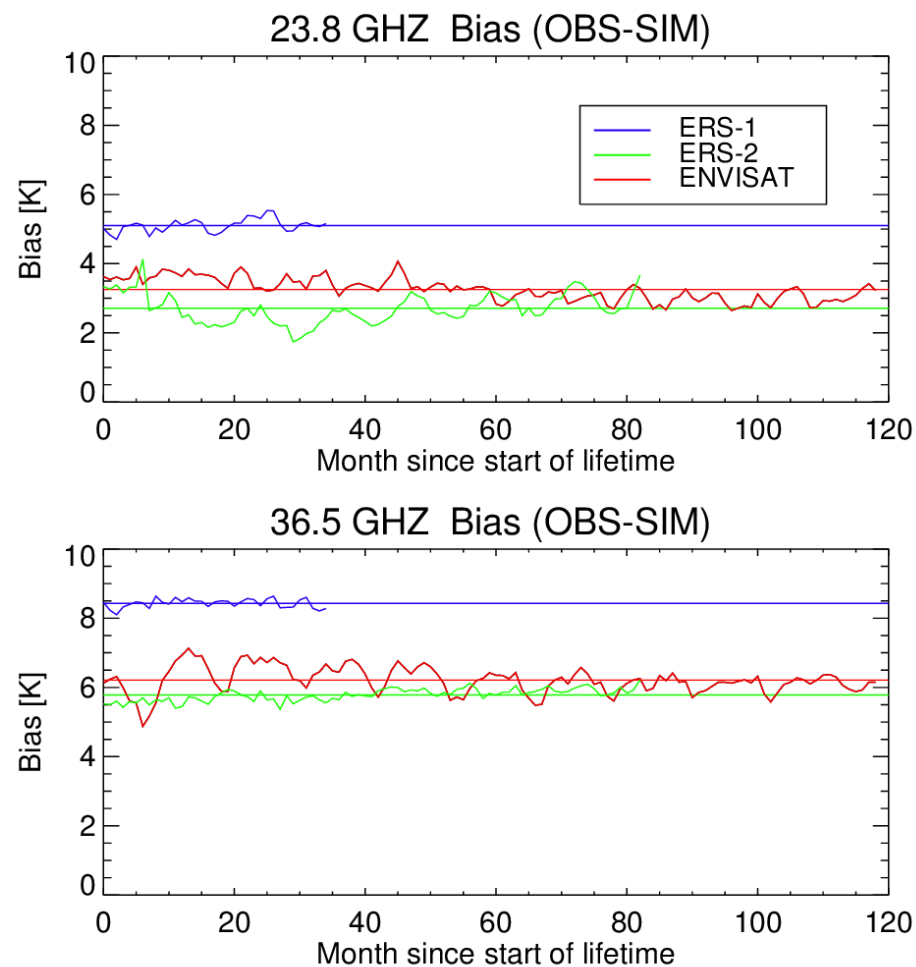
- MWR time series is well calibrated and temporarily stable.
- Remaining  $\sim 2$  K discontinuity between ERS-1 and ERS-2 can be addressed via bias correction/intercalibration.
- Differences between different satellites do not depend on model.
- Difference between different models in expected range.

## Combining MODIS/AATSR and MWR

- Established collocation routine to combine three instruments
- Applied cloud-mask to find cloud-free microwave observations. Excellent tool for calibration assessment
- Histograms show excellent agreement SIM/OBS
- Basis for bias correction



## Intercalibration



## Intercalibration

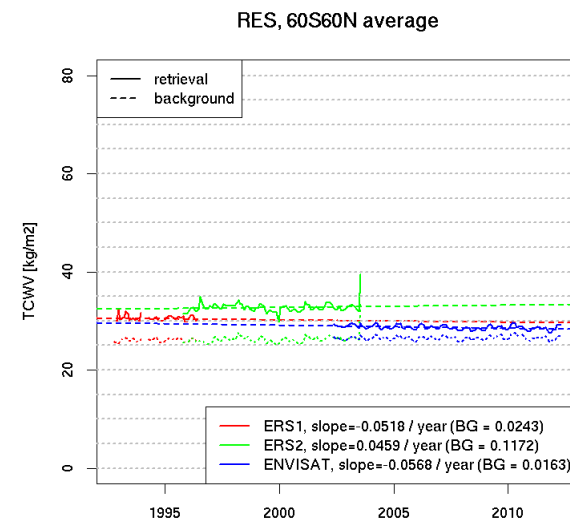
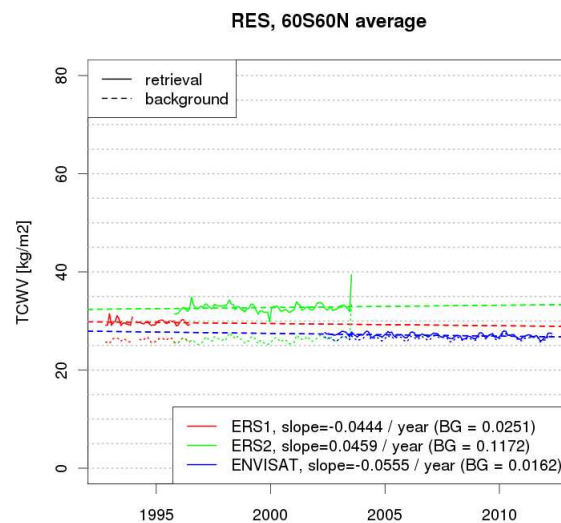
- Address shifts between instruments as fixed bias and provide bias-correction constant in time for each sensor

Table 1: Bias values for all three MWRs. These numbers need to be subtracted from the observed brightness temperatures. I.e., if the observed brightness temperature is 150 K and the bias value is -0.3 (negative 0.3, as for EnviSat, 23 GHz), then the bias corrected Tb is  $150 + 0.3 = 150.3$  K.

	Bias 23 GHz [K]	Bias 36 GHz [K]
ERS-1	+1.55 (positive)	+5.65 (positive)
ERS-2	<b>-0.85 (negative)</b>	+3.00 (positive)
ENVISAT	<b>-0.30 (negative)</b>	+3.43 (positive)

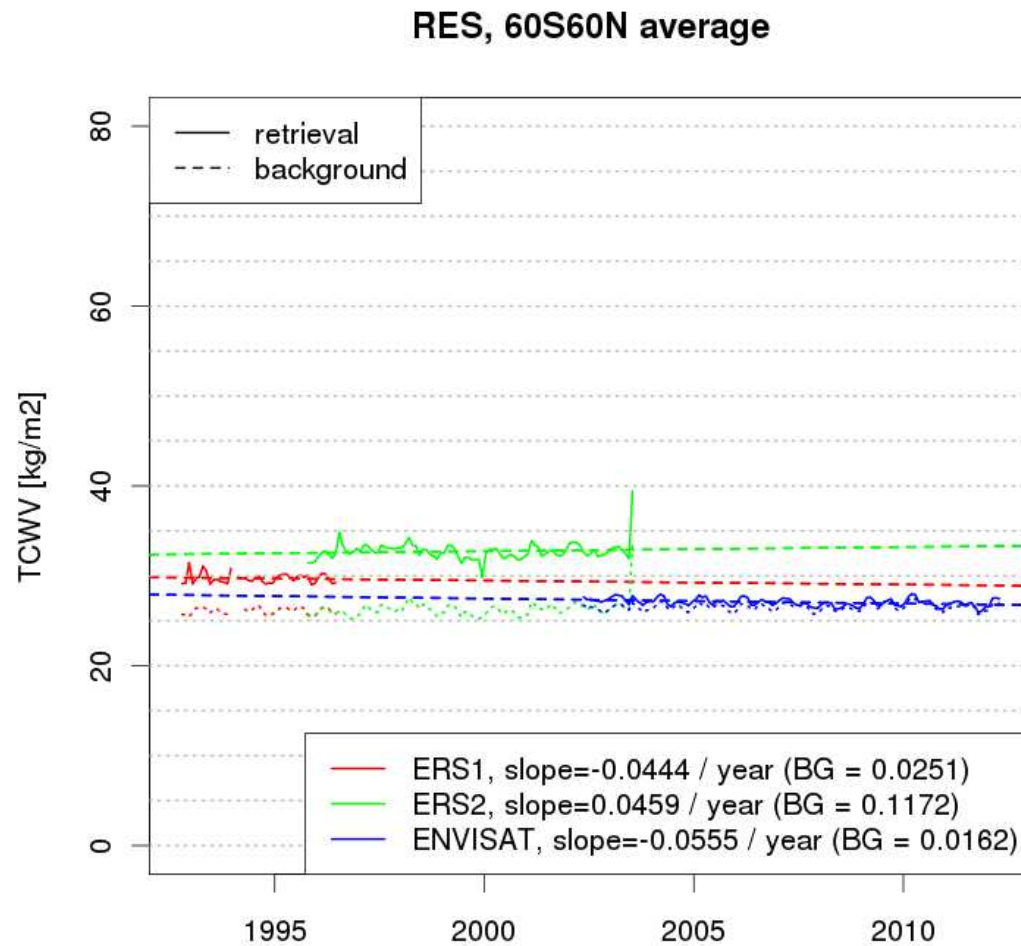
## First run TCWV

- Hot-off-the-press first results (first cut)
- Will need to significantly improve bias correction



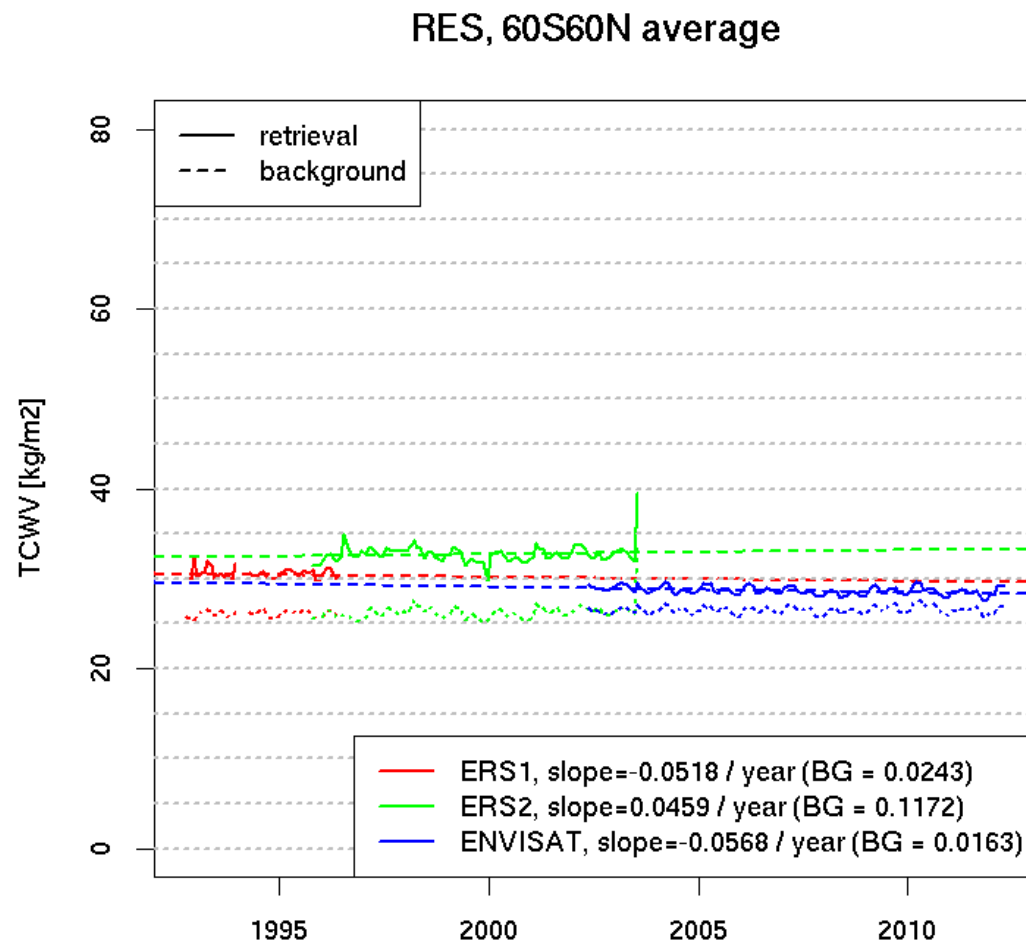
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WITHOUT



## ERS/Envisat MWR Recalibration and Water Vapour FCDR Generation (EMiR)

WITH  
ENVISAT, ERS-  
1 only





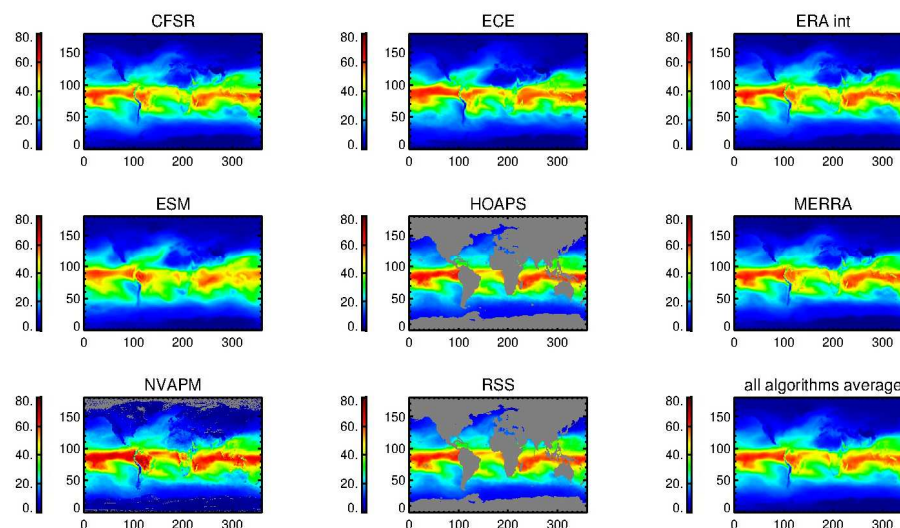
## Integration with GEWEX - GVar

- GVar is ongoing GEWEX assessment of satellite-based water vapor products
- EMiR dataset will be part of GVar TCWV assessment.
- Out of eight global TCWV climate datasets, EMiR is the ONLY dataset over ocean that does not depend on SSM/I time series
- Highly valuable independent dataset

## Integration with GEWEX - GVar

- Below are examples for the eight datasets currently included in GVar.

Total Water vapor January 1998



- EMiR will be included by the end of 2015

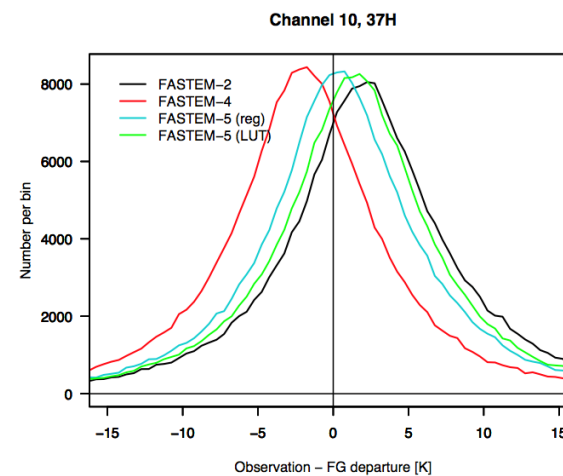
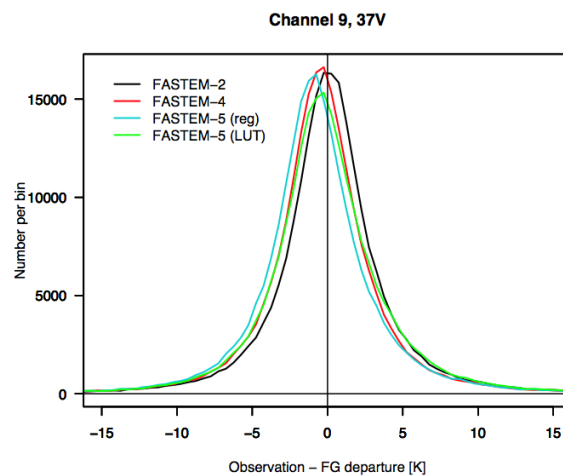
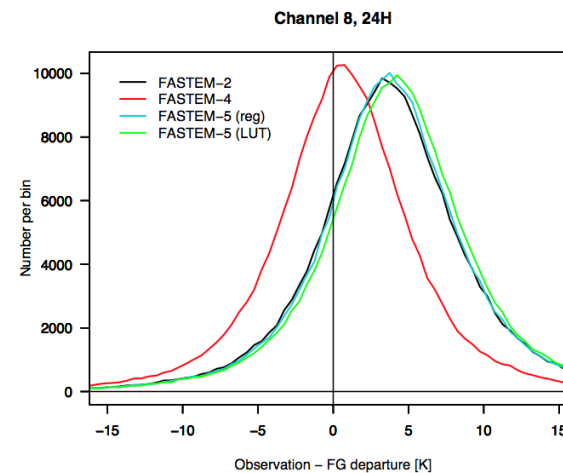
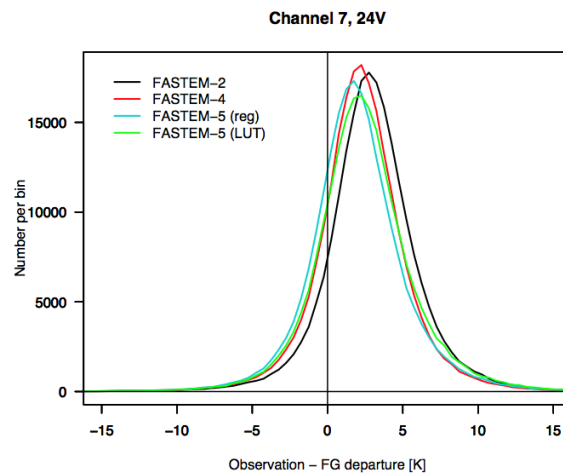
## Way forward

- Fully address intercalibration. We are very close but need to study appropriate bias-correction schemes
- Possibly try out several schemes and study impact on retrieval (Innovative error estimation technique)
- Establish validation pathway (Marc will talk about this)
- Provide data to users (Ulrika)

# Backup slides



# ERS/Envisat MWR Recalibration and Water Vapour FCDR Generation (EMiR)



**TECHNICAL M**

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Evaluation of the microwave ocean surface emissivity model FASTEM-5 in the IFS

Niels Bormann, Alan Geer and Stephen English

Research Department

February 2012

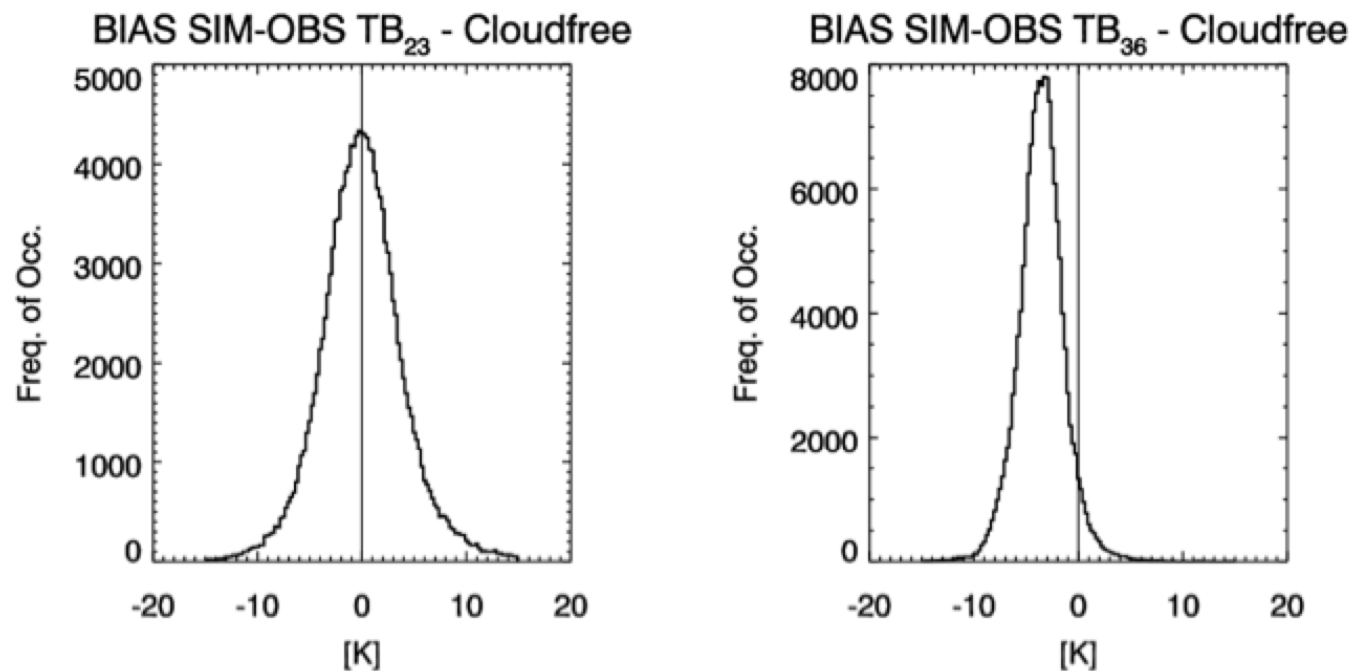
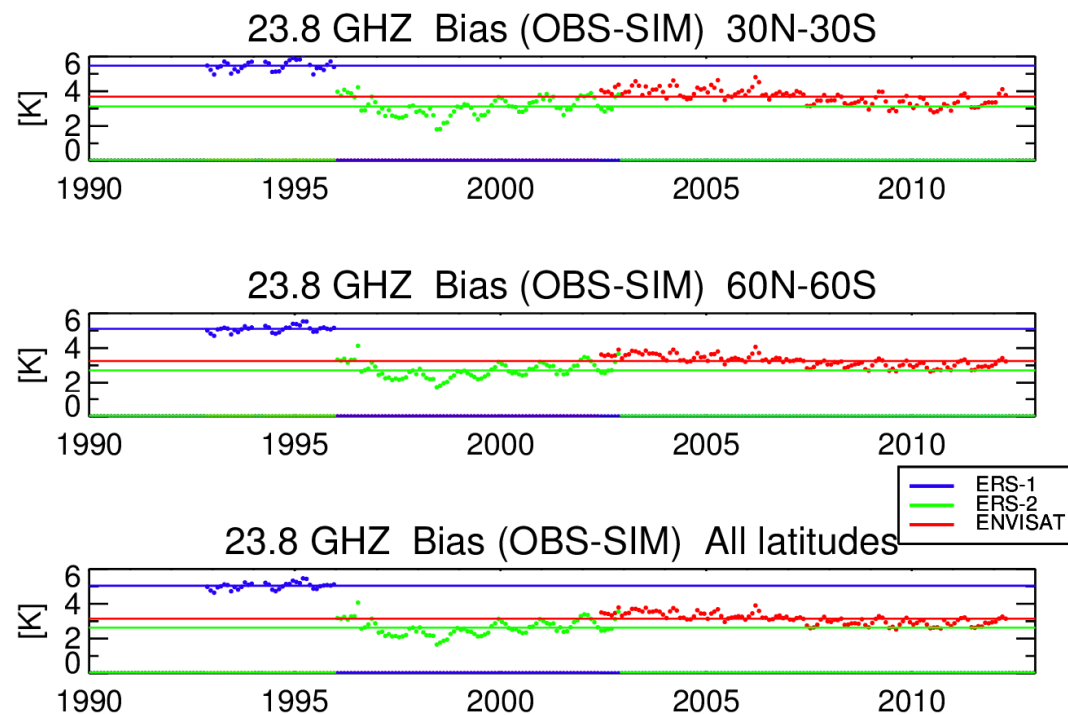
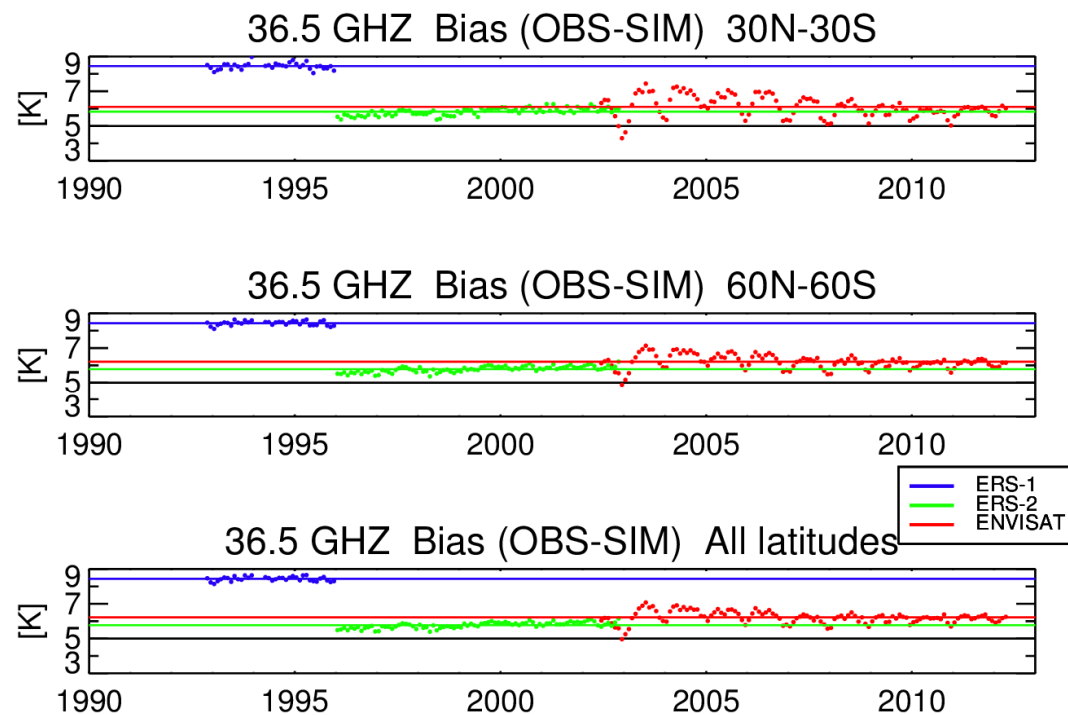


Figure 1: Histograms of global cloud-free biases Envisat MWR against RTTOV. The mean values are -0.30 K (23.8 GHz, left panel) and +3.43 K (36.5 GHz, right panel). Standard deviations are 4.44 K (23.8 GHz) and 2.46 K (36.5 GHz).

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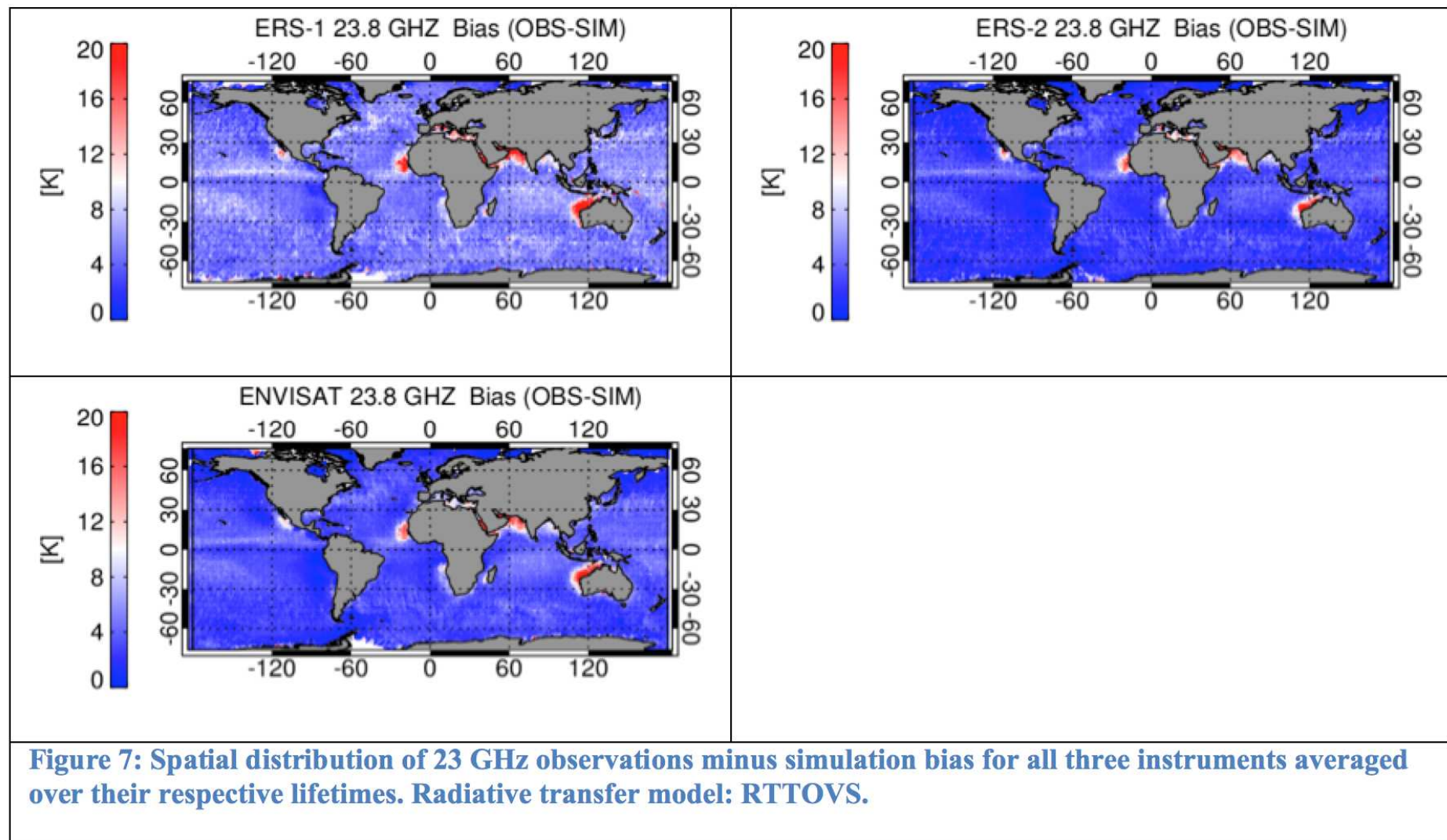


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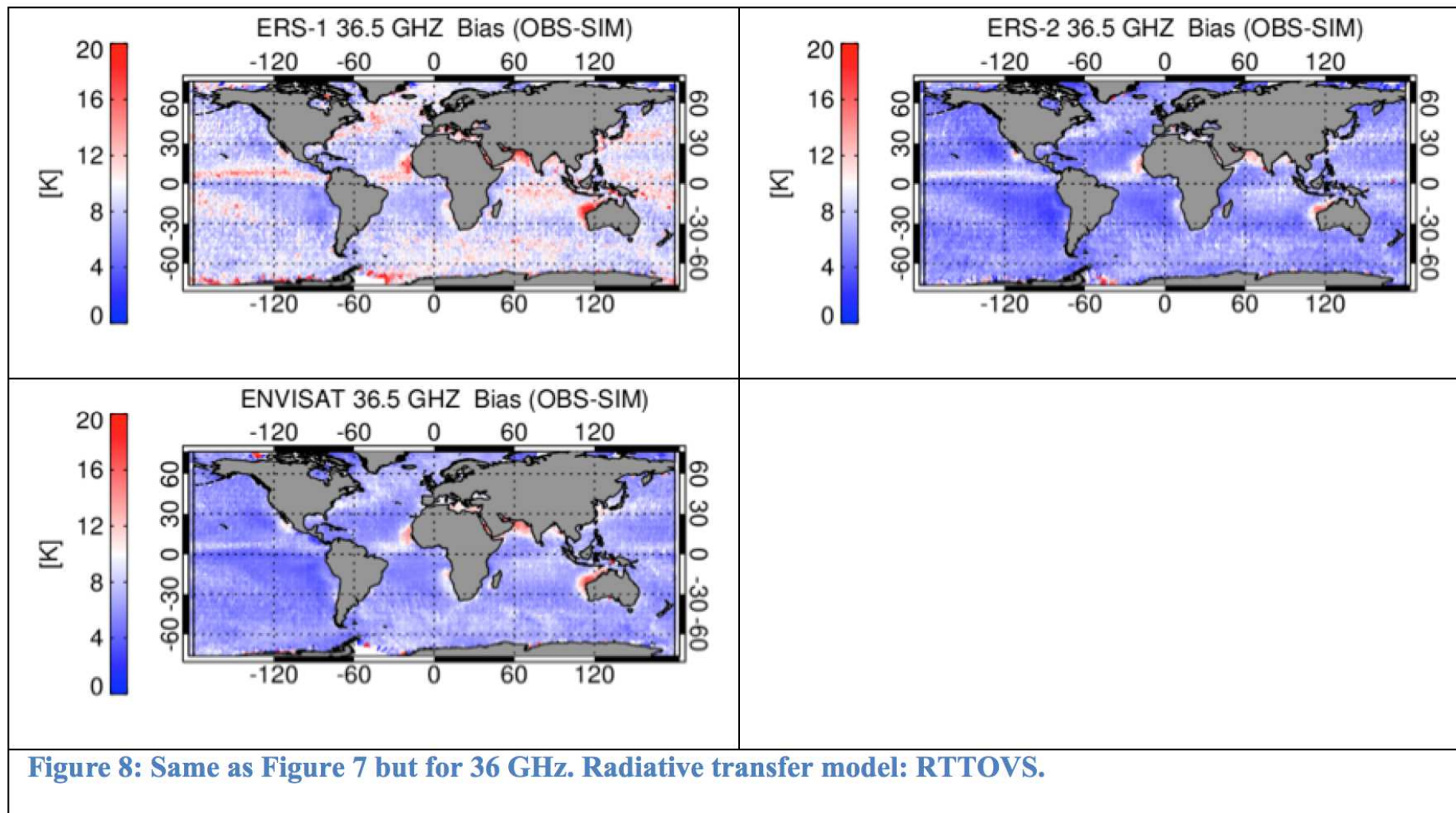




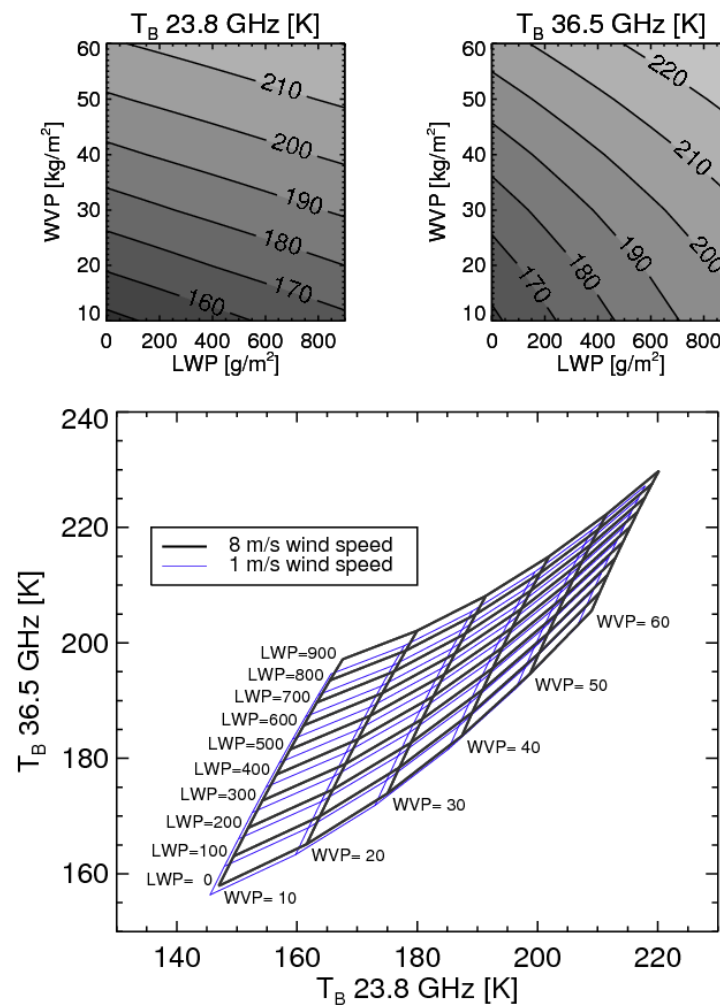
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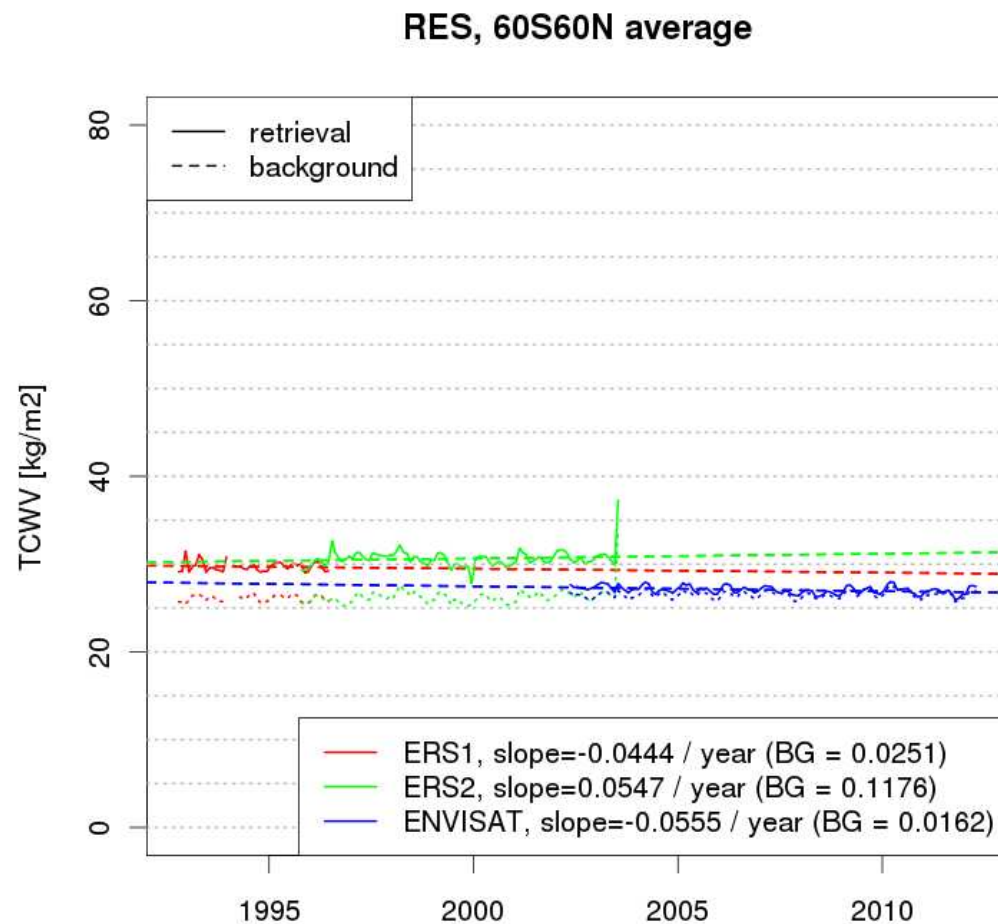
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## Assessment of MWR calibration quality for FCDR generation

- Assessed reprocessed MWR TBs from ESA ERS and Envisat Altimetry dataset against independent model
- Combined MERIS/AATSR cloud mask with MWR on Envisat to assess clear-sky biases.
- Developed bias correction/intercalibration scheme needed for FCDR generation
- Models and methods transferable to Sentinel-3
- Implemented physical retrieval for Total Column Water Vapour Retrieval

## Outlook/Relevance for Sentinel-3

- Sentinel-3 will provide invaluable data to further maintain this unique microwave climate time series.
- All results, methods and retrievals will be directly applicable to Sentinel-3
- Combination of VIS/NIR/IR sensors with MWR directly applicable to Sentinel-3. Provides excellent tool for assessing and improving MWR calibration/intercalibration