

# The 17-year ROM SAF radio occultation climate data record

Kent B. Lauritsen, Hans Gleisner, Eva Howe, Nils Marving, Johannes K. Nielsen, Lars Ø. Rasmussen, Stig Syndergaard

DMI, Copenhagen, Denmark

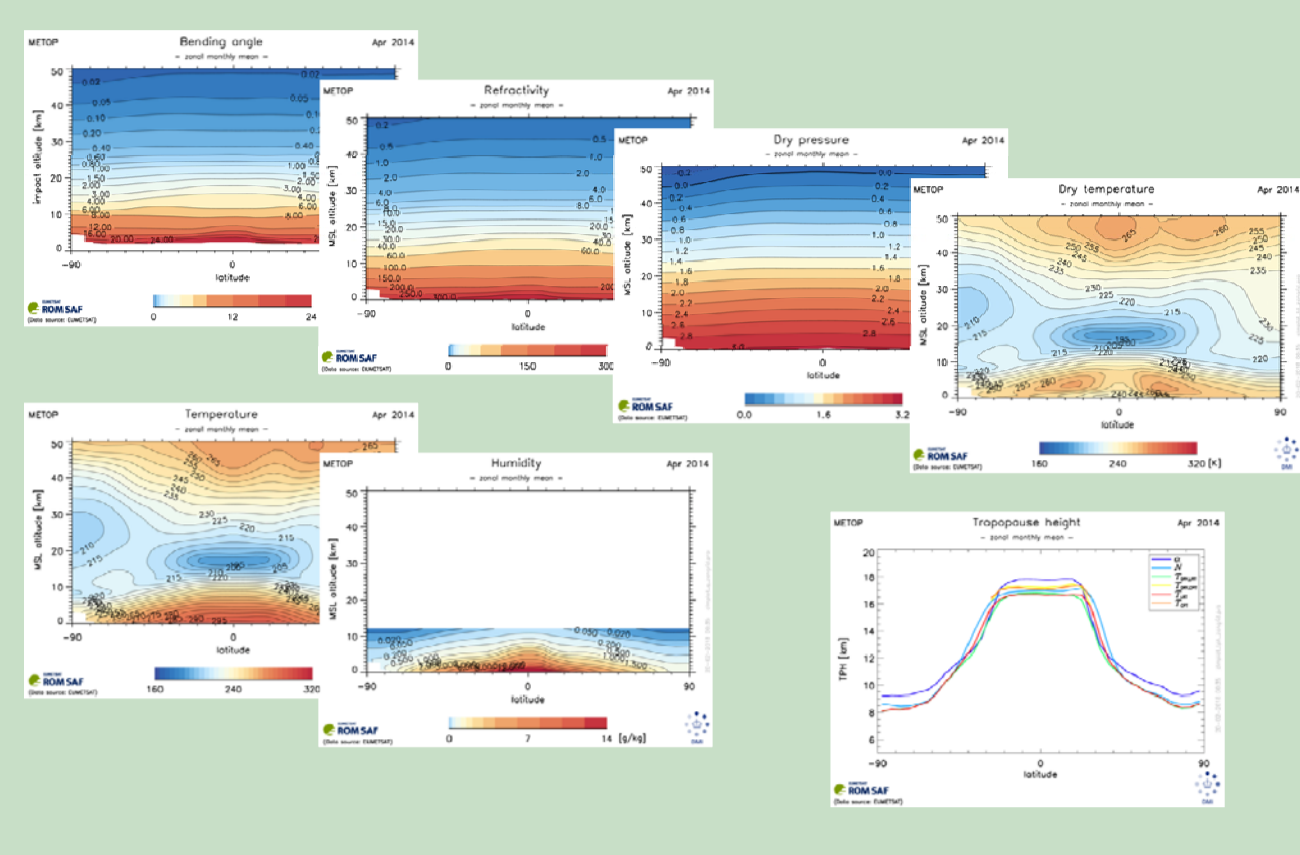


## ABSTRACT

We present results from a validation of the 17-year ROM SAF radio occultation (RO) Climate Data Record (CDR), based on processing of Metop, CHAMP, GRACE, and COSMIC data using excess-phase and amplitude data from EUMETSAT (the Metop mission) and UCAR (the CHAMP, GRACE, COSMIC, and Metop missions). We show examples of usage of the RO data, e.g., monitoring of the Quasi-Biennial Oscillation (QBO) and Sudden Stratospheric Warming (SSW) phenomena. We further discuss how RO measurements provide a direct means of measuring the geopotential heights of upper-troposphere and lower-stratosphere pressure surfaces and mean tropospheric temperatures. We also show how RO data can be used for trend analyses and discuss that trend estimates obtained from RO data are most significant near the tropopause and in the mid-latitude stratosphere.

The Radio Occultation Meteorology Satellite Application Facility (ROM SAF) is a decentralised operational processing facility under EUMETSAT. The main objective of the ROM SAF is to generate and deliver operational radio occultation products from GNSS RO instruments onboard Metop, Metop-SG, Jason-CS (Sentinel-6) and from other satellites for NWP and climate applications. The 17-year ROM SAF CDR is publicly available from: <http://www.romsaf.org>. Further information about the ROM SAF products and services are available at the website.

## PRODUCTS: EXAMPLES OF GRIDDED MONTHLY MEANS



## CLIMATE DATA RECORDS: MISSIONS AND PARAMETERS

### CDR v1.0 data records:

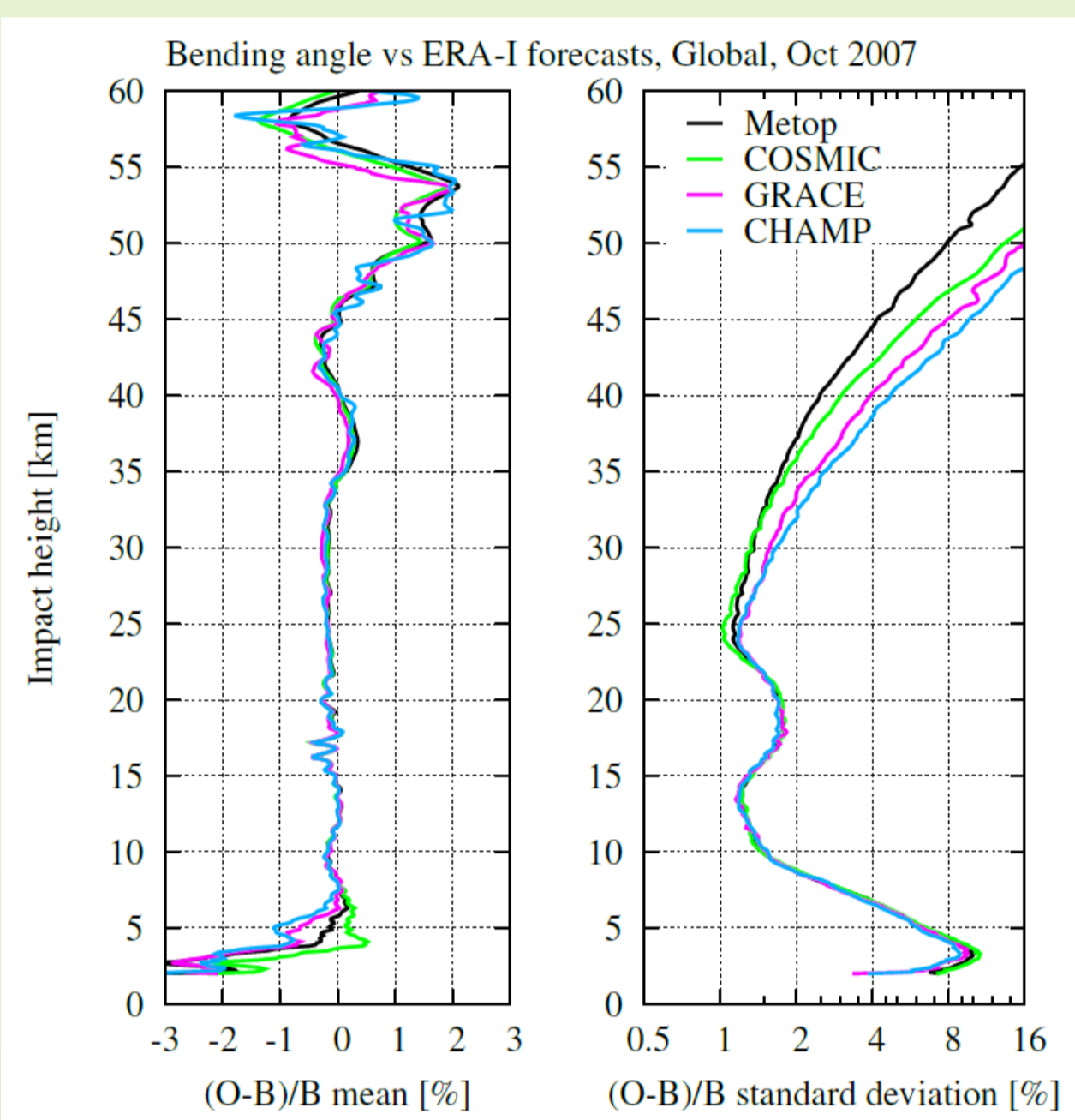
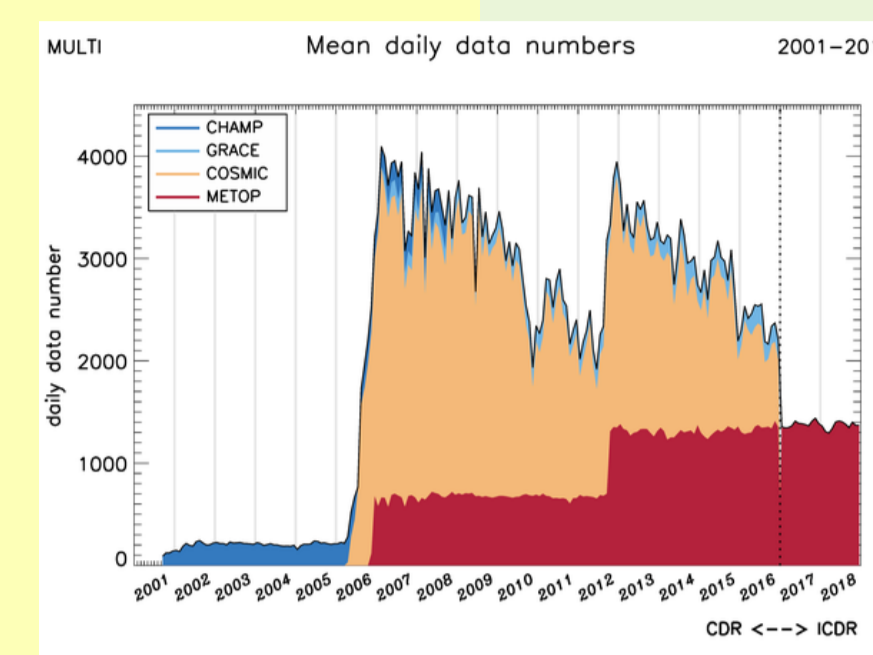
- GRM-29-R1: **Metop-A and B** (2006–2016)
- GRM-30-R1: **COSMIC** (2006–2016)
- GRM-32-R1: **CHAMP** (2001–2008)
- GRM-33-R1: **GRACE** (2007–2016)
- GRM-28-R1: **Multi-mission** (2001–2016)

### Interim CDR v1.0 data records:

- GRM-29-11: **Metop-A and B** (2017 – present)

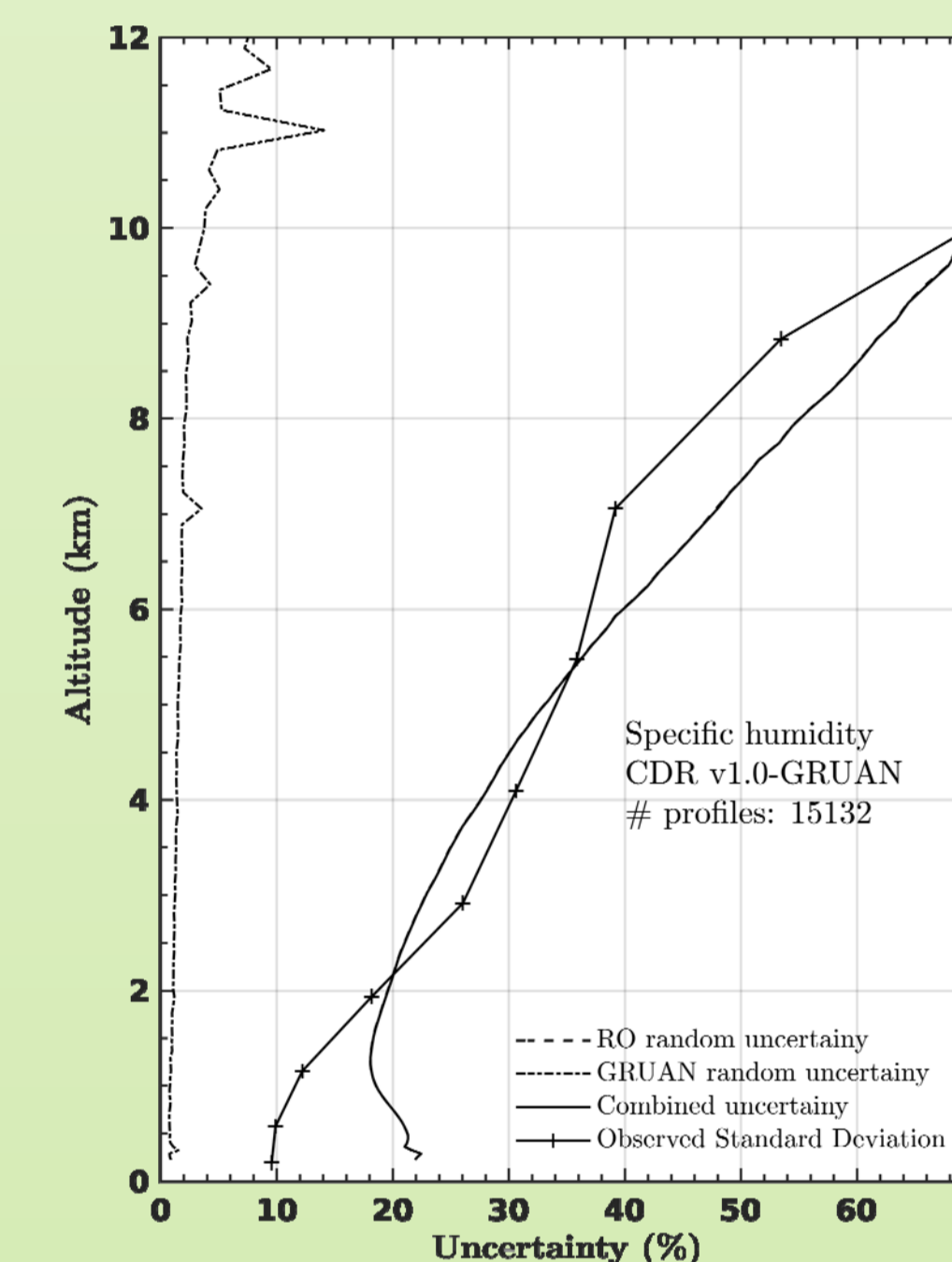
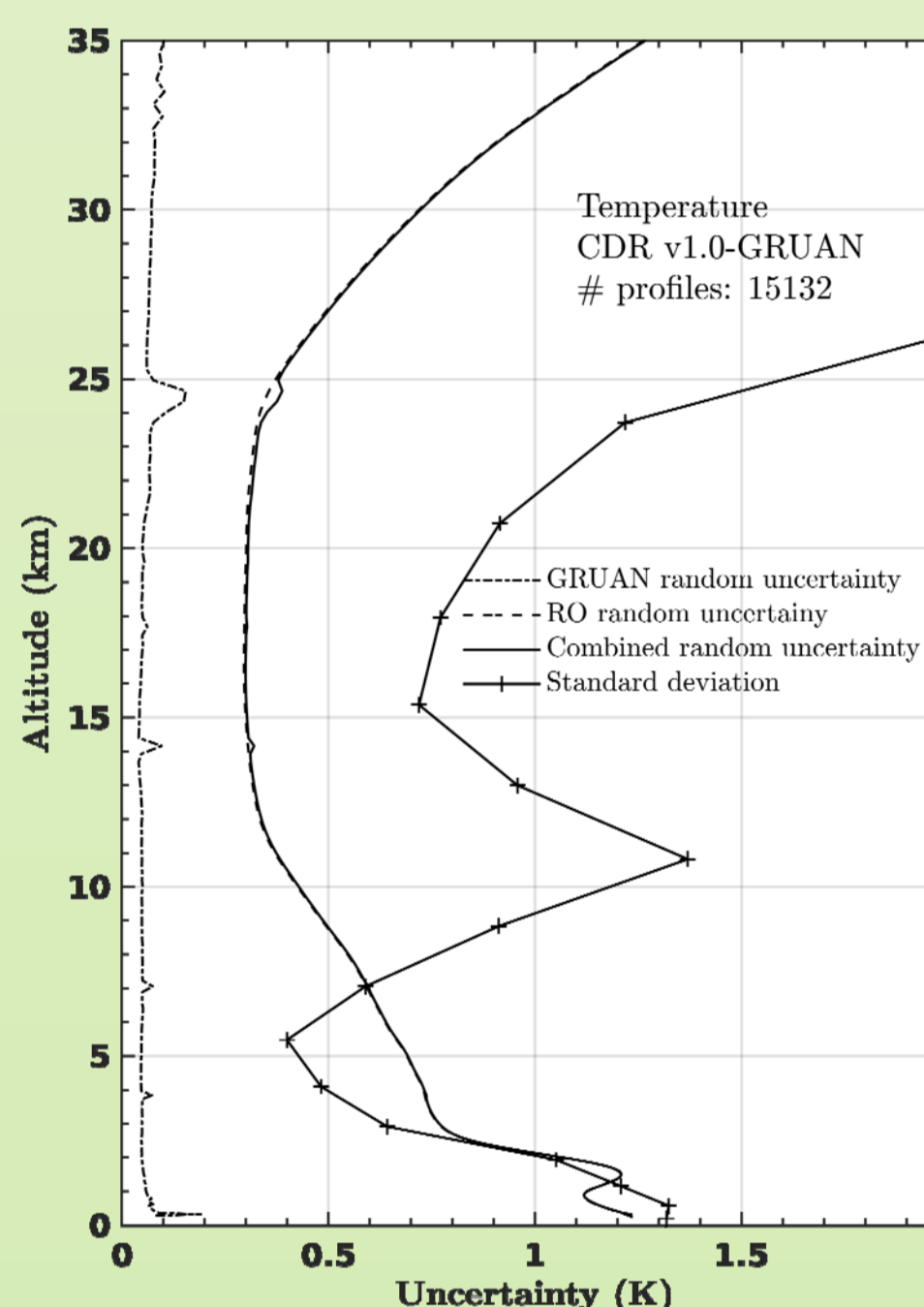
### Contents

- Bending angles (Level 1B)
- Refractivity and dry temperature (Level 2A)
- Temperature, humidity, pressure (Level 2B)
- Surface pressure, tropopause height (Level 2C)
- Gridded data of all variables, inc. geopotential height (Level 3)
- In total: **16 RO climate data records per mission**



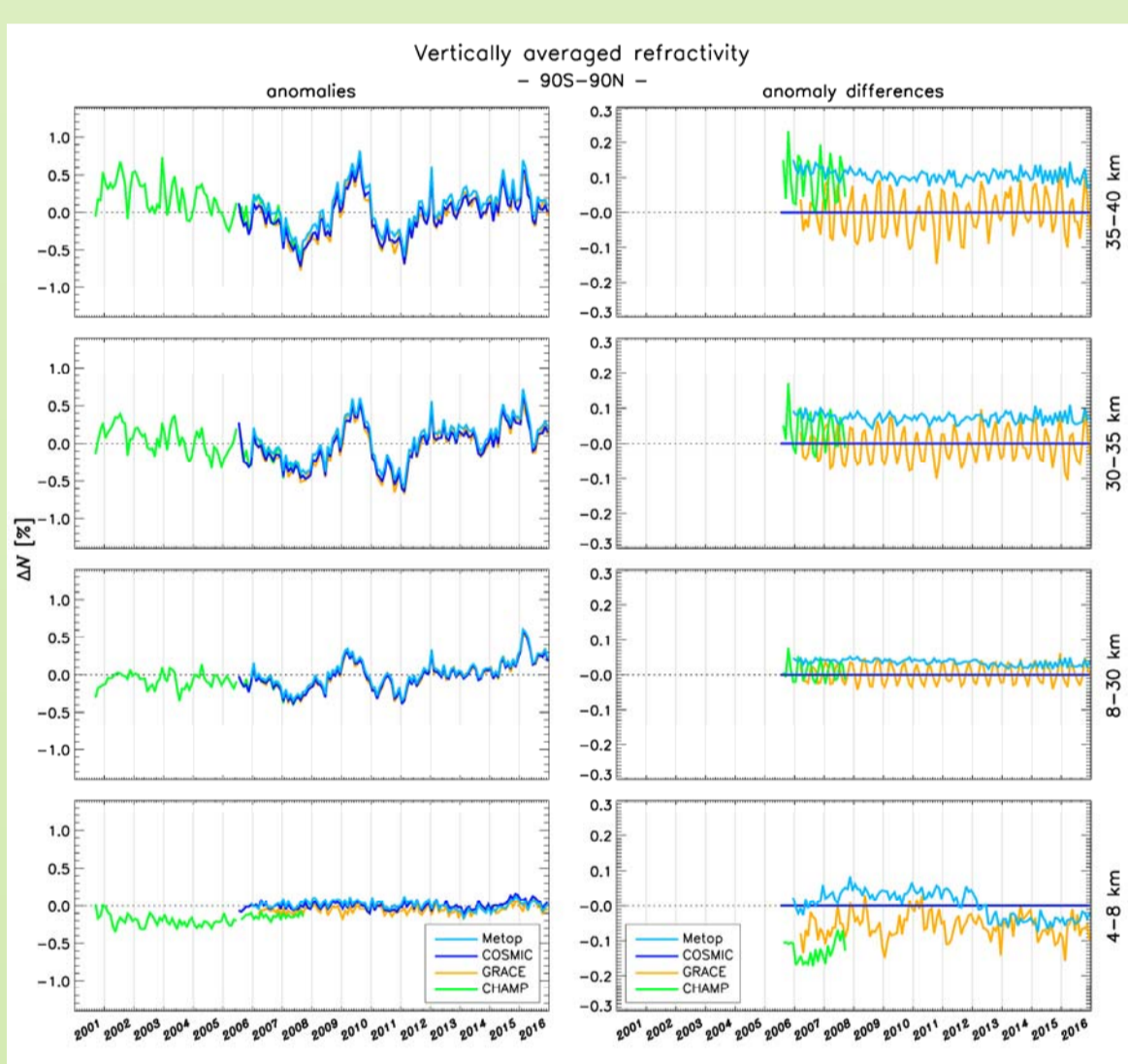
**BENDING ANGLES FOR DIFFERENT MISSIONS**  
Monthly global profile statistics of bending angle for different missions

Categories of satellite products			
Near Real Time	current	accurate	consistent
Offline	current	accurate	consistent
Data Record	current	accurate	consistent
Interim Data Record	current	accurate	consistent

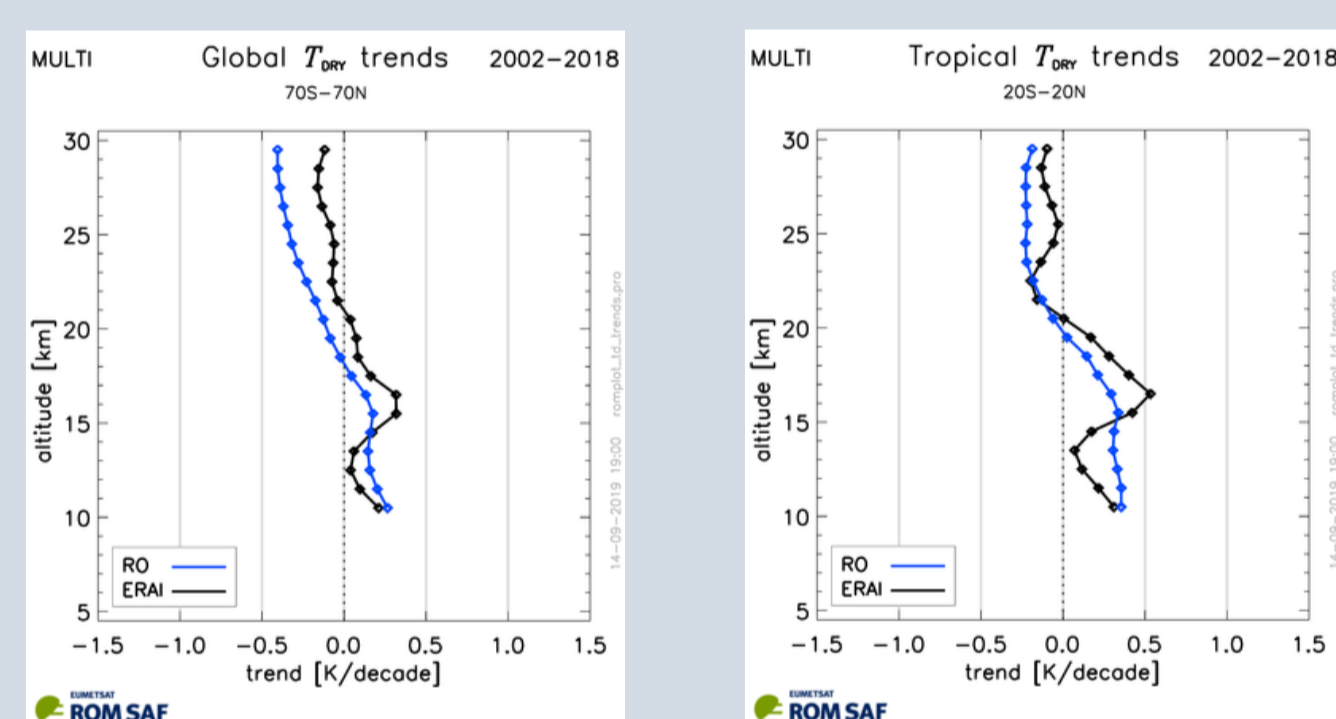


## UNCERTAINTY OF TEMPERATURE AND SPECIFIC HUMIDITY

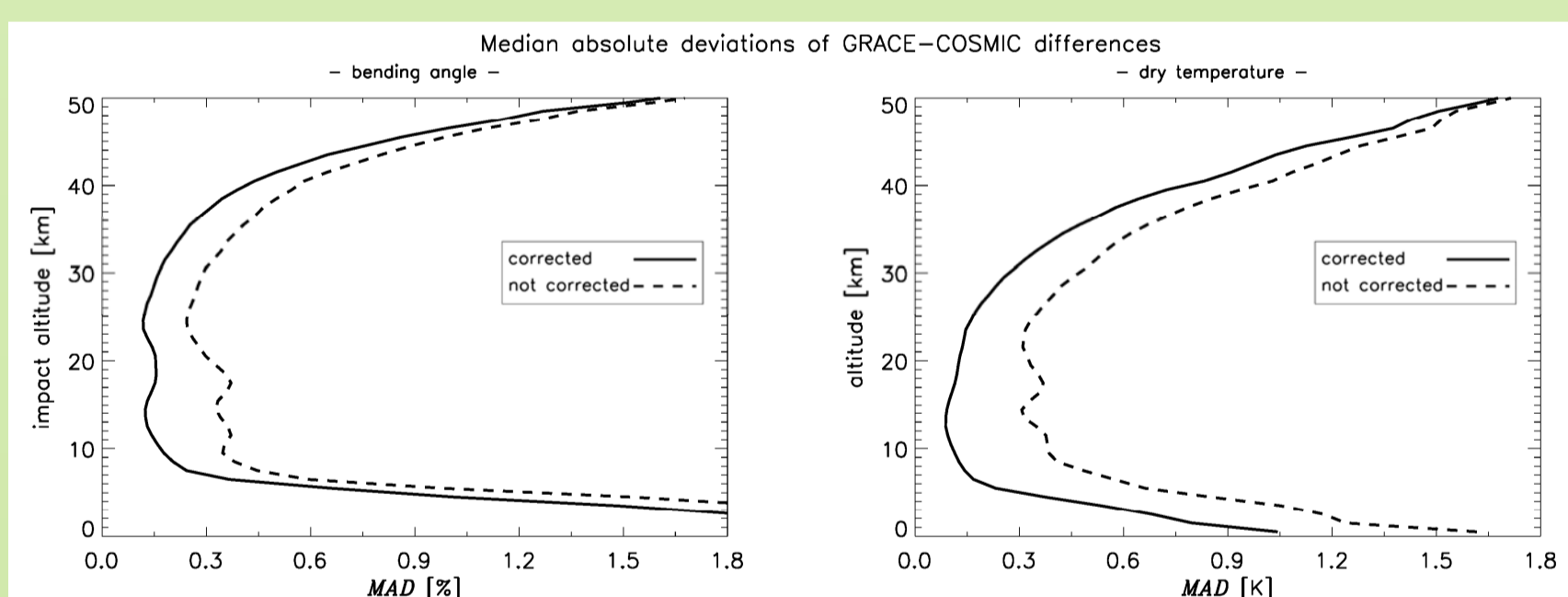
Specific humidity and temperature uncertainty validated with GRUAN radiosondes. Both ROM SAF CDR v1.0 and GRUAN provides profile by profile uncertainty estimates. This allows for validation of the estimated random uncertainty, which is determined by the error covariance matrices used in 1D-Var. Tropospheric specific humidity errors match with estimated uncertainty, while stratospheric temperature uncertainty is underestimated in CDR-v1.0.



## TEMPERATURE TRENDS AS FUNCTION OF ALTITUDE



The upper-tropospheric warming is particularly strong in the tropics. The temperature trends seen in RO data is roughly consistent with the ERA-Interim reanalysis, but the latter show a weaker stratospheric cooling due to a negative temperature bias relative to RO in the time period before 2007 (not shown here).

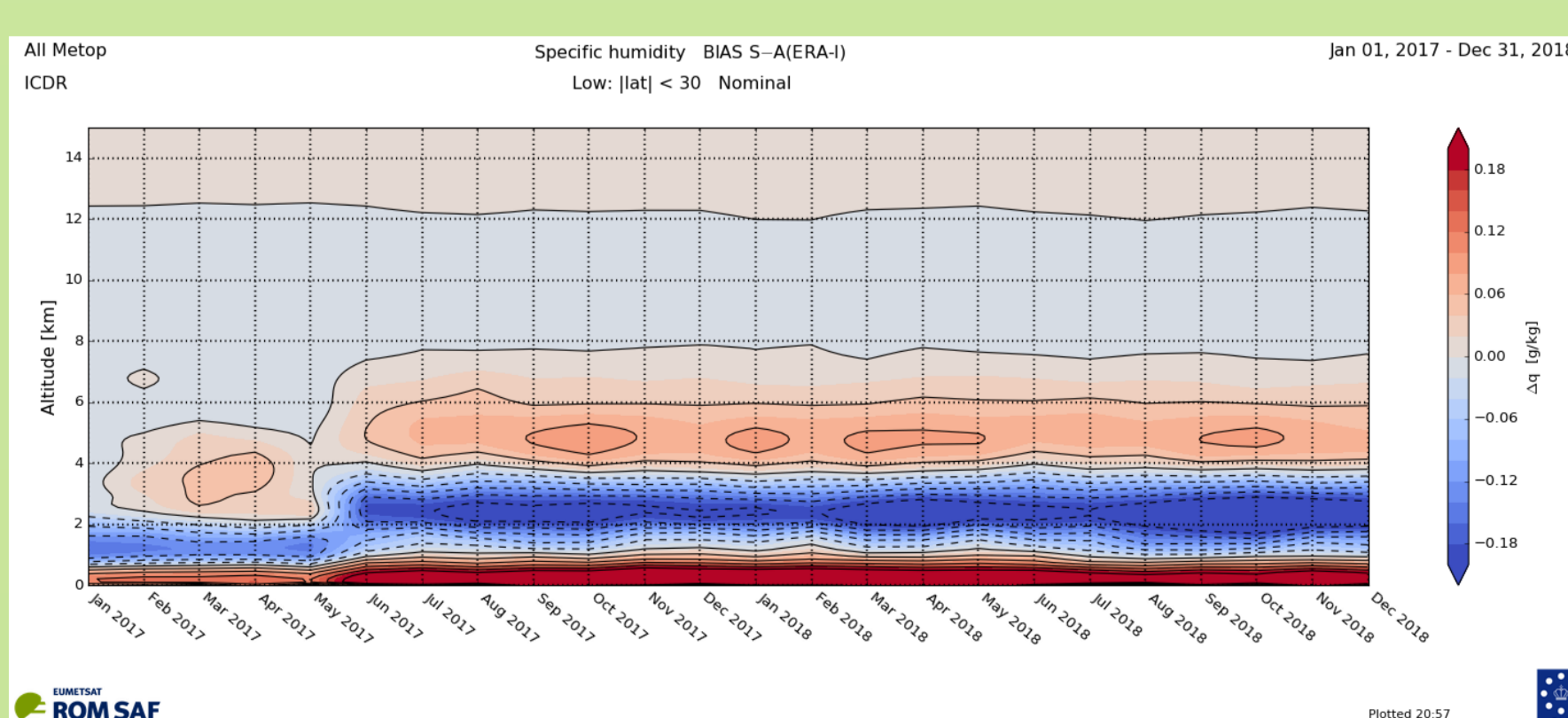
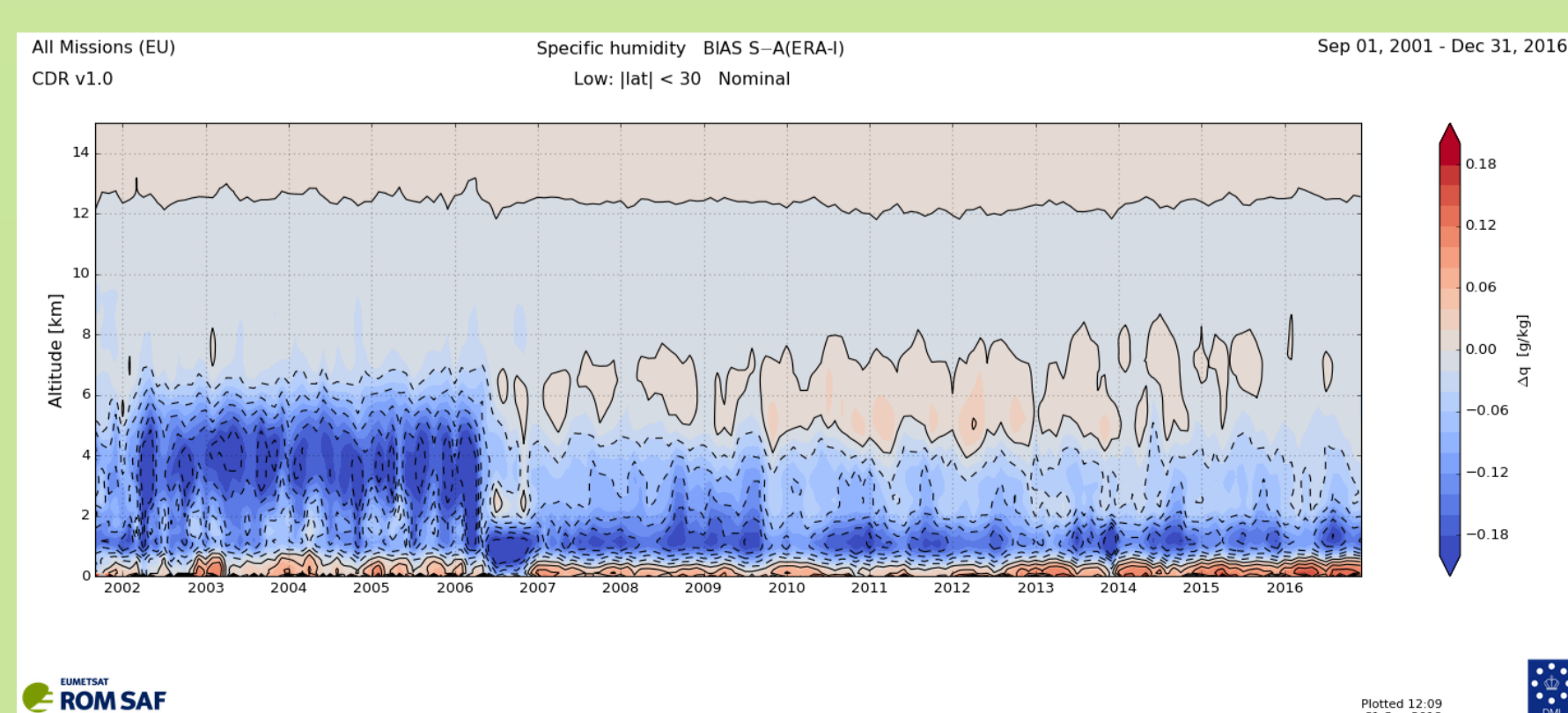
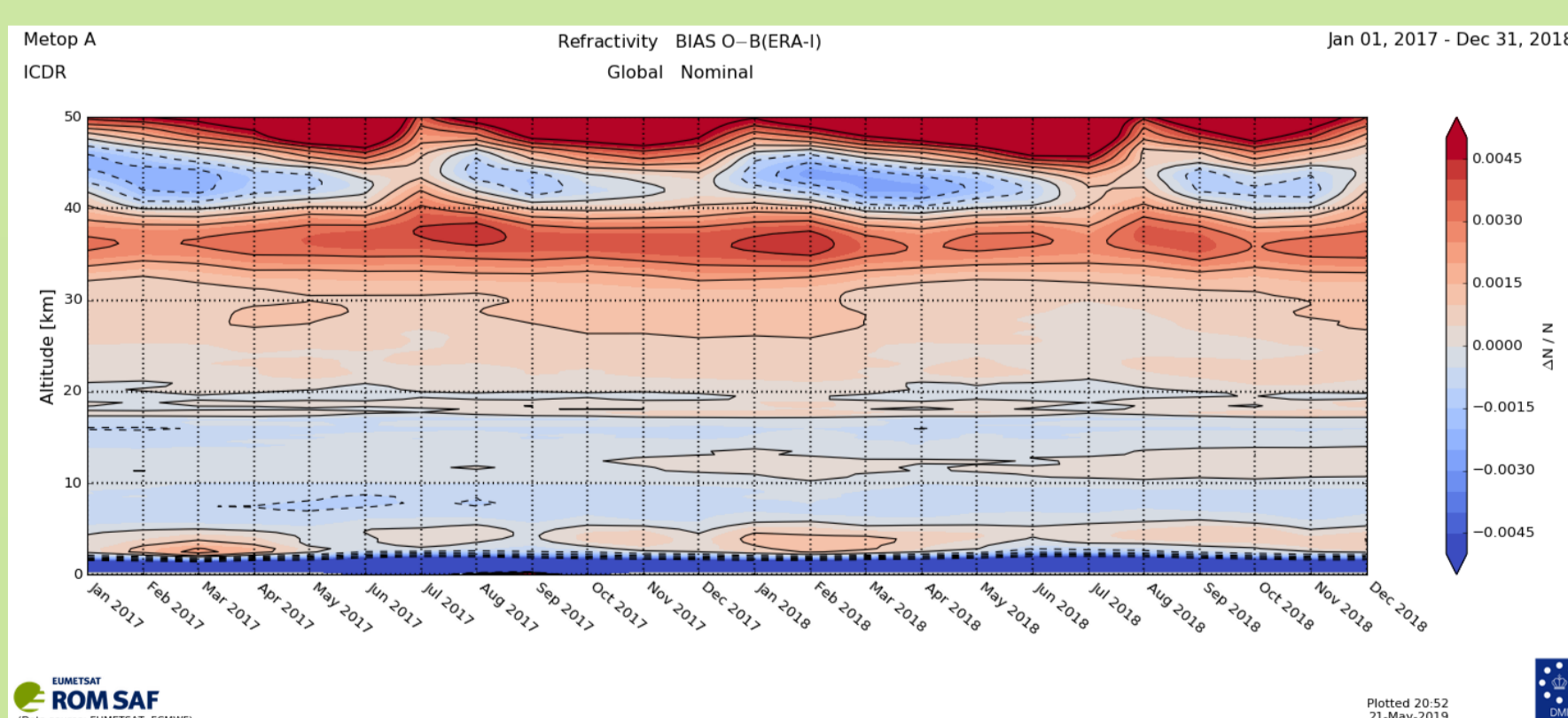
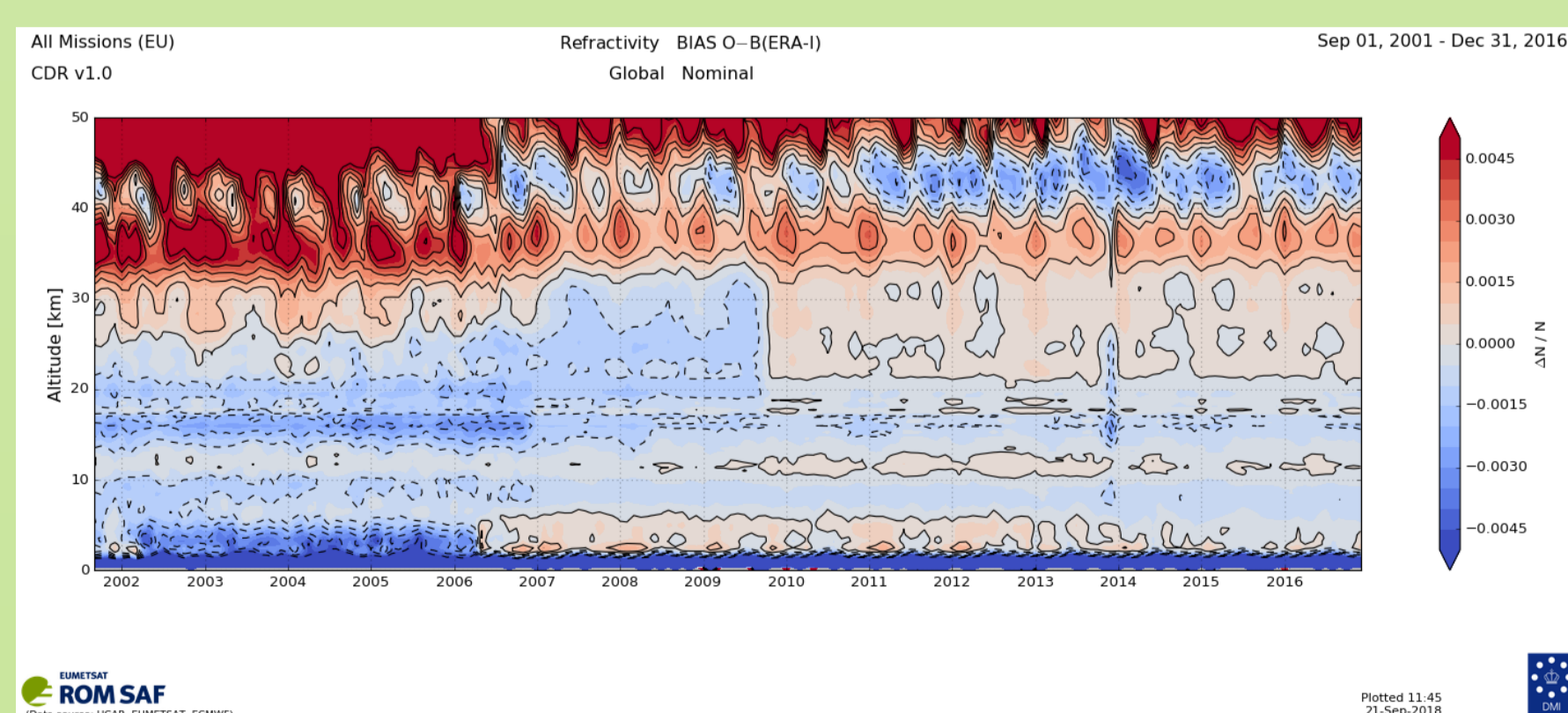


## ANOMALIES AND DIFFERENCES FOR DIFFERENT MISSIONS

(top) Anomalies and differences between anomalies (CHAMP, GRACE, Metop relative to COSMIC)  
(bottom) Mean-Absolute-Deviation (MAD) for differences GRACE-COSMIC with and without sampling error correction

## REFRACTIVITY AND SPECIFIC HUMIDITY TIME SERIES COMPARED TO ERA-I

(top panels) Refractivity O-B bias, global  
(bottom panels) Specific humidity S-A bias, low latitudes

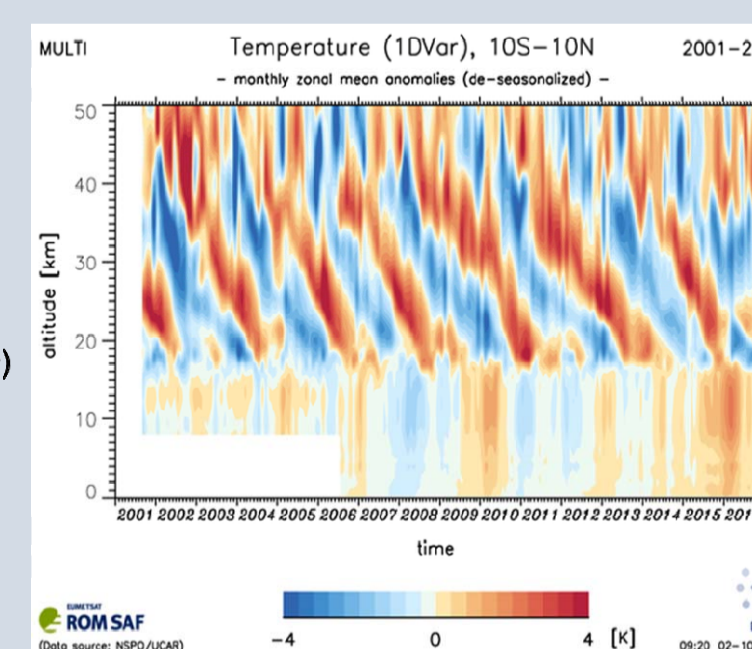


## TIME SERIES OF MONTHLY MEAN DATA

- Temperature
- Equatorial monthly means
- De-seasonalized

Semi-annual variability dominated by - Quasi-Biennial Oscillation (QBO) in the stratosphere - El Niño-Southern Oscillation (ENSO) in the troposphere

Low-latitude tropopause clearly visible



## SUDDEN STRATOSPHERIC WARMINGS

Winter 2008-09

Winter 2012-13

