GRAS Status and possible future European RO Mission / Cooperation

GRAS Team at EUMETSAT

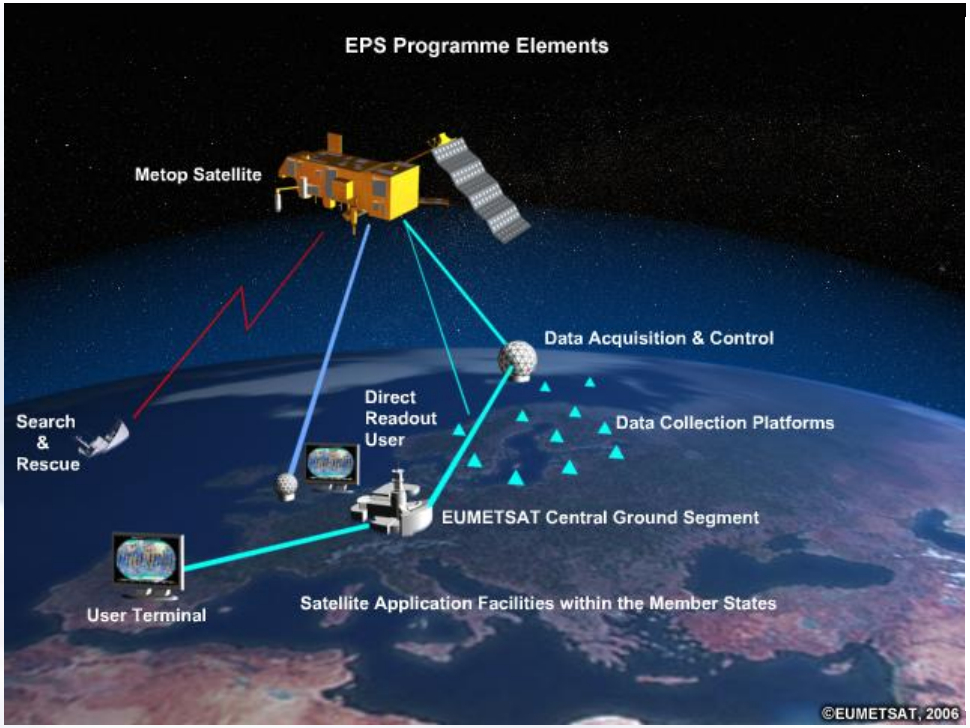
(Contact: Axel.vonEngeln@eumetsat.int)

Overview

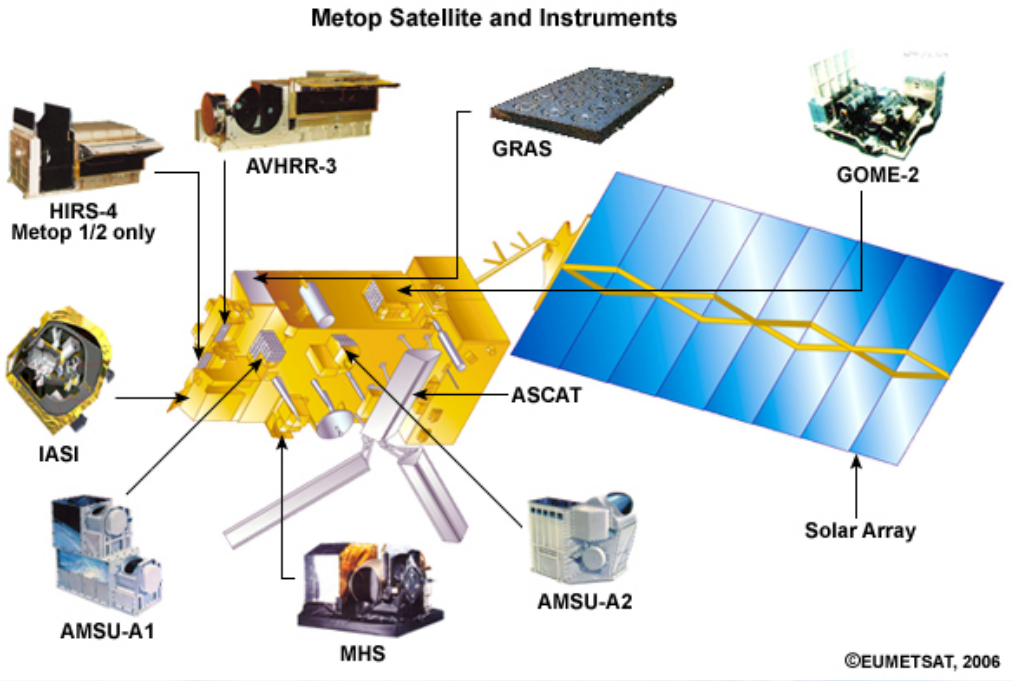
- EUMETSAT Polar System
- GRAS Instrument
- Future Radio Occultation Missions / Cooperation
- Summary

EUMETSAT Polar System

Programme Elements



Space Segment



GRAS Instrument

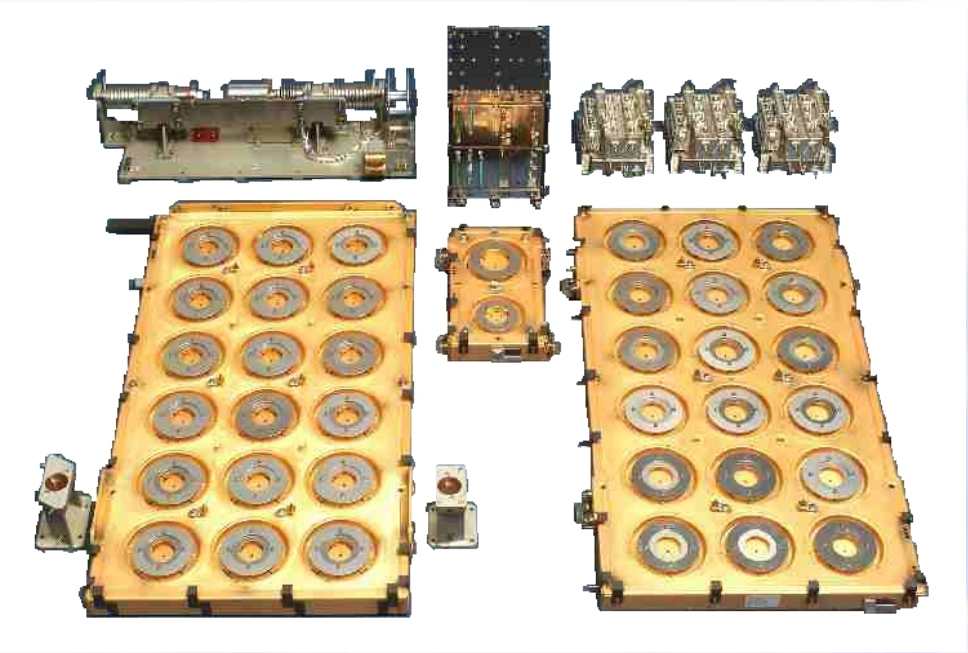
GRAS Fact Sheet

GPS channels:
- 2 rising, 2 setting (atm.)
- 8 zenith channels (orbit)

observations:
- > 600 profiles / day

level 1b products:
- bending angle

level 2 products:
- temperature
- water vapour
- climate applications



GRAS Instrument Components

EPS METOP

EUMETSAT

GRAS Processing

Input:

- Measurement data from Svalbard ground station
- GPS Clocks and Orbit Data from support network

1. **Metop orbit processing:**
   - 1min sequential processing of clocks and orbits
2. **Bending angle processing:**
   - Zero differencing
   - Geometrical optics
   - Dual frequency tracking
   - Open loop data not yet included

EPS METOP

EUMETSAT

GRAS Products and Timeliness

L1B provided by EUMETSAT in Near Real Time (2h 15 min):

- **thinned bending angles on GTS: BUFR**
- **bending angles on EUMETCast: BUFR, EPS**

L2 provided by GRAS SAF in Near Real Time (3h):

- **thinned refractivities, temperature on GTS: BUFR**

Climate data provided by EUMETSAT / GRAS SAF offline:

- **re-processing of orbits, phases at EUMETSAT and re-processing at GRAS SAF for climate applications (currently planned)**

EPS METOP

EUMETSAT

Brief History on the GRAS Instrument

- Metop launch on 19 October 2006
- GRAS instrument switch on 26 October 2006
- entering navigation mode on 26 October 2006
- first setting occultation 27 October 2006 (07:12 UTC)
- first rising occultation 27 October 2006 (07:17 UTC)

Since then the instrument worked very reliable with just a few outages.

Brief History on the GRAS Data Processing

- data dissemination in test mode from May 2007 (restricted)
- data declared pre-operational 19 February 2008
- data declared operational 15 April 2008 (PPF Version 2.10)

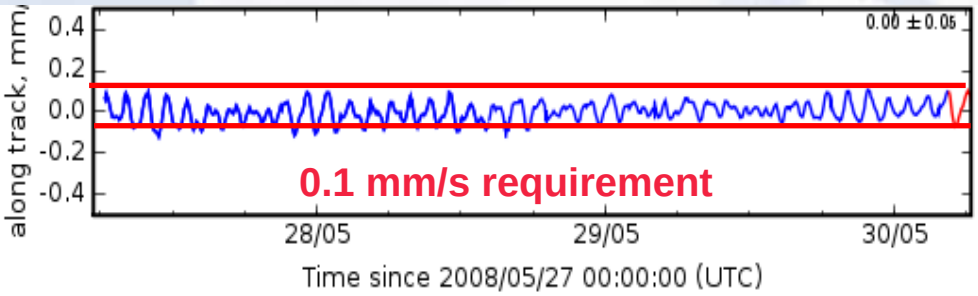
Since then several improvements of the processor, currently we run version 2.11 with 2.12 in the making.

GRAS Processor Update & Monitoring

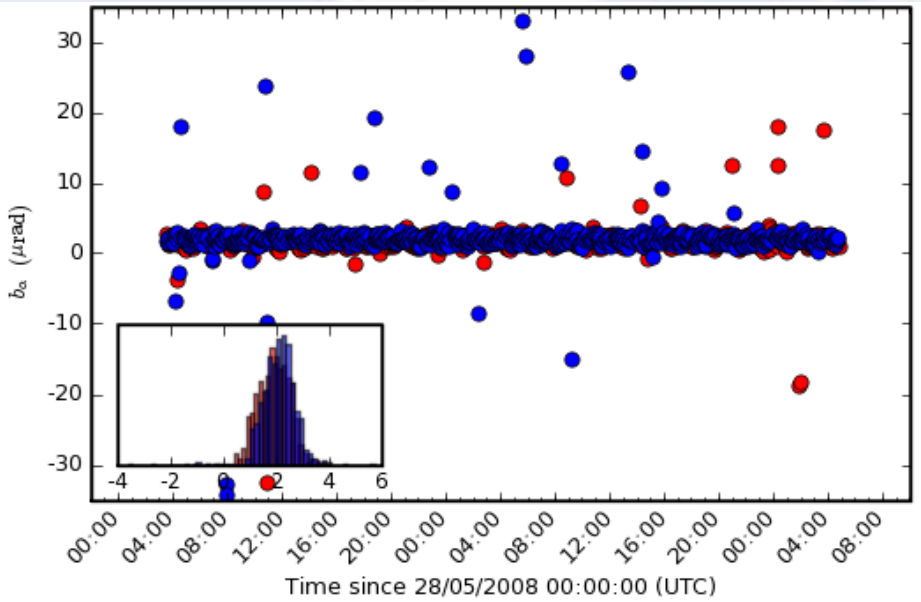
Installation Process:

1. Offline Testing
2. Installation on Testing Platforms
3. Installation on Operational Platform

Orbit: Along Track Velocity



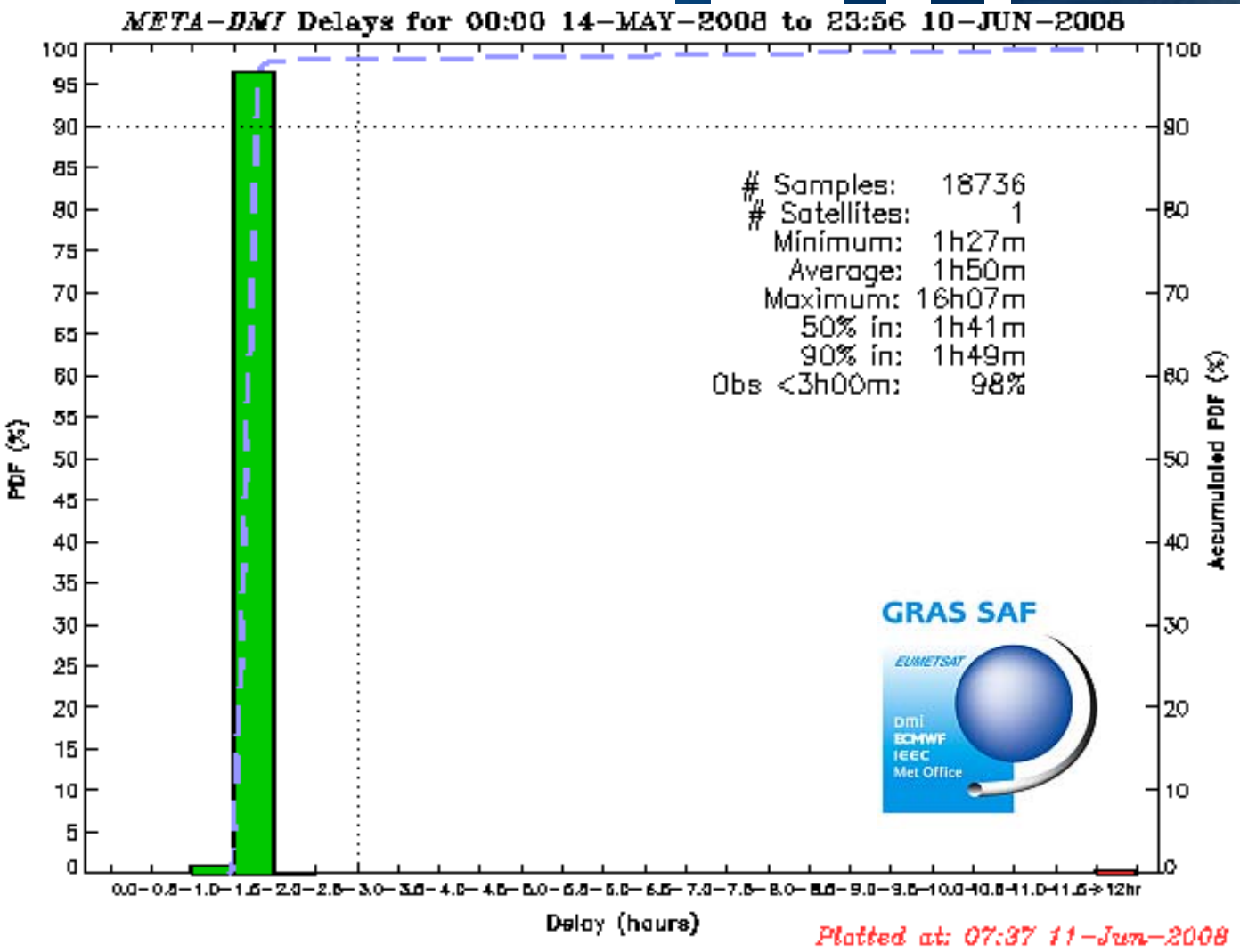
Bending Angle: Bias



EPS METOP

EUMETSAT

GRAS SAF Monitoring of Timeliness



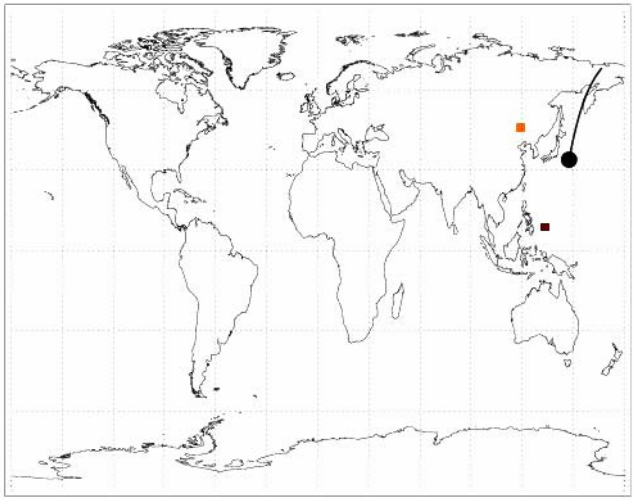
GRAS timeliness measured at UK Met Office, taken from:

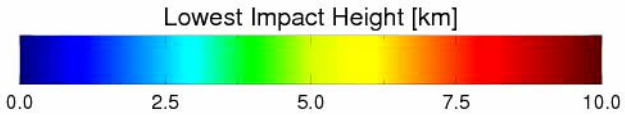
monitoring.grassaf.org

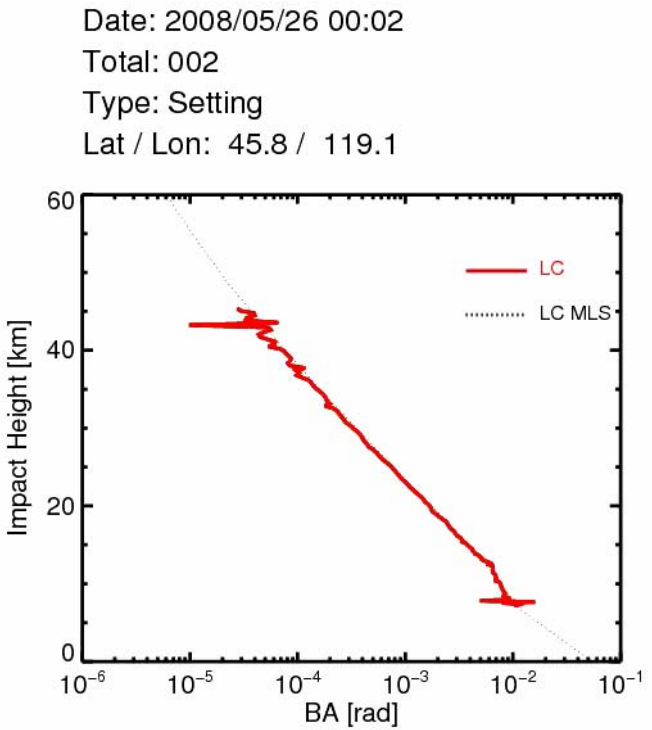
EPS METOP

EUMETSAT

GRAS Measurement Animation





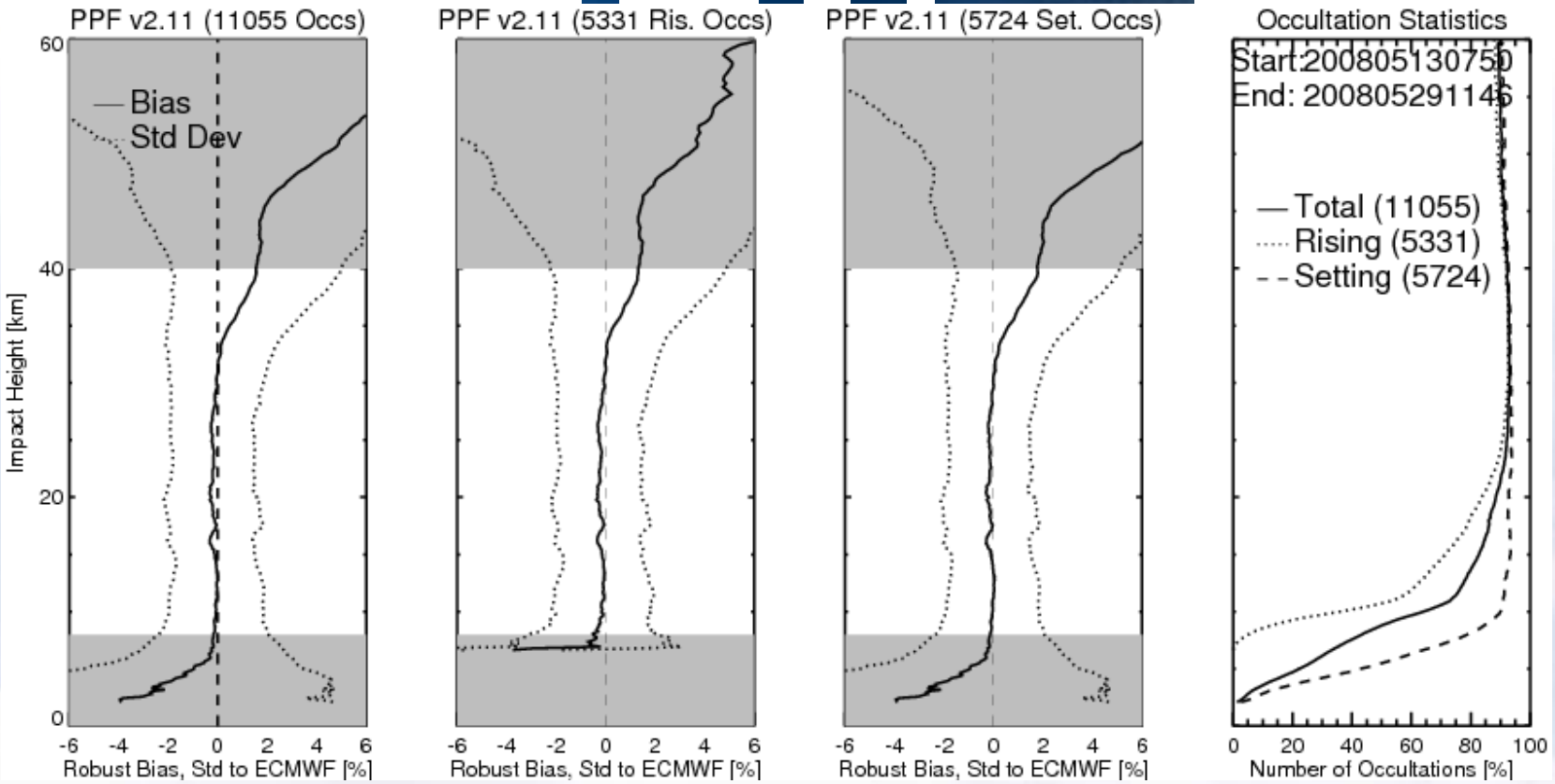


PPF 2.11 Data

EPS METOP

EUMETSAT

PPF 2.11 Validation against ECMWF

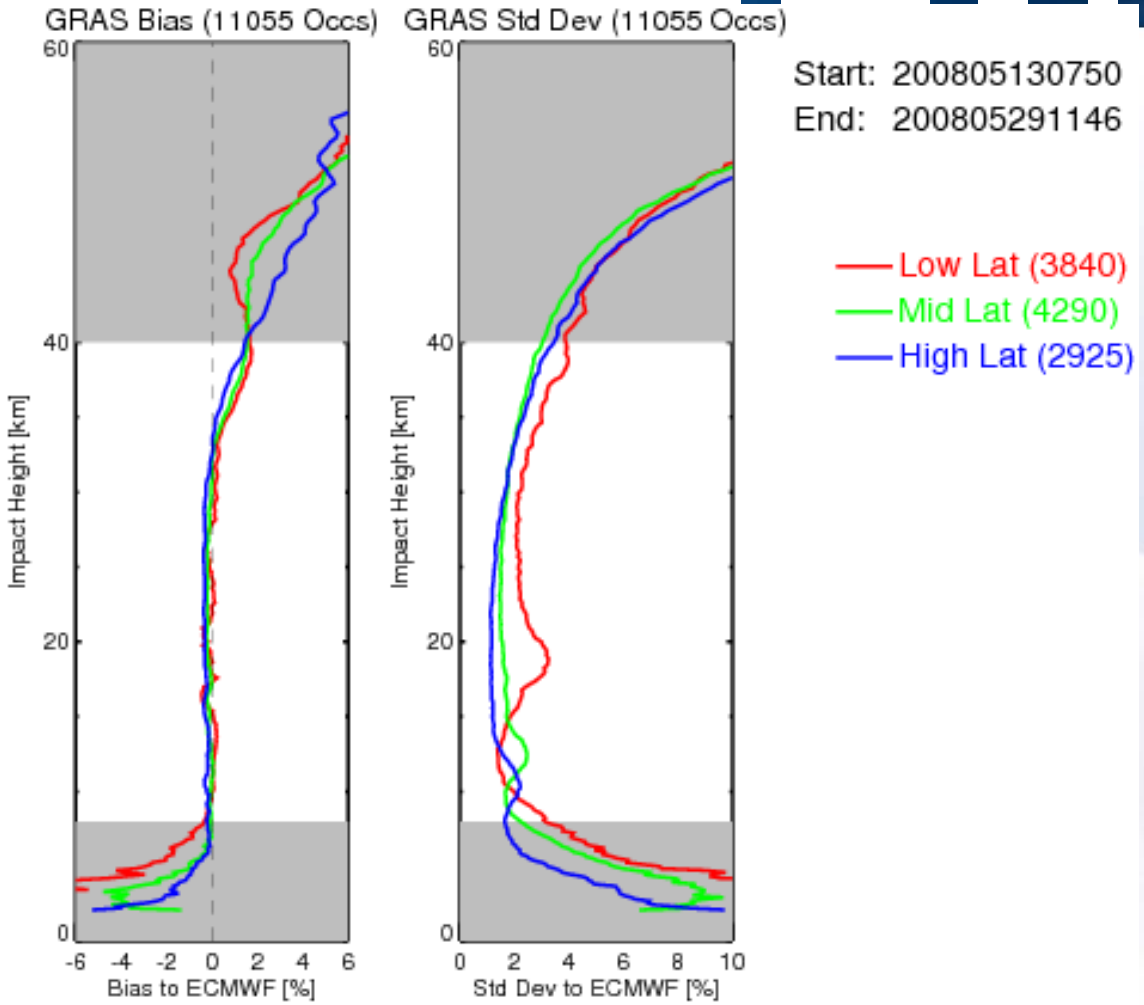


Left: all occultations; Middle left: rising ones; Middle right: setting ones (Solid line bias, dotted line standard deviation); Right: Percentage of occultations entering statistics (robust stats, de-weighting outliers). Grey areas: used for POD monitoring (top); affected by multi-path and geometrical optics retrieval (bottom).

EPS METOP

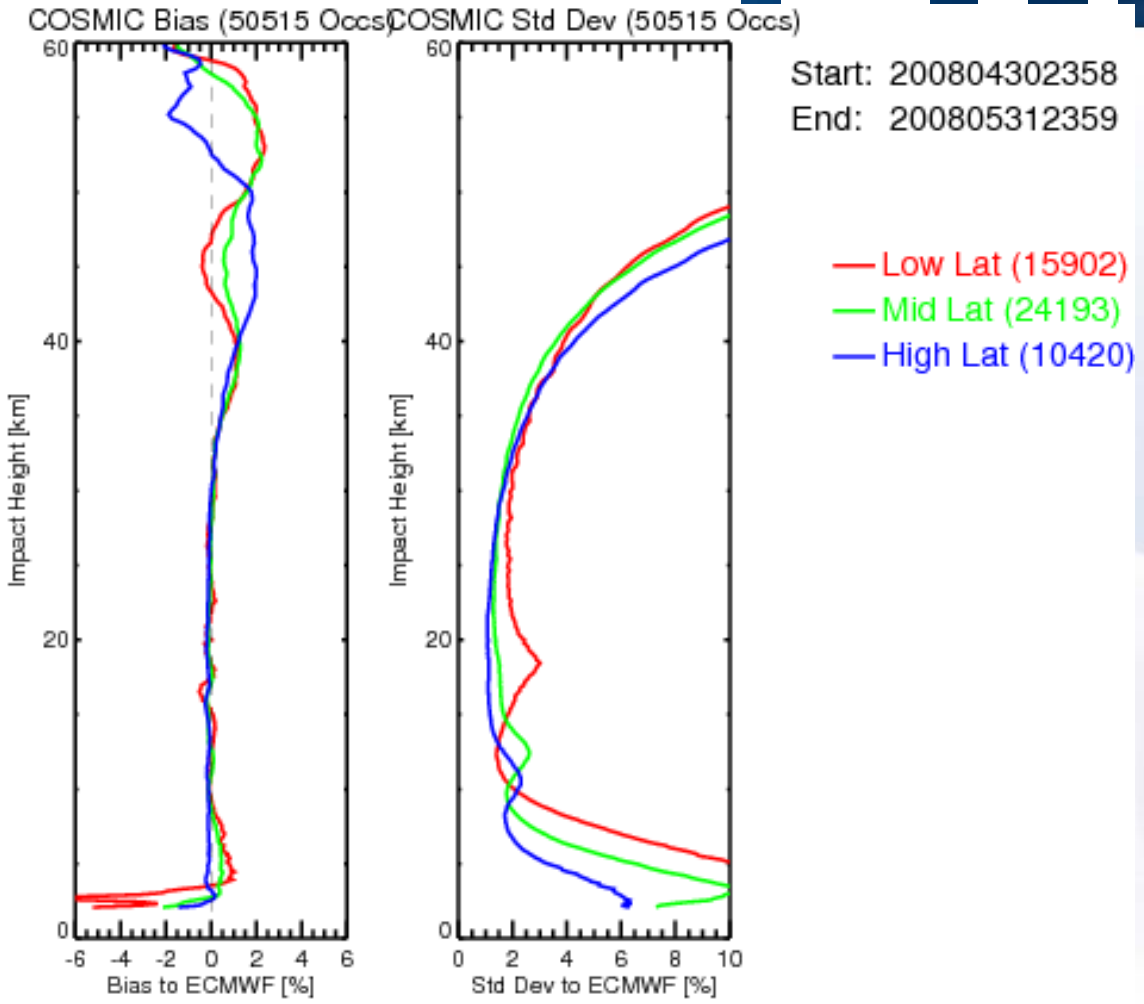
EUMETSAT

PPF 2.11 Validation against ECMWF (by Latitude)



Left: bias against ECMWF; Right: standard deviation against ECMWF (robust stats, de-weighting outliers). Grey areas: used for POD monitoring (top); affected by multi-path and geometrical optics retrieval (bottom).

COSMIC Validation against ECMWF (by Latitude)

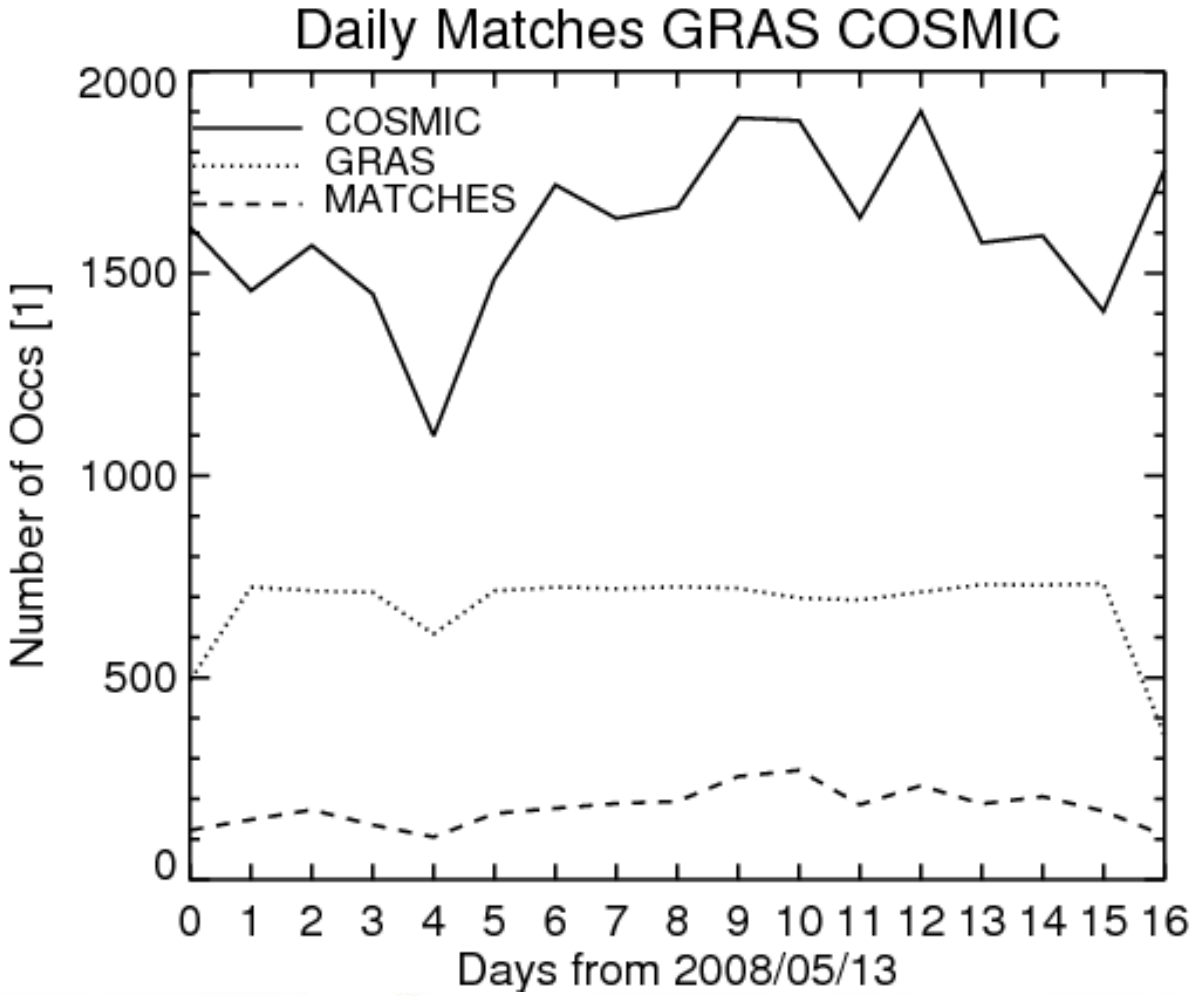


Left: bias against ECMWF; Right: standard deviation against ECMWF (robust stats, de-weighting outliers).

EPS METOP

EUMETSAT

GRAS COSMIC Matches Daily

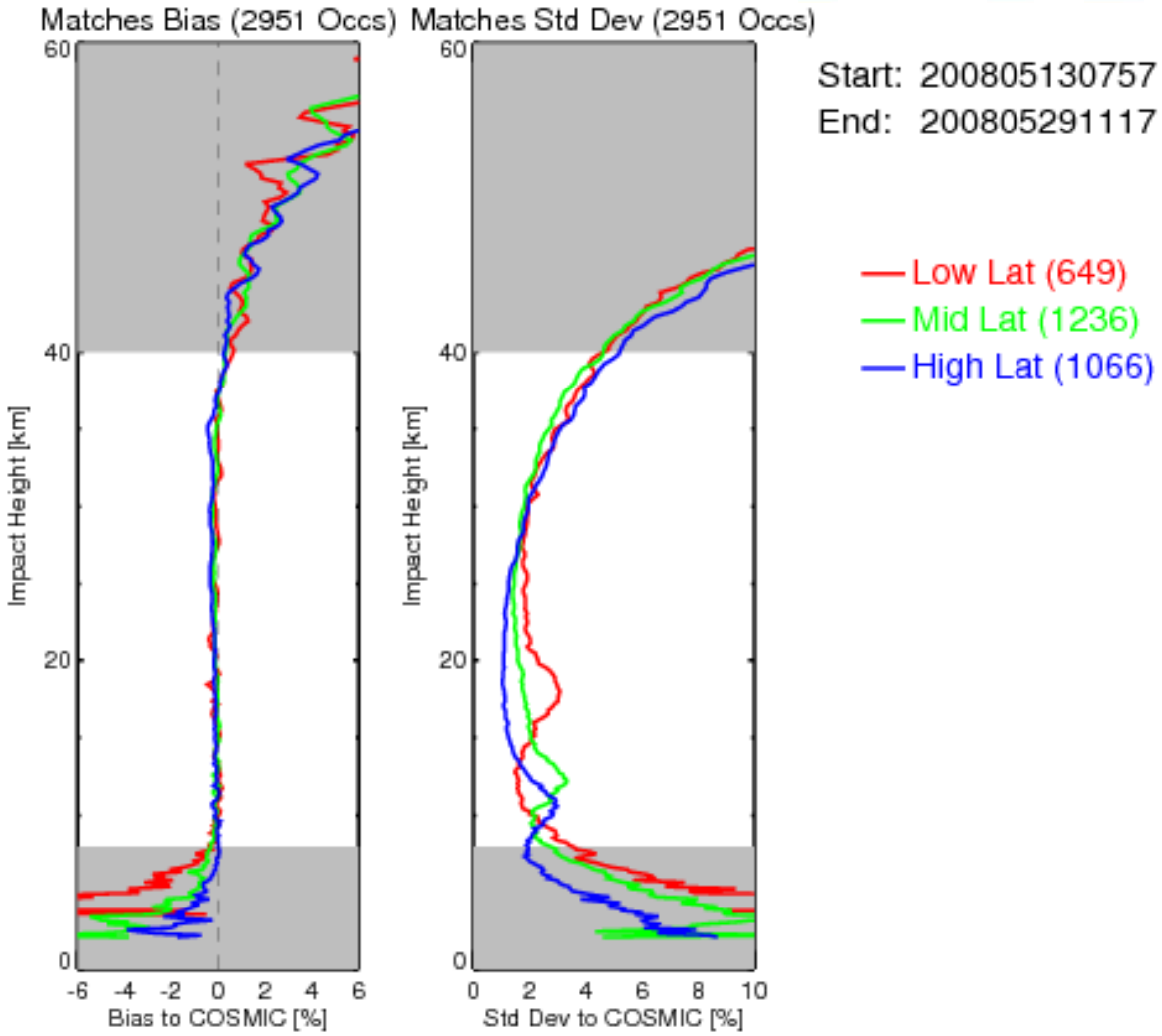


- ~17 days in May 08
- v2.11 (GS3, no QC)
- COSMIC raw
- 300 km / 3 hours

EPS METOP

EUMETSAT

GRAS COSMIC Matches Stats



Left: bias against COSMIC; Right: standard deviation against COSMIC (robust stats, de-weighting outliers). **Grey areas: used for GRAS POD monitoring (top); affected by GRAS multi-path and geometrical optics retrieval (bottom).**

EPS METOP

EUMETSAT

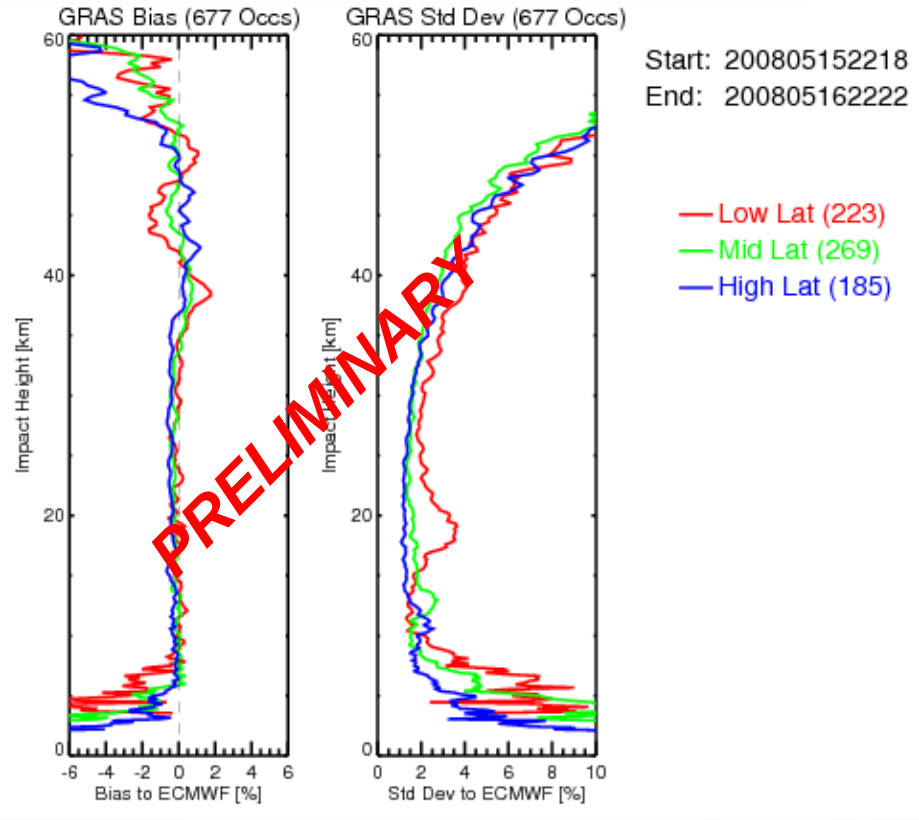
PPF 2.12 Outlook

Plans to include:

- improved QC for bending angles
- QC flagging of orbit resets

Likely not possible:

- correct antenna position / orbit



Possible future European RO Mission / Cooperation

- **Metop:**
  -GRAS will be flying up to 2020 on Metop A-C !!

- **Post-EPS:**
  -radio occultation mission is discussed

- **COSMIC Cooperation:**
  - currently provide station data (GSN)

Summary

- **GRAS Instrument:**
  - **excellent performance up to ~ 40 km**
  - **excellent timeliness**
  - **data is assimilated into ECMWF model**
  - **lower troposphere needs raw sampling / wave optics**
  - **improvements to quality flags scheduled**

- **Future of RO in Europe:**
  - **a lot more GRAS data coming the next years**
  - **RO is one possible mission in Post-EPS program**