THE GRAS SAF PROJECT: FIRST RESULTS FROM METOP

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ABSTRACT

The GRAS SAF is part of EUMETSATs network of Satellite Application Facilities (SAFs) under the EUMETSAT Polar System (EPS). The objective of the GRAS SAF is to deliver operational radio occultation products from the GRAS occultation instruments (Global Navigation Satellite System Receiver for Atmospheric Sounding) onboard the three MetOp satellites. The Leading Entity is the Danish Meteorological Institute (DMI) and this is also the physical location of the operational GRAS SAF processing and archiving center. The other project partners are the IEEC (Institute d'Estudis Espacials de Catalunya, Barcelona, Spain), the Met Office (Exeter, UK), and the European Center for Medium-range Weather Forecasts (ECMWF). The GRAS SAF started the operational phase in March 2007 and will start to deliver validated products in 2007. The archiving of GRAS SAF products is done locally at DMI with user interfaces at the GRAS SAF and the UMARF archive at EUMETSAT.

The operational GRAS SAF Processing and Archiving Center receives raw and preprocessed GPS radio occultation data from the GRAS instrument, processes these into vertical height profiles of refractivity, temperature, pressure, and humidity, and distribute these products continuously in NRT (near real time, within 3 hours from sensing) to numerical weather prediction users. In addition, offline products (improved products, within 30 days from sensing) will be disseminated to e.g. climate monitoring users. Another objective of the GRAS SAF is to supply the software package ROPP (radio occultation processing package) containing tools for 4D-VAR-assimilation of radio occultation data into numerical weather prediction models. The results of several NWP assimilation impact trials using RO data from e.g. CHAMP and COSMIC satellites show a clear positive impact on NWP forecasts in the upper troposphere and lower stratosphere.

Because raw GPS radio occultation data are calibration free and the assumptions are known, RO data is also well suited for climate investigations and monitoring. There are several methods that can be used to construct climate data: standard binning-and-averaging techniques, fitting of global spherical harmonics to the observational data, or assimilation of the RO data into climate models and subsequent extraction of climate data from that model. We are currently undertaking studies on how to best exploit the GRAS data, both for construction of an accurate single-source climate data base with known error characteristics of the data and for provision of global climate monitoring.

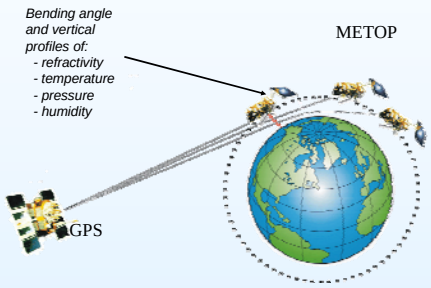


Figure 1. *Principle of radio occultation measurements. A polar Low Earth Orbit satellite (here: EPS/Metop) observes the phase delay and amplitude of the navigation signal from a GPSS satellite, rising or setting behind the Earth. The bending angle of the refracted ray path can be converted into a near-vertical profile of refractivity, temperature, pressure and humidity. Metop has one antenna for rising and setting occultations, respectively, and currently records approximately 650 profiles per day, distributed across the entire globe.*

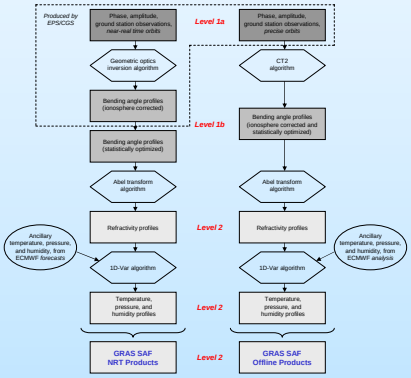
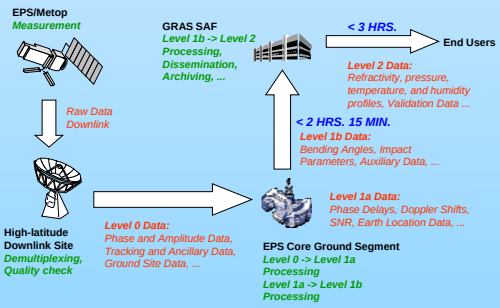


Figure 2. *Simplified processing chart of the GRAS SAF system, showing the way from the phase and amplitude measurement of the GPS signal to the released meteorological products.*
Left: *Schematic showing of the NRT processing steps to SAF Level 2 products. Ancillary temperature and humidity profiles are used to constrain the simultaneous, statistically optimal, retrieval in the 1D-VAR scheme. SAF Level 2 products include a thinned bending angle profile derived from the EPS/CGS Level 1b profile.*
Right: *Schematic showing of the Offline processing steps to SAF Level 2 products. Ancillary temperature information is necessary to retrieve humidity profiles, but no external information is used to produce the 'dry' temperature & pressure profiles.*

Figure 3. *Simplified product and data flow diagram, showing the way from the measurement onboard Metop to end user product dissemination. The 3 hours constraint is for NRT products, suitable for NWP purposes.*



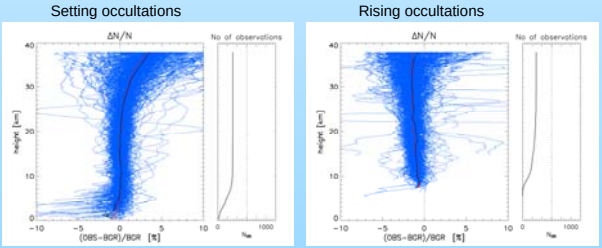


Figure 5. Refractivity statistics for GRAS data, Sept 9, 2007; 600 profiles.

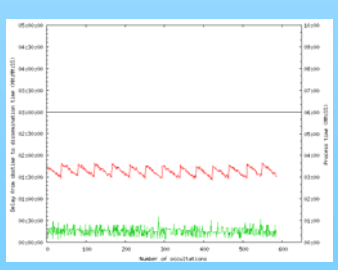


Figure 4. Procesing times for one day of GRAS data (Sept).