GRAS SAF Open Loop Workshop
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The GRAS SAF Project and Aim of the Workshop

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GRAS SAF Open Loop Workshop: The GRAS SAF Project and Aim of the Workshop

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Aim

Measured time-dependent, wave-field signal:

$u(t) = u_{phys}$ which includes:

noise + multipath + critical refraction + horizontal grad. + tracking errors + …

- Understand GRAS and its open-loop capabilities
- Spawn new ideas for open-loop research
- Future common interests and interaction on open-loop topics

GRAS SAF means:

Global navigation satellite system
Receiver for
Atmospheric
Sounding

Satellite
Application
Facility

Host Institute: Danish Meteorological Institute (Denmark)
Kent B. Lauritsen, Hans Gleisner, Frans Rubek, Martin B. Sørensen

Partners: Institute d'Estudis Espacials de Catalunya (Spain)
Antonio Rius, Estel Cardellach, Santi Oliveras

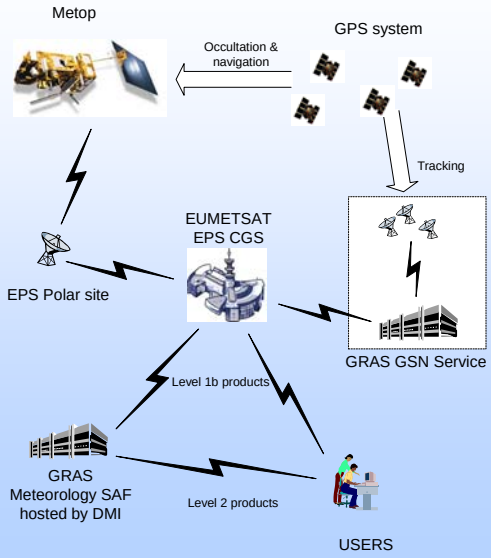
The Met Office (UK)
Dave Offiler, Axel von Engeln, Adrian Jupp, Christian Marquardt

Associated Scientists: Sean Healy (ECMWF), Josep Aparicio (Canada)

Project Overview and Plans

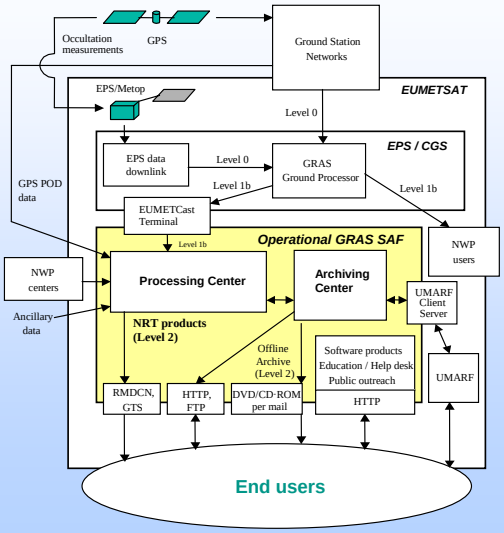
- GRAS SAF project started in 1999
  - Operational facility for generating and delivering atmosphere products from the GRAS instrument on Metop
  - 5+2½ years developments
- Partner Institutes
  - Danish Meteorological Institute (Host institute)
  - Met Office, UK
  - IEEC, Spain
- Milestones
  - 2000 Requirements Review (User and Science Requirements)
  - 2001 Requirements Review (Design Requirements)
  - 2003 Critical Design Review
  - 2004 Infrastructure Readiness Review
  - 2005 System Test Results Review
  - 2006 System Validation Test Results Review
  - 2007 Operational Readiness Review

Processing and Data Levels

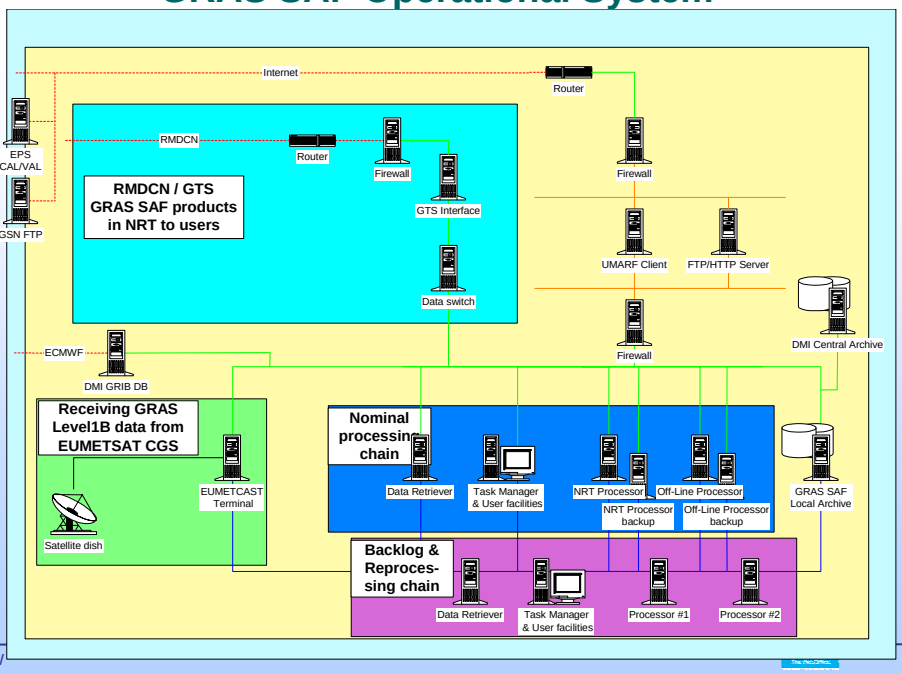


- Level 1b product generation and dissemination by the EPS CGS
- Level 2 product generation and dissemination by the GRAS SAF
- GRAS GSN provides GPS POD products and ground based measurements
- GRAS GSN network will contain 25 stations and will be based on existing networks
- Product archiving and off-line user access via UMARF in EUMETSAT
- Product archiving includes raw data, level 1b, level 2 and all GSN products

GRAS SAF Data Flow Model



GRAS SAF Operational System



GRAS SAF Products Time Requirements

Near-Real Time Products: (NRT)

To be delivered less than 3 hours after measurement, using RMDCN (Regional Meteorological Data Communication Network).
Mainly for NWP use.

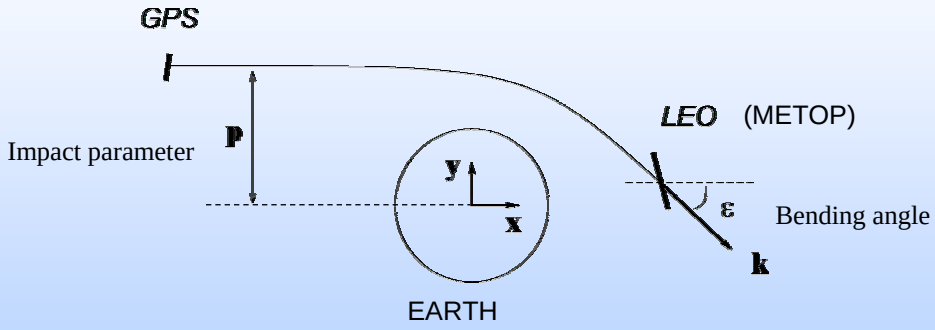
Offline Products:

Improved products re-processed using precise satellite orbits, additional NWP input, etc.
To be delivered less than 30 days after measurement, using FTP, DVD/CD-ROM, WWW download, a.o.
Mainly for climate research use.

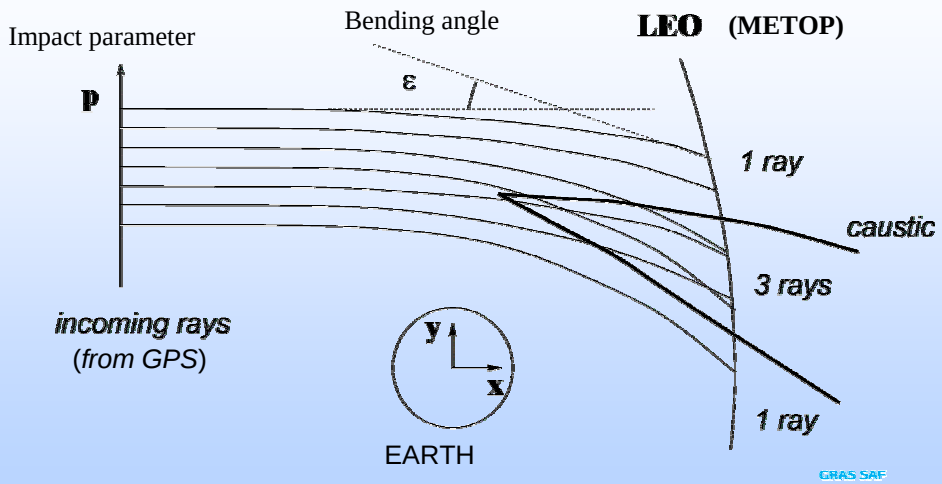
GRAS SAF Main Products Overview

Data Product	*Characteristics*
Bending Angle Profile	Bending angle as a function of impact parameter (offline only)
Refractivity Profile	Neutral Refractivity as a function of height and location of the occultation
Temperature, Specific Humidity, Pressure Profiles	Temperature (dry/wet), specific humidity (water vapor), and dry pressure and associated error estimates as a function of height and location of the occultation
Climate Maps	Maps of e.g. refractivity at constant geopotential height
Assimilation S/W Products (ROPP)	Statistically optimal 1D-Var refractivity retrieval code Forward models for 4D-Var: - Direct assimilation of bending angle or refractivity profiles into an NWP model - Plane-averaged refractivity forward model for assimilation into an NWP model

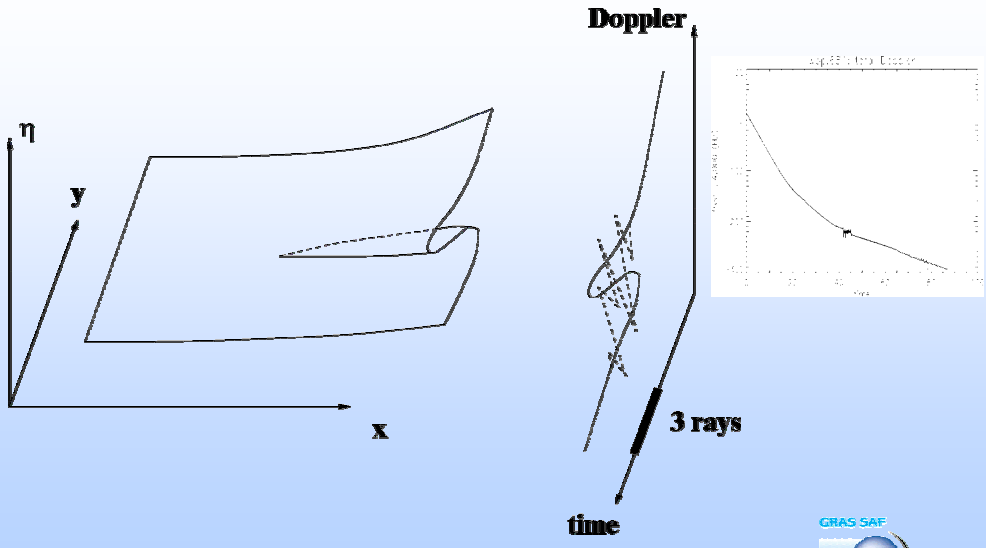
Radio Occultation Geometry



Water Vapor & Atmosphere Multipath



Schematic Ray Manifold



RO Processing

Closed loop: SNR + phase $\rightarrow$ $u(t) = A(t)\exp(i\Psi(t))$

Open loop: pre-processing $\rightarrow$ $u(t)$

Standard method (1-ray): Doppler shift ('wave vector'): $\omega(t) = \frac{d\Psi(t)}{dt}$

Map to impact parameter (CT/FSI, multi-ray):

$$u(t) \rightarrow w(p) = A_p(p)\exp(ik\Psi_p(p))$$

Wave vector along the *p*-coordinate: $\xi(p) = k\frac{d\Psi_p(p)}{dp}$

2005: World Year of Physics

1905: Annus Mirabilis, Einstein's papers on:

Brownian motion (+his PhD): $D = k_B T / \gamma$ $\rightarrow$ characterization of (thermal) noise

Photo electric effect: $E = hf - E_B$ $\rightarrow$ quantum physics (atomic clocks)

Special relativity: $\tau = \tau_0 / \sqrt{1 - v^2/c^2}$ $\rightarrow$ GPS system

When will we have the RO Open-Loop Annus Mirabilis! :-)