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Open Loop and GRAS Ground Processing Prototype

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Open Loop and GRAS Ground Processing Prototype (GPP)

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GRAS Ground Processor Prototype

- During the development of Metop phases C/D, the GRAS Ground Processor Prototype (GPP) has been developed
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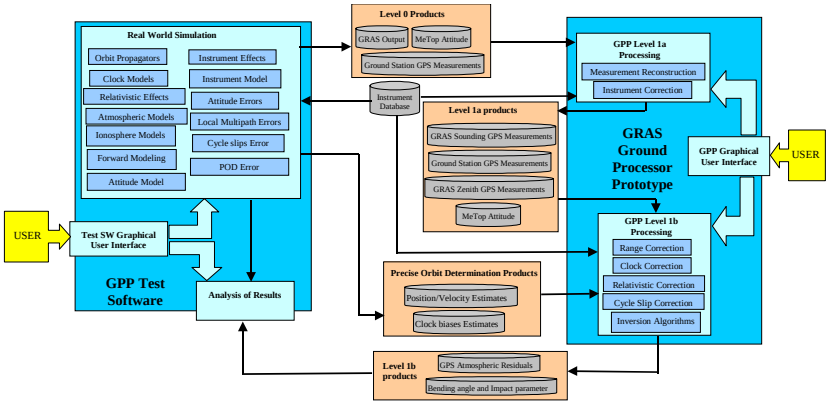
- This is a software tool developed by GMV under SES supervision within Astrium-ED / Astrium-EF GRAS Contract
- The objective was to provide an overall set of algorithms to convert GRAS instrument measurements to level 1b products (bending angle and impact parameters) within specified requirements.

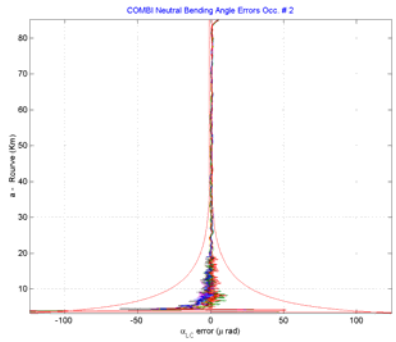
GRAS Ground Processor Prototype



GRAS Ground Processor Prototype Testing

- **GRAS GPP has been tested with different input data and environmental conditions:**
  - **Simulated data from the GPP Test Software (extensive error components user selectable)**
  - **Simulated atmospheric diffraction with Refractivity bump**
  - **Data from the GRAS instrument fed by a GPS simulator**

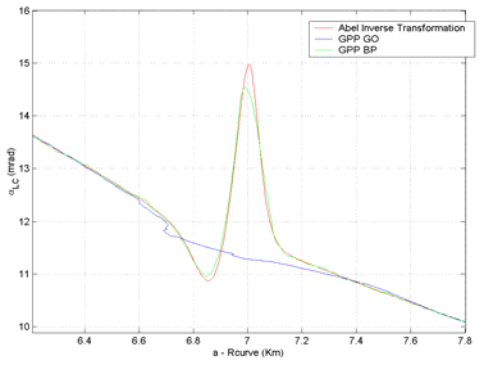
GPP results with simulated close loop data



Error in GO/BP Neutral Bending angle as a function of height

In this Figure ten runs are plotted for a Normal velocity occultation

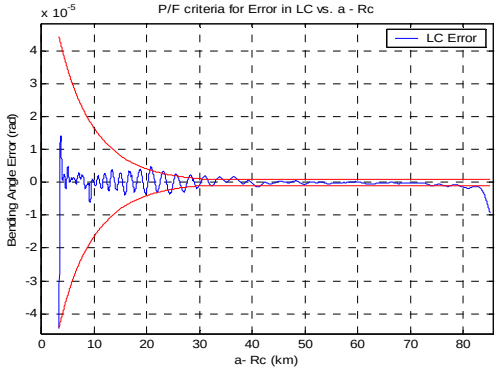
GPP results with simulated close loop data (Refractivity bump)



Neutral Bending angle retrieval as a function of height

Atmospheric diffraction phenomena can be processed using Back Propagation in GPP

GPP results with GPS simulator and GRAS Instrument



Error in GO Neutral Bending angle as a function of height

The sinusoidal signal between 10 and 40km is due to the GPS simulator

The red curve corresponds to the specifications

GRAS Tracking altitude Performance

- **Atmospheric environment**
  - **Thin-dry and Dense-wet extreme bi-exponential atmospheres**
  - **Double Chapman ionosphere**
  - **6dB weather front for setting occultations**

- **Starting altitude for tracking in different modes:**

	AS ON		AS OFF		Specification
Mode	**Rising occ**	**Setting occ**	**Rising occ**	**Setting occ**	
Dual Frequency	**3.9 to 9.0 km**	**4.9 to 6.4 km**	**2.8 to 6.8 km**	**0.1 to 0.4 km**	**12 km**
Single Frequency	**0.3 to 2.6 km**	**0.1 to 0.2 km**	**0.3 to 2.6 km**	**0.1 to 0.2 km**	**5 km**
Raw Sampling (OL)	**0.1 to 0.8 km**	**0.1 to 0.2 km**	**0.1 to 0.8 km**	**0.1 to 0.2 km**	**<5 km**

GRAS Overall Performance

- **GRAS Requirements**
  - **Bending angle error < 1μrad or 0.4%**
- **GRAS Performance Budget (in μrad)**

SD2 Bending angle Error at 30km [urad]	Velocity bins				
Error source :	10%	30%	50%	70%	90%
GRAS Rx BA error	0.621	0.451	0.403	0.370	0.354
External BA error	0.362	0.349	0.343	0.335	0.332
Total BA error (1σ)	**0.719**	**0.570**	**0.529**	**0.499**	**0.485**

GRAS Ground Processor Prototype Conclusions

- **GRAS results have been presented in Matera (I) at the URSI Radio Occultation Symposium (13-15 October 2003)**
- **Algorithms are adequate to process GRAS data within Performance requirements**
- **Interfaces with GRAS real instrument as well as with simulated data have been checked**
- **Predicted detailed error budget from Industrial Manufacturer has been confirmed using GPP**
- **GRAS Instrument with GPP achieves GRAS requirements**

Open Loop data in GRAS GPP

- GRAS Instrument can provide Open Loop data when GPS C/A code phase signal is locked but never with L2 acquisition/tracking
- GPP is able to process Open Loop data when Single Frequency (close loop) data is generated at the same time
- Knowledge of GPS Navigation data message bit stream is needed to remove the 50Hz sign ambiguity on Open Loop data
- Sign of the GPS Navigation data message is known when Single Frequency and/or Dual Frequency states are reached
- GRAS requirements are met without need for Open Loop (only) data processing

GRAS in Raw Sampling Mode

- Raw Sampling (RS) is selectable to 1000, 500 or 250Hz
- No RS is implemented for Zenith data
- Forcing GRAS Instrument in Raw Sampling mode:
  - For setting occultations there is No possibility to force RS as signal are acquired at high altitude and tracked in the highest Tracking State till L2 is lost
  - For rising occultations RS can be forced using selectable parameters (delaying the start of L2 signal acquisition)