



The Metop GRAS atmospheric sounding mission Ground Support Network (GSN)

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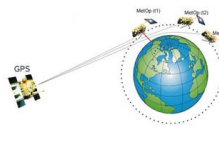
- GNSS
- Receiver for ... on board Metop
- Atmospheric
- Sounding



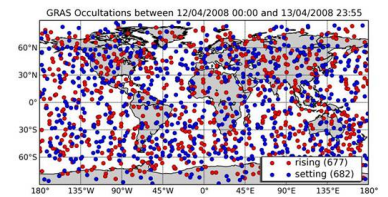
- Ground
- Support
- Network



Atmospheric Sounding



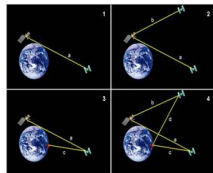
- GPS signal travels through the atmosphere
- Through relative spacecraft motions, occultation profiles are generated
- Fore and aft antennas on Metop allow monitoring of both setting and rising occultations
- Two occultations can be observed by each antenna
- Max. per day per satellite ~500 occ.



Generation of sounding profiles

- EUMETSAT will operate three Metop S/C (polar LEO)
- ... and generate atmospheric sounding products in NRT
- ... for delivery to European Met Offices within 2.15 hours
- The generation of profiles requires precise orbits and clock solutions for both Metop and the occulting GPS satellite
- Metop POD to be performed in-house, using GRAS GPS receiver (zenith antenna)
- The GPS products are considered 'Support Data', to be provided externally

Supporting differenced processing methods



- Method 1: un-differenced
- Method 2: eliminate GRAS clock
- Method 3: take out the GPS clock (replace by ground clock)
- Method 4: double differencing not yet implemented
- For method 3, accurate ground clock solutions and ground tracking data of the occulting satellite are required
- EUMETSAT delivers a table of predicted occultations to ESOC and ESOC return the necessary ground data (SSD)

Support data for occultation processing

- GPS orbits (for Metop POD and occultation processing)
- GPS clock solutions
 - Low-rate for Metop POD
 - High-rate for occultation processing
- EOP data (for Metop POD)
- Auxiliary data (TZD, Meteo, Nav msg...)
- High-rate, selected, ground receiver data
- High-rate ground clock solutions

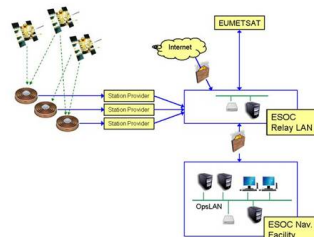
Support data key requirements

- The most fundamental requirements were analysed:
 - Timeliness: 60 min. for orbits and clocks
 - Clock accuracy: 1 ns at 2-sigma for each satellite
 - Clocks to be interpolated at 50 Hz
 - GPS satellite velocity accuracy requirement
 - Guaranteed high availability (99% & limited interruptions)
 - Can be operated for 15 years, 2 satellites in parallel
 - Extensible to other missions with similar requirements

High-level design

- A dedicated and fully redundant network of approximately 25 prime sites (and a total of 46 sites)
 - existing network operators: GFZ, NRCan and Fugro Seastar
- A processing centre in ESOC
- GPS orbits computed every 3 hours, delivering predictions
- Clocks computed every 15 minutes, not predicted
- To support the 50 Hz GRAS data rate, compute and deliver 1 Hz GPS clocks (not interpolated)

High Level Design

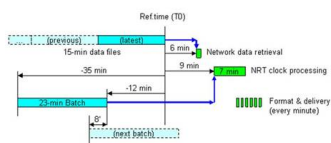


The GSN Network (prime sites)



Key issue: timing of the clock products

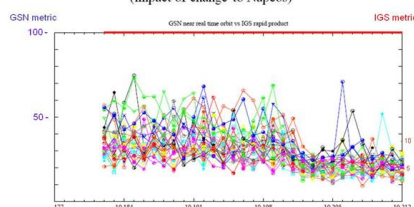
- Using predicted orbits, batch 1-Hz clock determination every 15 minutes for 23 minute arcs (15 + 8 minutes overlap)



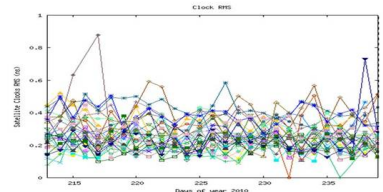
Key performance indicators

- System has been fully operational since Metop launch (October 2006), meeting requirements
- Extensive monthly report delivered to EUMETSAT including all key performance indicators
- Availability (measured): 99.7 %
- Service interruptions: 0-1 per month (required <3)
- NRT orbit and clock product accuracy met consistently

GPS NRT orbit accuracy (cm) (impact of change to Naples)



GPS NRT clock accuracy (ns)



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