

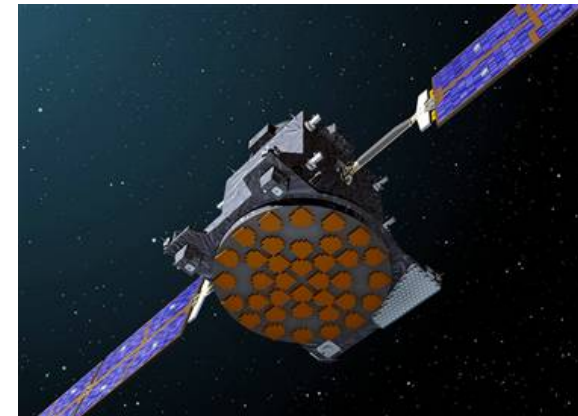


The benefits of combined processing of observations from different Global Navigation Satellite Systems

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Motivation

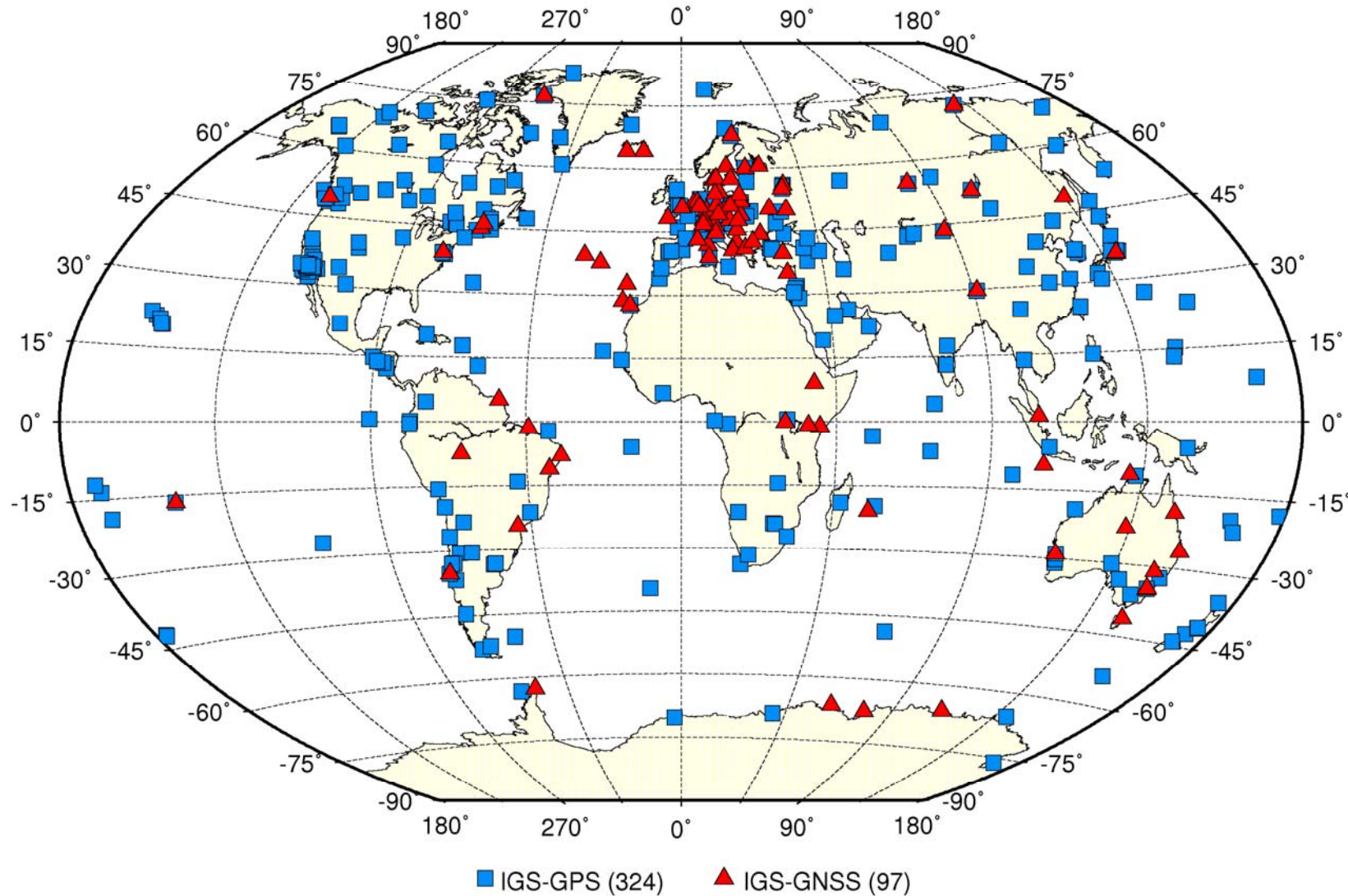
- IGS = International **GNSS** Service => not only GPS!
 - Called GNSS Service since 2005!
 - IGS network has rapidly become a GNSS tracking network since 2008!
- GLONASS is going towards full constellation by 2009
 - Currently 19 active satellites, six more to be launched this year
- Galileo is coming!
 - First two test satellites are flying (GIOVE-A and GIOVE-B)
 - Global tracking network available (13 GNSS)
 - New and better signals!
- Compass developments!?
- Additional GPS satellite provide some benefits
 - Additional other GNSS satellites with different orbit characteristics' may provide even more benefits (ERPs, Geocenter, yearly “signals”)
 - ***but*** biases between different GNSS systems may obscure the potential benefits



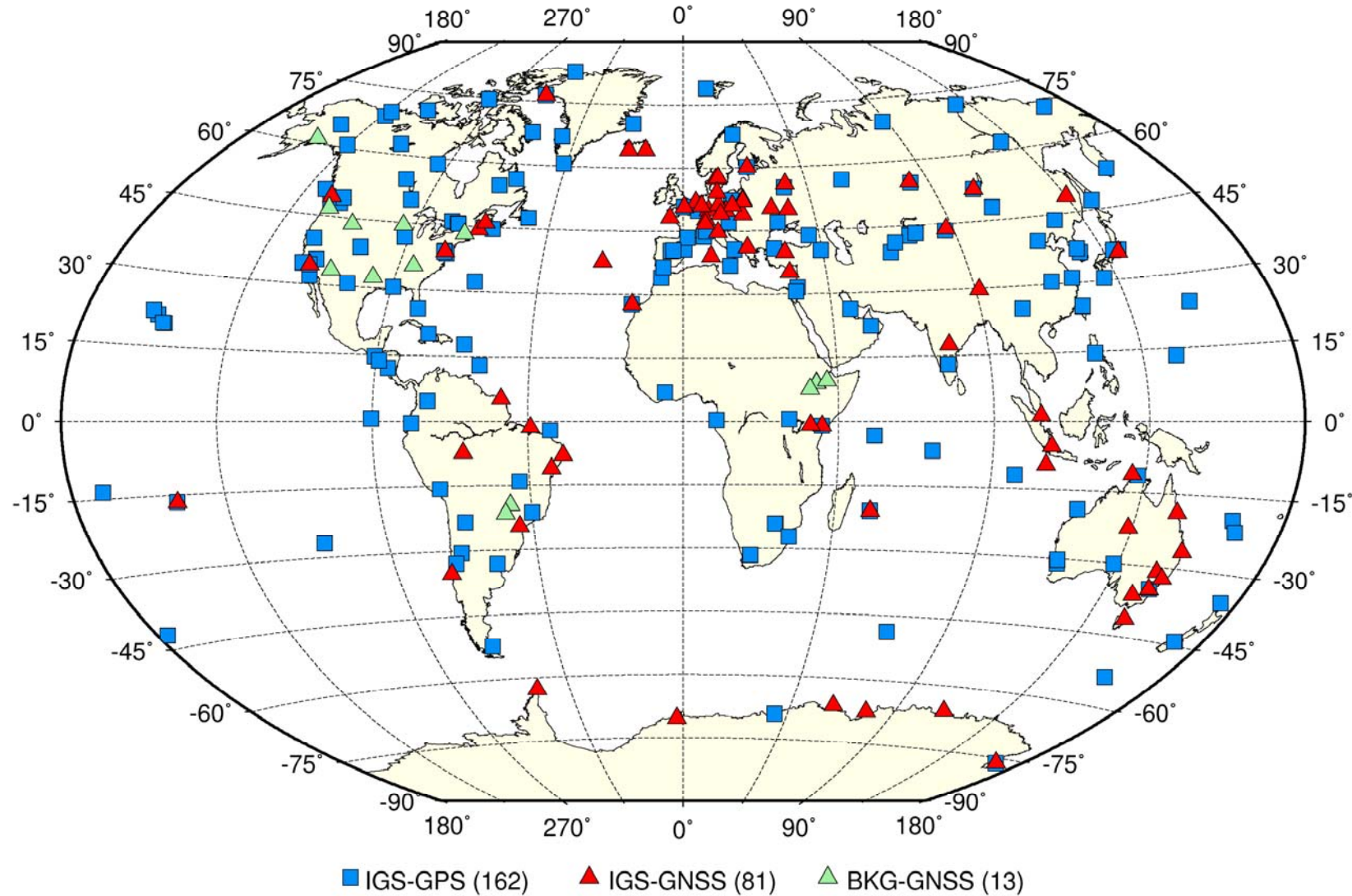
GNSS is a fact today and will rapidly grow in the next years!

IGS GNSS Tracking Network

Date: 06/03/2009

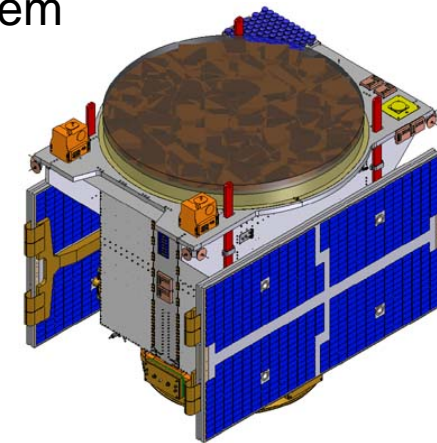


IGS + CORS + BKG Tracking Network



Different Benefits of GNSS processing

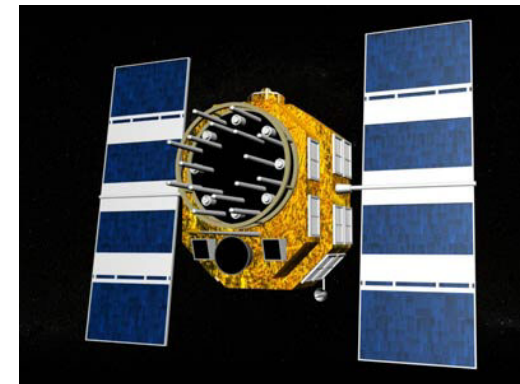
- Benefits from an Analysis Centre point of view
 - One single solution to be generated not one per GNSS system
 - All products in the same reference system
 - Quality improvement of common parameters (ERP, Tropo, GeoCenter, Clocks)
- Benefits from an IGS “service” point of view
 - One single solution not one per GNSS system
 - Fully homogeneous solution, all products in one reference system
- Benefits from a USER point of view
 - Improved solution quality
 - Use one single product in a unified reference system
 - » There are a significant amount of GNSS users
 - Current situation is HORRID for GNSS users
 - Most GNSS users use CODE or ESA products not IGS products



Uniform GNSS orbit and clock solutions are very much needed!

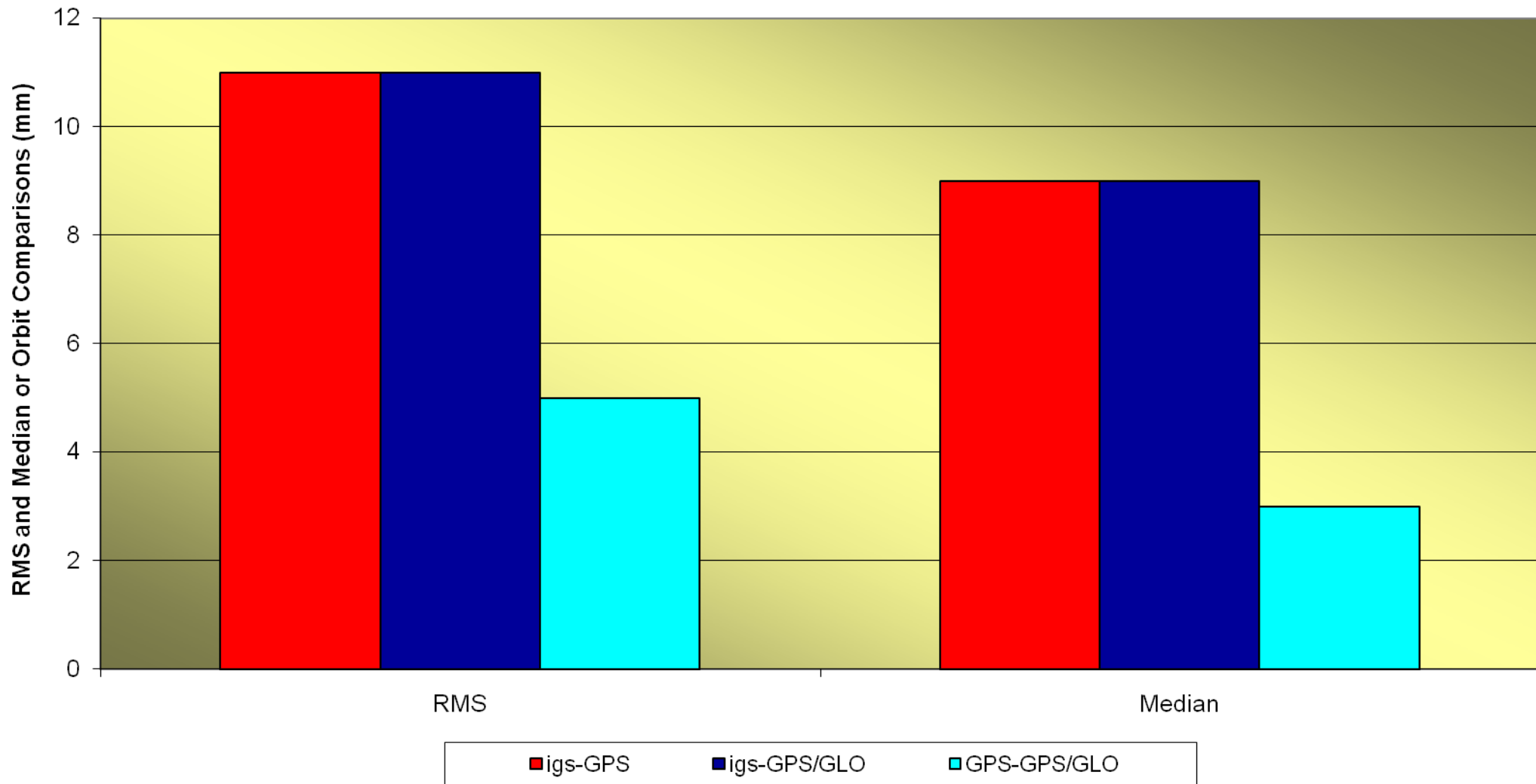
ESOC IGS GNSS Processing

- ESOC is the only AC providing GNSS orbits ***and*** clocks
 - ESOC provides GNSS products only for its “final” products
 - Ultra and Rapid products will follow shortly
 - » Waiting for platform switch Sun -> Linux
 - CODE is the only other AC providing true GNSS solutions
 - » for Ultra, Rapid, and Final products, but...do not include GLONASS clocks
- ESOC processing setup
 - We select 110 stations from a set of >300 stations
 - » Using “preferred” list followed by “geometry based” selection
 - » More stations will be used after switching platform
 - All data is processed in one single batch solution
 - » True GNSS solution from start to finish
 - » After the ambiguity fixing step two final solutions are made
 - GNSS solution for the IGS
 - GPS-only solution for internal quality checking



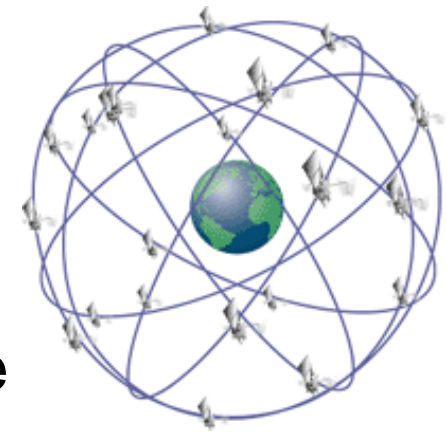
But ...do our Analysis Centre products benefit?

GNSS Impact on GPS Orbit Comparison



GPS-only vs GNSS Products

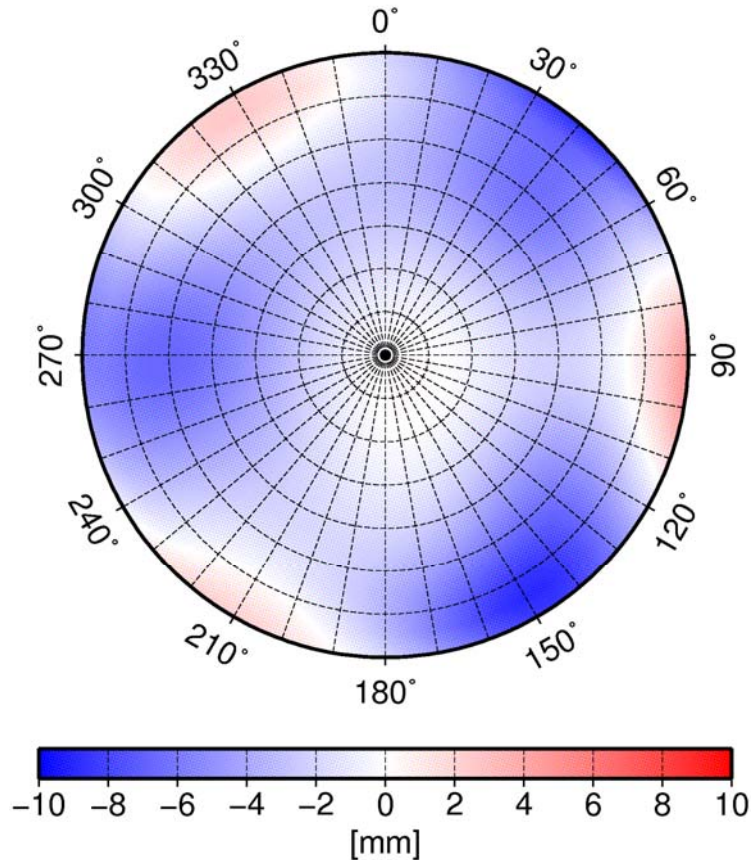
- Orbits compared to IGS are more or less the same
 - But the differences are significant
- Orbit overlaps have very similar quality
 - GNSS solution slightly better than GPS-only solution
 - » GLONASS shows clear 8-day period in along-track
 - » GPS shows clear 14-day period in RAAN
- Station coordinates repeat more or less the same
 - GNSS solution slightly better than GPS-only solution
 - » Systematic scale difference over the last weeks (0.05ppb)
- ERPs “overlaps” have very similar quality
 - Differences are significant



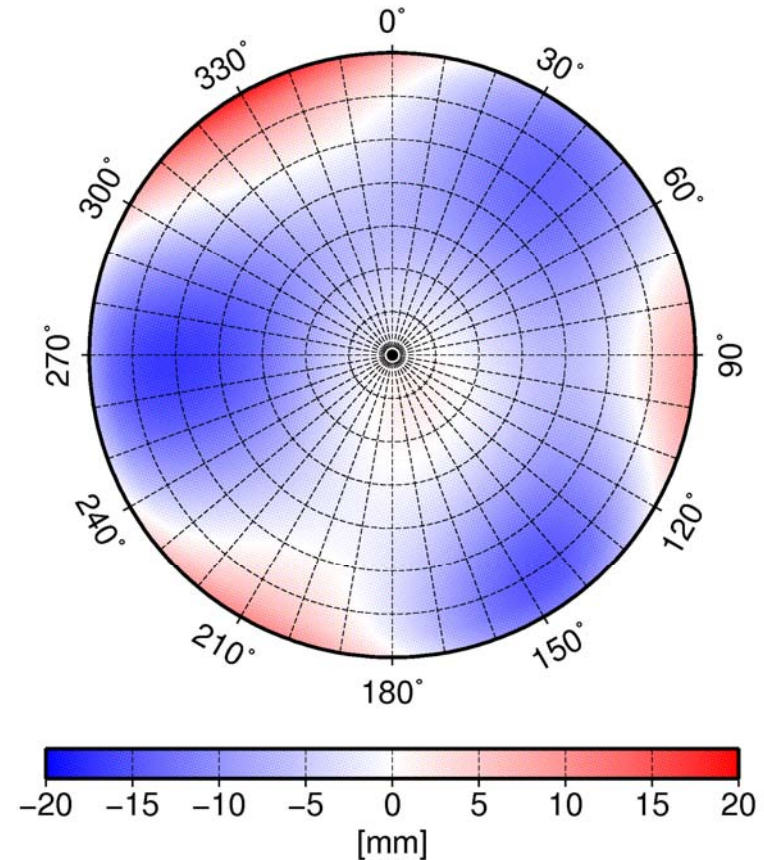
GLONASS contribution still not strong enough...but getting there!!
Number of observations per GLONASS satellite is ½ that of GPS
PCV issues and Integer Ambiguity Resolution Missing

GNSS Issues: Antenna PCVs (GLONASS)

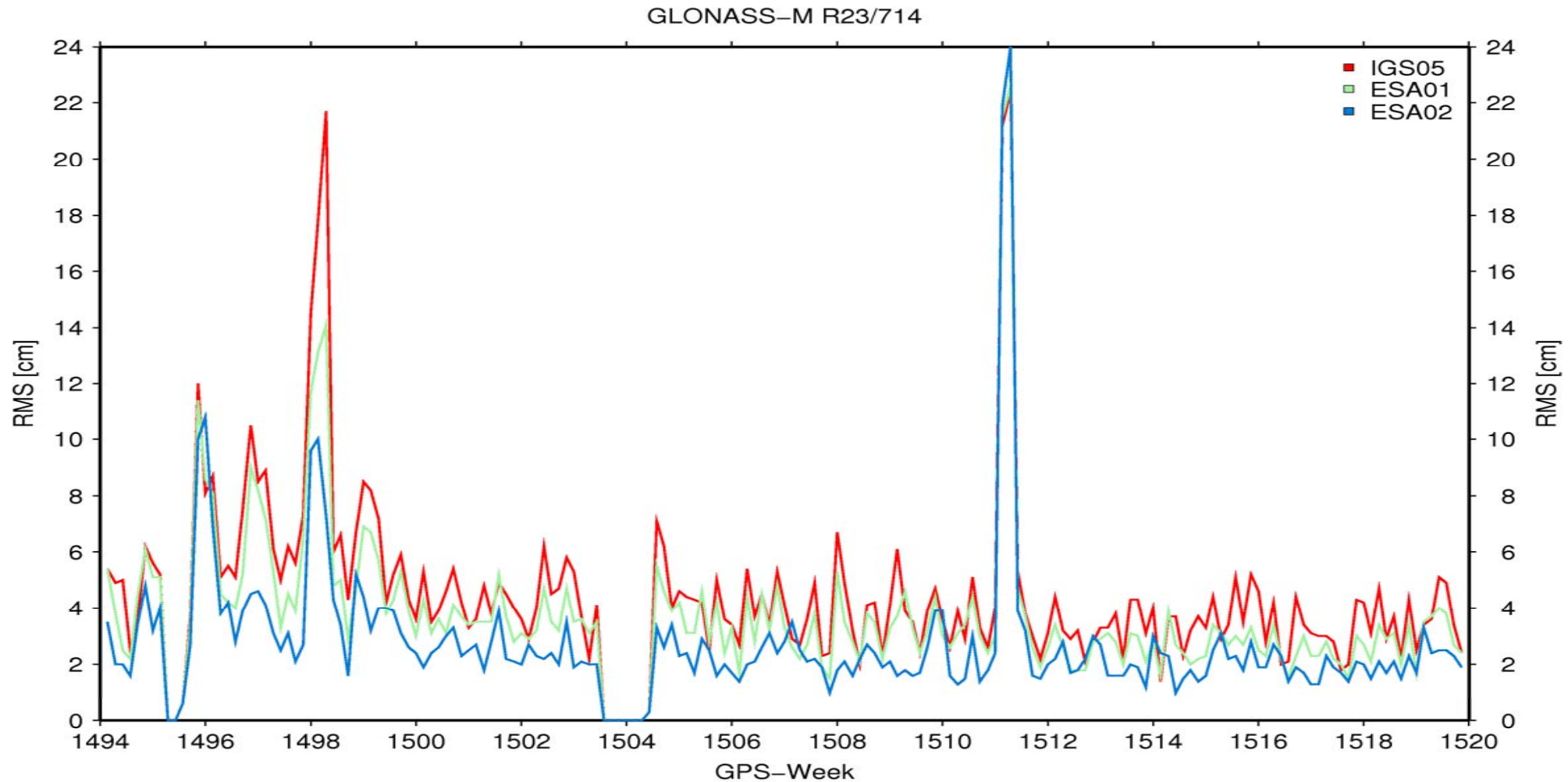
Post-Fitted Residuals / Model IGS05.ATX



Estimated PCVs (Modell ESA02.ATX)

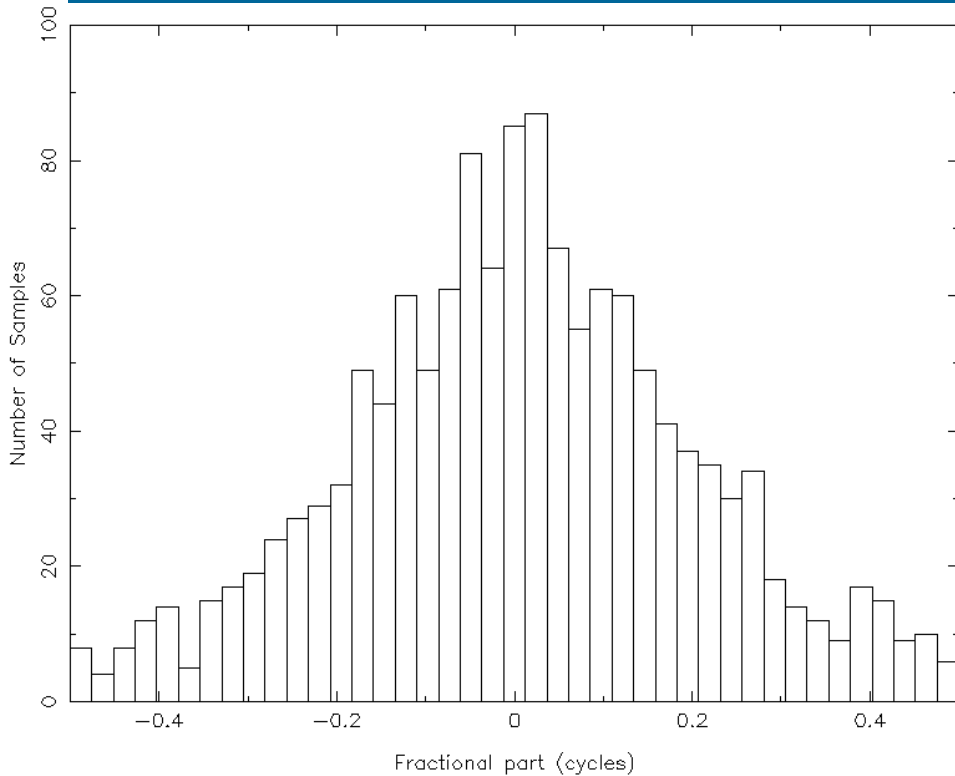


Effect of PCVs on the orbit quality

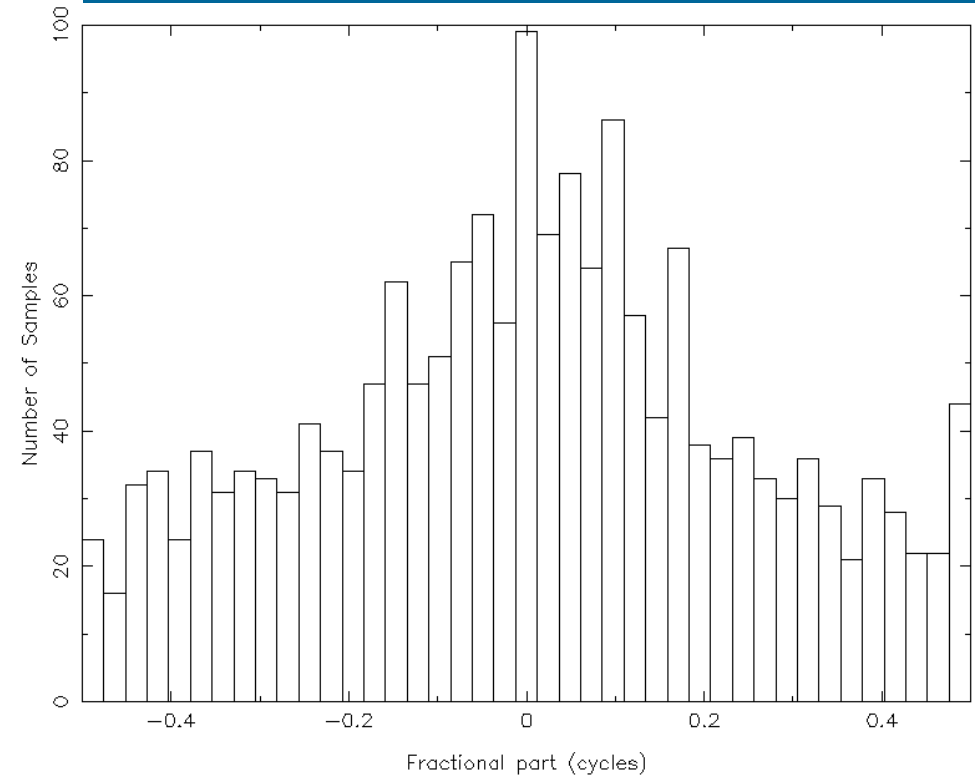


GLONASS Integer Ambiguity Resolution

Melbourne-Wübbena fractionals
 GPS only

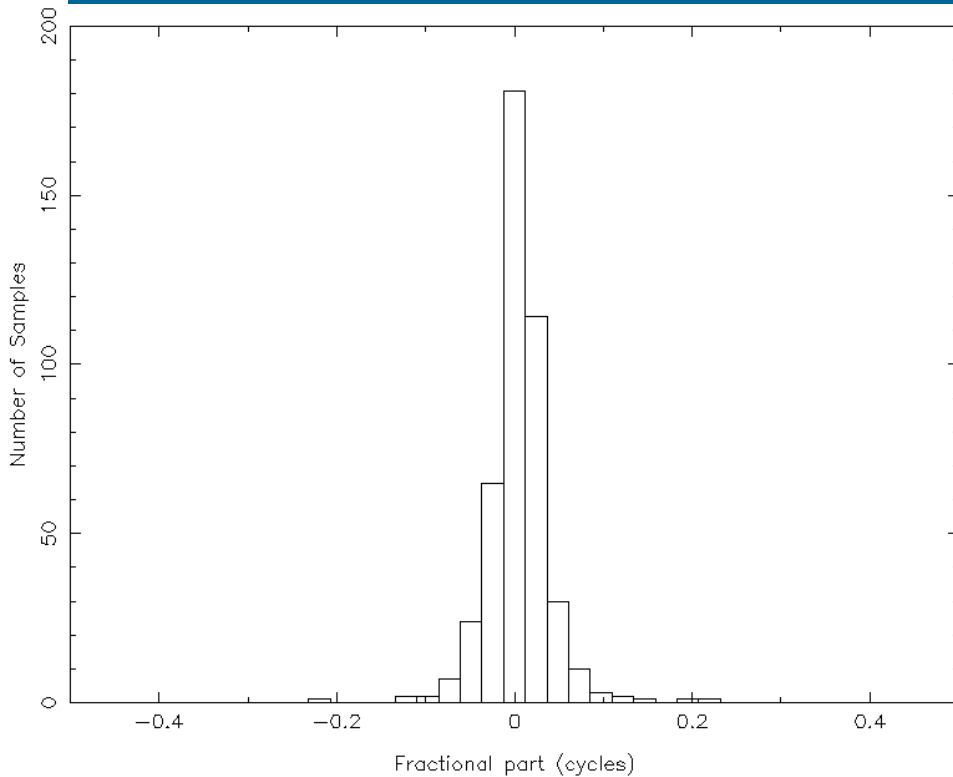


Melbourne-Wübbena fractionals
 GLONASS only

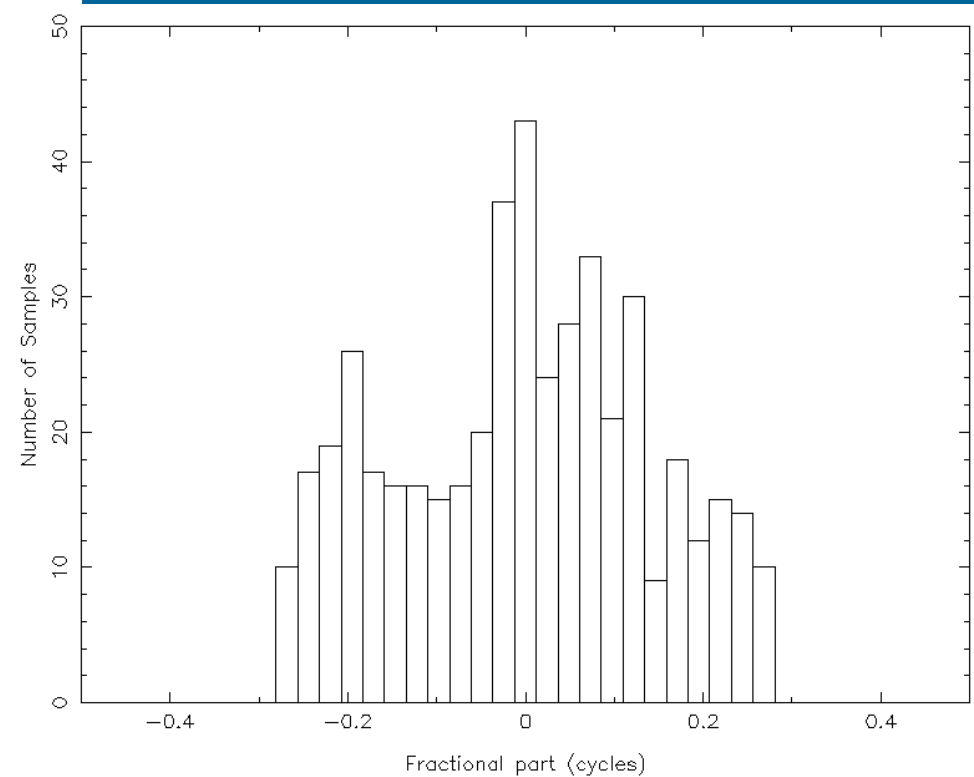


GLONASS Integer Ambiguity Resolution

**Narrow Lane fractionals
GPS only**

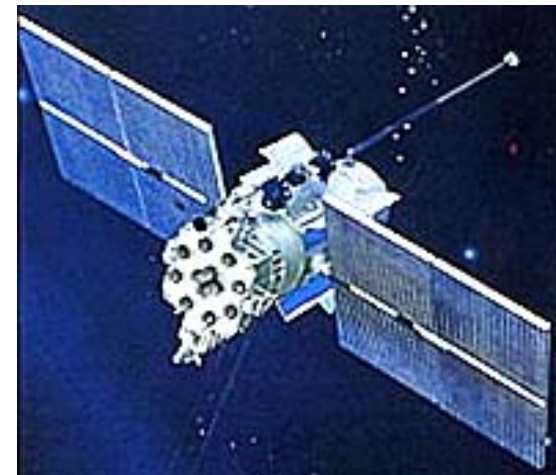


**Narrow Lane fractional
GLONASS only**



Summary

- Over the last 12 months the IGS network developed rapidly from a GPS only to a true GNSS tracking network
 - Many thanks to all the network/station operators!!
 - IGS products will have to follow!
- GLONASS is going towards full constellation by 2009
 - Currently 19 active satellites, six more to be launched this year
- Users would benefit from true GNSS orbits and clocks
 - SAPOS and EUPOS in Europe
 - Many real-time networks and RTK services are GNSS
 - » The IGS is lacking behind
 - ESOC will start producing 30 second GNSS clocks soon!
- No clear benefits for AC productsyet....
 - More work on GLONASS needed



Conclusions

- GNSS users benefit from GNSS products
 - Ease of use!
 - In particular real-time and kinematic users, but...
 - ...also users in high latitudes, i.e. > 55 degrees.
- No clear benefits for AC productsyet....
 - Denser tracking network (progressing rapidly)
 - More satellites (6 more satellites in 2009 expected)
 - Improved PCV models (for receiver and transmitter antennas)
 - Integer ambiguity resolution (initial results are positive)
- Other benefits
 - Reduce effects of GPS periodic effects (sidereal and ~yearly)
 - All GLONASS satellites have SLR reflectors
 - » GPS-35/PRN05 is decommissioned (but still transmitting)



Thank You!

