Australian Government
Geoscience Australia

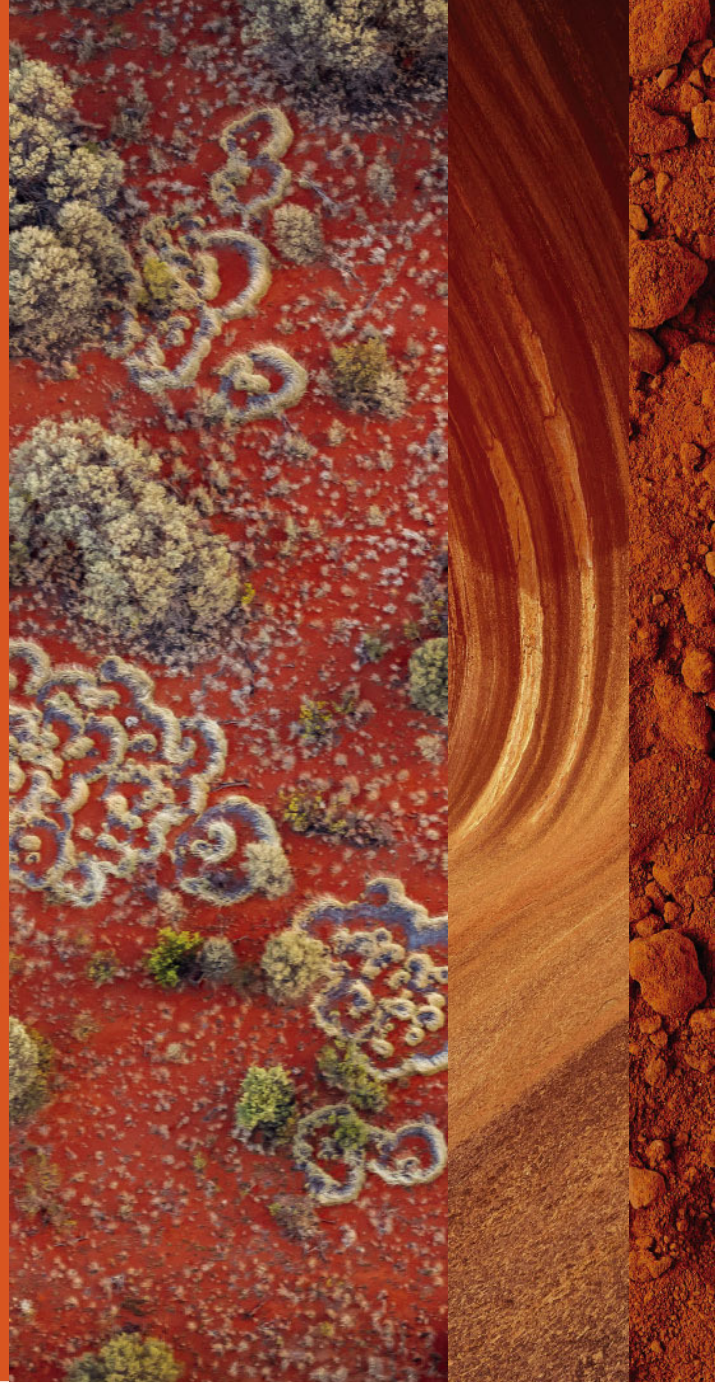
POSITIONING AUSTRALIA

IGS INTERNATIONAL GNSS SERVICE

Multi-GNSS orbit solutions from the third IGS Reprocessing

Salim Masoumi and Michael Moore

Tour de l'IGS - 02 June 2021



Third IGS reprocessing of the GNSS products (Repro3)

IGS products

- Broadcast (IGS real-time service)
- Ultra-rapid
- Rapid
- Final
- Reprocessing

Repro3

- Station positions
- Satellite orbits
- Station & satellite clocks
- Satellite attitude & biases
- Earth orientation parameters
- Troposphere

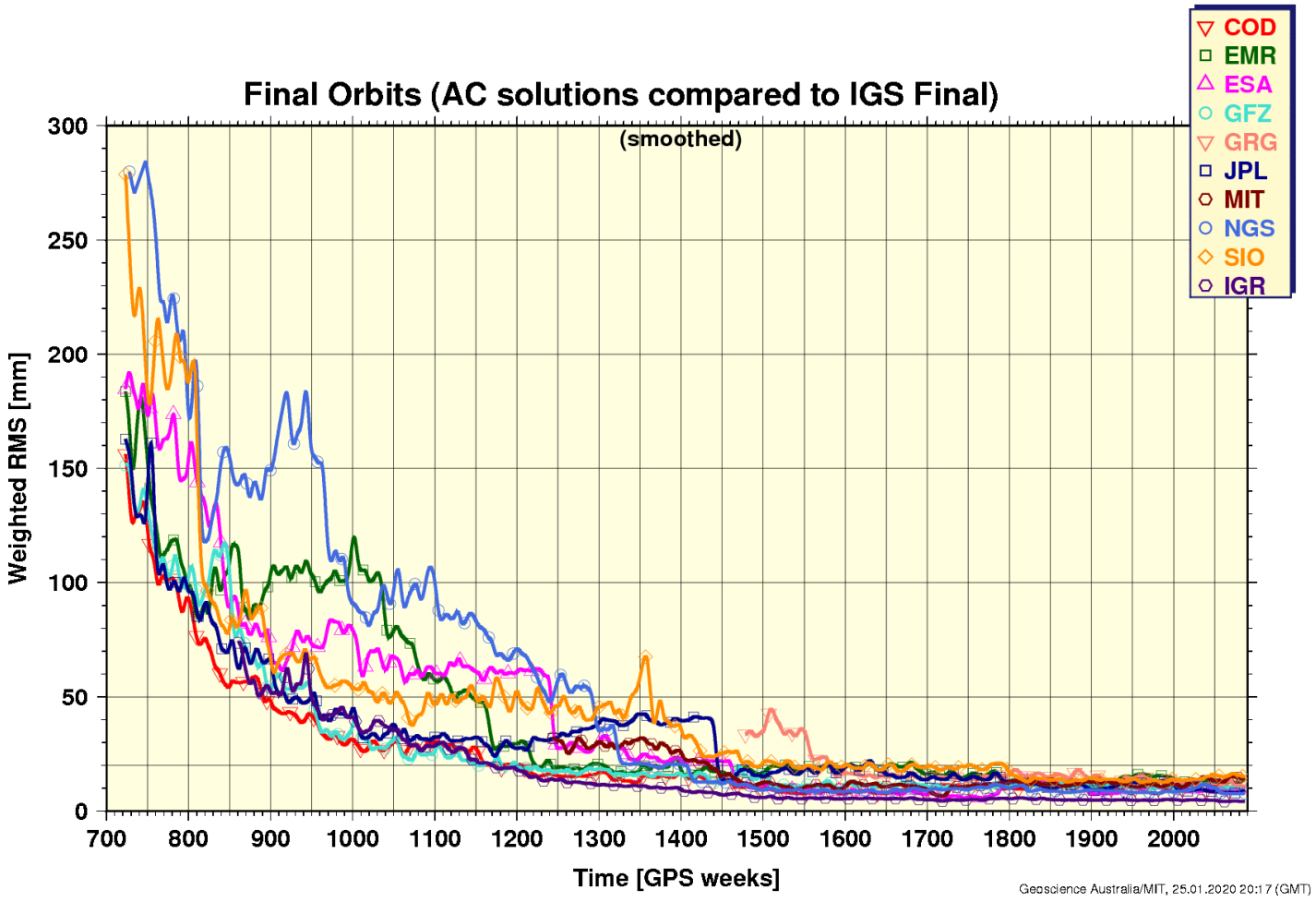
Repro3 satellite orbit submissions

Analysis Centre	GPS	GLONASS	GALILEO
COD	1994 - 2020	2002 - 2020	2013 - 2020
ESA	1995 - 2020	2009 - 2020	2015 - 2020
GFZ	1994 - 2020	2012 - 2020	2014 - 2020
GRG	2000 - 2020	2008 - 2020	2017 - 2020
JPL	1994 - 2020		
MIT	2000 - 2020		2017 - 2020
NGS	1994 - 2020		
TUG	1994 - 2020	2009 - 2020	2013 - 2020
WHU	2008 - 2020	2010 - 2020	

Analysis Centres agreed on a set of recommendations for analysis techniques and modelling at Potsdam workshop – April 2019, e.g.:

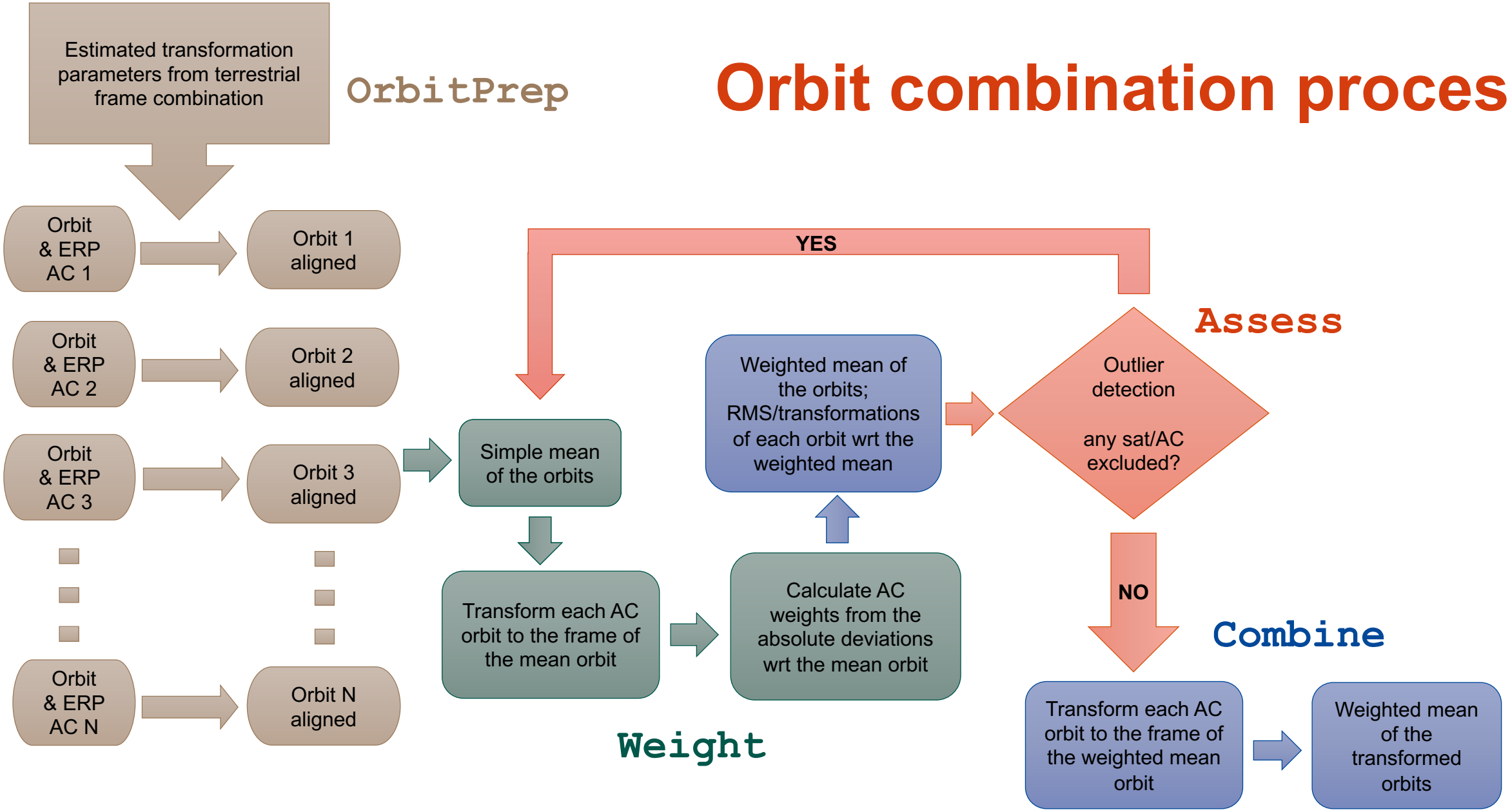
- Solar radiation pressure: min. ECOM-1/ECOM-2/GPSM; preferred Box-Wing+empirical
- HF-EOP: Desai-Sibois/Gipson
- Ionosphere: 2nd order effect/GIM

Current (traditional) combination software

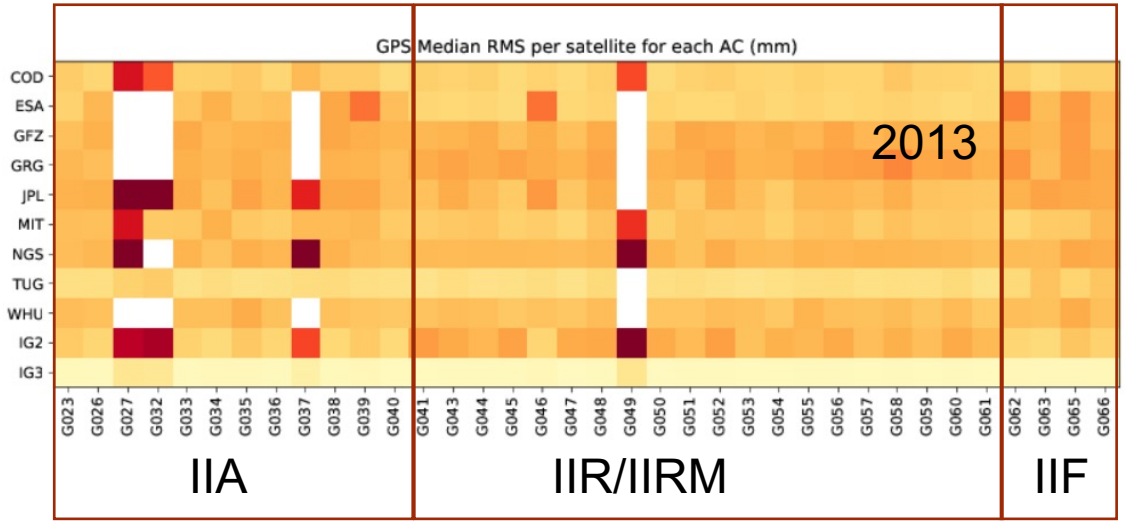


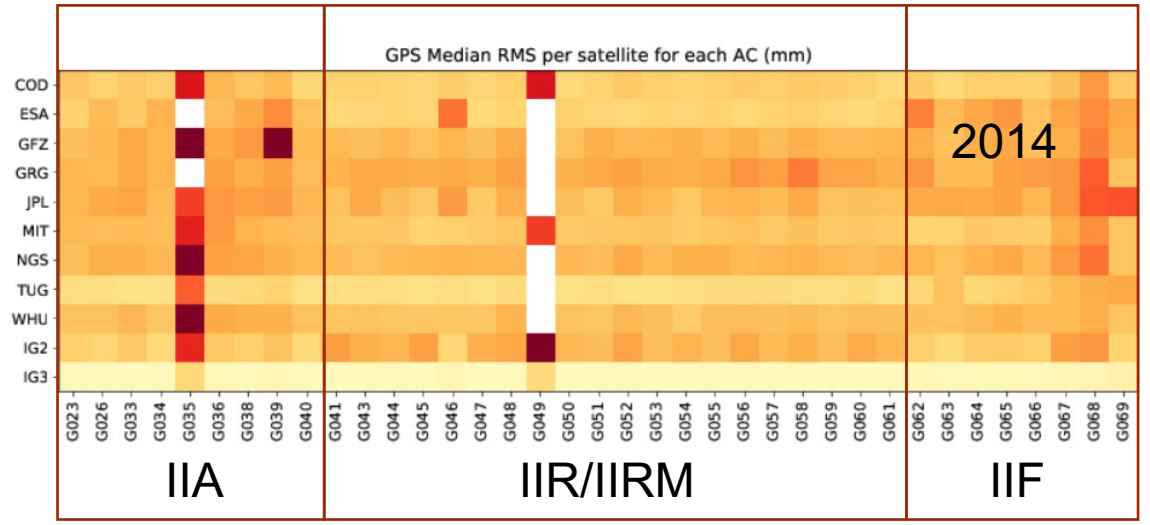
- Provided combinations for over 20 years
- Based on the algorithm in 1995 paper: "*Gerhard Beutler, Jan Kouba, Tim Springer: Combining the orbits of the IGS Analysis Centers*"
- Robust algorithm: minimizing the absolute deviations of individual orbits wrt a weighted average of the orbits for estimating Helmert transformation parameters
- Reliable for use in precise positioning science and applications
- Limited to GPS and GLONASS combinations
- Need to upgrade the software for multi-GNSS combination

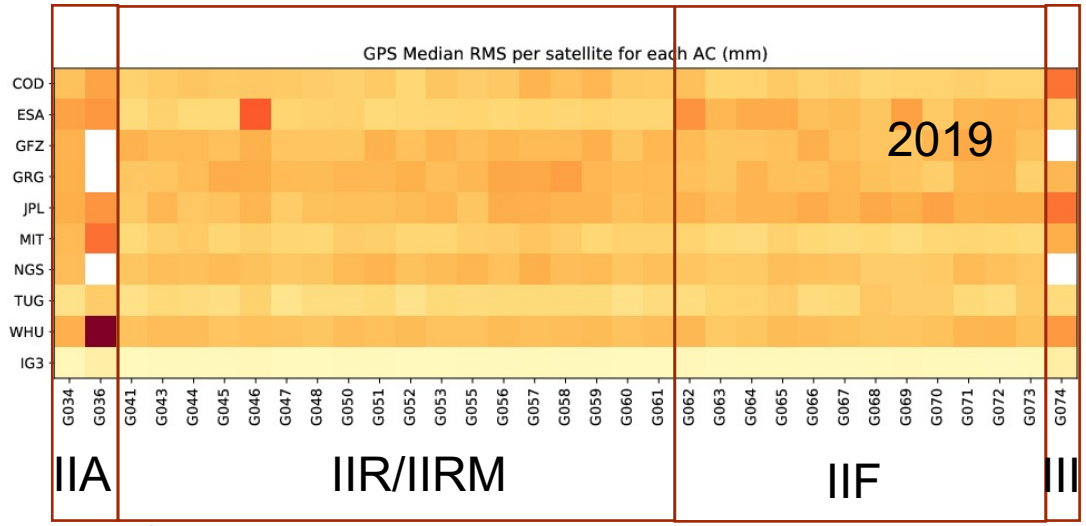
Orbit combination process

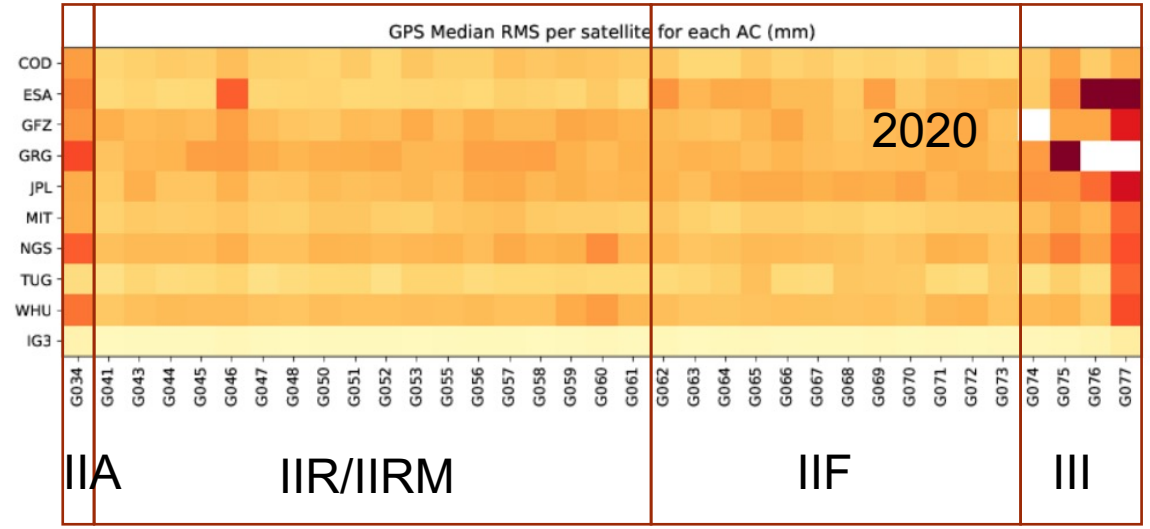


Repro3 - Median satellite RMS per AC - GPS

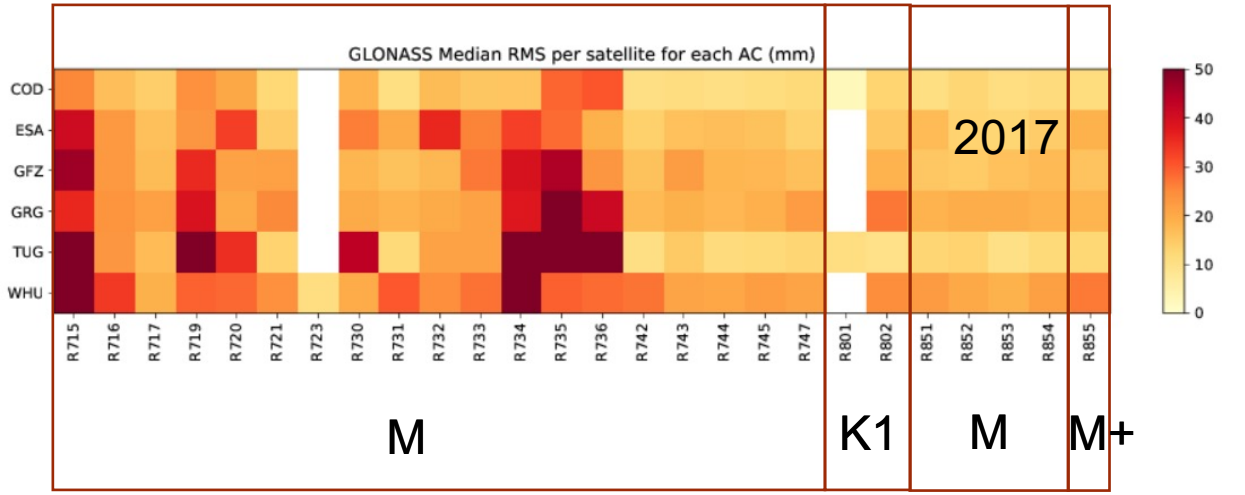


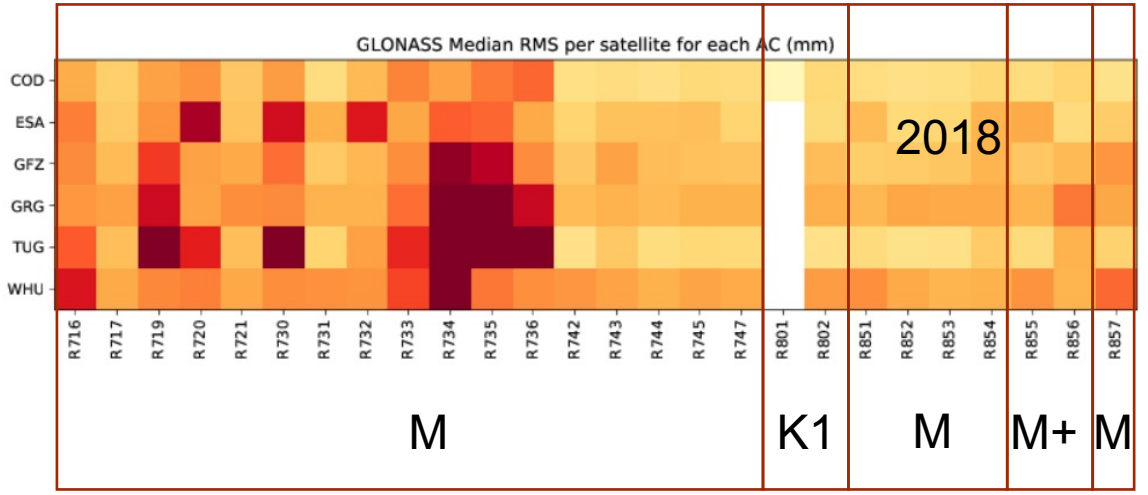


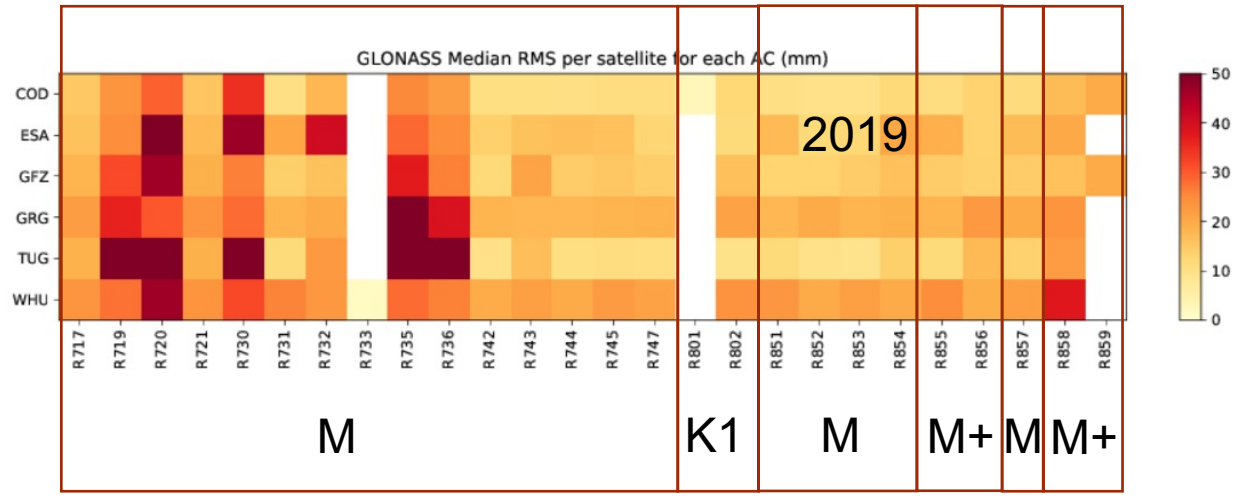


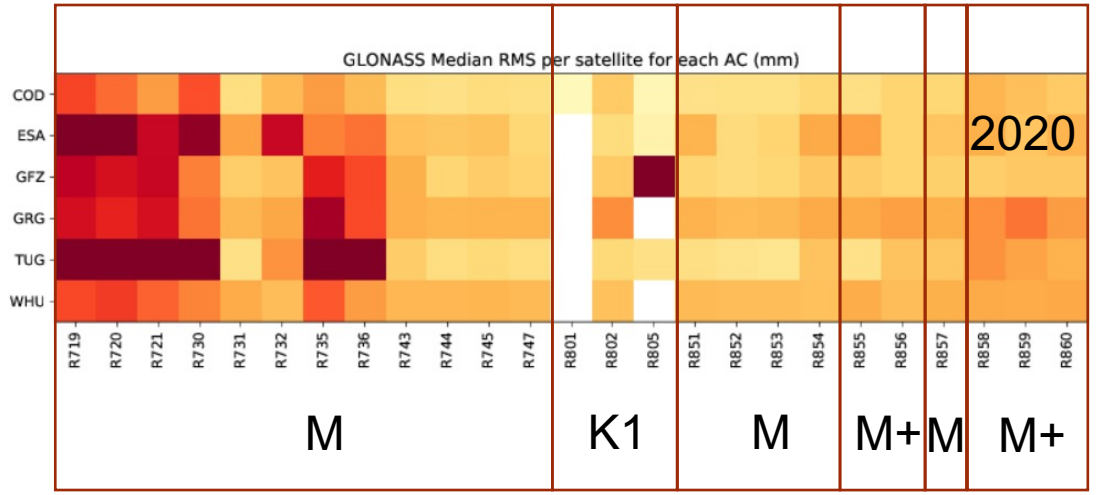


Repro3 - Median satellite RMS per AC - GLONASS

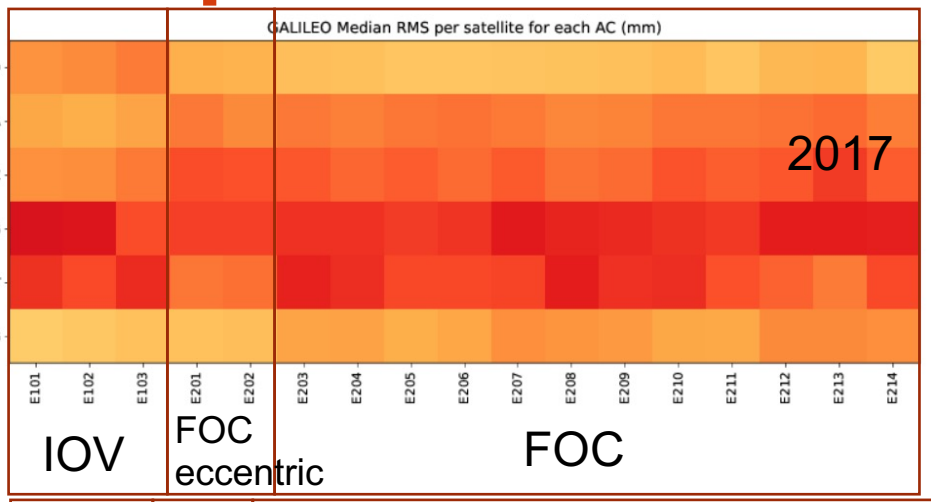


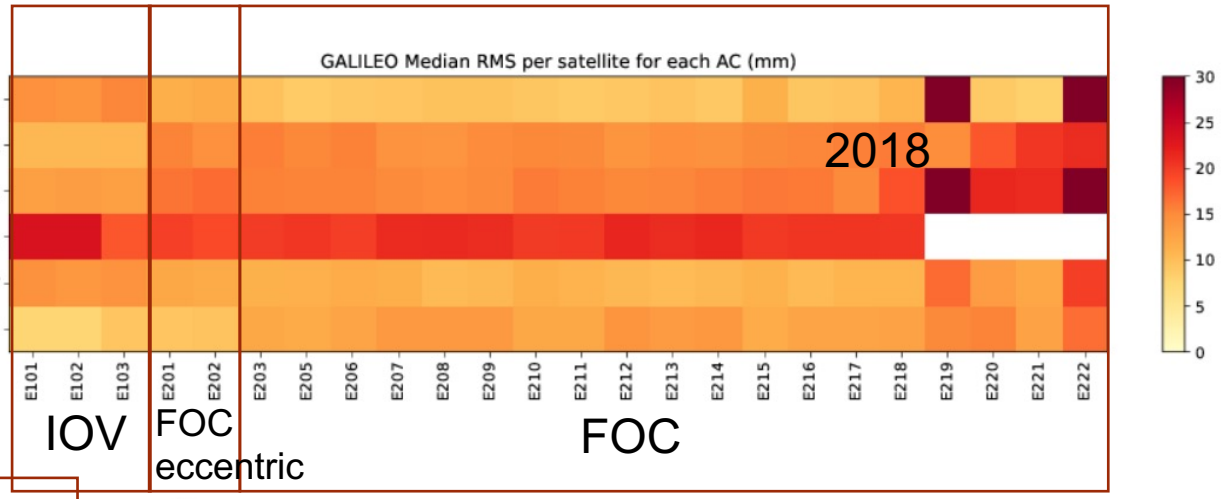


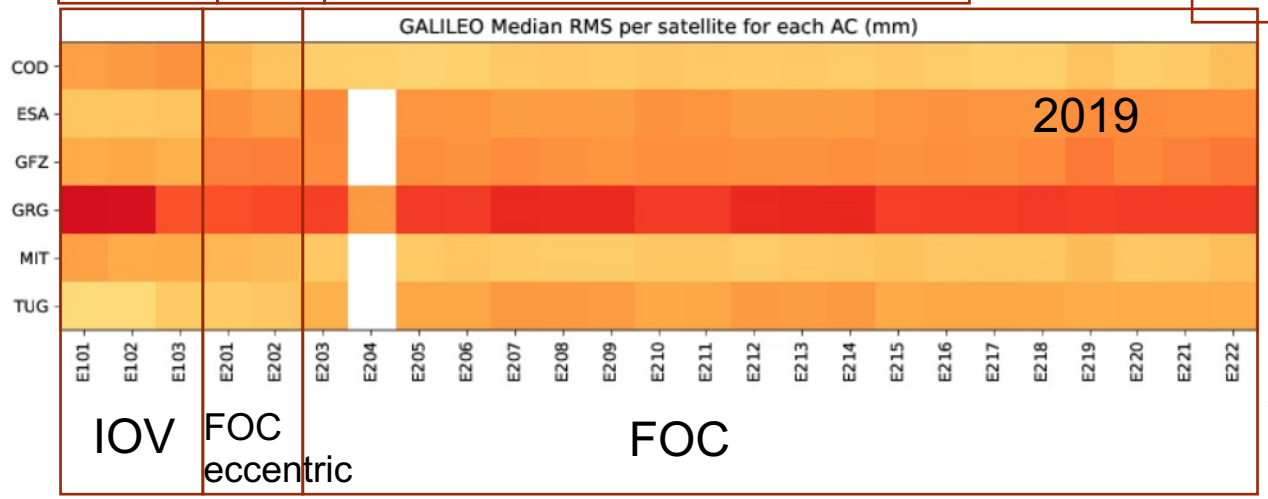


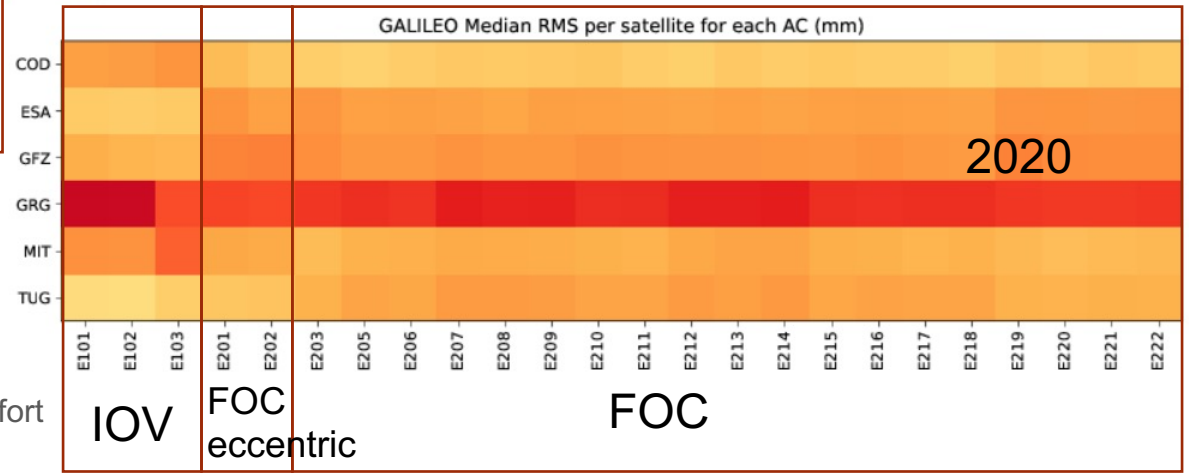


Repro3 - Median satellite RMS per AC - GALILEO

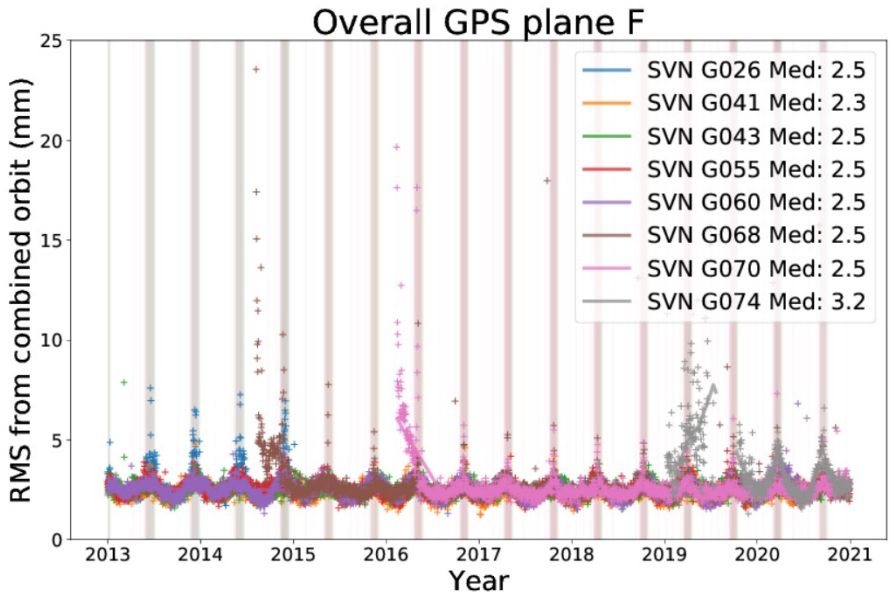


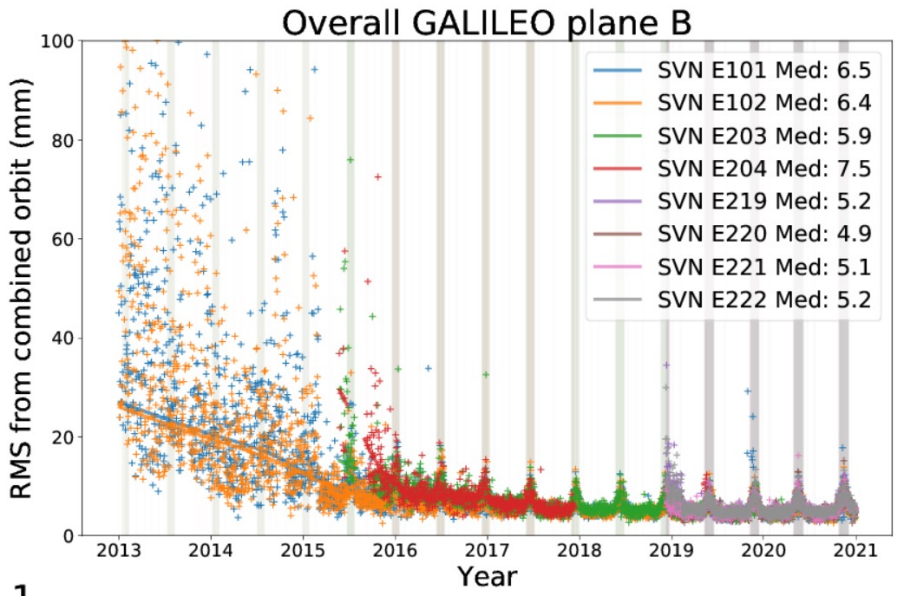


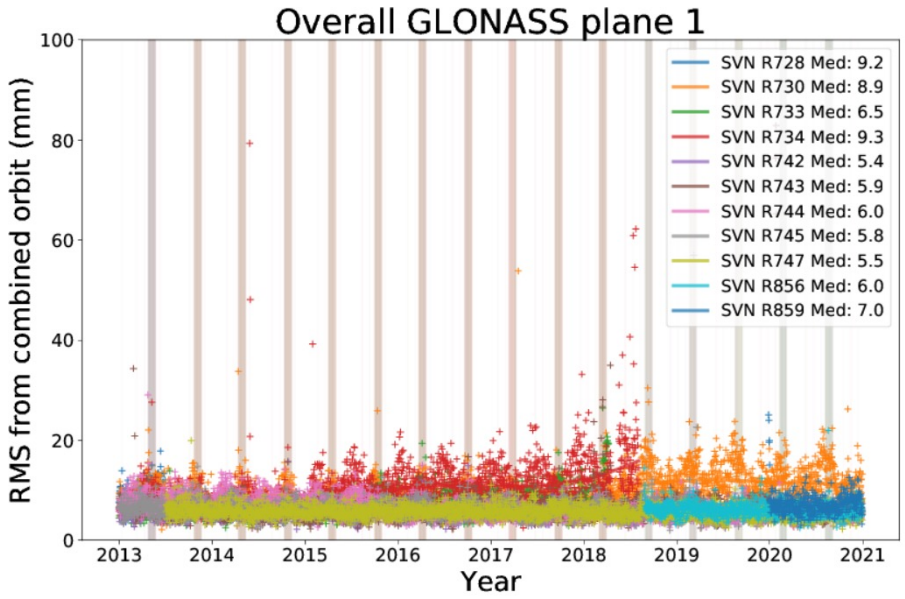




Repro3 - Overall satellite orbit RMS statistics

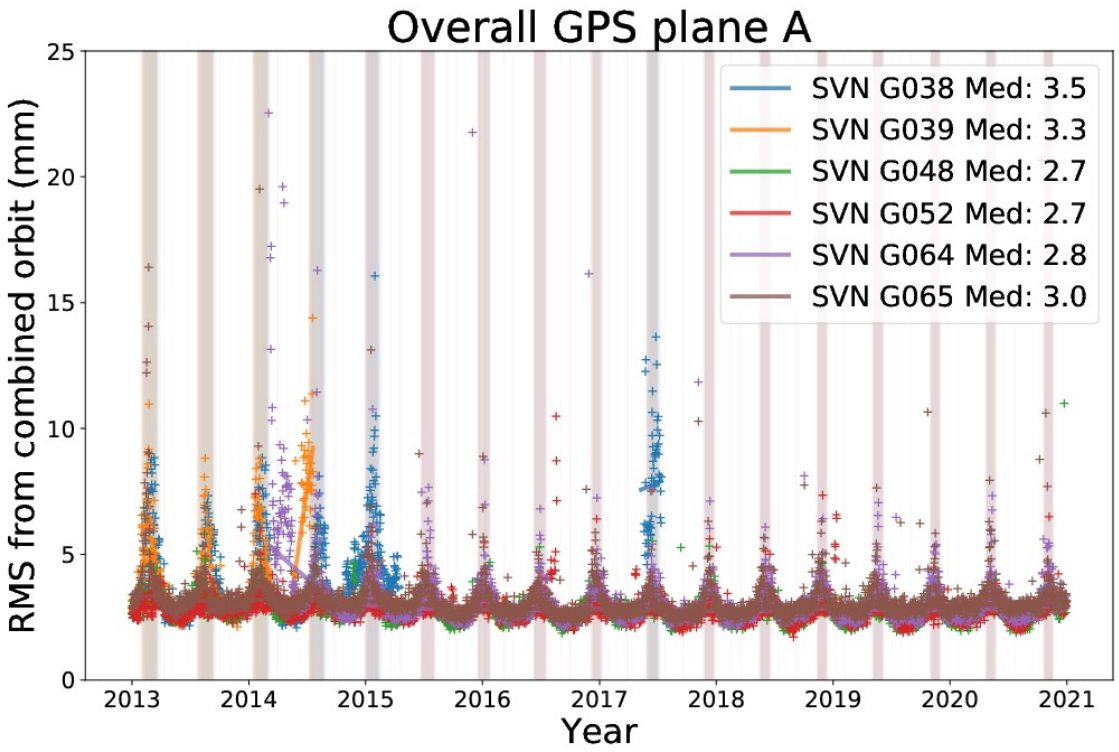




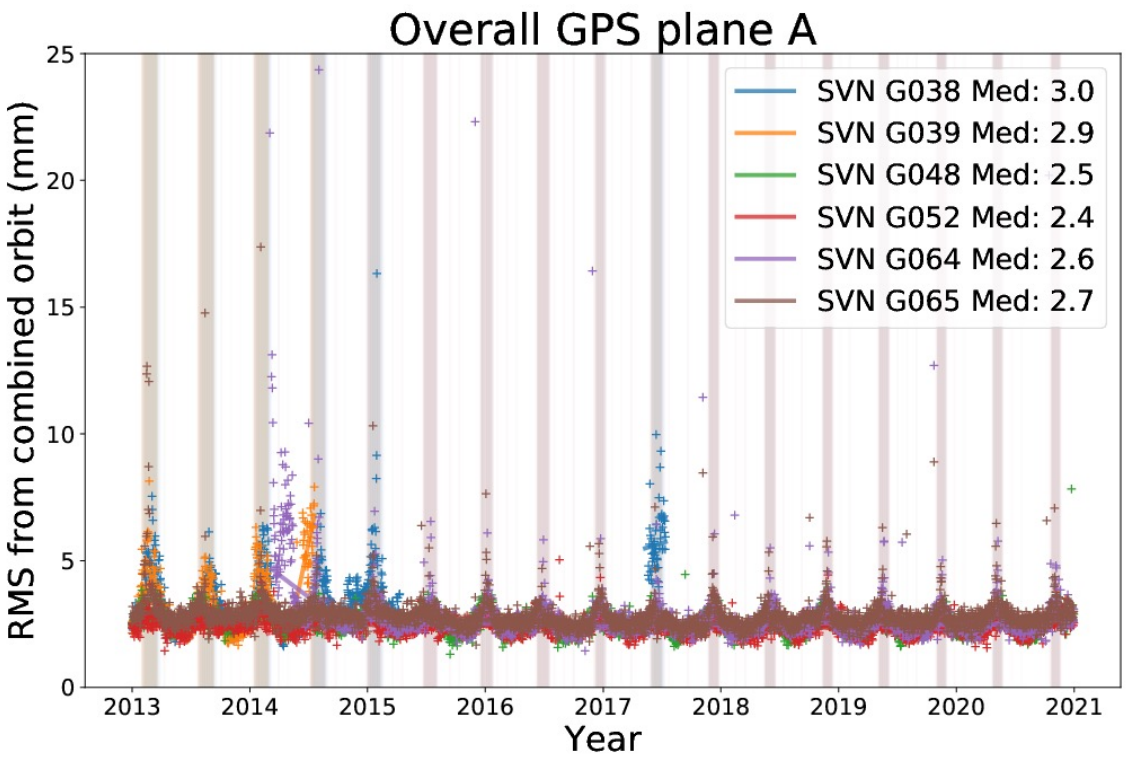


AC global weighting vs satellite-specific weighting

Global weighting

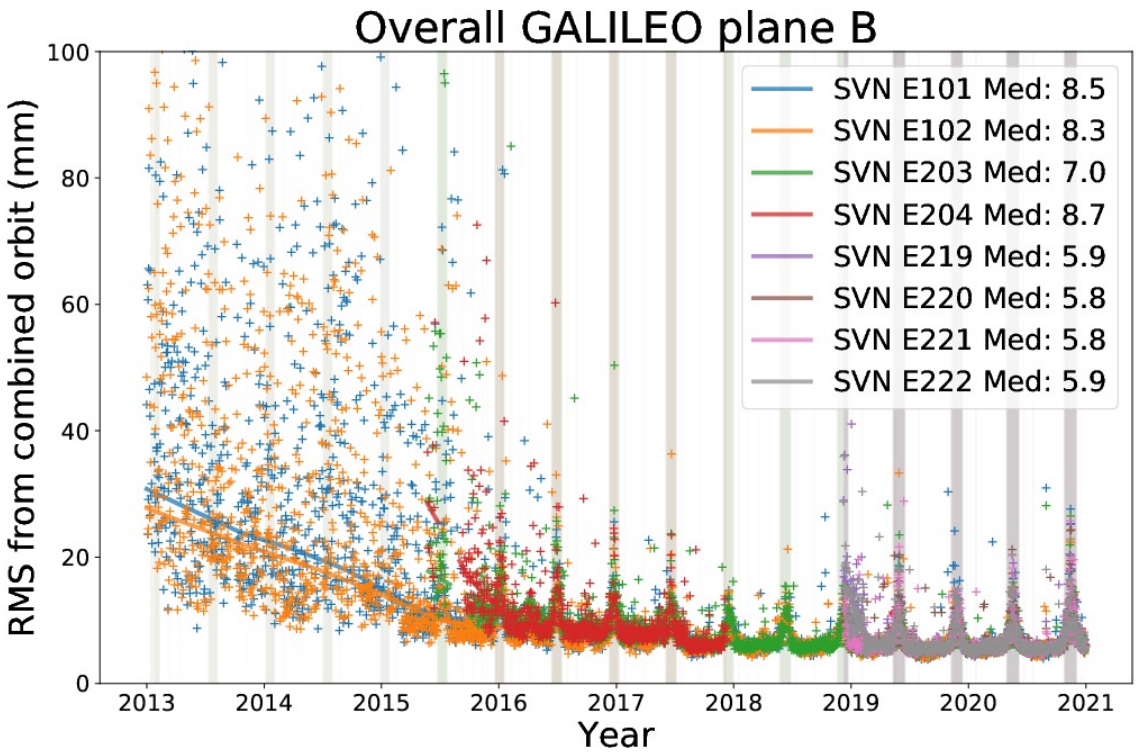


Satellite-specific weighting

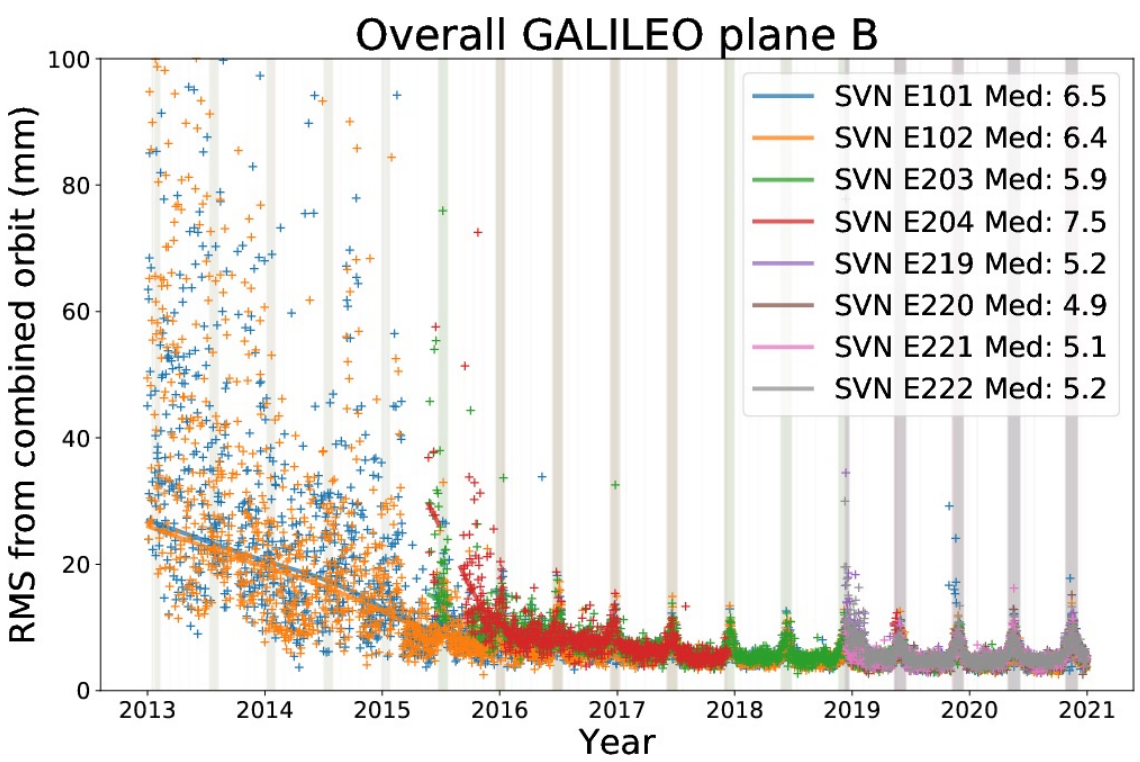


AC global weighting vs satellite-specific weighting

Global weighting

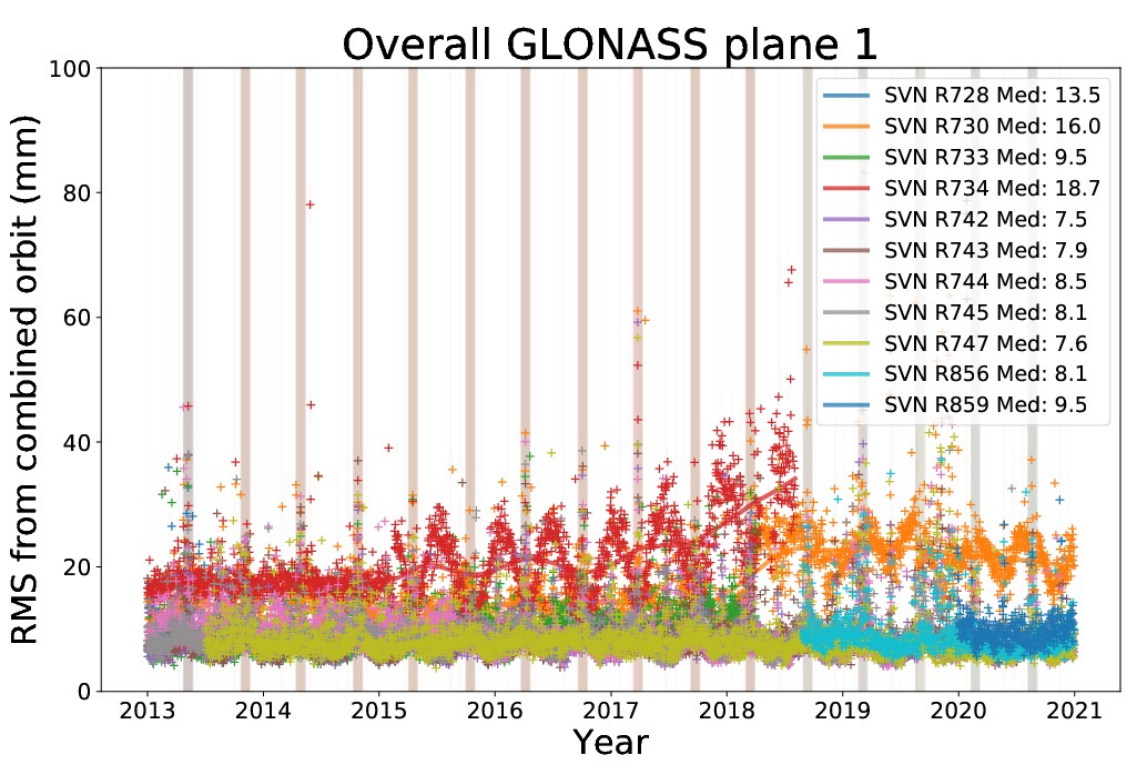


Satellite-specific weighting

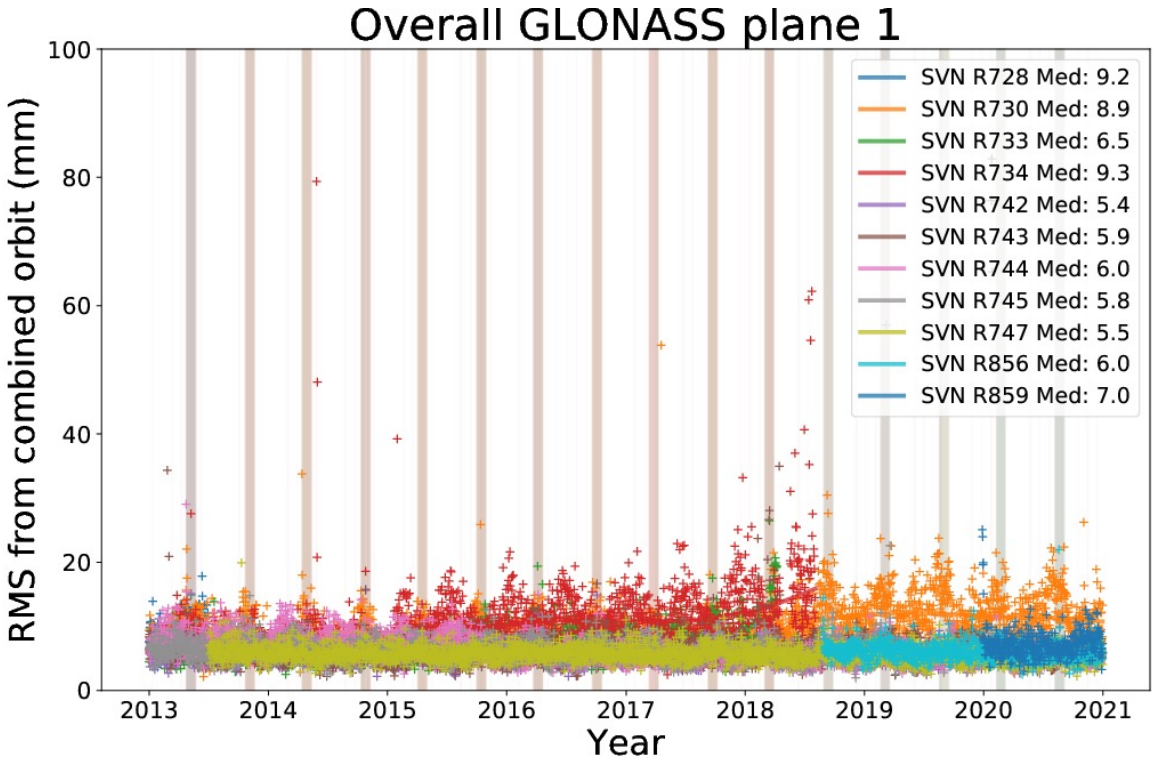


AC global weighting vs satellite-specific weighting

Global weighting

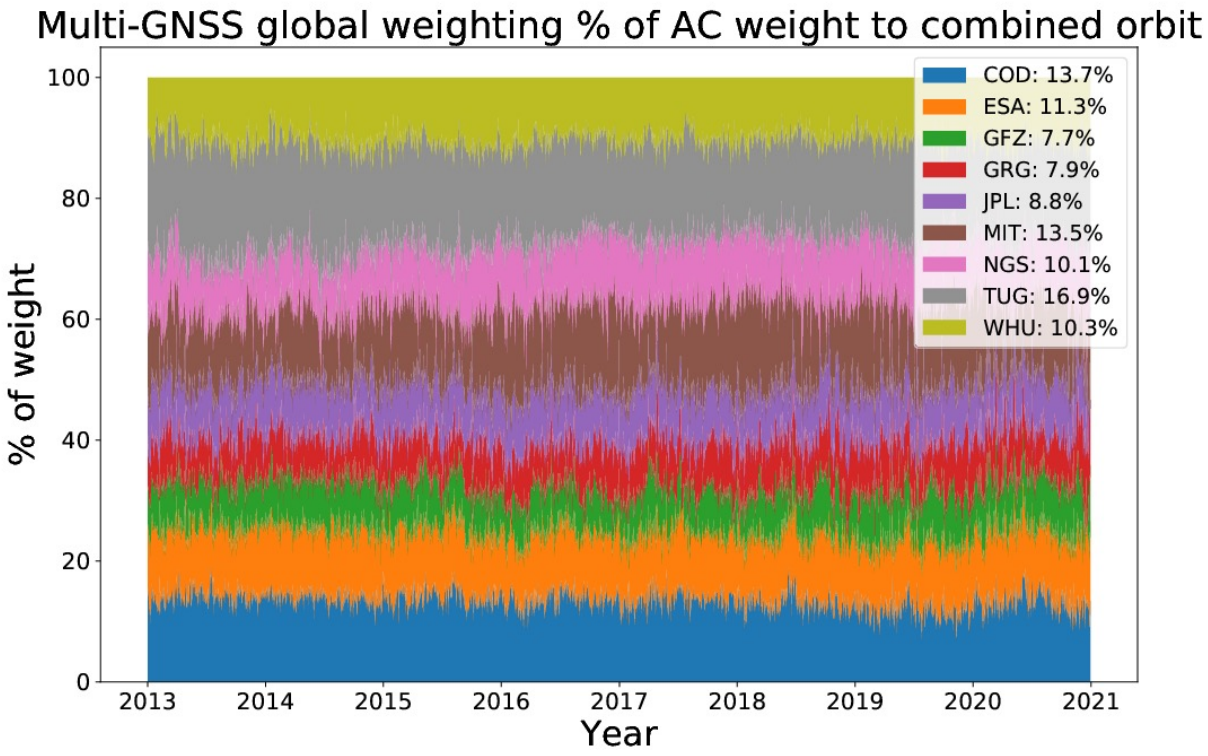


Satellite-specific weighting

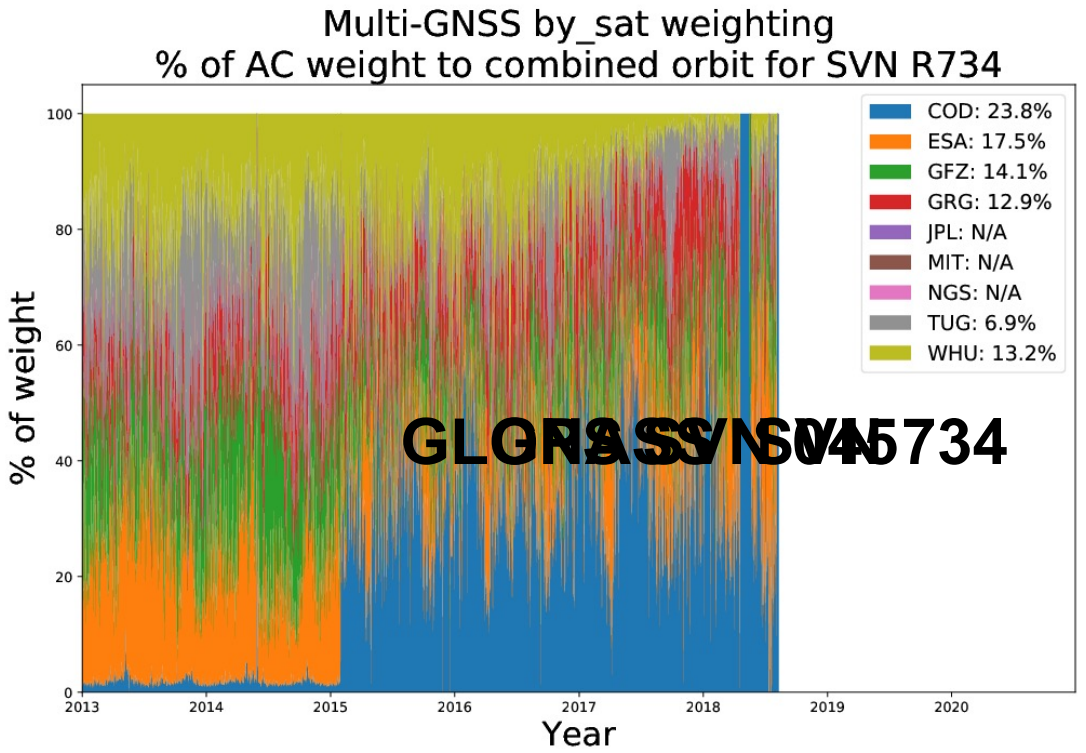


AC global weighting vs satellite-specific weighting

Global weighting



Satellite-specific weighting



Weighting only based on GPS, as not all the AC solutions have all the three constellations
GLONASS and GALILEO satellites have no role in deciding how they are being weighted!

AC global weighting vs satellite-specific weighting

- The traditional global AC weighting is only based on GPS, which may compromise the robustness for the GLONASS and GALILEO. The satellite-specific AC weighting helps maintain the robustness of all the multi-GNSS satellite orbit solutions
- There may be concerns about the satellite-specific weighting not preserving the internal consistency of the AC orbit solutions; the preliminary tests have not shown a significant impact on the PPP results yet; more PPP analyses can be performed
- Constellation-specific weighting may be regarded as an approach in-between; however, given the different modelling issues of the satellites within each constellation (particularly GLONASS, and also the other systems like BeiDou for the future), this does not resolve all of the issues
- Validation of the orbits with satellite laser ranging (SLR) observations can be a great tool to assess the weighting approaches, as was performed for the experimental multi-GNSS combinations

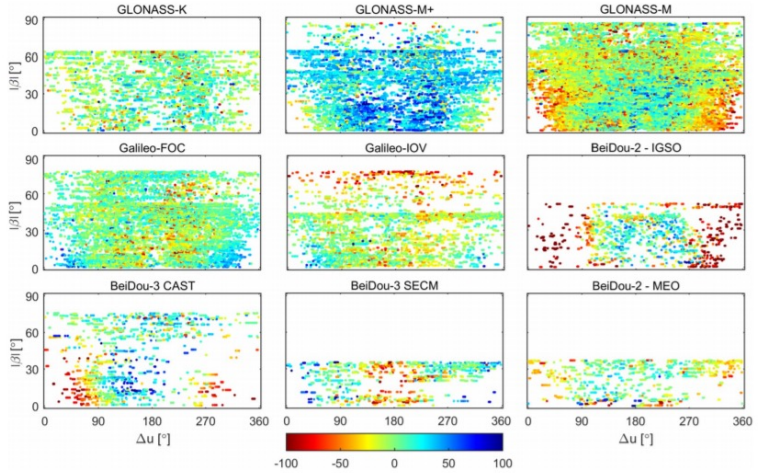
GPS Solutions (2020) 24:54
https://doi.org/10.1007/s10291-020-0965-5

ORIGINAL ARTICLE

Check for updates

Quality assessment of experimental IGS multi-GNSS combined orbits

Krzysztof Sośnica[1] · Radosław Zajdel[1] · Grzegorz Bury[1] · Jarosław Bosy[1] · Michael Moore[2] · Salim Masoumi[2]



AC global weighting vs satellite-specific weighting

- **The Bottom line:** three sets of solutions for repro3:
  - **IGS0:** Traditional GPS-only combined orbits using the traditional current software
  - **IGS1:** Multi-GNSS combined orbits using the traditional global AC weighting algorithm
  - **IGS2:** Multi-GNSS combined orbits using the satellite-specific AC weighting

Final remarks and future direction

- Repro3 combined orbits released by about November 2021
- Post repro3:
  - Switch of the operational products to the repro3 standards
  - Multi-GNSS inclusion for the operational products
  - Deployment of the new combination software