

Beacons designation by DORIS receivers

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Content



An answer to a question from IDS about unexpected high residuals for Wettzell and Gavdos



How the DORIS receivers choose between the beacon signals in visibility for acquisition ?



Impact of this choice on the position residuals



What should we do for Genesis?

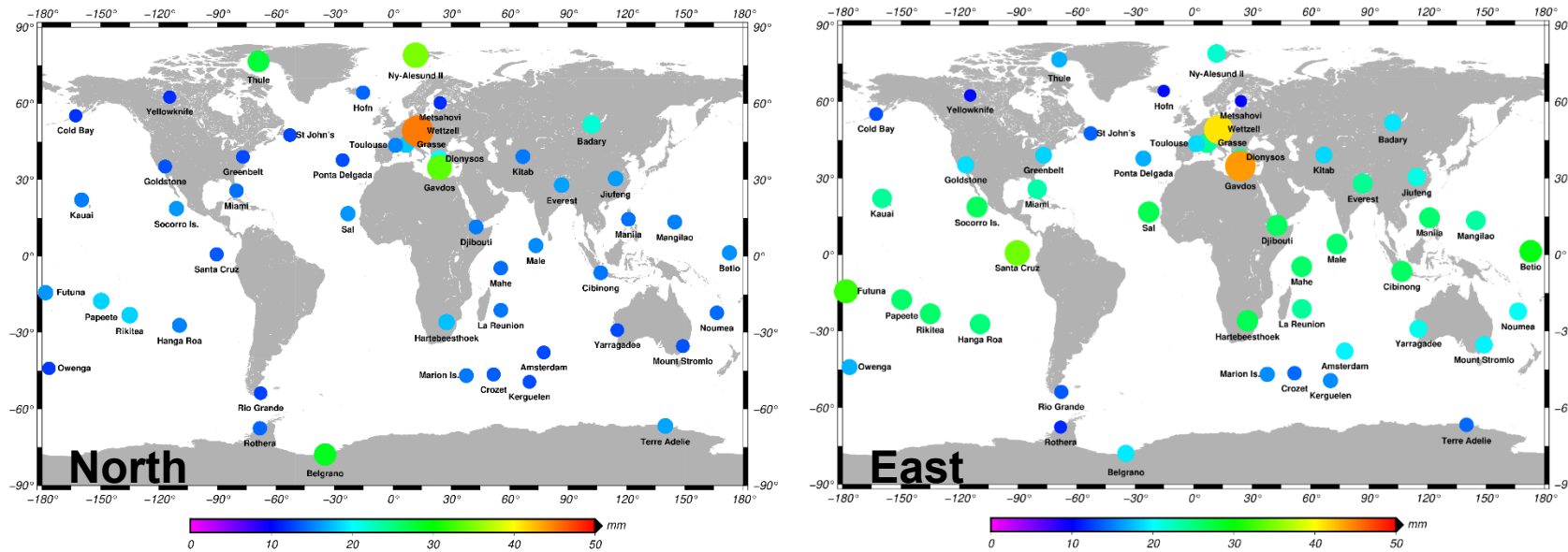


Conclusion

Question from Guilhem Moreaux

Why, for Jason 3 and Sentinel 6MF only, Gavdos and Wettzell residuals are higher than other beacons?

- Based on single-satellite position solutions from AC GOP, GRG, GSC et IGN
- Residuals = differences between single-sat solutions and DPOD



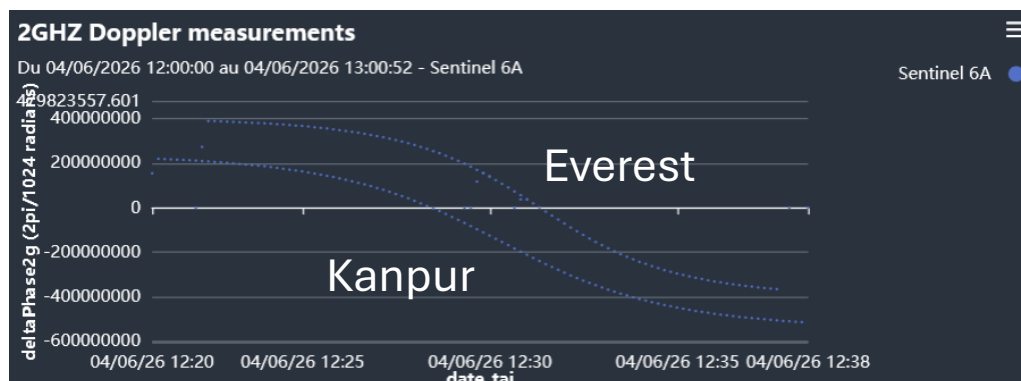
By courtesy of G Moreaux

Could it be related to the frequency shift for these two beacons?

But Grasse, in the same area, has also a frequency shift and shows correct residuals

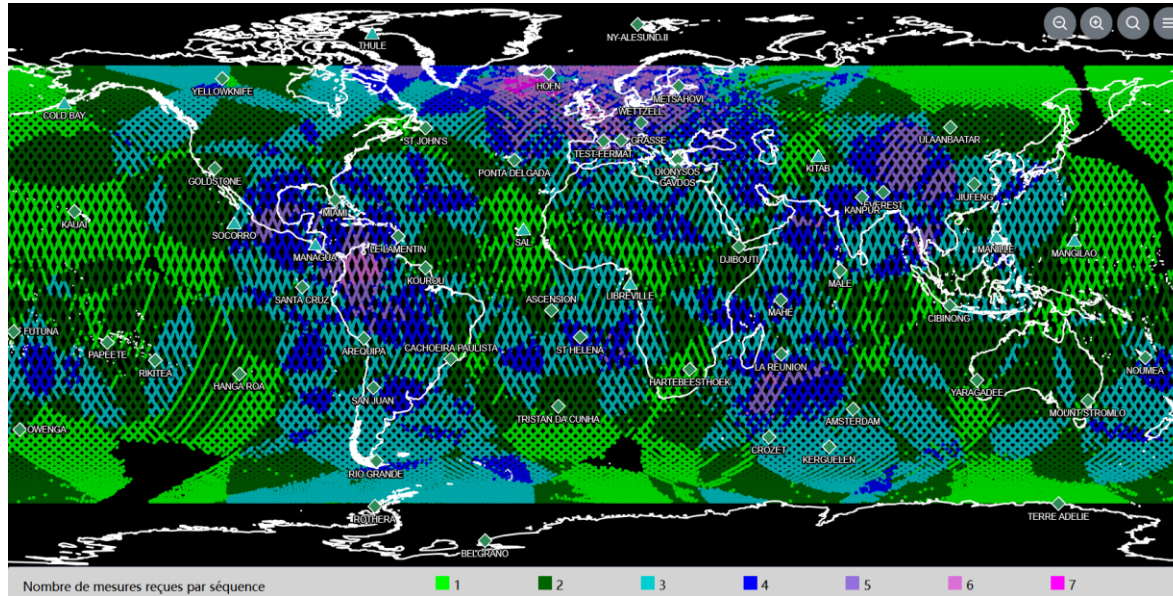
Beacons context

- Wettzell is an IDS beacon, sometimes Off for VLBI operations
- Wettzell, Gavdos and Grasse have the same priority for pass selection
 - ❖ Most important beacons must be considered in priority
 - Master beacons : 250
 - Time frequency beacon : 150
 - All others : 50
- They are in the same over-beaconed area: more risk of jamming between beacons (Doppler collisions)
- They are configured to shift their frequency to limit (but not totally suppress) the jamming at low orbits
 - ❖ Ex Kanpur: k factor = -21, shifted because of proximity to Everest

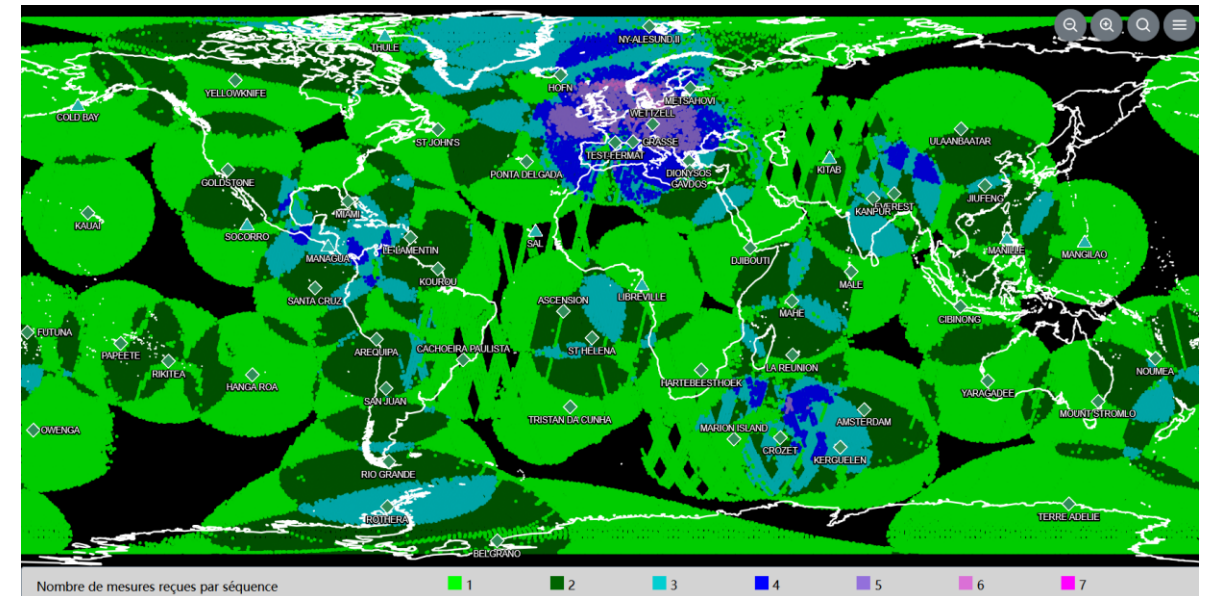


- As all IDS Beacons, they are not programmed on board in DIODE navigator designation mode

DORIS measurements coverage maps



Sentinel 6B



Saral

Co-visibility between beacons increase with altitude

10 beacons in visibility (above 5° elevation) for Jason/Sentinel 6 orbits, **6** for Saral

But only **7 channels** in a DORIS DGXX(S) receiver

A choice must be done for the beacons to be tracked

DORIS beacon designation modes



DORIS Designation modes

Multiple designation modes, each operating with different characteristics

Spectral analysis with criteria for selecting beacons to be tracked
DAS-N/-F/-T (level/ frequency/ random)

DIODE designation

Once DORIS is locked onto a signal, it keeps tracking



DAS-F

In this mode, DORIS instruments select the beacons that offer **the higher frequencies**, based on a spectral analysis of the signals in the Doris frequency bands



DAS-N

In this mode, DORIS instruments select the beacons that offer the **higher reception levels**, based on a spectral analysis of the signals in the Doris frequency bands



DAS-T

In this mode, DORIS instruments select **randomly** the beacons that are present on a spectral analysis of the signals in the Doris frequency bands



DIODE (Navigator)

In this mode, measurements are performed from the beacons selected by DIODE, taking into account criteria in descending order :

- Beacon priority
- Continuity of the Pass on each channel tracking (elevation < 5deg)
- Otherwise lowest beacon number

DORIS receivers' configurations

satellite	Altitude (km)	UT number in DIODE	UT number in DAS-T
Cryosat 2	717	1, 2, 3, 4	5, 6, 7
Saral	800	1, 2, 3, 4, 5	6, 7
Sentinel 3	814	1, 2, 3, 4, 5	6, 7
SWOT	890	1, 2, 3, 4, 5	6, 7
HY-2C	957		1, 2, 3, 4, 5, 6, 7
HY-2D	971		1, 2, 3, 4, 5, 6, 7
Jason, Sentinel 6	1336	1, 2, 3, 4, 5, 6	7
Genesis (TBC)	6000	1, 2, 3, 4, 5, 6, 7	

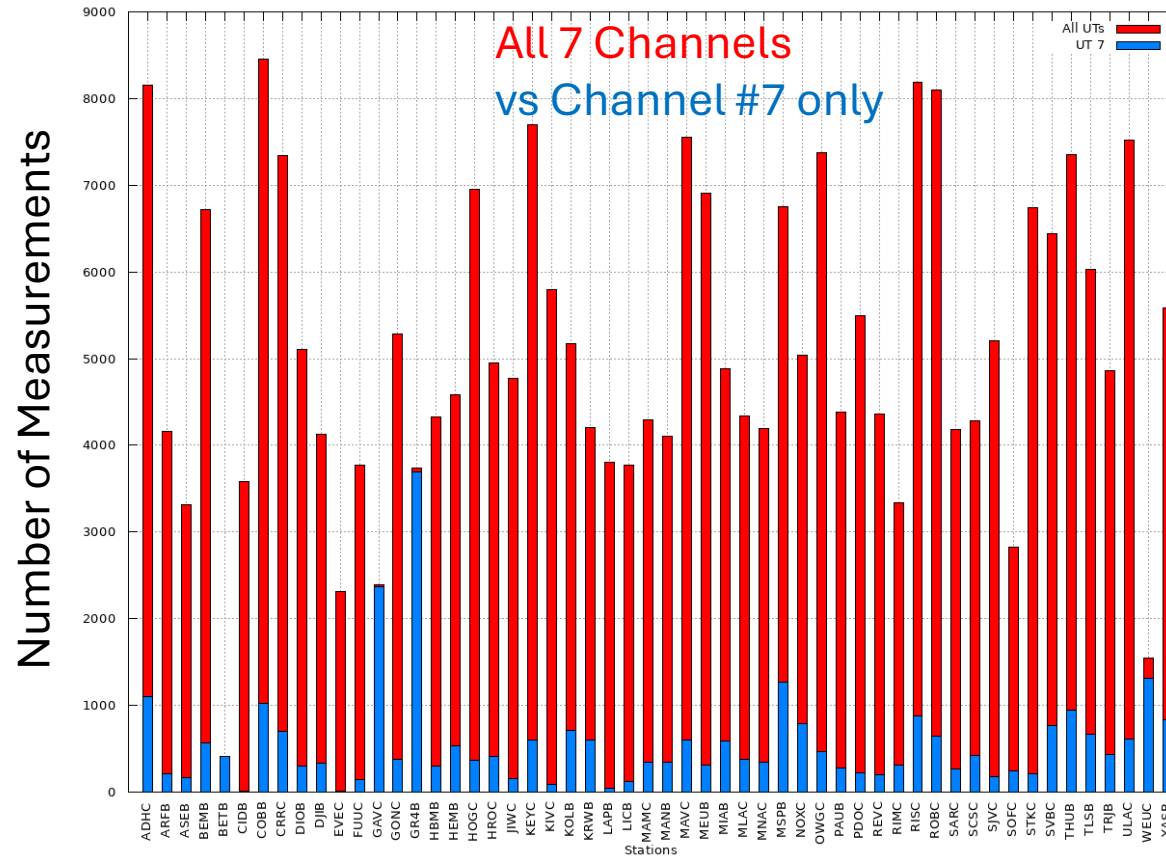
**UT Unit of Treatment
= Channel**

DIODE function is not onboard HY-2C, HY-2D missions

Designation modes can be modified during lifetime of the mission if necessary (memory upload)

Gavdos, Wettzell and Grasse acquisition

Gavdos, Wettzell and Grasse are not programmed on-board $\Rightarrow$ not known so cannot be designated by DIODE



Satellite: Jason-3

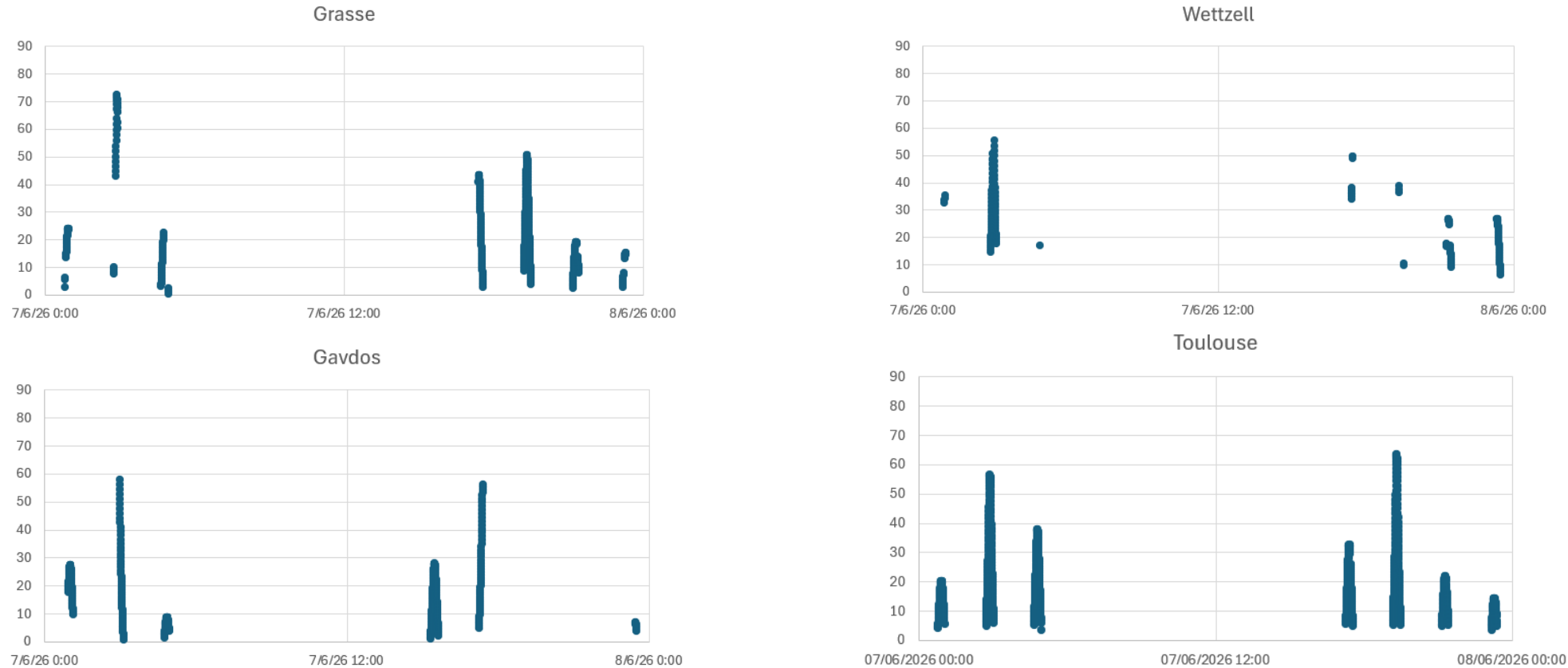
1 Cycle Time Period: 2025/09/01-2025/09/10

Gavdos, Grasse and Wettzell stations are almost exclusively received on UT 7 in DAS-T

They are received if UT 7 is free, and randomly with other visible beacons not already assigned to a UT

By courtesy of G Moreaux

Gavdos, Wettzell and Grasse Passes 1/2

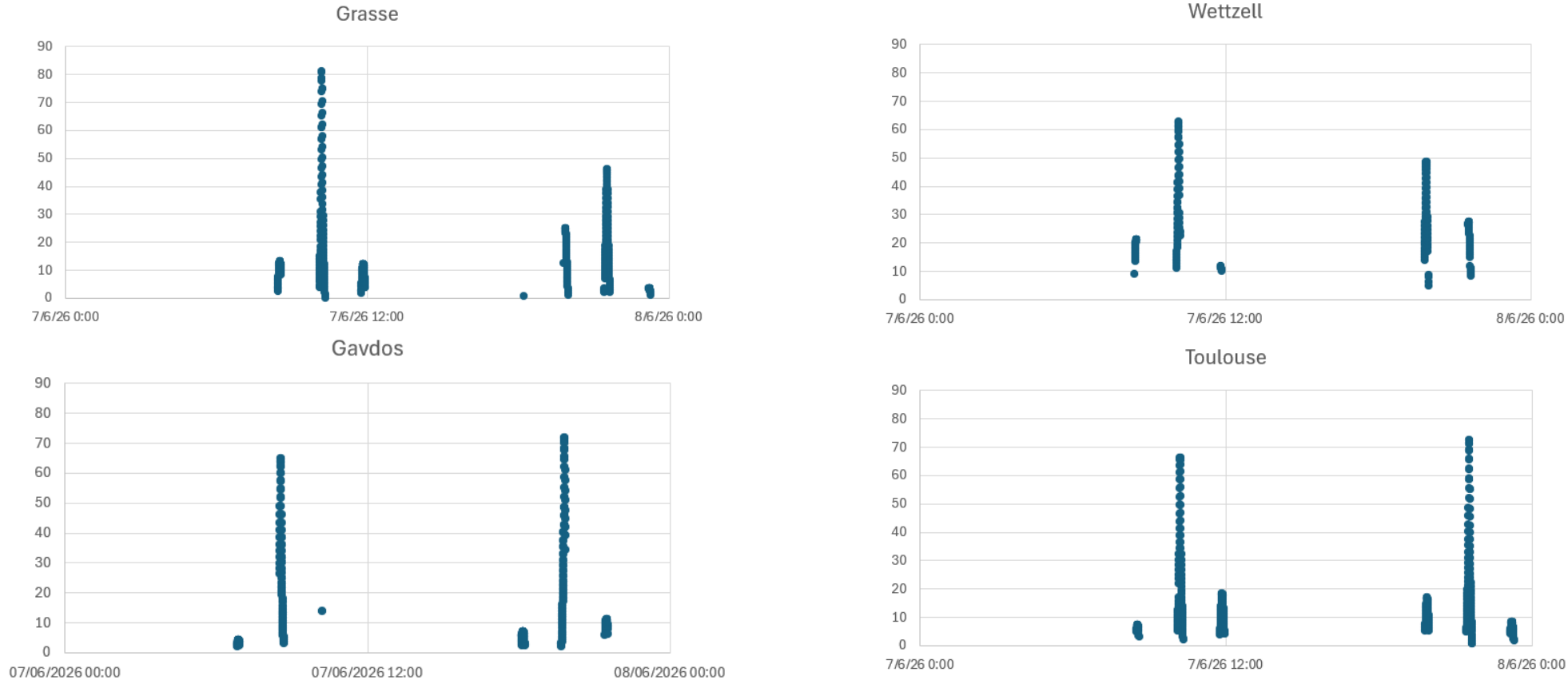


Elevation (deg) of measurements received on-board Jason-3 for 7 June 2026

Compared to Toulouse: less, shorter, discontinuous and asymmetric passes

Due to the satellite-network geometry, on a full Cycle Grasse is received more often than Gavdos and Wettzell

Gavdos, Wettzell and Grasse Passes 2/2



Elevation (deg) of measurements received on-board Sentinel-3A for 7 June 2026

Compared to Jason-3: 2 UT available in DAS-T mode

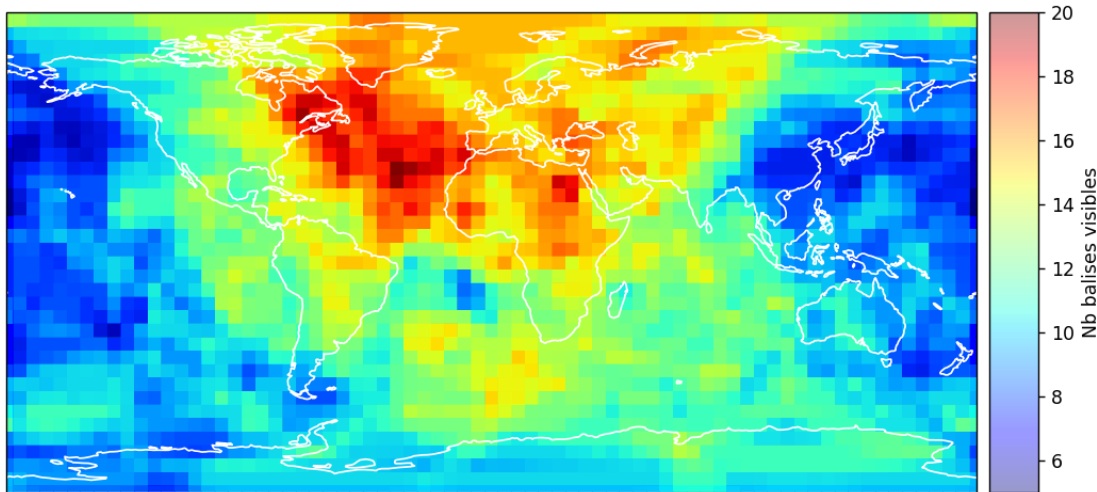
⇒ increased chances of receiving these 3 beacons

Genesis case 1/2

*An ESA mission - Contract was carried out under a programme of and funded by the European Space Agency

IDS Workshop

Genesis mission: altitude 6000km, inclination 95.5°



Up to 20 beacons will be in co-visibility (above 5°).

- More beacons within a smaller cone of visibility than on LEO orbits
- Increased number of Doppler collisions

DORIS DGXX-S receiver with 7 UT

The designation mode will be crucial to offer the best measurements

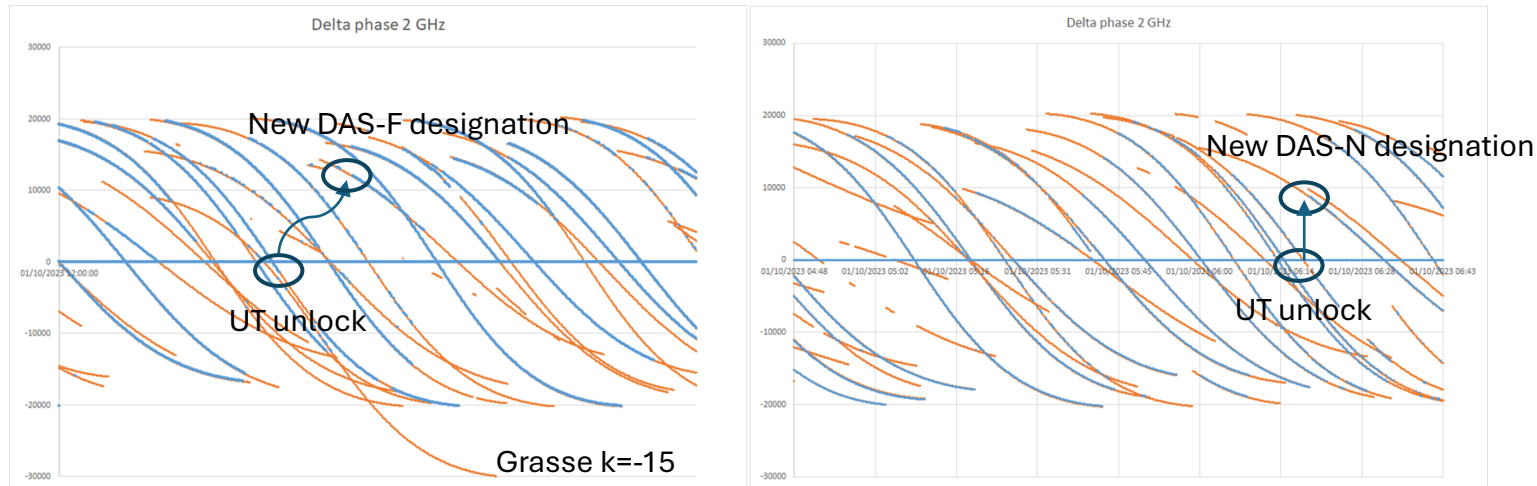
But what is the best for the users: duration of the passes, low elevation measurements for tropospheric estimation, continuity, high C/N0, measurements on all beacons or a sub-network, ...?

Genesis case 2/2

*An ESA mission - Contract was carried out under a programme of and funded by the European Space Agency

IDS Workshop

Simulation of 2GHz Doppler measurements and tests at the DORIS lab (duration ~2 Hours)



DAS-F gives priority to higher frequency signals (beginning of passes but lower C/N0). If a UT unlocks, it may relock on a new beacon. Beacons with negative frequency shift might be not tracked.

DAS-N gives priority to high-power signals. If a UT unlocks, it may relock on a new beacon (asymmetric pass, beginning of the pass might be lost).

DIODE designation may consider a sub-network in priority, but other beacons might never be tracked. If a UT unlocks, it will relock on the same beacon if not jammed (best continuity, when no highest priority beacon appears in visibility).

In any mode, in MEO lower power degrades measurements at low elevation and Doppler collisions may affect the continuity

DIODE Navigator designation is foreseen for pass continuity but must be adapted to optimize measurements on 7 channels vs localization Users' needs

DORIS receivers have 4 beacon selection modes

- ❖ DAS-F: spectral analysis based on the higher frequency received
- ❖ DAS-N: spectral analysis based on the higher power level received
- ❖ DAS-T: spectral analysis with random choice between the signals received
- ❖ DIODE Navigator designation for the longest possible duration considering the beacons' priorities
- ❖ Selection modes are configured for each channel and can be modified on-board

Selection modes have an impact on the measurement availability, and then on the positioning accuracy and residuals

- ❖ Number of measurements, symmetry and continuity of passes are key parameters
- ❖ Tests with DORIS Hardware Bench for GENESIS orbit, are in progress for different configurations

What choices should we prioritize for the Genesis mission?

- ❖ Best power level, but with loss of measurements at low elevations?
- ❖ Users' needs are awaited to adapt DIODE designation
- ❖ These needs can be expressed to the Genesis WG 4 (DORIS): G. Moreaux or O. Dumond