GNSS data assimilation at Météo-France
Recent changes

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Outline

- Information from DSO/DOA (Upper-air Observation Department)
- GNSS in the operational models
- GNSS variational bias correction
- Ongoing and further work

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Delayed installation of GNSS Station

- **Delayed installation because of late in new ship delivery.**
- **Fort St Charles (UXK5JTU/ASFR1) :**

– Available since july 2019

– GNSS station installation getting start at the beginning of 2020

– Atlantic road

Trimble GNSS antenna

This GNSS antenna will be installed on board the ship (Fort St Charles) to calculate the ZTD with a kinematic PPP trajectography calculation.

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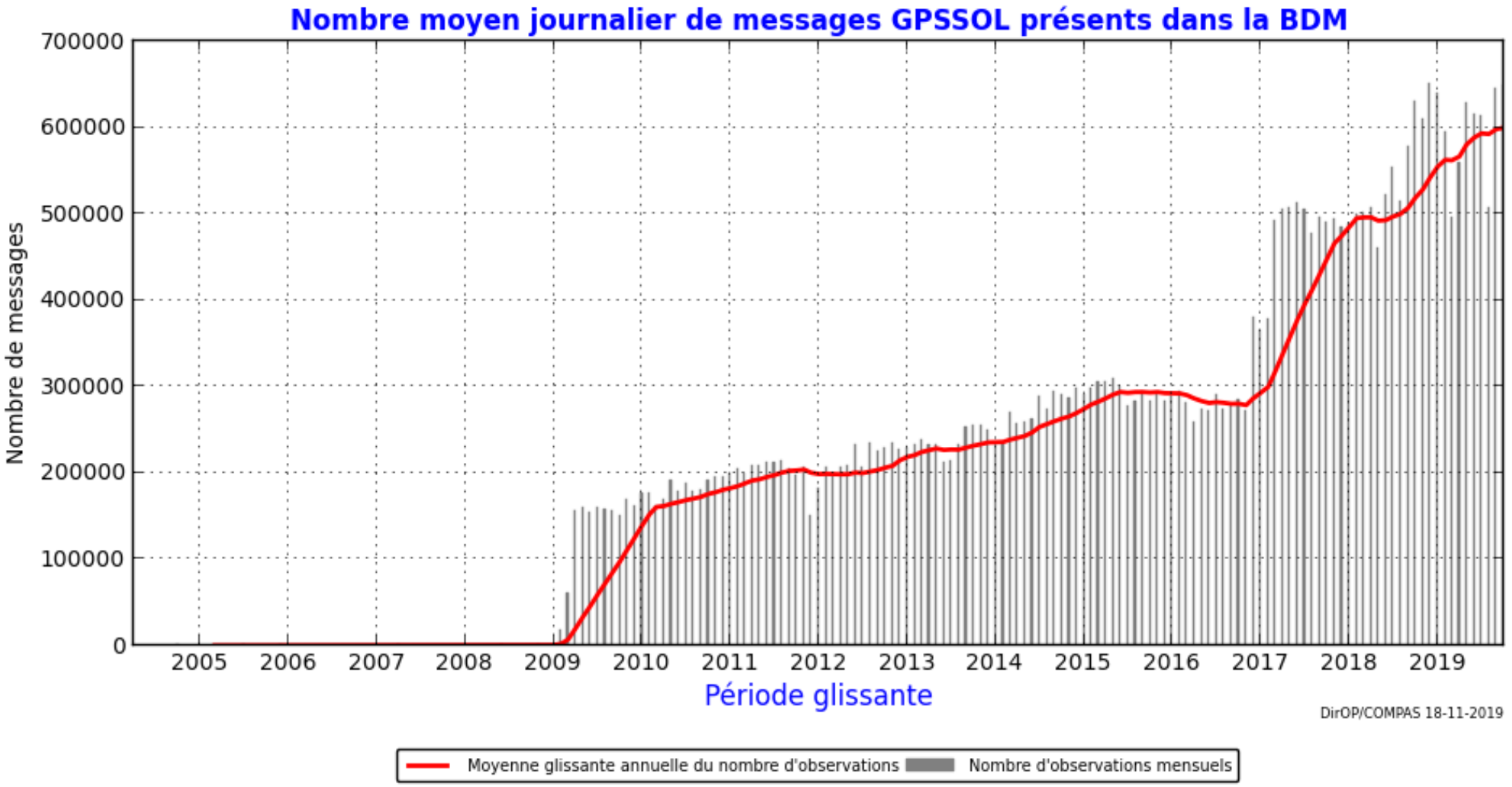
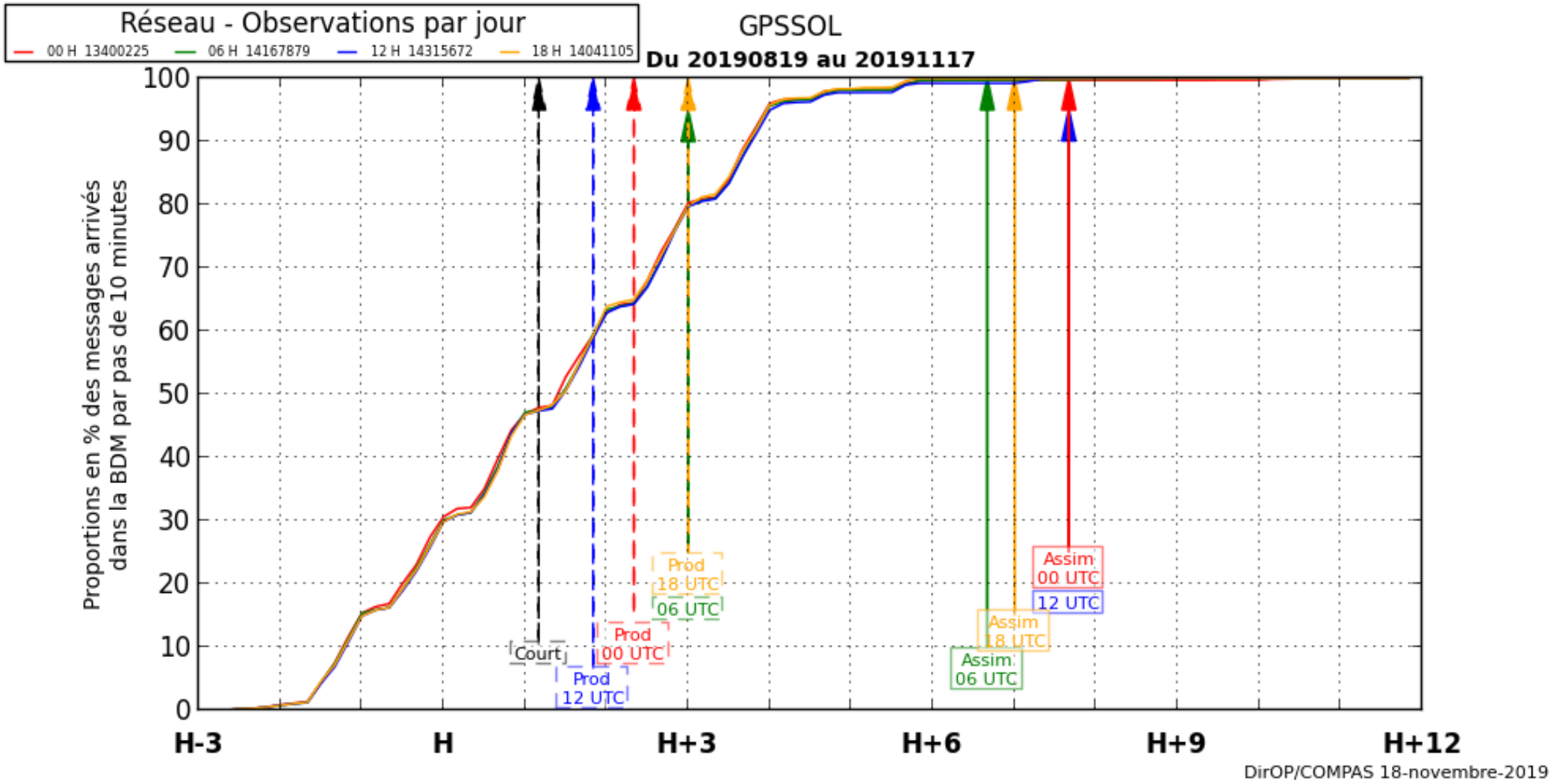
GNSS in the operational models

- 2005-2006 : First experiments to evaluate the impact of ZTD GNSS data in the global model ARPEGE (Poli et al., 2007; JGR)
- First implementation in the operational models : ARPEGE, ALADIN (in 2006) and in AROME (in 2008) using a white list approach
- After several experiments, a significant extension of the white list for AROME was put in operations in September 2011
- September 2012 : Operational suite with an extended white list and a dynamic selection of the observations during the assimilation.
- September 2017 : Modification of the geographical thinning
- Mid 2019 : Operational variational bias correction in ARPEGE & AROME

GNSS in the operational models



GNSS in the operational models



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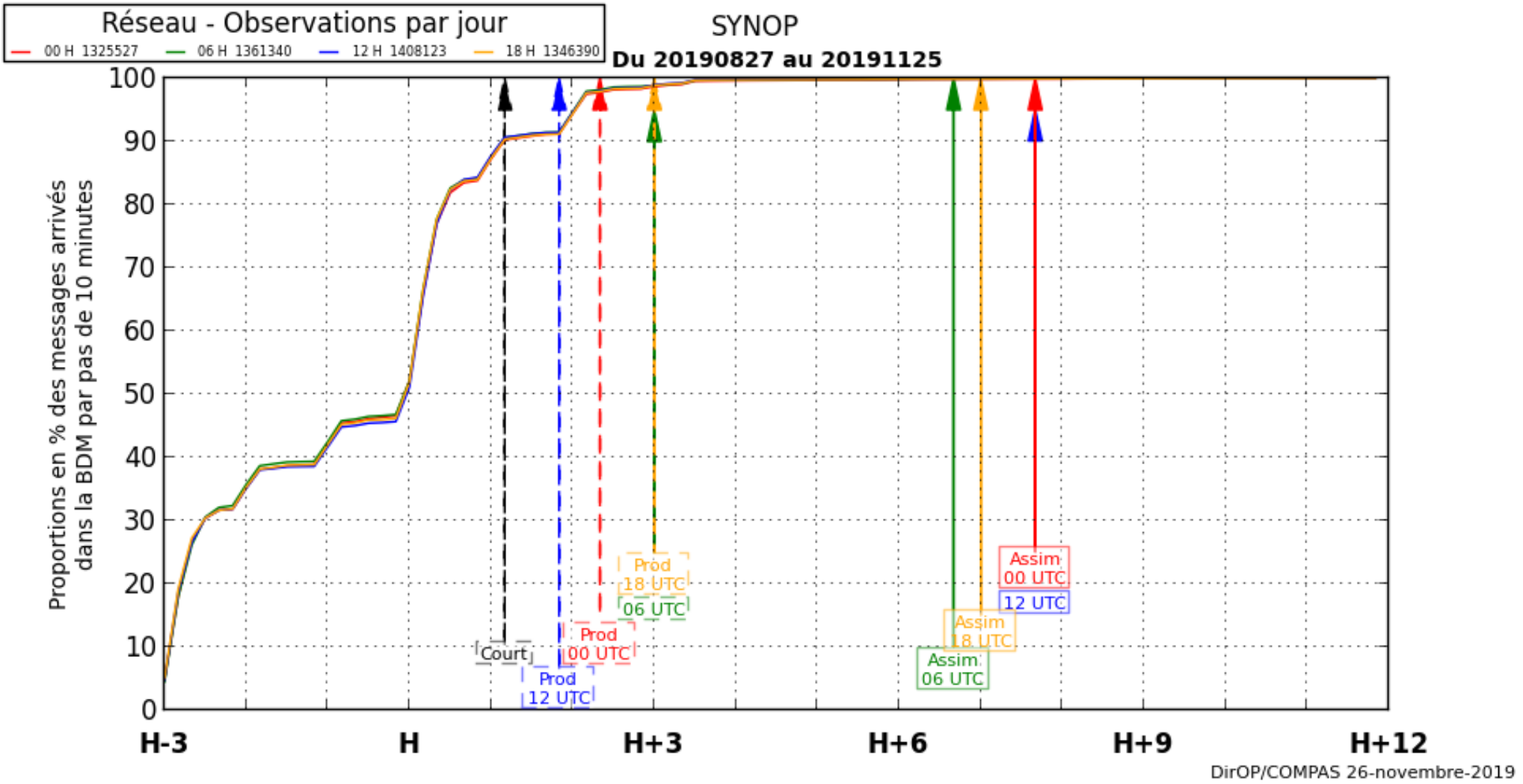

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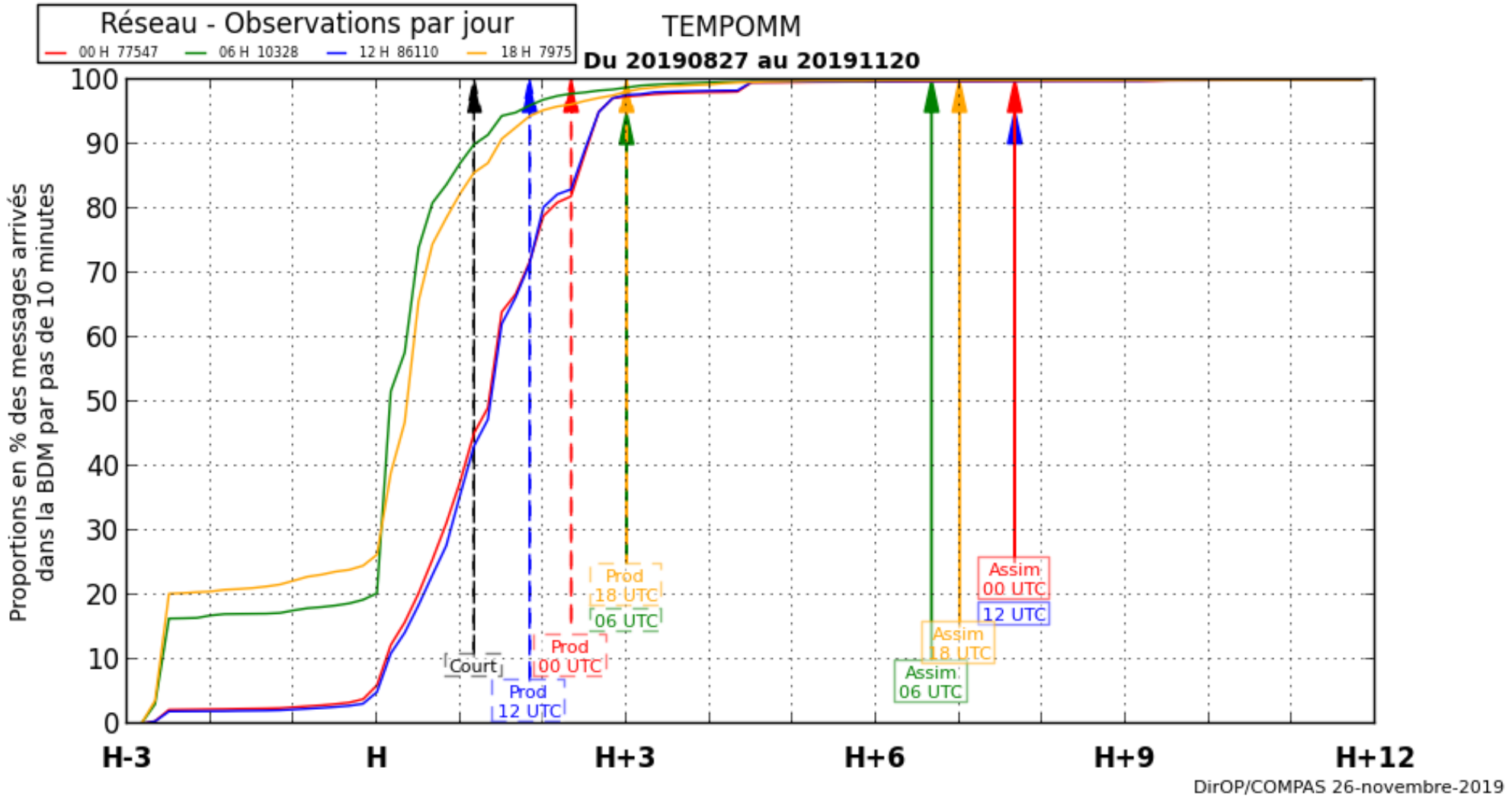

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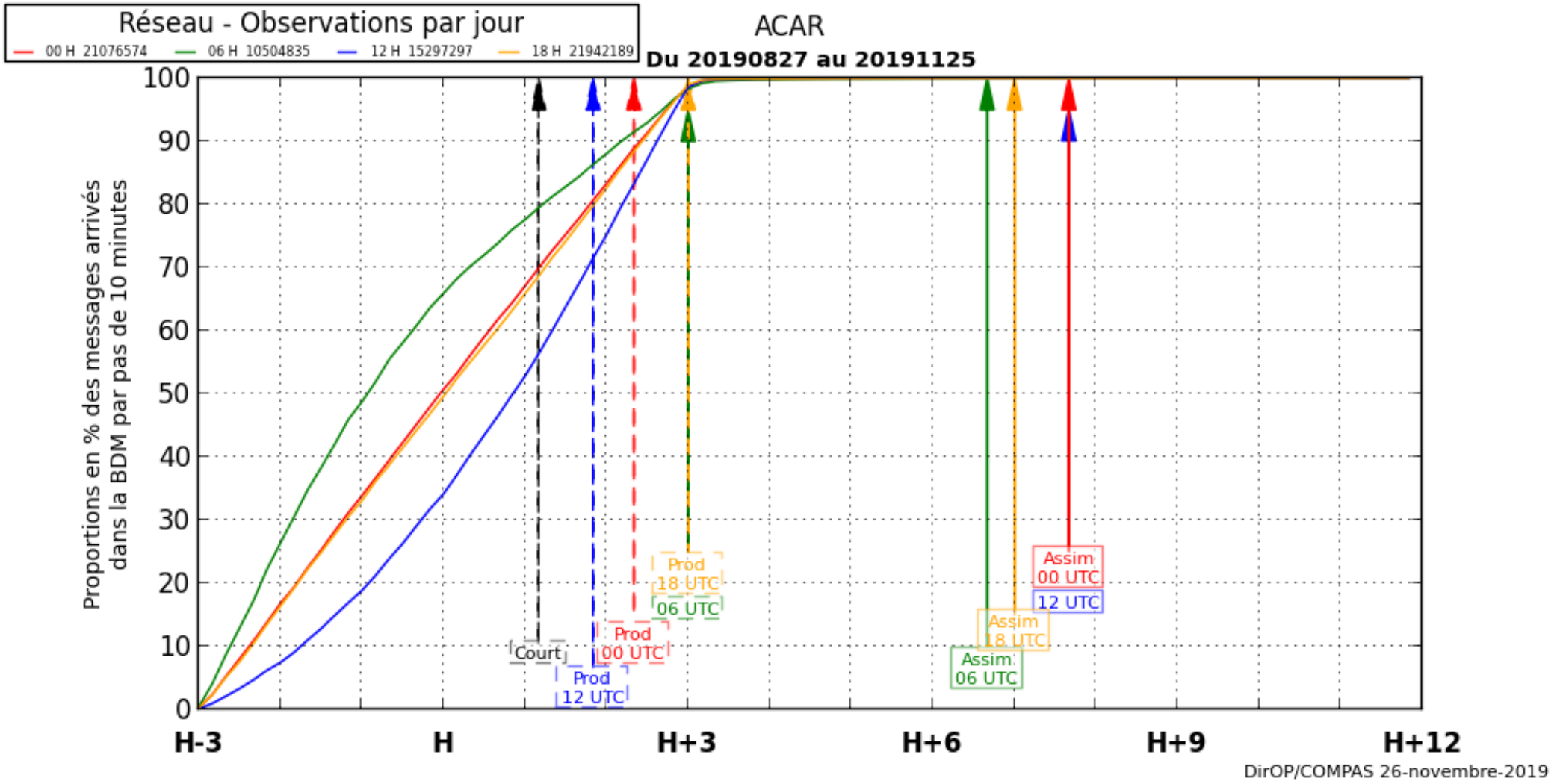

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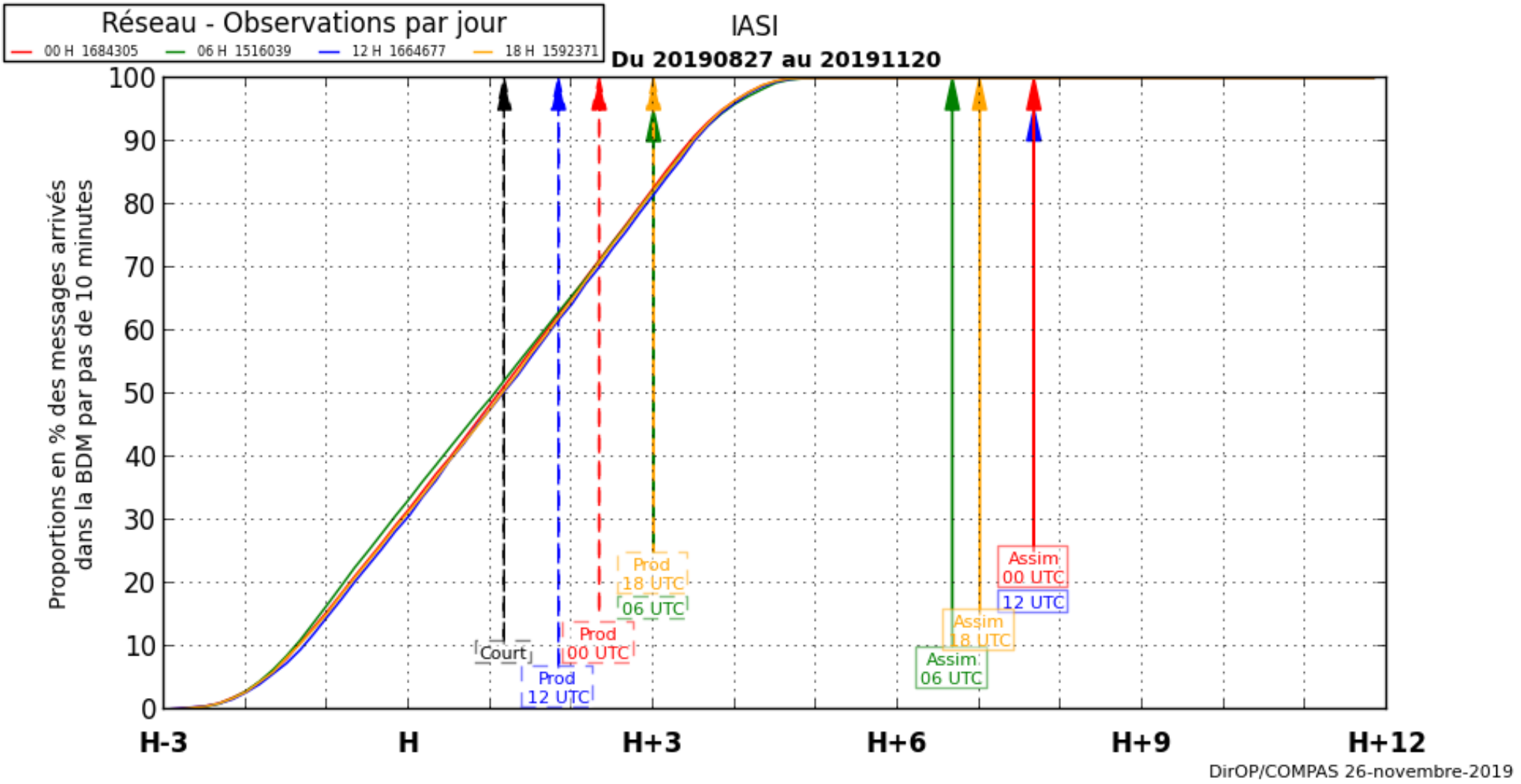

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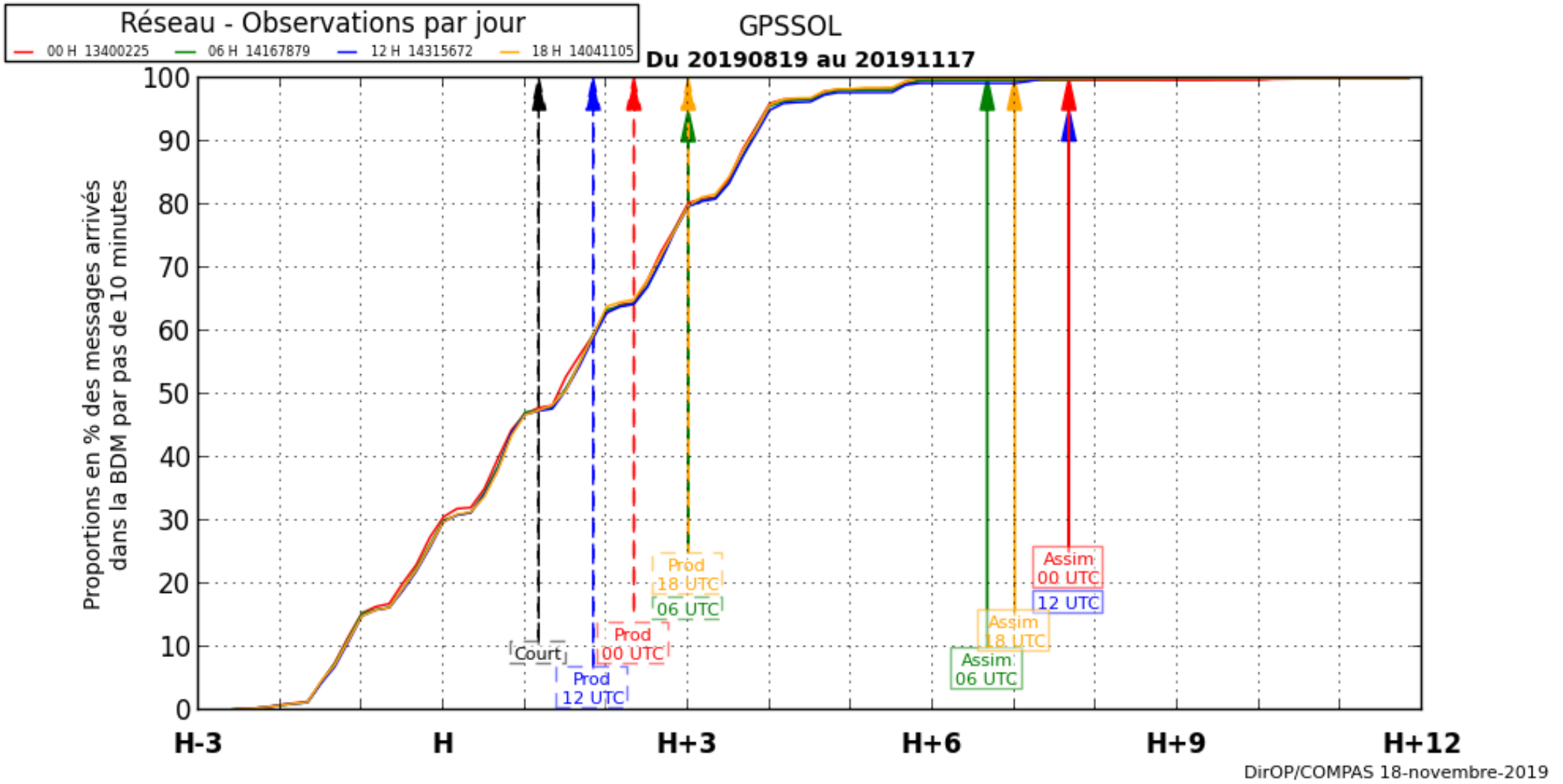

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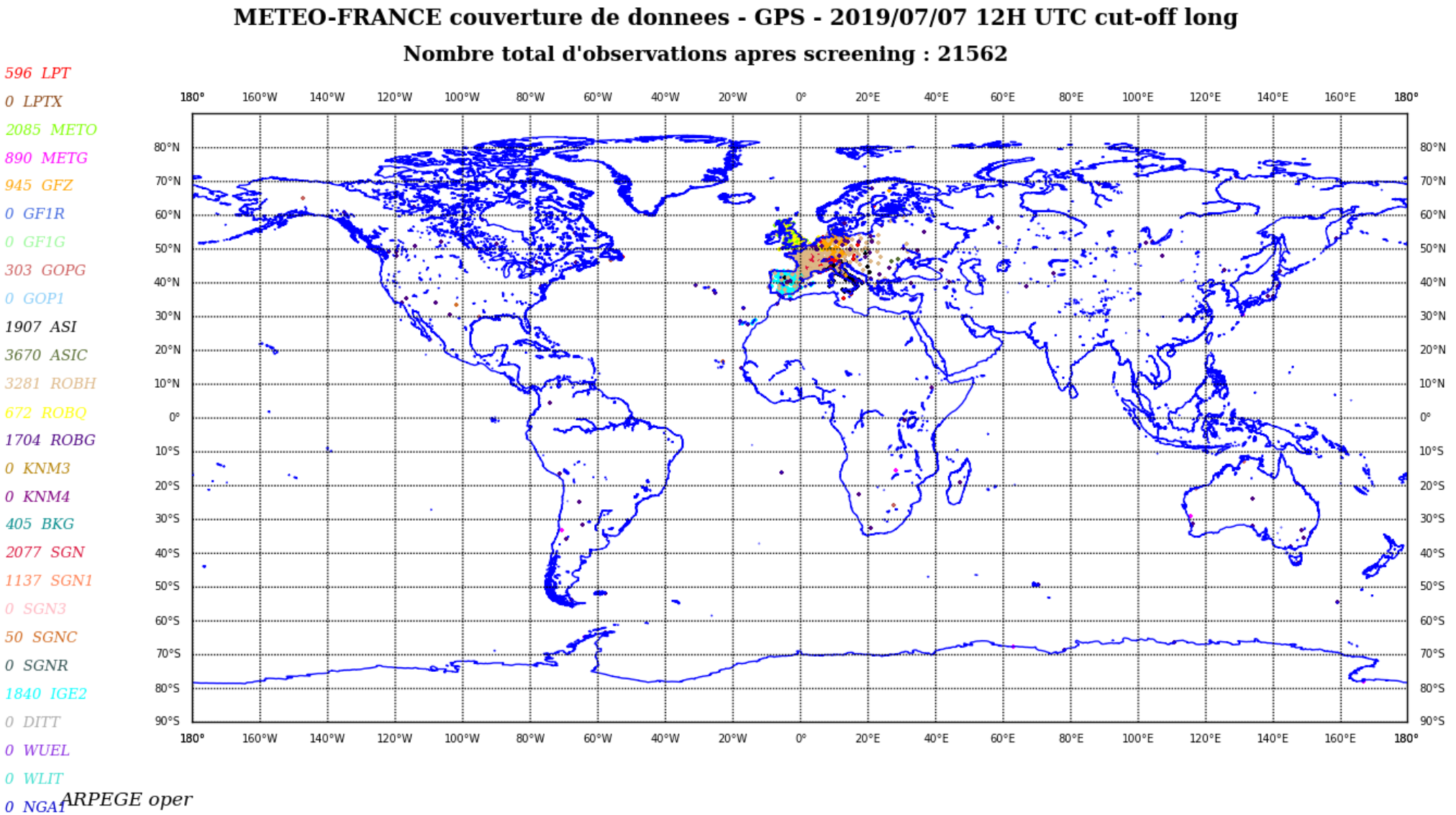

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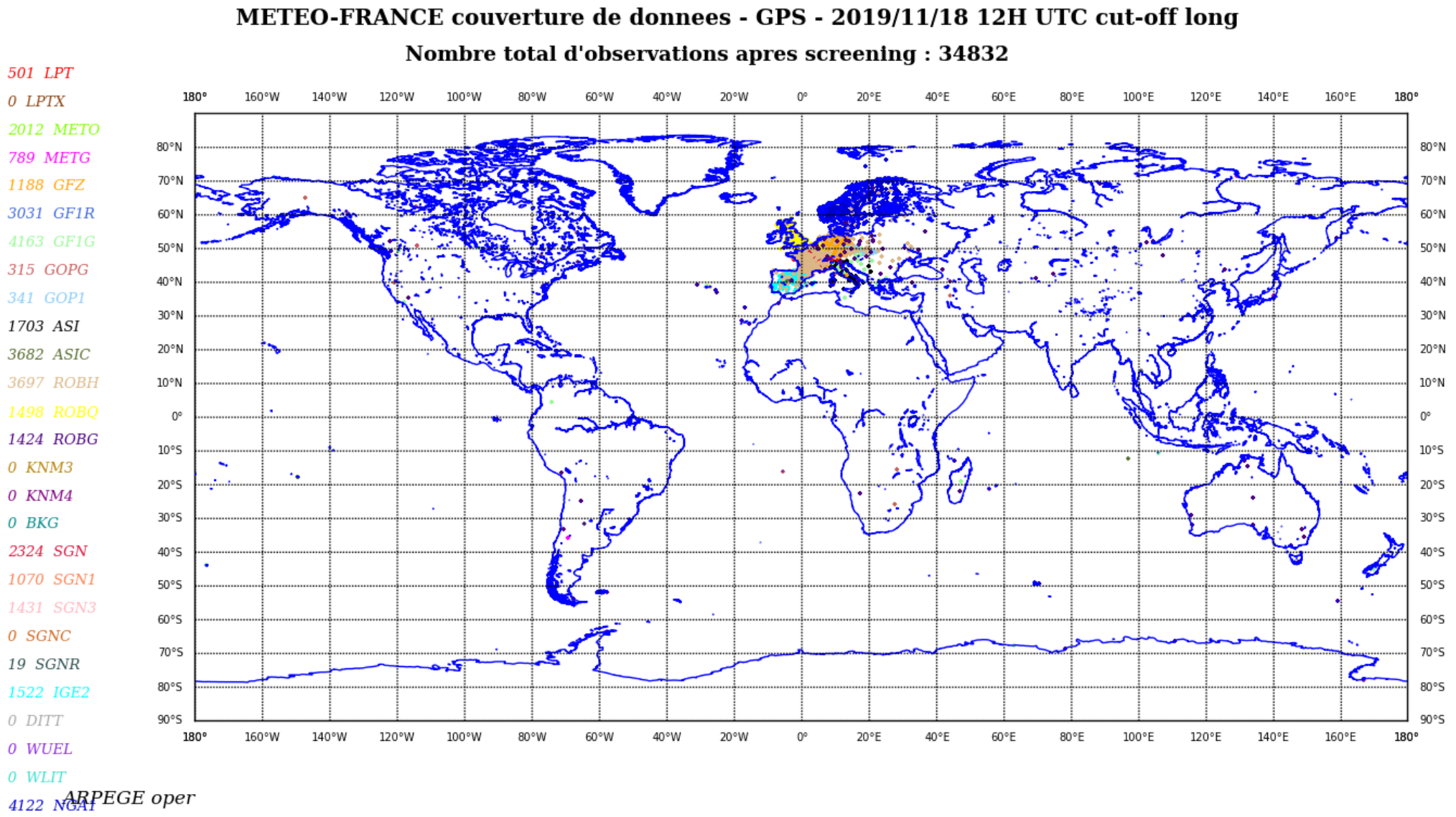

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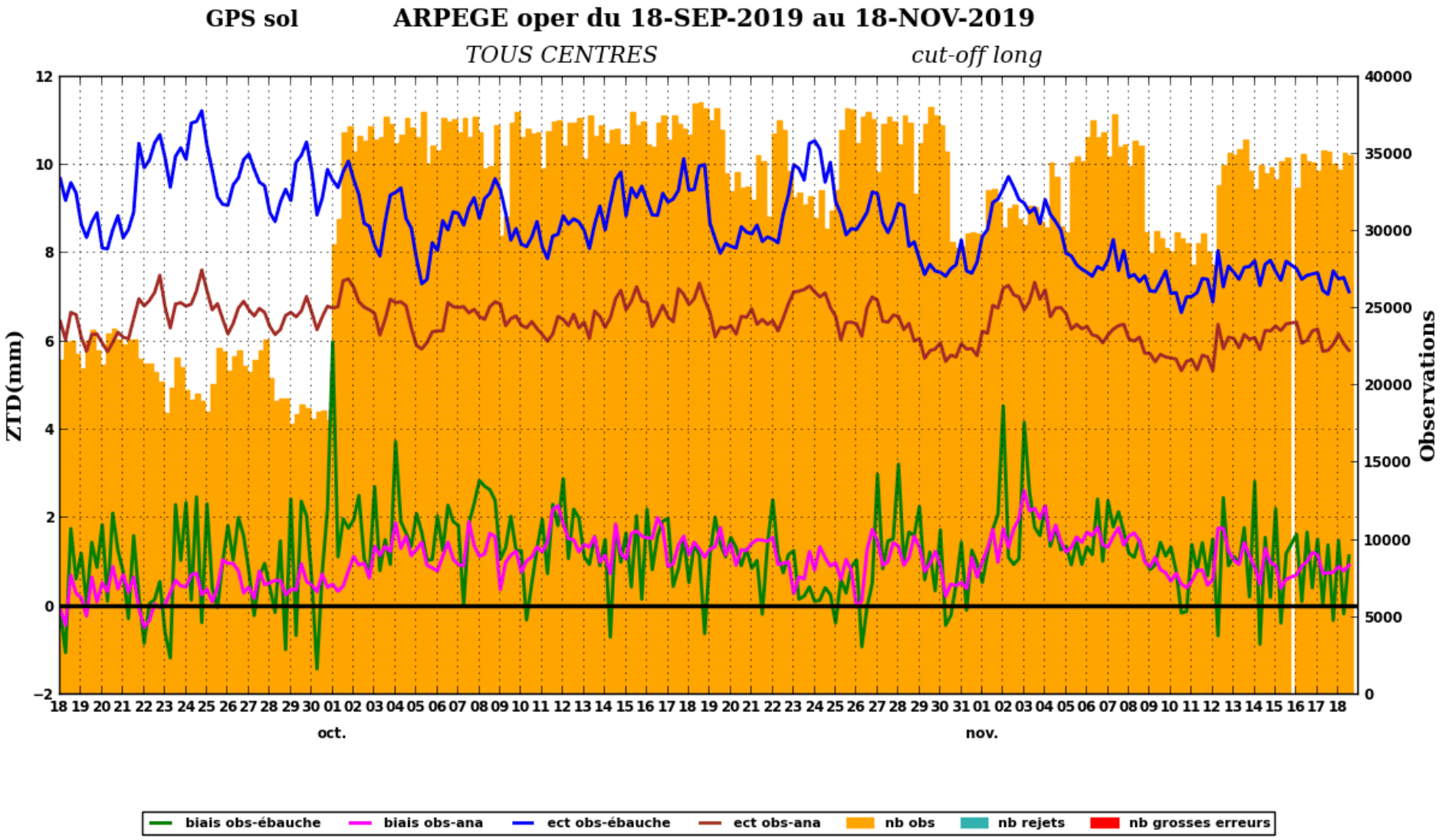
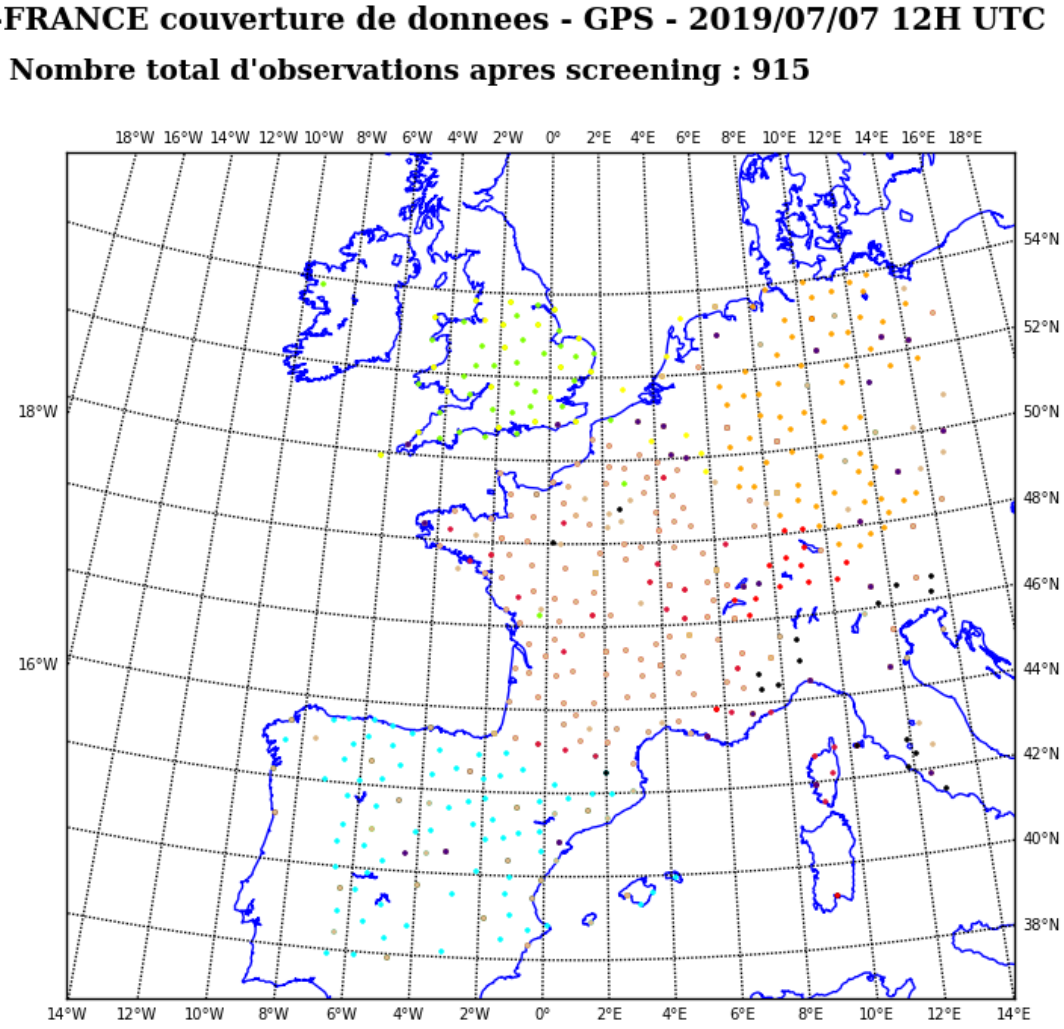


GNSS in the operational models

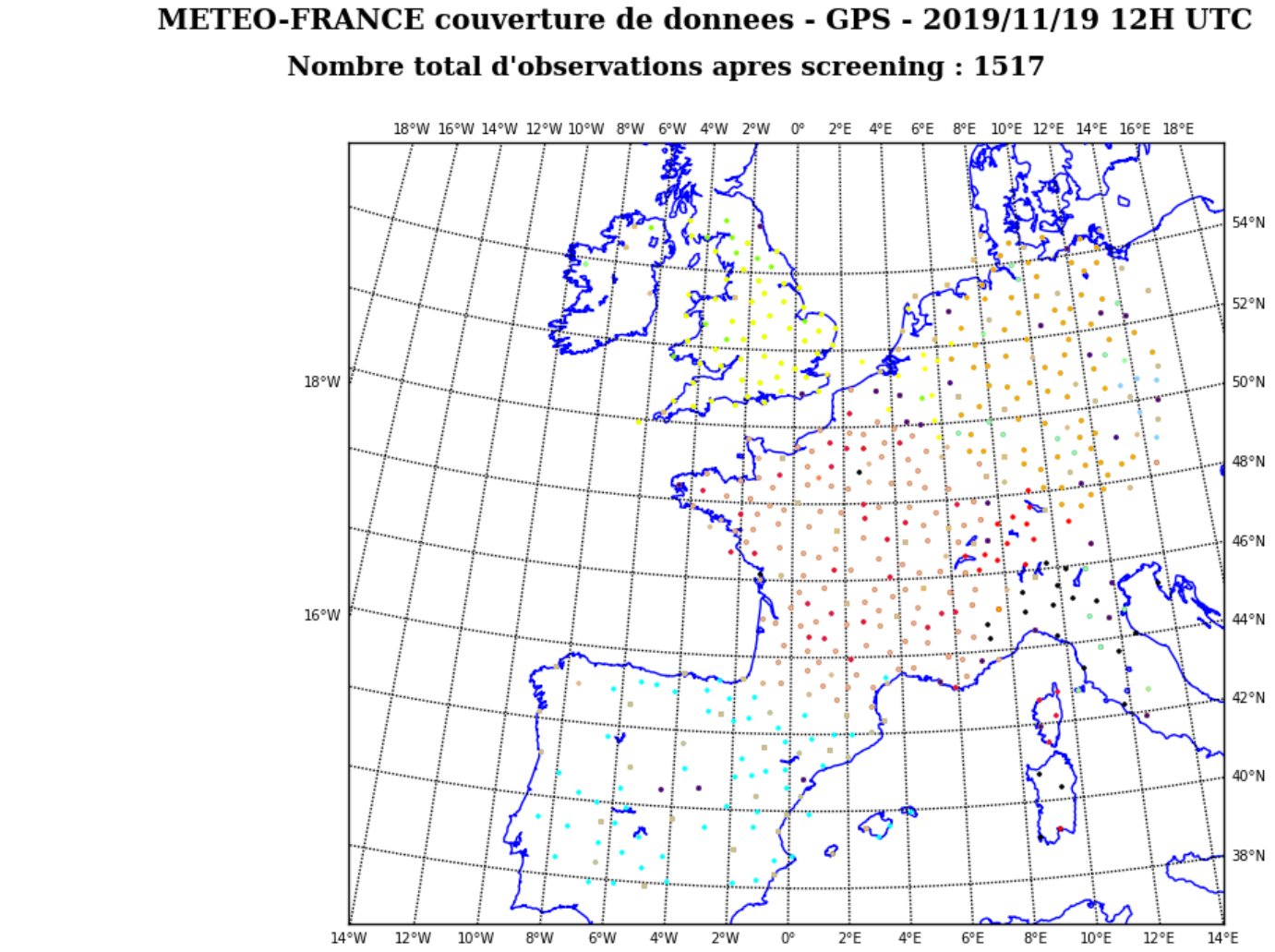
63 LPT
0 LPTX
90 METO
2 METG
67 GFZ
0 GF1R
0 GF1G
5 GOPG
0 GOP1
65 ASI
0 ASIC
198 ROBH
40 ROBQ
27 ROBG
0 KNM3
0 KNM4
33 BKG
143 SGN
71 SGN1
0 SGN3
0 SGNC
0 SGNR
111 IGE2
0 DITT
0 WUEL
0 WLIT
0 NGA1



AROME France oper

GNSS in the operational models

67 LPT
0 LPTX
121 METO
2 METG
79 GFZ
152 GF1R
175 GF1G
3 GOPG
18 GOP1
69 ASI
0 ASIC
221 ROBH
91 ROBQ
30 ROBG
0 KNM3
0 KNM4
0 BKG
188 SGN
92 SGN1
103 SGN3
0 SGNC
0 SGNR
102 IGE2
0 DITT
0 WUEL
0 WLIT
4 NGA1



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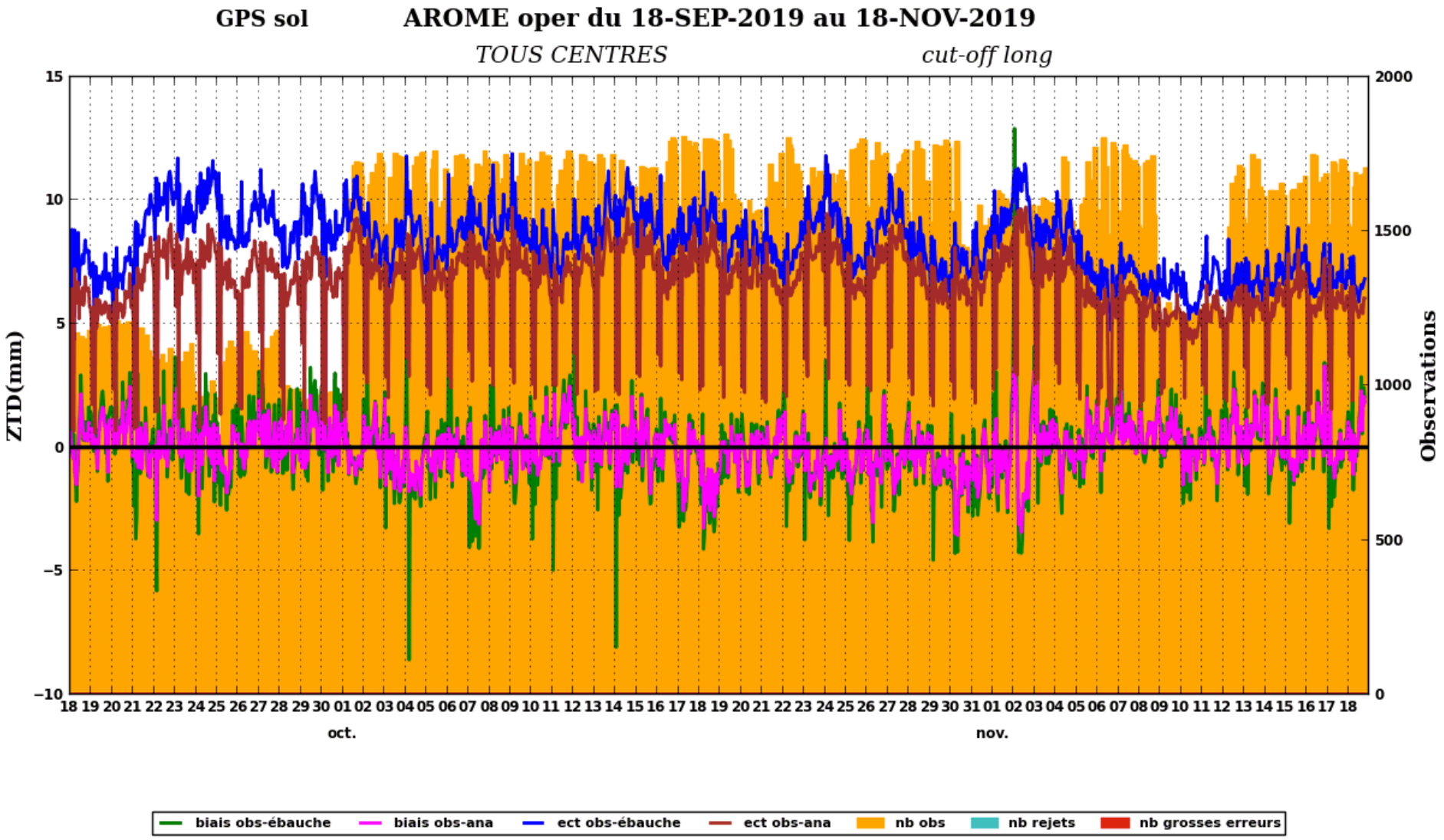

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Variational bias correction

The bias is computed following the scheme introduced in Harris and Kelly, 2001. It can be expressed as a linear combination of bias predictors (such as the TCWV, the thickness of given atmospheric layers, ...). For a given observation, the estimated bias can be expressed as follows :

$$b(x,\beta) = \sum_{j=1}^{N} \beta_j p_j(x)$$

where $p_j(x)$ are the N bias predictors and ß$_j$ the N bias prediction coefficients.

An augmented control vector that includes bias prediction coefficients can be defined : $z^T = [x^T \beta^T]$

The error covariance matrix of z is defined as : $Z = < \tilde{e}^b (\tilde{e}^b)^T > \text{where } z^b = z^t + \tilde{e}^b$

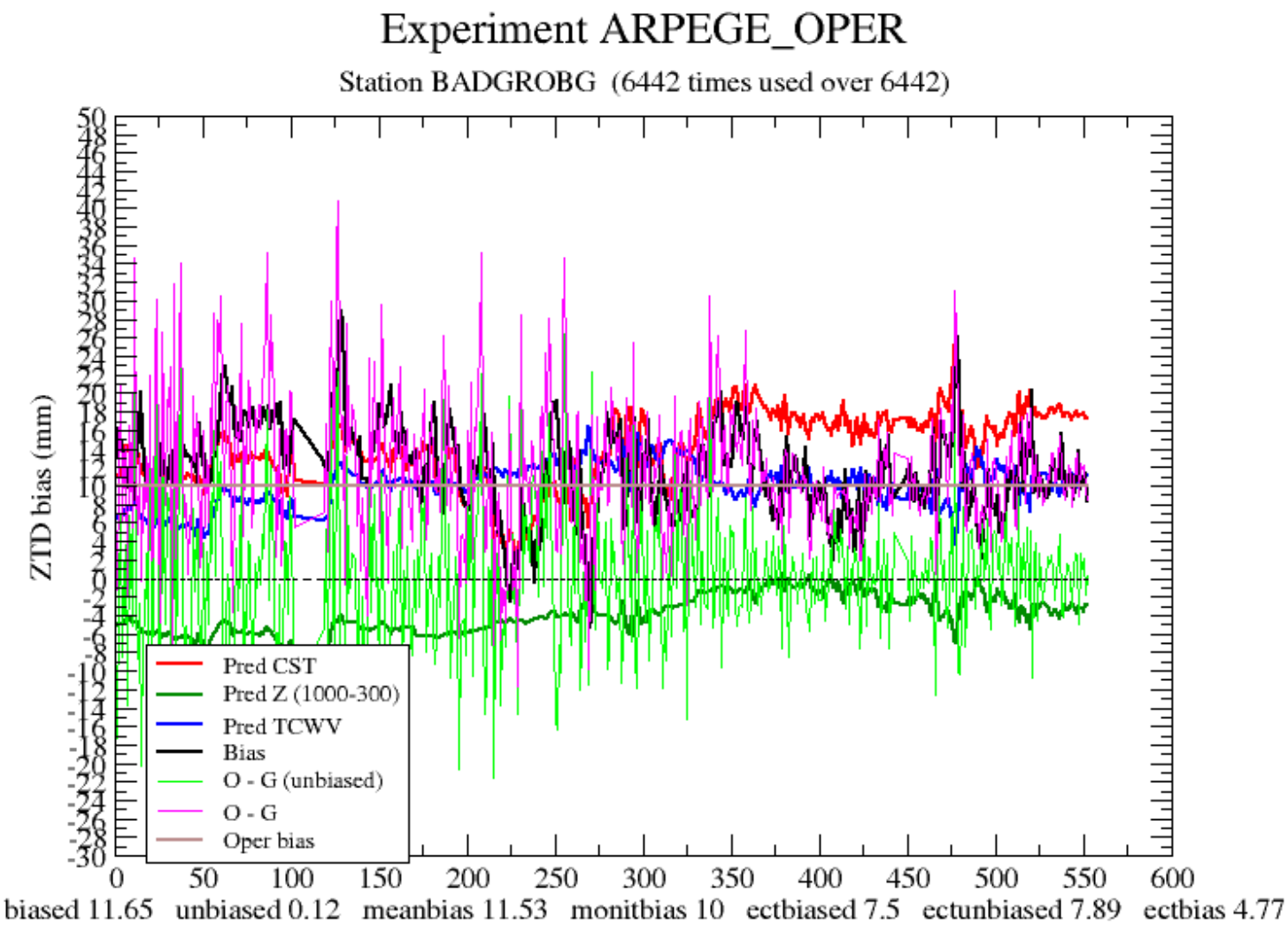
It is currently assumed that parameter estimations errors and state estimation errors are not correlated, which leads to :

$$Z = \begin{bmatrix} B_x & 0 \\ 0 & B_\beta \end{bmatrix}$$

The extended observation operator that accounts for the bias is defined as follows :

$$\tilde{H}(z) = H(x) + b(x,\beta) = H(x) + \sum_{j=1}^{N} \beta_j p_j(x)$$

Variational bias correction



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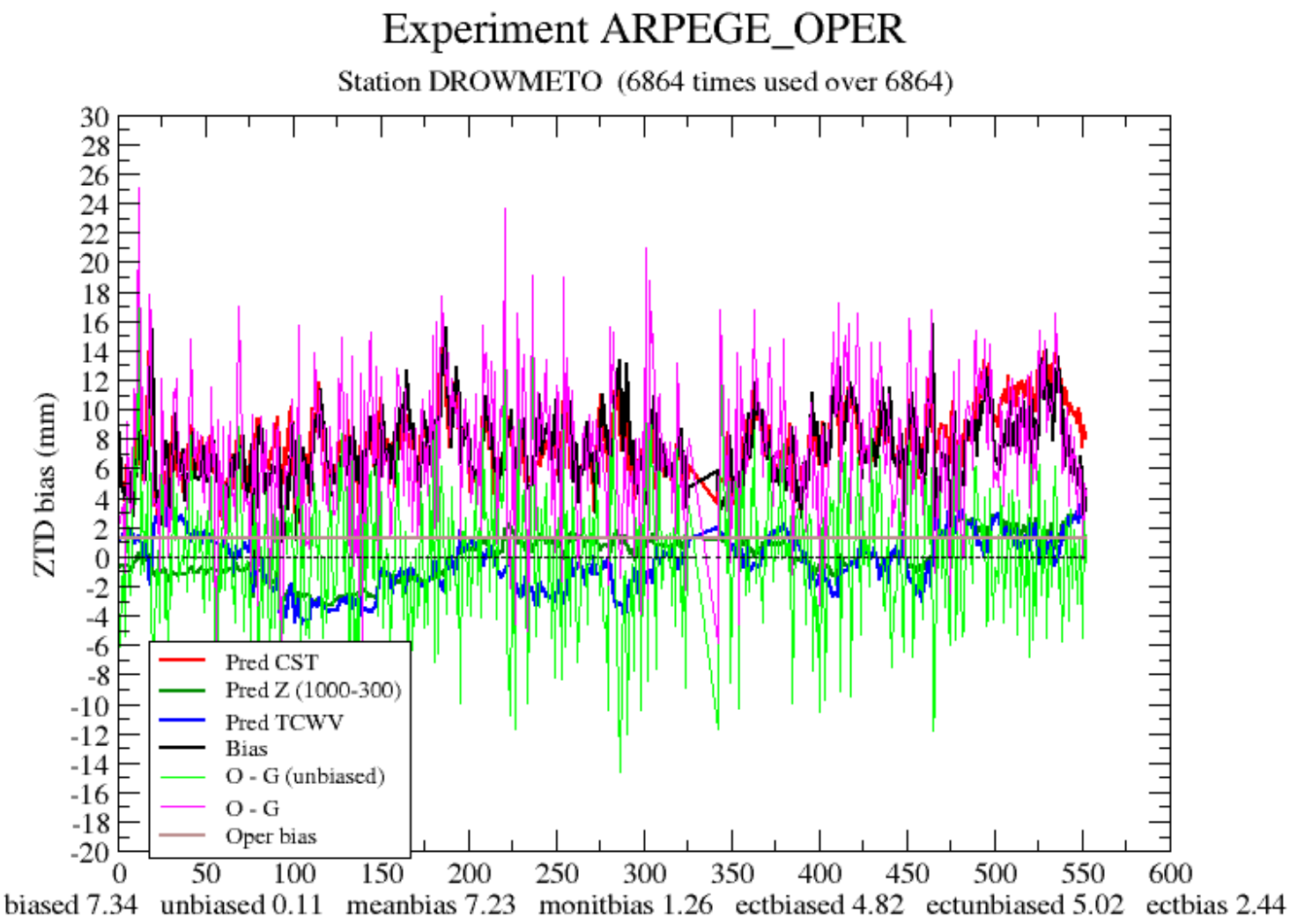
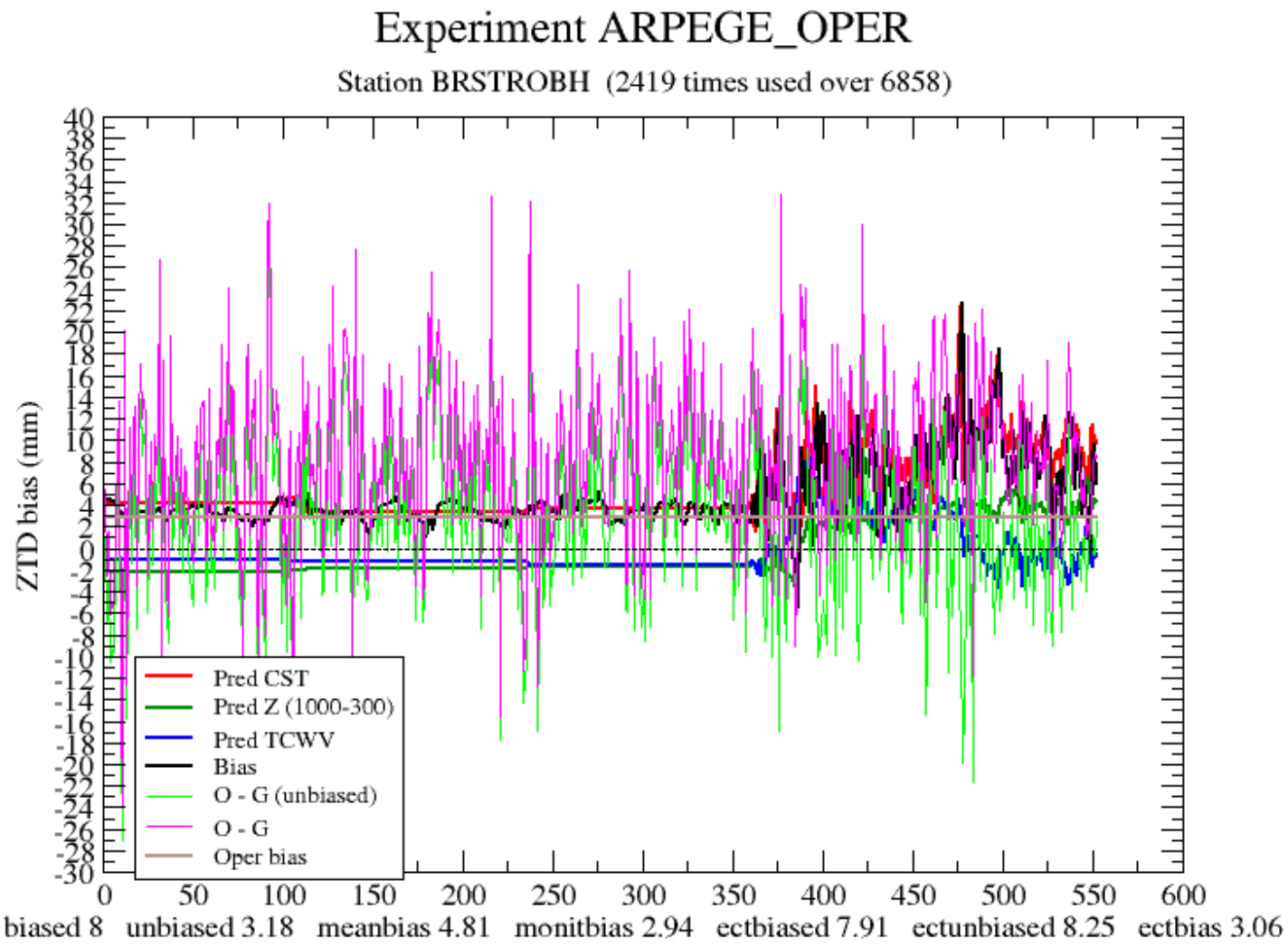


Variational bias correction



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GNSS uning

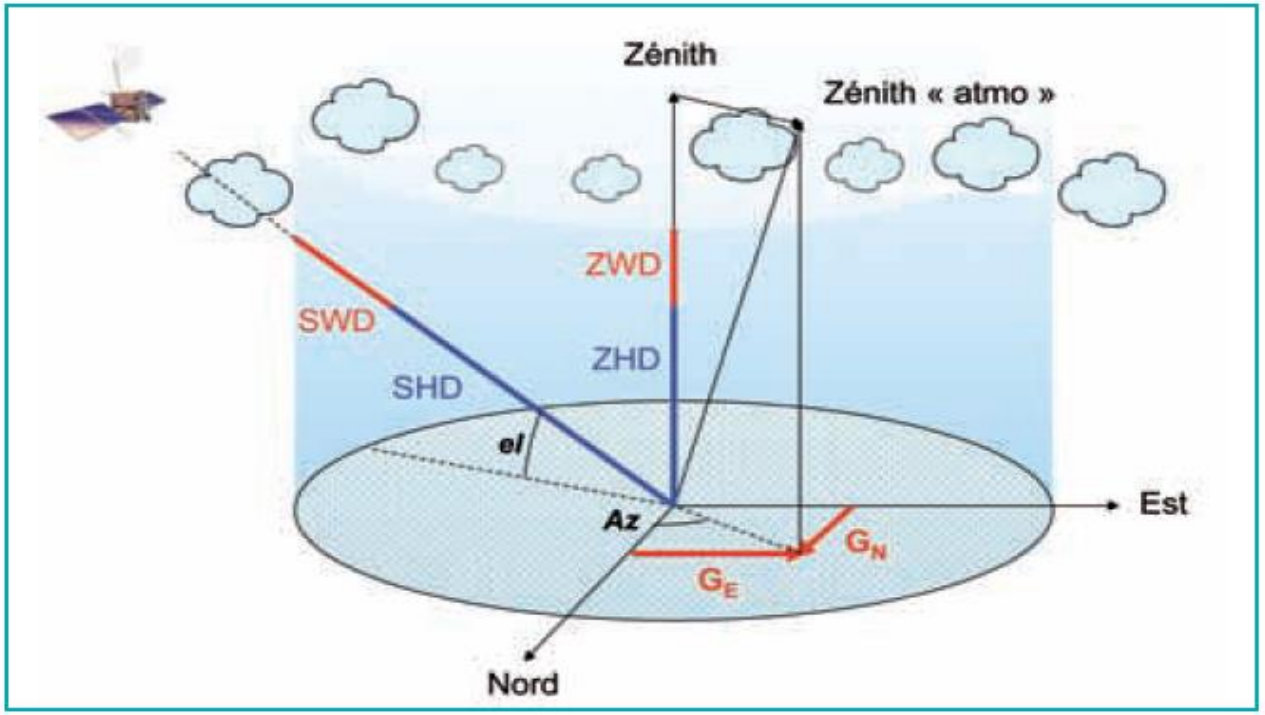
Operational options :

- Reduction of the rejection threshold : 2.5 sigma(O-G)
- Minimum value of the sigmaO : 6 mm
- Minimum interdistance between stations : 40 km
- Irregular update of the whitelist

Studied options :

- Evaluation of the obs errors with the Desroziers method
- Retune the rejection threshold according to the new obs errors
- Decrease of the minimum interdistance between stations in Arome
- Automation of the whitelist update

Horizontal tropospheric gradients



$$G_N = 10^{-6} \int_0^{\infty} z \left[\frac{\partial N(z)}{\partial y}\right] dz$$

North-South tropospheric gradient

$$G_E = 10^{-6} \int_0^{\infty} z \left[\frac{\partial N(z)}{\partial x}\right] dz$$

East-West tropospheric gradient

Horizontal tropospheric gradients

Plans

- ❑ Validate the tangent linear and the adjoint (done)
- ❑ Tune the direct observation operator (almost done)
- ❑ Data assimilation experiments
- ❑ Operational implementation when gradients are available

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Thanks for your attention