Examples of recurrent performance analysis of DORIS stations

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Summary

- Motivation of the analysis
- Methodology
- 3 examples of analysis
  - Wettzell
  - Managua
  - Kitab
- Statistics of 2017 POD residuals
- Conclusions

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Introduction

It is necessary to **regularly check the stations « health »** with an analysis of the signal characteristics:

- Amplitude : received power
- Phase : residuals of CNES POD adjustment

Which station ?

- After a station renovation
- New site installation
- When a problem is raised in the DORIS network meetings
- Evaluation after a beacon evolution (eg. 3.2)

What data length ?

At least 1 month in order to analyse a minimum of 3 cycles

How frequent ?

Between 1 and 5 stations analyzed per year since 2005 (see next slide).

DORIS stations analyzed since 2005

STATION	DATE OF ANALYSIS	
Kourou	December	2005
Yellowknife	March	2006
Papeete	November	2006
Ascension	March	2007
Reykjavik	June	2007
Betio	June	2007
Rikitea	June	2007
Toulouse	September	2007
Monument Peak	March	2008
Rio Grande	September	2008
Kauai	September	2008
Fairbanks	September	2008
Mount Stromlo	December	2008
Yellowknife	September	2009
Mahe	September	2010
Grasse	September	2010
Easter Island	September	2010
Ascension	December	2010
Arequipa	December	2010
La Réunion	December	2011
Jiufeng	March	2012
Saint Helene	March	2012
Badary	June	2012
Sal	December	2012
Mahe	March	2013
Nouméa	September	2013
Saint John's	December	2013
Everest	March	2014
Tristan da Cunha	June	2014
Le Lamentin	September	2014
Greenbelt	December	2014
Owenga	April	2015
Socorro	June	2015
Goldstone	December	2015
Djibouti	June	2016
Wettzell	July	2016
Managua	November	2016
Kitab	June	2017

Since 2005, 35 sites avec been analyzed.
3 stations have been analyzed twice (Yellowknife, Mahe, Ascension)

analyzed stations

Results presented here

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Methodology

Power attenuation (ATT) = {**measured** received power – **theoretical** received power} on both frequencies (400 MHz & 2GHz).

The theoretical power is given by:

$$P_{theo} = P_{tran} - l_{gr} + g_{gr}(\theta) - p_{path} + g_{boa}(\theta) - l_{boa}$$

gr = ground, *boa* = on-board, *l* = cable loss, *g* = antenna gain, θ = elevation, p_{path} = path loss

POE residuals (RES) : DORIS-only 2 GHz residuals from CNES POE

For a given couple beacon/satellite, we calculate the **mean of all values** (ATT or RES) located in a *lat* x *lon* = 0.5° x 0.5° square. In order to eliminate the biases (cable length, etc.) we subtracte the mean calculated for the entire geometries.

The results are **compared with the fisheye views** (360° views) from IGN if available, or other pictures of interest

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Wettzell

- A DORIS station was installed in Wettzell (Germany) in 2003-2004 to test **shifted frequency** transmissions. Abandoned due to frequent DORIS transmission cut-off for **VLBI sessions**

- Wettzell remains an excellent site for the **co-location of geodetic techniques** (GGOS) → new tests to evaluate the interferences between DORIS and VLBI:
  - 2012-2014 in Greenbelt
  - 2016 on site at Wettzell

Wettzell

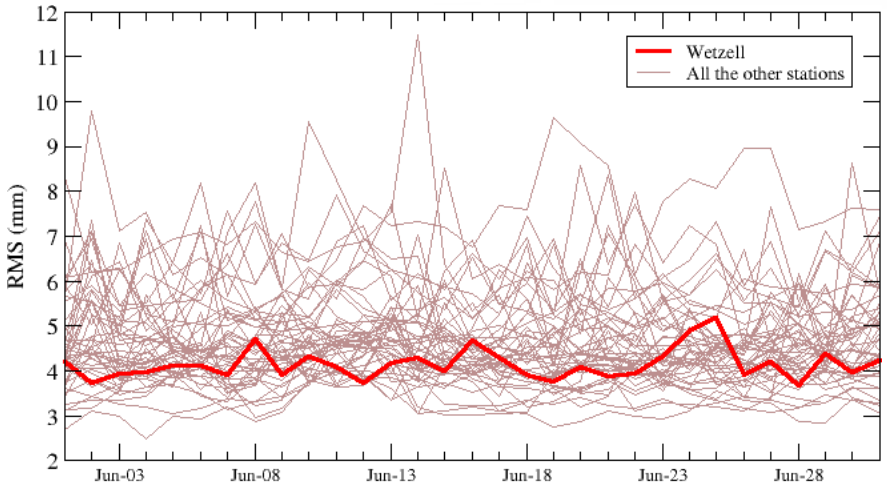
Recommendations:

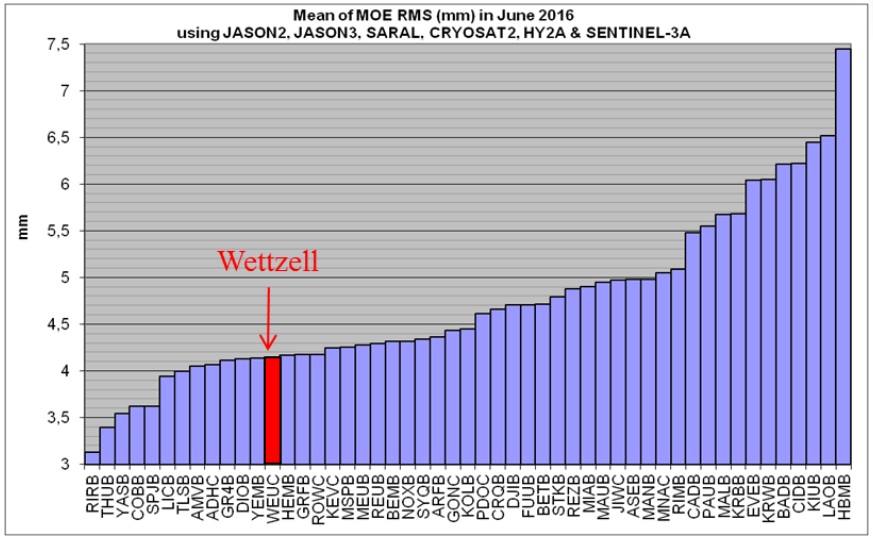
- Minimum of **100 m** between DORIS and VLBI antennas
- **No direct view** between DORIS and VLBI antennas **or** installation of a radio-frequency **barrier**

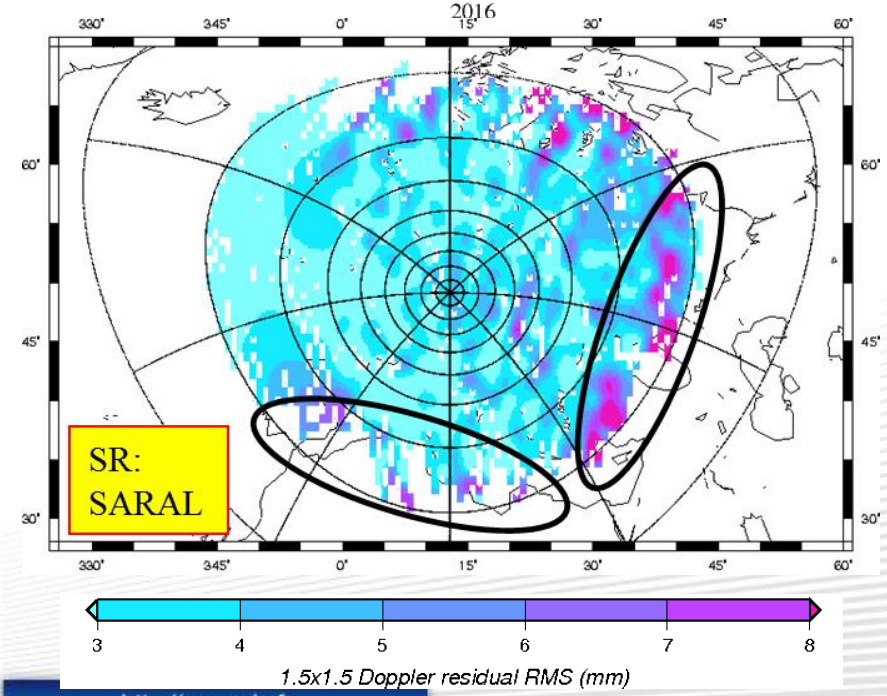
20m VLBI antenna

Twin 13m VLBI antennas

Wettzell







- RMS stable in time and among the best in the network (13th / 50), similar to other European stations like TLSB, GR4B, DIOB, MEUB
- Small degradations below 20° in the South West an East directions (trees + hill)
- No multipaths effects
- The good performances led to the installation in Sept. 2016

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Managua

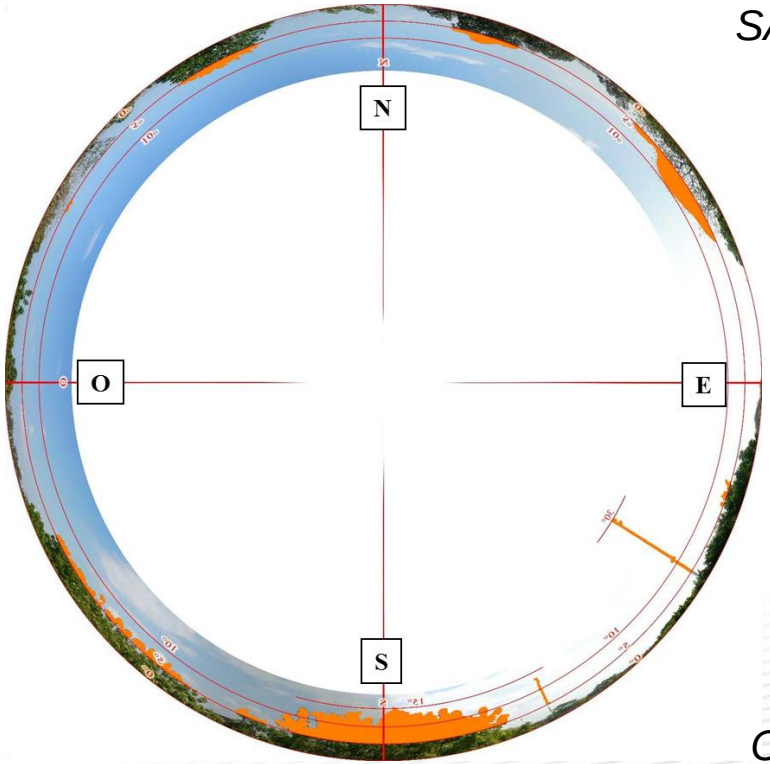
- 2010 : interference of MIAB with TV antennas → removal of MIAB
- 2013 : Recognition mission in Managua, Nicaragua's capital
- 27/04/2016 : Beacon installed → MNAC

IDS newsletter #2
Visibility circles at 800 km altitude, 12° cut-off

- Complementary to the Lamentin station,
- Improve the network robustness,
- Will give information on the Carribean tectonic plate, (no DORIS station untill then).

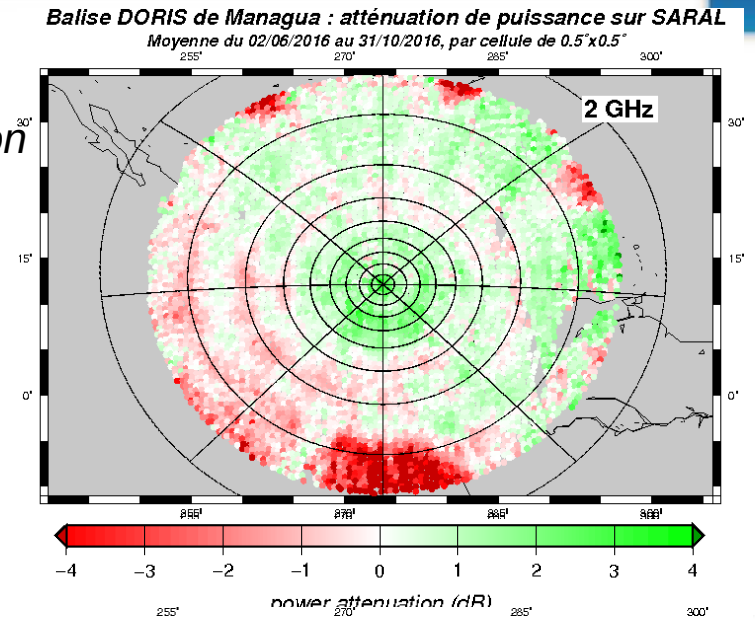
Managua

5 months analysis

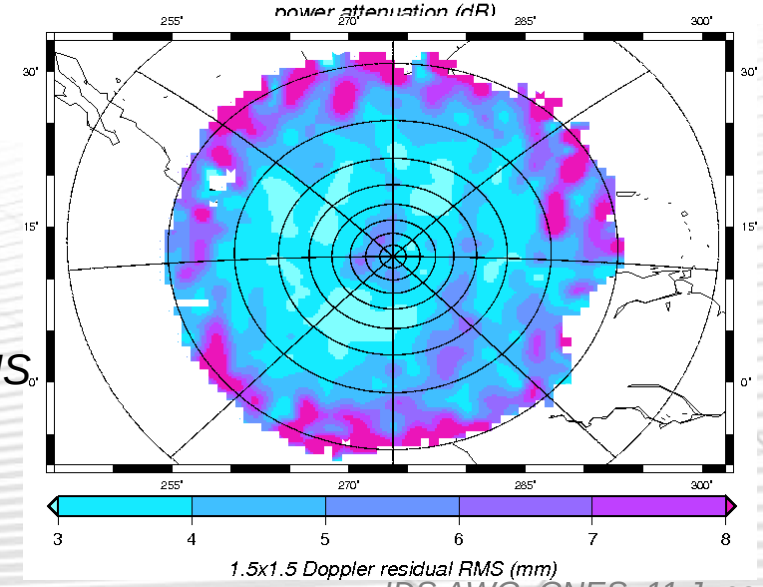


Fisheye view of MNAC environment

Power attenuation as seen from SARAL



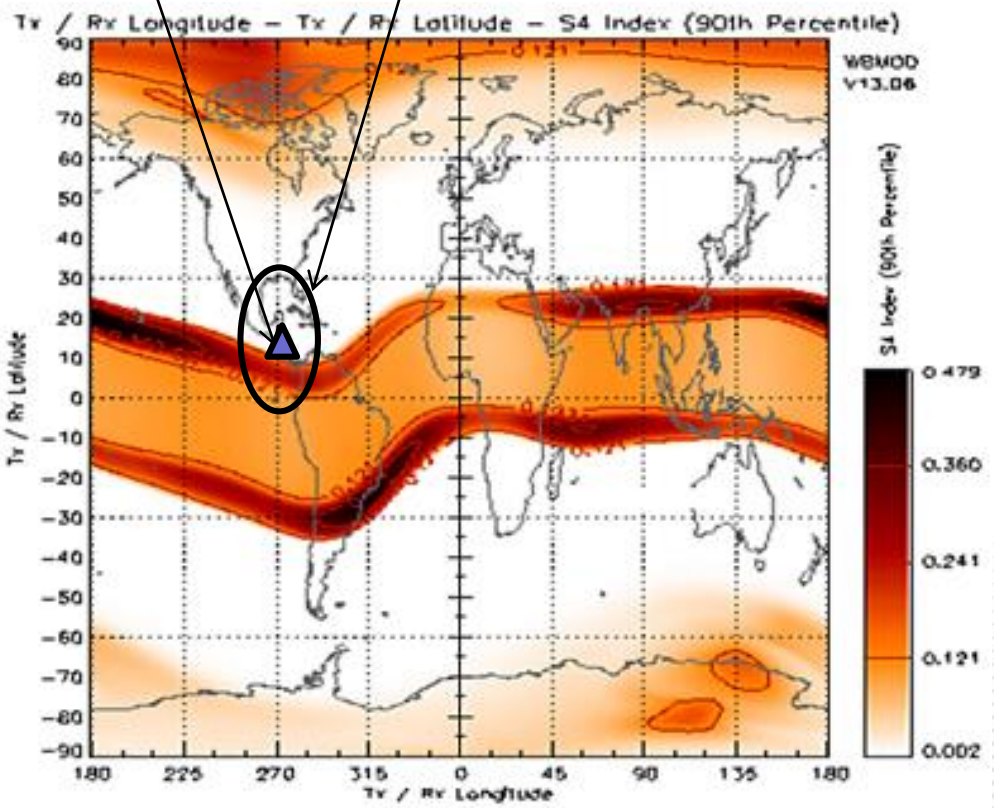
CNES POD RMS of SARAL



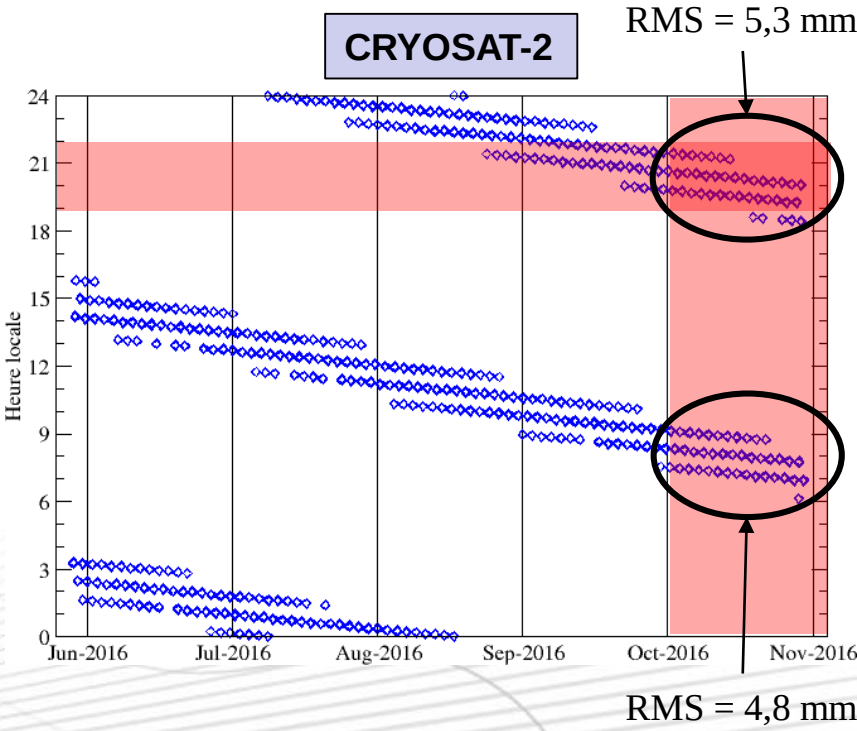
Managua

Visibility circle of
Cryosat-2 at 8° elevation

MNAC



Modèle climatologique WBMOD (IPS)



➔ Certainly a small influence of the ionospheric scintillation on the POD RMS

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Kitab

- **1991** : First installation at the Astronomical Observatory of Kitab (Uzbekistan) → KITA
- **1996** : 1st renovation → KITB
- **2001** : 2nd renovation → KIUB
- **2011** : degradation → new renovation needed
- **Sept 2013** : Recognition mission
- **Juin 2016** : Move of DORIS → KIVC

Visibility circles at 800 km altitude, 12° cut-off

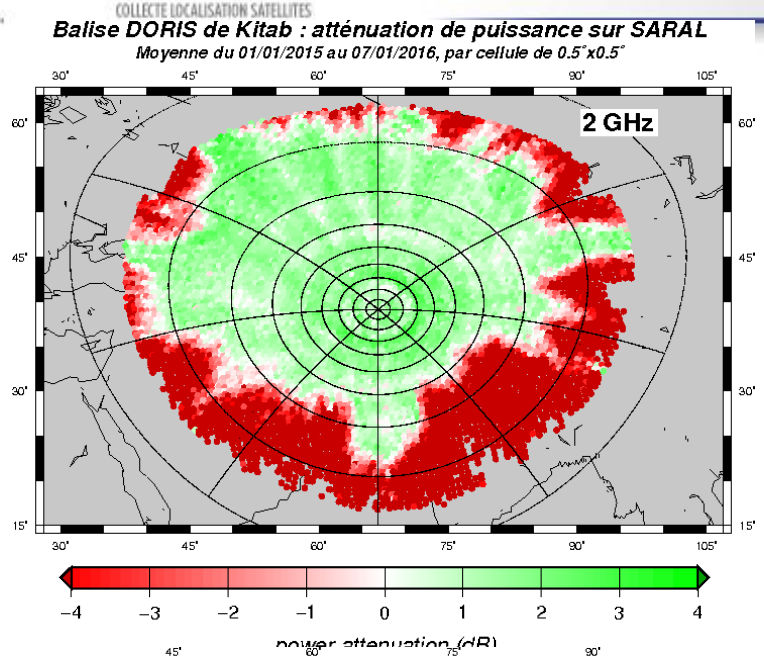
Kitab

Old site (KIUB):
Masking rate > 5° = **16,9%**

New site (KIVC):
Masking rate > 5° = **3,6%**

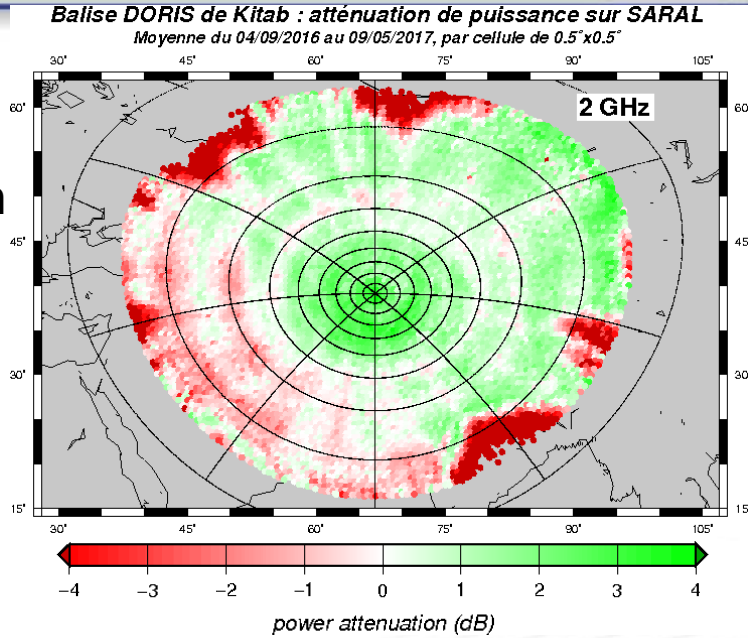
No masks > 15° (shaded trees have been cut)

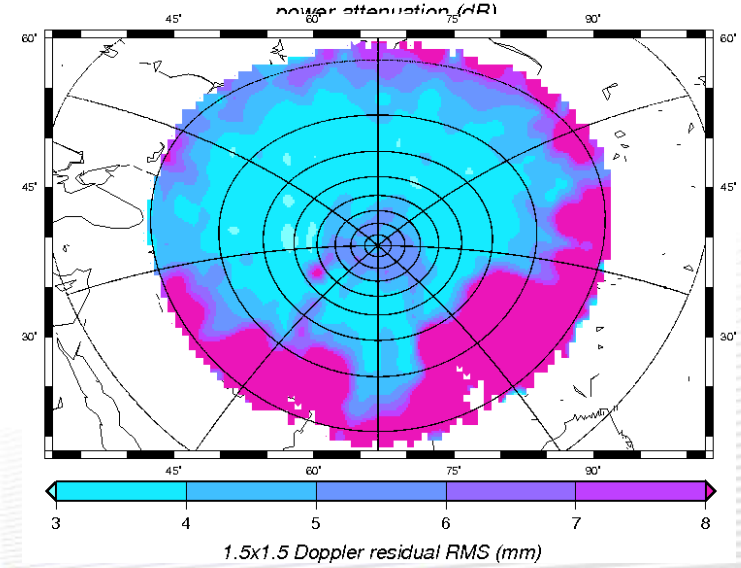
Kitab



Power attenuation

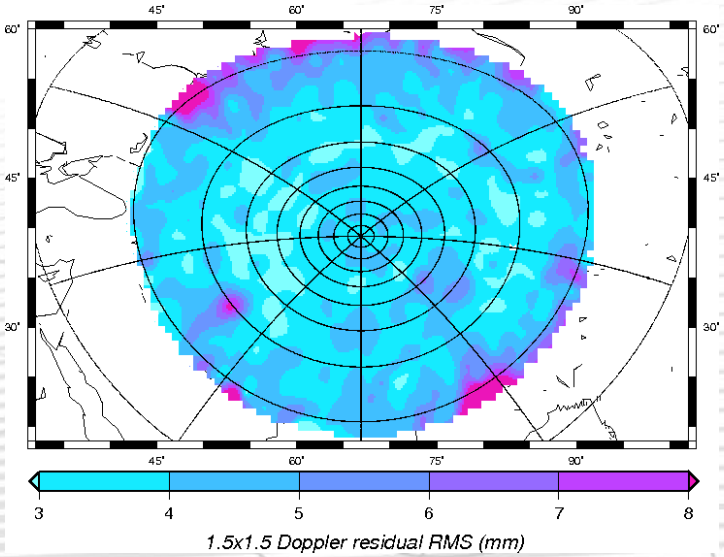
KIUB ⇨ KIVC





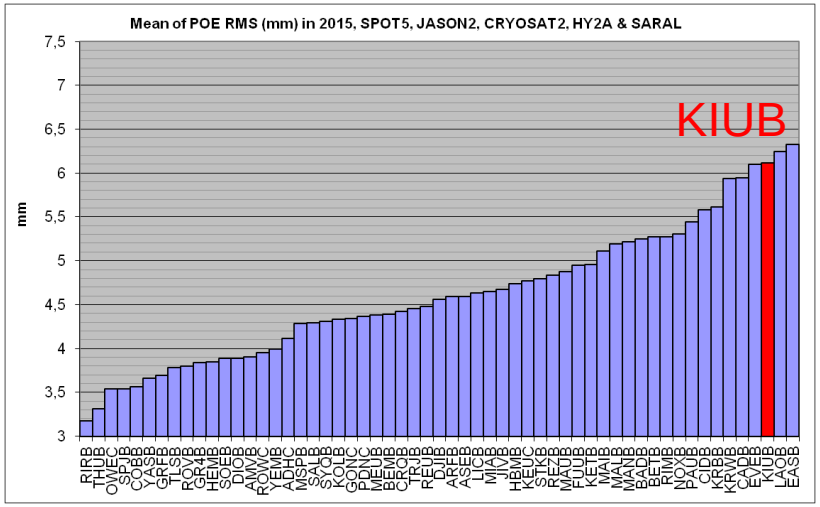
CNES POD RMS

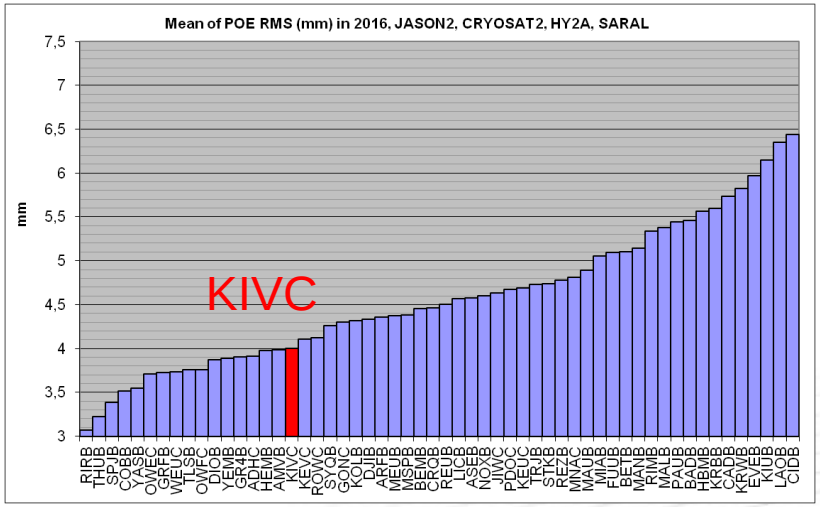
KIUB ⇨ KIVC



Kitab

Network ranking:





Mean POD RMS ~**6 mm**
→ 55th / 57 in 2015

Mean POD RMS ~**4 mm**
(30% improvement)
→ 17th / 56 in 2016

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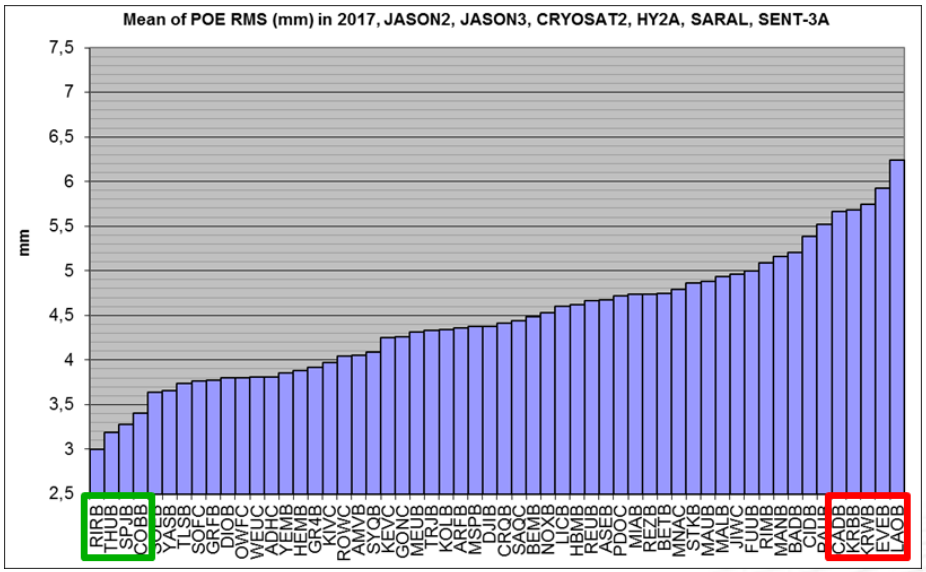
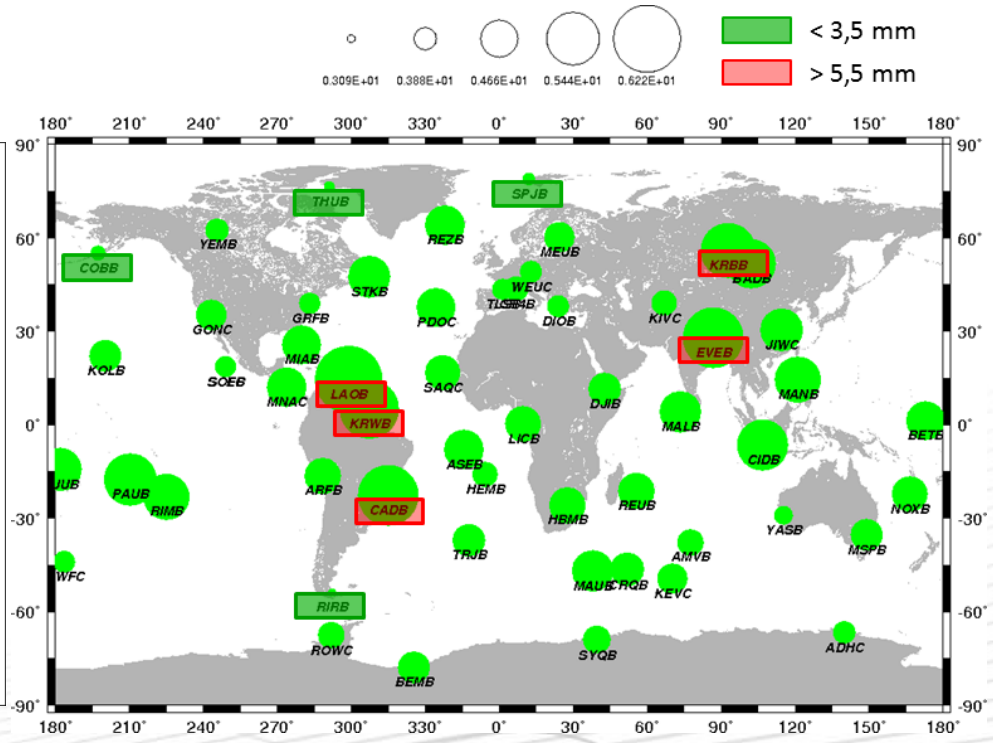
Summary of POD RMS in 2017

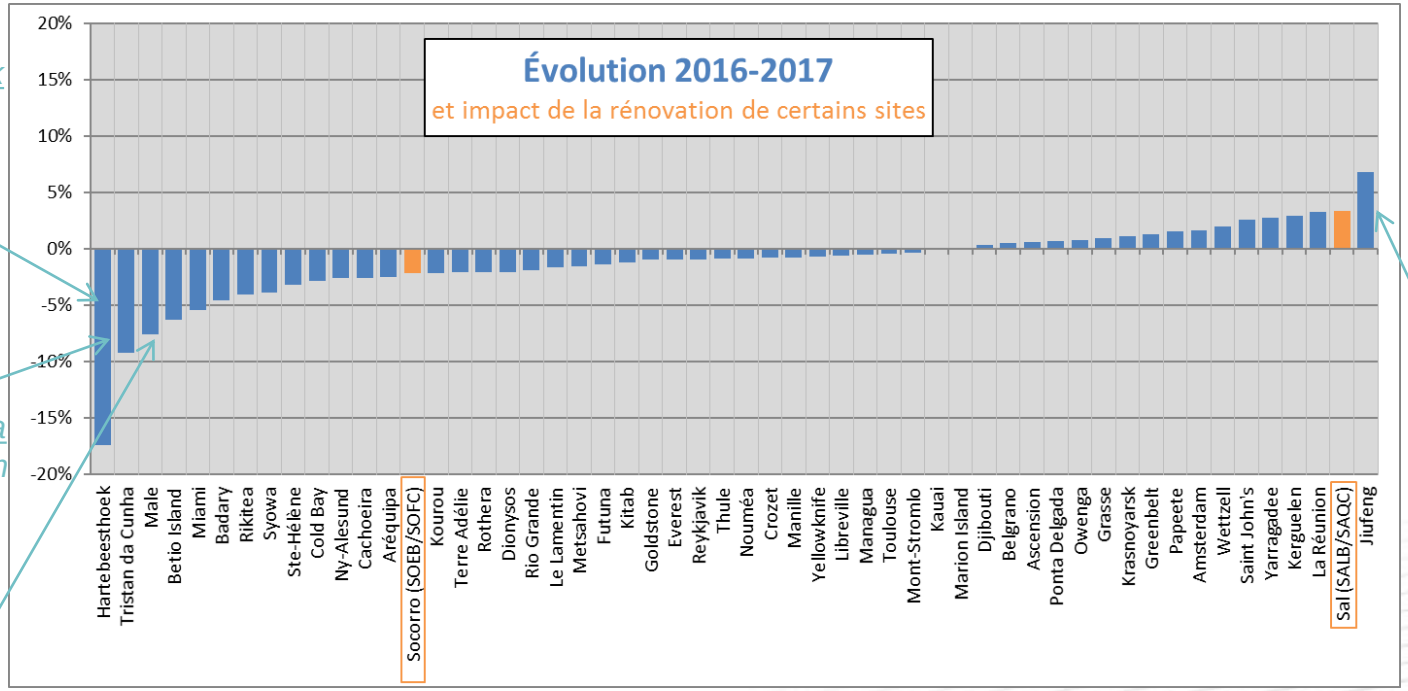
Statistics established from all common mission in 2016 & 2017 :
JA2, JA3, CR2, HY2, SRL et S3A





- Distribution between 3 et 6 mm (same distribution than in 2016)
- Rio Grande is still the best station (for many years)
- No changes from 2016 to 2017 for the best stations (the best 4 are unchanged, in the same order)

POD RMS: evolution from 2016 to 2017



Hartebeesthoek noisy period from March to August 2016

Tristan da Cunha noisy period from May to October 2016

Malé : noisy period from May to October 2016

Jiufeng still the effect of the growing vegetation

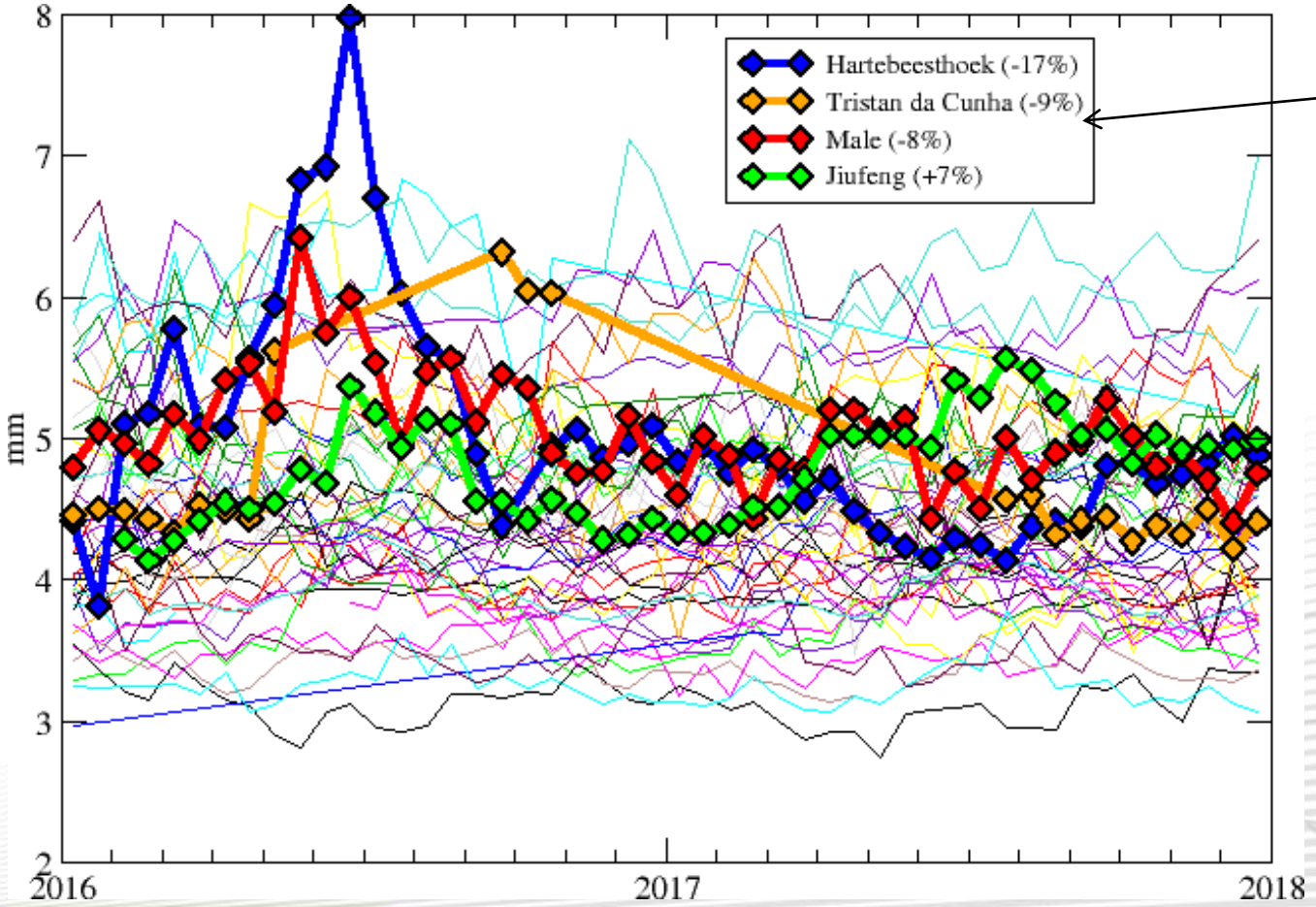
The global RMS is slightly better in 2017 than in 2016. Maybe due to the oncoming of the solar minimum ?

POD RMS: evolution from 2016 to 2017

DORIS POE RMS

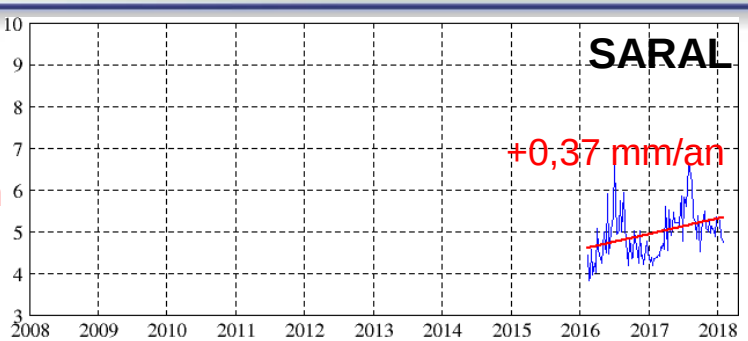
Mean on 15 days

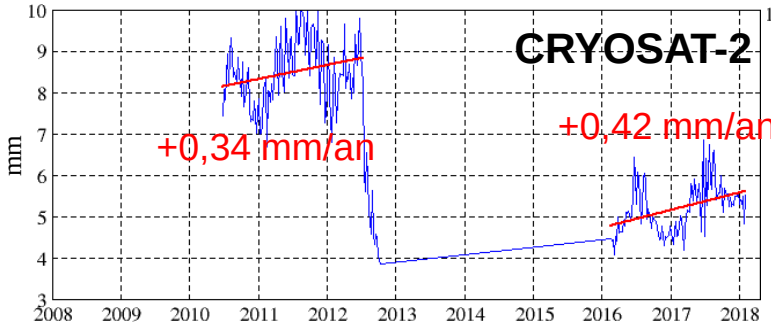
Common missions in 2016 & 2017 = JA2, CR2, HY2, SRL, JA3 et S3A

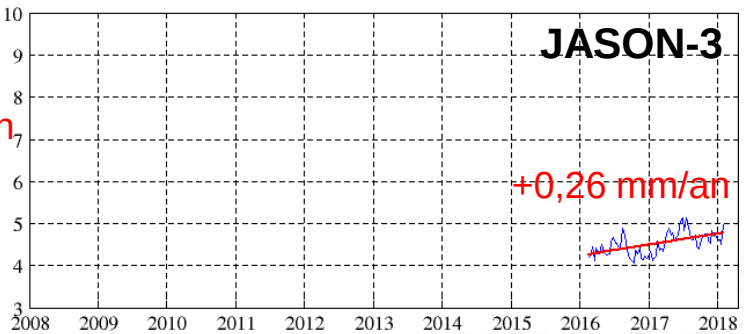


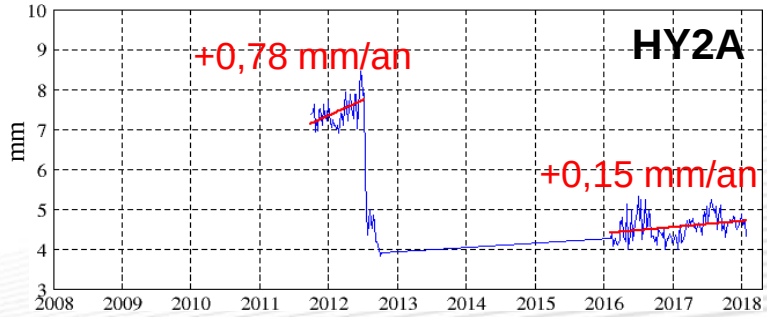
Stations whose varation from 2016 to 2017 exceeds +/- 7%

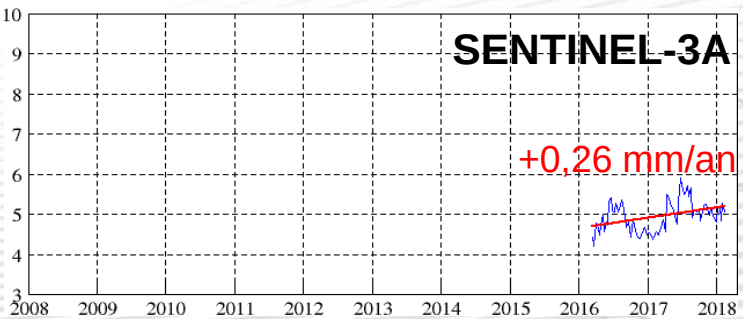
Focus on Jiufeng











Since 2016, raise of +0,3 mm/yr due to the vegetation growth.

A this rate, Jiufeng will again be the « worst » station (~6 mm) in late 2020

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We perform regular analysis of the local (station) DORIS signal in terms of power attenuation and POD residuals.

Useful to explain problems or to evaluate the quality of a site renovation or new installation

Will be continued to improve the network robustness