# Analysis of a possible future degradation in the DORIS geodetic results related to changes in the satellite constellation

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## Context:

The DORIS constellation is aging. Most satellites are past their expected lifetime. Only 4 satellites are available for geodesy in 2006.

| Satellite | Launch date | Comment |
|---|---|---|
| SPOT-2 | Jan 22, 1990 | |
| TOPEX/Poseidon | Aug 10, 1992 | Lost on November 2, 2004 |
| SPOT-3 | Sep 26, 1993 | Lost on November 15, 1996 |
| SPOT-4 | Mar 24, 1998 | |
| SPOT-5 | May 4, 2002 | |
| ENVISAT | Mar 1, 2002 | |
| Jason-1 | Dec 7, 2001 | Affected by South Atlantic Anomaly (SAA) effect (*) |

(*) see Willis et al., CR Geoscience, 2005; Lemoine and Capdeville, J Geod, in press

**Goals:**

- Analyze the sensitivity of the current DORIS geodetic results (station position and polar motion) to the size of the DORIS constellation.
- Verify if some satellites are most important or less important than others

**Methodology:**

Reprocess actual DORIS data in 2005 (weekly solution) in different cases

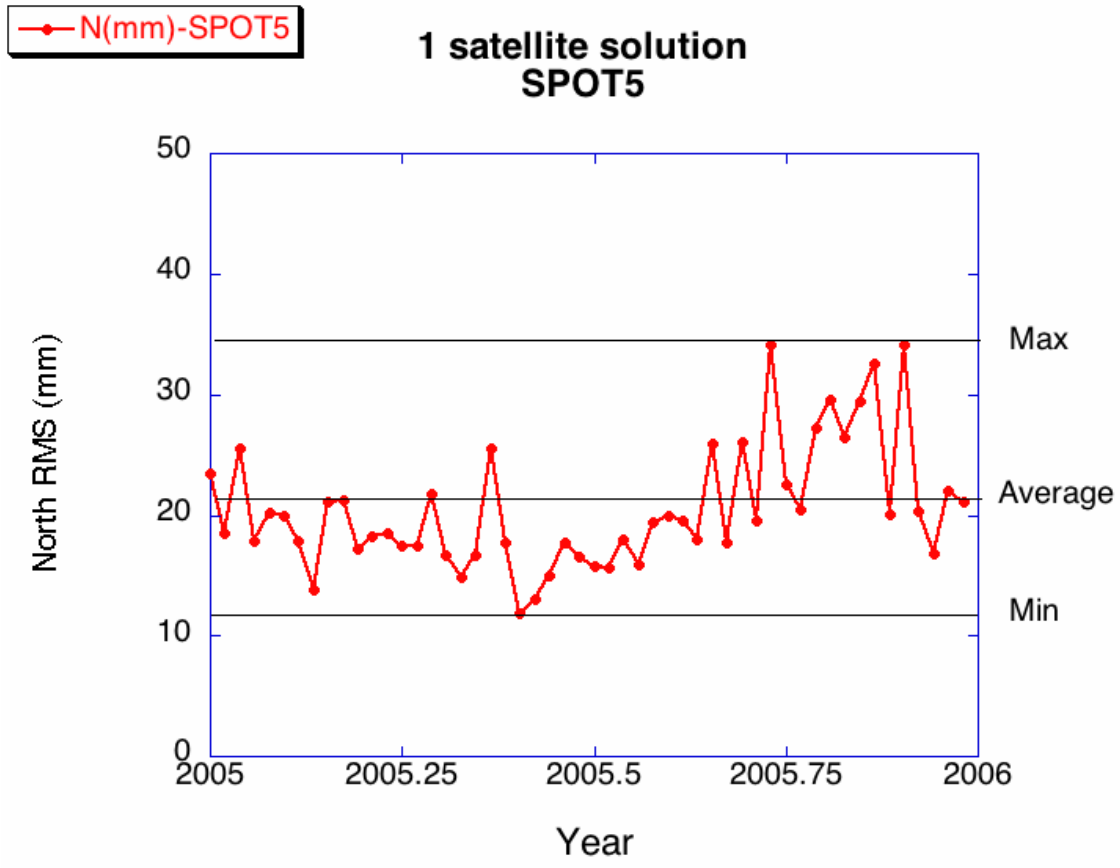
Select only a sub-set of available DORIS satellites:

1 satellites = 4 cases, 2 satellites = 6 cases
3 satellites = 4 cases, 4 satellites = 1 case

Weekly results (station positions) are compared to a long-term cumulative solution (positions/velocities estimated since 1993)

For each case, derive from the 52 individual weekly solutions

- the worst results (max)
- the best result (min)
- the mean result (average)



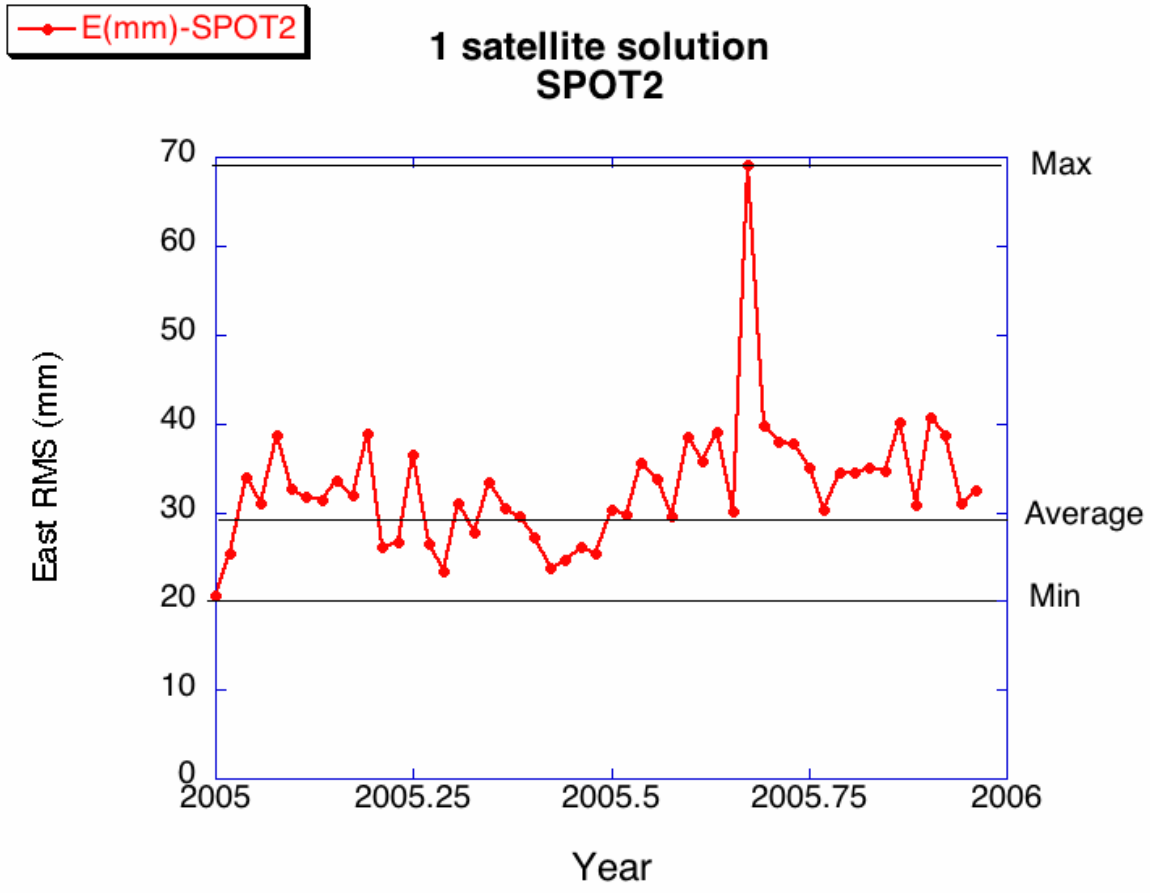

Test case = 3

1 satellite = SPOT5

North component
Comparison toward IGN04D02 cumulative solution (1993-2005)

This correspond to the best case for a single satellite solution

Minimum value, maximum value and average values will be used to compare this test case with other cases (different selection of DORIS satellite)



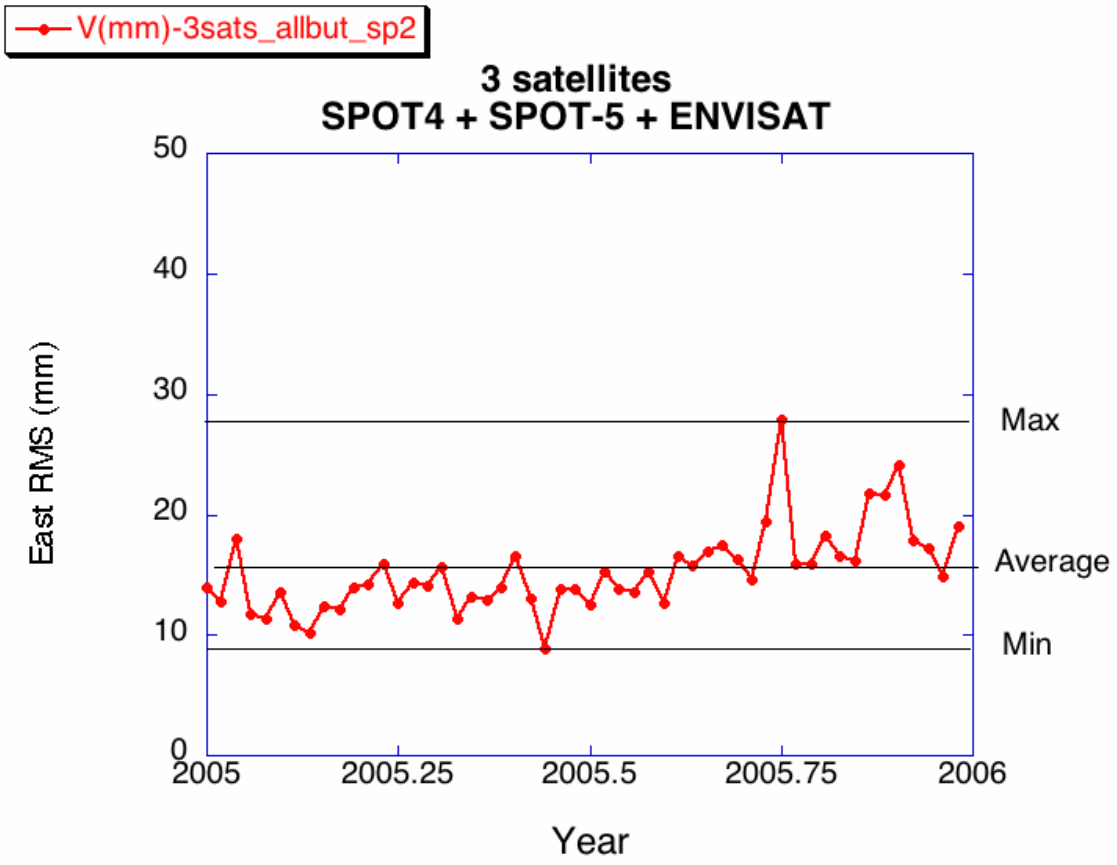

Test case = 1

1 satellite = SPOT2

East component
Comparison toward IGN04D02 cumulative solution (1993-2005)

This correspond to the worst case for a single satellite solution

Single-satellite solutions are more sensitive to possible lack of data (mostly around satellite maneuvers) than multi-satellite solutions




Test case = 14

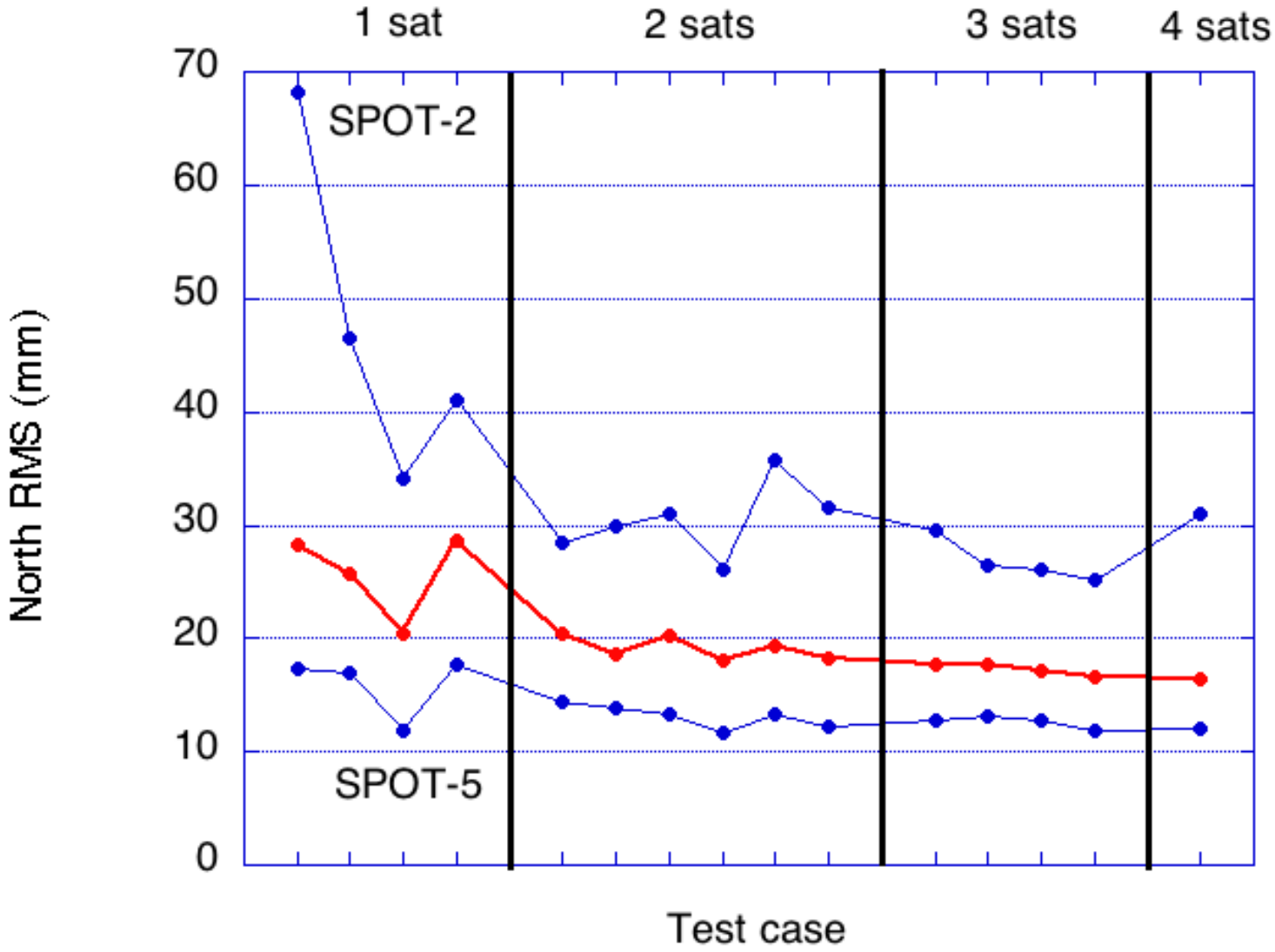
3 satellites = SPOT-4 + SPOT-5 + ENVISAT

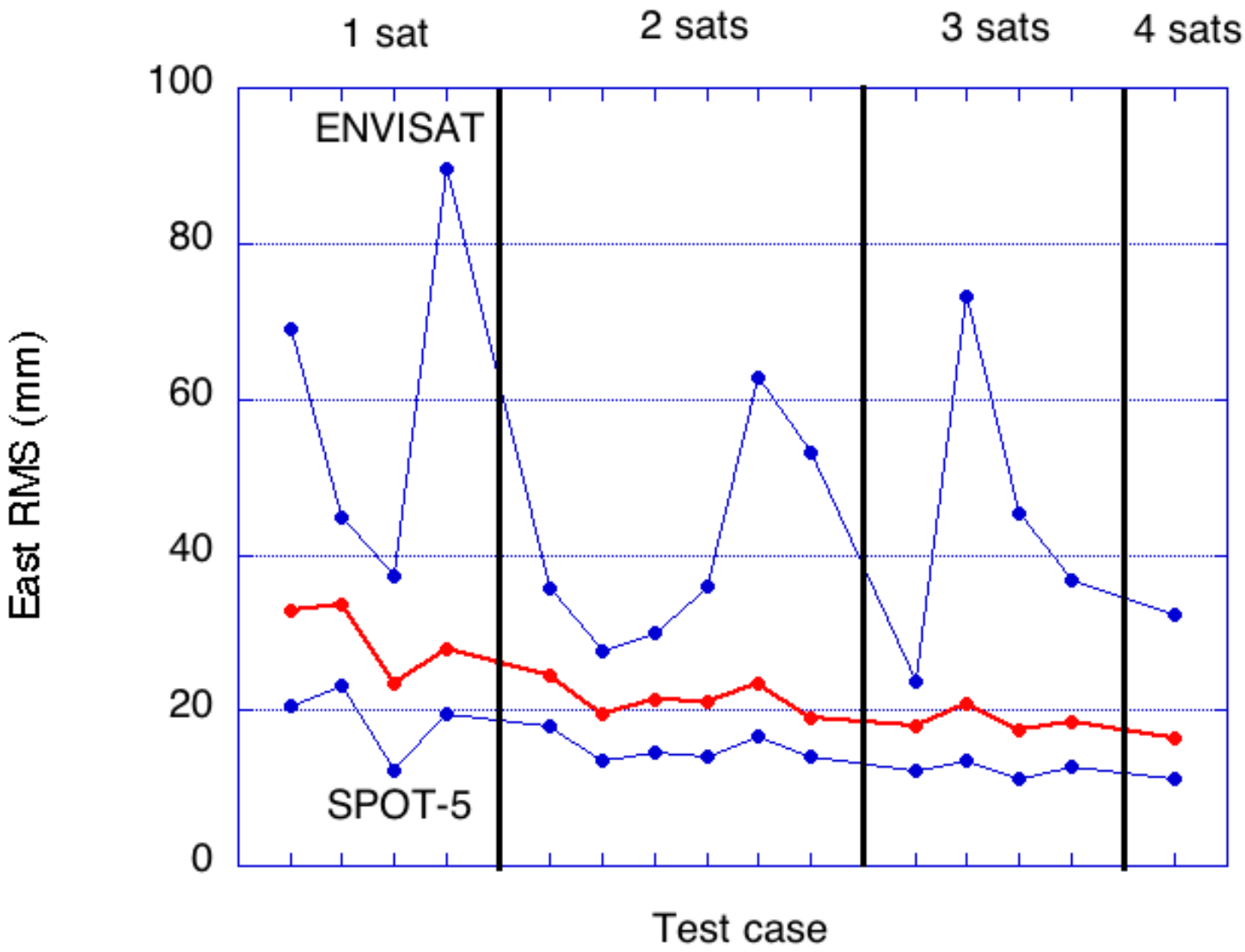
Vertical component
Comparison toward IGN04D02 cumulative solution (1993-2005)

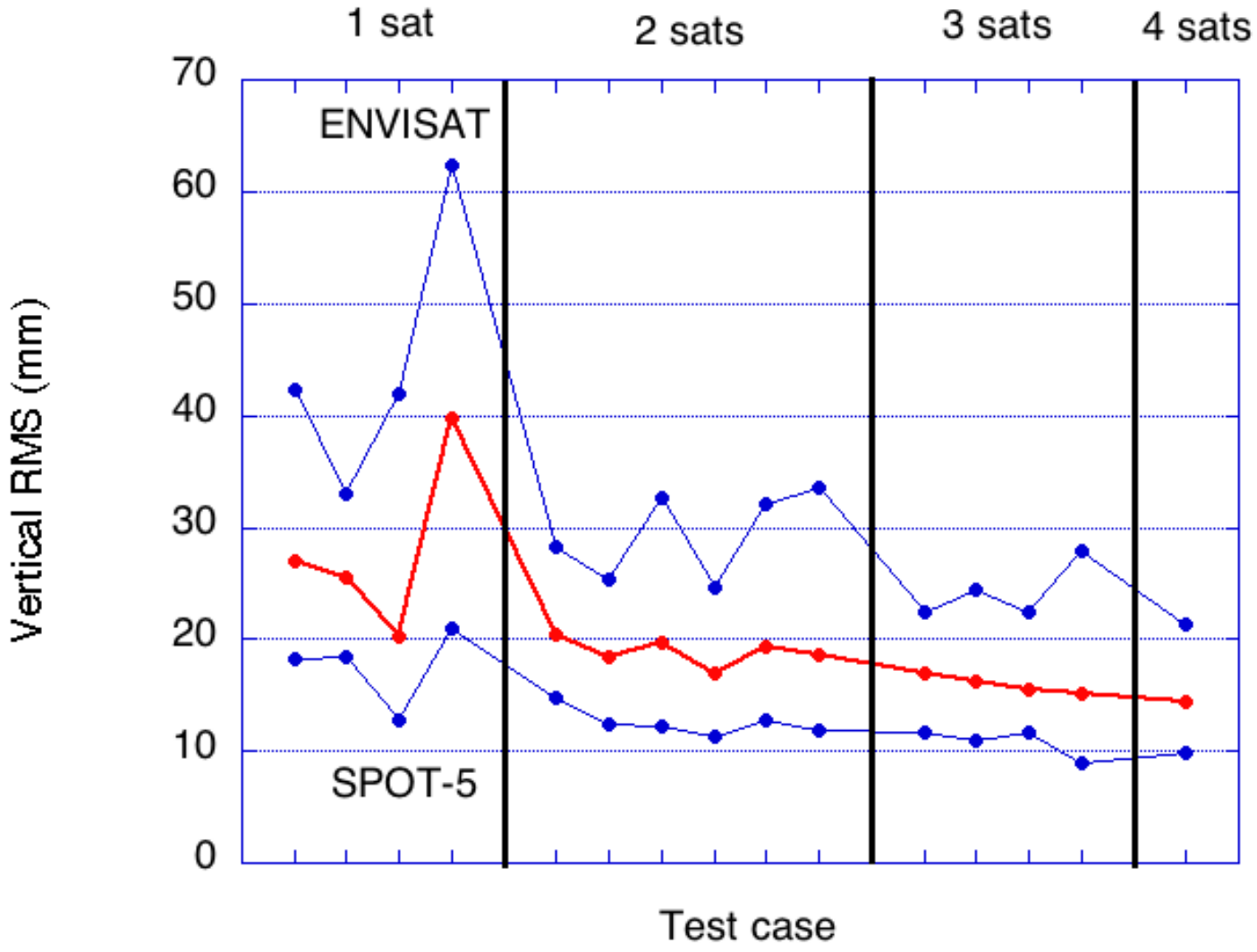
This corresponds to the most likely situation in the near future (losing SPOT-2 satellite)

Results are barely degraded

| | 4 satellites | 3 satellites |
|---|---|---|
| Min (mm) | 9.8 | 8.9 |
| Average (mm) | 14.5 | 15.2 |
| Max (mm) | 21.4 | 27.9 |


1 sat
2 sats
3 sats
4 sats
70
60
50
40
30
20
10
0
SPOT-2
SPOT-5
North RMS (mm)
Test case


1 sat
2 sats
3 sats
4 sats
100
80
60
40
20
0
East RMS (mm)
ENVISAT
SPOT-5
Test case


1 sat
2 sats
3 sats
4 sats
70
60
50
40
30
20
10
0
ENVISAT
SPOT-5
Vertical RMS (mm)
Test case

# Test case description

| Test case | Number of satellites | Satellites |
|---|---|---|
| 1 | 1 | SPOT-2 |
| 2 | 1 | SPOT-4 |
| 3 | 1 | SPOT-5 |
| 4 | 1 | ENVISAT |
| 5 | 2 | SPOT-2 + SPOT-4 |
| 6 | 2 | SPOT-2 + SPOT-5 |
| 7 | 2 | SPOT-2 + ENVISAT |
| 8 | 2 | SPOT-4 + SPOT-5 |
| 9 | 2 | SPOT-4 + ENVISAT |
| 10 | 2 | SPOT-5 + ENVISAT |
| 11 | 3 | SPOT-2 + SPOT-4 + SPOT-5 |
| 12 | 3 | SPOT-2 + SPOT-4 + ENVISAT |
| 13 | 3 | SPOT-2 + SPOT-5 + ENVISAT |
| 14 | 3 | SPOT-4 + SPOT-5 + ENVISAT |
| 15 | 4 | SPOT-2 + SPOT-4 + SPOT-5 + ENVISAT |

For each test case, data are processed on a daily basis from January to December 2005
Results are then combined into weekly solutions

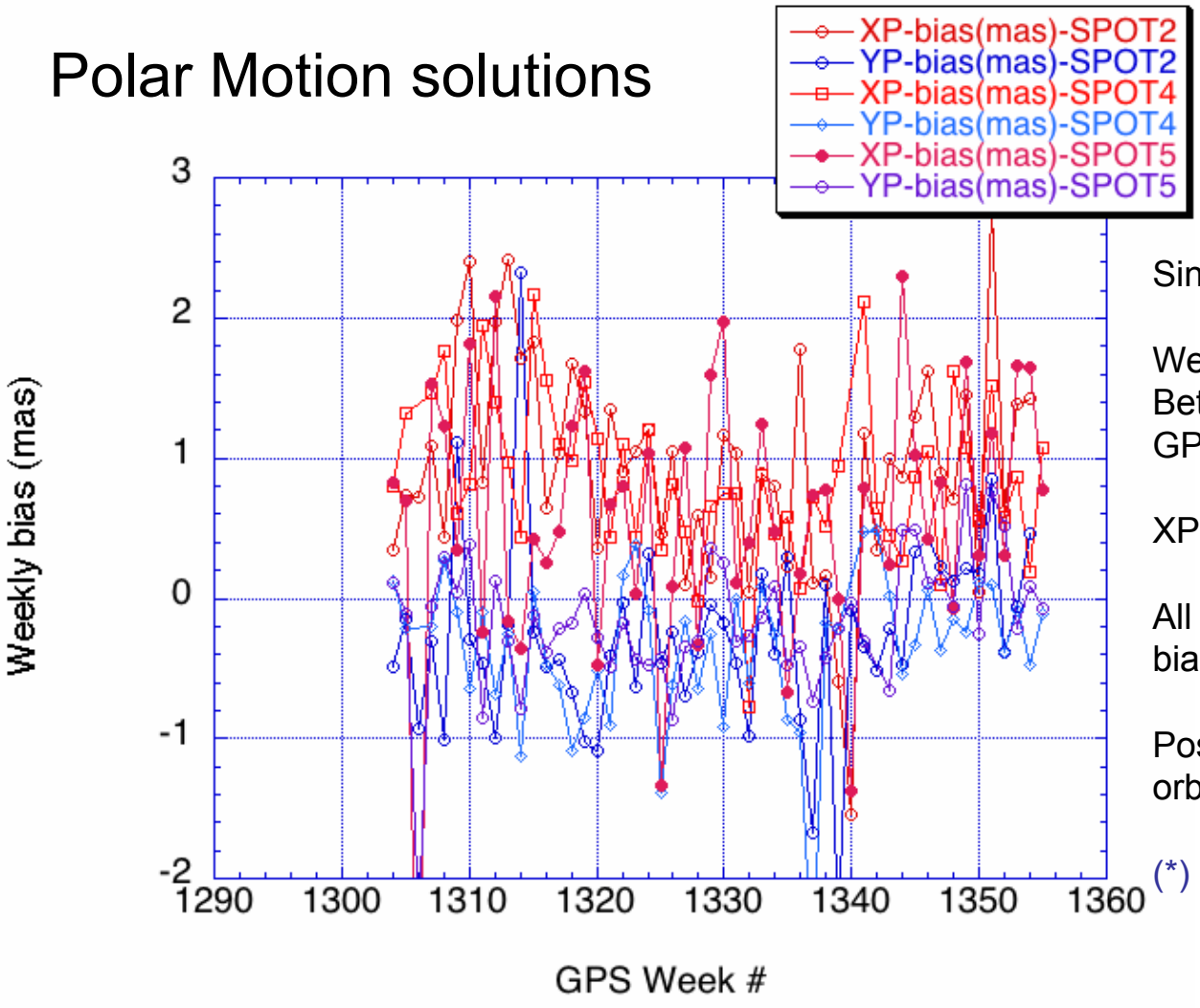
Daily solutions are not combination from single-satellite daily solutions but are reprocessed
All common parameters are used (station position, EOP but also ground station clocks and wet zenith tropospheric delays) (*)

So results from case (15) correspond exactly to what is regularly submitted as IGN/JPL solution to the International DORIS Service (IDS) (**)

Results from cases (1) to (14) would then Correspond to the IGN/JPL solution if 1 or more DORIS satellite would have been lost before 2005

(*) See Willis et al., Adv. Space Res., 2003
(**) See Willis et al., CR Geoscience, 2005

# Polar Motion solutions




Single satellite solutions

Weekly mean of daily differences Between DORIS and GPS/JPL Polar Motion

XP component show a larger bias (*)

All SPOT solution show systematic biases in XP and in YP

Possible common source of error in orbit computation (under investigation)

(*) See Gambis, J Geod, in press

# CONCLUSIONS

More DORIS satellite help provide most accurate results

For single-satellite solutions, best results are obtained with SPOT-5 (dual-channel receiver, lower noise) and worst results are obtained with ENVISAT

Losing 1 DORIS satellite (from 4 to 3) would degrade the station position accuracy by 5 % to 25 % (worst in East). Losing SPOT-2 (oldest satellite) would create less harm

Losing 2 DORIS satellite (from 4 to 2) would degrade the station position accuracy by 10 % to 45 % (worst in East). Best results could be maintained if SPOT-5 is still available