Progress on CNES mascon (mass concentration) solution
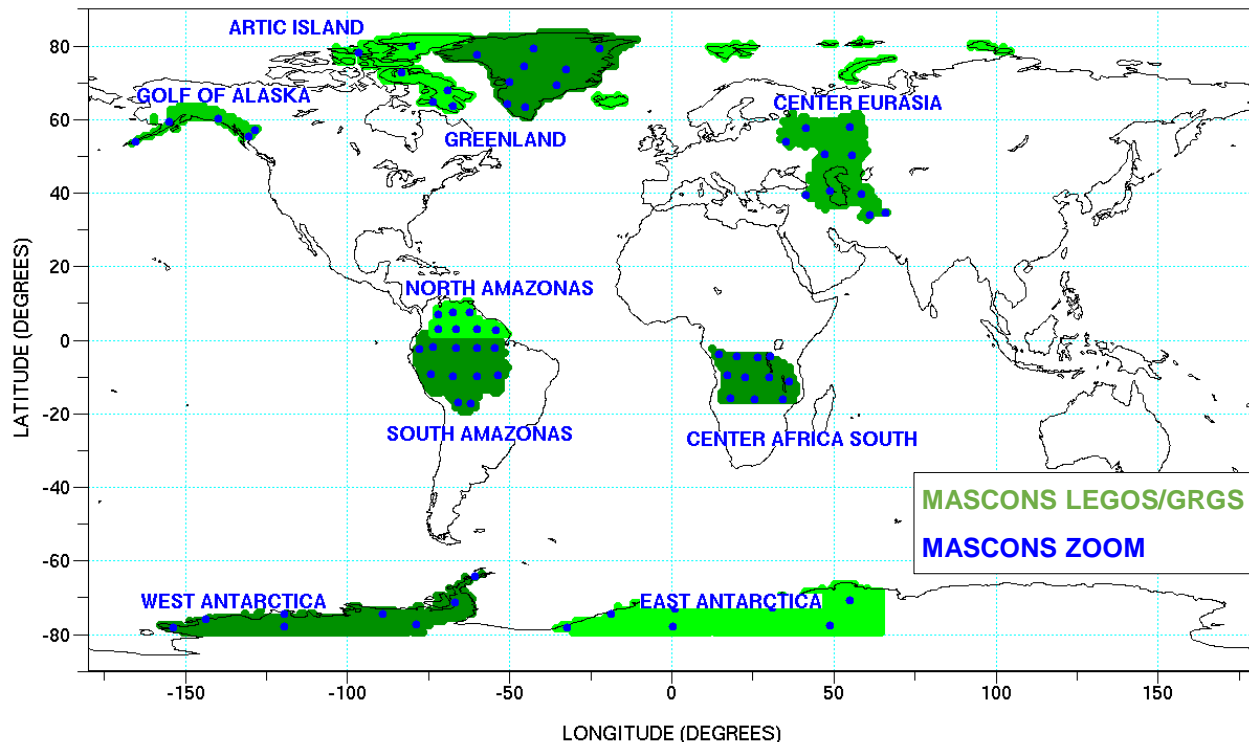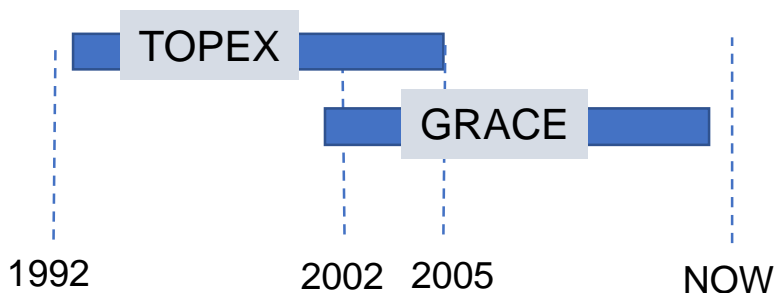
J. Moyard, F. Mercier, A. Couhert from CNES POD Team

April 4, 2019

CONTEXT OF THE STUDY

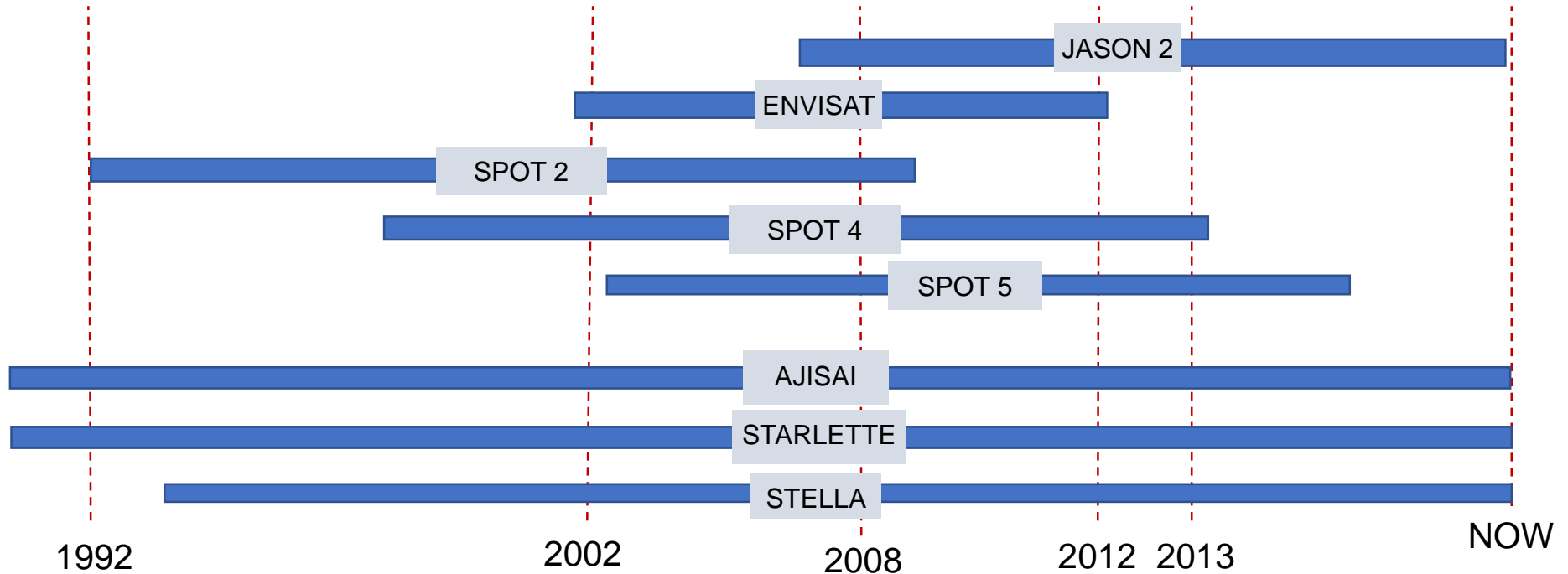**Try to improve TOPEX/Poseidon(T/P) orbits**

The POE-F standards include the last RL04 version of CNES/GRGS mean Time Variable Gravity model, based on GRACE data:

TOPEX

GRACE

1992   2002 2005   NOW

9 regions with strong annual signals and/or linear trends

Missions SLR and DORIS

JASON 2 · ENVISAT · SPOT 2 · SPOT 4 · SPOT 5 · AJISAI · STARLETTE · STELLA

1992 · 2002 · 2008 · 2012 · 2013 · NOW

Dynamic orbit determination process uses only DORIS measurements (σ=5mm over 10s) or SLR measurements (σ=2.0cm), with static mean field CNES/GRGS RL03

Change modelisation approach

Old approach with stacking and filtering steps

Stacking process

Reduction to 9 mascons
3 months solutions

FILTERING STEP

9 MASCONS
values ready to be used
(bias/drift/annual terms)

POE-F ORBIT DETERMINATION
with **static** GRGS gravity field RL03
+
119 mascons introduction using
dynamic at convergence
(one more iteration)

New approach, mascons models are directly defined using information from normal equations

Stacking process

Reduction to 9 mascons
Bias/drift/annual terms on each mascon
adjusted globally (36 parameters)

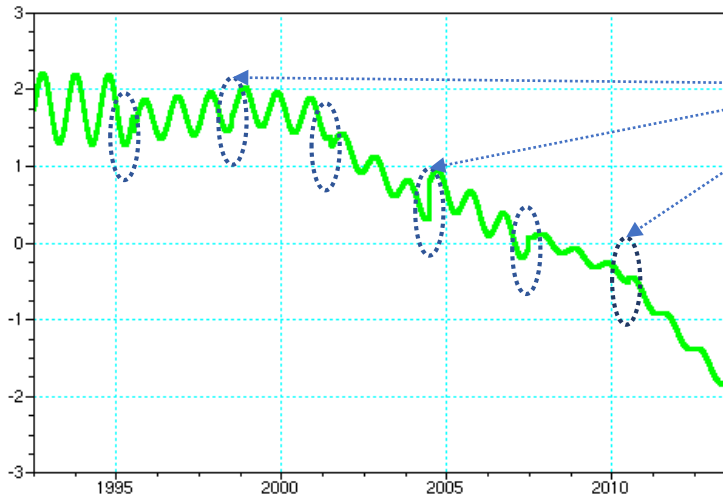**In final, 36 parameters models adjusted for each period**

© cnes

Observations

Studied period 06/1992 → 06/2013
36 parameters model adjusted on 3 years intervals, DORIS only
No constraint in adjustment of {bias,drift,annual term} between each period

GREENLAND

Good consistency in { bias, drift, annual term } adjusted between each period for Greenland, Center Eurasia, Center Africa South, … thanks to polar orbits presents in DORIS constellation

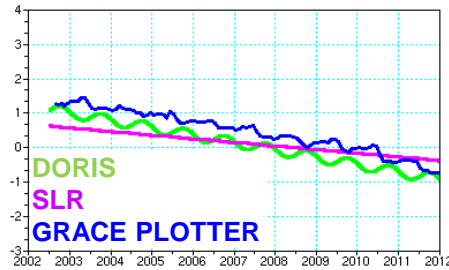NORTH AMAZONAS

More 'jitter' for mascon model North Amazona, South Amazona, …

Observations

Comparison between DORIS and SLR Period 2002→2012 Unit in TeraTons

Annual phase problem on Antartica regions

Equatorial regions correctly observed by SLR, drift or bias problem for DORIS

Adjusted Greenland mascon seems better using DORIS
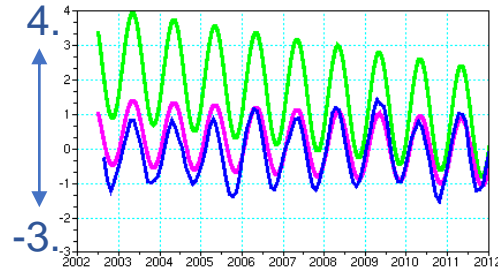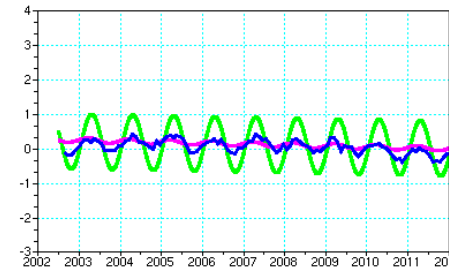

GREENLAND
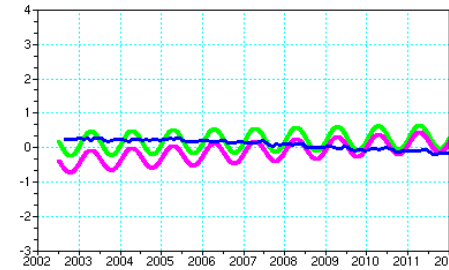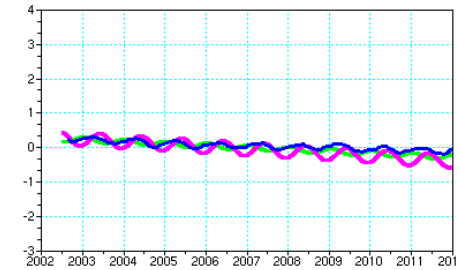
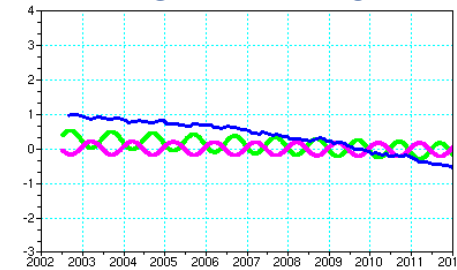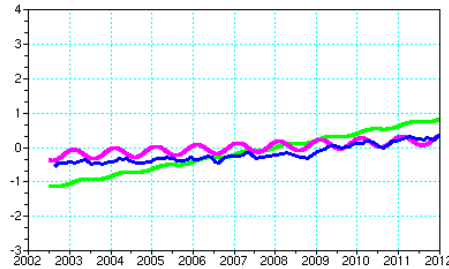DORIS
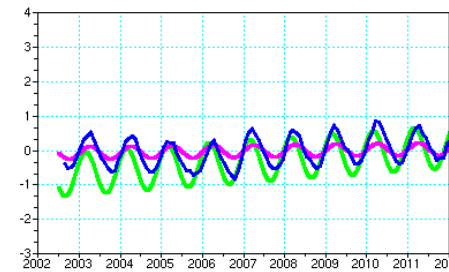SLR
GRACE PLOTTER

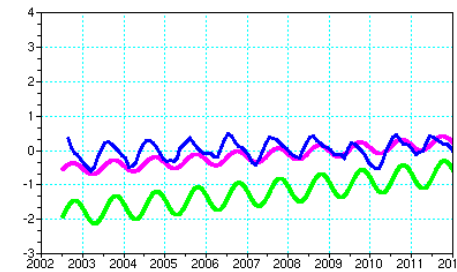ARTIC ISLAND

GULF OF ALASKA

SOUTH AMAZONAS

CENTER EURASIA

WEST ANTARTICA

EAST ANTARTICA

CENTER AFRICA SOUTH

NORTH AMAZONAS

Observations

Focus on covariance, Greenland mascon, period 2002→2012

Mission	Bias	Drift	Annual(cos)	Annual(sin)
spot2	0.0420	0.0000464	0.0434	0.0446
spot4	0.0230	0.0000231	0.0321	0.0323
spot5	0.0178	0.0000178	0.0248	0.0248
jason2	0.2000	0.0001710	0.0993	0.1020
envis1	0.0189	0.0000220	0.0258	0.0260
ajisai	0.0835	0.0000829	0.1145	0.1130
stella	0.0096	0.0000113	0.0133	0.0128
starlt	0.0658	0.0000628	0.0932	0.0915

Focus on adjusted parameters correlation

DORIS orbit determination

119 mascons

Threshold on abs(values)>0.7

No strong correlation between the empirical and the mascons adjusted parameters
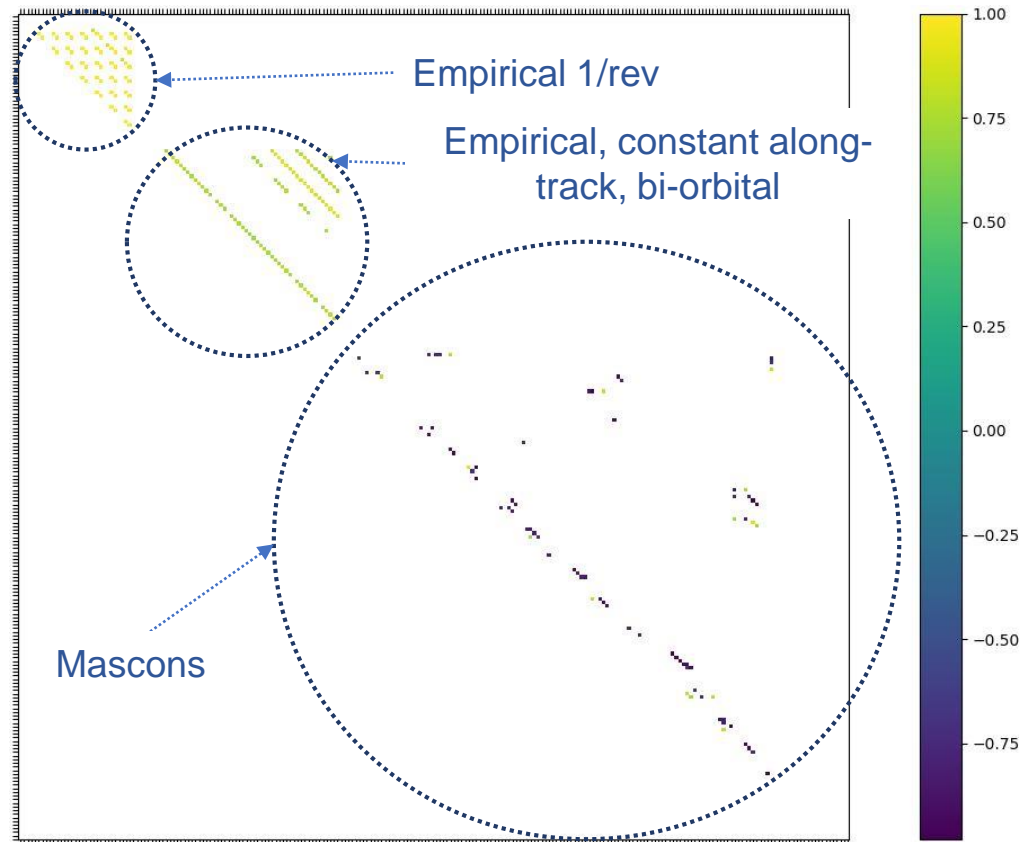
Empirical 1/rev

Empirical, constant along-track, bi-orbital

Mascons

Observations

Focus on adjusted parameters correlation

Period 2002 → 2012

DORIS+SLR

36 parameters model

Same correlation patterns between biais drift and annual terms

Good separation between bias drift annual terms, model is well defined
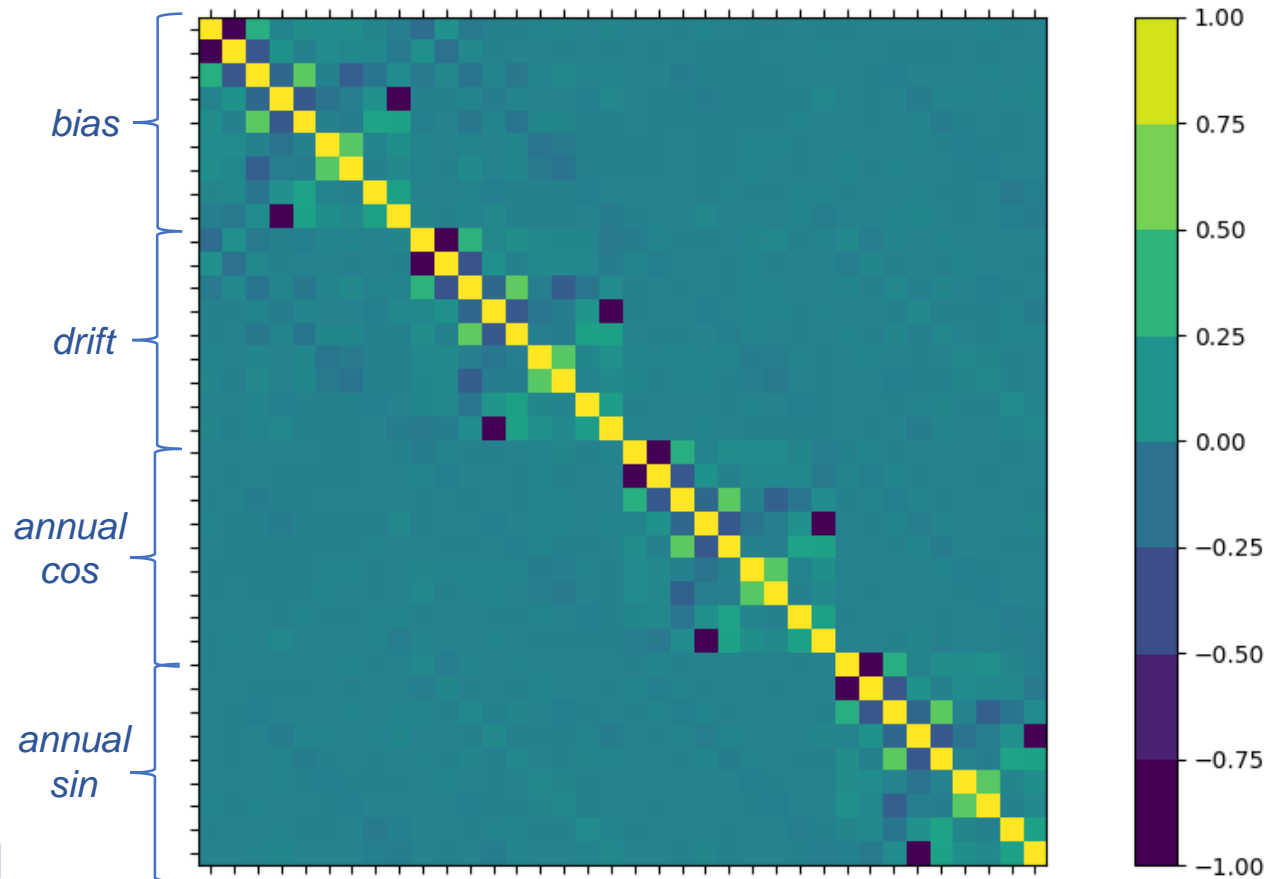
Observations

Focus on adjusted parameters correlation

Period 2002 → 2012

DORIS+SLR

36 parameters model

Should group together

Greenland & Artic island
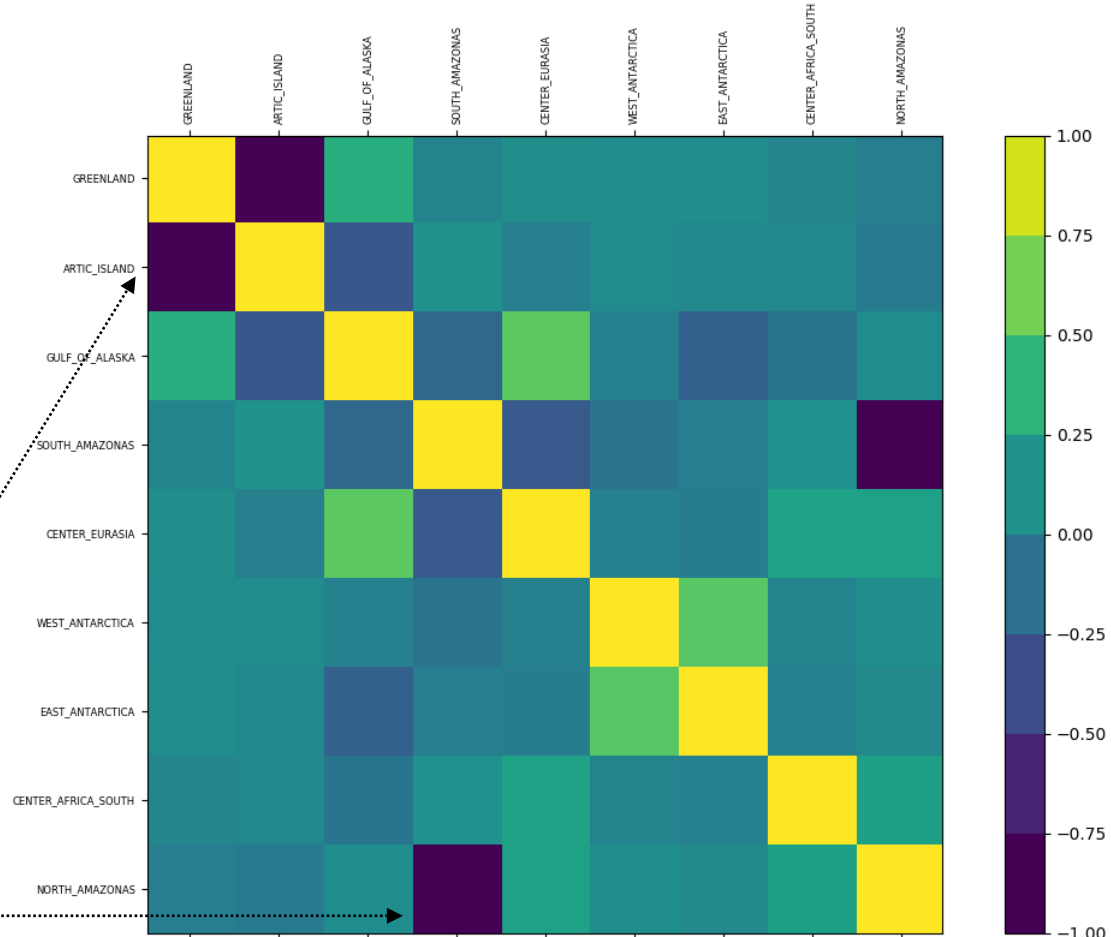
North & South Amazonas

Independent solutions on Greenland + Artic Islands, period 2002 → 2012

GREENLAND

ARTIC ISLAND

GREENLAND + ARTIC ISLAND

DORIS
SLR
GRACE PLOTTER
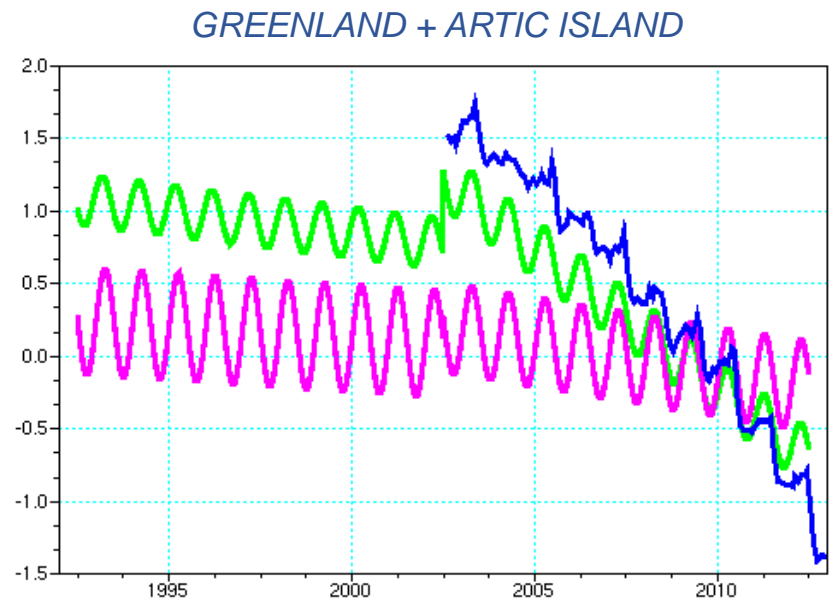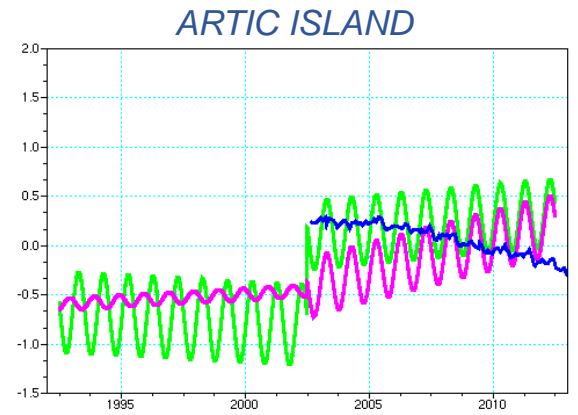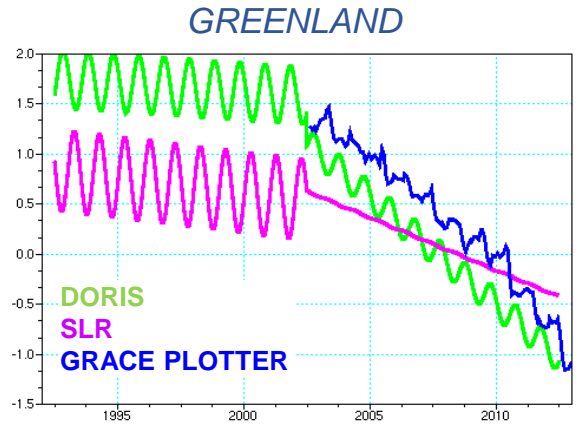
Validation

GRACE Plotter Tools

Period 2002 → 2012

Unit in TeraTons

DORIS + SLR

Adjusted drift need

to be improved on

some mascons like

Greenland, South AMAZONAS

→ quite equivalent

GREENLAND
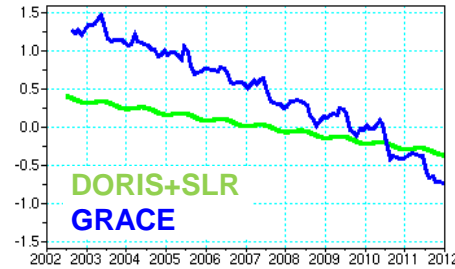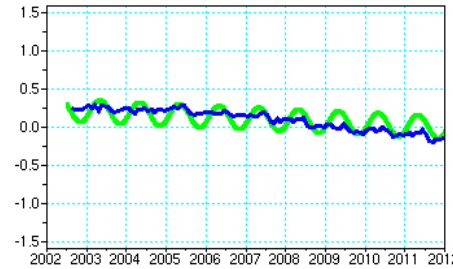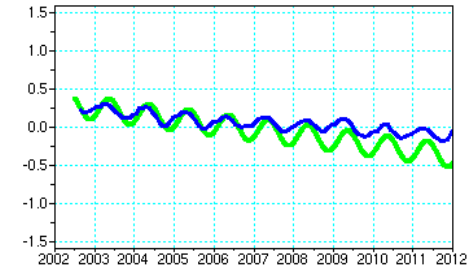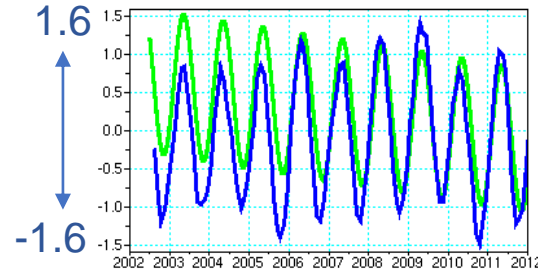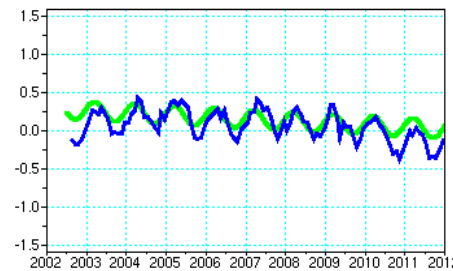
DORIS+SLR
GRACE

ARTIC ISLAND

GULF OF ALASKA
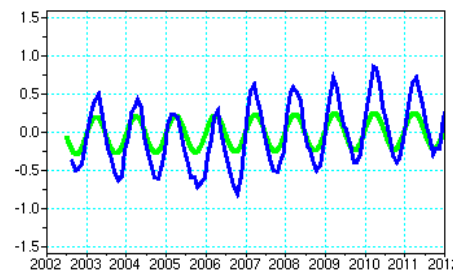
1.6

-1.6

SOUTH AMAZONAS
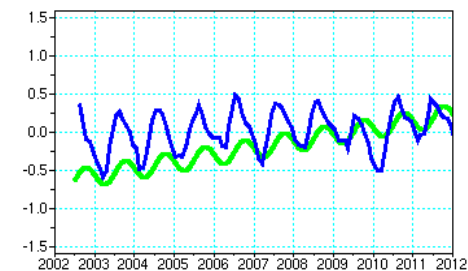
CENTER EURASIA
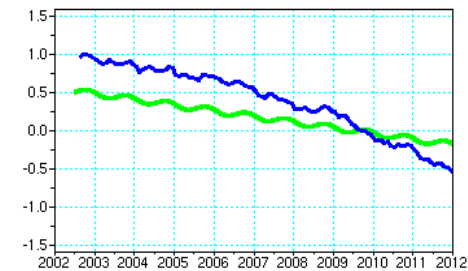
WEST ANTARTICA
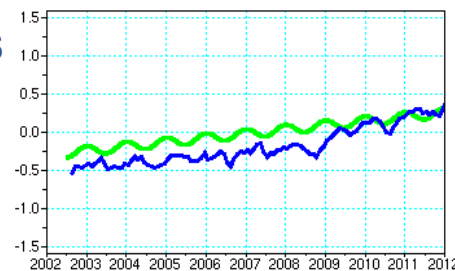
EAST ANTARTICA

CENTER AFRICA SOUTH
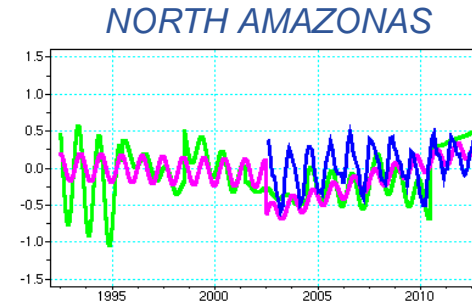
NORTH AMAZONAS

Validation

GRACE Plotter Tools

Period 1992->2013

Unit Teratons
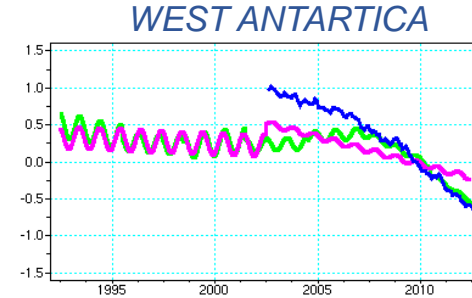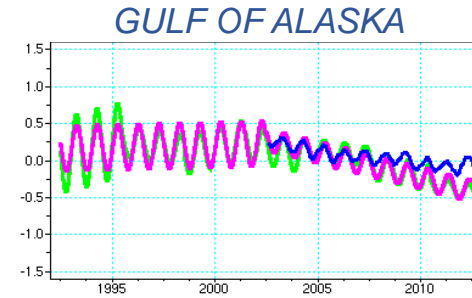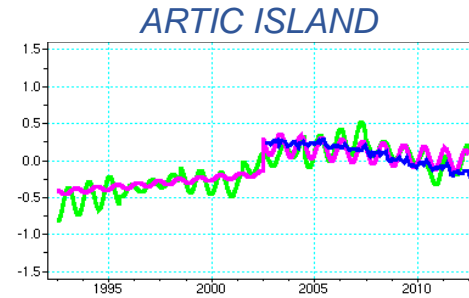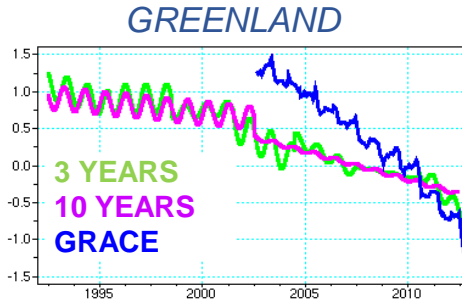
DORIS + SLR

Globally, 3 years or 10 years intervals give equivalent behaviour

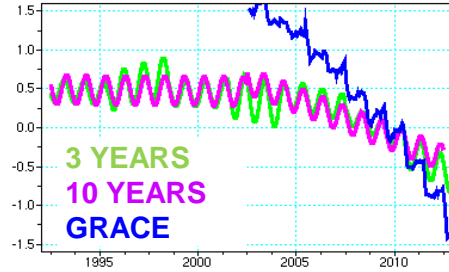**West Antartica, using shorter adjustment period fits better with GRACE**
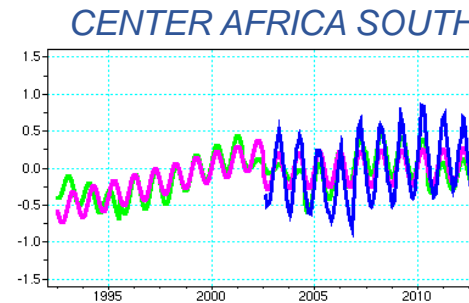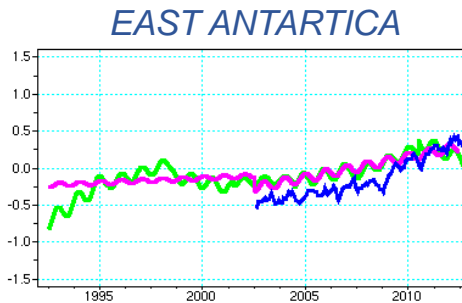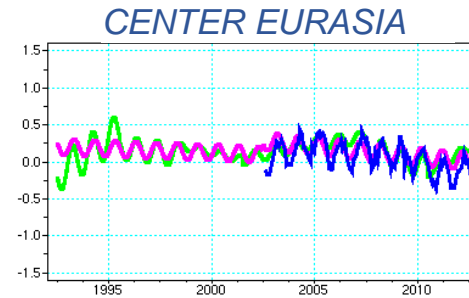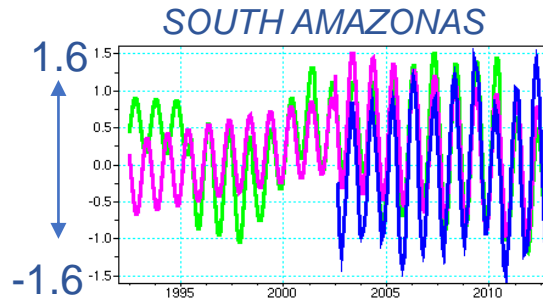
GREENLAND — 3 YEARS / 10 YEARS / GRACE

ARTIC ISLAND

GULF OF ALASKA

SOUTH AMAZONAS

CENTER EURASIA

WEST ANTARTICA

EAST ANTARTICA

CENTER AFRICA SOUTH

NORTH AMAZONAS

Validation

GRACE Plotter Tools

Period 1992->2013

Unit Teratons

DORIS + SLR
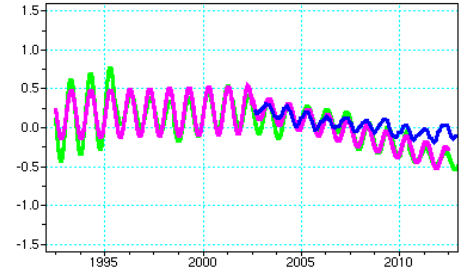
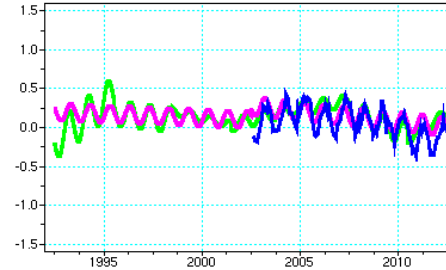**Better adequation on 'grouped regions', in particular on the annual phase term**

GREENLAND + ARTIC ISLAND

3 YEARS
10 YEARS
GRACE

GULF OF ALASKA

NORTH + SOUTH AMAZONAS

1.6

-1.6

CENTER EURASIA

WEST ANTARTICA

EAST ANTARTICA

CENTER AFRICA SOUTH

CONCLUSION

New approach using 36 parameters models, 4 terms by mascon, gives interesting results

Model seems to be well defined, i.e. no significant problem of observability

For this model Equatorial regions are correctly observed by SLR and DORIS missions give interesting results for high latitudes regions

This model could be improved

Integrate all available DORIS missions

Global annual terms, or integrate constraint, for all periods intervals (i.e. force coherency of the annual phase term)

Regions definition ?

(Under evaluation) Impact of reduced dynamic orbits