Federal Agency for
Cartography and Geodesy

Geophysical fluids: Models and their impact on space-geodetic solutions

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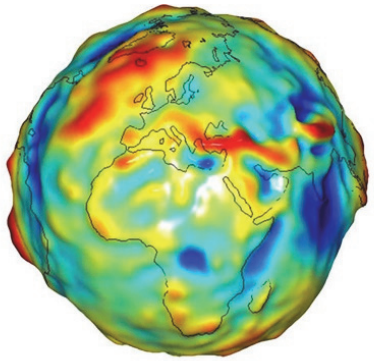
Model Compilation



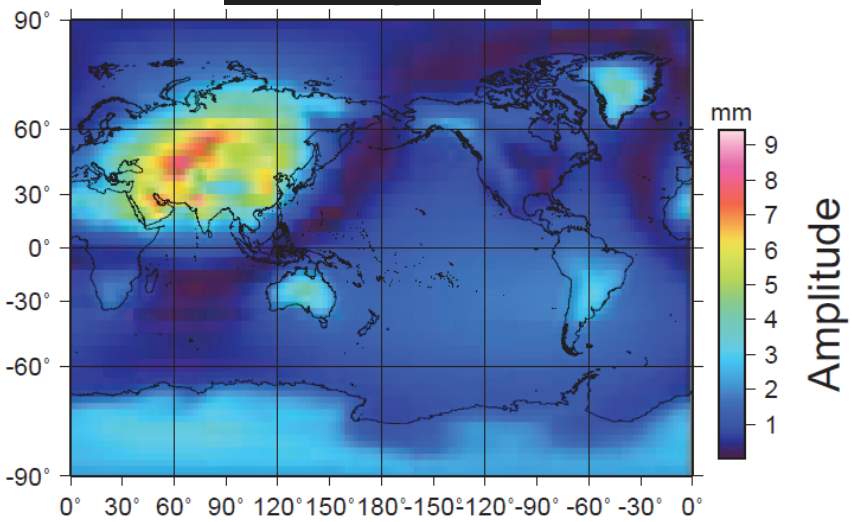
	Deformation			Gravity		
	Atmo.	Ocean	Hydro.	Atmo.	Ocean	Hydro.
GGFC	X	X	X	-	-	-
NASA	X	X	X	-	-	-
TU Vienna	X	-	-	X	-	-
Uni Strasbourg	X / X	-	X	X	-	X
GFZ	(X)	(X)	(X)	X	X	(X)

Model Compilation

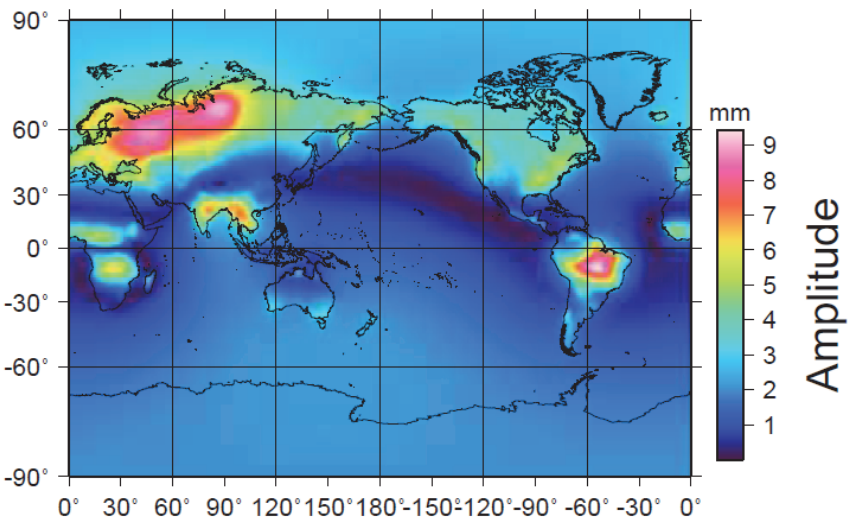
Atmosphere	Temp. Res.	Spatial Res.	Timespan	Model
GGFC	6 h	2.5 °	1980 – now	NCEP
NASA	6 h	2.5 °	1976 – now	NCEP
TU Vienna (V4)	6 h	1 °	1997 – 2013	ECMWF
Strasbourg	3 h / 6 h	0.5 °	2001 – 2013 2002 – 2013	ECMWF+ IB ECMWF + MOG2D ERAinterim + IB
Ocean				
GGFC	12 h	2.5 °	1993 – 2012	ECCO1
NASA	12 h	1 °	1993 - 2013	ECCO1
Hydrology				
GGFC	1 month	2.5 °	1979 – 2012	GLDAS (NOAH)
NASA	1 month	1 °	1979 – now	GLDAS (NOAH)
Strasbourg	3 h / 6 h	0.5 °	2001 – 2013	GLDAS (NOAH) ERAinterim

Yearly signals

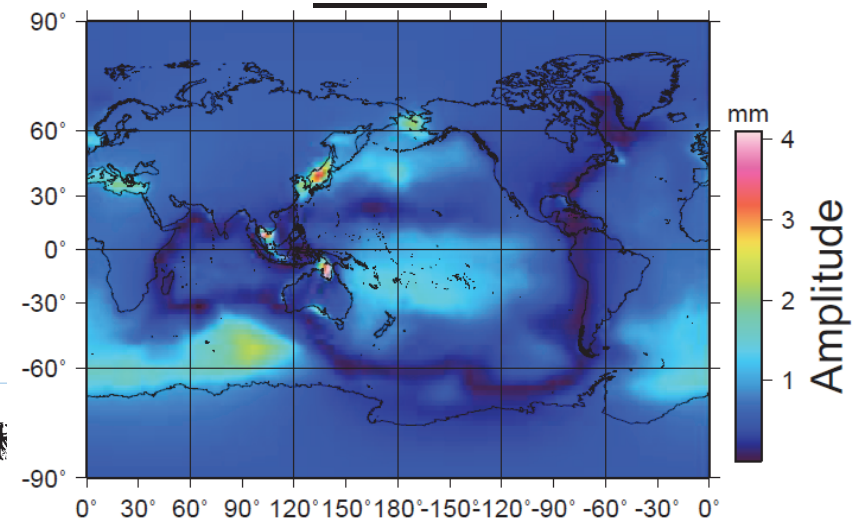
Atmosphere



Hydrology

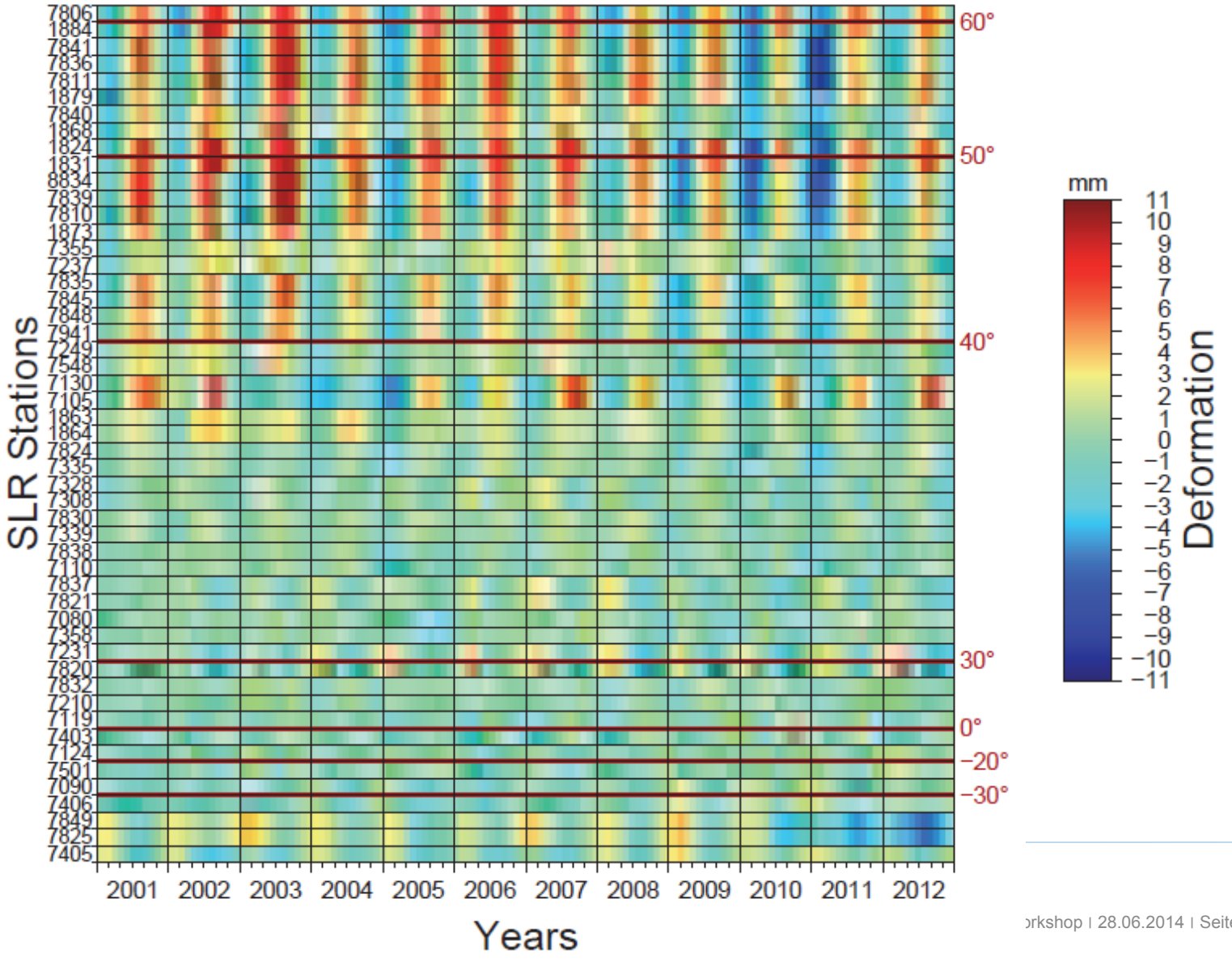


Ocean



- NASA grids used
- Min. 19 years of grids
- Solved together with linear trend and offset

Hydrology loading at SLR stations



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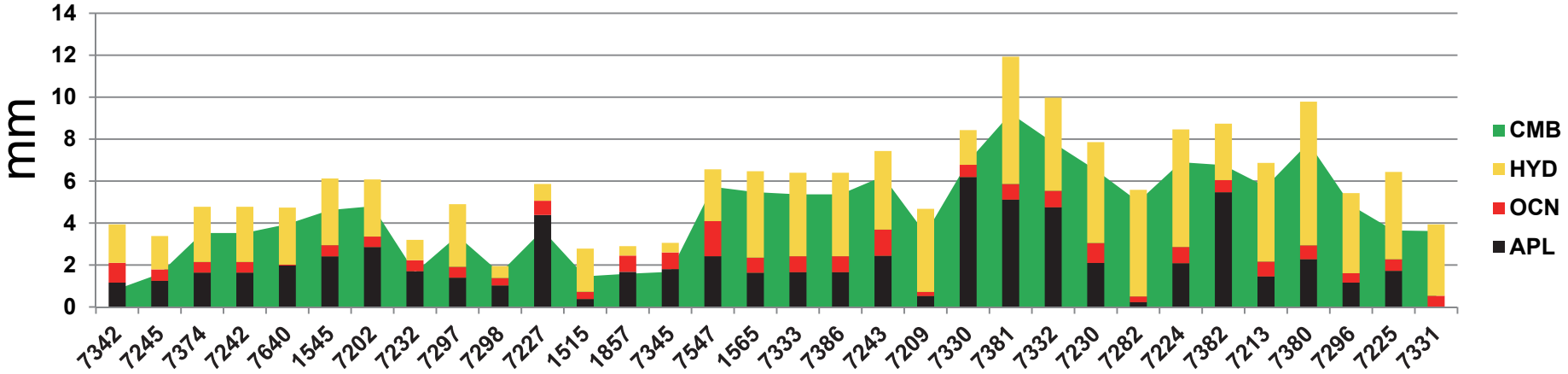
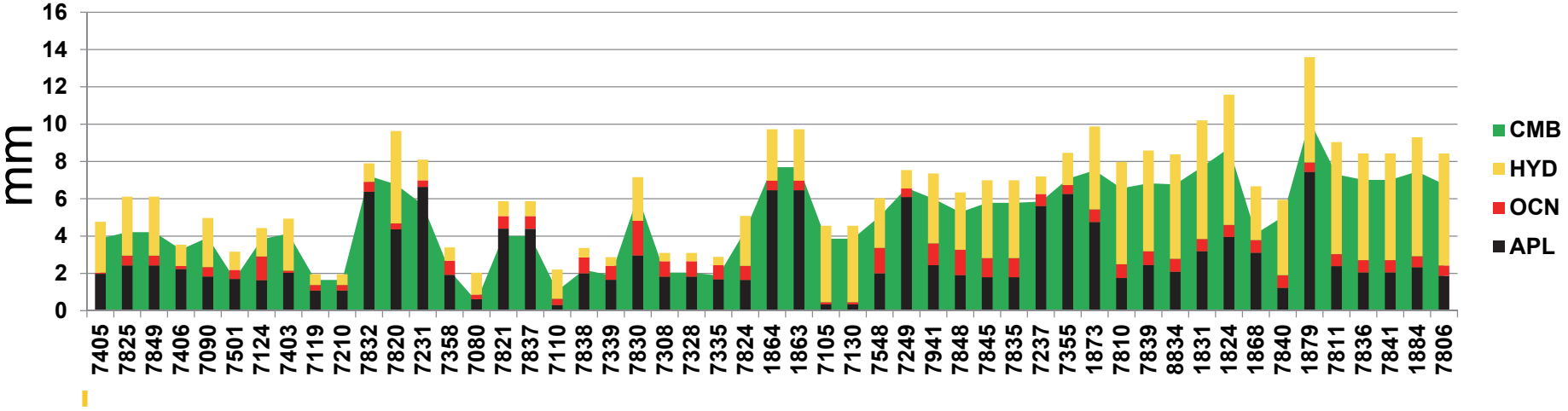
Signal at stations (up component)

VLBI stations (sorted by latitude)

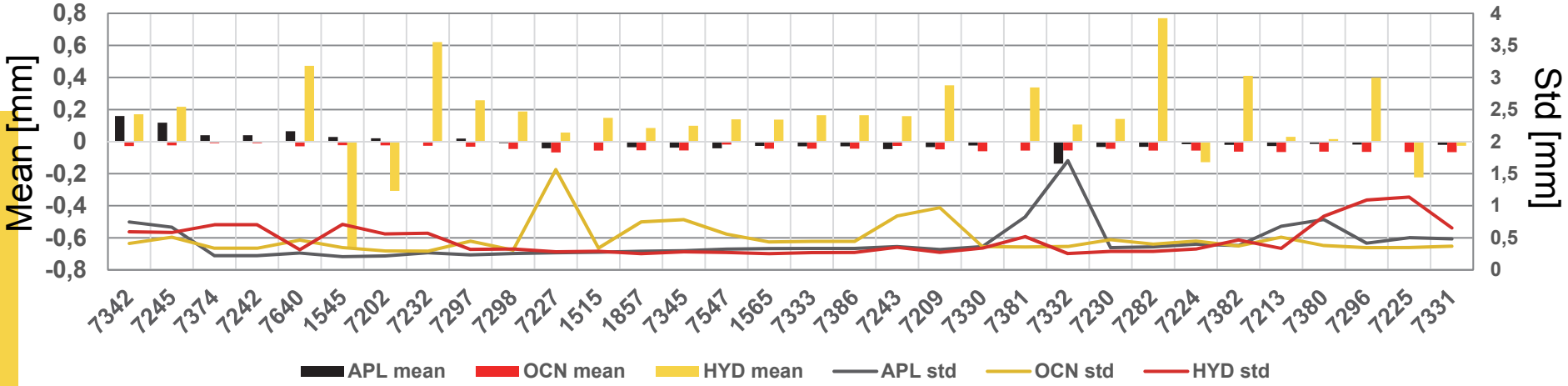


SLR stations (sorted by latitude)

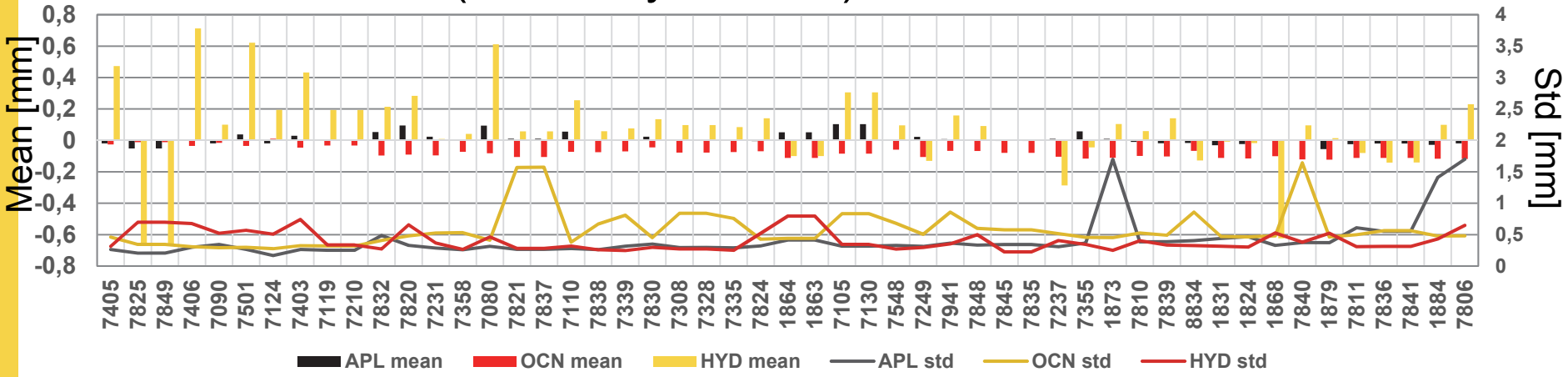


Model differences : NASA – GGFC (up)

VLBI stations (sorted by latitude)

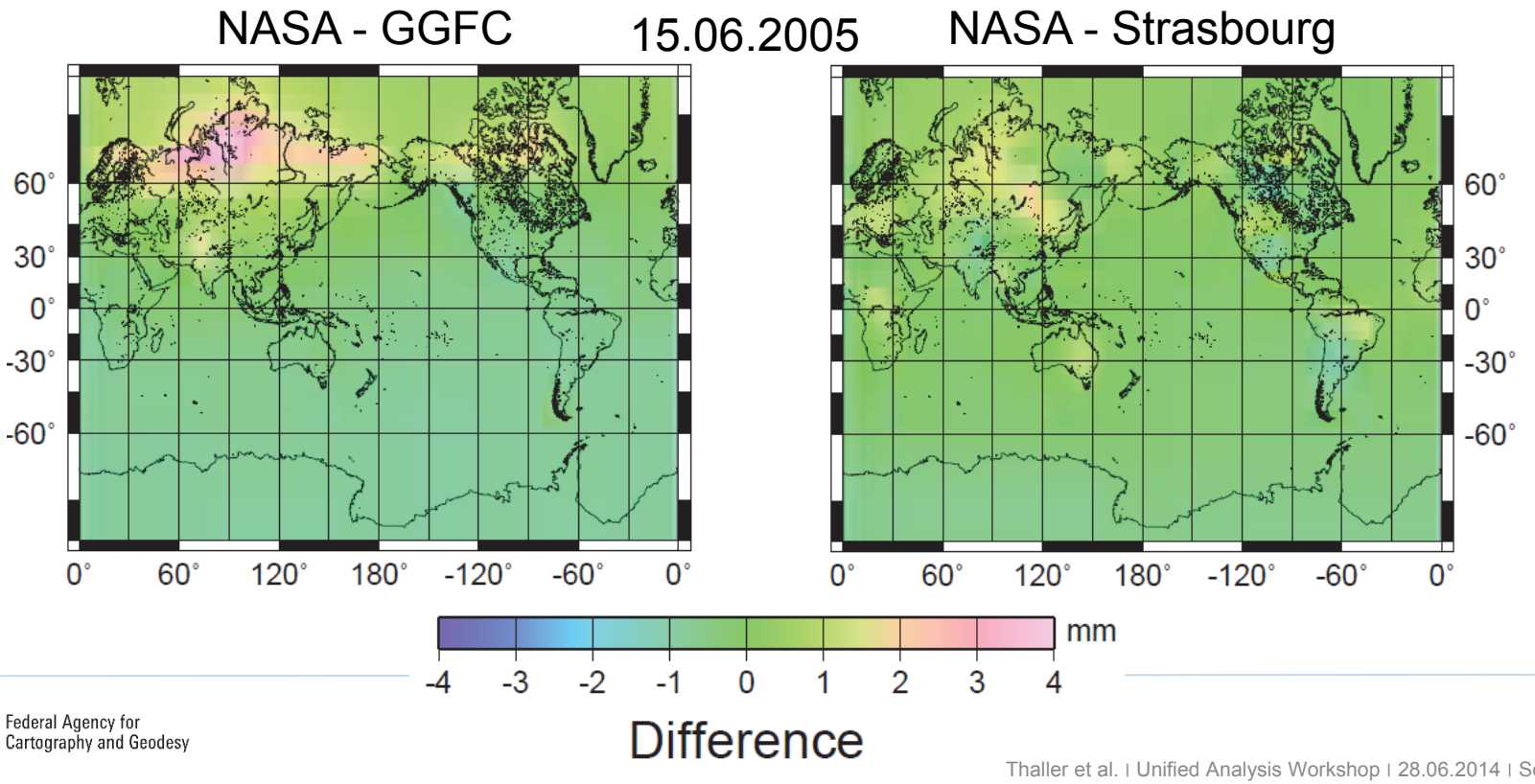


SLR stations (sorted by latitude)



Grid differences - Hydrology

- Differences calculated for a 2.5° grid
- Spatial interpolation for NASA model (1° -> 2.5°)
- Temporal mean for Strasburg grid (3h -> 1day)



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VLBI and SLR processing

SLR:

- 11 years of LAGEOS-1/-2 and Etalon-1/-2 data
- Bernese GNSS Software: used in daily ILRS analysis at BKG AC
- Gridded loading values

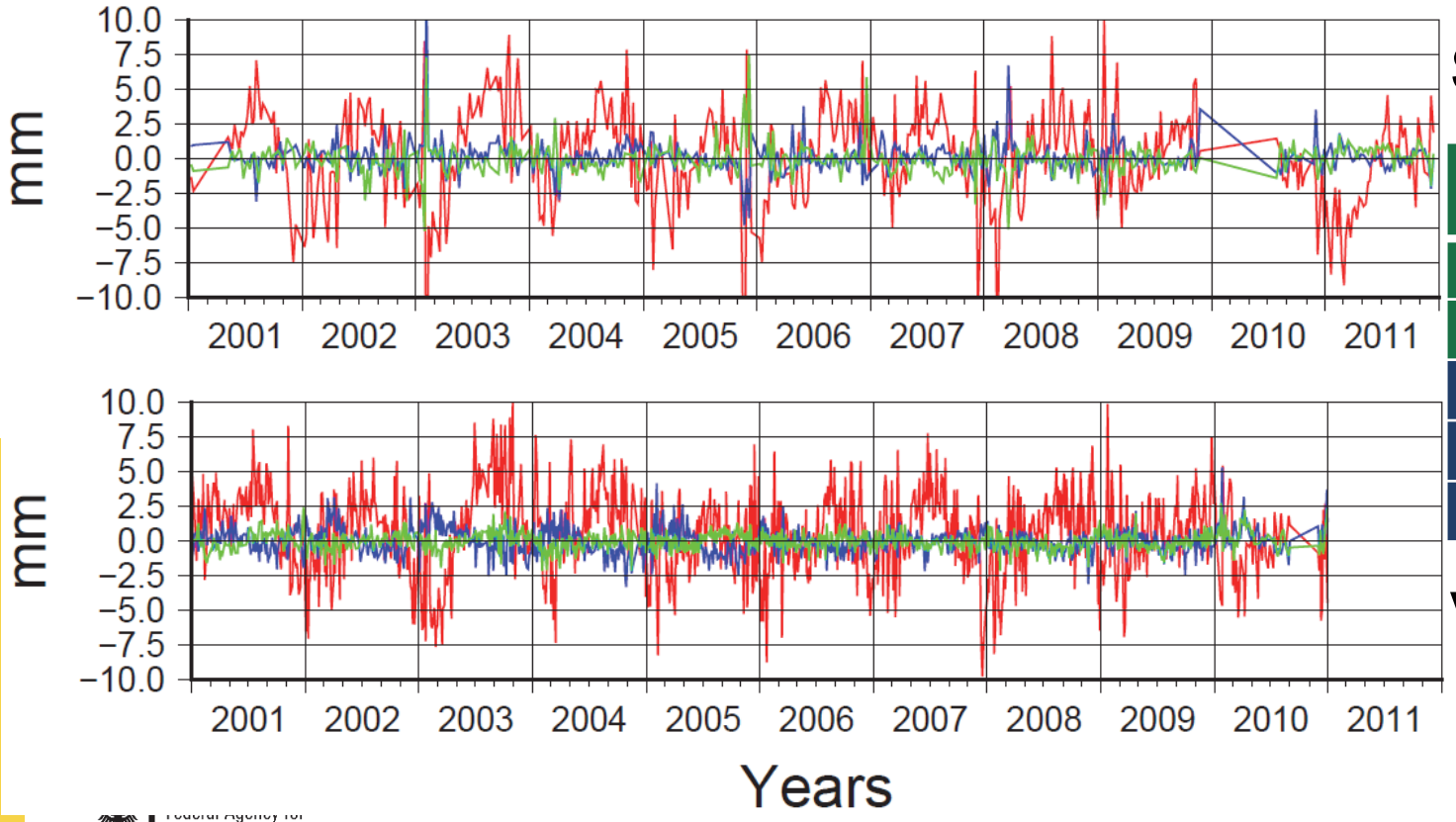
VLBI:

- 10 years of R1 and R4 sessions
- Calc/Solve Software: used in IVS analysis at BKG AC
- Station specific loading series (interpolated from grids)

Processing done with different selections of models

Impact on station coordinates: Wettzell

Differences in north, east and up w.r.t. reference solution



SLR

SLR	dn [mm]	de [mm]	du [mm]
mean	-0,100	0,080	0,167
std	1,070	1,111	3,552
VLBI			
mean	-0,022	-0,064	0,563
std	0,635	0,941	3,084

VLBI

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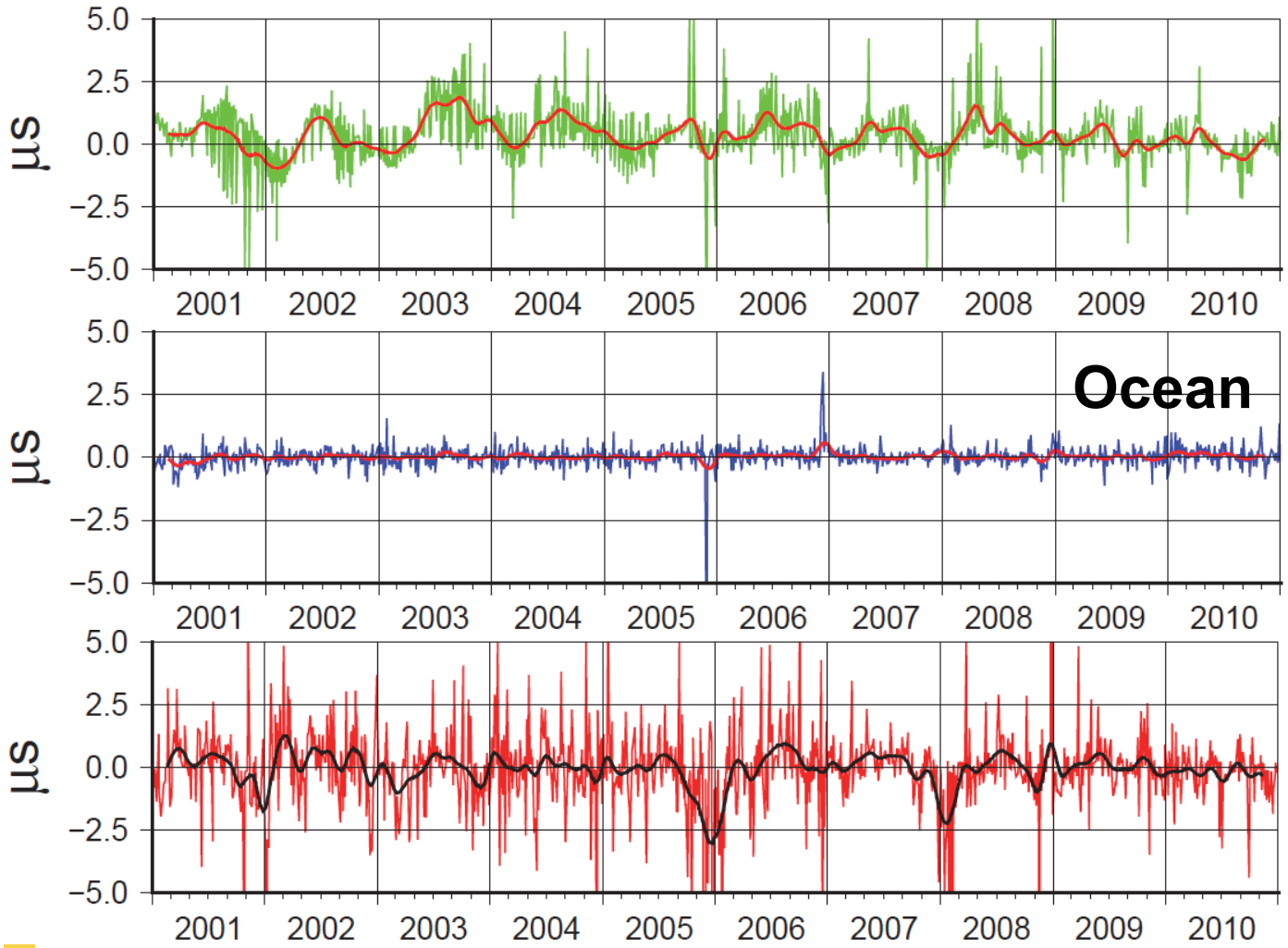
Earth rotation parameter – UT1



	mean [µs]	std [µs]
cmb	0,263	2,311
apl	-0,071	1,734
ocn	0,023	0,411
hyd	0,310	1,080

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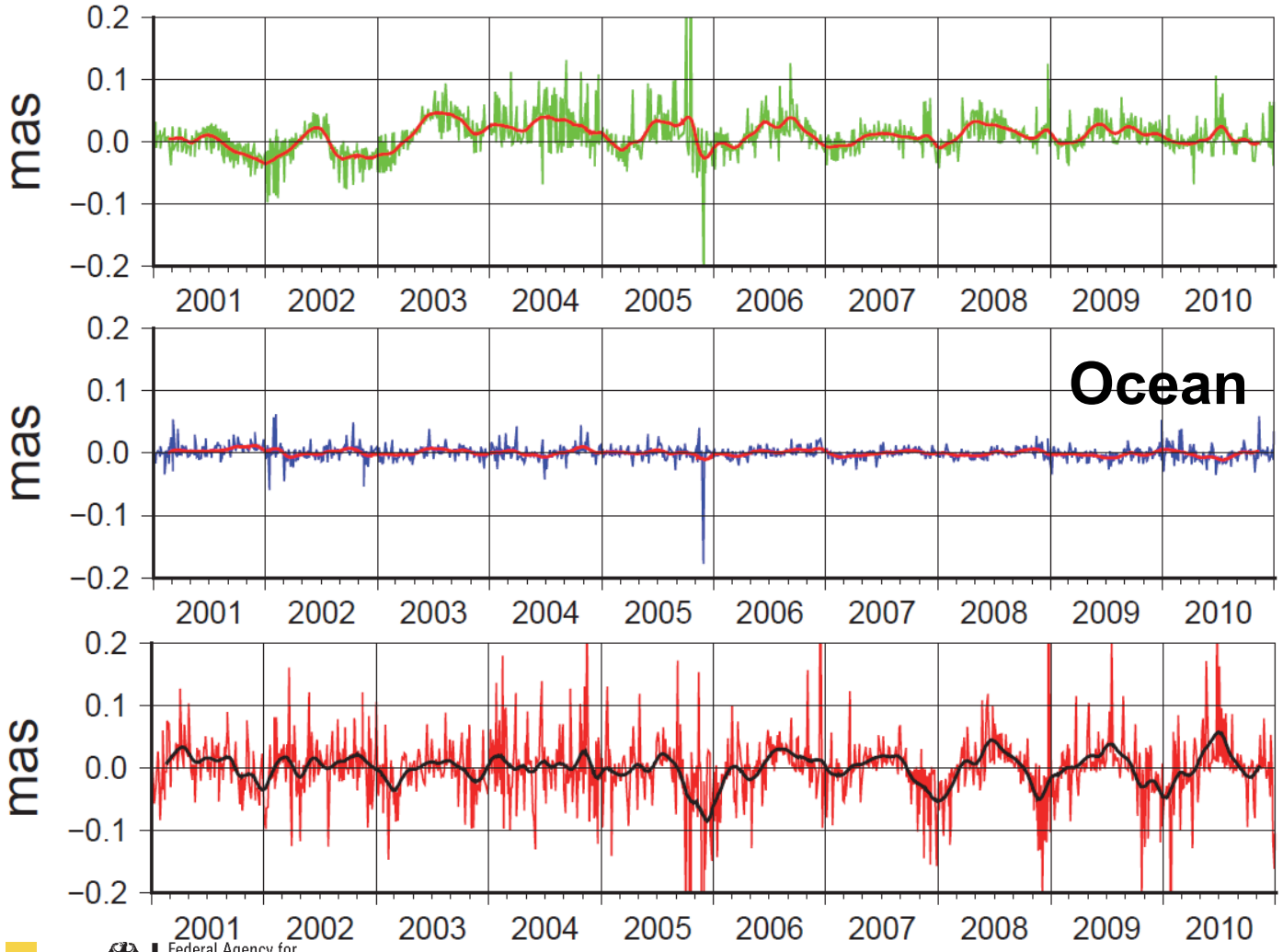
Earth rotation parameter – Y-pole (VLBI)



	mean [µas]	std [µas]
cmb	8,000	70,830
apl	-0,464	56,668
ocn	0,438	12,142
hyd	8,021	32,085

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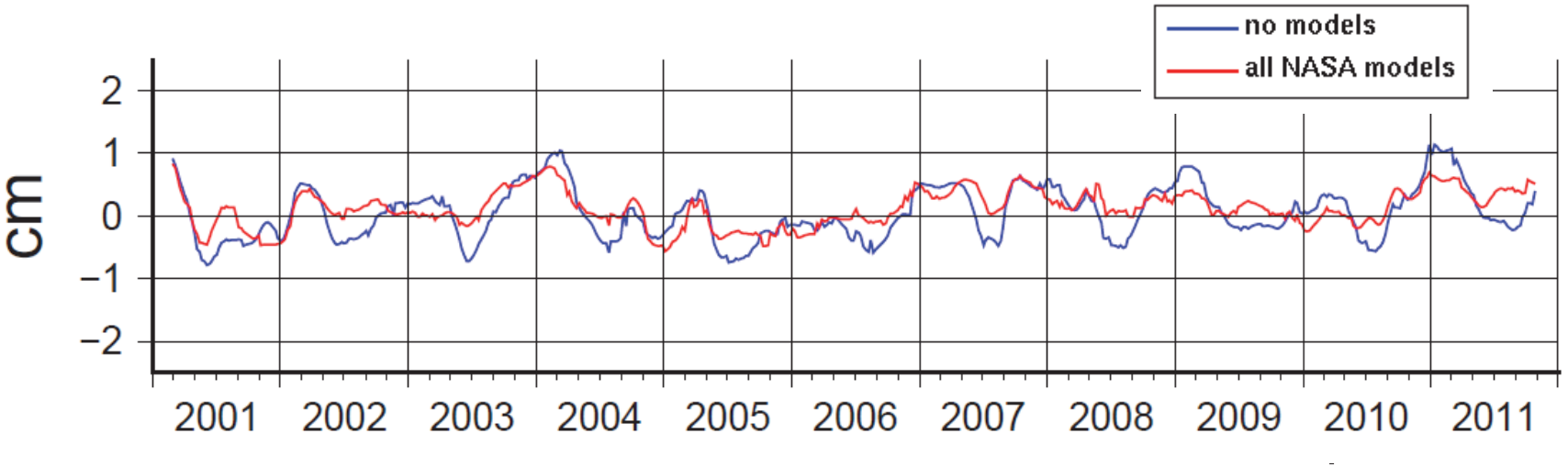
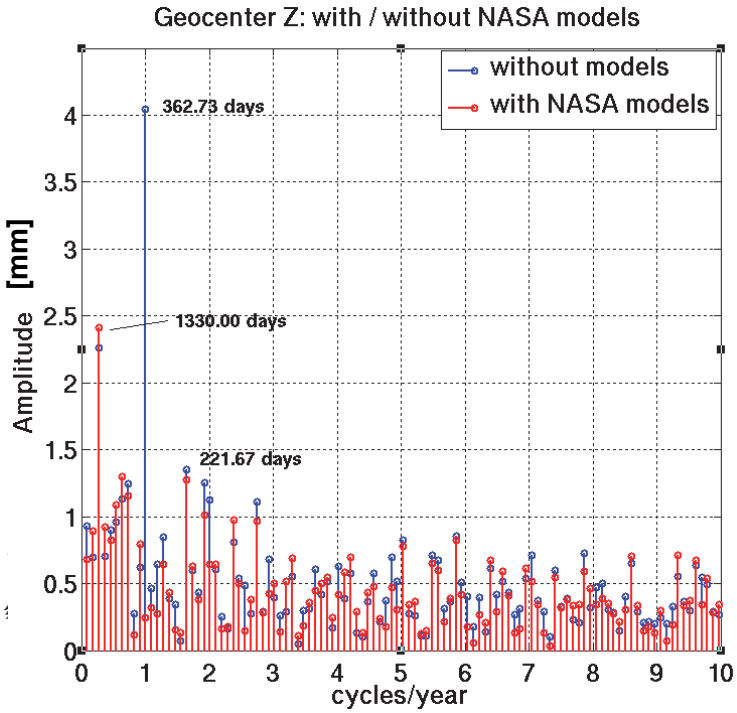
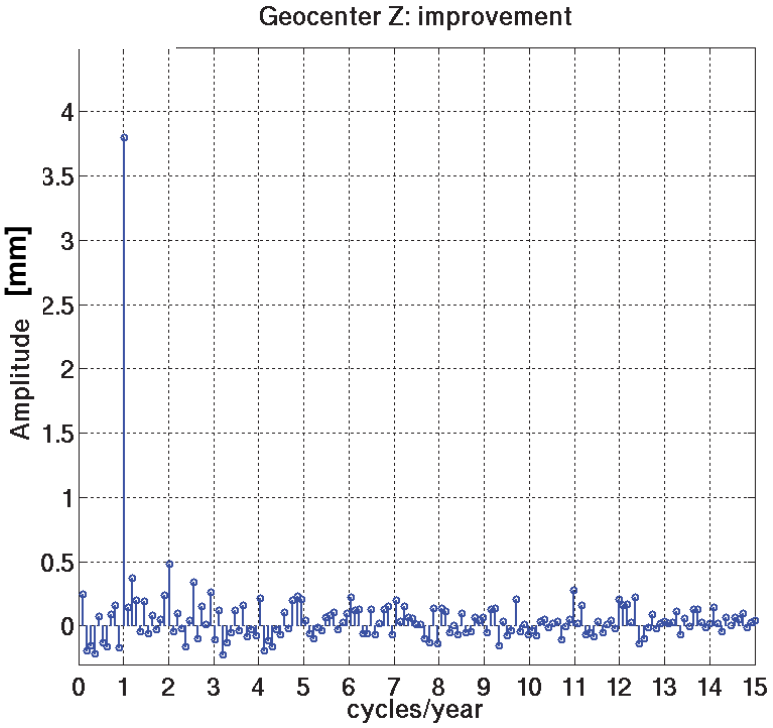
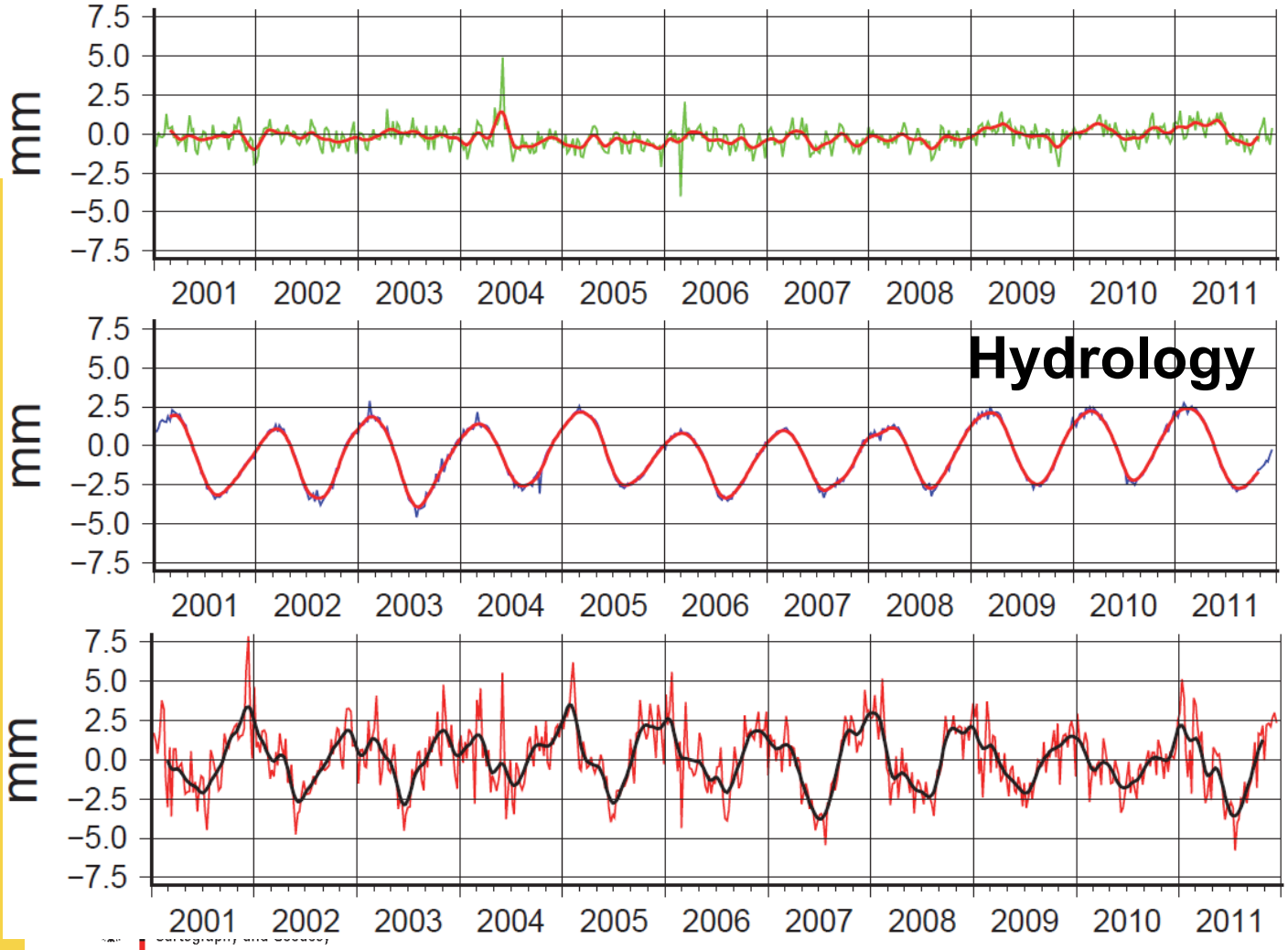
Geocenter coordinates





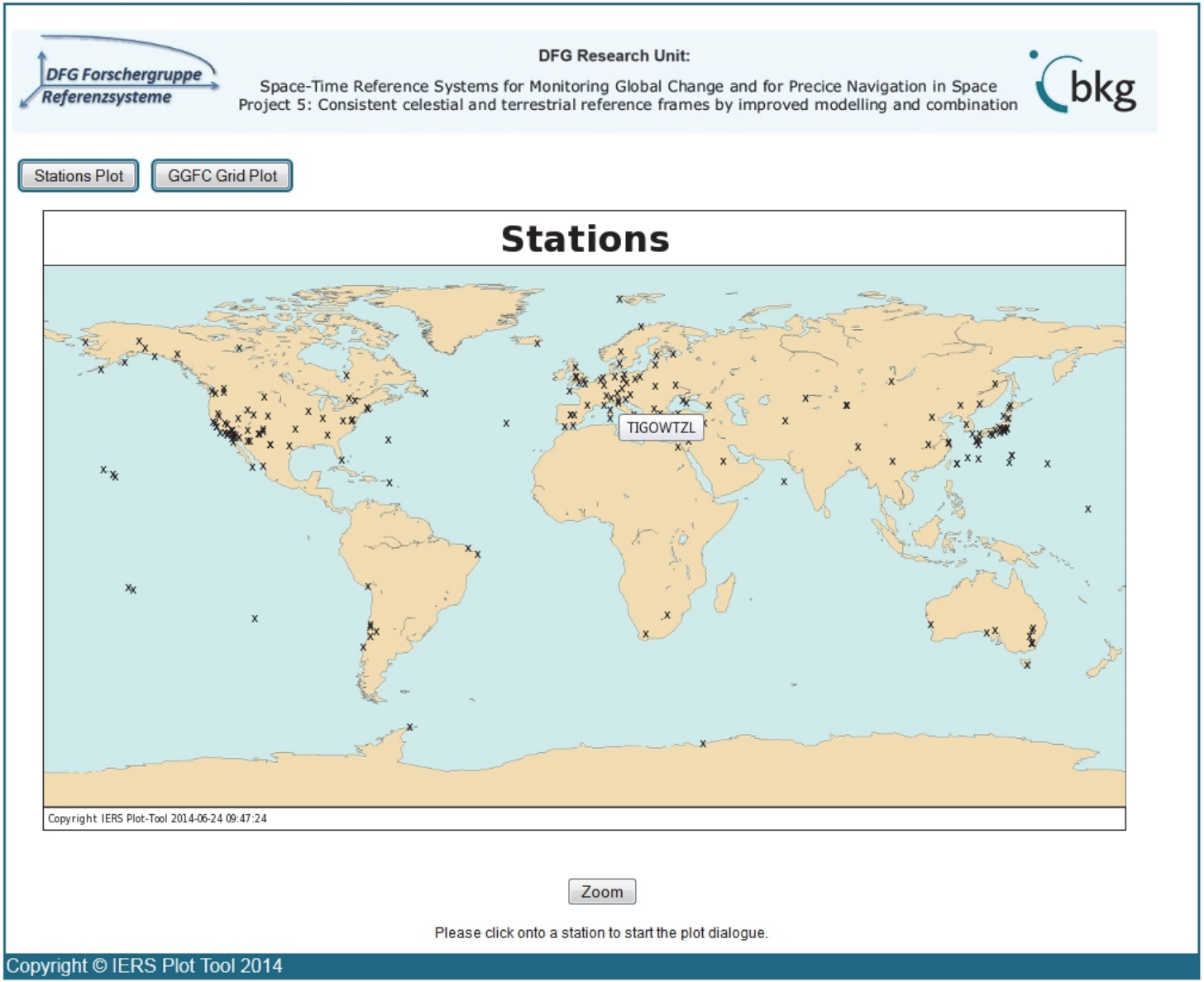


Geocenter coordinates – model impact



	mean [mm]	std [mm]
cmb	-0,688	3,248
apl	0,054	2,066
ocn	-0,192	0,708
hyd	-0,521	1,749

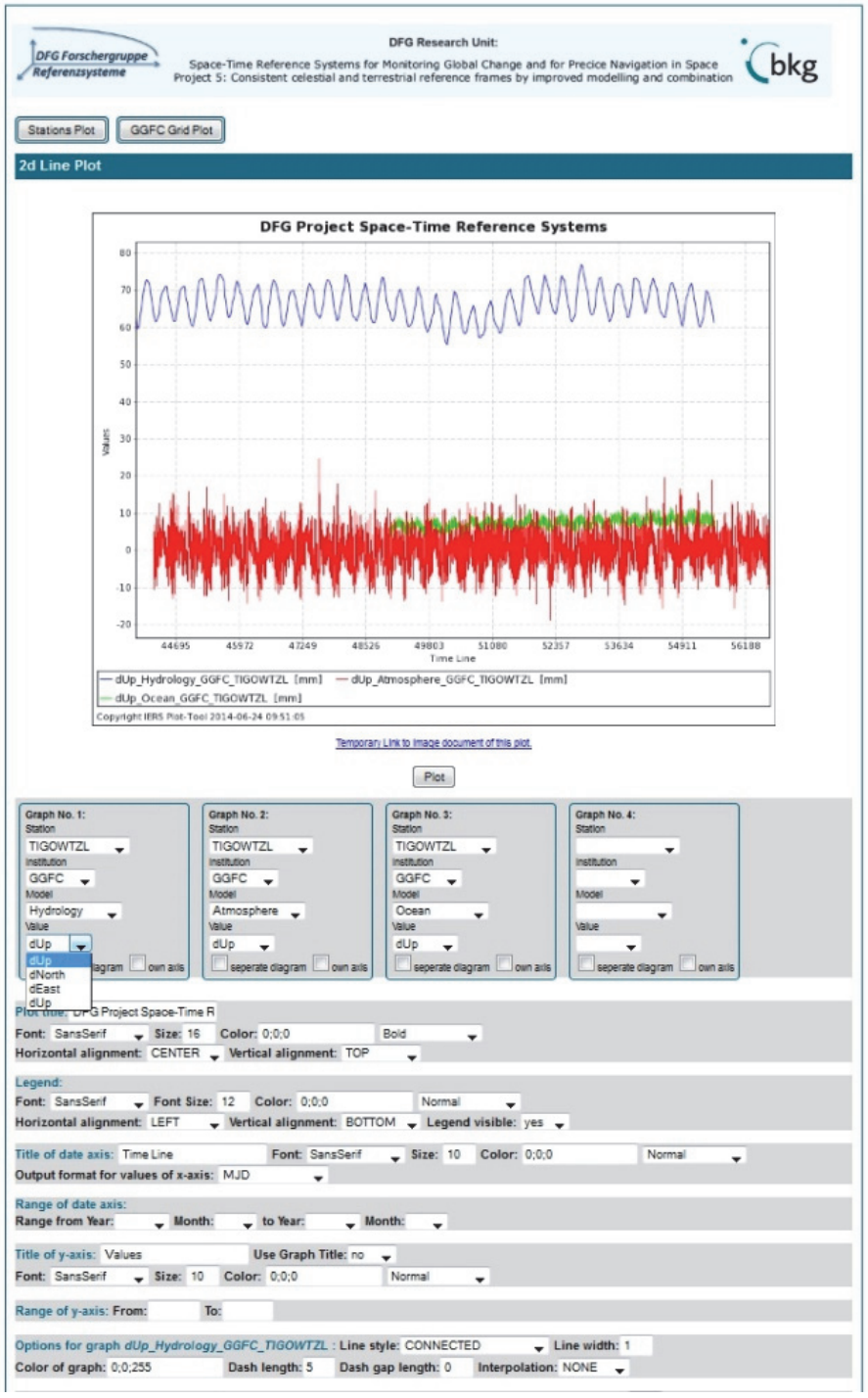
Preparing an online tool



Preparing an online tool

Federal Agency for Cartography and Geodesy

Preparing an online tool



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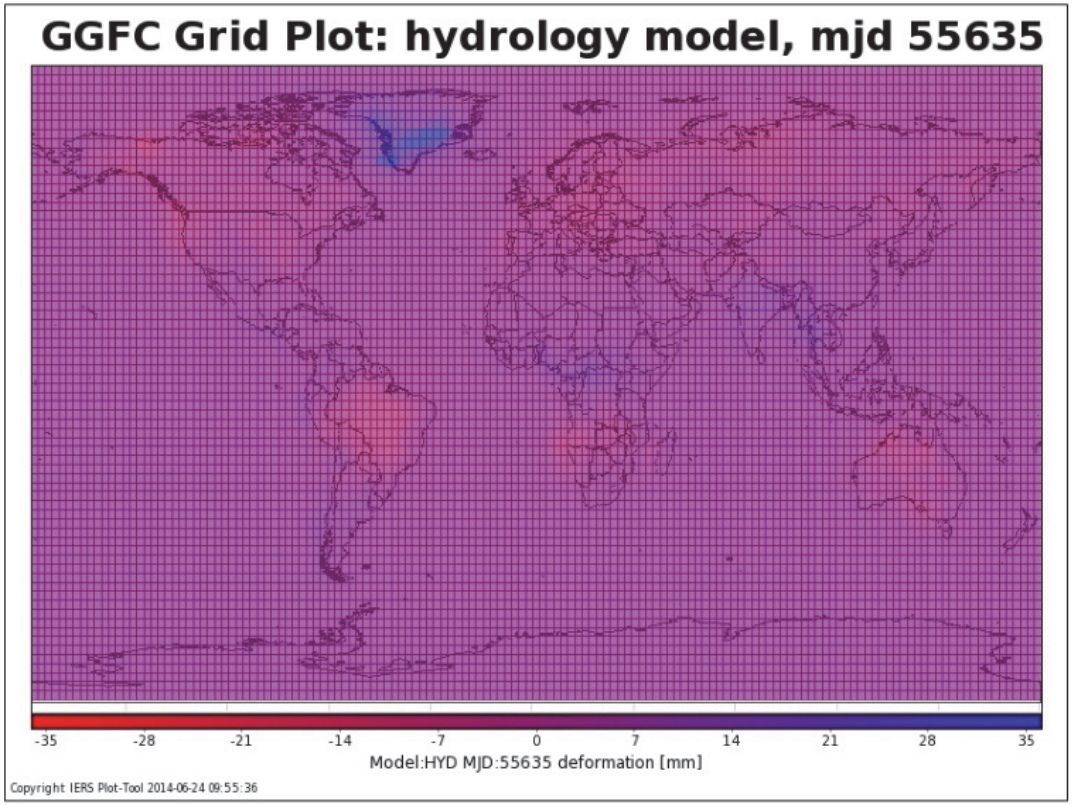
DFG Forschergruppe Referenzsysteme

DFG Research Unit:

Space-Time Reference Systems for Monitoring Global Change and for Precice Navigation in Space
Project 5: Consistent celestial and terrestrial reference frames by improved modelling and combination

bkg

Stations Plot | GGFC Grid Plot



Temporary Link to image document of this plot

Plot

Data set:

Hydrology model	Ocean model	Atmosphere model	Combination of models
Epoch (MJD) 55635	Epoch (MJD)	Epoch (MJD)	Epoch (MJD)

Plot title: GGFC Grid Plot hydro
Font: SansSerif Color: 0;0;0 Bold
Horizontal alignment: CENTER Vertical alignment: TOP

Value Range form to

Federal Agency for Cartography and Geodesy

Thank you for your kind attention!

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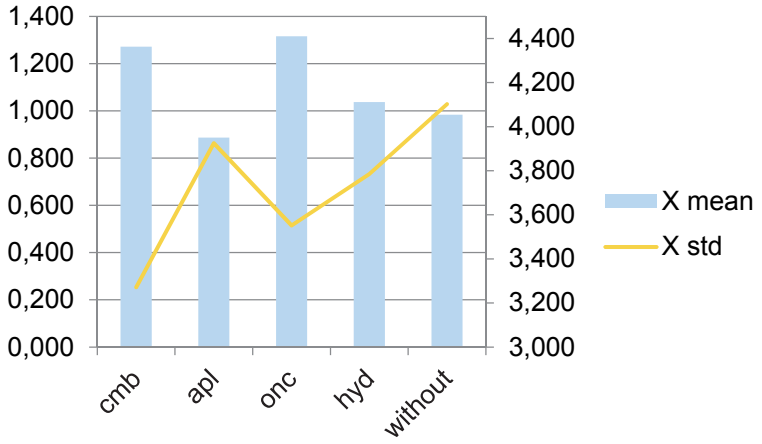
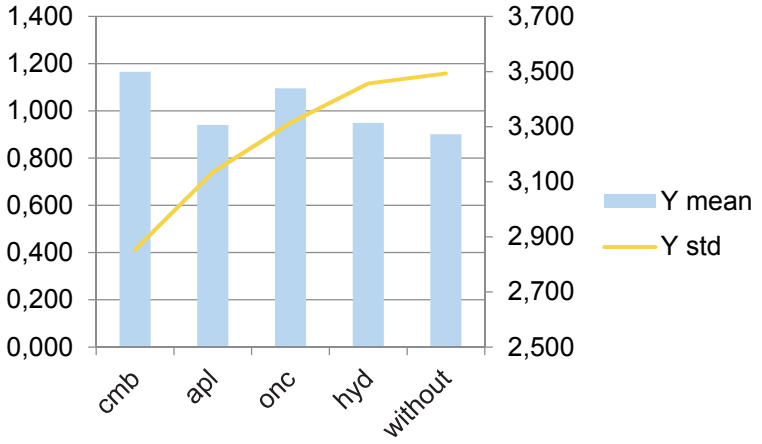
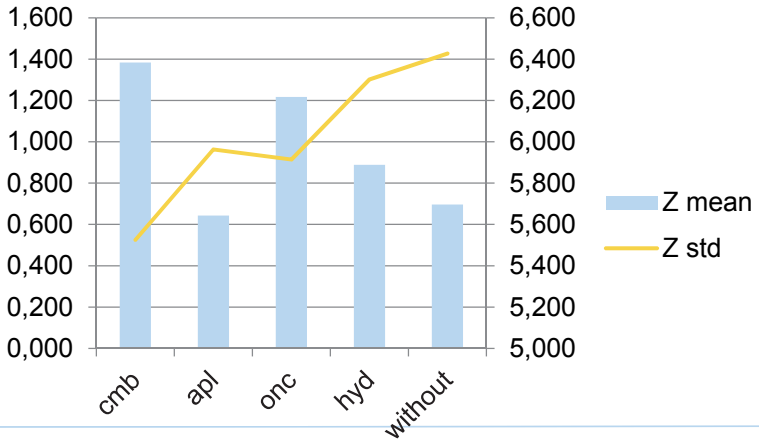
This work was funded by the DFG as a part of the Research Project (FOR1503): **„Space-Time Reference Systems for Monitoring Global Change and for Precise Navigation in Space“**

Visit our website:
www.referenzsysteme.de

GCC statistics



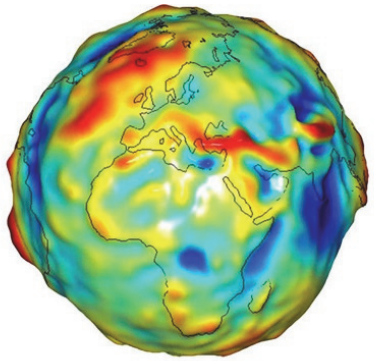




Conclusions

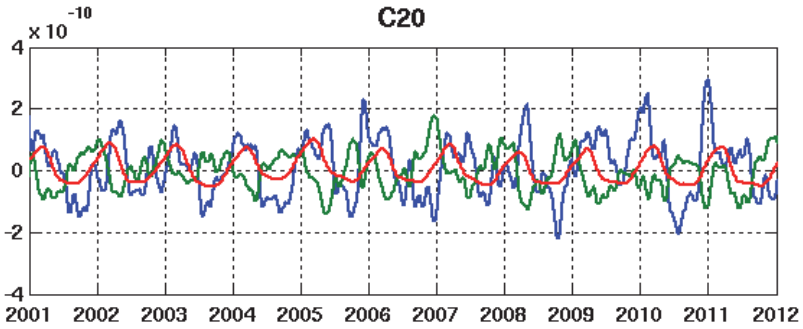
- Many different models available
  - Validation is necessary
- With SLR / VLBI hard to say which model performs best
  - Sparse network
  - Gaps in time series of station positions
- Seasonal variations in geocenter can be explained by the sum of atmosphere + ocean + hydrology
- Further investigations:
  - multi-year solution
  - model tests with GNSS and combined solutions

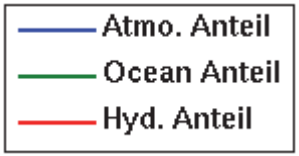
Model Compilation

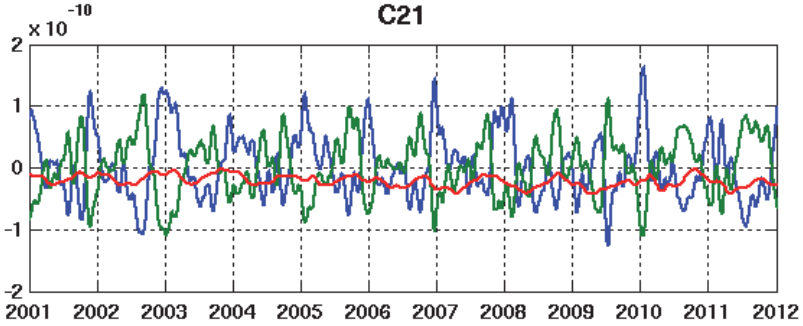


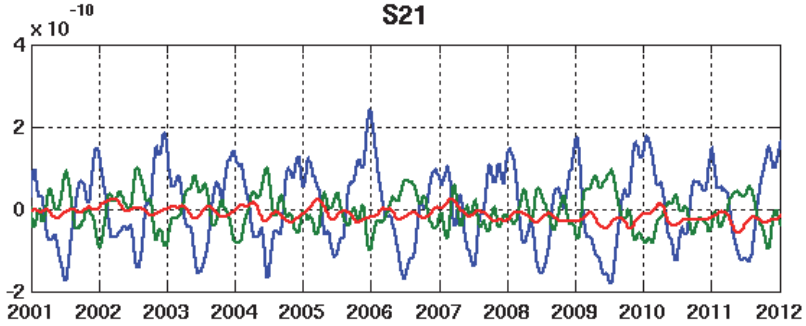
	Deformation			Gravity		
	Atmo.	Ocean	Hydro.	Atmo.	Ocean	Hydro.
GGFC	X	X	X	-	-	-
NASA	X	X	X	-	-	-
TU Vienna	X	-	-	X	-	-
Uni Strasbourg	X / X	-	X	X	-	X
GFZ	(X)	(X)	(X)	X	X	(X)

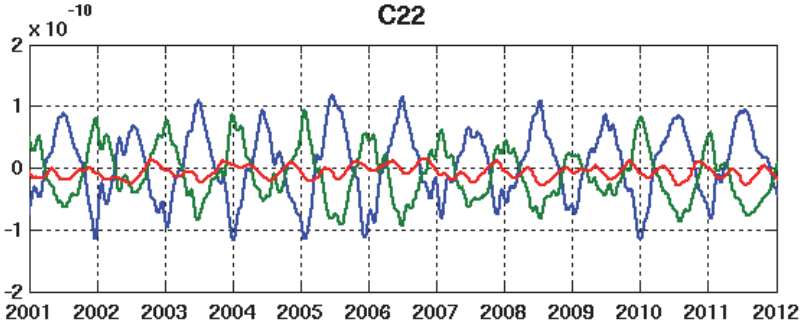
Gravity impact - einzeln

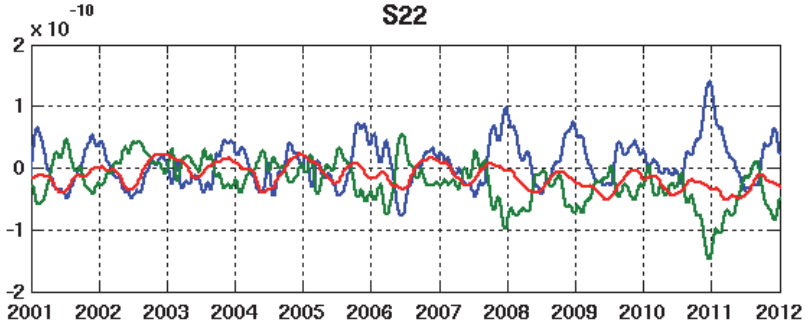




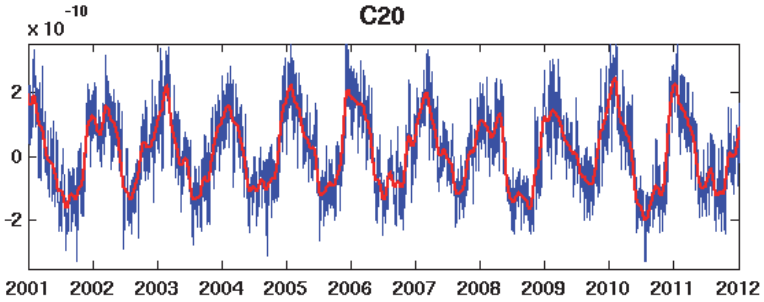


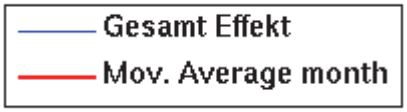


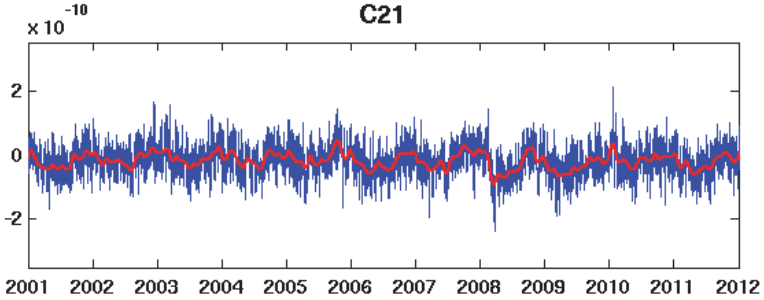


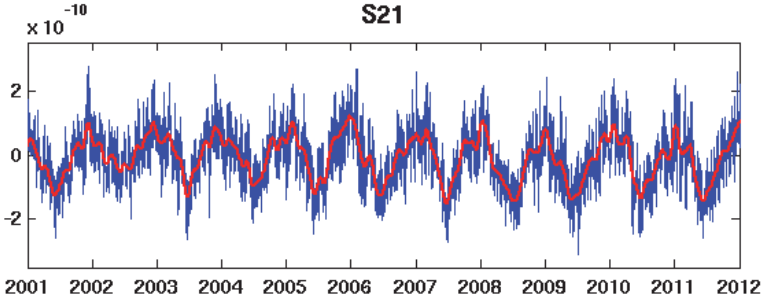


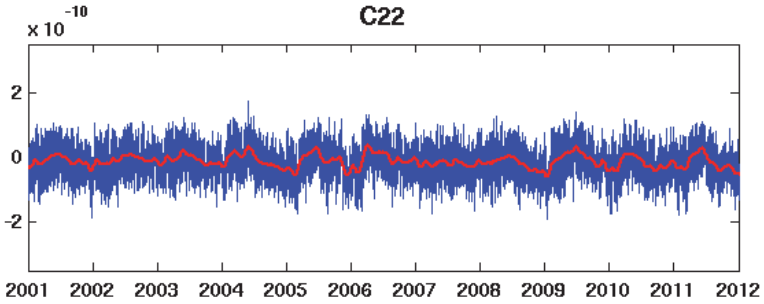
Gravity impact - gesamt

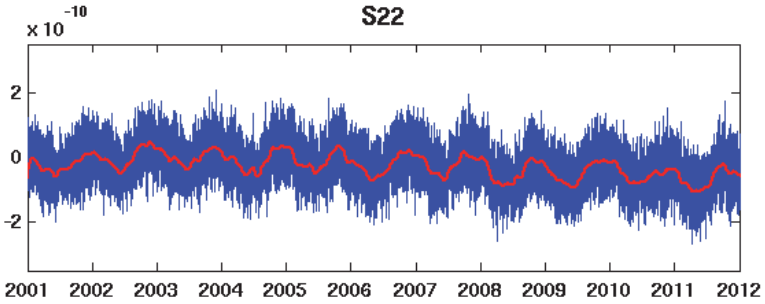




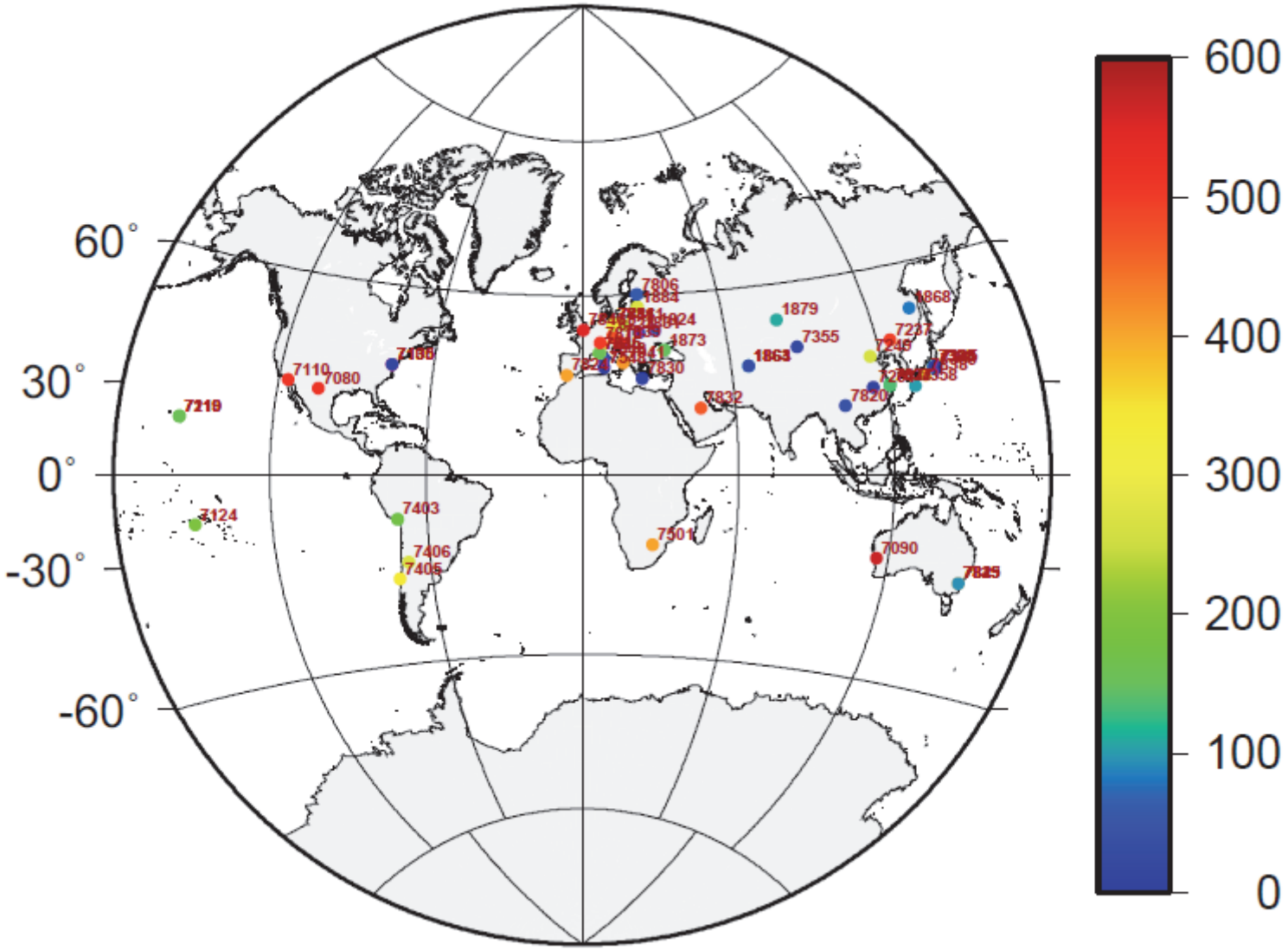




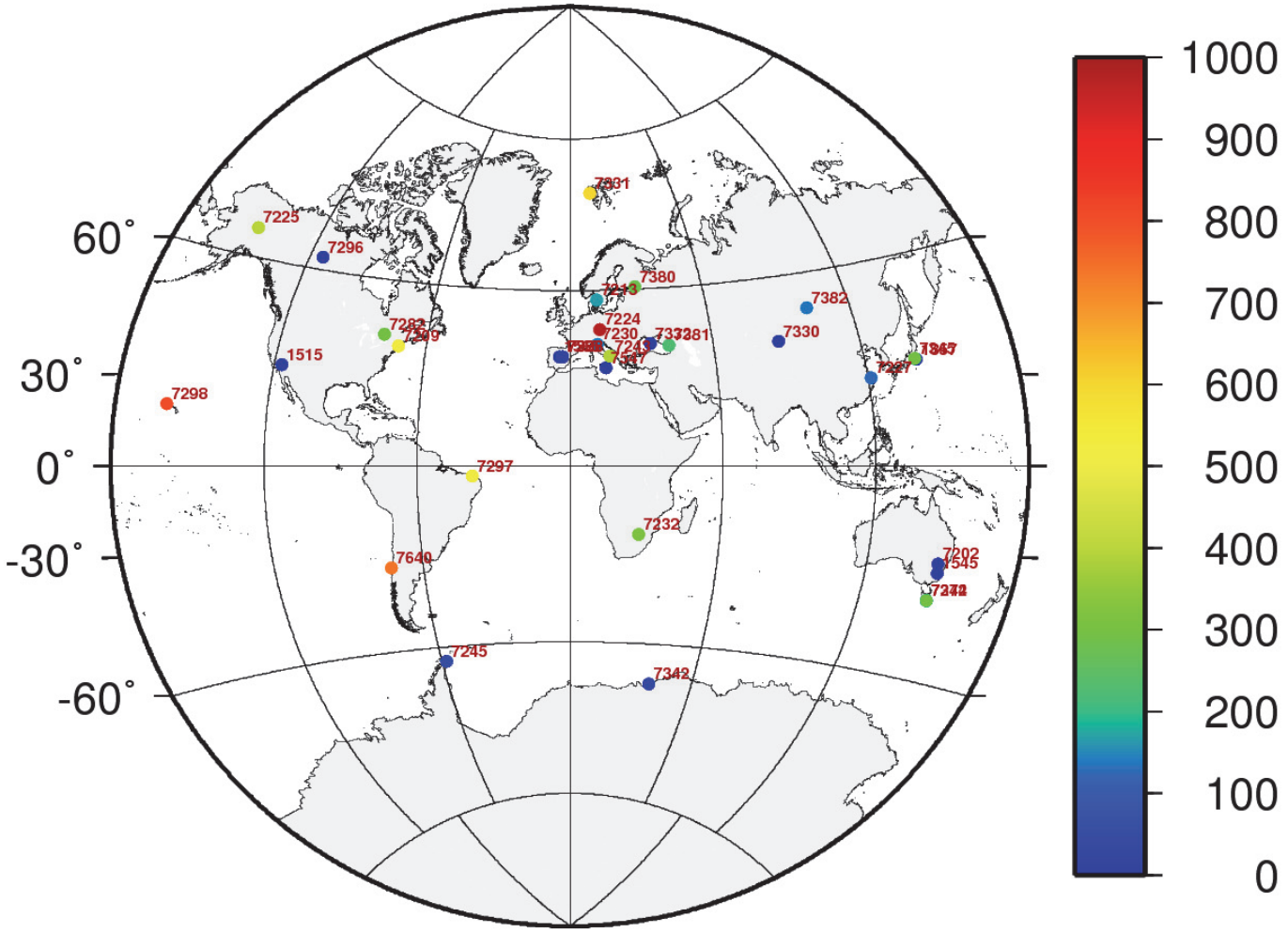




SLR stations



VLBI stations



ERPs – External comparison

Reference: IERS C04 series

	X-pol Mean	RMS	Y-pol Mean	RMS	UT1 Mean	RMS	LOD Mean	RMS
	[µas]		[µas]		[µs]		[µs]	
No models	-51	216	14	229	-0.33	34.1	-1.2	56.9
NASA models	-49	213	12	226	-0.23	34.1	-1.1	56.8
GGFC models	-49	214	10	227	-0.25	34.1	-1.1	56.8