Federal Agency for
Cartography and Geodesy

Geophysical fluid models for atmosphere, ocean and hydrology and their impact on SLR analysis

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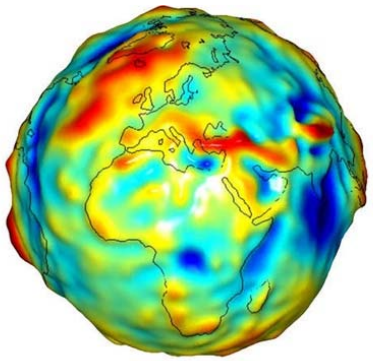
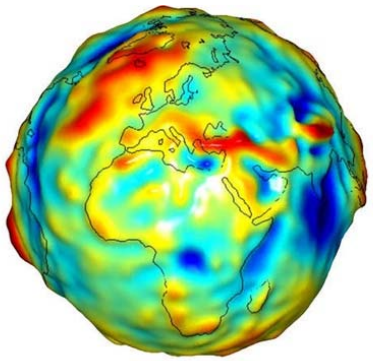
Federal Agency for Cartography and Geodesy

Geophysical Models – Compilation 1



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

Geophysical Models – Compilation 1



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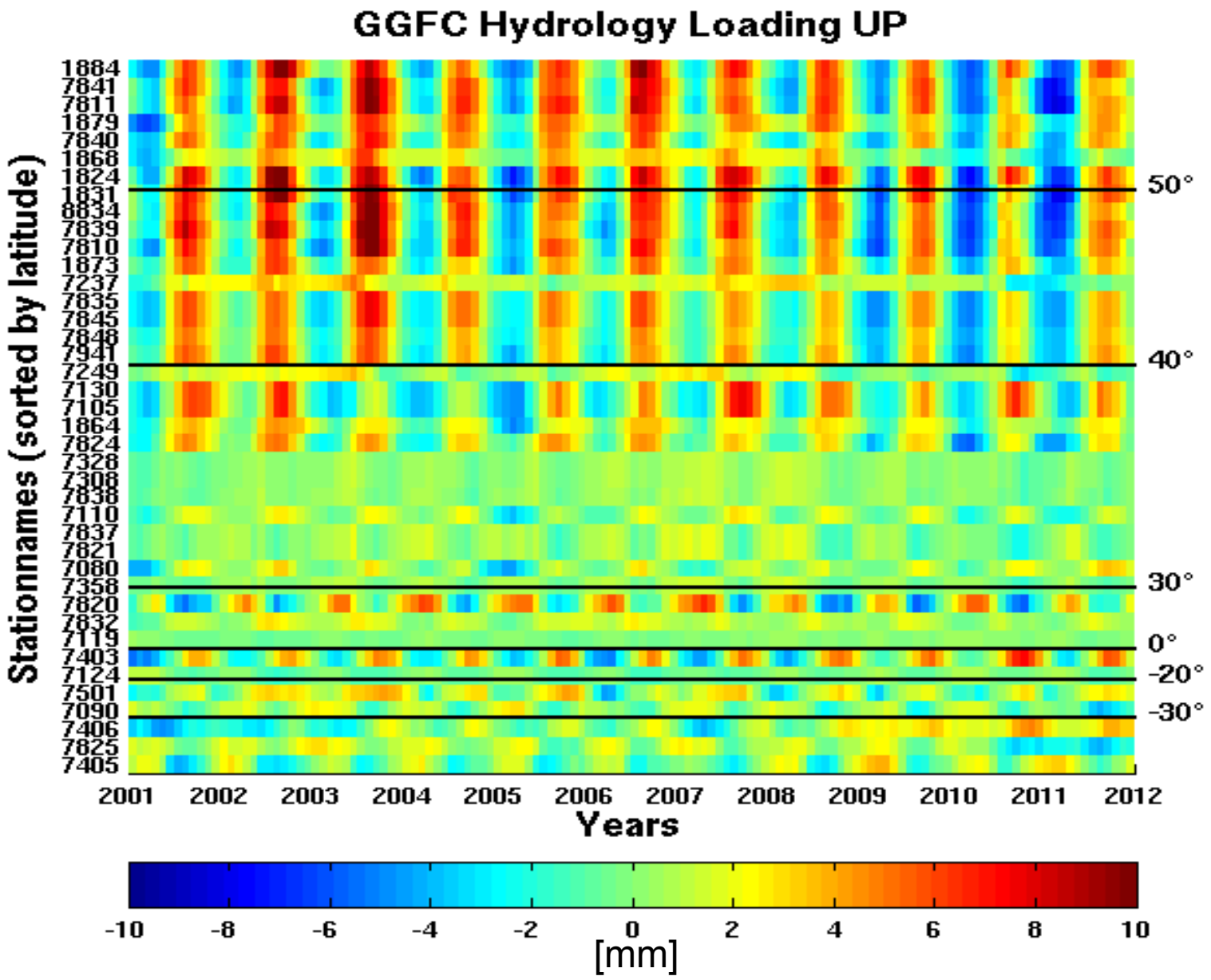
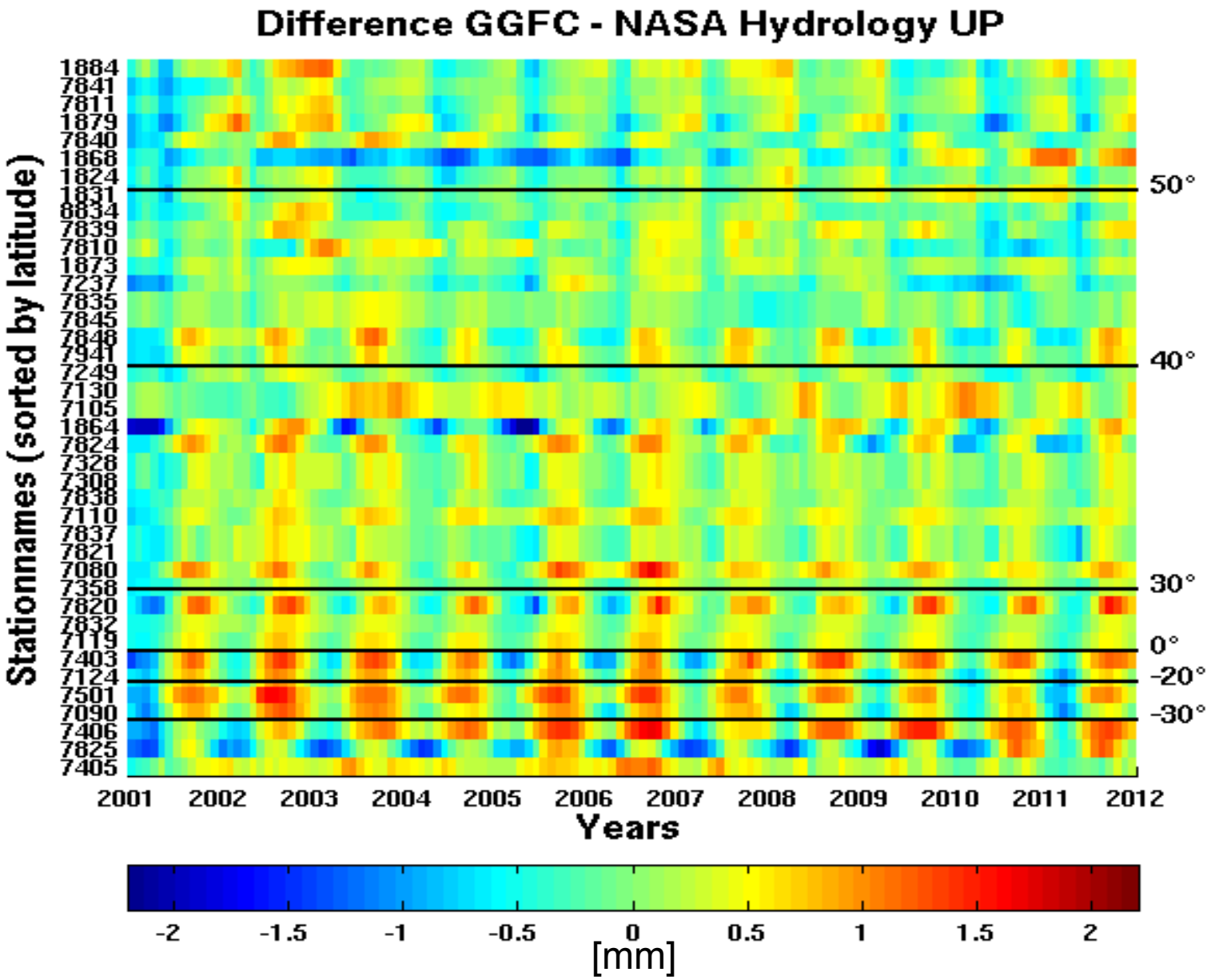
TU Vienna	X	-	-	X	-	-
Uni Strasburg	X / X	-	X	X	-	X
GFZ	(X)	(X)	(X)	X	X	(X)

Hydrology loading



Hydrology loading



Data used in this analysis

- Normalpoints from Lageos 1 + 2 and Etalon 1 + 2
- Time span: 2001 – 2011
- Tidal loading models:
  - FES2004
  - Ray and Ponte 2003
- Gravity effect from GFZ (AOD 1B (RL5))
- 1. Run: Non tidal models from GGFC
- 2. Run: Non tidal models from NASA

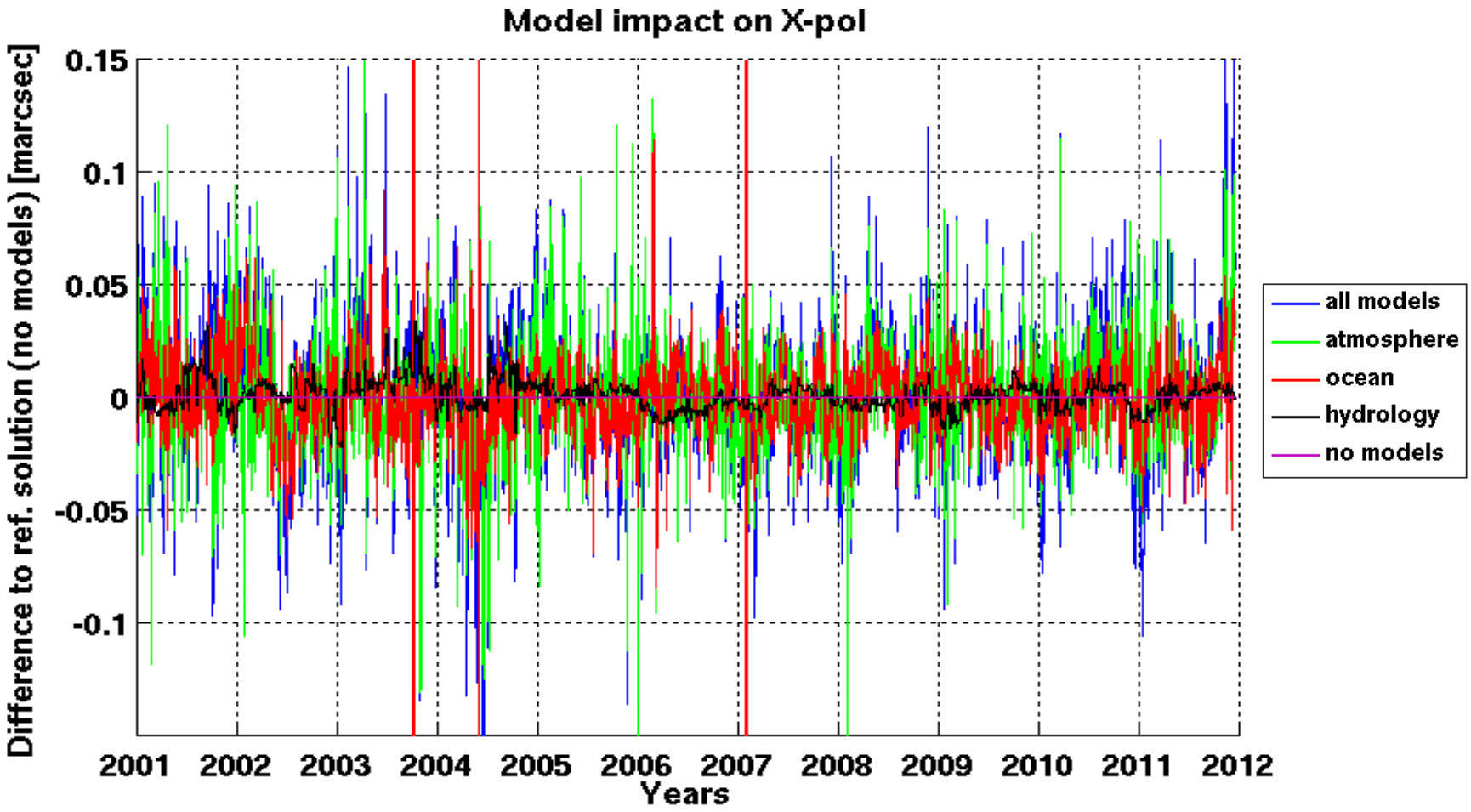
- Software: Bernese Software
  - Software used in daily ILRS analysis at BKG AC
  - Needs gridded models

Earth rotation parameters
External comparison

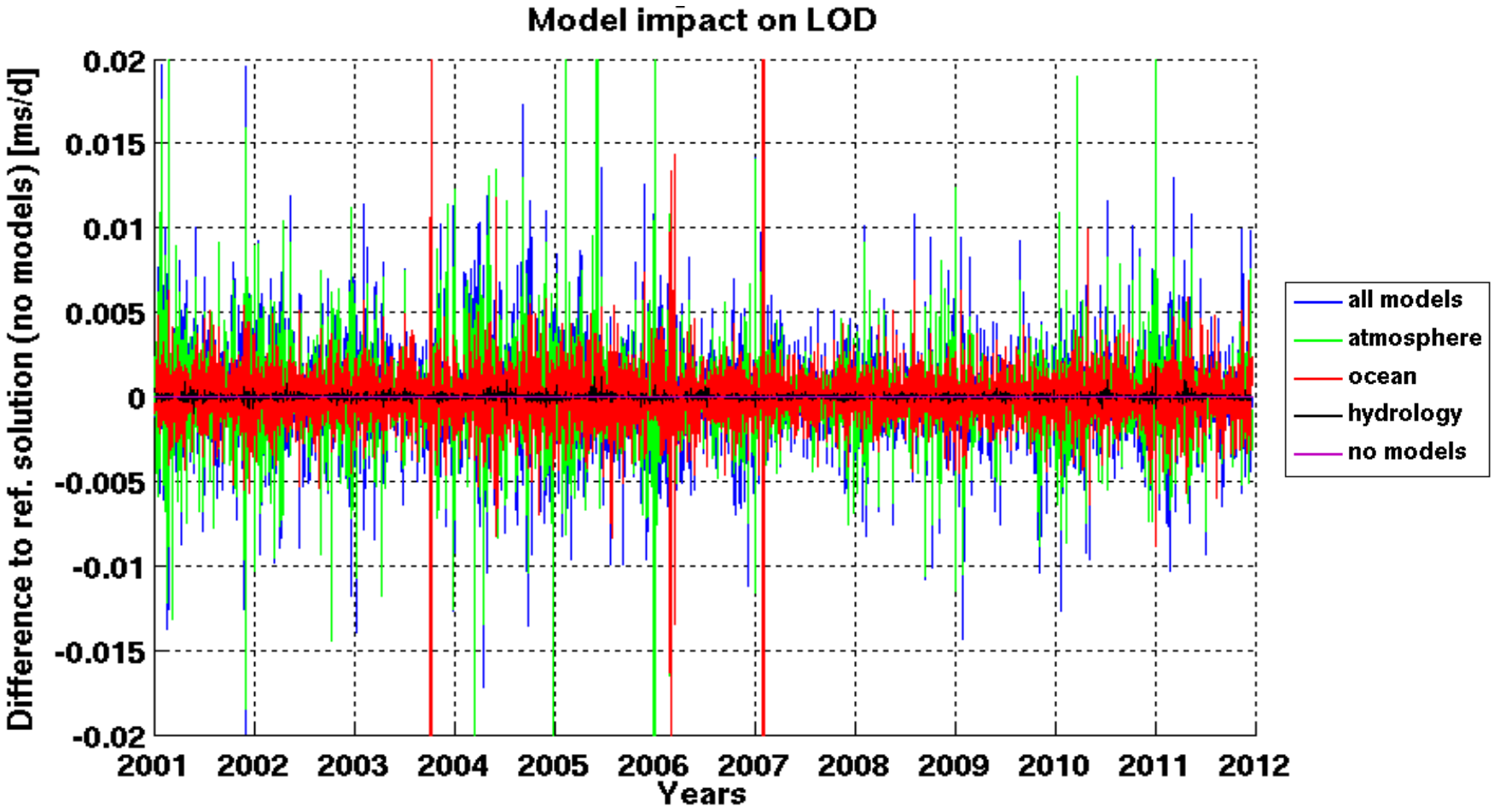
Reference: IERS C04 series

	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

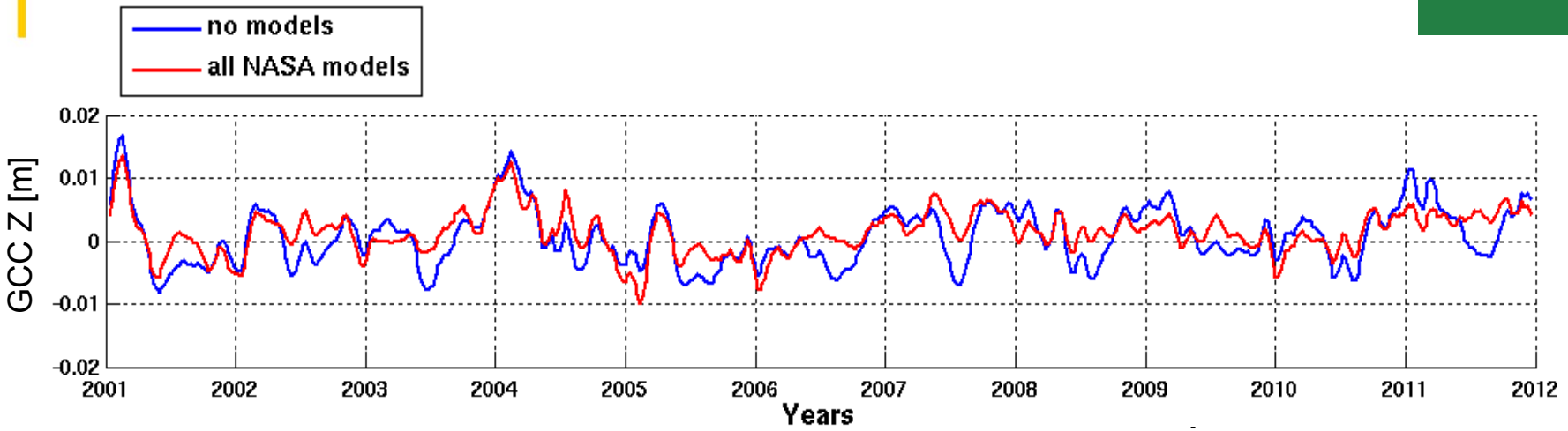
Earth rotation parameters
Internal comparison

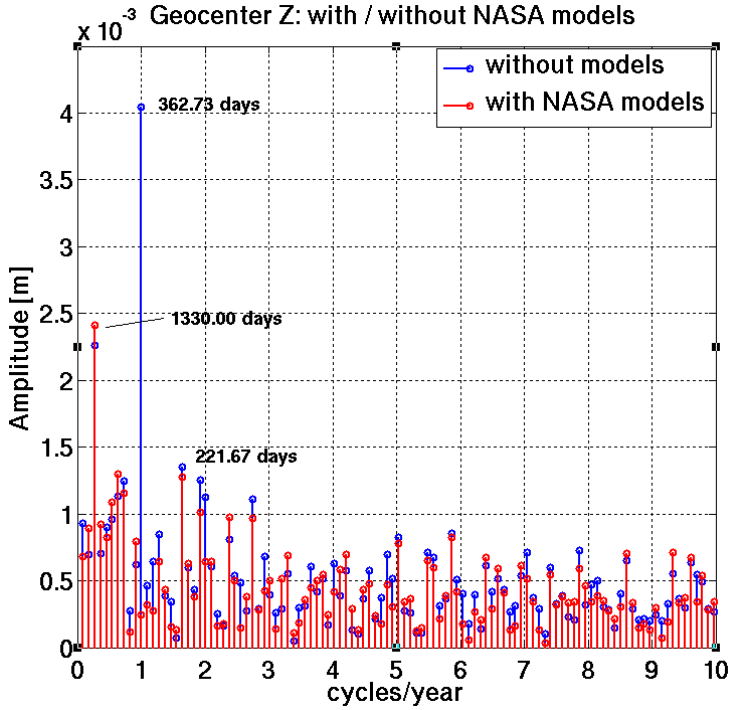


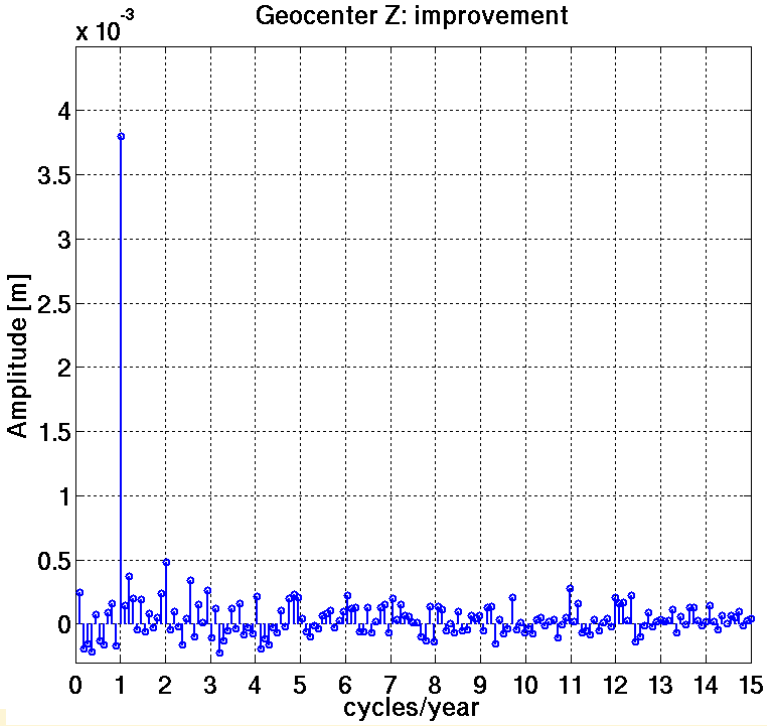
Earth rotation parameters
Internal comparison



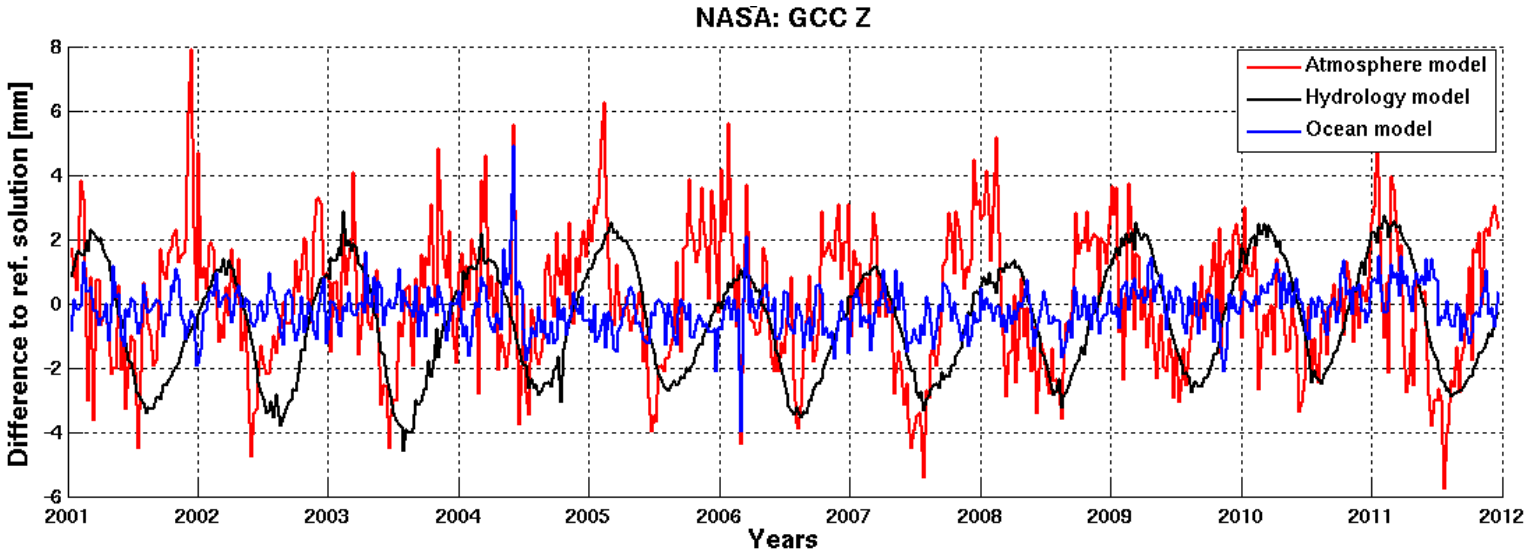
Geocenter coordinates

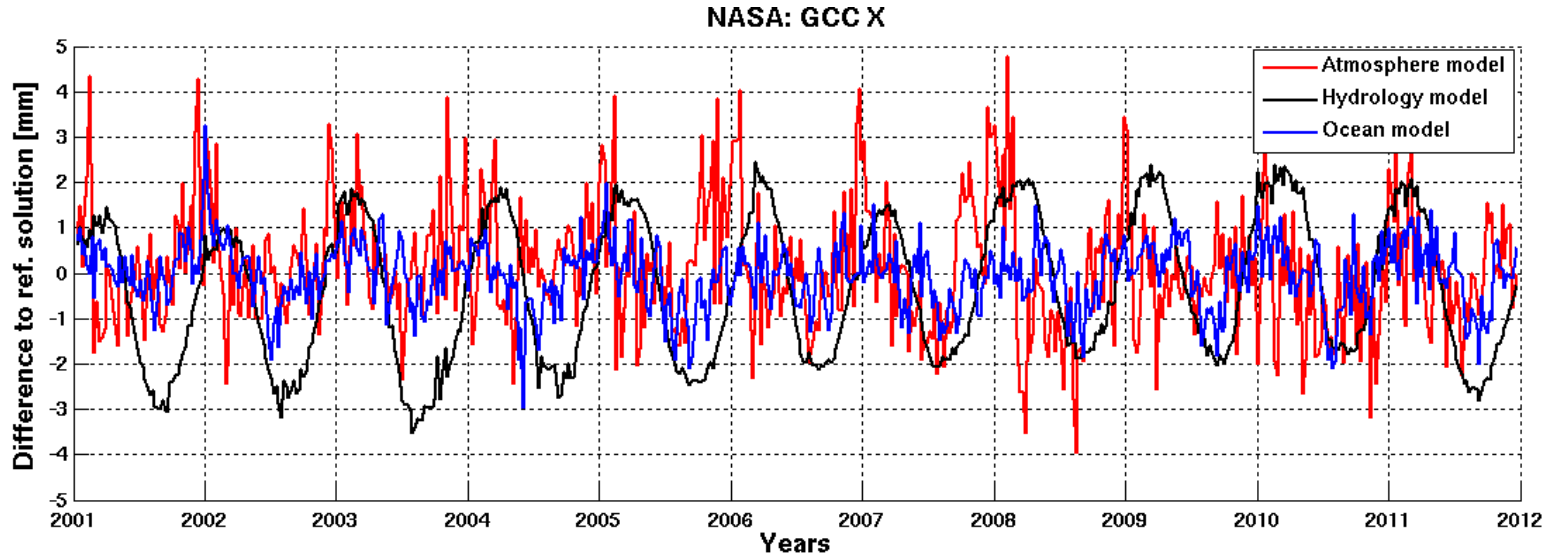






Geocenter coordinates
Impact of individual models





Conclusions

- Many different models available
  - Validation is necessary
- With SLR 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:

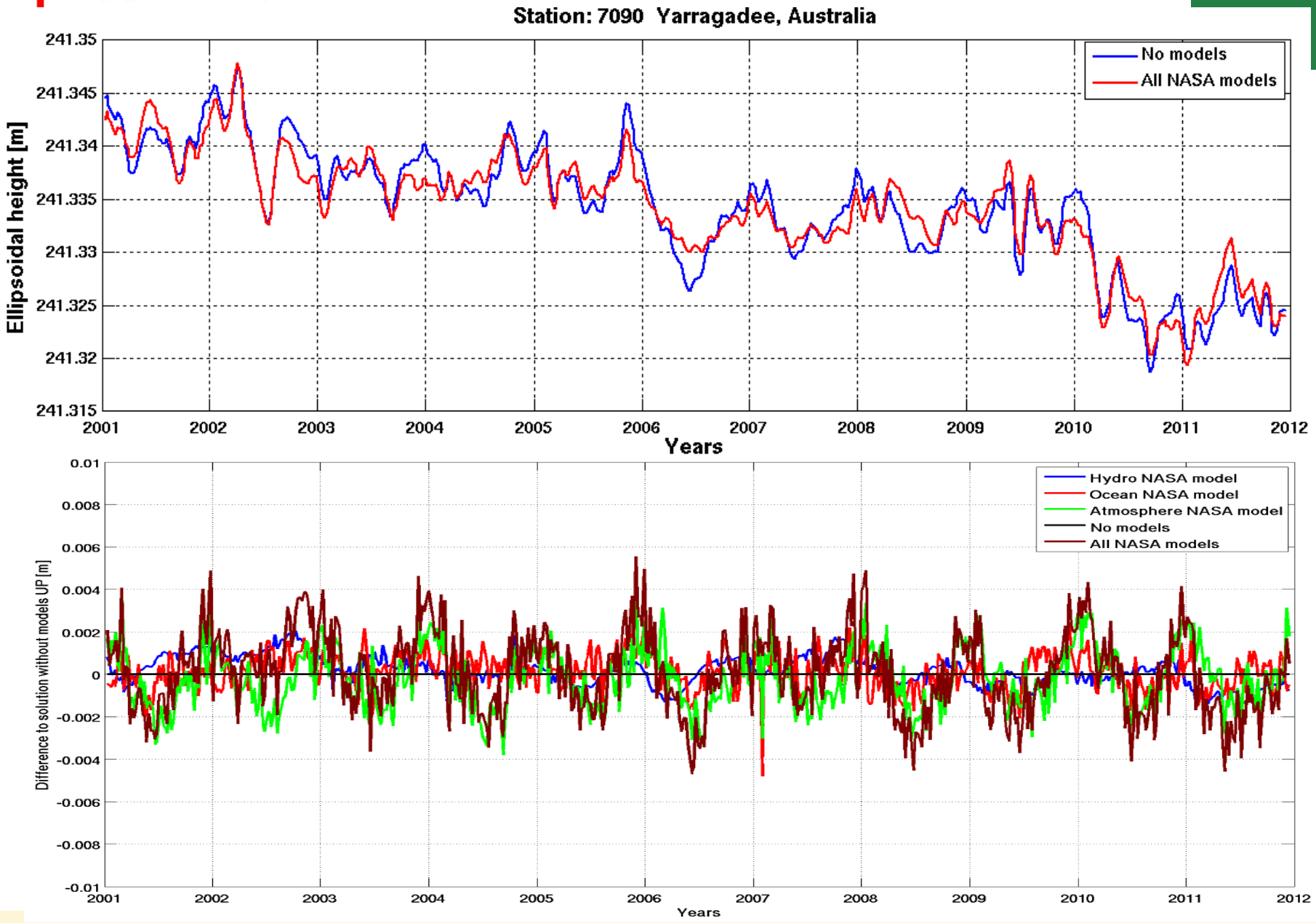
- multi-year solution
- model tests with GNSS and VLBI, combined

Acknowledgments

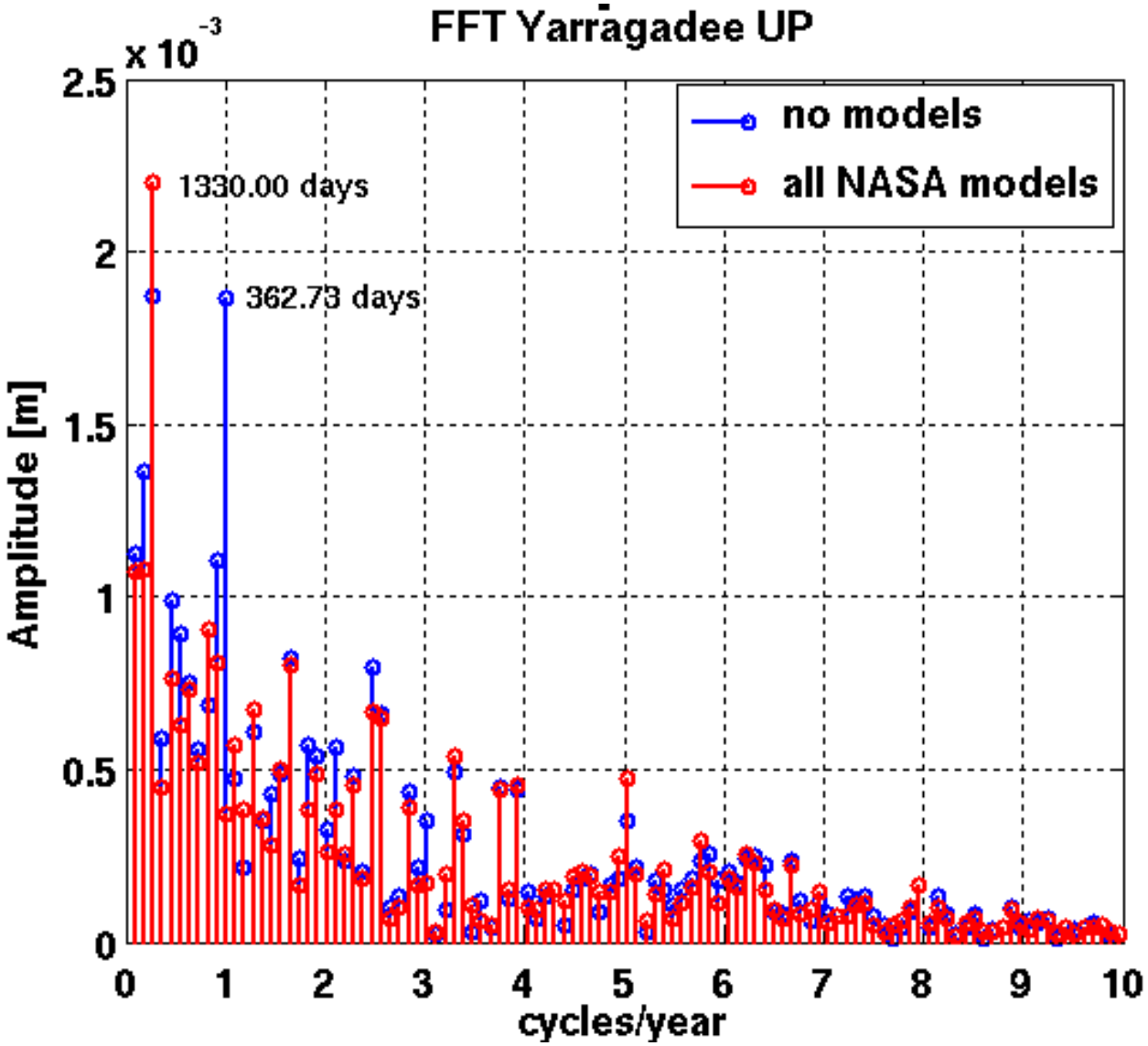
This work was funded by the DFG as a part of the Research Project (FOR1503): „Space-Time Reference Systems for Monitoring Global Change and for Precise Navigation in Space“

Visit our website: www.referenzsysteme.de

Station coordinates



Station coordinates



Geophysical Models – Compilation 2

Atmosphere	Temp. Res.	Spatial Res.	Timespan	Model
GGFC	6 h	2.5 °	1980 – now	NCEP
NASA	6 h	2.5 °	1976 – now	NCEP
TU Wien	6 h	1 °	1997 – 2013	ECMWF
Strasburg	3 h	0.5 °	2001 – 2013 2002 – 2013	ECMWF Operational ECMWF + MOG2D
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)
Strasburg	3 h	0.5 °	2001 – 2013	GLDAS (NOAH)

Ocean and Hydrology models includes trend and offset!

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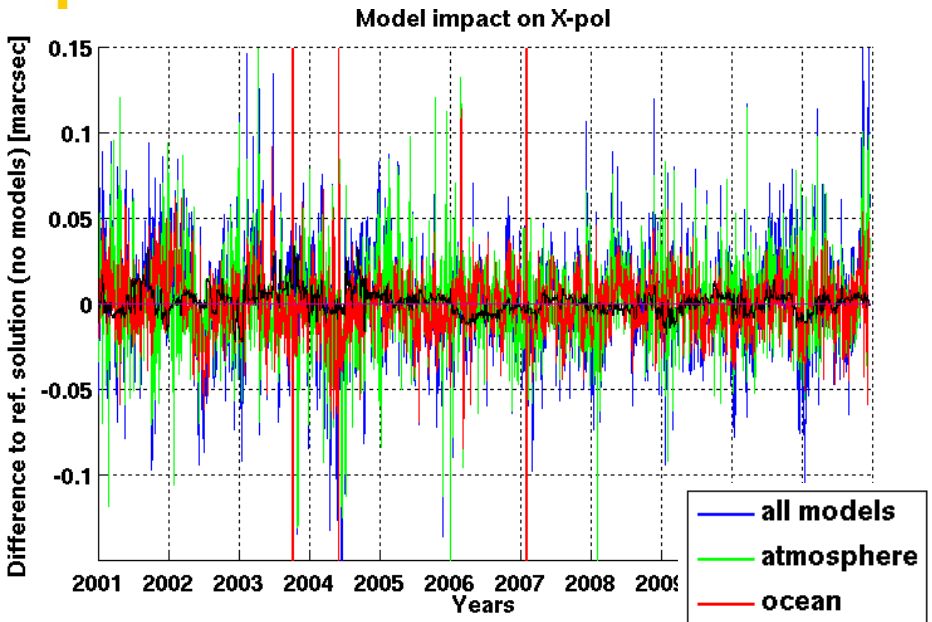
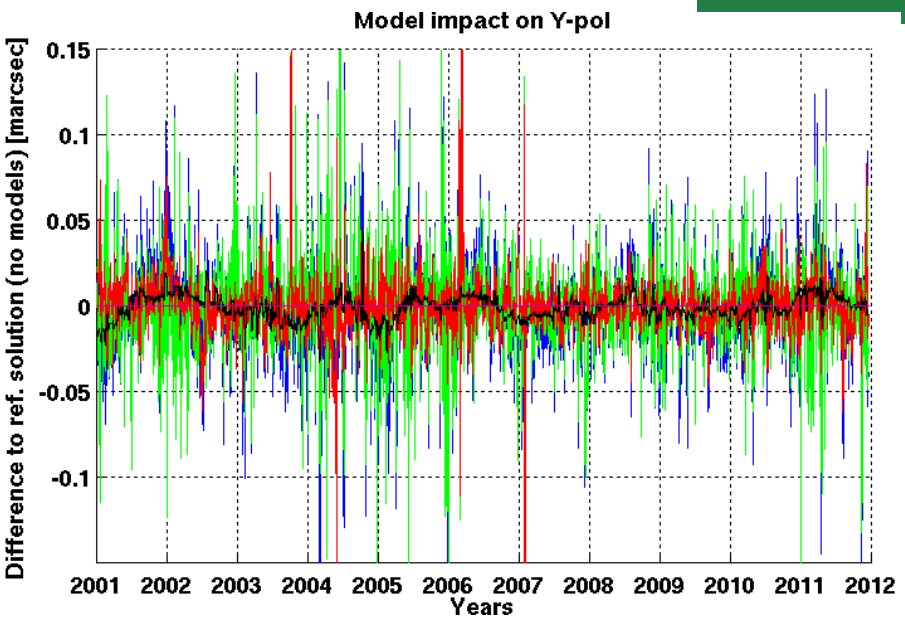
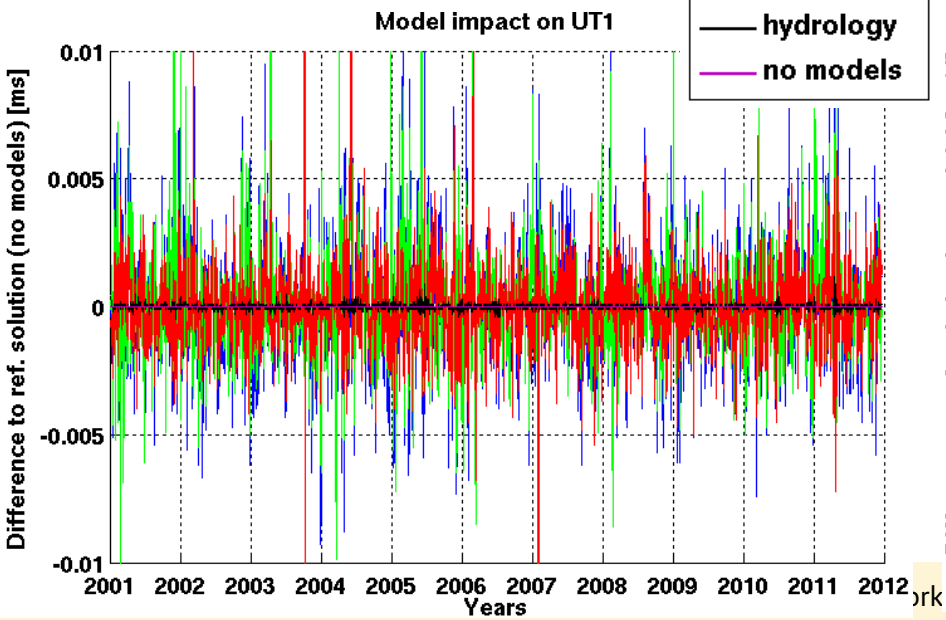
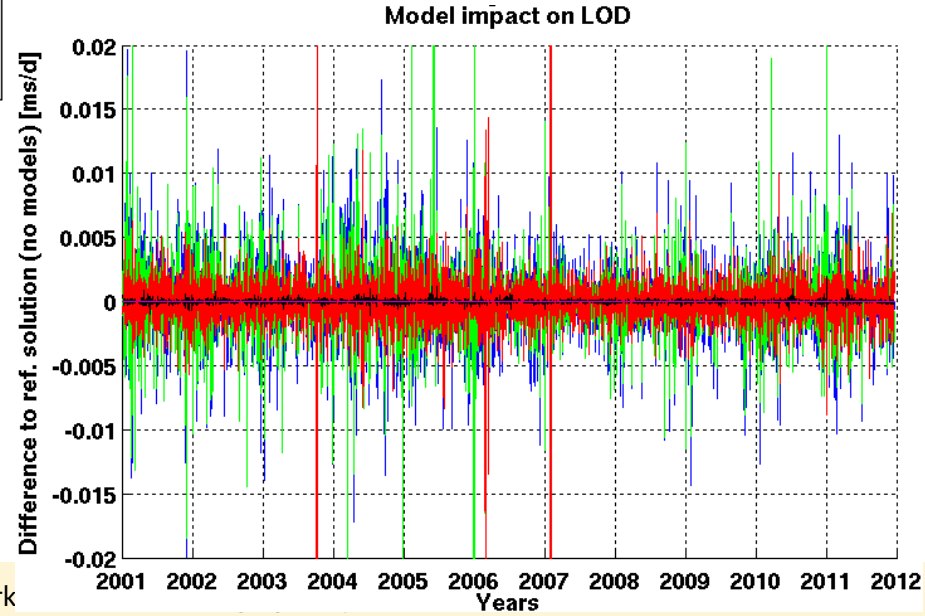
Earth rotation parameters
Internal comparison

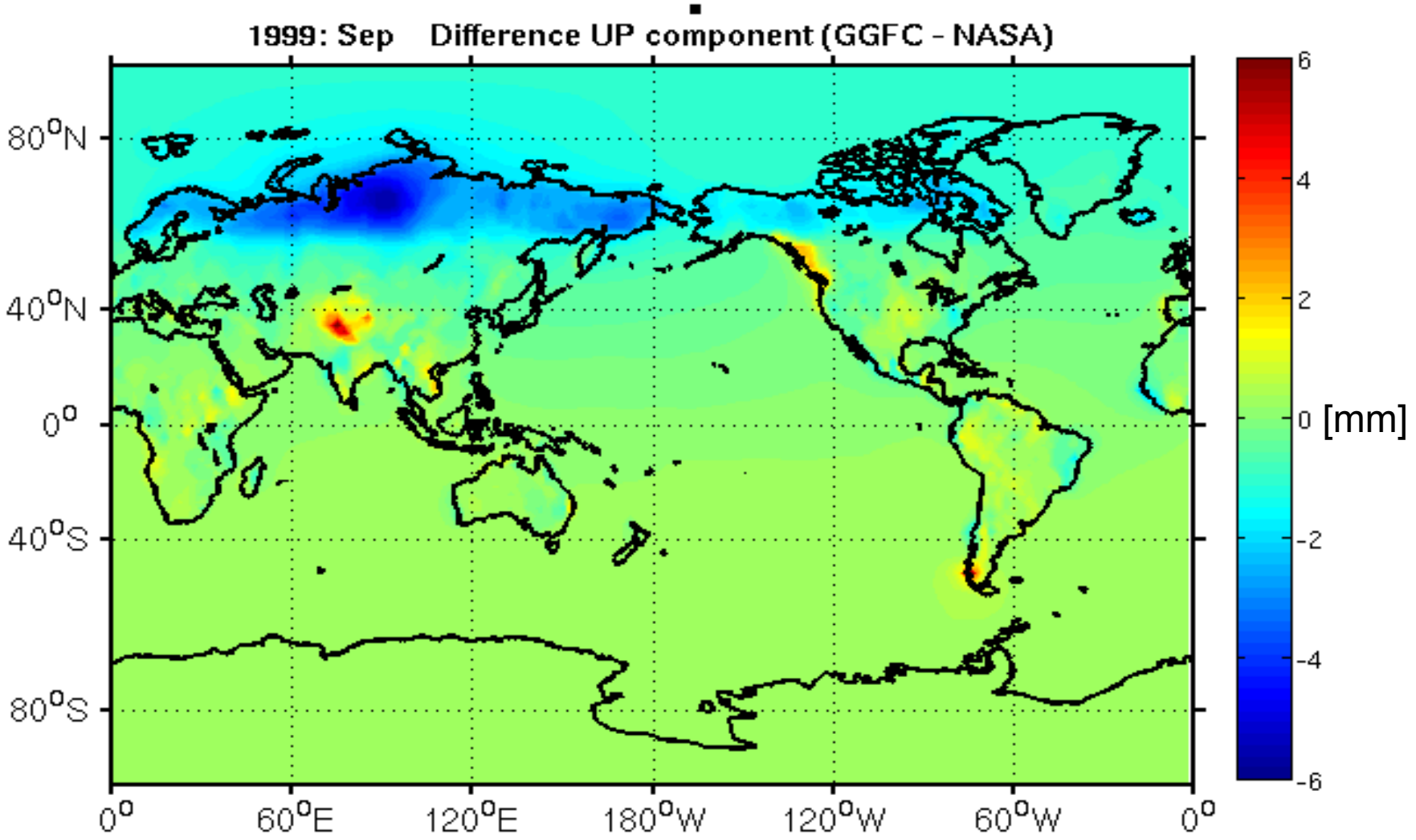




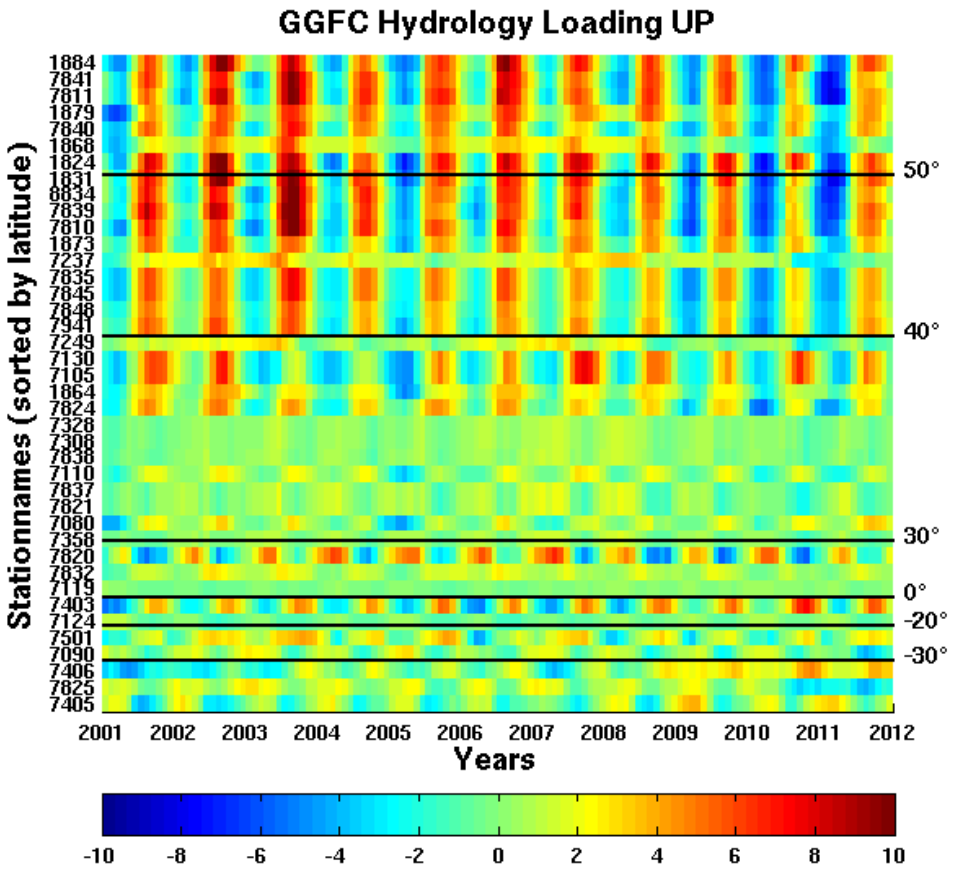


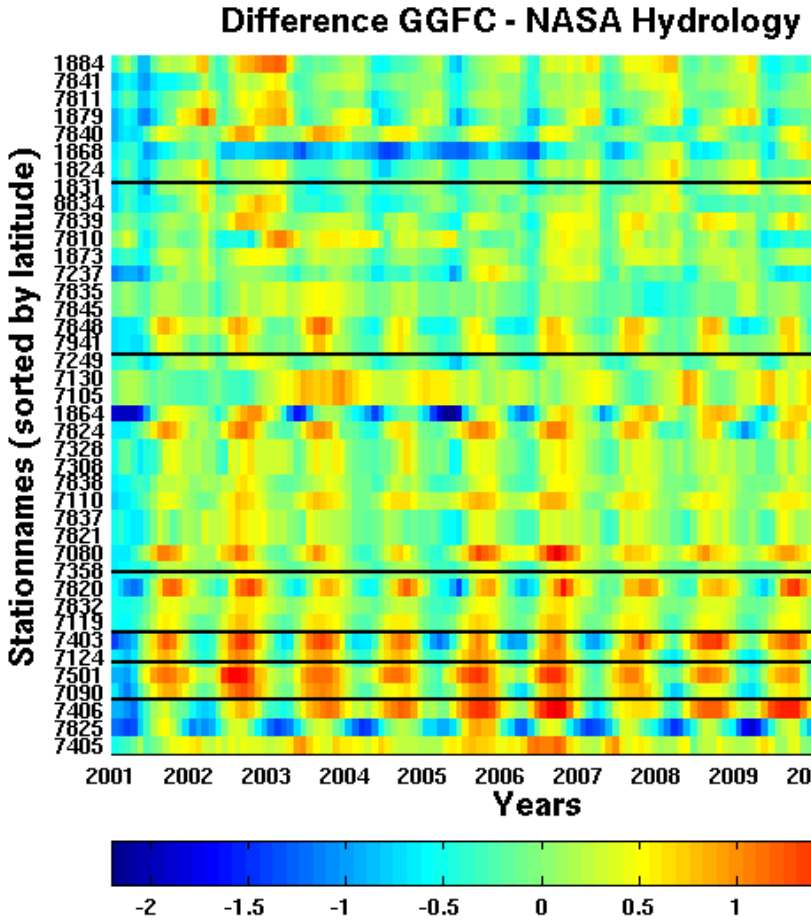


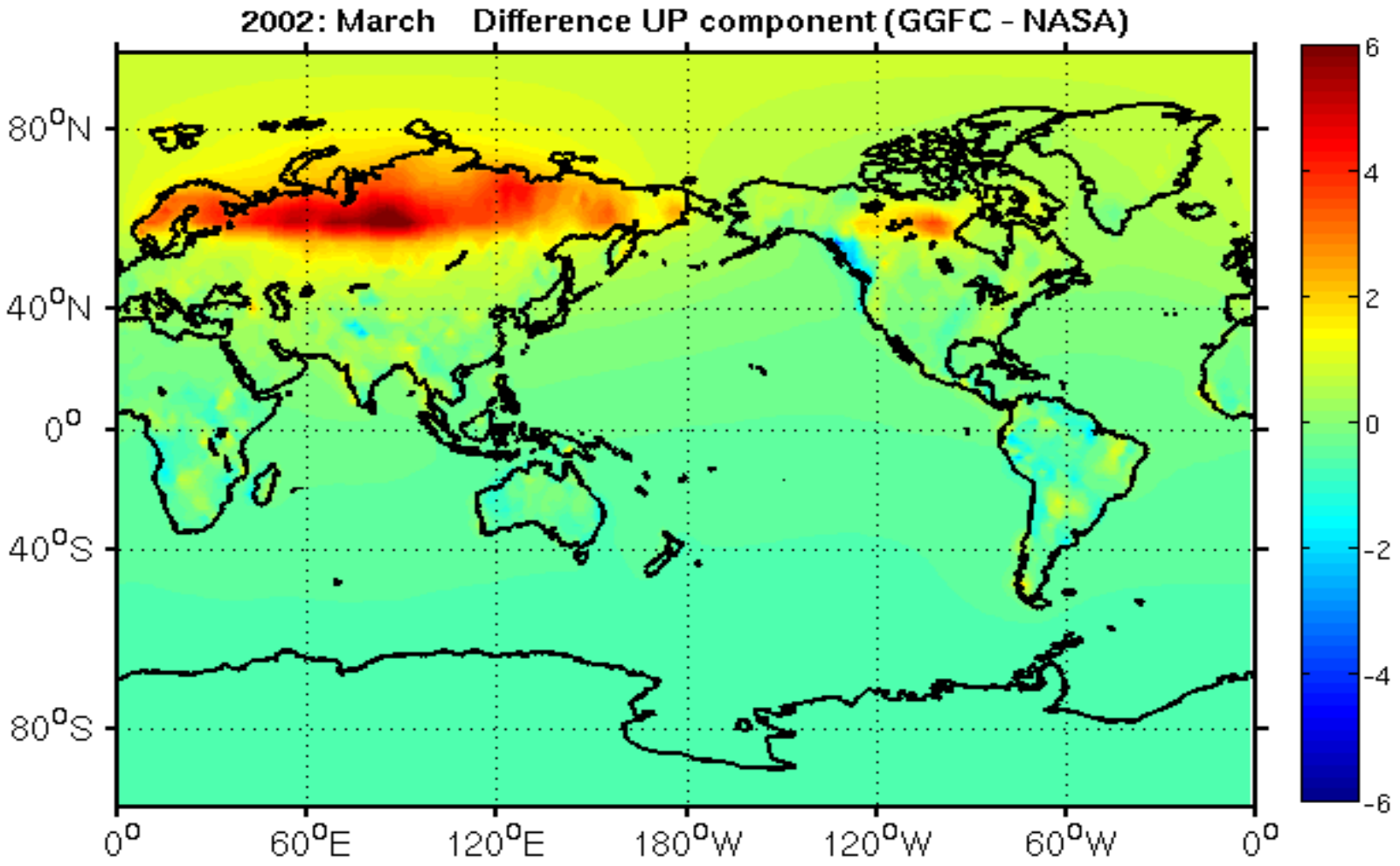
Hydrology loading

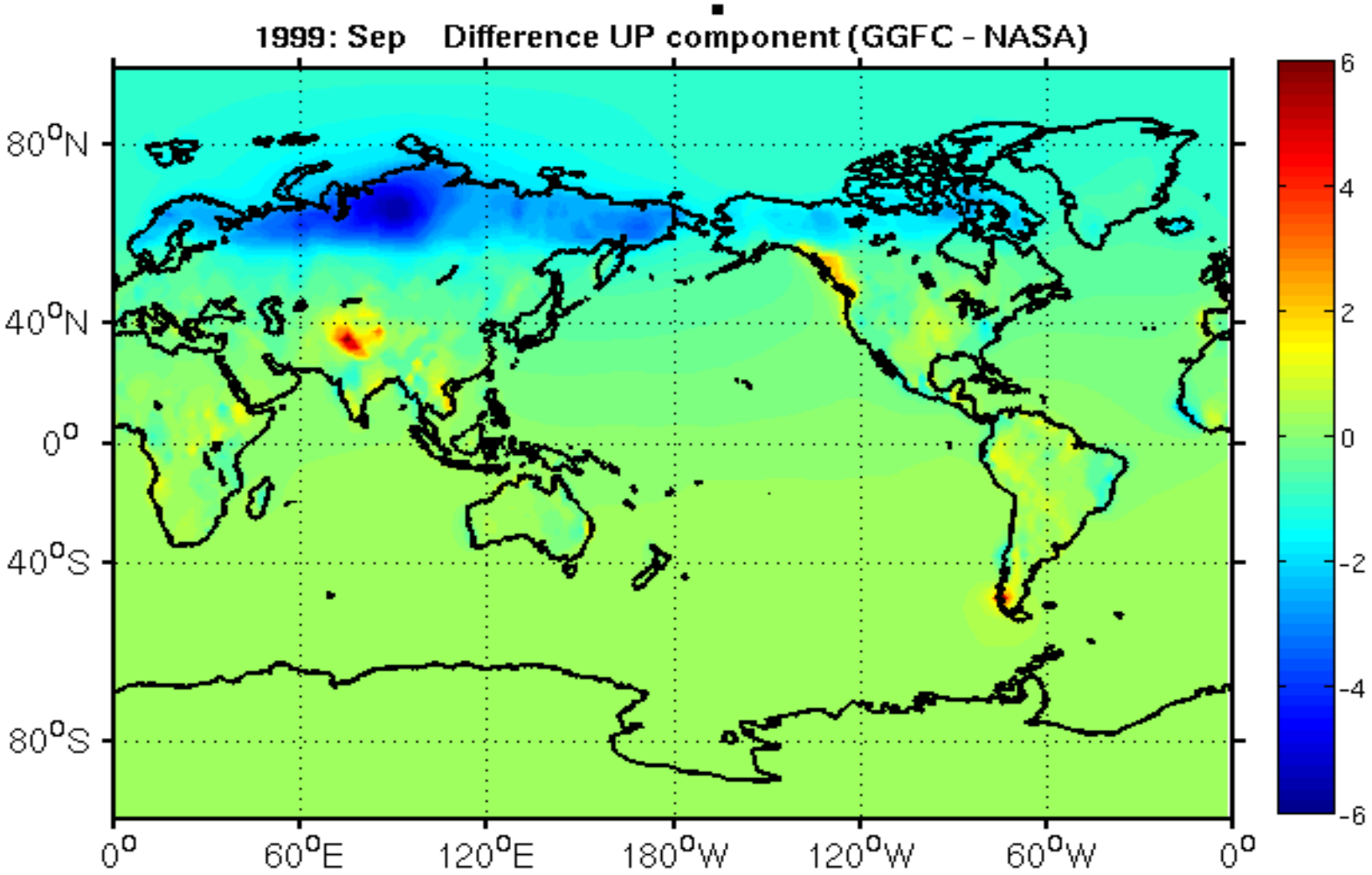


Hydrology models

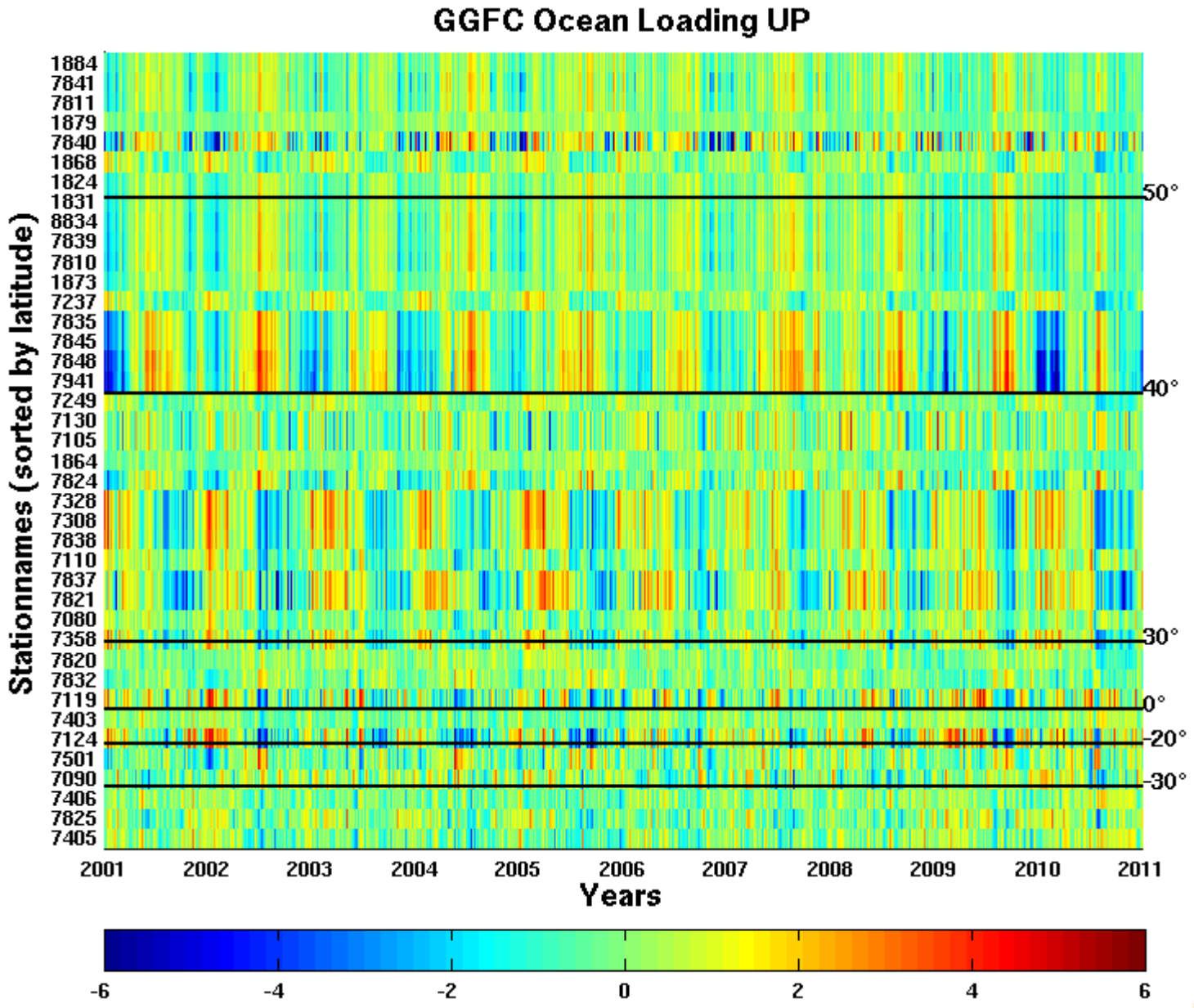




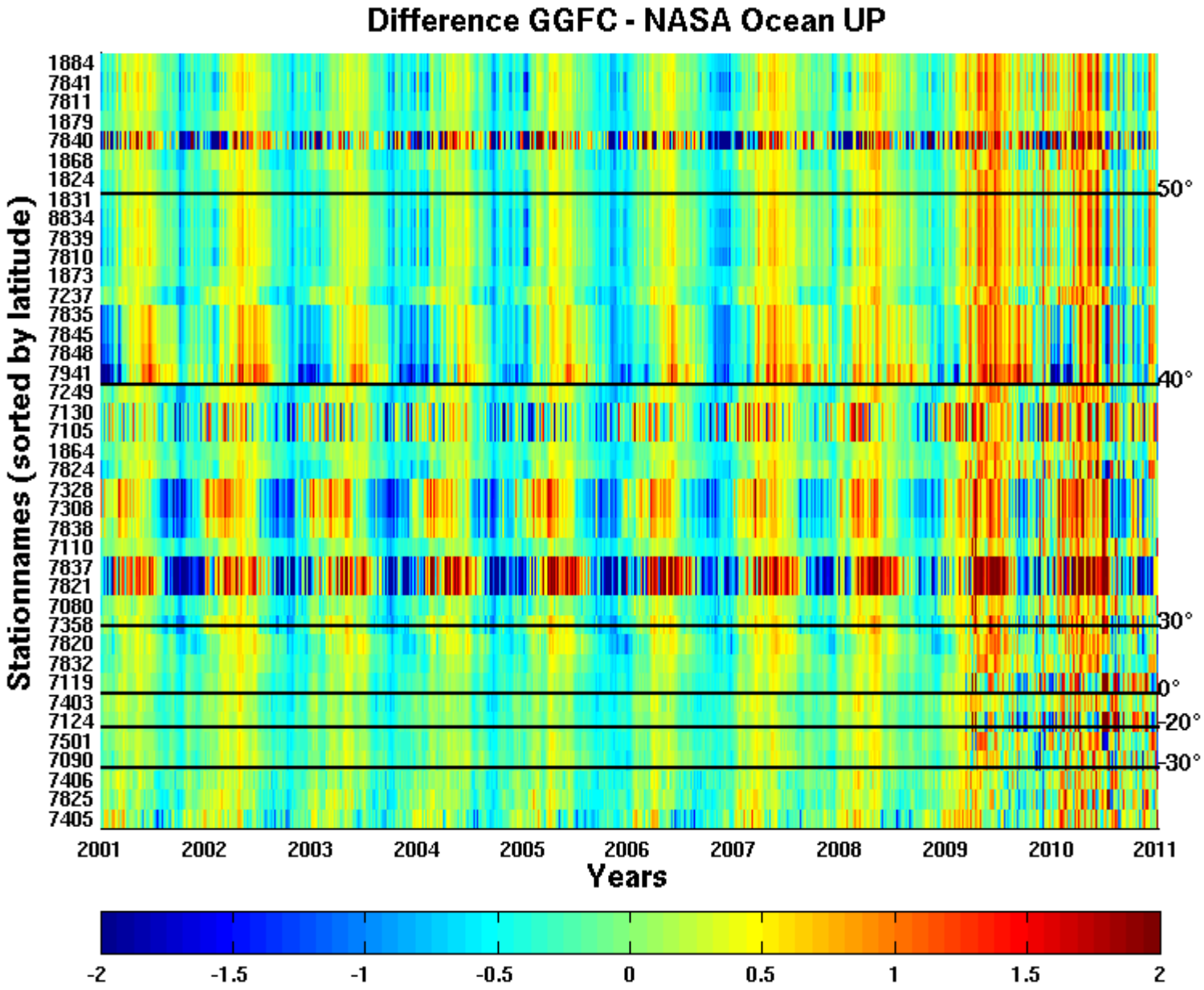

2002: March Difference UP component (GGFC - NASA)
80°N
40°N
0°
40°S
80°S
0°
60°E
120°E
180°W
120°W
60°W
0°
6
4
2
0
-2
-4
-6


1999: Sep Difference UP component (GGFC - NASA)
80°N
40°N
0°
40°S
80°S
0°
60°E
120°E
180°W
120°W
60°W
0°
6
4
2
0
-2
-4
-6

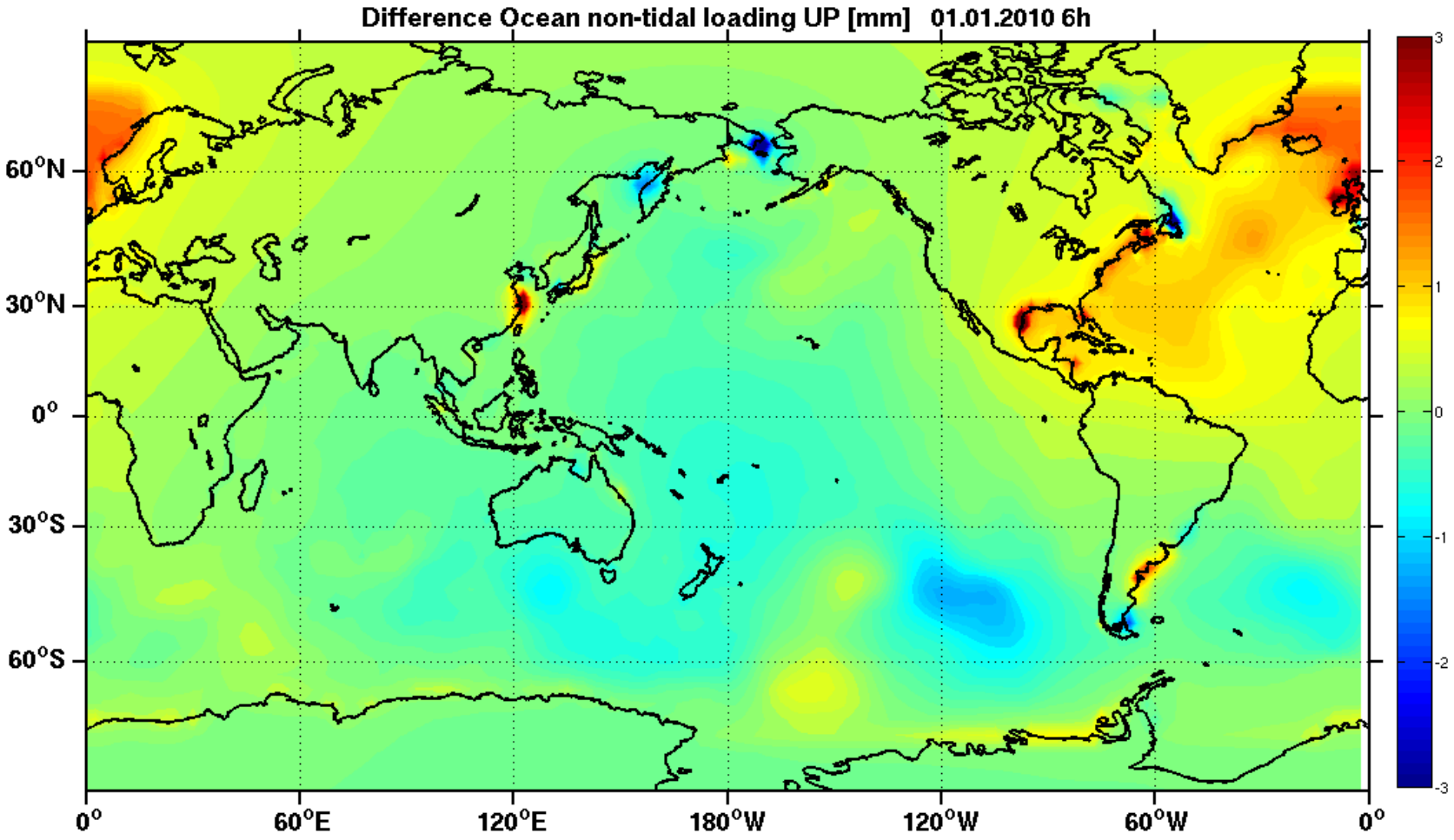
Ocean non tidal loading



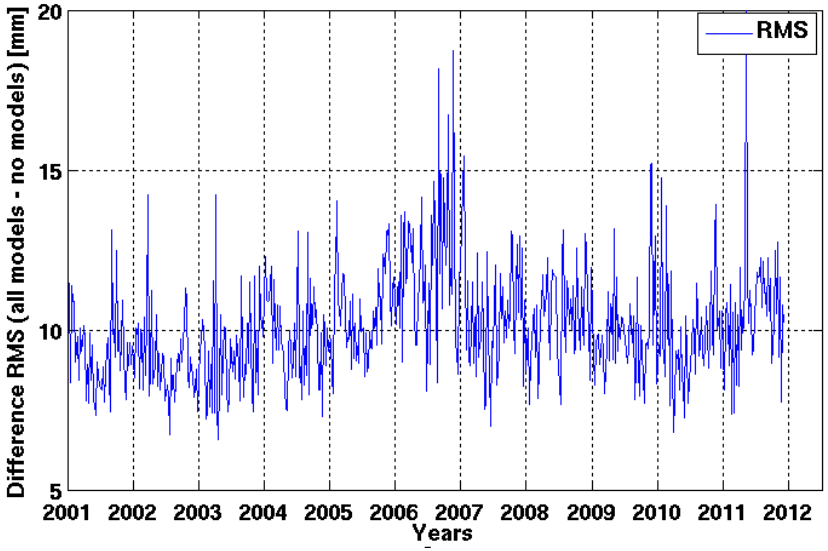
Ocean non tidal loading



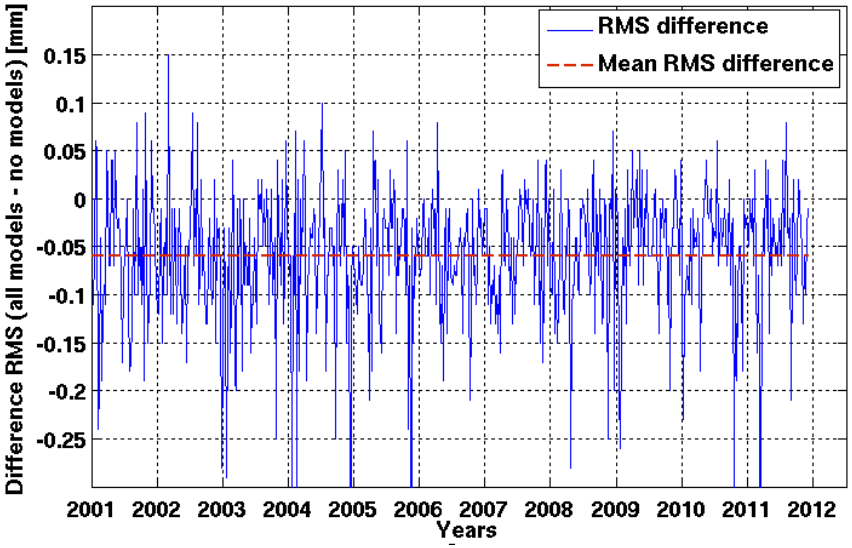
Ocean non tidal loading

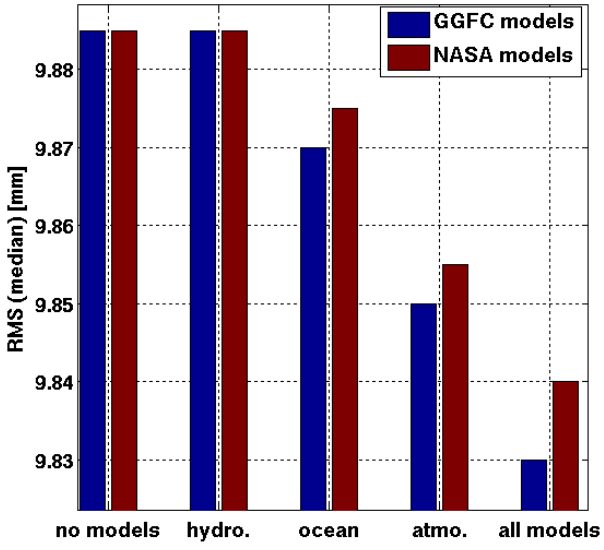


RMS comparison (eventuell weg)

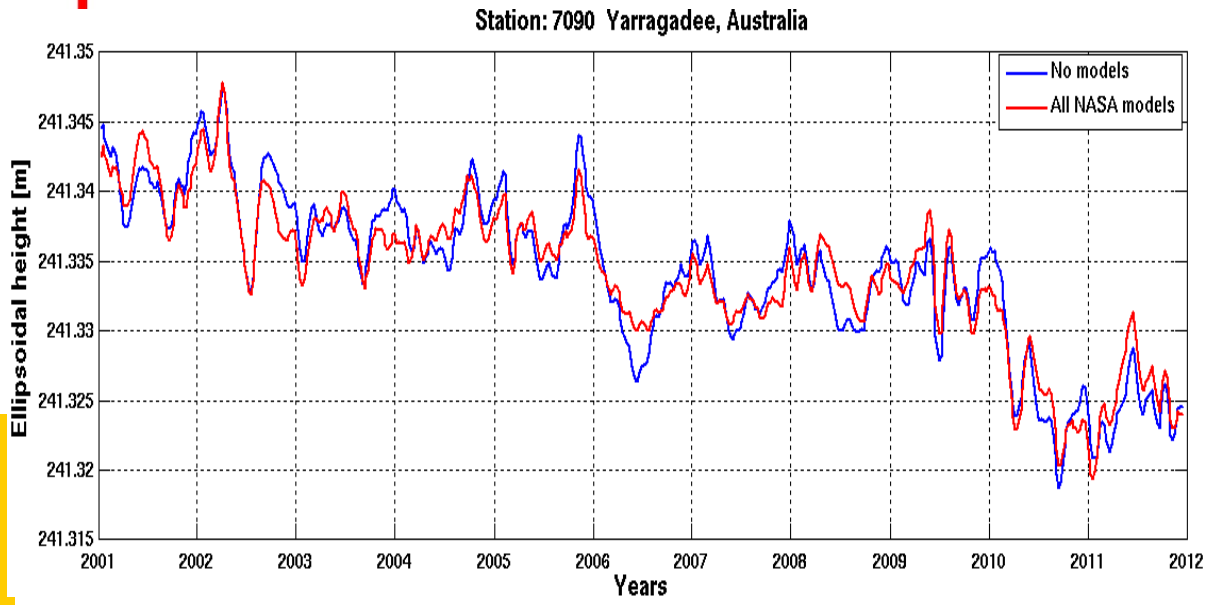


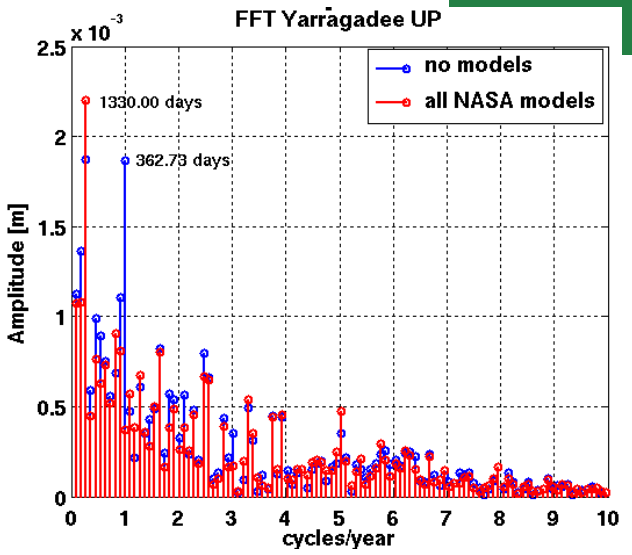
- Better modelling → smaller RMS
- Difference between RMS
  - RMS (all models)- RMS (no models)
  - Mean difference = -0.06 mm
- Histogram of RMS median values
  - Small improvement visible if models are used
  - Biggest impact → atmosphere

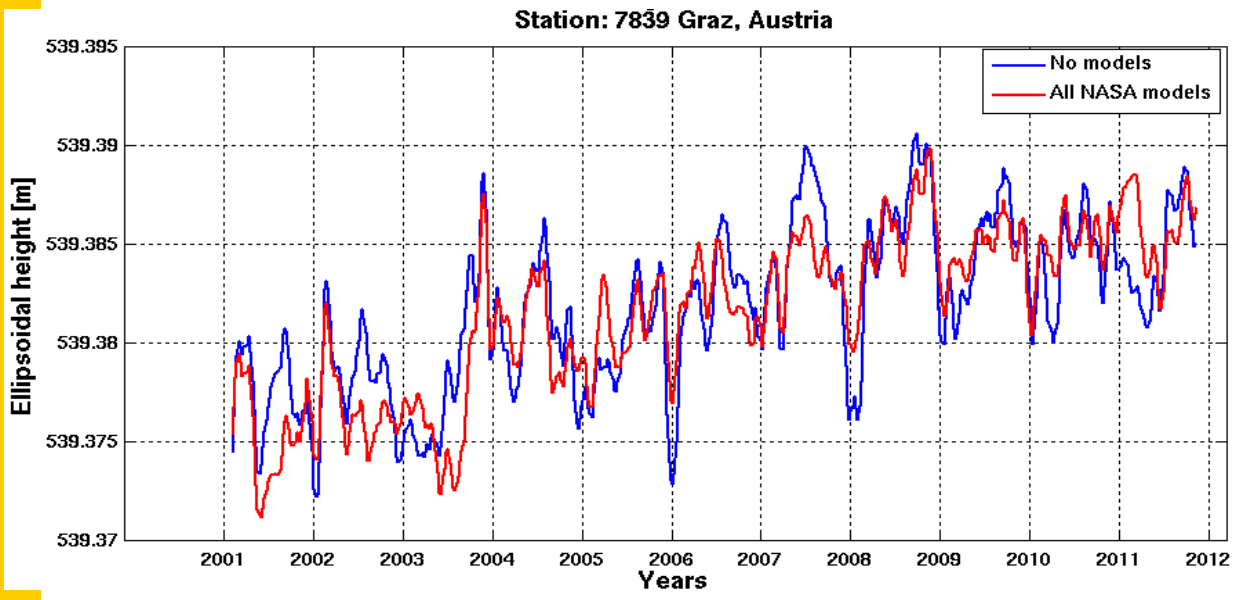


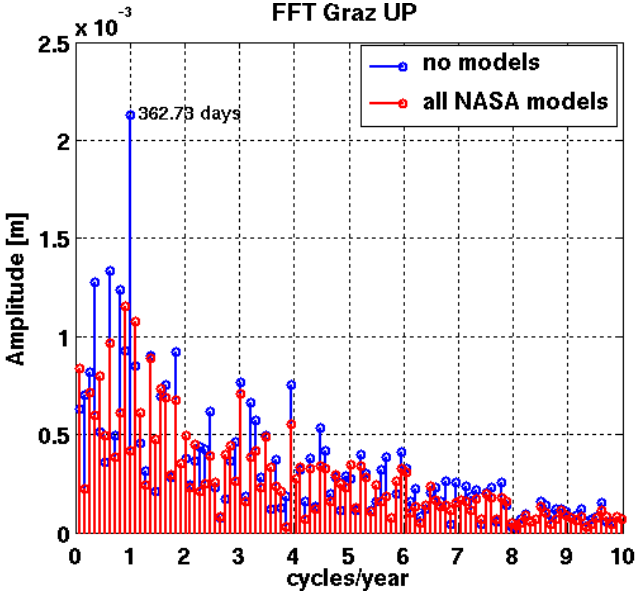


Station coordinates

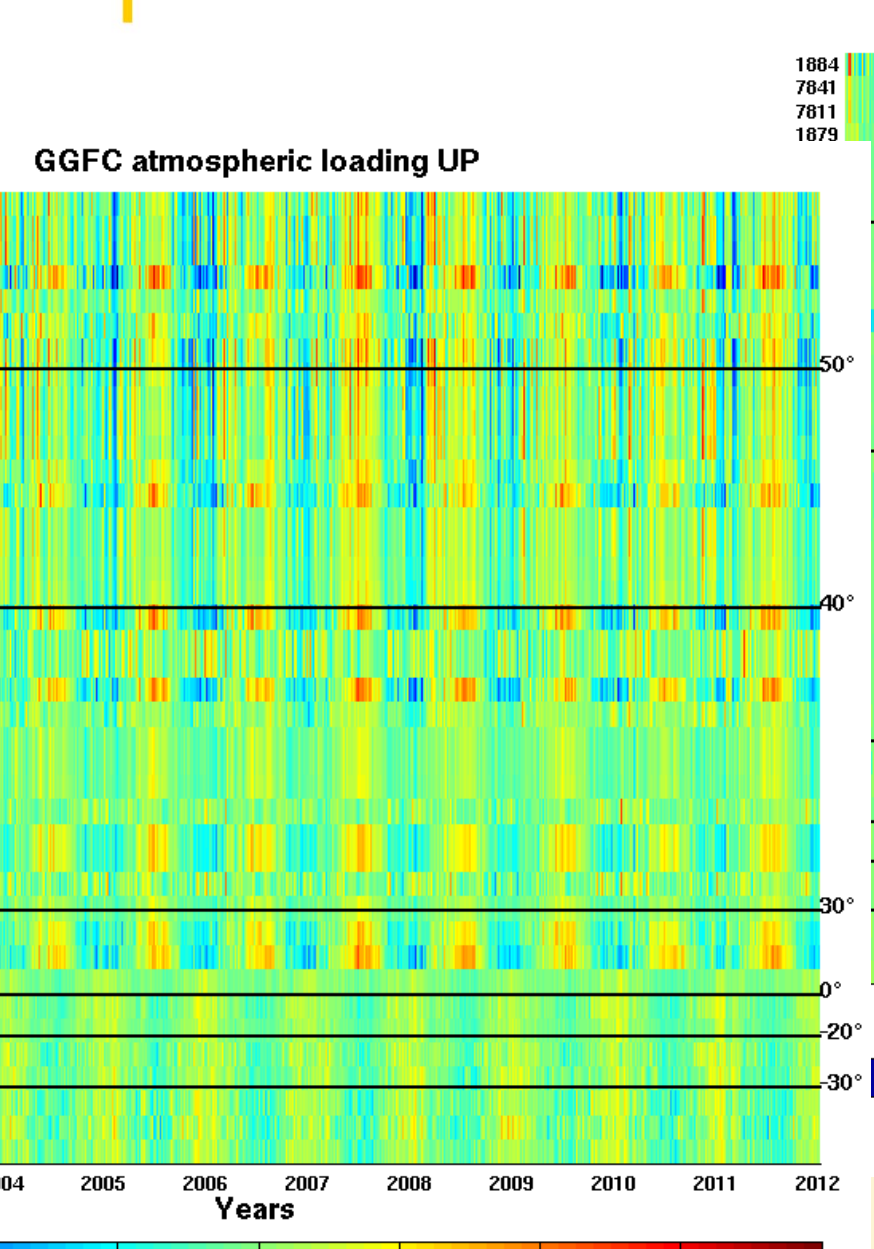


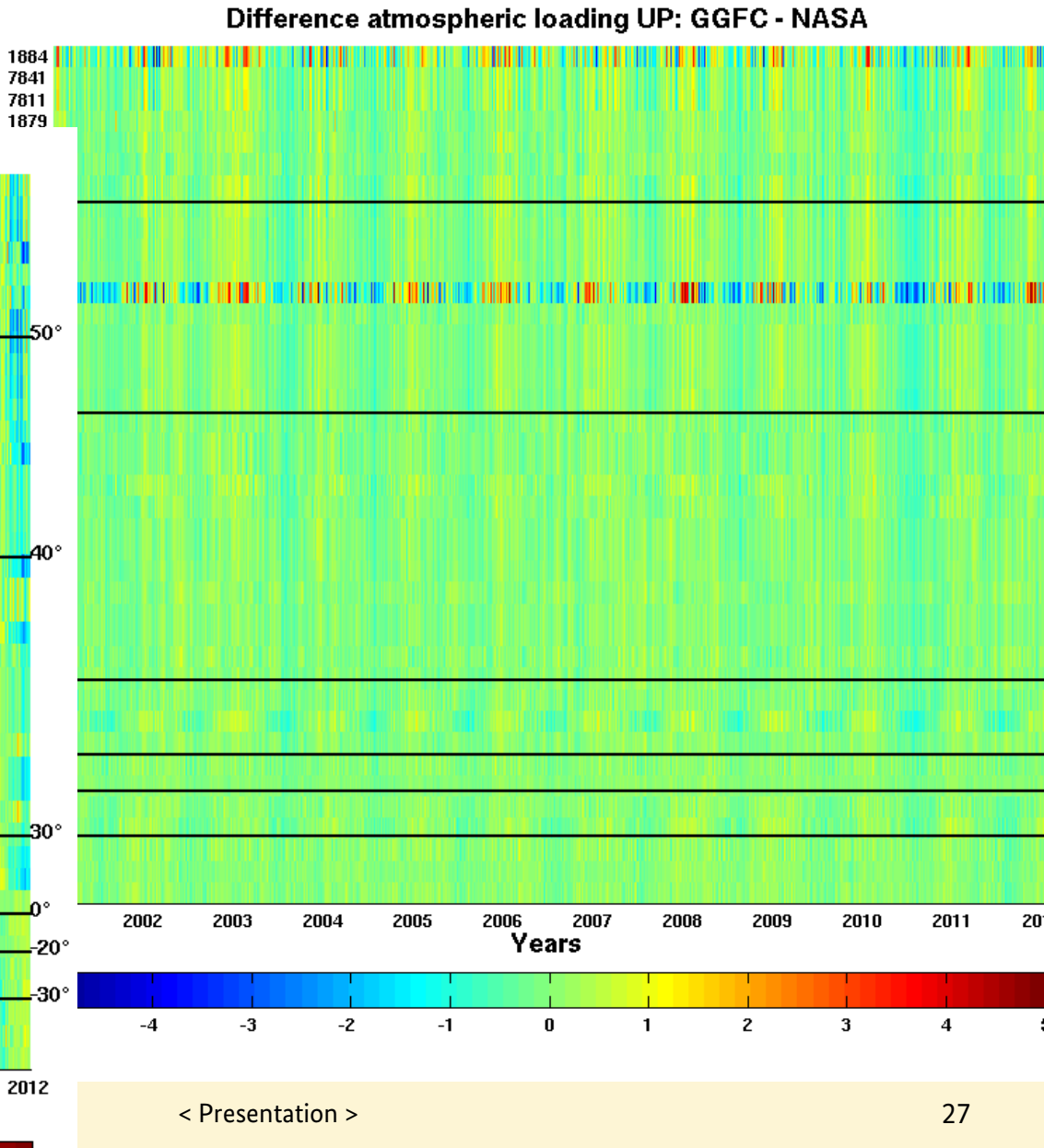




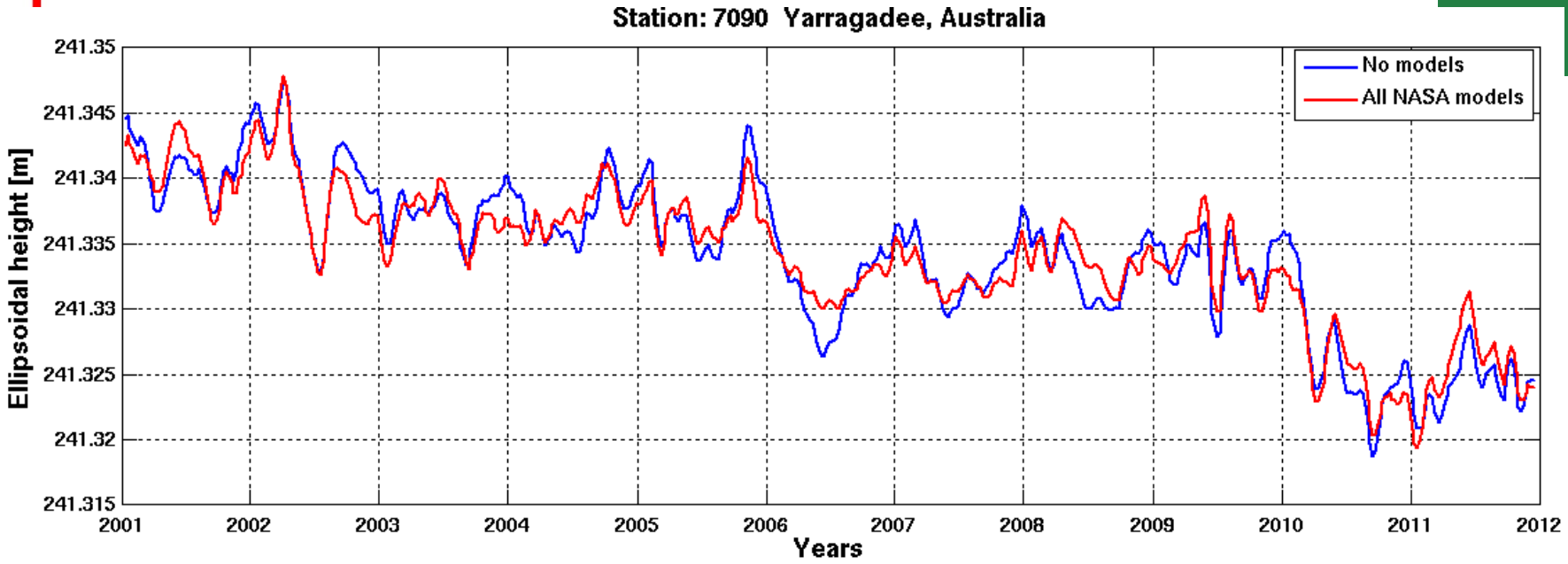


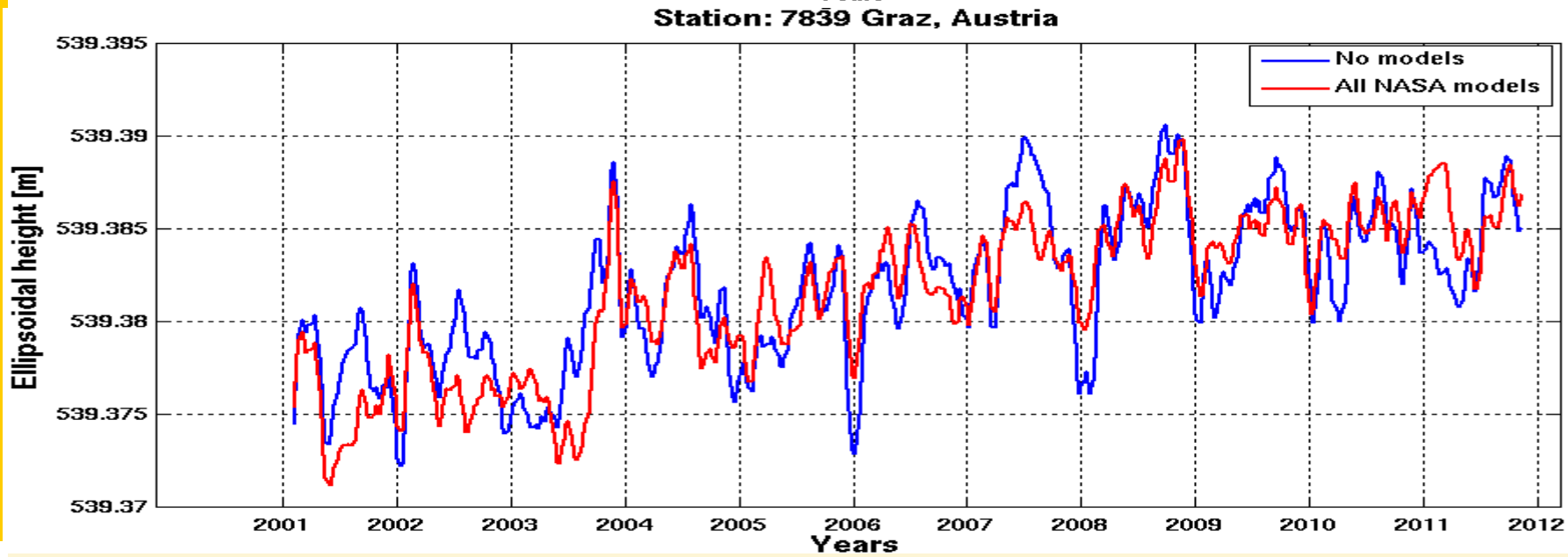
Atmosphere


GGFC atmospheric loading UP
50°
40°
30°
0°
-20°
-30°
2005
2006
2007
2008
2009
2010
2011
2012
Years


Difference atmospheric loading UP: GGFC - NASA
1884
7841
7811
1879
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Years
-4
-3
-2
-1
0
1
2
3
4

Station coordinates





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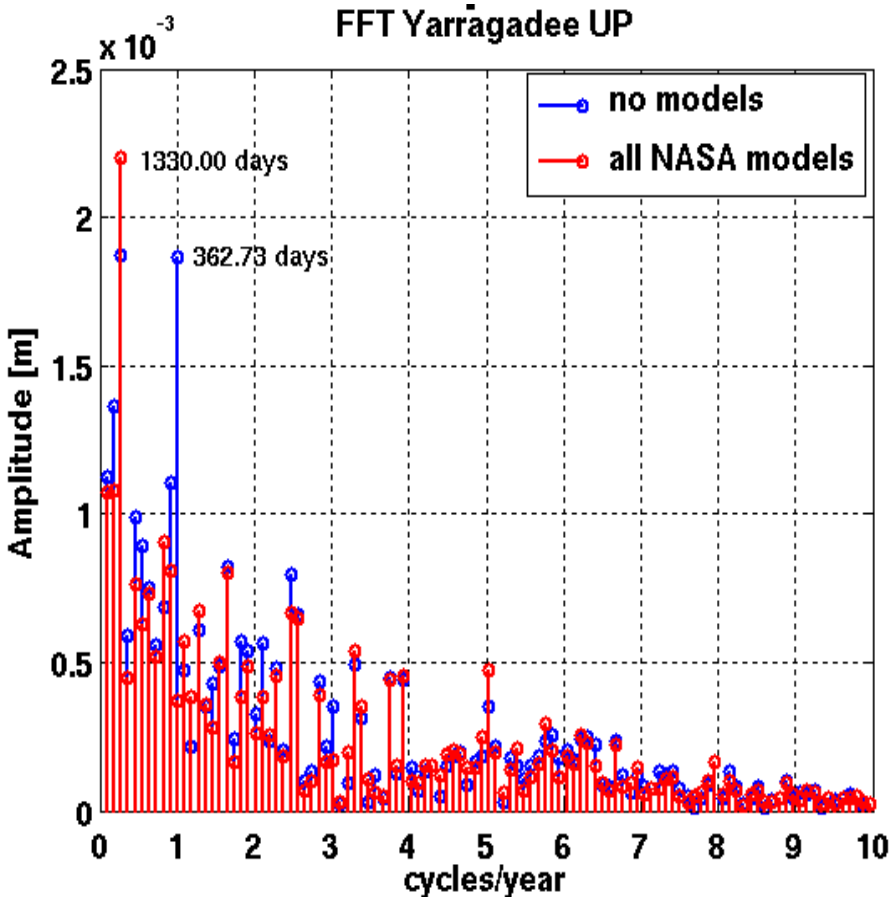

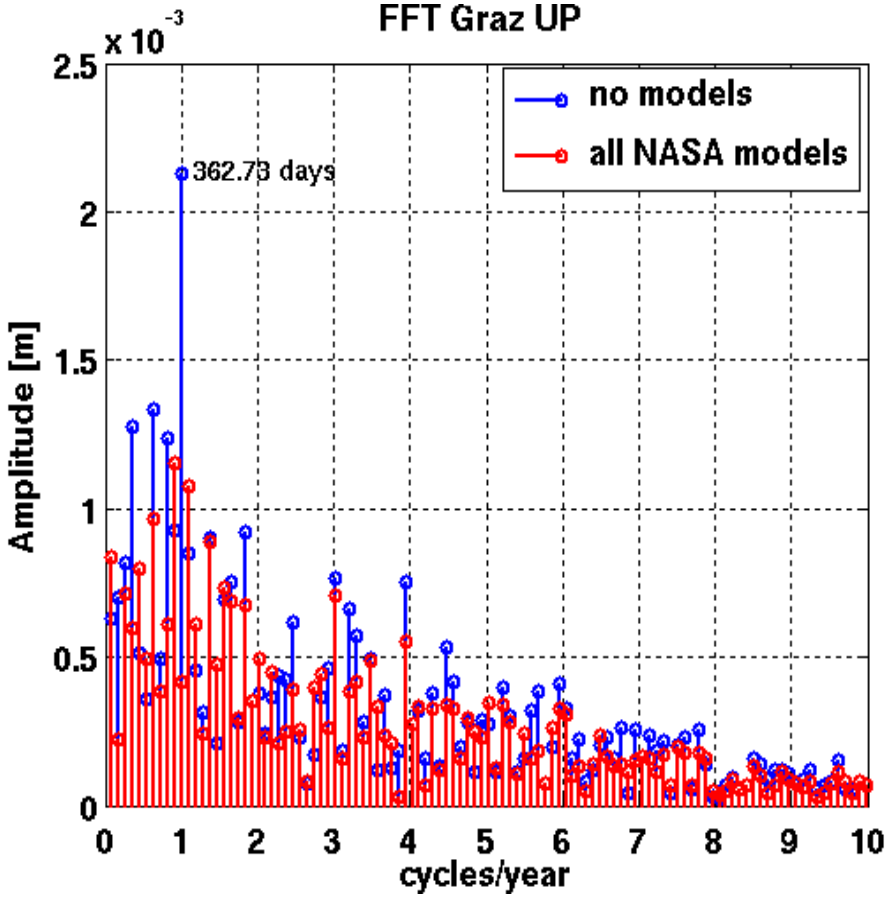

Station coordinates