Detecting regional scale water mass variations with GRACE

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GSTM 2013, Austin

Outline

- Gravity field determination methods: dynamic vs. radial basis function
- Comparisons with global hydrological model (WGHM).
- Regional applications.
- Conclusions.

Methods

RL05, RBF, Kalman

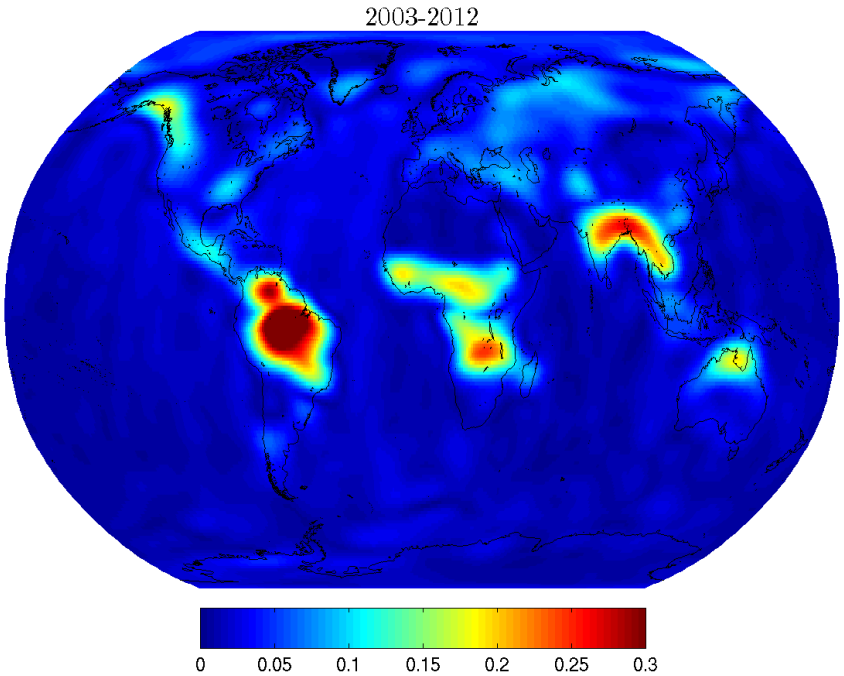
Inputs and post-filtering

Ch. Gruber et al., *Earth on the Edge: Science for a Sustainable Planet, IAG Symposia 139, DOI 10.1007/978-3-642-37222-3__51*

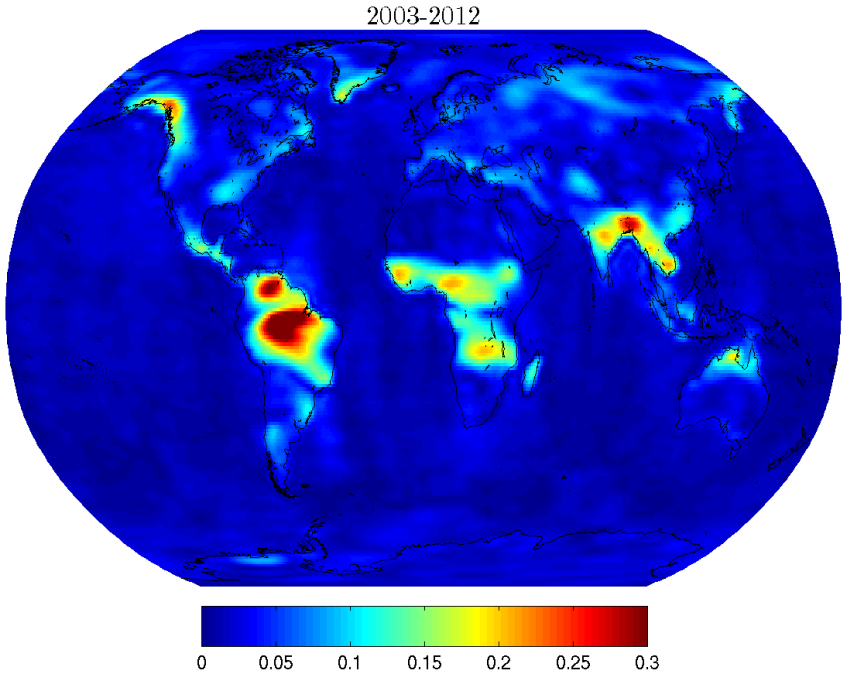
- **RL05 (monthly and weekly)**: standard dynamic approach.
- **RBF**: radial basis function (Poisson kernel)
  - **monthly**: regularized (Tikhonov) inversion of 1 month accumulated in-situ data.
  - **daily**: Kalman filter

	KBRR LEVEL-1B	**EPOSOC** dynamic orbit processing	**AOD1B** atmosph. ocean	**TIDES** solid E. direct t. ocean t.	**EIGEN6C** static	**EIGEN6C** annual semiannual trends	**WGHM** monthly	**Domain**	**Post-filtering**
RL05	✓	✓	✓	✓	✓	✓		SH	DDK2
RBF monthly	✓	✓	✓	✓	✓			grid	no
RBF daily **Stochastic**	✓	✓	✓ ✓	✓	✓	✓	✓	grid	no

Average Seasonal Amplitudes

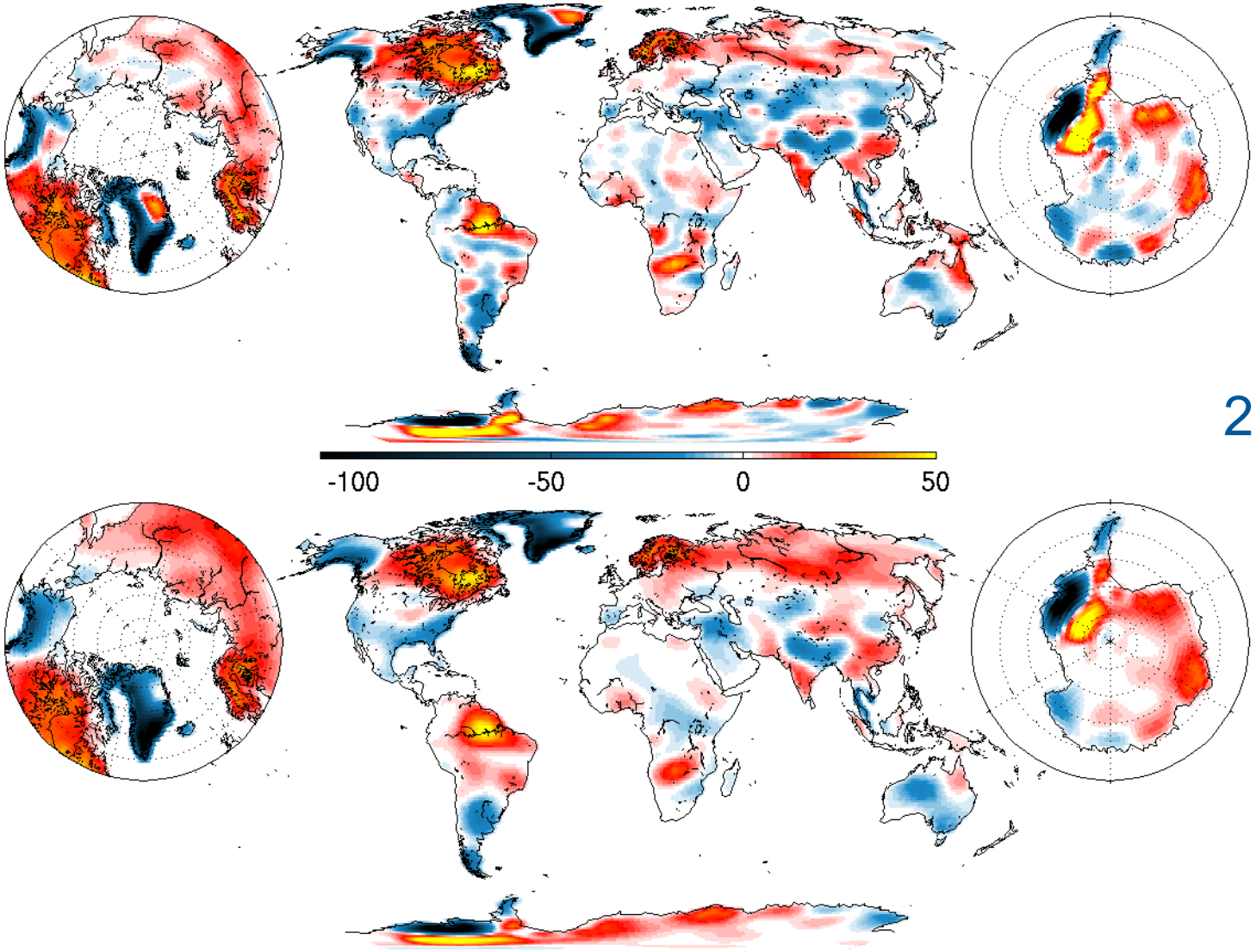


RL05



RBF

Trends

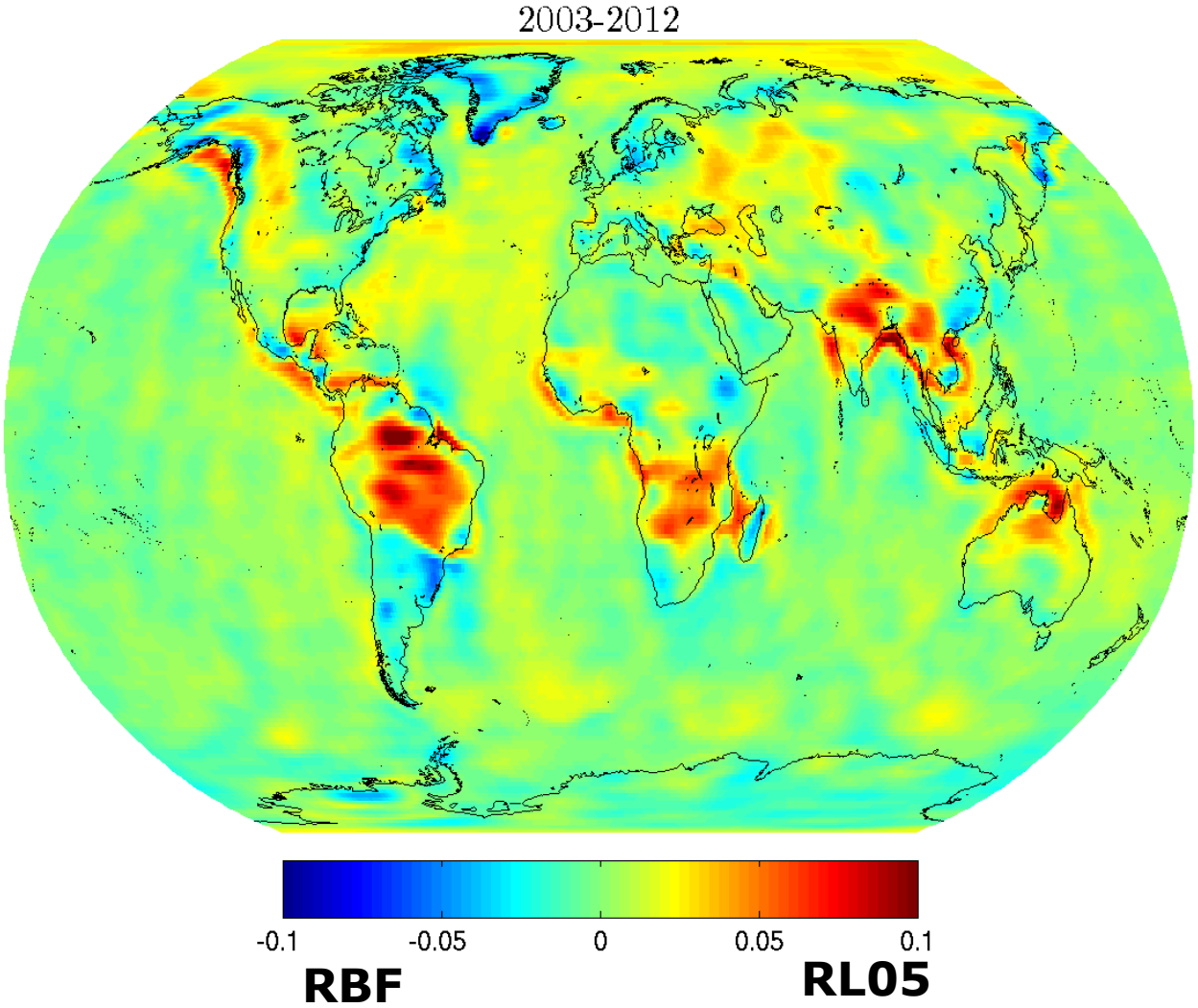


RBF

2003-2009

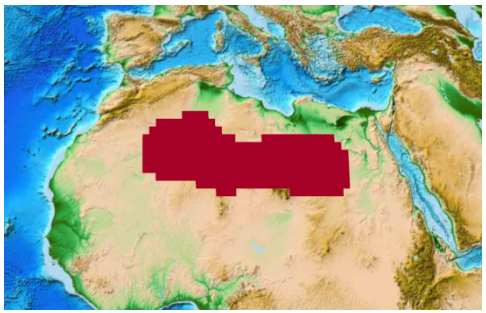
RL05

Amplitude differences



Noise estimation

Statistics for Sahara basin:



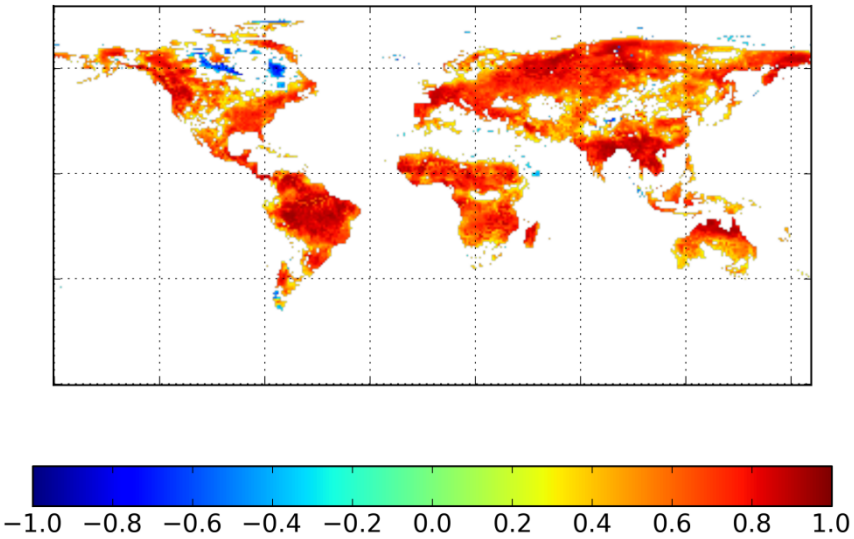
Sahara	DDK1 (~530km)		DDK2 (~340km)		DDK3 (~240km)	
	wMean	wRMS	wMean	wRMS	wMean	wRMS
RL05	1.13	0.15	1.53	0.21	2.49	0.35

Sahara	no post-filtering!	
	wMean	wRMS
RBF	1.77	0.33

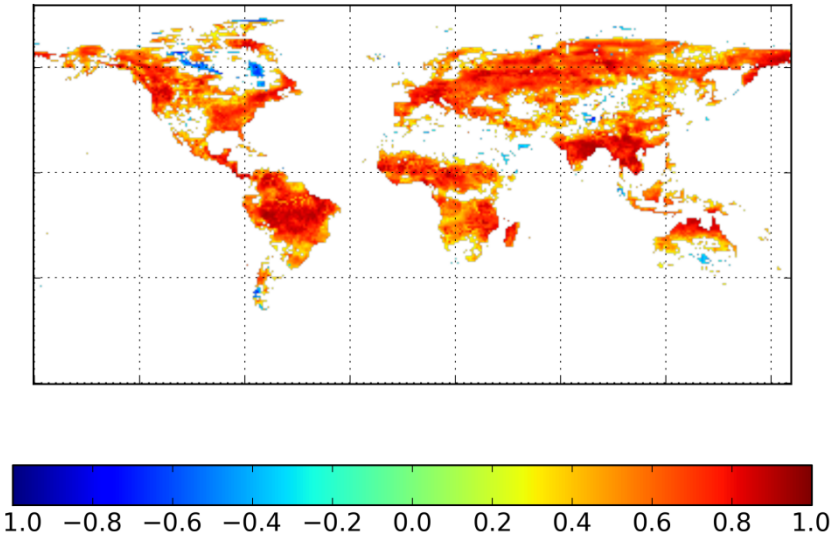
Comparisons with WGHM

Correlation with hydrology
2003-2012

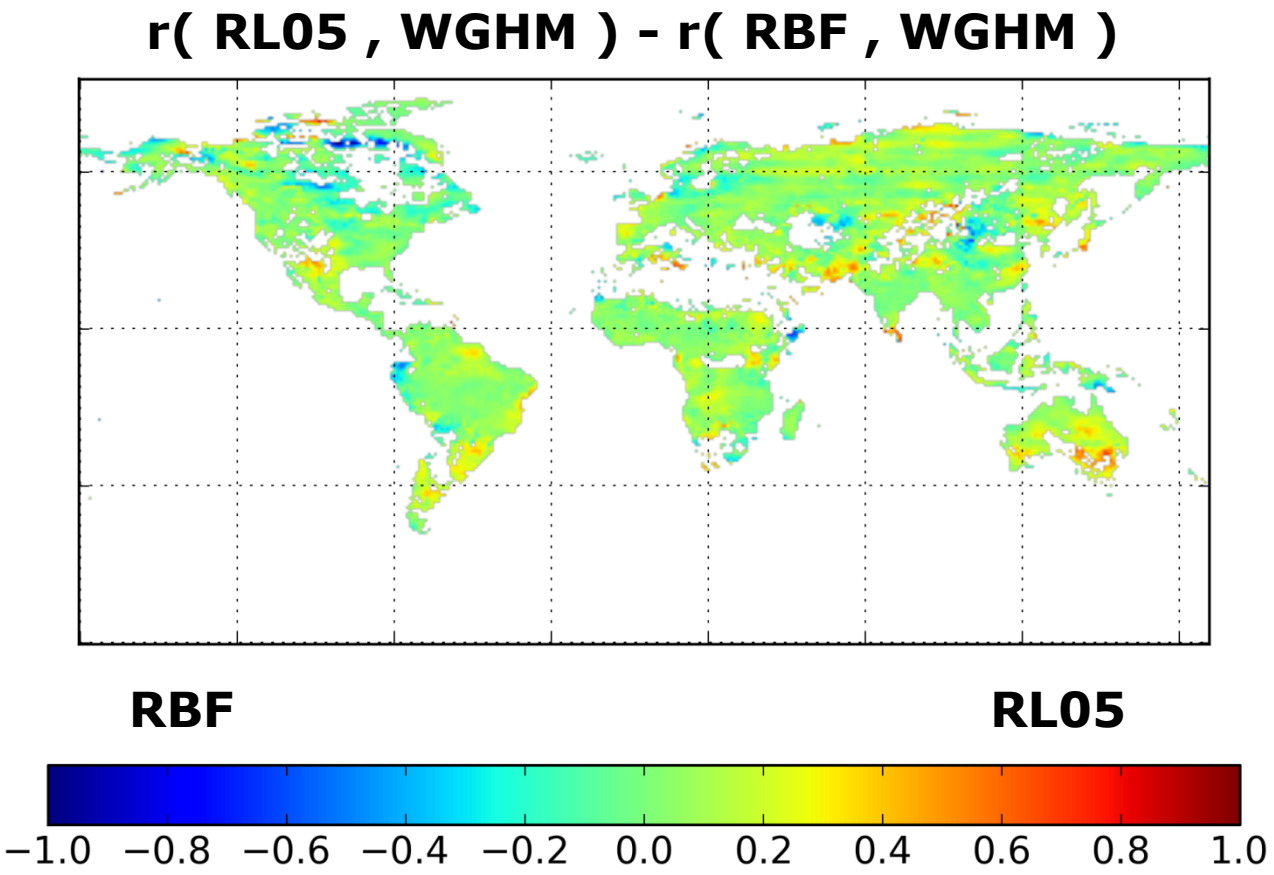
r(RL05 , WGHM) , p < 0.005



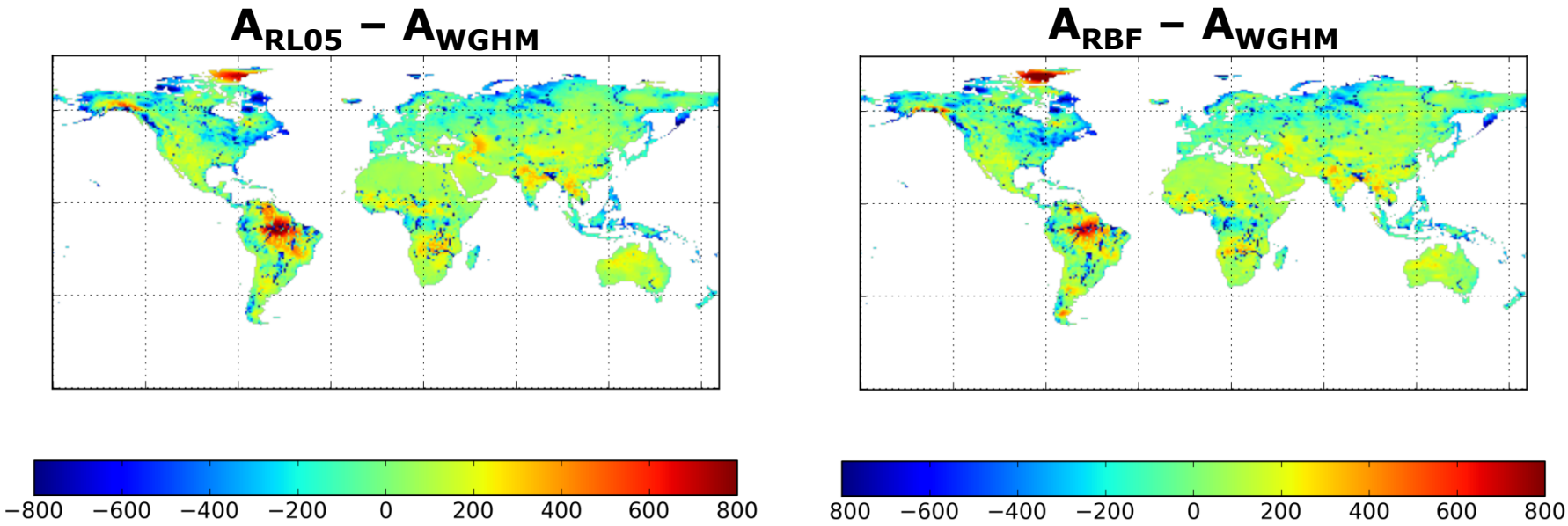
r(RBF , WGHM) , p < 0.005



Correlation differences
2003-2012

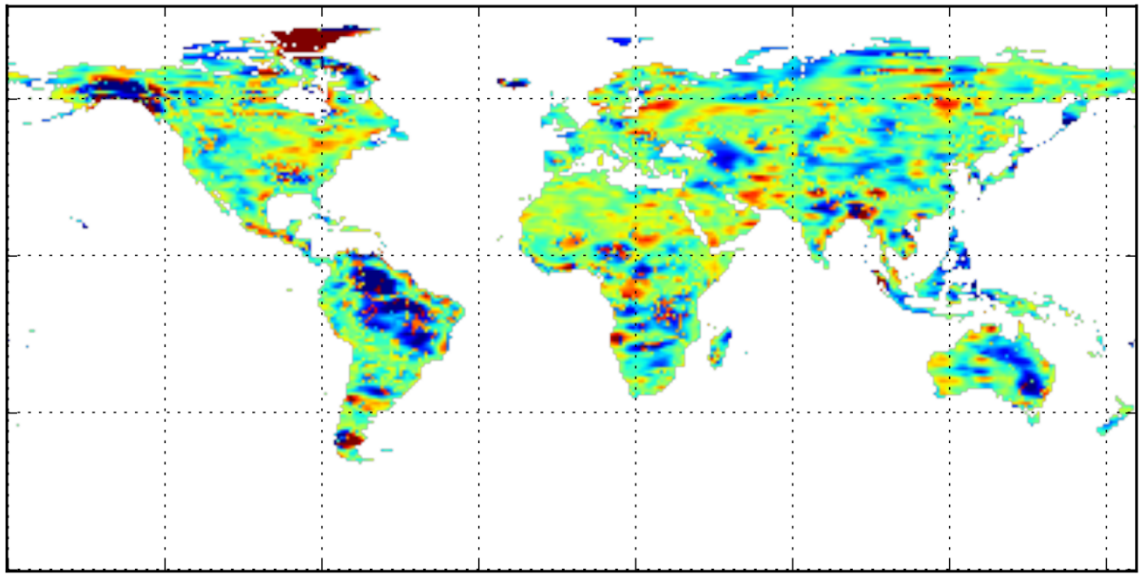


Amplitude differences
2003-2012



Amplitude differences
2003-2012

$| A_{RBF} - A_{WGHM} | - | A_{RL05} - A_{WGHM} |$



RBF RL05

−150 −120 −90 −60 −30 0 30 60 90 120 150

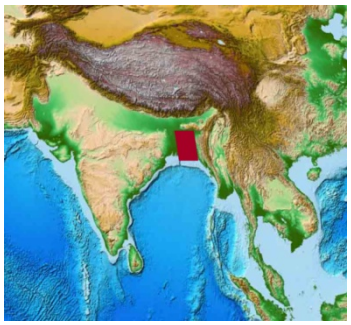
RBF: better localization of hydrological signals = less leakage

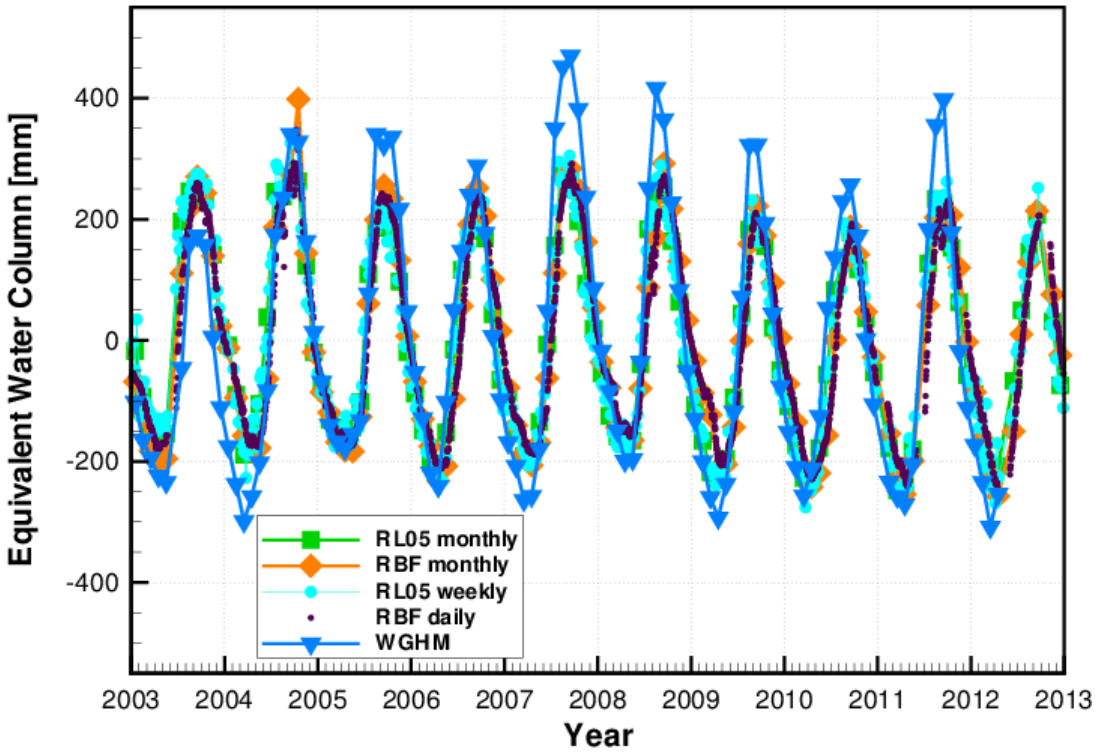
Regional Applications

Bangladesh

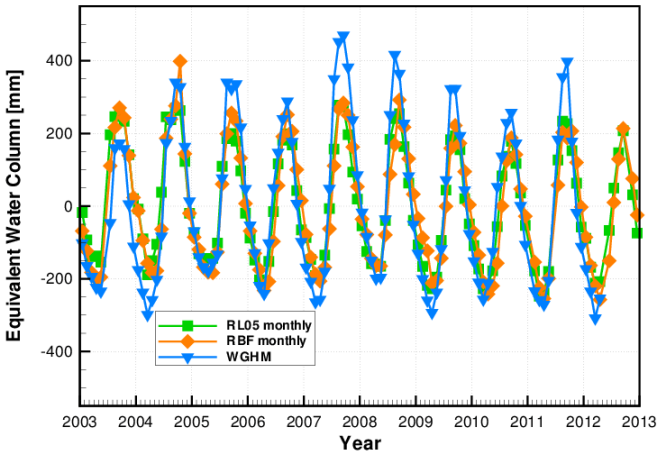
Correlations (monthly):

RL05/RBF	0.95
WGHM/RL05	**0.93**
WGHM/RBF	0.90

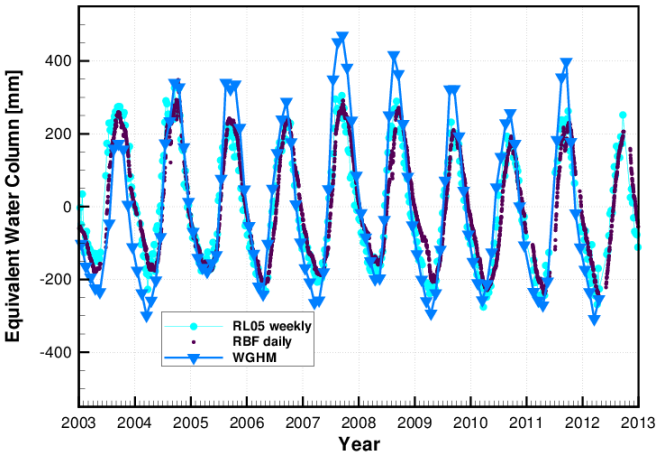




monthly

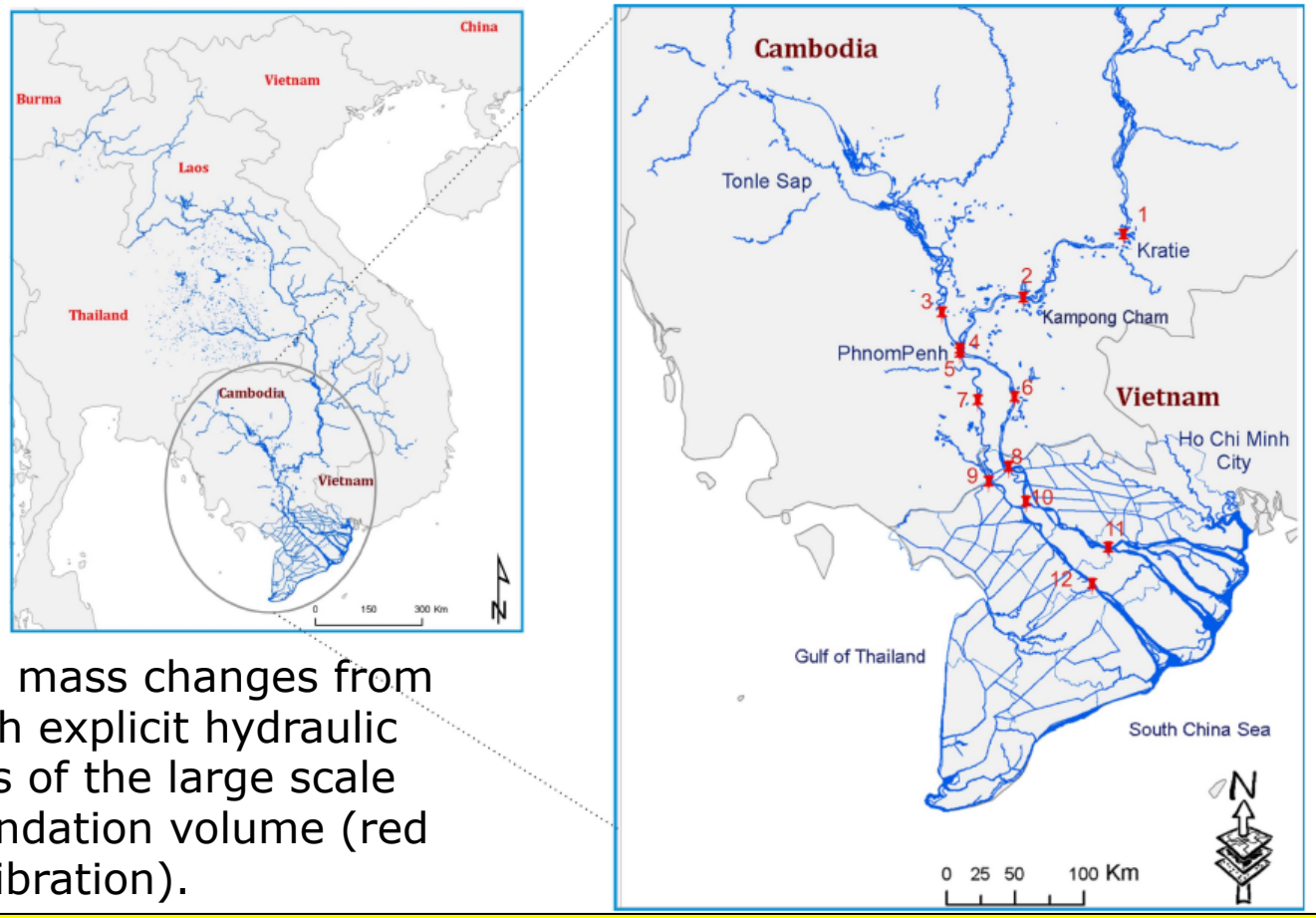


submonthly



GRACE vs. "In situ Hydrology"

Mekong Delta

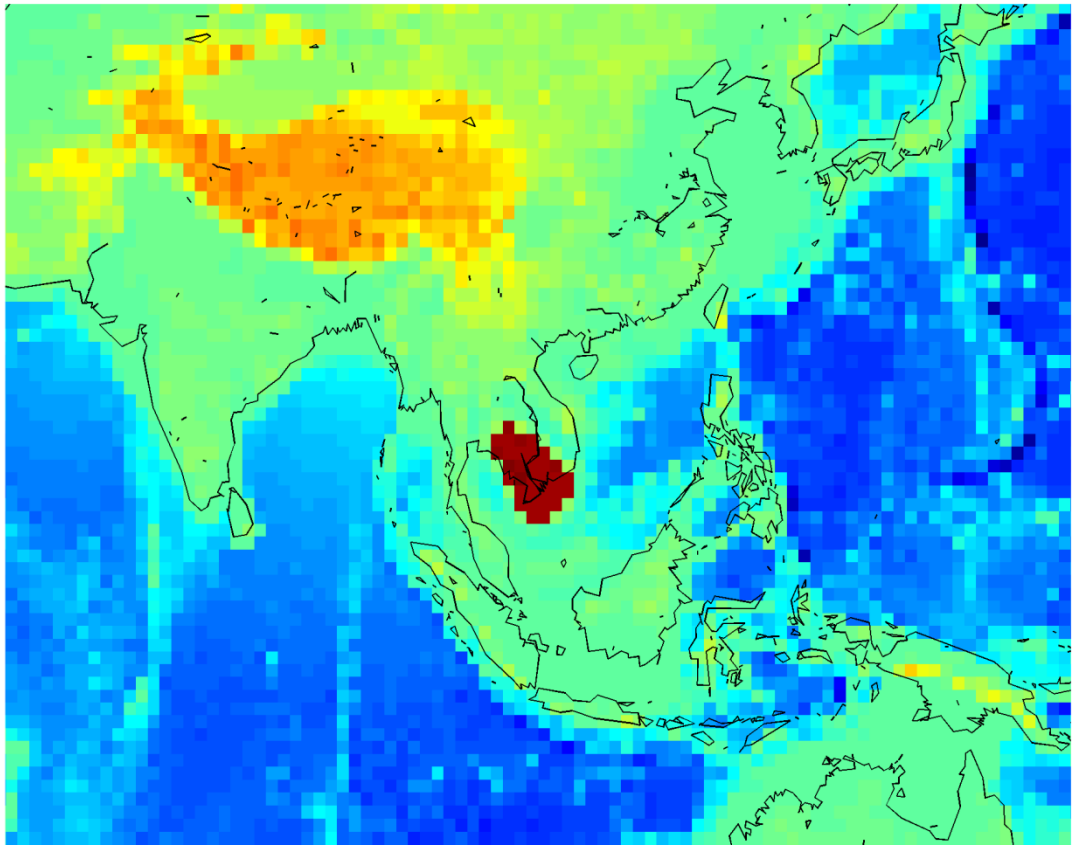


Comparing mass changes from GRACE with explicit hydraulic simulations of the large scale annual inundation volume (red points: calibration).

Dung et al."Multi-objective automatic calibration of hydrodynamic models utilizing inundation maps and gauge data" (2011), *Hydrology and Earth System Sciences.*

GRACE vs. “In situ Hydrology”

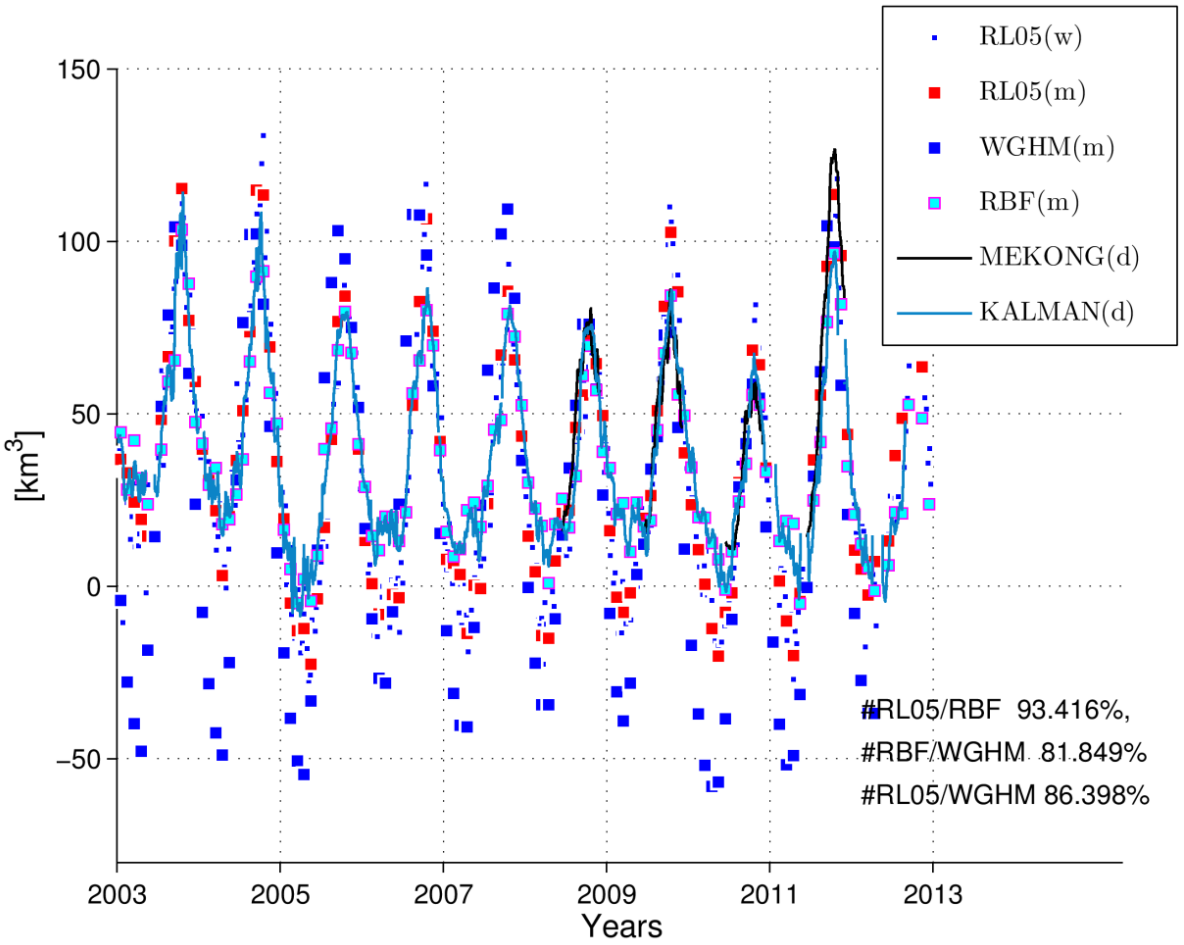
Mekong Delta



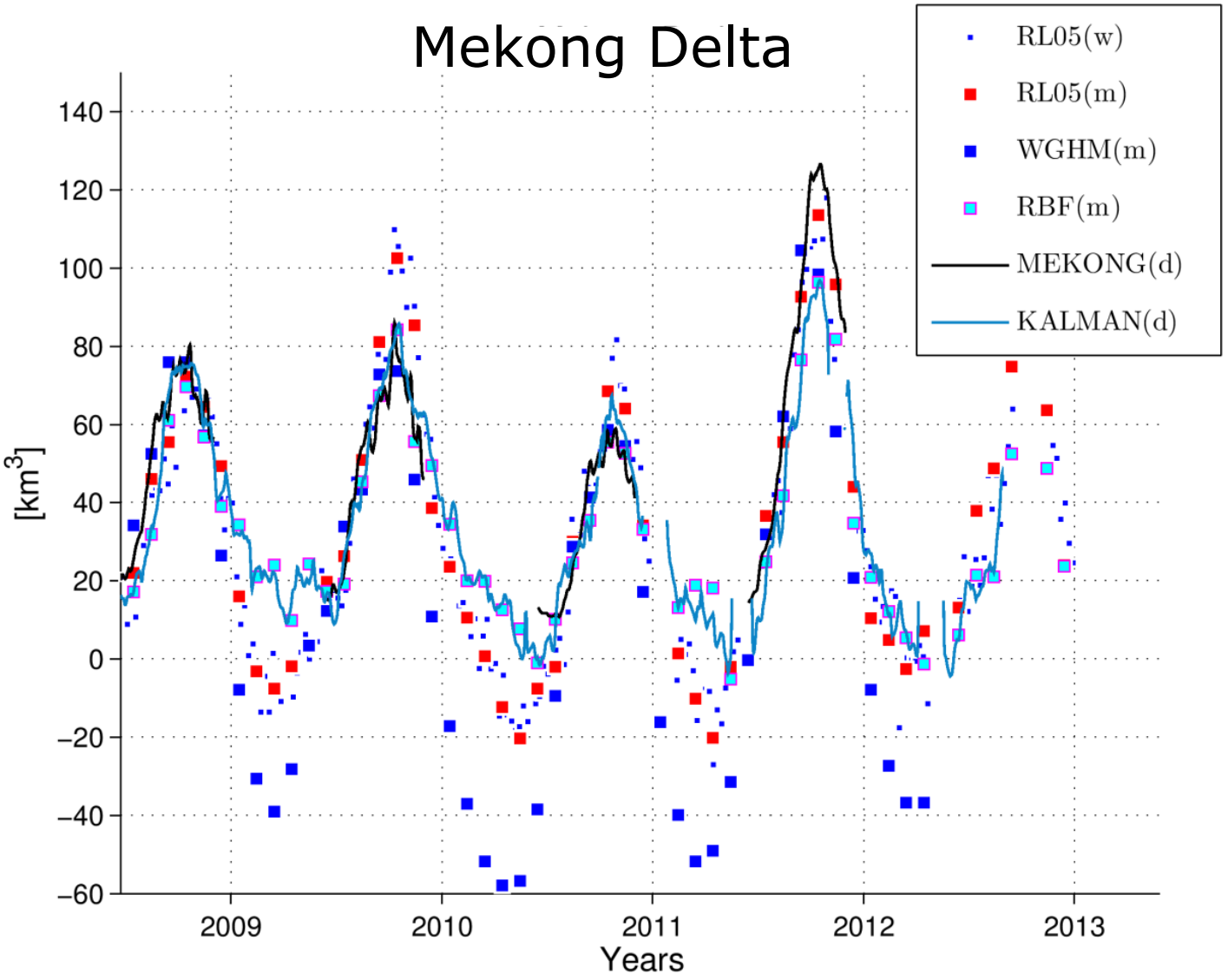
- leakage in / leakage out: how to choose a good mask?

GRACE vs. "In situ Hydrology"

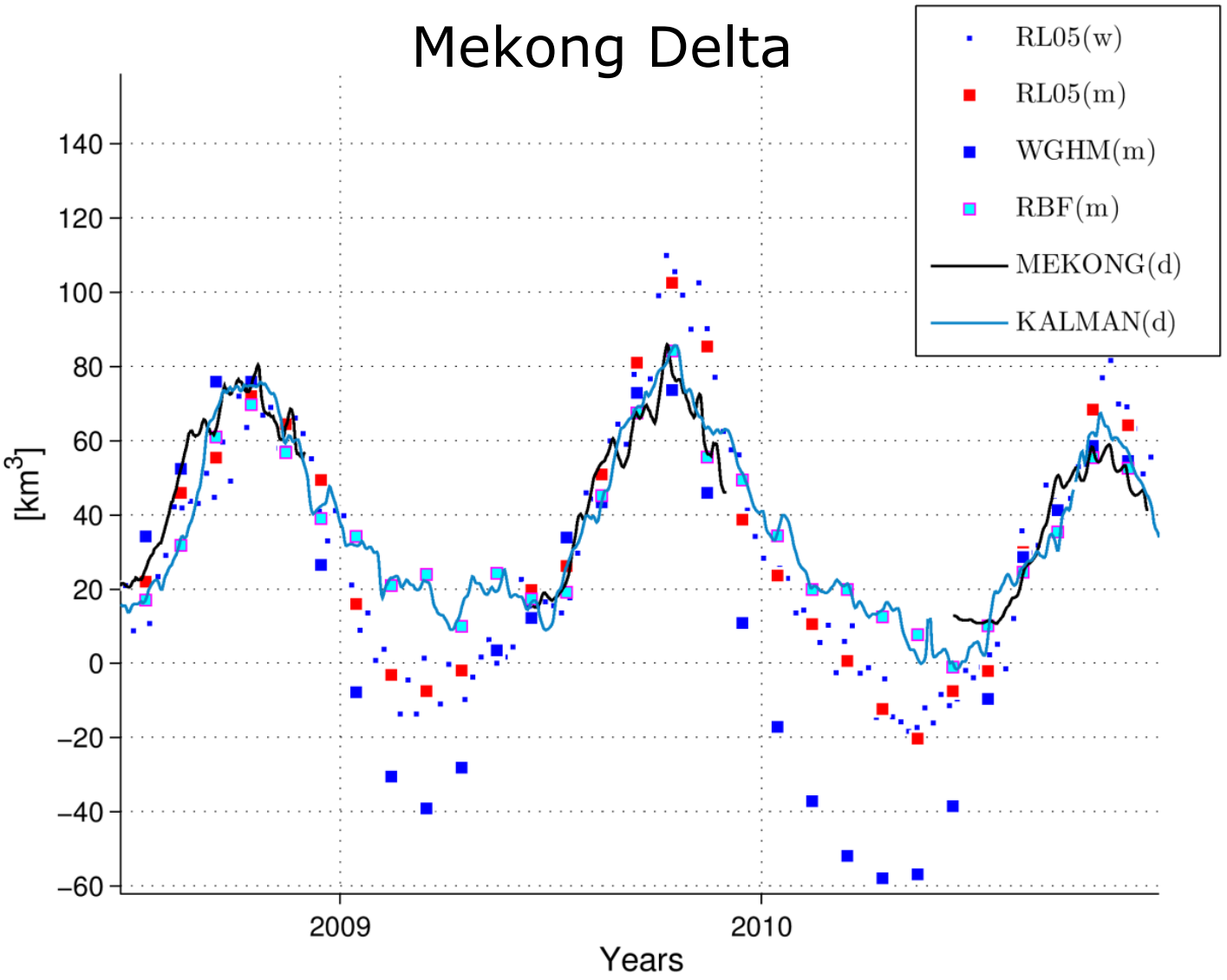
Mekong Delta



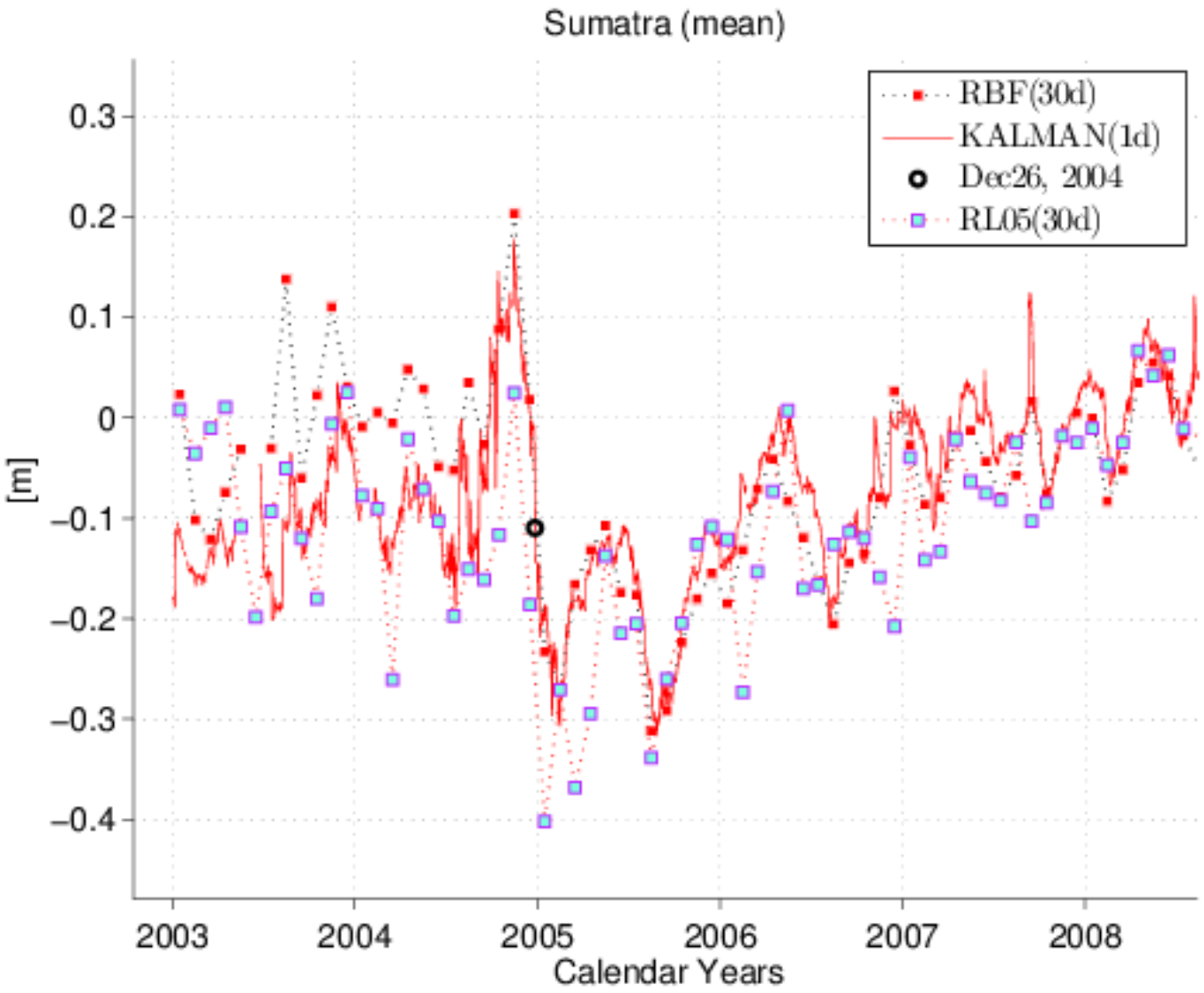
GRACE vs. "In situ Hydrology"



GRACE vs. "In situ Hydrology"



Detection of Sumatra Earthquake



Conclusions

- Intention: higher spatial and temporal resolution by radial basis function and Kalman filtering.

- Different approaches: similar results and new potentiality.
- Conversion of KBRR to in-situ gravitational acceleration works well.
- Relatively low computational cost.
- Provided as (user-friendly) Level-3 products, i.e. in form of monthly or daily grids.
- Already regularized, i.e. no smoothing has to be applied.

- Global and regional applications.
- Near-real-time applications.
- Validated against independent data (WGHM, GPS).
- Very good agreement with hydrologic modeling in Mekong Delta.