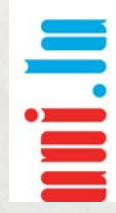


Hydrological mass changes inferred from high-low satellite- to-satellite tracking data



Tonie van Dam, Matthias Weigelt



Mohammad J. Tourian
Nico Sneeuw



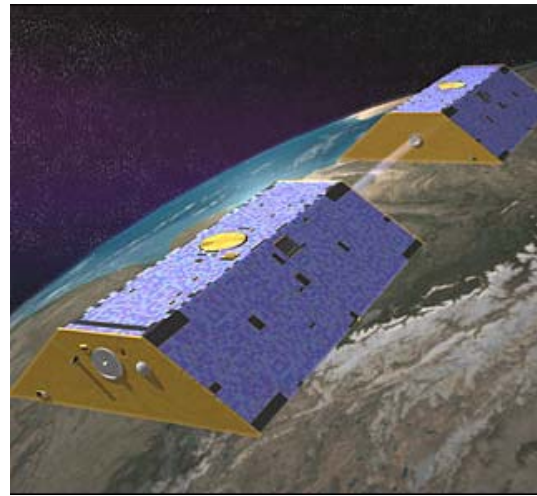
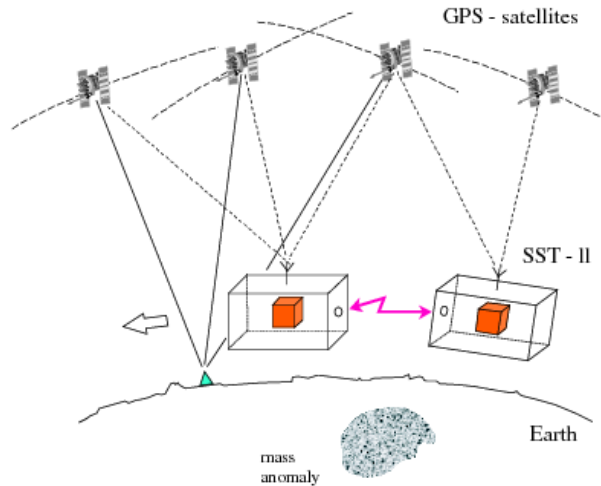
Adrian Jäggi
Lars Prange

RUES | RESEARCH UNIT
IN ENGINEERING
SCIENCES



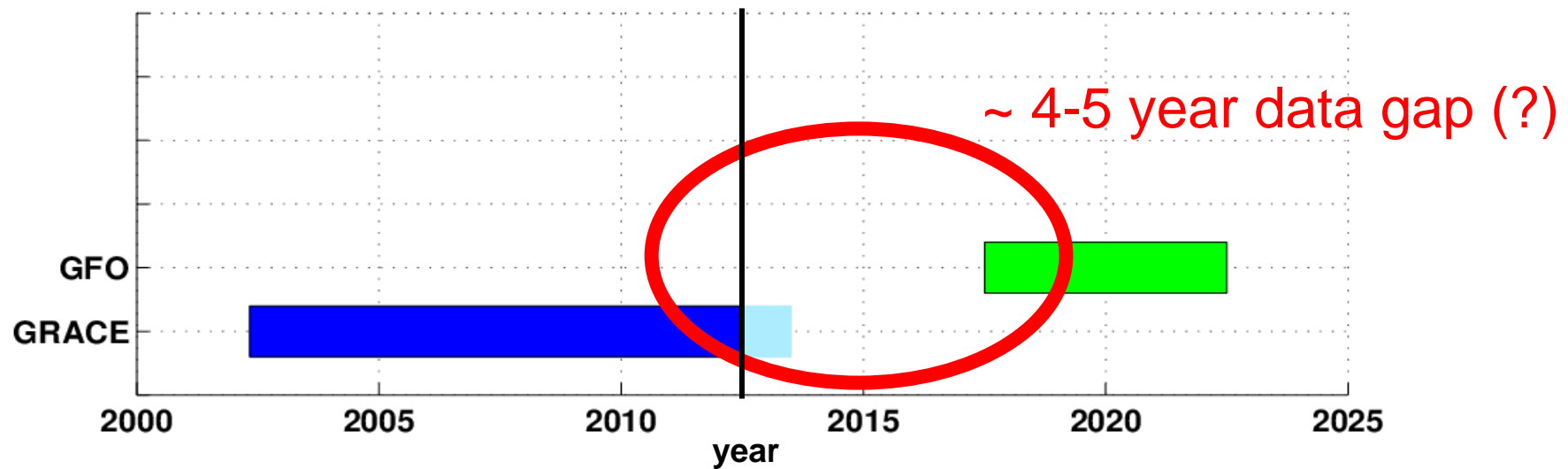
GRACE und GRACE Follow-On (GFO)

Low-low



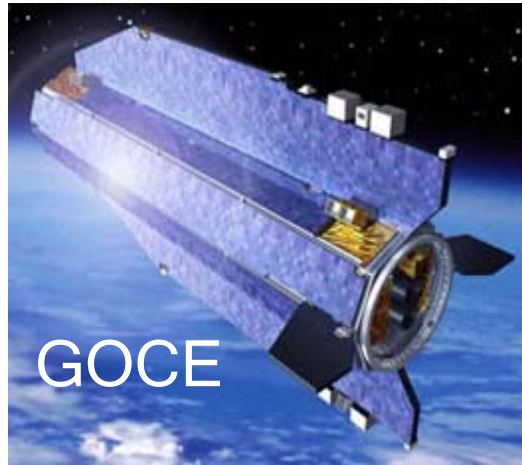
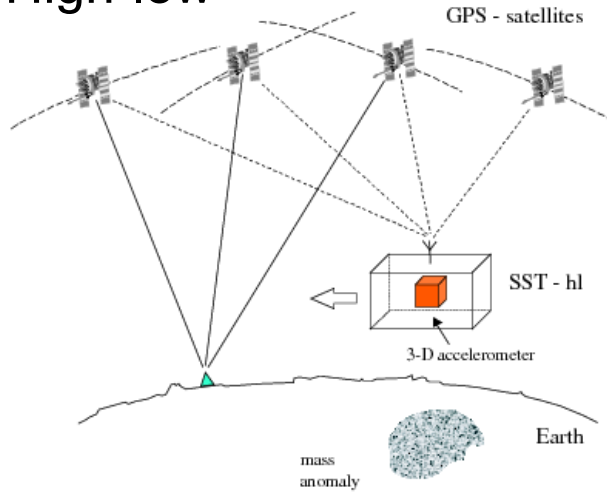
© CSR Texas

- K-Band (Laser)
- GPS
- Accelerometer



Other gravity field missions

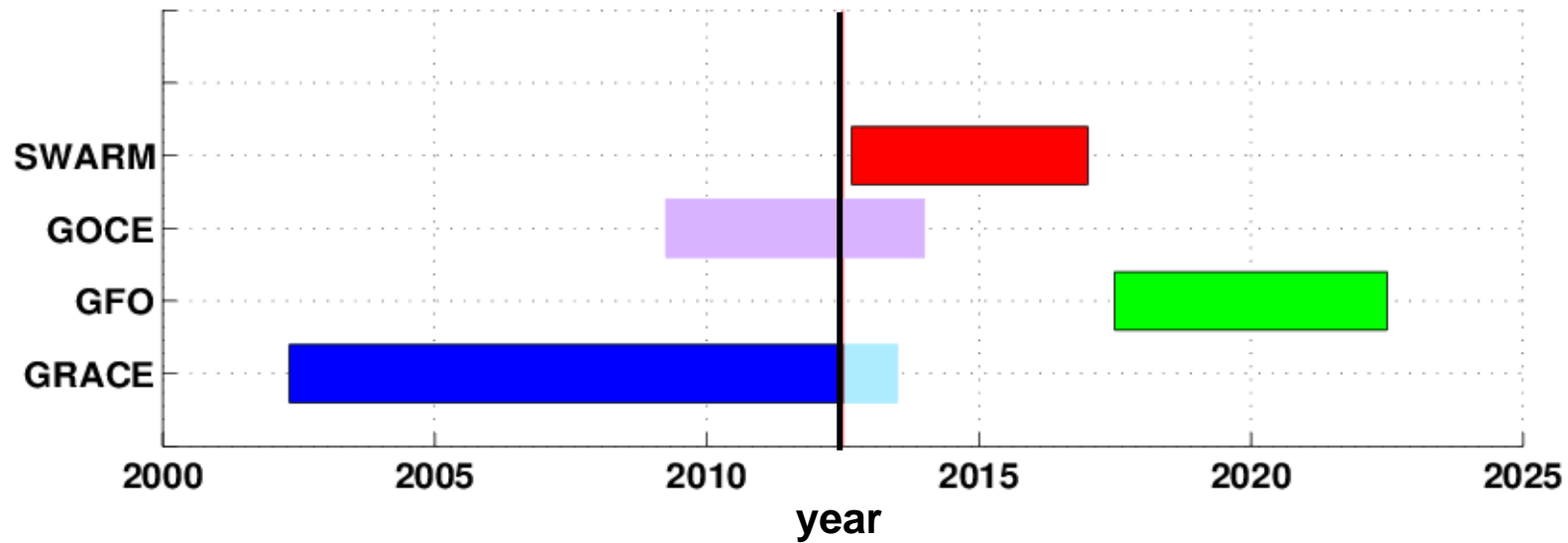
High-low



© ESA



© EADS Astrium



CHAMP

AIUB



RUES

RESEARCH UNIT
IN ENGINEERING
SCIENCES



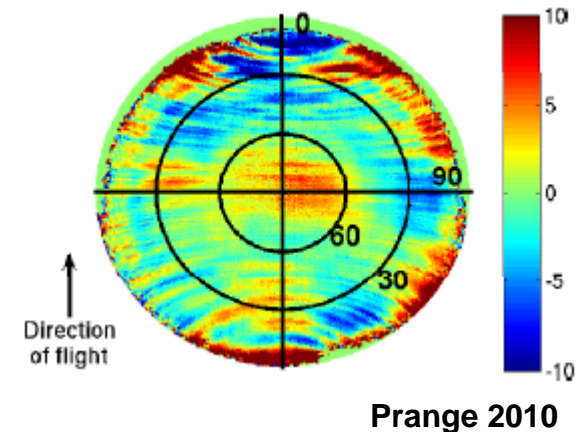
CHAMP reprocessing

GPS positions:

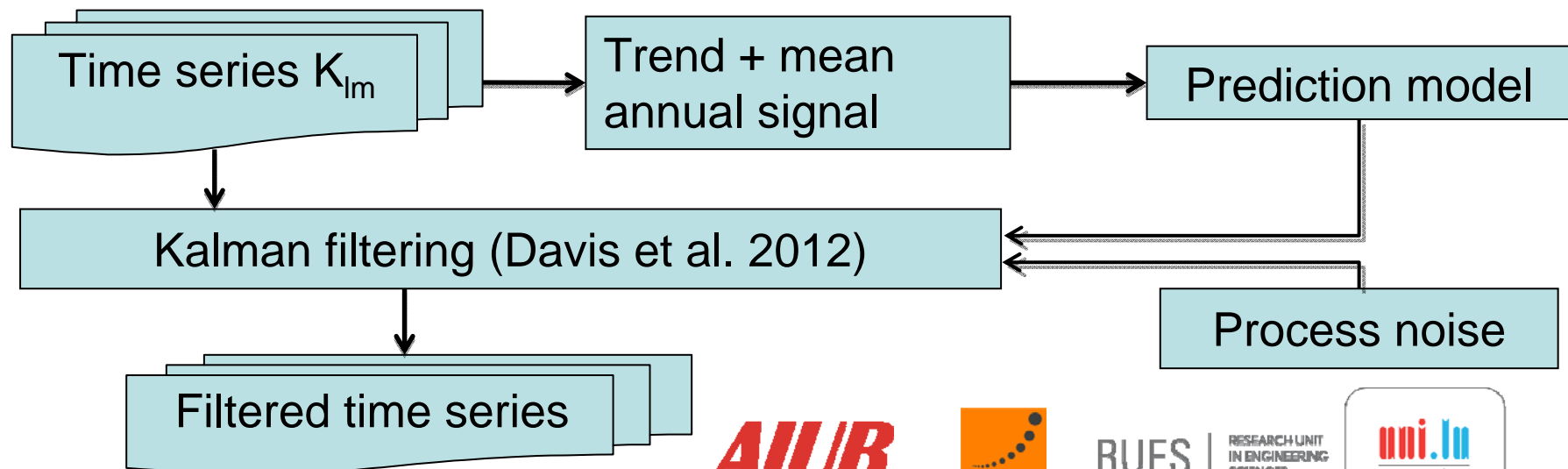
- 10 s sampling
- empirical absolute antenna phase center model

Approach:

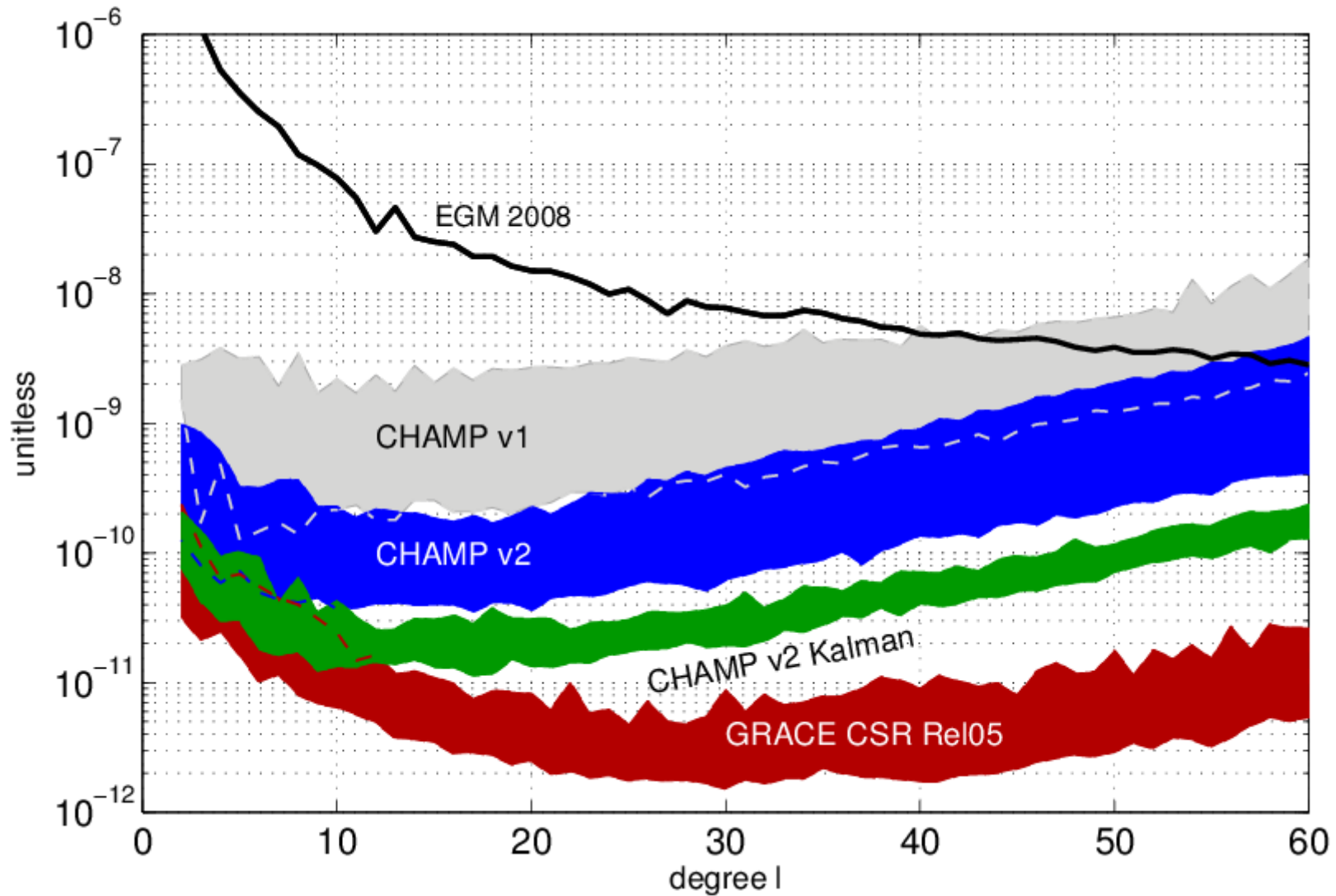
- acceleration approach
- no accelerometer data used
- no regularization and no *a priori* model / information



Postprocessing with a Kalman filter:



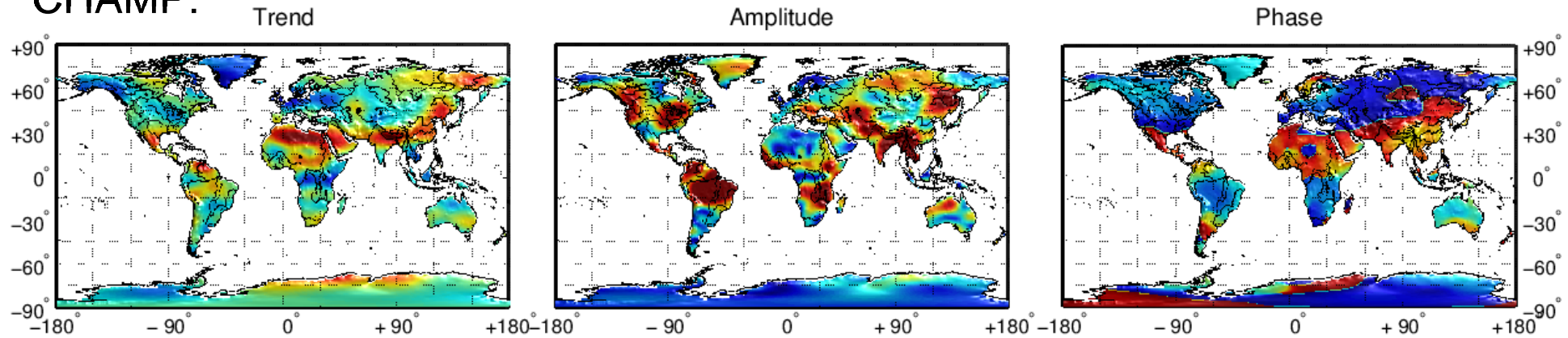
Filtered monthly gravity field solution



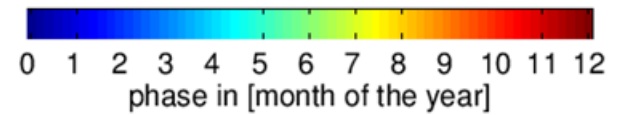
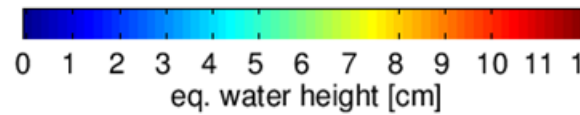
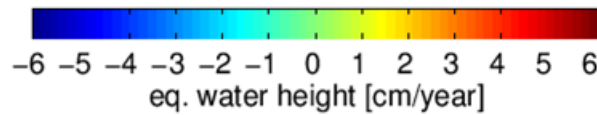
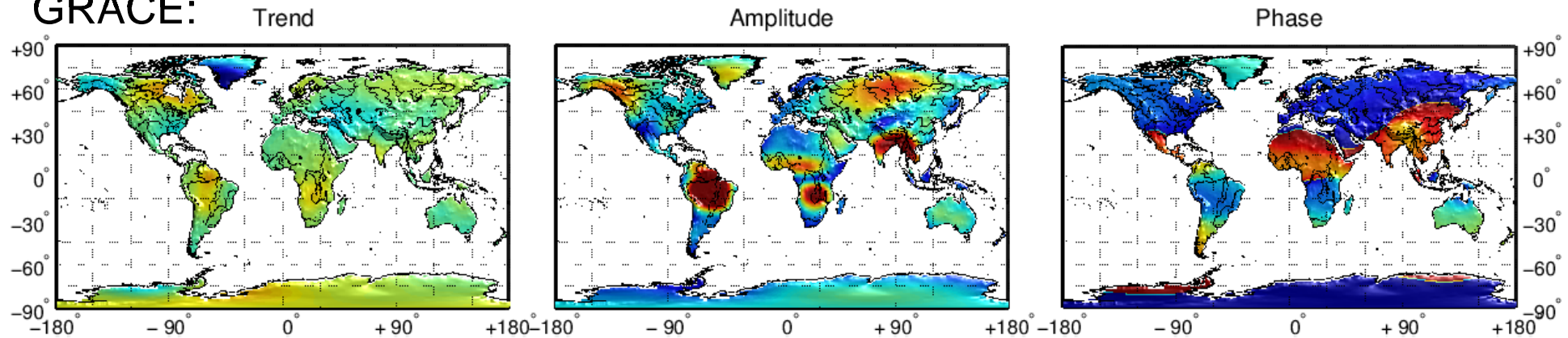
CHAMP vs. GRACE

750km

CHAMP:



GRACE:



EVALUATION WITH HYDRO- METEOROLOGY

AIUB



RUES

RESEARCH UNIT
IN ENGINEERING
SCIENCES



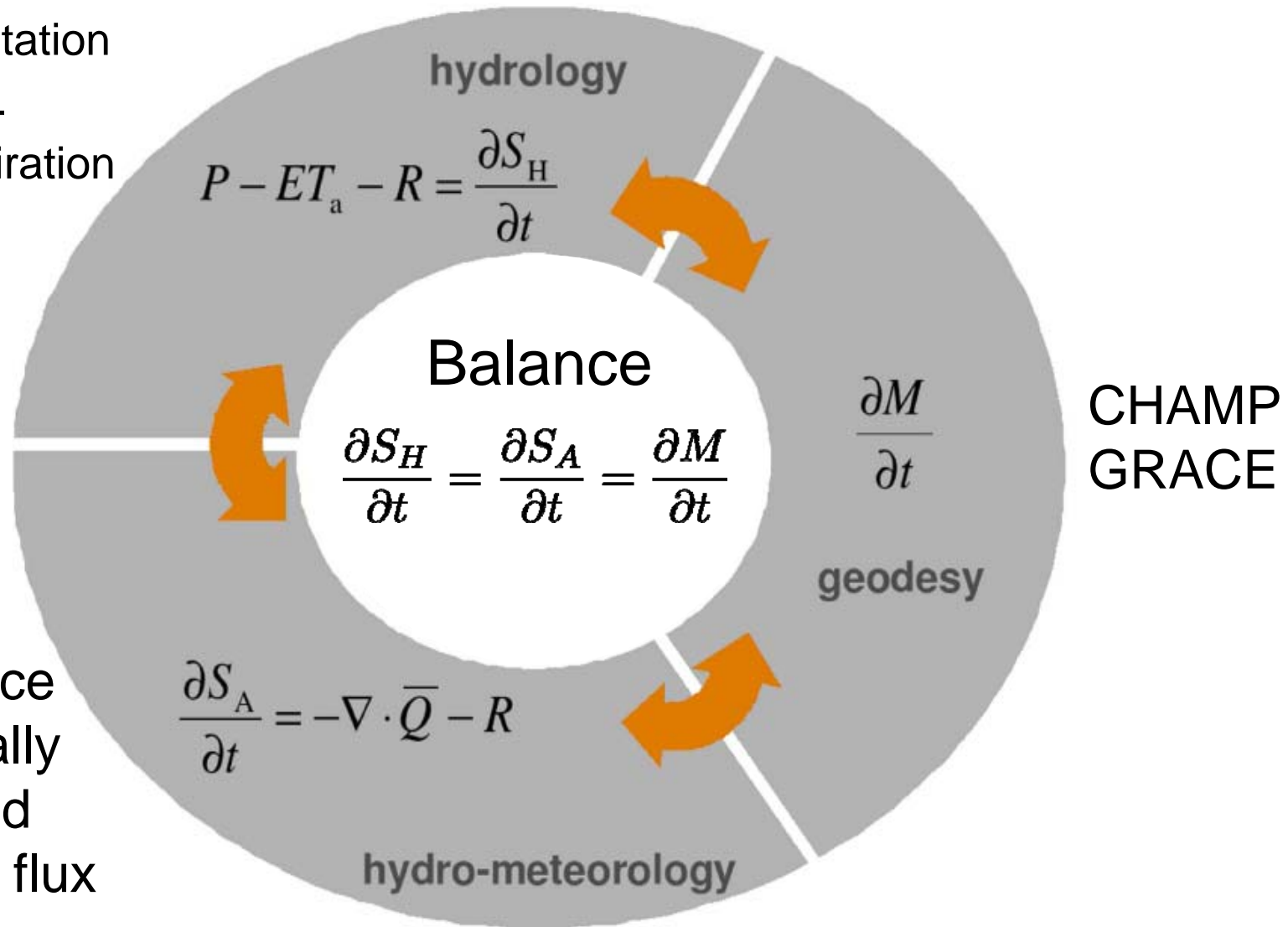
Mass change as a hydrological observable

P = precipitation

ET_a = evapo-
transpiration

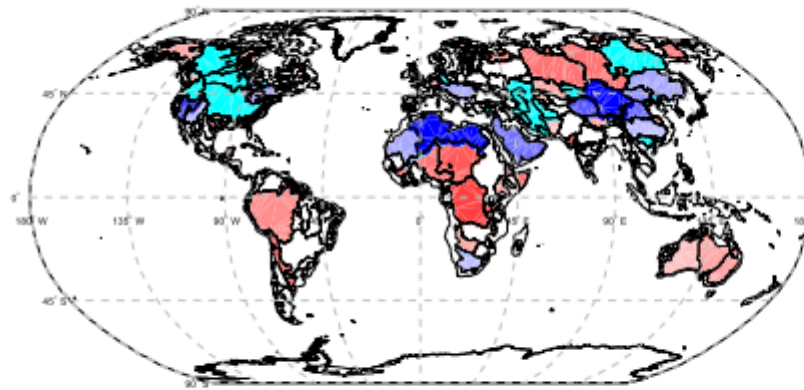
R = runoff

$\nabla \cdot \bar{Q} =$
divergence
of vertically
integrated
moisture flux

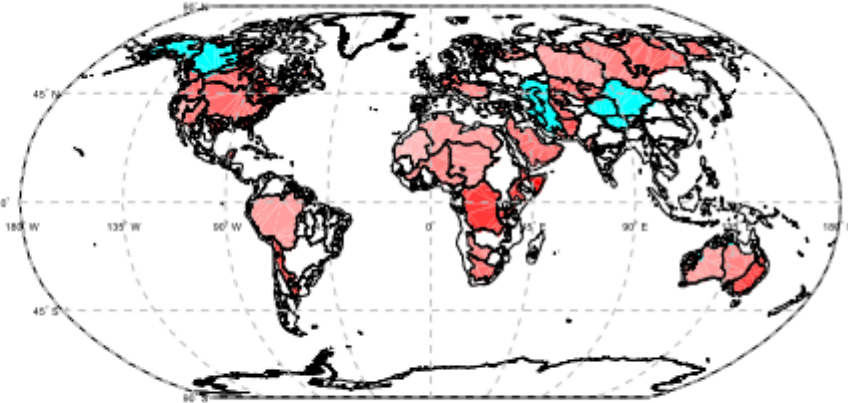


Mass estimate & correlation – 750km

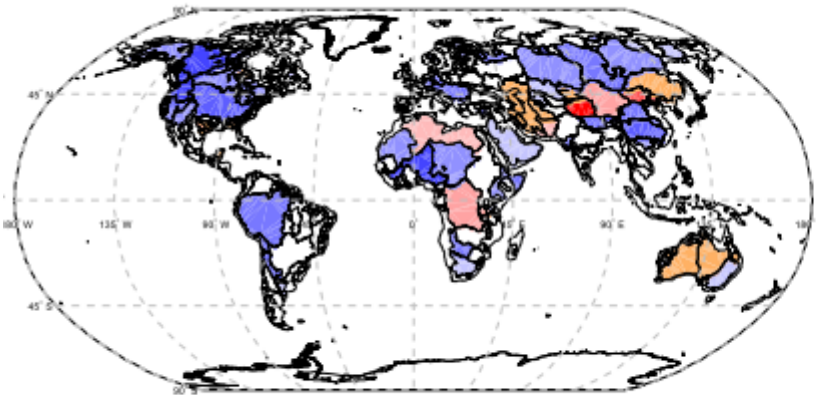
RMS(dM/dt) / RMS(dS/dt), dM/dt from CHAMP (filtered with G750)



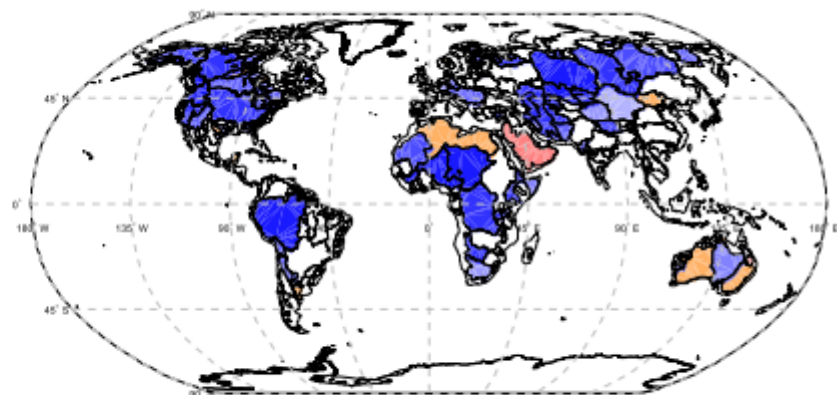
RMS(dM/dt) / RMS(dS/dt), dM/dt from GRACE (filtered with G750)



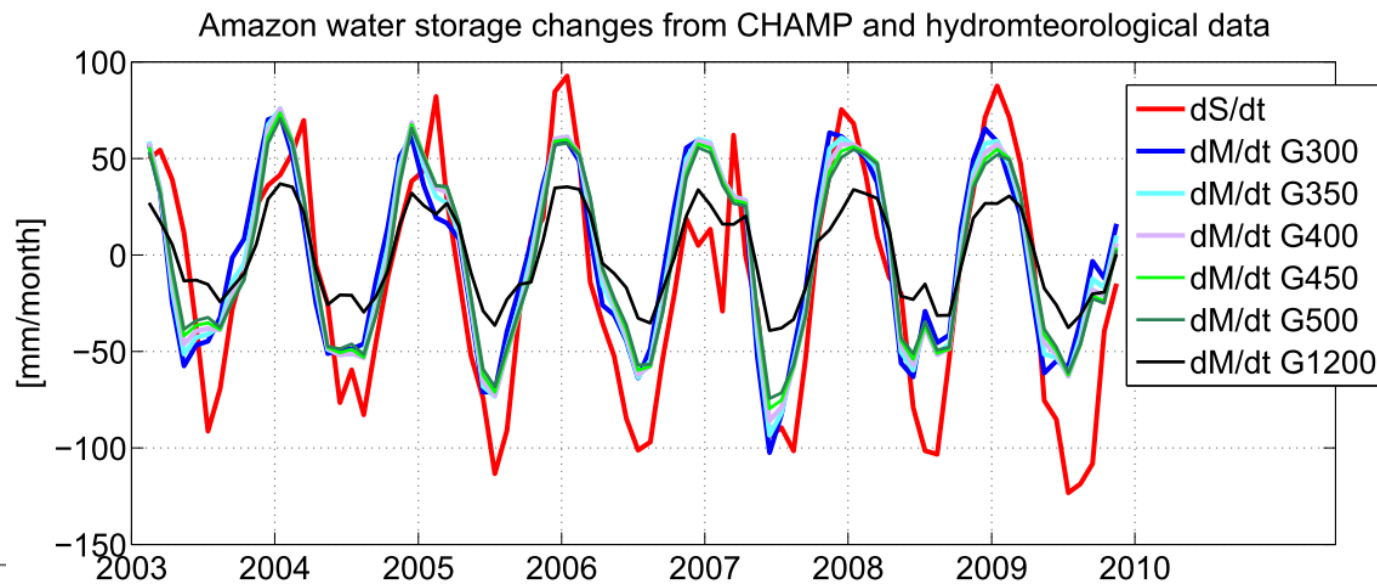
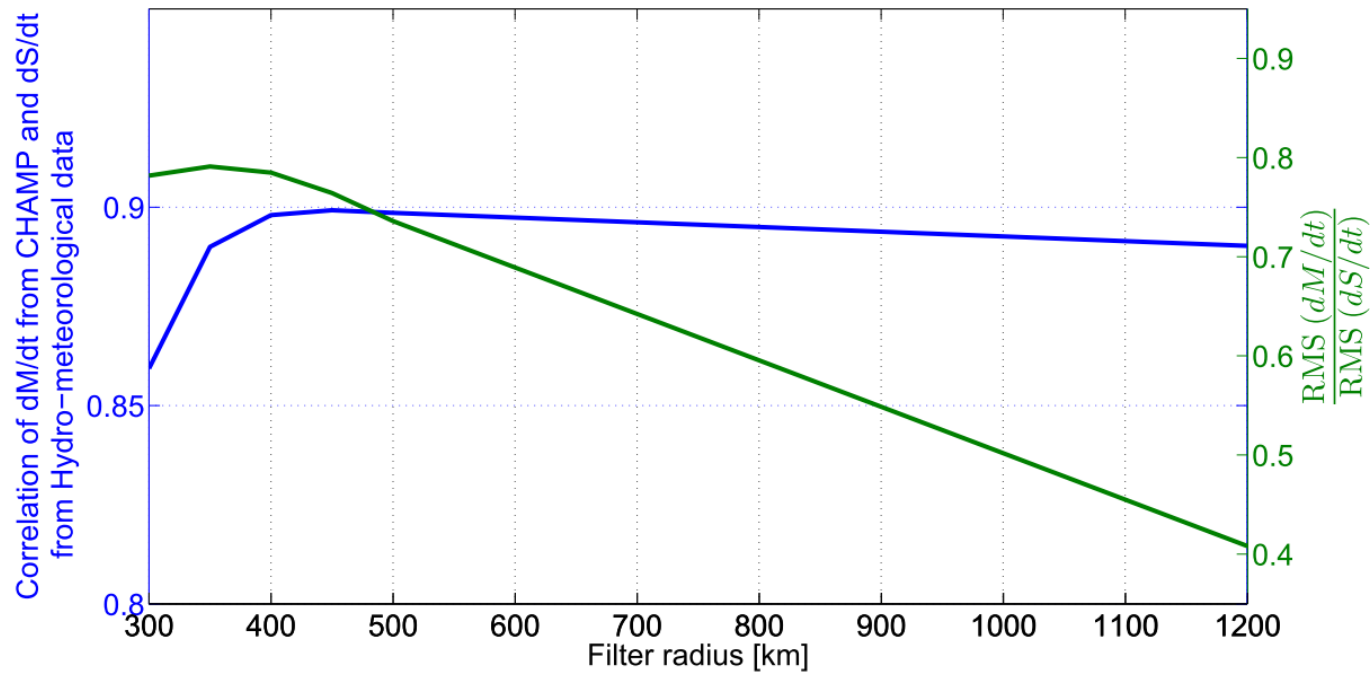
Correlation of dM/dt from CHAMP (filtered with G750) and dS/dt



Correlation of dM/dt from GRACE (filtered with G750) and dS/dt



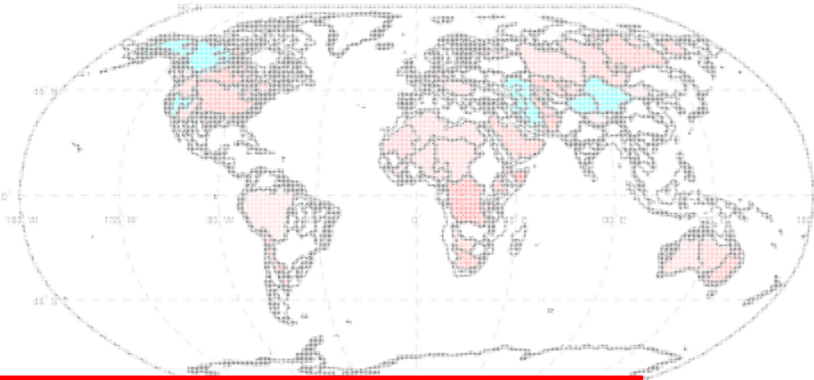
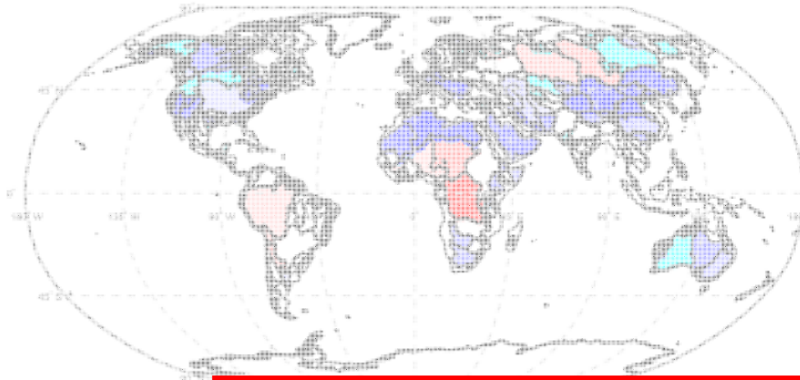
Filter size for Amazon basin



Mass estimate & correlation – 450km

RMS(dM/dt) / RMS(dS/dt), dM/dt from CHAMP (filtered with G450)

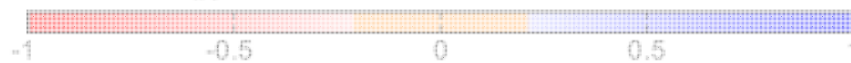
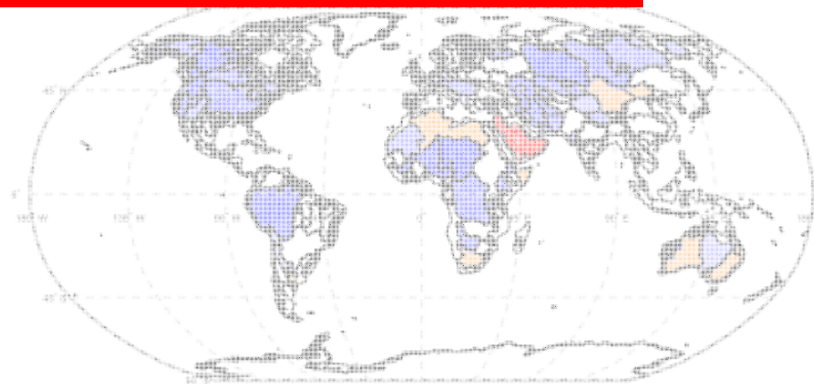
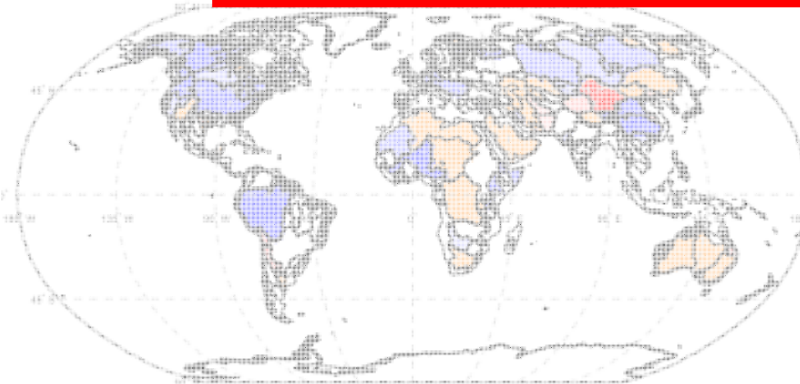
RMS(dM/dt) / RMS(dS/dt), dM/dt from GRACE (filtered with G450)



“Optimal” filter radius is catchment and signal dependent (see Tourian 2013)

Correlation of dM/dt

dM/dt and dS/dt



EVALUATION WITH GPS

AIUB

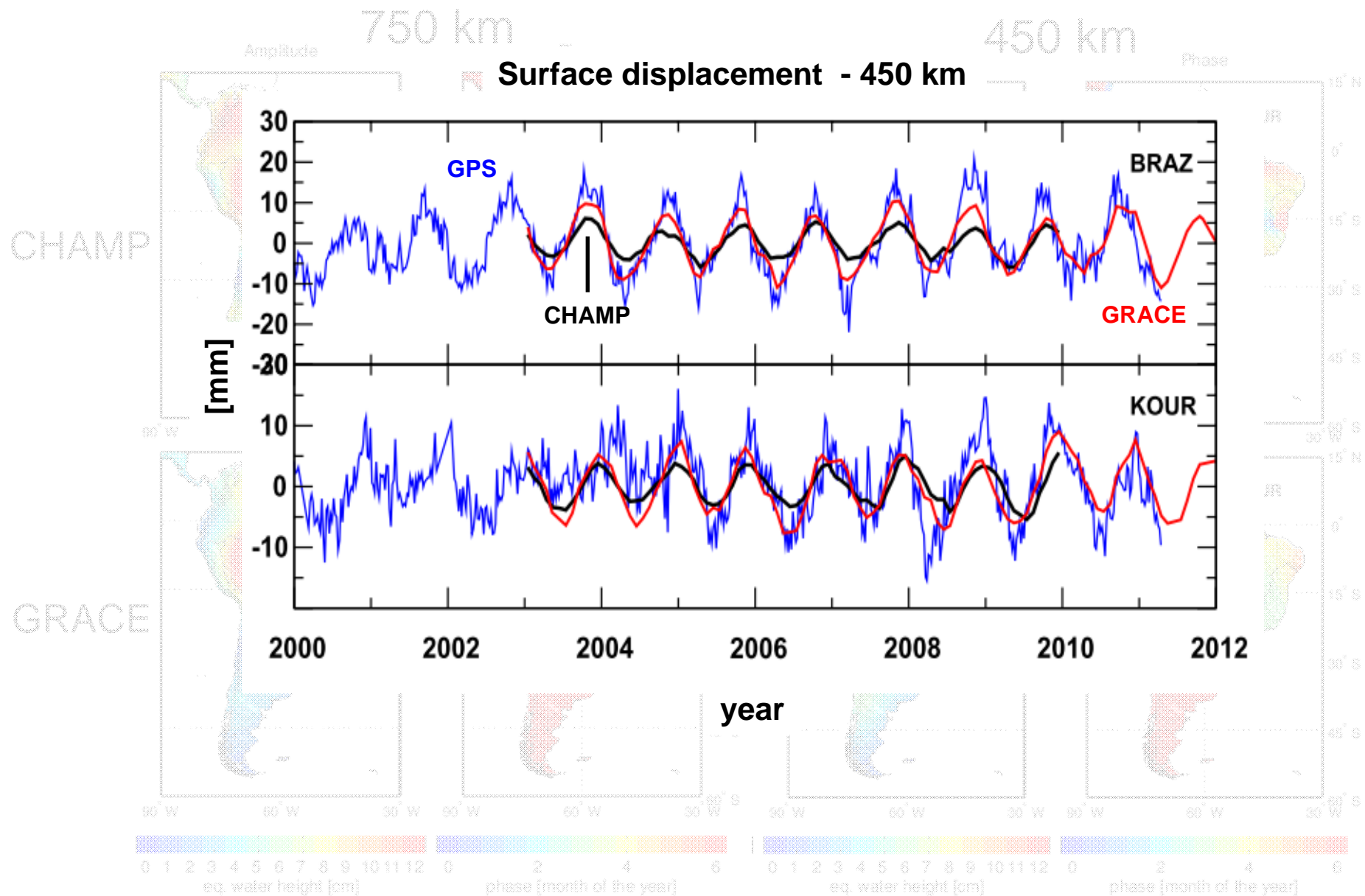


RUES

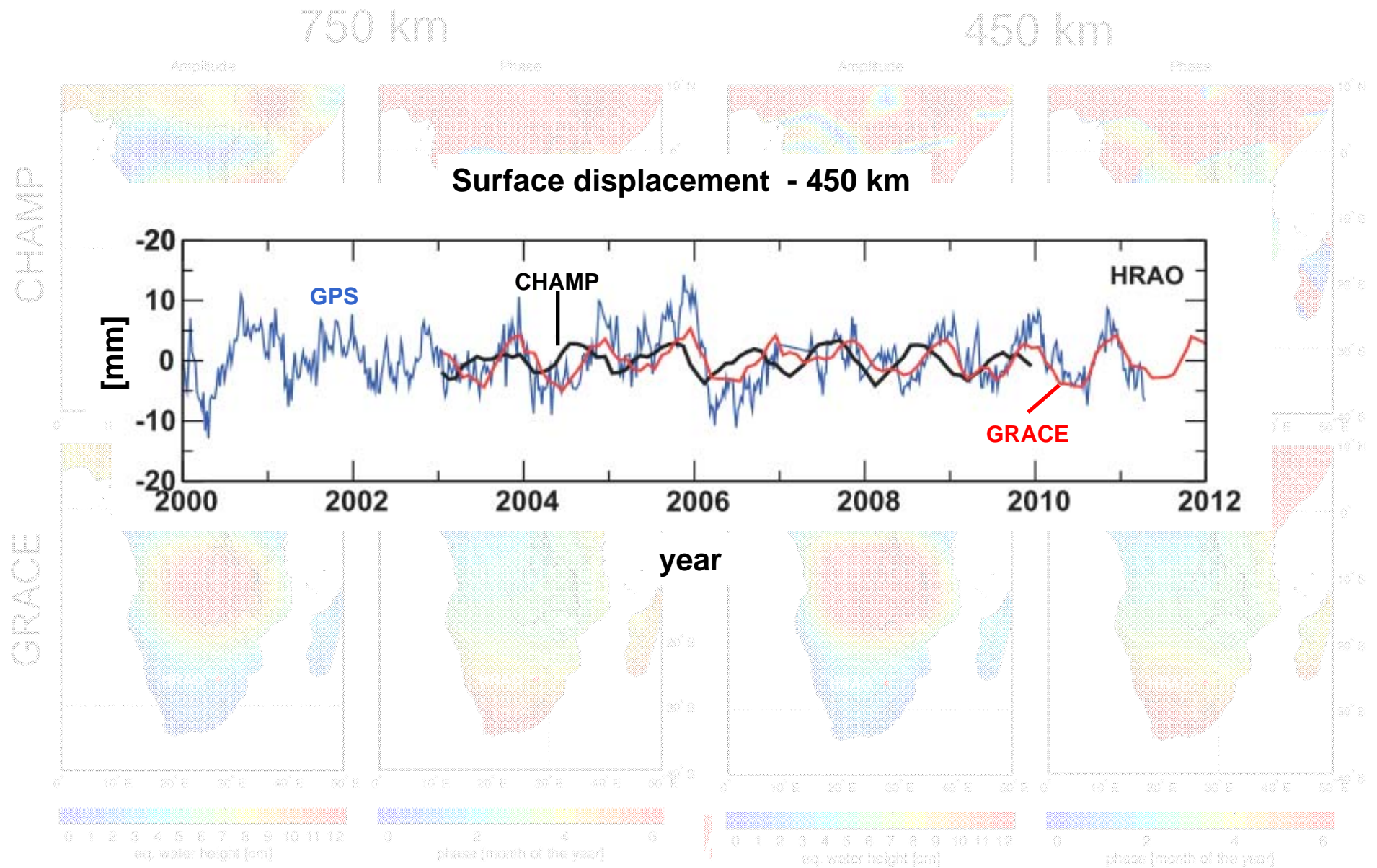
RESEARCH UNIT
IN ENGINEERING
SCIENCES



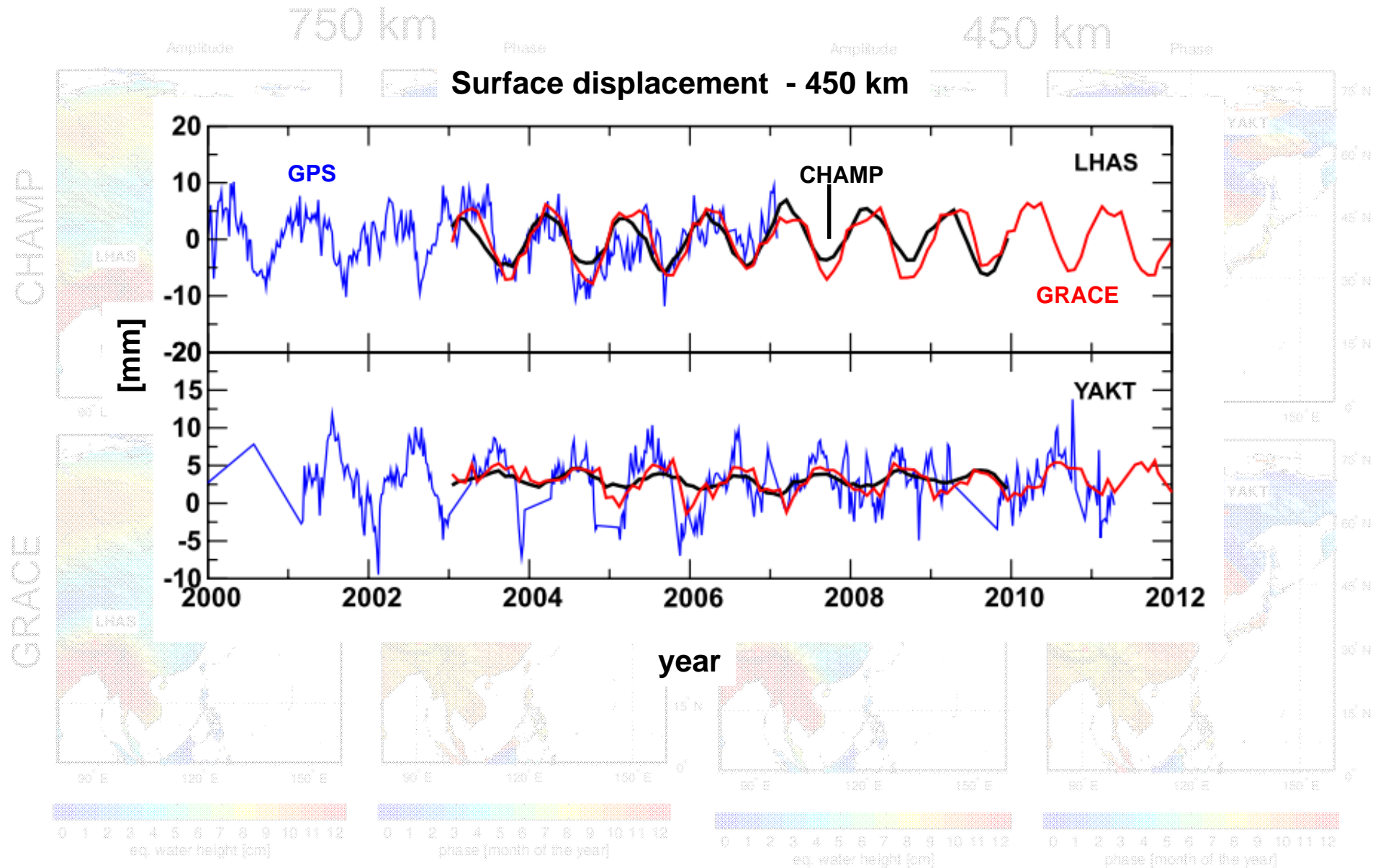
Loading analysis - Amazon



Loading analysis – South Africa



Loading analysis – East Asia



SUMMARY

AIUB



RUES

RESEARCH UNIT
IN ENGINEERING
SCIENCES



Summary

- Time variable gravity field from high-low SST
- Long wavelength features
- Refinement in the processing possible/necessary
 - Spatial error pattern needs to be understood
- Filter dependency on catchment and application
 - Processing might include a beneficial smoothing!
- Remarkable agreement with hydro-meteorology and GPS
- Expectations for SWARM:
 - better GPS receiver
 - three satellites