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

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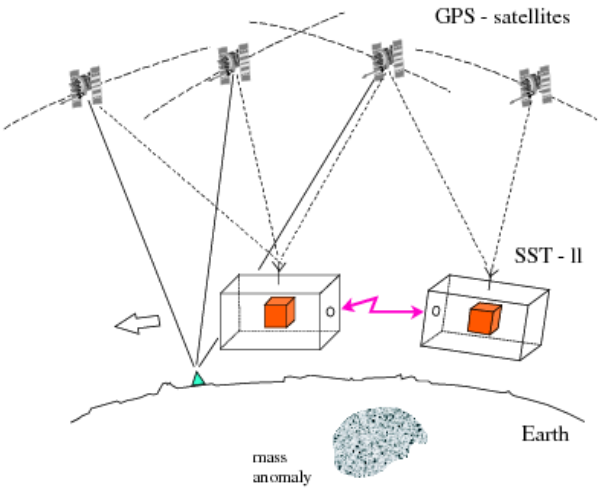
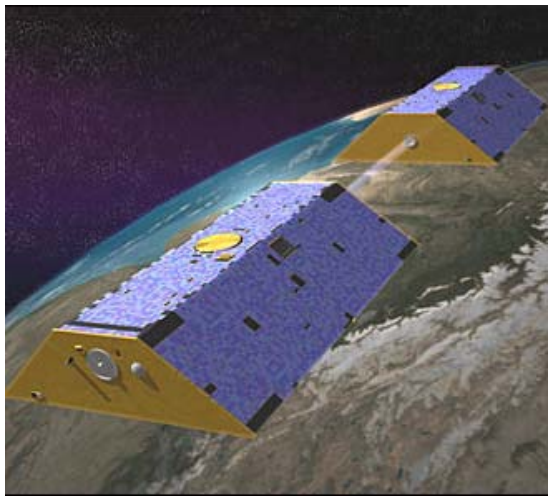
GRACE und GRACE Follow-On (GFO)

Low-low





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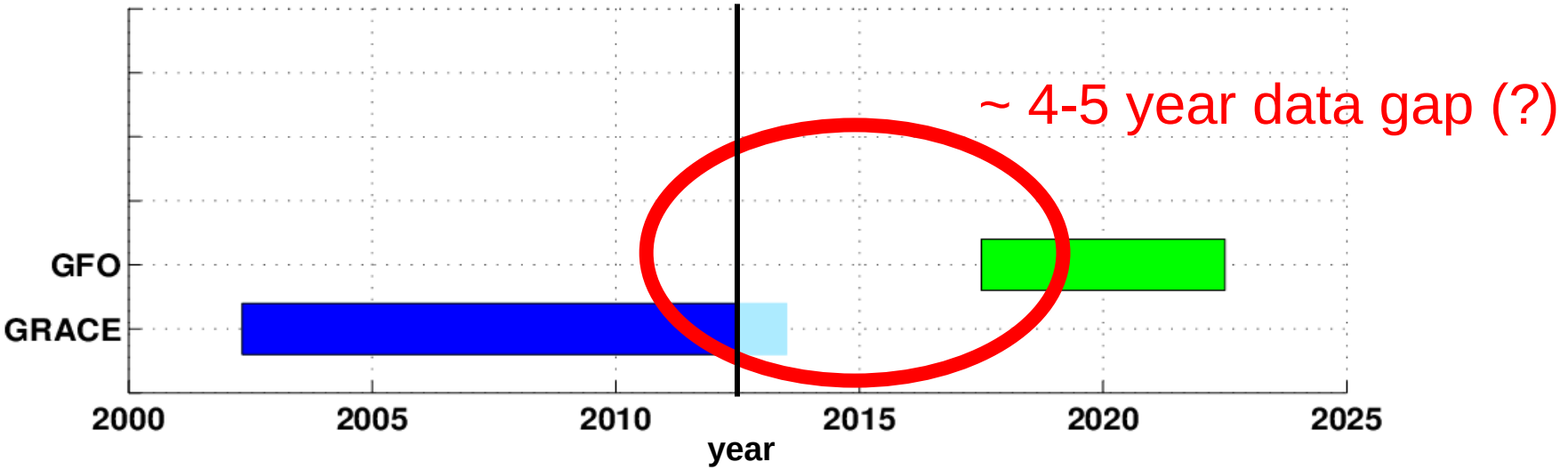
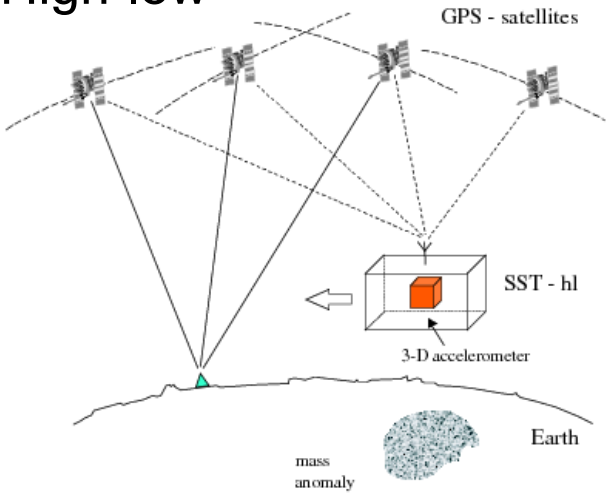
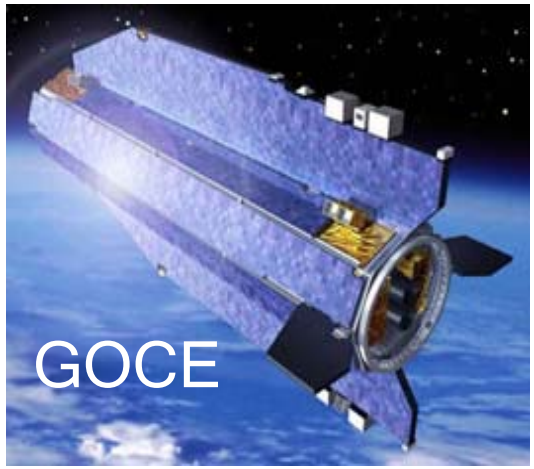
- K-Band (Laser)
- GPS
- Accelerometer



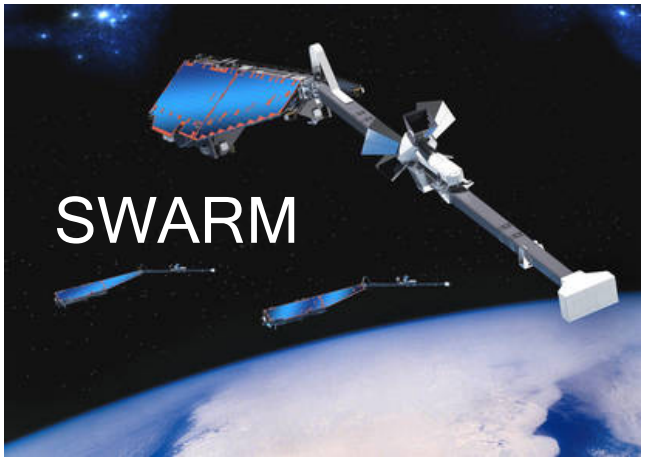
Other gravity field missions

High-low





© ESA



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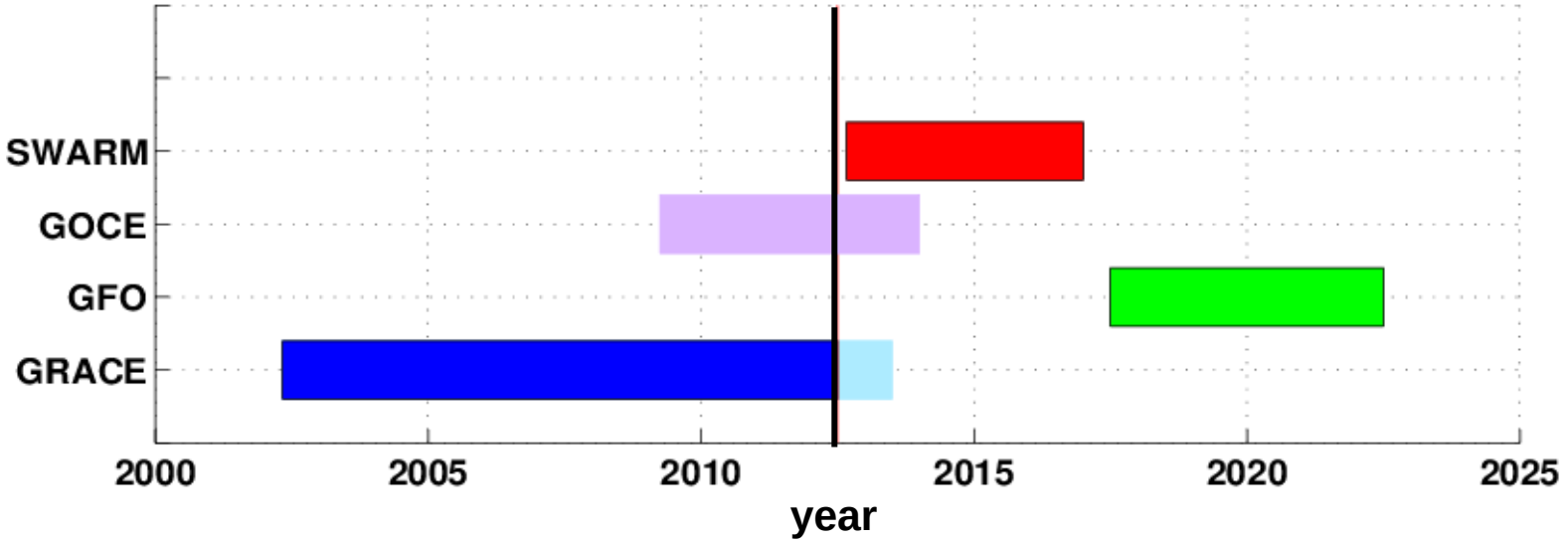
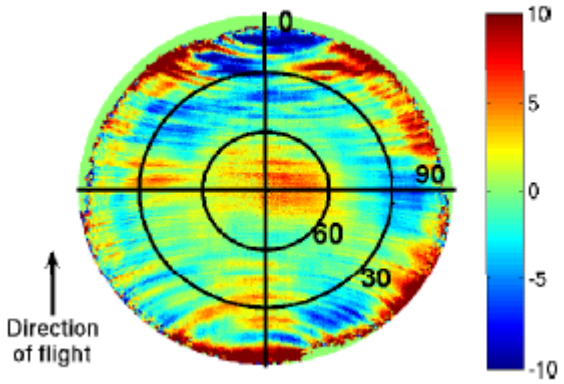


CHAMP

CHAMP reprocessing

GPS positions:

- 10 s sampling
- empirical absolute antenna phase center model

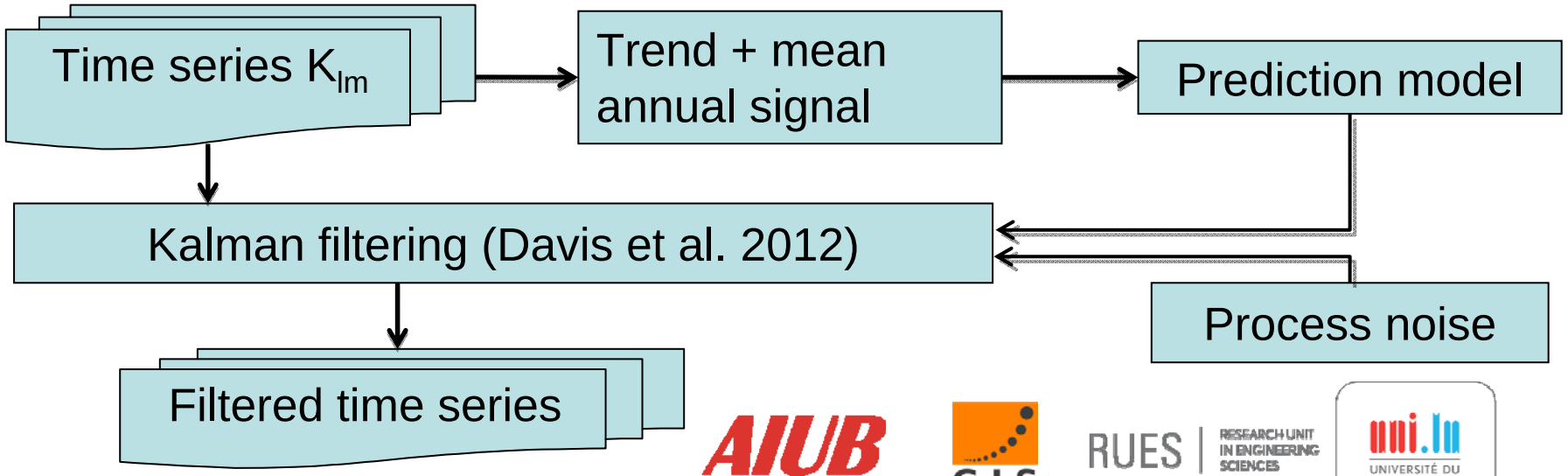


Prange 2010

Approach:

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

Postprocessing with a Kalman filter:



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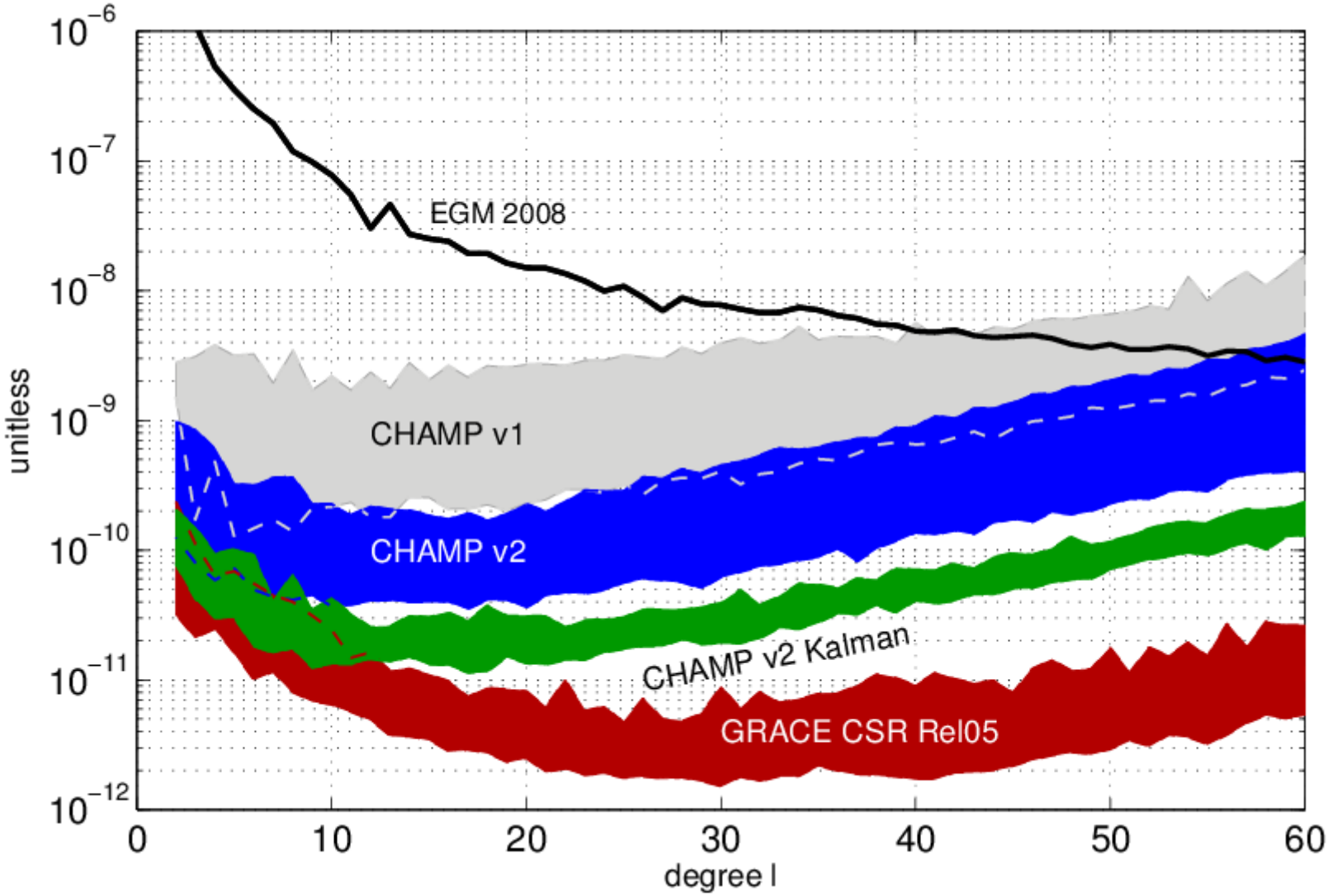
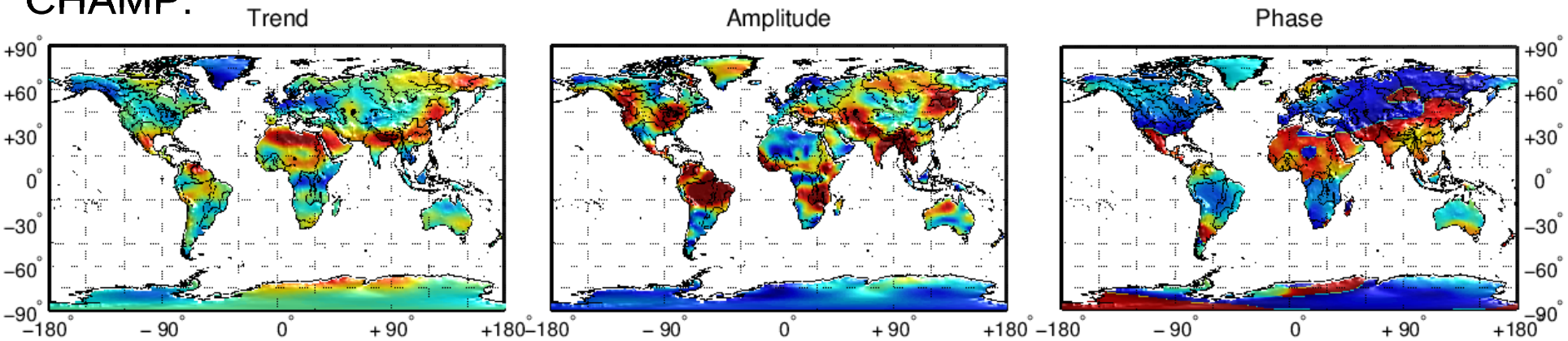
Filtered monthly gravity field solution



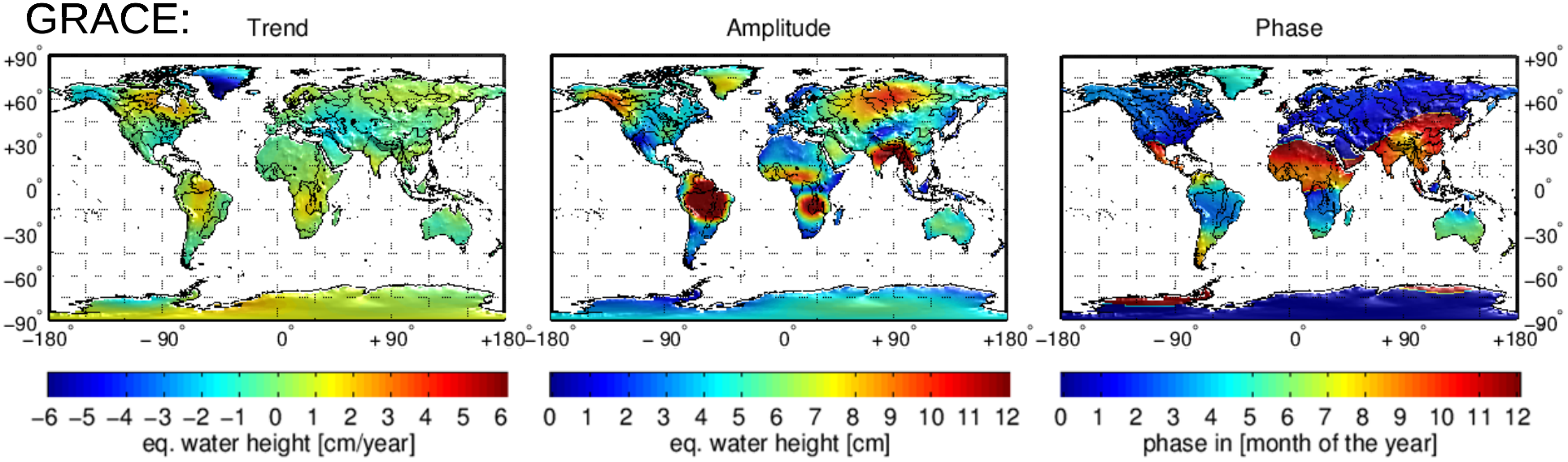
CHAMP vs. GRACE

750km

CHAMP:



GRACE:



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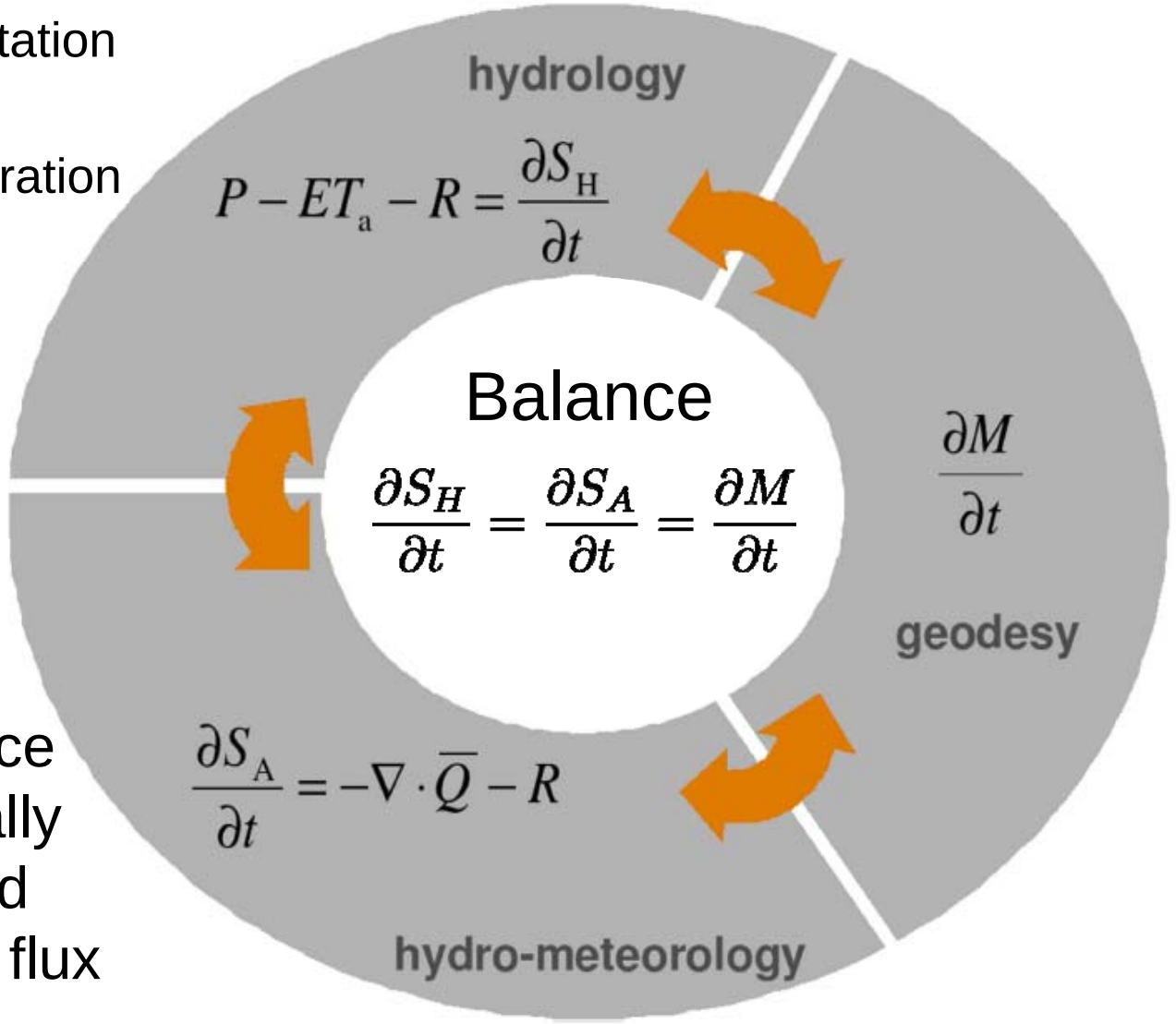
EVALUATION WITH HYDRO-METEOROLOGY

Mass change as a hydrological observable

P = precipitation

ET_a = evapo-transpiration

R = runoff

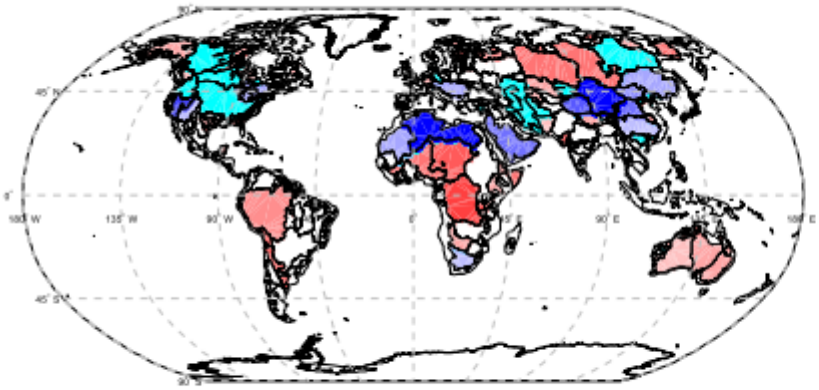


CHAMP
GRACE

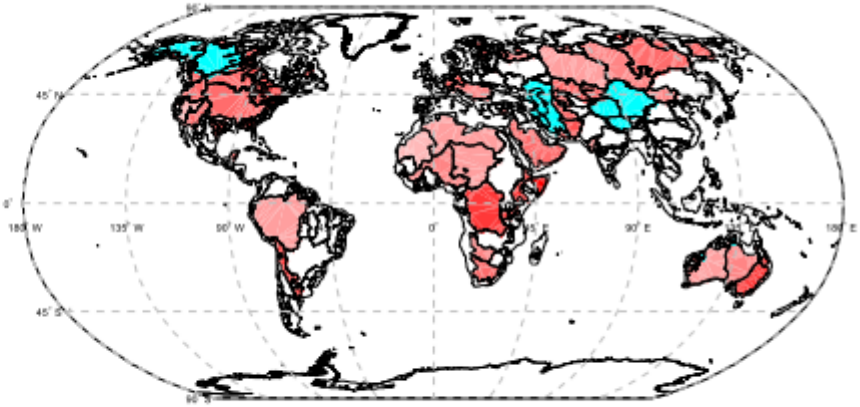
$\nabla \cdot \bar{Q}$ = divergence of vertically integrated moisture flux

Mass estimate & correlation – 750km

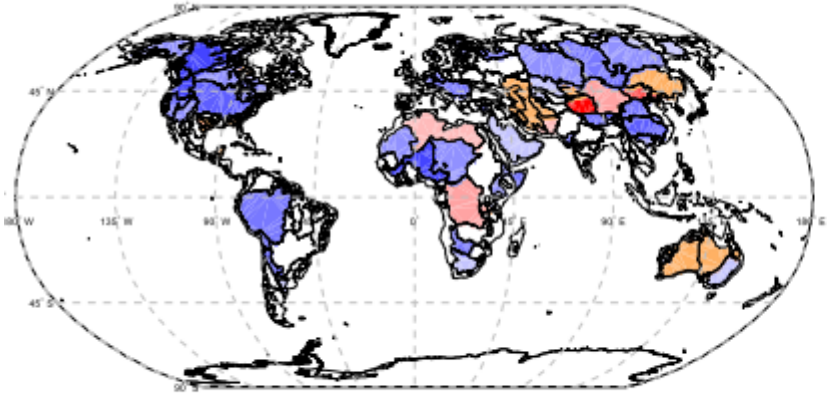
RMS(dM/dt) / RMS(dS/dt), dM/dt from CHAMP (filtered with G750)



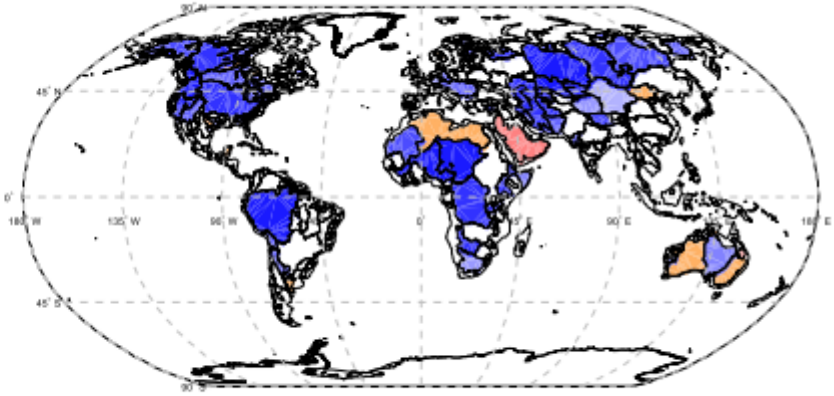
RMS(dM/dt) / RMS(dS/dt), dM/dt from GRACE (filtered with G750)



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



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



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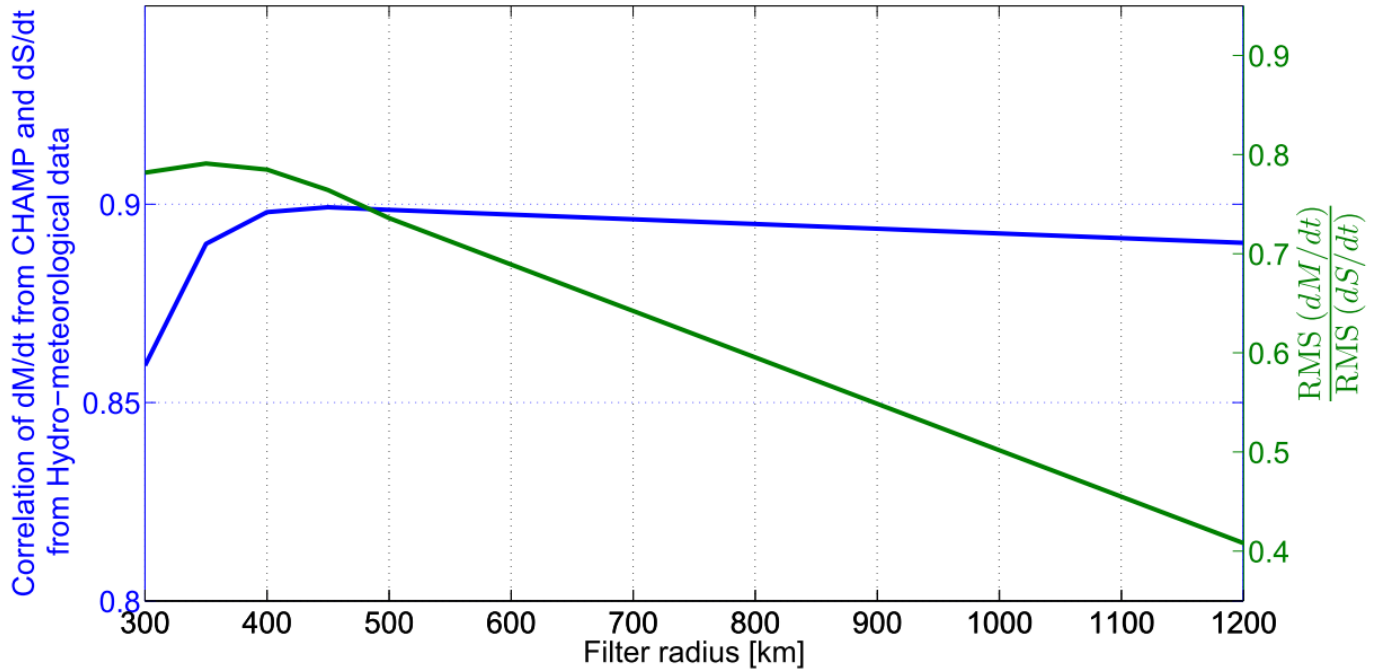
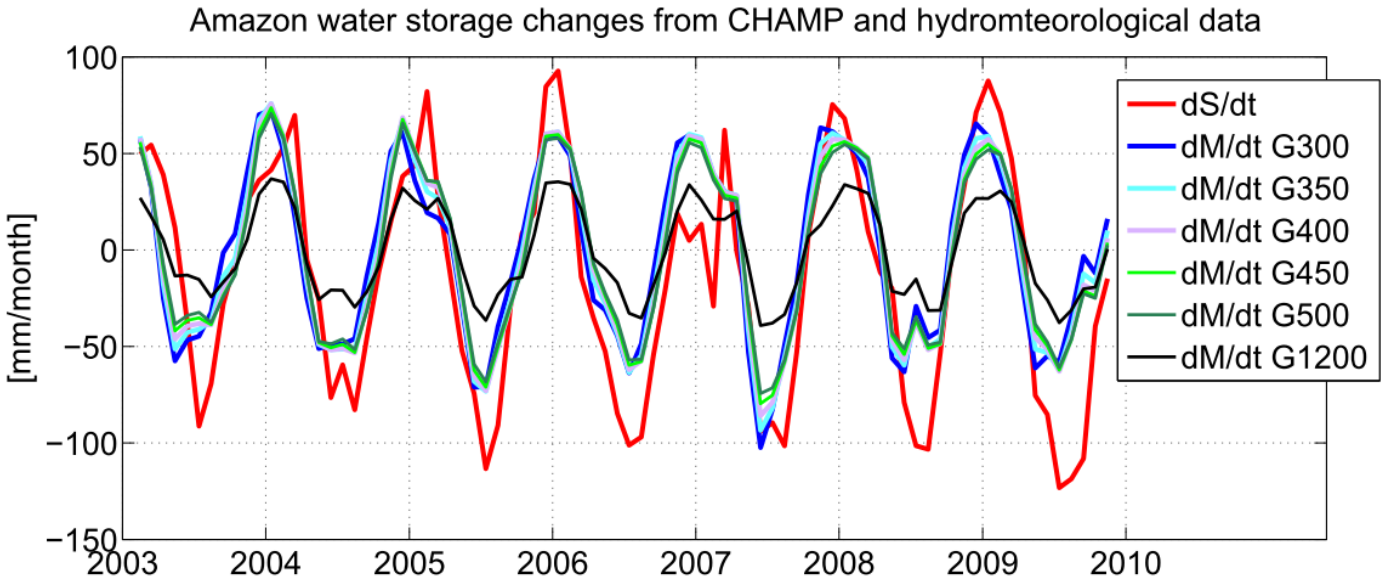
Filter size for Amazon basin





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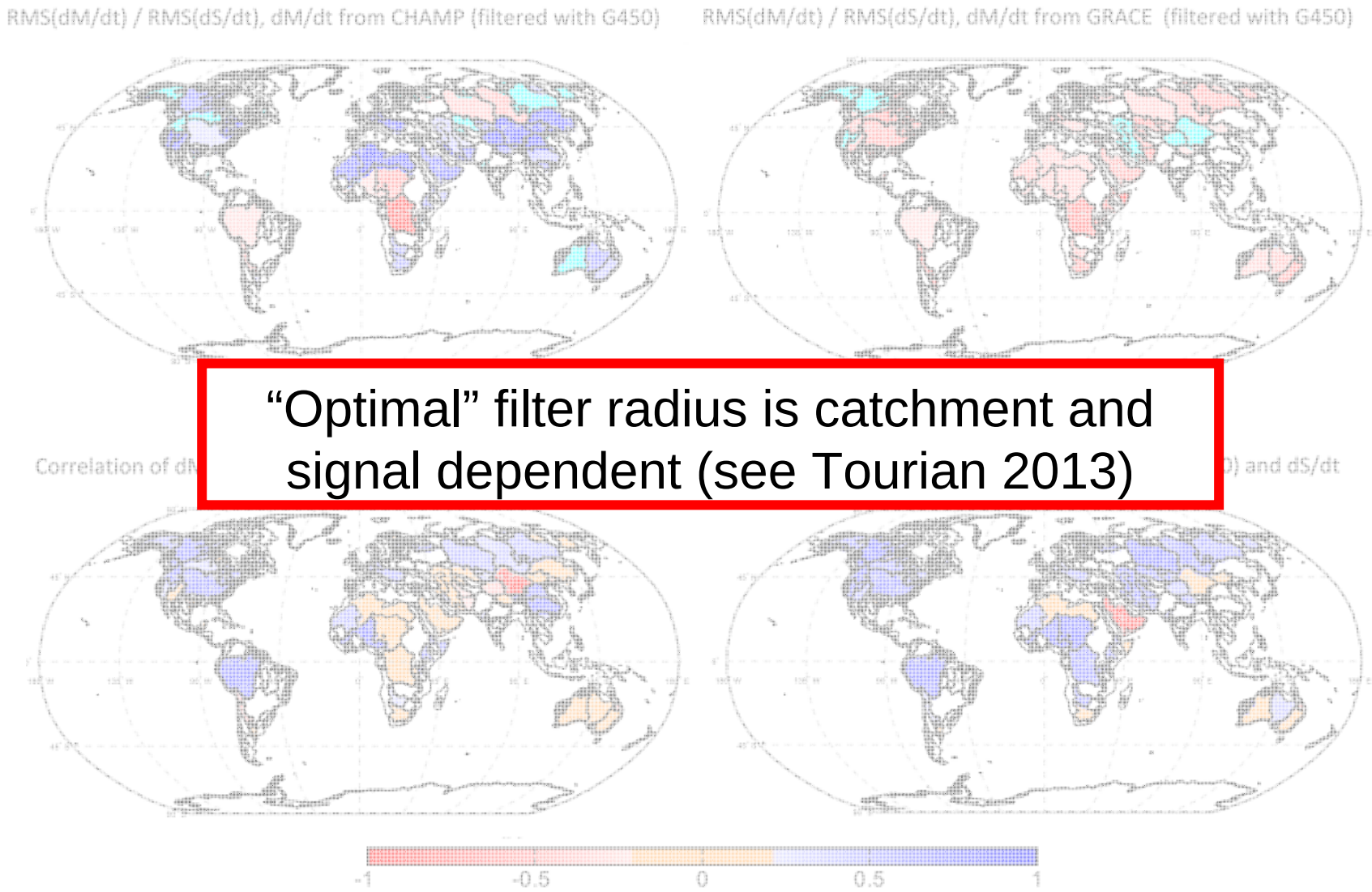
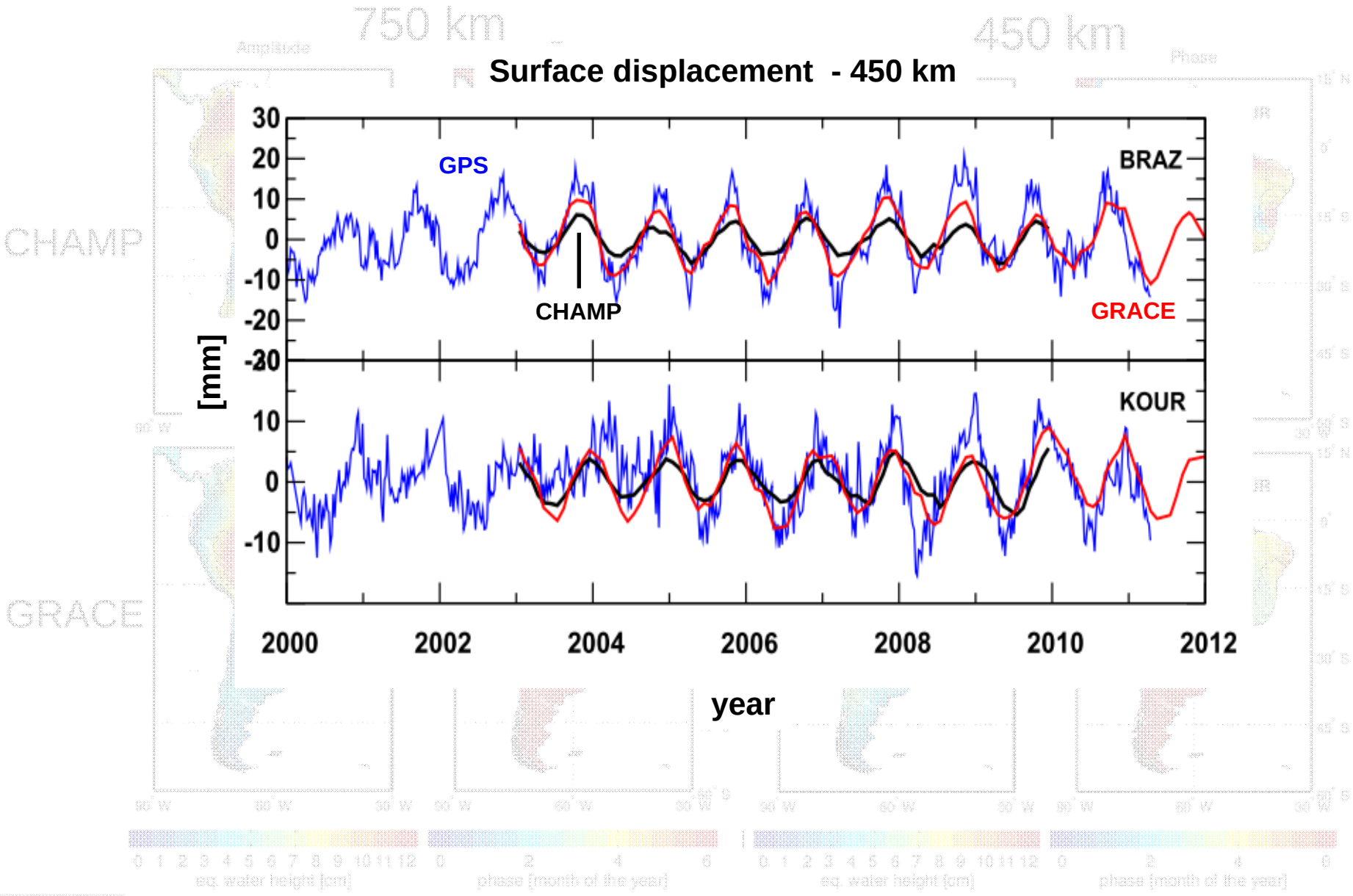
Mass estimate & correlation – 450km



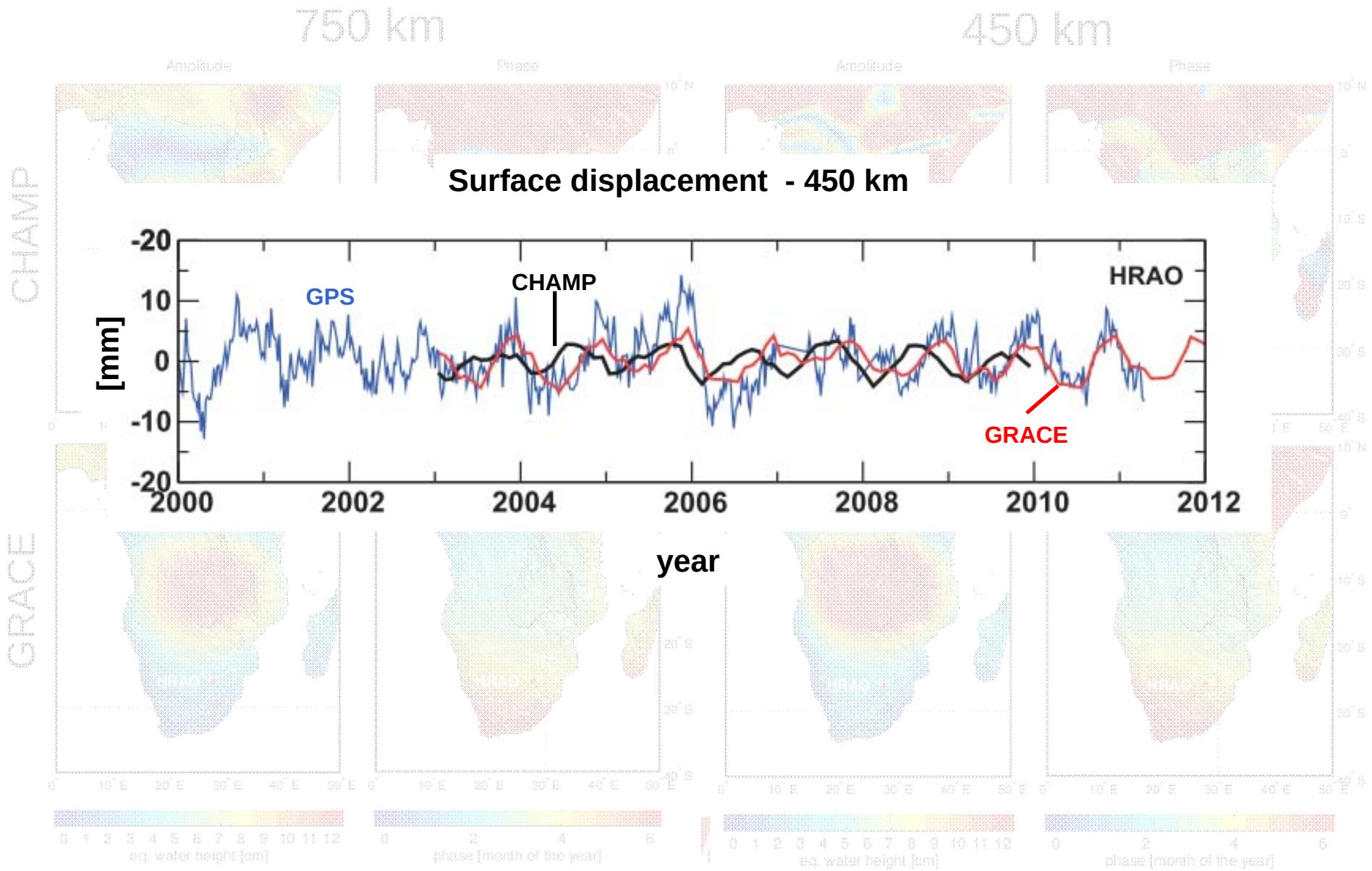
"Optimal" filter radius is catchment and signal dependent (see Tourian 2013)

EVALUATION WITH GPS

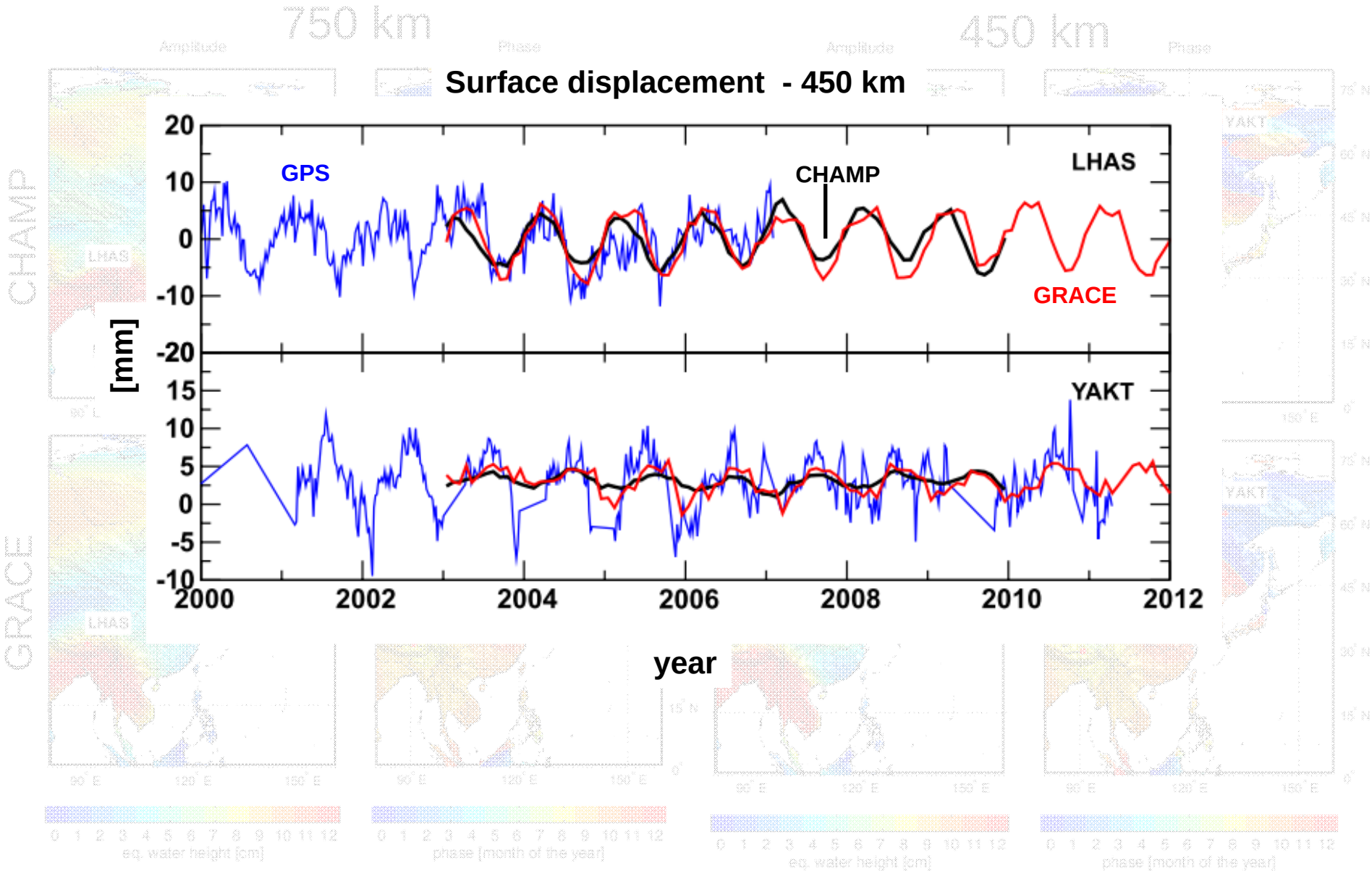
Loading analysis - Amazon



Loading analysis – South Africa



Loading analysis – East Asia



SUMMARY

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