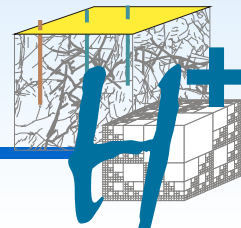


A few notes on GRACE information content for ESM improvement

Laurent Longuevergne
Géosciences Rennes

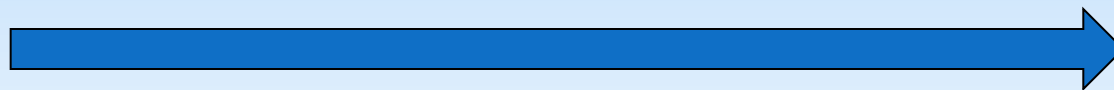
Co-workers

Tales Carvalho-Resende
Annette Eicker
Jürgen Kusche
Di Long
Bridget Scanlon
Richard Taylor



coevolution occurs when changes in species' genetic compositions reciprocally affect each other's evolution so that both have become dependent on each other

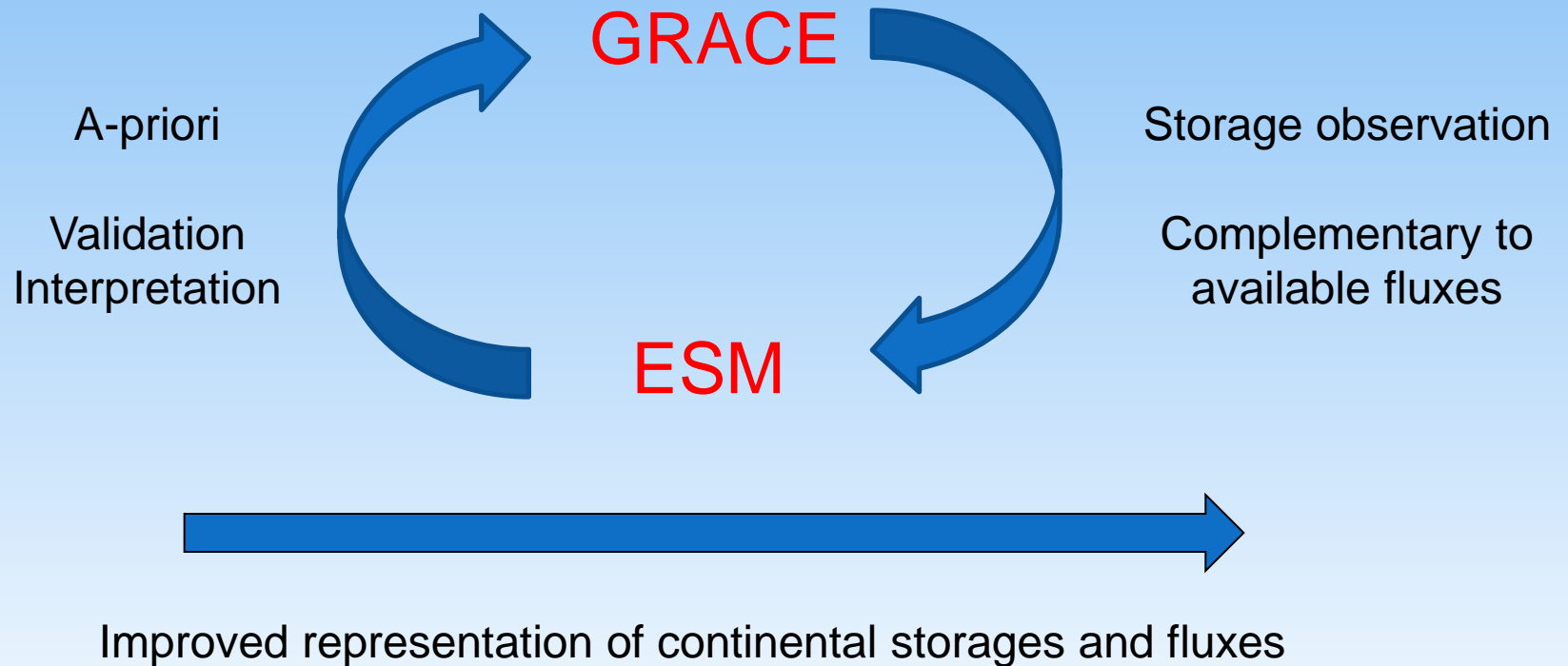
2



Complexity of pollinisation system



coevolution occurs when changes in species' genetic compositions reciprocally affect each other's evolution



- A geodetic tool for hydrological studies

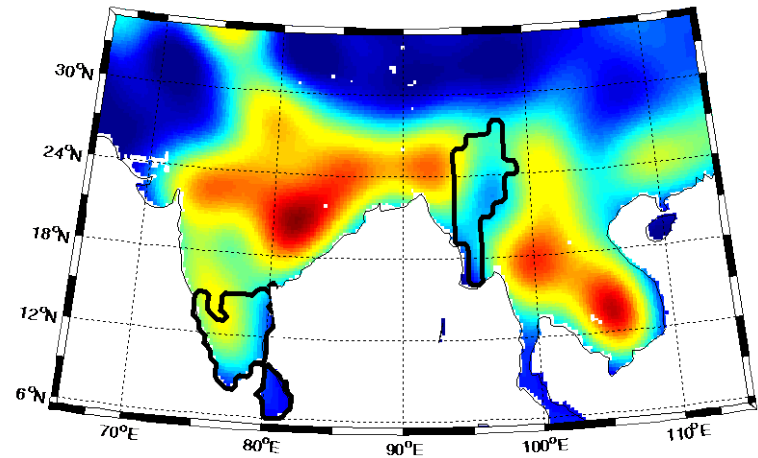
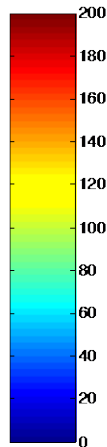
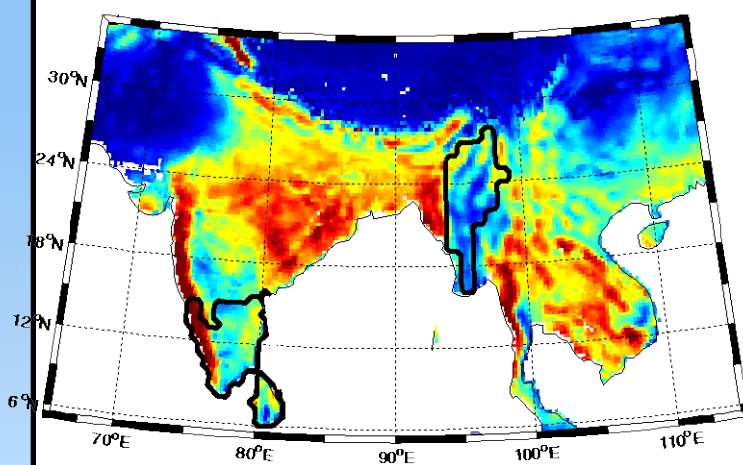
Gravity measurements are provided by 2 chasing satellites (Tom & Jerry)

They do not carry remote sensing tools, the measurement system are the satellites by themselves

Satellite distance measured at the μm level over 220 km separation



- GRACE provides a spatially filtered image of reality



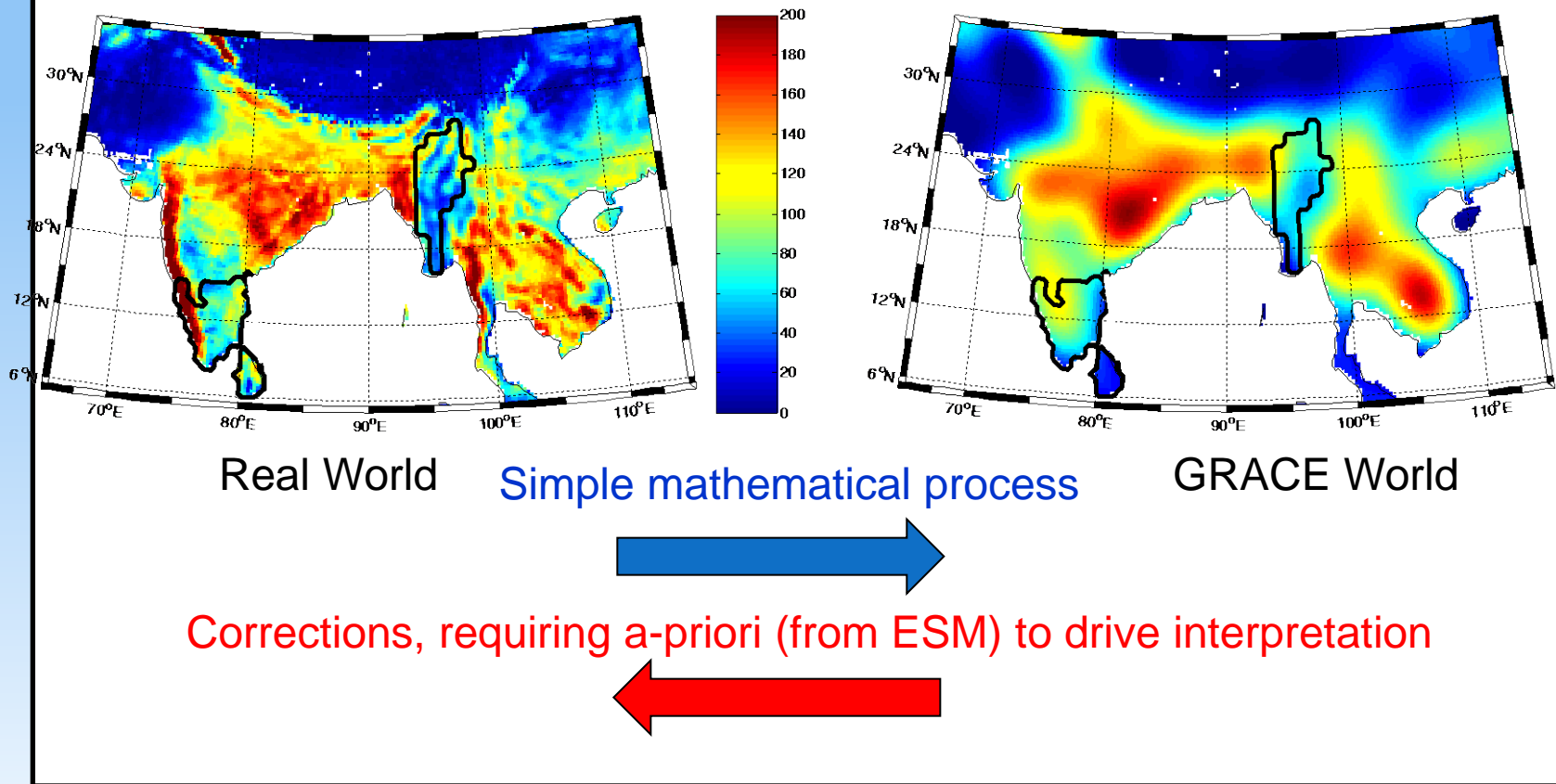
Amplitude of seasonal water storage variations

Modeled by GLDAS-NOAH
hydro-meteorological model

Same map, considering only
large-scale variations seen
by GRACE
(truncation degree 60)



- GRACE provides a spatially filtered image of reality



Alternate needs: disaggregate GRACE total water storage

The community Noah land surface model with multiparameterization options (Noah-MP):

2. Evaluation over global river basins

Zong-Liang Yang,¹ Guo-Yue Niu,^{1,2} Kenneth E. Mitchell,³ Fei Chen,⁴ Michael B. Ek,³ Michael Barlage,⁴ Laurent Longuevergne,⁵ Kevin Manning,⁴ Dev Niyogi,⁶ Mukul Tewari,⁴ and Youlong Xia³

Global-scale assessment of groundwater depletion and related groundwater abstractions: Combining hydrological modeling with information from well observations and GRACE satellites

Petra Döll¹, Hannes Müller Schmied¹, Carina Schuh¹, Felix T. Portmann¹, and Annette Eicker²

First satellite of (a long?) generation able to remotely sense:

- total water storage (including GW)
- robustness of long-term changes (interpretability of trends)

(1) validate ESM improvement



Value of GRACE for ESM improvement

Assimilation of GRACE Terrestrial Water Storage Data into a Land Surface Model: Results for the Mississippi River Basin

BENJAMIN F. ZAITCHIK

*Earth System Science Interdisciplinary Center, University of Maryland, College Park, College Park, and Hydrological Sciences
Branch, NASA Goddard Space Flight Center, Greenbelt, Maryland*

MATTHEW RODELL

Hydrological Sciences Branch, NASA Goddard Space Flight Center, Greenbelt, Maryland

Integration of GRACE mass variations into a global hydrological model

S. Werth *, A. Güntner, S. Petrovic, R. Schmidt

Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences, Telegrafenberg, Potsdam, 14473, Germany

Calibration and evaluation of a semi-distributed watershed model of Sub-Saharan Africa using GRACE data

H. Xie¹, L. Longuevergne², C. Ringler¹, and B. R. Scanlon³

¹International Food Policy Research Institute, 2033 K Street NW, Washington D.C. 20006, USA

²CNRS – UMR 6118, Géosciences Rennes Université Rennes 1, 35042 Rennes, France

³Bureau of Economic Geology, Jackson School of Geosciences, University of Texas, Austin, TX 78713-8926, USA

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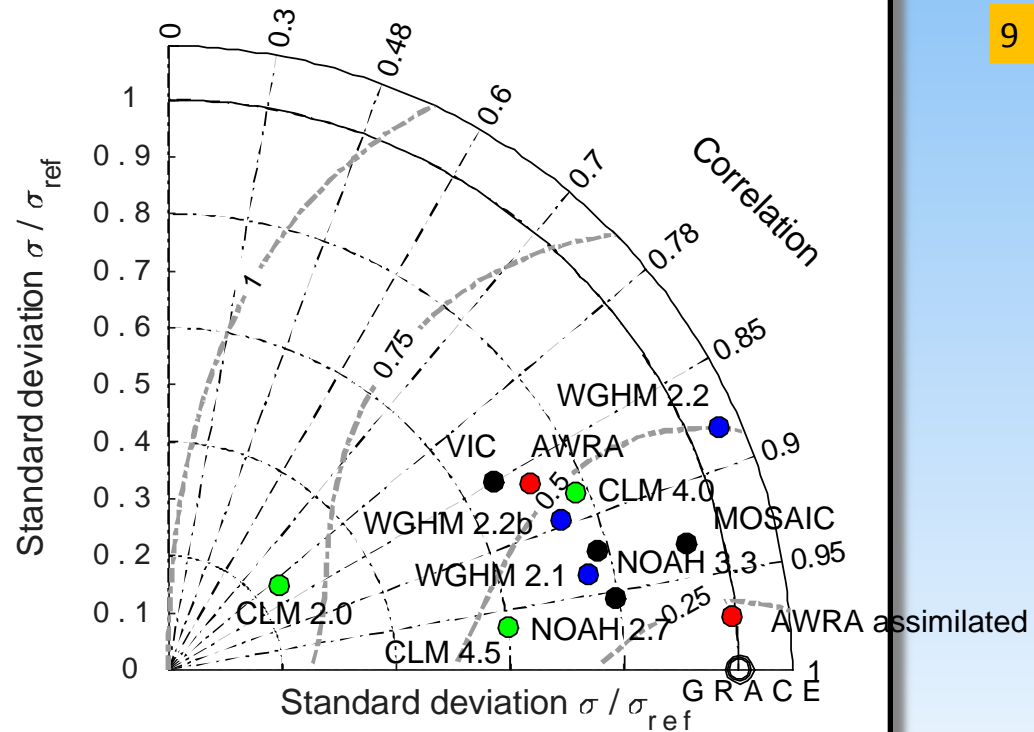
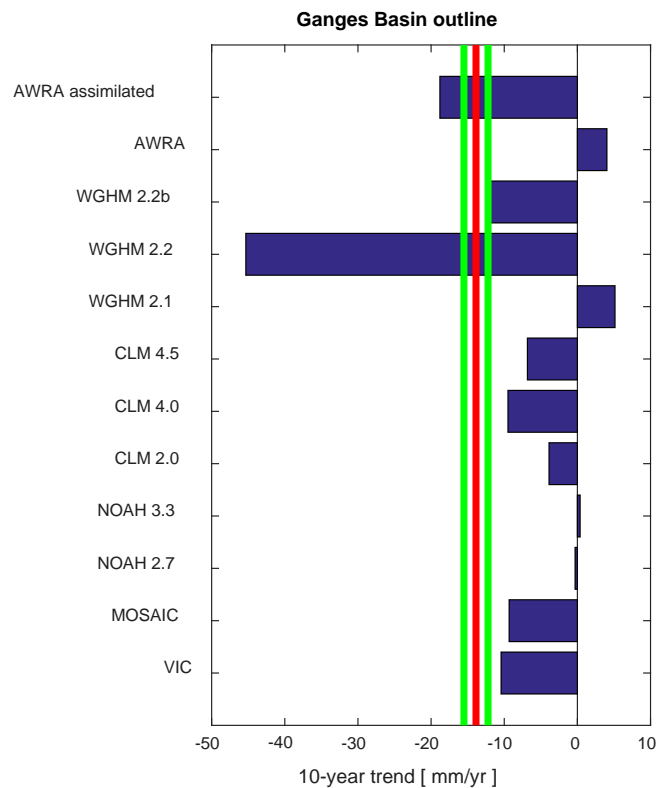
(2) improve ESM through calibration / assimilation



GRACE senses masses, not spatial scales

- Example : Bengale basin

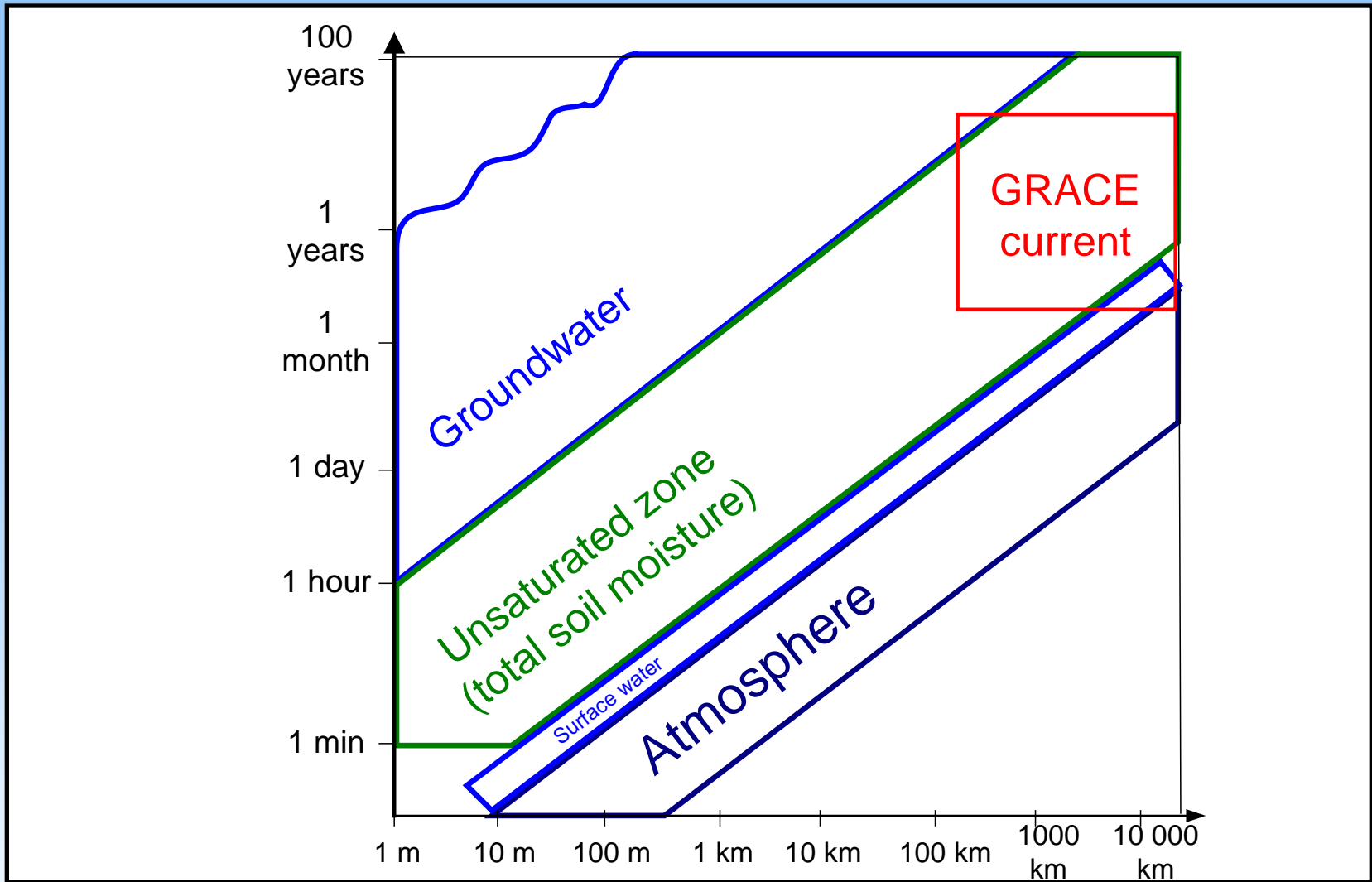
10-year trend [mm/yr]



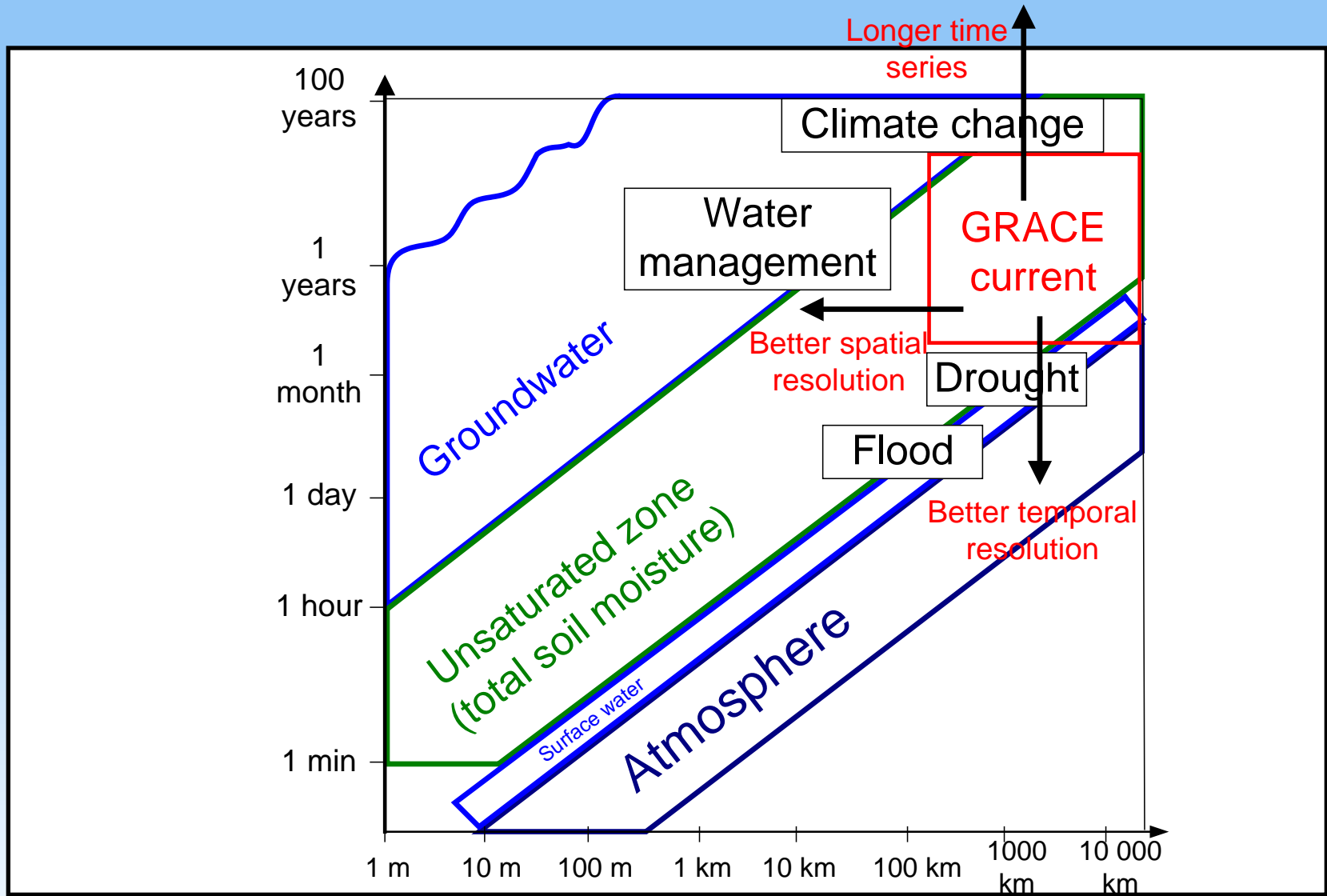
- (1) GRACE resolution is ~ 300 km, does it capture the small-scale variability required to analyse GW processes ?



Expected signals and applications



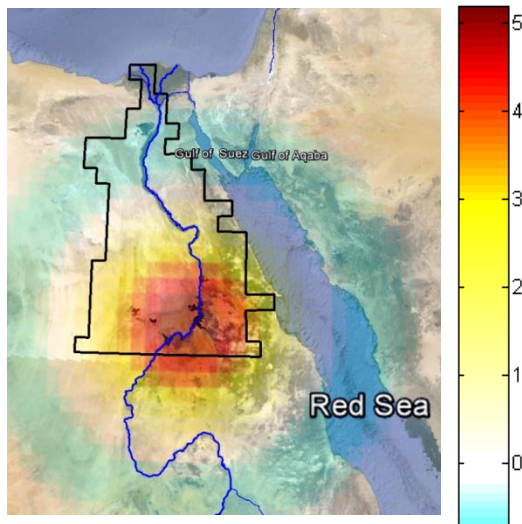
Expected signals and applications



GRACE senses masses, not spatial scales

- A simple example : Lake Nasser

- Lake area : 6200 km², level variations up to 7 m
- Basin area : 410 000 km²



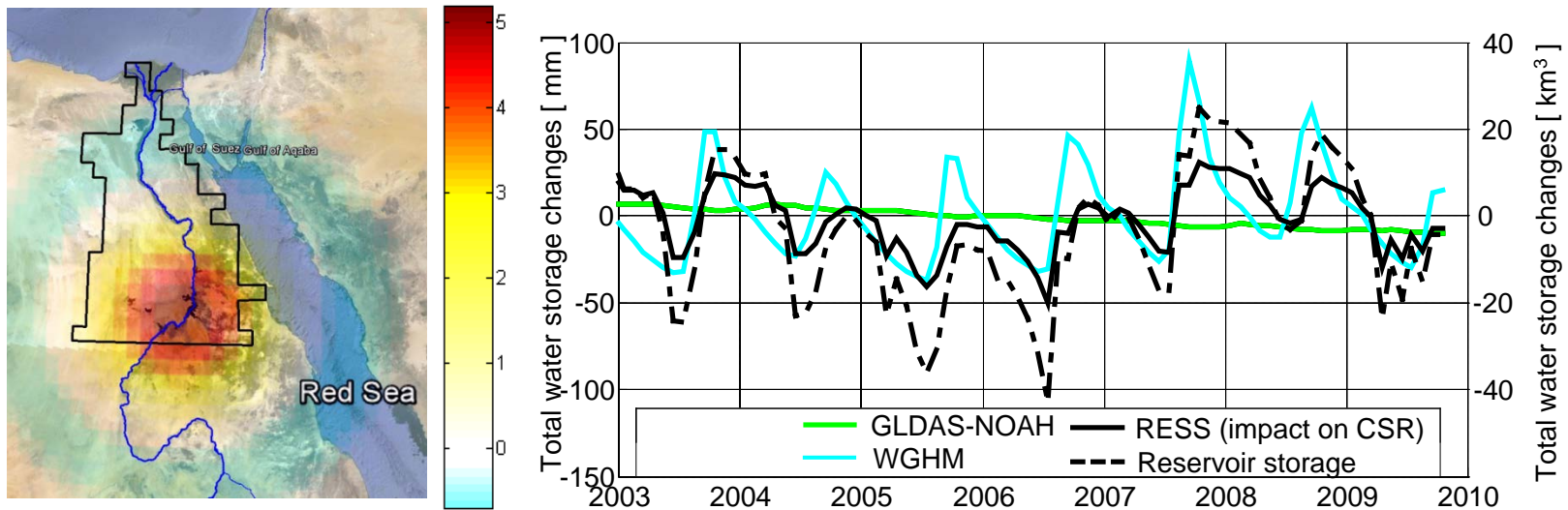
Impact of a 1 km³ mass [mm]
⇔ 160 mm lake level increase



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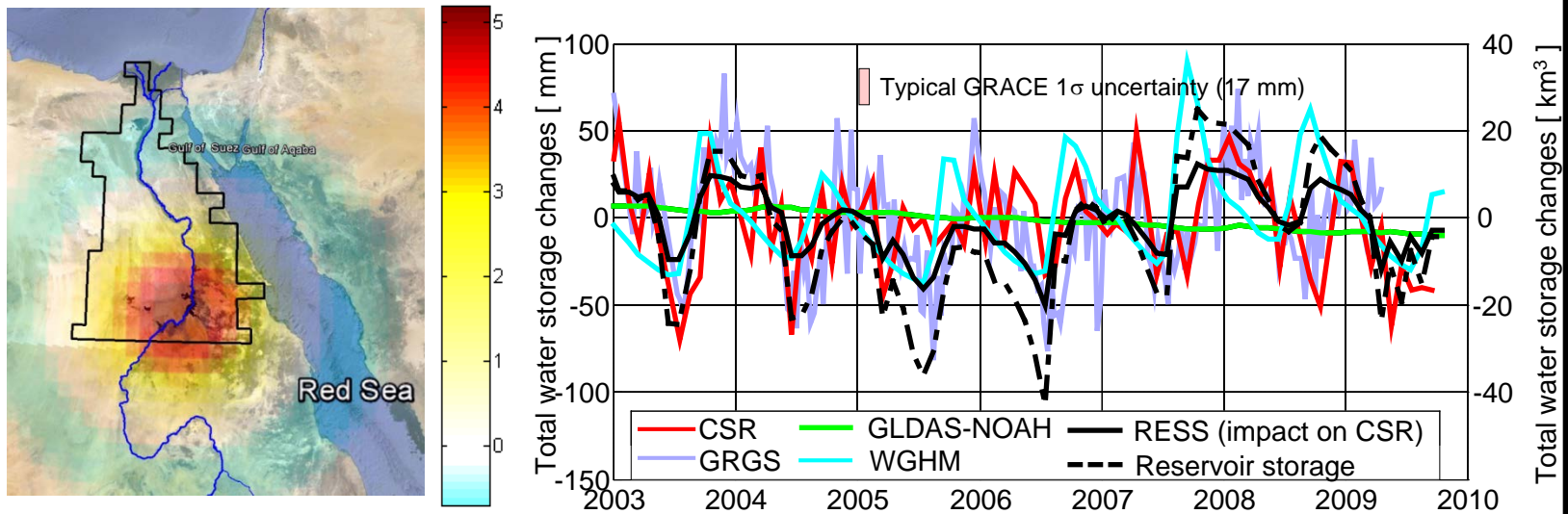
Water storage variations in the basin from
different sources



GRACE senses masses, not spatial scales

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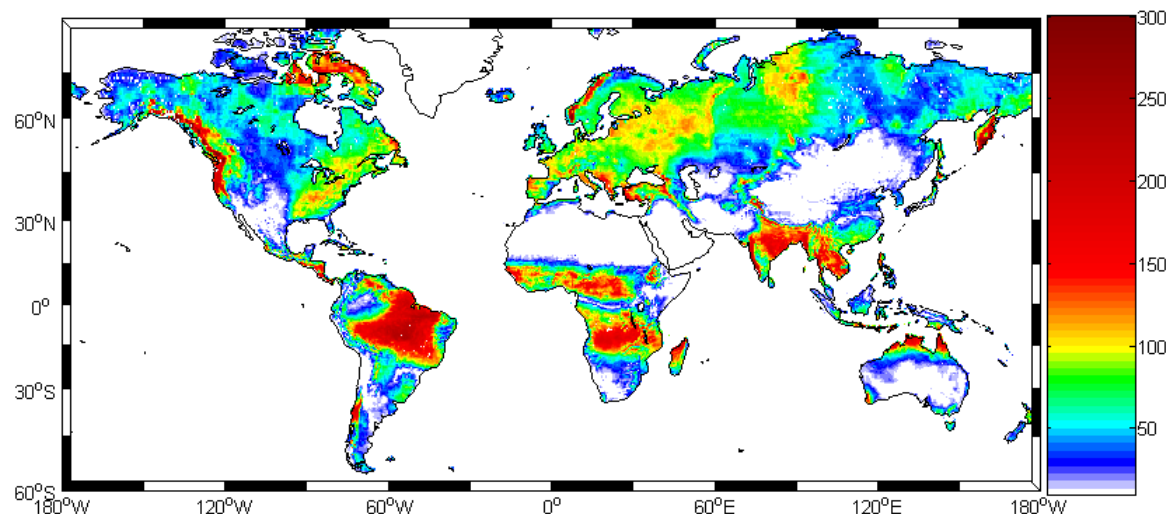
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Water storage variations in the basin from
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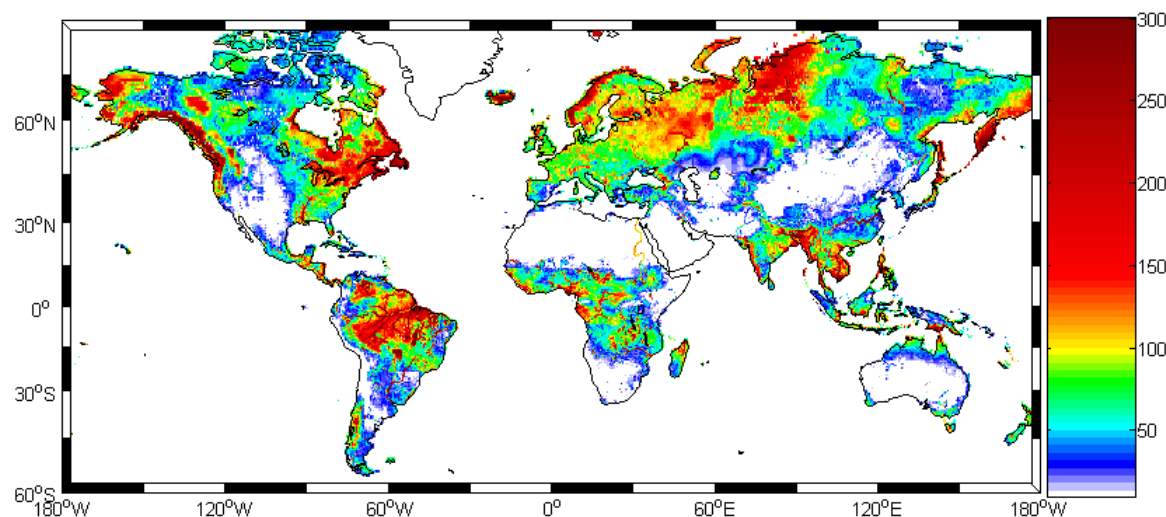


GRACE senses masses, not spatial scales

- Amplitude of the seasonal variations



GLDAS-NOAH v2.7

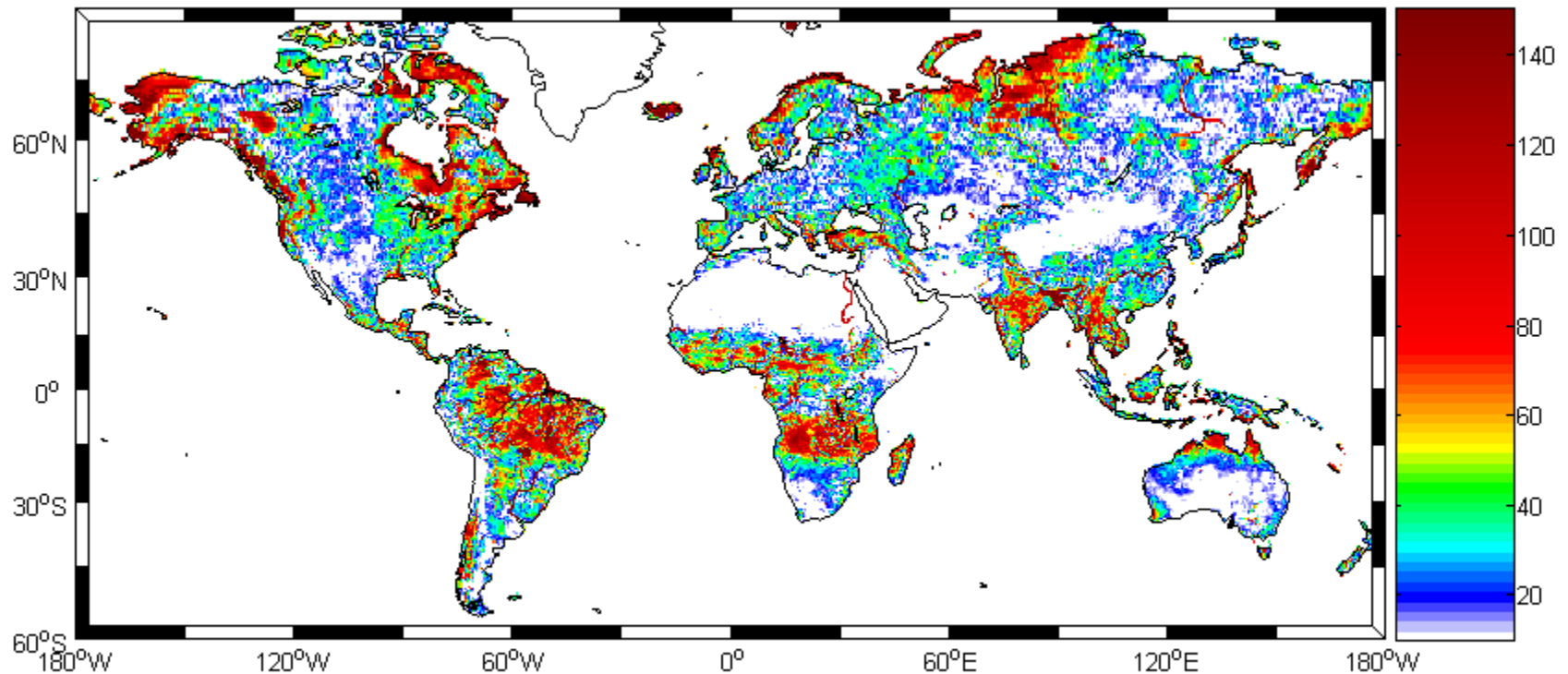


WGHM v2.1

GRACE senses masses, not spatial scales

- Amplitude of the seasonal variations

Difference between GLDAS-NOAH and WGHM



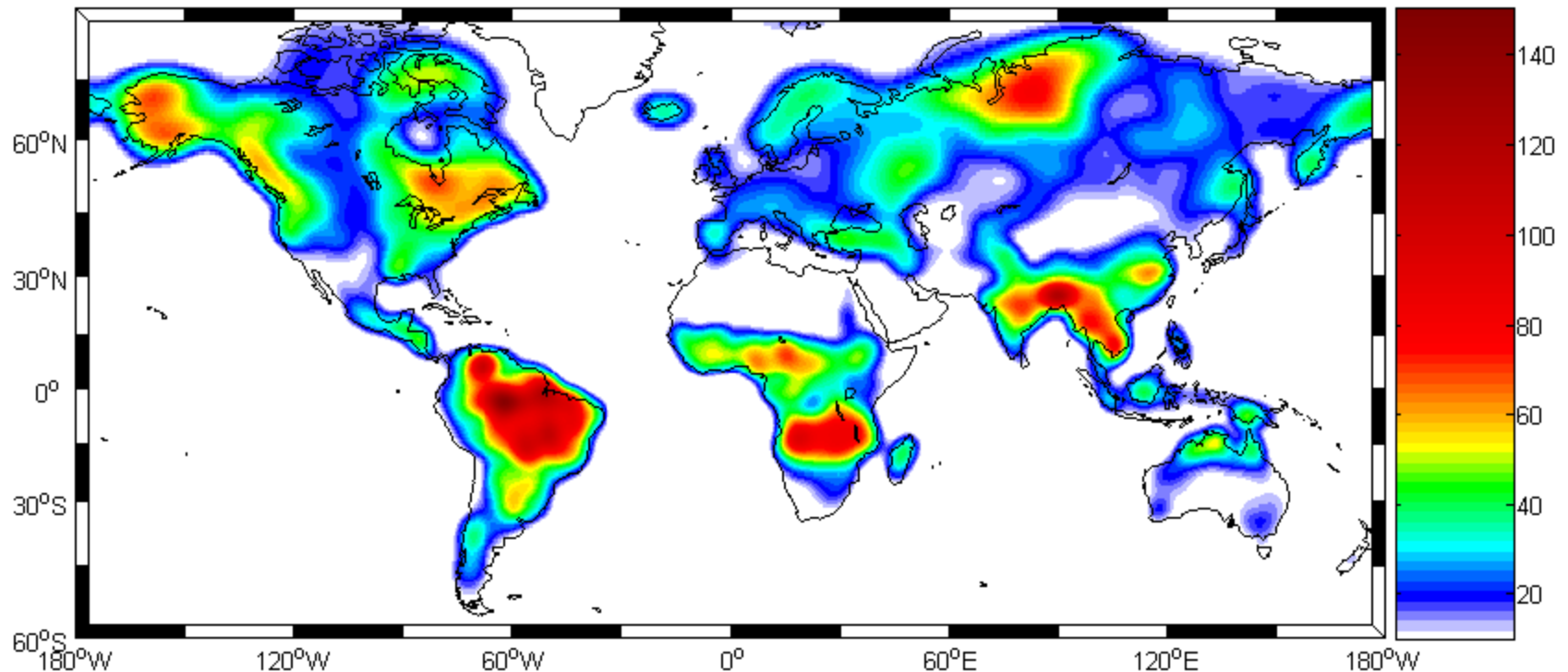
- Significant impact of lateral water redistribution & water concentration from a wide contributing area within a small size hydrological system



GRACE senses masses, not spatial scales

- A global point of view

Difference between GLDAS-NOAH and WGHM at GRACE resolution

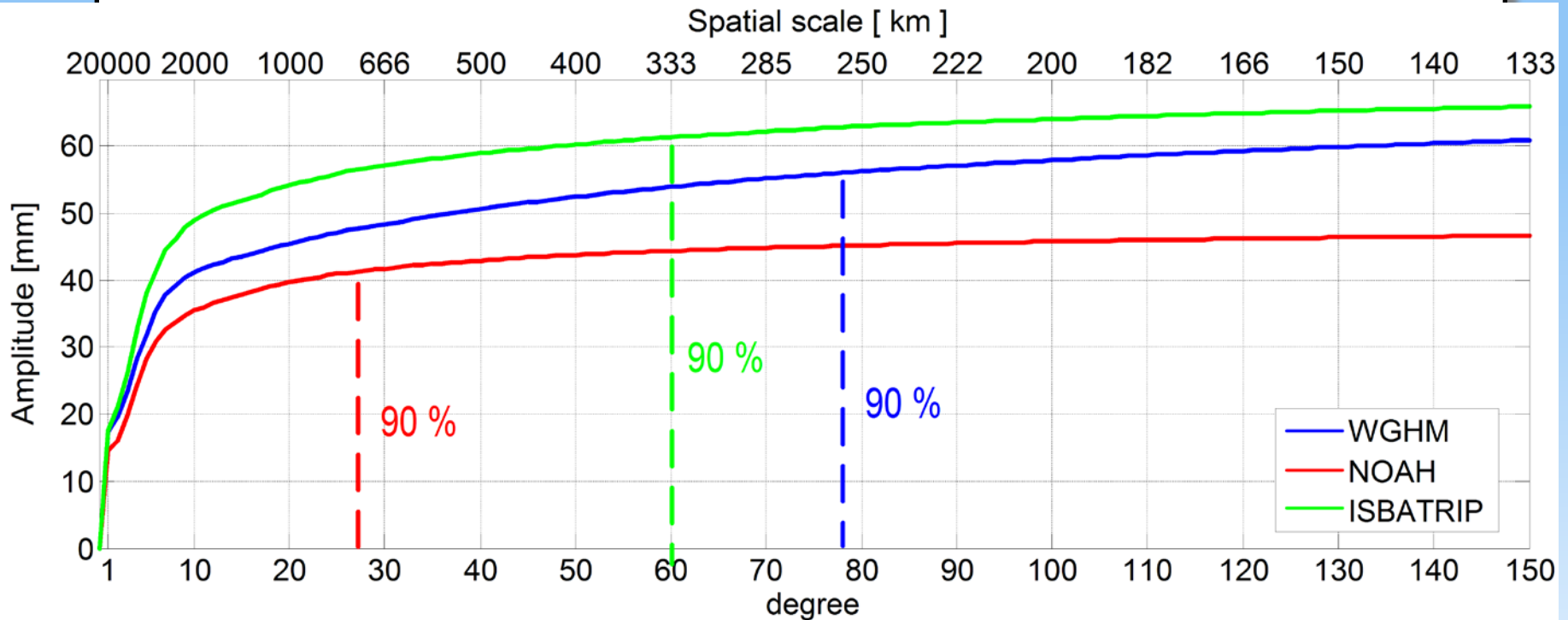


- These small scale structures disappear at GRACE resolution
- Tough, GRACE is sensitive to these “small scales” structures



GRACE senses masses, not spatial scales

- What are “useful” scales? (let’s consider GRACE noise-free)



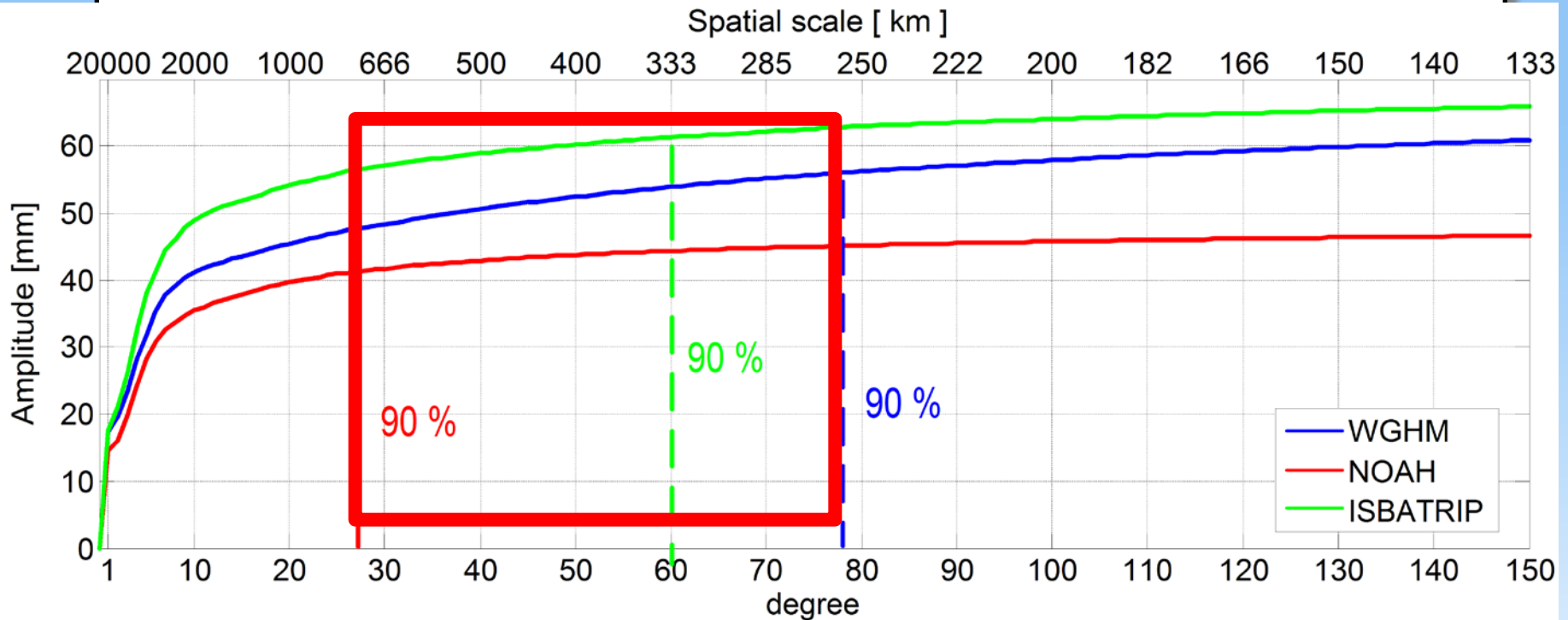
Model difference is diverging with increasing spatial resolution

- soil moisture processes alone are fully described up to ~ 700 km spatial resolution
- lateral water redistribution processes have energy beyond



GRACE senses masses, not spatial scales

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Model difference is diverging with increasing spatial resolution

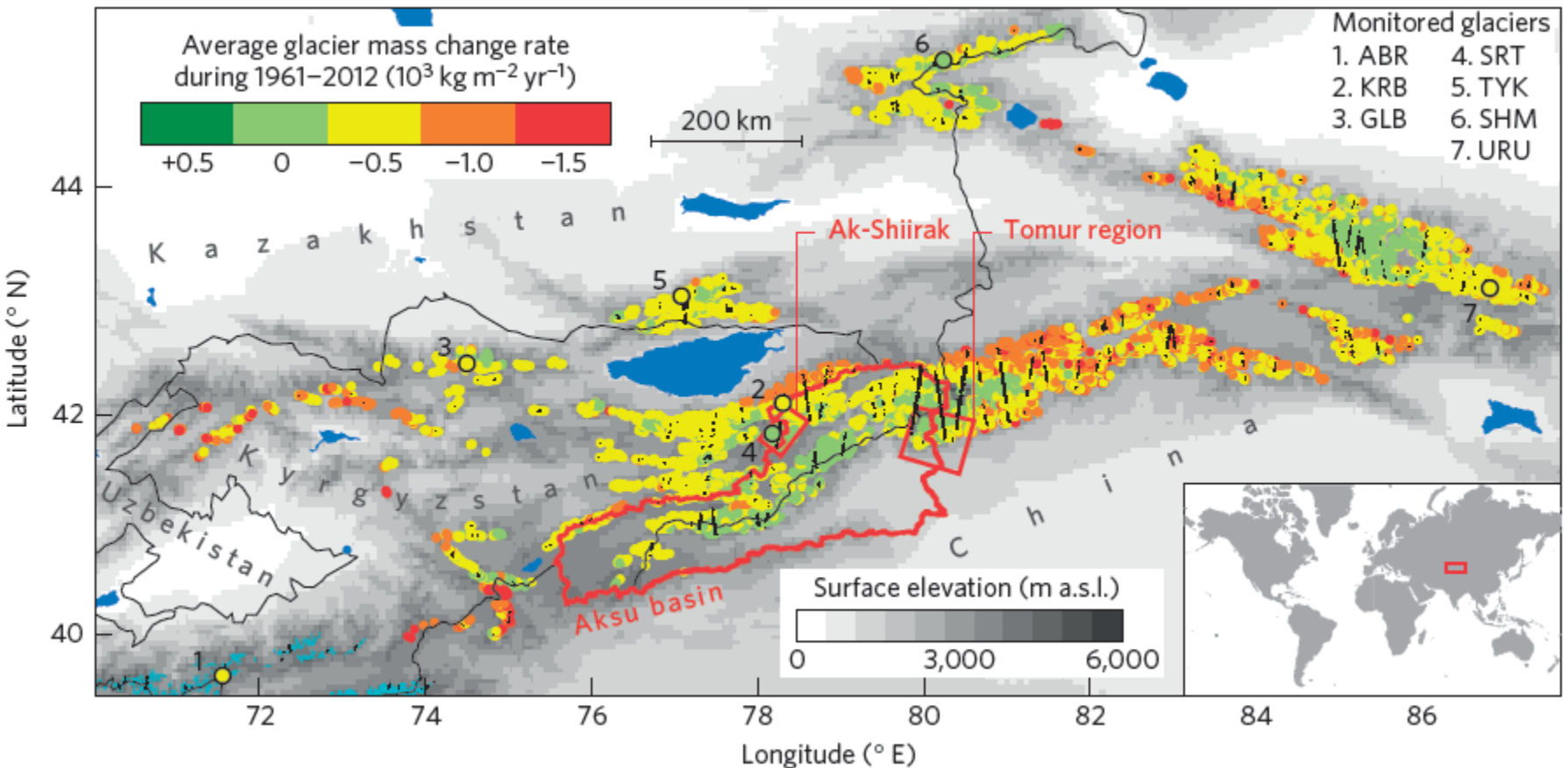
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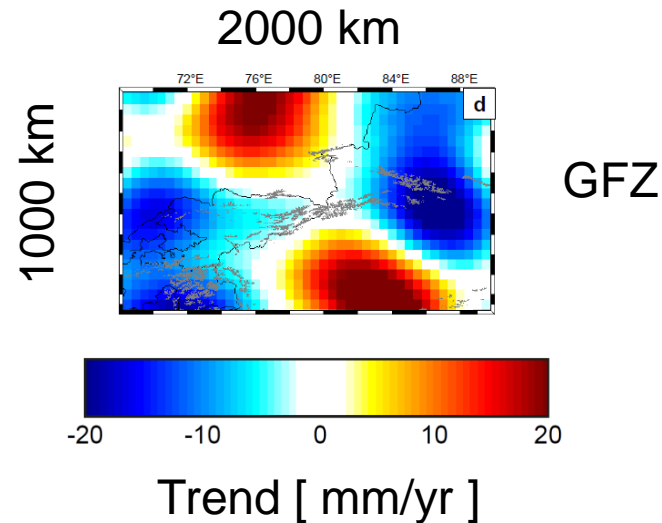
- (2) Well, GRACE is not noise-free, can it capture high degrees accurately for ESM improvement?



- A close look at the Tianshan region

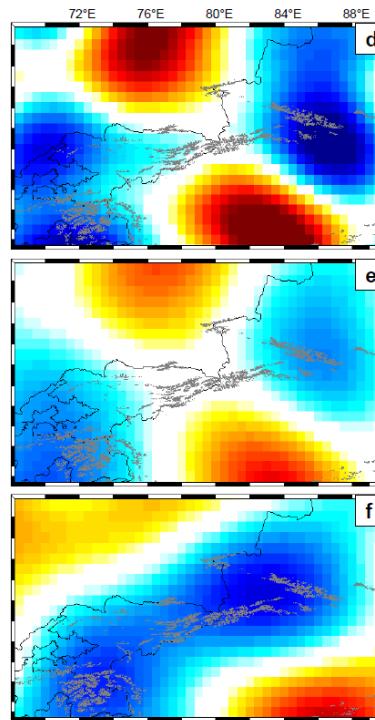


- A close look at the Tianshan region : GRACE ICE estimate

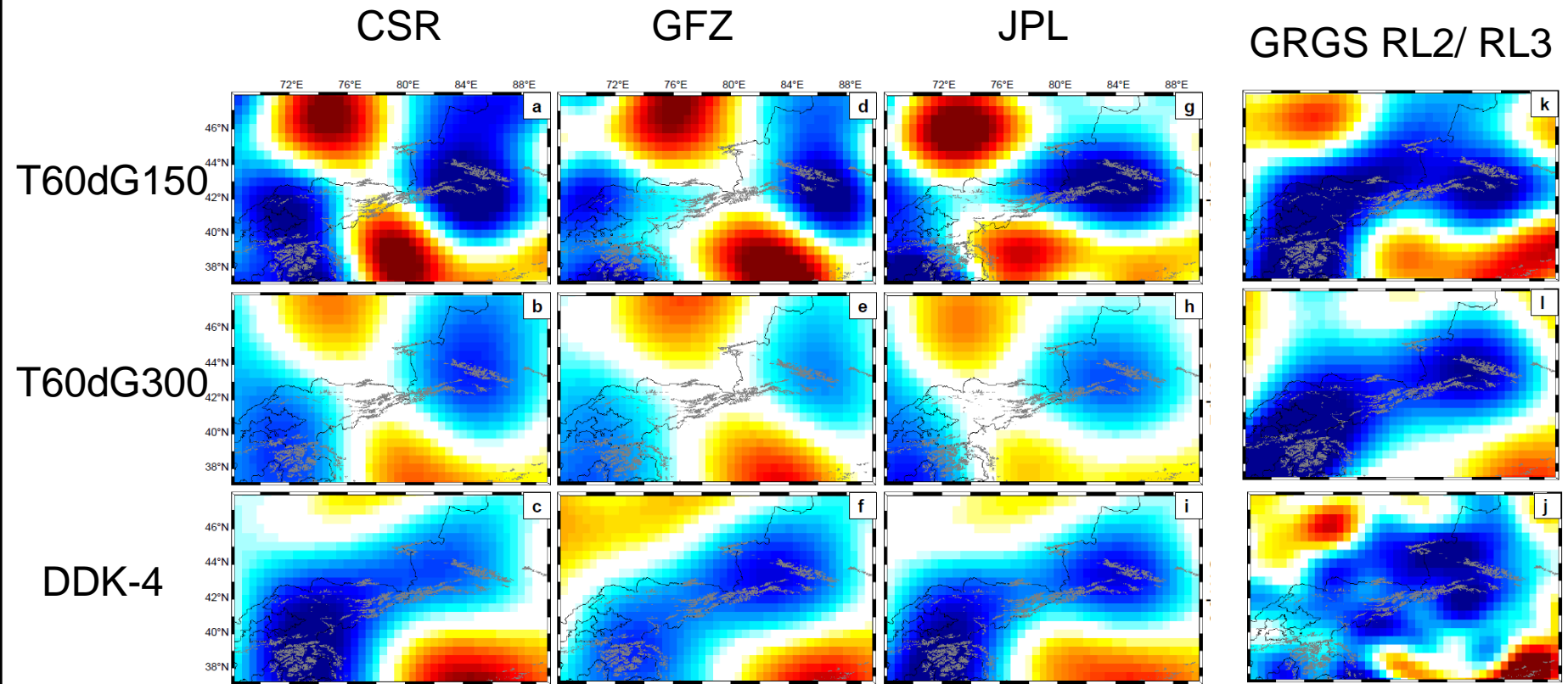


- A close look at the Tianshan region : GRACE ICE estimate

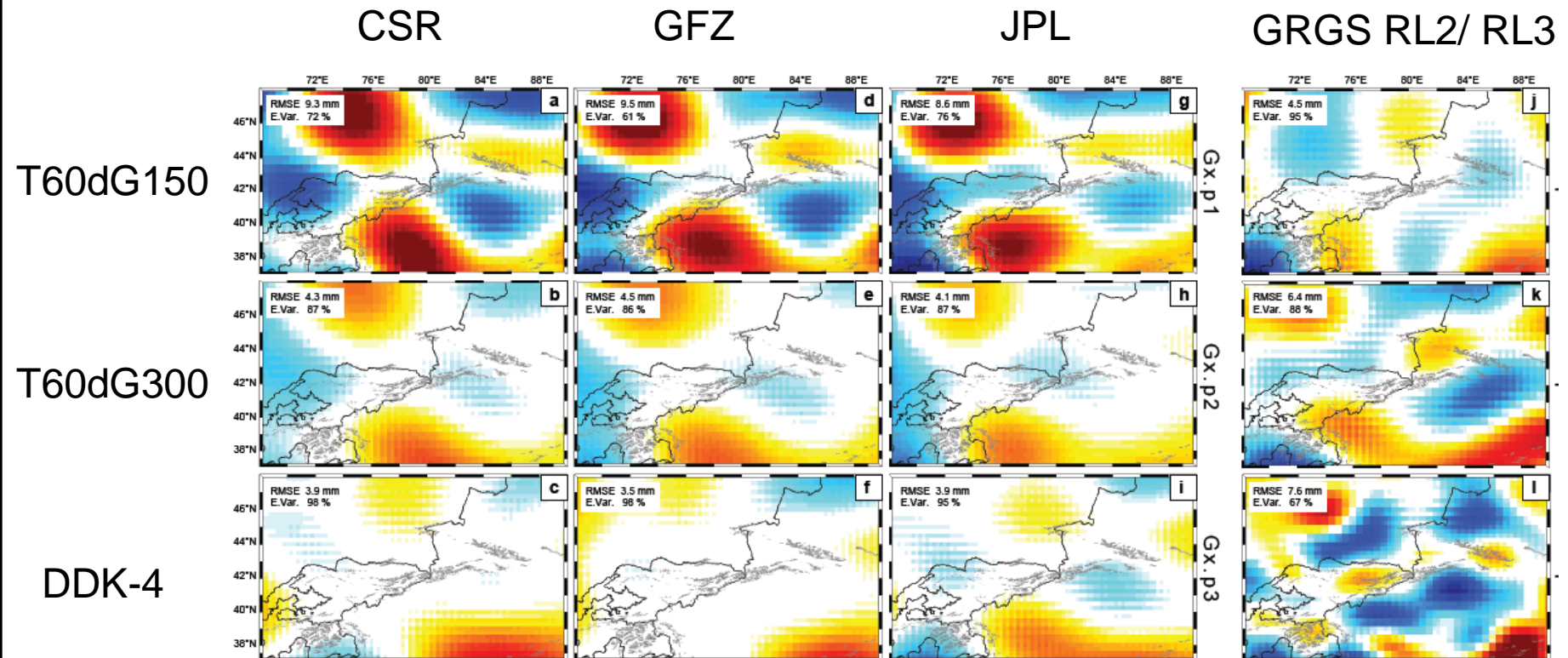
GFZ



- A close look at the Tianshan region : GRACE ICE estimate



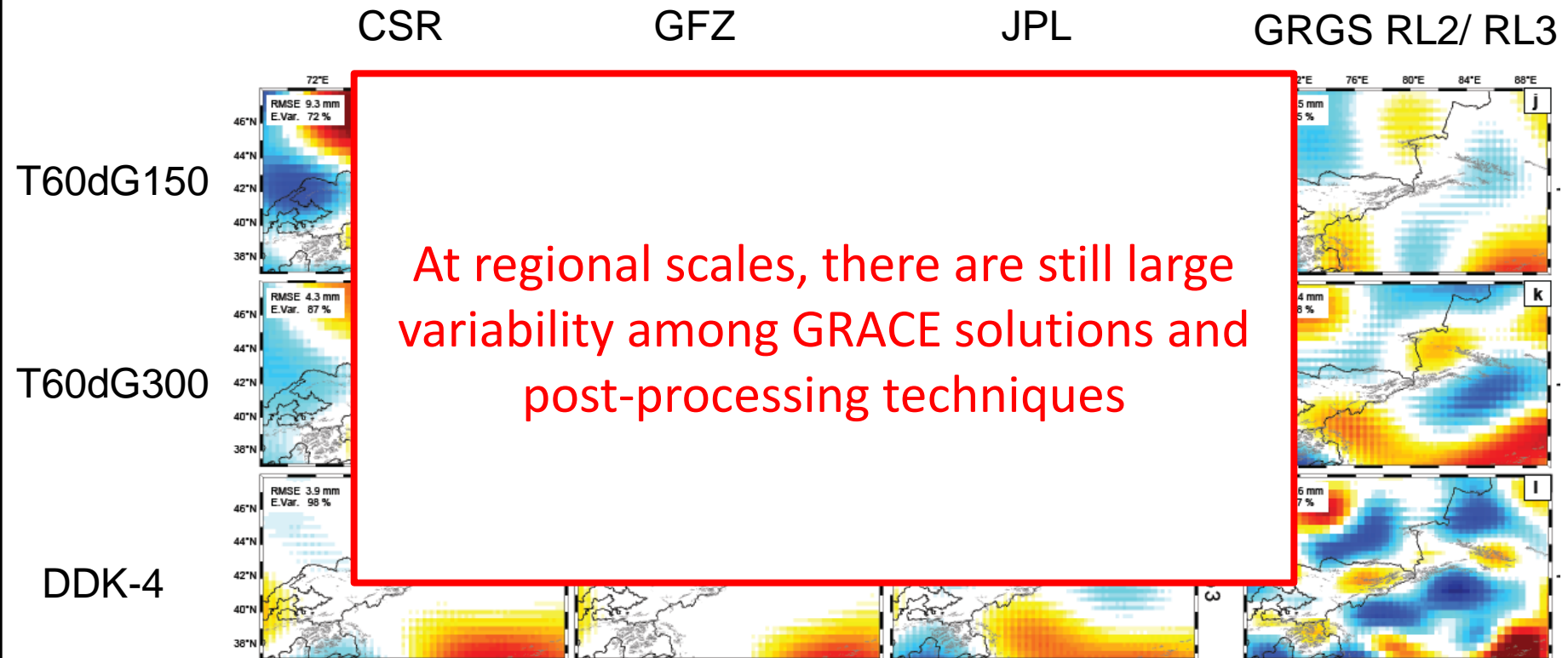
- Residuals: GRACE – all modeled contributions (space, time)



Error budget: ~ 50% GRACE, 50% ESM



- Residuals: GRACE – all modeled contributions (space, time)

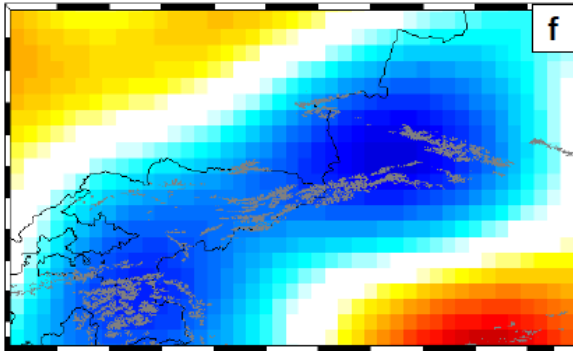


Error budget: ~ 50% GRACE, 50% ESM

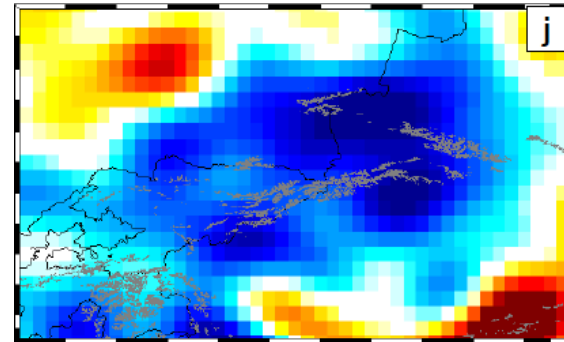


- Current status

Previous generation
products



Next generation
products



GRACE solutions are continuously improving with growing experience



Thank you

