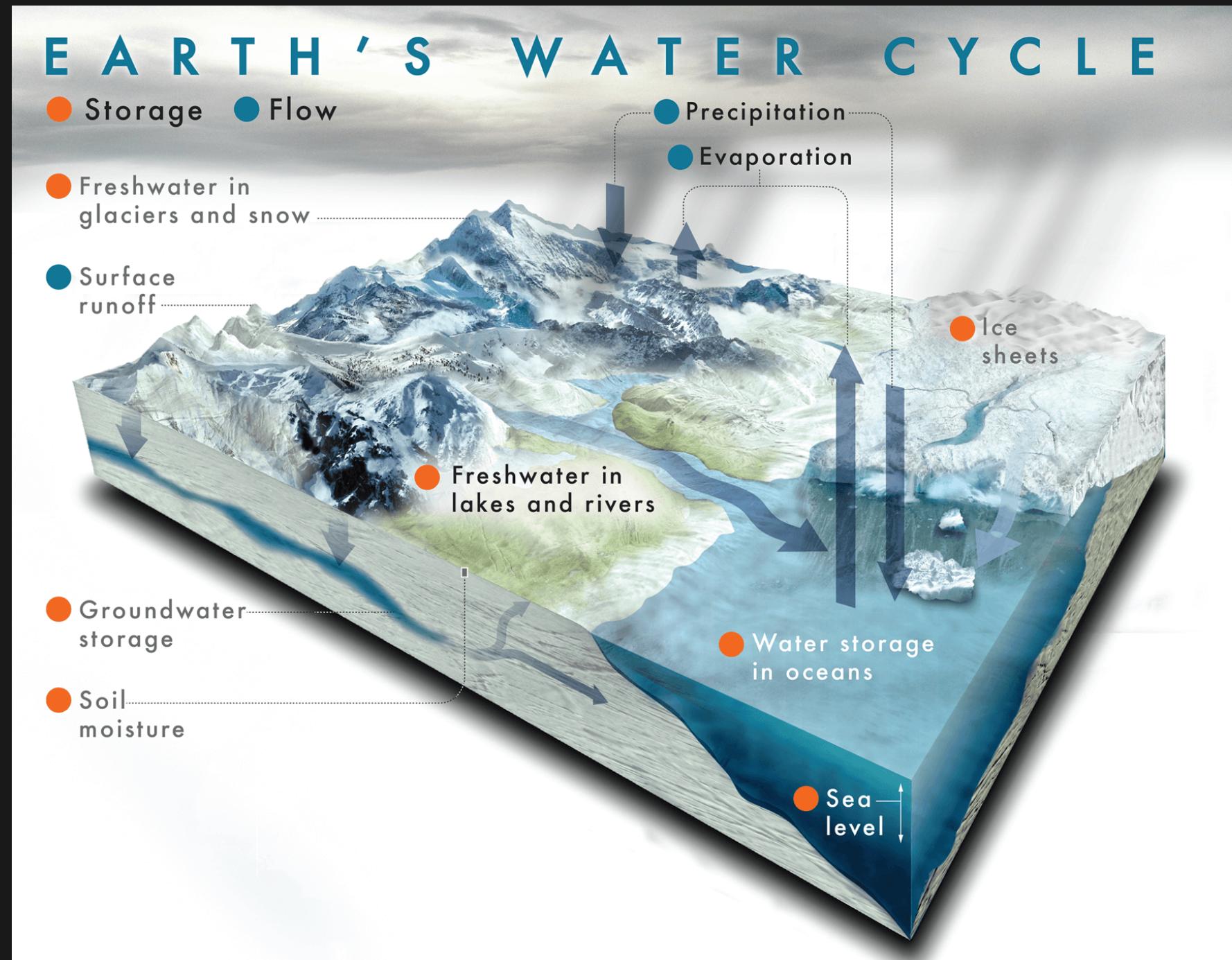
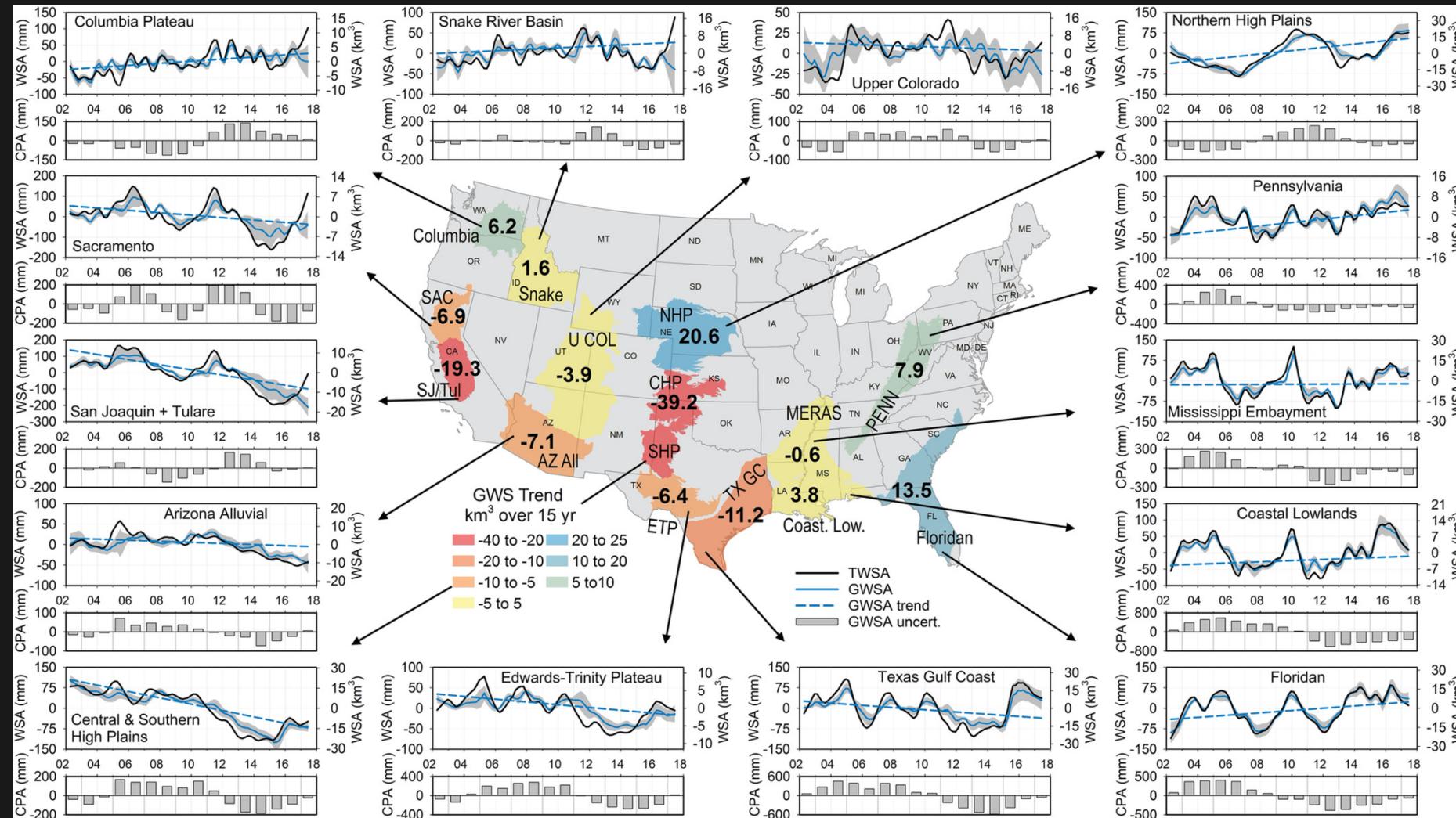


Gravity and the Water Cycle II: showcases and current research

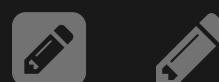
Part of EOAFrica R & D



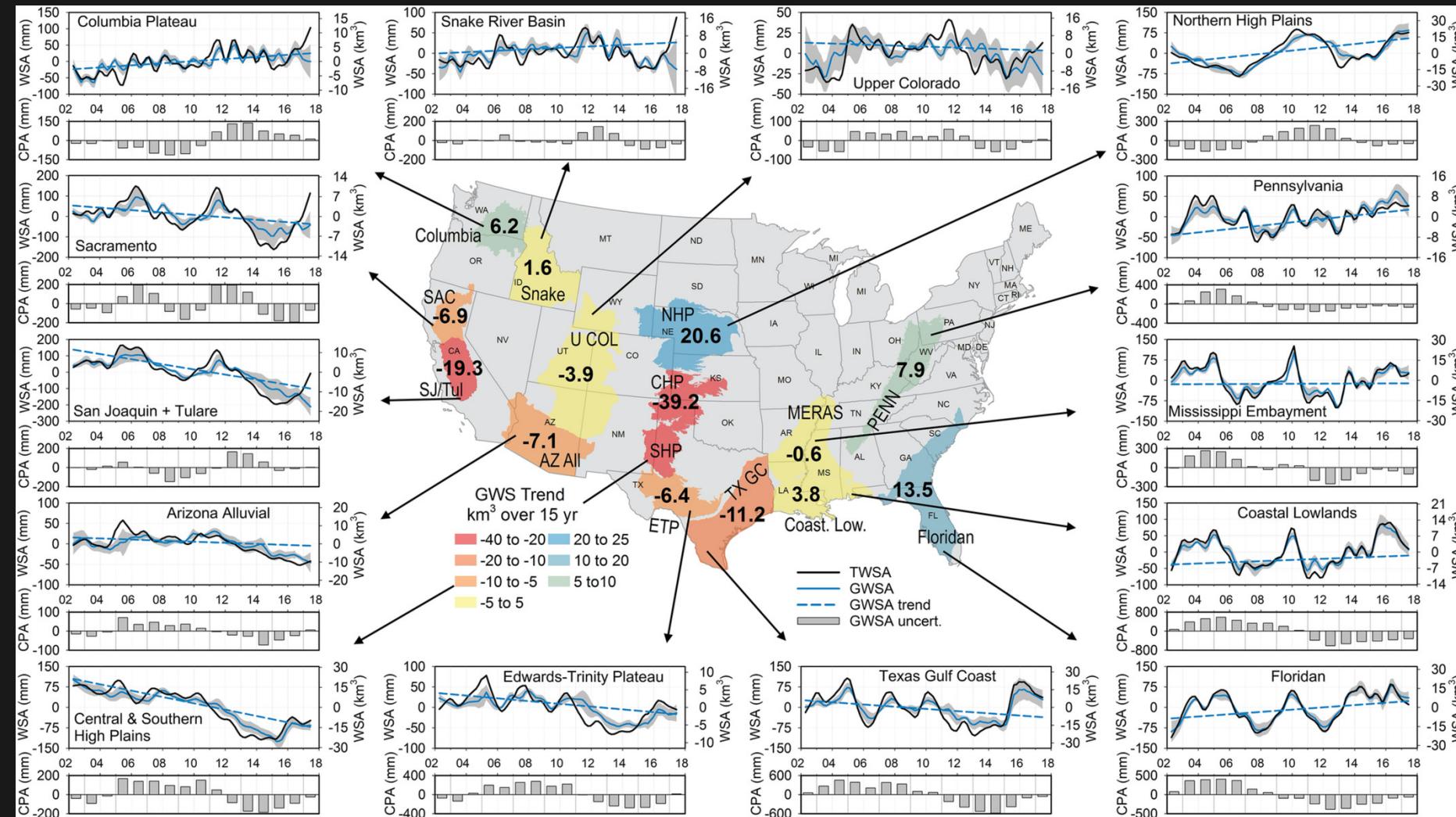
Showcase I: Rateb et al 2020. Comparison of Groundwater Storage Changes From GRACE Satellites With Monitoring and Modeling of Major U.S. Aquifers



From Rateb et al. 2020, Water resources research. WSA: water storage anomaly, CPA:cumulative precipitation anomaly



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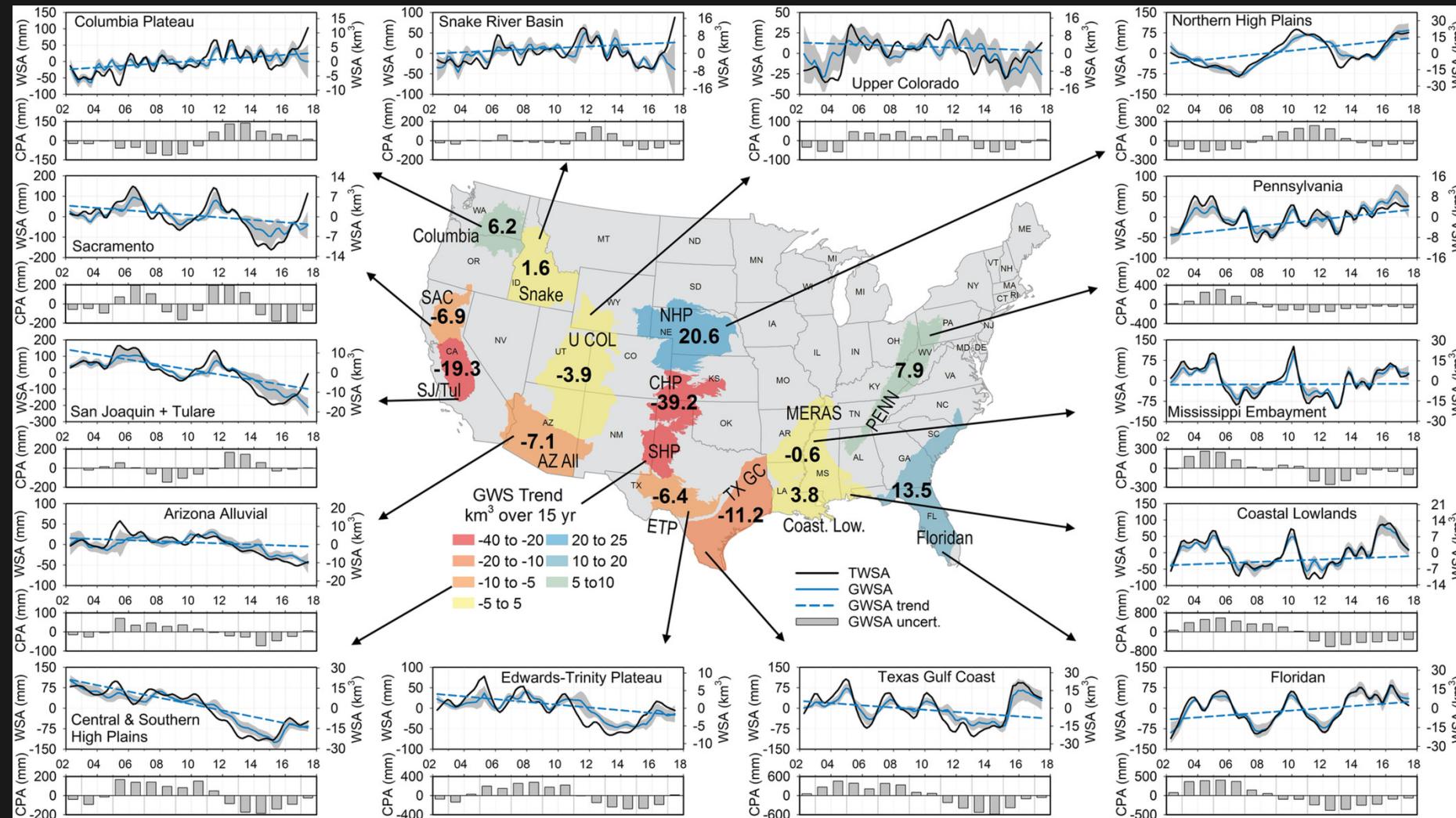


- Net US decrease in aquifer volume of 90 km^3 over 15 years, but signs vary per aquifer

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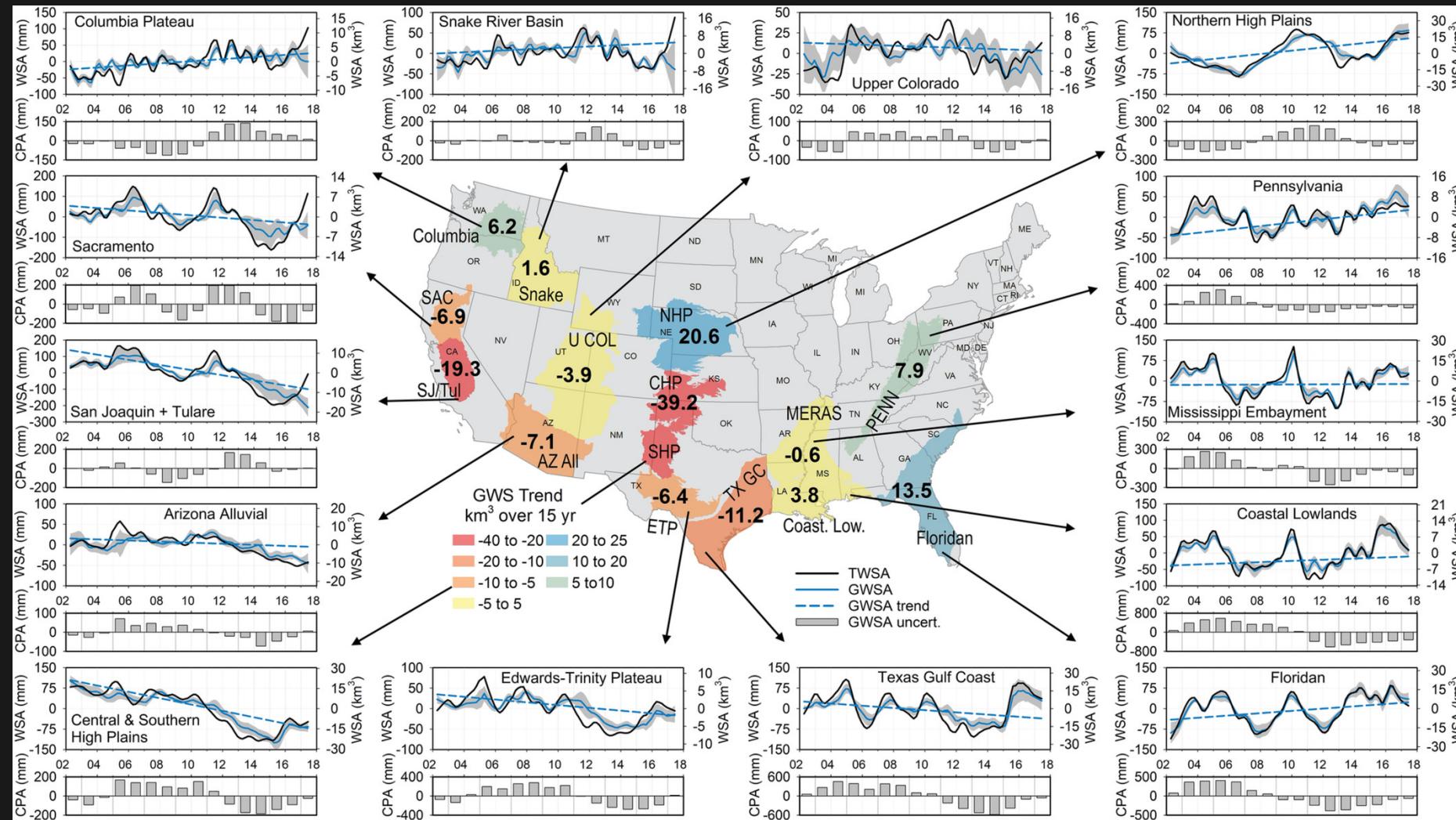


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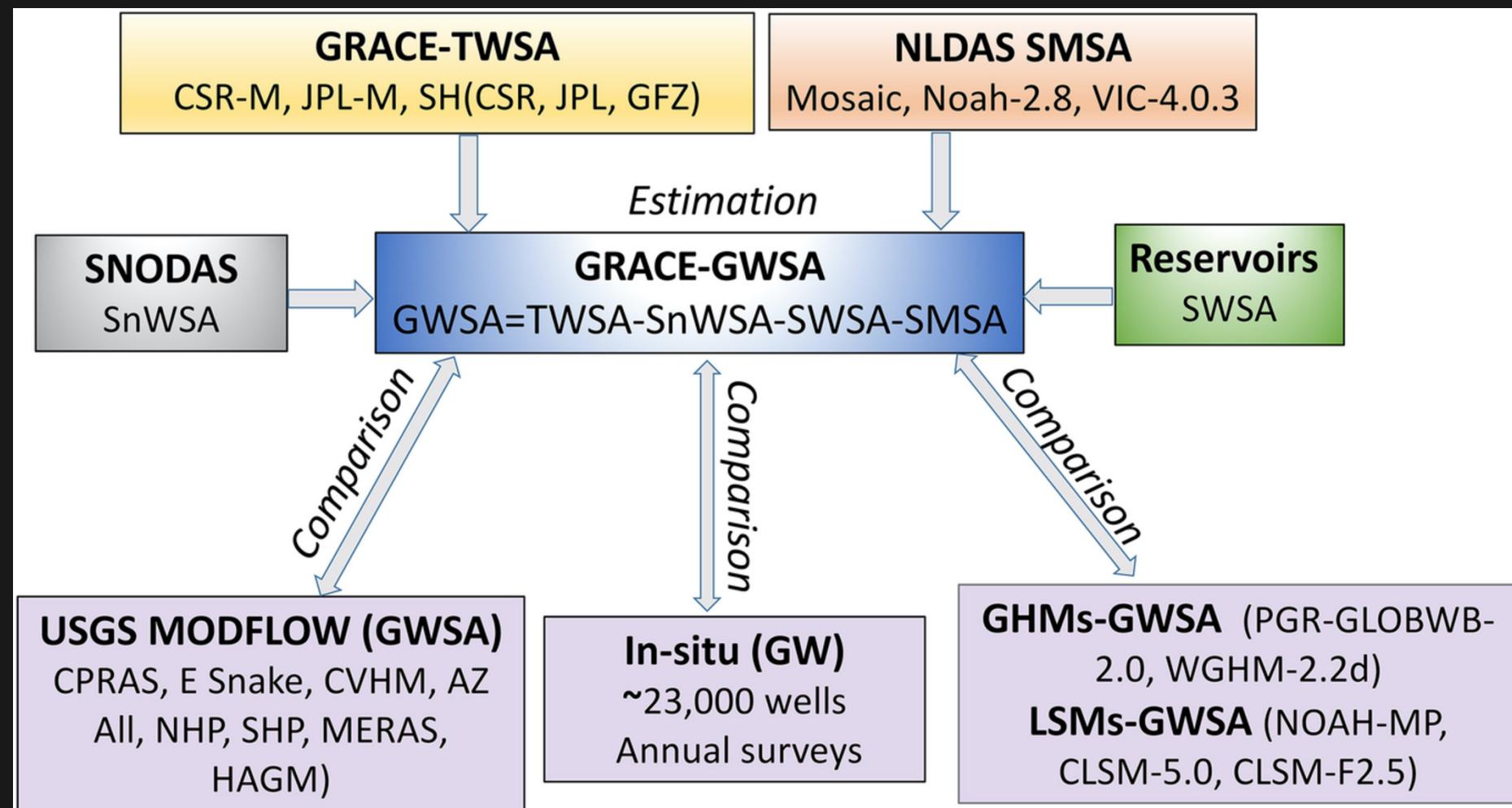


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- Net US decrease in aquifer volume of 90 km³ over 15 years, but signs vary per aquifer
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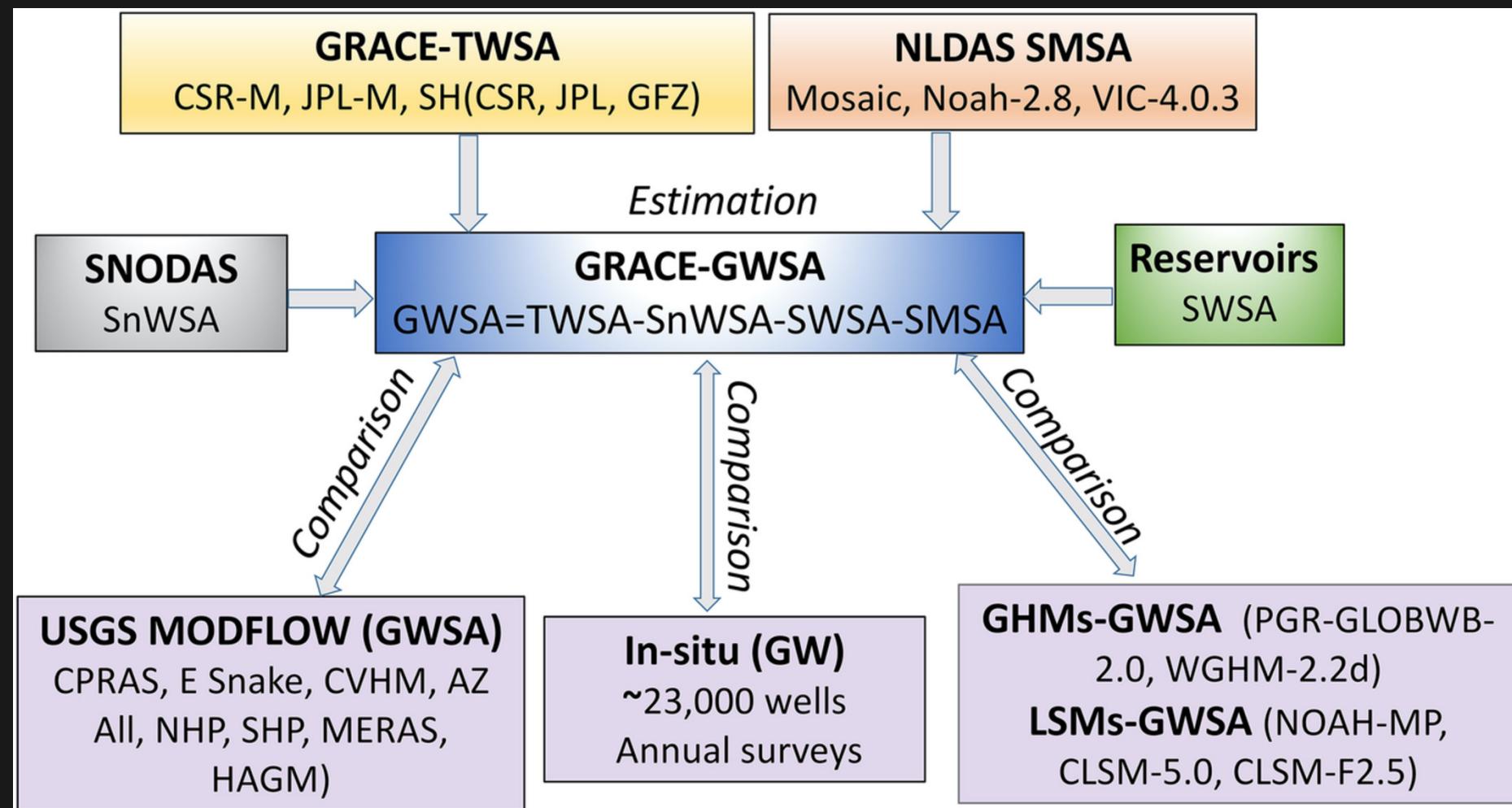
Showcase I: Rateb et al 2020. Data and Methods



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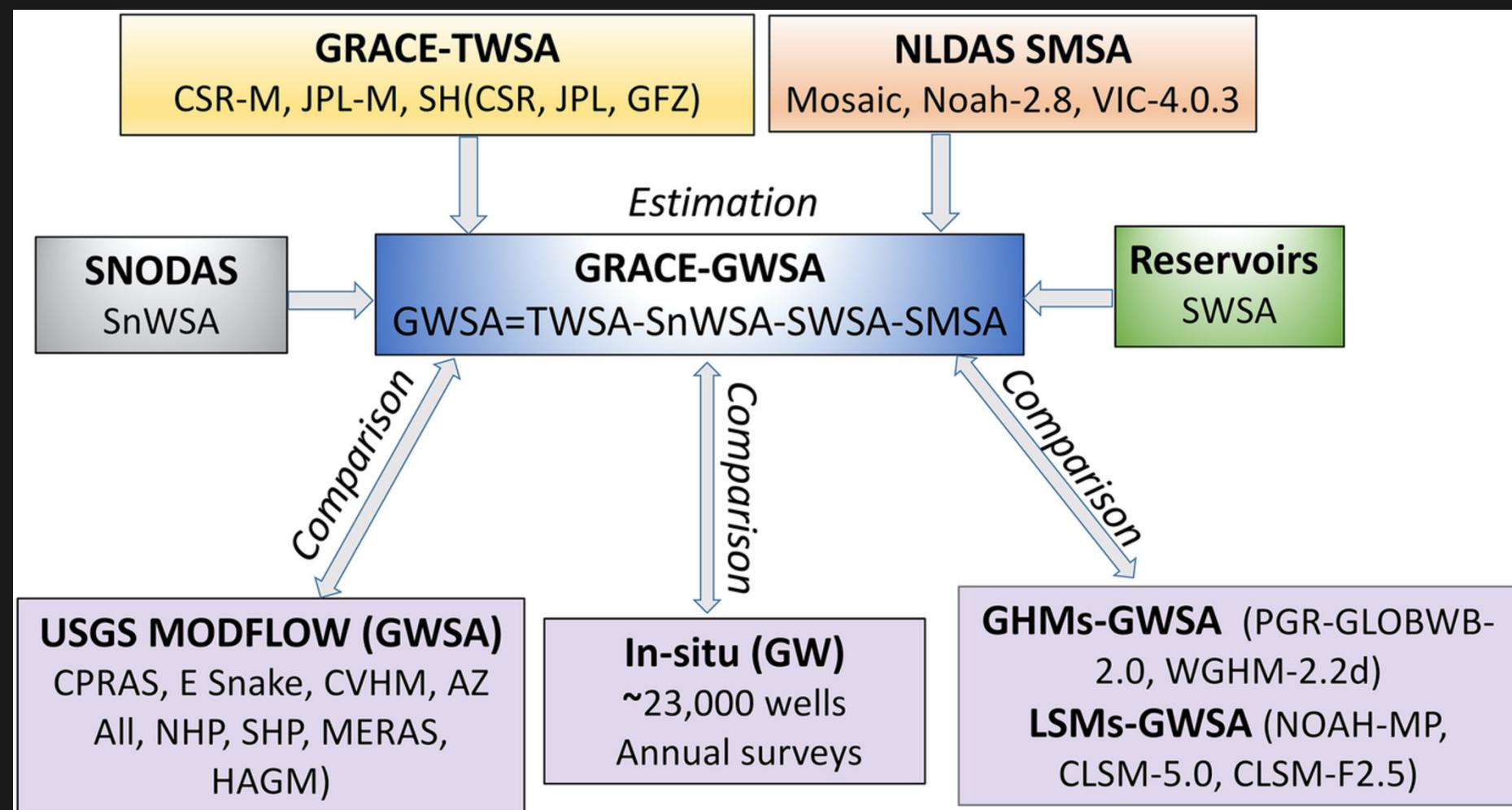


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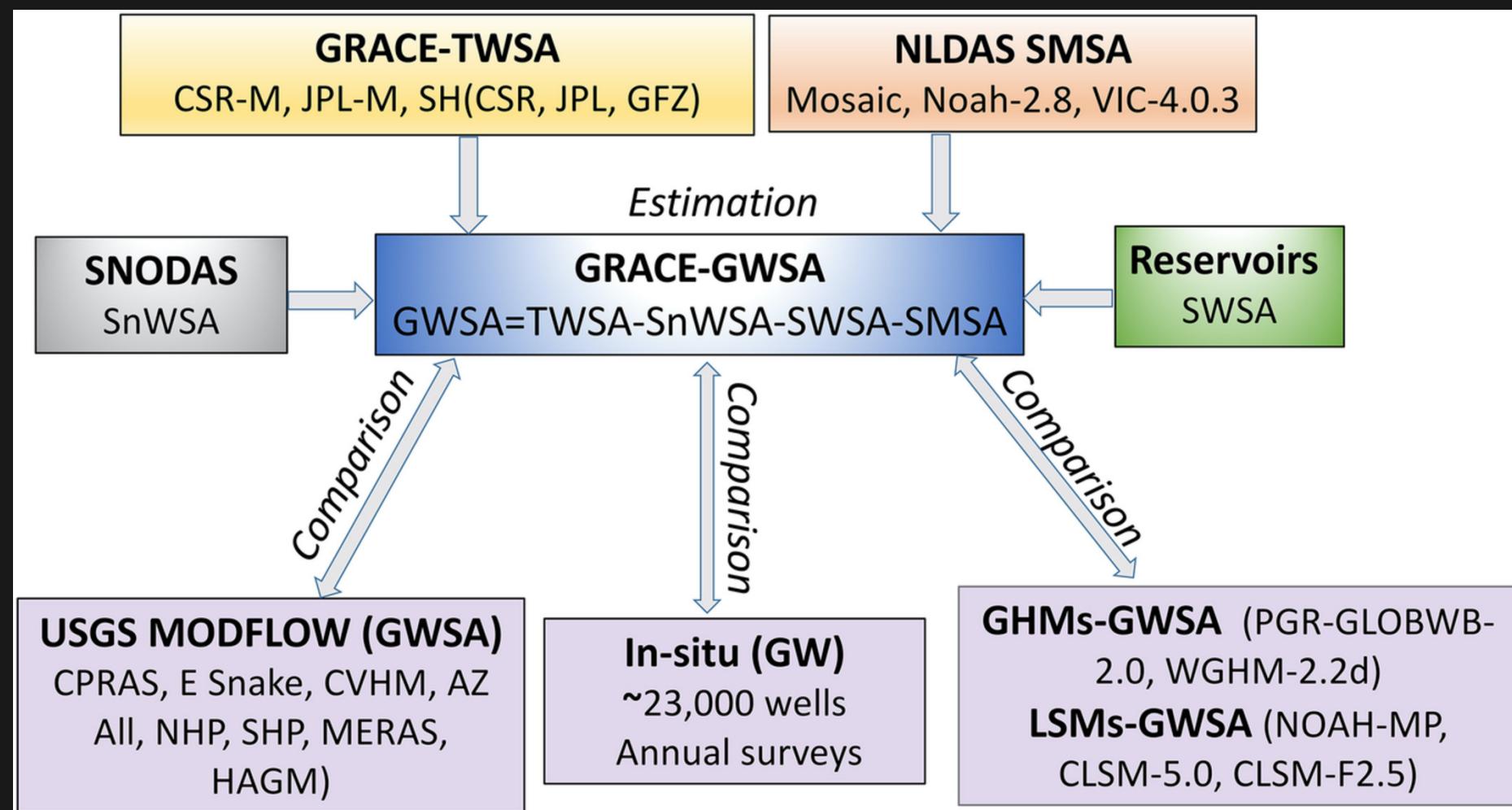


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Showcase I: Rateb et al 2020. Data and Methods



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- validation with well data, regional modflow models, hydrological models

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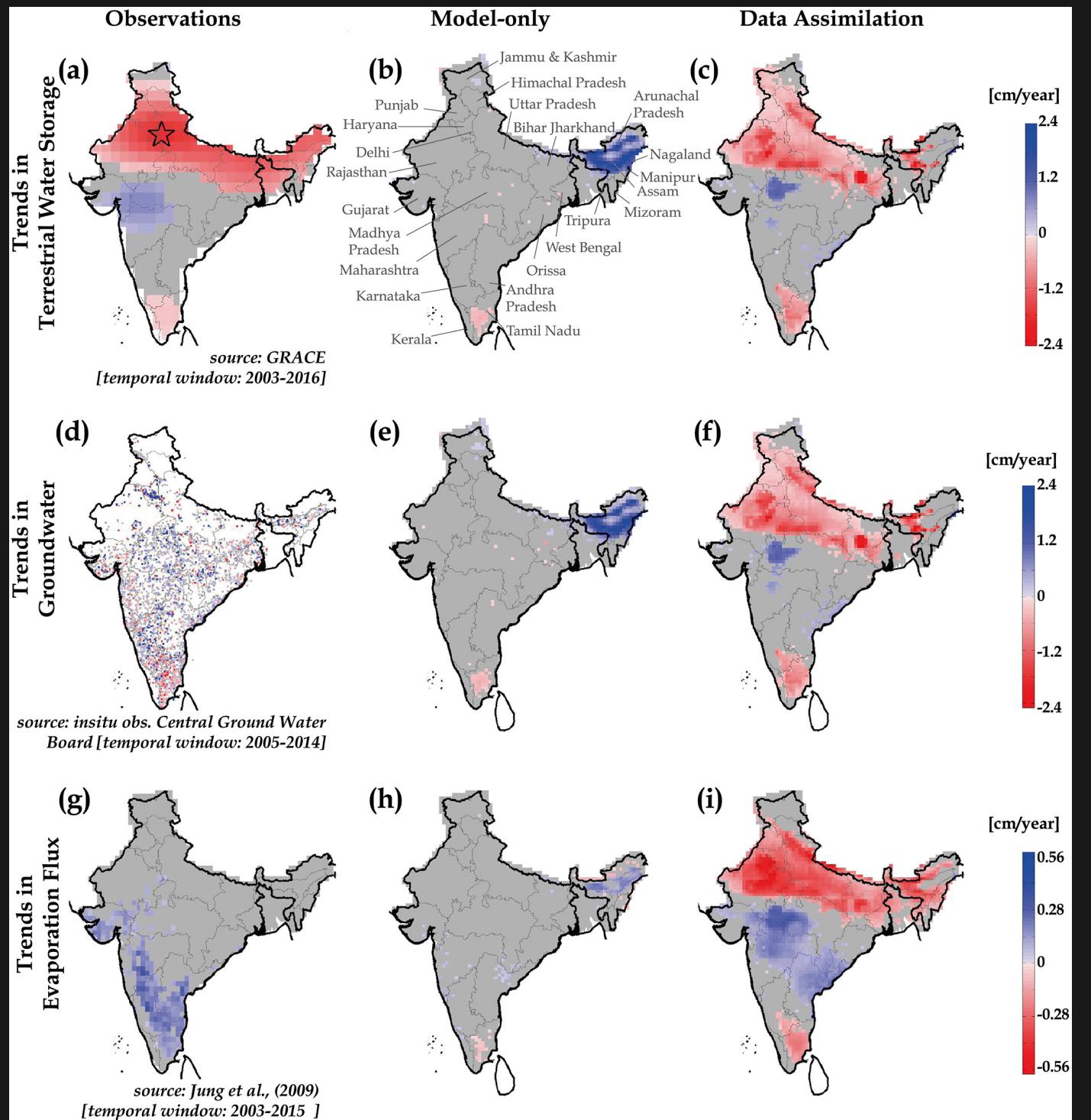


Showcase I: Rateb et al 2020. Open questions and uncertainties

- Why such large differences between global hydrological models and GRACE?
- Results mainly focus on GRACE 'mascon' solutions. How much is the true signal attenuated in these solutions?
- Uncertainties in storage coefficients $\Delta GWS = S_c \Delta GWLs$
- How well do the ground well data represent large scale signals. confined versus unconfined aquifers, local change of hydraulic head due to pumping



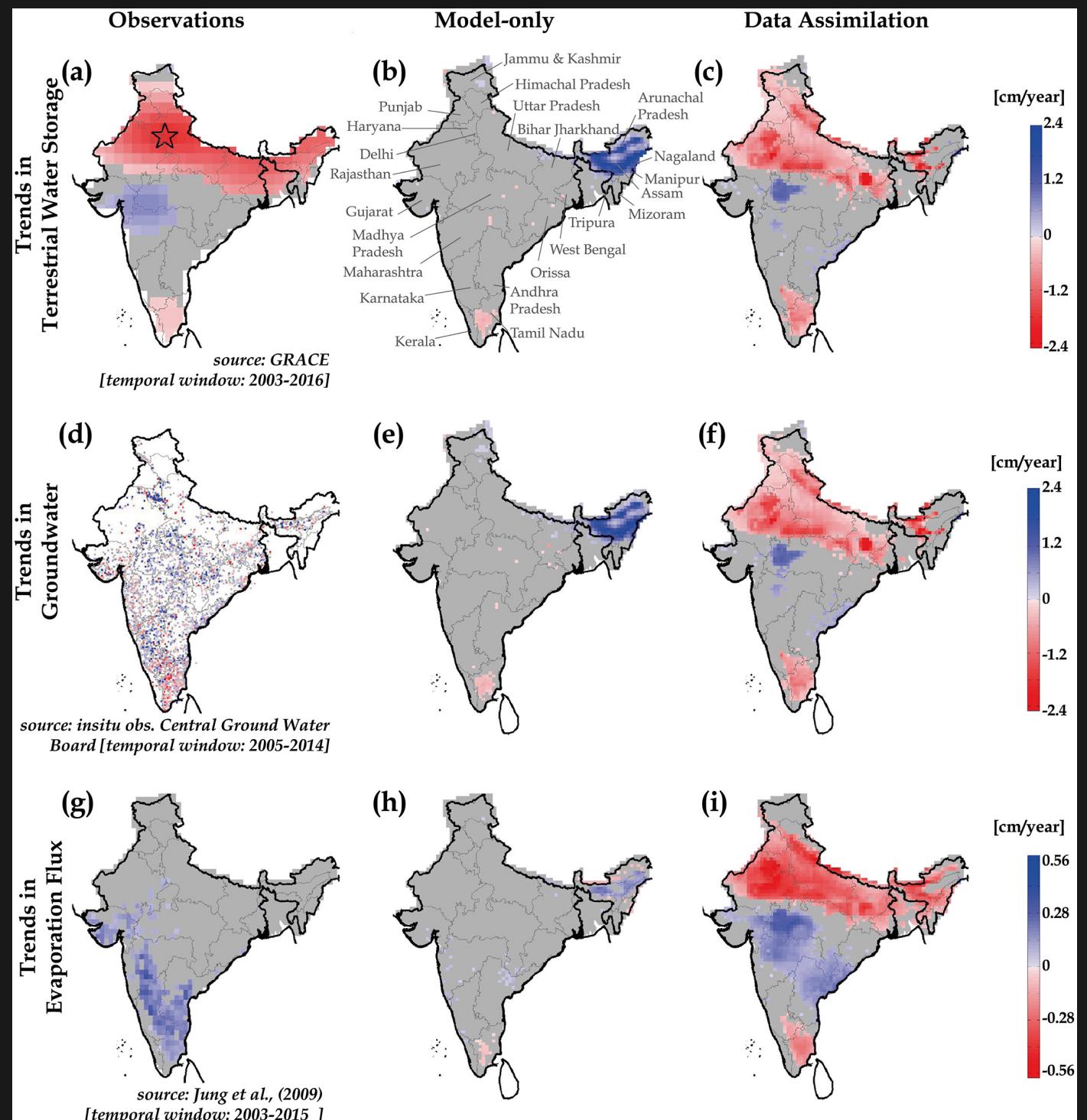
Showcase II Girotto et al 2017, *Benefits and pitfalls of GRACE data assimilation: A case study of terrestrial water storage depletion in India*



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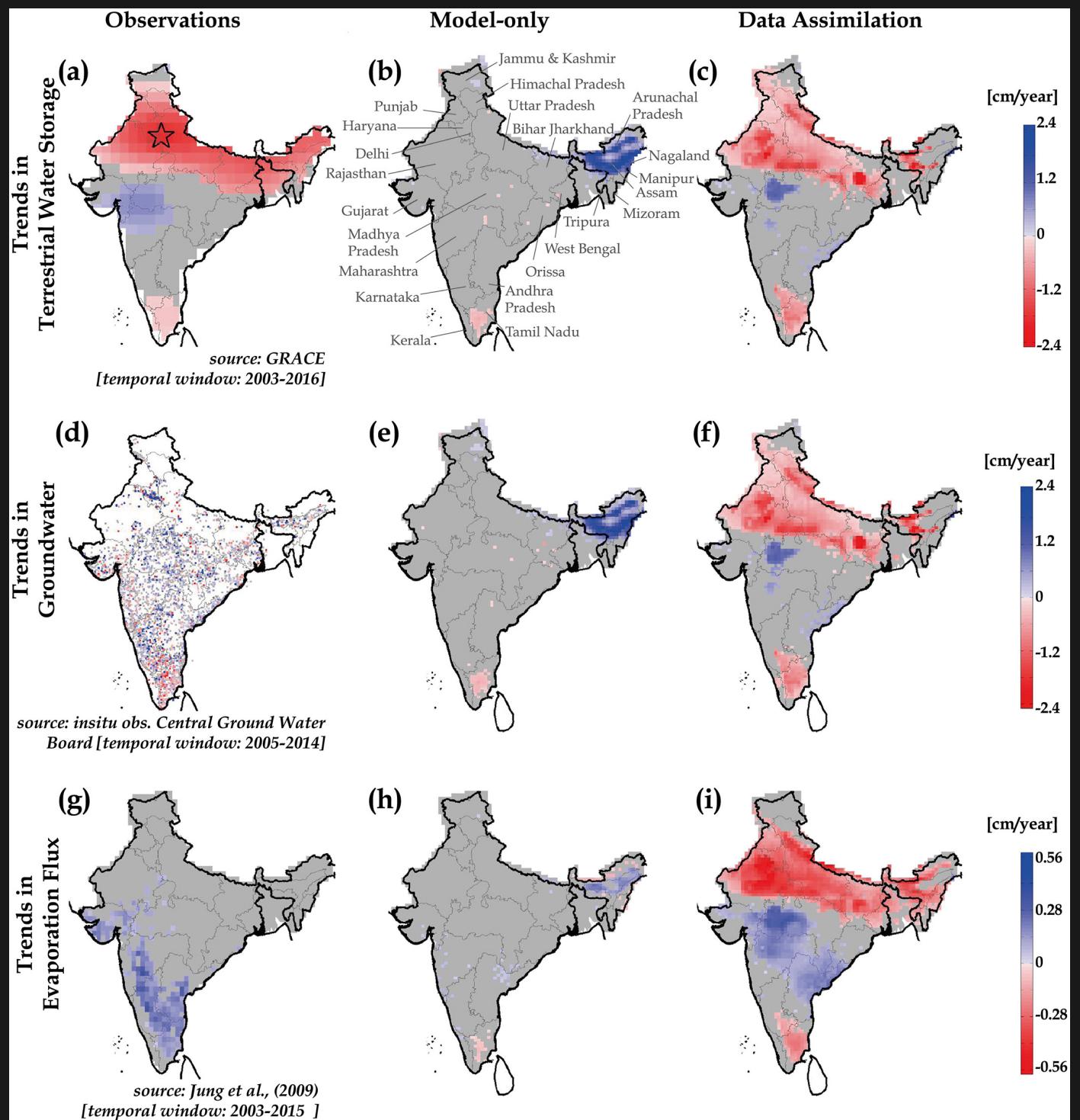


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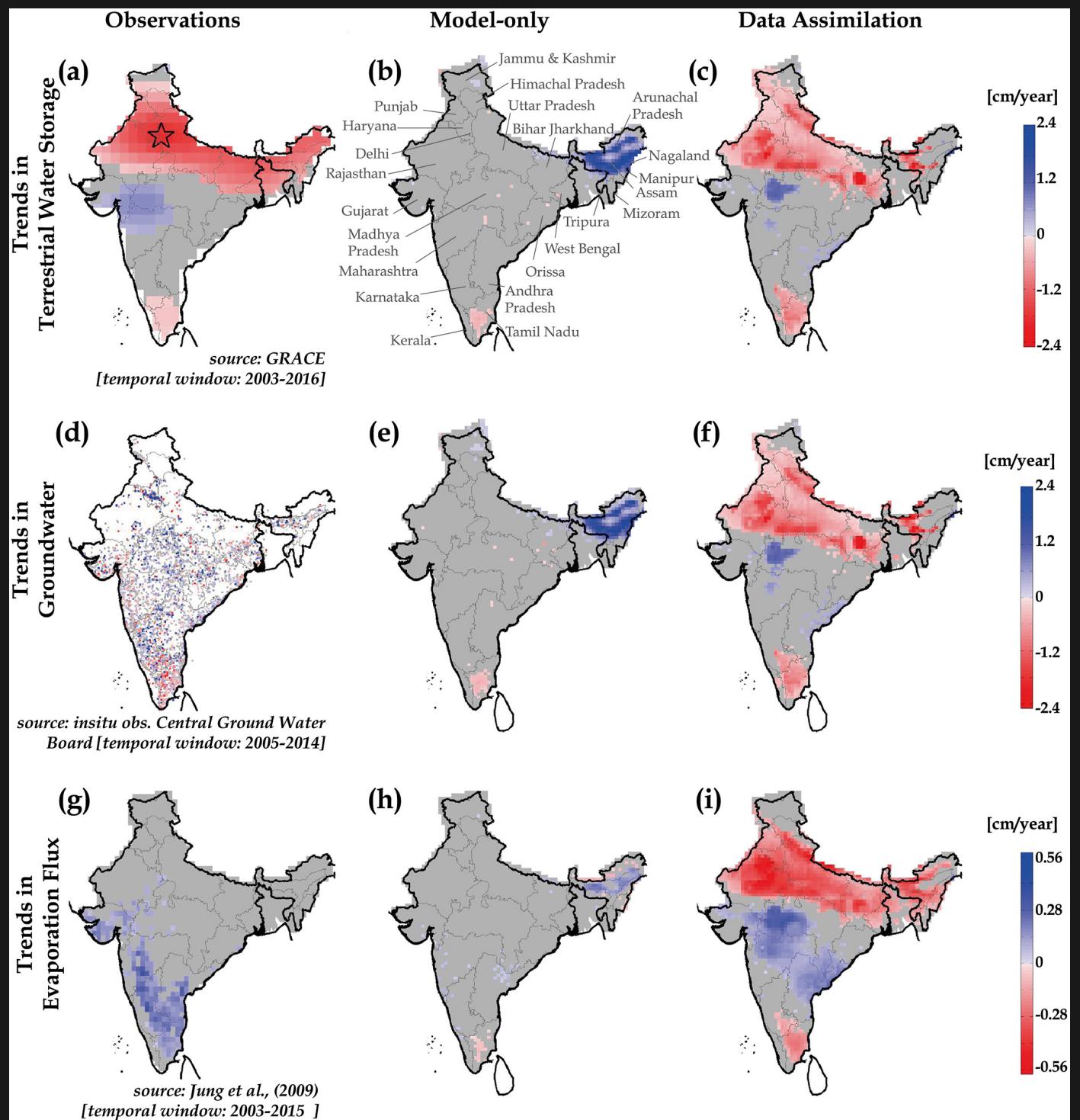


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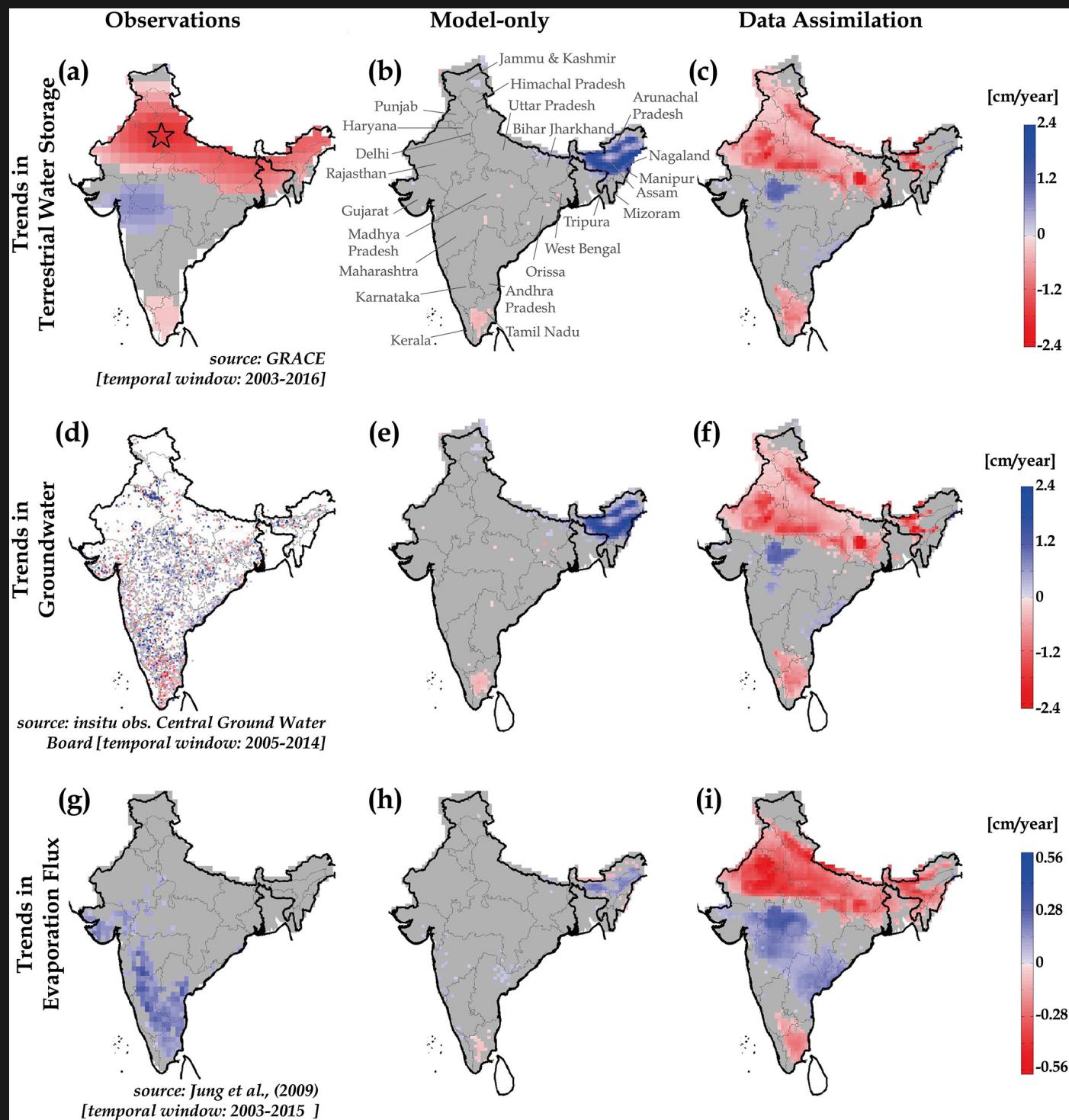


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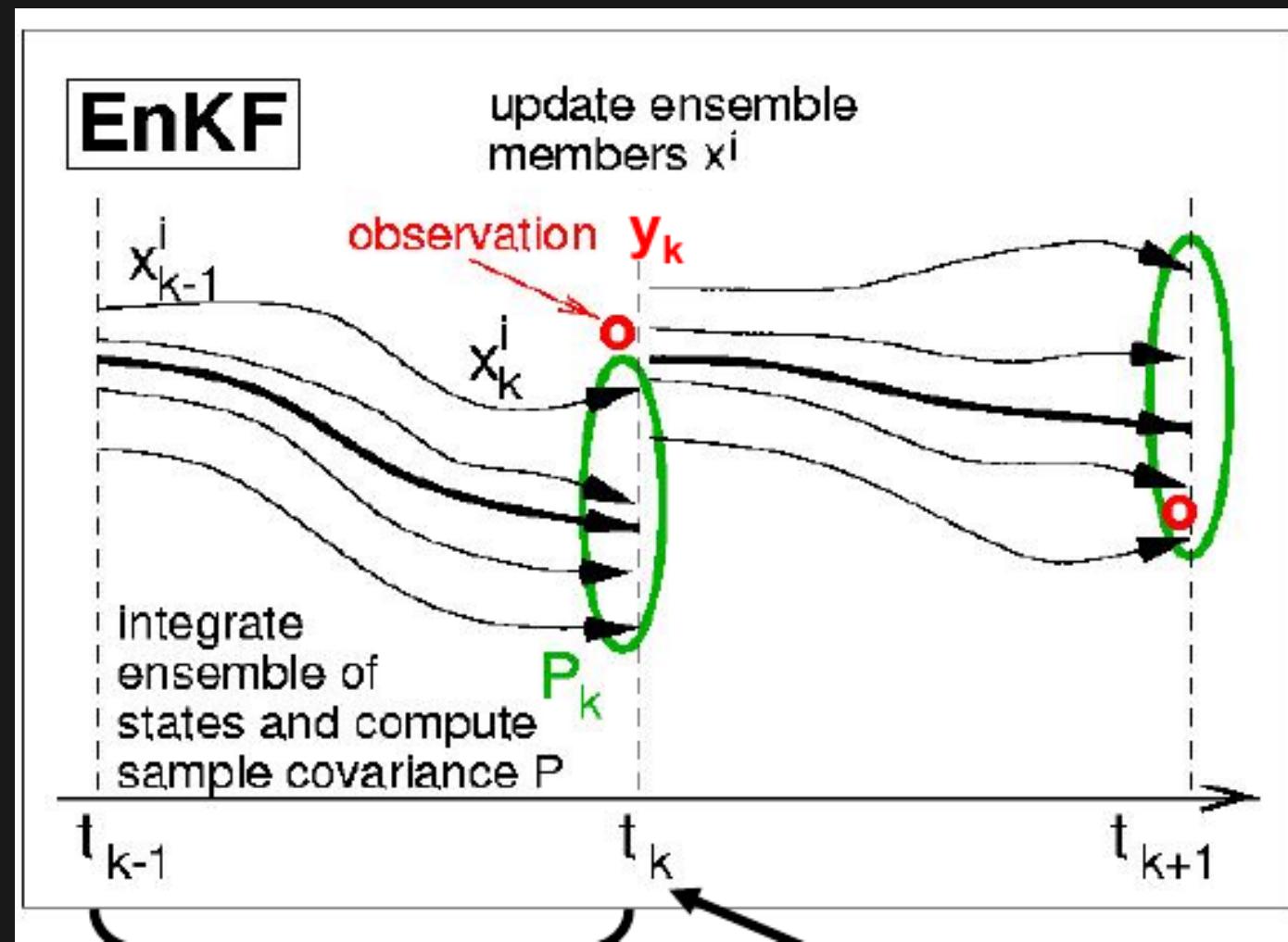


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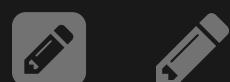
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Showcase II Girotto et al 2017, Data and Methods

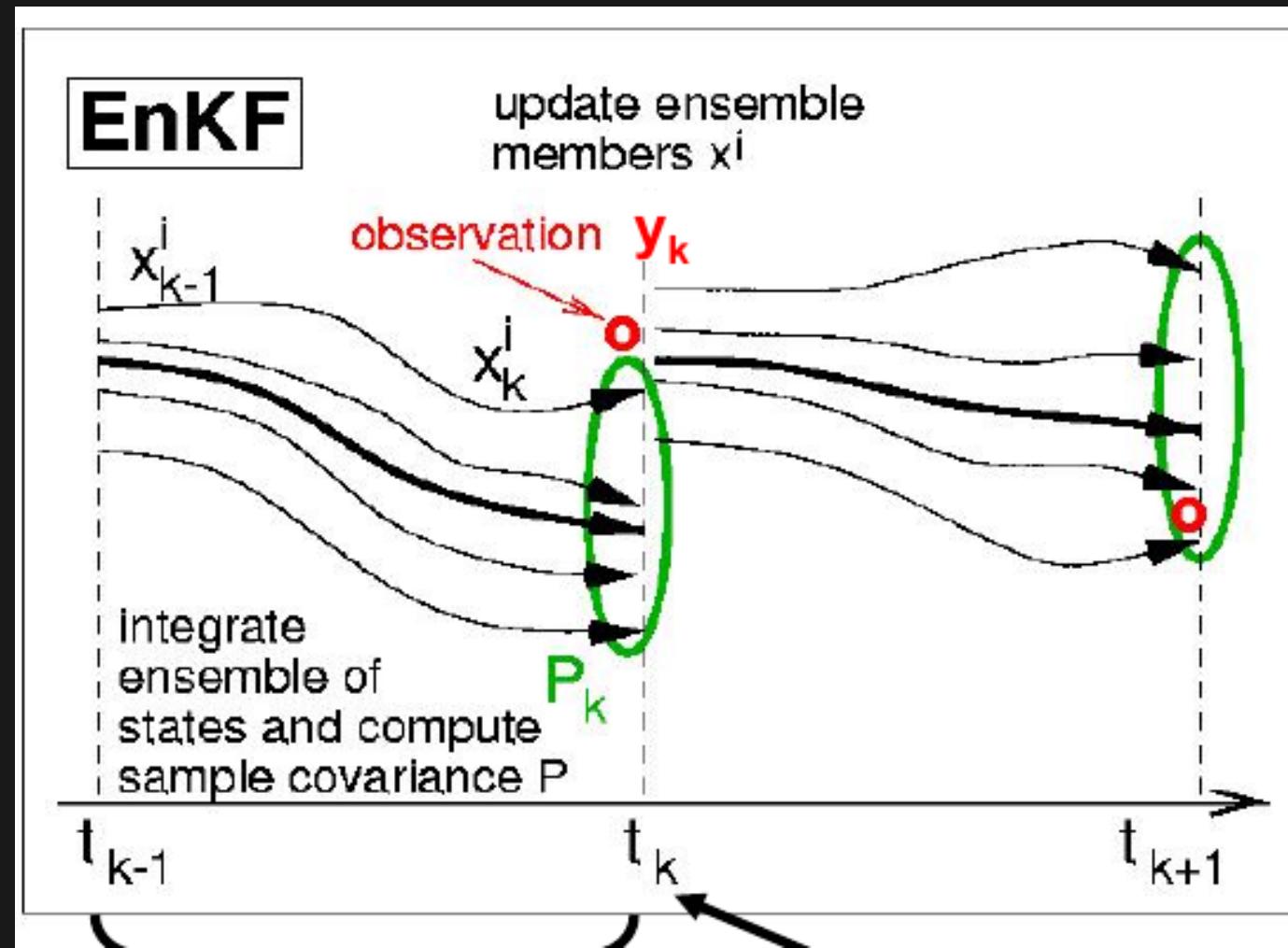


Graphical depiction of the ensemble Kalman filter. Source: Rolf Reichle

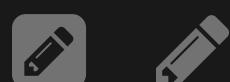


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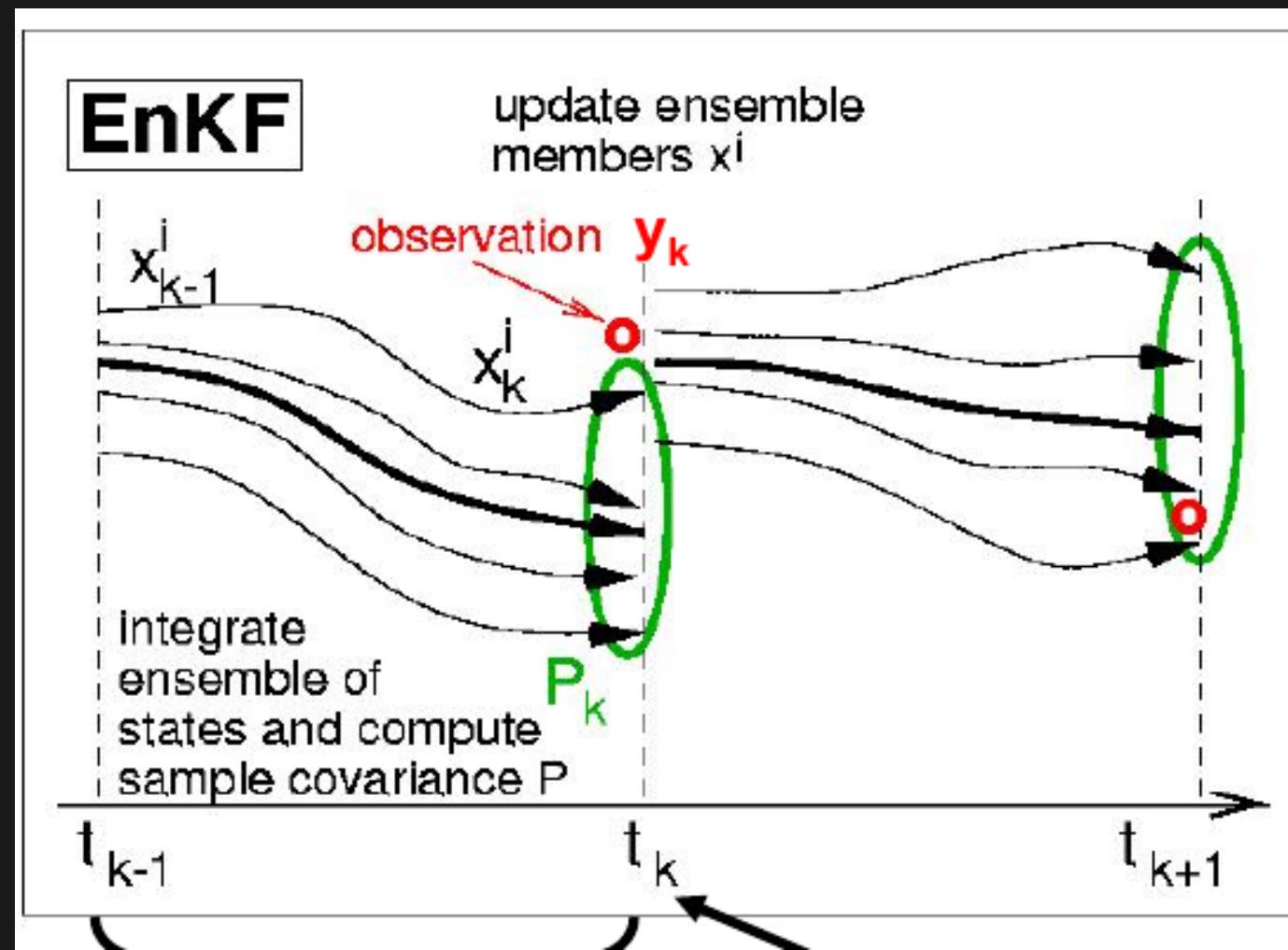
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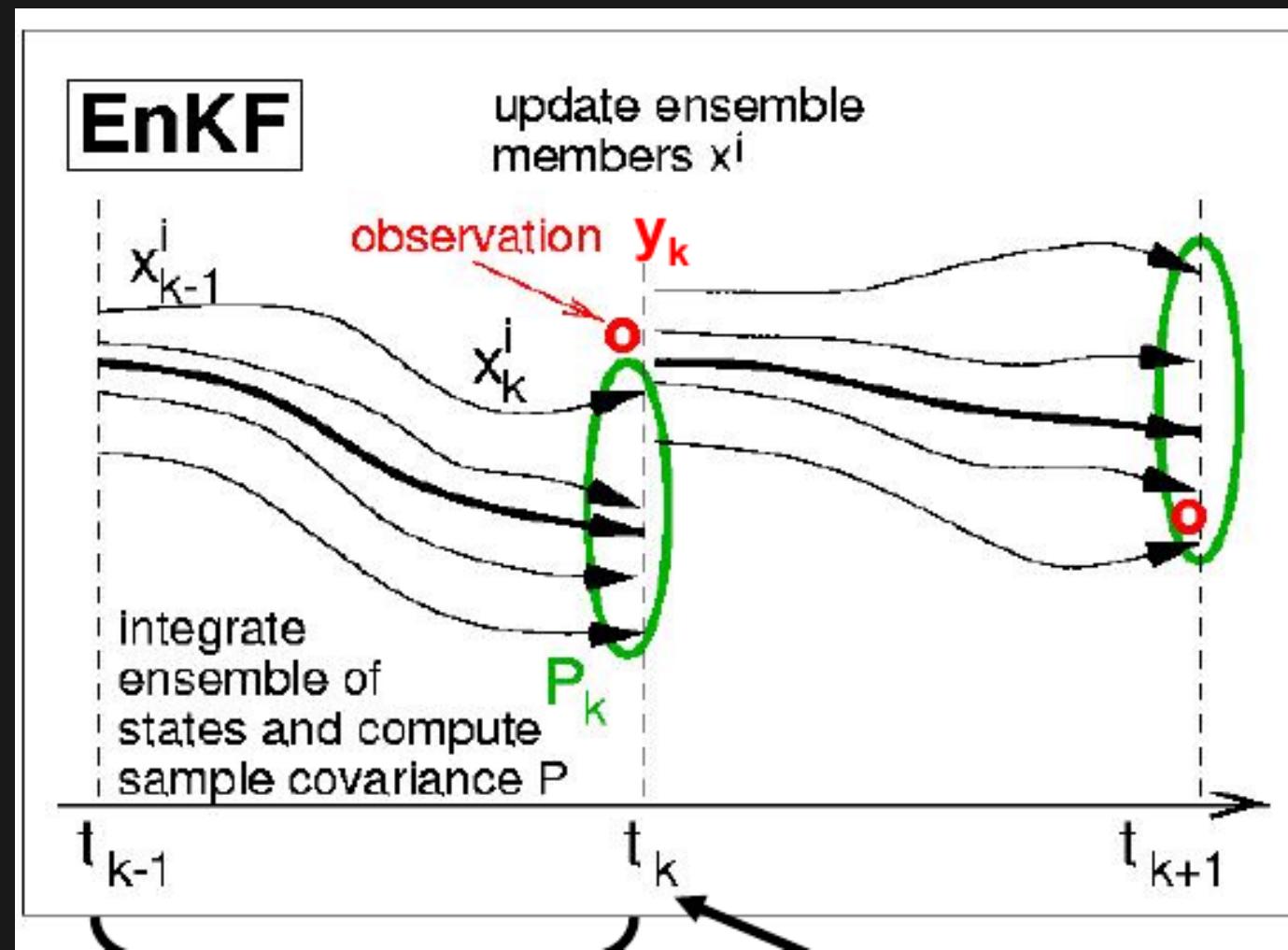
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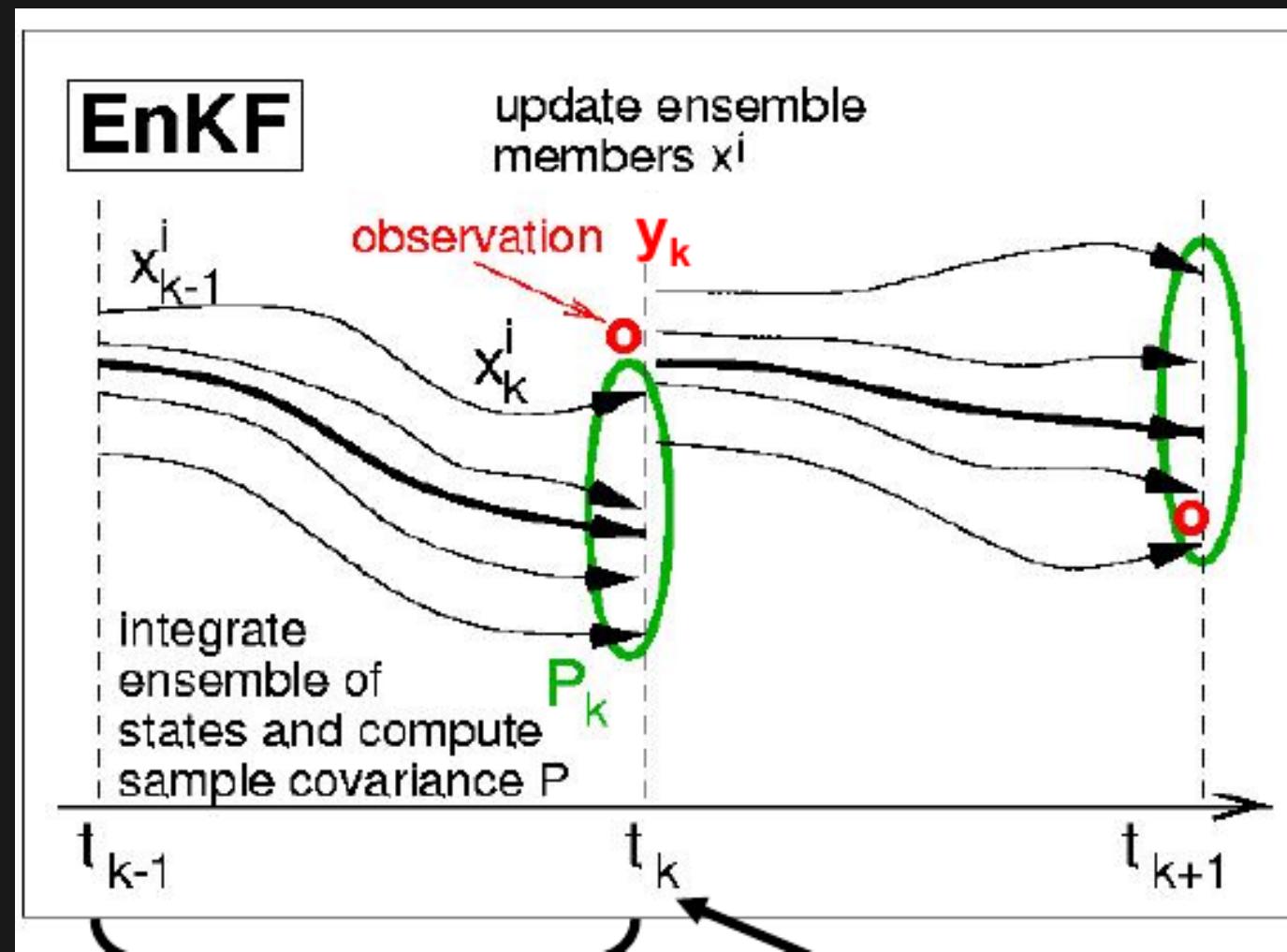
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Showcase II Girotto et al 2017, Open questions and uncertainties



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- Model does not incorporate human GWS extraction. Which makes it physically inconsistent with GRACE observations



Showcase II Girotto et al 2017, Open questions and uncertainties

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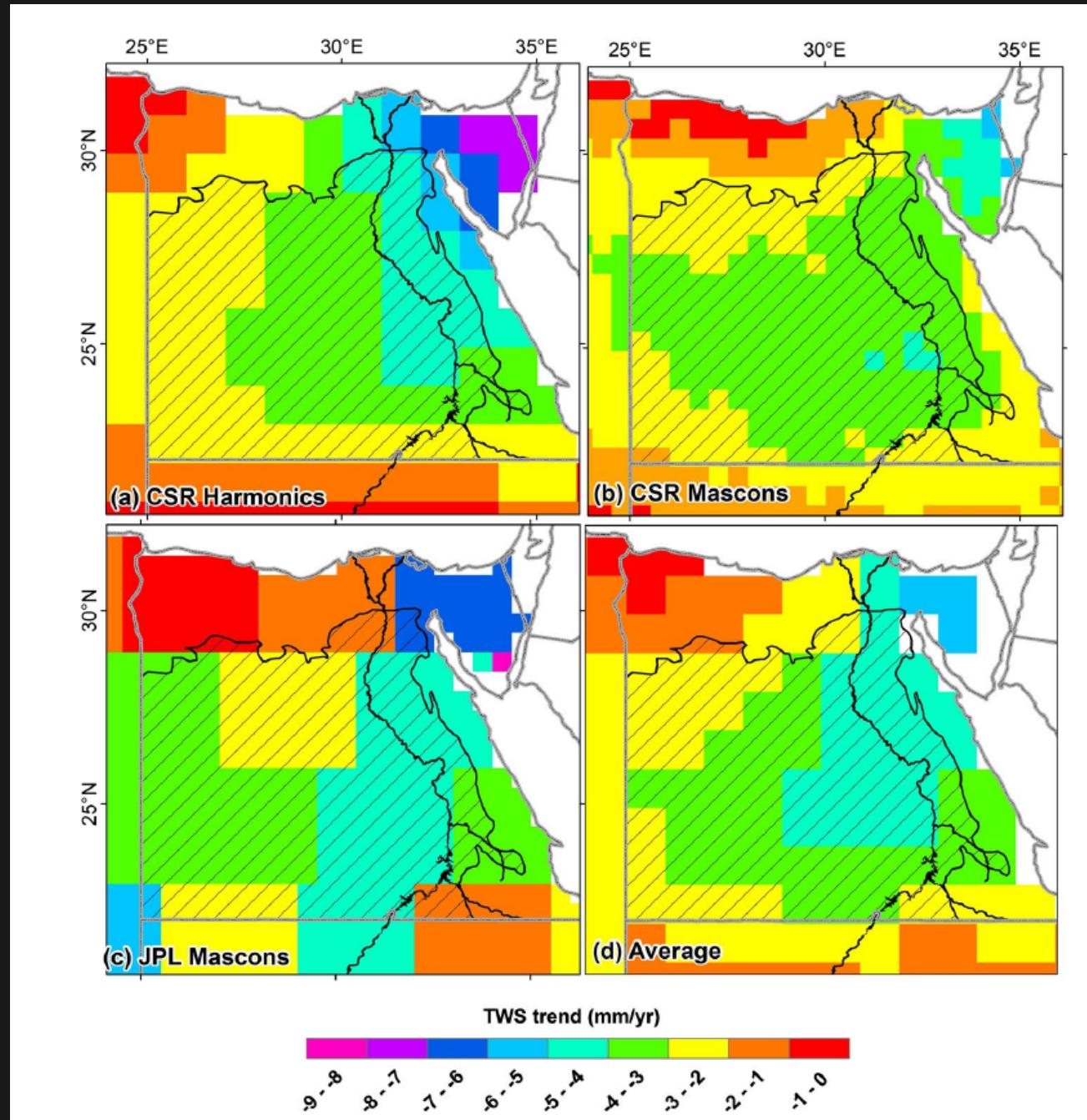


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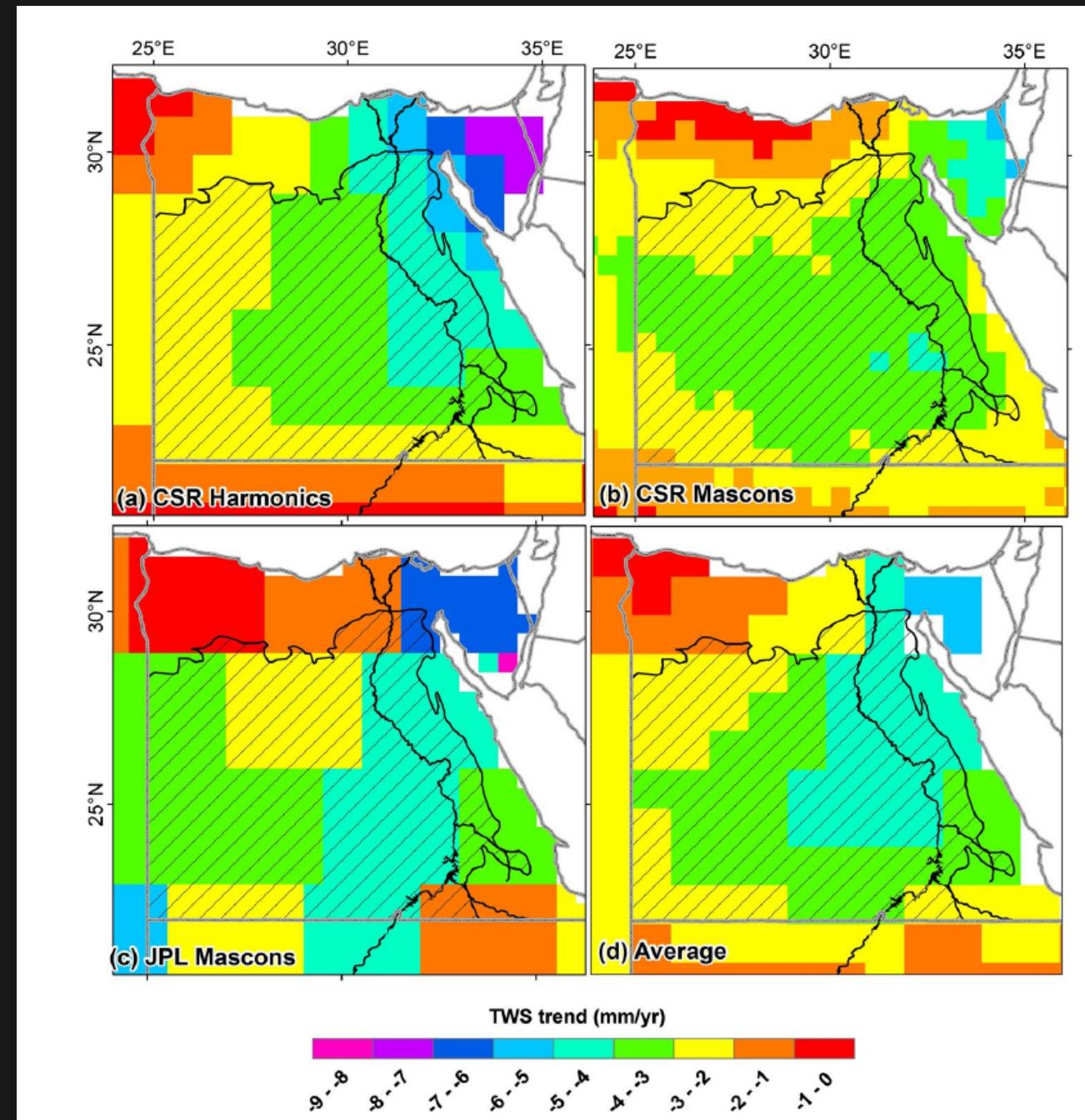
Showcase III Ahmed and Abdelmohsen et al 2018, *Quantifying Modern Recharge and Depletion Rates of the Nubian Aquifer in Egypt*



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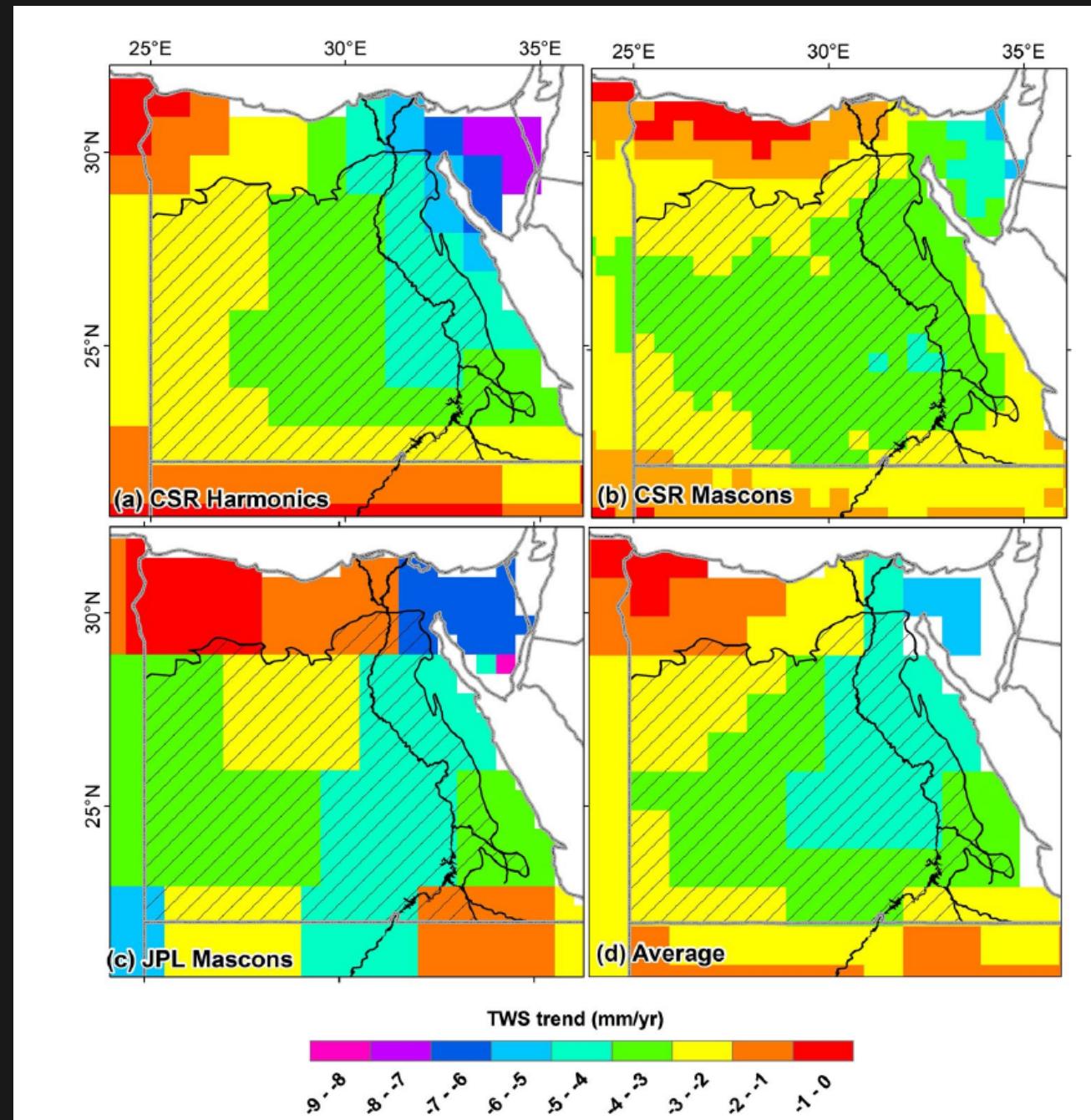


- Use of GRACE to estimate Total water storage change

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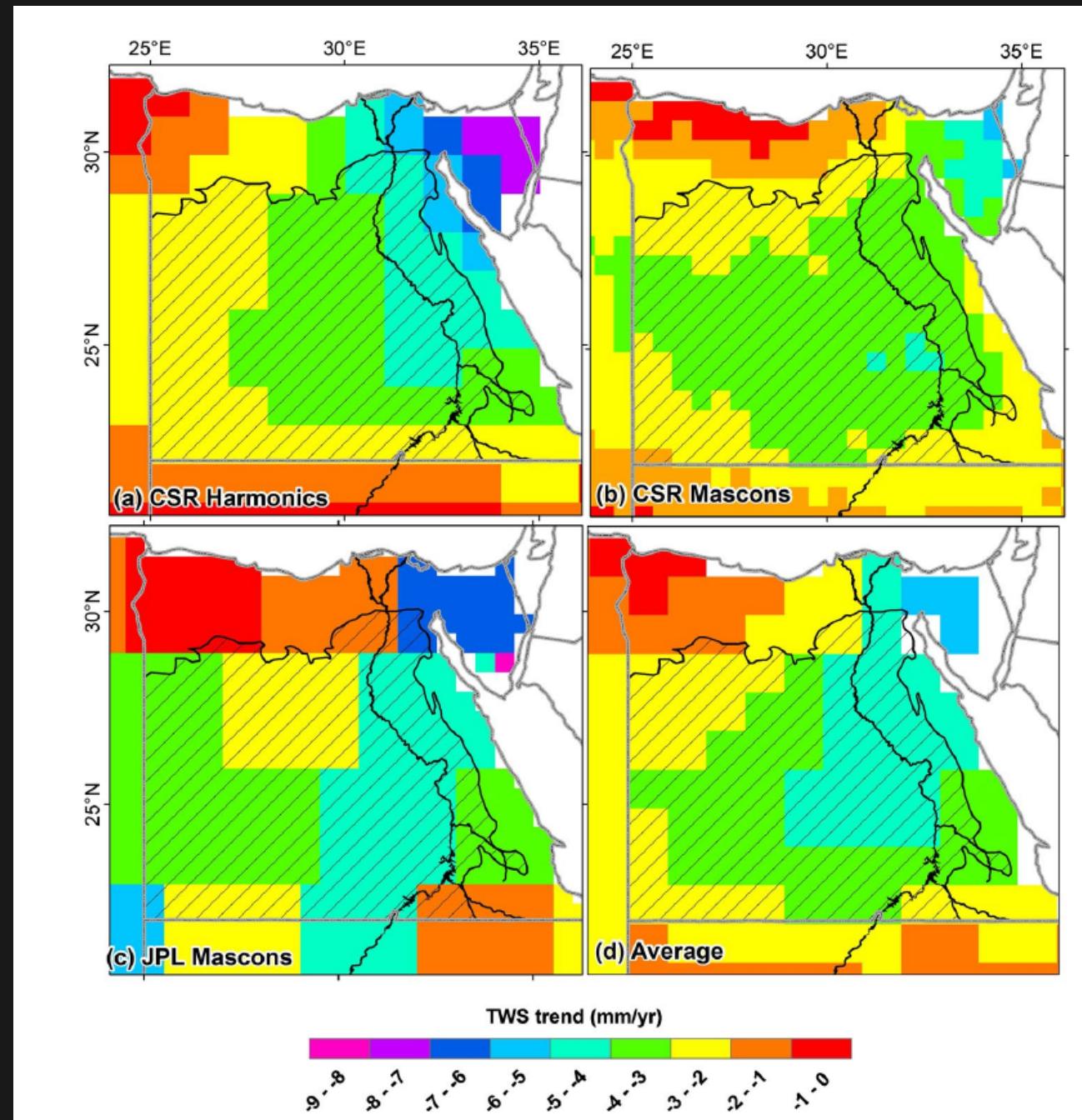


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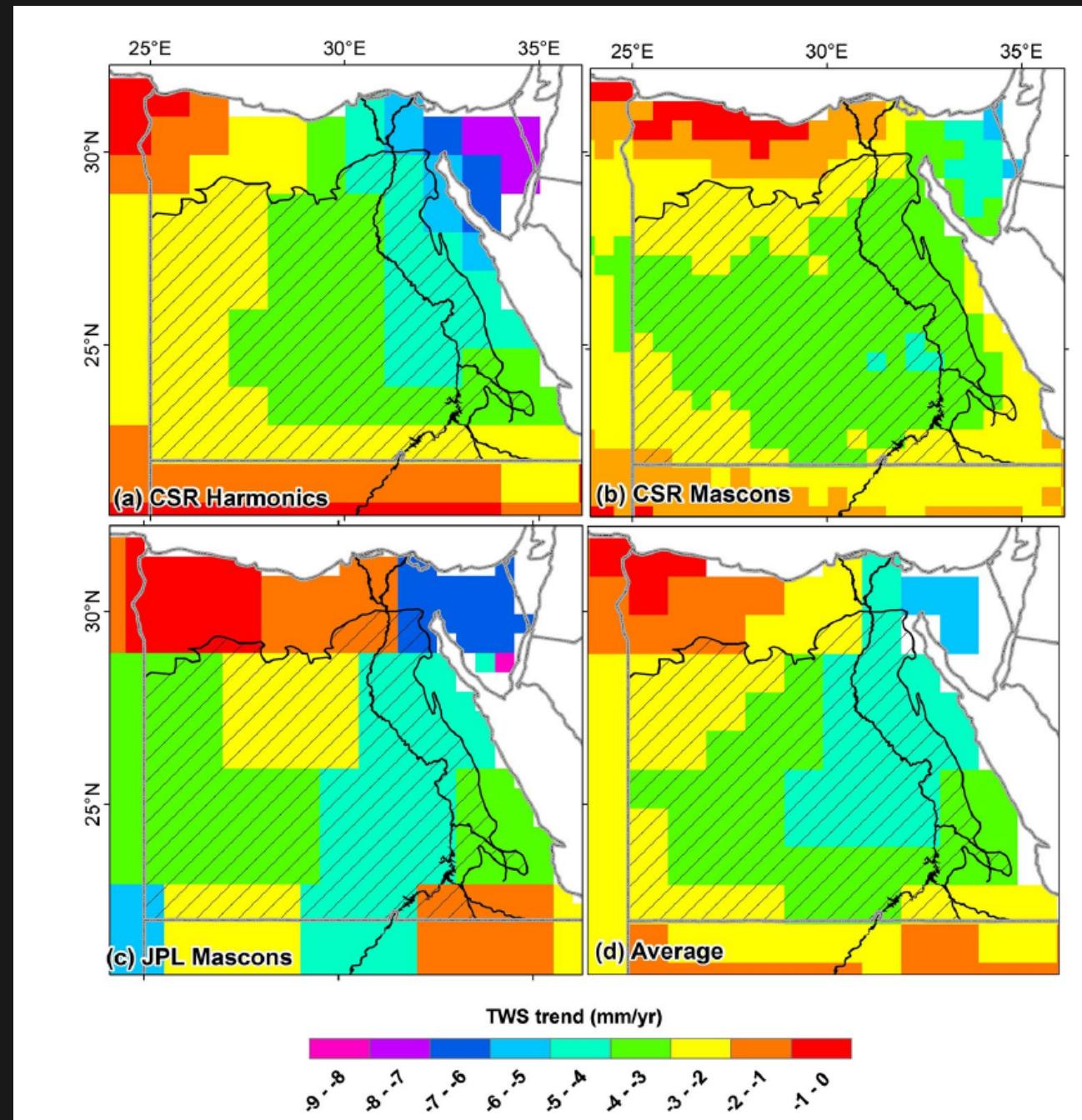


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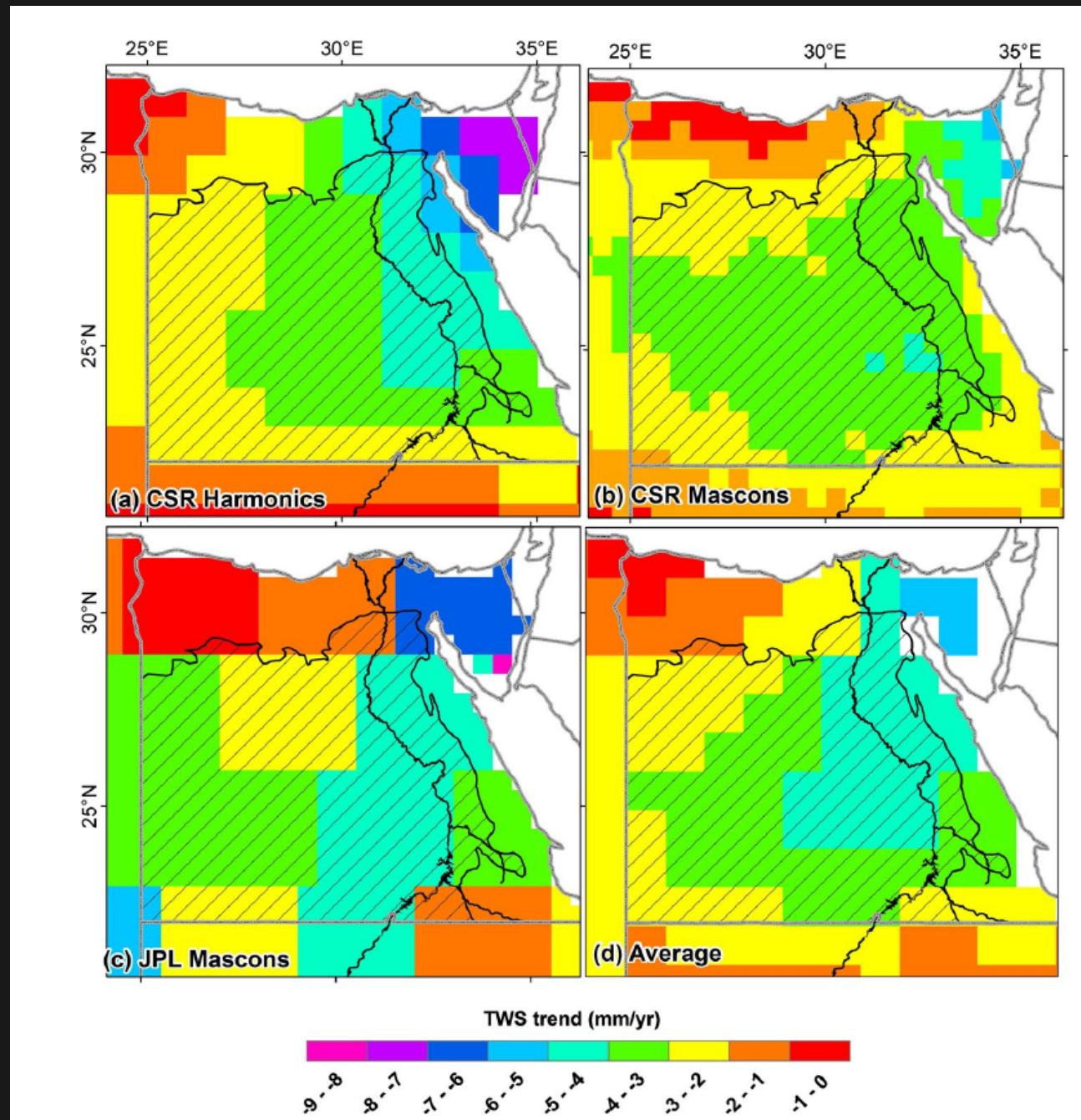


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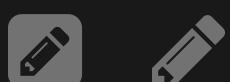


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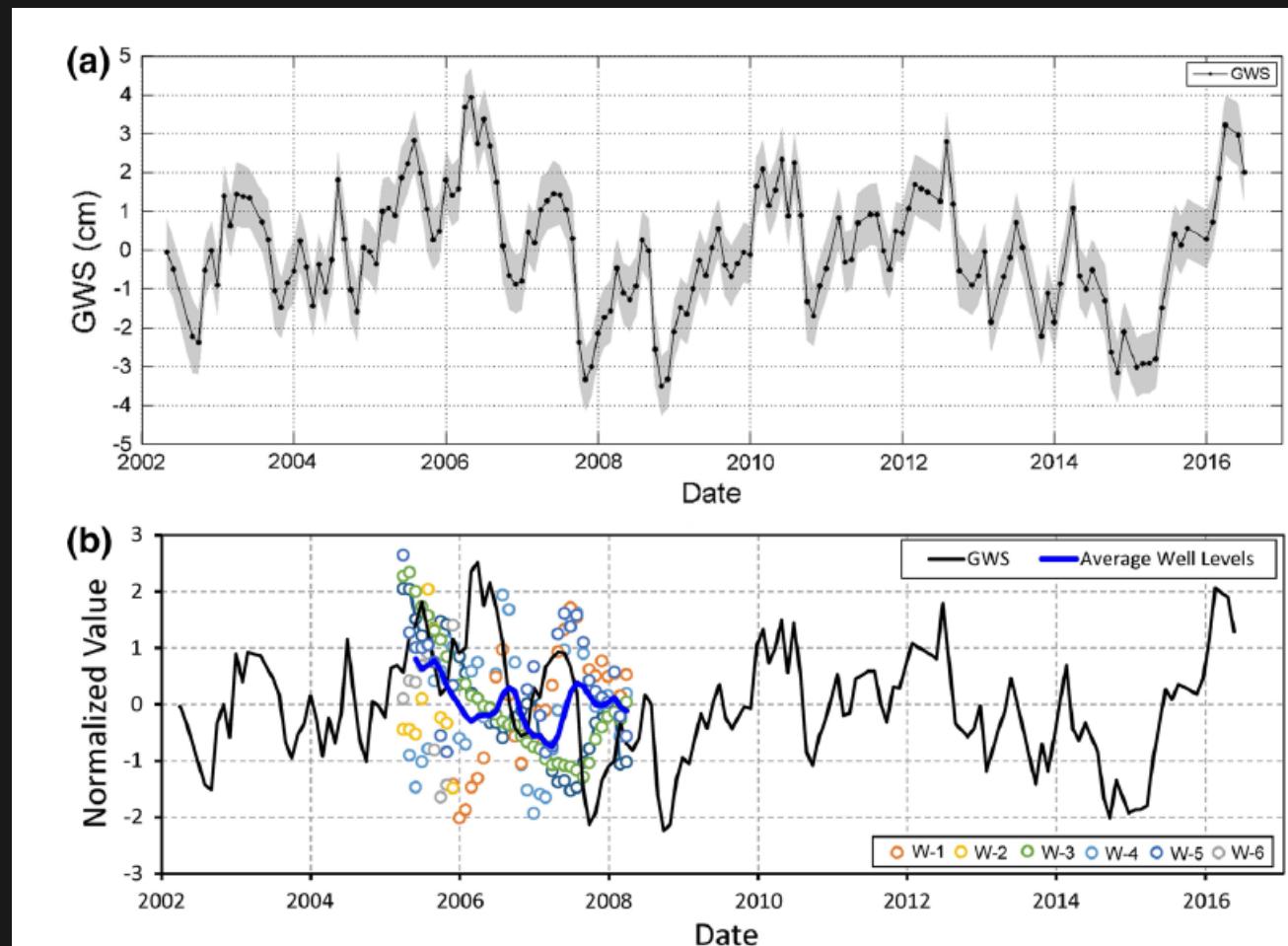


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Showcase III Ahmed and Abdelmohsen et al 2018, Data & Methods

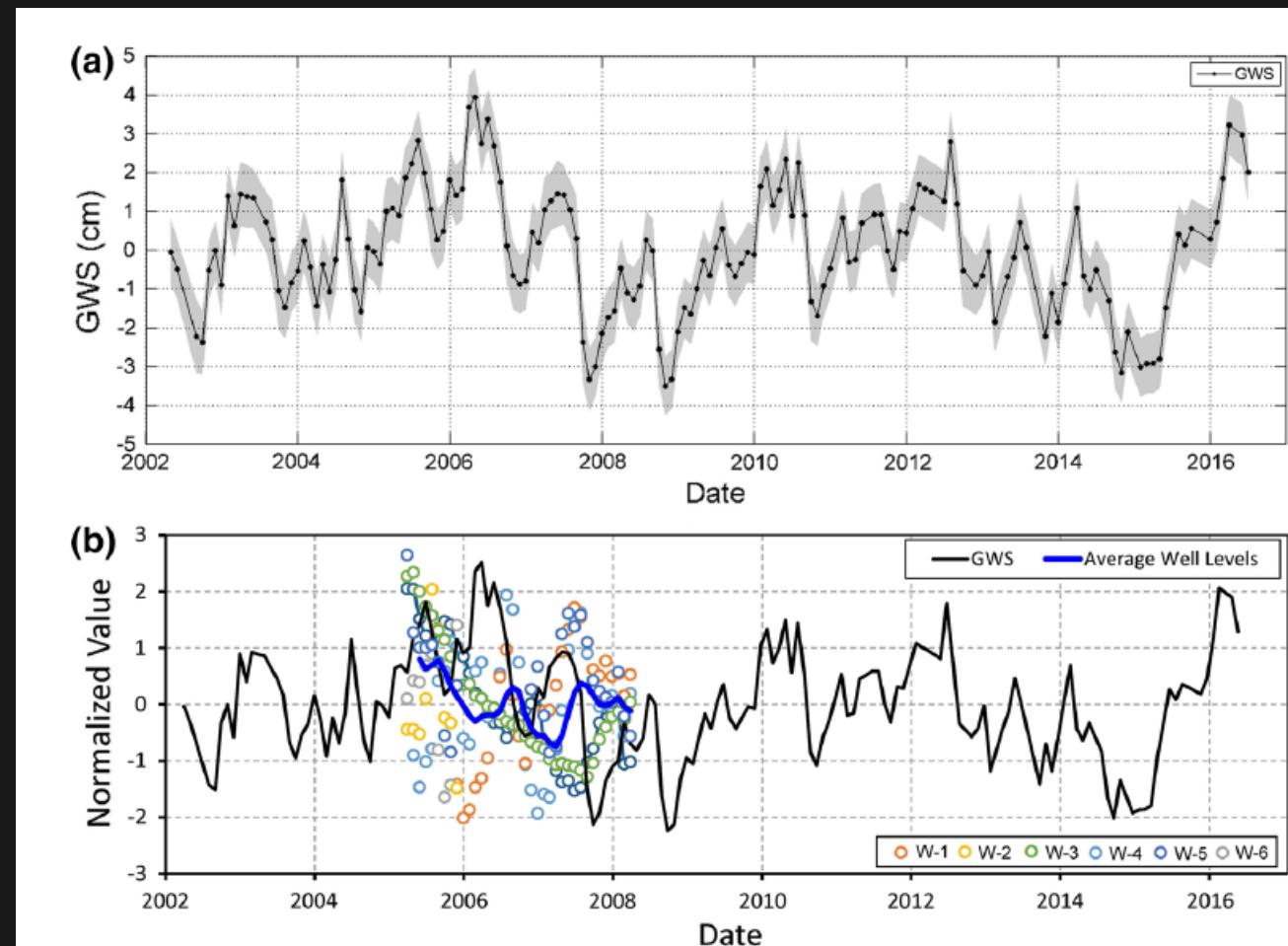


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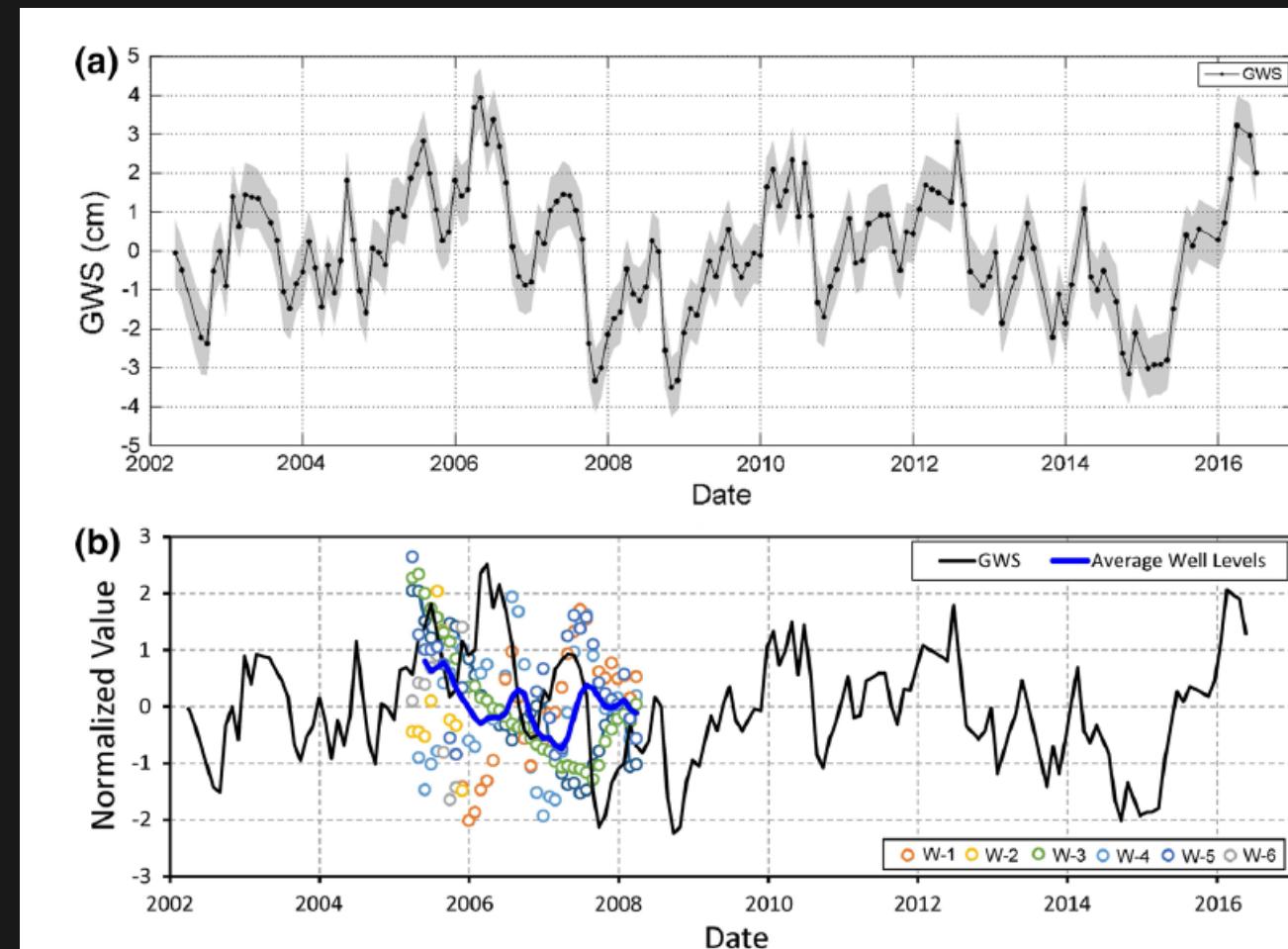
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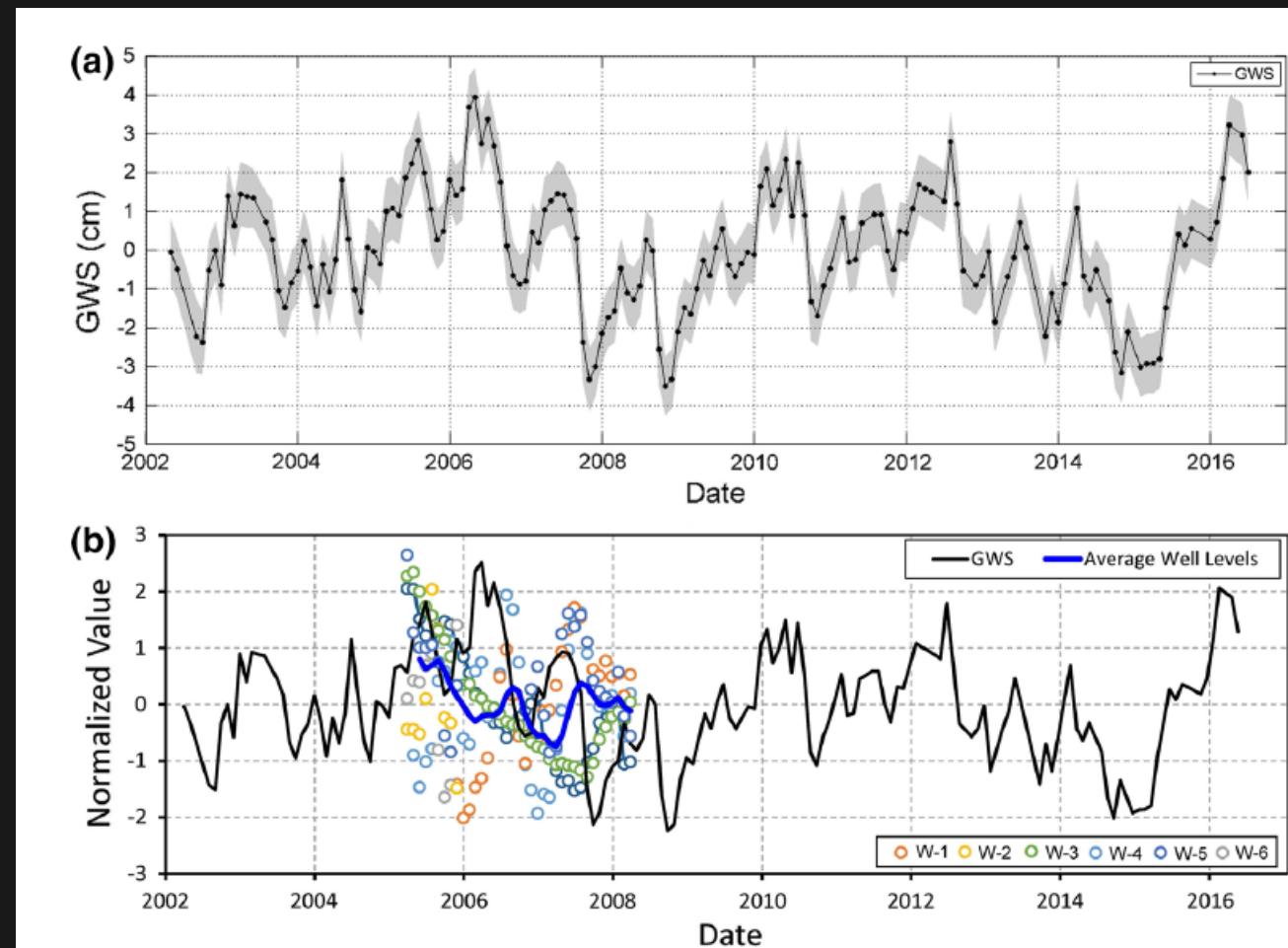


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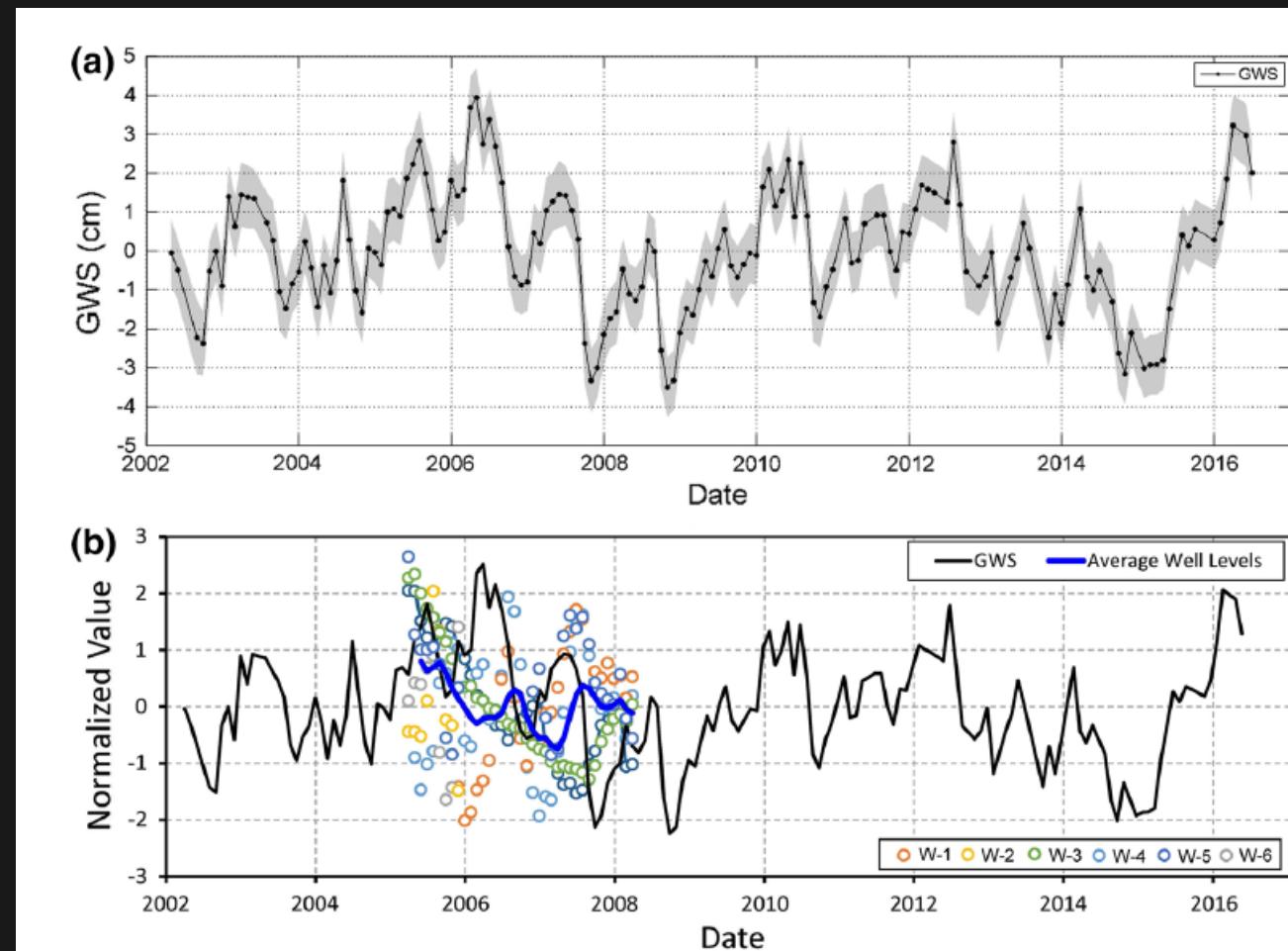


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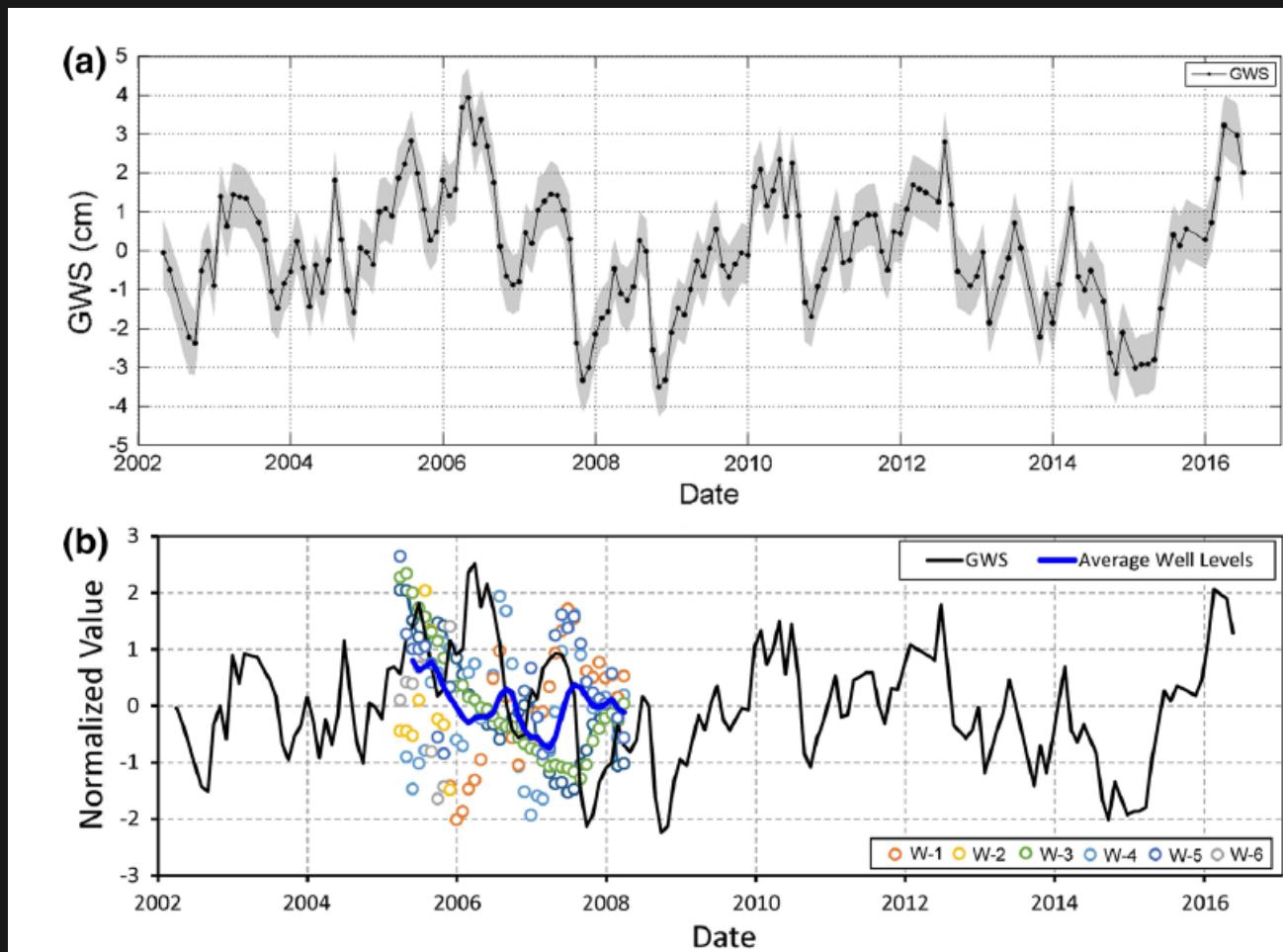


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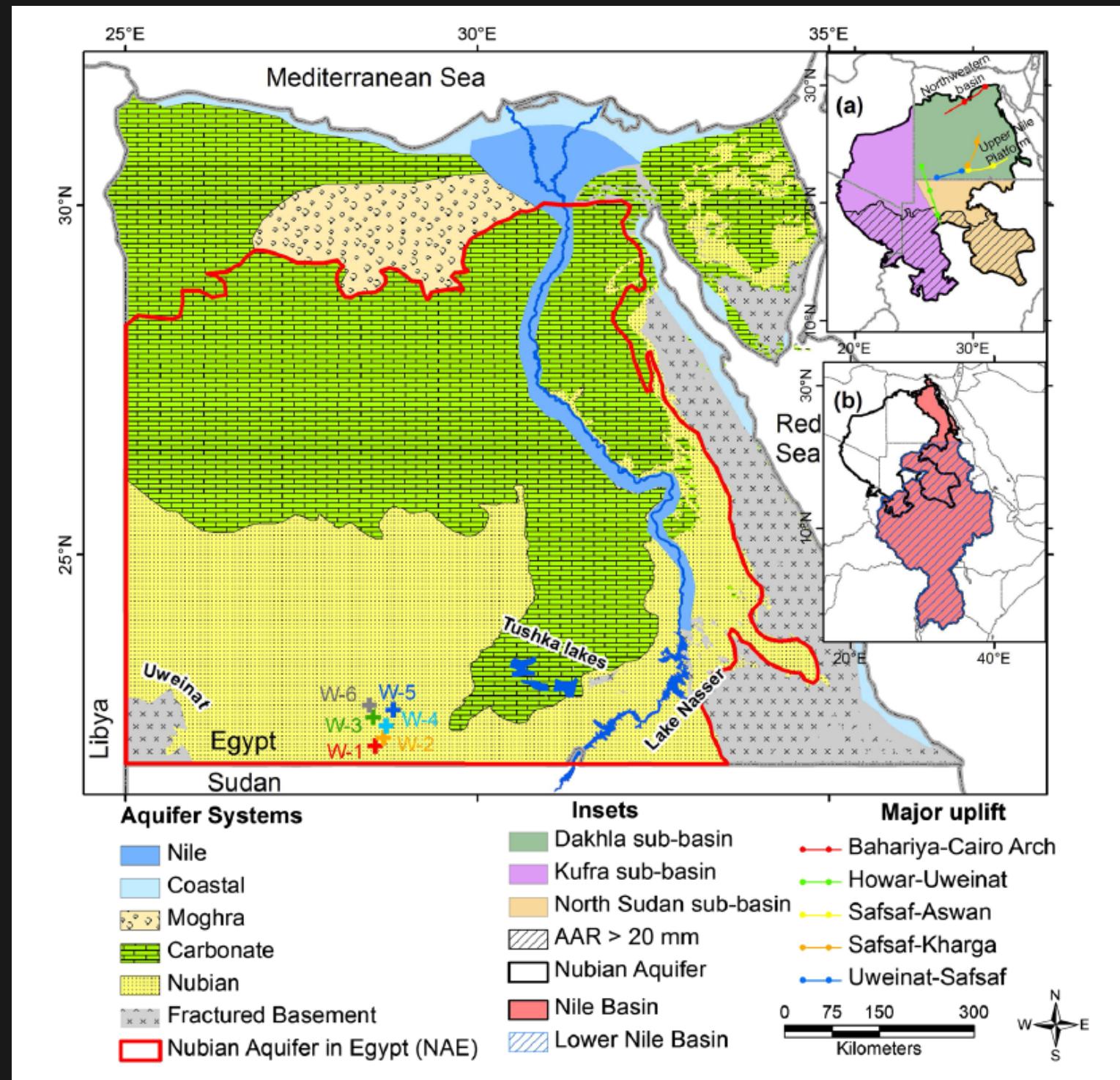


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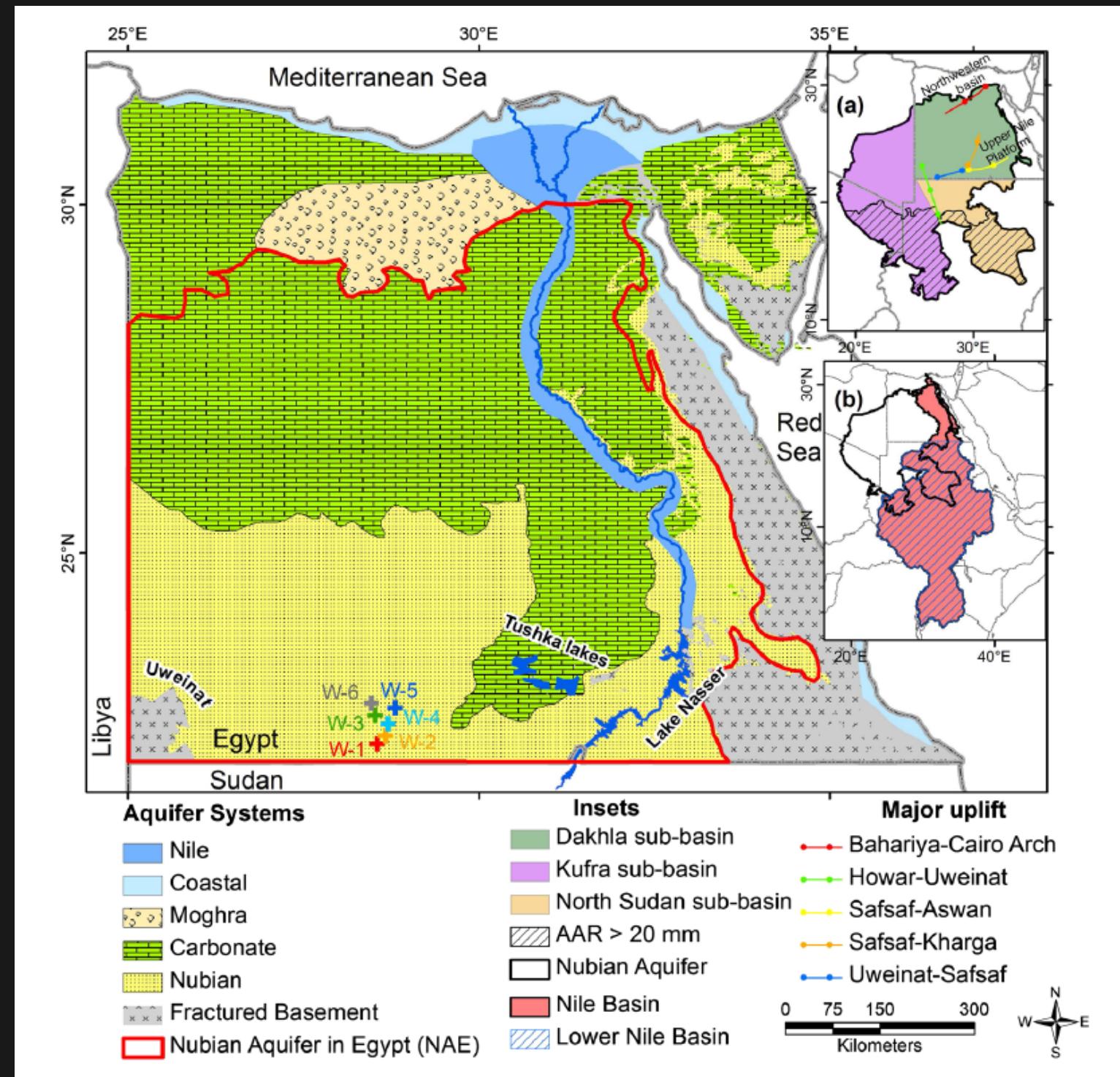
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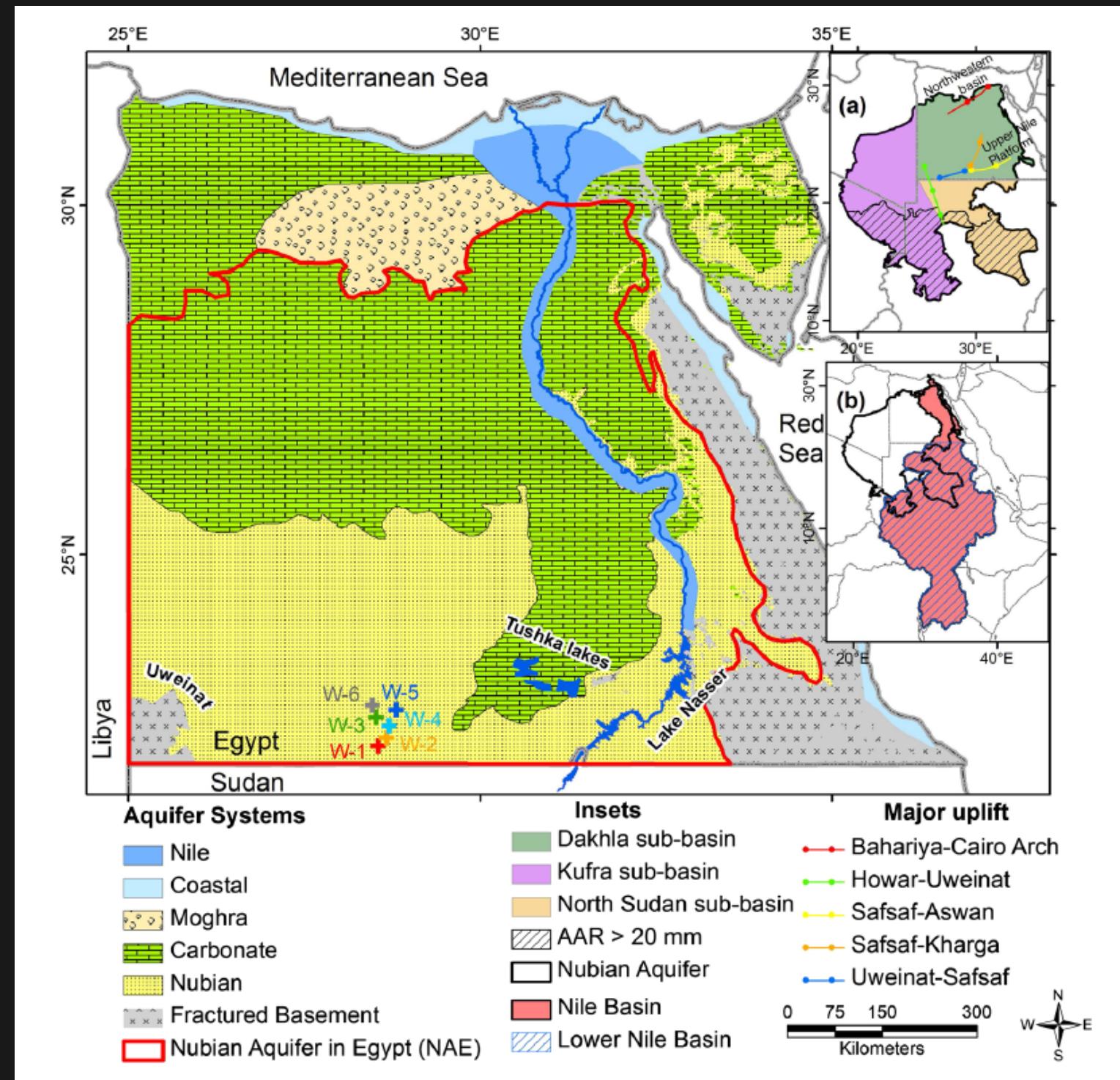


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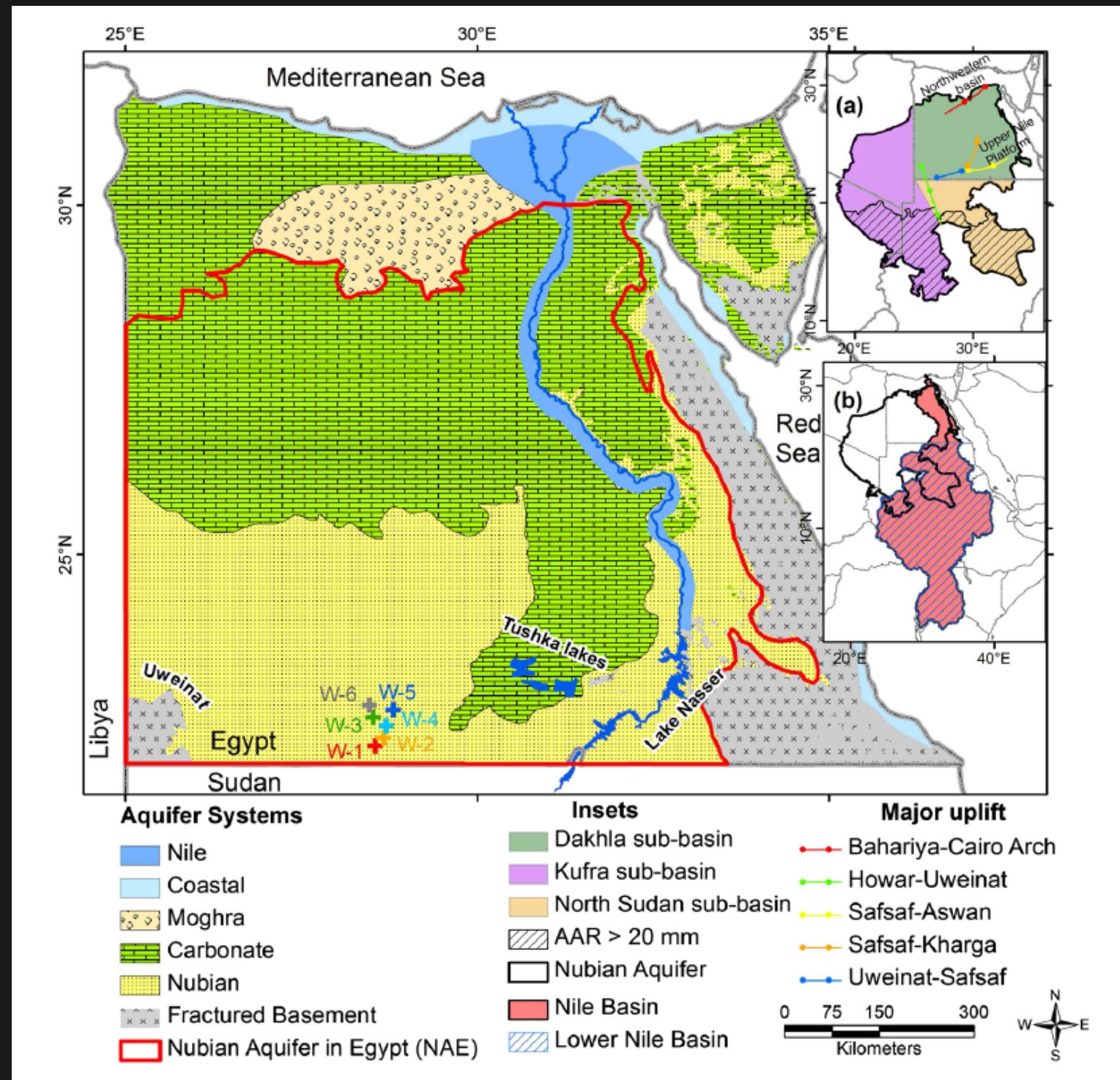


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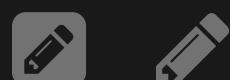


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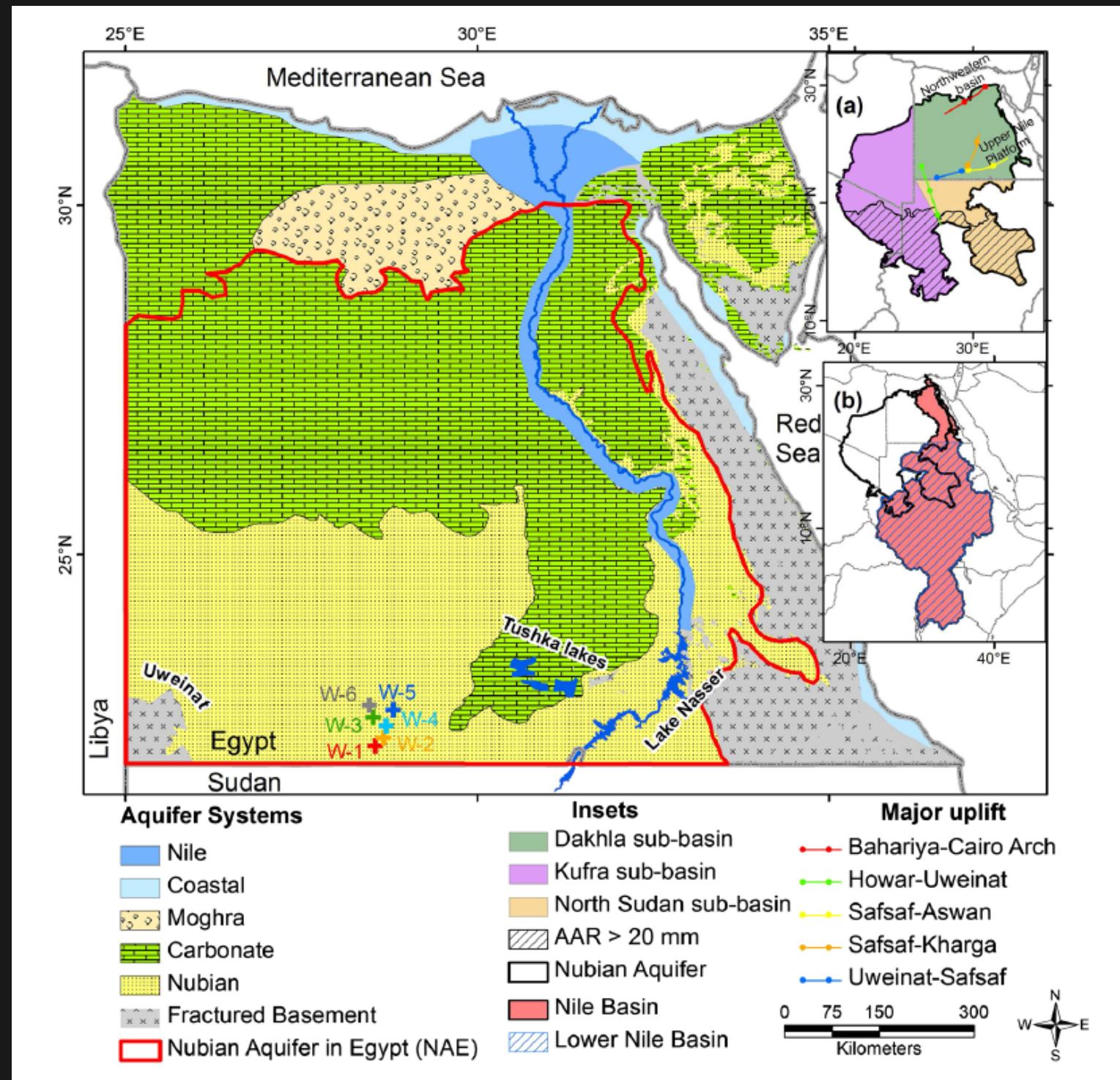


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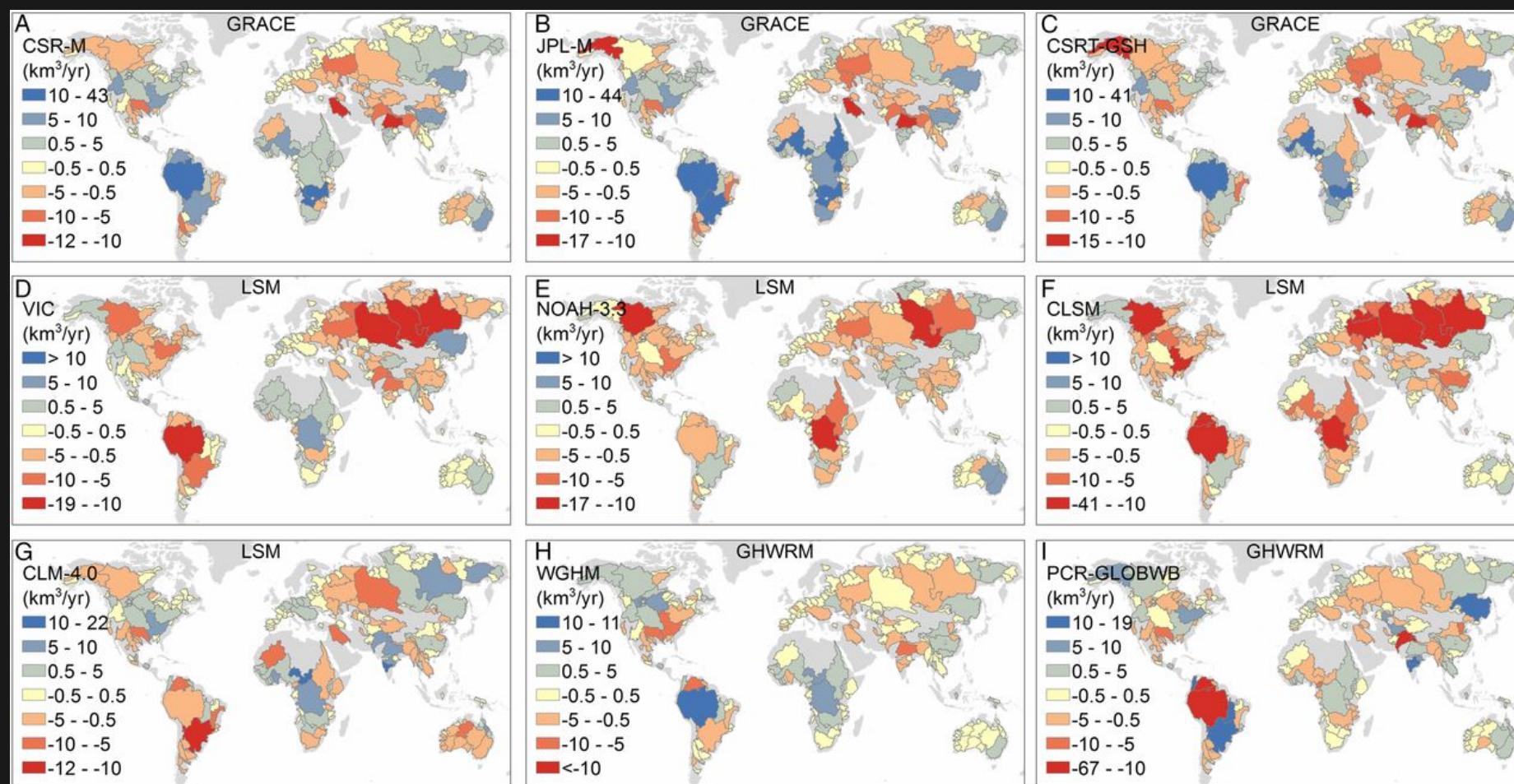


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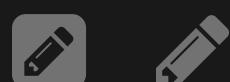
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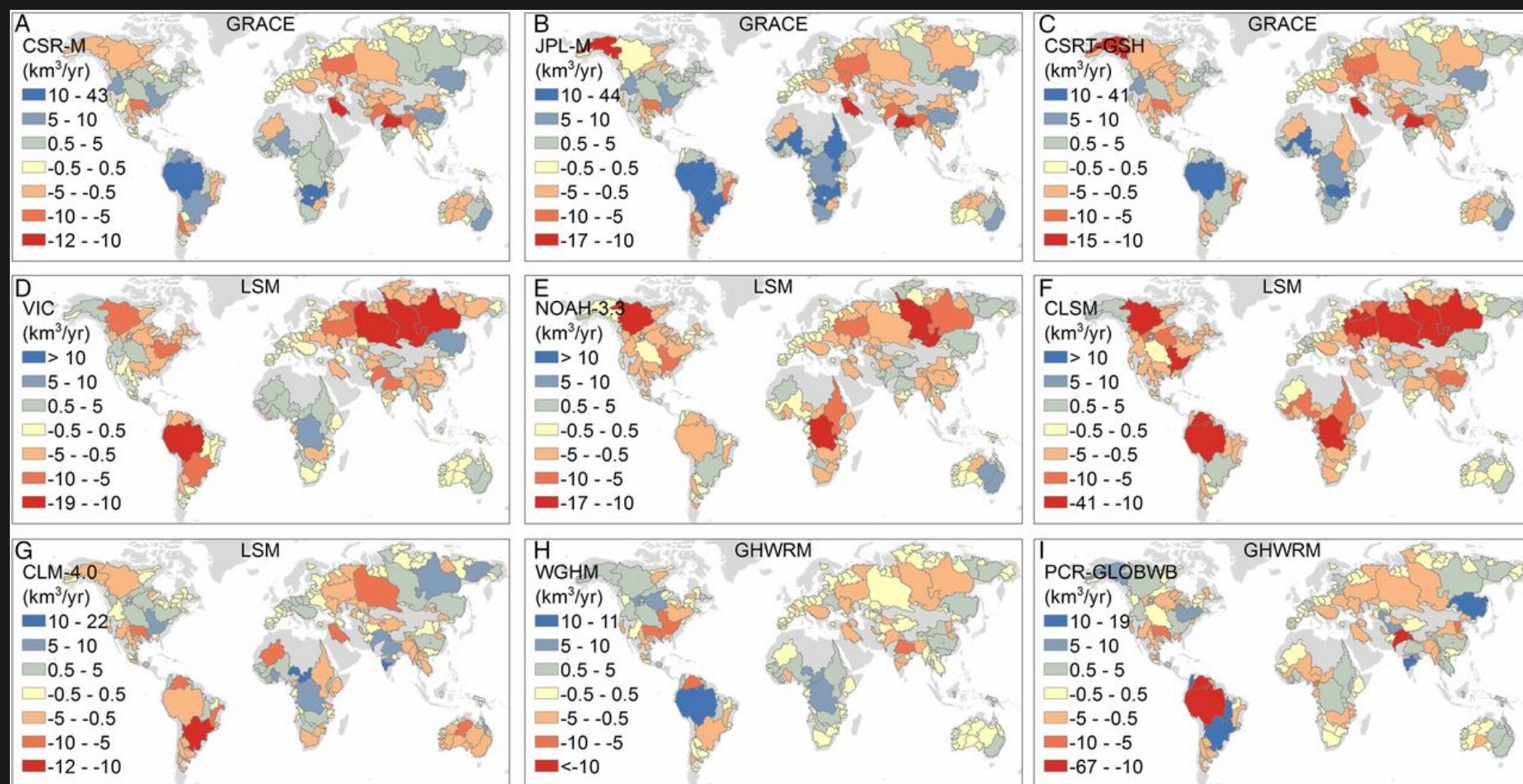
Showcase IV Scanlon et al 2018 *Global models underestimate large decadal declining and rising water storage trends relative to GRACE satellite data*



From Scanlon et al. 2018, PNAS

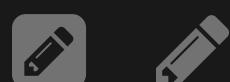


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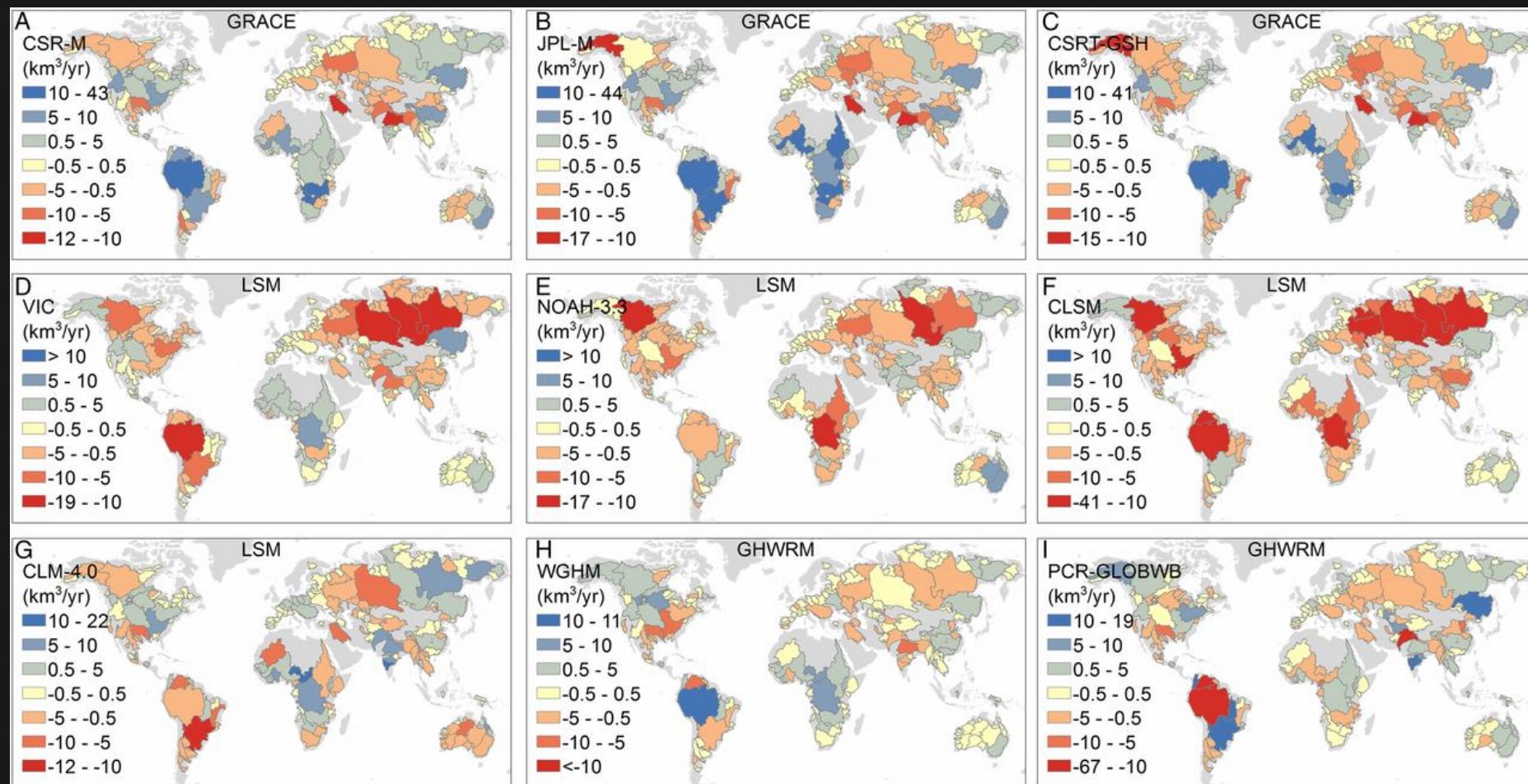


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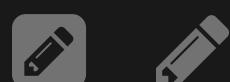


Showcase IV Scanlon et al 2018 *Global models underestimate large decadal declining and rising water storage trends relative to GRACE satellite data*



From Scanlon et al. 2018, PNAS

- Use GRACE to estimate watershed trends
- models underestimate trends relative to GRACE and sometimes even don't agree in sign



What have you learned?



What have you learned?

- Several studies exists which use GRACE/GRACE-FO for groundwater applications



What have you learned?

- Several studies exists which use GRACE/GRACE-FO for groundwater applications
- GRACE provides information at large spatial scales and a fair amount of corrections are needed to strip soil moisture snow and surface water effects



What have you learned?

- Several studies exists which use GRACE/GRACE-FO for groundwater applications
- GRACE provides information at large spatial scales and a fair amount of corrections are needed to strip soil moisture snow and surface water effects
- Information from satellite gravimetry is highly complementary to well data and modelling data.

