

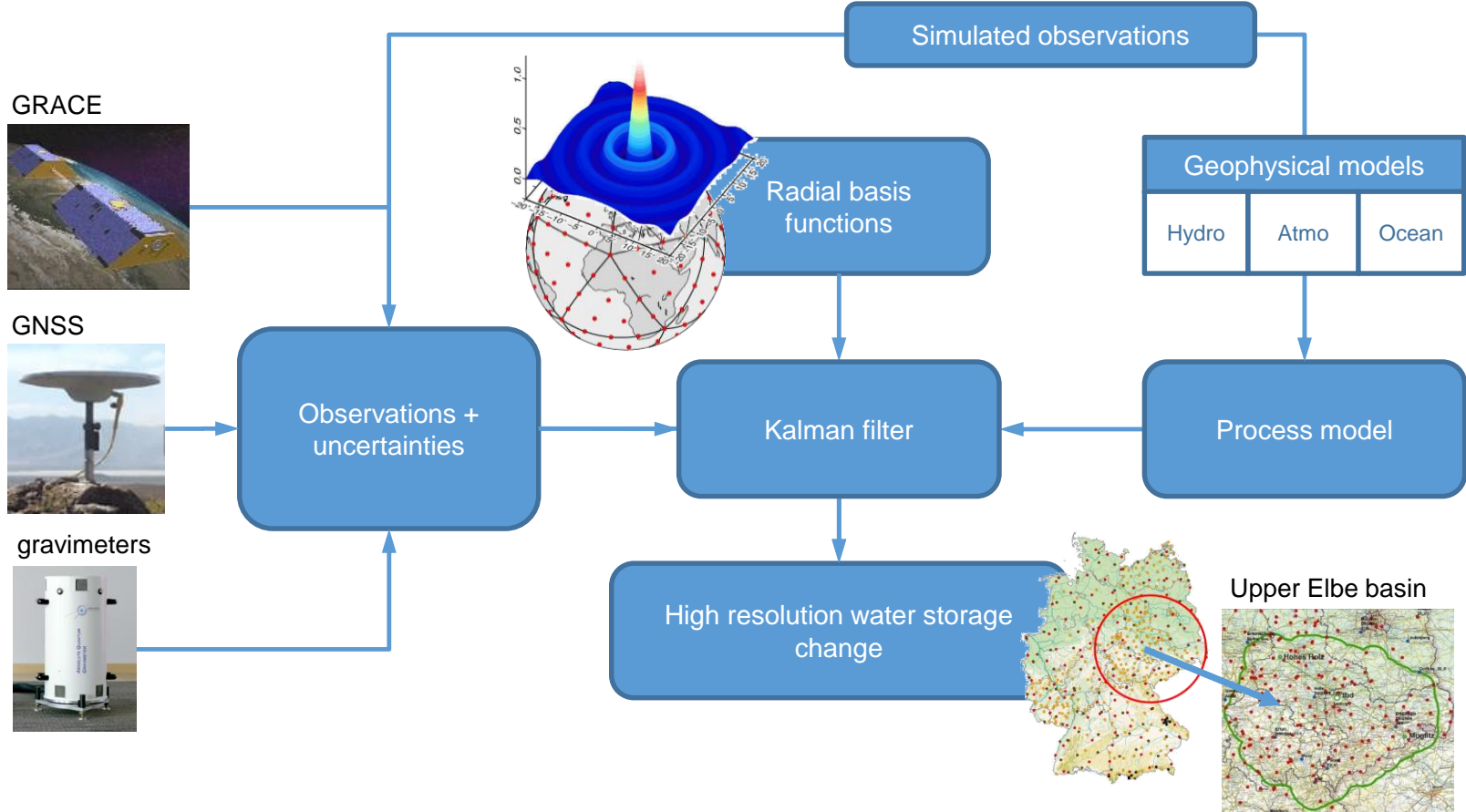
Regional modeling of water storage variations in a Kalman filter framework

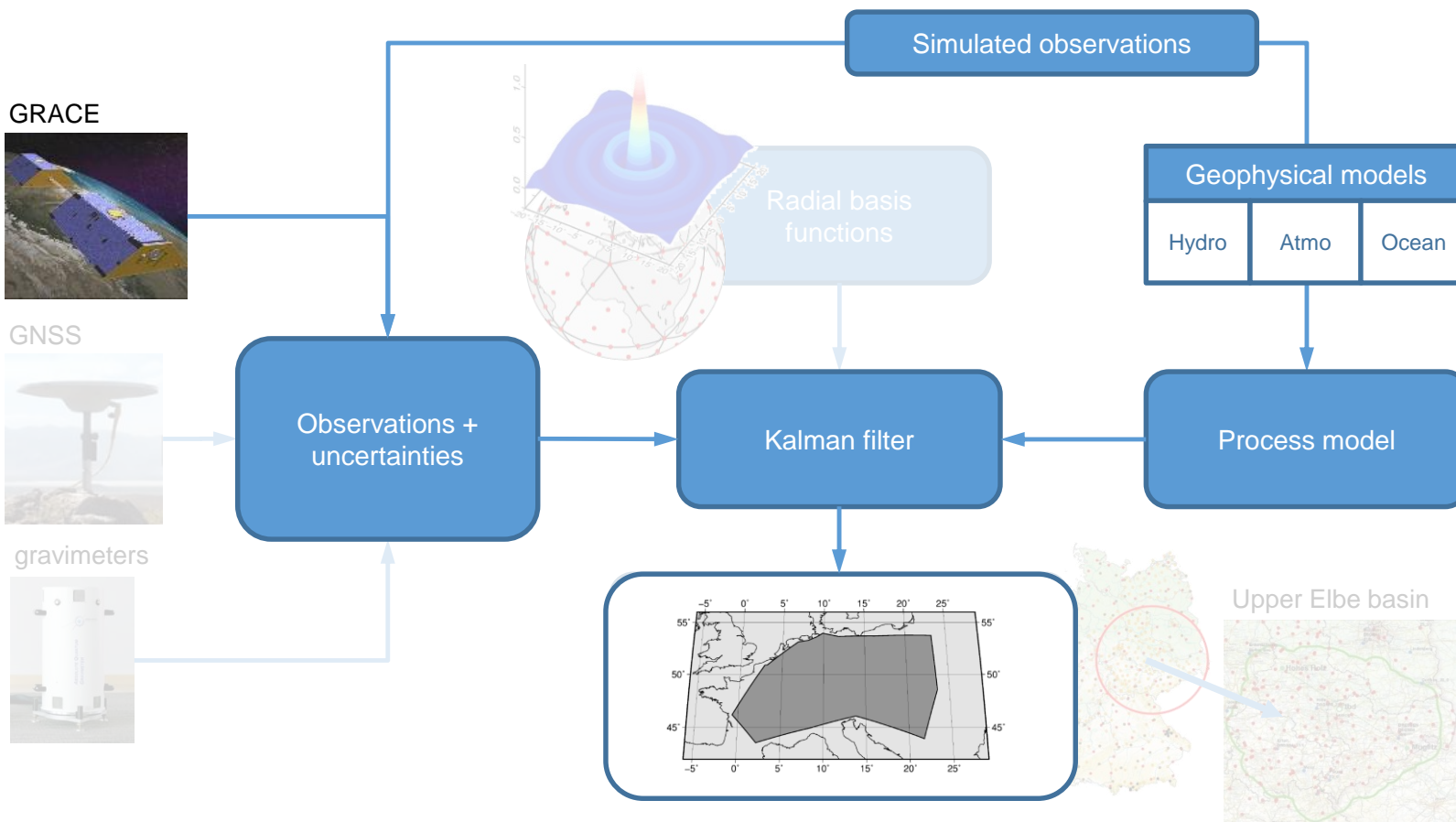
Viviana Wöhnke¹, Annette Eicker¹, Laura Jensen¹, Matthias Weigelt²

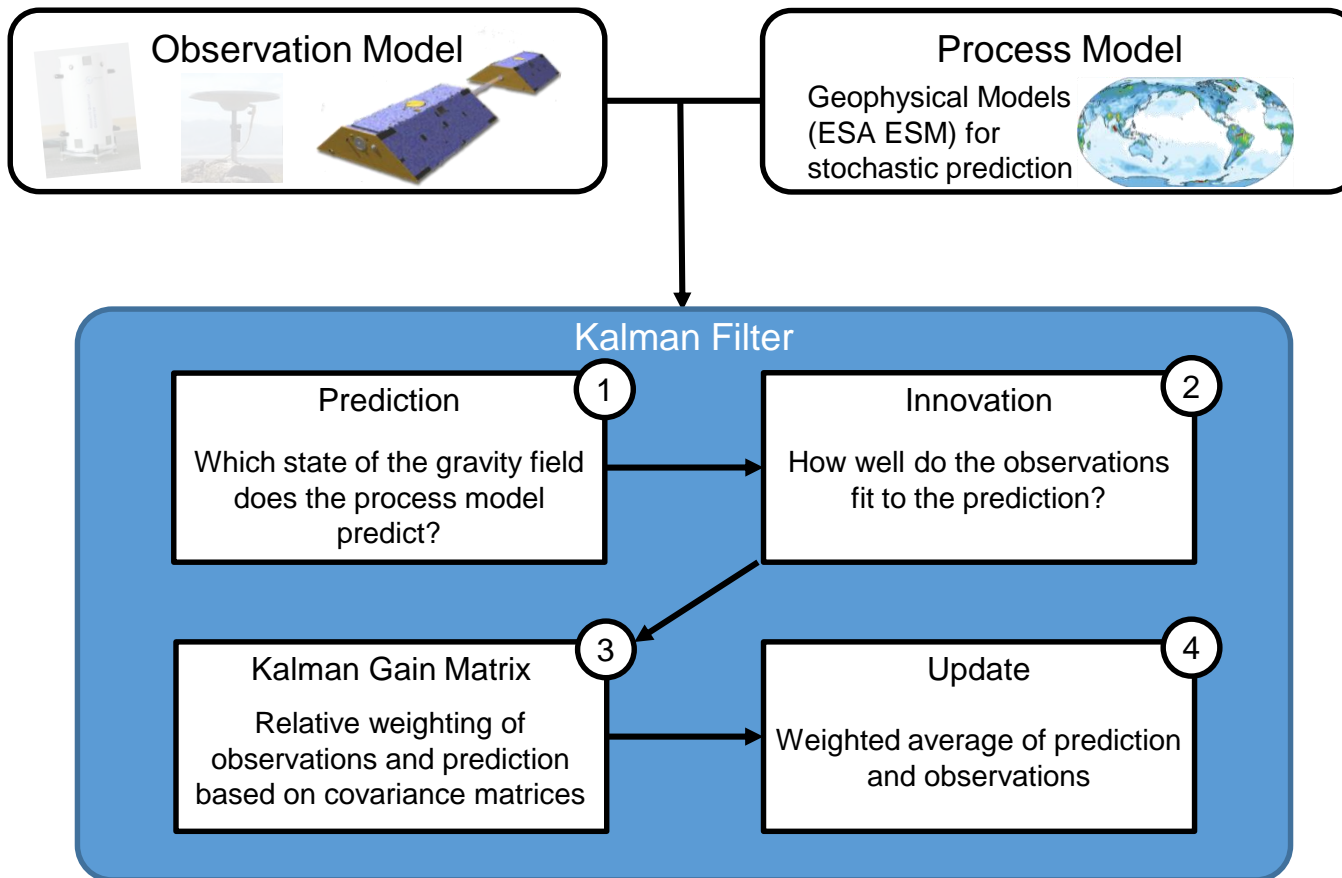
¹HafenCity University Hamburg, Geodesy and Geoinformatics, Hamburg, Germany

²Leibniz University Hannover, Institute of Geodesy, Hannover, Germany

24 May 2022

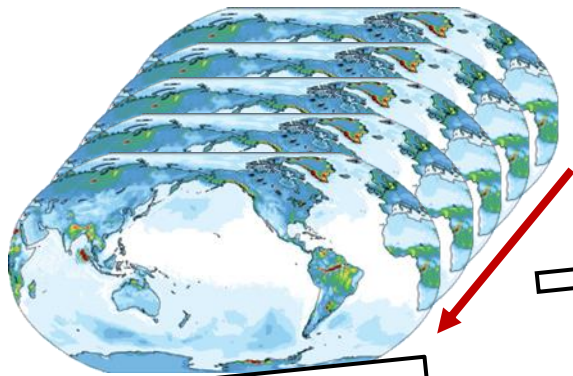




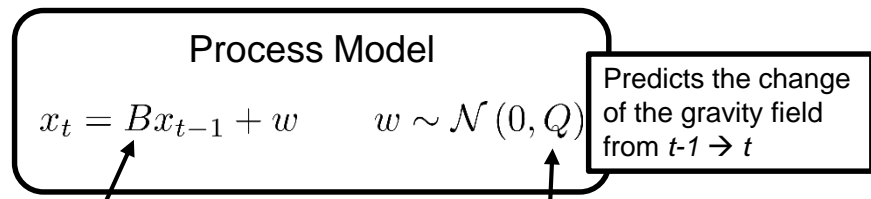




**Geophysical
Models (ESA ESM)**



Only stochastic information,
not model output used directly



State transition matrix

Covariance matrix of the process noise

Spatial correlation:

- Where are areas with large variability?
- How much do nearby points differ?

$$\Sigma \begin{pmatrix} \mathbf{x}_{i-1} \\ \mathbf{x}_i \end{pmatrix} = \begin{pmatrix} \Sigma & \Sigma_{\Delta} \\ \Sigma_{\Delta}^T & \Sigma \end{pmatrix}$$

Temporal correlation:

- How fast does a signal vary at each place?

Stochastic prediction

$$B = \Sigma_{\Delta} \Sigma^{-1}$$

$$Q = \Sigma - \Sigma_{\Delta} \Sigma^{-1} \Sigma_{\Delta}^T$$

Observation Model

$$l_t = A_t x_t + v_t \quad v_t \sim \mathcal{N}(0, R_t)$$

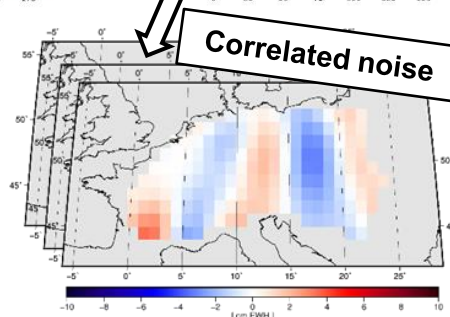
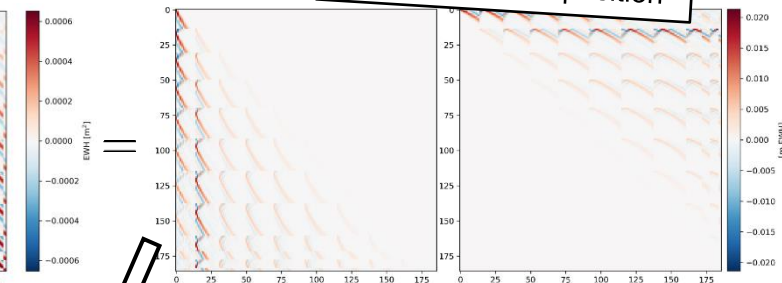
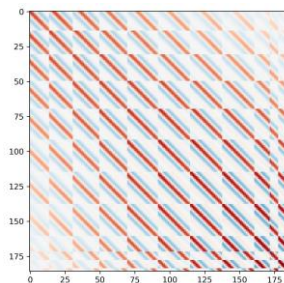
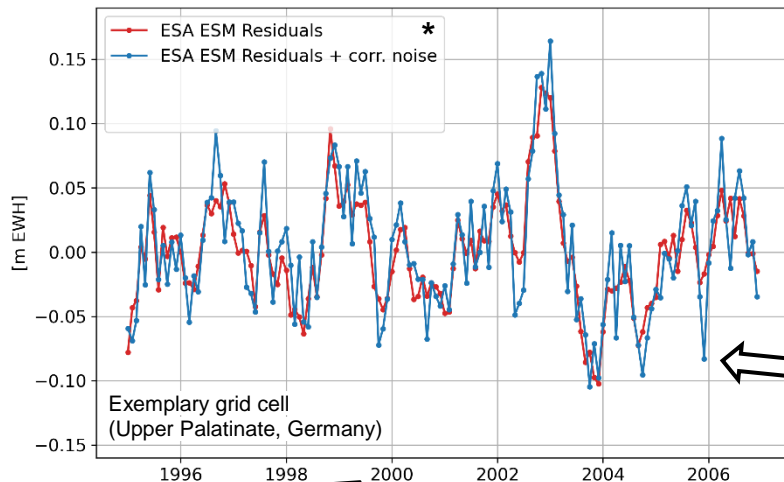
Process Model

$$x_t = Bx_{t-1} + w \quad w \sim \mathcal{N}(0, Q)$$

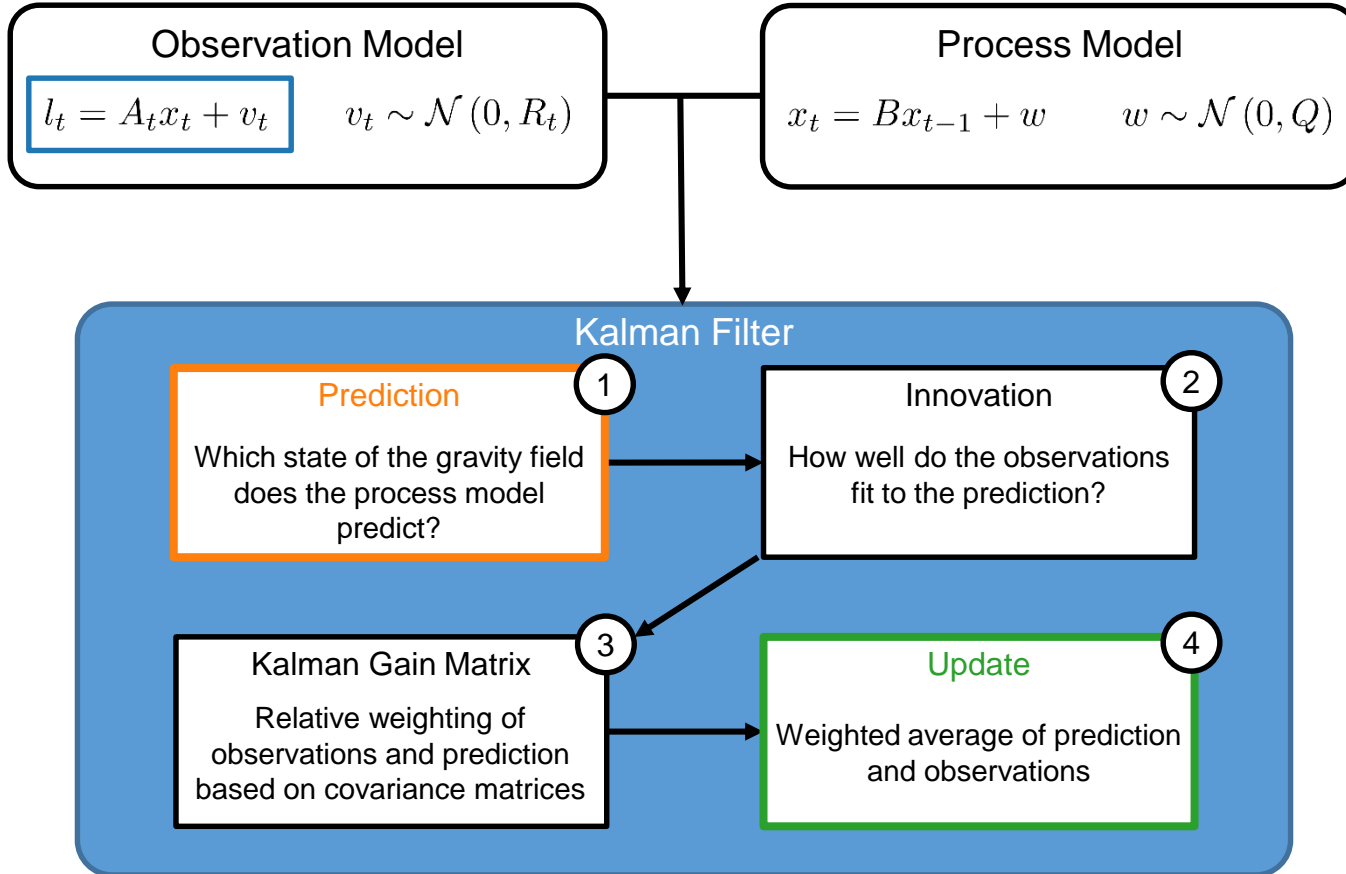
Covariance matrix of the
observations: GRACE

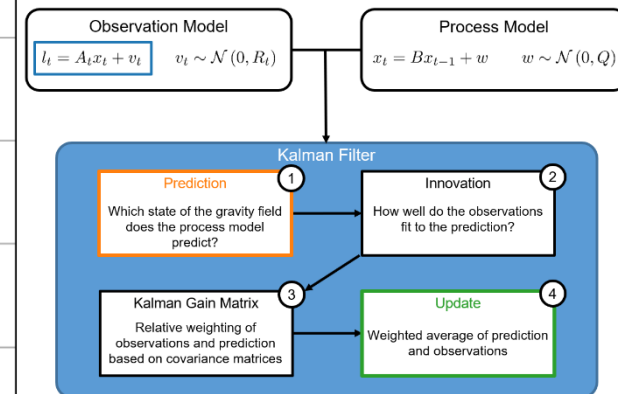
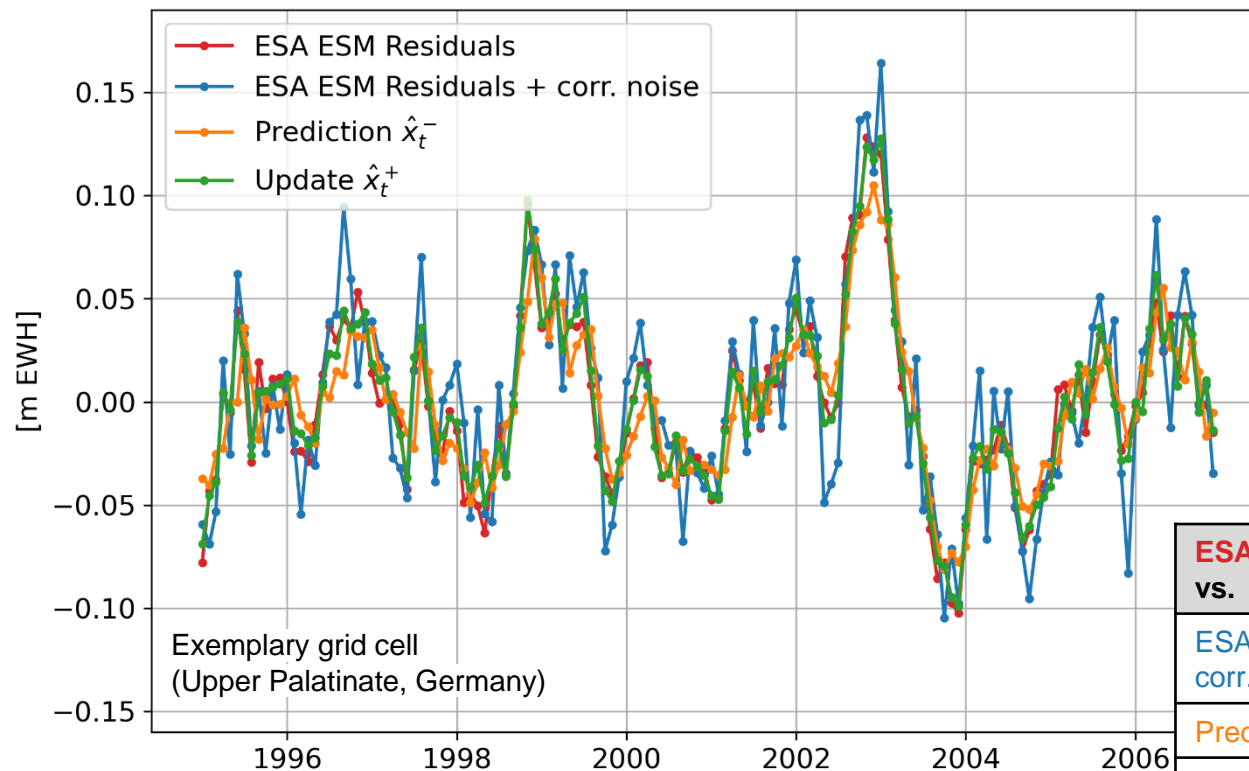
$$\Sigma = W^T W$$

Cholesky decomposition



* mean, linear trend and
annual signal removed





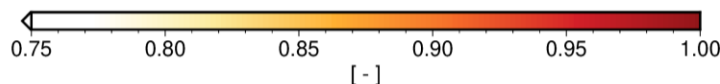
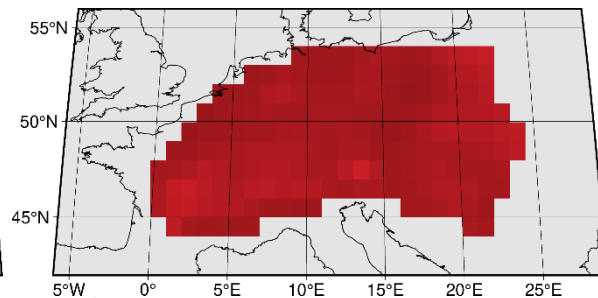
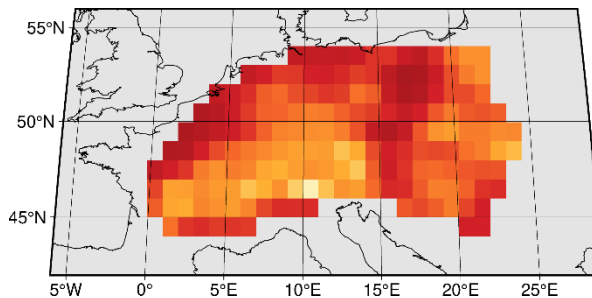
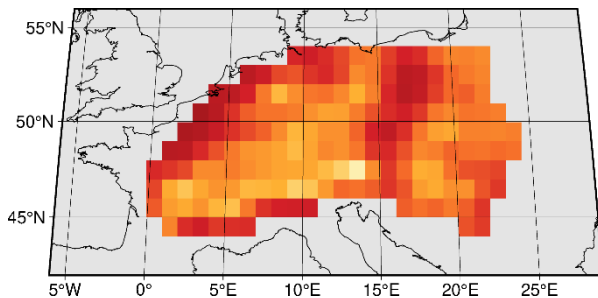
ESA ESM vs.	Correlation	RMSE
ESA ESM + corr. noise	0.885	0.023
Prediction	0.897	0.018
Update	0.985	0.007

ESA ESM + correlated noise

Prediction

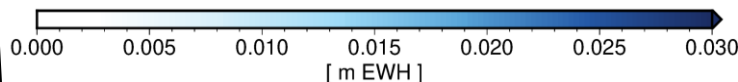
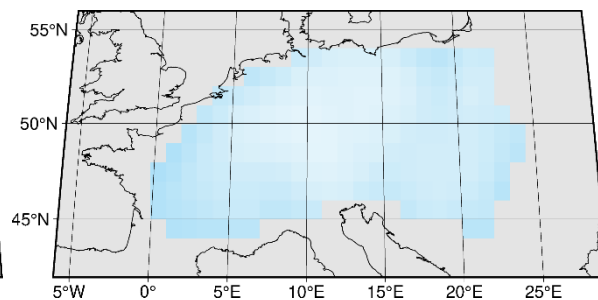
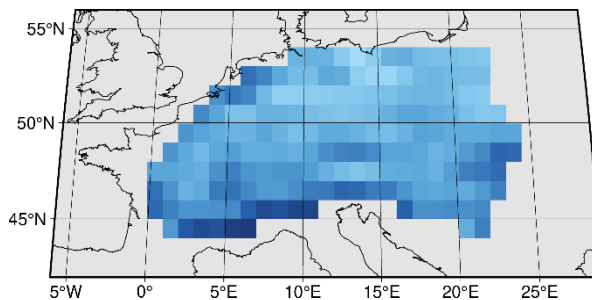
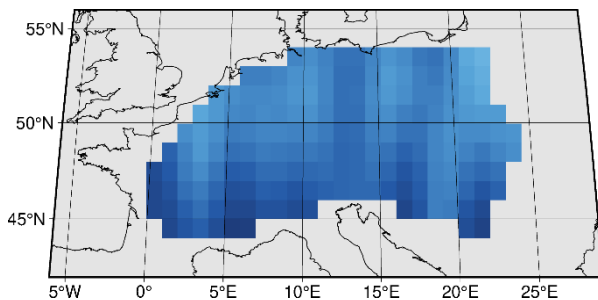
Update

Correlation



larger is better

Root Mean Square Error



smaller is better

