The detection of the magnetic fields induced by ocean circulation – An observing system simulation experiment

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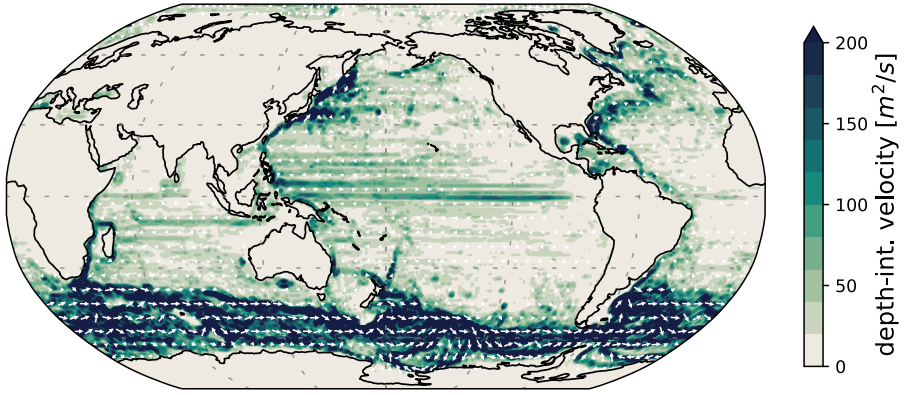
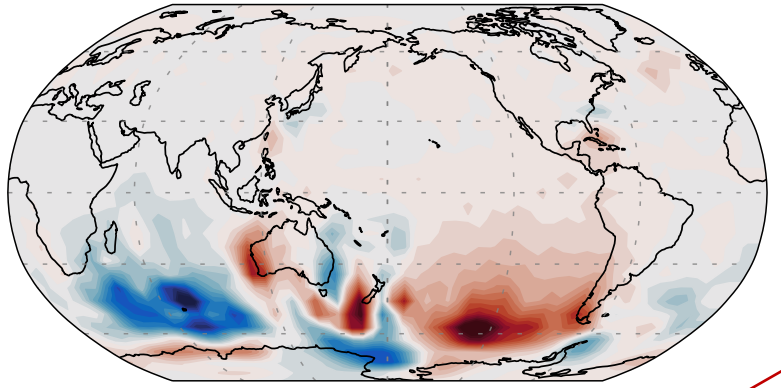
Ocean Induced Magnetic Signals

- **Movement** of conducting sea water through Earth's magnetic field induces **magnetic signals**



ECCO2 Ocean Model



Calculated using X3DG-Solver

Still unobserved

Goal:

- Identification of ocean-induced magnetic signals in satellite observations
- Using ocean-induced magnetic signal as new source of information

Challenge:

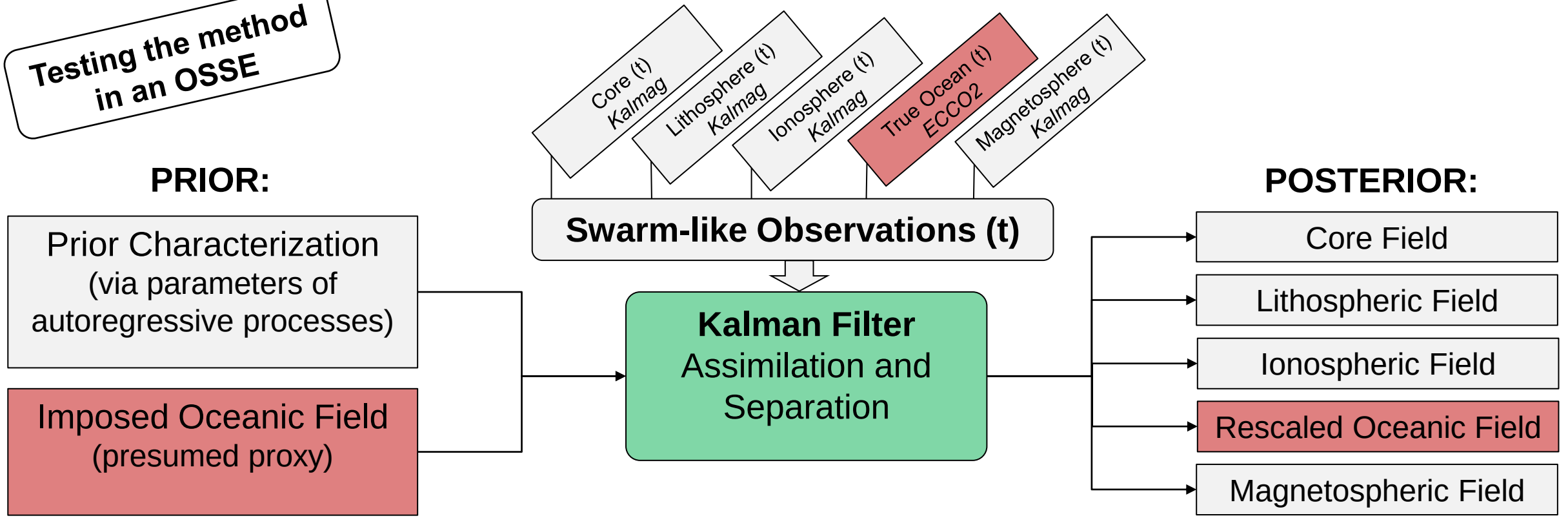
- Difficult separation from other magnetic contributions due to: complex temporal behavior and low magnitude

Observing System Simulation Experiment (OSSE)

Proposed method:

- Assimilation of geomagnetic observations using Kalman filter-based approach
- Extension of Kalmag model (*Baerenzung et al.)*

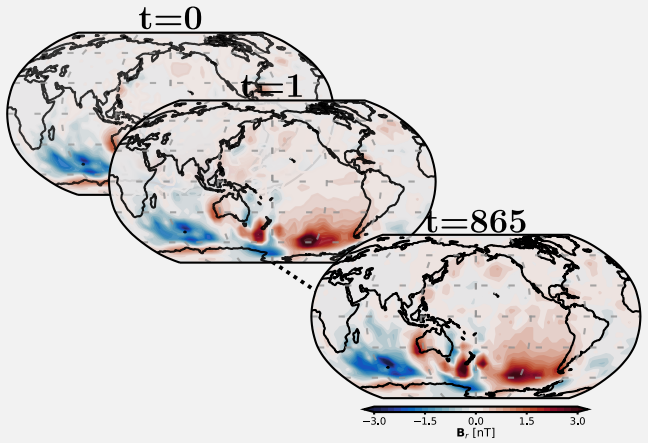
Testing the method in an OSSE



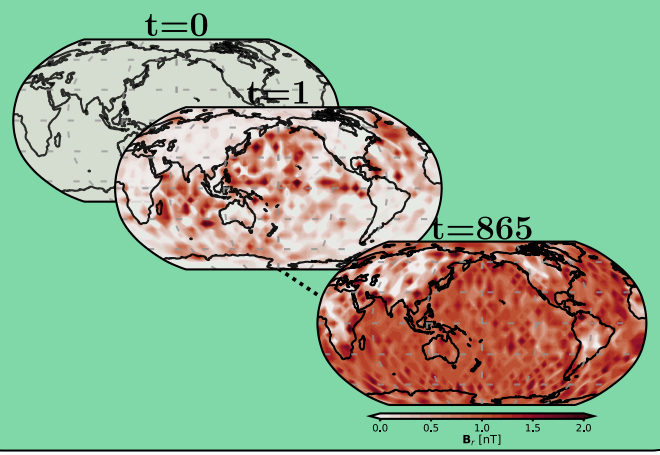
Detectability of Ocean Induced Magnetic Field

- Using the assimilation to determine a local scale factor for the presumed proxies
- Evaluating detectability through the evolution of the scale factor under the influence of observations

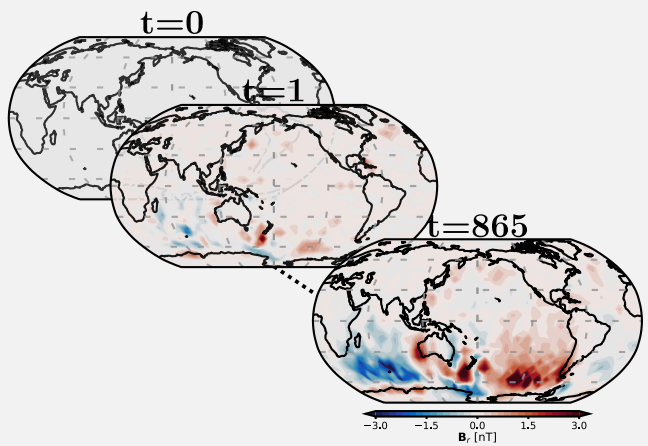
Prior:
Imposed magnetic field



Kalman Filter
Scale factor k(x,y):



Posterior:
Rescaled magnetic field

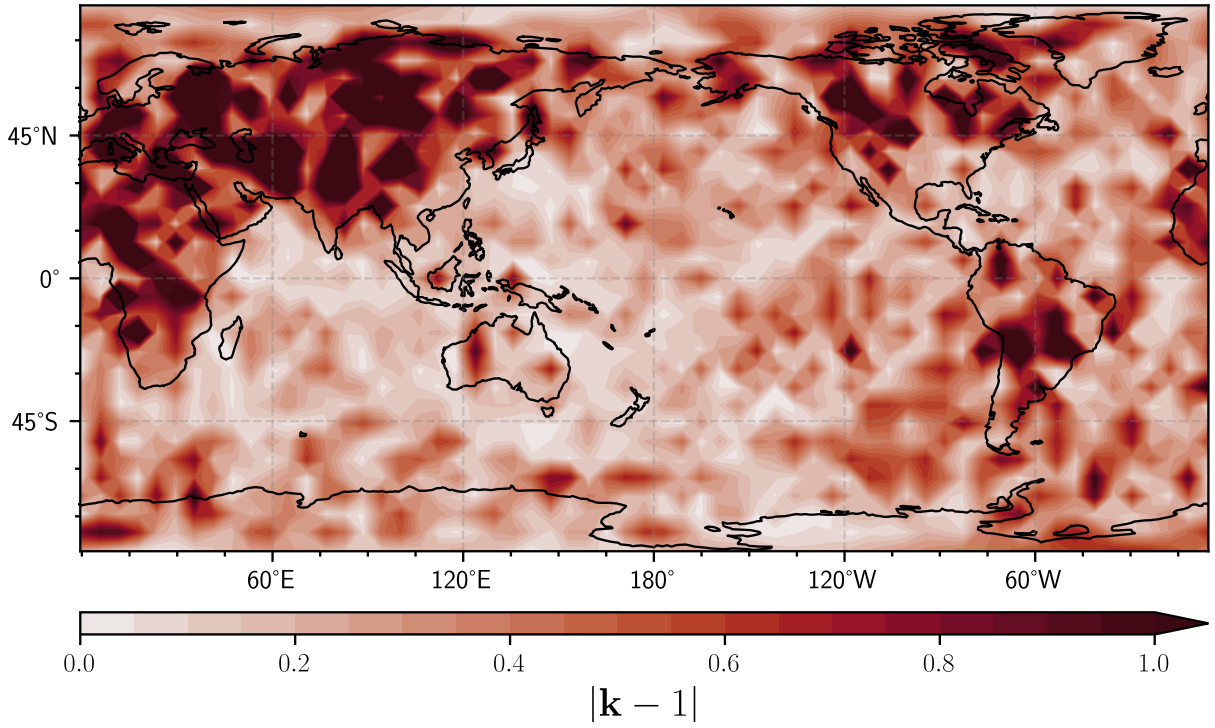


scale factor is initialized ~$\mathcal{N}(0,1)$

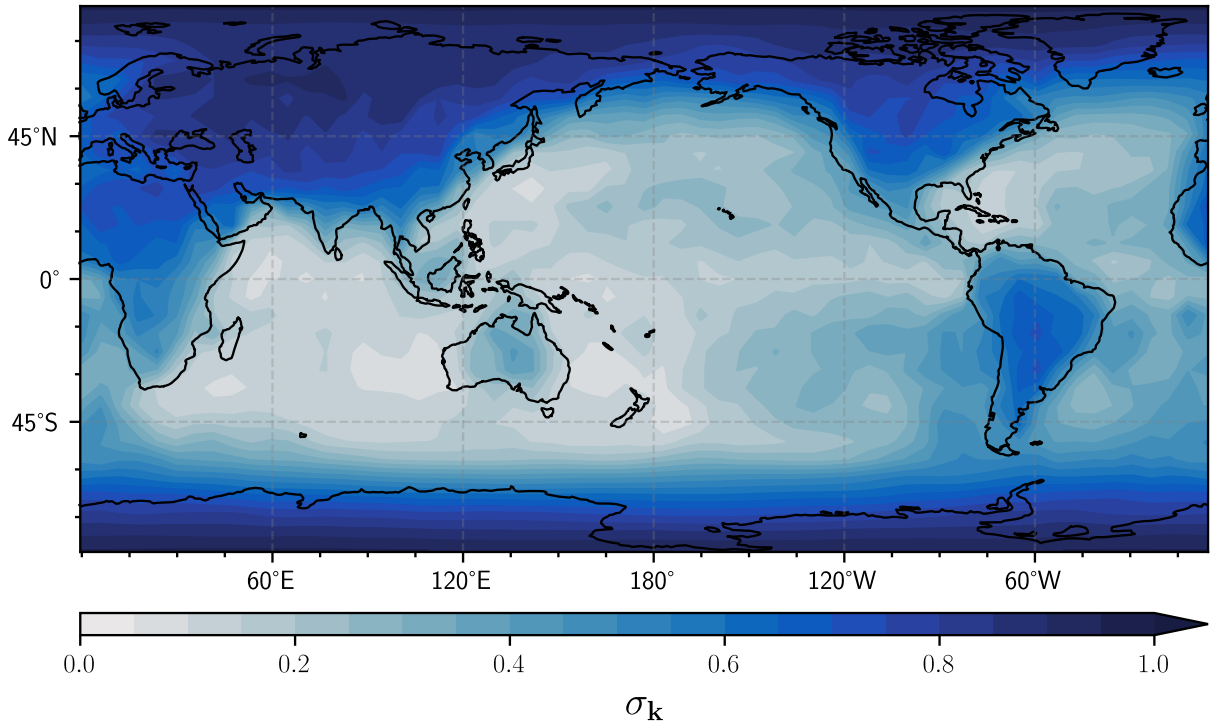
Assimilation Results: Ideal Scenario

- Imposed magnetic field and true magnetic field are chosen as identical
- Final scale factor after the assimilation is expected to equal **k(x,y) = 1**

Final scale factor deviation:



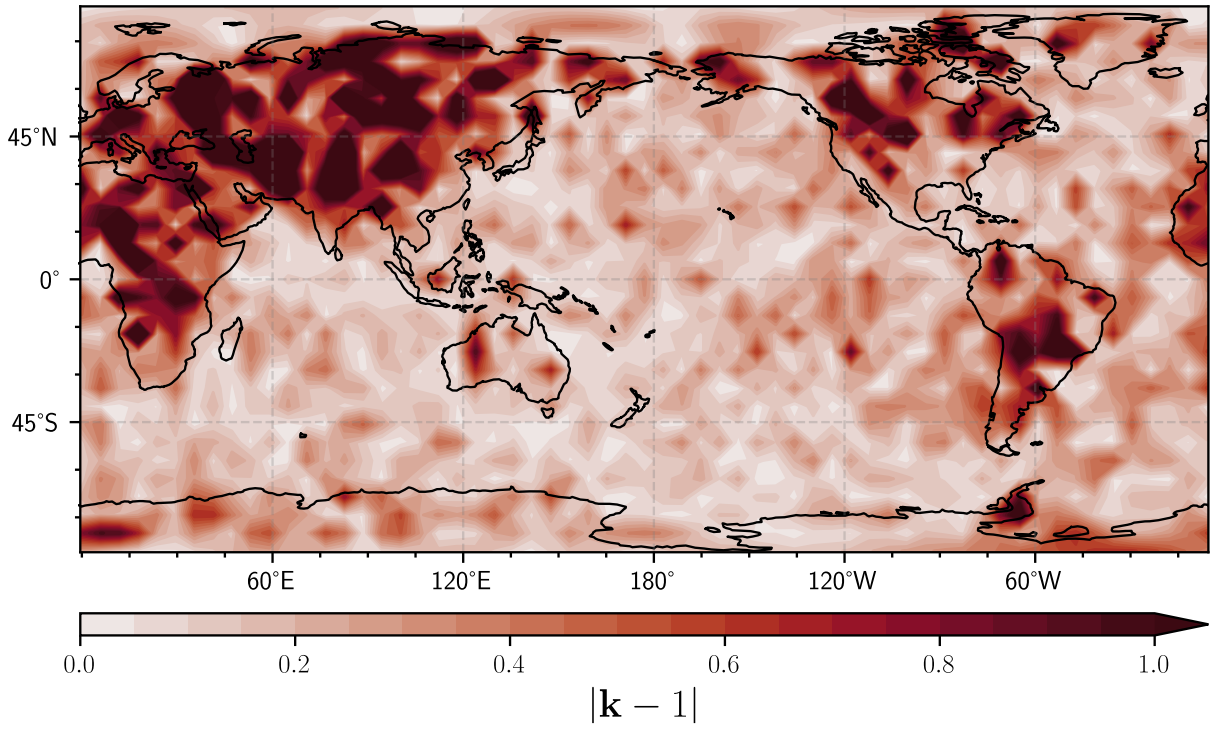
Final associated uncertainty:



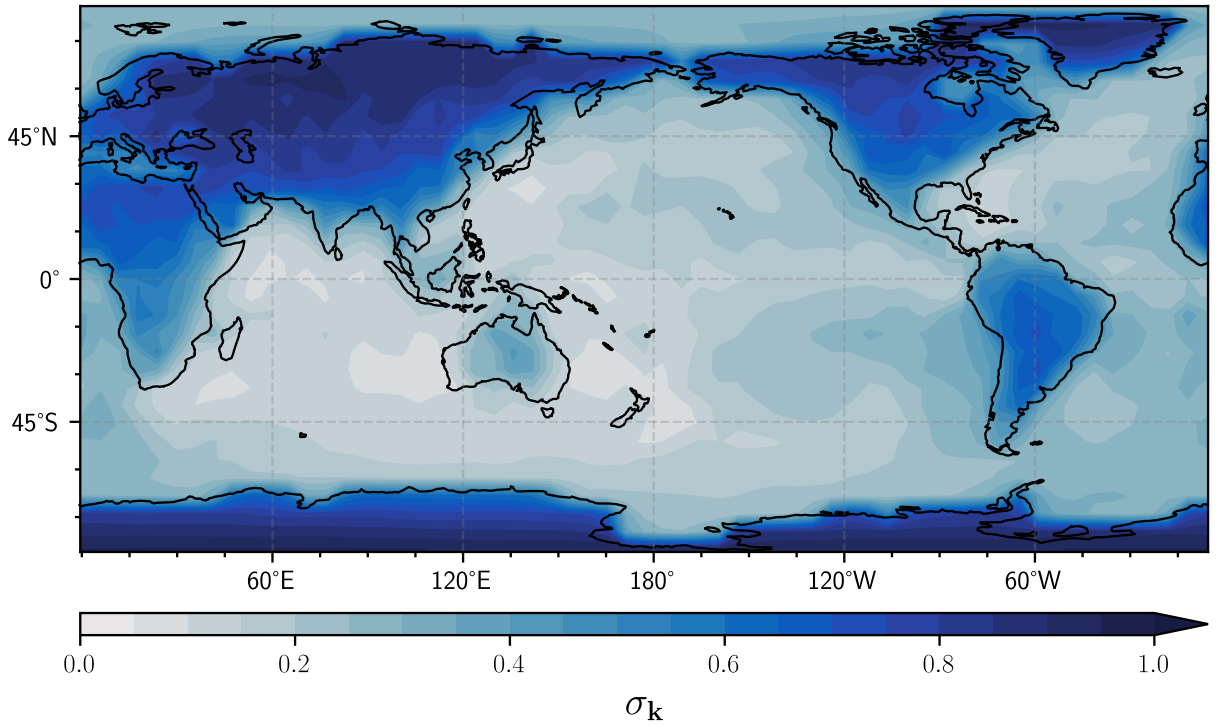
Improved Results Through Spatial Constraints

- Incorporating **spatial correlation** between nearby scale factor (a priori exponentially decaying spatial covariance)

Final scale factor deviation:



Final associated uncertainty:



Take Away:

- The assimilation results obtained from the OSSE are promising:

  In an ideal scenario ocean-induced magnetic signals *can be identified* in swarm-like observations using the proposed Kalman filter approach

- Incorporating spatial constraints improve the assimilation results

Thank you for your attention!