USING SOLA FOR INVESTIGATING REGIONAL DYNAMICS OF FLOW AT THE TOP OF THE OUTER CORE

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OVERVIEW

- **Introduction to SOLA**
  - Subtractive Optimally Localized Averages

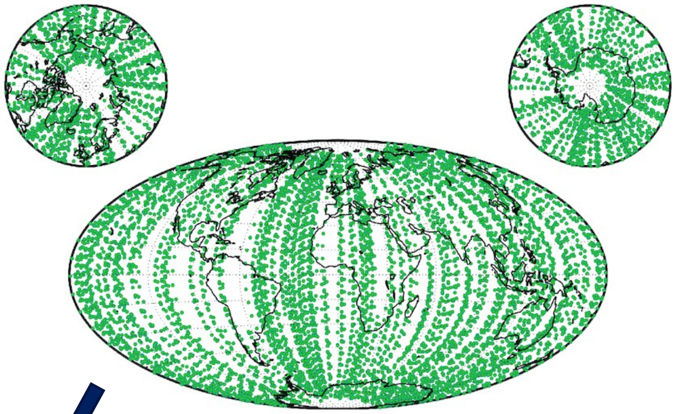
- **Producing pygeodyn core surface flows**
  - General methodology
  - Challenges incorporating SOLA into existing pygeodyn

- **Current Results**

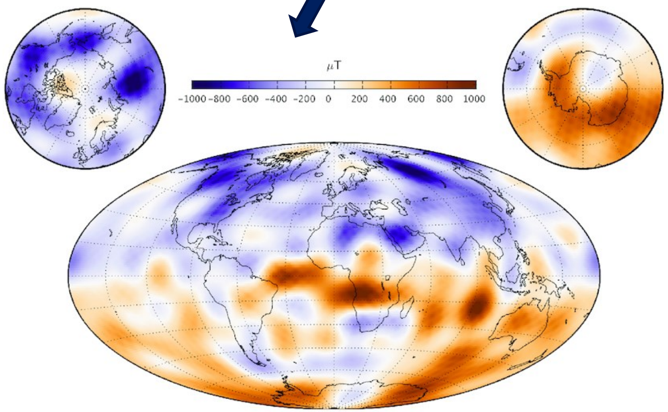
- **Future directions**

Introduction to SOLA

- **Subtractive Optimally Localized Averages (SOLA)**
- **Produce averaging kernels to obtain stable local estimates of the time derivatives of MF at the CMB (or other radii)**
- **Can be used to produce high resolution models of spatio-temporally localized SA and SV**



(d) Location of observations used in March 2017 example.



(a) Map collecting local estimates of CMB radial field $\widehat{B_r}(\mathbf{r}_0, t_0)$ in [μT].

FIGURES FROM HAMMER AND FINLAY, 2018

Introduction to SOLA

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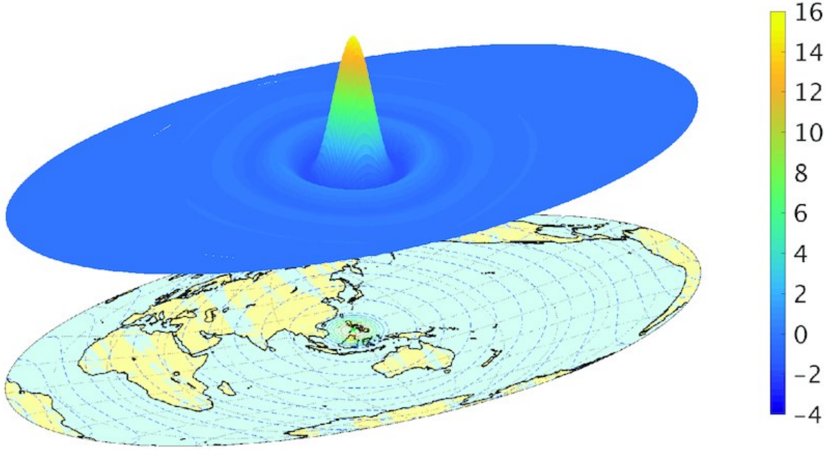
- **Can be used to produce high resolution models of spatio-temporally localized SA and SV**

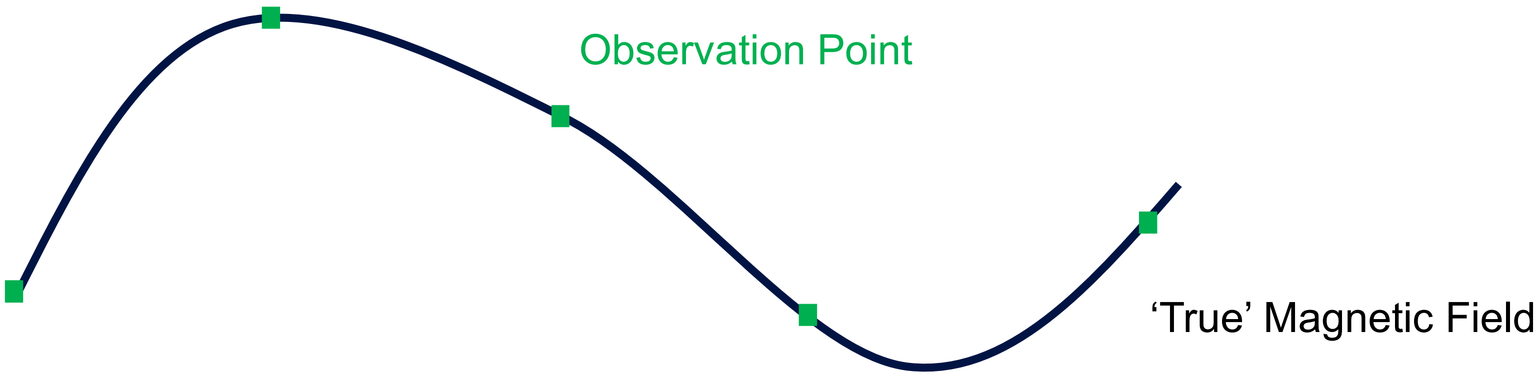


(a) SV averaging kernel for $\lambda = 2.5 \times 10^{-4}\mathrm{nT}^{-1}$. Kernel width $\approx 30°$.

FIGURE FROM HAMMER AND FINLAY, 2018

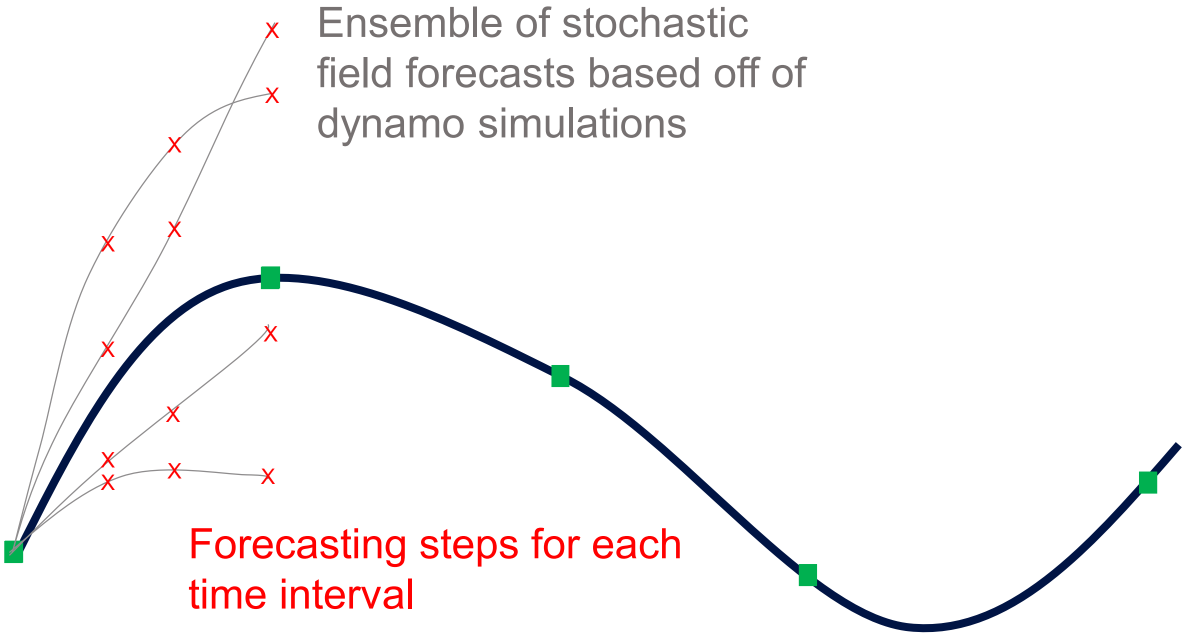
Producing pygeodyn core surface flows

- Time-dependent stochastic flow inversion model with a Kalman filter



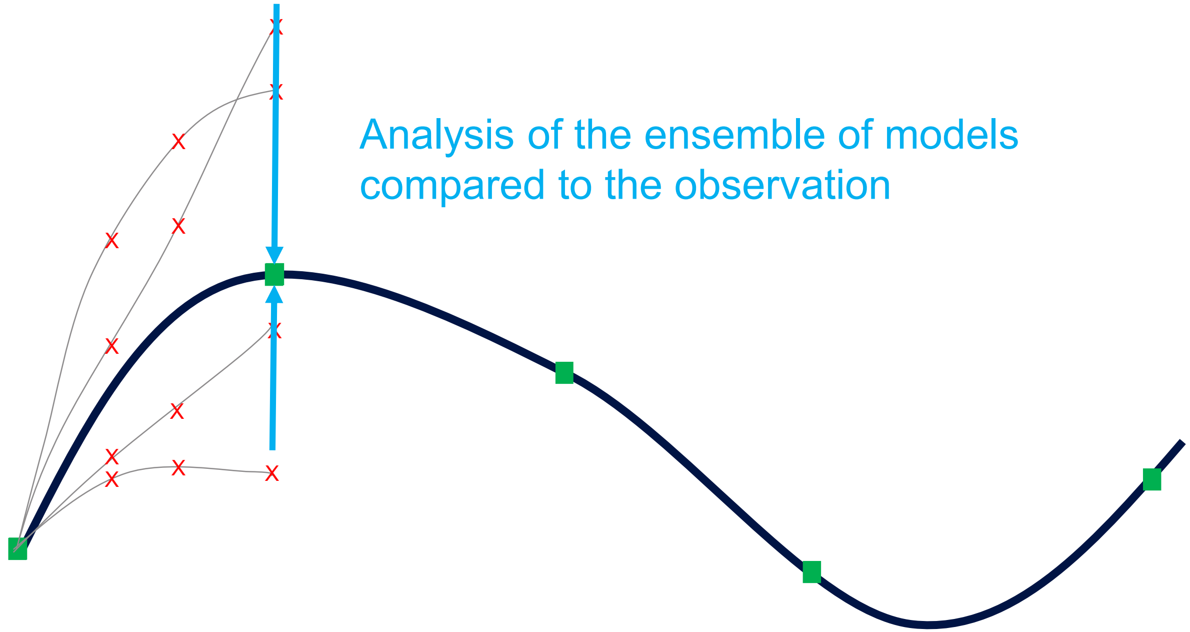
Producing pygeodyn core surface flows

- **Time-dependent stochastic flow inversion model with a Kalman filter**



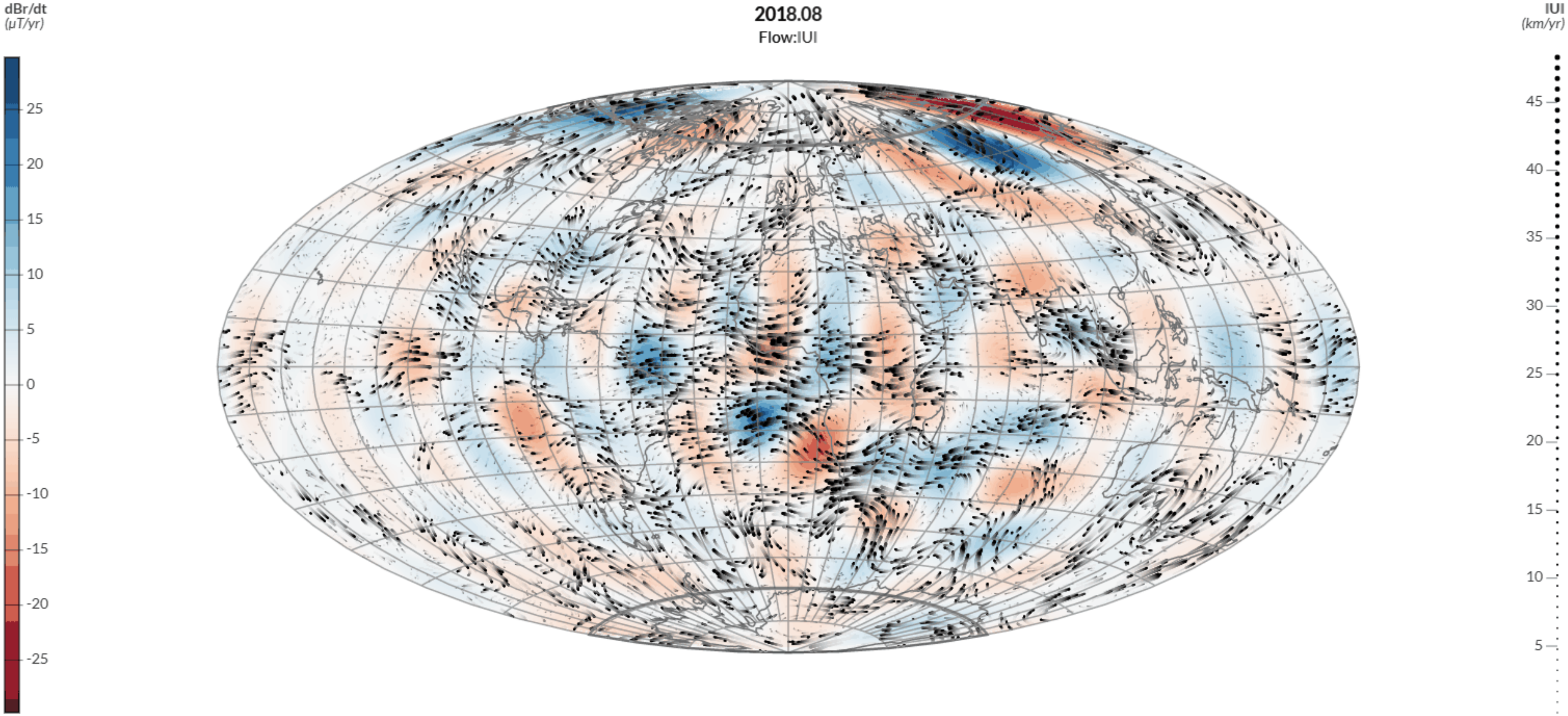
Producing pygeodyn core surface flows

- **Time-dependent stochastic flow inversion model with a Kalman filter**



Analysis of the ensemble of models compared to the observation

CHAOS-7


dBr/dt
(μT/yr)
25
20
15
10
5
0
-5
-10
-15
-20
-25
2018.08
Flow:IUI
IUI
(km/yr)
45
40
35
30
25
20
15
10
5

Producing pygeodyn core surface flows

- **To maximise the benefit of the SOLA data, we want to incorporate the spatial weighting into our flow inversions**

- **For SOLA location j, we have to consider all the Lebedev locations i**

Observation Data

Observation operator

$$Y^{SOLA} = Hx$$

Observed data in spectral form

$$\mathrm{H}_i = \sum_{j=1}^{N_{Leb}} w(j,i) M(\theta_i, \phi_i) G[A(b), I]$$

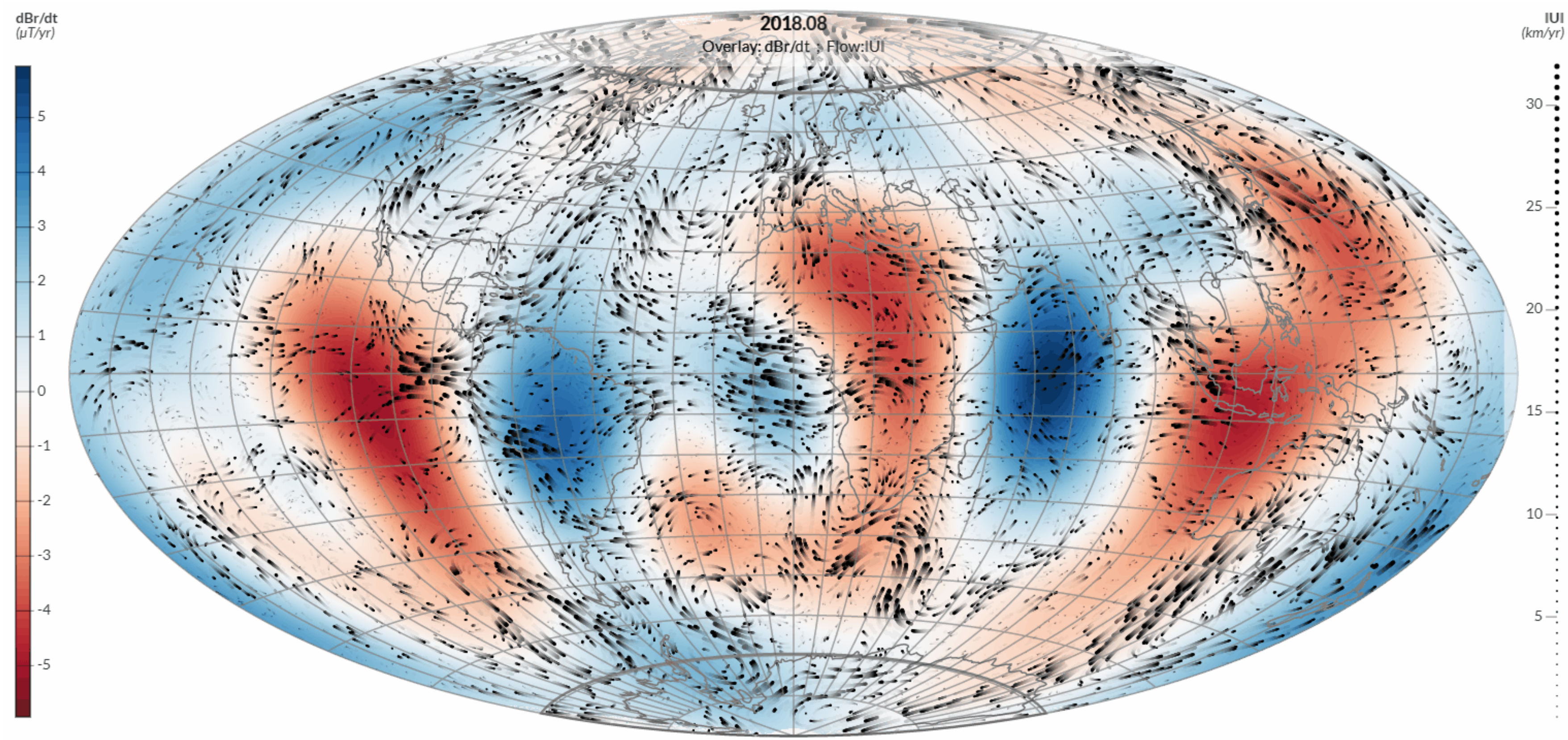
Sum over the locations

Averaging kernel from SOLA

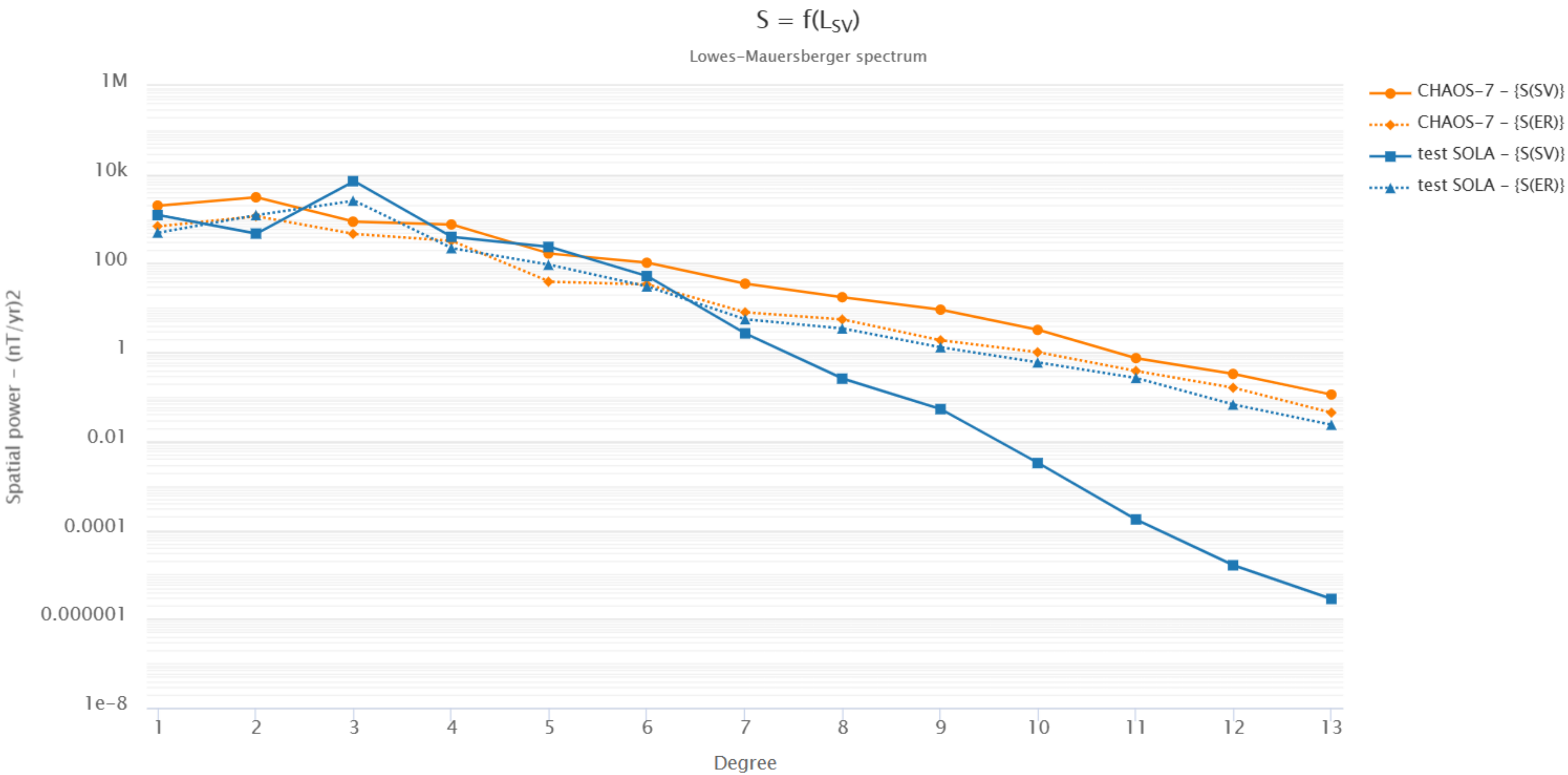
Locations of the Lebedev points

Gaunt-Elsasser

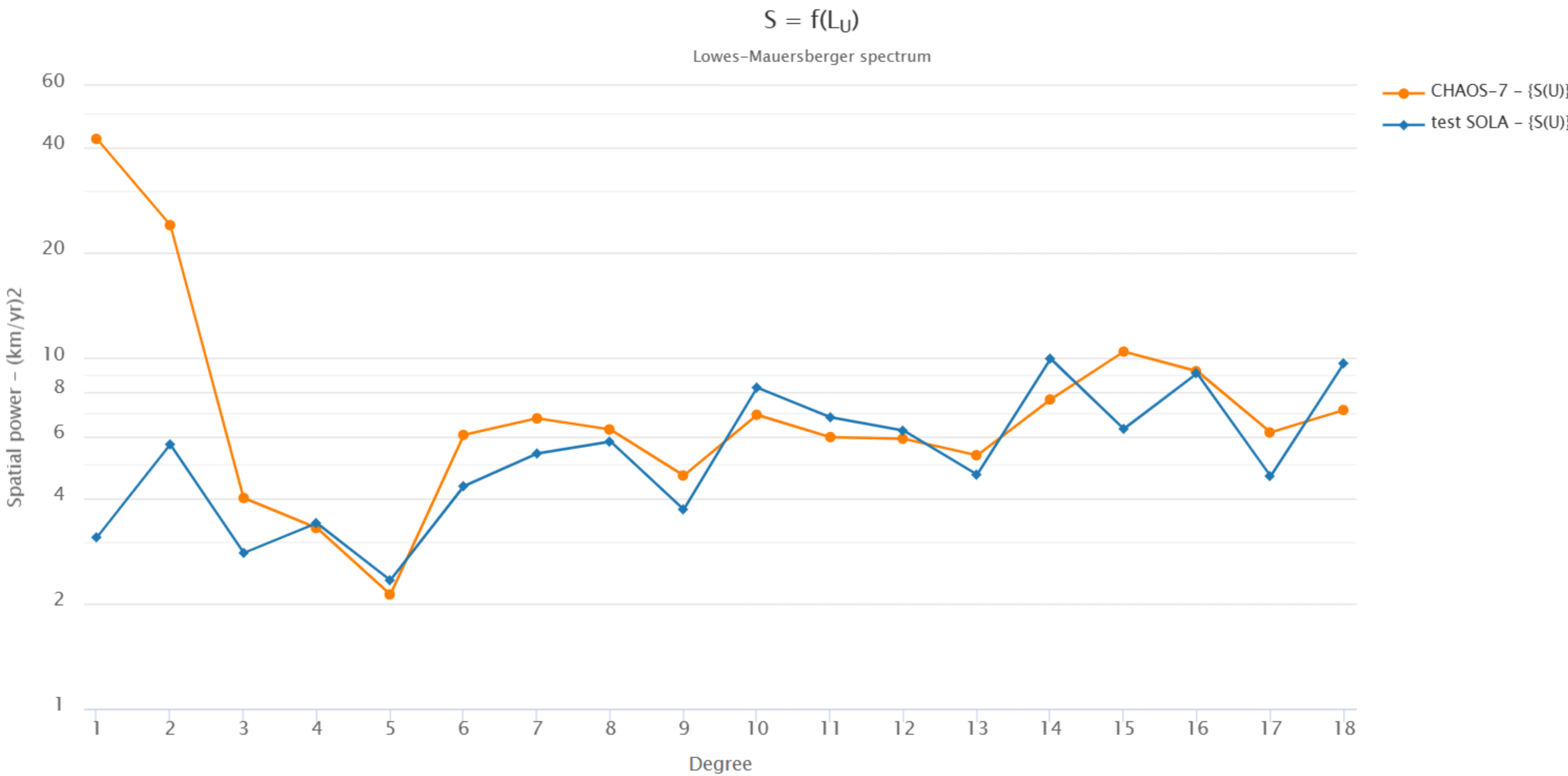
Current Results



Current Results – SV Spectral Energy



Current Results – Flow Spectral Energy



Future Directions

- **Run over a longer time-series that covers all of the satellite era**
- **Take advantage of the point estimates for regional studies**
- **Investigate shorter period wave dynamics**

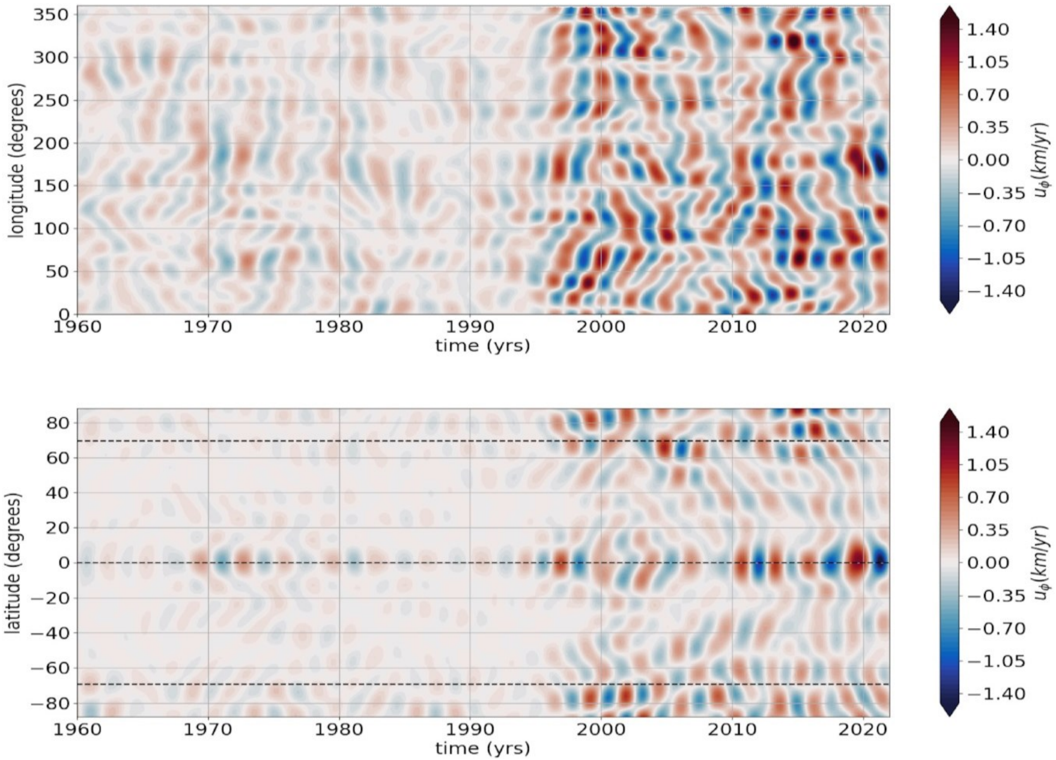


FIGURE FROM ISTAS ET AL., 2023

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