# Forecasting the Dst index from L5 in-situ data using PREDSTORM: Accuracy and Applicability

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# Mapping L5 data to L1: STEREO-B as L5 proxy

- Assume what is seen at L5 (60° angle diff) will arrive later at Earth

- ST-B was near L5 around 2009/2010 —> good proxy for testing!

- Using solar rotation speed and angle difference between ST-B and Earth, adjust time for solar wind to rotate from ST-B to Earth (Thomas+2018)

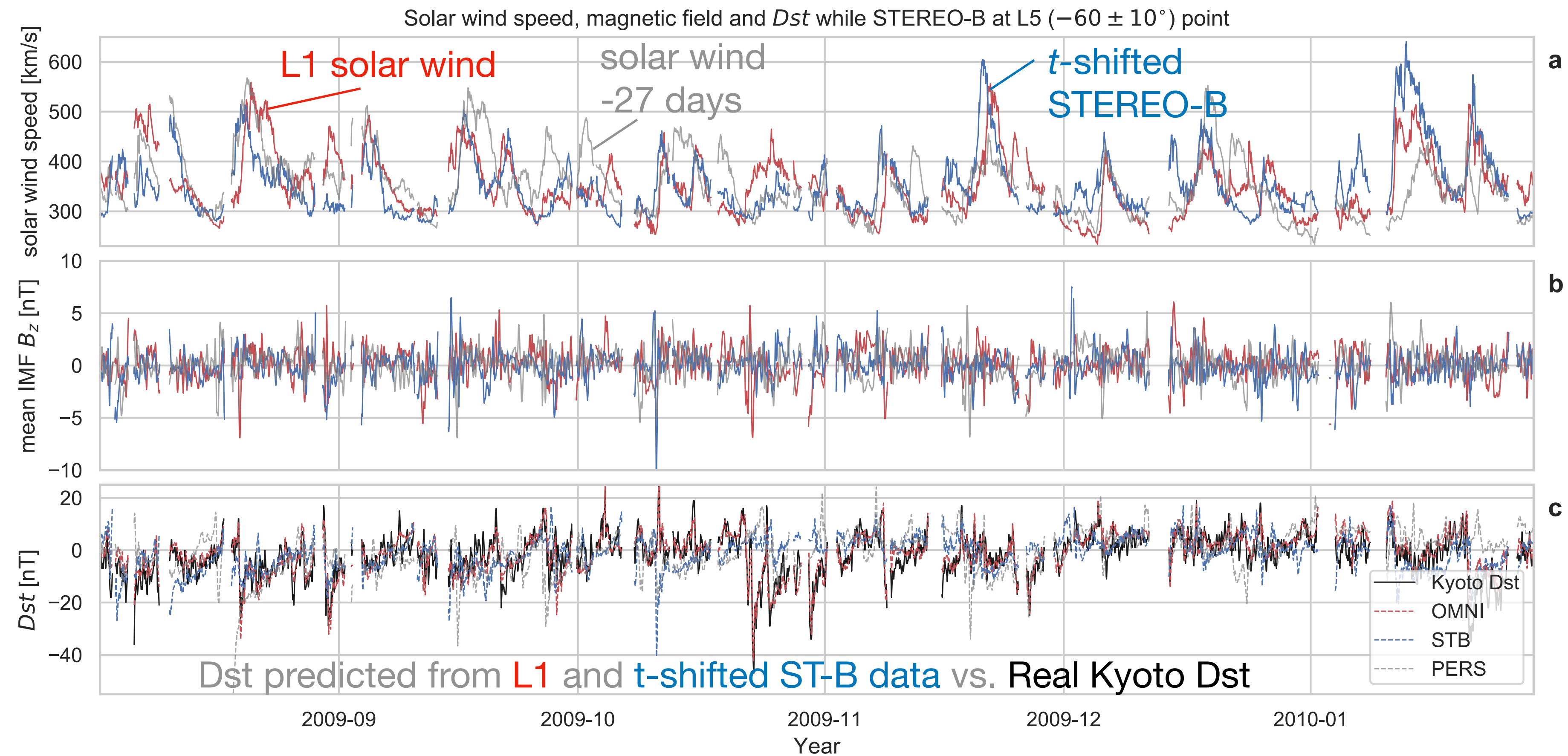- Also adjust for expansion due to different distances from Sun (Simunac+2009)



Solar wind speed, magnetic field and *Dst* while STEREO-B at L5 (−60 ± 10°) point
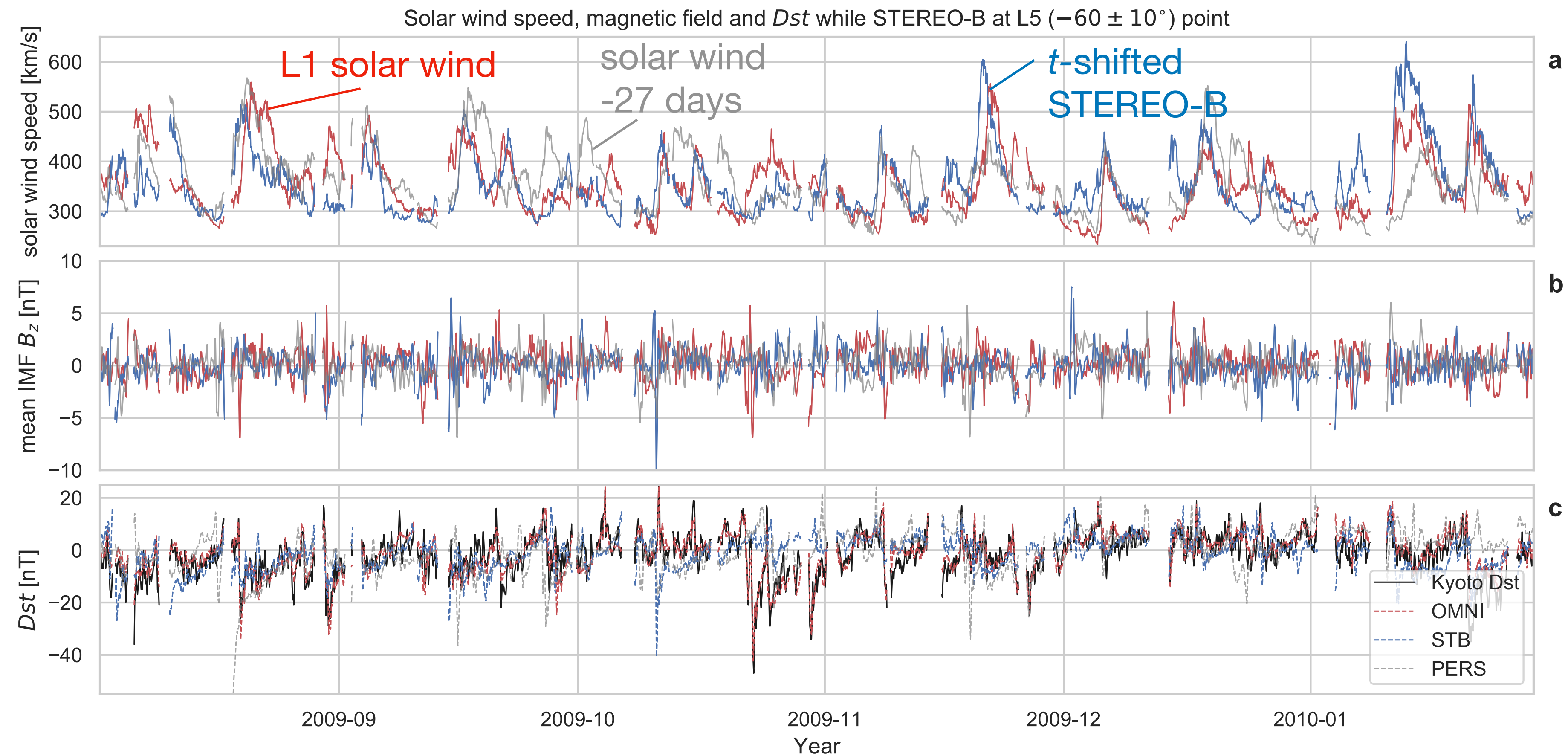
—> **Result:** forecast of ambient solar wind at L1 for the next 4.5 days!
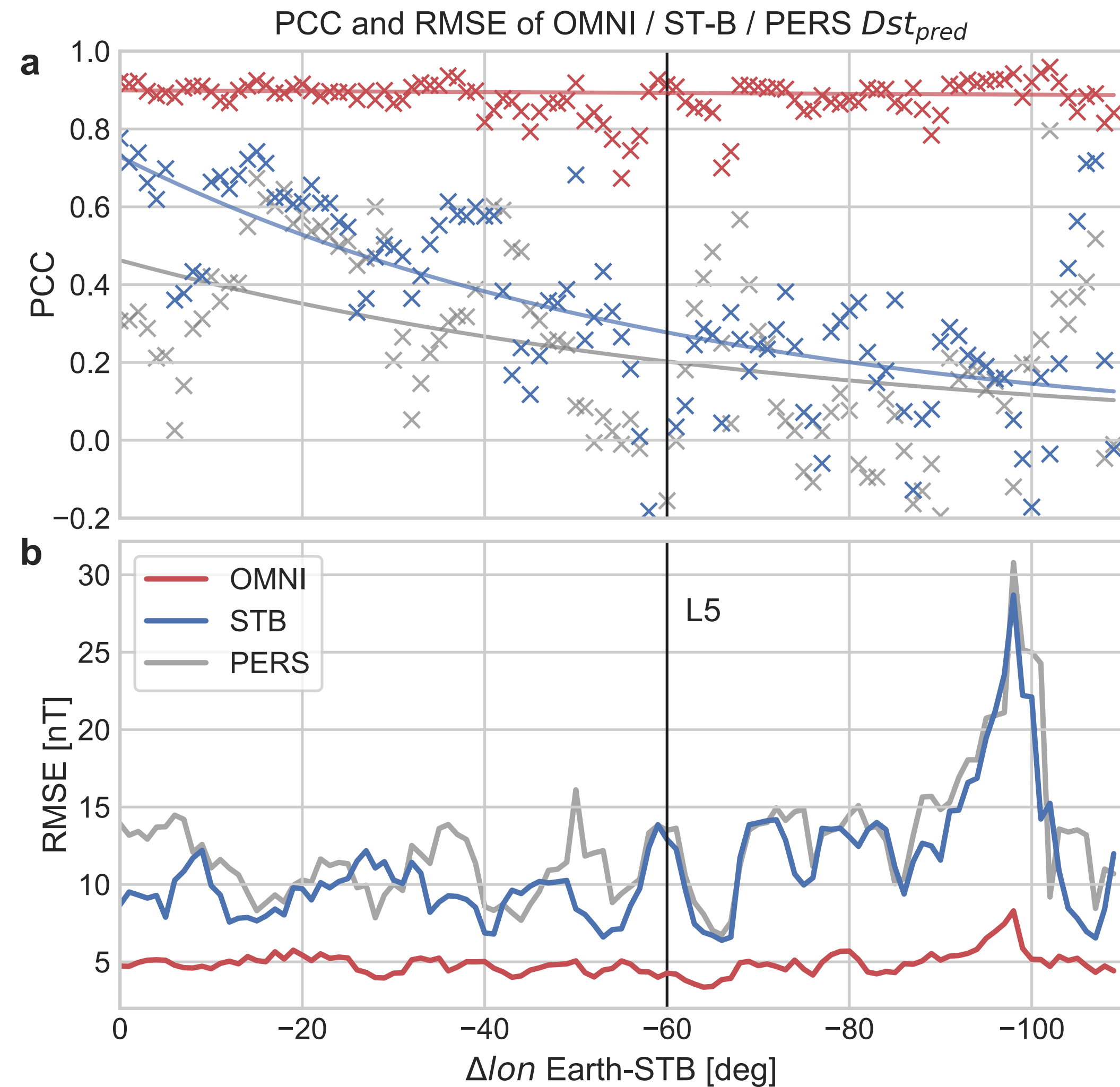
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# Prediction of Dst: Application

- ST-B data mapped to Earth can be treated as L1 data —> **predict Dst**

- Temerin-Li-2006 method for **L1 solar wind to Dst forecast**

- Dst calculated for time range **2007 - 2012** (ST-B varied between 0 - 100° from the Earth).

- —> compare models for validation analysis!



Solar wind speed, magnetic field and *Dst* while STEREO-B at L5 (−60 ± 10°) point

Dst predicted from L1 and t-shifted ST-B data vs. Real Kyoto Dst

# Prediction of Dst: Accuracy

PCC and RMSE of OMNI / ST-B / PERS $Dst_{pred}$



- Evaluate accuracy of *Dst* forecast from ST-B in comparison to L1 measurements and 27-day persistence

- **Correlation coefficient** (top, PCC) and **root-mean-square-error** (bottom, RMSE) vary over angle difference (Δlon) from Earth, decreasing with increasing distance

- ST-B shifted data **performs better than basic persistence** up until Δlon ~ 80/90°

# Prediction of Dst: Real-time Application



L1 real time solar wind from NOAA SWPC for 2020-04-21 13:00 UT & STEREO-Ahead Beacon
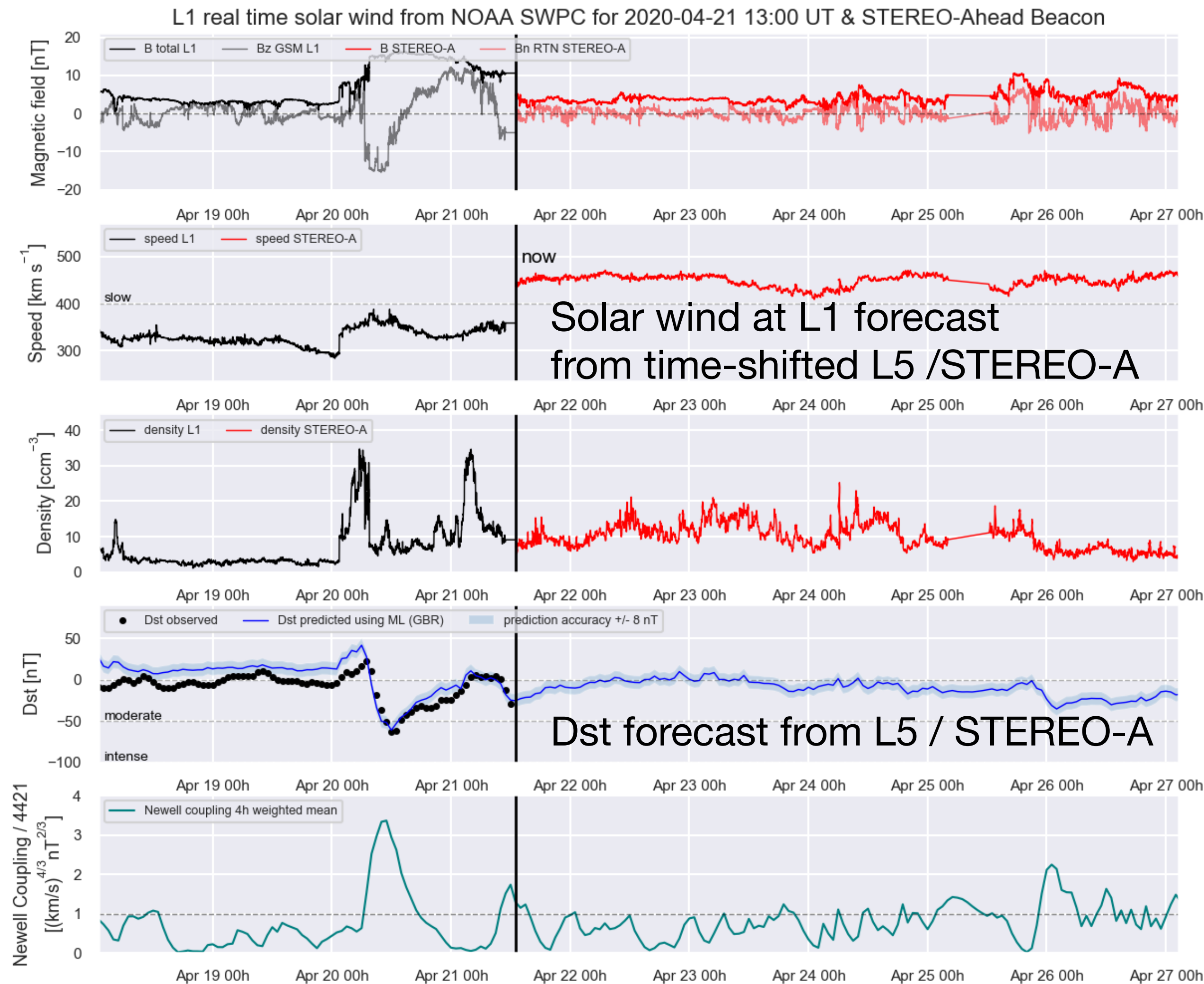
- Predictions for the next days made in real-time using **STEREO-A** data

- Show NOAA real-time L1 data (past) and next 5 days (future forecast) with time-shifted ST-A data

- Dst calculated from real-time L1 and time-shifted data for comparison

- Forecast available online at https://www.helioforecast.space/solarwind

Helio4Cast Group, Graz, Austria

https://twitter.com/chrisoutofspace

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# Results

- Solar wind measurements near L5 can be time-shifted to Earth assuming corotation of solar wind structures

- STEREO-B used as a proxy for L5

- Results of Dst predicted from t-shifted ST-B solar wind data near L5 performs better than 27-day persistence

- DOI / Paper preprint: 10.1029/2019SW002424 / https://www.researchgate.net/publication/341042251_Prediction_of_Dst_during_solar_minimum_using_in_situ_measurements_at_L5

- Code: https://github.com/helioforecast/Predstorm

# References

- Simunac, K. D. C., Kistler, L. M., Galvin, A. B., Popecki, M. A., & Farrugia, C. J. (2009). In situ observations from STEREO/PLASTIC: a test for L5 space weather monitors. Annales Geophysicae, 27(10), 3805–3809.

- Temerin, M., & Li, X. (2006). Dst model for 1995–2002. Journal of Geophysical Re- search: Space Physics, 111(A4).

- Thomas, S. R., Fazakerley, A., Wicks, R. T., & Green, L. (2018). Evaluating the skill of forecasts of the near-Earth solar wind using a space weather monitor at L5. Space Weather, 16(7), 814–828.

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