Linear and Neural Network Estimates of Magnetic Filling Factors on Sun-Like Stars

CENTER FOR
ASTROPHYSICS
HARVARD & SMITHSONIAN

Timothy Milbourne[1,2], David F. Phillips[2], Nick Langellier[1,2], Raphaëlle D. Haywood[3], Steven Saar[2], Ronald L. Walsworth[2,4,5,6], and the HARPS-N Solar Telescope Collaboration

[1]Physics Dept. Harvard University, Cambridge MA USA. [2]Harvard-Smithsonian Center for Astrophysics, Cambridge MA USA. [3]Astrophysics Group, University of Exeter, Exeter EX4 2QL, UK. [4]Physics Dept. UMD, College Park MD USA. [5]Electrical & Computer Engineering Dept., UMD, College Park MD USA. [6]Quantum Technology Center, UMD, College Park, MD USA.

Use Available Solar Observations to Estimate Magnetic Filling Factors

Use combination of **solar S-index** and **TSI** to reproduce **SDO/HMI filling factors** of specific magnetic features:

- Linear fit of S-index to TSI → Plage
- Fit residuals → Spots
- Time information → Network

Also train multilayer perceptron to extract filling factors directly
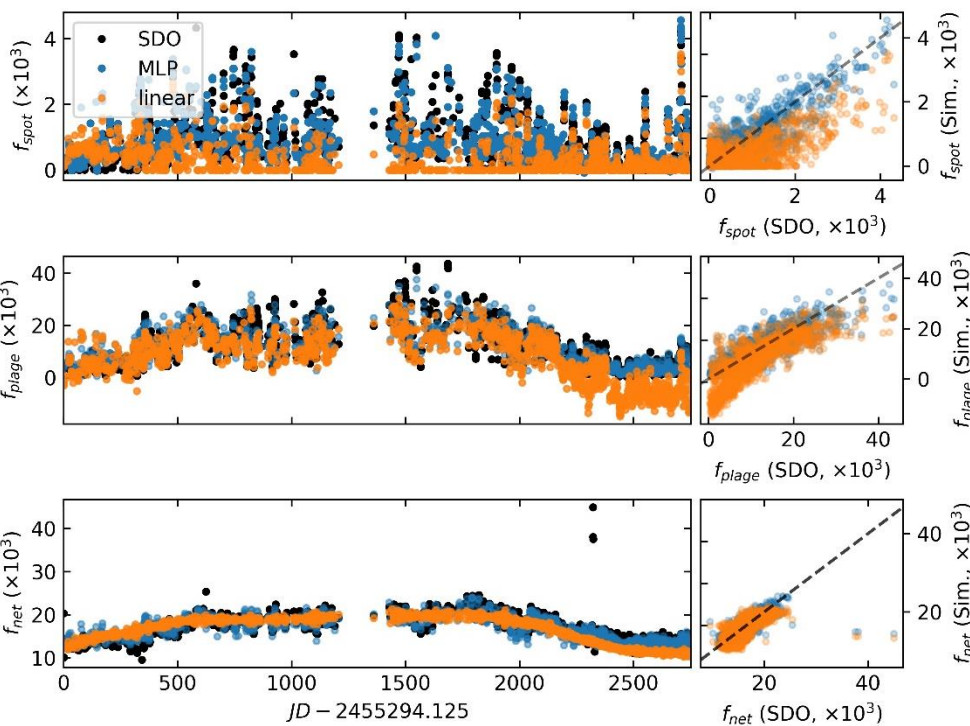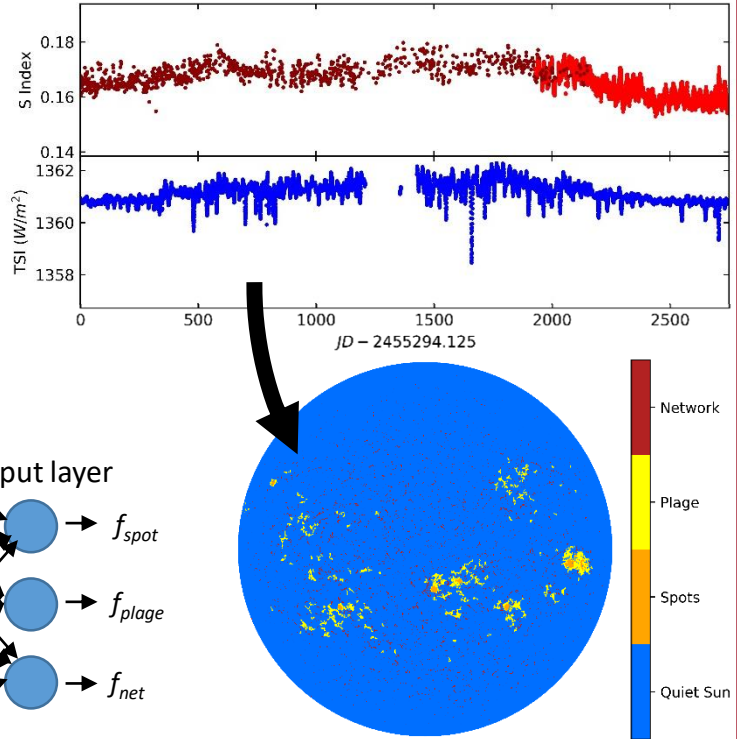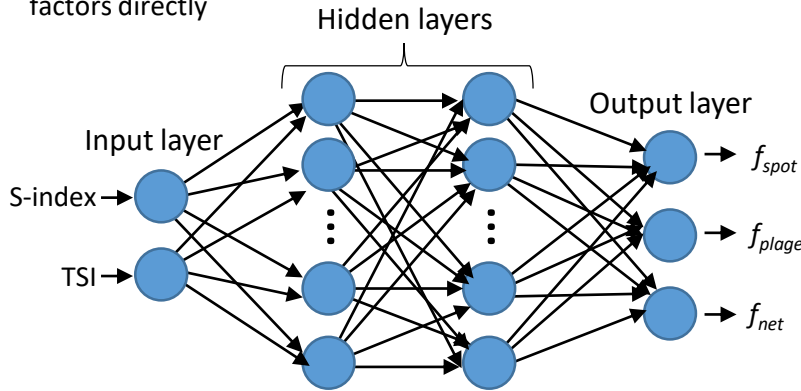
Results

Both techniques produce filling factors highly correlated with HMI-derived values. But does this help with RVs? Expected activity-driven RVs to depend on active region size (Milbourne et al. 2019):

- RV RMS: 1.82 m/s
- Decorrelating with S-index: 1.37 m/s
- Decorrelating with estimated filling factors: 1.37 m/s
- Decorrelating with HMI filling factors: 1.23 m/s

These techniques are good first step, but further work is needed!