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The WHOLE SUN Project: Understanding the Energy Budget of the Solar Atmosphere

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The WHOLE SUN Project

WHOLE SUN is an international collaboration that aims to improve our current understanding of the Sun's energy, magnetic field, and dynamics. By utilizing state of the art computational facilities, our end game is to couple several solar dynamic models to create the first core-to-atmosphere numerical model of the Sun.

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 810218). It is a collaboration between UiO, University of St. Andrews, Max Plank Institute for Solar System Research, University of Paris-Saclay, and the IAC.

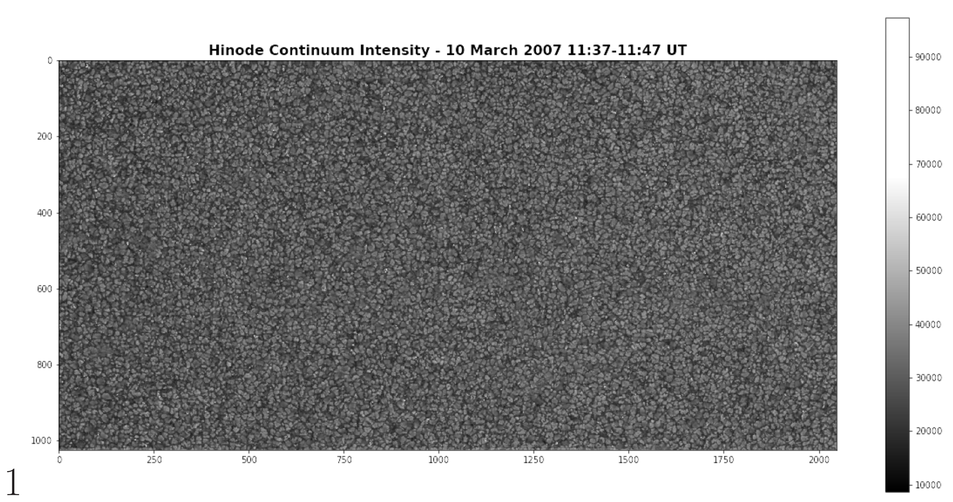
Our Puzzle Piece: Working Package 4 (WP4)

Through WP4, we aim to understand the link between solar magnetic structure and the solar atmospheric energy budget.

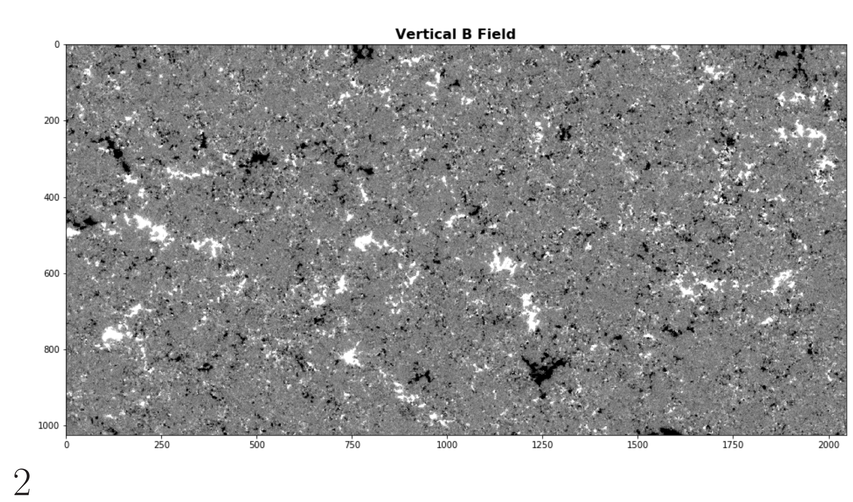
- How do certain magnetic topologies evolve in time?
- What is the correlation between magnetic field and chromospheric heating?
- How can we better understand outputs from solar interior models?
- How can we use atmospheric model outputs as inputs for solar wind models, etc.?

Quiet Sun Observations

The **Quiet Sun** is defined by the areas of the Sun's magnetic field that are comparatively **inactive**; i.e. the network in between active regions. These magnetic fields are small, but they are **not necessarily zero** and are thought to contribute to atmospheric heating. The question is: **How much?** To approach this question, we employ both observational and computational methods. **Figures 1-3** demonstrate observations of the Quiet Sun magnetic field.



1



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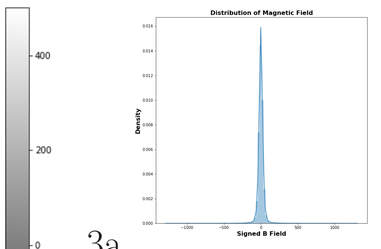
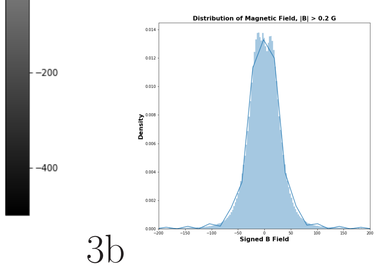


3a



3b

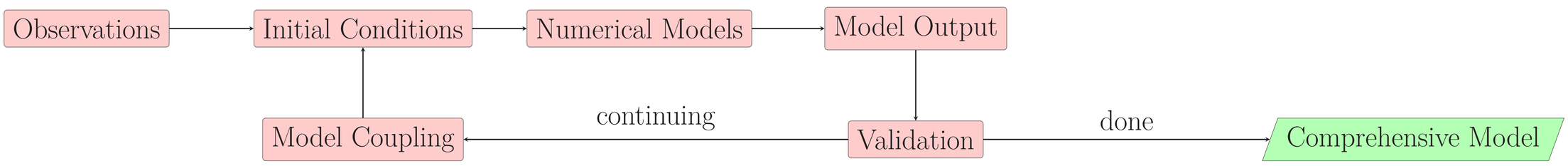
Figure 1 shows the continuum intensity (Stokes I) of the solar disk center measured by *Hinode* on 10 March 2007 between 11:37-14:37 UT.

Figure 2 shows the vertical magnetic flux densities inferred from Stokes V profiles at the FeI 630.15 nm line.

Figures 3a and 3b demonstrate the distribution of Quiet Sun magnetic field strengths. As expected, the majority of the values are zero or nearly zero as seen in **Figure 3a**. In **Figure 3b**, field values $|B| < 0.2$ G are filtered out to visualize the distribution of nonzero values.

Quiet Sun in Models

To understand possible contributions of the Quiet Sun magnetic field to atmospheric heating, it is necessary to evolve an initial field in time using MHD and radiative transfer models such as our in-house model *Bifrost*. In the coming years, we intend to form a comprehensive statistical representation of Quiet Sun magnetic fields, use *Bifrost* to understand time-evolved Quiet Sun dynamics, and eventually be able to couple *Bifrost* to other solar dynamics models in the WHOLE SUN collaboration.



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