NSF's National Solar Observatory

MULTI-HEIGHT MEASUREMENTS OF THE SOLAR VECTOR MAGNETIC FIELD

BERTELLO L., PEVTSOV A., PEVTSOV A. A.

NATIONAL SOLAR OBSERVATORY, BOULDER, COLORADO

Questions addressed by long-term full-disk vector magnetic field observations at different heights (photosphere and chromosphere)

- What is the origin of the magnetic field and helicity observed in the photosphere (deep seated vs. near surface dynamo or both)?
- How is magnetic helicity stored in the solar atmosphere and how does it affect the amount of available magnetic energy and solar eruptions?
- What is the coupling between magnetic fields and flows throughout the solar atmosphere?
- Where are the solar source boundaries of the fast and slower solar wind?

Space weather research and operations

- Synoptic maps derived from magnetic field measurements are the main drivers of coronal and heliospheric models. They constitute a critical product for space weather operations, research, and modelling of solar atmosphere and the heliosphere.
- While simple models such as the PFSS model only require synoptic maps built from B_{LOS} measurements, advanced MHD models are driven by synoptic maps generated from the three components of the observed magnetic field

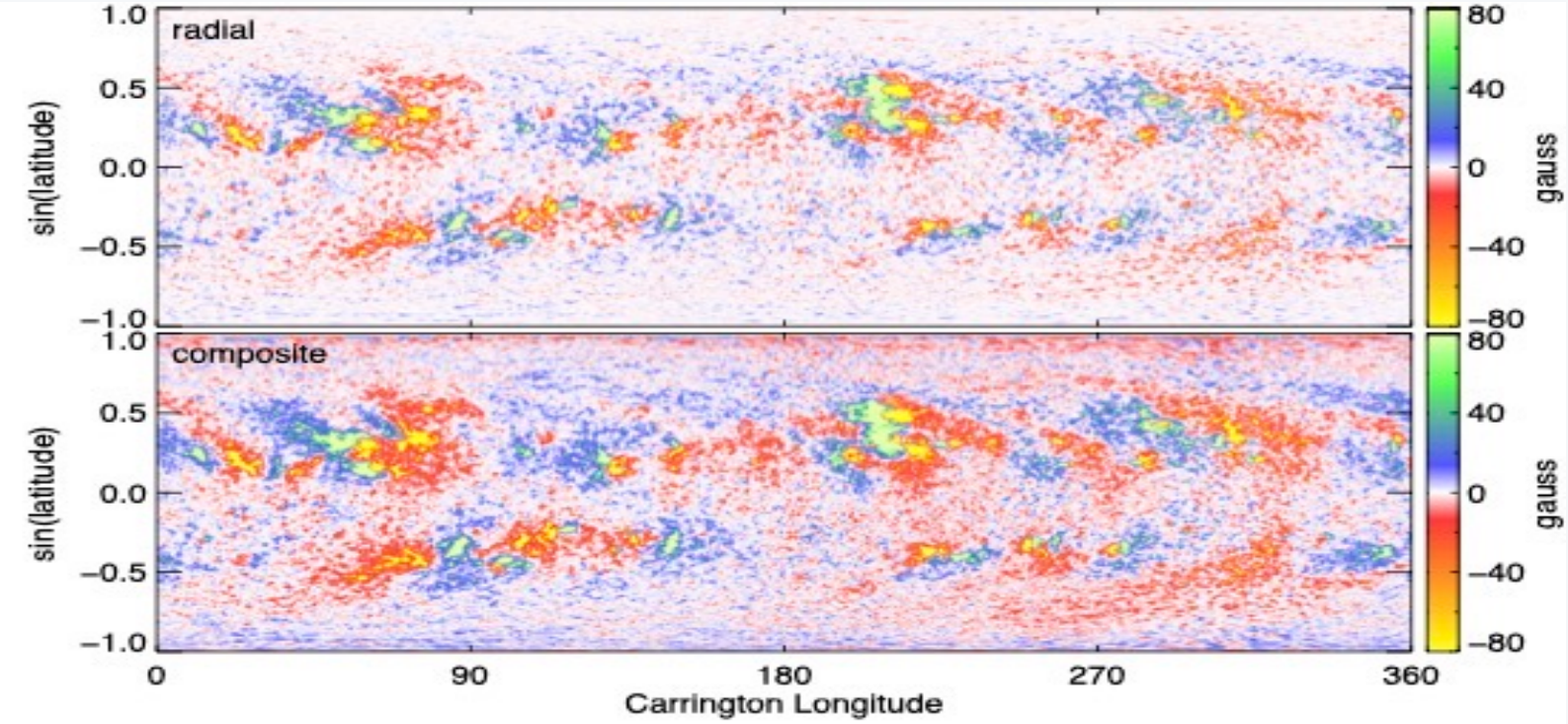
Limitations affecting quality of vector synoptic maps

- Uncertainties related to magnetic field measurements (e.g. noise level, calibration issues, etc...).
- Limitation of Zeeman polarimetry and imperfect instrumentation in representing true orientation of the solar magnetic fields with weaker polarization signals. Poor sensitivity to weak magnetic field.
- Choice of inversion code.
- Choice of disambiguation method.
- Assumptions used to build the synoptic charts (e.g. time evolution, SDR, polar fields, etc...).

Possible solutions to some of these issues

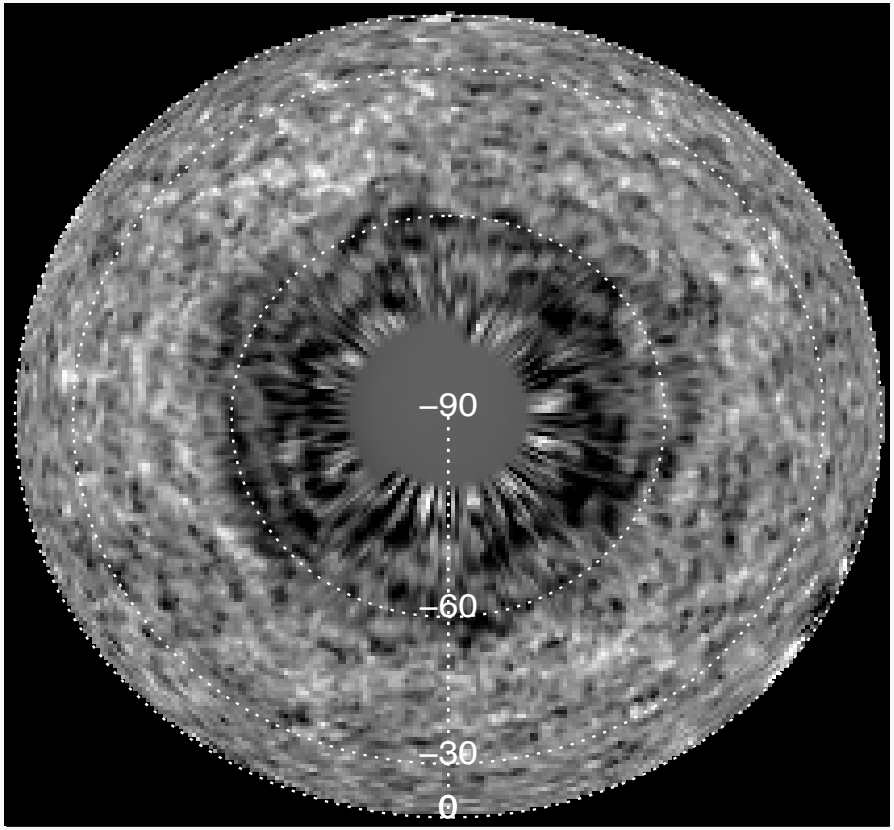
- Better measurements (S/N) of the transverse component of the solar vector magnetic field. ngGONG will address this issue
- Improved pole-filling techniques. A novel approach, based on Singular Spectrum Analysis (SSA), is currently being tested at NSO
- Exploit the best properties of both full-Stokes and longitudinal magnetic field measurements when creating radial synoptic charts by merging these two types of measurements together (composite synoptic map).

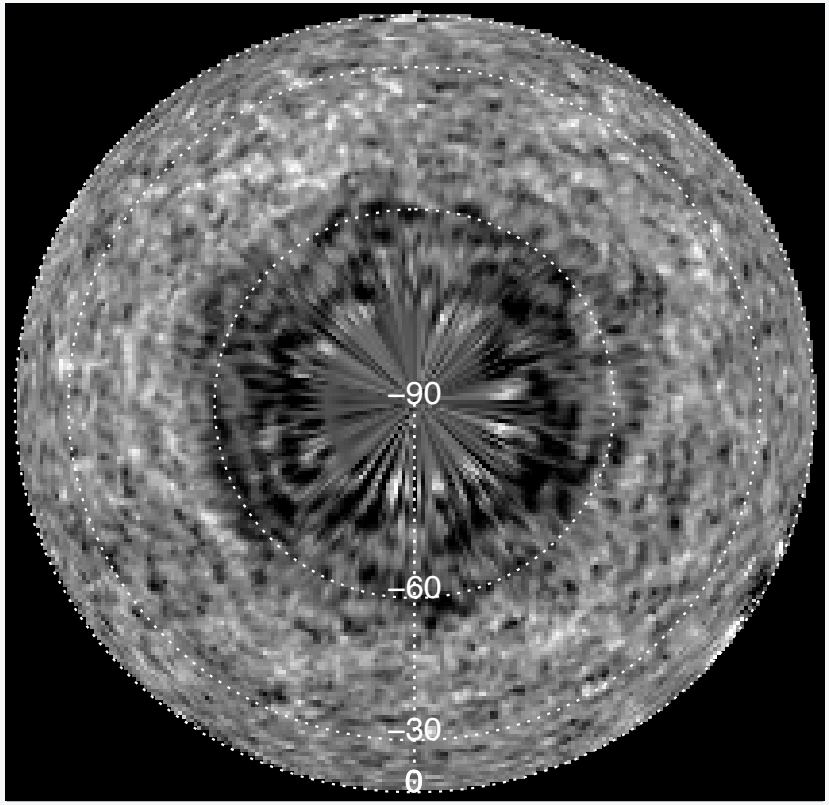
Composite synoptic map



Comparison between radial (top) and composite synoptic charts (bottom) derived from SOLIS/VSM FeI λ630.2 nm vector and longitudinal magnetic field observations for Carrington rotation 2119 (Jan-Feb 2012). Note the enhanced weak magnetic field in the composite chart.

SSA Pole-filling: An Example





Singular Spectrum Analysis is applied to fill the unobserved southern polar regions in this SDO/HMI Carrington rotation 2209 (Sep-Oct 2018) radial synoptic map.
Left: Unfilled polar view Right: Filled polar view. Images are saturated at +/- 20 Gauss.