SO/PHI data request form

(Cruise phase + first science orbit; SO/PHI-Team internal version)

Long-term evolution of AR with FDT (a.k.a. synoptic+)

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Science case

The evolution of the magnetic field in active regions (ARs) is key to the understanding of coronal mass ejections (CMEs) and flares. The build-up of large-scale currents, mostly in the emergence phase (lasting days to weeks [1]), results in increased magnetic (free) energy and helicity. This, in turn, is at the core of storage-and-release models that are currently used to interpret CMEs. In particular, magnetic helicity can be used to characterized the storage-and-release models in a general way that is independent of the details in which CMEs are triggered, and has been recently considered as a potential forecasting tool. The validation of such studies requires a continuous monitoring of individual ARs.

Continuous monitoring of ARs was so far limited to a few days (vector observations beyond the +/-40 heliographic degrees are often consider to be too noisy for some coronal model techniques). This means that the full process of emergence and activity, let alone decay, of individual ARs was never continuously observed. On the other hand, in such type of studies, the numerical effort required by modeling (e.g. a full 3D NLFFF extrapolation for every considered time snapshot) is still significant, and re-binning of high-resolution observations is often employed (e.g.,in [2] HMI magntograms covering 4 days mostly at 1-hour cadence are re-binned to 2" prior to extrapolation).

SO/PHI, in coordination with HMI, offers the unique possibility of following an AR for a much longer span of time than done so far. While this project could benefit from high-resolution magnetograms, the observing constraints of regular cadence and long coverage may be easier accommodated for FDT than for HRT. The on-disc FDT resolution during, e.g., the Perihelion and Northern windows of NMP1 will always be smaller then 1030 km, which is slightly better than the 2" (re-binned) HMI resolution employed in [2]. Hence, combining SDO/HMI and PHI/FDT a coherent modelling of AR evolution with a ~2" spatial resolution and 1-hours cadence over ~200 heliospheric degrees is possible in principle, which will demonstrate for the first time the potential for long-term AR monitoring by SO/PHI, and offer a unique application for helicity studies. The required observation cadence will depend on the evolution phase in which the AR will be, typically 1 hour for an emergence phase (which will be technically unfeasible), to 6 -or possibly even longer- hours in the late decaying phase. Both these options are presented as optimal and minimal, respectively, for best adaptation.

[1] see, eg. van Driel-Gesztelyi and Green Living Rev. Solar Phys. 12 (2015)

[2] Thalmann et al ApJ 887 (2019)

Requirements / data	Optimal	Minimal
Type of solar feature	Active region	Active region
HRT or FDT	FDT	FDT
Physical parameters needed (available: B_LOS, vector B, v_LOS, I_c, raw data)	Vector B	Vector B
Total length of observation	12 days	12 days
Cadence (maximum 1 dataset/min)	1 hour	6 hours
Pointing needs	Disc centre	Disc centre
Orbit needs (spatial resolution/co-rotation/angle to Earth/angle to other spacecraft)	NMP1: from late Perihelion (φ>60) to end of North Window	NMP1: From late Perihelion (φ>60) to end of North Window
Total number of datasets:	288	48
Full frame 2k x 2k or partial frame 1kx1k, 0.5kx0.5:	Full frame	Full frame
Full resolution or 2x2, 4x4 binned data	Full resolution	Full resolution
noise level (default 10-3):	Default	Default
Co-observations with other instruments:	EUI (synoptic for context and validation)	EUI (synoptic for context and validation)
Special requests	None	None