Amplifying variability of solar-like stars by active longitudes and nesting

Emre Işık[1], Alexander I. Shapiro[2], Sami K. Solanki[2,3], Natalie A. Krivova[2]

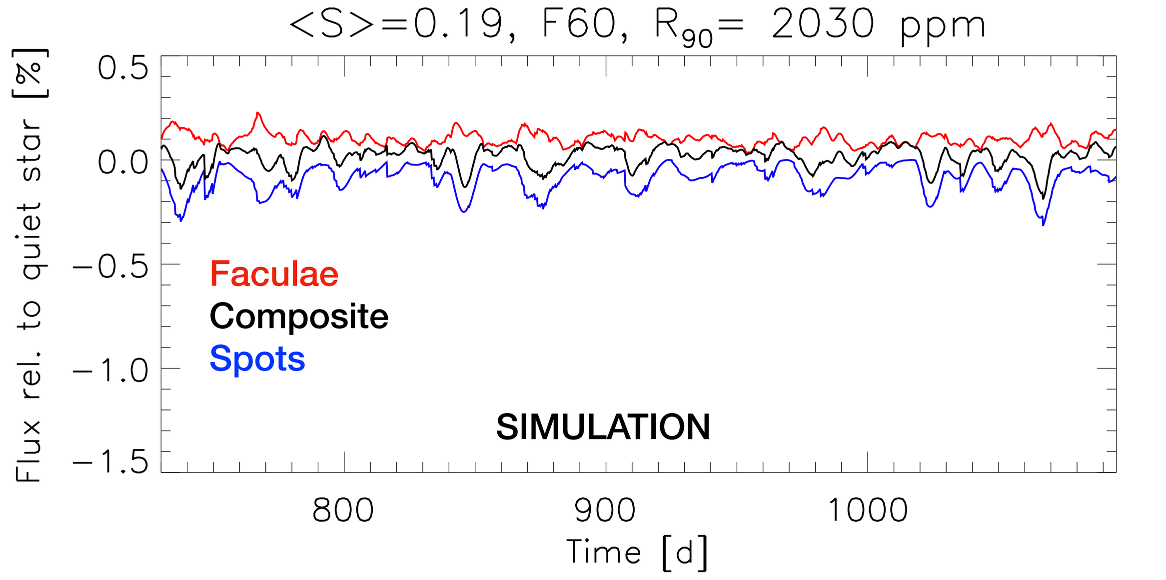
[1] Department of Computer Science, Turkish-German University, Şahinkaya Cd. 94, Beykoz, Istanbul, Turkey [emre.isik@tau.edu.tr]
[2] Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany [shapiro@mps.mpg.de]
[3] School of Space Research, Kyung Hee University, Yongin, Gyeonggi-Do, 446-701, Republic of Korea

Many solar-type stars with near-solar rotation periods exhibit much stronger variability than the Sun (Reinhold et al. 2020). Some of these stars even show very regular, sine-like light curves. Motivated by solar activity complexes, we developed a numerical model to quantify the effect of active-region (AR) nesting and active longitudes on stellar brightness variations in the rotational time scale. Modelling ARs with facular and spot components, we simulated light curves covering four years and using the Kepler passband. We found that the combined effect of the degree of nesting and the activity level, both being somewhat higher than on the Sun, can explain the whole range of observed light-curve amplitudes of solar-like stars. While nesting at random longitudes can explain variability amplitudes and light-curve morphology in many cases, active-longitude-type nesting reproduces sine-like light curves and the highest amplitude variability.

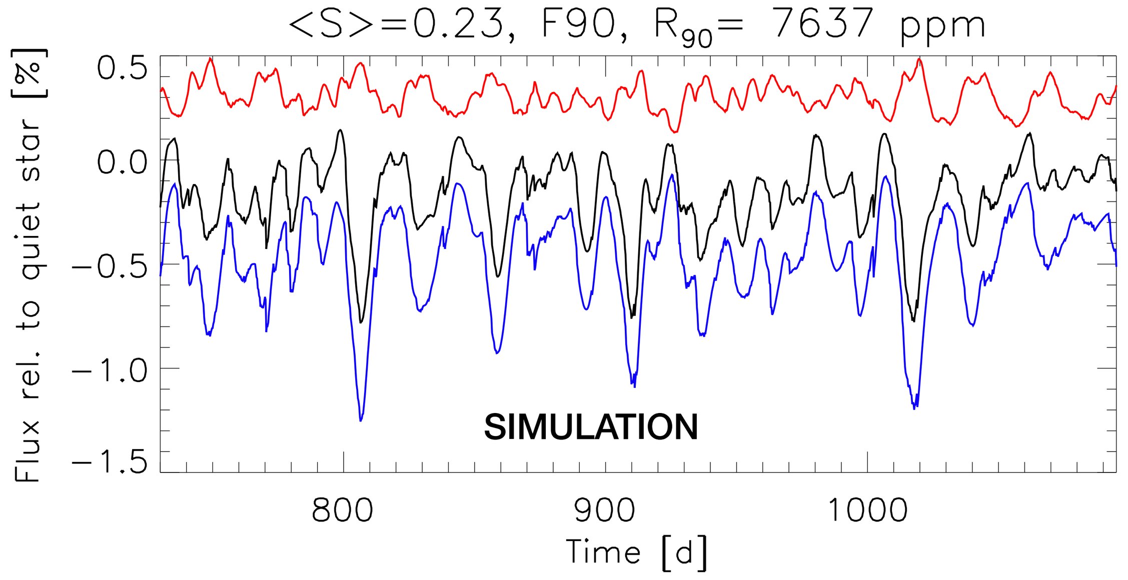
Click for more details: Işık et al. 2020 ApJ Lett., 901, L12

Brightness variability increases not only with activity level, but also with active-region nesting.

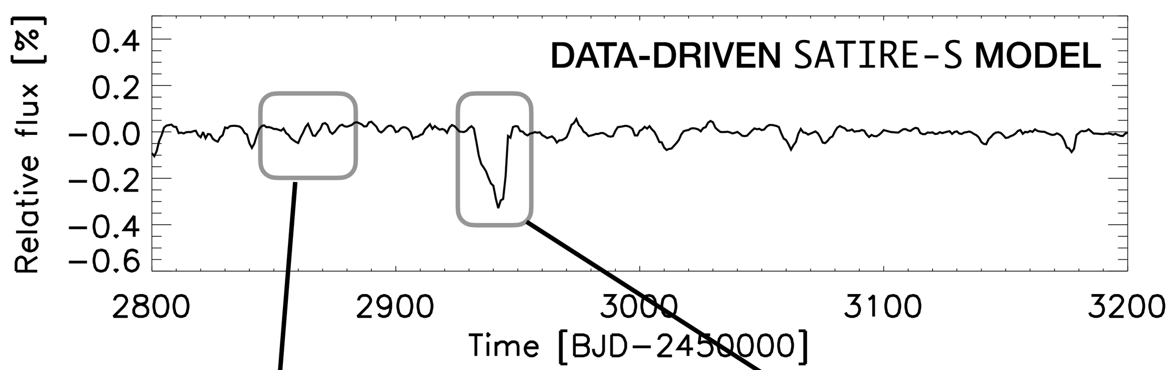
Sun during a strong maximum (nesting 60%)



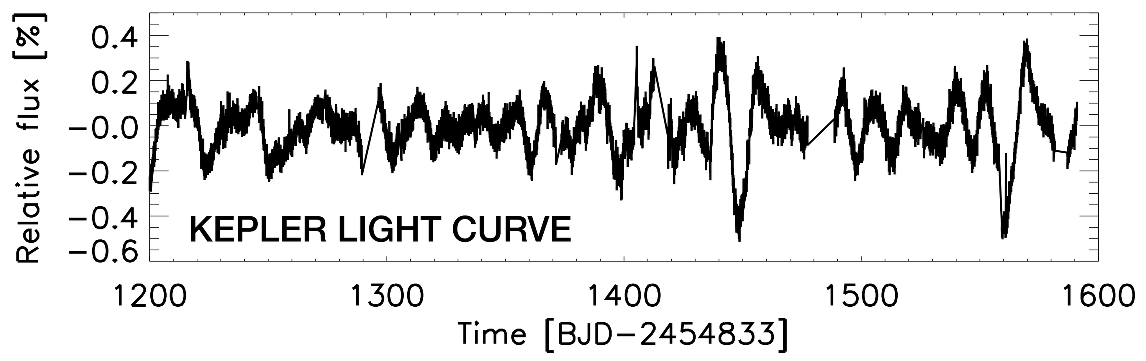
More active Sun (nesting 90%)

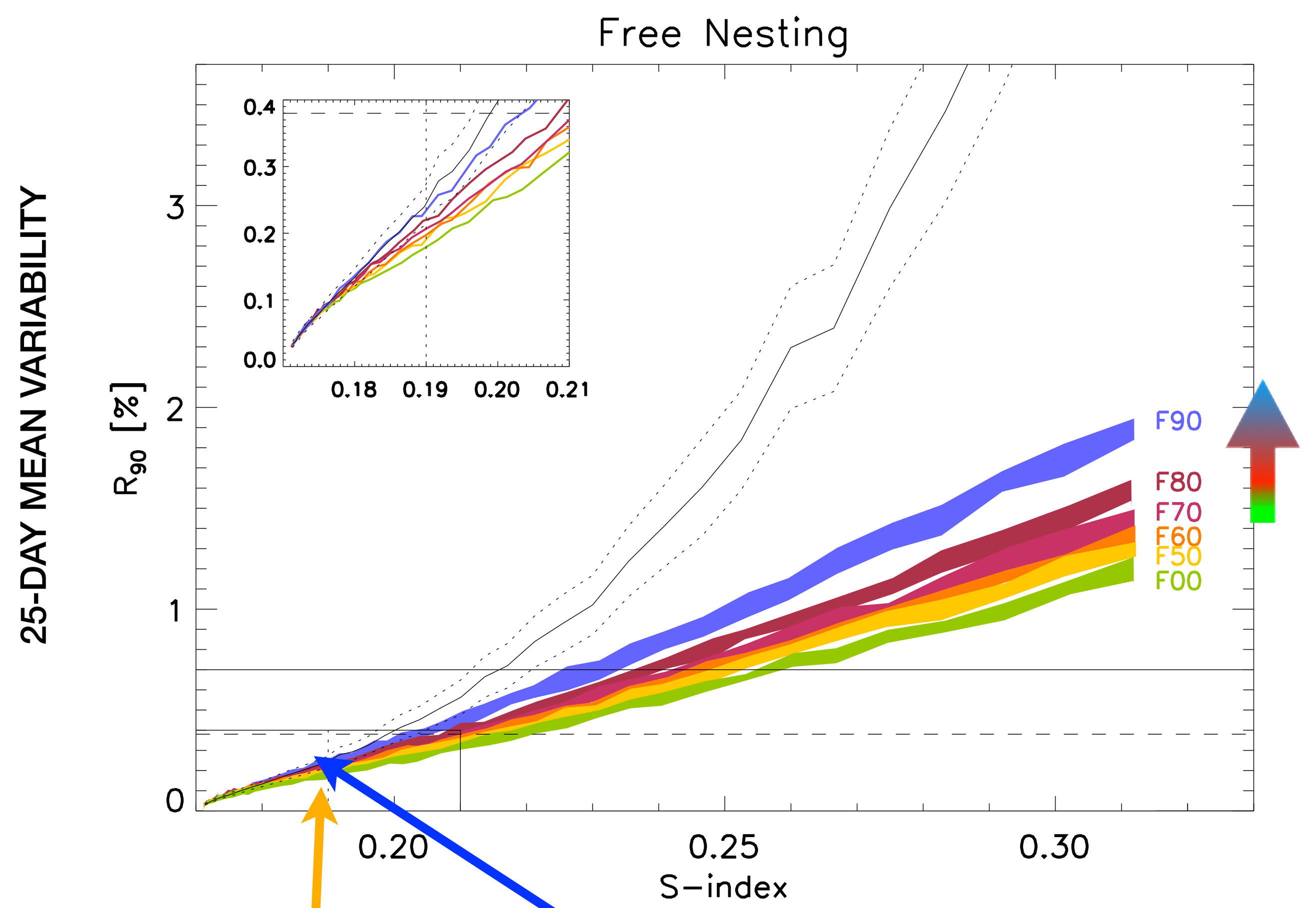


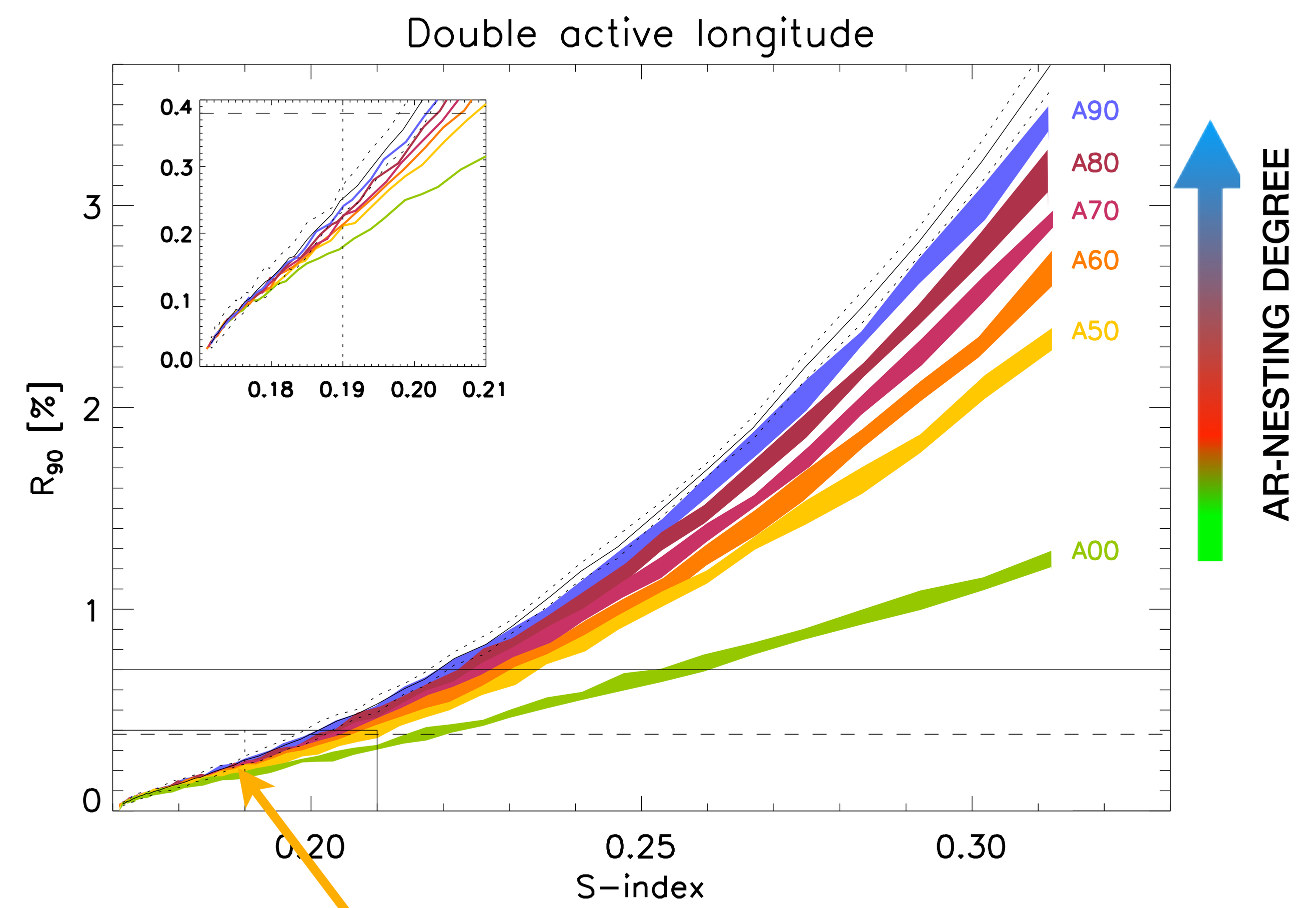
The Sun during a typical maximum

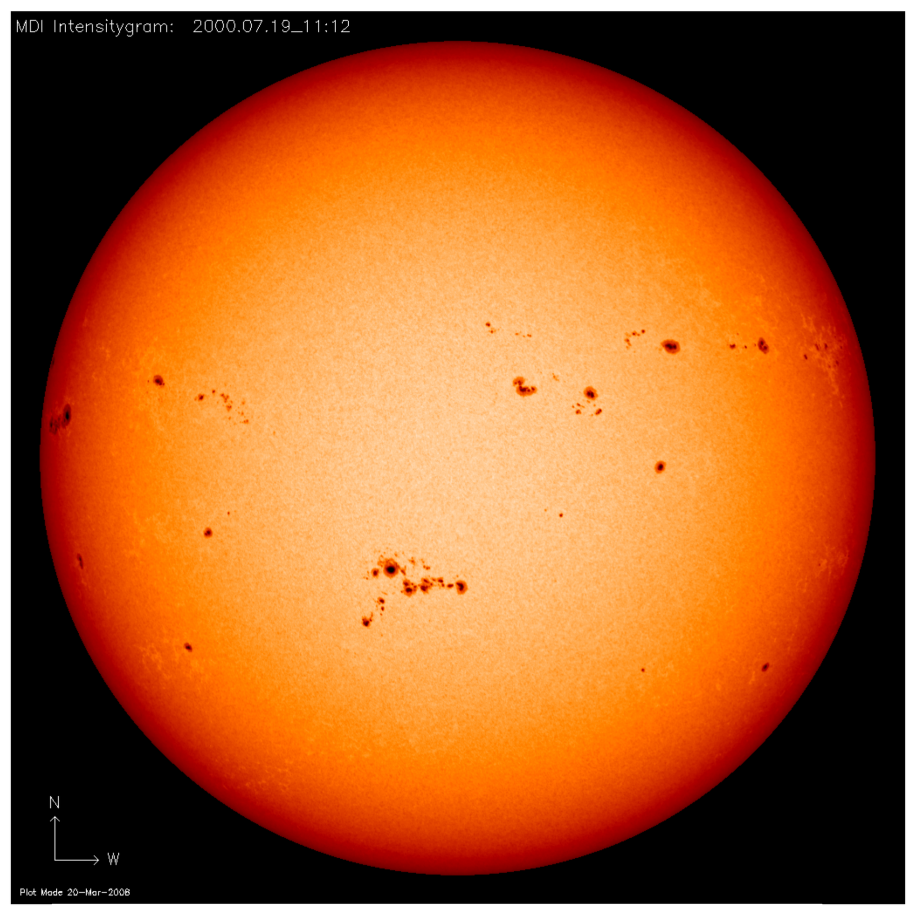


Solar-like star observed by *Kepler*

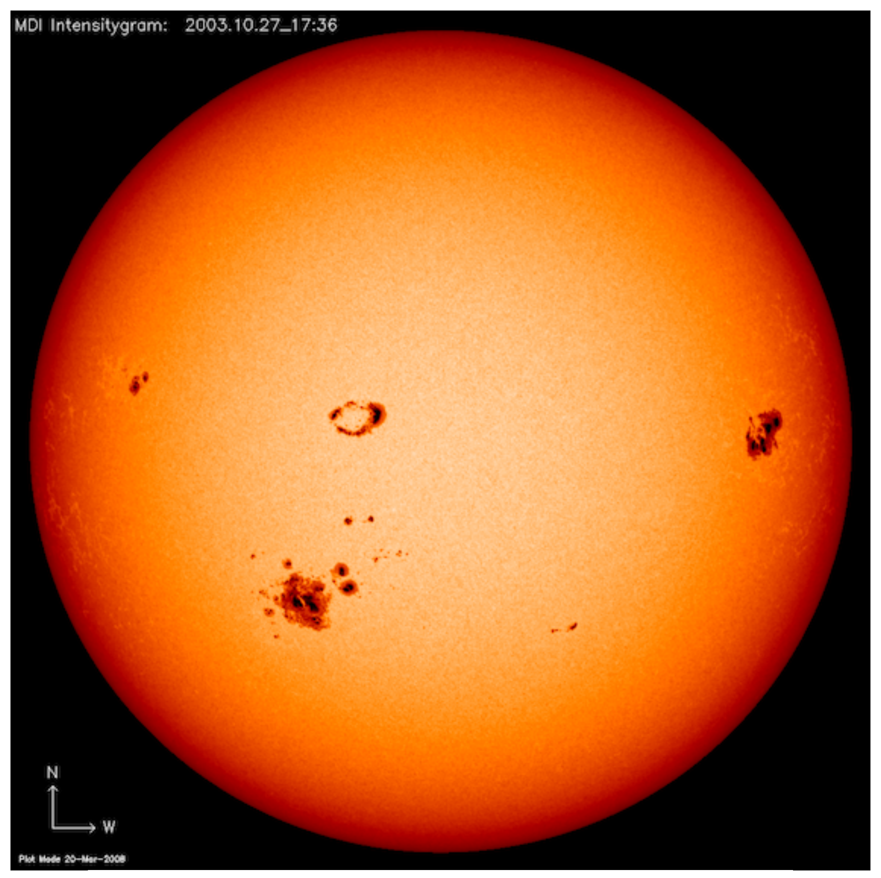




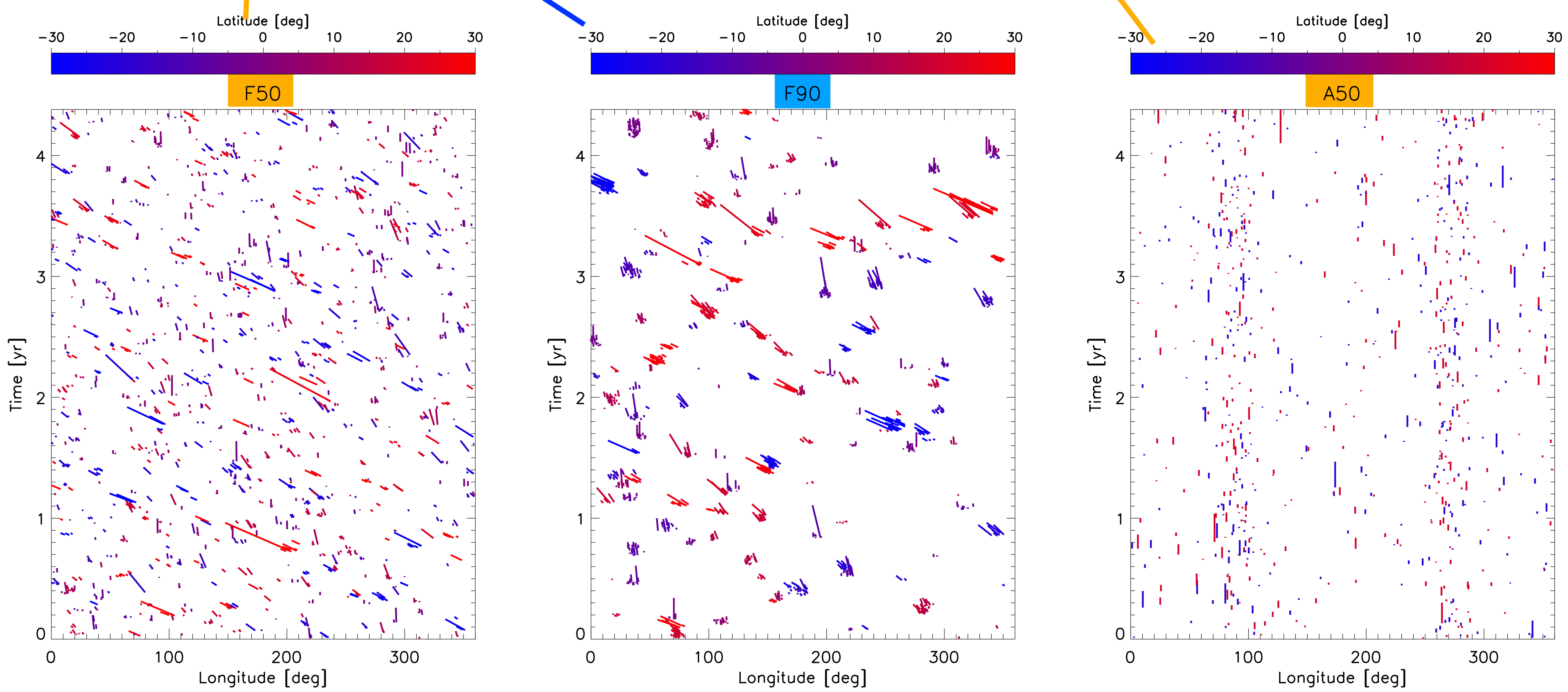




TYPICAL CONFIGURATION
(weakly nested)



RARE CONFIGURATION
(strongly nested)



Active-region emergence events and lifetimes (only the spot component shown)