Study of the magnetic structures in full-disk solar Ca II K images and sun-like stars connection

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Introduction

- **Aim :** Study the global dynamics and evolution of chromospheric magnetic structures

- **Ca II K structures** = Main contribution to the **solar irradiance** which plays a important role in the **chemistry of Earth atmosphere**
  - → Study the long-term brightness variation of the chromosphere
  - → Useful for climate model construction

- **Ca II K emission** = Indicator of **stellar magnetic activity**
  - → Can serve as a « **Rosetta stone** » between the Sun and solar-like stars
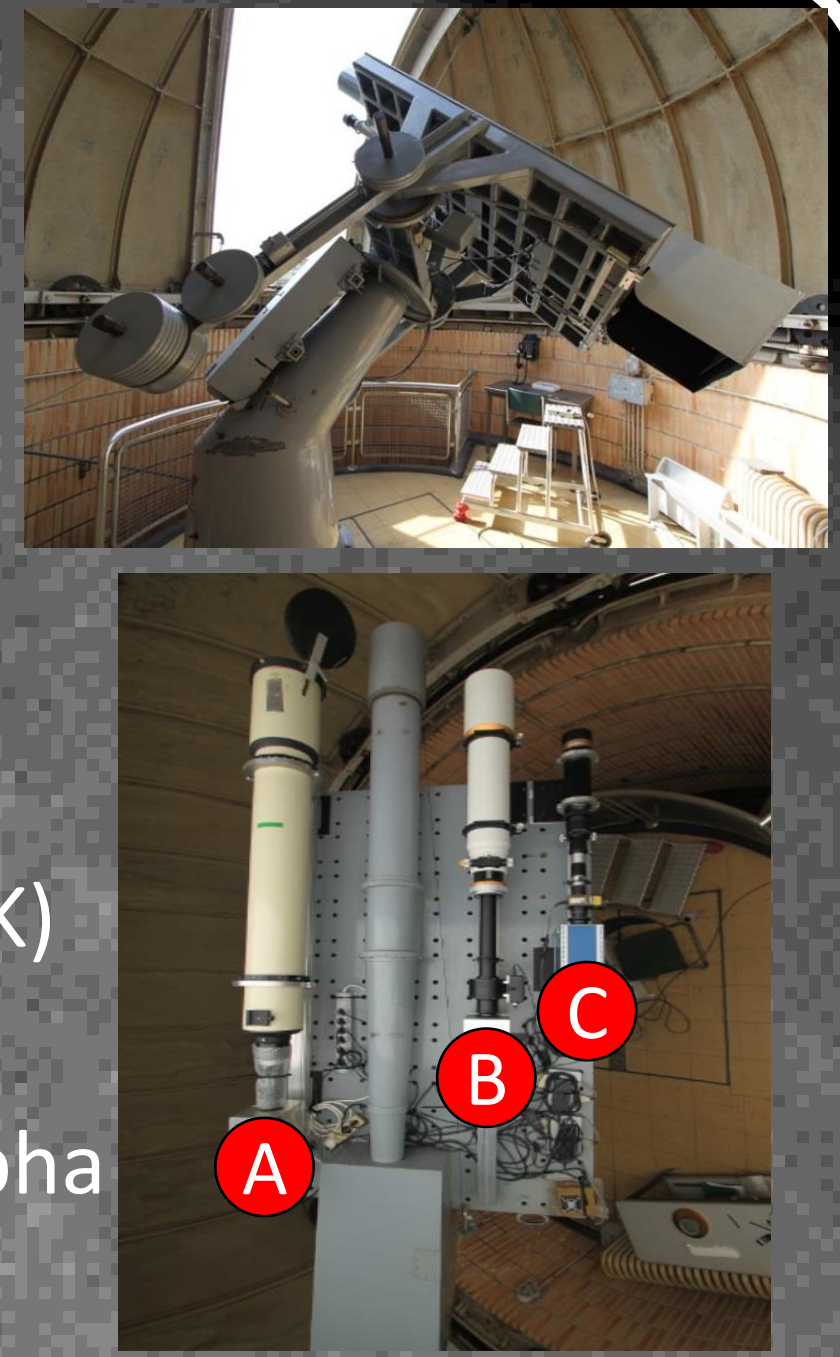 - → Suspected to be affected by **inclination angle of stellar rotation axis**
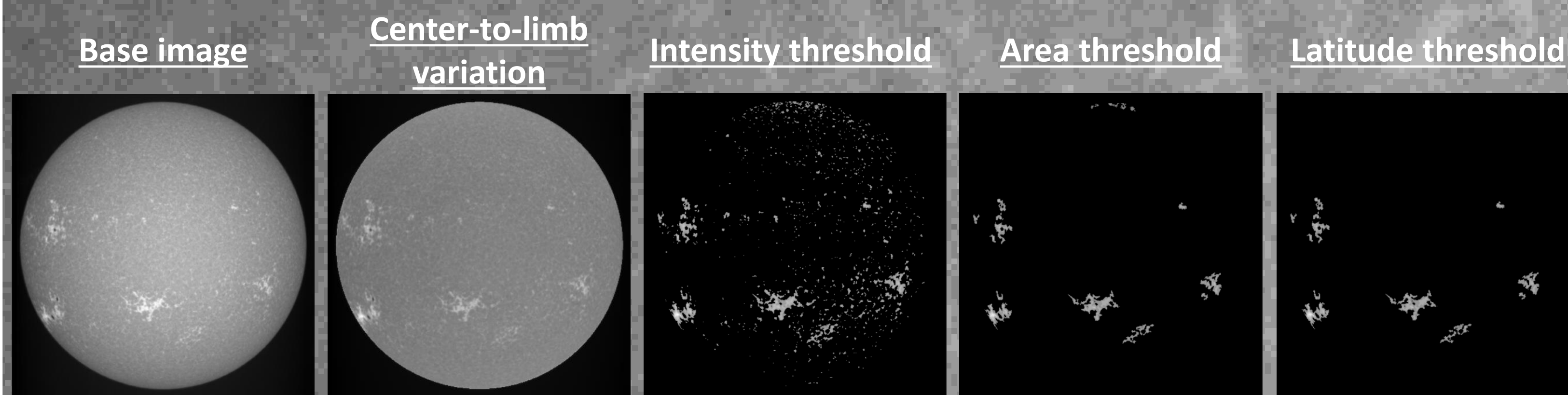

Bright plages / Chromospheric network / Bright plages and sunspots group / Chromospheric network
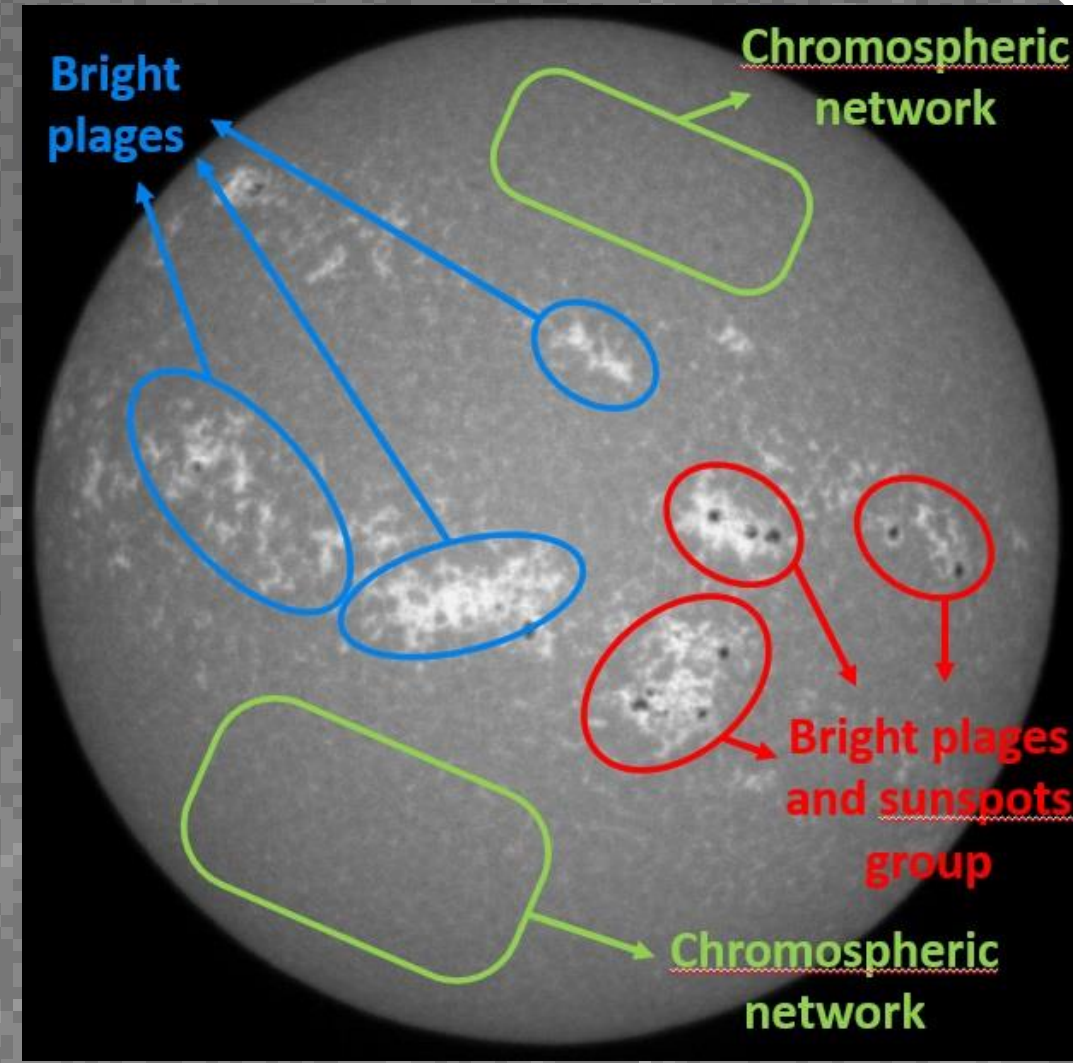
Dataset

USET : « **U**ccle **S**olar **E**quatorial **T**able »

- **Ground based** station located in Uccle, Brussel, Belgium

- Observing the Sun's **photosphere** and **chromosphere** simultaneously in 3 wavelenghts
  - A **White Light** (WL)
  - B **Calcium II K** (Ca II K)
  - C **H alpha** (Hα)

MAGES :

- From **2012** for Ca II K and **2002** for White light and H-alpha
- Acquired 7 days/week when the weather permits
- CCD images : 12 bit | 2048 x 2048 pixels
- 3 modes: **Manual** | **Synoptic** (every 15 min) | **Continuous** (every 10-20 sec)
- Total of **21.265 Ca II K images** since 2012

Plage-segmentation

Base image → Center-to-limb variation → Intensity threshold → Area threshold → Latitude threshold

Correction of the intensity for the limb darkening effect

95th percentile of whole-disk intensity distribution

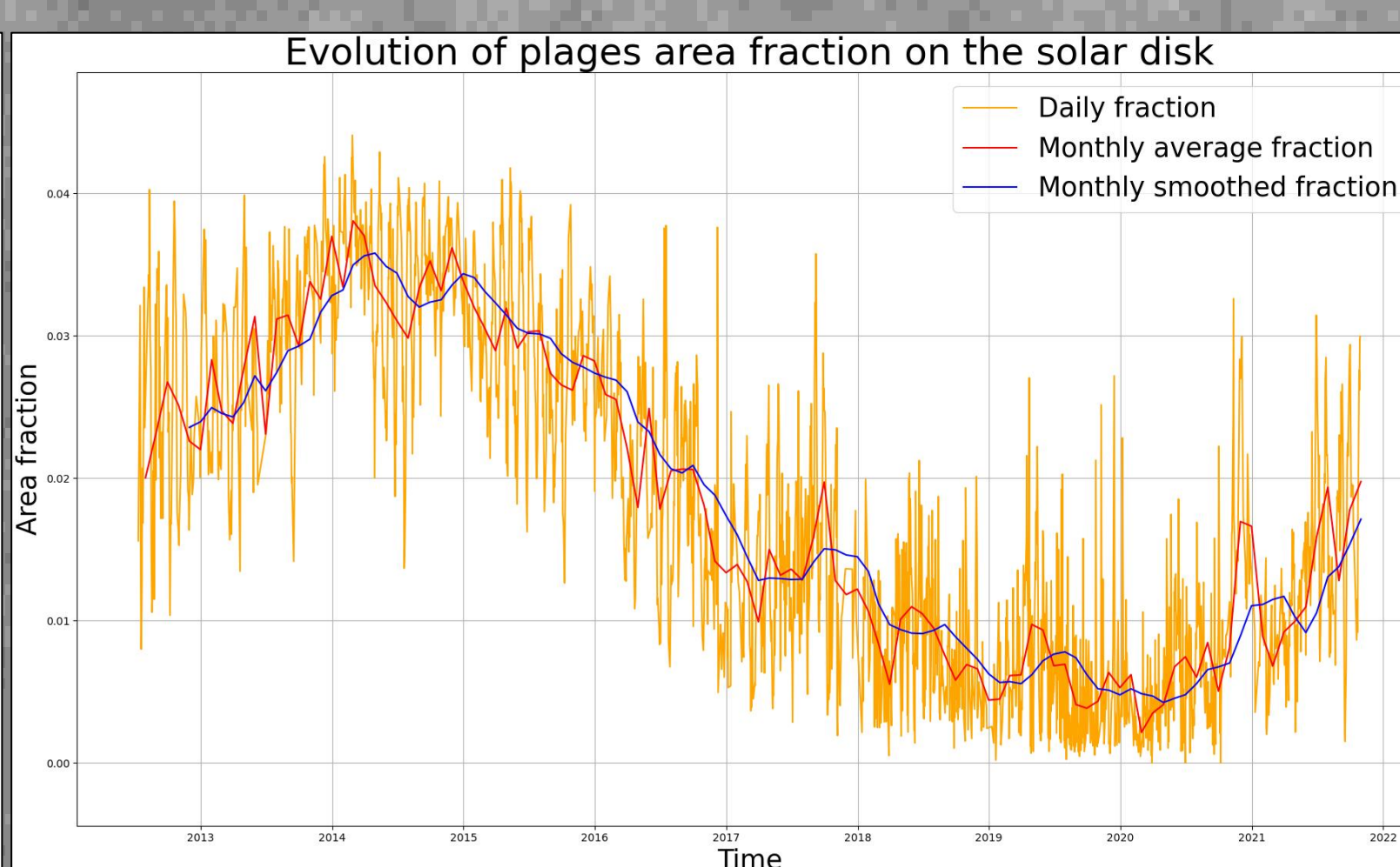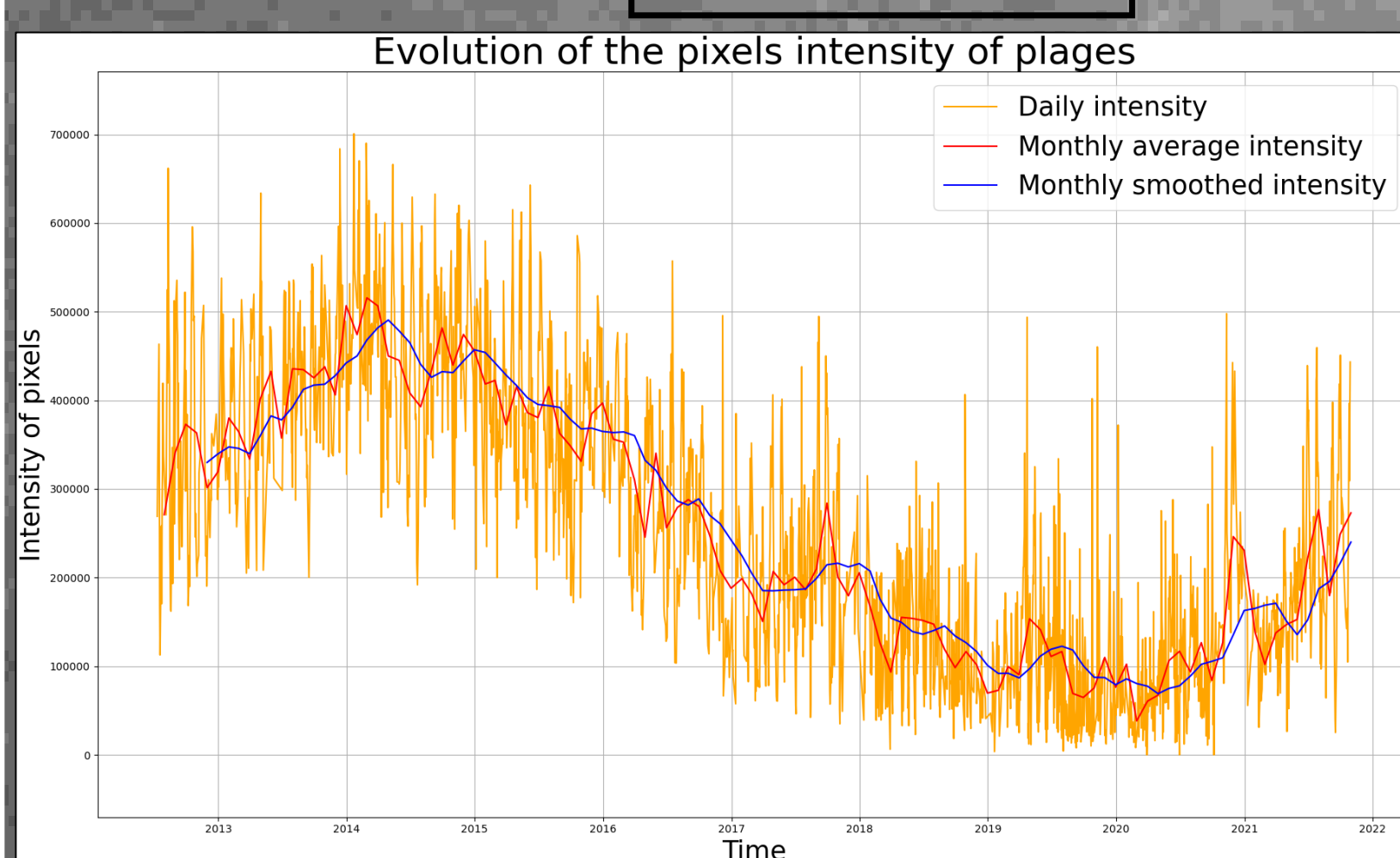Selection of connected components with area > chromospheric network cell

Selection of connected components > 50° of latitude
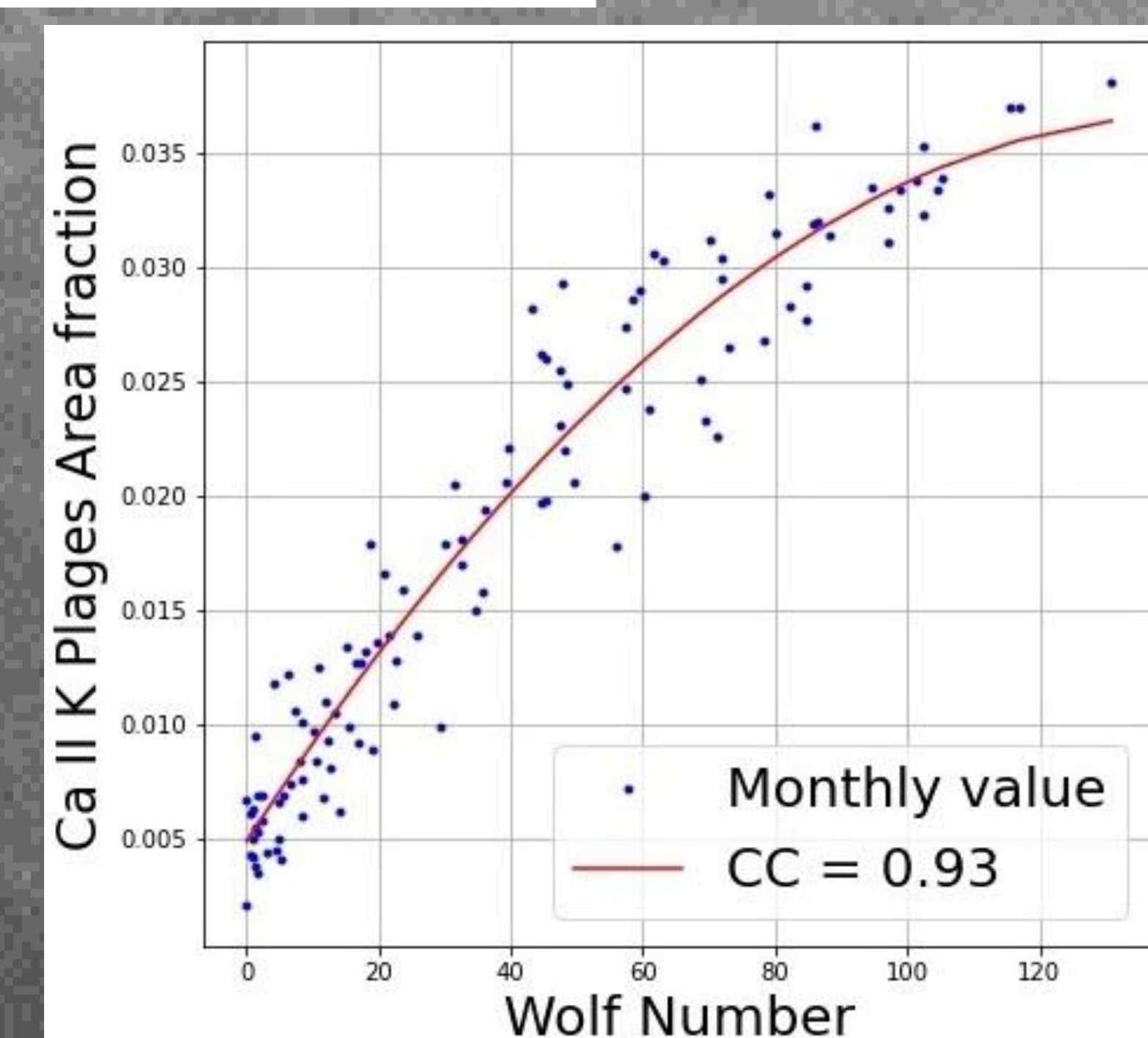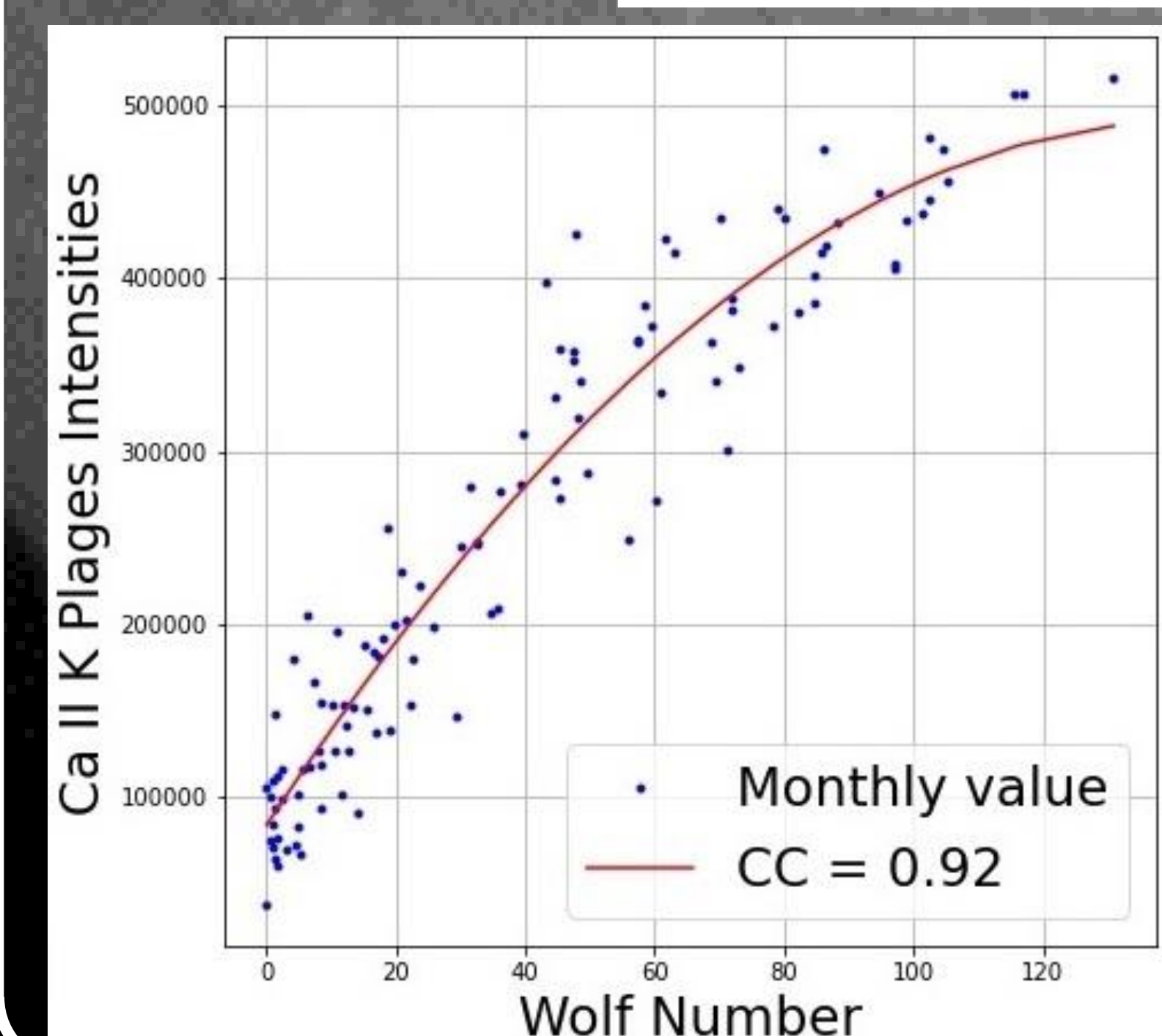
l = Intensity
i = Plages pixel

$$I_{tot} = \sum_i I_i$$

$$A_{plage} = \frac{N_{plage}}{N_{SD}}$$

A = Area fraction
N = Pixels number
SD = Solar disk

Evolution of the pixels intensity of plages
- Daily intensity
- Monthly average intensity
- Monthly smoothed intensity

Evolution of plages area fraction on the solar disk
- Daily fraction
- Monthly average fraction
- Monthly smoothed fraction

Validation of time series

Monthly value / CC = 0.92

Monthly value / CC = 0.93

Construction of synoptic maps

Deprojection + **Selection of a specific slice** + **Assembling** + **Normalization**

Synoptic Map from 01/08/2014 to 31/08/2014
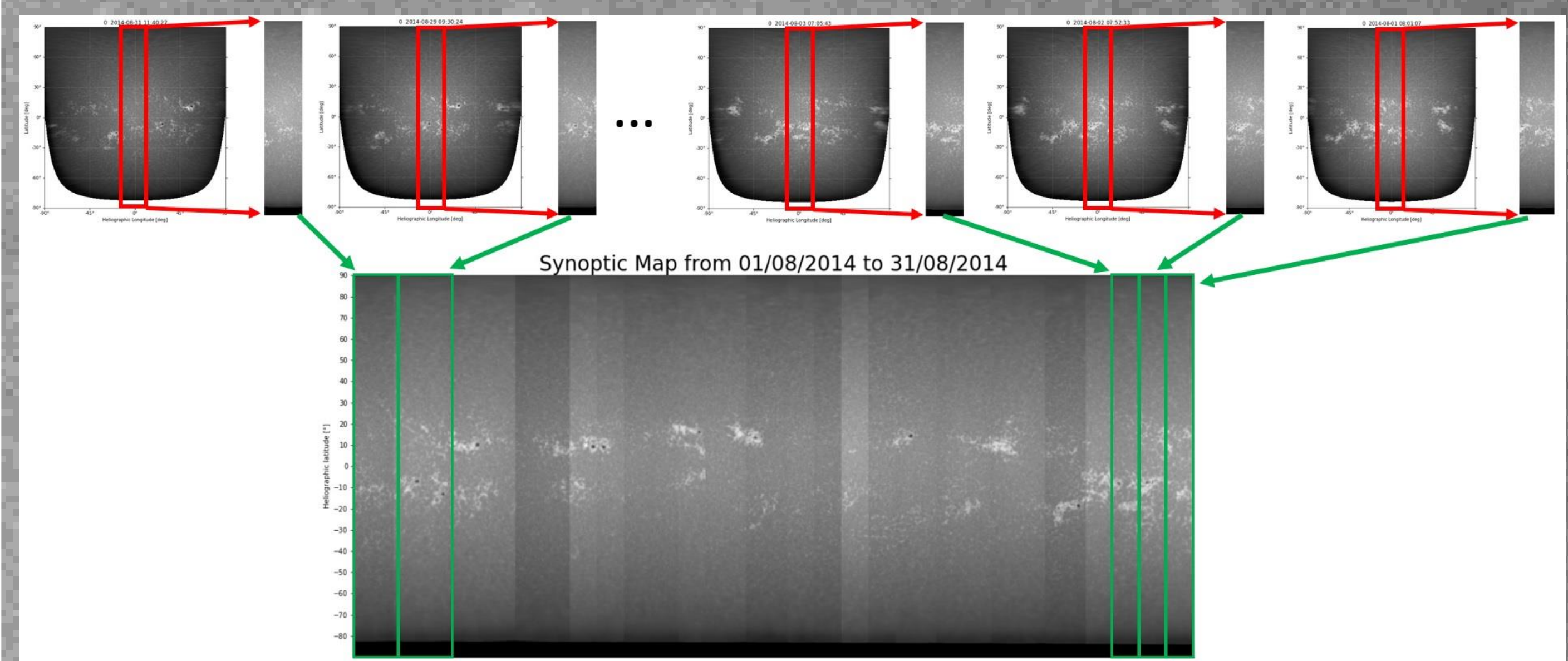
Synoptic map (Sun's equator view)

Synoptic Map from 01/08/2014 to 31/08/2014
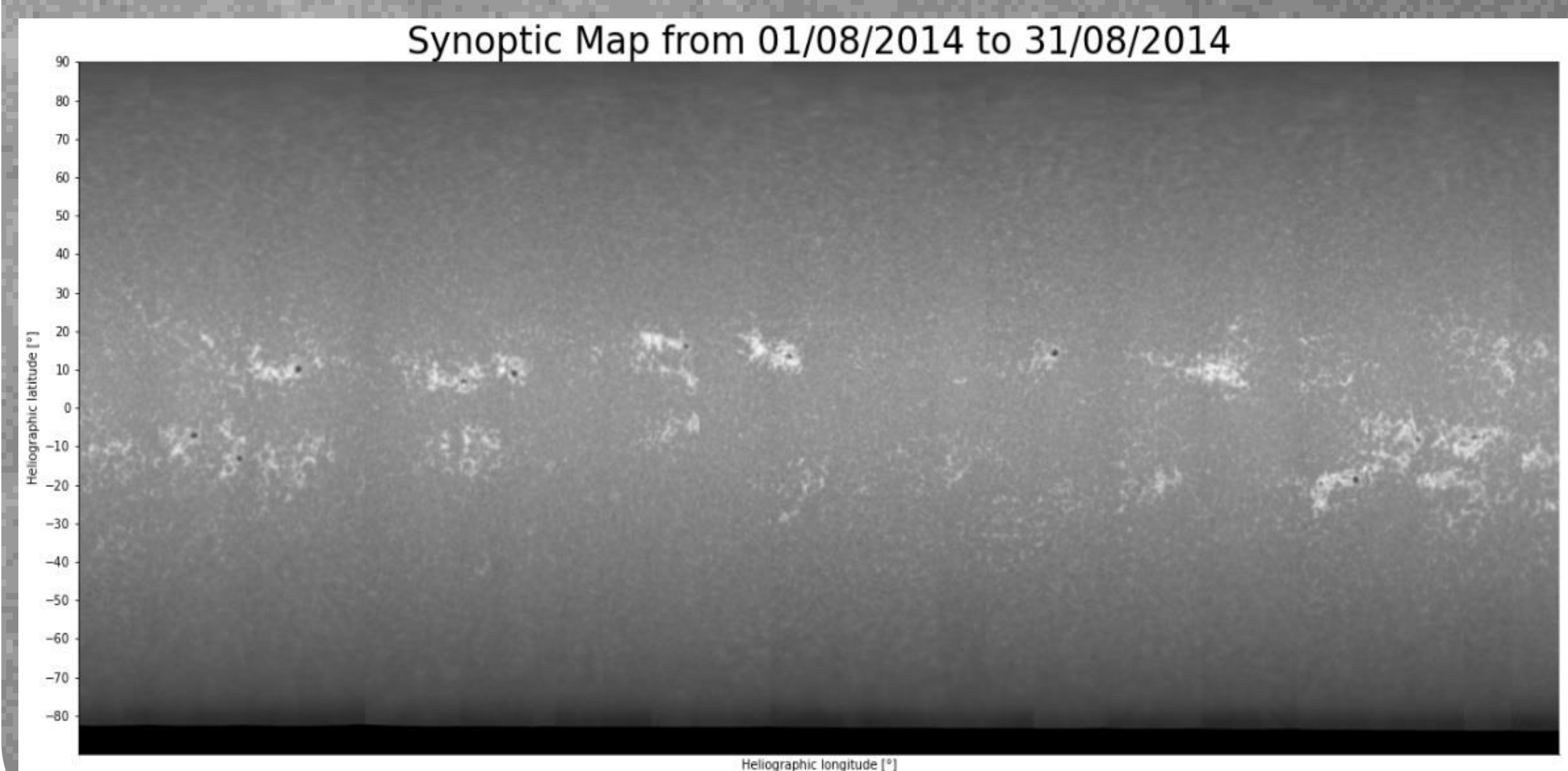
Analysis

- Data : **Monthly** averaged value
- Fit : **Second-order** polynomial
- Correlation coefficient : **High** for both time series

Monthly value / Fit 1D / Fit 2D / Fit 3D / Fit 4D

Correlation coefficient for Area fraction VS Wolf Number

Best polynom degree
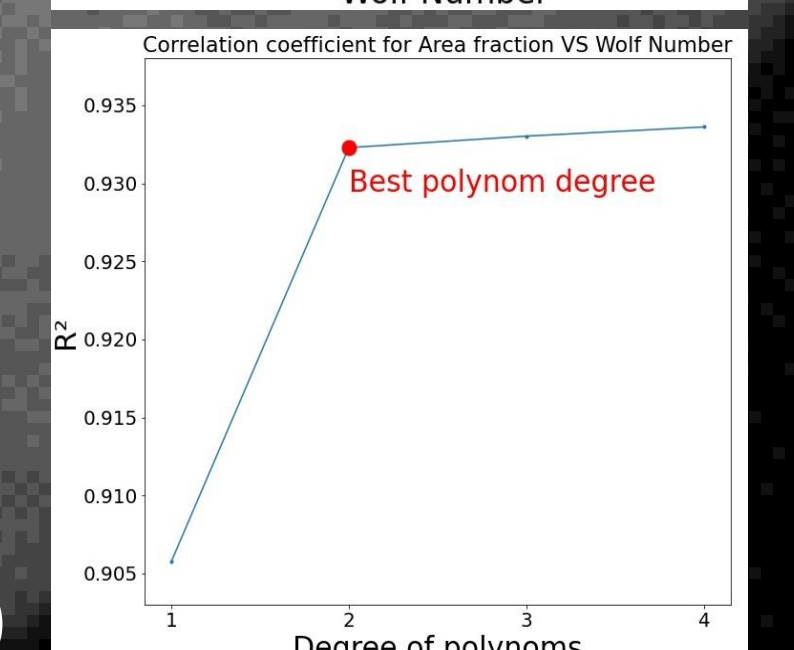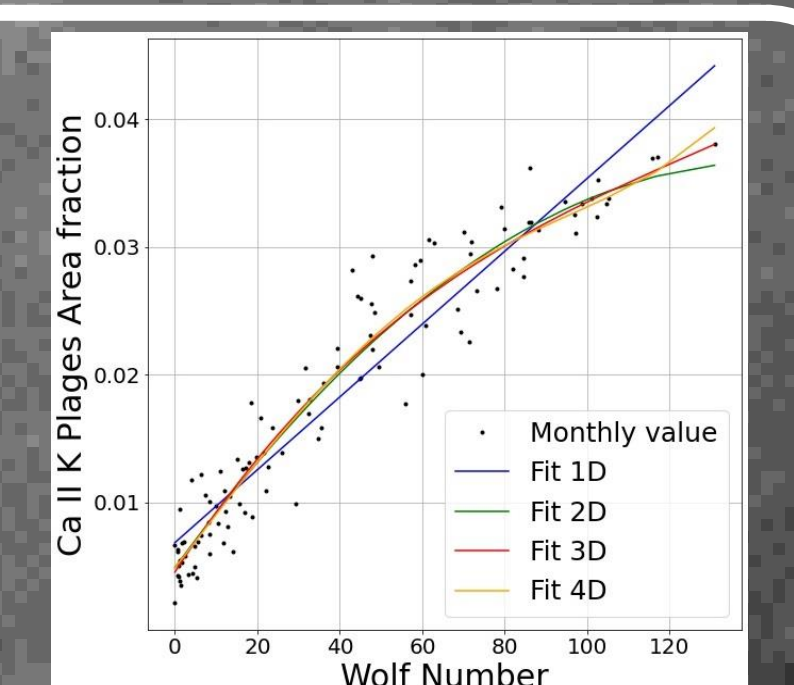
<u>Source Wolf Number Data :</u> USET (Royal Observatory of Belgium)

Perspectives

- Using solar-like stars S-index from TIGRE telescope (Mexico) to find a correlation with our **Ca II K emission time series** (intensity and area fraction)
- **Plages segmentation** of the **synoptic map** to study the brightness variation from any inclination angle

Paper poster

USET website