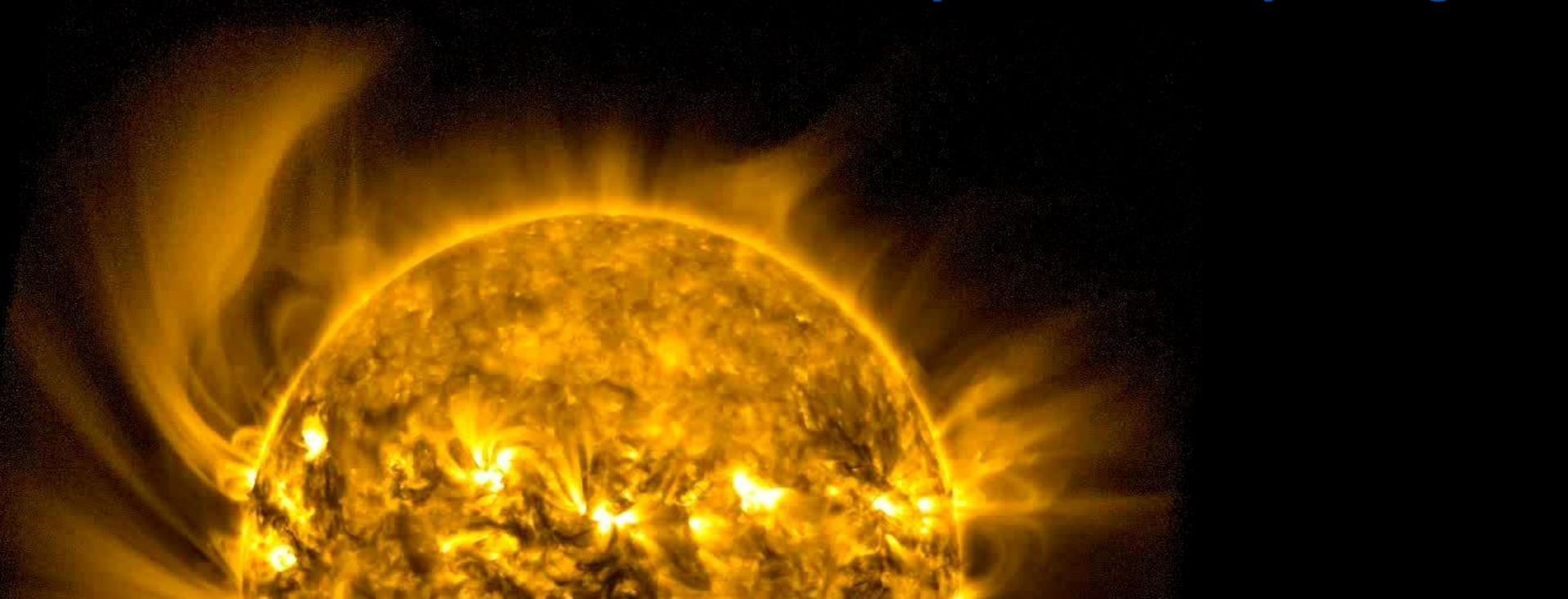


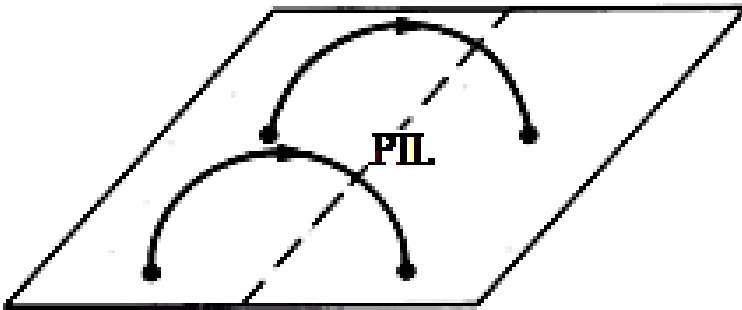
Observational analysis of coronal fans

Dana Talpeanu – University of Bucharest
Laurel Rachmeler – Royal Observatory of Belgium

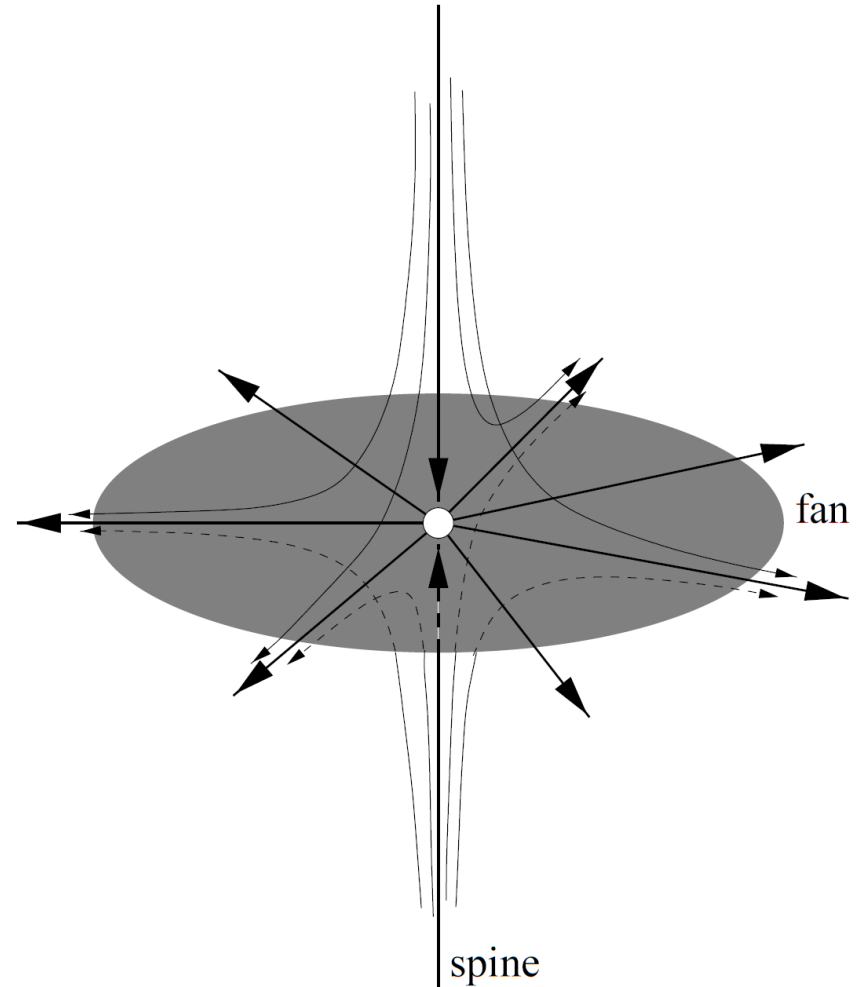


1. Magnetic topology

- Magnetic null point
- Polarity inversion line
- Separatrix surface



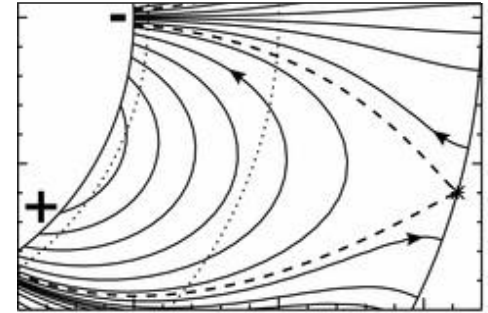
Ballegooijen & Martens (1989)



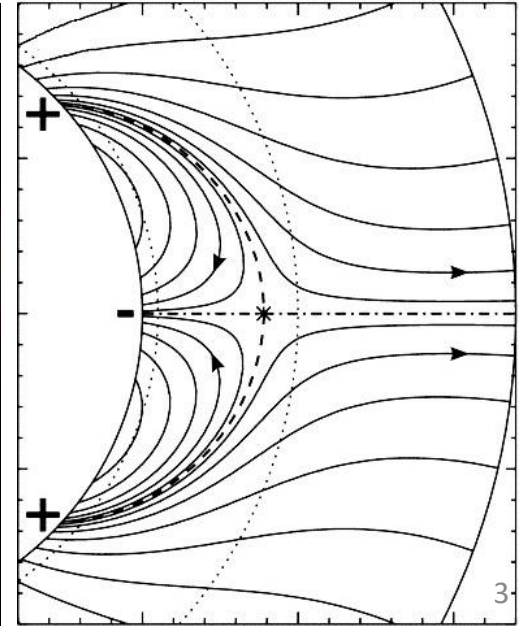
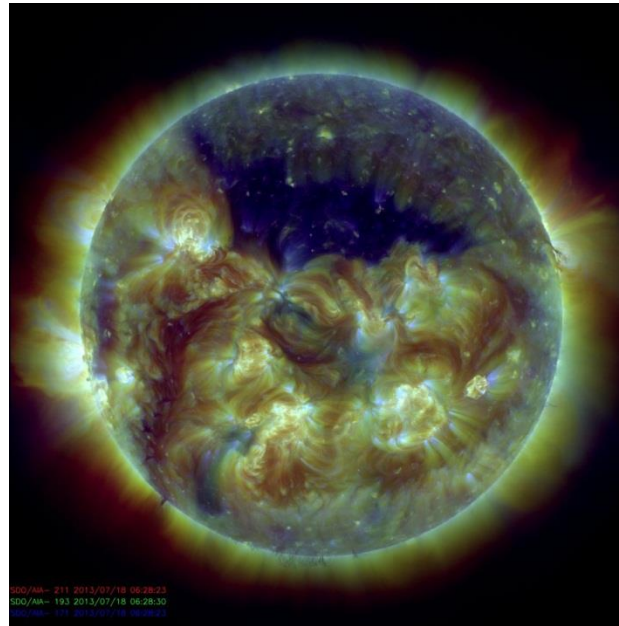
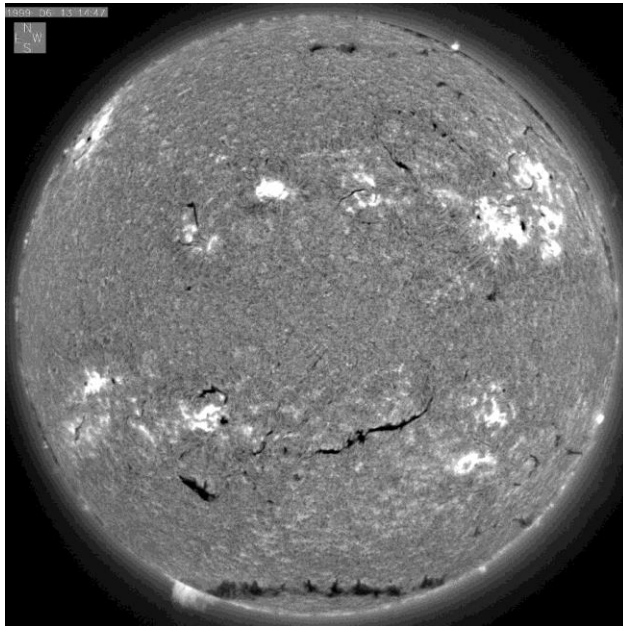
Longcope (2005)

2. Solar structures

- Filaments
- Coronal holes
- Coronal streamers and pseudostreamers

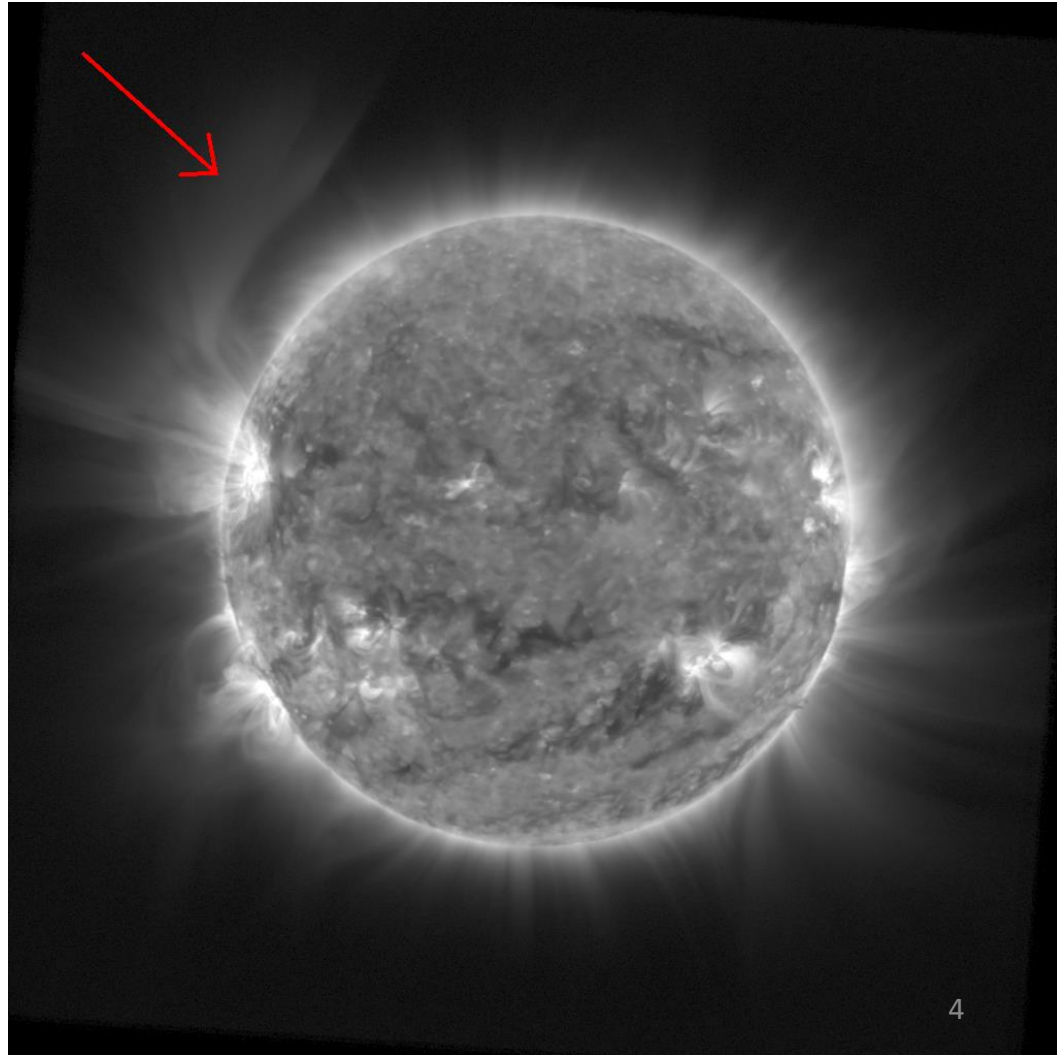


Rachmeler et al. (2014)



3. Coronal fans

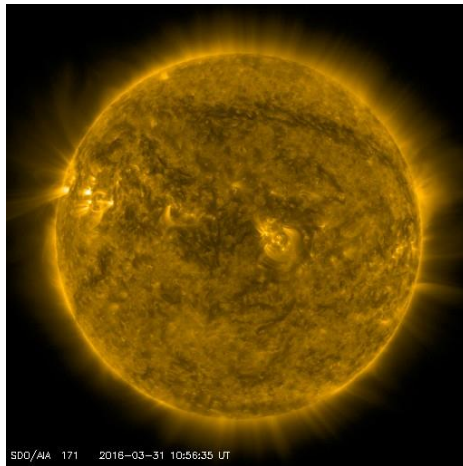
- Large structures
- Last long periods of time
- Usually – at the boundary of an open field lines domain



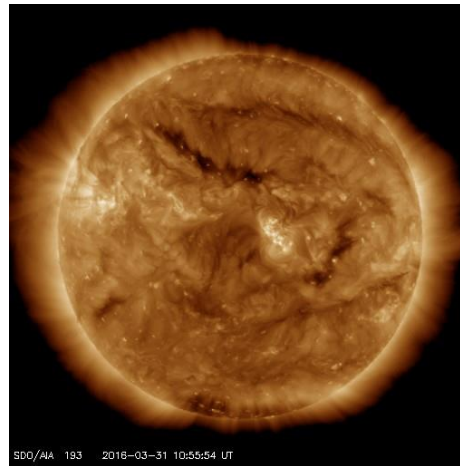
4. Data used

- SWAP movies (PROBA2)
- SWAP images with the fan on the limb and on the centre of the disk
- HMI magnetograms (SDO)
- $H\alpha$ images (from Earth observatories)
- AIA images (SDO) overlapped from 3 wavelengths:

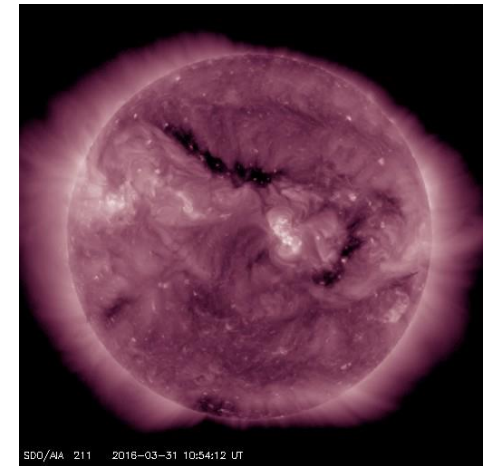
171 Å



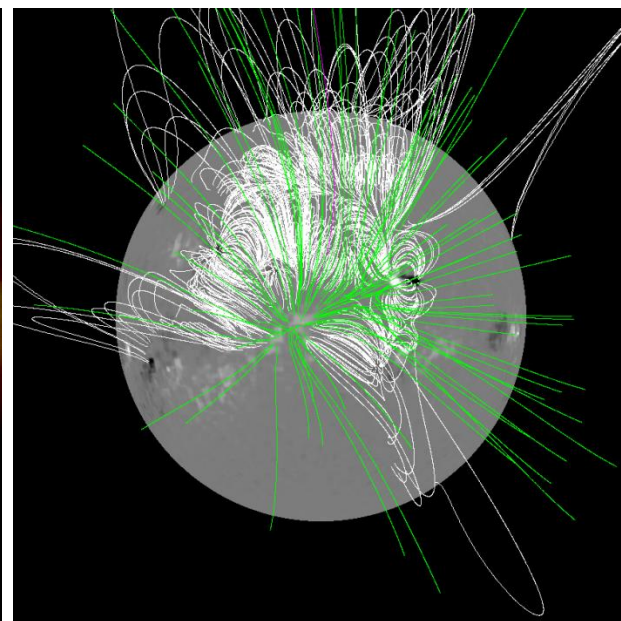
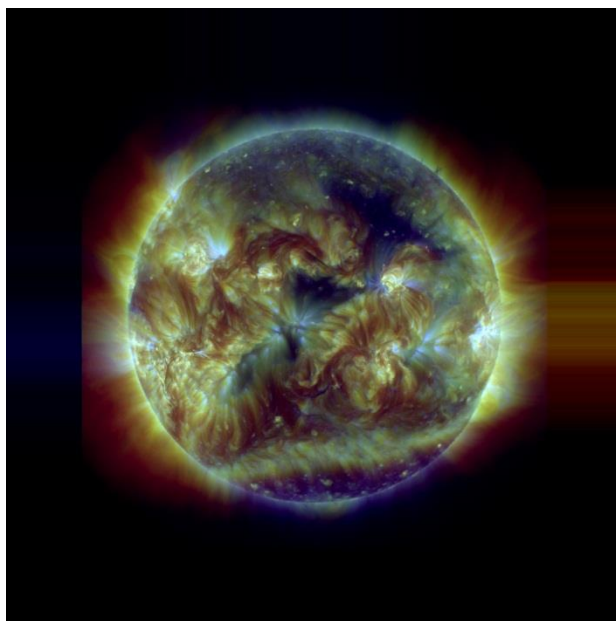
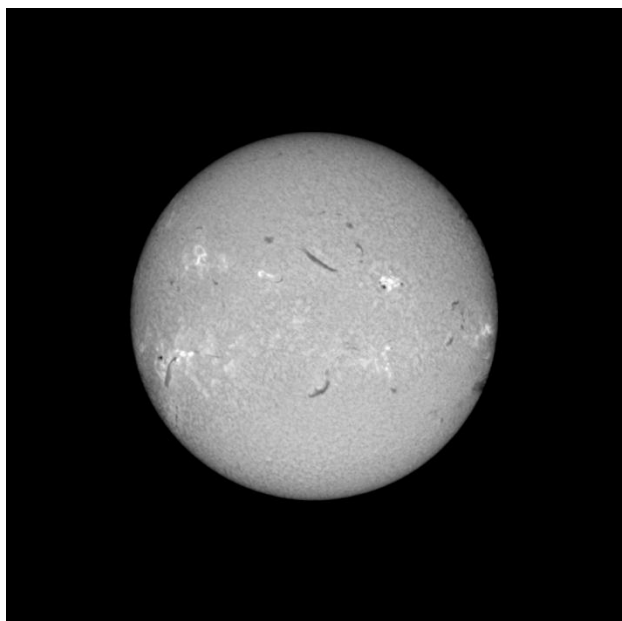
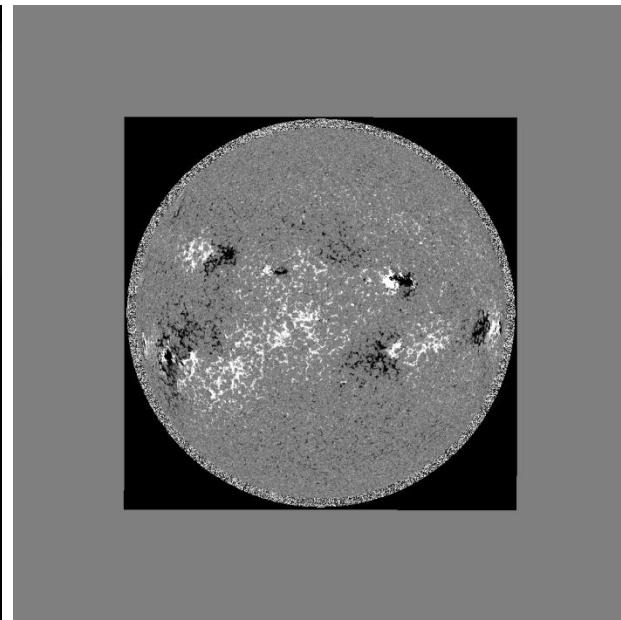
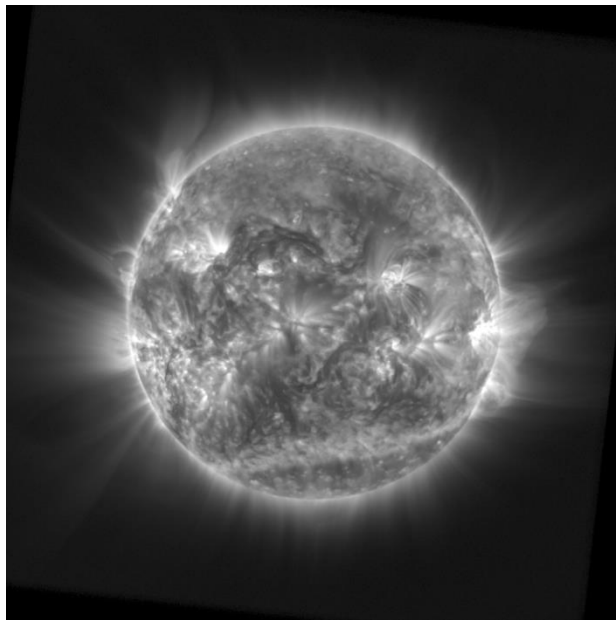
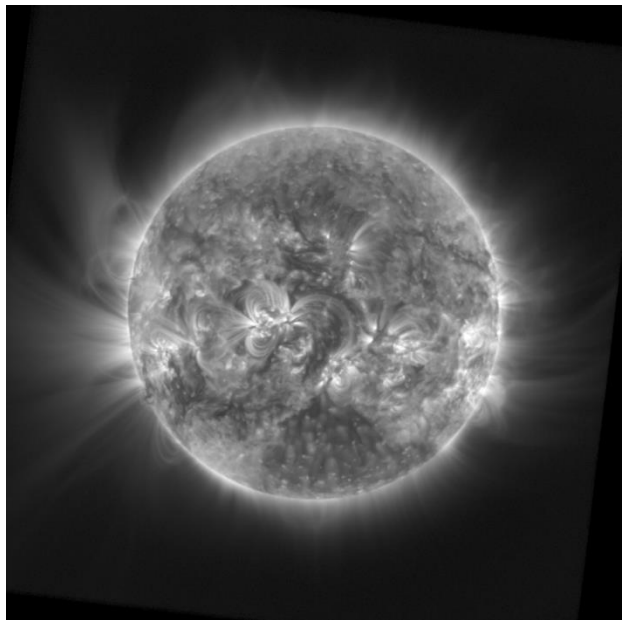
193 Å



211 Å



- PFSS extrapolations



5. The programs

- Program 1:

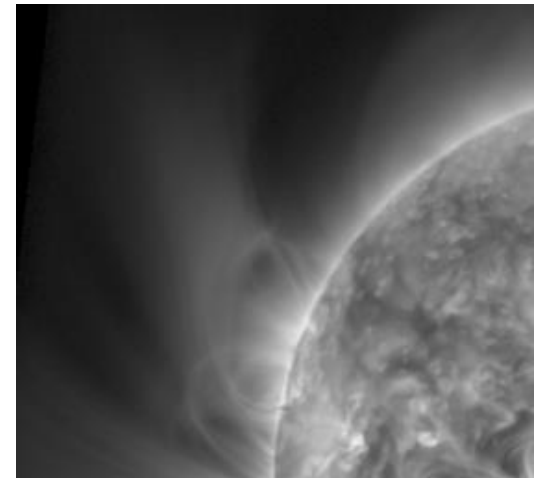
- Purpose:

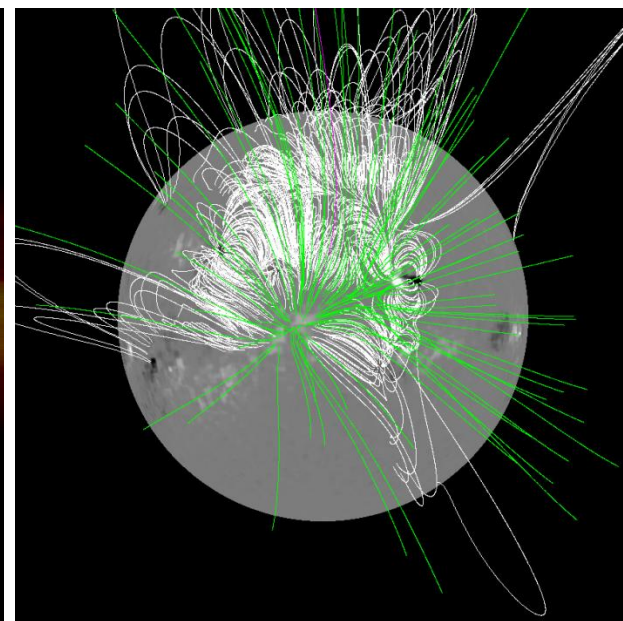
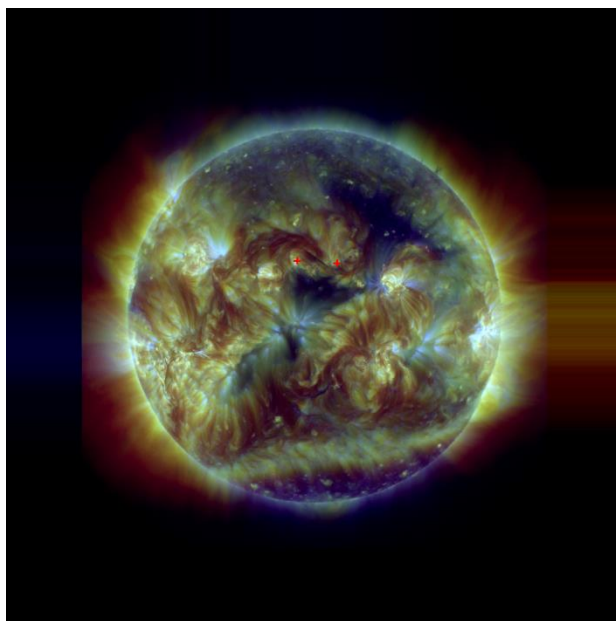
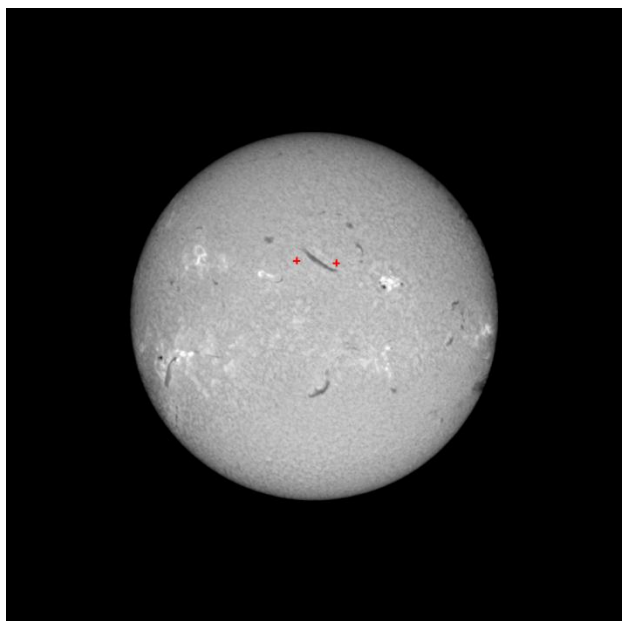
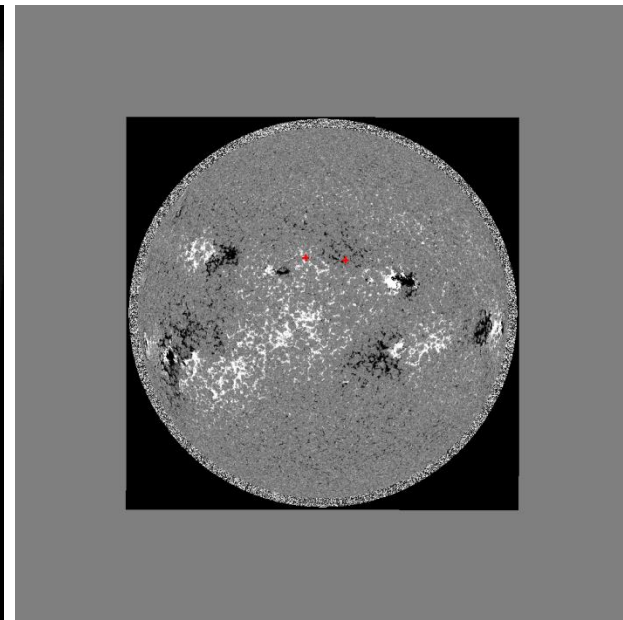
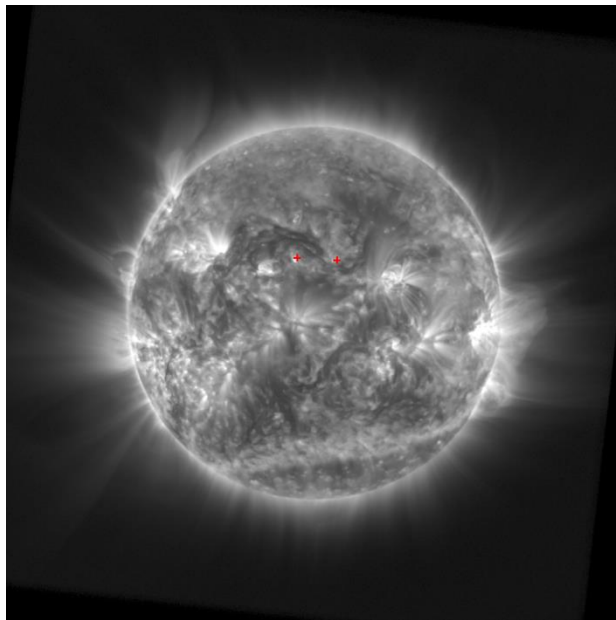
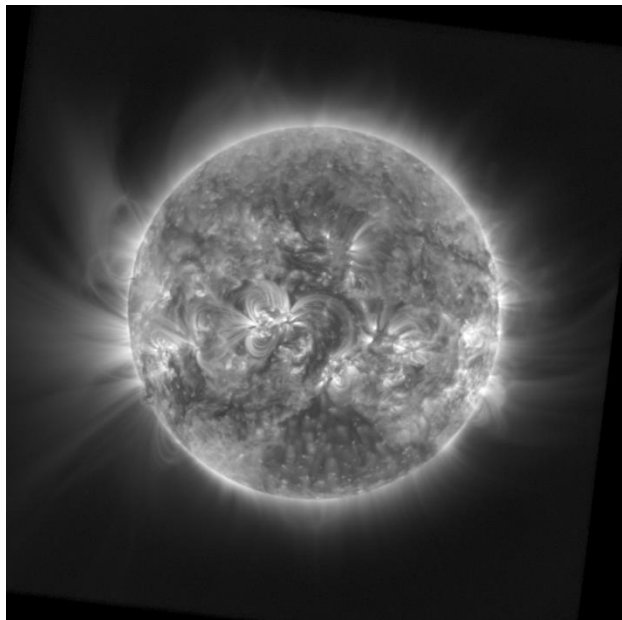
- fans <-> filaments, active regions
 - magnetic field domain

- Steps:

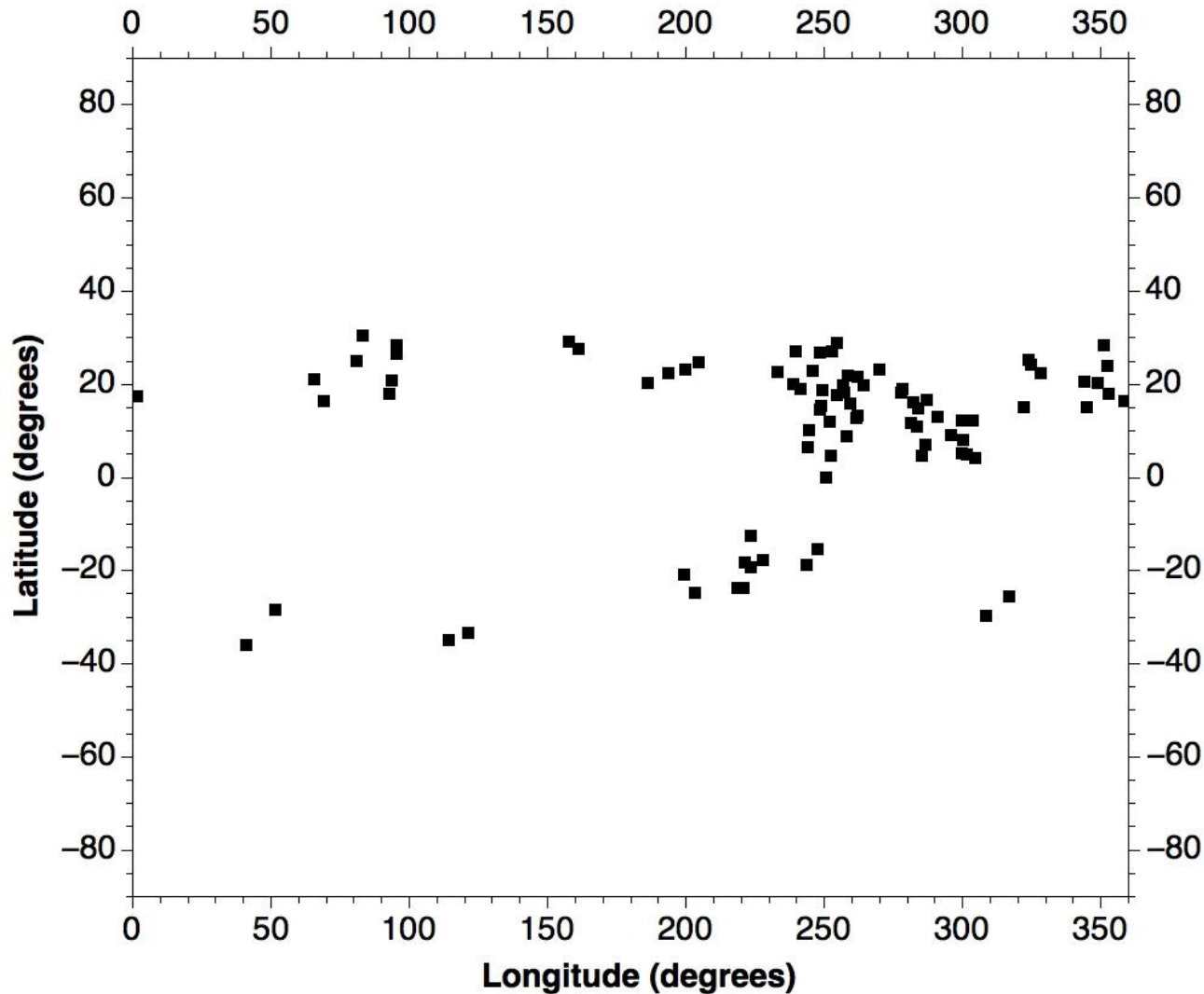
- SWAP and H α images, HMI magnetogram
 - calibrated SWAP images
 - footpoints coordinates in SWAP images
 - image coordinates (pixels) -> Carrington coordinates
 - differential time corrections
 - footpoints coordinates in H α and HMI images
 - plots the footpoints over the images
 - saves all the images

- Program 2:
 - Purpose: correlation footpoints <-> coronal holes
 - Steps:
 - AIA images in 171 Å, 193 Å, 211 Å
 - footpoints coordinates
 - time corrections
 - rescales the final image
 - plots the points
 - saves the image
- PFSS analysis:
 - footpoints -> separatrix surfaces
 - open magnetic field lines -> polar open lines
- Correlation knee – streamers?





Fans footpoints coordinates distribution on the solar disk

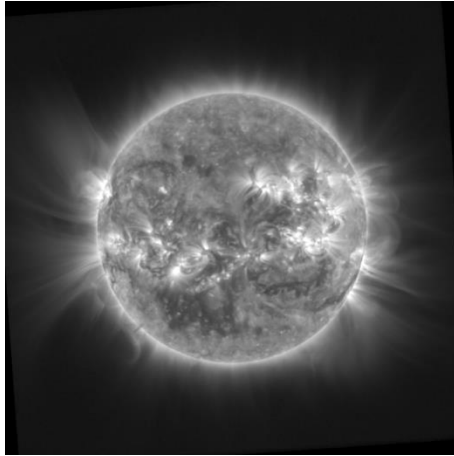


6. Case study

- Longest living fan: 20140408NE
- Split into 2 on 30 September 2014
- 7 Carrington rotations
- Evolution of the shape and footpoints

The evolution of the 20140408NE fan shape during 7 Carrington rotations
(from 2149 to 2155), present on the eastern limb of the Sun

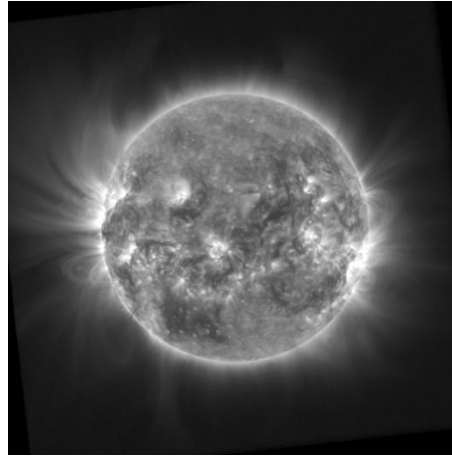
2149



2014 - 04 - 08

16:51:30 UT

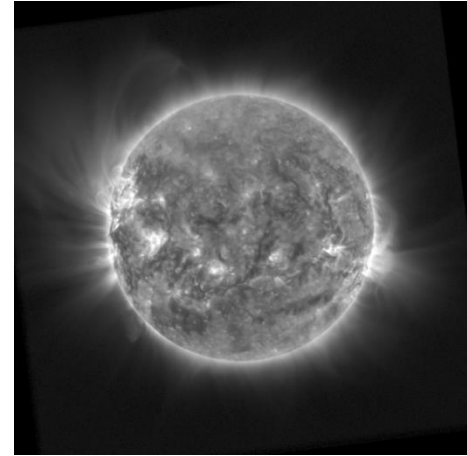
2150



2014 - 05 - 06

04:44:39 UT

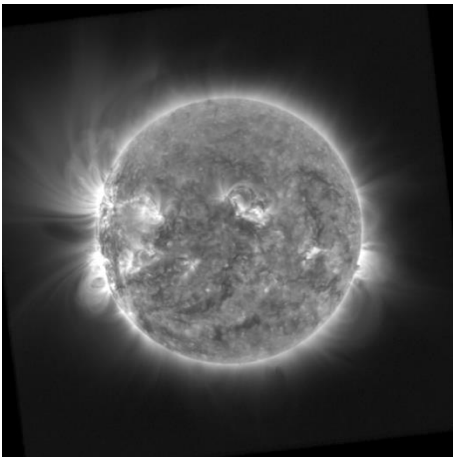
2151



2014 - 06 - 02

11:13:28 UT

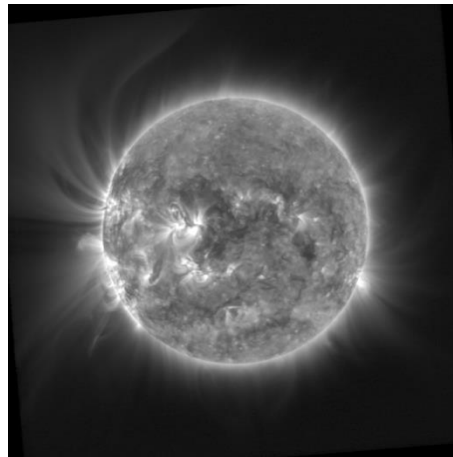
2152



2014 - 06 - 29

05:10:27 UT

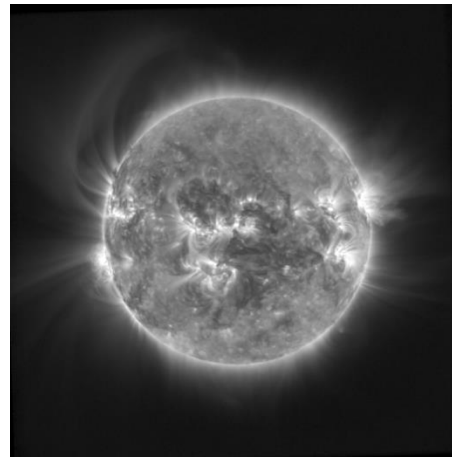
2153



2014 - 07 - 26

18:24:45 UT

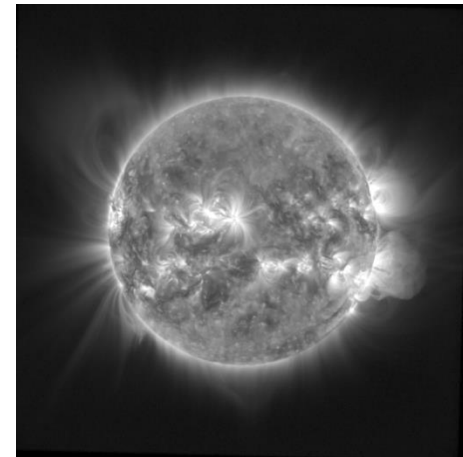
2154



2014 - 08 - 22

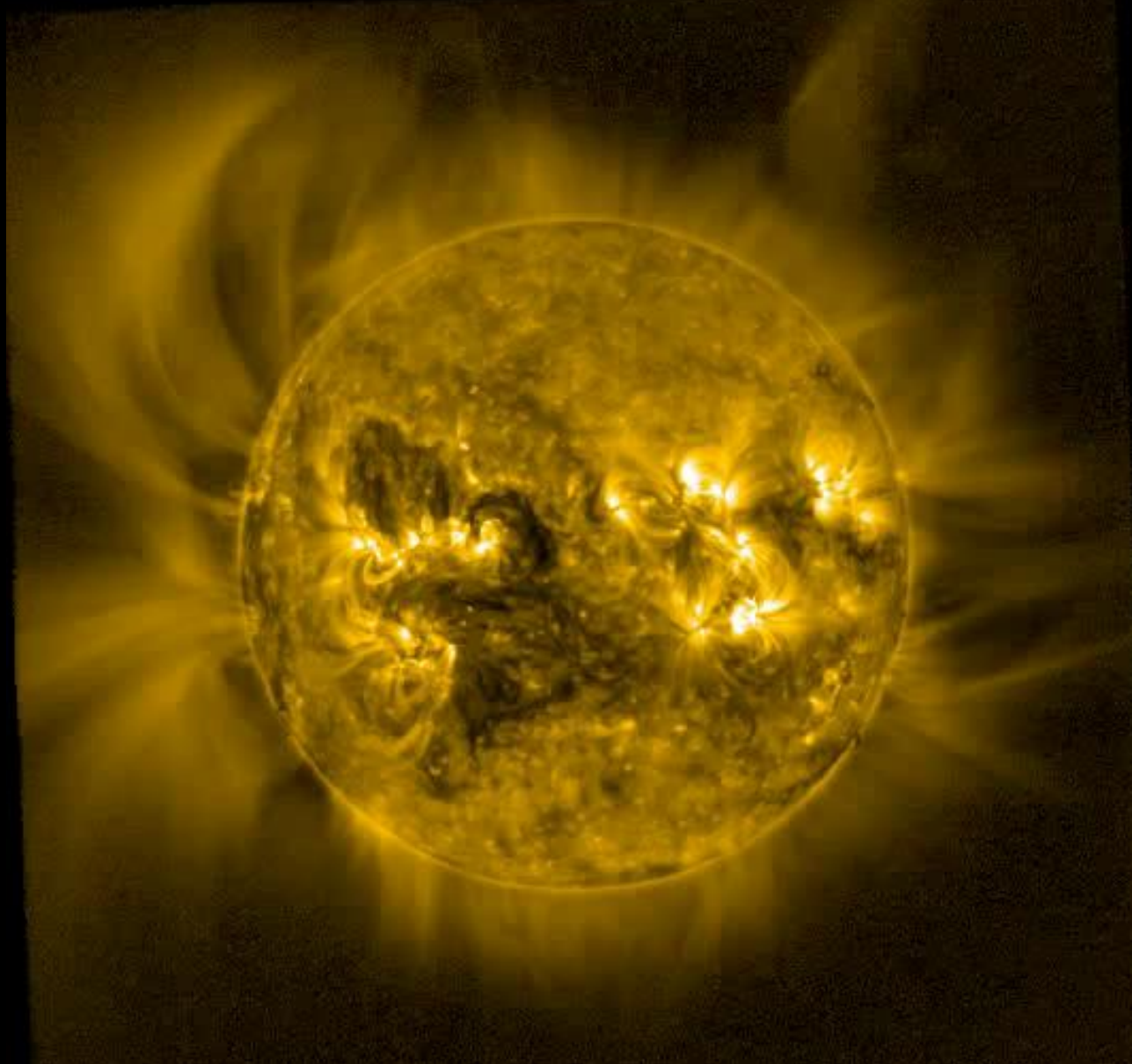
23:31:34 UT

2155



2014 - 09 - 17

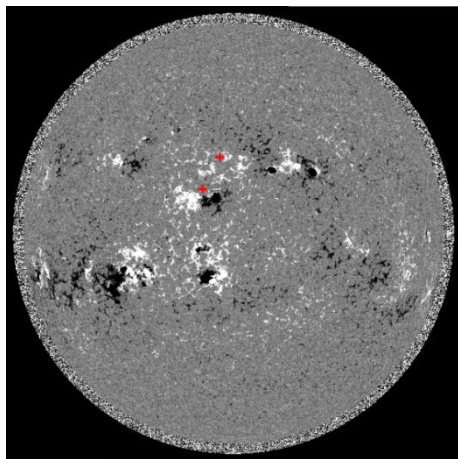
17:47:32 UT



PROBA2/SWAP 17.4nm 2014-08-21 11:24:52

The evolution of the 20140408NE fan footpoints during 7 Carrington rotations (from 2149 to 2155) plotted on the HMI magnetograms

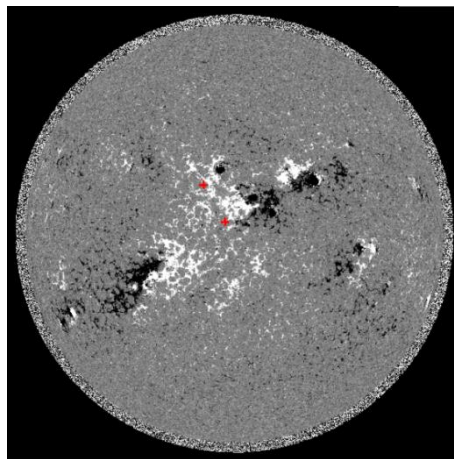
2149



2014-04-15

12:12:00 UT

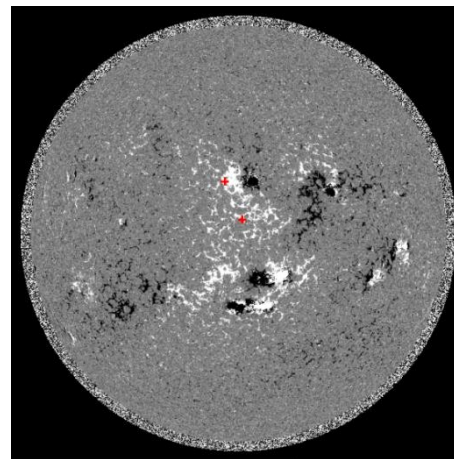
2150



2014-05-12

17:28:30 UT

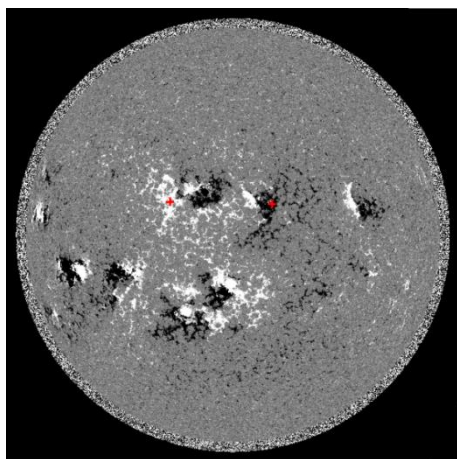
2151



2014-06-09

01:31:30 UT

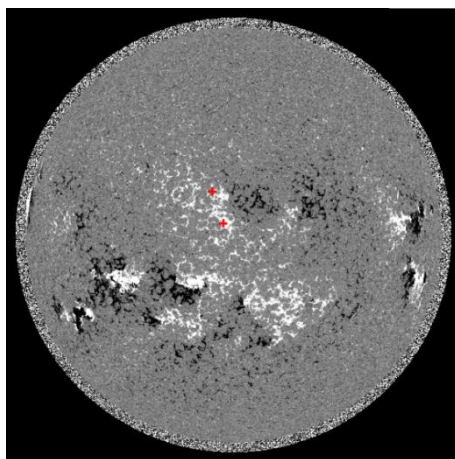
2152



2014-07-04

20:11:15 UT

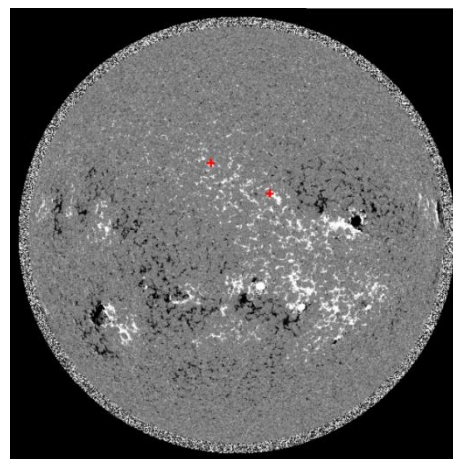
2153



2014-08-01

17:55:30 UT

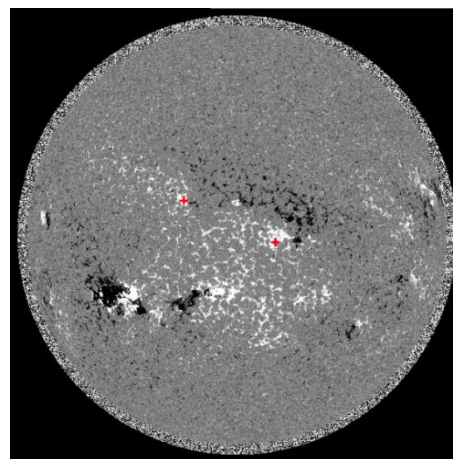
2154



2014-08-29

23:54:00 UT

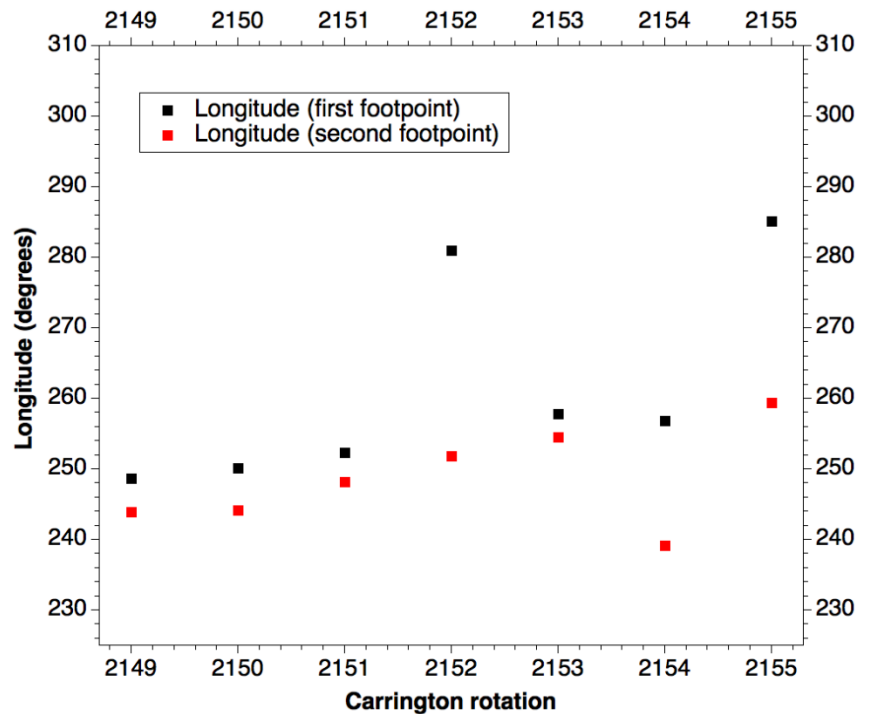
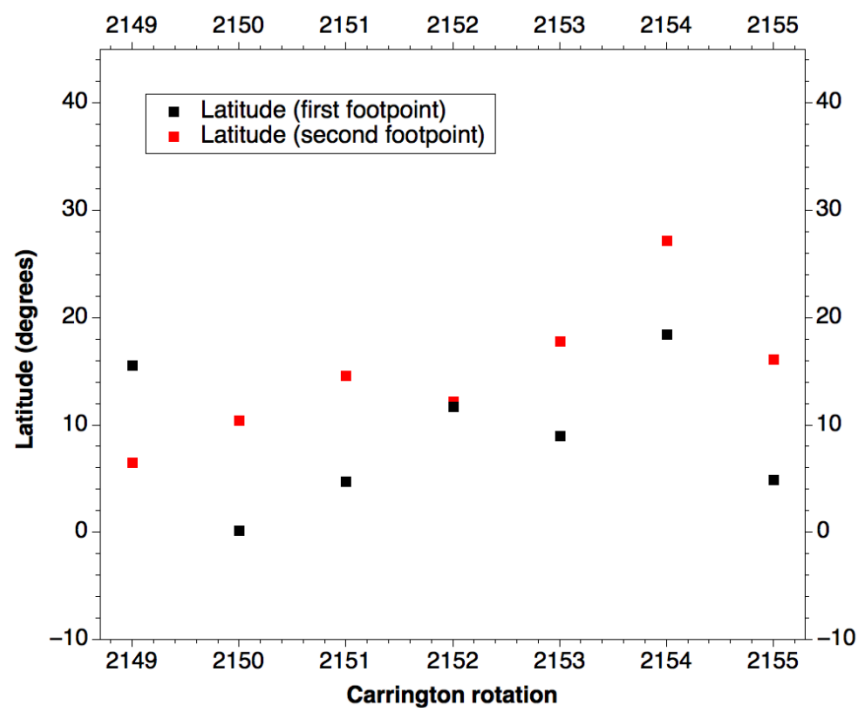
2155



2014-09-24

04:33:00 UT

The dependence of footpoints coordinates (latitude – left and longitude – right) on Carrington rotation



7. Conclusions

- 15 fans analysed (lifespan 1 - 7 CRs)
- Almost all the cases:
 - open field lines near the footpoints
 - the fan -> separatrix surface
 - the footpoints don't cross a PIL (stay in the same magnetic domain)
 - footpoints within active region bands
- Approx. half the measurements:
 - active regions near footpoints
 - open field lines -> same sign as the polar open field lines
 - footpoints near coronal holes
- NO footpoints inside a coronal hole
- In 1/3 of the measurements: filaments near footpoints
- Knee varies -> streamers and pseudostreamers

Thank you for your attention!

