Statistical study of Solar filaments since 1919

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Abstract: Science board of Paris Observatory funded the data capture of tables associated with Meudon synoptic maps of Solar activity, which were published for observations ranging from 1919 to 1992. The EU HELIO project developed automatic recognition codes, especially concerning filaments based on observations between 1996 en 2014 (and soon, up to now). We plan to fill the gap between the two catalogues in the short term. But it is already possible to study filaments behavior over quite long periods of time.
We present here the first series of results obtained from this analysis which give some clue about the way Solar activity behaves in various parts of the cycle, and about the way if depends on the hemisphere where activity occurs. This information could then be correlated with events catalogues (e.g. flares, CMEs, …) in order to link those phenomena with concrete Solar activity.

Introduction

Solar features are the visible signature of Solar activity ruled by the Solar cycle. The understanding of Solar cycle is based on sunspots number. We propose here to extend this study using filaments data from 1919 up to now

Synoptic maps of Solar Activity

L. d'Azambuja published in 1928 the first series of « Cartes Synoptique de la Chrosmosphère Solaire », starting with Carrington rotation n° 876 (March-April 1919). It was published continuously until 2002 except a gap between 1992 and 1996.
Maps represent a synthesis of Solar activity during the rotation. Amongst other information, those maps are associated with tables giving a detailed description of filaments during the considered Carrington rotation. Figure 1 shows an example of a synoptic map and Figure 2 the associated filaments' table.

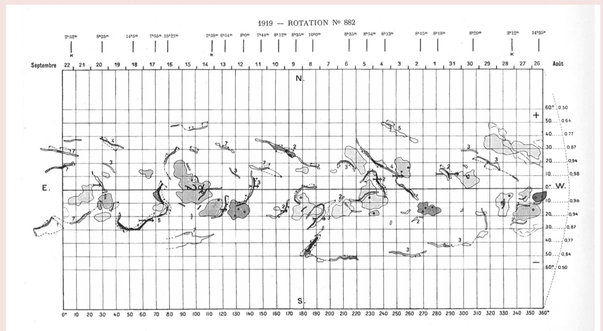


Fig. 1: Synoptic map of Solar activity, Carrington rotation 882 (Aug.-Sept. 1919)

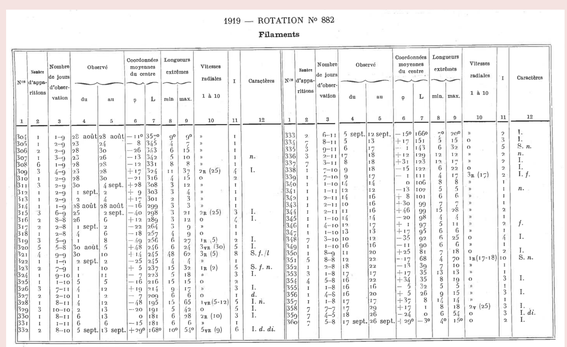


Fig. 2: Filaments' data for Carrington rotation 882 (Aug.-Sept. 1919)

Heliophysics Feature Catalogue (HFC) is available at http://voparis-helio.obspm.fr/hfc-gui/ or through the HELIO web page (http://www.helio-vo.eu/). It was built in the frame of the EU FP7 HELIO project (Bentley et al., 2011) and contains description of structures obtained using automatic detection codes.

Figure 3 shows a plot of some features extracted from HFC.
HFC contains the following features:

- Filaments (1996-2014)
- Prominences (2003-2012)
- Active regions (1996-2013)
- Coronal holes (1996-2013)
- Sunspots (1996-2015)
- Type III radio bursts (1996-2011)
- Metric radio sources (1999-2015)

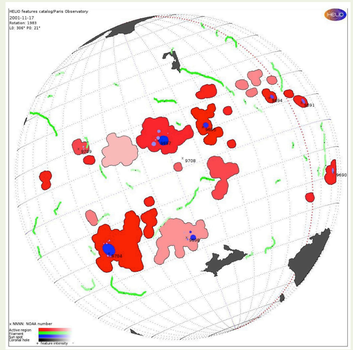
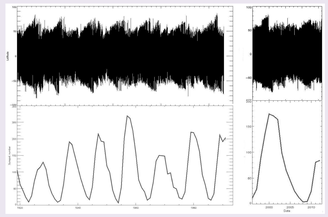


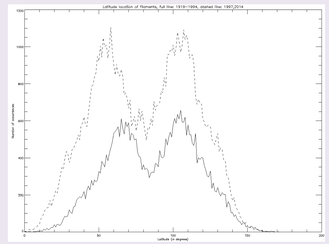
Fig. 3: Solar features extracted from HFC data for 17th of November, 2001. Grey: Coronal holes, Red: Faculæ, Blue: Sunspots, Green: Filaments. NOAA regions are labelled.

First results

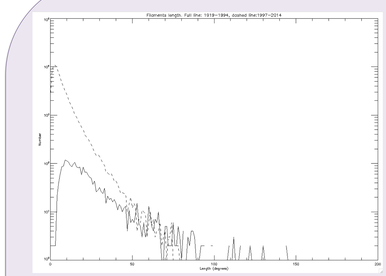
We present hereafter some preliminary results obtained from the raw information deduced from filaments' tables

Right: Upper panel shows butterfly diagram for filaments latitude. Lower panel gives sunspot number.

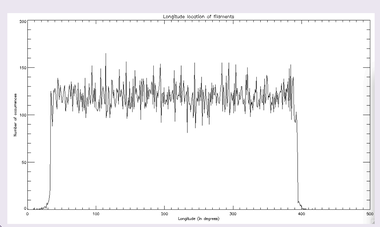




Left: Latitude location of filaments. Full line: 1919-1994. Dashed line: 1997-2014. 90° corresponds to the Solar equator. Note the asymetry in the recent period of time.

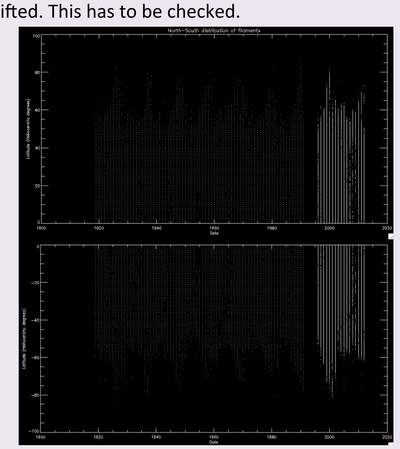


Left: Distribution of filaments length. Full line: for 1919-1994. Dashed line for 1997-2014.



Left: Distribution of filaments longitude. No significant specific longitude seems to correspond to fialements' location

The following figure shows the latitude distribution of filaments. Symetry is not obvious and should be studied, as well as the position of the maximum on each cycle for each hemisphere could be slightly shifted. This has to be checked.



Future prospects

Two main directions should be followed, to continue this study:

1. Compare global behavior of filaments, with sunspots' one. Check whether maximum and minimum of Solar cycle correspond or not (a very rough analysis seems to emphasize a slight shift between them).
2. Analyze filaments data as a function of the period of the Solar cycle they occur. We already know that for latitude, but this should be extended to filaments length which distribution probably vary during the cycle; also to their evolution (bending, splitting… and maybe 'Disparitions brusques'); as well as to the number of appearances during various parts of the Solar cycle.

Some useful references

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