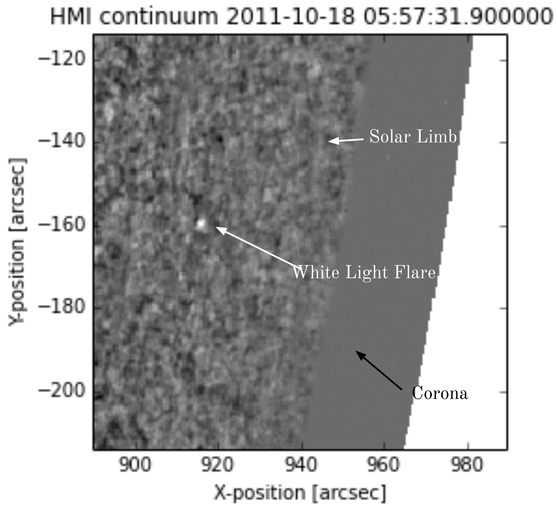
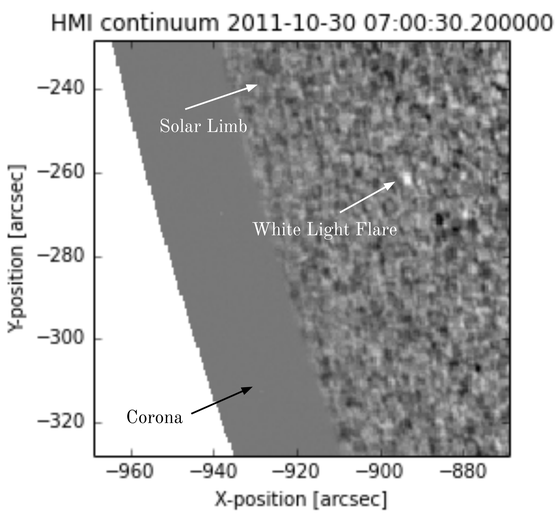
An Analysis of the Location of White Light Flares in the Sun's Atmosphere

Michelle Carey, Juan Carlos Martinez Oliveros



This image of a white light flare was taken using the SDO satellite on October 18, 2011.



This image of a white light flare was taken using the SDO satellite on October 30, 2011.

Abstract

When flares occur in the Sun's atmosphere, electromagnetic radiation in all wavelengths is emitted. Flares observed at visible wavelengths are called "white light" flares. Little is known about white light flares since the radiation from the Sun in the visible range greatly outshines what is produced during solar flares. Since white light flares are hard to see, it is not clear in what part of the solar atmosphere they occur. The point of this research is to identify where in the corona white light emission in produced during a flare. Depending on what will be discovered affects the validity of solar flare theories, particularly the Standard Flare Model, that have been a foundation in heliophysics. To answer this question a catalog of flares has been constructed as well as a code created in SunPy to obtain images of the flares from the catalog for further analysis of the location of white light flares.

Introduction

White light flares are the visible electromagnetic emission created during a solar flare. Solar flares are violent releases of energy in the Sun's atmosphere. They occur as a result of the Sun's magnetic field becoming twisted as the Sun's equator rotates faster than it's poles. As the magnetic field twists, magnetic loops emerge out of the Sun. The plasma in the Sun's atmosphere are magnetically attracted to the loops and travel up the loop. Eventually the loop breaks because it can't stretch anymore. When it breaks, particles are accelerated out into space and back towards the Sun. As a result of a change in density between two layers of the Sun's atmosphere the particles that were accelerated back toward the Sun impacts into the denser layer called the Photosphere and emit x-rays. Sometimes white light is emitted along with the x-rays. According to the standard flare model, x rays will be emitted where the loop emerges out of photosphere this location is called the footpoints. Since the density is not enough to cause a large amount of heat at the footpoints, the standard flare model predicts that white light is emitted below the footpoints where it is denser. A white light flare analyzed by Martinez Oliveros (2012), showed the white light flare occurring at the same location as the footpoints. The point of this research is to identify where in the corona white light emission is produced during a flare. of all flares of 12-25 KeV energy emission from 2011 to 2013. From this catalog I have analyzed these flares to determine whether white light emission normally occurs below the footpoints, or co-spatially which means the standard flare model is incorrect, or if that occurrence was an anomaly.

Discussion

A code was written in python this summer with the help of Juan Carlos Martinez Oliveros. This code downloads pictures of the Sun from Solar Dynamics Observatory (SDO) and then crops them around the area we know a flare occurred. The satellite takes a picture every 45 seconds. In my code, we look at data from 30 minutes before the flare and 30 minutes after. This means each date has 119 pictures associated with it. We will then compiled the 119 pictures into a movie for each date and analyze it carefully to see if we can identify a flare. The focus of research this summer has been on developing a code to perform the necessary tasks. The code is mainly compiled of loops since we want to do the same task many, many times. This code is able to find, download, and crop pictures quicker than person could ever do. Once the flares are identified in the pictures, further analysis will be done to measure the depth of the flare's occurrence in the Sun's atmosphere.

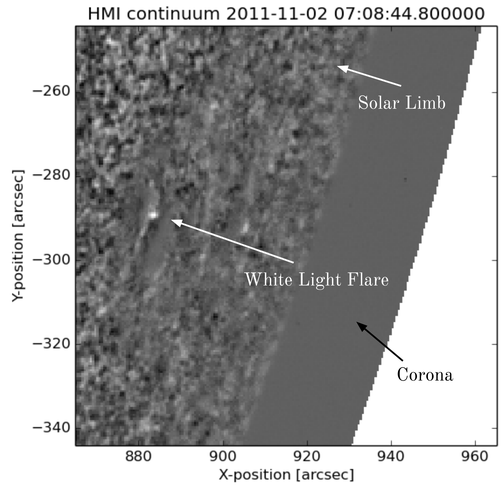
Acknowledgements

A special thanks to Claire Raftery for encouragement and support. Thank you also to Juan Camilo Buitrago-Casas for helping me debug the code.

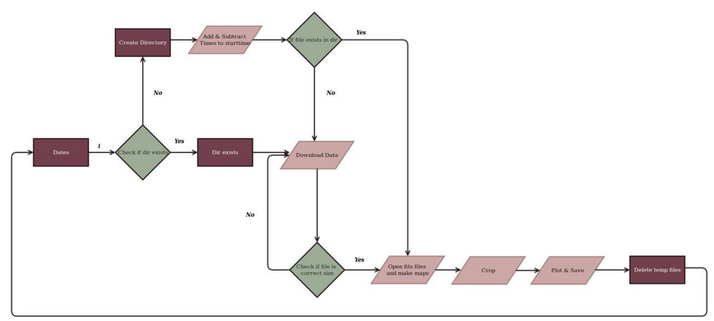
Bibliography

Martinez Oliveros, Juan Carlos. "The Height of a White-light Flare and Its Hard X-ray Sources." ArXiv.org ArXiv:1206.0497 (2012): n. pag. Print.

Melrose, D. B. "A Solar Flare Model Based on Magnetic Reconnection between Current-carrying Loops." *The Astrophysical Journal* 486.1 (1997): 521-33. Web.



This image of a white light flare was taken using the SDO satellite on November 2, 2011.



This is a flowchart that shows the actions the code performs and the checks it does to insure the data is correctly downloaded.