Aligning ALMA and IRIS images using SDO

Download and preparation of SDO, ALMA and IRIS data

1-Download the ALMA image using the SALSA database (http://sdc.uio.no/salsa/) in this case we worked with D06 region. Also, you should to download SALAT library available in the before the link.

2-Download IRIS data and its library available in https://iris.lmsal.com/itn26/introduction.html

NOTE: It is very important that in step 2 the downloaded data have co-observation with ALMA. To verify this, the IRIS page (Link shown above) recommends using the page https://iris.lmsal.com/search/

3- Download and cropping SDO image taken has central pixel the helioprojective coordinate (Tx,Ty) corresponding the region that have you chosen (For D06 region is -Tx, Ty= -128, -400 arcsec). (To do this, use the program called ejecute_download.ipynb)

NOTE: In this step the clipping of the SDO data was done by taking a radius (in arc seconds) around the center pixel that was 1.8 times the radius of the ALMA FoV.

3.1 We rotate the SDO image to the North of the SDO image going to be the North of the sun. (To do this, use the program called ejecute_download.ipynb).

The program called ejecute_download.ipynb download, clip and rotate SDO data when running all notebook cells

4- Create the data cubic of the images obtained in the step 4 (To do this use the program "create_data_cube" located in the file "function_used.py")

The alignment process was divided into two steps:
1- align ALMA images with IRIS
2- Align the IRIS images with SDO

STEP 1:

------------------- Aligning IRIS'S images with ALMA'S images ---------------------

In this part of the process, the idea is to align the ALMA images using IRIS. To do this, we will make use of the fact that the FoV of IRIS is greater than ALMA to do a 'scan' of IRIS with ALMA and thus find the pixel where there is the maximum correlation between both images.

NOTE: It is necessary to put both images at the same resolution so that the pixel size in arcsec has the same value for both. In this case the IRIS images were scaled to the ALMA pixel size.

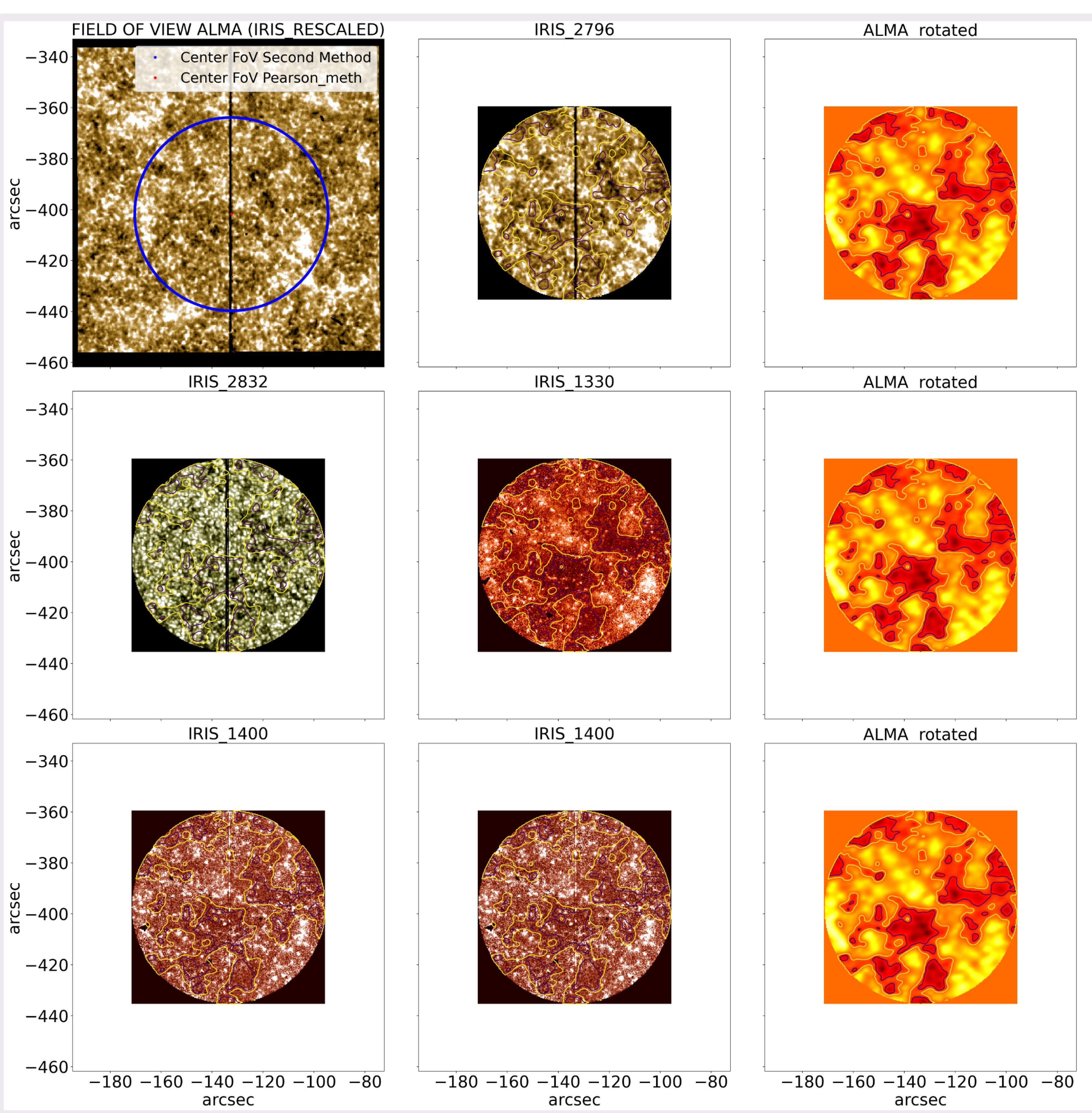
Once the pixel where the images are aligned (where there is a maximum correlation) has been found, a reference pixel must be found for which the helioprojective coordinates are known in order to find the helioprojective coordinates of the pixel where the correlations of the images are maximized. we will get the pixel reference Aligning IRIS images with SDO/AIA-304-1600-1700-HMI images.

The program where the maximum correlation between the images is found is called 5-funtion_alignig_iris_pearson_and_second_method.ipynb

NOTE: The alignment was made with the data in which there was co-observation between IRIS, ALMA and SDO.
NOTE: To align the images, both the ALMA and SDO images were rotated so that the north of the images coincided with the north of the Sun. The IRIS images do not have this problem since the north of these images is already aligned with the solar North

STEP 1: Result ALMA images were aligned with the IRIS images.

Result ALMA images were aligned with the IRIS images.



STEP 2:

------------------------- Aligning IRIS'S images with SDO'S images --------------------------
When the ALMA data was aligned with IRIS, the
the pixel for which the maximum correlation between the images was obtained was found. Now it is necessary to find the projective helium coordinates of that pixel to complete the alignment.

Obtaining a reference pixel for a (snapshot) photograph from IRIS is necessary because IRIS ONLY provides the reference pixel coordinates for the first (snapshot) photograph, i.e. the reference pixel provided by IRIS in the NO Images header. correspond to one hour (UTC) prior to the co-observation of IRIS with ALMA.

NOTE: The alignment was made with the data in which there was co-observation between IRIS, ALMA and SDO.

NOTE: To align the images, both the ALMA and SDO images were rotated so that the north of the images coincided with the north of the Sun. IRIS images do not have this problem since the north of these images is already aligned with the solar north

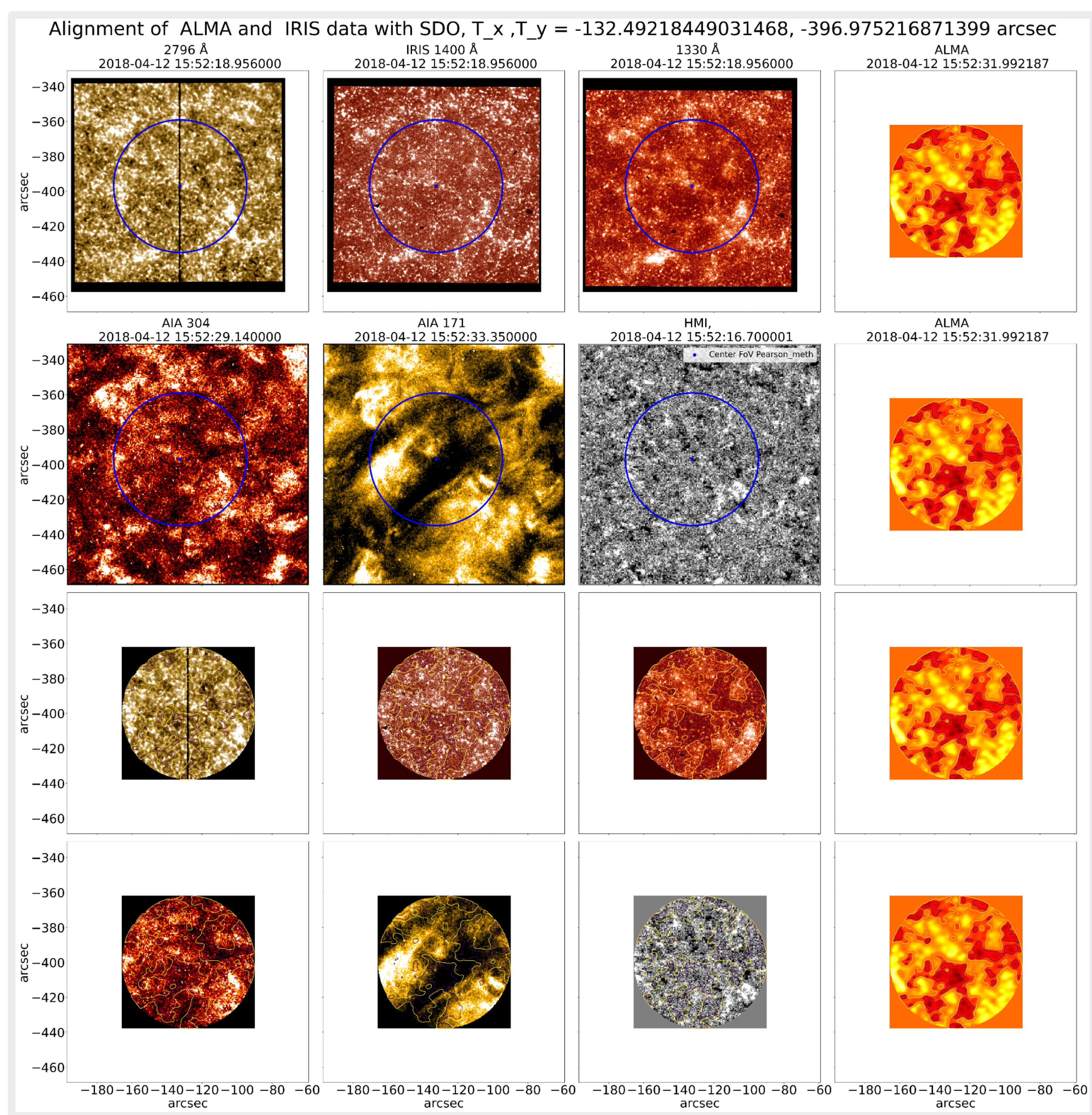
The alignment was carried out following a process analogous to the command in " --Aligning IRIS'S images with ALMA'S images--" except that in this case a clipping of the images was made around the pixel where the maximum correlation was found, the clipping was done taking a FoV slightly higher than the SOUL.
The cropping of the SDO images was done taking the coordinates found in the SALSA database as the central pixel, around which a window was taken that was 1.8 times larger than the FoV of the soul.
The cuts of the IRIS/SDO images were done to optimize the program, since not doing it in this way the computational time required for the alignment would be very long.

The IRIS 1330, 1400, 2796, 2832 cropped images were normalized by their standard deviation and then all averaged, this was done using the "cutting_iris_data" function.
The image obtained from the aforementioned average was aligned using the SDO filters of AIA 1600,1700, 304 and HMI, the above was done using the "aligning_IRIS_with_SDO_two" function.

The alignment was done using the functions "aligning_IRIS_with_SDO_two" and "cutting_iris_data" available in the file " execute_aligning.ipynb"

STEP 2: Result IRIS Alignment with SDO

Result IRIS, ALMA images thah were aligned with the IRIS images.



Two scripts were created to make the alignment easy for other people to use.
1- The stage of downloading the SDO data, the crop, and the rotation of the images was automated using the ejecuta_download.ipynb notebook.
Then the alignment process was done using the execute_aligning.ipynb function.

NOTE: It is important to fill in the information requested in the "parameters.xlsx" file, since it is with these parameters that the data will be downloaded and aligned.

The data to carry out the alignment is available at the following link is google drive https://drive.google.com/drive/folders/16ARfy7l5b7Zb7prfA978IJweITePjSbG?usp=sharing

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