McIntosh Archive Maps of Solar Cycle 24

Note: For the purposes of the documentation for the McIntosh Archive and this document, "we" refers to the cartographers, Hewins and McFadden, along with the primary advisor for this ongoing project, Sarah Gibson at HAO/NCAR.

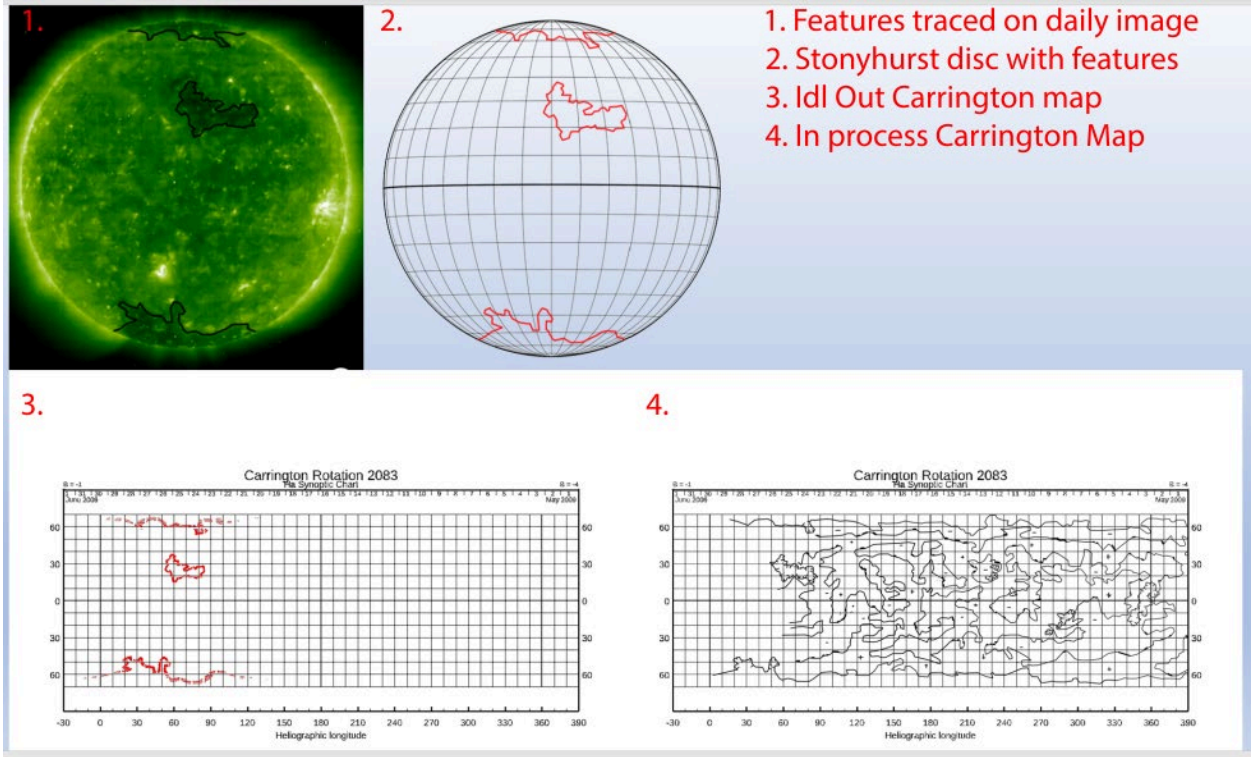
There have been a few changes in the production of SC24 maps and all maps that follow SC24 production. As He 10830 Å data is no longer consistently available, and so we switch to using EUV data. Instead of the traditional paper and pencil mapping technique, a new digital approach has been developed and used. We are still producing the last maps for SC24 now, and will update this website again by fall 2025, but additional maps beyond SC24 are included in the archive. Finally, this will be the first full solar cycle of maps to be made entirely without Patrick McIntosh and since his death in 2016.

EUV data – Although the production of 10830 Å data has fallen to a level that makes mapping impossible, EUV data is readily available and easily accessed through Helioviewer. A comparison of EUV data to He 10830 Å data was conducted and is available in Hewins et. al. 2023. After working with multiple EUV wavelengths, the cartographers decided to use Solar and Heliospheric Observatory (SOHO) EIT 195 Å and Solar Dynamics Observatory (SDO) AIA 193. SOHO data is used for CR2078 (beginning 17 December 2008) – CR2098 (ending 10 June 2010). SDO data use begins with CR2099 (beginning 10 June 2010) – CR2225 (ending 6 June 2020).

https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2023JA031343

The paperless mapping technique is designed to closely imitate the original paper and pencil methods while increasing accuracy and reducing the possibility of human error. Instead of printing daily images of the sun and tracing the features on the paper printout, the daily image is opened in Photoshop and the features are traced (1.). The next step is to overlay a Stonyhurst disk on the daily image. A Stonyhurst disk is a transparent circular grid with lines of longitude and latitude appropriate for the position of the earth in relation to the equatorial plane of the sun (B angle), that can overlay a solar image to reference the positions of features. The original mapping technique uses Stonyhurst discs at 1-degree increments ranging from 0 to +-7 degrees over a year. However, the Earth's position in relation to the equatorial plane of the Sun almost always falls between these 1-degree increments, for example on the day of writing this the B angle is -6.653. With paperless mapping, Sungrid Stonyhurst discs are used. There are 365 of these discs, one for each day of the year, thus each one is precisely accurate for that day of the year. In the original method, the Stonyhurst disc is overlayed on the paper image and the marked features are hand drawn on a separate sheet of paper with a square grid (known as a quick look) to convert from spherical latitude and longitude to rectilinear latitude and longitude or mapping coordinates. With paperless mapping the Stonyhurst transparency is overlayed on the daily image in Photoshop and the features that were marked on the daily image are traced directly onto the transparency (2.). The Stonyhurst transparency is then

moved from Photoshop into an IDL terminal where specialized IDL programs convert the traced data on it into rectilinear coordinates and place them in the appropriate location on a Carrington map for that specific rotation ("IDL out"). With the original method, the quick look is placed on a light table and the Carrington map being made ("in-process") is placed over it in a position lined up at the correct longitude such that the new data will partially overlap with data previously transferred to the in-process Carrington map in this manner. The features on the quick look are integrated with the existing data on the map by tracing adding approximately 60 degrees of new data. Similarly, with paperless mapping, the Idl Out map (3.) is opened in Photoshop and the in-process Carrington map is overlayed automatically lining up with the correct longitude such that the new data partially overlaps the data previously transferred onto the Carrington map. The features on the Idl Out map (4.) are integrated with the existing data on the in-process map by tracing adding approximately 60 degrees of new data. This is done with all three types of data (Hα, magnetograms and He 10830 Å for the original method and Hα, magnetograms and EUV for the paperless method) at a cadence of approximately 5 days for the original method and 4 days with the paperless method. On average each paperless Carrington map uses 7 days of each of the 3 types of data and the original method used 6 days.



Pre-release – We wanted to get all the completed maps we have out to the public now, but we have 28 CRs left to complete in SC24.

Parker Perihelion and eclipse – Although the first few PSP perihelion maps were coronal hole maps, the remainder of them and a map of the April 2024 eclipse are being made with EUV, H Alpha and magnetogram data. Included in this release as complete maps are the PSP 8th, 11th, 15th, 18th perihelion and the April 2024 eclipse. https://whpi.hao.ucar.edu/

Patrick McIntosh passed away on October 16th, 2016. The last two cartographers he trained Robert McFadden and Ian Hewins were entrusted with completing his work with SCs 20 - 23 and publishing it. The result was this archive. Now with SC24, we have continued his work, improved upon the techniques he used, and are working with machine learning experts to bring our solar cartography approach into modern times.

Orion Space Solutions/ArcField hosted our SC24 efforts through an NSF grant. We are greatly appreciative of the support we have been given by HAO/NCAR over the past 10 years.

We hope to continue the work to include SC25 and are currently seeking funding.