CHMAP: Coronal Hole Mapping and Analysis Pipeline

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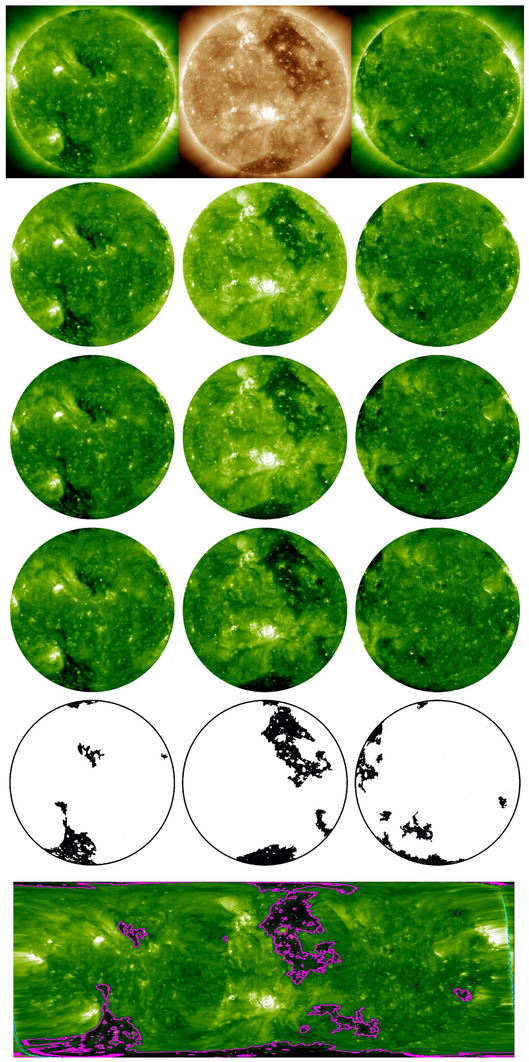
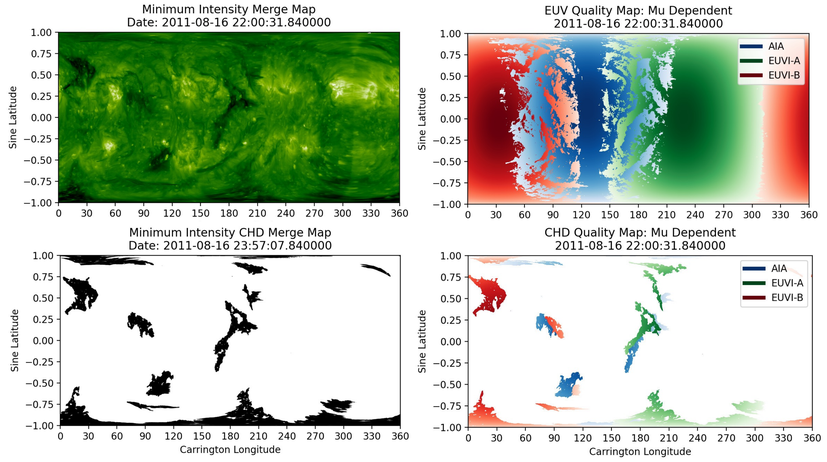
Introduction

Since the launch of Stereo A and B in 2007 there have been multiple spacecraft making Extreme UltraViolet (EUV) observations of the sun from varied perspectives. Here we present an automated methodology to merge all available instruments into full-sun Carrington maps with coronal hole detection. Our open source python implementation, CHMAP (github.com/predsci/CHMAP), makes this an accessible pipeline with these key features: 1) A modern database approach for handling 14+ years of EUV imaging data and derived quantities. 2) Data-derived image corrections for center-to-limb and inter-instrument intensity variations based on long-term, 6+ month moving averages. 3) Flexible full-sun mapping methods and map types, including synchronic, synoptic, time-averaged, and minimum intensity merged maps. 4) A new technique to identify and track the evolution of individual coronal holes and associated patches using time-dependent clustering methods and connectivity graphing.

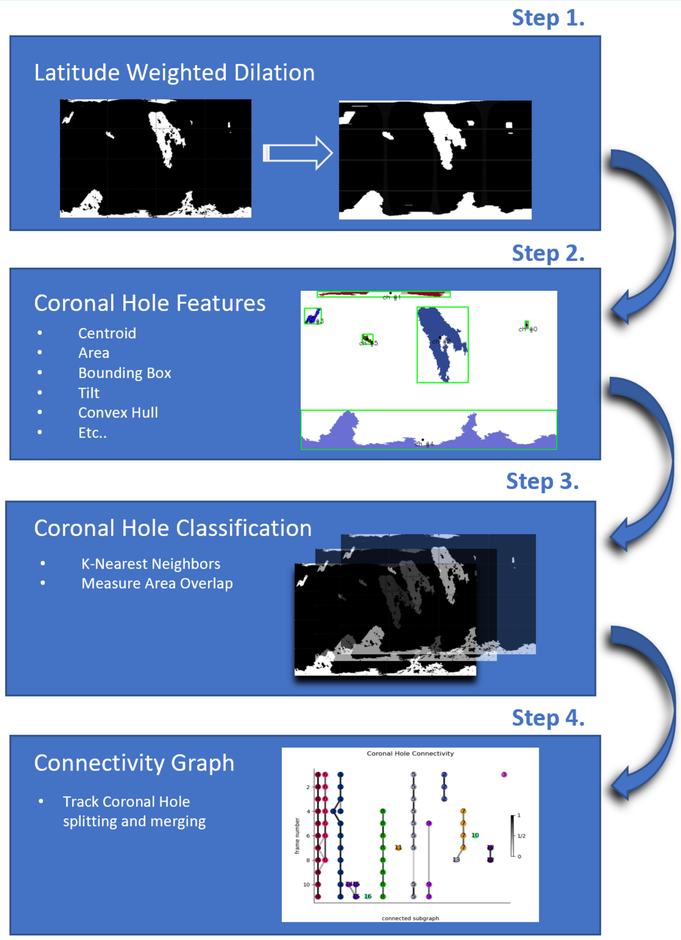
Detection Pipeline



Synchronic Map Products

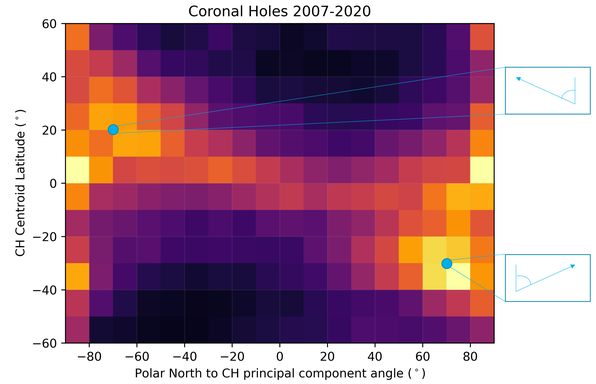


Coronal Hole Identification and Tracking



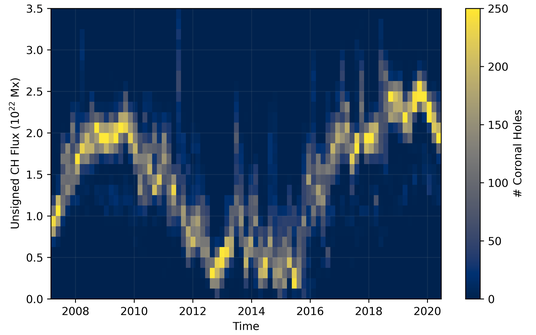
Coronal Hole Database Mining

Differential rotation expressed in coronal hole tilt

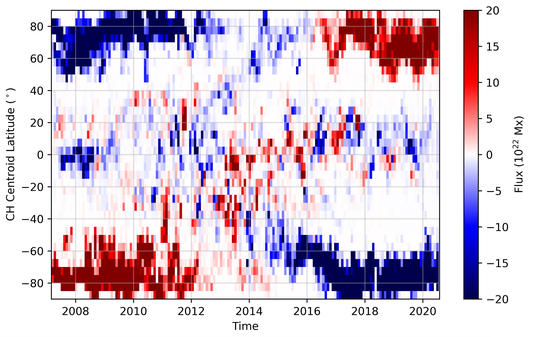


The resulting coronal hole boundaries, detected at a 2-hour cadence, can be used as a measure for coronal open flux or to constrain coronal models. In total, the pipeline contains 55k+ synchronic maps (viewable at q.predsci.com/CHMAP-map-browser) and 325k+ individual CH detections with meta-data for coronal open flux, area, and orientation.

Unsigned coronal flux 2D histogram binned to 60-day intervals



Coronal hole centroid latitude 2D histogram binned to 60-day intervals (flux magnitude is a sum in each bin)



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Available Tools

- Python codebase: github.com/predsci/CHMAP
- Code Documentation: predsci.github.io/CHMAP
- Database Browser: q.predsci.com/CHMAP-map-browser