STRIDE-CH: Sub-Transition Region Identification of Ensemble Coronal Holes

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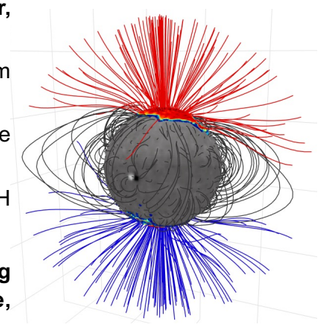
Motivation

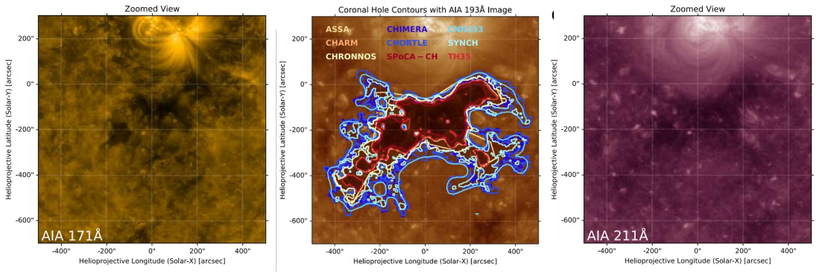
Steady solar wind is fundamental to space weather, but predictive models need to be validated

- Ambient steady solar wind originates primarily from Coronal Holes (CHs)
- CHs host magnetic field lines that are “open” to the heliosphere
- Quantitative validation of modeled CHs requires CH boundary detection in solar imagery



Advances have been made in CH detection using Extreme UV (EUV) imagery observed from space, but observational challenges remain

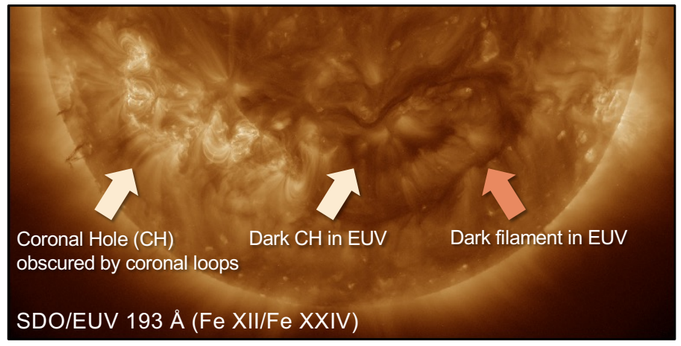
1) Bright coronal loops extrude from the solar disk and obscure CHs regions
   - Coronal Loops: Hot plasma in closed magnetic field regions
2) Filaments have a similar dark appearance to CHs
   - Filaments: Cool plasma in closed magnetic field regions
3) Lack of ground truth in boundary location
   - Disagreement amongst optical filters and detection methods

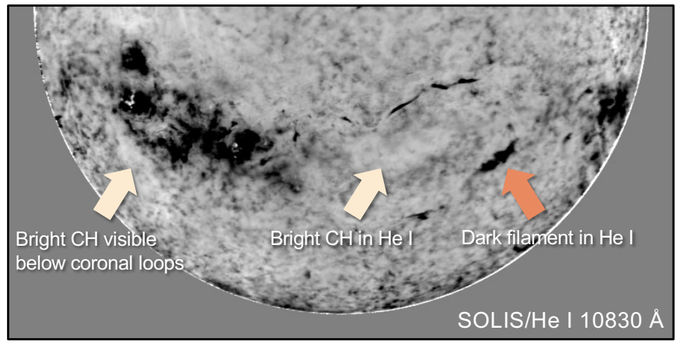


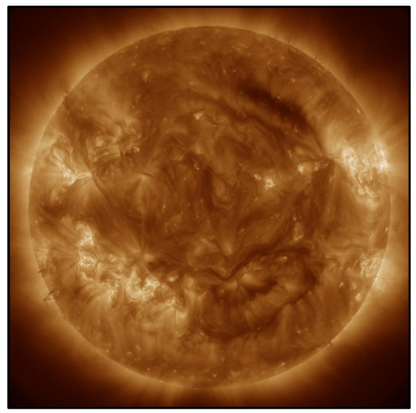
Reiss et al., 2021

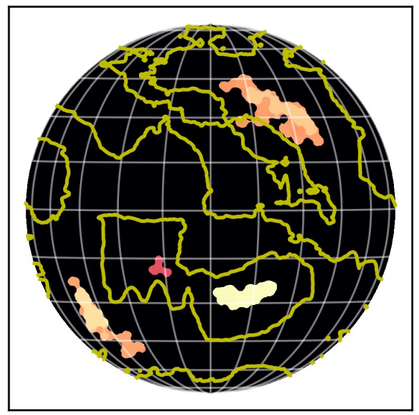
Methods

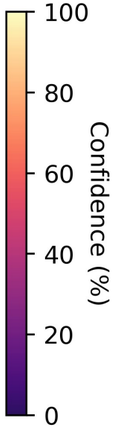
1) Use a He I 10830 Å image of the upper chromosphere captured by ground-based observatories
   - CHs now appear bright and **unobscured by active regions**
2) Apply a threshold and morphological operations to retain bright, coherently-shaped candidate regions
3) Assign greater confidence to candidates with high unipolarity in the magnetic field map of the underlying photosphere
   - CHs are now **disambiguated from filaments**
4) Create an ensemble of CH boundaries by varying threshold level and kernel size for morphological operations, then threshold away predominantly bipolar regions
   - Distinct CH boundaries **confront the lack of ground truth** with physically motivated confidence

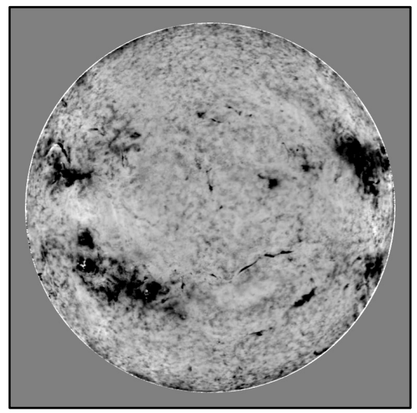


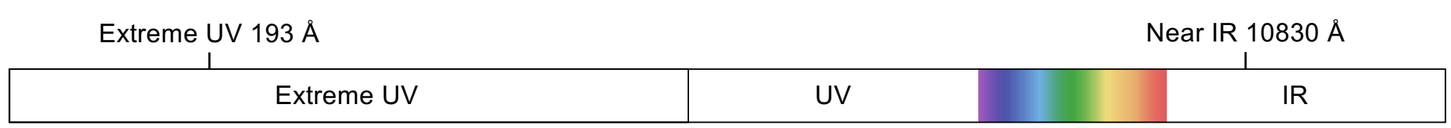












A new detection method provides a unique, **multi-physics constraint** for solar space weather models with **quantified confidence**

Weaknesses

1) Boundary location uncertainty is enhanced due to poor contrast in He I relative to EUV
2) While STRIDE-CH detects CHs obscured by active regions in EUV, it fails to detect CHs near the limb from VSM observations
   - VSM instrumental effect of noise in He I near limb adds to challenging off-line of sight view
3) Lack of availability in full-disk He I observations since 2015

Future Work

1) Quantitative validation of STRIDE-CH against state-of-the-art CH detection methods
2) Fuse CHs detected in He I 10830 Å with complementary EUV-derived CHs to construct a global CH map for model validation
3) Advocate for reinstatement of full-disk He I observations in future ground-based observatories

Please contact me at the email below if you have any questions or ideas towards better quantifying uncertainties and optimally fusing with EUV-derived CHs!

Ensemble Image Segmentation of Coronal Holes in Sub-Transition Region Observations (J. Landeros, in prep) | jalanderos@ucsd.edu