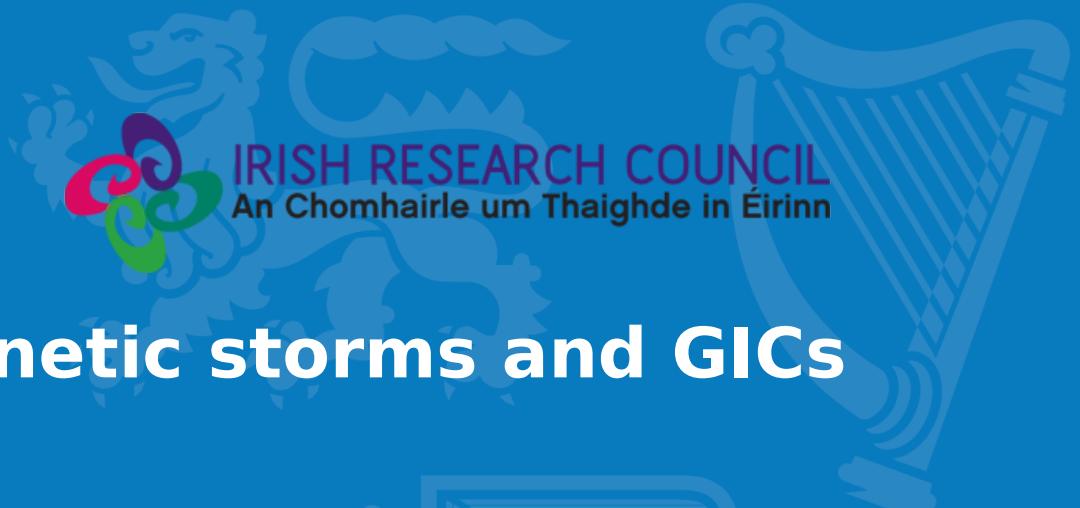




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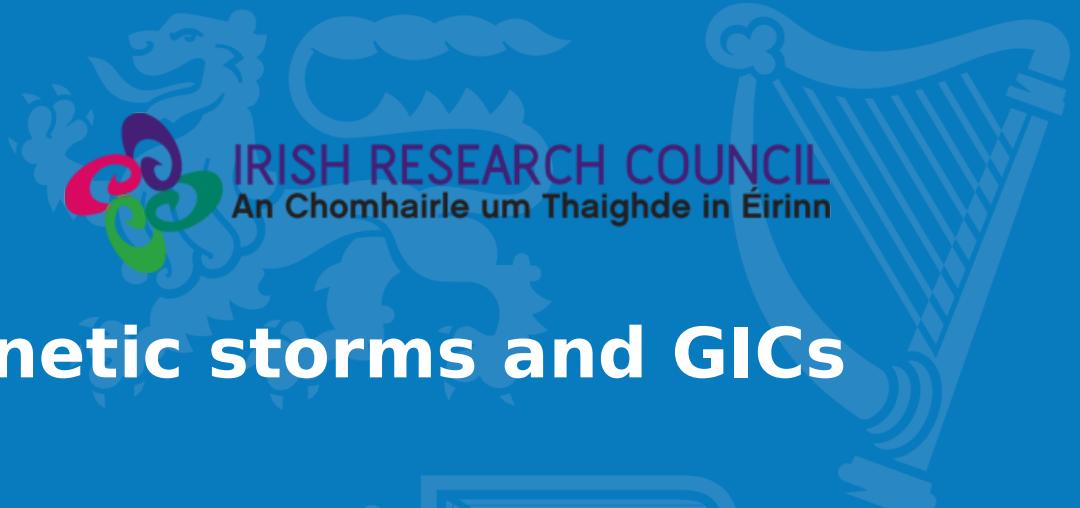
# Forecasting geomagnetic storms and GICs from Coronal Holes



Tadhg M. Garton  
Joan Campanya  
Sean P. Blake  
Peter T. Gallagher  
05<sup>th</sup> September 2017



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# Forecasting geomagnetic storms and GICs from Coronal Holes



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# Forecasting geomagnetic storms and GICs from Coronal Holes





# Forecasting geomagnetic storms and GICs from Coronal Holes



# Objectives

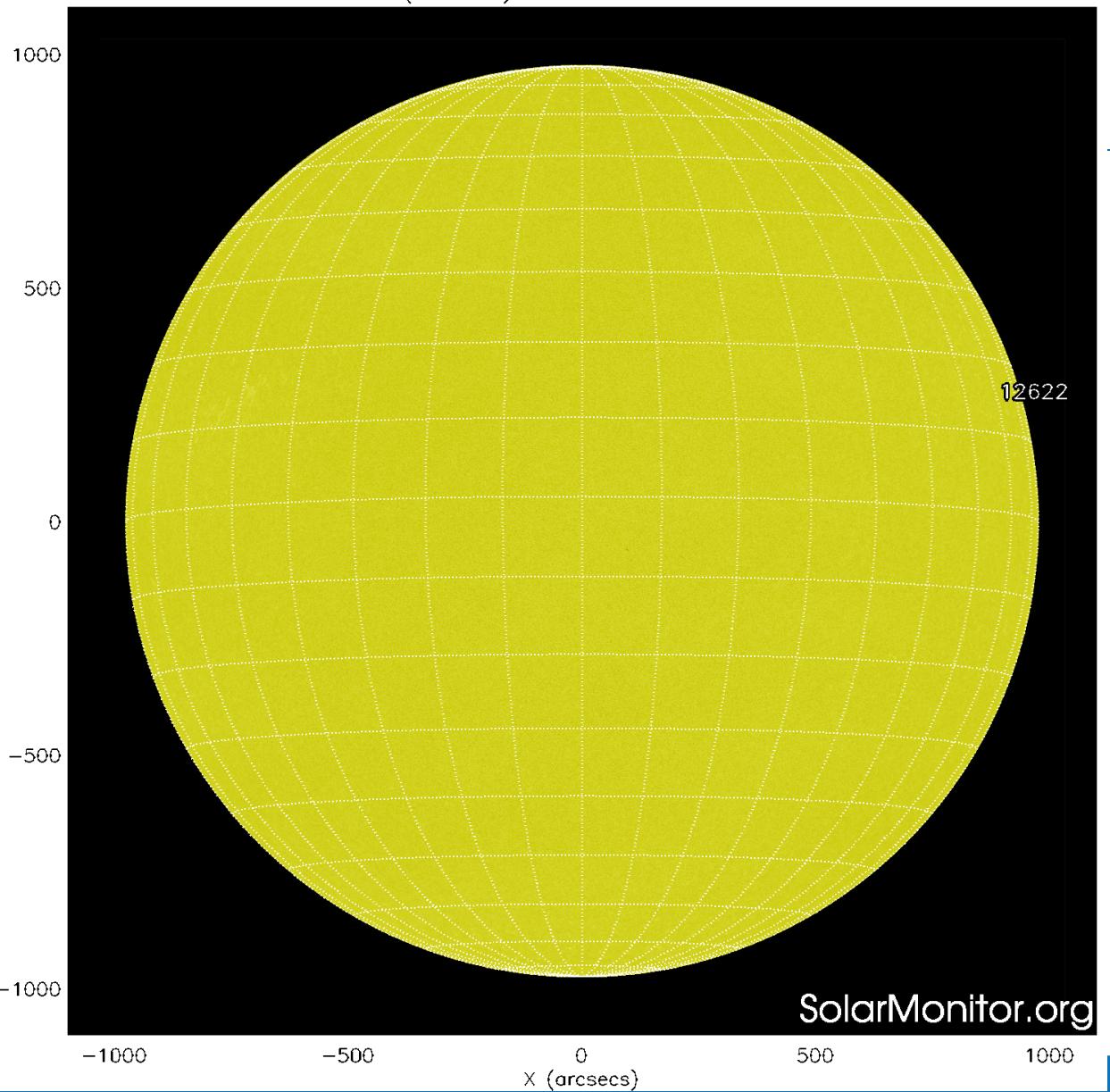
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1. To implement a new algorithm to detect and characterize coronal holes and their properties
2. Correlate these properties with geomagnetic activity
3. Ultimately to predict space weather effects from coronal holes



# The Sun

SDO HMI (6173 Å) 1-Jan-2017 19:34:29.600



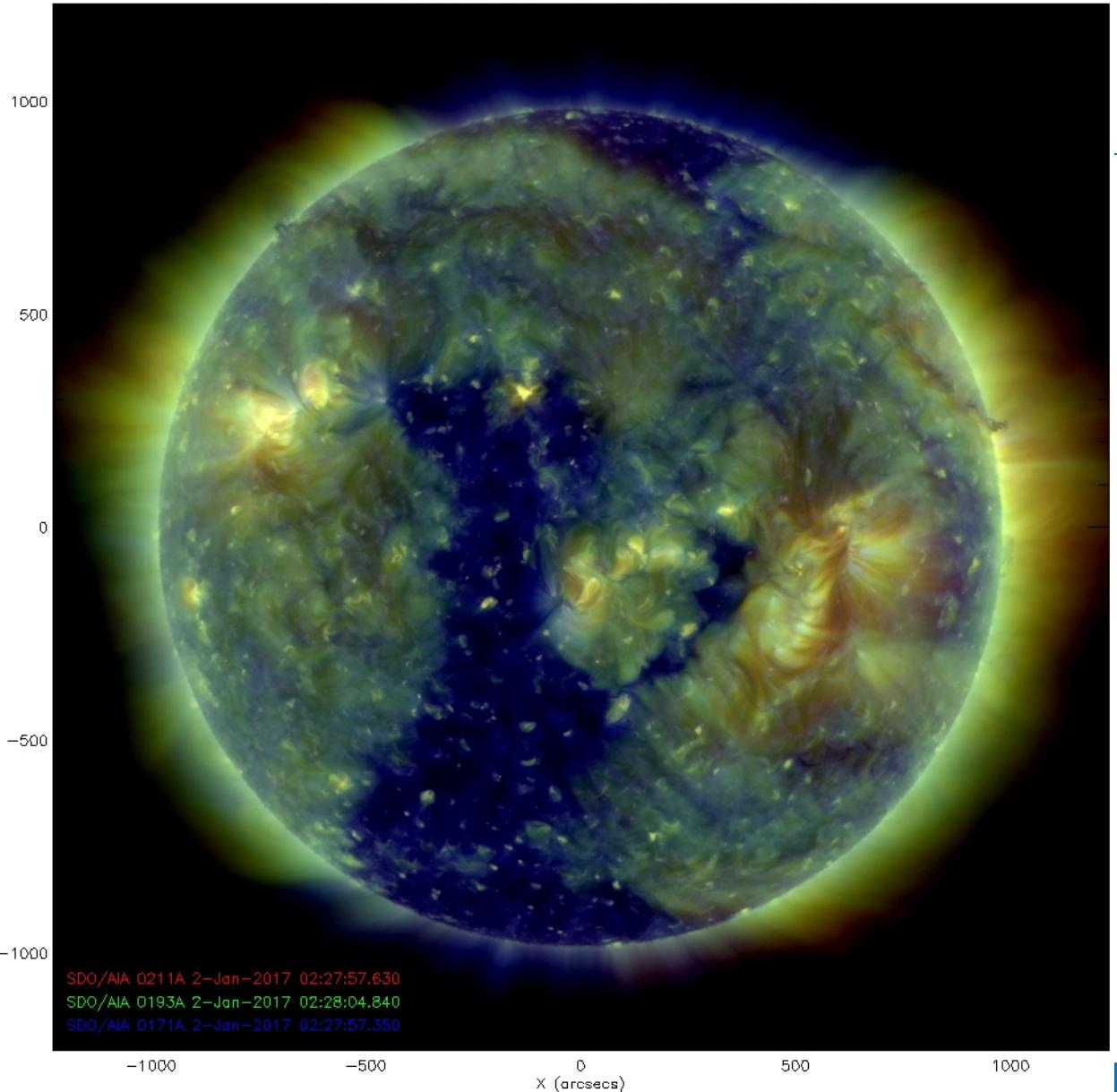
The Sun in visible  
wavelengths



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# The Sun

SDO AIA 171,193,211 Å 2-Jan-2017 02:28:04.840



The Sun in visible  
wavelengths

The Sun in X-Ray  
wavelengths as taken  
by the SDO satellite

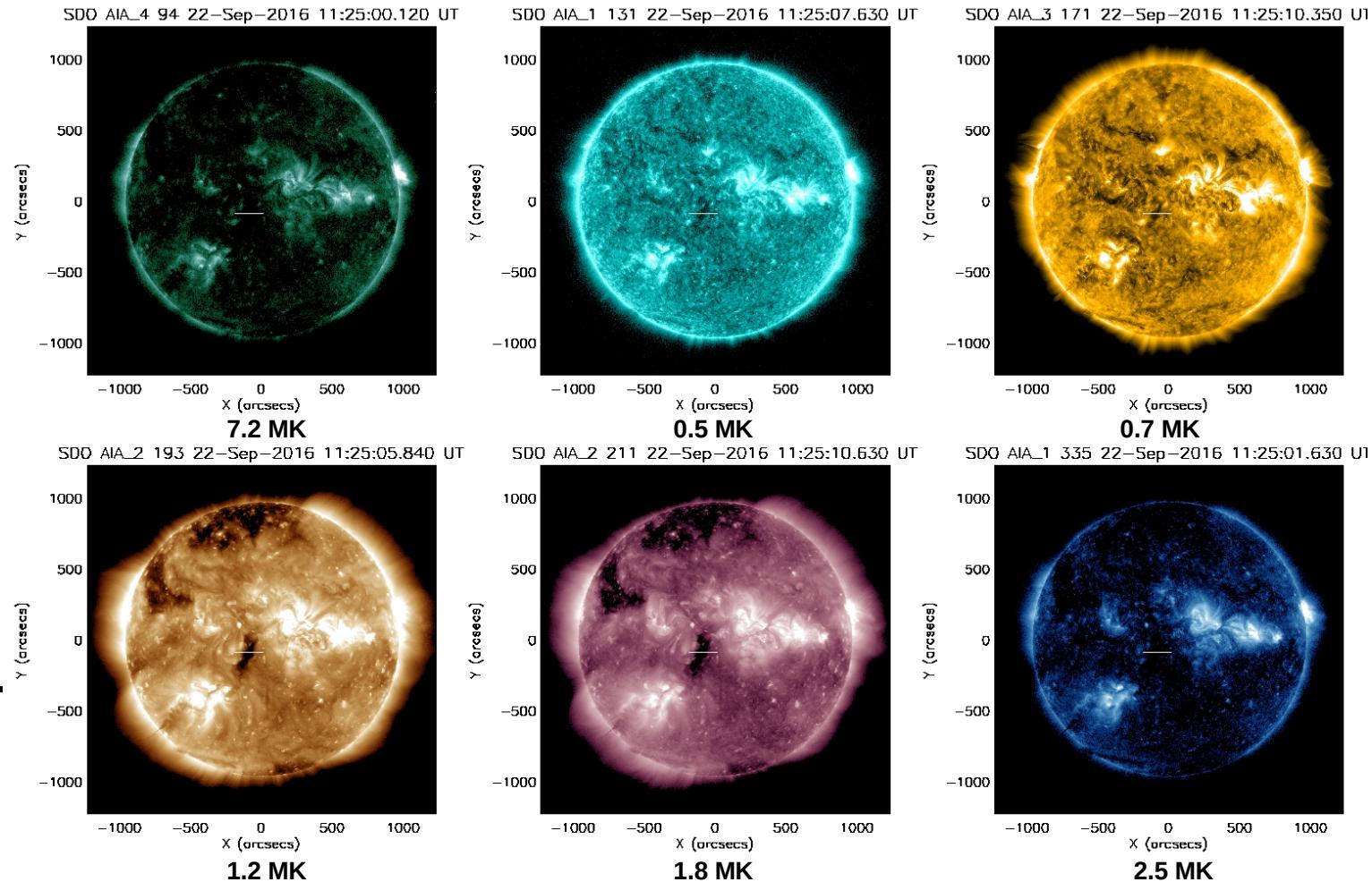


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# What is a coronal hole?

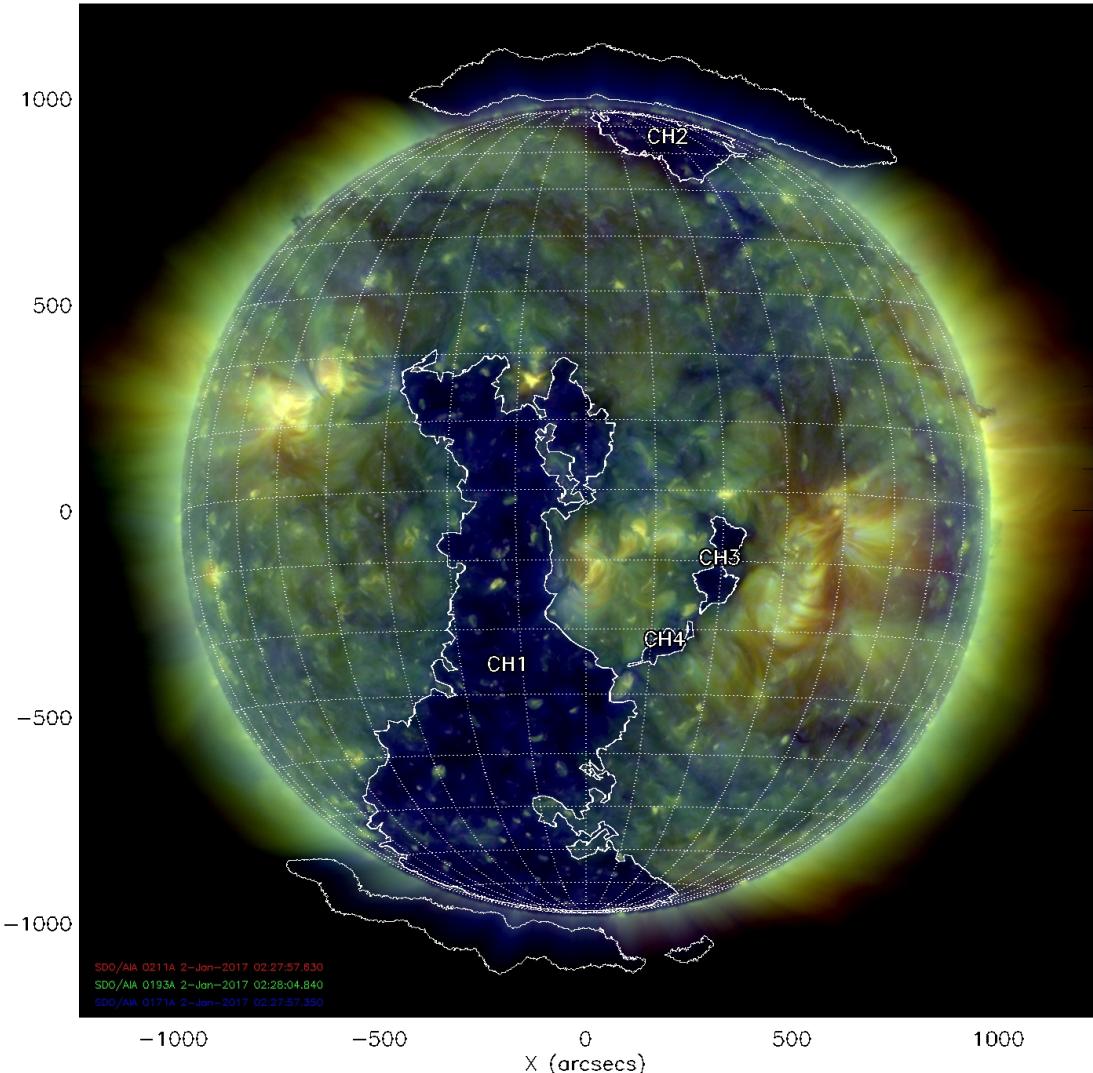
## What defines a coronal hole?

- Low temperature.
- Low density.
- Unipolar in nature.



# CHIMERA

[solarmonitor.org/chimera.php](http://solarmonitor.org/chimera.php)



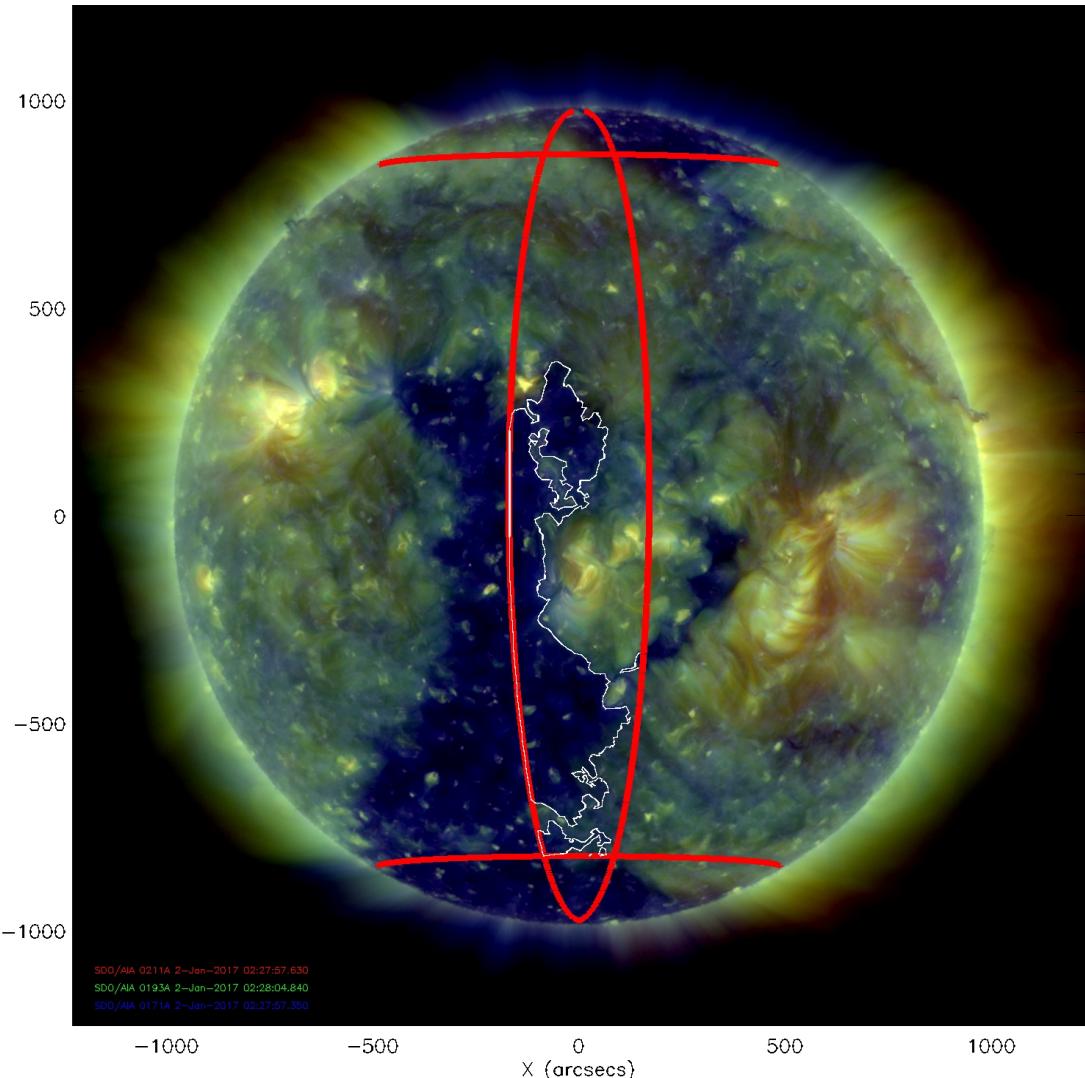
Garton, T. M., Gallagher, P. T., and Murray, S. A. Automated Coronal Hole Identification via Multi-Thermal Intensity Segmentation. *Journal of Space Weather and Space Science: Topical Review*. (Under review)



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# CHIMERA

[solarmonitor.org/chimera.php](http://solarmonitor.org/chimera.php)

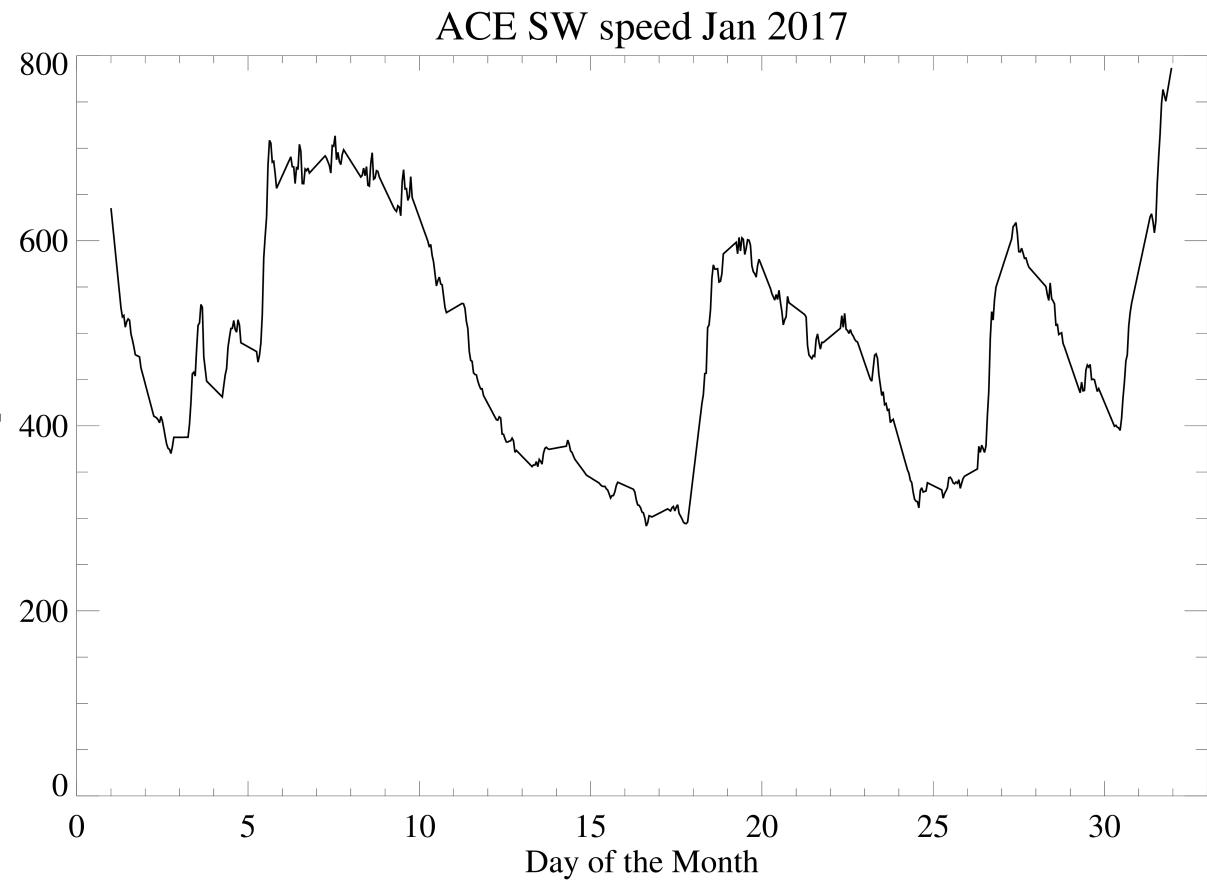
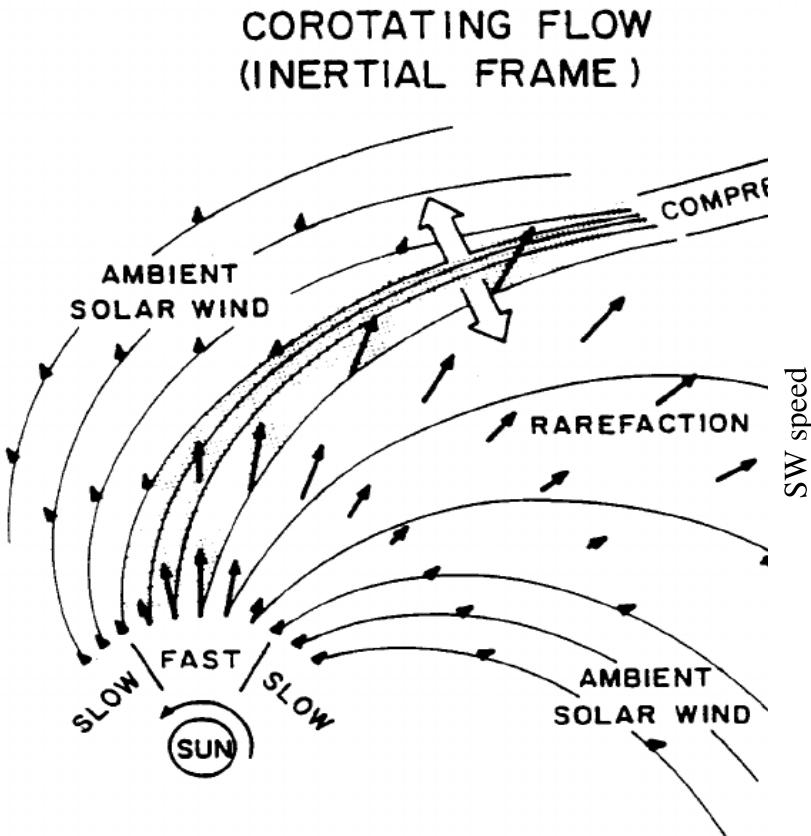


Garton, T. M., Gallagher, P. T., and Murray, S. A. Automated Coronal Hole Identification via Multi-Thermal Intensity Segmentation. *Journal of Space Weather and Space Science: Topical Review*. (Under review)



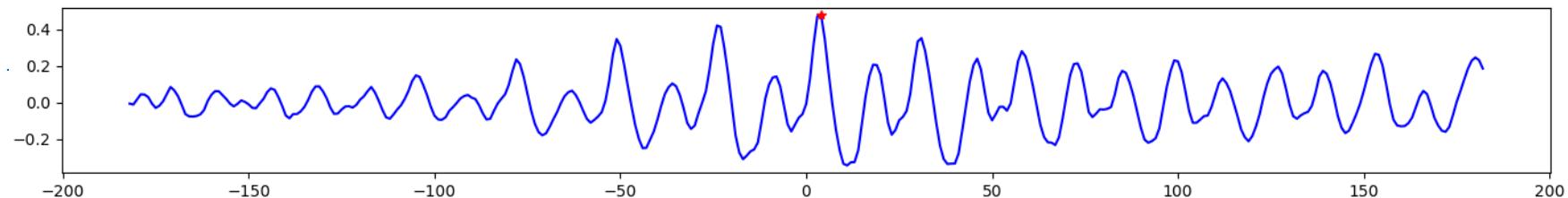
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# High Speed Solar Wind

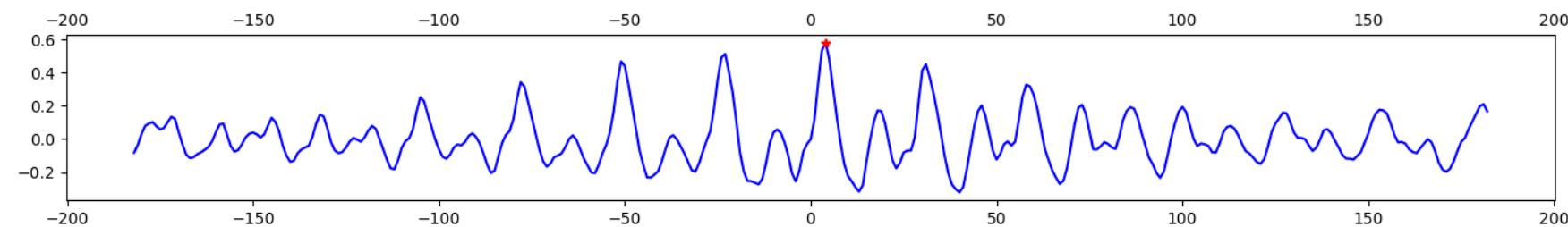


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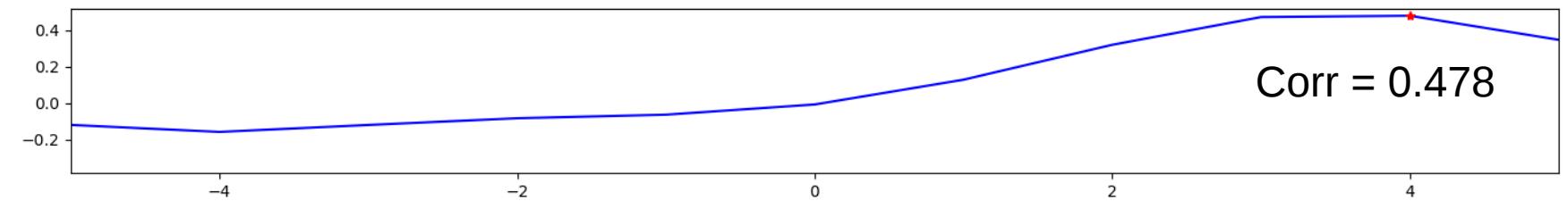
V wind – CH  
Area (A)



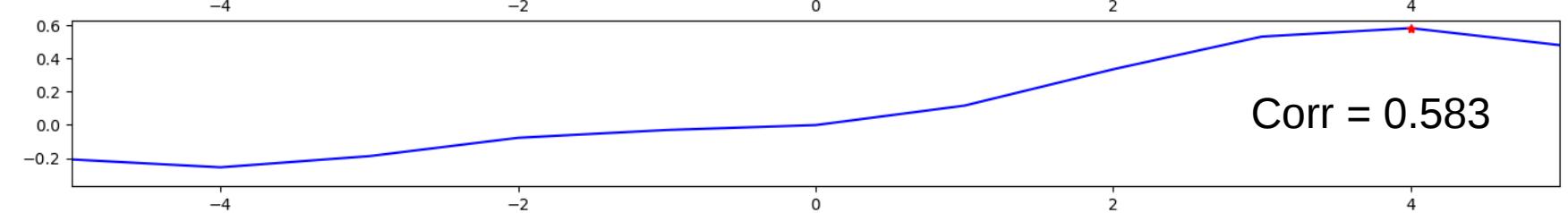
V wind –  
 $\sqrt{A^*|B|}$



V wind – A

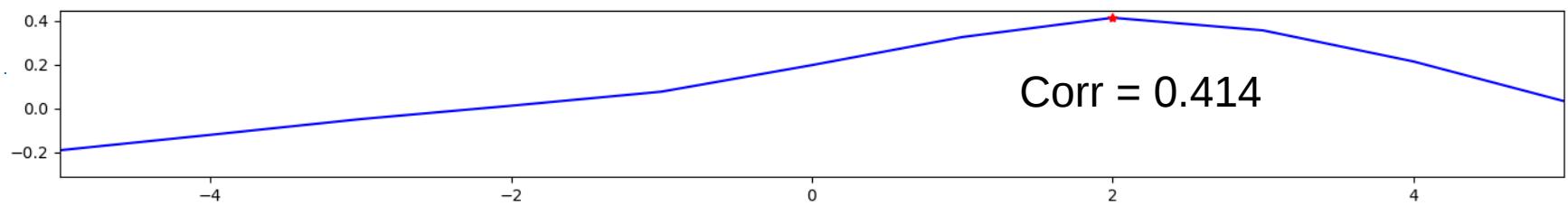


V wind –  
 $\sqrt{A^*|B|}$

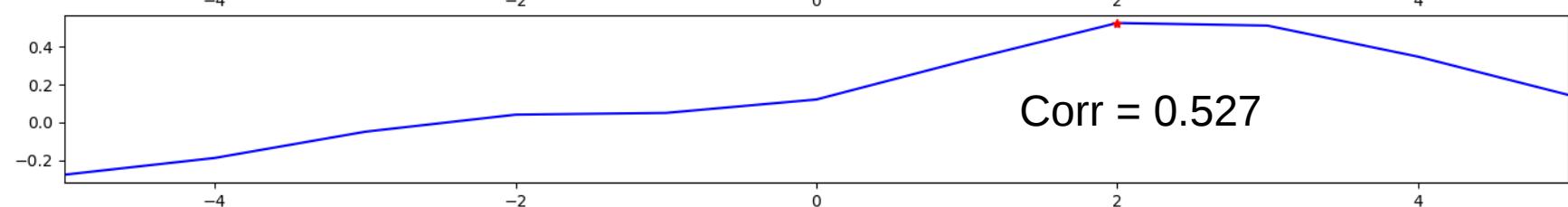


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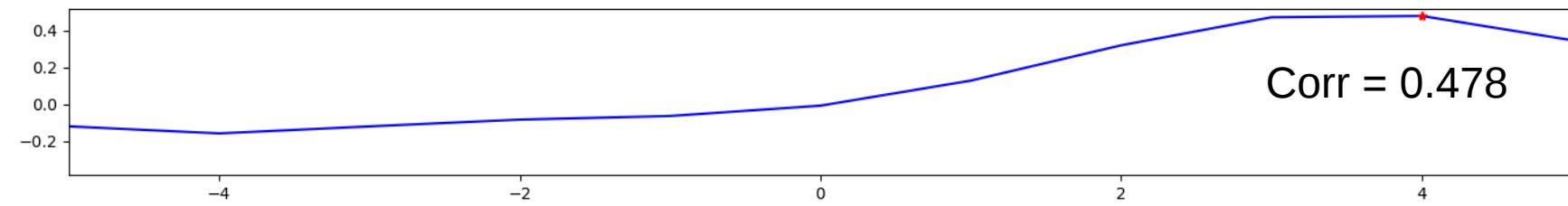
V wind – CH  
Area (A)



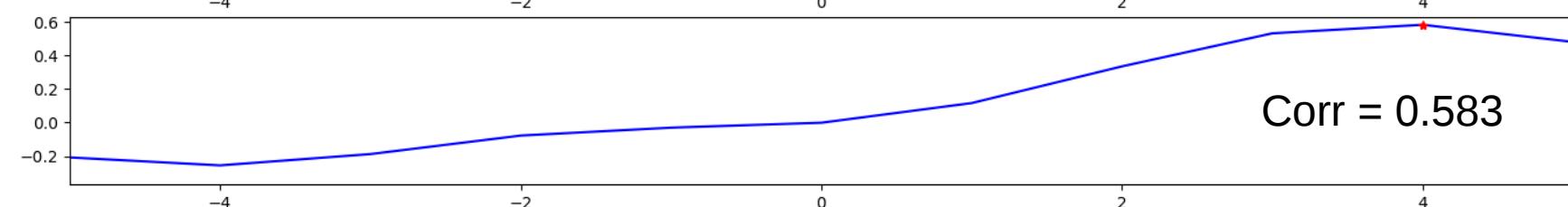
V wind –  
 $\sqrt{A^*|B|}$

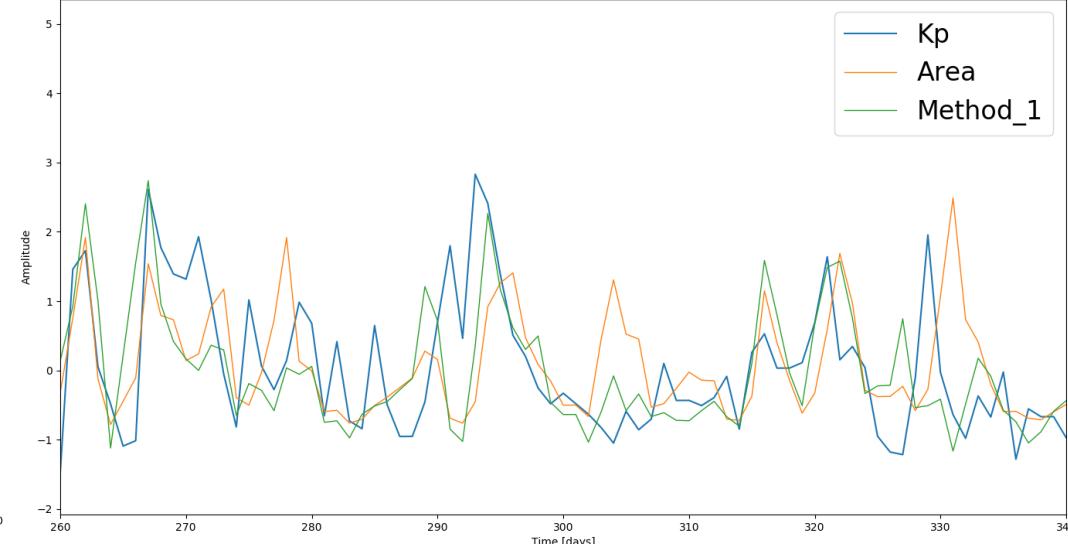
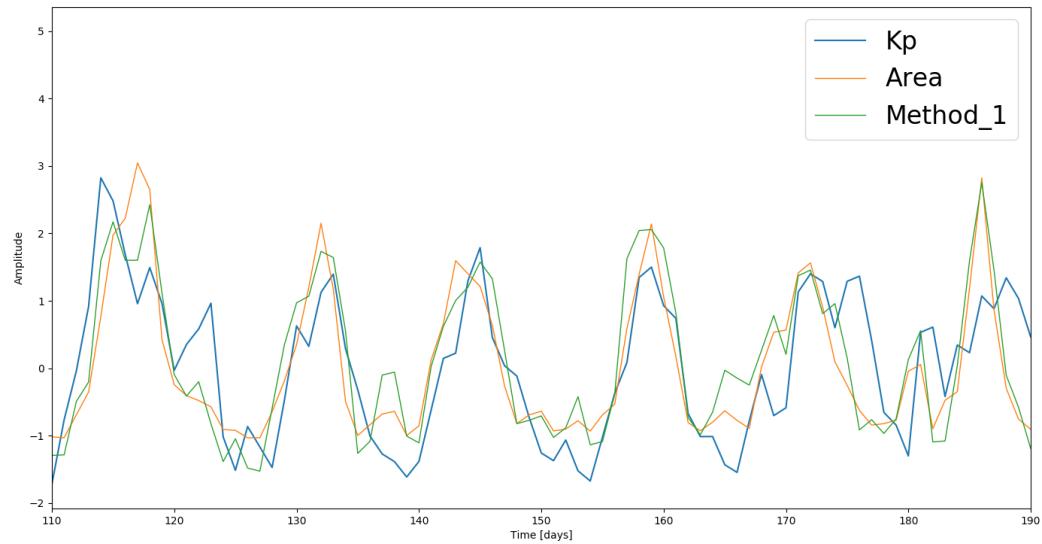
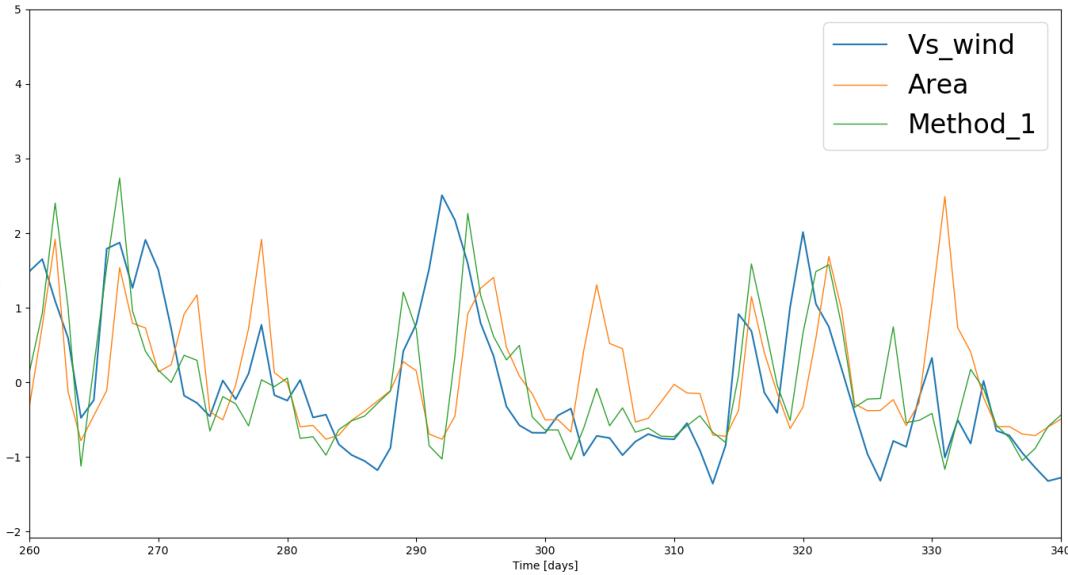
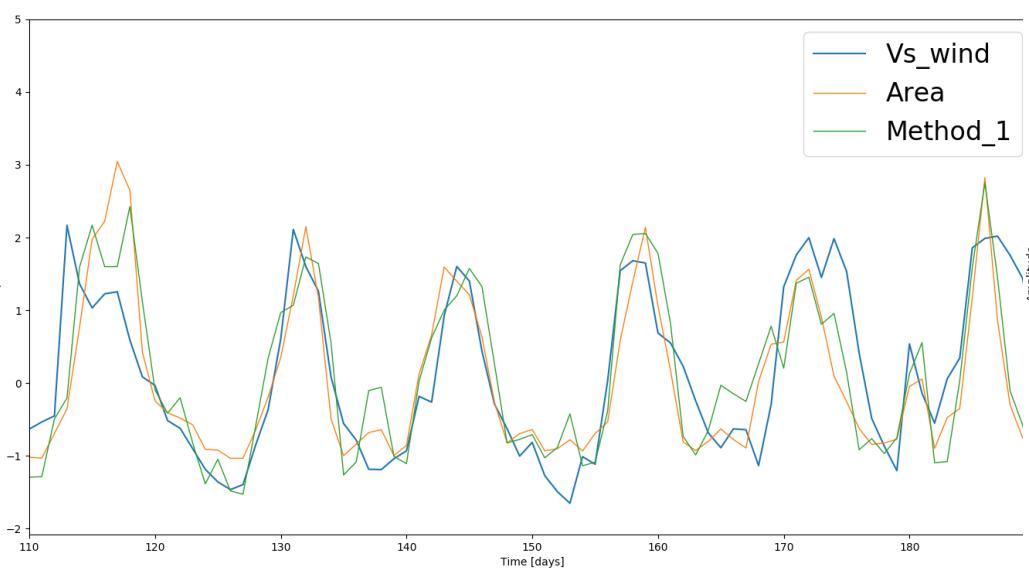


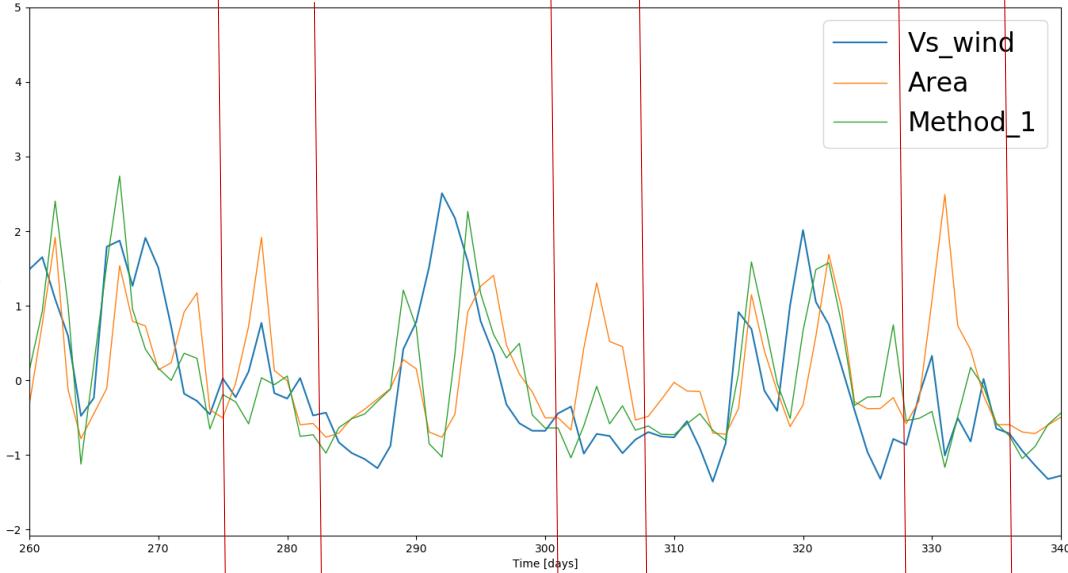
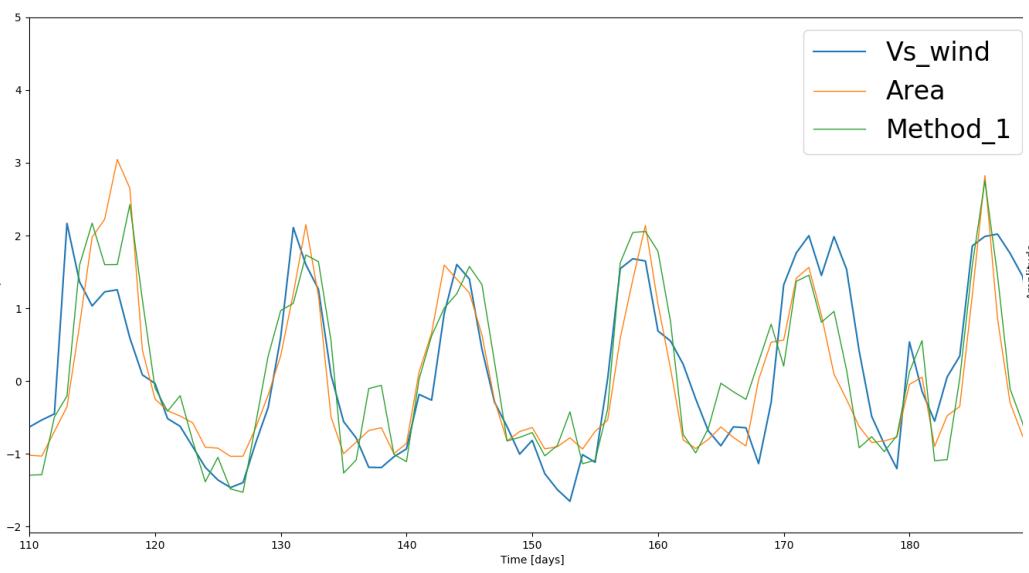
V wind – A



V wind –  
 $\sqrt{A^*|B|}$



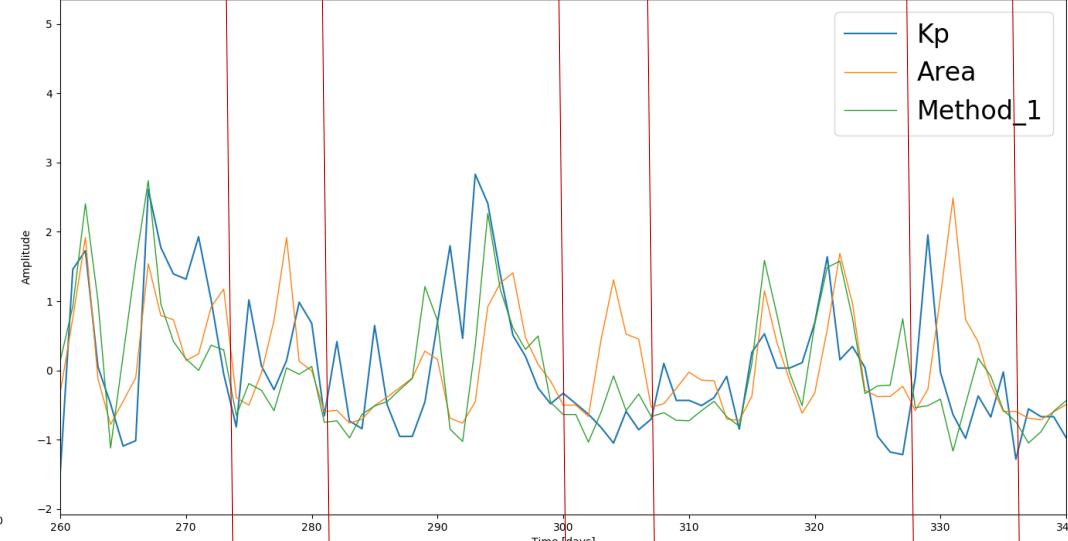
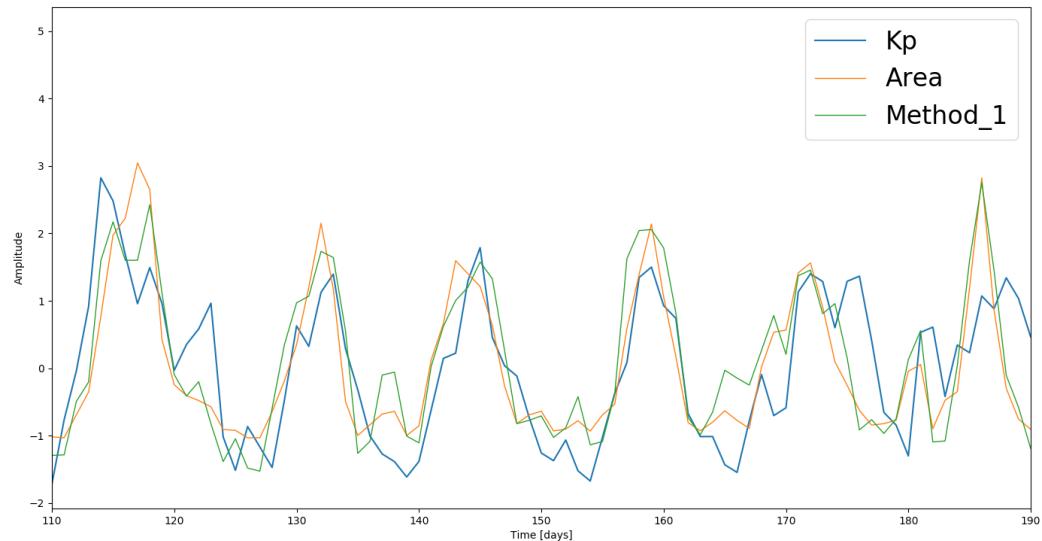




1

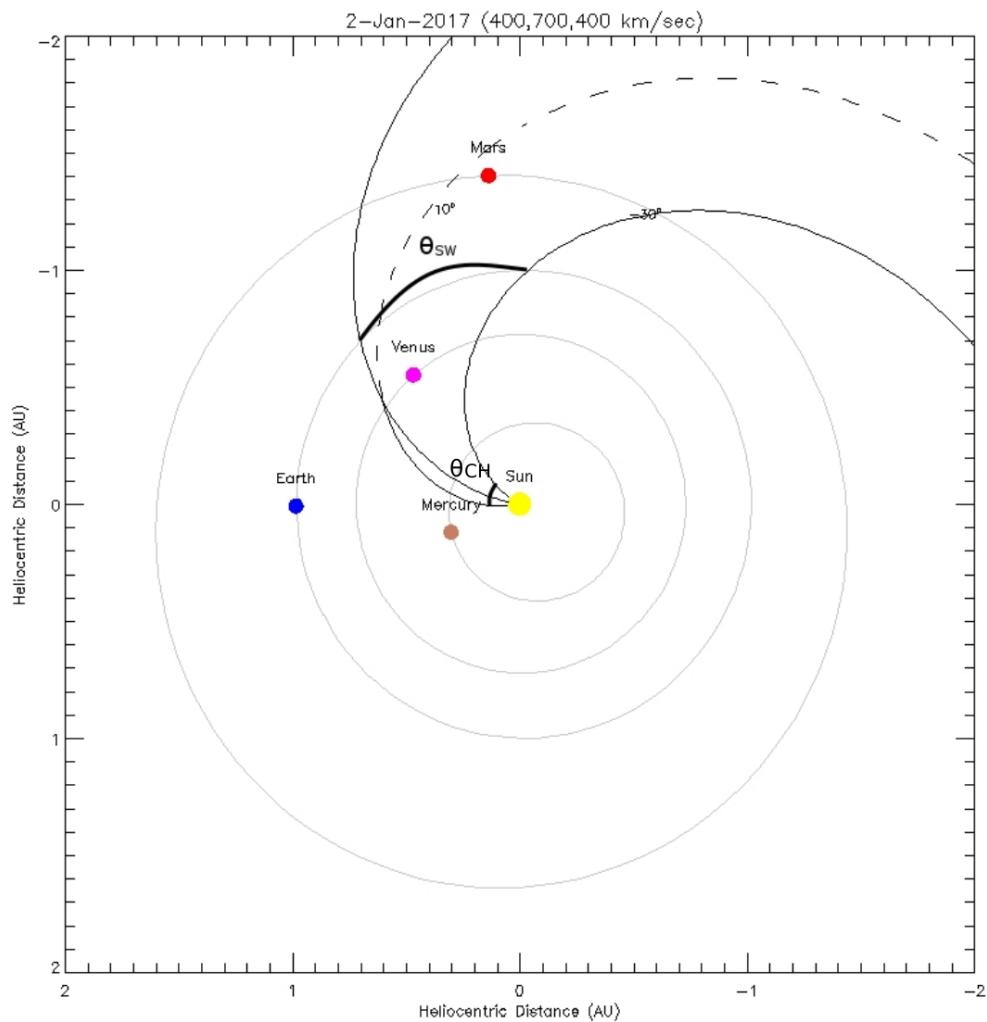
2

3



# Angular expansion of solar wind

$$\gamma = \theta_{SW} / \theta_{CH}$$

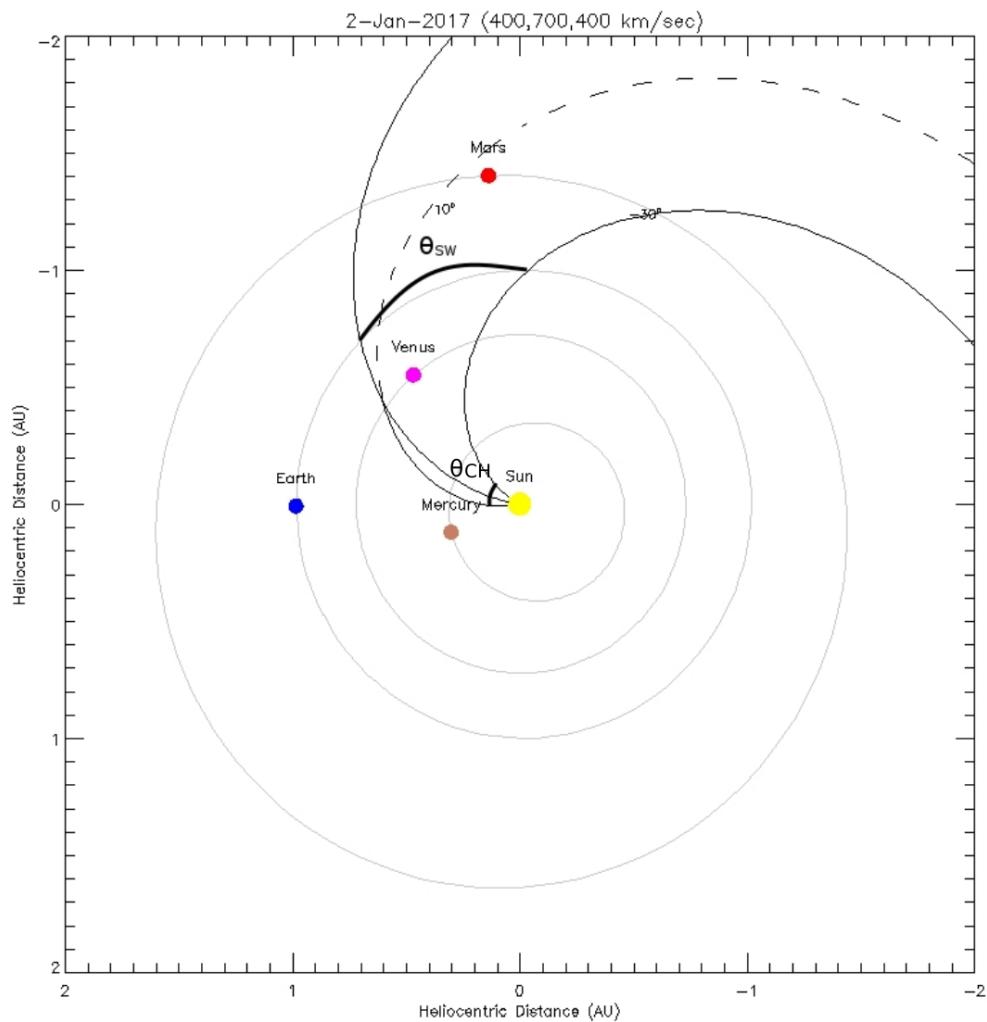


# Angular expansion of solar wind

$$\gamma = \theta_{SW} / \theta_{CH}$$

$$\gamma = (\Delta t^* \omega) / \theta_{CH}$$

$$\Delta t = (\gamma / \omega)^* \theta_{CH}$$

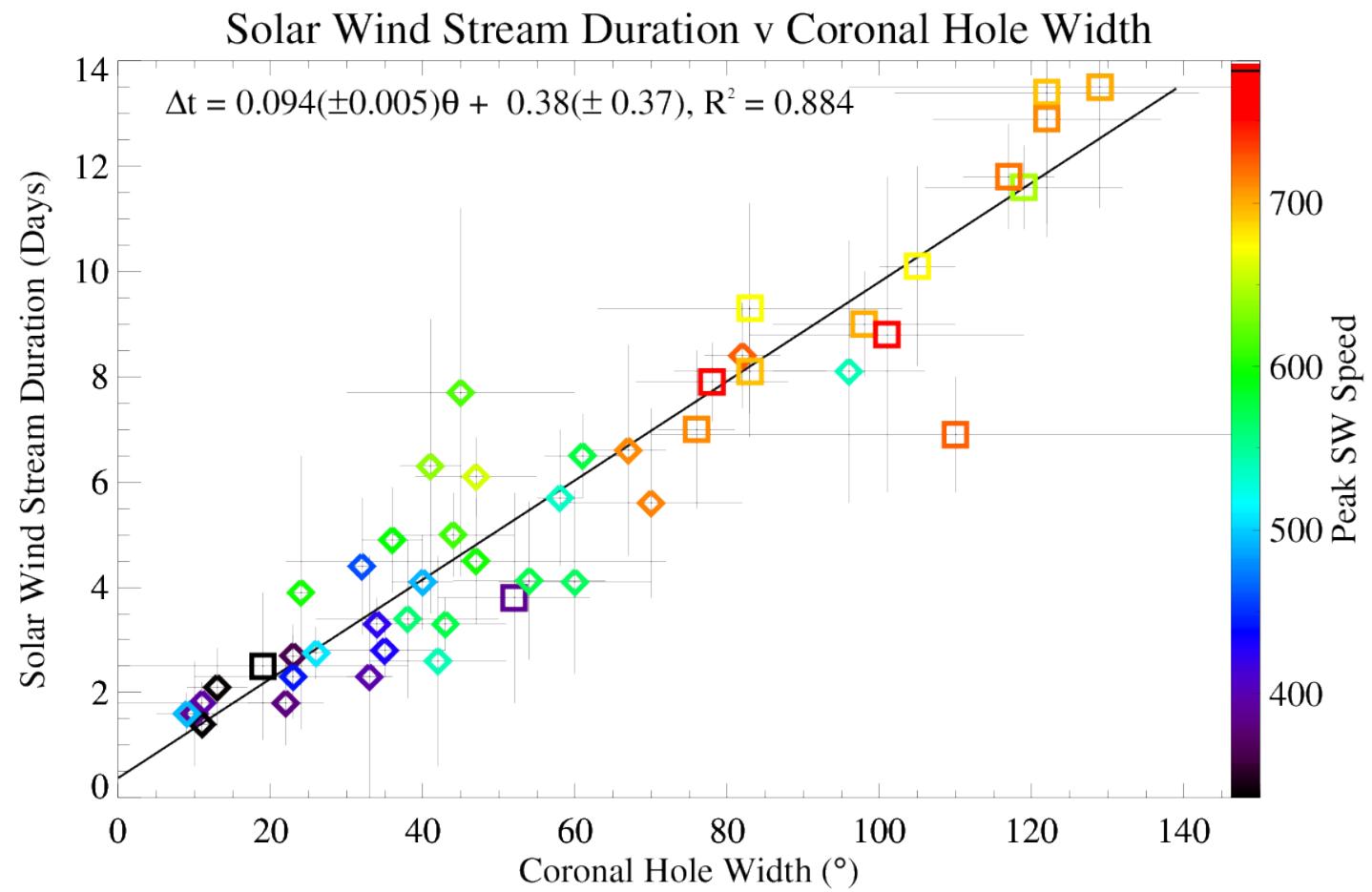


# Angular expansion of solar wind

$$\gamma = \theta_{\text{SW}} / \theta_{\text{CH}}$$

$$\gamma = (\Delta t^* \omega) / \theta_{\text{CH}}$$

$$\Delta t = (\gamma / \omega)^* \theta_{\text{CH}}$$



# Angular expansion of solar wind

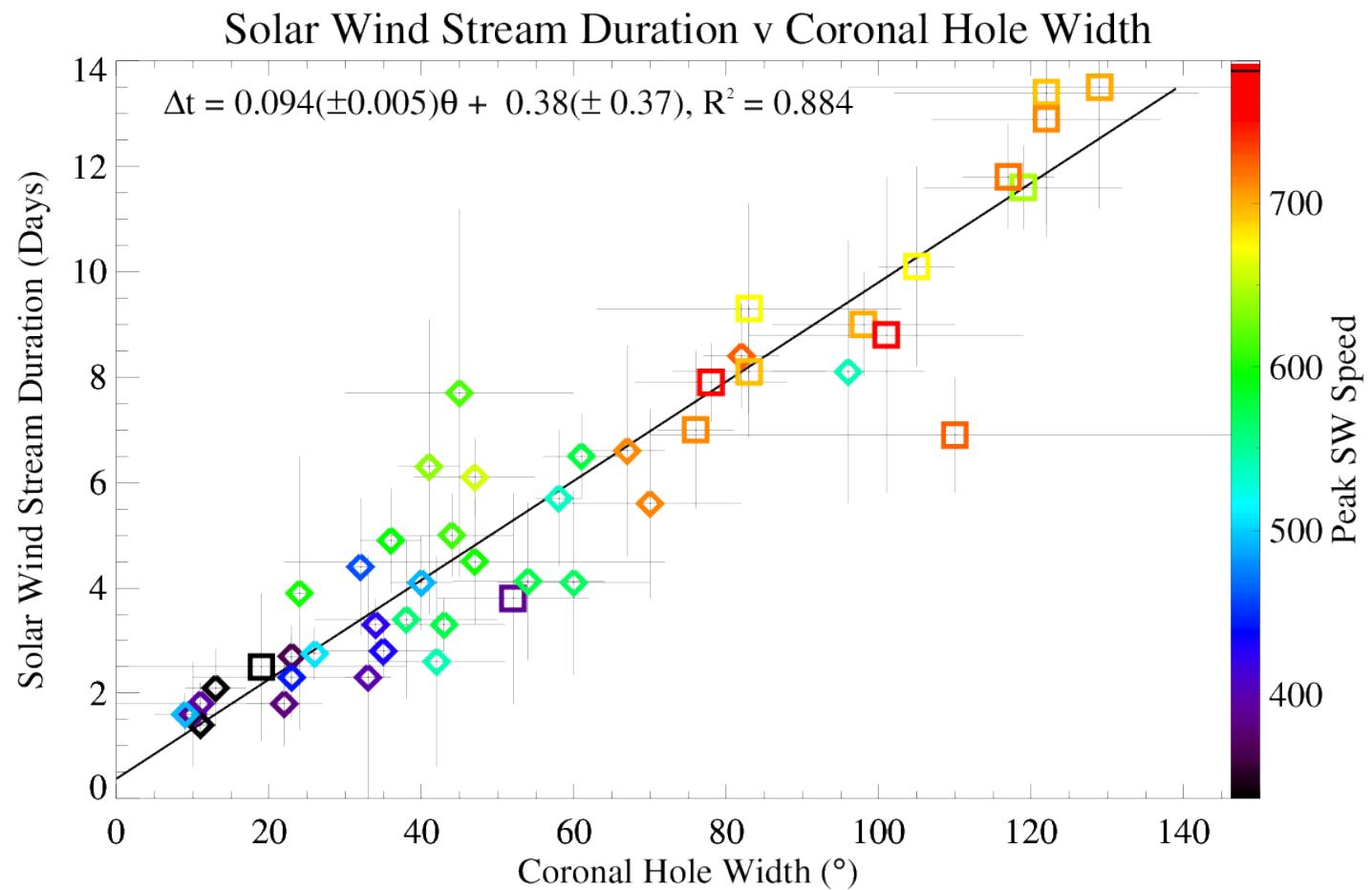
$$\gamma = \theta_{\text{SW}} / \theta_{\text{CH}}$$

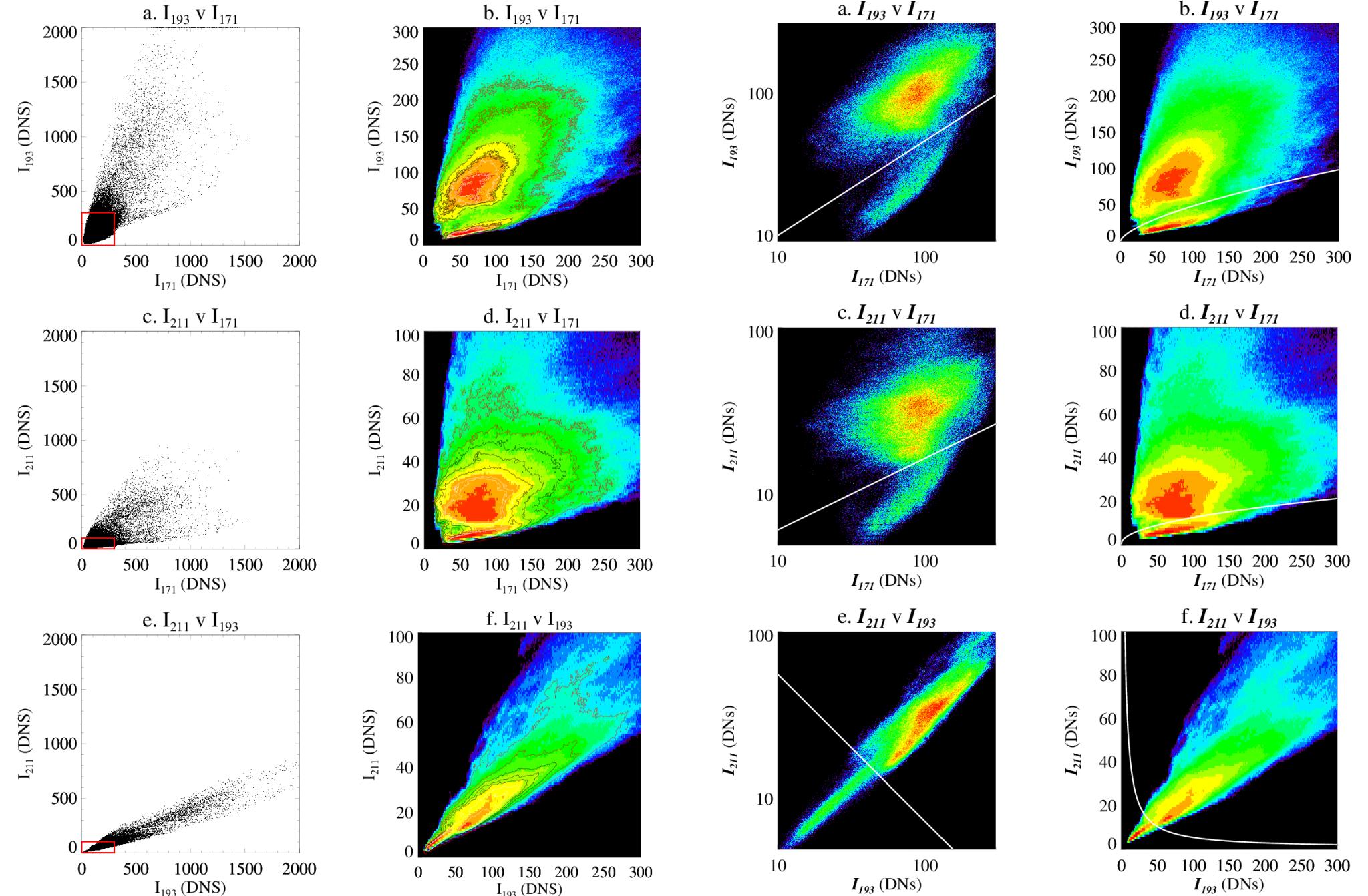
$$\gamma = (\Delta t^* \omega) / \theta_{\text{CH}}$$

$$\Delta t = (\gamma / \omega)^* \theta_{\text{CH}}$$

$$(\gamma / \omega) = 0.094 \pm 0.005$$

$$\gamma = 1.241 \pm 0.066$$





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