# Automatic Analysis of EUV Solar Features using Solar Imagery for the GOES-R SUVI

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The GOES-R Solar UltraViolet Imager (SUVI) Level 2+ products, upon delivery, will present to the forecasters in the NOAA/SWPC Forecast Office preliminary analysis of data from the GOES-R series SUVI instruments. This preliminary analysis will include identification of solar coronal hole boundaries, solar bright region statistics, solar flare locations, and total irradiance for each of the SUVI Extreme Ultraviolet (EUV) channels. These products will add to the forecasters' ability to determine the impact due to the solar wind on the Earth's magnetosphere and the potential for ionospheric disturbances due to the variability in EUV irradiance. Presented here are brief explanations of three individual products and a demonstration of the current versions for each product.

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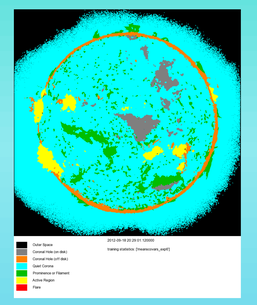
## Introduction:

The GOES-R Solar UltraViolet Imager (SUVI) is a normal incidence telescope designed to image the Sun in 6 channels in the Extreme Ultraviolet wavelengths (EUV). The basis for the GOES-R Risk Reduction funded SUVI Phase 3 product development are the SUVI processed product(L1b) as well as the SUVI.19 product, the Thematic Map (seen right). The Thematic Maps are used to differentiate individual solar features such as coronal holes, bright regions, prominences, etc. The three products discussed here are intended to aid in Space Weather forecasting by automatically determining coronal hole boundaries, collect data on bright regions, and precisely locate solar flares when they occur.



## The SUVI L2+ Phase 3 Products:

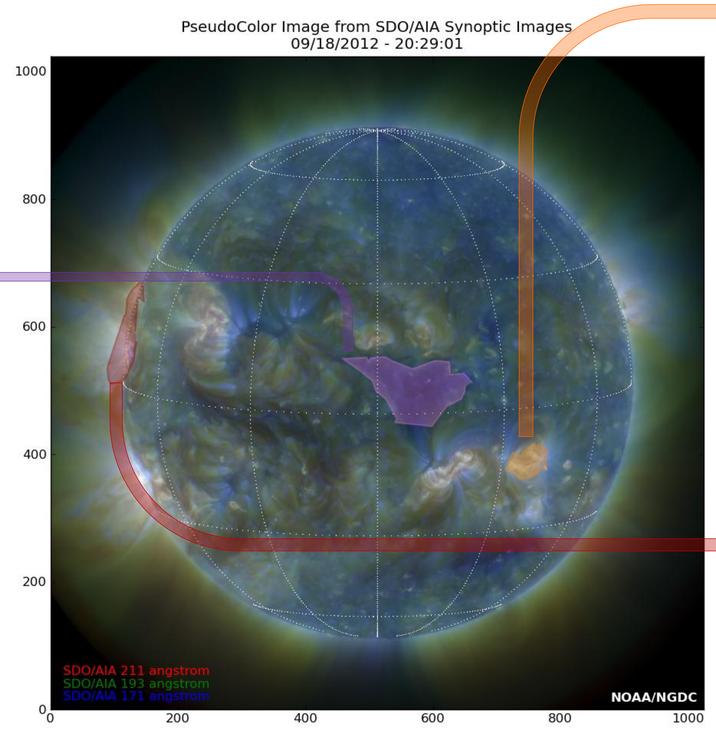
There are 3 products in the GOES-R Risk Reduction Phase 3 Cycle for SUVI. These products and the phenomena they are associated with are described here along with a representation of the output product SDO/AIA synoptic data is being used consistently throughout the Phase 3 development as very good proxy data due to the similarities in channel wavelengths and resolution.

### SUVI.16: Coronal Hole Boundaries

The areas known as coronal holes on the Sun indicate areas of open magnetic field lines in the solar corona. These coronal holes are the origins of the high speed solar winds that can have a severe impact upon the Earth's magnetosphere. This impact can lead to increased exposure to energetic particles and magnetic impulses for space-based infrastructure. The Coronal Hole Boundary product for the GOES-R series SUVI instruments will automatically identify individual coronal holes and determine a finite number of vertices that accurately describe the coronal hole. The output of the product is a table in netCDF of the heliographic coordinates of these vertices, a representation of which is found in **Table 1** (right). The accuracy of this product relies heavily on the accuracy of the Thematic Map product (SUVI.19), which is currently under implementation at SWPC under the GOES-R Proving Ground program.

**Table 1.**

| Coronal Hole Data | |
|---|---|
| Vertices (Heliographic Latitude/Longitude) | |
| 6.69 | 21.9 |
| 8.79 | 19.99 |
| 8.63 | 16.78 |
| 11.51 | 16.58 |
| 11.89 | 13.28 |
| 10.15 | 8.07 |
| 11.92 | 3.57 |
| 12.93 | 1.68 |
| 12.65 | -1.53 |
| 11.79 | -1.96 |
| 12.79 | -2.41 |
| 12.44 | -7.96 |
| 10.2 | -4.57 |
| 9.77 | -3.98 |
| 7.48 | -1.08 |
| 5.33 | -0.36 |
| 3.31 | 1.93 |
| -0.97 | 4.32 |
| -1.81 | 3.88 |
| -2.8 | 12.14 |
| 1.48 | 15.63 |
| 3.06 | 19.14 |
| 4.47 | 19.96 |
| 5.76 | 20.16 |




### SUVI.13 Bright Region Data

Bright Regions in the EUV are often associated with sunspots and are frequently the source of EUV flares. The GOES-R SUVI Bright Region Data product will automatically determine the location , peak brightness, total brightness, and total area of the Bright Region. The product will also associate the Bright Region with a known sunspot (SRS Association) if the right conditions are met. **Table 2** contains a representation of the Bright Region product.

**Table 2**

| Bright Region Data | | | | | |
|---|---|---|---|---|---|
| | | Peak Flux (W sr$^{-1}$ m$^{-2}$) | | Total Flux (W sr$^{-1}$ m$^{-2}$) | |
| **Bright Region Location:** | -11.94 Latitude 34.96 Longitude | **Channel 0094** | 48.0 | **Channel 0094** | 39464.6 |
| **Total Area (Helio Sq. Degrees):** | 76.5 | **Channel 0131** | 440.4 | **Channel 0131** | 202731.3 |
| **XRS Flare Condition:** | 0 | **Channel 0171** | 4227.9 | **Channel 0171** | 3222773.8 |
| **EUV Flare Condition** | 0 | **Channel 0193** | 5568.9 | **Channel 0193** | 4775856.8 |
| **SRS Association:** | NOAA 1596 | **Channel 0211** | 3561.0 | **Channel 0211** | 2803193.5 |
| | | **Channel 0304** | 964.8 | **Channel 0304** | 534708.1 |

### SUVI.14 Flare Location

EUV Flares are often the cause of radio blackouts (due to thermospheric heating) and are often associated with Coronal Mass Ejections (CMEs). The SUVI Flare Location product is triggered when a Solar Flare is detected by the GOES XRS instrument (XRS flare condition) and if there are flare pixels classified in the Thematic Map (EUV flare condition), and reports the location of the flare in heliographic coordinates and provides a copy of the Bright Region Data from which the flare originated. An example can be found in **Table 3**. *Please note: No flare occurred at this date/time. This is just for demonstration purposes.*

**Table 3**

| Flare Location | | | | | |
|---|---|---|---|---|---|
| | | Peak BR Flux (W sr$^{-1}$ m$^{-2}$) | | Total BR Flux (W sr$^{-1}$ m$^{-2}$) | |
| **Flare Location:** | 1.01 Radii, 78.8° from N | **Channel 0094** | 196.3 | **Channel 0094** | 151351.2 |
| **Total BR Area (Helio Sq. Degrees):** | N/A (offdisk) | **Channel 0131** | 794.0 | **Channel 0131** | 530449.9 |
| **XRS Flare Condition:** | 1 | **Channel 0171** | 6810.9 | **Channel 0171** | 7549812.2 |
| **EUV Flare Condition** | 1 | **Channel 0193** | 12511.4 | **Channel 0193** | 13939814.0 |
| **BR SRS Association:** | None | **Channel 0211** | 7644.1 | **Channel 0211** | 8346380.5 |
| | | **Channel 0304** | 917.3 | **Channel 0304** | 575837.9 |

## Conclusion:

The GOES-R Risk Reduction Phase 3 SUVI products are ready to enter the validation phase of development before delivery to NOAA/NWS/SWPC. Validation of the product outputs will be against other well established solar feature identification strategies, such as the NASA SDO Feature-Finding algorithms and the CHARM model by Dr. Larisza Krista (NOAA/SWPC). NOAA/NGDC will continue throughout the validation phase to cooperate with SWPC and the forecasters in the Space Weather Forecast Office to tailor the products to the forecasters' needs and to ensure that the forecasters will be working with the most reliable data possible.