

Solar Ultraviolet Imager (SUVI) Thematic Maps Proving Ground

- **Background**
- **Development and Implementation**
- **Results and Planned Assessment**
- **Next Steps**

**S. M. Hill, J. Vickroy,
R. Steenburgh**
NOAA Space Weather Prediction Center
(SWPC), Boulder, CO

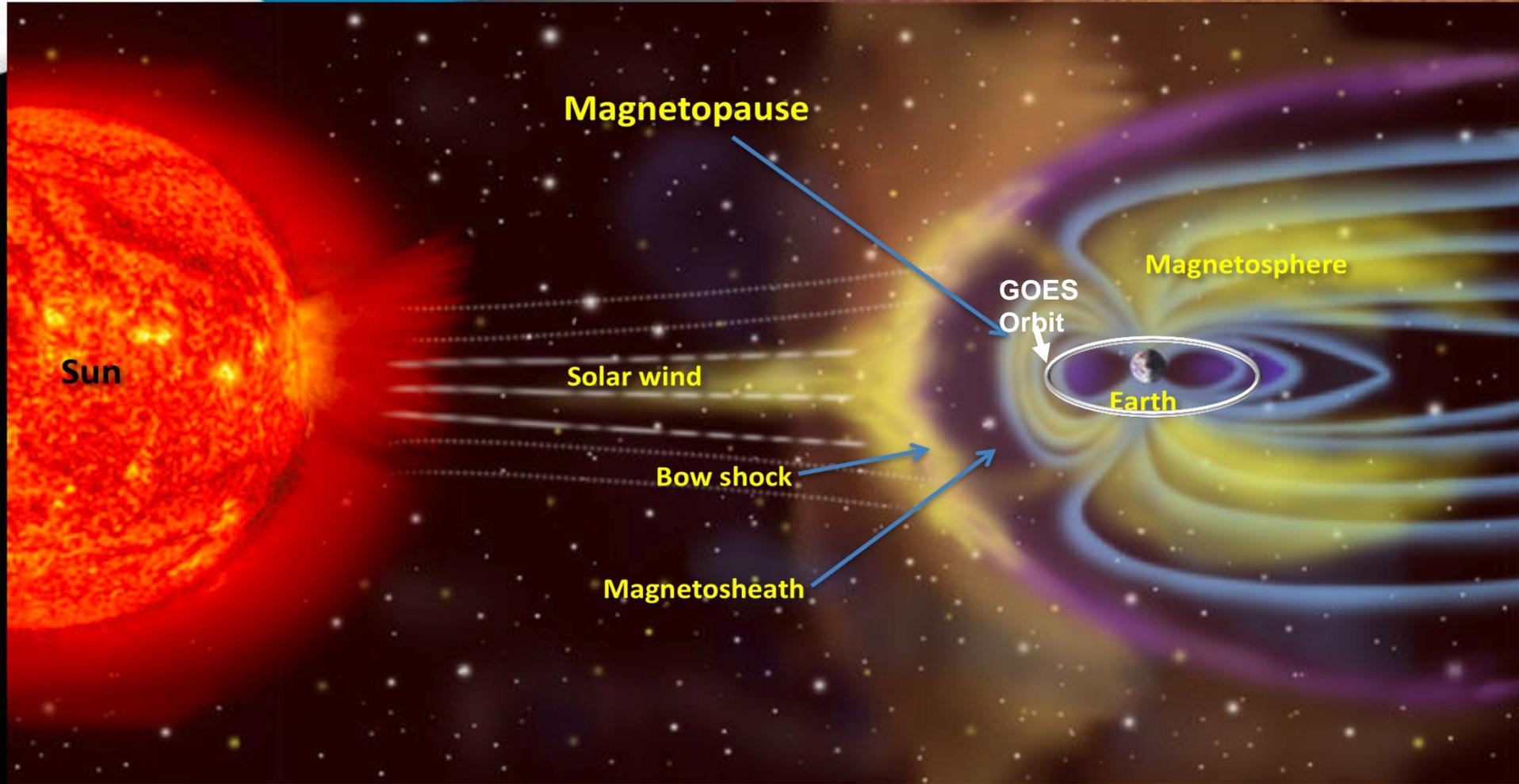
J. Darnell
National Geophysical
Data Center
Boulder, CO

E. J. Rigler
US Geological Survey
Golden, CO

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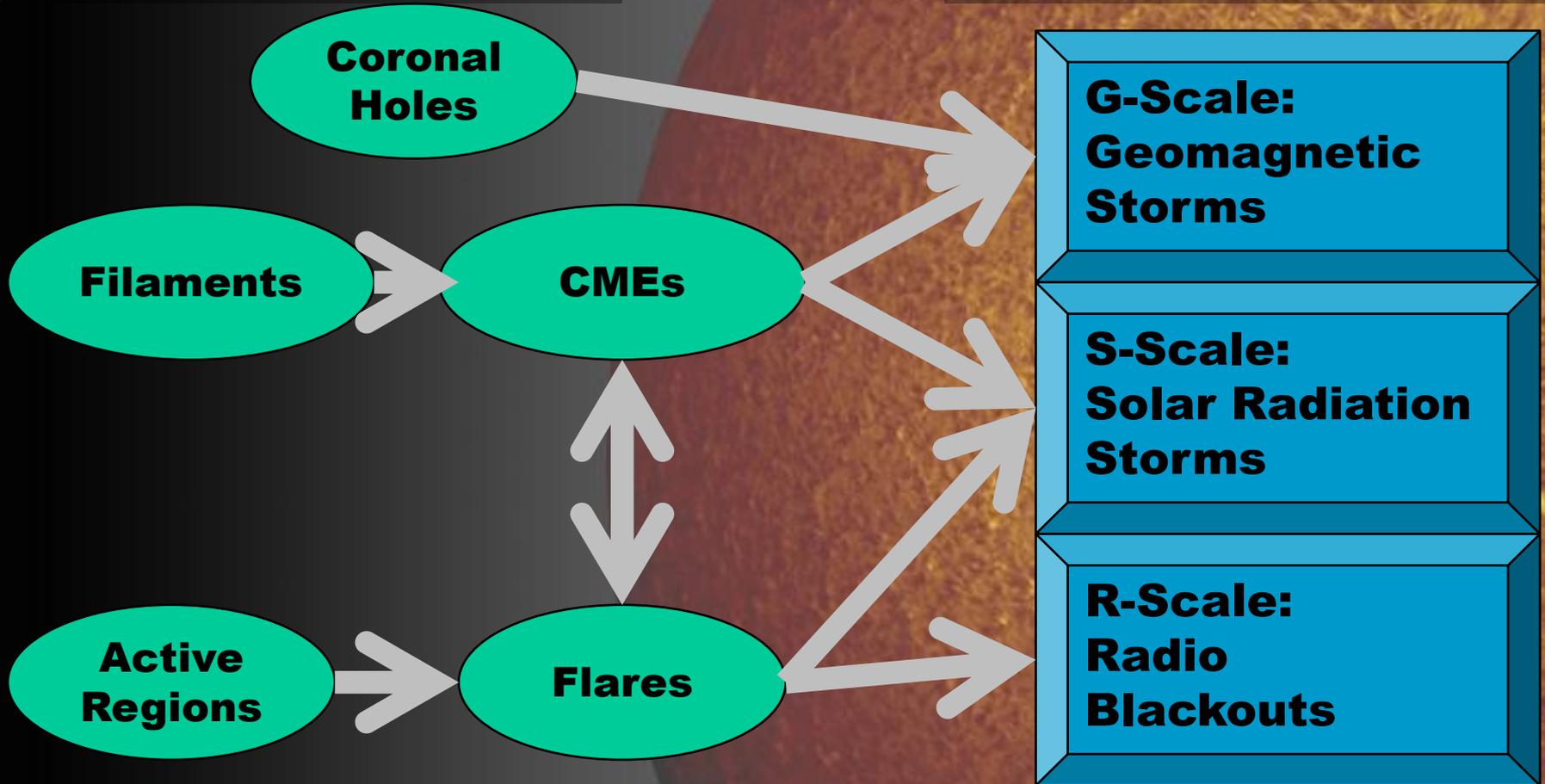
The Space Weather Domain



Phenomena and Impacts

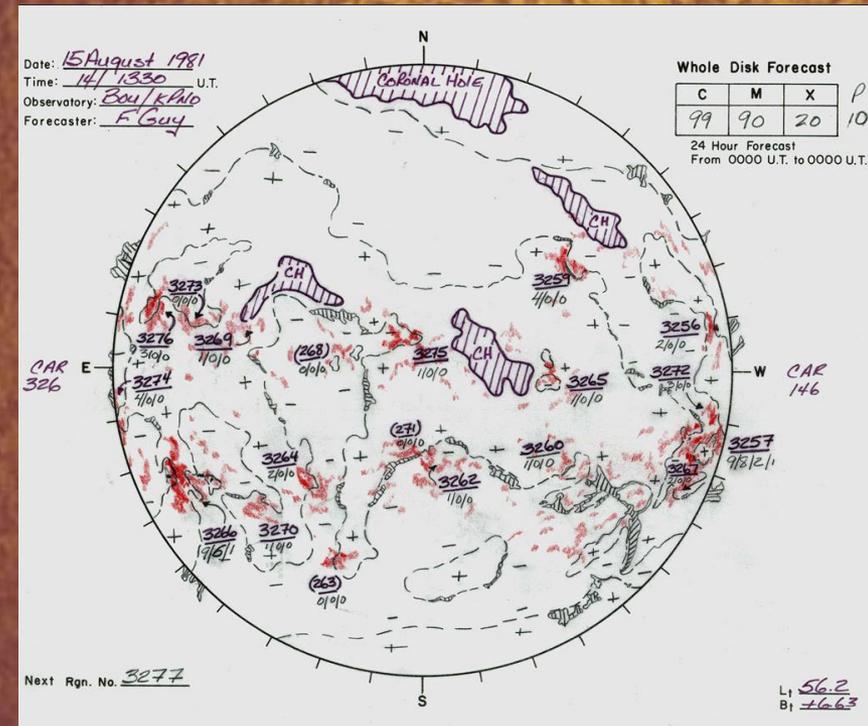
Solar Phenomena

NOAA Scale Impacts



Forecaster Workflow and Tasking

- **Scheduled**
 - Synoptic Analysis Drawings
 - Coronal hole boundaries for recurrent solar wind
 - Active regions for situational awareness and flare probabilities
- **Event-Driven**
 - Flare location (2 min) for solar radiation storms and radio blackouts
 - CME source region for model initiation



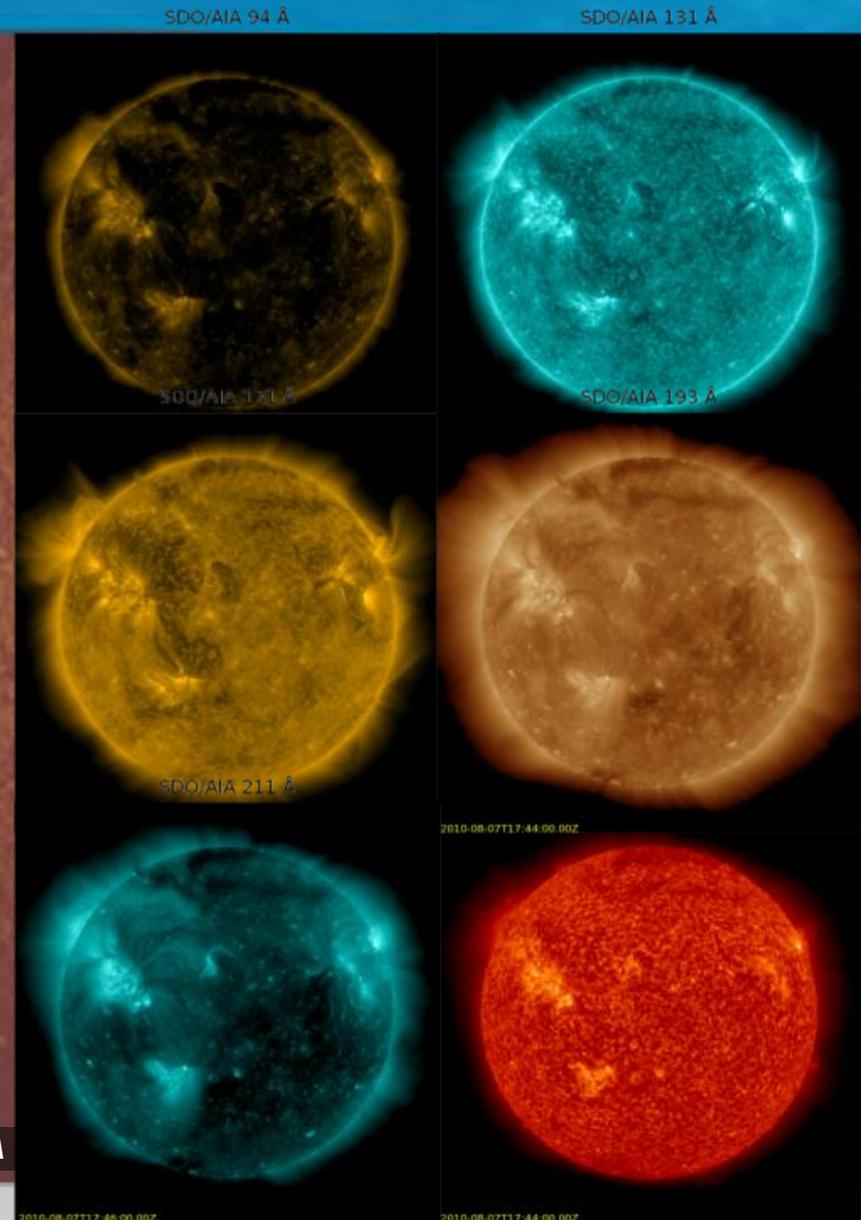
SUVI Image Interpretation

The Sun presents highly complex surface and atmospheric features that are currently interpreted by forecasters by subjective visual inspection.

GOES-R SUVI will provide six spectral channels in the EUV at rapid cadence.

The current approach can be time consuming and exhibit substantial forecaster-to-forecaster variability.

Image Credit: NASA SDO AIA



Observation and Interpretation Challenges

- Coronal holes: Very low EUV radiance
 - Issue: LOS confusion with bright material
- Flares: Intense radiance & high temperatures
 - Issue: Scattering and saturation in major flares
 - Issue: Minor flares appear similar to active regions
- Filaments: Optically thick in some bands
 - Issue: Low radiance confusion with coronal holes

Automated Classification and Retrieval Challenges

- **Line-of-Sight Integration**

- Sun's atmosphere (corona) is thick shell with very large heliographic variations in surface conditions and scale height
- Mostly optically thin leads to integration along LOS

- **Broadband (SXI)**

- Gives good qualitative separation of features due to greater contrast dependence on temperature in X-rays
- Mix of continuum and many lines makes quantitative retrievals difficult

- **Narrowband (SUVI)**

- Very good for quantitative retrievals because of (mostly) single line temperature dependencies
- Contrast is lower at longer wavelengths

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Algorithm Selection

• Physics-Based

- Differential Emission Measure (DEM) Retrieval
- Continuum of values do not necessarily simplify forecaster interpretation
- Models are not mature enough to ingest such data

✓ Statistical

- Multispectral Bayesian classification
- Segments images in to a limited number of meaningful classifications
- Extensive heritage in terrestrial remote sensing
- Forecaster training of algorithm ensures results are aligned with traditional visual interpretation

Proving Ground Plan

- **Year 1 (6/11-5/12)**: Develop pseudo-operational system
 - Establish proxy data pipeline
 - Create framework to run algorithm
 - Develop decoder to display outputs on AWIPS2
- **Year 2 (6/12-5/13)**: Evaluate system
 - Present in real-time to forecasters
 - Create software for more routine (re-)training of algorithm
 - Retrain and modify algorithm according to forecaster feedback

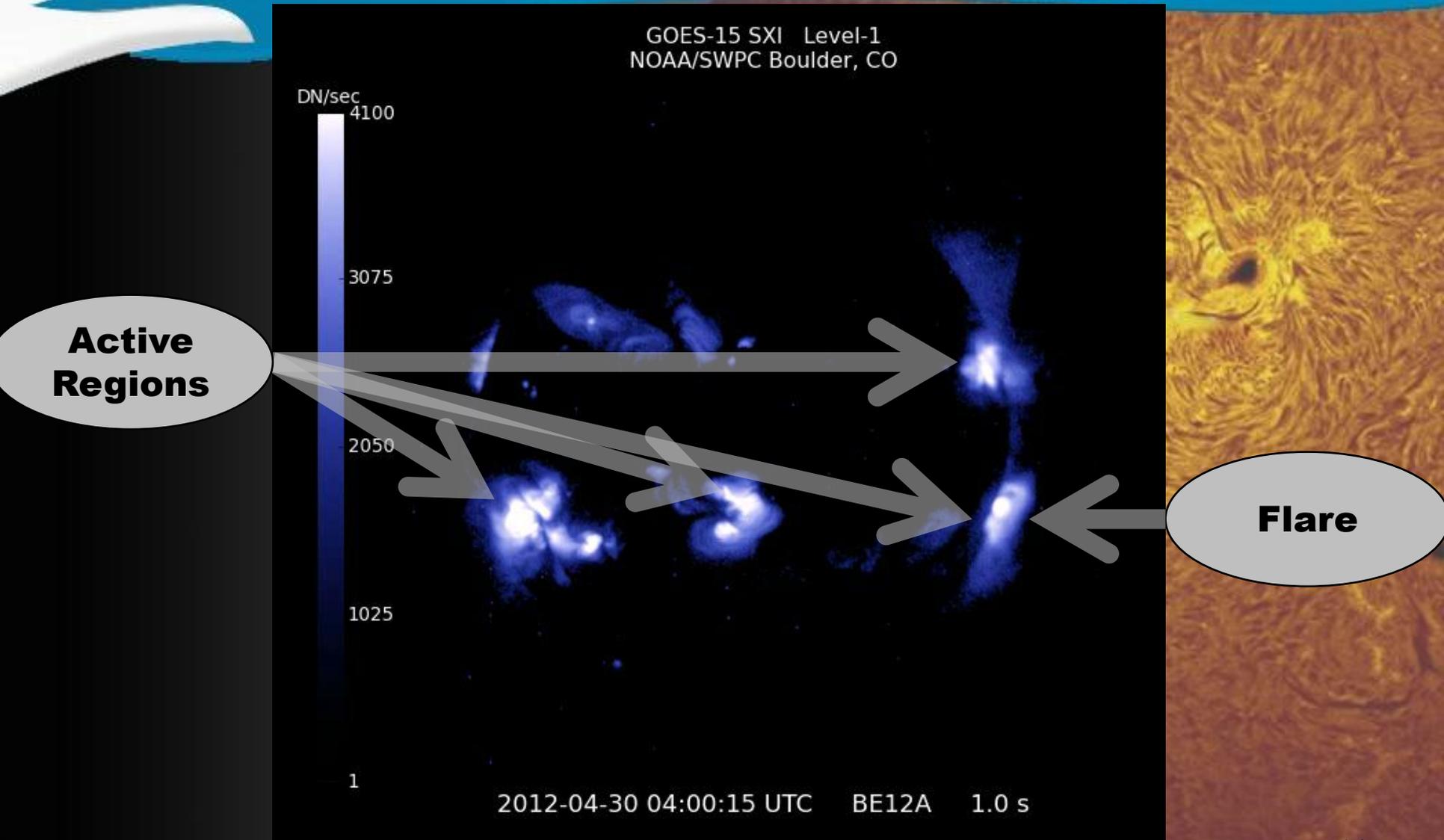
Algorithm/Program Description

- **Code**
 - Algorithm implemented in AWG standard FORTRAN
 - Framework built in Python
- **Data source**
 - NASA Solar Dynamics Observer (SDO) Atmospheric Imaging Array (AIA)
 - Synoptic real-time data set on 3-minute cadence
 - 1024x1024 pixels, 2.5 arcsec sampling
 - Six spectral channels

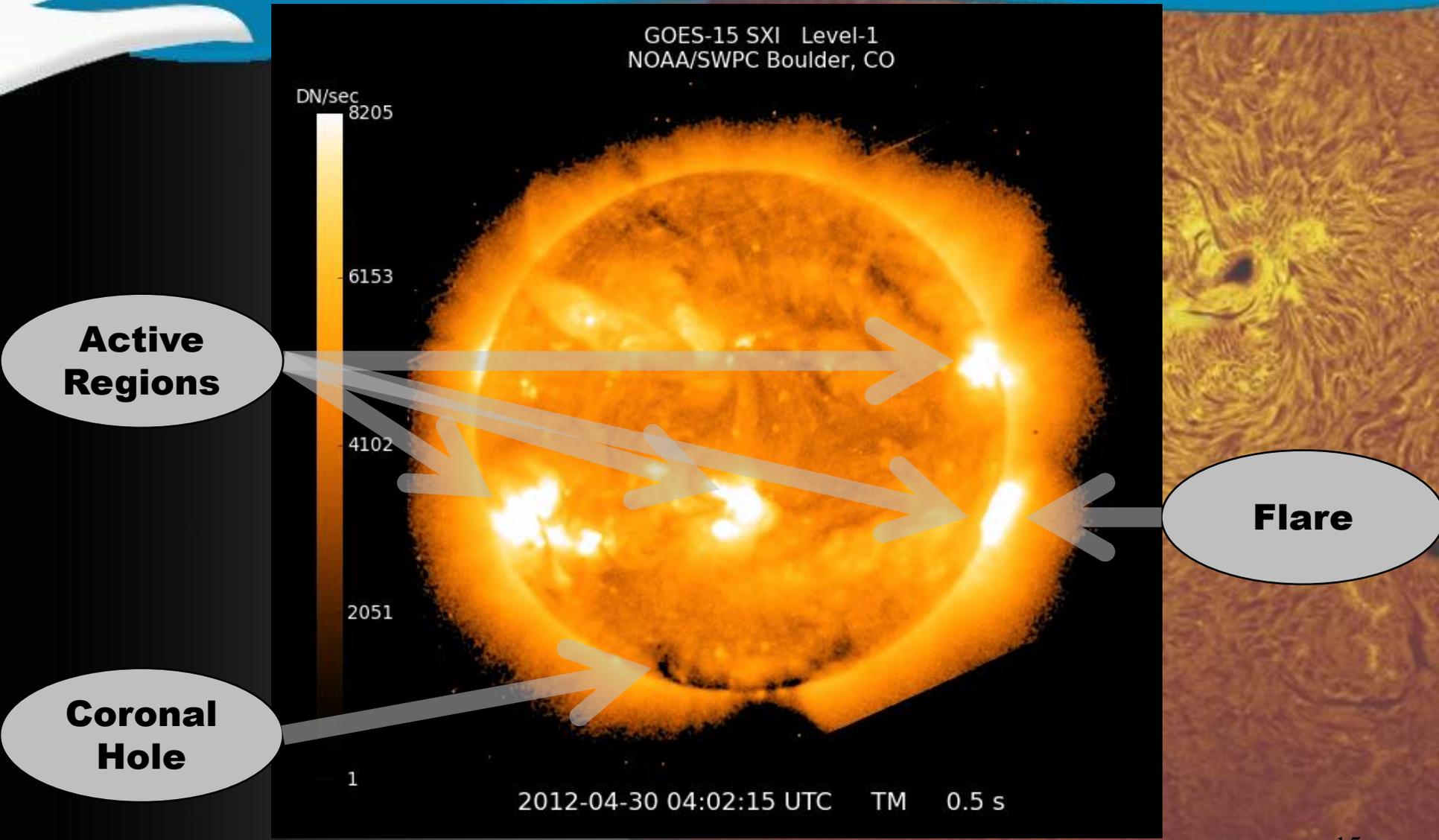
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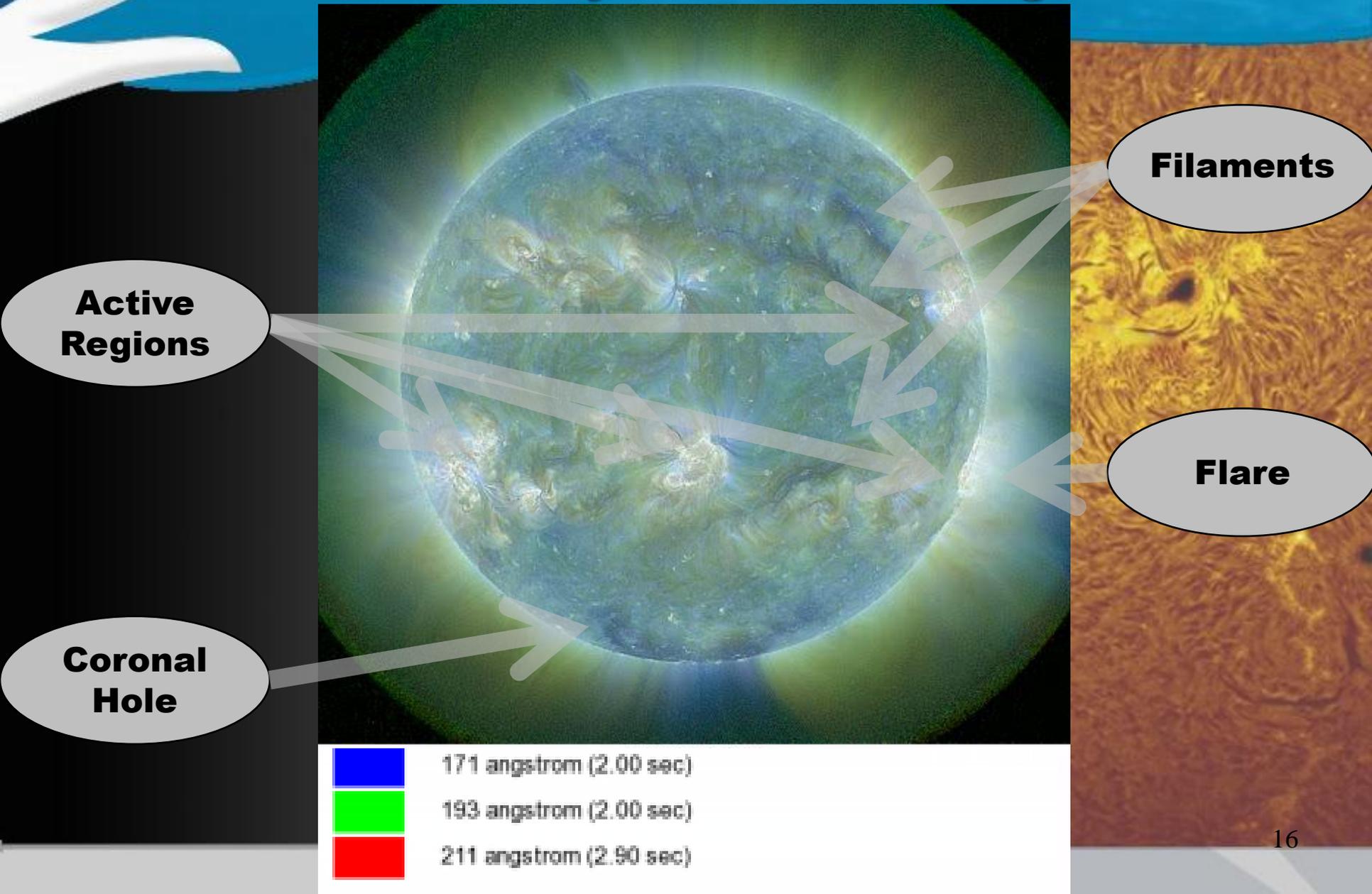
SXI "Active Region" Image



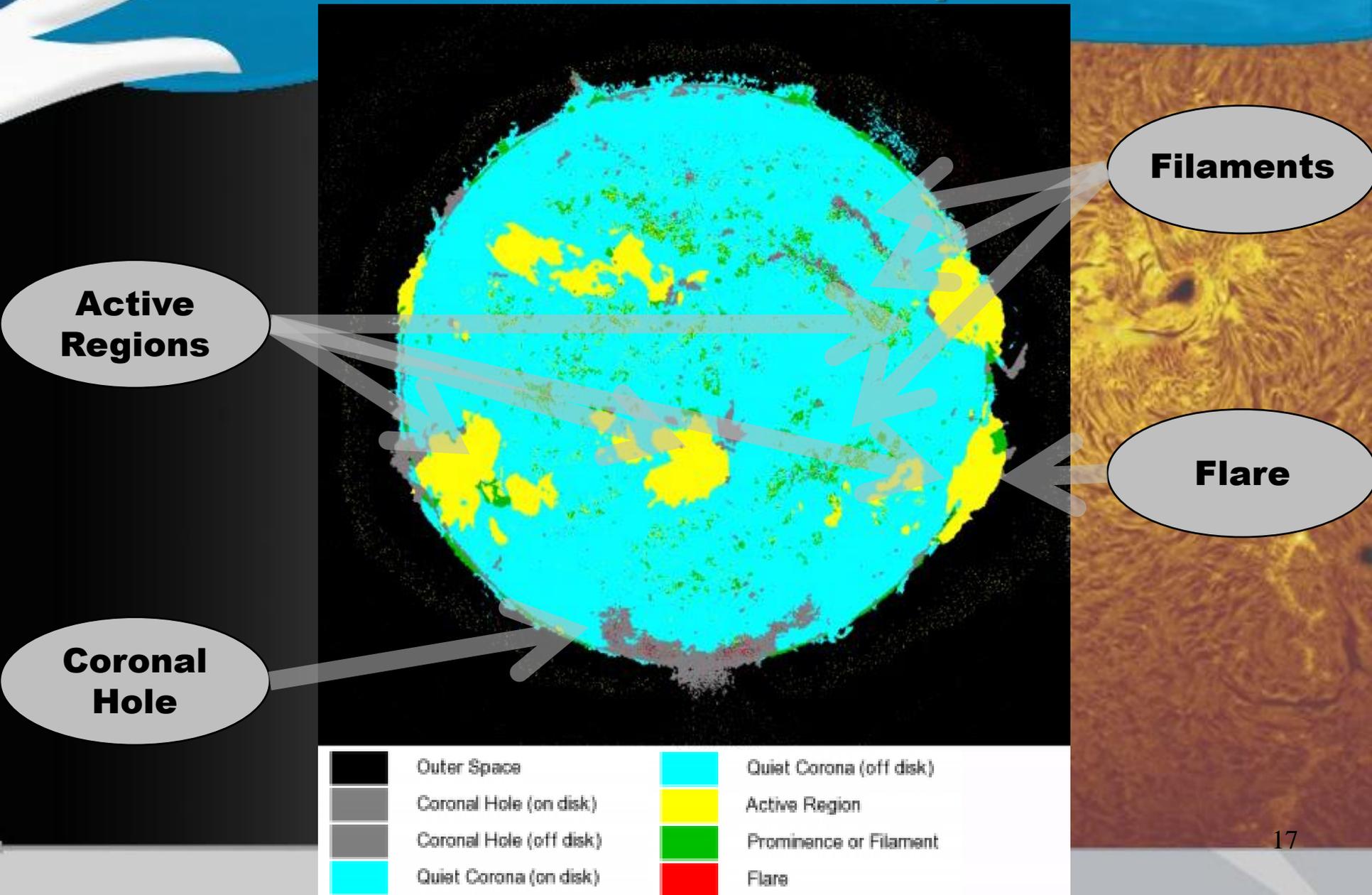
SXI "Coronal Structure" Image



SUVI Proxy Tri-Color Image



SUVI Thematic Map

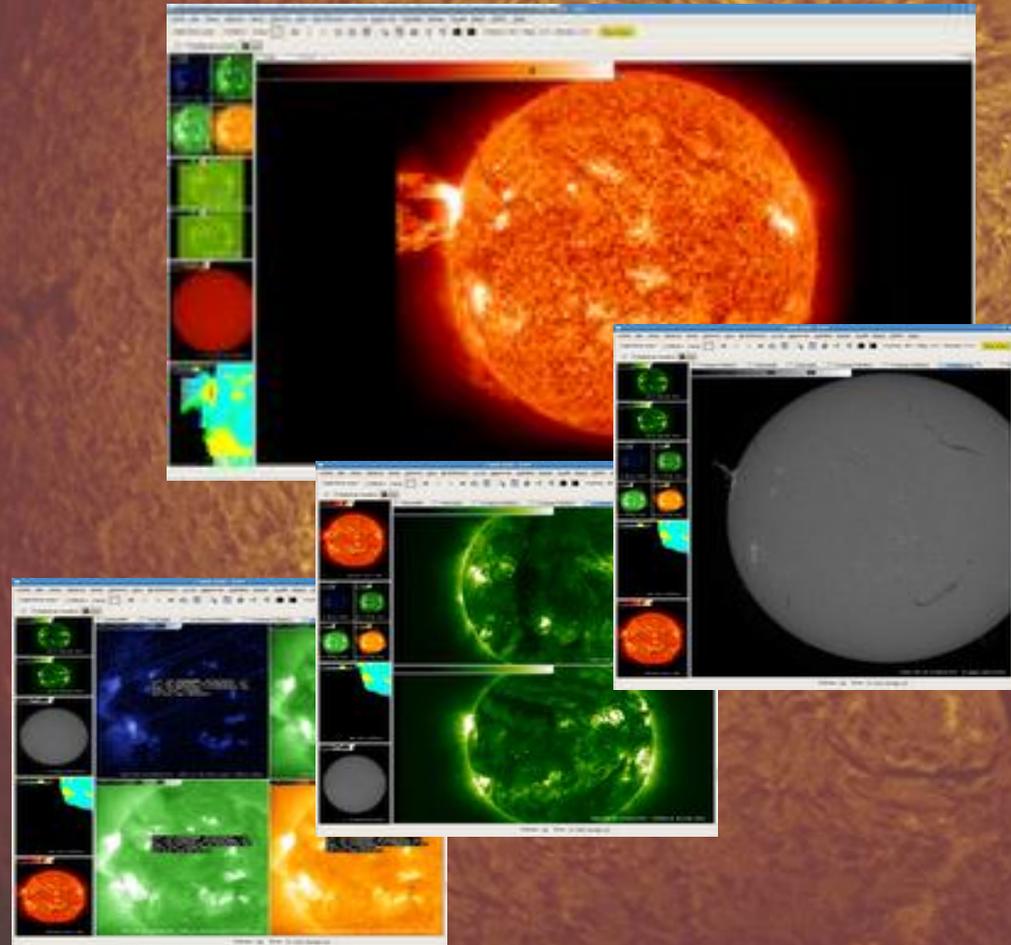


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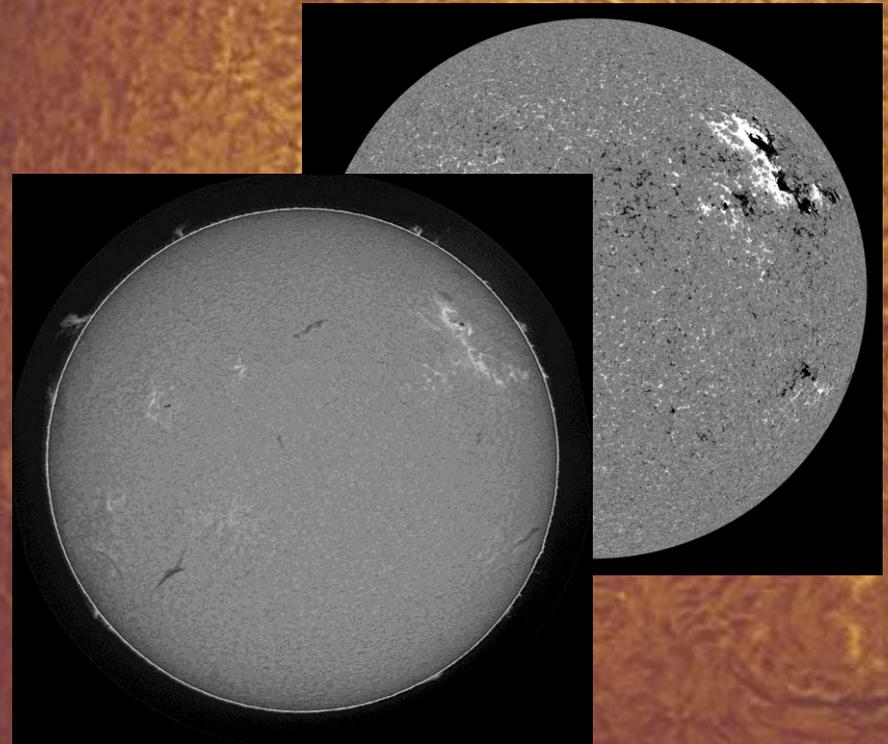
Planned Improvements

- AWIPS 2 display to forecasters
- Broader training scenarios
- Additional contextual constraints
- Probability thresholds
- Null identifications



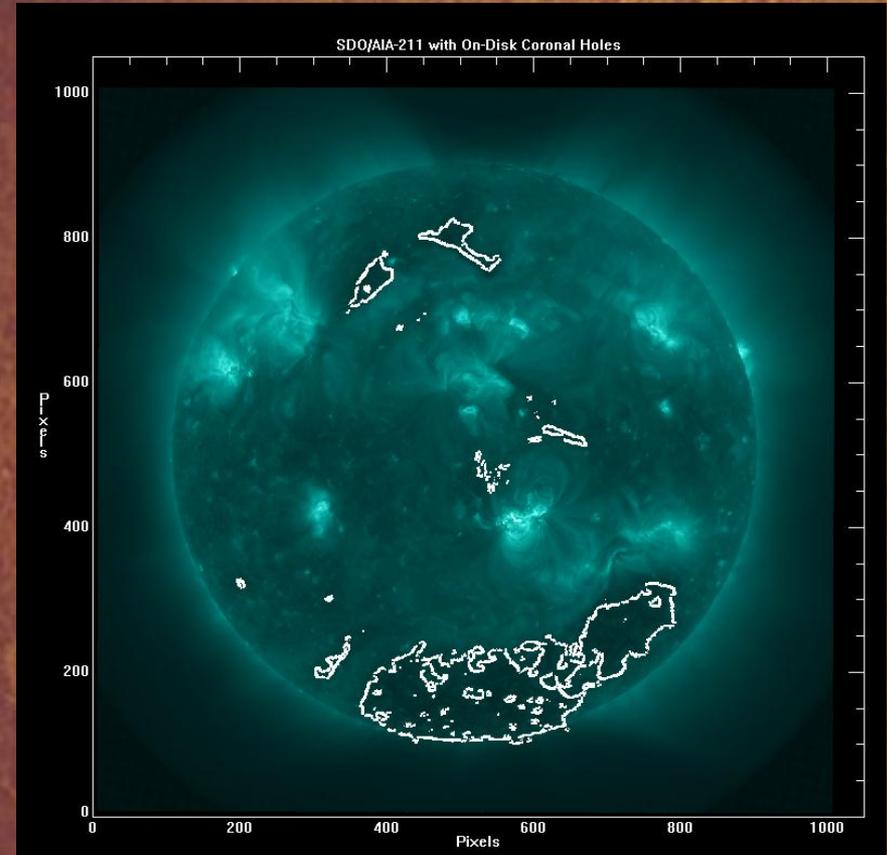
Data Diversity

- Incorporate additional, non-GOES spectral channels, e.g. H-alpha
- Study incorporation of 'non-spectral' data sets, e.g., magnetograms
- Study uses of temporal differences



Downstream Products

- Planned
 - Coronal hole boundaries
 - Flare location
 - Active region statistics
- Research
 - Temporal differences for coronal dimmings and waves



Summary

- SUVI Thematic Maps are ready for forecaster evaluation
- The Maps have been integrated into a prototype AWIPS 2 system
- Product provides guidance, forecaster is always in-the-loop
- Successful evaluation will lead to reduced forecaster workload and less variability
- A number of improvements are being considered