



# BRICS Network for Constant Monitoring of the Sun (NCMS)

Observe the Sun 24/7 and be aware of any events

Collaboration: Pulkovo (Kislovodsk), Ussuriysk, Irkutsk & Crimea Observatories,

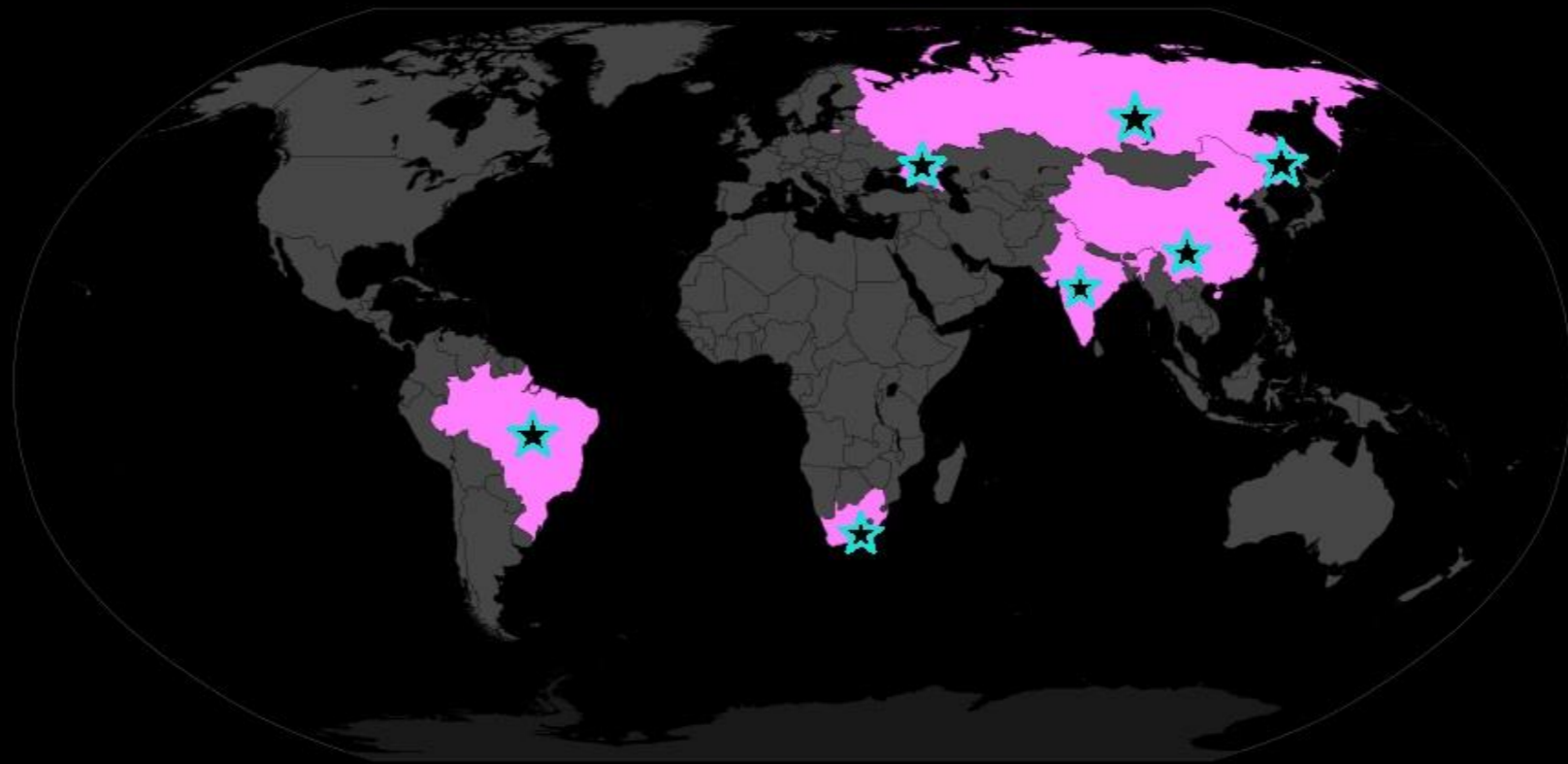
**Russia,**

Huairou Solar Observatory, **China**

National Institute for Space Research, **Brazil**

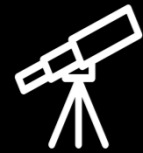
# Global challenge for BRICS

Real-time space weather forecast requires 24/7 monitoring of the Sun. National observatories can provide only a **partial** monitoring.

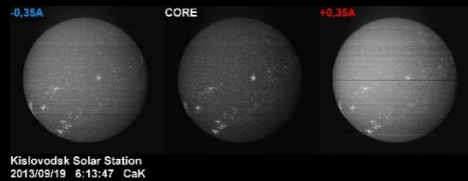


Integration of BRICS countries into a network enables **continuous** tracking of solar activity and real-time forecasting of space weather events.

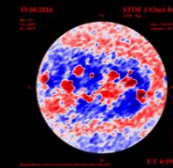
# NCMS model



24/7 patrol telescope network observes the Sun in several spectral lines



Solar observatories measure large-scale magnetic fields



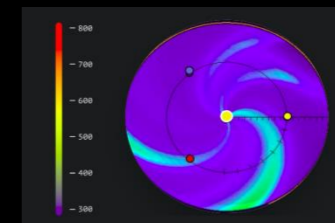
Data mining centers process data flows and detect new events (solar flares, coronal mass ejections, etc)



Updating a database of solar observations



Updating a solar wind model



Production of space weather forecast and alerts

# NCMS in focus

7 automated solar patrol telescopes. 3 in Russia and at least 1 in each of BICS

24/7 continuous observation of the Sun and real-time forecasting

5 solar magnetographs incl. 1 solar vector magnetograph

15 Gb daily from each of automated telescopes

7 day forecast of solar wind and tracing of CMEs up to 3 days



# NCMS road map



2019

Select locations and start construction of telescopes  
Build a data center and elaborate API

2020

Mount and calibrate telescope network  
Adjust a solar wind model

2021

Launch an online space weather monitoring and forecasting service  
Run 24/7 data production

# Project costs

Construction of 1 telescope – 70K (x7)

Telescope infrastructure – 20K (x6)

Telescope operational costs – 10K / year (x7)

Data center equipment – 200K

Data center operational costs – 30K / year

Data center personnel – 100K / year

Total – 810K and 200K / year



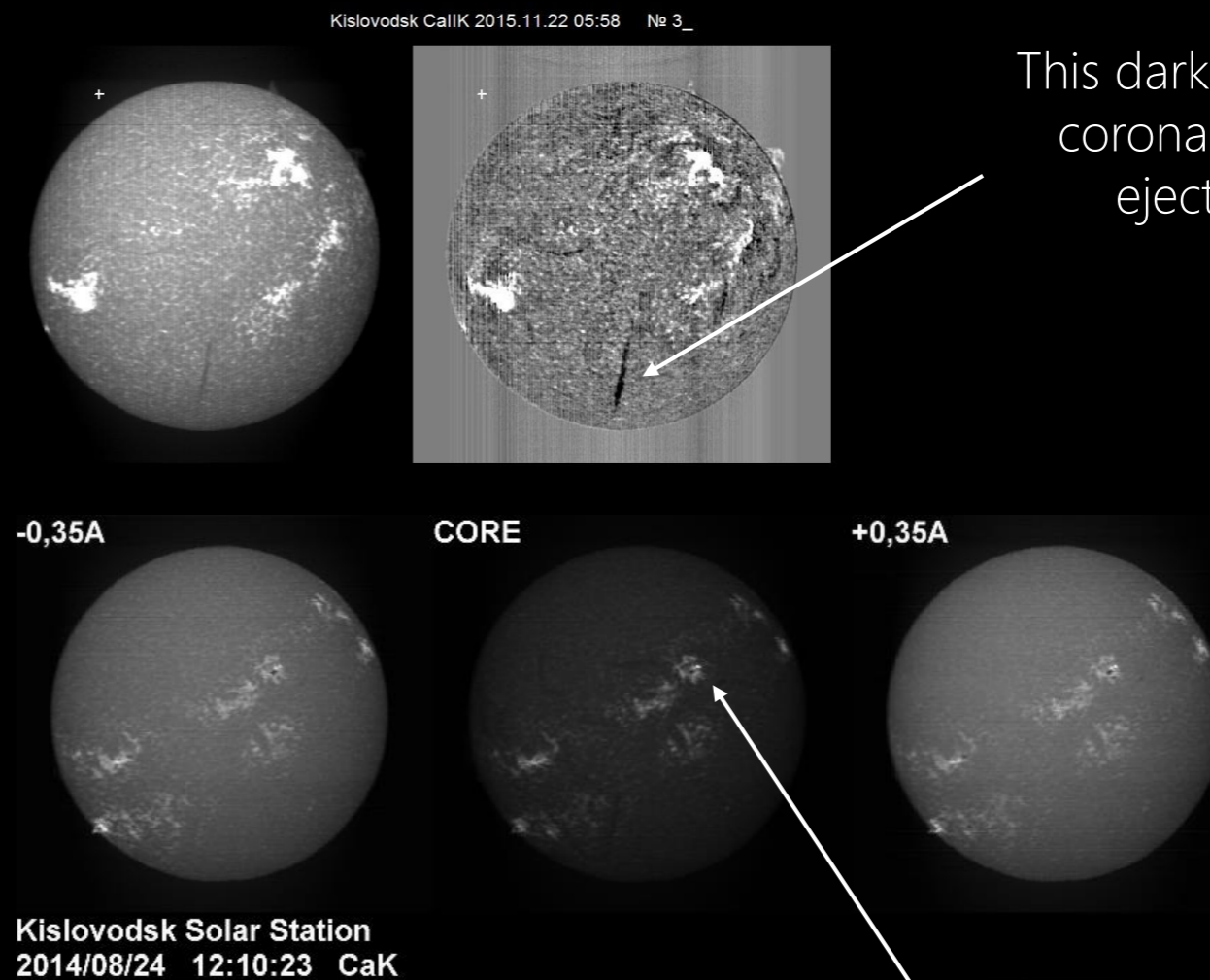


# Patrol telescope for solar monitoring

Fully automated solar patrol telescopes observe the Sun in CaII-K, H $\alpha$  and white light every 1 minute. It allows detection of solar flares and coronal mass ejections over the whole disk. Two telescopes operate daily in Russia and can be **easily combined with the new ones from BRICS into a global network.**



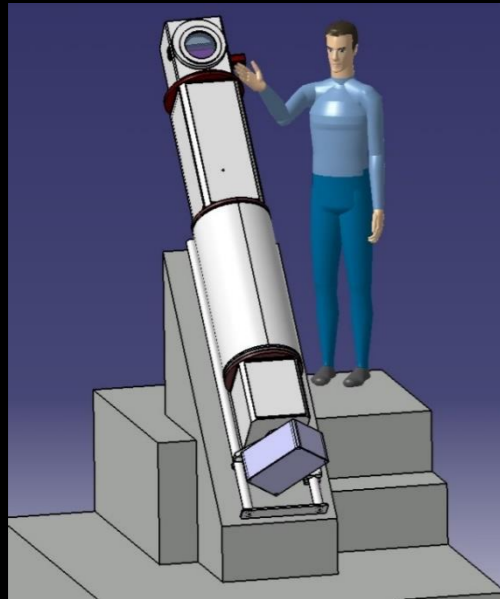
Solar patrol telescope at the Kislovodsk Mountain Astronomical Station



This dark line is a coronal mass ejection

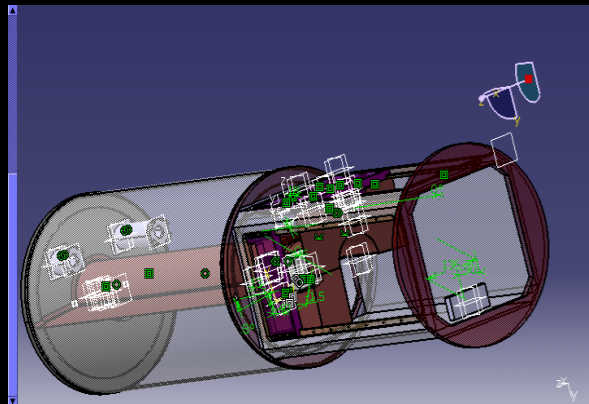
This bright spot is a solar flare

# Under the hood of the patrol telescope

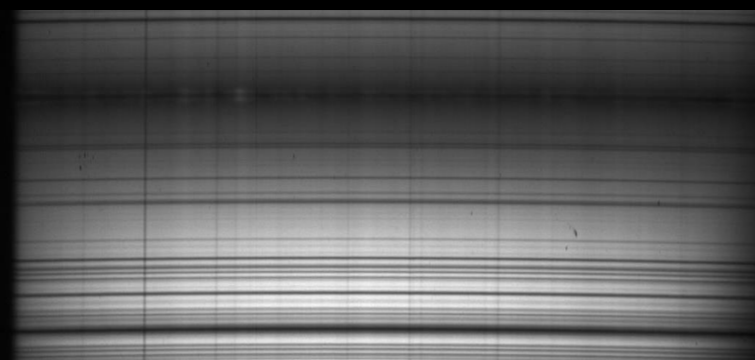


Focal distance of the main mirror: 2000 mm  
Main mirror diameter: 100 mm  
Detector type: CCD matrix  
Matrix resolution:  $4000 \times 2672$  pixels  
Solar optical resolution:  $\sim 2$  arcsec  
Spectral resolution (R): 40K  
Effective spectral resolution at CaII-K:  $0.1 \text{ \AA/pix}$   
Effective spectral resolution at H $\alpha$ :  $0.16 \text{ \AA/pix}$

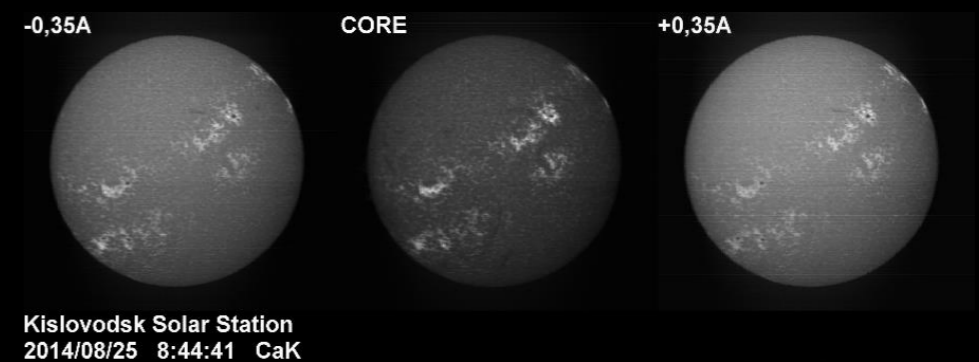
## How it works



Spectrograph scheme



Scanned solar disk along a spectrograph entrance slit

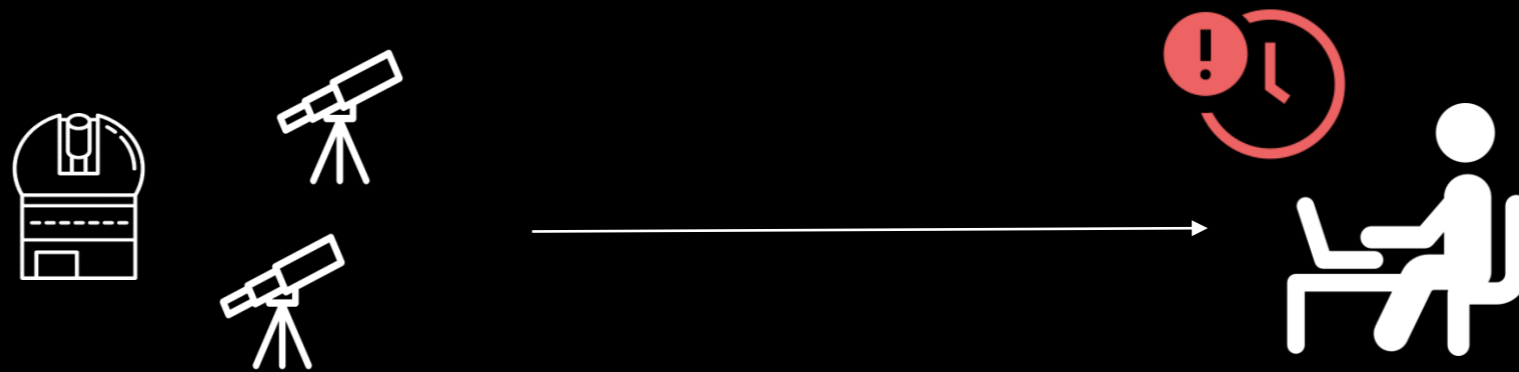


Solar disk images at the core and wings of spectral line

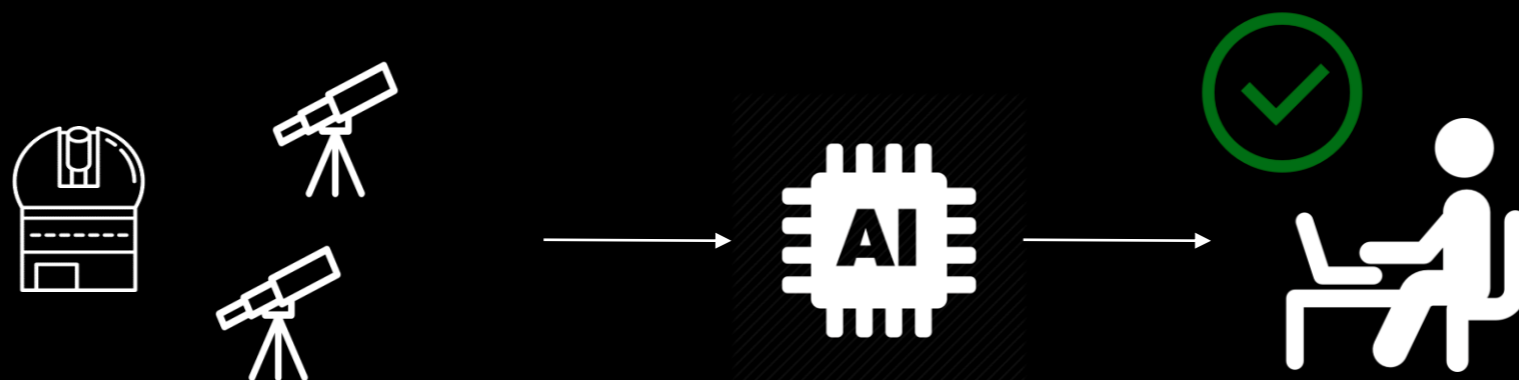


# Data processing challenge

Global observational network will produce a large flow of raw data, while the number of experts to process data in real-time is very limited. This will cause **delays** in a forecast production.



Machine learning algorithms were demonstrated to provide an expert-level solar data processing. They are able to **speed up** routine workflows.

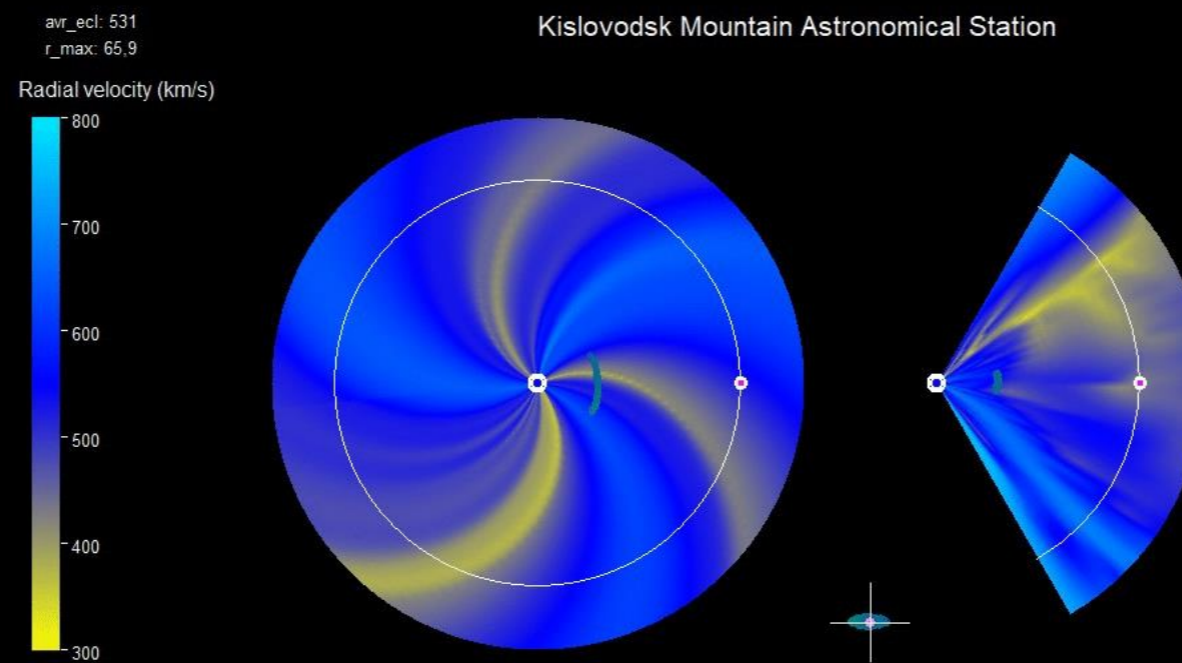


# NCMS real-time outcome

Solar wind forecast up to 7 days and tracing of CMEs up to 3 days

Detection of solar flares and estimation of X-ray flow

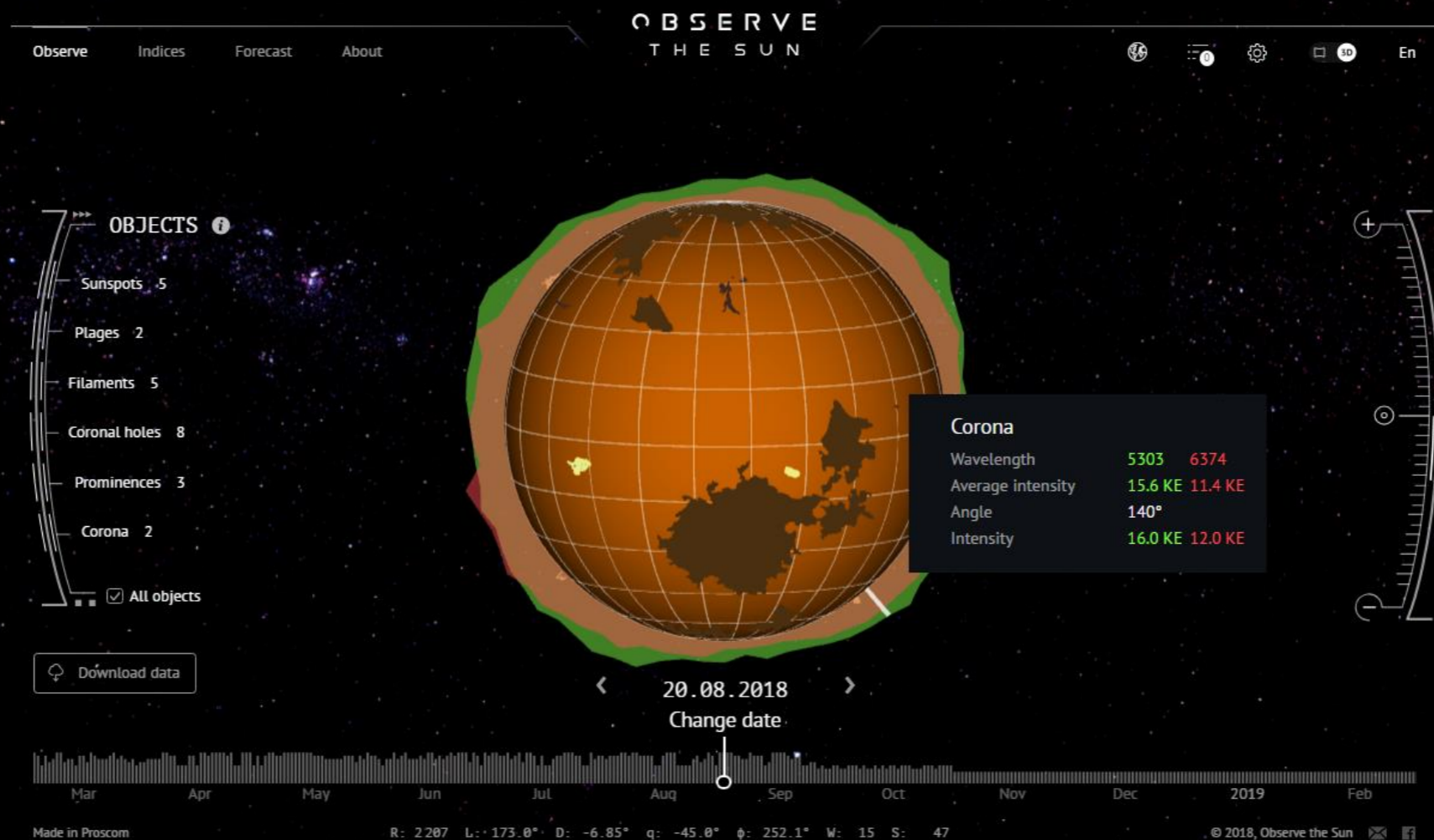
Space weather indices and alerts



Solar wind and CME prediction model

# NCMS and long-term observations

NCMS extends and complements catalogues of solar observations. More accurate models can be elaborated and validated on this basis.



Daily updated catalogue of solar active regions.  
Learn more at <http://observethesun.com>



# Conclusion

BRICS solar monitoring network

enables 24/7 real-time space weather forecasting



extends current catalogues of solar observations



provides a common database

