



# Forecast Space Weather Chains

Yihua Zheng



# Linkage of space weather events



## (example 1, flare/CME)

- Flare/CME
- SEP (if any)
- CME arrival (in-situ data)
- Geomagnetic storm (indicated by Kp, or Dst)
- Other impacts (ring current/radiation belt dynamics, aurora, enhanced total electron content,)



# Flare/CME examples



- March 7, 2012 event
  - [http://bit.ly/March7\\_2012\\_event](http://bit.ly/March7_2012_event)
  - <https://goo.gl/MhUp50> (an alternative view)
- The March 15, 2015 storm
  - [http://bit.ly/20150317\\_geomagnetic\\_storm](http://bit.ly/20150317_geomagnetic_storm)



# Coronal Hole High Speed Streams (HSS)



- Coronal hole HSS
  - Also leads to geomagnetic storms, but long duration and weaker (Kpmax 6 to 7, not exceeding 7)
  - Enhancement of the outer edge of the outer radiation belt (e.g., effective for pumping up the energetic electron flux at GEO orbit)
  - Examples:
    - 2015-06-07
      - [http://bit.ly/HSS\\_20150607\\_extended](http://bit.ly/HSS_20150607_extended)
      - <https://goo.gl/CRqv3h>
    - 2016-05-07 (Kp=7)
      - <https://goo.gl/XwppcY>



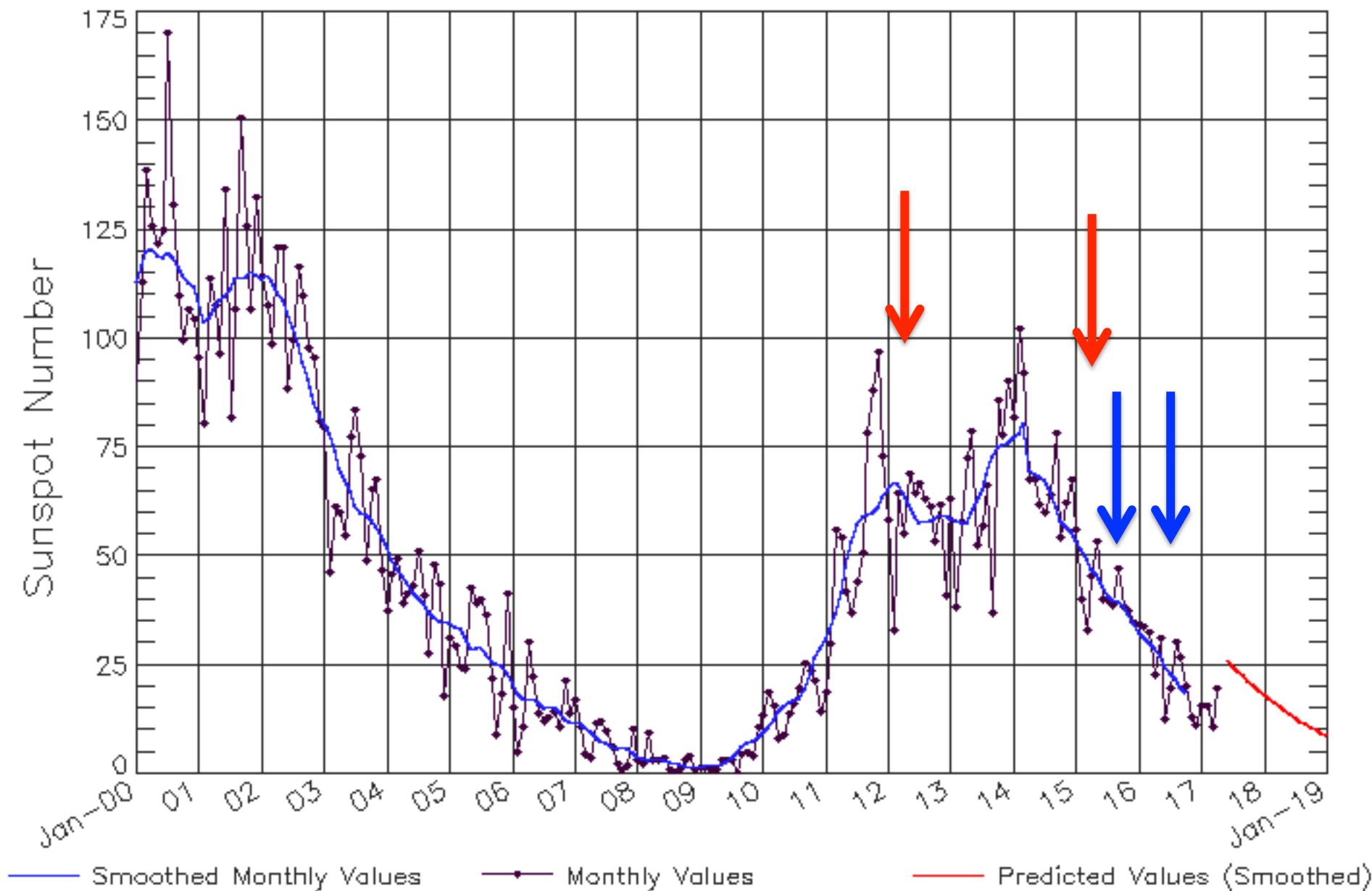
# Exception

many x-class flares, no  
accompanying CMEs

- AR2192 X class flares and the Oct 14 CME
  - [http://bit.ly/AR2192\\_XclassFlares\\_oct14CME](http://bit.ly/AR2192_XclassFlares_oct14CME)

# ISES Solar Cycle Sunspot Number Progression

Observed data through May 2017





# Other Examples



- The Jan 23 – 27, 2012 SEP events
  - <https://goo.gl/H1qWYb>
- AR 1429 timeline
  - <https://goo.gl/GPLJkX>
- The Galaxy 15 Event
  - [http://bit.ly/galaxy15\\_charging\\_event](http://bit.ly/galaxy15_charging_event)



# More (Other layouts)



- <http://swrc.gsfc.nasa.gov/main/demo>
  - Examine various layouts here

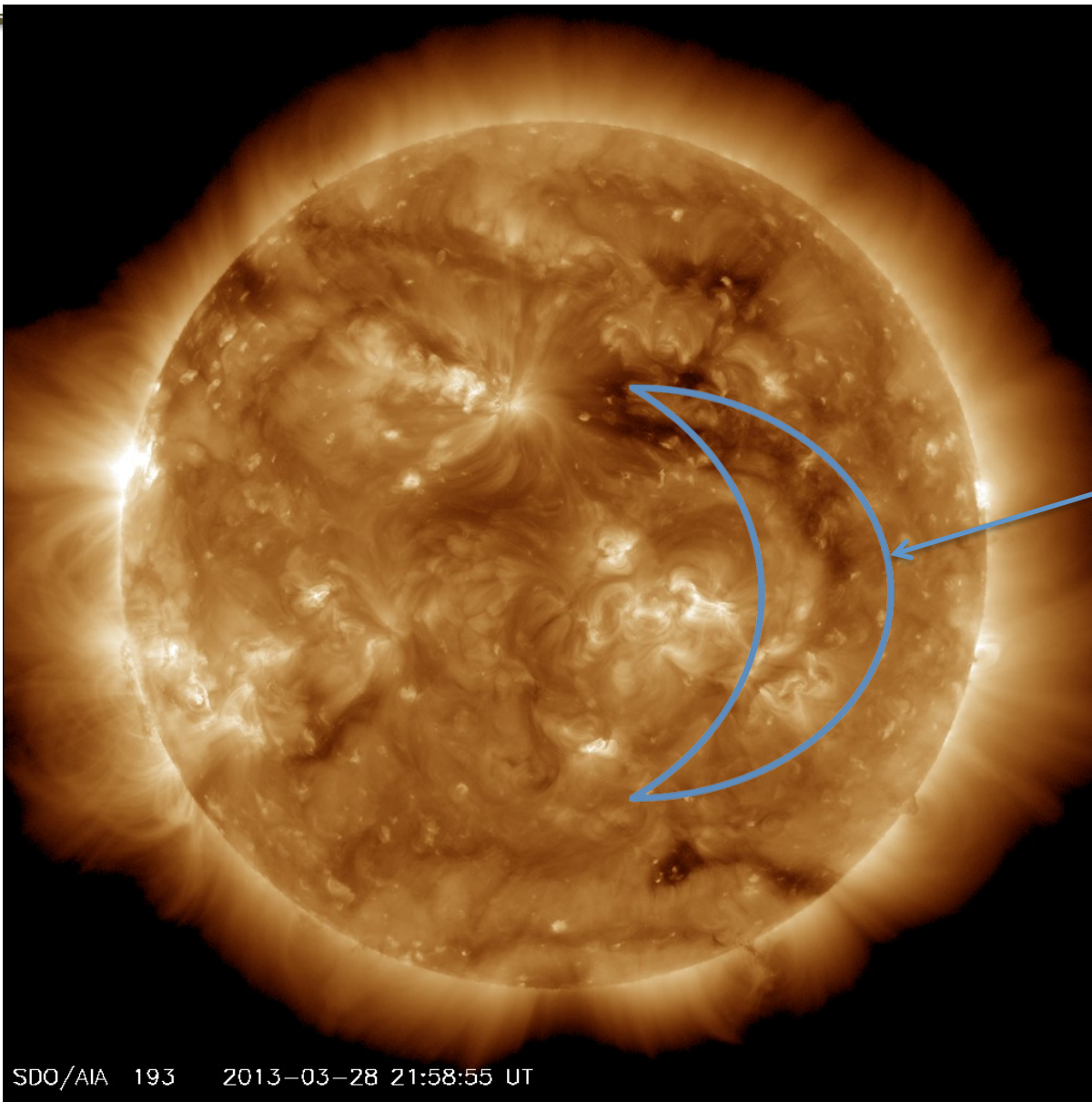




extras



# The Coronal Hole possibly responsible for the aurora at Saturn around May 20, 2013



Coronal Hole

Well, I tried 😊



# The Coronal Hole possibly responsible for the aurora at Saturn around May 20, 2013

