



# MiniMax24 Observation Campaign

A year-long SCOSTEP campaign on Sun-Earth Connection

Scientific Committee on Solar Terrestrial Physics  
(SCOSTEP)

Climate & Weather of the Sun-Earth System (CAWSES)

50<sup>th</sup> UNCOPUOS/STSC Meeting 2013 February 13 Technical Presentation by Nat Gopalswamy  
Agenda item 10. Space Weather

# MiniMax24

A year-long SCOSTEP campaign on Sun-Earth Connection

- SCOSTEP has declared the year 2013 – as the Year of MiniMax24
- MiniMax24 is a Year-long Scientific Campaign in 2013
- Science Workshop to analyze the campaign data in 2014
- Outreach activities explaining extreme solar variability and its implications for space weather and Earth's climate

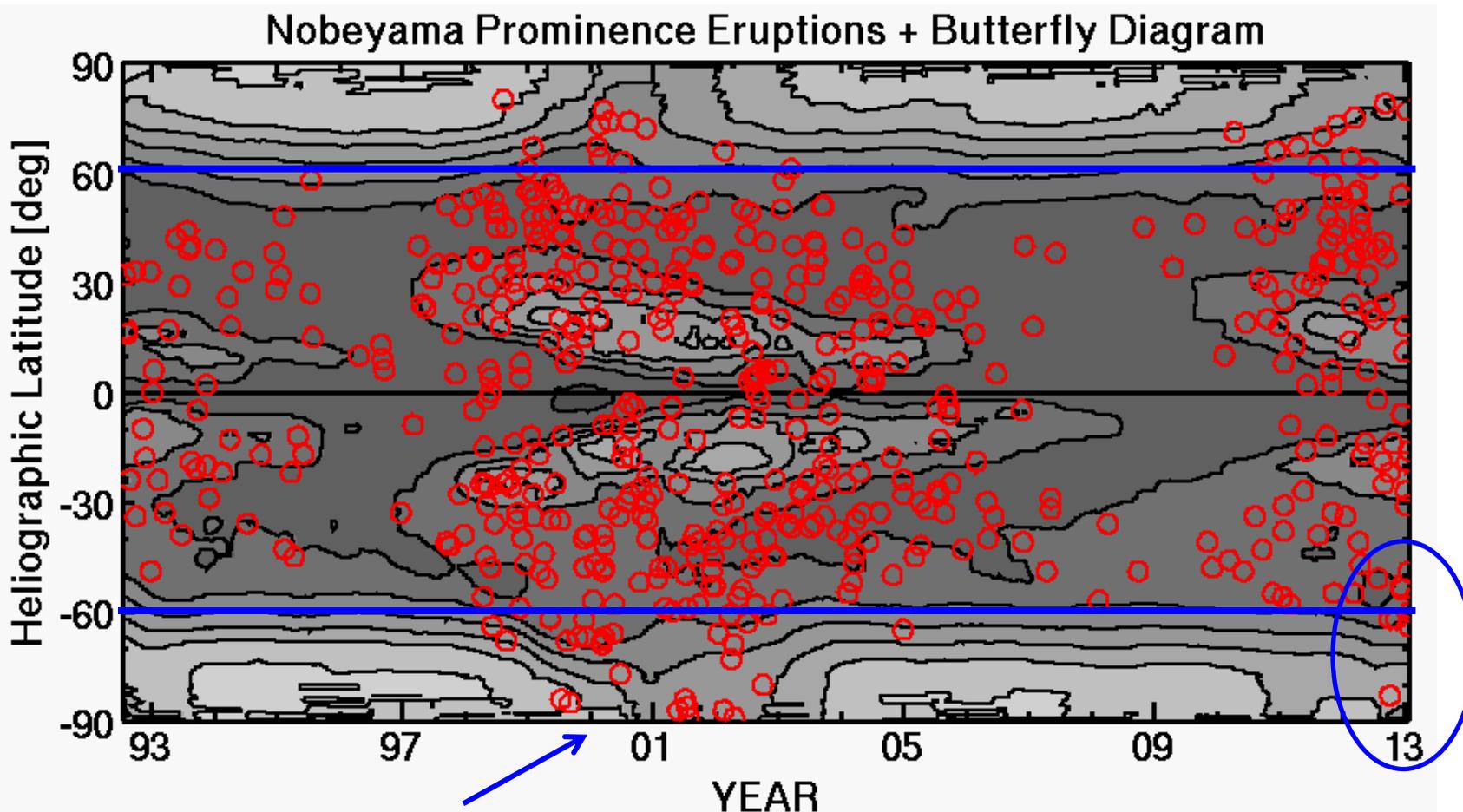
# MiniMax24

A year-long SCOSTEP campaign on Sun-Earth connection

- Marks that we are in the maximum phase of solar cycle 24
- Marks that the activity level of cycle 24 is relatively low
- Low activity means weaker space weather effects
- Less radiation received at Earth: climate implications

# Sun in Maximum Phase?

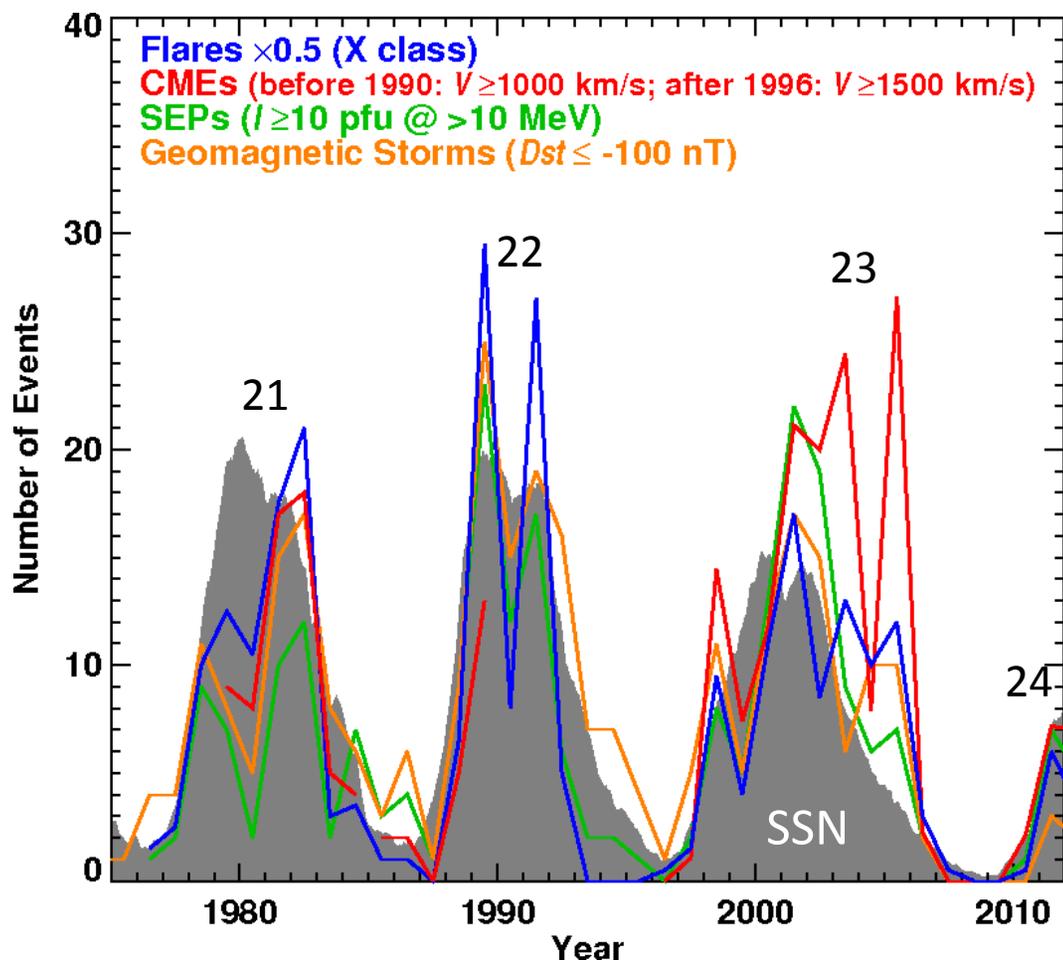
Each circle is an eruption event on the sun observed in Japan  
During the maximum phase eruptions happen above 60° latitude  
In the north pole, max conditions since 2011; just begun in the south



High-latitude. activity during max phase (23)

Gopalswamy et al., 2003; 2012

# Space Weather is Milder



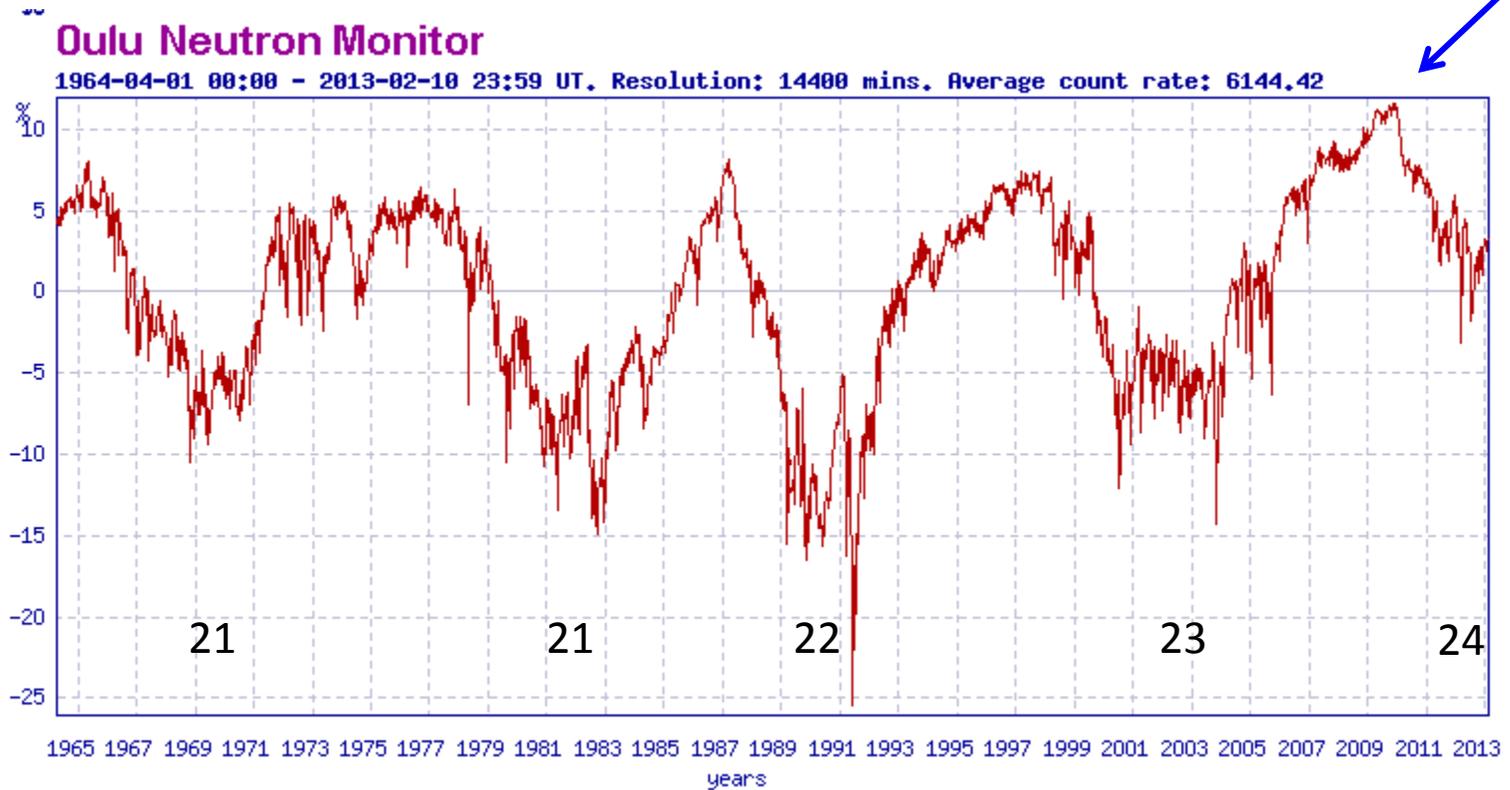
Weaker activity of the Sun means milder space weather

- less number of particle radiation events
  - Less number of geomagnetic storms
- But occasionally dangerous storms occur even during the waning phase of activity

Less drag on Earth-orbiting satellites

- increased lifetime and less fuel spent to maintain orbit
- Bad part: space debris live longer when there is low solar activity

# Earth Receives More Cosmic Rays



Low solar activity → More cosmic rays arriving at Earth

Cosmic ray levels remain high even though the Sun is in its activity maximum phase

The MiniMax24 campaign will monitor the cosmic ray level to understand this cycle and their potential implications for Earth's Climate

# MiniMax24 Campaign

- Daily Observations of the Sun and Geospace
- Focus on two targets:
  - 1. Solar Flare Target – selected by the Max Millennium observers.
  - 2. Non-flare Target – selected by the MiniMax24 campaign team
- 35 observatories/institutes from 17 countries are currently in the campaign
- More expected to join

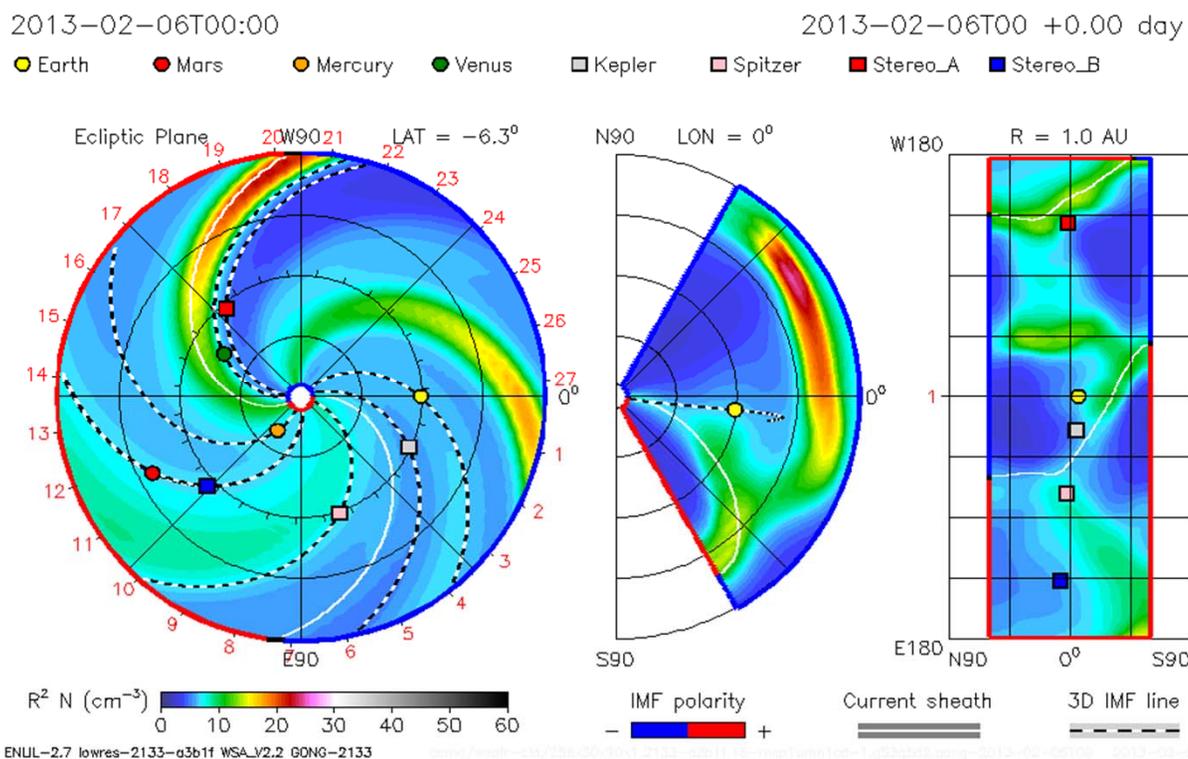
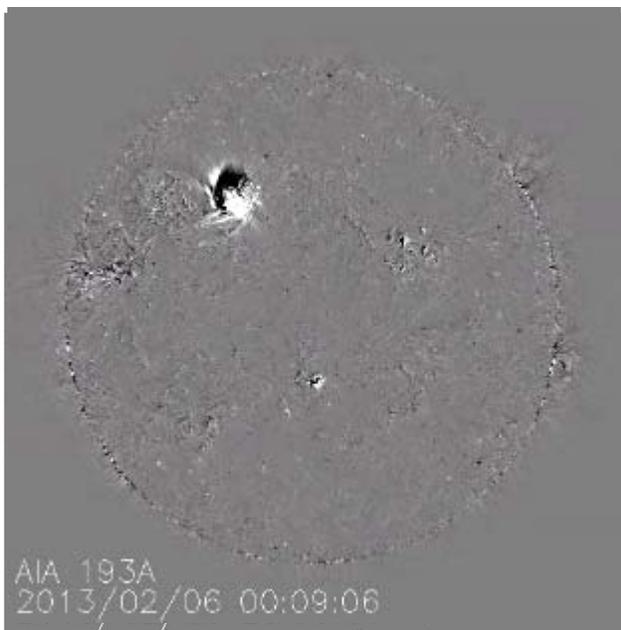
Austria (coordination)  
Belgium  
Brazil  
China  
Croatia  
Denmark  
Finland  
India  
Ireland  
Italy  
Japan  
Kazakhstan  
Slovakia  
Turkey  
UK  
USA (Coordination)

## MiniMax24: Campaign Data

- A wiki page has been established:  
[https://igam02ws.uni-graz.at/mediawiki/index.php?title=Main Page](https://igam02ws.uni-graz.at/mediawiki/index.php?title=Main_Page)
- Includes a **community portal** to record and inform interesting events
- Any observer can register on this page, participate in the campaign, and edit the community portal page
- Data shared instantly

# One of the MiniMax24 Events

## Explosion on the Sun on Feb 6



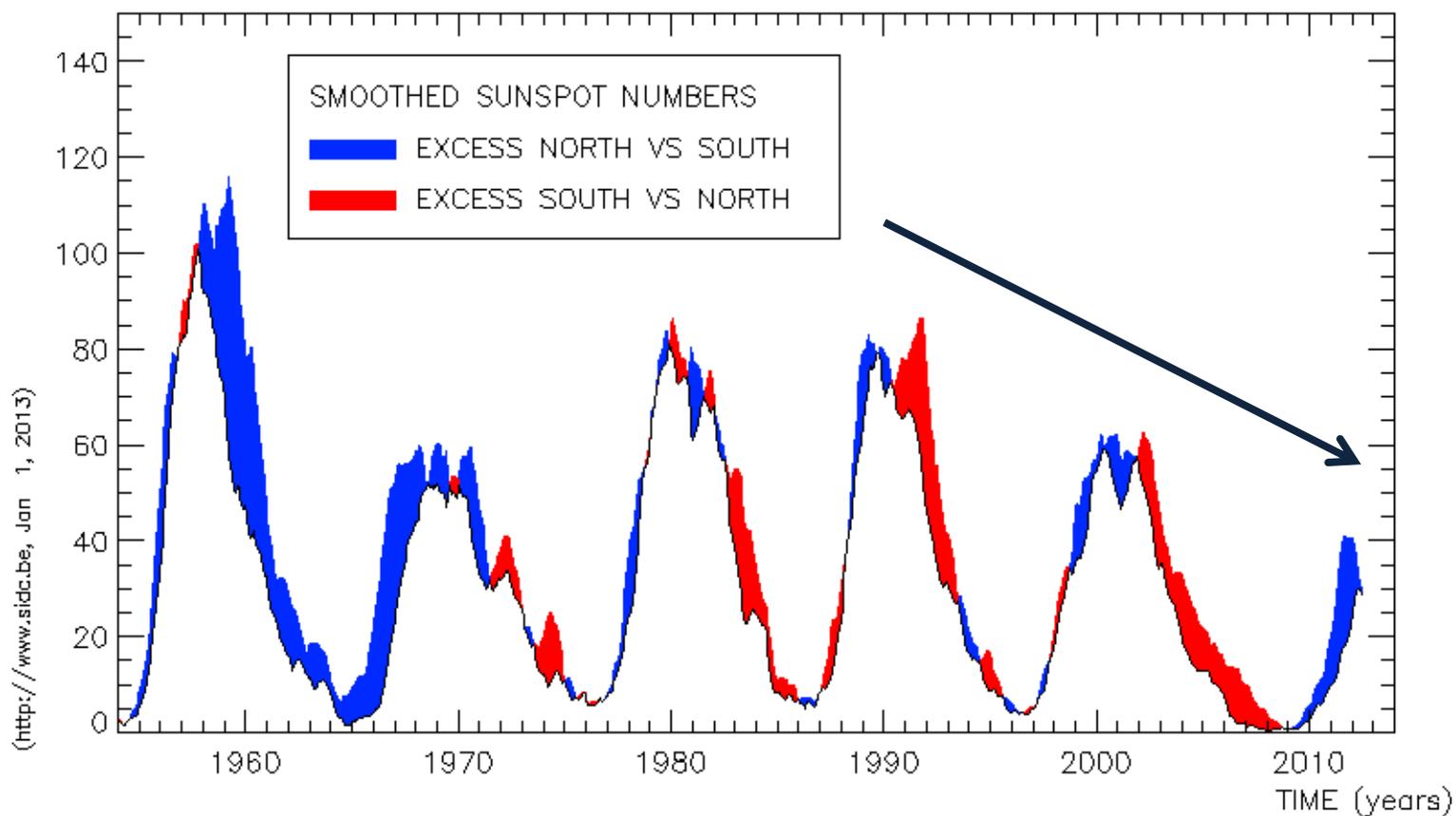
Movie from NASA's  
Solar Dynamics Observatory

.... delivered a glancing blow to earth on February 8

Such models are run at NASA's Goddard Space Flight Center  
to predict the arrival time of solar storms at Earth

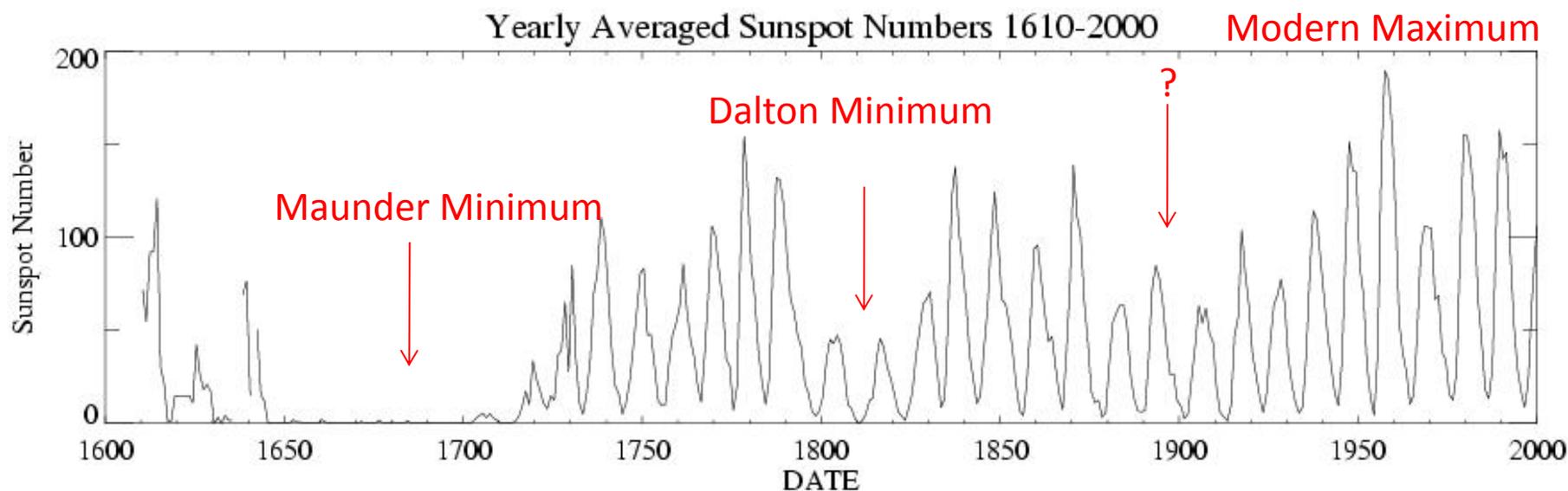
# Progressive Decline in Solar Activity

There is a possibility that we may be entering into a global minimum  
The sunspot maximum may be small if the southern hemisphere  
of the Sun does not produce a greater sunspot number



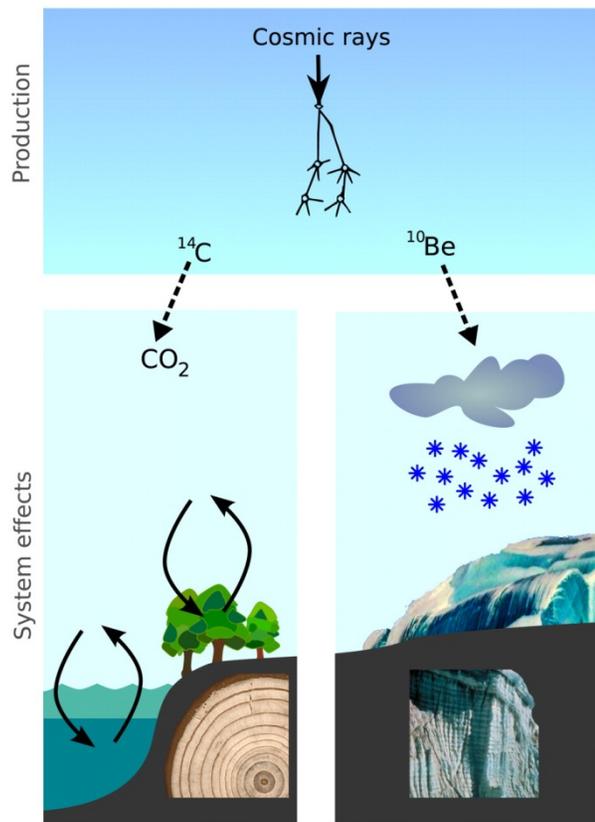
# Grand minima

Two (possibly three) grand minima have been identified since the 1600s. The deepest one was during 1645 – 1715 and was associated with the “little ice age” in Europe. If indeed we are going through an epoch of low solar activity, we have direct measure of the Sun’s contribution on climate change



There are also grand maxima: long periods of enhanced solar activity

# Long-term indicators of solar activity

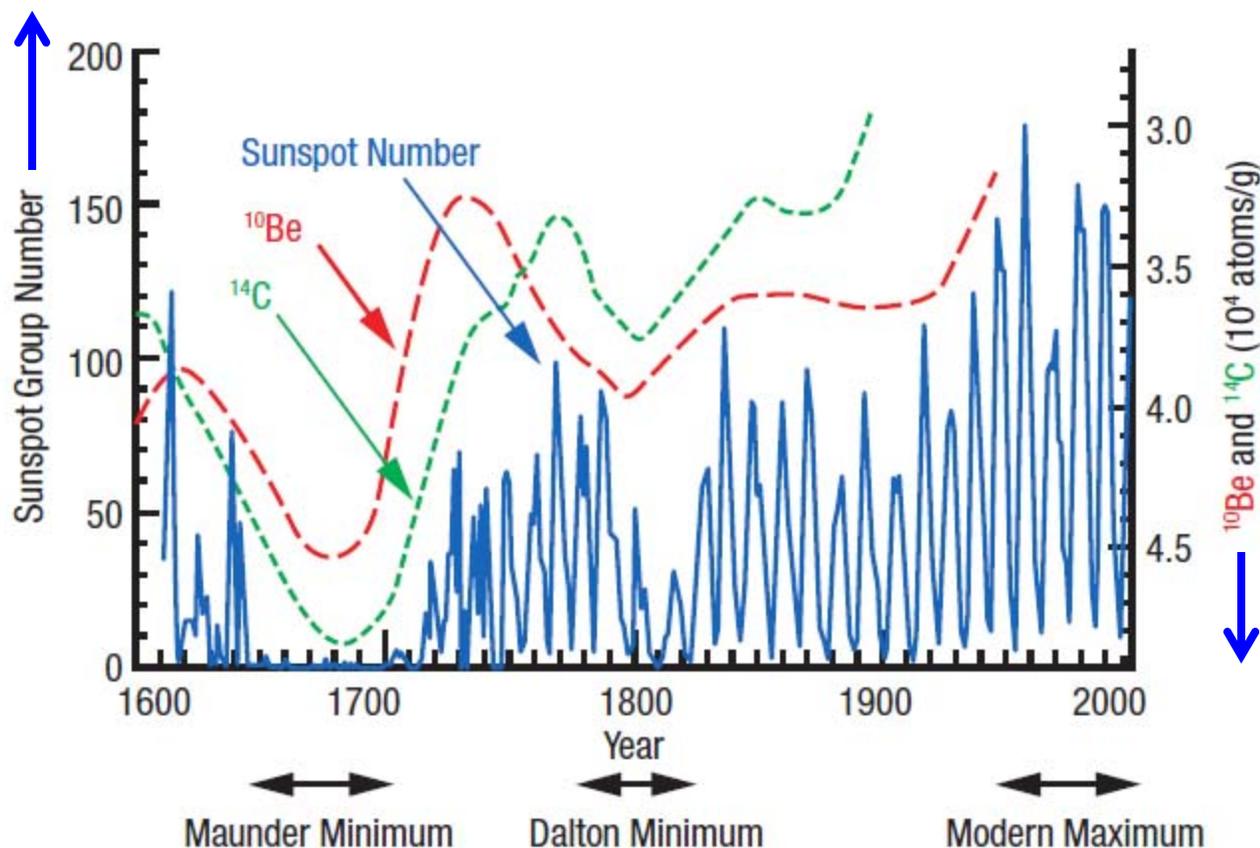


PNAS

- Sunspot number (Eddy, 1976)
- Geomagnetic Activity: Solar magnetic field interacting with earth's magnetic field (Silverman, 1992)
- Cosmogenic nuclides: Weaker Solar activity  $\rightarrow$  higher GCR flux at Earth's atmosphere  $\rightarrow$  Higher production of Be10 and C14  $\rightarrow$  Higher Be10 concentrations in ice core and C14 in tree rings (Usoskin et al. 2007; Miyahara et al., 2006)

# Cosmogenic Nuclides & Sunspot Number

The grand minima are clearly correlated with enhanced production of cosmogenic nuclides

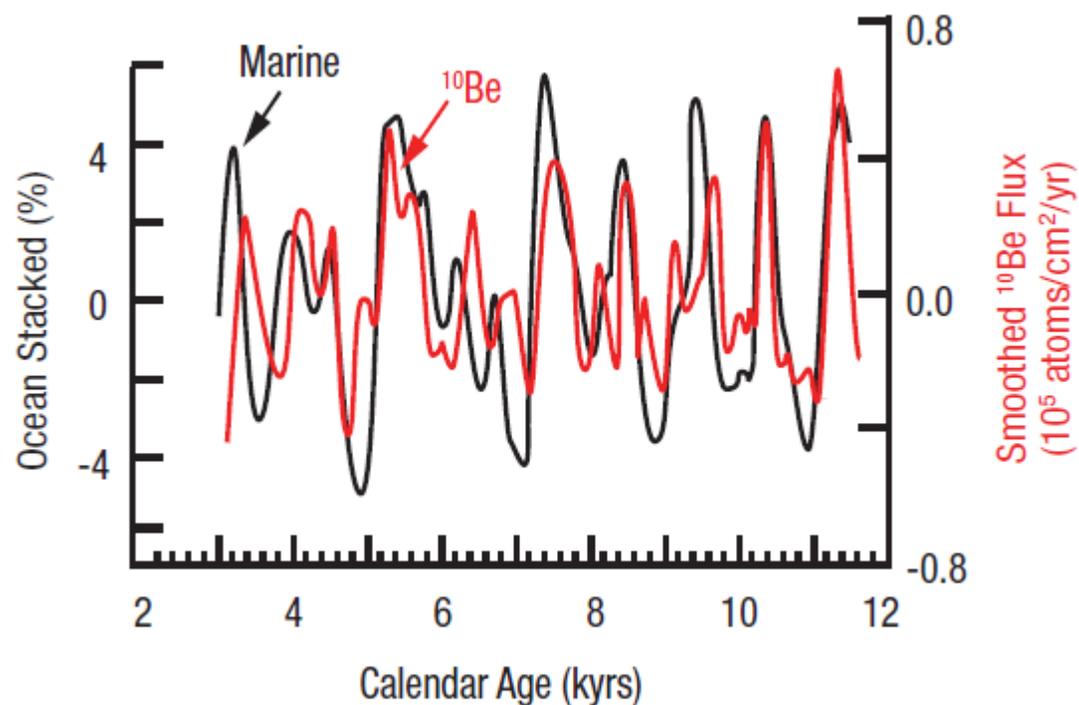
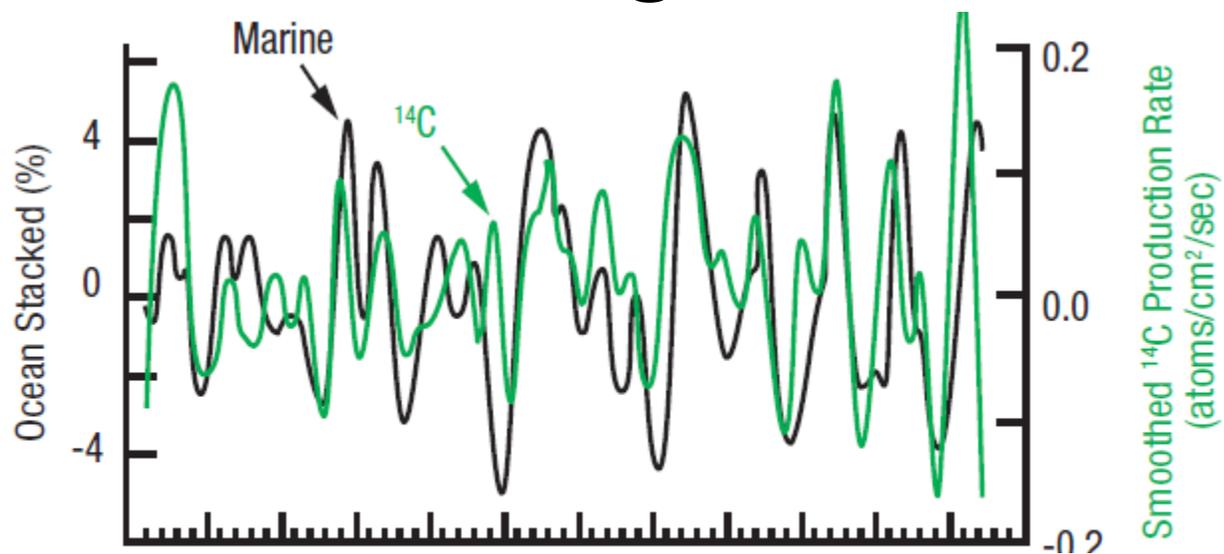


$\text{Be}^{10}$  comes down due to rain or snow

$\text{C}^{14}$  from photosynthesis and sequestration in the tree trunk

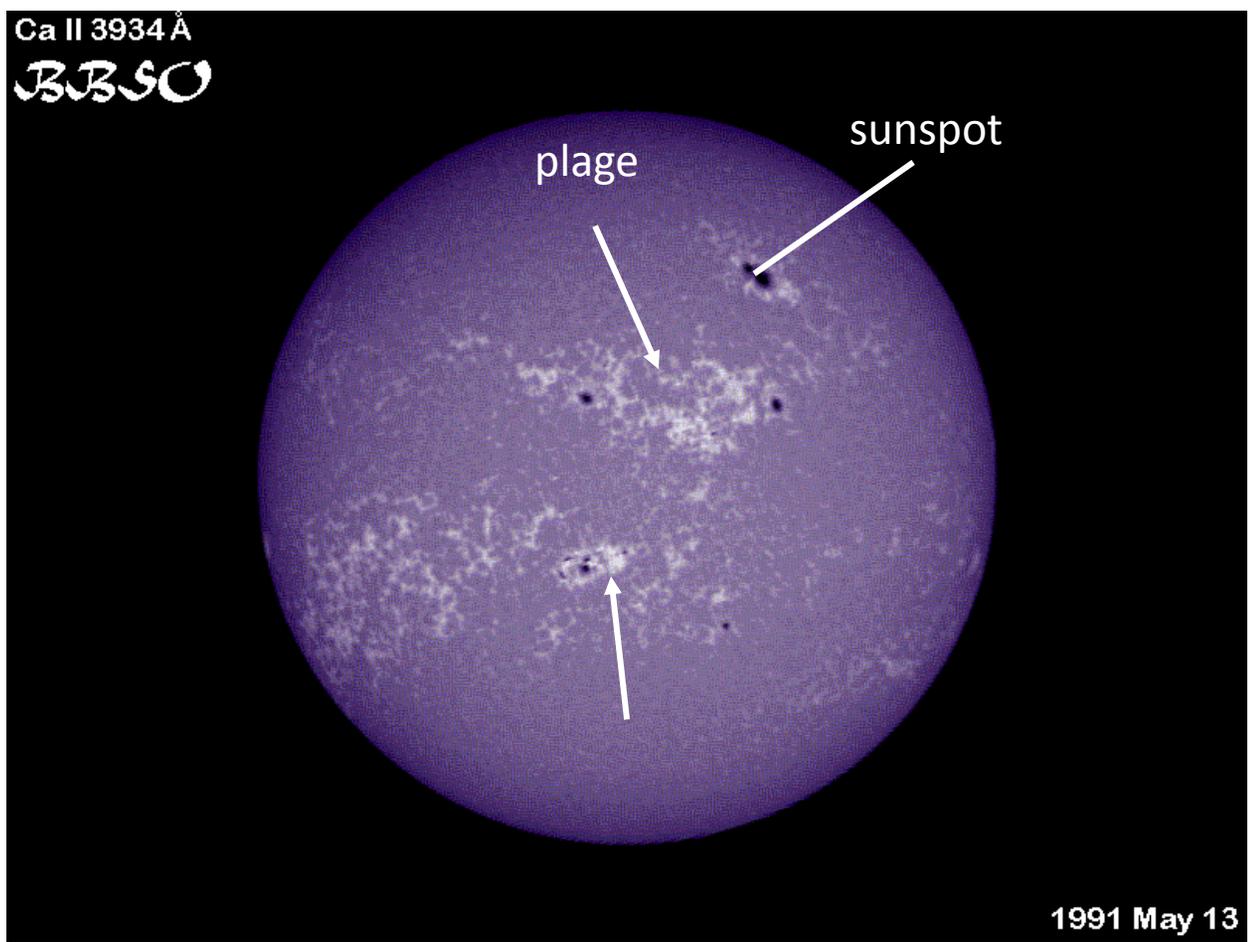
Eddy, 2009

## ... Over a longer Period



The variation tells us about magnetic activity. We need info on the irradiance for climate connection

# Why Low Solar Activity Implies Radiation Received at Earth?



Sunspots reduce the amount of radiation received by Earth

But sunspots emerge with surrounding bright magnetic regions known as plages

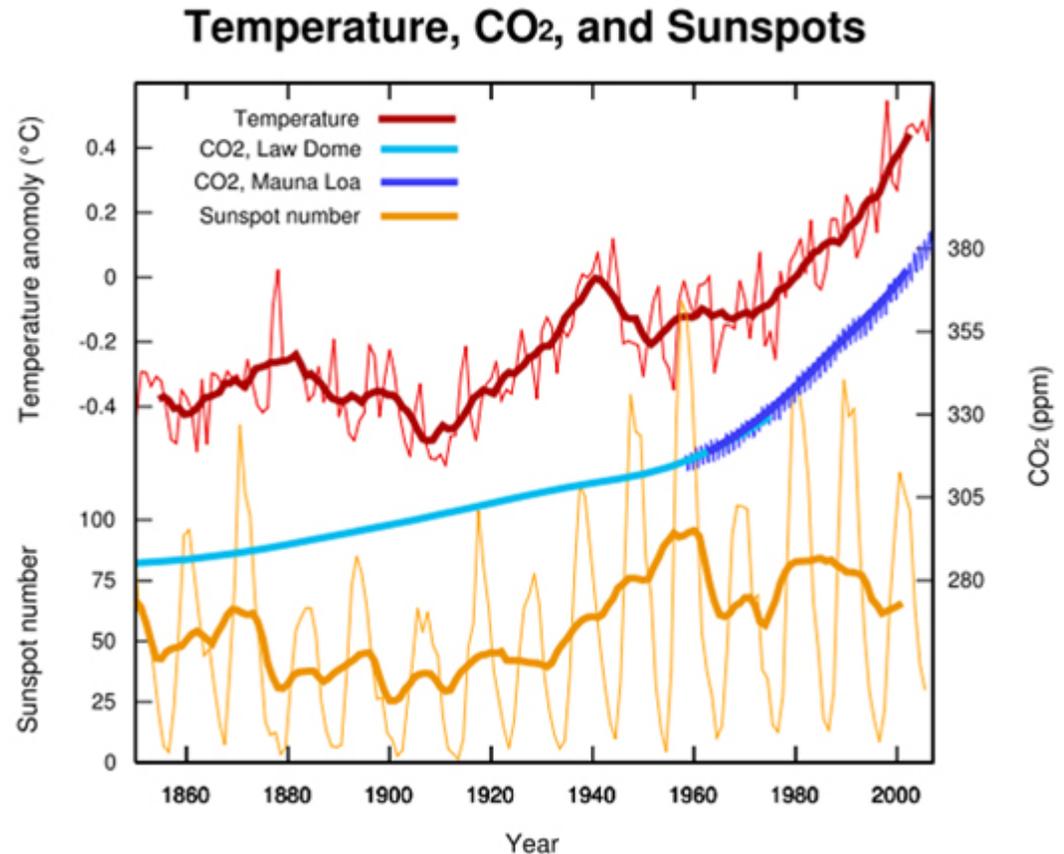
Plages indicate more radiation is received by Earth

The net result is more radiation when more magnetic activity

Image taken during the maximum phase of cycle 21

## ... But CO<sub>2</sub> seems to dominate

According to IPCC assessment, the growth of greenhouse gases since 1750 exerts a 10 times larger influence on climate than changes in sun's brightness



Stanford solar center

# Summary

- MiniMax24 recognizes the diminished activity of the Sun in the maximum phase of solar cycle 24
- MiniMax24 is a campaign of international cooperation to understand behavior of the Sun and its impact on climate and space weather
- MiniMax24 Campaign page:
- [https://igam02ws.uni-graz.at/mediawiki/index.php?title=Main\\_Page](https://igam02ws.uni-graz.at/mediawiki/index.php?title=Main_Page)