

# **CAN THE SOLAR ACTIVITY INFLUENCE THE OCCURRENCE OF REVOLUTIONS AND ECONOMIC RECESSIONS?**

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# Outline

- **What are the sunspots, solar cycles, and solar maximums and how does solar activity impact Earth?**
- **Literature: Jevons and Chizhevsky; recent research**
- **Methodology: Comparison of data series; average of standardized cycles centered along solar maximums; using economic models and simulations.**
- **Findings: Revolutions and Recessions do occur more often around and after solar maximums.**
- **Implications: Predictions for the solar maximum of 2024**

# What Are the Sunspots, Solar Cycles, and Solar Maximums and Minimums?

Solar activity fluctuates with approximately 11-year period known as the "solar cycle". The cycle is not exactly regular, and significant variations have been observed over centuries.

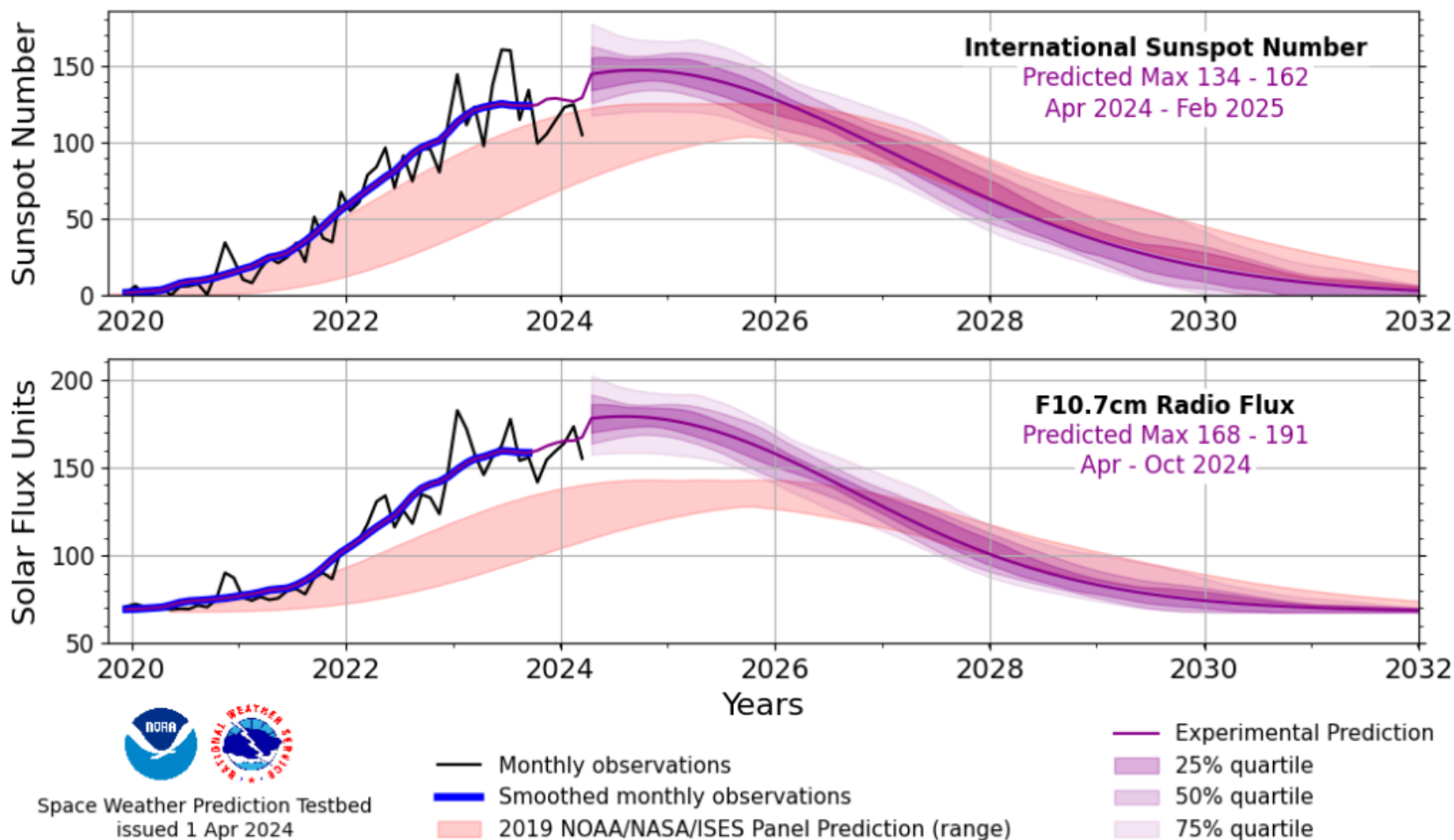
The cycle can be measured by counting the "sunspots" on the sun surface. Sunspots are temporary phenomena on the photosphere of the sun that appear visibly as dark spots compared to surrounding regions.

The period of elevated solar activity with the highest number of sunspots during the cycle is called "solar maximum", while the period of lowest activity when no sunspots are observed is called "solar minimum".

Around solar maximums or shortly after them, various types of solar activity reach their maximums levels: ultraviolet radiation and X-rays, proton emission, solar wind, solar flares, coronal mass ejections (CME), etc.

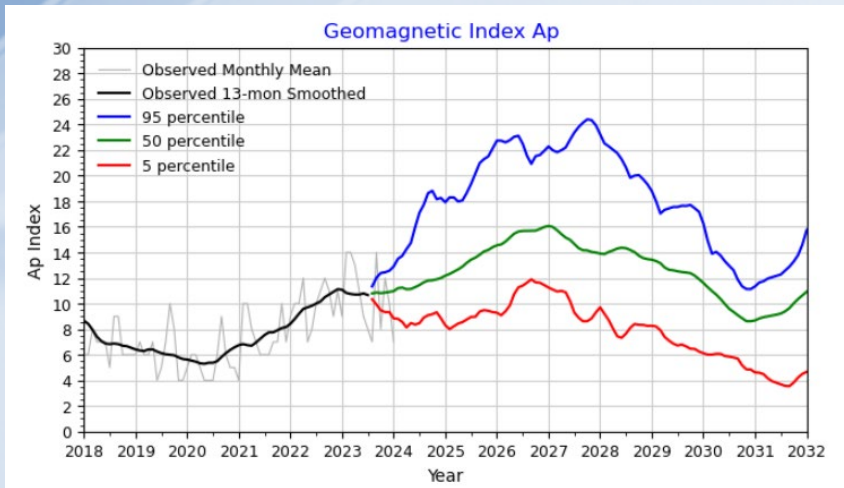
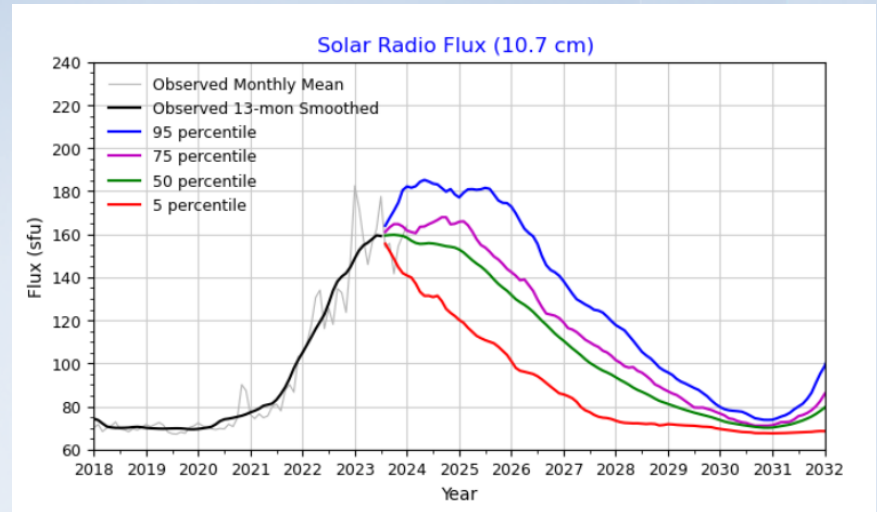
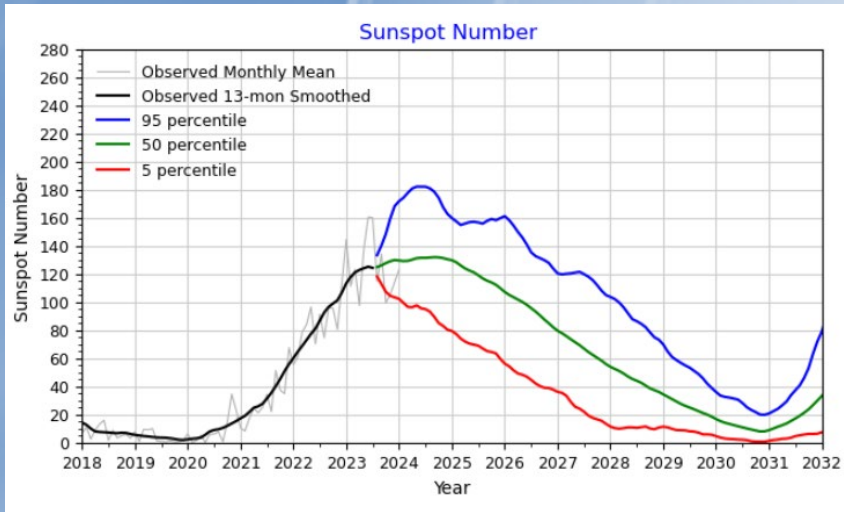
# According to NOAA, 25<sup>th</sup> solar cycle will reach its maximum in 2024 or early 2025

## Experimental Solar Cycle 25 Prediction



Source: NOAA, <https://testbed.swpc.noaa.gov/products/solar-cycle-progression-updated-prediction-experimental>

# NASA Projections of Selected Series (Updated February 6, 2024)



# Impact on Earth

Physical impact: Disruptions of radio and telecommunications; fluctuations in the geomagnetic field ("magnetic storms"); electromagnetic impulses in power grids. "Carrington event" in 1859; "solar storms" in 774/775 and 993/994? Solar Storm of July 2012 that missed the Earth by one week.

Human health hazard: Geomagnetic storms caused by solar activity affect people with cardiovascular health conditions, increasing chances of stroke and heart attack and exacerbating brain disorders.

# Literature: From Classics to Modern



**William Stanley Jevons** (1875-79): “Commercial crises” in Europe in the XIX century occurred at intervals of 11 years, broadly matching the average solar cycle length. “Beautiful coincidence”. Link to bad harvests.



**Alexander Chizhevsky** (1924, 1938, 1976):  
Revolutions and “most important historical events involving large numbers of people” occur much more often in the three years around sunspot maximums.

**Modern research:** Growing body of literature documenting various aspects of solar activity’s impact on Earth.

# Methodology

**Comparison of data series.** Comparing economic, political, or social data series with the series for sunspots or other indicators of solar or geomagnetic activity.

**Standardized cycles.** Identifying cycles, finding their maximum and minimum points, "standardizing" them to same length, "stacking" cycles so that their maximum and minimum points overlap, finding average values corresponding to particular phases.

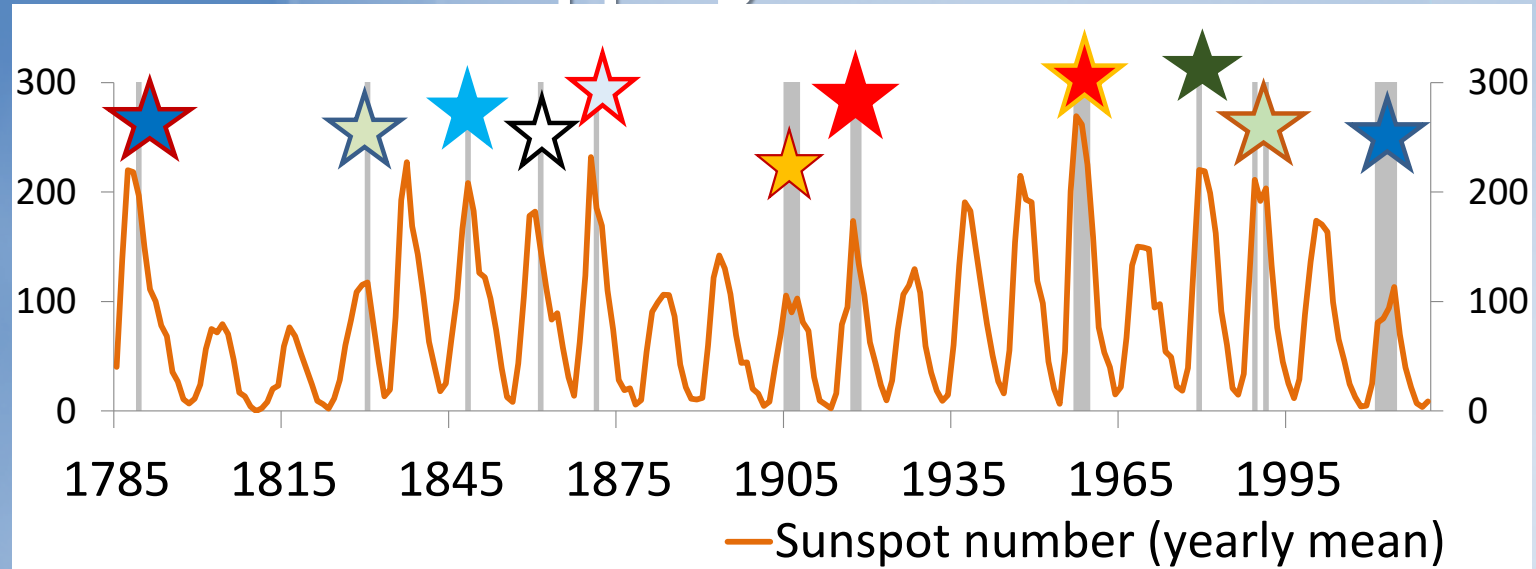
**Econometric models.** Using sunspot numbers as explanatory variable in econometric models for US recessions.

**Simulations.** Running program simulations to emulate the actual data for the US recessions and determine their probability chances.



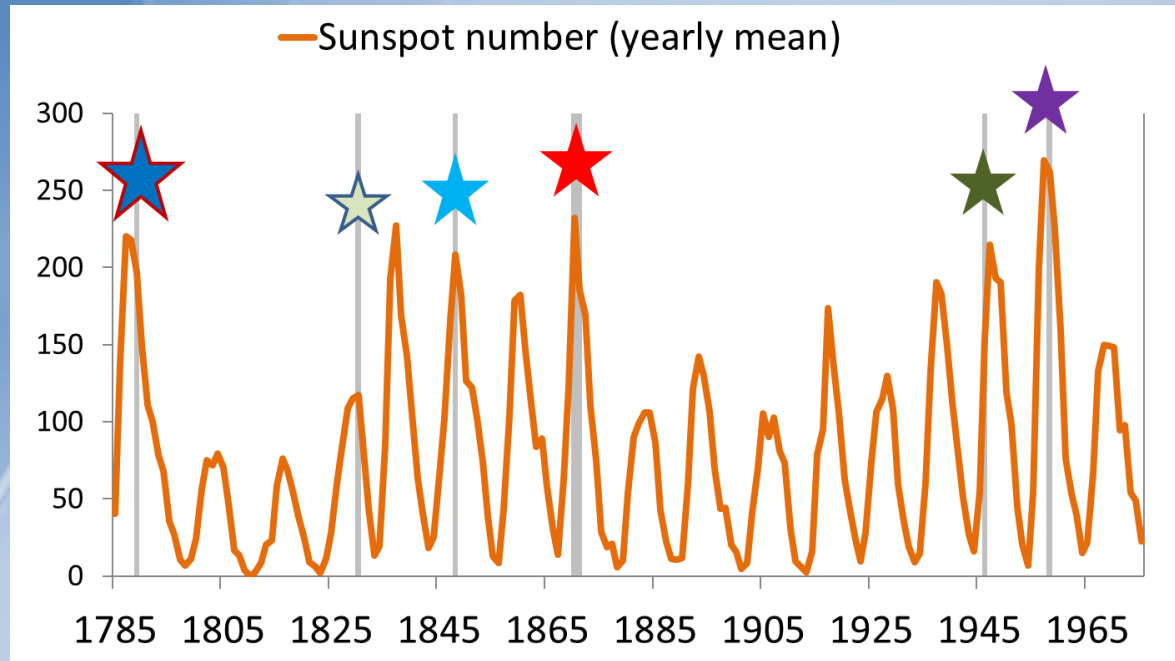
# REVOLUTIONS

# Revolutions overlapping with solar maximums



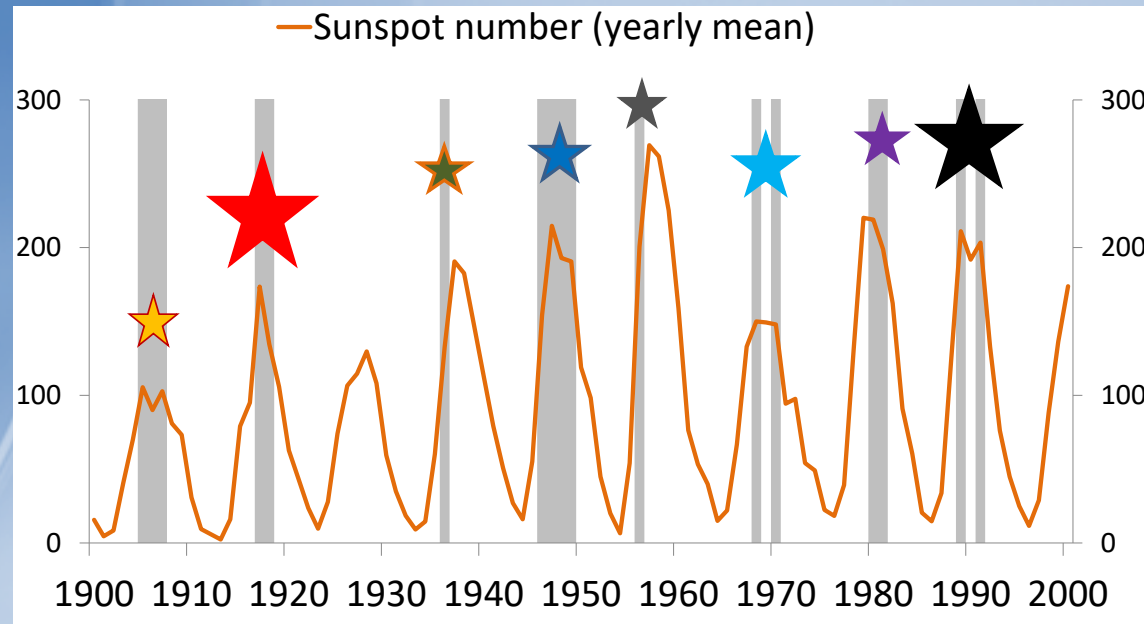
	Years	Events
	1789	Great French Revolution
	1830	Revolutions in Europe (France, Poland, Germany, Italy, Greece)
	1848	Revolutions in Europe (Italy, France, Germany, Austria, etc.)
	1861	Secession of 13 southern US states that formed the C.S.A.
	1871	Uprising in Paris "Paris Commune"
	1905-07	Revolution of 1905-07 in the Russian Empire
	1917 1918	February Revolution, Great October Socialist Revolution in Russia Revolution in Germany, collapse of the Austro-Hungarian Empire
	1957-59	Revolution in Cuba
	1979	Islamic Revolution in Iran
	1989 1991	Fall of Berlin Wall, collapse of communism in Eastern Europe Collapse of Soviet Union and Yugoslavia
	2010-14 2013-14	"Arab Spring": Revolutions in Egypt, Libya, Syria, Yemen, Tunisia, etc. Revolution in Ukraine



# French Republic Timeline, 1785-1975



Years	Events
★ 1789	Great French Revolution, precursor of the First Republic
★ 1830	Second Revolution (July Revolution)
★ 1848	Third revolution, birth of the Second Republic
★ 1870	Birth of the Third Republic
★ 1871	Uprising in Paris, “Paris Commune”
★ 1946	Birth of the Fourth Republic
★ 1958	Algiers crisis, birth of the Fifth Republic

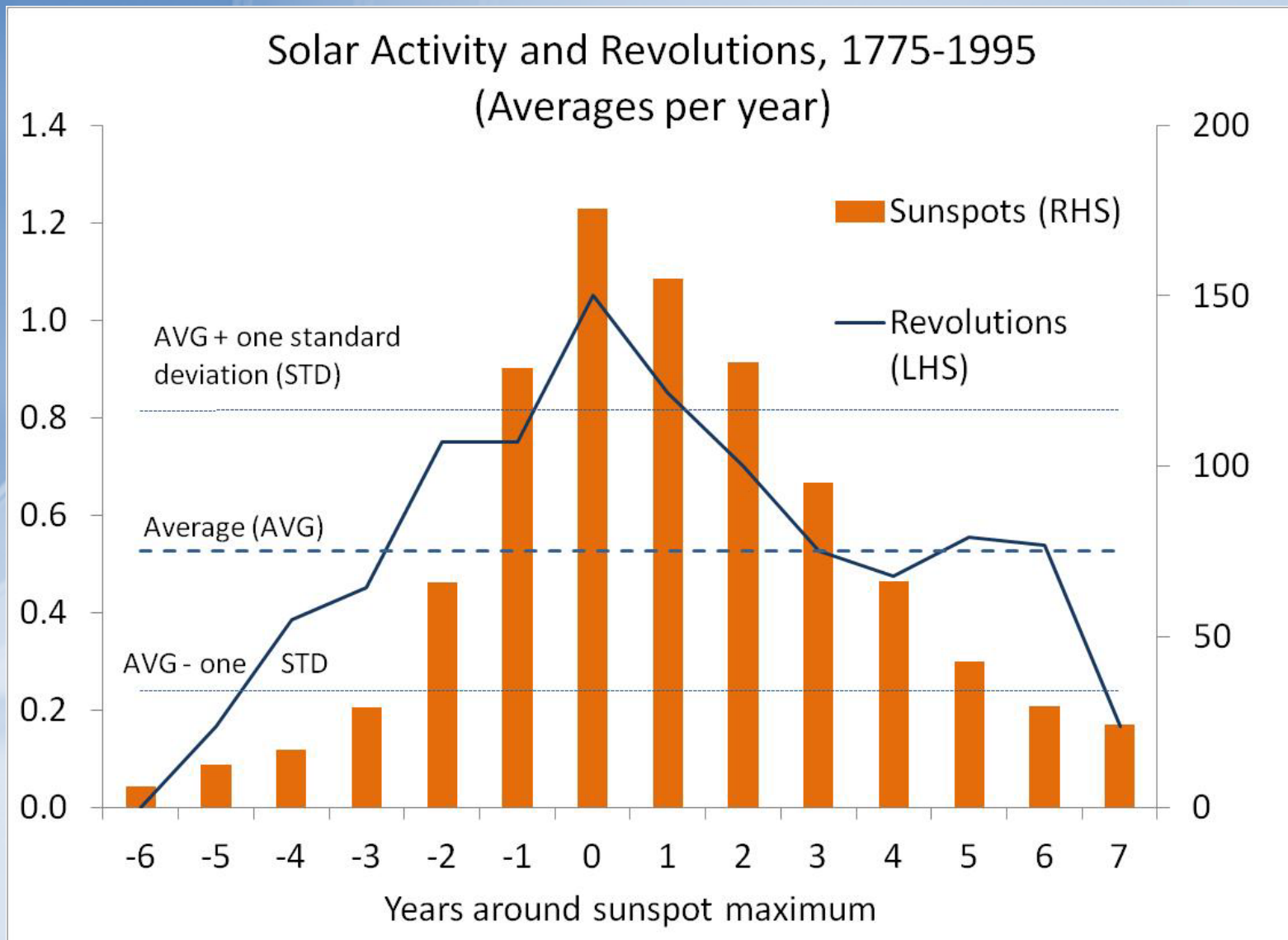
# Advent and Demise of Communism in Europe



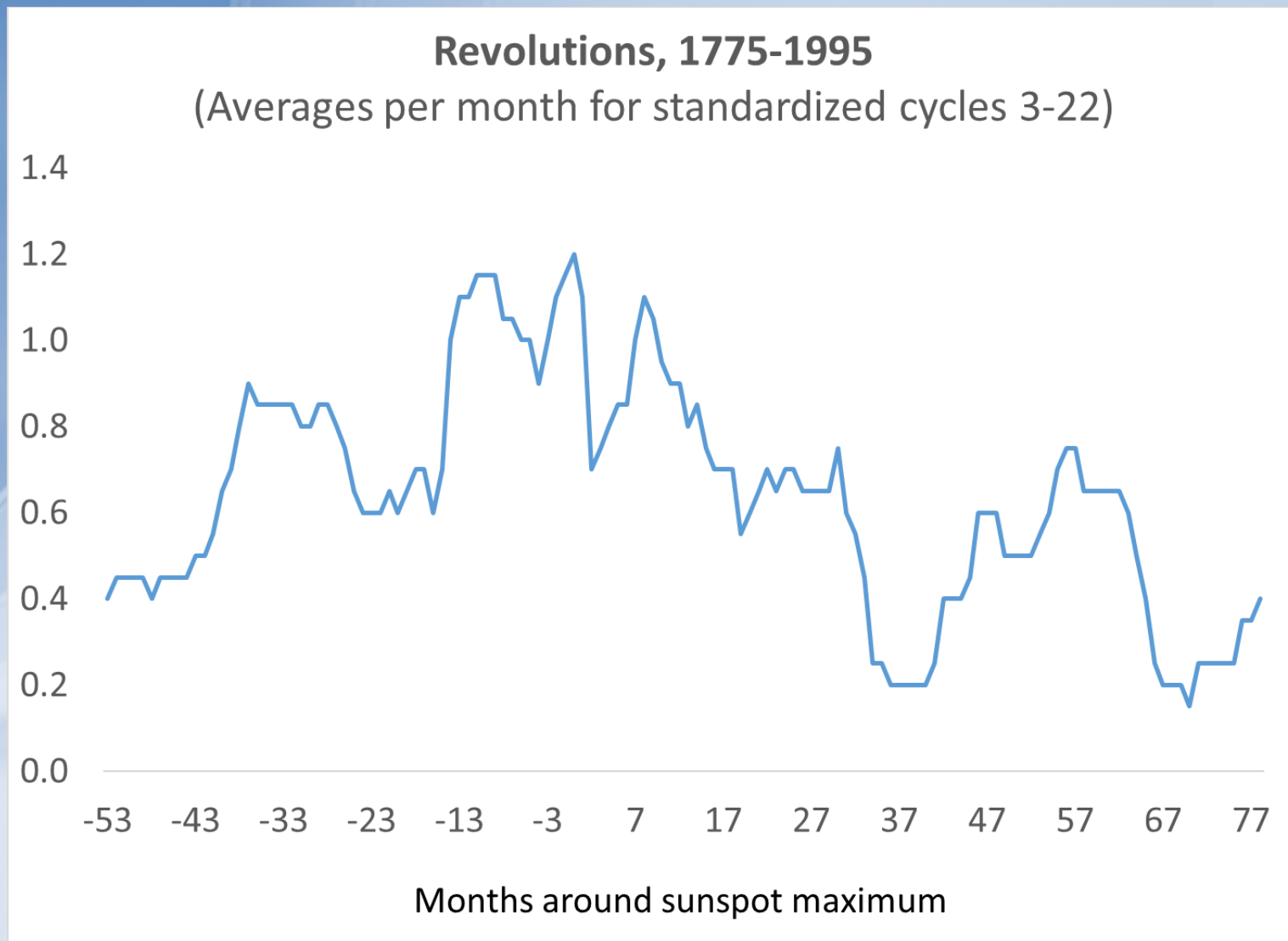
Years	Events
 1905-07	Revolution of 1905-07 in the Russian Empire
 1917  1918	February Revolution, Great October Socialist Revolution in Russia Revolutions in Germany, Hungary, collapse of Austro-Hungarian Empire
 1936	Revolution in Spain
 1946-49	Conversion of Eastern Europe to socialism
 1956	Hungarian revolution, <u>Poznań</u> protests in Poland
 1968	“Prague Spring” in Czechoslovakia
 1970	Protests in Poland
 1980-81	Polish crisis, “Solidarity” trade union, martial law
 1989	Fall of Berlin Wall, collapse of communism in Eastern Europe
 1991	Collapse of Soviet Union and Yugoslavia

Sources: WDC-SILSO; history textbooks.

# On average, revolutions occur more often in the years of solar maximums



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# Two Most Recent Revolutionary Waves and Major Terrorist Attacks

## Colar Cycles, Two Most Recent Revolutionary Waves, and Major Terrorist Attacks



Sources: WDC-SILSO; history textbooks.

# Student protests in the U.S. against the war in Gaza

These protests look similar to the student protests in 1968-69, amid the cyclical maximum of solar activity in the solar cycle #20 in November 1968. The epicenter of these protests in the U.S. was the same: Columbia University.

**1968:** A series of protests at Columbia University in New York City were one among the various student demonstrations that occurred around the globe in that year. The Columbia protests erupted over the spring of that year after students discovered links between the university and the institutional apparatus supporting the United States' involvement in the Vietnam War. The protests resulted in the student occupation of many university buildings and the eventual violent removal of protesters by the New York City Police Department.

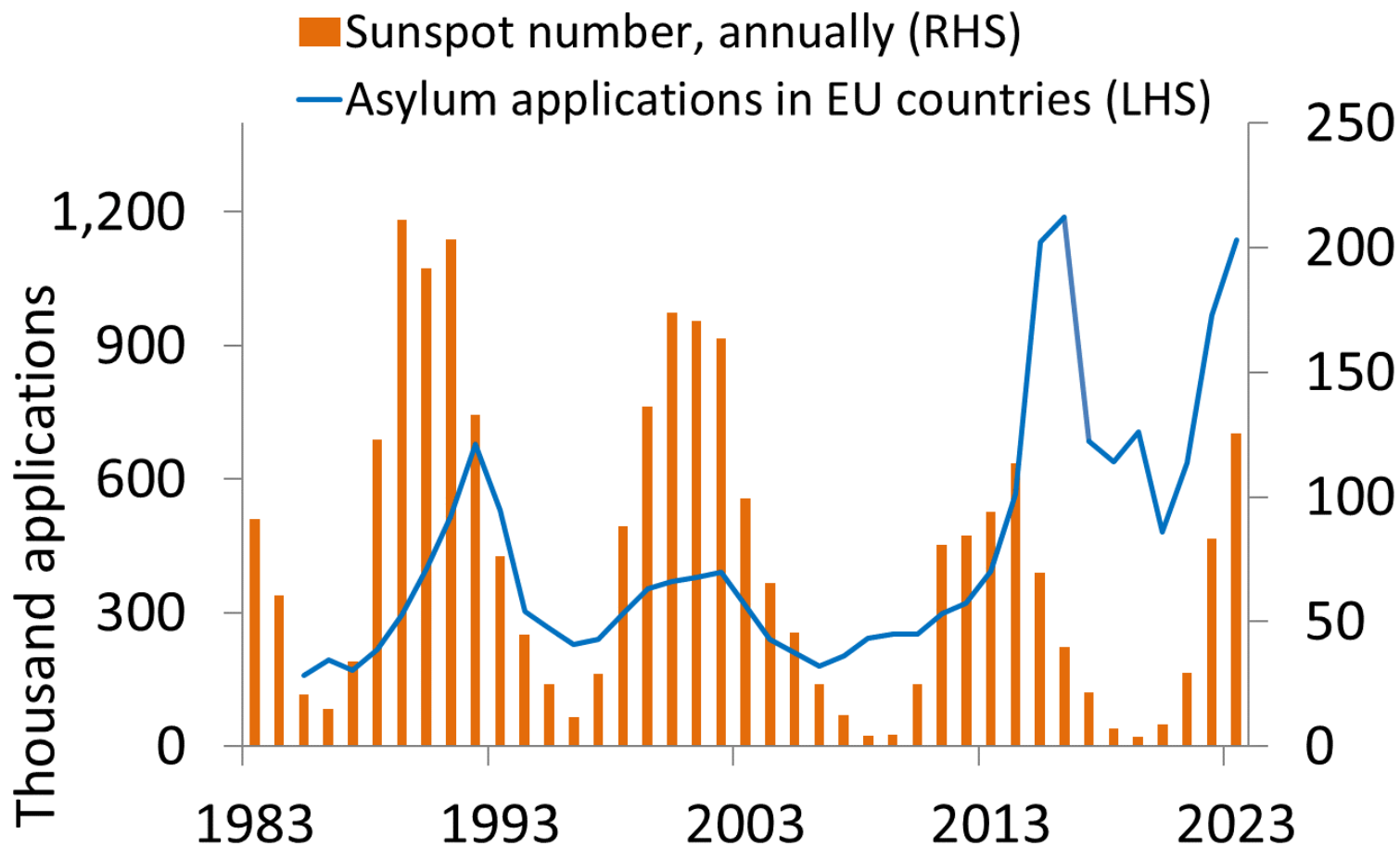
**2024:** Columbia president faces key vote of censure from faculty as protests continue nationwide

- Pro-Palestinian protests continue at major US universities, where several schools have called police on protesters, leading to the arrests of hundreds across the country.
- At New York's Columbia University, the epicenter of the demonstrations, protesters against the war in Gaza are demanding the school cut ties with Israeli academic institutions and disinvest its funds from Israel-linked entities. Protesters at other campuses have similar demands.



# What starts with revolutions ends in ... refugee flows

## Sunspots and Asylum Applications in EU, 1985-2023

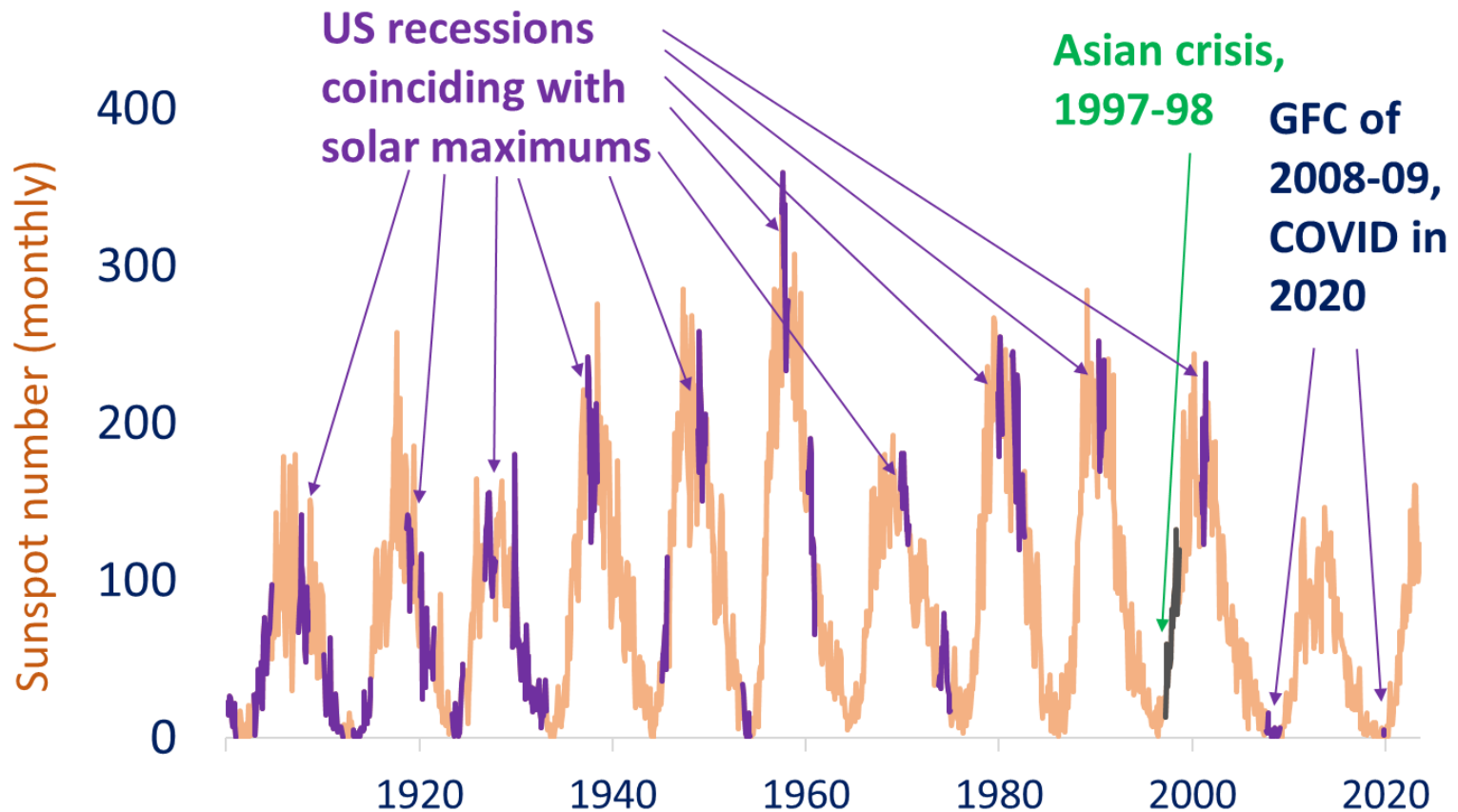


Sources: Eurostat; UK Government; WDC-SILSO; and author's calculations. Data for 14 EU countries and UK reporting numbers for all years.

# RECESSIONS

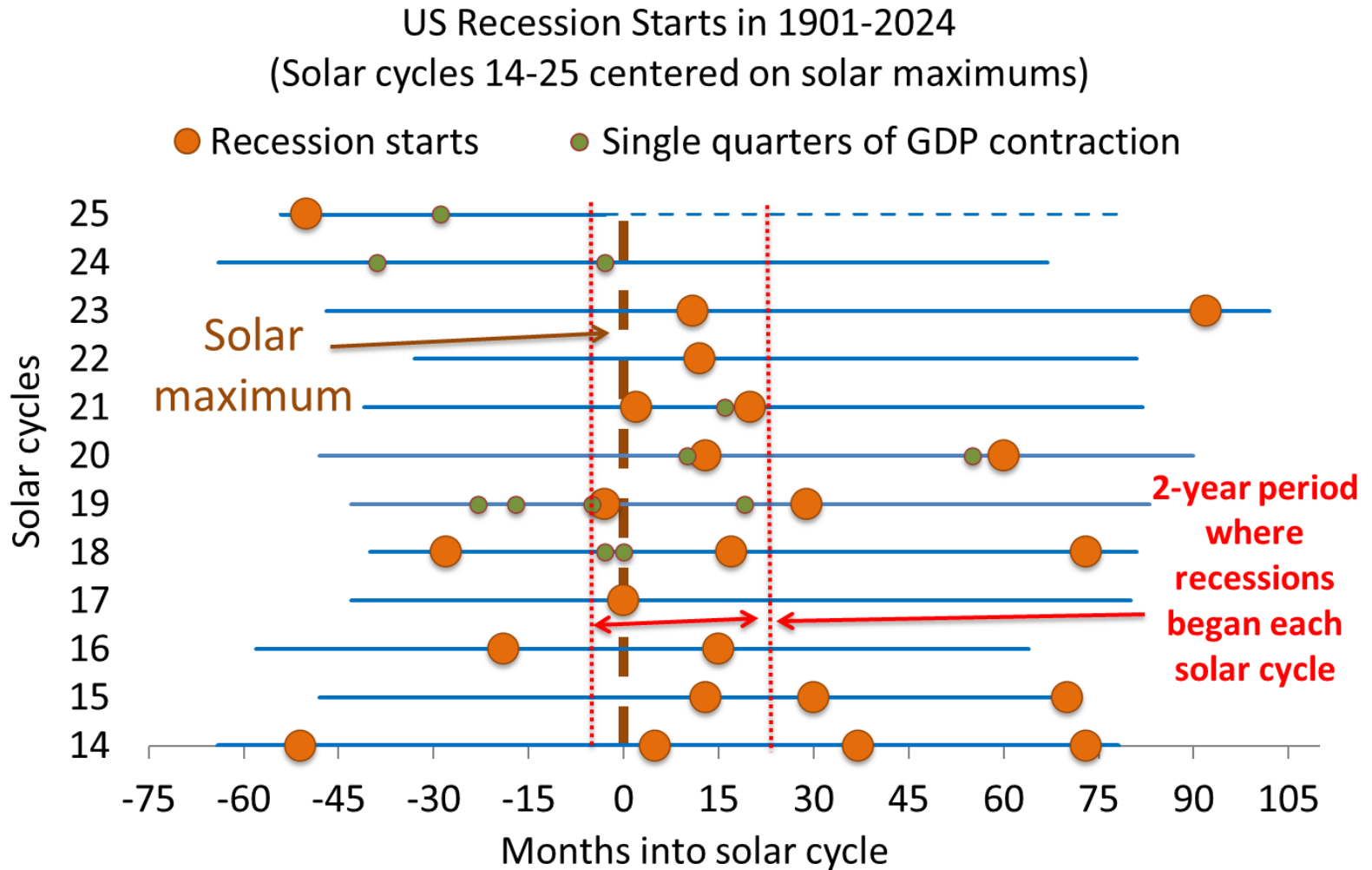
# In XX century, each solar maximum overlapped with a recession in the US economy

## Solar Cycles, US Recessions and Recent Global Crises, 1900-2023



Sources: WDC-SILSO; NASA; NBER.

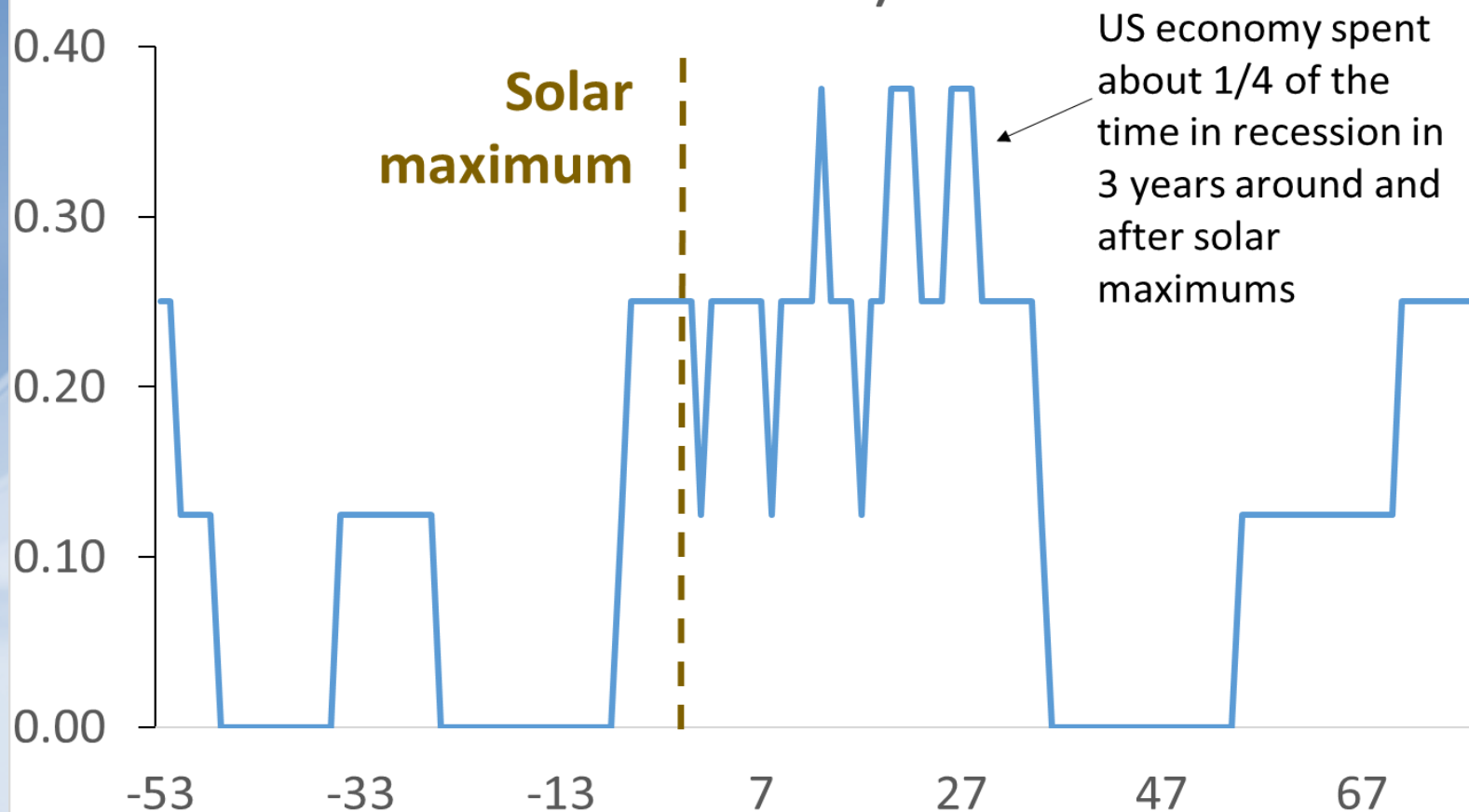
# For over 100 years, each solar maximum overlapped with a recession in US economy



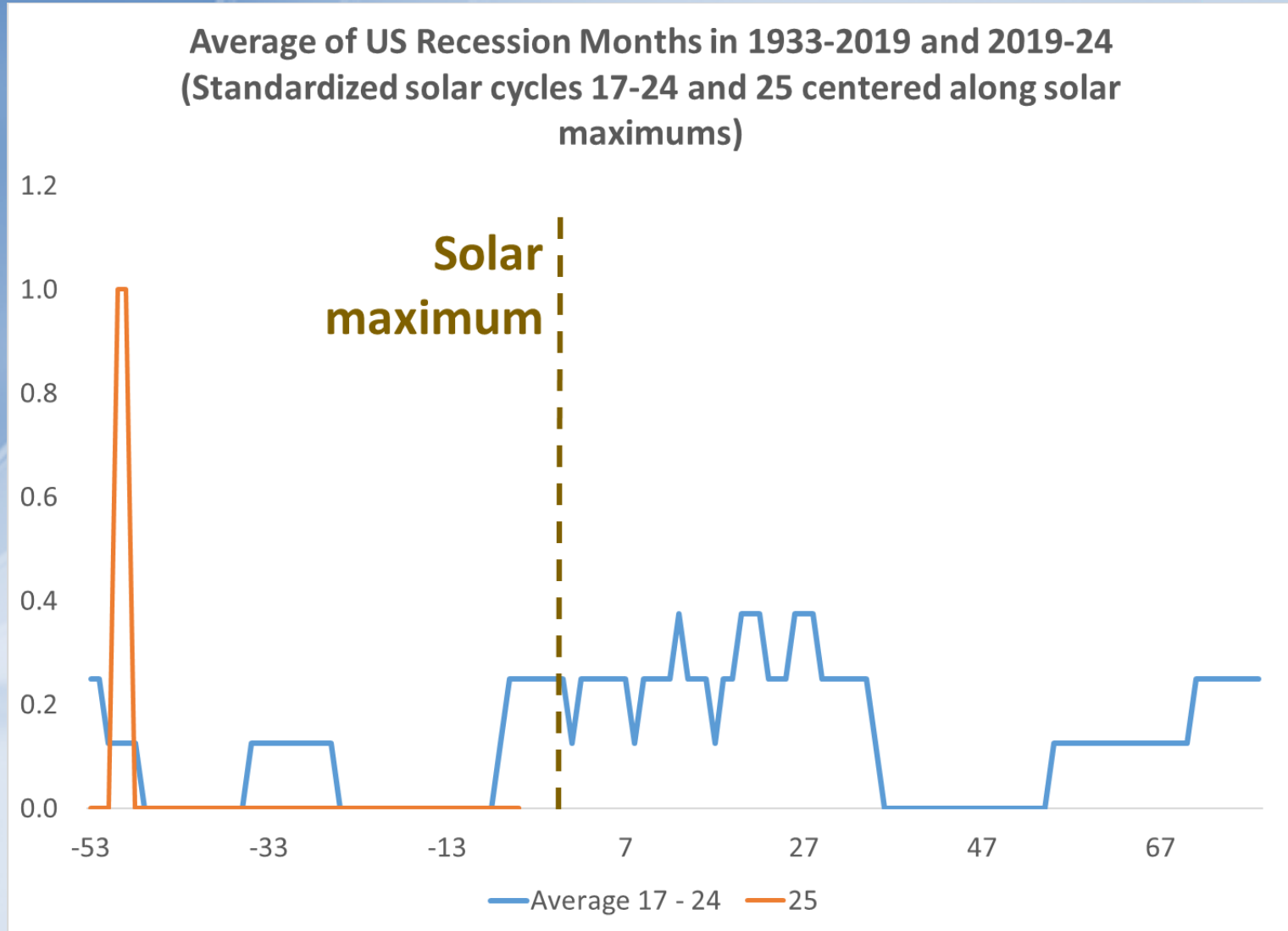
Sources: NBER; FRED; NASA; and author's calculations.

# Since 1933, US economy spent 1/4 of time in recession in about 3 years after solar maximums

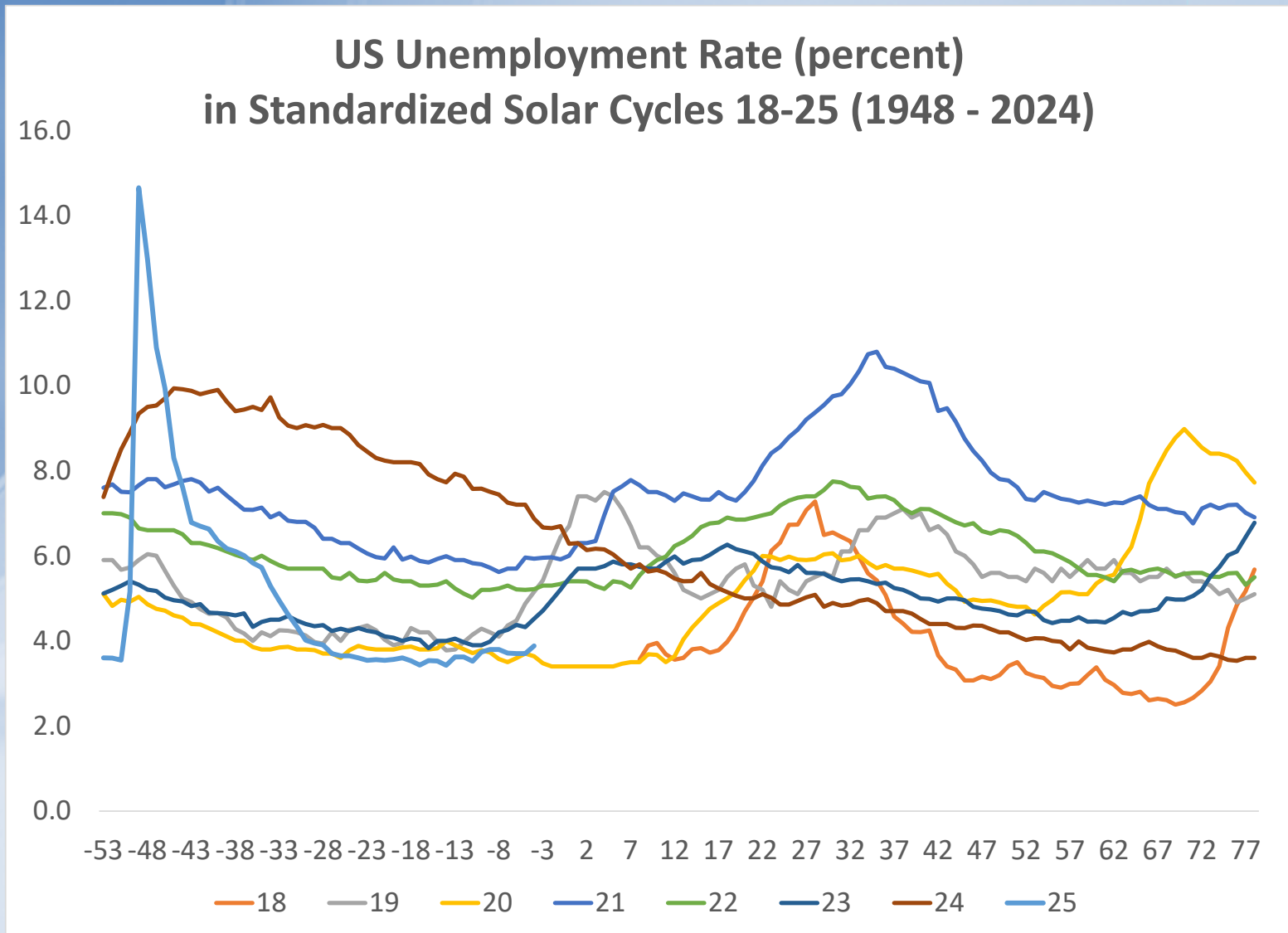
Average of US Recession Months in 1933 - 2019  
(Standardized solar cycles 17-24 centered along solar maximums)



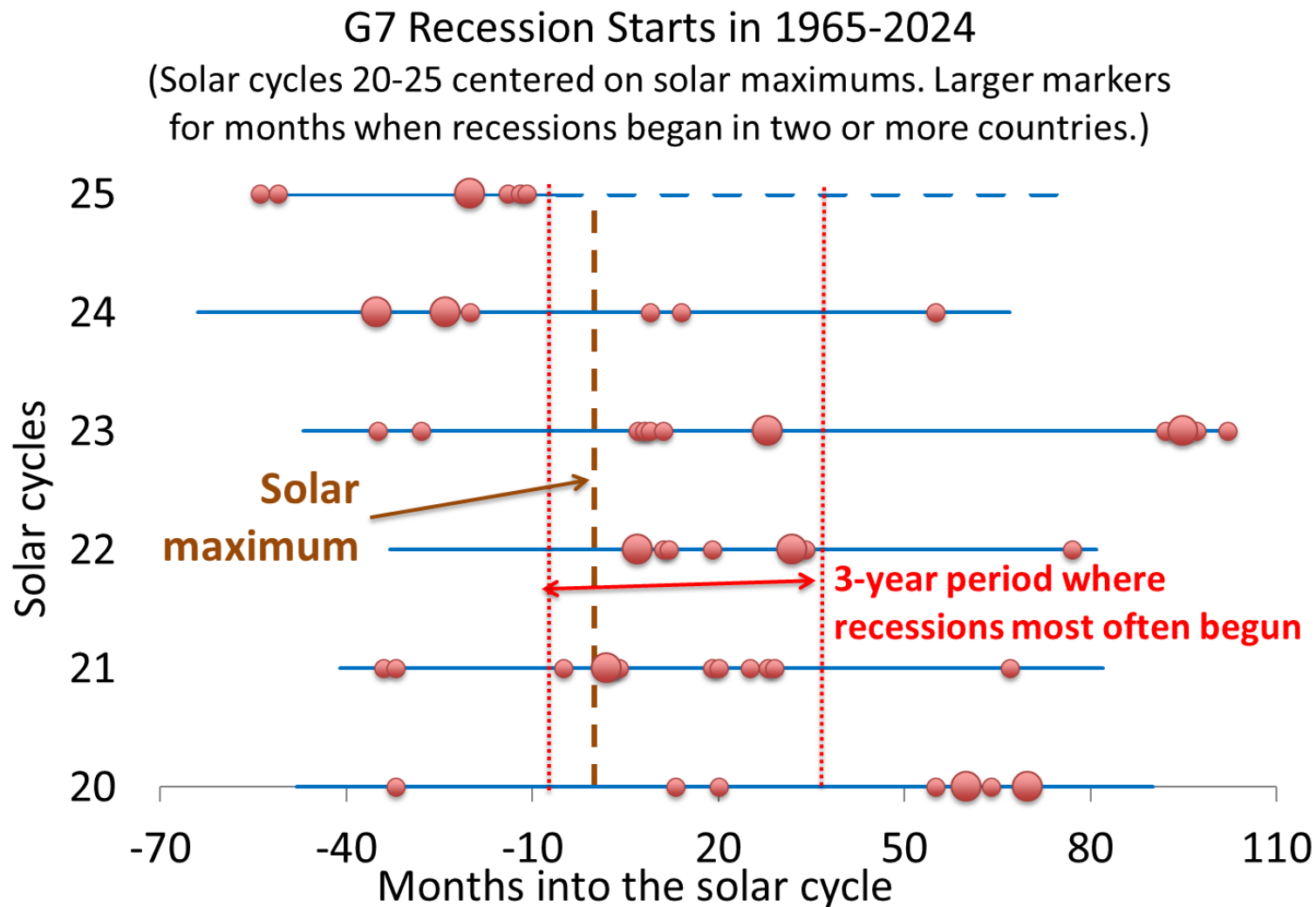
# Average of US Recession Months in 1933-2019 and 2019-24



# US Unemployment Rate, 1948 - 2024



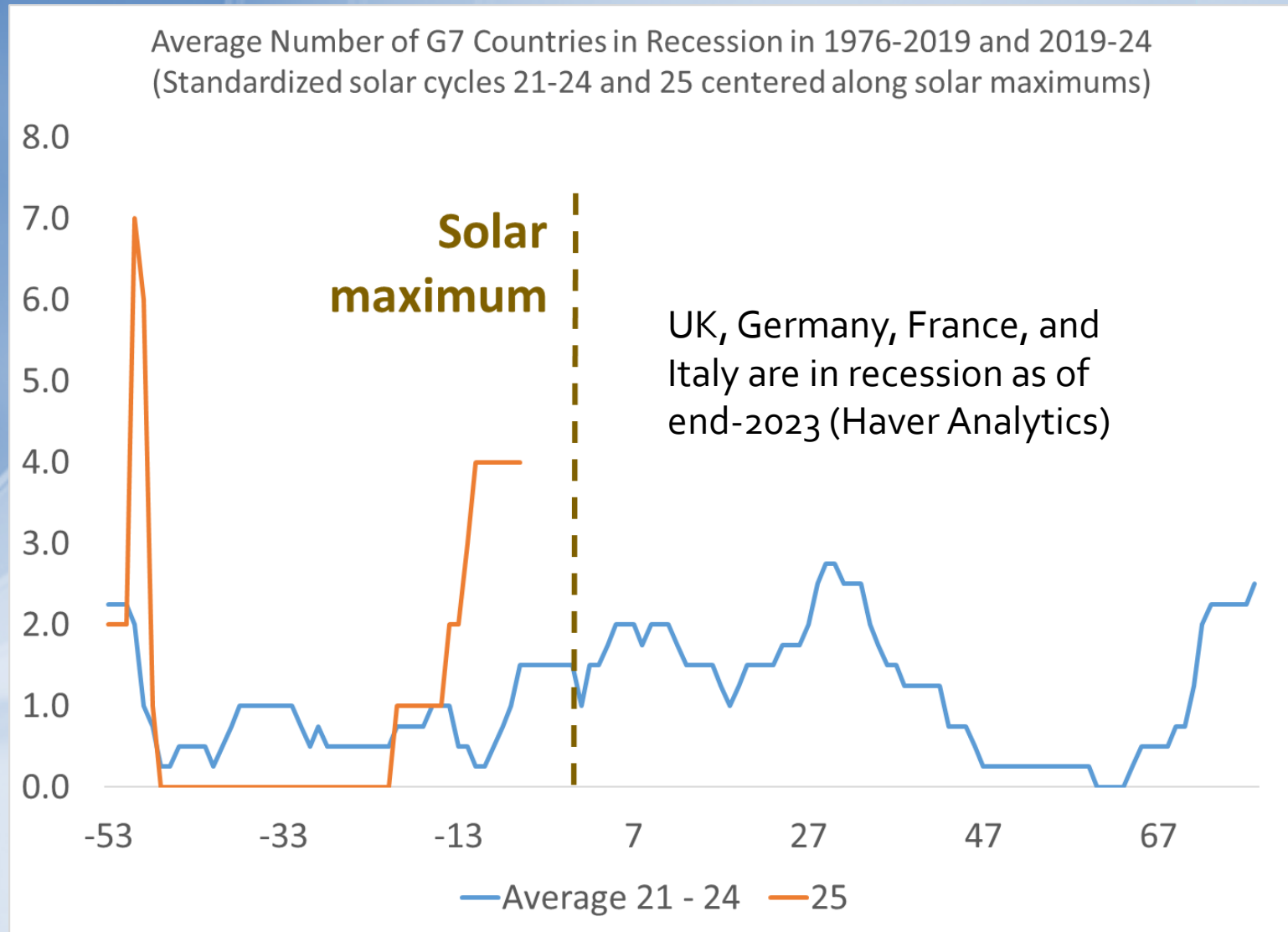
# Since 1965, 3/5 of G7 recessions started in 3 years around and after solar maximums



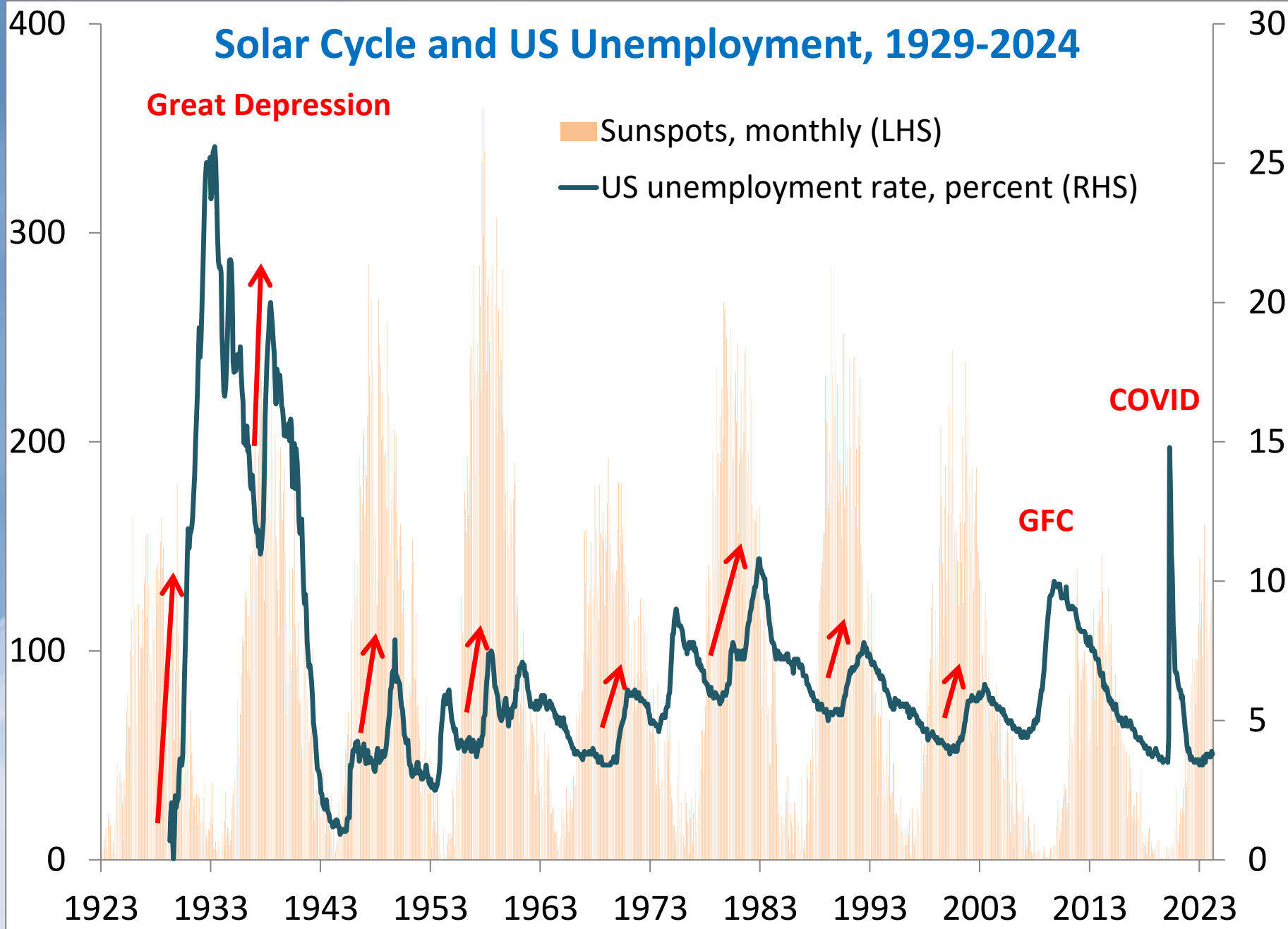
Source: NBER; ECRI; NASA; and author's calculations.



# Since 1976, number of G7 economies in recession increased in about 3 years after solar maximums



# Solar Cycle and US Unemployment, 1929-2024



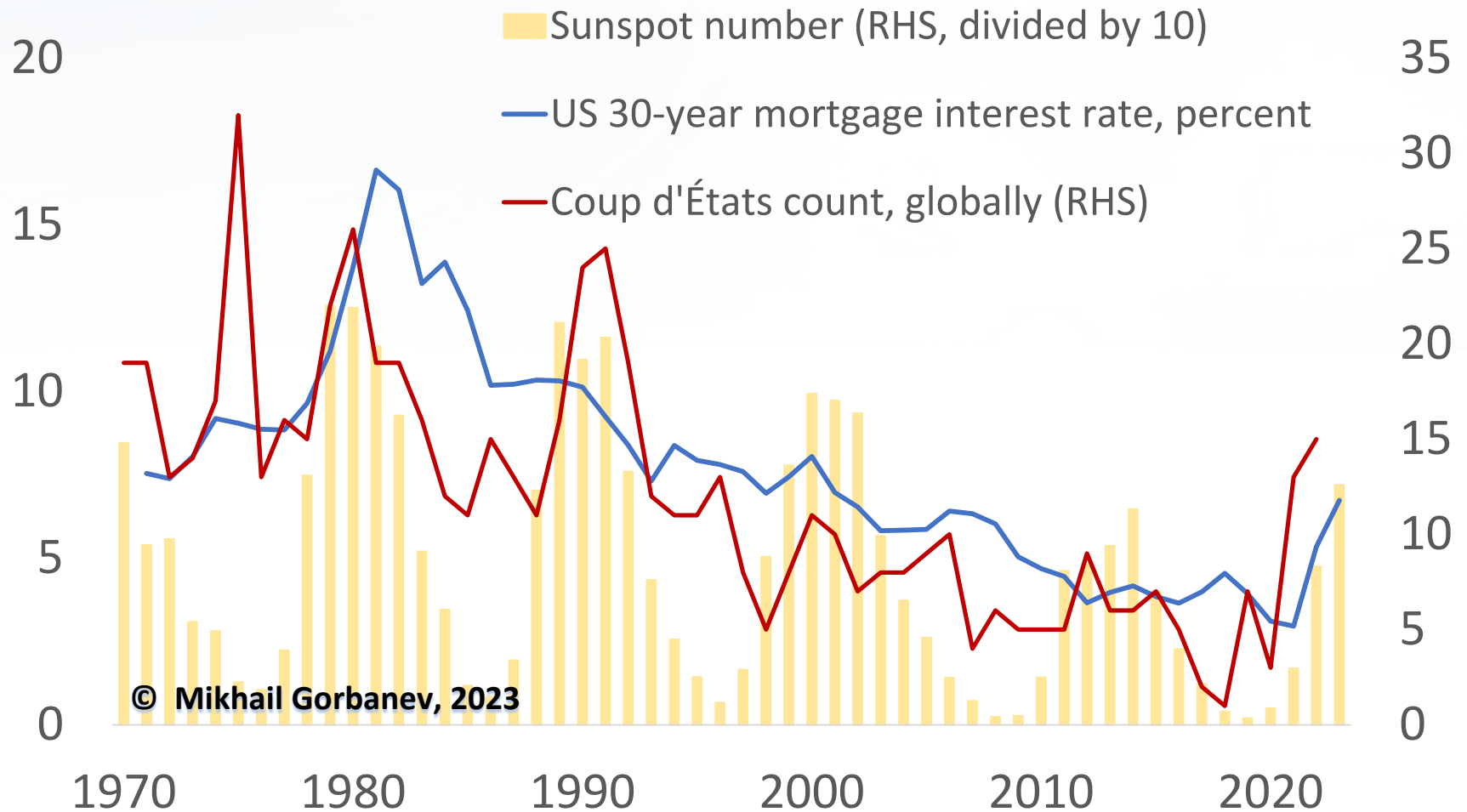
# Open Discussion

**How to design statistical tests?**

**Use in econometric models?**

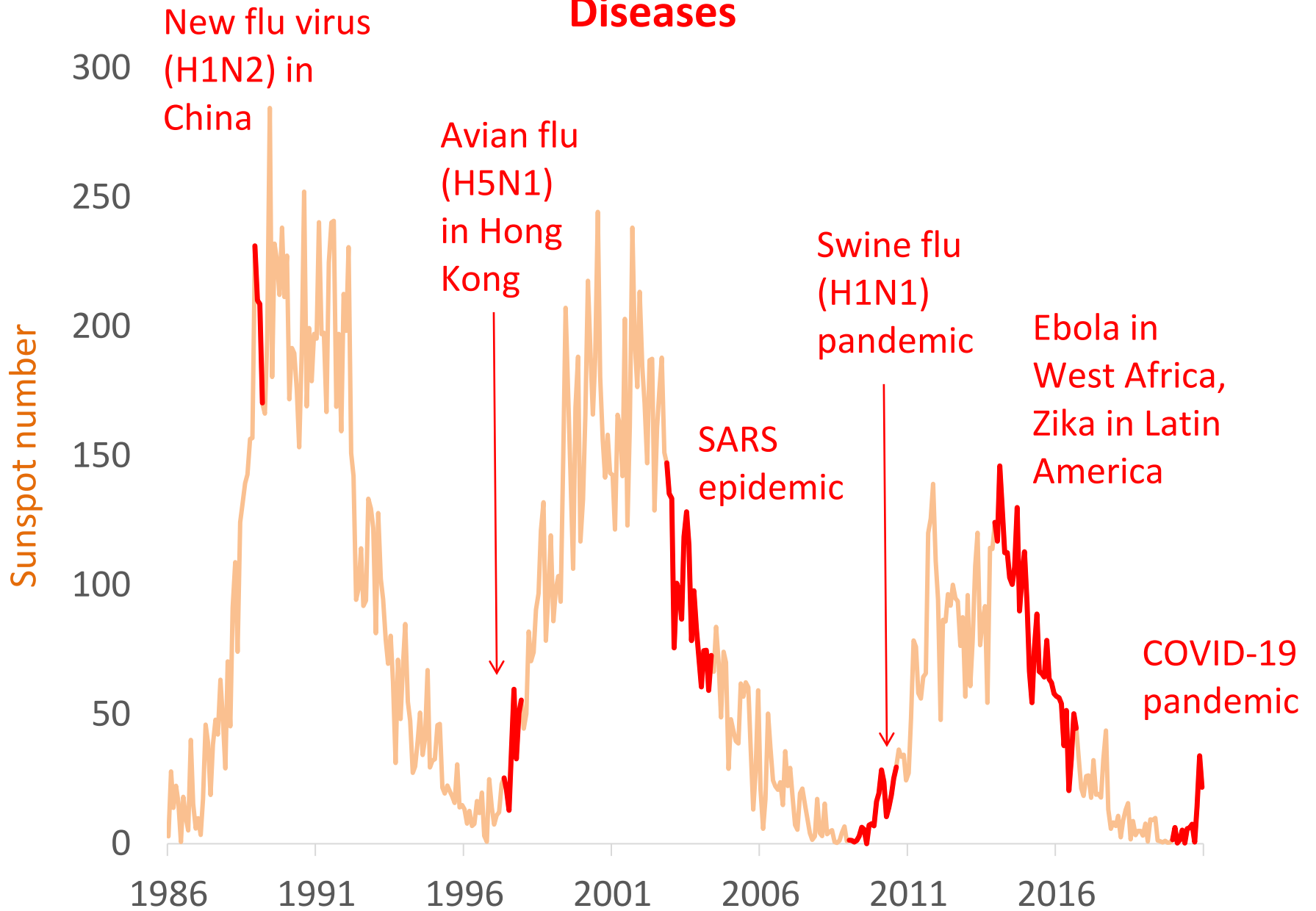
**Value for projections and policy discussions?**

# Coup d'États and US Mortgage Rates, 1970 - 2023

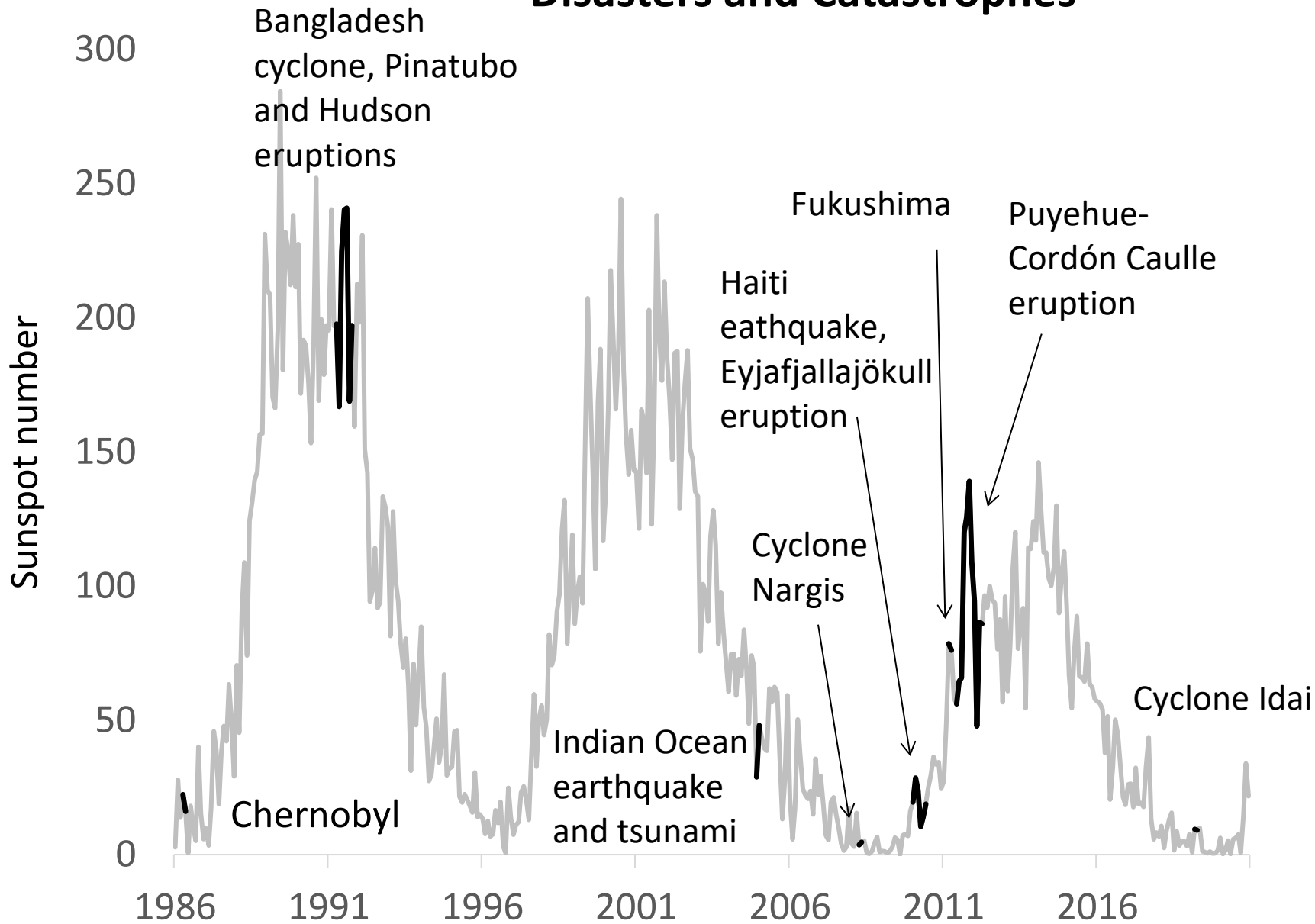


Sources: Cline Center Coup d'État Project Dataset; FRED; WDC-SILSO; and author's calculations.

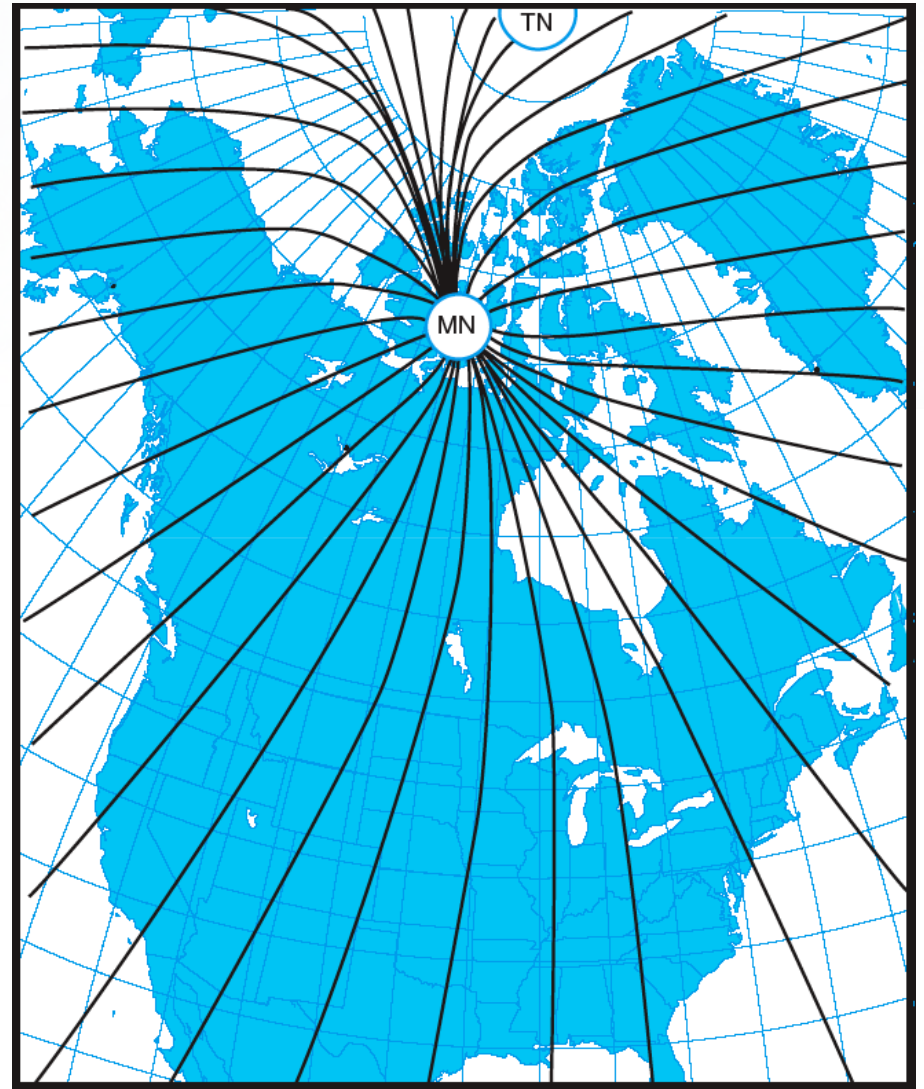
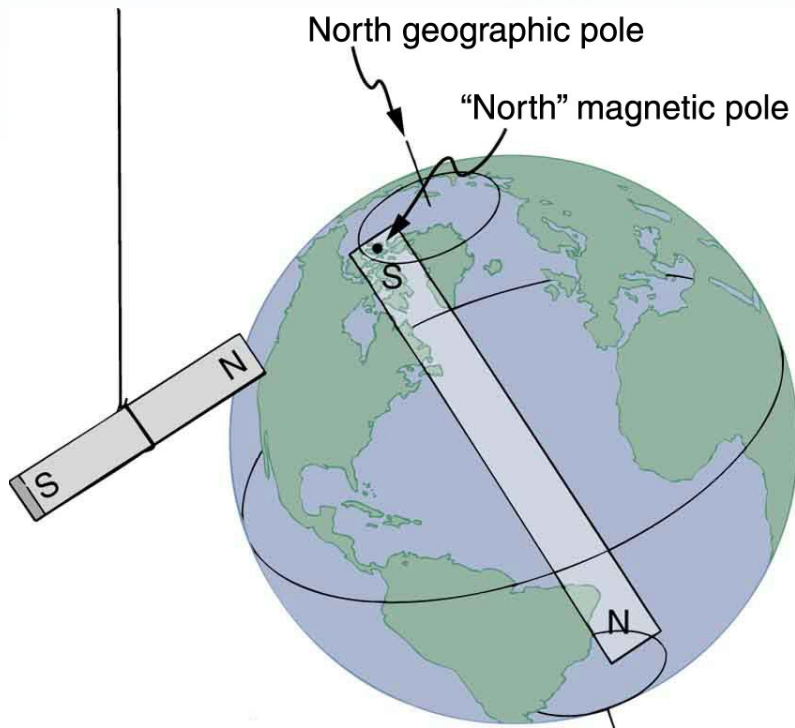
# Diseases



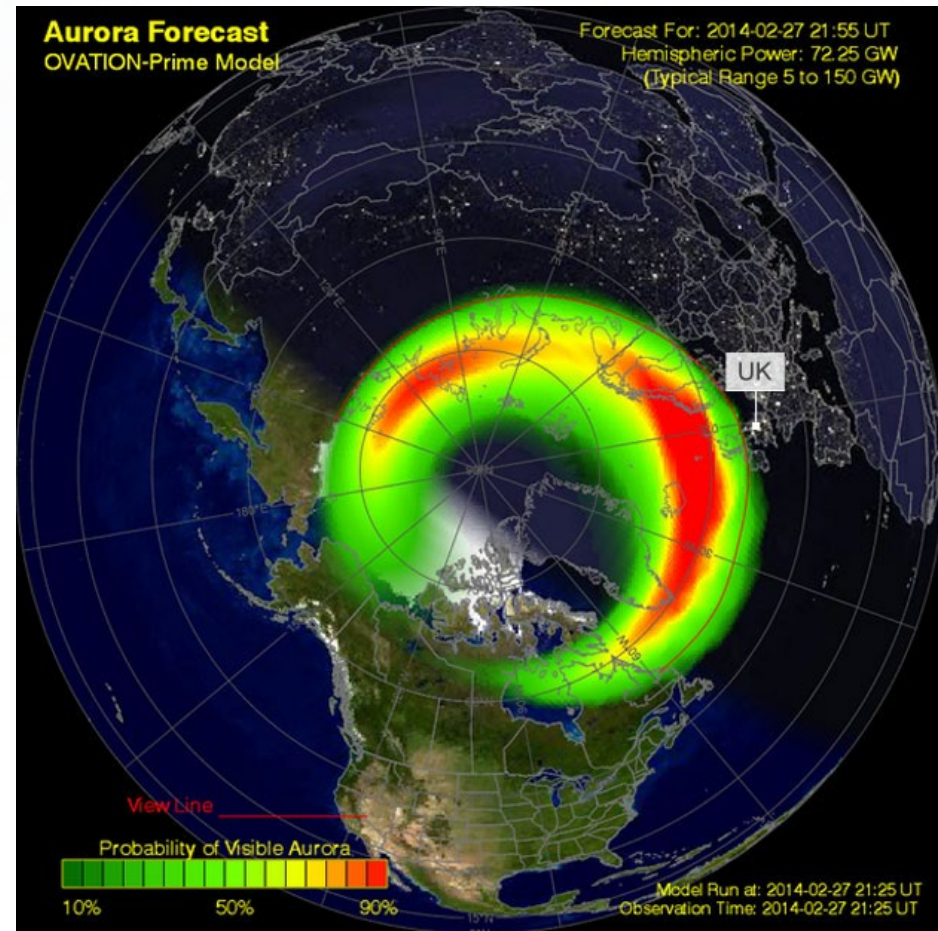
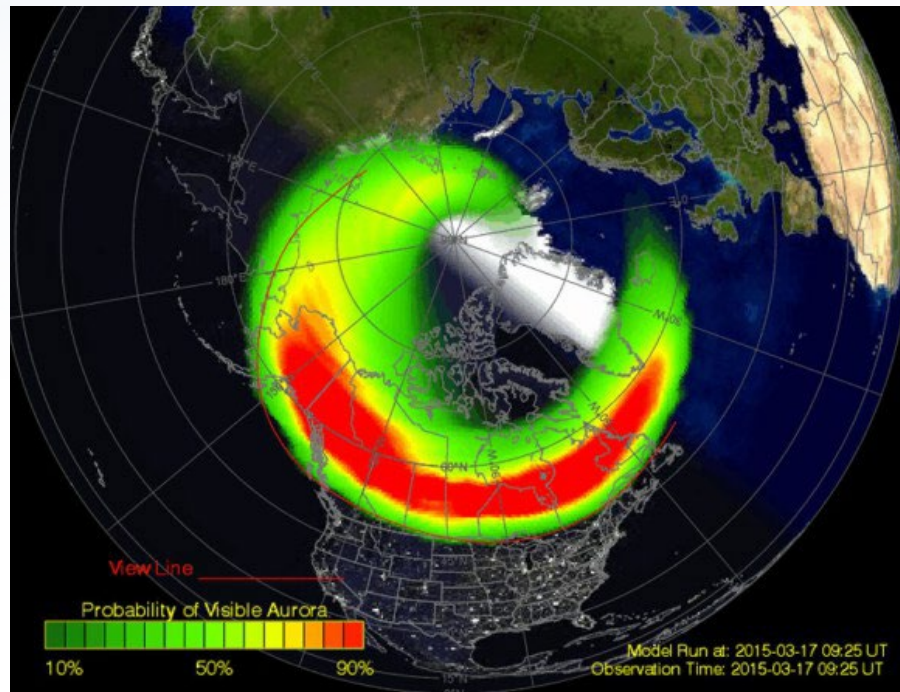
# Disasters and Catastrophes



# Earth's South Magnetic Pole is in Canada



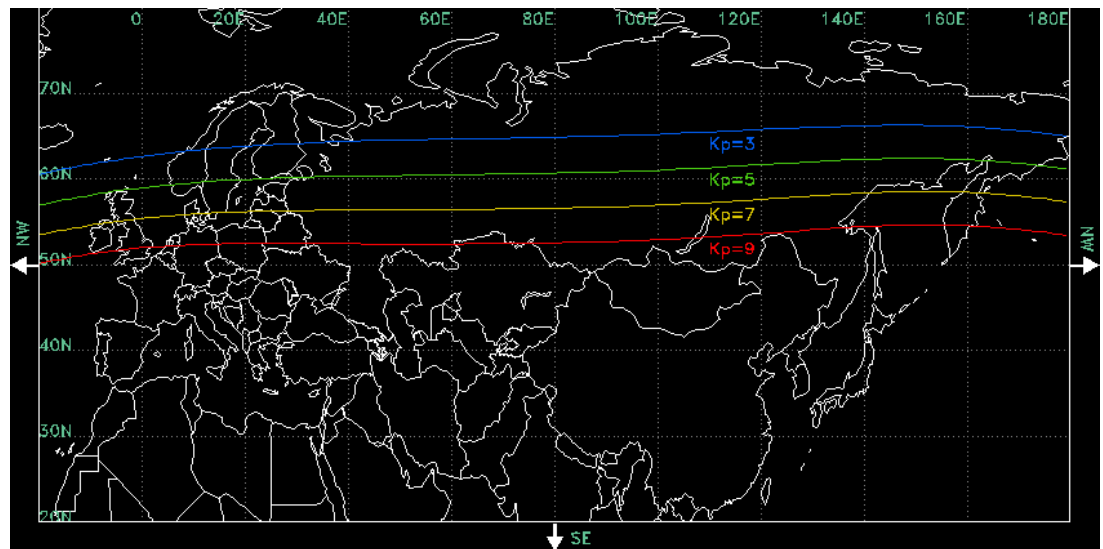
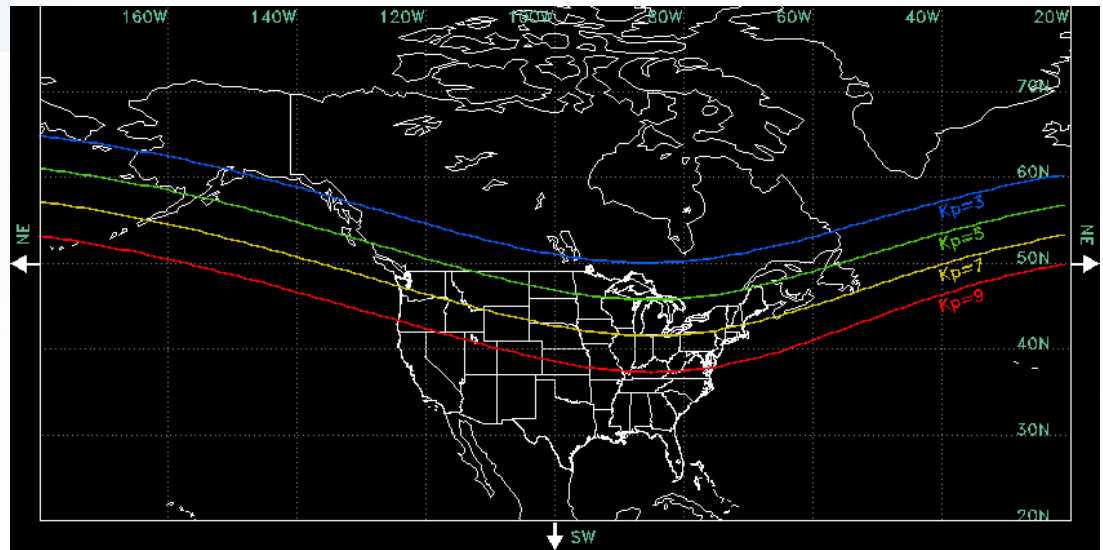
# Aurora Oval





# Boundary of the Aurora

Boundary of the aurora at different levels of geomagnetic activity; a  $K_p=3$  corresponds to low levels of geomagnetic activity, while  $K_p=9$  represents high levels



# Useful links

ScienceCasts: Here Comes Solar Maximum

<https://www.youtube.com/watch?v=k87JdeyQ-m8>

Carrington-class CME Narrowly Misses Earth

<https://www.youtube.com/watch?v=7ukQhycKOFw>

Documentary on Solar Storm

<https://www.youtube.com/watch?v=Mgt81Kr2Dk4>