Space weather: extreme event exercise

CIVIL AVIATION AUTHORITY
OF NEW ZEALAND
Te Mana Rererangi Tūmatanui o Aotearoa

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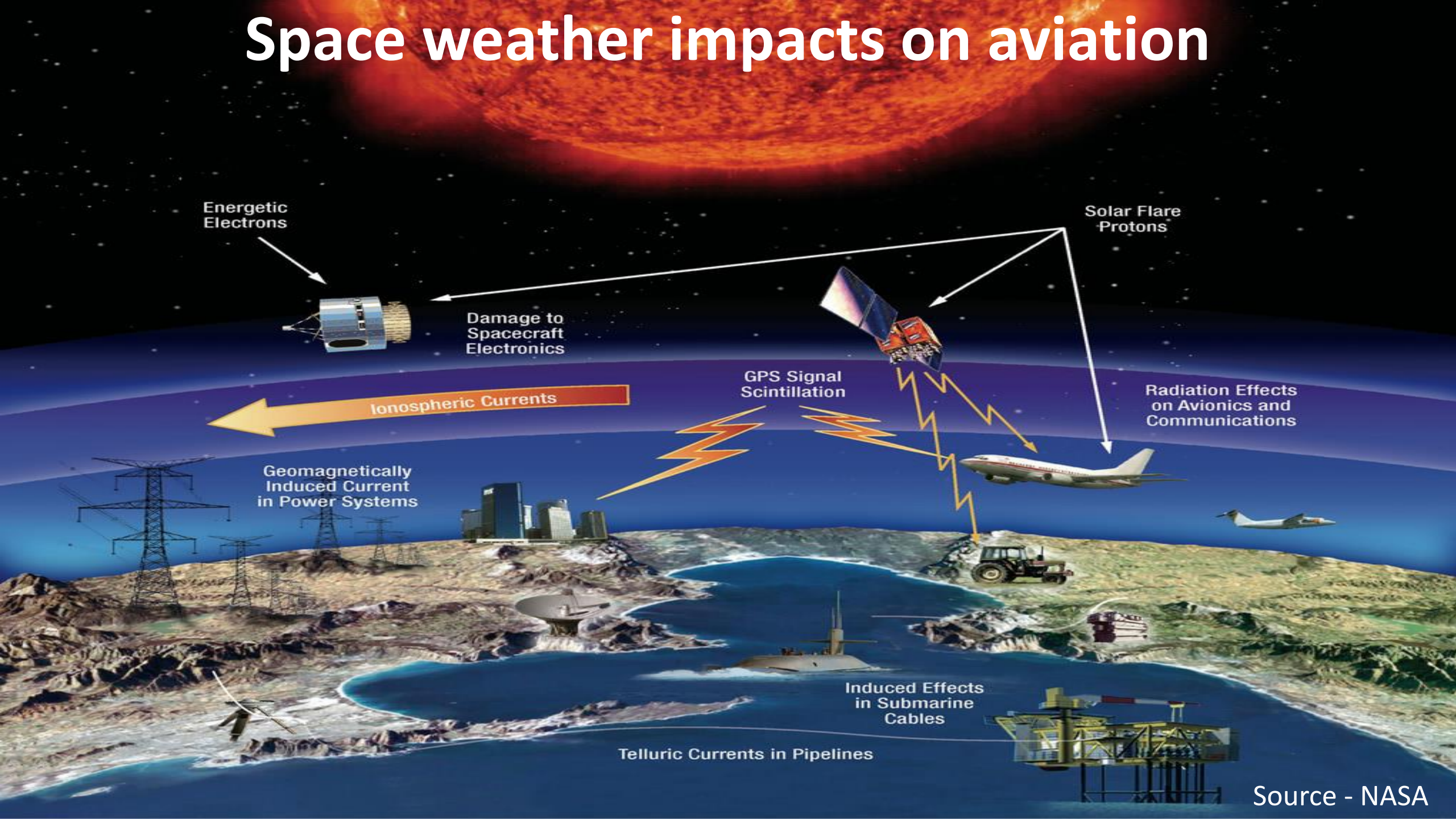
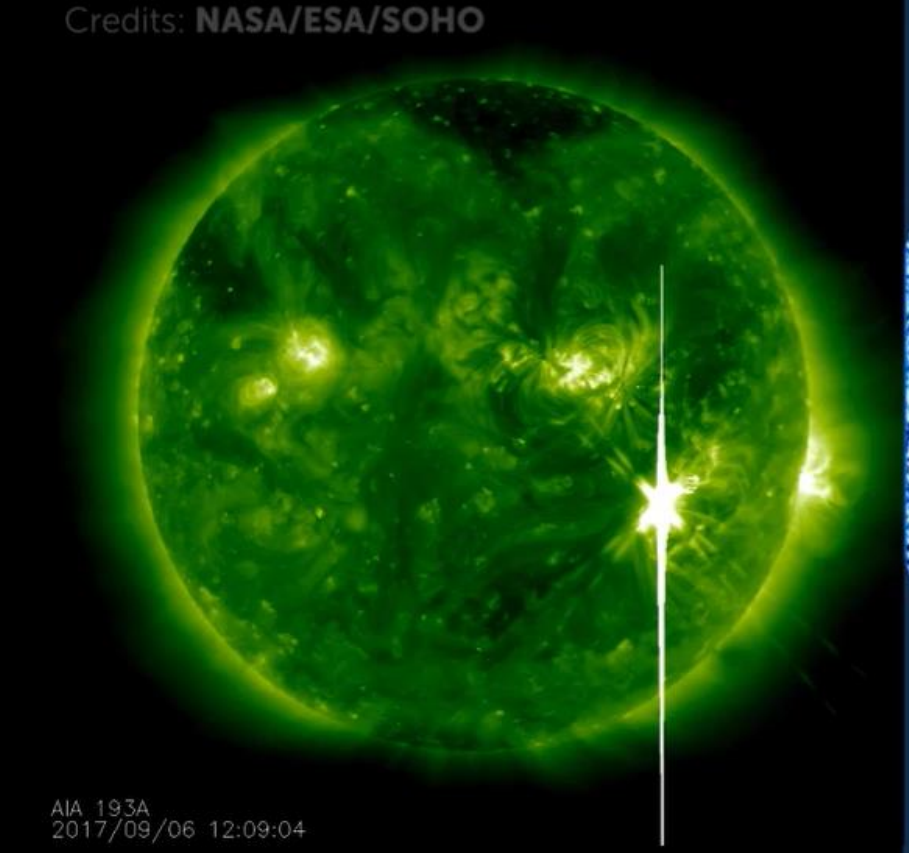
Outline of talk:

- What is space weather?
- Impacts of space weather on aviation
- Overview of aviation exercise

Space weather impacts on aviation



Source - NASA



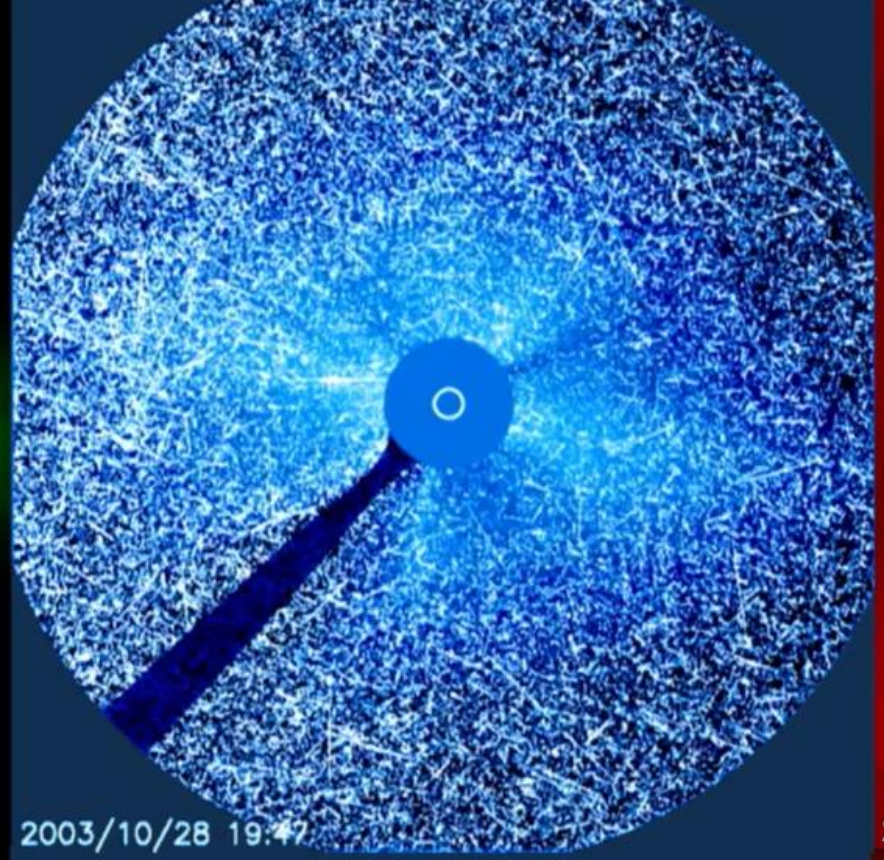
Solar flares

8 mins

HF/VHF/UHF

GPS

Radars

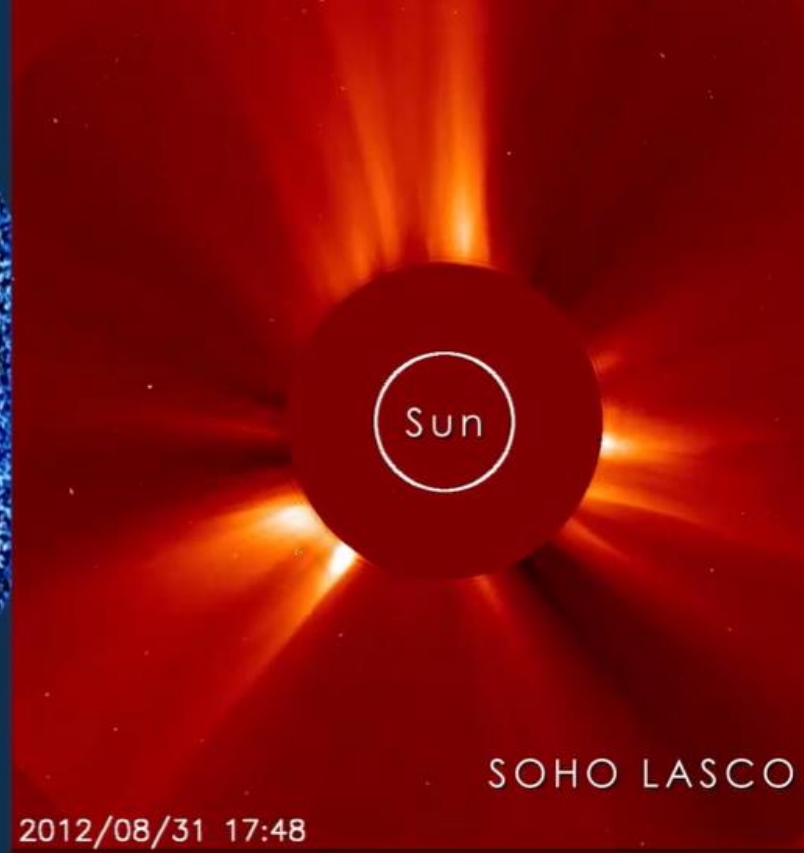


Particle radiation

10 mins – hours

Satellite

Aviation



Coronal mass ejections

0.5 – days

Geomagnetic storms

Ionospheric storm

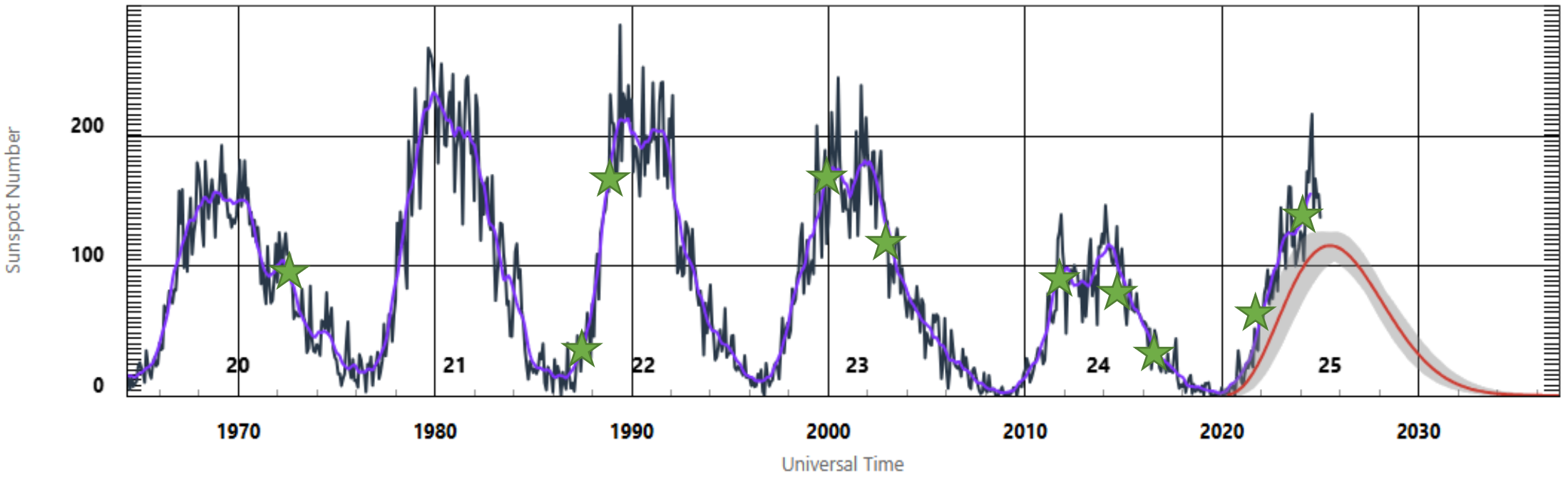
Radiation belt storms

Scintillation storm

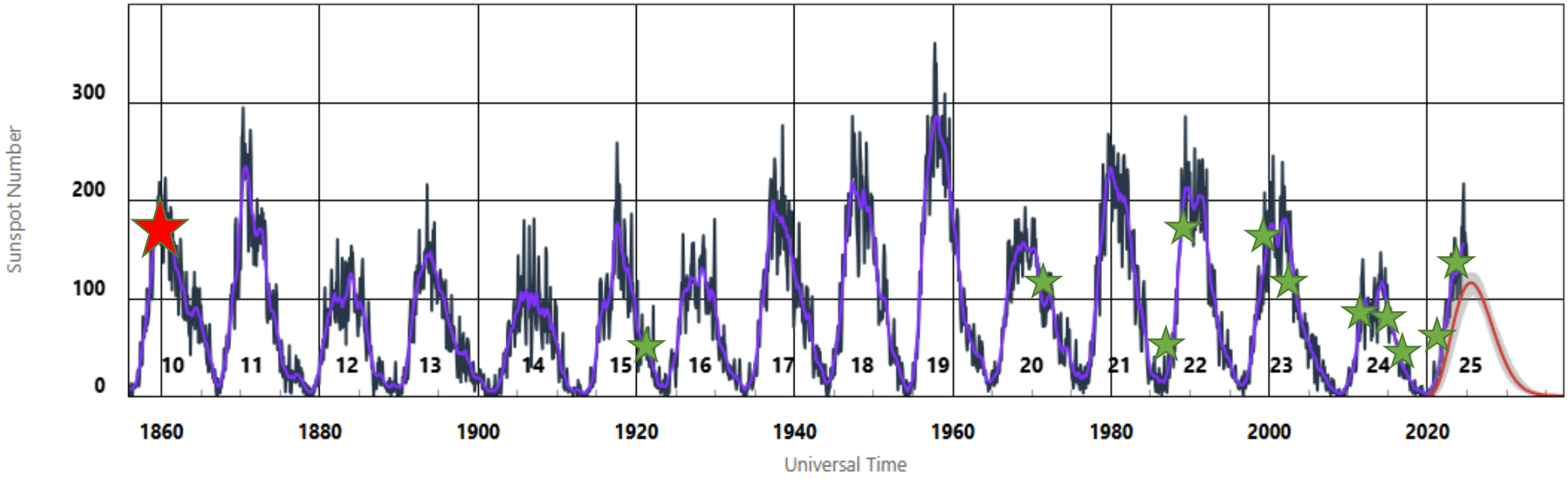
https://www.sws.bom.gov.au/vid/Space%20Weather%20Impacts%20and%20Extremes.mp4

Source – BoM

Space weather in modern times



Space weather in context…



Historical comparison of May 2024 event

Index	May 2024	Oct 2003	Mar 1989	May 1921	Sep 1859
Disturbance Storm Index (DST)	-412	-383	-589	~-907*	~-1200*

DST – an index of magnetic activity, derived from a network of near-equatorial geomagnetic observatories (higher negative values generally correlate with stronger storms).

*Estimated values

Source – NOAA/SWPC

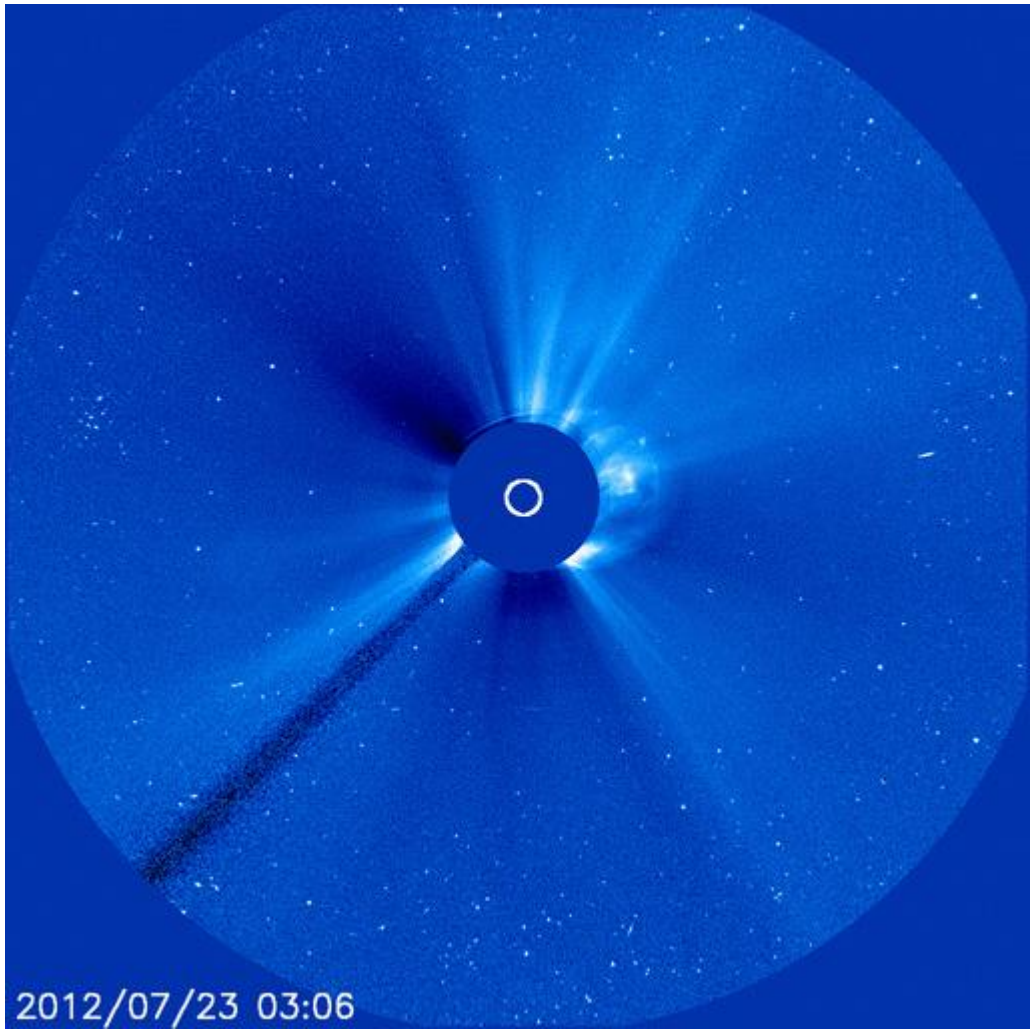
Extreme space weather

1859 Carrington event:

- Aurora visible in tropical latitudes
- Telegraph machines operated with no batteries, telegraph offices set on fire.

If such a storm occurred today….

- Impacts on ALL space-based & HF communications, navigation and weather forecasting services
- Could be global blackouts up to years long, if no preventative measures taken (eg shutting down grids)
- Major disruptions to financial markets, banking, telecommunications, business transactions, emergency and hospital services, the pumping of water and fuel, food transport.



Carrington event sized CME shot into space on July 23, 2012. Super fast, travelling at estimated 2930 km/s.

Earth would have been in the path of the CME (~14hr travel time), if it had happened nine days earlier.

Aviation-focused SWX exercise – 20 Feb 2025

- Attendees from CAA, Airways, Air NZ, GNS Science, MetService, LINZ, MOT, supported by NEMA.
- Used the new NEMA National Space Weather Response Plan as the framework.
- Scenario – ‘Carrington Event’ (1 in 100yr) geomagnetic storm.
- Focused on the period between first indication of an extreme event (T-15hr), through to confirmation of extreme level storm (T-15min).

Exercise outcomes

- There is a 6-12hr window between the warning of a potentially extreme CME and its impact on Earth – clear and consistent communication is most important during this period.
- Planes will be able to continue to fly and safely land with the loss of comms and navigation, but restarting operations *after* may be hard.
- The loss of power will cause the biggest impact – no ability to pump fuel, screen passengers or get a weather briefing – makes it difficult to fly anyway.

Next steps…

- Education in ‘peacetime’ critical to a good outcome later…
  - Refreshed Vector article (last one in 2019)
  - Space weather information to be included in relevant GAPs and ACs
  - NEMA is developing guide for consistent messaging during such events
- Consider the usefulness of one NOTAM to cover all impacted systems
- International collaboration – share exercise outcomes, discuss issues at relevant meetings and with other organisations. Extreme space weather is a global problem, so need to learn from each other.