

Climatology

Schematic framework of anthropogenic climate change drivers, impacts and responses

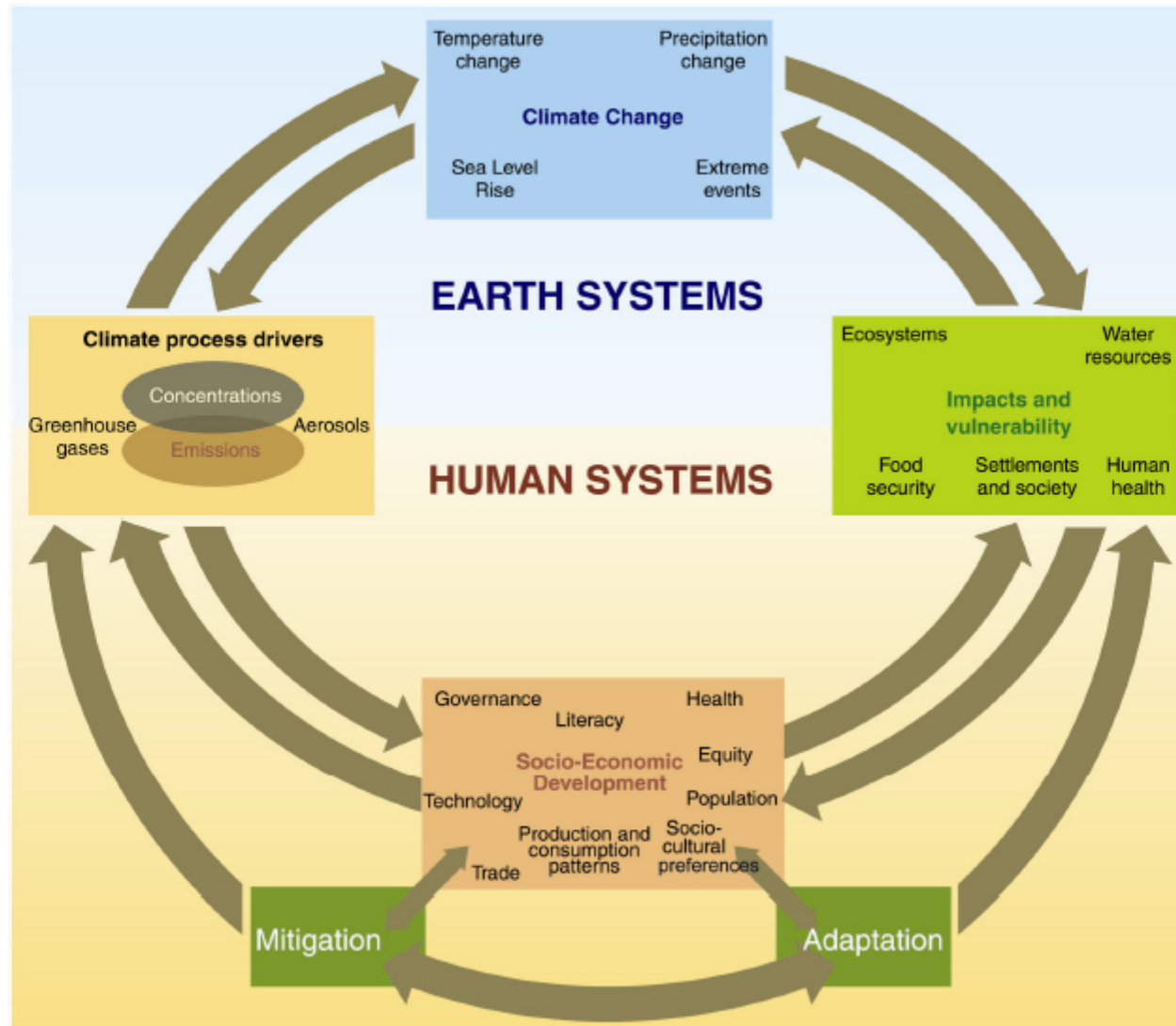
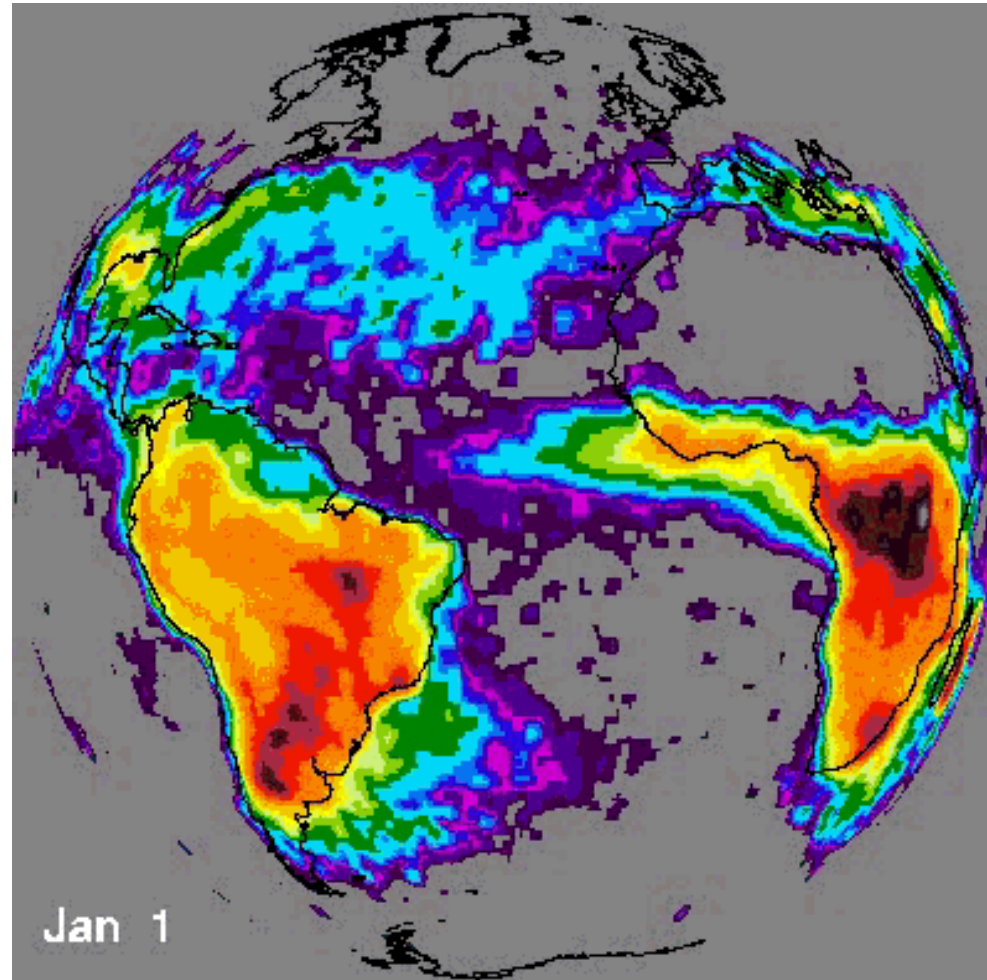
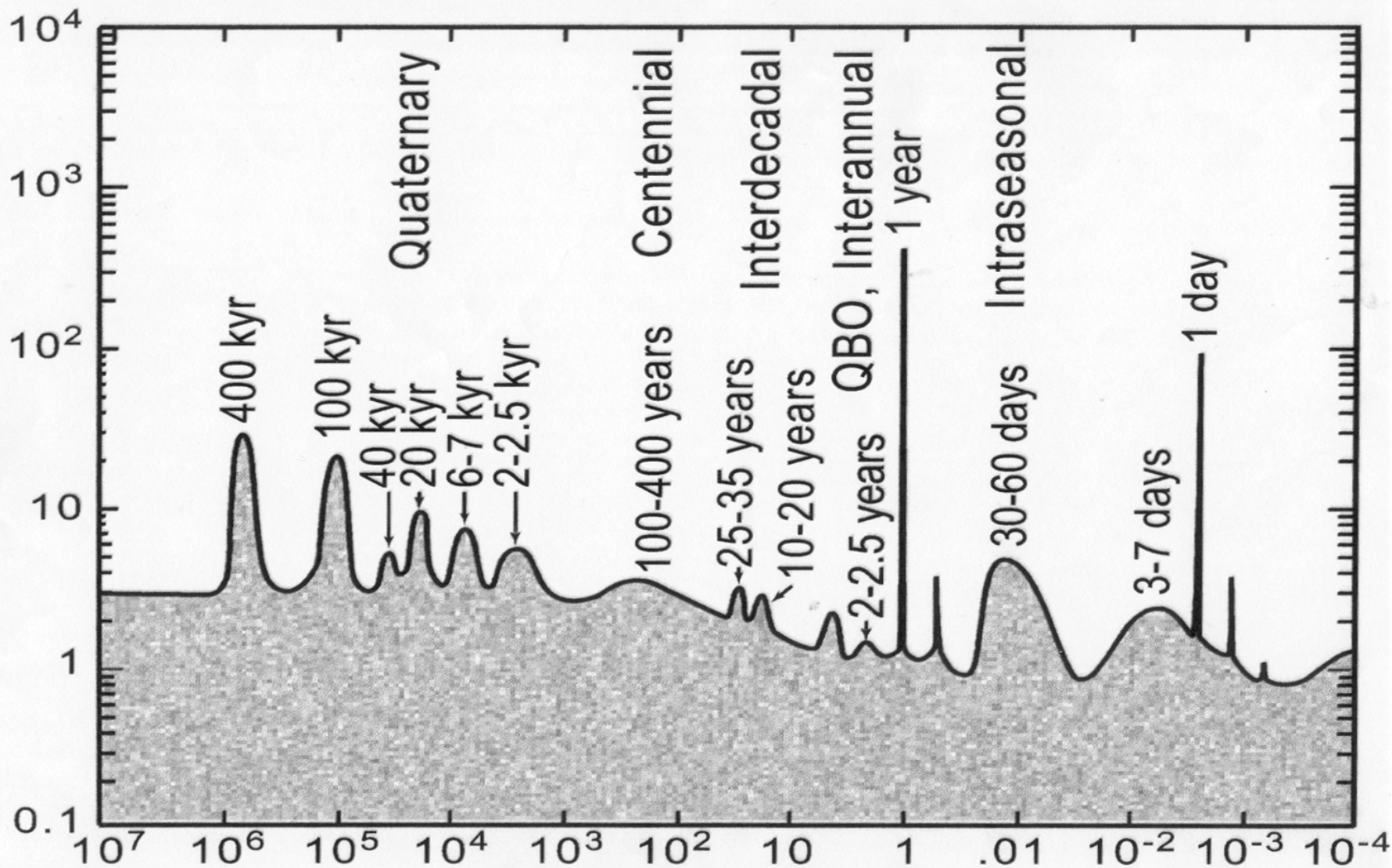


Figure I.1. Schematic framework representing anthropogenic drivers, impacts of, and responses to climate change, and their linkages.

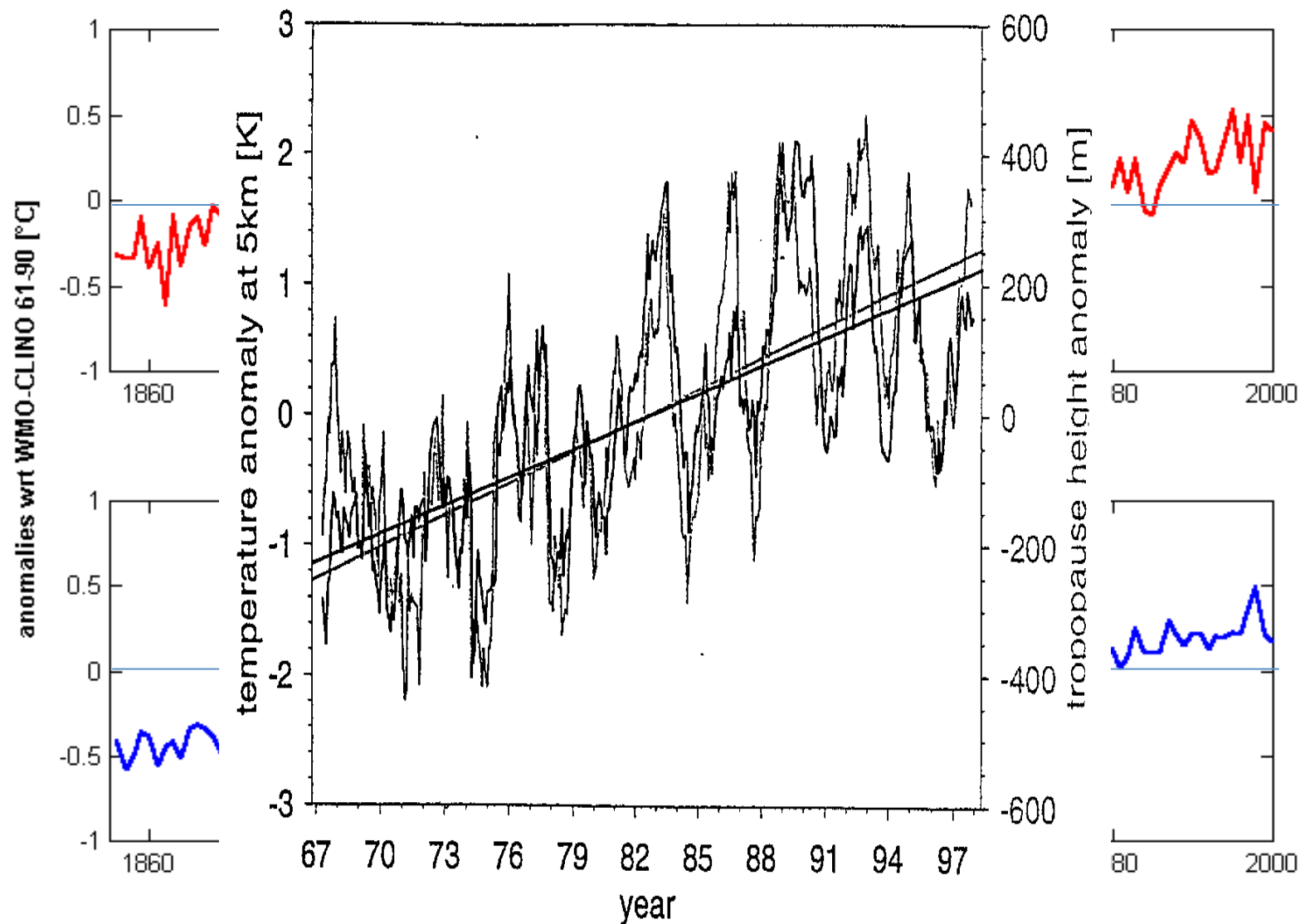
Earth's breath, from years to centuries



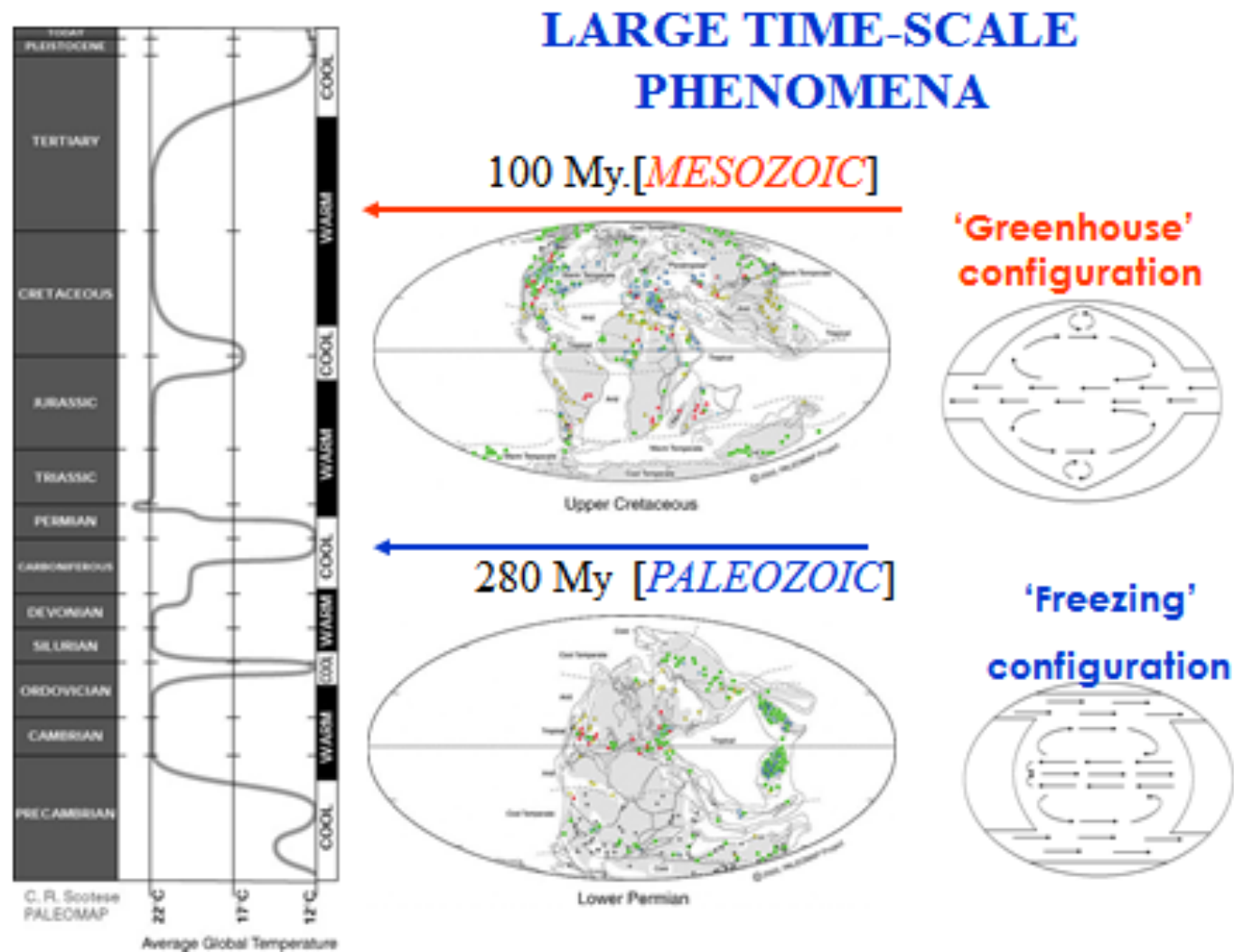
Variability, why?



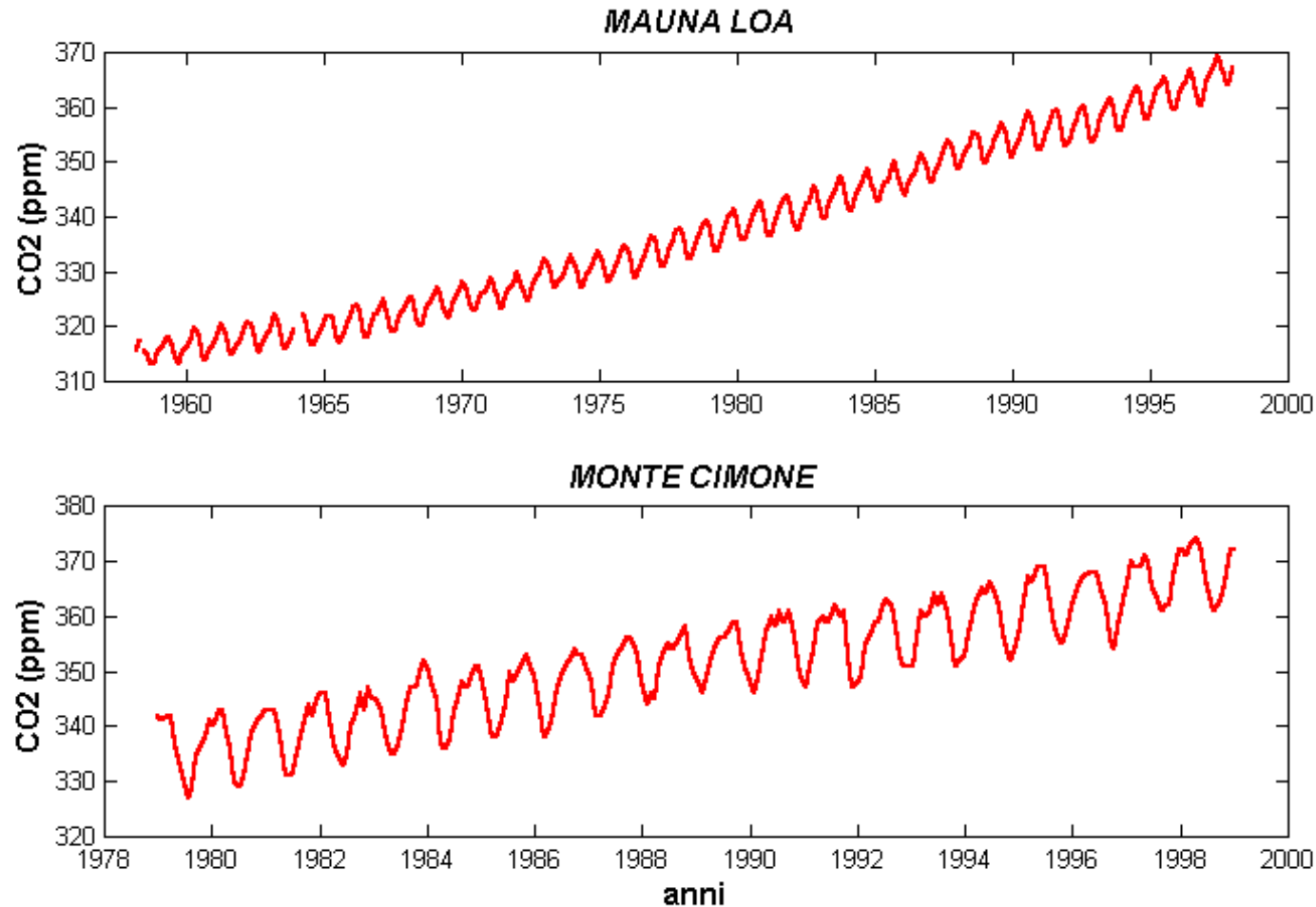
Variability in Earth's mean temp, where?



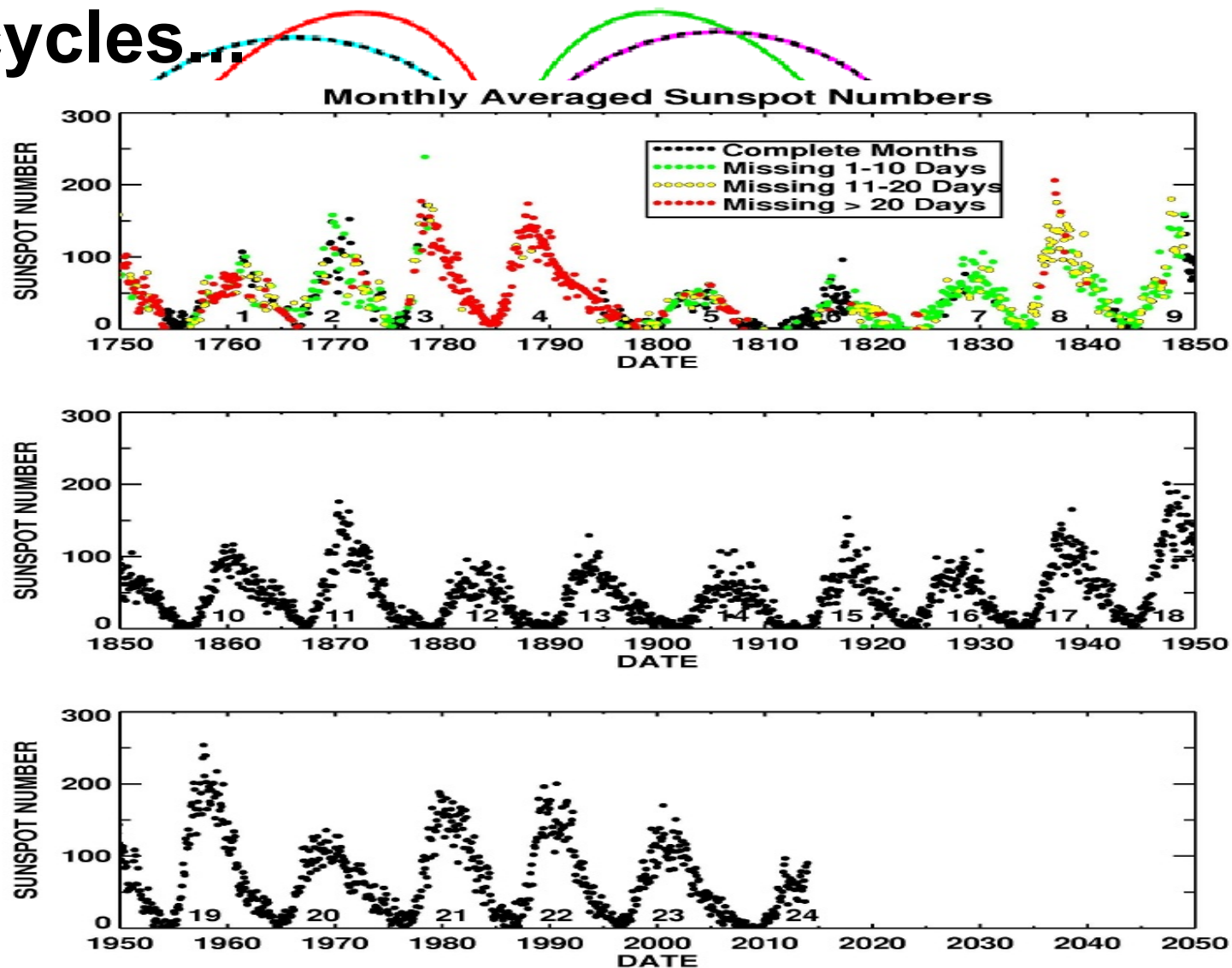
Complexity, same MET methodology?



Complexity, multidisciplinary approach?



Predictability, water cycle, carbon cycle, solar cycles. Cycles



Predictability, predict what?

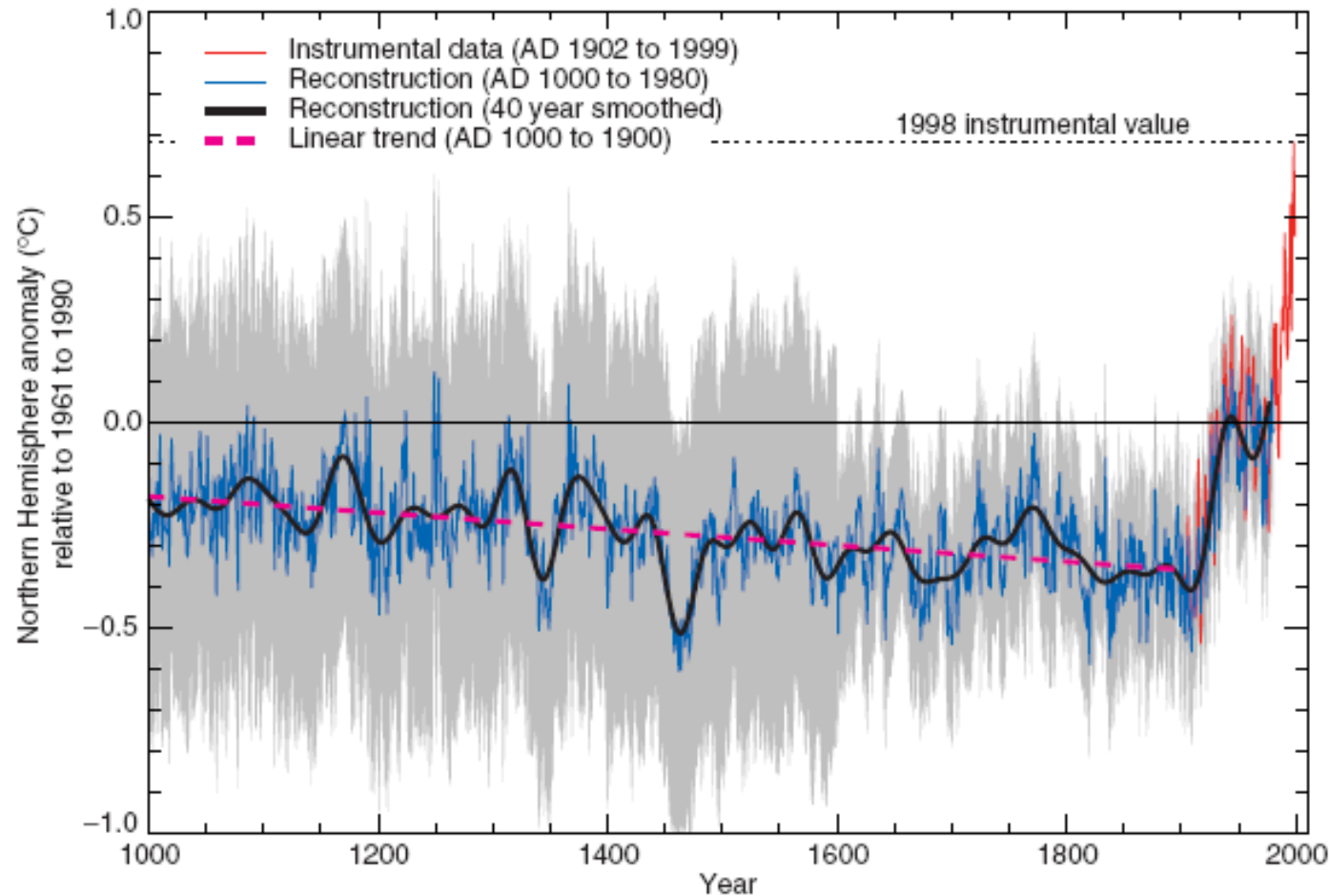
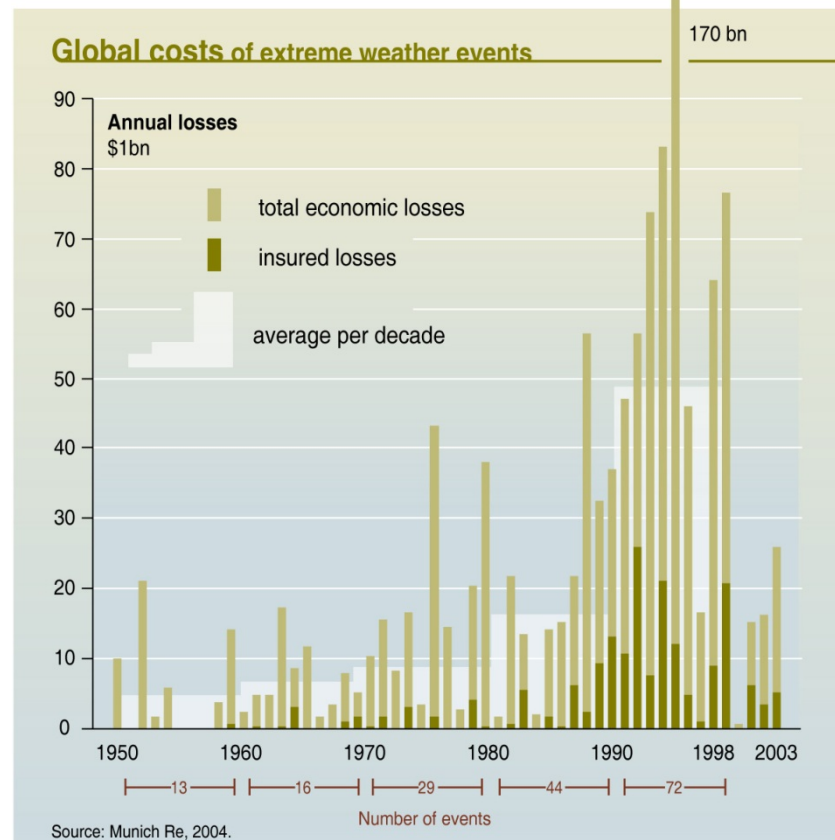


Figure 2.20: Millennial Northern Hemisphere (NH) temperature reconstruction (blue) and instrumental data (red) from AD 1000 to 1999, adapted from Mann *et al.* (1999). Smoother version of NH series (black), linear trend from AD 1000 to 1850 (purple-dashed) and two standard error limits (grey shaded) are shown.

Global costs of extreme weather events

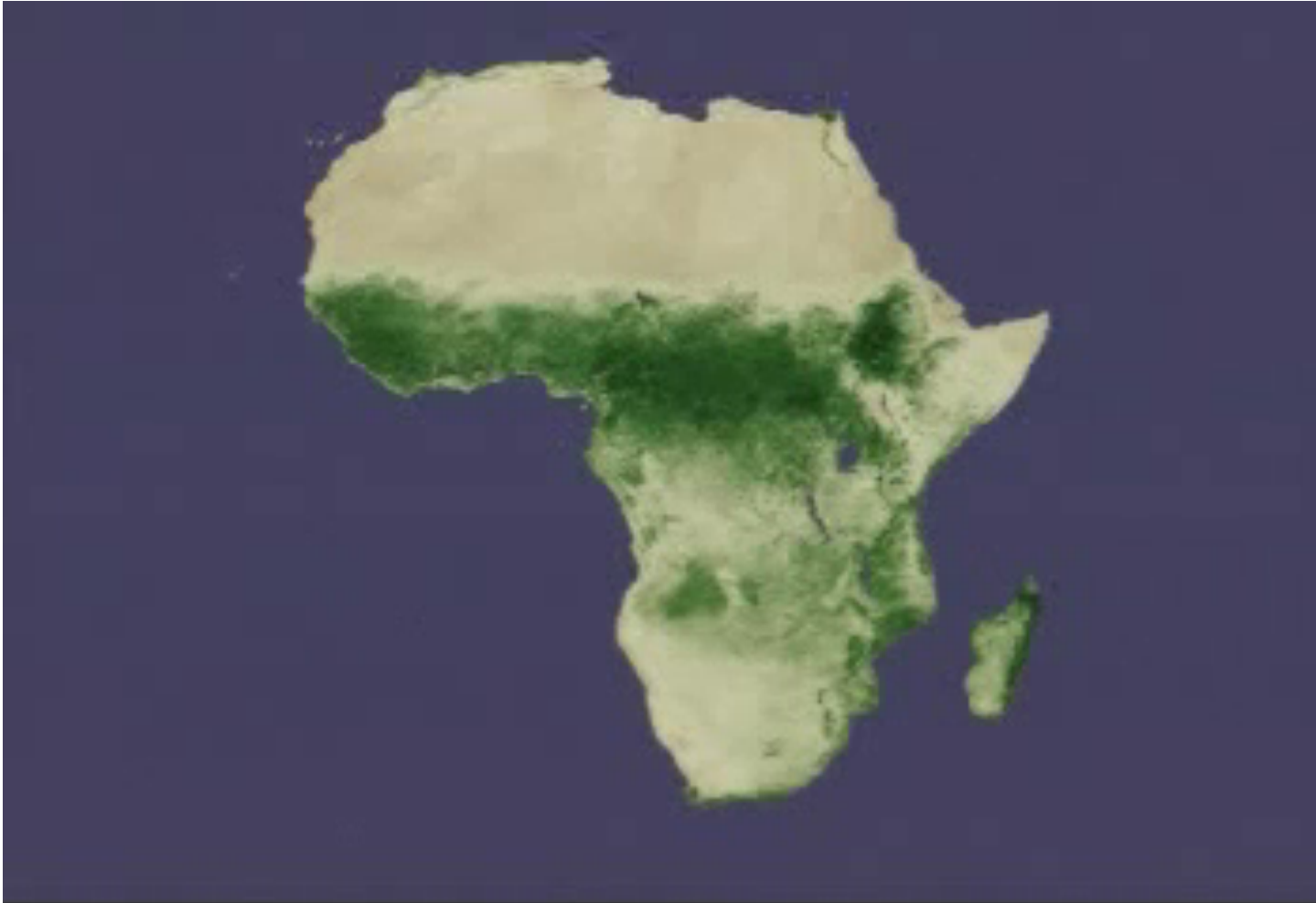


Climatology is not only a matter of heavy computing

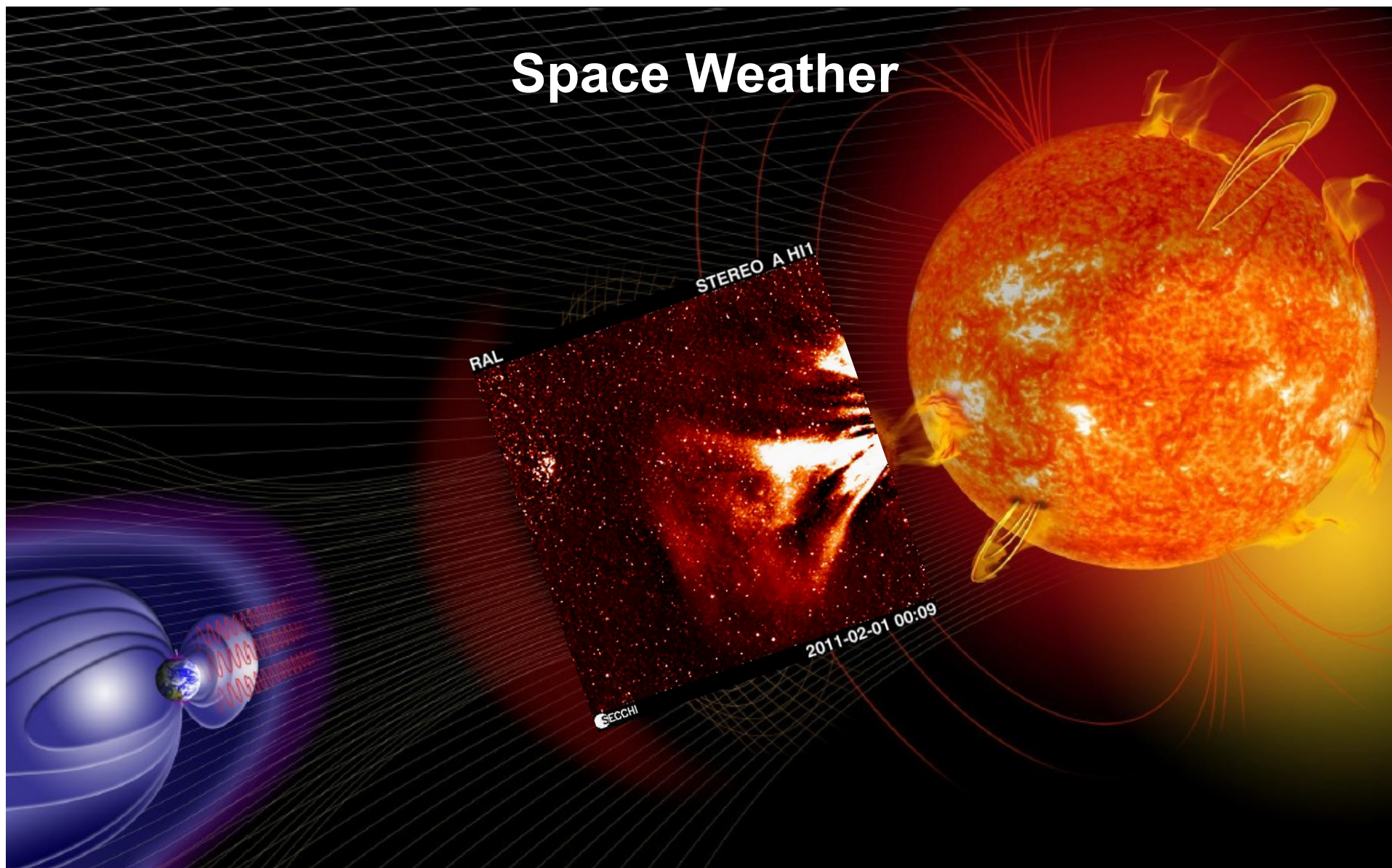


Richardson's Forecast Factory:
64000 human computers!

Vegetation Index



Space Weather



***WINTER COLLEGE ON OPTICS LIGHT: A BRIDGE BETWEEN EARTH AND SPACE
DANELE BIRON METEOROLOGY CLIMATOLOGY SPACE WEATHER ICTP 2015***



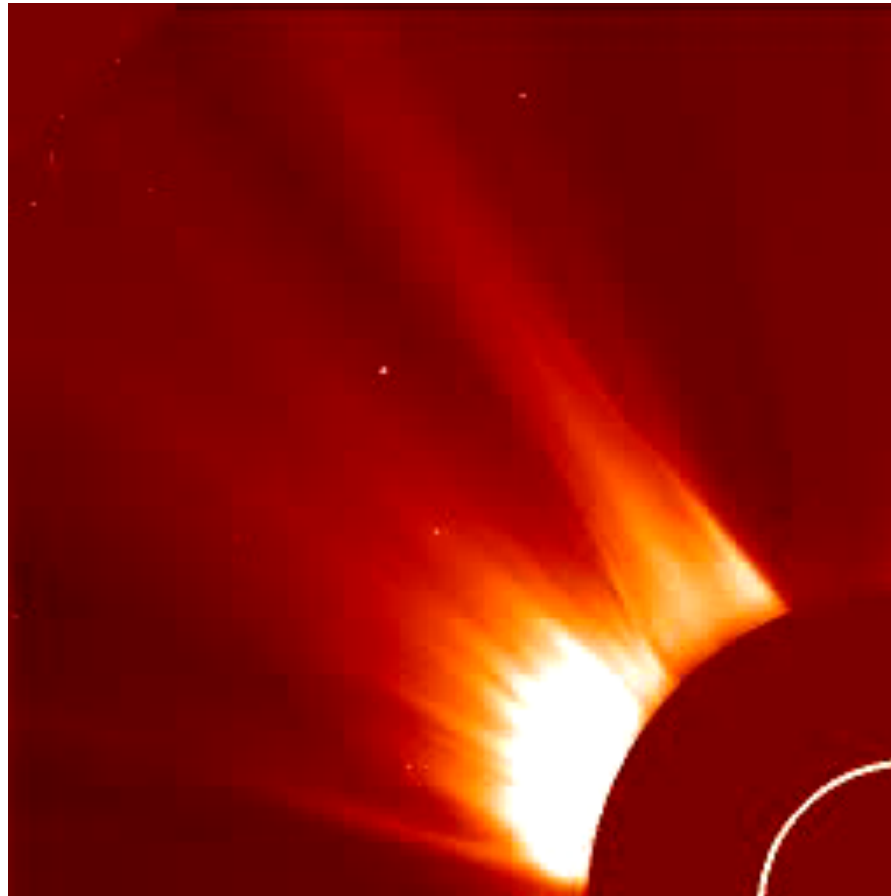
ESA

Space Weather Space Situational Awareness



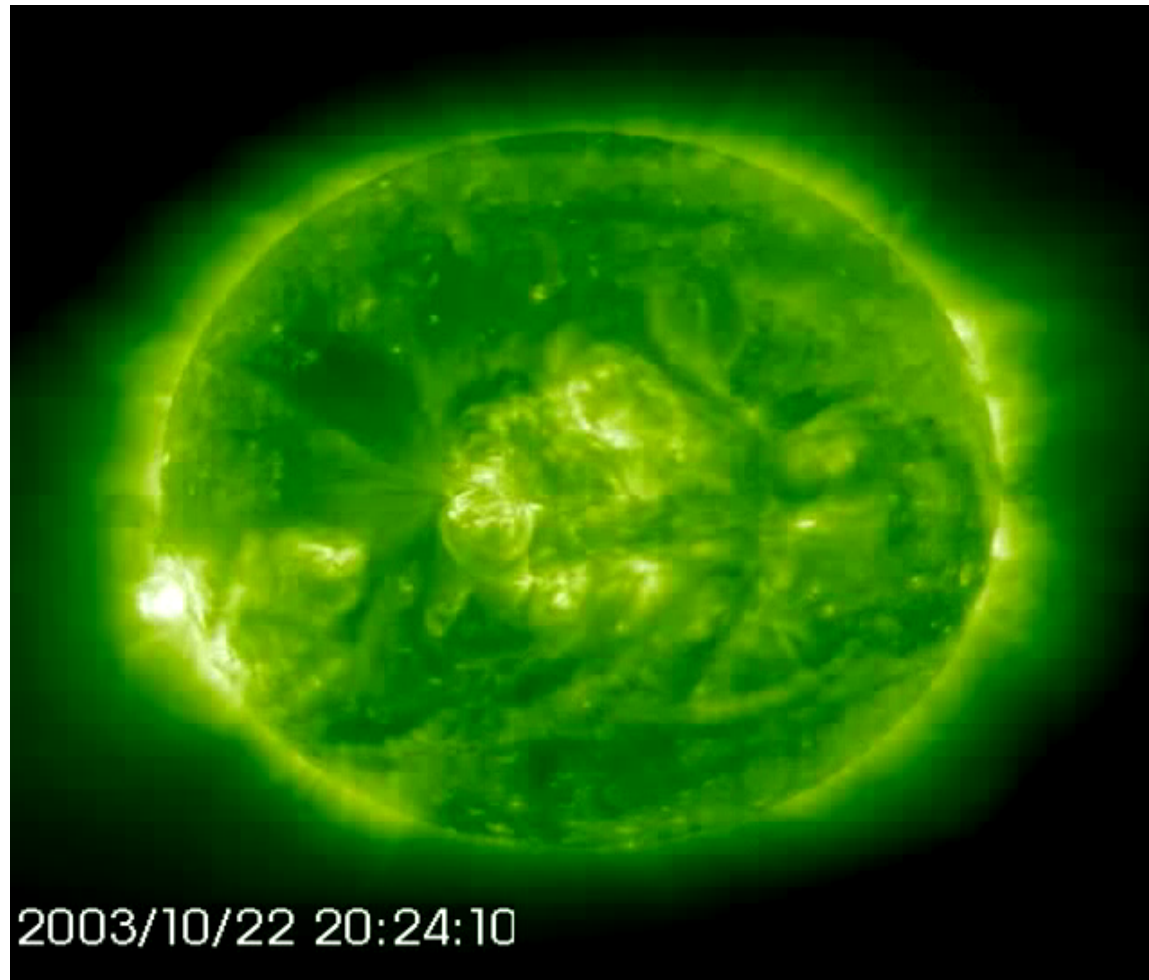
Coronal Mass Ejection

A Coronal Mass Ejection, or CME, is a large burst of coronal material ejected away from the Sun, often at speeds up to 1000 km/s and in extremely more than 2000 km/s.



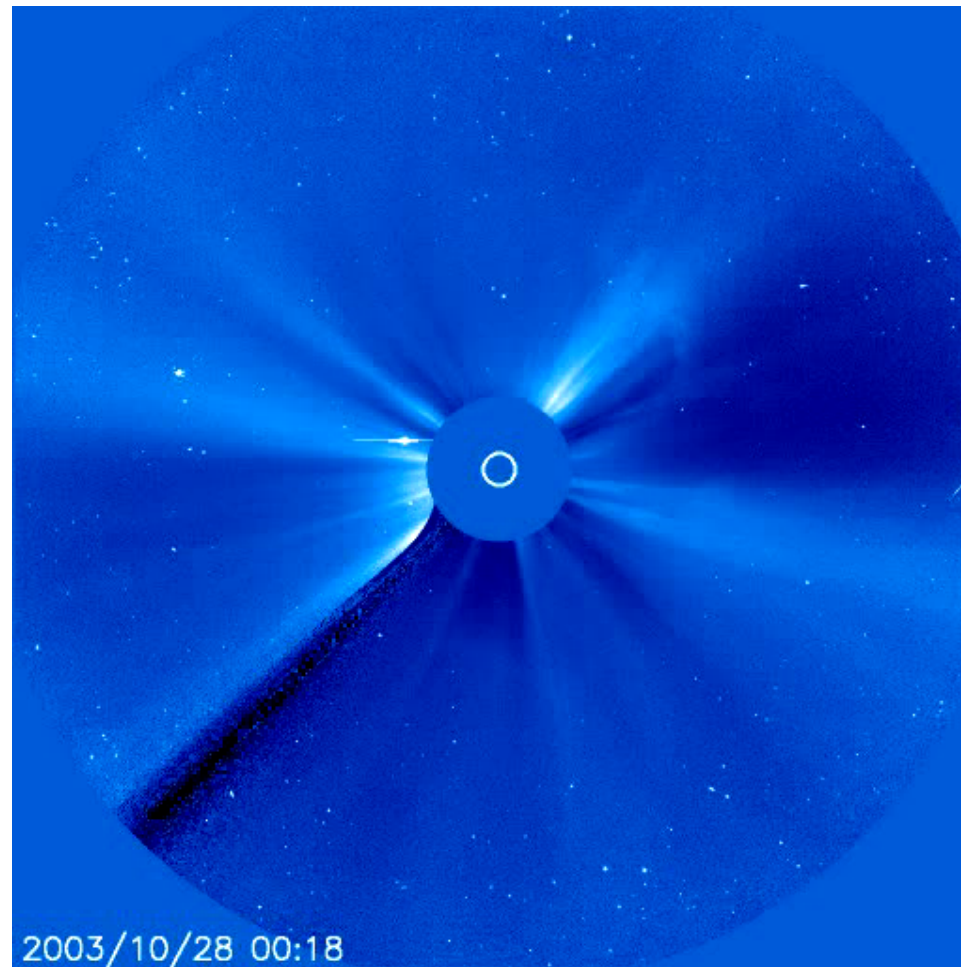
FLARE

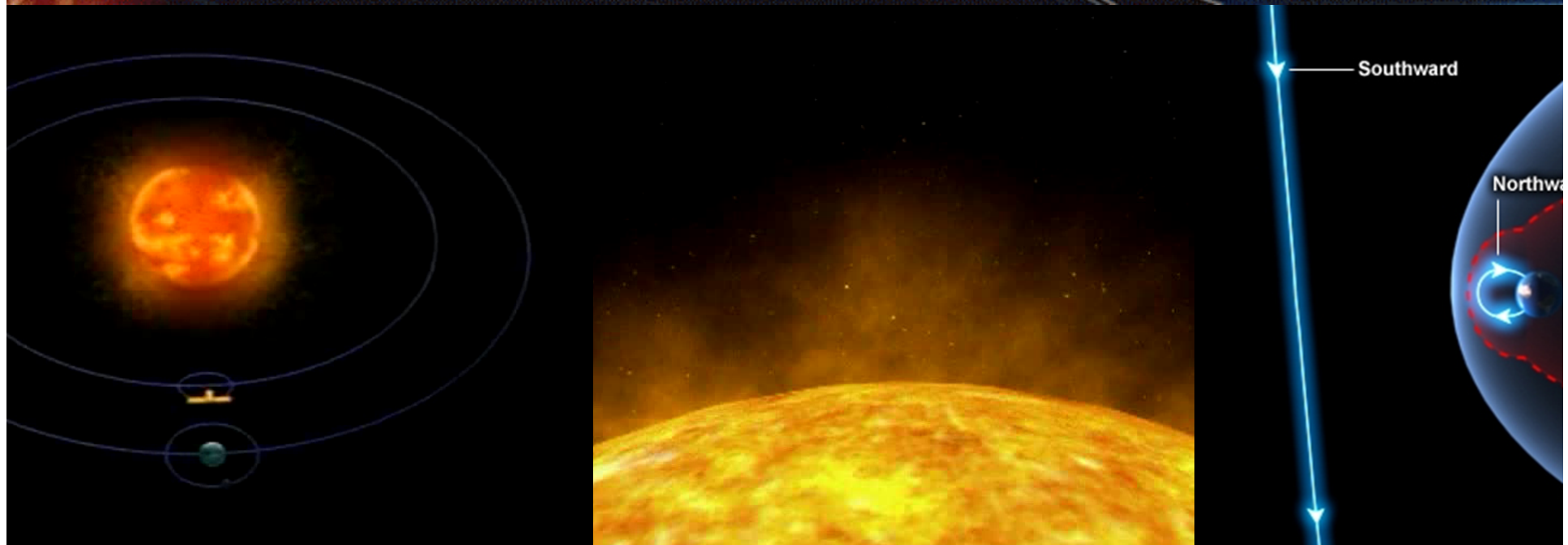
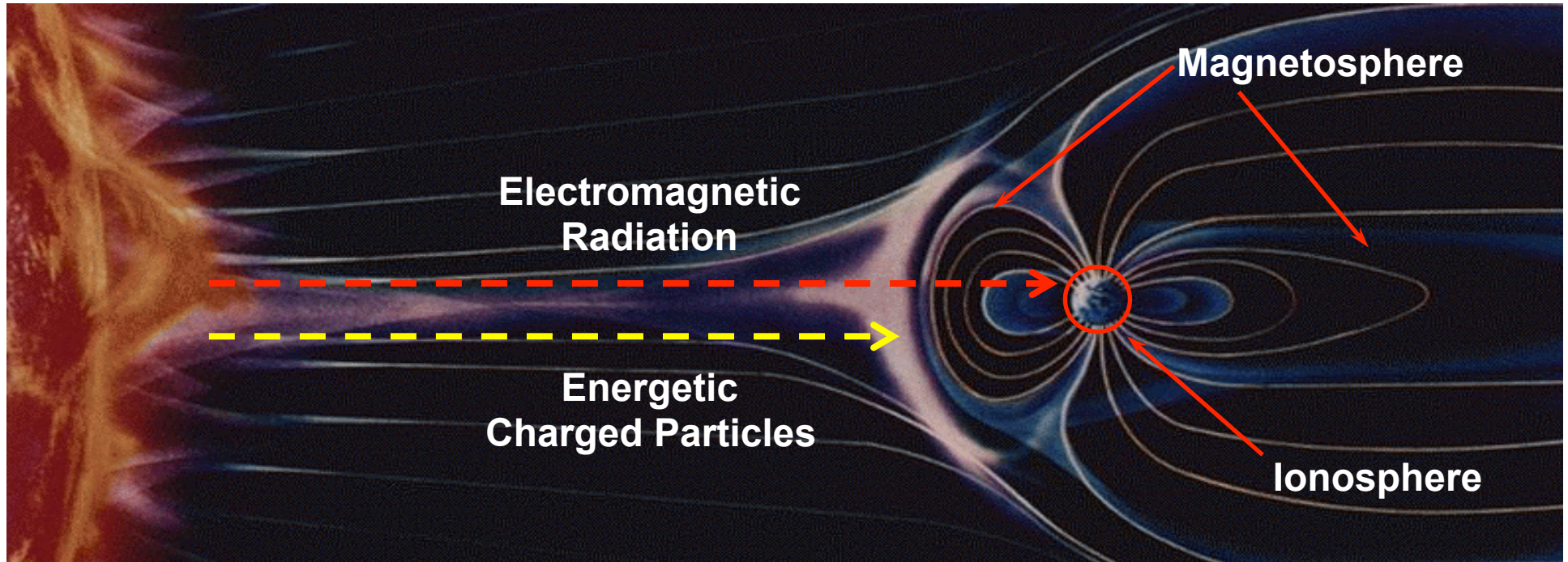
A solar flare is seen as a sudden variation of brightness across the electromagnetic spectrum, including X-ray wavelengths.



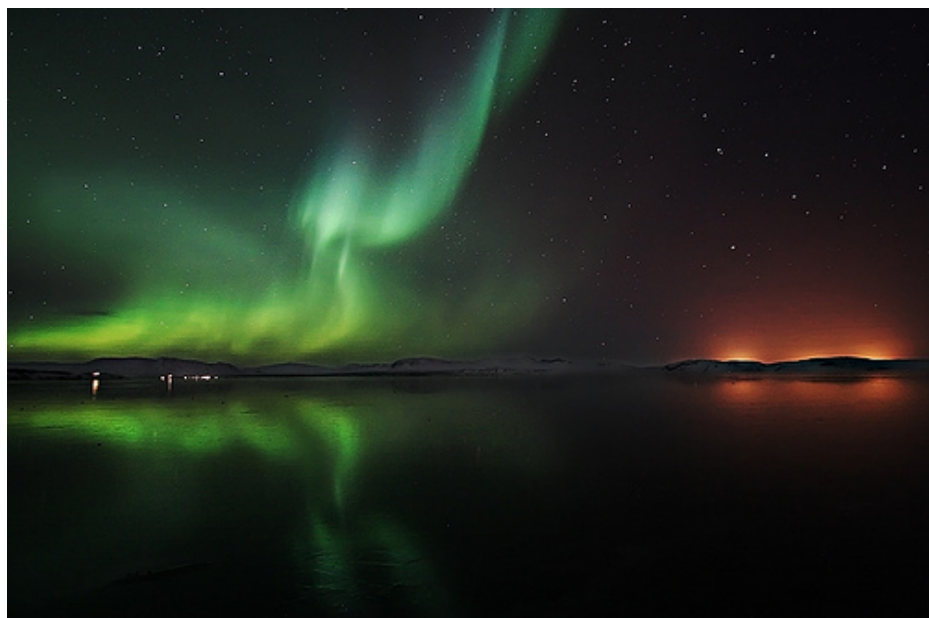
Radiation

Electrons and Protons traveling to Earth, reaching it usually in hours,
but rarely in only 15-20 minutes by near-relativistic velocities.



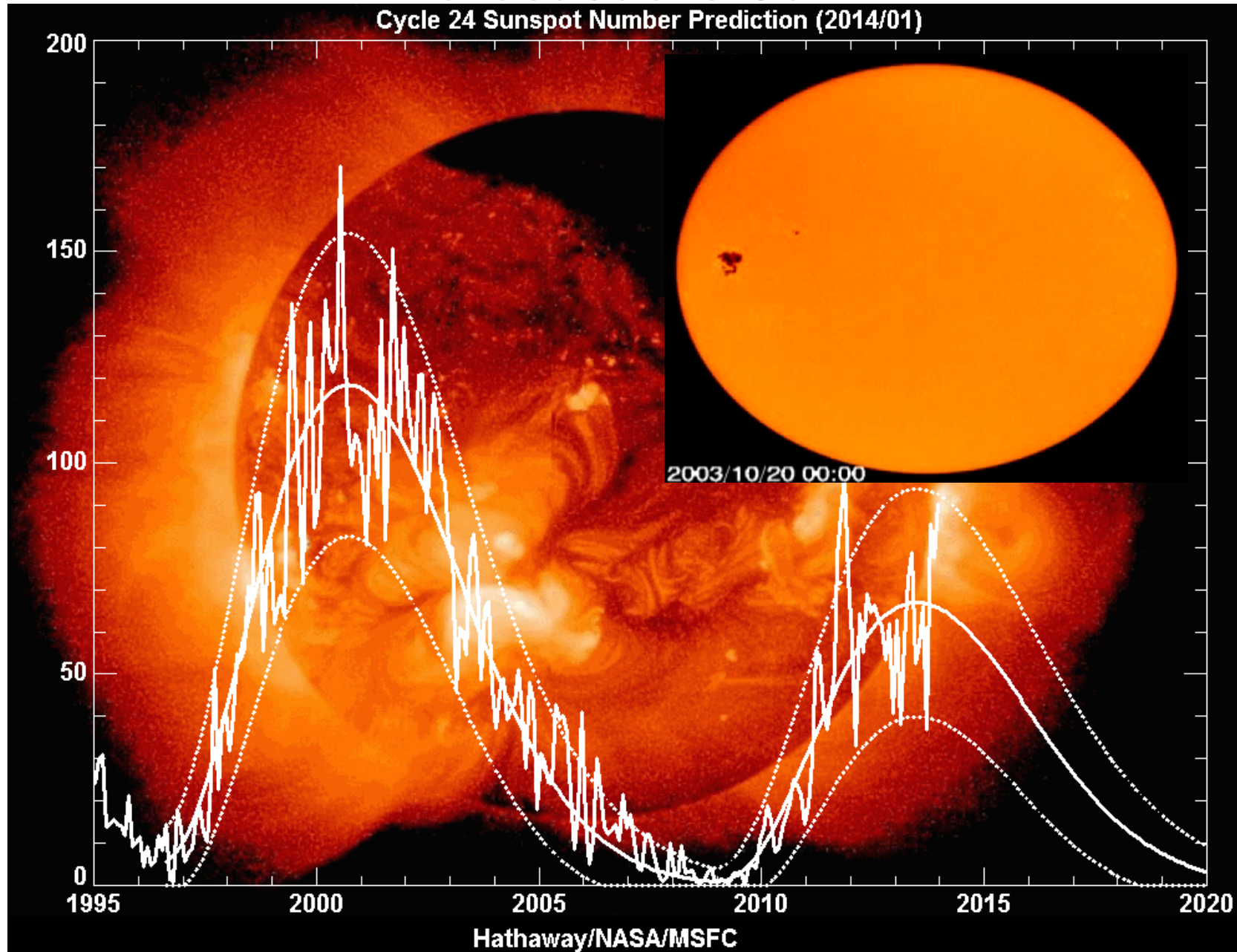


Auroras

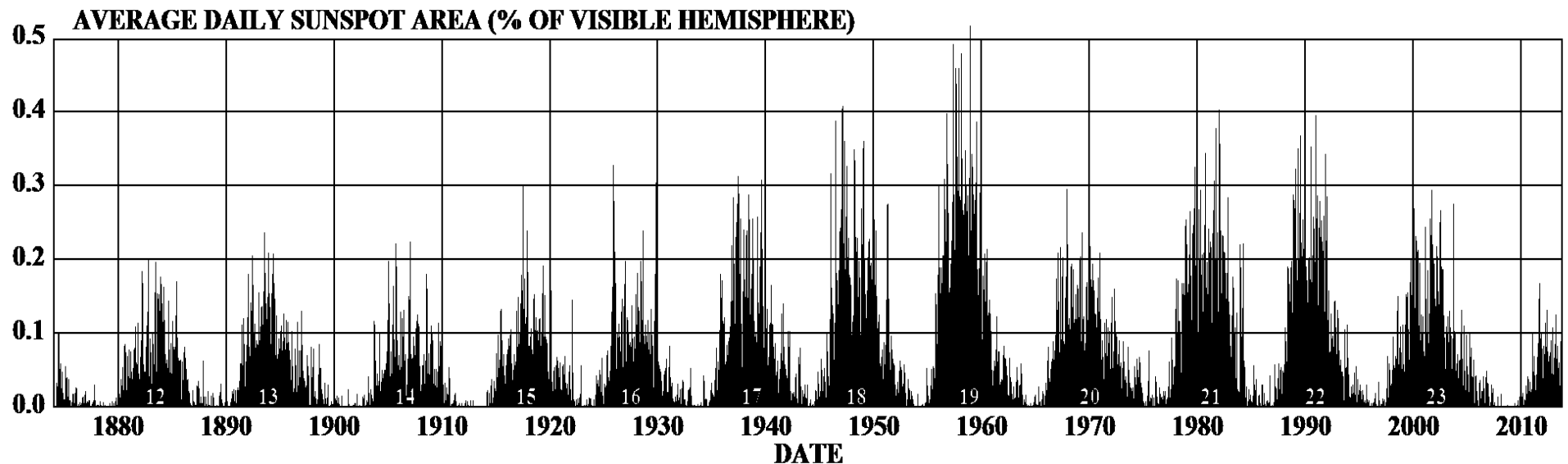
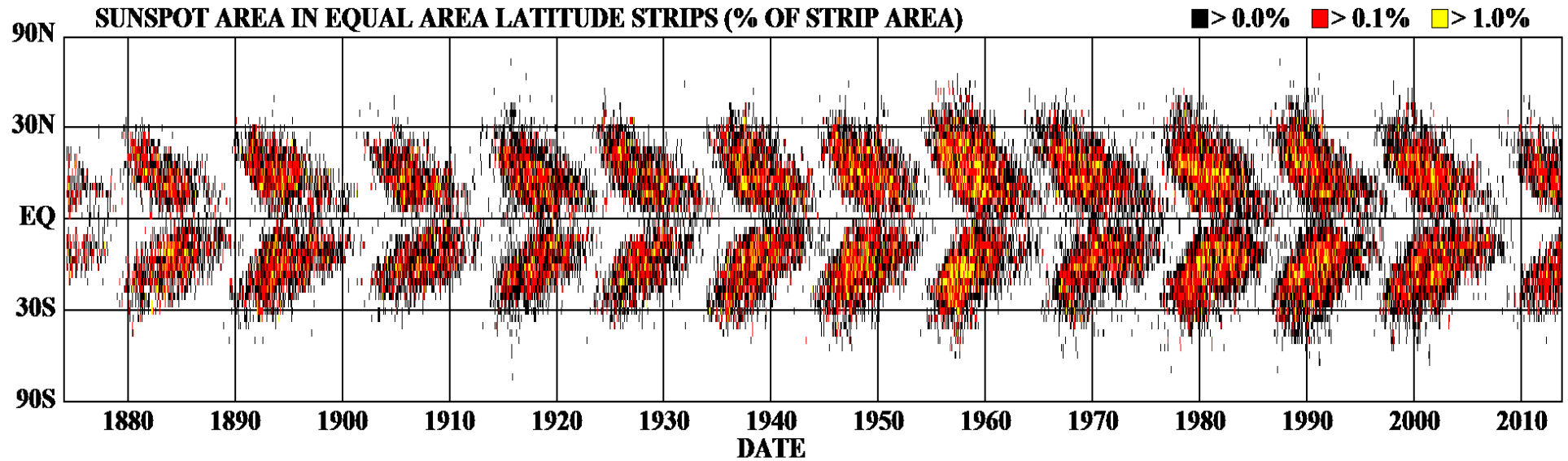


Forecast the Sun

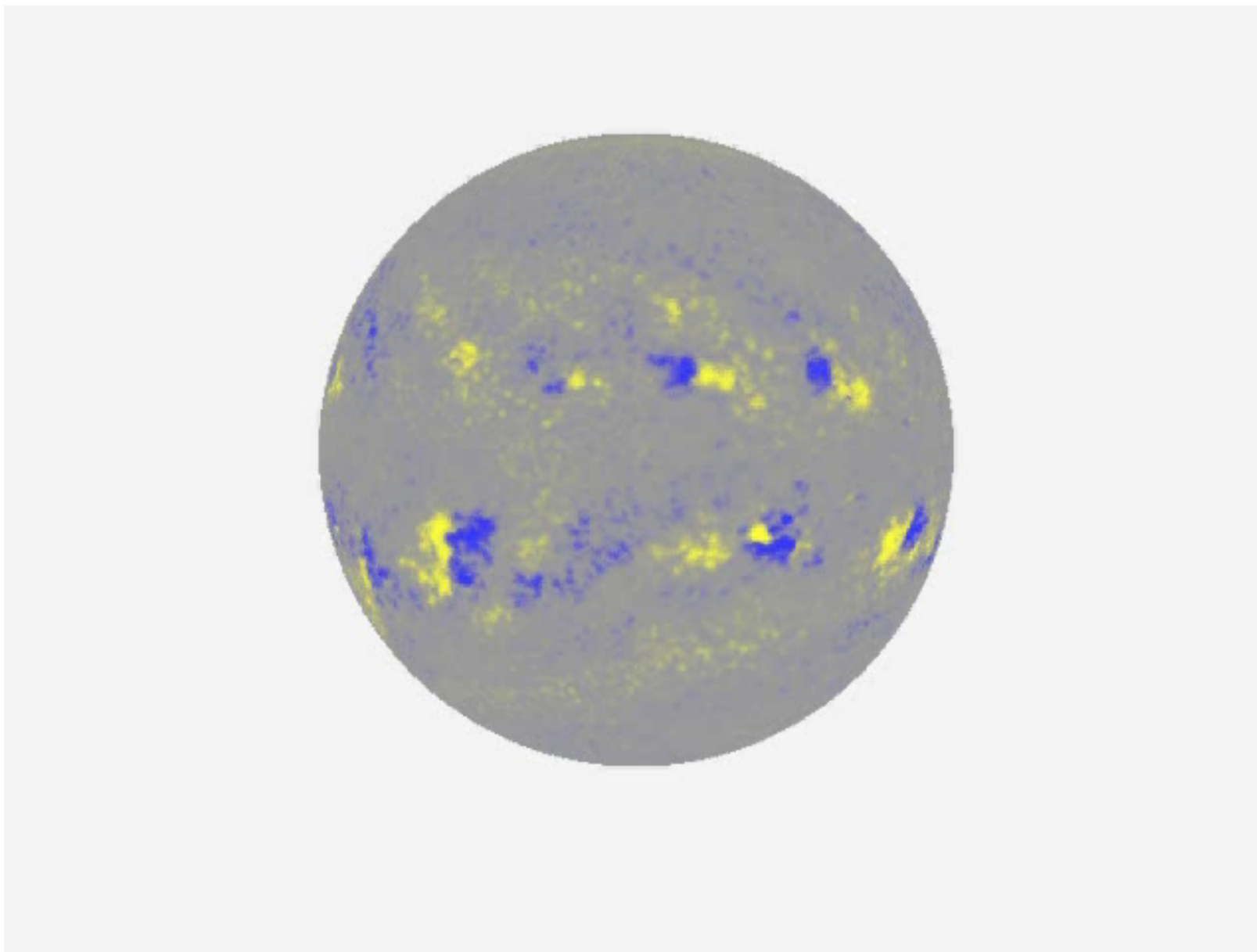
Cycle 24 Sunspot Number Prediction (2014/01)



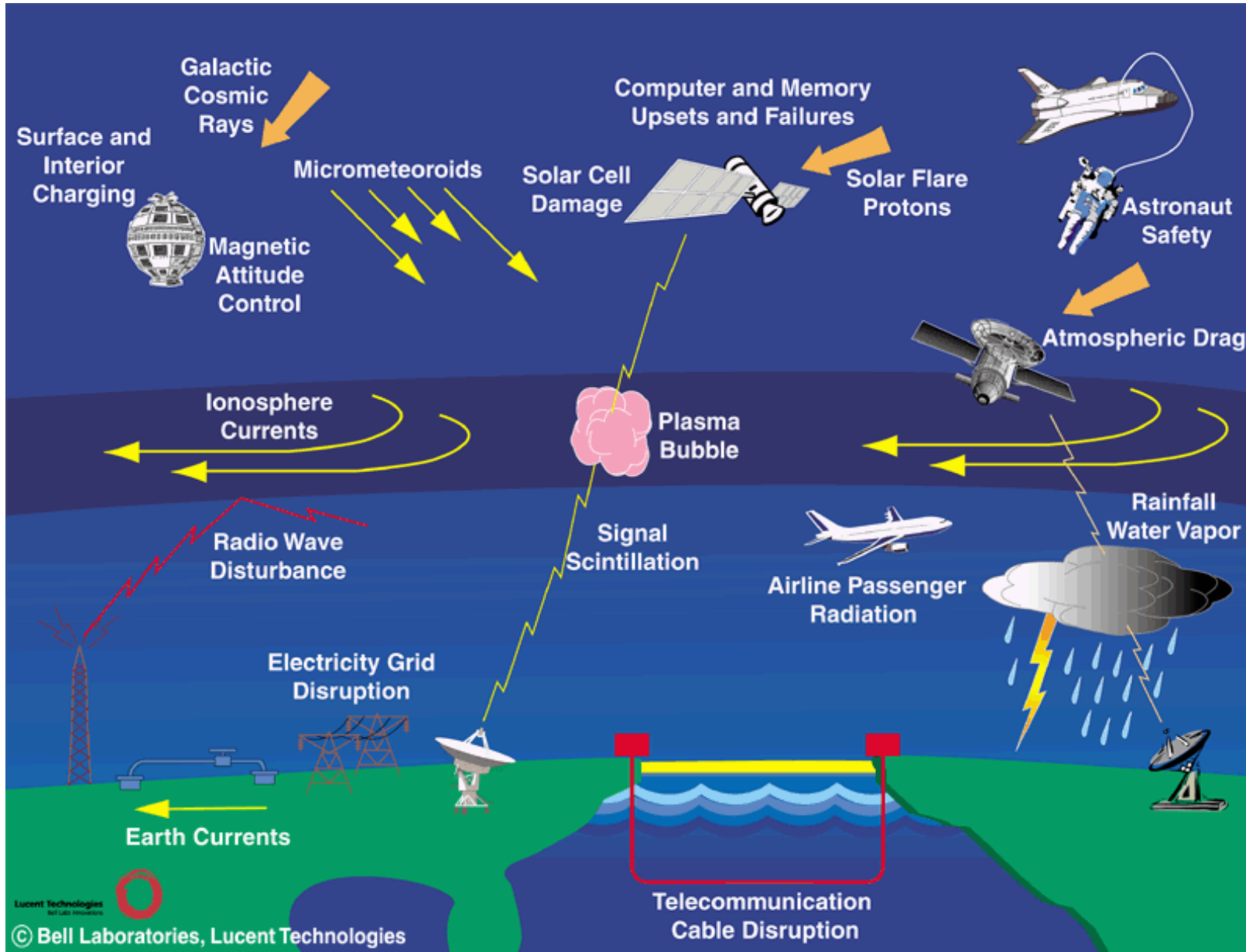
DAILY SUNSPOT AREA AVERAGED OVER INDIVIDUAL SOLAR ROTATIONS



Forecast the Sun

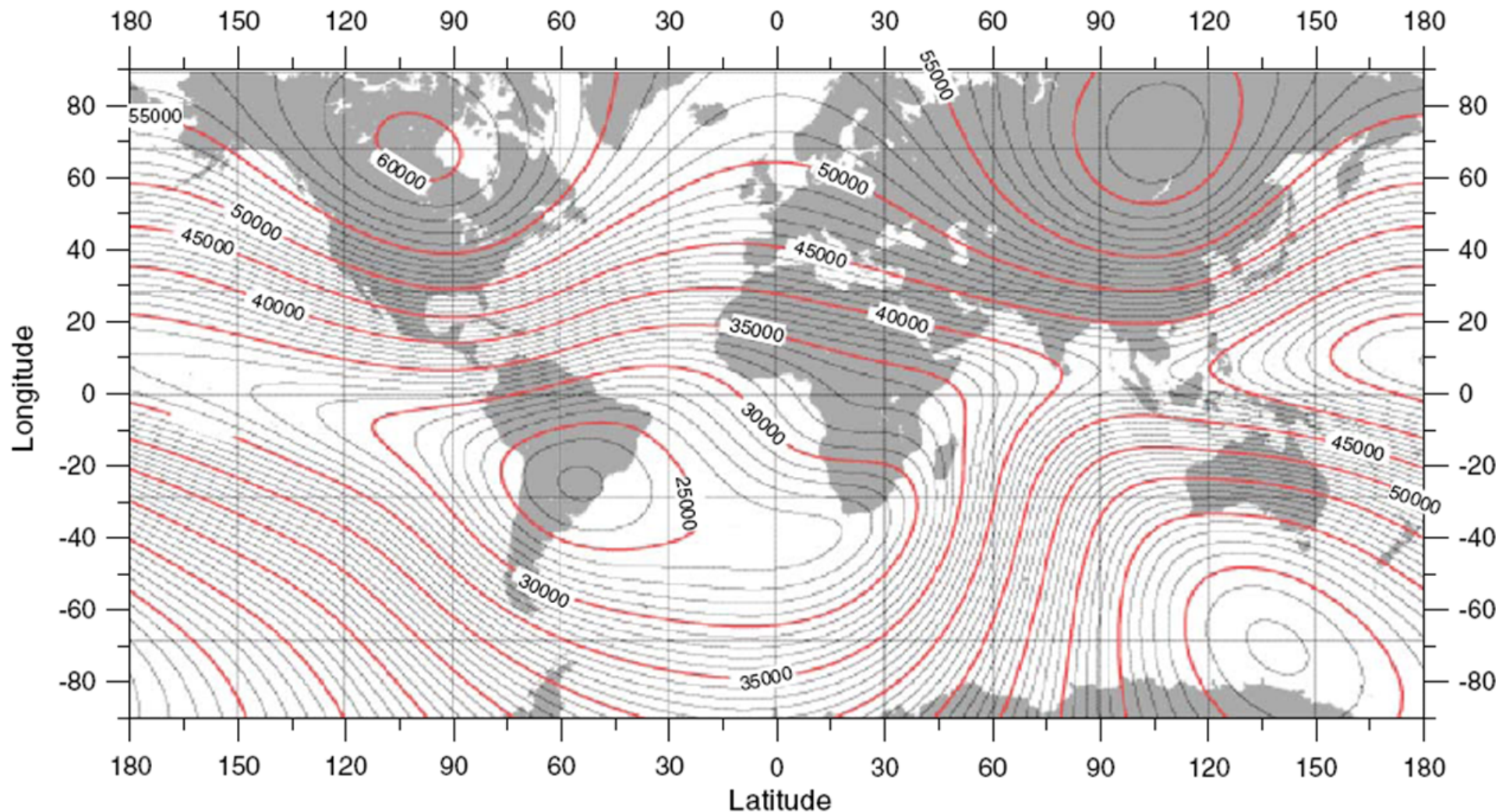


Space Weather Events Synopsis



Terrestrial Magnetic Field

US/UK World Magnetic Chart - Epoch 2000
Total Intensity - Main Field (F)



Radio Blackout

UHF
SATCOM

SATELLITE
OPERATIONS
(TT&C)



GLOBAL
POSITIONING
SYSTEM

SHF
SATCOM

SOLAR
RADIO
BURSTS

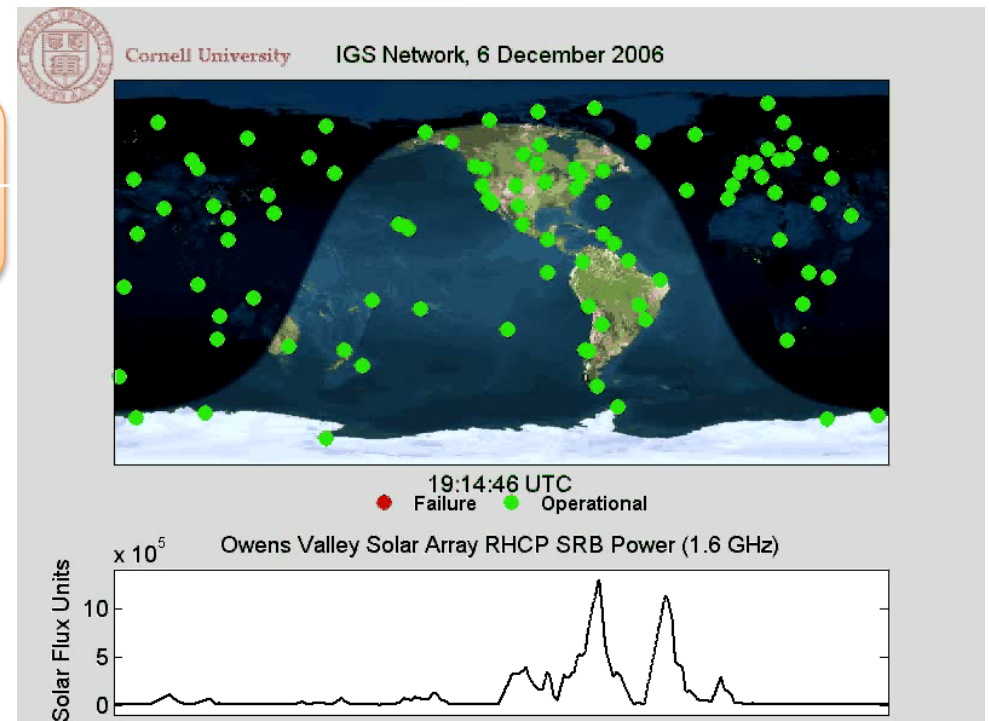


Wide Area
Augmentation
System

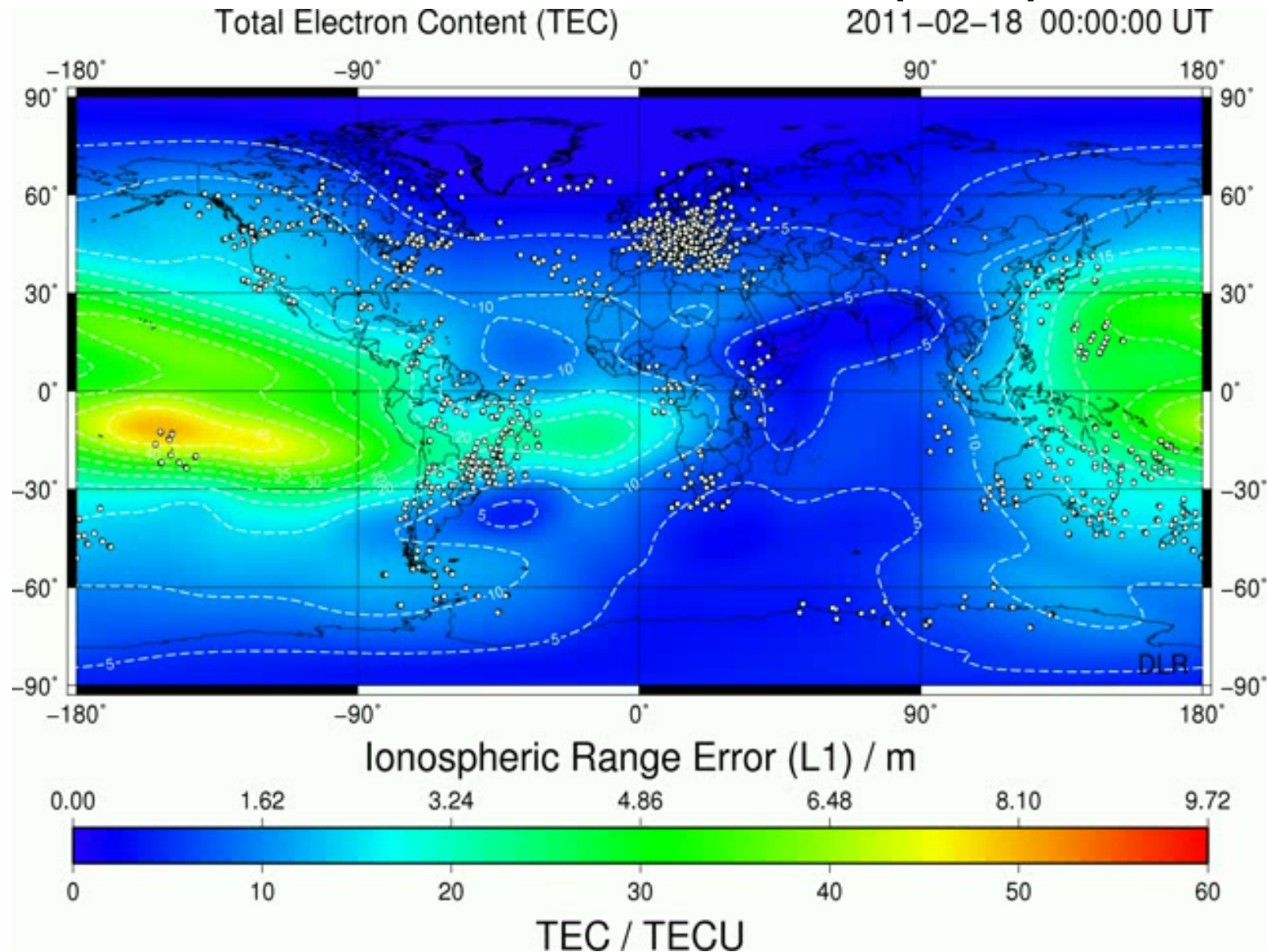
EHF
SATCOM

RADAR

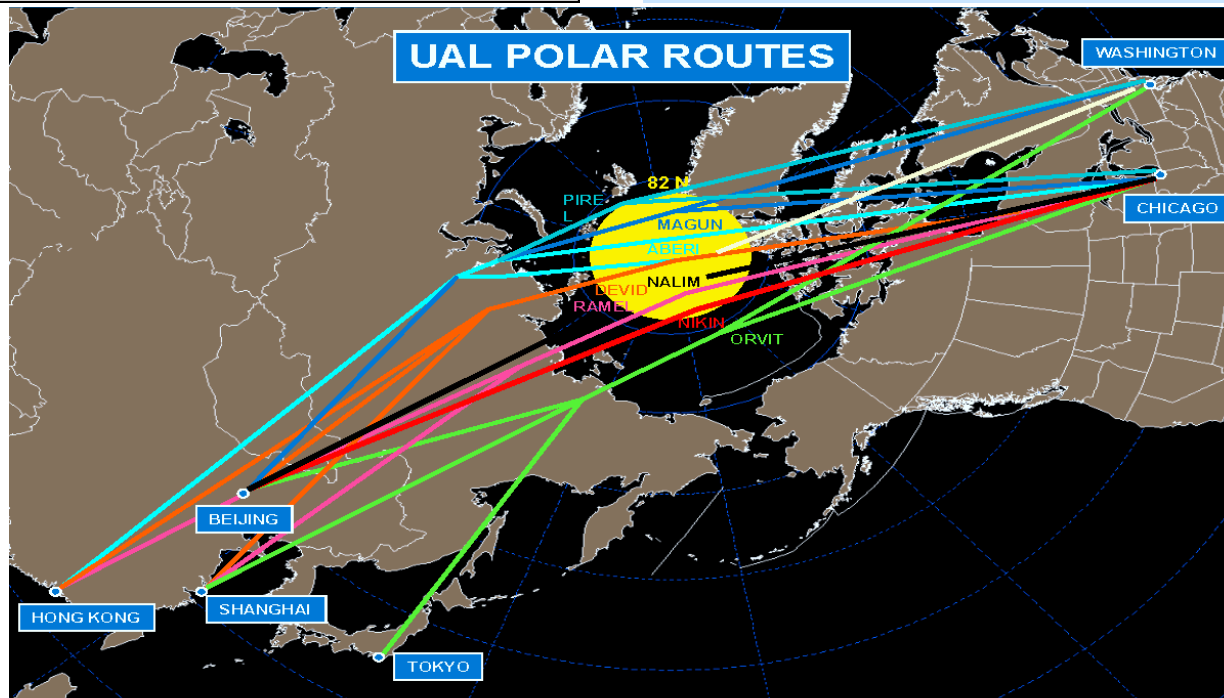
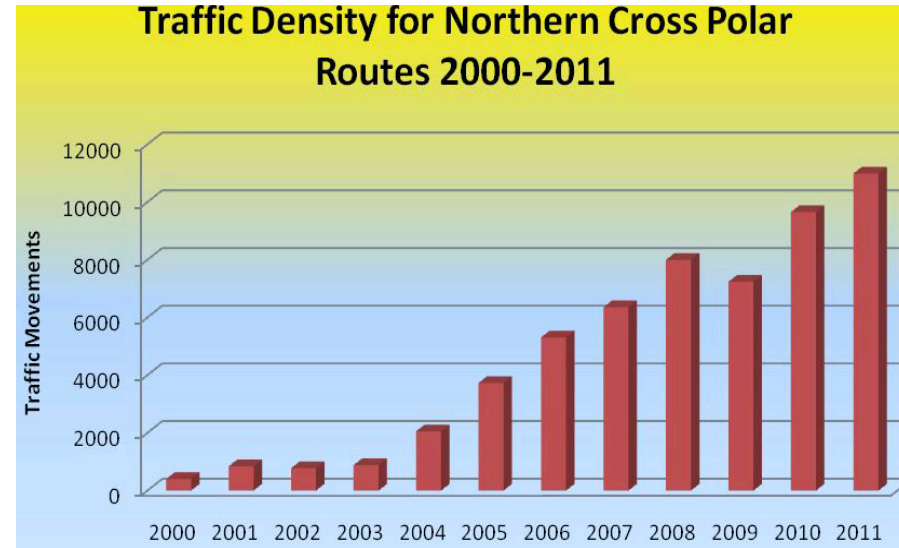
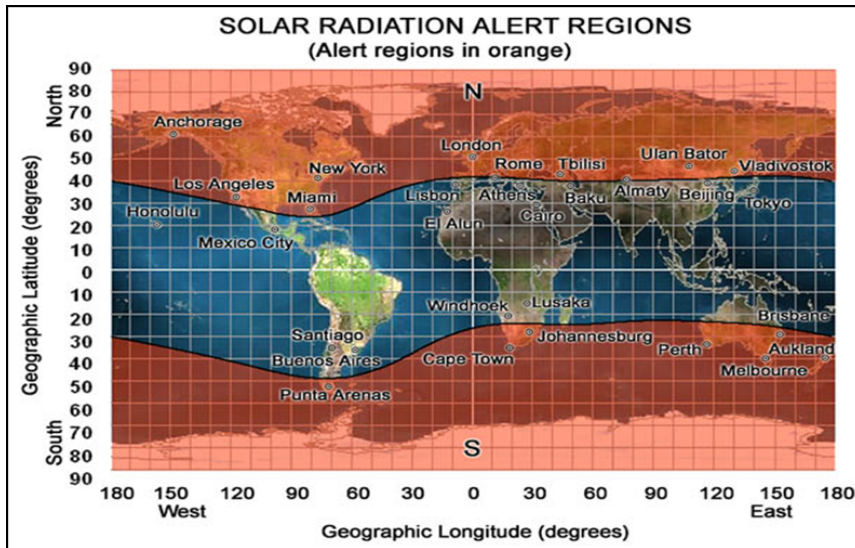
MICROWAVE
LOS



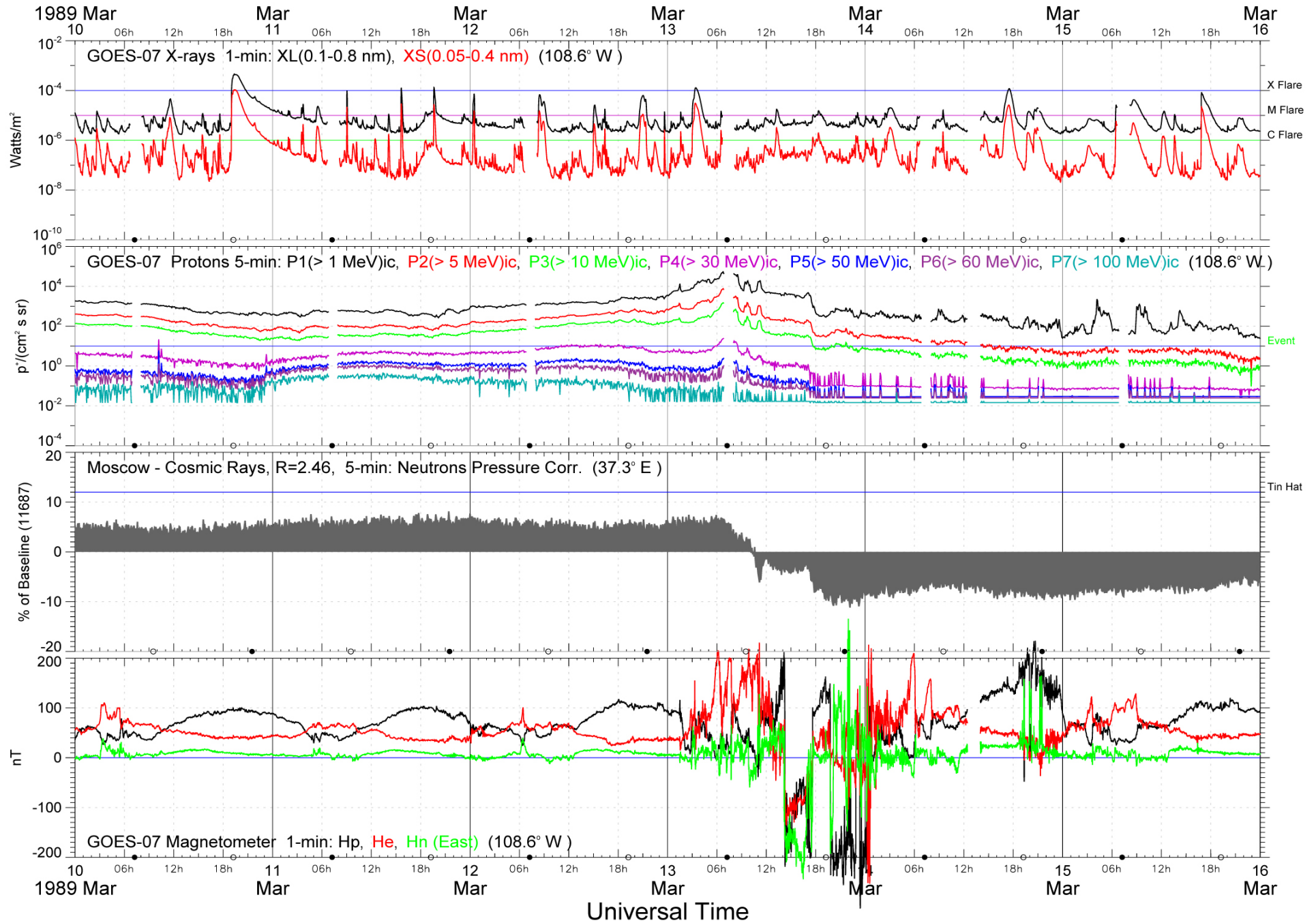
Total Electron Content (TEC)



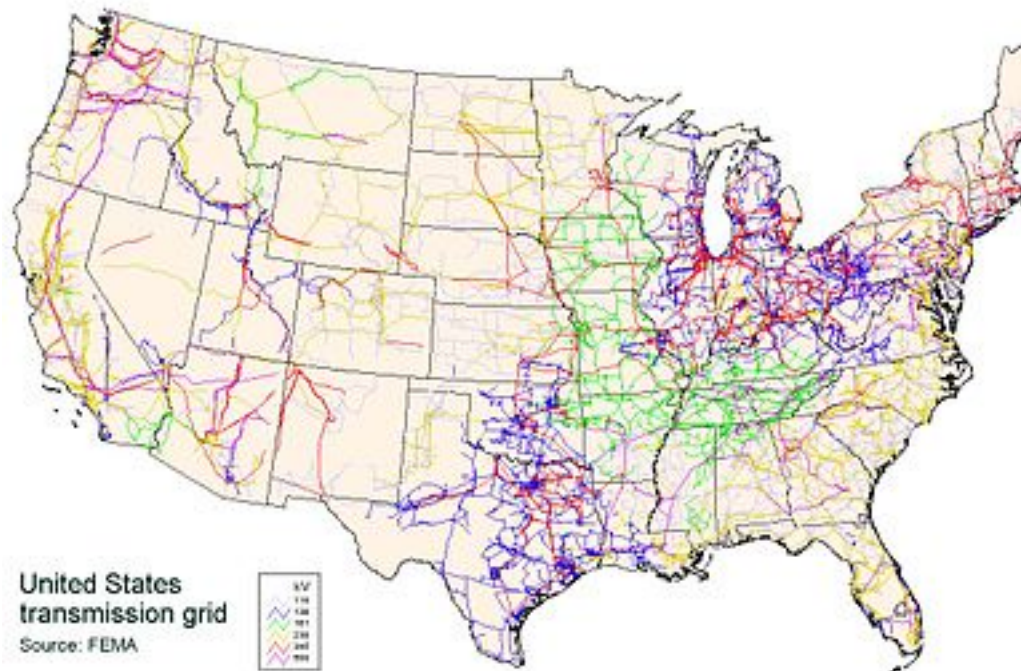
Solar Radiation Storm



Extreme Event: 1989-03-10 00h - 1989-03-15 24h



Geomagnetic Storm

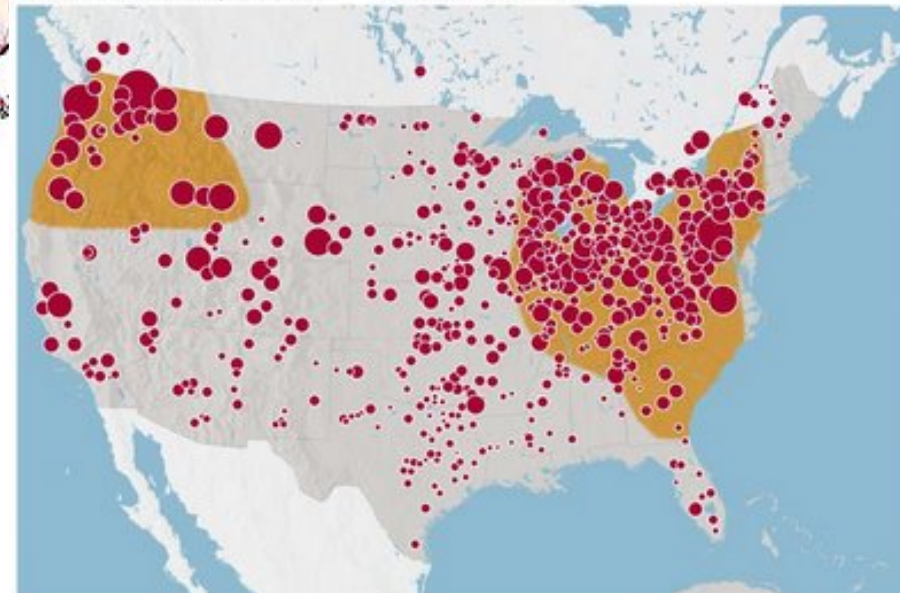


Blackout warning

A severe geomagnetic storm would damage transformers in the grid, leading to blackouts across wide areas of the US

● Areas of probable power system collapse

● Vulnerable transformers



Prediction is difficult, especially about the future
Niels Bohr

*HINTER COLLEGE ON OPTICS LIGHT: A BRIDGE BETWEEN EARTH AND SPACE
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Grazie.

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