

Building a *Virtual Earth* - to better understand the real world

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What can we do with all this Geospatial Data?

- model the Earth's surface
- model its sub-surface
- model its oceans
- model its atmosphere
- model its social-economics

**It's time to model the Whole Earth System
- a challenge whose time has come!**

Earth Observing Satellites are generating Big Data sets



We are entering an era of Big Data Earth Science

- an era of exascale computing resources:

exaflops and exabytes

10^{18}

Fortunately, we are on the path to understanding this complexity through modelling, simulation & visualisation

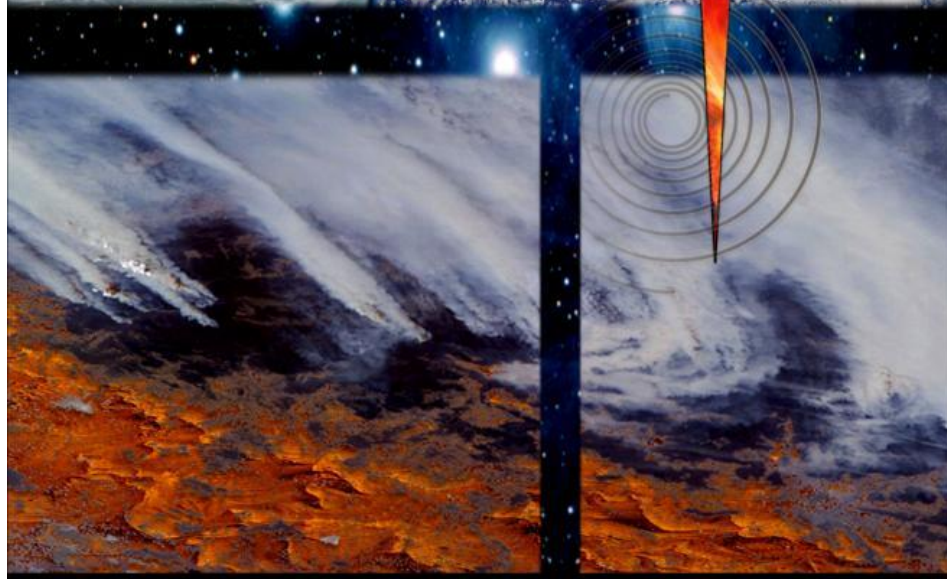
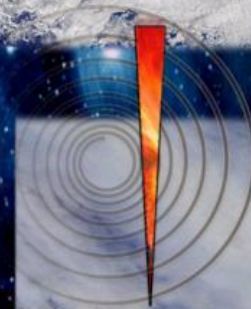
And JRC/INSPIRE/EU and GEO and OGC are making the data freely available!

We should also try to holistically re-integrate what specialised science has dis-integrated into silos over the last 200 years!

We have new power tools:

- HPC + Cloud + Internet + Mobile + Remote Sensing
- Real-time predictive big data visual analytics
- Software, statistics, algorithms & apps
- New forms of civic engagement
- Interactive visual narratives

International Centre for Earth Simulation



ICES is more than a research program, it's about ...

- Insights into risk & predictability
- Public safety and policy guidance
- Long term food, water & energy security

*ICES is global thinking, independent, not-for-profit,
for public good & philanthropically funded!*

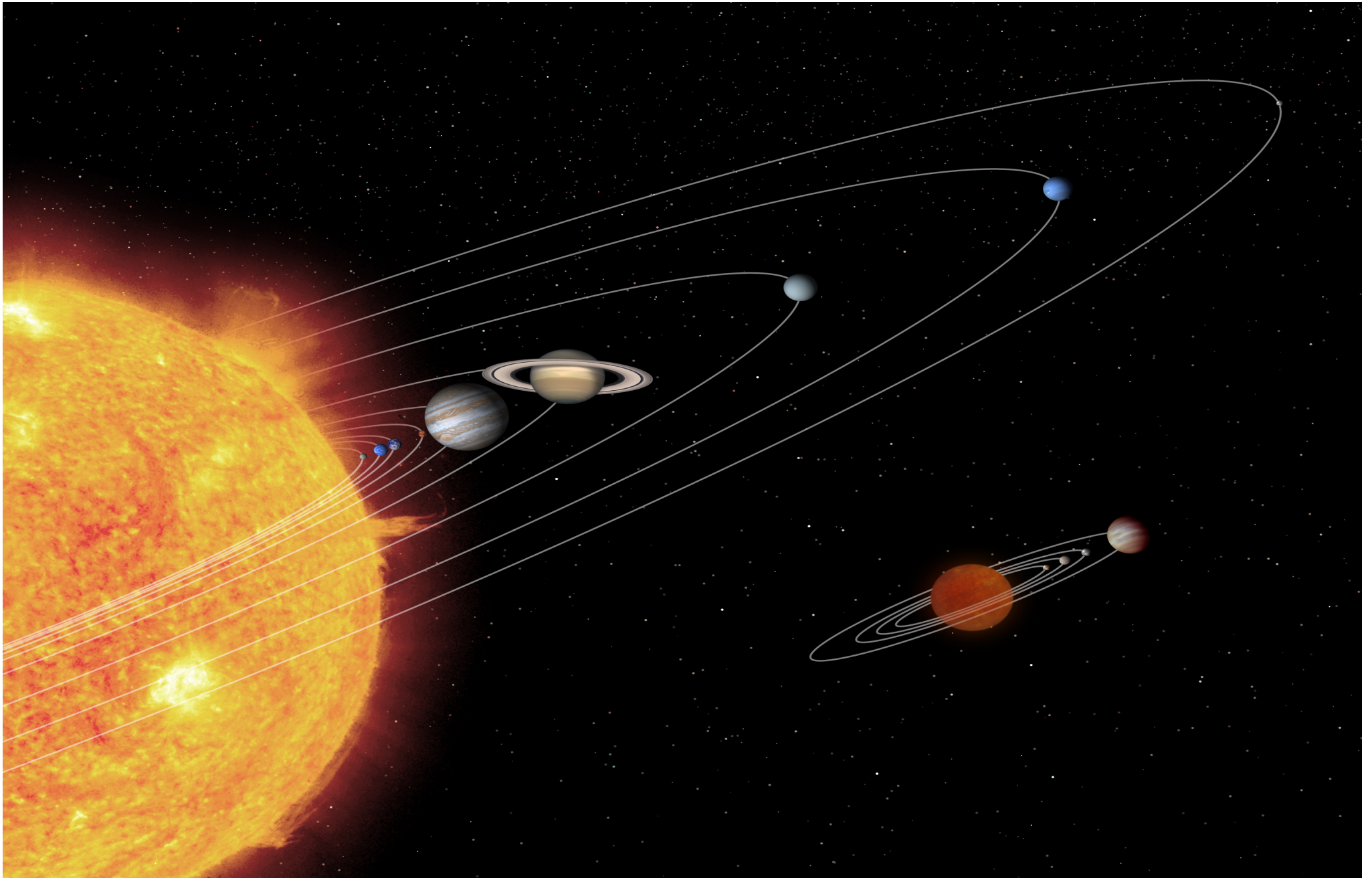
The real world is massively complex



Indeed, everything is connected to everything!

- Everything is interconnected
- Everything is teleconnected
- Everything is telecoupled

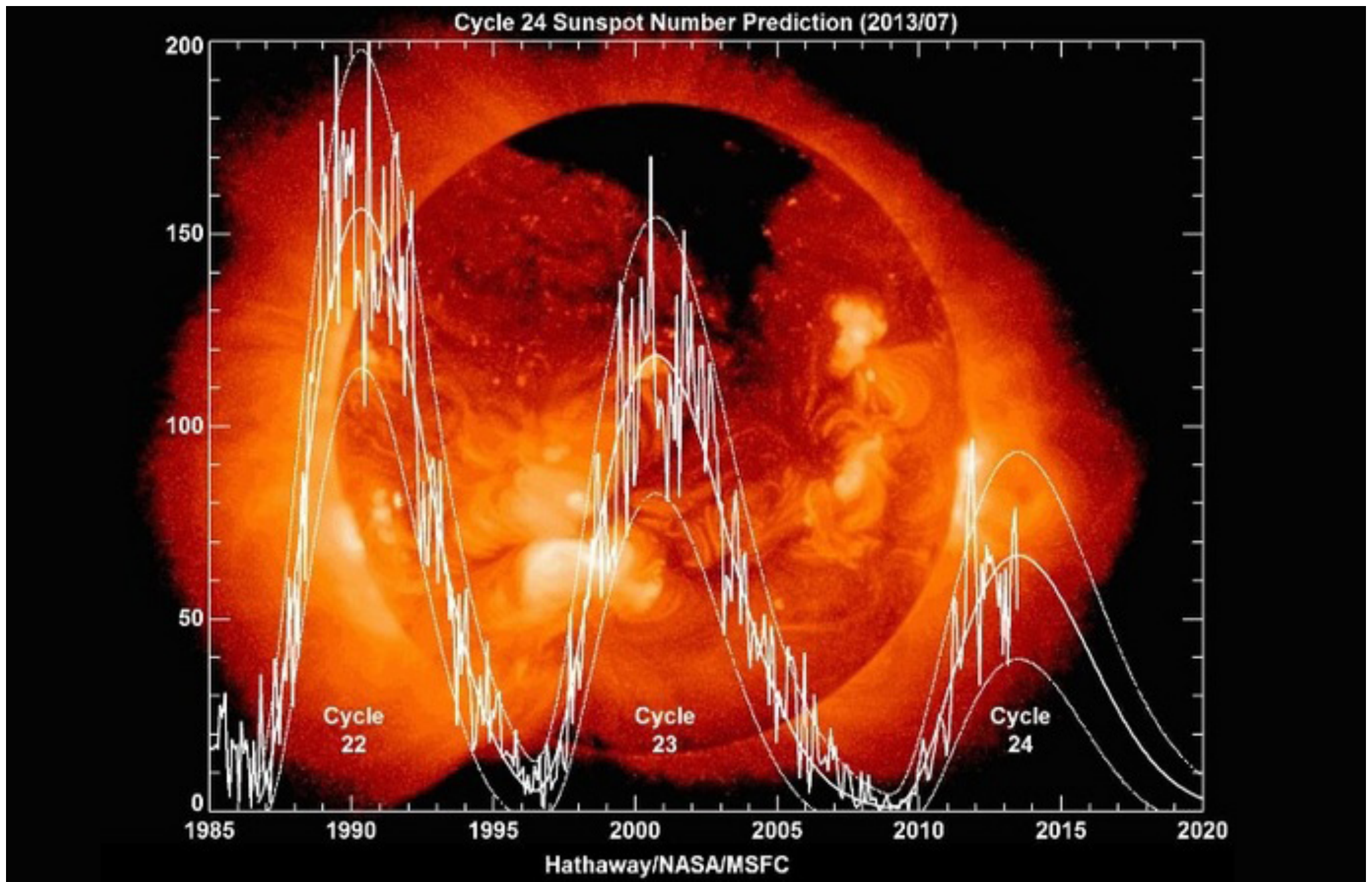
The entire Solar System is dynamically interconnected



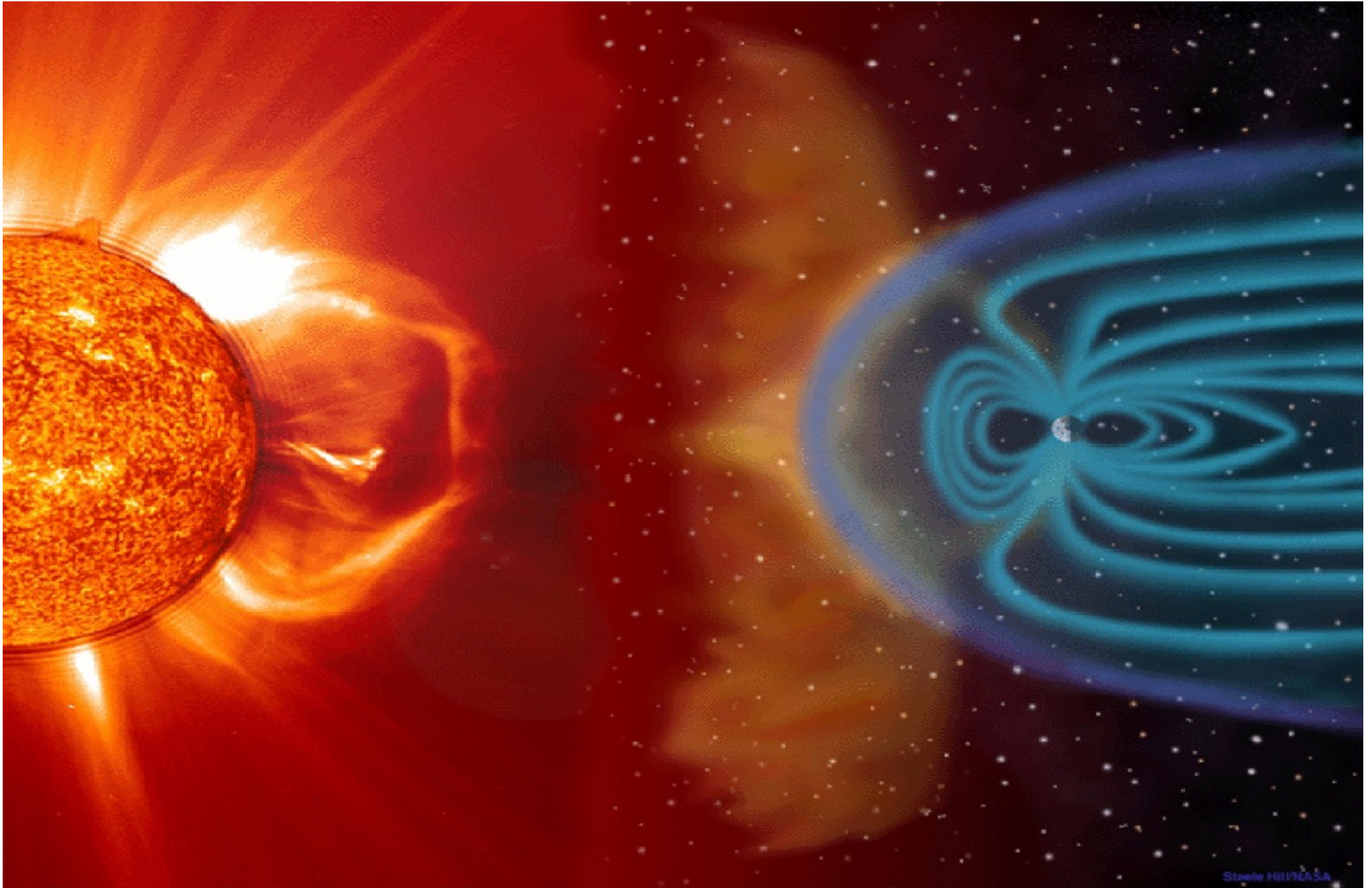
Our Sun is the central driver



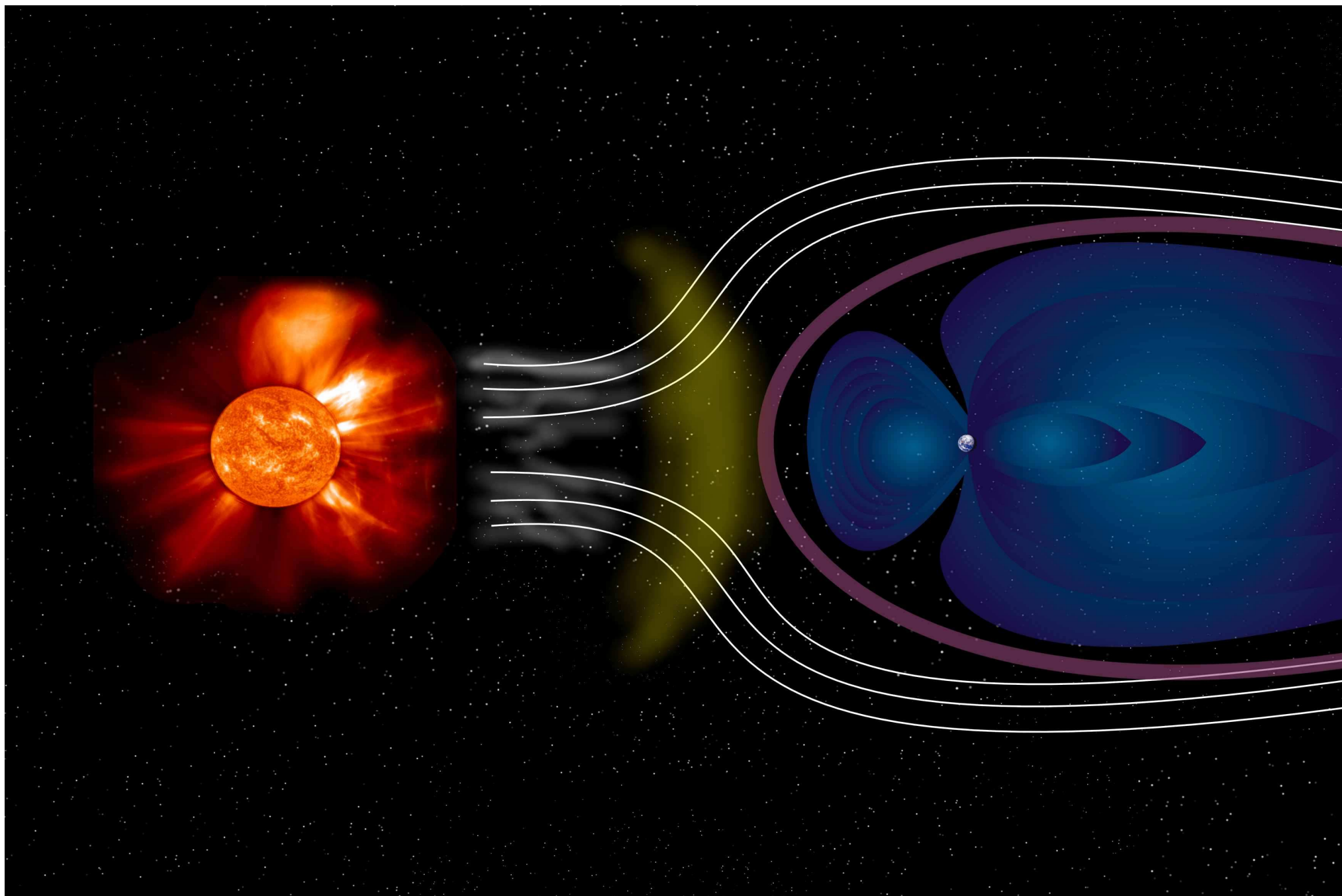
It has a variable 11-year sunspot cycle



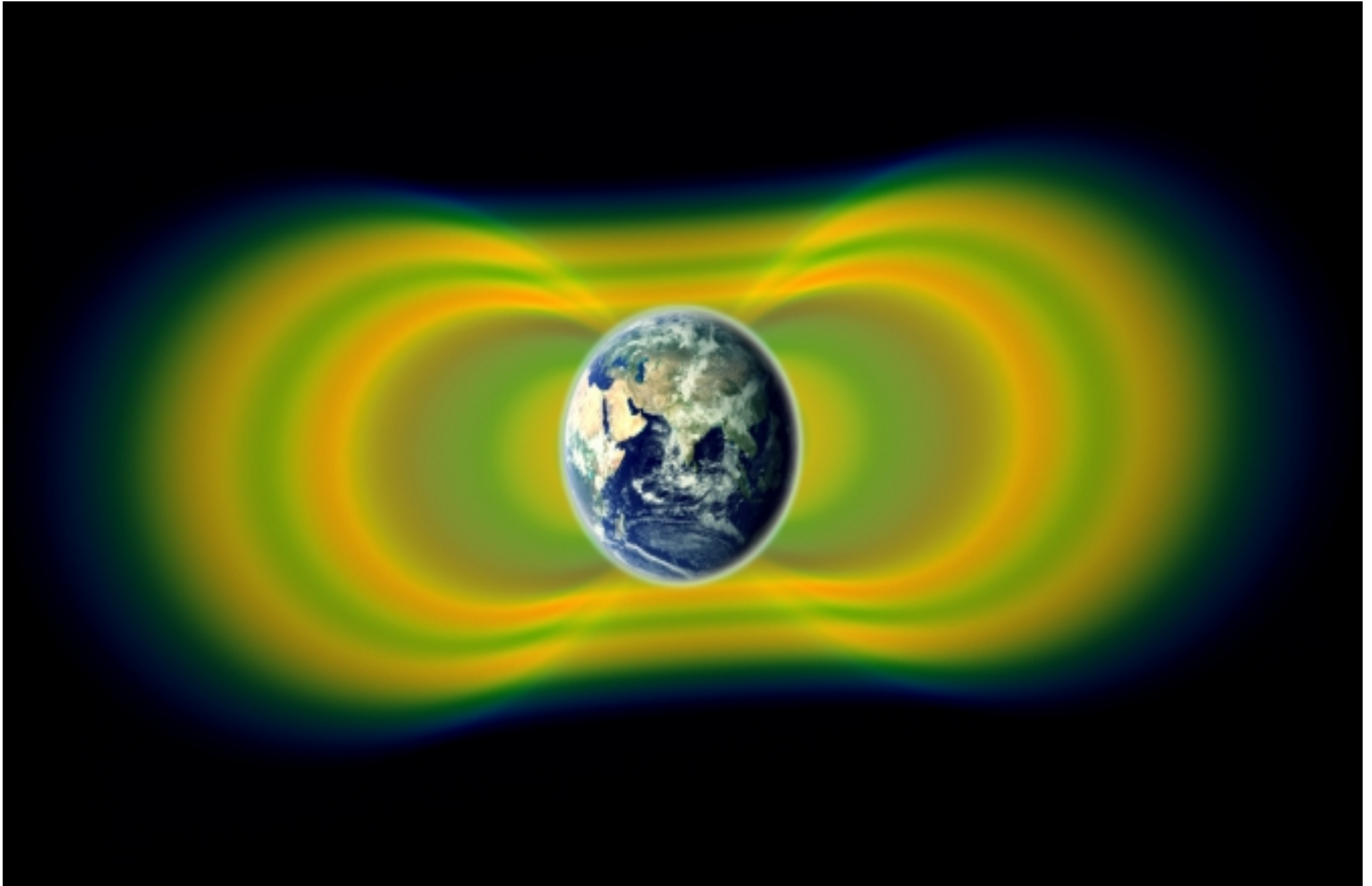
There is much 'space weather' between Sun & Earth



Fortunately the Earth has a multi-layer shield



... 3 Van Allen plasma belts



... that bleed down to the Earth's ionosphere



causing geomagnetic superstorms (Carrington 1859)



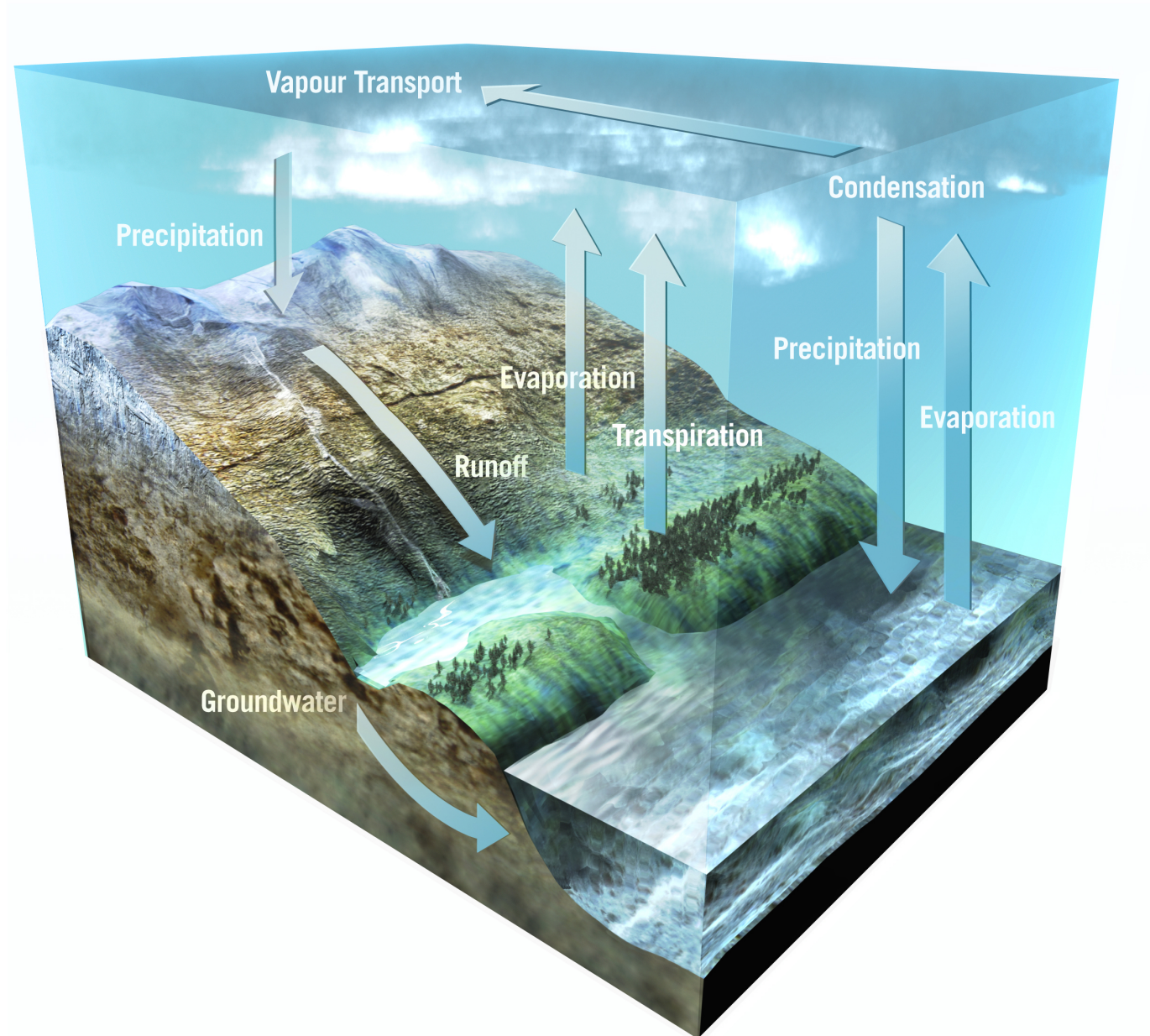
Our climate is mainly driven by Ocean-Wind coupling



Convection & cloud physics are still a puzzle



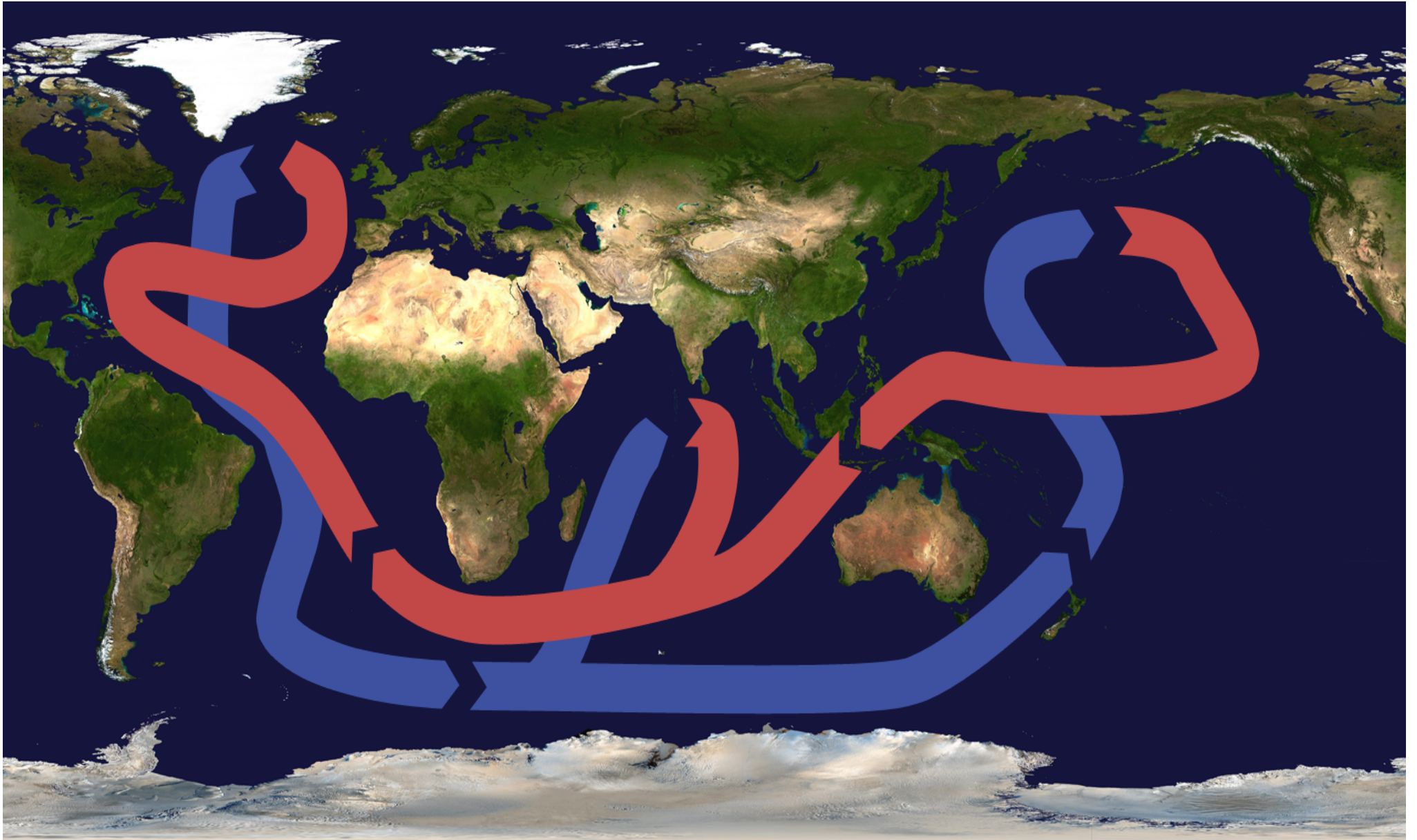
But the global cycling of C-N-P-S-H₂O-etc is a mystery



Taking energy out of the wind system is not a freebie!



The ocean itself is a giant conveyor belt



Thermohaline circulation by Brisbane CC BY-SA 3.0 using
NASA Goddard Space Flight Center images from Visible Earth