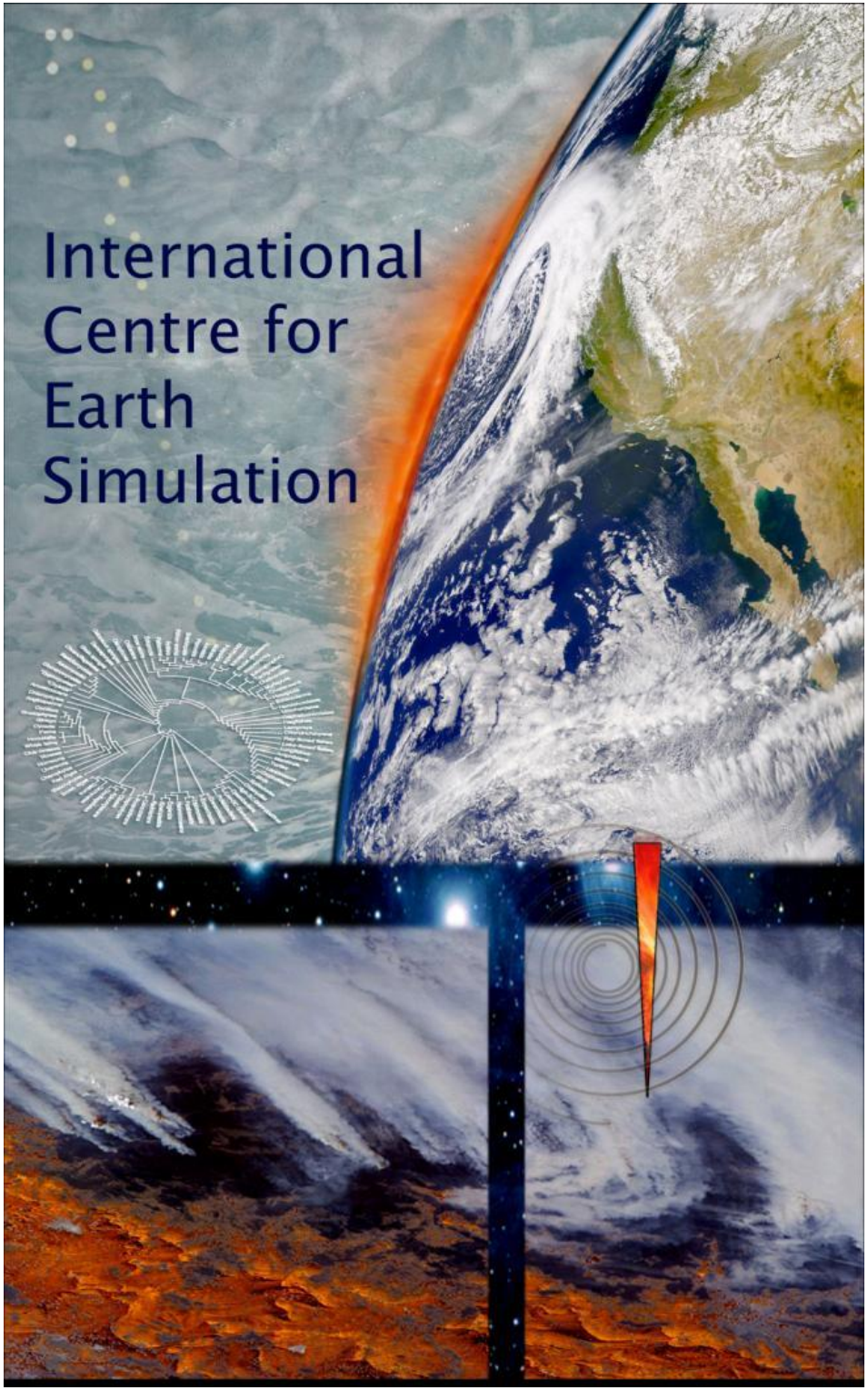
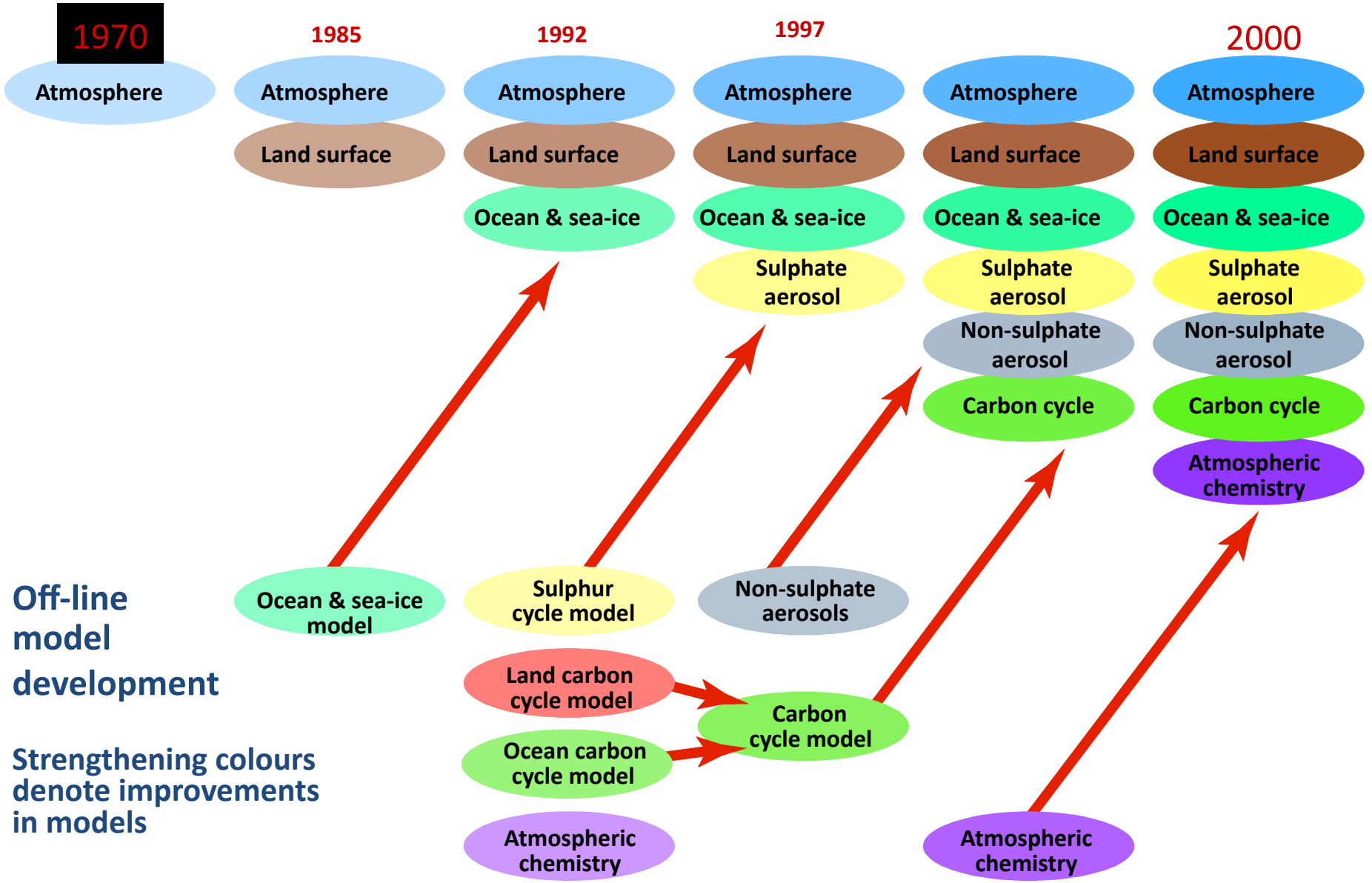
Simulation-based research has no limits!

Bob Bishop
Founder & President
ICES Foundation
4 Oct 2013, Amsterdam

Modelling the Whole Earth System
– a challenge whose time has come!


International
Centre for
Earth
Simulation

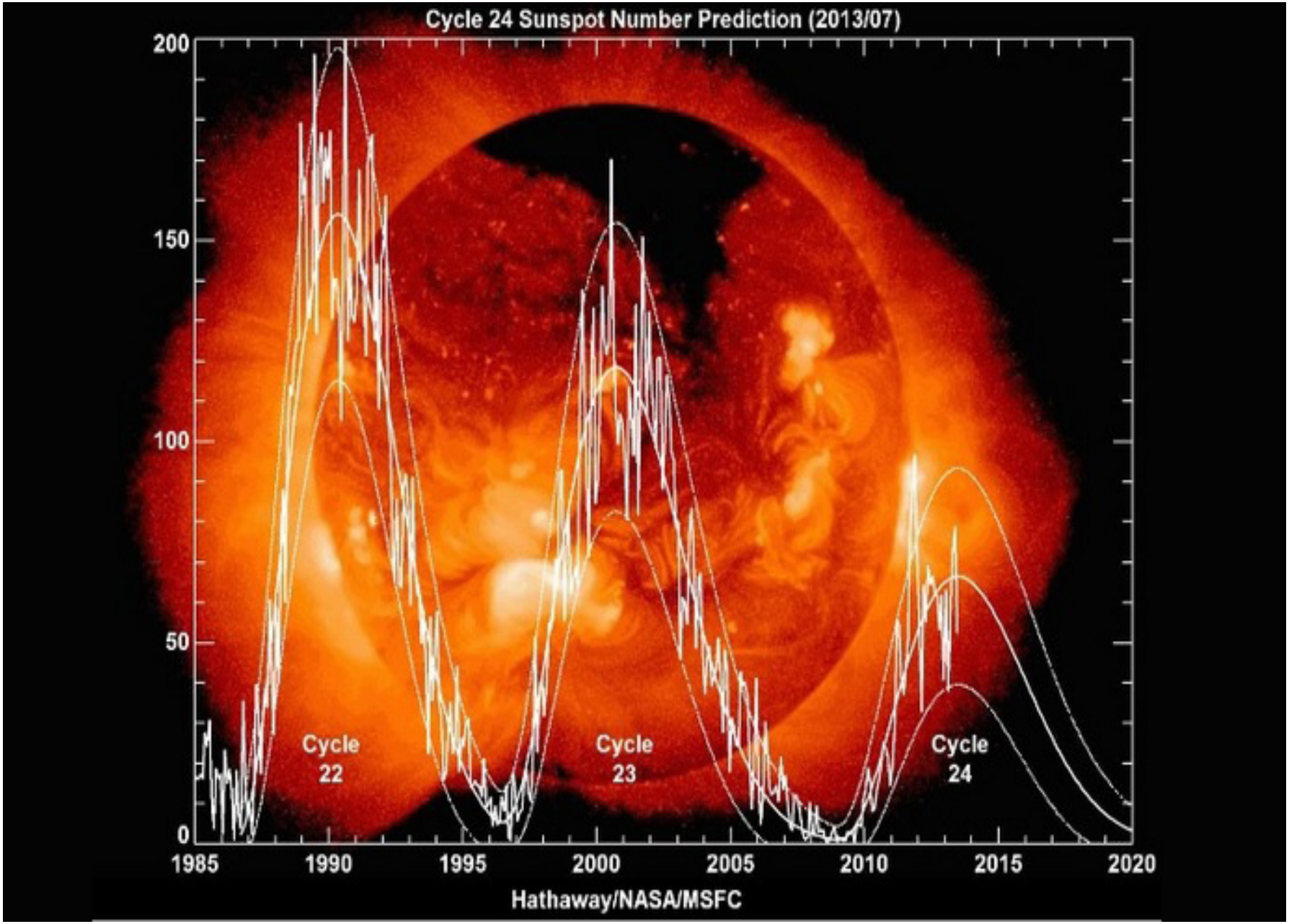
Towards Comprehensive Earth System Models



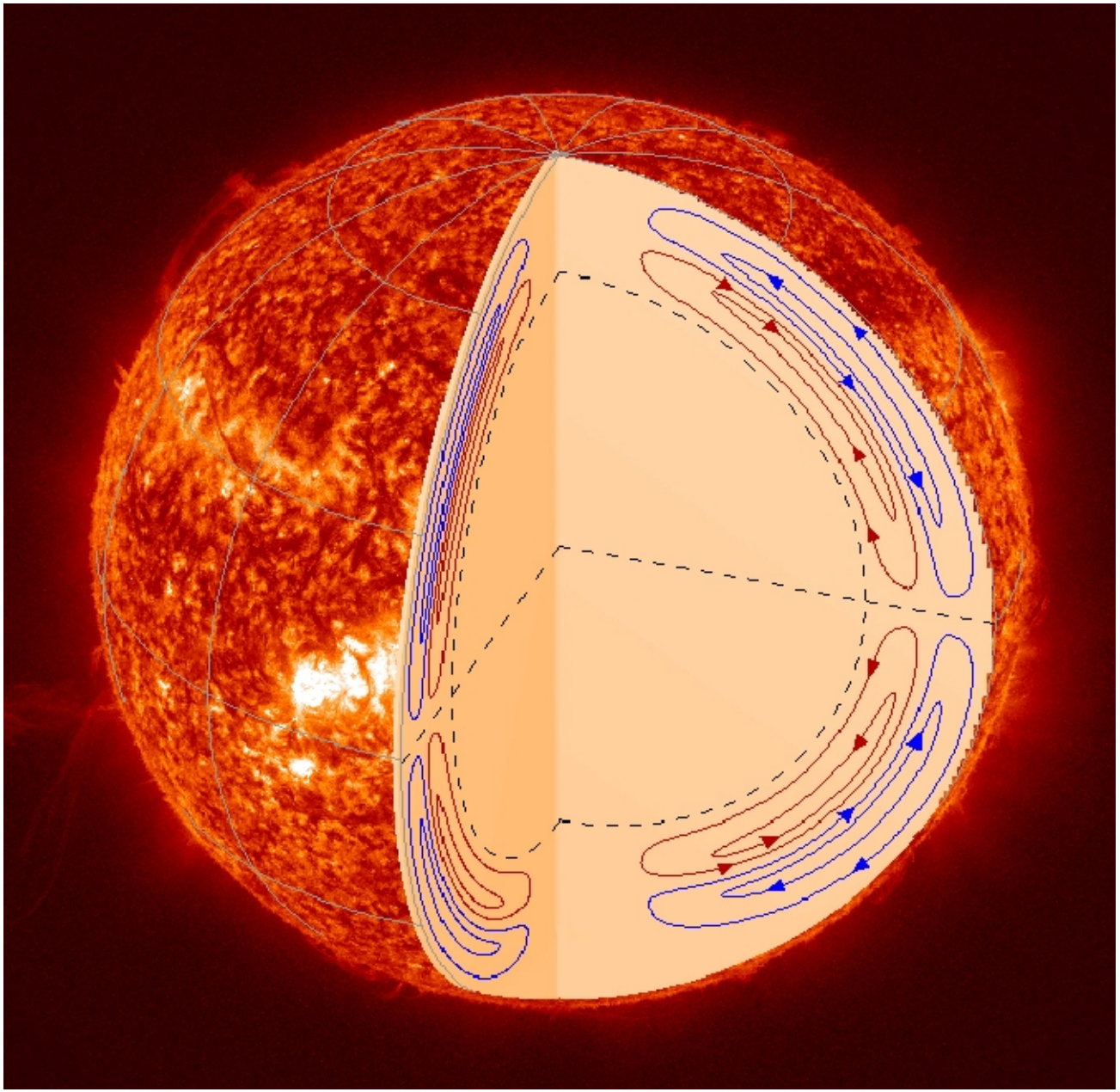
The Met.Office Hadley Centre

To model the Earth, one must first model the Sun

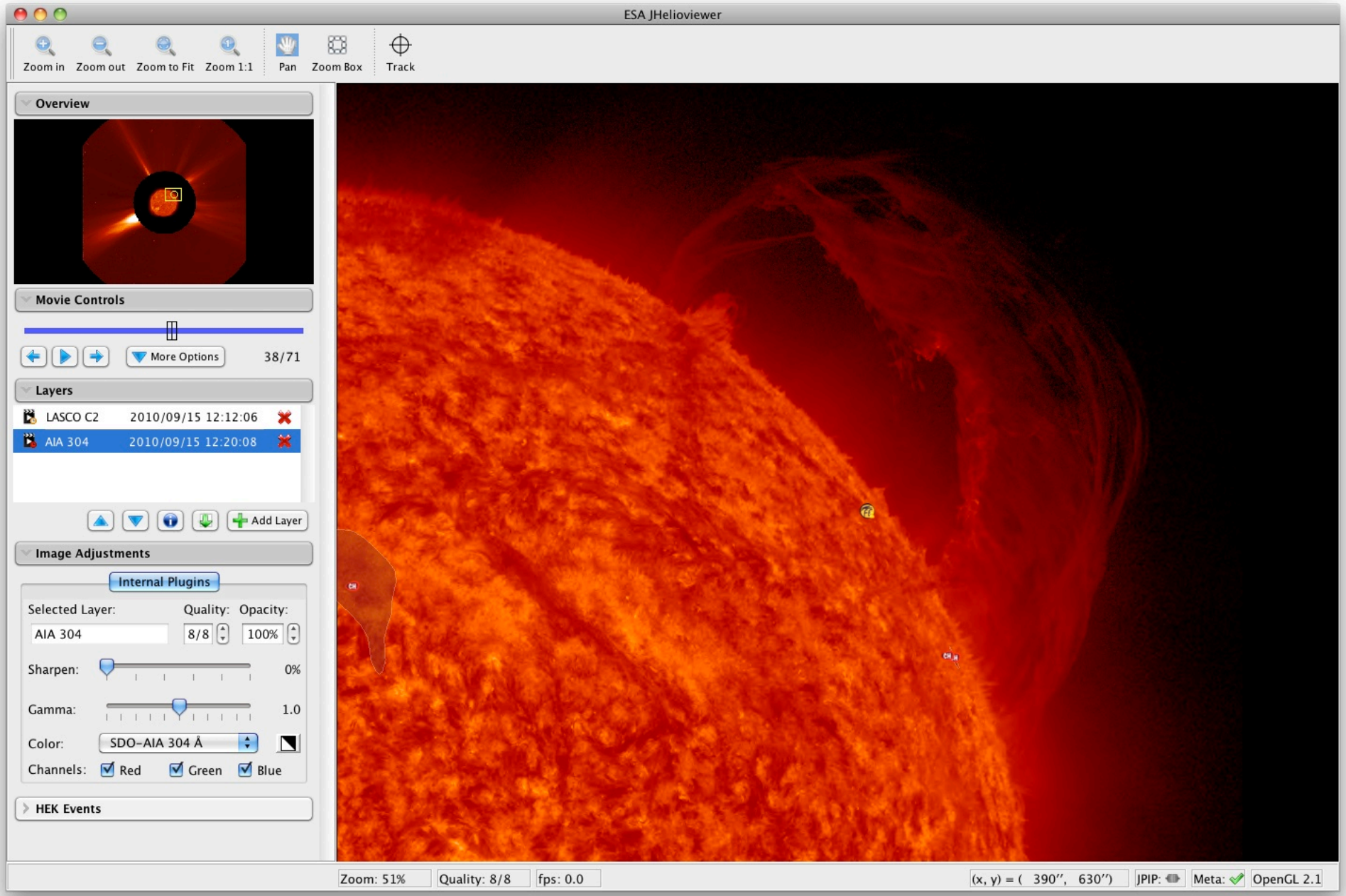
The Sun's 11-year solar cycle is a major control signal



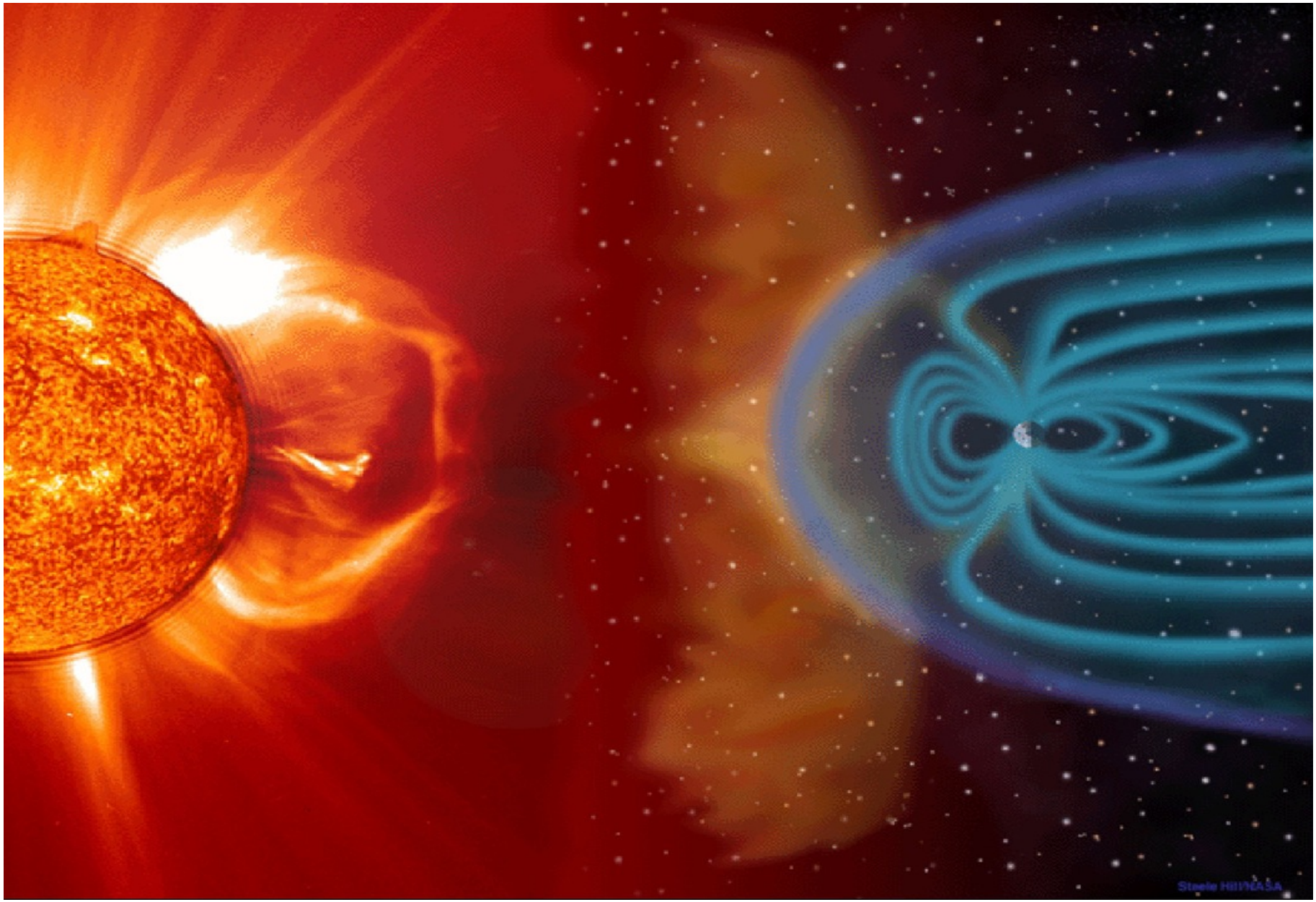
The Sun’s internal structure is complex and dynamic



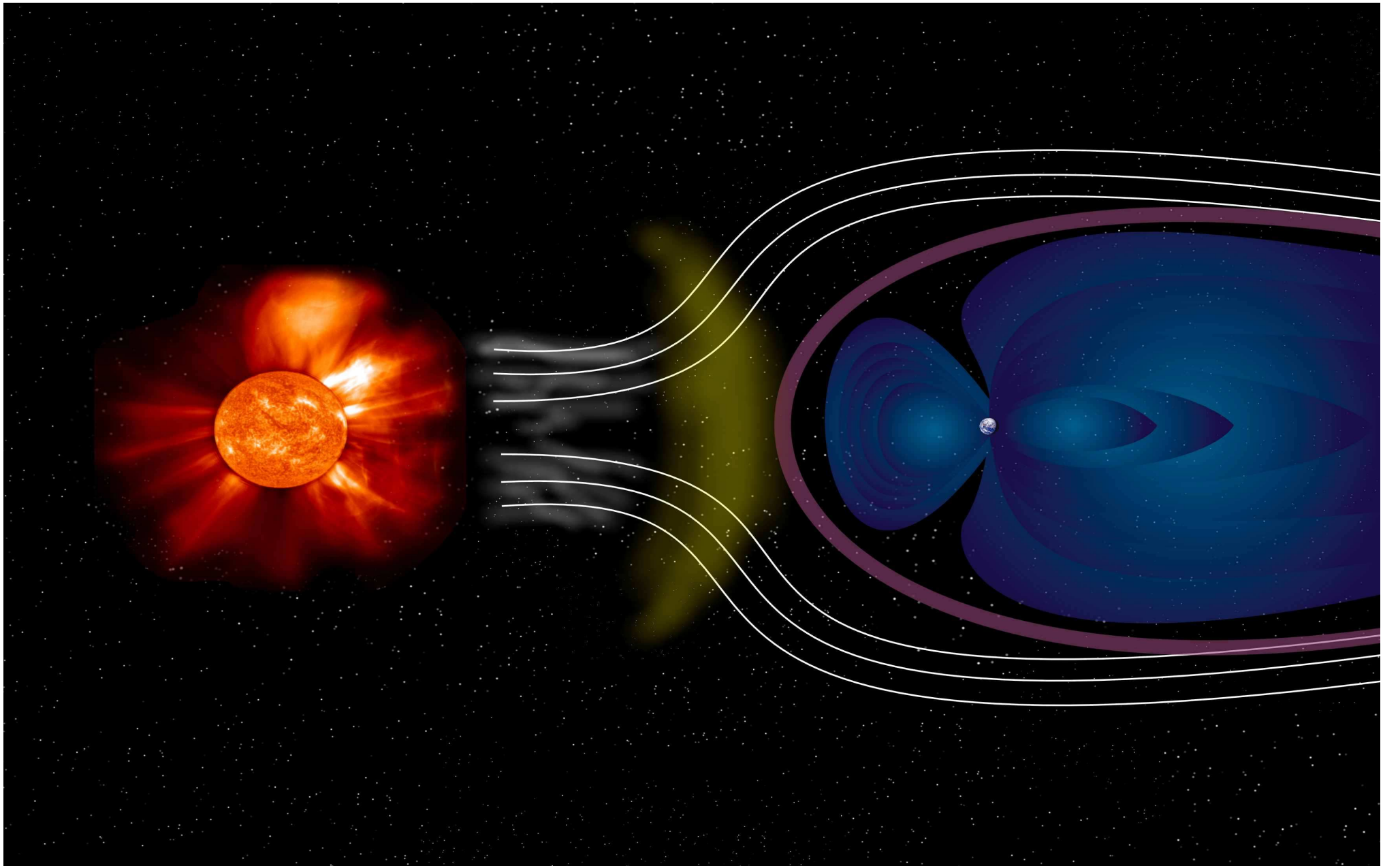
Magnetic loops extend for millions of km into space



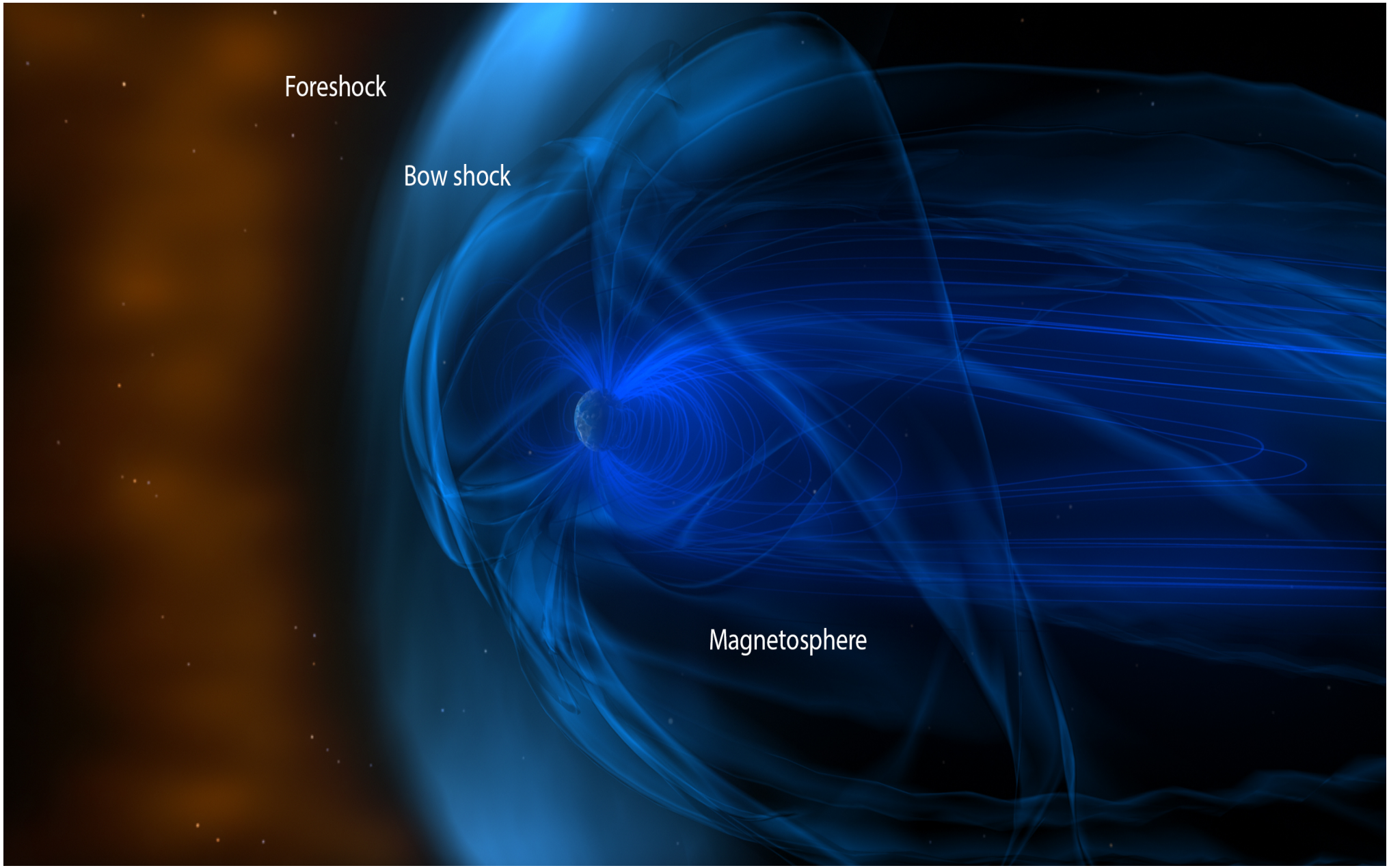
Many complex interactions between Sun and Earth



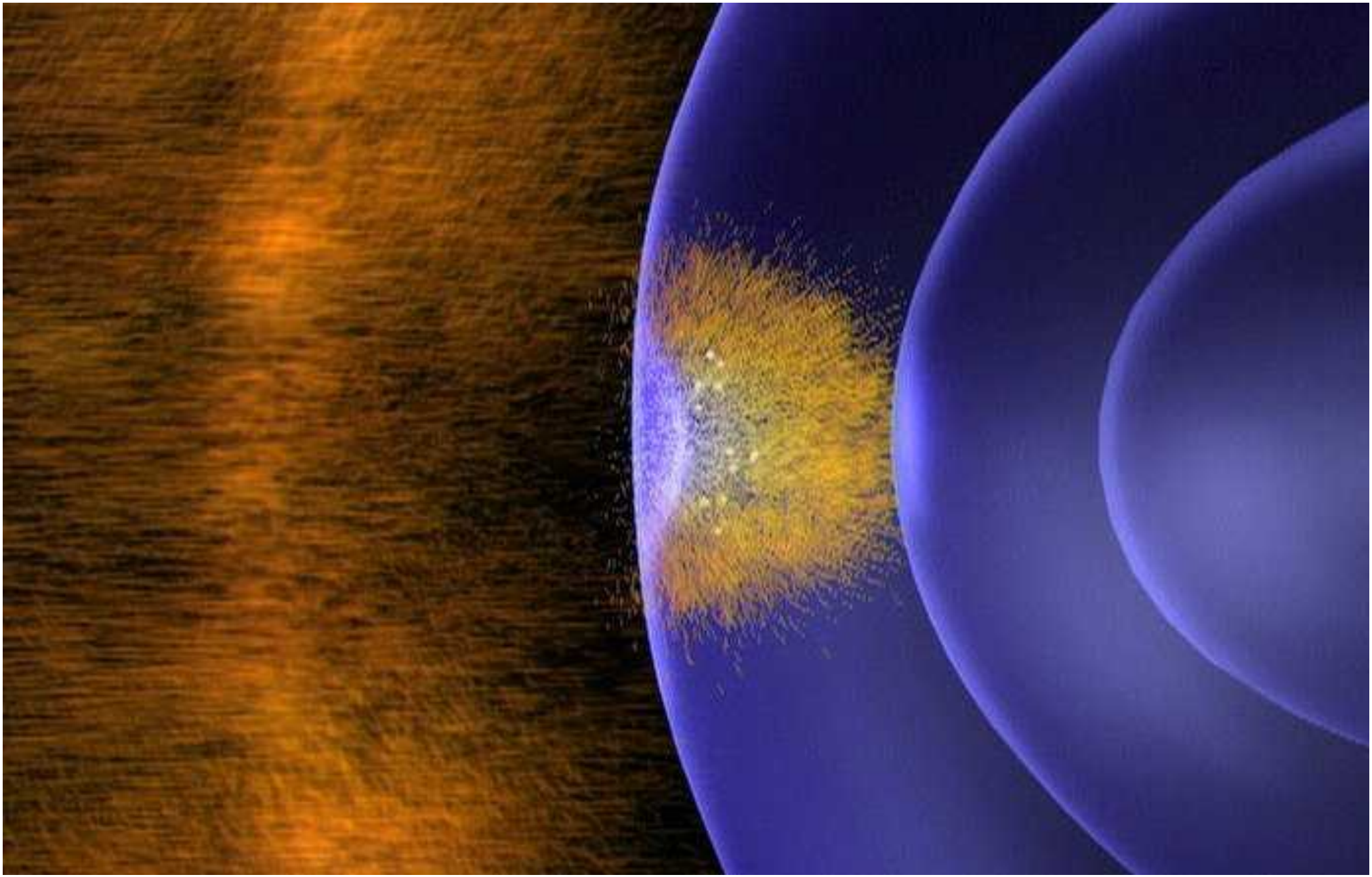
The Earth's magnetosphere acts as a deflection shield



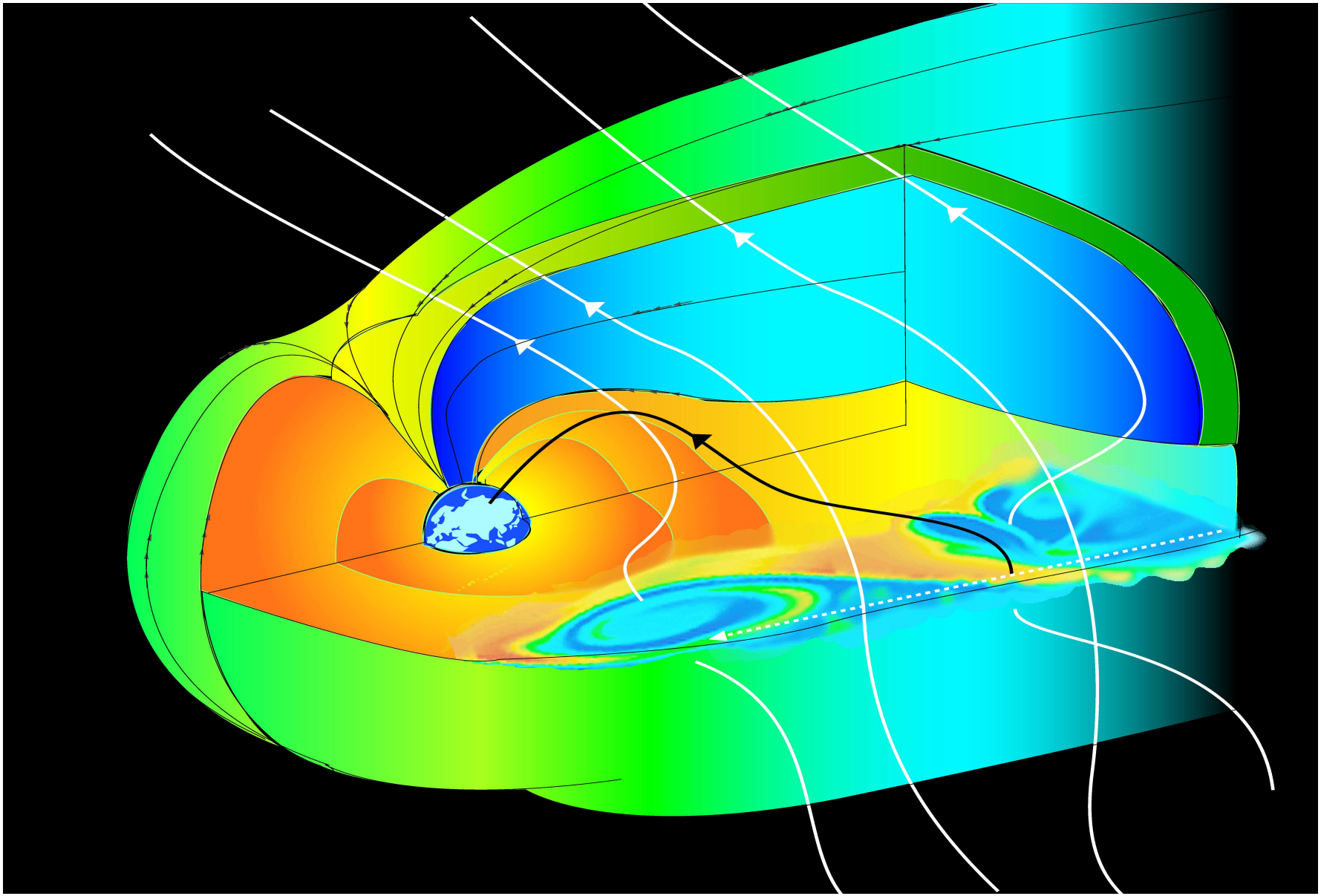
Everything in continuous motion at the same time!



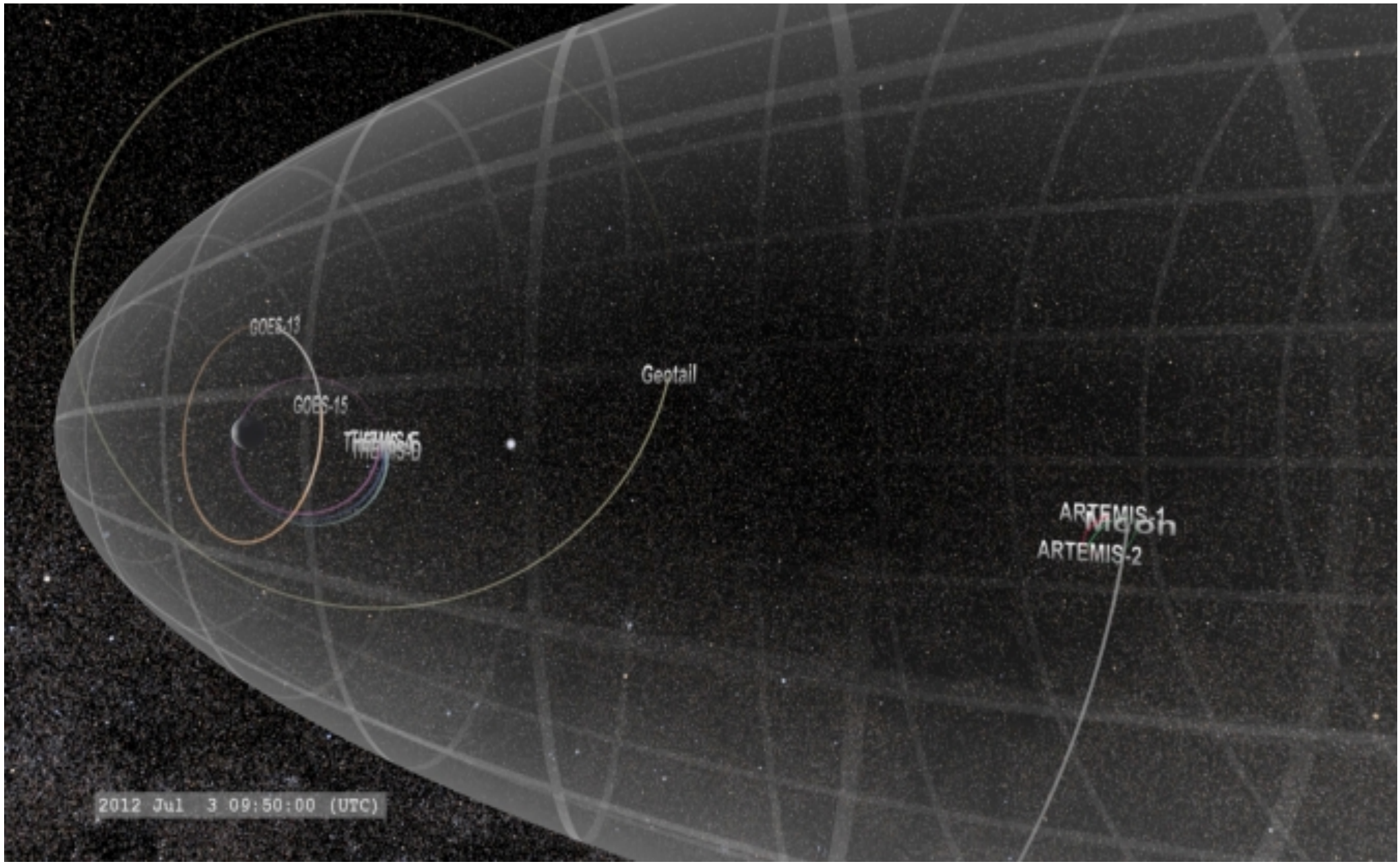
There are large leakage currents …



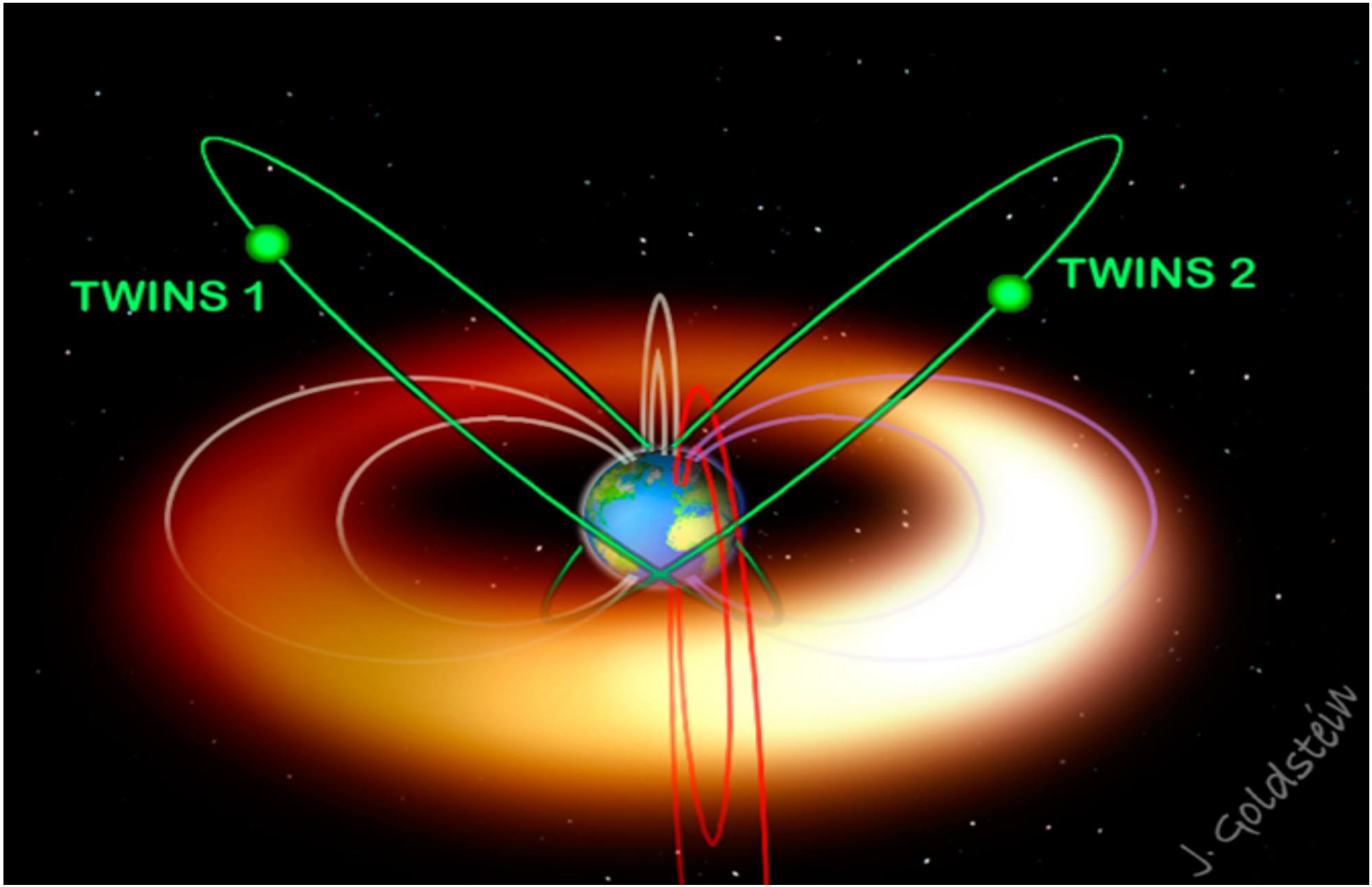
… enormous electric fields, and …



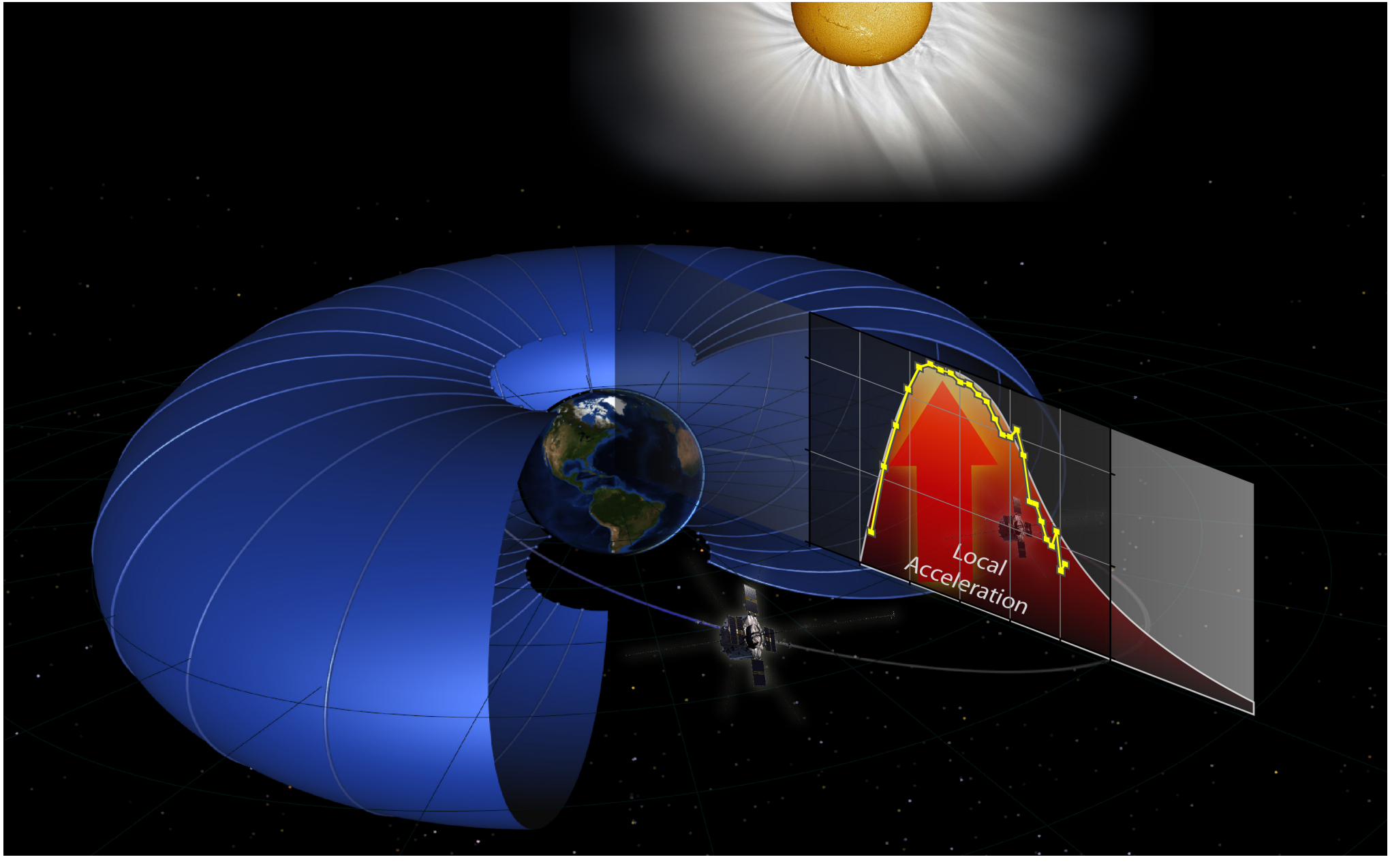
significant energy transfers within the magnetosphere



Not to mention the three Van Allen plasma belts



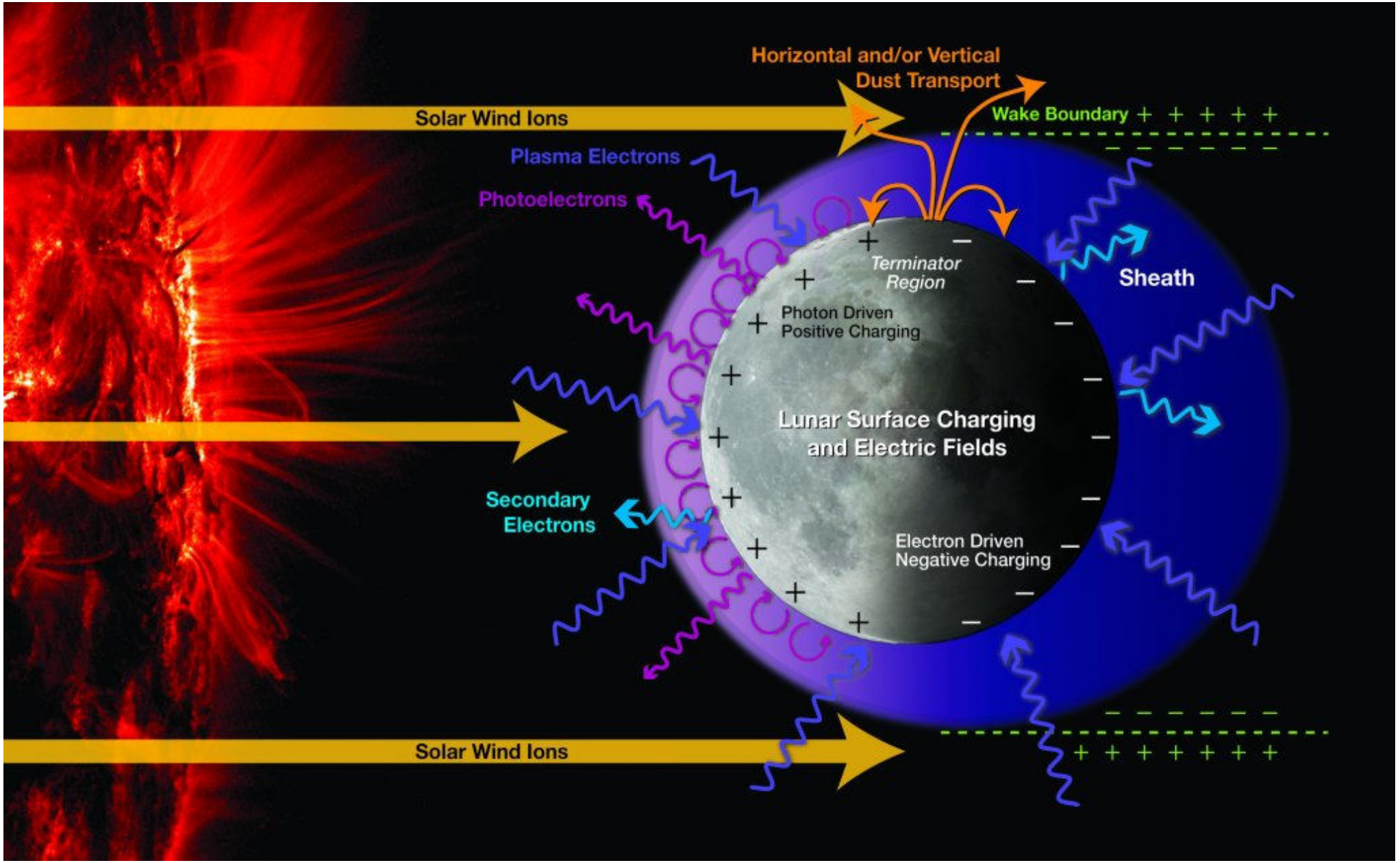
… which act to accelerate electrons, protons & ions



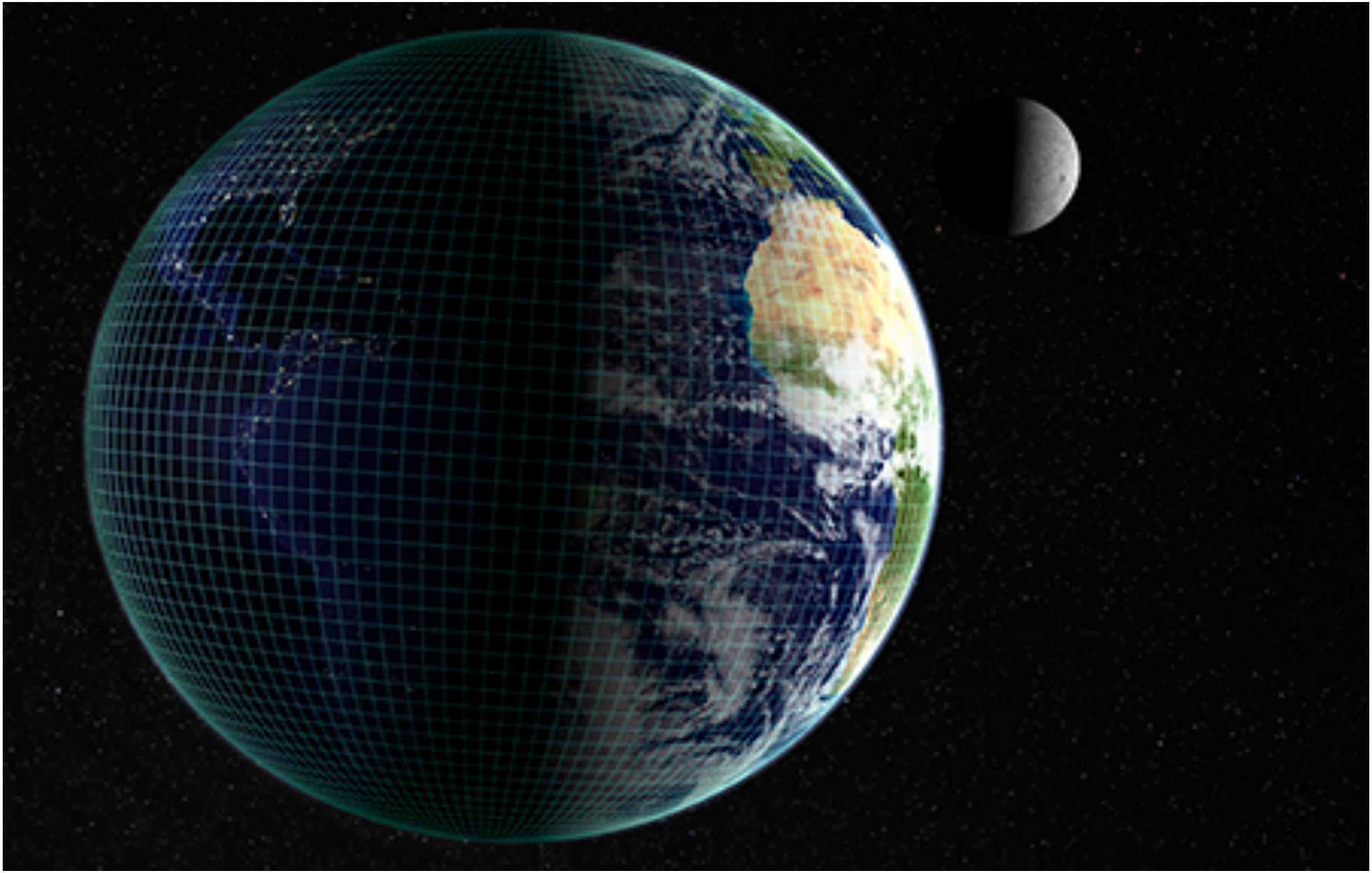
.. that bleed down to the Earth's surface & ionosphere

Interestingly, our Moon has no magnetosphere

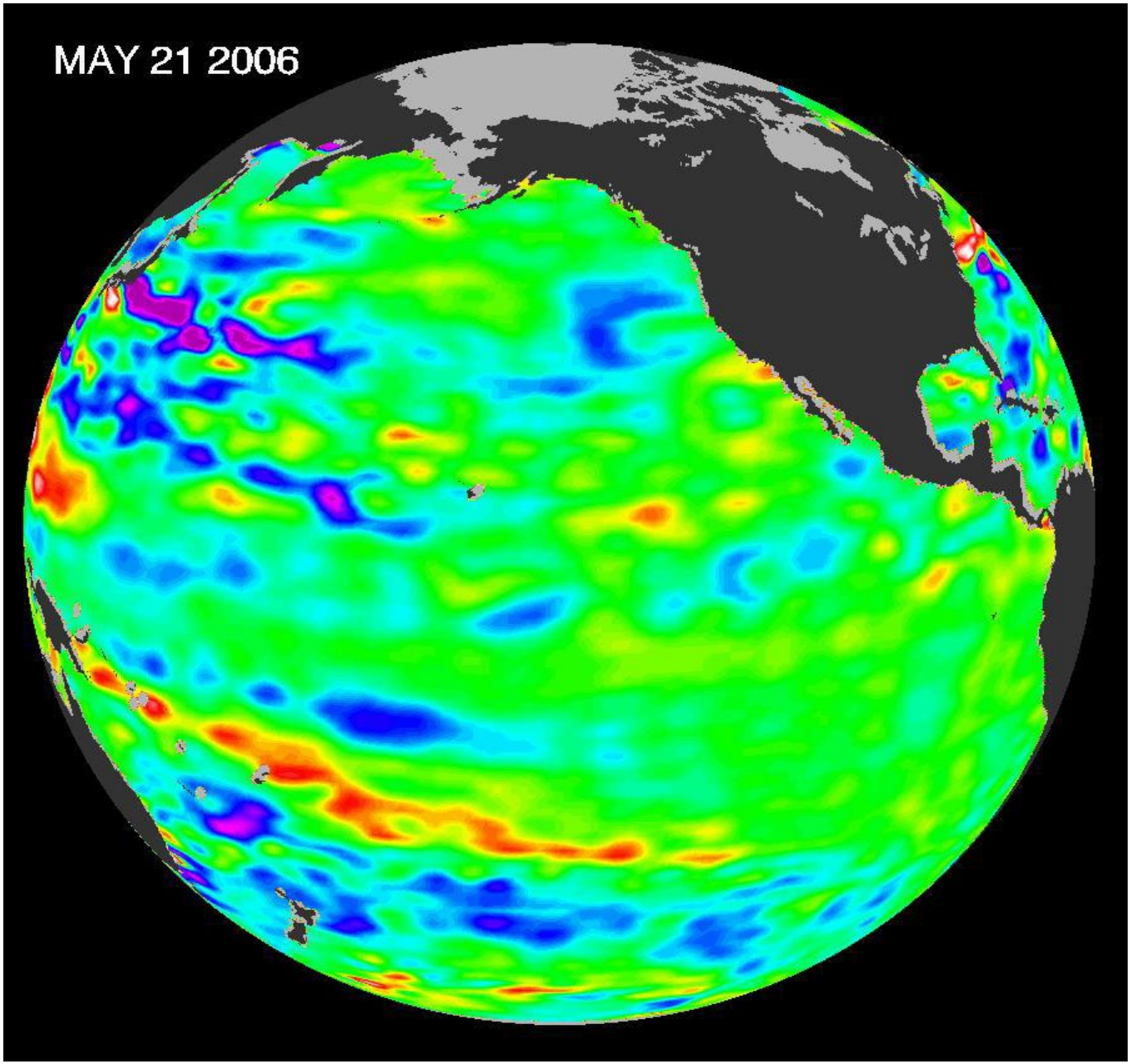
But it has an ionosphere … coupled with the Earth's



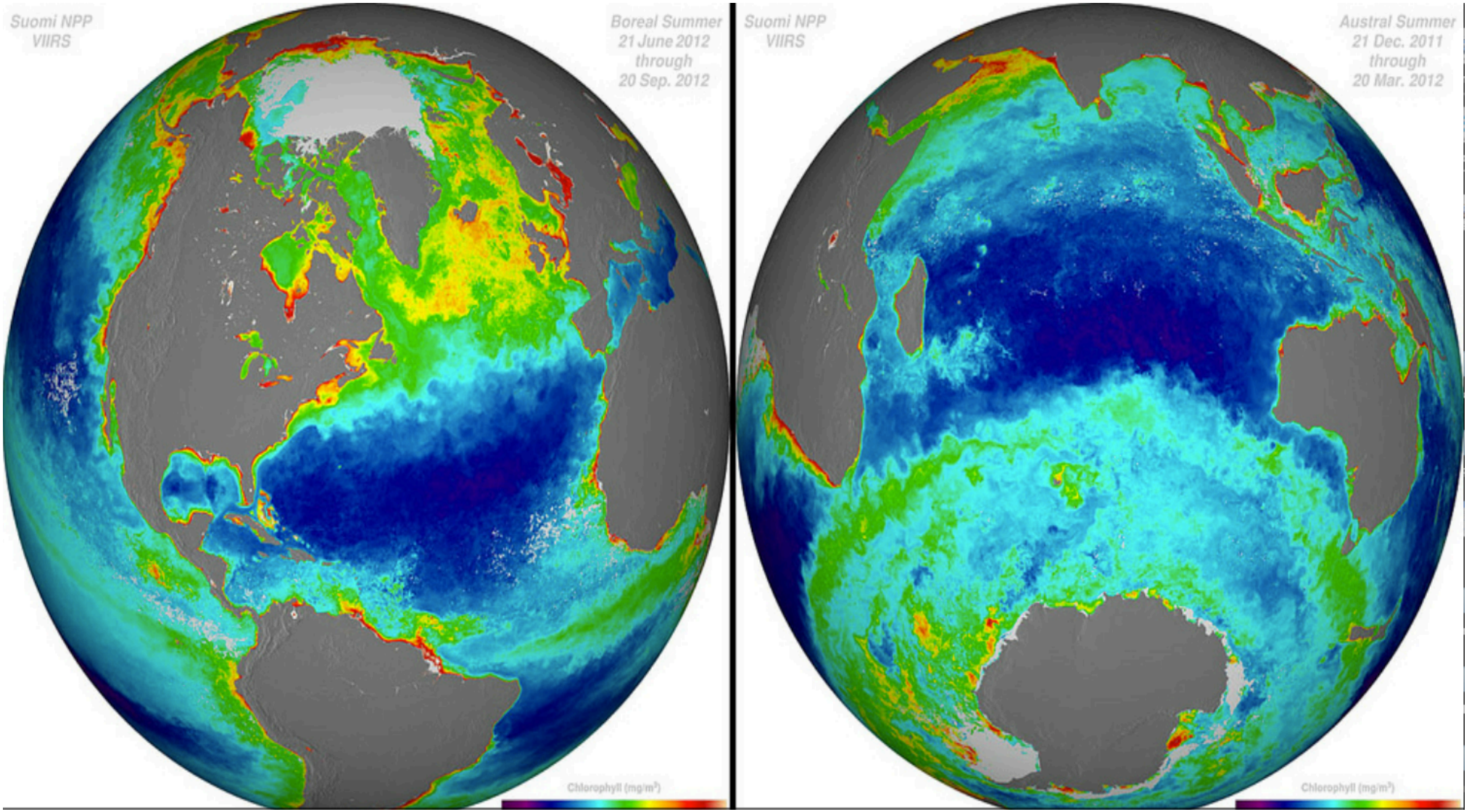
The Moon creates tides, currents and winds on Earth



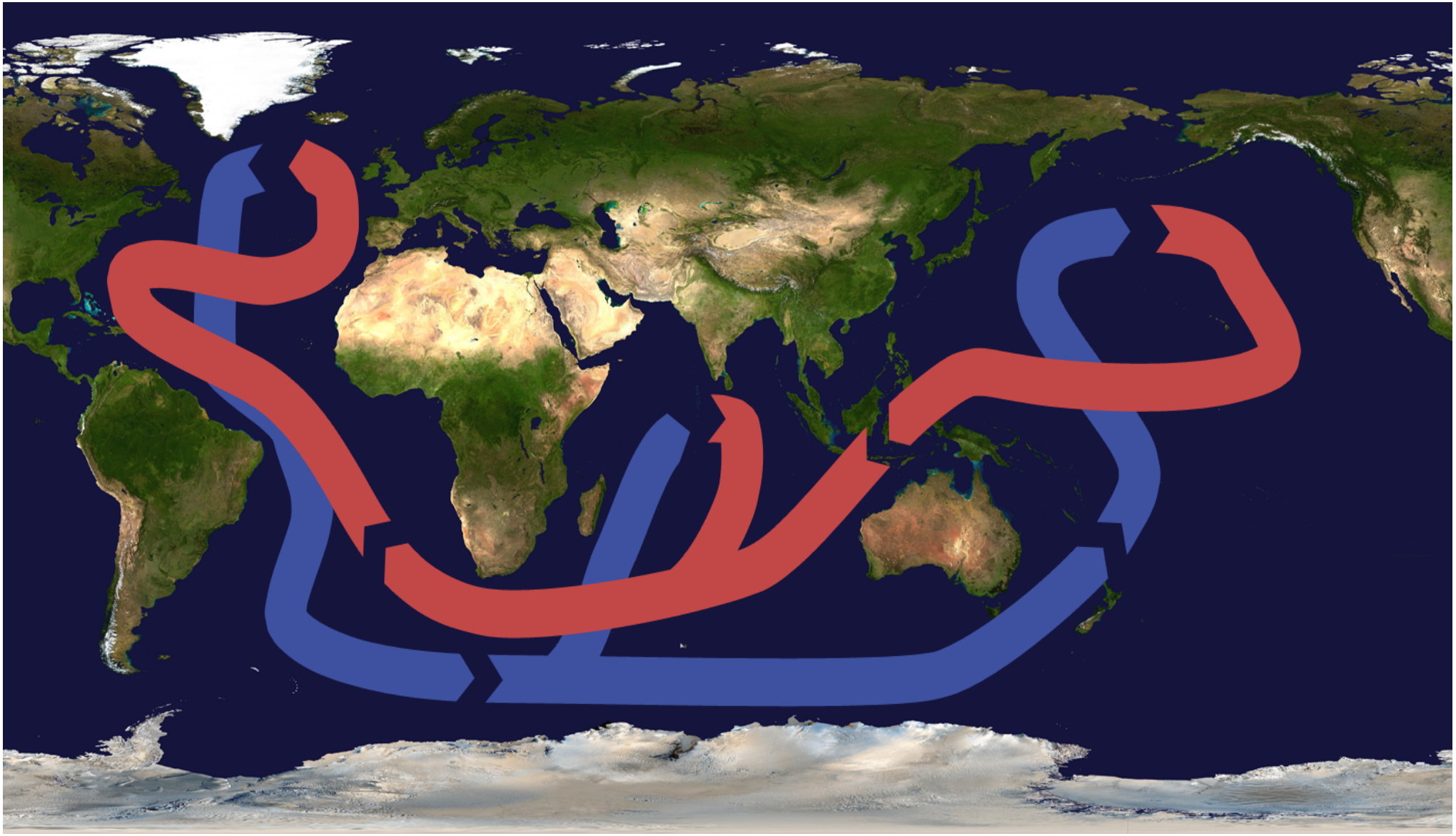
… mixing the ocean's temperature and salinity



Leading to multiple chlorophyll patches & ecosystems

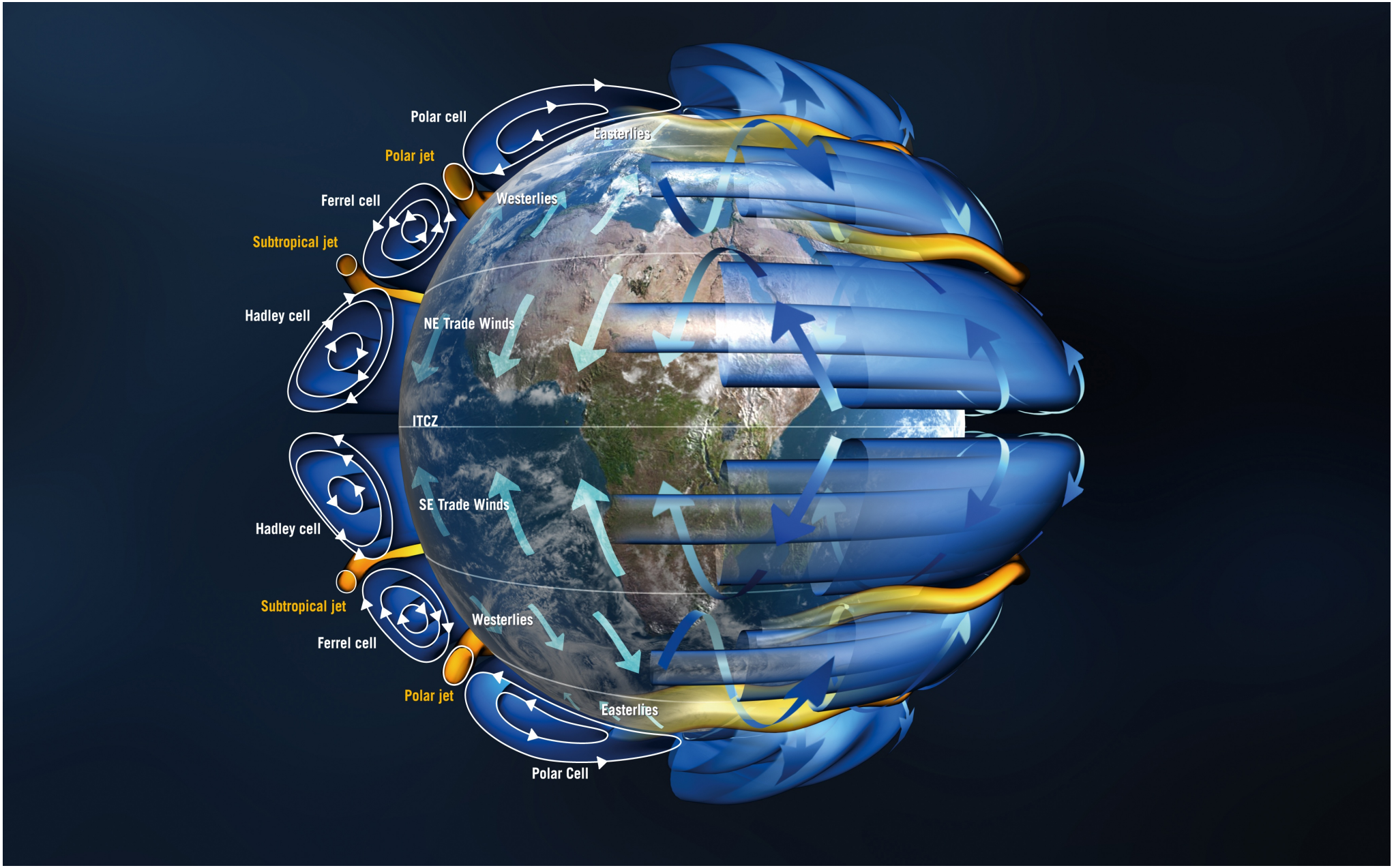


Which influence the Global Ocean Conveyor Belt



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

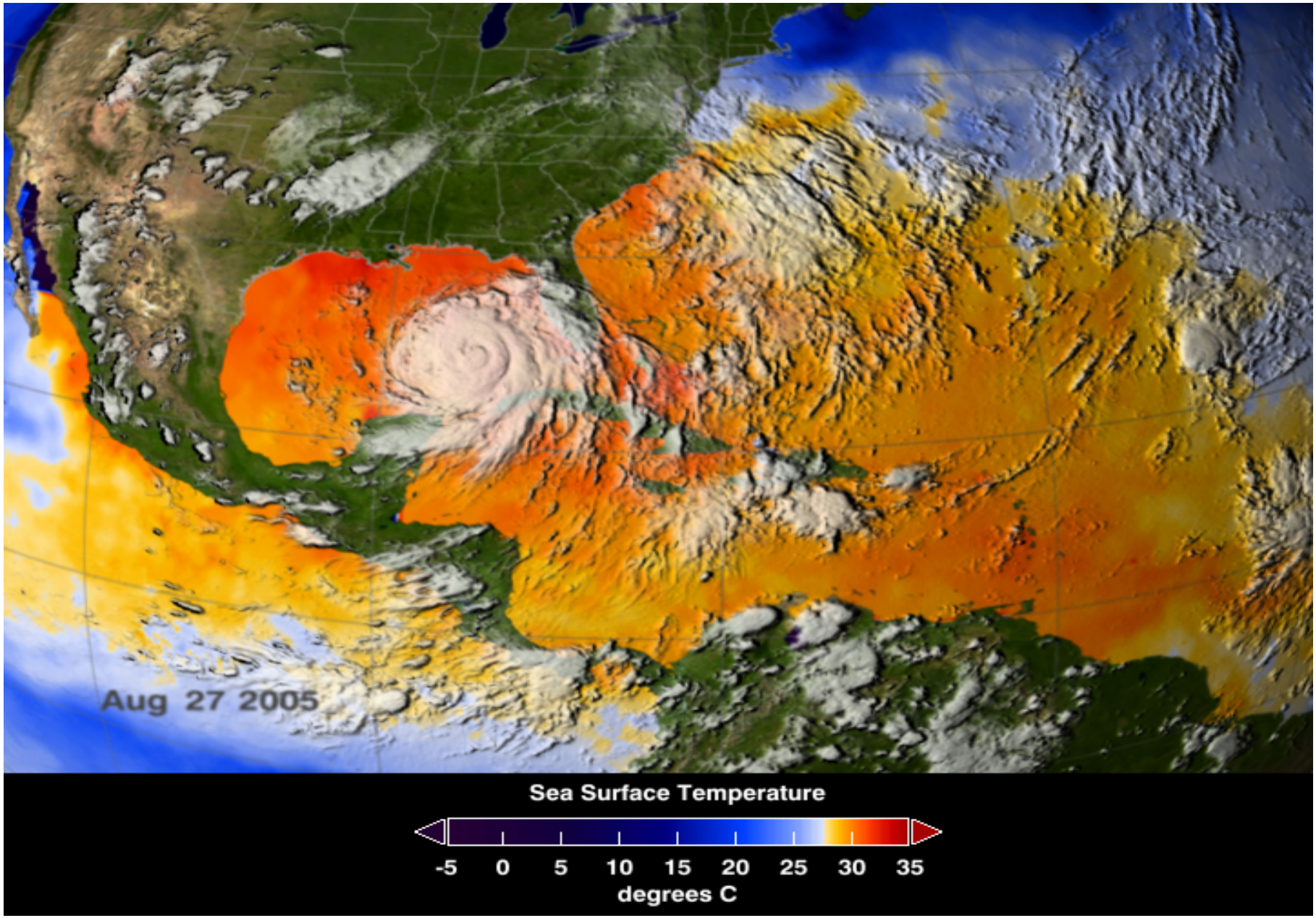
Ocean-Wind coupling is key to climate modelling



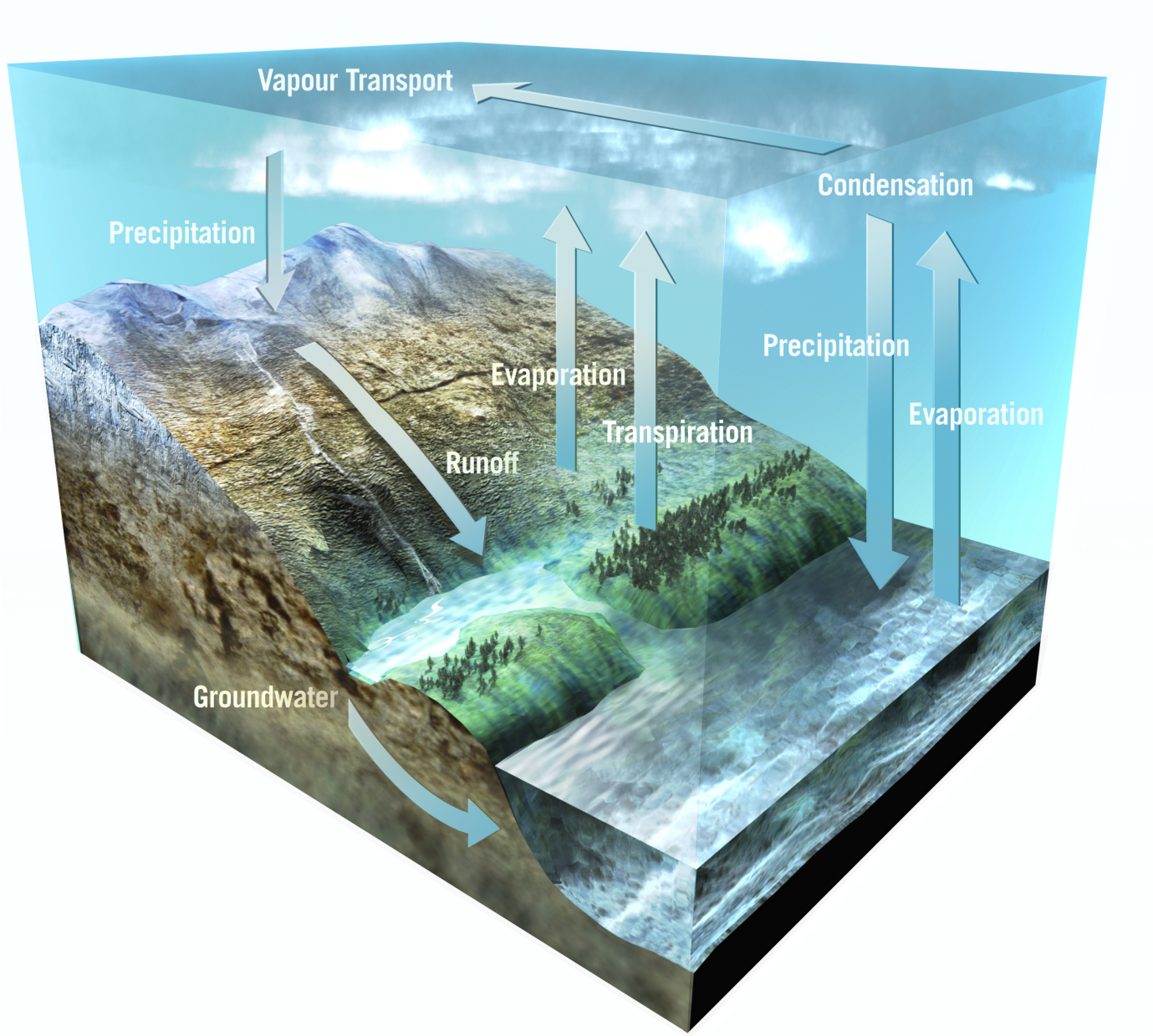
Denmark: taking energy out of the wind system

Convection & Cloud Physics are still a puzzle

Katrina 2005: an example of massive energy transfer

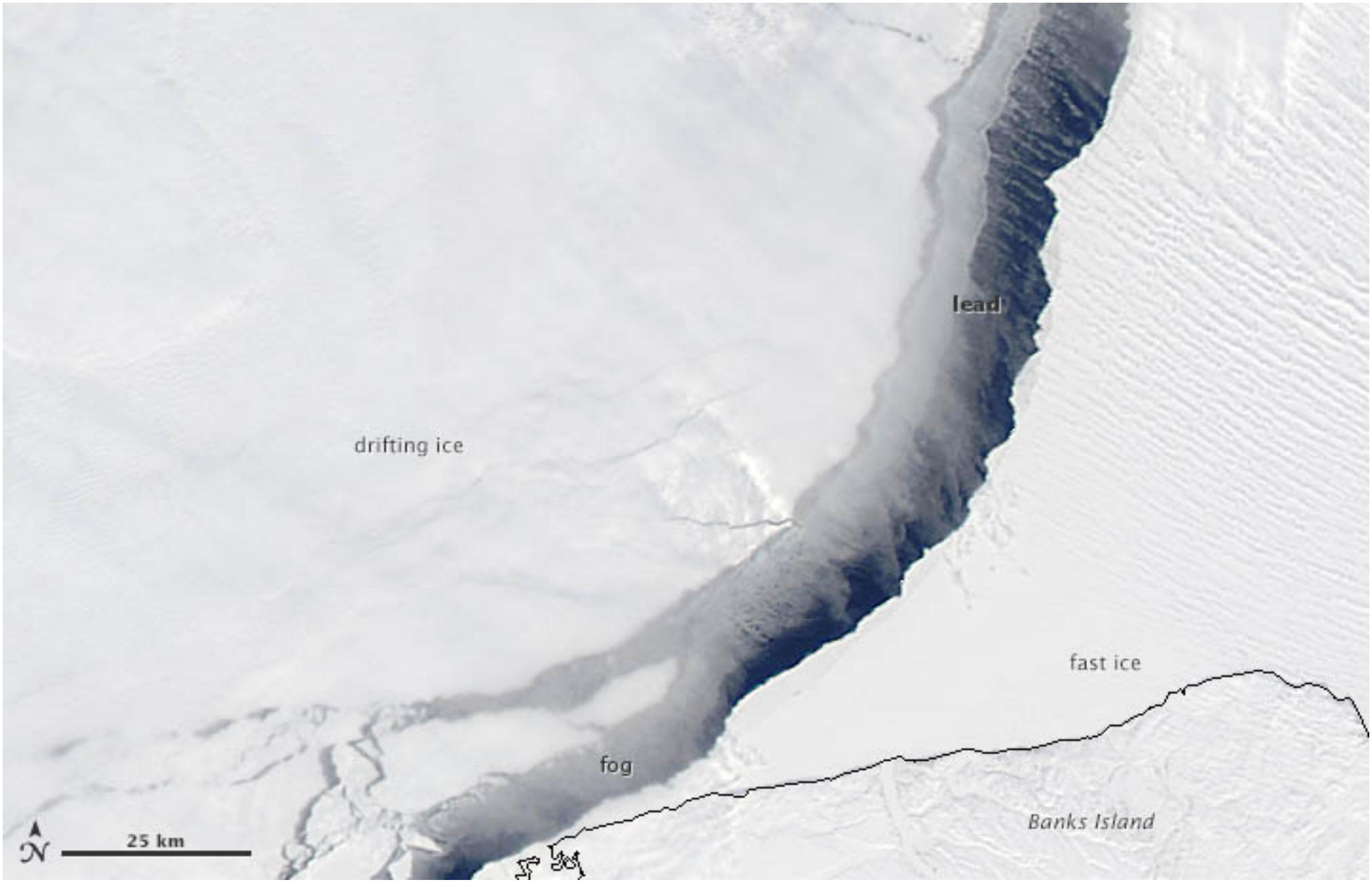


The need to describe the global cycling of C-N-P-S-H_2O

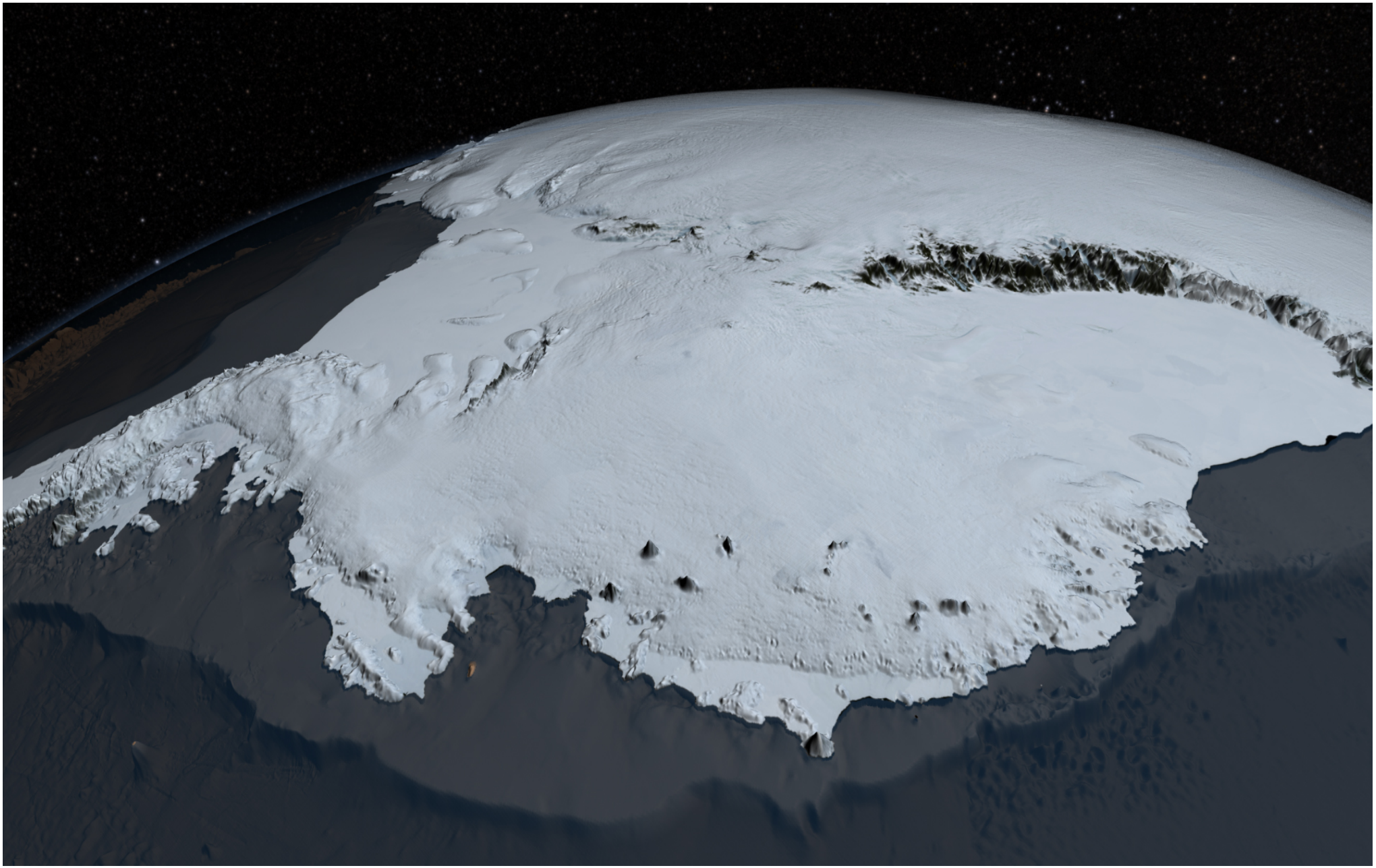


Our Cryosphere is becoming unstable: ice-free Arctic Ocean

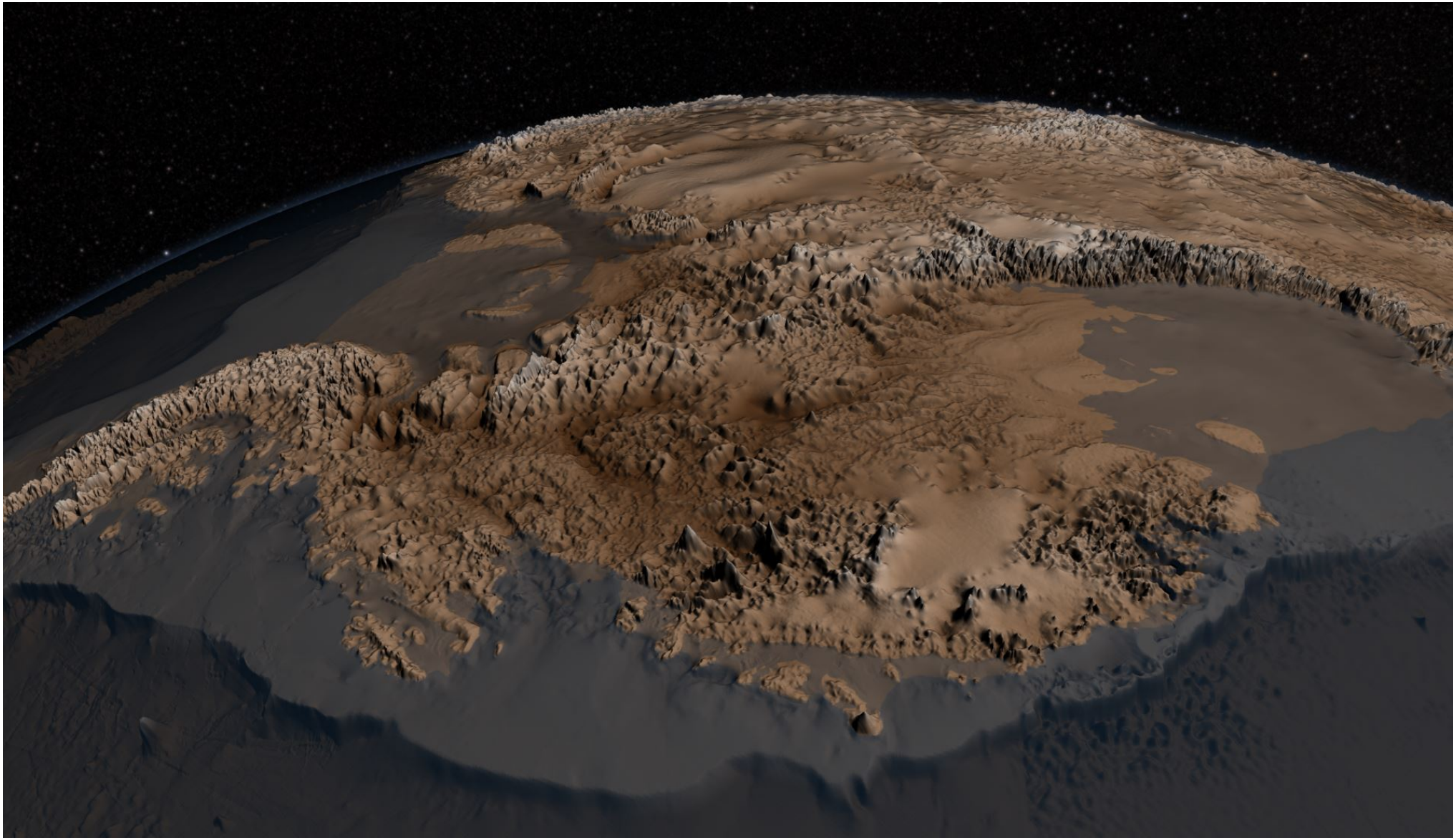
Glacial retreat, loss of ice-sheets & permafrost



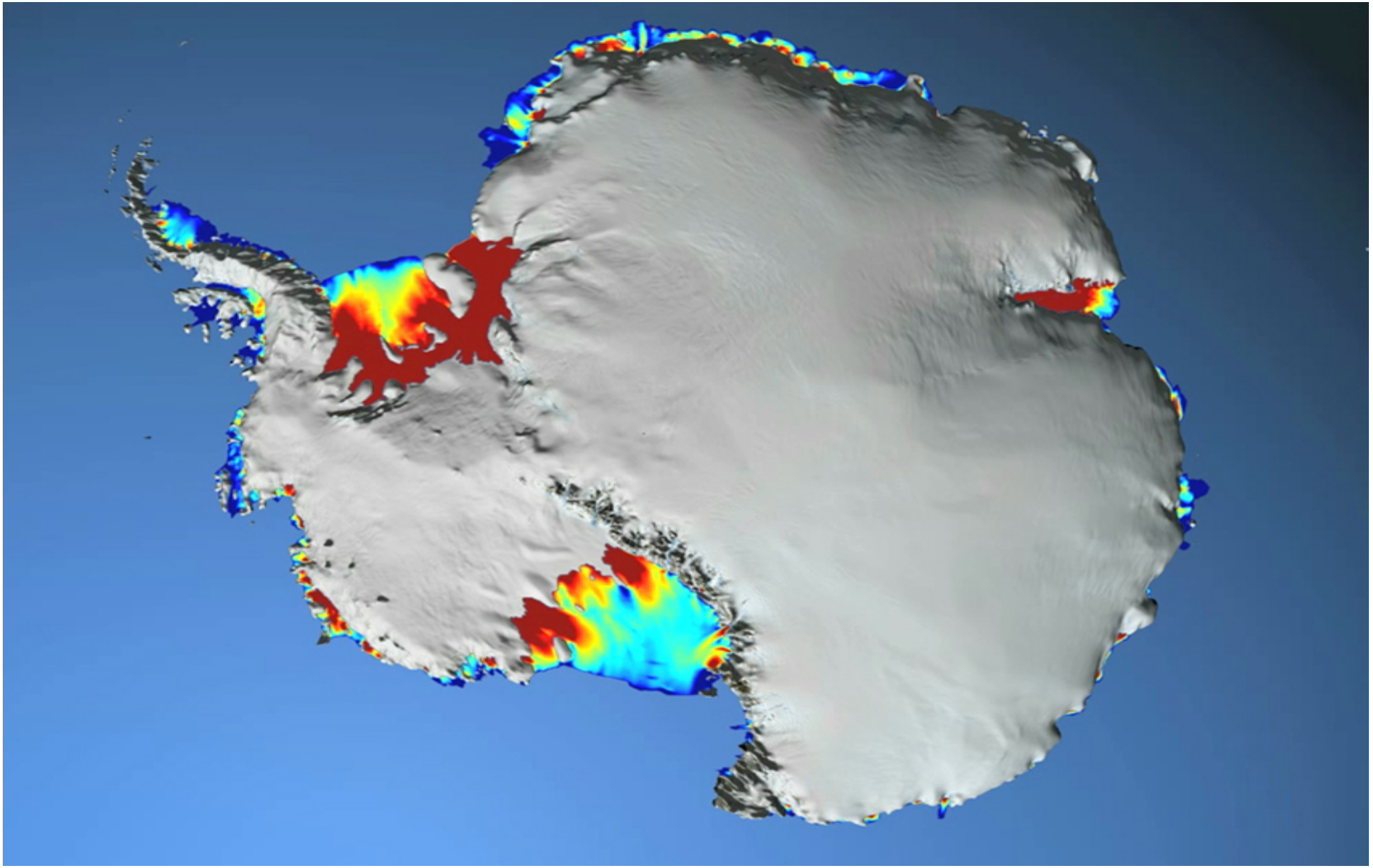
Antarctica: a major influence on the global climate



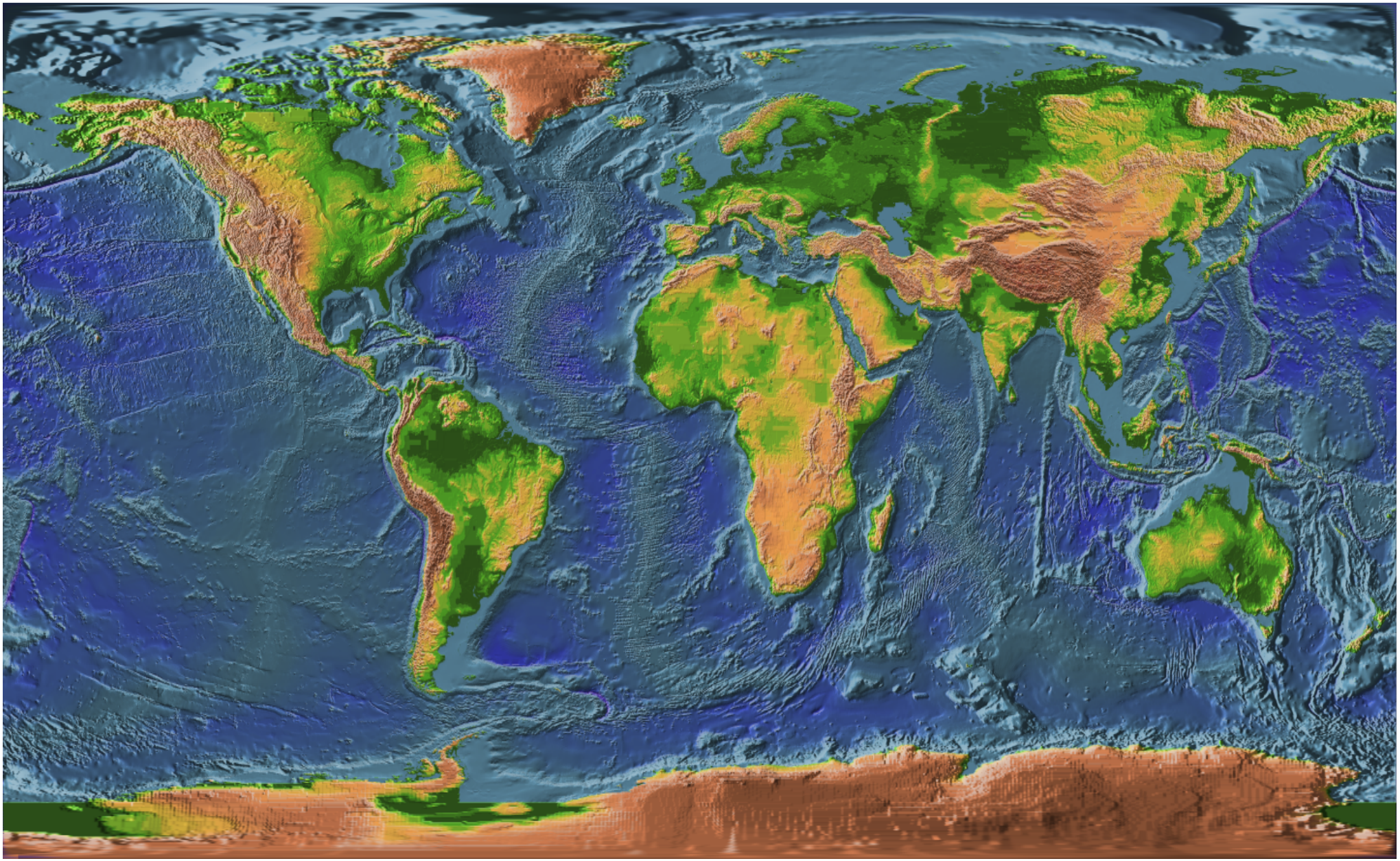
Below the surface: ancient lakes, fjords, and life forms



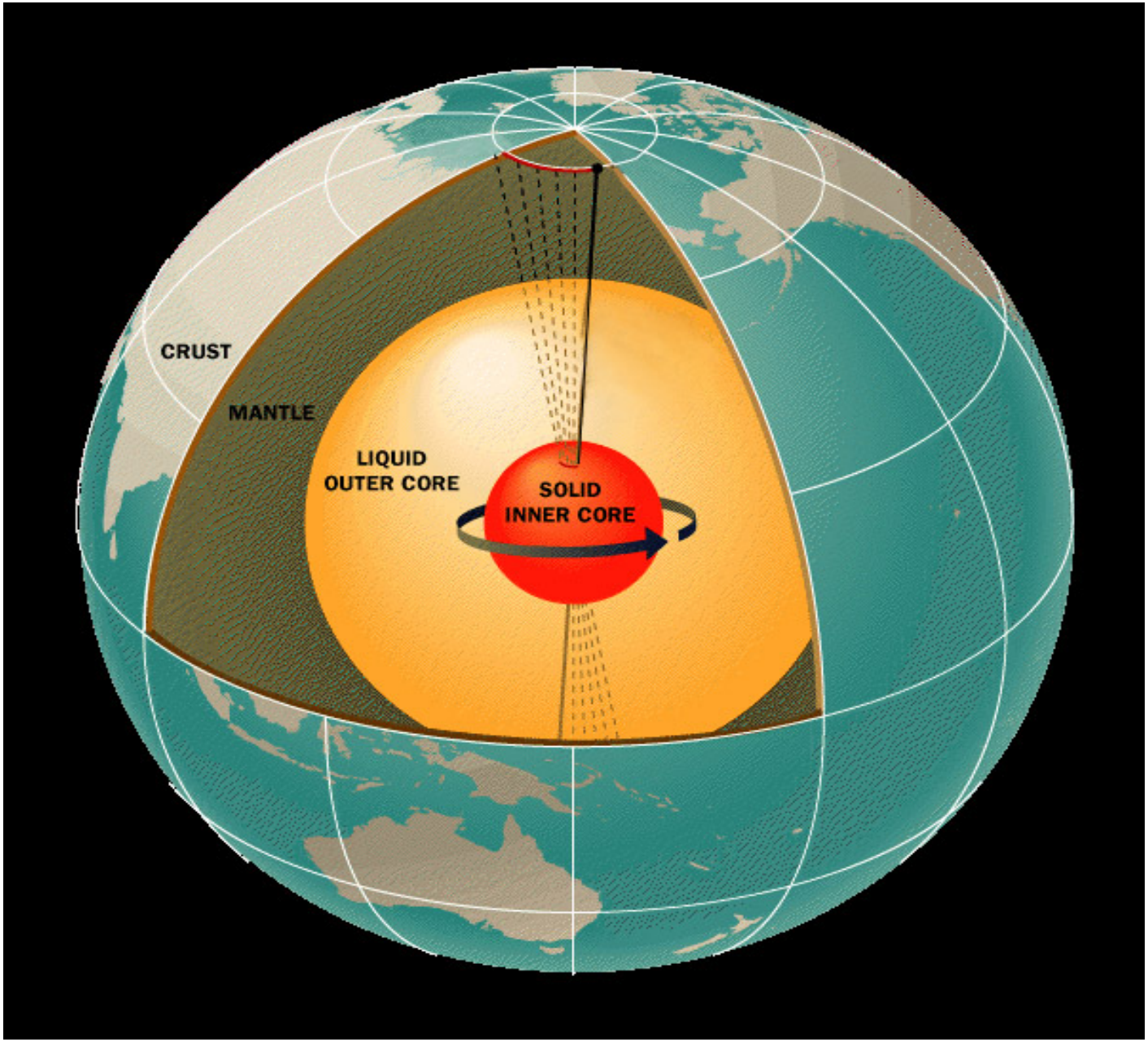
20 million km^2 of ice, average 4km thick – but thinning



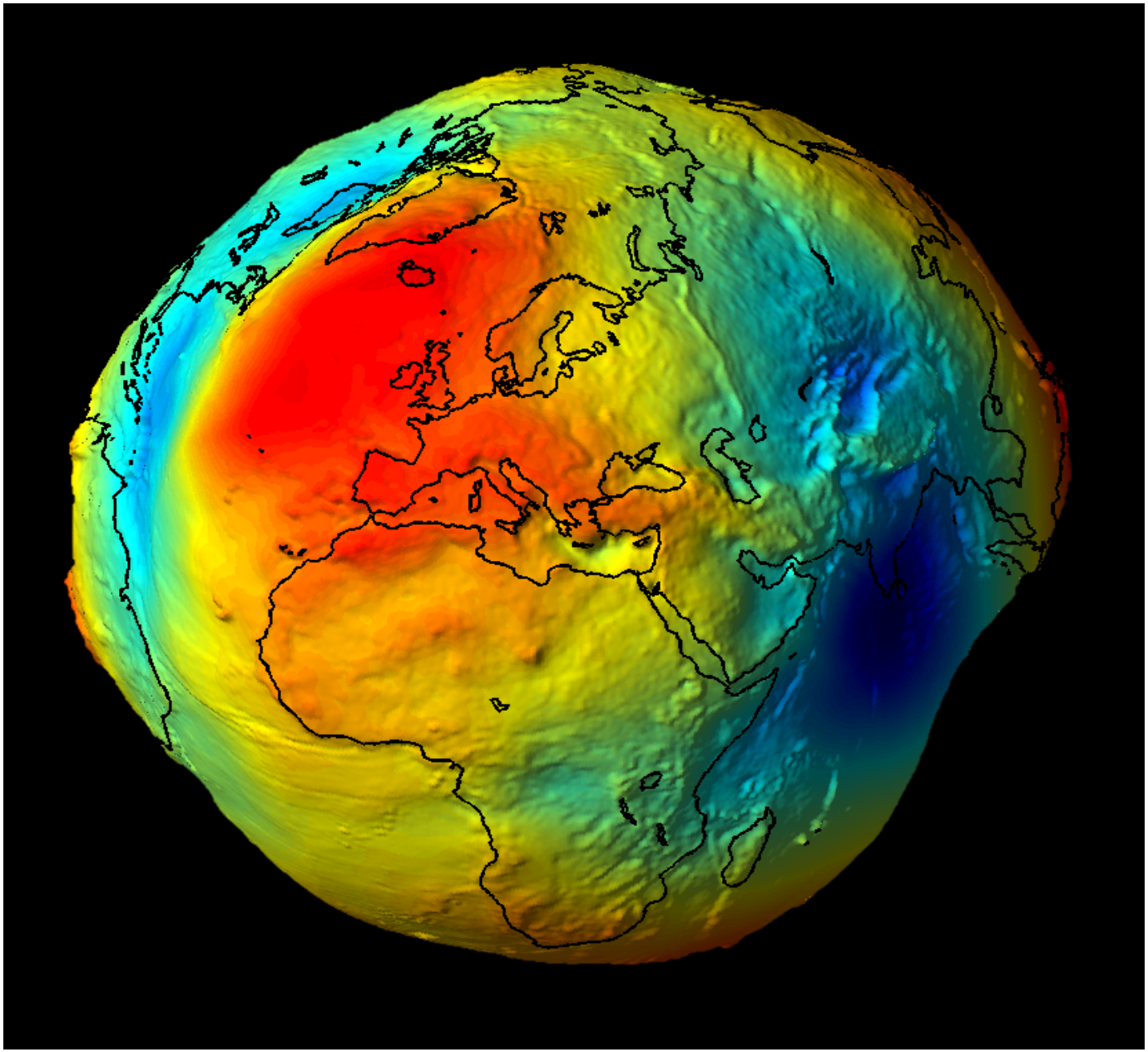
Bathysphere: evidence of subduction & extreme life



Earth’s dynamic core: origin of our magnetosphere



Variations in gravity reflect sub-surface make up



Over 200 active volcanoes out-gassing aerosols & CO_2

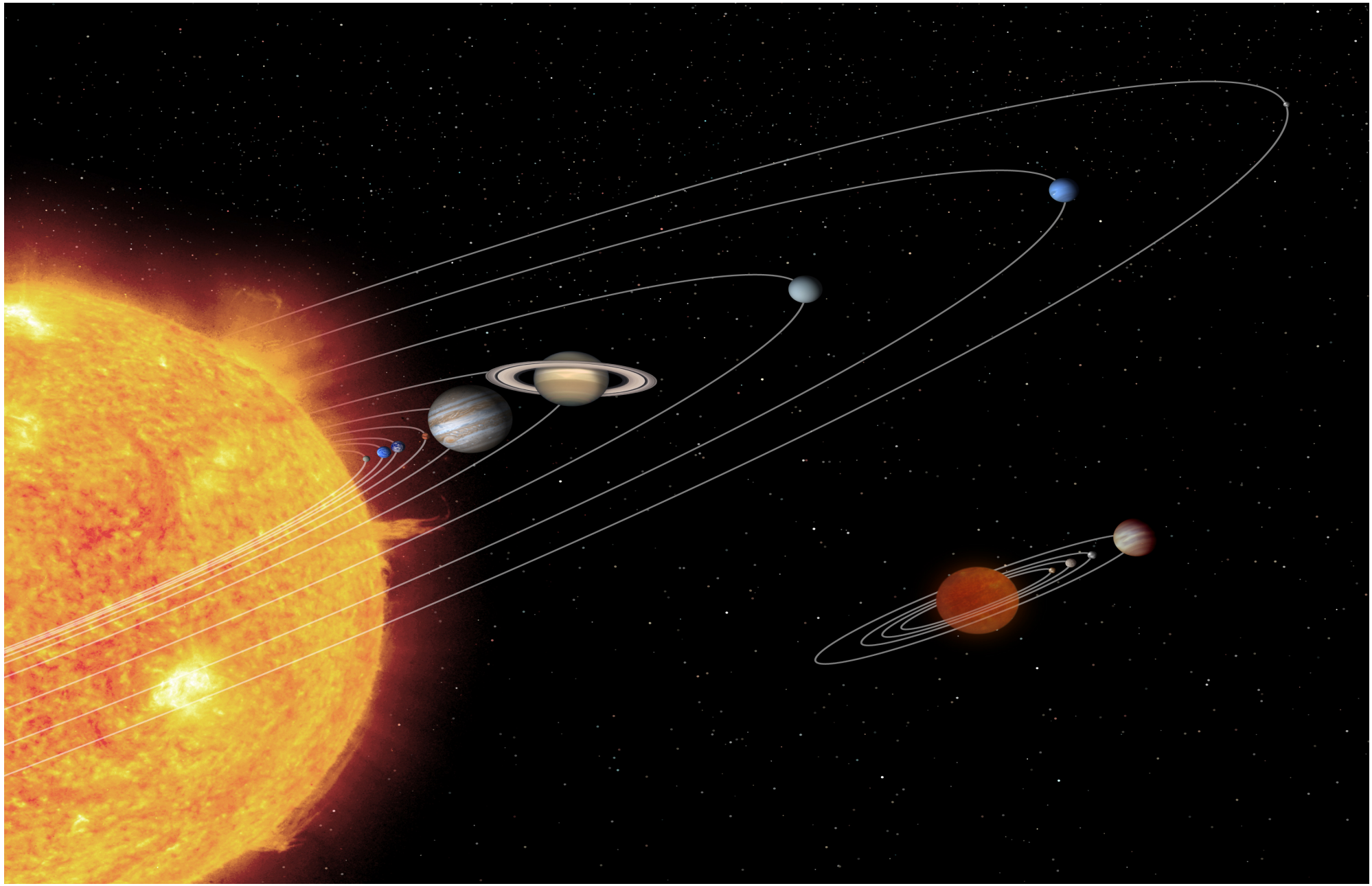
Many share their plumbing with nearby subduction zones

Seattle based group co-founded by ICES & Metanoiaa

Cascadia Resilience Center

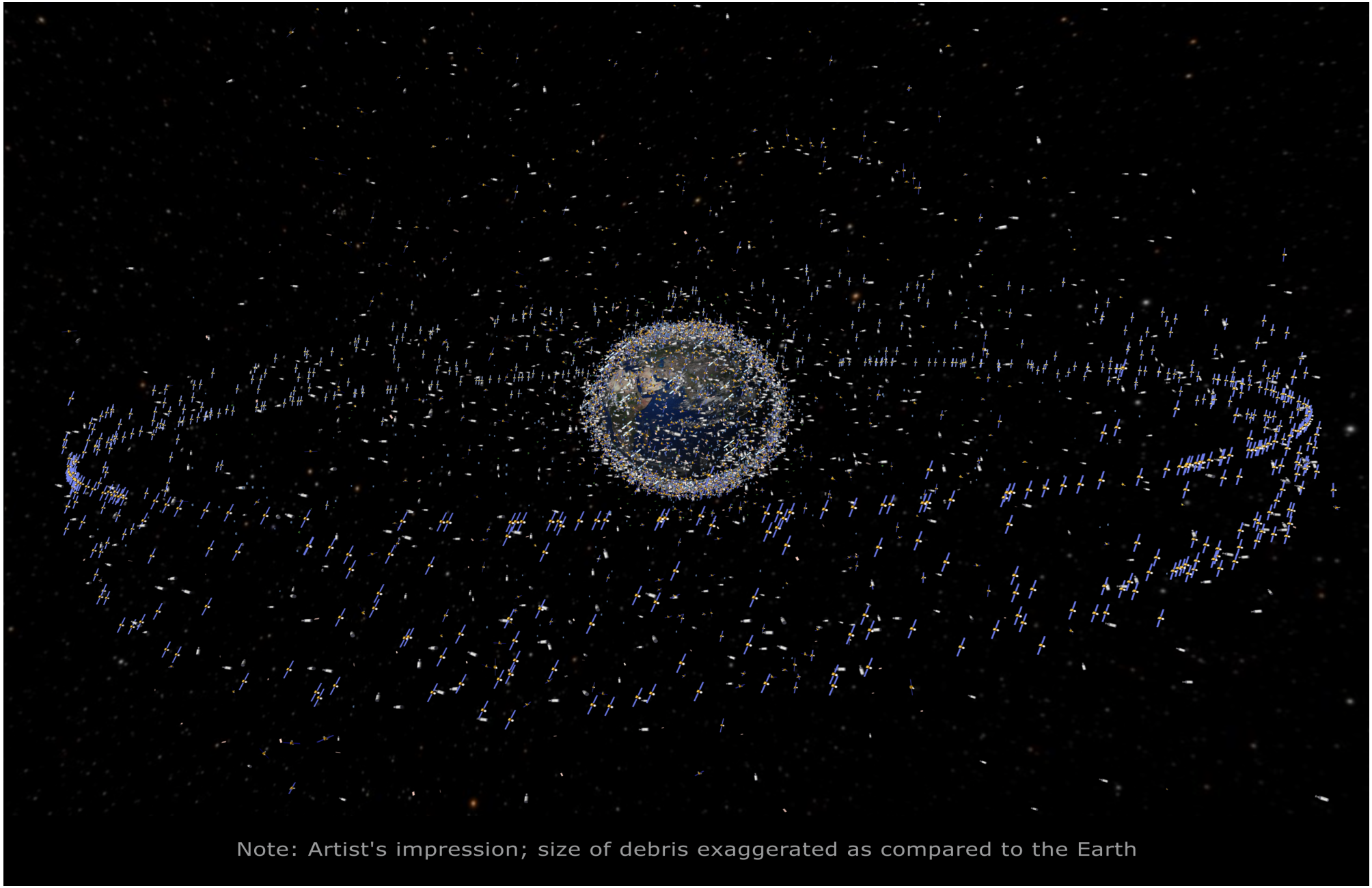
Earth Observing Satellites maintain long-term records

Indeed, our Solar System is highly interconnected



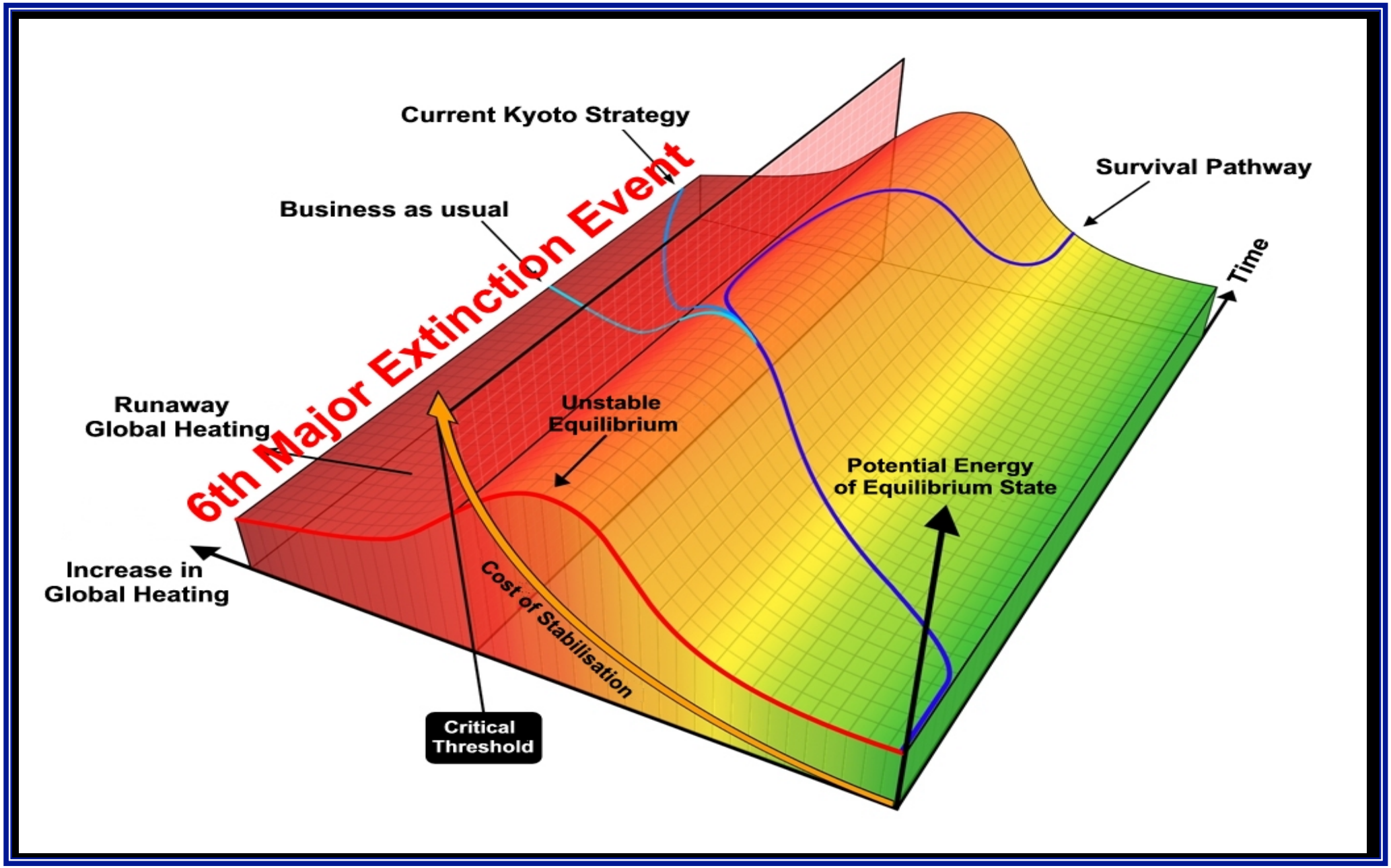
Jupiter alone is 300 x mass of Earth and has 67 moons

There are millions of NEOs capable of striking Earth



Such as the meteorite over Chelyabinsk 15.02.2013

Can we avoid severe socio-economic consequences?



Helping guide the successful transformation of human society in an era of rapid climate change and frequent natural disasters.

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