

Engaging the public in science narrative – using modelling, simulation, visualisation & big data tools

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Science is specialised & reductionist,
whereas
the public requires a more integrated view

- Telling the truth, attractively
- Using visual narrative
- Storytelling
- Humour



Bridging the communications gap

- Bringing ICT, domain science & citizen science together
- Networking eScience centres around the world
- Helping to drive Open Data policies
- Open access publishing
- Open source code
- Open standards
- Open science

Here is our Tool Kit:

- Modelling, Simulation & Flowing-time Visualisation
- Big Data visual predictive analytics
- Collaborative Intelligence
- Artificial Intelligence
- Machine learning
- The Internet of Things

Two great challenges of the 21st Century

- Modelling the Human Brain
 - a challenge already taken up
 - EU Human Brain Project
 - US, China, Japan, Australia projects
- Modelling the Whole Earth System
 - integrating the natural & socio-economic sciences
 - from global to local, from soil to sky
 - a challenge whose time has come!

Modelling the Whole Earth System

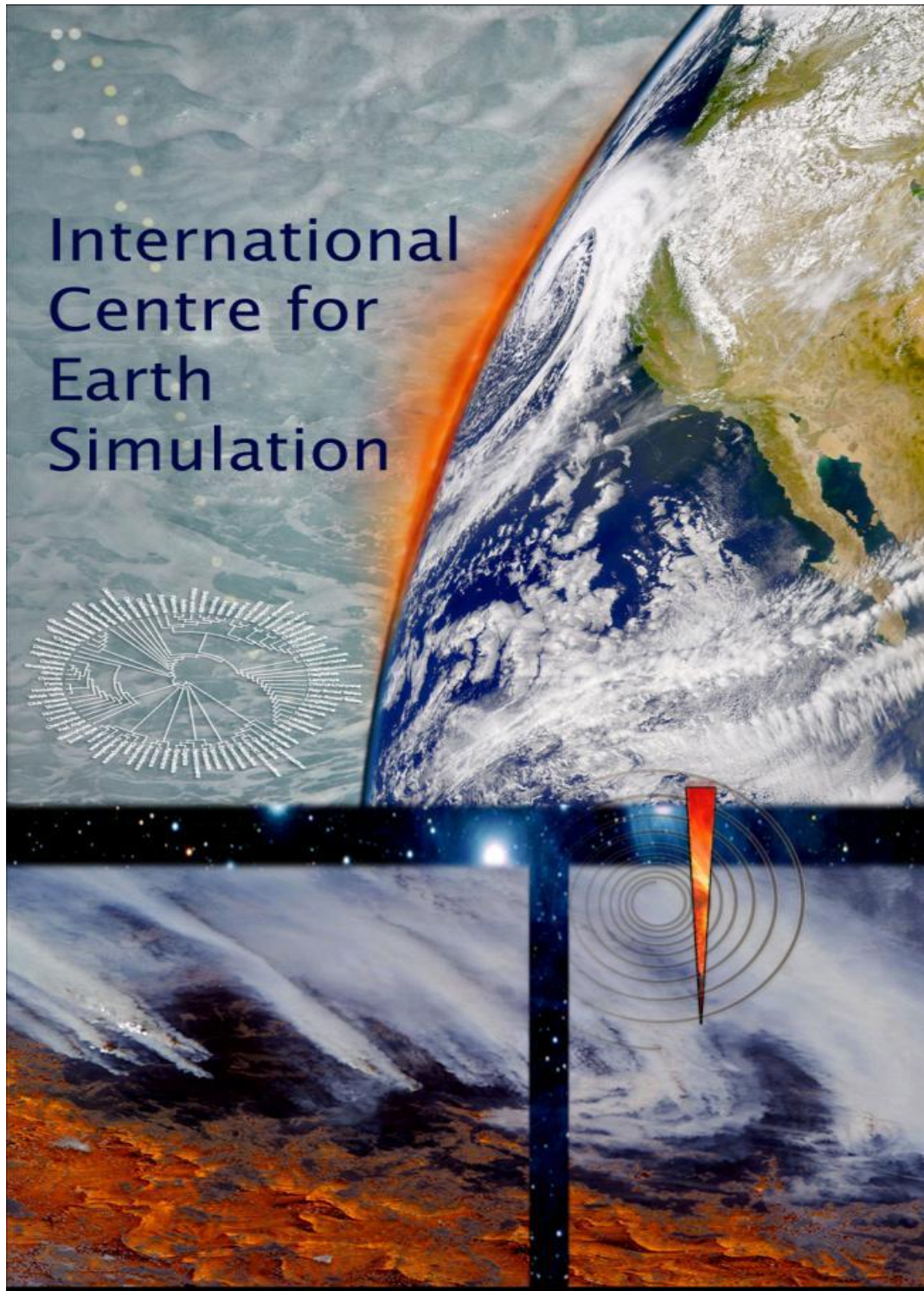
- Multiscience, multi-scale, unitary & seamless
- All underlying biogeophysical processes
- Causes and effects - and consequences
- Impact of Nature on Human Society
- Impact of Society on Nature!

Holistically speaking

- Everything is transforming
- Everything is connected
- Everything is in motion



International Centre for Earth Simulation



ICES is about improving our understanding of ...

- extreme weather, floods, droughts, cold, dust storm
- climate change, global warming, sea-level rise
- natural capital resource depletion
- energy-food-water security
- disaster risk management
- risk & resilience

Improving public safety, well-being & sustainability

ICES Organization Philosophy

- Global
- Neutral
- Independent
- Not-for-profit
- Multi-disciplinary

Swiss based, Geneva HQ, Worldwide partnerships

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

The real world is massively complex



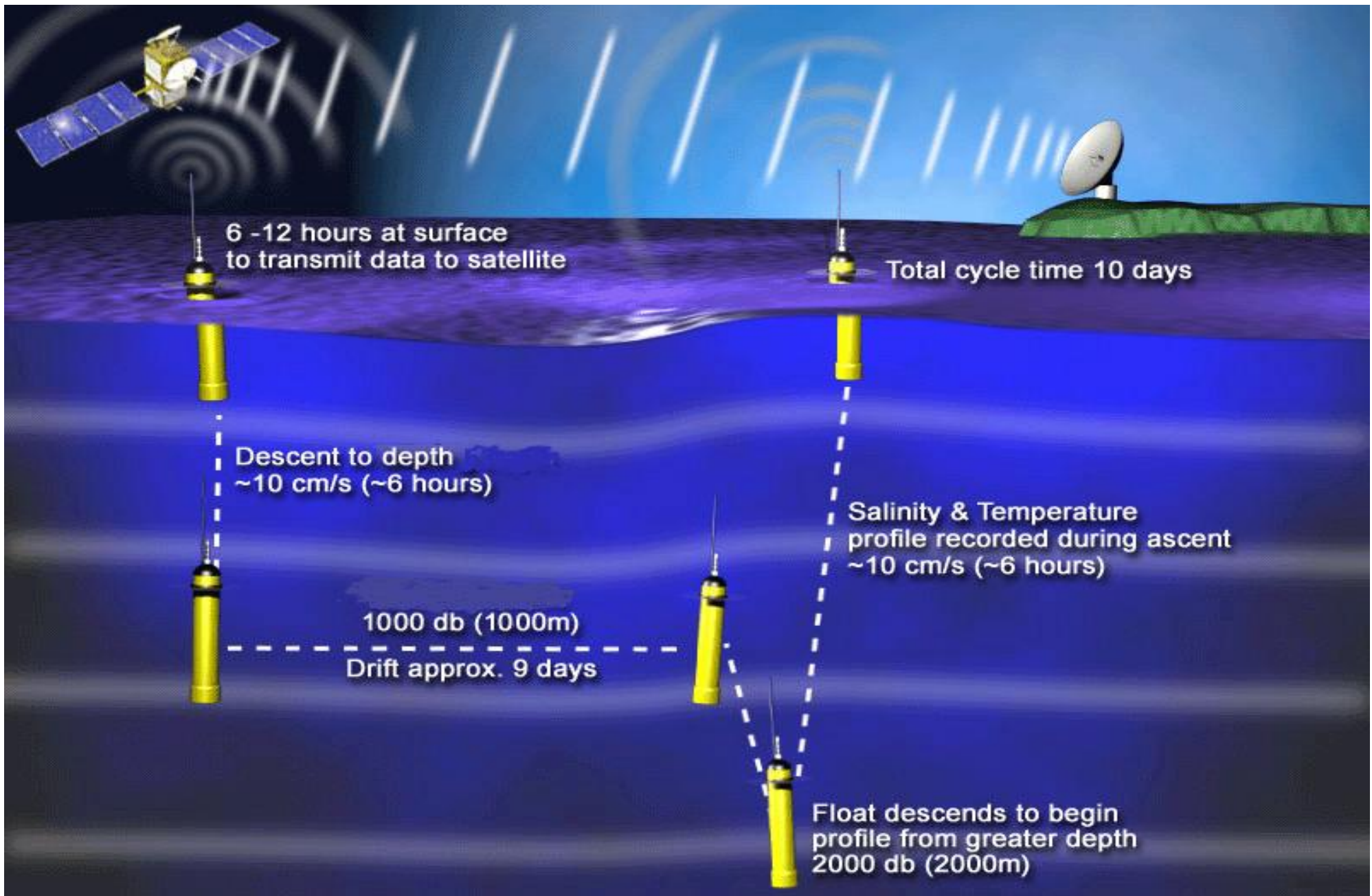
The moon adds to that complexity



Earth Observing Satellites look down on what we do



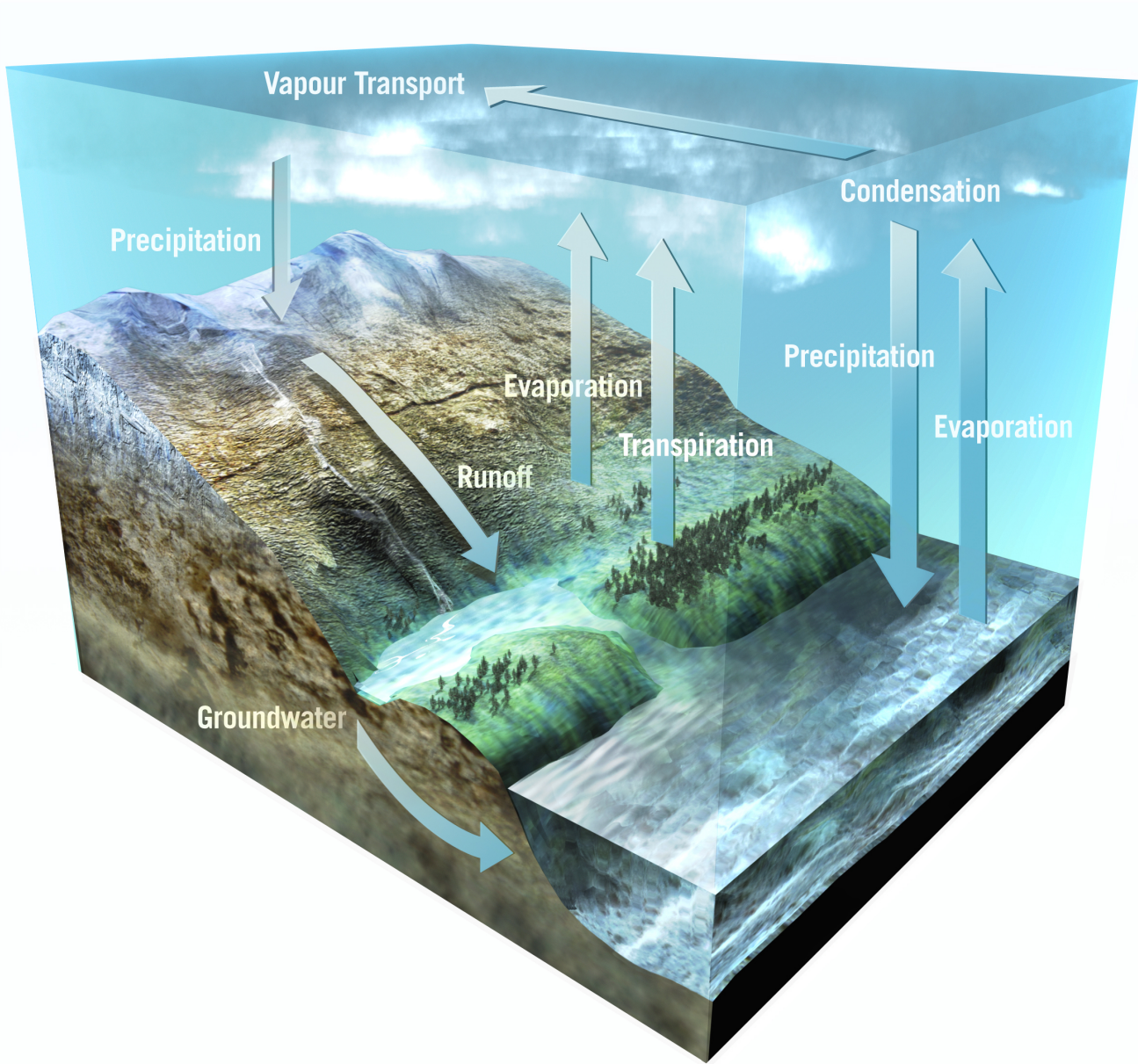
Sensor floats sample the ocean's surface



Supercomputers crunch the numbers



Co-evolution, feedback & synergy between processes



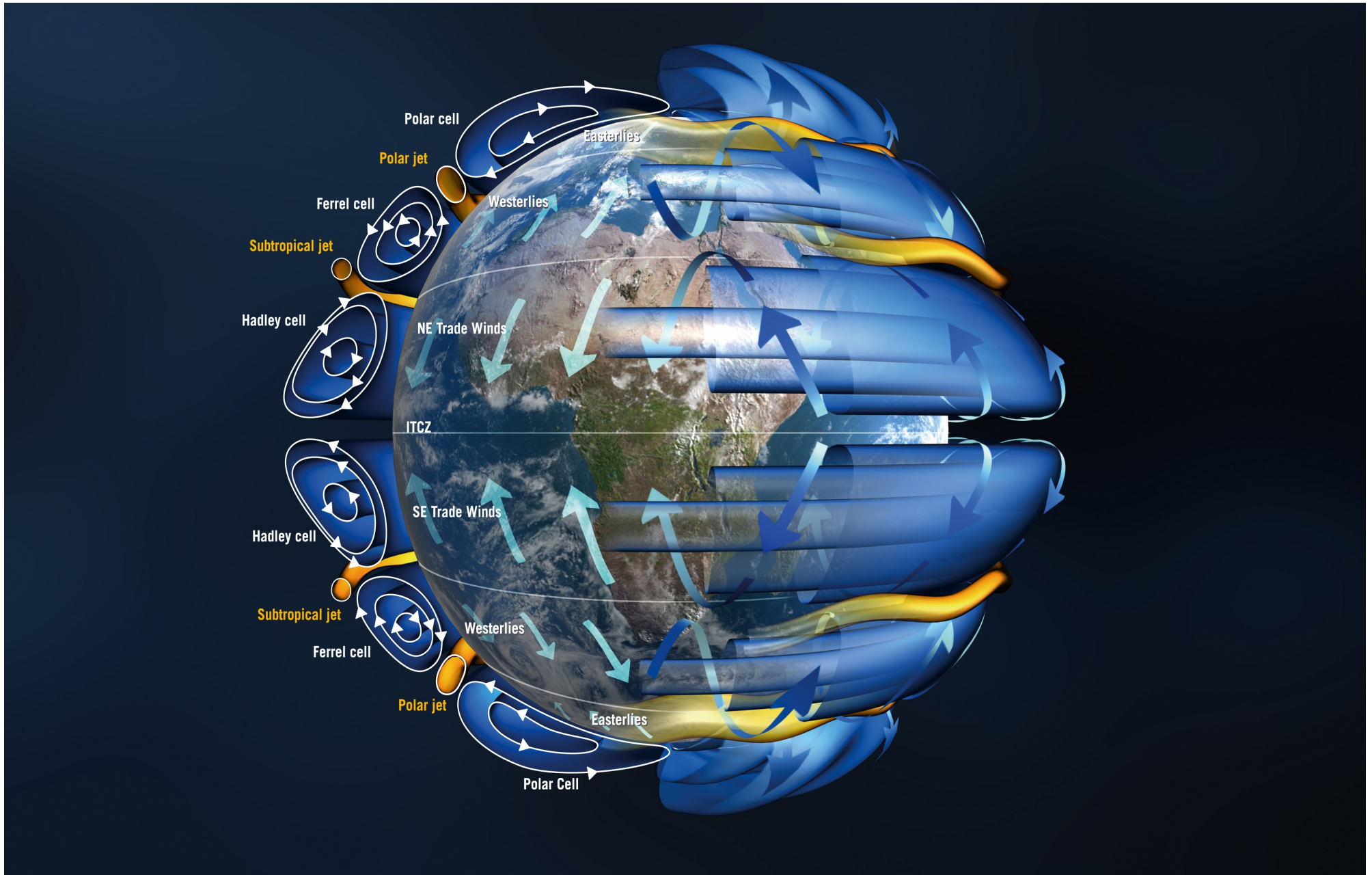
Convection & cloud physics are highly complex



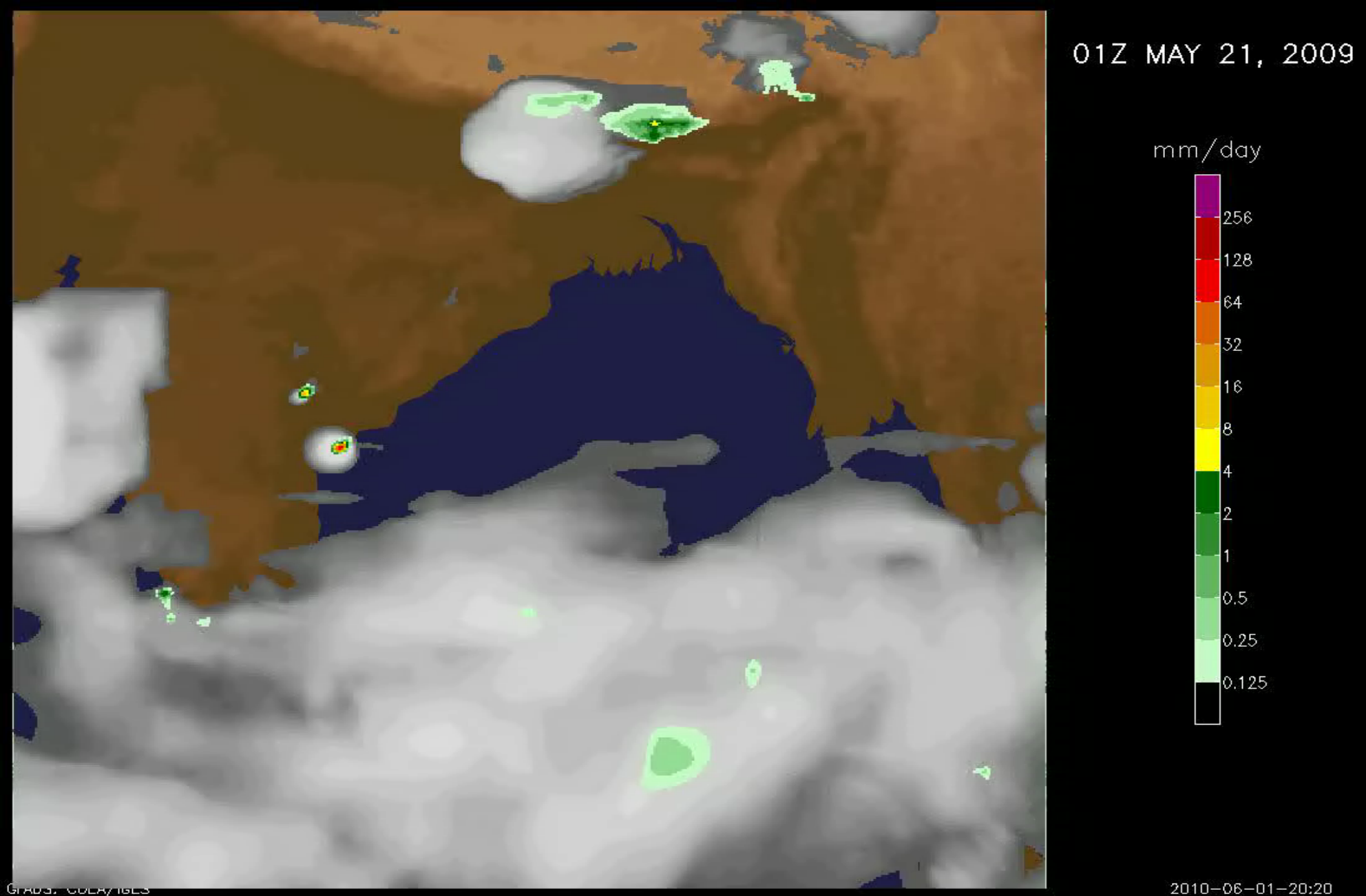
Coastal zones are extremely non-linear in behaviour



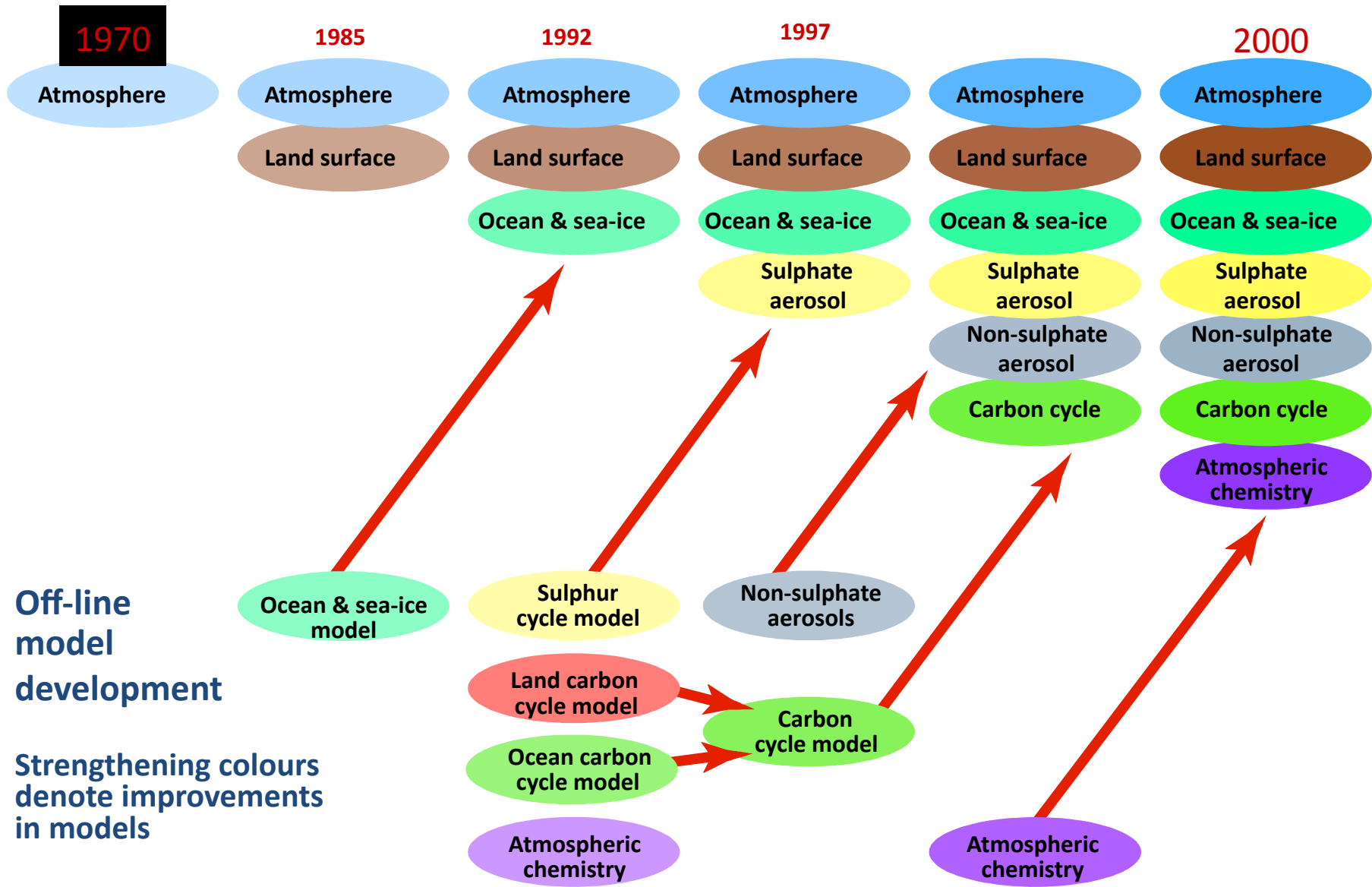
Land-Sea-Sky couplings & fluxes drive our climate



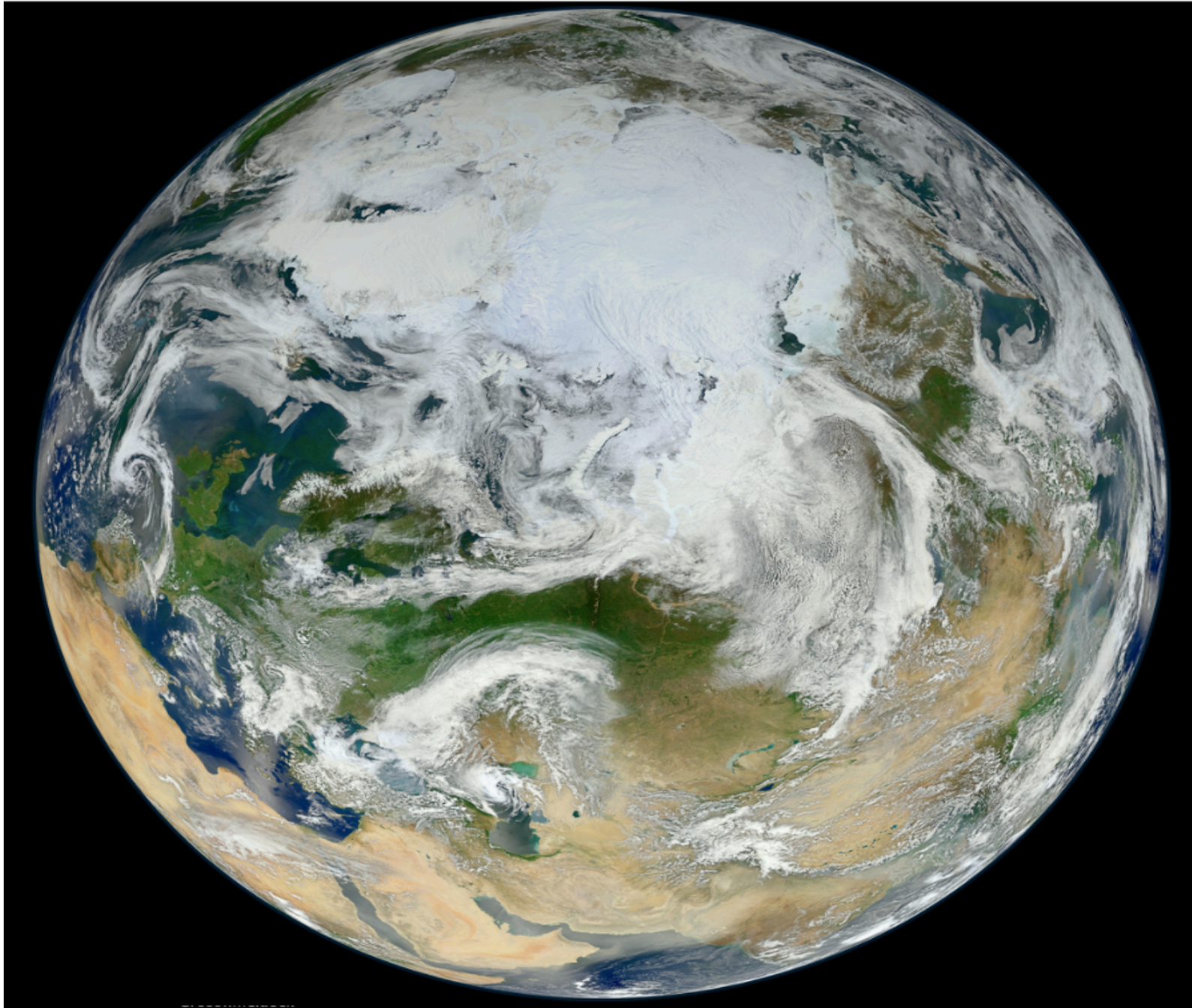
Models explain some of the dynamics, but not all



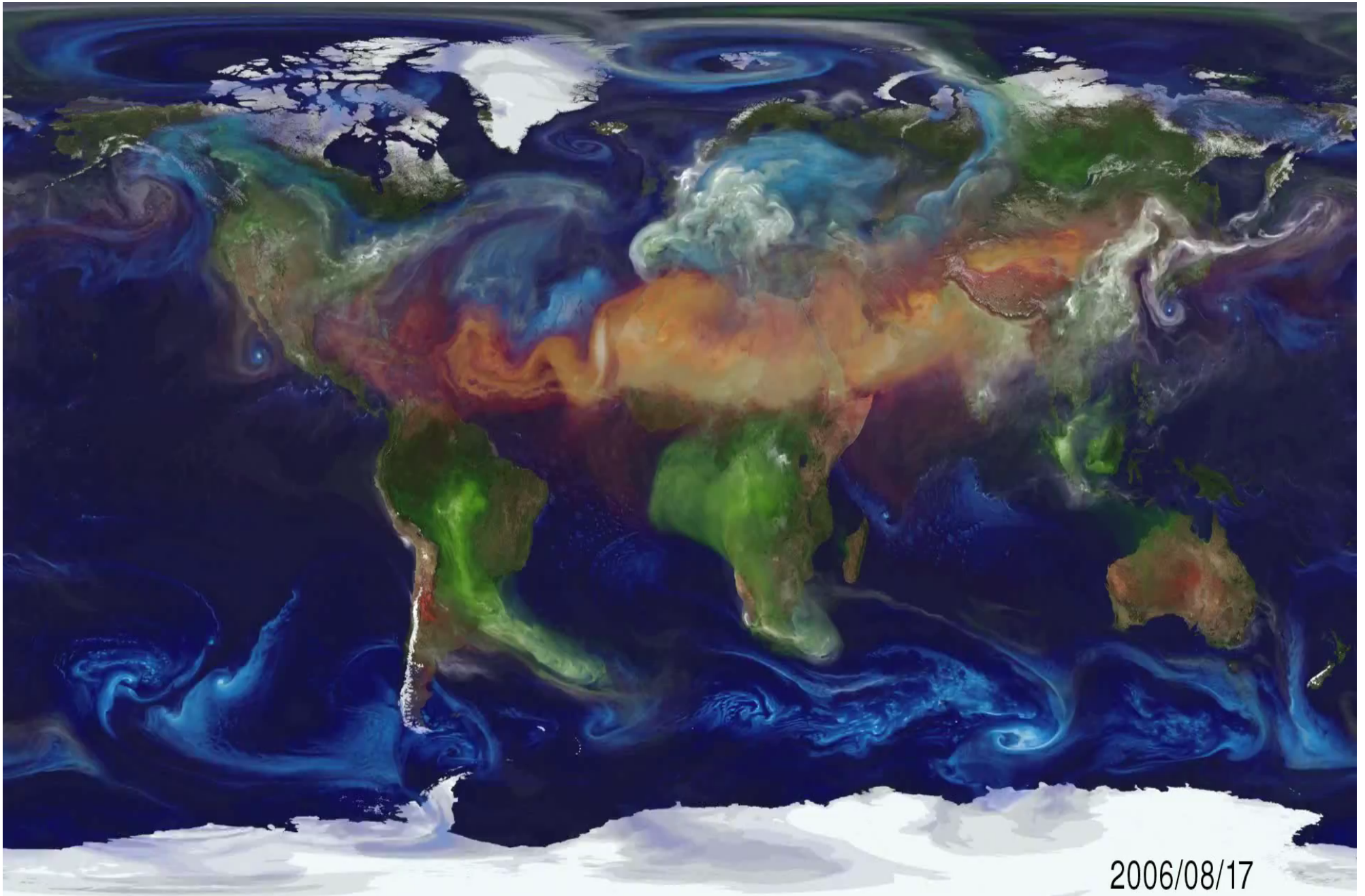
Towards Comprehensive Earth System Models



From space Nature is seamless & borderless!

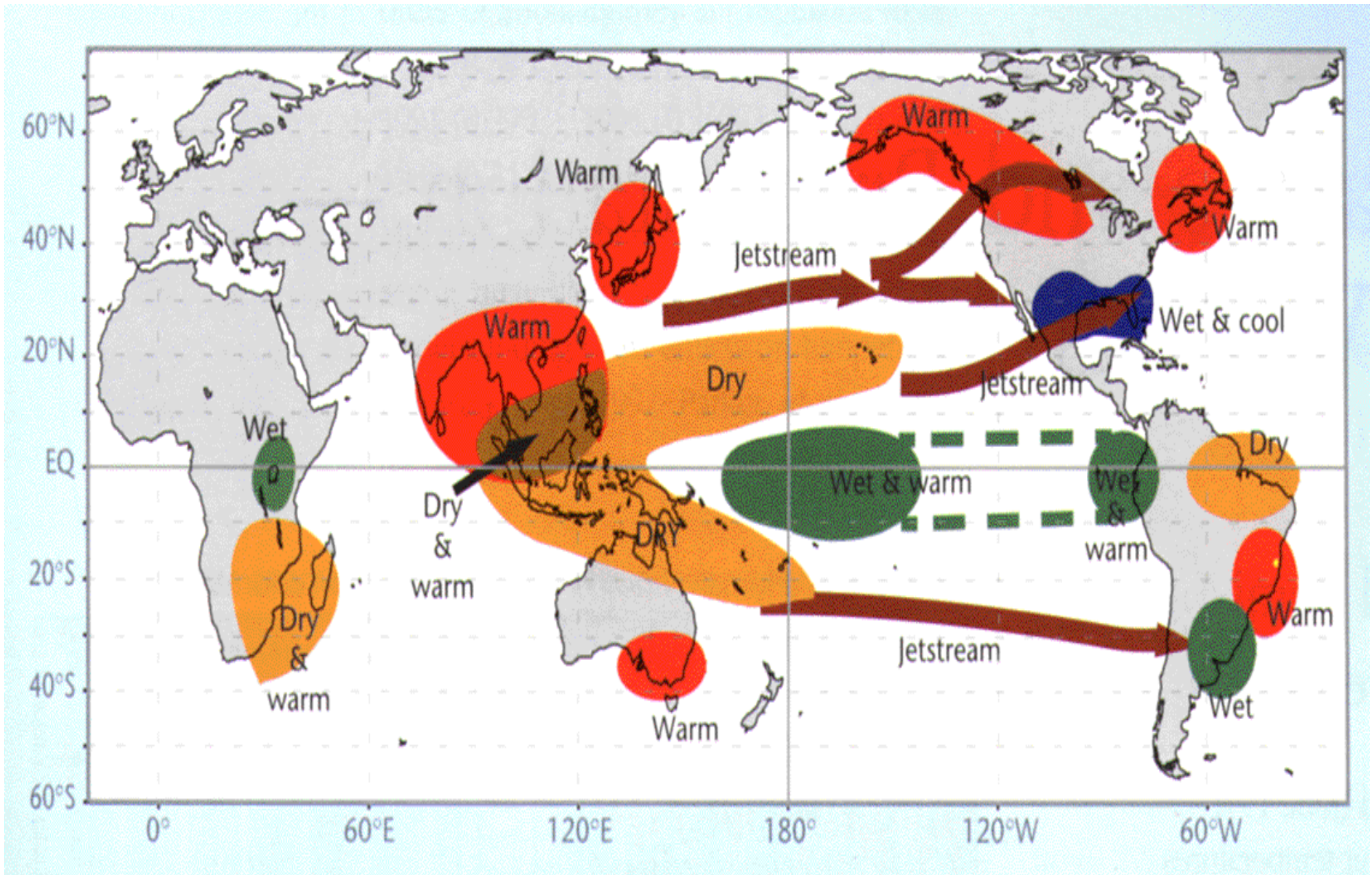


Aerosol dispersion links the whole planet



2006/08/17

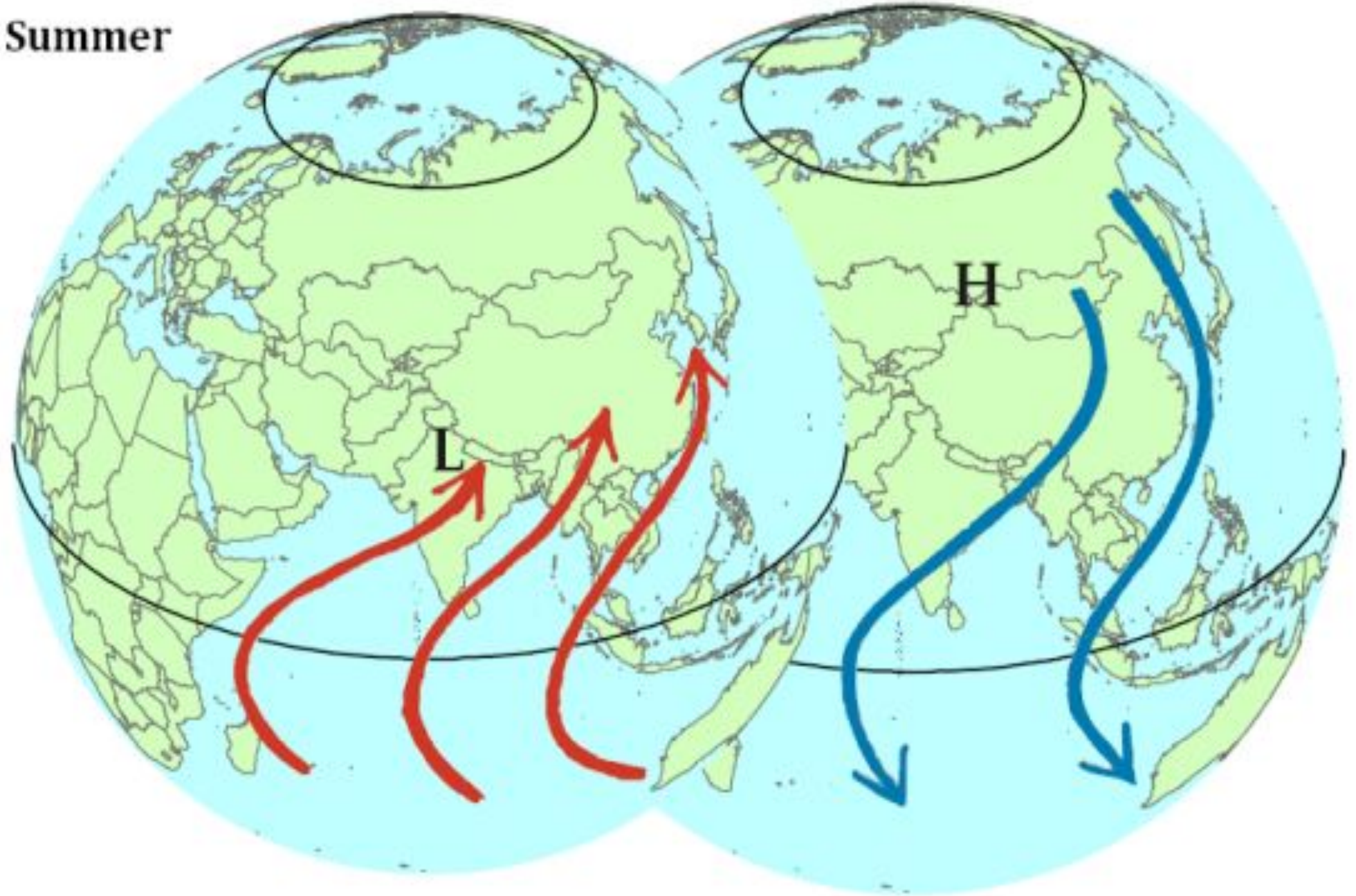
The Monsoons & El Niño also link the whole planet



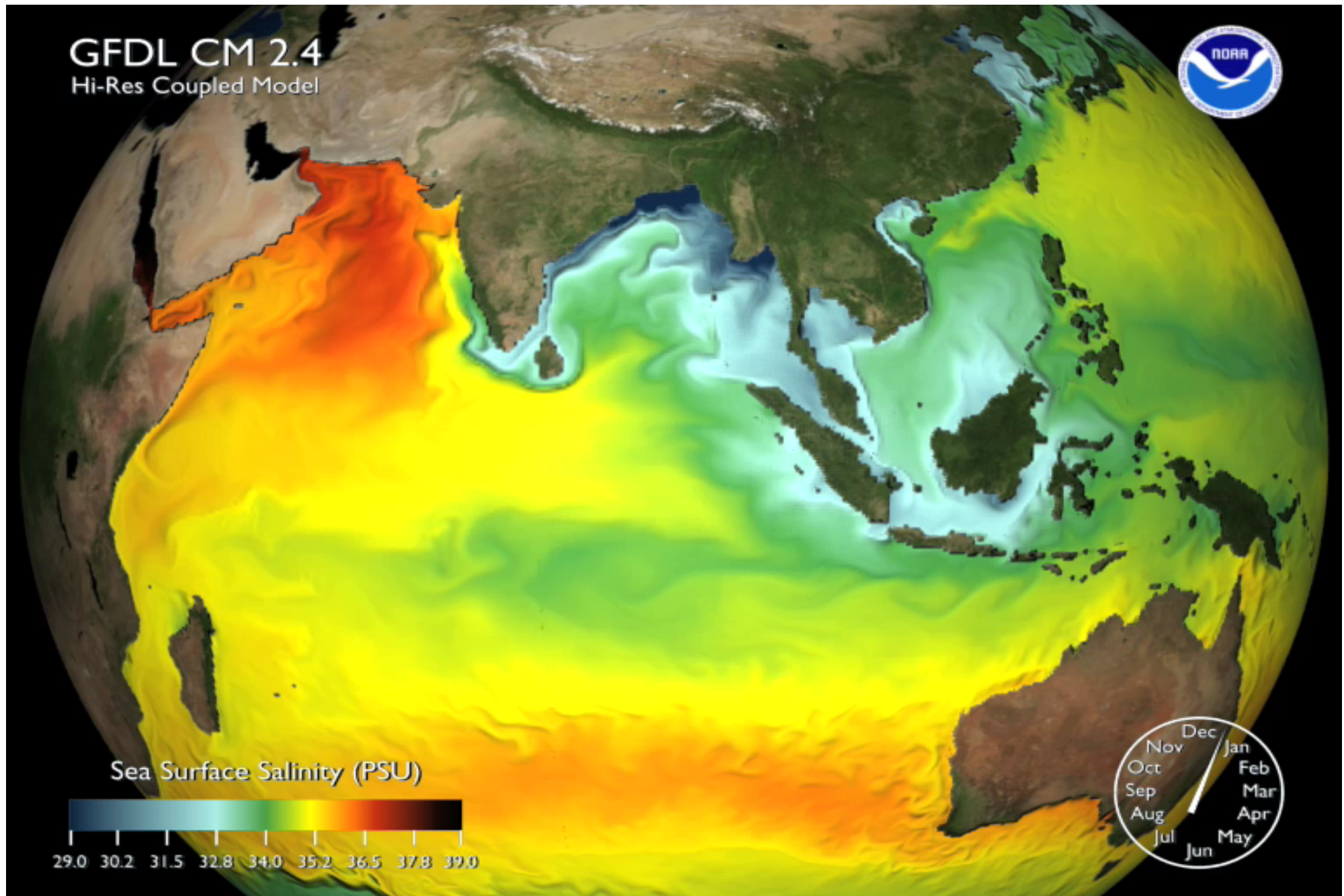
Monsun

Winter

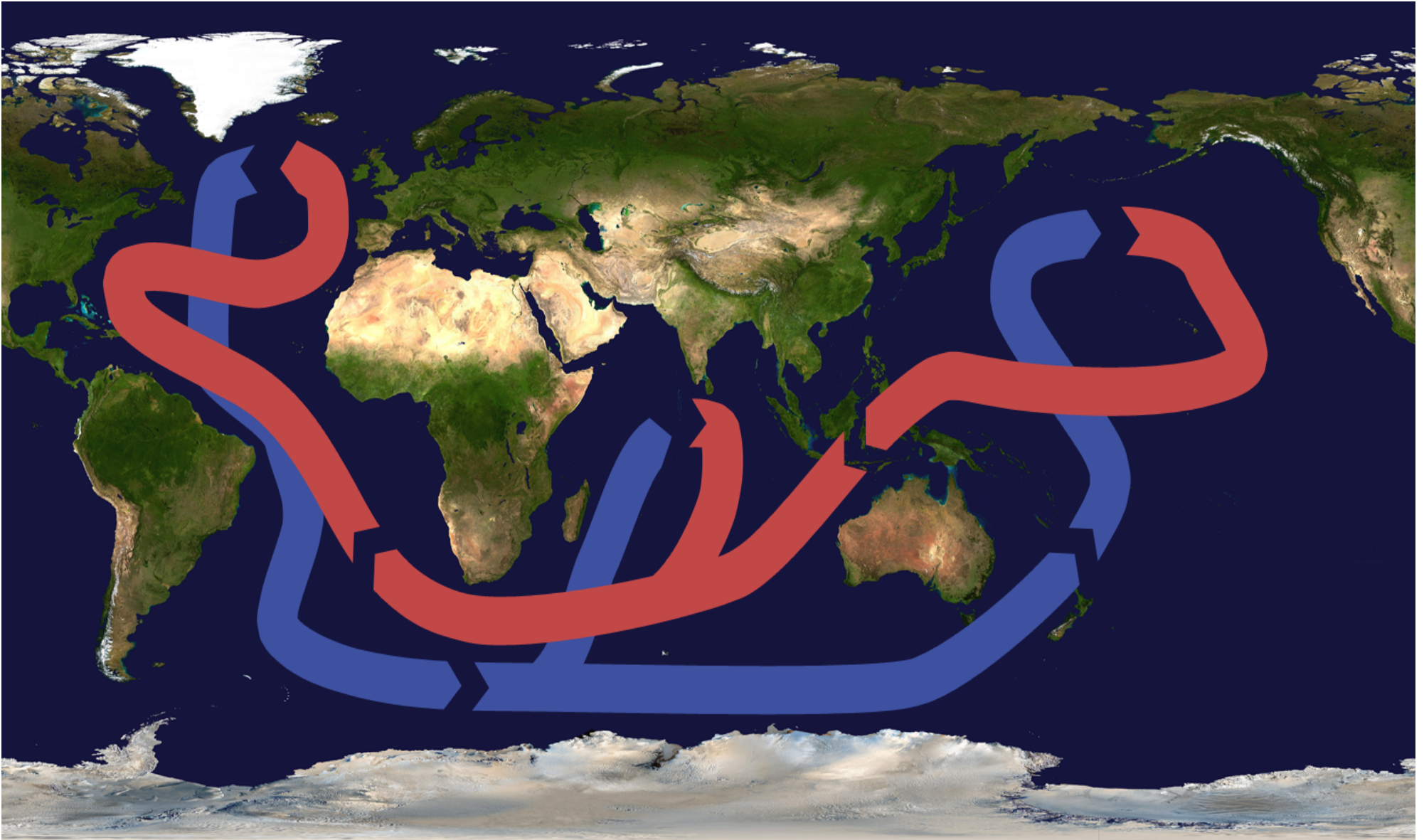
Summer



Sea Surface Salinity & Temperature affect evaporation

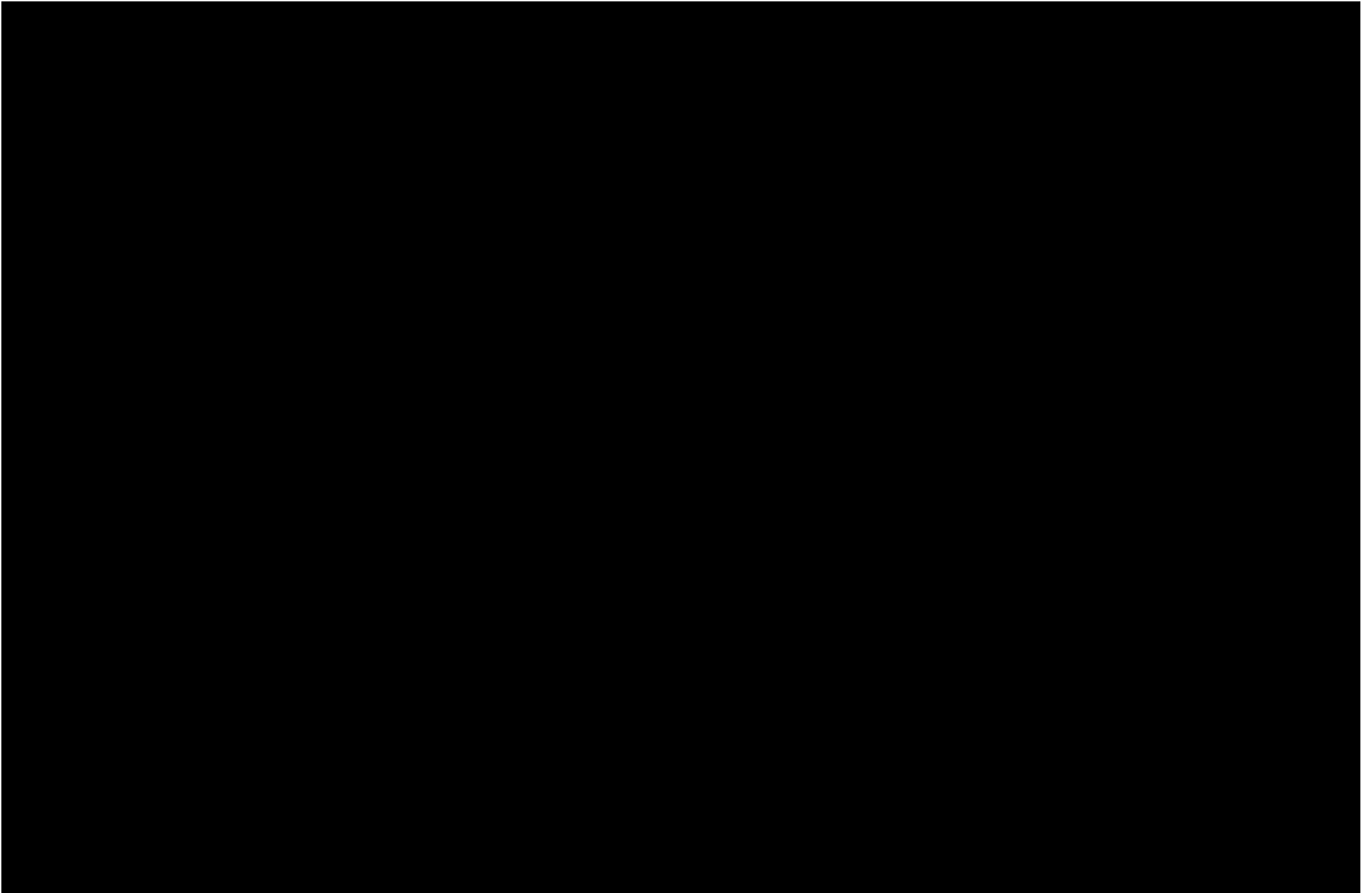


The Ocean Conveyor Belt links all regions of the world

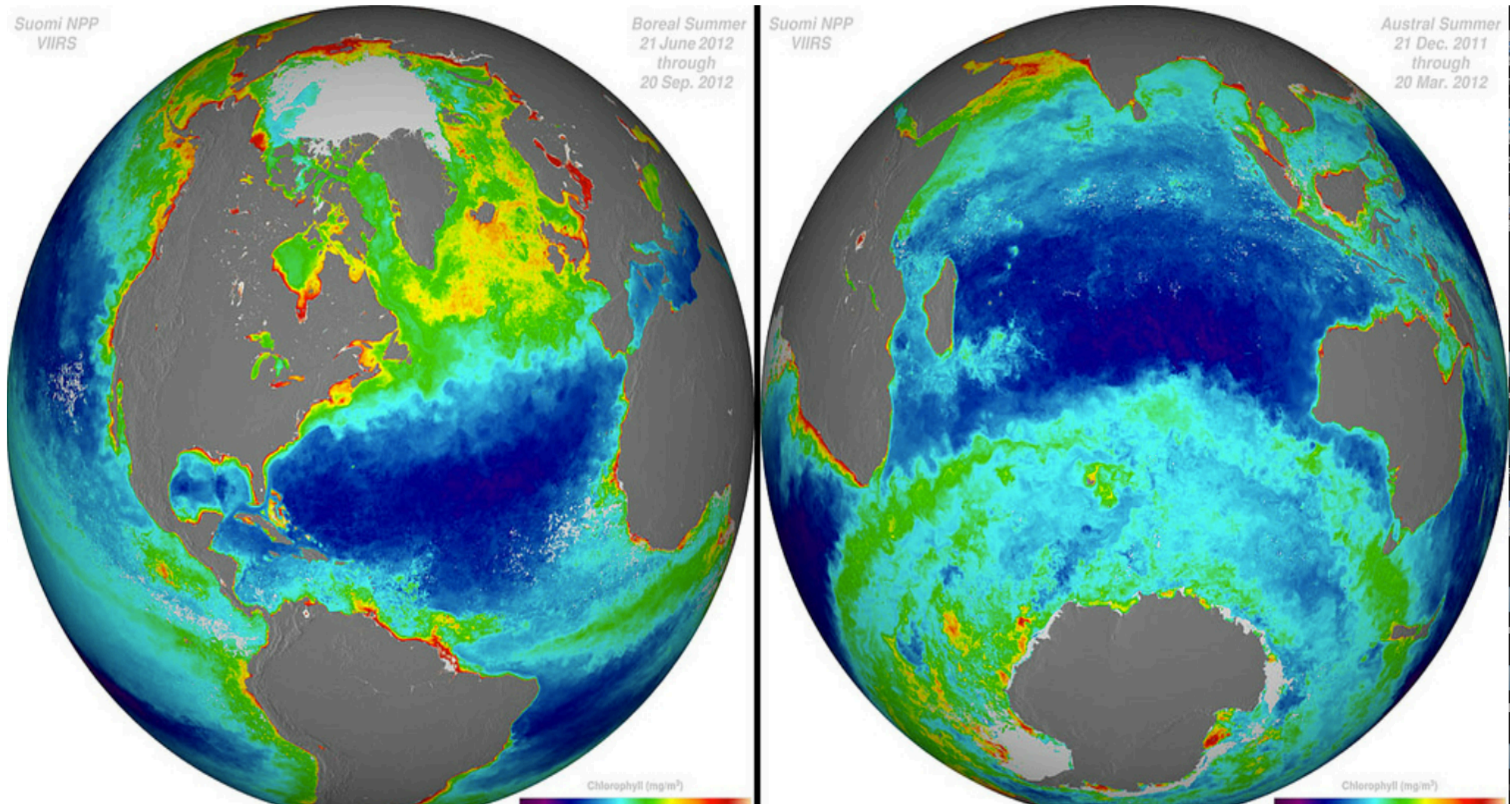


Thermohaline circulation by Brisbane CC BY-SA 3.0 using
NASA Goddard Space Flight Center images from Visible Earth

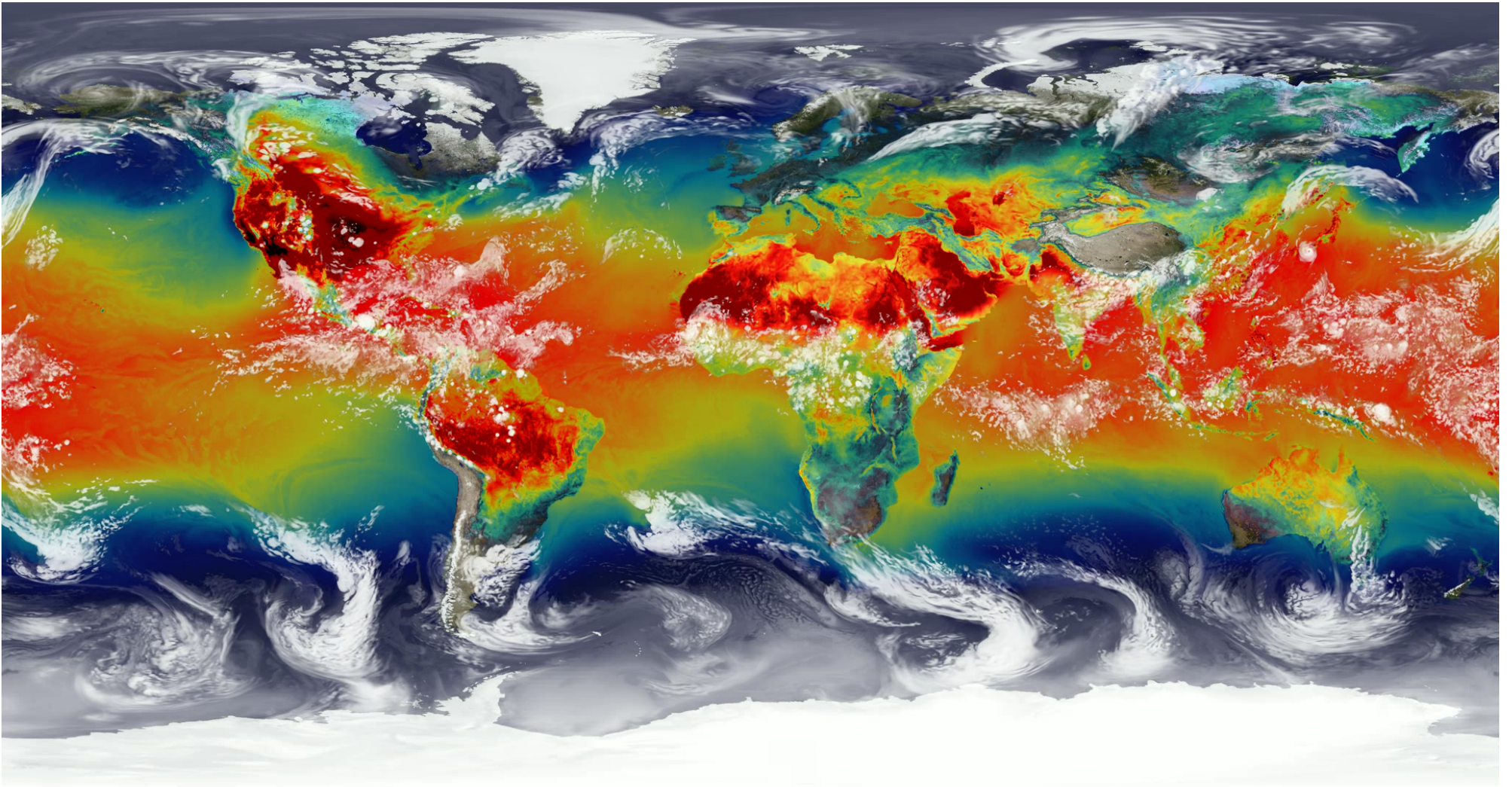
Surface eddy currents transfer heat regionally



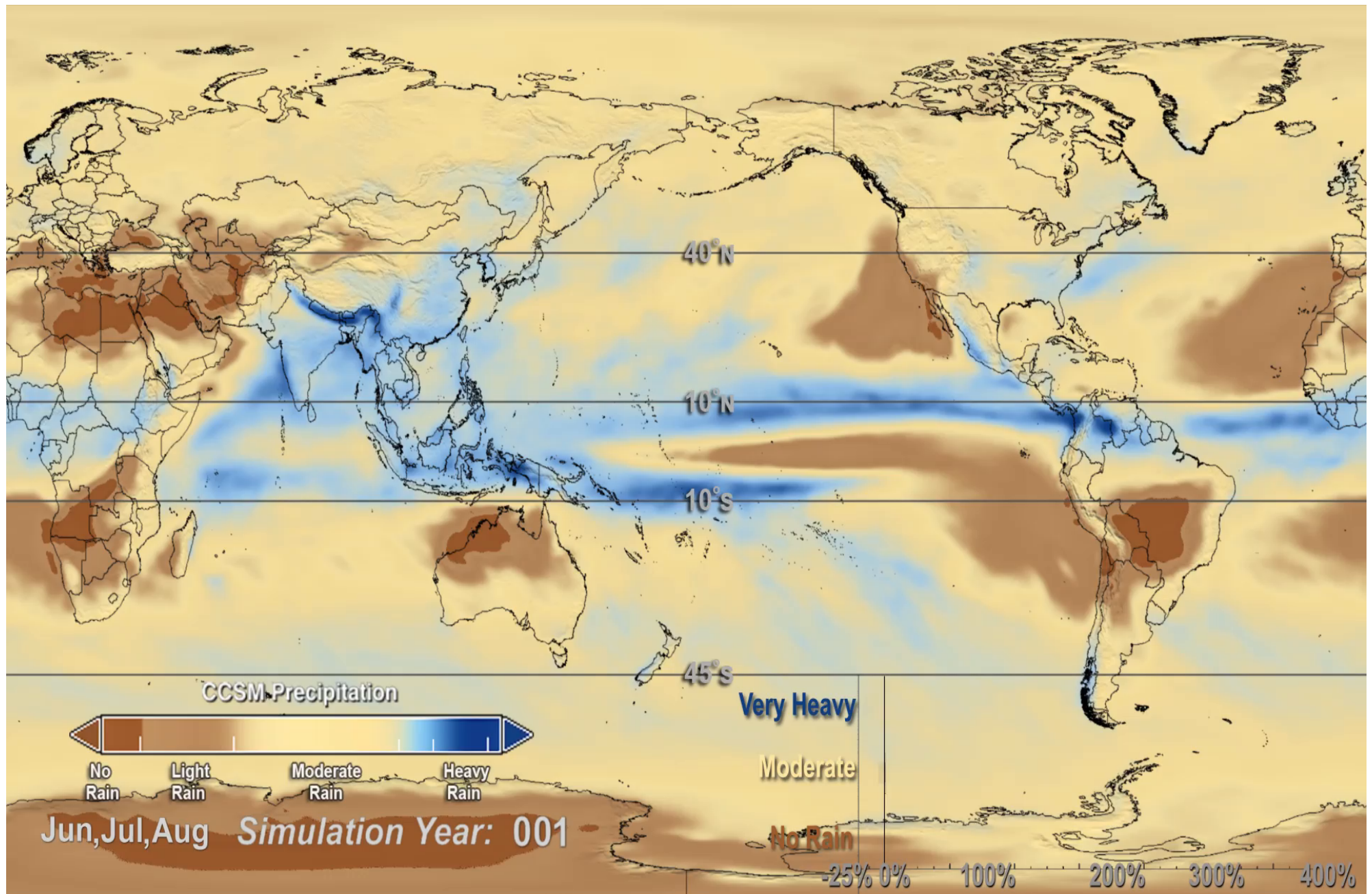
Chlorophyll & phytoplankton are the base of ocean life



Planetary temperatures are rising



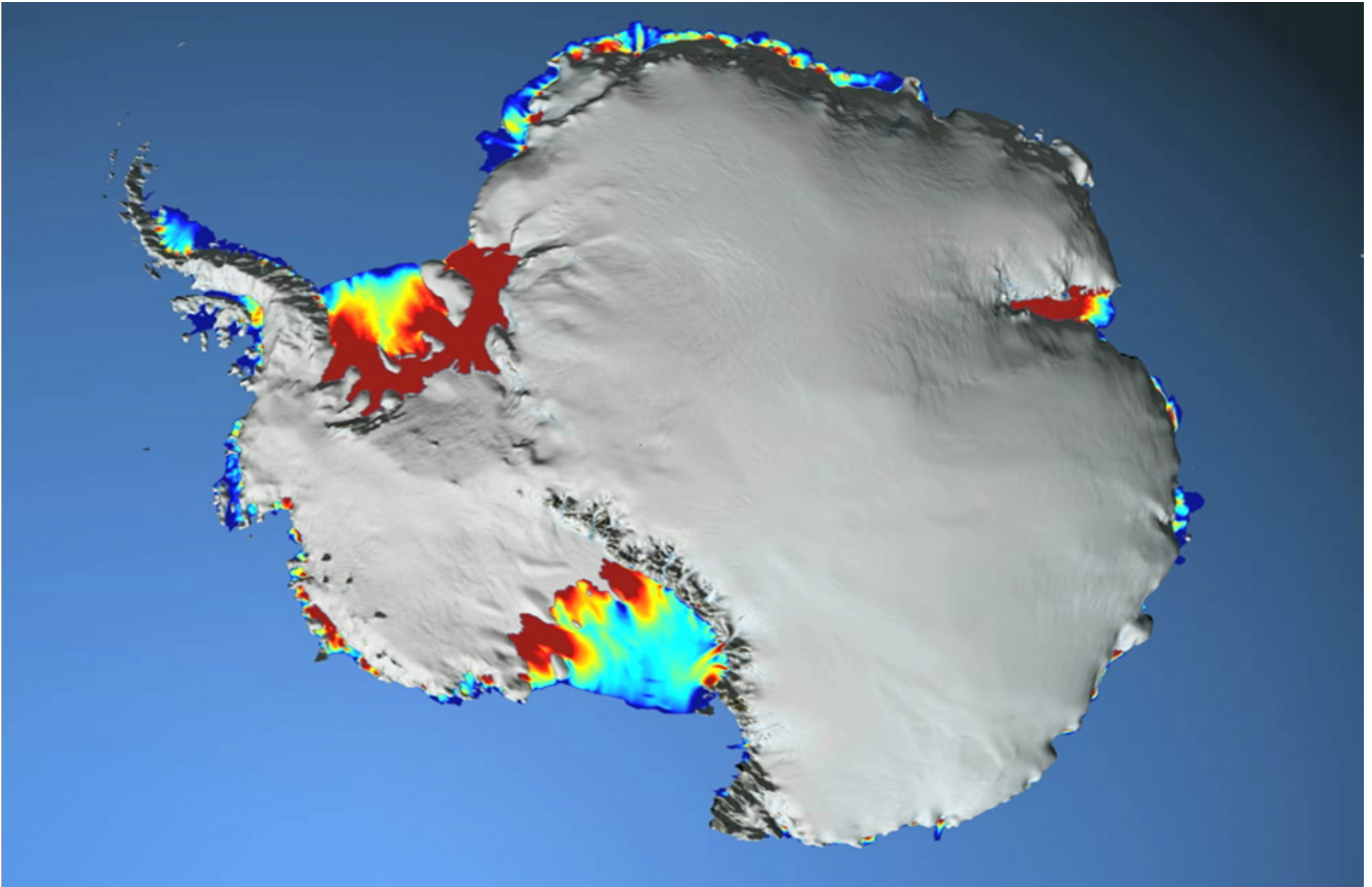
140 year projection of drought & precipitation



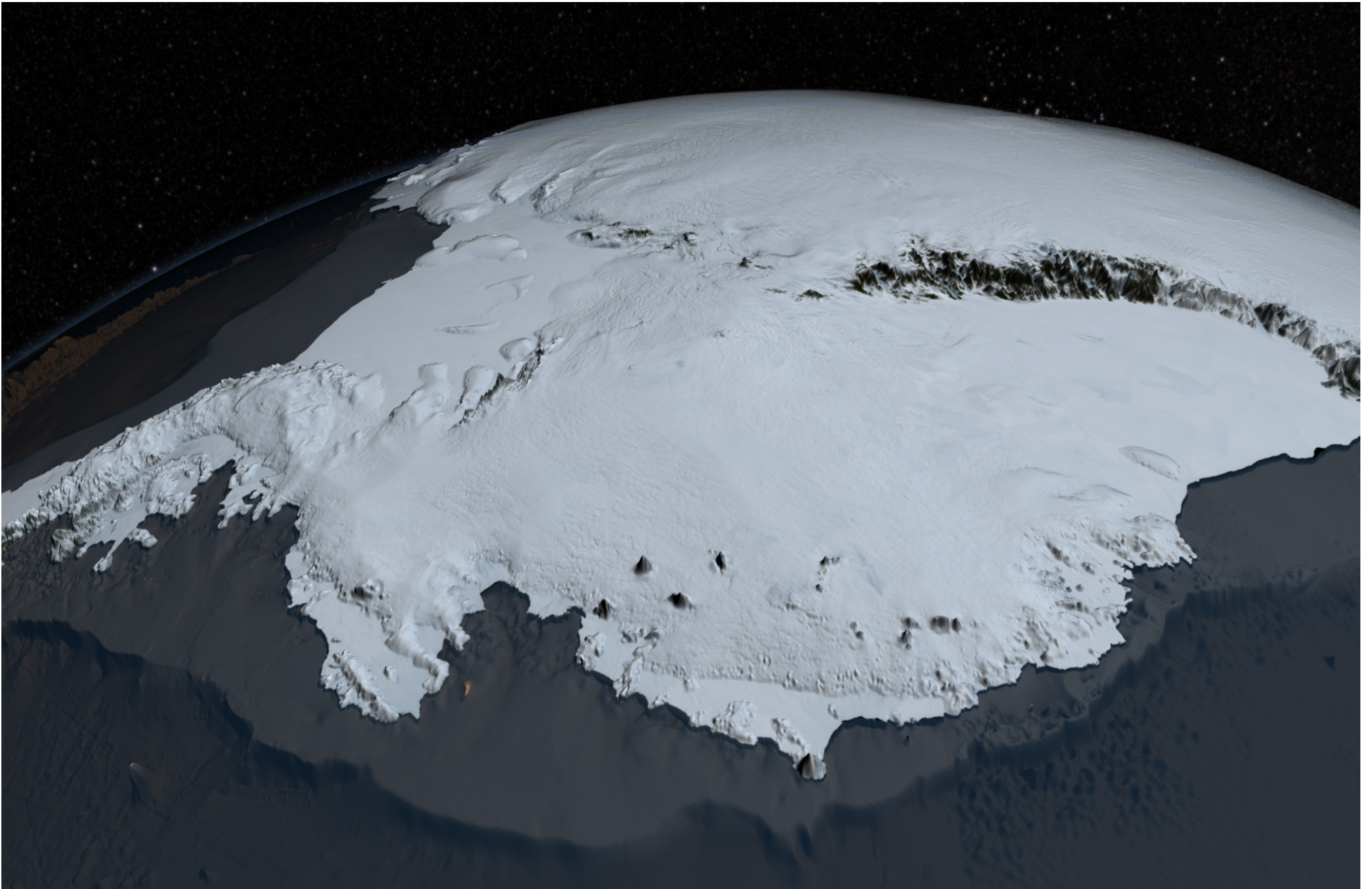
The polar regions are under great threat



Antarctica: glacial retreat and warming ocean currents



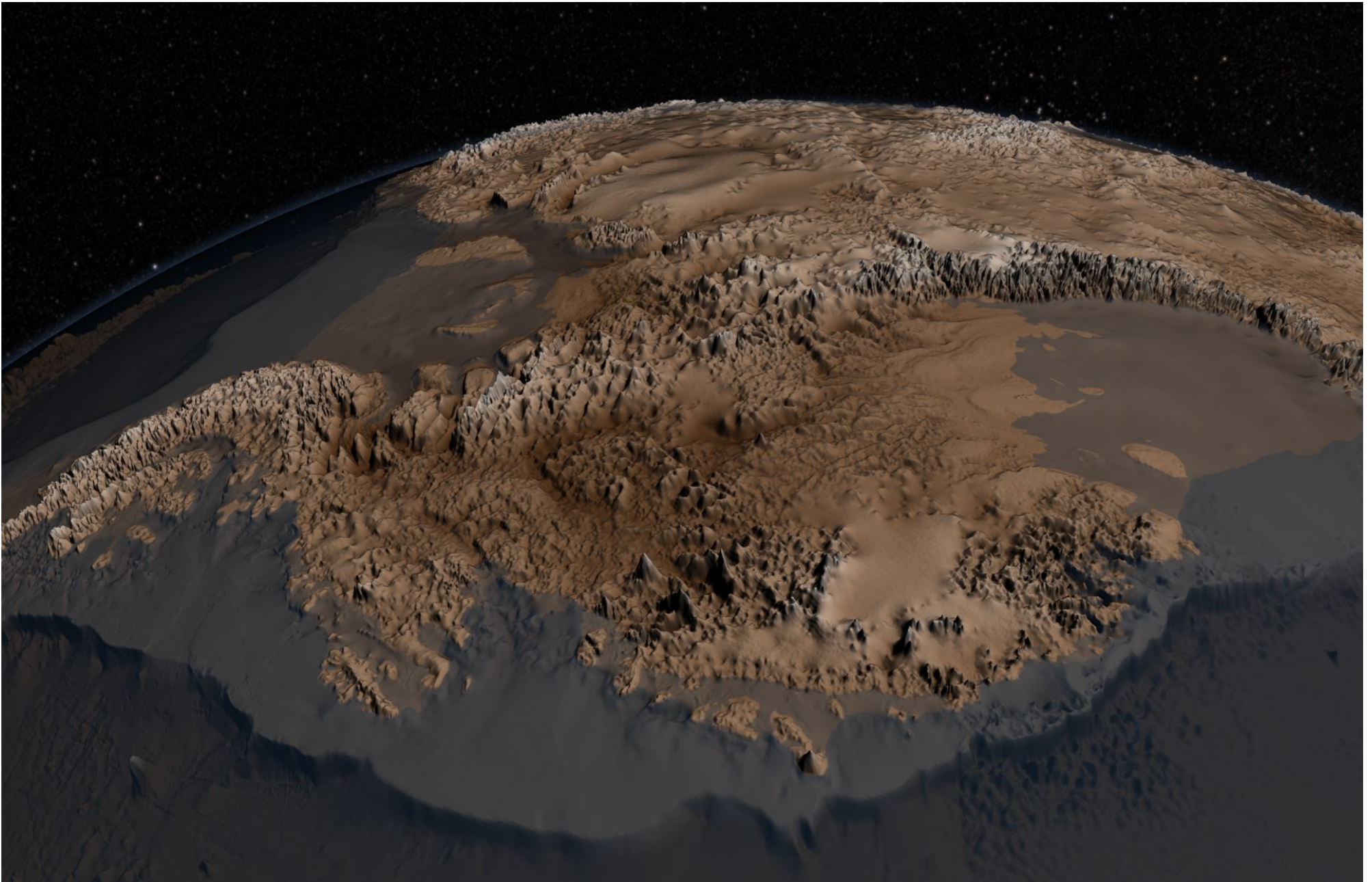
Antarctica: a major influence on the global climate



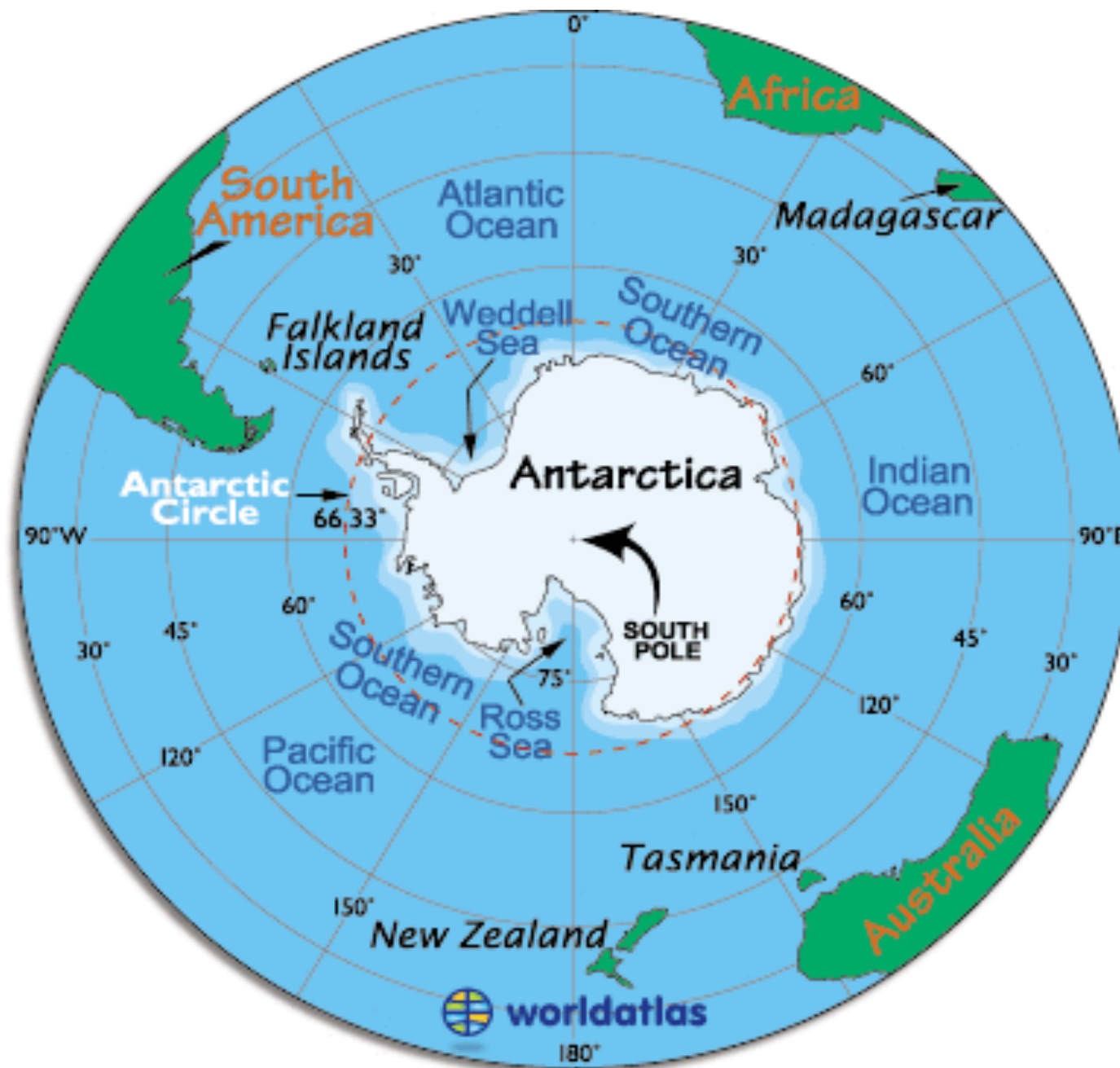
Antarctica: 14M km² area, 2 km thick



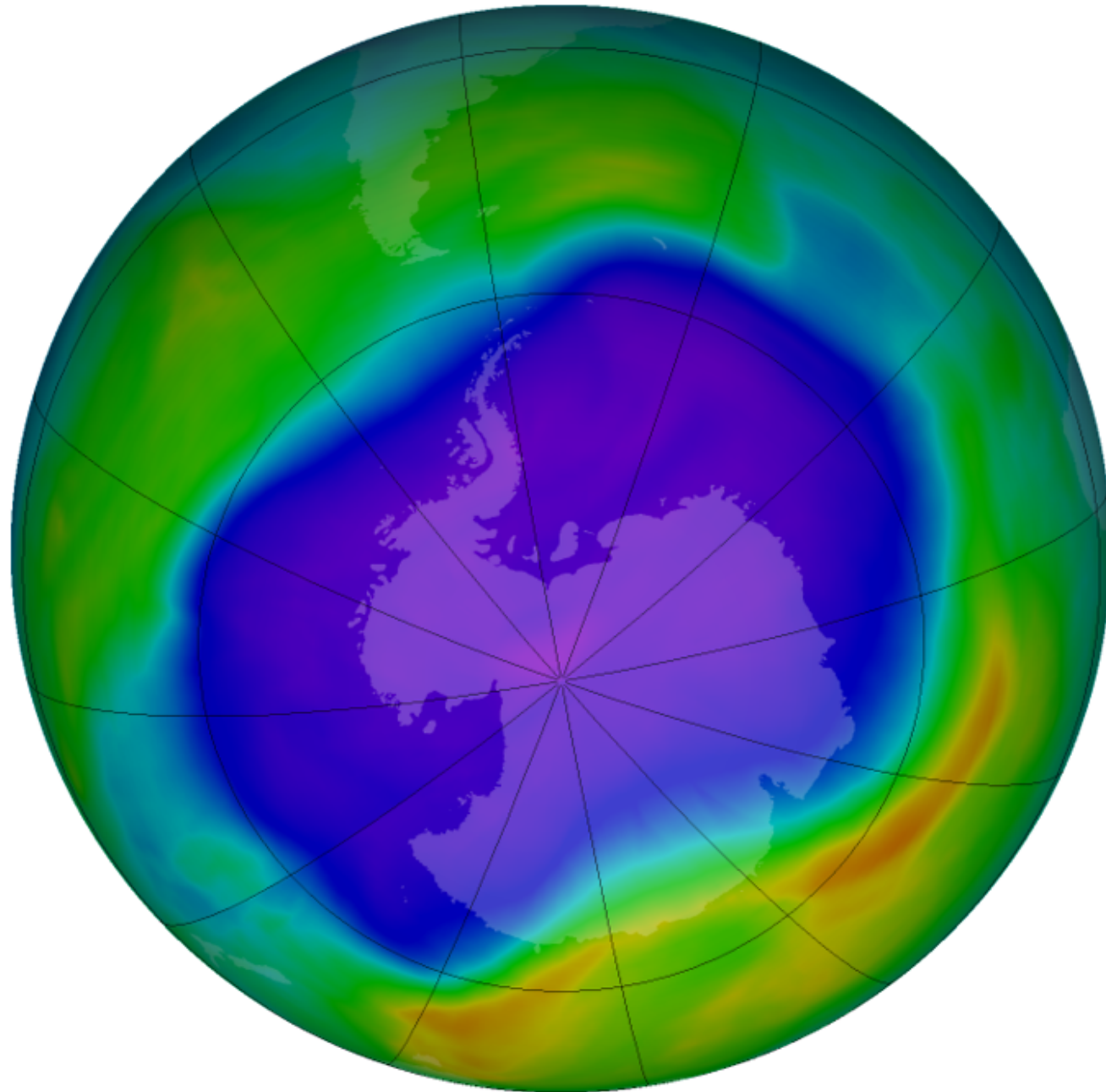
Below the ice: ancient lakes, fjords & life forms exist



The Southern Ocean circulates around Antarctica



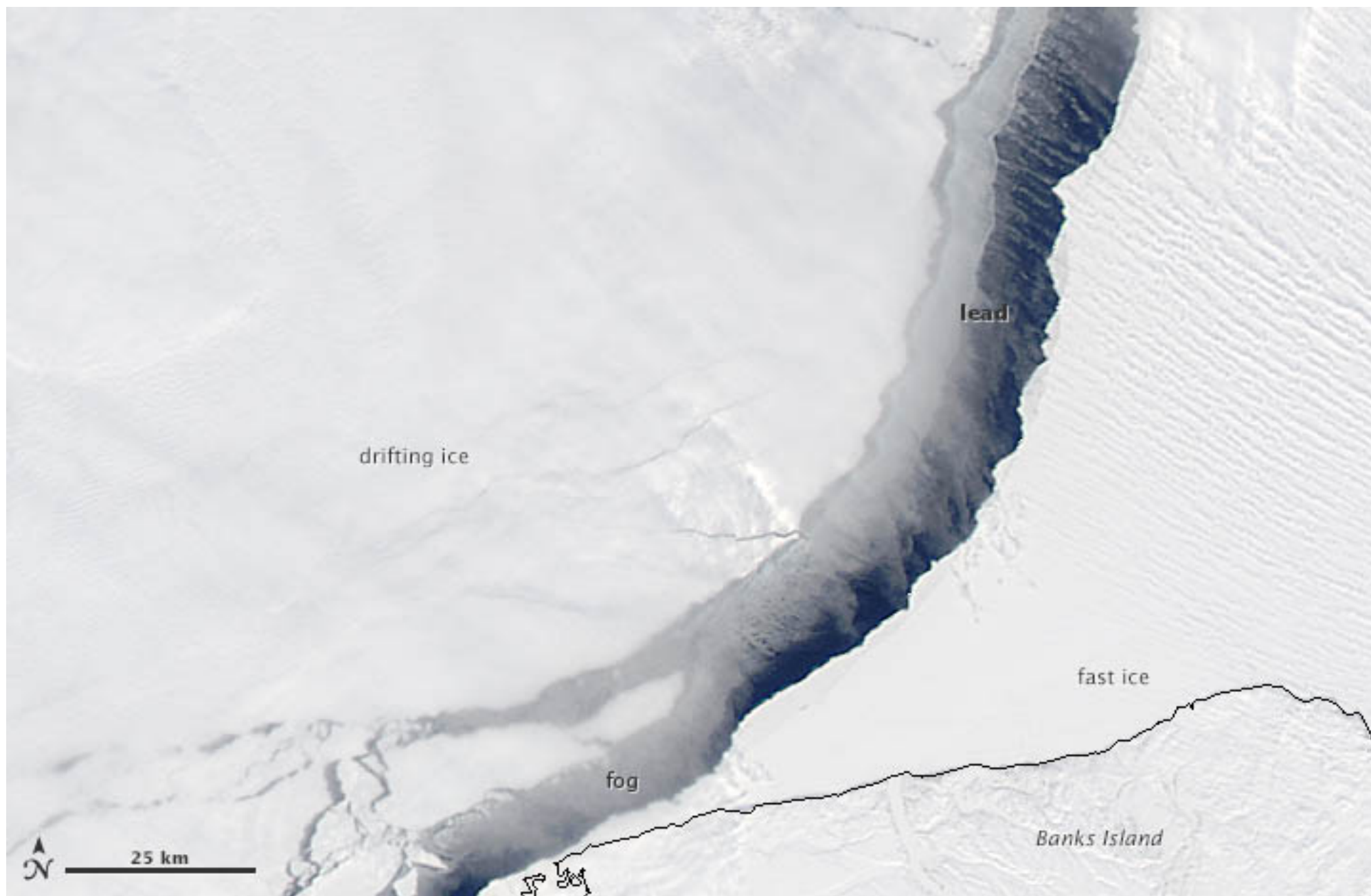
Luckily for us, the Ozone Hole is slowly being closed!



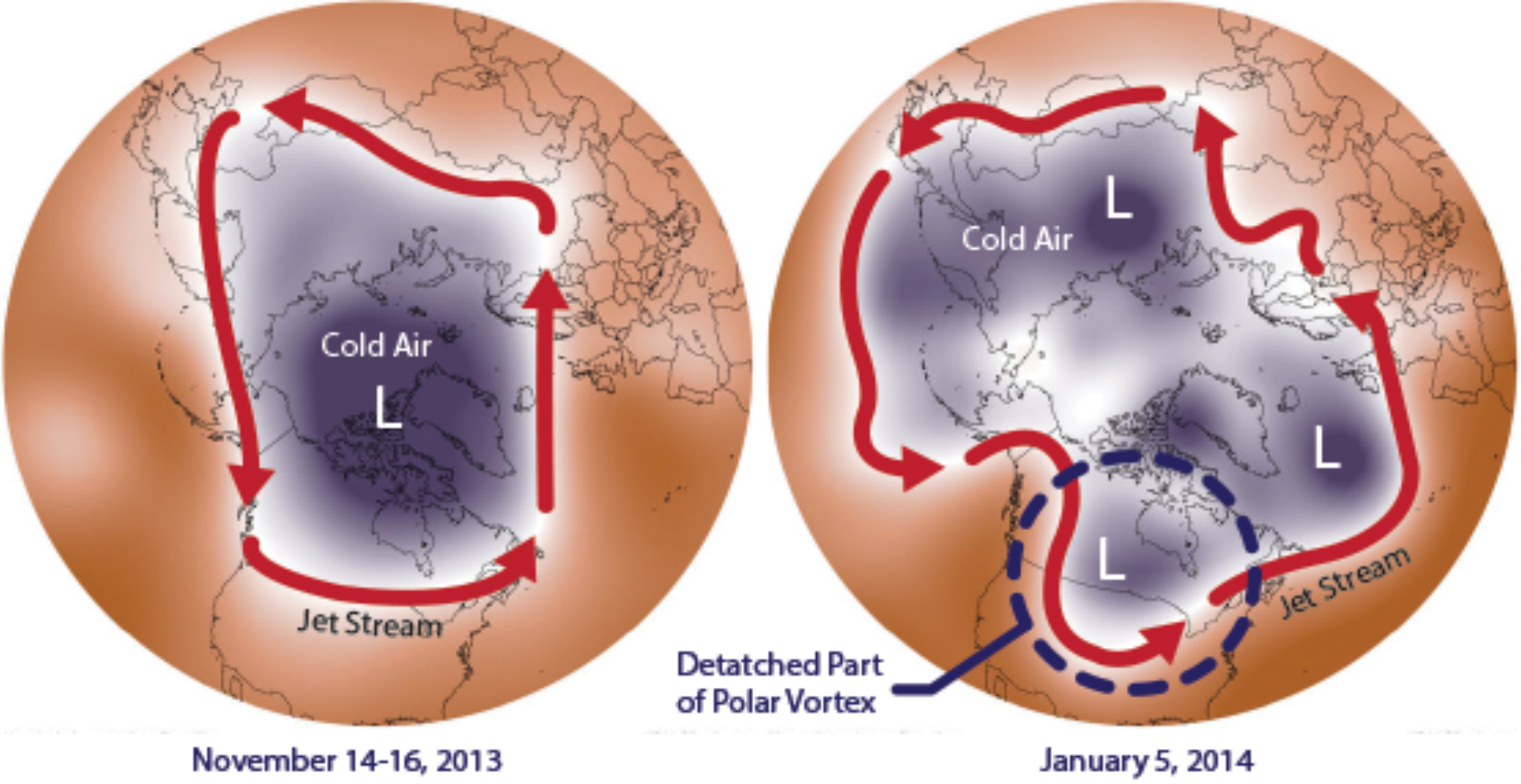
The Arctic Ocean is rapidly becoming ice free



Arctic glacial retreat, loss of ice-sheets & permafrost



The Northern Polar Jet Stream has become unstable



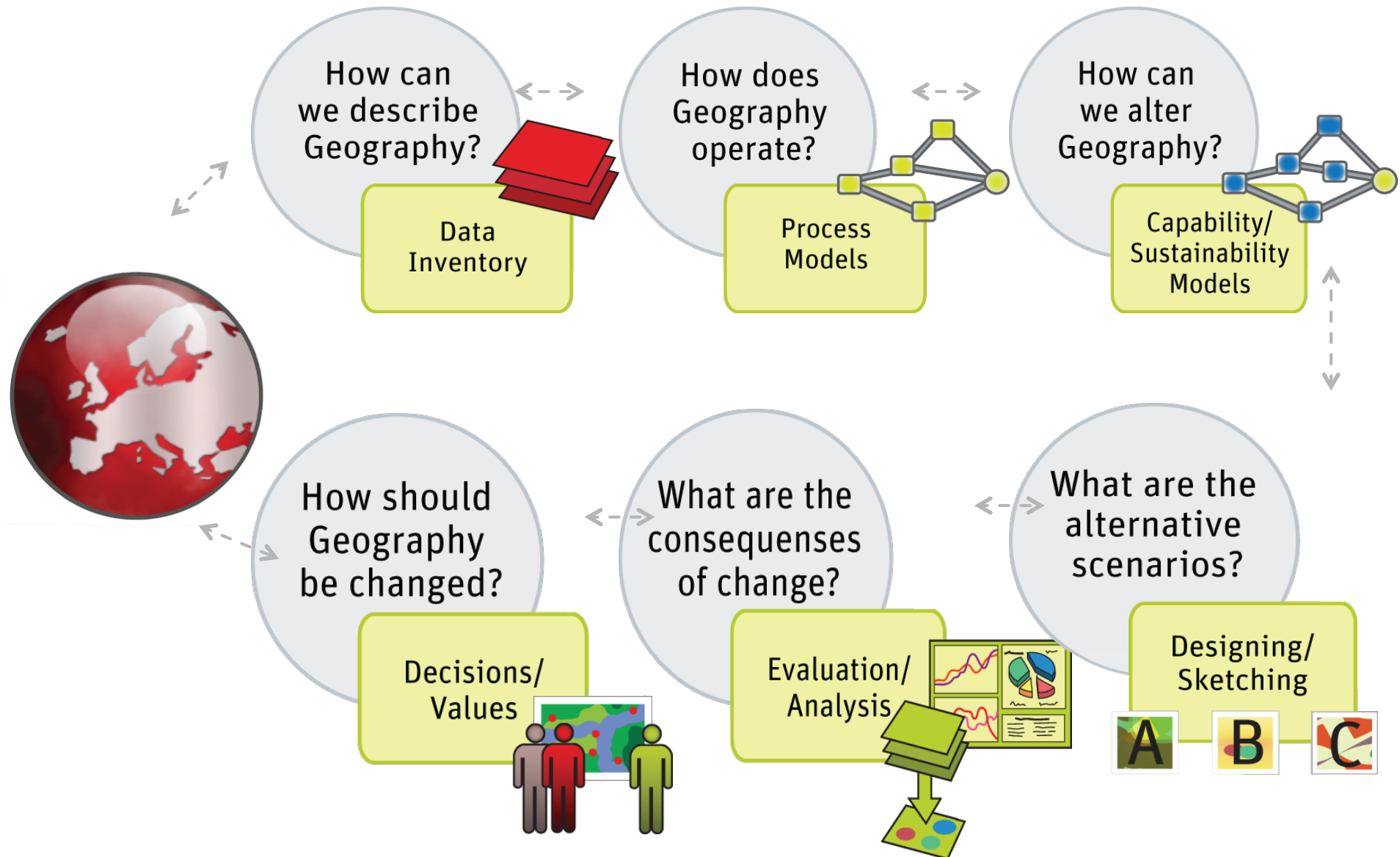
Key is to understand how all Earth Systems interact!



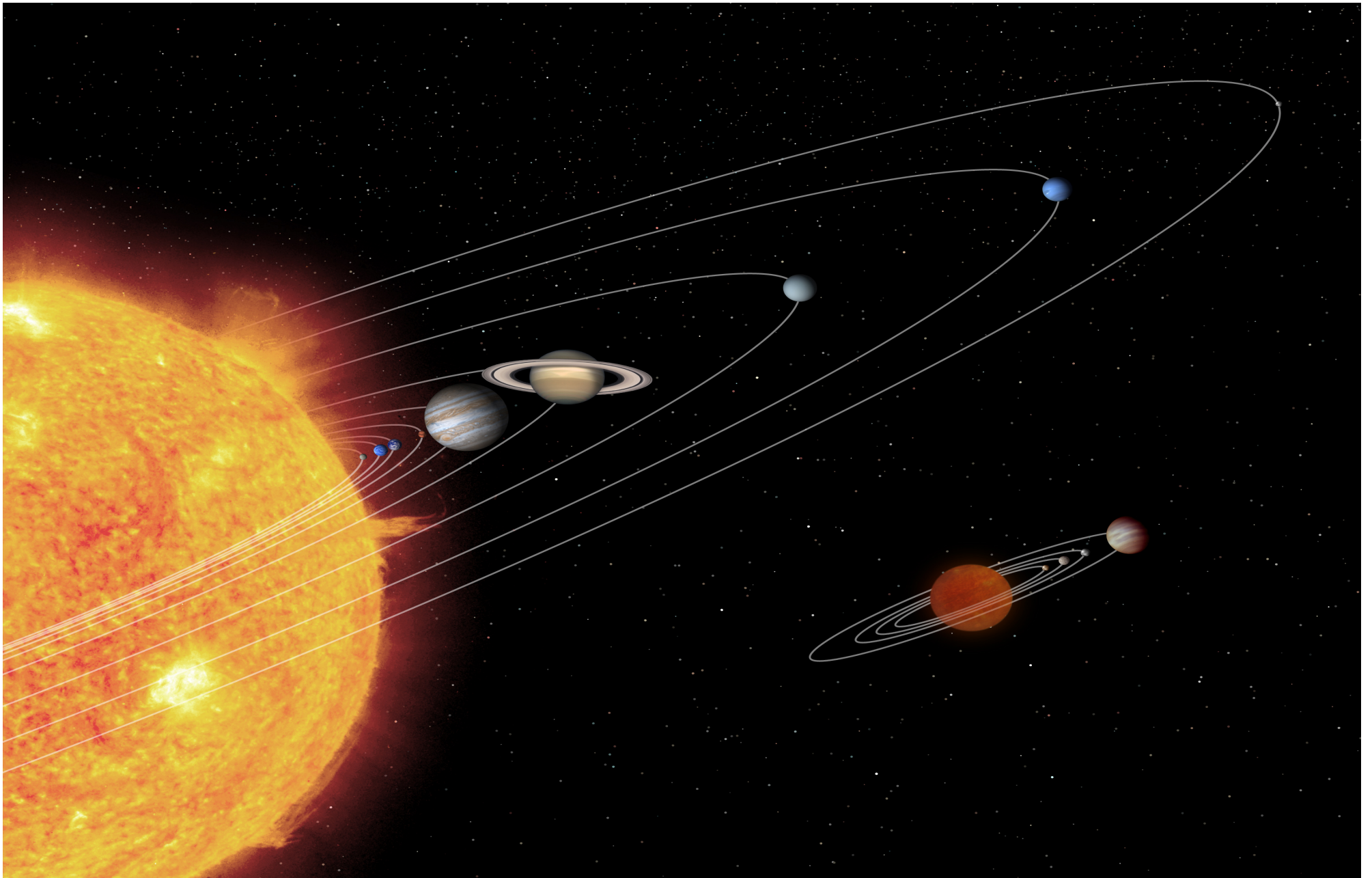
Ecologies: the global-to-local view, from soil-to-sky



ICES-TEST venture for for city-regional modelling



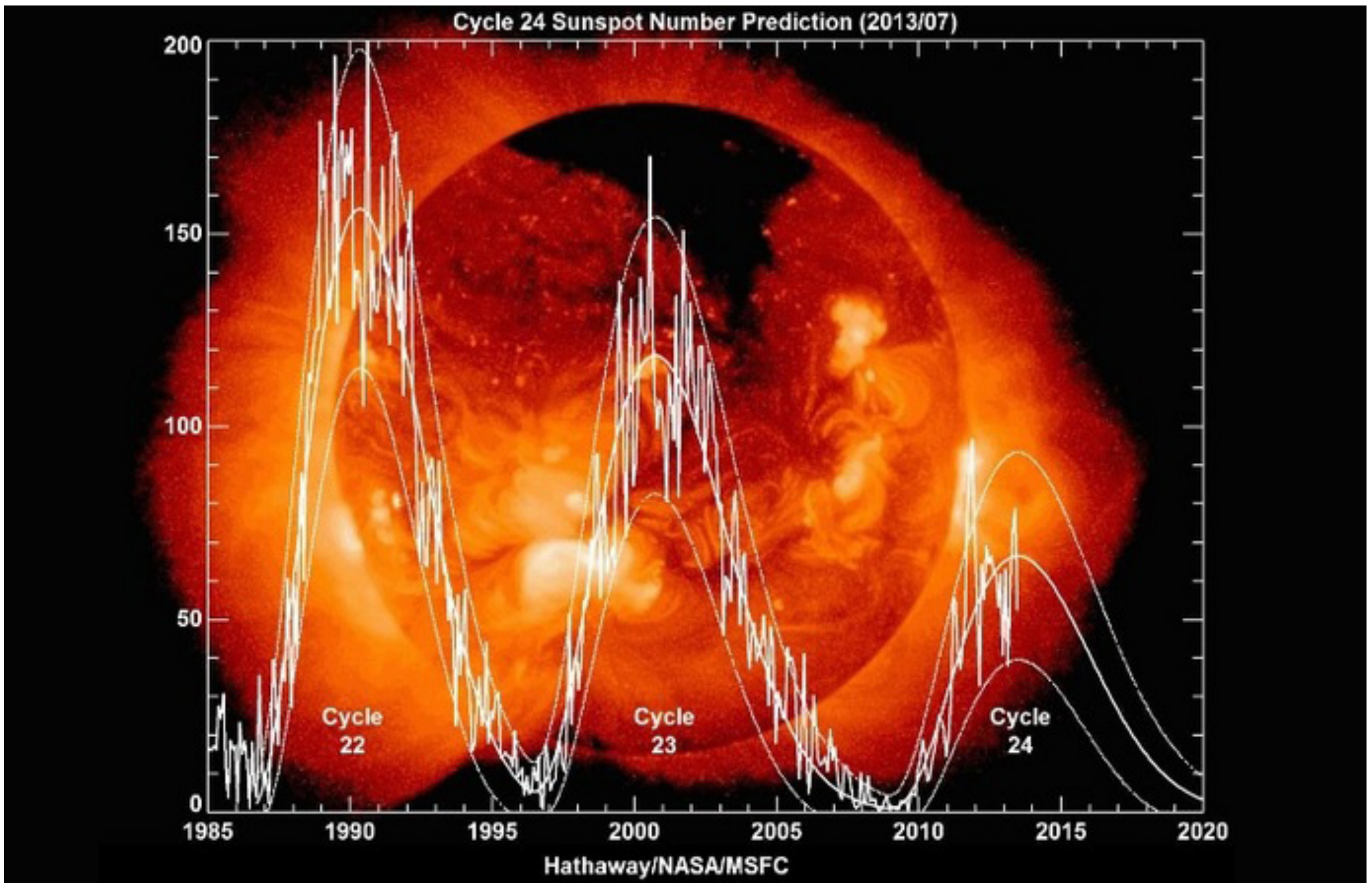
The entire Solar System is dynamically interconnected



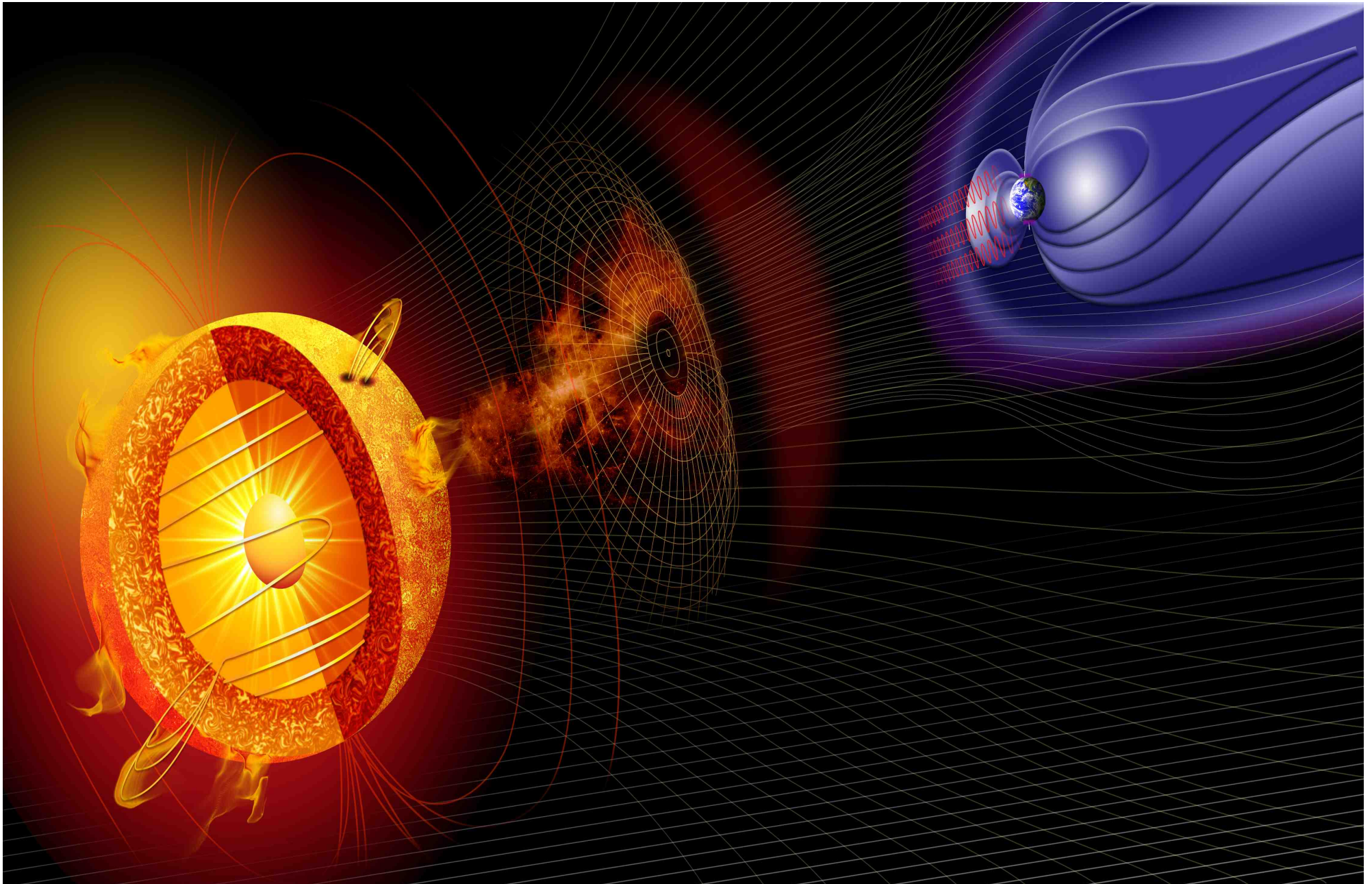
Our Sun is the central driver



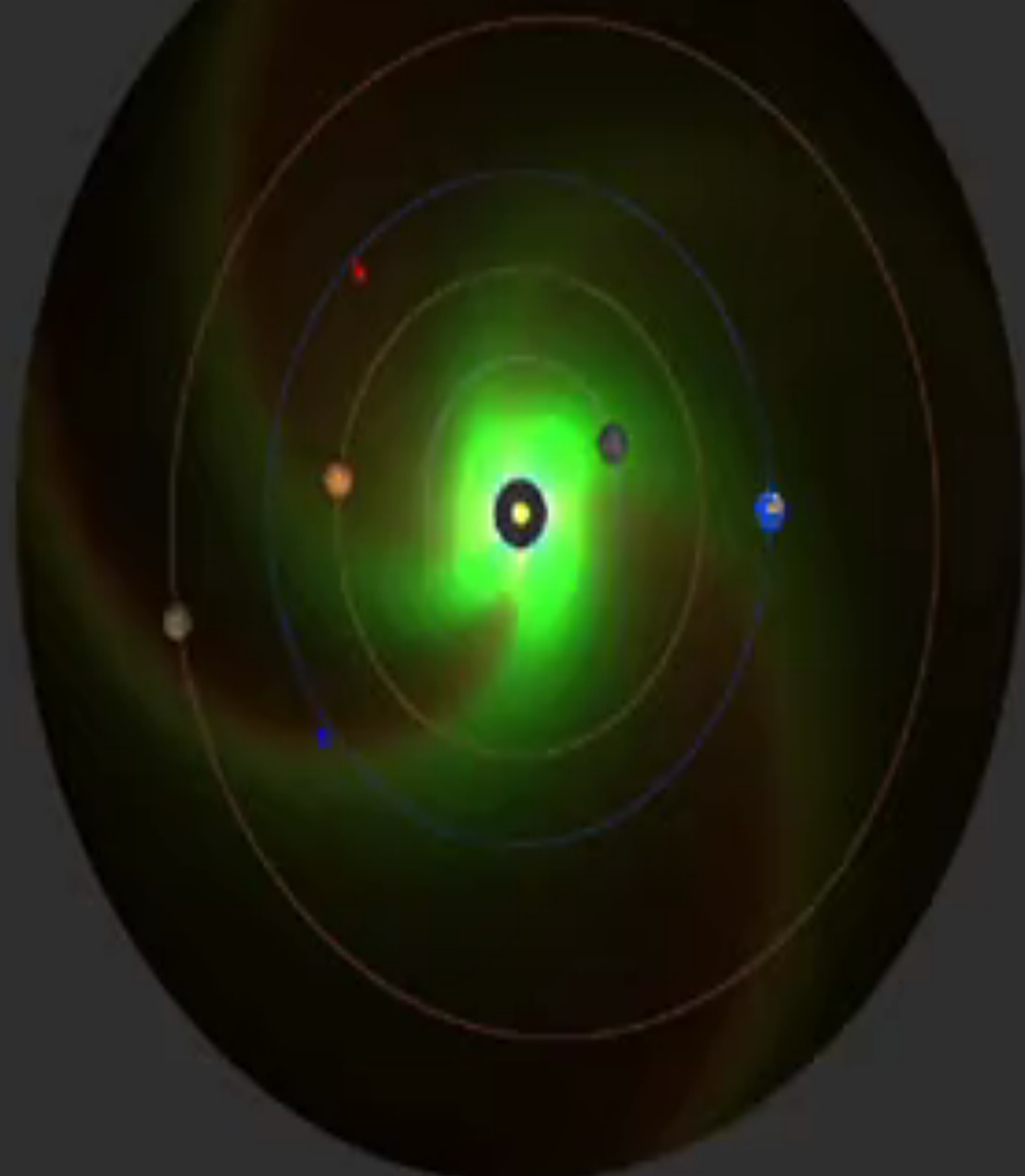
Our Sun has a variable 11-year sunspot cycle



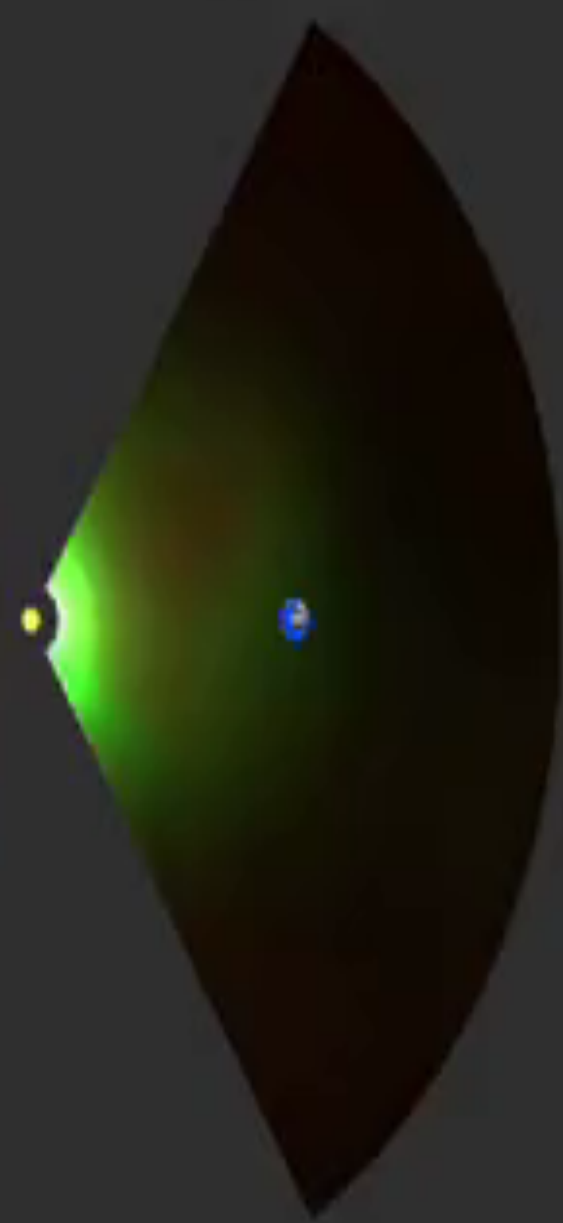
Space Weather between Sun & Earth is a new science



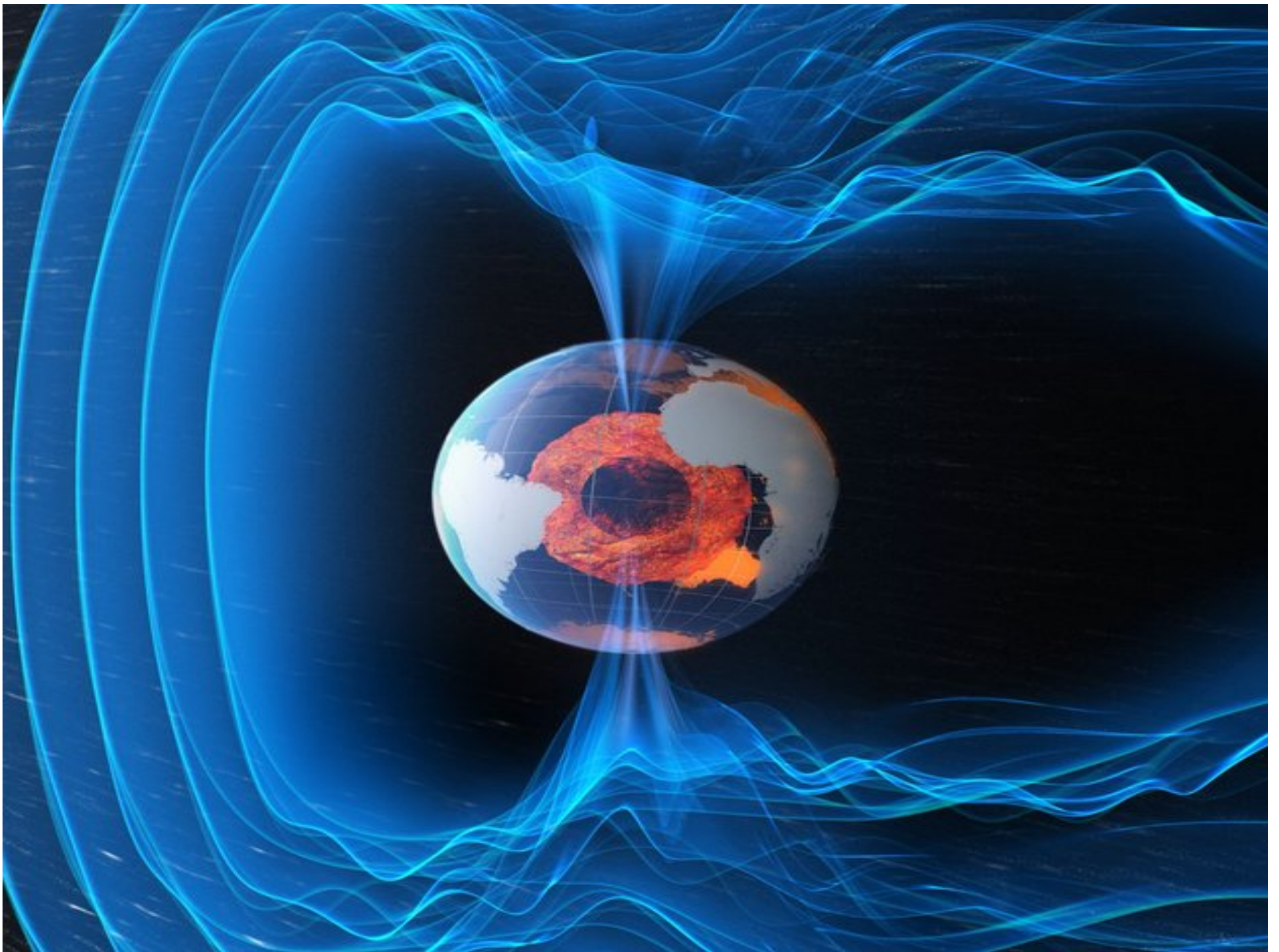
Top View



Side View



2013 Mar 14 00:00:07 UTC



High energy particles leak down to Earth at the poles



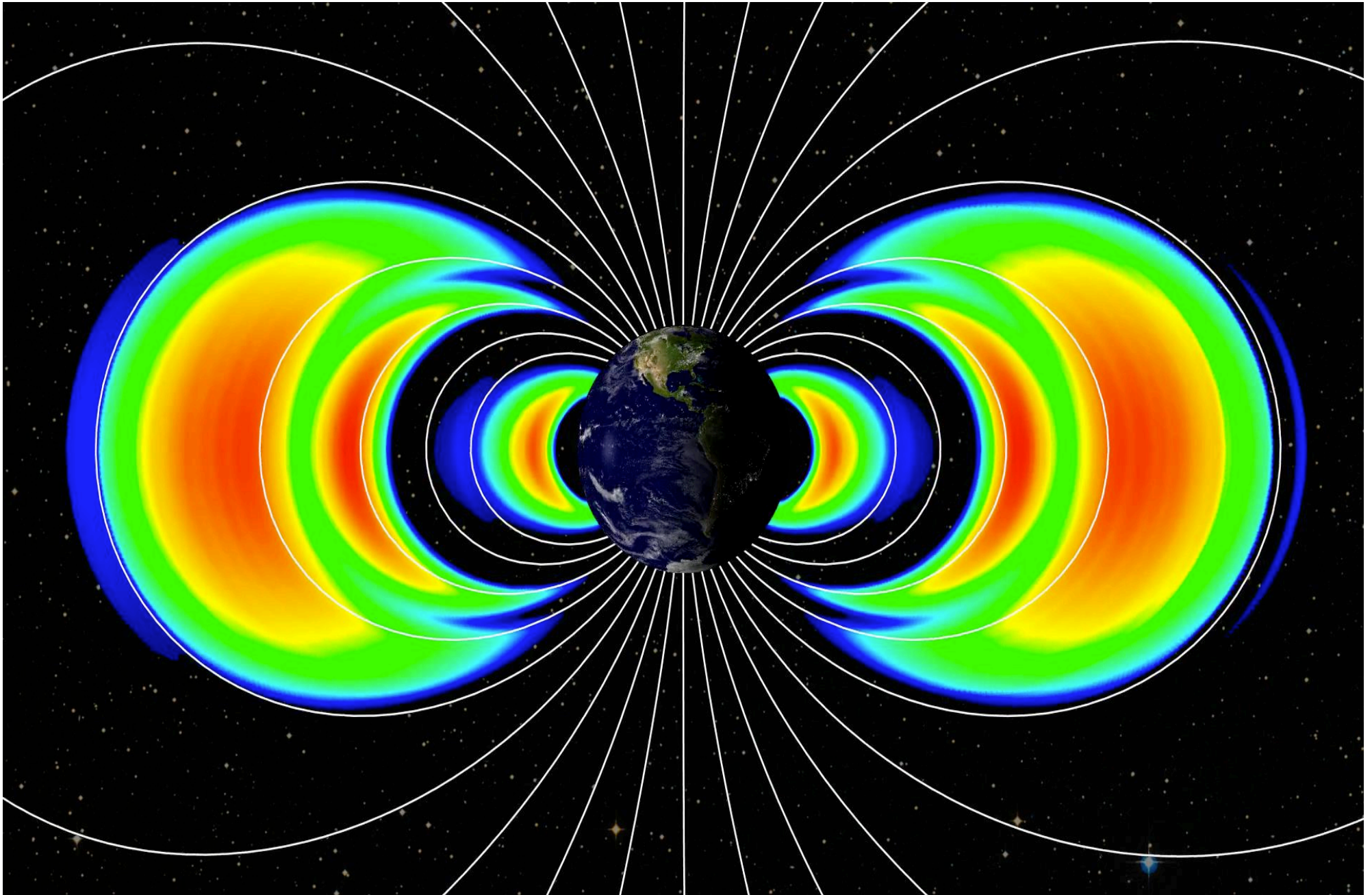
Creating enormous currents in the Earth's ionosphere



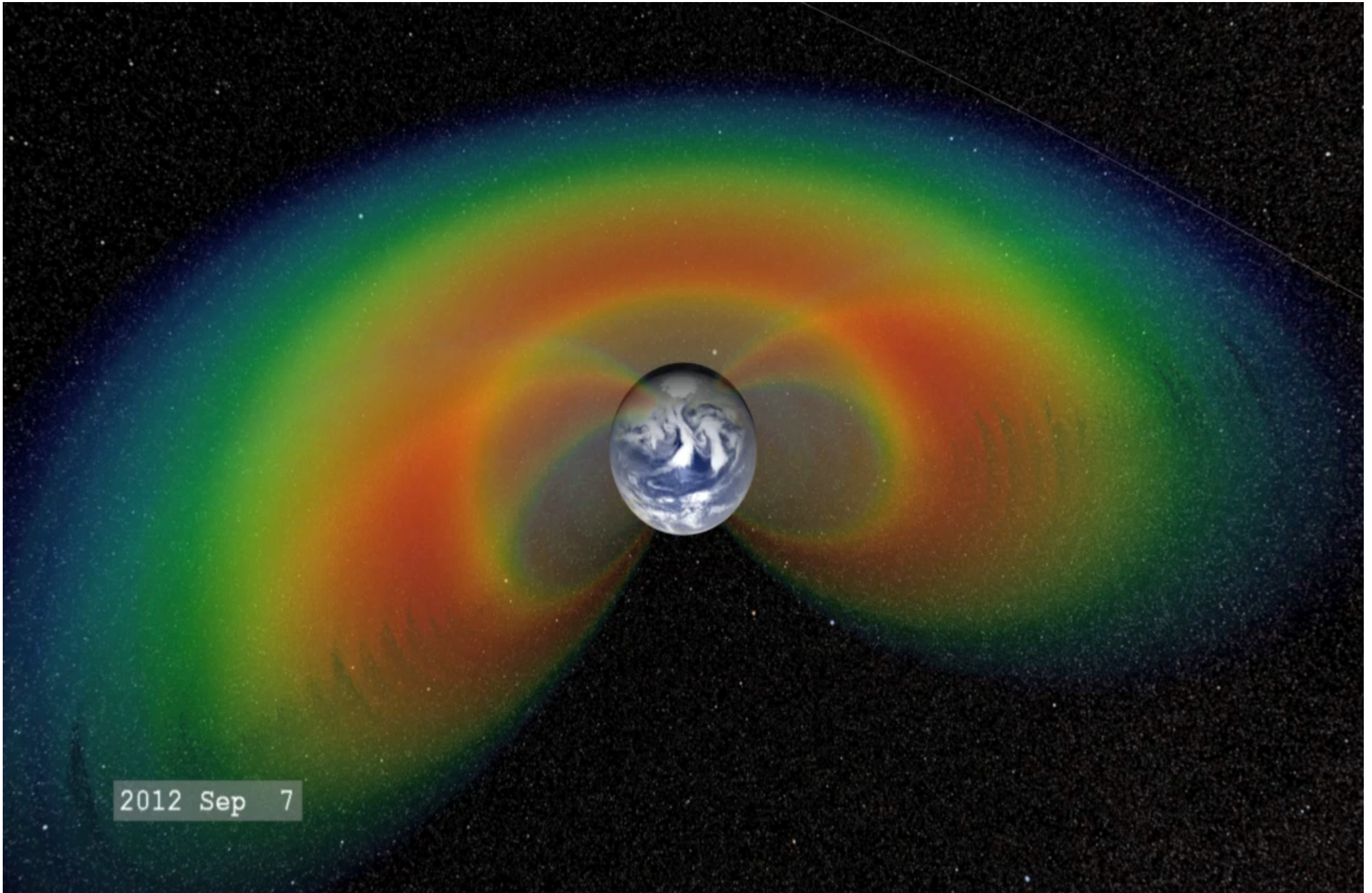
And possibly causing geomagnetic super-storms



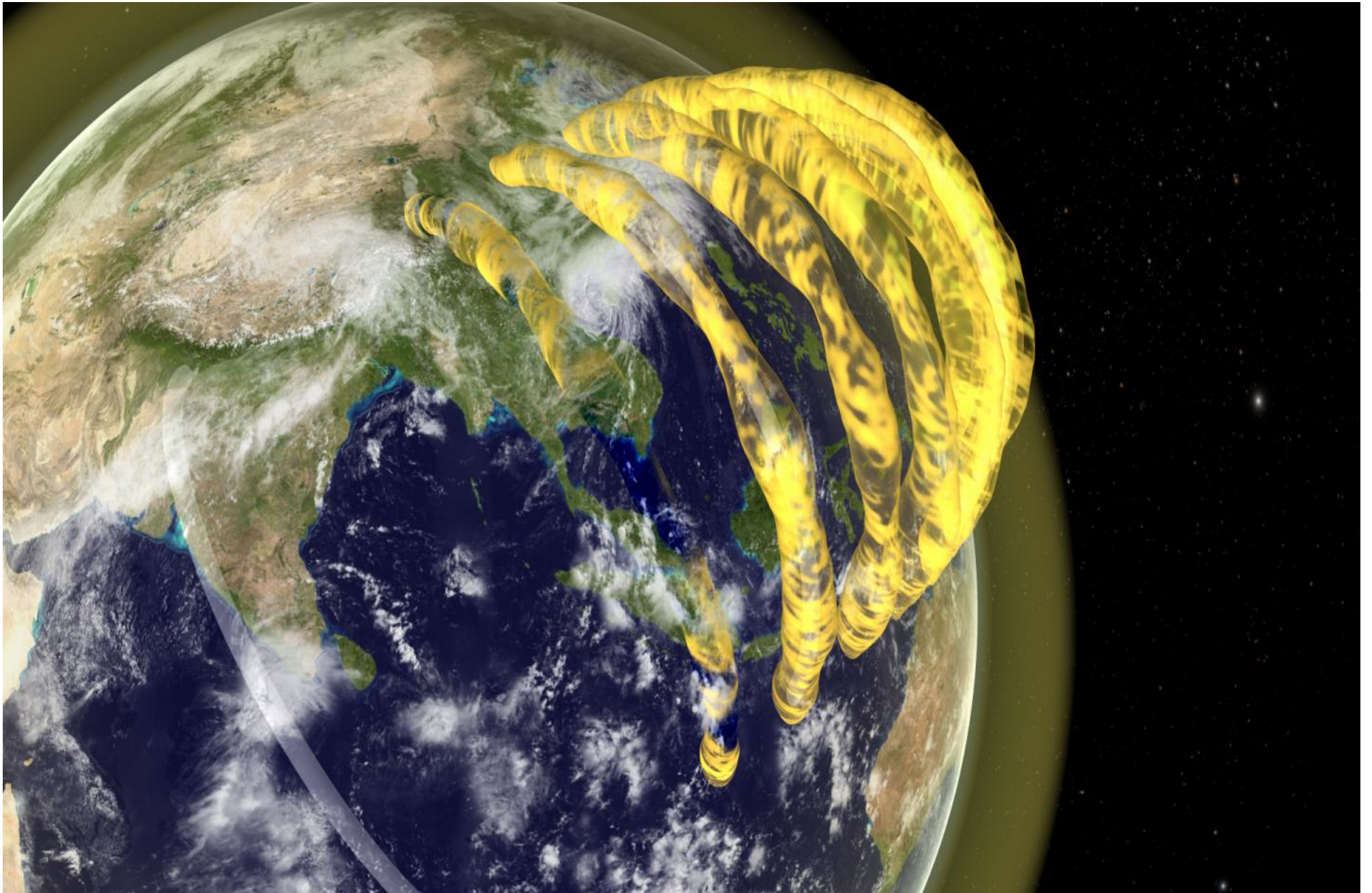
Van Allen radiation belts are trapped in the magnetosphere



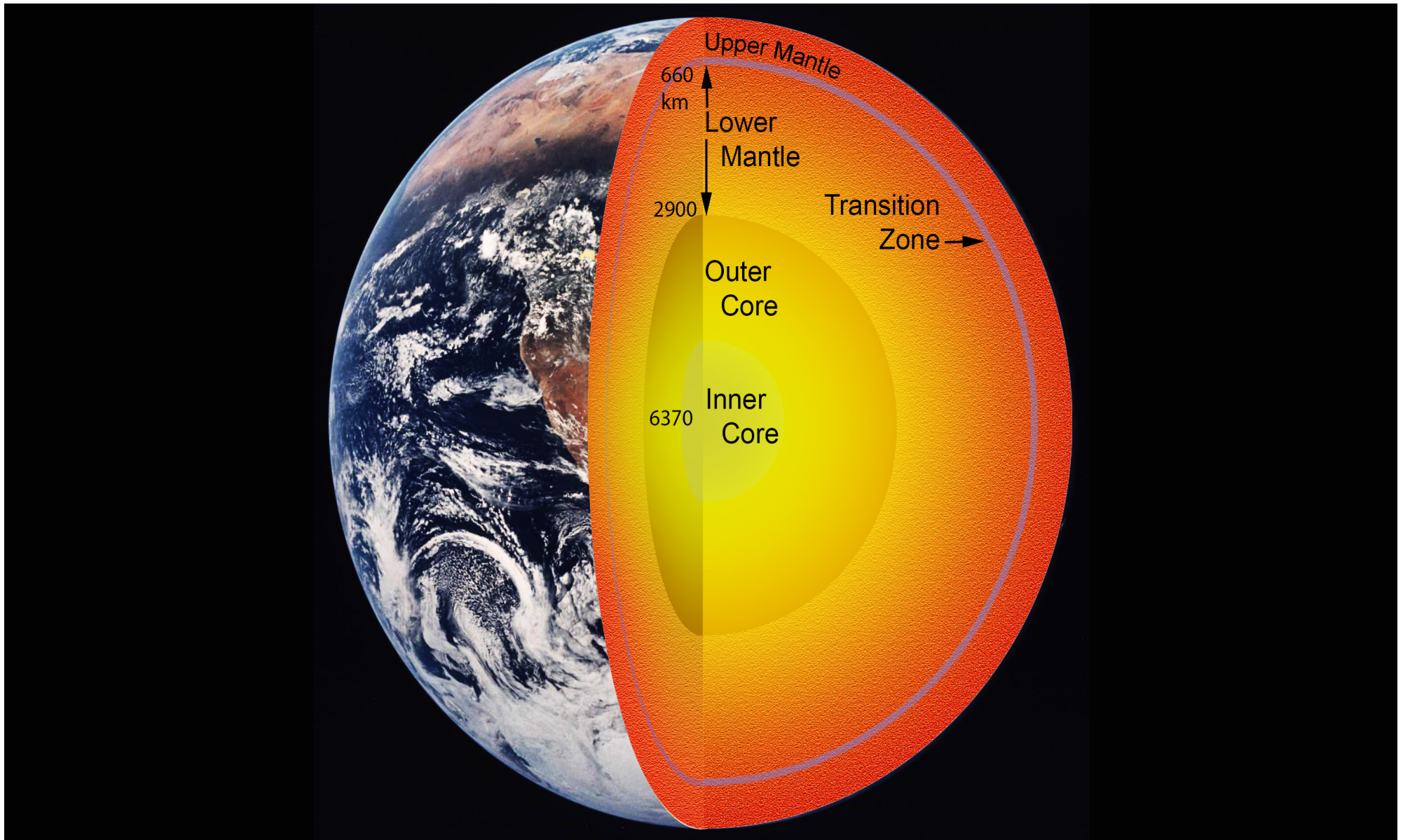
These belts are dynamic and variable



‘Plasma tubes’ have recently been viewed



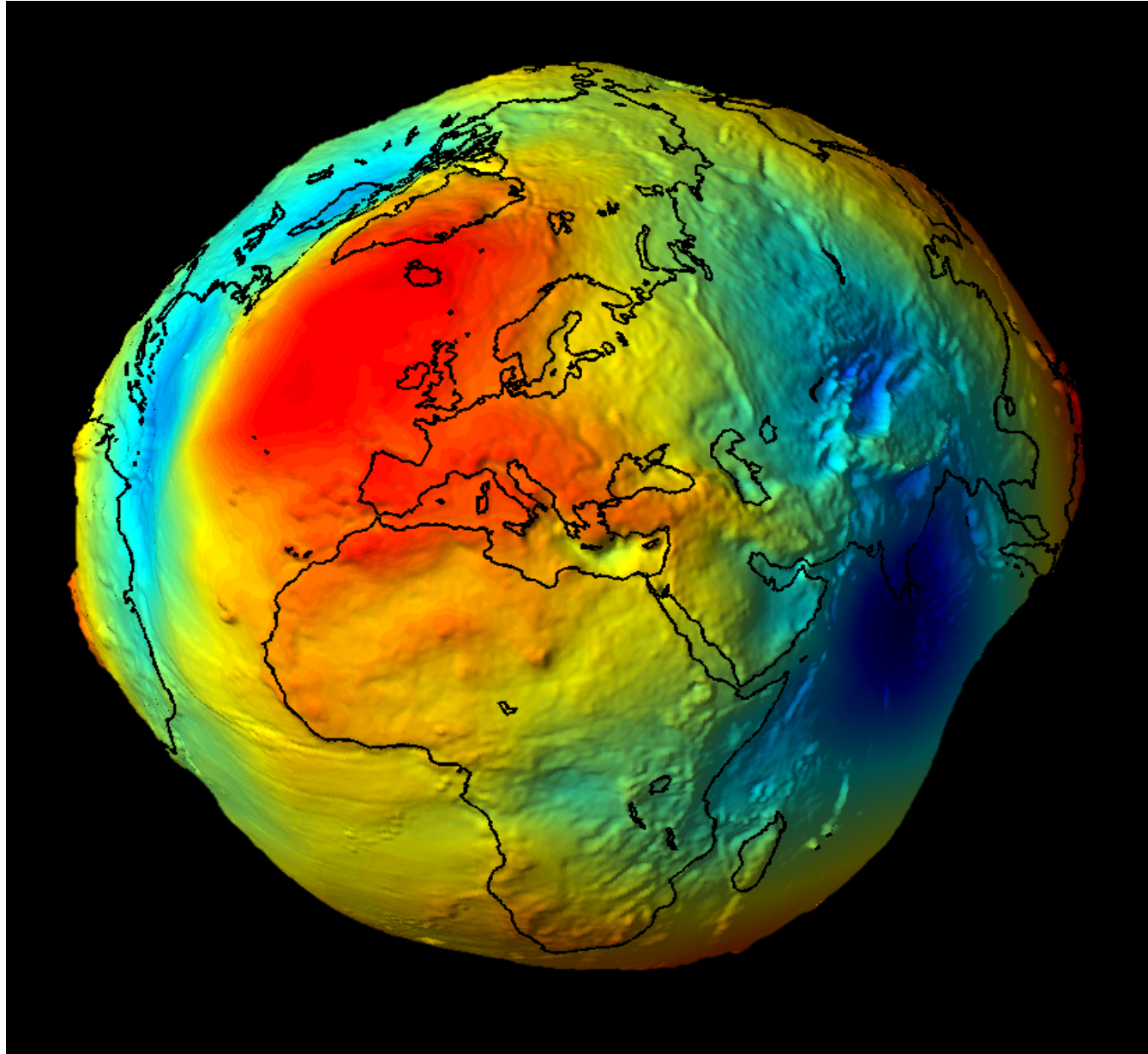
Our picture of the inner Earth is incomplete



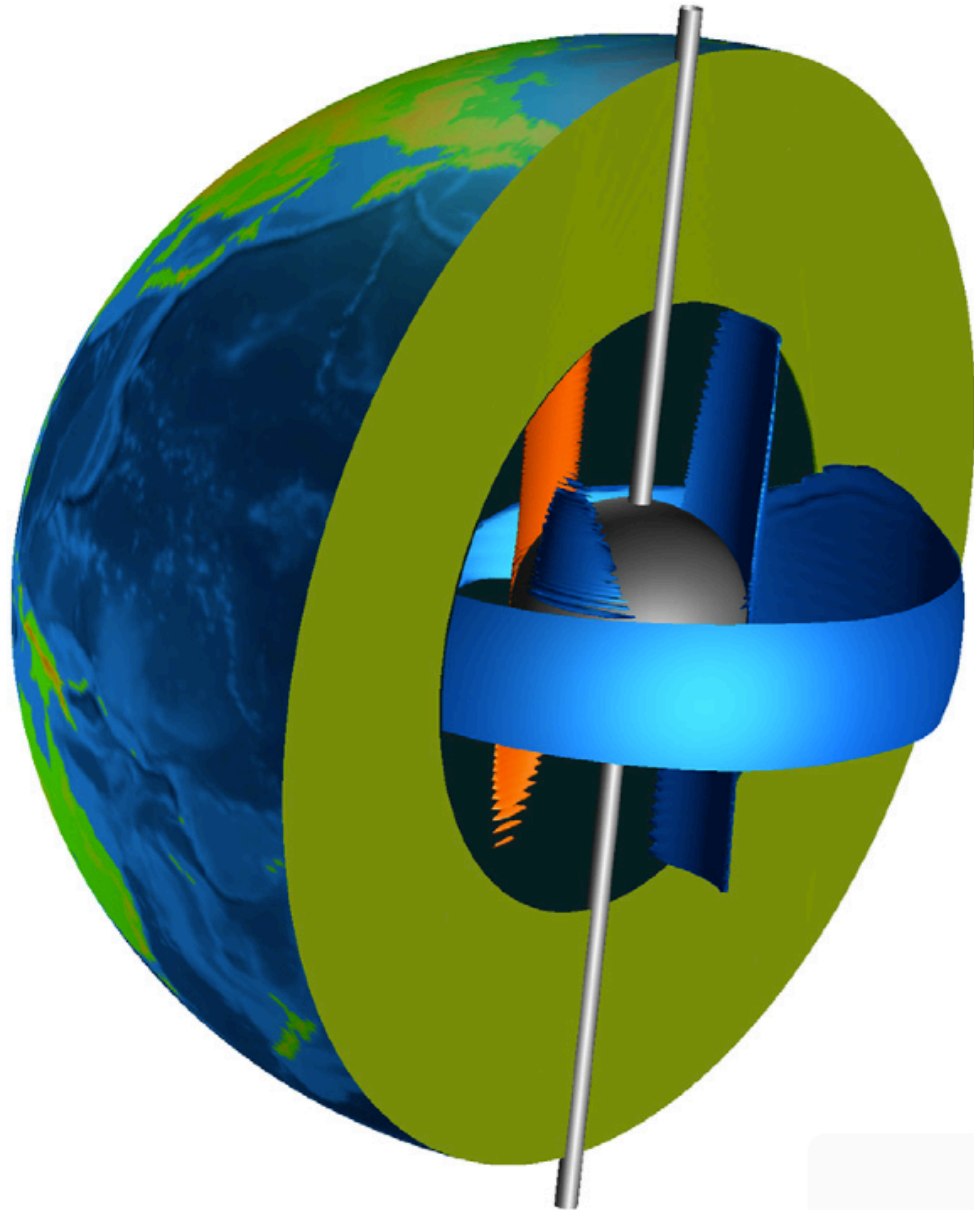
European Space Agency's SWARM mission



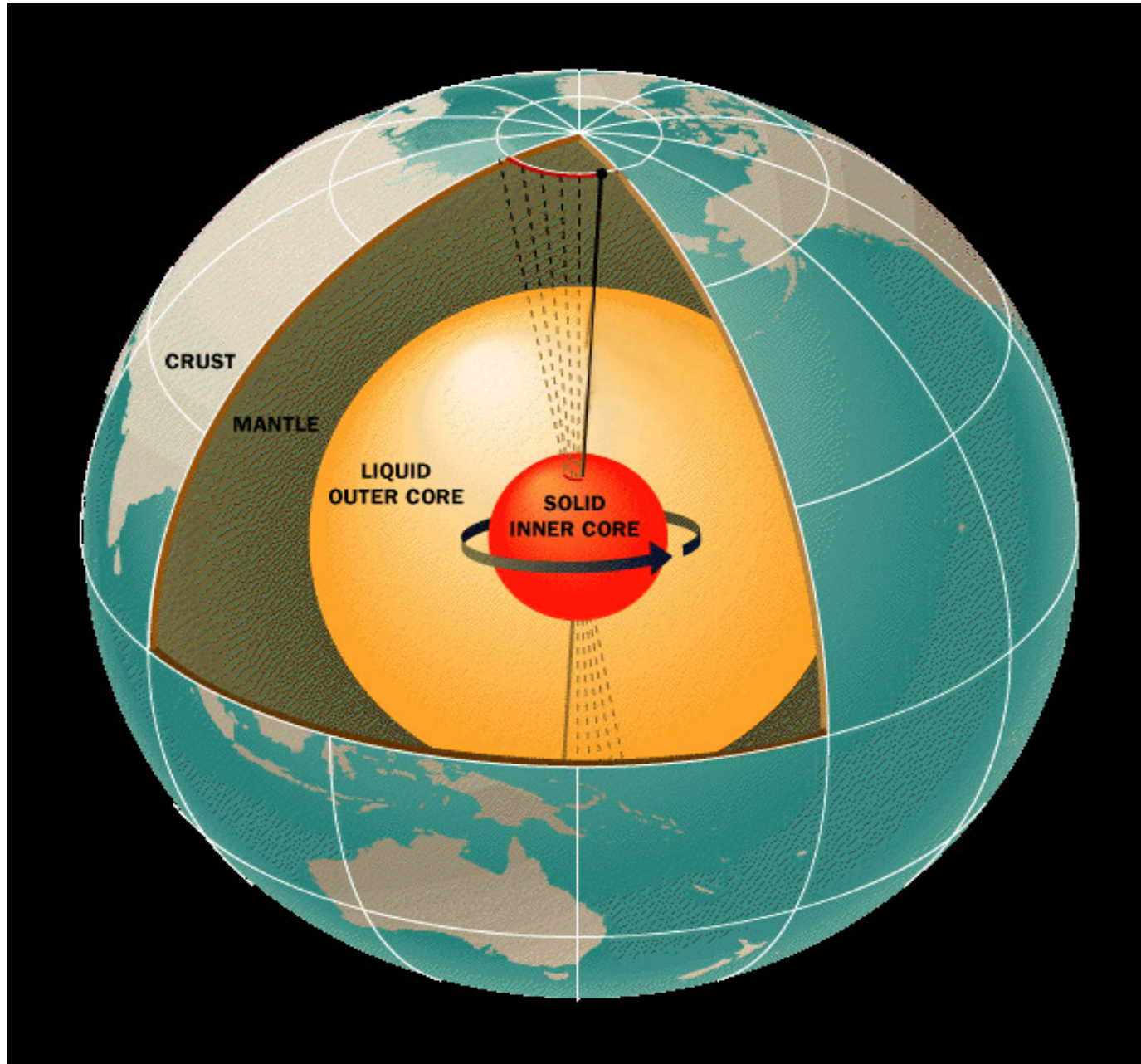
Variations in gravity reflect sub-surface make up



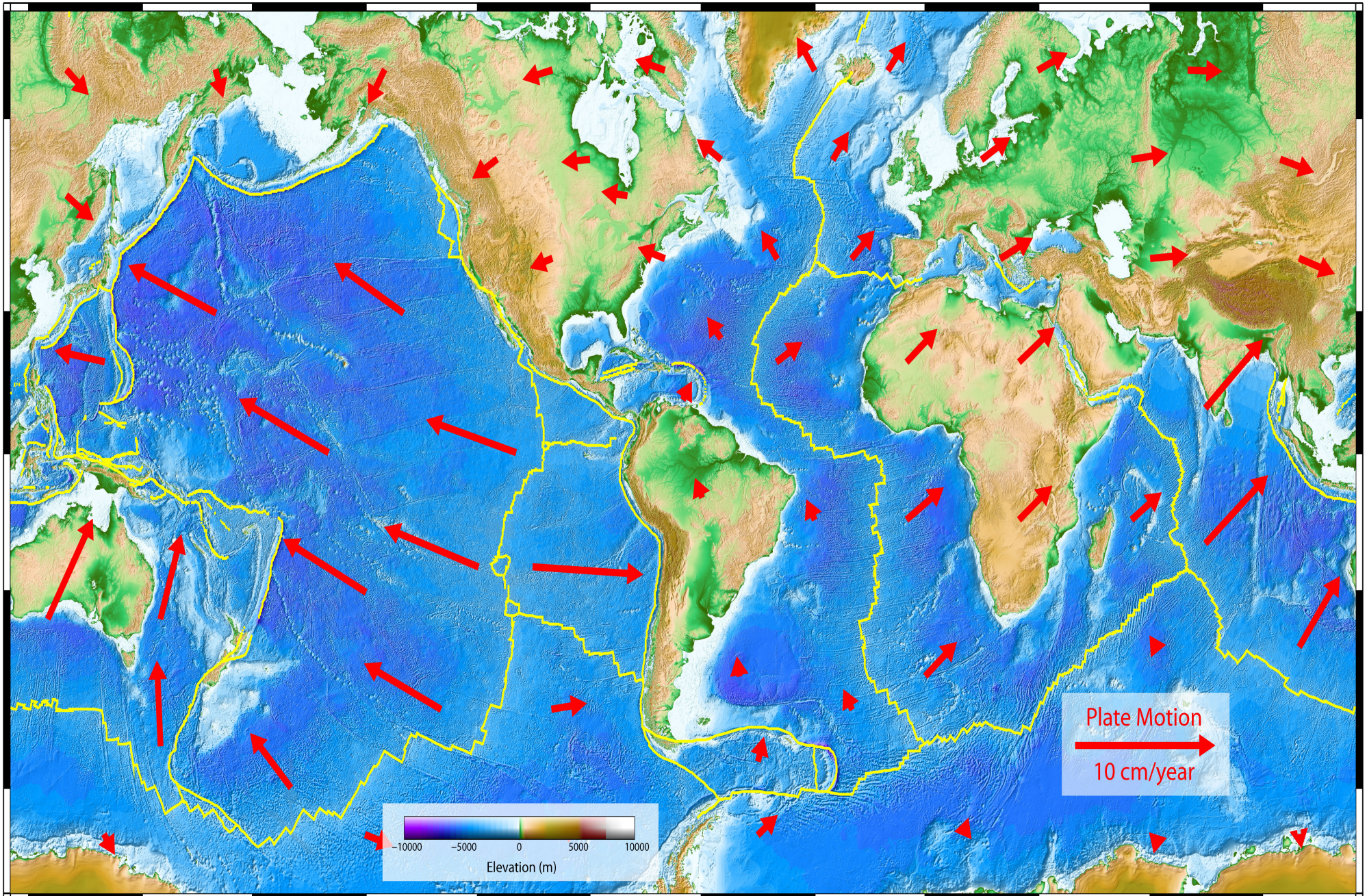
Earth's magnetic axis drifts and sometimes flips!



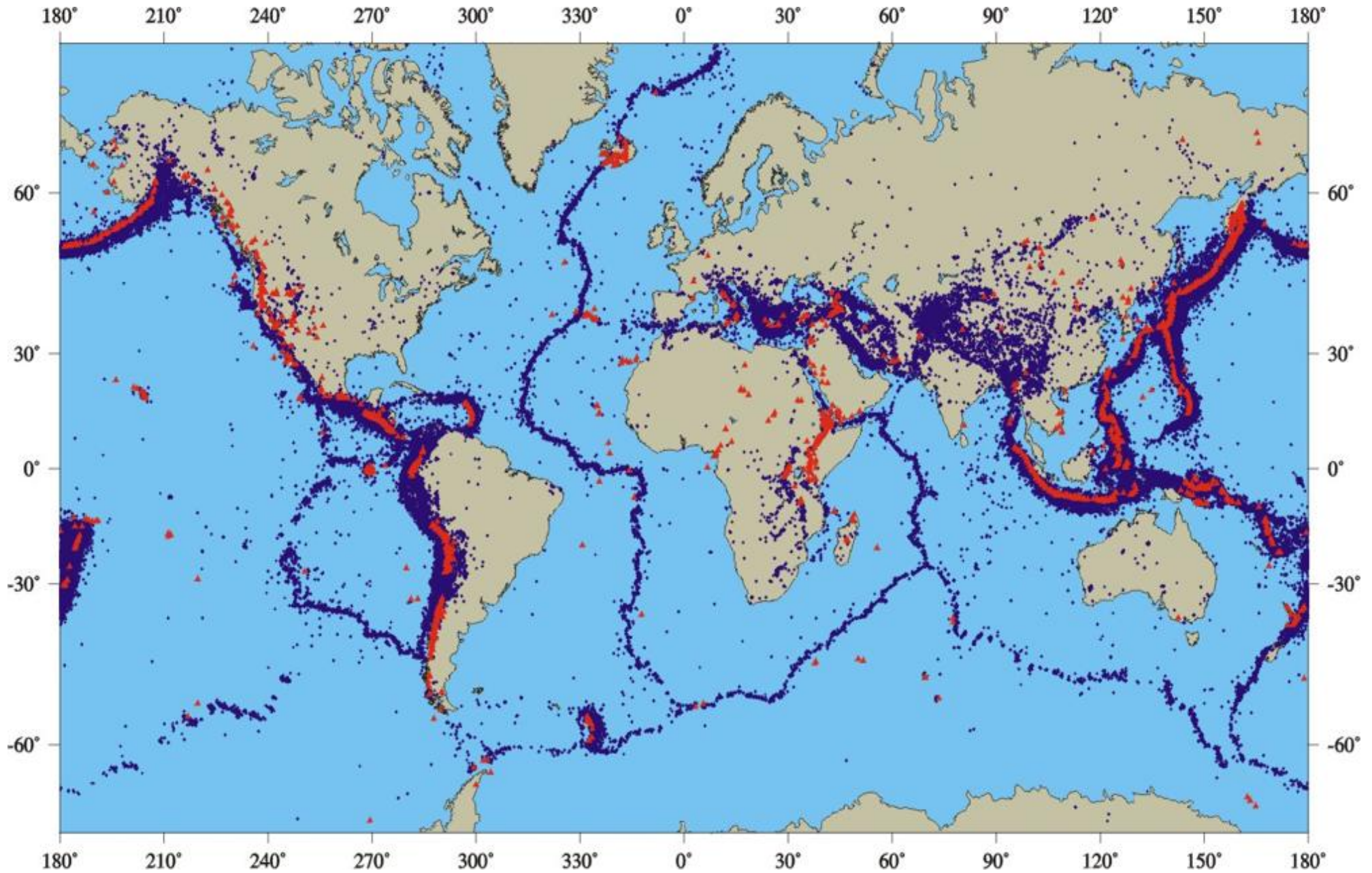
Earth's core, mantle and crust are all dynamic

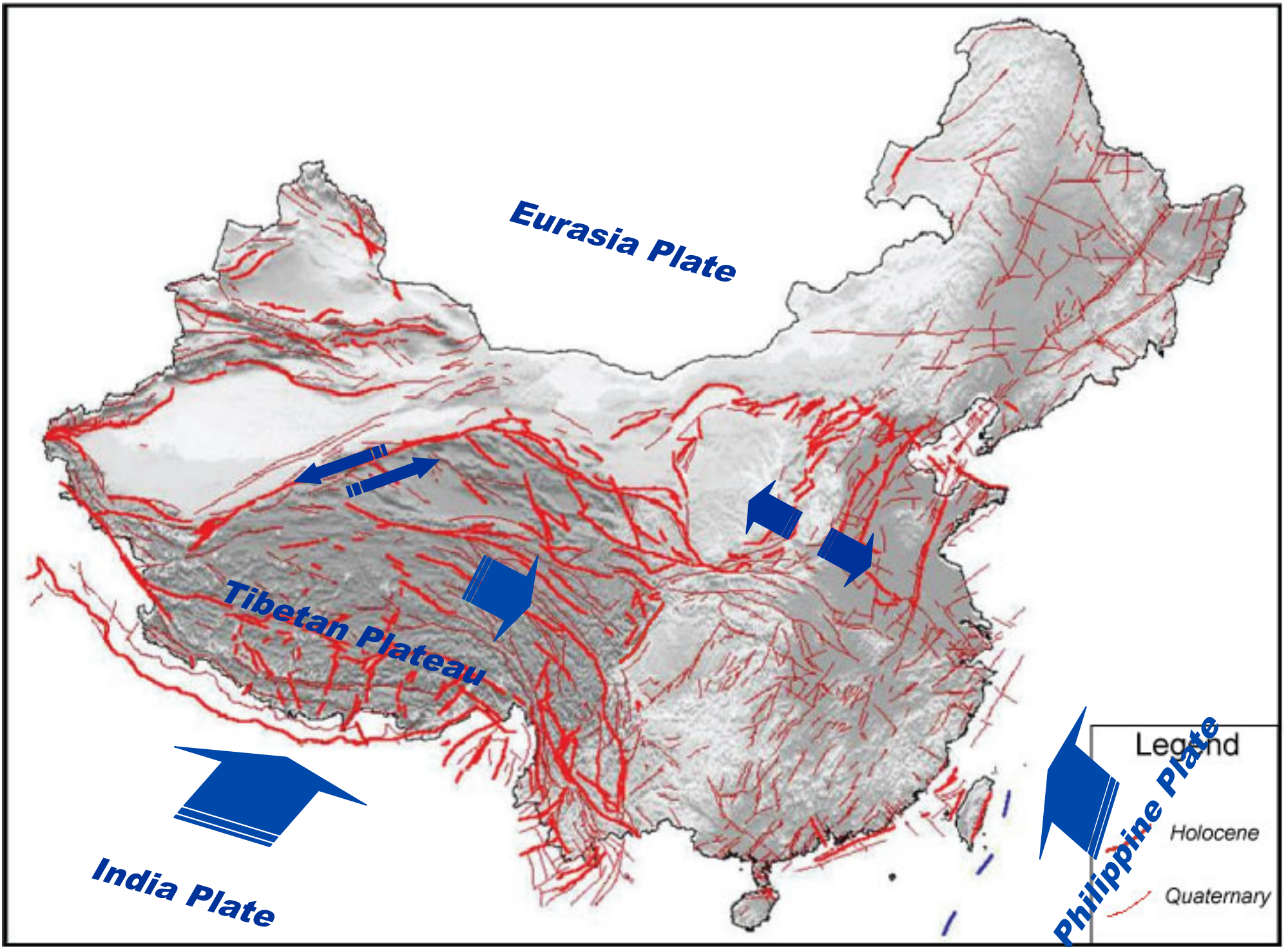


Earth's crust floats on the mantle - plate tectonics prevails



Quakes are a daily occurrence throughout the world





Eurasia Plate

Tibetan Plateau

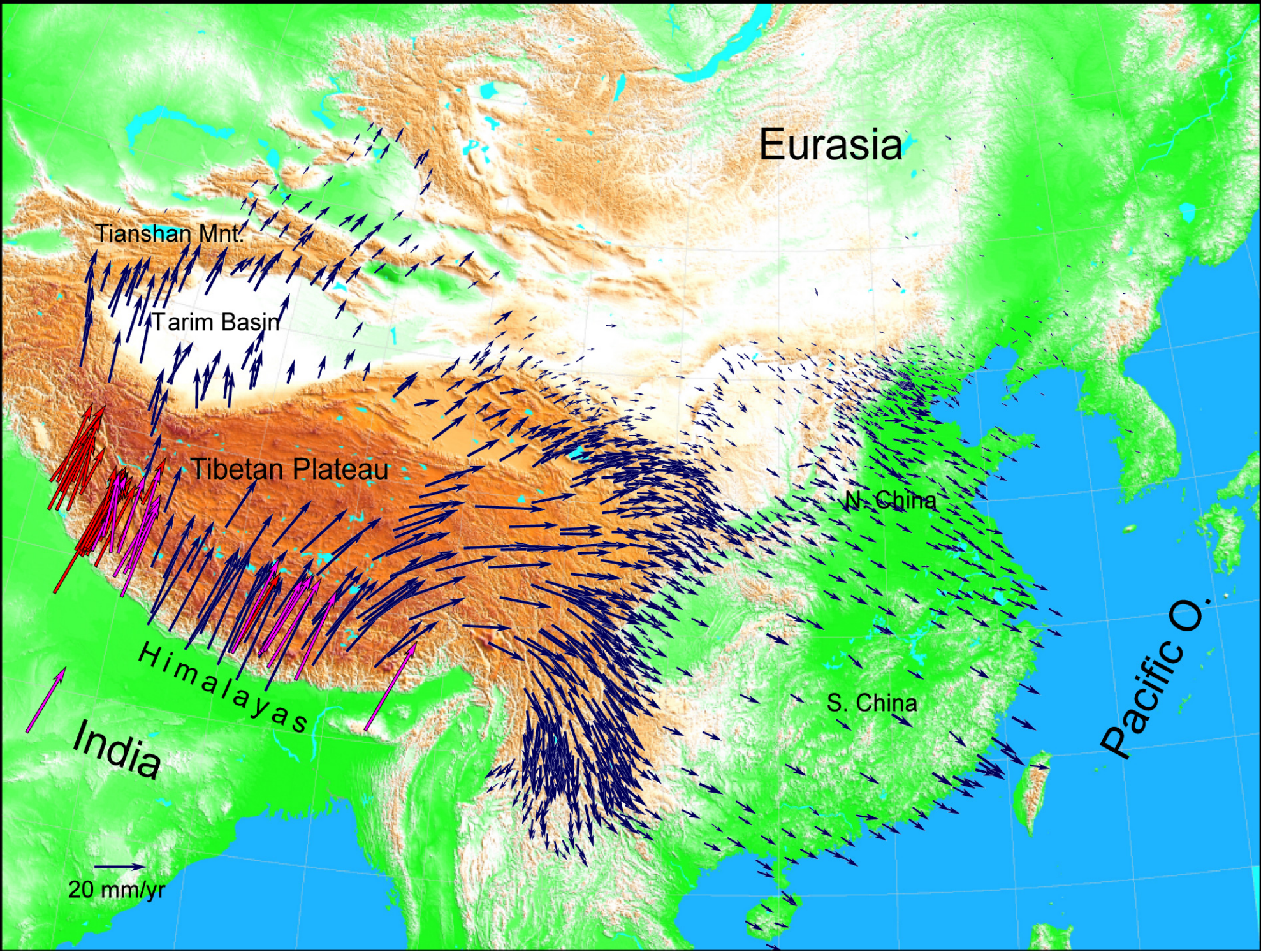
India Plate

Philippine Plate

Legend

Holocene

Quaternary



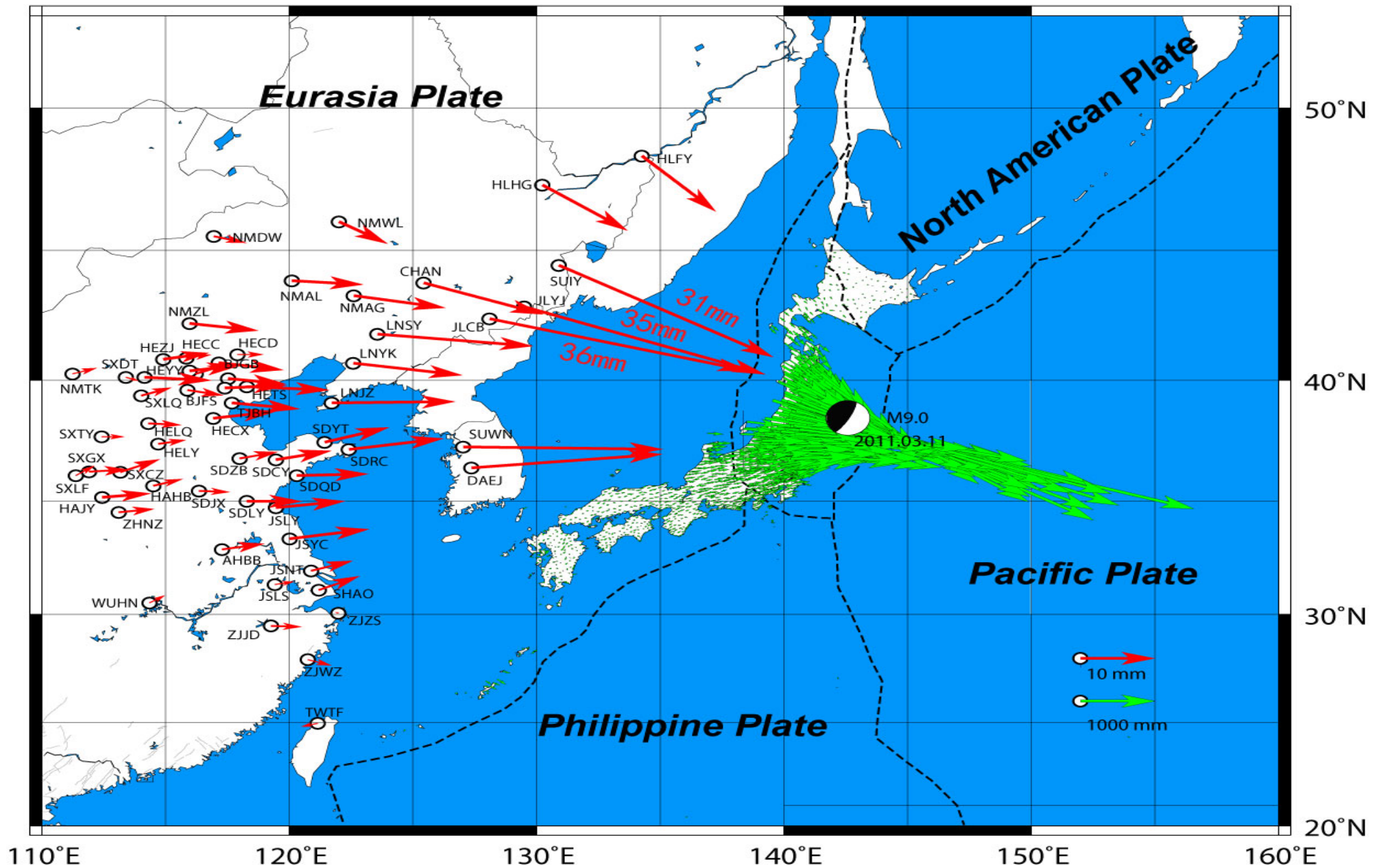
Nepal 2015 quakes were a wake up call



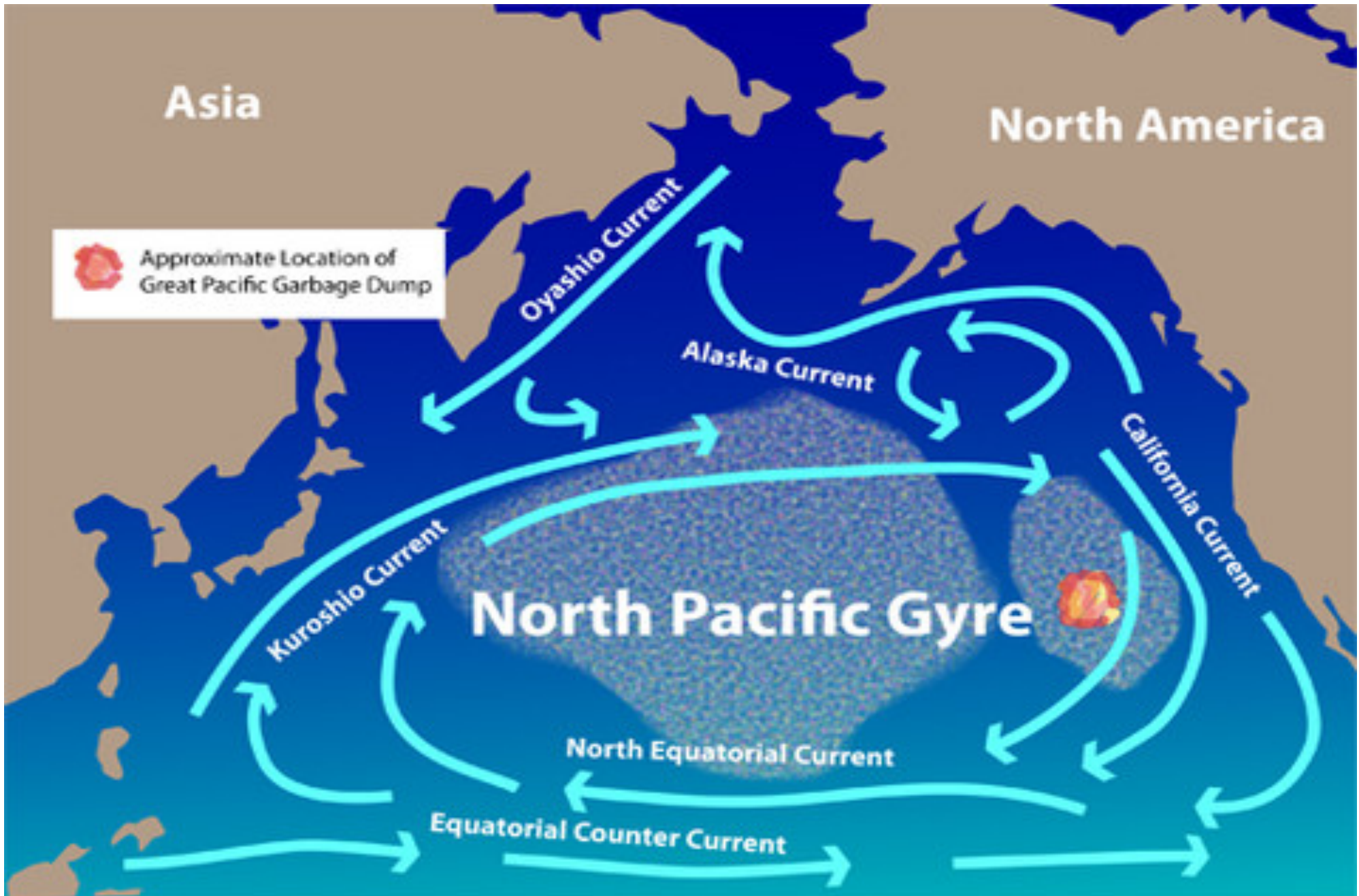
This image was tweeted by @ashbel_nialler

The Great East Japan Earthquake

11 March 2011



Bioaccumulation within the North Pacific Gyre



Cascading domino effects



U.S. Navy photo by Mass Communication Specialist 3rd Class Kevin B. Gray/Released)

The Ring of Fire includes 452 major volcanoes!



Daily, an average 20 volcanoes out-gas aerosols & CO₂



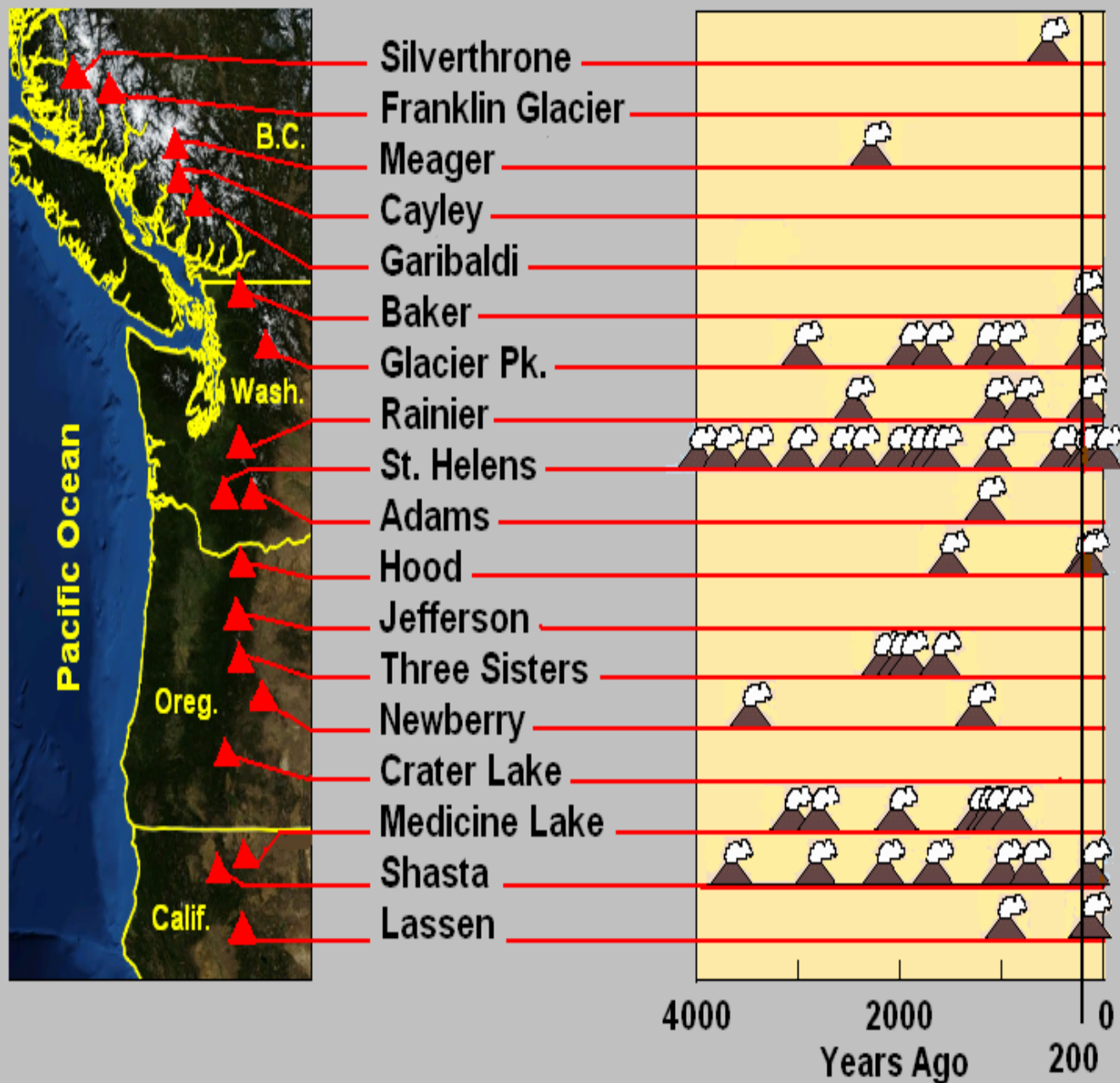
Subduction zones create volcanoes



Cascadian subduction has created 18 volcanoes



Cascade Eruptions During The Last 4,000 years



Interconnected challenges
require
Interconnected resources!

The Himalaya Project

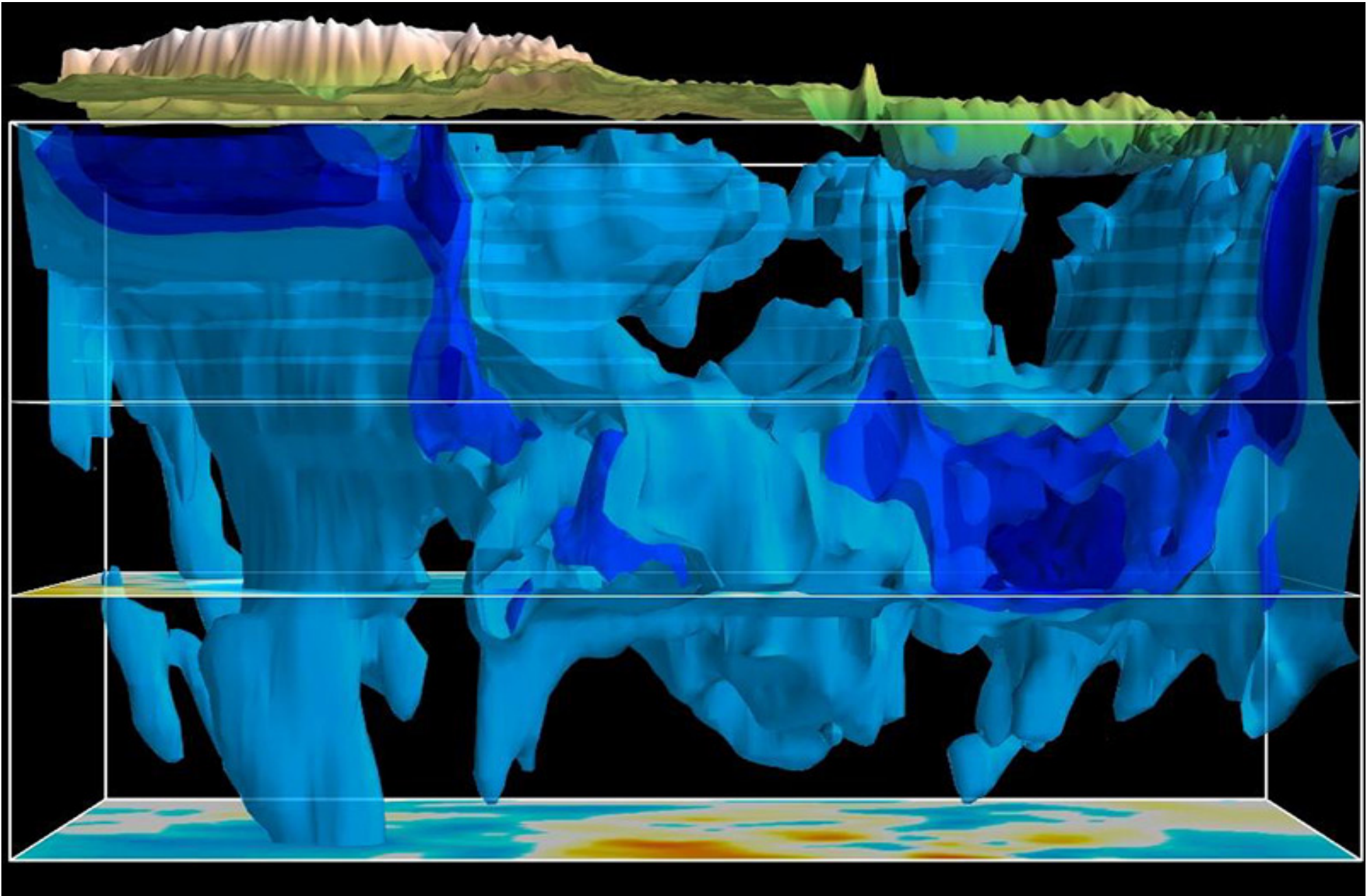
- The importance of the Himalaya-Tibetan Plateau structure
- The strongest & most widespread monsoon
- Impacting on 45% of world's population
- Highly fragmented into 16 countries
- The challenge of integration

In collaboration with Chinese Academy of Sciences

- Institute of Advanced Physics

- Laboratory of Atmospheric Sciences & Geophysical

Earth's crust below the Tibetan Plateau



Our Natural & Social Systems are interwoven

They interact and sometimes cause:

- Sequential collapse
- Synchronous collapse
- Multiple synchronous collapse

Cascading dominoes fall across sectoral silos!

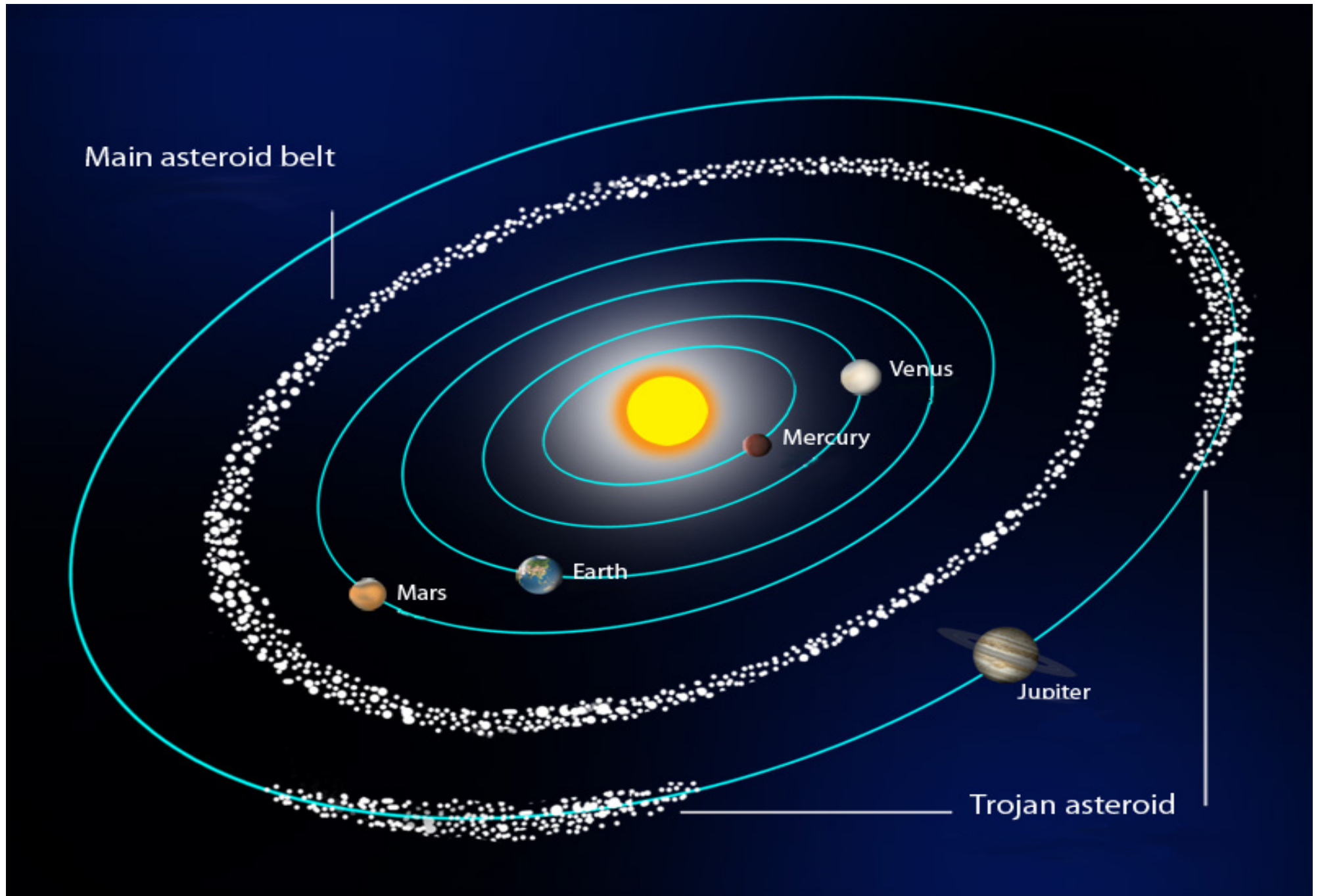
A recent list of Natural-Social cascading crises

- 2000 SE Asia smoke haze
- 2003 European heatwave
- 2004 Sumatra tsunami
- 2005 Hurricane Katrina
- 2007 England floods
- 2008 Wechuan earthquake
- 2010 Haiti earthquake
- 2010 Icelandic ash cloud
- 2010 Russian heatwave
- 2010 Deepwater Horizon oil spill
- 2011 Pakistan floods
- 2011 Queensland floods
- 2011 Tropical Cyclone Yasi
- 2012 Superstorm Sandy
- 2013 North German floods
- 2013 Supertyphoon Haiyan
- 2014 UK floods
- 2015 Nepal earthquake

Chelyabinsk: 1200 hospitalized as meteorite explodes



Jupiter slings asteroids from Main Belt towards Earth



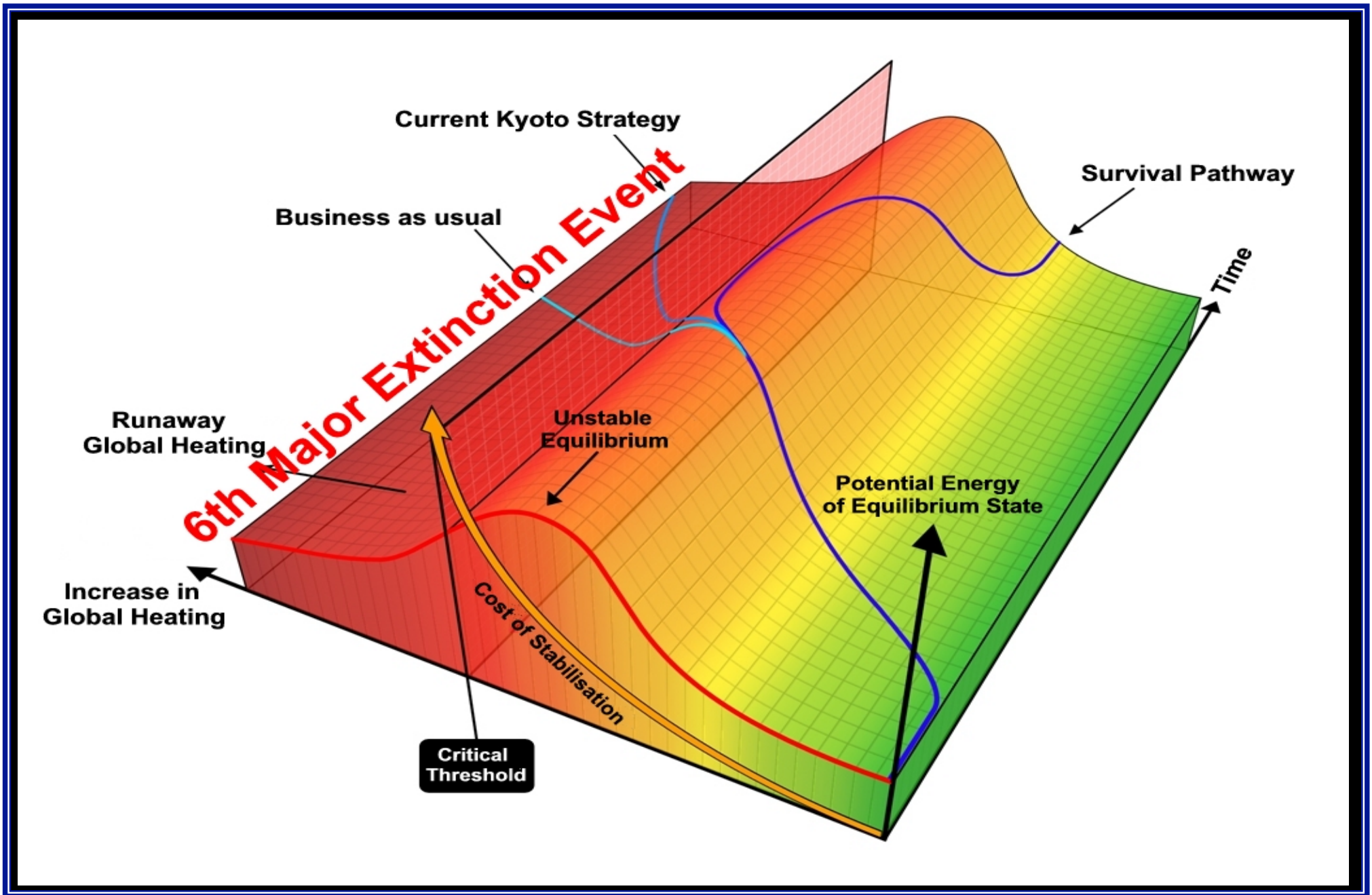
Jupiter alone = 300 x mass of Earth and has 67 moons



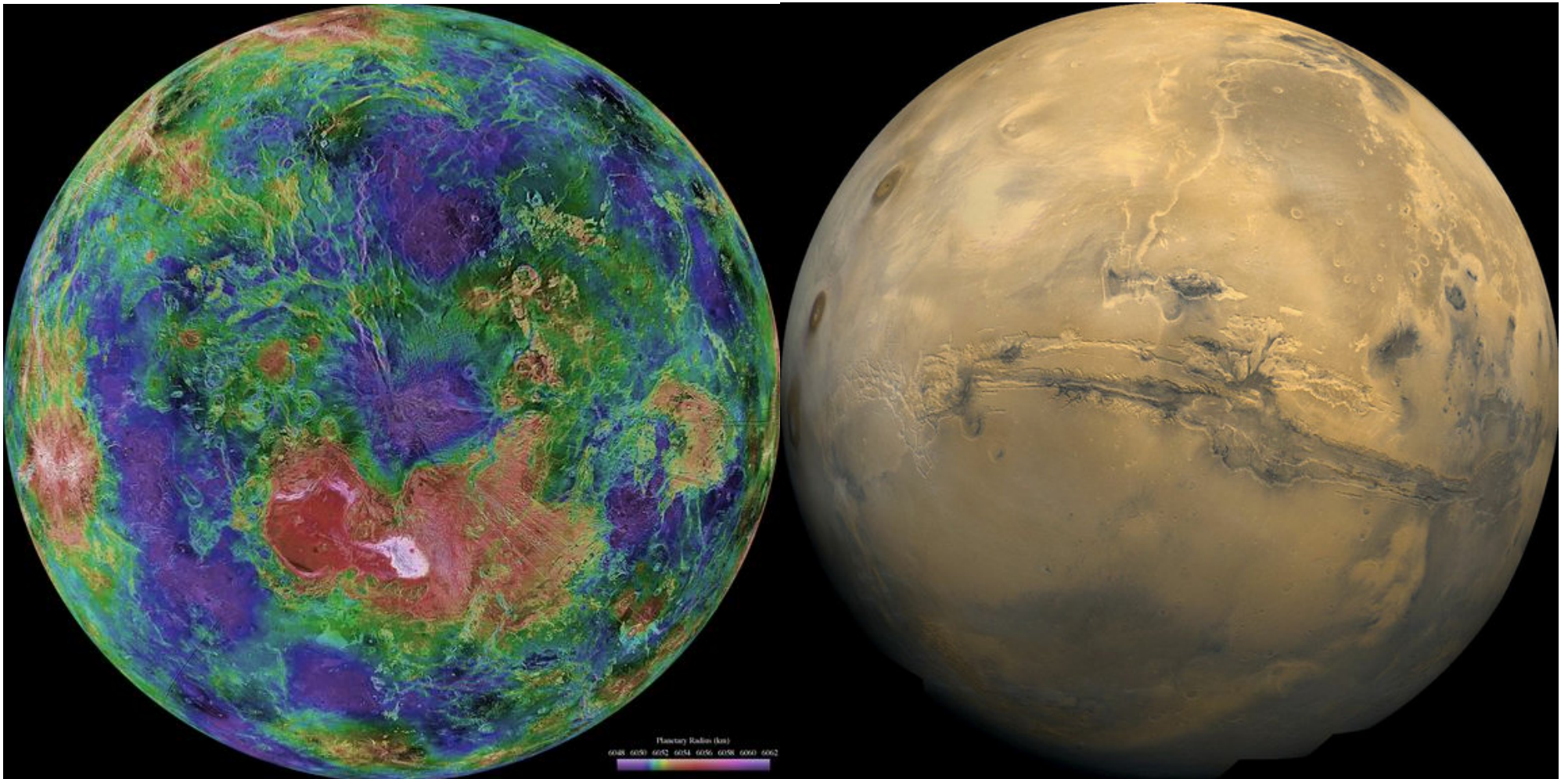
Image credit: NASA



How close are we to an extinction event?



Could Future Earth = Venus? Mars?





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

www.icesfoundation.org

The Human Brain Project

- Building a science-based visual narrative
- Using interactive, immersive cockpits
- Open source modeling & simulation
- Big data predictive analytics
- Global cooperative network

Integrating everything we already know!

Blue
Brain
Project