

Pollution and the planet:

perspectives on being outside the 'Safe Operating Space'

Dr Sarah Cornell

People are changing the global environment

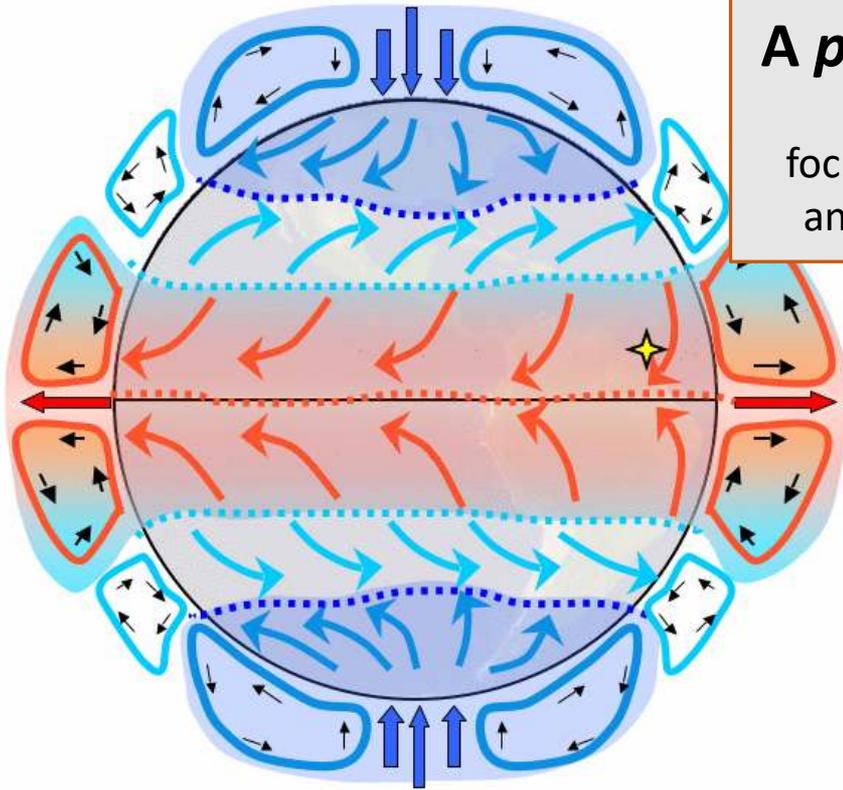


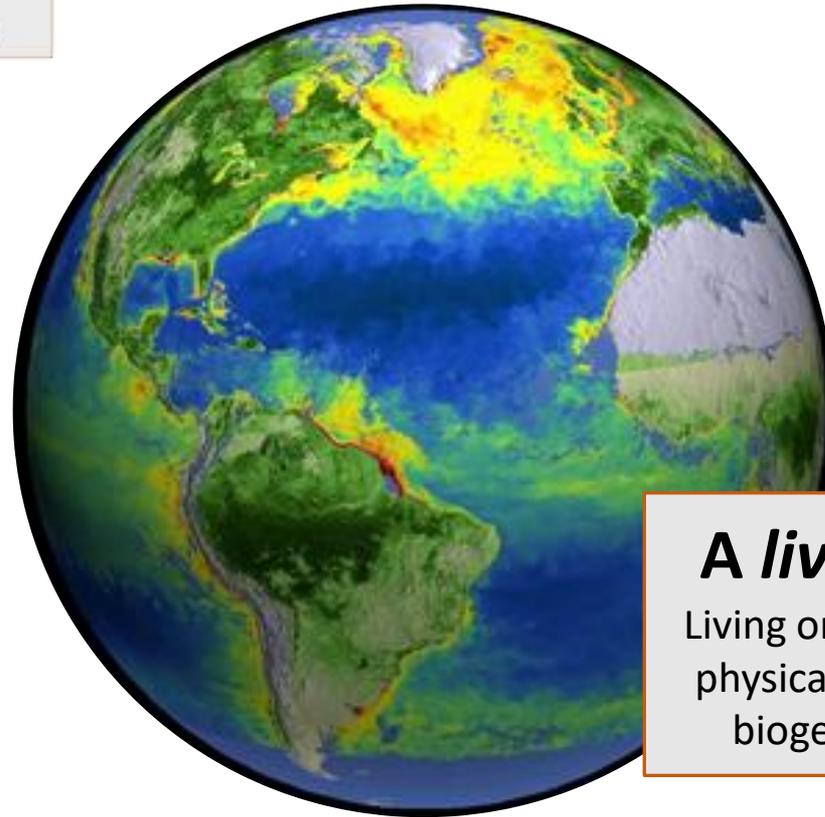
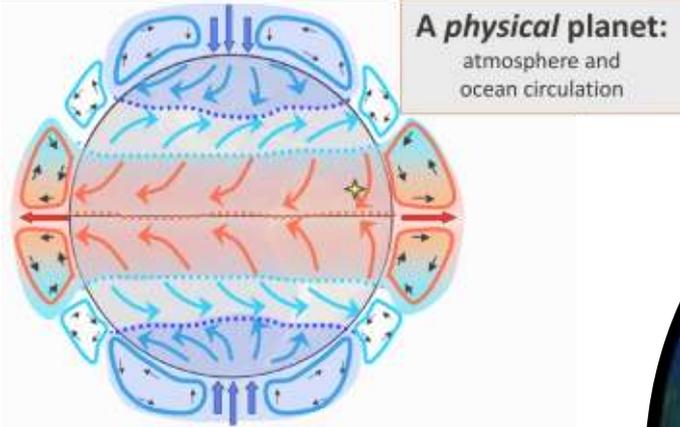
Image: www.greenpassport.us/wp-content/uploads/2013/03/pollution-prevention.jpg

**What do
global change
scientists think?**

A physical planet:

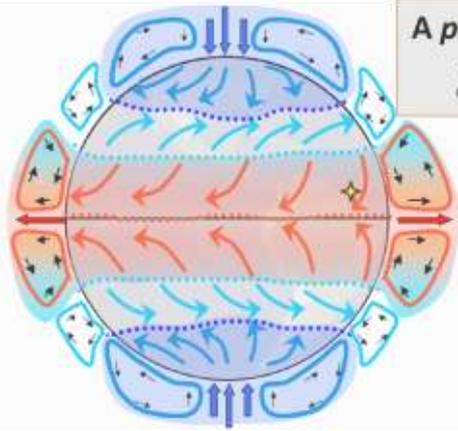
Climate science
focuses on atmosphere
and ocean circulation



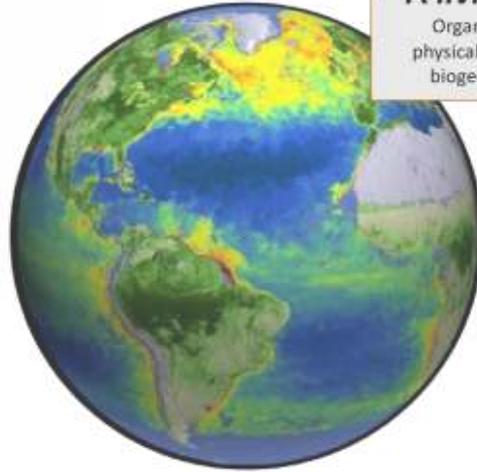


A living planet:
Living organisms alter their physical environment and biogeochemical flows

Land and ocean chlorophyll concentration
(image: ESA)

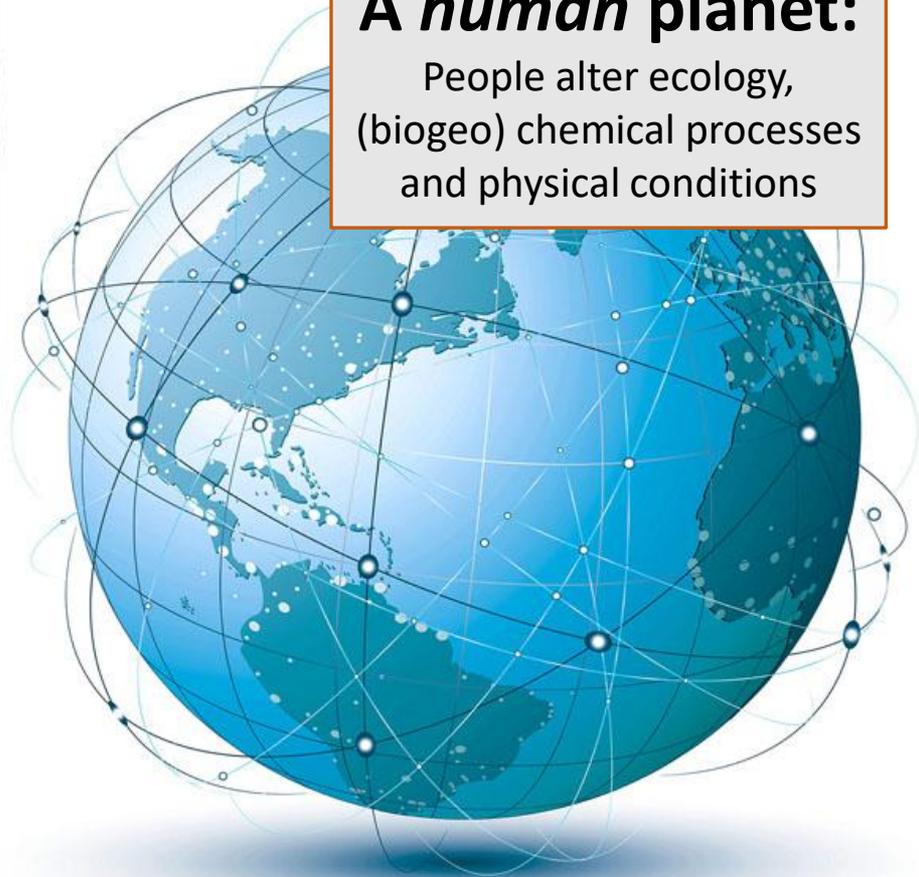


A physical planet:
atmosphere and
ocean circulation



A living planet:
Organisms alter their
physical environment and
biogeochemical flows

A human planet:
People alter ecology,
(biogeo) chemical processes
and physical conditions



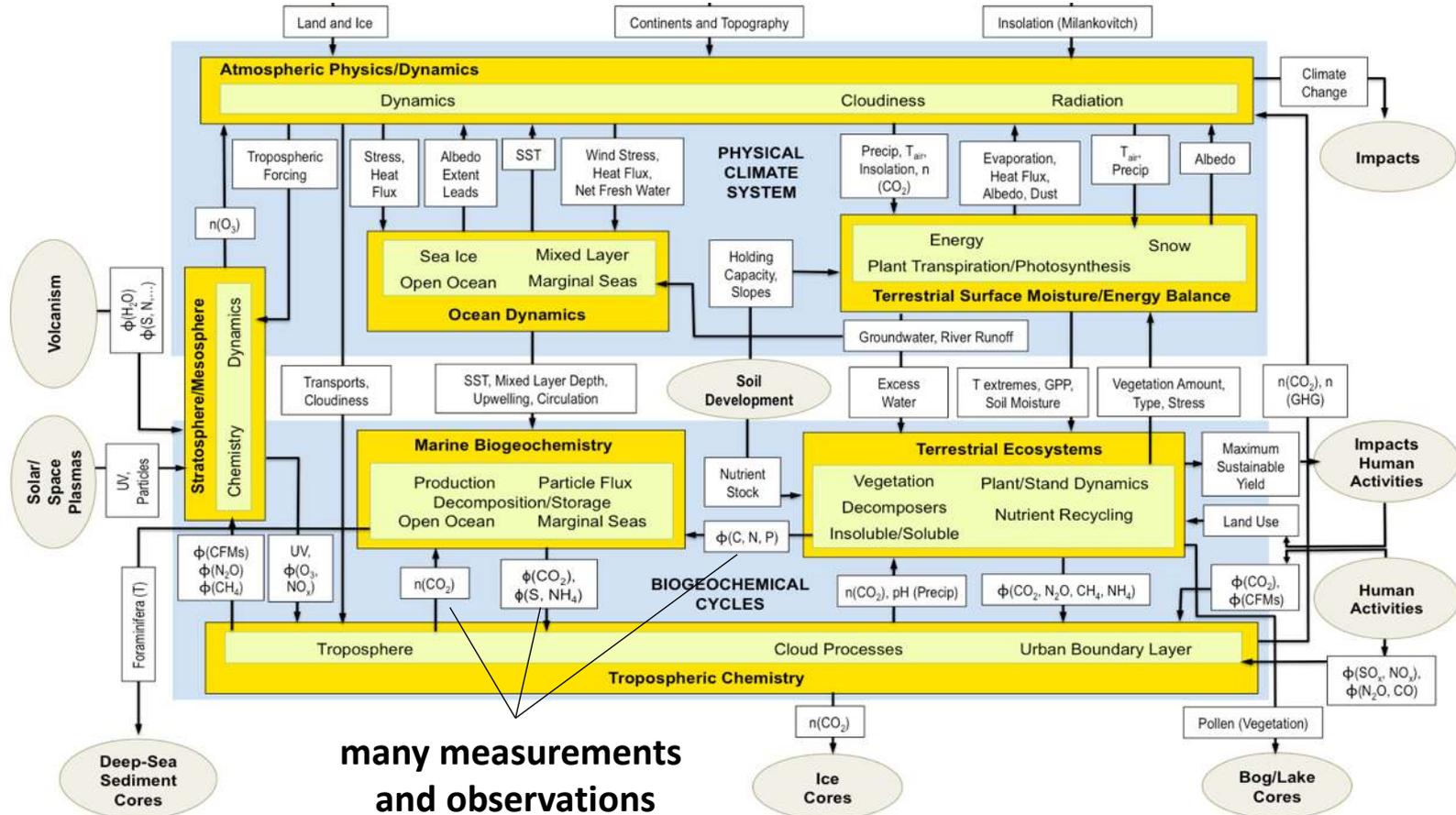
Global change scientists
use observations
(from fieldwork and from space)
experiments, theories and models
to understand how the **'Earth system'** works

What does a systems approach mean?

- All systems have structure or organization.
- All systems function in some way.
- All systems show some degree of integration – components act together as a coherent whole.
- Change in one component is ‘sensed’ throughout the system. Responses of other components result in the regulation of the system overall.

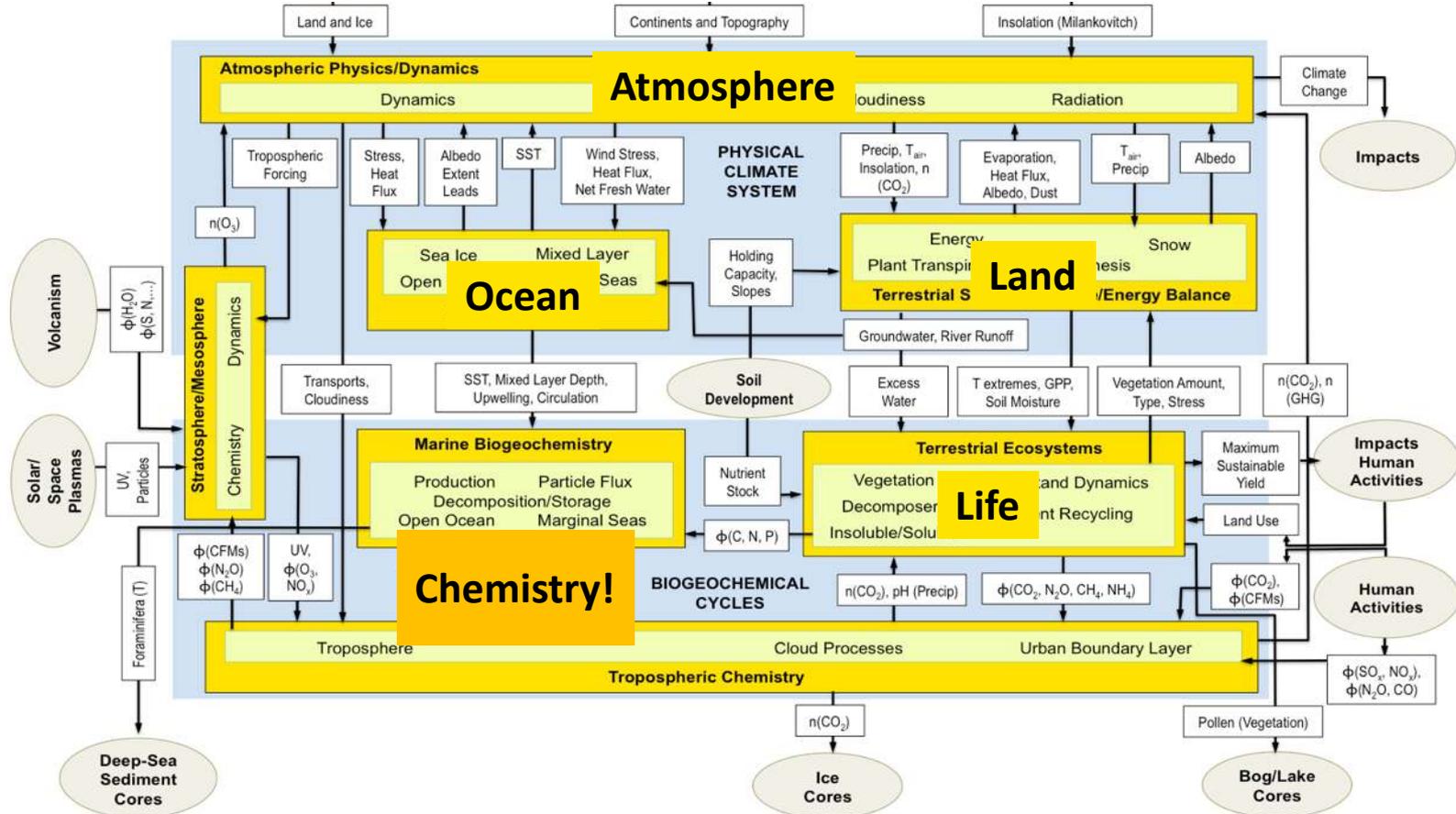
The 'Bretherton Diagram' shows the linked processes in most Earth system models

(ESSC NASA Advisory Council 1988)



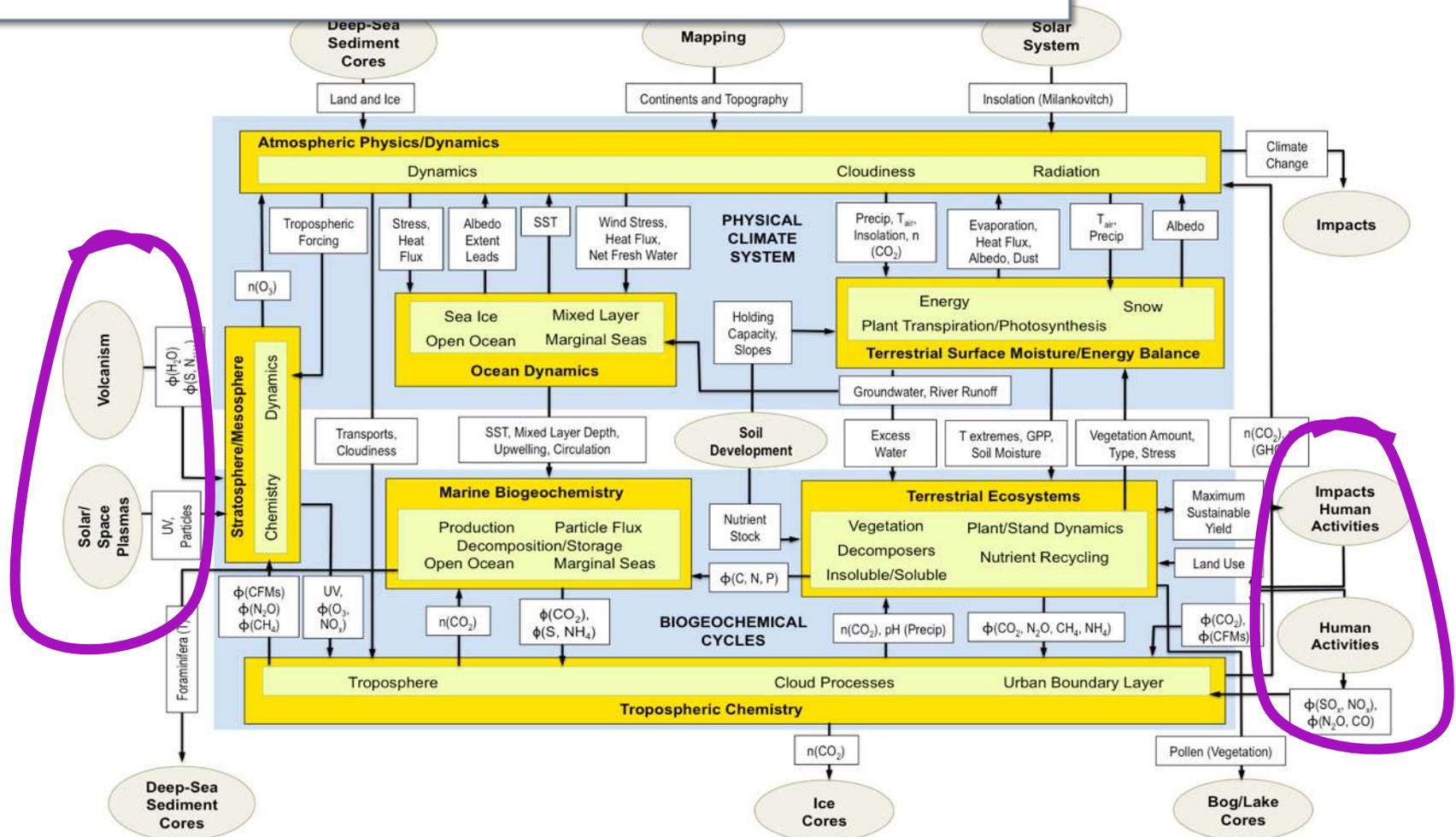
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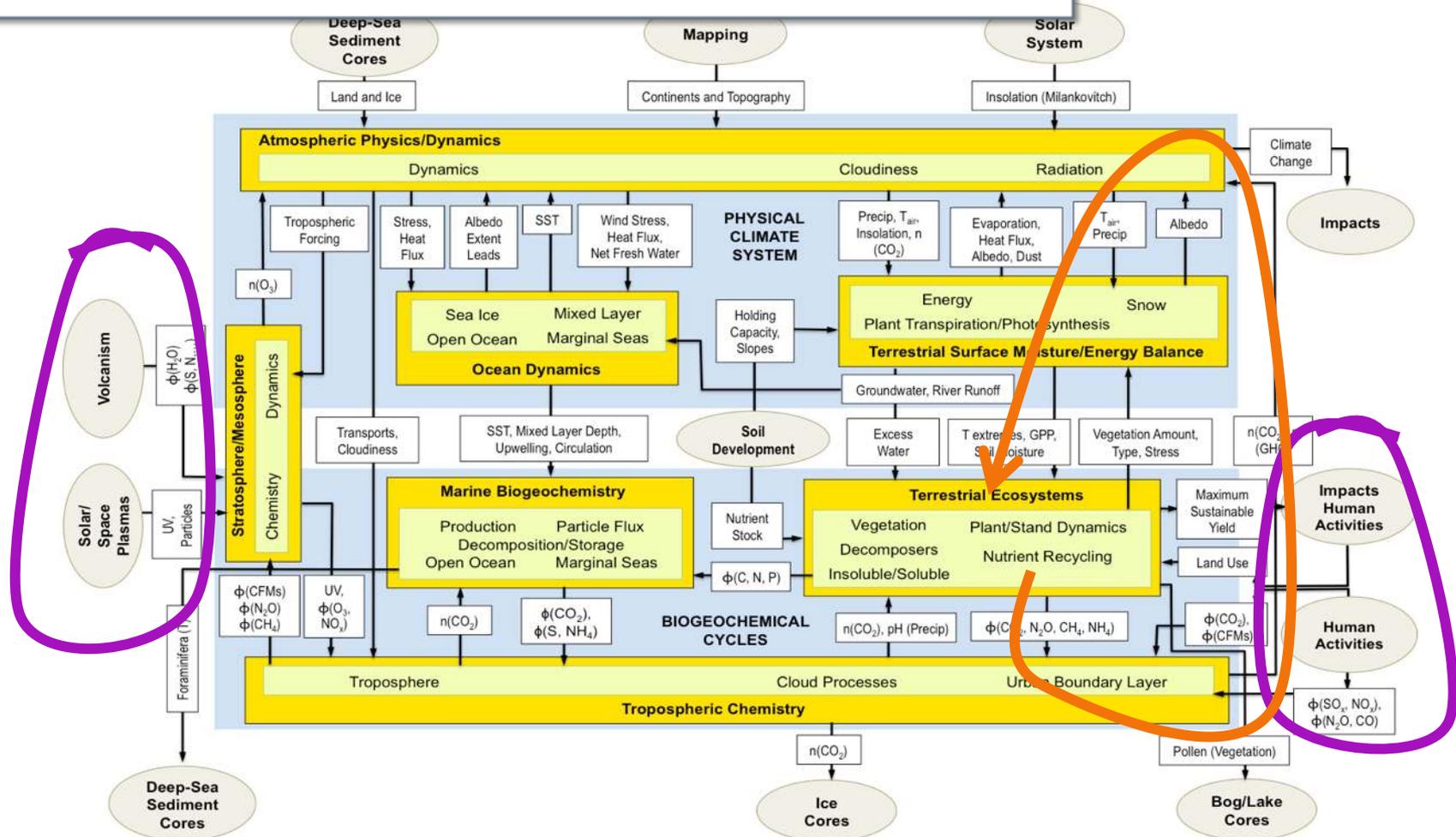
Forcings are perturbations that drive system changes.
Feedbacks are induced changes within the system

The 'Bretherton Diagram'
 (ESSC NASA Advisory Council 1988)

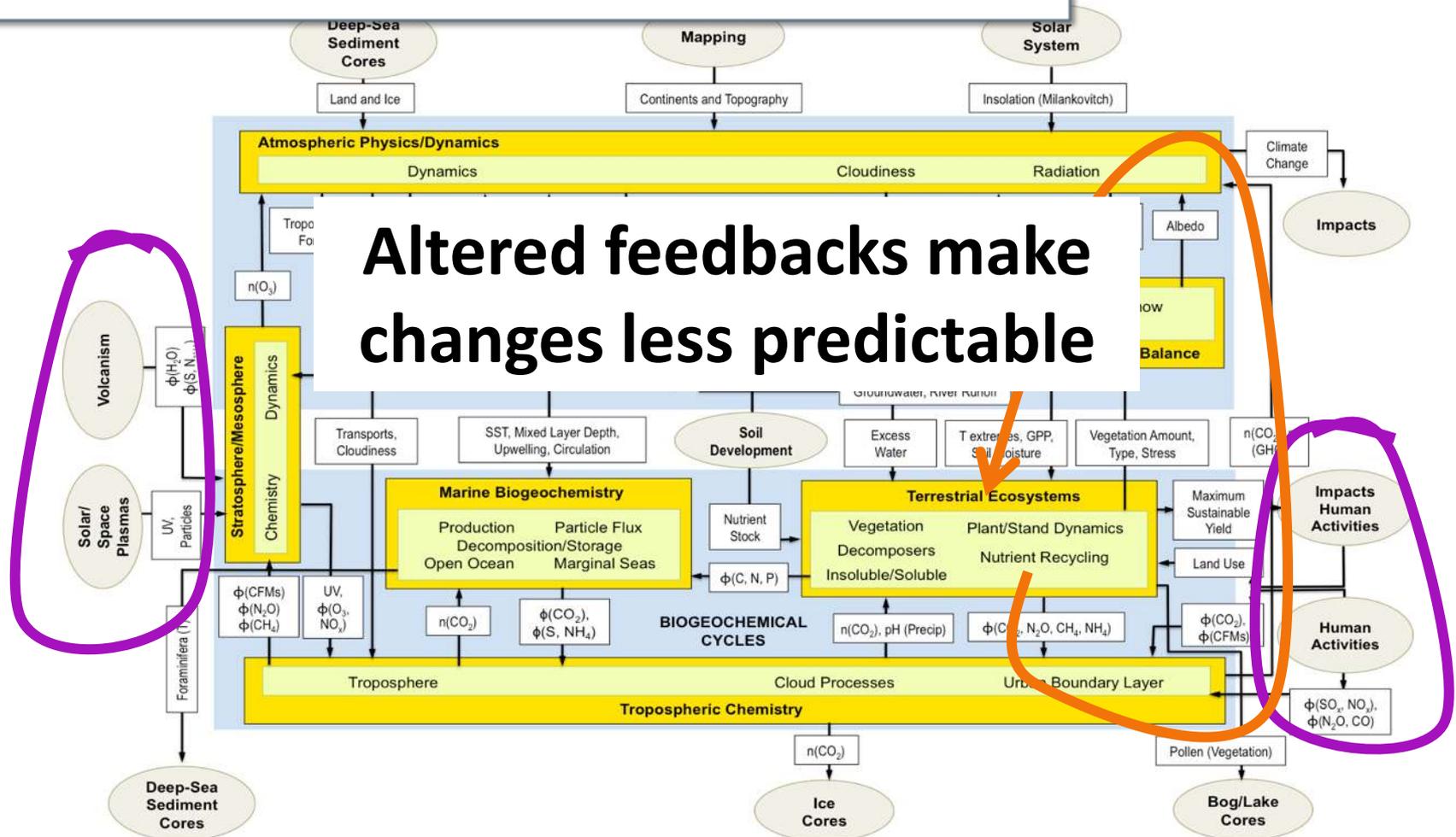


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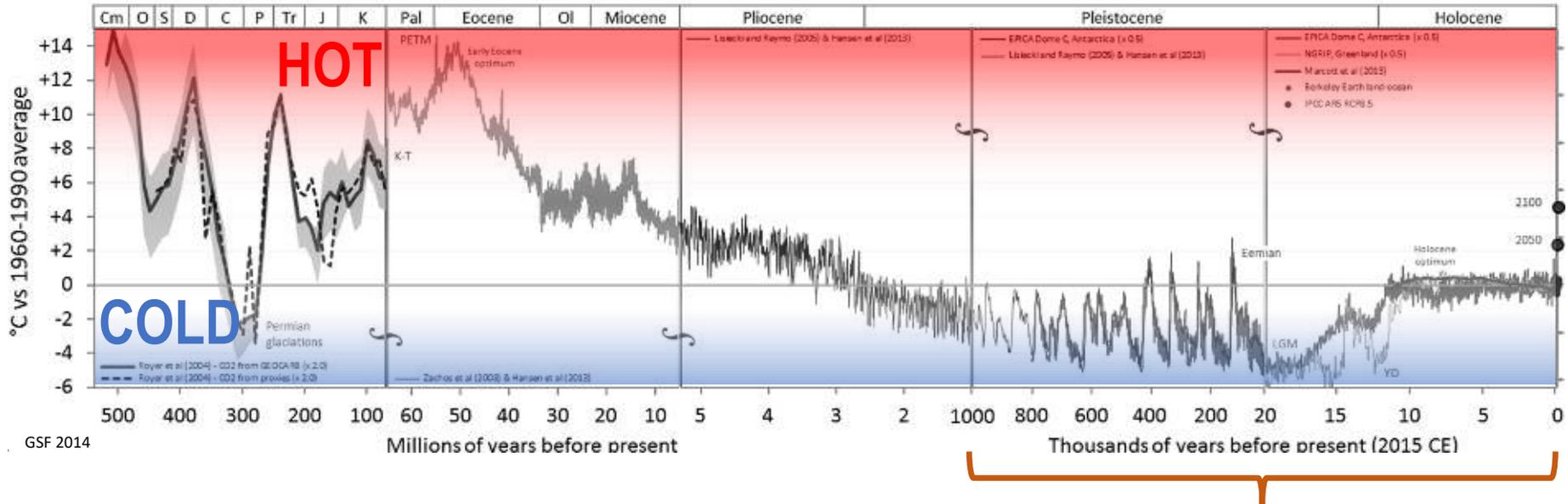


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**What is the 'state'
of our planet?**

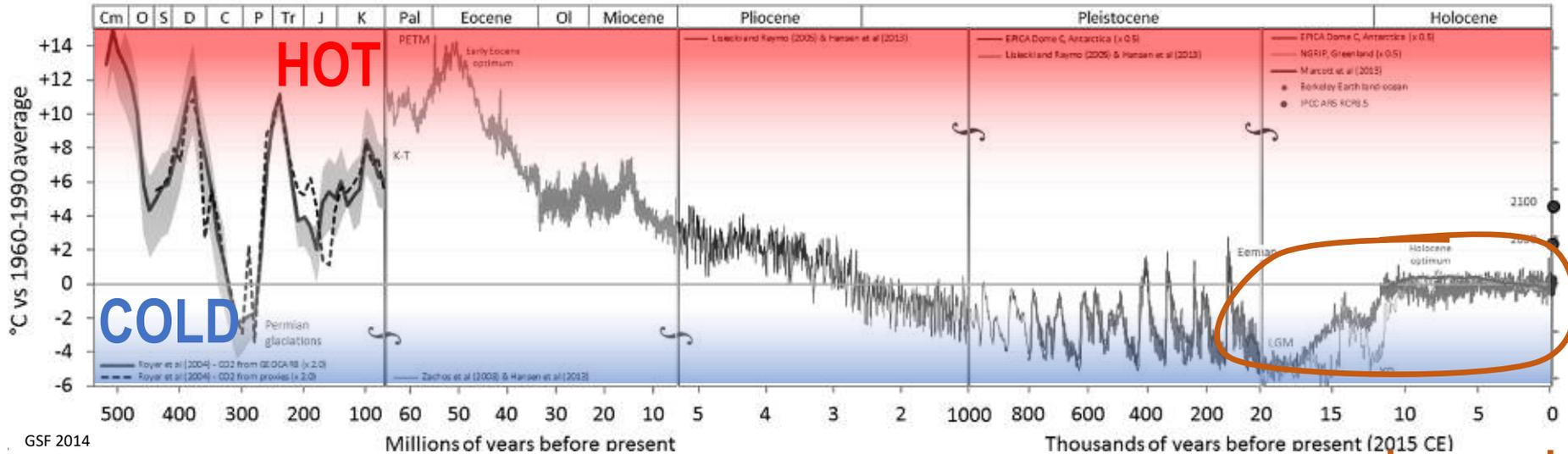
What is the 'state' of planet Earth?



GSF 2014

For the past ~million years,
Earth has oscillated between ice-ages
and warm interglacial periods

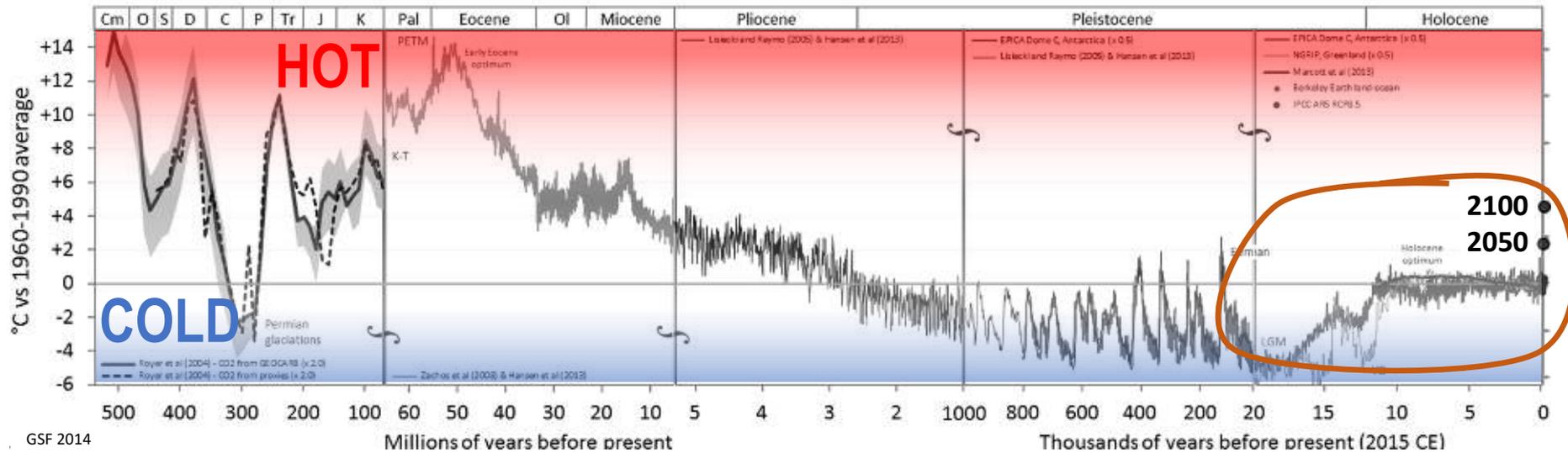
What is the 'state' of planet Earth?



GSF 2014

For the past 10 000 years,
Earth's climate and ecosystems
have been comparatively stable

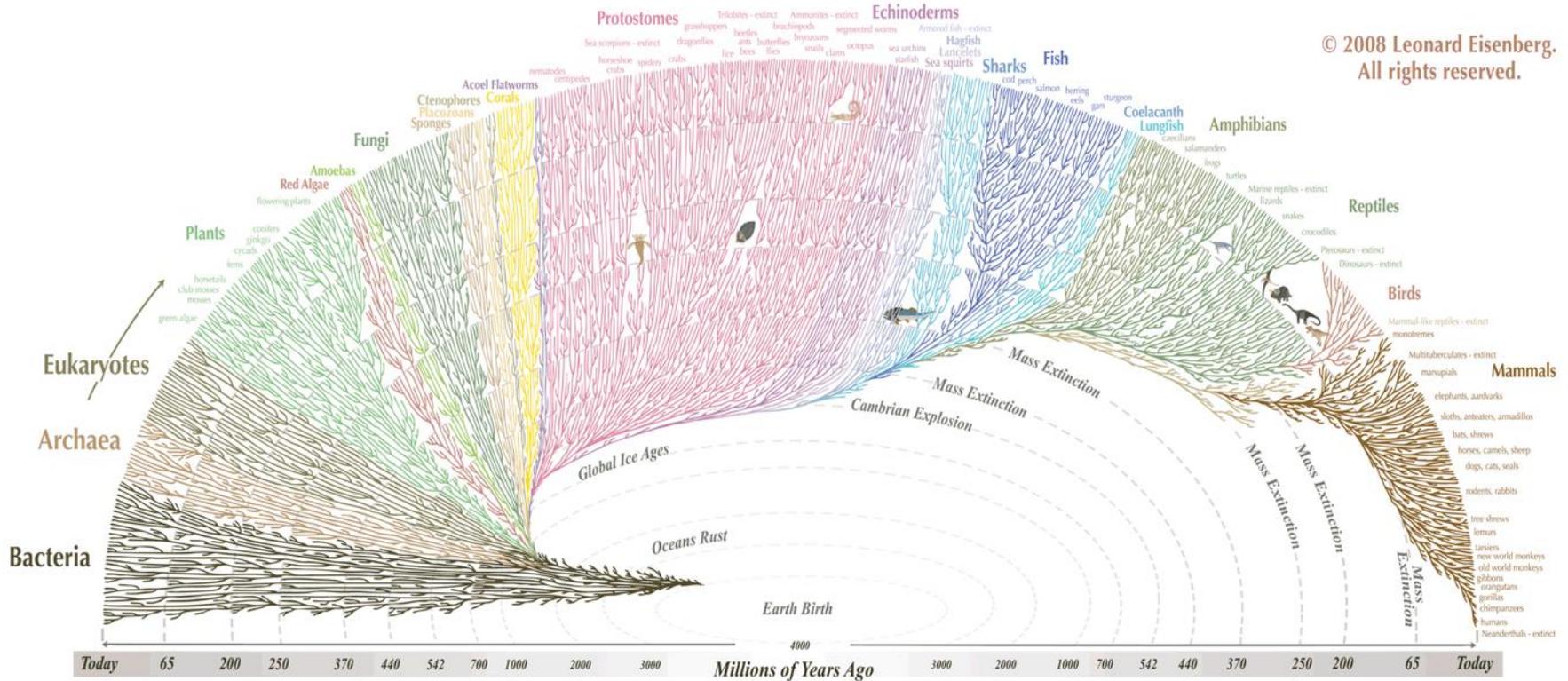
What does Earth system change mean?



GSF 2014

Temperatures are **rising** because of human activities.
Today's living world is not adapted
to these climatic conditions.

What does Earth system change mean?



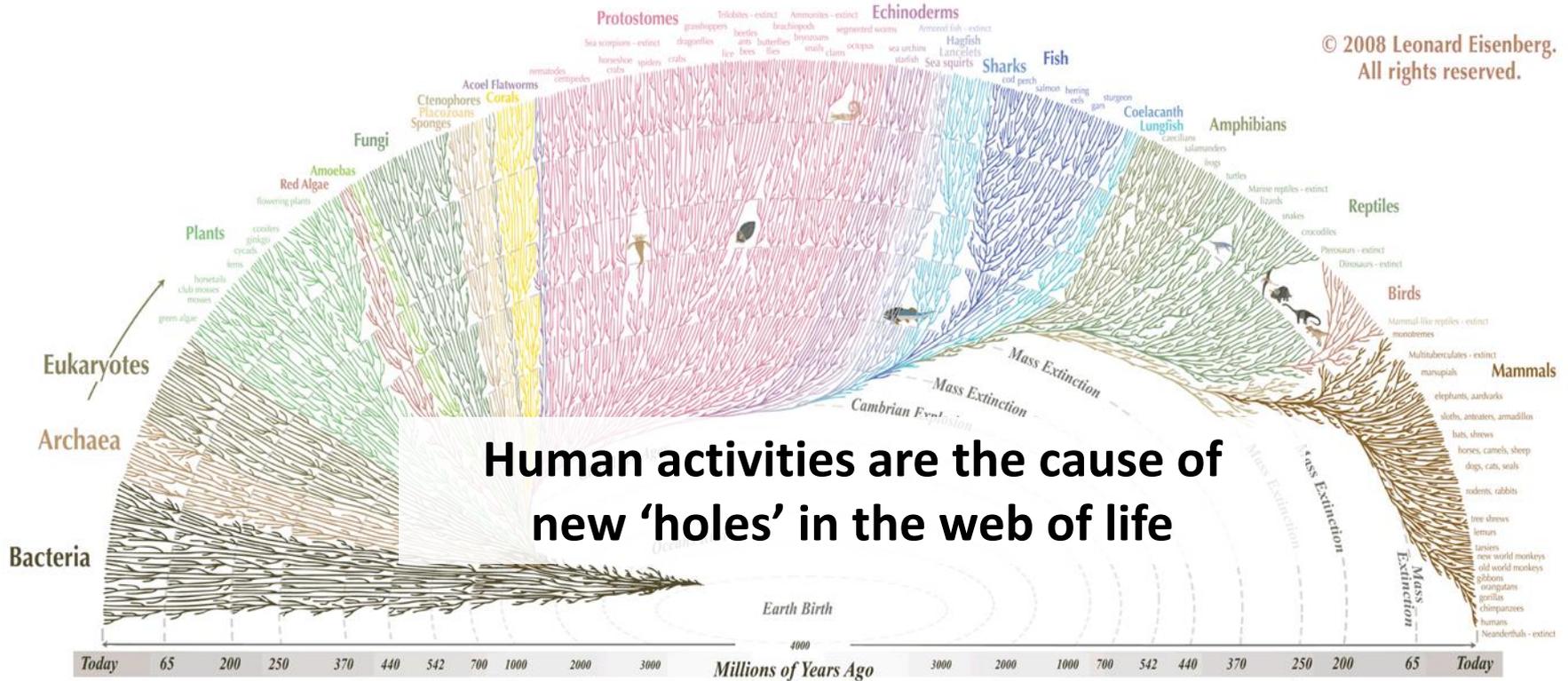
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All the major and many of the minor living branches of life are shown on this diagram, but only a few of those that have gone extinct are shown. Example: Dinosaurs - extinct



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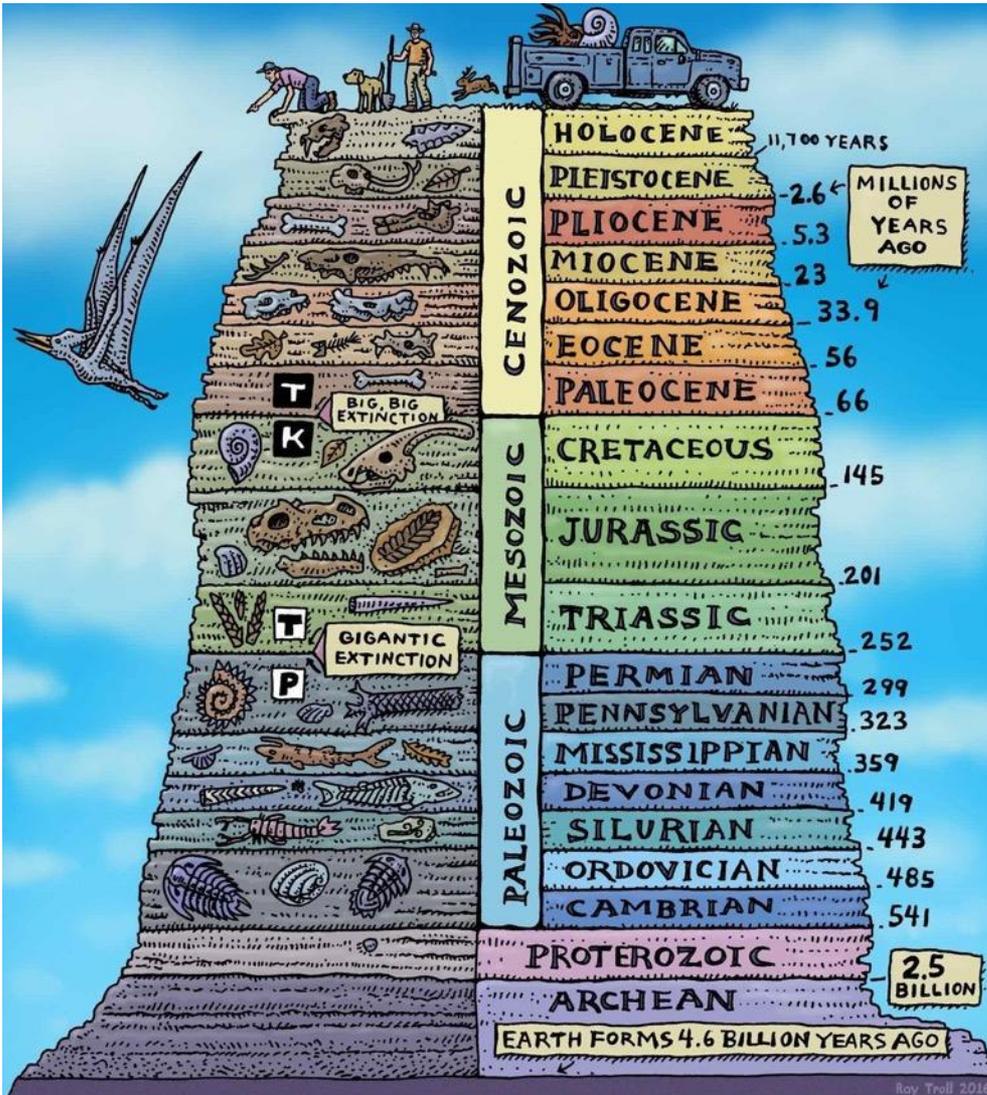
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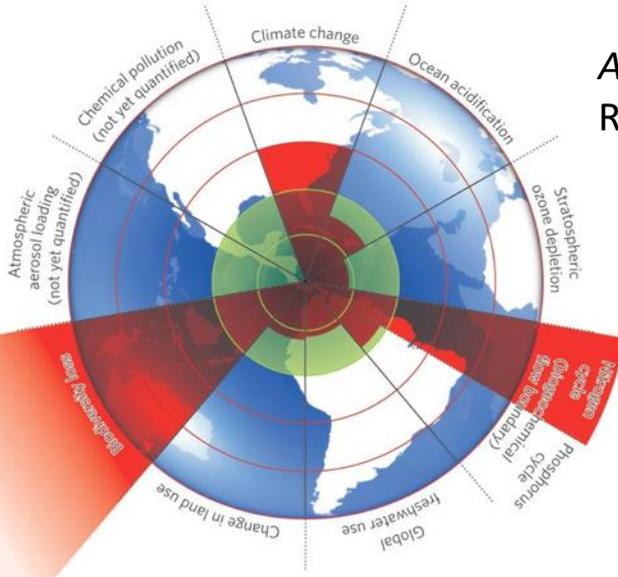
**Entering the
'Anthropocene'**
– human activities that change both the physical and living environment are now enough to leave a pervasive and persistent geological signature

Image: Ray Troll/Troll Art

**What is the
planetary boundaries
framework?**

- Today's human-driven changes are bigger in magnitude and faster in rate than many changes in Earth's geological past
- Today's ecosystems and human societies are best adapted to the conditions of the relatively stable 'Holocene baseline'
- Global sustainability means reducing the **red alerts** of rising risks – '*staying within*' the safe operating space for humanity

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A safe operating space for humanity

Rockström et al 2009, Nature

The Planetary Boundaries framework identifies biophysical conditions for global sustainability

In 2009, three of nine processes already showed Earth system disturbance

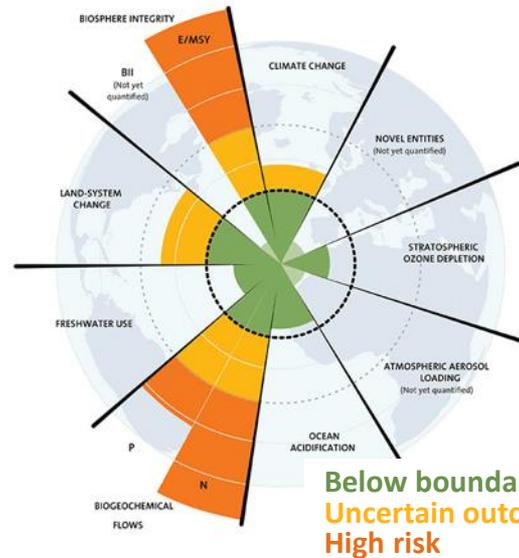
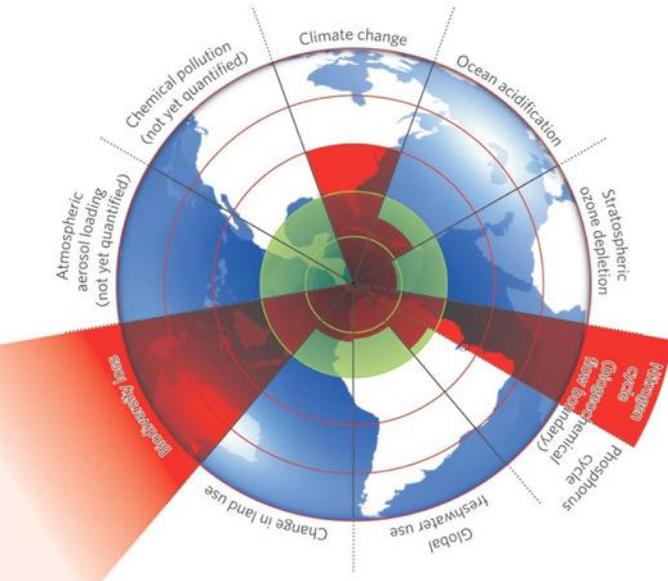
What *are* planetary boundaries?

- ‘Dashboard’ of human-altered Earth system dynamics
- Precautionary measures for continued functioning
- Global complement to local impact indicators
- Scientifically defined, of interest to business and policy
- Interacting pressures, building up fast

Since 2009:

- **new scientific assessments**
- **more evidence of human impact**
- **stronger calls for urgent global action**

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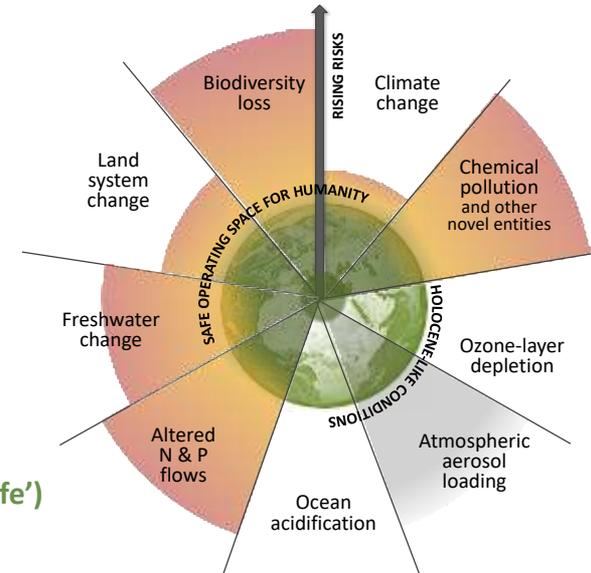
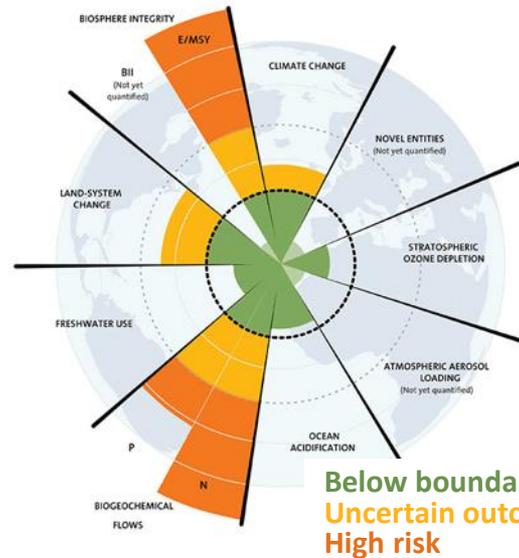
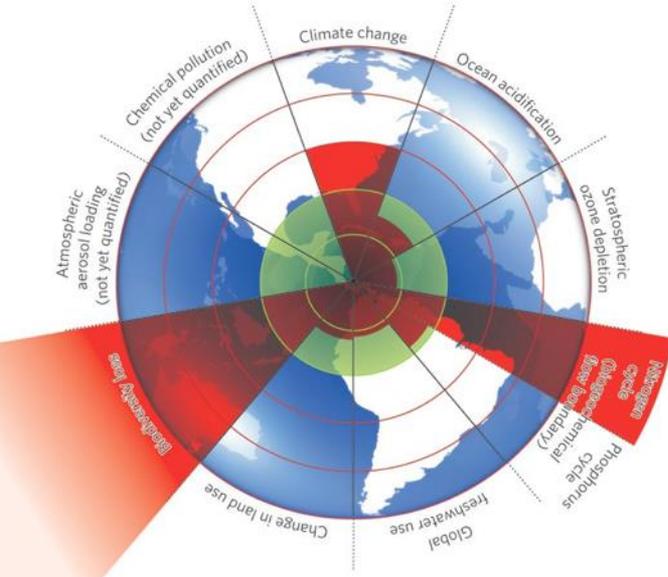


*Planetary boundaries:
Guiding human development
on a changing planet*
Steffen et al 2015, Science

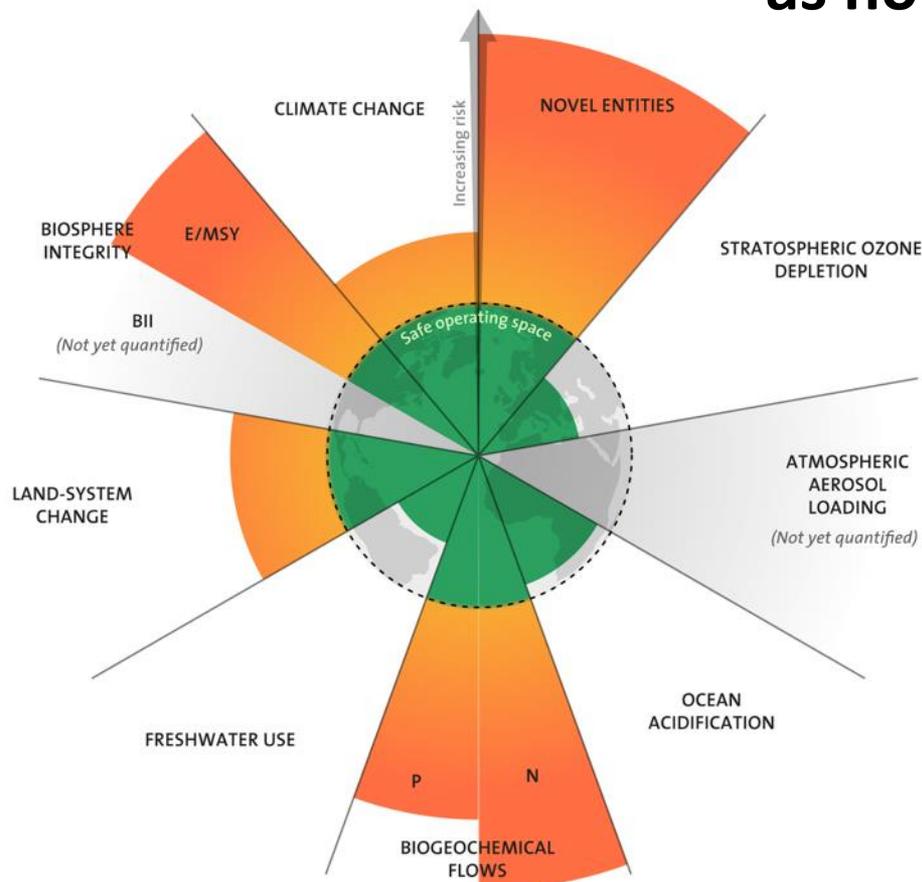
**In 2015,
four of nine boundaries
were overstepped**

Below boundary ('safe')
Uncertain outcomes
High risk

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What does it mean to consider chemical pollutants as novel entities in the Earth System?



Novel entities have **large-scale impacts** that threaten integrity of Earth system processes

Physical, biogeochemical, ecological changes **to climate stability and ecosystem resilience**

Synthetic substances have **no 'natural variability' nor biophysical precedent** that allows Earth system thresholds to be identified

No single control variable captures all 'safe operating space' conditions – quantification of pressures offers a precautionary approach

Weight-of-evidence? **Planetary Boundary for novel entities is now overstepped**

**Planet-scale problems,
people-scale challenges**

Global change, global action – Where can top-down analysis go?

“The problem is the idea that the planet has a cockpit, and in that cockpit, we can change course.
The planet doesn’t work like that”

Maarten Hajer, Utrecht University



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Countries agree to end plastic pollution in ambitious global treaty

A legally binding agreement between 175 countries encompasses all stages of plastic's life cycle, from production to consumption and disposal



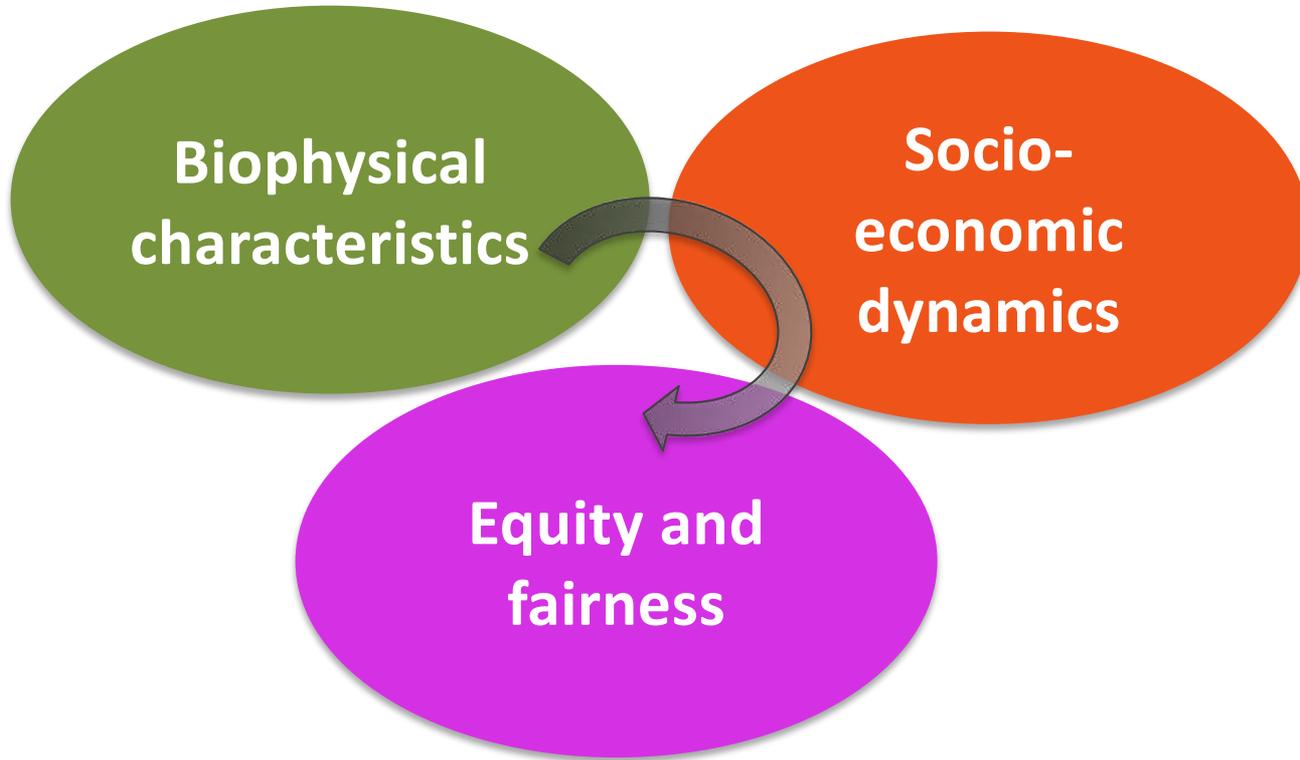
ENVIRONMENT 1 March 2022 , updated 2 March 2022

By [Adam Vaughan](#)

Chemical pollution is as much of a planetary emergency as climate change and biodiversity loss

<https://www.unep.org/resources/making-peace-nature>, 2021







Jocke Berglund, Sweden. Winner of 2005 Wildlife at the Museum competition. The feature was formed partly by a storm and partly by the impact on the soil by forestry machinery.

**Human knowledge grows, but the
human animal stays much the same.
Science enlarges human power.
It cannot make human life more reasonable,
peaceful or civilized...**

John Gray, *Heresies*