Further enhancing and understanding of the Earth climate cycles and observation gaps

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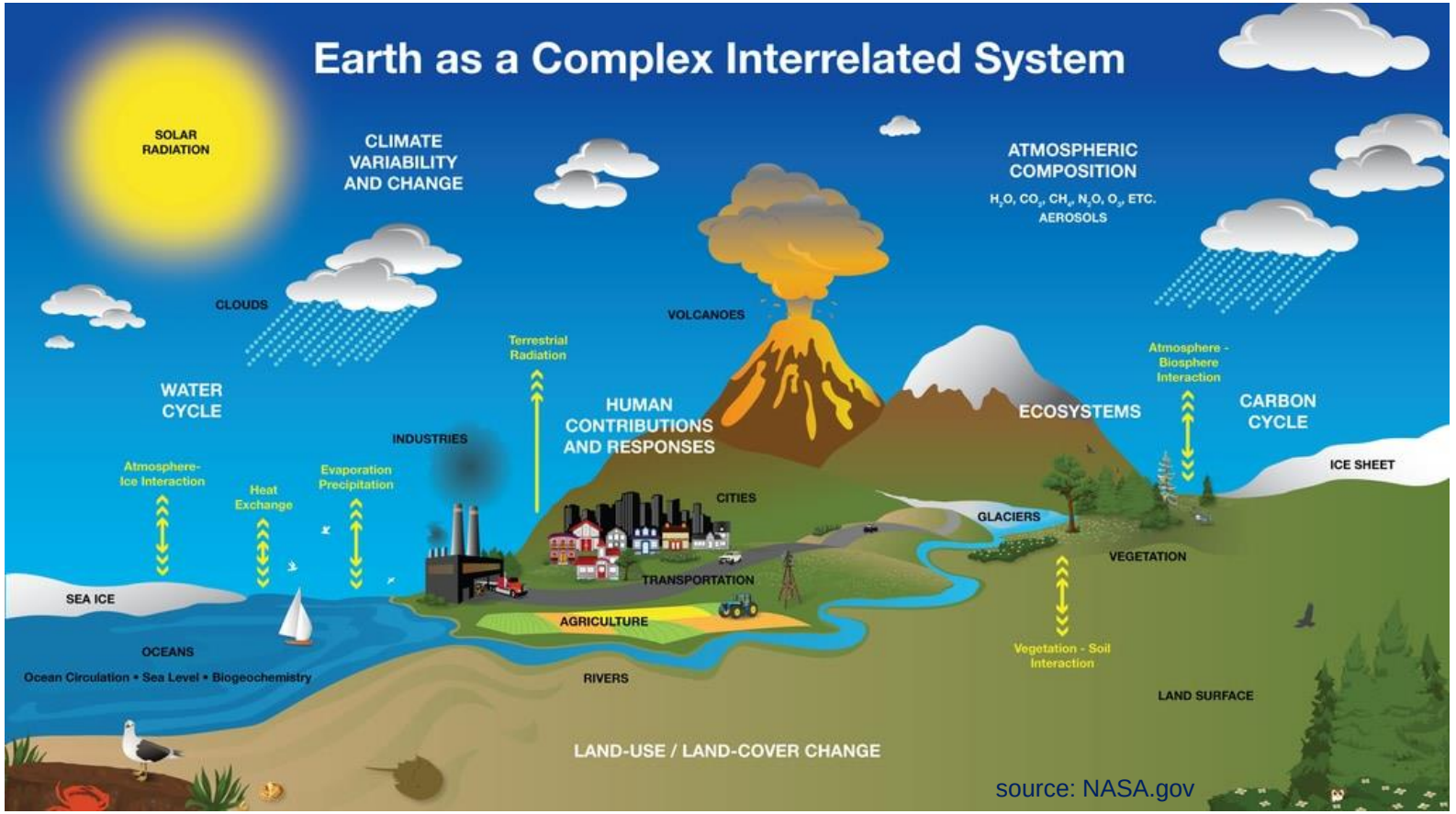
Understanding, monitoring and predicting Earth system cycles ultimately relies on observations

EXPLAINER



Earth system cycles …

- **sustain life** on Earth through the transfer, exchange & storage of heat, water, carbon, … **across all domains** - the atmosphere, ocean, land, cryosphere and biosphere.
- interactions are triggered and altered by **natural variations** of the climate system to maintain and balance the **life-sustaining** natural **rhythm** of the Earth system cycles.

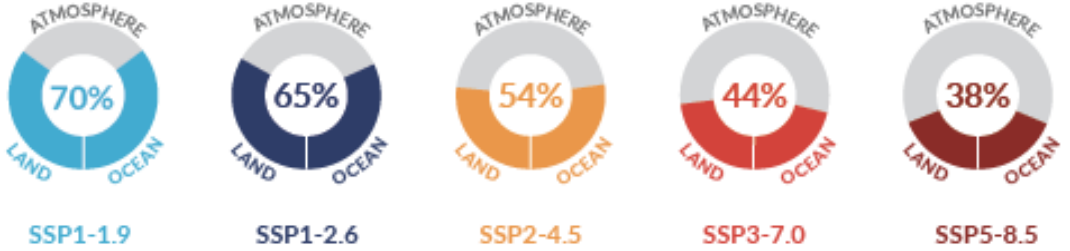
Systematic climate observations across all domains are the **foundation for monitoring, understanding and predicting** Earth cycles natural rhythm, their underlying processes, and future evolutions are needed to close knowledge gaps.

Long-term pressure from climate change affects the natural rhythm of all cycles across all domains.

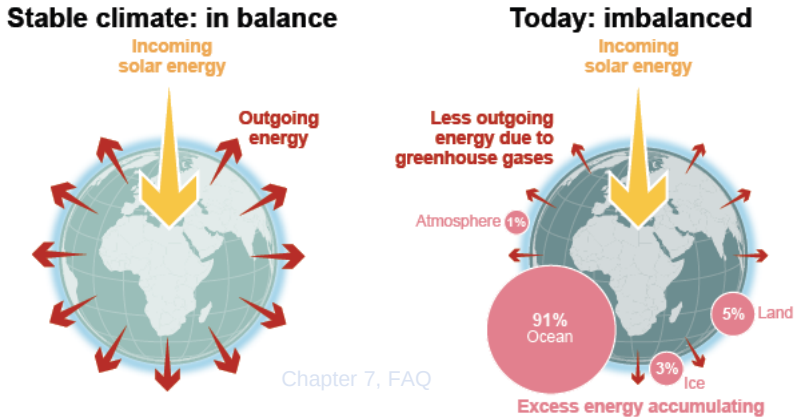
EXPLAINER

Carbon & nitrogen cycles: Human activity has caused an accumulation of well-mixed GHG (CO2: 47%, CH4: 156%, N2O: 23 %)*, lowering land & ocean sink dynamics

* above pre-industrial (1750) levels



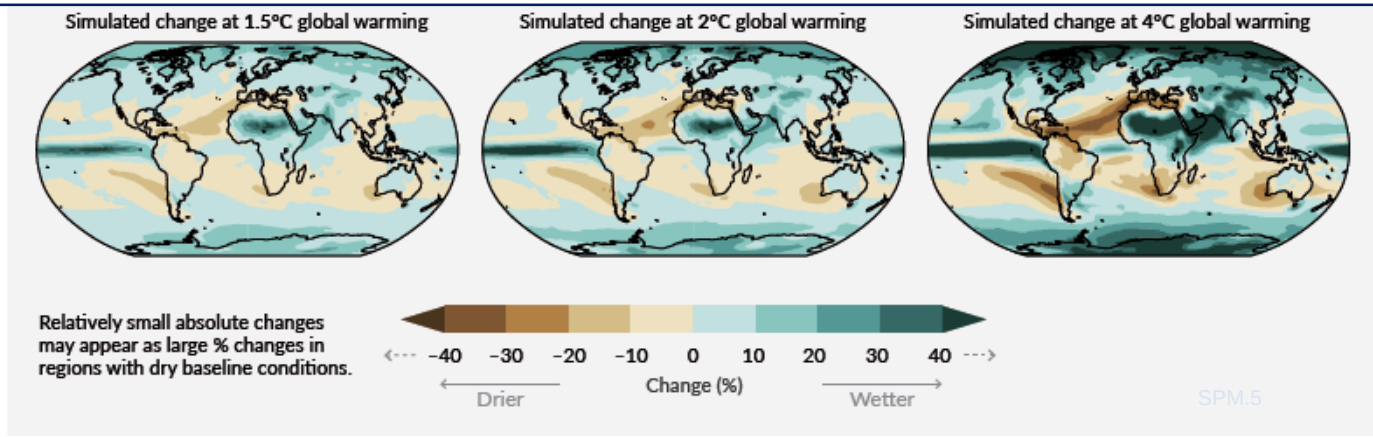
SPM.7



Chapter 7, FAQ

Energy Cycle: Human activity has caused an imbalance of the natural energy flows, leading to an accumulation of surplus heat warming all domains: Ocean, Atmosphere, Land, Cryosphere

Water Cycle: Human activity has caused an intensification of the water cycle & is projected to further intensify, including its variability, global monsoon precipitation and the severity of wet and dry events



SPM.5

With increasing warming, feedbacks between climate change & the cycles become larger, intensifying related impacts & their severity

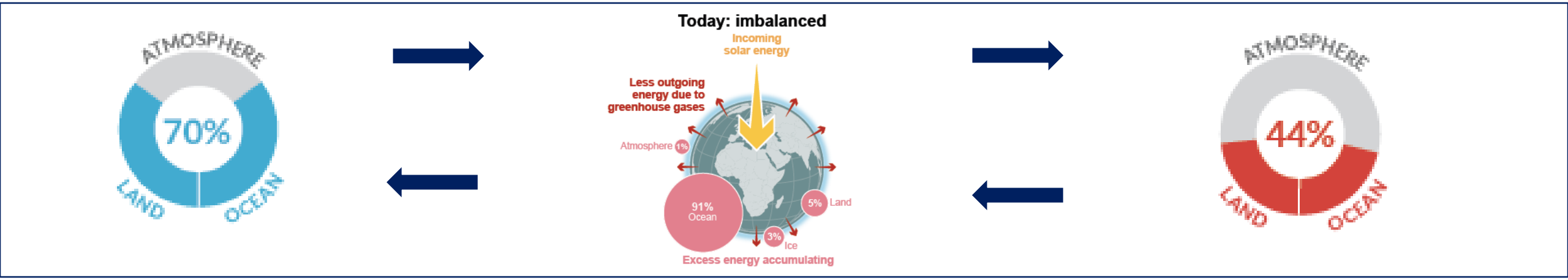
RECOMMENDATION

EXAMPLE: THE OCEAN HEAT-CARBON NEXUS

Carbon sinks set the airborne fraction, which **sets radiative forcing** that drives the additional heat in the atmosphere

The **ocean** sets the **thermal response** through ocean heat uptake

Feedback: ocean warming **weakens** the ocean **sink**, which **increases** the airborne fraction, and hence the **radiative forcing**

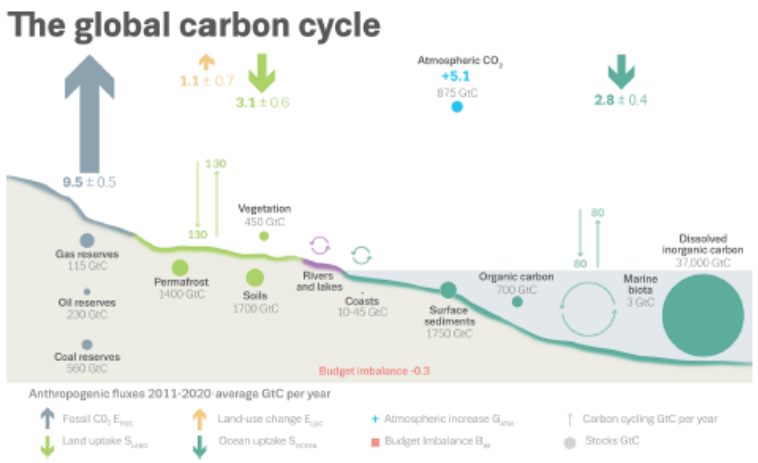


Precise **understanding, monitoring** and **predicting** Earth's climate can only be achieved through a **comprehensive view of the Earth system cycles** and underlying processes of transfer, exchange and storage **across all components**, and related **feedbacks** with climate change **across all time scales**. ➔ **GCOS IP**

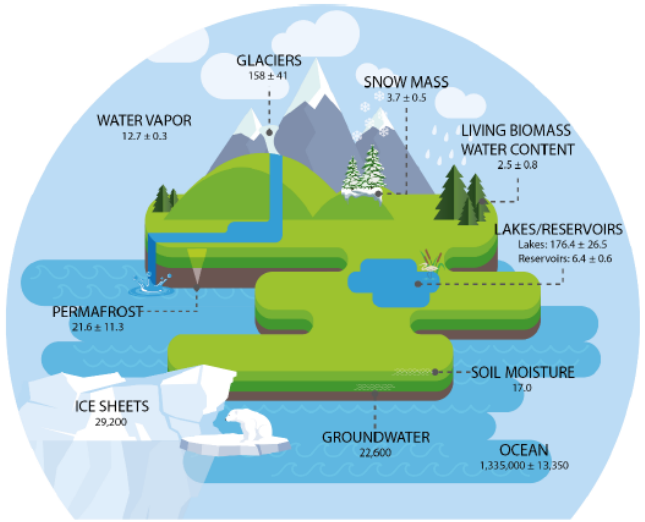
From science to policy: supporting the climate service value chain

OUTCOME

EXAMPLE: Regular knowledge updates of Earth's cycles under GCOS & the global carbon project assessing today's capacities

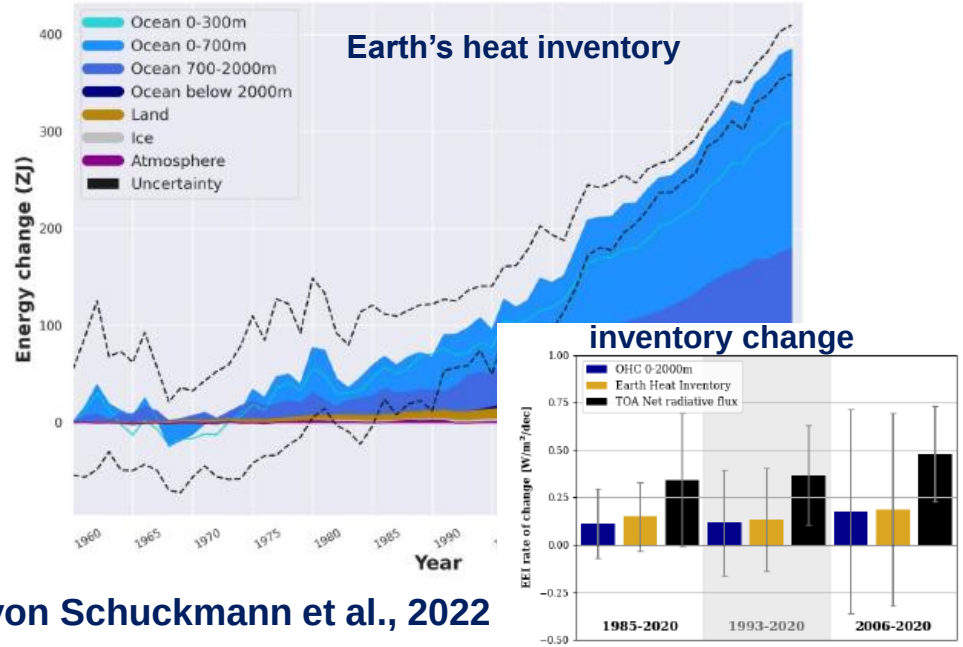


Friedlingstein et al., 2022

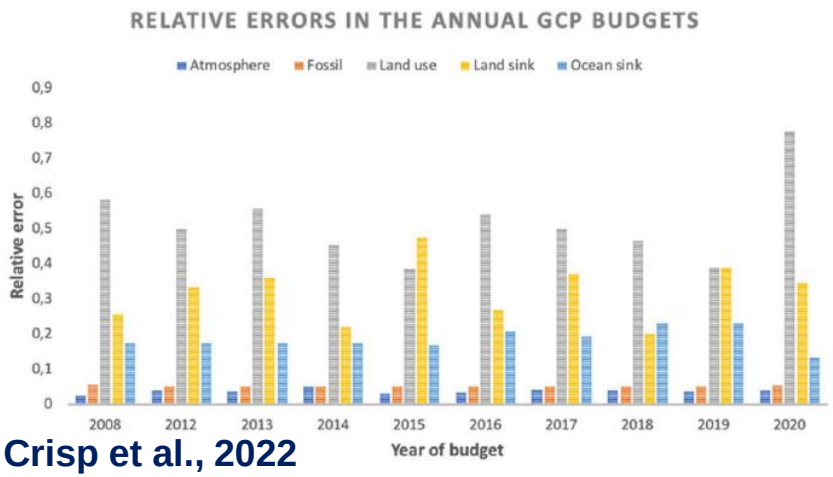


GLOBAL WATER STORAGES

Dorigo et al., 2021



von Schuckmann et al., 2022



Crisp et al., 2022

To **monitor, understand and predict** the Earth system cycles & their feedbacks, **systematic** and **long-term measurements** are fundamental, and need to be **sustained** and **enhanced** in the future to support decisions on **climate change action** and **sustainable development**

A critical element of setting out a robust climate policy regime and credible targets is ensuring the accuracy of the climate trajectory.

CONCLUSION

- The Earth's system **cycles are the most robust indicators** informing on the state and future evolution of **climate change.**
- **Recognition** that both the **natural cycle and the anthropogenic perturbation of the cycles** need to be considered together to accurately monitor, understand and predict **the climate trajectory**.
- Urgent need to **fill observational & knowledge gaps** for a better understanding of the Earth system cycles to achieve any UNFCCC & Paris Agreement **targets for net-zero**.
- Work directly with the **observing, prediction, and research communities** to maintain focus and regularly evaluate progress on responding to multilateral agreements (UNFCCC, Paris agreement) while **synthesizing** and **communicating** information about current capacities and gaps **to decision makers**
- Leverage and **improve** monitoring, understanding and prediction of related **regional change & impact** across all time scales in support of **adaptation strategies**