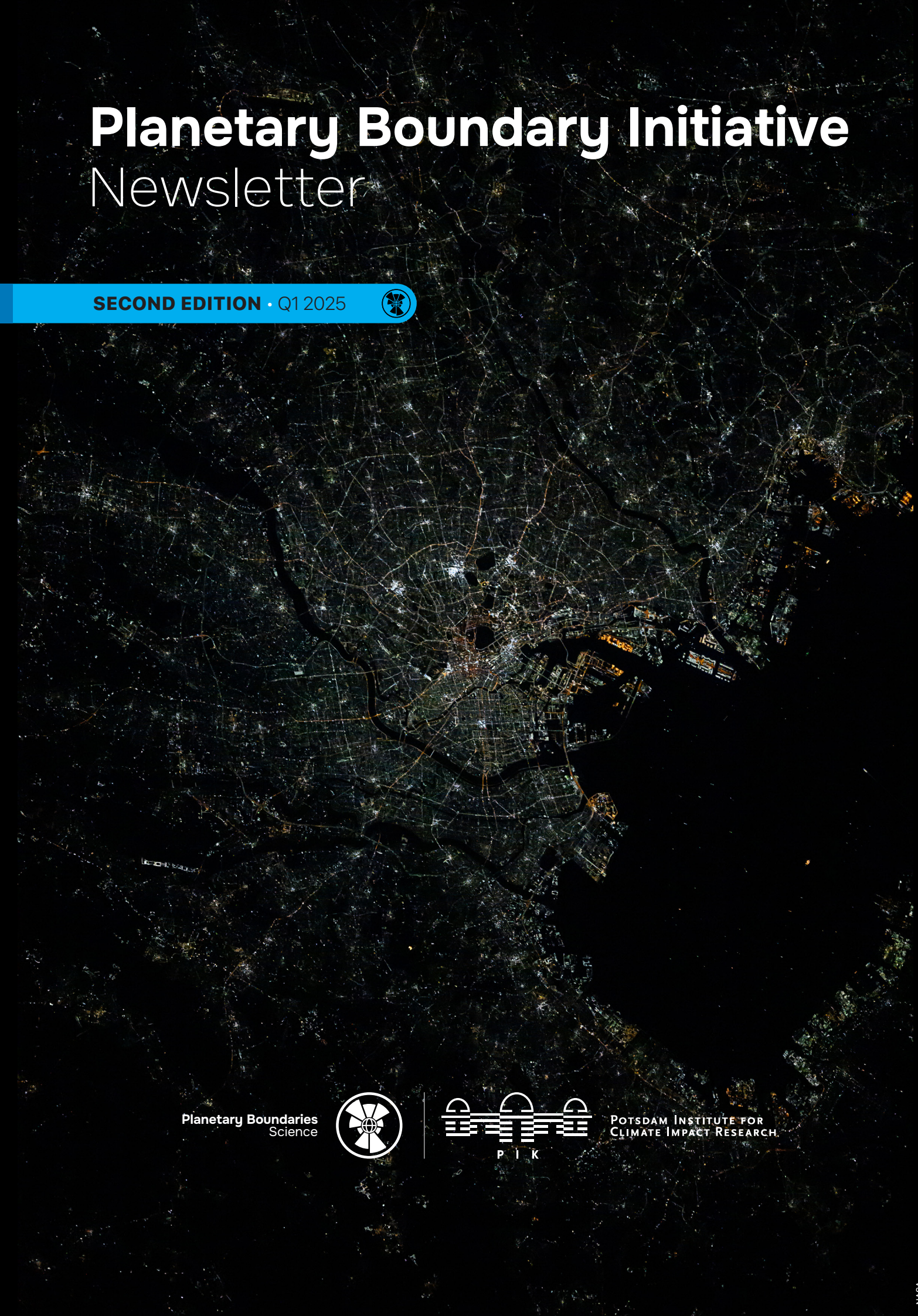
Planetary Boundary Initiative
Newsletter

SECOND EDITION • Q1 2025



Planetary Boundaries
Science

PIK
Potsdam Institute for
Climate Impact Research

NASA

Planetary Boundaries are key rules that help us keep Earth safe and healthy for life on the planet. For this newsletter we will focus on how passing, or transgressing, those boundaries can lead to higher risks from tipping points that fundamentally alter Earth's systems.

Key components of the Earth's oceans, ice sheets and forests can switch to fundamentally different states, driven by nonlinear processes. This can happen when human pressures like greenhouse gas emissions, deforestation and pollution exceed critical levels — tipping points. The consequences would be practically irreversible and potentially catastrophic for billions of people and many future generations on Earth. **One of the primary motivations behind setting Planetary Boundaries is to avoid crossing these tipping points.** As part of the Planetary Boundary Science initiative, we are investigating such tipping point risks.

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WELCOME TO THIS SECOND NEWSLETTER OF THE **PLANETARY BOUNDARY INITIATIVE (PBI).**

Here, you will find updates on **PBScience** and related research efforts conducted at the PIK and beyond. Read on for news on our steadily growing science initiative, cutting-edge **Planetary Boundaries (PB)** research results, and exclusive insights into the PBScience effort.

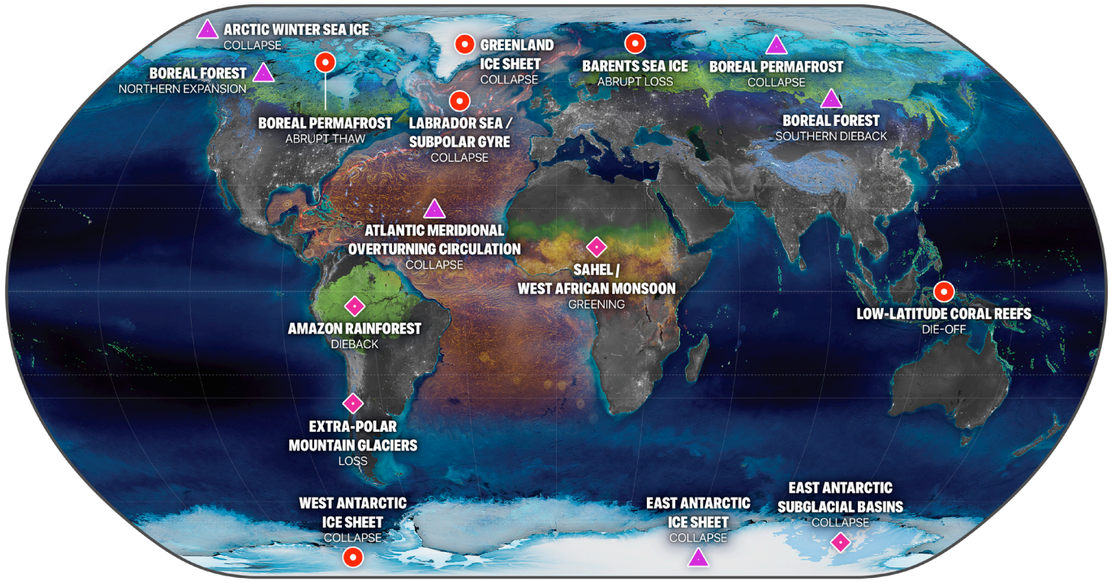
In this edition, we focus on **tipping points science**.

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TIPPING POINT SCIENCE WITHIN PBI

Earth's subsystems, from lakes to continental ice sheets or ocean circulations, have self-reinforcing feedbacks that either dampen or amplify changes. When amplifying feedbacks dominate, they can push a system past a threshold: A tipping point is transgressed, causing a shift to a new stable state — like a rainforest turning into a savanna due a shift from a self-moistening to a self-drying feedback. Such shifts can occur abruptly and irreversibly, thereby dramatically exacerbating the risks of a changing planet.

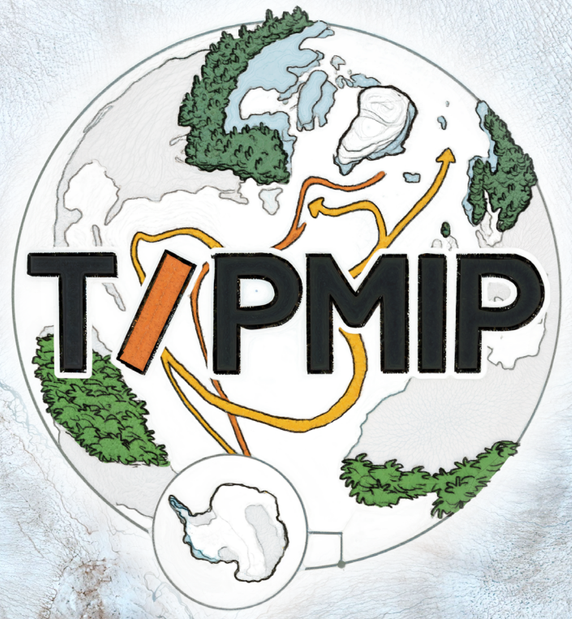
CLIMATE **TIPPING ELEMENTS**



Amstrong McKay et al., Science (2022) | GLOBAÏA.

While the transgression of tipping points would have far-reaching impacts and incur associated high-end risks on the global climate, ecosystems and societies, they are also associated with some of the highest uncertainties within projections of future climate change. Here, state-of-the-art models of the Earth system and its components are indispensable tools to shed light on the dynamics of tipping points, the likelihood of their crossing as well as the associated impacts on the planet and people. These models allow us to make sense of observations of the past and present, and to make projections for the future.

Global modelling efforts around tipping points are streamlined in the **Tipping Points Modelling Intercomparison Project (TIPMIP)**. It is led by **Ricarda Winkelmann** via **PIK**, the **Max Planck Institute of Geoanthropology** and the **Earth Commission**, constituting a key pillar of the Planetary Boundary Science initiative. TIPMIP serves as the interface between models as used in the **IPCC** (Intergovernmental Panel on Climate Change) context and Planetary Boundaries science within the PBScience initiative.



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RECENT TIPPING POINT SCIENCE HIGHLIGHTS

In this segment, we share new exciting developments pushed forward by our scientists and collaborators, including their research and advocacy.



GLOBAIA





RAISING AWARENESS OF **TIPPING POINTS** FOR **EUROPEAN** AND **AMERICAN GOVERNANCE**

Text: Sina Loriani | Photos: Ben Poulter

The high-end risks associated with **Earth System Tipping Points** (ESTPs) significantly increase the urgency in climate change mitigation, and require a more complex understanding of possible future scenarios. Governance actors need to be made aware of the additional challenges and deep uncertainties associated with tipping dynamics, which can play out abruptly and lead to severe, irreversible changes in the Earth system with widespread impacts. To this end, PB-TIP and TIPMIP scientists have been meeting with actors in Europe and the U.S. to raise awareness on this topic.

The PB-Tip scientists Donovan Dennis and Dr. Sina Loriani engaged in discussions with the **office of the U.S. Senate Budget Committee**, providing an overview on the current state of tipping point science. Furthermore, they followed an invitation of the **Office for Science and Technology Policy (OSTP)** at the White House, exchanging with then-deputy director for Climate and Environment at the OSTP, Dr. Jane Lubchenco, and her team.

Moreover, in view of the new European Commission taking office in December 2024, experts from various domains and institutions met in Brussels on November 5-6th to discuss the **needs for anticipatory governance of ESTPs**. The workshop was convened by the Commission's Joint Research Centre and several other policy departments, the University of Oslo, and PIK. The attendees were policy makers, scientists from the Earth System and socio-economic modelling domains, the Earth Observation community, insurance and finance experts, and several international organisations. A policy brief "Earth System Tipping Points are a threat to Europe" resulted from the meeting, offering recommendations to the European Union and its member states to address the risks of ESTPs. It was disseminated among the policy departments of the Commission in time to inform the Preparedness Union Strategy.



EXTENDING THE SCIENTIFIC NETWORK: **TIPMIP GOES WEST**

Text and Photo: Donovan Dennis

A MIP (**model intercomparison project**) is, by nature, a large collaboration. An, if not the, key utility of MIPs is their capacity to facilitate comparison of different models (which have different structures and setups), offering insight into both the fundamental functioning of the system(s) of interest as well as the behaviours, tendencies, and biases of individual models. Therefore **a MIP is only as good as its parts and the collaborative network** it brings together under its protocol(s).

TIPMIP is an ambitious MIP. Their goal: systematically assess the risk and likelihood of crossing tipping points in each particular system. (For more information about TIPMIP, see www.tipmip.org). In late 2023 the TIPMIP team noticed they were doing a fair job of bringing along European and Asian modelling groups, but that, conspicuously, North American partners numbered just a handful. To bring new partners into the TIPMIP fold, PB-TIP scientists Dr. Sina Loriani and Donovan Dennis set out on the "**TIPMIP Goes West**" trip for one month in mid-November 2024. Their journey began in Berkeley, California and ended at the TIPMIP General Assembly in Baltimore, Maryland, with stops at many of the major centres of Earth system science in the western United States and along the eastern seaboard. Overall, the team strengthened collaborations with colleagues at numerous institutions, including the National Center for Atmospheric Research in Boulder and NASA Goddard in New York.

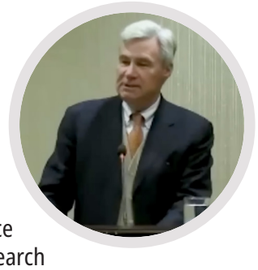


TIPMIP GENERAL ASSEMBLY IN BALTIMORE

Text: Donovan Dennis | Photos: Donovan Dennis & Sina Loriani

Maryland, on the east coast of the United States, has more than 3100 miles of low-lying, tidal shoreline, making it a highly vulnerable U.S. state to global sea level rise. Further sea level rise induced by tipping in the Antarctic and Greenland ice sheets presents a serious threat to the city's resilience and therefore Baltimore's Inner Harbor served as a fitting backdrop for the **second TIPMIP General Assembly**, held there from 4.-7. December of 2024.

Regular meetings of the TIPMIP community are essential for advancing the project's important work, particularly in the early phases wherein development of various modelling protocols requires close multi-stakeholder collaboration. Though all under the umbrella of Earth system tipping points, different communities and scientific realms have differing priorities in terms of the scientific questions which should be asked, and therefore in-person discussions and negotiations are an essential component of TIPMIP's development. In Baltimore, scientific sessions highlighted early results from the first TIPMIP experiments as well as synergies with previous community modeling efforts across the various Earth systems of interest.



Additional highlights from the meeting included two evening events. On 5. December, **U.S. Senator and Senate Budget Committee then-Chairman Sheldon Whitehouse** joined assembly participants to deliver remarks on the critical importance of TIPMIP and tipping points research broadly. The following evening, participants gathered in the IMAX theatre of the Maryland Science Center to view films from **Open Planet Studios** highlighting tipping points and equity, followed by discussion.



TIPPING POINTS AT THE **AGU FALL MEETING**

Text and photo: Donovan Dennis

Immediately after the TIPMIP General Assembly, PB-TIP staff members Dr. Sina Loriani, Donovan Dennis, Dr. José Licon-Salaiz, Dr. Nico Wunderling, and Karoline Ramin traveled 45 minutes south to Washington, D.C. to present at the **American Geophysical Union's annual Fall Meeting**. Tipping points were a highlight for many conference attendees, with one of the annual meeting's first-ever sessions exclusively on tipping points (convened by, among others, TIPMIP Initiator and Lead Prof. Dr. Ricarda Winkelmann and PB-TIP scientist Donovan Dennis) filling to standing room only. Presentations by Drs. Sina Loriani and Nico Wunderling in that session were met with positive feedback from attendees and media organisations present.

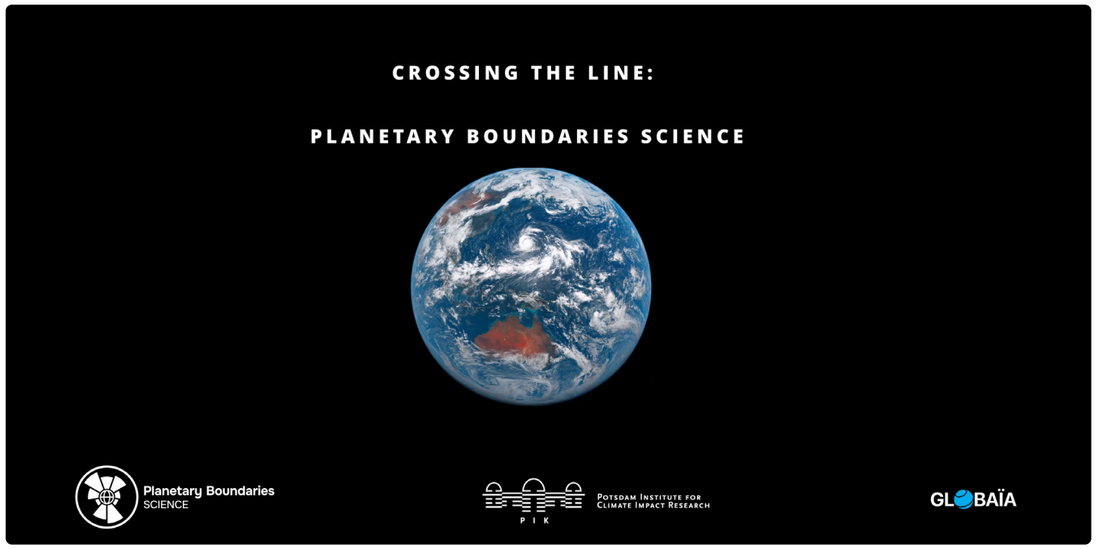


PRESENTING THE PB FRAMEWORK AT THE **BTW 2025**

Text: Hannes Rauhe | Photos: BTW & visit-erlangen.de

The BTW (Conference on Database Systems for Business, Technology and Web) is the most important database conference in the German-speaking area. As a former database engineer, Dr. Hannes Rauhe specializes in managing and analyzing extensive Earth system data to assess critical planetary boundaries at the PBScience Lab. At the BTW 2025 conference, he engaged with experts in data engineering, data science, and machine learning, exploring how advancements in these fields can enhance our work. Discussions on scalable data integration and analytics were particularly relevant to improving the lab's workflows for handling and analyzing complex environmental data. He also had the opportunity to present the planetary boundaries framework to the German database research community.

BTW 25 Bamberg



PLANETARY BOUNDARIES **EXPLAINER VIDEO SERIES** CHANNEL GOES **LIVE**

This month our new **Planetary Boundaries Science YouTube channel** can be discovered by searching YouTube under @PlanetaryBoundariesScience. The channel is now live with the first of a series of short, understandable planetary boundaries videos. The series will include interviews with key scientists, experiments and will help spread our outreach to the general public. Keep checking back for new videos each month.

OUTLOOK

UPCOMING EVENTS, ACTIVITIES AND PUBLICATIONS RELATED TO THE PLANETARY BOUNDARY INITIATIVE AND RELATED RESEARCH TEAMS

APRIL 2025

Expert for ocean tipping joins the team: In the effort to study Earth System Tipping Points across systems, TIPMIP needs to assemble a core team of experts for tipping points in each major domain. The hired postdoc will lead our engagement with the wider community working on ocean circulation systems.

APRIL-MAY 2025

Our research groups will team up to co-host a joint session on Earth resilience in the Anthropocene: tipping points, planetary boundaries, and human-Earth system interactions at the annual assembly of the **European Geosciences Union (EGU 2025)**, one of the world's most important geoscientific conferences covering all disciplines of the Earth, planetary, and space sciences.

5-7 MAY 2025

The Planetary Boundaries Science Lab (PBScience) will host the **PB-Ocean Workshop** at PIK following submissions by various experts to improve the representation of the ocean within the Planetary Boundaries framework. In addition to these invited experts, several honorary guests, among them Dr. Sylvia Earle and Prof. Katherine Richardson, will be attending.

MAY AND JUNE 2025

Workshops to engage policy makers: Governance of tipping points requires anticipatory action in the presence of deep uncertainties, both for mitigation as well as for intersectoral preparedness for catastrophic scenarios. We will host workshops between Earth system scientists and representatives from various German and Norwegian national policy departments to co-design tools to be utilised in the context of tipping points governance.

9-13 JUNE 2025

Members of the PBScience Lab will organise a side event at the 2025 United Nations Conference to Support the Implementation of Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development (or UN Ocean Conference 2025 for short). It will take place in Nice, France, and will be co-hosted by France and Costa Rica. This conference's overarching theme is "Accelerating action and mobilizing all actors to conserve and sustainably use the ocean".

30 JUNE- 3 JULY 2025

Tipping points conference in Exeter, UK

PIK, the **Max Planck Institute of Geoanthropology** and **Exeter University's Global Systems Institute** jointly host the **Global Tipping Points Conference**. It will build upon the previous conference in 2022 and the Global Tipping Points Report launched at **COP28** in December 2023. The conference will cover the risks from climate tipping points and opportunities for positive tipping points for different regions, communities, sectors, and supply chains. Alongside keynotes and research sessions, it will feature hands-on, action-driven workshops with experts and leaders from academia, policy, and business.

JULY 2025

Look out for the third edition of our newsletter, which we plan to release in July 2025.





NASA

Meet the Team

In this segment, we introduce you to people working to advance the Planetary Boundary Initiative. In this second edition of our newsletter, get to know the two scientific leads of PIK's **PB-Tip Project**, Dr. **Jonathan Donges** and Dr. **Sina Loriani**.

Planetary Boundaries
SCIENCE



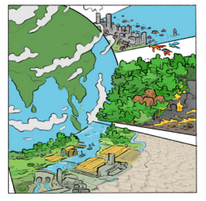
Dr. Jonathan Donges

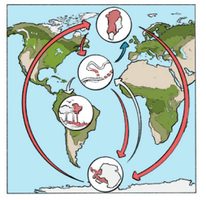
Jonathan is deputy lead of the **Earth Resilience Science Unit** (ERSU, led by Prof. Dr. Ricarda Winkelmann and Prof. Dr. Johan Rockström) at PIK and co-leads the **PB-Tip** project within the ERSU research theme **Whole Earth System and Resilience Analysis**. In recognition of his work on advancing a complex systems perspective on human-Earth system interactions in the Anthropocene, he has received multiple awards, including the prestigious German Research Foundation's Heinz Maier-Leibnitz Prize 2019. Jonathan holds a PhD in Theoretical Physics from **Humboldt University Berlin** and has published more than 130 academic papers on Earth system analysis, climatology, paleoclimate, social- ecological systems, complex networks, complex systems theory, nonlinear dynamics, and time series analysis. Besides his scientific work, he likes to experiment with planetary gardening and beekeeping.



Dr. Sina Loriani

Sina is deputy lead of the ERSU at PIK and co-leads the **PB-Tip** project within the ERSU research theme **Tipping Point Risks**. His work focuses on tipping points in the Earth system, particularly methods for detecting them in Earth system model datasets. He contributes to the **Earth Commission**, co-led the section on Earth system tipping points in the **Global Tipping Points report** and is part of the core team setting up TIPMIP. Before his work in climate research, he received a PhD in quantum sensing at the **Leibniz University** of Hannover, investigating tests of general relativity using atom interferometry. In his free time, Sina is an avid illustrator for several projects and pursues science communication with comics.







THANK YOU...

for your interest in Planetary Boundaries science. By providing us with feedback on our activities, you can help us to continuously improve our outreach efforts: pbscience@pik-potsdam.de

Google Earth, Maxar