Abstracts of key note speakers

Global change and tree distribution – local to global perspectives

Niklaus E. Zimmermann, Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Switzerland

Plants and animals have started to respond to climate and global change e.g. by migration, and these range shifts will likely be associated with considerable species turnover, which in turn will alter vegetation structure, biomes and functional compositions. While we have a somewhat good knowledge on the degree of expected range shifts, we do not know whether all species will actually be able to cope with the rapid shifts. And for those who likely can make it, we still have considerable uncertainty as to how fast these plant species can migrate to those areas that become suitable in the future. Moreover, front and rear edges of species ranges will likely be affected differently by a changing climate due to different response processes to ongoing changes. I will summarize knowledge from empirical and hybrid models on expected range shifts for tree from local to continental and global scales, with details from case studies.

The key transformational role of forests in the Anthropocene

Marc Palahí, European Forest Institute (EFI), Finland

For the last 200 years we have relied on a fossil-based economy. This has supported huge economic and population growth, technological development and social prosperity. But it has also created great environmental challenges like climate change and biodiversity loss. These have a cascading effect on other global issues like food and water security, poverty, migration and human health. Therefore, we need to transform our economy, to ensure a sustainable future for future generations. We need to move from a linear, fossil-based economy towards a circular, bio-based one which prospers within the renewable boundaries of our planet. European forests are central to this transformation. They are our most important biological infrastructure, playing a key role in the resilience of our continent, regions and cities by offering ecosystem services link to the sustainability of precious resources like water, soil and biodiversity. But our forests have another role too. They are our main source of non-food and non-feed biological renewable resources. With advances in science and technology these resources can be transformed into a diversity of biomaterials, which can be as soft as cotton or as resistant as steel. New bio-based solutions can replace fossil-based and non-renewable raw materials and products. Therefore, our forest resources are crucial to build a resilient society as well as transform our economy to prosper within the planetary boundaries.

Drought in tropical forests: from physiological mechanisms to tree distribution patterns

Bettina Engelbrecht, Plant Ecology, University of Bayreuth, Germany

Tropical forests are among the most diverse systems on earth, and provide regionally and globally important ecosystem services. The most pervasive patterns of tree distributions and diversity in tropical forests worldwide are correlations with rainfall and/or soil moisture. Projecting

consequences of climate change requires distinguishing among potential factors producing these patterns, and a mechanistic understanding of the underlying processes. Using a pronounced rainfall gradient across the Isthmus of Panama as a model system, we are combining a variety of experimental and observational approaches. We show that drought directly shapes plant performance and distributions in tropical forests, and that species differential drought sensitivity is driven by physiological mechanisms of desiccation tolerance, rather than by avoidance of desiccation. Current work examines the additional roles of nutrients and of herbivore and pest pressure in driving the prominent distribution and diversity patterns across moisture gradients in tropical forests.

Does forest diversity matter for drought resilience?

William Anderegg, Biology, University of Utah, USA

Drought impacts carbon, water, and energy cycles in forests and may pose a fundamental threat to forests in future climates. Plant hydraulic transport of water is central to tree drought responses, and the diversity of plant hydraulic strategies may influence forests' response to drought. In a combined analysis of eddy covariance measurements, remote-sensing data of plant water content variation, model simulations, and plant hydraulic trait data, we test how hydraulic diversity within and across ecosystems affects large-scale drought responses. We find that current plant functional types are not well-suited to capture hydraulic variation and that higher hydraulic diversity buffers ecosystem variation during drought. Our results demonstrate that tree functional diversity, particularly hydraulic diversity, may be critical to simulate in plant functional types in current land surface model projections of future vegetation's response to climate extremes.

Three trillion trees — the role of forests and their changes in the global carbon cycle

Julia Pongratz, Max Planck Institute for Meteorology, Hamburg, Germany

The around three trillion trees on this globe serve two roles in the global carbon cycle: as natural sinks to anthropogenic emissions and as sources and sinks associated with land use change by deforestation, afforestation and many forms of forest management. Understanding and quantification of these roles at the global scale require the use of Earth system models, providing challenges and opportunities: Challenges comprise the upscaled depiction of management practices known in detail on local scale and the provisioning of global datasets. I show how different assumptions on distributing FAO forest harvest rates across forests in global models yield vastly different results for the carbon stocks. The inclusion of forest harvest and other land management practices lead to a substantial increases in estimated global land use emissions, challenging in turn our understanding of sinks needed to balance the carbon budget. Opportunities from Earth system modeling arise for example from the consistent inclusion of biogeophysical effects. Observational evidence on large scales has recently emerged, underpinning the largely cooling role of forests locally in the mid and low latitudes. However, coupled models accounting additionally for nonlocal effects by, e.g., advection and atmospheric circulation changes, find a warming effect, which would partly offset carbon-related benefits of afforestation. This highlights the need to distinguish between forests' role to adapt to climate change locally or to mitigate global climate change.