2025 ATTO Summer School - Amazon forests under global change
Sep 19 – 29, 2025

1. **Objective:**

To offer scientific theory and methods to investigate forest functioning, biodiversity, and forest-atmosphere interactions in the context of global change.

2. **Overview:**

Tropical forests play a crucial role in global carbon and biogeochemical cycles. However, their response to global changes—such as biodiversity loss, land use change, increased atmospheric carbon dioxide (CO_2) and other greenhouse gases, rising temperatures, and alterations in precipitation patterns—remains highly uncertain. In this context, the Amazon Tall Tower Observatory (ATTO) project takes an interdisciplinary approach, incorporating meteorology, atmospheric chemistry and physics, biogeochemistry, and forest ecology, to study the Amazon Forest in light of global change. All these research fields are investigated with different approaches ranging from observations to model-data integration and model simulations. During the summer school, attendees will develop activities of field measurements, data analysis, and modeling, within the ATTO project scientific framework. The program will commence with two days of introductory lectures and safety training in Manaus, followed by field measurements, data analysis, and modeling at the ATTO experimental site in the Uatumã Reserve, located approximately 150 km from Manaus.
The summer school is part of the ATTO project (www.attoproject.org), which is funded by the Brazilian Ministry of Science, Technology, and Innovation and the German Federal Ministry of Education and Research.

3. **Target public:**

The course will host about 15 outstanding master's or Ph.D. students, with 50% of them preferably from Latin American countries. The course is free, but students must cover travel costs and accommodation in Manaus. Candidates can apply for travel support (see item 9).
Please be aware that most of the summer school will occur at the field site, in the middle of the central Amazon Forest, under high humidity and temperature conditions, and with a basic lodging infrastructure (sleeping in a hammock). See more information on the website (www.attoproject.org).
The summer school will be in English.

4. **Teaching Scholars:**

Susan Trumbore – Max Planck Institute for Biogeochemistry (MPI-BGC), Germany; Eliane Gomes Alves – MPI-BGC, Germany, and INPA, Brazil; Hella van Asperen – MPI-BGC, Germany; Santiago Botía – MPI-BGC, Germany; Manon Sabot - MPI-BGC, Germany; Philipp Papastefanou - MPI-BGC, Germany; Jürgen Kesselmeier – Max Planck Institute for Chemistry (MPIC), Germany; Christopher Pöhlker - Max Planck Institute for Chemistry (MPIC), Germany; Achim Edtbauer – MPIC, Germany; Flávia Durgante – Karlsruhe Institute for Technology (KIT), and INPA, Brazil; Cléo Quaresma Júnior – Federal Institute of Pará State (IFPA), Brazil; among others.

5. **Procedure:**

Students will follow a common agenda, including lectures, measurements, data analysis, model-based analysis, and model simulations. After two introductory days with talks from keynote speakers at the National Institute for Amazonian Research (INPA) (Days 1 and 2), they will learn the principal measurements performed in the ATTO site on the the topics - greenhouse gases, biogenic volatile organic compounds, aerosols, forest functioning and biodiversity (Days 3-7); then, they will develop field measurement, model-based analysis and model simulation projects (Days 8-9), for which students will work in separate groups. Theoretical assessments, including data analysis, will be conducted for each project. Students will be mentored during measurements and modeling and provided with independent pre- and post-analysis tasks. The last (Day 10) will be used to present the results of each measurement/modeling project as a final group-based presentation.

6. **Main topics that will be addressed:**

I. Greenhouse gases

The global atmosphere contains less than 1% of Greenhouse Gases (GHG); nevertheless, it is largely affected by small changes in their concentration. The accumulation of GHGs since the pre-industrial period (~1750) due to human activities has led to global warming and yet unknown consequences for ecosystems and societies. Two very important GHGs are CO_2 and CH_4, and the Amazon Forest plays a crucial role in cycling these two gases regionally and globally. CO_2 uptake via photosynthesis and carbon storage by vegetation counteract anthropogenic emissions, but, at the same time, the Amazon represents a significant source of CH_4, contributing to about a third of the global wetland emissions.

II. Biogenic Volatile Organic Compounds

Biogenic Volatile Organic Compounds (BVOCs) are gases emitted by soil, microorganisms, animals, and, mostly, plants. In plants, they have functional roles of defense against biotic and abiotic stressors. In the atmosphere, they are very reactive and participate in processes such as GHG formation/degradation and the formation of particles, which contribute to cloud formation and affect the Earth's radiative budget, thereby affecting the climate. The Amazon Forest is the largest source of BVOCs to the global atmosphere, which makes it a unique region to study their emissions and interactions with the climate. BVOC emission measurements at

different scales (soil, leaf, and canopy) and manipulated experiments can provide an interactions in the Amazon.

III. Aerosols

Aerosols (airborne suspended particles) have nice properties in the atmosphere, like sunlight scattering, nucleation, or chemical reaction components. Primary biological aerosols and secondary organic aerosols are important to the nucleation processes that start cloud formation, influencing the hydrological cycle. In the Amazonian atmosphere, the natural aerosol composition is very diverse and complex, comprising a variable mixture of biological particles emitted from the forest ecosystem, long-range transported dust, marine aerosols from the Atlantic Ocean, and smoke particles from deforestation fires. For the forest, such particles are significant to biogeochemical and hydrological cycling, climate, and atmospheric chemistry.

IV. Biodiversity and Forest Functioning

The Amazon Forest is home to a high diversity of tropical tree species that occur in different forest ecosystems, ranging from flooded forests (Várzea and Igapó), forests with sandy soils (Campinas and Campinaranas), and upland forests as “terra-firme”. Forest ecosystems’ role in the carbon and water cycles depends on the functional characteristics of the species that inhabit them. Functional characteristics such as tree growth rate, wood density, and specific leaf area are related to a more acquisitive or conservative behavior in using carbon in the ecosystem. Meanwhile, anatomical characteristics of vessels and other hydraulic traits are related to water use efficiency and solute transport from the roots to the crown. Recognizing the functional characteristics of different forest ecosystems allows us to understand how ecosystem dynamics can respond to different climatic events and affect biogeochemical cycles.

8. **Selection Process:**

Applications should be written in English and combined in one .pdf file with the CV, a motivation letter (max. two pages), and one recommendation letter.
Applications must be emailed to egomes@bgc-jena.mpg.de.
Candidates should apply by June 20, 2025.
Attendees should be vaccinated against yellow fever and COVID-19, and have travel insurance (this is mandatory!).

9. **Travel support**

We have limited funding to support the participants financially, but candidates can apply for our travel grant. In your motivation letter, please add an explanation for why you need travel support (max. 1 page) and the amount required to cover your travel costs, including flight tickets and hotel for four days in Manaus (in euros).