Congress Centre Davos, 5 June to 7 June, 2019

WELCOME

to USYS2019 at the Congress Centre Davos

Content

USYS2019

PROGRAMME

WEDNESDAY, 5 JUNE, 2019

14:15 – 14:30 *Welcome*

SESSION 1

Chair: Martin Ackermann

14:30 – 15:00 **Nicolas Gruber** (IBP)
Ocean extremes: too hot, too sour, no breath

15:00 – 15:30 **Diana Santelia** (IBZ)
Regulation of stomatal opening at the leaf/atmosphere interface for plant adaptation and survival

15:30 – 16:00 **Julie Tolu** (IBP)
Insights on the chemical forms of selenium in soils – a crucial step to predict its bioavailability

16:00 – 16:30 *Coffee break*

SESSION 2

Chair: Sebastian Doetterl

16:30 – 17:00 **Arun Bose** (ITES)
The potential role of transgenerational epigenetic effects for the acclimation of Pinus sylvestris to drought

17:00 -17:30 **Daniela Domeisen** (IAC)
Heat wave or cold air outbreak? — On the predictability of our weather on weekly to monthly timescales

17:30 – 18:00 **Hubert Pausch** (IAS)
Big is better: The sequencing of animals at population scale for an efficient mapping of complex traits

18:00 – 18:10 **USYS initiatives**

19:30 *Dinner at Hotel Seehof*

THURSDAY , 6 JUNE, 2019

SESSION 3

Chair: Iselin Medhaug

08:30 – 09:00	**Tony Patt** (IED) Why saving the climate is like building an airport
09:00 – 09:30	**Anita Narwani** (IBZ) Phyt to compete: evolutionary responses to competition for resources in phytoplankton
09:30 – 10:00	**Sophie Thanner** (IAS) Animal health and welfare – an important aspect of livestock in the world food system
10:00 – 10:30	*Coffee break*

SESSION 4

Chair: Hubert Pausch

10:30 – 11:00	**Edouard Davin** (IAC) From cities to hillslopes, what do observations and models tell us about the climate benefits of trees?
11:00 – 11:30	**Michael Sander** (IBP) Plastic in the underground: on the biodegradation of synthetic polyesters in agricultural soils
11:30 – 12:00	**Sebastian Doetterl** (ITES) Global soil respiration will be less resilient to warming than anticipated
12:00 – 13:30	*Lunch buffet at the Congress Center*

SESSION 5

Chair: Lenny Winkel and Eva Lieberherr

13:30 – 14:15	**Science Speed Dating** Talk about your research, outreach and joint projects
14:15 – 15:00	**D-USYS slogan competition**
15:00	*Hike to Schatzalp, followed by tea at the hotel Schatzalp*
19:30	*Apéro in the lobby of Hotel Seehof*
20:15	*Conference dinner*

FRIDAY, 7 JUNE, 2019

SESSION 6

Chair: Eva Lieberherr

08:30 – 09:00	**Alex Widmer** (IBZ) Plant adaptation: ancient alleles in a warming world
09:00 – 09:30	**Andreas Rudow** (ITES) Ecological Macroscopes – How pan-european gene conservation data reveal species metapopulations behavior on an evolutionary scale
09:30 – 10:00	**Florence Metz** (IED) Comparative environmental politics: How to mobilize political will for environmental policy decisions?
10:00 – 10:30	*Coffee break*

SESSION 7

Chair: Alex Widmer

10:30 – 11:00	**David Bresch** (IED) Breaking the Tragedy of the Horizon – reflections on disclosure challenges of climate-related financial market risks
11:00 – 11:30	**Mana Gharun** (IAS) Over twenty years of ecosystem CO2 fluxes from a subalpine forest in Davos
11:30 – 12:00	**Heini Wernli** (IAC) Understanding the formation of hot and cold temperature extremes
12:00 – 12:15	*Farewell*

ABSTRACTS

(IN CHRONOLOGICAL ORDER)

Ocean extremes: too hot, too sour, no breath

Nicolas Gruber and the Environmental Physics Group
Institute of Biogeochemistry and Pollutant Dynamics, ETH Zürich

Extreme events on land are known to shape the structure of ecosystems and substantially affect their functioning. But our understanding of the role of such events in the marine realm is very poor, especially for those associated with the marine stressors ocean warming, ocean acidification, and loss of oxygen. Given our expectation of the ocean to continue to warm and acidify, these extreme events very likely will become more frequent and intense in the future. For example, we have recently shown that between 1982 and 2016, the number of days with extreme sea-surface temperatures, aka marine heatwaves, has doubled, and that this number is projected to further increase by more than 20 for a global warming of 2 degrees Celsius (Frölicher et al., 2018). Although similar changes are likely in store for extremes in ocean acidification and deoxygenation, we know presently very little about the characteristics of these extreme events and how they will impact marine ecosystems and ocean biogeochemistry. Of particular concern are the compound events, i.e., those where more than one of these stressors is outside the norm. Here we investigate extreme events in ocean warming and biogeochemistry from the global to the regional scale, focusing on the eastern tropical and subtropical Pacific, as this represents a region of high variability and naturally occurring low pH and oxygen concentrations, and as such is very prone to an intensification of these stressors. To this end, we are combining analyses of in-situ and remote observations with model output from regional high-resolution models and using a combination of relative (temperature) and absolute (oxygen and saturation state with respect to aragonite) thresholds to define extremes. Very preliminary initial results suggest a strong interannual variability in the occurrence of compound events, largely owing to the dominant influence of El Niño/Southern Oscillation in altering the baseline upon which individual ocean or atmospheric weather driven extremes can occur. We also tend to find relatively few triple whammies, i.e., where all three stressors are extreme. In contrast, double whammies, i.e., where oxygen and the saturation are low are rather common, largely due to the tight coupling between these two conditions through the respiration of organic carbon.

Frölicher, T. L., E. M. Fischer, and N. Gruber (2018), Marine heatwaves under global warming, Nature, 560(7718), 360–364, doi:10.1038/s41586-018-0383-9.

Regulation of stomatal opening at the leaf/atmosphere interface for plant adaptation and survival

Diana Santelia
Institute of Integrative Biology, ETH Zürich

Life on Earth as we know it would not be possible without the evolution of plants, and without the transition of plants to live on land. Through microscopic pores in the leaf epidermis, called stomata, plants transpire a vast volume of water while they take up CO2 for photosynthesis. By doing so, plants helped shape changes in the terrestrial landscape and atmospheric composition of the planet over time and keep playing a critical role in maintaining both the global water cycle and climatic stability. However, for plants themselves, the parallel flow of water out of leaves during photosynthesis represents one of the greatest costs associated with life on land. To optimize daytime water use and survive the harsh of the terrestrial environment, plants have evolved the capacity to actively control stomatal pore aperture in response to fluctuating environmental factors. Stomatal opening and closure depend upon changes in the turgor pressure of the two flanking guard cells, caused by movements of osmotically active solutes in and out of the cell. Research in my laboratory demonstrated that guard cell starch metabolism is one of the key components of stomatal control. Starch is a complex polymer of glucose, which is degraded during stomatal opening to generate osmotically active organic compounds to increase guard cell turgor. Without this breakdown in starch – in plants lacking guard cell-specific glucan hydrolases – stomata open more slowly and to a lesser extent, with severe consequences for CO2 assimilation and plant growth. We also discovered that guard cells, despite having chloroplasts, are dependent on the leaf mesophyll for their carbohydrates, supplied via the action of two plasma membrane hexose/proton symporters – STP1 and STP4. These are highly expressed in guard cells and critical for stomatal function. This tight coordination between mesophyll and guard cell carbohydrate metabolism shows that a timely allocation of carbon from source leaves to the small symplastically-isolated guard cells is essential to regulate stomatal opening and CO2 uptake.

Insights on the chemical forms of selenium in soils – a crucial step to predict its bioavailability

J. Tolu, S. D. Chékifi, S. Bouchet, L.H.E. Winkel

Institute of Biogeochemistry and Pollutant Dynamics, ETH Zürich, and Eawag,
Swiss Federal Institute of Aquatic Science and Technology

Selenium (Se) is an essential micronutrient for humans, which is required for optimal protection against cancers, cardiovascular and infectious diseases. However, up to 1 billion people are estimated to have too low selenium intakes. Main dietary sources are food crops and animal products, and the content of selenium in soils and the ability of plants to take up selenium from the soil, i.e., its bioavailability, play a major role in the selenium status of food products.

To assess selenium bioavailability, its chemical form, referred to as species, needs to be known. However, identifying and quantifying selenium species is challenging due to the generally very low soil concentrations and complex forms of selenium, e.g., associations with soil organic matter or elemental Se nanoparticles. Therefore, current methods for selenium speciation can only give information on a small fraction of the total selenium content in soils.

In this talk, a developed method will be presented that gives new chemical information on selenium species extracted from different soil fractions. Application of the new method on soils from Hawaii, covering a wide range of chemical and climatic conditions, demonstrates that from 70 to 100% of extracted Se species can be determined and quantified. Knowledge of selenium speciation in soils and its controlling factors paves the way to predict bioavailability of selenium in soils and selenium levels in food crops.

The potential role of transgenerational epigenetic effects for the acclimation of Pinus sylvestris to drought

Arun K. Bose, Arthur Gessler, Barbara Moser, Thomas Wohlgemuth and Andreas Rigling

WSL Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf, Switzerland.
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Recent research showed evidences of transgenerational epigenetic effects (i.e. effects resulting from changes in gene function of an organism and not from changes in DNA transferred to its offspring) for the acclimation capacity of trees.

We quantified the potential role of such effects on seed growth and mortality of Scots Pine. For that purpose, we collected seeds from an experimental field site (Pfynwald) close to the dry edge of distribution of Scots pine. Specifically, we used seeds from control trees (growing under naturally dry conditions), from irrigated trees (receiving the double amount of natural precipitation since 2003), and from formerly irrigated trees ("irrigation-stop" treatment; irrigation from 2003–2013; naturally dry condition since 2014). We performed two experiments, one at the experimental site and another one under controlled greenhouse conditions. In the field, we let the seeds of all three origins germinate and grow in control, irrigated, and irrigated-stop plots. In the greenhouse, seeds of the three origins were grown in standard soil under different temperature, water availability and light regimes.

Our results showed that seedlings from irrigated trees were less tolerant to stress (hot drought) as indicated by increased mortality than seedlings from control trees. However, seedlings originating from irrigated trees had higher growth than those from control trees when they were adequately watered and exposed to full sunlight. Seedlings originating from the irrigation-stop treatment displayed similar growth and survival responses to seedlings from irrigated trees.

The results of higher growth in moist condition but higher mortality in dry condition of seedlings originating from adult trees that were released from drought compared to those from control trees point to the role of transgenerational epigenetic effects for the adjustment to environmental conditions. This effect may, however, be overridden by environmental conditions during germination and seedling stage in the field.

Heat wave or cold air outbreak? – On the predictability of our weather on weekly to monthly timescales

Daniela Domeisen
Institute Atmospheric and Climate Science, ETH Zürich

Persistent extreme temperature anomalies can induce significant damage to ecosystems and impact human health. In particular, heat waves are projected to become more severe and more persistent with the changing climate. However, it remains a challenge to predict the onset, duration or end of a heat wave or cold air outbreak on timescales of 2 weeks or more. Longer predictable lead times of these extreme events would provide an improved possibility for warnings and emergency planning measures. This presentation explores our current ability to make predictions of extreme events at timescales of weeks to months as well as the challenges ahead, in particular with respect to remote effects on our weather that may be possible to utilize for improving long-term weather forecasts.

Big is better: The sequencing of animals at population scale for an efficient mapping of complex traits

Hubert Pausch
Institute of Agricultural Sciences, ETH Zürich

The DNA-based prediction of an individual's genetic value was introduced in many cattle populations a decade ago. Since then, breeding companies all around the globe rely on genomic predictions to select breeding animals, thus almost doubling genetic gain compared to progeny testing. The implementation of genomic prediction resulted in the accumulation of massive genotype data. With an estimated number of more than 3 million individuals that have been genotyped, more genotype data have been collected in cattle than any other species. The high abundance of genomic data together with the systematic recording of dozens of phenotypes in millions of animals make cattle populations highly amenable to the genetic mapping of complex traits – even for traits that are difficult to assess in many other species, e.g., fertility. Cattle are an appealing species to identify genetic determinants for fertility. Millions of cows and heifers are inseminated artificially using semen collected from bulls that are housed at semen collection centers. To ensure high reproductive success, the semen quality of these bulls is examined using microscopic and computer-assisted techniques twice a week. To identify genetic determinants of male fertility, we analysed 20 million artificial inseminations that were performed with semen from more than 10'000 bulls that were genotyped at 650'000 single nucleotide polymorphisms. Genome-wide association testing between dense genotypes and phenotypes for either semen quality or reproductive success enabled us to identify sequence variants that are associated with reduced fertility, idiopathic subfertility or infertility. Nowadays, tens of thousands of bulls that are supposed to be used for semen collection are genotyped at such variants. Bulls that carry variants associated with low fertility are excluded from artificial insemination, thus ensuring high insemination success and preventing major economic losses resulting from impaired fertility.

Why stopping climate change is like building an airport

Tony Patt
Institute of Environmental Decisions, ETH Zürich

Climate policy is in a time of turmoil. From the bottom, young people are marching on the streets, demanding that politicians listen to them to a degree not seen since 1968. From the top, the Paris Agreement upends the entire architecture of the Kyoto Protocol. And in between, at the national level, there is a heated debate about what sort of public policies are actually likely to drive the needed changes in society, at the needed pace.

The debate is unfolding at meetings of the Intergovernmental Panel on Climate Change Working Group III, of which I am a member. And it is playing out on the editorial pages of leading newspapers. One day the NZZ publishes an editorial saying that we need one single instrument – an effective carbon tax – and to get rid of many other policies. Another day the New York Times publishes an Op-Ed article saying that we need massive public-sector investment into new infrastructure, a "green New Deal." These may both seem like good ideas. But in fact they represent the two poles of the debate, and the poles are not well compatible with each other. Each of the policy instruments may or may not work on its own, but they don't work well together.

In this talk, I will explain this debate. I will show how the two sides can be linked to separate branches of economics, the two branches having – in some ways – diametrically opposed models of how market forces shape the economy. I will explain the logic of each side, and the types of political action that each side supports. And finally, I will explain why, a few years ago, I changed my mind about which side is right. What I now believe is that eliminating greenhouse gas emissions will be easy, if other stuff has happened first: technological innovation, massive changes in infrastructure, and an innovative regulatory environment. We can learn from past examples. Airports are one example.

Phyt to compete: evolutionary responses to competition for resources in phytoplankton

Anita Narwani
Aquatic Ecology Department, EAWAG

Resource limitation is a major driver of ecological and evolutionary dynamics of all organisms, including phytoplankton. Short-term responses to resource limitation include plastic re-wiring of the molecular and metabolic phenotypes of cells. Yet little is known about the evolution of resource requirements and the molecular phenotype after longer-term selection by resource limitation. Can competitive abilities adapt to limiting resources? Do requirements for different resources evolve independently or are trade-offs intrinsic? What is the metabolic basis of this evolutionary adaptation? To answer these questions we combined experimental evolution of the green alga Chlamydomonas reinhardtii under multiple different types of resource limitation, with estimates of change in population-level resource requirements and protein expression. In this talk, I will present our findings from these experiments.

Animal health and welfare – an important aspect of livestock in the world food system

Sophie Thanner, Alexander Grahofer, Sébastien Goumon
Institute of Agricultural Sciences, ETH Zürich

The implementation of high levels of animal health and welfare in livestock systems and animal-based food supply chains is becoming an increasingly important component of agricultural sustainability and food security schemes. Within the one-health approach, animal health is a key factor for food security, promoting access to nourishing and safe food, economic well-being and preventing the spread of zoonotic pathogens. Animal health and welfare status are closely related as stressful conditions can lead to compromised immune system and thus a greater susceptibility to disease, which ultimately may impacts food safety and production. Within the multi-dimensional concept of animal welfare, ethology provides an understanding of how animals interact with their physical and social environment and how production systems may affect them. Thus, as part of a comprehensive approach to livestock systems, our scientific expertise in animal health, behaviour and welfare focuses on stress response in various conditions (farrowing environments, transportation and slaughter), understanding of social behaviour (social preferences, emotional contagion) and developing new methods of assessment of emotional state (thermography, acoustic analyses) and stress reactivity (biomarkers). Additionally, our research addresses challenges related to animal health at the very beginning of the animal food production chain and including an epigenetic perspective on embryo development, the innate immune system of high-performance livestock and investigations of the farrowing process and the puerperal period. The gained knowledge should help to reduce the antimicrobial usage and increase the performance of the animals with the same amount of resources. Understanding underlying metabolic mechanisms and solving challenges in animal health and welfare for efficient foodstuff production is of utmost importance as livestock significantly and increasingly contributes to worldwide food security, but as well to environmental problems.

From cities to hillslopes, what do observations and models tell us about the climate benefits of trees?

Edouard Davin
Institute Atmospheric and Climate Science, ETH Zürich

There is ample evidence that forest losses in past centuries have contributed to anthropogenic greenhouse gas emissions. It has thus been argued that reversing this trend by fostering forest expansion could deliver "negative emissions", an essential element in climate mitigation scenarios. Beside carbon mitigation, trees may have other co-benefits (or adverse side effects) including in particular the local to regional impacts on climate through the alteration of land surface properties. This presentation will review the available evidence concerning the climate benefits of trees highlighting in particular how context-specific these benefits might be.

Some of the questions that will be addressed are:

- What can we learn from the past concerning the role of trees in the climate system?
- Is re/af-forestation a promising climate mitigation strategy and where should it be prioritized?
- Do tree species and forest management matter?
- Are trees in cities an efficient way to alleviate the urban heat island effect?
- What challenges in models and observations need to be tackled to better answer these questions?

Plastic in the underground: on the biodegradation of synthetic polyesters in agricultural soils

Michael Sander

Institute of Biogeochemistry and Pollutant Dynamics, ETH Zürich

Non-degradable plastics accumulate not only in marine and freshwater systems but also in terrestrial environments. The latter include agricultural soils that receive significant inputs of plastics through the use of these materials in agricultural applications. One promising strategy to overcome accumulation of plastic from agriculture in soils is to replace non-degradable, conventional materials with biodegradable polymers. The latter include polyesters that are specifically designed to be degradable by soil microorganisms under formation of carbon dioxide and microbial biomass. While these materials are already marketed, the process of polyester biodegradation in soils remains poorly studied and understood.
This contribution will provide an overview on our research efforts directed towards obtaining a mechanistic understanding of polyester biodegradation in agricultural soils. More specifically, I will showcase and discuss results from our work and highlight existing knowledge gaps related to the three key steps in the overall biodegradation processes: (i) colonization of the polyester surface by microbial degraders, (ii) hydrolysis of the polyester bonds in the polymers by extracellular esterases exuded by microbial colonizers, and (iii) microbial utilization of mono- and small oligomers released from the polyesters through enzymatic hydrolysis. In addition to experimental findings, the contribution will highlight some of the analytical approaches that we developed to study the above steps. Finally, I will provide an outlook which hopefully will provide a good basis for discussion and input from the larger D-USYS community.

Global soil respiration will be less resilient to warming than anticipated

Sebastian Doetterl[1], Johan Six[2], David Haaf[3]

[1]Institute of Terrestrial Ecosystems, [2]Institute of Agricultural Sciences,
[3]Institute of Biogeochemistry and Pollutant Dynamics, ETH Zürich

Soil respiration is an important factor in understanding the effects of climate change in terrestrial ecosystems and controlled by a large range of biotic and abiotic factors. We elucidated the effect of warming on soil respiration at the global scale by combining experimental results with a large database on climate, vegetation and soil related
parameters using machine learning techniques. We show, here, that temperature sensitivity of soil respiration is, in contrast to common understanding, predominantly controlled by soil properties, and less so by climate or vegetation related factors. The interplay of these controls is spatially highly variable with decreasing influence of temperature towards the equator and growing influence of soil variables. We estimate
an additional 10-16 Pg carbon will be respired from soils annually by 2050 which is equal to 100-160 % of anthropogenic emissions from fossil fuel burning and cement production and by far exceed current estimates of land use change emissions. We conclude that to understand soil respiration increases globally, models have to take into account a complex, non-linear interplay of soil, vegetation and climate factors. Furthermore, we drastically need to improve our process understanding in data poor regions such as boreal and tropical zones.

Plant adaptation: ancient alleles in a warming world

Alex Widmer
Institute of Integrative Biology, ETH Zürich

Plants as sessile organisms are typically expected to be adapted to their local environment. Adaptation is an evolutionary process that is driven by natural selection acting on heritable variation in traits affecting plant fitness. The Alps provide an ideal arena for studies of plant adaptation because populations growing along altitudinal gradients are exposed to pronounced differences in abiotic and biotic environmental conditions that occur over short spatial distances and thus in the potential presence of gene flow. To study plant adaptation to contrasting environmental conditions at high and low altitudes in the Alps, and to identify the genetic basis of adaptive trait variation, we use a combination of reciprocal transplant experiments, phenotypic selection analyses, and genomic analyses in natural populations of wild carnations. We find that phenotypically divergent populations from high and low altitudes are adapted to local environmental conditions, that phenotypic divergence is maintained by contemporary natural selection, and that ecological divergence of key phenotypic traits relies on ancient alleles whose origin is estimated to predate the species' origin. Such ancient alleles have likely mediated plant adaptation during past climatic changes and may provide the genomic substrate for adaptation to changing climatic conditions in a warming world.

Ecological Macroscopes – How pan-european gene conservation data reveal species metapopulations behavior on an evolutionary scale.

Andreas Rudow
Institute of Terrestrial Ecosystems, ETH Zürich

Due to the tremendous amount of components and the manifold relationships beween them ecosystems are still too complex to understand and predict their behavior completely. Particularly in the forest ecosystems structured by long-lived tree species, relevant processes like several species interactions as well as the adaptation or migration of species populations act on very long temporal and large spatial scales. As the development of information and remote sensing technology progresses rapidly, an integral ecological macroscope based on multiple data sources will be in reach in the near future. The pan-european network of gene conservation units and its database (EUFORGEN/EUFGIS) offer the potential to build up an ecological macroscope by linking demographic, genetic and management monitoring data on tree species populations with remotely sensed environmental monitoring data on large spatial and long temporal scales.

Comparative environmental politics: How to mobilize political will for environmental policy decisions?

Florence Metz
Institue of Environmental Decisions, ETH Zürich

Climate change, land use or pollution are among the most crucial long-term problems that the world faces today. To mitigate climate change or environmental problems, policies are necessary that support sustainability transitions. However, political will to adopt policies that promote timely transitions lags behind. In my presentation, I will provide an overview of my research about factors that inhibit and mobilize actors' political will for policies that promote transitions towards a more sustainable future. With examples from the sectors of water, agriculture, land-use, flood risk management and climate change, I will talk about the political challenges in addressing environmental problems. I will cover aspects of coalition formation, policy networks, political systems, policy integration, elite's policy preferences and framing.

Breaking the Tragedy of the Horizon – reflections on disclosure challenges of climate-related financial market risks.

David N. Bresch
Institute for Environmental Decisions, ETH Zürich

Starting from the notion of Ostrom's Tragedy of the Commons, Mark Carney, governor of the Bank of England and chair of the Financial Stability Board (FSB), explained in his seminal speech 29 September 2015 that "once climate change becomes a defining issue for financial stability, it may already be too late". As well as bringing higher temperatures, changes in precipitation and a range of other impacts, climate change will also influence the likelihood and intensity of extreme weather events. Collectively, these 'physical risks', threaten the interests of investors, both regarding assets as well as supply chains. Therefore, the FSB Task Force on Climate-related Financial Disclosures (TCFD) has developed guidelines to provide information to investors about – besides liability and transition risks – physical risks associated with climate change. Natural catastrophe models have long been used by the insurance industry to assess extreme weather event risk, yet these models are proprietary, do not offer global cover and have not been coupled with climate impact models either. Hence the need for globally consistent, open-source and -access models to quantify physical risks, both today and under difference scenarios of a changing climate. We present such an open and globally consistent physical risk quantification framework with the potential to become increasingly sophisticated over time as our understanding of the impacts of climate change improves. Yet substantial challenges remain, not least regarding ways to aggregate such single-company risk disclosures in a meaningful way – as financial stability is not threatened by creative destruction (Schumpeter) of single market players, but by systemic collapse due to the failure to internalize known externalities such as climate change (Stern). Hence not even mandatory disclosure will be enough to breaking the Tragedy of the Horizon – but voluntary efforts represent a key step in the right direction.

Over twenty years of ecosystem CO2 fluxes from a sub-alpine forest in Davos

Mana Gharun, Lukas Hörtnagl, Werner Eugster, Philip Meier, Susanne Burri, Nina Buchmann
Institute of Agricultural Sciences, ETH Zürich

Forest ecosystems play a major role in the global cycles of carbon and water. This exchange of carbon is strongly affected by changes in the atmospheric conditions. Focusing on direct measurements, this study uses over twenty years of eddy covariance measurements to assess long-term changes in CO2 fluxes in a sub-alpine forest in Switzerland. The ICOS Candidate Class 1 Ecosystem site Davos (CH-DAV) is a sub-alpine coniferous forest dominated by Norway spruce (Picea abies (L.) Karst) and is located at 1639 m elevation, in the eastern part of the Swiss Alps.

We aim to address three main research questions in this study:
1) How did the net ecosystem exchange of carbon (NEE) change since the start of the measurements in 1997?
2) How did the contributions of gross primary productivity (GPP) and ecosystem respiration (Reco) to NEE change over this period?
3) How did the 2018 extreme summer affect the capacity of the forest for CO2 uptake?

Understanding the formation of hot and cold temperature extremes

Heini Wernli
Institute for Atmospheric and Climate Science, ETH Zürich

Temperature extremes come in different flavors, e.g., as few very cold days in mid-winter, as a late frost in spring, as unusually mild periods in winter, or as an extended heat wave in summer. Since such events have a strong impact on environment and society, it is important to understand the mechanisms leading to their formation. Several studies used statistical techniques to identify large-scale flow conditions associated with temperature extremes. In contrast, our approach is based on air parcel trajectories that allow quantifying the role of different physical processes in the formation of air masses with extreme temperatures. We can analyze the effects of pure transport (e.g., warm air from the tropics is transported to Europe) and of processes changing the temperature of an air parcel (e.g., heating from the underlying ocean, or heating due to large-scale descent and adiabatic compression). Examples are shown for Europe, Australia and the Arctic. European cold events are most frequently induced by advection of cold air masses from the Arctic and Russia. Rather surprisingly, for hot extremes in both Europe and SE Australia, horizontal advection of already warm air is rather negligible and strong adiabatic warming due to subsidence and local warming caused by enhanced radiation and surface heat fluxes dominate. For warm extremes in the Arctic a combination of different, simultaneously occurring, processes are important: transport of warm low-level air of subtropical origin, ocean heating of initially cold low-level air of polar origin, and adiabatic warming of strongly descending air. The simple trajectory-based diagnostics lead to an improved process understanding of the formation of temperature extremes, revealing a rather complex interplay of physical processes, in particular for the formation of hot extremes.

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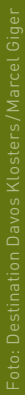

Thank you for your interest.