Doctoral Days 2025 –Weaving Networks, Growing Ideas

Report of Contributions

Contribution ID: **2** Type: **60s-Pitch + Scientific Poster**

Towards Equitable Governance of Marine Carbon Dioxide Removal (mCDR)

Marine carbon dioxide removal (mCDR) poses profound governance challenges at the ocean–climate nexus. While often framed through technical and legal lenses, mCDR governance risks reproducing historical inequities by sidelining Global South actors, privileging dominant epistemologies, and neglecting justice concerns. This transdisciplinary PhD project examines how equity is defined, operationalized, and contested in mCDR governance, and how more just governance futures might be co-imagined. Drawing on environmental and epistemic justice, decolonial theory, and institutional ethnography, the research develops a justice-centered analytical framework and applies it to key governance arenas, including the London Convention and Protocol. Through participatory co-production and stakeholder engagement, the project aims to identify barriers, uncover normative assumptions, and support plural imaginaries of equitable ocean governance.

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Contribution ID: **3** Type: **60s-Pitch + Scientific Poster**

Feasibility study on the repurposing of the doublet well at the Groß Schönebeck research platform

Since 2000, the Groß Schönebeck site has served as a multidisciplinary research platform, investigating the extraction of geothermal energy via a ~4.4 km doublet well system. As part of the TRANSGEO project, a study was conducted to explore alternative geothermal development options at the site. The study considered the potential of utilising the existing infrastructure for electricity generation and heating purposes. Although the Rotliegend formation was identified as a potential geothermal reservoir with a temperature of ~150℃, it was found to be insufficiently permeable for commercial-level heat production. The study therefore implemented two new technological approaches: an open-system development scenario involving a fracture-dominated Enhanced Geothermal Systems (EGS) and a closed-system scenario involving a single-well coaxial Deep Borehole Heat Exchanger (DBHE) concepts. The fracture-dominated EGS concept is designed to extract heat from the Rotliegend Formation at a depth of 4.2 km, while the coaxial DBHE concept utilises the highly conductive salt layers of the Zechstein Formation at a depth of 3.8 km. A series of numerical simulations were conducted using the CMG STARS software to assess the optimal energy yield from each well. The study's results are complemented by a discussion of measures that could be implemented to increase the feasibility of the concept, as well as an economic assessment of the investment required for the hypothetical development scenarios versus the potential revenue. In accordance with the local regulatory framework, the study provides a comprehensive overview of the procedural steps of the field development phase, with a particular focus on the two scenarios.

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Contribution ID: **4** Type: **60s-Pitch + Scientific Poster**

RMT Field Campaign at Laacher See (Eifel): Imaging of CO2-rich fluids rising near the surface

Since the last eruption of the Laacher See volcano (LSV) in the East Eifel volcanic field (EEVF) around 12.9 kyr ago, the volcanic activity beneath the LSV can still be traced by several gas emissions in the lake and its surroundings. This continuous gas flux is related to CO2 originating from the magmatic system in the upper mantle to the shallow crust at about 10 - 30 km depth, from where CO2 ascends to the surface along preferential fault pathways and leaks out at dry and wet (mixed with iron-rich water) CO2 springs, known as mofettes.

Here, we focus on the CO2 degassing sites of the EEVF on the east shore of the LSV and near the small town of Wassenach north of the LSV with the aim of identifying the CO2-enriched fluid pathways in the first ten to one hundred meters of depth. For this purpose, we have carried out Radio-Magnetotelluric (RMT) measurements in a frequency range of 1 - 256 kHz along six profiles that follow and cross the visible mofettes on the surface, thus indicating the directions of the faults and fluid pathways at depth. RMT is a powerful electromagnetic (EM) method to determine the near-surface electrical conductivity distribution, as this parameter is very sensitive to fluids and volatile compounds.

The associated electrical conductivity models resulting from a 2D inversion of the measured RMT data support the hypotheses of distinct vertical and horizontal CO2 migration pathways, which are represented as conductive reservoirs and channels in contrast to the more resistive carbonate rocks in the upper 30 m. These findings underscore that the RMT method is a useful tool to further constrain the complex fluid and CO2 pathways underneath mofettes in more detail.

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Contribution ID: **5** Type: **60s-Pitch + Scientific Poster**

Probabilistic Solar Wind Speed Forecasting Using Deep Distributional Regression With Solar Images

The solar wind, a stream of charged particles originating from the Sun, poses significant risks to technology and astronauts. It is driven by large structures on the solar surface like coronal holes and active regions, which can be identified in extreme ultra-violet (EUV) solar images several days before they become geoeffective. In this work, we propose to use a distributional regression algorithm to forecast the solar wind speed at the Lagrange 1 point from solar images. Instead of predicting a single value, this method models the entire conditional distribution as a function of input features. It allows computing the uncertainty of predictions and specifying the probability of the solar wind speed exceeding certain thresholds, which is especially useful for extreme event predictions like coronal mass ejections and high-speed solar wind streams (HSSs). In a deep learning approach, we couple a vision transformer with a probabilistic regression head, additionally using physical input parameters, such as past solar wind properties and solar cycle information. We predict the solar wind speed distributions with a one-hour cadence four days in advance. Our method is trained and evaluated using cross-validation on 15 years of data. We perform a large study comparing different combinations of SDO channels and show that a combination of three different wavelengths provides the most accurate predictions. Our model reaches an RMSE of 75 km/s and an HSS peak RMSE of 78 km/s for the means of the predicted distributions. Additionally, the model approximates the heavy-tailed solar wind speed distribution well and predicts accurate confidence intervals. We show that our model is on par with current state-of-the-art models regarding the general accuracy of predictions, but predicts extreme events significantly better and furthermore enables full uncertainty quantification. That demonstrates the advantages of probabilistic models over standard regression approaches and highlights the potential for operational space weather forecasts.

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Contribution ID: **6** Type: **60s-Pitch + Scientific Poster**

Learning to Learn Ahead: Parameter Forecasting in Neural Networks for the Prediction of Remote Sensing Observations

The growing volume and frequency of streaming remote sensing data present challenges for real-time modeling and forecasting. Traditional batch learning is unsuitable for such dynamic environments, while standard online learning frameworks, though more adaptive, face key limitations. These include one-step-ahead forecasting, prediction latency due to retraining dependencies, and vulnerability to huge shifts in data distribution over time. To address these issues, we propose a novel framework that models the evolution of neural network parameters in relation to specific predictor variables. Our method trains an initial CNN on historical data, captures successive model weight snapshots during online updates, and applies an ML algorithm (e.g., Polynomial Regression) to forecast future parameter states. A new model instantiated with these forecasted weights can predict future data without waiting for retraining. This approach enables multi-horizon prediction, eliminates retraining delays, and, most importantly, is more robust to shifts in distribution. Experiments were conducted on the AMOC (Atlantic Meridional Overturning Circulation) collapse dataset to validate the performance of our model and compare it with traditional batch learning techniques.

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Contribution ID: **7** Type: **60s-Pitch + Scientific Poster**

Identifying and Modeling Pathways between Flood and Health in Vietnam and Germany

Previous hydrological research has focused on the physical basis of flood events. Thereby hydrodynamic models are established often ignoring societal and economic factors. This omission can lead to mischaracterization of flood events. Recently, the pathways between flooding and economic damage have therefore been integrated into the models. However, impacts on physical and mental health are underrepresented in ongoing studies. The aim of my project is to bridging this gap. I plan to map the linkages between physical characteristics of floods, regional socioeconomic factors, and physical and mental health outcomes.
In the first part of the PhD project, a longitudinal structured household survey of Ho Chi Minh City (HCMC), Vietnam, conducted in 2020 and in 2023, is analyzed. HCMC faces recurring seasonal flooding, especially between June and November. The survey allows for a comparison of flood characteristics, flood perception, and disaster preparedness. Three flood events were reported across in the two survey waves. In total, 559 participants answered the questionnaire in both 2020 and 2023, of whom 303 described a recent and a severe event. Of the 559 participants, over half experienced a flood between the survey waves. Participants described self-reported morbidity of various diseases for several household members following the respective floods. The aim of the descriptive study is to identify potential connections between this morbidity and flood characteristics and/or household characteristics. In the next step of the project, the results of the descriptive analysis can be used to develop models describing the pathways between floods and health in HCMC which can eventually be transferred to other regions of Vietnam.

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Session Classification: Show yourself!

Contribution ID: **8** Type: **60s-Pitch + Scientific Poster**

Investigations and approaches for modeling GNSS clocks in a global network

Global Navigation Satellite Systems (GNSS) are one of the most important techniques for positioning, navigation and the realization of the International Terrestrial Reference Frame (ITRF), which forms the basis for many coordinate-related applications in the geosciences. The basic principle of GNSS is to measure the time difference between the transmission of a microwave signal at the satellite and its reception at the ground station. For this reason, clock information is required on both sides.

The quality of the clocks used varies strongly and ranges from highly stable atomic clocks on board of the satellites (e.g. hydrogen masers) to less stable quartz oscillators, which are built into most GNSS receivers. To compensate for the resulting synchronization errors, current GNSS analysis models generally introduce epoch-wise clock biases into the observation equations. The often-made assumption of a pure white noise behavior for the estimated clocks leads to negative effects in the results, especially to high correlations between the clocks and other geodetic parameters. Modeling the clock behavior to reduce the number of unknowns can be a solution to this problem, but requires a high degree of stability for the corresponding clocks.

We present our comprehensive investigations into the clock quality within the station network of the International GNSS Service (IGS). Those IGS ground stations, that are connected to an external H-maser clock, are considered in a global network analysis over a period of one year. The generated clock products are used to compare the frequency stabilities within the station network, as well as with the mean behavior of different satellite blocks. Additionally, the results of first modeling approaches are shown.

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Session Classification: Show yourself!

Contribution ID: **9** Type: **60s-Pitch + Scientific Poster**

The Role of Triaxial Strain in Deformation Compartmentalizations of the Tibetan Plateau: Insight from "Scaled"Numerical Models

The collision between the Indian and Eurasian Plates induces simultaneous widespread crustal shortening and extension in the Tibetan Plateau. Collision-induced crustal deformation at regional, orogenic scale is compartmentalized into networks of active faults of locally diverse tectonic regimes. Yet, the correlation between triaxial strain and deformation patterns requires better quantification. We carried out 3D "scaled"numerical models simulating and extending laboratory analogue models of triaxial tectonics involving simultaneous horizontal shortening and orthogonal extension. Our results demonstrate two strain fields, i.e., constriction and flattening strain, which are accommodated by four types of fault networks, respectively: Constriction strain is accommodated by (i) dominant normal faults linking with strike-slip faults and/or (ii) predominant strike-slip faults linking with normal faults, while flattening strain displays (iii) a predominant strike-slip pattern and/or (iv) thrust-dominant regimes with strike-slip faulting. An important implication of our models is that the locally diverse deformation styles are consistent with the regional principal strain tensor in the Tibetan Plateau. Responding to the same overall geological settings, flattening strain is characterized by strike-slip faults in the Shan Plateau and by thrust faults kinematically linked to strike-slip faults in Northern Tibet. Simultaneously, strike-slip as well as extensional regimes accommodate constriction strain in Central-southern Tibet.

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Contribution ID: **10** Type: **60s-Pitch + Scientific Poster**

Interferometric radar satellite and in-situ well time-series reveal groundwater extraction rate changes in urban and rural Afghanistan

Population growth, climate change, and a lack of infrastructure have contributed to an increase in water demand and groundwater exploitation in urban and rural Afghanistan, resulting in significant ground subsidence. Based on a 7-year-long Sentinel-1 radar-interferometric time-series (2015–2022), we assess country-wide subsidence rates. Of particular focus are urban Kabul and the growing agricultural sector of rural Ghazni. In Kabul, we compare spatiotemporal subsidence patterns to water table heights and precipitation amounts. In Ghazni, we monitored the transition from ancient to modern irrigation techniques by mapping solar-panel arrays as a proxy for electrical water pumping and evaluating the vegetation index as a proxy for agricultural activity. Several cultural centers (Kabul, Ghazni, Helmand, Farah, Baghlan, and Kunduz) exhibit significant subsidence of more than ~5 cm/yr.

In Kabul, ground subsidence is largest near the city center with a 6-year total of 31.2 cm, but the peripheral wells of the Kabul basin exhibit the highest water-table drops. In Ghazni, with a 7-year total of 77.8 cm, subsidence rates are dramatically accelerating since 2018. The barren land was transformed into farmland and traditional irrigation was replaced by electrical water pumps to tap groundwater. As a result, m-wide and km-long desiccation cracks appeared in the area with the highest irrigation volume and subsidence.

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Contribution ID: **11** Type: **60s-Pitch + Scientific Poster**

Effects of the hydrogeochemical variability of pore water in the Opalinus Clay and its surrounding aquifers on uranium migration

Pore water and groundwater from the containment providing rock zone (CRZ) and surrounding aquifers provide the initial chemical conditions and boundaries for reactive transport simulations of radionuclide migration in the context of the disposal of highly radioactive waste. Hydrochemical differences between these units cause gradients in the pore water profile across the CRZ, which affect sorption, diffusion and thus migration of radionuclides, like uranium. However, pore water and groundwater compositions differ on the spatial and temporal scales relevant to safety assessments. To quantify the impact of this variability, we performed one-dimensional simulations of uranium migration through Opalinus Clay using the geochemical code PHREEQC, varying both initial and boundary conditions. Our results show that uranium migration distances differ by several decametres over one million years depending on the initial pore water composition in the CRZ. Variations in groundwater chemistry only affect natural uranium concentrations close to the contacts between CRZ and its bounding aquifers. Consequently, the pore water composition in the CRZ is more decisive for uranium migration than hydrochemical variations in embedding aquifers.

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