

**Pressemitteilung****Max-Planck-Institut für Biogeochemie****Dr. Eberhard Fritz**

14.10.2019

<http://idw-online.de/de/news725217>Forschungsprojekte, Kooperationen  
Geowissenschaften, Umwelt / Ökologie  
überregionalMax-Planck-Institut  
für Biogeochemie**AI for Understanding and Modelling the Earth System – International Research Team wins ERC Synergy Grant**

**Prestigious European Research Council grant will support interdisciplinary team's work to improve climate models and the way how Earth system data are analysed and interpreted by combining machine learning with physical models of the atmosphere and land.**

An interdisciplinary team of four researchers from the German Aerospace Center (DLR), the Max Planck Institute for Biogeochemistry, the University of Valencia, and Columbia University has been awarded a 2019 European Research Council (ERC) Synergy Grant to understand and model the Earth system with machine learning, one of the important approaches of artificial intelligence (AI). The prestigious award — 10 million euros over six years — will support the team's groundbreaking work in rethinking the development and evaluation of Earth system models, which are the basis for understanding and projecting climate change.

Prof. Veronika Eyring from DLR's Institute of Atmospheric Physics and corresponding Principal Investigator (cPI) says: "We teamed up to join forces and combine our multidisciplinary expertise in climate modeling, terrestrial ecosystems, machine learning, and cloud parametrizations to address some of the main limitations in the simulation and analysis of climate change. This will allow us to better understand processes and to discover unknown causes and drivers in the Earth system."

The motivation for the newly funded ERC project "Understanding and Modelling the Earth System with Machine Learning" (USMILE) is that there are still some fundamental limitations in understanding the Earth system, which also limits our ability to accurately simulate climate change. While Earth system models have improved significantly in the past decades, the models' ability to simulate both global and regional Earth system responses, which are key for assessing climate change and its effects on the planet's ecosystems and populations, is limited by the representation of physical and biological small-scale processes, such as clouds, stomata, and microbes.

"Our central hypothesis is that this lack of understanding can be solved using machine learning. Firstly, we now have a massive amount of Earth observation data, with unprecedented spatial and temporal coverage for many processes. Secondly, high-resolution cloud-resolving models are now available that explicitly resolve small-scale processes such as clouds. But those simulations are computationally very expensive, and can therefore only be run for a short time," says Prof. Pierre Gentine, co-PI of the project from Columbia University's School of Engineering and Applied Science.

"And thirdly, the field of machine learning has quickly evolved, enabling breakthroughs in the detection and analysis of complex relationships and patterns in large multivariate datasets. We can now not only fit and model complex functions but also learn causal relations," adds Prof. Gustau Camps-Valls, co-PI of the project from the University of Valencia.

The team will develop machine learning algorithms to enhance Earth observation datasets accounting for spatio-temporal covariations, as well as developing machine-learning-based parameterisations and sub-models for

clouds and land-surface processes that have hindered progress in climate modelling for decades. In addition, they will detect and understand modes of climate variability and multivariate extremes, and uncover dynamic aspects of the Earth system with novel deep learning and causal discovery techniques.

Traditionally, physical modelling and machine learning have often been treated as two different worlds with opposite scientific paradigms: theory-driven versus data-driven. “Even though it has extraordinary potential, machine learning has not yet been widely adopted to address the urgent need for improved understanding and modelling of the Earth system. We hope that, by bridging between physics and machine learning, we will be able to revolutionize Earth system modeling and analysis, leading to more robust climate projections on the long-term,” says Prof. Markus Reichstein, co-PI from the Max Planck Institute for Biogeochemistry. He adds: “USMILE can drive a paradigm shift in the current modelling of the Earth system towards a new data-driven, physics-aware science.”

The team is supported by the Computer Vision Group around Prof Denzler at the Friedrich Schiller University which contributes its many years of expertise in the development of machine learning techniques for anomaly and causality detection.

From the Earth and Solar System Research Partnership of the Max Planck Society (ESRP), the colleagues around Prof Stevens from MPI for Meteorology will participate in the project with high-resolution simulations.

ERC Synergy Grants are awarded to groups of two to four co-PIs who have complementary skills, knowledge and resources, and can jointly address research problems that could lead to breakthroughs not possible by the individual PIs working alone. The four PIs on the USMILE project all work at the intersection of Earth system and data science with complementary expertise. “We are excited to work together on this interdisciplinary team and thank the ERC for giving us this great opportunity,” says Prof. Veronika Eyring.

Set up by the European Union in 2007, the European Research Council is the premier European funding organization for excellent frontier research. Every year it selects and funds the very best, creative researchers of any nationality and age to run projects based in Europe. In most cases, ERC Synergy groups are interdisciplinary, often using multidisciplinary approaches, and meet regularly over the course of the project.

wissenschaftliche Ansprechpartner:

Veronika Eyring  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)  
Institut für Physik der Atmosphäre (IPA)  
82234 Wessling, Germany  
Phone: +49-8153-28-2533  
Email: Veronika.Eyring@dlr.de

Markus Reichstein  
Department Biogeochemical Integration  
Max-Planck-Institute for Biogeochemistry, Jena  
D-07745 Jena  
phone: +49 3641 576200  
e-mail: markus.reichstein@bgc-jena.mpg.de

Pierre Gentile  
Dept of Earth & Env Eng  
Earth Institute, Columbia University  
pg2328@columbia.edu  
+1 (212) 854-0306

Gustau Camps-Valls  
Image Processing Laboratory (IPL)  
Universitat de València  
46980 Paterna (València). Spain  
phone : +34 963 544 064  
<http://isp.uv.es>  
[gustau.camps@uv.es](mailto:gustau.camps@uv.es)

URL zur Pressemitteilung: <http://erc.europa.eu/news/erc-2019-synergy-grants-results> News of the ERC



The USMILE team, from left to right: Prof. Pierre Gentine, Prof. Markus Reichstein, Prof. Gustau Camps-Valls, and Prof. Veronika Eyring  
Foto: USMILE