Biography

Lennart Marien studied applied mathematics at the University of Hamburg with a focus on numerical methods for partial differential equations. In 2013 he graduated with a thesis on the numerical solution of unilateral contact problems arising in the simulation of lung tissue during respiration. During his time as a student he also worked as a research assistant at the Max-Planck-Institute for Meteorology in Hamburg which sparked his interest in geoscientific applications of mathematics, and especially in climate science.

From 2013 to 2014 he worked as a scientist at the Climate Service Center Germany (GERICS) in Hamburg developing products and models to assist stakeholders in understanding and adapting to climate change. In 2014 Lennart entered a PhD program at GERICS. His PhD work aimed at reducing the pressure gradient error in the regional climate model REMO. This error is associated with the use of terrain-following coordinate systems. While such coordinate systems have many advantages, e.g. a simplification of the lower boundary conditions, they also lead to substantial truncation errors in the computation of the pressure gradient force, an important driver of atmospheric motion. This is particularly pronounced in the vicinity of strong orographic gradients, i.e. in mountainous areas. Without careful balancing of the truncation errors models can suffer from mountain-induced spurious flow with negative impact on cloud and precipitation processes. In his PhD-thesis "Towards well-balancing the regional hydrostatic climate model REMO" Lennart explored a novel approach to reduce the pressure gradient error.

Machine Learning methods for assessing causal links in heterogenous data: applied to Climate Change and Health

It is well established that physical stress due to high temperatures can induce myocardial infarctions, especially in people with preexisting medical conditions such as diabetes or hyperlipidaemia. In light of the expected global average temperature increase due to anthropogenic climate change this raises the question whether the risk of heat-related infarctions can be expected to increase in the future. This project aims at answering this question by developing data-driven models for the risk of heat-induced infarctions in the Augsburg area based on a multitude of socio-economic, health and environmental data. This project is a joint activity of the Climate Service Center Germany (GERICS) at the Helmholtz-Zentrum Geesthacht (HZG), and the Helmholtz-Zentrum München (HMGU) within the Digital Earth framework. State-of-the-art machine learning and artificial intelligence algorithms will be applied alongside more standard statistical methods to identify causal links in the data and build predictive risk models. Once established these models will be applied to derive projections of future risk under conditions of projected climate change, to estimate future societal impacts e.g., in terms of mortality or medical expenditures as well as inform the development of adaptive strategies.

Our data-driven approach has two main pillars. On the one hand the KORA (Kooperative Gesundheitsforschung in der Region Augsburg) dataset, collected and maintained by the HMGU. On the other hand observations of extreme temperatures, and projections of future climate change from the regional climate model REMO operated at GERICS and the EURO-CORDEX ensemble.

The KORA cohort study provides extensive health data for the Augsburg region including a comprehensive infarction registry allowing the correlation of population health with environmental and socio-economic factors. Incorporating further data such as building structures, weather observations and demographic composition, the KORA data will be quintessential in accurately modelling the relationship between infarction risk and environmental stressors such as heat-waves and sustained high night temperatures (tropical nights).

The ensemble climate change projections will be key in projecting the modelled risk into the future under conditions of climate change. To that end, the developed risk models for the Augsburg region will be applied to the regional ensemble data to derive estimations of future changes in risk due to climate change. The inclusion of additional socio-economic data will serve to eliminate confounding factors, e.g. due to an aging society that inherently is more susceptible to health-related risks.

Moreover, the project aims at bridging the disciplinary and scientific boundaries between health and climate science by fostering collaboration between experts within the Helmholtz community. The developed approaches and workflows will therefore be made available to partners in the Digital Earth project. The subject of environment and health is complex and touches many branches of science making transdisciplinary research efforts indispensable.