PhD project - Adaptive data reduction techniques for extreme-scale atmospheric models in climate simulation

You want to apply your data science knowledge to the basic research questions and societal challenges of our modern world? Our scientists in HDS-LEE address some of the most pressing issues of our time, such as energy transition, climate change and resource scarcity, brain function, drug design, identification of diseases at very early stages.

As Helmholtz School for Data Science in Life, Earth and Energy (HDS-LEE), we aim to educate and train the next generation of data scientists during their doctoral thesis in close contact to domain-specific knowledge and research in three application domains: Life and medical science, earth science, energy systems and material science. Visit HDS-LEE at: https://www.hds-lee.de/

The German Aerospace Center (DLR) is the national aeronautics and space research center of the Federal Republic of Germany. Its extensive research and development work in aeronautics, space, energy, transport, digitalization and security is integrated into national and international cooperative ventures. In addition to its own research, as Germany's space agency, DLR has been given responsibility by the federal government for the planning and implementation of the German space program. DLR is also the umbrella organization for the nation's largest project management agency.

The High-Performance Computing department of the DLR Institute for Software Technology (SC-HPC) is cooperating with other institutes of DLR and external partners especially on the following topics:

- Parallel Algorithms and Data Structures,
- Mathematical Modelling and Scalable Simulation Software,
- Parallelization Techniques for Modern Computer Architectures,
- High-Performance Data Analytics, and
- Quantum Computing.

We are looking for a **PhD-student (f/m/d)** in numerical simulation to work within a project linked to the "Helmholtz School for Data Science in Life, Earth and Energy (HDS-LEE)". The successful candidate will develop adaptive mesh based data compression methods for massively parallel atmospheric chemical simulations.

Project overview

Accurate simulation of the Earth's atmospheric chemistry is one of the key challenges in predicting anthropogenic climate change. While the partial differential equations that describe the fluid dynamics are already challenging with their high degree of nonlinearity and the requirement of relatively fine meshes, the chemical reactions involve two to three orders of magnitude more variables and equations. A promising strategy to overcome this data output bottleneck is using adaptive mesh coarsening. In this thesis we will enhance the Modular Earth Submodel System (MESSy) framework with the capability to coarsen the output data of atmospheric chemistry simulations via the AMR library t8code and combine the mesh coarsening with advanced tensor-train based data compression methods.

Ozone gas on original (left) and coarsened (right) mesh
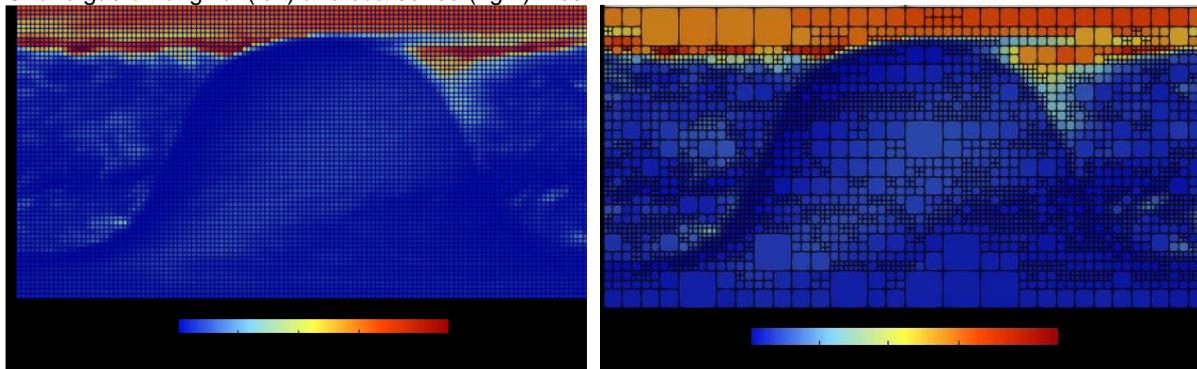
Your Job

- Develop new data compression methods for atmospheric chemistry simulations.
- Extend commonly used open-source software frameworks for atmospheric chemical simulations and adaptive mesh refinement.
- Investigate different mesh coarsening and data representation strategies.
- Develop new tensor-train based data compression methods for chemical reaction data.
- Develop new data storage formats for adaptively coarsened simulation data and integrate them in existing post-processing pipelines.
- Benchmark and evaluate the developed techniques on current supercomputers.

Your Profile

- You have a high interest to apply your data science knowledge to atmospheric chemistry simulations
- University degree in either computational engineering science, computer science, applied mathematics, data sciences, simulation sciences, or physics
- Good experience with numerical simulations
- Good programming skills in C or C++
- Programming skills in Fortran are advantageous.
- Experience with parallel computing is a clear advantage.
- Experience with adaptive mesh refinement is advantageous.
- Experience with atmospheric chemistry models is advantageous.
- Ability to work independently as well as collaboratively in an international, interdisciplinary team; good communication and organizational skills
- Very good command of the English language (TOEFL or equivalent evidence)
- High level of scholarship as indicated by bachelor and master study transcripts and two reference letters

Our Offer

The HDS-LEE PhD position will be located at DLR in Cologne in the SC-HPC department. We offer you

- Outstanding scientific and technical infrastructure – ideal conditions for successfully completing a doctoral degree
- A highly motivated group as well as an international and interdisciplinary working environment
- Continuous scientific mentoring by your scientific advisors
- Chance of participating in (international) conferences
- Unique HDS-LEE graduate school program
- Qualification that is highly welcome in industry
- Further development of your personal strengths, e.g. via a comprehensive further training program

We offer you an exciting and varied role in an international and interdisciplinary working environment. The position is for a fixed term of 3 years. Your salary is in line with 100 % of pay group 13 of the Collective Agreement for the Public Service (TVöD).

Equal career prospects for women and men. We especially foster women in data science and offer individual career planning. We welcome applications from disabled persons.

Become a part of HDS-LEE.

Apply to and contact for further information: Dr.-Ing. Achim Basermann Achim.Basermann@dlr.de

Apply until: 31th October 2021

Starting date: January to March 2022