CFEL SCIENCE

SEMINAR

11th December 2019 - 2:00 p.m.

CFEL-bldg. 99, seminar room IV

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Multiscale problems and numerical approaches in geosciences

Applications in geosciences - examples are atmospheric tracer dispersion or wave propagation in the ocean - most often involve processes acting on a large range of spatial and temporal scales. Capturing such scale ranges in numerical methods is difficult and poses challenging mathematical problems. Resolving small scale features in a large scale domain, where the large scale influences the behavior of the small scale has long been approached by adaptive numerical methods. In atmospheric sciences adaptive mesh refinement has proved quite successful in a number of applications, some of which will be demonstrated.

However, in many situations small scale processes influence the evolution of the large scale states, but cannot be resolved numerically. Yet, physically the small scale structurally influences the large scale. In these situations a novel multi-scale method is being developed, which relies on multi-scale finite elements. These methods have been utilized for elliptic and parabolic partial differential equations. By combining such approaches with a Lagrangian framework we could make them accessible to transport dominated (hyperbolic-type) equations.

While adaptive mesh refinement can be seen as some kind of downscaling approach, where large scale influences are propagated to the small scale, the multi-scale method can be interpreted as a structure-preserving upscaling approach. The ideas behind both methods will be introduced together with some remarks on computational efficiency and prototypical applications.

Host: Robin Santra – CFEL-DESY Theory Division