DFG Roundtable Workshop (19 July 2019)

University perspectives on the planned "National Earth-System Modeling (ESM) Strategy"

A significant part of ESM-related research in Germany is carried out at universities. Over the past decades, scientists affiliated with universities have accounted for more than 75% of the scientific publications in this research area (based on Web of Science®). The university-based landscape in this field is characterized by a great diversity in terms of disciplines and topics, but also with regard to size of individual ESM user groups. Of particular importance are process-oriented model developments, which often account for a considerable share of collaborative research projects funded by the DFG (e.g. SFB, FOR, SPP, EXC). With regard to model development, universities have a long record of accomplishments in developing new components for ESMs. However, due to the complexity of current and future ESMs, as well as the increasing efforts to run and operate the required hardware, the developments have continuously shifted from universities to non-university institutions.

The national ESM strategy and its potential implementation provides a unique opportunity for future research and training activities at universities. Easy access to a state-of-the-art ESM system would allow universities not only to cooperate at eye-level with non-university partners, but also to contribute significantly to further ESM developments and to a national ESM strategy.

To enable university use of the envisioned ESM system requires (i) technical support to implement and to locally run models and tools on the very diverse range of computing facilities that university scientists use, and (ii) support for students (documentation, training, help desk) to get new users productive quickly.

University users will contribute back to the ESM community by (i) developing new model components such as parameterizations, diagnostic and verification tools, and (ii) educating and training of the next generation of scientists, who will be users of the national ESM system in academic and non-academic work environments. The universities contribute the essential resources for their training and supervision.

The involvement of universities in a national ESM strategy will work optimally if it is ensures that the ESM development is driven by grand scientific challenges[1]. Accordingly, process-oriented basic research should be on an equal footing with application-oriented aspects. Key to success in terms of acceptance and implementation of a national ESM strategy will be transparent processes for both, development and decision-making. With respect to governance, involvement of the DFG at a "management" level should be foreseen as well as a representation of university-based scientists on a scientific-strategic level (e.g. via DFG Senate Commission for Earth-System Research).

While the potential availability of a well-maintained national ESM infrastructure (software including analysis tools and user services) would be of major benefit for small groups at universities, it also carries the risk of restricting scientific freedom by implicitly urging proposers to use the national ESM infrastructure. However, open access to the codes, a transparent governance structure, as well as diversity of codes applied at universities should be considered and seen as a strength rather than a shortcoming in this context.

[1] For example building on the WCRP grand challenges (Melting Ice and Global Consequences, Clouds, Circulation and Climate Sensitivity, Carbon Feedbacks in the Climate System, Weather and Climate Extremes, Water for the Food Baskets of the World, Regional Sea-Level Change and Coastal Impacts, Near-term Climate Prediction)

To promote the development and application of the evolving ESM infrastructure at universities and to support a sustainable network of users and long-term collaborations across a wide range of ESM applications, a DFG funded “Priority Program” (SPP) is seen as an ideal framework.

Specific Recommendations for the three working groups of the national ESM process

WG 1: ESM components and configurations

- Research questions (“grand challenges”; see above) must drive the decision on ESM components and configurations.

  Regarding the “scientific issues”, basic research to understand Earth-system processes should be treated with equal priority as the more application-oriented topics.
- The following topics should be included under the heading of basic understanding:
  - Stratosphere and mesosphere processes,
  - paleoclimate problems ,
  - land-atmosphere feedbacks,
  - predictability and extreme events
  - interaction of terrestrial and marine biota with the physical part of the climate system,
  - nonlinear dependence of climate change on climate base states, and
  - evaluation using observational data.

- “ESM configuration” needs to be clearly defined in this context. From a university perspective, it is a tested and validated working set up that is well documented and usable at the level of PhD students. Examples for configurations include:
  - Seamless prediction from weather to climate, upper atmosphere modeling, paleoclimate modeling,
  - high and low resolution,
  - limited area configurations
  - option for coupled data assimilation, and
  - choice to include tracers such as water isotopes.

WG 2: Shared modelling infrastructure

- Universities use very different hardware, so there is an urgent need for as much flexibility as possible with regard to the testing and production environment.
- Access to HPC infrastructure is important for universities, because generally not sufficient capacities are available within its own IT infrastructure.
- The installation procedure should be kept simple and there must be support from the expert team, which should be easy to use when needed. Support should encompass technical issues and support for students (training, documentation, help desk)
- To handle irregular model grids, tools must be available that make it easy to analyze the model data in a flexible way. A uniform data interface is desirable. Expert support should be provided for the analysis of physical quantities requiring intervention in the post-processing part of the ESM system.
- Quality criteria should be available for changes to the ESM code. An ESM support team should provide support for adapting new code according to these criteria.

WG 3: Governance

- Universities need to be represented in the governance structure both, at a “management” level (via DFG) and a scientific level (initially via Senate Commission for Earth-System Science).
- The access and the handling of code, documentation, tutorials, etc. should be regulated according to the open-source philosophy.
- Access to the ESM system should not limit international cooperation. The code must be free and unrestricted for use in international projects.
- With regard to model developments, a transparent policy is needed that specifies how changes flow back into the main stream of the ESM system. The envisioned “gate keeper” needs to let also developments pass that are not a scientific priority of the “core development team”. An instance for “conflict resolution” should be foreseen for the gate keeper, who should represent the scientific community.

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