Advanced Computation and I/O Methods for Earth-System Simulations

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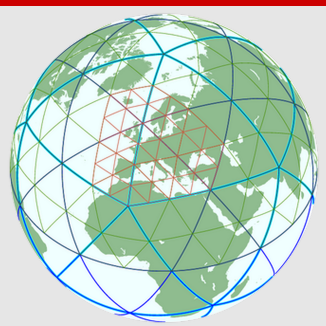
AIMES

Goals

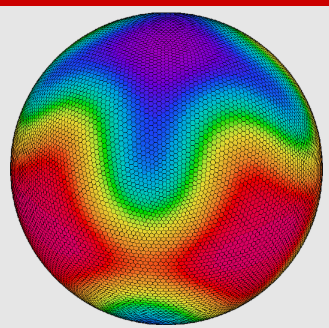
Address key issues of icosahedral earth-system models

- Enhance programmability and performance-portability
- Overcome storage limitations
- Additional benefit: a common benchmark for these models

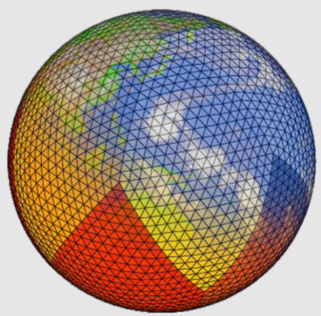
Covered models



ICON

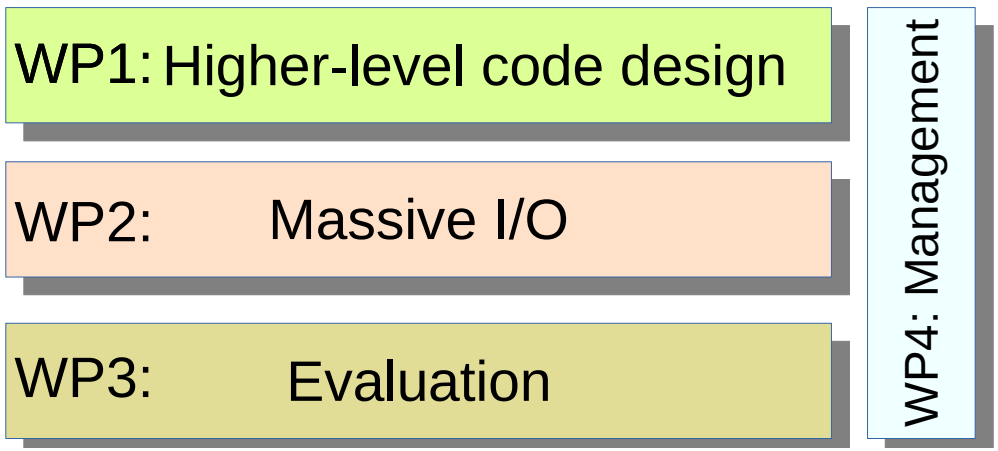


DYNAMICO



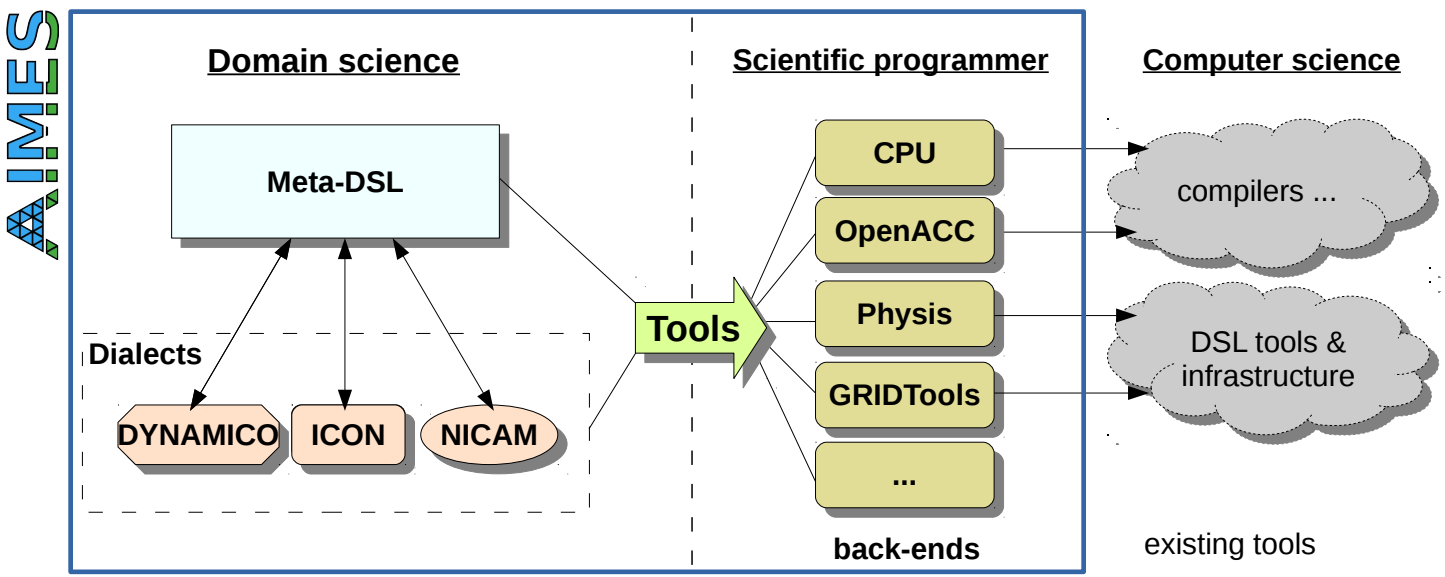
NICAM

Work-Package overview



Objectives: WP 1 Towards higher-level code design

- Separation of concerns: Domain science, scientific programmer, CS
  - High level of abstraction, close to application domain
  - Independence of hardware-specific features, e.g. memory-layout
  - Convertible into existing languages and DSLs



Objectives WP2/WP3

WP 2: Massive I/O

- Optimization of I/O middleware for icosahedral data
  - Throughput
  - Metadata handling
- Design of domain-specific compression
  - User-interfaces for specifying variable accuracy
  - Methodology for identifying the required variable accuracy
  - Novel compression schemes

WP 3: Evaluation

- Evaluating the DSL and domain-specific I/O advancements
- Providing a common benchmark package for all models

Partners and Expertise

Funded partners


Thomas Ludwig (Universität Hamburg)
I/O middleware, compression, ICON DSL


Thomas Dubos (Institut Pierre Simon Laplace)
Application I/O servers, compression, DYNAMICO


Naoya Maruyama (RIKEN)
DSL (Physis), GPUs, NICAM


Takayuki Aoki (Tokio Institute of Technology)
DSL (HybridFortran), language extension, peta-scale apps

Cooperation Partners

- DKRZ *(I/O, DSL)*
- DWD *(ICON, DSL, I/O)*
- University of Exeter *(Math. aspects in the DSL)*
- CSCS *(GPU/ICON, GRIDTool, compression)*
- Intel *(DSL-backend optimization for XeonPhi, CPU)*
- NVIDIA *(DSL-backend optimization for GPU)*
- The HDF Group *(I/O, unstructured data, compression)*
- NCAR (MPAS developers, another icosahedral model)
- ATOS (former Bull)
- Cray

Information exchange, participate in workshops, [hardware access]

Relevance within SPPEXA

SPPEXA Topics

- Data Management and Exploration
  - I/O middleware, performance and compression
- Application Software
  - Icosahedral earth-science models
- Programming
  - Abstraction level, performance-portability

Relevance within SPPEXA

SPPEXA Goals

- Effort towards standardization
  - Common Meta-DSL for icosahedral models
  - I/O interfaces/schemes for compression
- Support for early researchers
  - We offer research stays
- Networking
  - Open workshops
  - Collaborate with H2020 and SPPEXA projects e.g. Exastencil
- Applicability beyond the scientific domain
  - Advancement of I/O middleware feed back to communities
  - DSL tools and strategies can be used for other domains

Appendix

WP 1: Towards higher-level code design

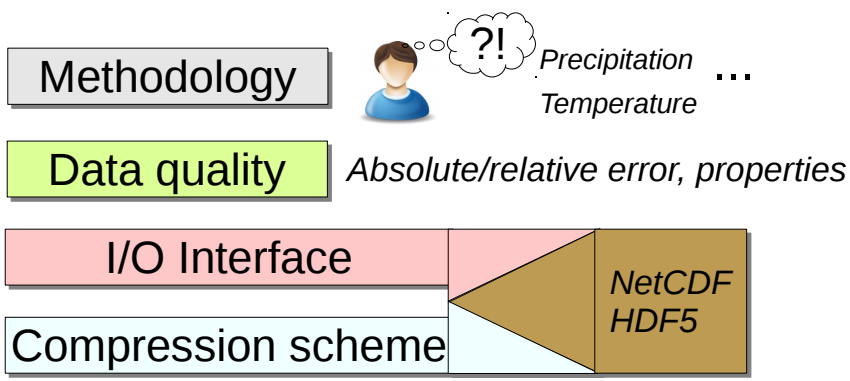
Tasks

- Develop and reformulate key parts of models into DSL-dialects
  - 1.1 DYNAMICO
  - 1.2 ICON
  - 1.3 NICAM
- 1.4 Design a common DSL concepts for all ICO models
- 1.5 Develop a source-to-source translation tool and mappings

WP 2: Massive I/O

Tasks

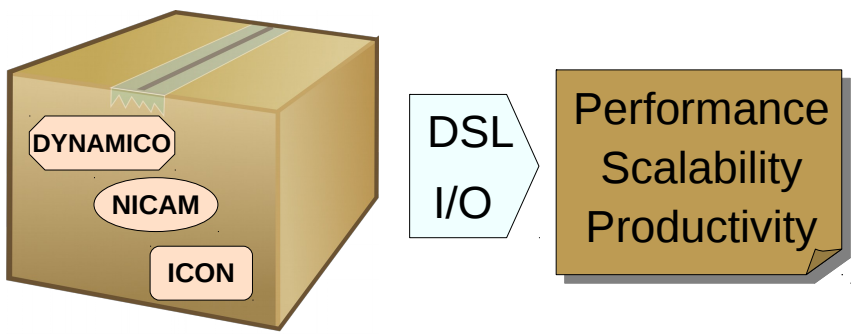
- 2.1 Optimize file formats for ICO data
- 2.2 Data reduction concepts
- 2.3 API for user-defined variable accuracy
- 2.4 Identifying required accuracy
- 2.5 Lossy compression schemes



WP 3: Evaluation

Tasks

- Selection of representative test cases
- Extraction of simple kernels
- Common benchmark packagage/mini-IGCMs
- Benefit of the DSL for kernels/mini-IGCMs
- Estimating benefit for full-featured models
- I/O advances for full models



WP 4: Management

Tasks

- Project management
- Internal communication
- Quality assurance
- Dissemination
- Involvement with third-parties (standardization bodies, SPPEXA, H2020)