Breakout group outputs

Computational Challenges

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Data Challenges

- Dycores (computational PDEs): native grid is increasingly incomprehensible.
- Data volume will change practices
- post- and pre-processing: now same order of magnitude as modeling to do the analysis
- Climate run restarts: becoming very large for high resolutions, must be done more often due to higher node failure rate, or use fault tolerant algorithms
- Metadata model for grids is missing... not only data model needed, but also tools to access the data. Models spit out too little metadata, e.g., the definition of the function space (FV, FE, ..)

Performance challenges

- Scalability...
- Global communication
- Per core performance still a concern
- Minimizing layers of parallelism to attain reasonable hybrid performance
- What can 'exascale' architectures give us scientifically?
- Do we really need exascale for climate research ?

Code challenges

Portability, programmability, software sustainability

- Unit testing: scientists need to do more, but education opportunities needed
- Adopting new programming paradigms, potential demise of explicit parallelism... what will the exascale programming model be?
- Are there alternatives to Fortran/C + MPI ??
- Insufficient training of code developers

Platform Challenges (hardware, OS, compiler, libraries)

- Reliability, fault-tolerance,
- Silent errors (error checking)
- Reproducibility if the same simulation is rerun (overlap with methodology). But how is it defined? Bit-4-bit for debugging?
- Ensure the same climate over different platforms (not only numerical issue). Error growth rate sufficient?

Ways to collaborate

- Need to make more effective use of hpc numerical libraries
- MetaFor dealt with meta data for climate forum (defunct) -- this should be continued within IS-ENES.
- Development of post- and pre-processing community (does CDO cover this?)
- Can we develop a CMIP-like protocol for machine verification?
- More involvement from standards' communities, e.g., FT-MPI within MPI-3 standardization
- Foster educational initiatives to incorporate best practices from software engineering principles. Long-term to develop new generation
- Develop climate kernels or mini-applications to provide computer scientists
- Creating, then advertising cooperation success-stories between computational and climate scientists
- Engagement with exascale community (EESI/IESP) -- documenting the needs of the ES community; need international cooperation programming paradigms