HPC for Climate Modelling and Simulation

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Synthesis and next steps

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Structure

- Significance
- Strengths
- Challenges
- Threats/bottlenecks
- Opportunities
- Next Steps

Significance

- **Importance of climate action: 'our future'**

- **Policy implications**
  - **Mitigation and adaptation**
  - **Climate services**
  - **Economic impacts**

- **HPC is a must**

HPC & Data for Climate

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Strengths

- Potential for high value co-operation
- Excellent scientific expertise
- International excellence
- Well established institutes
- Experience of co-operation and sharing of information
  - (examples: ENES for climate and ECMWF for NWP with links between the two, HIRLAM and ALADIN for regional NWP)
- International collaboration (eg: WCRP and WMO)

- Access to HPC resources:
  PRACE: More than 400 million core hours for 12 projects
  5% of the total number of resources and 4% of the total number of projects

Challenges (1)

- **Understand and predict climate variability and change**
- **Grand Challenge : scientific and computational**
- **System challenges (capacity, I/O performance)**
- **S/W challenges (s/w engineering, computational, optimisation)**
- **Model complexity: Climate models towards earth systems models ; will also be the case for weather models**
- **Quality of weather and climate predictions: depend on quality of s/w and HPC**
- **Link between climate and weather prediction**

  Establish commonalities (Science, modelling approach, production constraints and data sharing, HPC challenges)
- **Common strategy across EU (Strategy for model data, access, interoperability, model simulation environment, input/ouput systems, visualization tools, evaluation data [high resolution, Earth System data])**

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Challenges (2) DATA

- Easy access to climate quality-data
- Data management and Value chain
- Data Analysis and integrating models
- Huge volume data: distributed and archiving ;
- Efficient data storage models, data mining
- Reuse, interoperability
- Working together on data (existing international standards for climate and weather ; Research Data Alliance)

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Challenges (3) HPC

- **Need capability and capacity**
- **Improve on: algorithms, computational, model environment**
- **Common themes and sharing**
- **Co-design is a necessity**
- **Training and skill development**
- **Parallelisation: how to share the load and result**
- **Access to HPC resources (national, PRACE, ECMWF,other sources?)**
- **Portability of codes, Codes at European level, Common libraries**

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Challenges (4) HPC

Co-design and co-testing of:

- Basic model components
- Data bases
- Benchmarking suites
- Information hubs among climate and weather prediction

Involvement of HPC vendors at an early stage for co-design:

- Access to new architectures; Access to vendor testing facilities

Challenges (5)

- **Lack of business models**
- **Climate services for decision makers and business**
- **Transformative aspects of HPC & Data for value chain**
- **Climate information on regional-to-local scale and in territorial planning**

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Threats/bottlenecks(1)

- **Joint efforts and division of work (e.g. different models in Europe but sharing of some components)**
- **Cooperation/sharing of large modelling centres**
- **Integration of smaller climate modelling research groups, Regional collaboration**
- **Disaster risk reduction (regional hazard early warning system)**
- **HPC availability : facilities adapted to needs; availability for some countries (e.g. to full members of ECMWF for weather)**
- **Scalability (data, computation, models, codes)**
- **Code-modernization**

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Threats/bottlenecks (2)

- **Data management (reuse, common libraries, value chain)**
- **Transfer and distributed access, data mining**

- **Industry participation**
- **Co-design**
- **Longer-term commitment of participating institutes – planning and funding security**

- **Research scientist career / research data engineer**
- **No Fortran experience anymore!**

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Opportunities

- **PPP to play a key role**
- **Key players to work together (National Meteorological and Hydrological Services, ECMWF, climate modelling centres, computing centres etc..)**
- **Existing networks (eg:ENES, met services, regional climate forums, WMO Climate network)**
- **Value chain (including climate impact research and climate services)**
- **Cost saving**
- **Wider use of GEANT**
- **HPC CoE: critical mass and key players**
- **HPC Exascale**
- **PRACE resources**
- **Policy actions**
- **H2020 funding opportunities**

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Next steps

- Organise a network and meet every six months :
  - Events in the near future
    - ENES for climate; next meeting HPC workshop 17-19 March 2014 ;
    - ECMWF for weather; HPC workshop on 14-15th April 2014
- Explore joint actions at European level
  - (eg: IS-ENES 1 and 2)
- Agree on and develop a Common strategy
  - (eg: ENES infrastructure strategy)
- Identify common tasks and sharing mechanisms:
  - Some progress in ENES; to be further elaborated between climate and weather
- H2020 (present and next WP 2016-17)
- HPC CoE and Exascale FET: to be explored
- Climate services : (eg: COPERNICUS Climate change : integrate model results with other sources of data)
- PRACE access : (eg: collaboration PRACE/ENES)

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Expectations on policy contributions for climate actions

- Description of existing gaps in the EU capacity to reliably project climate change, daily local weather over the short, medium, longer term.
- Description of what is needed in order to close the gaps.
- Estimate of the market value, description of stakeholder interest related to gap closing.
- Reliable projection of how climate change will evolve in function of different GHG concentrations in the atmosphere, and how such climate change translates into daily local weather patterns.
- Identification of time, location, nature and impact of any projected dangerous climate change -> identification of dangerous daily local weather along the projection period up to 2030, 2050…2100 under different GHG concentration scenarios.
- Mapping of current, evolving socio-economic fabric, organisation, input/output in terms of emission/removal profiles and concentrations of GHG in the atmosphere, daily weather evolution.
- Evidence on the necessary quality, intensity levels of mitigation and adaptation to be recommended over the time up to 2050, beyond.
- Evidence on the extent to which projected daily local weather poses a threat to critical knots, processes, items of key socio-economic value adding networks, notably related to weather tolerance of agricultural, food production/processing/trade/distribution, general mobility/transport system (for people, raw material, goods/services), housing/building/infrastructure stock, energy system.
- Evidence on the impact of land use, land cover, water use, raw material/nutrient flows on climate change and vice versa.

Christine Moeller, DG Climate Action: 27th February 2014