



# Convergence of Weather and Climate Simulation

Philipp Neumann, Joachim Biercamp Deutsches Klimarechenzentrum (DKRZ)



#### The Multiscale Challenge

#### Uniform warming (4°C) in a water planet experiment (CMIP5)

#### CHANGE IN CLOUD RADIATIVE EFFECTS

"...A deeper understanding and better representation of the coupling between water and circulation, rather than a more expansive representation of the Earth System, is thus necessary to reduce the uncertainty in estimates of the climate sensitivity and to guide adaptation to climate change at the regional level. This knowledge should help focus efforts and lead to progress in reducing the imprecision of climate models in the next 50 years. Here, Numerical Weather Prediction (NWP) provides a good example. By focusing on key limitations in the model initialization,

**spatial resolution, and the representation of key parameterized processes**, NWP has improved forecast skill substantially over the past 30 years..."





#### To Parameterise Or Not to Parameterise?











### **Global High-Resolution Simulations**



- High level of detail  $\rightarrow$  100-1000m horizontal resolution
- Less parametrisation  $\rightarrow$  In the limit, we know the equations!
- Visualisation: N. Röber





## ESiWACE: Centre of Excellence in Simulation of Weather and Climate in Europe



Earth System Data Middleware





### Scalability







#### Perspectives

- Previous slide: 0.1-0.3 simulated years/day at 5km resolution
- Long-term goal:
  - 1km simulations at 1 simulated years/day
  - 3km ensemble simulations at 1 simulated years/day
  - → this will require at least exascale computing and corresponding data handling capability
  - $\rightarrow$  challenge: model=long-term development
- ESCAPE/ESCAPE-2: The revolutionary path
  - DSLs to enhance programmability/portability
  - Mixed precision arithmetics
  - Increasing the levels of concurrency
    - → dwarf=,,submodel" concept
- DYAMOND: Intercomparison of global high-resolution models

   → currently 7 groups from Europe, USA, Japan