Ensemble Simulations on highly Scaling HPC Systems (EnSIM)

FZ Jülich (JSC and ICG2), DLR (Braunschweig and Köln), Fraunhofer SCAI

Associated partners: Airbus Deutschland, Volkswagen, DWD, Bayer Technology Services

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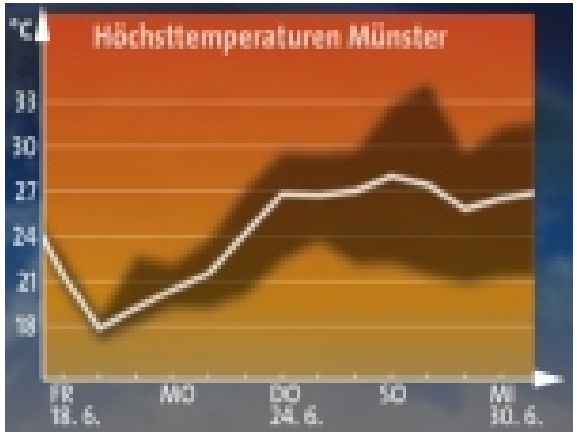
What are ensemble simulations?

- A few dozen to several hundreds of simulation runs with varying input parameters or constraints.
- Each simulation is moderately parallel; all simulations firstly run completely independent from each other in separate partitions of a large HPC system.
- Each run generates individual data which have to be efficiently collected and evaluated by, for example, principal component analyses.
- Challenge: to efficiently combine the generation and control of the ensemble simulations and the evaluation of the arising *data cloud*.
- Ensemble control and analysis have to be adapted to the given highly parallel distribution of the data.



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EnSIM project objectives

- To demonstrate and prove the potential of ensemble simulations for a new quality of results in various application fields.
- To develop a library for adaptive data and process management and parallel ensemble data analysis (open source).
- To prove the usefulness of petascale computers for industrial simulation applications

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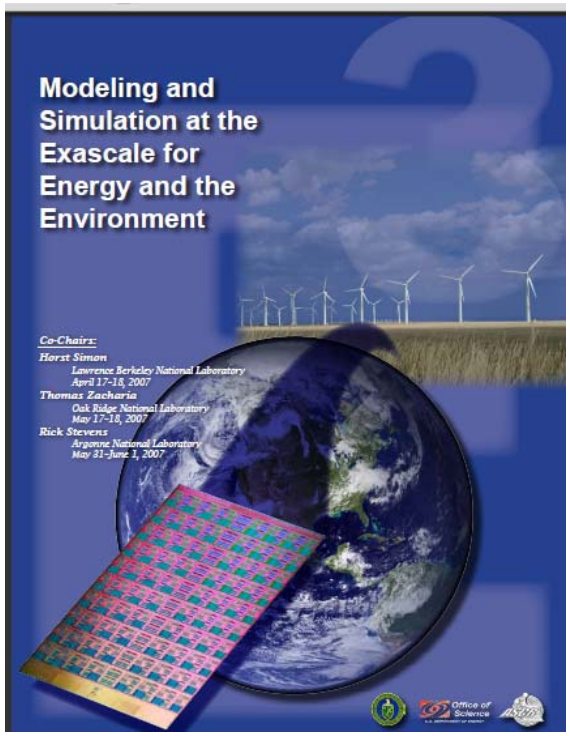
Ensemble simulations are important for future exascale platforms

One approach to dealing with uncertainty is to perform multiple ensemble runs (parameter sweeps) with various combinations of the uncertain parameters. Since the space of parameters will be of high dimension, we will have to address the challenges of designing efficient parameter sweep methods for highdi-mensional spaces. Recent advances in approximation theory and data mining methods, such as sparse grids, offer new approaches to this problem. Furthermore, recent results in approximation theory can be used to guide us in using exascale computing power to search for efficient methods.



(Source: Horst Simon et al. Modeling and Simulation at the Exascale for Energy and the Environment)

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Work packages

- WP1: Evaluation and demonstration of the potential of highly parallel ensemble simulations
  - Scenarios from important application areas (plane aerodynamics, crash simulation, atmosphere processes, material sciences)
- WP2: Development of a library for adaptive data and process management and parallel ensemble data analysis, availability as open-source software
- WP3: Adaptation and opitimization of the library for the computer architectures of GCS and for future exascale architectures

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