Scaling Cascades in Complex Systems

SFB 1114

Interdisciplinary CRC 1114

Mission: Mathematical description and investigation of complex processes in physics, (bio)chemistry, meteorology and geosciences.

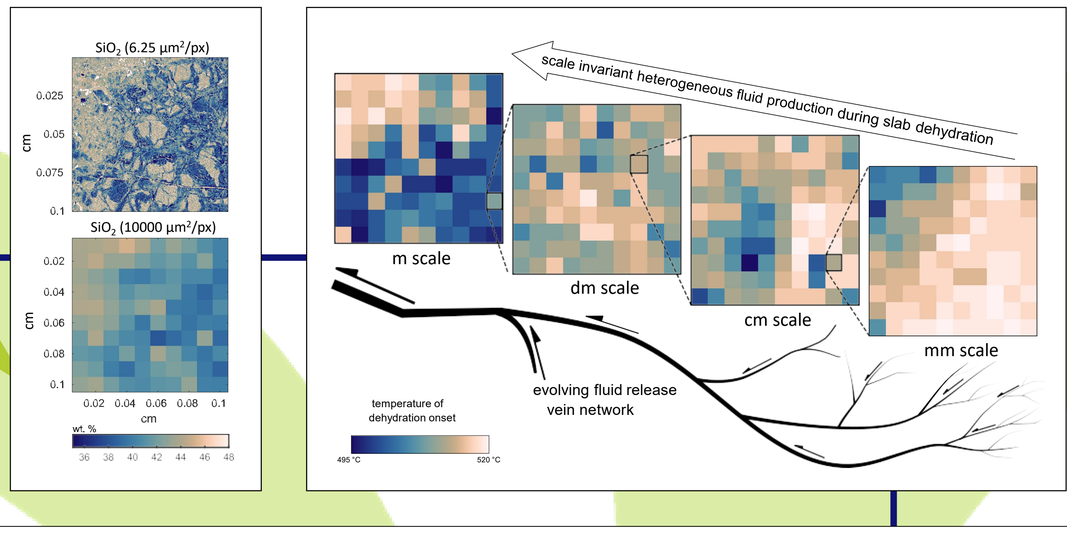
...at 5 locations in Berlin and Brandenburg.

Brandenburgische Technische Universität Cottbus - Senftenberg

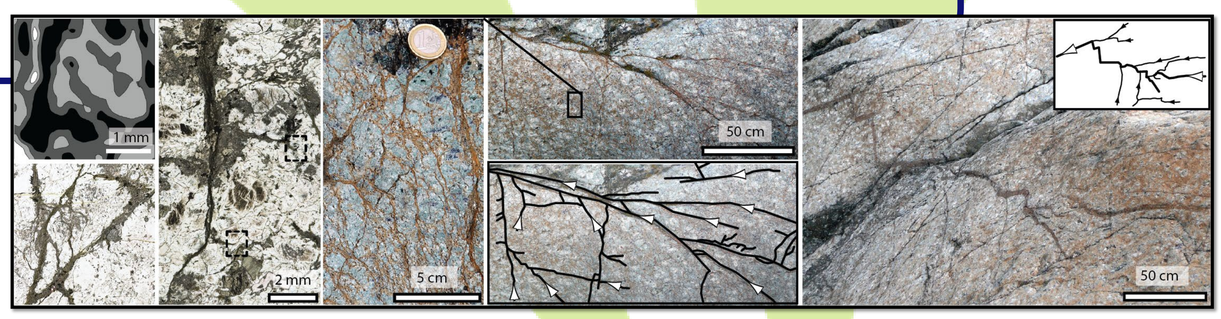
What are ... Scaling Cascades in Complex Systems?

Complex processes involving cascades of scales are ubiquitous in nature. Such processes have more than two characteristic scales, their smallest and largest scales are widely separated, and many of their scales are important in determining the characteristics of the process.

Experiments and observations often provide only limited insights into such processes, but with increasing computing power there is hope for progress via simulations.



Project Co9 „Dynamics of rock dehydration on multiple scales“ investigates dehydration processes in rock. To model the processes, information collected from rock samples is simplified. This allows the different scales to be compared.

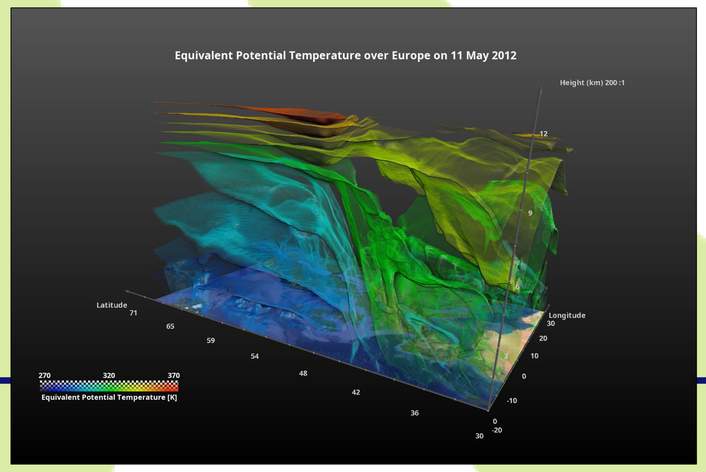


Water in rock

Rocks, especially those that were the seabed many thousands of years ago, contain water. This water is bound to the various chemical components of the rock. Under certain circumstances (high heat and pressure in the earth's interior), these bonds are broken, the water forms droplets, forms channels, creates cracks and then potentially earthquakes. This process is called dehydration.

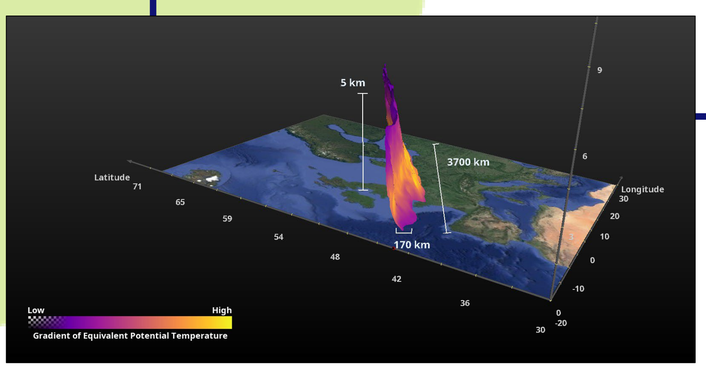
Geologists and mathematicians are working together to develop a mathematical model to describe the dewatering process, which represents all stages (as well as space and time scales).

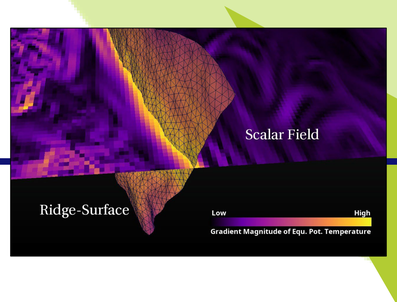
The mathematicians examine this model and validate it using rock samples and actual observations made by the geologists.



Projekt Co6 „Multiscale structure of atmospheric vortices“ investigates convection processes in the atmosphere.

The developed visual data analysis is shown, in whose 3D representation (unlike traditional 2D representation) information such as the tilt of the processes in space or the temperature gradients by altitude can also be analyzed.





Weather phenomena

Atmospheric weather phenomena occur in various sizes, but always interact with each other.

The position of a cold weather front (several 100 km in size, several days long) determines the occurrence of individual thunderstorm cells (~1-10 km, a few hours). The basic physical processes can be described mathematically.

Meteorological observations provide the necessary data and verification. The visualization of the processes plays an important interdisciplinary role.

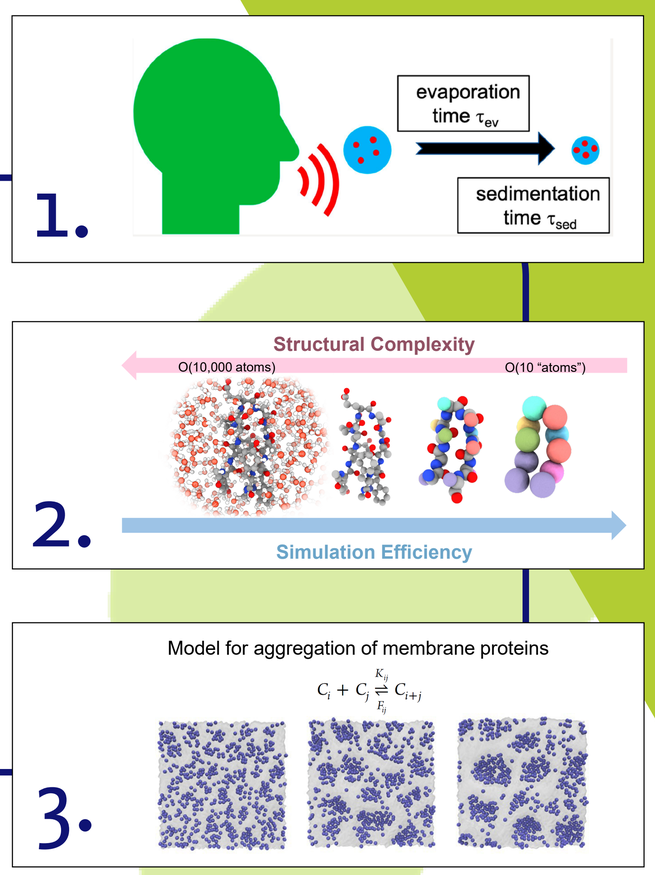
New methods are currently being developed that can visualize weather phenomena not only in 2D as usual, but also in 3D, thus providing important additional information.

And on the smallest scale...

How do individual particles, molecules and proteins behave? What influence do variables such as temperature or concentration density have? How do these tiny components interact with each other or along a membrane? How can these processes be described and visualized?

Some examples from projects of the CRC1114:

1. Distribution of aerosol droplets in indoor air
   (Projekt Co2: „Interface dynamics: Bridging stochastic and hydrodynamic descriptions")
2. Enabling the simulation of very complex processes by simplifying the structures with the help of coarse-graining
   (Projekt Co3: „Multiscale modeling and simulation of spatio-temporal master equations"
3. Description of the behavior of proteins along the membrane of (human) cells
   (Projekt Ao4: „Efficient calculation of slow and stationary scales in molecular dynamics")



More about us...

and more about

...the underlying mathematics
...the altogether 14 research projects
...the PhD program
...the outreach activities

can be found on our website:
www.sfb1114.de

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