SPICE

Ludwig-Maximilians-University Munich

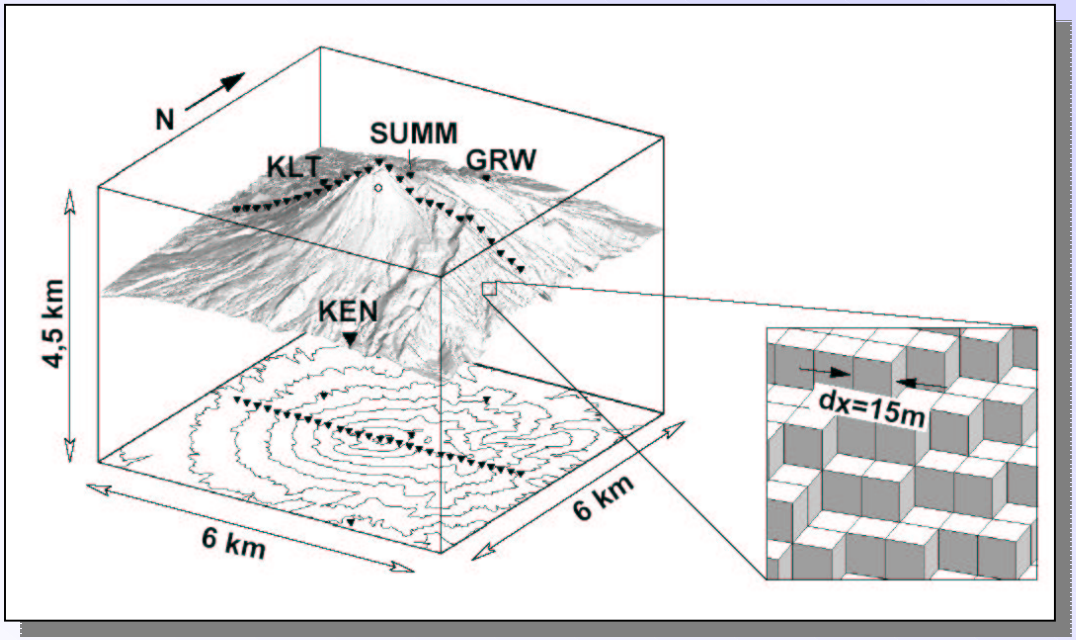
Scientists involved

Staff:	Peter Bunge (geodynamics) Heiner Igel (seismology) Joachim Wassermann (volcanology, networks) N.N. (system administrator)
SPICE personnel:	Erika Vye (Administrator) Marco Stuppazini (postdoc, SEM modelling) N.N. (Ph.D. student)
Postdocs:	Alain Cochard (Rupture dynamics, rotations) Guoquan Wang (earthquake scenarios)
Ph.D. Students:	Haijiang Wang (scenarios), Gilbert Brietzke (rupture), Wiwit Suryanto (Rotations), Markus Treml (global wave propagation), Toni Kraft (swarmquakes), Michael Ewald (scenarios), Melanie Reichhardt (unstructured grids)
Masters students:	Teresa Reinwald (scenarios, rotations), Peter Danecek (spherical meshes), Bernhard Schuberth (SEM), Steffi Rieger (WebSim3d, php)

Volcano seismology

technical challenges

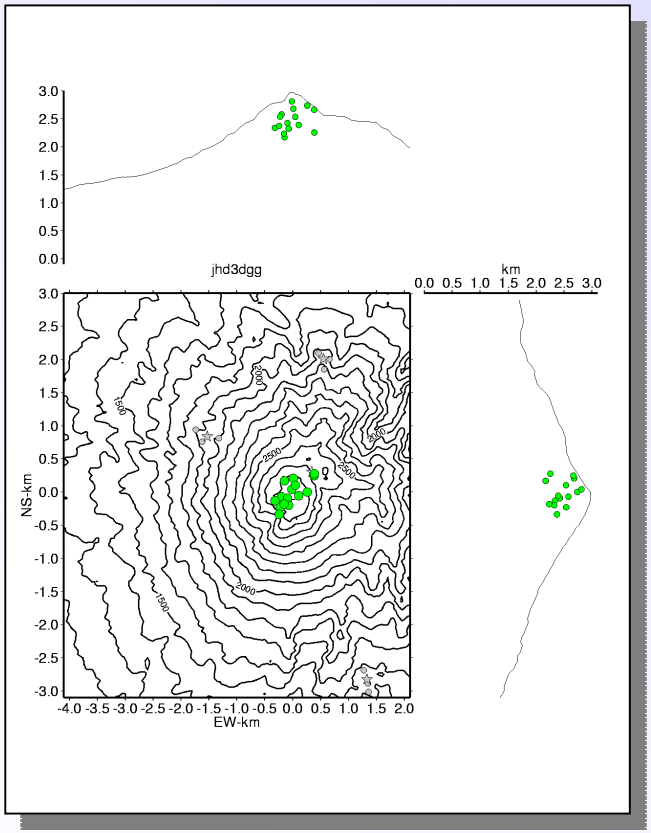
- Modelling free surfaces with very strong topography
- Highly heterogeneous structures
- Complex source processes
- Surface sources (pyroclastic flows)

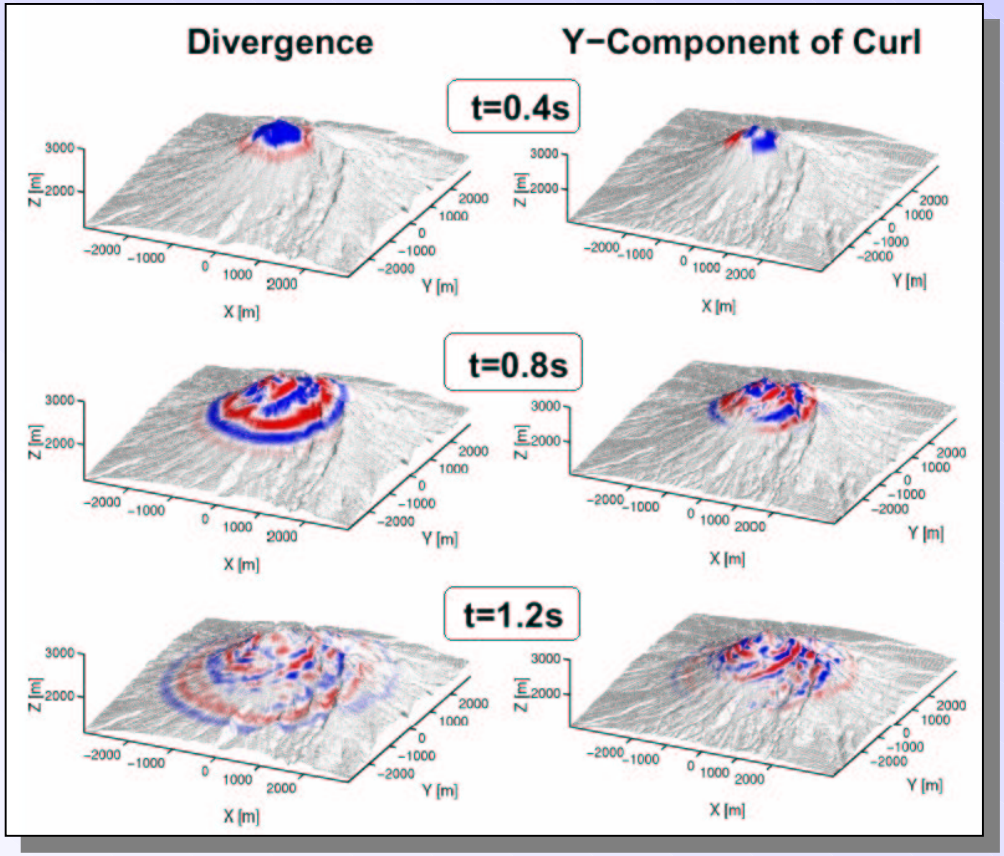


Ripperger, Igel, Wassermann, 2003

Volcano seismology

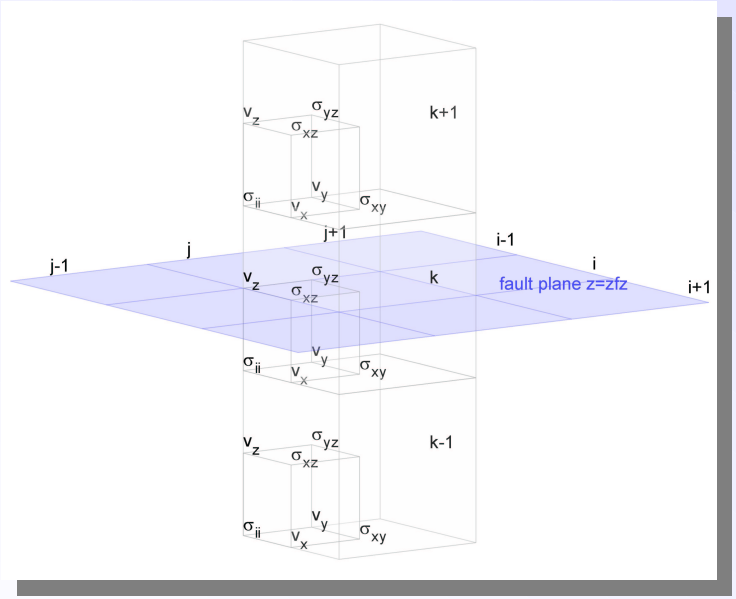
Topographic vs. internal scattering
Dome growth – summit sources

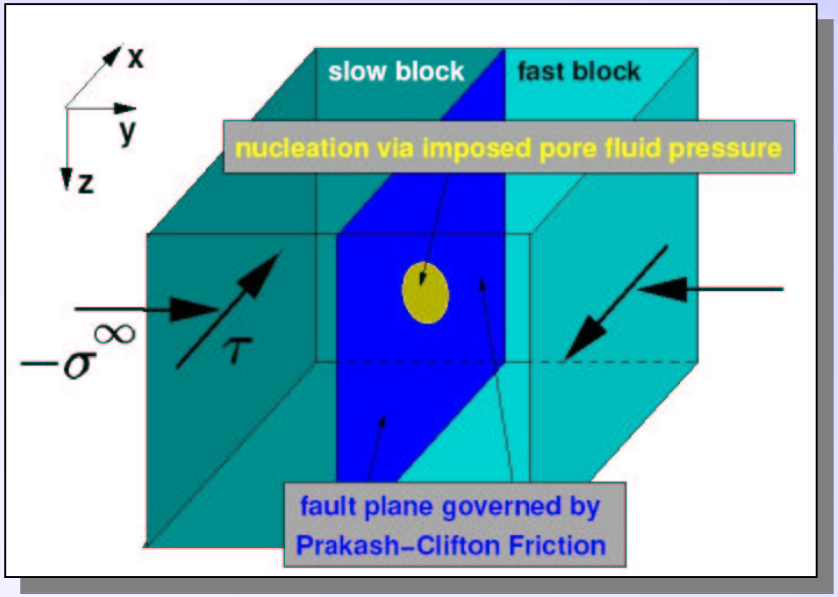




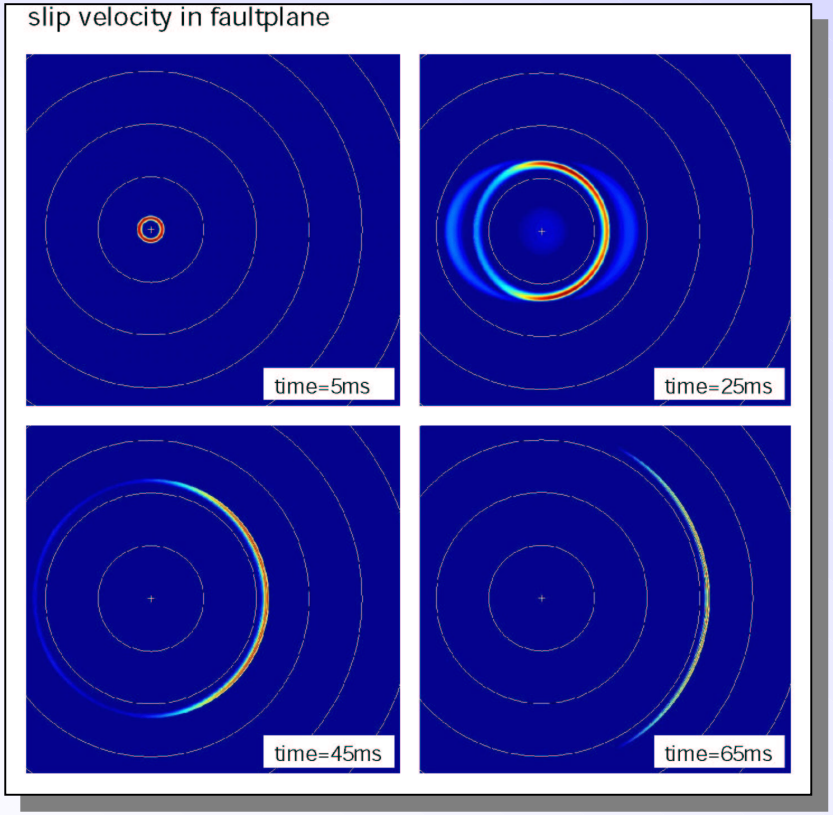
Dynamic rupture
technical challenges

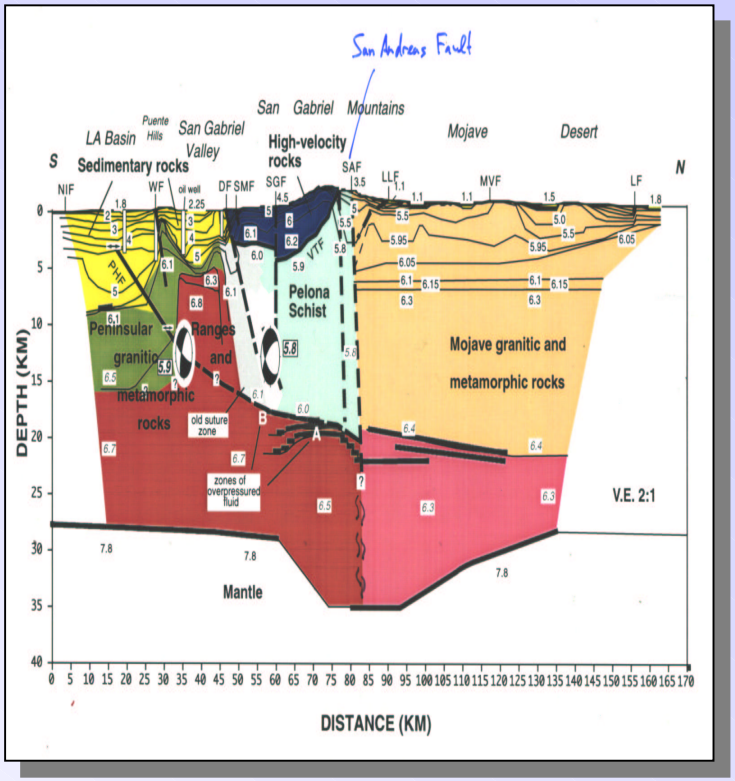
- Frictional boundary conditions (stability, convergence)
- Rupture at material interfaces
- rupture at non-planar surfaces
- Multiple fault interaction
- Small space and time scales to resolve frictional behaviour
- Nonlinear material behaviour (e.g. damage rheology)





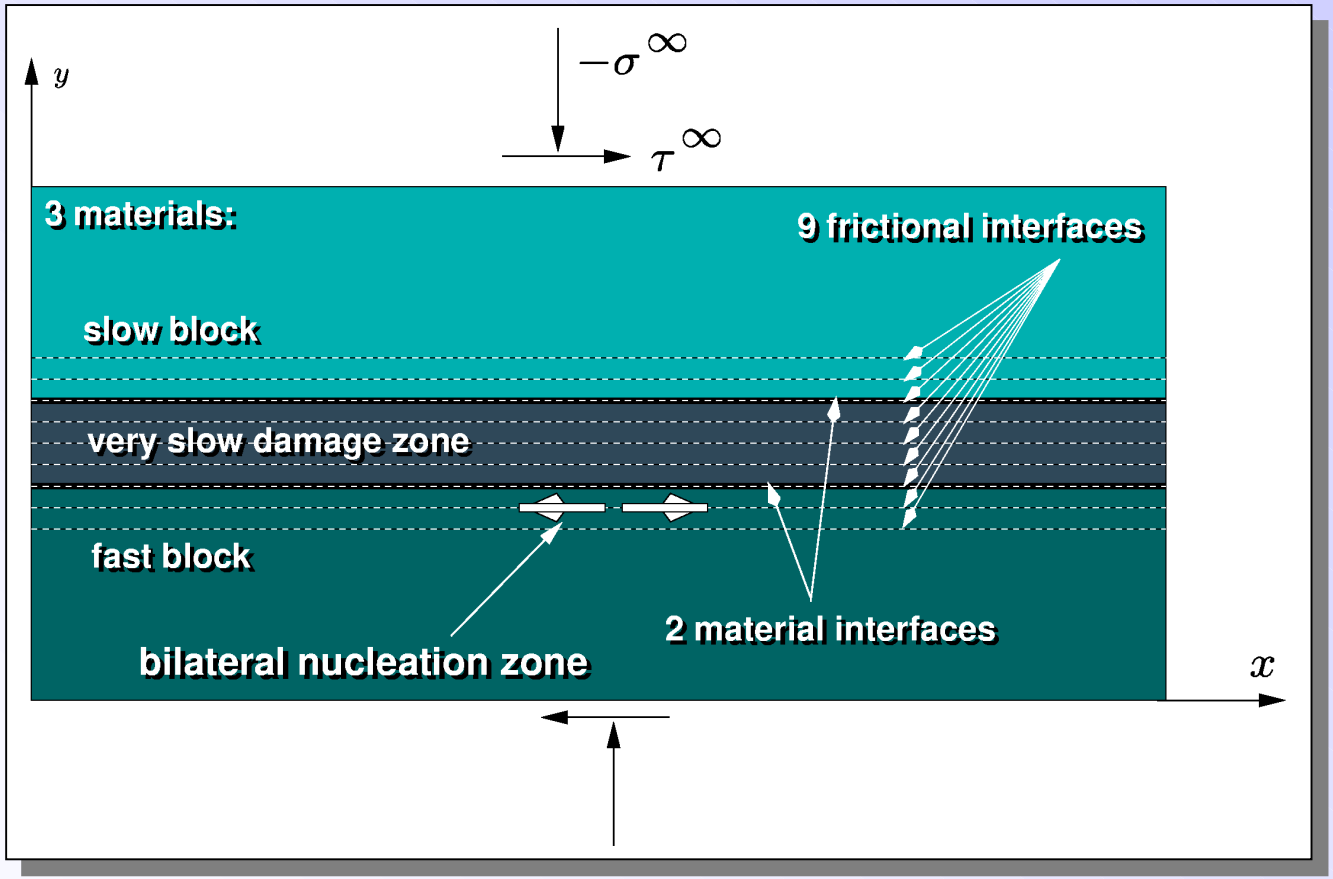
Dynamic rupture
material interfaces





Dynamic rupture

fault interaction - heterogeneity



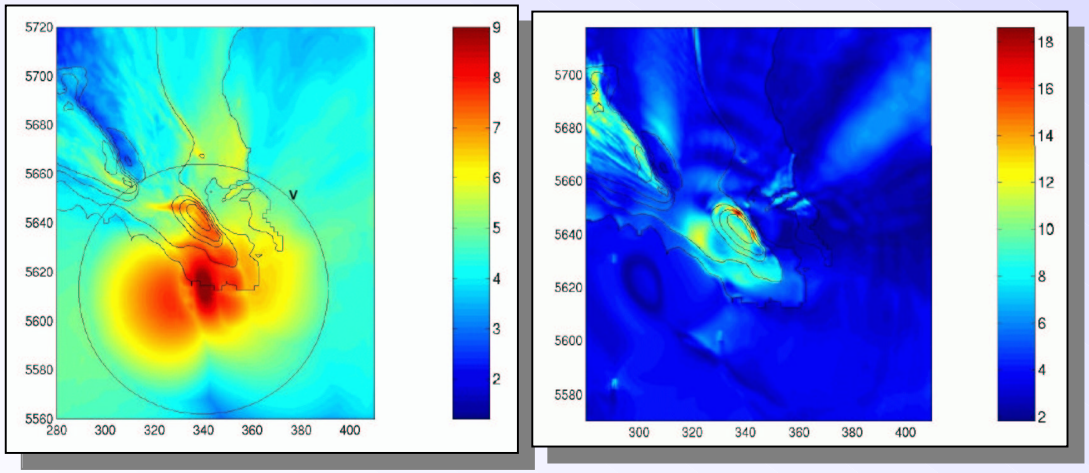
Brietzke and Ben-Zion, 2003

Earthquake scenarios

scientific objectives

- Accurate calculation of strong ground motion for regional earthquake scenarios
- Accurate prediction of hazard and risk scenarios for specific regions and time intervals
- Incorporation of earthquake scenario simulations into probabilistic hazard analysis

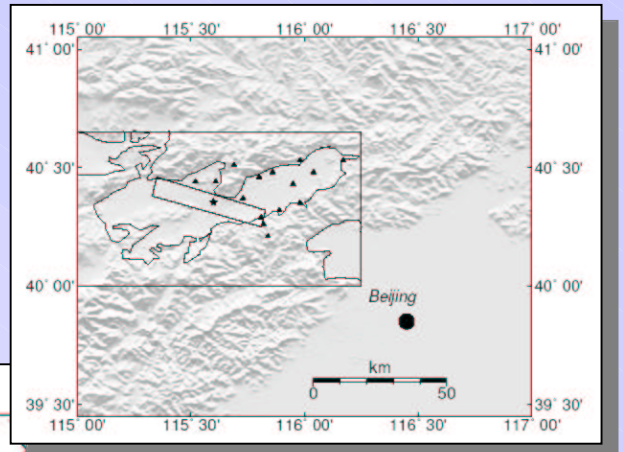
Shaking hazard

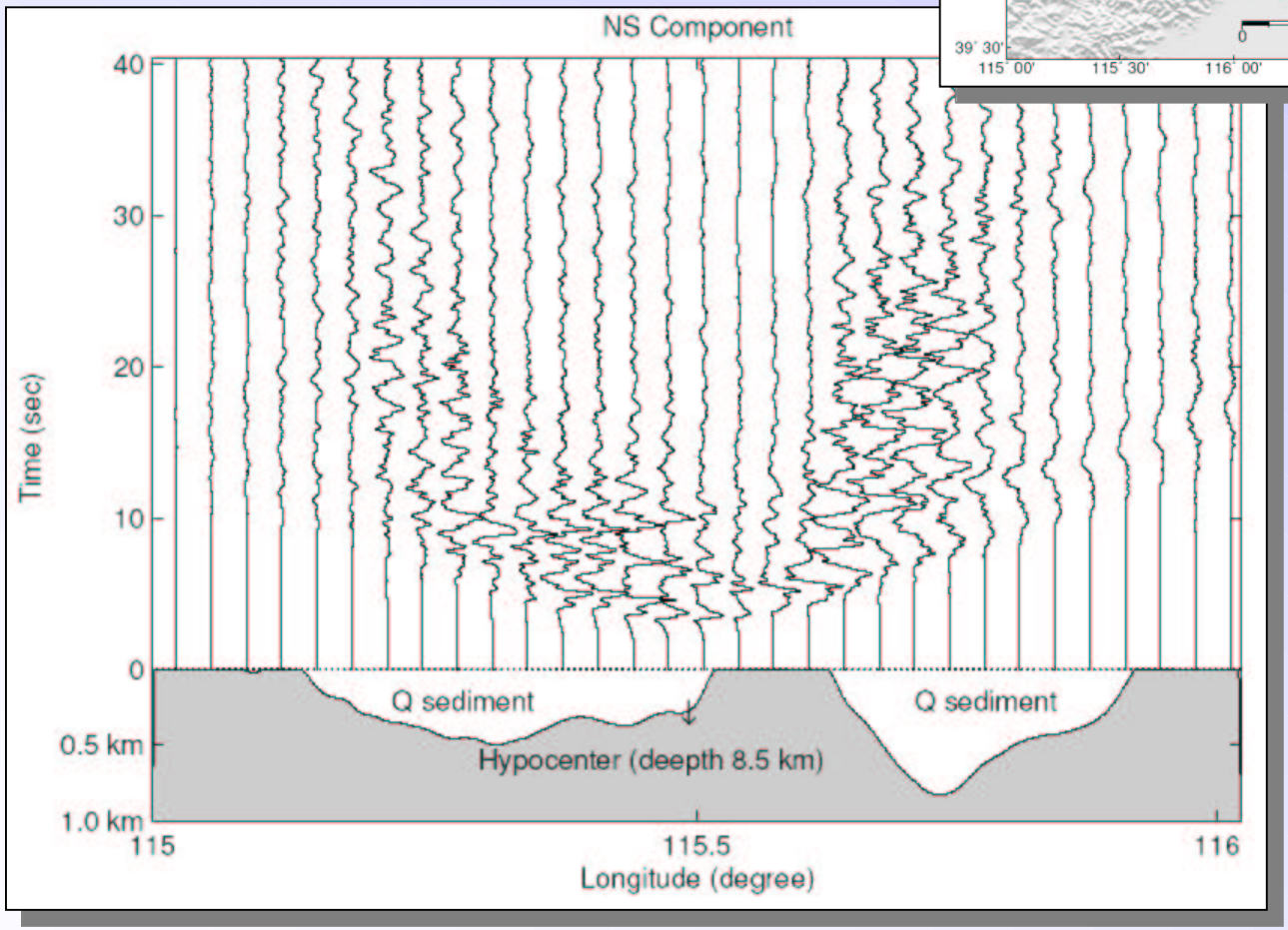


Amplification

Earthquake scenarios

Finit sources - randomness

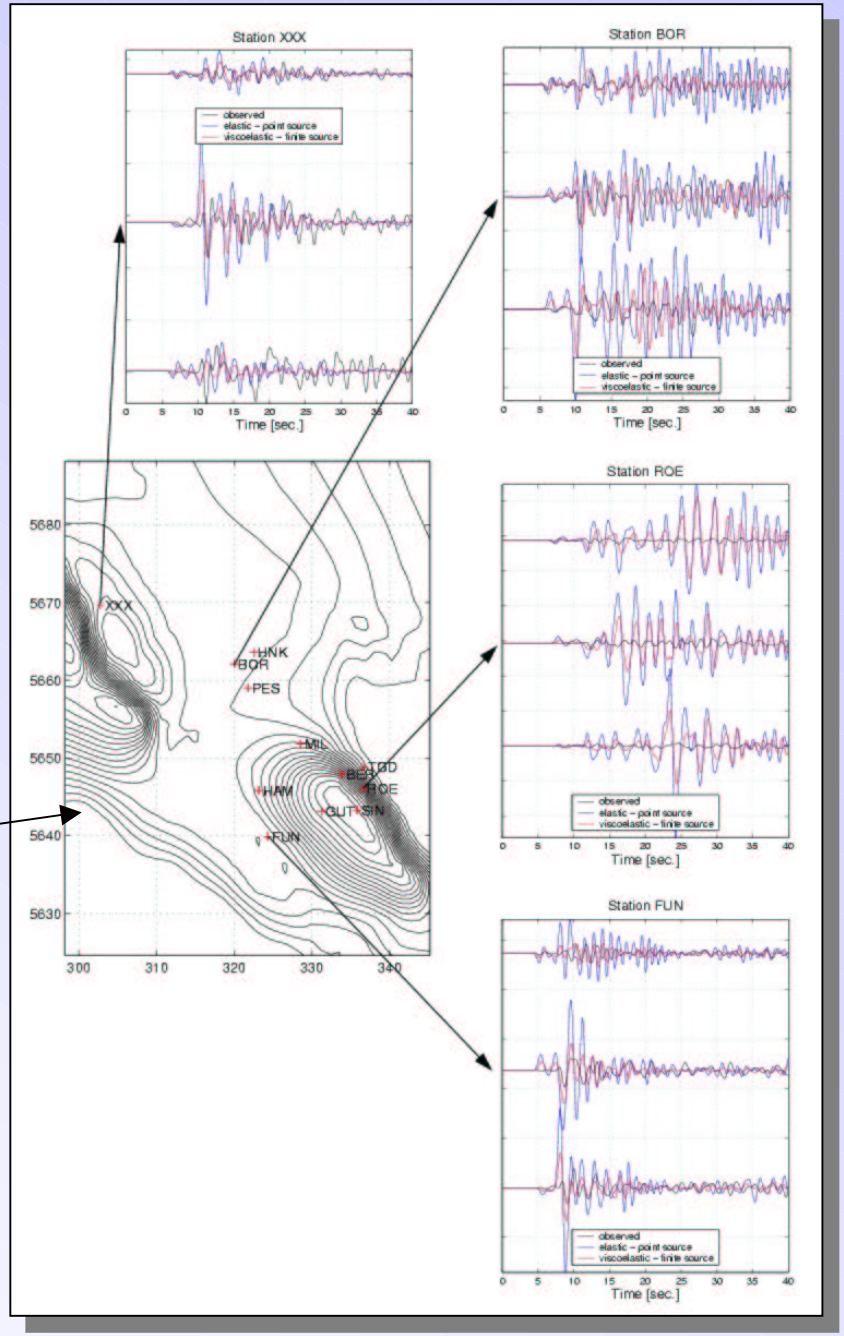




Earthquake scenarios

Comparison with observations
M4.9, July 2002
Cologne Basin, Germany

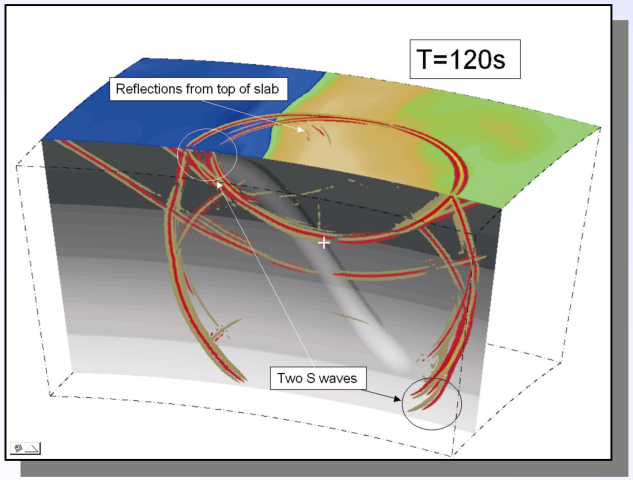
Cologne Basin topography

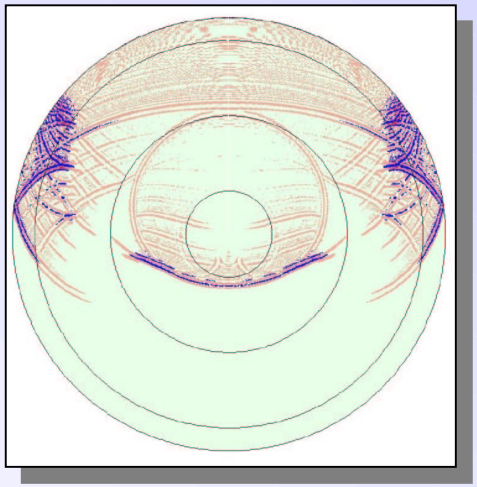


Global seismology

scientific objectives

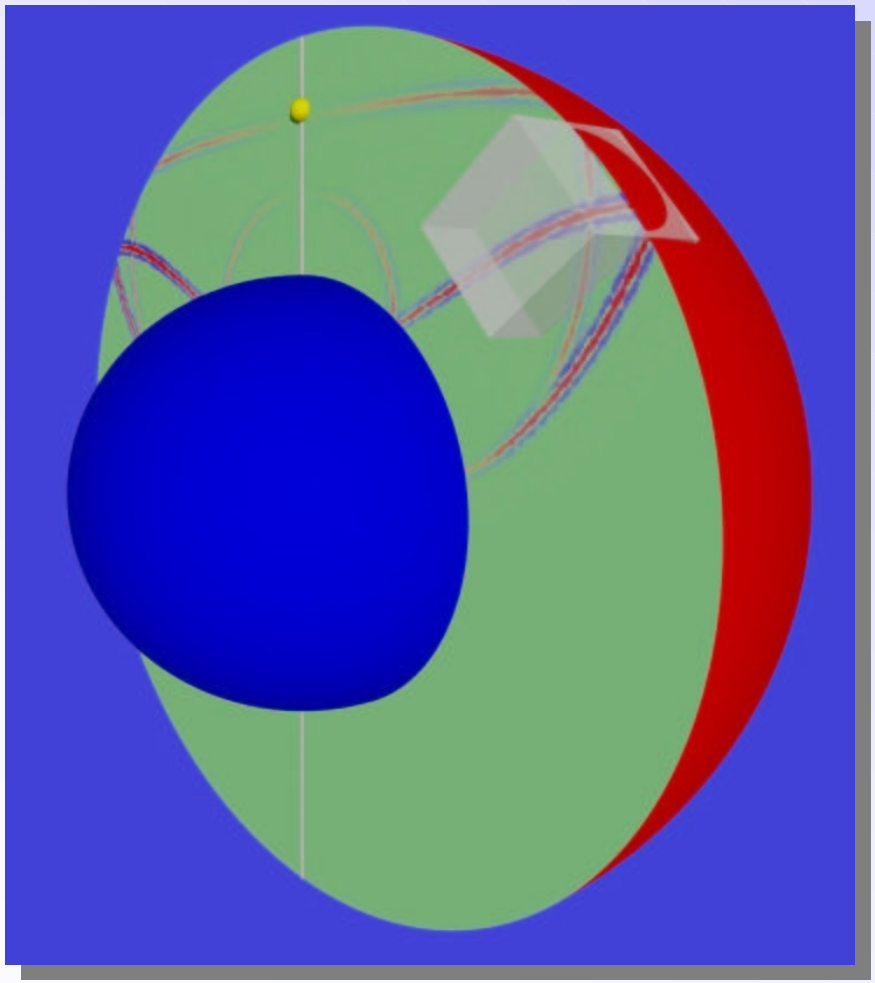
- 3D wave effects of structures like plumes, subduction zones, D"
- High resolution imaging of global earth structure (geodynamics)





Global seismology

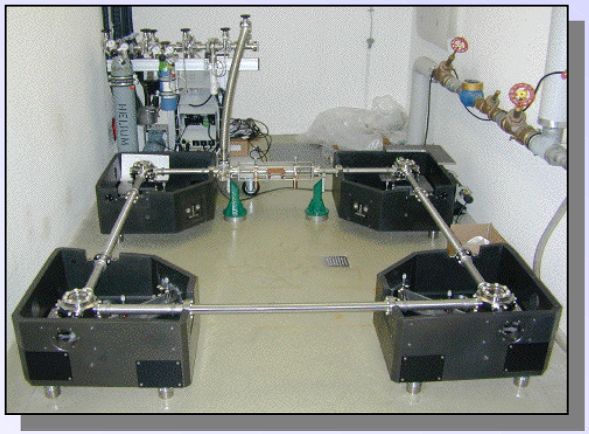
hybrid approach

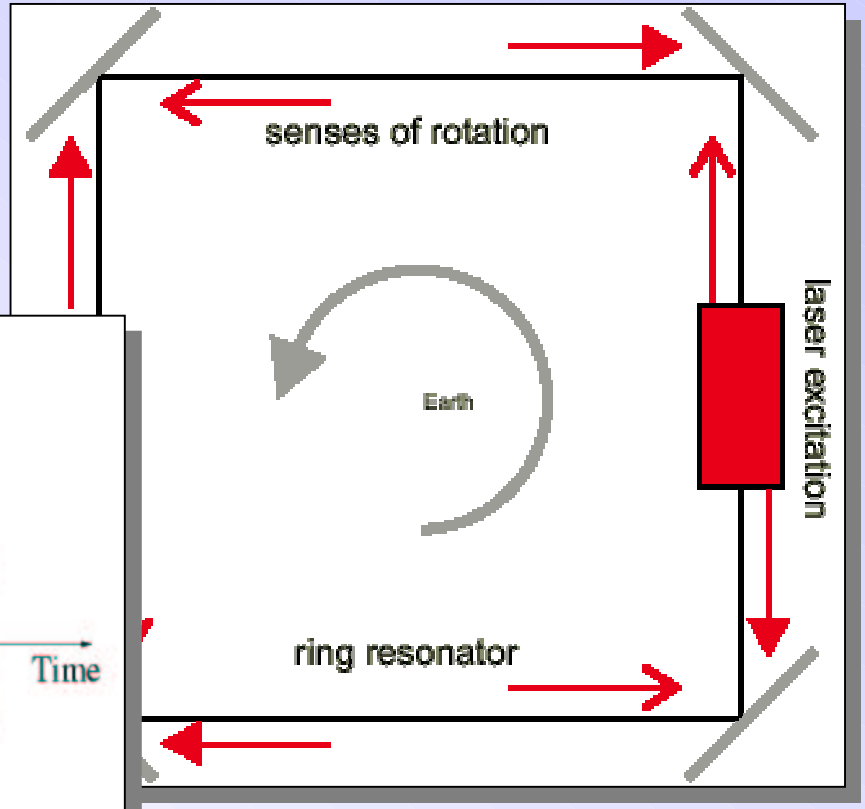


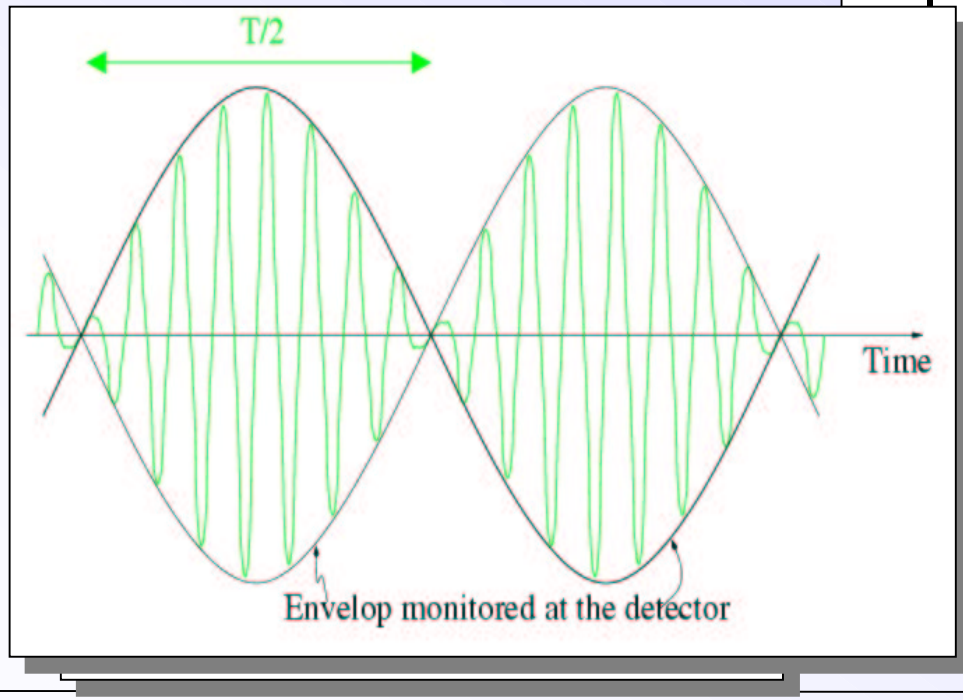
- Combining axisymmetric approach with 3D spherical section
- Allows modelling higher frequencies
- Localized 3D structure (e.g. plumes, subduction zones)
- Phenomenological studies

How can we observe rotations?

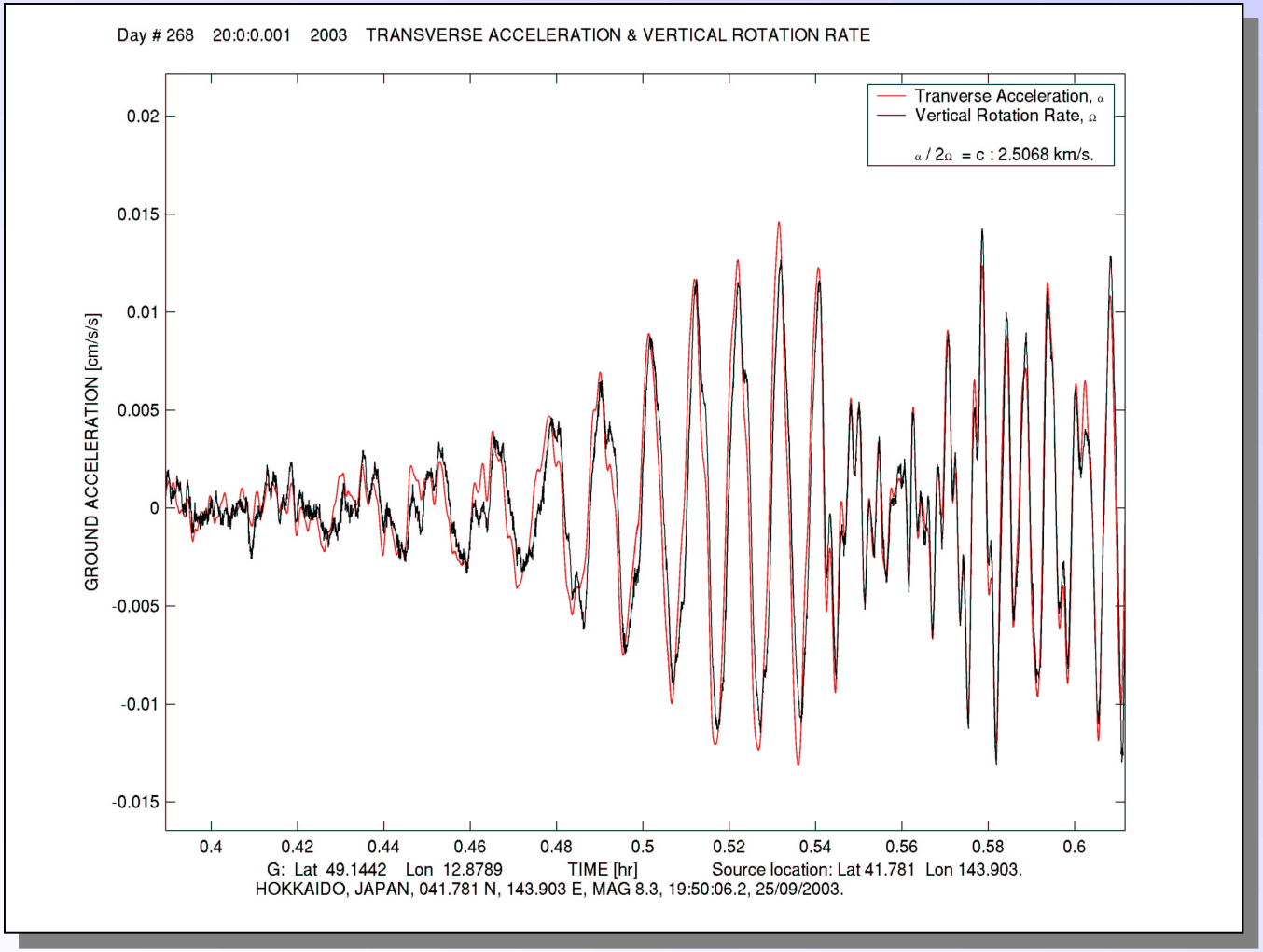
-> ring laser



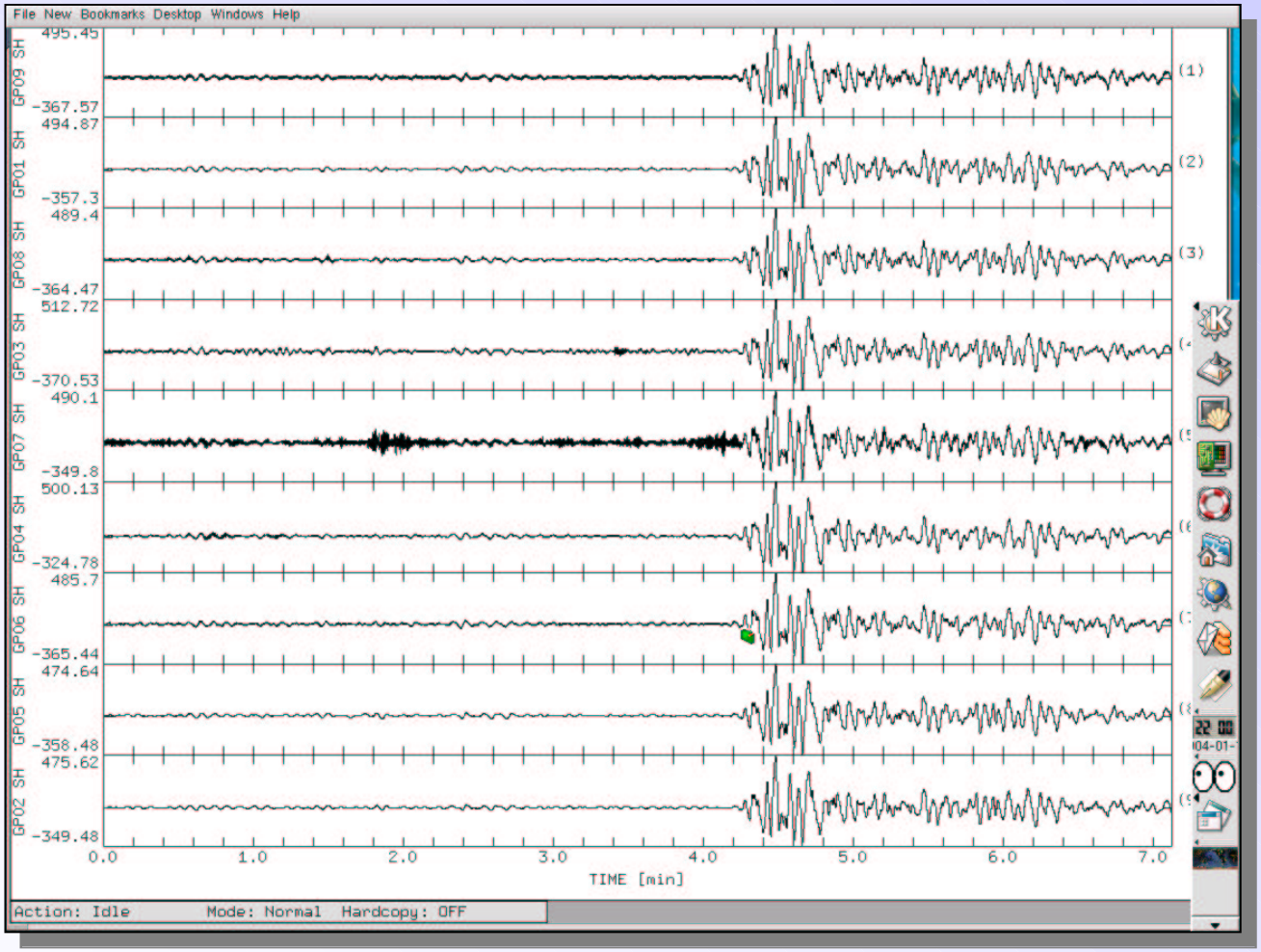


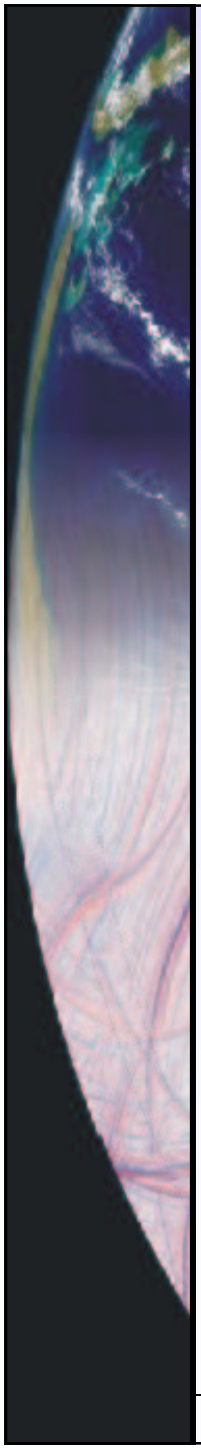


Rotational Motions



Rotational Motions



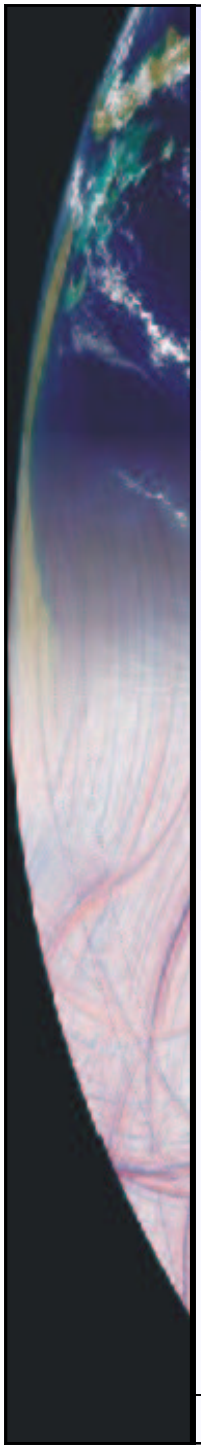


Methods

- Finite differences (high-order, optimal operators)
- Pseudospectral methods (Chebyshev)
- Unstructured grid methods (finite volumes, natural neighbours)
- Spectral elements
- Parallelization using MPI (message passing interface)

Related projects

- International Quality Network: Georisk (until end 2004) seismology and volcanology
- Rotational motions in seismology (instruments, observation and modelling)
- Other projects on global wave propagation, high-performance computing, earthquake scenarios (German Research Foundation)
- SISMOVALP (alpine valley ground motion)
- Software engineering for SPICE (to be applied for)



Infrastructure

- National high-performance computing center (www.lrz.de) with 1.5TB RAM Hitachi (to be replaced 2005)
- Software support through seminars (MPI, Programming)
- Approx. 1 Million Euro for Linux Cluster in Geophysics to be built in the near future (startup Bunge)
- Database hardware through SPICE grant