Northeim Nov. 2005

DWG8 Planetary Interior and Composition

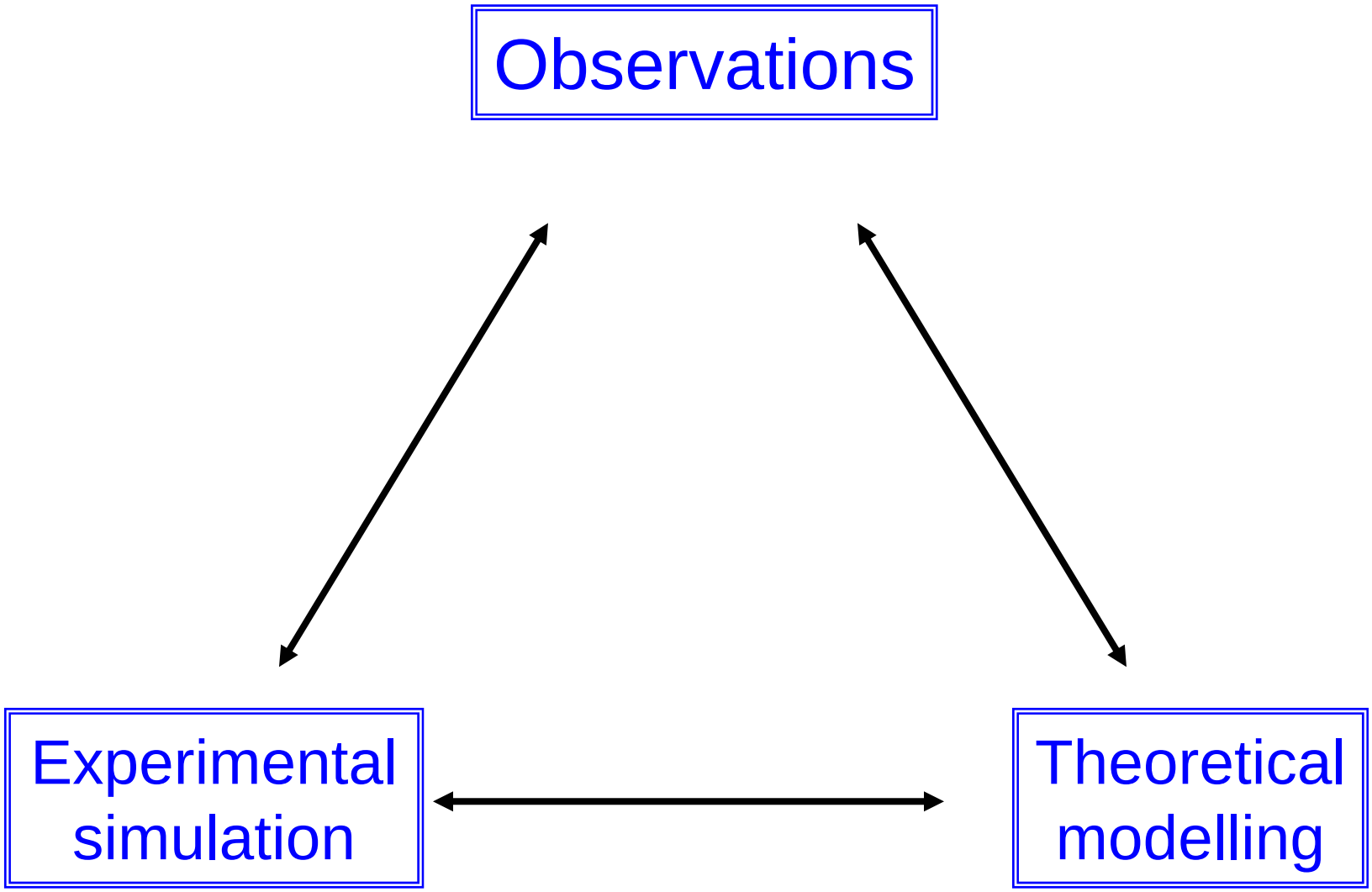
M. Toplis; O. Grasset; U. Christensen

DWG8 Planetary Interior and Composition

Science cases

- Large scale compositional gradients
- Planetary volcanism and tectonics
- Internally produced magnetism

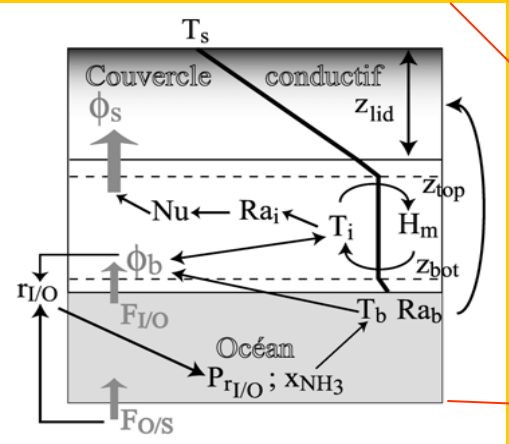
General approach



Understanding the deep interior of planets requires a complementary approach

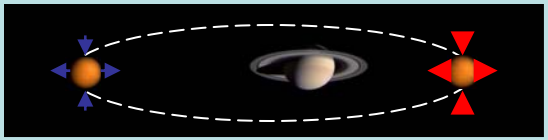
Numerical modelling

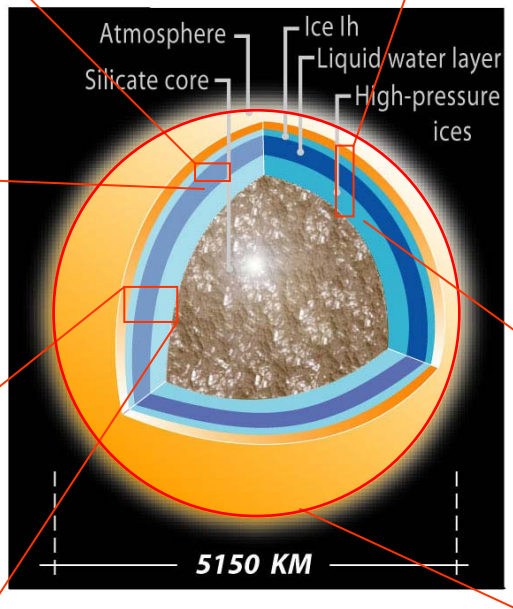
(heat transfer, volcanism/tectonic, chemical exchanges)



In-situ measurements

-Magnetic fields (DWG 2)
-Orbital constraints
- Sample return (DWG 3,4,6,7,8)
-DIRECT measurements (radar for icy bodies, Surface heat flux, seismometers, …)

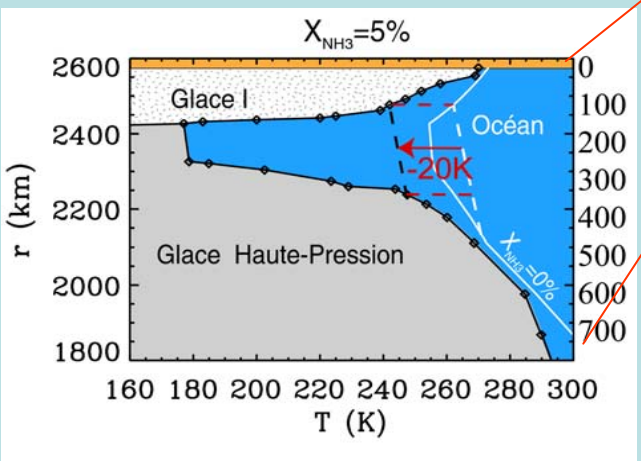




The example of Titan

Experiments

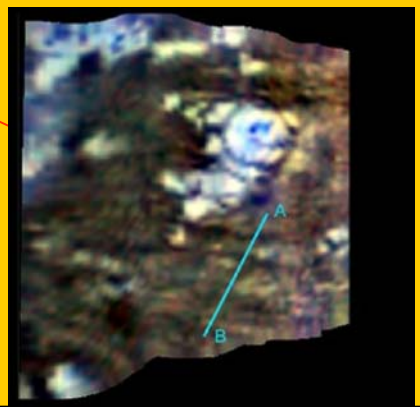
(phase diagrams, geochemistry, rheology, …)



Surface studies

(DWG3+5 – N3)

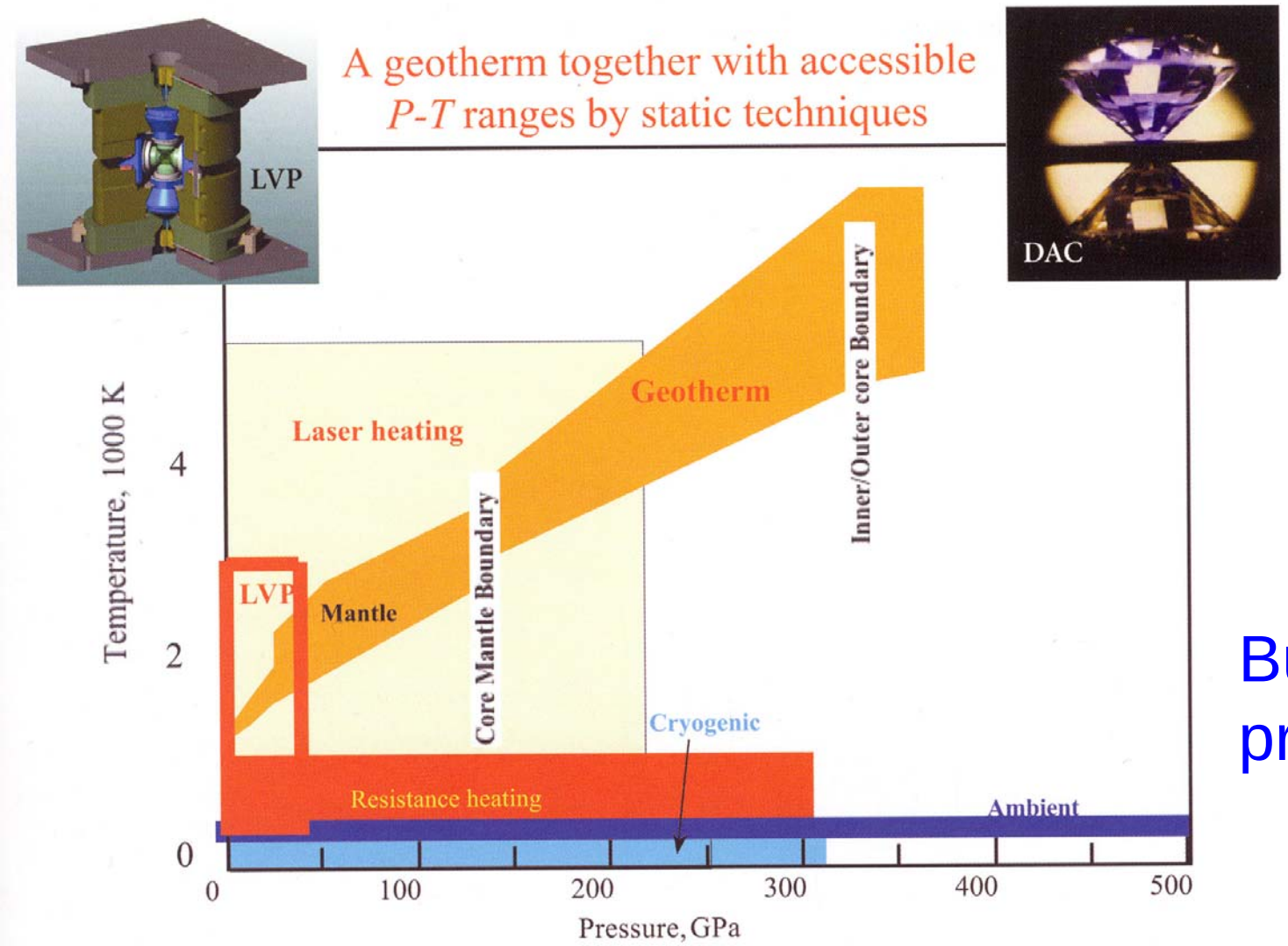
(mineralogy, tectonics, volcanism, …)



Limitations

Experimental simulation: Technological limits

(attain and maintain experimental conditions)



But regular progress…

Limitations

Relevance of numerical models limited by experimental data on appropriate materials
(have to identify the priorities)

More serious problem is lack of direct characterisation of the internal structure…

Progress will only come from efficient interaction of experiment/simulation/observation
AND direct knowledge of the deep interior
(as is the case for understanding how the Earth works)

Science case 1) Compositional gradients in the solar syster

Questions	Requirements and suggestions	Target	Interactions
Are there systematic gradients of Fe/Si; volatile/refractory; (ice)/silicate/metal; oxidation states: at the scale of the solar system ? at the scale of Jovian moons ?	•Sample return •Internal structure: crust(icy or silicate)/mantle (solid or liquid) / core: seismology; radar; geodesy •Comparison with meteorites •Process of core formation	Mercury Mars Asteroids Europa	•DWG3+5 •DWG4+9
•If there are large scale compositional gradients, what does that tell us about formation mechanisms?	•Models of solar system formation		
•How do surface rocks compare in composition to the (deep) interior? (Vertical compositional gradients)	•Surface mineralogy and composition •Models of differentiation and large scale movement.	Mars Moon Titan	•DWG3+5 •DWG4+9
•What is the role of surface alteration? (composition of the atmosphere, volatiles etc...)	•Surface mineralogy and composition (Remote sensing and in-situ measurements) •Effect of atmosphere on signal and mechanisms	Mars Moon Titan	•DWG3+5 •DWG4+9
•Role of distribution of dust through global "weather systems".	•Circulation models and observations	Mars	•DWG1 •DWG3+5
•Giant planets - Is there a silicate (rocky) core? If so, how big?	•Equations of state at very high pressure (ab-initio calculations and shock experiments) •Seismology	Jupiter Exoplanets	•DWG6+7 •DWG2

Science case 2) Planetary volcanism and tectonics

Questions	Requirements and suggestions	Target	Interactions
•Why is there plate tectonics on Earth, but not other planets?	•Phase relations and partial melting reactions (P, T, composition) with particular accent on cryovolcanism •Determine nature of heat sources (internal radioactive decay/tidal) and quantify rate of heat loss. •Quantify role and dynamics of solid (and maybe liquid) state convection.	Venus Mars	
•How can we explain the spatial and temporal evolution of volcanism?		Io Mars Moon Titan	
•What are the implications for the chemical differentiation of the planetary system (mantle - crust -atmosphere)?	•Geochemical constraints (including meteorite collections) •Numerical modelling	Mars Moon Titan	•DWG3+5 •DWG4+9
•Resurfacing of planetary surfaces through volcanism	•Surface mineralogy, composition, craters, …. •Internal structure (seismometers…) •Direct evidence for deep liquid layers on icy planets	Europa Io Venus	•DWG3+5
•Link to tectonic features observed at the surface	•Morphology of surface volcanoes •Experimental constraints on rheological properties	Mars Titan Venus	•DWG3+5 •DWG6+7

Science case 3) Planetary magnetism

Questions	Requirements and suggestions	Target	Interactions
• Why do some planets have an external magnetic field and others not?	•Composition of the bulk core (if incongruent crystallisation is important) •Seismic data, Geodectic data (such as tidal forcing,) •Better characterisation of magnetic fields, distinguishing from internal from external sources of magnetic field). •Experimental constraints on dynamo •Numerical simulations	Mars Moon Titan	•DWG2
•Why are there differences in the properties of the magnetic field? (Mercury only weak; Saturn axi-symmetric; Mars ancient then none....)		Mercury Saturn Mars Ganymede	•DWG2
•Is it an essential condition to have a solid inner core? (driving compositional convection, rather than thermal convection		Solar system planets Exoplanets	•DWG2 •DWG6+7