EARTH ROTATION AND GLOBAL DYNAMIC PROCESSES - JOINT RESEARCH ACTIVITIES IN GERMANY

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ABSTRACT. An extended project has been defined and proposed to the German Research Foundation (DFG), in order to organize joint research in "Earth rotation and global dynamic processes" in Germany. Funding for about 10 related sub-projects (with 12 co-workers) is envisaged. The main objective of this coordinated project is to describe and explain the physical phenomena which contribute to the variations of Earth rotation. Interactions and couplings of the various sub-systems shall be taken into account to a much higher extent than in previous studies. The contributions of various groups and scientific disciplines enable a comprehensive and integral treatment of Earth rotation as well as a dedicated study and analysis of the dynamic processes involved. This paper gives an overview about the planned research activities and the actual status of the project.

1. INTRODUCTION

For Earth rotation research, the Earth is considered as a complex system of interacting dynamic components. The variations of Earth rotation are global and integral indicators of ongoing changes in the dynamics of the Earth, both for the redistribution of masses inside and outside the Earth and for mass motions like wind and ocean currents. The most important interactions and interrelations are shown in Figure 1. A variety of relevant dynamic processes has direct or indirect effects. The interactions between the individual processes are highly complex. As the research area is rather wide, relevant scientific improvements can only be expected by the collaboration of different scientific fields such as geodesy, geophysics, meteorology and oceanography, and through close clustering of modelling, observation and data processing techniques. For this reason the existing competences in Germany are brought together. They are coordinated with further national and international research activities in neighbouring fields in an optimal way.

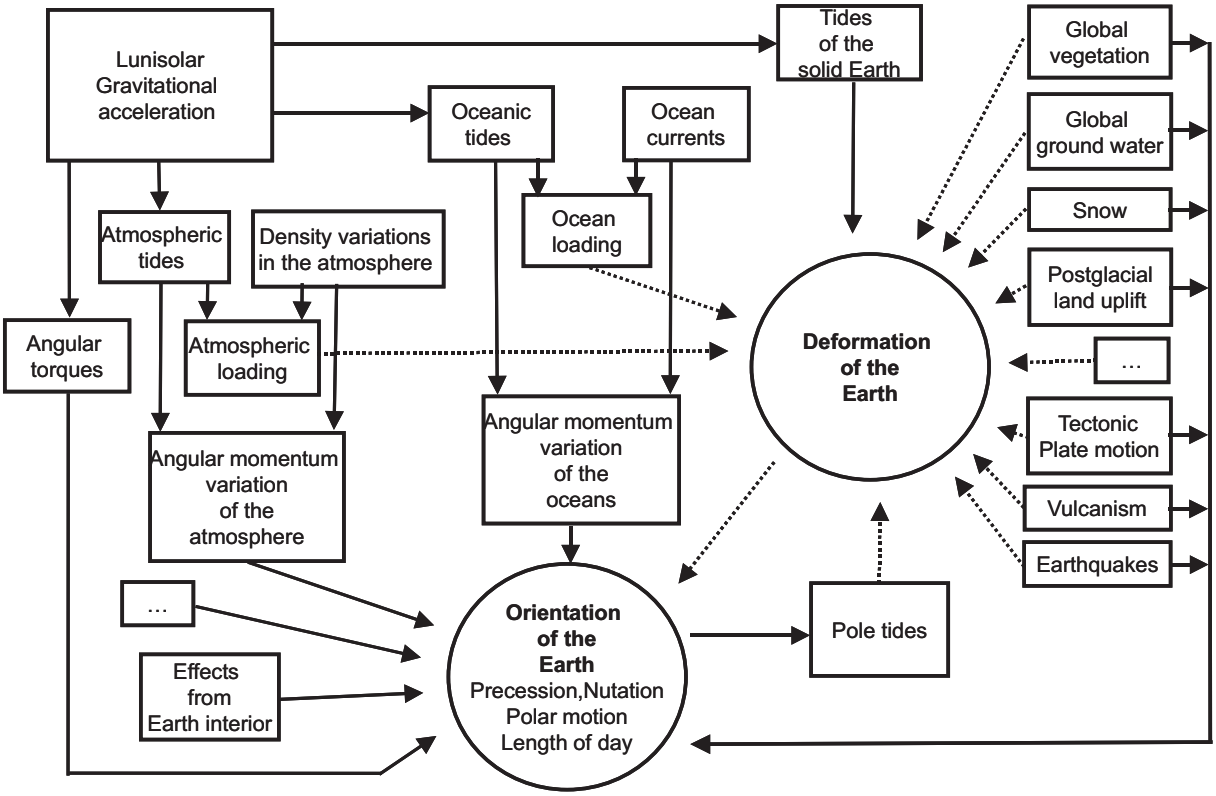

Figure 1: Components und influences in the Earth system with relevance to Earth rotation (Source: Schuh et al., 2003). Direct influences of dynamic processes on the Earth rotation are indicated by solid lines, indirect influences which are affected by the deformation of the Earth by dashed lines.

2. OBJECTIVES AND SPECIAL INTERESTS OF THE RESEARCH PROJECT

The particular importance of this research project is the integral treatment of Earth rotation based on existing or new observation data. Herein the interaction of modelling and data processing plays an important role. This integral treatment is only possible within the envisaged research unit using the demonstrated spectrum of competences. Comprehensive consistency is the key issue. The components of the Earth system which are relevant for Earth rotation as well as their coupling and interaction will be modelled consistently, covering time scales of some hours up to decades and longer. Furthermore, a new net-based information and communication system (ERIS) will be established which shall be used as a research tool. Standards and interfaces required for the research work will also be defined here.

The scheduled projects will provide significant contributions to outstanding international activities such as the project GGOS (Global Geodetic Observing System) which has been established and coordinated by the International Association of Geodesy (IAG). GGOS will support the analysis and interpretation of all geodetic methods for observing the Earth system. The consistent modelling as well as the combination and integration of the various observation methods therefore present important efforts to global geodesy.

3. THE RESEARCH UNIT

The research unit consists of highly competent scientists and institutions from geodesy, geophysics, meteorology and oceanography. The group comprises experts of observation techniques, data processing/analysis and in particular modelling, the central aspect of the scheduled project. Some of them have already contributed to bundle projects in the field of Earth rotation. On the side of the observation techniques, the modelling of those methods has to be improved which have not reached the required sub-cm level of accuracy (mostly LLR). In modelling it is important to cover all components which are relevant for the description of the Earth system with respect to Earth rotation and for a better understanding of global dynamic processes. Considering the German research institutions, a number of university groups and several non-university institutions have to work together in order to achieve the aspired objectives (see Table 1). Furthermore, there exist cooperations with external partners as well as personal and institutional engagements in national and international scientific projects, programs and services like, e.g., the IERS, IGS, IVS, ILRS and others.

Institutions	**Contributing Scientists**
Geodesy	
Bundesamt für Kartographie und Geodäsie BKG Frankfurt	B. Richter, T. Klügel
Deutsches Geodätisches Forschungsinstitut DGFI, München	H. Drewes, D. Angermann
Forschungseinrichtung Satellitengeodäsie FESG, TU München	M. Rothacher, U. Schreiber
Geodätisches Institut GIUB, Universität Bonn	A. Nothnagel
Geodätisches Institut GIH, Universität Hannover	H. Kutterer
Institut für Erdmessung IfE, Universität Hannover	J. Müller
Institut für Geodäsie und Geophysik IGG, TU Wien	H. Schuh, R. Weber
Institut für Planetare Geodäsie IPG, TU Dresden	M. Soffel, S. Klioner
Meteorology	
Institut für Meteorologie IfM, Freie Universität Berlin	U. Ulbrich, P. Nevir, G. Leckebusch
Oceanography	
Alfred-Wegener-Institut für Polar- und Meeresforschung AWI, Bremerhaven	J. Schröter
Institut für Planetare Geodäsie IPG, TU Dresden	M. Thomas
Geophysics	
GeoForschungsZentrum GFZ, Potsdam	H. Greiner-Mai

Table 1: Participating scientists and institutions, divided into the respective disciplines

The expected benefit of the research unit is manifold. The individual sub-groups contribute with their corresponding competences. The cooperation within the envisaged research unit furthermore enables numerous synergetic effects through exchange of results and products as well as their mutual check through analyses and validations, respectively. The individual projects cover the following topics:

1. Earth Rotation Information System: Development of a virtual Earth rotation system for geodetic and geoscience applications (ERIS) (BKG, IPG);
2. Earth rotation and the ocean's circulation (AWI, IPG);
3. Consistent post-Newtonian nutation series of a "rigid" Earth model (IPG);
4. Mass motions in the Earth's core and mantle and their influence on polar motion and the gravity field (GFZ);

5. Lunar Laser Ranging: Consistent modelling for geodetic and scientific applications (IfE, FESG);
6. Integration of Earth rotation, gravity field and geometry using space geodetic observations (DGFI, FESG);
7. Modelling of episodic-transient signals in measurements of large ring lasers (FESG, BKG);
8. Investigation of sub-daily and episodic variations of Earth rotation (IGG, FESG, GIUB);
9. Usability of time-variable Earth orientation parameters and gravity field coefficients from satellite missions for mutual validation and combined analysis (GIH, IfE);
10. Long-term ERP time series as indicator for global climate variability and climate change (IfM, IPG).

The network of the individual projects is shown in Figure 2. There exists a close relationship and interaction between almost all projects, where ERIS serves as structural and scientific interface. Further details about the individual projects or the whole research unit can be obtained from the authors.

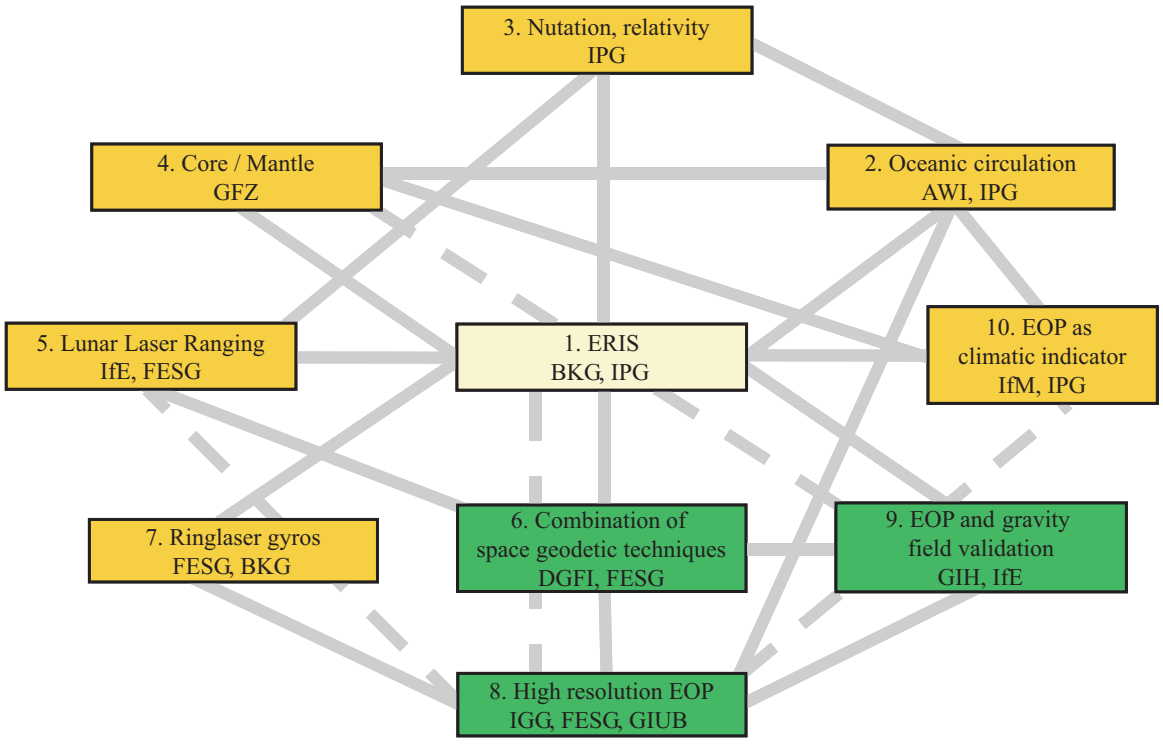

Figure 2: Network of individual sub-projects. The colours indicate the contributions of the projects to the fields of modelling (brown) and data processing/analysis (green). The information and communication system ERIS serves as a structured interface for all sub-projects.

4. EXPECTED RESULTS

The results can widely be discussed and analysed by means of comprehensive scientific exchange through several communication channels. Thus, a management system of high quality can be set up and consequently be realized.

In the same way as the overall goals (section 2), the expected results contribute to modelling as well as data processing and analysis. The main scientific results, which are expected within a medium time interval and which will be of high international interest, will briefly be outlined. It is expected to achieve improvements in modelling, both for the individual sub-systems of the Earth system (hydrosphere, atmosphere, ...) and for the description of the interaction between them. Thereby the interpretation of EOP data becomes more transparent, e.g. of the sub-daily, but also of the long-term parts of the signals. Modelling will be extended, e.g. with respect to the anthropogenic induced climate variations or climate prognoses. Especially in these fields, a lot of scientific results can be transferred to the service sector and support the monitoring systems of global Earth observation programs like GMES (Global Monitoring for Environment and Security). Furthermore, the Earth rotation models will be embedded in a more consistent manner into Einstein's theory of gravity.

5. STATUS AND OUTLOOK

A joint research activity covering "Earth rotation and global dynamic processes" has been set up. The overall goal of this research project is the integral and inter-disciplinary treatment of Earth rotation, where the interaction of modelling and data processing, based on existing or new observation data, plays an important role. All dynamic processes affecting Earth rotation, including their interactions, shall be considered. Time scales of some hours up to decades and longer will be covered.

The project has been proposed as a so-called 'research unit' to the German Research Foundation (DFG) for funding. The pre-evaluation in 2004 was positive, so that full proposals were prepared and submitted to the DFG at the end of 2004. If the research unit will now be evaluated sucessfully, the start of the work in the projects is planned for the mid of 2005.

6. REFERENCES

Schuh, H., R. Dill, H. Greiner-Mai, H. Kutterer, J. Müller, A. Nothnagel, B. Richter, M. Rothacher, U. Schreiber und M. Soffel (2003): Erdrotation und globale dynamische Prozesse. Stand und Ziele der Modellbildung, der Mess- und der Auswerteverfahren. Mitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 32, Frankfurt/Main.