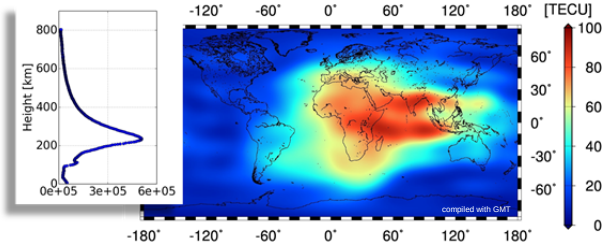
## Cross-Cutting Research Topics

The overarching topics Atmosphere and Regional Gravity Field are cross-related to the research areas Reference Systems and Satellite Altimetry.

All space-geodetic observing systems are strongly influenced by the state and dynamics of the Atmosphere including ionosphere and thermosphere. Combining various space-geodetic techniques, DGFI-TUM generates

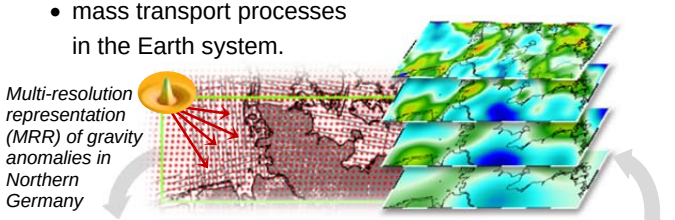
- high-resolution multi-scale ionosphere products in (near) real time using Kalman filtering
- forecast models regarding the effects of space weather
- thermosphere models considering thermosphere-ionosphere coupling and data assimilation for precise positioning and orbit determination.




*Left: Electron density [el/m$^3$] profile derived from COSMIC occultation measurements; right: Vertical total electron content map at St. Patrick's Storm Day, March 17, 2015, 1:00 pm, caused by coronal mass ejection.*

DGFI-TUM derives high resolution static and time-variable Regional Gravity Fields by multi-level combination of observations from different sources in order to investigate

- the realization of a unified height system
- the spatio-temporal relationship between geoid and sea surface (dynamic ocean topography)
- mass transport processes in the Earth system.



*Multi-resolution representation (MRR) of gravity anomalies in Northern Germany*

| Input | air-/shipborne, terrestrial gravimetry | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | altimetry | | | | | | | | | | | | |
| | satellite gravimetry | | | | | | | | | | | | |
| resolution [km] / SH degree | 20000 1 | 6700 3 | 2900 7 | 1300 15 | 650 31 | 320 63 | 160 127 | 80 255 | 40 511 | 20 1023 | 10 2047 | 5 4095 | ... |
| MRR level | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | ... |

## Collaboration in International Scientific Organizations

DGFI-TUM has continuously been involved in internationally coordinated research activities and collaborates intensively in the frame of international scientific organizations. In particular, the institute recognizes the outstanding role of IAG's Scientific Services that form the backbone of national and international spatial data infrastructure. In this context, DGFI-TUM operates data centers, analysis centers and research centers and has taken leading positions and supporting functions in IAG's Commissions, Projects, Working and Study Groups. In IAG's Global Geodetic Observing System (GGOS) that coordinates the generation of high-quality science data products under predefined standards and conventions, DGFI-TUM has a position of particular importance by chairing the GGOS Bureau of Products and Standards (http://ggos-bps.dgfi.tum.de).

## Further Information and Access to Data

DGFI-TUM distributes science data, derived products and results via its web site and dedicated data bases:

- Homepage of DGFI-TUM with general information about our activities, interational engagement and publications as well as links to science data products: ***http://www.dgfi.tum.de***
- Open Altimeter Data Base (OpenADB): ***http://openADB.dgfi.tum.de***
- Data Base for Hydrological Time Series of Inland Waters (DAHITI): ***http://dahiti.dgfi.tum.de/***

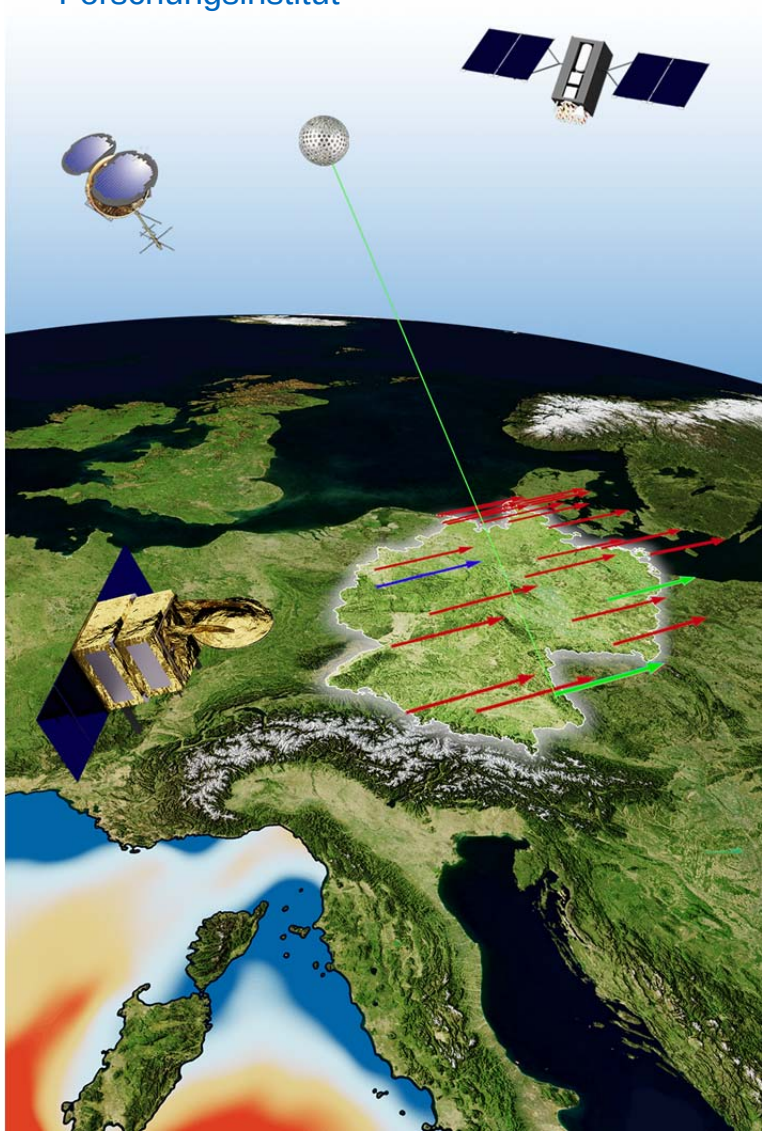
**Technische Universität München**
Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)

Arcisstraße 21
80333 Munich
Germany
**www.dgfi.tum.de**



# DGFI-TUM

## Deutsches Geodätisches Forschungsinstitut



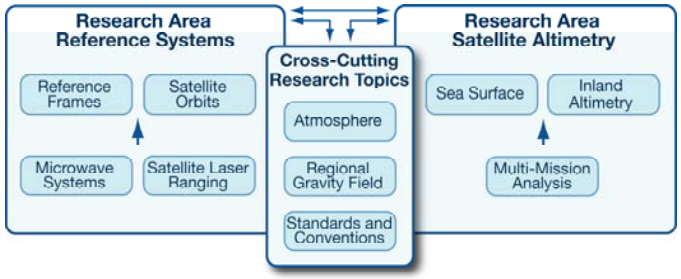
# DGFI-TUM

The Deutsches Geodätisches Forschungsinstitut is a research institute of the Technical University of Munich in the Faculty of Civil, Geo and Environmental Engineering.

Our scientific activities are oriented towards geodetic basic research with the ambition to provide a comprehensive and long-term valid metric of the Earth system for science and practice at highest precision and consistency.

## Research

Research at DGFI-TUM is structured into the two research areas *Reference Systems* and *Satellite Altimetry*, each subdivided into several research topics, and three cross-cutting research topics:




In strong international and interdisciplinary collaboration, DGFI-TUM processes, analyses and combines observations from all relevant space-geodetic observing systems and complementary data sources at the highest level of scientific knowledge. In particular, the institute possesses unique competence in determining the Earth's time-variable surface geometry (solid Earth and water surfaces), atmospheric disturbances and regional gravity fields. It contributes to the operation and scientific data processing of the Geodetic Observatory Wettzell (Germany) in the frame of the Research Group Satellite Geodesy (FGS) and operates several worldwide distributed GNSS stations. DGFI-TUM collaborates at key positions in international scientific organizations (in particular within the framework of IUGG, IAG and IAU), and thus contributes to shaping the future direction of international geodetic research.

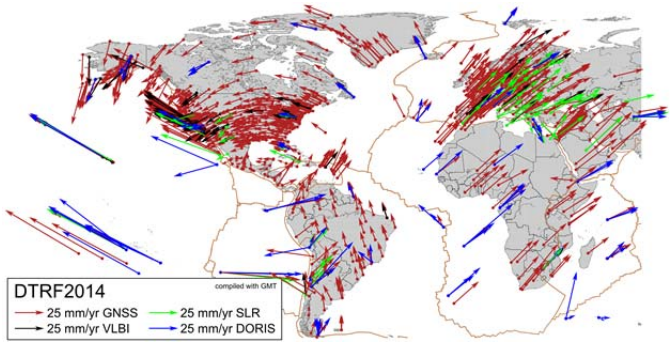
# Reference Systems

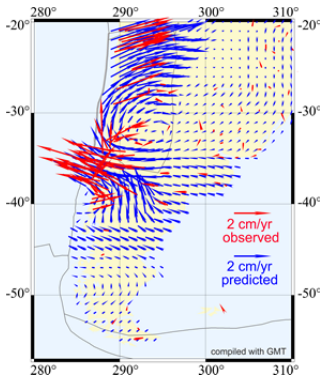
For many years, DGFI-TUM has been taking a leading position in the realization of global and regional horizontal and vertical terrestrial reference systems from a combined analysis of the geometrical space-geodetic observing systems VLBI, SLR, GNSS and DORIS.


Geodetic Observatory Wettzell

Research highlights:

- realization of the International Terrestrial Reference System (ITRS). Most recent solution: DTRF2014
- determination of regional reference frames and their kinematics (e.g. SIRGAS for Latin America)
- joint realization of the terrestrial and the celestial reference system and the Earth orientation parameters
- SLR multi-satellite orbit determination and integration of geometry, Earth rotation and gravity field.

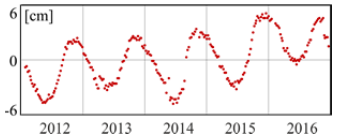



*Top: DTRF2014, positions and horizontal velocities of geodetic observing stations.*

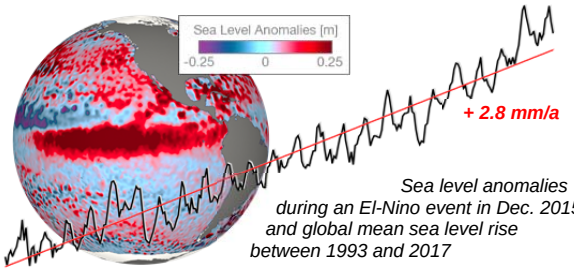
*Left: Surface deformation in the Andean zone inferred from GNSS data. The impact of the Maule earthquake (Mw 8.8) in 2010 is visible.*

*Below: Vertical motion of the GNSS station Manaus, Brazil. DGFI-TUM investigates an improved handling of such seasonal and non-linear station motions.*




# Satellite Altimetry

DGFI-TUM determines, monitors, and investigates the water level of the open ocean, in sea-ice regions, in coastal areas, and of inland water bodies. Research is based on our carefully harmonized and cross-calibrated multi-mission data set from the complete record of all radar and laser altimeter missions since 1992. The data and derived high-level products are provided in DGFI-TUM's Open Altimeter Data Base (OpenADB).




*Sea level anomalies during an El-Nino event in Dec. 2015 and global mean sea level rise between 1993 and 2017*

The target of our research is the determination of most accurate water levels using advanced analysis methods and improved orbit information in order to

- compute reliable sea level trends on global, regional and local scales including uncertainty information
- study the dynamic ocean topography and variations of ocean surface currents
- develop empirical ocean tide models
- assess and predict water resources in lakes, reservoirs, rivers and wetlands.

*Water level time series of the Danube River and two lakes near Munich from DGFI-TUM's data base for inland altimetry* DAHITI *(http://dahiti.dgfi.tum.de)*