Federal Agency for
Cartography and Geodesy




Geodetic Observatory Wettzell

of the Federal Agency for Cartography and Geodesy (BKG) and the Technical University of Munich (TUM)

bkg Bundesamt für Kartographie und Geodäsie

FESG Forschungseinrichtung Satellitengeodäsie der TU München

Tasks

Geodesists all over the world are keeping an eye on the shape and orientation of the Earth in space by measuring continental drift and Earth orientation parameters (EOPs). These measurements are performed using the following space geodetic techniques:

- Measurement of very long distances by radiointerferometry (VLBI)
- Measurement of distances to satellites using laser beams (SLR)
- Positioning with the help of satellite navigation system (GNSS)
- Measurement of distances to satellites using Doppler technique (DORIS)

At the Geodetic Observatory Wettzell in the Bavarian Forest, the Federal Agency for Cartography and Geodesy in cooperation with the Technical University of Munich has combined these measuring techniques at a single location. Thus, Wettzell takes on the role of a fundamental station, that allows to compare and combine the results from the various techniques.

Linking this information allows to realize global reference frames providing the basis for numerous tasks in the field of earth sciences (e.g. continental drift, variations of the sea level), in spaceflight, but also in everyday life (e.g. surveying, navigation).

Geodetic Observatory (Bavarian Forest)

Together with the observatories AGGO (Argentine-German Geodetic Observatory) in Argentina and O'Higgins in Antarctica, in which the BKG is also involved, Wettzell contributes considerably to the realization and maintenance of global reference frames within an international network. This includes a reference system rotating with the Earth for determining positions on the Earth's surface (ITRF - International Terrestrial Reference Frame) and a space-fixed reference system not rotating with the Earth for determining positions in space (ICRF - International Celestial Reference Frame). Both systems are connected by the rotation of the Earth, that is described by Earth orientation parameters (EOPs). Considering the ongoing mass redistribution inside the Earth (e.g. due to changes in the atmosphere and ocean), there is an effect on the speed of Earth's rotation. Therefore, the EOPs must be observed continuously.

In addition to the geodetic space techniques, measuring systems provide additional data, that are necessary for aquisition, evaluation and interpretation of the measuring results. These include

- a time and frequency system, consisting of several atomic clocks contributing to the generation of the universal time scale UTC,
- a superconducting gravimeter for recording gravity changes,
- a hydrological monitoring network for recording underground mass variations,
- sensors for monitoring atmospheric parameters and
- seismometers for registration of earthquakes.

These tasks can only be solved by a close international cooperation. The services of the International Association of Geodesy (IAG) coordinate the observations, the data flow and the analyses and provide the results on the Internet.

Radio Interferometry

The technique of VLBI (Very Long Baseline Interferometry) allows to measure distances between radiotelescopes distributed worldwide with about one centimeter accuracy. For this purpose, signals from radio sources in the universe are recorded and the small differences in arrival time resulting from the positions of the telescopes are evaluated. Beside the station coordinates and their variations, all important Earth orientation parameters which include the coordinates of the rotation axis of the Earth and the Earth‘s rotational speed are obtained.

The 20-meter radio telescope operated since 1983 was designed for the special requirements of geodesy and participated up to now in the most geodetic observations worldwide.

Since 2012, the two Twin radio telescopes are in operation additionally. Because of their smaller size of 13.2 meter, they reach slew speeds of up to twelve degrees per second allowing the realization of new measuring programmes with more observations. One of the Twin telescopes is equipped with a special broad-band receiving system to increase the accuracy of measurement.

20-meter radio telescope

13-meter Twin radio telescope

Laser Ranging

The technique of satellite laser ranging (SLR) is based on the measurement of the travel time of short laser pulses. These are reflected by retroreflectors mounted on satellites. Besides a precise determination of the satellite orbits, this technique allows the determination of the coordinates of the observing stations as well as the center of mass and the gravity field of the Earth.

WLRS, 75-centimeter telescope

SOS-W, 50-centimeter telescope

The Wettzell Laser Ranging System (WLRS) is in operation since 1990. With its 75 centimeter diameter transmitting and receiving tele-scope it is also able to measure distances to reflectors on the Moon. The run-time measurement with a precision of a few pico-seconds (one picosecond = one trillionth of a second) allows ran-ging accuracies of one to two centimeters.

The new Satellite Observing System Wettzell (SOS-W) is espe-cially designed for tracking fast moving low Earth orbit satellites. The system is in operational service since 2015 and reaches e.g. for the satellite LAGEOS (Laser Geodynamics Satellite) a measu-ring accuracy of less than one centimeter.

Satellite Navigation Systems

The term GNSS (Global Navigation Satellite Systems) comprises the satellite navigation systems

- GPS (USA)
- GLONASS (Russland)
- Galileo (Europa)
- Beidou/Compass (China)

In addition to several GNSS Permanent Stations, the Observatory Wettzell also operates a GNSS Operation Center. From here, about 24 permanently installed GNSS stations worldwide are controlled. Their data are retrieved, checked and provided on an hourly or daily basis.

These data contribute to the determination of station coordinates, orbit parameters of the GNSS satellites and Earth orientation parameters.

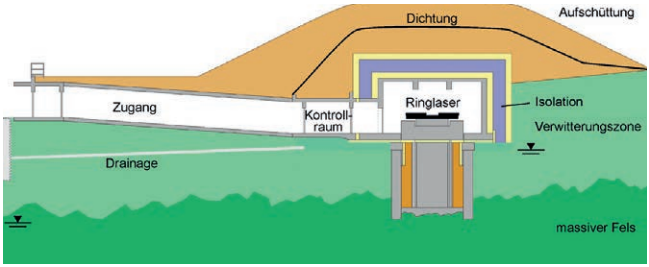
Measuring platform with GNSS antennas

The ring laser „G“

Beside the routine operation, new measurement methods are developed at the Observatory Wettzell. This includes a local rotation sensor, the ring laser „G“. This unique instrument records in particular the short-term variations of the Earth rotation. The measurements can reveal a change in the length-of-day by 0.1 milliseconds.

Ring laser „G“ in the underground lab

The ring laser „G“ has a size of 4 meters by 4 meters. In order to stabilize its operation conditions and to protect it against external environmental influences like variations in temperature, the ring laser is mounted in an underground lab at the premises of the observatory.



Underground lab for ring laser „G“

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