HYDRO INTERNATIONAL INTERVIEWS REINER RUMMEL

Pioneer for Space Geodesy

The field of geodesy is undergoing a revolutionary change. The developments of the last few decades have altered the views and work of professional surveyors, researchers and developers immensely, think of GPS, INSAR but also the Gravity and steady-state Ocean Circulation Explorer (GOCE) mission carried out by the European Space Agency. Co-initiator of this mission that measures the gravity field from space, Professor Reiner Rummel,

What is your biggest contribution to the science of geodesy?

That's difficult. I think my contribution to the Gravity and steady-state Ocean Circulation Explorer (GOCE) satellite mission would probably count as the biggest. I was one of the initiators of this project and I am still responsible for the level-2 processing of the data. The mission itself is a great success. But… if you would look into my heart it's probably the education of many young people over the years that I consider my greatest contribution. It gives me great pleasure seeing them successfully contributing to our field.

What is your strength in both your scientific work and your teaching?

If I have a strength, it would probably be the ability to translate sometimes rather complex issues into much simpler words. For teaching as well as for the work related to the GOCE satellite mission it is vital to be able to rephrase and simplify, because sometimes it's easy to drown in the complexity.

Can you explain in a few sentences what GOCE does and what it means?

GOCE measures the gravity field of the earth in the greatest possible detail. It is the first time we have done this from space using the principle of gradiometry and with the data collected a new geoid was derived and first unveiled in 2009. We are still in the process of improving this geoid by collecting additional data to make it more accurate.

What difficulties did you encounter?

To measure the gravity field from space – that is, from satellite altitude – you have to build in a few tricks, because gravity is strongly attenuated at satellite height. Gradiometry is used as the measurement principle to counteract this damping effect. This is therefore the first time that gradiometry is being used from space, which is not easy.

Can you already name an effect of the outcomes of GOCE on hydrography?

One of the projects we carry out for the European Space Agency is the unification of the height systems of many countries into a single system. The height systems in each country now refer to a benchmark or tide gauge, for instance, in the Netherlands it is the Amsterdam Ordnance Datum (NPA). This datum has been adopted by several other countries, but there were also countries setting their own standard. Usually 'mean sea level' at a tide gauge is adopted as height reference, but mean sea level varies from place to place. We can bring them into one system using GOCE. Large-scale leveling has become history thanks to GOCE. In Germany, for instance, first-order levelling has probably been carried out for the last time, and in the United States and Canada GOCE results are already used.

Were there any interesting findings in unifying these height systems?

Yes, we carried out an interesting exercise with colleagues from Liverpool to check the American height system in order to try and settle an interesting historical dispute between geodesists and oceanographers. When oceanographers calculate the slope of the sea level along the East coast the sea level bulges towards the equator, while geodetic levelling shows the opposite: an increase towards northern latitudes. We have now used the new data and the discrepancy has gone. Outcome: the geodesists were wrong, the oceanographers were right!

Are there other practical uses of GOCE outcomes?

Yes, you can now convert GPS height to physical height much more precisely than in the past. This will make life much easier in construction projects like building bridges between two countries separated by sea, etc. Especially in the lesser developed world, Africa or Southeast Asia, it could stimulate economies, while building in areas with many islands or areas where the height system was simply not accurate becomes much easier.

Can you share early conclusions from GOCE related to oceanography?

What I find sensational is that we are now able to compare the Pacific and the Atlantic Ocean easily. Another major leap, is research in the ocean circulation patterns of the Antarctic region, without the need for in-situ drifter or ship data, but based only on data collected by GOCE and satellite altimetry.
It makes it possible to study the circumpolar current in the Antarctic. Even more important is that we have created a standard, a baseline-measurement, on which we can base any changes in the future. It is just very important basic material.

Will GOCE eventually change our profession dramatically?

There is a revolution going on in the whole field. This revolution is not just related to gravity and thus to GOCE, but to GPS, INSAR and GRACE as well. We are talking about millimetre accuracy and we are now even able to see temporal changes. This is important, because for the first time geodesy is now able to contribute to issues such as climate change, to tectonic changes but also to changes due to planning. And for the first time in history sea level rise can now be divided into its contribution due to thermal expansion and that of melting water of the ice shields, for the first time we can quantify how much ice is melting in Greenland or Antarctica, and for the first time we can quantify changes in ground water on the continents. This is in itself really sensational!

How do you see the future of geodesy?

I see that we are penetrating many more fields that we did not touch before, like hydrology, oceanography and hydrography and geophysics, but also land management and disaster management. The key word for me is the Global Geodetic Observing System, previously extensively described in this magazine, but it is good to note again that one global reference system on a millimetre scale on an Earth that is wobbling and bobbling is a major accomplishment. We extensively pushed this idea because it is a precondition for further progress in geodesy. First of all, because this connects satellite and terrestrial work and secondly because it provides for a global system. Geodesists are coming out of their shells and showing the world their good work while almost by definition geodesists do their work in silence and modesty. In geodesy we have the tendency to say - this is no longer our field of experience so let hydrographers or oceanographers do the application based on our geodetic data; other fields are less hesitant to practice geodesy.

Is it expected to affect the work of an oceanographer?

GOCE stands for Gravity and steady-state Ocean Circulation Explorer. The main scientific application of the mission is oceanography. Without data having to be collected at sea we can now, for instance, measure the level of the Gulf stream and its deviation from the geoid. We derive ocean velocity from the mountains and valleys on the ocean measured by GOCE, so we can now measure transport of mass or heat which is extremely important for climate change.

Should oceanographers and geodesists look towards each other more?

Of course oceanography is a very difficult field, and joint scientific programmes and meetings are helping to exchange information for the good of terrestrial geodesy and oceanography. At TUM we work together with the National Oceanographic Center in Liverpool, UK and the Alfred Wegener Institute in Bremerhaven, Germany. It sometimes takes a while to find a common language, but eventually both sides benefit enormously. So I would definitely advise working together.

You are now partially retired, but still active. If you had 25 more years of research ahead of you, what would be your absolute priority in research and development?

It is difficult - at my age you start looking back rather than ahead. I had the privilege of working in this field in a particularly interesting time. Over the last 40 years, technology has advanced at an enormous pace. I predict that this growth could still go on for a few more decades. I expect height to be measured with clocks, I expect new types of gravimeters based on atomic interferometry, I expect time to play a very prominent role in the future of geodesy, I also expects clouds of small satellites to carry out measurements and I expect an explosion in the use of unmanned aerial vehicles. The link between terrestrial and airborne data and space data is of highest priority for the next decade. We can do so much from space now that we have an enormous problem in between. In my field of research we are lacking detail in spatial and temporal detail. I see a number of companies investing in airborne instrumentation products of a much better quality. It is with great pleasure that I see this happening and if I had time this would really be a field in which I would like to be active.