GGOS AND THE IMPORTANCE OF THE COMBINATION OF SPACE TECHNIQUES. H. Kutterer, Bundesamt für Kartographie und Geodäsie, Richard-Strauss-Allee 11, D-60598 Frankfurt am Main.

A deeper insight into the phenomena and processes within the Earth system such as plate tectonics or sea level rise is of outstanding interest and importance both for science and society. Geodesy as a discipline provides and develops observation techniques which allow on the one hand to derive a highly accurate global geodetic reference frame and on the other hand to determine parameters which describe relevant quantities of the Earth system. Today, the use of space-geodetic techniques is essential as they are the indispensable basis for geodesy to act globally.

Regarding (mainly) geometric quantities there are four well-established space-geodetic techniques: satellite laser ranging (SLR), very long baseline interferometry (VLBI), global navigation satellite systems (GNSS), and doppler orbitography and radio positioning integrated by satellite (DORIS). In terms of physical quantities of the Earth system, gravity field missions such as CHAMP, GRACE and GOCE led to significant improvements. Further satellite missions provide valuable information about the geometric surface of the Earth – on land and on sea.

It is well known that depending on the individually underlying physical principles each technique has its own sensitivity or even uniqueness – together with characteristic weaknesses – in determining the respective parameters. Hence, the combination of the different space-geodetic techniques is the key to high quality contributions of geodesy to Earth system research. This is due to the fact that the strengths of the different techniques are capable to compensate respective weaknesses of other techniques. This holds both for the parameters of a global geodetic reference frame as well as for the parameters referring to physical processes such as water vapor content.

Whereas the geometric techniqes are combined on a routine basis today, the combination of geometric and physical techniques has not yet been established operationally. However, SLR as a traditionally geometric technique provides access also to low-order gravity field coefficients and thus serves as an important link between geometry and gravity.

It should be noted that the combination of space-geodetic techniqes has various aspects. From a mathematical point of view either identical or mutually transformable parameters are requested in the observation equations of the different techniques. From an observational point of view care has to be taken that times and places have to referenced mutually: observation schedules have to synchronized and local ties have to be provided either on Earth between terrestrial instrumentation or on the satellites.

From a standardizational point of view unique constants, background models, etc. have to be agreed on, provided comprehensively as additional information in the metadata, and used accordingly in the processing. And from an organizational point of view dedicated structures, workflows and ressources have to be available. In total, this requires a solid theoretical framework, a sustainably maintained and operated infrastructure and an efficient organization.

The characteristics mentioned above summarize the fundamental idea, possible realization and foreseeable benefits of the GGOS – the Global Geodetic Observing System of the International Association of Geodesy (IAG). It has been described in detail in [1]. Since 2014 a revised strategic plan is available for the GGOS which addresses for strategic focus areas: (1) geodetic information and expertise, (2) global geodetic infrastructure, (3) services, standards and support, and (4) communication, education and outreach. A joint effort of all IAG components is needed to further develop and promote the GGOS.

In the presentation the main ideas, the various perspectives, the present state and the next steps of GGOS are illustrated. In particular, the actual importance of a comprehensive and thorough integration of space-geodetic techniques is motivated and discussed.

[1] Plag H.P. and Pearlman M. (2009): *Global Geodetic Observing System: Meeting the Requirements of a Global Society on a Changing Planet in 2020*. Springer.