*Dr. Urs Wegmüller*
*☎ +41-31-951 70 05*

# Gamma Remote Sensing AG
# ANNUAL REPORT 2018

## RESEARCH AND DEVELOPMENT

**ESA - Snowlab (2016 – 2019)**

In 2018 the SNOWSCAT X- to Ku-band scatterometer was operated for snow measurements at the "Davos-Laret Remote Sensing Field Laboratory", Switzerland. The objective is to resolve layer structures in the snow pack. Again, Snowscat was also operated in a tomographic mode. In winter 2018/19 the measurements will be continued, most likely with the 1-40 GHz Wide-band Scatterometer WBScat, in combination with the L- and X-band radiometers ELBARA and MORA operated by WSL-Birmensdorf.

**ESA - CCI – Glaciers 2 (2014-2018)**

The main objectives of the Glaciers-CCI Project 2 (coordinated by University of Zürich, Switzerland) in the frame of the Climate Change Initiative (CCI) are to provide EO based services for glacier monitoring, as developed and demonstrated under the DUE GlobGlacier Project and CCI Glacier. GAMMA's responsibilities are in the glacier flow monitoring and in the service and system engineering.

**ESA - CCI – Biomass (2018-2021)**

The main objectives of the CCI Biomass Project (coordinated by Aberystwyth University, UK) in the frame of the Climate Change Initiative (CCI) are to provide EO based services for forest biomass monitoring, as developed and demonstrated under the DUE GlobBiomass Project. GAMMA has the technical lead, with responsibilities in the algorithm development, system implementation and the generation of the global biomass products.

**ESA - CCI – Permafrost (2018-2021)**

The main objectives of the CCI Permafrost Project (coordinated by GAMMA, with T. Strozzi acting as project manager, and B.GEOS, with A. Bartsch acting as science leader) is to deliver a permafrost related climate data record which complies with the requirements of the climate user community. The work builds upon elements developed and demonstrated under the ESA DUE GlobPermafrost project. GAMMA's responsibilities are in the coordination of the work, mountain permafrost thematic products, overall system design engineering and the production of subsidence maps on Arctic permafrost sites.

**ESA - CCI – Snow (2018-2021)**

The main objectives of the CCI Snow Project (coordinated by ENVEO, Austria) in the frame of the Climate Change Initiative (CCI) is to provide based on EO data essential climate variables for snow. GAMMA's responsibilities are in the system design engineering.

**ESA Snow Concepts Study - Scientific Evaluation of Mission (2016 – 2018)**

In this study under the lead of FMI, GAMMA is involved in the development of concepts to monitor snow mass and other cryopspheric parameters.

**ESA - Dragon 4 Cooperation Programme (2016-2019)**

The Dragon Programme focuses on exploitation of ESA, Chinese, and third party mission EO data for geo-science and applications development in land, ocean and atmospheric applications in 50 joint Sino-European projects. GAMMA is involved in forest, glacier dynamics and permafrost projects.

**ESA - GlobPermafrost (2016-2019)**

ESA has launched the GlobPermafrost initiative to develop, validate and implement information products to support the research communities and related international organizations like IPA and CliC in their work on understanding permafrost better by integration of Earth Observation data. In this project coordinated by Zentralanstalt für Meteorologie und Geodynamik (ZAMG), GAMMA has the lead for the mountain permafrost thematic products and the overall system design engineering and will produce subsidence maps on Arctic permafrost sites.

**ESA – Information content of multi-spectral SAR data (2015-2018)**

In this project, led by GAMMA, the capability of improving retrievals and classifications using multi-spectral SAR data is investigated. GAMMA is responsible for the forest biomass and the water body phenology themes.

**ESA – Exploitation of S-1 for Surface Soil Moisture Retrieval at High Resolution (2016-2018)**

In this project, led by CNR-ISSIA, the objective is to develop and generate surface soil moisture products at 100m spatial scale, based on multi-temporal Sentinel-1 C-band SAR backscatter and L-band radiometry soil moisture products of the ESA SMOS and NASA SMAP missions.

**ESA –SMOS Expert Support Laboratory for Level 2 - Soil Moisture (2014-2019)**

The tasks of the SMOS ESL for soil moisture include the development, implementation and assessment of SMOS soil moisture retrieval algorithms. GAMMA contributed new algorithm ideas arising from 2-stream radiative transfer modeling that are now being further tested and that may be introduced at a later stage into the operational processor.

**ESA – Wide-Band Scatterometer Development (2017-2018)**

In this project GAMMA develops and builds the coherent, polarimetric 1 – 40 GHz scatterometer WBScat. A design incorporating a Vector Network Analyzer and a front end with 3 wide-band horn antennas is foreseen. The WBScat shall support tower based measurements of snow, crops and soil.

**ESA – Biomascat (2018-2019)**

The objective of this project under the ESA EO SCIENCE FOR SOCIETY program is the assessment of vegetation carbon dynamics from multi-decadal spaceborne Scatterometer and SAR observations. GAMMA develops and applies the biomass retrieval algorithms, the Max-Planck Institute, Jena incorporates the biomass maps in their climate modeling and provides feedbacks on their usefulness.

**KTI/CTI - Development of a car-borne repeat-pass differential interferometric synthetic aperture radar (SAR) system at L-band for ground displacement measurements. (2016-2018)**

In this project GAMMA and the Earth Observation & Remote Sensing Group, ETH Zurich (EO-ETHZ) develop and test a car-borne repeat-pass differential interferometric synthetic aperture radar. In 2018 the focus of the work on GAMMA side was on the development of the L-band hardware while EO-ETHZ gained experience with the acquisition and processing of car-borne SAR data using a modified GPRI-II Ku-band system. In addition, the new L-band radar hardware was successfully tested in a series of measurement campaigns. The feasibility of repeat-pass interferometry using the car-borne L-band SAR could be confirmed.

## EO SERVICES, CONSULTING AND TRAINING

### Deformation Maps, DEMs , Landcover/Landuse and Change/Hazard Products

A variety of products were generated in 2018 for customers in Switzerland, Europe, and North America using data of the ERS, ENVISAT, Radarsat, ALOS-1/2, TerraSAR-X, Cosmo-Skymed, RISAT, and Sentinel-1 satellites. SAR, InSAR, offset tracking and Persistent Scatterer Interferometry (PSI) were used to generate forest biomass maps, deformation maps, deformation histories, terrain heights, and glacier velocity maps.

For Sentinel-1 near-real-time processing capability is applied for glacier velocity and ground stability mapping.

In 2018 we also continued providing services using the GAMMA Portable Radar Interferometer (GPRI).

### Consulting

GAMMA's consulting activity included SAR and interferometric processing related aspects, application development support, and radar system engineering. GAMMA also supported users of GAMMA Instruments (GPRI, ELBARA) with the acquisition and processing of the data. Furthermore, user specific adaptations of GAMMA hardware were developed and implemented.

In the ANCSI Project “EO-ROFORMON Project on Prototyping an Earth-Observation based monitoring and forecasting system for the Romanian forests (2016-2019)”, GAMMA is part of the Scientific Advisory Board.

### Training courses

In 2018 we organized again training courses for SAR, SAR interferometry, and Interferometric Point Target Analysis (IPTA). Further courses will follow in Jan. 2019 (IPTA) and Mar. 2019 (for information see our homepage http://www.gamma-rs.ch). We also trained users in the operation of GAMMA Instruments (GPRI, ELBARA) and the related data processing.

## GAMMA SOFTWARE

In 2018 GAMMA continued to provide licenses for its user-friendly and high quality software to support the entire processing from SAR raw data to products such as digital elevation models, deformation, and landuse maps. The software consists of the Modular SAR Processor (MSP), Interferometric SAR Processor (ISP), Differential Interferometry and Geocoding (DIFF&GEO), Land Application Tools (LAT), and Interferometric Point Target Analysis (IPTA), complemented by the stand-alone module for Geocoding and image registration (GEO). The use of Sentinel-1A and 1B is well supported. In 2018 support for ScanSAR interferometry was further strengthened – in anticipation of the launch of the Radarsat Constellation Mission (RCM) that will use ScanSAR as the main acquisition mode. Besides we addressed the mitigation of ionospheric effects in SAR interferometry and facilitated importing of digital elevation models.

License sales activities were continued with new licenses sold in Europe, Asia, Australia and North America. User contacts indicate that the advanced algorithms and our competent support are important features of our software. This is also confirmed by an increasing number of running maintenance contracts. Many long-term users updated their license to the current version to be able to process data acquired by the newest SAR satellites (Sentinel-1, ALOS-2, Gaofen-3). On several occasions the software was presented to potential customers.

## GAMMA INSTRUMENT DEVELOPMENT

### Terrestrial X- to Ku-band scatterometer (SNOWSCAT)

In 2018 the X- to Ku-band scatterometer SNOWSCAT was measuring at the WSL-SLF "Davos-Laret Remote Sensing Field Laboratory", Switzerland in the frame of the ESA Snowlab project.

### GAMMA Portable Radar Interferometer (GPRI)

There was again a significant interest in the GAMMA Portable Radar Interferometer (GPRI). More than 20 instruments are in operation by users in Europe, North America and Asia. The primary application is displacement monitoring over glaciers, rock glaciers, rocks, slopes, and infrastructure. Besides the standard instruments, instruments supporting polarimetric and bistatic measurements were built. Existing customers promote the instrument with their high quality results.

### GAMMA L-band radiometer (ELBARA)

There is one more ELBARA L-band radiometer on stock, ready to be sold.

### GAMMA L-band SAR

In 2016 GAMMA started the development of an L-band Synthetic Aperture Radar (SAR). In collaboration with the Earth Observation & Remote Sensing Group, ETH Zurich (EO-ETHZ). In 2018 the main hardware development could be finished and the L-band SAR was operated from the roof of a car and from a 10 m long rail. The feasibility of repeat-pass interferometry using the car-based SAR could be confirmed.

### GAMMA WBScat

In the frame of an ESA project GAMMA started the development of the VNA based, polarimetric, 1-40 GHz Wide-Band Scatterometer (WBScat). In fall 2018 the front-end (mounted antennas) were calibrated at ESTEC. In Dec. 2018 outdoor measurements with the WBScat will be started at the "Davos-Laret Remote Sensing Field Laboratory", Switzerland.

## VARIA

GAMMA employees are members of national (SIP, SED, SGPF, CHGEOL, FAN) and international (IEEE, RSPSoc, AGU, EARSEL) organizations, acted as peer reviewers (various journals, books), were members of scientific committees, and engaged in University teaching and PhD supervision (FSU Jena, ETH Zürich, SLU Umeå).

# PUBLICATIONS

**Articles in journals and books:**


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**Media and press releases:**

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Copernicus Sentinels to help measure Earth's biomass https://sentinels.copernicus.eu/web/sentinel/news/-/article/copernicus-sentinels-to-help-measure-earth-s-biomass