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Gamma Remote Sensing AG
ANNUAL REPORT 2020

RESEARCH AND DEVELOPMENT

ESA – Biomascat (2018-2020)

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, Max-Planck Institute, Jena incorporates the biomass maps in their climate modeling and provides feedbacks on their usefulness.

ESA – ESA SnowLabNG (2020-2021)

GAMMA supports WSL-Birmensdorf in the operation and data quality assessment of the WBScat (1-40 GHz Wide-band Scatterometer) during campaigns at Laret-Davos, Switzerland (winter 2019/2020) and Sodankyla, Finland (foreseen in winter 2020/2021 but delayed due to COVID-19 restrictions in Finland).

ESA – CCI+ - Glaciers (2019-2022)

The main objectives of the CCI+ Glaciers Project (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. Furthermore, within Option 6 of the precursor project ESA CCI Glaciers, GAMMA is contributing to an Ice Marginal Lake Inventory of Greenland.

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. GAMMA has the technical lead, with responsibilities in the algorithm development, system engineering, 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 GmbH, 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 at 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 essential climate variables for snow based on EO data. GAMMA's

responsibilities are in the system design engineering and the system implementation of the AVHRR Snow Cover Fraction processor.

ESA – Exploitation of S-1 for Surface Soil Moisture Retrieval at High Resolution (2016-2020)

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 radiometer soil moisture products of the ESA SMOS and NASA SMAP missions.

ESA –SMOS Expert Support Laboratory for Level 2 - Soil Moisture (2014-2020)

The tasks of the SMOS ESL for soil moisture include the development, implementation and assessment of SMOS soil moisture and additional land-surface retrieval algorithms. GAMMA contributed new algorithm ideas relevant for applications to the Cryosphere 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 (2017-2020)

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 2 x 3 wide-band horn antennas was chosen. WBScat can be used in support of tower-based measurements of snow, crops and soil.

ESA – Scientific Campaign Data Analysis for an Alpine Snow Regime (SCANSAS, 2020-2022)

The aim of this activity is to perform an in-depth analysis of the ESA SnowLab and ESA SnowLabNG active and passive microwave data acquired within the two projects as well as the available meteorological data, snow physical data, and ground data. The resulting knowledge gain supports the definition of future microwave mission concepts dedicated to remote snow observations in terms of required data accuracy, optimal combination of frequencies, and observation geometry.

CTI/Innosuisse - Development of a car-borne repeat-pass differential interferometric synthetic aperture radar (SAR) system at L-band for ground displacement measurements (2016-2020)

In this project GAMMA and the Earth Observation & Remote Sensing Group, ETH Zurich (EO-ETHZ) developed and tested a car-borne repeat-pass differential interferometric synthetic aperture radar. In 2020, the feasibility of repeat-pass DInSAR-based mobile mapping of surface displacements could be confirmed and consolidated further with a test case of a well-known landslide in Brinzauls, Switzerland. The Innosuisse project was successfully completed in 2020.

Eurostars RAMON (2019-2022)

The objective of the Eurostars RAMON Project, coordinated by GAMMA with the partners SATIM and ICEYE Polska, are to design, develop and test an innovative radar-based landslide monitoring service to support different phases of the landslide risk management. The service combines existing, established elements as landslide velocity maps derived from stacks of satellite SAR data using Persistent Scatterer Interferometry with completely new near-real-time monitoring elements, as urgently required during crisis situations, made possible using a novel microsatellite constellation and terrestrial radars.

ESA AALM4INFRAM (2019-2020)

In this project we develop and assess EO based services as a high-level building and infrastructure stability management aid in permafrost areas. The project is coordinated by GAMMA who is responsible for the SAR based EO elements. Partners are the Danish Technical University and ASIAQ, Greenland, who contribute geotechnical competence, in-situ information and optical EO components.

ESA Worldcover (2019-2021)

The aim of this project under the lead of VITO is to deliver to the public a land cover map of the entire globe at 10m resolution based on its Sentinel-1 and 2 data. GAMMA contributes the pre-processing of Sentinel-1 SAR data, including quality assessments and support to the thematic classification chains.

Global Temporal Coherence Maps using Spaceborne SAR Data (2020-2021)

Under a contract with JPL/NASA Earth Big Data and GAMMA generate global Sentinel-1 coherence maps.

EO SERVICES, CONSULTING AND TRAINING

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

A variety of products were generated in 2020 for customers in Switzerland, Europe, and North America using data of the ERS, ENVISAT, Radarsat, ALOS-1/2, TerraSAR-X, Cosmo-Skymed, 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 2020 we also continued providing services using the GAMMA Portable Radar Interferometer (GPRI); in addition first services using GAMMA's L-band SAR were provided.

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. L-band SAR) with the acquisition and processing of the data. Furthermore, user specific adaptations of GAMMA hardware were developed and implemented.

Training courses

In 2020 the scheduled training courses for SAR, SAR interferometry, and Interferometric Point Target Analysis (IPTA) could not take place because of COVID-19. To support new software users we provided documented demo examples and supported the users over the internet. Courses will again be scheduled for 2021 (for information see our homepage http://www.gamma-rs.ch) and will hopefully take place. We trained users in the operation of GAMMA Instruments (GPRI, GAMMA L-band SAR) and the related data processing.

GAMMA SOFTWARE

In 2020 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. The software was updated for NovaSAR, Capella and SAOCOM, and further developments related to ScanSAR interferometry with Radarsat Constellation Mission (RCM) were implemented.

License sale activities were continued with new licenses sold in Europe, Asia, 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, PAZ, Gaofen-3, ICEYE, NOVASAR, ASNARO2, RCM, SAOCOM, Capella). On several occasions the software was presented to potential customers.

Further information related to the GAMMA Software is available online:

General information:
www.gamma-rs.ch/software
www.gamma-rs.ch/uploads/media/GAMMA_Software_information.pdf
Technical reports, conference and journal papers:
www.gamma-rs.ch/uploads/media/GAMMA_Software_references.pdf
Release notes / upgrade information:
www.gamma-rs.ch/uploads/media/GAMMA_Software_upgrade_information.pdf

GAMMA INSTRUMENT DEVELOPMENT

GAMMA WBScat / Terrestrial X- to Ku-band scatterometer (SNOWSCAT)

The development of the VNA based, polarimetric, 1-40 GHz Wide-Band Scatterometer (WBScat) was completed (except for some reports and documentation). After comparative measurements the SNOWSCAT instrument at the WSL-SLF "Davos-Laret Remote Sensing Field Laboratory", Switzerland, was replaced by the WBSCAT instrument (ESA Snowlab project).

GAMMA Portable Radar Interferometer (GPRI)

There was again a significant interest in the GAMMA Portable Radar Interferometer (GPRI). More than 30 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. Our 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) which has been successfully tested for repeat-pass DInSAR-based mobile mapping of surface displacements with car-mounted and UAV-mounted system configurations, as well as a rail-mounted configuration. In 2019/2020, first GAMMA L-band SAR instruments were sold.

VARIA

In 2020 our work was affected by the COVID-19 pandemic. Especially travelling to customers, attending conferences, and holding training courses was significantly affected. Some of us worked and are still working

primarily from home – a related robust solution was already in place before the pandemic. But overall we are in a good position, the staff is healthy and motivated and business and finances are solid.

GAMMA employees are members of national (SIP, SED, SGPF, CHGEOL, FAN) and international (IEEE, RSPSoc, AGU, EARSEL, EGU) 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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D. Houtz, R. Naderpour, and S. M., "Portable L-Band Radiometer (PoLRa): Design and Characterization," Remote Sensing, vol. 12, no. 17, p. 2780, 2020.

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R. Naderpour, D. Houtz, and M. Schwank, "Snow wetness retrieved from close-range L-band radiometry in the western Greenland ablation zone," Journal of Glaciology, pp. 1-12, 2020.

E. Næsset et al. (incl. M. Santoro), "Use of local and global maps of forest canopy height and aboveground biomass to enhance local estimates of biomass in miombo woodlands in Tanzania," Int. J. Appl. Earth Obs. Geoinf., vol. 89, p. 102109, Jul. 2020, doi: 10.1016/j.jag.2020.102109.

J. Peng et al. (incl. O. Cartus, U. Wegmüller), "A roadmap for high-resolution satellite soil moisture applications - confronting product characteristics with user requirements," Remote Sensing of Environment 252, 112162, vol. 252, p. 112162, 2021, doi: 10.1016/j.rse.2020.112162.

N. Prakash, A. Manconi, and S. Loew, "Mapping landslides on EO data: Performance of deep learning models vs. Traditional machine learning models," Remote Sensing, vol. 12, no. 3, 2020, doi: 10.3390/rs12030346.

M. Santoro et al., "The global forest above-ground biomass pool for 2010 estimated from high-resolution satellite observations," Earth Syst. Sci. Data Discuss., 2020, doi: 10.5194/essd-2020-148.

E. Shehaj, K. Wilgan, O. Frey, and A. Geiger, "A Collocation Framework to Retrieve Tropospheric Delays from a Combination of GNSS and InSAR," Navigation, vol. 67, no. 4, pp. 823–842, 2020, doi: 10.1002/navi.398.

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Sciences, vol. 375, no. 1794, 2020, doi: 10.1098/rstb.2019.0128.

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D. Zheng et al. (incl. M. Schwank), "Impact of Soil Permittivity and Temperature Profile on L-Band Microwave Emission of Frozen Soil," IEEE Trans. Geosci. Remote Sens., 2020.

Articles in conference proceedings:

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C. Magnard, U. Wegmüller, and C. Werner, "Persistent Scatterer Interferometry in mountainous areas: advantages of working in map geometry," SARWatch Workshop, Vilamoura, Portugal, 2020.

A. Manconi, R. Caduff, T. Strozzi, O. Frey, C. Werner and U. Wegmuller, "Monitoring displacements of complex landslide with broadband multiplatform radar techniques," Swiss Geoscience Meeting 2020, Zurich, Switzerland, 2020.

M. Santoro, O. Cartus, N. Carvalhais, S. Besnard, and N. Fan, "Forest above-ground biomass estimates across three decades from spaceborne scatterometer observations," in EGU General Assembly, 2020, doi: 10.5194/egusphere-egu2020-19673.

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U. Wegmüller, C. Magnard, C. Werner, T. Strozzi, R. Caduff, and A. Manconi, "Methods to avoid being affected by non-zero closure phase in InSAR time series analysis in a multi-reference stack," SARWatch Workshop, Vilamoura, Portugal, 2020.