

# Gamma Remote Sensing AG

## ANNUAL REPORT 2009

### RESEARCH AND DEVELOPMENT

#### **FP7 - SAFER: Services and Applications for Emergency Response (2009-2011)**

In this project coordinated by Infoterra France GAMMA supports INGV with land surface deformation information for earthquakes, volcanoes, and over a site in Rumania. In 2009 results over the Abruzzi Earthquake and the Etna Volcano were derived.

#### **ESA - GMES - TERRAFIRMA (2005-2009, 2010-2012)**

The focus of the ESA GMES project TERRAFIRMA-II (coordinated by NPA, UK) is on using SAR interferometric techniques to map surface motion of a large number of European Cities and landslides. GAMMA is involved with the SAR data processing for several European cities and Swiss landslides. In December 2009 the new coordinator Altamira and ESA signed the contract for Terrafirma III (2010-2012).

#### **ESA - GMES - RESPOND-II (2006-2009)**

The focus of RESPOND-II (coordinated by Infoterra, UK) is on providing EO based services for the humanitarian sector. GAMMA's involvement is in the provision of thematic maps with a particular focus on generating SAR based information products in the context of natural hazards (e.g. landslides).

#### **ESA - Dragon II Cooperation Programmes (2008-2010)**

The Forest Dragon projects are coordinated by FSU Jena, Germany. GAMMA provides technical support to European and Chinese partners on data processing and interpretation.

#### **ESA 20716/07/NL/EL, Ku-Band Scatterometer Development (2007-2010) & NOSREX (2009-2010)**

Under this contract GAMMA and its partners IAP, ENVEO, WSL-SLF developed a simple, well-calibrated, and transportable scatterometer at X- to Ku-band for enabling ground-based campaigns over snow-covered areas. In late 2009 we started working on a number of amendements requested by ESA in CCN1. During the winter 2009/2010 the SNOWSCAT instrument is used by the Finnish Meteorological Institute in the frame of the NOSREX project, supported by GAMMA.

#### **ESA 21013/07/NL/FF, ELBARA II L-Band Radiometer Systems for SMOS CAL/VAL Purposes (2007-2009) & Campaign support (2009-2011)**

GAMMA and its partners IAP and Metaplan built 3 L-band radiometers to be used for SMOS CAL/VAL Purposes. In 2009 the radiometers were delivered to ESA's selected users in Finland, Germany, and Spain where they are now in operation.

#### **ESA - DUE - GlobGlacier (2007-2010)**

The main objectives of the GlobGlacier Project (coordinated by University of Zürich, Switzerland) are to define EO based services for glacier monitoring, demonstrate and implement services for a selected user group, validate the services, maintain a data base of the GlobGlacier products through the GLIMS database and thereby contribute to new scientific results in the domain of climate change detection, sea level contribution, climate and hydrological modeling. GAMMA's responsibilities are mainly in the context of glacier flow monitoring.

#### **ESA 21659/08/NL/LvH, Understanding Directionality in Surface Scattering by Imaging Radar (2008-2010)**

In this study GAMMA and its partners CNR – ISSIA Bari, Italy and Ludwig-Maximilians-Universität München, Germany try to improve the understanding of directional scattering effects taking place in the scattering of radar waves over natural surfaces, to assess how these effects affect the measurement of backscattering coefficient when standard calibration techniques are applied, and to investigate detection and correction techniques for these effects.

**ESA 21206/07/NL/HE, METAWAVE (2008-2010)**

The full title of this study coordinated by ARGOSS, NL is „Mitigation of Electromagnetic Transmission errors induced by Atmospheric Water Vapour Effects (METAWAVE)“. Its main motivation is to look for new methods which can be used to eliminate or reduce the effects of errors induced by the atmospheric path delay (mainly atmospheric water vapour) thereby improving the usability of spaceborne remote sensing for InSAR applications. In the second half of 2009 GAMMA addressed the potential of InSAR techniques to contribute to the retrieval of atmospheric water vapor information. Based on GPS and INSAR data Integrated Water Vapor maps over Switzerland were derived.

**ESA - DUE - GlobSnow (2008-2011)**

The ultimate aim of the GlobSnow project coordinated by the Finnish Meteorological Institute, Finland is the development of the knowledge and technical capacity necessary to implement a sustainable global snow monitoring service fulfilling the Global Climate Observation System (GCOS) implementation plan requirements. For this purpose the identification and specification of the user requirements, the standardization and homogenization of data sets and algorithms required to qualify for a relevant FCDR, and the demonstration and validation of the implemented service in collaboration with the user community are addressed within GlobSnow. GAMMA's main responsibility is the data processing system design and implementation.

**ESA Support to Science Element Study BIOMASAR (2008-2009)**

The objective of this study coordinated by Friedrich-Schiller-University Jena, Germany, is the validation of a novel biomass retrieval algorithm based on hyper-temporal Wide-Swath and Global Monitoring ENVISAT ASAR datasets. In 2009 the validation of the algorithm was completed and growing stock maps were generated over Sweden, and parts of Siberia and Canada.

**JAXA Kyoto&Carbon (K&C) Initiative**

The objective of the ALOS K&C Initiative is to define, develop and validate thematic products derived primarily from ALOS PALSAR data that can be used to meet the information requirements relating to Conventions, Carbon Cycle Science and Conservation of the environment. GAMMA supported related activities on forest change detection of the Friedrich-Schiller University Jena, Germany, and the Swedish Agricultural University, Umeå, Sweden.

**ESA - VAE - POLInSAR mapping services for forestry (2009/2010)**

GAMMA supports Dendron in the ESA's Value Adding Element project on „POLInSAR mapping services for forestry“. GAMMA responsibilities concern SAR, INSAR and polarimetric processing of Radarsat-2 and ALOS PALSAR polarimetric data.

**ESA 22140/08/I-I-EC, GLOF: Glacier Lake Mapping (2008-2010)**

In this DUE Innovators project GAMMA and the University of Oslo address the mapping of glacier lakes primarily using high resolution SAR data. Initially well known sites in the Alpes are used to develop and consolidate the methodology. The main application sites are then in the Himalayan and in Tajikistan.

**ESA 22526/09/I-LG, ERS-ENVISAT Tandem Cross-Interferometry Campaigns: Case Studies (2009-2011)**

Under this contract GAMMA conducts research on ERS-ENVISAT Tandem (EET) Cross-Interferometry (CInSAR) for a variety of applications including DEM generation, ice motion, snow cover, desert and vegetation. For many of the proposed sites suited data pairs were acquired during the EET campaigns in winter 2007/08 and 2008/09. First results could already be presented in journals and at conferences.

**ESA - DUE - GlobPermafrost (2009-2011)**

In this DUE Project project coordinated by the TU Wien GAMMA provides on one hand DEM and surface motion information over northern permafrost regions using SAR interferometry and on the other hand GAMMA is responsible for the data processing system design and implementation.

## **PRODUCTS AND SERVICES**

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

A variety of products were generated in 2009 for customers in, Europe, Asia, North America and South America using data of the ERS, ENVISAT, Radarsat, ALOS, TerraSAR-X, and Cosmo-Skymed satellites. SAR interferometry and Interferometric Point Target Analysis (IPTA) were used to generate deformation maps, deformation histories, terrain heights, and path delay maps in a pre-operational manner.

In 2009 we continued providing services using the GAMMA Portable Radar Interferometer (GPRI). Measurements over landslides, rock instabilities, glaciers, and infrastructure were acquired.

### **Consulting**

GAMMA's consulting activity included SAR and interferometric processing related aspects, application development support, and radar system engineering.

### **Training courses**

In 2009 we organized again training courses for SAR, SAR interferometry, and Interferometric Point Target Analysis (IPTA). Further courses, will follow in 2010. For information on future courses it is referred to our homepage (<http://www.gamma-rs.ch>).

## **GAMMA SOFTWARE**

In 2009 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).

In 2009 the upgrades for the newer sensors (Radarsat 2, Cosmo-Skymed, TerraSAR-X) were consolidated. Utility of the software for interferometry using spotlight mode data was confirmed for TerraSAR-X and Radarsat-2. The high resolution data of these sensors were also found to be very suited for IPTA, resulting in very high point densities. Furthermore, improvements to the functionality could be realized, e.g. to better support polarimetry.

License sales activities were continued with new licenses sold in Europe, Asia, North and South America, Oceania, and Africa. User contacts indicate that the advanced algorithms supported and our competent support are important features of our software. This is also confirmed by an increasing number of running maintenance contracts. On several occasions the software was presented to potential customers.

## **GAMMA HARDWARE**

Taking advantage of the experience gained during the development of the GAMMA Portable Radar Interferometer (GPRI), the X- to Ku-band scatterometer SNOWSCAT, and the ELBARA radiometers GAMMA offers now also hardware on a commercial basis. In 2009 first orders for GPRI systems were received and the manufacturing of GPRI instruments of the second generation was started.

## **VARIA**

GAMMA employees are members of national (SIP, SED) and international (IEEE, RSPSoc, AGU) organizations, acted as peer reviewers (various journals), were members of scientific committees (ESA Cat-1 project evaluation, CoreH2O Science Team, Tandem-X Science Team, various conferences), and engaged in University teaching (FSU Jena).

## PUBLICATIONS

### Articles in journals and books:

- Askne J. and M. Santoro, "Automatic model-based estimation of boreal forest stem volume from repeat pass C-band InSAR coherence," *IEEE Trans. Geosci. Remote Sensing*, Vol. 47, 2, pp. 513-516, 2009.
- Gambolati G., P. Teatini, M. Ferronato, T. Strozzi, L. Tosi and M. Putti, "On the uniformity of anthropogenic Venice uplift," *Terra Nova*, 21(6): 467-473, DOI: 10.1111/j.1365-3121.2009.00903.x, 2009.
- Groisman, P. Y., Clark, E. A., Kattsov, V. M., Lettenmaier, D. P., Sokolik, I. N., Aizen, V. B., Cartus, O., Chen, J., Conard, S., Katzenberger, J., Krankina, O., Kukkonen, J., Machida, T., Maksyutov, S., Ojima, D., Qi, J., Romanovsky, V., Santoro, M., Schullius, C. C., Shiklomanov, A. I., Shimoyama, K., Shugart, H. H., Shuman, J. K., Sofiev, M. A., Sukhinin, A. I., Vörösmarty, C., Walker, D., Wood, E. F., "The Northern Eurasia Earth Science Partnership: An example of science applied to societal needs," *Bulletin of the American Meteorological Society*, vol. 90, 5, pp. 671-688, 2009.
- Parcharidis, I., M. Fomelis, P. Kourkoulis, and U. Wegmüller, "Persistent Scatterers InSAR to detect ground deformation over Rio-Antirio area (Western Greece) for the period 1992–2000," *Journal of Applied Geophysics*, pp. 348-355, 2009, doi:10.1016/j.jappgeo.2009.02.005
- Paul F., A. Kääb, H. Rott, A. Shepherd and T. Strozzi, *GlobGlacier: A new ESA project to map the world's glaciers and ice caps from space*, *EARSeL eProcs*, Vol. 8, No. 1, 2009.
- Santoro M., J.E.S. Fransson, L.E.B. Eriksson, M. Magnusson, L.M.H. Ulander, and H. Olsson, "Signatures of ALOS PALSAR L-band backscatter in Swedish forest," *IEEE Trans. Geosci. Remote Sensing*, Vol. 47, 12, pp. 4001-4019, 2009.
- Strozzi T., P. Teatini and L. Tosi, "TerraSAR-X reveals the impact of the mobile barrier works on Venice coastland stability," *Remote Sensing of Environment*, 113: 2682-2688, doi:10.1016/j.rse.2009.08.001, 2009.
- Wegmüller U., M. Santoro, C. Werner, T. Strozzi, A. Wiesmann, and W. Lengert, "DEM generation using ERS-ENVISAT interferometry," *Journal of Applied Geophysics* Vol. 69, pp 51–58, 2009, doi:10.1016/j.jappgeo.2009.04.002.
- Articles in conference proceedings:**
- Pantze, A., Krantz, A. H., Fransson, J. E. S., Olsson, H., Santoro, M., Eriksson, L. E. B., Ulander, L. M. H., "Mapping and monitoring clear-cuts in Swedish forest using ALOS PALSAR satellite images," *Proceedings of IGARSS'09*, Cape Town, 12-17 July, 2009.
- Rommen, B., Mika, A., Gale, L., Zelle, H., Hanssen, R., Liu, S., Matzler, C., Morland, J., Wegmüller, U., Werner, C., Santoro, M., "The ESA METAWAVE project: Correcting for atmospheric water vapour effects in InSAR products," *Proceedings of EuCAP 2009*, 3rd European Conference on Antennas and Propagation, Berlin, 23-27 March, pp. 3428 - 3432, 2009.
- Santoro M., U. Wegmüller, T. Strozzi, J. Askne, and J.E.S. Fransson, "Examples of thematic mapping with ERS-ENVISAT Tandem, Cross-Interferometry," *Proc. Fringe'09*, Frascati, Italy, 30. Nov. – 4. Dec. 2009.
- Strozzi T., R. Delaloye, H. Raetzo and U. Wegmüller, "Radar interferometric observations of destabilized rockglaciers," *Proceedings of the FRINGE 2009 Workshop*, Frascati, Italy, 30 November - 4 December 2009.
- Strozzi T., L. Tosi, P. Teatini, C. Werner and U. Wegmüller, "Monitoring land subsidence within the Venice Lagoon with SAR interferometry on trihedral corner reflectors," *Proceedings of IGARSS 2009*, Cape Town, South Africa, 13-17 July 2009.
- Strozzi T., U. Wegmüller, C. Werner, A. Wiesmann, R. Delaloye and H. Raetzo, "Survey of landslide activity and rockglaciers movement in the Swiss Alps with TerraSAR-X," *Proceedings of IGARSS 2009*, Cape Town, South Africa, 13-17 July 2009.
- Strozzi T., R. Delaloye, H. Raetzo, and U. Wegmüller, "Radar interferometric observations of destabilized rock glaciers," *Proc. Fringe'09*, Frascati, Italy, 30. Nov – 4. Dec. 2009.
- Tanase, M., de la Riva, J., Perez-Cabello, F., Santoro, M., "Backscatter properties of X- and C-band SAR in a mediterranean pine forest affected by fire," *Proceedings of 7th EARSeL Workshop on Advances in RS and GIS Applications in Forest Fire Management*, Matera, 2-5 September, 2009.
- Tanase, M., Santoro, M., de la Riva, J., Perez-Cabello, F., "Backscatter properties of multi-temporal TERRASAR-X data and the effects of influencing factors on burn severity evaluation in a mediterranean pine forest," *Proceedings of IGARSS'09*, Cape Town, 12-17 July, 2009.
- Tanase, M., Santoro, M., Wegmüller, U., de la Riva, J., Perez-Cabello, F., "Properties of X- and C- band repeat-pass interferometric SAR coherence in mediterranean pine forests affected by fires," *Proceedings of 7th EARSeL Workshop on Advances in RS and GIS Applications in Forest Fire Management*, Matera, 2-5 September, 2009.
- Tosi L., P. Teatini, T. Strozzi, L. Carbognin, G. Brancolini and F. Rizzetto, "Present ground surface dynamics in the North Adriatic coastland," *Rendiconti online Soc. Geol. It.*, Vol. 9, pp. 64-66, 2009.
- Walter D., U. Wegmüller, V. Spreckels, W. Hannemann, and W. Busch, "Interferometric monitoring of an active underground mining field with high-resolution SAR sensors," *Procs. ISPRS Hannover Workshop*, 2. – 5. Jun. 2009
- Wegmüller U., L. Petrat, K. Zimmermann, and I. Al Quseimi, "The potential of high resolution satellite interferometry for monitoring enhanced oil recovery," *Procs. 5<sup>th</sup> European Symposium on Improved Oil Recovery*, Paris, France, 27-29. Apr. 2009.
- Wegmüller U., M. Santoro, C. Werner, T. Strozzi and A. Wiesmann, "ERS-ENVISAT Tandem Cross - Interferometry Coherence estimation," *Proc. IGARSS'09*, Cape Town, South Africa, 13-17 Jul. 2009.
- Wegmüller U. and M. Santoro, "ERS-ENVISAT Cross-Interferometry results over Egypt," *Proc. Fringe'09*, Frascati, Italy, 30. Nov – 4. Dec. 2009.
- Wegmüller U. A. Wiesmann, and M. Santoro, "Merging of an EET CInSAR DEM with the SRTM DEM," *Proc. Fringe'09*, Frascati, Italy, 30. Nov – 4. Dec. 2009.
- Wegmüller U. M. Santoro, and T. Strozzi, "ERS-ENVISAT Cross-Interferometry results over the Mackenzie River Delta, Canada," *Proc. Fringe'09*, Frascati, Italy, 30. Nov – 4. Dec. 2009.
- Wegmüller U. C. Werner, M. Santoro, T. Strozzi, and A. Wiesmann, "ERS-ENVISAT Tandem data over sea and shelf ice," *Proc. Fringe'09*, Frascati, Italy, 30. Nov – 4. Dec. 2009.
- Wegmüller U. M. Santoro, and T. Strozzi, "DEM generation above 60° North using ERS-ENVISAT Cross-Interferometry," *Proc. Fringe'09*, Frascati, Italy, 30. Nov – 4. Dec. 2009.
- Werner C., A. Wiesmann, T. Strozzi, M. Schneebeli and C. Mätzler, "The SnowScat Instrument: Initial Processing and Calibration of Polarimetric Backscatter Data acquired in Davos in Support of the CoreH2O Mission," *Proceedings of the Advanced RF Sensors and Remote Sensing Instruments Workshop*, 16-18 November 2009.