FRINGE 96
INSAR Quantitative Evaluation

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Abstract

We will present the INSAR Quantitative Evaluation Study, conducted for ESA/ESRIN. The INSAR consortium coordinated by Matra Cap Systèmes gathers 9 European partners to validate interferometry for 5 applications over more than 15 test sites, from Antarctica to northern Norway Islands. The INSAR project aims to evaluate and quantify interferometric SAR approach towards conventional measurements, with ground truth reference data, in the field of the following applications : digital elevation model (DEM) production ; hydrology ; forestry ; earth science (earthquake and volcanoes monitoring) and glaciology (ice monitoring).
Keywords:quantitative evaluation, applications, interferometry, INSAR project

INSAR Consortium partners are 10 industrial and academic organizations working on SAR images in different fields :

CNES, Toulouse, France. (interferometry expert)
Chalmers University of Technology, Göteborg, Sweden. (forestry)
GRGS, Toulouse, France. (earthquake monitoring)
Institut für Navigation, Stuttgart, Germany. (glaciology in antarctic)
Institut de Physique du Globe de Paris, Paris, France. (volcanoes survey)
ISTAR, Sophia Antipolis, France. (DEM production)
Norsk Polarinstitutt, Oslo, Norway. (glaciology in arctic)
Remote Sensing Laboratories, Zurich, Switzerland. (DEM production & forestry)
Synoptics, Wageningen, the Netherlands. (hydrology)
MCS, Vélizy-Villacoublay, France. (DEM production)

Management of the INSAR project is performed by MCS. Technical reporting is performed by ESA experts. We will focus our presentation on the three scientific tasks in which MCS is involved: Project organisation, DEM production, INSAR processor system specification, and WWW demonstrator

Introduction

INSAR project is conducting for ESA/ESRIN by MATRA CAP SYSTEMES, leading to a quantitative evaluation of the INSAR technique towards several applications and their conventional measurement techniques. The project has begun in march 1995, and will end before the end of the year. An European Consortium has been constituted, composed of the industrials and academic organizations detailed on figure 1. All the members of the INSAR Consortium have an expertise in their application area, and the applications are covering a large spectrum :

DEM production : three techniques are evaluated : ISTAR, RSL (Small 1996)and MCS ;

Hydrology : interferometric DEM are compared with SPOT DEM and GPS measurements, and coherence is used in hydrological models (SYNOPTICS) ;

Forestry : interferometry can detect with forest changes, and gives an estimation of the forest parameters (Chalmers University of Technology Dammert 1996 & Askne 1996 and RSL) ;

Glaciology : at Norsk Polarinstitut (Lefauconnier 1996)and Institut für Navigation (Rott 1996) ice movements and quality are to be measured in arctic and antarctic;

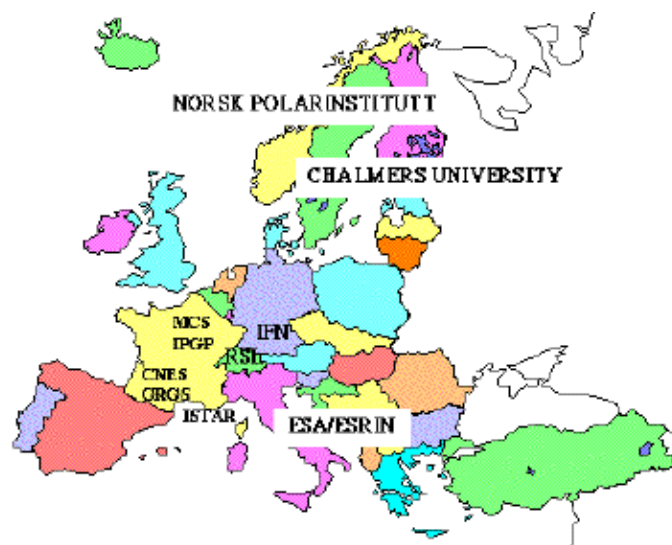Earth sciences : both earthquakes (Feigl 1996)and volcanoes monitoring (Briole 1996) applications are studied.

Figure 1: Composition of the Consortium

Several test sites have been chosen by the members of the Consortium all over the world. Following figure gives examples of the test sites locations.
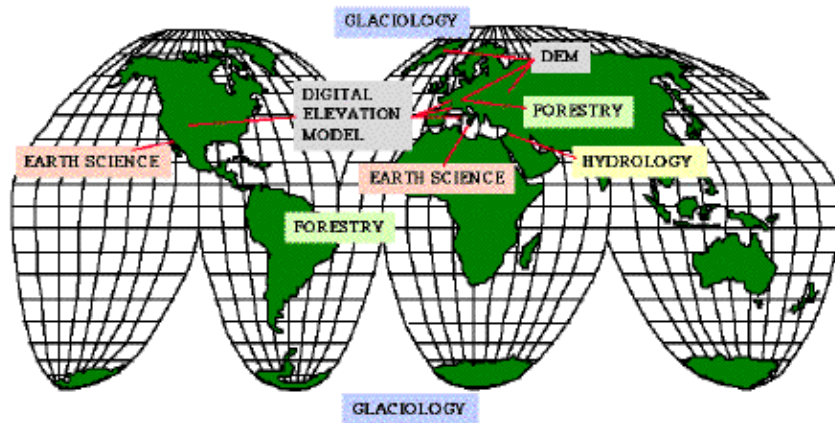
Figure 2: Some of the test sites

The INSAR project

The INSAR project includes the following parts :

Management of the Consortium

> a common evaluation methodology is needed from all the members of the Consortium ;
> Scientific work
> application evaluation (all members of the Consortium, see other publications)
> DEM study
> INSAR processor system specification
> WWW demonstrator

ESA role

ESA has delivered an important number of images in the INSAR study, so that each member of the Consortium may process interferograms, and evaluate its method towards its application extensively.

ESA is also the technical expert for all the application evaluation.

Evaluation methodology

In order to get all the quantitative results available in a common form, a generic evaluation method is to be used by all the members of the INSAR Consortium. For example, for each application, the following items are needed :
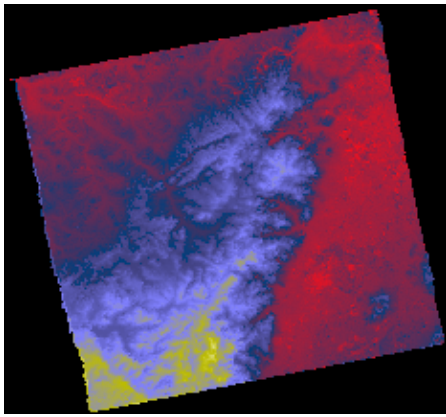
An overview of the application is performed

> what is the context of the application area
> what are the common sources of data for that application
> a connection with radar interferometry is to be added
> The conventional measurement techniques are described
> what are the problems or drawbacks of these methods
> what is new with interferometry
> Specific works include
> test sites description
> problems addressed in the evaluation
> detailed results over each test site
> Some of the members of the INSAR Consortium will present their results at FRINGE 96, and the hole package will be available at ESA at the end of the project.
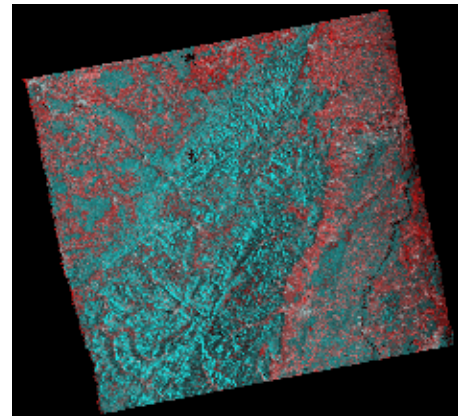
DEM study

H. Tarayre has developed during her PhD-thesis at MCS (Tarayre, 1996 a) a software to produce DEM with interferometry. Production of Digital Elevation Models (DEM) from SAR images through INSAR, seems now possible by using semi automatic phase unwrapping algorithms. This approach will provide a third method to evaluate the DEM production techniques with interferometry (ISTAR, RSL and MCS).

The following example has been used for the algorithmic validation, in France, over Vosges. First image is the DEM produced and second one a combination of the orthorectified amplitude and coherence images.

(click on the images)

Figure 3: DEM of the Vosges

Figure 4: Amplitude and coherence of the Vosges

A validation based on ground control points coming from 1/25000 scale maps (Tarayre 1996 b) give a rms error of 15 meter for a hilly terrain, and 35 meters on stronger relief area, to be compared to the theoritical error from 10 to 14 meters.

Another test site has been choosen over Marseille, with TANDEM images. MCS will unwrap the fringes, and produce the DEM, and the final validation is to be performed by ISTAR, using the ISTAR DEM Marseille database as a reference.

INSAR processor system specification

Based on CNES expertise (Massonnet 1996) an INSAR processor system has been specified by MCS, designed to be able to produce high level interferograms. Main steps of the INSAR processor system are :

> correlation of the two input images, and interferogram computation ;
> DEM ingestion and simulation over the input DEM (suppression of the fringes from the known terrain), then filtering of the histogram ;
> optimisation of the phase function.
> An interferometric quicklook facility is foreseen in a massive interferometric production system, at least in order to choose quickly correct interferometric couples (based on coherence criteria).

WWW demonstrator

At the end of the whole project, a WWW demonstrator will gather the quantitative evaluations of every applications, in order to be accessed by the scientific community, either specialist or non-specialist of the considered applications.

The following figure is the home page of the WWW demonstrator. The whole demonstrator could be available at ESRIN near the end of the year.

Figure 5: Home page of the WWW demonstrator

Conclusion

The INSAR study is currently ending, and will propose the first quantitative evaluation of the INSAR techniques towards the conventionnal measurement ones for the 5 considered applications. It is a necessary step for understanding the interferometric market.

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