Differential Interferometry

Wide-Area Deformation and Stability Monitoring

Differential SAR (Synthetic Aperture Radar) Interferometry (DifSAR) has revolutionised the surveying of ground motion anomalies. Never before have we been able to map and monitor in a single process the stability of very large areas with centimetric accuracy. DifSAR reveals centimetric-level displacement fields over wide areas (up to 100 x 100 km^2 per process) and spanning timescales from several weeks to a few years. DifSAR thus allows users to determine the extents and magnitudes of ground motions over very large areas.

Photographs courtesy and © ICC, Spain; GSI, Ireland; PGI, Poland; BGS, Belfast, BGS IPR/43-16C British Geological Survey © NERC. All rights reserved.

DifSAR is ideal for monitoring the displacement of suspected areas of instability, such as mining or extraction fields, or across faults and unstable slopes, and after events such as earthquakes. This non-invasive monitoring system reduces the need for ground surveys, presenting a highly cost-effective method, especially for remote areas, where survey mobilisation and access costs are high.

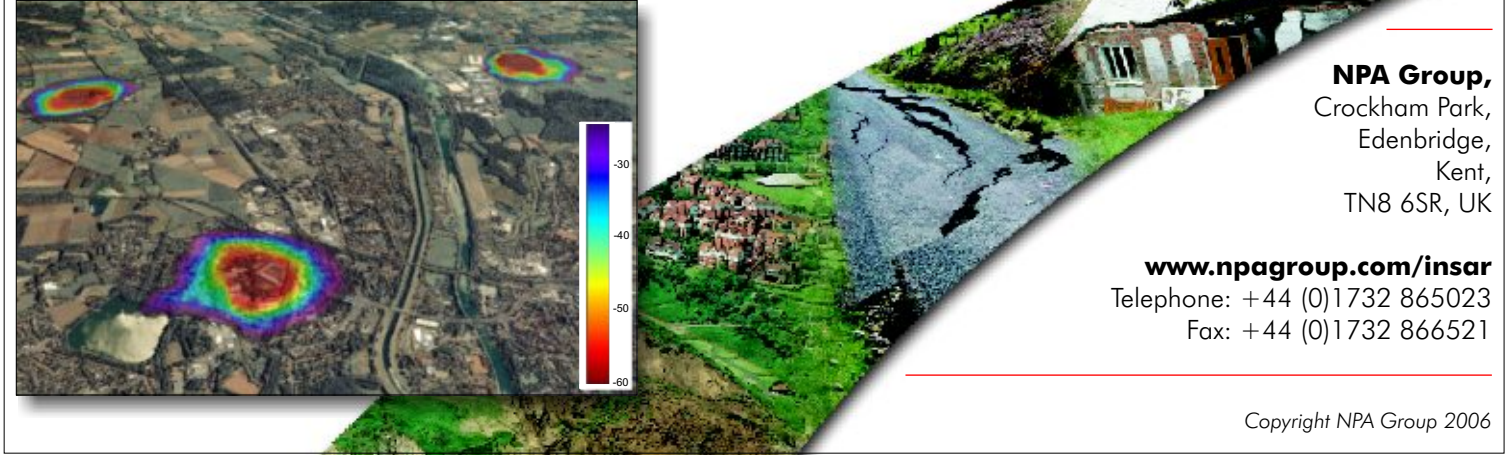
To map ground displacements, two SAR images of the same place on the ground are acquired, but at different times the period separating the two determined by the investigator's objectives. Specialised processing then compares the signal phase component between the two images on a pixel by pixel basis, the result being an image of phase interference - an interferogram. Phase interference is caused by differences in the signal path length between the satellite and the ground, i.e. changes in the micro-topography during the period between the two image acquisitions. Phase interference is revealed in an interferogram as fringes, each complete fringe representing 28mm (1.1inch, for ERS/Envisat/Radarsat satellites) of displacement in the 'look' direction of the satellite. This amount is a function of the operating SAR wavelength. The timeframe over which motions can be monitored and measured is highly flexible and can range from the satellite unit repeat period of 3 or 5 weeks up to several months or years.

The DifSAR product comprises a deformation map in digital image format, which shows the measured displacement from one scene acquisition relative to another.

Case Study 1: Gas Transmission Pipeline, Germany

The image shows subsidence contours over a pipeline network in Dorsten, Germany, which is located over an area of rapid mining subsidence. The colour bar shows subsidence levels in millimetres over 35 days. DifSAR was applied, giving displacement measurements with sub-centimetre accuracy.

Ikonos imagery copyright 05/08/2003. ERS data copyright 12/02/1998, 19/03/1998. Interferometric processing by TRE



NPA Group,
Crockham Park,
Edenbridge,
Kent,
TN8 6SR, UK

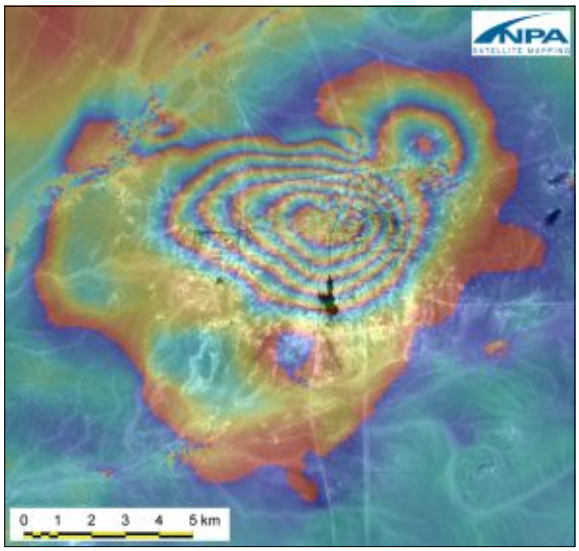
www.npagroup.com/insar
Telephone: +44 (0)1732 865023
Fax: +44 (0)1732 866521

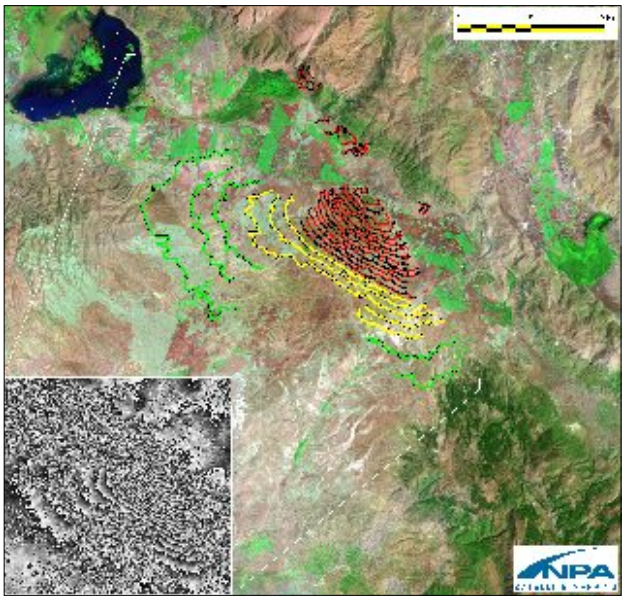
Case Study 2: Oil Field, Middle-East

Oil field displacement mapping and volume monitoring

The image shows subsidence contours caused by oil extraction from an oil field in the Middle-East, showing some 18cm of displacement at the image centre, measured over a period of 3.5 years.

This displacement map was created with the DifSAR technique. It may be used to investigate the impacts of the motion on local pipelines and other oil and gas infrastructure, or as an input to oil volume production modelling.





Case study 3: Earthquake, Dinar, Turkey

Earthquake displacement mapping and interpretation

The main image (left) shows displacement contours derived for the Dinar earthquake, Turkey (01-Oct-95, Richter magnitude 6.1) over a Landsat optical image.

The red, yellow and green fringe regions indicate respectively high, medium and low displacement intensity as interpreted from the interferogram (see greyscale image insert). This is the 'raw' result that was processed by NPA. It shows 20 displacement fringes, each representing 28mm of ground displacement (in the line of sight of the satellite).

NPA are currently managing a project called PIPEMON, a service aimed at providing accurate ground motion information in the vicinity of pipeline networks and other oil & gas infrastructure. PIPEMON is a project funded by the European Space Agency's (ESA) Earth Observation Market Development Programme (EOMD).

For more information please visit: **www.pipemon.com**

Technical specifications for DifSAR:

Potential area coverage	Worldwide
Data sources	SAR (Synthetic Aperture Radar) data acquired by ERS-1, ERS-2, Envisat (operated by ESA) or Radarsat (operated by RSI)
Measurement direction	Sensor line-of-sight (23° from vertical for ERS. Variable for Envisat)
Sampling interval	Every 24 days with Radarsat or 35 days for Envisat (single mode)
Relative movement resolution	Sub-centimetre movements detectable
Relative movement accuracy	Centimetric, depending on parameters such as atmospheric conditions and local topography
Relative spatial accuracy	+/- 5m in E-W, +/- 3.5m N-S
Absolute spatial accuracy	20m

NPA Group,
Crockham Park,
Edenbridge,
Kent,
TN8 6SR, UK

www.npagroup.com/insar
Telephone: +44 (0)1732 865023
Fax: +44 (0)1732 866521