VOLCANO MONITORING

Satellite-based monitoring of volcanoes

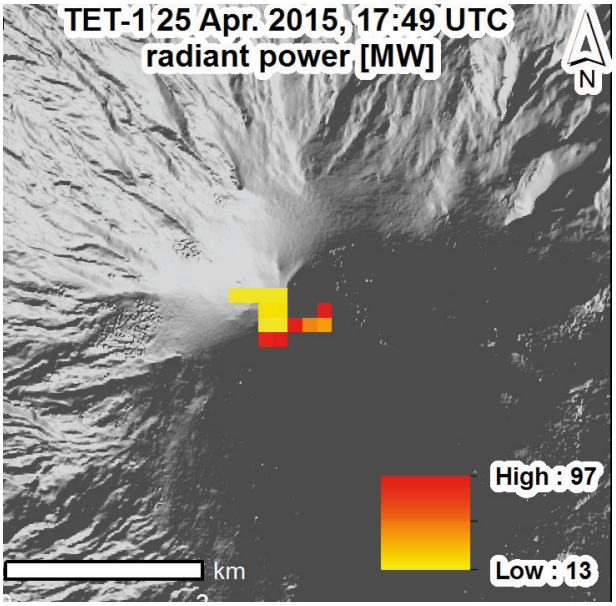
Volcanic eruptions cause significant risk on the local (~800 million people live <100 km distance around an active volcano), regional (air traffic affection) and global scales (influence on global climate). Volcanic hazards include lava flows, pyroclastic density currents, landslides, lahars, volcanic gas discharge, tephra and ash fallout. Nowadays, volcanic activity is monitored with ground-based, air and satellite-borne measurements (e.g., ash and hotspot detection, deformation monitoring). During eruptions volcanoes are often not accessible. Many volcanoes in the world are located in remote areas. **Satellite-based Earth Observation (EO)** provides a non-restrictive global monitoring of all sub-aerial volcanoes. The recently launched **Sentinel** missions provide EO data of an unprecedented high spatial and temporal resolution.

This fact sheet shortly describes the satellite-based methods for monitoring and analysis of volcanoes that were further developed within the project RIESGOS. These methodologies combine following remote sensing approaches:

- **Thermal remote sensing**
- Examination of **multispectral satellite data**
- Analysis of **synthetic aperture radar (SAR) data**

ANALYZING THERMAL VOLCANIC ACTIVITY

The experimental small satellite mission **FireBIRD** of **DLR** provides thermal data at much higher spatial resolution than operational thermal satellite sensors such as MODIS, VIIRS or Sentinel-3. Data from FireBIRD enables a more detailed detection and analysis of thermal volcanic activity. Within RIESGOS new procedures for atmospheric correction of FireBIRD data as well as for detection of thermal hotspots and the derivation of the **volcanic radiant power** were developed.



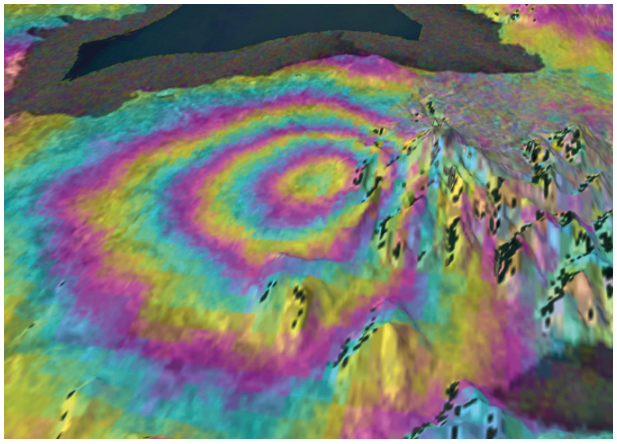
Volcanic radiant power derived from thermal data of the FireBIRD satellite TET-1 over the Chilean volcano Villarrica.

INVESTIGATING ICE-CAPPED VOLCANOES

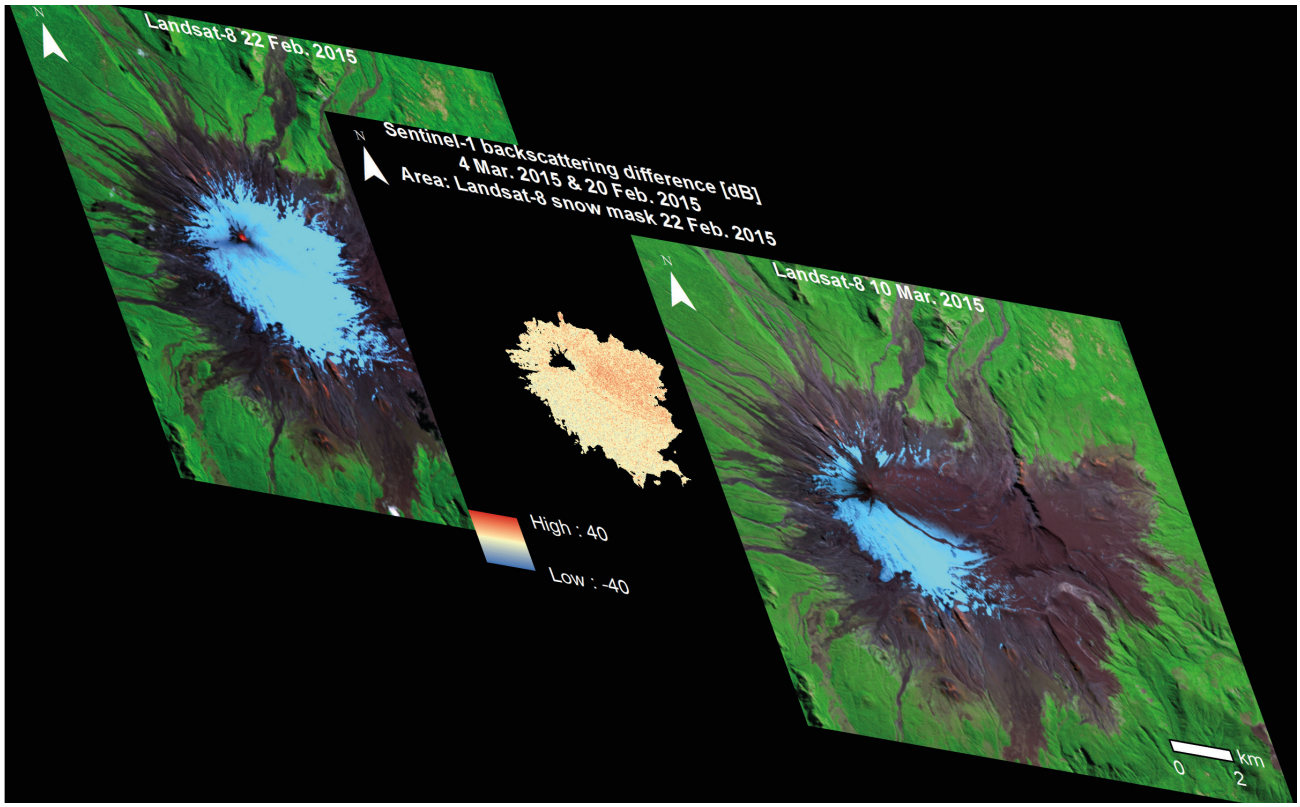
Interpretation of changes at ice-capped volcanoes is challenging. Multispectral satellite sensing requires clear sky conditions to provide useful imagery. Weather independent SAR imagery alone does not allow to differentiate between seasonal temperature related changes of the snow coverage and changes due to volcanic activity. Within RIESGOS a new approach was developed, combining multi-temporal analysis of multispectral and SAR data to detect **volcanic activity** at **ice-capped volcanoes**. Thereby, the temporal evolution of the SAR backscattering and the interferometric coherence are analyzed over the volcano glacier. Information about the extent of the ice cap is continuously updated whenever a clear sky multispectral image is available.

STUDYING GROUND DEFORMATION AT VOLCANOES

Differential SAR interferometry (DInSAR) enables the measurement of **deformation** of the Earth's surface due to **volcanic activity**. Thereby, interferometric phase information between two SAR data datasets acquired at the same imaging geometry are computed.



Sentinel-1 data-based differential SAR interferogram showing the subsidence of the Earth's surface due to the April 22, 2015 eruption at Calbuco Volcano, Chile.



Left: Landsat-8 false color imagery showing the ice cap (light blue) at Villarrica Volcano, Chile as of February 22, 2015: middle: strong increase of the Sentinel-1 SAR backscatter between February 20 and March 4, 2015 at the eastern flank of Villarrica Volcano showing the effects of the March 3, 2015 volcanic eruption already on the next available SAR image acquired one day after the eruption; right: the next clear sky multispectral image of Landsat-8 (acquired on March 10, 2015) confirms the volcanic eruption.

More information about the project:
www.riesgos.de

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