InSAR observations, high resolution tropospheric models and extreme meteorological events in western Greece - Using CRL (http://crlab.eu) as a pilot site for the NISAR mission

CORINTH RIFT LABORATORY

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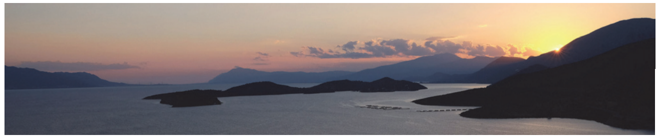
Extreme meteorological events in the Mediterranean regions

Extreme meteorological events are a threat for the inhabitants of the Mediterranean regions. There are every year several violent storms with heavy rain and/or winds, and the occurrence of floods, flash floods, landslides, …, that often produce fatalities, *e.g.* Bab el oued, Algeria, 2001, west of Athens 2017, Vaison-la-Romaine, France 1992, Messina, Italy, 2015, Corsica 2018. Those events induce also a high economical cost for the society. Their impact increases because of the increasing population of the Mediterranean with the development of urban and peri-urban zones in many hazardous places. Those events are also becoming stronger because of the climate change, with the Mediterranean hurricanes (« medicanes ») becoming stronger and more frequent due to the increasing temperature of the sea.

Constraining tropospheric models with GNSS and InSAR

The observation, modelling and forecast of the medicanes require data both from space and in situ. Since the early development of GNSS and InSAR in geophysics, it has been clear that the troposphere is the major limitation in the accuracy of precise positioning. Reciprocally, and for the same reason, accurate tropospheric parameters can be retrieved from GNSS and InSAR data, and can be of major interest for constraining tropospheric models.

The Corinth rift, an adequate site for improving the tropospheric models in a Mediterranean mountainous area



We believe that, coupled with GNSS and multi-constellation InSAR, the NISAR mission will be of major interest for improving the tropospheric models for an area like the Corinth rift area where mountains higher than 2 km are located at less than 10 km from the Mediterranean sea.

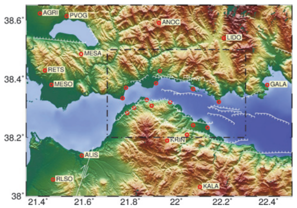
The Corinth rift as a possible pilot site for NISAR preparation, validation, calibration, and application

NISAR NASA - ISRO SAR Mission

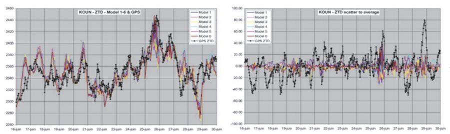
The CRL area could be a test site for the preparation of NISAR, and later a validation/calibration place. This would be done in synergy with the other InSAR missions like the Sentinels, and in synergy with the development of Galileo and other GNSS constellations to enrich the accurate real time range sounding of the troposphere in azimuth. Additional sensors could be added inland and also at sea in the NFO area and surroundings, to accompany the NISAR mission.

The CRL GNSS array - Analysis of the zenithal tropospheric delays

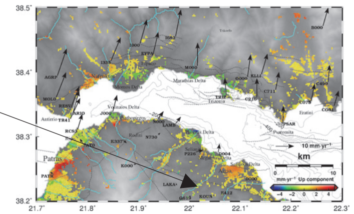
Our team is working since ~30 years in the rift of Corinth which is one of the most seismic areas of the Mediterranean, with large and localized strain rates across its major tectonic structures. A permanent GNSS array exists since 2000. We produce routinely interferograms from the Sentinel and other missions. Except when large earthquakes occur (*e.g.* the M_w = 6.2 of June 15, 1995) the dominant signal in interferometry is due to the troposphere. The tropospheric delays at the GNSS stations (vertical and along the line of sights) are very efficient to correct the interferograms at wavelength larger than 10 km. But this wavelength exceeds the typical size of a mountain range or a nearby valley and is also larger than the size of the deformation field produced by small earthquakes like the two events of Efpalio in January 2010 (M = 5.3).



CRL permanent GNSS array



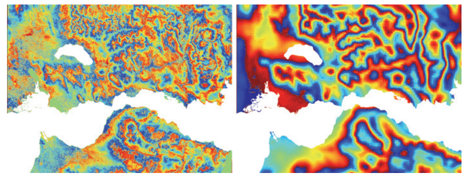
Observed (black) and WRF models of the ZTD at the GNSS station KOUN. Coherence is good at and the week-scale but large scatters exist at the day-scale (up to 80 mm, *i.e.* > 2 C-band fringes)



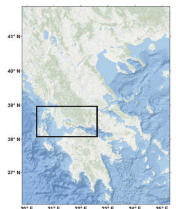
Horizontal and vertical velocities from GNSS and InSAR respectively (Elias and Briole, 2018)

Sentinel-1 interferograms and meteograms in the CRL area

We compared the Sentinel-1 interferograms with synthetic interferograms ("meteograms") made by re-analysis of the troposphere running the WRF model with 1 km pixels (*i.e.* smaller than the size of the valleys) with various initial conditions and set of parameters (http://wrf.crlab.eu). The meteograms mimic the interferograms partly but not very well, especially at short wavelengths (<10 km) where it is not rare to se interferogram and meteograms with opposite signs. This shows the weakness of the tropospheric modeling in mountainous areas at these spatial and temporal scales, where InSAR could thus provide constraints.



Interferogram and meteogram for the period 18/9/2016-30/9/2016 (04:30am)



Context of the CRL Near Fault Observatory

Being one of the most ancient and advanced near fault observatories (NFO) of EPOS (http://www.epos-pi.org), the Corinth Rift Laboratory gathers scientists from various disciplines and al number of permanent instruments operated in the field in a sustainable manner.

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Co-financed by Greece and the European Union

Acknowledgements for the mission of N. Roukounakis

The mission of N. Roukounakis was supported by the project "THESPIA II - Foundations of synergistic and integrated management methodologies and tools for monitoring and forecasting of environmental issues and pressures" (MIS 5002517)) which is implemented under the Action "Reinforcement of the Research and Innovation Infrastructure", funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-financed by Greece and the European Union (European Regional Development Fund).