

# Planning DSO contribution to EUREF densification project.

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## DSO Recent Activity

Dionysos Satellite Observatory (DSO) and Higher Geodesy Laboratory of the National Technical University of Athens, have developed an automated processing scheme to accommodate the routine analysis of all available continuous GNSS stations in Greece.

This daily analysis process, is implemented for the last two years, yielding results which help us further understand the complicated tectonic setting of Greece and nearby regions.

Important results, include:

- the recent volcanic activity in *Santorini* (e.g. [2]),
- the 2014 *Kefallonia* earthquakes (e.g. [5], [4])

# SEISMO Project

In the framework of the SEISMO<sup>1</sup> Project, platform has been upgraded, to include:

- more GNSS stations, divided into sub-networks,
- manipulation, archiving & dissemination of GNSS data files,
- new processing capabilities (e.g. GPS+GLONASS processing),
- automatic archiving and publishing of results (via a dedicated web-site),
- integration with GSAC ([6]) and MySQL databases,
- new results and products

The platform was in practice re-designed & re-implemented.

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<sup>1</sup>South Aegean Geodynamic And Tsunami Monitoring Platform

# Motivation

Via our contribution to EUREF and interaction with its community, we hope to:

- expand & modernize our research activity,
- contribute to the GNSS community,
- take part in ongoing/future projects,
- expand our knowlegdbase,
- improve our academic services (NTUA is a University)

# Velocity Field

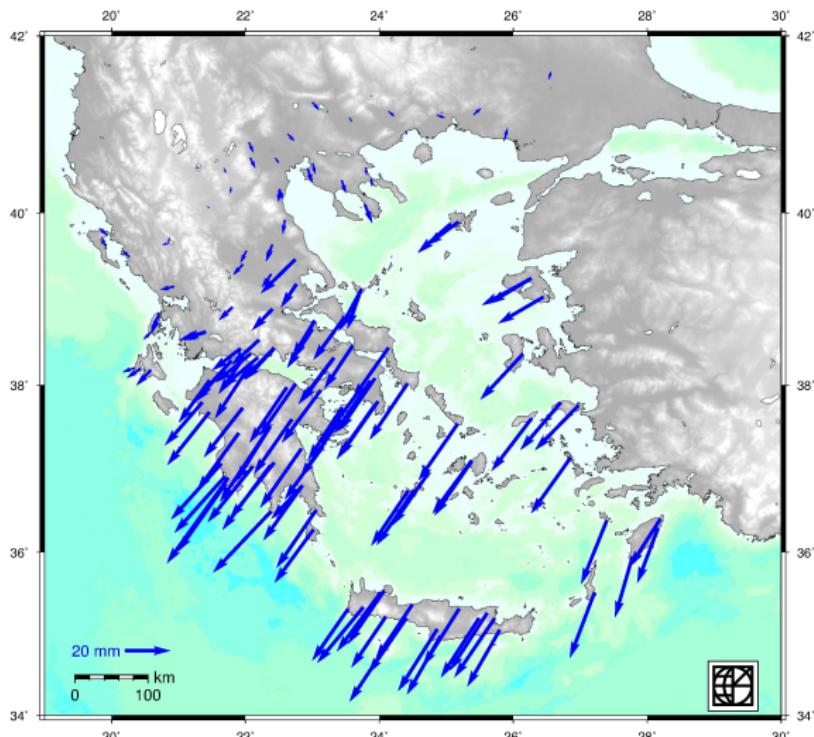


Figure: Velocity field in Greece wrt stable Europe [3].

# Densification Network Selection

To contribute to the Densification we have to establish a credible dataset (network). This has proven to be rather challenging !

Currently we process whatever we can get our hands on ...

Problems:

- Inhomogenous dataset (RINEX, raw files, etc).
- Various maintainers, different mentalities.
- Different acquisition methods/rates.
- Hardly any log files.
- Wide variety of equipment (not always included in atx files).

# COMET/NTUA Network

- established along the Hellenic Arc
- homogenous (geodetic type) equipment
- credible time-span (early 2004 - late 2011)
- data acquisition stopped at late 2011
- equipment is old & GPS-only
- needs repairing

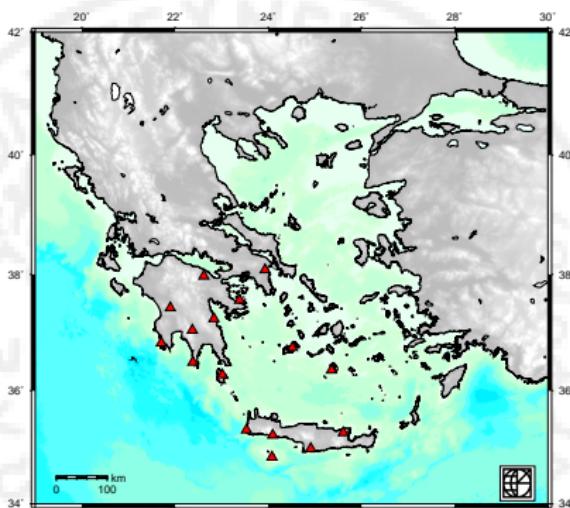


Figure: COMET/NTUA network.

Can be used for EUREF densification “as is”.

# NOA/GEIN and others

- covers (sparsely) all of Greece
- credible time-span (newest stations at 2012)
- inconsistent providers (for some stations)
- no log files

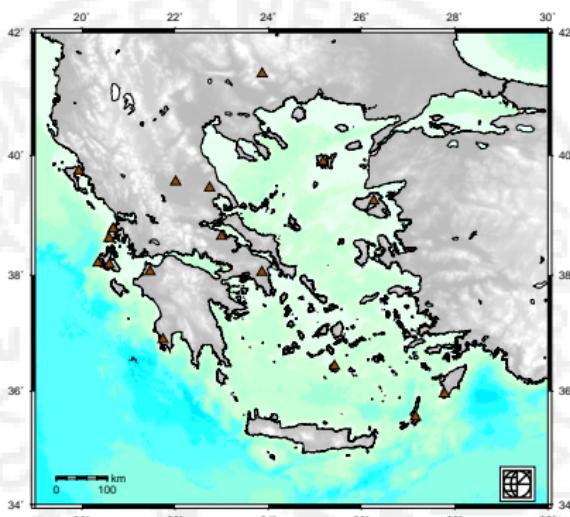


Figure: NOA/GEIN network.

Unusable sites: atal, stef (no calibration).

# Tree-Company / URANUS

- dense network,  
covers all of Greece
- homogenous  
(geodetic type)  
equipment
- limited time-span  
(late 2013 onwards)
- no log files
- commercial usage  
oriented
- ~ 2 years of data  
lost !

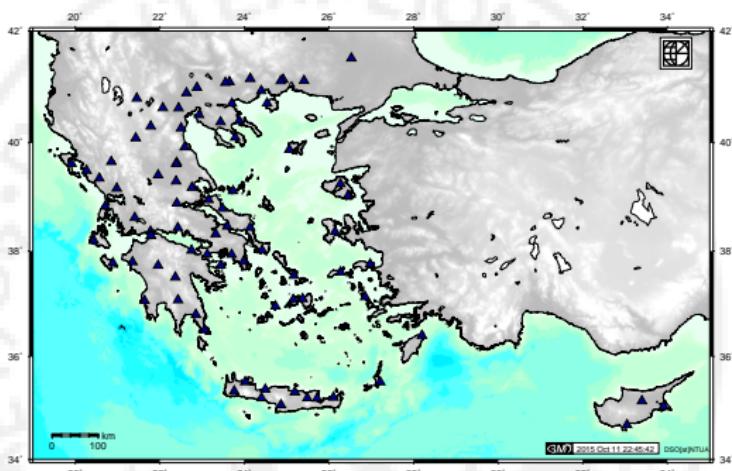


Figure: Tree-Company URANUS network.

Can only use sites with time-span > 2 years.

# HEPOS

- dense network, covers all of Greece
- homogenous (geodetic type) equipment
- credible time-span (late 2007 onwards)
- limited access ( $\sim 5$  stations)!!

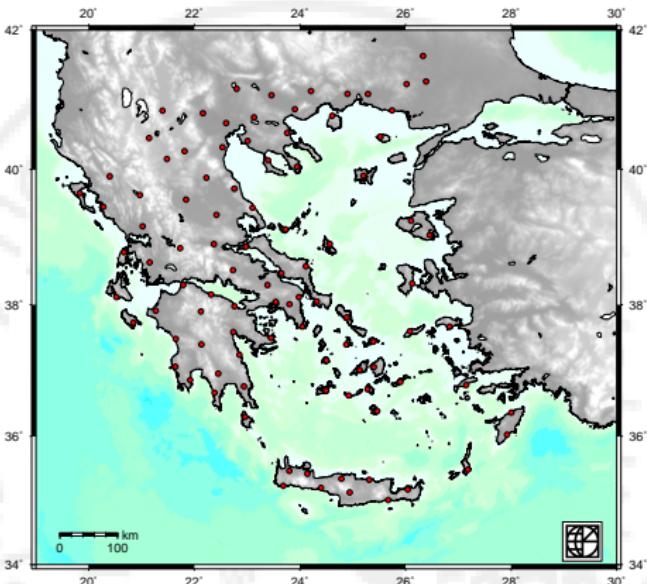


Figure: HEPOS network.

Can only use somewhere between 5 and 10 sites for a time-span of  $\sim 4$  years.

## Local Networks

### Corinth Rift.

- credible time-span
- only covers the Corinth Rift
- inconsistent providers
- no log files & equipment changes

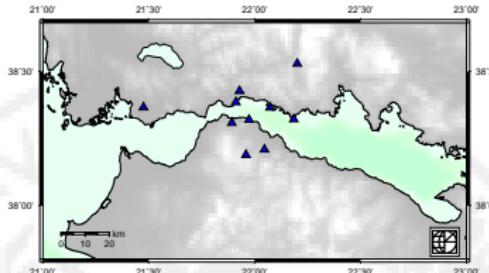


Figure: CRLab network.

**Santorini Network.** Most of the stations installed post-2011 to monitor the *inflation episode*.

- localized
- limited time-span

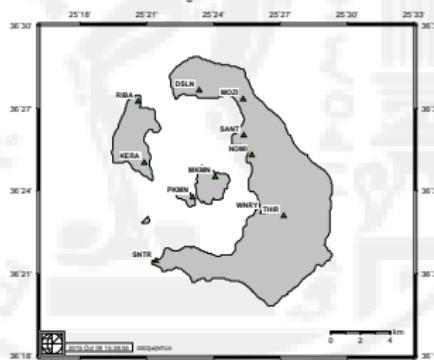


Figure: Santorini network.

## Densification Network

The network to be used for the Densification, will look something like this ...

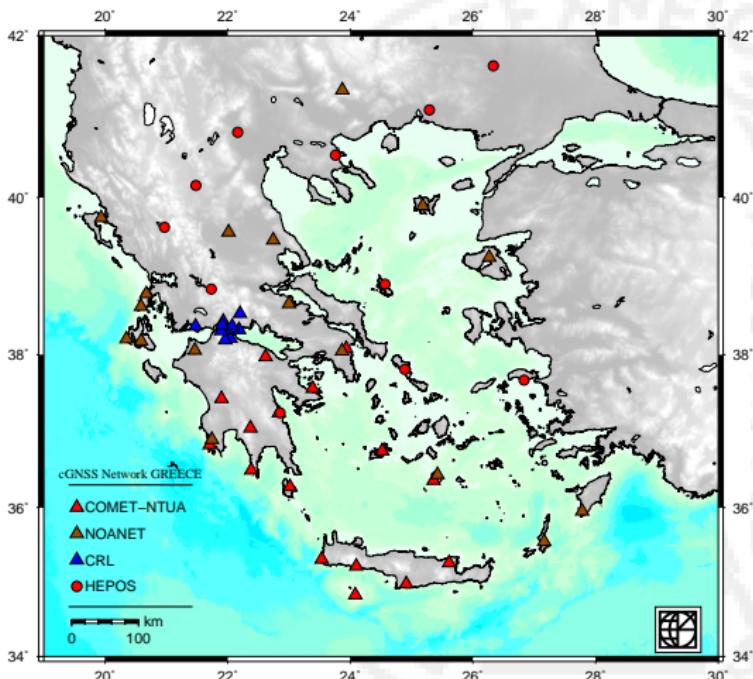


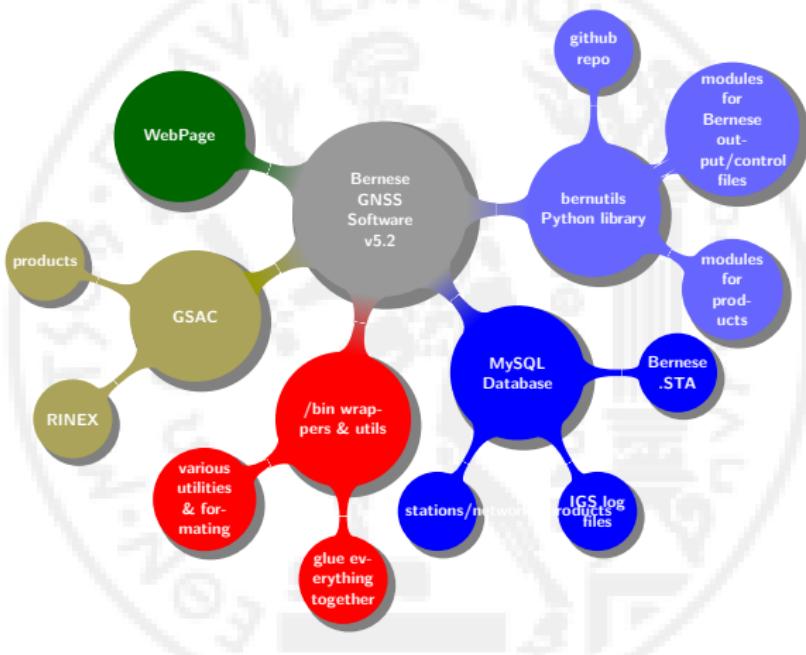
Figure: Densification network (preliminary).

# The Scheme

The core tool/software is Bernese GNSS Software v5.2[1].

Integration with

- MySQL database,
- Python library
- GSAC
- wrappers (shell)



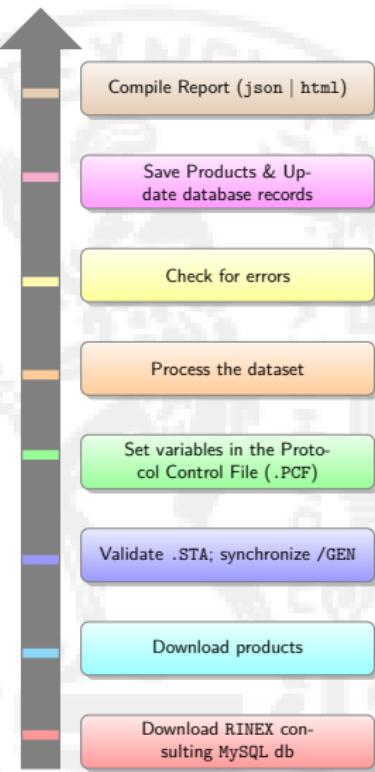
## Compliance wrt EUREF standards

Processing is consistent with EUREFF standards (Guidelines for Analysis Centres).

- SINEX with required info/blocks,
- Reference frame IGB08,
- IERS Conventions 2010,
- IGS/CODE products,
- ocean loading corrections (FES2004),
- atmospheric tidal loading corrections,
- $3^\circ$  elevation cut-off angle; elevation dependent weighting,
- GMF and/or VMF1; Chen-Herring gradient parameter,
- ambiguities fixed (length-dependent algorithm),
- use GLONASS obs (when available)

# Workflow

```
$>ddproces.sh --year=  
--doy= --session=  
--bern-loadgps=  
--campaign=  
--satellite-system=  
--solution-id=  
--save-dir=  
--analysis-center=  
--use-ntua-products=  
--append-suffix=  
--elevation-angle=  
--update= --pcv=  
--apply-exclude-list
```



## Results & Output

## 4. Solution Identifiers

### Array of Objects

**expand**

## **5. PCE Variables**

### Array of Objects

Page 1

## 6. Saved products

## Array of Objects

page 1

## 7. Warnings

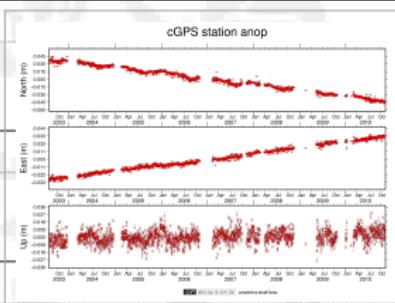
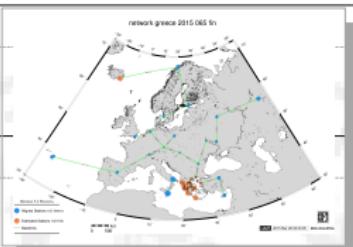
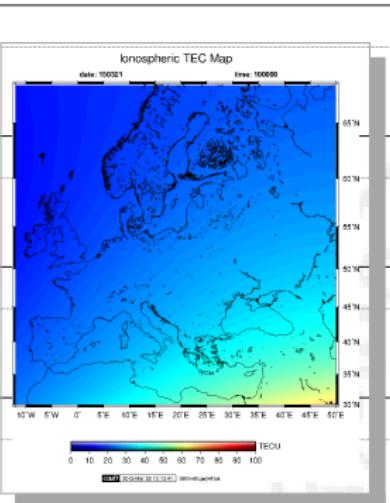
### Array of Objects

2000

## **8 Ambiguity Resolution Summary**

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### **Array of Objects**



Baseline	sta1	sta2	length (km)	Method	N. of Amb.	Percentage	Satellite system
AUKL	AUT1	KLOK	139.7	pbnl	74	54.1	GPS
AULE	AUT1	LEMN	199.6	pbnl	60	55	GPS
KCTL	KATC	TILO	59	pbnl	50	90	GPS
KLRL	KLOK	RLSO	174.2	pbnl	74	41.9	GPS

# Web Resources

Visit, Browse, Interact, Comment

- **Dionysos Satellite Observatory**  
<http://dionysos.survey.ntua.gr/>
- **GSAC repository** [http://dionysos.survey.ntua.gr/dsoportal/\\_datacenter/gsacrepos.html](http://dionysos.survey.ntua.gr/dsoportal/_datacenter/gsacrepos.html)
- **Ftp site** [http://dionysos.survey.ntua.gr/dsoportal/\\_datacenter/ftpdata.html](http://dionysos.survey.ntua.gr/dsoportal/_datacenter/ftpdata.html)
- **Kefallonia earthquake** [http://dionysos.survey.ntua.gr/dsoportal/\\_projects/supersites/cephalonia/](http://dionysos.survey.ntua.gr/dsoportal/_projects/supersites/cephalonia/)
- **Ionospheric Remote Sensing** [http://dionysos.survey.ntua.gr/dsoportal/\\_projects/IonoRemSens/](http://dionysos.survey.ntua.gr/dsoportal/_projects/IonoRemSens/)

Thank you very much for your attention !



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*Astronomical Institute, University of Bern*, 2007.
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Data, products and preliminary results  
*The Volcanic and Geodynamic Field of the South Aegean, International Workshop, 20-22 May, Santorini, Greece*

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Fault modelling of the early-2014 ~ M6 Earthquakes in Cephalonia Island (W. Greece) based on GPS measurements  
*Tectonophysics*, Volumes 644–645, 184–196, 2015, Pages 184–196



Merryman Boncori J.P., Papoutsis I., Pezzo G., Tolomei C., Atzori S., Ganas A., Karastathis V., Salvi S., Kontoes C., Antonioli A.

The February 2014 Cephalonia Earthquake (Greece): 3D Deformation Field and Source Modeling from Multiple SAR Techniques

*Seismological Research Letters*, Vol.86(1), 2015

## References III



### UNAVCO

GSAC – Geodetic Seamless Archive Centers: Open-source Software for Geodesy Data Repositories  
*available at <https://www.unavco.org/software/data-management/gsac/gsac.html>*



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IGb08: an update on IGS08  
*IGSMAIL [6663] <http://igscb.jpl.nasa.gov/pipermail/igsmail/2012/007853.html>, 2012*



### Boehm J., B. Werl, and H. Schuh (2006)

Troposphere mapping functions for GPS and very long baseline interferometry from European Centre for Medium-Range Weather Forecasts operational analysis data  
*Journal of Geophysical Research, vol. 111, B02406, 2006*