

XI Hotine-Marussi Symposium, Genoa, 10 Sep 2026



Cyprus Supersite

**CYGOS: An Integrated GNSS–InSAR Geodetic Observatory for Monitoring
Crustal Deformation and Geohazards in the Eastern Mediterranean**

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Coordinator of CyCLOPS Strategic Infrastructure Unit

Coordinator of the CyGOS Permanent GEO-GSNL Supersite



Why Cyprus

A plate-boundary laboratory, until recently without dense geodetic coverage

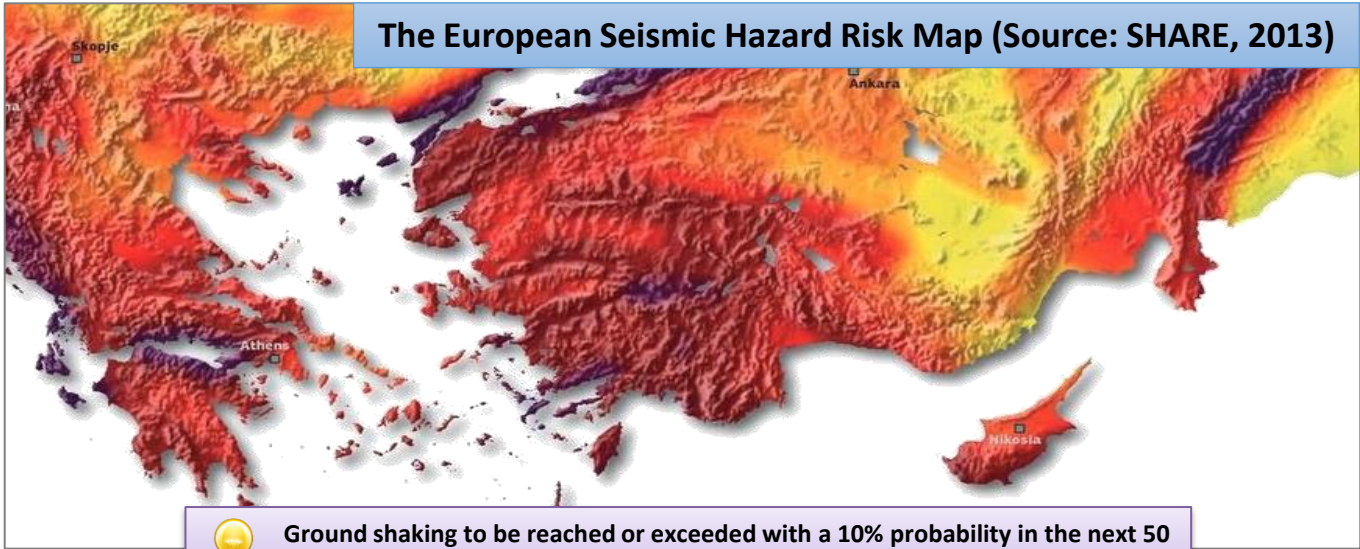
- **Located at the boundary of the subduction zone** (African and Eurasian plates)
- **Exhibits multi-hazard dynamics:** earthquakes, landslides, subsidence, rockfalls and coastal uplift
- **Hosts rapidly evolving geohazards:** active landslides impacting gravely infrastructure and communities
- **Limited historical geodetic/ space monitoring:** gaps in deformation understanding and hazard quantification
- **Need for high-resolution, multi-sensor EO** to monitor both slow and rapid deformation processes



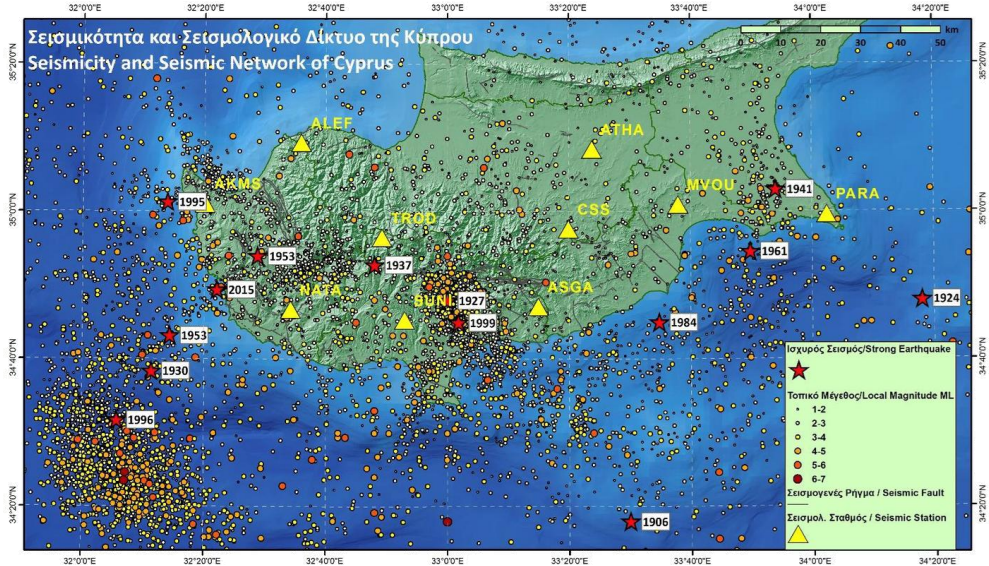
Cyprus provides a unique testbed for integrating EO, in-situ data and operational geohazard monitoring within GSNL

Why Cyprus

Damaging shaking and active landslides, documented across the island



Ground shaking to be reached or exceeded with a 10% probability in the next 50 years (shaking to be expected on the human lifetime of a standard building)



Current Infrastructure for Monitoring Geohazards

The CyCLOPS National Strategic Infrastructure – Cyprus Geodetic Backbone

- **22 GNSS stations**
 - 12 permanent
 - 10 mobile (deployed to Aols)
- **12 Trihedral Triangular CRs**
 - 6 pairs permanently installed to 6 permanent stations (GNSS-CR collocation)
- **4 MetaSensing Electronic CRs (ECR-C)**
 - 2 co-locate with permanent stations
 - 2 deployed in areas of interest
- **17 precise weather stations** (Vaisala PTU307/Indigo 520)
- **16 tiltmeters** (Jewell D-711-A)
- **Latest geodetic equipment** (Laser Scanners, UAVs, industrial-grade Total Stations etc.)



○ EPOS station

○ EPN station

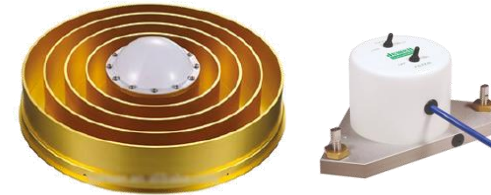
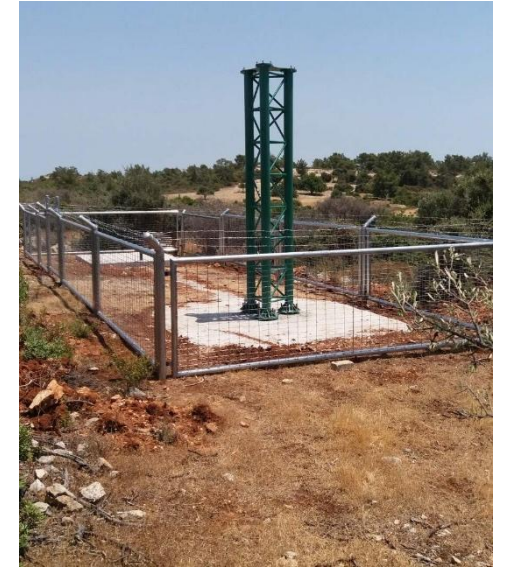
The Permanent Segment (PS)

Collocated GNSS, meteorology and tilt — compliant with IGS Tier-1 requirements

Each site features:

- 1x Trimble® Alloy high-rate (100Hz) GNSS receiver
- 1x Trimble® Ti-v2 Choke Ring Antenna (SCIGN radome)
- 1x Vaisala PTU-307/ Indigo 520 weather station
- 1x Jewell D-711-A tiltmeter
- 2x calibration-grade triangular trihedral corner reflectors

✓ Fully compliant with IGS requirements for Tier-1 stations



💡 Two (2) Corner Reflectors to support both **ascending** and **descending** satellite tracks yielding 50% more data for deformation monitoring

The Permanent Segment (PS)

Tier-1 Monumentation Considerations

- Two types for Tier-1 monumentation:
 - 6x UNAVCO **Shallow Drilled Braced Monuments** (Type 1)
 - Quadpod anchored at a depth of 2m in solid bedrock using high-quality epoxy resin (HILTI HIT-RE-500 v4)
 - 6x Inhouse designed **Stainless Steel Truss** (Type 2)
 - 3m/4.5m-tall
 - Anchoring to bedrock using stainless anchors and high-quality epoxy resin
 - Submillimetric vibration at 140km/h wind speed



Type 1

💡 **Electrostatic paint coating for increased durability and corrosion avoidance**

💡 **High stability monumentation according to UNAVCO ranking**



Type 2

🌟 **Zero-order reference points**

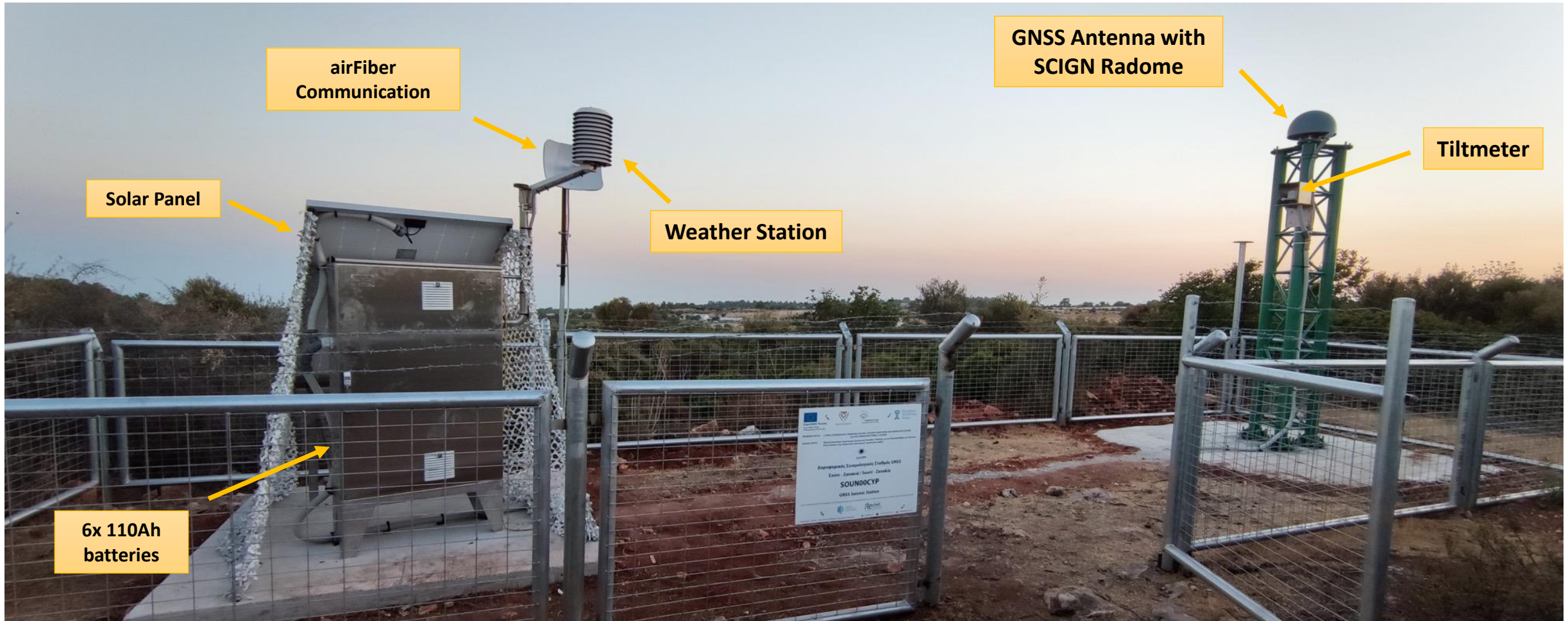
Permanent Segment (PS)

ASGA Permanent Station (Type 1 monument) – EUREF (EPN) – EPOS



Permanent Segment (PS)

SOUN Permanent Station (Type 2 monument)



Permanent Segment (PS)

Calibration-grade Corner Reflectors

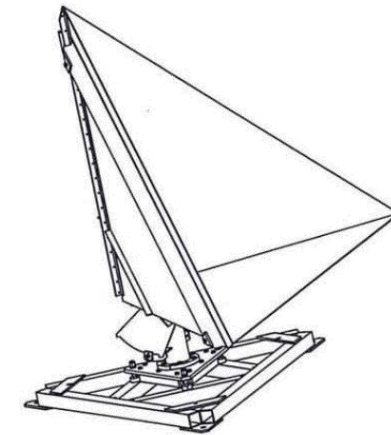


 Installation carried out entirely by our team

Azimuth Adjustment Range: -180° to $+180^{\circ}$

Elevation Adjustment Range: -10° to $+45^{\circ}$

**Permanent Monumentation Considerations
(anchored in solid bedrock)**



Support for Sentinel-1, TerraSAR-X, COSMO-SkyMed etc (2m corner length)

Collocation ties InSAR to the datum

Corner-reflector pairs tie line-of-sight displacement to the geodetic frame



GNSS CORS



CR for Descending Pass



Seismograph



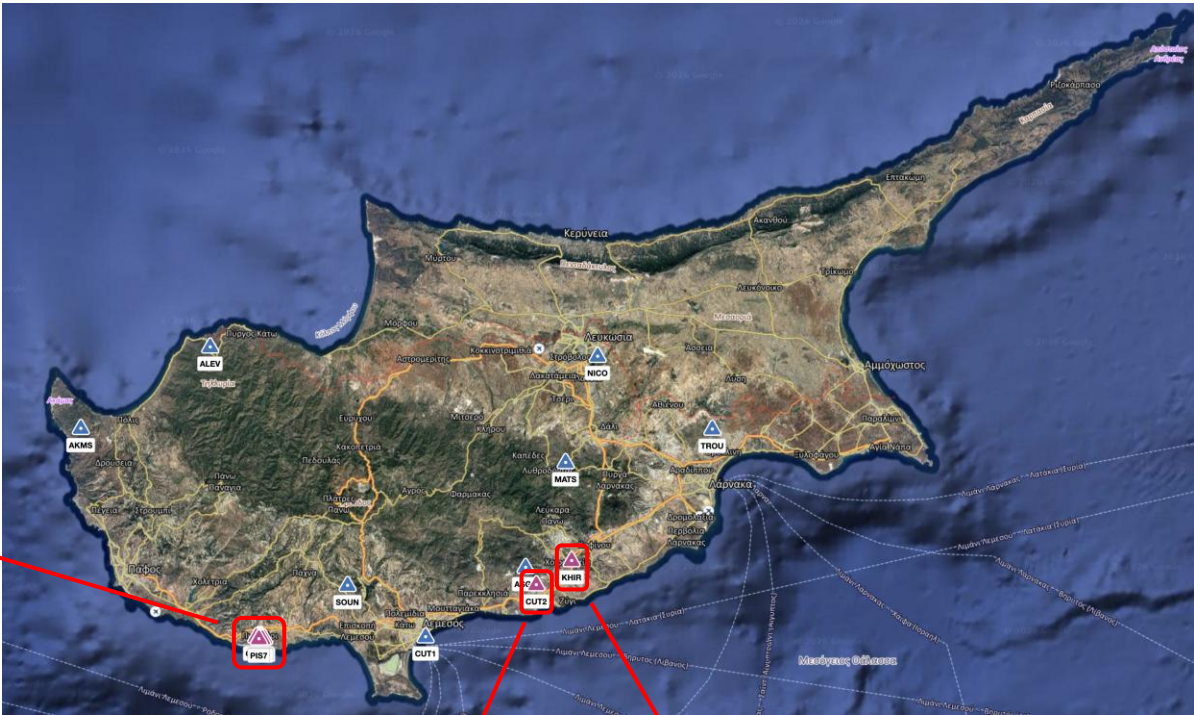
CR for Ascending Pass

Mobile Segment (MS)

The network follows the hazard – mobile stations deployed to active areas of interest



Pissouri Cluster



Vassiliko Open Pit Mine

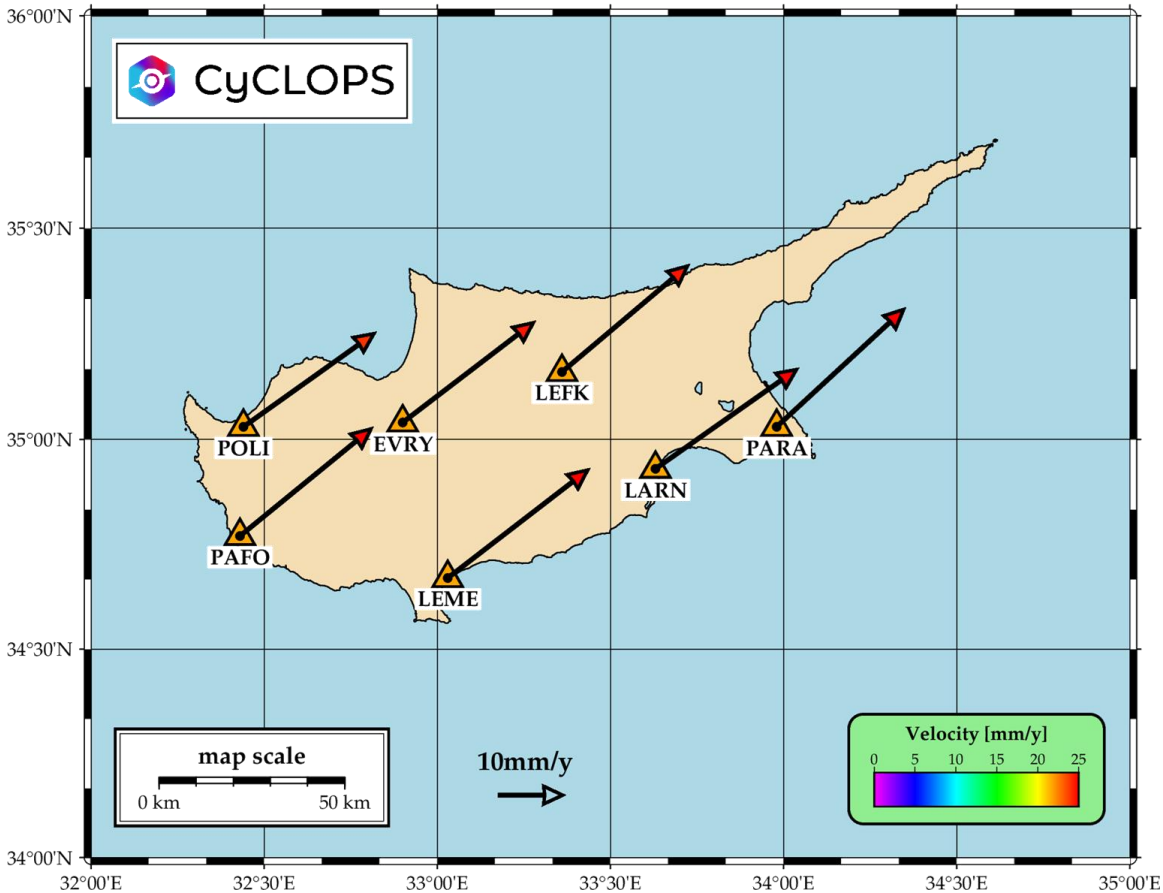


Khirokitia Archaeological Site

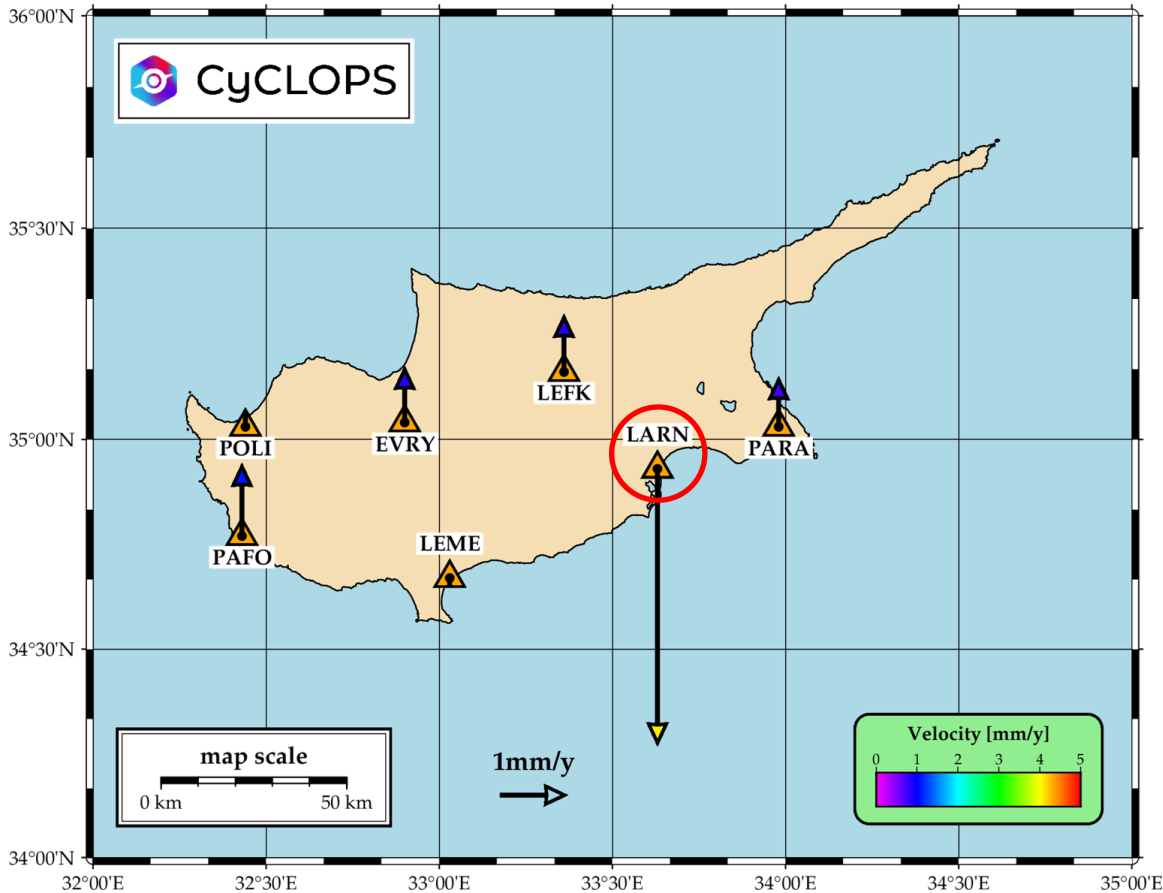
CyCLOPS Products

Velocity Estimation of the Cyprus National RTK Provider Station Network (CYPOS)

CYPOS CORS Horizontal Velocities (IGS2020)



CYPOS CORS Vertical Velocities (IGS2020)

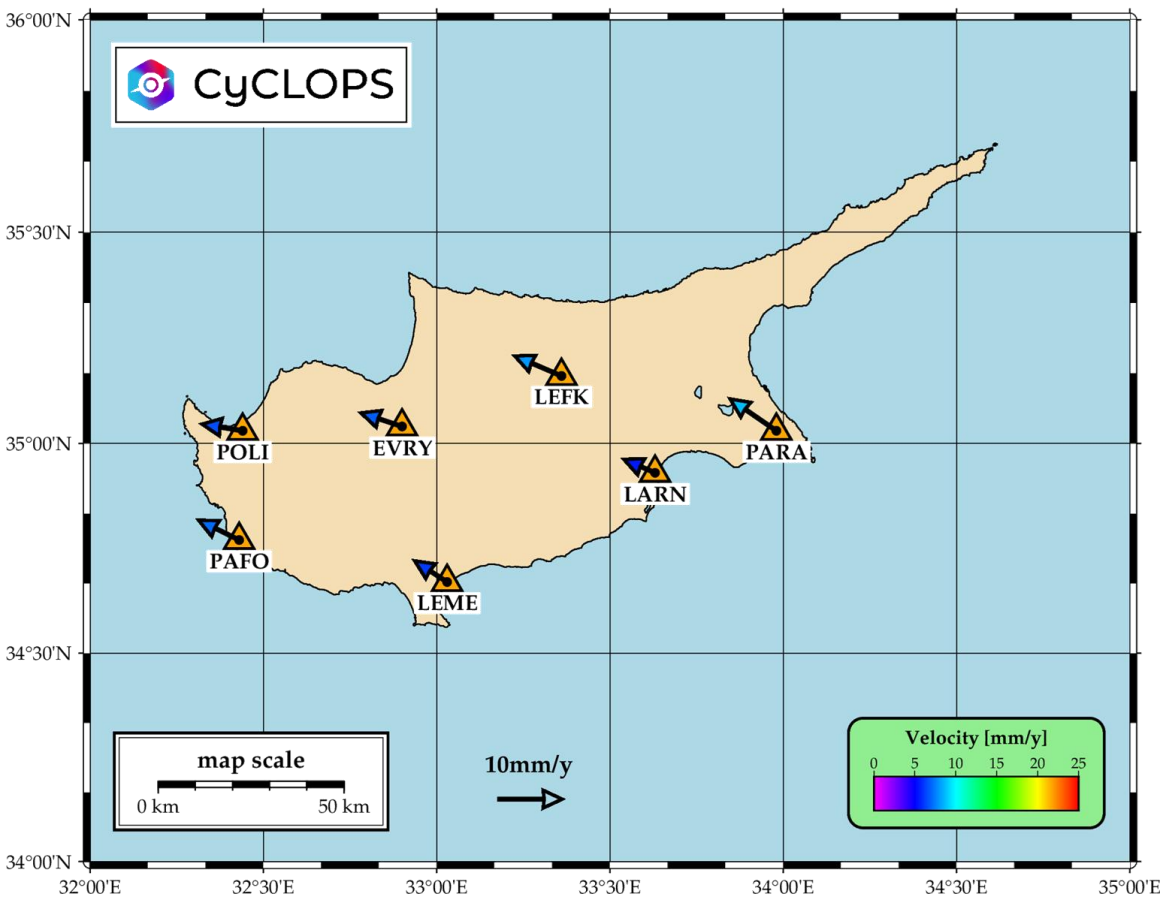


Processing Period: 2011 - 2025

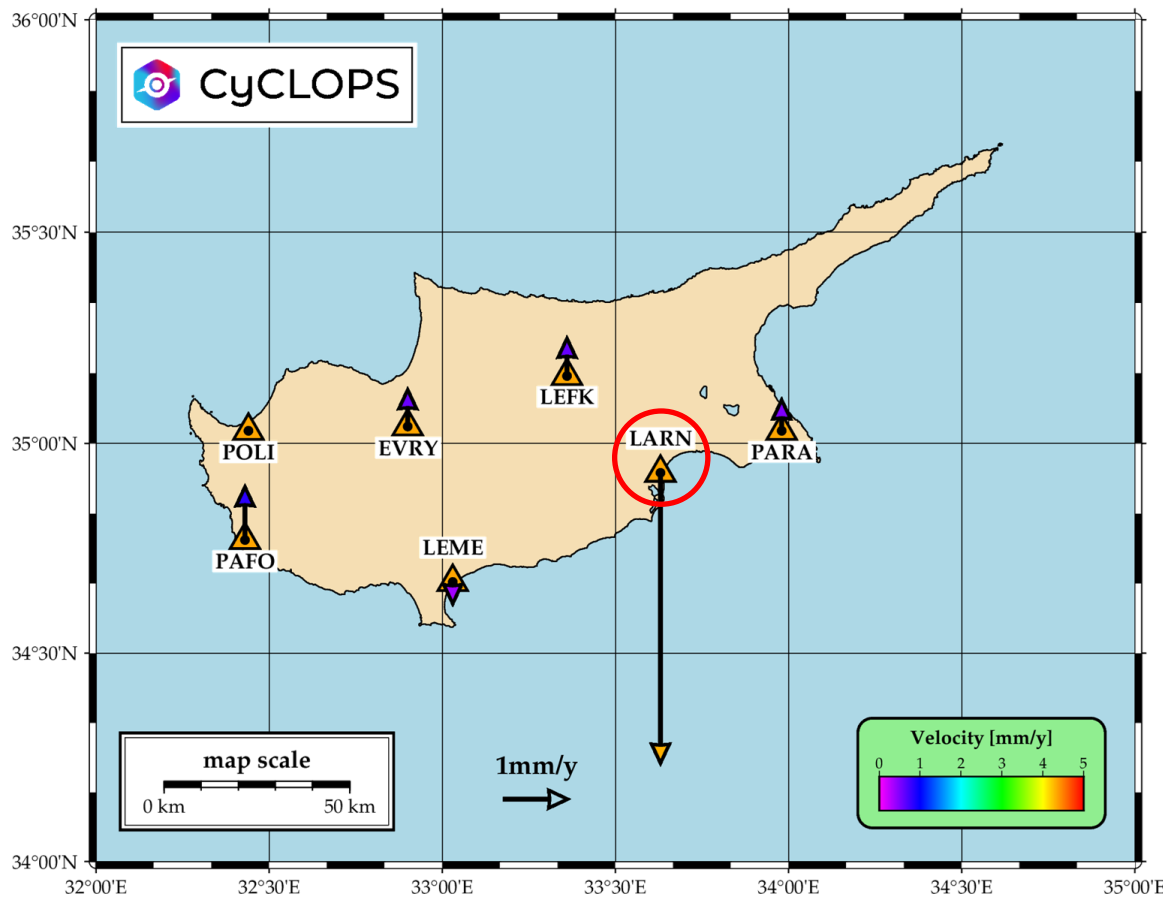
CyCLOPS Products

Velocity Estimation of the Cyprus National RTK Provider Station Network (CYPOS)

CYPOS CORS Horizontal Velocities (ETRF2000)



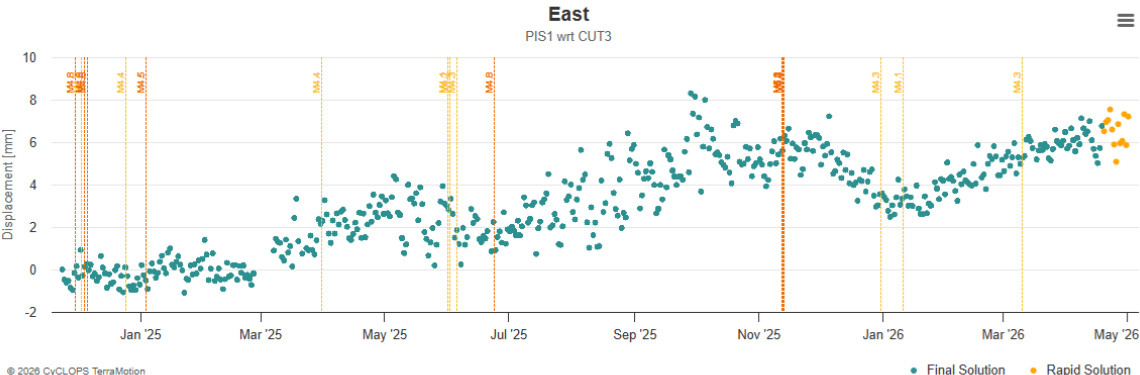
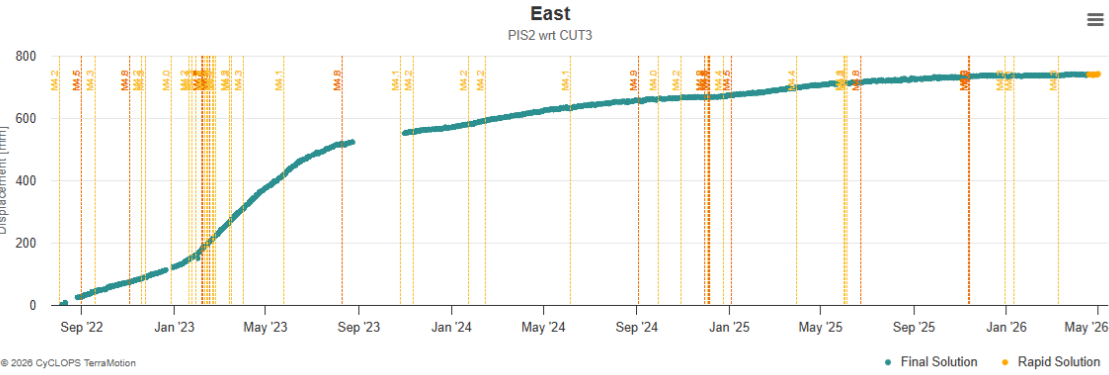
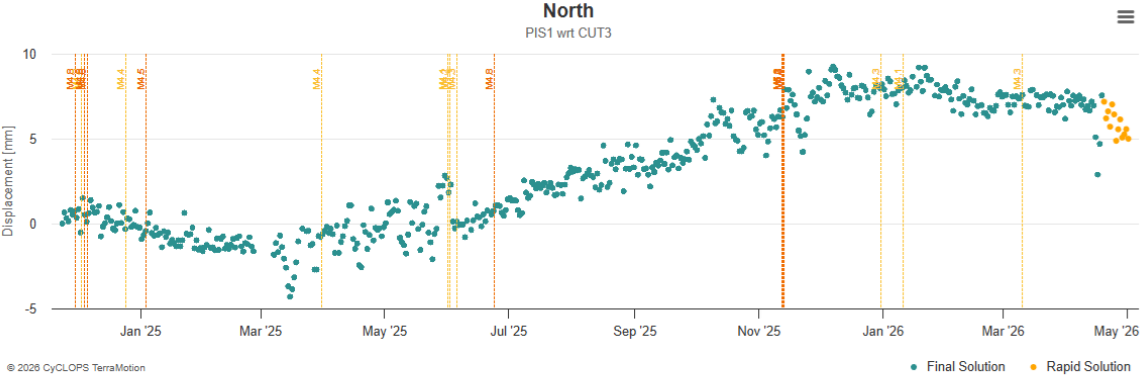
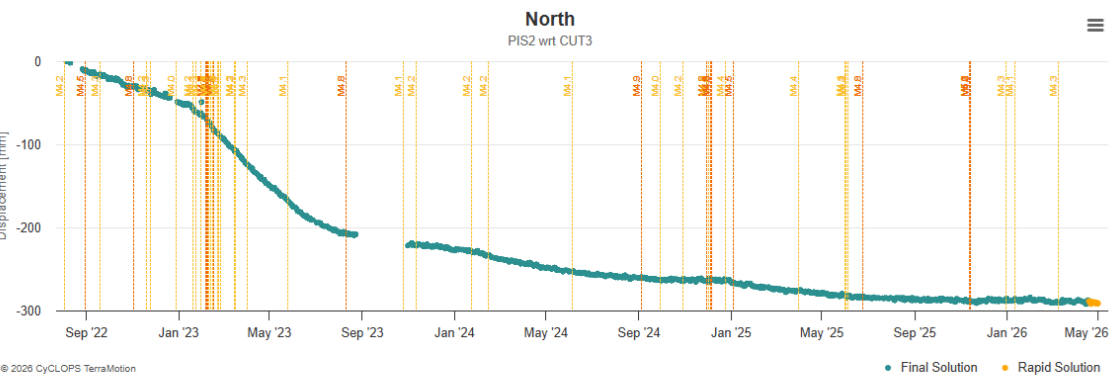
CYPOS CORS Vertical Velocities (ETRF2000)



Processing Period: 2011 - 2025

Monitoring an Active Landslide

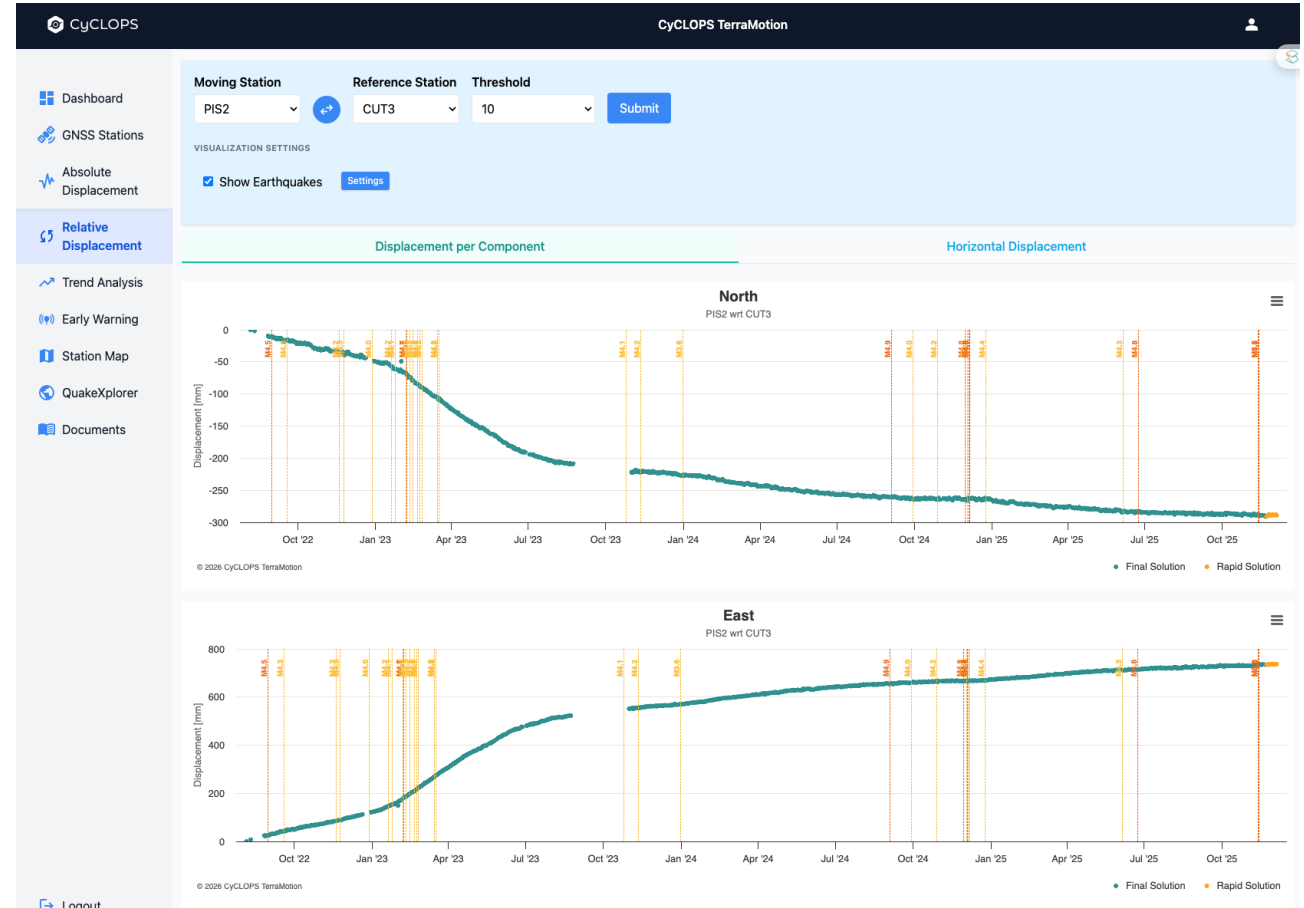
Pissouri Village — daily NEU time series, rapid (1 d) and final (15 d) solutions



Observations reach users as a service

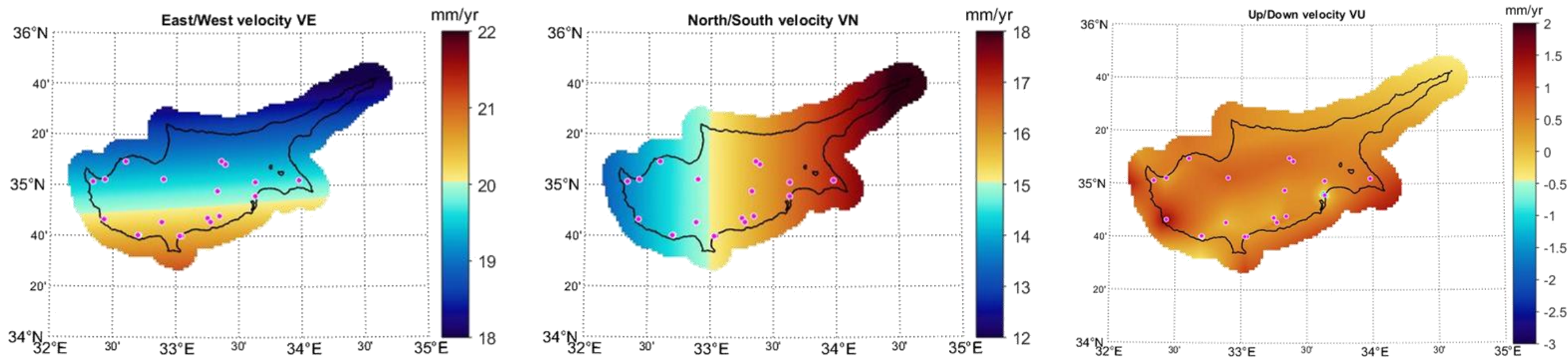
Inventory, displacement, trend analysis, alerting and earthquake catalogue

- **Station inventory** — metadata and site photographs
- **Absolute displacement** — daily NEU, rapid (1 d) and final (15 d)
- **Relative displacement** — baselines to reference stations
- **Trend analysis** — localised linear trends, 15 d and 30 d
- **Alerting** — yellow/orange/red at station and block level
- **Rainfall** — WMO compliant rainfall analysis fed by our rain-gauges in Pissouri.
- **QuakeXplorer** — searchable multi-source earthquake catalogue



National Velocity Model

Estimation of the first velocity model for Cyprus

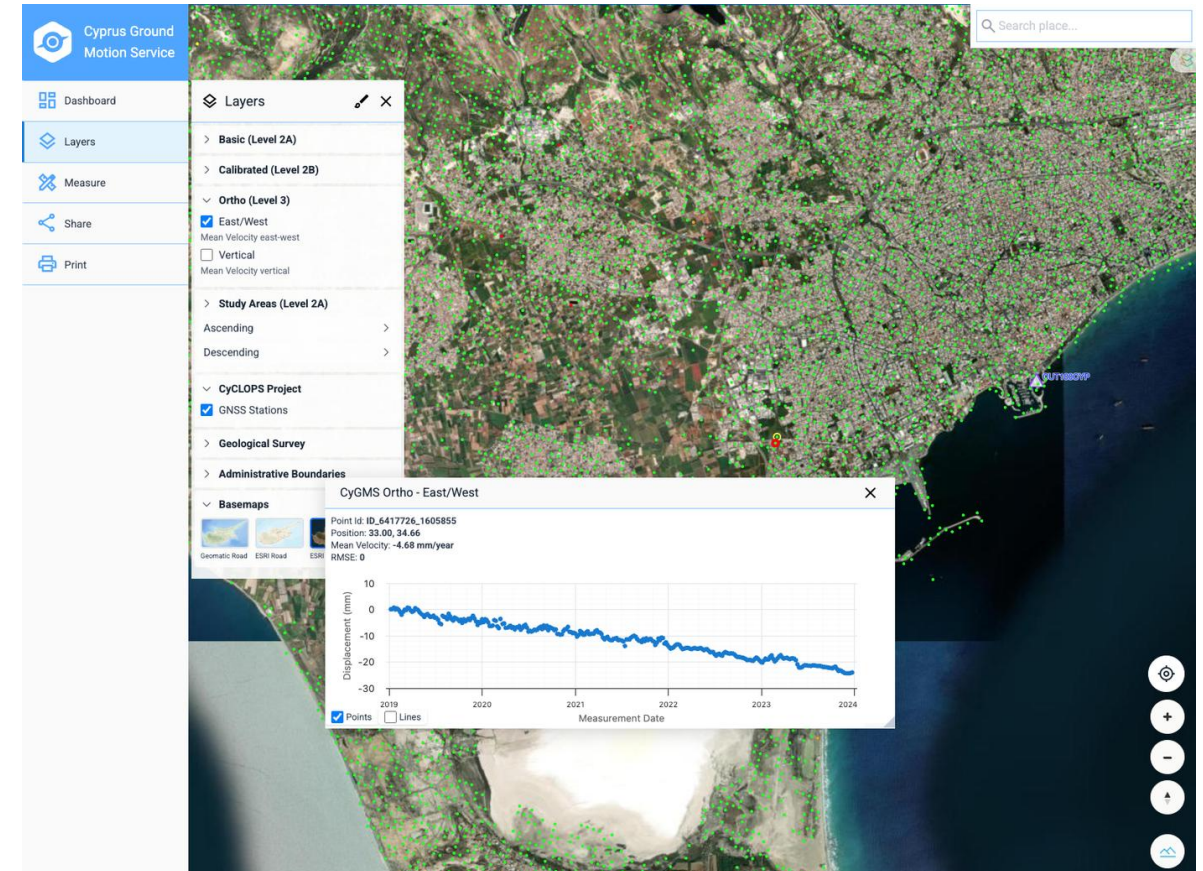
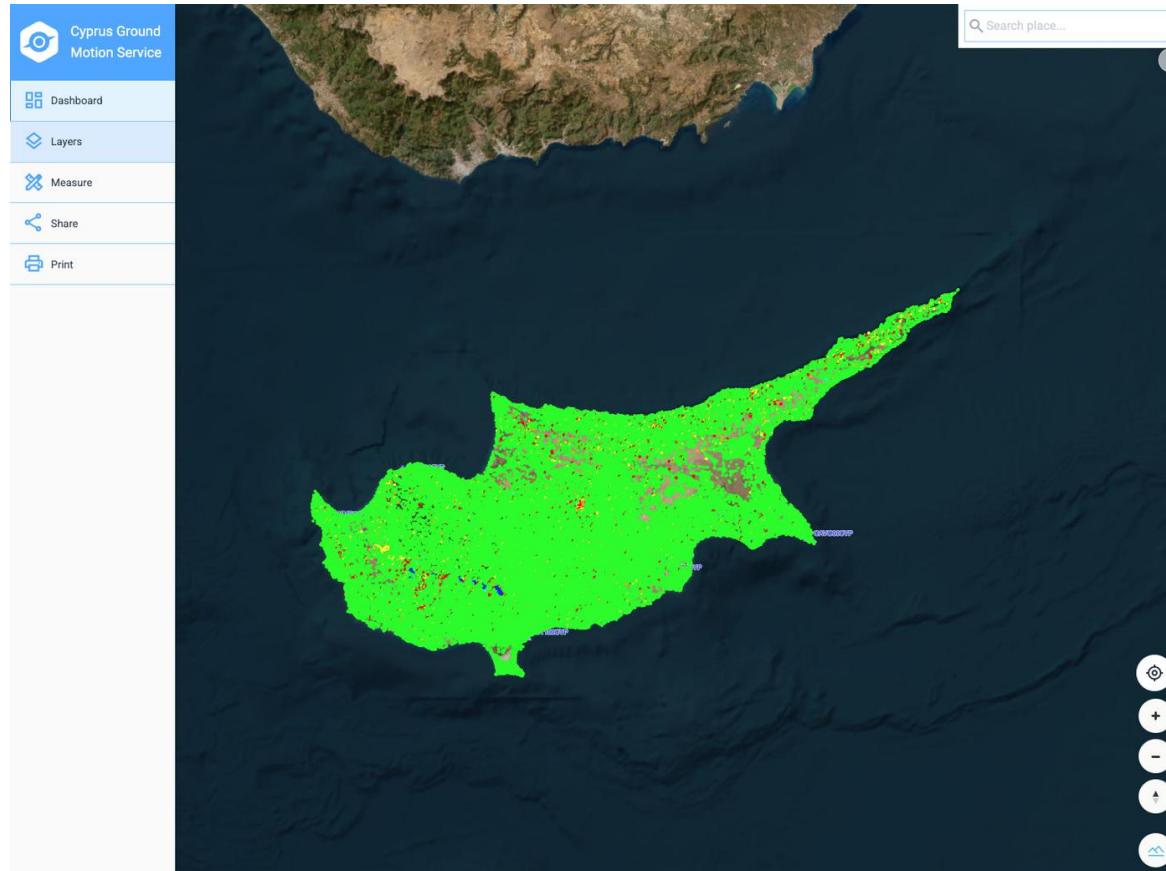


💡 Euler Pole-derived model from selected GNSS velocities

💡 Natural Neighbor interpolation from selected GNSS velocities

CyGMS: National Ground Motion Service

EGMS-interoperable basic, calibrated and ortho products in both ETRF and ITRF

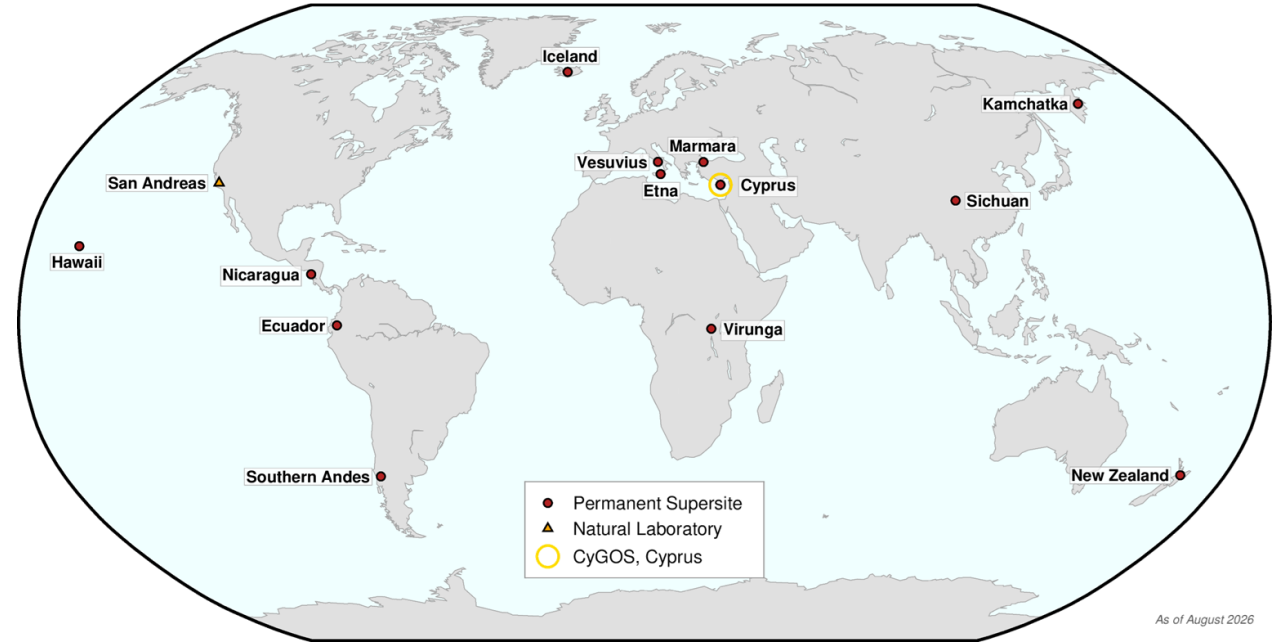


<https://cygms.cut.ac.cy>

Geohazards Supersites and Natural Laboratories

The transition from an infrastructure to a Permanent GEO-GSNL Supersite

- Proposal submitted in 2024 and assessed by CEOS
- In November 2025, CyGOS became the **14th permanent supersite**.
- So far, the CyGOS team has received SAOCOM (L-band) and COSMO-SkyMed (X-band).
- Reception of PLEIADES is planned in the forthcoming months.



GEO-GSNL: an initiative of the Group on Earth Observations (GEO) under which the space agencies of the Committee on Earth Observation Satellites (CEOS) provide high-resolution (commercial) satellite data over designated hazard sites, and the site operators open their in-situ observations and results in return. CyGOS holds Permanent Supersite designation.

A Two-way Exchange for Mutual Benefit

We receive mission data; we return CORS observations, Cal/Val and a SAR testbed

- **What we get:**
 - High-quality EO data from CEOS missions
- **What we provide:**
 - GNSS CORS data (currently supporting EPOS, EPN)
 - Corner Reflector validation (CEOS WG Cal/Val communication initiated)
 - Testbed for current & Future SAR missions
 - Derived deformation products
 - A dedicated API service is currently under development to enable flexible data + products dissemination to the scientific community

CyGOS



Biannual progress assessment

A three-tier governance model

National backbone, scientific partners, and the wider GSNL/CEOS community

Who uses the products

Mitigation — Geological Survey Dept

Preparedness — GSD, Civil Defence

Response — Civil Defence

Recovery — Ministry of the Interior

Science — GSNL, universities

Tier 1: Core National Layer

- CUT (Coordinator & Technical Backbone)
- GSD (End-user Authority)

Tier 2: Core Scientific Partners

- DLR
- AUTH
- NOA

Tier 2 is open

We invite new scientific partners to join

Tier 3: Wider Community

- GEO-GSNL
- CEOS

Roadmap

What is next?

- Multi-SAR Integration (Q2 2027)
- New version of CyGMS (Q3 2027)
- Permanent segment densification (end of Y3)
- Delivery of API and other data + products dissemination services (end of Y1)
- Second version of EWS (Q2 2027)
- Go regional



CyGOS is transitioning from a national infrastructure to an operational GSNL Supersite delivering calibrated, multi-sensor geohazard intelligence.





For further information contact

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THANK YOU



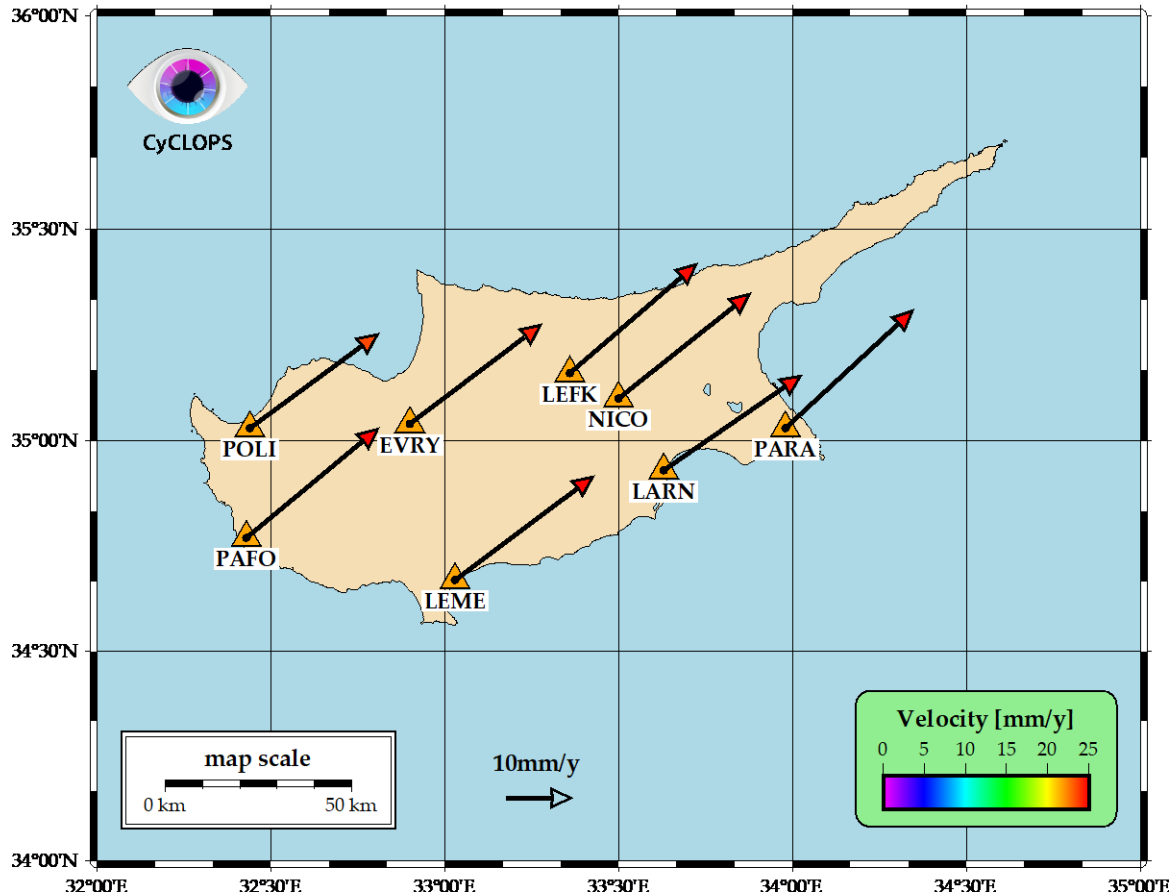
Backup

Supporting material

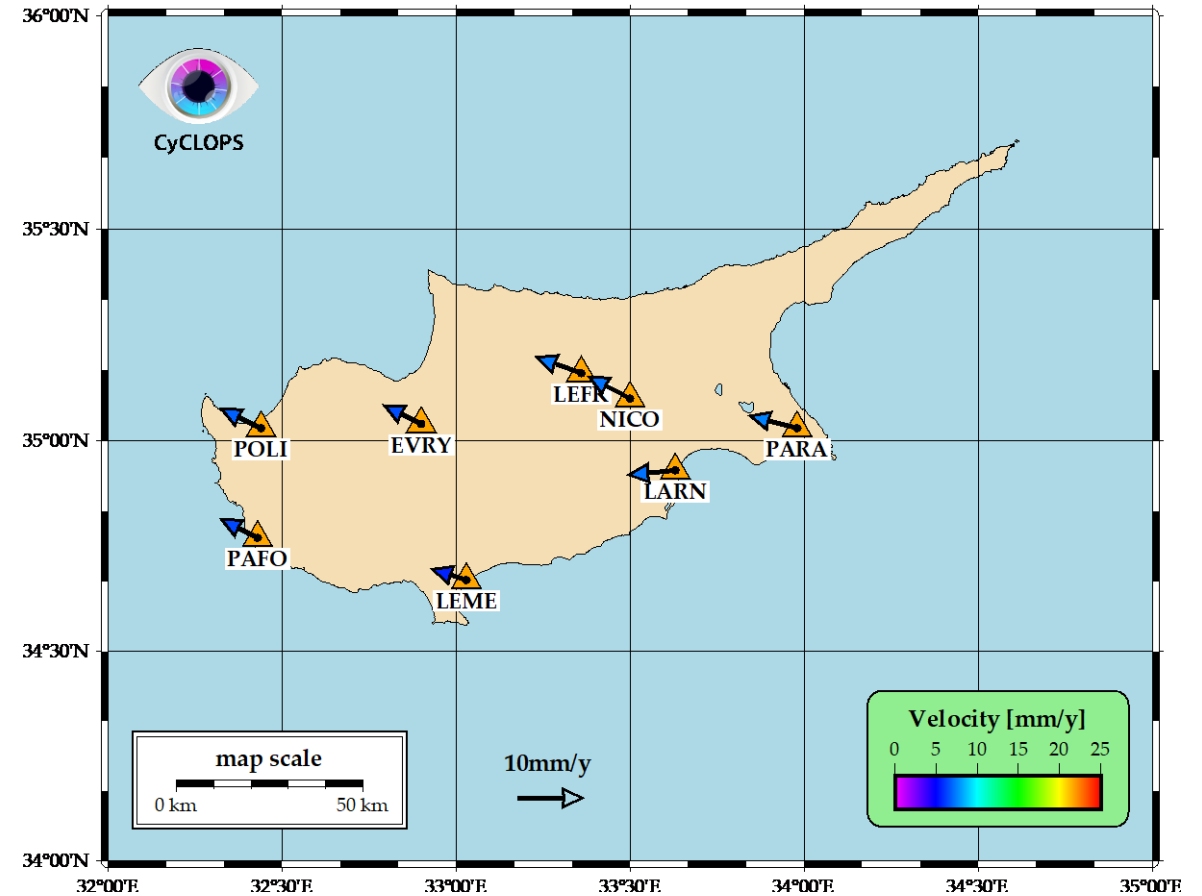
B1 — Velocities in ITRF2014 and ETRF2014

Horizontal fields, CYPOS CORS network, 2012–2020

CYPOS CORS Horizontal Velocities (ITRF2014)



CYPOS CORS Horizontal Velocities (ETRF2014)



Processing Period: 2012 - 2020

B2 — Monumentation

Type 1 UNAVCO shallow drilled braced; Type 2 in-house stainless truss

- Two types for Tier-1 monumentation:
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Type 1



Type 2

💡 **Electrostatic paint coating for increased durability and corrosion avoidance**

💡 **High stability monumentation according to UNAVCO ranking**

🌟 **Zero-order reference points**

B3 — Power and telemetry

Solar, 330 Ah bank (5 days autonomy), airFiber link, 24/7/365 operation

Features:

- Designed according to our own specific requirements;
- Made of **stainless steel** with a **custom ventilation system**;
- **Solar powered**;
- 6x batteries yielding a total electric charge of **330Ah** (5 days of light outage);
- **Battery balancer** and **telemetry** modules to monitor energy output on a 24/7/365 basis;
- **System telemetry** is carried out via **airFiber** connection.



B4 — ASGA station

Type 1 monument; contributes to EUREF (EPN) and EPOS



B5 — Corner reflector design

Azimuth $\pm 180^\circ$, elevation -10° to $+45^\circ$, 2 m corner length

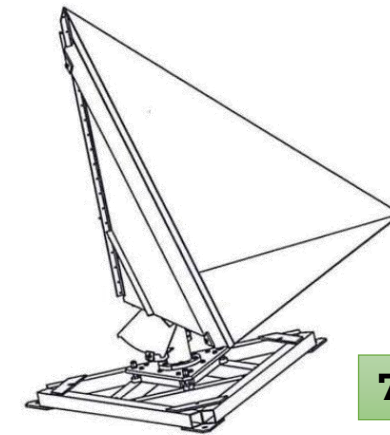


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Azimuth Adjustment Range: -180° to $+180^\circ$

Elevation Adjustment Range: -10° to $+45^\circ$

**Permanent Monumentation Considerations
(anchored in solid bedrock)**



7.1K EUR / unit

Support for Sentinel-1, TerraSAR-X, COSMO-SkyMed etc (2m corner length)

B6 — Mobile segment equipment

Mobile CORS, terrestrial laser scanner, UAS, electronic corner reflectors

- **5x mobile integrated GNSS CORS** deployed in areas on interest (Aoi)
- Same GNSS, weather station and tiltmeter equipment as in the PS
- **1x Terrestrial laser scanner** (Trimble® X9) for accurate mapping while monitoring landslides and dynamic incidents.
- **Tactical-grade UAS** (AgEagle eBee X RTK)
- **2x MetaSensing Electronic Corner Reflectors** (ECR) collocated with mobile GNSS CORS

Specifically-designed mast to minimize **thermal expansion** and contraction effects



B7 — EO data

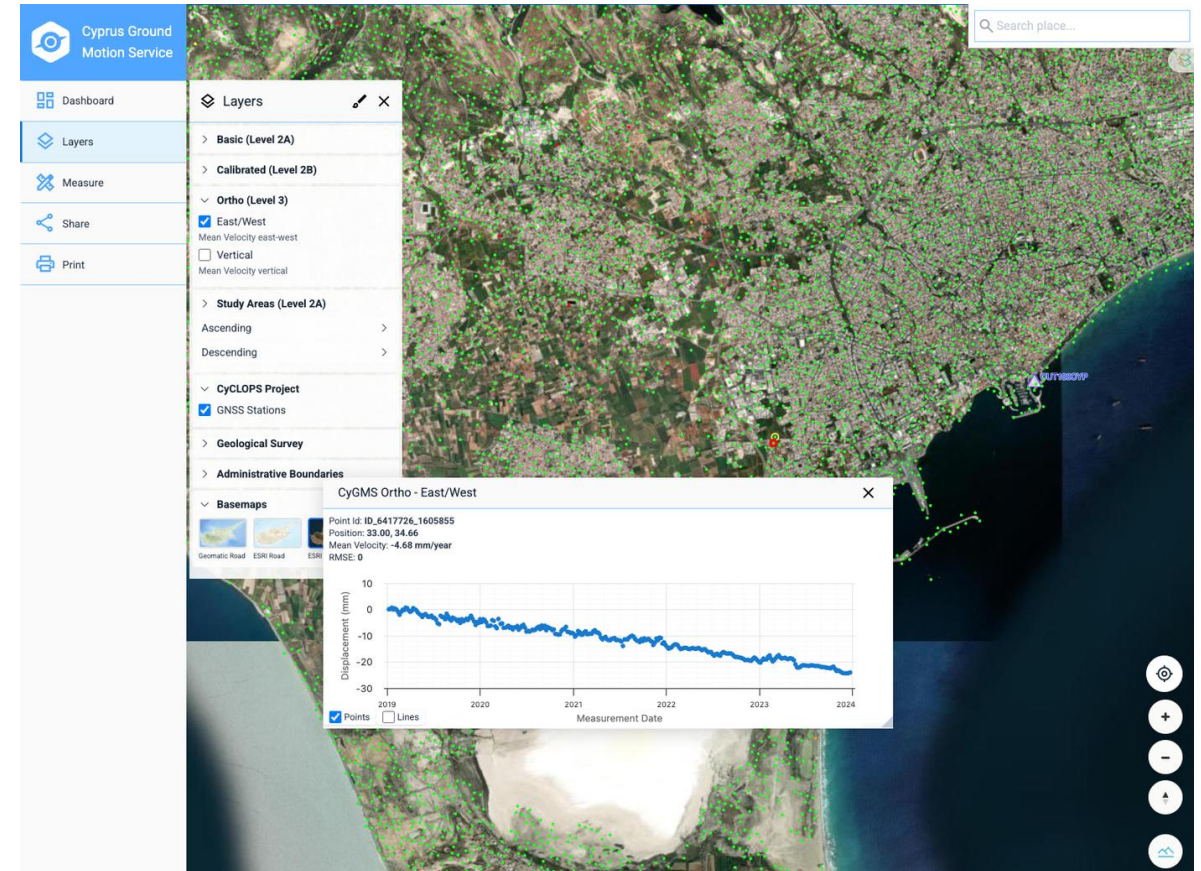
Sentinel-1 baseline; COSMO-SkyMed, SAOCOM and TerraSAR-X requested

■ Main EO Sources:

- Sentinel-1 (baseline)

■ Requested Data:

- COSMO-SkyMed (high resolution X-band)
- SAOCOM (L-band)
- TerraSAR-X (targeted monitoring, previous request)
- PLEIADES (?)

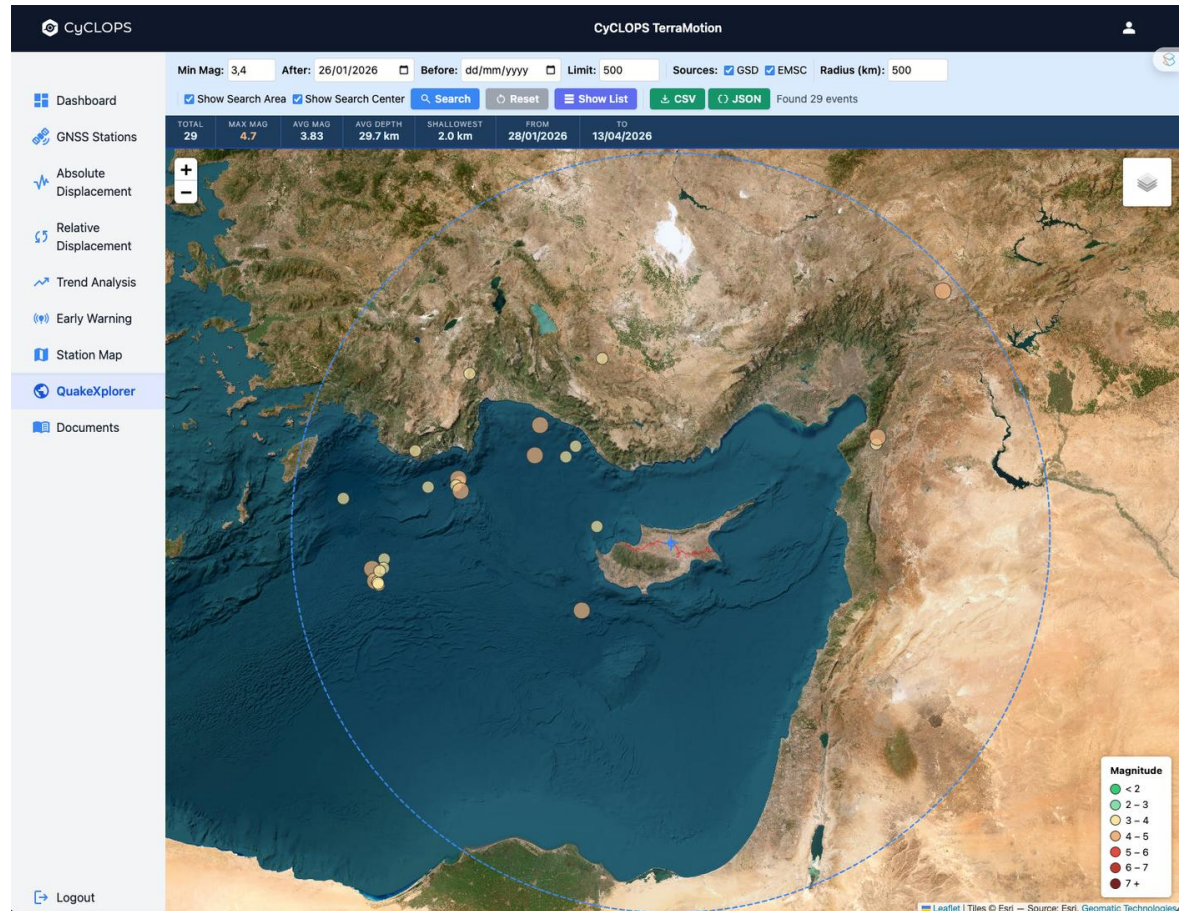


B8 — Platform detail

Trend analysis, alert thresholds and QuakeXplorer

Platform Modules

- **Trend Analysis:** Localized linear trends at 15d and 30d time periods (P01-P99 velocity breakdown)
- **Early Warning System:**
 - Displacement alerts (YELLOW/ ORANGE/ RED) at station and kinematic block-level.
- **QuakeXplorer:** Multi-source searchable earthquake catalog with filtering and data export functionality



What is CyGOS?

A national geodetic observatory built on CyCLOPS, and a GEO-GSNL Permanent Supersite

