

Schweizerischer Erdbebendienst  
Service Sismologique Suisse  
Servizio Sismico Svizzero  
Swiss Seismological Service

**ETH** zürich

# The future strong motion national seismic networks in Central America designed for earthquake early warning.

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MINISTERIO DE  
MEDIO AMBIENTE Y  
RECURSOS NATURALES



OVSICORI-UNA  
INSTITUTO DE INVESTIGACIONES OBSERVATORIO  
VULCANOLÓGICO Y SISMOLÓGICO DE COSTA RICA



Schweizerische Eidgenossenschaft  
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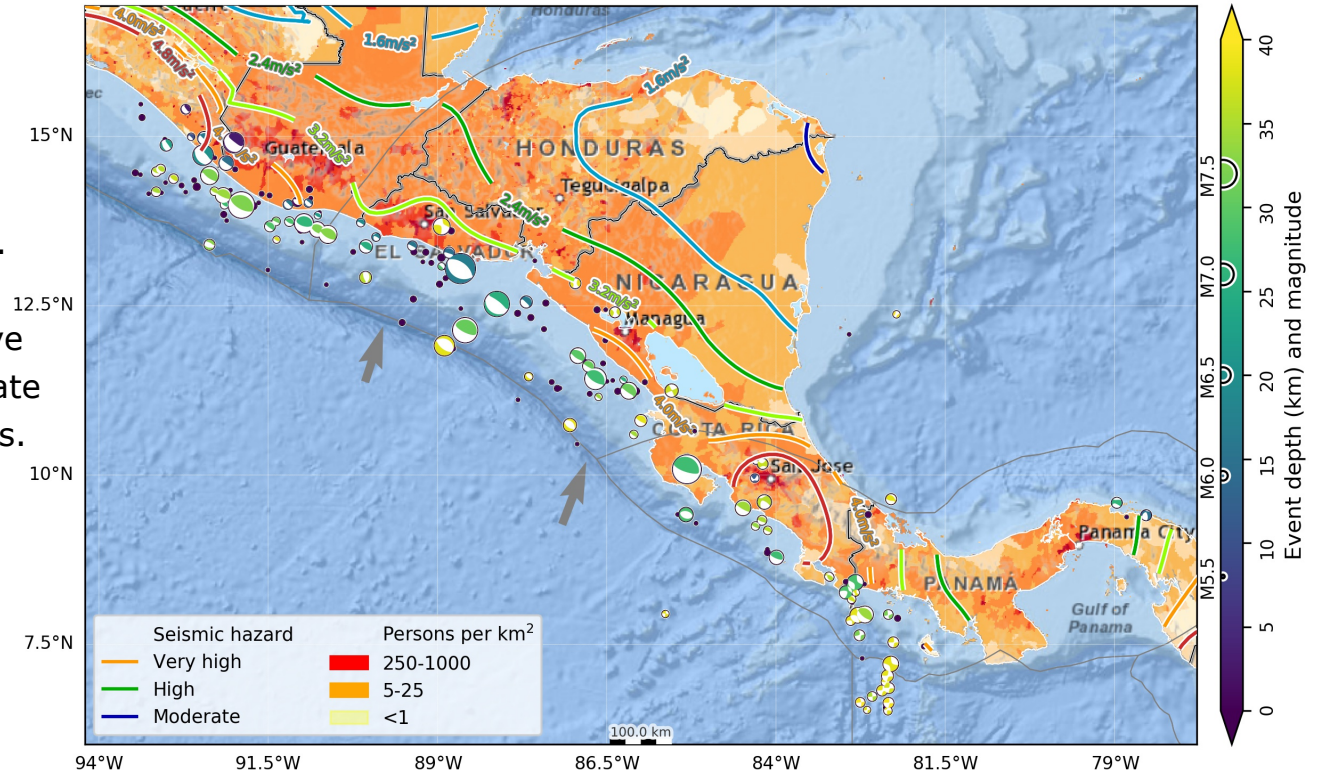
Swiss Agency for Development  
and Cooperation SDC



# Why is EEW important in Central America?

## And what to expect?

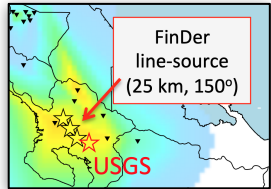
- **Cities at high risks:** major urban centres in CAM lie within high seismic hazard contour lines. The biggest earthquakes occur offshore. The most dangerous earthquakes are the massive offshore events and moderate events under the main cities.
- **EEW cannot always be provided:** at best, EEW can provide only seconds of warning for on-shore earthquakes, and may only provide alerts after strong motion starts in some cases.
- **Rapid earthquake notification matters during large earthquakes:** an EEW-ready network will provide rapid earthquake notification for all earthquakes, before systemic infrastructure failures begin.
- **Enhancing the big picture:** an EEW-ready network enables tsunami early warning and enhances volcano early warning.





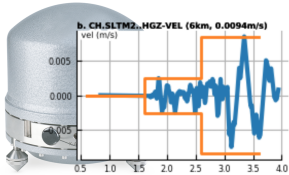
# EWARNICA2: A Swiss/Cam collaboration (2018-2021)

EWARNICA builds EEW capabilities at the national level.  
EEW *strengthens societal resilience* and can **save lives** in future seismic crises.



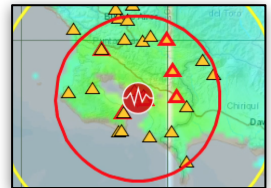
## Outcome 1: Science.

Improved EEW performance for application across Central America - Methods. Enabling EEW in Central America



## Outcome 2: Performance and Deployment.

Extension of the geographical coverage of EEW in Nicaragua and across Central America - Networks



## Outcome 3: Dissemination.

Extension of the reach of the EEW beyond the seismological community - Outreach. Moving towards operational EEW in Nicaragua and El Salvador.

- **Methods dev. & perf. tracking:** SED-ETHZ
- **Playbacks:** INETER, RSN, MARN, OVSICORI.
- **Systems:** INETER, MARN, RSN, OVSICORI.
- **Instrumentation:** INETER (**25 new EEW-ready permanent stations**), MARN (**25**), INSIVUMEH (**13**), UP (**4**), UNAH/COPECO (**4**).
- **Communication:** INETER.

Additionally, EWARNICA also means:

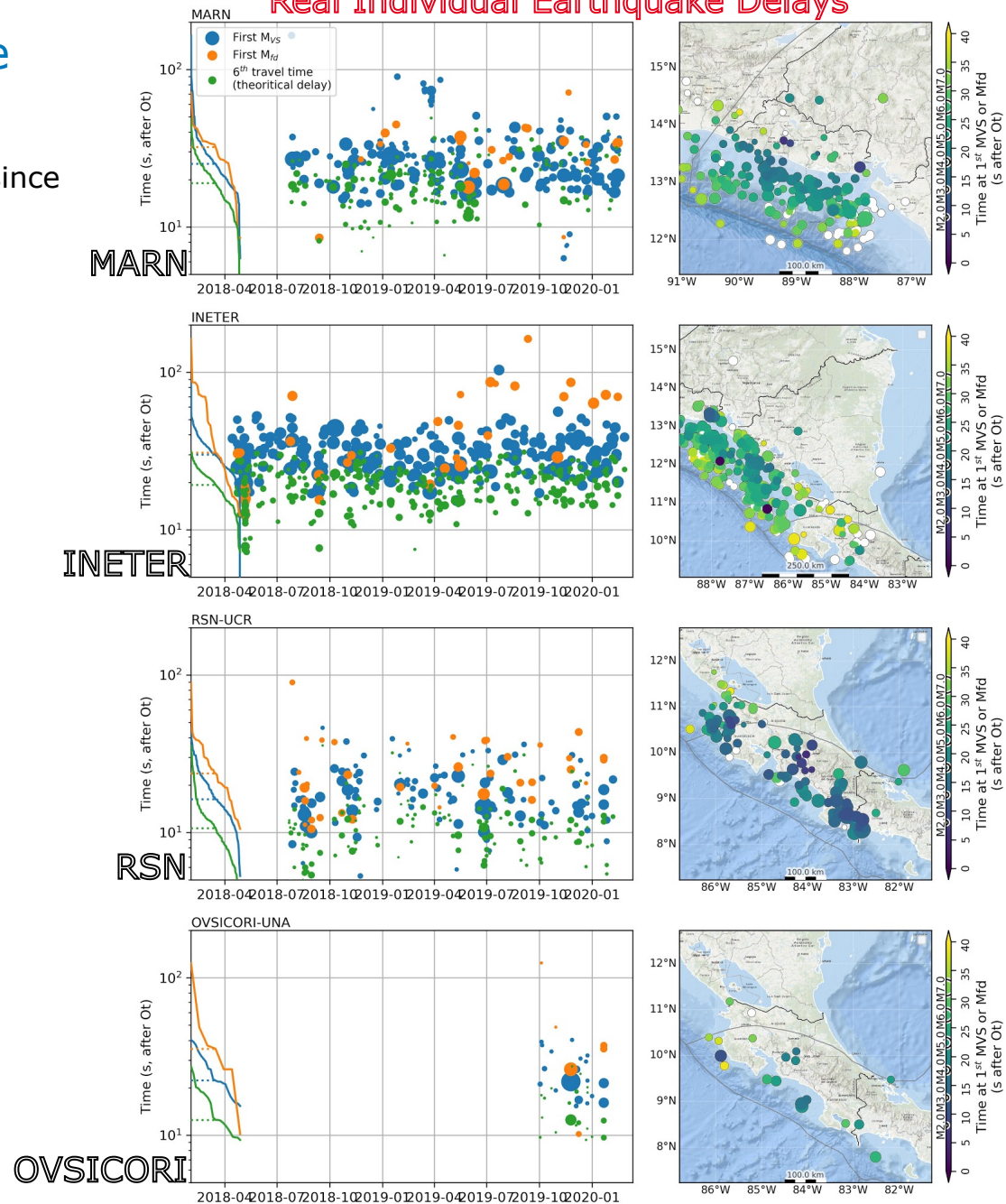
- ensuring each seismic network operates at **excellent level**,
- **training, supporting and building capabilities** at *each* participating seismic network,
- fostering **best practice, collaboration and data sharing** across the region,
- **strengthening ties** between science, civil authorities, and the public,
- a platform that can be used to secure **long term funding** in the region.



## Is EEW currently feasible in the region?

Figure shows actual **delays** from real events since 2018 at each network.

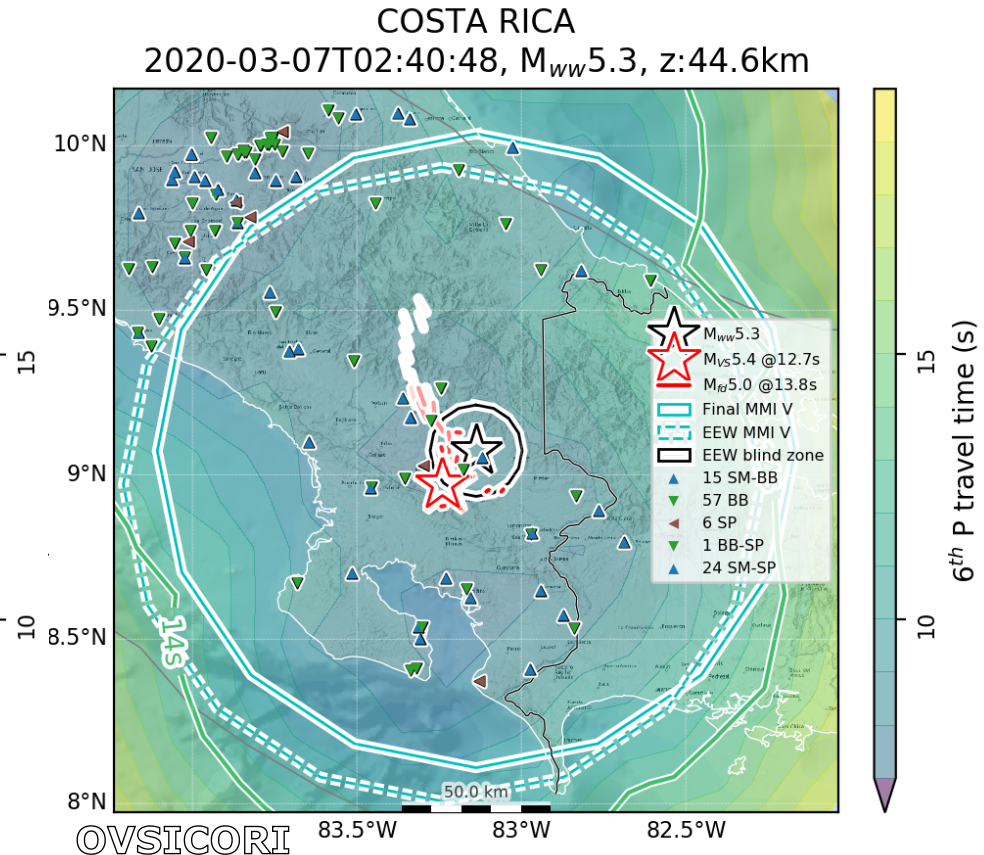
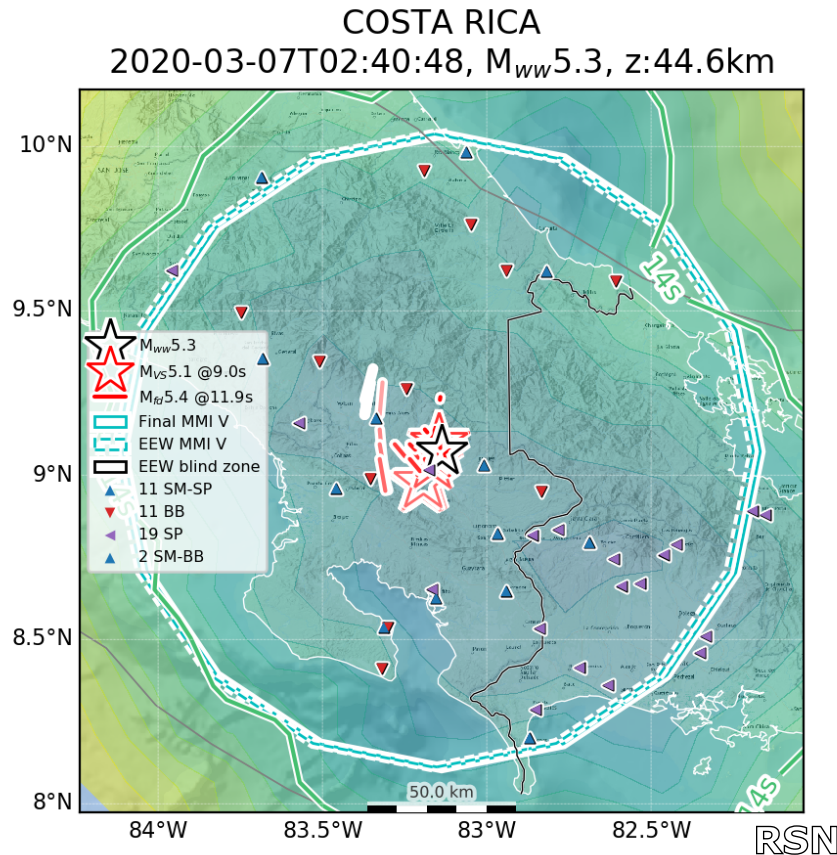
- **El Salvador / MARN:** Considering that the majority of earthquakes are offshore, results are quite encouraging. Positive warning times for San Salvador are already being reached for subduction events
- **Nicaragua / INETER:** Considering that earthquakes are both onshore and offshore in Nicaragua, results can be improved
- **Costa Rica / RSN:** Considering that earthquakes are often onshore in Costa Rica, excellent results should be considered with caution.
- **Costa Rica / OVSICORI:** Similar to RSN so far, in progress.





# EEW in Costa Rica is feasible

## Event Review for M5.2 Golfito (40km) event (RSN + OVSICORI)



### The 2020-03-07 Mw5.2 Golfito earthquake in Costa Rica:

- Very (@RSN) similar actual and model performances.
- EEW @ MMI>IV in a 20km (@RSN) to 10km (@OVSICORI) wide area.
- EEW 25s before shaking in San Jose (MMI III-IV).



# The selected accelerograph

Excellent for both general and EEW-specific uses  
**if installed and maintained with best practices.**

## Class A accelerometer:

- Excellent noise resolution - reaches below many broadband sites in the region.
- High performance and linearity during strong motion.

## EEW-ready single-unit instruments:

- Robust packaging and hardware (ease of deployment, configuration and management).
- Speed and stability of data streaming using SeedLink (all Central American institutes use SeisComP3; EEW to be built on existing networks).

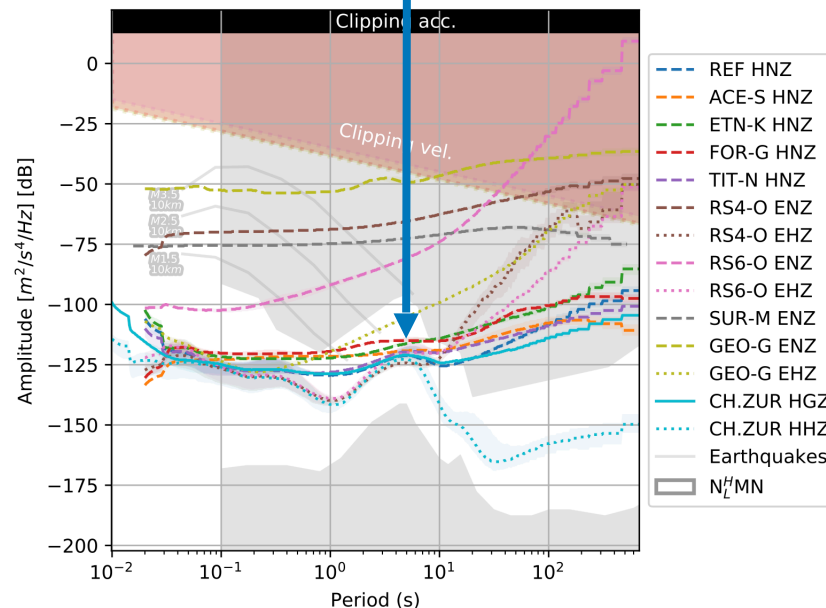


## Capabilities:

- Detection of M1 events at 10 km, improving catalogue completeness.
- Broadband signal, recording static displacement complimentary with GNSS network.
- High gain, will not clip during large events, unlike common seismometers.

## Critical issues for deployment:

- Selected sites must minimise environmental noise sources (***never*** inside buildings, ideally outside towns).
- Maintain up-to-date metadata if anything changes (as with all network stations).
- Maintain operation.
- Sustain real-time data communication.





# Vault design - a first proposal

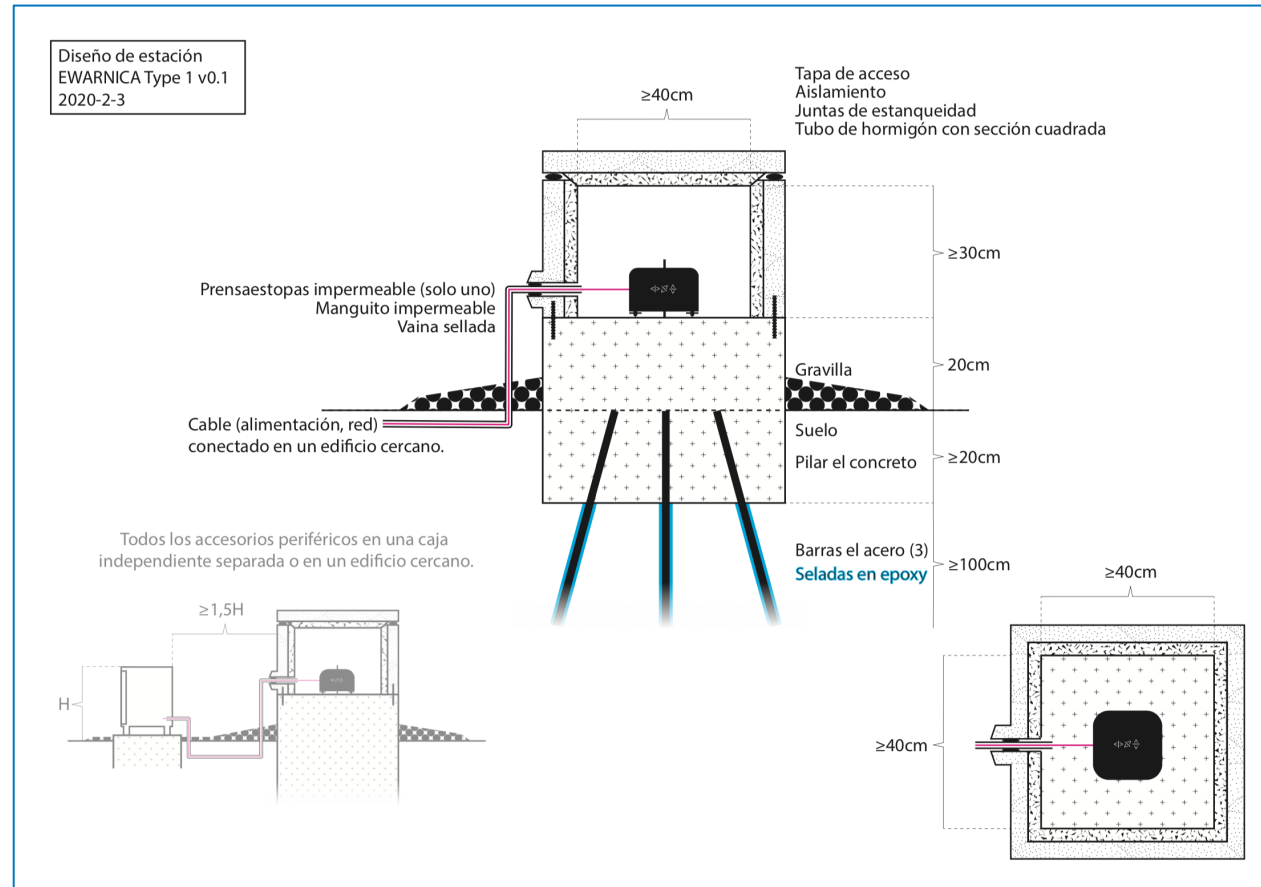
**Goal:** rapid, cheap deployment that can collect high quality **free-field** data with minimal infrastructure.

## Easy building and maintenance:

- A dedicated and separate instrument vault.
- Concrete pillar is above ground level (no flood damage).
- Steel bars can be added for quiet site on soft ground, sealed to host rock with epoxy.

## Requirements:

- Steady real time data communication.
- Stable power supply.
- Thermal insulation (minimise temperature variation at site).
- Protection against lightning, using local knowledge of risk.
- Protection against flooding.



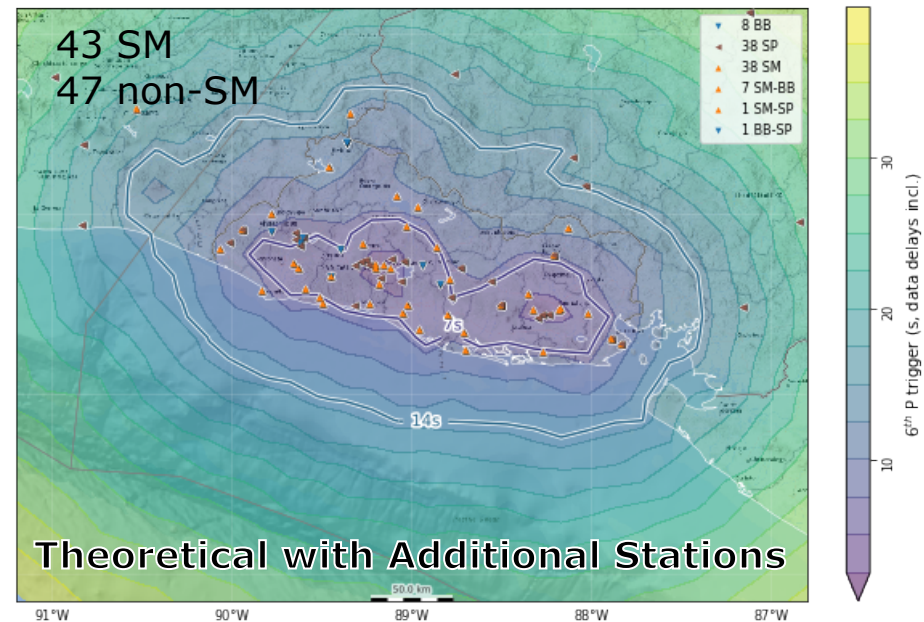
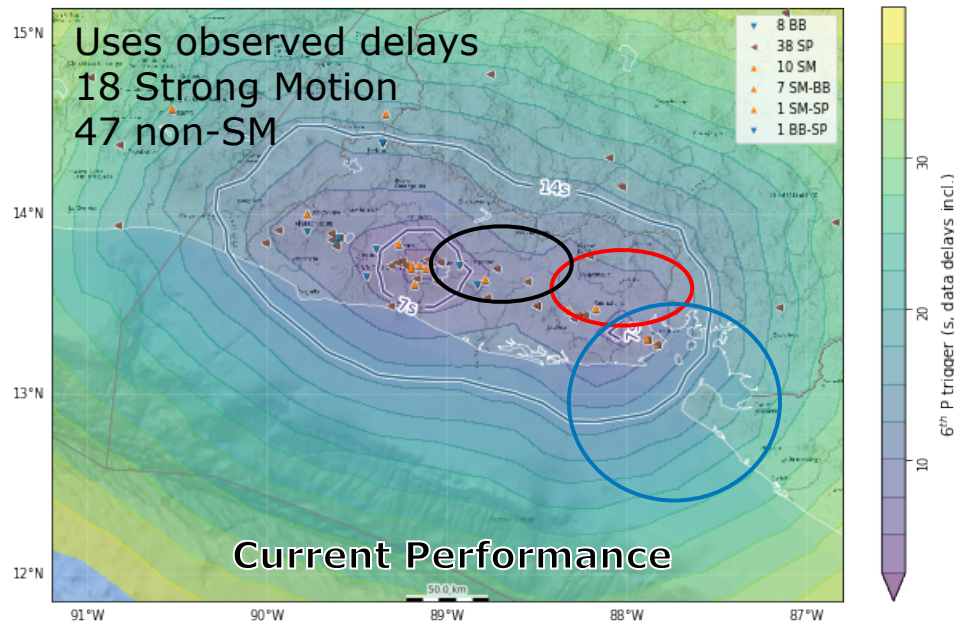


# Deployment performance

## Example: MARN (n:25)

The EEW capability of the National Seismic Networks will be strengthened by the addition of new EEW stations

- **Targets:** in addition to offshore events, MARN aims at the **Gulf of Fonseca**, the **San Vicente** and **San Miguel** crustal fault segments.
- **Sites:** new stations will preferably be built within lands managed by MARN ; MARN has also planned to recycle old unused sites with existing vaults and L-shape pillars.





# Enabling EEW by strengthening seismic networks across Central American

The EEW capability in CAM will be strengthened by the addition of new EEW stations and data sharing.

Note significant differences between theoretical and real performances between Nicaragua and El Salvador - reflecting challenges to share data in this region.

