ΕΡΓΑΣΤΗΡΙΟ ΠΑΡΑΚΤΙΑΣ & ΘΑΛΑΣΣΙΑΣ ΕΡΕΥΝΑΣ
ΙΥΜ - ΙΤΕ

ΛΕΙΤΟΥΡΓΙΚΑ ΜΟΝΤΕΛΑ ΓΙΑ ΤΗΝ ΚΡΗΤΗ

Θαλάσσια κυκλοφορία: POM, Κυματικό: WAM 4th cycle, SWAN

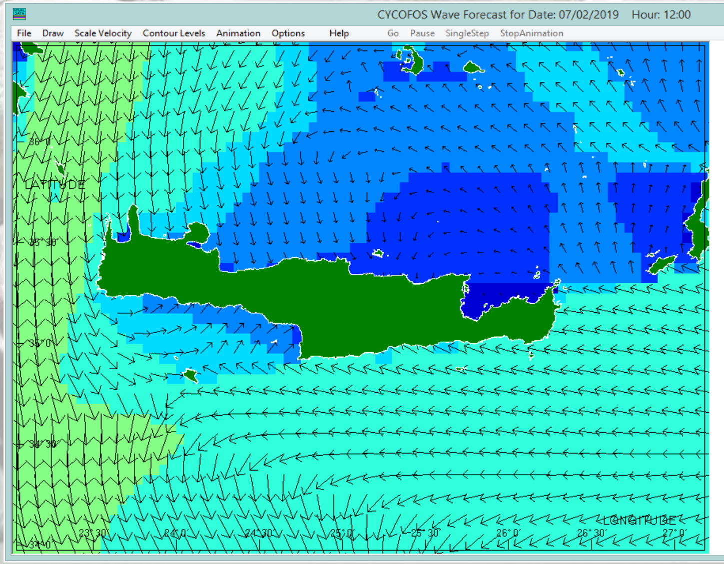
(POM, WAM πλέγμα 1x1 km, χρησιμοποιούνται στην υπηρεσία COASTAL CRETE, SWAN σε ιεραρχικό πλέγμα 5x5 και 1.5x1.5 km)

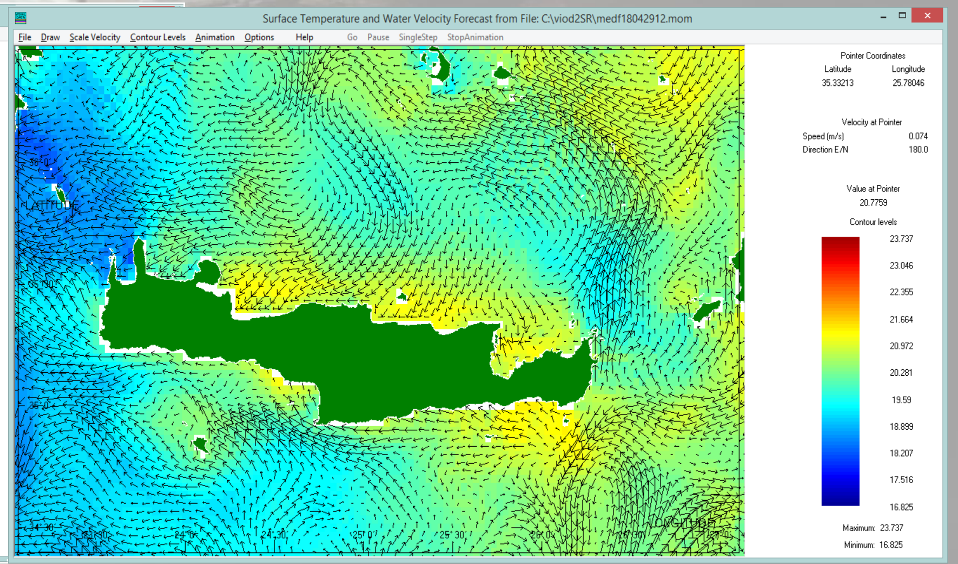
Θαλάσσια ρύπανση: MEDSLIK-II

(πλέγμα POM, για ανάκτηση ρευμάτων)

και Delft3D *(χρησιμοποιείται στα 9 παρατηρητήρια της ΟΔΥΣΣΕΙΑΣ)*

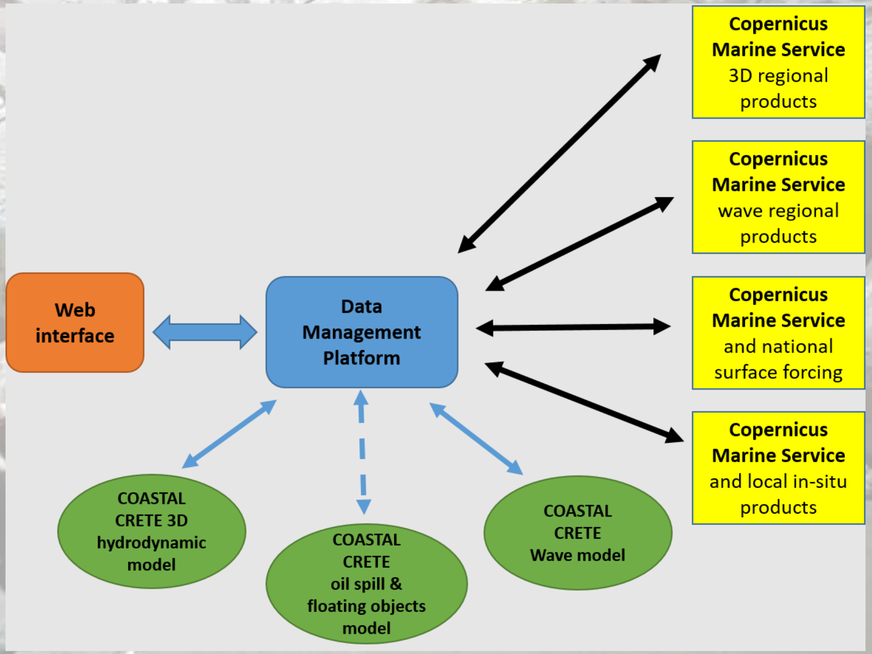
Περιοχή εφαρμογής γύρω από τη Κρήτη

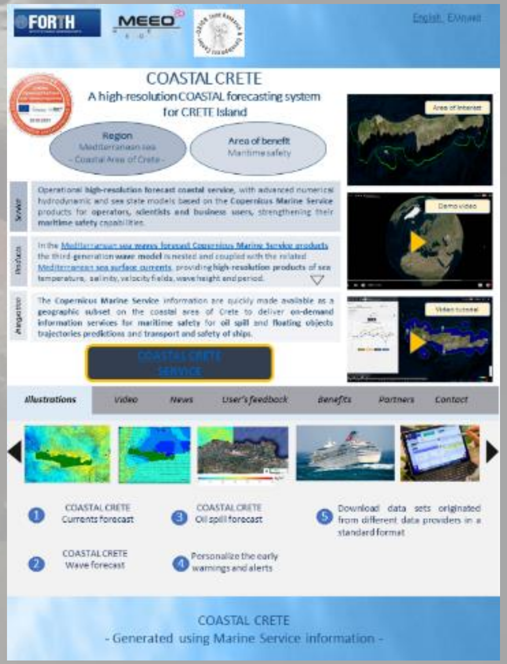




ΥΠΗΡΕΣΙΑ COASTAL CRETE

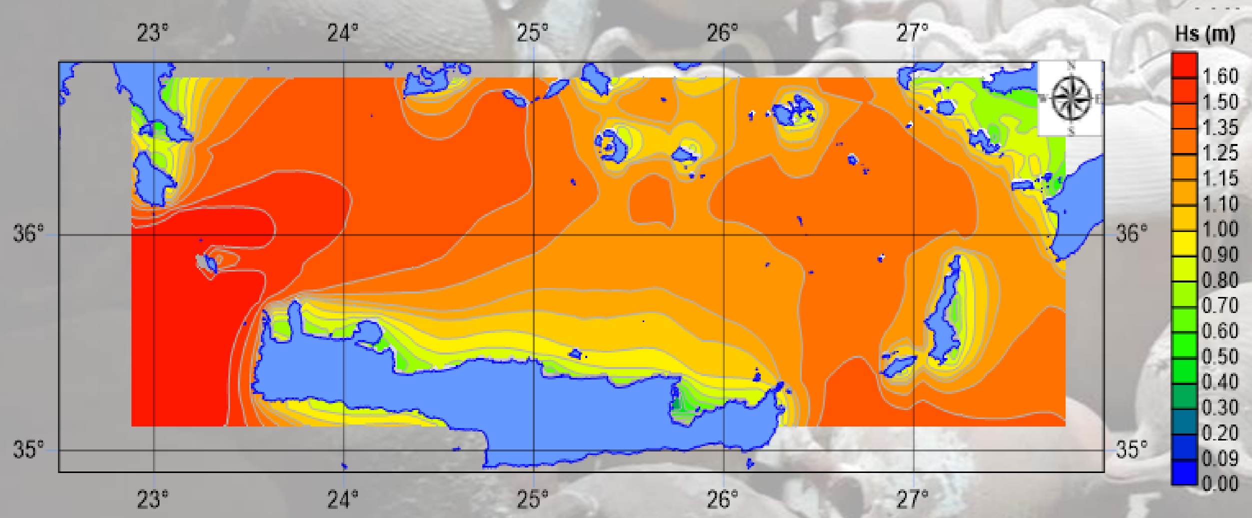
- ✓ Χρηματοδότηση από MERCATOR Ocean International, CMEMS
- ✓ Πρόβλεψη ρευμάτων-κυμάτων γύρω από τη Κρήτη με έμφαση στο παράκτιο χώρο, χρησιμοποιώντας περιοχικά δεδομένα και προϊόντα CMEMS
- ✓ Δωρεάν υπηρεσία για εξοικείωση με τα προϊόντα CMEMS, προσέλκυση νέων χρηστών στη Κρήτη. Υποστηρίζει διαχείριση & σχεδιασμό σε παράκτιο & θαλάσσιο τουρισμό, θαλάσσιες μεταφορές, θαλάσσια επιτήρηση και ασφάλεια (αντιμετώπιση ΚΑ & ρύπανσης)



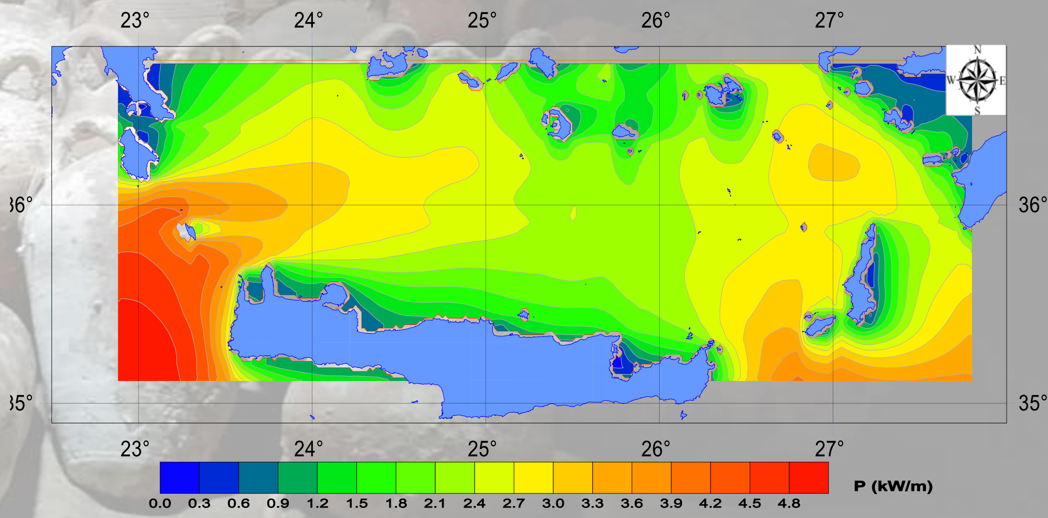


ΑΤΛΑΣ ΑΙΟΛΙΚΟΥ & ΚΥΜΑΤΙΚΟΥ ΔΥΝΑΜΙΚΟΥ ΓΙΑ ΤΟ ΑΙΓΑΙΟ

- ✓ Χρηματοδότηση από ΕΛΙΔΕ/ΓΓΕΤ (Σύμβαση 1237)
- ✓ Εκτίμηση μετεωρολογικών παραμέτρων και ύψους κύματος για υπηρεσία nowcasting (6 ωρών) και πρόβλεψης (3 & 6 ημερών), εποχιακές προβλέψεις και αποκλιμάκωση σε παράκτιες περιοχές της Κρήτης, με χρήση ΤΝ για ελαχιστοποίηση της αβεβαιότητας
- ✓ Ανάπτυξη υπηρεσιών δεδομένων για τον τουρισμό, θαλάσσια επιτήρηση και ασφάλεια



Mean Winter Distribution of Significant Wave Height (Hs)



Mean Annual Wave Power Distribution per Unit Crest

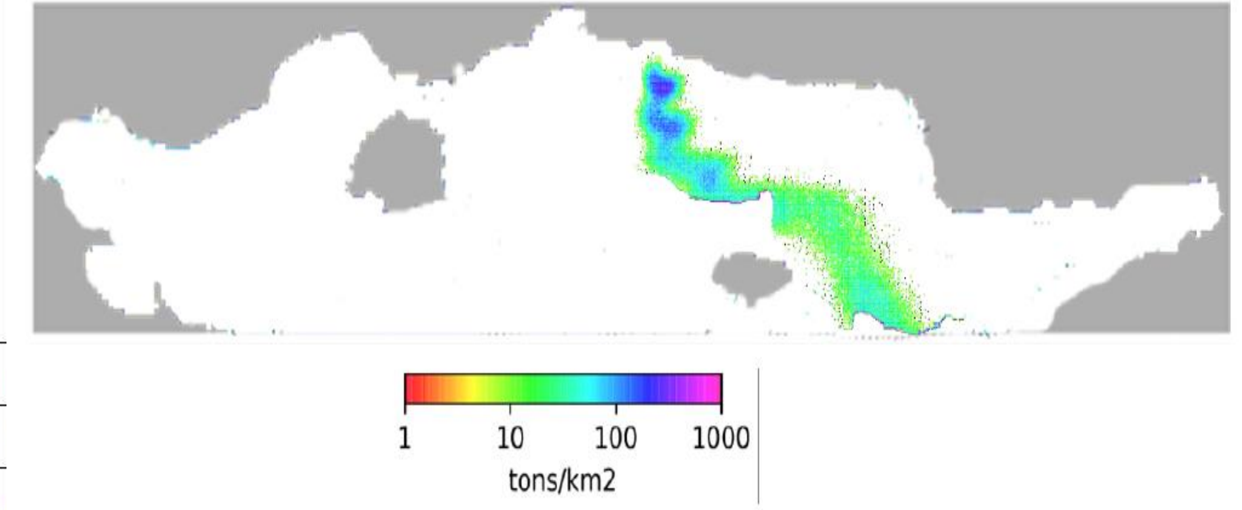
Η ΟΔΥΣΣΕΙΑ στη Καβάλα

Παρατηρητήριο Λιμανιού

Μοντέλο MEDSLIK-II

Ναυτικό ατύχημα στη περιοχή με διαρροή πετρελαίου
10 Νοεμβρίου 2018
Επιφανειακά ρεύματα
10 Νοεμβρίου 2018

Επιφανειακή συγκέντρωση πετρελαίου
15 Νοεμβρίου 2018

Data Information	
Model identifier	Thracian Sea
Domain Name	Thracian Sea
Available Variables	Sea level (m), current speed (ms^{-1}), current direction (^{o}), sea water temperature (^{o}C), sea water salinity
Geographical coverage	
Spatial resolution	
Temporal resolution	
Temporal coverage	
Local Stations	Kavala Port, Kariani buoy
Vertical coverage	From -1372 to 0 m
Hindcast	1 day
Forecast	2 days
Update frequency	Daily

DECATASTROPHIZE EU Humanitarian Aid and Civil Protection

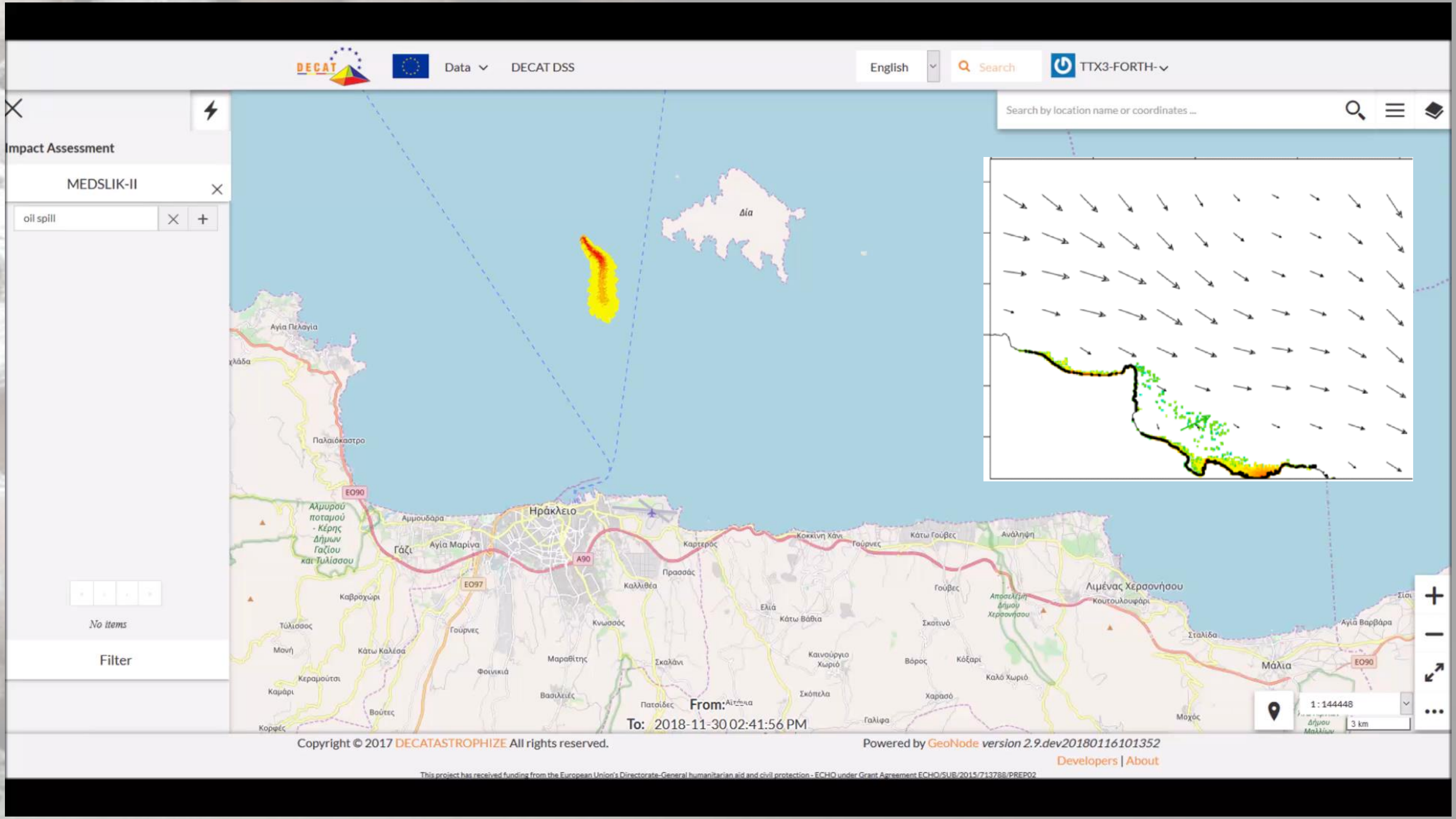
Σύστημα υποστήριξης αποφάσεων/πρότασης δράσεων για την αντιμετώπιση <u>πολλαπλών</u> καταστροφών (πλημμύρα, πυρκαγιά, σεισμός, πετρελαιοκηλίδα). Πολυκλαδική άσκηση ΤΤΧ

ΤΤΧ 21/11/2017

πετρελαιοκηλίδα (MEDSLIK)-ΙΤΕ, τσουνάμι (ComMIT), πυρκαγιά (FARSITE)-ΠολΚ

Συμμετέχοντες: ΠΚ-ΠΠ, Δ-Η&Μ&Χ, πυροσβεστική, λιμενικό, ΕΚΑΒ, αστυνομία, ΕΕΣ, ΟΛΗ, στρατός

Ναυτικό ατύχημα βόρεια του Ηρακλείου με ρύπανση στη ακτή Ένθετη η ακτογραμμή που πλήττεται



EGU2018

Modelling of oil spills from deep sea releases

COASTAL & MARINE RESEARCH LABORATORY IACM - FORTH

Katerina Spanoudaki (1), Nikolaos Kampanis (1), Nicolas Kalogerakis (2), George Zodiatis (3) and George Kozyrakis (1)

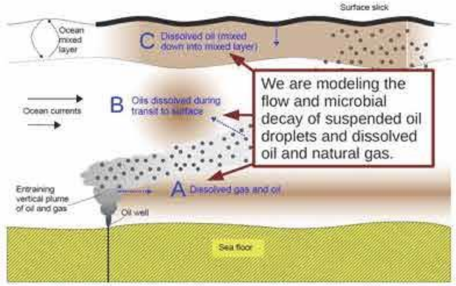
(1) Coastal & Marine Research Laboratory, Institute of Applied and Computational Mathematics, Foundation for Research and Technology-Hellas (kspanoudaki@gmail.com),
(2) School of Environmental Engineering, Technical University of Crete, Greece,
(3) Oceanography Center University of Cyprus, Nicosia, Cyprus

1. Aim & Scope

- Accidental deep-sea oil releases are of particular concern, as the potential for such accidents increases dramatically with the expansion of the offshore industry to more extreme and demanding environments.
- During the 2010 DWH accident, huge amounts of oil were released into the Gulf of Mexico, adversely affecting marine wildlife. What prevented a worse outcome was the ability of nature to degrade oil: **hydrocarbon-degrading microbes can feed on the crude oil**.
- Although **oil biodegradation by native bacteria is one of the most important natural processes that can attenuate the environmental impacts of marine oil spills**, very few oil spill models include biodegradation kinetics of spilled oil, mostly represented as a first order decay process.
- To this end, and prompted by the international tenders for granting exploration and exploitation rights for the block areas of Southwest and West Crete, a new Lagrangian deep-water oil release module has been developed.
- Biodegradation kinetics of oil droplets are represented in the model, to enhance prediction of fate and transport of deep sea oil spills.

2. Model Description

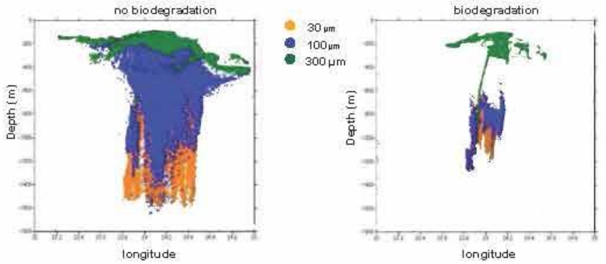
- Representing oil biodegradation as a 1st order decay process neglects the effect of several important parameters that can limit biodegradation rate, such as **oil composition, microbial population, availability of dissolved oxygen and nutrients and oil droplets-water interface**.
- To this end, MEDSLIK-II (http://medslikii.bo.ingv.it/) has been recently modified in the frame of the EU project Kill-Spill (http://www.killspill.eu/), to incorporate biodegradation kinetics of oil droplets (MEDSLIK-III).
- The "pseudo-component" approach has been adopted for simulating oil weathering processes: chemicals in the oil mixture are grouped by physical-chemical properties. The fate of each component is then tracked separately.
- Biodegradation of oil droplets is modelled by Monod kinetics.
- The kinetics of oil particles size reduction due to the microbe-mediated degradation at water-oil particle interface is represented by the shrinking core model.
- A new Lagrangian deep-water oil release module, namely MEDSLIK-DeepSea, has been developed, for predicting the fate of the spill until reaching the sea surface.
- The Lagrangian plume model is represented by elements that trace the plume's trajectory. Each Lagrangian element represents a mixture of water, oil and gas, where the gas might be present in different states, i.e. as free gas in gas bubbles, dissolved in the water phase, or bound in gas hydrates.
- Changes in the mass and composition of the element are accounted for by the turbulent entrainment of ambient water, and by other processes such as leakage of gas bubbles and oil droplets from the plume, dissolution of gas in seawater, and formation or disintegration of gas hydrates.



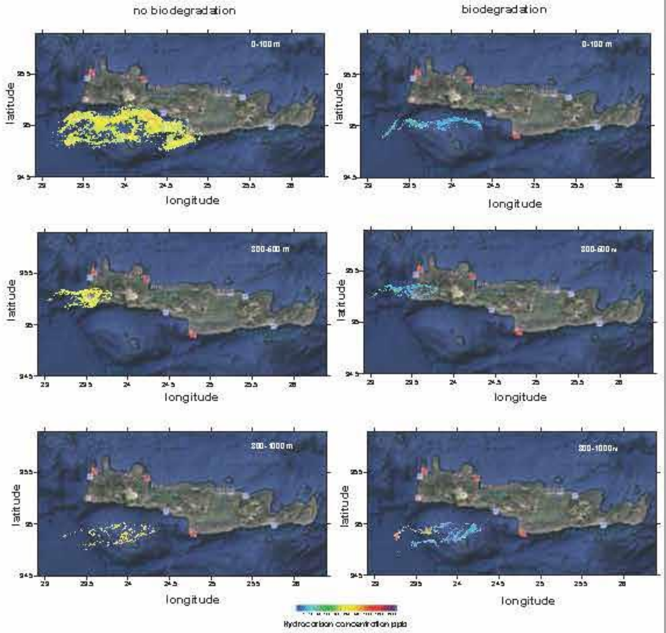
- The motion of the element is computed from the conservation equations for mass, momentum and buoyancy.
- Biodegradation kinetics of oil droplets are also represented in the model, to enhance prediction of fate and transport of deep sea oil spills.
- Based on the rate of the crude oil release and the type of pipe failure, the initial droplet size distribution generated by the jet of crude oil can be estimated. Furthermore, using existing models of dispersants' action, the effect of mitigation measures on biodegradation rates can be quantified.

3. Results & Conclusions

- The new integrated model has been used to simulate the pollution hazard for the coasts of Crete.
- Several scenarios have been considered to assess the interactive effects of **initial droplet size distribution, dispersants' action, and biodegradation on the fate and transport of the subsurface spill.**



- Indicative results are shown for a hypothetical spill, southwest of Crete, of 6000 tons/day of oil and 4000 tons/day of methane.
- An initial droplet size distribution of 10-300 μm is assumed, consistent with droplet sizes of dispersant-treated oil.
- Oil droplets with 300 μm initial diameter rise rapidly to the surface.
- Oil droplets with initial diameter of 30 μm are found mostly in the subsurface after 30 days of spill.
- Differences in horizontal and vertical transport when oil biodegradation is not considered and when biodegradation kinetics are included is related to how long a droplet remains before becoming dissolved.



- The figure shows predicted hydrocarbon concentrations after 30 days of spill, at selected depths, for 2 model scenarios: (a) when oil biodegradation is not considered and (b) when biodegradation kinetics are included.
- Results indicate that biodegradation considerably affects oil transport, increasing depth distributions and decreasing the horizontal distribution of oil droplets.
- Model results when no biodegradation is considered show considerably higher concentrations in mid-depth and, especially, near-surface waters, with a significantly larger horizontal distribution.
- This research indicates that improvement in knowledge of biodegradation processes is important for accurate prediction of subsurface oil spills fate and transport. The integrated model can be used for assessing different bioremediation strategies under deep sea conditions of high pressure and low temperature.

Long-term modelling of the Corsica oil spill fate and transport incorporating biodegradation kinetics

COASTAL & MARINE RESEARCH LABORATORY IACM - FORTH

Katerina Spanoudaki, George Kozyrakis and Nikolaos Kampanis

EGU2019

1. Aim & Scope

- On the morning of October 7th 2018, the Tunisian vessel Ulysse collided with the Cypriot container ship CSL Virginia around 28 km north of Cap Corse, causing the leak of 530 m^3 of Bunker fuel. That day the spill spread over 25 km and formed 7 distinct slicks.
- On the same day, the RAMOGEPOL Agreement between France, Monaco and Italy was and offshore response operations began.
- During the operational phase (11-16 October) 12 spill response vessels recovered over 1,000 m^3 of oily water. On October 16th, oil began to wash up on the shores, along the stretch of the coastline from Cap Lardier to the Gulf of Saint-Tropez. By October 25th it had affected 49 beaches.

- In the present work the spill has been reconstructed using a modified version of the Lagrangian oil spill model MEDSLIK-II.
- The model has been forced using hourly ocean currents at a horizontal resolution of 1/24° provided by CMEMS and ECMWF 6hr analysis atmospheric fields.
- Model results have been corrected by reinitializing oil spill simulations from the observed locations.

2. Model Description

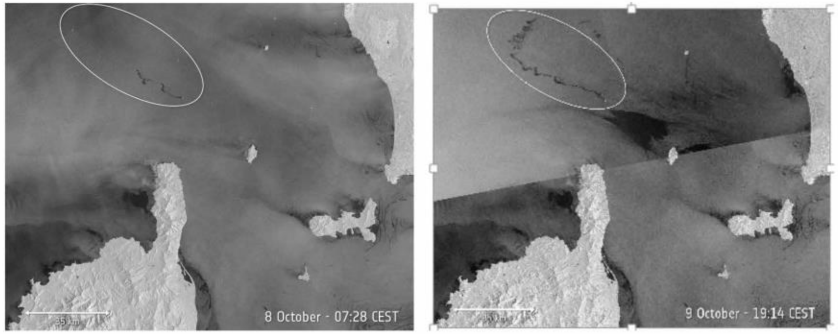
- MEDSLIK-II (http://medslikii.bo.ingv.it/) has been recently modified in the frame of the EU project Kill-Spill (http://www.killspill.eu/), to incorporate biodegradation kinetics of oil droplets (MEDSLIK-III).
- The "pseudo-component" approach has been adopted for simulating oil weathering processes: chemicals in the oil mixture are grouped by physical-chemical properties. The fate of each component is then tracked separately.
- Biodegradation of oil droplets is modelled by Monod kinetics. The kinetics of oil particles size reduction due to the microbe-mediated degradation at water-oil particle interface is represented by the shrinking core model.
- A pseudo-component evaporation model (Jones, 1997) is used in the new version of the model.
- The initial spill has been categorized in 4 aliphatic and 4 aromatic pseudo-components as shown in Table 1. The fate of each component (evaporation, dispersion, emulsification, dissolution, biodegradation) is tracked separately.

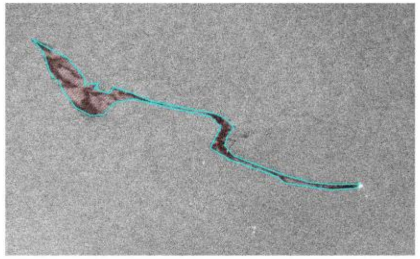
Table 1: PCs used in the modified MEDSLIK-II for the Corsica oil spill

Distillation cut	1 (high volatility and solubility)	2 (semi-volatile and soluble)	3 (low volatility and solubility)	4 (non-volatile, insoluble)
Boiling Point	<180 °C	180-265 °C	265-380 °C	>380 °C
Molecular weight	50-125	125-168	152-215	>215
Aliphatic compounds	C4 – C10 (PC 1)	C10 – C15 (PC 2)	C15 – C20 (PC 3)	>C20 (PC 4)
PC percentage in oil mixture	4%	5%	18%	23%
Aromatic compounds	MAHS: BTEX and substituted benzenes (-to C3-benzenes) (PC 5)	C4 benzenes, 2 ring PAHs (- to C2-naphthalenes) (PC 6)	C3-, C4-naphthalenes, 3-ring PAHs (PC 7)	≥C4 ring aromatics (PC 8)
PC percentage in oil mixture	3%	3%	12%	10%

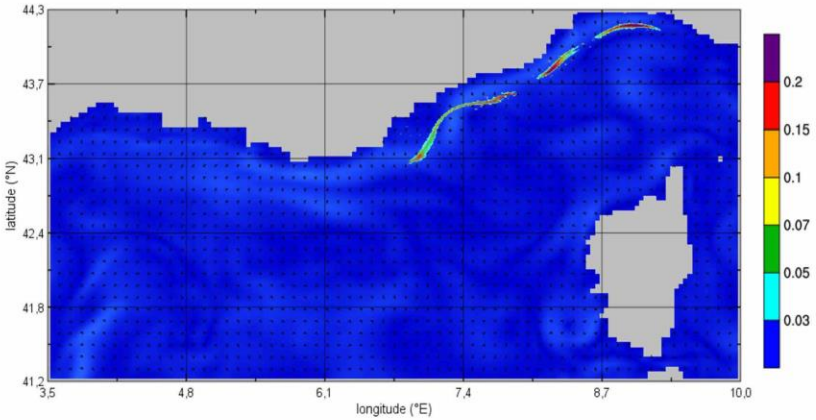
3. Results & Discussion

- Image of the spill captured by Snetinel-1 are edited to capture geometric characteristics and reinitialize the model.

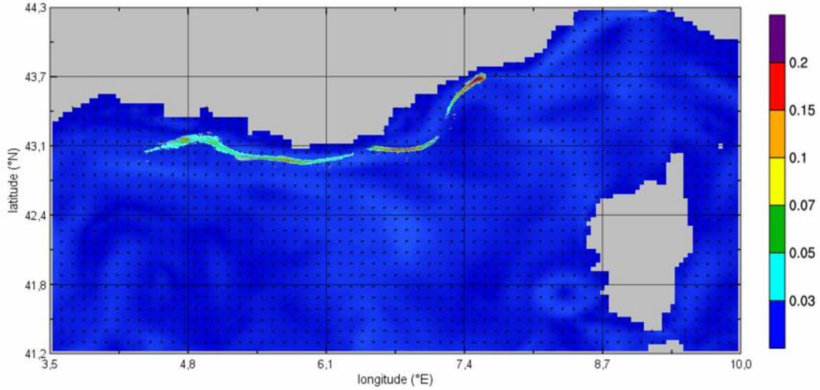




- Simulation of oil slick trajectory



Surface oil concentration on 13/10/2018 (kg/ m^3)



Surface oil concentration on 18/10/2018 (kg/ m^3)

The dispersion of radioactive effluent in the Eastern Mediterranean from a hypothetical accidental spill from the nuclear power plant at Akkyyu

George Zodiatis[1,2], Robin Lardner[3,2] Katerina Spanoudaki[1], George Kozyrakis[1] and Nikos Kampanis[1]

(1) Coastal & Marine Research Lab., Institute of Applied & Computational Mathematics, Foundation for Research and Technology, Crete, Greece
(2) ORION Joint Research and Development Center, Nicosia, Cyprus
(3) Simon Fraser University, Burnaby, British Columbia, Canada

EGU General Assembly 2019 Vienna | Austria | 7–12 April 2019

OS3.5 : Marine Pollution Assessment, Predictions and Risk Mapping

Background and objectives:

The Fukushima radioactive effluent leakage in the Pacific Ocean was caused primary as a result of the catastrophic tsunami affected the Japanese coast, following the offshore Tōhoku earthquake on 11 March 2011. The Eastern Mediterranean Levantine Basin is considered an area with high seismicity, while in the past centuries the historical sources reported coastal mass disasters, from the nowadays known phenomenon of tsunami.

The consequences of a possible radioactive accident from the planned nuclear power plant at Akkyyu, located at the southern coast of Turkey in the Cilician Levantine Basin, has been first investigated during a multi-disciplinary approach back in 2000, in the frame of the *"Radiological Impact Assessment in the Southeastern Mediterranean Area" (Vosniakos et al. 2000; Zodiatis and Lardner 2000).*

Nowadays, the construction activities of the Akkyyu nuclear power plant are taking place and is important to re-examine the dispersion simulations using new and high resolution met-ocean data, in-contrary to those simulations carried out two decades ago with limited available, those days, climatological data and low resolution met-ocean data.

The objective of the present work is to investigate the extend of the radioactive effluent leakage in the Cilician Levantine basin, following a hypothetical accident from the cooling system of the Akkyyu nuclear power plant, similar to the Fukushima accident, using high resolution 3D sea currents, winds and waves data downscaled from the CMEMS-Med MFC Copernicus Marine Environment Monitoring Service of the Mediterranean Monitoring and Forecasting Center and the general dispersion module MEDPOL of the well established MEDSLIK model.

Methodology

The data from the CYCOFOS Levantine hydrodynamical model (Zodiatis et al., 2018) downscaled from the CMEMS Med MFC products at a resolution of 1.8 km were used for the radioactive effluent dispersion simulations for 3 periods, winter, summer and spring characterizing the general circulation in the Eastern Mediterranean Levantine basin. The Asia Minor current is the dominant feature of the circulation pattern in the Cilician Levantine area, flowing along the southern coast of Turkey. Periodically, offshore cyclonic and anticyclonic eddies are generated in the sea area between Turkey and Cyprus, as a result of the fluctuation of the Asia Minor current. Moreover, the SKIRON 5 km resolution winds and the CYCOFOS 5 km resolution wave data for the entire Mediterranean Sea were used.

The current dispersion simulations followed the scenarios as those that were used in the frame of the *"Radiological Impact Assessment in the Southeastern Mediterranean Area"*. The radioactive effluent leakage is assumed to be continues for a period of 30 days with a rate of leakage of 5 m³ /hour for 20 days of water containing an initial concentration of Cs_{137} radioactivity of 800 MBq/Kg. Three seasons of the year have been considered, winter, spring and summer. Moreover, additional scenarios were examined considering the effluent leakage to be at different locations from the Akkyyu coastal zone.

Fig. 1) Schematic circulation of the Eastern Mediterranean based on MFS modeling with assimilation of in-situ data, showing the Asia Minor current in the Cilician Levantine basin (Pinardi et al., 2015).

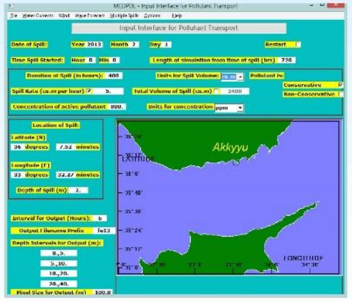


Fig. 2) The MEDPOL module of MEDSLIK interface with the Akkyyu dispersion modeling parameters.

Results:

The physiographic of the Akkyyy coastal area with a small bay at the east, the strong Asia Minor current flowing westward along the Turkish coast and the periodically generation of temporal small scale anticyclonic vortices in the very near coastal area of Akkyyy, restricted the extend of the dispersion of the radioactive effluent leakage of the Cs137, presumably along the coastal zone of Turkey, with higher concentrations in the vicinity of the small bay of the Akkyyy area, as during winter 2013.

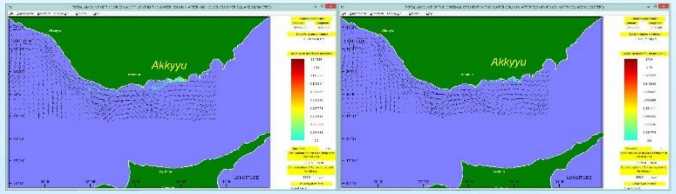


Fig. 3) Left: dispersion of Cs137 after 20 days with a leakage of 5m³/h. Right: dispersion of Cs137, after 30 days, winter 2013.

Fig. 4) The extend of the affected coastal area from the dispersion of Cs137, after 30 days, winter 2013

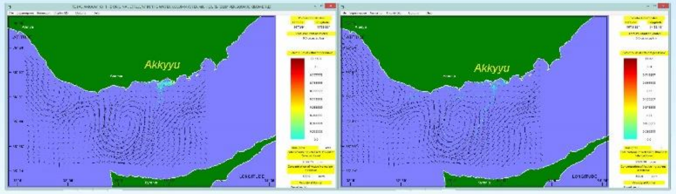


Fig. 5) Left: dispersion of Cs137 after 20 days with a leakage of 5m³/h. Right: dispersion of Cs137, after 30 days, summer 2013.

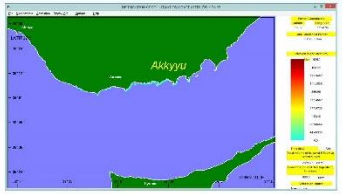


Fig. 6) The extend of the affected coastal area from the dispersion of Cs137, after 30 days, summer 2013

The fluctuation of the Asia Minor current during summer 2013 was mainly responsible for the generation of an anticyclonic eddy in the middle of the Cilician basin, opposite the Akkyyy side. This flow pattern resulted in the extend of the dispersion of the radioactive effluent offshore south, along the eastern periphery of the eddy. Nevertheless, the coastal areas affected during this period was the southern coastal area of Turkey.

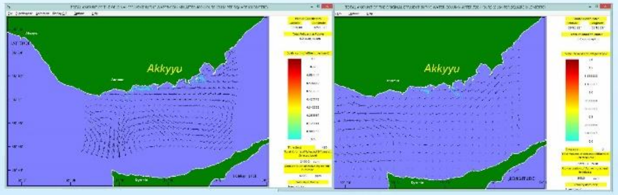


Fig. 7) Left: dispersion of Cs137 after 20 days with a leakage of 5m³/h. Right: dispersion of Cs137, after 30 days, spring 2015.

Fig. 8) The extend of the affected coastal area from the dispersion of Cs137, after 30 days, spring 2015

Similar dispersion patterns of the radioactive effluent shown also when a reversal of the Asia Minor Current is occurred, as in March 2015, with the extend of the dispersion to be restricted again along the coastal zone of Turkey.

Conclusions:

The dispersion of radioactive effluents of Cs137 from a hypothetical accident through the cooling system of the planned Akkyyu power plant, using higher resolution met-ocean data from the CMEMS Med MFC and the dispersion module of MEDSLIK, shown that the dispersion is dominated presumably by the Asia Minor current, the temporal coastal small scale anticyclonic vortices, the offshore seasonal cyclonic and anticyclonic eddies in the Cilician Levantine basin and the physiography of the coastal Akkyyy area, in respect to the location of the effluent outfall. All the examined scenarios shown that after 30 days of simulations the most affected area is the southern coast of Turkey with higher concentrations at the vicinity of the coastal area of Akkyyy.

.References:

Pinardi Nadia, Marco Zavatarelli, Mario Adani, Giovanni Coppini, Claudia Fratianni, Paolo Oddo, Simona Simoncelli, Marina Tonani, Vladislav Lyubartsev, ŞrdjanDobricic, Antonio Bonaduce (2015). Mediterranean Sea large-scale low-frequency ocean variability and water mass formation rates from 1987 to 2007: A retrospective analysis. Progress in OceanographyVolume 132, 318–332.

Vosniakos F.K, Cigna A.A., Foster P, Vasilikiotis G (Eds) (2000). "Radiological Impact Assessment in the Southern Mediterranean Area", VolI and Vol II, Thessaloniki, ISBN 96 028 700 87.

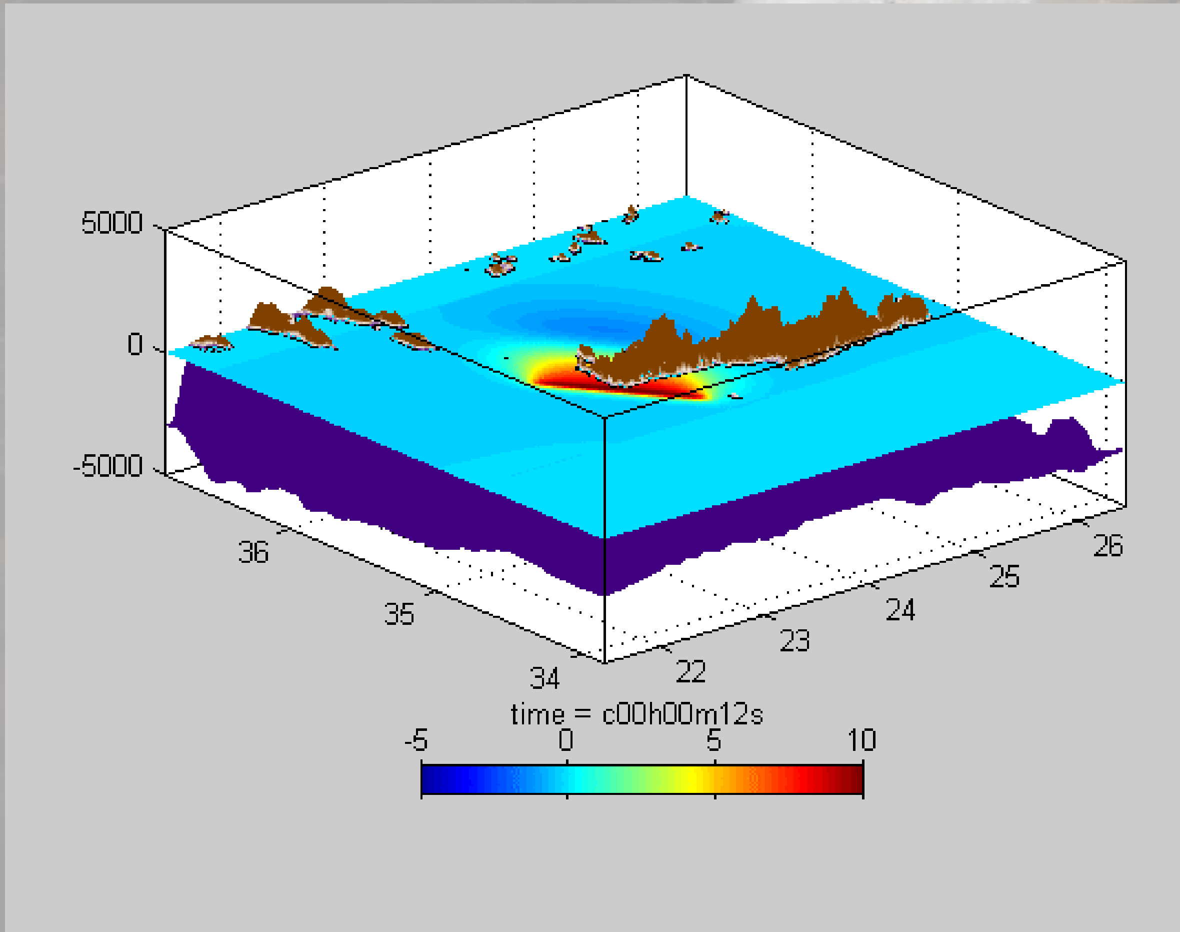
Zodiatis G. and R. Lardner(2000). Chapter 5.2.2: The Dispersion of radioactive effluent in the sea from an accidental spill at a hypothetical nuclear power plant at Akkuyu. In "Radiological Impact Assessment in the Southern Mediterranean Area", Vol. I, 236 pages, Vosniakos F.K, Cigna A.A., Foster P, Vasilikiotis G (Eds), Thessaloniki, ISBN 96 028 700 87.

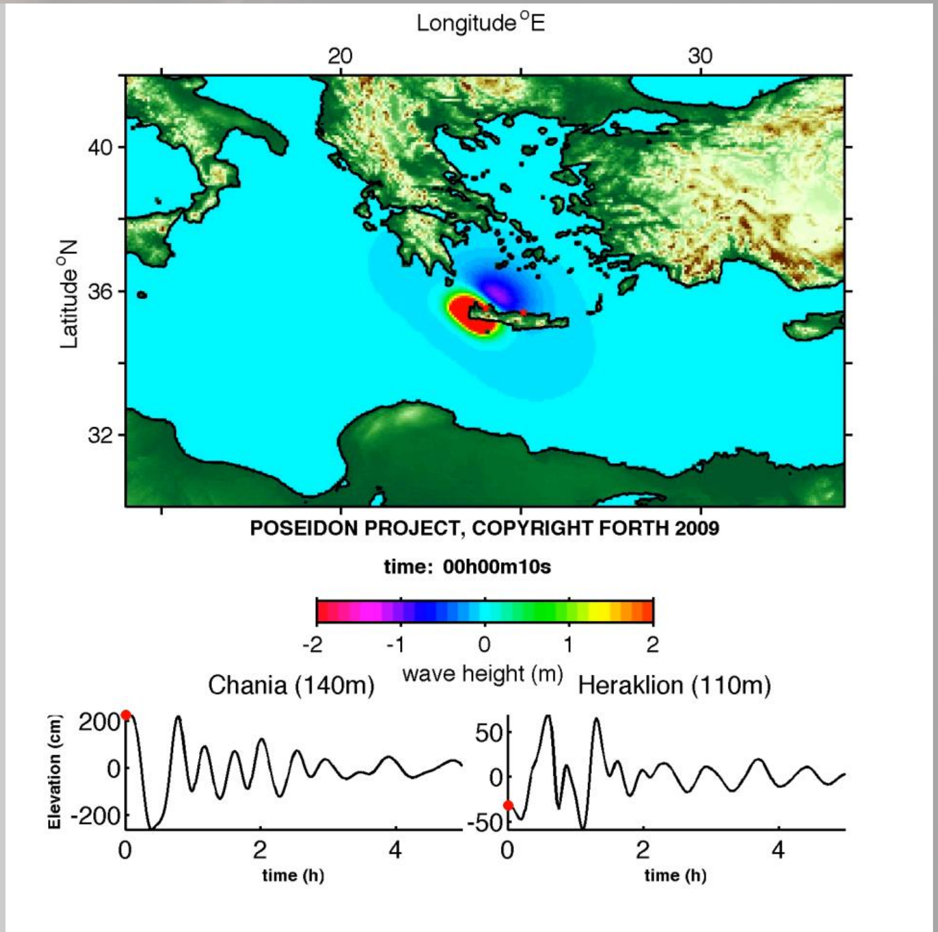
Zodiatis George, Hari Radhakrishnan, George Galanis, Andreas Nikolaidis, George Emmanouil, Georgios Nikolaidis, Robin Lardner, Stavros Stylianou, Marios Nikolaidis, Sarantis Sofianos, Vasilis Vervantis (2018). Downscaling the Copernicus marine service in the Eastern Mediterranean. OM14A: Advances in Coastal Ocean Modeling, Prediction, and Ocean Observing System Evaluation. AGU, Ocean Science meeting, 11-16 Feb., Portland, Oregon.

POSEIDON: Earthquake followed by Tsunami in the Mediterranean
Civil protection TTX & FSX

Βασισμένη στην αναπαράσταση του σεισμού του 365 έξω από τα Φαλάσερνα (Δ Κρήτη)

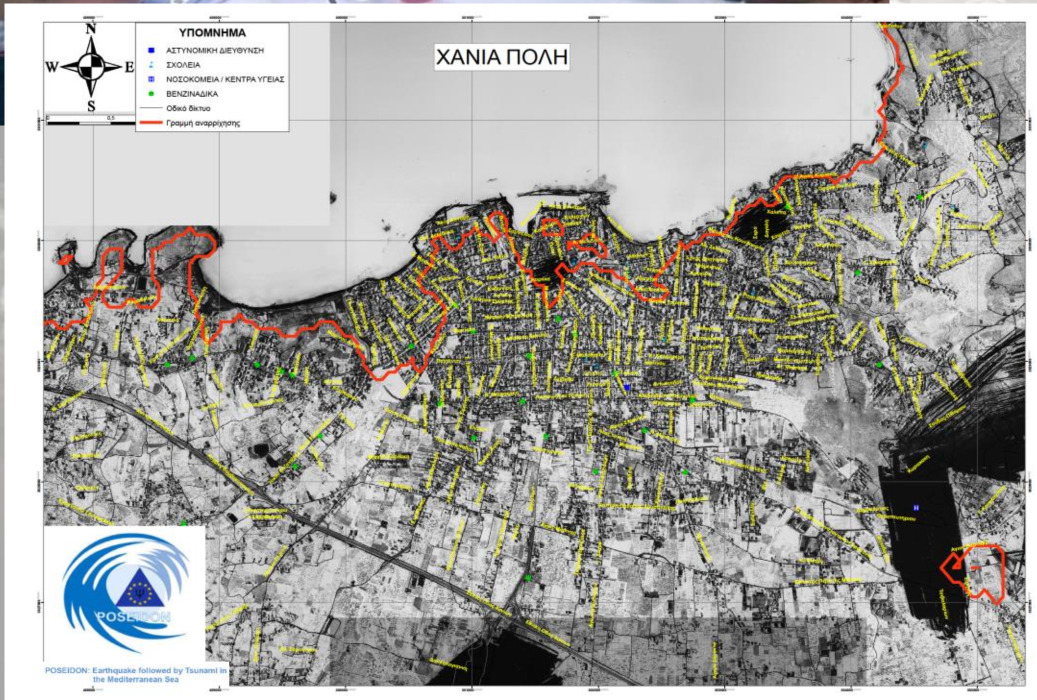
POSEIDON TTX 29-05-2011, FSX 26-11-2011

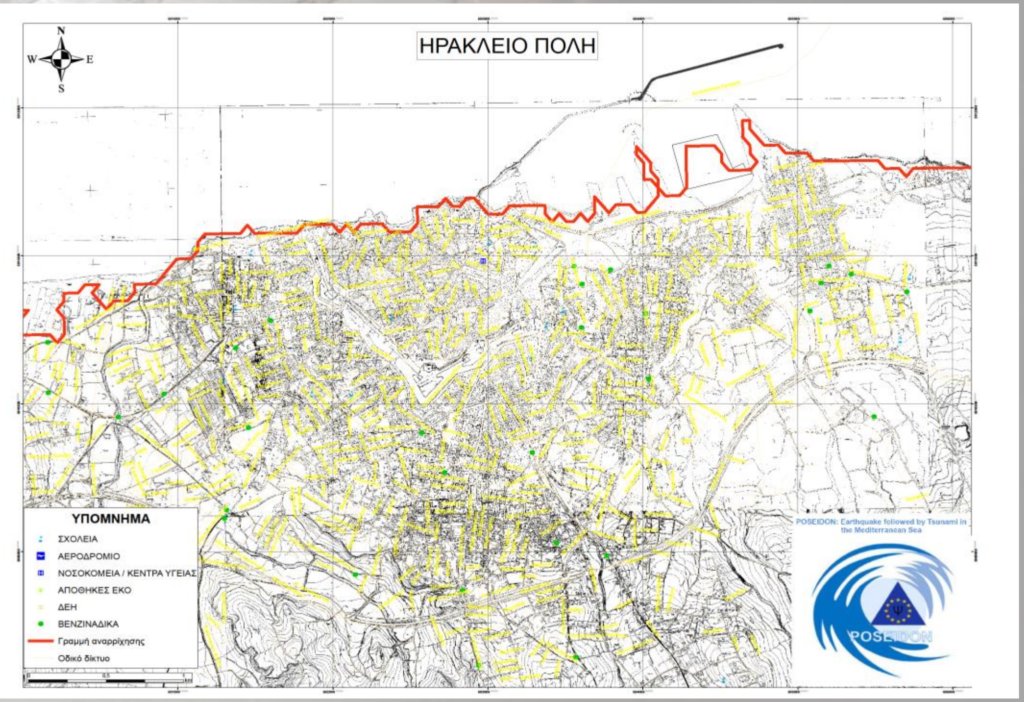




… και στο παρασκήνιο οι

Ν. Καλλιγιέρης, Β.Φλουρή, Γ. Αλεξανδρακης






ΕΡΓΑΣΤΗΡΙΟ ΠΑΡΑΚΤΙΑΣ
& ΘΑΛΑΣΣΙΑΣ ΕΡΕΥΝΑΣ
ΙΥΜ - ΙΤΕ