e-shape solutions: Unlocking the potential of Earth Observation data for climate change and urban

Modeling and Satellite applications for weather and dust forecasts at touristic sites in the Mediterranean

Stavros Solomos

Research Centre for Atmospheric Physics and Climatology, Academy of Athens

14 - 15 February 2023
9.30 – 17.00 CET
Valletta, Malta
Malta Council for Science and Technology

e-shape

An event co-organised by

Xjenza

The Malta Council for Science & Technology

eurisy
ACTING COLLECTIVELY TO BRIDGE SPACE AND SOCIETY

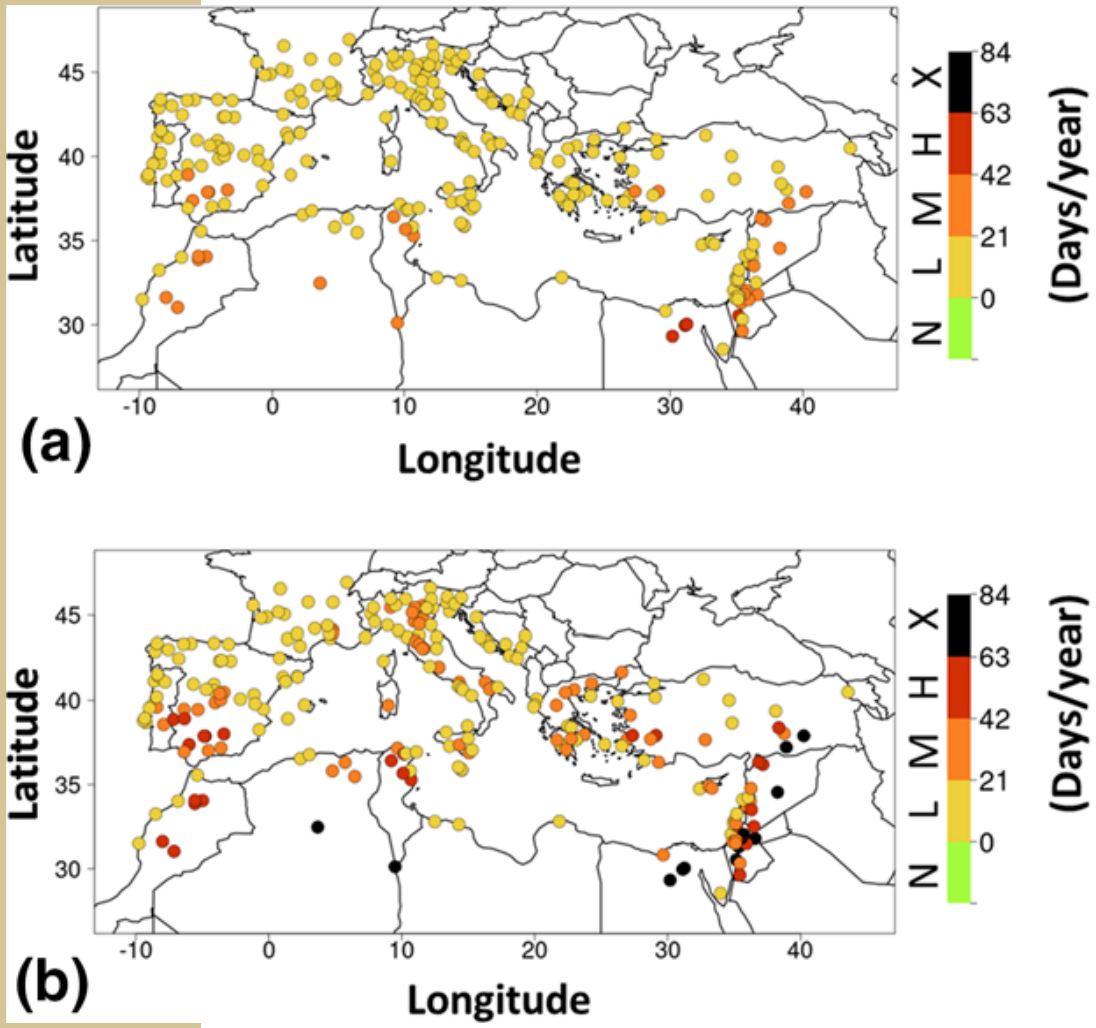
Effects of climate change on cultural heritage monuments

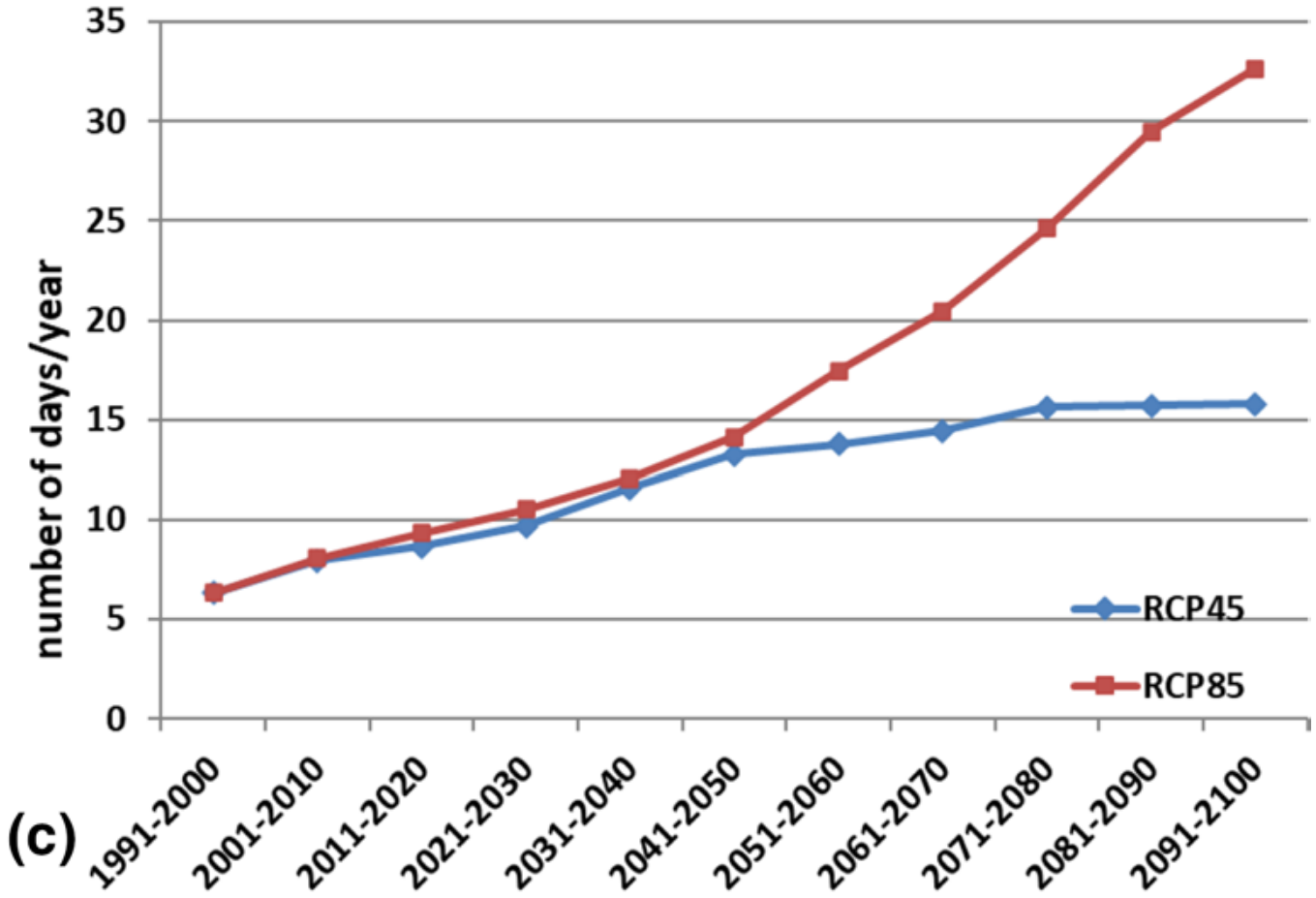
6 climate and 1 seismic indexes are used to calculate the vulnerability of UNESCO cultural heritage monuments in the Mediterranean

- **Extreme heat**
- **Extreme Fire Weather**
- **Extreme precipitation/ flooding/ landslides**
- **Aridity**
- **Frost**
- **Sea level rise**
- **Seismic Hazard**

Kapsomenakis J., Douvis C., Poupkou A., Zerefos S., Solomos S., Stavraka T., Melis N. S., Kyriakidis E., Kremlis G., Zerefos C.,*Climate change threats to cultural and natural heritage UNESCO sites in the Mediterranean, Environment, Development and Sustainability, 1573-2975, https://doi.org/10.1007/s10668-022-02677-w, 2022*

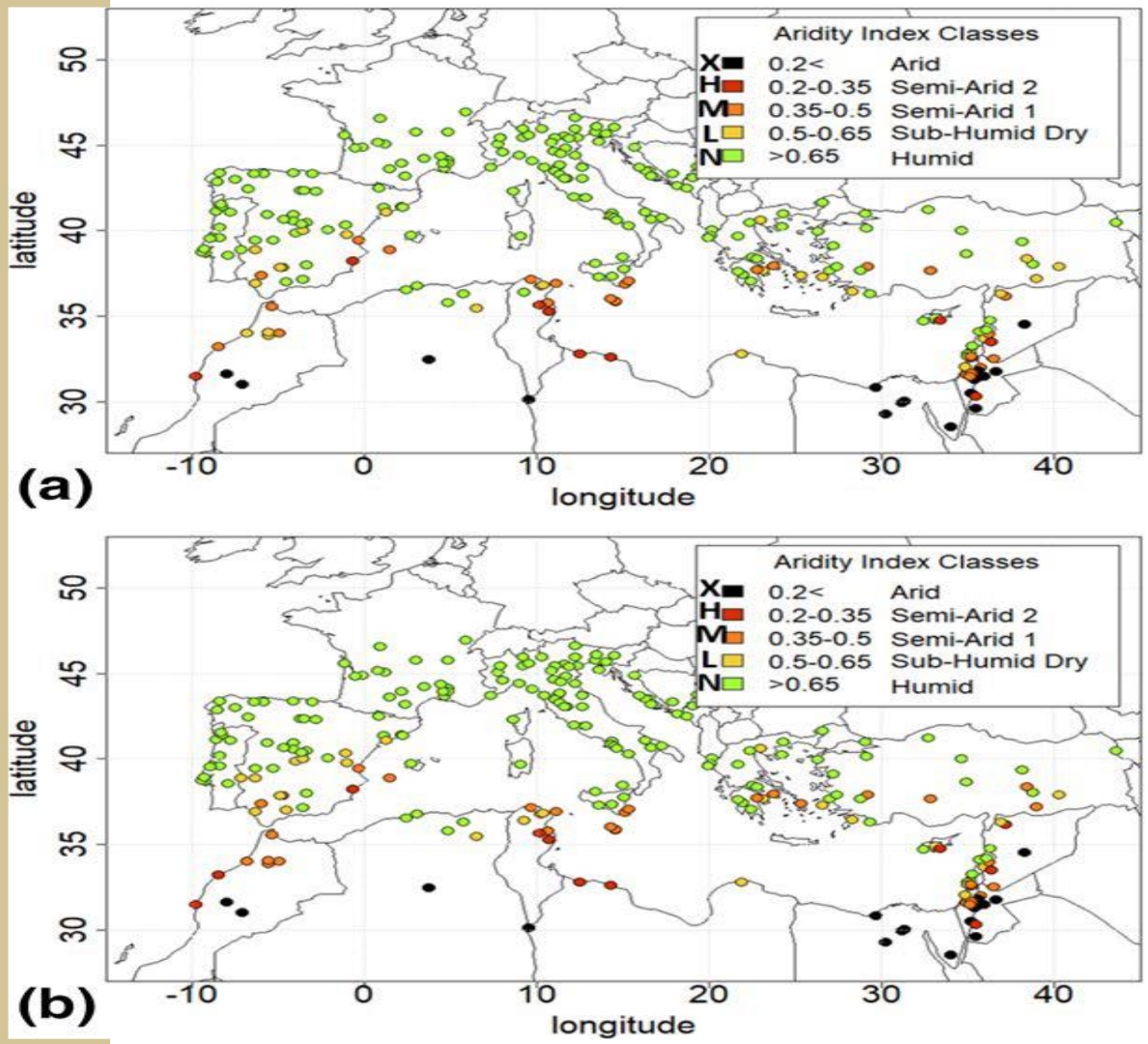
Number of days with extreme temperature (TX37)

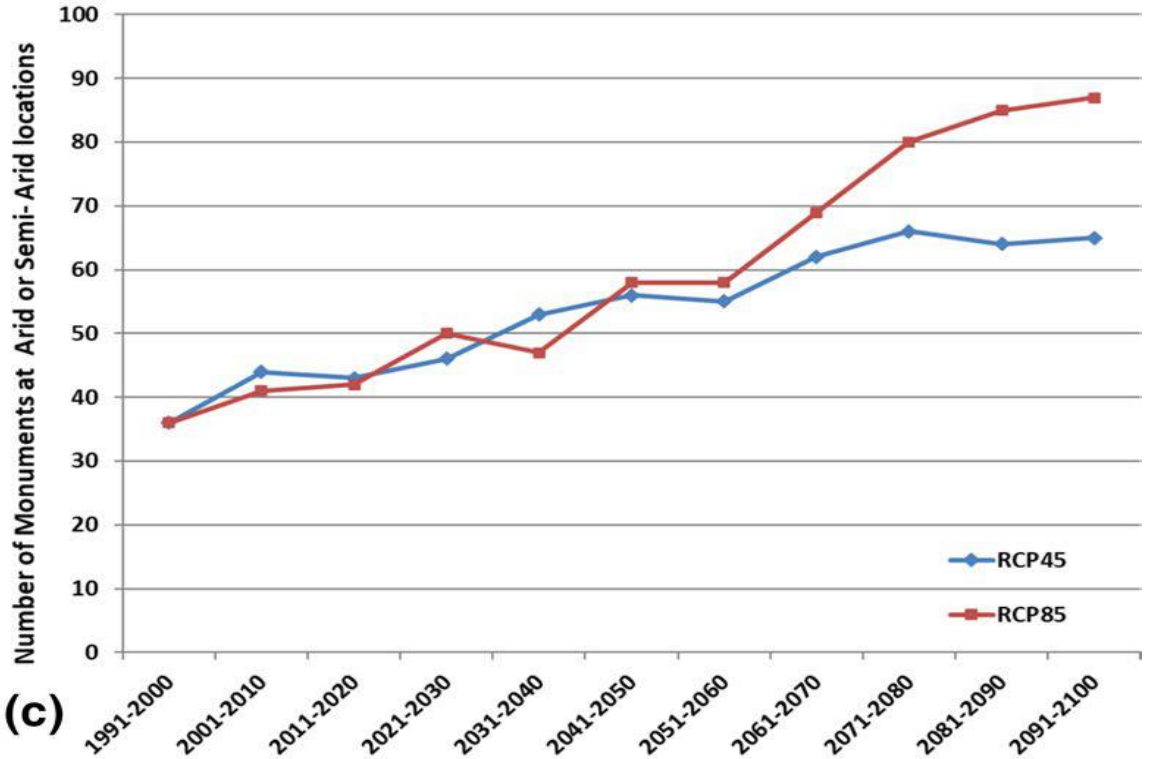




Kapsomenakis J., Douvis C., Poupkou A., Zerefos S., Solomos S., Stavraka T., Melis N. S., Kyriakidis E., Kremlis G., Zerefos C., *Development and Sustainability,2022*

Aridity Index





Kapsomenakis J., Douvis C., Poupkou A., Zerefos S., Solomos S., Stavraka T., Melis N. S., Kyriakidis E., Kremlis G., Zerefos C., Development and Sustainability,2022

e-shape

Seasonal preparedness

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EuroGEO Showcases:
Applications Powered
by Europe

The CRITERION web service

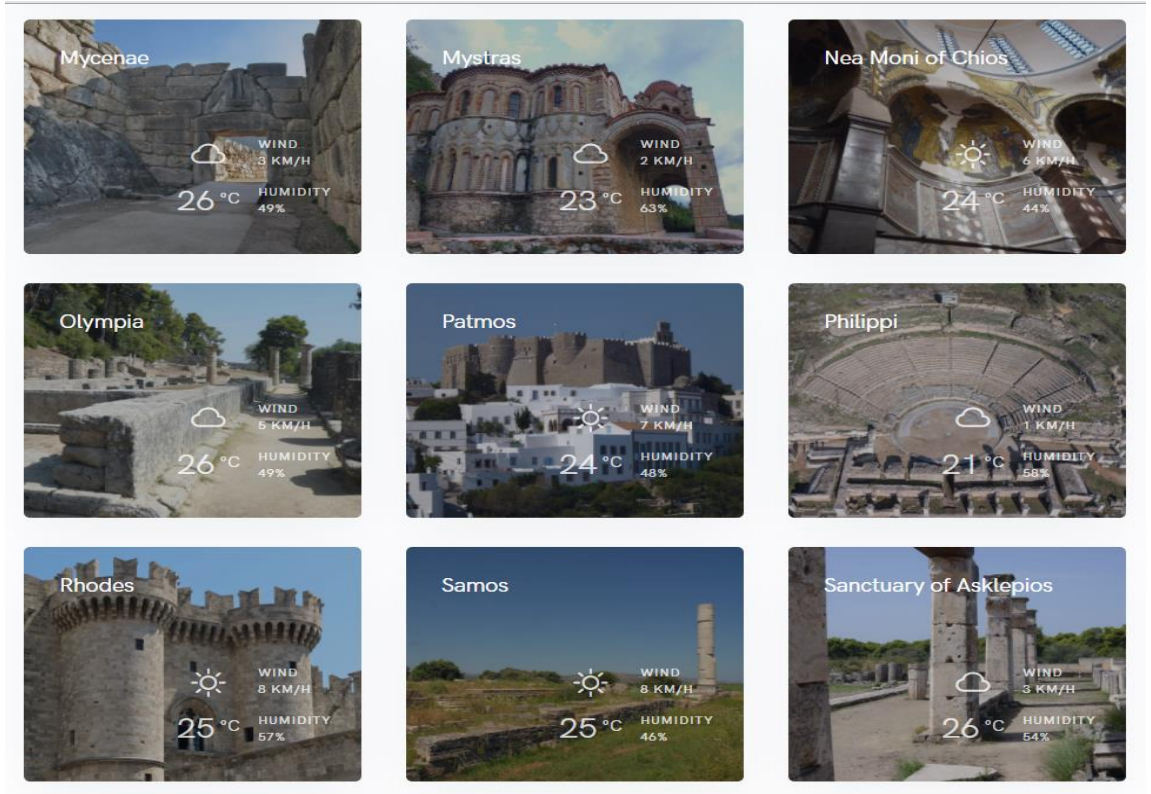
e-shape

CRITERION web service in a nutshell

Seasonal Preparedness for Cultural Heritage Monuments

CRITERION web service is developed in the frame of EuroGEO e–shape Showcases at the Academy of Athens and co-designed with the Institute of Greek Tourism Confederation (INSETE).

CRITERION provides detailed short-term and seasonal forecast at 20 historical sites in Greece defined as UNESCO Cultural Heritage Monuments.



Monument information, detailed forecasts and graphs

Can be expanded to other sites of interest worldwide

Scientific and technical details are available here:

https://unesco-weather.gr/

Solomos Stavros, Lida Dimitriadou, John Kapsomenakis, Ioannis Binietoglou, Panagiotis Nastos, Christos Zerefos, Development of the weather and climate service "CRITERION" for the touristic sector in e-SHAPE, FMI's Climate Bulletin: Research Letters, Vol. 4, Issue: 1, DOI: https://doi.org/10.35614/ISSN-2341-6408-IK-2022-03-RL

Co-design with the

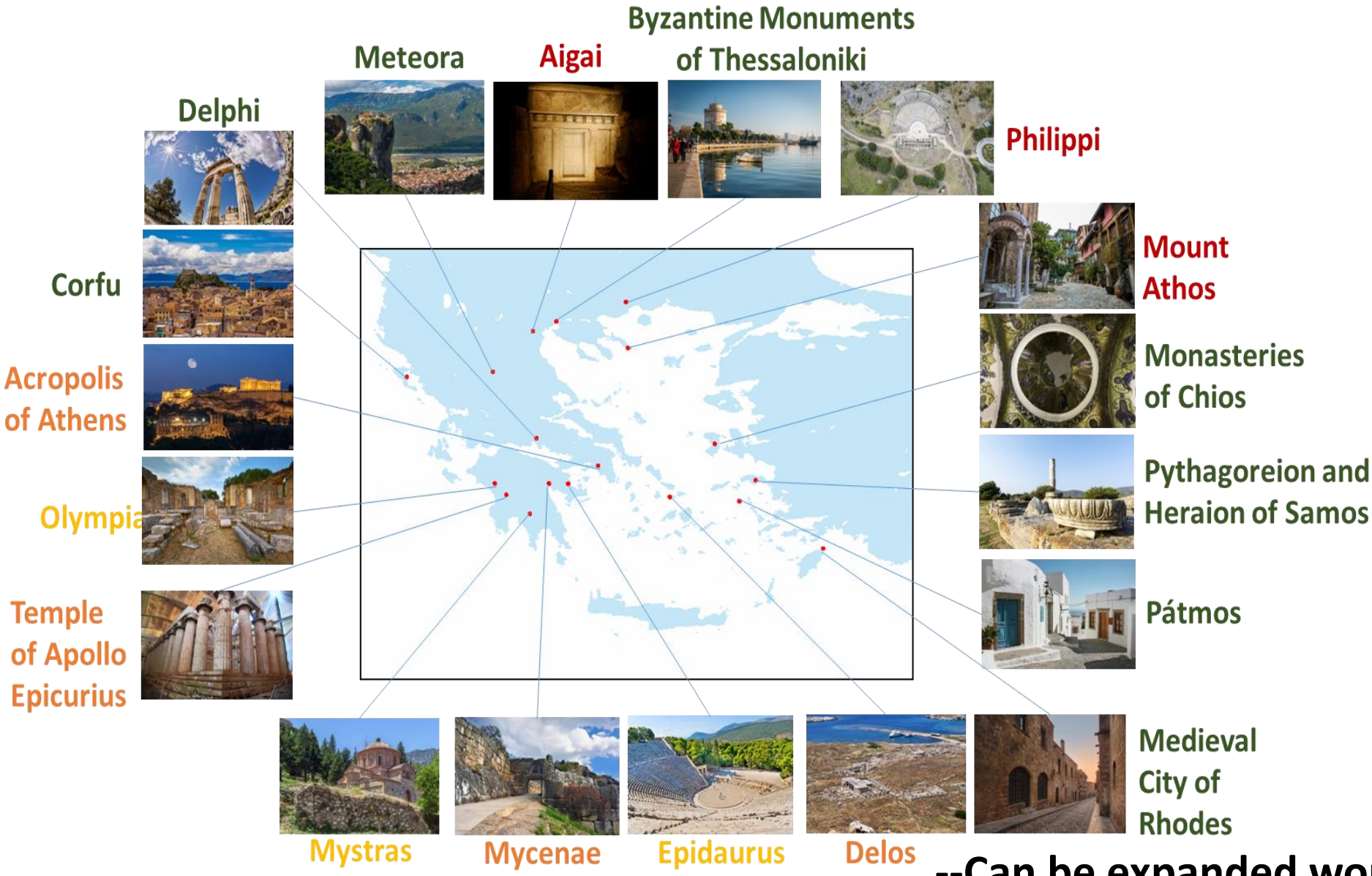
INSTITUTE OF GREEK TOURISM CONFEDERATION (INSETE)

Practical question: Tourists in Greece have several options on which places to visit during their time schedule

Suggestions by INSETE:

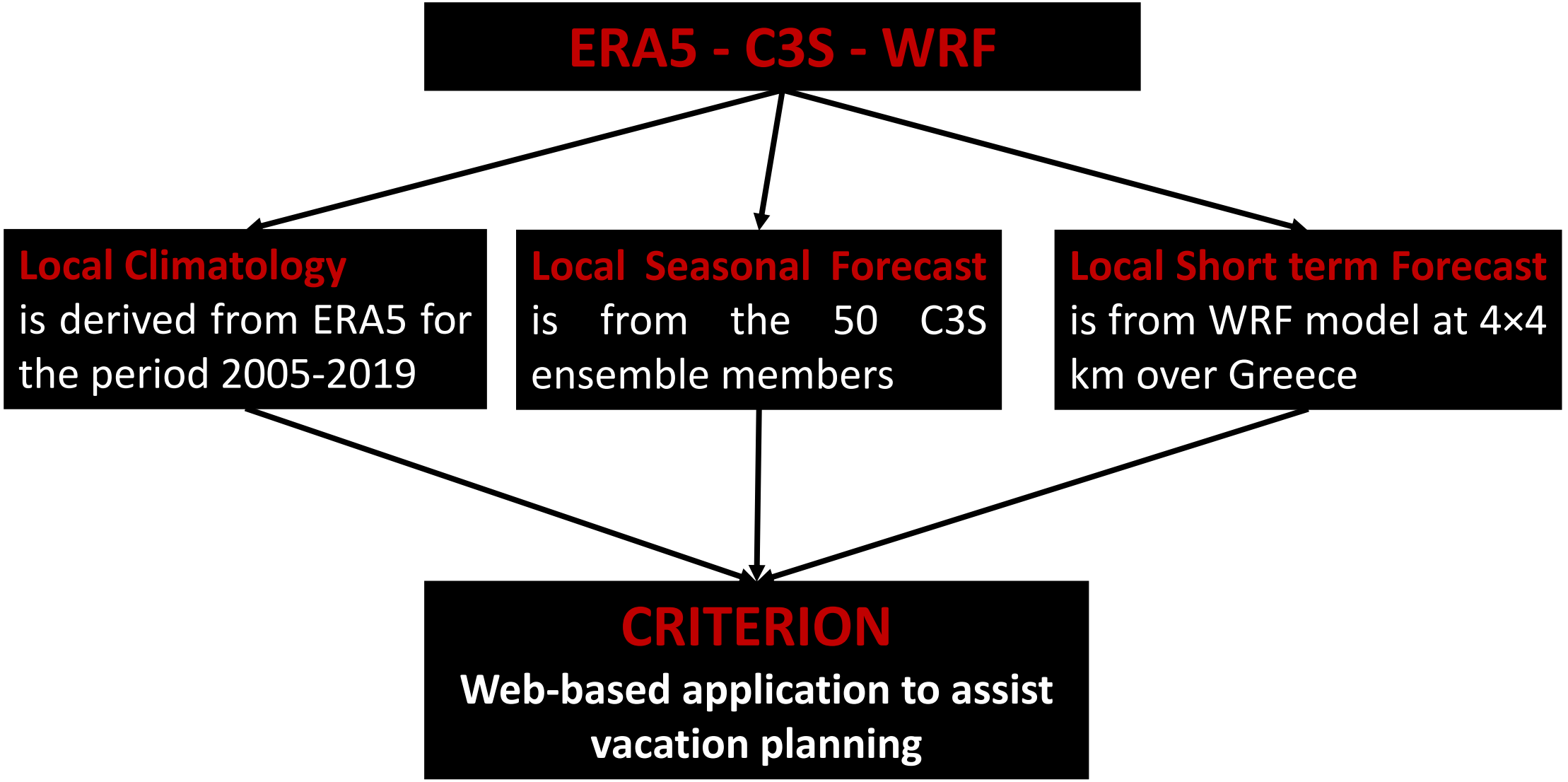
- Focus on UNESCO cultural heritage monuments
- Simple user-friendly interface

UNESCO cultural heritage sites in Greece



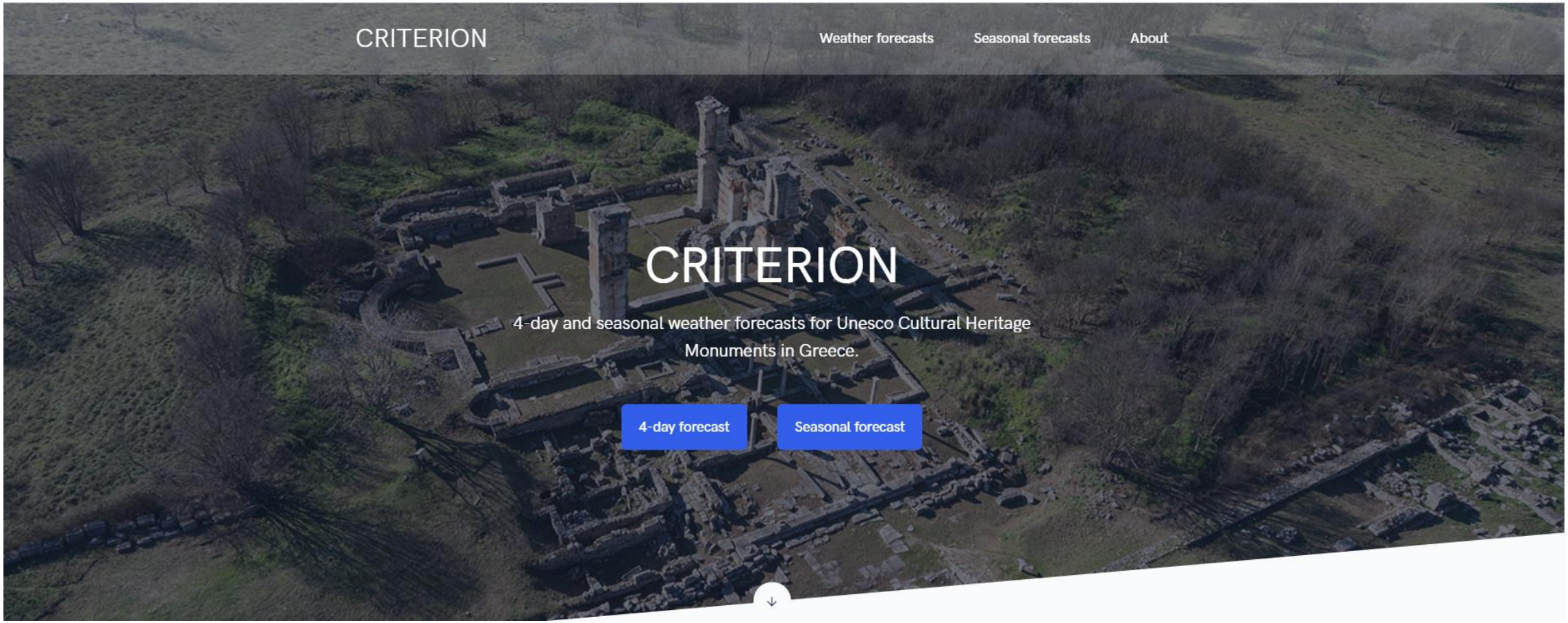
--Can be expanded worldwide--

Methodology



Solomos et al., FMI Research Letters, 2022

Front Page



https://unesco-weather.gr/

Quick- view

https://unesco-weather.gr/

4-day forecast

4-day forecast | Seasonal forecast

3 June

Thursday

Acropolis

Current forecast

WIND 1 KM/H

24 °C HUMIDITY 43%

	Thu	Fri	Sat	Sun
	3/6	4/6	5/6	6/6
	25°C	28°C	28°C	31°C
	15°C	18°C	18°C	20°C

Aigai

Current forecast

WIND 2 KM/H

24 °C HUMIDITY 35%

	Thu	Fri	Sat	Sun
	3/6	4/6	5/6	6/6
	28°C	29°C	30°C	31°C
	14°C	17°C	18°C	19°C

Corfu

Current forecast

WIND 2 KM/H

24 °C HUMIDITY 44%

	Thu	Fri	Sat	Sun
	3/6	4/6	5/6	6/6
	27°C	29°C	31°C	32°C
	15°C	19°C	20°C	21°C

Seasonal forecast

4-day forecast | Seasonal forecast

2021

Jun

Acropolis

	May	Jun	Jul
	12°-30°C	15°-34°C	18°-35°C
	24%-99%	27%-97%	30%-92%
	0-14km/h	0-12km/h	0-14km/h

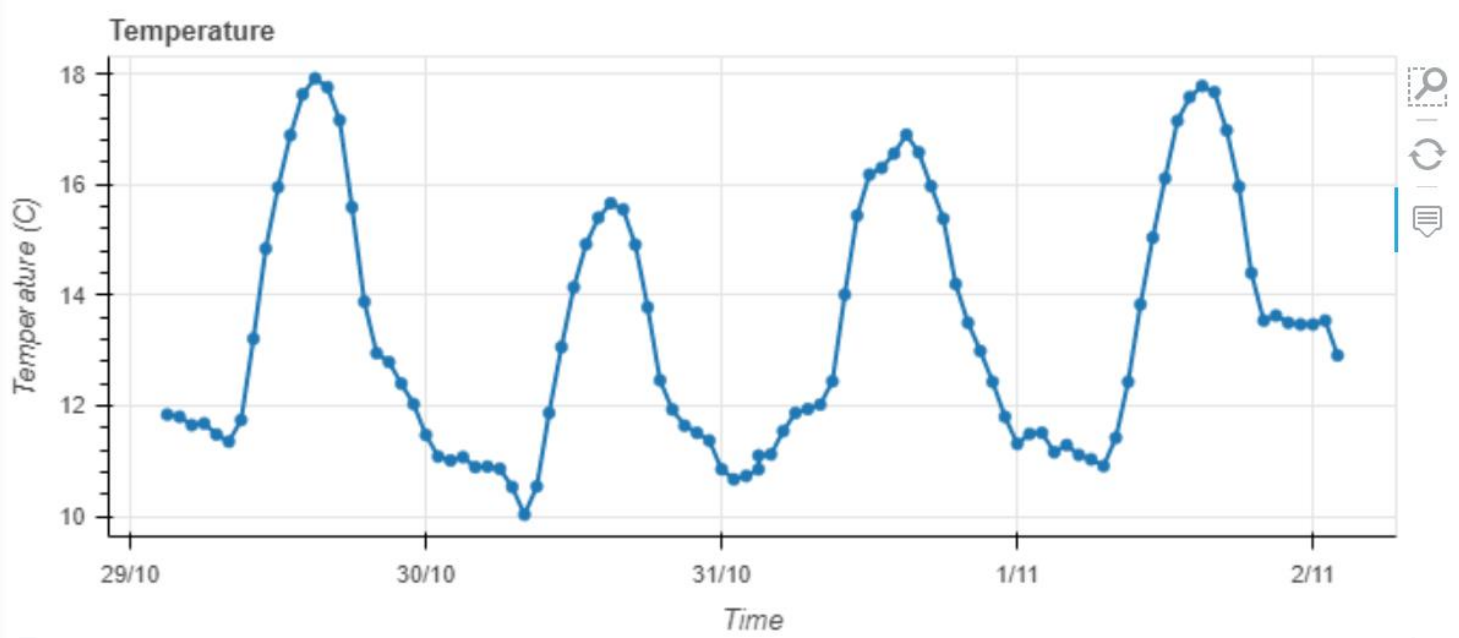
Aigai

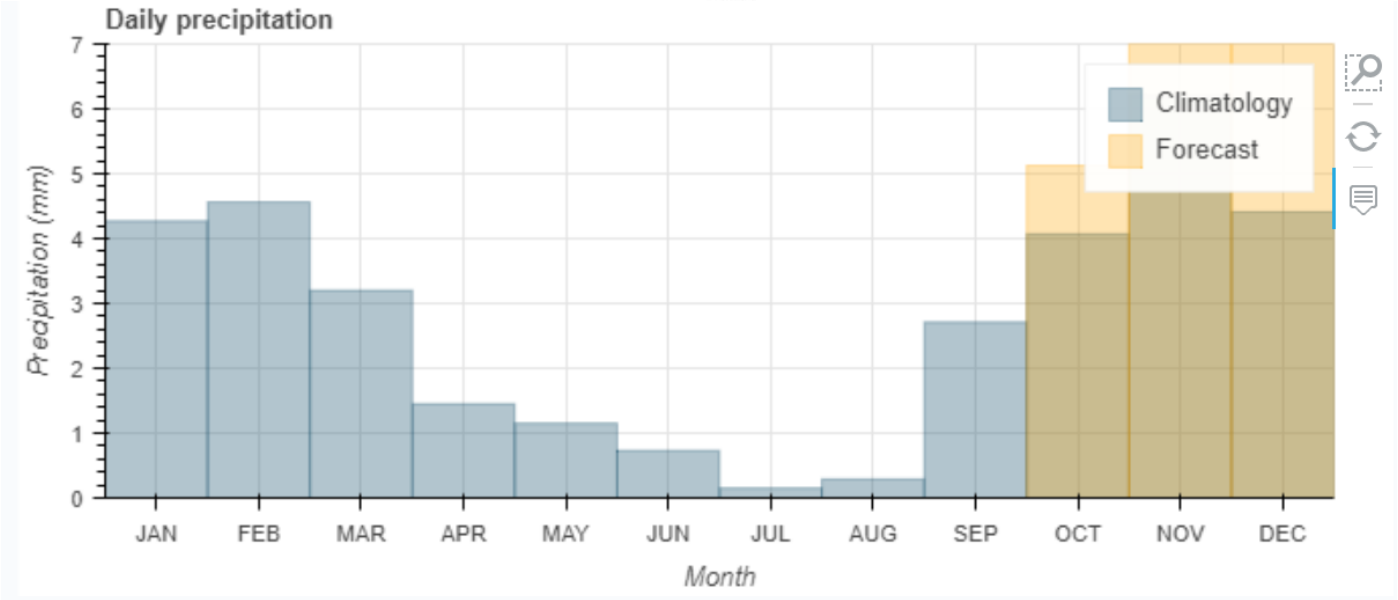
	May	Jun	Jul
	8°-33°C	10°-39°C	15°-40°C
	24%-98%	17%-97%	14%-96%
	0-7km/h	0-7km/h	0-7km/h

Corfu

	May	Jun	Jul
	12°-27°C	13°-30°C	18°-32°C
	33%-98%	39%-99%	45%-95%
	0-11km/h	0-10km/h	0-10km/h

Detailed Graphs





User example

airbnb

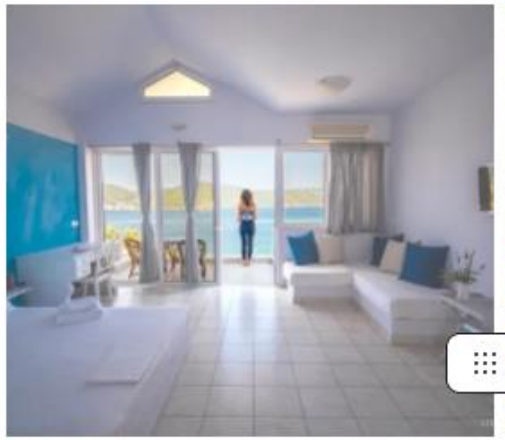
Ξεκινήστε την αναζήτησή σας

Γίνετε οικοδεσπότης

Live-Bio: Experience Authentic Greece!!

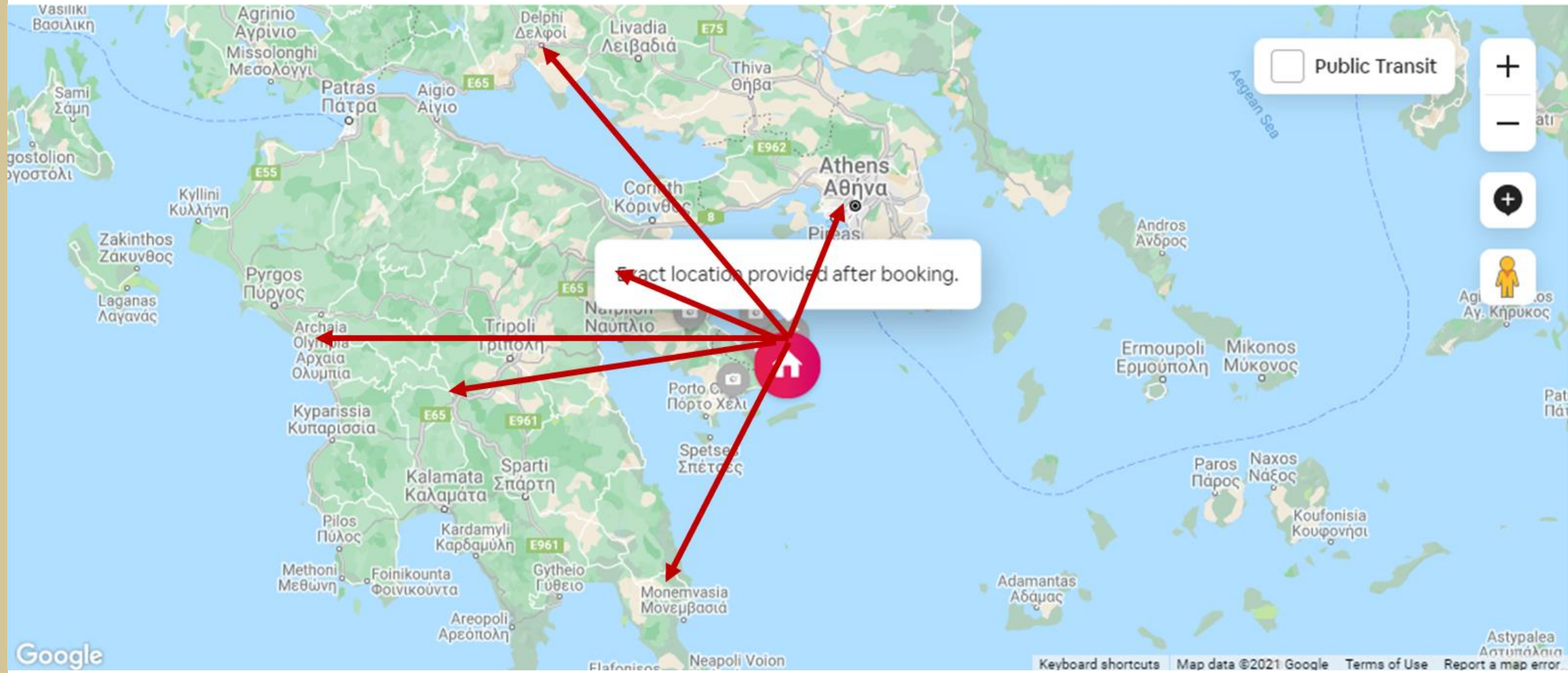
★ 5,0 (45 κριτικές) · Superhost · Poros, Αττική, Ελλάδα

Κοινοποίηση Αποθήκευση



Εμφάνιση όλων των φωτογραφιών

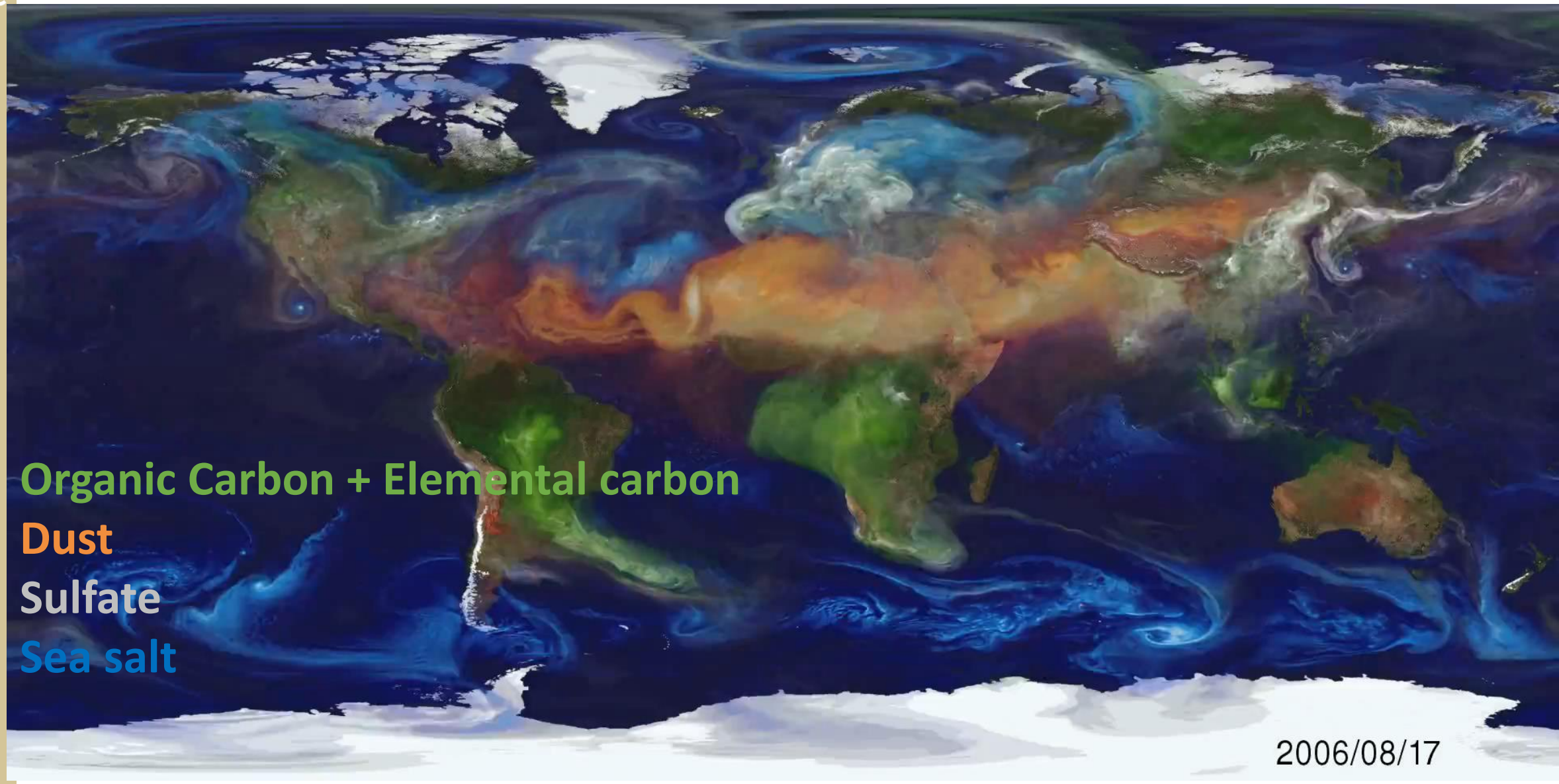
Day tripping choices



e-shape

e-shape

NASA | GEOS-5 Aerosols



Mineralogy of Dust Emissions and impacts on Environment and Health

EARTH OBSERVATION

NUMERICAL MODELING

IMPROVE DUST REPRESENTATION IN MODEL SIMULATIONS

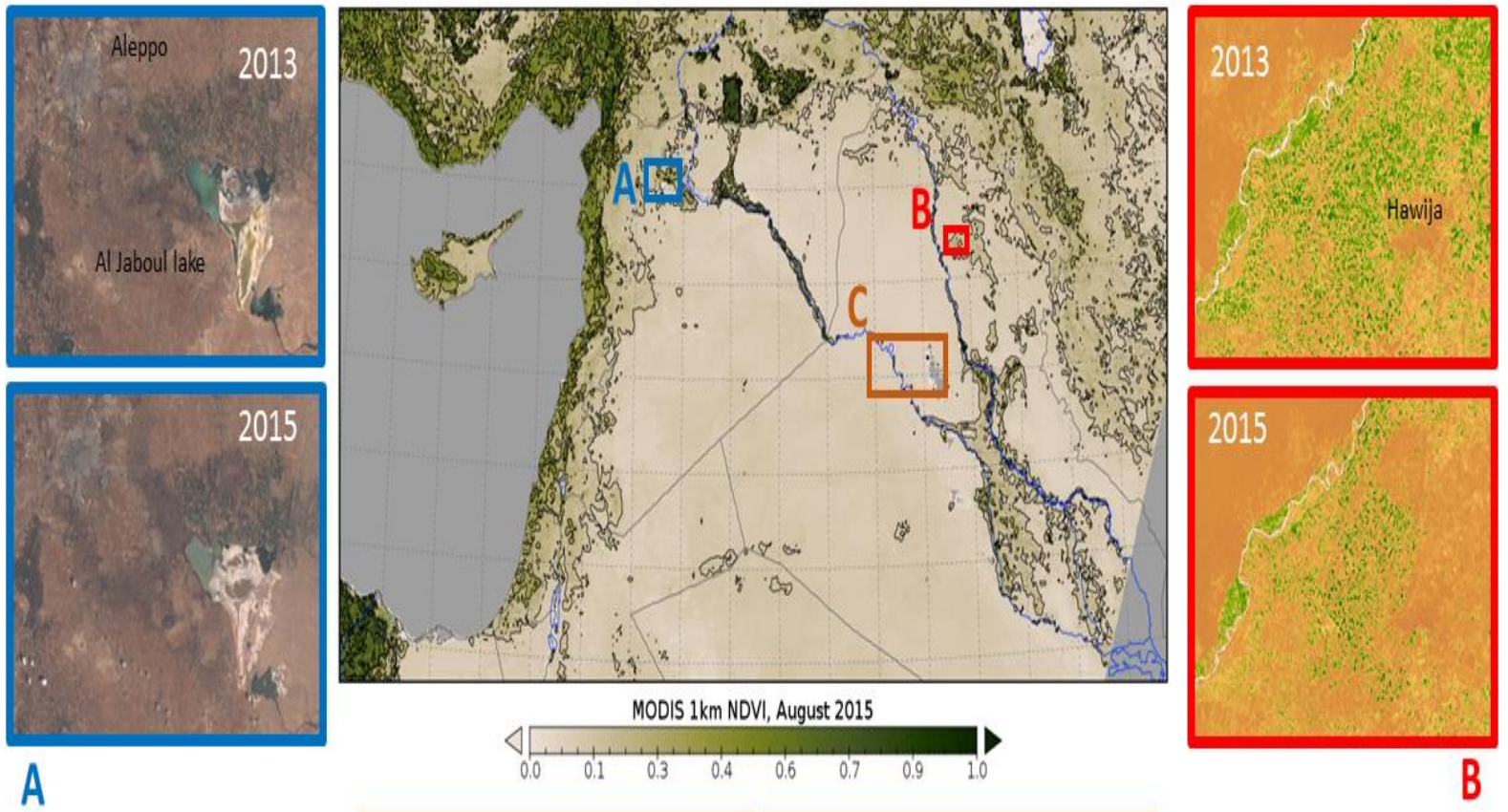
MEGDETH

http://www.megdeth.gr

This study is supported by the Hellenic Foundation for Research and Innovation project MegDeth (HFRI no.703)

Satellite detection of changes in landuse as aftermath of war

Landsat 8 natural color



Landsat 8 NDVI

A) changes of cultivation patterns and drying of nearby Al Jaboul lake in Aleppo region, Syria

B) large areas remained uncultivated in the region of Hawija, Kirkuk Province, Iraq

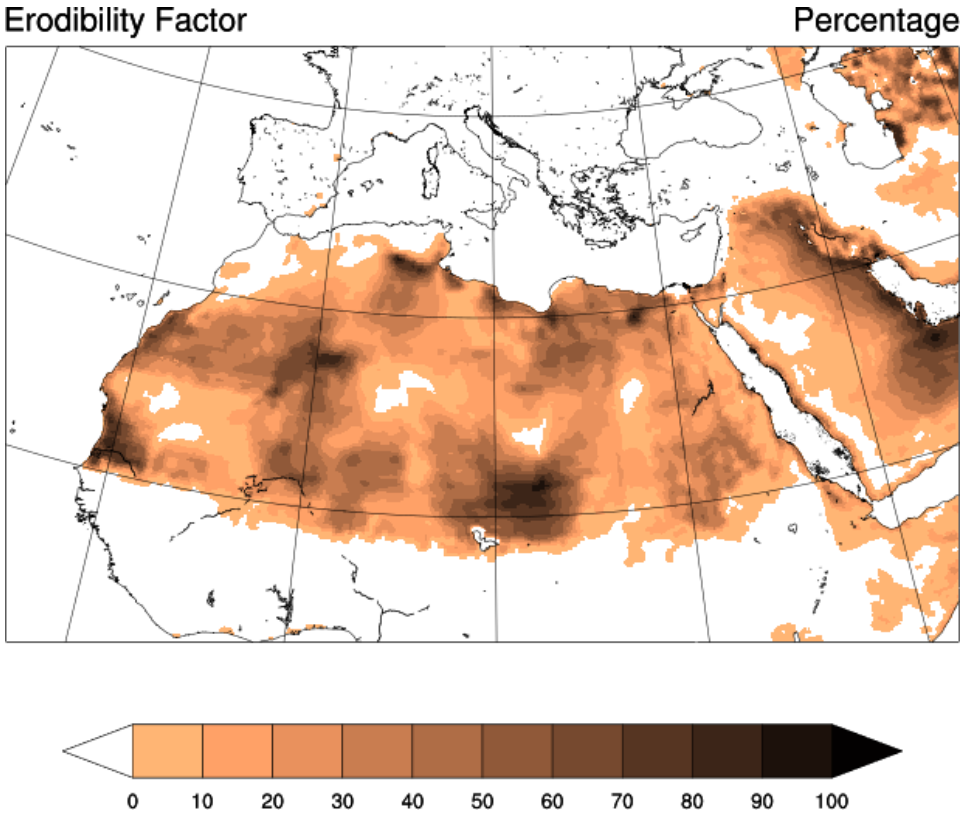
Solomos, S., Ansmann, A., Mamouri, R.-E., Binietoglou, I., Patlakas, P., Marinou, E., and Amiridis, V.: *Remote sensing and modelling analysis of the extreme dust storm hitting the Middle East and eastern Mediterranean in September 2015, Atmos. Chem. Phys., 17, 4063-4079, https://doi.org/10.5194/acp-17-4063-2017, 2017.*

Development of a dynamic dust source map for WRF-Chem based on satellite observations

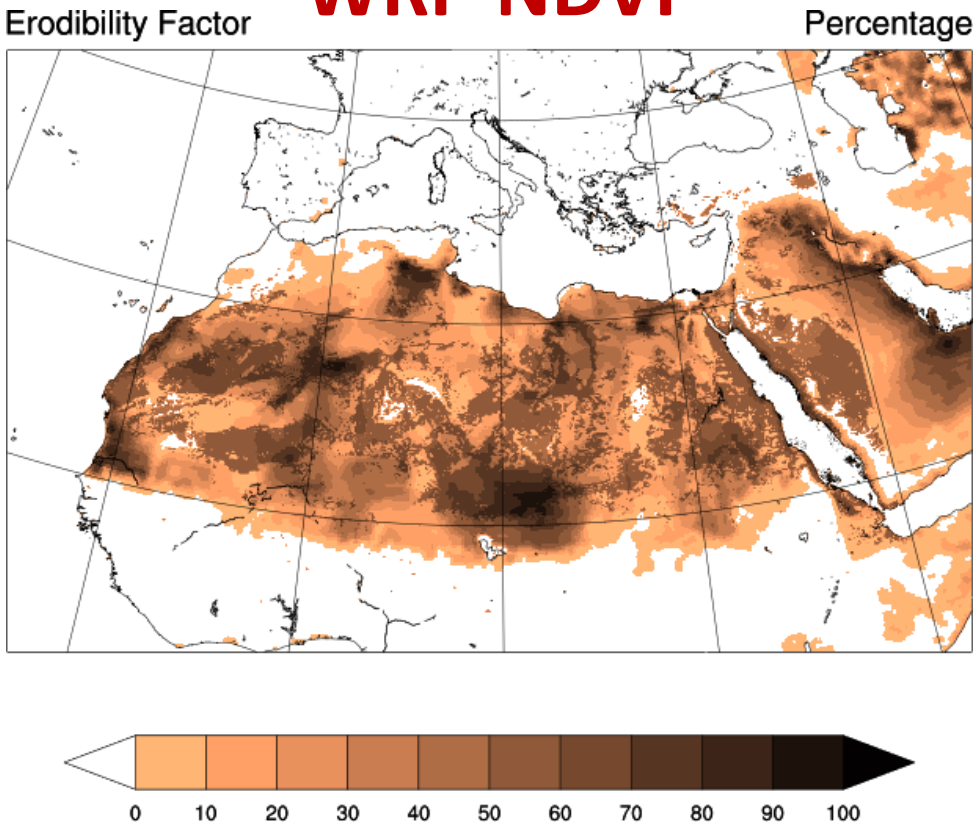
Dynamically scale the erodibility factor in WRF-Chem (GOCART-AFWA) dust module based on NDVI<0.1

Erodibility factor (%)

WRF-CTRL



WRF-NDVI

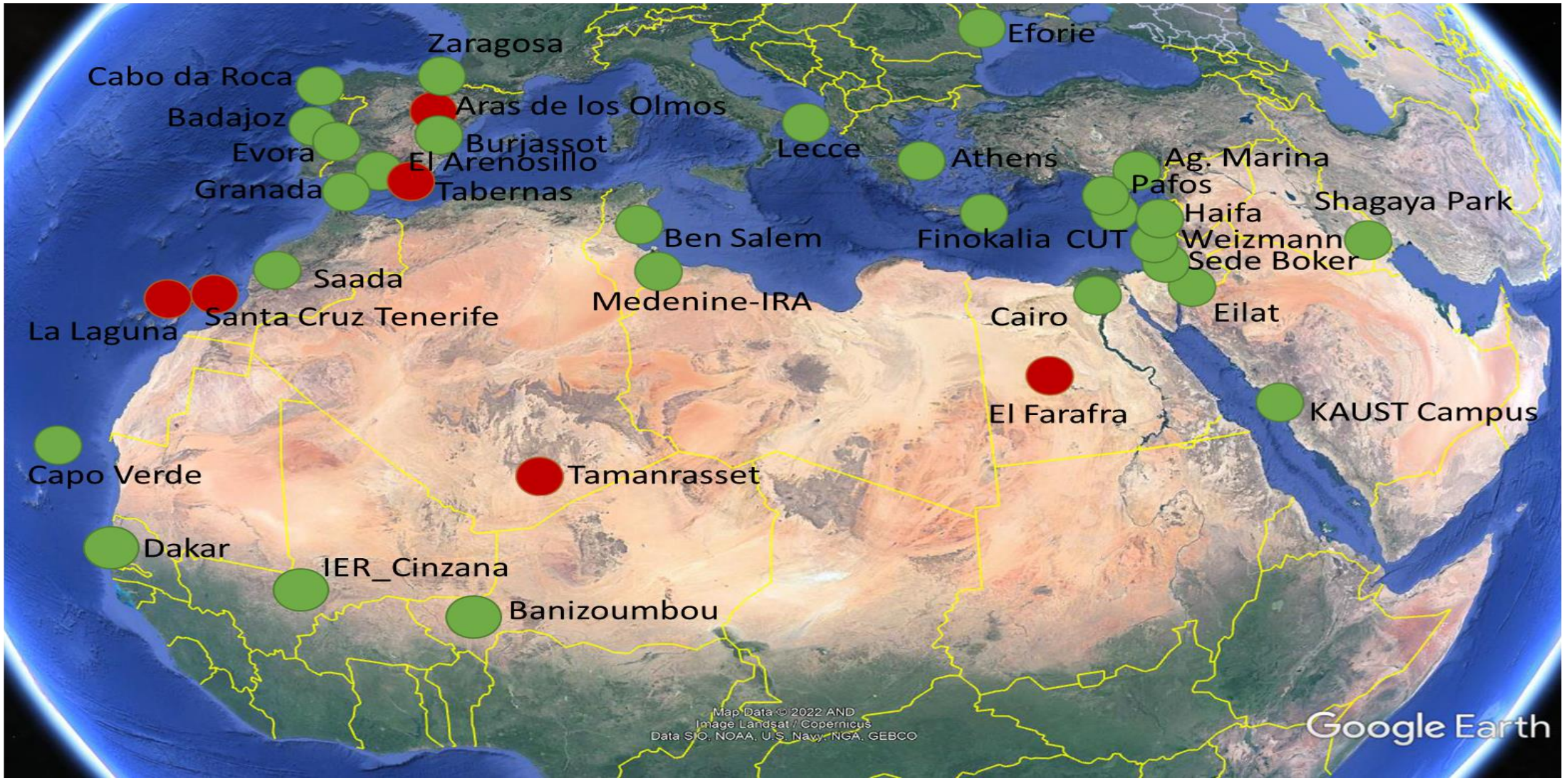


Spyrou, C.; Solomos, S.; Bartsotas, N.S.; Douvis, K.C.; Nickovic, S*. Development of a Dust Source Map for WRF-Chem Model Based on MODIS NDVI. Atmosphere 2022, 13, 868. https://doi.org/10.3390/atmos13060868*

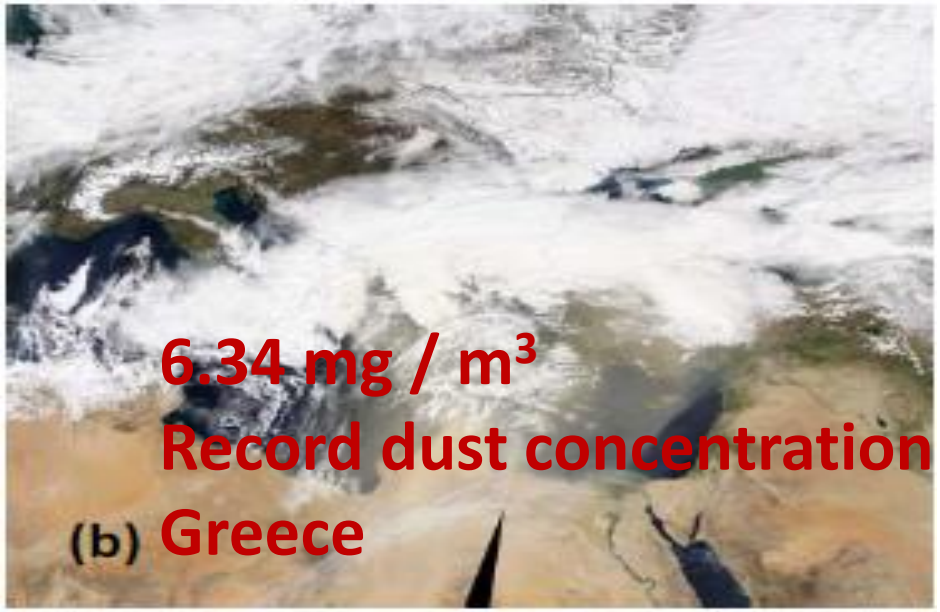
Assimilation of Earth Observation data improves model performance

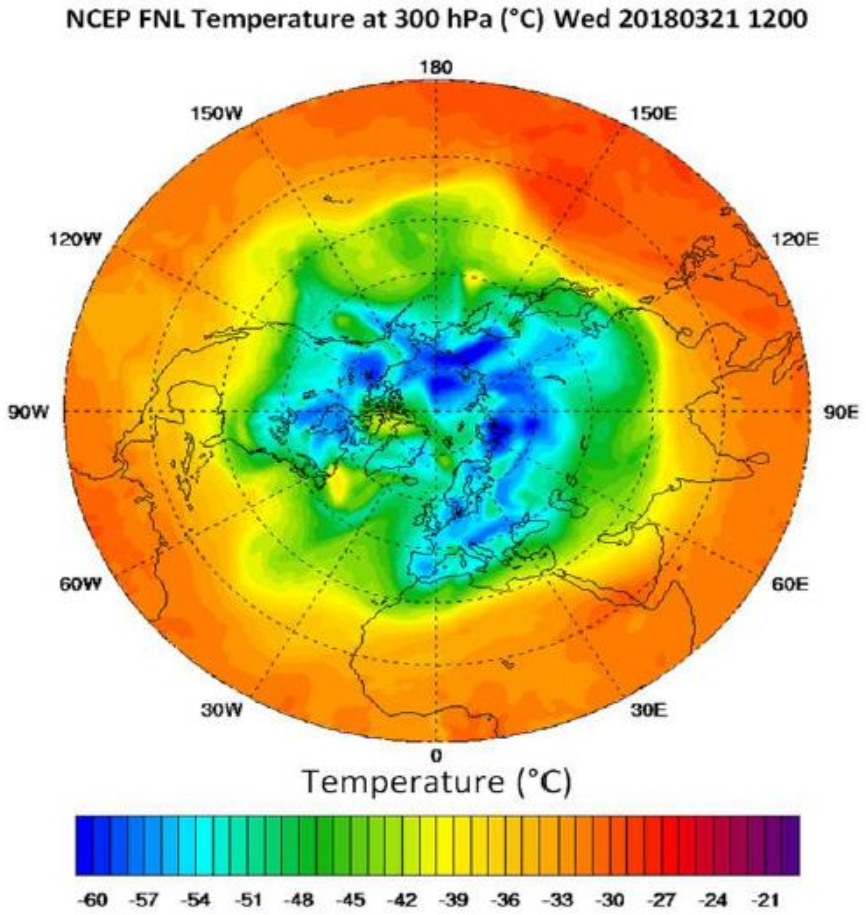
Better performance for the WRF-NDVI simulations

Better performance for the WRF-CTRL simulations



Dust Intrusions in the Mediterranean
From tropospheric folding to Khamsin and Foehn winds





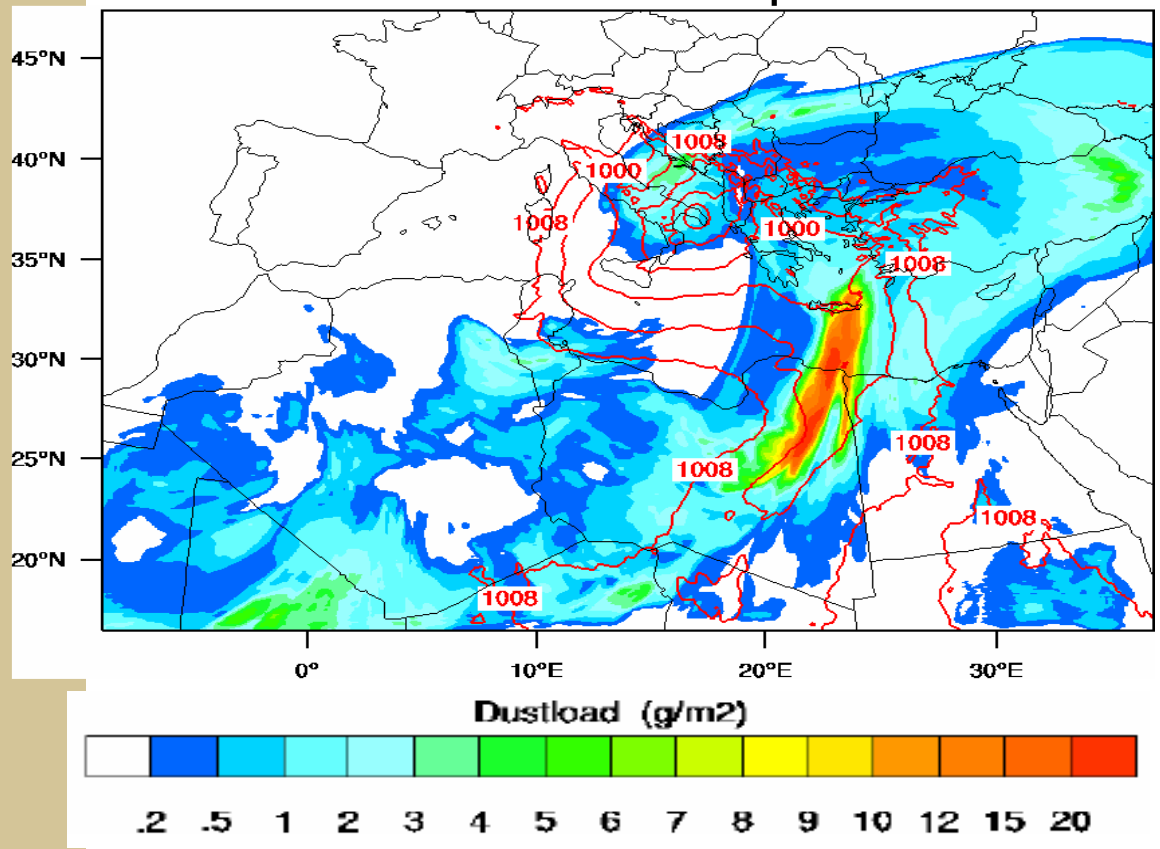
- tropospheric folding
- upper level PV- anomaly
- baroclinic trough propagation
- lower troposphere baroclinicity

Polar vortex weakening NCEP FNL (1°×1°)

Solomos, S., Kalivitis, N., Mihalopoulos, N., Amiridis, V., Kouvarakis, G., Gkikas, A., Binietoglou, I., Tsekeri, A., Kazadzis, S., Kottas, M., Pradhan, Y., Proestakis, E., Nastos, P.T., Marenco, F. *From Tropospheric Folding to Khamsin and Foehn Winds: How Atmospheric Dynamics Advanced a Record-Breaking Dust Episode in Crete. Atmosphere 2018, 9, 240., 2018*

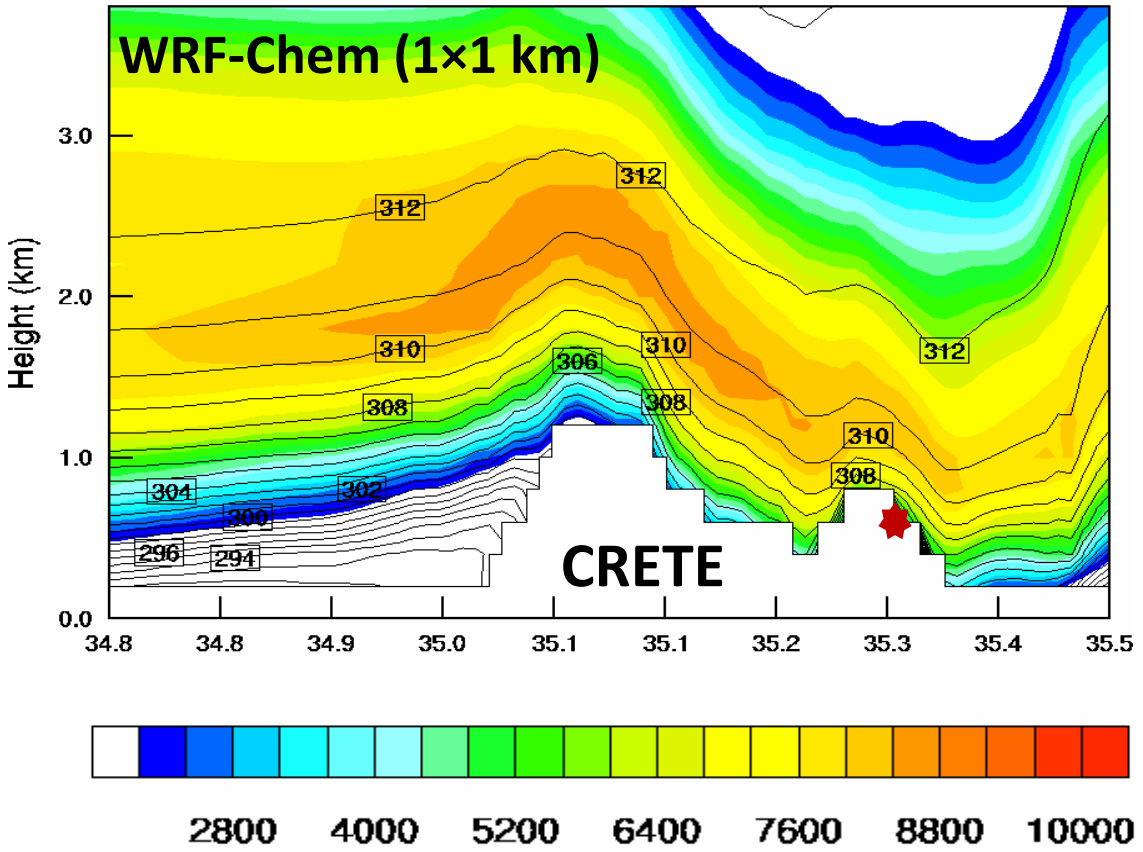
From tropospheric folding to Khamsin and Foehn winds

Dust load and sea level pressure



Transport of dust inside the warm conveyor belt (**Khamsin** wind)

Dust concentration (color scale in μg/m^3) and theta (K)



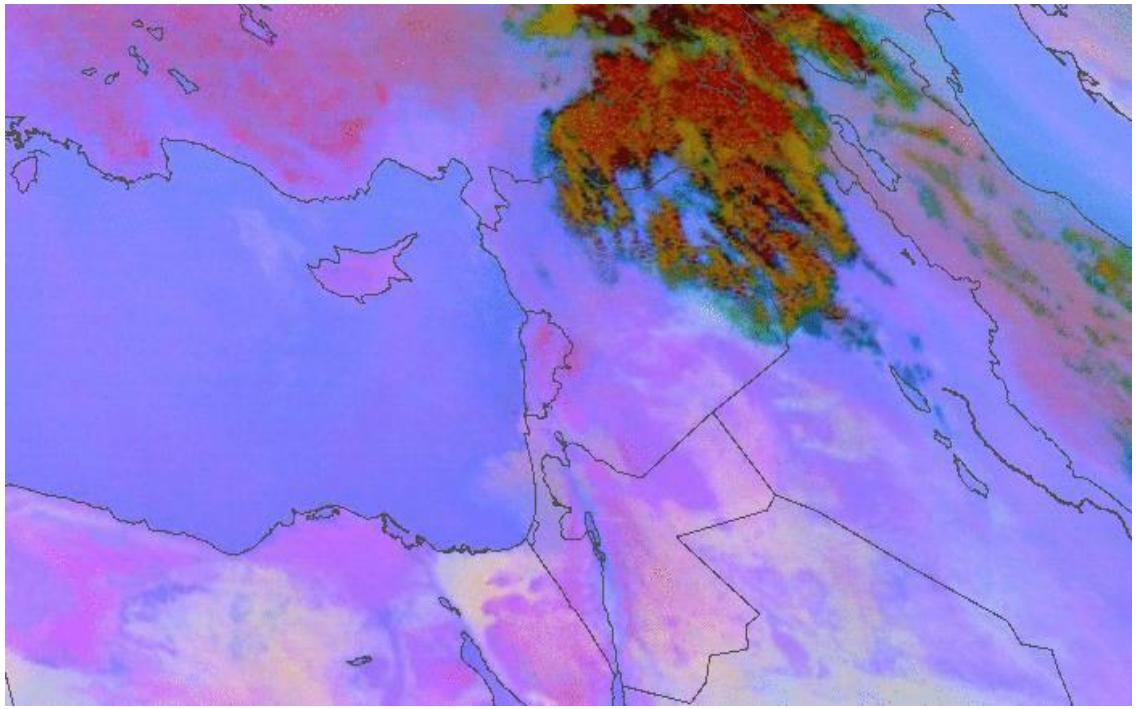
Foehn *(Λίβας)* wind at the lee side of Crete and downward mixing of dust

Convective outflows density currents and haboobs

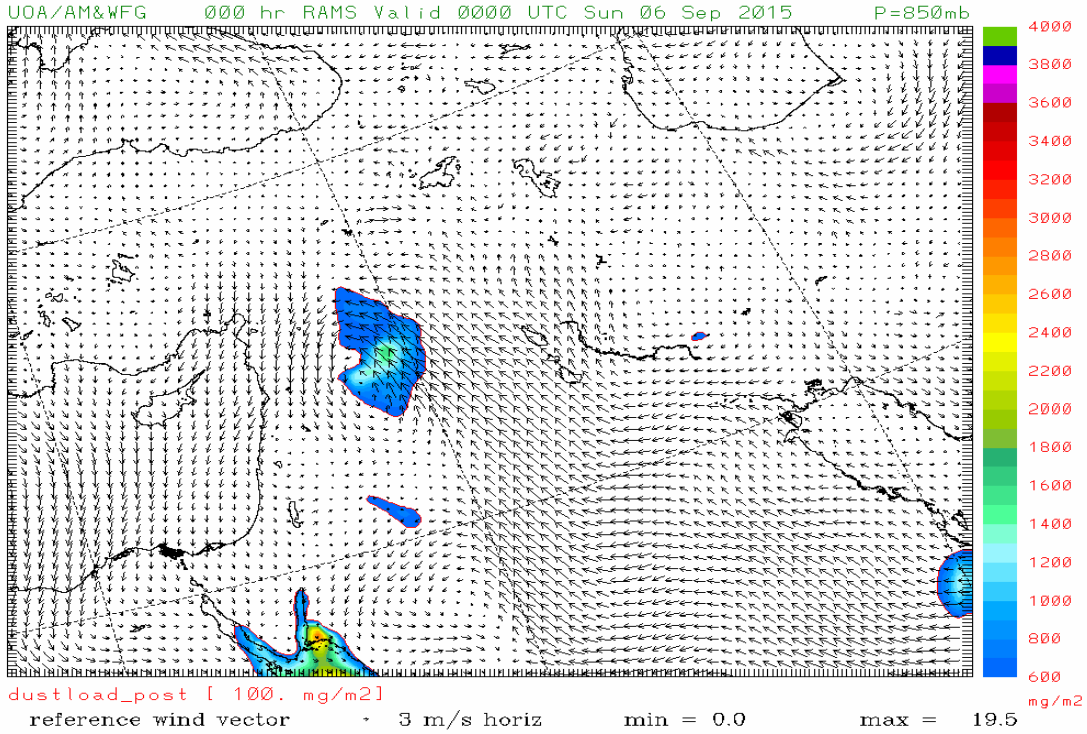
Phoenix 2006

Tehran, Iran, June 2014

Generation of mesoscale density currents from convective outflows



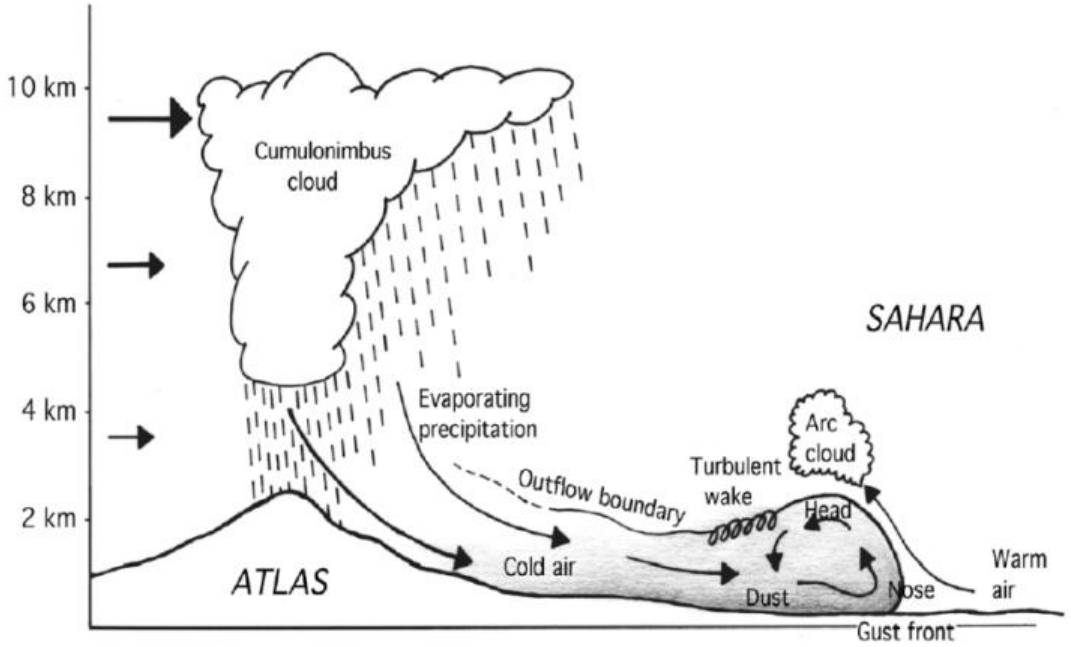
Satellite (MSG-SEVIRI)



RAMS-ICLAMS Model

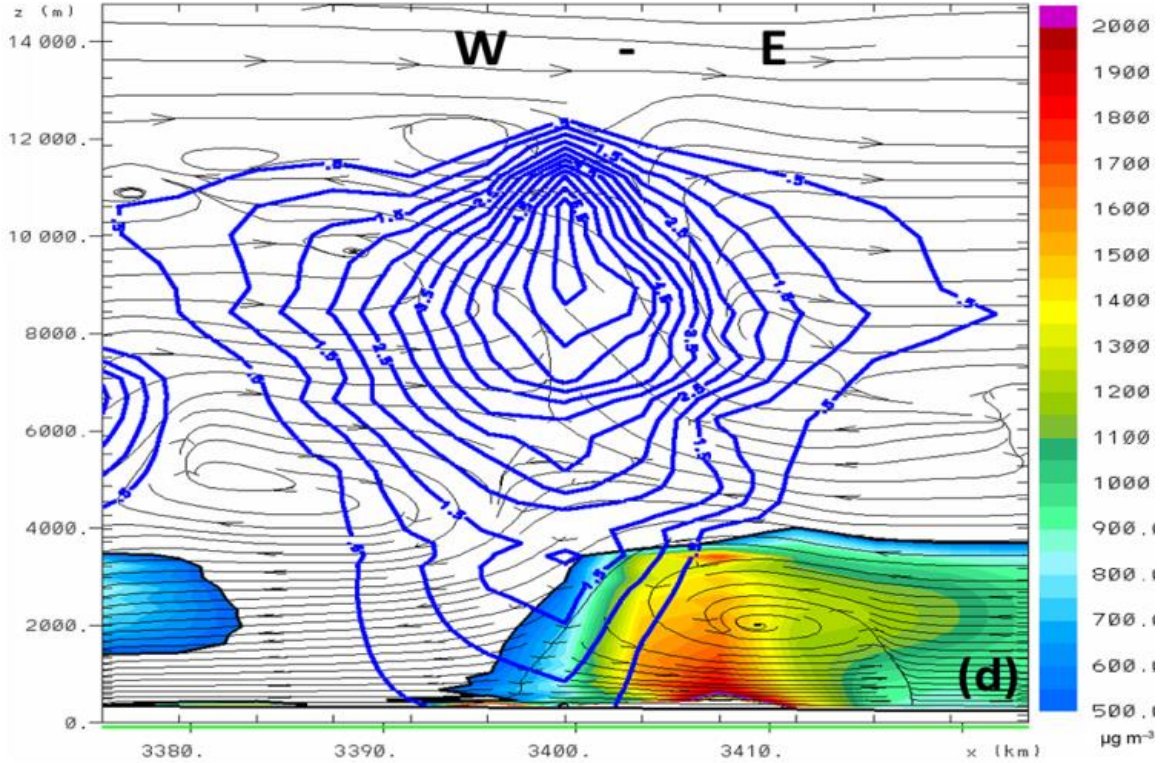
***Mamouri, R.-E., Ansmann, A., Nisantzi, A., Solomos, S., Kallos, G., and Hadjimitsis, D. G.**: Extreme dust storm over the eastern Mediterranean in September 2015: satellite, lidar, and surface observations in the Cyprus region, Atmos. Chem. Phys., 16, 13711–13724, doi:10.5194/acp-16-13711-2016, 2016.*

Vertical structure of storm cell and haboob



Knippertz, et al., 2007, JGR

Total condensate mix. ratio (g/kg), dust concentration (µg/m3), and Streamlines



RAMS-ICLAMS model 2×2 km

Solomos, S., Ansmann, A., Mamouri, R.-E., Binietoglou, I., Patlakas, P., Marinou, E., and Amiridis, V.*: Remote sensing and modelling analysis of the extreme dust storm hitting the Middle East and eastern Mediterranean in September 2015, Atmos. Chem. Phys., 17, 4063-4079, https://doi.org/10.5194/acp-17-4063-2017, 2017.*

e-shape

Next Development Steps in CRITERION include:

- Extension to other locations in Europe
- Climate change considerations at cultural heritage monuments
- Forecast of dust intrusions at the locations of touristic interest

H.F.R.I. Hellenic Foundation for Research & Innovation

This study is supported by the Hellenic Foundation for Research and Innovation project MegDeth (HFRI no.703)

MEGDETH

http://www.megdeth.gr

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Thank you!

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