HOMOGENIZATION AND GRIDDING OF THE GREEK TIME SERIES

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Short Presentation

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Objective

- Development of **the first digital climate atlas** for Greece based on homogenized series.

- Previous atlas produced in 1935 (Mariolopoulos and Livathinos, 1935).

Data

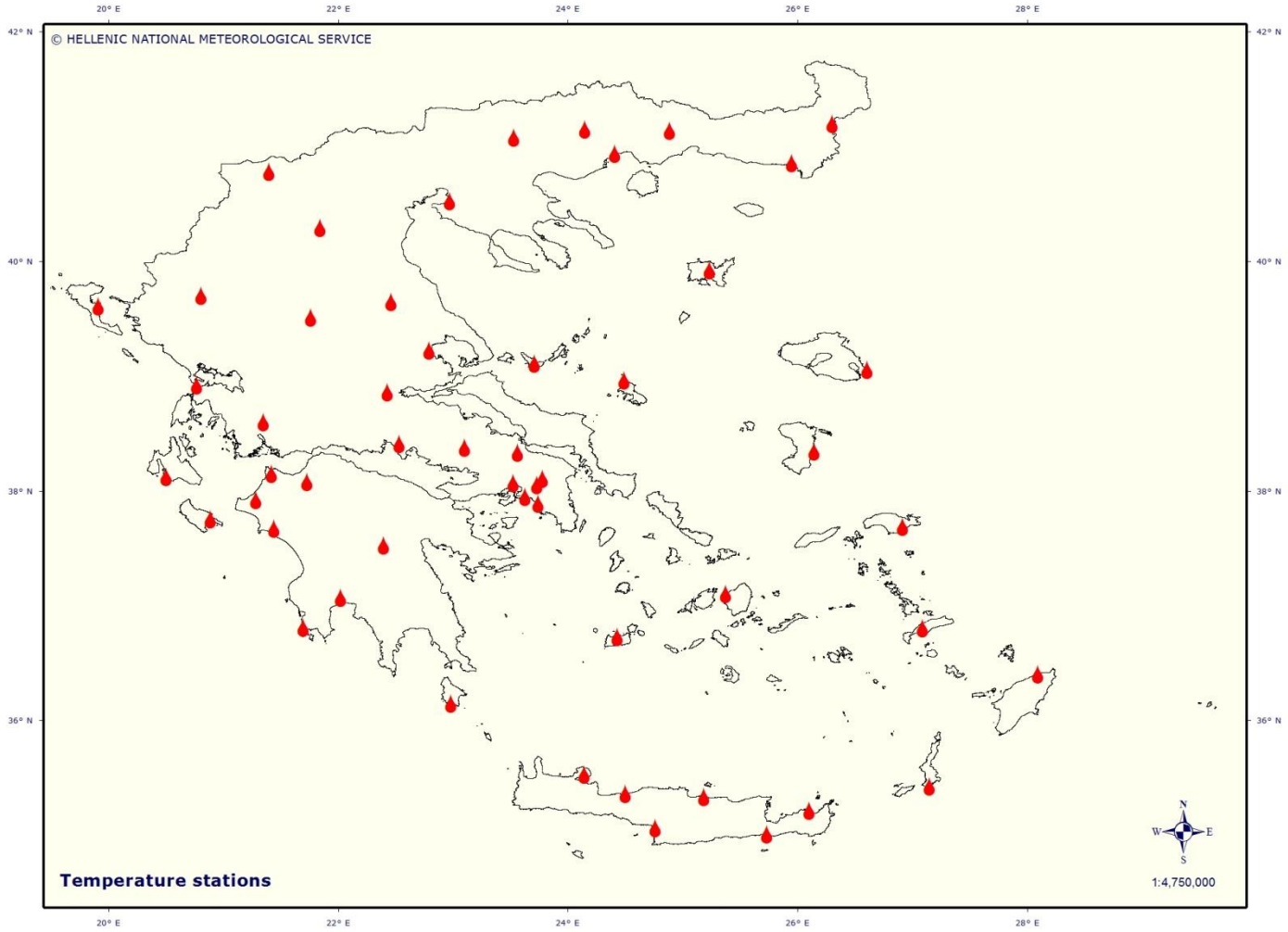
– 52 monthly temperature (min, max, mean) series.

– 44 monthly sunshine duration data.

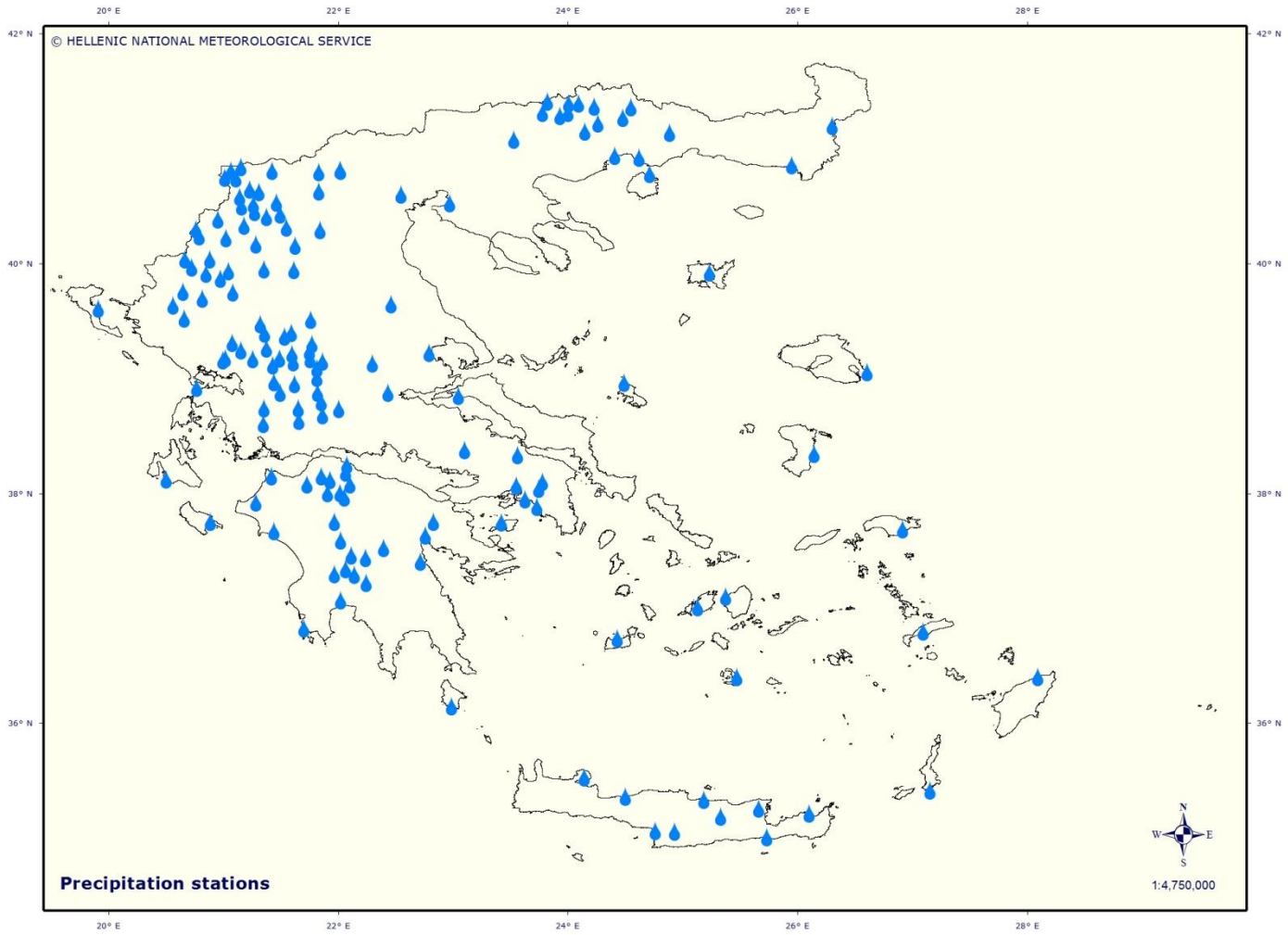
– 157 monthly precipitation series.

(Cover the climatological normal period 1971-2000).

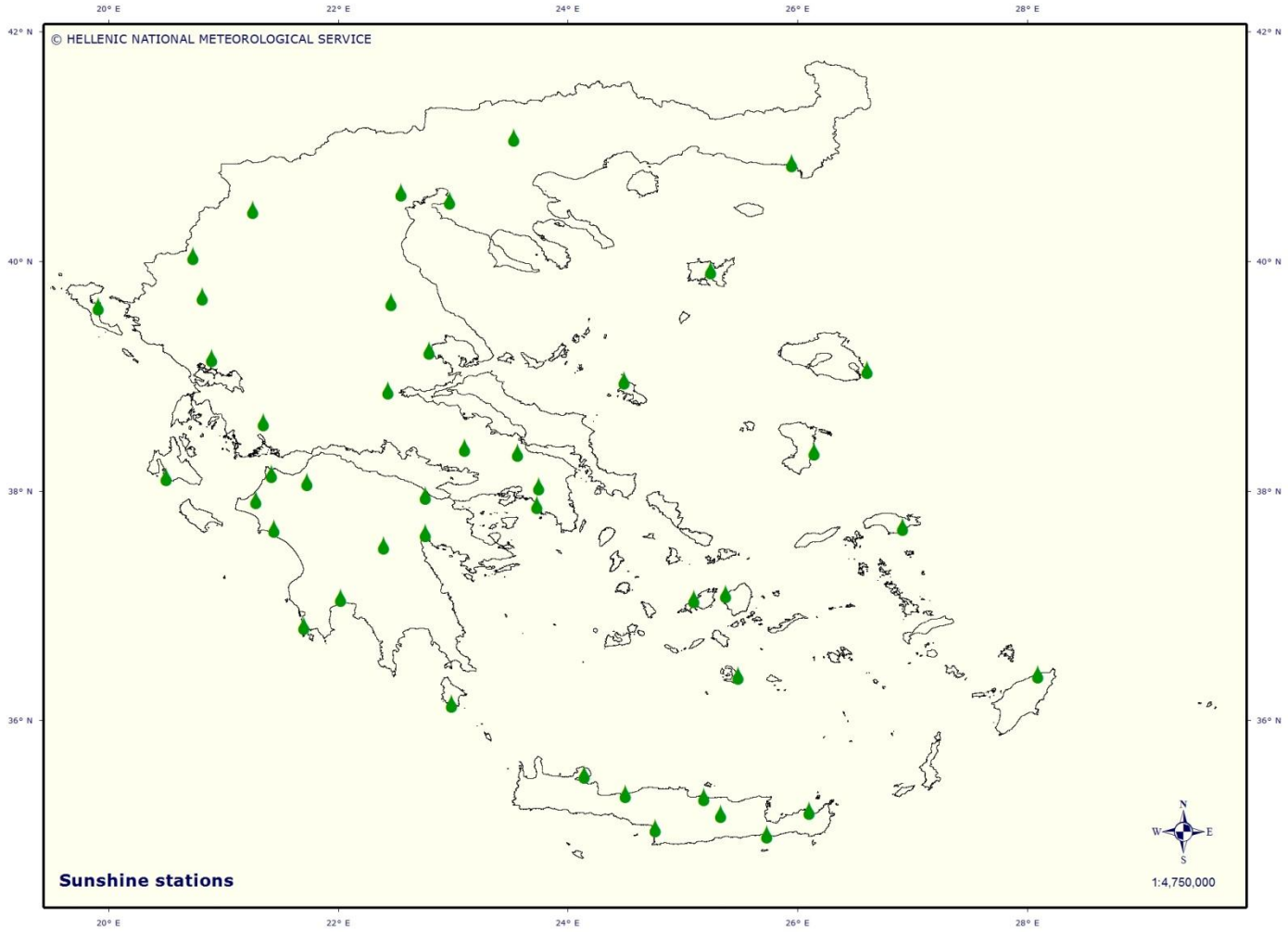
Temperature Stations



Precipitation stations



Sunshine Duration Stations



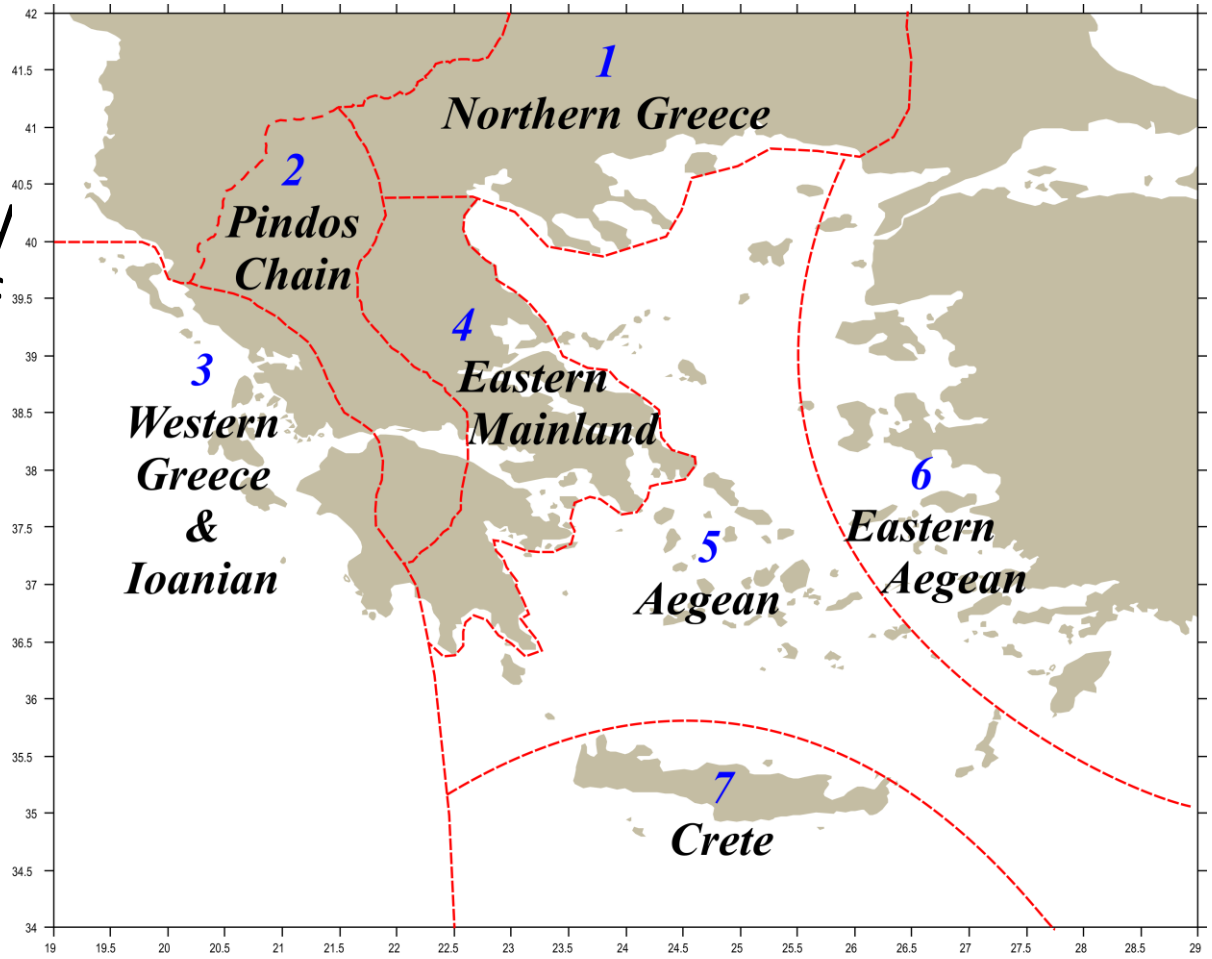
Homogenization Methods

- HOMER
  - Action COST ES0601 HOME www.homogenisation.org
  - Intercomparison of methods.
  - Unified method and software HOMER, with the best methods for detection and correction.

- Results cross – checked using MASH, ACMANT and CLIMATOL.

Homogenization Procedure

Applied separately on the datasets of each of the climatic regions shown.



Homogenization Results

Mean Temperature

Number of examined stations: 52
Number of breaks: 56

Min Temperature

Number of examined stations: 52
Number of breaks: 75

Max Temperature

Number of examined stations: 52
Number of breaks: 51

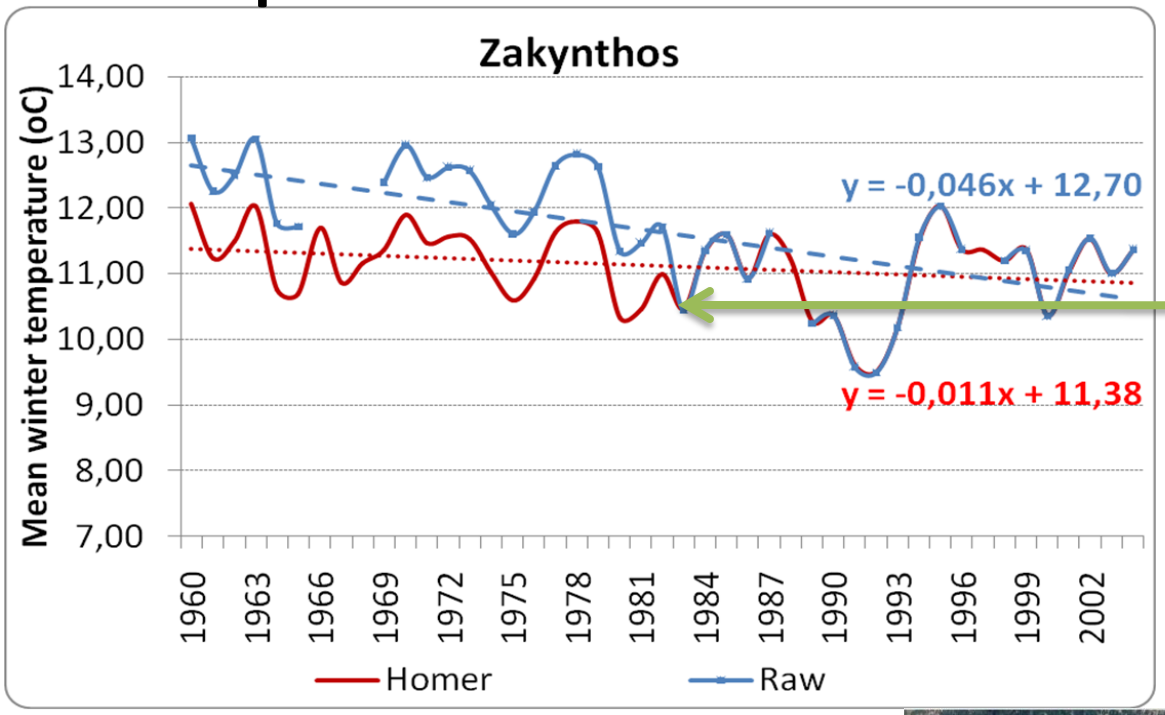
Sunshine Duration

Number of examined stations: 44
Number of breaks: 10

Precipitation

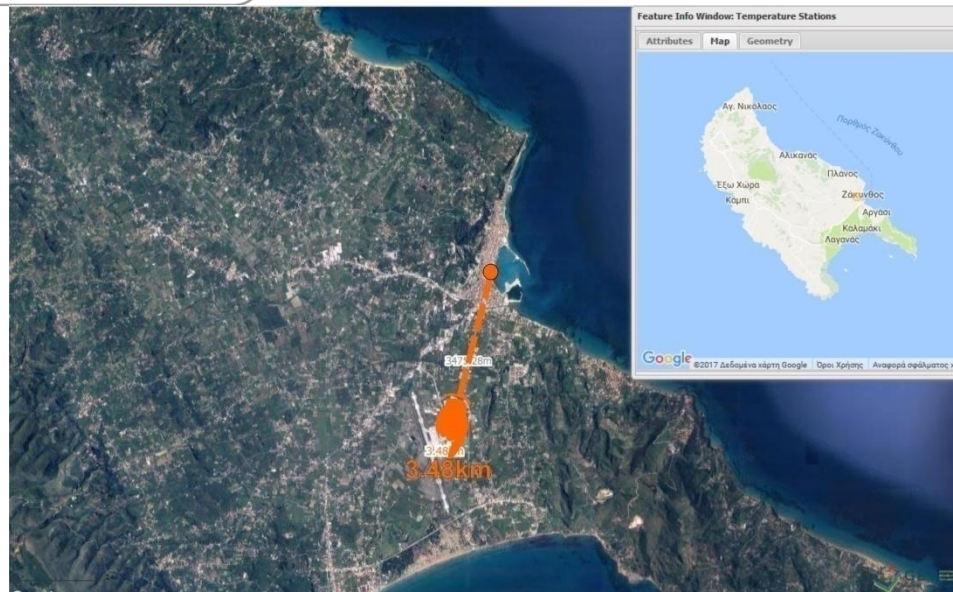
Number of examined stations: 157
Number of breaks: 65

Example of Break Detection & Correction

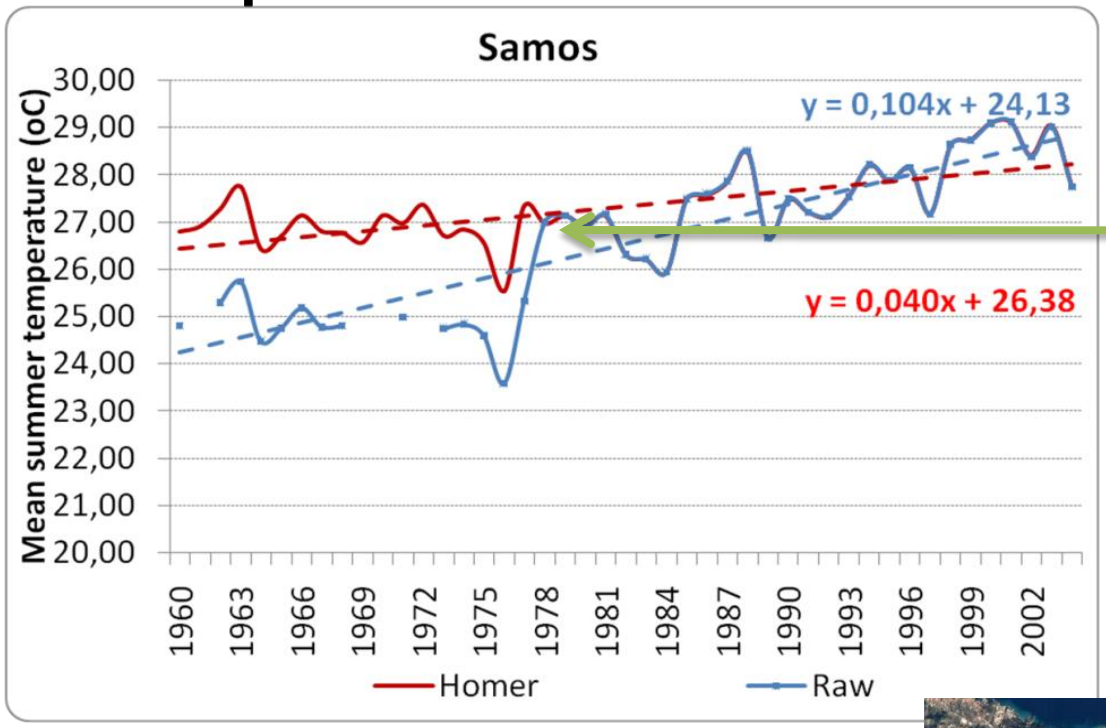


Break Point: May 1982

Relocation (~3.48km) to the south side of the island

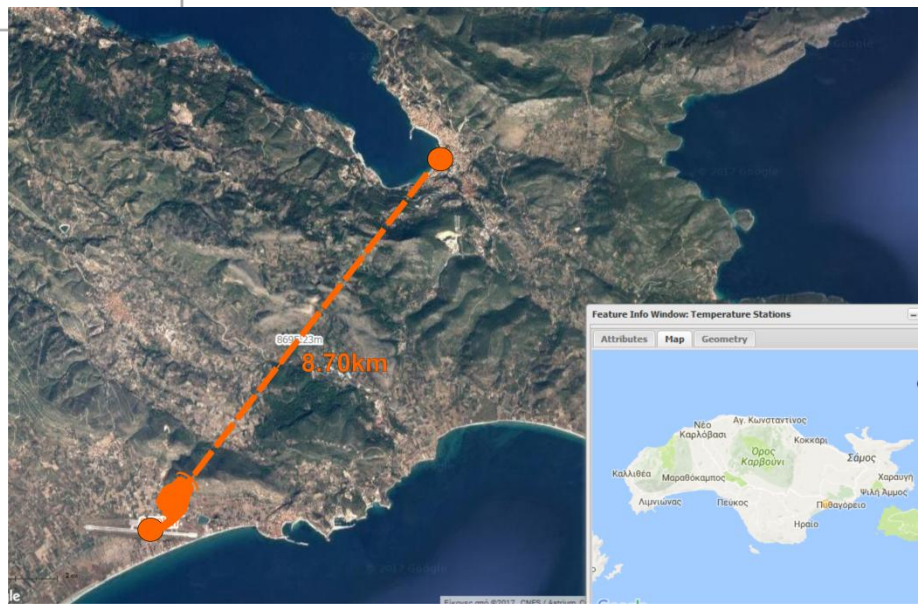


Example of Break Detection & Correction

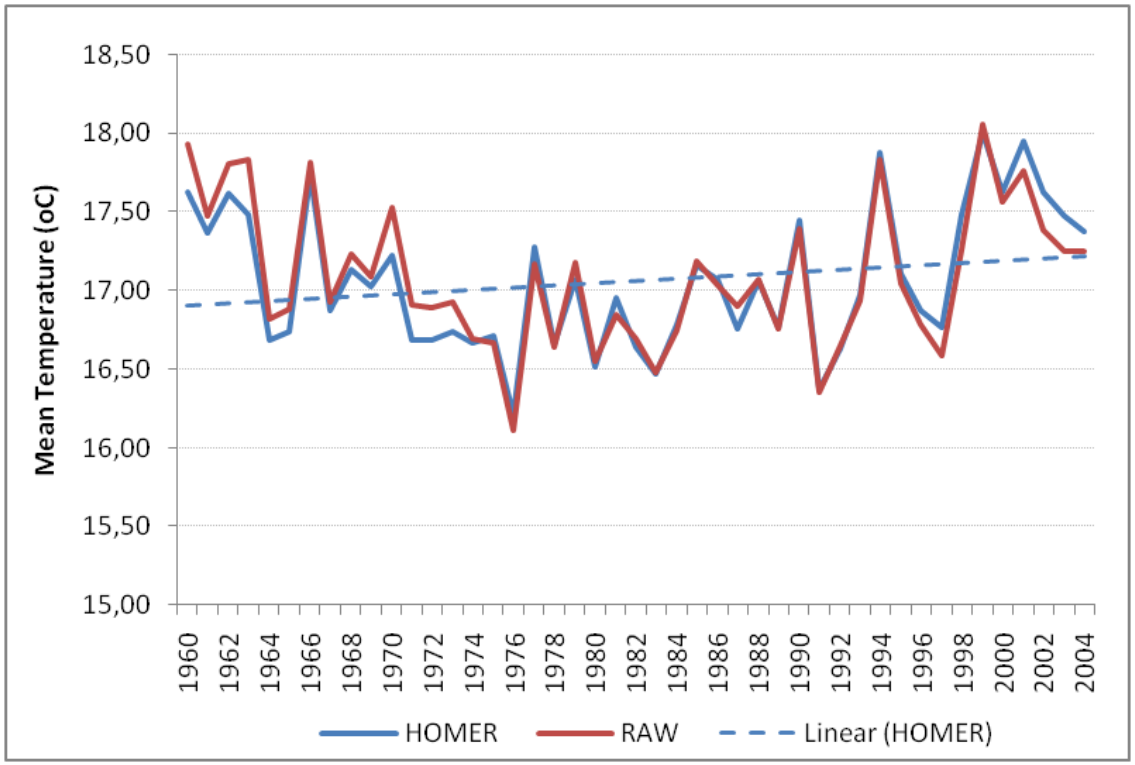


Break Point: April 1978

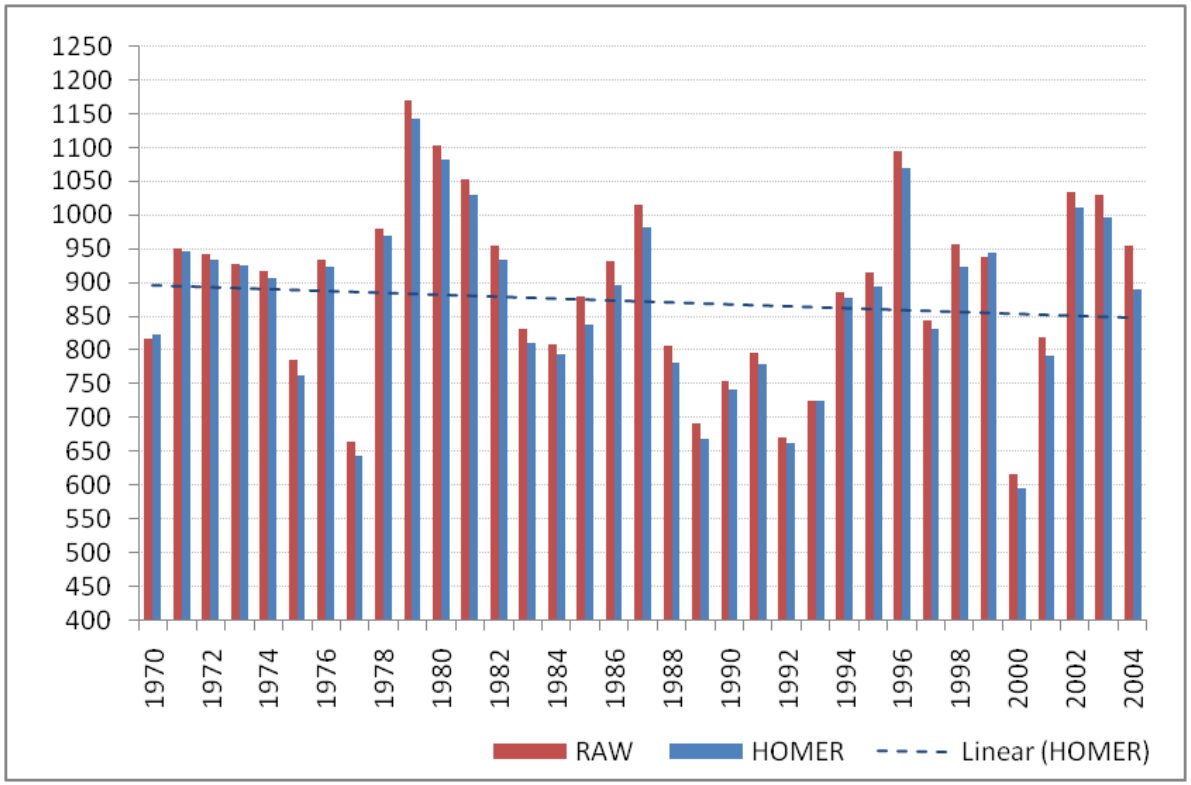
Relocation (~8.7km) to the south side of the island



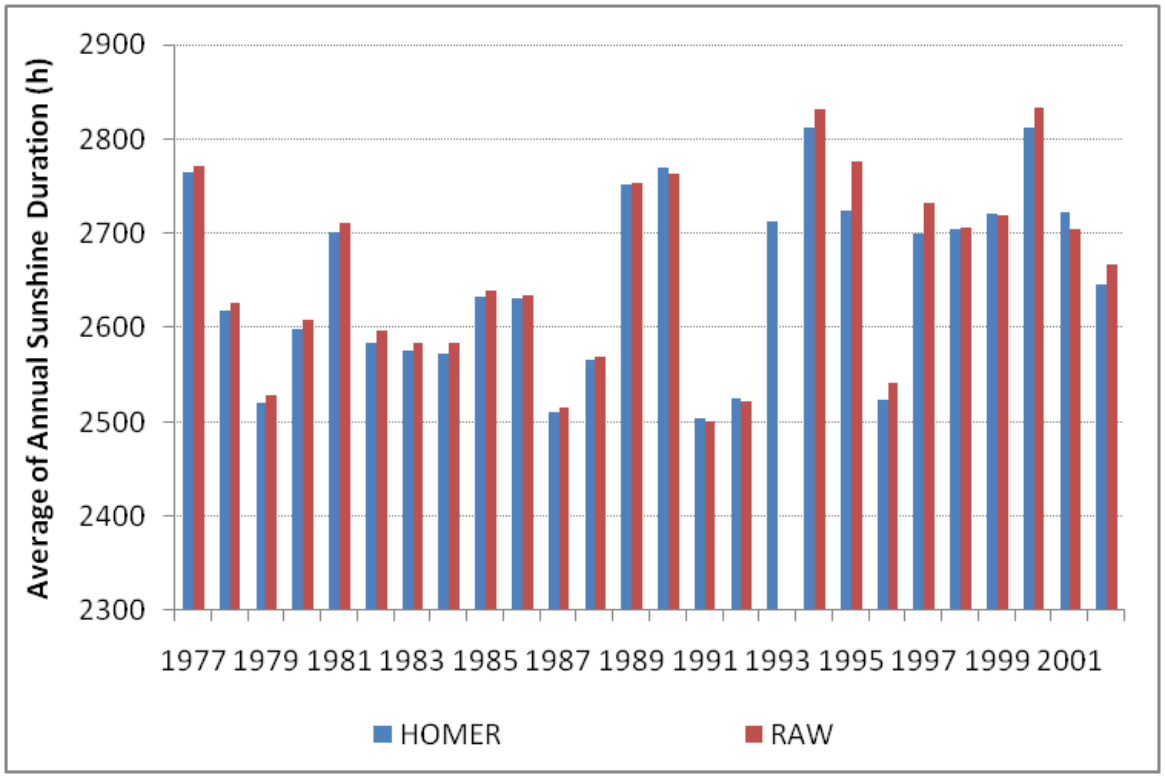
Average Annual Mean Temperature before and after homogenization



Average Annual Precipitation Series before and after homogenization



Average Annual Sunshine Duration Series before and after homogenization



Homogenization Results

- The most frequent identified reasons for inhomogeneities:
  - station relocation from towns to airports
  - change of observation practices.

- The majority of breaks (for both temperature and precipitation series) occurred in the ’80s; confirmed by metadata (during that period many stations were relocated to airports to cover aviation needs).

- No clear improvement of precipitation series (due to smaller correlations between stations).

Spatial Interpolation

- Procedure of the estimation of a variable at an location where the variable is not measured, using data from surrounding locations for which there are measurements.

- Creation of surfaces of continuous values.

- Based on mathematical functions.

Methodology (1)

- Elevation data come from the DEM originating from NASA (SRTM) 90 x 90 m (http://srtm.csi.cgiar.org) were used as predictors of temperature, precipitation and sunshine duration.

- Interpolation method MISH developed for meteorological purposes (Szentimrey & Bihari, 2014) was applied. *(Special thanks to Tamas Kovacs, Tamas Szentimrey and Zita Bihari)*

MISH

The main advantages of MISH method:

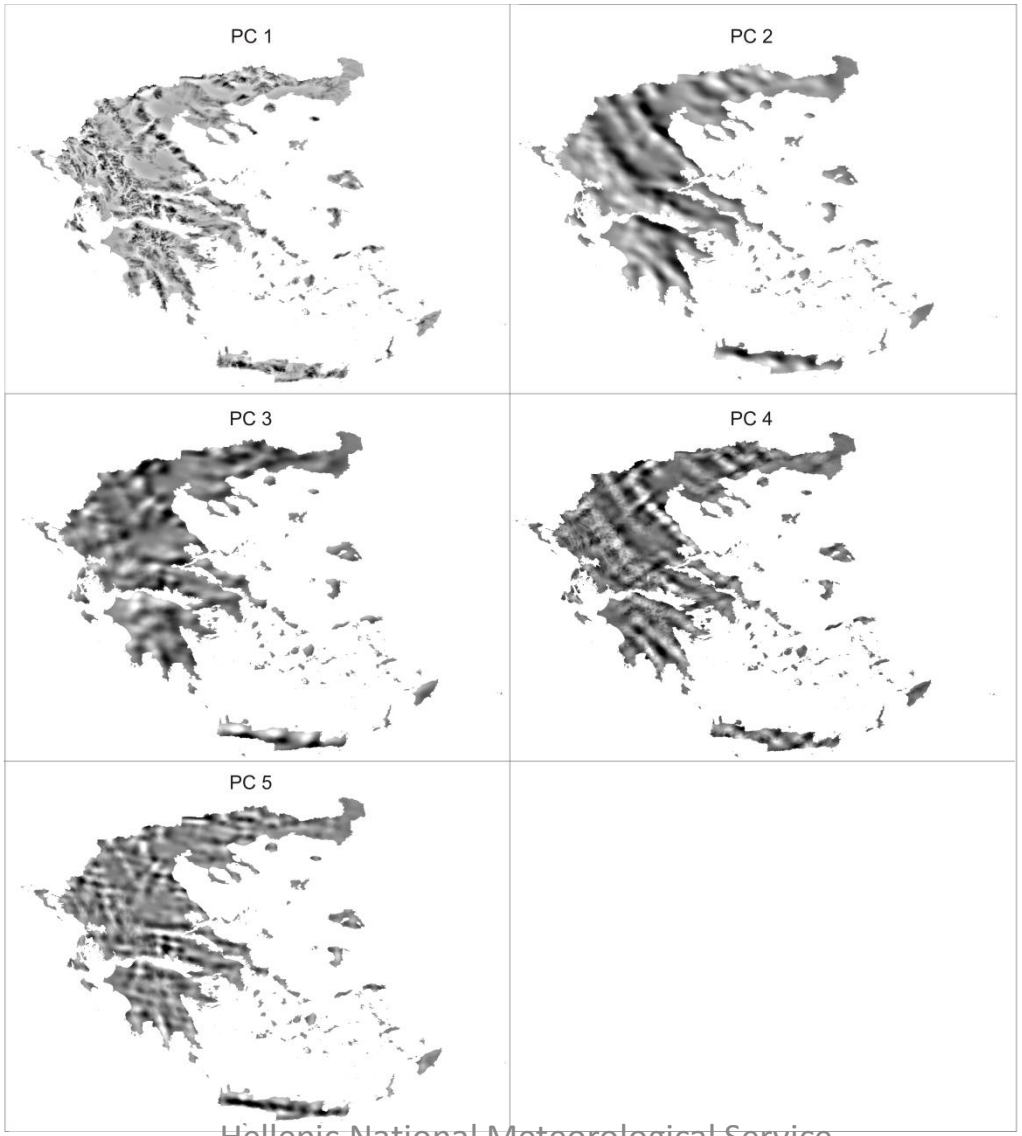
- Requires homogenized data series.
- Gets information of long term data series (usually geostatistical methods use a single realization in time for modelling but meteorological data are spatio-temporal data!).
- Calculates the optimum interpolation parameters which are certain known functions of the climate statistical parameters.
- The interpolation formula depends on the climate parameter.

Methodology (2)

- First 15 principal components proposed by the AURELHY interpolation method (Analyse Utilisant le Relief pour les besoins del‘ Hydrométéorologie) were used as geophysical variables.

First 5 AURELHY PCs

PC1: peaks-valleys



PC2: East-West Slopes

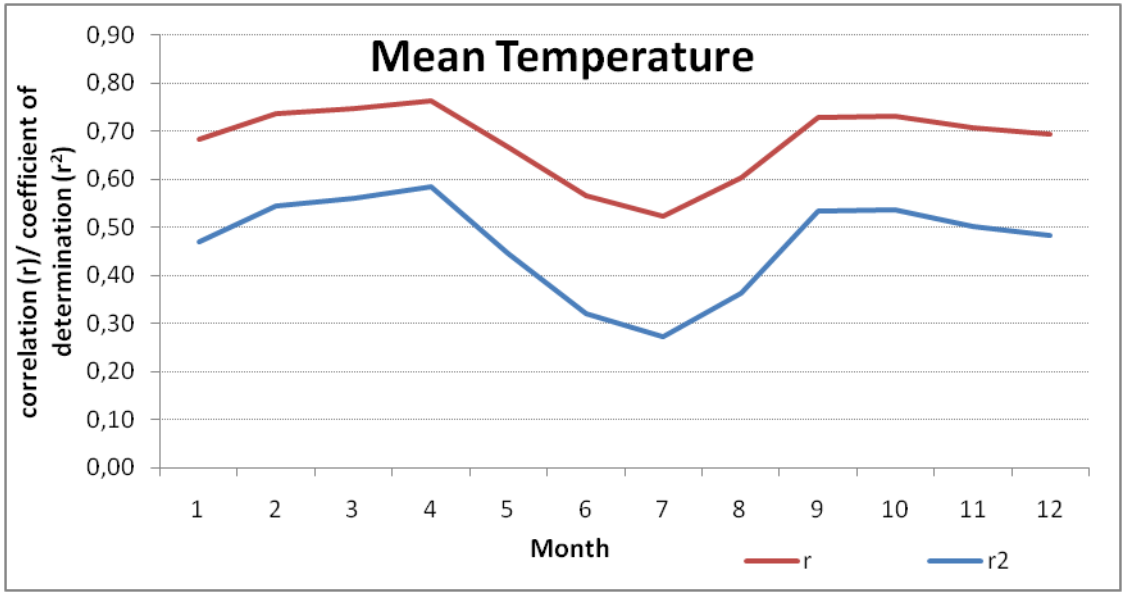
PC3: North-South Slopes

PC4: North-South Saddles

PC5: Northeast-Southwest Saddles

What we learned from the first attempt of interpolation using only elevation & AURELHY

- Bad correlation coefficients for temperature and even worse for precipitation!



What we learned from the first attempt of interpolation using only elevation & AURELHY

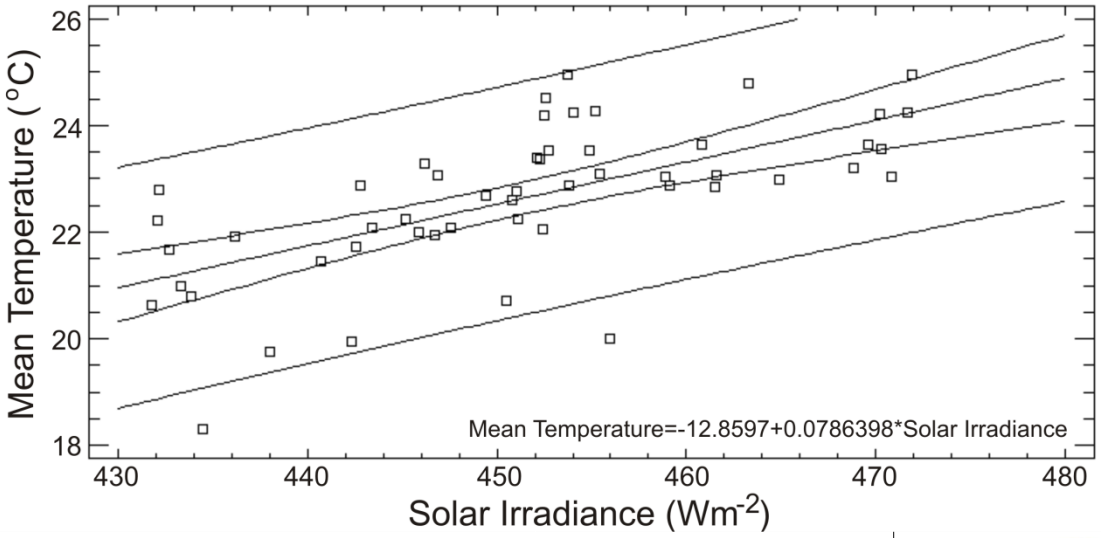
- Elevation and AURELHY variables are not sufficient to describe the meteorological parameters in Mediterranean countries where the maritime influence and solar irradiance are important !!!
- Additional geographical parameters were needed, marine and solar radiation effects should be taken into account !

Additional Geophysical Parameters

(Besides elevation and the first 15 AURELHY PCs):

- Euclidian distance to the coastline (km),
- land to sea percentage coverage (%) within a 10 km radius,
- latitude ϕ (decimal °),
- solar irradiance on the earth's surface ($W.m^{-2}$) (calculated via libRadtran (Mayer and Kylling, 2005))

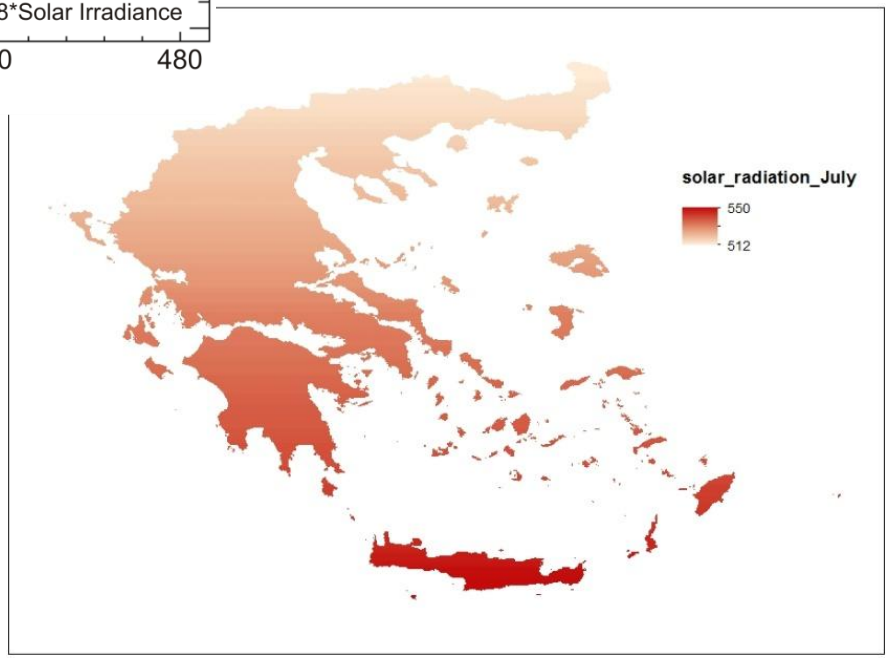
Why Solar Irradiance ?



Linear regression between mean temperature and solar irradiance in September

r=0.65, R^2=41,7 %

Solar Irradiance in July ($W.m^{-2}$)



Spatial Resolution

- 20 geophysical variables in total were used.

- All of them (except the land to sea percentage coverage) calculated within an 800 m radius and at a spatial resolution of 0.5’ × 0.5’ (0.0083333333^{o}), i.e. a range from 689 m (at 42^{o} N) to 769 m (at 34^{o} N).

- 1 166 400 grid points over Greece.

Results

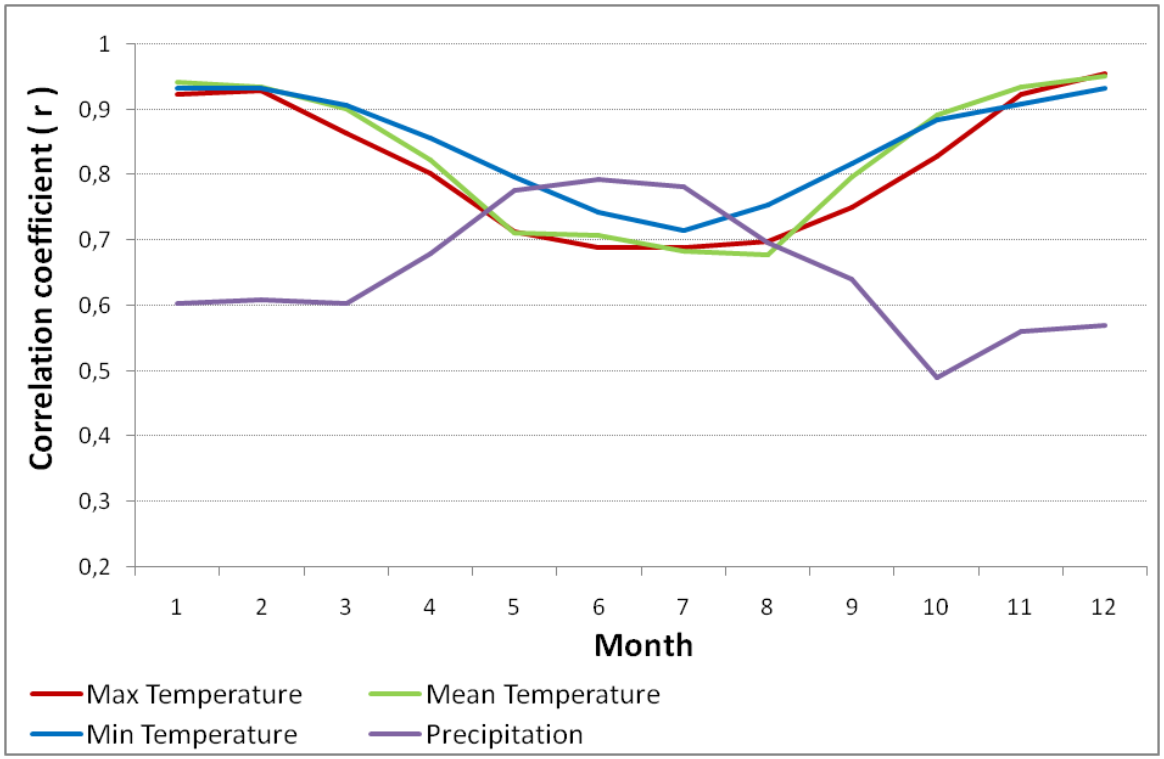
- 5 or 6 geographical variables used in the linear regressions to describe meteorological parameters.

- Elevation, land to sea percentage and solar irradiance are the most commonly used variables in linear regressions.

- Latitude also seems to affect temperature and precipitation.

- North-south saddles were found to be related to temperature only during winter.

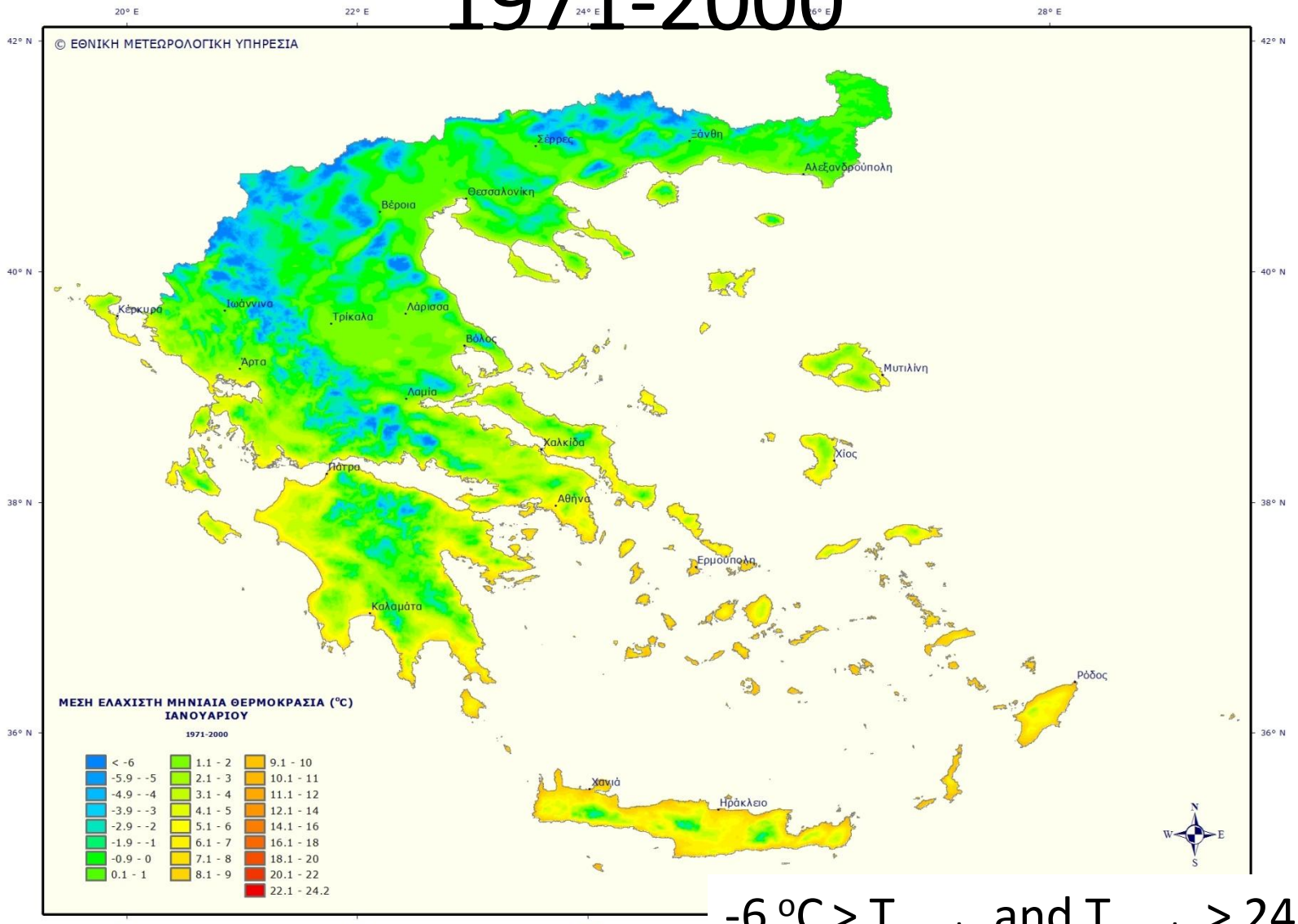
Correlations



- Temperature range: **0.8** - **0.95,** October - April; **0.7** May – September (because of the lower spatial variability of air temperature?).

- Precipitation: **0.6 - 0.8** March – September; drops to **0.5** from October to December.

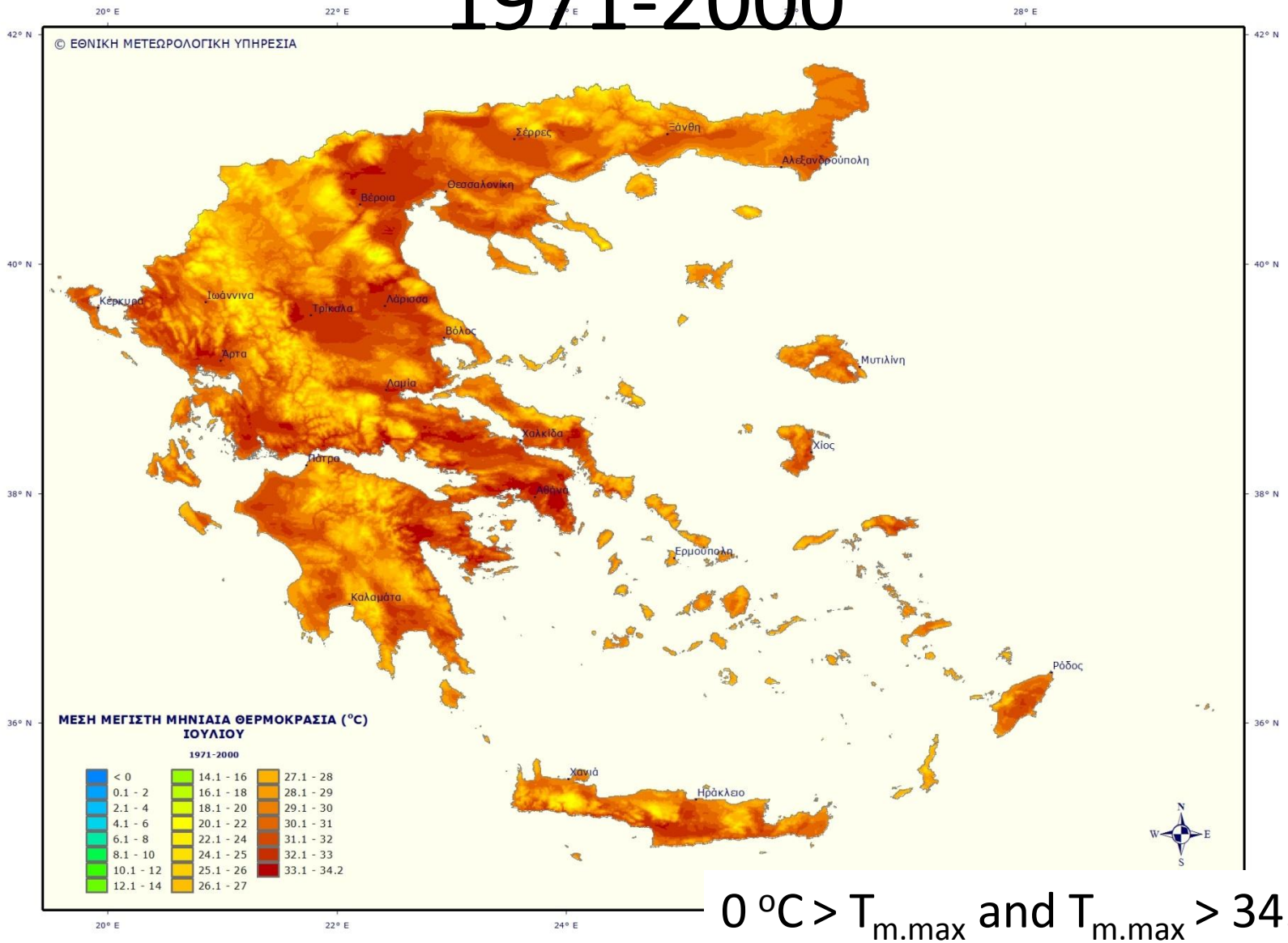
Min Temperature in January 1971-2000



$-6\ ^{o}C > T_{m.min}$ and $T_{m.min} > 24.2\ ^{o}C$

$2\ ^{o}C > T_{y.mim}$ and $T_{y.min} > 17\ ^{o}C$

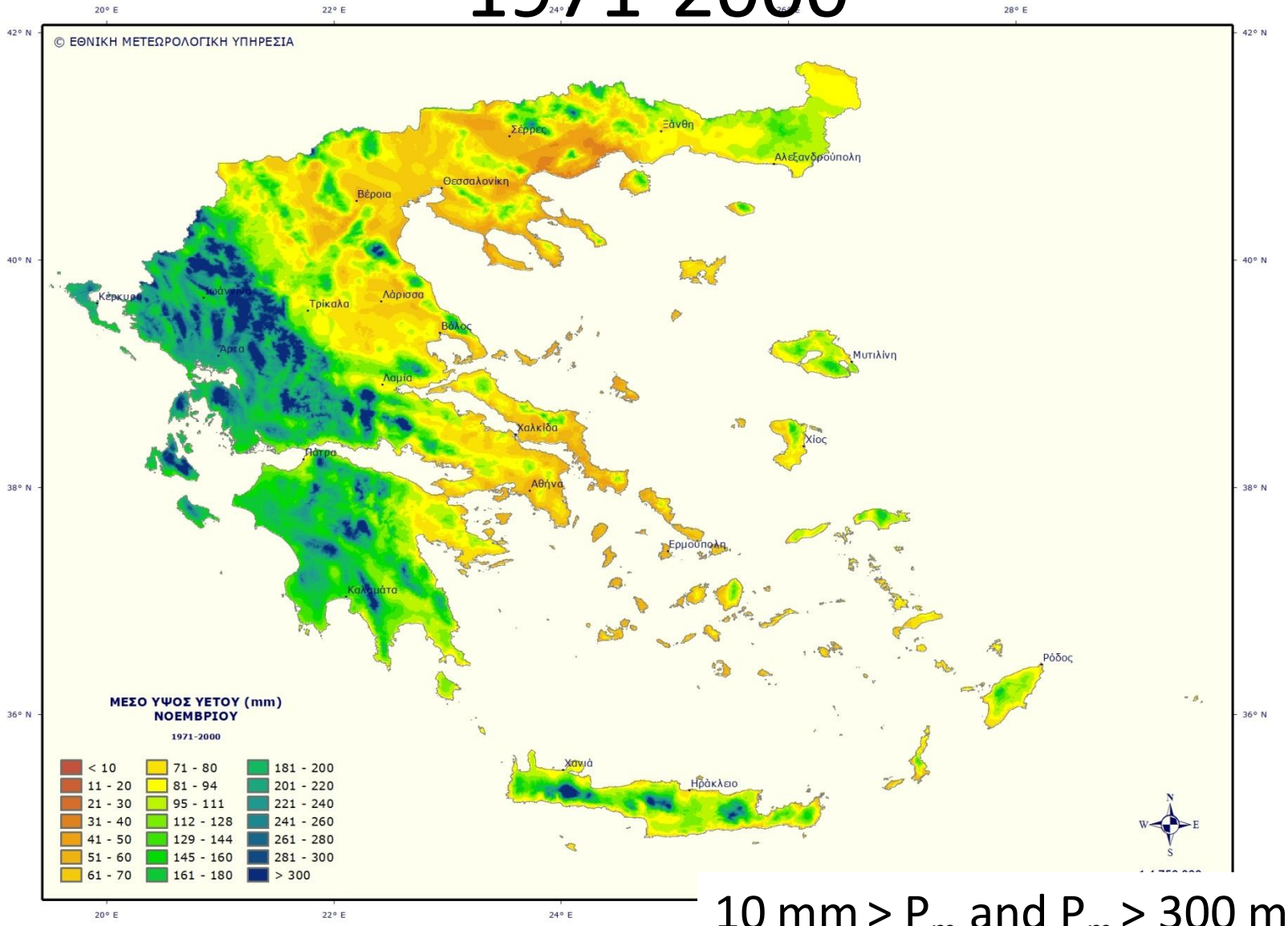
Max Temperature in July 1971-2000



$0\ ^{o}C > T_{m.max}$ and $T_{m.max} > 34.2\ ^{o}C$

$12\ ^{o}C > T_{y.max}$ and $T_{y.max} > 23.6\ ^{o}C$

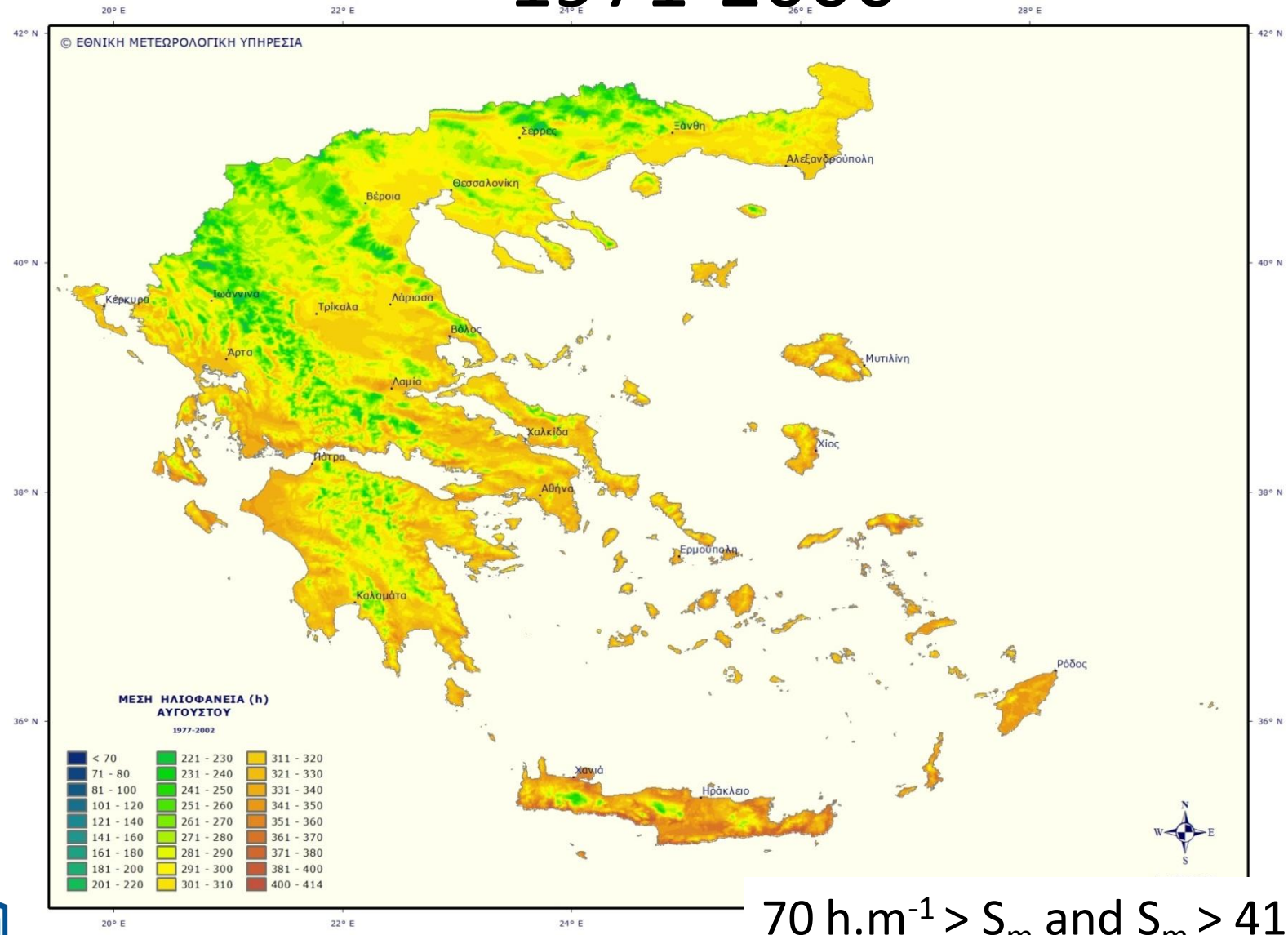
Total Precipitation in November 1971-2000



$10\ mm > P_m$ and $P_m > 300\ mm$

$300\ mm > P_y$ and $P_y > 2000\ mm$

Sunshine Duration in August 1971-2000



$70\ h.m^{-1} > S_m$ and $S_m > 414\ h.m^{-1}$

$1900\ h.y^{-1} > S_y$ and $S_y > 3100\ h.y^{-1}$

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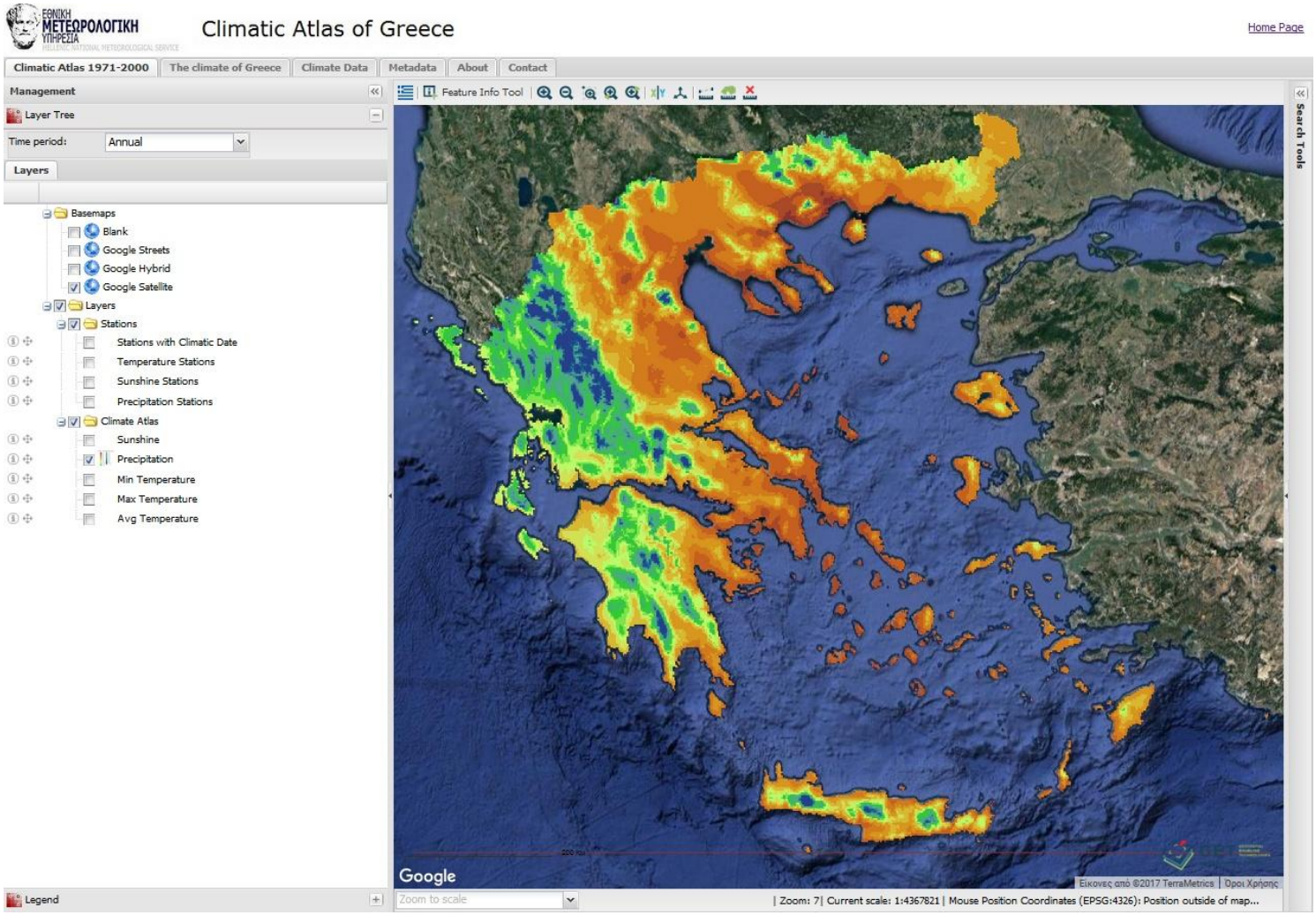

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