

## Progress Report 1: Extreme sunsets in Europe

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Place	Country	Latitude	Longitude
Cabo São Vicente	PT	37.017°	−9.000°
Caminha	PT	41.870°	−8.864°
Ayamonte	ES	37.174°	−7.355°
Cabo Touriñán	ES	43.050°	−9.300°
Pointe Sainte-Anne	FR	43.385°	−1.753°
Pointe de Corsen	FR	48.433°	−4.897°
Dunmore Head	IE	52.109°	−10.482°
Aghernagallagh	IE	54.269°	−10.082°
Cape Wrath	UK	58.626°	−5.005°
Land’s End	UK	50.064°	−5.715°
Nordkapp	NO	71.206°	25.784°
Farsund	NO	58.088°	6.593°

Table 1 List of places of interest in connection with sunsets. Roughly we list the Southwestern and Northwestern most locations in Portugal (PT), Spain (ES), France (FR), Ireland (IE), United Kingdom (UK) and Norway (NO). Figure 1 shows a cartography.

## 1. INTRODUCTION

Previously, Mira-Pérez (2016) identified the last sunset in mainland Europe over the course of one calendar year. Extreme points were found in Portugal (autumn and winter), Spain (early spring and late summer) and Norway (spring and summer).

In 2023 and 2024 we addressed the issue of the extreme sunset in Europe, including the British Isles and the extreme sunsets in the countries of our partners.

For that purpose we developed a selected a series of places of interest in the project. The series is listed in Table 1. A map with locations is shown in

A script in `octave` was written to do the following tasks:

1. Compute the solar declination on every day of the year 2024, assisted by `xplanet`.
2. Compute sunset times for every location and every calendar date in 2024 taking into account the equation of time, geographical coordinates (table 1) and the formula for sun height as a function of solar declination and time, see Pierrehumbert (2010).

Sunset times are approximate since atmospheric refraction is hard to simulate.

## 2. RESULTS

The script referred above resulted in a  $366 \times 12$  matrix  $A$  with each element  $A_{ij}$  showing sunset times for location  $i$  and for calendar date  $j$ . This matrix was analyzed to provide extreme sunset by country and extreme sunset for the overall series of locations.

### 2.1. Analysis by country

Table 2 listed pairs of NW and SW most locations in the selected countries with the “transition dates”, when the NW location ceases or starts displaying the latest sunset in the country.

Figure 2 shows in full detail the case of Ireland and the rationale behind Table 2. The figure brings the array of sunset lines that goes through Aghernagallagh. They were built up from the sunset times in the matrix  $A$  for the location. The color gradient goes from the winter sunset (blue) to the summer sunset (red), with the equinoctial lines in white, and upright. During one calendar year the lines move from winter to summer (blue to red) and then back (red to blue).

Dunmore is also signaled in Figure 2. The sunset time is coincidental in either location when the sunrise line connects both. This happens twice per year. Values are noted in Table 2.

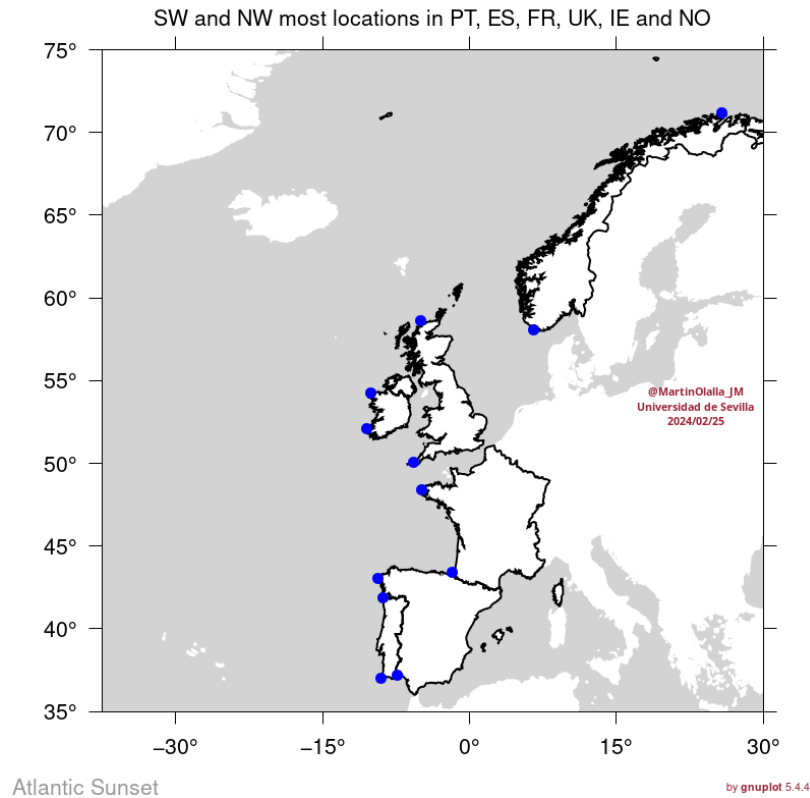


Figure 1 Map of Europe indicating (blue circles) the places of interest listed in Table 1 and corresponding to the Southwestern and Northwestern most locations in Portugal, Spain, France, Ireland, United Kingdom and Norway. Country borders are highlighted in black lines.

	SW location	NW location	$\Delta$ lat	$\Delta$ lon	Date 1	Date 2
PT	Cabo São Vicente	Caminha	4.85	0.14	21/Mar	21/Sep
ES	Ayamonte	Cabo Touriñán	5.88	-1.94	19/Feb	22/Oct
FR	Pointe Sainte-Anne	Pointe de Corsen	5.05	-3.14	03/Feb	07/Nov
IE	Dunmore Head	Aghernagallagh	2.16	0.40	27/Mar	14/Sep
UK	Land's End	Cape Wrath	8.56	0.71	22/Mar	20/Sep
NO	Farsund	Nordkapp	13.12	19.19	19/Apr	22/Aug

Table 2 List of extreme sunsets in Portugal (PT), Spain (ES), France (FR), Ireland (IE), United Kingdom (UK) and Norway (NO) obtained from the script described in section 1. Date 1 signals the calendar date when SW location ends showing the latest sunset time of the two. Date 2 signals the calendar date when SW location starts showing the latest sunset time of the two. The case of Ireland is shown in Figure 2

## 2.2. Global analysis

Figure 3 (top) shows the evolution of sunset time at selected locations. Note that times are given in universal time (UTC) format and not in local times. The color map brings darker colors at lower latitude locations and lighter colors at higher latitude locations.

We computed the extreme sunset by calendar date by maximizing the matrix  $A$  row-wise. In figure 3 this envelope is noted by a dark thick line.

For a more global perspective of the issues discussed here Figure 3 (bottom) shows a sketched with the latest sunrise time as a function of calendar date, and the transition points from one location to another.

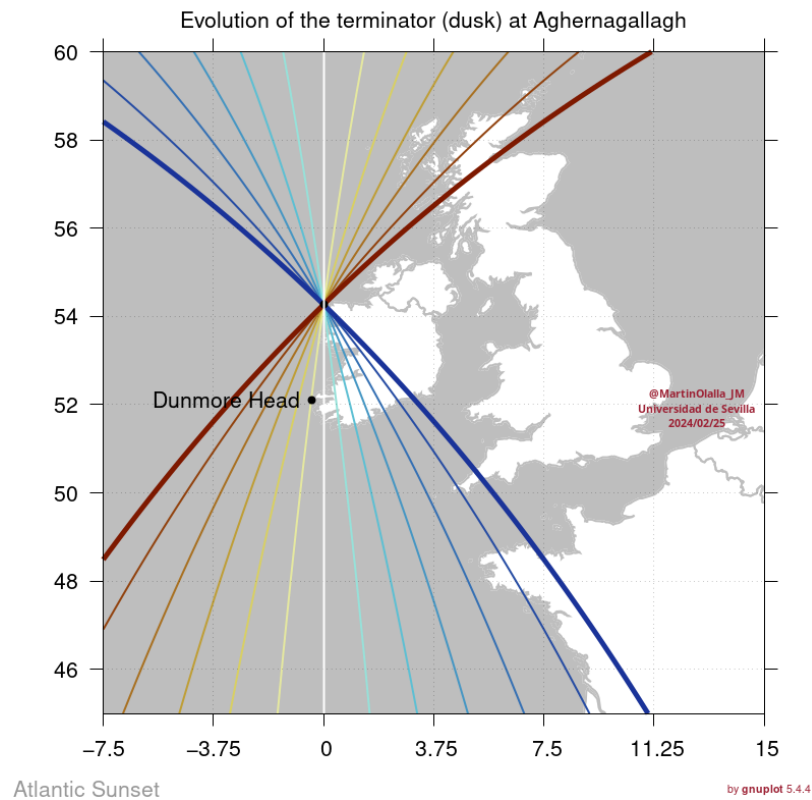


Figure 2 The evolution of sunset lines at Aghernagallagh (Ireland) the gradined of colors blue to red goes from winter solstice to summer solstice. Dunmore End is also located in the map. At two given dates of the year the sunset time occurs synchronously in either location. See table 2.

### 3. CONCLUSION

Helped by the results here presented, the partners of this project can launch timed proposals that target specific characteristics of the locations with latest sunset either at a country level or at Europe level.

### 4. DISCLAIMER

This document does not considered Açores (Portugal) and Canary Islands (Spain) due to their Western most locations.

### REFERENCES

Mira-Pérez, Jorge (2016), "The last sunset on mainland europe," *Cartography and Geographic Information Science* **45**, 56–61.  
 Pierrehumbert, Raymond T (2010), *Principles of planetary climate* (Cambridge University Press).

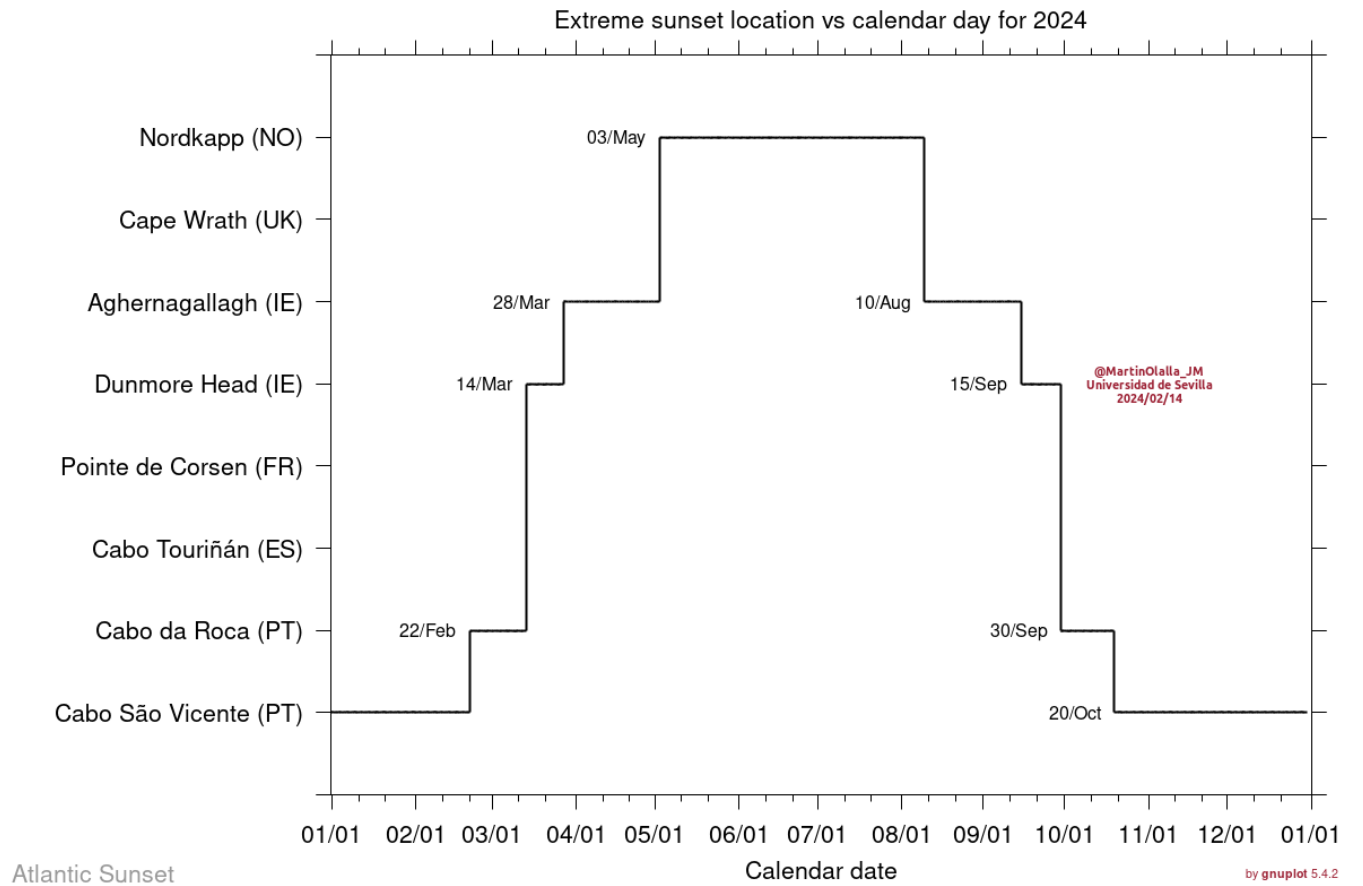
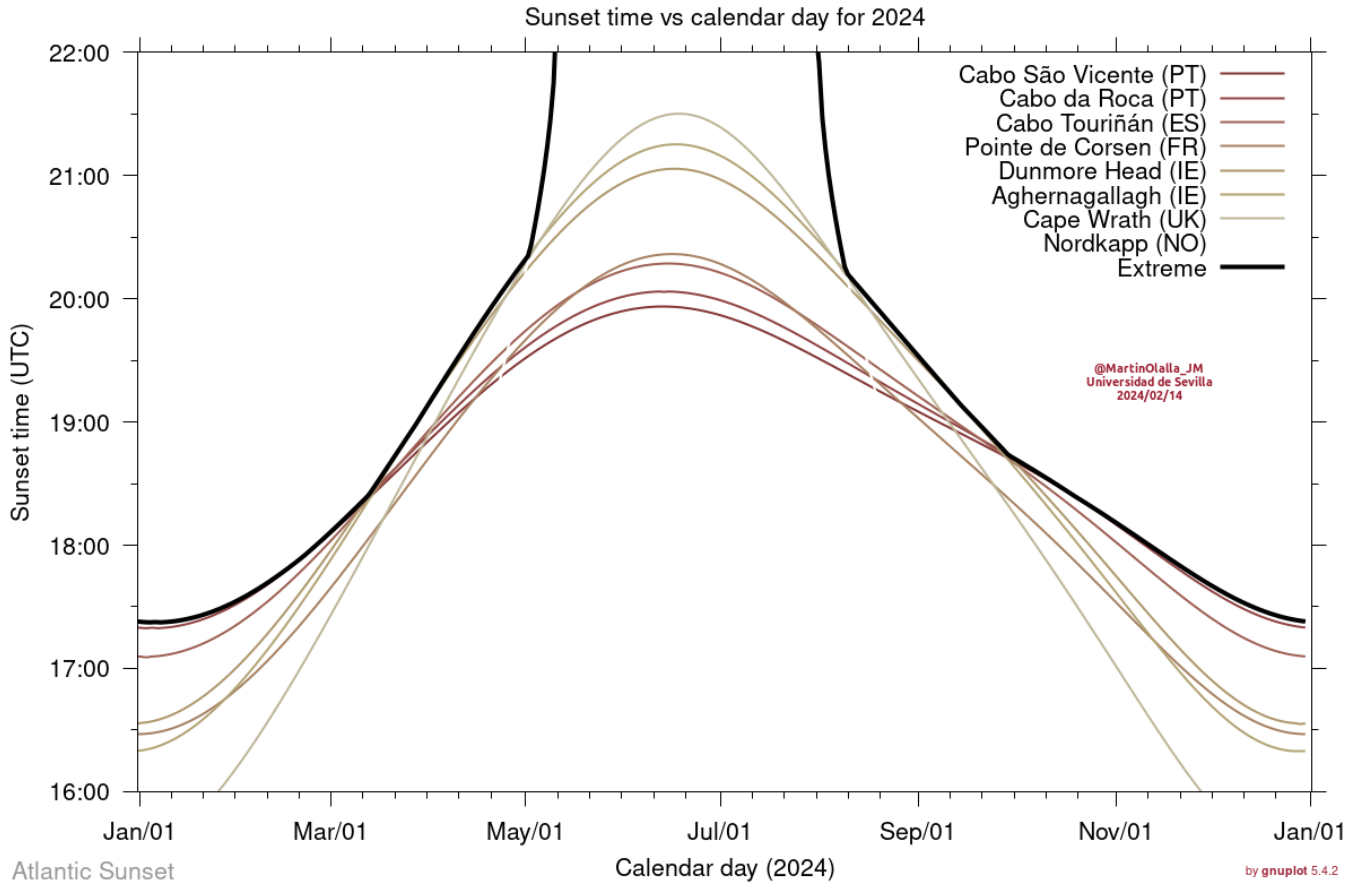


Figure 3 The evolution of sunset time (UTC) in selected locations (top). Color map brings darker colors at lower latitude locations. The envelope of extreme sunsets is noted by a thick dark line. The bottom panel locates the latest sunrise by calendar date.