European Commission

Identification of weather factors affecting refugees and migrants following the central Mediterranean route

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Joint Research Center

Contents

Period of Analysis

January 2009 to May 2017

Methodology

Utilising both Analysis and
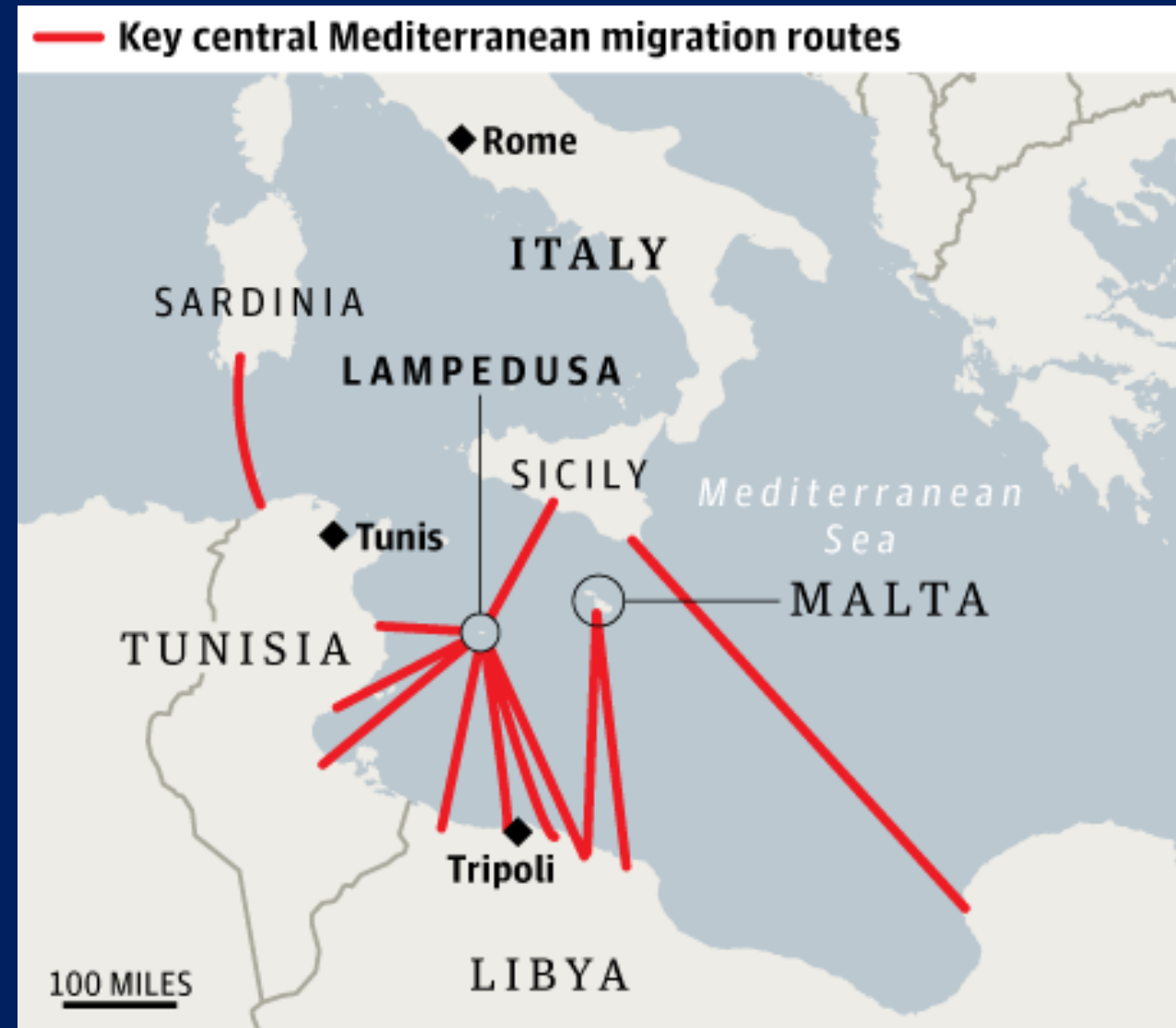
Short-Range HIRES (T+6 & T+12)

Routes from the EU to USA and Canada

Hotspot

EURTF

EURTF CATANIA

EURTF PIRAEUS

Three (3) main routes
of immigrant crossings

Central Mediterranean Route (CMR)

Key central Mediterranean migration routes

Rome

ITALY

SARDINIA

LAMPEDUSA

SICILY

Tunis

Mediterranean Sea

MALTA

TUNISIA

Tripoli

100 MILES

LIBYA

Journey to Italy or Malta via the Central Mediterranean Route (CMR)
*lasts between 2 to 6 days*

In 2015 and again in 2016 and 2017
*CMR has re-emerged as the world's deadliest migration route*

A study by Katsiaficas (2016)
concludes that movements of migrants and refugees are highly adaptable; migrants and smugglers respond to changing immigration, enforcement, and visa policies, as well as a range of other conditions (such as weather conditions) in origin, transit, and destination countries
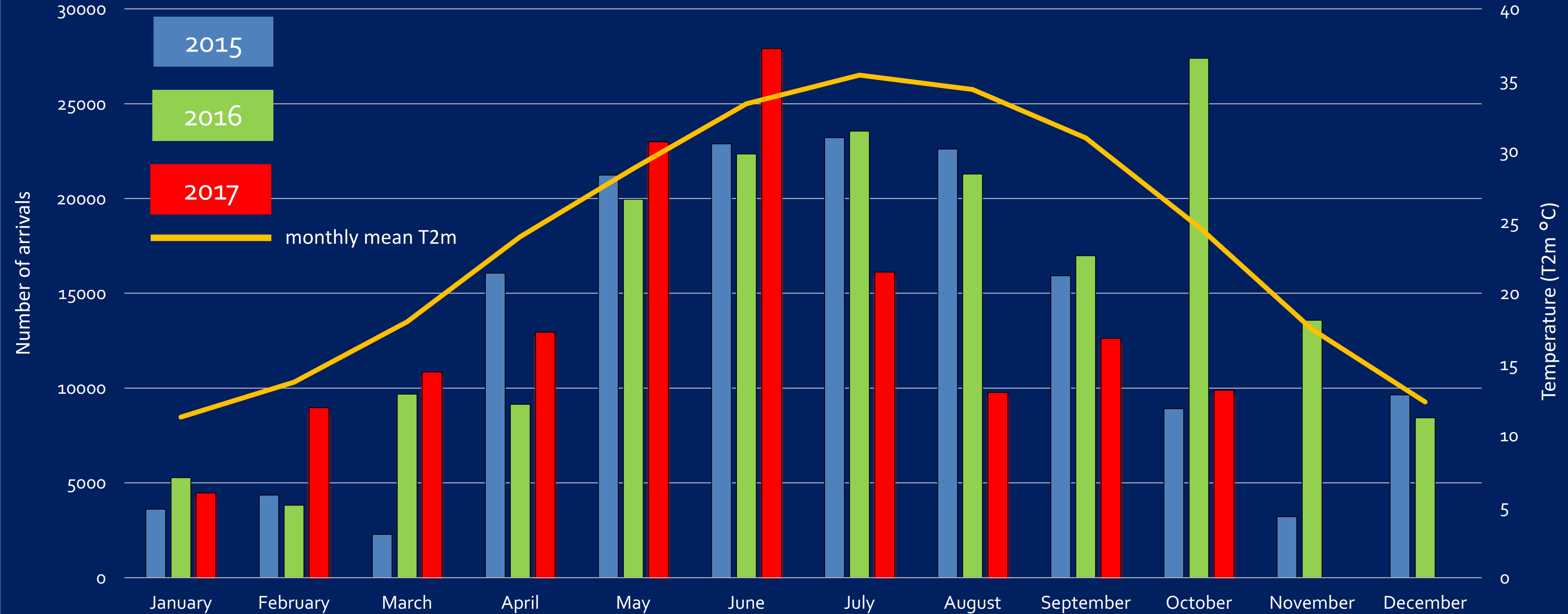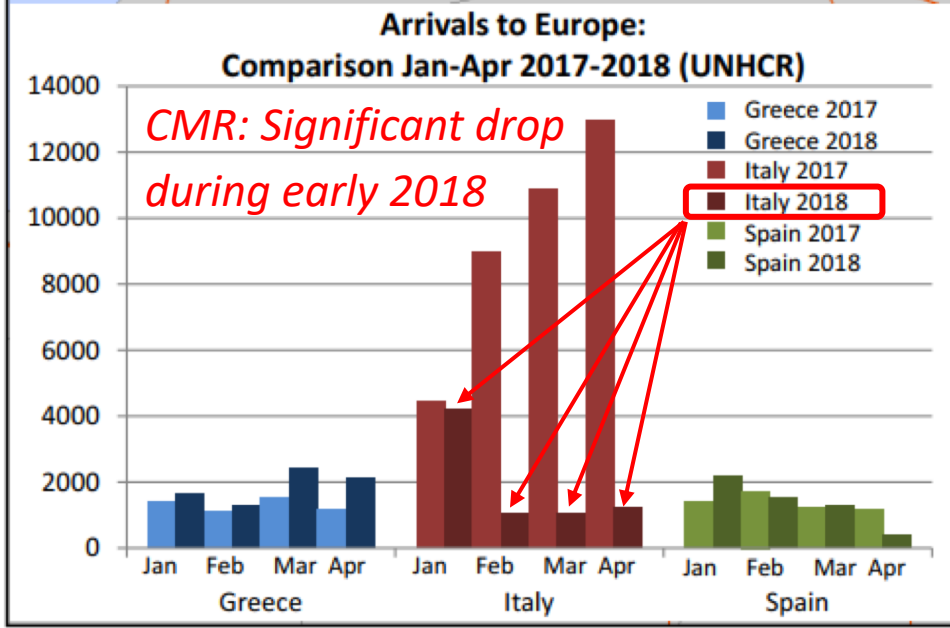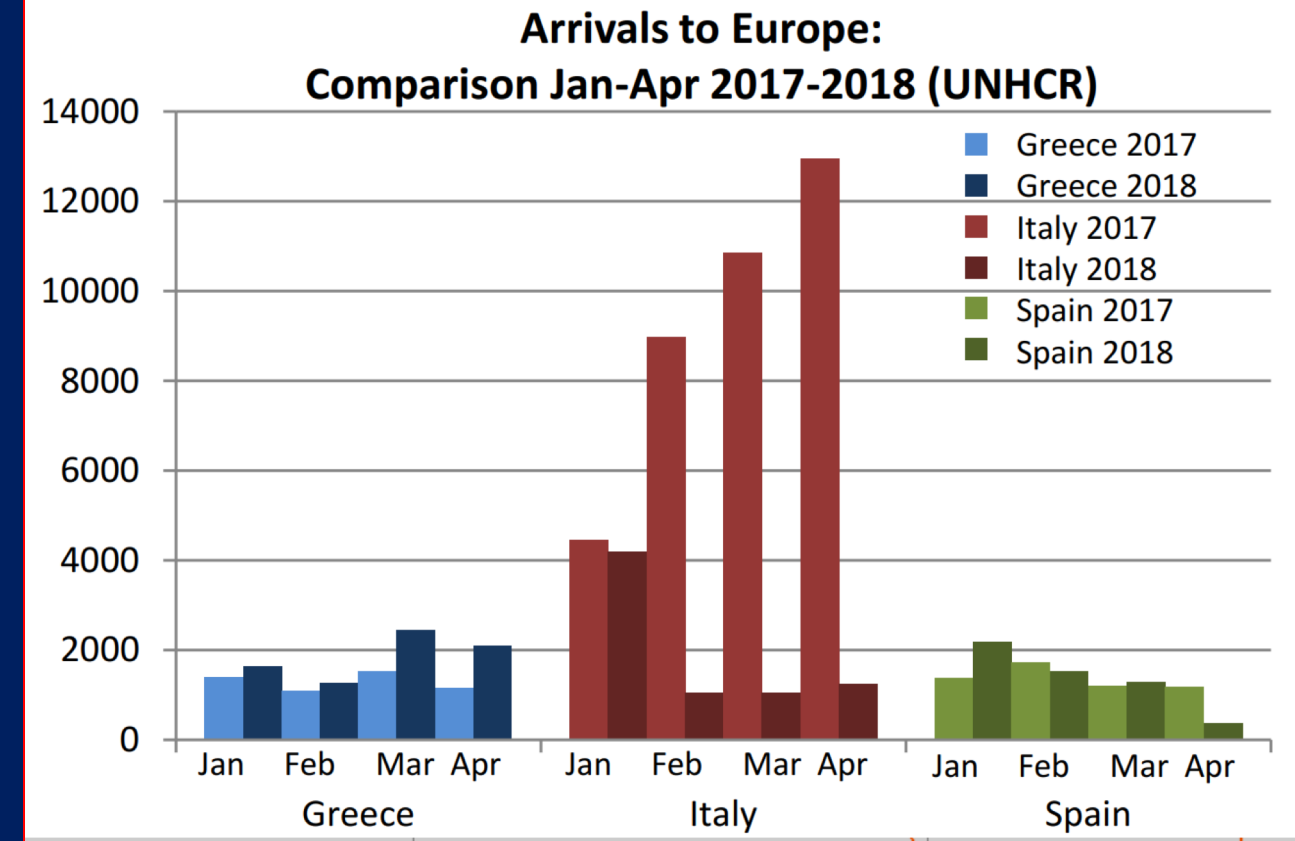
Eastern Route
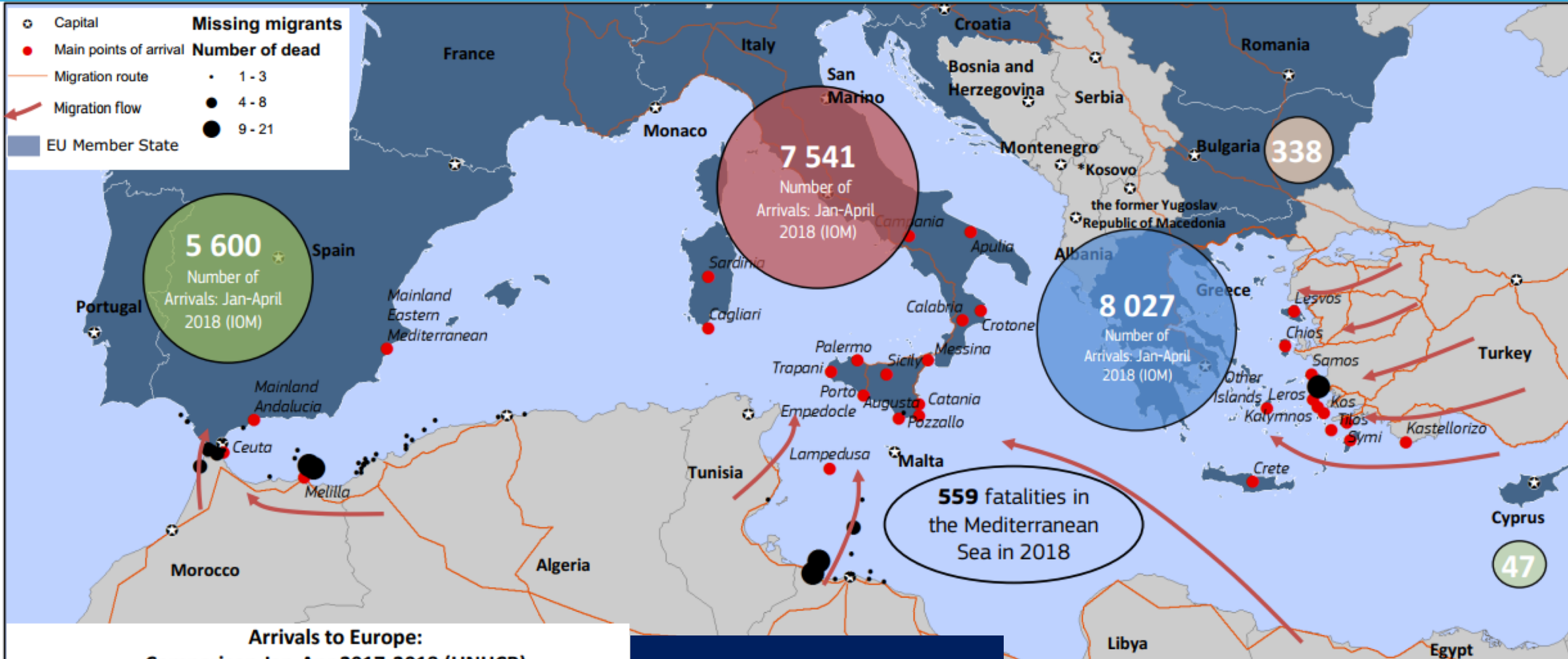*Monthly maxima > 200,000*
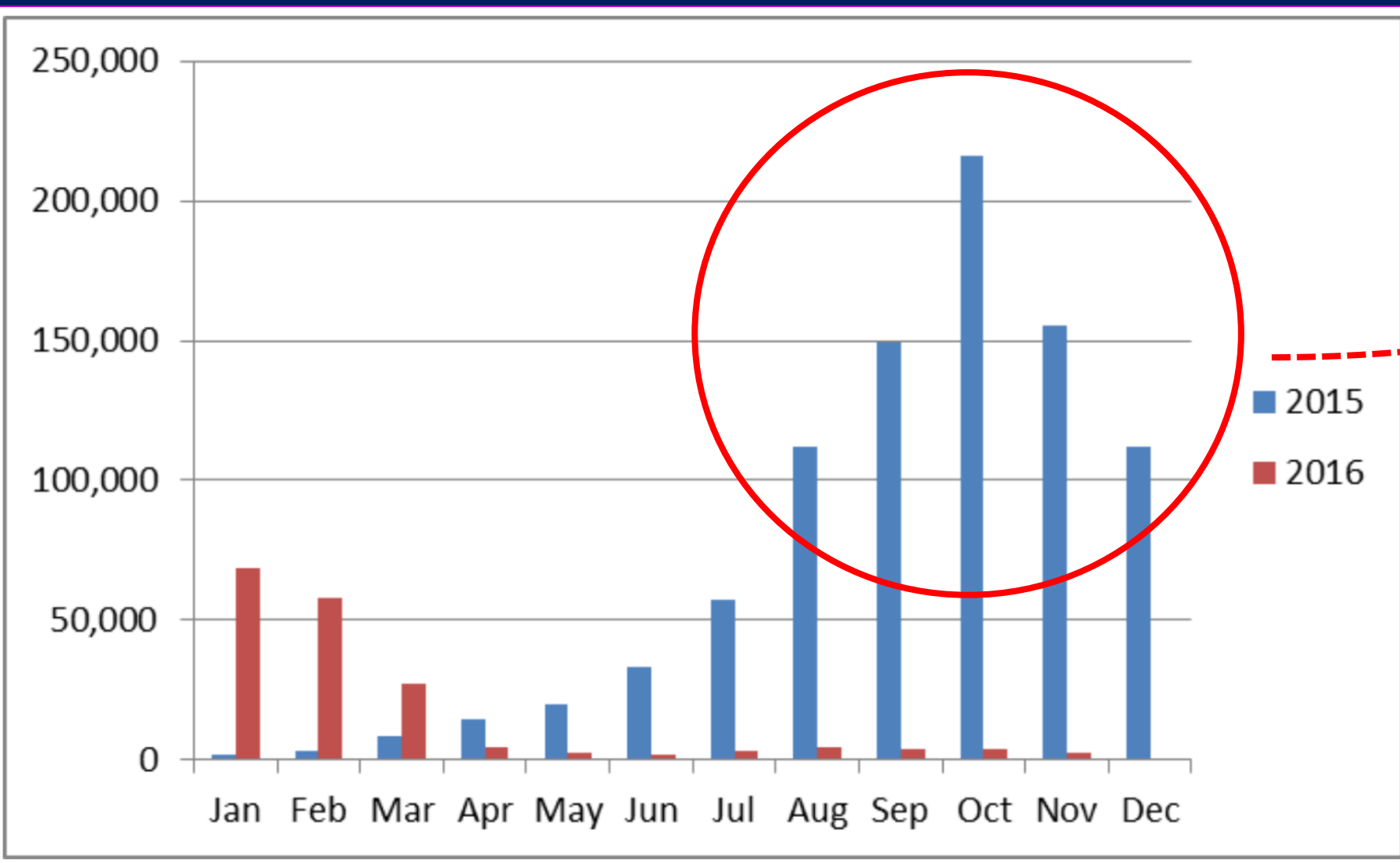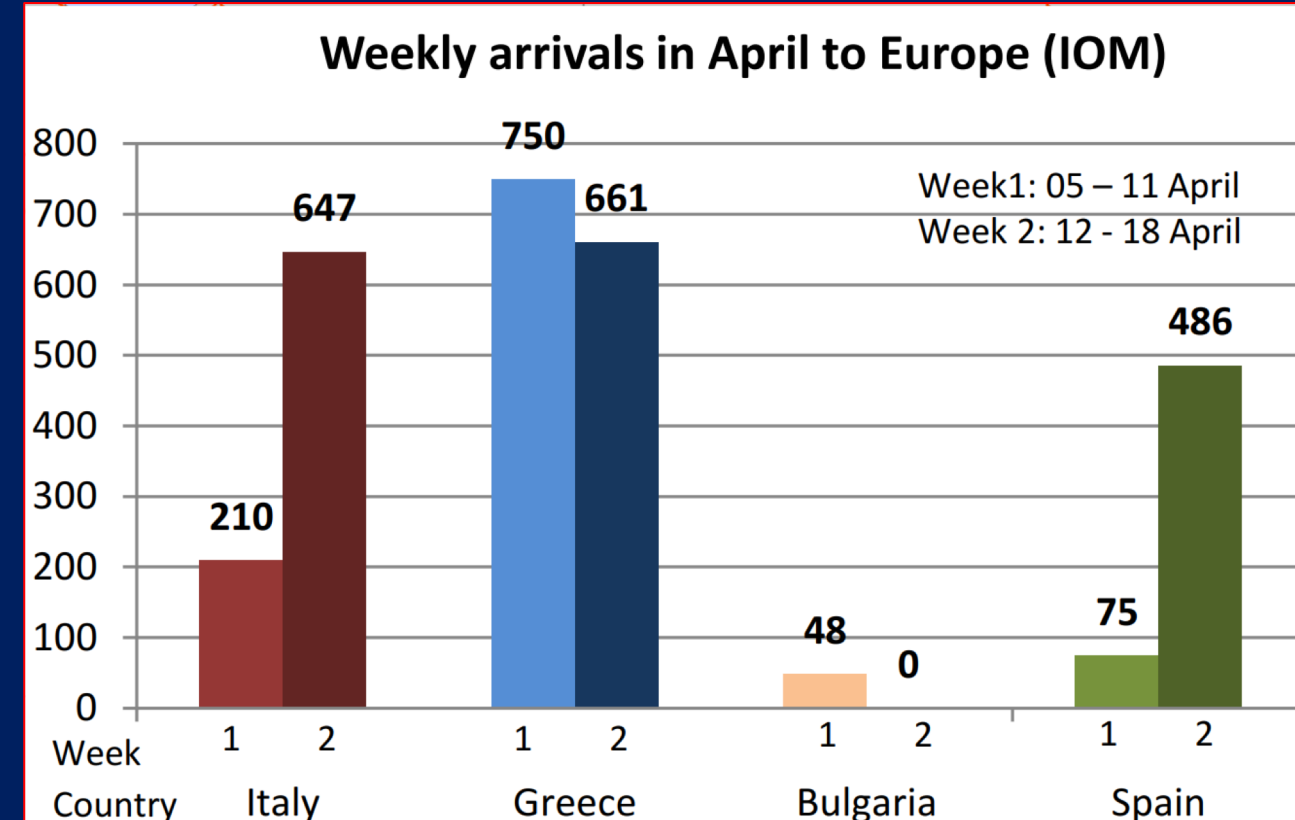
Central Route
Monthly maxima > 25,000
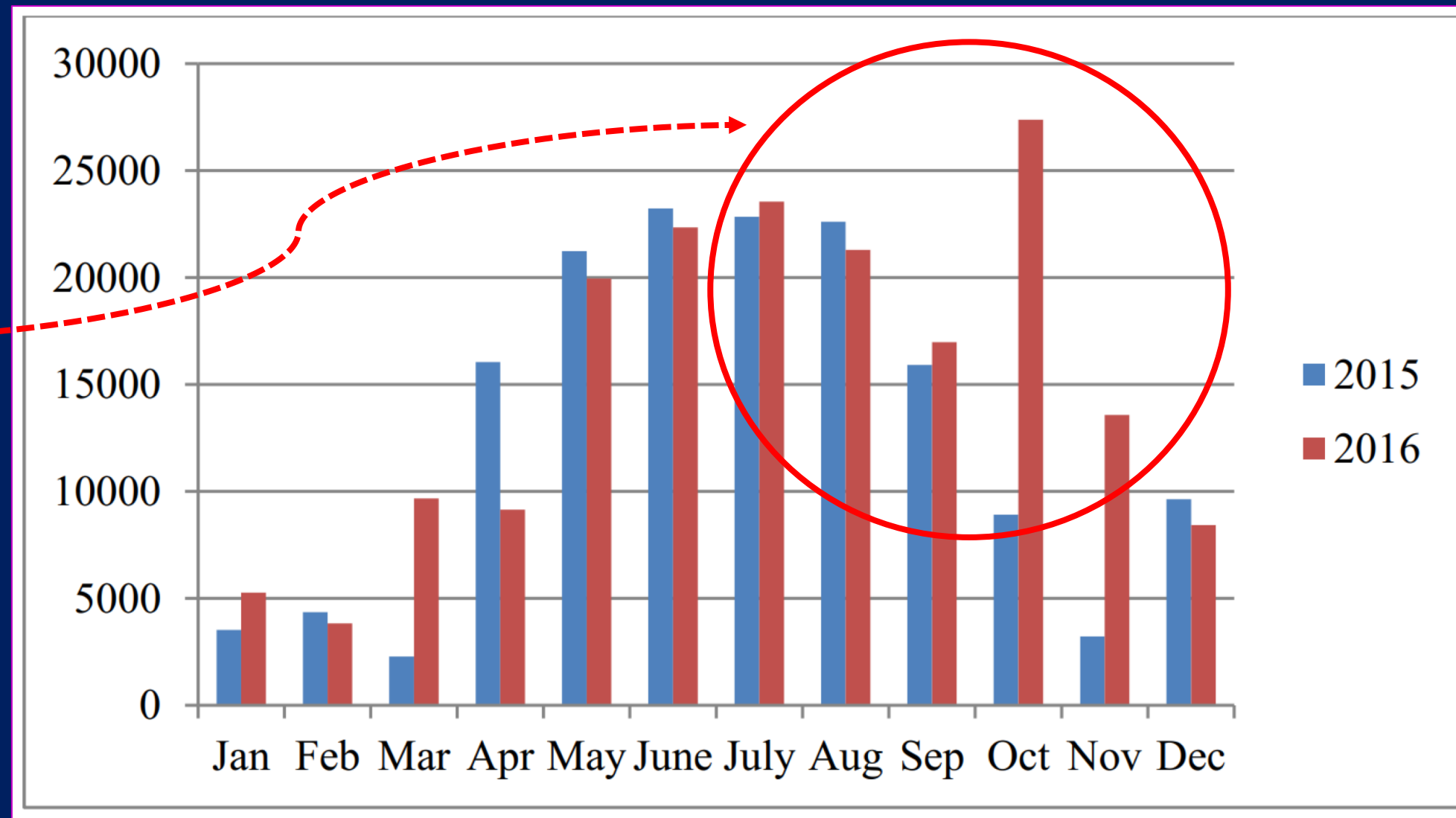
Clear tendency
of shifting from eastern to central route

CMR - Number of arrivals (2015-2017) – *Source: Italian Ministry of Interior*

Emergency Response Coordination Centre (ERCC) | DG ECHO Daily Map | 20/04/2018
Refugee Crisis | Arrivals to Europe

European Commission

Legend:
- Capital
- Main points of arrival
- Migration route
- Migration flow
- EU Member State

Missing migrants — Number of dead
- 1 - 3
- 4 - 8
- 9 - 21

7 541 Number of Arrivals: Jan-April 2018 (IOM)

5 600 Number of Arrivals: Jan-April 2018 (IOM)

8 027 Number of Arrivals: Jan-April 2018 (IOM)

338

47

559 fatalities in the Mediterranean Sea in 2018

Arrivals during early 2018

Arrivals to Europe: Comparison Jan-Apr 2017-2018 (UNHCR)

Greece 2017, Greece 2018, Italy 2017, Italy 2018, Spain 2017, Spain 2018

CMR: Significant drop during early 2018

Weekly arrivals in April to Europe (IOM)

Week1: 05 – 11 April
Week 2: 12 - 18 April

Week Country	Italy		Greece		Bulgaria		Spain	
	1	2	1	2	1	2	1	2
	210	647	750	661	48	0	75	486
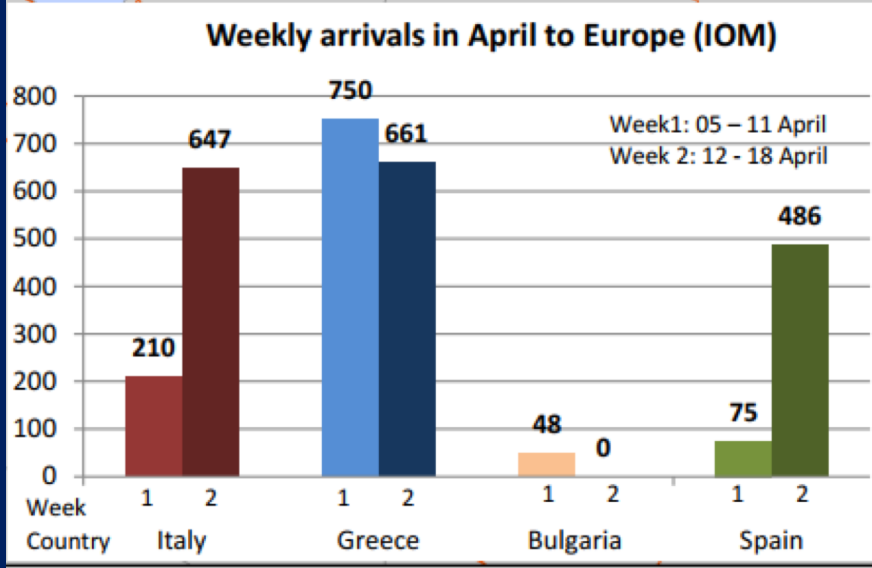
Monthly Number of Arrivals following Central and Eastern Mediterranean Routes

Since journey to Italy or Malta lasts between 2 to 6 days many weather elements might significantly affect the crossing such as …
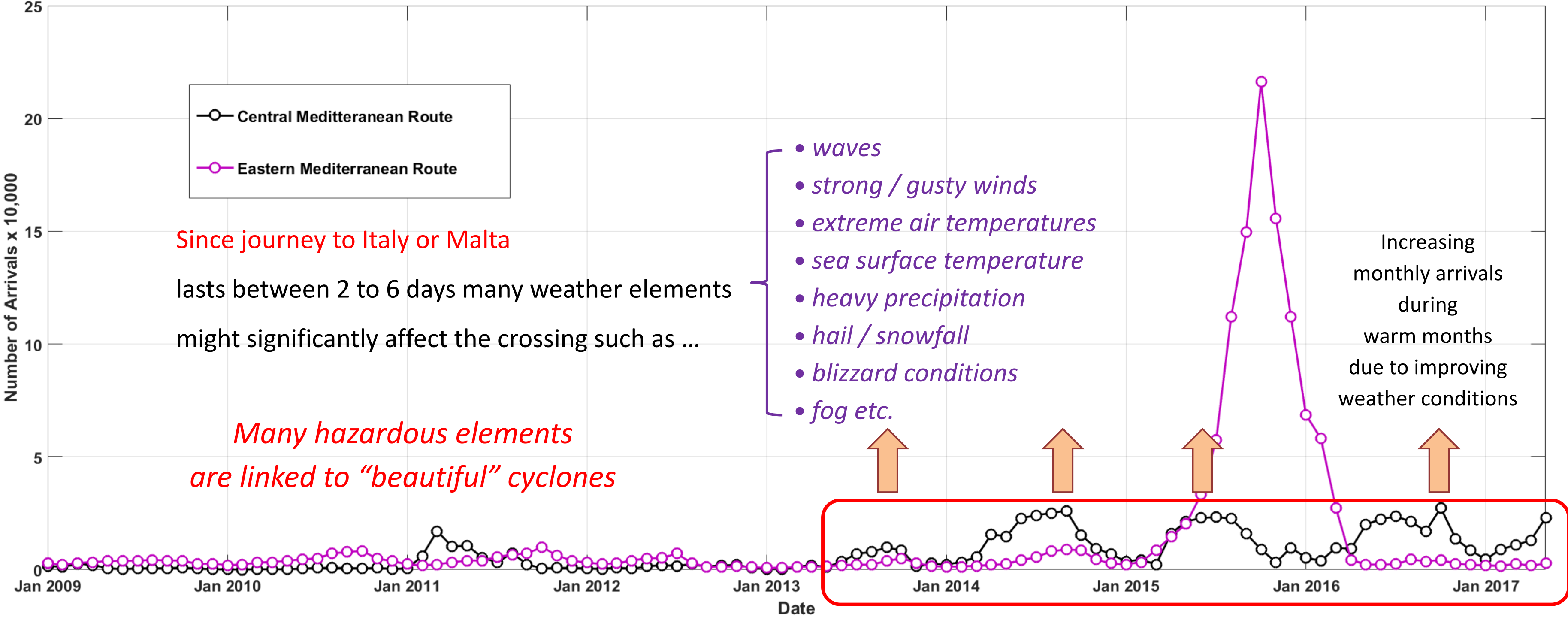
- *waves*
- *strong / gusty winds*
- *extreme air temperatures*
- *sea surface temperature*
- *heavy precipitation*
- *hail / snowfall*
- *blizzard conditions*
- *fog etc.*

Many hazardous elements are linked to "beautiful" cyclones

Increasing monthly arrivals during warm months due to improving weather conditions

Strong NAO

Weak NAO

DRY · WET · More storms · WET · DRY · Stronger trade winds

WET · Cold but dry winter · DRY · Fewer storms · WET · Lighter trade winds
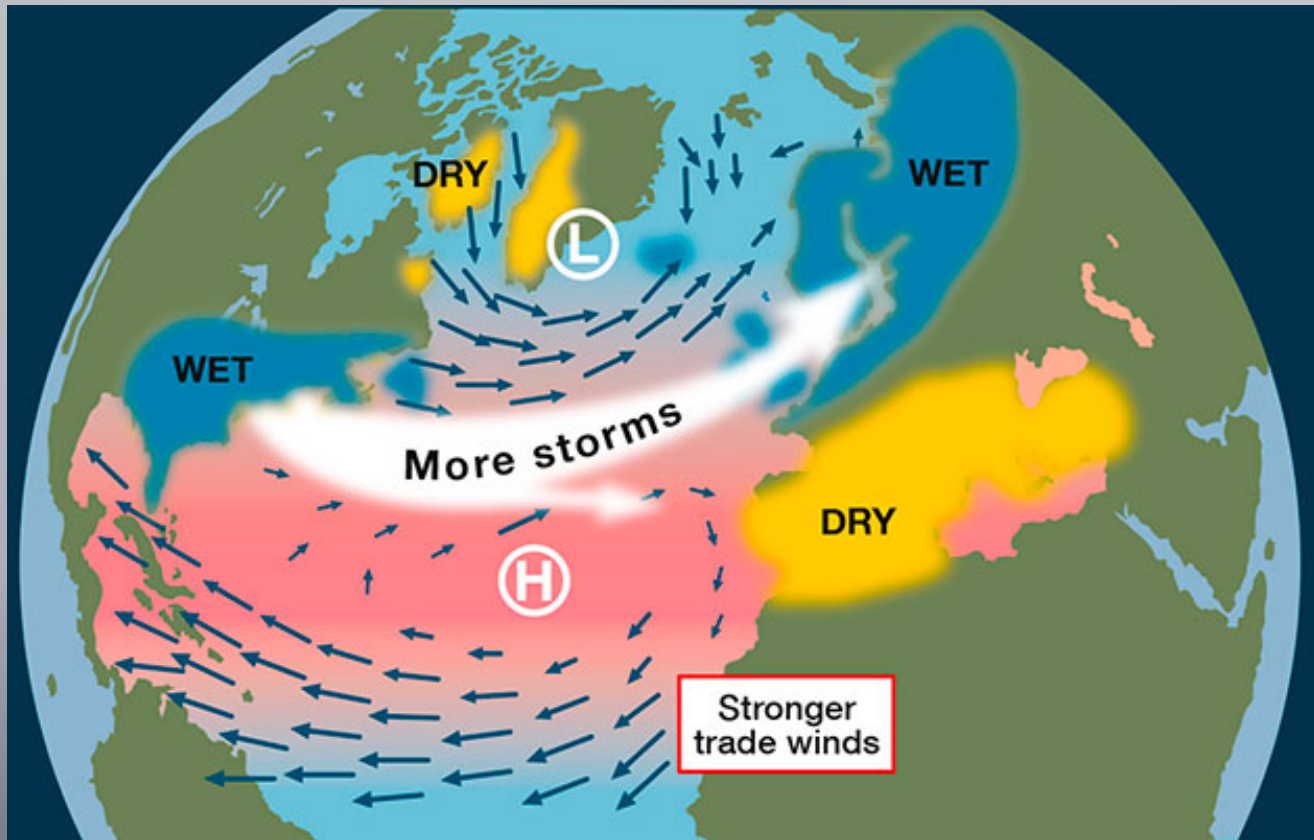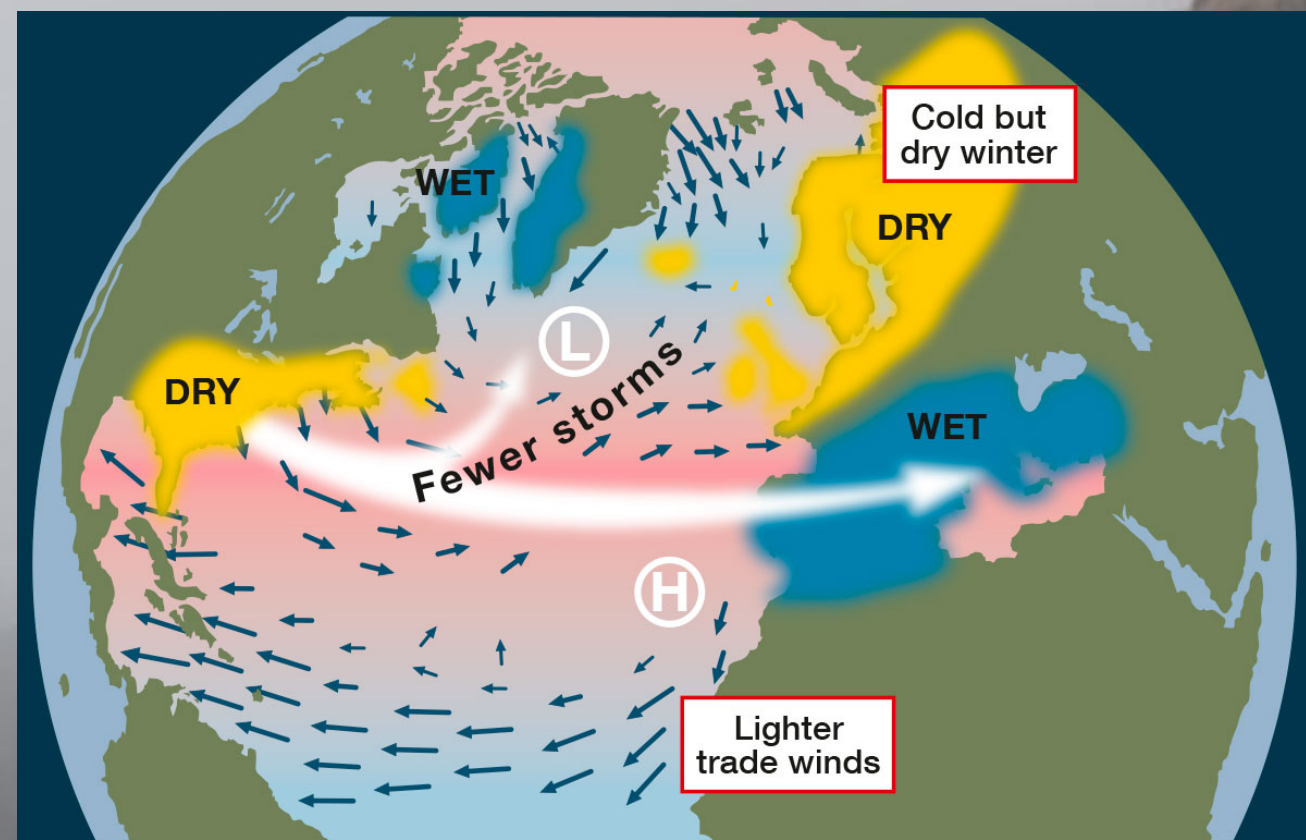
WORLD NEWS
The science behind the brutal beauty of Mediterranean cyclones

http://www.euronews.com/2014/11/10/the-science-behind-the-brutal-beauty-of-mediterranean-cyclones
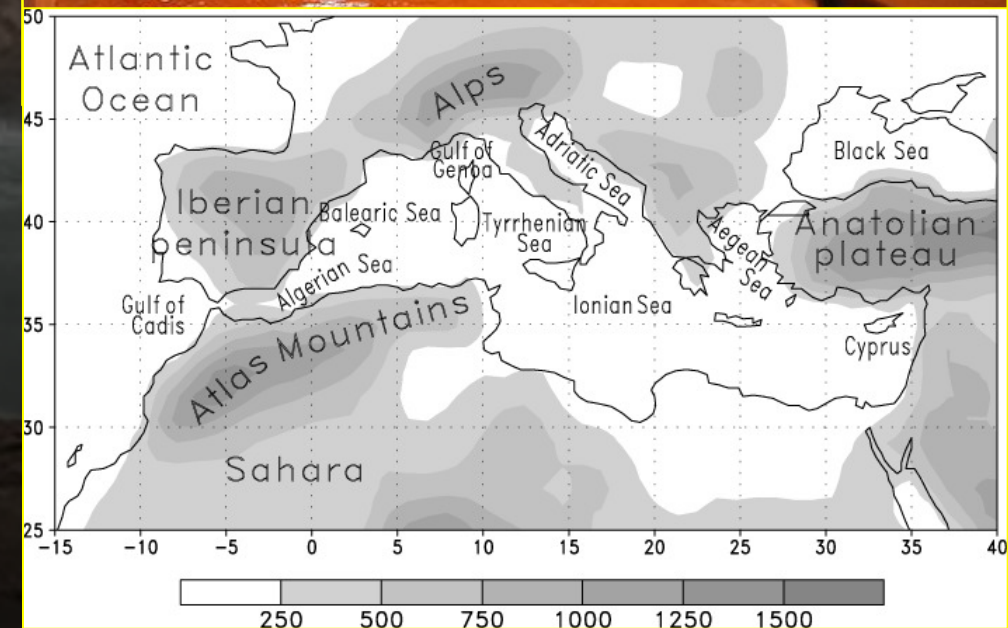
Main Prevailing Weather Conditions over Mediterranean (a glimpse on winter cyclone entering track frequencies)

46%

31%

23%

MISTRAL

BORA

BORA/ETESIAN

LEVANTE

WESTERLY

SIROCCO

WINTER [October through May]

SUMMER [June through September]
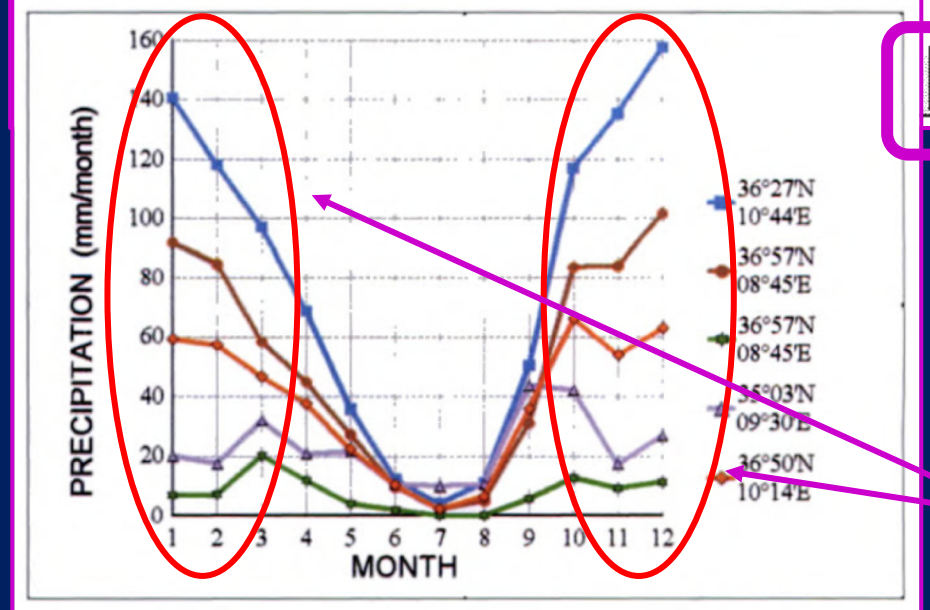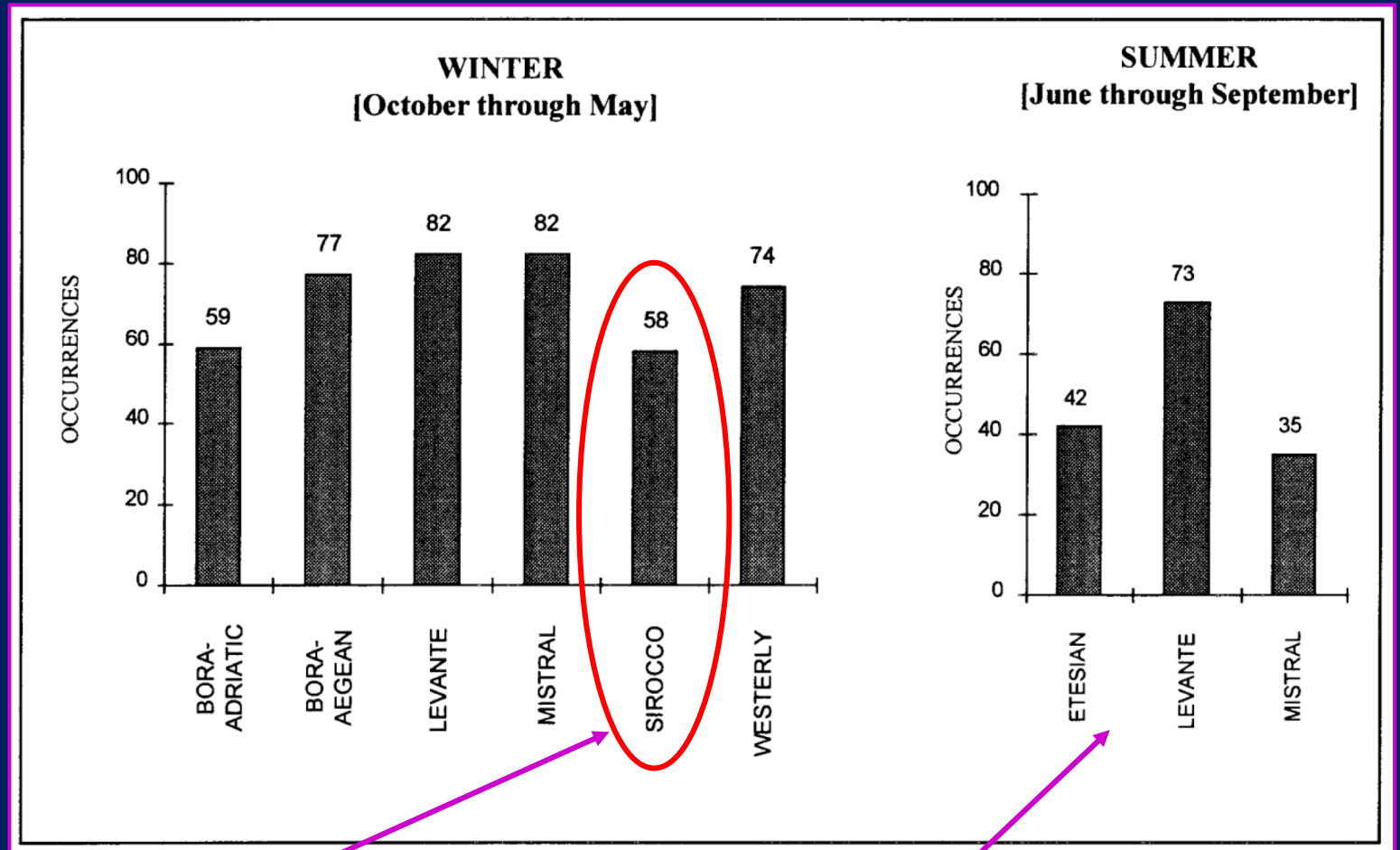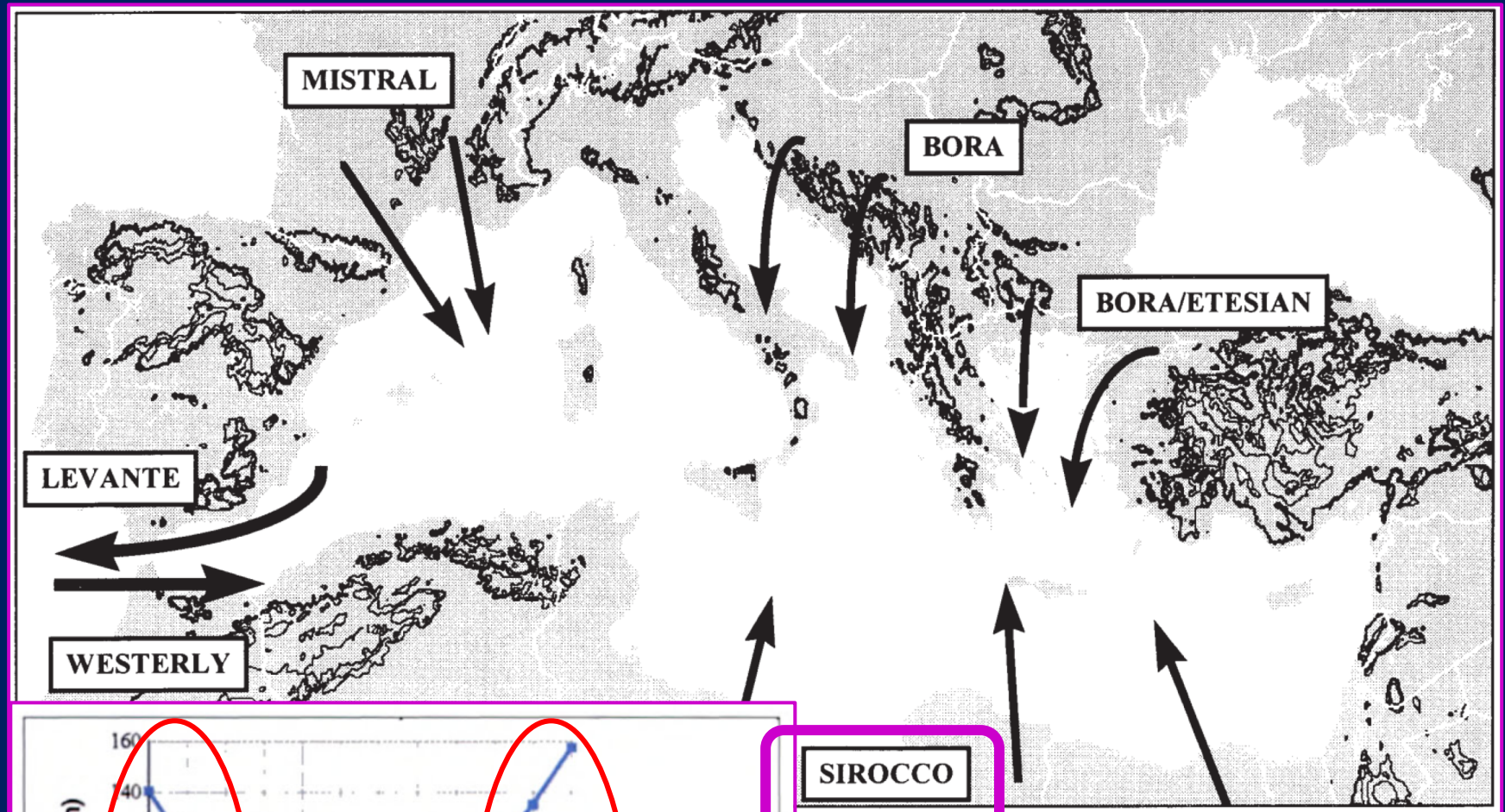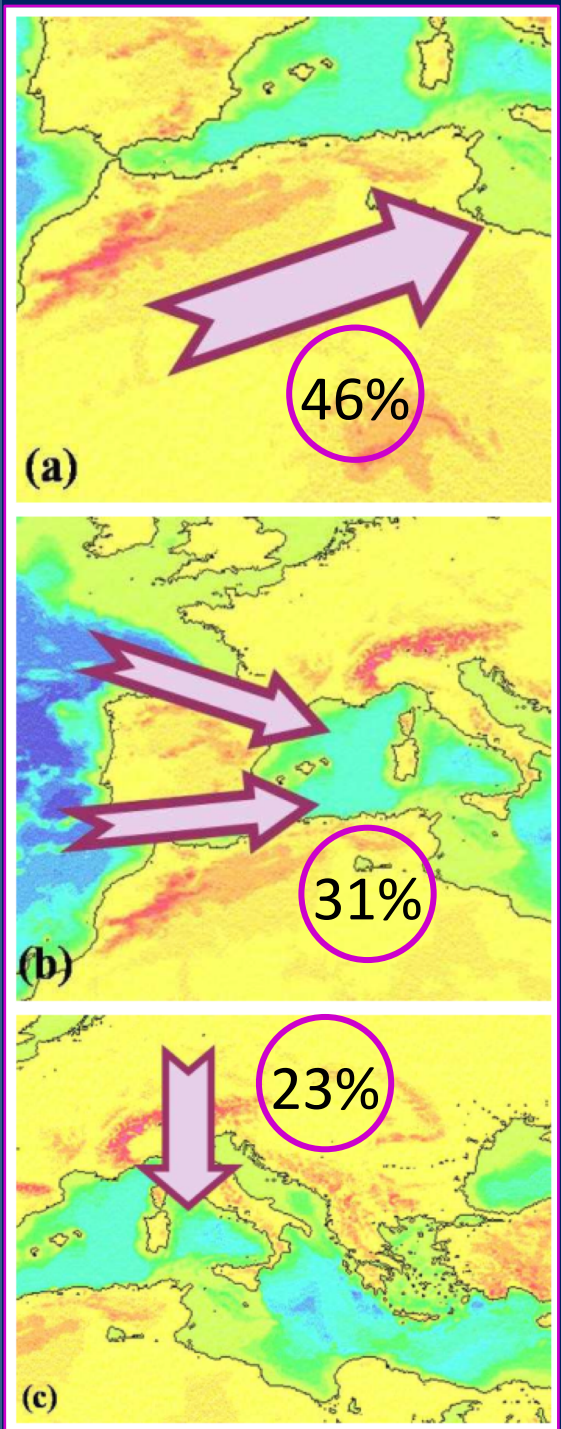
Sirocco Gale (62-74 km/h)

Distinctly higher precipitation during winter (over 5 stations in Tunisia)

No Sirocco Gale events during warm months of the year (Feb 95 – Sep 96)

MEDITERRANEAN SEA

European Commission

Initial Point of Study
35N, 13E

Initial Parameter of Study
Significant Wave Height (SWH)
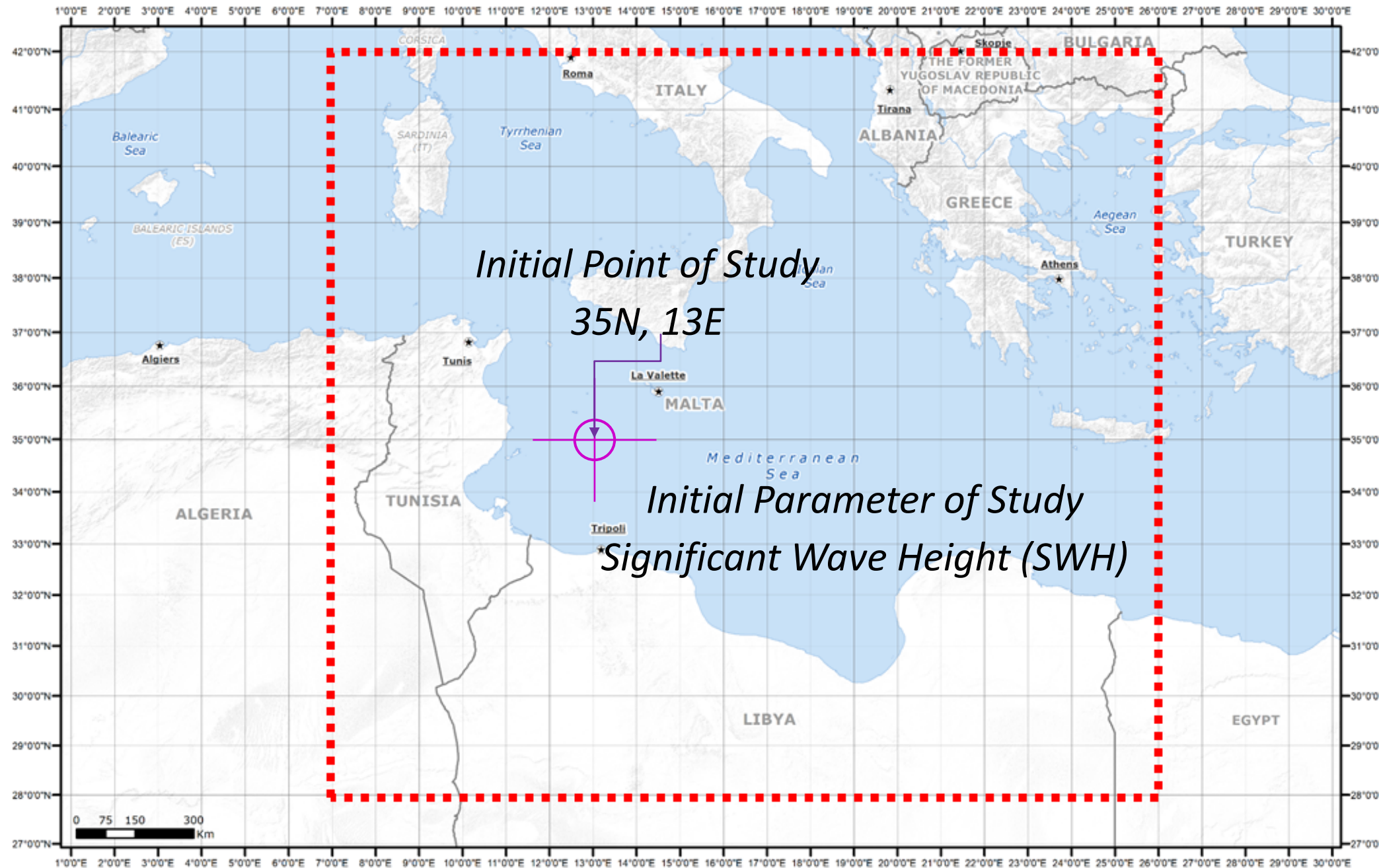
Data and Methodology

Initial Point of Study
Sea area south of Lampedusa (35N, 13E)

Utilising Oper Analysis
Pinpointing SWH values
over selected (initial) point

Focusing on 2 time periods
(1) Jan 2009 to May 2017
(2) Nov 2013 to May 2017

Preliminary Results: Correlations are based on monthly values

Monthly Number of Arrivals and Monthly Mean of Daily Maximum SWH (Significant Wave Height) valid for sea area of Lampedusa (35N,13W)

Legend:
— Monthly Mean of Daily Maximum SWH
— Monthly Number of Arrivals x 10,000

Time Period	Correlation
Jan 2009 – May 2017	-0.4146
Jan 2010 – May 2017	-0.4554
Jan 2011 – May 2017	-0.4985
Jan 2012 – May 2017	-0.5604
Jan 2013 – May 2017	-0.7268
Nov 2013 – May 2017	-0.8589

Possible SWH critical value (threshold)
~1.4 meters

Clear signals of
increasing arrivals with decreasing SWH

Same approach for 300 points
for a set of model parameters
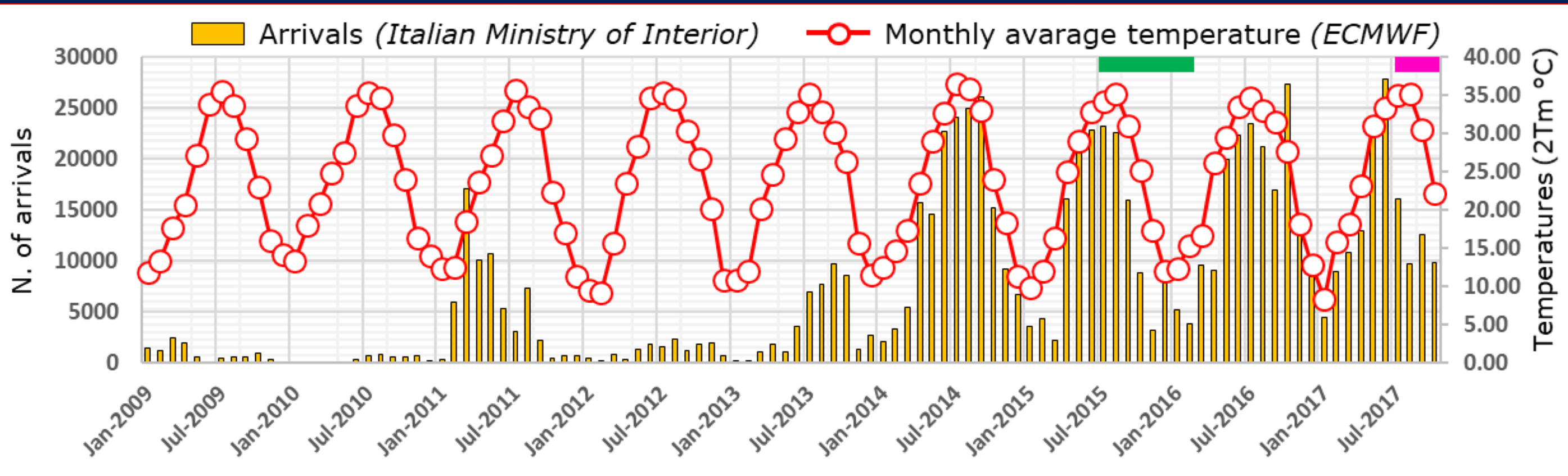
Selected Model Parameters

Non-Extreme Mode

Symbol	Parameter
SWH	Significant Wave Height
HMAX	Maximum Wave Height
WS	Wind Speed at 10 meters
FG6	Wind Speed Gusts at 10 meters
T2M	Air Temperature at 2 meters
MX2T6	Maximum Temperature at 2 meters
MN2T6	Minimum Temperature at 2 meters
SST	Sea Surface Temperature
PRECI	Total Precipitation
SNOW	Total Snowfall

Extreme Forecast Index (EFI) Mode

Symbol	Parameter
WSI10	EFI for Wind Speed at 10 meters
FGI10	EFI for Wind Speed Gusts at 10 meters
TI2	EFI for Air Temperature at 10 meters
TPI	EFI for Total Precipitation
SFI	EFI for Total Snowfall

Monthly values are calculated by averaging daily values

Daily values are calculated by averaging or accumulating 00 − 06 − 12 − 18 UTC Analysis & Short-Range HIRES (T+6 & T+12) values

Results: Correlating the number of refugees
to SWH (Significant Wave Height) for Period 2
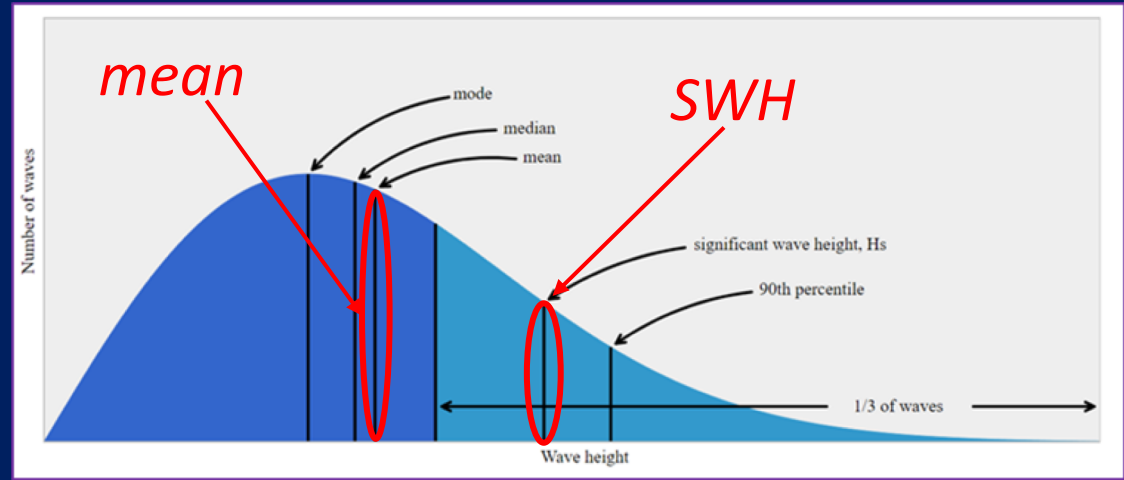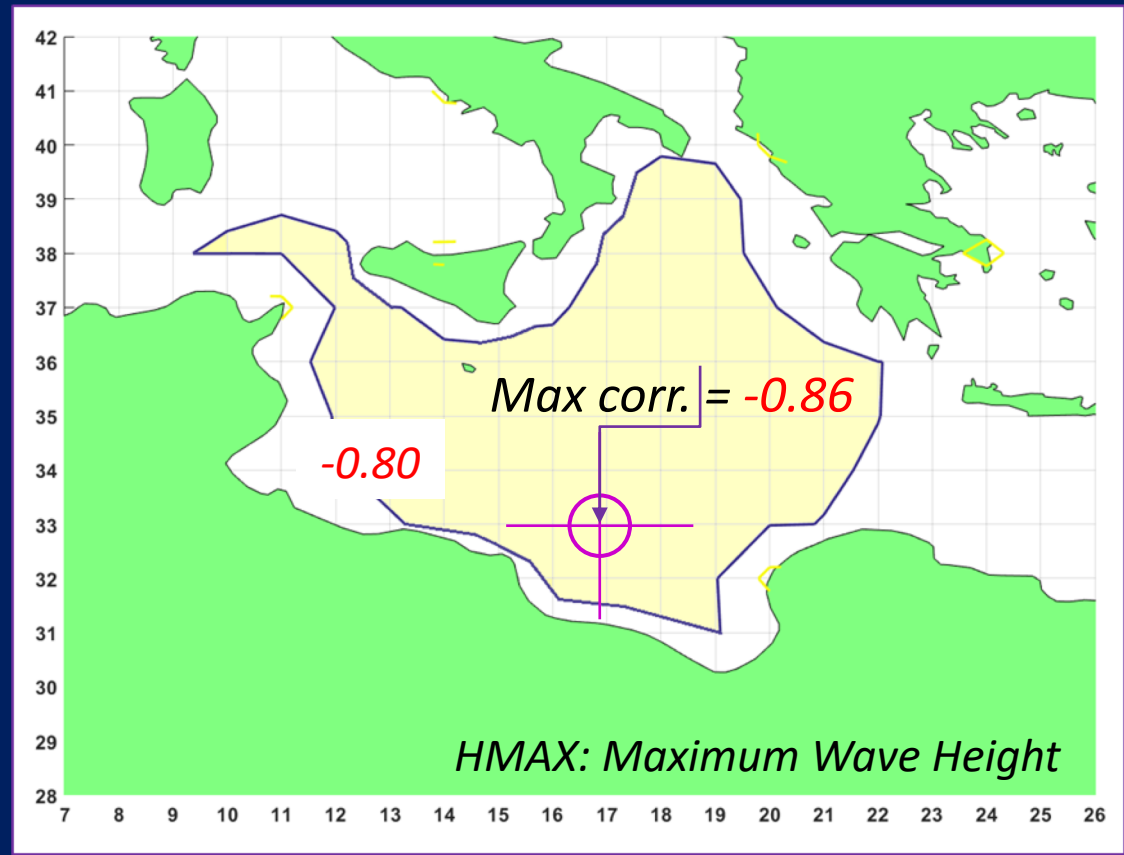
Correlations between SWH / HMAX and number of monthly arrivals were found distinctly high !!!

Max corr. = -0.86

-0.80

HMAX: Maximum Wave Height

Max corr. = -0.86

-0.80
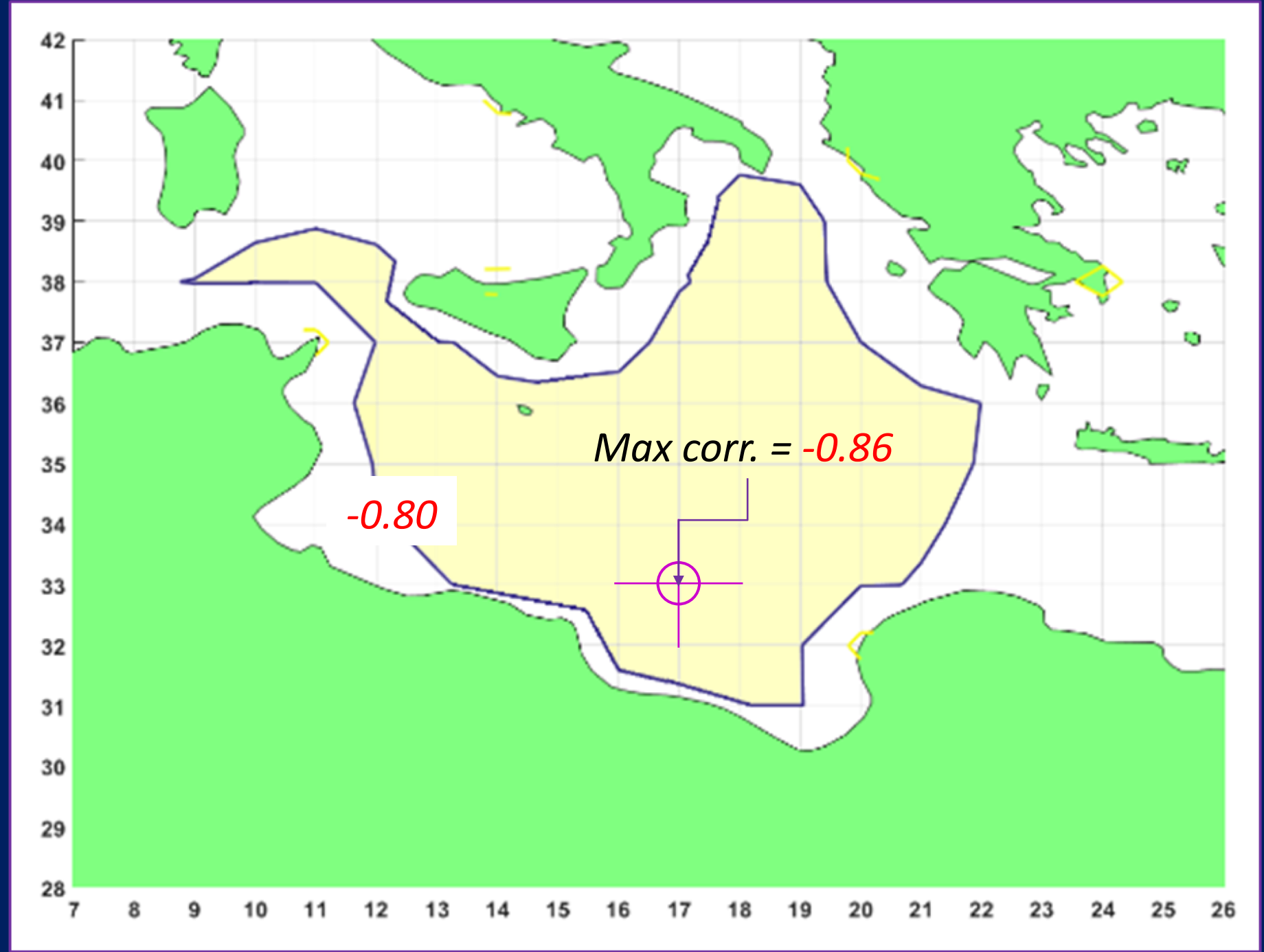
Correlation between SWH and number of monthly arrivals
Yellow shaded areas contain values lower than -0.80 with an absolute minimum of -0.86 at position (33N, 17E)

Correlation between WS and number of monthly arrivals
Yellow shaded areas contain values lower than -0.80 with an absolute minimum of -0.85 at position (37N, 18E)

WS: Wind Speed at 10 meters

Max corr. = -0.85
-0.80
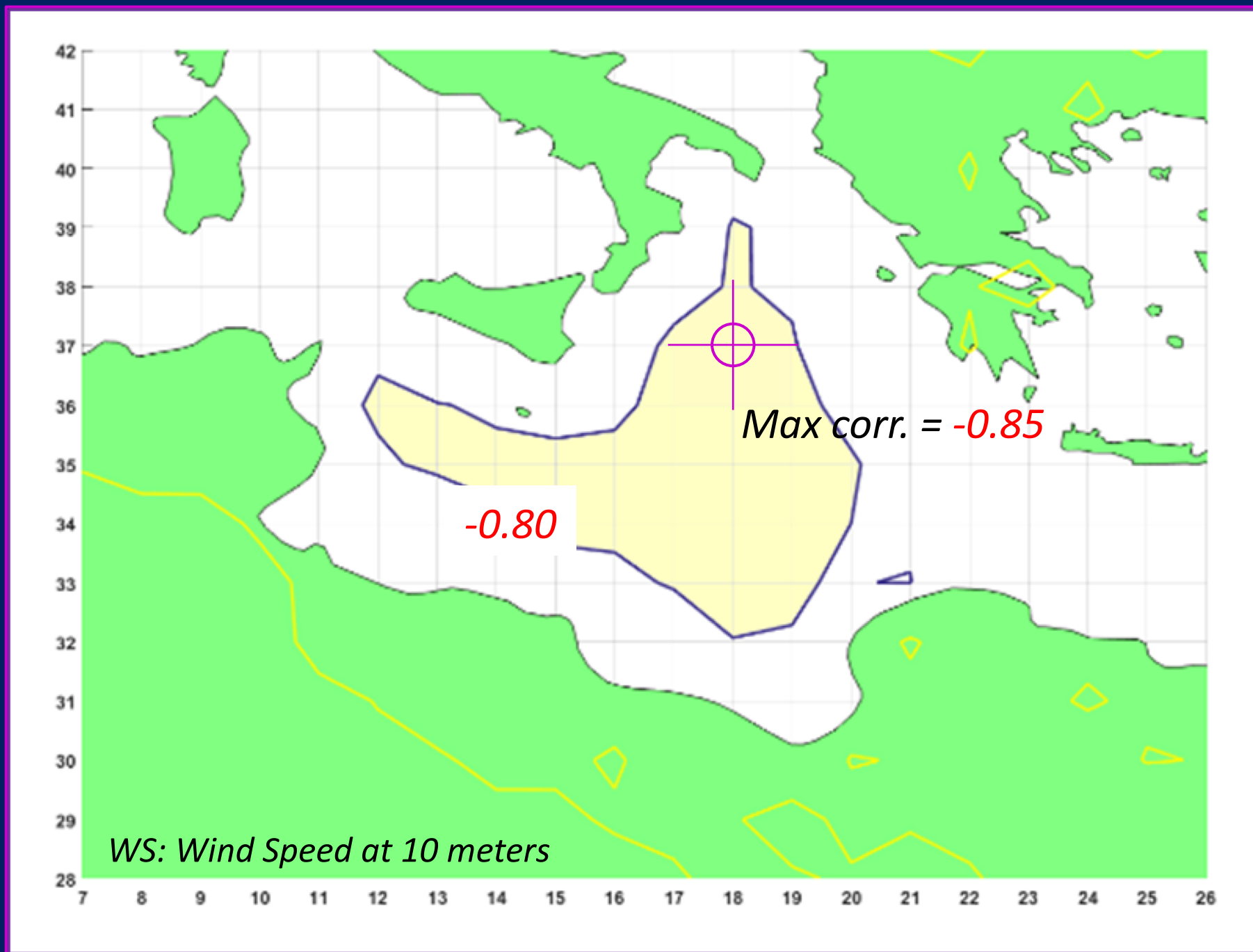
Correlation between FG6 and number of monthly arrivals
Yellow shaded areas contain values lower than -0.80 with an absolute minimum of -0.85 at position (36N, 18E)

FG6: Wind (Maximum) Gust during last 6 hours

Max corr. = -0.86
-0.80
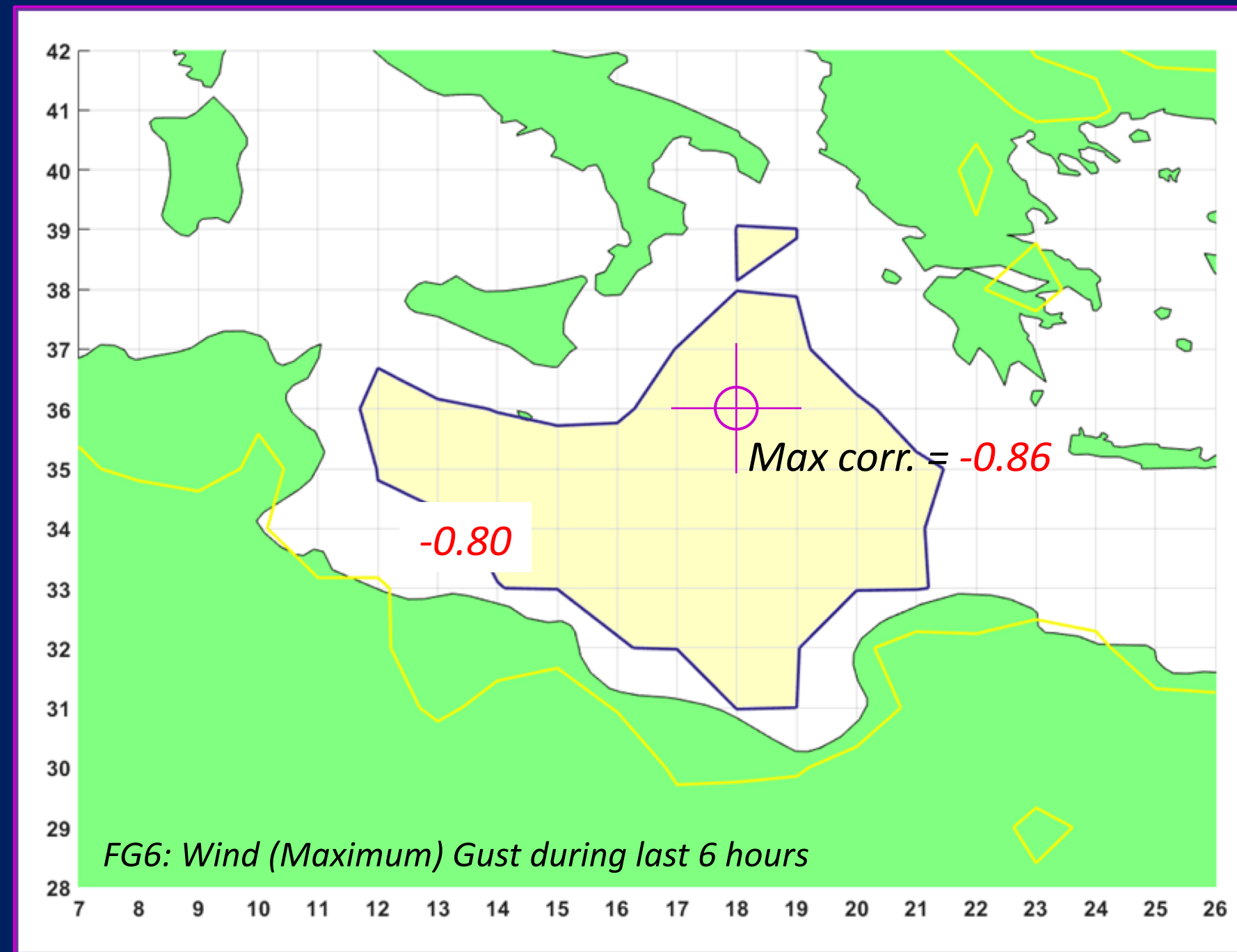
Correlation between T2M and number of monthly arrivals

Shaded (yellow) areas contain values higher than 0.90 with an absolute maximum of +0.91 at position (32N, 8E). Orange line corresponds to 0.85 correlation. Lilac shaded area corresponds to values ranging from 0.75 to 0.80

Annex 5. Temperature of air at 2 meters with daily and monthly configuration of Mean – Mean   *Positive Correlations forT2M …*

|	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
42	0.82	0.82	0.87	0.84	0.84	0.86	0.85	0.84	0.85	0.85	0.83	0.83	0.84	0.83	0.84	0.84	0.84	0.84	0.84	0.84
41	0.81	0.81	0.85	0.83	0.82	0.82	0.83	0.86	0.85	0.85	0.84	0.84	0.83	0.83	0.85	0.84	0.84	0.84	0.83	0.83
40	0.81	0.82	0.86	0.82	0.82	0.82	0.82	0.83	0.83	0.84	0.84	0.84	0.83	0.84	0.84	0.85	0.84	0.85	0.84	0.85
39	0.81	0.82	0.84	0.82	0.82	0.82	0.82	0.82	0.83	0.84	0.86	0.83	0.83	0.83	0.85	0.85	0.87	0.84	0.84	0.85
38	0.82	0.81	0.82	0.81	0.81	0.81	0.86	0.87	0.86	0.83	0.83	0.83	0.83	0.82	0.82	0.85	0.86	0.84	0.84	0.84
37	0.84	0.83	0.88	0.86	0.85	0.80	0.80	0.81	0.87	0.82	0.82	0.82	0.82	0.81	0.81	0.86	0.84	0.83	0.84	0.83
36	0.90	0.90	0.90	0.88	0.81	0.80	0.79	0.79	0.79	0.81	0.81	0.80	0.80	0.80	0.79	0.79	0.80	0.81	0.82	0.82
35	0.89	0.91	0.91	0.89	0.86	0.80	0.79	0.78	0.79	0.79	0.79	0.79	0.79	0.78	0.78	0.79	0.79	0.79	0.80	0.81
34	0.90	0.90	0.90	0.88	0.82	0.79	0.79	0.78	0.78	0.78	0.78	0.78	0.77	0.77	0.77	0.77	0.78	0.78	0.78	0.78
33	0.90	0.90	0.90	0.90	0.89	0.86	0.80	0.79	0.78	0.77	0.77	0.77	0.76	0.76	0.76	0.79	0.77	0.77	0.76	0.76
32	0.91	0.91	0.90	0.90	0.90	0.90	0.90	0.89	0.87	0.78	0.77	0.77	0.76	0.84	0.87	0.86	0.85	0.84	0.77	0.76
31	0.91	0.91	0.91	0.90	0.90	0.90	0.89	0.89	0.88	0.87	0.86	0.78	0.77	0.80	0.87	0.86	0.86	0.86	0.85	0.85
30	0.91	0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.88	0.87	0.86	0.86	0.86	0.87	0.86	0.87	0.87	0.86	0.86
29	0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.88	0.88	0.87	0.87	0.87	0.87	0.86	0.86	0.87	0.86	0.87	0.86	0.86
28	0.90	0.90	0.89	0.89	0.89	0.88	0.88	0.88	0.87	0.87	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
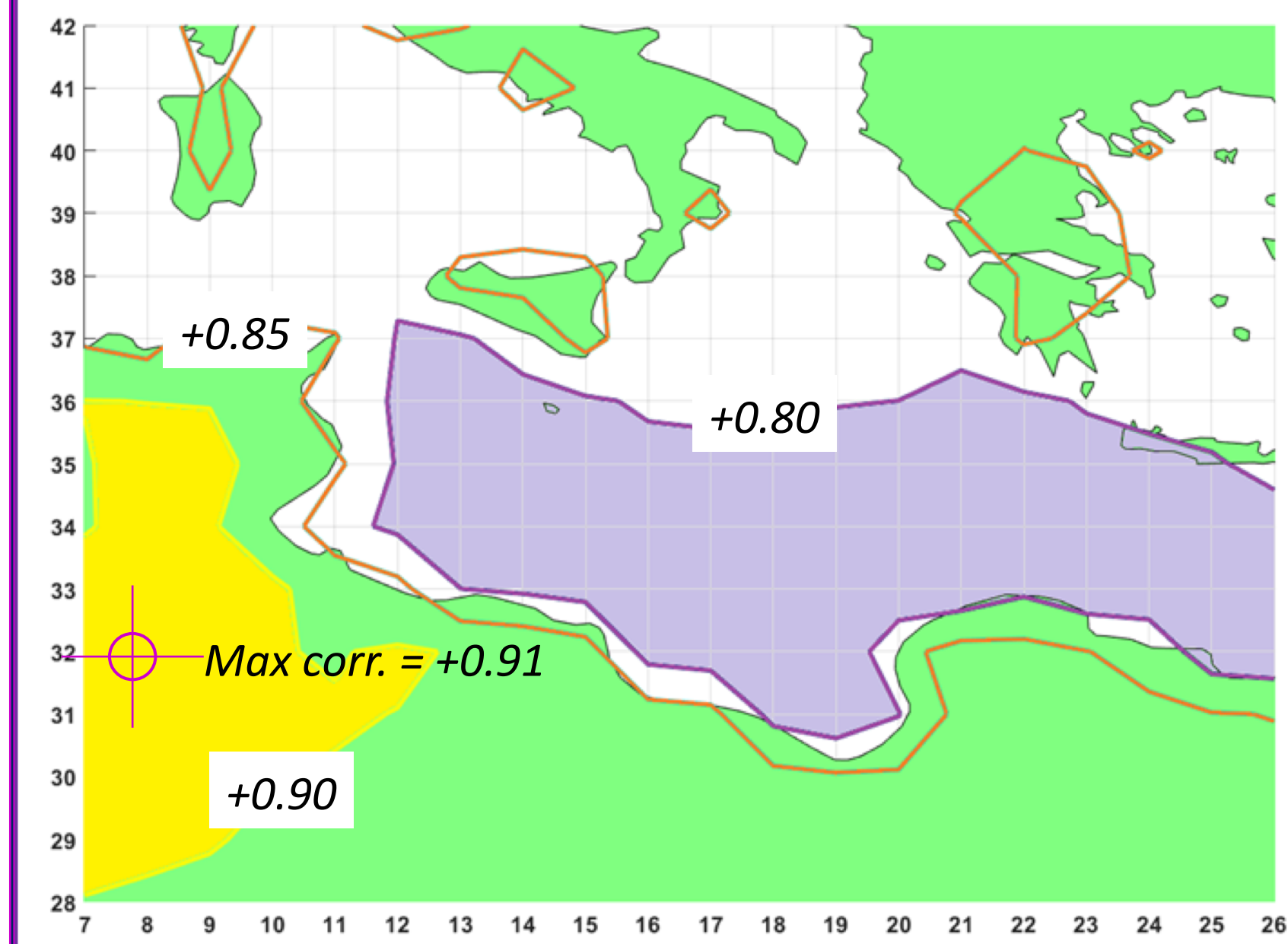
Left panel: Correlation between SST and number of monthly arrivals. Shaded (yellow) areas refer to values higher than +0.65 with an absolute maximum of 0.82 at position (42N, 16E). Max corr. = +0.82. +0.65
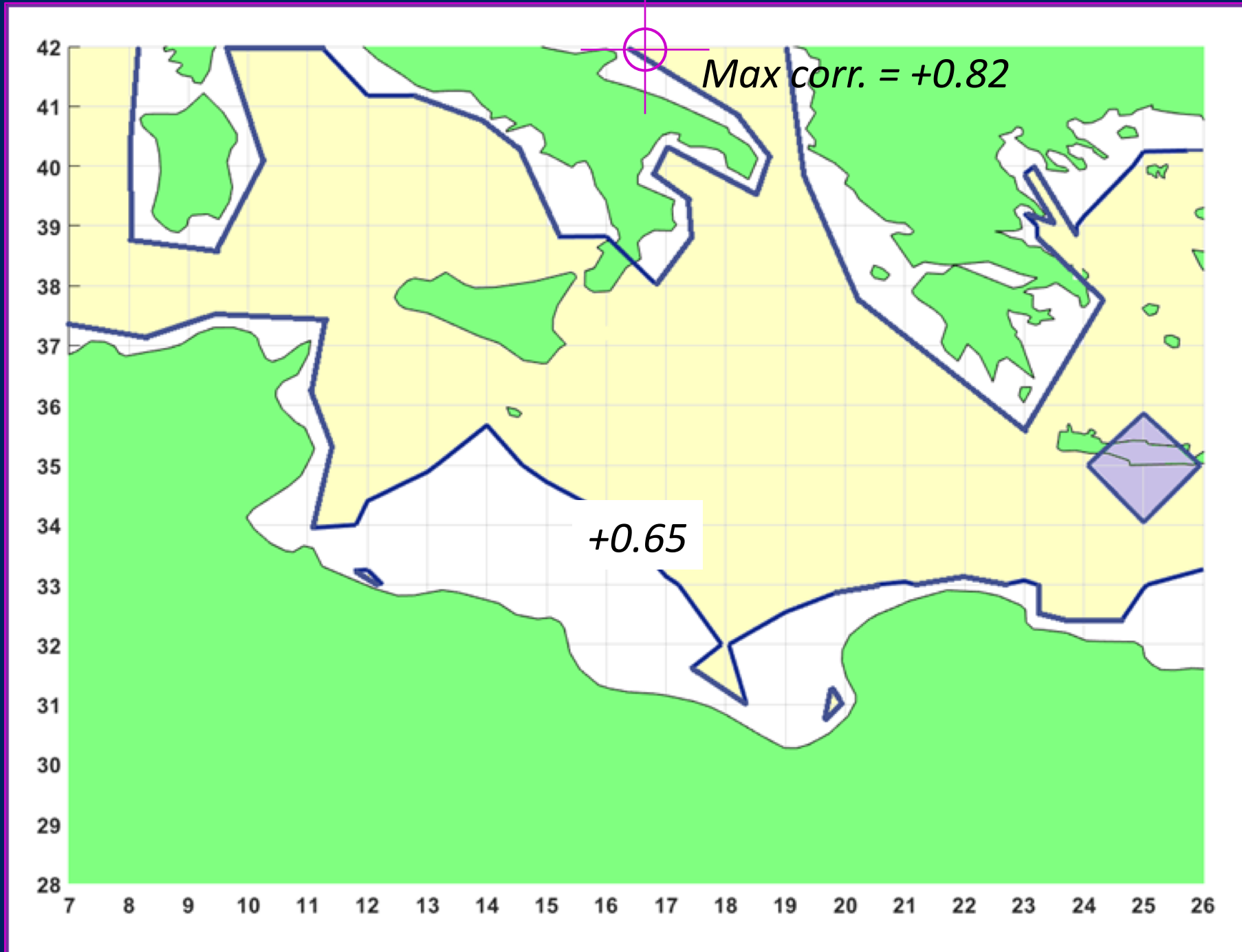
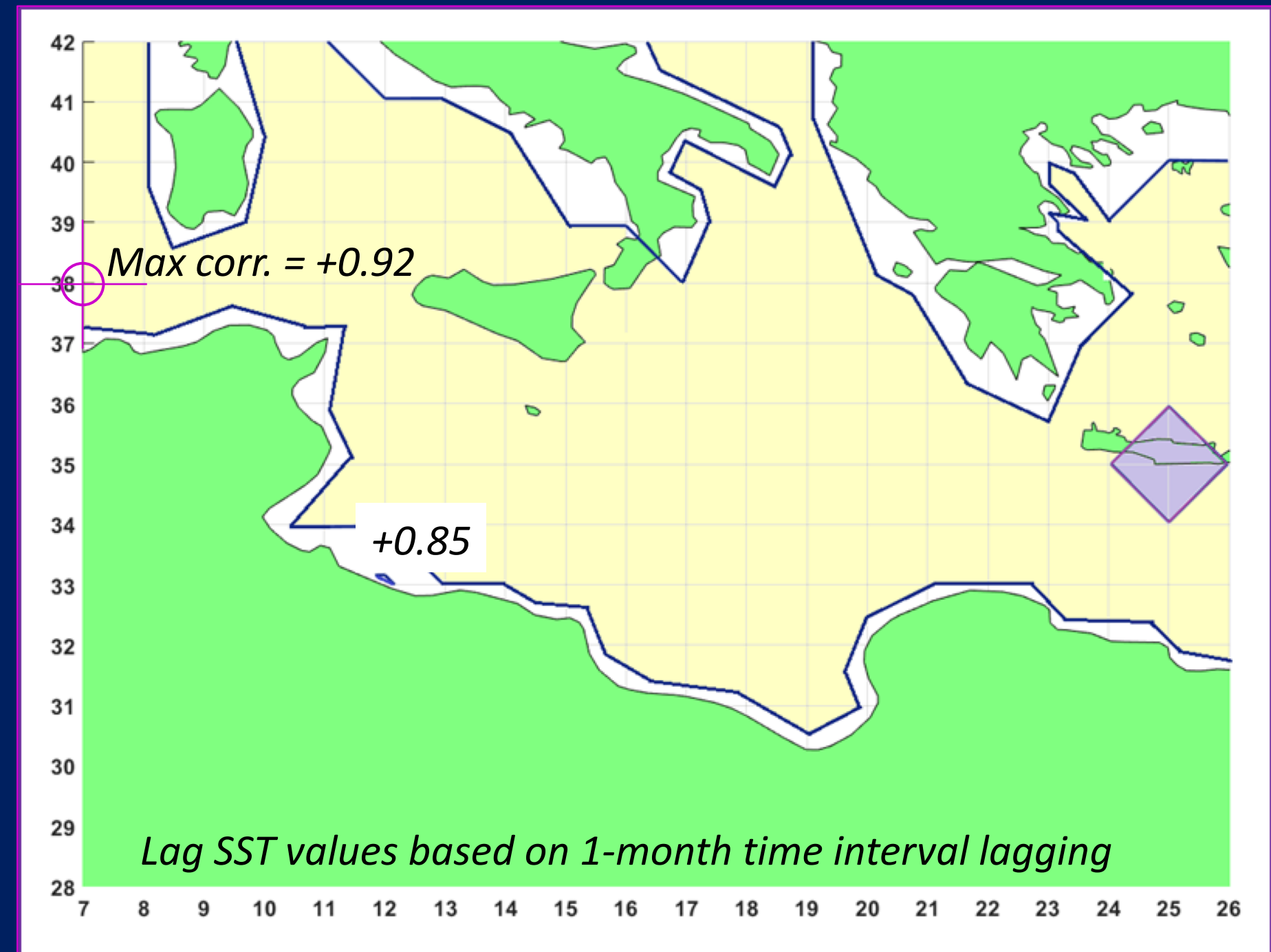**Right panel:** Correlation between Lag SST and number of monthly arrivals. Shaded (yellow) areas refer to values higher than 0.85 with an absolute maximum of 0.92 at position (38N, 7E). Max corr. = +0.92. +0.85. Lag SST values based on 1-month time interval lagging

Are weather conditions a decisive factor for CMR crossings ?

w2eu.info - welcome to europe

For freedom of movement: Independent information for refugees and migrants coming to Europe
من اجل حرية التنقل : معلومات مستقلة للآجئين و المهاجرين القادمين الى اوروبا
Pour la libre circulation: Informations indépendantes pour réfugiés et migrants arrivant en Europe
برای آزادی و حرکت : اطلاعات مستقل برای پناهندگان و مهاجران آینده در اروپا

Topics

Contacts
Overview
Safety at Sea
Dublin III
Asylum
Gender
Minors
Regularization
Detention
Deportation
Living
Family
Medical
Work

Risks, Rights and Saftey at Sea: Central Mediterranean

last update: January 2015

For twenty years, the EU has been denying visas to most applicants. Many of them wish to emigrate anyway and attempt to cross the sea clandestinely. This crossing constitutes an offence, and is above all dangerous: during the last twenty years, more than 17,000 deaths have been recorded at the maritime borders of the European Union. This document aims neither at deterring people from nor encouraging them to attempt the crossing, but rather at providing objective information about risks, rights and vital safety measures to take at sea. Part of it can save your life but will not make the crossing any safer for all that.

Emergency Contacts Coast Guards

Italy: + 39 065 908 45 27

Malta: + 356 21 257 267

Libya: + 218 21 44 46 799 or + 218 21 56 30 257

Tunisia (Ministry of Defence): + 216 71 560 240

Alarm Phone Nr.: / + 334 86 51 71 61

WHEN YOU DECIDE TO LEAVE, READ THIS:

Countries

Albania
Austria
Belgium

Buy a life vest and supplies and take care of your important belongings

Check the navigation and communication equipment

Make sure that the emergency equipment on board works

Do not get on board an overloaded or damaged boat

Check the weather forecast at departure & destination

• Check that the weather is good for the next three days at departure and destination points. Check on internet (WWW.METEOCONSULT.COM >> METEO CONSULT MARINE), or by downloading the METEO CONSULT MARINE application on your smartphone. Take time to make yourself familiar with it!

WWW.METEOCONSULT.COM >> METEO CONSULT MARINE

Check the weather for next 3 days for departure & destination …

… by downloading the

METEO CONSULT MARINE application on your SMARTPHONE.

Take time to make yourself familiar with it !

Are weather conditions a decisive factor for CMR crossings (cont.) ?

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Home > Test

⭐ WEATHER **TEST** : Port (Private Spot)
Location: Tarabulus, Longitude: 13 ° 11 ', 844 E Latitude: 32 ° 52', 884 N

test port near Tripoli (Libya)

Chercher un spot, un port, un mouillage...

SEA 18	THU 19	FRI 20	SAT 21	SUN 22	MON 23	MAR 24	SEA 25	THU 26	FRI 27	SAT 28	SUN 29	MON 30	MAR 31	SEA 01
24°	27°	27°	25°	24°	24°	23°	23°	24°	24°	25°	25°	24°	24°	26°
11 nds	15 nds	15 nds	6 nds	7 nds	13 nds	17 nds	9 nds	9 nds	12 nds	11 nds	10 nds	7 nds	10 nds	10 nds

T + 14 days

WEDNESDAY 18 OCTOBER
NO OPINION OF COUP DE VENT
Our forecasters by phone at 32.64 *

RELIABILITY Index 90

HOURLY VIEW | SYNTHETIC VIEW | COMPARE MODELS

THE BULLETIN
ON TEST:
Estimated at 12h00 | next update at 3:00 pm
◁ Previous Hours | Next Hours ▶

	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h	00h	01h	02h	03h	04h
WIND															
Wind speed (nds)	2	2	4	9	9	10	11	11	11	11	11	12	11	11	
Rafales (nds)	3	3	-	-	10	11	-	12	13	13	14	14	15	14	14
Wind direction (km)	115°	70°	45°	50°	65°	75°	85°	95°	100°	115°	120°	125°	130°	140°	145°
WAVES															
Total sea (m)	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Sea of wind (m)	0.1	0.1	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	
Direction swell (°)	60°	60°	60°	60°	60°	60°	60°	60°	60°	60°	60°	60°	60°	60°	60°
Height Houle (m)	0.3	0.4	0.3	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1
Wave period (sec)	9	9	9	9	9	9	8	8	8	8	8	8	8	8	8
Wave length (m)	121	121	124	122	124	119	119	111	110	105	104	98	97	94	93
T ° Sea (° C)	26	26	26	26	25	25	25	25	25	25	25	25	25	25	25
WEATHER Time															
High cloud (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Average cloud (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low cloud (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amount of precip. (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thunderstorm (%)							10	20	30	20	20	10	10		
T ° of air (° C)	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Feels Like (° C)	31	32	32	30	29	29	28	27	27	26	26	26	26	25	25

BRIEFING

EXPERT OPINION

Sunny. Wind variable around 3 pm becoming east-northeast around 6 pm then east around 9 pm. Strength 1 in the afternoon forcing 3 in the late afternoon. Beautiful sea to little rough.

Identification by Maximum Correlations of Selected Model Parameters

Non-Extreme Mode

Param	Max (Absolute) Correlation
SWH	-0.86
HMAX	-0.86

Param	Max (Absolute) Correlation
WS	-0.85
FG6	-0.86

Param	Max (Absolute) Correlation
T2M	+0.91
MX2T6	+0.89
MN2T6	+0.92

Param	Max (Absolute) Correlation
SST	+0.82 / +0.92 (1-month lag)

Param	Max (Absolute) Correlation
PRECI	-0.75

Param	Max (Absolute) Correlation
SNOW	-0.61

Suggested Parameters for Forecast Guidance

- Significant Wave Height / Wind Gusts / Air Temperature
- Sea Surface Temperature / Precipitation / Snowfall

Extreme Forecast Index (EFI) Mode

Param	Max (Absolute) Correlation
WSI10	-0.18
FGI10	-0.24

Param	Max (Absolute) Correlation
TI2	-0.45

Param	Max (Absolute) Correlation
TPI	-0.72

Param	Max (Absolute) Correlation
SFI	-0.72

Suggested EFI Parameters

- EFI Precipitation / EFI Snowfall

Example of possible product maps

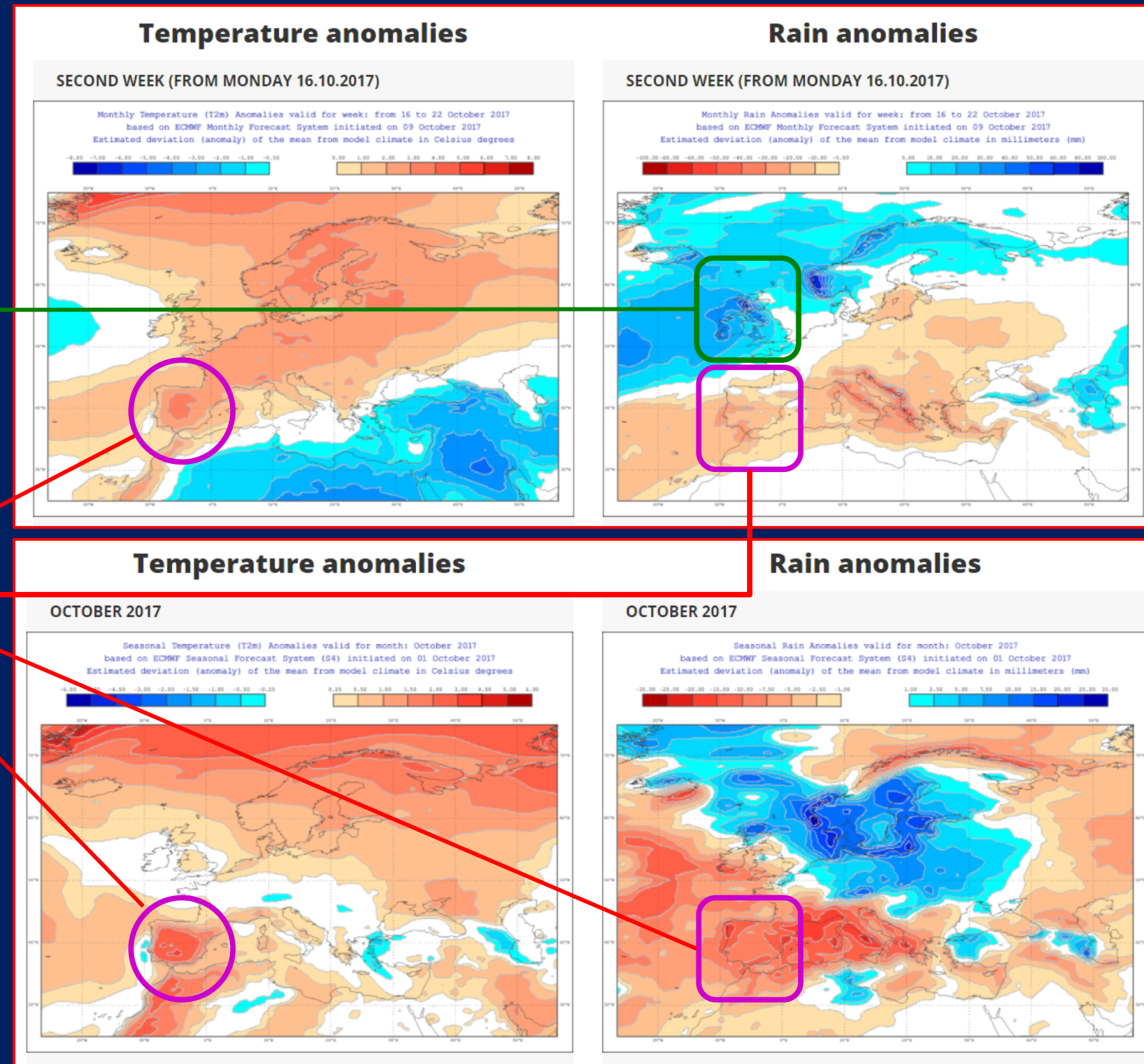## Selected parameters of strong influence

Negative Correlation

- *Significant Wave Height (SWH)*
- *Wind Gusts (FG6)*
- *Precipitation (PRECI)*
- *Snowfall (SNOW)*
- *EFI – Precipitation (TPI)*
- *EFI – Snowfall (SFI)*

Positive Correlation

- *Air Temperature (T2M)*
- *Sea Surface Temperature (SST)*
- *Lag Sea Surface Temperature (LSST)*

Alarm Bell for Ophelia ?

Portugal Fires

Temperature anomalies

SECOND WEEK (FROM MONDAY 16.10.2017)

Monthly Temperature (T2m) Anomalies valid for week: from 16 to 22 October 2017
based on ECMWF Monthly Forecast System initiated on 09 October 2017
Estimated deviation (anomaly) of the mean from model climate in Celsius degrees

Rain anomalies

SECOND WEEK (FROM MONDAY 16.10.2017)

Monthly Rain Anomalies valid for week: from 16 to 22 October 2017
based on ECMWF Monthly Forecast System initiated on 09 October 2017
Estimated deviation (anomaly) of the mean from model climate in millimeters (mm)

Temperature anomalies

OCTOBER 2017

Seasonal Temperature (T2m) Anomalies valid for month: October 2017
based on ECMWF Seasonal Forecast System (S4) initiated on 01 October 2017
Estimated deviation (anomaly) of the mean from model climate in Celsius degrees

Rain anomalies

OCTOBER 2017

Seasonal Rain Anomalies valid for month: October 2017
based on ECMWF Seasonal Forecast System (S4) initiated on 01 October 2017
Estimated deviation (anomaly) of the mean from model climate in millimeters (mm)

Possible Products might be used (after Validation) in the format of weekly and monthly anomalies (EFFIS)

As in the case of forest fires such weather element anomalies should be used as forecast guidance

if weather conditions are more or less favourable to an increased number of refugee and migrant arrivals

Next steps after defining critical values

Based on the time needed for crossing (2 to 6 days)

- Forecast horizons of **5 to 7 days** seem more appropriate

High Resolution

Day 0-10
1 HIRES member
8 km

Medium-Range

Day 0-10 (15)
51 EPS members
16 (32) km

Extended-Range

Day 10-32
51 MFS members
32 km

Long-Range

Month 0-7
51 SFS members
64 km

Seasonal Forecast System (MFS)

- Seven (7) monthly ensemble mean values
- Combined seasonal values as DJF – MAM – JJA & SON

Monthly Forecast System (MFS)

- Four (4) weekly ensemble mean values

Medium-Range Ensemble Prediction System (EPS)

- Mean value over the 1st 7-day interval
- Mean value over the 2nd 7-day interval

Single Model Forecast Guidance

- Mean value over the 1st 5-day interval
- Mean value over the 2nd 5-day interval

LAG Correlations between 5-Day Number of Arrivals and Mean Significant Wave Height

Legend:
- Lag 0
- Lag 1
- Lag 2
- Lag 3
- Lag 4
- Lag 5
- Lag 7
- Lag 10
- Lag 15
- Lag 30
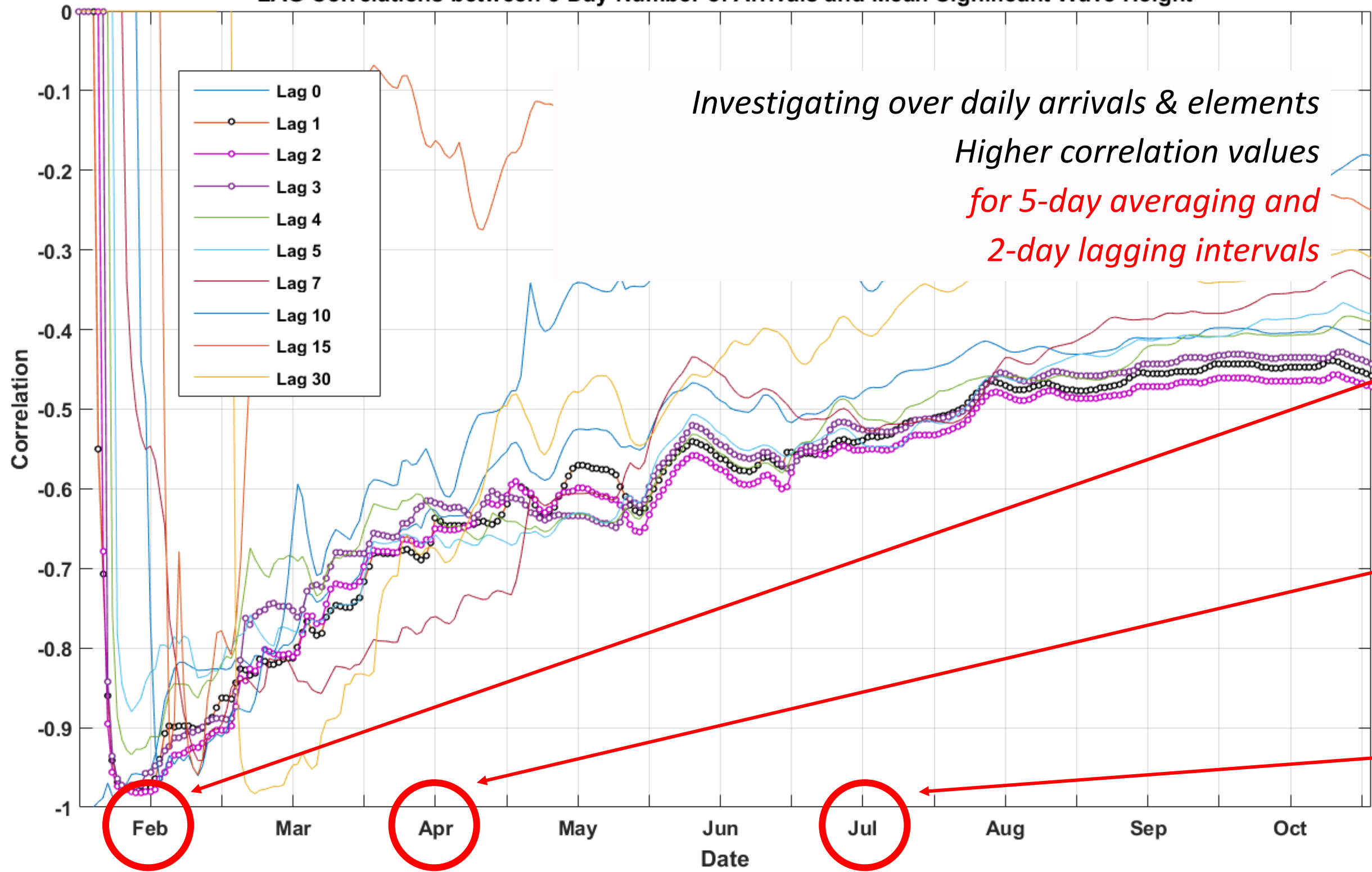
Investigating over daily arrivals & elements
Higher correlation values
for 5-day averaging and
2-day lagging intervals

Interior Minister Marco Minniti
justifying 87% reduction

2 February 2017
MoU with the leader of
Libyan Authorities

31 March 2017
Leaders of southern Sahara
tribes visiting Rome

13 July 2017
Meeting mayors of the most
important 14 Libyan cities

Y-axis: Correlation
X-axis: Date (Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct)

Summary

- Strong relationship between weather elements and arrivals on a monthly basis

- The elements most affecting arrivals with correlations > 0.80
    - SWH – WS
    - T2M – MAX – MIN – SST (especially with 1-moth lag mode)

- Less promising results in extreme mode – most probably due to the monthly scale used

- Lagging improves results for SST

- It seems that next investigation should focus on daily arrivals

- First results show best agreement by applying a 5-day interval averaging with a 2-day lagging period

- Results will define future "tailored" products

DAILY HEADLINES

Wider Middle East

Libya: More than 12 migrants were shot dead by human traffickers last week while trying to escape a camp in Libya, where some were subjected to "torture and abuse", the United Nations said Friday. The incident, previously reported by 'Doctors Without Borders' and local sources, occurred on 23 May, 2018 in the town of Bani Walid which is 170 kilometres southeast of Tripoli. (AFP) more

Tripoli

170 km

Bani Walid

Questions ?

Some extra slides …

Monsoons could result in 'enormous deaths' among Rohingya refugees

Nearly a million Muslim refugees living in camps in Bangladesh at risk, rights groups warn
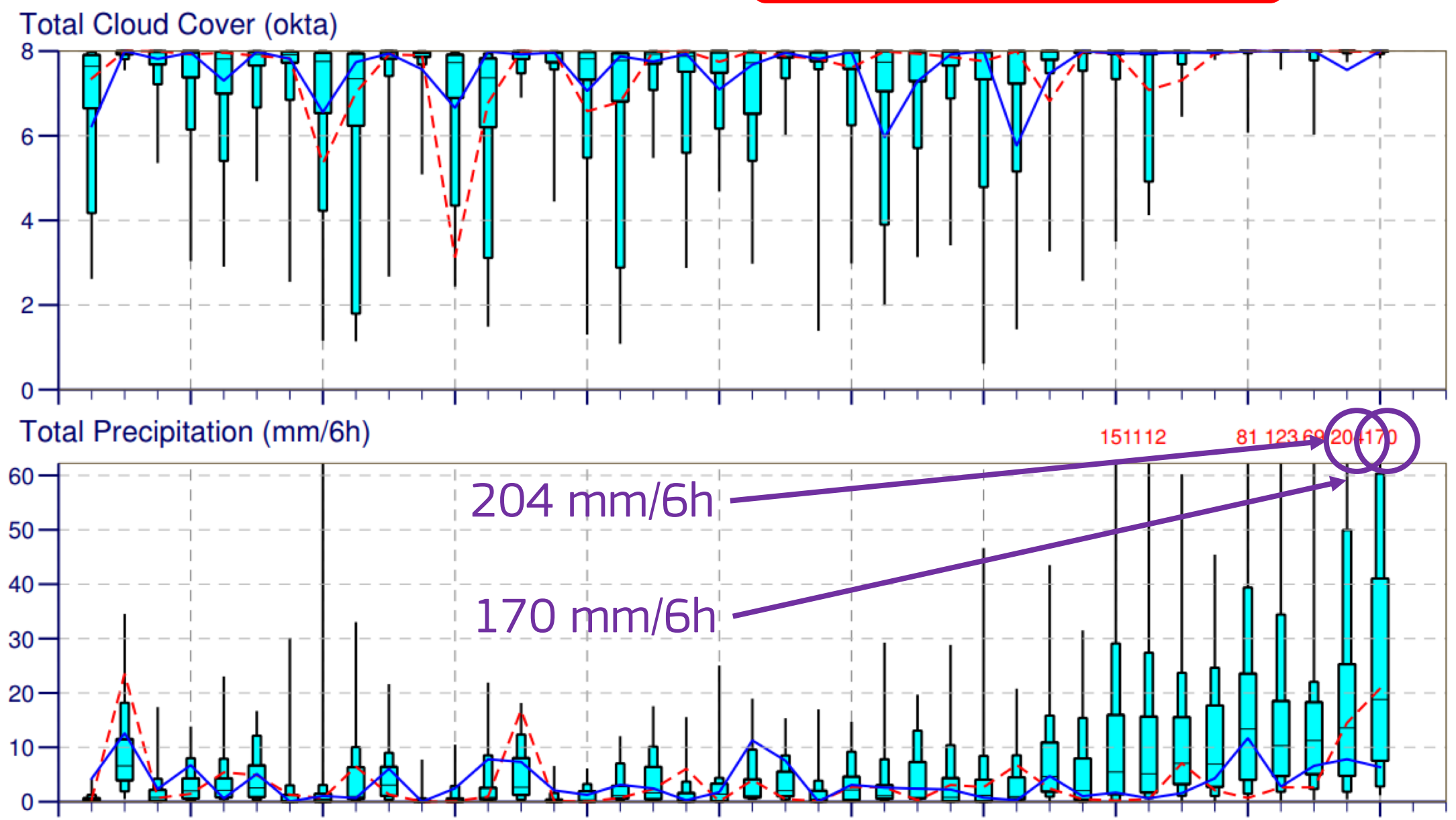
▲ Rights groups say the bamboo-and-plastic structures at Cox's Bazar were not built to withstand storms. Photograph: Zuma/Rex/Shutterstock

ENS Meteogram
Gundum, Bangladesh 21.16°N 92.19°E (ENS land point) 18 m
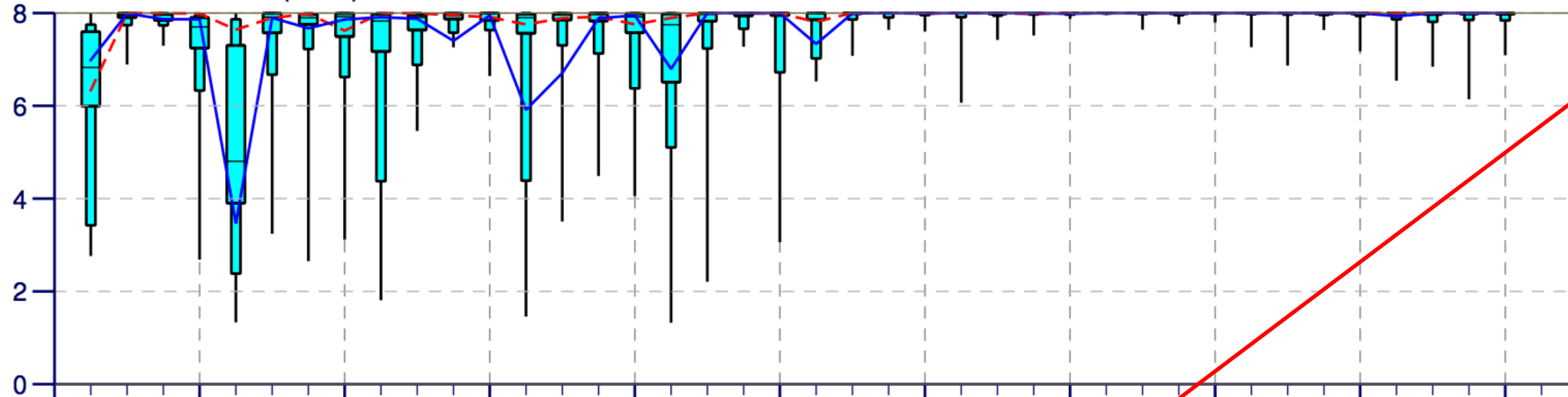High Resolution Forecast and ENS Distribution Saturday 2 June 2018 00 UTC

Total Cloud Cover (okta)

Total Precipitation (mm/6h)

204 mm/6h

170 mm/6h

ENS Meteogram
Gundum, Bangladesh 21.16°N 92.19°E (ENS land point) 18 m
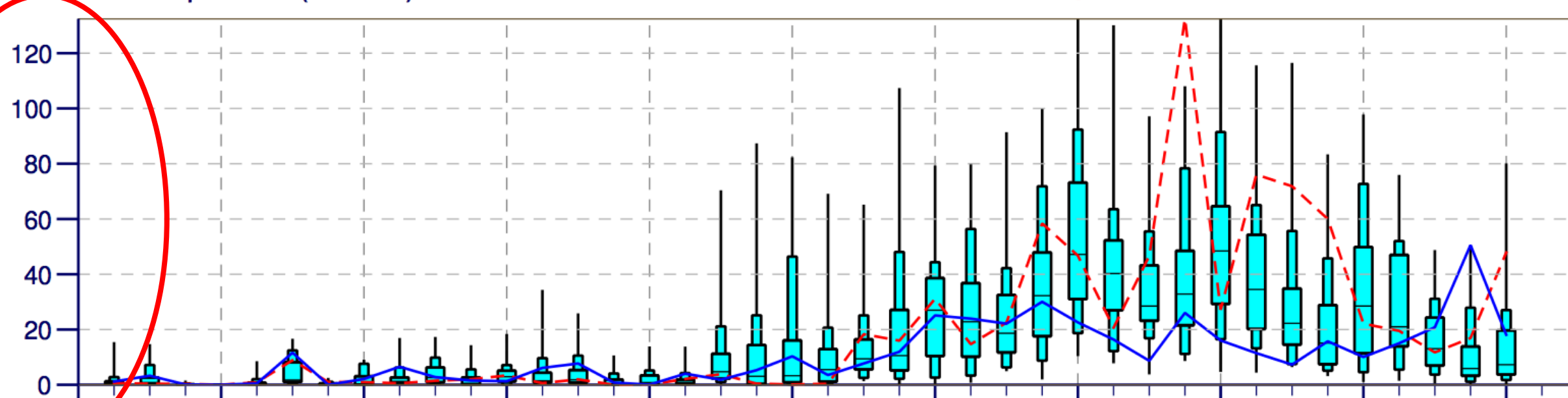High Resolution Forecast and ENS Distribution Tuesday 5 June 2018 00 UTC

Total Cloud Cover (okta)

Total Precipitation (mm/6h)

Monster seems slowly approaching…

164   142