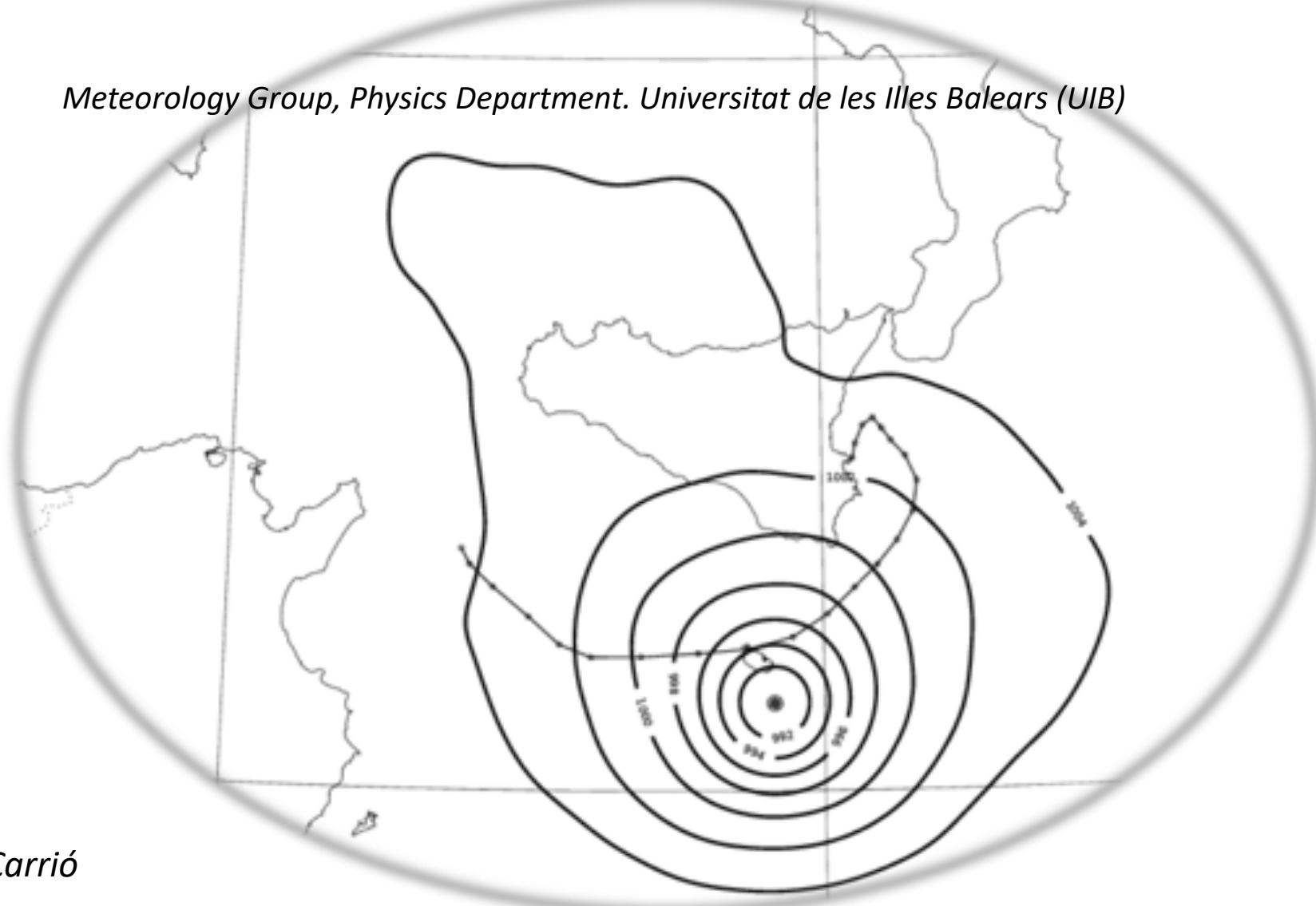


Assimilation of remote sensing data over the Western Mediterranean. Experiences with EnKF



Universitat
de les Illes Balears

Meteorology Group, Physics Department. Universitat de les Illes Balears (UIB)

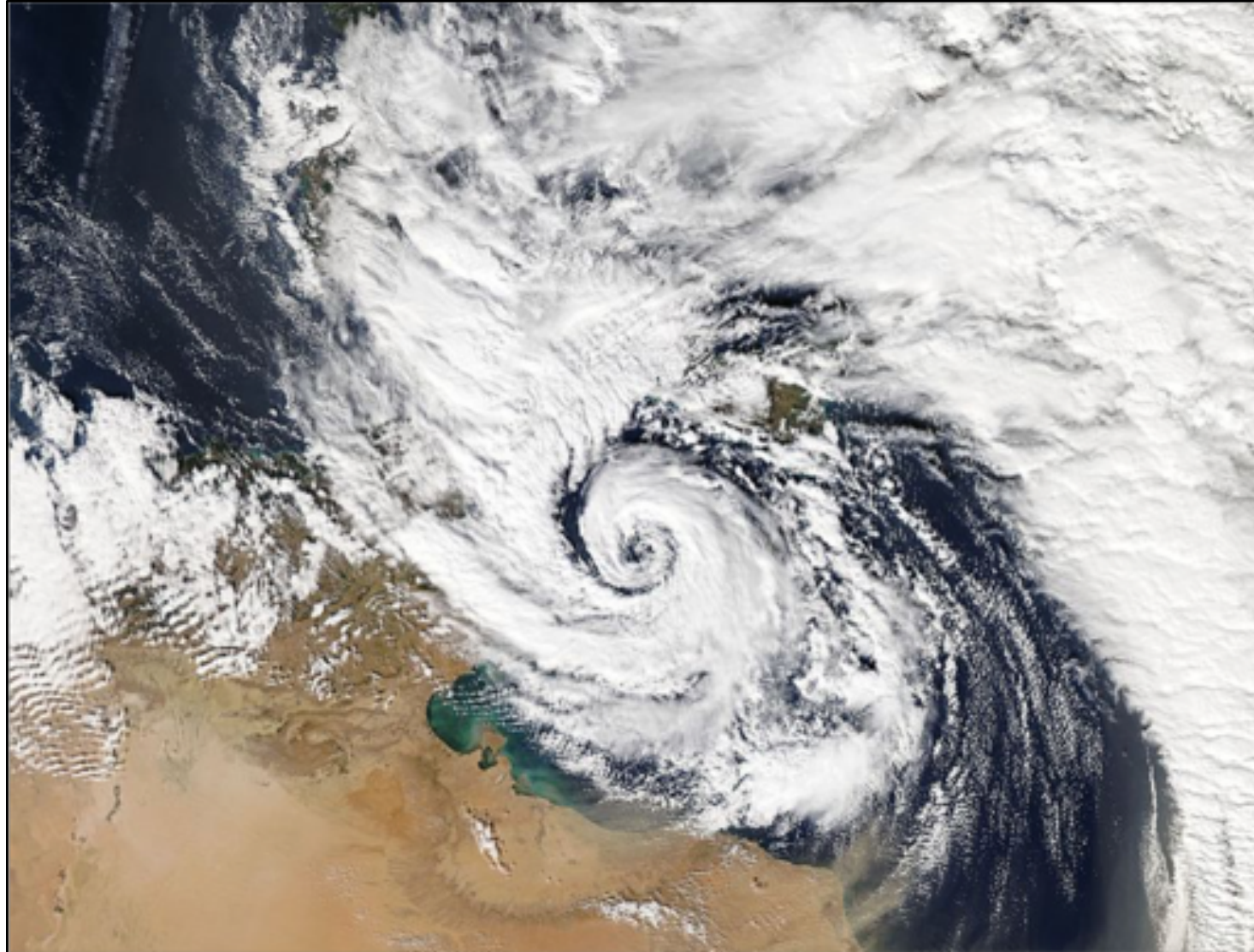


1. INTRODUCTION

1. INTRODUCTION: Brief overview of the 7 November 2014 medicane

Qendresa medicane:

Visible MODIS image at 16 UTC 7 November 2014

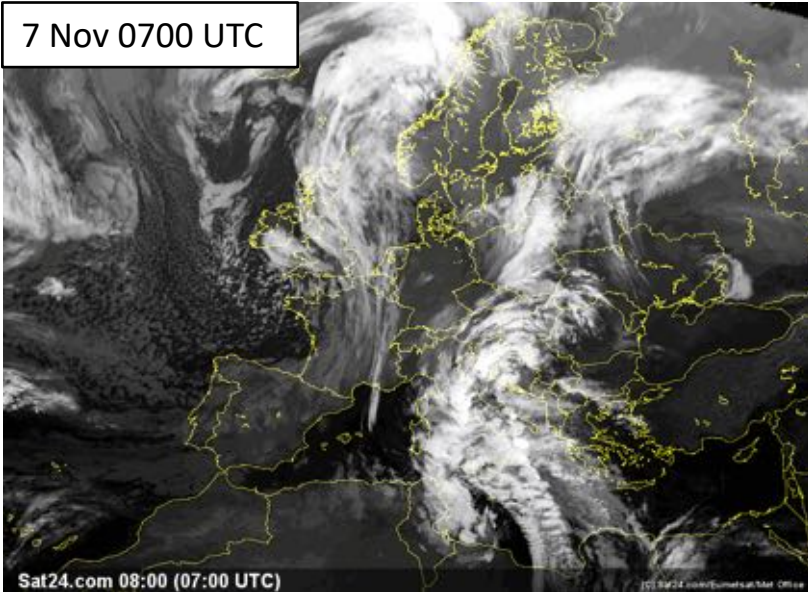


MODIS satellite image from NASA

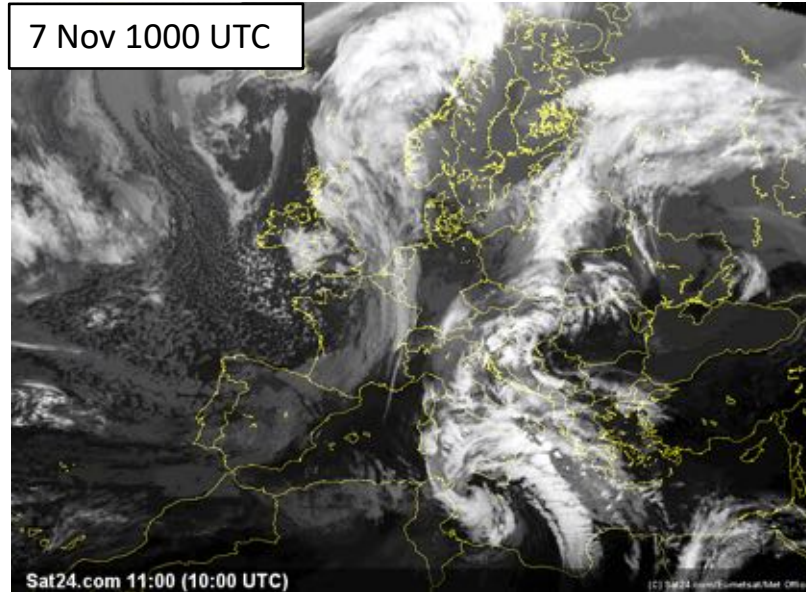
1. INTRODUCTION: Brief overview of the 7 November 2014 medicane

Overview case study:

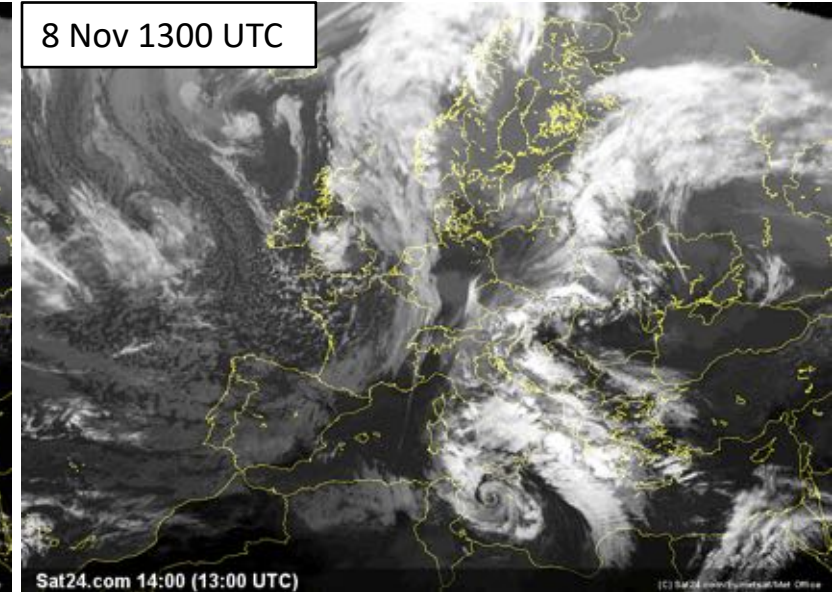
7 Nov 0700 UTC



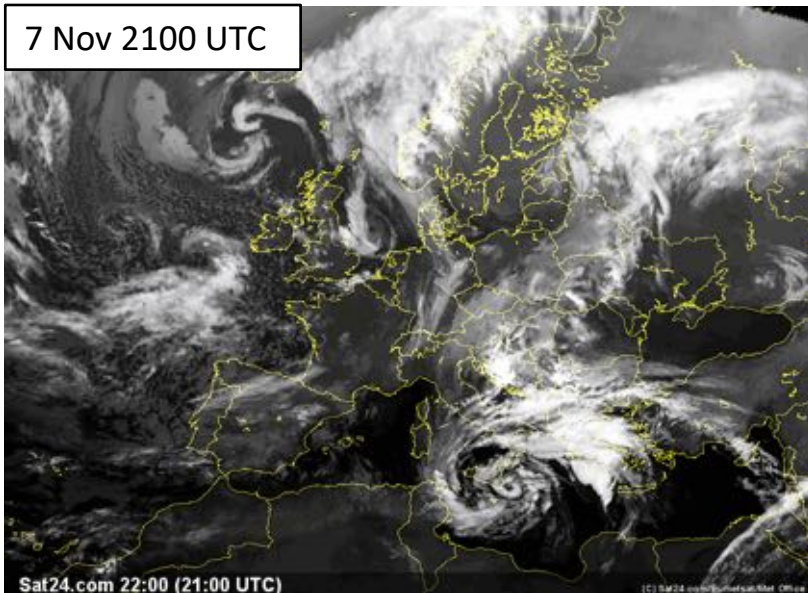
7 Nov 1000 UTC



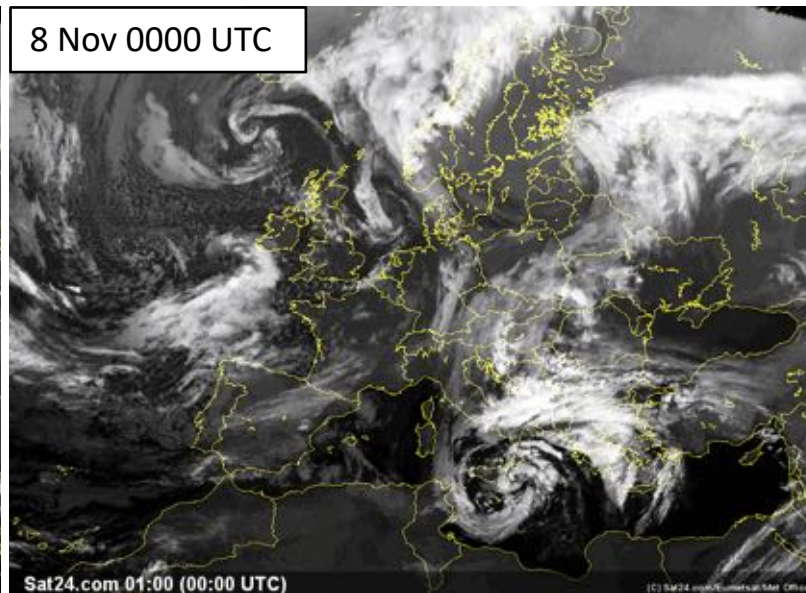
8 Nov 1300 UTC



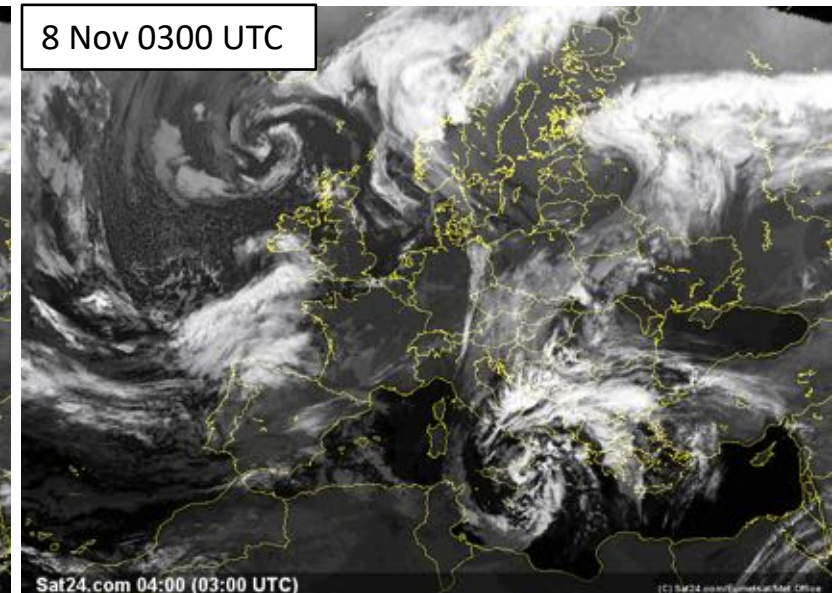
7 Nov 2100 UTC



8 Nov 0000 UTC

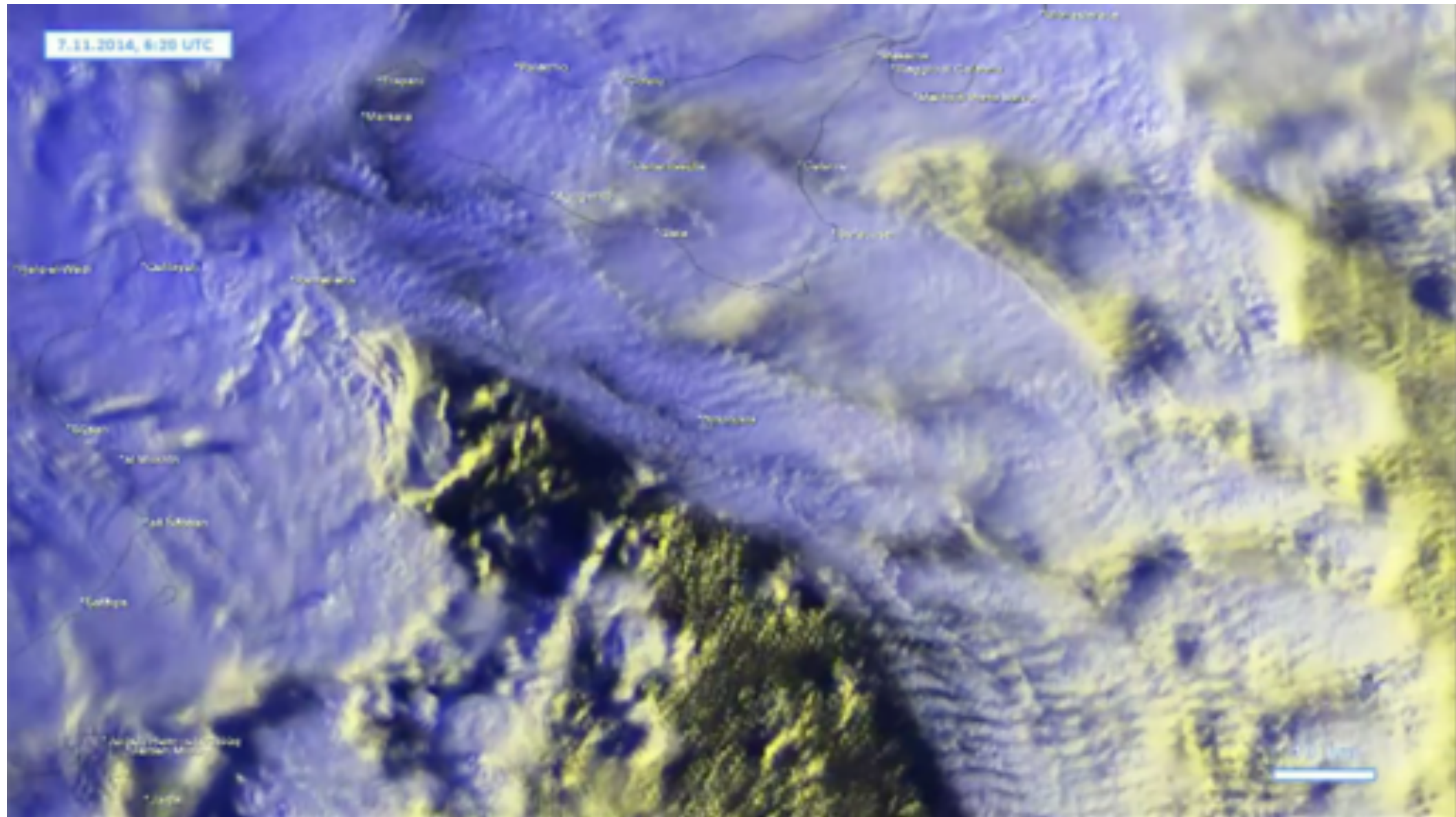


8 Nov 0300 UTC



1. INTRODUCTION: Brief overview of the 7 November 2014 medicane

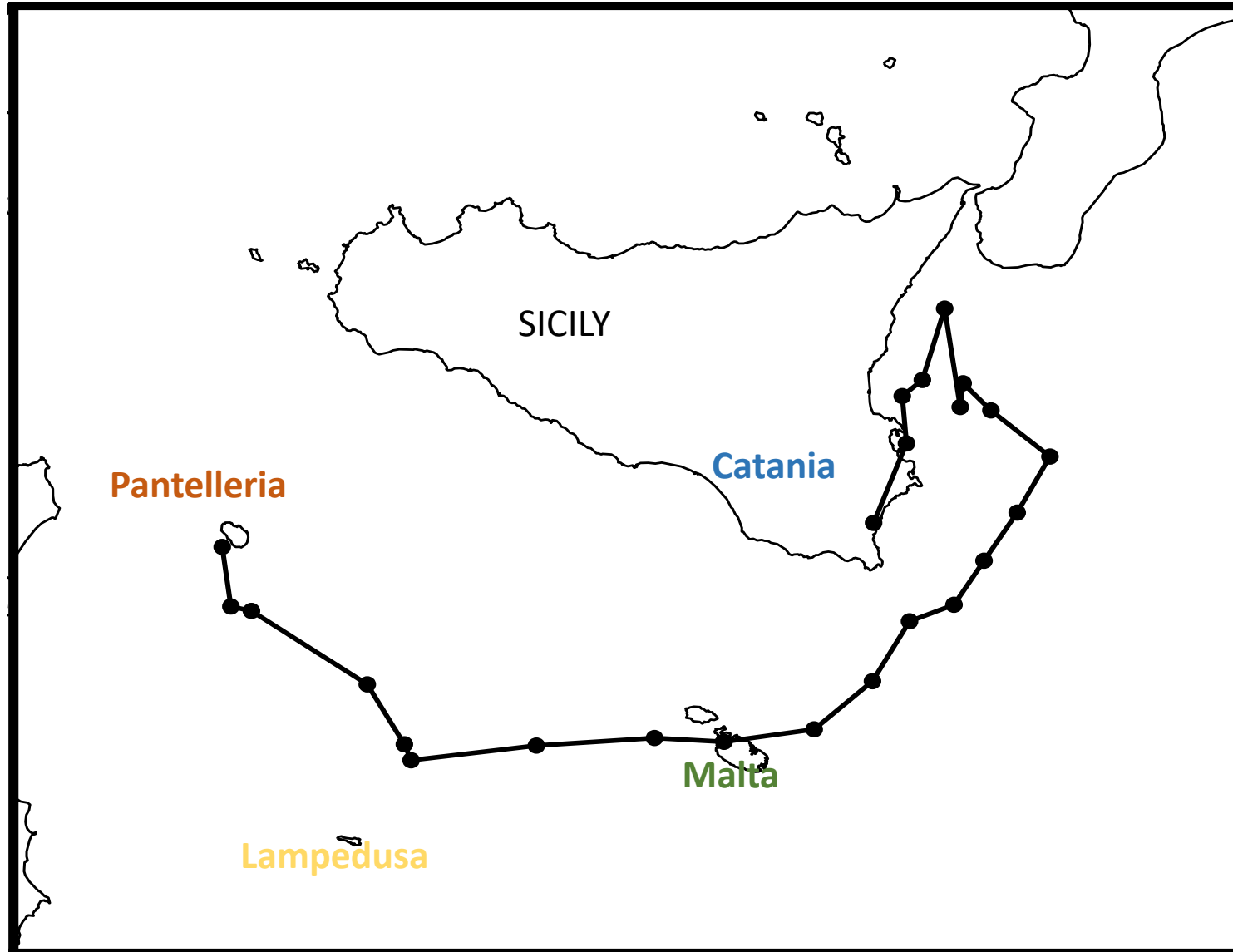
Overview case study:



1. INTRODUCTION: Brief overview of the 7 November 2014 medicane

Overview case study:

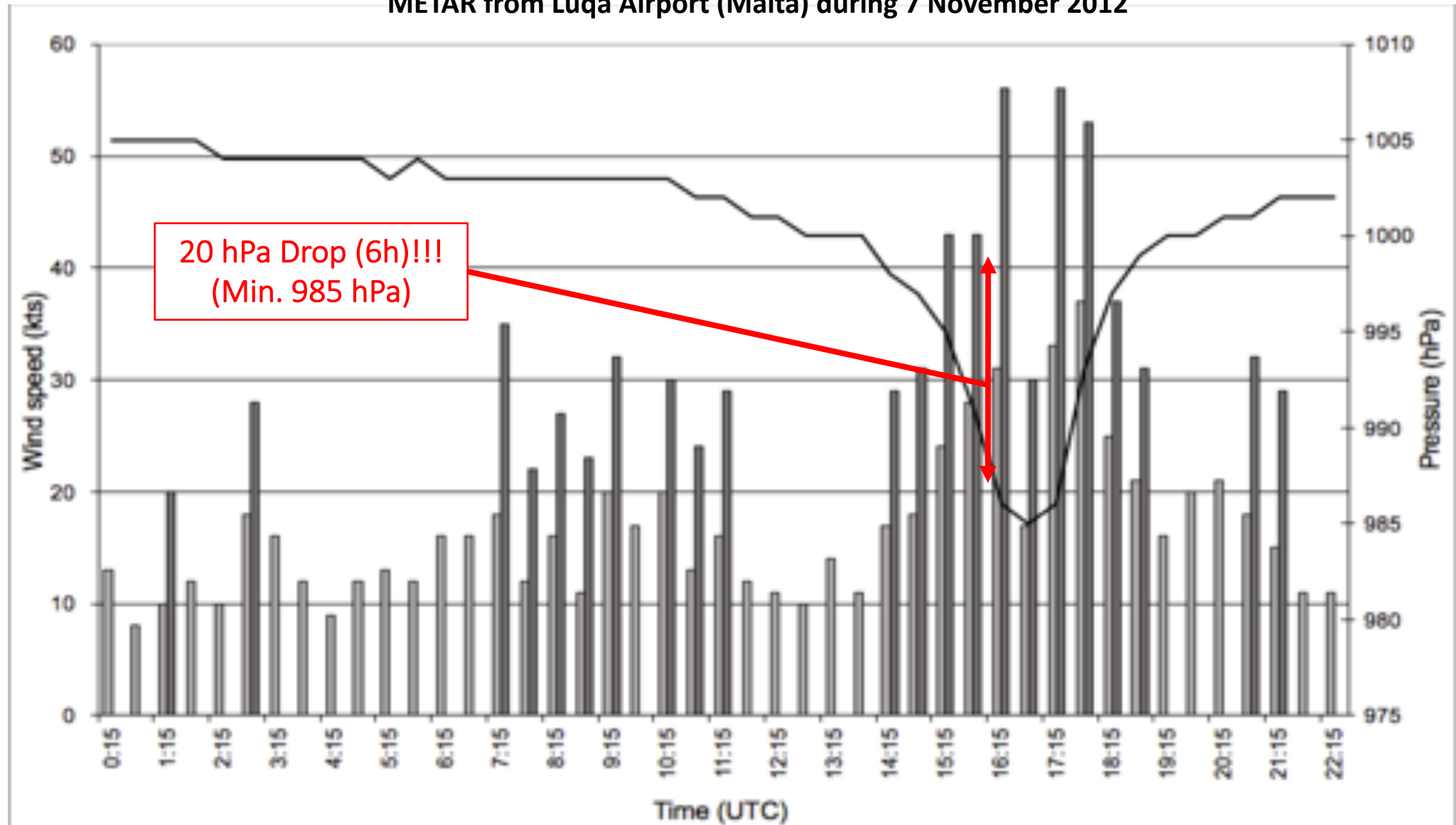
Quendresa **track** from 08 UTC 7 November to 08 UTC 8 November 2014



1. INTRODUCTION: Brief overview of the 7 November 2014 medicane

Overview case study:

METAR from Luqa Airport (Malta) during 7 November 2012



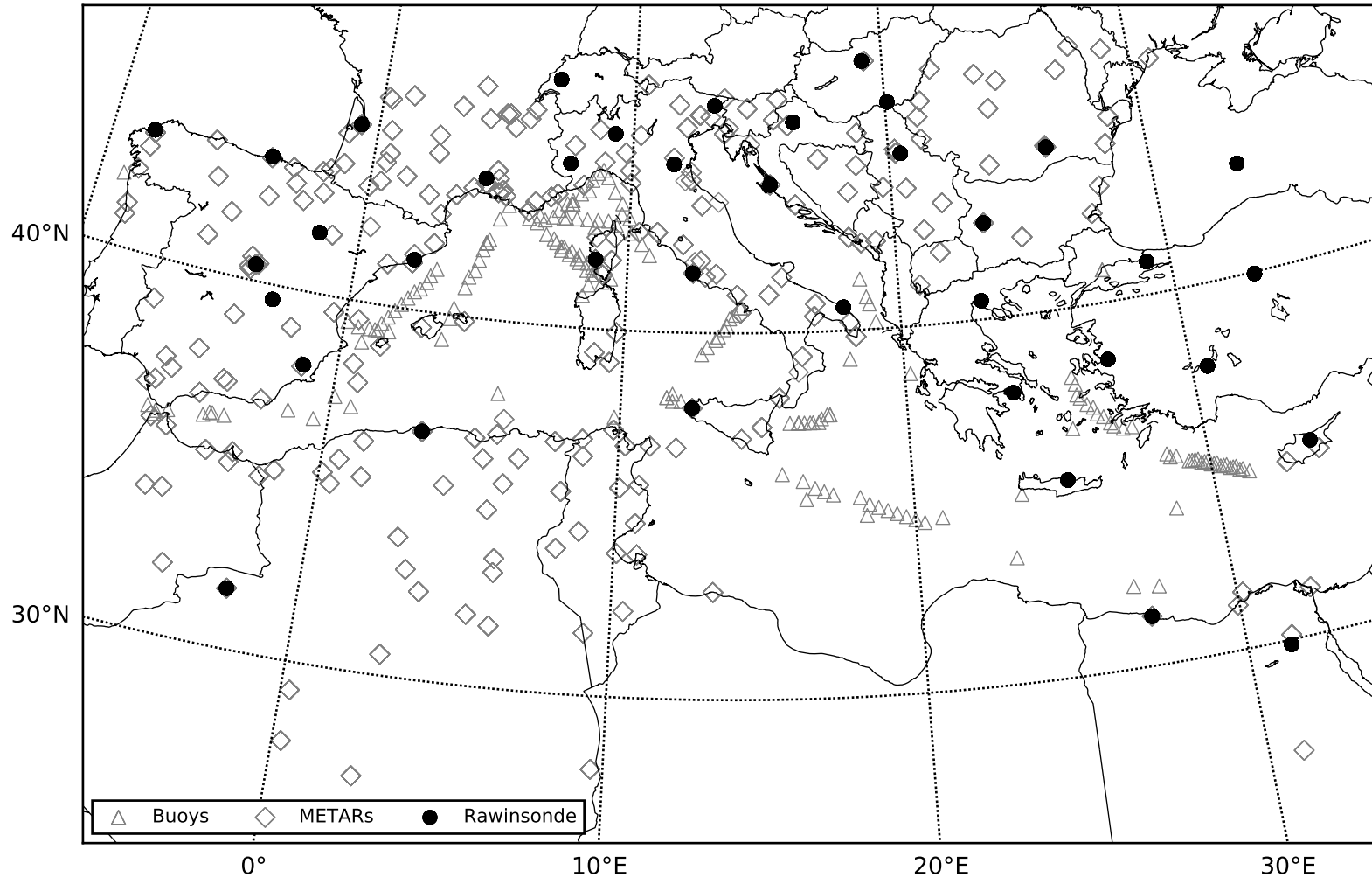
2. AVAILABLE OBSERVATIONS

2. AVAILABLE OBSERVATIONS: *In-situ* Conventional (SYN)

Observations to be assimilated:

- Hourly QC *in-situ* conventional DA from MADIS database:

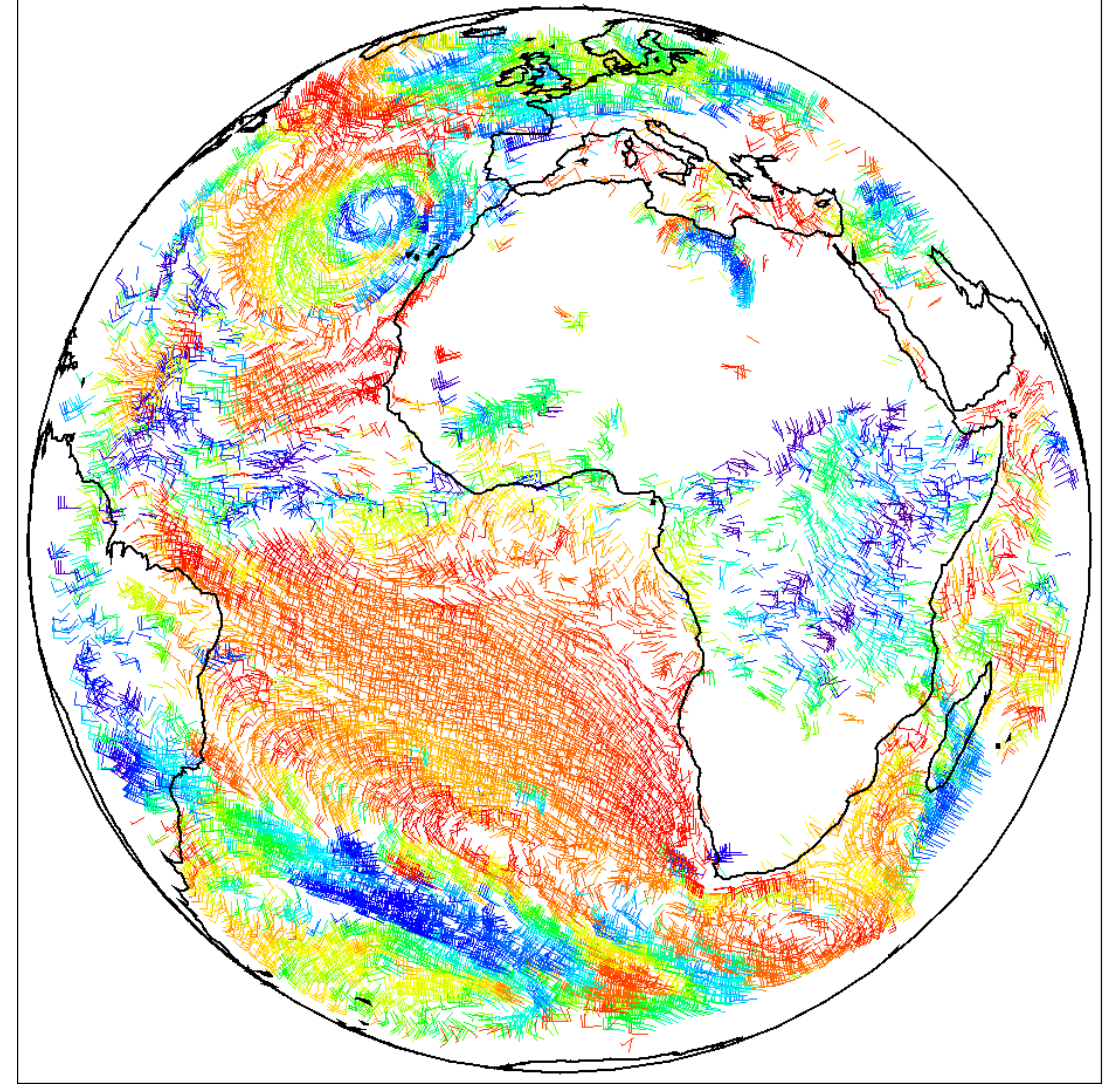
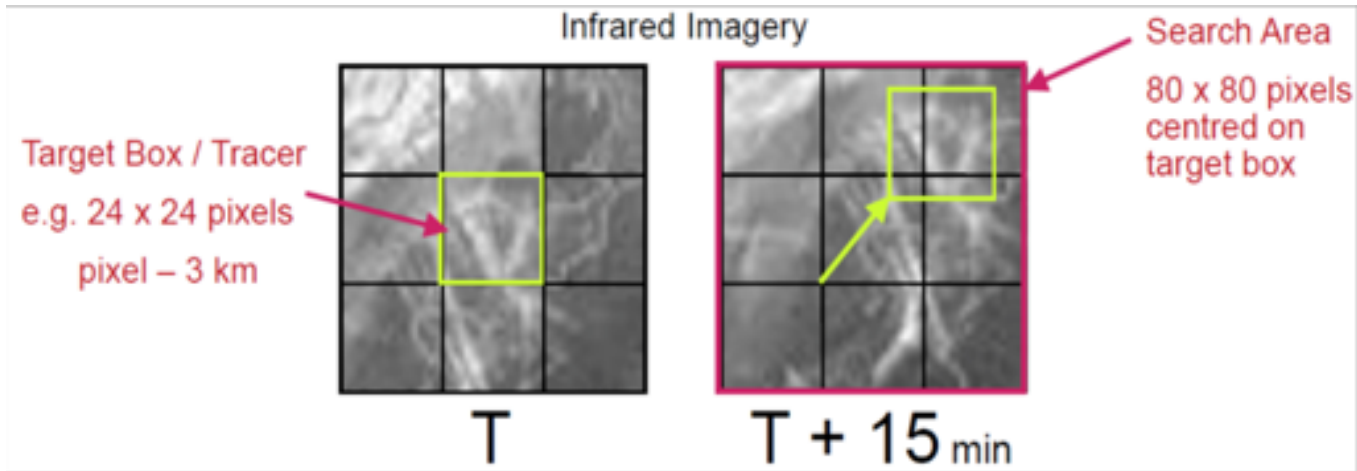
Observations available on **7th November 2012 at 12 UTC**



2. AVAILABLE OBSERVATIONS: *In-situ* Conventional (SYN)

Observations to be assimilated:

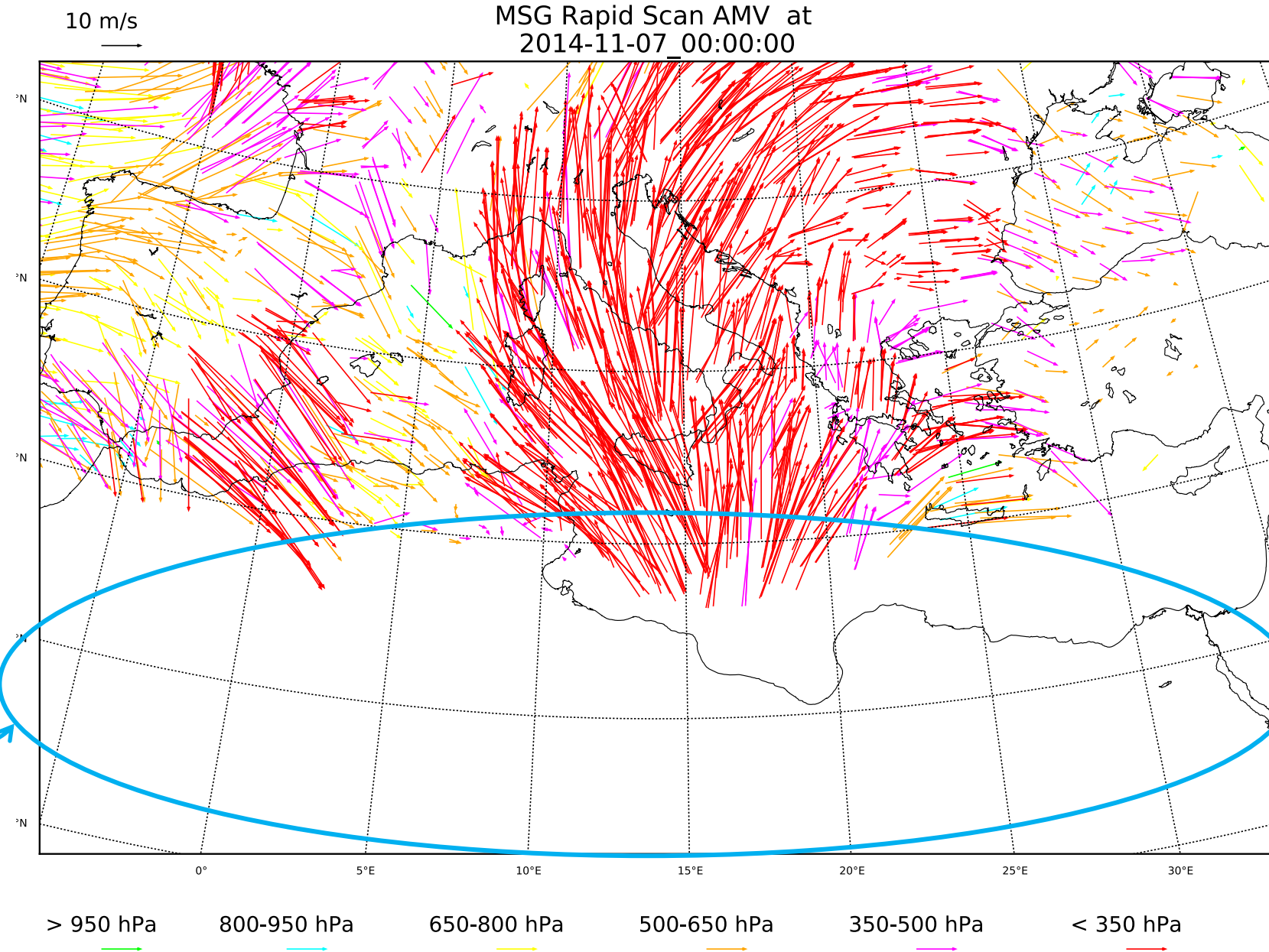
- Satellite data from **SEVIRI instrument** onboard MSG
- 20-minutes **Rapid Scan Atmospheric Motion Vectors** (RSAMV)
- **Wind field** information through the **entire atmosphere**
- These observations are obtained identifying a certain cloud pattern and following its evolution



2. AVAILABLE OBSERVATIONS: Rapid Scan Atmospheric Motion Vectors (AMVs)

Rapid Scan Atmospheric Motion Vectors:

Southern part of parent domain
not covered by RS-AMV
observations!!!!

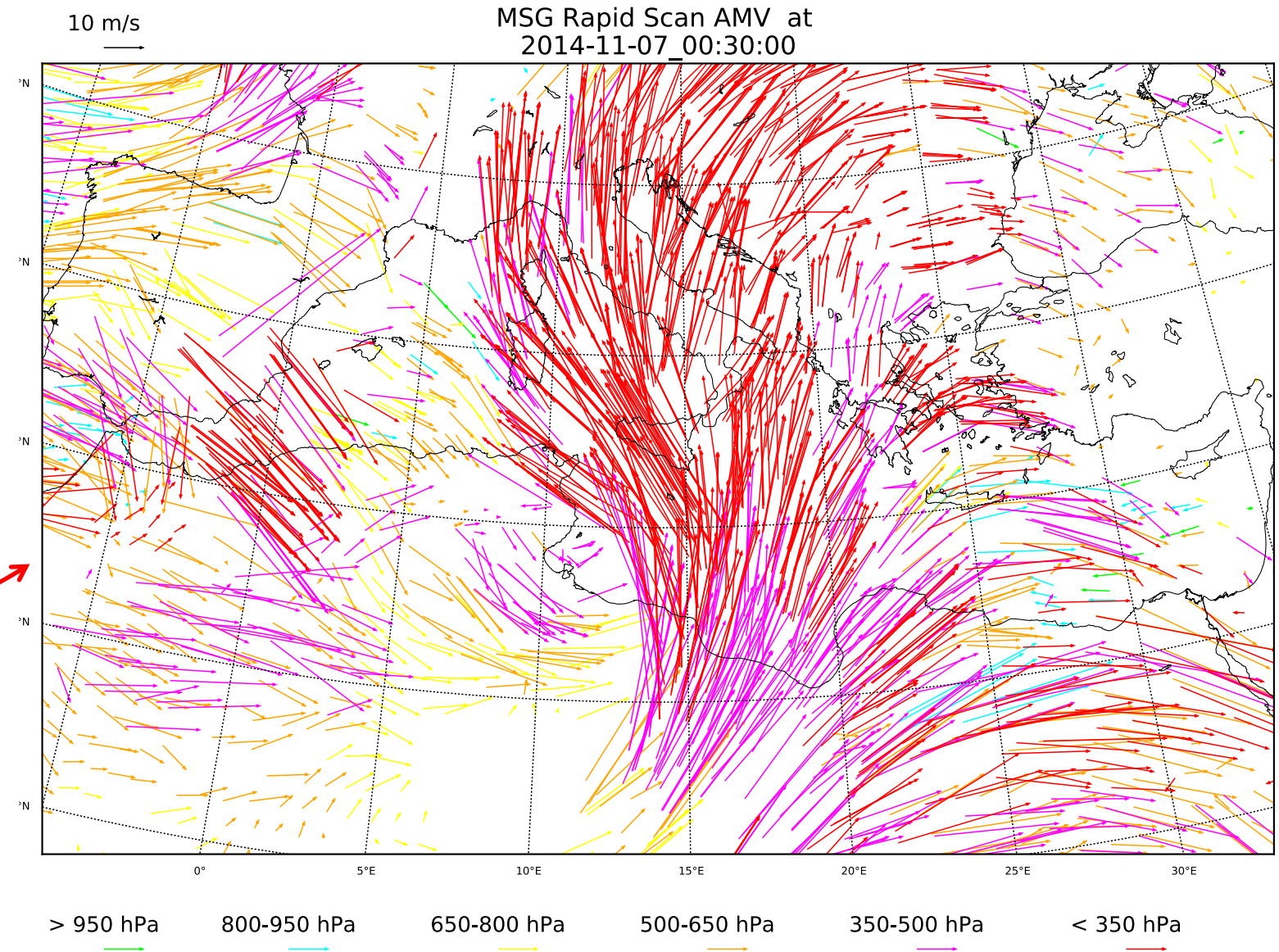


2. AVAILABLE OBSERVATIONS: Rapid Scan Atmospheric Motion Vectors (AMVs)

Amospheric Motion Vectors (global):

Temporal resolution: 1-h

Full spatial cover over
parent domain!!!!

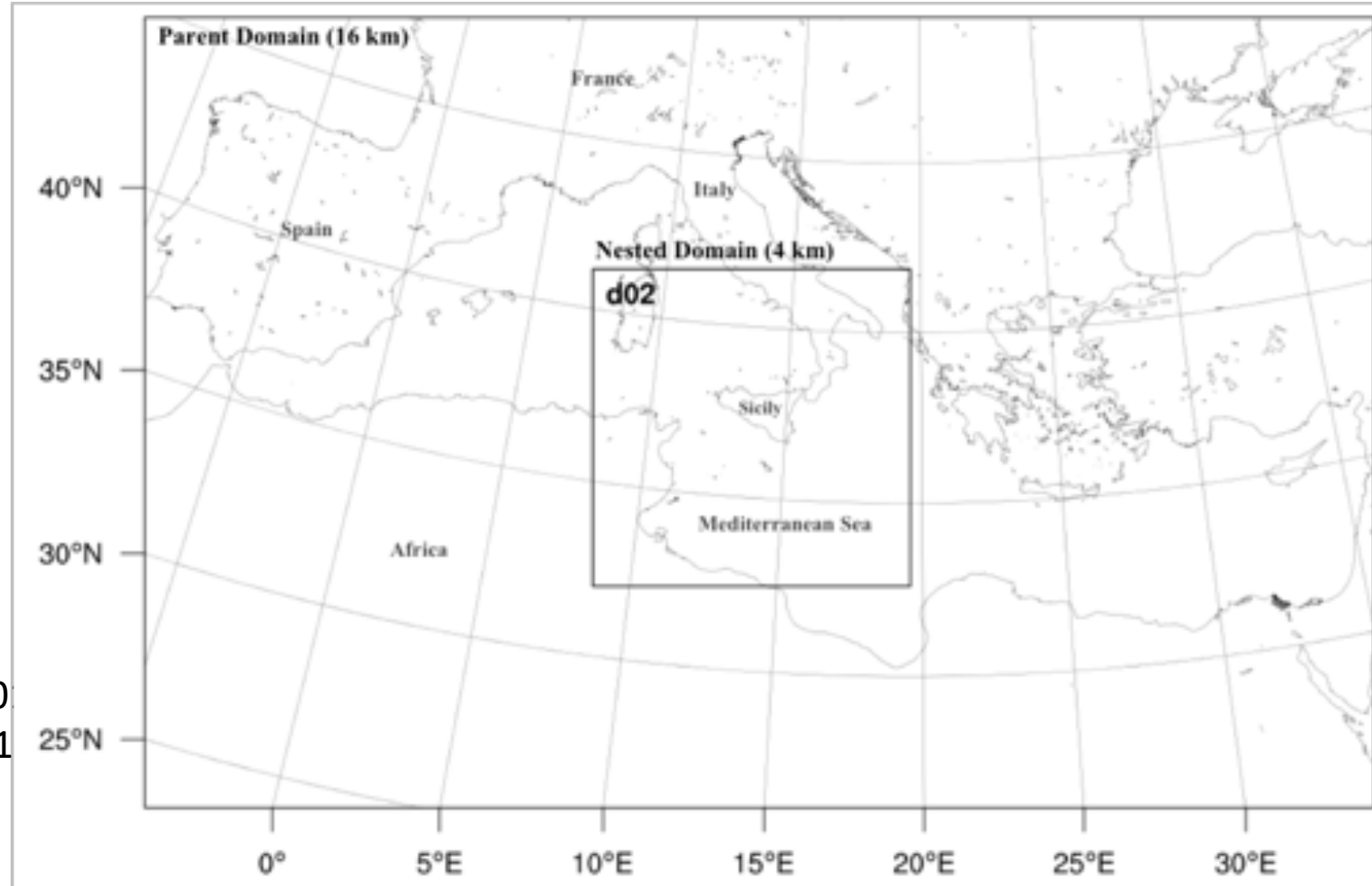


3. METHODOLOGY

3. METHODOLOGY : Numerical Model

Numerical Model Configuration:

- **WRF-ARW** model V3.7.1: Fully compressible, non-hydrostatic model
- Initial and Boundary Conditions from **EPS-ECMWF** (16 km)
- **One way-nesting:**
 - D01: $\Delta x = \Delta y = 16 \text{ km}$ (245x253x51)
 - D02: $\Delta x = \Delta y = 4 \text{ km}$ (253x253x51)
 - 51 terrain-following etha levels
- Start simulation time: 12 UTC 6 November 201
- End simulation time: 12 UTC 8 November 201

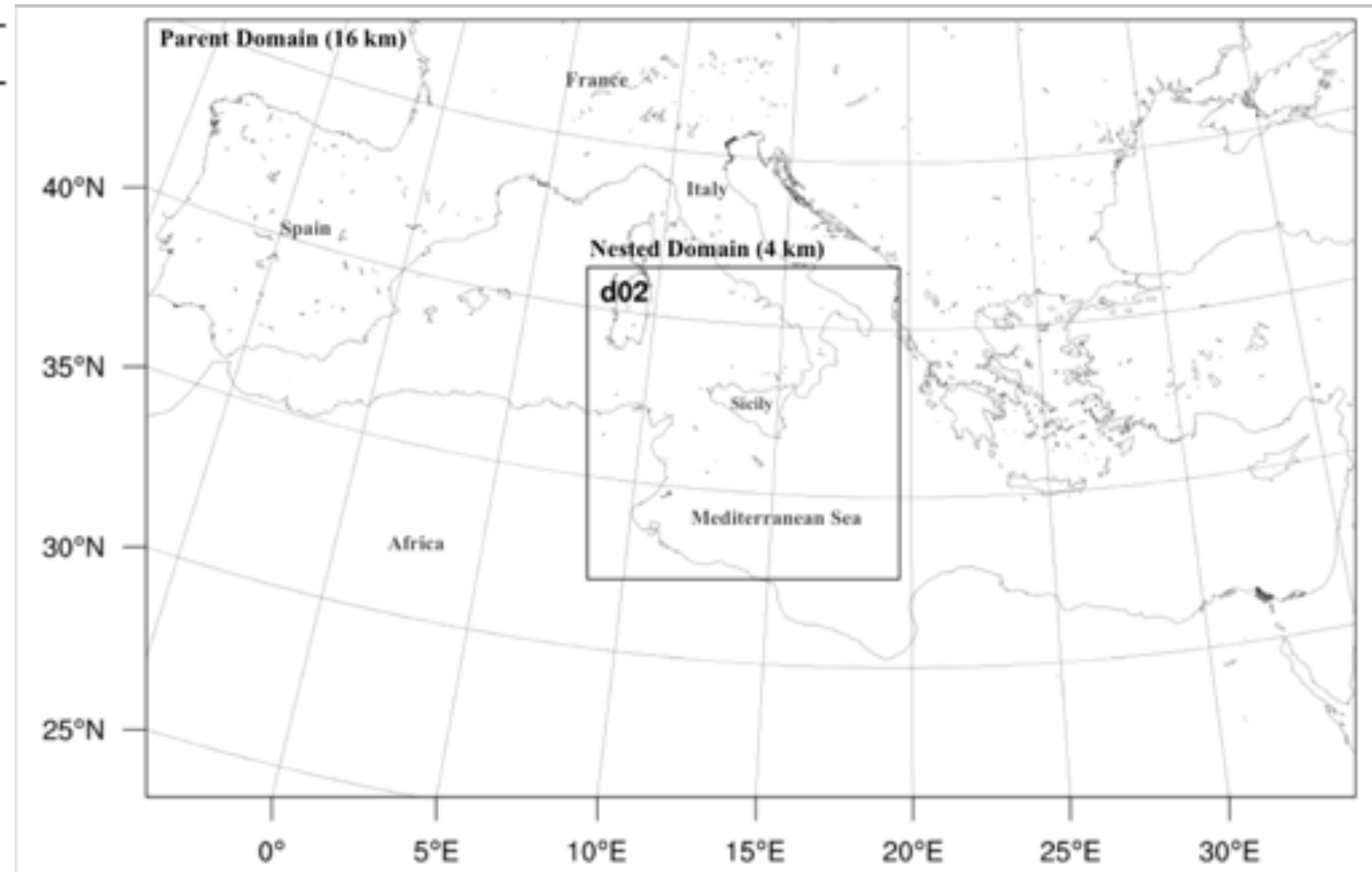


3. METHODOLOGY : Numerical Model

Numerical Model Configuration:

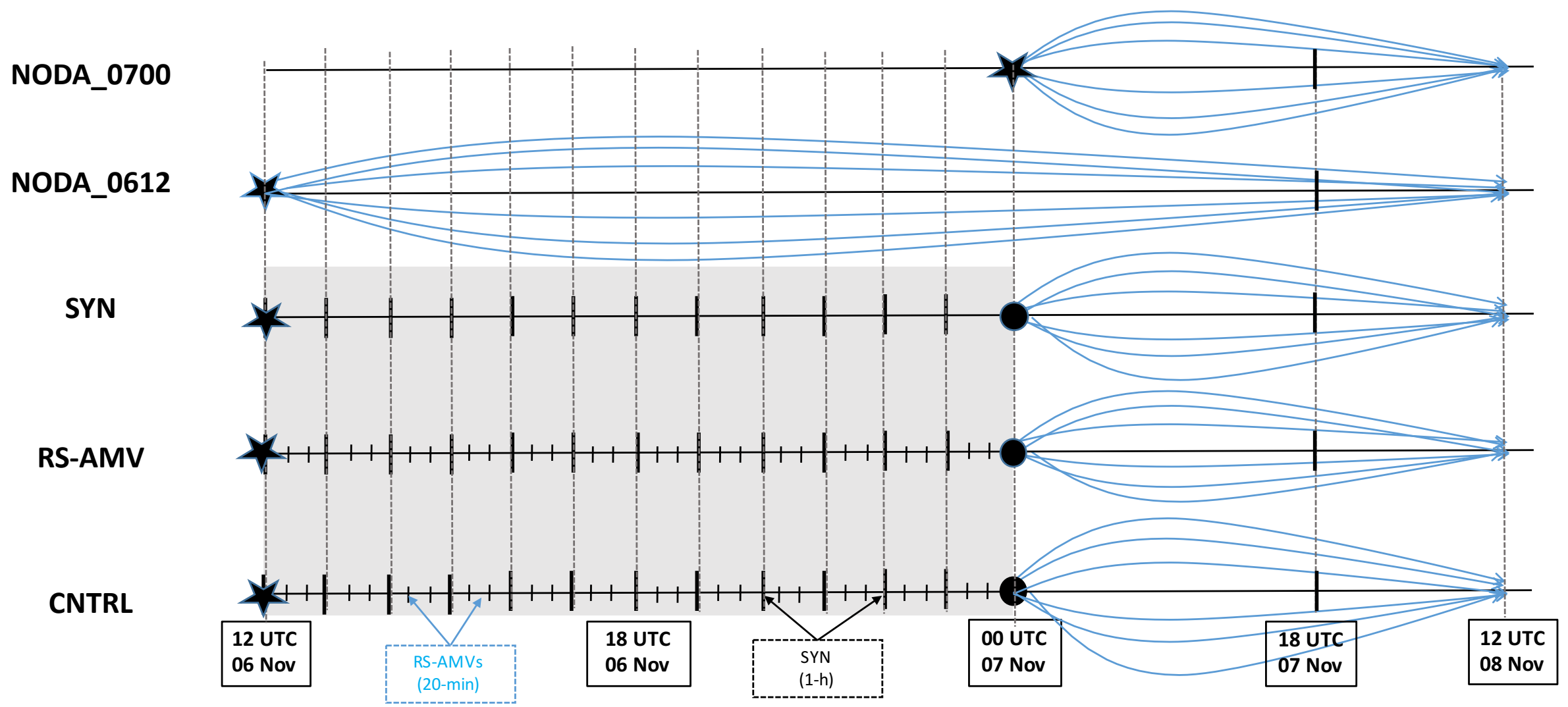
- Ensemble of 36 members using different physical parameterizations:

Multiphysic Configuration					
Ensemble Members	Microphysics	Cumulus	PBL	Land Surface	SW/RW radiation
1	Thompson	KF	YSU	Noah	Dudhia
2		KF	YSU		RRTMG
3		KF	MYJ		Dudhia
4		KF	MYJ		RRTMG
5		KF	MYNN2		Dudhia
6		KF	MYNN2		RRTMG
7	Thompson	GF	YSU	Noah	Dudhia
8		GF	YSU		RRTMG
9		GF	MYJ		Dudhia
10		GF	MYJ		RRTMG
11		GF	MYNN2		Dudhia
12		GF	MYNN2		RRTMG
13	Thompson	Tiedke	YSU	Noah	Dudhia
14		Tiedke	YSU		RRTMG
15		Tiedke	MYJ		Dudhia
16		Tiedke	MYJ		RRTMG
17		Tiedke	MYNN2		Dudhia
18		KF	MYNN2		RRTMG
19	Thompson	KF	YSU	Noah	Dudhia
20		KF	YSU		RRTMG
21		KF	MYJ		Dudhia
22		KF	MYJ		RRTMG
23		KF	MYNN2		Dudhia
24		KF	MYNN2		RRTMG
25	Thompson	GF	YSU	Noah	Dudhia
26		GF	YSU		RRTMG
27		GF	MYJ		Dudhia
28		GF	MYJ		RRTMG
29		GF	MYNN2		Dudhia
30		GF	MYNN2		RRTMG
31	Thompson	Tiedke	YSU	Noah	Dudhia
32		Tiedke	YSU		RRTMG
33		Tiedke	MYJ		Dudhia
34		Tiedke	MYJ		RRTMG
35		Tiedke	MYNN2		Dudhia
36		Tiedke	MYNN2		RRTMG



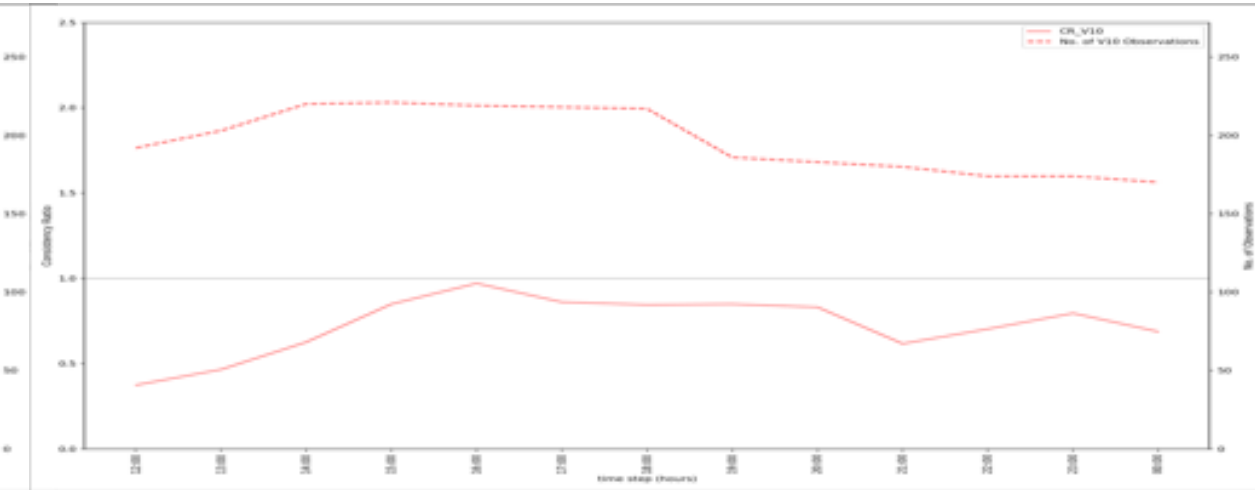
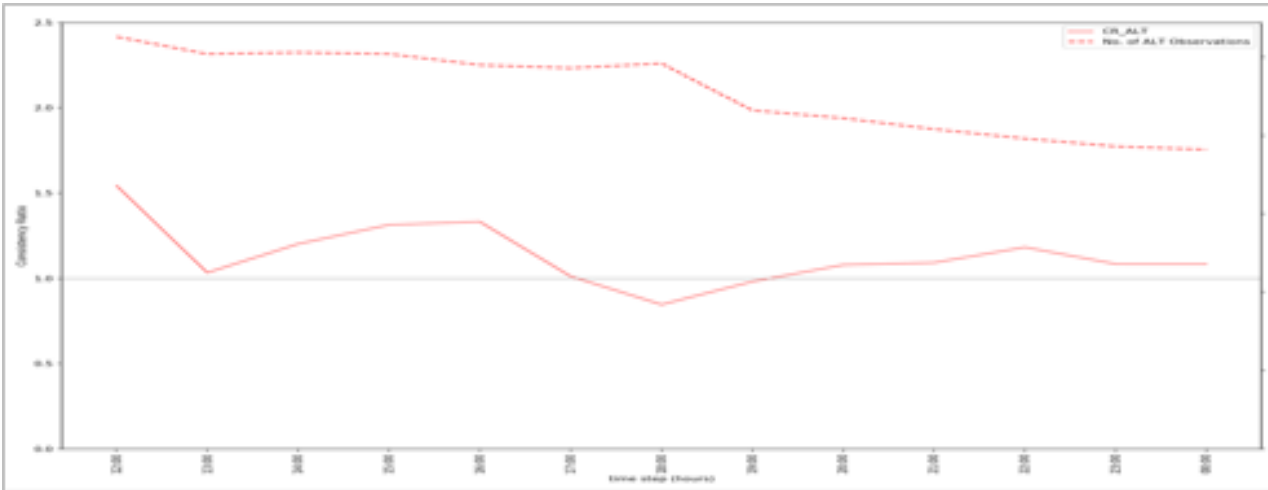
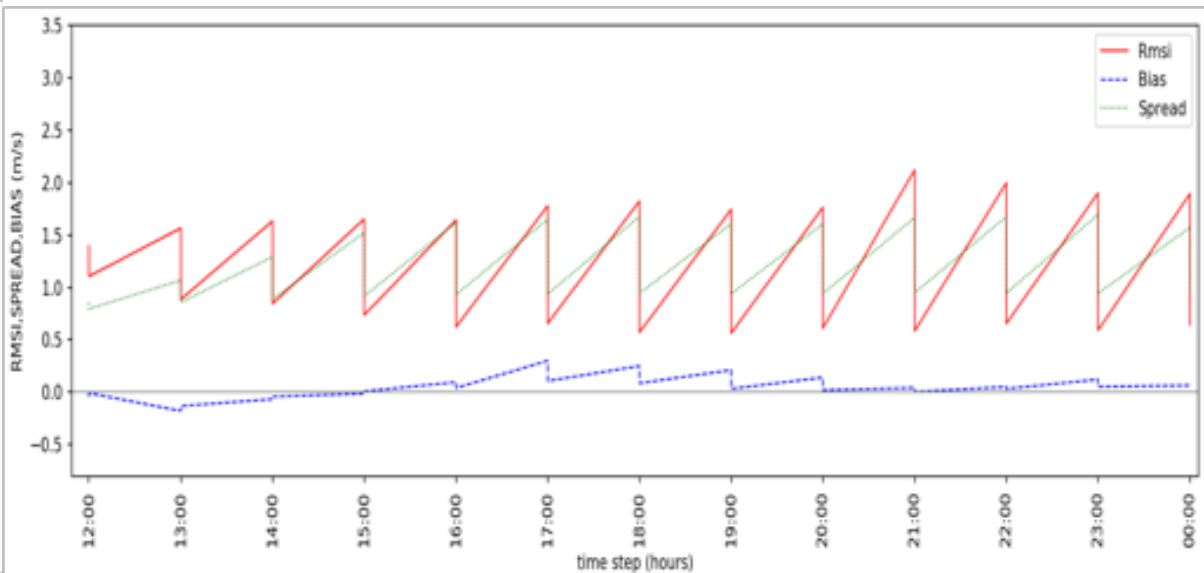
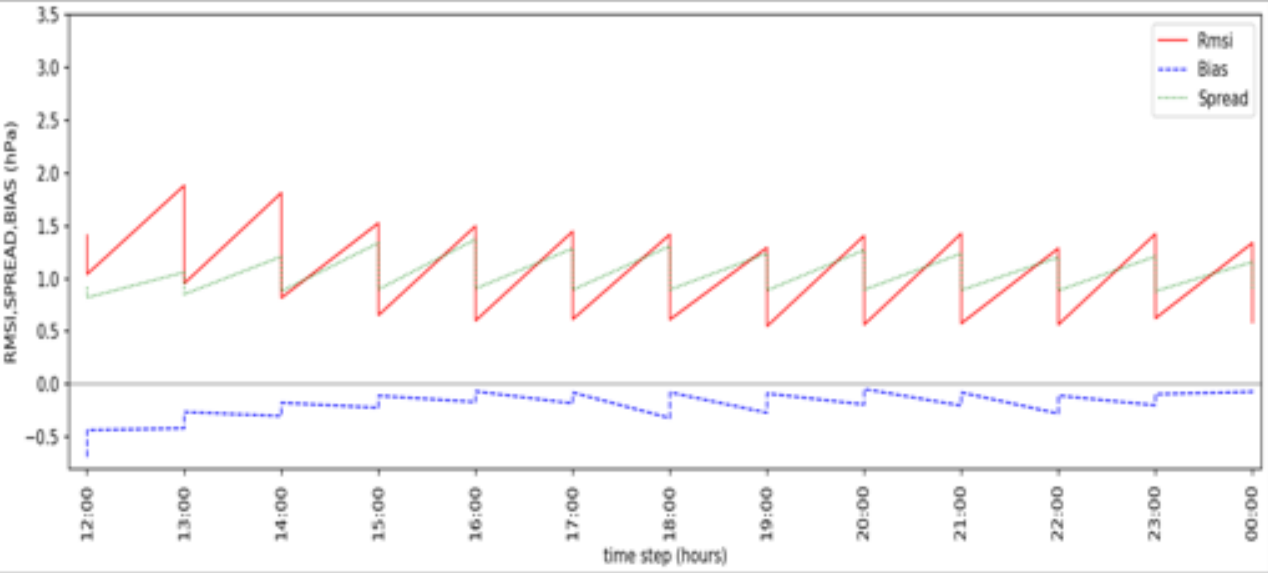
3. METHODOLOGY : Experimental Design

Experimental Design:



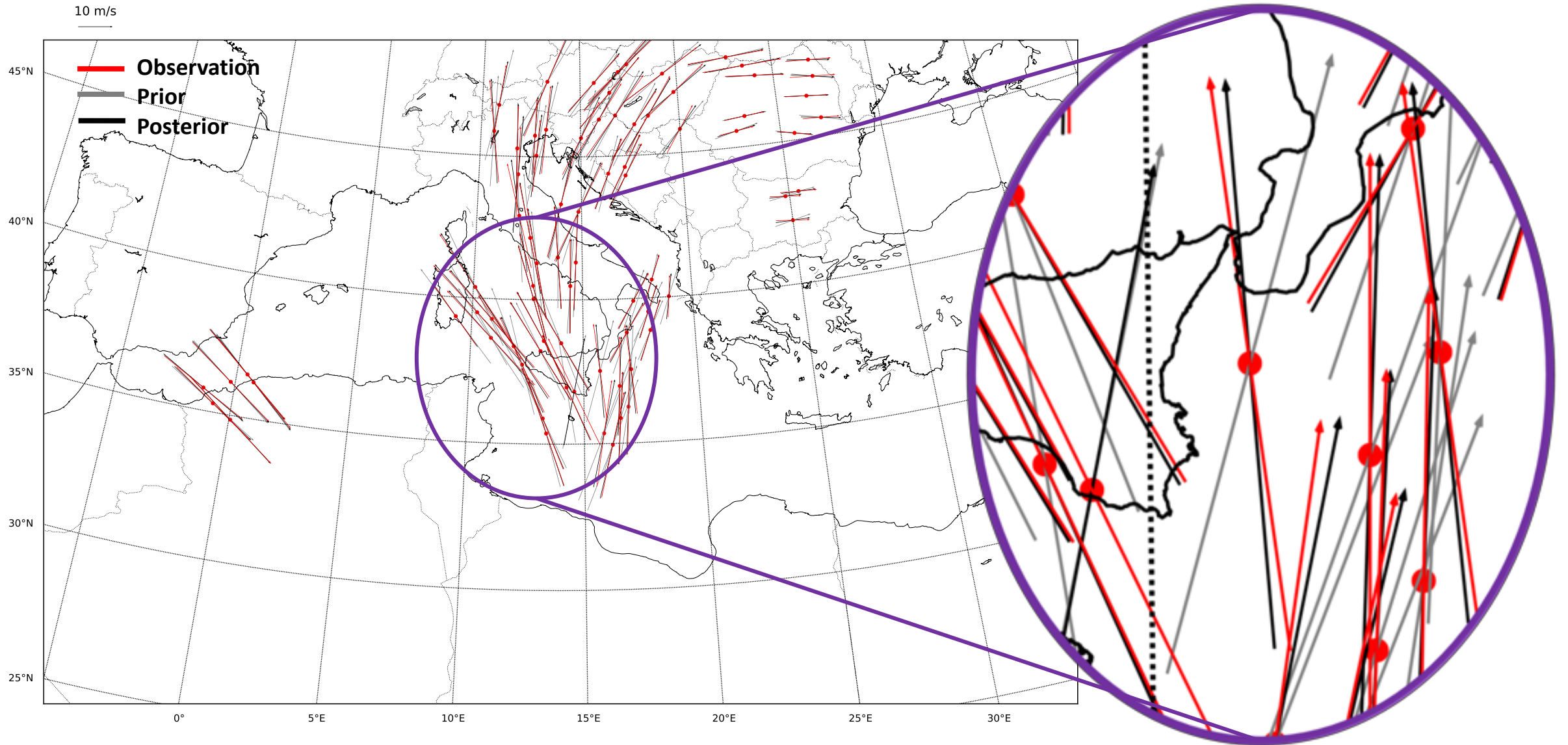
3. METHODOLOGY : Experimental Design

Observation-space Diagnostics:



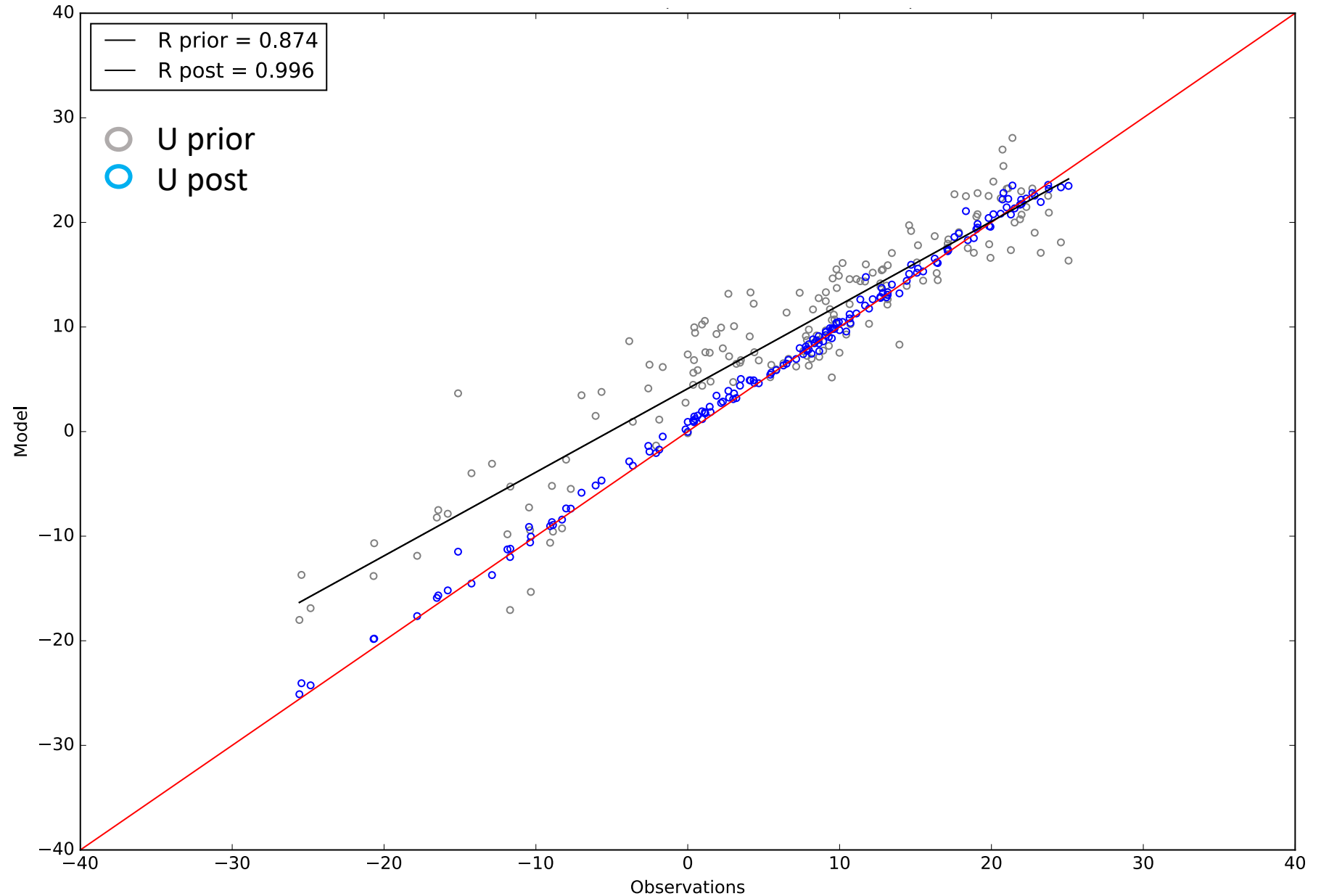
3. METHODOLOGY : Experimental Design

Observation-space Diagnostics:



3. METHODOLOGY : Experimental Design

Prior vs Posterior Correlation



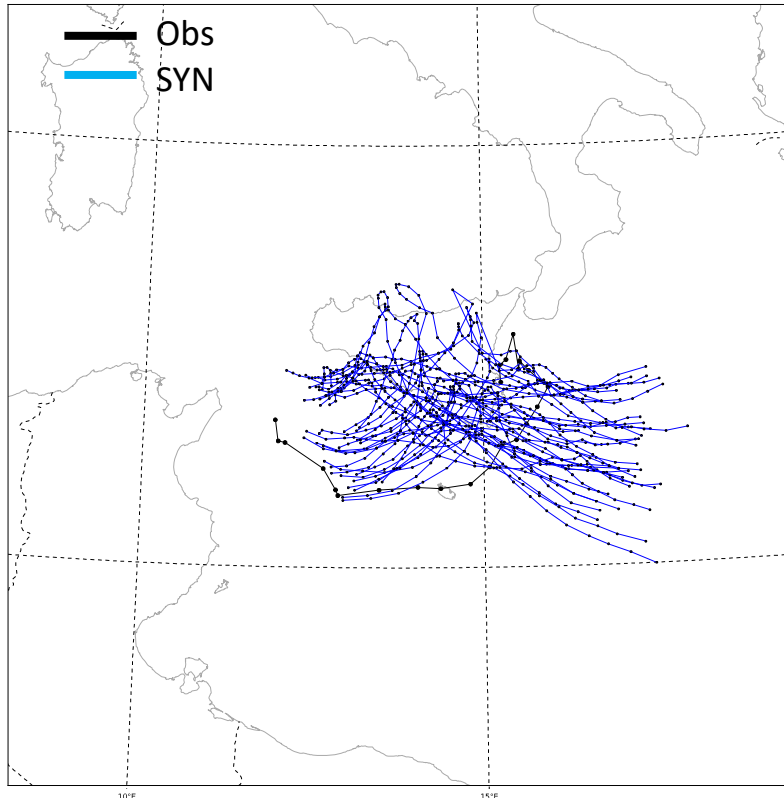
4. PRELIMINAR RESULTS

4. PRELIMINAR RESULTS

MEDICANE ensemble track:

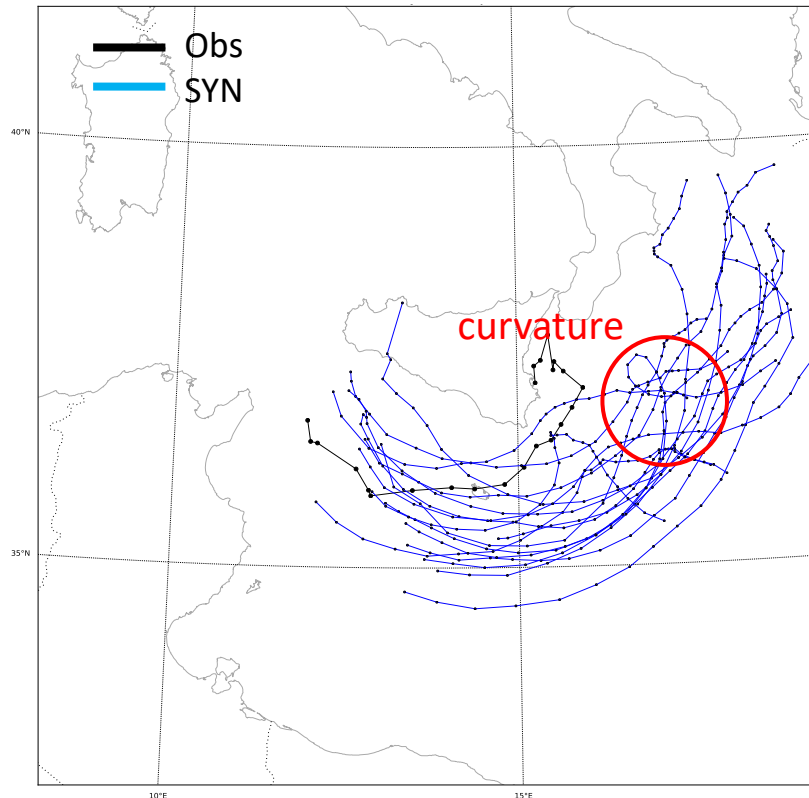
NODA's Tracking

- **23/36** ensemble members can depict a **medicane** signature
- **NO member is able to reproduce curvature** cyclone



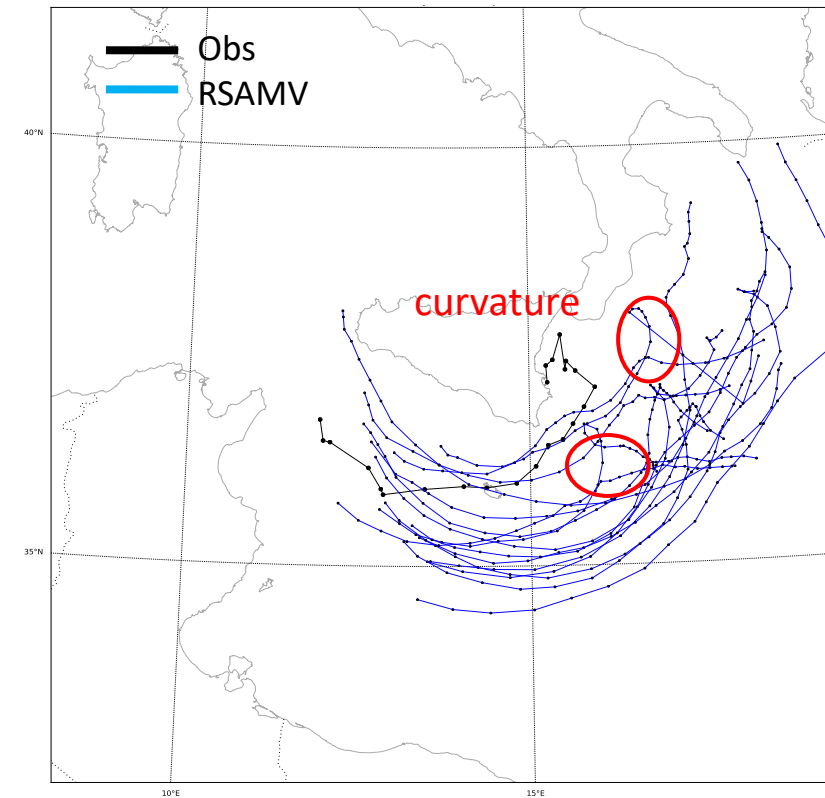
SYN's Tracking

- **17/36** ensemble members can depict a **medicane** signature
- **Some members reproduce curvature** (spatial shift)
- Most cyclone's tracks shifted towards the south



CNTRL's Tracking

- **21/36** ensemble members can depict a **medicane** signature
- **Some members reproduce curvature** (spatial shift)
- Most cyclone's tracks shifted towards the south

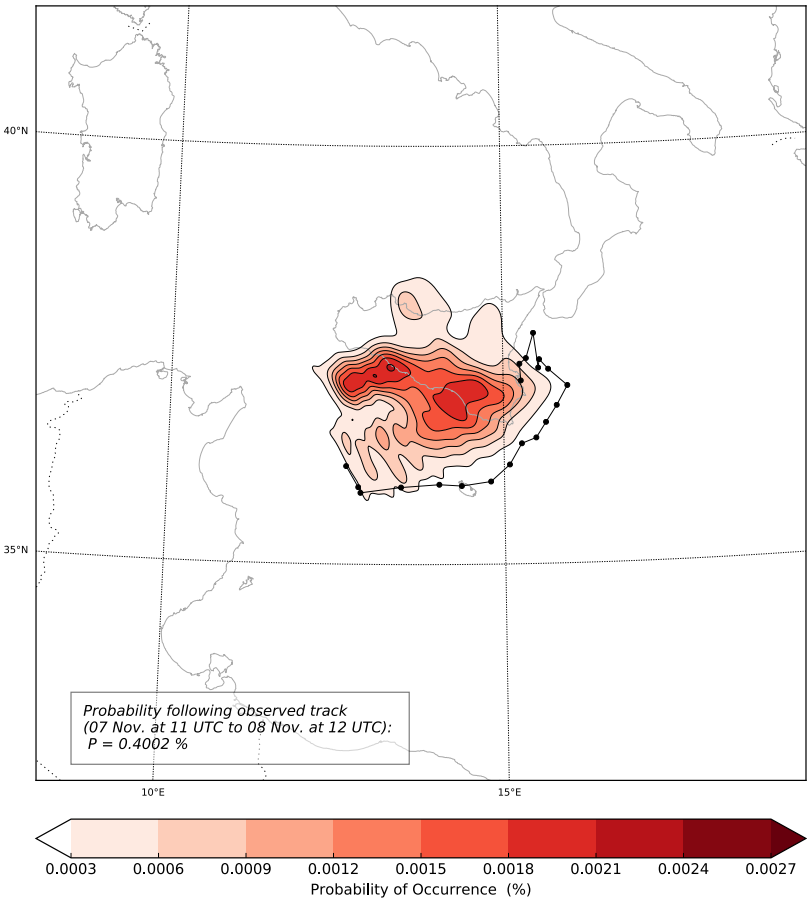


4. PRELIMINAR RESULTS

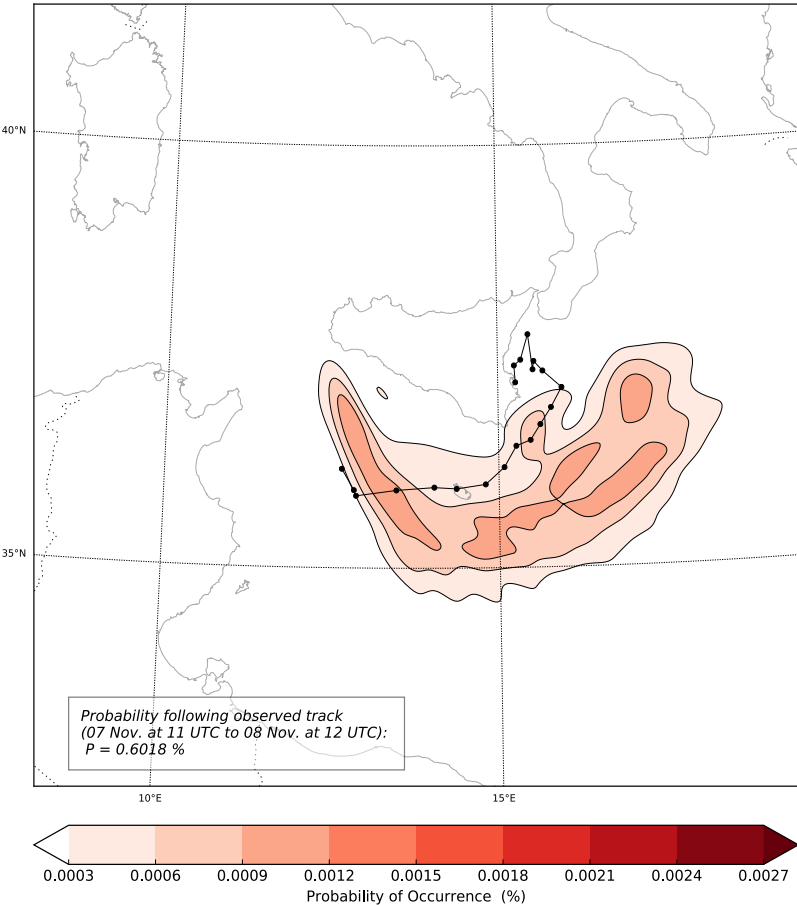
MEDICANE probability track:

Quantitative verification: **Probability of occurrence of the cyclone center** by means of Kernel Density Estimation (KDE) from 00 UTC 7 November to 00 UTC 8 November

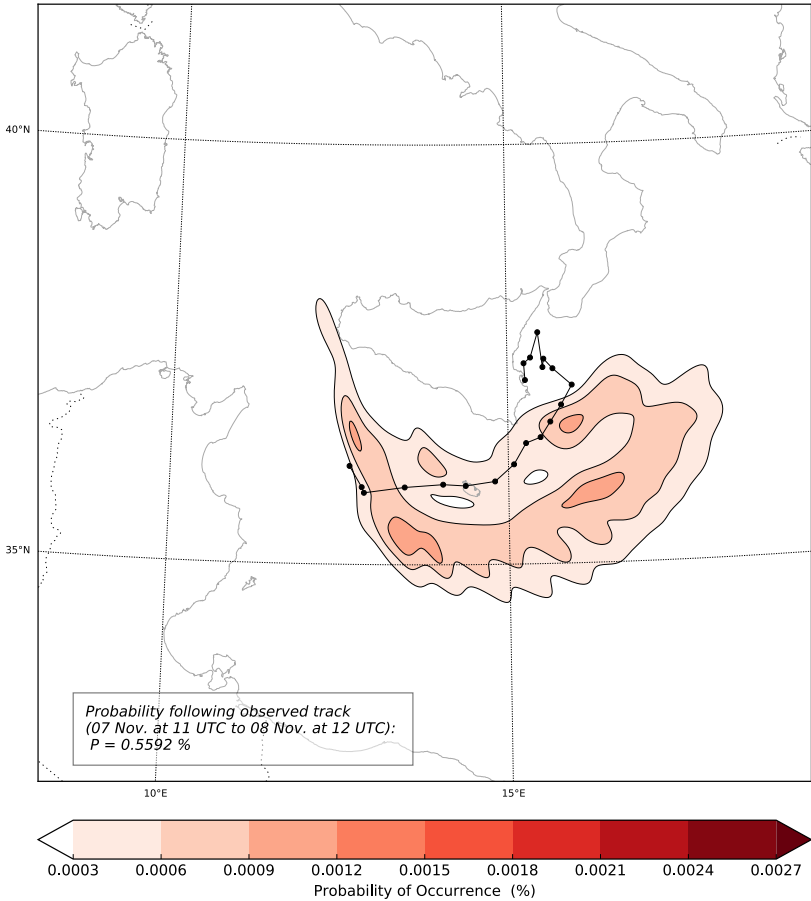
NODA ($P = 0.4002 \%$)



SYN ($P = 0.6018 \%$)



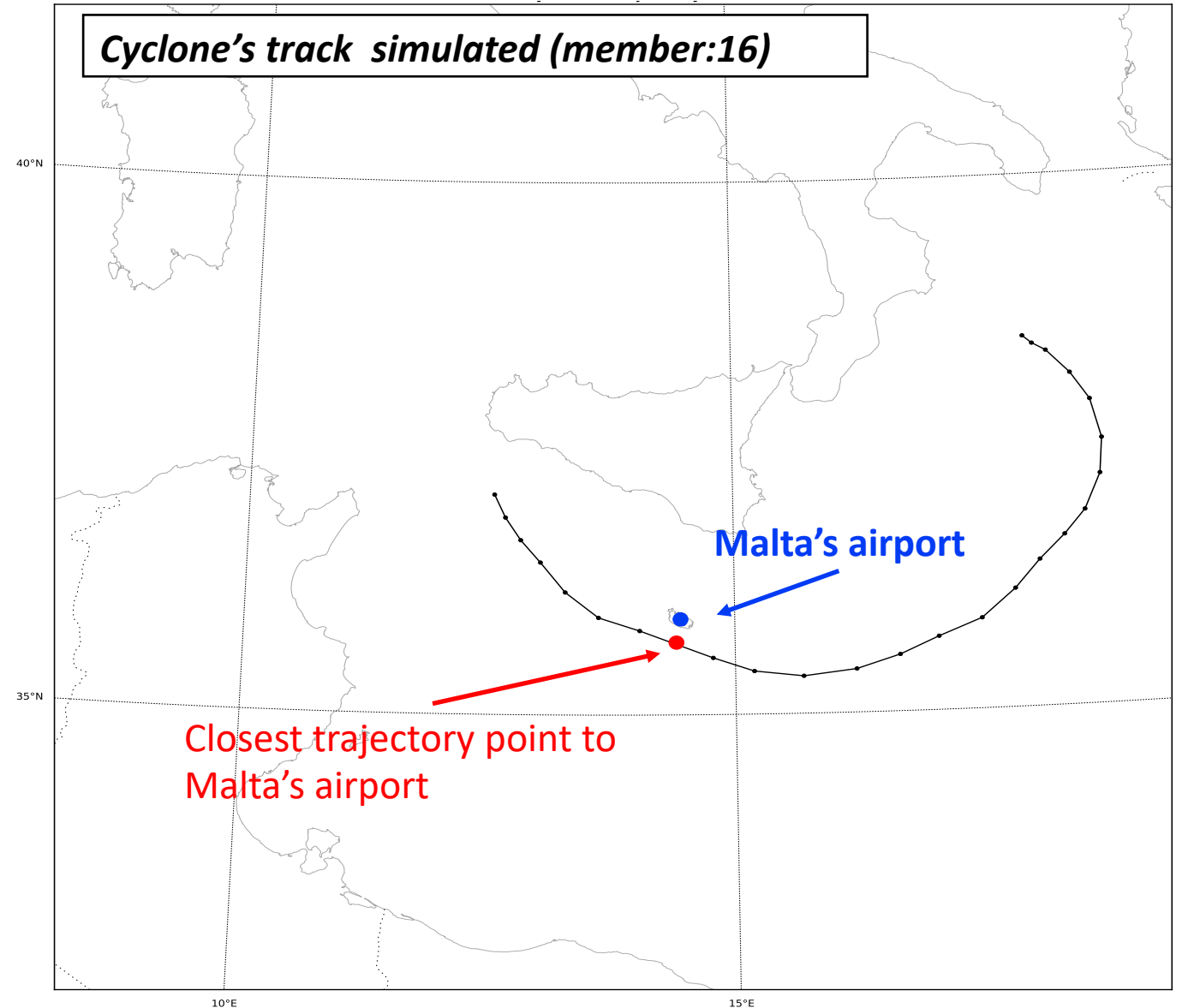
CNTRL ($P = 0.5592 \%$)



4. PRELIMINAR RESULTS

Cyclone Intensity:

- **Quantitatively assess** the skill forecast of each numerical experiment
- Compare **MSLP** measured over Malta's airport against ensemble members
- We evaluate the **time-evolution of the MSLP** of the **closest trajectory point** for each ensemble member

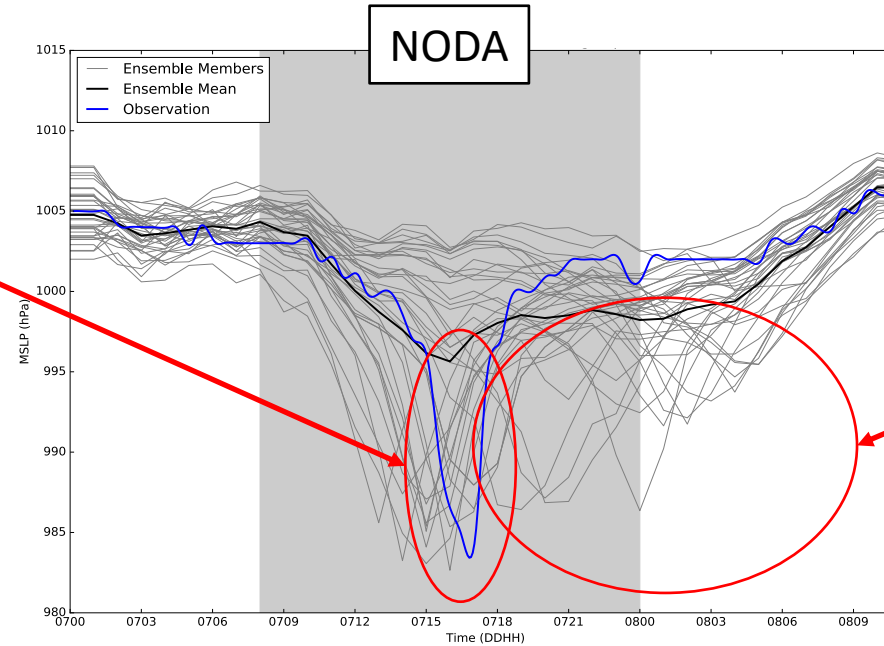


4. PRELIMINAR RESULTS

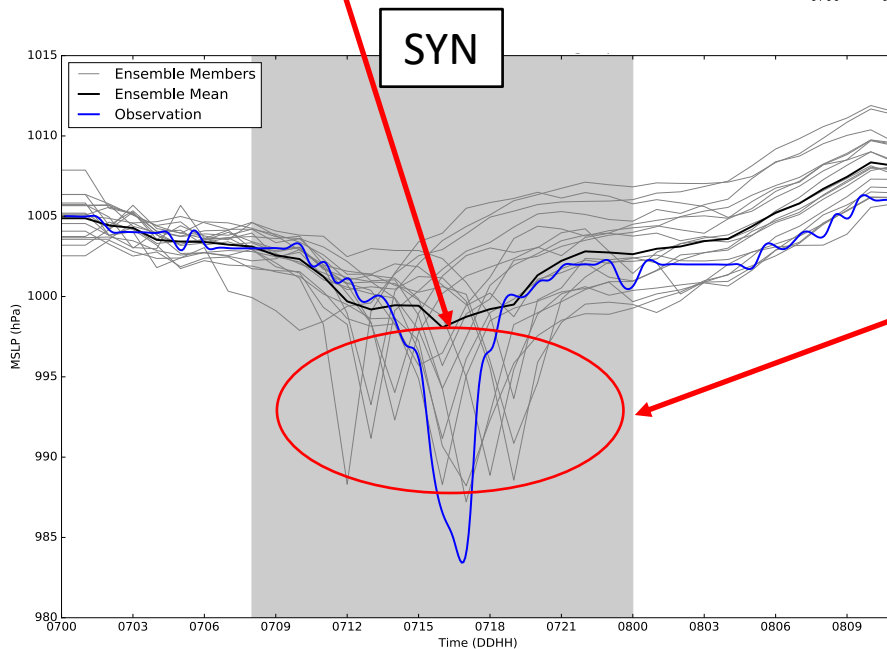
Cyclone Intensity:

Only few members depict MSLP drop centered at the time it was observed in Malta

Assimilation of conventional data reduces spread and some of the ensemble members are correctly located

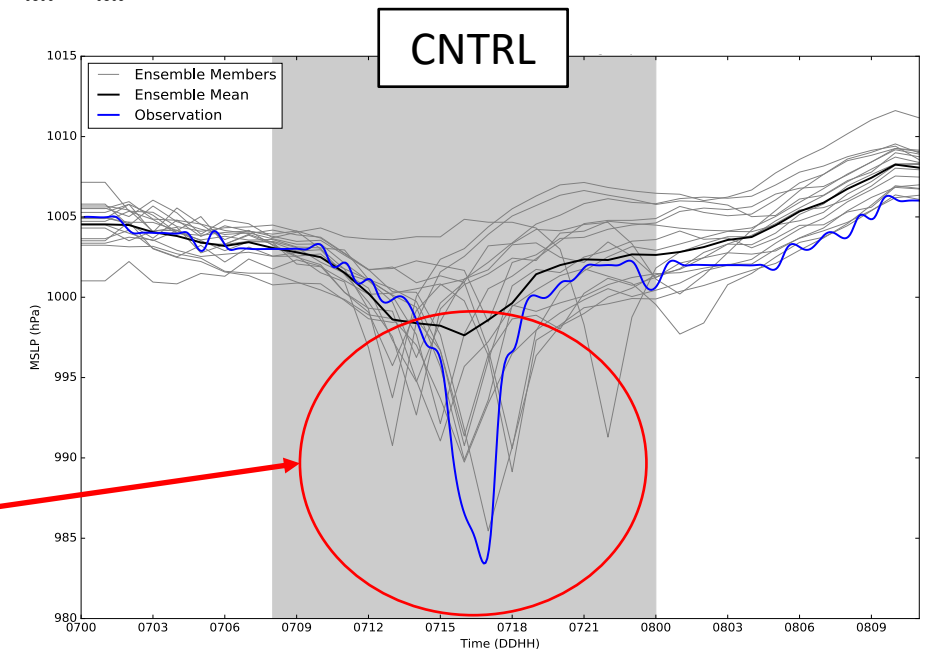


Most of the ensemble members perform a shallow cyclone which is also shifted from observations (large spread)



Ensemble members do not depict observed intensity

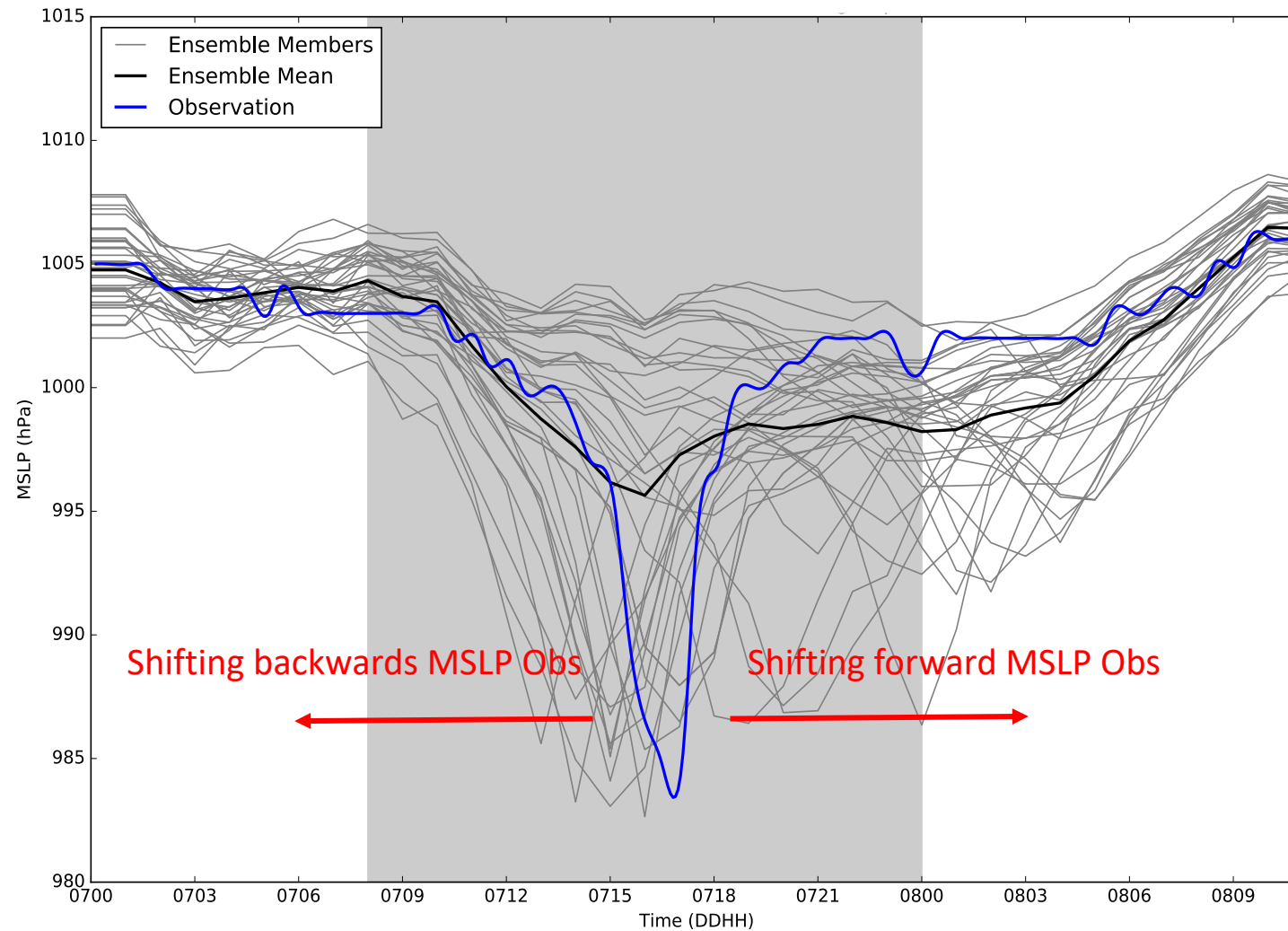
Assimilation of RSAMV help to push some members towards observations



4. PRELIMINAR RESULTS

Cyclone Intensity:

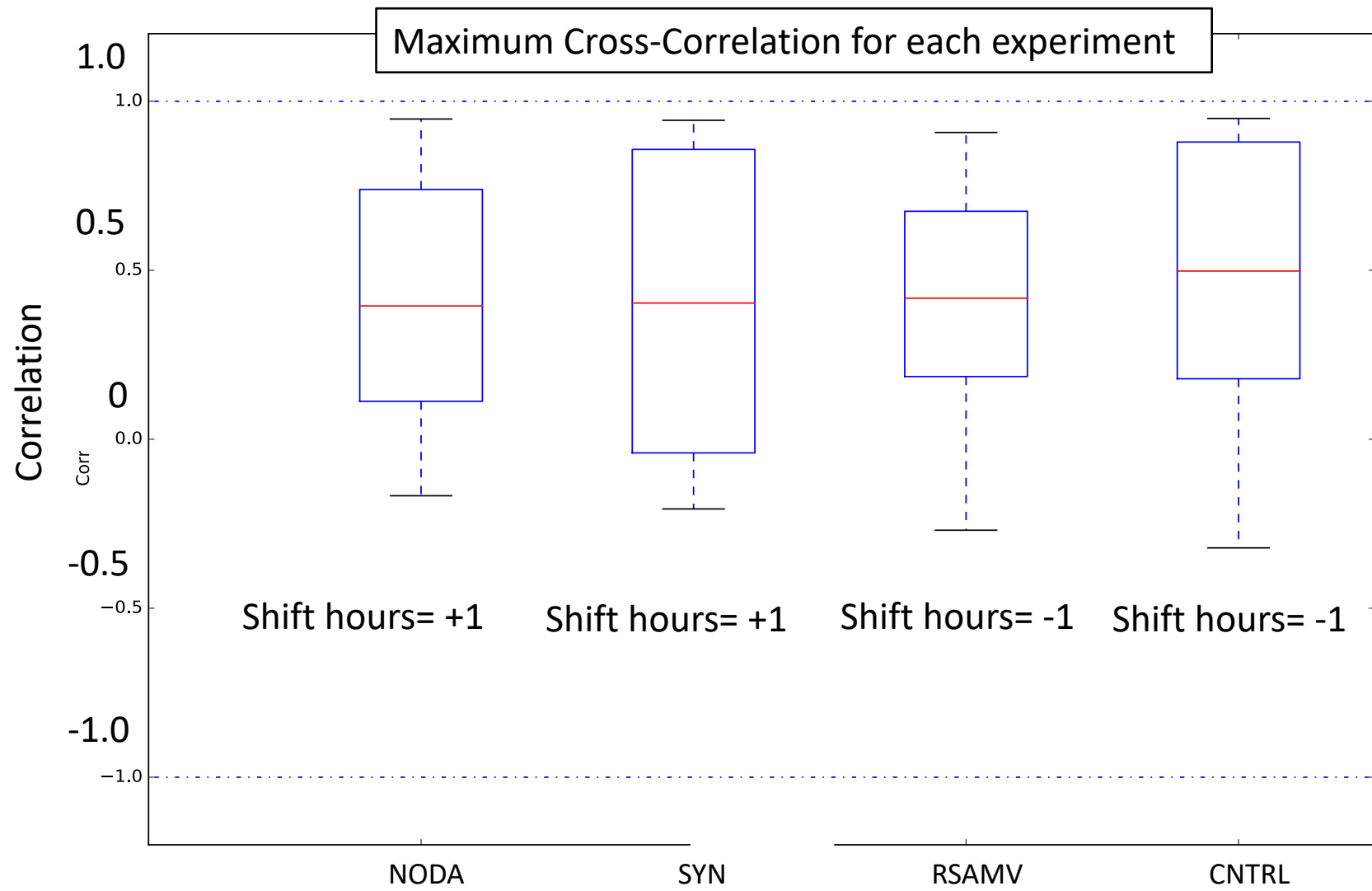
- Quantitative verification through time Lagged-Correlation



4. PRELIMINAR RESULTS

Cyclone Intensity:

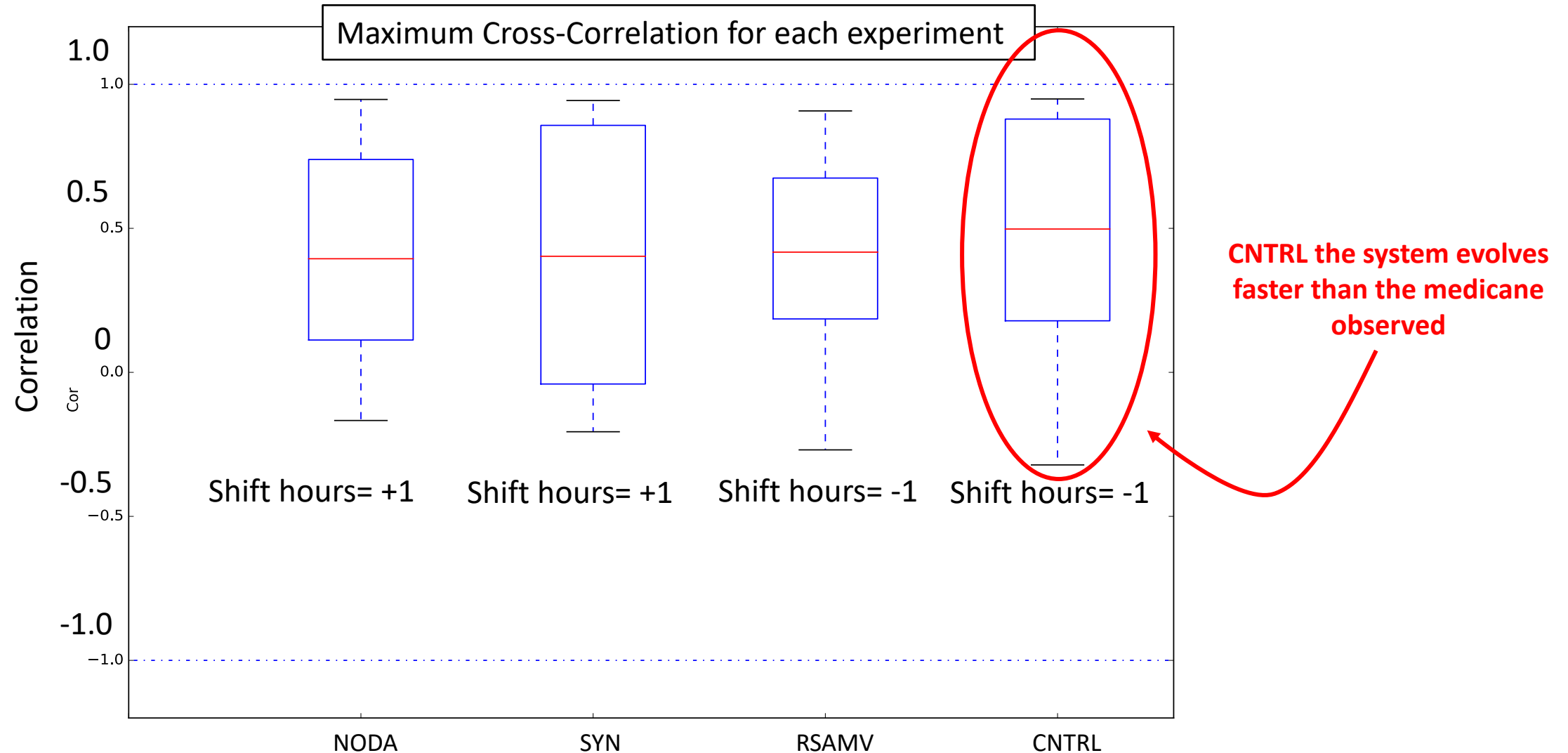
➤ Quantitative verification through time **Lagged-Correlation**



4. PRELIMINAR RESULTS

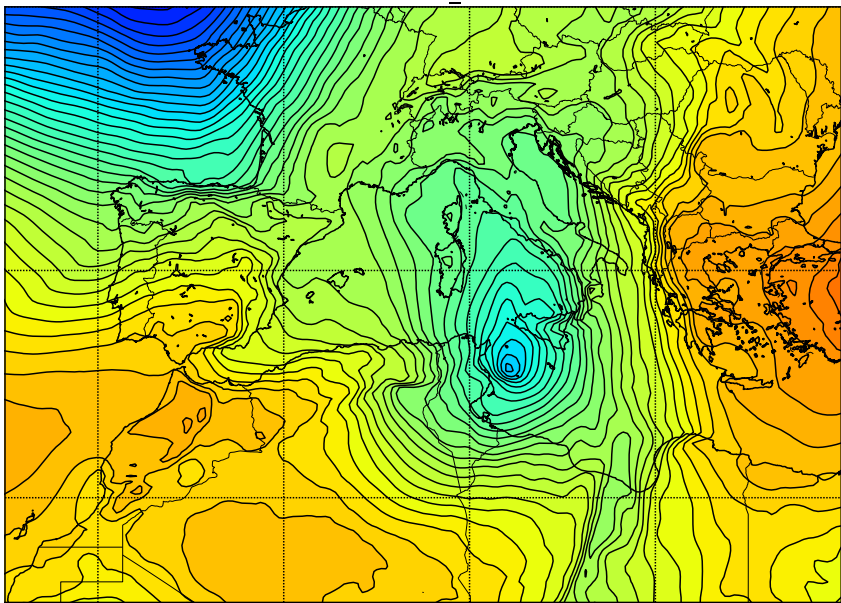
Cyclone Intensity:

- Quantitative verification through time Lagged-Correlation

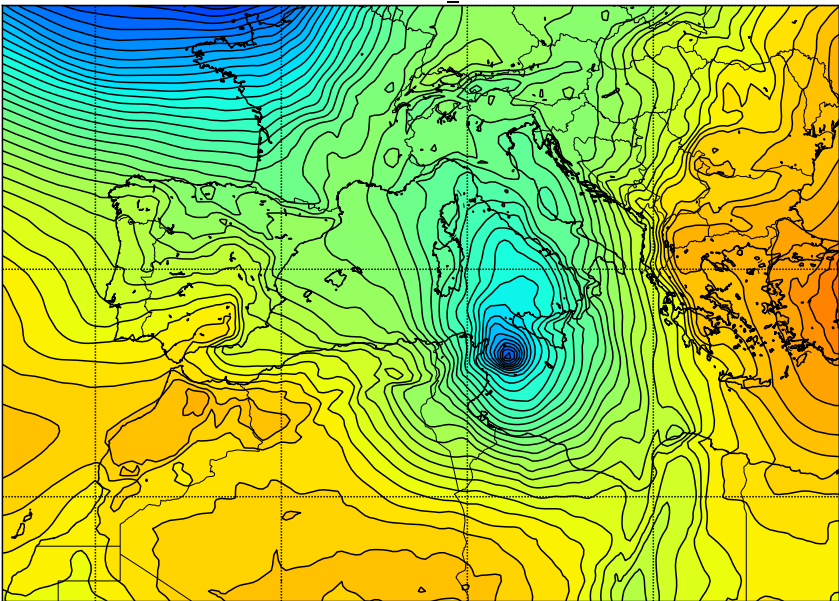


4. PRELIMINAR RESULTS

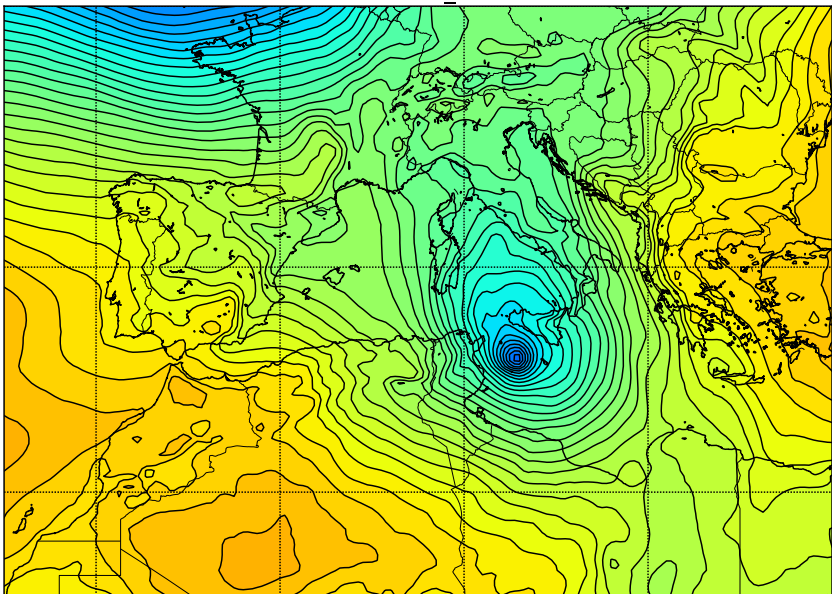
07 Nov
00 UTC



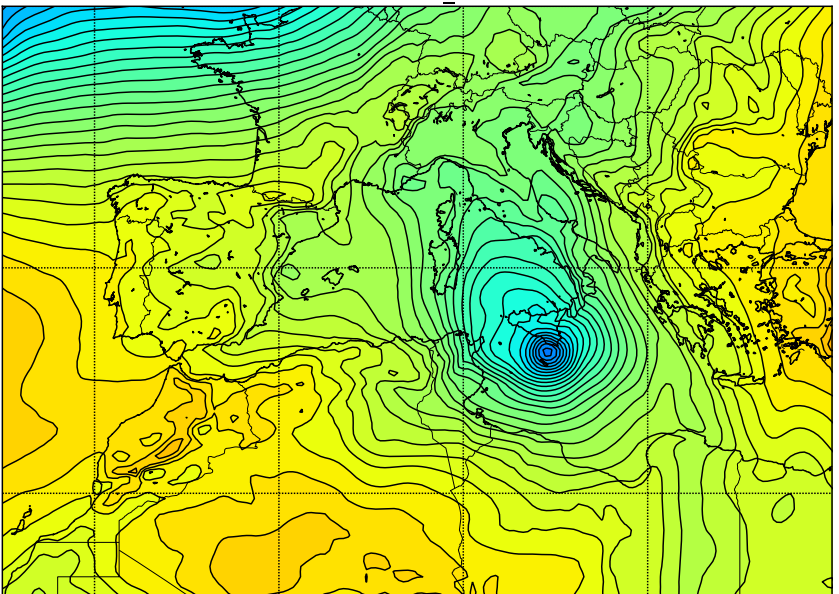
07 Nov
06 UTC



07 Nov
12 UTC



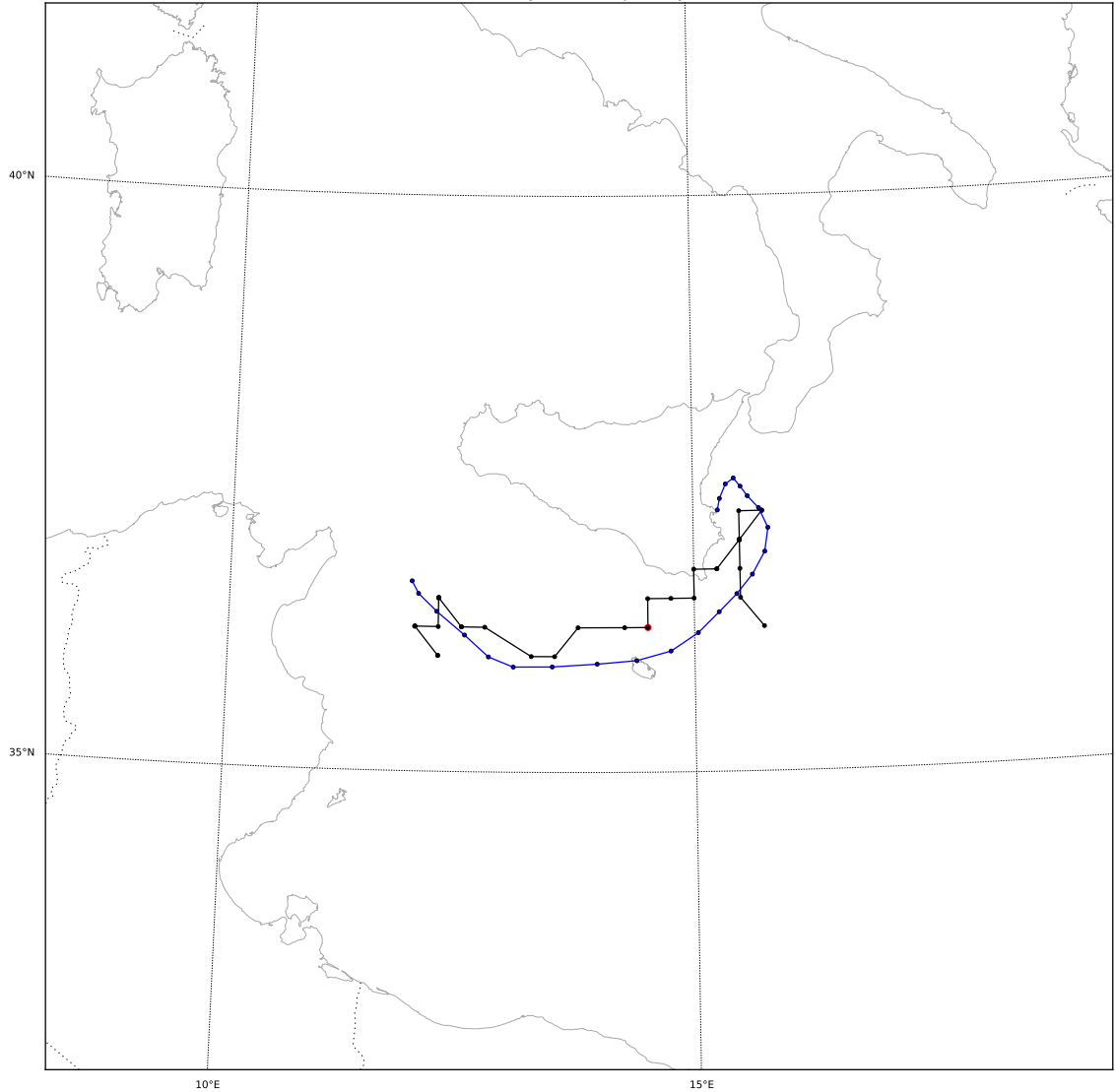
07 Nov
18 UTC



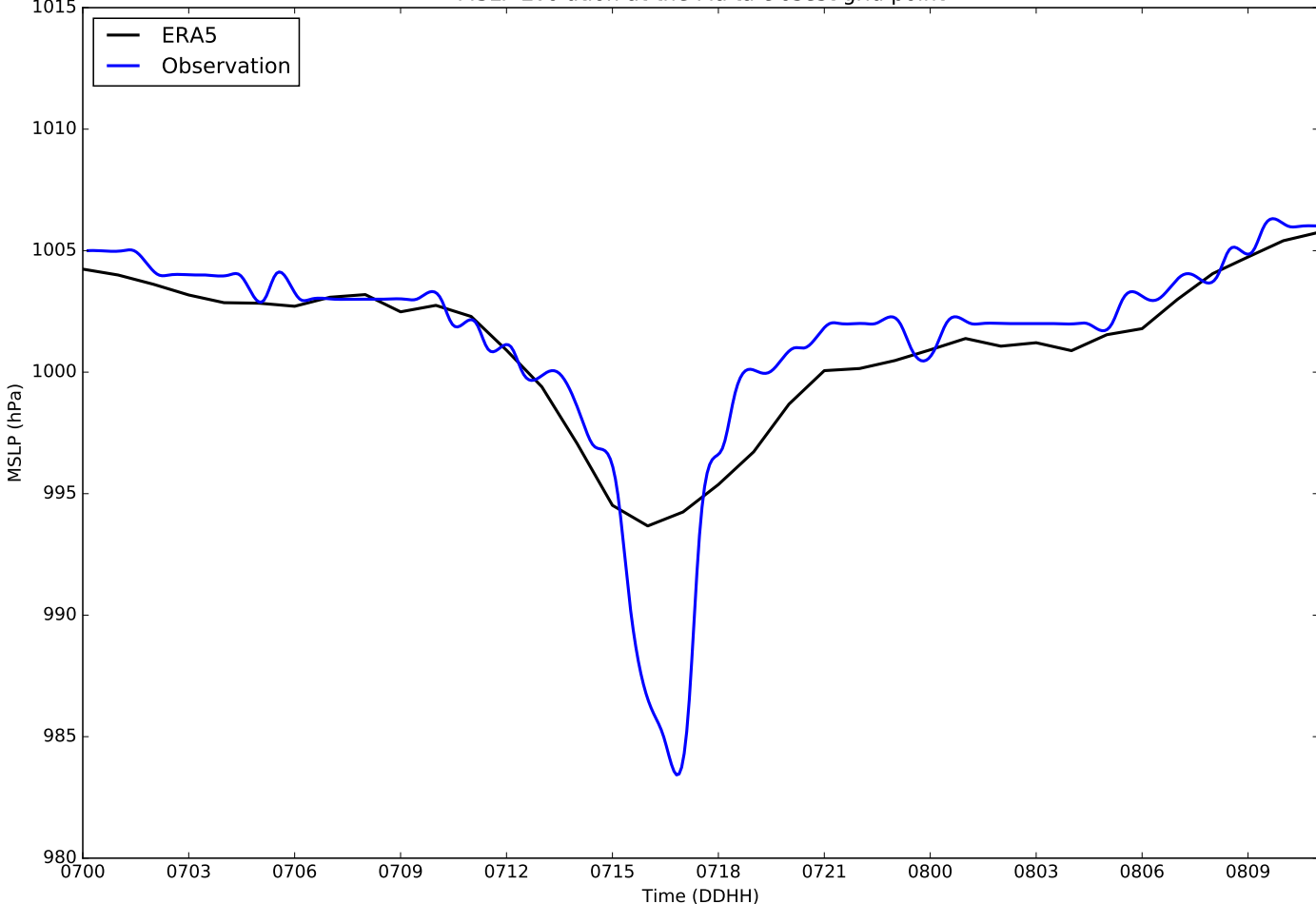
4. PRELIMINAR RESULTS

ERA5 Track and MSLP Verification:

Simulated Cyclone Trajectory ERA5



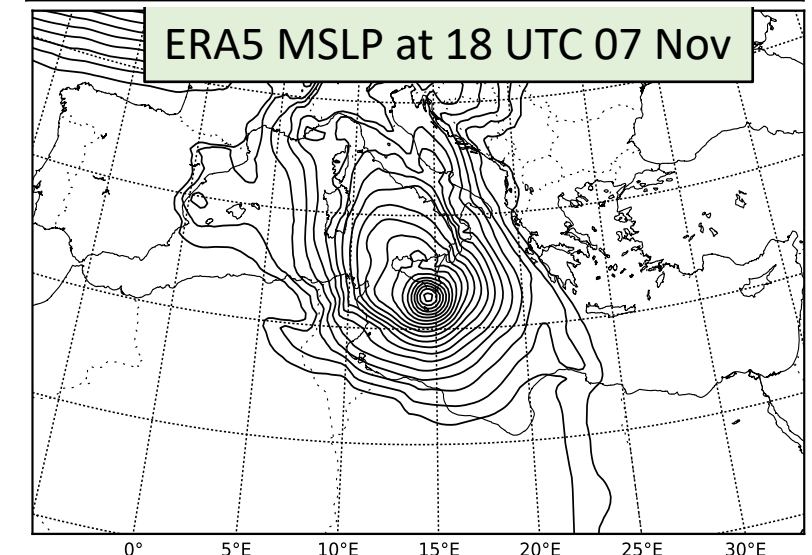
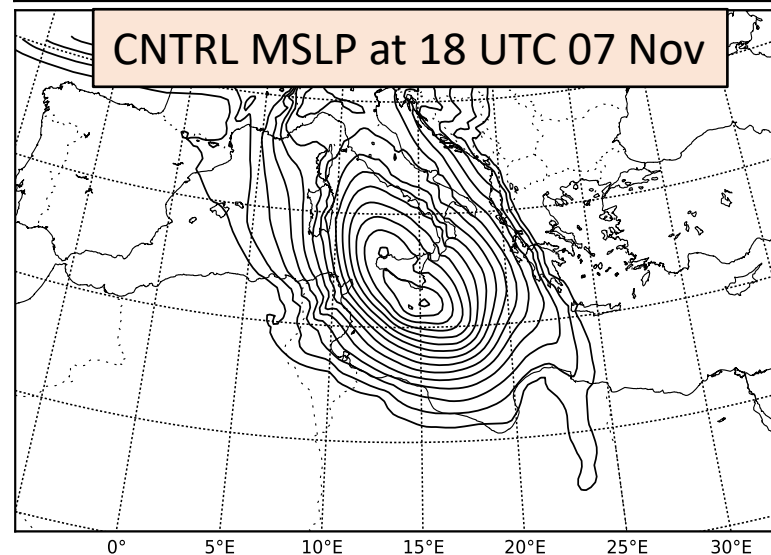
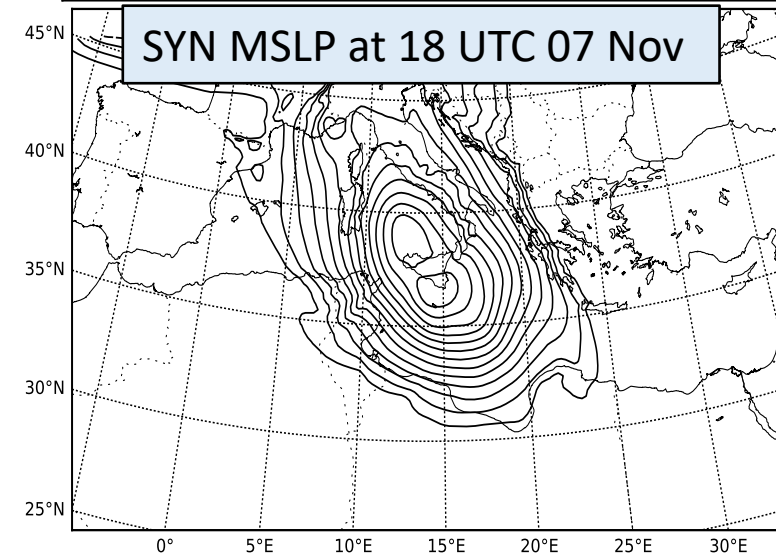
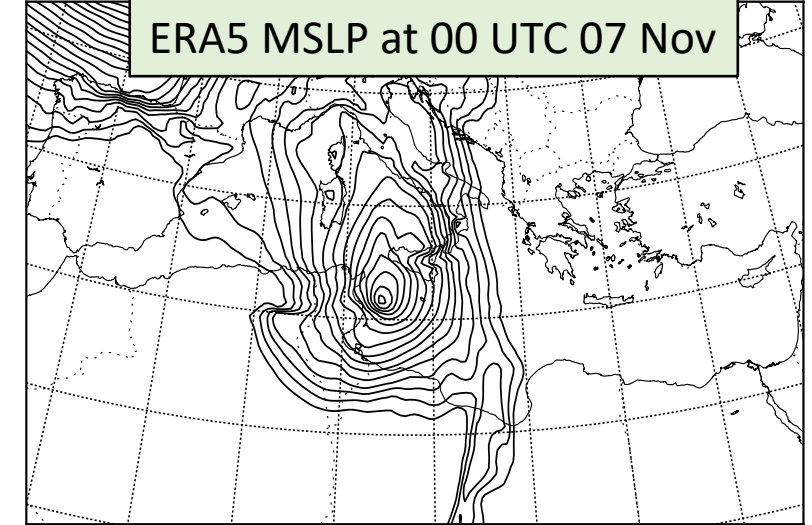
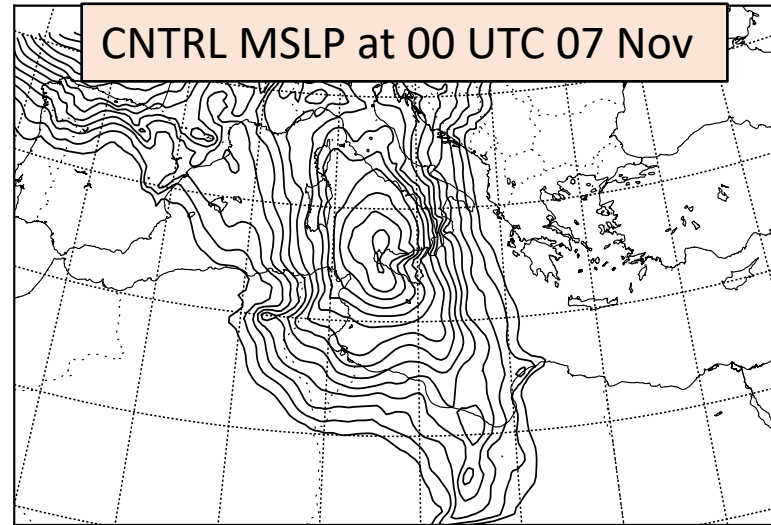
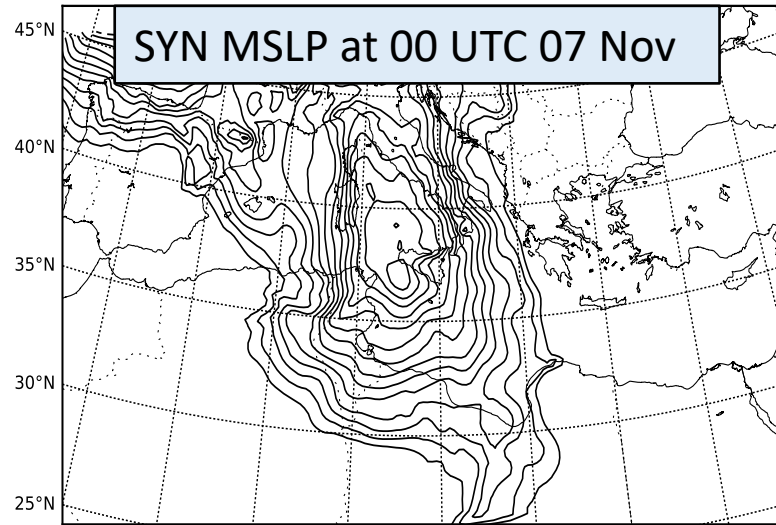
MSLP Evolution at the Malta closest grid point



4. PRELIMINAR RESULTS

Limited Predictability Improvements: Main Reasons

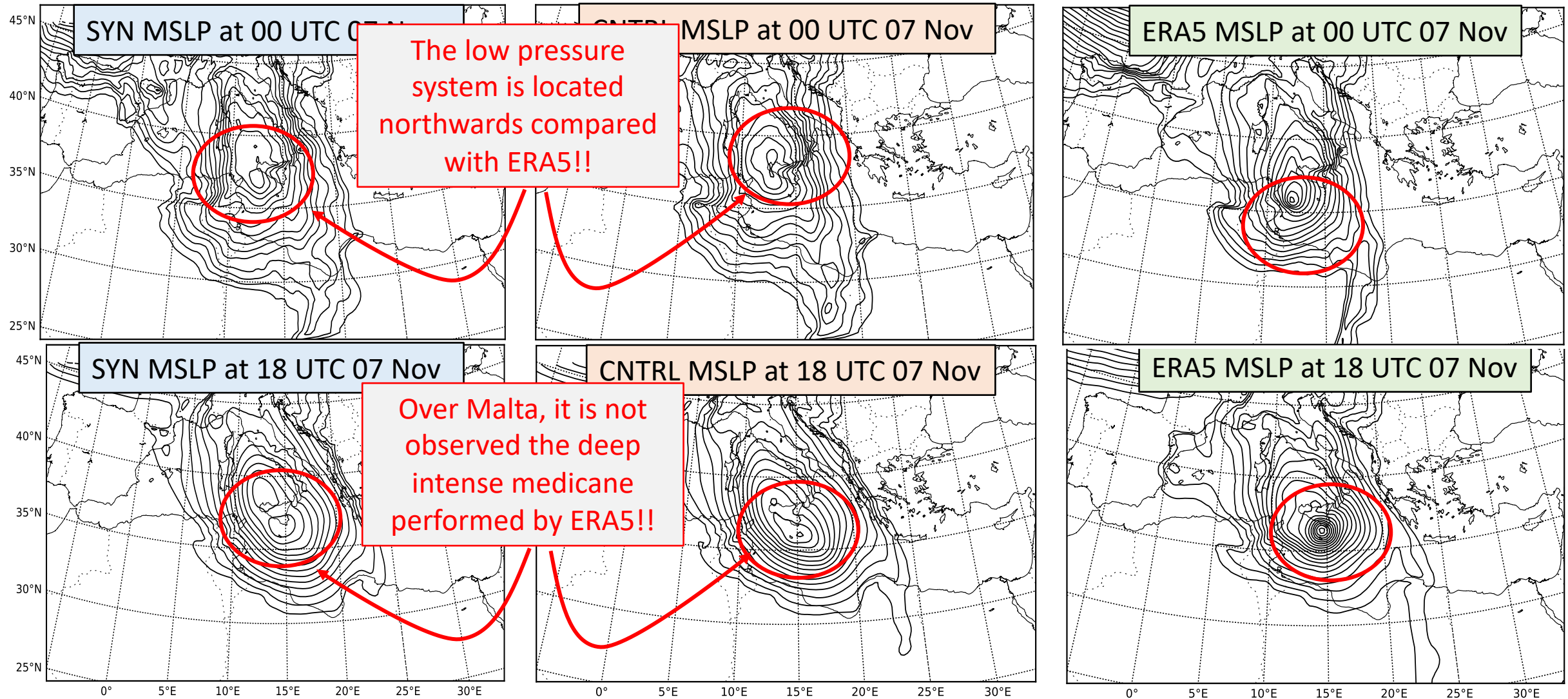
- **Poor analysis** (new IC) estimation in comparison with reanalysis **ERA5**



4. PRELIMINAR RESULTS

Limited Predictability Improvements: Main Reasons

- **Poor analysis** (new IC) estimation in comparison with reanalysis ERA5



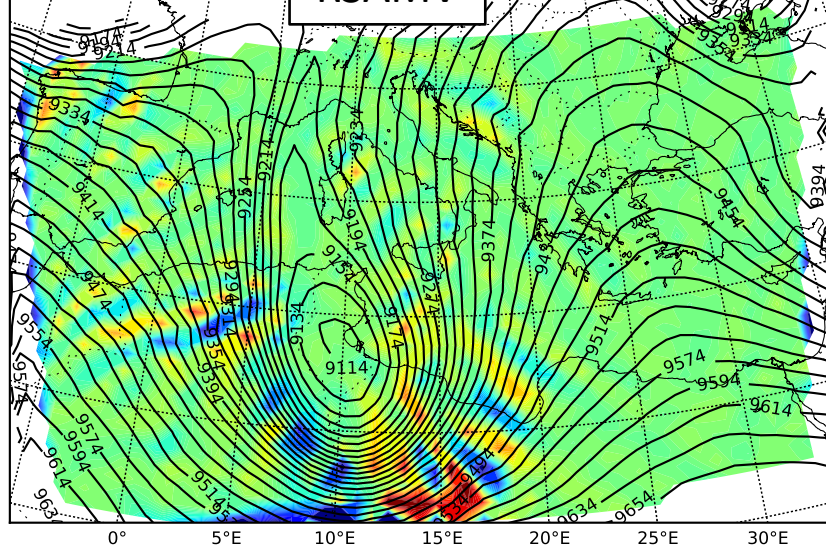
4. PRELIMINAR RESULTS

Limited Predictability Improvements: Main Reasons

- Poor analysis (new IC) estimation in comparison with reanalysis ERA5
- Influence of **upper-level dynamics**
- **Vorticity advection at 300 hPa at 00 UTC 7 November**

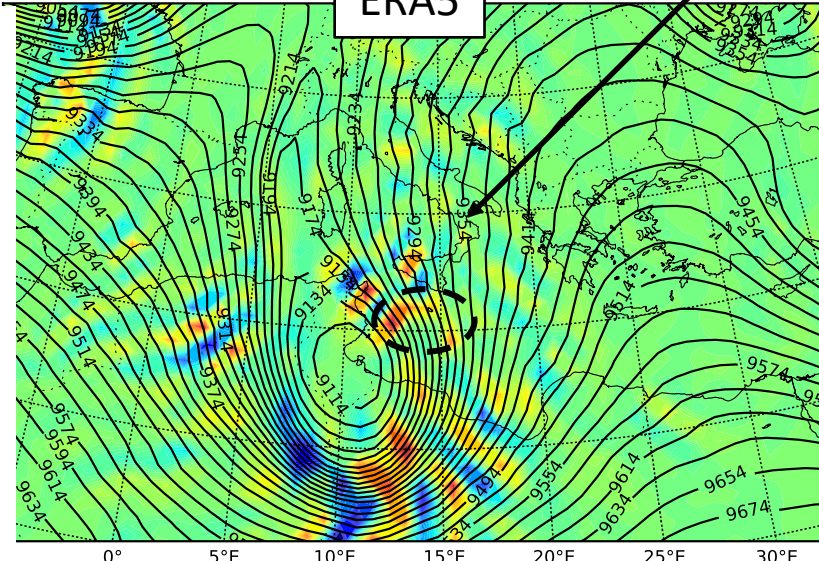
Positive vorticity advection
over region where center of
the cyclone develops

RSAMV



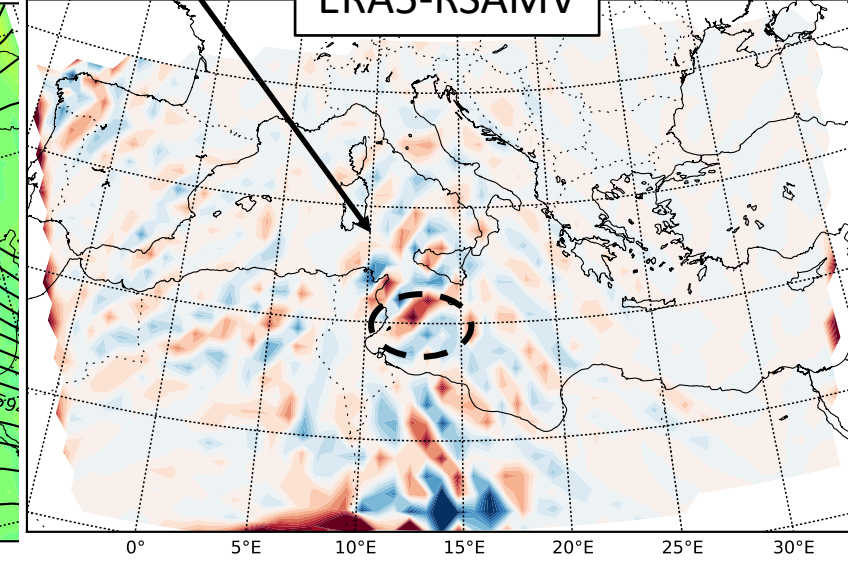
Vorticity (s⁻¹)

ERA5



Vorticity (s⁻¹)

ERA5-RSAMV



Geopotential (gmp)

COASTEPS CGL2017-82868-R (MINECO/AEI/FEDER, UE)

FPI-CAIB (Conselleria d'Innovació, Recerca i Turisme
del Govern de les Illes Balears and the Fons Social
Europeu)



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"A way to make Europe"



Universitat
de les Illes Balears