Towards a medicane climatology from ERA5 Reanalysis & Probabilistic forecast of medicanes from EPS

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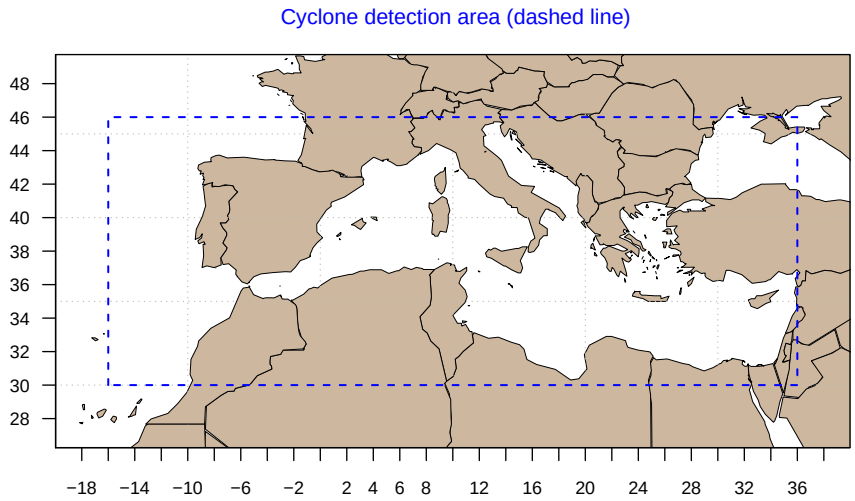
COASTEPS Project CGL2017-82868-R (MINECO/AEI/FEDER, UE)

Overview

1. Med-cyclones description: Tools
   - Tracking
   - Cyclone phase space
   - MEDICANE definition from NWPM outputs
2. ERA5 Reanalysis: medicane events
3. ECEPS: Medicane Probabilistic Forecast

Cyclone tracking

- Cyclone definition
  - MSL Pressure minima
  - $\Delta\ p\ \geq\ 0{,}5\ 10^{-2}\ hPa\ km^{-1}$ in 6/8 directions
  - Domain: zero-vorticity line
- Steering level: 700 hPa
- Cyclone Intensity:
  - Geostrophic Circulation
  - MSLP gradient
  - 10m Wind



Cyclone Phase Space (Hart, 2003)

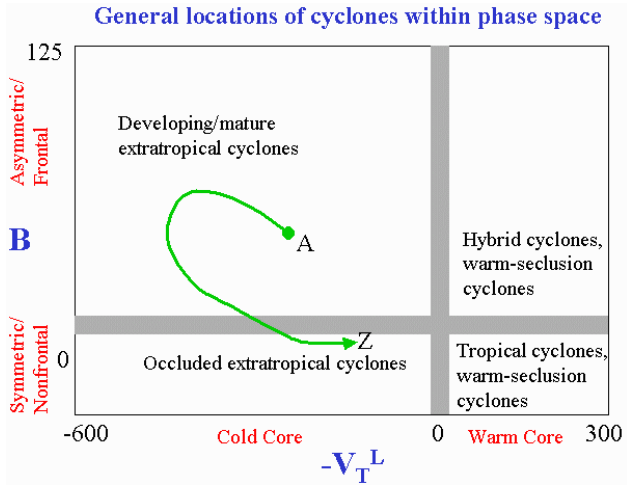
1. Parameter B, thickness symmetry (in a 500 km radius circle)

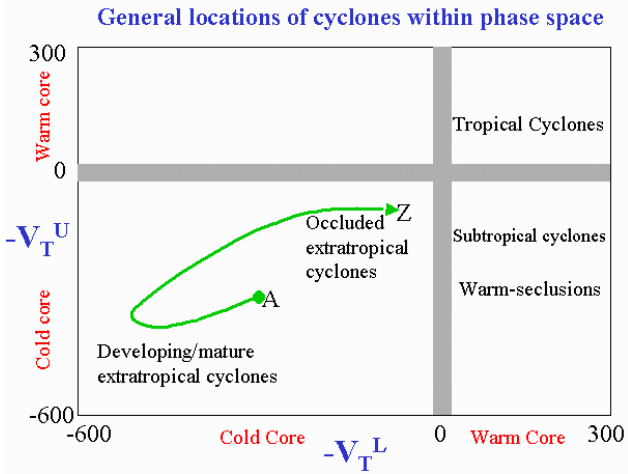
   * **Med-cyc**: calculated in a variable circle, with warm core radius (or 91 km in absence of WC)

2. $-V_T^L$, Low tropospheric thermal wind
3. $-V_T^U$, Upper tropospheric thermal wind

   * **Med-cyc**: with Hart's & modified vertical layers

     $300 - 600 - 900$ hPa & $400 - 700 - 925$ hPa





Definition of medicane

Definition of MEDICANE from NWPM outputs

1. $\Delta\ p\ \geq\ 3{,}2\ 10^{-2}\ hPa\ km^{-1}$ Very intense
2. $B < 10m$ Symmetrical
3. $-V_T^L > 0,\ -V_T^U > 0$ Deep WC

Other parameters can be taken into account to define a medicane:

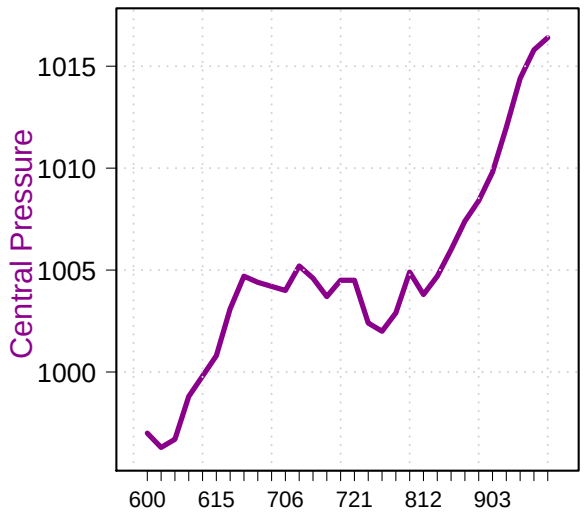
- Wind threshold ($V10m$)
- Size: maximum radius
- Steering level
- Presence of an 'eye'
- Convection

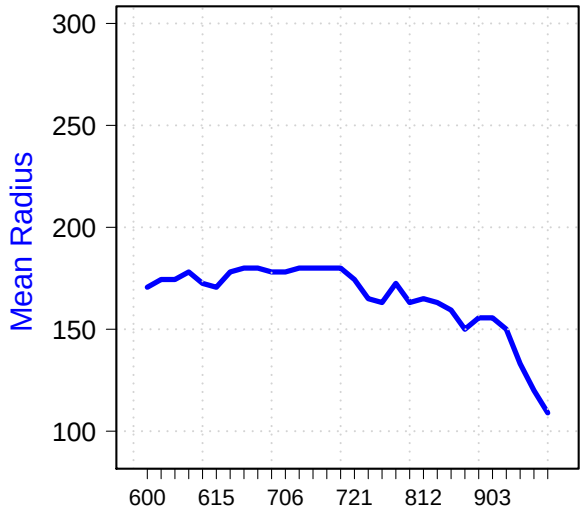
ERA5 Reanalysis

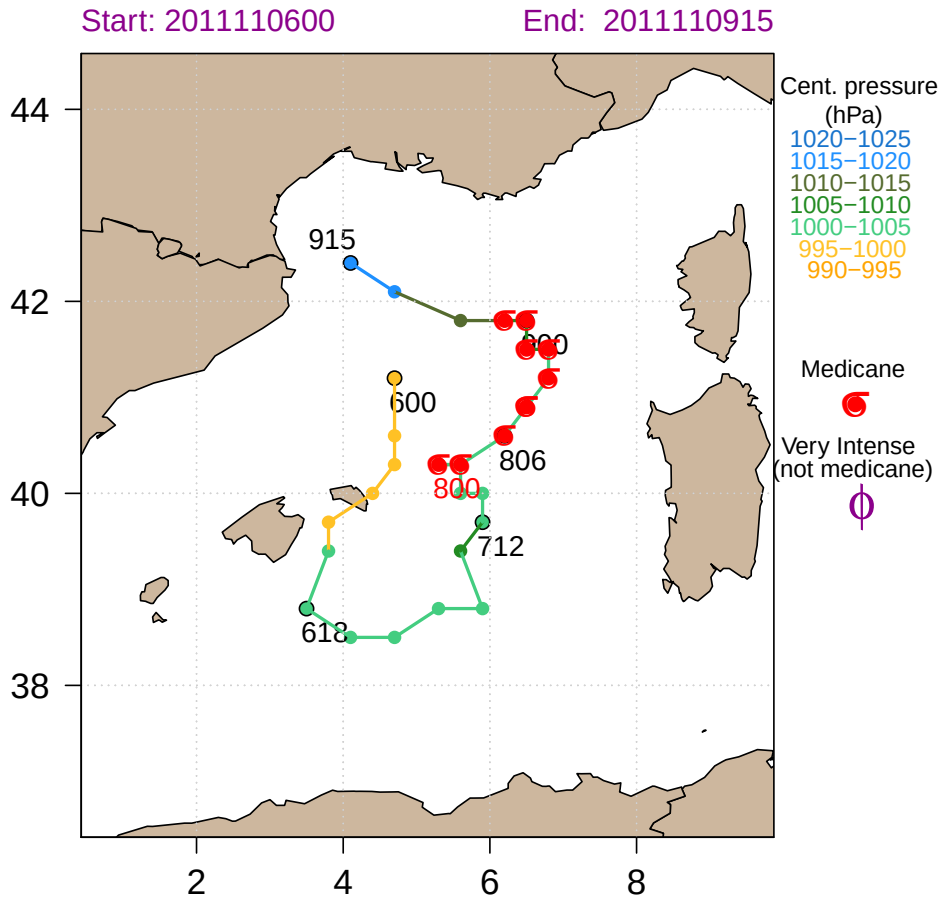
- Using a more recent and advanced version of the ECMWF IFS model than ERA-Interim
- IFS Cycle 41r2, offering a higher horizontal resolution of 31 km and 137 vertical levels from the surface up to 0.01 hPa (around 80 km)
- Providing hourly estimates of atmospheric variables
- Using more satellite observations in the data assimilation
- Homogeneous database: 1979-onward

Medicane events (Med-cyclones project)		Other Medicane events
22 Jan 1982		
26 Sep 1983	T*	
7 Apr 1984	T	
29 Dec 1984	T	
14 Dec 1985	T*	2 Oct 1986
5 Dec 1991	T	
16 Jan 1995	T*	
11 Sep 1996	T	
7 Oct 1996	T*	
10 Dec 1996	T*	
26 Jan 1998	T	
19 Mar 1999	T*	
Jan 2000		
25-27 May 2003	T	
Dec 2005		
25-26 Sep 2006		22 Mar 2007
Nov 2007		17 Oct 2007
6-8 Nov 2011 Rolf		
Jan 2014		
7 Nov 2014 Qendresa		
Oct 2016		13-15 Dec 2015
Oct 2017		Nov 2017 Numa
T (82-07): Tous & Romero (2011)		

Medicane November 6-8, 2011 (Rolf)

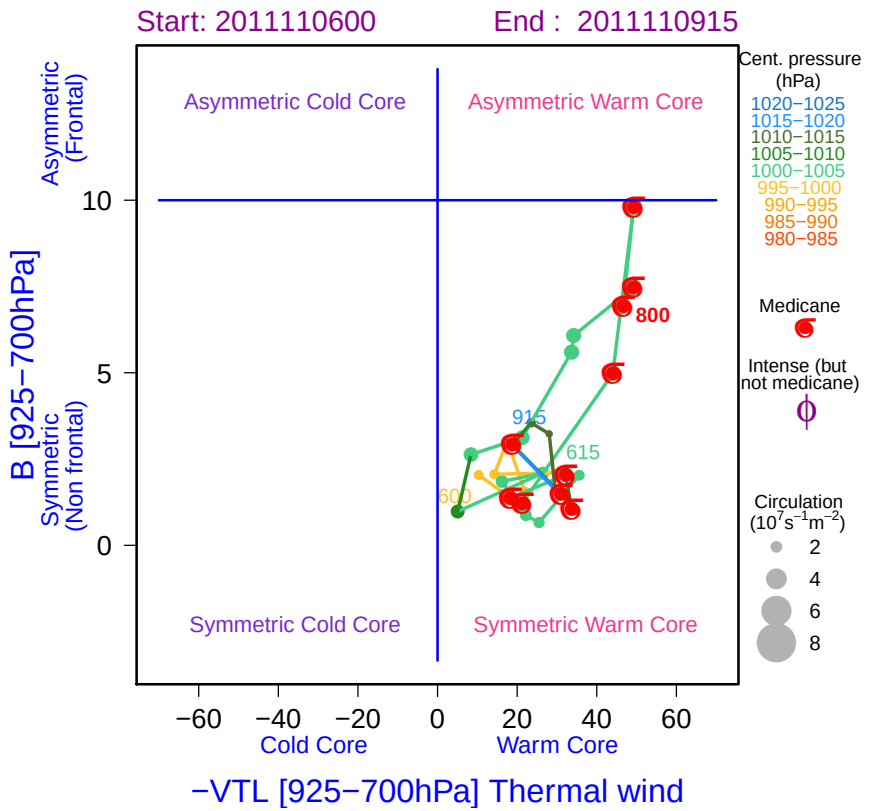


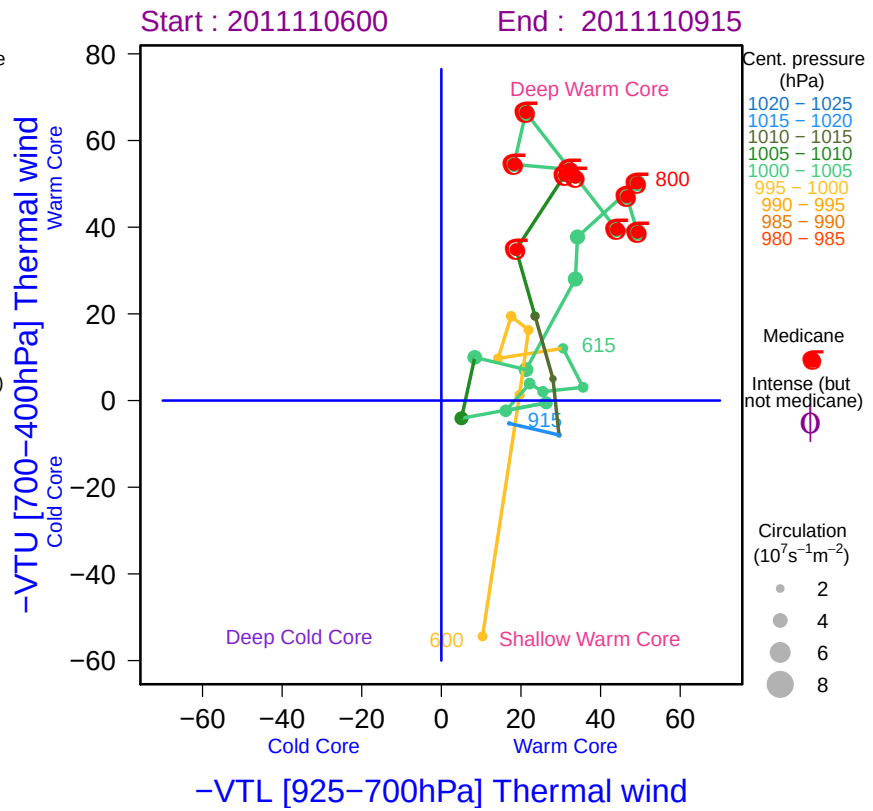




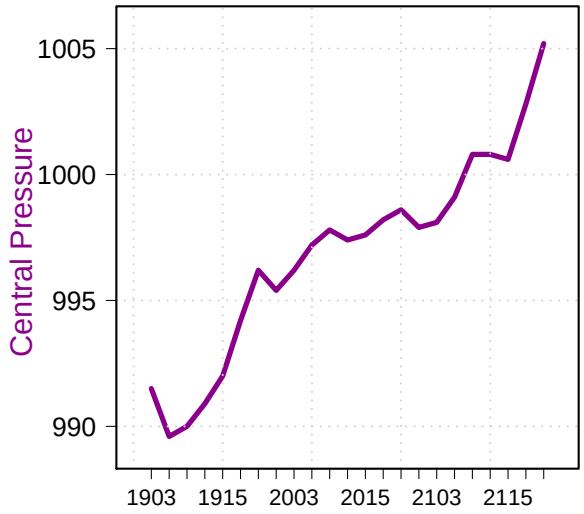
- Symmetrical
- Deep Warm Core
- Very intense

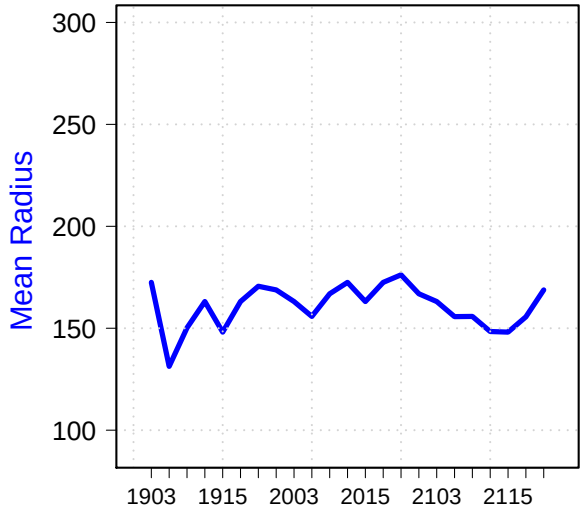
Medicane November 6-8, 2011 (Rolf)

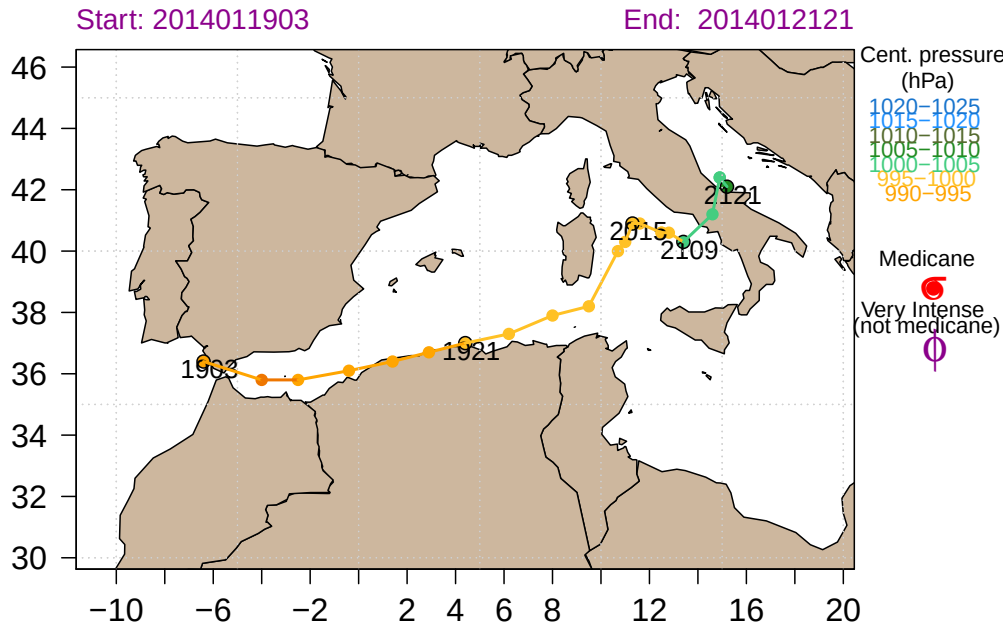




Medicane January 20, 2014

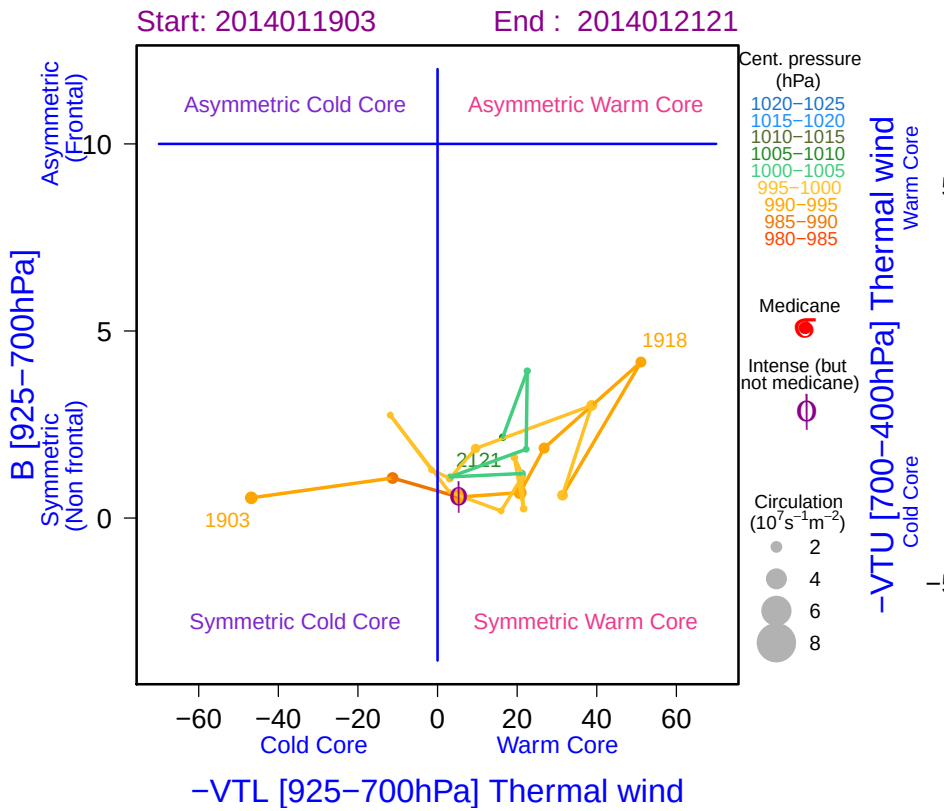


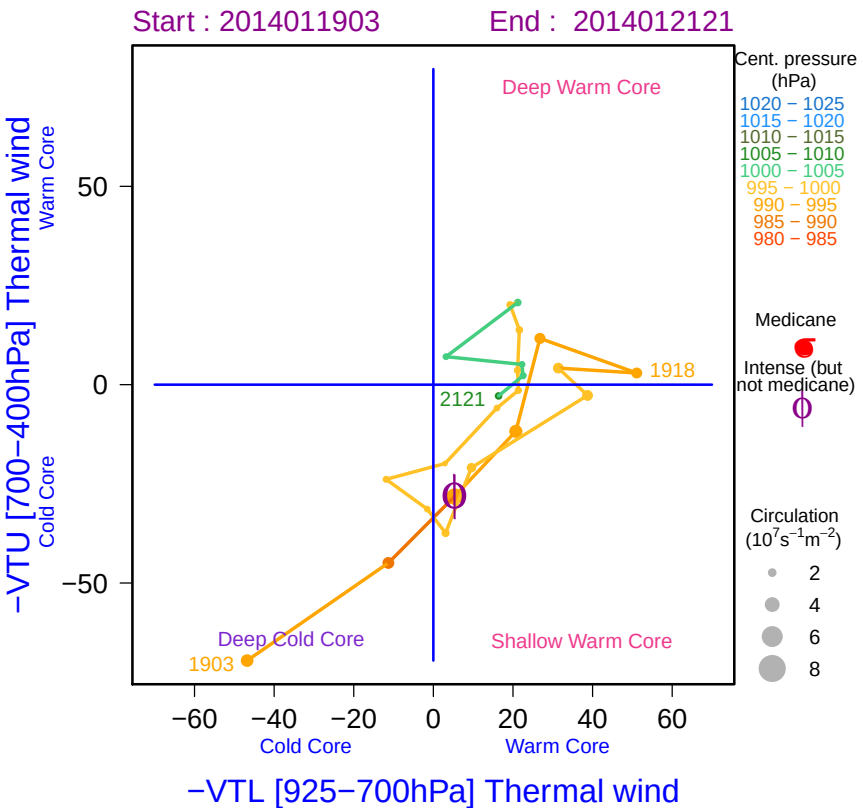




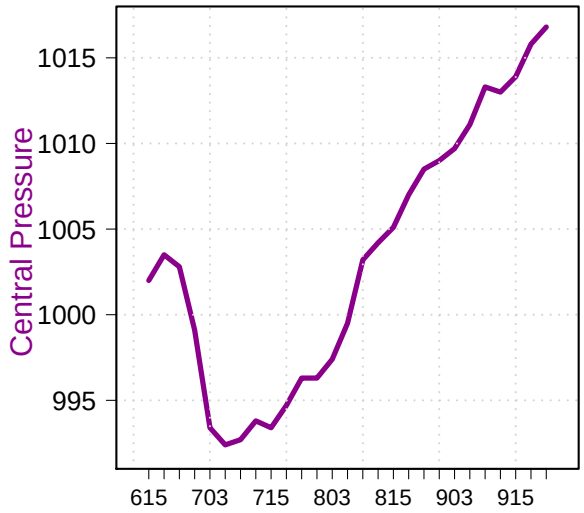
- Symmetrical
- Deep Warm Core
- Non intense enough!!!

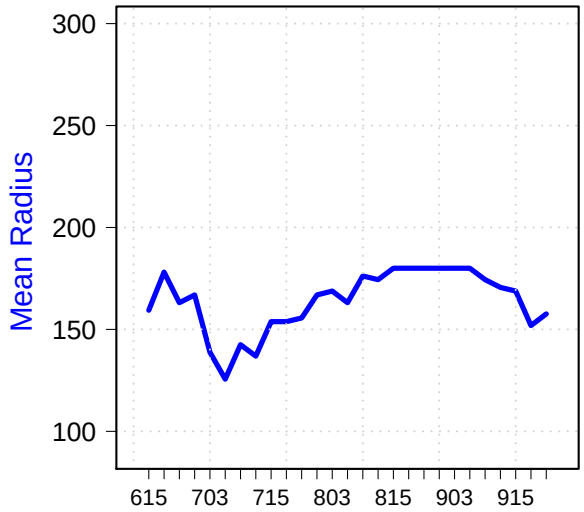
Medicane January 20, 2014

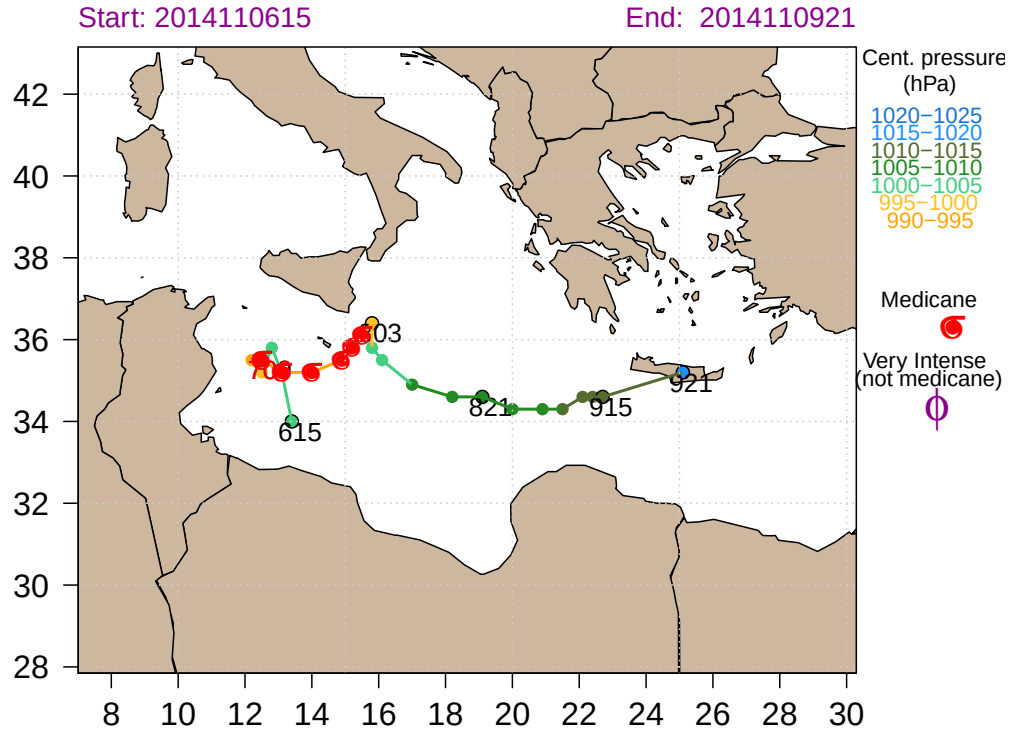




Medicane November 7, 2014 (Qendresa)

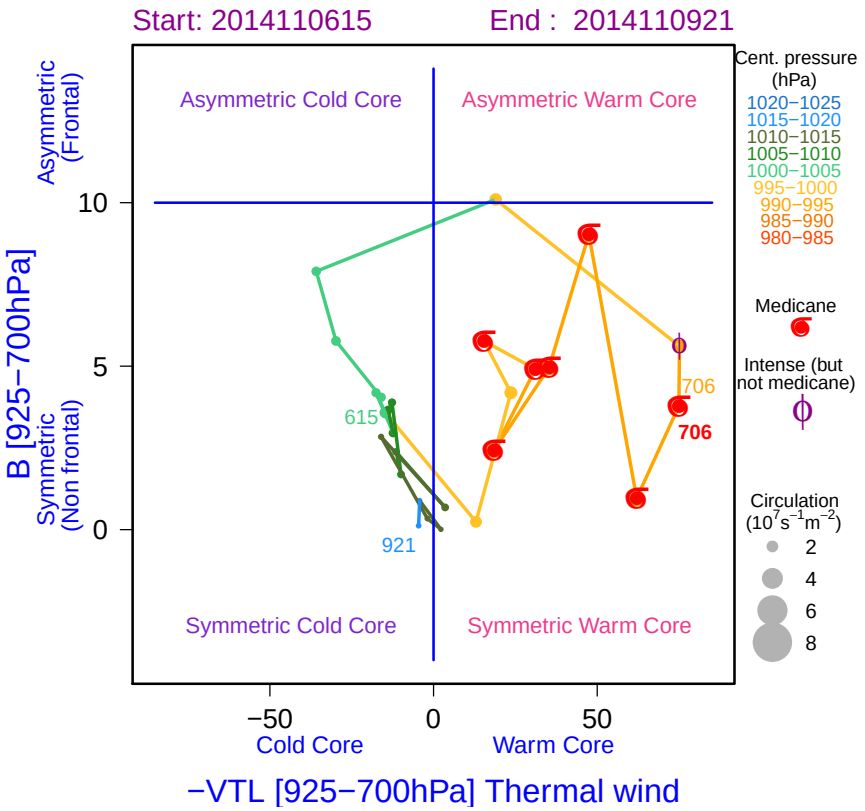


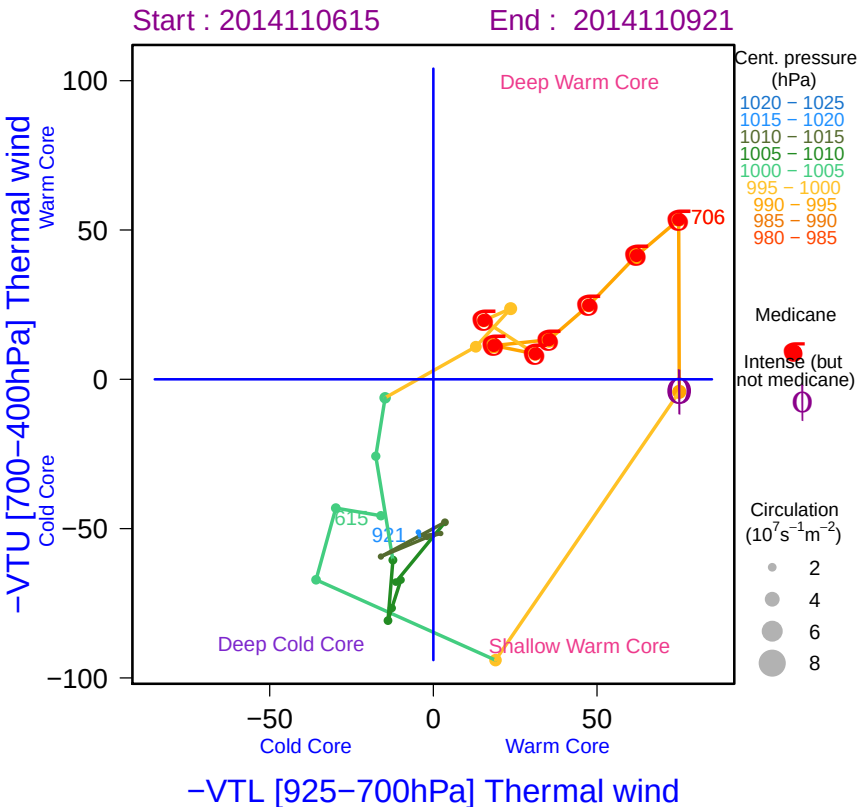




- Symmetrical
- Deep Warm Core
- Very intense

Medicane November 7, 2014 (Qendresa)





Medicane probabilistic forecast

Specific products have been developed to help medicane forecast from EPSs

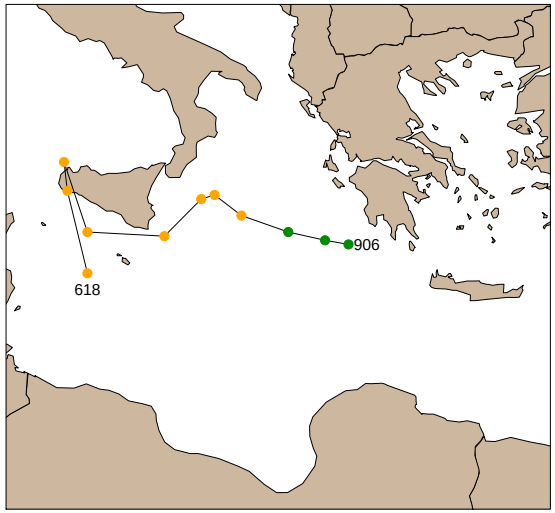
- to summarize predominant characteristics
- but showing extreme values

1. ECEPS
2. AEMET-γ-SREPS

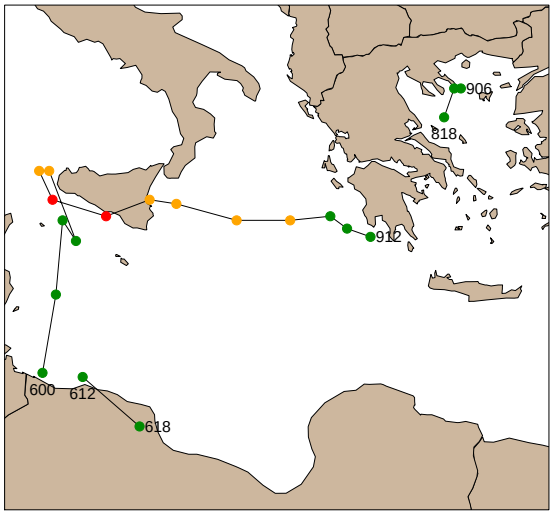
Cyclone Forecast Products

Cyclone Forecast Products

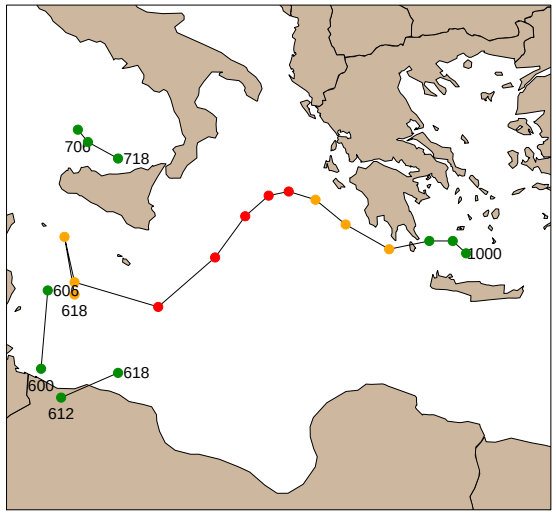
Cntr



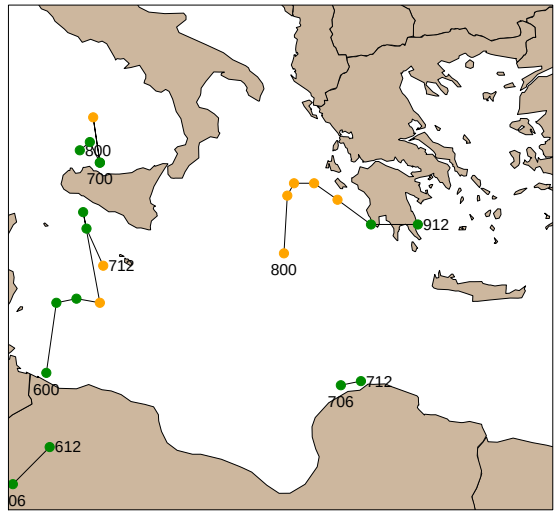
Member 1



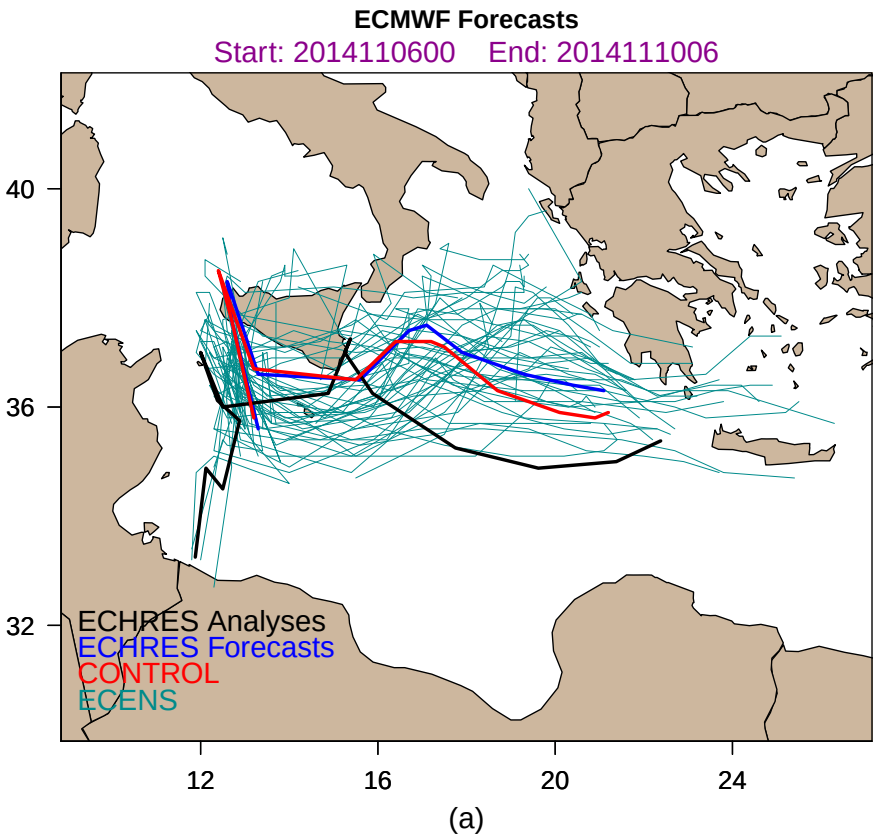
Member 2



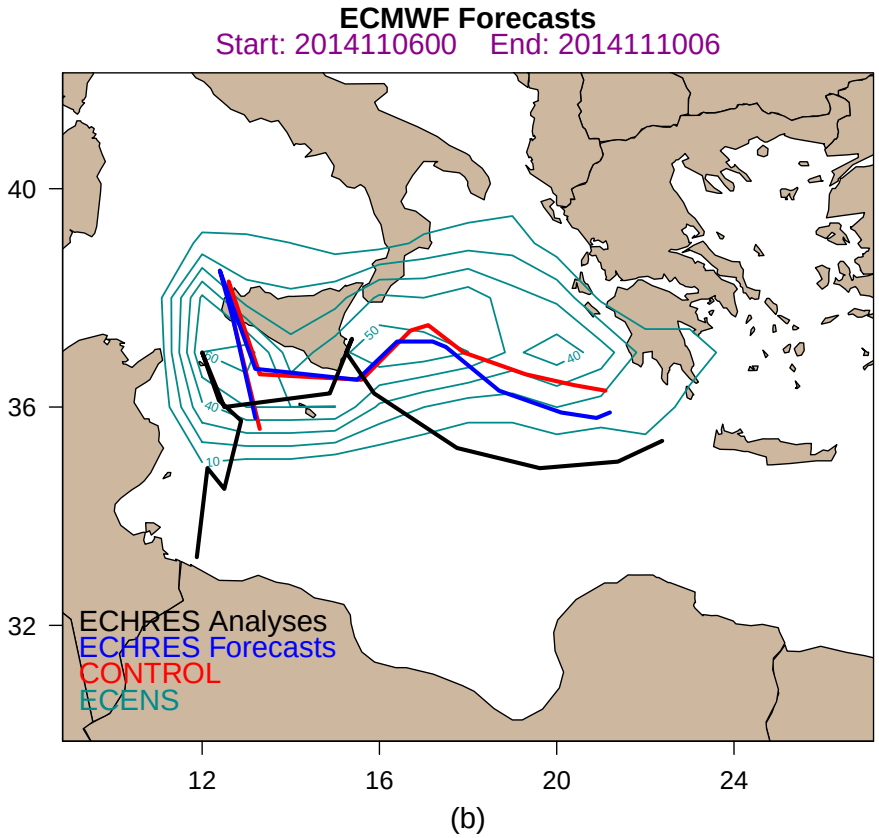
Member 3



TRACKS

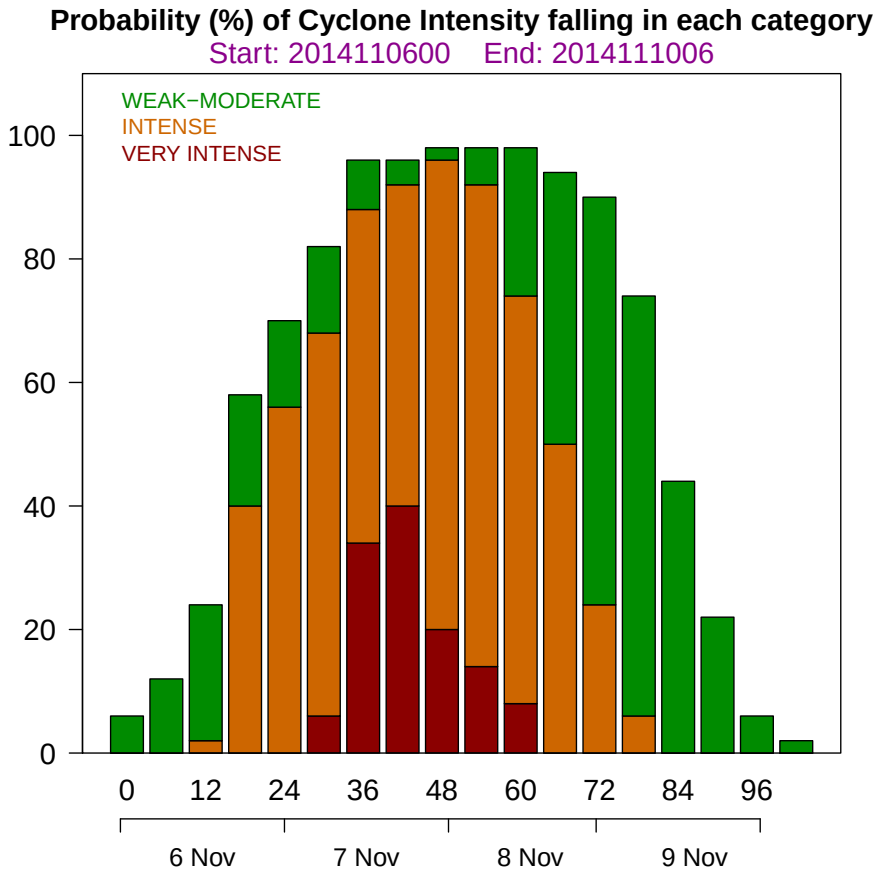


Tracks

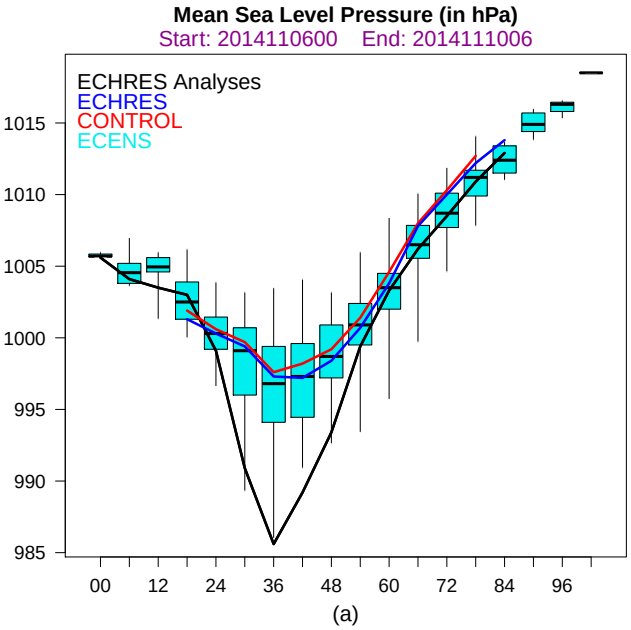


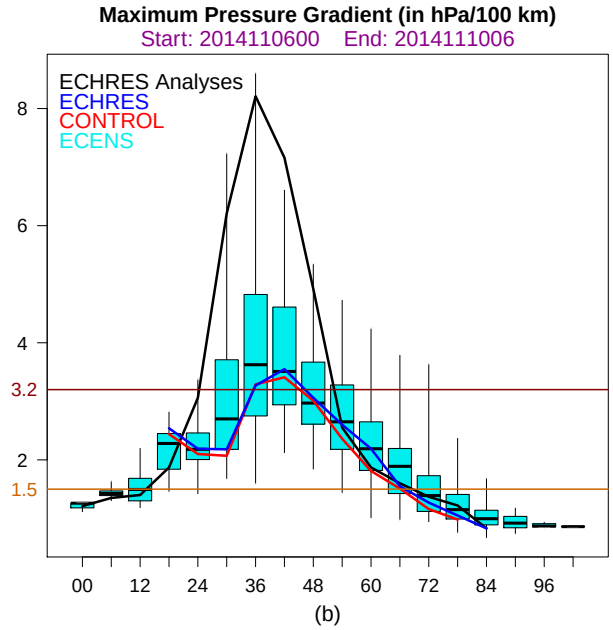
Track probability

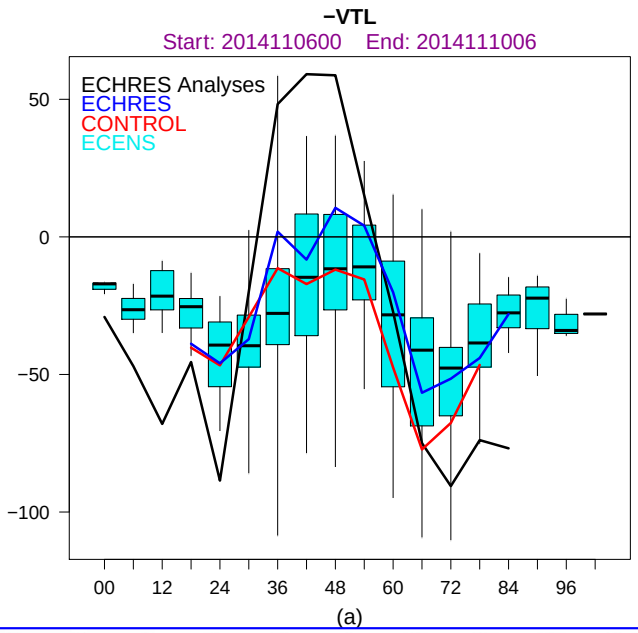
INTENSITY

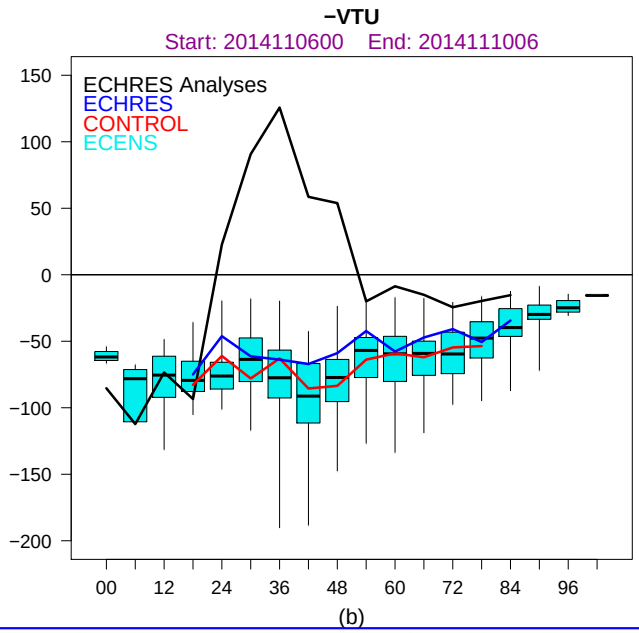

Probability (%) of Cyclone Intensity falling in each category
Start: 2014110600 End: 2014111006
WEAK−MODERATE
INTENSE
VERY INTENSE
100
80
60
40
20
0
0
12
24
36
48
60
72
84
96
6 Nov
7 Nov
8 Nov
9 Nov

EPS-grams

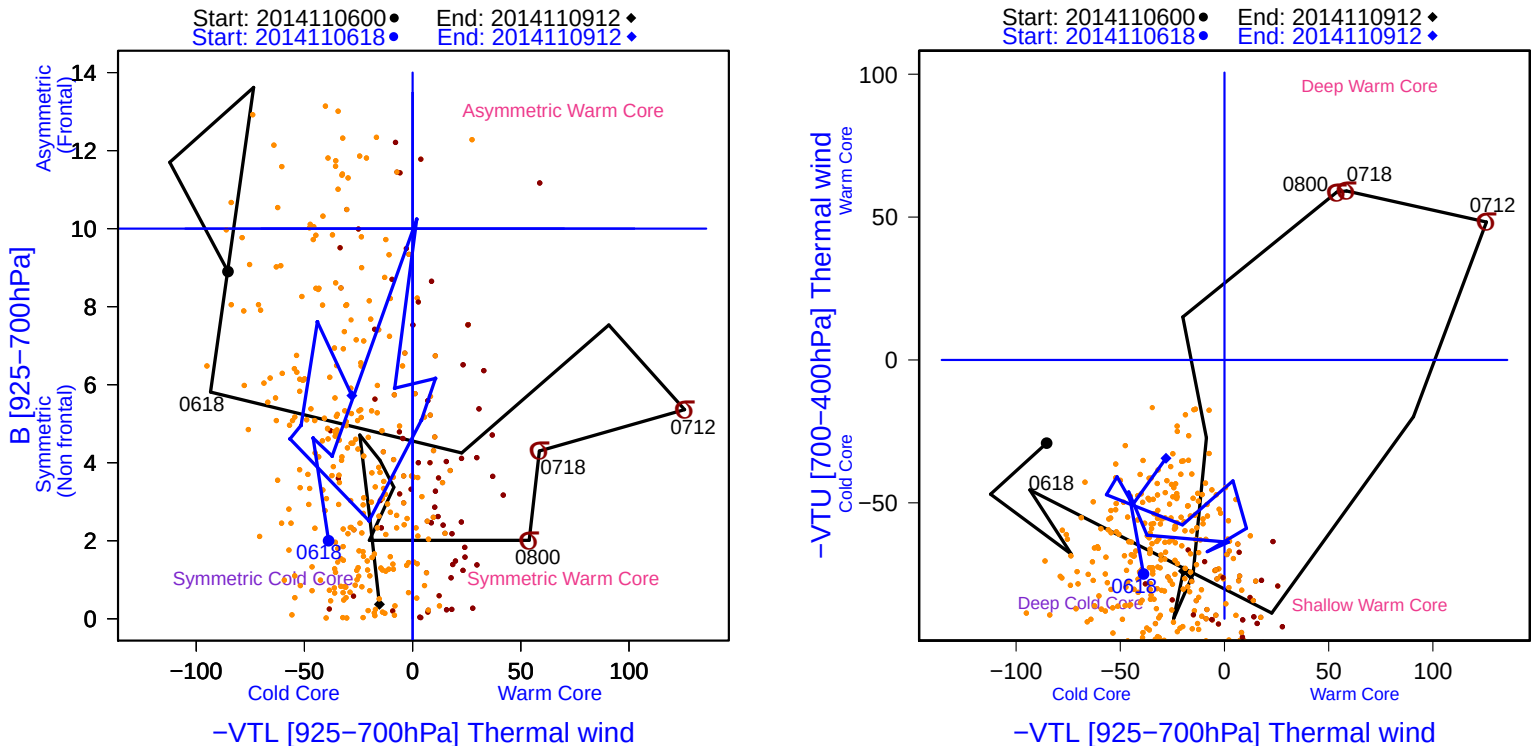

Mean Sea Level Pressure (in hPa)
Start: 2014110600 End: 2014111006
ECHRES Analyses
ECHRES
CONTROL
ECENS
1015
1010
1005
1000
995
990
985
00 12 24 36 48 60 72 84 96
(a)


Maximum Pressure Gradient (in hPa/100 km)
Start: 2014110600 End: 2014111006
ECHRES Analyses
ECHRES
CONTROL
ECENS
8
6
4
3.2
2
1.5
00 12 24 36 48 60 72 84 96
(b)


−VTL
Start: 2014110600 End: 2014111006
ECHRES Analyses
ECHRES
CONTROL
ECENS
50
0
−50
−100
00 12 24 36 48 60 72 84 96
(a)


−VTU
Start: 2014110600 End: 2014111006
ECHRES Analyses
ECHRES
CONTROL
ECENS
150
100
50
0
−50
−100
−150
−200
00 12 24 36 48 60 72 84 96
(b)

Phase diagrams



Analysed (black line) and forecast (blue line) cyclone evolution by ECHRES.
Points: intense (orange) and very intense (red) forecast cyclones by ECENS

Future work

1. A better medicane definition (HyMeX Med-cyclone ST)
   - Best definition for Intensity
   - Track
   - Size
2. Is it possible to obtain a climatology of medicanes from ERA5?
   - Medicane frequency
   - Tropical Transition
3. Medicane Probabilistic Forecast from higher resolution EPSs
   - What resolution is needed?
   - Other suitable products?