

JGU JOHANNES GUTENBERG UNIVERSITÄT MAINZ

**EMS Annual Meeting** 

Predictability of Medicanes in the ECMWF ensemble forecast system

Enrico Di Muzio, Michael Riemer, Andreas H. Fink, Michael Maier-Gerber

> Budapest, September 5, 2018







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#### **MEDICANES**

- Tropical-like (hybrid) cyclones
- Formation and sustainment:
  - originating from the synergy of an upper-level trough and a preexisting low
  - form over much colder SST than hurricanes due to cold upper levels increasing instability
  - may attain a moderate warm core
- Mostly occur in fall and winter
- Features:
  - small size, 100 to 300 km
  - marked axial symmetry
  - strong pressure gradients
  - sustained winds normally reach tropical cyclone intensity, rarely and briefly hurricane intensity
  - occasionally have an eye



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### **Case studies and data**



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Data used:

- ECMWF operational analysis:
  - 16 km resolution until March 2016, then 9 km
  - used as **<u>REFERENCE DATA</u>**
- ECMWF ensemble forecast:
  - 32 km resolution until March 2016, then 18 km
  - ~20 runs (init. times 00Z and 12Z) from 10 to 0 days before each storm
  - 50 members + control forecast

<u>Medicane</u>	<u>Region</u>	<u>Dates</u>	<u>Lowest mslp</u>
Rolf	Balearic Islands	2011, Nov 6-9	996 hPa
Ruven	West. Med., Tyrrhenian Sea	2013, Nov 18-20	991 hPa
llona	West. Med., Tyrrhenian, Adriatic	2014, Jan 19-22	991 hPa
Qendresa	Str. of Sicily, South. Med.	2014, Nov 7-9	986 hPa
Xandra	West. Med., Tyrrhenian	2014, Nov 30-Dec 3	989 hPa
Stephanie	Bay of Biscay	2016, Sep 14-16	998 hPa
Trixie	Southern Med.	2016, Oct 29-31	1001 hPa
Numa	Tyrrhenian Sea, Ionian Sea	2017, Nov 14-19	1002 hPa

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Maier-Gerber, M., Pantillon, F., Di Muzio, E., Riemer, M., Fink, A. H., & Knippertz, P. (2017). Birth of the Biscane. *Weather*, **72(8)**, 236-241.



#### **Object-oriented approach**

Predictability of Medicanes in the ECMWF ensemble forecast system



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• Storm is considered an <u>object</u>



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- A <u>track-averaged distance</u> is eventually obtained
  - ensemble members with distance exceeding a threshold are considered to have no storm









#### **Predictability metrics**

Predictability of Medicanes in the ECMWF ensemble forecast system



#### **Predictability metrics**

• Mean sea level pressure



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- Symmetry
  - > It represents the <u>axial symmetry</u> of the pressure field in the vicinity of the storm
  - Nondimensional parameter, ranging from -∞ to 1, where 1 corresponds to a perfect circle



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  - > One of the three parameters used in <u>Cyclone Phase Space</u> (CPS) diagrams (Hart 2003)
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  - > Spatial distribution represented by ellipse, median by vector



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#### **Results - cyclone position**



### **Results - cyclone position**



**SPREAD** 

**MEDIAN** 



### **Results – cyclone thermal structure**



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#### **Results - kinematics**



#### **Results - kinematics**





### Conclusions



# Conclusions



#### **Results**

- There are <u>early signals</u> of cyclone occurrence already 5 to 7 days in advance
- Forecast jumps occur in most cases
- <u>Consistent distribution</u> of cyclone position errors between consecutive forecasts
- Thermal structure forecasts show a <u>non-gradual evolution</u> and only improve at short lead times
- <u>Compactness and symmetry</u> are generally <u>underpredicted</u> but forecasts improve at short lead times

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#### **Discussion**

- The <u>object-based method</u> allows a better identification of features in forecasts, especially at early times
- Medicanes appear to be <u>low-probability events</u> that are hard to capture early in advance
- Forecast jumps are found for most cases, suggesting the existence of <u>predictability</u> <u>barriers</u>
- The ECMWF ensemble model can <u>successfully</u> <u>reproduce Medicanes</u>, albeit at short lead times especially
- There is <u>potential to Medicane forecasts</u> due to early signals of cyclone occurrence and consistent cyclone position

### **Results - upper-level trough**



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#### Enrico Di Muzio

### **Results - upper-level trough**



