COST Action CA19109 “MedCyclones” – Working Group 2

Deliverable D2.1

Report on available datasets

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We define a research protocol starting from the catalogue of climatological datasets (past and future climate). There is a consensus for concentrating efforts on identifying and tracking cyclones for climatological purposes with two frameworks for current and future climate, namely reanalysis data and climate simulation data.

The first dataset is the latest reanalysis product from the European Centre for Medium Range Weather Forecasts (ECMWF), ERA5 (Hersbach et al. 2020). The ERA5 data are openly available on single and model levels through the Climate Data Store, supported by ECMWF and Copernicus (https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels?tab=overview). The data are available at 0.25° horizontal resolution at 1-hourly intervals from 1950 to present.

Climate data are freely available from phase 2 of the Med-CORDEX initiative, providing baseline simulation runs including historical and future scenarios. The updated list of coupled regional climate model (RCM) runs is available at: https://www.medcordex.eu/baseline-runs.php.

In WG2 we host four specific research initiatives, in which model data and tailored products are made available to the COST members, as detailed for each initiative in the following.

(1) MedCyclones Tracks Task Team (3T, lead: E. Flaounas)

This initiative has a twofold objective: first to combine a wide number of cyclone tracking methods in order to provide a climatological "best tracks" dataset and second, to develop a methodology that performs daily tracking of cyclones, applied to forecast simulations.

10 different cyclone tracking methods have contributed to the initiative. E. Flaounas devised a new tool that combines the cyclone track outputs from different tracking methods and rejects the ones that were only identified by single methods. For a rather short target period of one month (September 2006), it was demonstrated that the new tool was able to reject a high number of "bogus" tracks. Most of these tracks were artifacts of the tracking methods and did not correspond to organized mesoscale vortices. As a result, the tool was shown to be promising for reasons of operational forecasting and for providing a climatological dataset of cyclone tracks.

The same exercise was repeated by performing an ensemble of cyclone tracking approaches. However, every cyclone tracks contributor now provided different datasets using alternative versions of same tracking methods. Therefore, the same analysis as in the first meeting was repeated with about 45 datasets, i.e. an ensemble of 5 datasets, produced from each cyclone tracking method. This was done to artificially increase the robustness of the outcome of tracks combination, under the hypothesis that different versions of same tracking methods would yield significantly different tracks (but retaining the robust cyclone tracks rather intact). Results were inconclusive with the hypothesis being hardly verified for some of the cyclone tracking methods.

The contribution of the same 10 tracking methods was further exploited but for a climatology of 42 years. This climatology derived from ERA5 in the period 1979-2020. Results confirmed the capacity of combined cyclone tracking methods in providing a climatological dataset that reduces dramatically "bogus tracks" and includes all major cyclone cases in the region.

A "best tracks" dataset was finally released and is available together with the scientific paper published on Waether and Climate Dynamics (Ed Copernicus):

Flaounas, E., Aragão, L., Bernini, L., Dafis, S., Doiteau, B., Flocas, H., Gray, S. L., Karwat, A., Kouroutzoglou, J., Lionello, P., Miglietta, M. M., Pantillon, F., Pasquero, C., Patlakas, P., Picornell, M. Á., Porcù, F., Priestley, M. D. K., Reale, M., Roberts, M. J., Saaroni, H., Sandler, D., Scoccimarro, E., Sprenger, M., and Ziv, B.: A composite approach to produce reference datasets for extratropical cyclone tracks: application to Mediterranean cyclones, Weather Clim. Dynam., 4, 639–661, https://doi.org/10.5194/wcd-4-639-2023, 2023.

The methodology has been already applied in different research and operational activities, such as for example the operational forecasting web site developed within the DynForMed initiative:

https://medcyclones.eu/dynformed/

and the investigation of the link between Mediterranean cyclone classification and the role of air-sea interaction in cyclone deepening, performed through a VM grant by Shira Raveh-Rubin.

(2) MedCyclones in convection-permitting models (MedCPM, lead: S. Berthou)

The idea of the initiative is to analyse Mediterranean cyclones in a set of hindcast simulations first and then in future simulations at km-scale resolution with explicit convection. Such simulations are increasingly available (e.g. CORDEX FPS - Convection over the Alps and H2020 EUCP simulations) for at least part of the Mediterranean.

Available simulations are:

- GUF COSMO (MedCordex domain, 0.0275°; 2000-2009) (Erwan Brisson)
- Météo France AROME 3km (Western Med, 30 years hindcast/present/mid-century/far-future) (Samuel Somot - EUCP)

- MOHC UM 2.2km (Western Med, 20 years hindcast/ 10 years present/mid-century/far-future) (Ségolène Berthou - EUCP)
- Uni. C. Louvain: WRF 4km (30years hindcast) (Claudia Pasquero)

Potentially available (EUCP partners):

- ETHZ 2.2.km (Western Med - EUCP)
- ICTP RegCM (Eastern Med - EUCP)

Simulations not yet run:

- Uni. of Bern WRF (driven by inhouse CESM) (Christoph Raible)

A recent STSM grant supported Lisa Bernini visit to the Free University of Berlin. The research carried out and planned fit the topic of this initiative, since will exploit a convection-permitting dataset to (i) determine potential feedback explaining the increase in frequency and strength of convective precipitation over land; (i) identify differences in the origin of precipitation associated with Mediterranean extratropical cyclones and tropical-like cyclones. This would give some insight into the physical processes leading to the development of this latter category and increases our understanding on how explicitly simulating convection affects different types of Mediterranean cyclones.

(3) Effects of air-sea interactions on Med Cyclone intensity and rainfall (AIR-SEA, lead: C. Pasquero)

The purpose of this action is to study how air-sea heat exchange in the Mediterranean, modifying the atmospheric boundary layer and the sea surface temperature, affects the cyclone life cycle and precipitation on variable timescales. To this aim, Med-CORDEX simulations and 9 additional high resolution simulations, either coupled or run with high resolution SST boundary conditions, are collected and/or under production.

(4) Mediterranean Cyclone Classification (MedCyClass, lead: S. Raveh-Rubin)

The purpose of this initiative is to classify Mediterranean cyclones to categories, based on the governing processes at their genesis. Diagnostic data were collected, including identified feature-based products from members who joined the initiative. Data are currently available for a test period of June 2013 - May 2014, based on ERA5, unless noted otherwise.

Data product	Description	Contact
Upper and mid-tropospheric PV	Vertically averaged PV over the isentropic (320-340 K) levels for upper-tropospheric PV, and isobaric (900-600 hPa) levels for mid-tropospheric PV.	Weizmann Institute of Science Yonatan.givon@weizmann.ac.il
PV cutoffs	Cutoffs identified on the isentropic levels 290-350K every 5K, following Portmann et al. (2020) and adapted for ERA5.	ETH Zurich Philipp Zschenderlein

		(philipp.zschenderlein@env.ethz.ch) Michael Sprenger (michael.sprenger@env.ethz.ch)
PV streamers	PV streamers identified on 5 isentropic levels, 320-340K in 5-K intervals, in ERA Interim, following the methodology in Wernli and Sprenger (2007).	ETH Zurich
Warm conveyor belts (WCBs)	Gridded WCB trajectories from ERA Interim, calculated according to an ascent criterion >600 hPa in 48 h, in Madonna et al. (2014).	ETH Zurich
Trough/ridge axes	Calculated based on 300-hPa geopotential height (Schemm et al. 2020).	ETH Zurich
Ocean data products	Available C-GLORS variables are ocean heat content (0-300-m layer), computed using the CMCC eddy-permitting global ocean reanalysis, C-GLORS v7 (Storto and Masina 2016). Sea surface temperature (SST) and net downward heat fluxes are provided at daily frequency from 1993-2019.	CMCC Enrico Scoccimarro (enrico.scoccimarro@cmcc.it) Dorotea Iovino (dorotea.iovino@cmcc.it)
Convective parameters (in production)	MU CAPE, 0-6 km wind shear and storm relative helicity, following Taszarek et al. (2021).	Mateusz Taszarek (mateusz.taszarek@amu.edu.pl)

In the figure one can find an example of the data gathered together in a region around a cyclone (big black dot is the cyclone centre). There is a high variability among cases already examined, and classification methods are currently discussed.

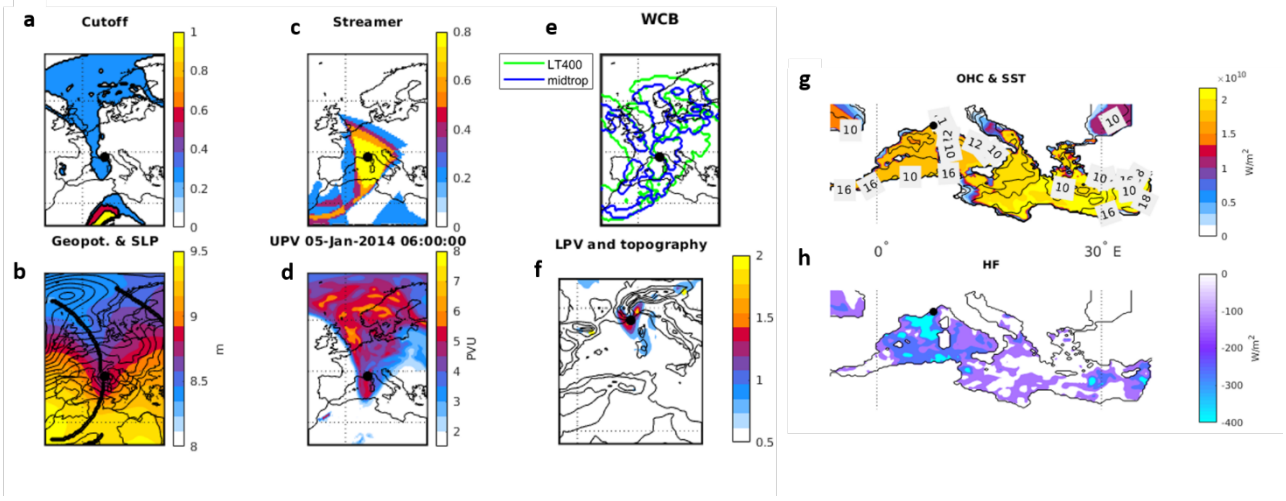

Fig. 1. Cyclone of 5 January 2014 (black dot) and the data products (a) cutoff mask, (b), geopotential at 300 hPa and trough axis, (c) streamer mask, (d) upper-tropospheric PV, (e) upper- and mid-tropospheric gridded WCBs, (f) topography and mid-tropospheric PV, (g) ocean heat content (shading) and SST (black, °C), (h) net downward heat fluxes.

References

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