A 15 years climatology of storm tracks by analysis of Vertical Maximum Intensities over north-eastern Italy: preliminary results

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Introduction

North eastern Italy is a spot of convective events in Central Europe (Poelman et al., 2016). A new approach to the study of storms in this region is presented.

An original system to detect storm tracks, that uses the MODE function from NCAR-DTC MET suite (Bullok et al., 2016), has been developed, based on VMI radar scans. MODE function is an object oriented framework for forecast verification purposes that compares coherent sequences of meteorological fields and provides, as output, a set of attributes that can be compared. In this case, VMI fields have been used as input, whereas outputs are storm centroid positions with associated properties, such as cell intensity (as percentile of dBZ distribution in the cell), area, distance between cells at different time steps, etc.

The MODE function needs manual definition of the parameters that control the object identification and pairing.

This system has been preliminarily applied over a 3 years long dataset of VMI scans, with time step of 10 minutes, derived from instruments hold by Slovenian environmental agency ARSO (www.arso.gov.si) and Italian Veneto Region environmental agency ARPAV (www.arpa.veneto.it), due to the temporary unavailability of Friuli Venezia Giulia region Fossalon radar.

Data and methods

For the purpose of this work, the version 8.1.1 of the MET tool has been used. MTD (MODE Time Domain tool) utility has been applied to a set of pre-processed NetCDF fields of VMI, joined together to form a composite image over the domain (SW to NE corners): 9.93 °E : 44.21 °N to 18.31 °E : 46.83 °N for the period: 15 Jun 2017 to 19 Sep 2019. Radar involved are: Lisca and Pasja Ravan (ARSO), Teolo and Loncon (ARPAV). Reflectivity threshold for object identification is set to 35 dBZ in order to exclude non- or weakly- convective events.

A first dataset is composed by single storm cells characterized by data, hour, centroid lat/lon, area, intensity (50th and 90th percentile dBZ), distance with the associated cell in the previous time step, differences in area, intensity, distance and angle of track with the previous cell. A second dataset focuses on cell tracks that are characterized by event ID, data, duration, centroid lat/lon and time of initiation, centroid lat/lon and time of dissipation, properties (mean, sum, min, max) of: intensity, area, distance between cells at adjacent time steps, angle of track.

Results

The map of tracks shows them in colours, according to the direction of propagation of every cell. Distribution of events per quadrant of cell propagation shows a clear predominance of SW to NE moving storms (almost 60% of the storms). The duration of storms by initiation hour or dissipation hour shows that longest storms predominantly initiate in the late morning/early afternoon, while dissipate during the evening.

Distribution of events during the year shows a lower peak when mean duration is considered. Yearly distribution per intensity and duration shows comparable shapes with a more pronounced summer peak in intensity. Yearly 2D distribution of dBZ intensity per month is more peaked in summer and decreases towards autumn, that has in general more “lower intensity” cases than spring - early summer.

Considering the frequency of cells passing through the domain, areas with maximum frequency of centroids are Veneto and Friuli Venezia Giulia (FVG) Prealps, western Slovenia and Croatia.

Daily distribution of storms shows that night and early morning storms are more frequent near the coast, while evening storms are typical of FVG Prealps. Night time convection is less frequent for central Austria part of domain.

Seasonal distribution of storms shows that autumn storms are more frequent towards the coast and at seaside and spatial distribution is comparable to night time convection one.

Computing the correlation matrix of the different properties of the events shows values above 0.5 when comparing cells area/intensity and distance run by the storm. There is also high correlation between distance/duration and maximum angle of the track (i.e. longest tracks are the most deviated during lifecycle). There is no correlation between centroid coordinates of initiation and intensity or between duration and maximum intensity. There is anticorrelation between the position of the maximum angle of track in the cell lifecycle and many other properties.

Conclusion

The development of such a storm track dataset is relatively easy, quick and cheap; it helps to explore further the features of convection and their relationship with environmental measurements or simulations. In synthesis:

PROS: easy, portable, light.

CONS: tricky tuning of identification parameters, some false signals, hard to discriminate storm split/merge phases (no information on radar volume).

References

Bullock, R., et. al., 2016: Method for Object-Based Diagnostic Evaluation NCAR Technical Note NCAR/TN-532+STR, 84pp.;

Poelman, D.R. et al., 2016: The European lightning location system EUCLID – Part 2: Observations. Nat. Hazards Earth Syst. Sci. 16: 607-616