CONCEPTUAL MODELS OF SEVERE STORMS INITIATION IN SOUTHEASTERN ROMANIA

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I. INTRODUCTION

Thunderstorms in Romania can be severe and cause significant damage and loss of life. As forecasters have difficulty forecasting their initiation, conceptual models, based on radar, satellite and synoptic observations, have been developed. These have provided invaluable guidance for forecasters.

Operational nowcasters forecast thunderstorms using the "ingredients method" (Johns and Doswell 1992) where deep moist convection is due to instability, moisture and lift.

Observations of storms whose buoyant updraft air originated in the boundary layer shows that they are initiated along or near low level airstream boundaries, especially in the south-eastern Romanian Plain.

The conceptual models focus, in particular, on low level convergence zones as lifting mechanisms, as well as explaining moisture and instability sources. They also include three-dimensional wind profiles conducive to the development of supercell storms.

II. LOW LEVEL BOUNDARIES IN SOUTH-EASTERN ROMANIA

Initiation of storms in southern Romania occurs in the vicinity of three types of low-level boundaries: synoptic, mesoscale, and convective (Stan-Sion and Soci, 2005).

Synoptic boundaries consist of fronts or the interaction of the synoptic flow with orography. The interaction of the synoptic flow with the curved shape of the Carpathian Mountains results in a convergence zone between the eastward and westward circulations (Fig.1).

Mesoscale boundaries include drylines, discontinuity lines produced by differential heating, convergence lines produced in the lee of a mountain chain, enhanced convergence at the exit of a canyon, sea-breeze fronts and mountain-breeze circulations. (Figs.3,4).

The last category, outflow boundaries and convective rolls, are the most difficult to predict as they are produced by the convection itself. Radar is the most appropriate tool to monitor the behaviour of the convectively generated cold pool and its associated gust front. Predicting the initiation of convective storms along an outflow boundary or its intersection with a previous boundary, such as the sea-breeze or the convergence line along a roll cloud, before the onset of the parent storm is difficult, if not impossible.

III. CONCEPTUAL MODELS

1. Wallachian back-building squall line. Romanian topography is dominated by the S-shape of the Carpathian Mountains, deflecting the flow from the general western circulation into two branches that converge in the Southern plain of Romania. (Fig.1a). This can be enhanced by the presence of two natural canyons on the river Olt and Danube (small blue arrows in Fig. 1b – bottom image, represent the flow through these canyons). Low level warm and moist advection from the Mediterranean Sea provides good conditions for storms initiations at the convergence zone. If the Northern flow prevails, then there are conditions for the development of a back-building convective line over the hills with Southern exposure to the sun. The new cells repeatedly form towards the west, where the warm and moist air is lifted by the gust front, producing a backward propagation of the system (Fig.2).

2. Boundary interactions with sea and mountain breezes. When the northern branch prevails the convergence line may interact with the mountain breeze (Fig. 3) or the sea breeze (Fig. 4). Severe convection may be initiated at these interaction zones.

3. Southern convergent flow - Lower Danube convergence line. An average of 10 tornadoes per year are observed in Romania (Oprea and Bell, 2009). The most severe cases were associated with a southerly flow toward a low pressure situated in the eastern part of the country (Fig.5). This flow advects moisture from the Black Sea and develops a strong convergence line in the vicinity of the Danube River.

IV. CONCLUSION

Three different types of low level boundaries that precede some severe convective episodes in south-eastern Romania are presented. The boundaries are related to local topographic circulations and the general synoptic flow. They include: convergence lines induced by the S shape of the Carpathian Mountains in south Romania; the Black Sea breeze convergence lines; and interactions between convective outflow boundaries and differential heating boundaries. The conceptual models presented in this paper provide valuable guidance for the nowcaster in assessing the environmental conditions that favour severe weather. Two of them, the Wallachian Back Building squall line and the Lower Danube Convergence line, represent specific patterns for severe convection initiation in Southern Romania. Examples of each type will be presented.

V. REFERENCES

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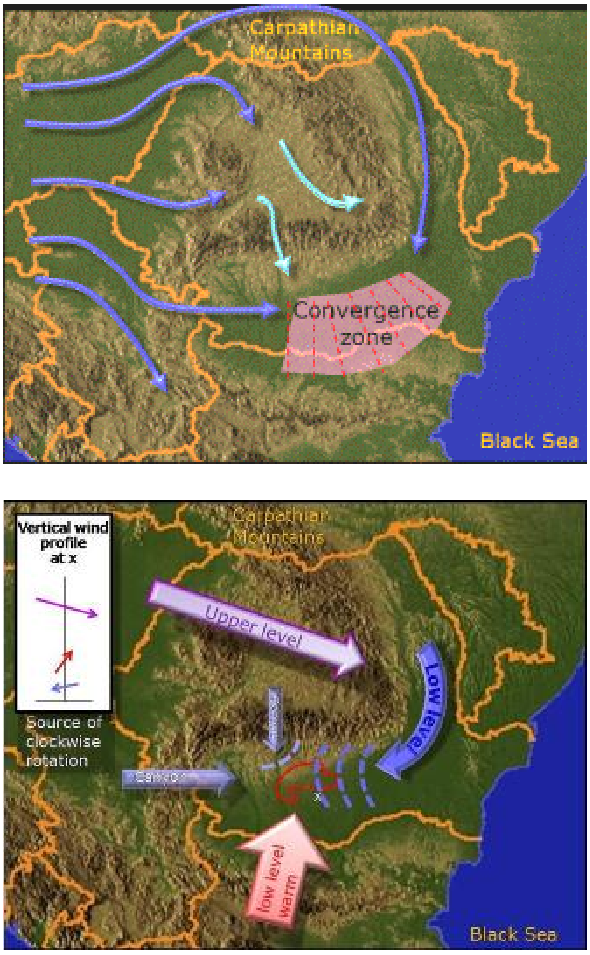

FIG. 1: The “Romanian Plain Convergence Zone”: Arrows depict the pericarpathian flows that converge in the middle of the Romanian Plain when a western high pressure system approaches the Carpathian Curvature. a) Upper image: the pink dashed region represents the convergence where convection is often initiated, also known as Wallachia region. B) Bottom image: the thin dashed line, oriented from North to South, or later from West to East (Fig.2), represents secondary “cold fronts” that can form at the leading edge of the Northern flow.

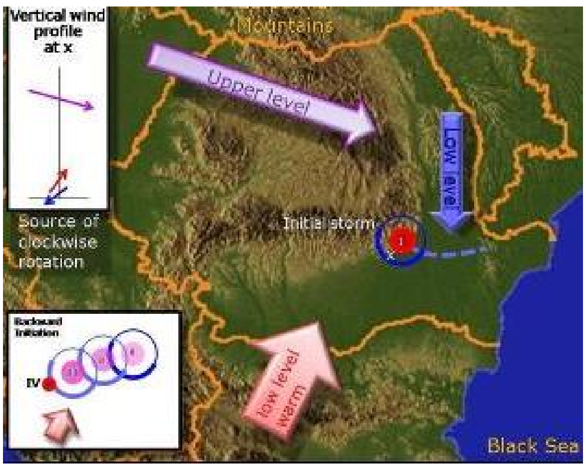

FIG. 2: Back building squall line. Initiation of convection on the side that receives the SW flow. The rectangle in the left lower corner represents the propagation of the storms toward the source of moisture and instability.

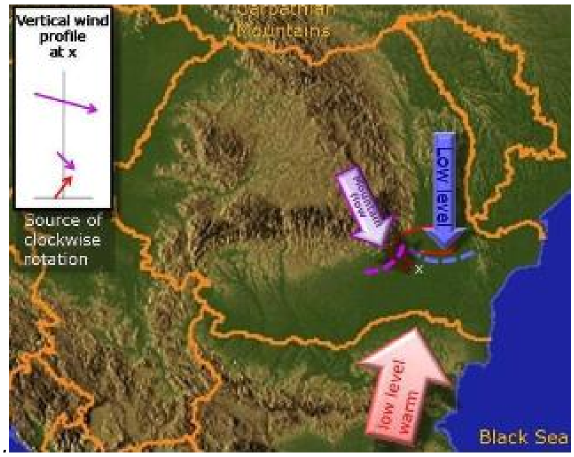

FIG. 3: Mountain breeze. Conceptual model for storm initiation in southeastern Romania when the Northern branch of the peri-carpathian low level circulation prevails (blue arrow).

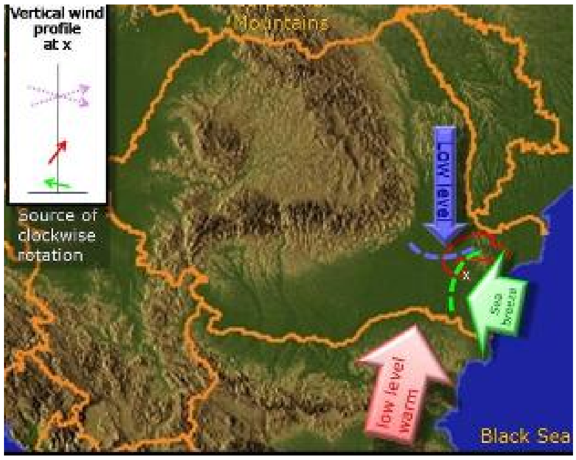

FIG. 4: Sea breeze. Conceptual model for storm initiation at the intersection of the Northern flow with the sea breeze.

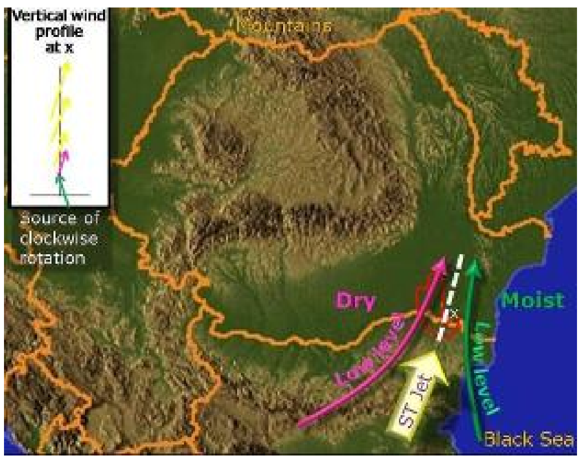

FIG. 5: Southern convergent flow. The conceptual model of the Lower Danube convergence line (white, dashed). It often extends further to the north, following the lowest orography.

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