Intercomparison of intense cyclogenesis events over the Mediterranean basin based on baroclinic and diabatic influences

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A large number of high impact cyclones all over the Mediterranean basin have been reported on the database of the MIDEX project. A detailed study on the impact and interaction of baroclinic and diabatic factors is carried out through a PV-based system of prognostic equations for 13 intense MIDEX cyclogenesis episodes occurred in different areas of the basin (Western, Central and Eastern Mediterranean). The main aim of the study is to investigate the possible similarities and differences about the relative weight of the considered cyclogenesis factors on the cyclogenesis evolution as function of cyclone type and geographical area.

1) PV-based prognostic equations

A closed system of PV-based prognostic equations (Duda and Bein, 2001) is used to solve the geopotential height tendency equations. Geopotential height (g) and streamfunction (f) are obtained from an initial PV distribution (g) via the PV inversion technique. The geopotential (g), streamfunction (f) and PV (f) tendencies are given by the solution of the Charney-Phillips balance equation and the Ekman's PV conservation equation (Ekman's formulation), using the frictionless and diabatic form. From the omega equation (1) the following equations are obtained (the vertical velocity ω, and with the continuity equation) the system is closed (giving the stream function f). Zonal homogonous and X-zonal forces for and lateral boundary conditions are used for the tendencies.

2) Factor separation

Since the technique is based on PV inversion, the dynamical study will be based on the effects of PV anomalies (PVa). The effects of the anomalies will be isolated using the Factor separation technique (Stein and Albert, 2001). This technique allows to obtain the individual effects and the mutual interactions of a set of different factors (in this study contributing to the total geopotential height tendency). In this case the following effects are looking:

- E0: Background flow
- E1: Upper level PV anomalies of ±00 hPa, RH<70 %
- E2: Low level PV anomalies of ±00 hPa, RH>70 %
- E3: Diabatic PV anomalies of ±30 hPa, RH>70 %
- E5: Interaction E3 & E2 | E12

3) Indications

The study is focused on the effects of each factor on the most relevant total geopotential height tendency signal at 950 hPa for the cyclogenesis episodes at each time step. An average of the effects of factor/interaction on the height tendency is calculated on the indicated space region at each time step. Negative values indicate deepening, moving or defining thermally, whereas positive values would fill the low. The E0, E1, E2, E3 and E5 have been used.

Figure shows cyclone trajectories (Mark lines), q' of 925 hpa. Blue (e.g., and pms, every 3h from 00), Son level pressures (green) and average mean pressure (red). Evolution of the isohyetic surface tendency by each factor/diabatic influence with this done moving the Bilbao area after the cyclone reached the sea.

4) Conclusions

- Generally case depended on results.
- Upper level PVs (E1) generally the most relevant.
- Low level PVs (E2) & E12 make secondary roles.
- Moisture (E3) significant role.
- W & C Mediterranean mainly dominated by PV anomalies (E2, E12), E12
- E-Mod, present different dependence (E2, E12, E12+BB)
- E2, E13 and E12 least contributions
- High deepening process when reducing the sea (focusing to the same state)
- Factors are often cyclogenetic and cyclical during lifecycle
- 'African' cyclones mainly characterized by Upper level E1 or E2
- 'Mediterranean' cyclones dominated by E1 and shown by E12
- 'Atlantic' type cyclones characterized initially strongly by E1

References

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