Diagnosing turbulence from NWP derived fields and ACAR Observations

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Observations

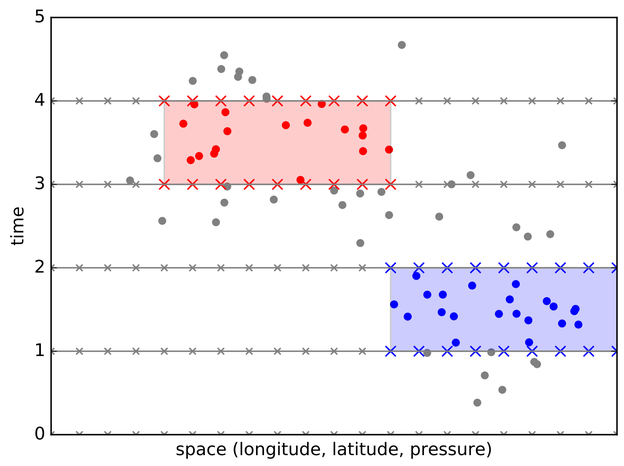
- Atmospheric turbulence is measured by airplanes using different methods. The most common are referred as the maximum derived equivalent vertical gust (DEVG) and the eddy dissipation rate peak (peak EDR).
- These magnitudes are designed to be independent of the characteristics of the airplanes, and can be used as a measure of the turbulence of the atmospheric airflow at a given point and time.

NWP derived fields

- It is a common practice to pair atmospheric turbulence measures with values of derived fields. Many works confirm the relationship of some derived fields with the production of turbulence.
- Some of them are the Richardson Number, Ellrod T1, the vertical wind shear, potential temperature rate, helicity density, turbulent kinetic energy.

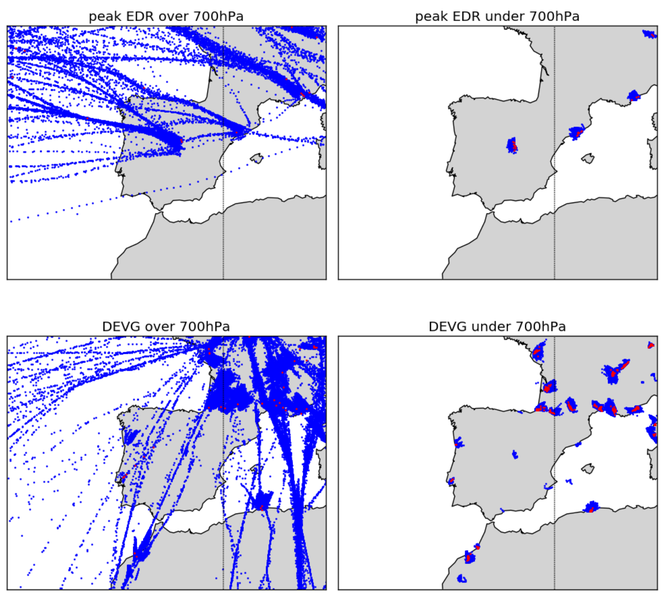
Clustering

- Many difficulties arises in the pairing process between observations and fields, due the lack of a dense network of observations and the granularity of the derived fields.
- In this work we propose a new method to pair turbulence observations from airplanes and derived fields values from numerical models.
- The method is based on clustering the turbulence observations, which are near from each other in an important number of cases. We used a fast hierarchical, agglomerative clustering routine. The distance for clustering is 80 km in the horizontal, 30 hPa of height and 3600s of time.
- Each cluster is paired with the values of the derived fields within the same neighborhood as the observational cluster.
- Using this method we evaluate a number of derived fields as turbulence predictors, and construct an index from the best of them, using the logistic regression technique.



Databases

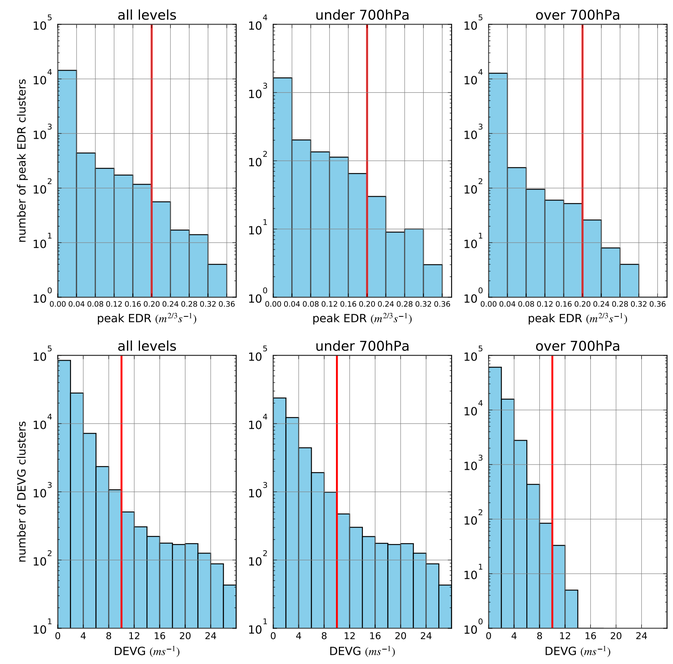
- The NCEP MADIS database has been used to get the ACAR observations whereas the HARMONIE-AROME model was used to obtain the derived fields.
- The study was done over the integration domain of the model, around the Spanish Peninsula, for a period of time of three months.



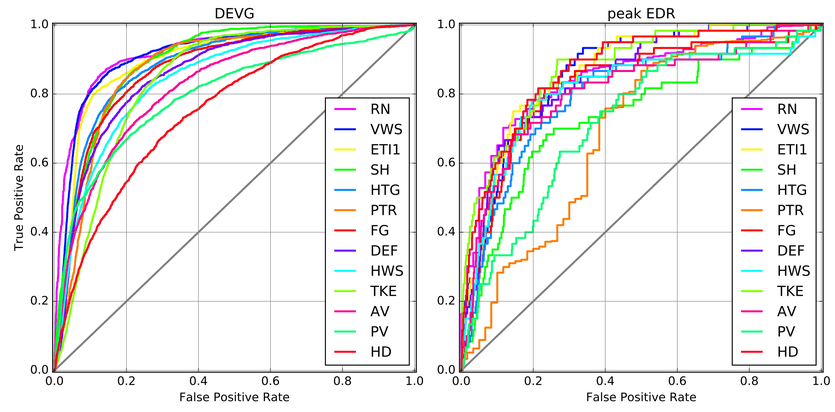
variable	total	over 700 hPa	under 700 hPa
peak EDR	15403	2209	13194
DEVG	124981	45164	79817

Results

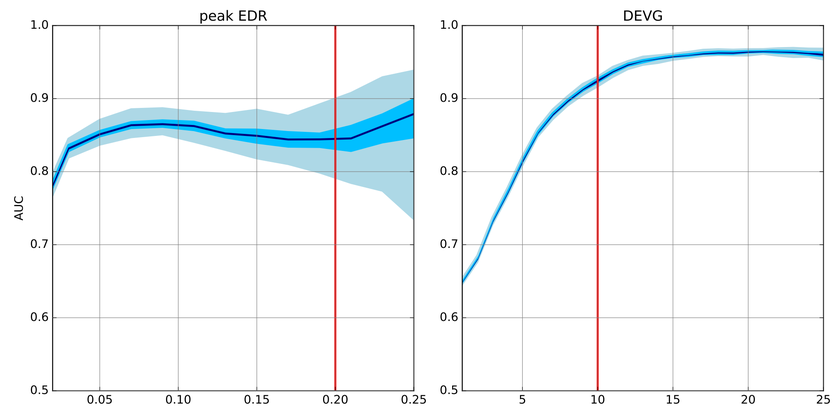
- Histogram of observations.



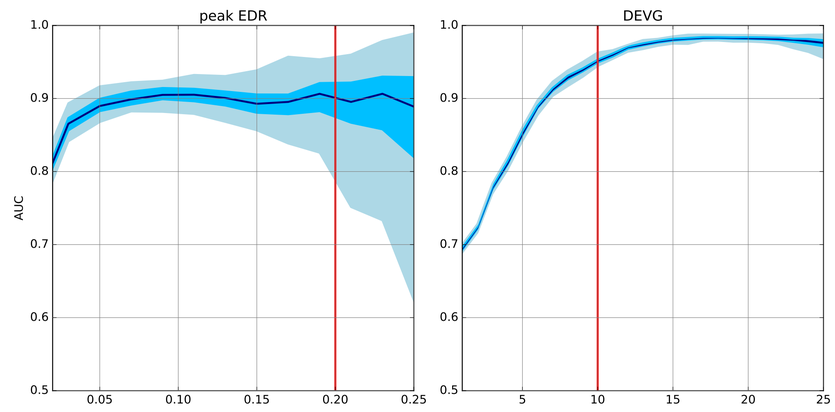
- Performance of individual NWP derived fields.



- Dependence of the AUC on the threshold, Richardson Number.



- Combined Index using a logistic regression with the Richardson number, potential rate temperature, vertical wind shear, helicity density, frontogenesis, TKE, and specific humidity.



Conclusions

- Surprisingly DEVG performs better than peak EDR for almost any derived field, threshold, and for low and high atmospheric levels.
- The Combined Index improves significantly the results of any individual derived field.

Some references

- SHARMAN, Robert; LANE, Todd. Aviation Turbulence. Basel, Switzerland: Springer International Publishing Switzerland, 2016.
- MÃLLNER, Daniel, et al. fastcluster: Fast hierarchical, agglomerative clustering routines for R and Python. Journal of Statistical Software, 2013, vol. 53, no 9, p. 1-18.
- BENGTSSON, Lisa, et al. The HARMONIE-AROME model configuration in the ALADIN-HIRLAM NWP system. Monthly Weather Review, 2017, vol. 145, no 5, p. 1919-1935.