# Atlantic hurricanes and European weather

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Tropical cyclones play a great role in the general circulation of atmosphere as they transfer large amounts of energy from tropical zone towards high latitudes. Interaction between tropical cyclones and the polar front accompanied by the release of energy accumulated by the vortex is often observed.

A case study concerning influence of an Atlantic hurricane on European weather is discussed in this paper. It is demonstrated that positive temperature anomalies in Europe in November 2008 were partly due to hurricane "Omar" which had been developing over the Atlantic ocean from the 13$^{th}$ to the 18$^{th}$ of October. The numerical ETA model of the atmosphere was used to predict trajectories and meteorological fields' dynamics in "Omar".

Tropical cyclone "Omar" originated from a tropical wave in the south-east of the Caribbean sea on the 13$^{th}$ of October 2008 and began moving northeastward. Its trajectory lay across the Central Atlantic. On the 15$^{th}$ of October "Omar" was given a status of a hurricane while the largest intensity of the vortex was registered on the 16.10 during its passage over Virginian Islands. On the 17.10 "Omar" had already possessed typical structure of a hurricane: the cloudless and windless eye of the storm in the centre and the circle of storm winds surrounding it. The wind speed reached 22 m/s at 10 meters and 25-30 m/s at 850 hPa. Kinetic energy maximum at almost all altitudes corresponded the area of the highest velocity values (Pic.1a). At the upper level of the boundary layer the kinetic energy maxima occupied the whole zone of "Omar" and an extra-tropical perturbation developing to the north of the hurricane (Рис.1 d). Vortices were not observed in the upper troposphere, a strong meridional flow (with wind speeds up to 30-50 m/s) possessing high values of kinetic energy corresponded these areas.

At 12 GMT on the 17.10 "Omar" started interacting with the polar front approaching low latitudes and the extra-tropical synoptic-scale disturbance mentioned earlier in the paper. Modification of the velocity field occurred. A strong southern flow uniting two cyclones appeared in the lower and in the middle troposphere. Their interaction expressed in consolidation of vorticity and kinetic energy maxima zones became apparent at 850 hPa (Pic. 1d,e,f).

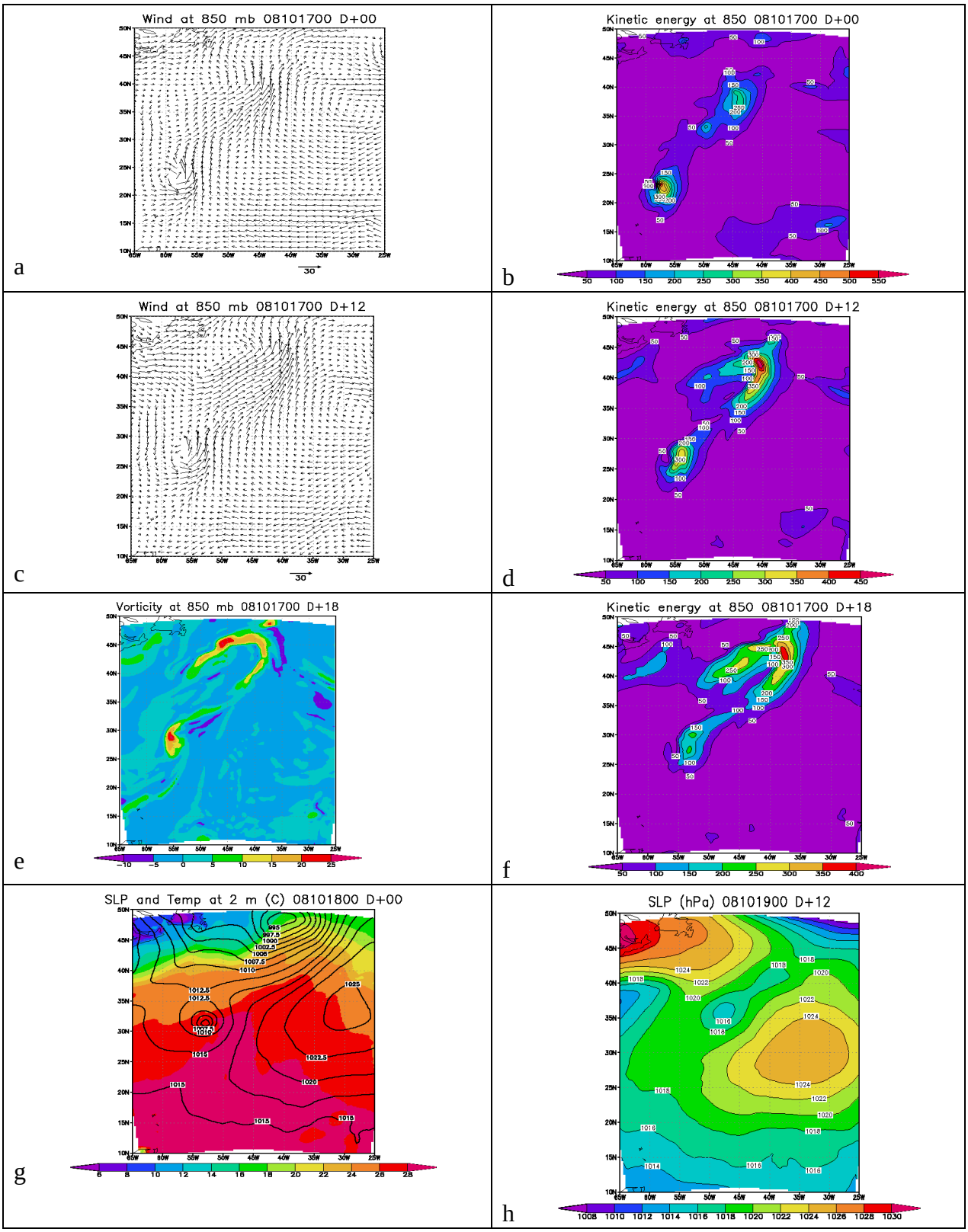
The absolute values of kinetic energy of the extra-tropical cyclone exceeded these in "Omar". Besides that, the polar-frontal cyclone began to deepen rapidly. The reinforcement of environmental flow happened at 250 hPa.

Both vortices were situated on the western periphery of North-Atlantic maximum and were propagating northeastward. The extra-tropical cyclone possessed a well-developed warm sector with a tropical maritime air mass circulating in it (Pic. 1g), while the cold polar and arctic air was penetrating behind the cold front. Both cyclones were rather small and weak, so they could not spread towards the upper troposphere. At the altitude of 1.5 km one could observe both cyclones, however, tropical cyclone "Omar" was expressed better (Pic. 1c)

Calculations made for 18 GNT 17.10 showed two separated fronts of the extra-tropical cyclone that had turned from a wave into a young cyclone (Pic.1e,f). An extensive common belt of vorticity joining two cyclones formed at 850 hPa (Pic.1e), it can serve as an indicator of interaction between the tropical cyclone and the polar front. In the end of the 17.10 a sufficient thermal heterogeneity appeared in "Omar" which was accompanied by the rapid deepening of the extra-tropical cyclone moving northeastward (Pic.1g).

The interaction of vortices continued during the 18.10. The south-western stream formed by the cyclones brought warm and very humid air in the northern regions of the Atlantic. On the 19.10 "Omar", being involved into the strong flow, began moving northeastward to European shore and got into the baric trough of the extra-tropical cyclone, which led to the merging of the cyclones. The polar front was clearly identified in the vorticity field and this powerful formation influenced considerably the weather in Europe.

So we can conclude that computational results produced by ETA model demonstrated that tropical cyclone "Omar" interacted with the polar front and the synoptic disturbance developing on it; the interaction of these structures led to the energy transfer from "Omar" to the extra-tropical cyclone and to the intensification of the latest. The large amounts of energy accumulated by the hurricane played a considerable role in the formation of positive temperature anomalies in autumn of 2008 in Europe.




Pic.1. a) Wind at 850 hPa 17.10.2008 0 GMT; b) Kinetic energy at 850 hPa 17.10.2008 0 GMT; c) Wind at 850 hPa 17.10.2008 12 GMT; d) Kinetic energy at 850 hPa 17.10.2008 12 GMT; e) Vorticity at 850 hPa 17.10.2008 18 GMT; f) Kinetic energy at 850 hPa 17.10.2008 18 GMT; g) Sea-level pressure and temperature at 2 meters 18.10.2008 0 GMT; h) Sea-level pressure and temperature at 2 meters 19.10.2008 12 GMT