On the evolution of tropical cyclones over islands

Glebova E.S., Pokhil A.E.
Hydrometeorological Centre of Russia
ek.glebova@gmail.com

The influence of small pieces of land (archipelagos, islands) on tropical cyclone's configuration and structure is investigated.

The evolution of meteorological fields in tropical cyclones was calculated with mesoscale numerical model of atmosphere ETA. Two typhoons of the Pacific ocean (Ketsana and Jangmi) and two hurricanes of the Atlantic (Gustav and Hanna) were studied. Computational results for some of them are discussed below.

Typhoon Ketsana formed on the 25th of September (2008) nearly in the centre of the Pacific ocean and developed till the 29th of September. At first it was developing as a tropical storm, but at 0 GMT on 28.09 it reached the category of a hurricane with velocities exceeding 45 m/s. The vortex crossed Philippines and approached the Southern Chinese Sea.

Sea level pressure, wind, kinetic energy, humidity and vorticity were calculated with the ETA model.

In the pictures 1a,b the storm winds area and the kinetic energy field on the 850 hPa isobaric surface during cyclone's passage over the archipelago are shown.

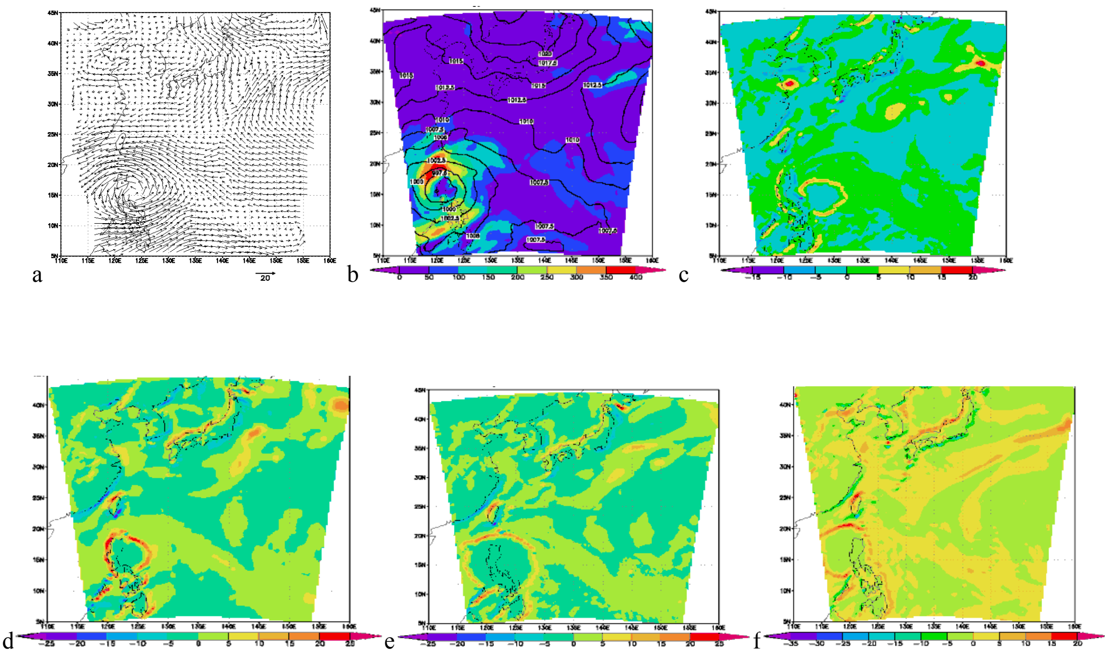
The computational results (pic.1 c,d,e,f) demonstrate clearly the vorticity field evolution. The storm winds circle and the area of the maximal vorticity have over the ocean the correct concentric form. As the typhoon approaches the land and begins moving over it, the circle loses its symmetric form, the vortex weakens strongly and, finally, the circle destroys. The energy in the part of the typhoon crossing the land is much less than the energy over the sea surface. When some parts of the cyclone have already crossed the island, the vorticity in them begins to increase (pic. 1d). Further the extension of the vorticity area is observed (pic.1e). It is accompanied by the weakness of the parts still crossing the land. The closed structure of the typhoon is destroyed due to the decrease in warm sea surface area reduction below the vortex (pic.1f).

Typhoon Jangmi. On the 23rd of September 2008 in the western part of the Pacific a tropical disturbance was formed. In a few hours it developed into a hurricane and was called Jangmi. On the 27th of September Jangmi became a supertyphoon with winds more than 60 m/s and with sea level pressure in the centre equal to 910 hPa. The typhoon reached Taiwan and brought heavy rains and choppy wind there. Pictures 2 a,b,c demonstrate the fields of pressure, kinetic energy and wind.

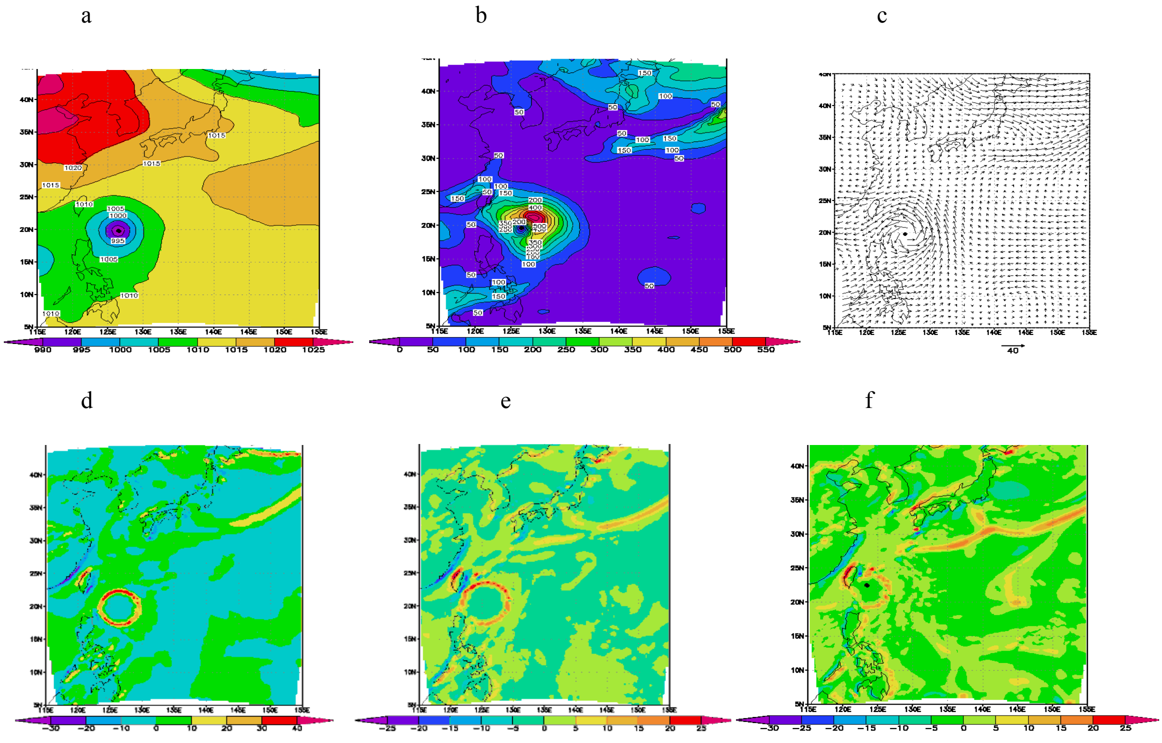
On the 25th of September the typhoon was moving over the ocean and the area of the vorticity maxima had a form of a small circle situated to the east from Philippines (pic.2d). Rapid intensification of the cyclone occurred on the 27th of September when it developed into a typhoon. At the same time a local maximum of vorticity at 1000 hPa over Taiwan appeared. (pic.2e). Typhoon's approach must have been the main reason for that. Under the influence of Philippines the storm winds circle in the south-west of the vortex was broken (pic.2e). At 12 GMT the wind circle was completely destroyed. At 18 GMT 27.09 the typhoon approached Taiwan. Strong decrease in the wind speed (to 16 m/s) and in the vorticity at 1000 hPa as well as storm wind circle's destruction was observed (pic.2f). The dynamics if the intensity was due not only to the increase in friction, but also to the relatively cold sea surface in the region. Notwithstanding this fact, the wind and the kinetic energy at 850 hPa remained high which evidences the weakness of the typhoon only near the surface.

Evolution of Caribbean hurricanes Hanna and Gustav (August 2008) over Antilles happened following the same scenario.

We can conclude that passage over even small and narrow pieces of land leads to the destruction of symmetric circulation and to considerable losses of kinetic energy in the cyclone. Kinetic energy and vorticity generation in the warm core decreases strongly due, first of all, to the decrease in horizontal pressure gradient which is caused by moving away from the warm sea surface. Returning on the ocean surface is followed by re-intensification of the cyclone.



Pic. 1. a) Real field of wind at 850 hPa at 0 GMT 26.09; b) Real field of kinetic energy at 850 hPa at 12 GMT 26.09. Calculated fields of vorticity at 1000 hPa for c) 6 GMT 25.09.; d) 0 GMT 26.09.; e) 6 GMT 26.09.; f) 18 GMT 26.09.



Pic.2. Real fields at 0 GMT 27.09: a) sea level pressure; b) kinetic energy at 850 hPa; c) wind at 850 hPa; d) corticity at 1000 hPa. Calculated fields of vorticity at e) 6 GMT 27.09 and f) 18 GMT 27.09.