Testing waterspout forecasting indices over the Adriatic sea using ALADIN model

Tanja Renko, Tomislav Kozarić, Martina Tudor
Meteorological and Hydrological Service, Grič 3, HR-10000 Zagreb, Croatia
tanja.renko@cirrus.dh.hr, tomislav.kozaric@cirrus.dh.hr, martina.tudor@cirrus.dh.hr

1. Introduction
Several waterspout events occur in Croatia every year. This has motivated us to develop and test a waterspout forecasting tool. Forecasting waterspout events is of great importance since they can be dangerous and cause damage, especially in a case of landfall. In our further work we plan to collect more data to improve the waterspout forecast. Still there is a need to collect more data to improve the waterspout forecast.

2. About the ALADIN model
ALADIN (Arktis Limitez Adaptation Dynamic development InterNational) is a limited-area model (LAM) built on the basis of the global ERS/ARPEGE model. The output surface wind fields from the 8-km resolution Croatian domain have been dynamically adapted to orography with a 2-km resolution. ALADIN model data are used to compute SWN and KHS for waterspout events in 2010.

3. SWN and KHS indices
• The KHS index is based on four criteria: wind shear 0-3 km (wind speed 10 and 15 m wind speed)
  • The KHS index includes wind shear, temperature differences, 850 mb wind speed, and the presence of thunderstorms.
  • The SWN index is based on four criteria: wind shear 0-3 km, temperature differences, 850 mb wind speed, and the presence of thunderstorms.
  • The SWN and KHS indices are used in the waterspout nomogram (SWN).

4. Waterspout cases of 2010
• 19 cases: 7 before noon, 3 around noon, 8 in the afternoon, and 1 after midnight. All but five cases are considered as thunderstorm-related, while the other 14 are considered as fair-weather. The KHS index is based on four criteria: wind shear 0-3 km, temperature differences, 850 mb wind speed, and the presence of thunderstorms.
• The SWN index is based on four criteria: wind shear 0-3 km, temperature differences, 850 mb wind speed, and the presence of thunderstorms.
• The SWN and KHS indices are used in the waterspout nomogram (SWN).

5. Summary/conclusion
The research shows that most of the analyzed waterspout events were thunderstorm-related; however, for those that were not fair-weather, more than 70% of the analyzed cases were thunderstorm-related. The KHS index is based on four criteria: wind shear 0-3 km, temperature differences, 850 mb wind speed, and the presence of thunderstorms. The SWN index is based on four criteria: wind shear 0-3 km, temperature differences, 850 mb wind speed, and the presence of thunderstorms.

6. References

01 January 2010
The waterspout activity was observed between Maksimika and the island of Hvar at 12:40 UTC. There was a single well-developed vortex that was connected to the base of a large convective cloud. Convection was associated with strong southeasterly flow in the middle troposphere at the leading edge of a trough extending from Alpine region to North Africa. At the surface a cold front was passing from southeast to the north in the Gulf of Genoa. Thermodynamical environment was favorable for waterspout development (KHS near 30, TT over 51). In this case the KHS index gives no values but the SWN for the area of interest (magenta dots) gives very good results, giving favorable conditions for waterspouts.

30 May 2010
The waterspout activity was observed in the middle of the day in the vicinity of town Poreč. The interesting thing was long duration of the waterspout from which we can conclude that multi-vortex event happened. As in the previous case this event was also connected to a well-developed deep convective cloud, associated to prefrontal cloud band with the surface cold front and the line of convergence just passing the Apirine region. The dominant flow was southeasterly due to short wave trough in the upper levels. In the North Adriatic vorticity advection (PVA) maximum was present, connected to left exit region of a jet streak, which was surely enhancing the convection. Again the KHS index failed because the values where to small in the region of interest, but the SWN gives favorable conditions for even thunderstorm-related waterspouts over the whole Adriatic, especially in Istria region (blue dots).

21 June 2010
The first day of summer 2010 in the Adriatic was also recorded as a day with waterspout activity. This time waterspout was observed near Dubrovnik airport in the southern Adriatic in the early afternoon hours lasting for 17 minutes. There was a closed low present over the Adriatic and a cold front has just passed the Dubrovnik area. In the middle troposphere cold advection with presence of cold core, together with positive vorticity advection in the region, set favorable conditions for insularity. In comparison with previous two analysed cases, the KHS index in this case show some significant values (higher than 1) in the upstream area, but also not as high as could be expected. SWN gives positive waterspout potential in the Dubrovnik area (red dots), again performing as good predictor of conditions favorable for waterspouts.

11 November 2010
The one of two November cases was reported near Dubrovnik around sunset, as we assume it was around 17 UTC. According to satellite image at 17 UTC there was some cloudiness near Dubrovnik, however no deep convective clouds, because there was no lightning activity around the time of interest. It seems that the waterspout was connected to a line of cumulus congestus clouds, so can be treated as fair-weather as defined in literature. The 300 hPa analysis chart shows long wave trough oriented north to south with axis crossing central Adriatic. A thermal trough axis was just a little bit to the west meaning that cold advection was present in mid-levels. The sounding from station of Biograd at 12 UTC showed no CAPE in the updraft, however some instability existed according to KI being a little less than 30 and TT index around 50. Again KHS waterspout index shows marginal values around 1 and SWN for Dubrovnik area (red dots) fulfills conditions for waterspout development, not necessary thunderstorm related, as was this case.