Cloud Model Simulation

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In 2017 a tornado took beneath the international airport „Wien Schwechat" place. It was caused by a supercell in the eastern parts of Austria. This poster presents a cloud model simulation about this special event. The model was set up with the help from Univ.-Prof. Vlado Spridonov, PhD. There are several very interesting parameters to look at, but only a few of them can be presented in this work.

Formation of a tornado

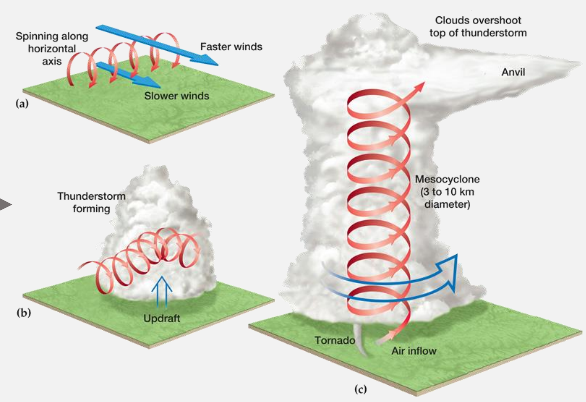
The basic fundament for a Tornado is strong vertical wind shear at the surface. A vortex with a horizontal rotation axis is formed. Caused by convection the vertical wind can increase. If there are strong upwinds nearby one of this horizontal vortexes it will be lifted and the axis will change their direction. It is now rotating vertically. Figure 1 showis this procces.

Supercell & Tornado over Schwechat

A supercell is a special category of thunderstorms. Because of their rotation a single cell can live for up to 8 hours and can cause heavy rainfall or hail. Figure 2 shows the simulation of the supercell over Schwechat. Figure 3 shows a picture captured on 10th July 2017. It is only a picture but you can really imagine the rotation of the tornado and the supercell over Schwechat.

Figure 1
Formationtheory of a Tornado

Credit: Pearson Prentice Hall, Inc.



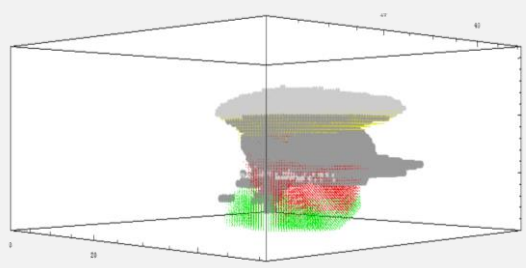


Figure 2
Simulation of supercell over Schwechat

Figure 3
Photo of Schwechat-Tonrado

Cloud resolving model

In order to capture the initiation of supercell storm and evolution of tornado we have conducted also a three-dimensional simulation using a cloud resolving model with fine horizontal grid resolution and small domain which covers the tornadic storm area of 61x61x60 km³. The cloud model is a 3-D non-hydrostatic, compressible time-dependent, model with dynamic scheme from Klemp and Wilhelmson (1978), thermodynamics proposed by Orville and Kopp (1977), and bulk microphysical parameterization scheme according to Lin et al. (1983). The present version of the model contains ten prognostic equations: three momentum equations, the pressure and thermodynamic equations, four continuity equations for the water substances, and a subgrid-scale kinetic energy equation. More information regarding the cloud model could be found in Telenta and Aleksic (1988), and Spiridonov and Curic (2005), Barth et al. (2007). The cloud model is initialized using a warm ellipsoid thermal bubble with the maximum temperature perturbation of 2.0 °C in the bubble centre as suitable for highly unstable atmosphere to trigger severe convective storm. The initial meteorological conditions were taken from upper air sounding from Wyoming University. A three-dimensional (3-D) runs were performed within small domain with size 51x51x20 km3 that covers the central part of Vienna City area and its southern part where supercell storm and tornado occurred. The horizontal grid length is 250 m, while the vertical resolution is 100m in the PBL layer and 250 at the higher altitudes, respectively. The time step of the model is 1 s and the smaller one is 0.2 s for solving the sound waves. The results are summarized and some of them are exhibited and discussed in the Results Section.

Conclusion

All in all cloud models are a great way to analyse former thunderstorms and hevy rain events. This is a very important step for the prediction of occurences like this.

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