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Upper air forcing of convection: the case of Gdańsk flood on 9 July 2001

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During the day of 9 July 2001 intensive convective precipitation in Gdańsk area (Poland) resulted in urban flash flood which damaged the town infrastructure and took human life. The accumulated precipitation exceeded locally 100 mm, reaching a quarter of the climatological annual sum for the area.
The convection developed within a quasi-stationary frontal zone which evolved and moved over south-western and central Europe during the previous days. The satellite water vapour (WV) imagery for that day indicates a presence in the area of dry intrusions of different origins which suggests a presence of stratospheric positive potential vorticity (PV) anomalies in the upper troposphere/lower stratosphere.
At that time, the event was not correctly forecasted by the operational regional COSMO model used by IMGW and working with horizontal grid step of about 14 km. A comparison of model induced PV distribution with PV signatures on WV images shows a presence of mismatches between the two at the time of model initialisation at 00.00 UTC. Later, the model induced PV and PV signatures on WV images diverge even stronger with further evolution of the system.
The study aims at reconstruction of the main features of the actual PV distribution in the upper troposphere/lower stratosphere at 00.00 UTC of 9 July 2001 and at assessing its influence on the convective development in the Gdańsk region. There is no general recipe to reconstruct the 3-dimensional PV distribution from the 2-dimensional WV imagery, so a number of alternative PV distributions at 00.00 UTC is tested. As they would result in alternative scenarios of PV evolution during the day, the likely scenario with its initial PV distribution is sought via its proximity to the actual evolution of PV signatures on WV imagery. The alternative scenarios are produced with a prognostic non-linear balanced (NLB) model based on conservation and invertibility of PV. The assumption that diabatic process do not significantly alter the PV distribution during that day is justified by close proximity of the NLB and COSMO evolutions of PV when the former is initialised with the PV distribution taken from the COSMO model.