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Automation of the hail suppression system in Serbia

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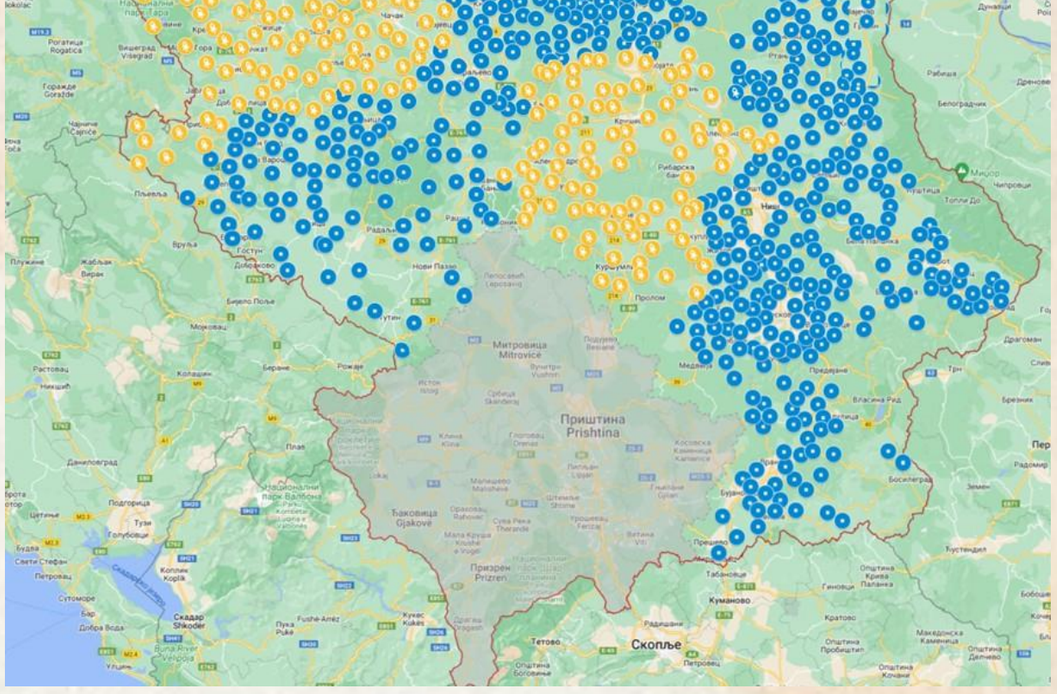
The Design of the Hail Suppression Rocket System in Serbia

The rocket system is based on radar measurement of convective clouds, software applications for automatic radar data processing and implementation of actions of HASIS (HAil Suppression Information System), network of launching stations. From the radar centers, launch stations are remotely controlled automatically and anti-hail rockets are fired without an intermediary. Each launching station is provided with one automatic multitube launcher equipped with 9 to 12 hail suppression rockets with remote commands. The launching stations are equally placed over the whole protected area.

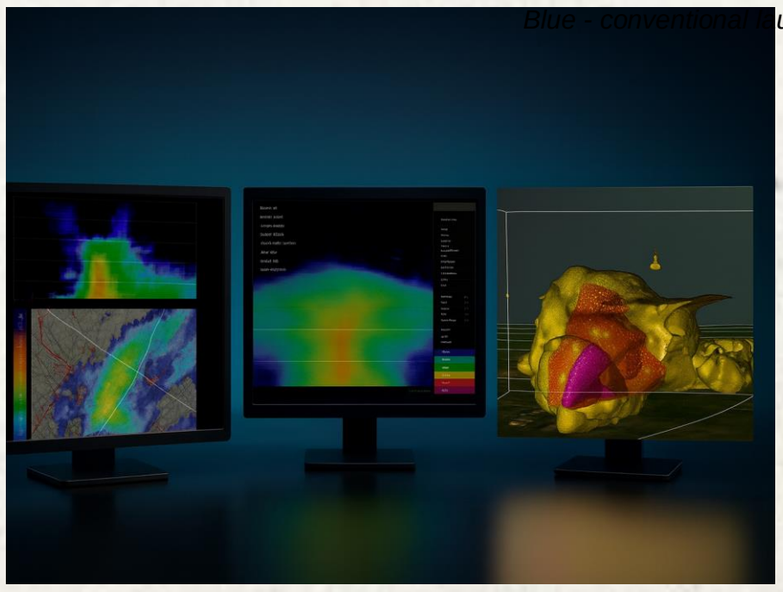
Automation has so far covered 5 of the 13 radar centers in Serbia, with a total of 532 ARLS, complete at 4 centers "Valjevo", "Fruška Gora", "Bajša" and "Samoš" with 488 ARLS (Automated Remote Launch Stations) and the first phase at RC "Bukulja" with 44 ARLS.
The plan is to automate all radar centers in the period from 2024 to 2028 and that real radar data are used for the numerical cloud model.

Radar control center "Fruška gora"



Red - 532 Automated Remote Launch Stations, Yellow - 236 ARLS projected in 2024-2025, Blue - conventional launch stations

Radar center worflow

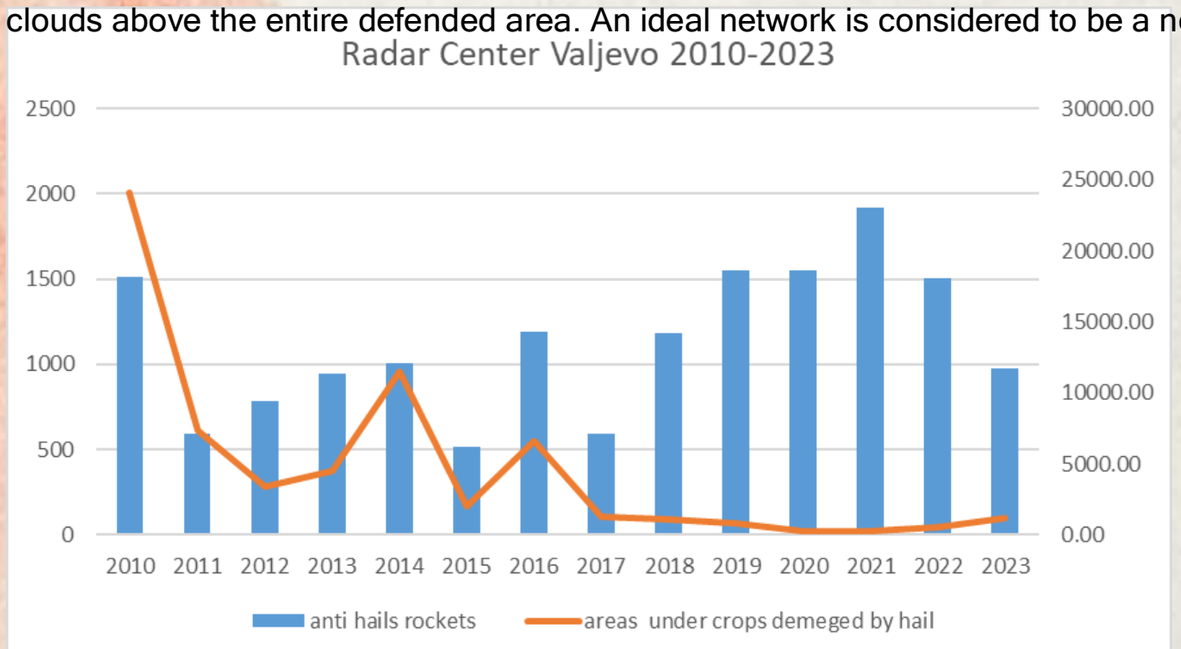


3D cloud visualisation

Station equipment

Rocket specifications

Trayal's rockets have a range of 6 to 12 km and carry 400 grams of agent AgJ, i.e. potential 10^{16} nuclei of crystallization, otherwise written 10,000,000,000,000,000 (ten million billion) potential nuclei, , and it seeds it in atmosphere where the temperature varies from -4° to -12 °C.. Therefore, in order to protect an area with rockets, it is necessary to have a built network with a sufficient number of launch stations, so that a sufficient amount of reagent can be inserted into the seeding zones of hail clouds above the entire defended area. An ideal network is considered to be a network of launch stations, which are at a distance of 7-8 km from each other.



Efficiency

Observing the affected areas with hail stones for the period from 2002 to 2025, in the territory of Radar Center "Valjevo" in the last five years with Trayal's automated system, they were reduced 6,5 times and from 1.7% to only 0.27%, that is, 2.7‰ of arable land. The table shows the basic data, and the graphic shows the data on the number of rockets fired and the areas where there was damage to crops and fruits. Investments in automation, through the protection of agricultural crops and fruits, paid off already in the first year.