

# INFLUENCE OF OROGRAPHY ON HAIL CHARACTERISTICS IN THE CONTINENTAL PART OF CROATIA

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**Abstract:** In the continental part of Croatia operational hail suppression has been conducted more than 30 years. The protected area is between Sava, Drava and Mura rivers and is part of Panonian basin. In the neighbouring Slovenia, very close to the western border of protected area, are mountains such as Pohorje, Haloze that are eastern ends of Alps, and also mountains in Croatia - Ivančica, Ravna Gora, Strahinčica, Plešivica, Medvednica and Kalnik, all with top heights of about 400 to 1100 m above mean sea level. The mountains in the eastern part of protected area, Psunj, Krndija, Papuk and Dilj are connected with above mentioned in the western part through relative lower mountain – Bilogora. The analysis shows influence of orography, especially in the western part with some greater mountains. This influence is seen in a greater number of days with hail and small hail in a hilly terrain and in a shorter average duration of a hailfall in the lee side of the mountains.

**Keywords:** *hail and small hail, orography, hailfall duration*

## 1. INTRODUCTION

Croatia is settled in the mid latitudes of the Northern Hemisphere, and therefore is exposed, mainly in the summer months - hail suppression season (01.05-30.09), to the frequent occurrence of thunderstorms, especially in the continental part where rich soil and modest climate enable intensive agricultural production. In the 1960s, aiming to protect agricultural production and reduce damage from hail, a hail suppression system was introduced in that area. The protected area is between Sava, Drava and Mura rivers and is part of Panonian basin. The whole protected area today is 25 177 km<sup>2</sup> and is covered with 492 hail suppression stations which are managed with 8 radar centres.

In the neighbouring Slovenia, very close to the western border of protected area, are mountains such as Pohorje, Haloze, Boč that are eastern ends of Alps, and also mountains in Croatia – Ivančica, Ravna Gora, Strahinčica, Žumberačka gora, Medvednica and Kalnik, all with top heights of 400 to 1100 m above mean sea level. The mountains in the eastern part of protected area; Psunj, Krndija, Papuk, Požeška gora and Dilj are connected with above mentioned in the western part through relative lower mountain – Bilogora.

## 2. DATA

During hail suppression operations in the period 1981-2004, about 10 000 reports were collected over the whole-protected area on the occurrence of hail or small hail on the hail suppression stations. During the 2001 hailpads were installed on all hail suppression stations, and this data collected in period 2001-2004 are also used in this analysis. Radar data collected in period 1981-2004 are used to determine direction and speed of Cb cells.

### 3. RESULTS AND ANALYSES

Radar data collected in period 1981-2004 enabled a good understanding of convective cell movement. Such analysis is made for all cells and cells with hail on the ground. Results show that more than 72% cells with hail on the ground come from western directions (W, NW and SW), with velocity between 25 and 70 km/h. This means that the most hailbearing cells come from Slovenia (Počakal, 1999).

From collected data, the mean number of days with hail and small hail is calculated for all station that continually worked in this period. On the basis of these parameters, spatial distribution of mean number of days with hail and small hail is made for the whole-protected area (Počakal, 2004). Western part is area with the greatest number of days with hail and small hail, specially are visible areas with average more than two days with hail per season on the lee side of mountains. Analysis of hailfall duration in this area shows shorter average duration of hailfall in the lee side.

Middle flat area has mostly, minimum of average number of days with hail and small hail in season, and the value ranges from 0.1 to 0.9 days.

Eastern part of protected is combination of these two above-mentioned parts. Areas with low mountains have greater number of days with hail then parts that are completely flat. Considering the primary western directions of hailbearing CB clouds, Požega valley is in the lee side of the surrounding mountains. This area has in average more days with hail and small hail (1.0-1.9 days) per season and shorter duration of hailfall then surrounding area.

Data from hailpads show reduction of hailstone diameter and kinetic energy, especially in area between mountains Ivančica and Medvednica (Zagorje), but for complete analysis there are not enough hailpad data from whole-protected area.

### 4. CONCLUSION

The analysis shows influence of orography, especially in the western part with some greater mountains. This influence is seen in a greater number of days with hail and small hail in a hilly terrain and in a shorter average duration of a hailfall in the lee side of the mountains.

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