Operational hail forecasting in Greece

Georgios Papavasileiou, Vasiliki Kotroni, Konstantinos Lagouvardos, and Theodore M. Giannaros

Institute for Environmental Research and Sustainable Development, National Observatory of Athens, Greece

papavasileiou@noa.gr PapavasileiouWX

1. Introduction

- Hail in Greece is a common phenomenon mainly during the warm half of the year from March to October.

- Often causing significant damage to crops, cars (e.g. broken windshields, dents), solar panels, solar water heaters, brick rooftops and greenhouses (Sioutas et al., 2009; Papavasileiou et al., 2022).

- According to Sioutas et al., 2009, only in Central Macedonia (Northern Greece), the estimated annual average crop hail loss is roughly estimated at about 20 million Euros.

- Nevertheless, to best of our knowledge, an operational hail forecasting system was missing in Greece.

- Since 2021, the METEO unit of the National Observatory of Athens (NOA) implemented a multi-model operational hail forecasting system.

2. Data and Methods

- In our forecasting system we make use of four high-resolution numerical weather prediction (NWP) models:

- BOLAM (6 km) operated by METEO/NOA
- WRF-ARW (2 km) operated by METEO/NOA
- MOLOCH (2 km) operated by METEO/NOA
- ICON-EU (7 km) operated by German Weather Service (DWD)

- We use the 00Z and 12Z initialization times over the domain of Greece extending from 18° to 30°E and from 34° to 43° N

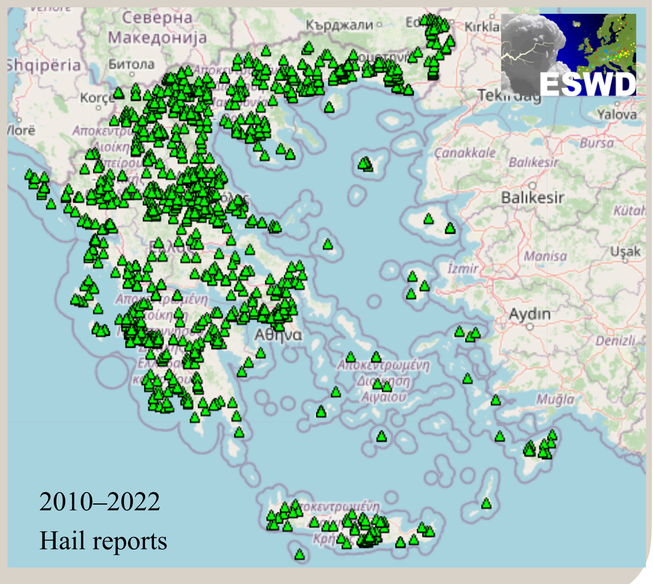
- We apply the Hail Size Index (HSI) that was developed by Mateusz Taszarek (see Czernecki et al., 2019, Taszarek et al., 2017) as an offline diagnostic tool for forecasting the expected maximum hail size.

$$HSI = \frac{\sqrt{10(CAPE - 200)} \times (BS - 5) \times (7000 - FL + LCL)}{194000} \times \sqrt{EL\frac{(LR - 4)^2}{10000000}}$$

- The lack of radar data and a nationwide hailpad network makes the validation of these forecasts challenging and is primarily based on online press news and social media reports collected at the ESWD.

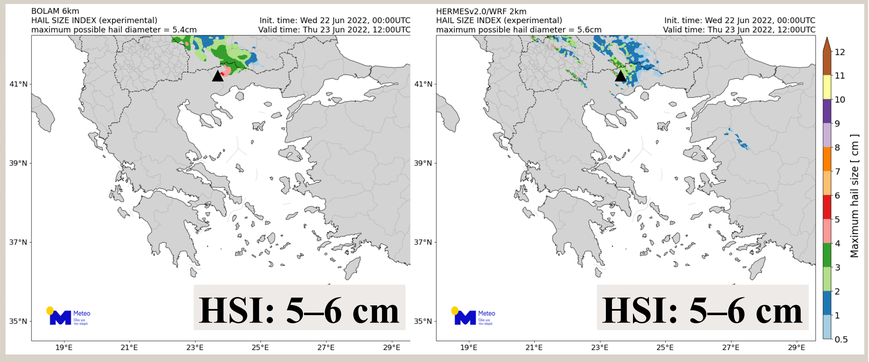
- We use hail reports from the European Severe Weather Database (ESWD) provided by the European Severe Storms Laboratory (ESSL).

- We primarily focus on large hail events (≥ 2.5 cm), but we also assess the predictability of high accumulation of small hail (≤ 2.5 cm) which can still pose a threat to agriculture and travel safety.

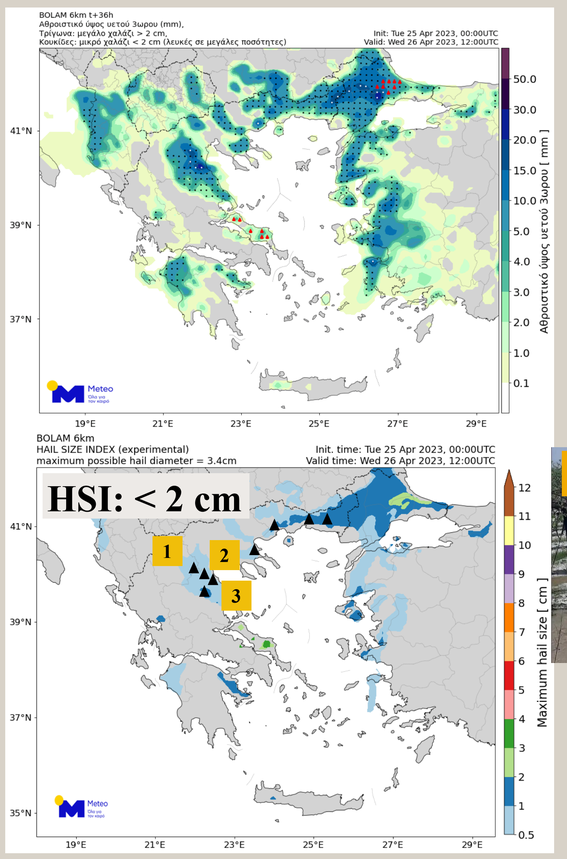


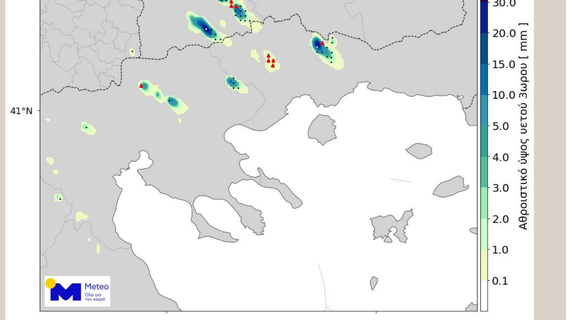
3. Hail size predictions

- Large hail

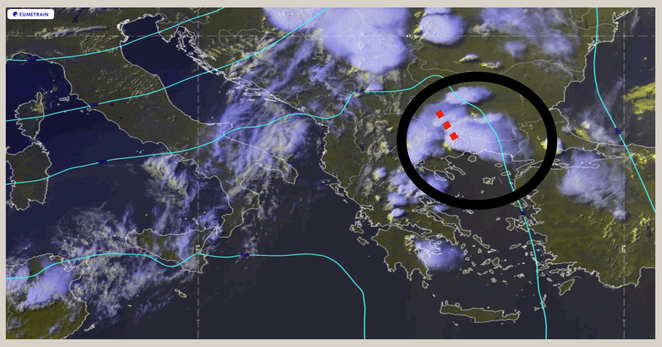


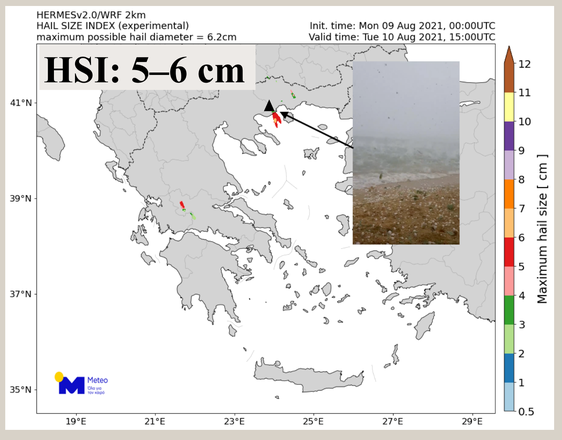
- High accumulation of small hail

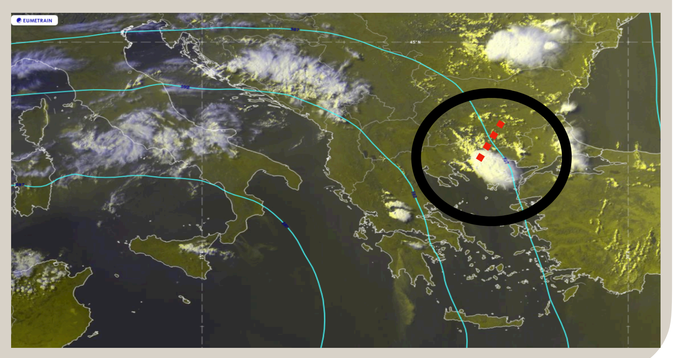


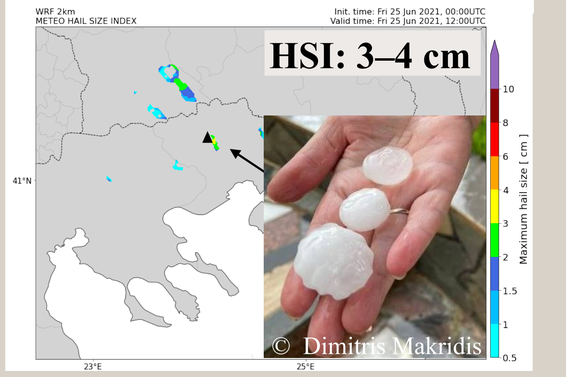


- Challenging storm predictability under weak synoptic forcing









4. Conclusions and outlook

- The operational hail forecasts produced by METEO are evaluated on a weekly basis, particularly during the warm half of the year.

- Our preliminary analysis after nearly two years of operations shows good agreement with observations, both qualitatively & quantitatively.

- In the future we aim to test a probabilistic forecasting approach using a pseudo-ensemble of NWP forecasts using the different NWP initializations.