ministero delle politiche agricole alimentari e forestali

IEEE Advancing Technology for Humanity

UNIVERSITÀ DI TRENTO

2020 IEEE INTERNATIONAL WORKSHOP ON METROLOGY FOR AGRICULTURE AND FORESTRY

Virtual Conference

MetroAgriFor

For further information, visit the website
www.metroagrifor.org

WORKSHOP PROGRAM

ATHENA SRL
Business and technology consulting

15:40 Understanding the tradeoffs of LoRaWAN for IoT-based Smart Irrigation

Bruno Queté, Federal University of ABC, Brazil
Alexandre Heideker, Federal University of ABC, Brazil
Ivan Zyrianoff, Federal University of ABC, Brazil
Dener Ottolini, Federal University of ABC, Brazil
João Henrique Kleinschmidt, Federal University of ABC, Brazil
Juha-Pekka Soininen, VTT Technical Research Centre, Finland
Carlos Kamienski, Federal University of ABC, Brazil

16:00 Enhancing Soil Measurements with a Multi-Depth Sensor for IoT-based Smart Irrigation

André Torre-Neto, Embrapa Instrumentation, Brazil
Jeferson Rodrigues Cotrim, Federal University of ABC, Brazil
João Henrique Kleinschmidt, Federal University of ABC, Brazil
Carlos Kamienski, Federal University of ABC, Brazil
Marcos Cezar Visoli, Embrapa Agricultural Informatics, Brazil

15:00 - 16:20 CET

Session 2.2 - Innovative Data Analysis Solutions in the Agri-Food Sector - PART 1

Room: *Virtual Room #2*

Chair: Chiara Cevoli, *University of Bologna, Italy*

15:00 Analysis of performances of a commercial threedimensional (3D) reconstruction camera

Domenico Giora, University of Padova, Italy
Andrea Pezzuolo, University of Padova, Italy
Diego Tomasi, CREA-Council for Agricultural Research and Economics, Italy
Francesco Marinello, University of Padova, Italy
Luigi Sartori, University of Padova, Italy

15:20 A data-driven methodology to assess the accumulation risk in agricultural insurance contracts

Andrea Marini, Idea-Re S.r.l., Italy
Loris Francesco Termite, Agrosit S.r.l., Italy

Massimiliano Proietti, Idea-Re S.r.l., Italy
Alberto Garinei, Guglielmo Marconi University, Italy
Gianluca Ferrari, Radarmeteo S.r.l., Italy
Marcello Marconi, Guglielmo Marconi University, Italy

15:40 Simply Time Domain Reflectometry system for food analysis
Eleonora Iaccheri, University of Bologna, Italy
Annachiara Berardinelli, University of Trento, Italy
Luigi Ragni, University of Bologna, Italy

16:00 In-field Vis/NIR hyperspectral imaging to measure soluble solids content of wine grape berries during ripening
Alessandro Benelli, University of Bologna, Italy
Chiara Cevoli, University of Bologna, Italy
Angelo Fabbri, University of Bologna, Italy

16:30 - 17:50 CET
Session 1.3 - Special Session on Integrated Water Management for Agriculture (PART II): Architectures, Platforms and Sustainability - PART 2
Room: *Virtual Room #1*
Chairs: Luca Roffia*, University of Bologna, Italy*
Cristiano Aguzzi*, University of Bologna, Italy*

16:30 e-SmallFarmer - A solution for small farming
Diogo Pinto, Polytechnic Institute of Braganca, Portugal
Rui Alves, Polytechnic Institute of Braganca, Portugal
Paulo Matos, Polytechnic Institute of Braganca, Portugal
Duarte Pousa, Polytechnic Institute of Braganca, Portugal

16:50 The SWAMP Farmer App for IoT-based Smart Water Status Monitoring and Irrigation Control
Ramide Augusto Sales Dantas, Federal Institute of Pernambuco (IFPE), Brazil
Milton Vasconcelos da Gama Neto, Federal Institute of Pernambuco (IFPE), Brazil
Ivan Dimitry Zyrianoff, Federal University of ABC, Brazil
Carlos Alberto Kamienski, Federal University of ABC, Brazil

2020 IEEE INTERNATIONAL WORKSHOP ON

METROLOGY FOR AGRICULTURE AND FORESTRY

VIRTUAL CONFERENCE / November 4-6, 2020

A data-driven methodology to assess the accumulation risk in agricultural insurance contracts

Andrea Marini, *Idea-Re S.r.l., Italy*

Loris Francesco Termite, *Agrosit S.r.l., Italy*

Massimiliano Proietti, *Idea-Re S.r.l., Italy*

Alberto Garinei, *DIS Guglielmo Marconi University, Italy*

Gianluca Ferrari, *Radarmeteo S.r.l., Italy*

Marcello Marconi, *DIS Guglielmo Marconi University, Italy*

Overview

- **Accumulation risk** in agricultural insurance contracts.

> **Accumulation**: concentration of similar risks in a particular area such that an insured event may result in **several losses at the same time.**
>
> [Roberts, R. A. (2005)]

- No systematic approach to handle accumulation risk in the agricultural insurance sector can be found in scientific literature.

Motivation

- Insurance agents need an **algorithmic way** to determine if request of a new insurance contract will expose the company to an excessive accumulation risk.
- The answer depends on **spatial distribution of the contracts** that are already in the company's portfolio.
  - Distribution of **insured value** of contracts located in the **neighborhood** of the new contract under evaluation.

Objective

- A natural question arises as soon as one tries to formulate a definite algorithm to evaluate the accumulation risk:

How does one define the extension of the neighborhood of a contract with respect to the accumulation issue?

- The main objective of this study is to provide a sensible answer to this question.

Proposal

- The **cumulus of damages** of two (or more) contracts happens when the **same weather event** determines harms on the crops covered by those contracts.

The characteristic distance between crops influencing the probability of occurrence of cumuli should be determined by the **typical extensions of the weather event** under consideration.

- The core of the proposed methodology is to use **historical data** to determine the **average extension** of the harmful weather events, assuming that this quantity can vary over the territory.

Available data

- Four different kinds of weather adversities were analysed in this study: **hail**, **cold wave**, **heavy rain** and **strong wind**.
- The available data span over four years (2016-2019) for hail, ten years (2010-2019) for cold waves, heavy rain and strong winds.
- For all of the adversities, **daily updated maps of measures** provided by radars and satellites were available, covering the whole Italian territory.
- The spatial resolution of the maps is equal to **0.01 degrees of latitude and longitude** (corresponding to pixels with an area of approximately 0.79×1.11-km^2 at the Italian latitudes).

Events' thresholds

- Cold wave, heavy rain and strong wind maps are characterized by binary values, based on defined thresholds for each measured variable.

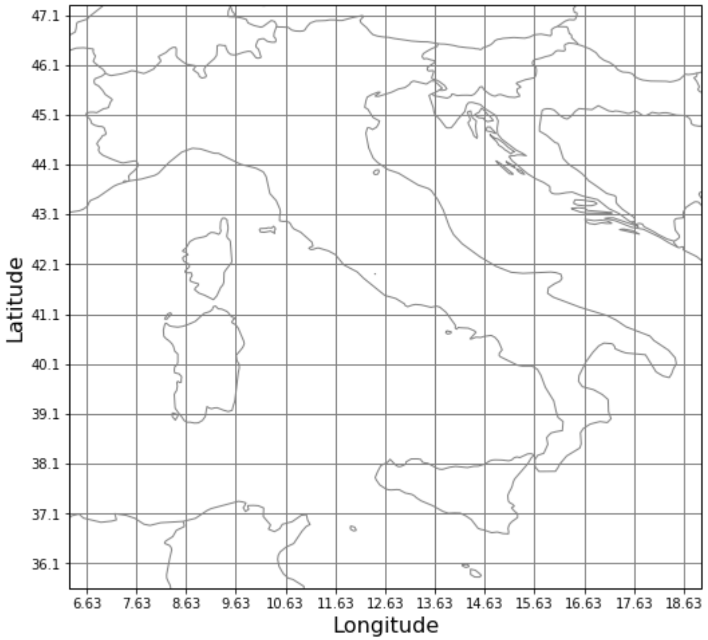
Weather event	Threshold
Cold wave	Temperature ≤ 0° C
Heavy rain	80 mm of rain in the last ten days (including the selected day) OR 30 mm of rain the selected day
Strong wind	Wind speed ≥ 50 km/h

- Hail maps show probability values for each pixel.

Strategy

The strategy to determine the average spatial extension of the adversities consists of **three steps**:

1. The territory is divided into **non-overlapping patches**, containing 100 pixels per side.
2. For each patch, the **average radius of extension** of the events is computed from **historical data**.
3. A **blur filter** is applied in order to smooth out the spatial variability of the radius of extension across the different patches.

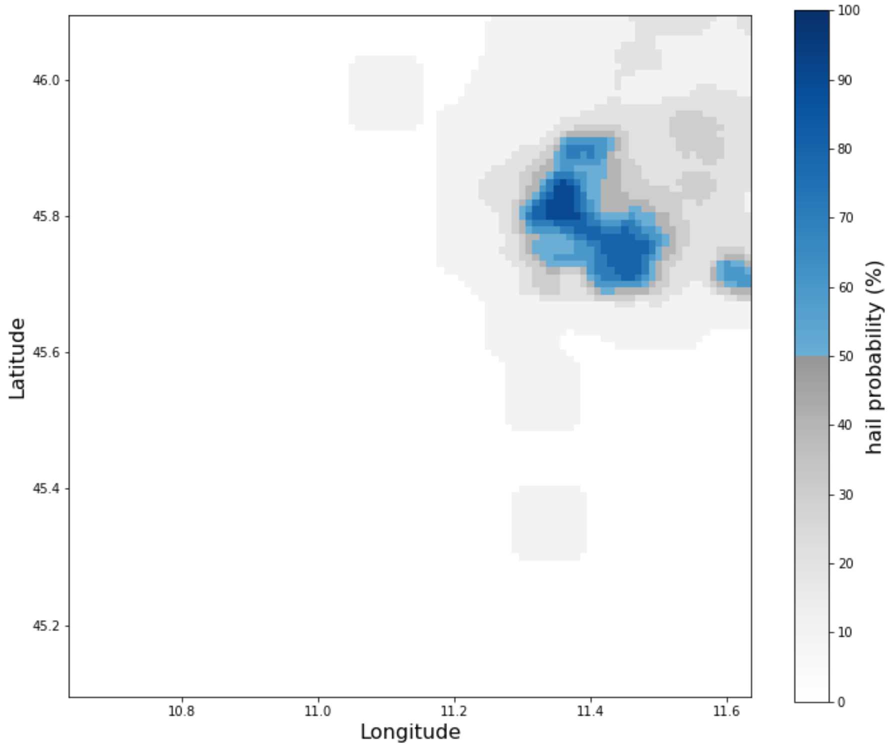


Methodology

- The average characteristic extension of each adversity event in each patch was matched to a **circle**.
- The **radius** of this circle was determined in the same way for all the adversities.

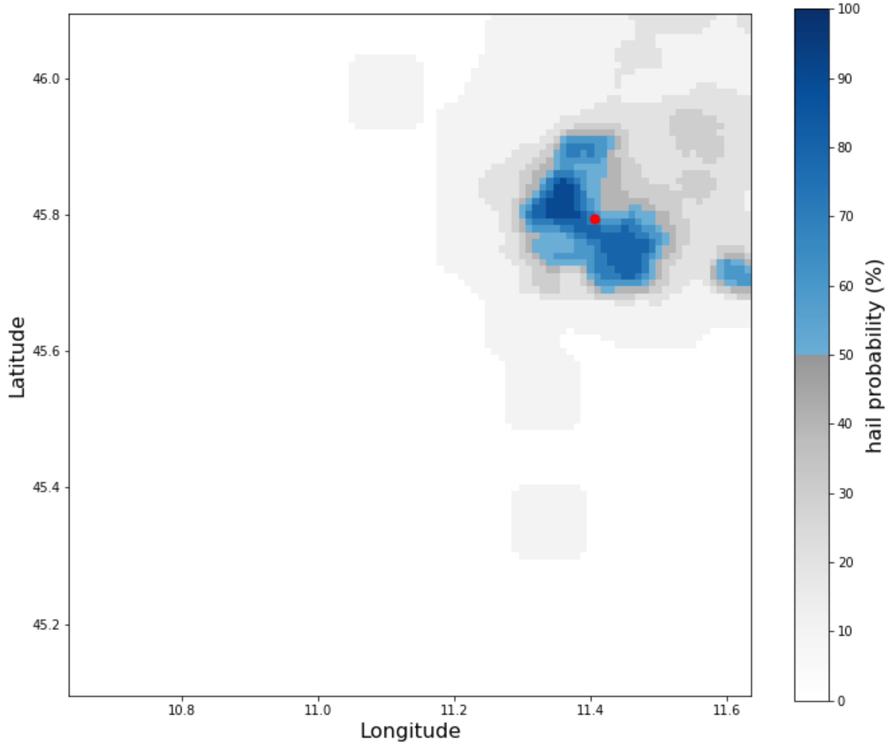
Methodology – step 1

- For the patch under consideration, take the map for day *t* and event *i.*
- Identify the **area** involved by the event, if any.
  - For hail assume that the event did happen where the probability ≥ 50%.



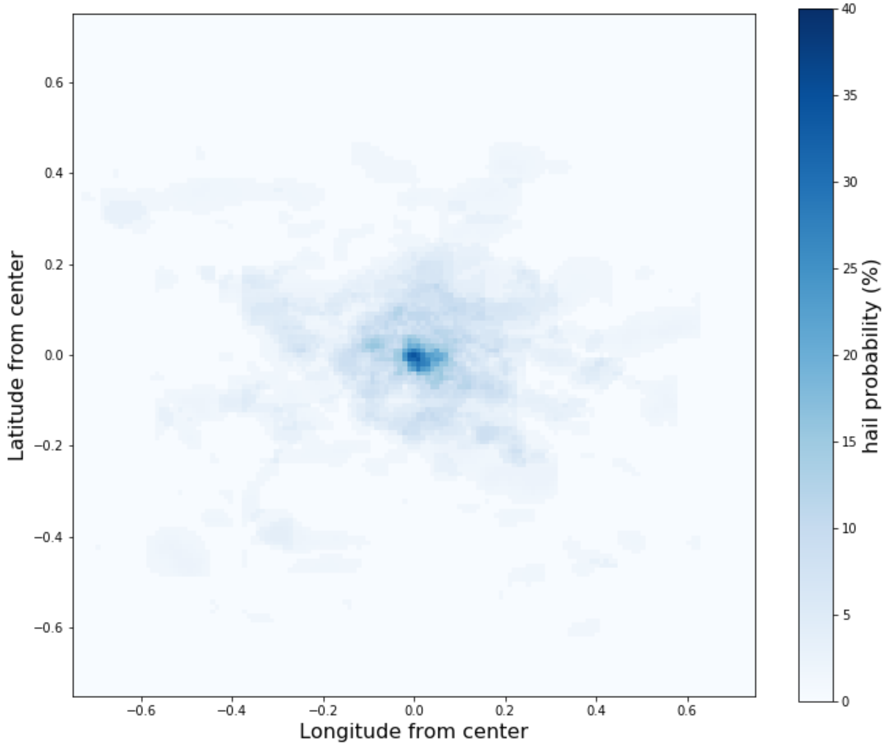
Methodology – step 2

- The "**barycentre**" of this area was identified. In the hail case this has been computed as the spatial center of probability.



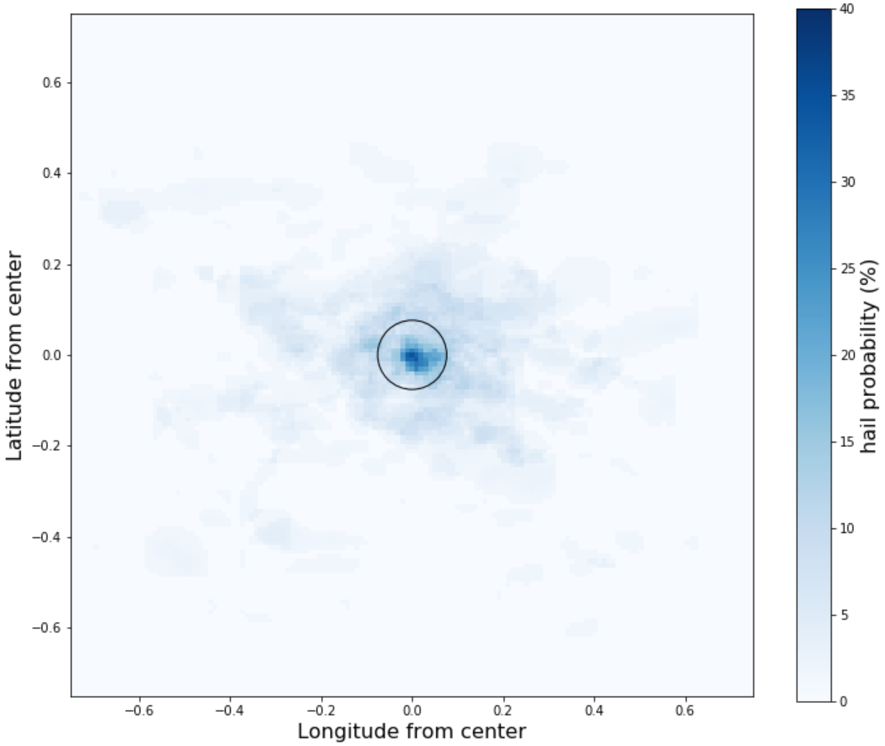
Methodology – step 3

- Then all the areas, resulting from detections made in different days, were **superimposed** after shifting them so to make their **barycentres coincide**, and the **average value of each pixel** was computed.
- In such way, it was possible to obtain a **single map** containing an **average value** for each pixel in a given patch.



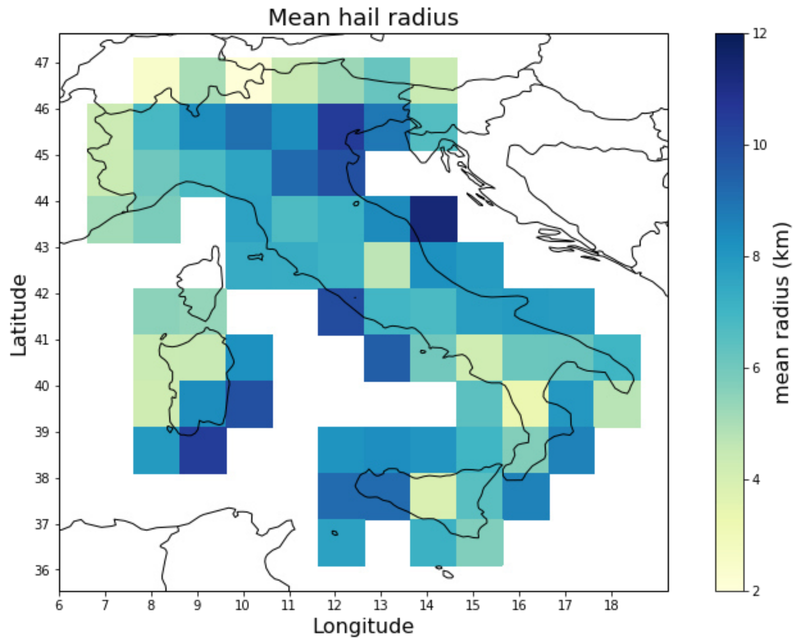
Methodology – step 4

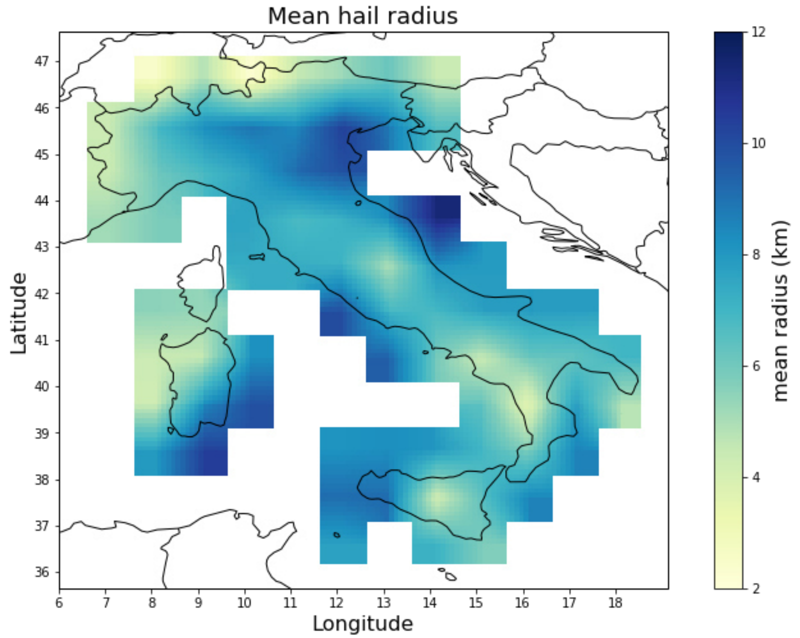
- This map in turn enabled the computation of the characteristic extension of extreme weather phenomena in every patch of the grid.
- Specifically, this was done by computing the **weighted sum of its pixels**, using the average values as weights.
- The length of interest was then defined as the **radius of the circle having an area equal to the weighted sum of the pixels.**



Methodology – step 5

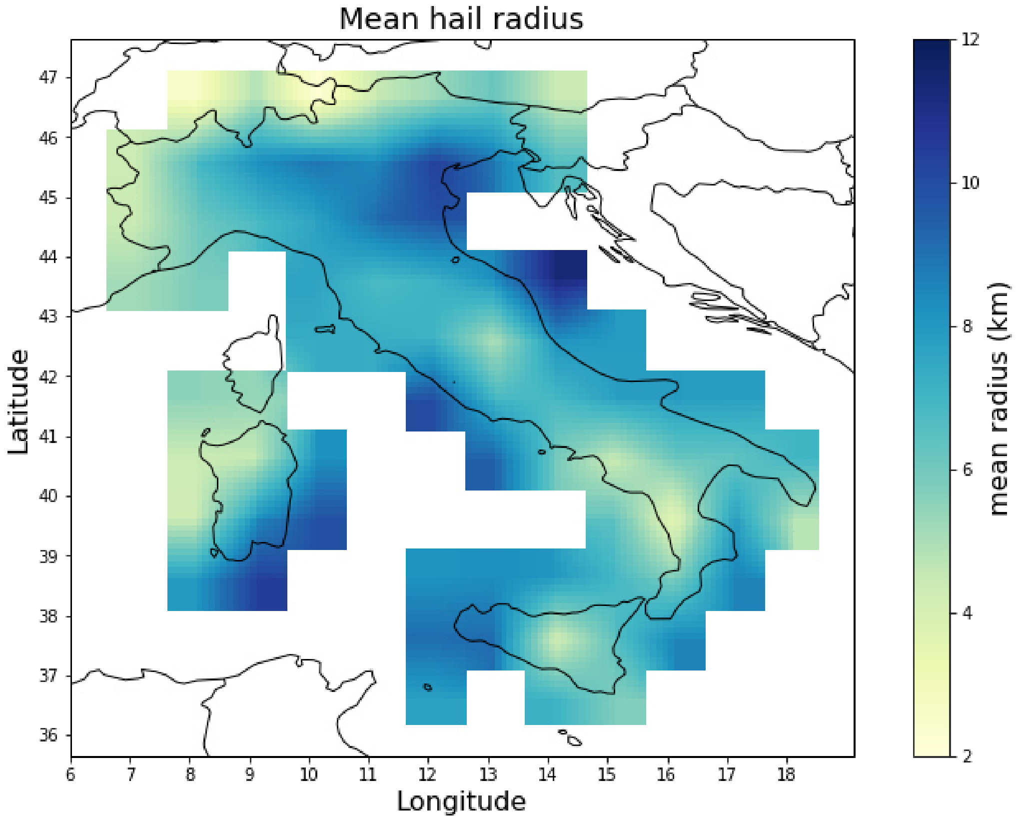
- Eventually, in order to **avoid abrupt variations** of the radius in adjacent patches, a **box blur filter** was applied.

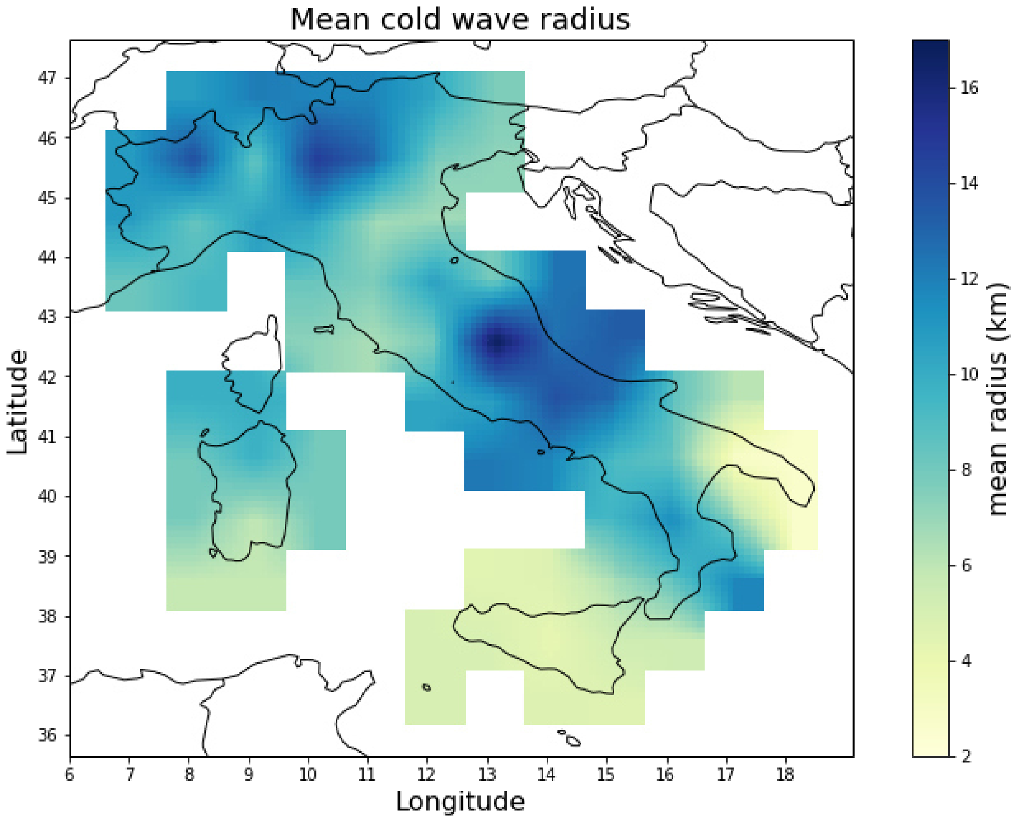




Results

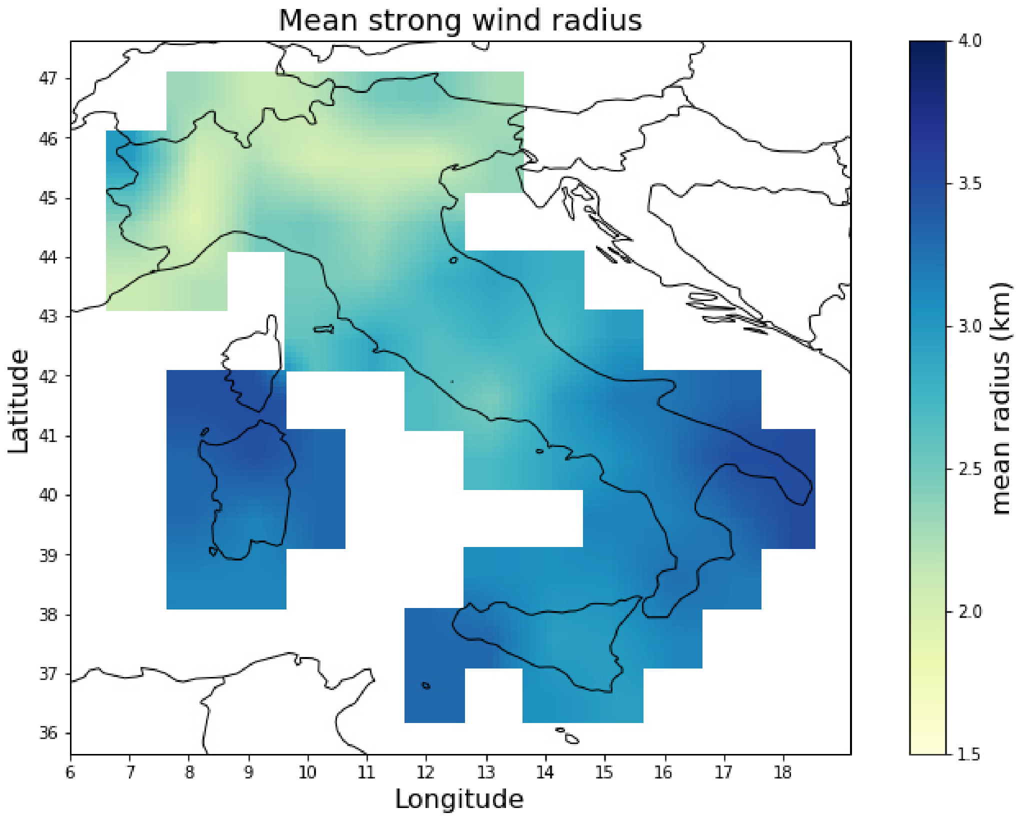
- Maps for **hail** and **cold wave**

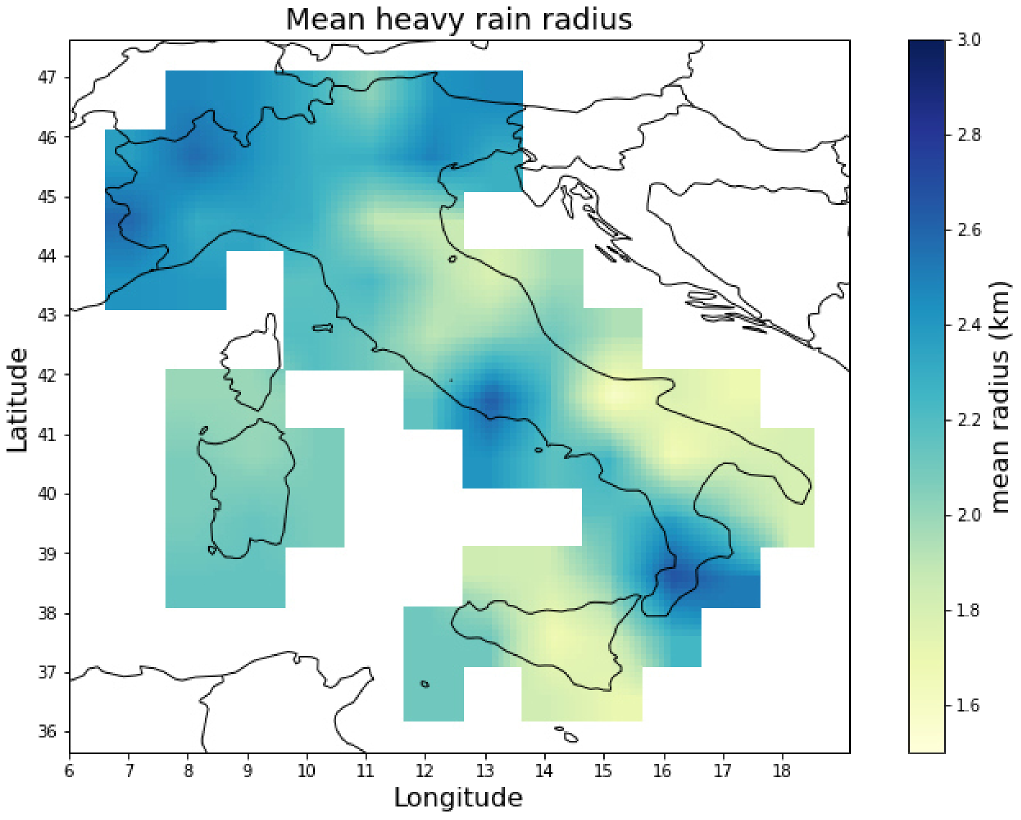




Results

- Maps for **strong wind** and **heavy rain**





Conclusions

- **Spatial analyses** were carried out with the aim of identifying the **characteristic extension** of **hail, cold wave, heavy rain** and **strong wind**.
- The results provide insurance agents with some **useful indications** about the **local impact of severe weather events** and can be of help in **assessing the probability of accumulation**.
- This kind of analysis represents the basis for the development of algorithms which may **automatically support agents in the decision process**.

Outlook

- There is room for **improvements**.
- *E.g.* remove the **arbitrariness** of the choice of the grid into which the territory is divided

cluster analysis