A DEEP LEARNING FRAMEWORK TO EMULATE THE CONVECTION PERMITTING DYNAMICAL MODELS FOR EXTREME PRECIPITATION

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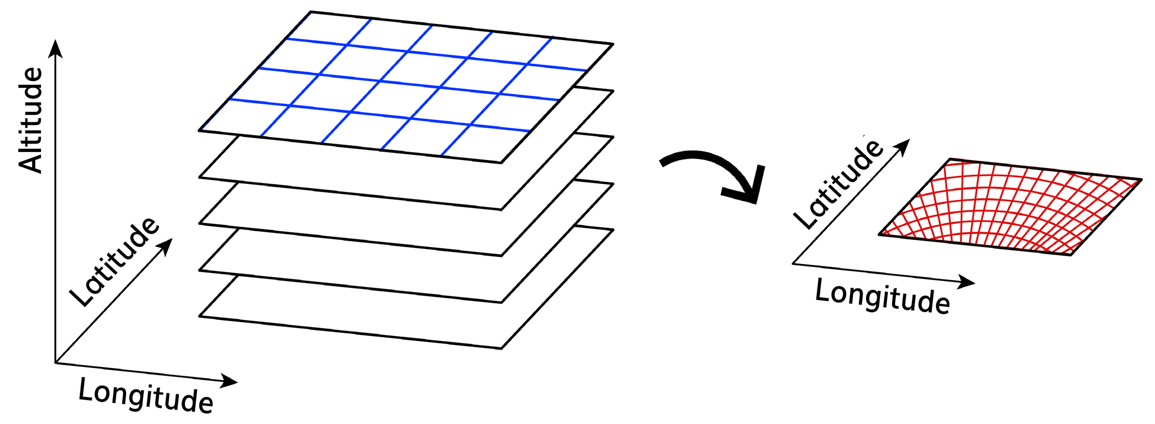
1. MOTIVATION AND OBJECTIVE

High-resolution precipitation estimates are required to correctly quantify the related hazard, but classical methods based on simulations of dynamical models are computationally too expensive. Thus, the study aims at deriving a data-driven approach to emulate the convection permitting dynamical models to derive high-resolution precipitation distribution, more efficiently.

The problem is tackled as a downscaling task, where high-resolution precipitation estimates are derived starting from low-resolution atmospheric parameters values. The proposed framework is based on deep learning architectures, following a supervised approach.

DOWNSCALING



LOW-RESOLUTION ATMOSPHERIC DATA

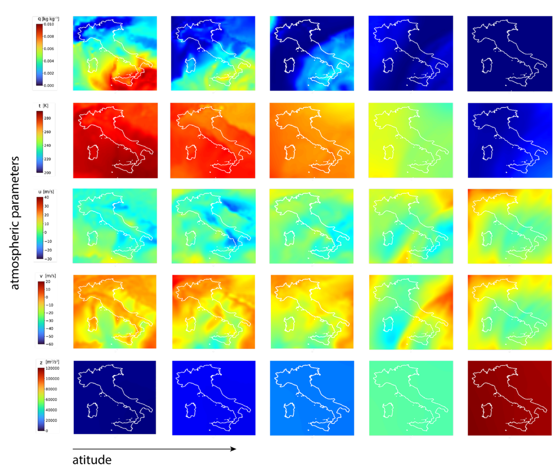
HIGH-RESOLUTION PRECIPITATION

2. DATA

Input datasets

Target dataset

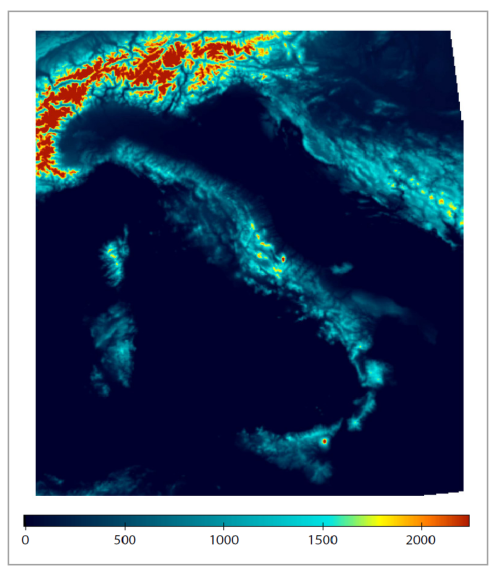
ERA5 REANALYSIS (25x25 km)



HUMIDITY, TEMPERATURE, WIND, GEOPOTENTIAL

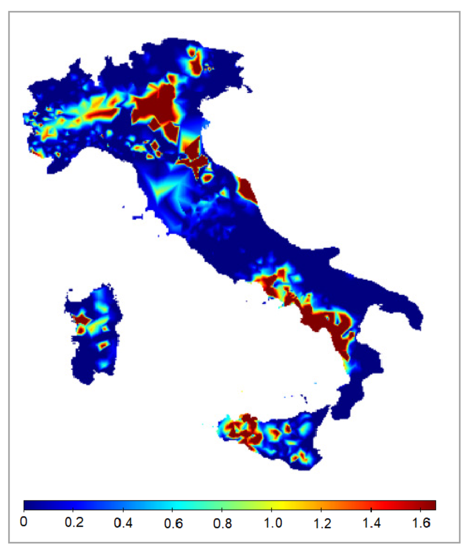
4D: lon, lat, altitude, time (hourly)

TOPOGRAPHIC ELEVATION (3x3 km)



2D: lon, lat

GRIPHO OBSERVATIONS (3x3 km)



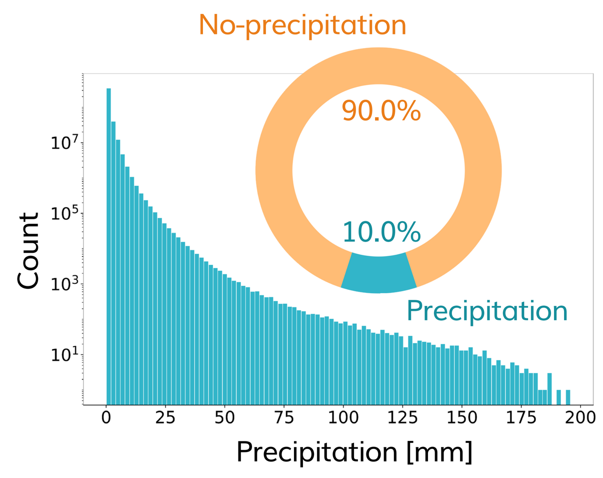
PRECIPITATION

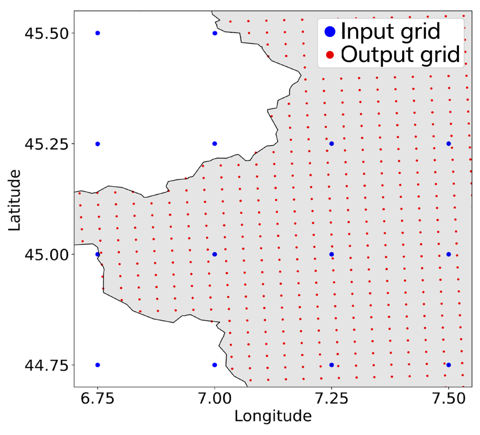
3D: lon, lat, time (hourly)

3. MAIN CHALLENGES

Severe precipitation is difficult to predict and working with real data (GRIPHO) is challenging.

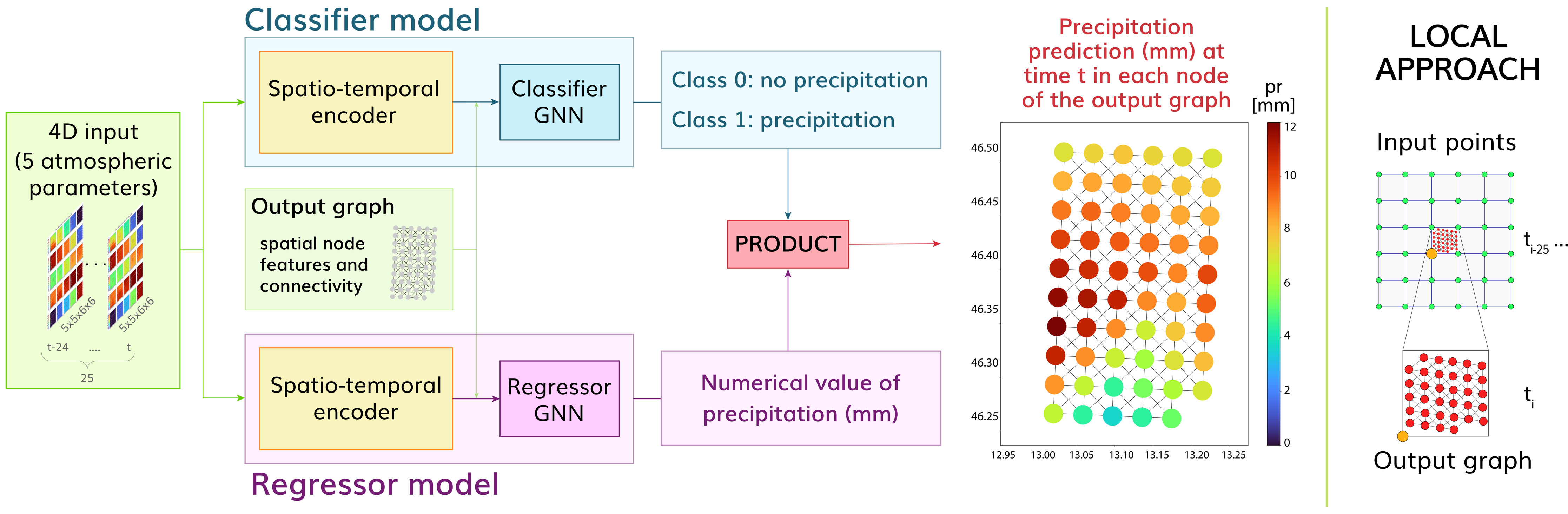
- Different grids for input and target
- Target unbalanced (~90% < 0.1 mm) and skewed





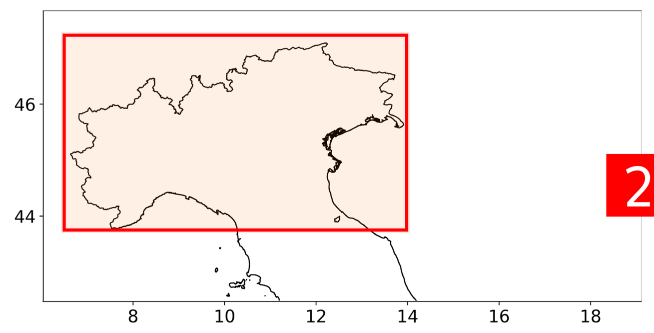
4. DEEP LEARNING FRAMEWORK (DL-model)

Convolutional and recurrent neural networks are adopted to capture the spatial and temporal dependencies in the atmospheric data and produce a low-dimensional encoding of the input. Graph neural networks are used to effectively model the irregular output grid as a graph.



5. TRAINING AND EVALUATION

The deep learning framework was trained on northern Italy for a time span of 15 years.

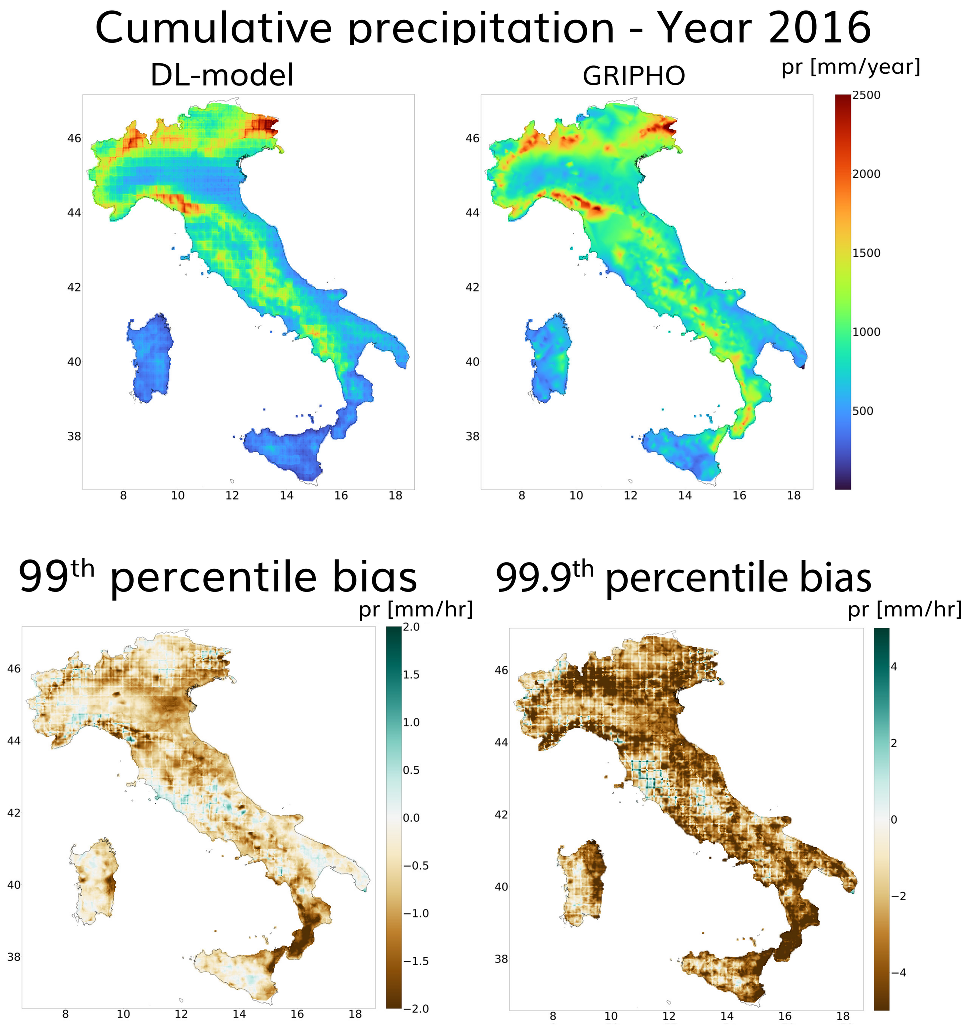


The capability of the DL-model to generalise both in space and time was then assessed. Two main input settings were considered in the **evaluation phase**:

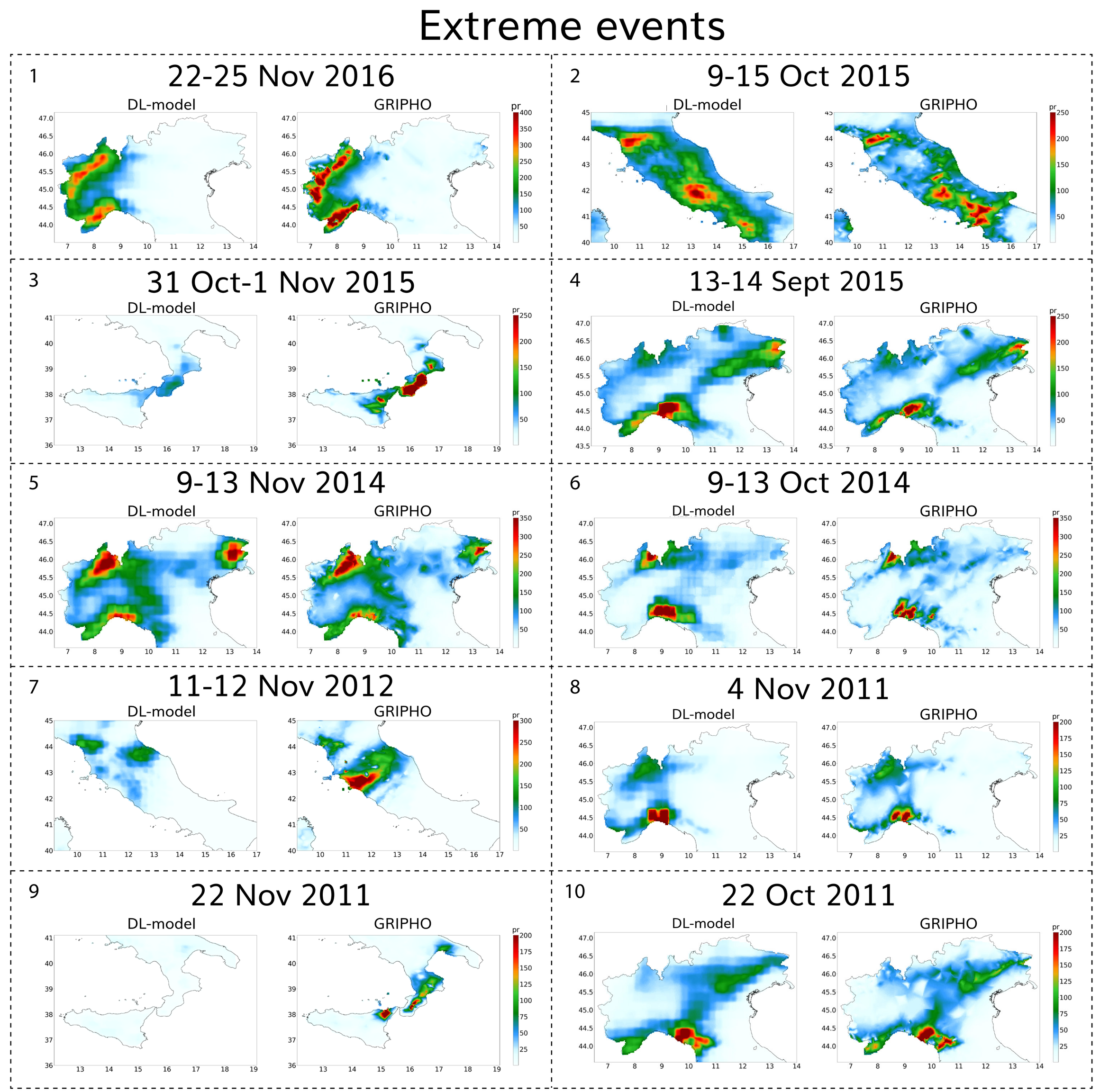
1. Real world (ERA5)
2. Model world (RegCM)

DL-model still trained on ERA5!

6. REAL-WORLD RESULTS



Extreme events



7. MODEL-WORLD RESULTS