AUTOMATIC DETECTION OF OVERSHOOTING TOPS AND THEIR PROPERTIES USING NEURAL NETWORKS

Convective systems are undergoing significant changes due to climate change, with both their frequency and intensity increasing. As storms become more severe, understanding their behavior is crucial for improving forecasts and minimizing damage. One of the key indicators of storm severity is the presence of overshooting tops (OTs) - convective cloud features that extend above the storm anvil. These structures are associated with strong updrafts and extreme weather phenomena such as large hail, intense rainfall, and tornadoes.

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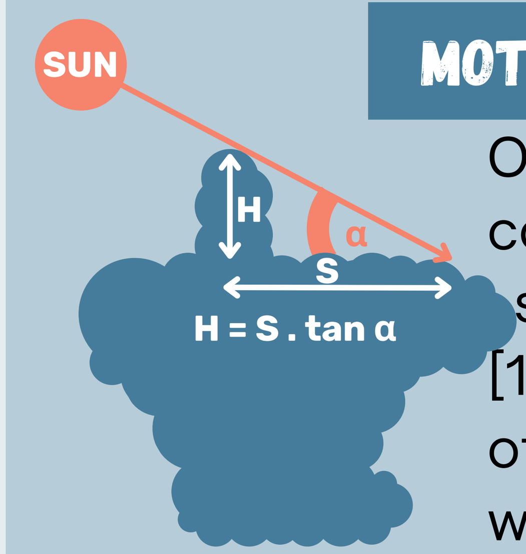
INTRODUCTION TO OT

OT is a cloud top property of convective storms when a strong updraft protrudes its equilibrium level. The most important feature for us is their height above the anvil.

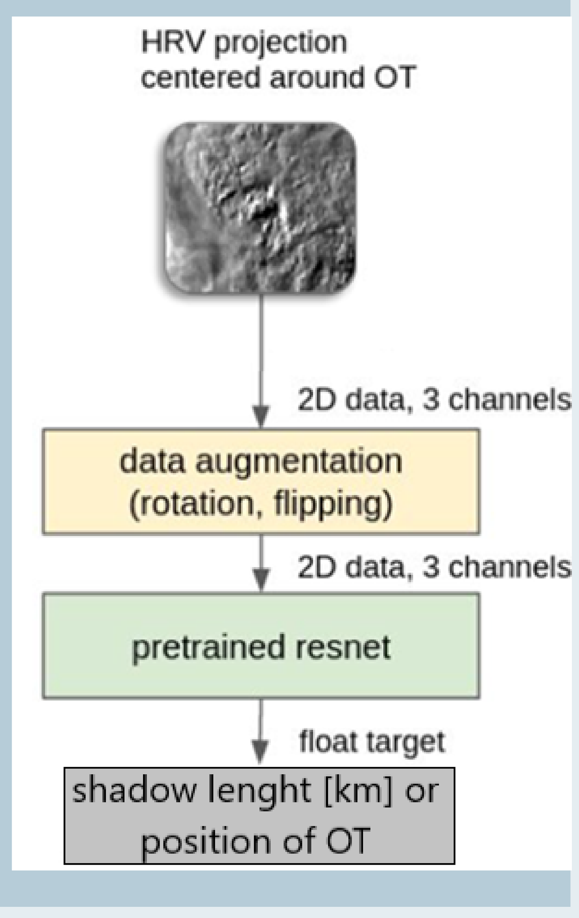


MOTIVATION

Overshooting tops correlate with the severity of storms [1]. Also, the height of OT correlates with the strength of updraft which correlates with severity [2].

MACHINE LEARNING METHODS

In both cases, estimation of shadow length and detection of the position of OTs we used a similar network, pretrained convolutional NN on 150x150 km HRV images. Regression or binary classification as output.



DATABASE

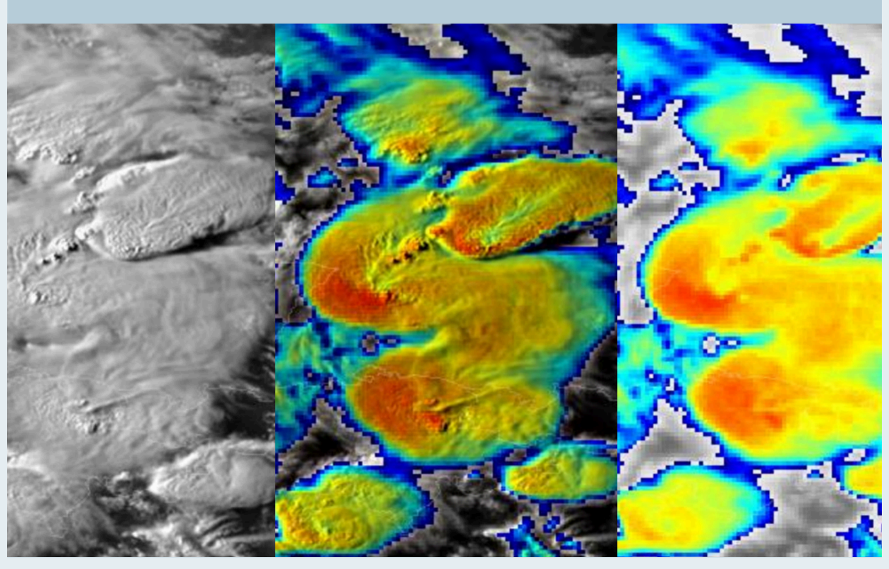
Manually detected OTs over Europe measured by Ján Kaňák. It was done during the summer seasons 2009-2014. This database consists of up to 10 000 cases.

OT was detected and measured its shadow, and from the shadow was calculated height of OT using simple geometry and sun angle.

SATELLITE DATA

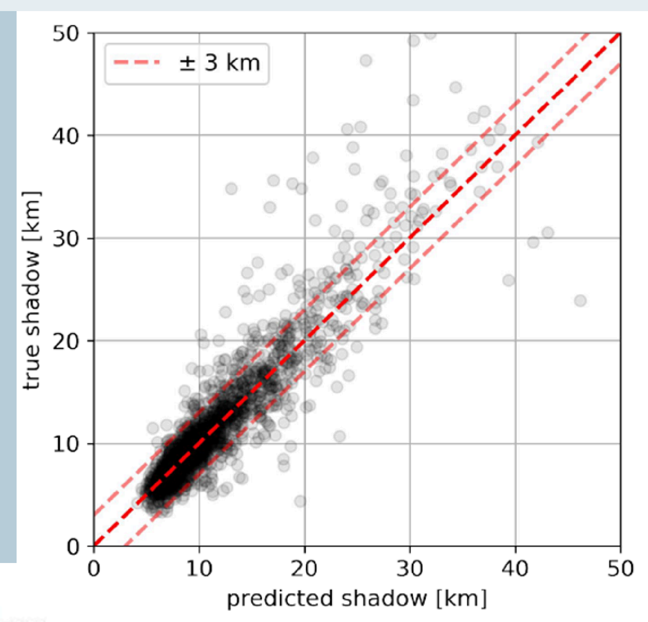
We can use 3 types of satellite data for OTs.

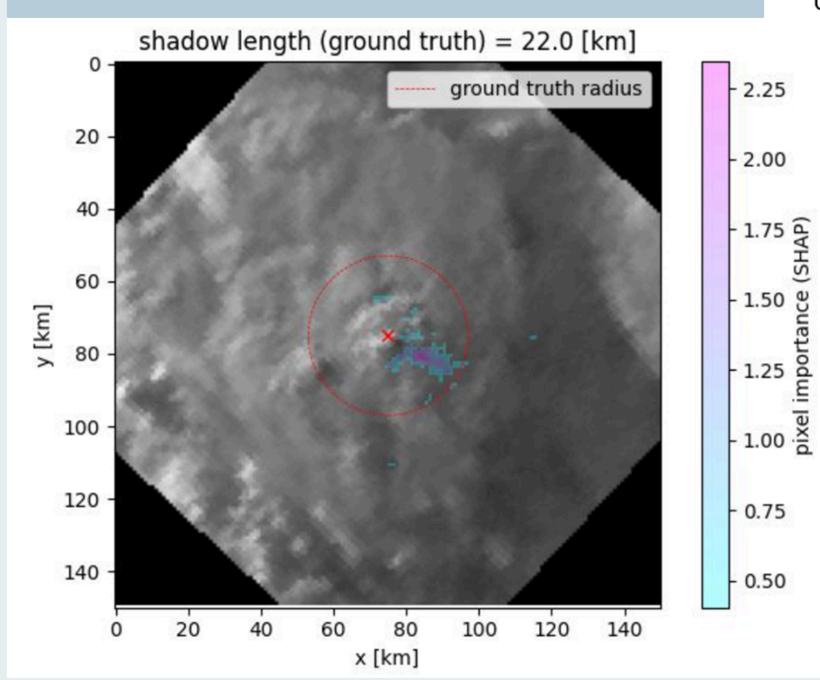
- Thermal channel - used usually.
- Visible channel - used by us.
- Combination (sandwich image)



LENGTH OF OT

Predicted shadow length from our model compared with real (manually measured) shadow length.

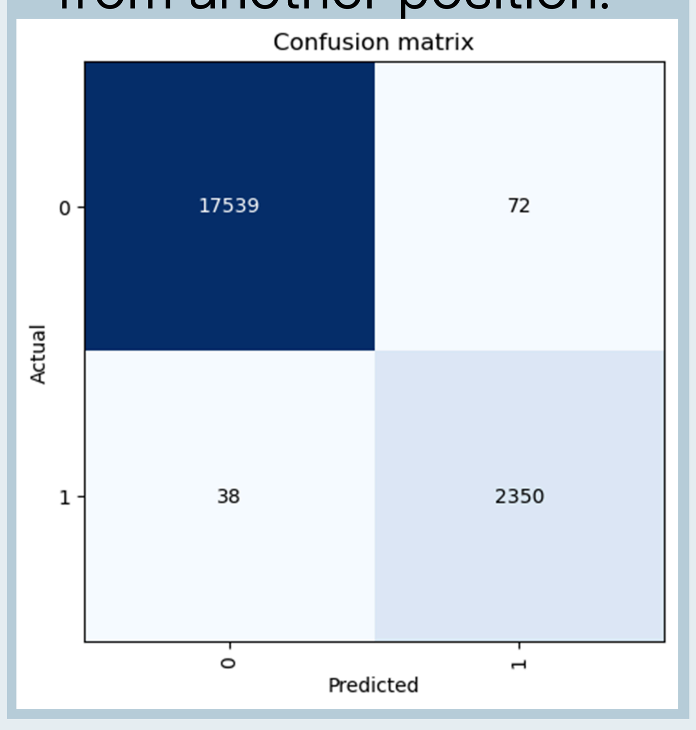




Next to only length, we can use the SHAP technique for the determination of the position of the shadow (px significance).

DETECTION OF OT

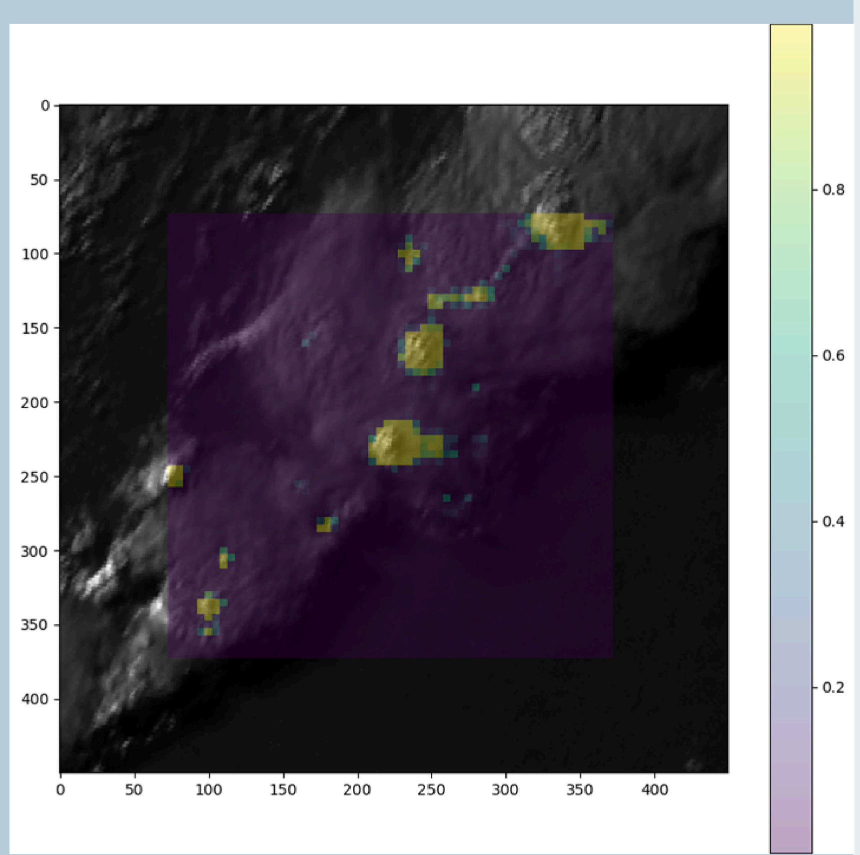
Another model was trained as a binary classificator, with positive cases from our database, and negative from another position.



PROBABILITY OF PRESENCE OF OT

With the trained model for the detection of OT, we created the product for estimating the probabilities of OT presence.

- For each pixels was created cutout of 150x150 km with this pixel in the middle.
- Our model was applied on every single image. The model output is the probability for the middle pixel.
- All these probabilities together give the final set of probabilities.



Related literature

[1] Mikuš, P. and Mahović, N. S. CORRELATING OVERSHOOTING TOPS AND SEVERE WEATHER. (2011)

[2] Fujita, T.T. Tornado Occurrences Related to Overshooting Cloud-Top Heights as Determined nnnfrom ATS Pictures. (1972)

Acknowledgements

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EXTENTION WITH FCI DATA

Our model was trained only on SEVIRI data. This case predicts usage also for FCI data (MTG), but with downsampling.