



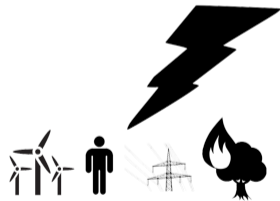
Identifying Lightning Processes in ERA5 Soundings with Deep Learning

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University of Innsbruck, Austria

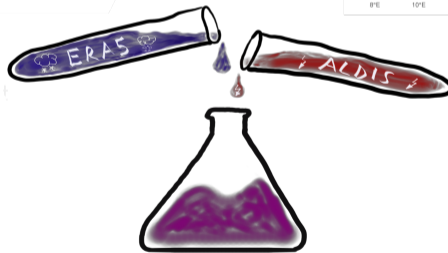
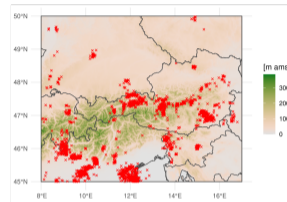
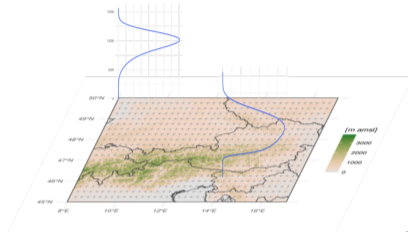
Motivation



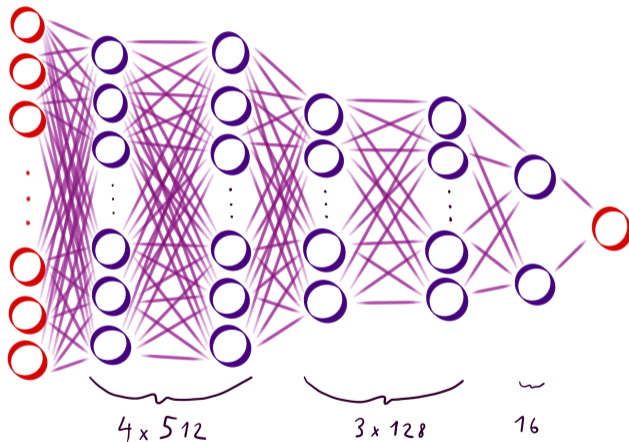
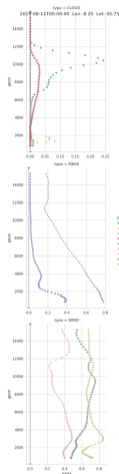
photo credit: Johannes Plenio



Used data set



Our model: Neural Network



Reference model





- Based on a Generalized Additive Model (GAM) ¹
- Trained on longitude, latitude, day of season, time of day and the following nine parameters defined by experts:
 - cape Convective available potential energy
 - cp Convective precipitation
 - cswc2040 Mass of specific snow water content between the -20°C and -40°C isotherms
 - ct_h Cloud top height in height above ground
 - ishf Instantaneous surface sensible heat flux
 - mcc Medium cloud cover
 - tcs1w Total column supercooled liquid water
 - wvc1020 Mass of water vapor between the -10°C and -20°C isotherms
 - 2t 2 meter temperature

¹Thorsten Simon, Georg J. Mayr, Deborah Morgenstern, Nikolaus Umlauf, Achim Zeileis. Amplification of Annual and Diurnal Cycles of Alpine Lightning, 18 October 2021, PREPRINT (Version 1) available at Research Square [<https://doi.org/10.21203/rs.3.rs-965951/v1>]


Model performance

Confusion matrices on test year 2019

Our model:

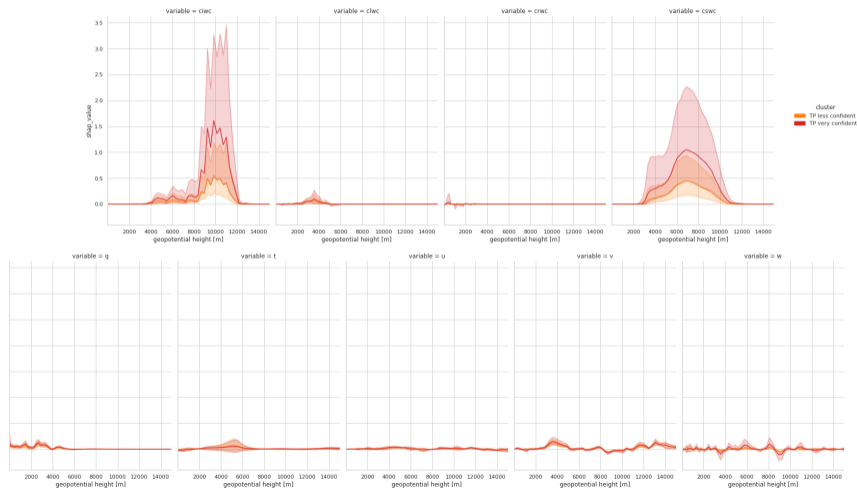
		
	1 395 354	39 864
	18 768	11 358

Reference model:

		
	1 391 564	44 623
	20 016	10 122

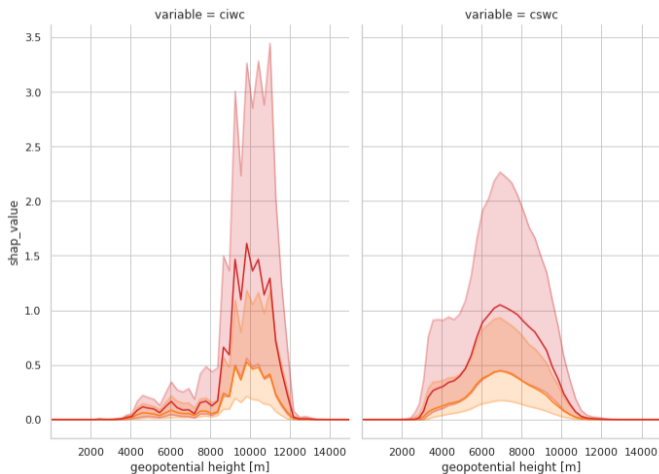
Looking into the black box

SHAP on true positives



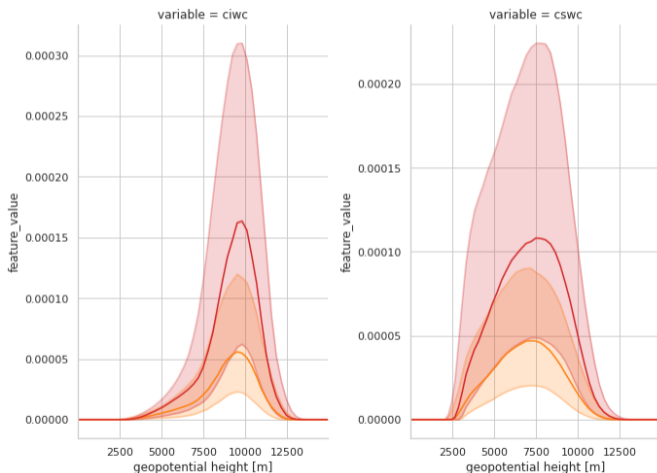
Looking into the black box

SHAP on cloud ice and snow content



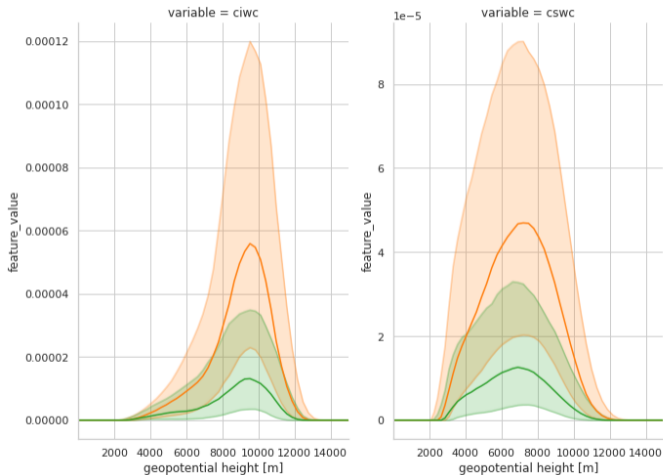
Atmospheric profiles

Cloud ice and snow content of true positives



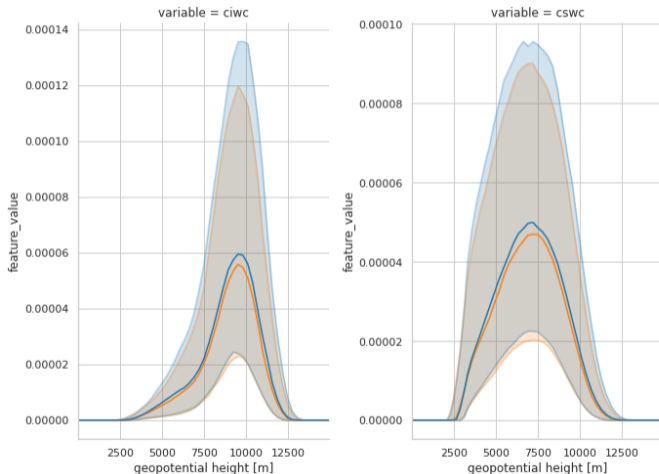
Atmospheric profiles

Ice and snow content on true positives, false negatives



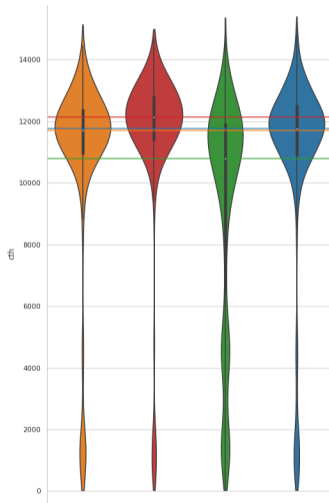
Atmospheric profiles

Ice and snow content on true positives, false positives



Atmospheric profiles

Cloud top height



Conclusion



photo credit: Johannes Plenio

Outlook

- Transfer of method to other lightning hot spots
- Gaining more insights into what the neural network has identified as patterns which lead to lightning
- Case Studies

References

- Peter Ukkonen, Antti Mäkelä. *Evaluation of machine learning classifiers for predicting deep convection*, 2019, Journal of Advances in Modeling Earth Systems, 11, 1784– 1802. <https://doi.org/10.1029/2018MS001561>
- Thorsten Simon, Georg J. Mayr, Deborah Morgenstern, Nikolaus Umlauf, Achim Zeileis. *Amplification of Annual and Diurnal Cycles of Alpine Lightning*, 18 October 2021, PREPRINT (Version 1) available at Research Square [<https://doi.org/10.21203/rs.3.rs-965951/v1>]

Fin.



Innsbruck (Seegrube) webcam facing south

photo credit: foto-webcam.eu