Understanding the relationship between clouds and surface downward radiation forecast errors with Unsupervised Deep Learning

Matthias Zech and Lueder von Bremen

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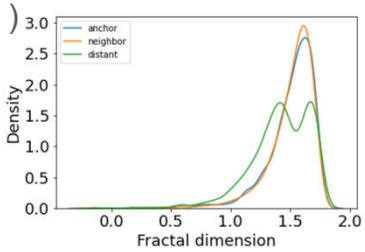


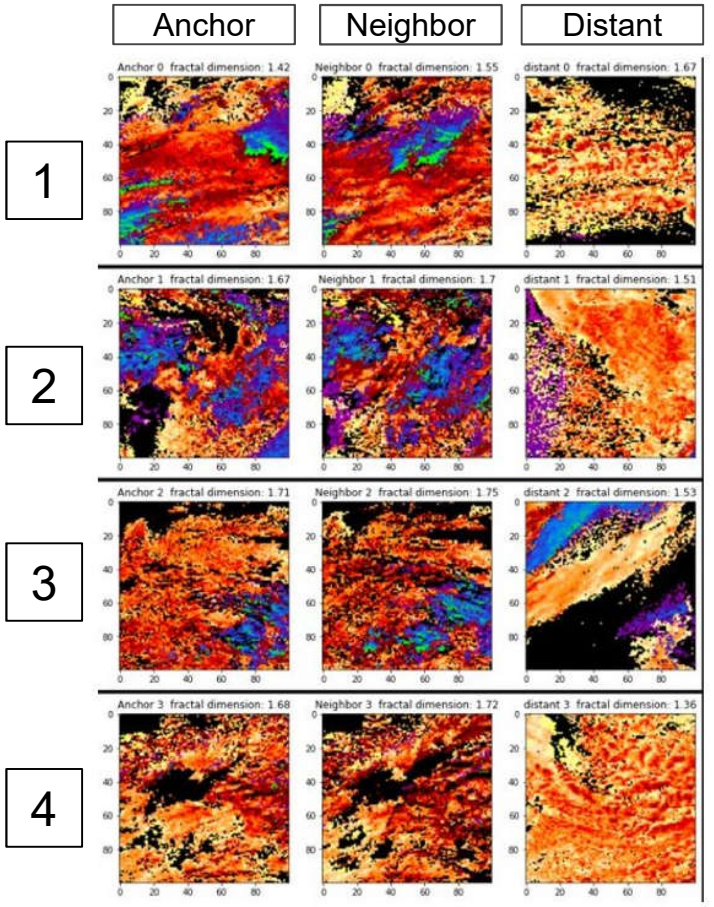
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Objective: Clustering of similar cloud situations to better understand day-ahead clearness forecast errors (ECMWF IFS) in Germany

Approach: Unsupervised Deep Learning (**Tile2Vec**) + hierarchical clustering

- 10 years of MODIS optical cloud thickness above Germany (100x100pxl)
- Pseudo-random sampling for day d:
  - **Anchor** t_a : Terra cloud thickness for day d
  - **Neighbor** t_n : Aqua cloud thickness for day d
  - **Distant** t_d : Random sampling within all other days until fractal dimension D of distant tile is different than those of close tiles ($| D_d - \frac{D_a+D_n}{2} | > 0.15$)



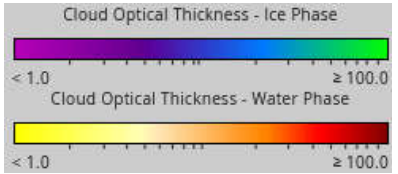


Exemplary sampled tiles of cloud optical thickness

Tile2Vec: Similar objects are closer together, different objects are further away

$$\min L(t_a, t_n, t_d) = \underbrace{\|f_\theta(t_a) - f_\theta(t_n)\|_2}_{\text{Minimize similar clouds}} - \underbrace{\|f_\theta(t_a - f_\theta(t_d)\|_2}_{\text{Maximize different clouds}} + \underbrace{m}_{\text{Rectifier}}$$

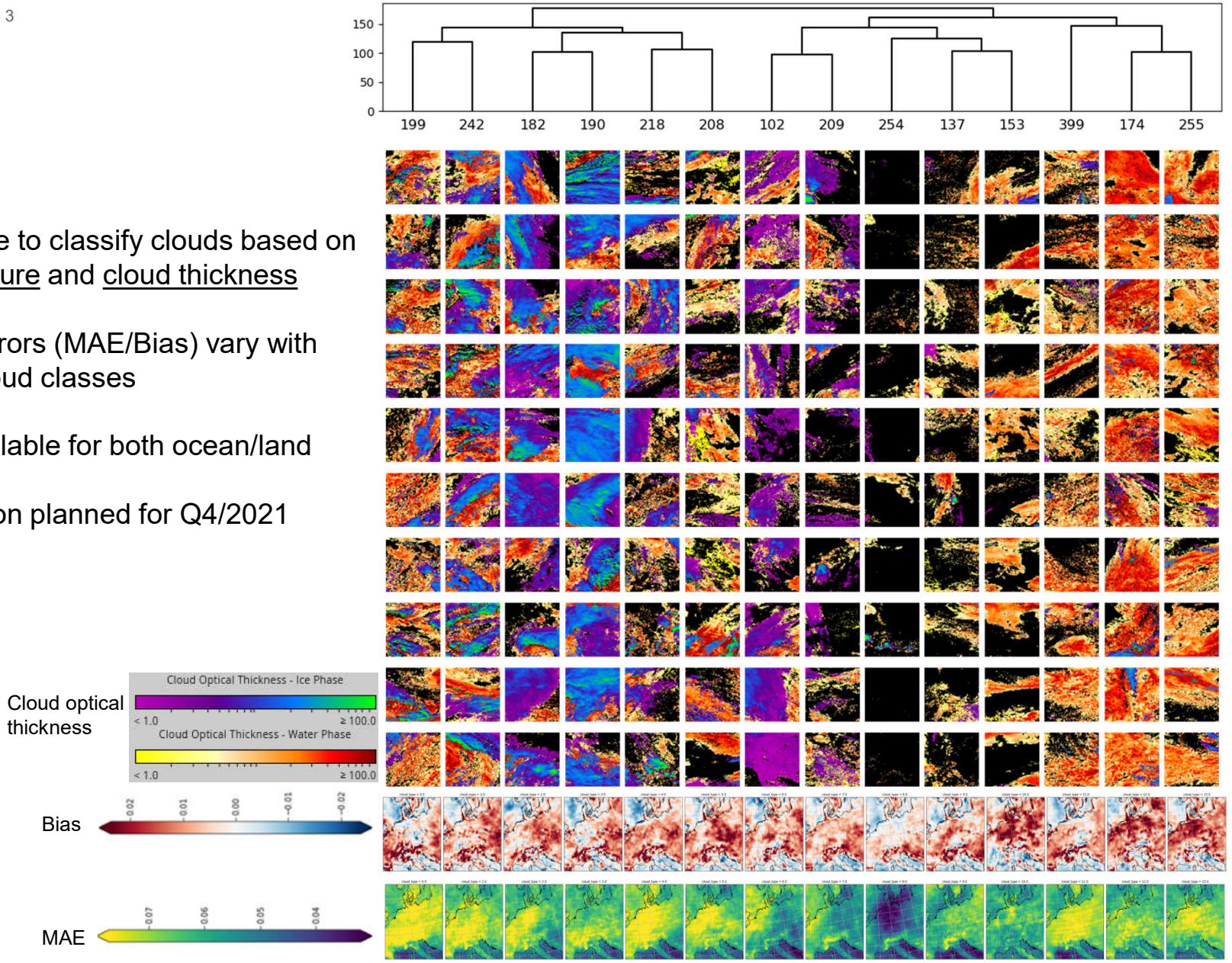
$L(t_a, t_n, t_d)$ ... Triplet loss
f_θ... A CNN with parameters θ





Conclusions

- Method able to classify clouds based on cloud structure and cloud thickness
- Forecast errors (MAE/Bias) vary with different cloud classes
- Method scalable for both ocean/land products
  → Publication planned for Q4/2021



Dendrogram, cloud classes and respective clearness day-ahead forecast errors

