Extratropical high-wind feature identification using a probabilistic random forest

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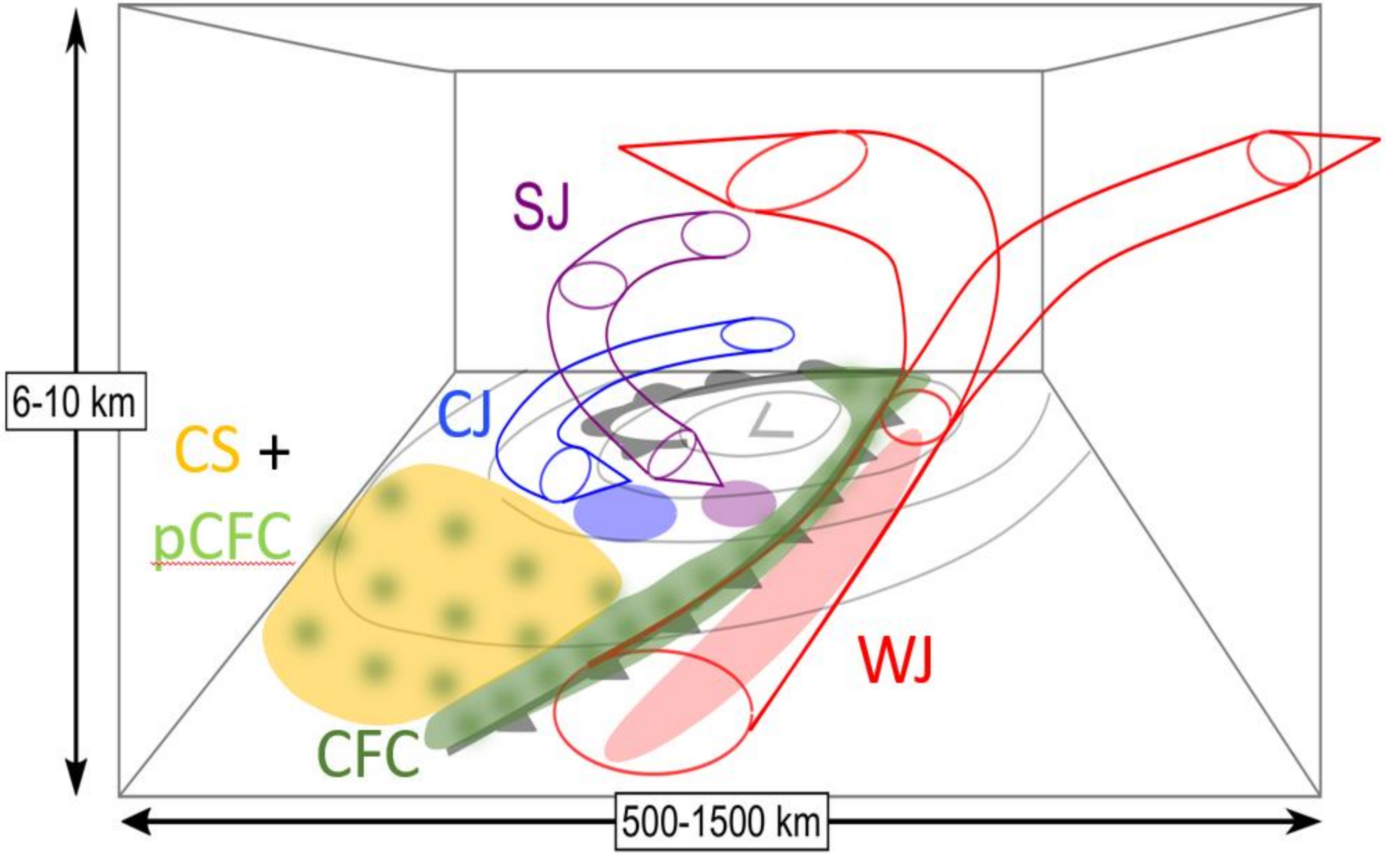
Causes of high winds

- Warm conveyor belt jet (warm jet, WJ)
- Cold conveyor belt jet (cold jet, CJ)
- Sting jet (SJ)
- Cold frontal convective gusts (CFC)
- Cold sector winds (CS) with embedded post-CFC (pCFC)

Differ in location, timing and other characteristics (e.g. Hewson and Neu; 2015)

→Do forecast error also differ?

→Can feature-dependent post-processing improve the forecast?



Eisenstein et al. (2022) preprint, WCDD, Fig. 1; adapted from Clark and Gray (2018), Fig. 7

Subjective Identification → Probabilistic Random Forest → Kriging

Interactive identification

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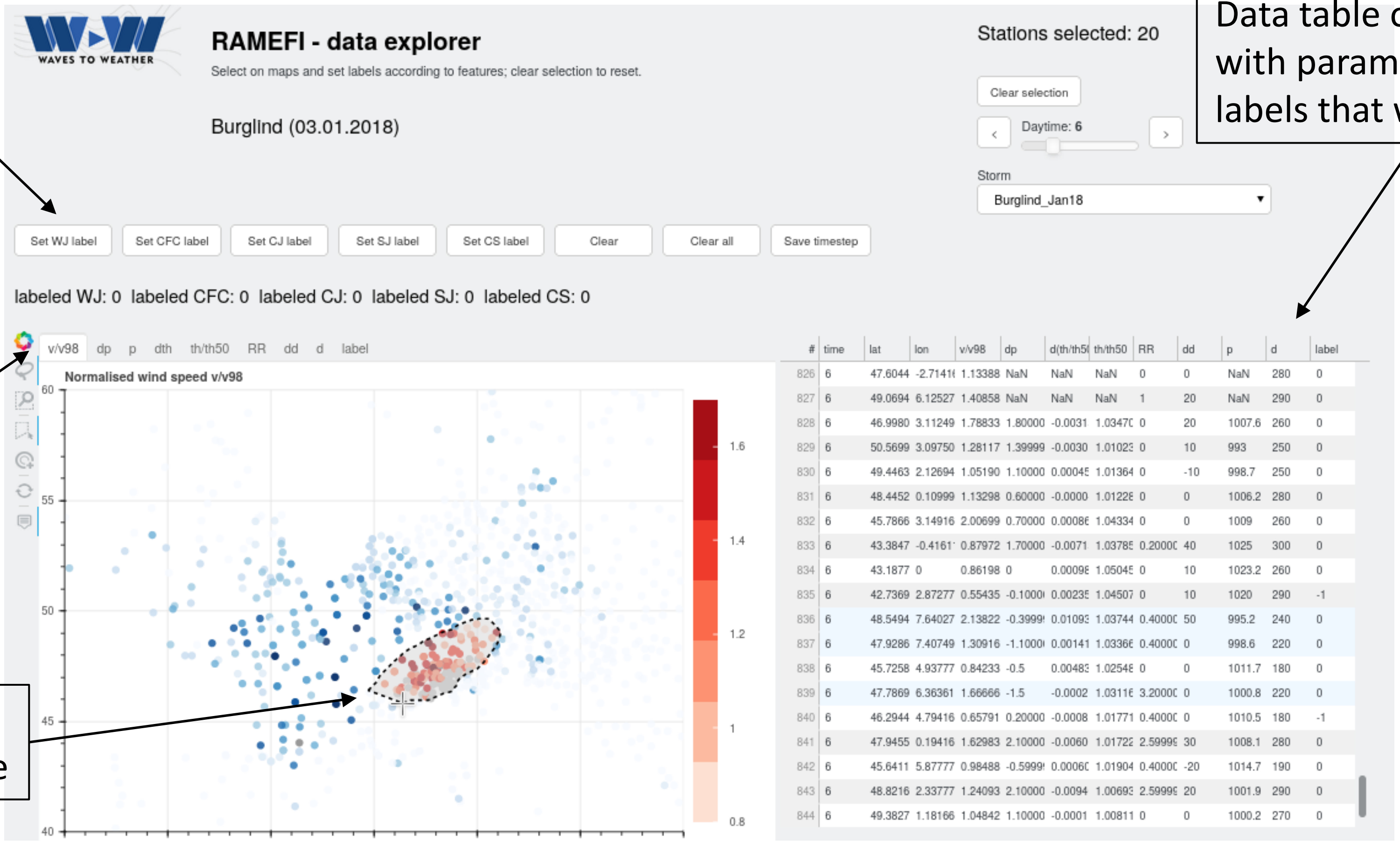
How does a meteorologist identify dynamical features with their synoptic knowledge?

→ Building an interactive tool to select feature areas by hand

Set label of selected stations in the table to a specific feature

Code available at
10.5281/zenodo.6541303



Data table of all stations with parameters and set labels that will be saved

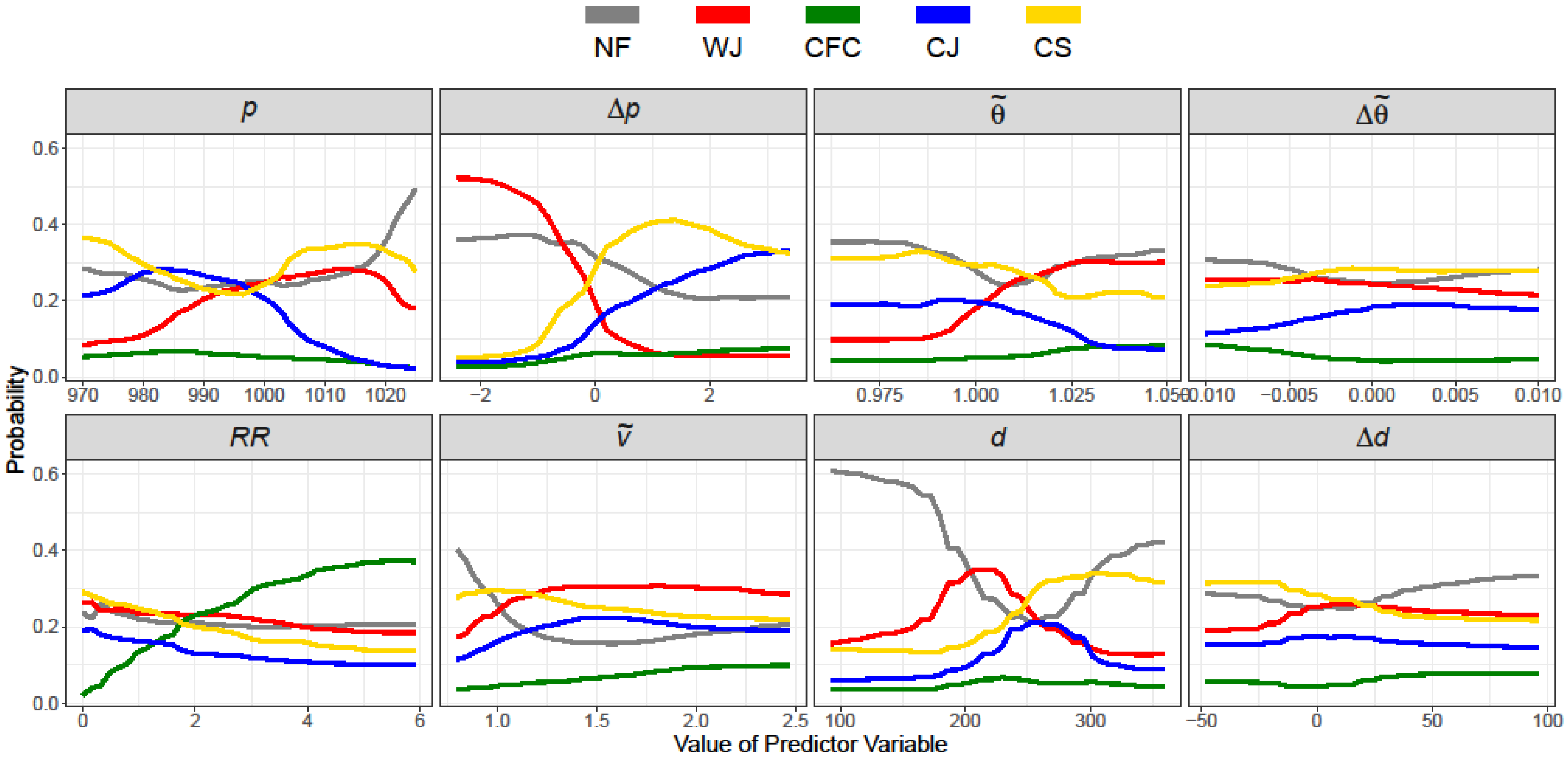
Choose which variable you want to see

Select area with mouse

Adapted from Eisenstein et al. (2022), preprint, WCDD

Predictor importance

- Pressure tendency Δ*p* important for distinction of warm and cold sector
- Mean-sea level pressure *p* indicates proximity to cyclone centre
- Precipitation *RR* most important for CFC
- Normalised potential temperature θ is helpful to identify warm sector
- Wind direction *d* can indicate location relative to cyclone centre

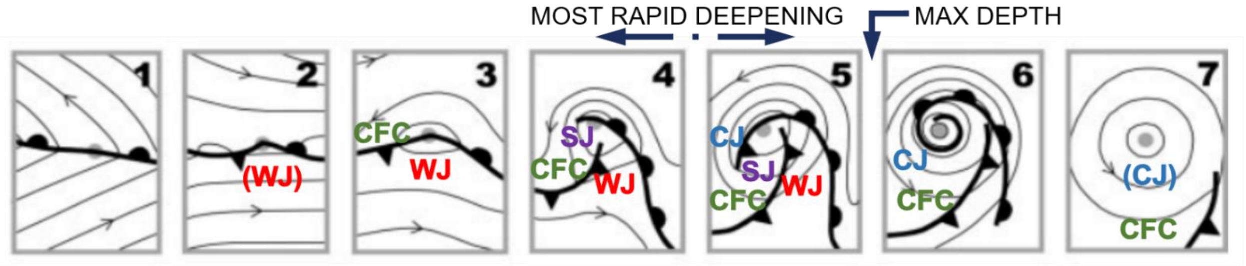


Eisenstein et al. (2022), preprint, WCDD, Fig. 10

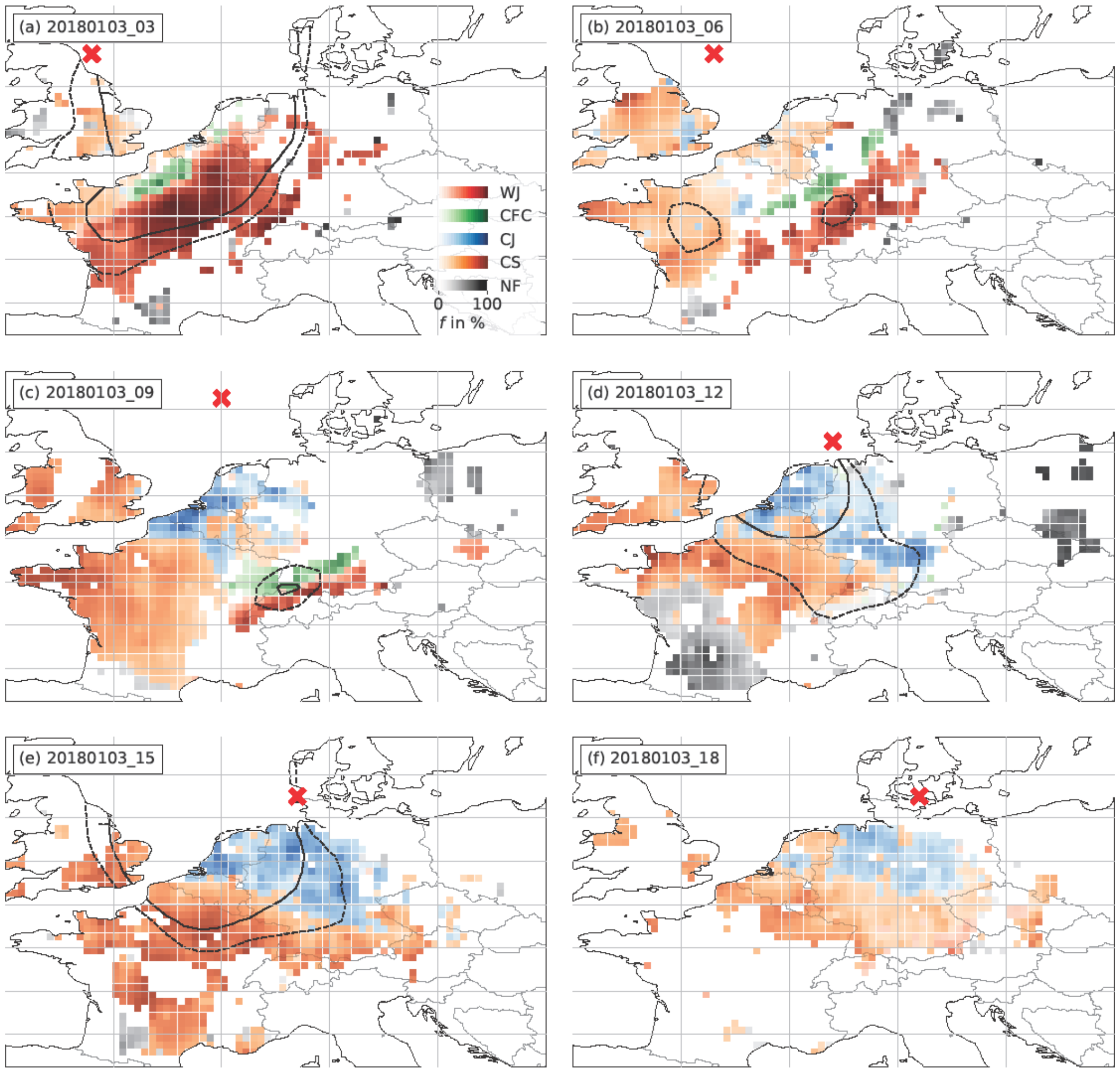
Burglind 03 Jan 2018

- Kriging used to interpolate probabilistic random forest prediction (with help of Ghulam A. Qadir)
- Although spatially and temporal independent, we gain coherent areas for each feature in both time and space as expected from literature (see lower figure)

Animations for Burglind and more case studies available at:
10.5281/zenodo.6541277



Adapted from Hewson and Titley (2010) and Hewson and Neu (2015)



Eisenstein et al. (2022), preprint, WCDD, Fig. 4

Summary and future plans

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Eisenstein, L., Schulz, B., Qadir, G. A., Pinto, J. G. and Knippertz, P.: Objective identification of high-wind features within extratropical cyclones (RAMEFI): Part I: Method and illustrative case studies. *WCDD*. [preprint], doi: **10.5194/wcd-22-29**, in review, 2022

Code available at
Eisenstein, L., Schulz, B., Qadir, G. A., Pinto, J. G. and Knippertz, P. (2022): RAMEFI (RAndom-forest based MEsoscale wind Feature Identification). *Zenodo*. doi: **10.5281/zenodo.6541303**

- *Next:* Feature climatology using observations (2001–2020) and COSMO-REA6 (2000 – 2019)
- *Planned*
  – Feature-dependent forecast error analysis and post-processing
  – Distinguish CJ and SJ from gridded data without explicit use of Lagrangian trajectories.

Sources

- Clark, P.A. and Gray, S.L. (2018) Sting jets in extratropical cyclones: a review. *Q J R Meteorol Soc*., 144: 943–969. doi: 10.1002/qj.3267
- Hewson, T. and Titley, H.A. (2010) Objective identification, typing and tracking of the complete life-cycles of cyclonic features at high spatial resolution. *Meteorol. Appl.,* 17: 355-381. doi: 10.1002/met.204
- Hewson, T. and Neu, U. (2015) Cyclones, windstorms and the IMILAST project. *Tellus A*, 6, 1-33. doi: 10.3402/tellusa.v67.27128
- Eisenstein, L., Schulz, B., Qadir, G. A., Pinto, J. G. and Knippertz, P. (2022) Objective identification of high-wind features within extratropical cyclones (RAMEFI): Part I: Method and illustrative case studies. *WCDD*. 10.5194/wcd-22-29 [preprint]
- Beckert, A., Eisenstein, L., Hewson, T., Craig, G. C., and Rautenhaus, M. (2021) Objective 3D atmospheric front detection in high-resolution numerical weather prediction data, EGU General Assembly 2021, online, 19–30 Apr 2021, EGU21-10055, doi: 10.5194/egusphere-egu21-10055