How do we identify flash droughts? Tools and Central European Croplands analysis

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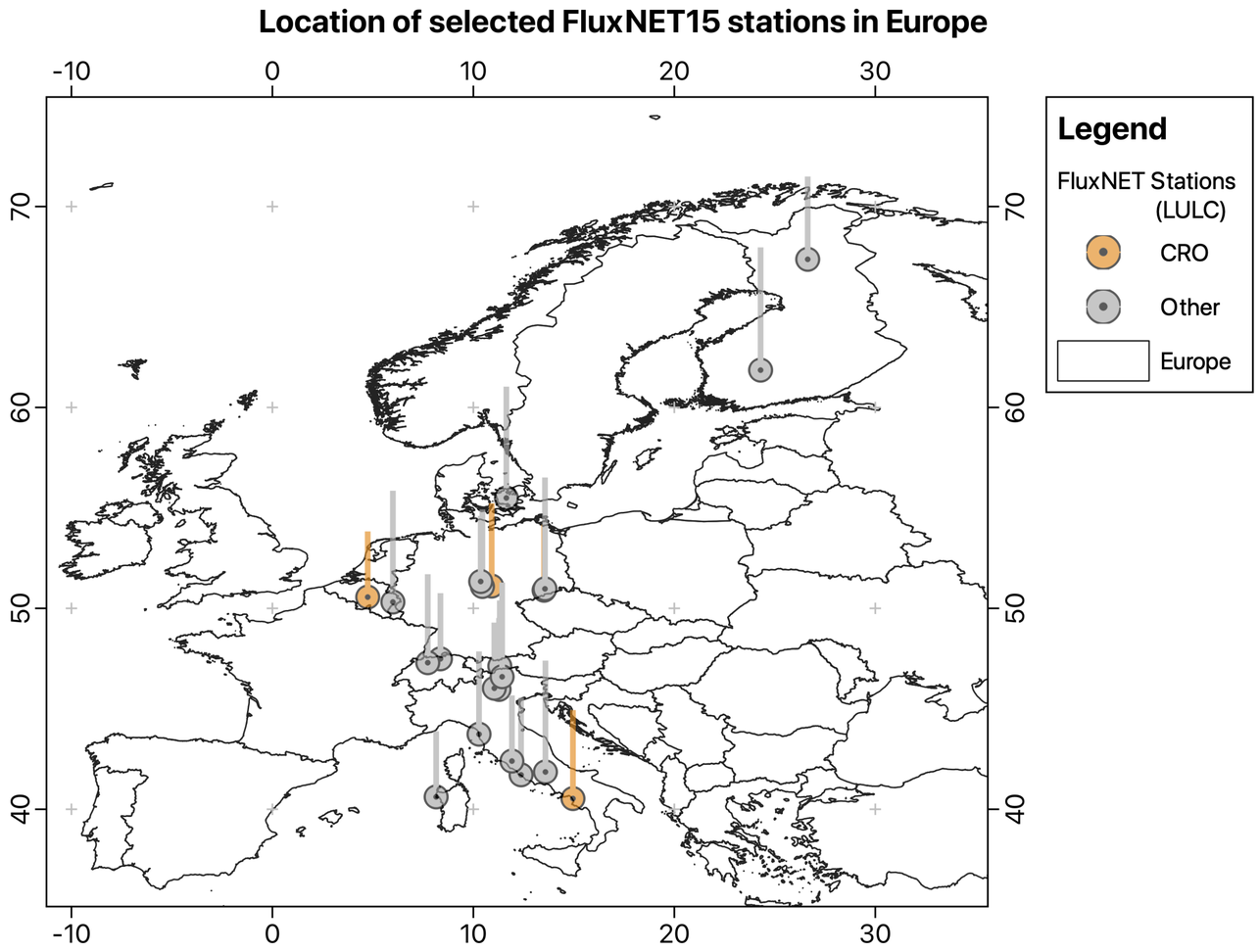
HS4.2 – Drought and water scarcity: monitoring, modelling and forecasting to improve hydro-meteorological risk management

Flash Droughts

- Flash droughts differ from the conventional droughts in its duration and onset.
- **Objectives**:
  - ☑ Compare methods and their performance on identifying events in Central Europe, building a tool to observe discrepancies among methods;
  - ☑ Implement all selected methods in R-language and build an open-source package to be available to the community.

Methodology - Selected Stations

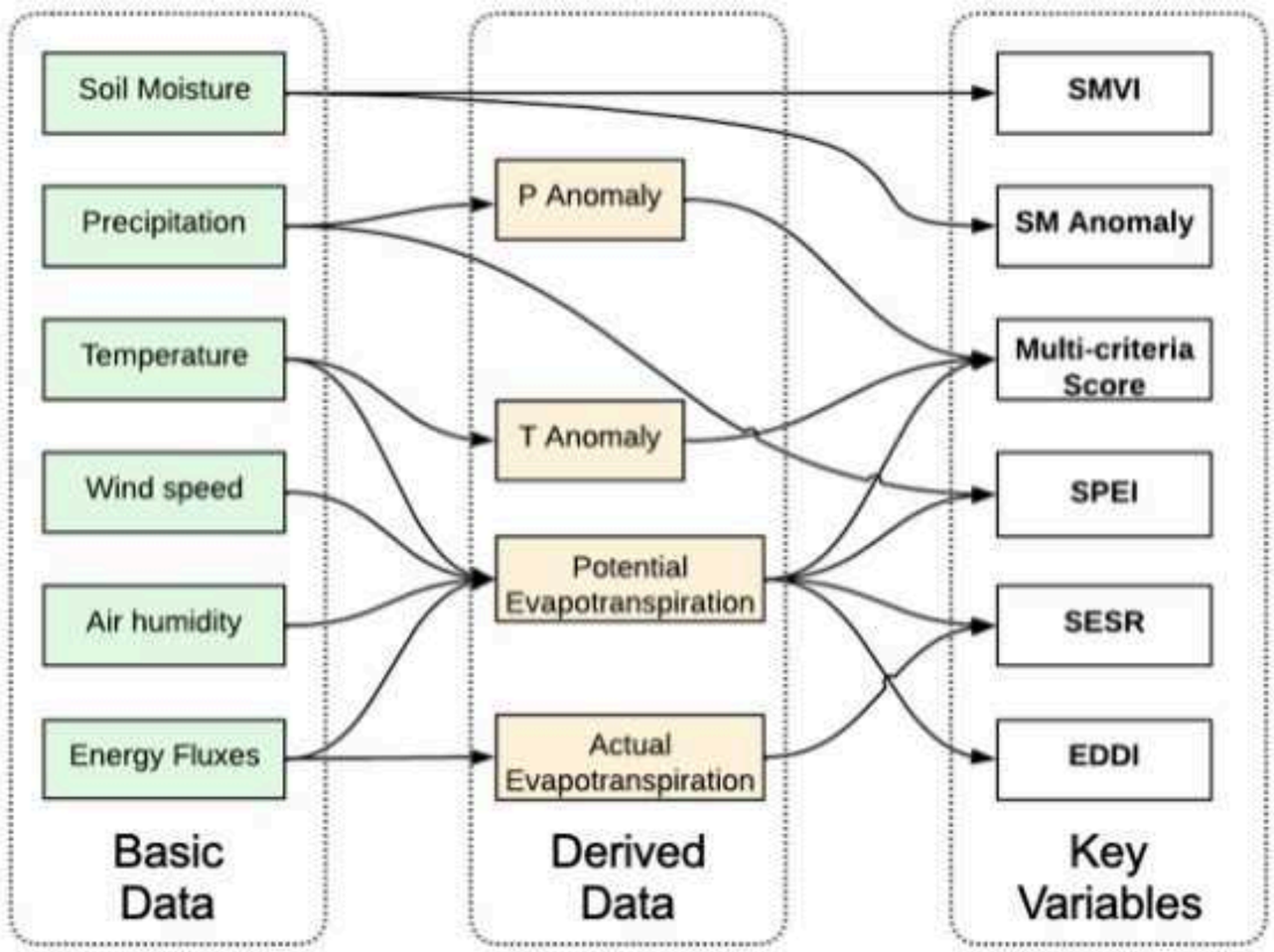
- 22 FLUXNET2015 in Central Europe were pre-selected, the data was analysed and complied in a Shiny App
  - > 10 years of data
  - Soil water content available
- Four FLUXNET2015 stations with **Cropland** were selected for analysis



Methodology - Selected Methods

- Different Variables
  - P, T, ET0, ETa, **SM**
    - **Soil Moisture**
      - Key variable (see definition)
      - Hard to obtain (scarce)

What is the best method that does not use Soil Moisture (proxy variables)?



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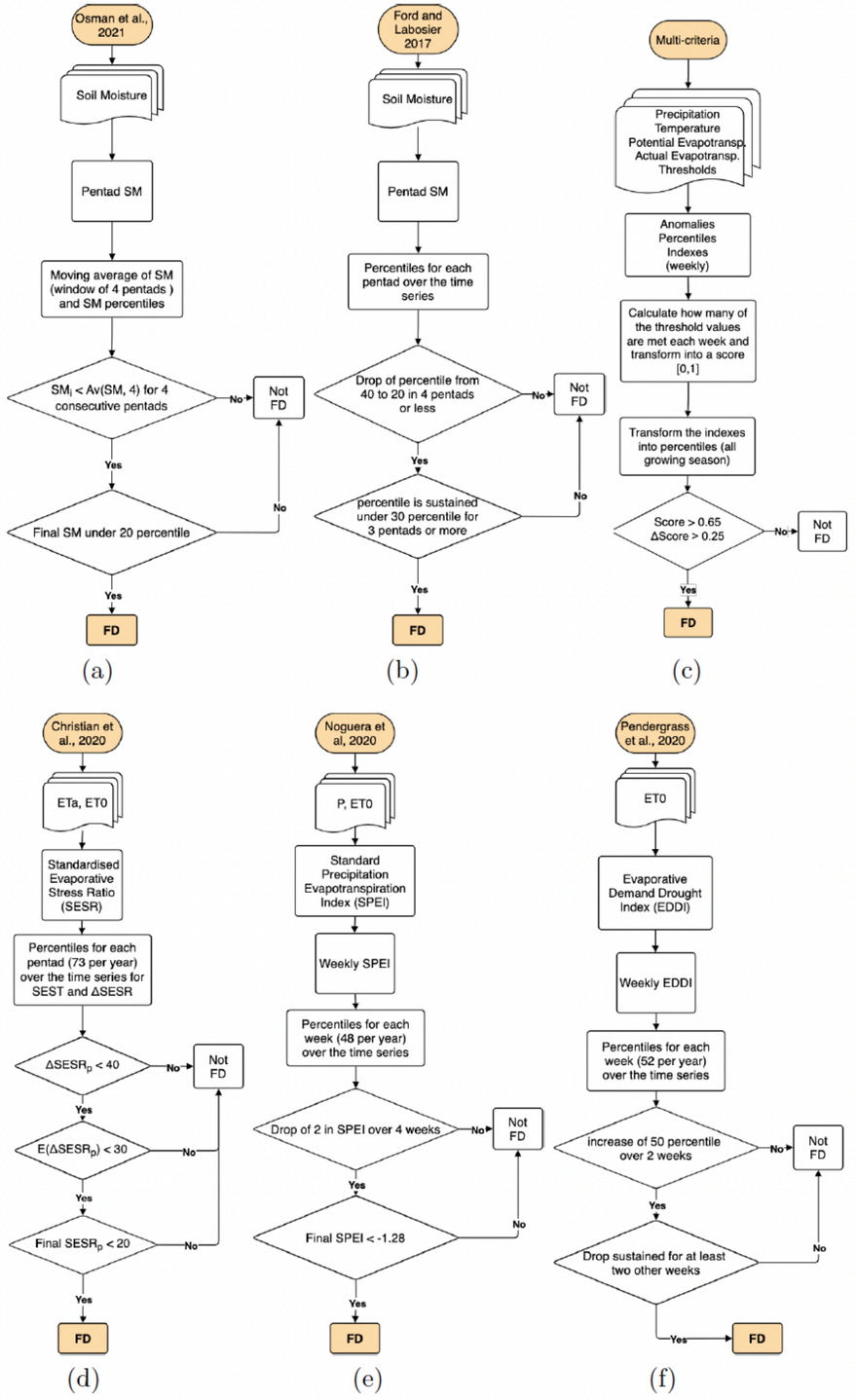
	Method	Variables
M1	Osman et al. (2021)	Soil Moisture
M2	Ford and Labosier (2017)	Soil Moisture
M3	Multi-criteria	Precipitation Temperature Actual Evapotransp. Potential Evapotransp.
M4	Christian, Basara, Otkin, Hunt, et al. (2019) Christian, Basara, Hunt, et al. (2020)	Actual Evapotransp. Potential Evapotransp.
M5	Noguera, Castro, and Serrano (2020)	Precipitation Potential Evapotransp.
M6	Pendergrass et al. (2020)	Potential Evapotransp.

Methodology - Flash Drought Identification

- Methods implementation:
  - Contacted all authors to fully understand the method's functioning



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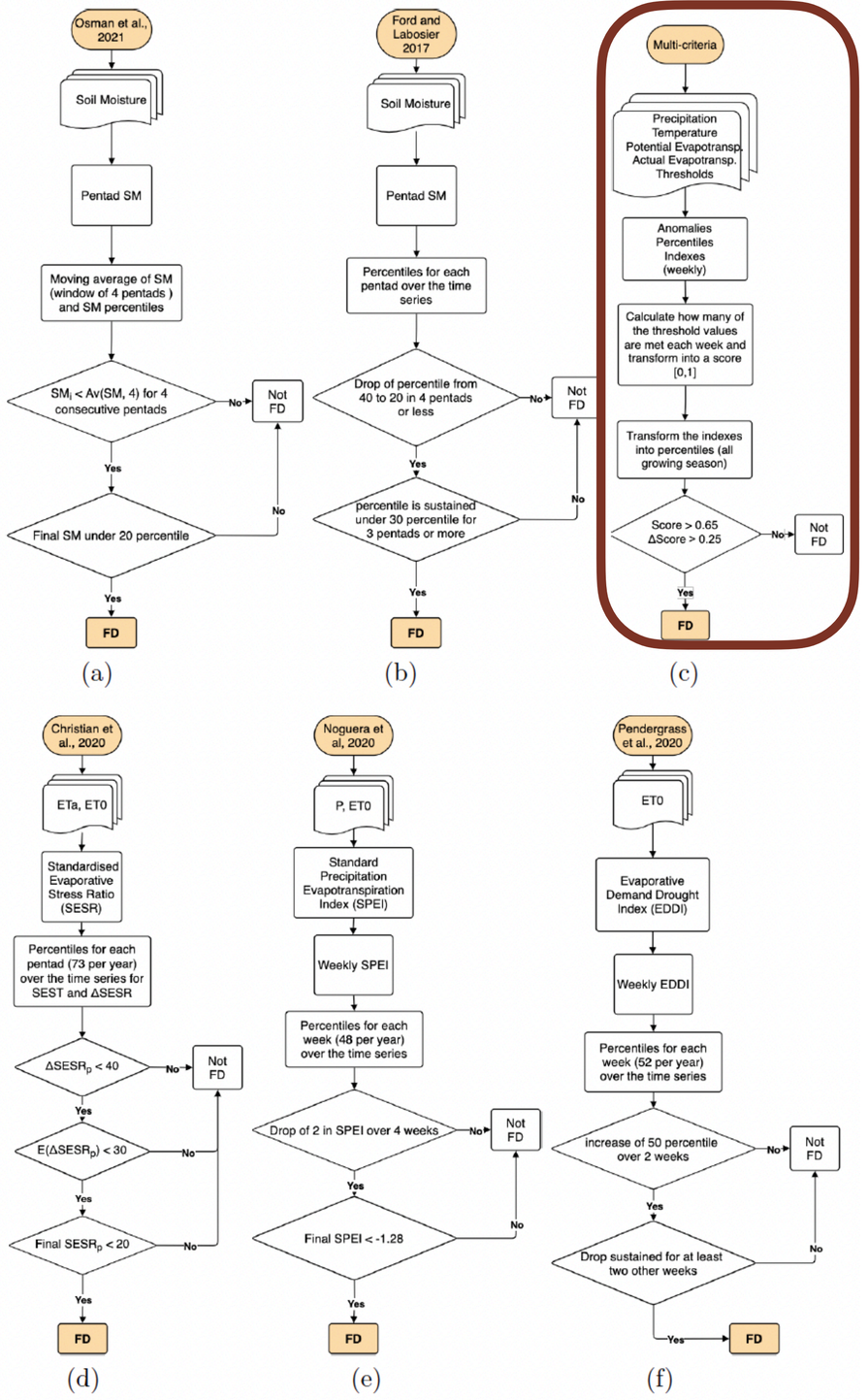


Methodology - Flash Drought Identification

- Methods implementation:
  - Contacted all authors to fully understand the method's functioning
  - Proposal of Multi-criteria method
  - Reproducibility
    - R-package
    - Shiny-App

Library of Flash Drought classificaition methods

Documentation for package 'fdClassify' version 0.4.1

- DESCRIPTION file.

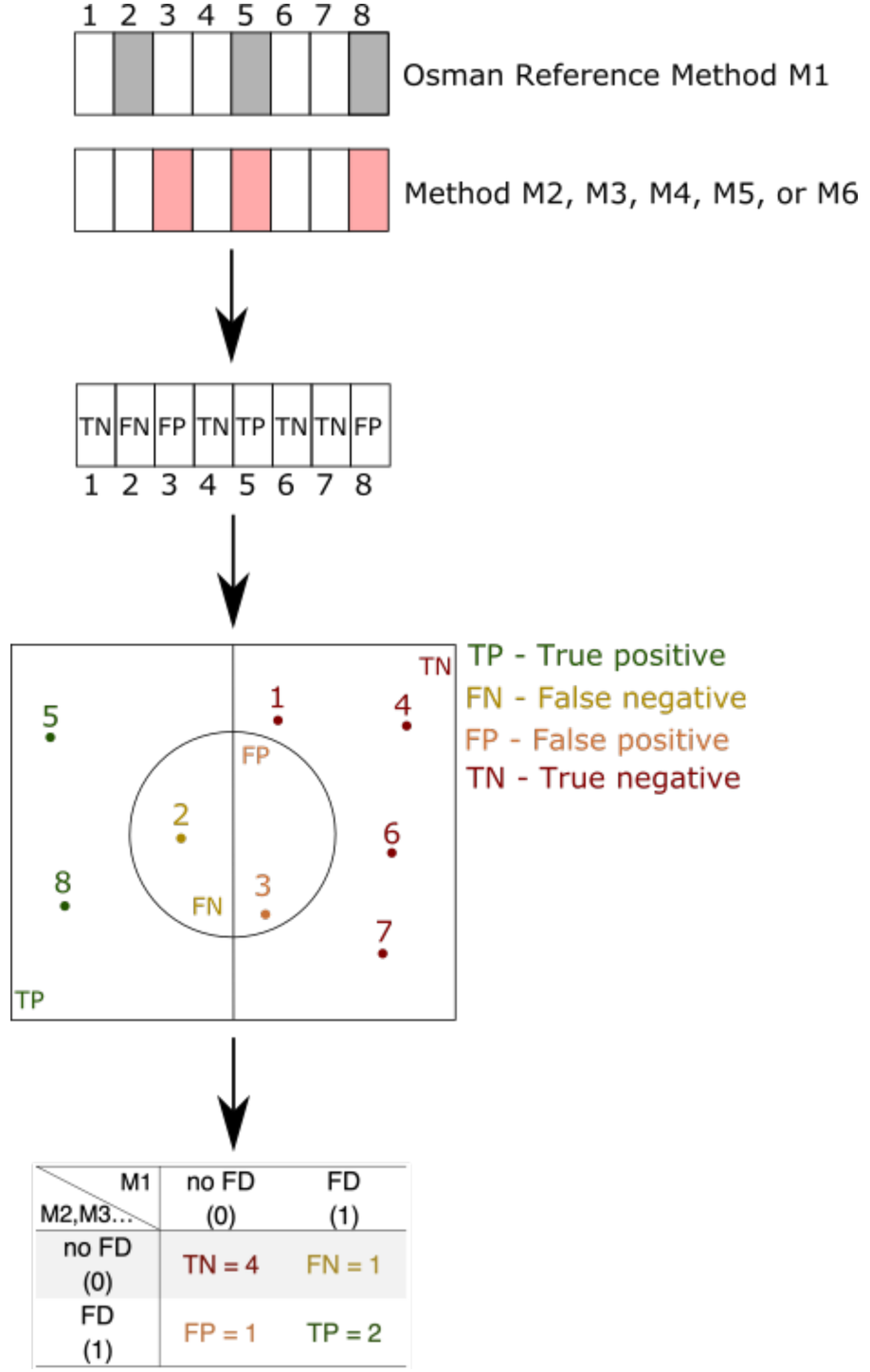
Help Pages

actual_evap_day	Calculate daily actual evaporation
alencar2021	FD identificaiton method proposed by the Author (Pedro Alencar)
Christian2020	FD identification method from Christian et al. (2020)
Christian_clean_data_week	Function to clean the ESR data (necessary before running Christian et al. method)
conf_matrix	Auxiliar (intern) function for calculating and exporting confusion matrix
de_tha_d	Daily data from FluxNET15 station Tharandt

Methods Comparison

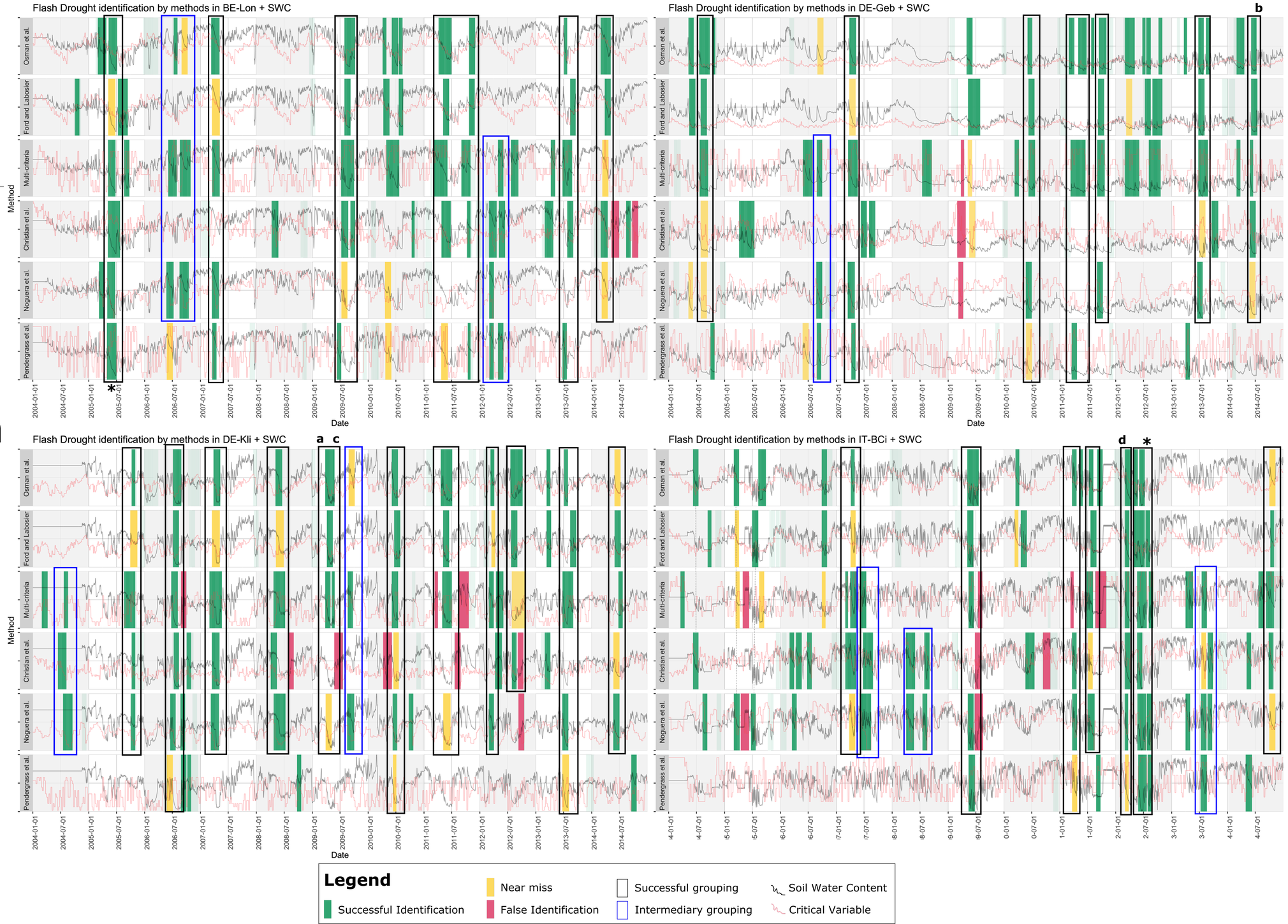
- **Confusion Matrix**
  - We borrow from data science and supervised learning confusion matrix metrics to assess method performance.
  - Comparison of a test method to a reference
    - *Reference method: Osman et al., 2021*

Metric	Equation
True negative rate (TNR)	$TNR = \frac{TN}{TN+FP}$
Negative predictive value (NPV)	$NPV = \frac{TN}{TN+FN}$
True positive rate (TPR)	$TPR = \frac{TP}{TP+FN}$
Positive predictive value (PPV)	$PPV = \frac{TP}{TP+FP}$
Matthews Correlation Coefficient (MCC)	$\frac{TP \times TN - FP \times FN}{\sqrt{(TP+FP)(TP+FN)(TN+FP)(TN+FN)}}$



Results

Co-identification



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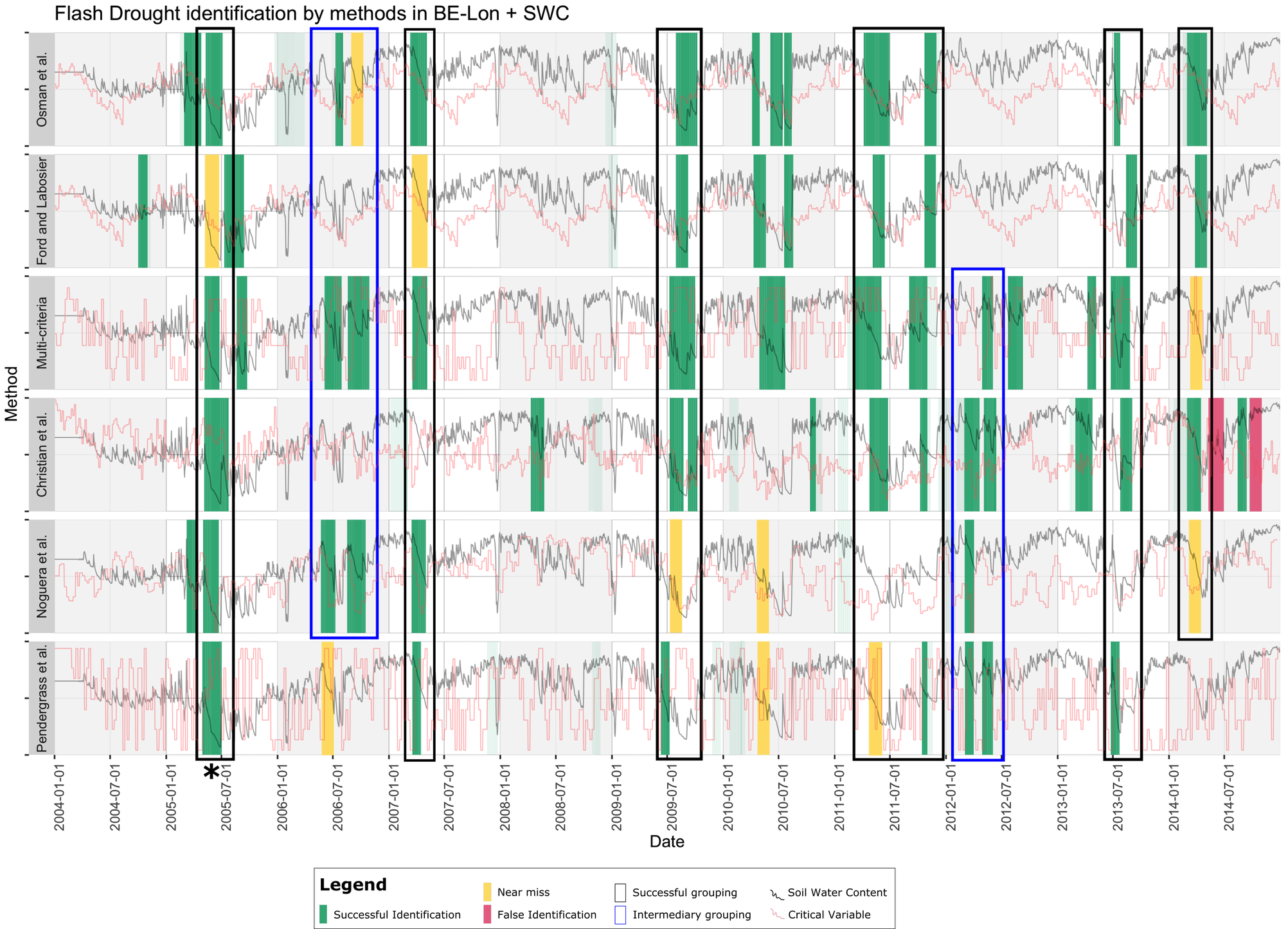
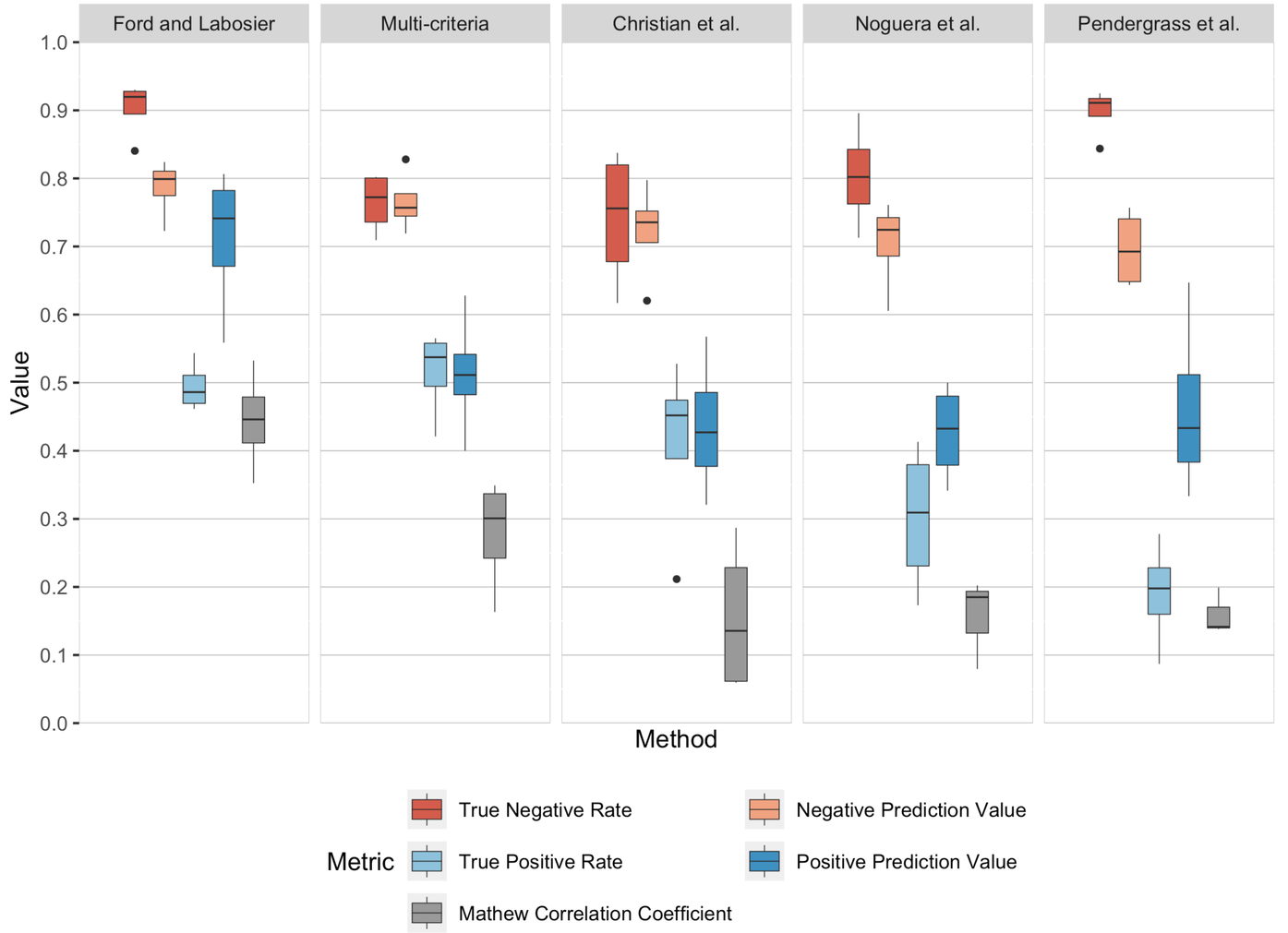


Methods Comparison

- Accuracy measurement: Mathew Correlation Coefficient (MCC)
  - *Accounts for randomness and non-balanced datasets*
- Trade-off
  - TPR x PPV (*precision x recall*)
  - TPR x TNR
  - TNR x NPV



Conclusions

- Methods show clear commonalities, however
  - performance varies by **region**, **climate**, and **land use**
- Preliminary analysis showed that FD on croplands in Central Europe are not rare (occurring every 1 to 2 years)
- The use of an **ensemble method**, using multiple variables and thresholds is suggested rather than a single-variable method
  - More flexible to identify different kinds of flash droughts and overcome miss-identification.

(Christophe Gateau/DPA, 2018)

Thanks!

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