Investigating Spatial Patterns And Characteristics Of Preconditioned Compound Flooding Over Europe

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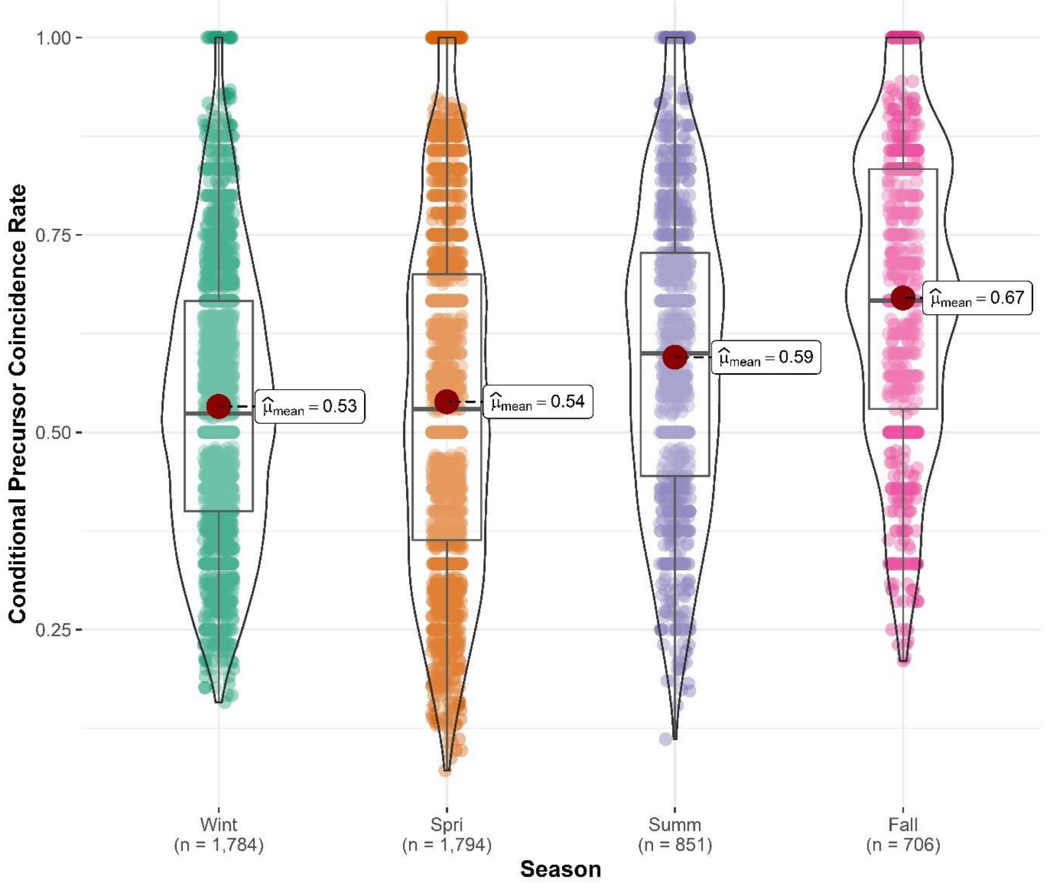

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EGU22-10435

Learning from IPCC AR6

- **Climate Change** - impacted almost all phases of the global water cycle[1]
- Extreme Precipitation events have **increased –** past few decades[1,2]
- Observed increases in precipitation extremes – not directly translated to observed increases in **flooding**[3,4]
- Decrease in **antecedent soil moisture –** decline in observed flood discharge[4]
- Preconditioned Compound Event[5]

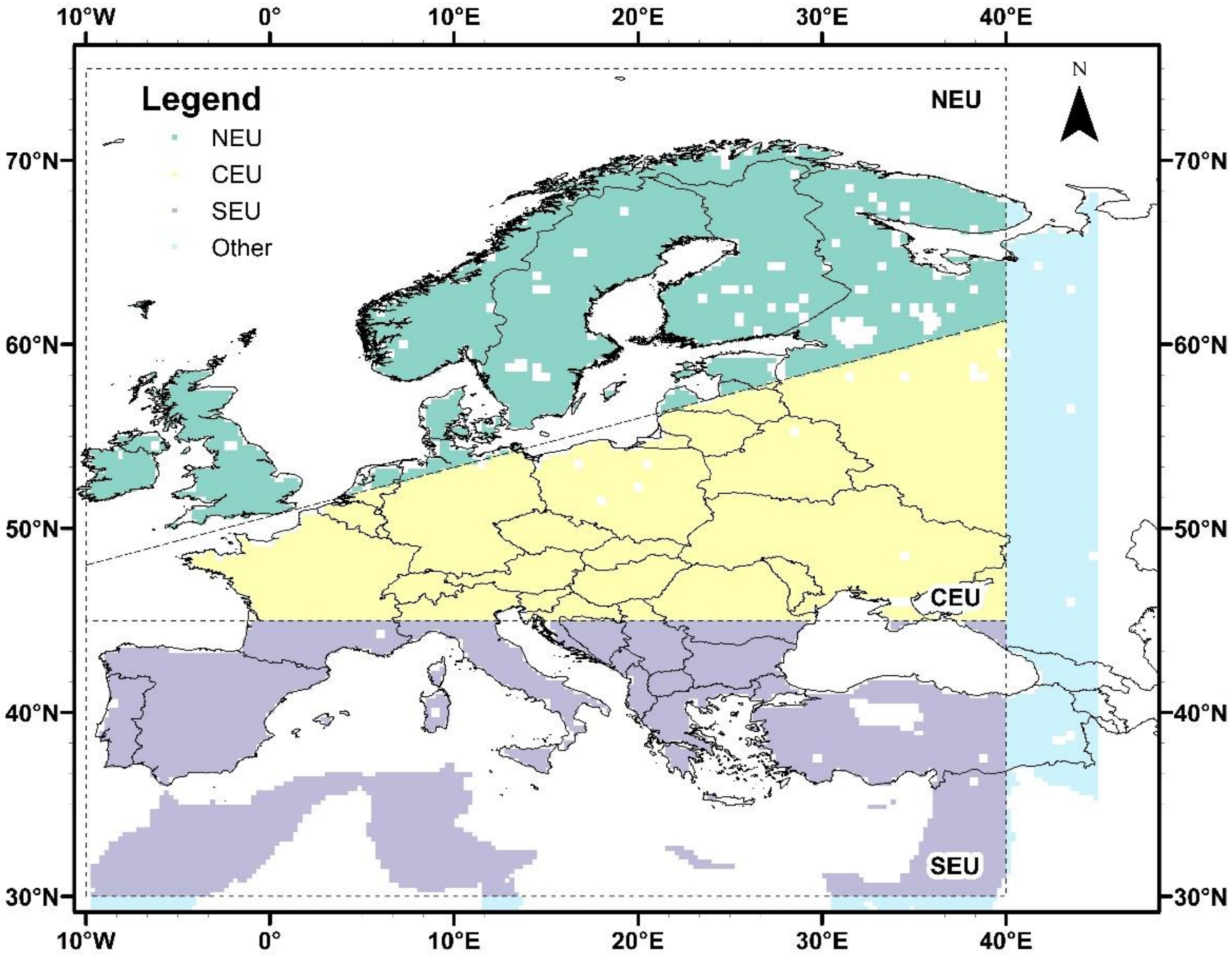
IPCC AR6 – ***"Low confidence in regional changes on flood frequency as it is strongly dependent on antecedent conditions!!!"***

1) IPCC AR6 – 2021
2) Roxy et al., 2017
3) Sharma et al., 2018
4) Wasko et al., 2020
5) Zscheischler *et al.* 2020

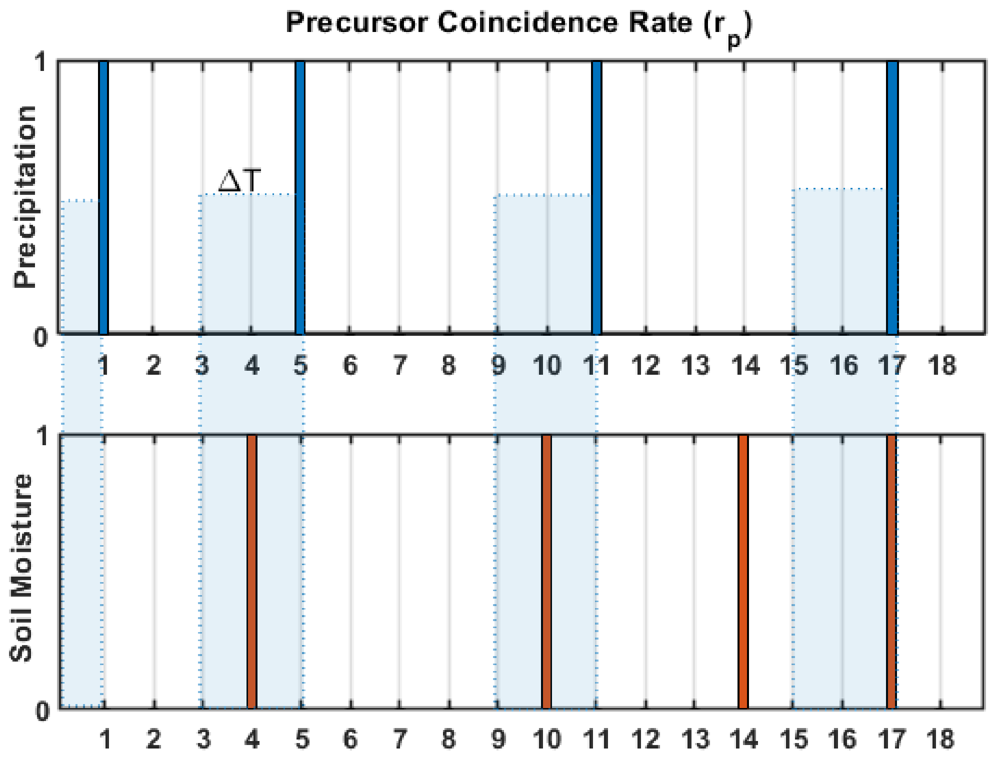
Research Objectives

RO1 Which regions over **Europe** c
of extreme **Precipitation (P)**
being extreme?

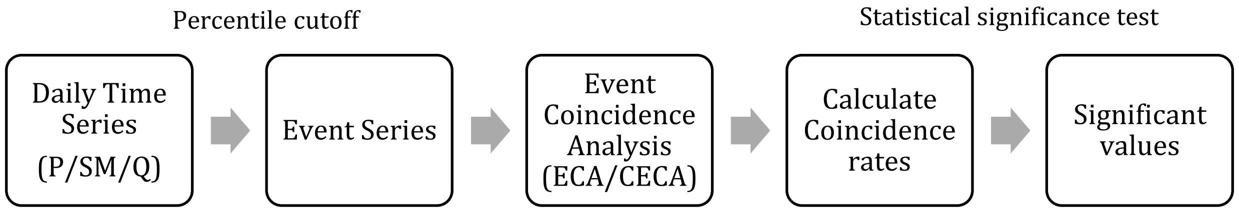
RO2 Does the impact of **SM-P** c
occurrence of **annual floods**



Event Coincidence Analysis

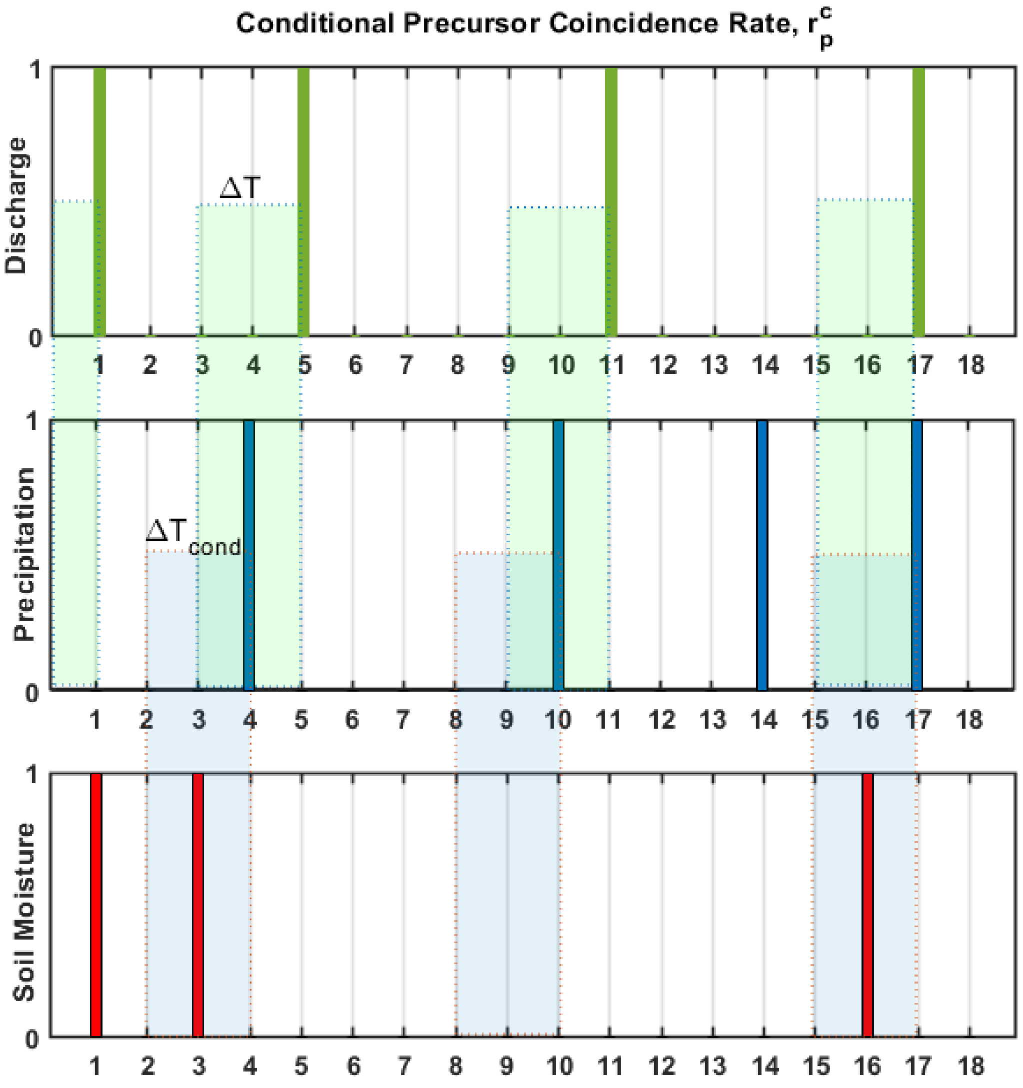


- Event Coincidence Analysis[1,2,3] (ECA) – quantifies and characterize - coincidences between event series
- Helps to consider the timings of well-defined events
- Two parameters - temporal tolerance interval ΔT and joint time delay of τ
- Statistical significance test[3] to ensure that observed coincidences are not random
- Recent studies[4,5] – disentangled SM-P Covariation patterns using ECA



1) Donges et al., 2011, 2016
2) Siegmund et al., 2016
3) Siegmund et al., 2017
4) Sun et al. 2018
5) A. Manoj J et al, 2022

Event Coincidence Analysis



Precursor coincidence rate[1]:

$$r_p(\Delta T,\tau) = \frac{1}{N_A}\sum_{i=1}^{N_A} H\left(\sum_{j=1}^{N_B} I_{[0,\Delta T]}\left(t_i^A-\tau\right) - t_j^B\right)$$

Conditional Precursor coincidence rate[2]:

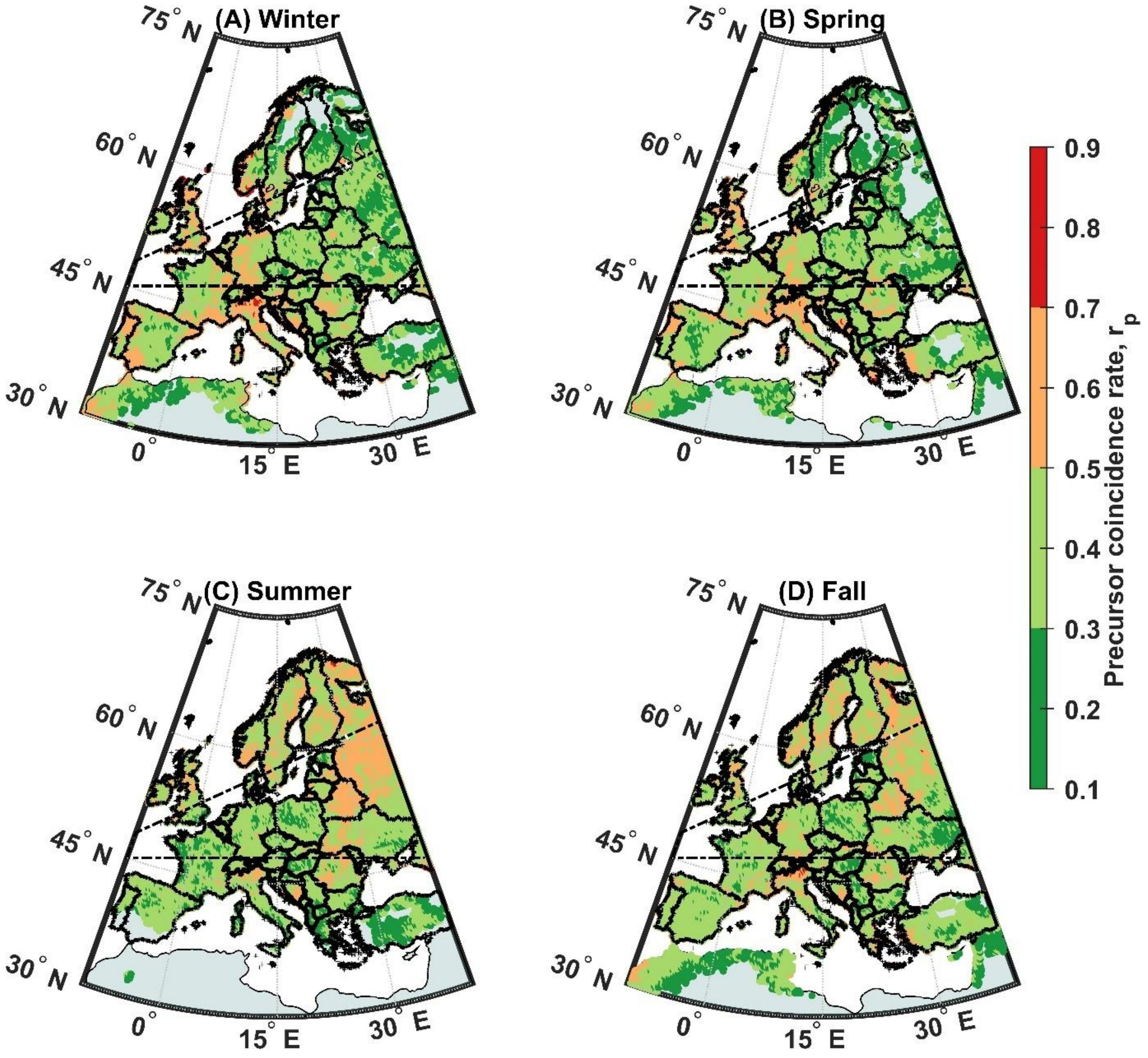
$$r_p^c = \frac{1}{N_A}\sum_{i=1}^{N_A} H\left(\sum_{j=1}^{N_B} H\left[\sum_{k=1}^{N_C} I_{[0,\Delta T_{cond}]}\left(\left(t_j^B-\tau_{cond}\right)-t_k^C\right)\right] I_{[0,\Delta T]}\left(\left(t_i^A-\tau\right)-t_j^B\right)\right)$$

r_p measures the fraction of P events preceded by at least one – SM type event, $r_p \in [0,1]$

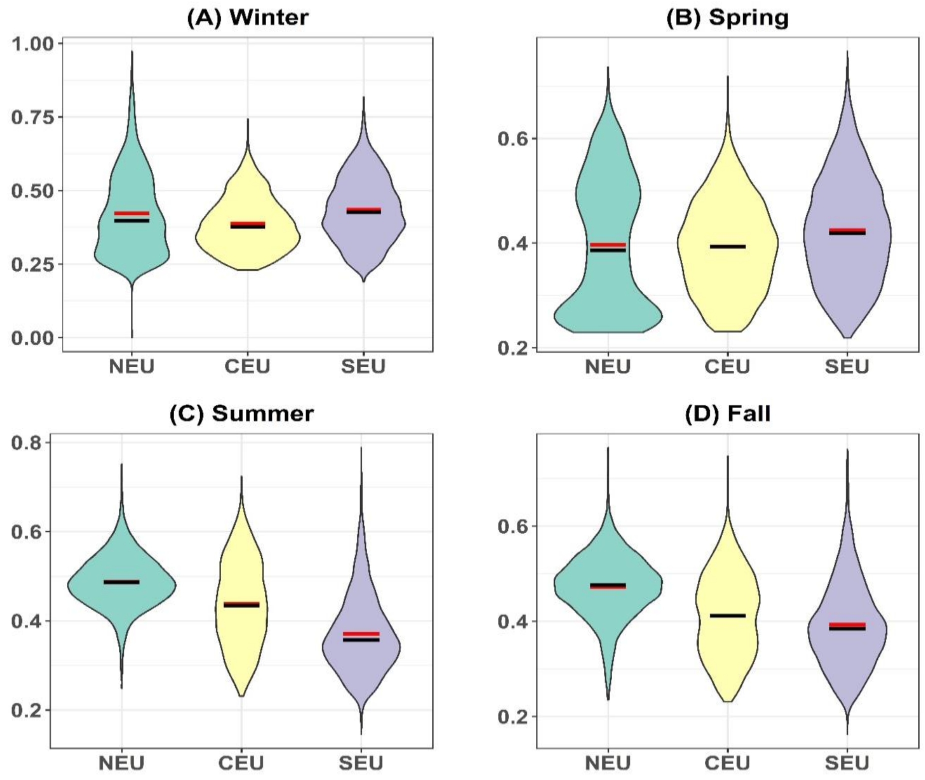
r_p^c measures the fraction of Q events preceded by at least one SM conditioned P event, $r_p^c \in [0,1]$

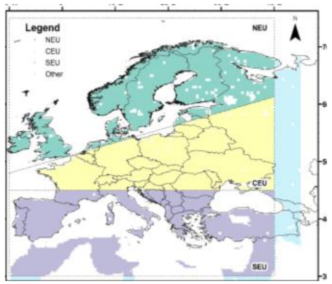
1) Donges et al., 2011, 2016
2) Siegmund et al., 2016
3) Siegmund et al., 2017

Spatiotemporal Patterns of SM-P Dependence

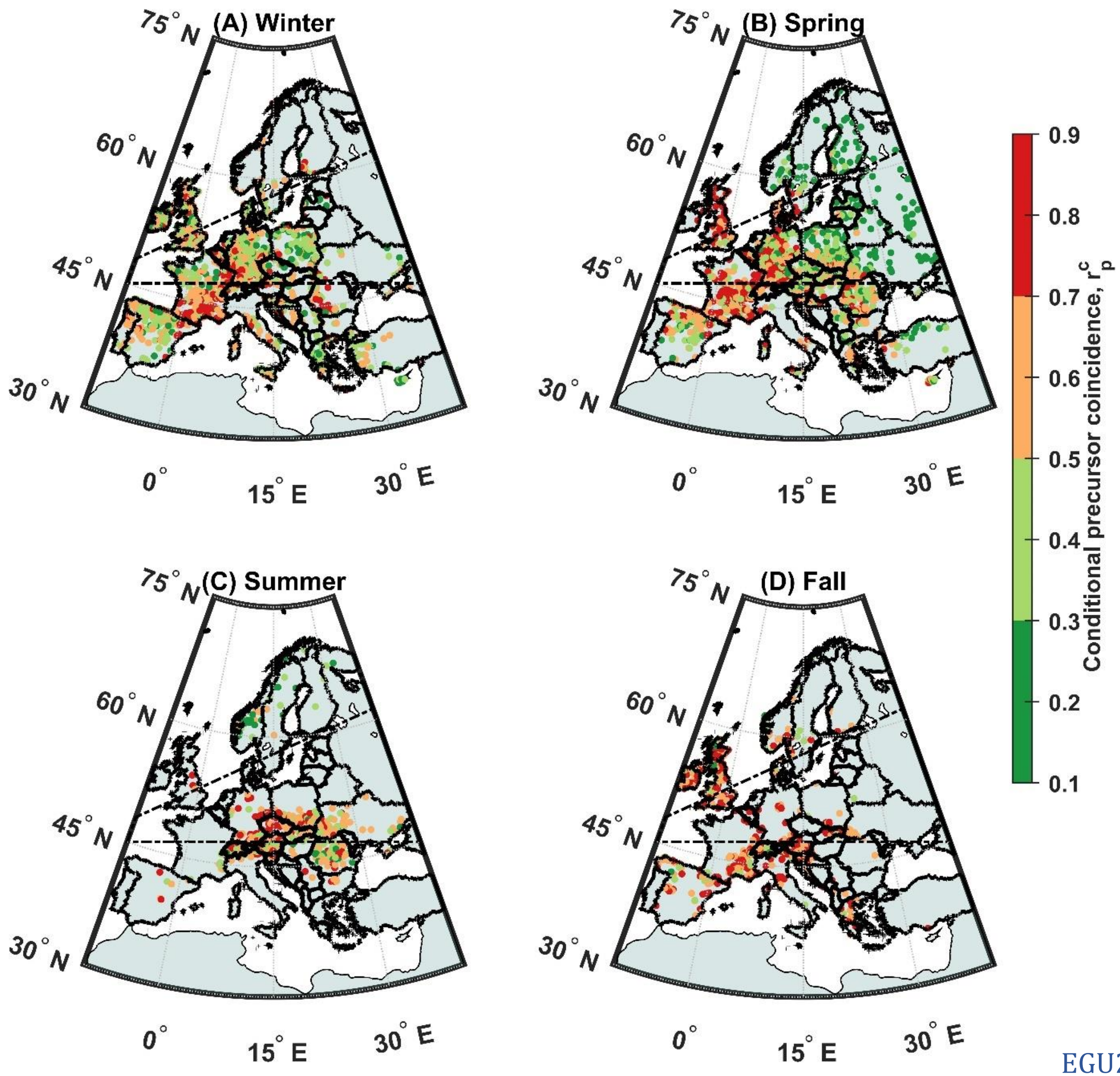


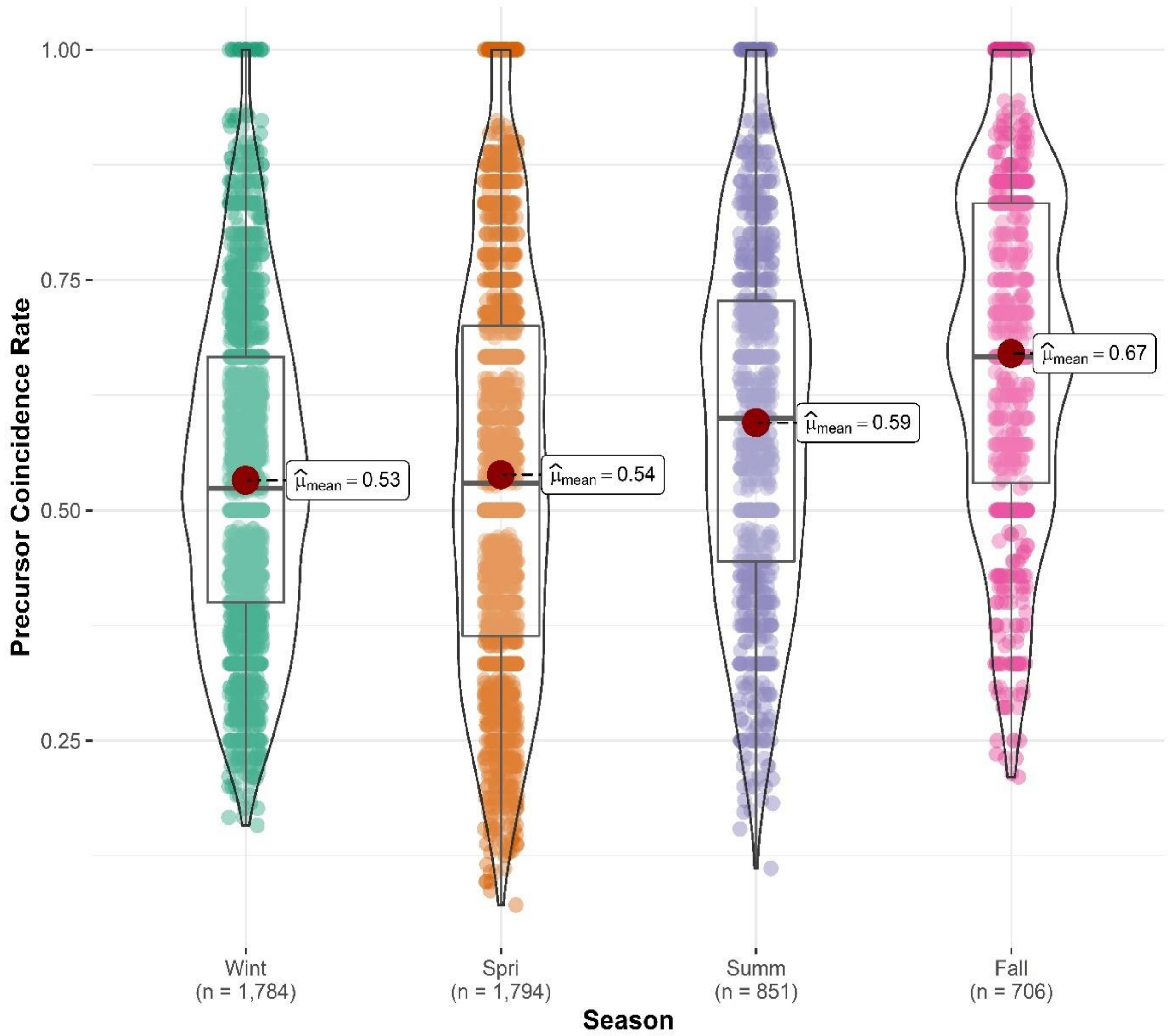
- SM-P coincidence rates - evaluated using E-OBS v24.0 (Precipitation), GLEAM v3.5 (Soil Moisture)
- 95th percentile limit, Temporal tolerance – 3 days
- Only grid points that are significant at α=0.05





SM-P Coincidences Prior to Annual Floods





Take Home Message

- Disentangled SM-P coincidences
- Seasonal shift – corresponds to climatological patterns
- Possible role of SM-P coincidence in peak annual floods
- Fraction of preconditioned floods – highest in fall

Limitation/Future Scope

- Difficult to characterize flood hazard only using statistical relationships
- Possible follow up using more variables/ changing the datasets
- Grid-based products - average state - over a large spatial domain
- Understanding the mechanisms within a catchment

Thank you!!

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