



# Trends in short-term precipitation variability

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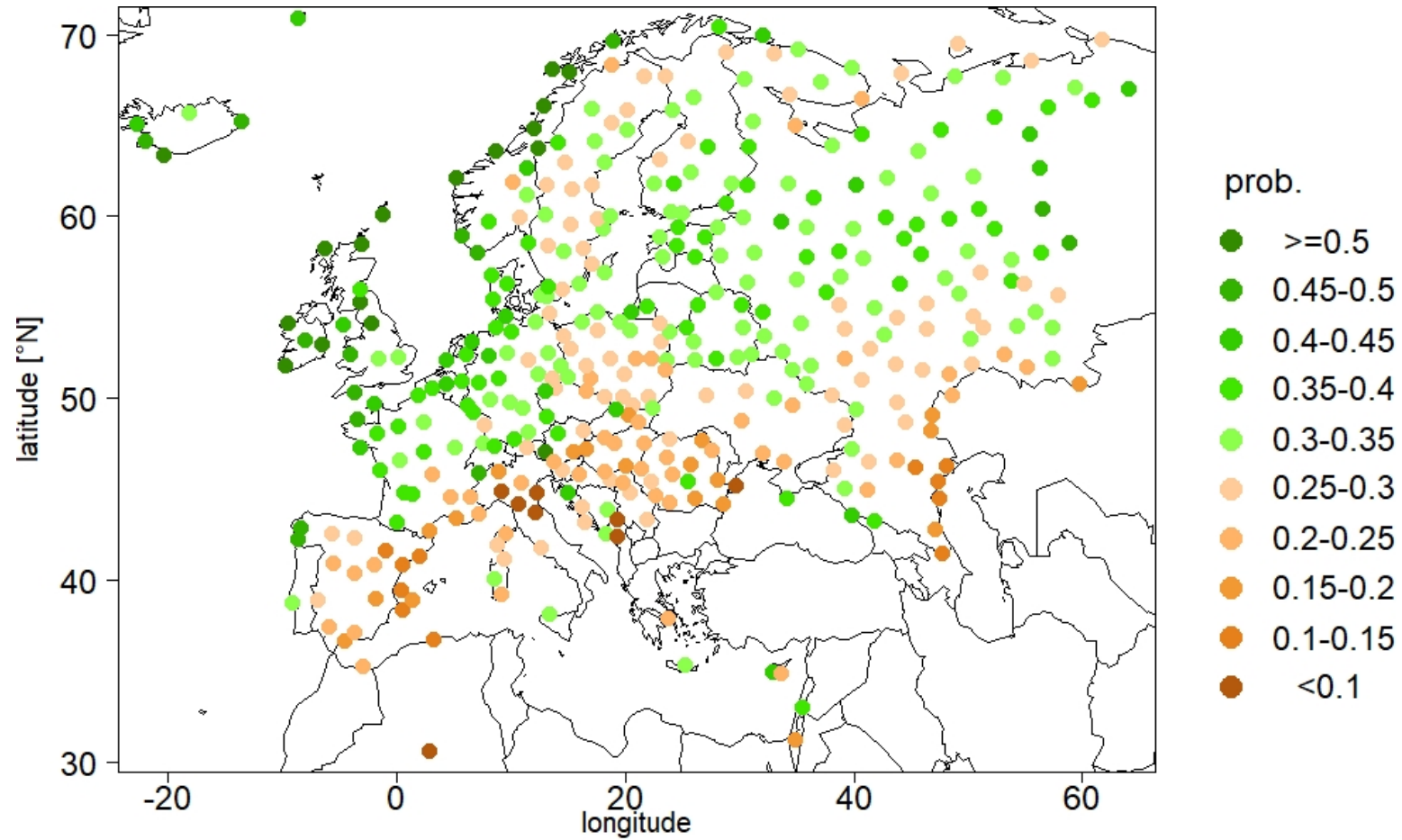
# Introduction

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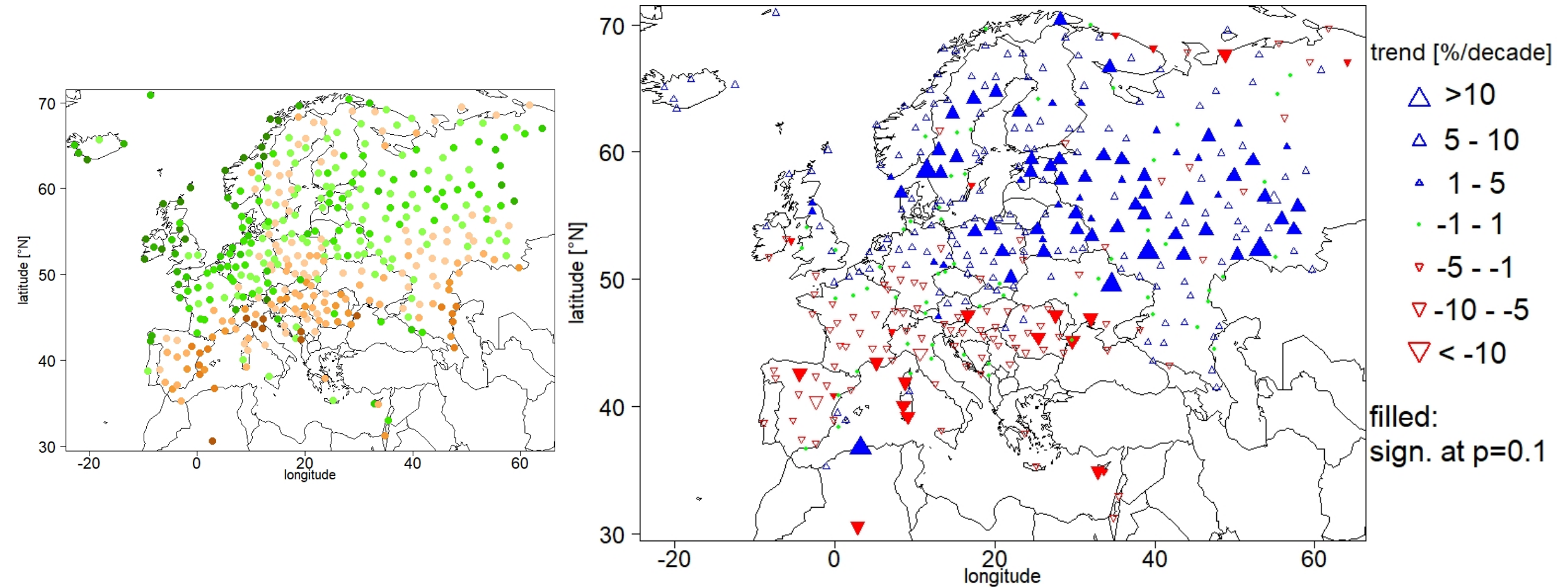
- Daily precipitation data from European Climate Assessment and Dataset project (ECA&D)
- 400 station in Europe
- Period 1961 – 2010
- Rainy days:  $pr \geq 1\text{mm}$
- wet-to-wet and dry-to-wet transition probabilities
- Long-term trends of seasonal values and their statistical significance are calculated by non-parametric methods (Mann-Kendall test)

# Probability of rainy days winter (DJF)

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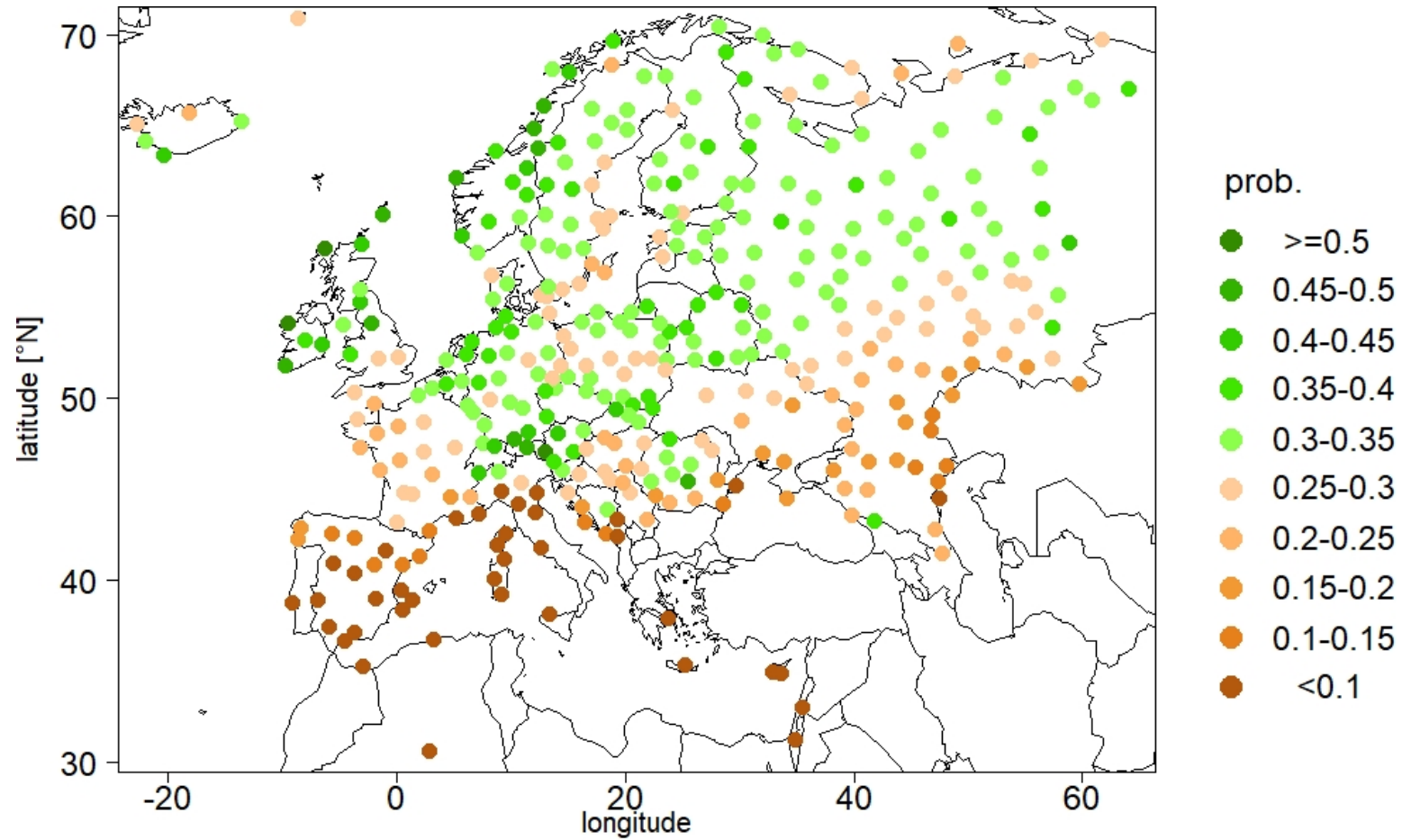


# Probability of rainy days and their trends winter (DJF)

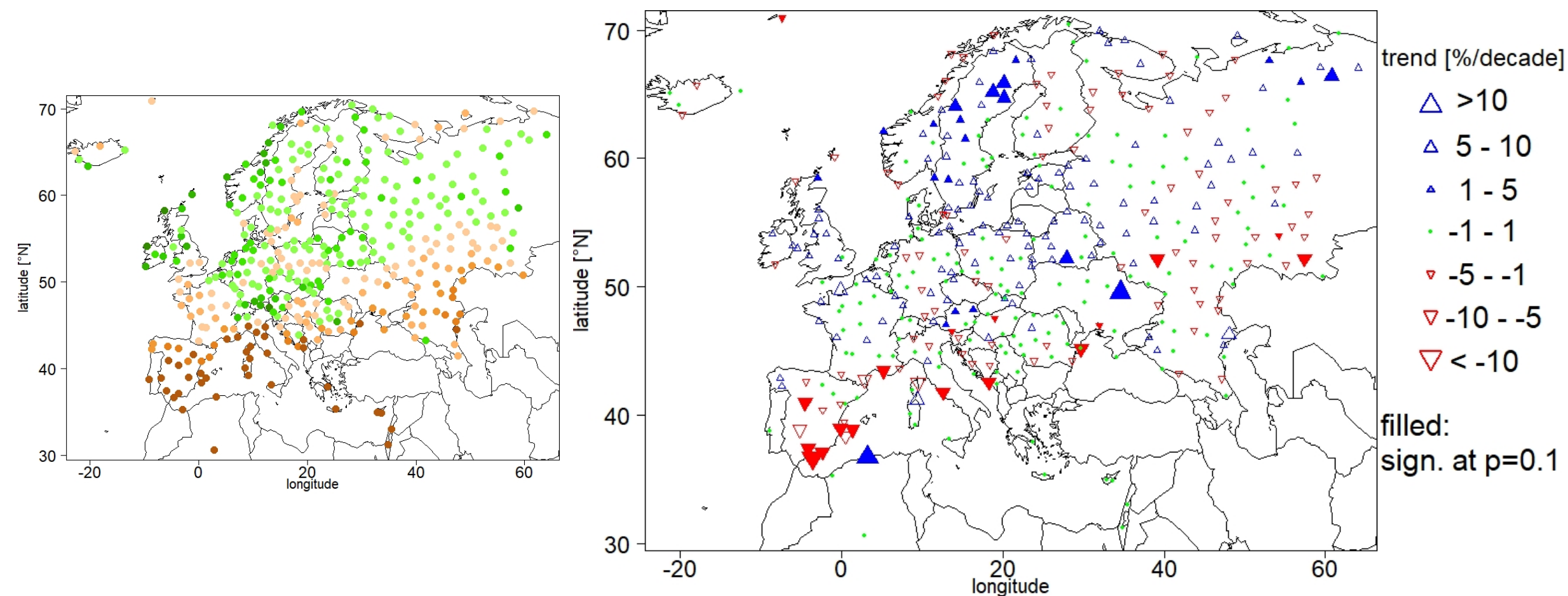


# Probability of rainy days summer (JJA)

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# Probability of rainy days and their trends summer (JJA)



# Probability of rainy days

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- The probability of rainy day is greater in winter than in summer
- In winter, the highest probability is in the British Isles, Western Europe and the coastal areas
- In summer, the probability of rain is higher in the norther half of Europe
- Rainy day probability trends are higher and more often statistically significant in winter than in summer







# Transition probabilities

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## Two-state first-order Markovian process

Example:

- Raining today  40% raining tomorrow (wet-to-wet)  
 60% no rain tomorrow (wet-to-dry)
- No rain today  20% raining tomorrow (dry-to-wet)  
 80% no rain tomorrow (dry-to-dry)

Transition matrix:

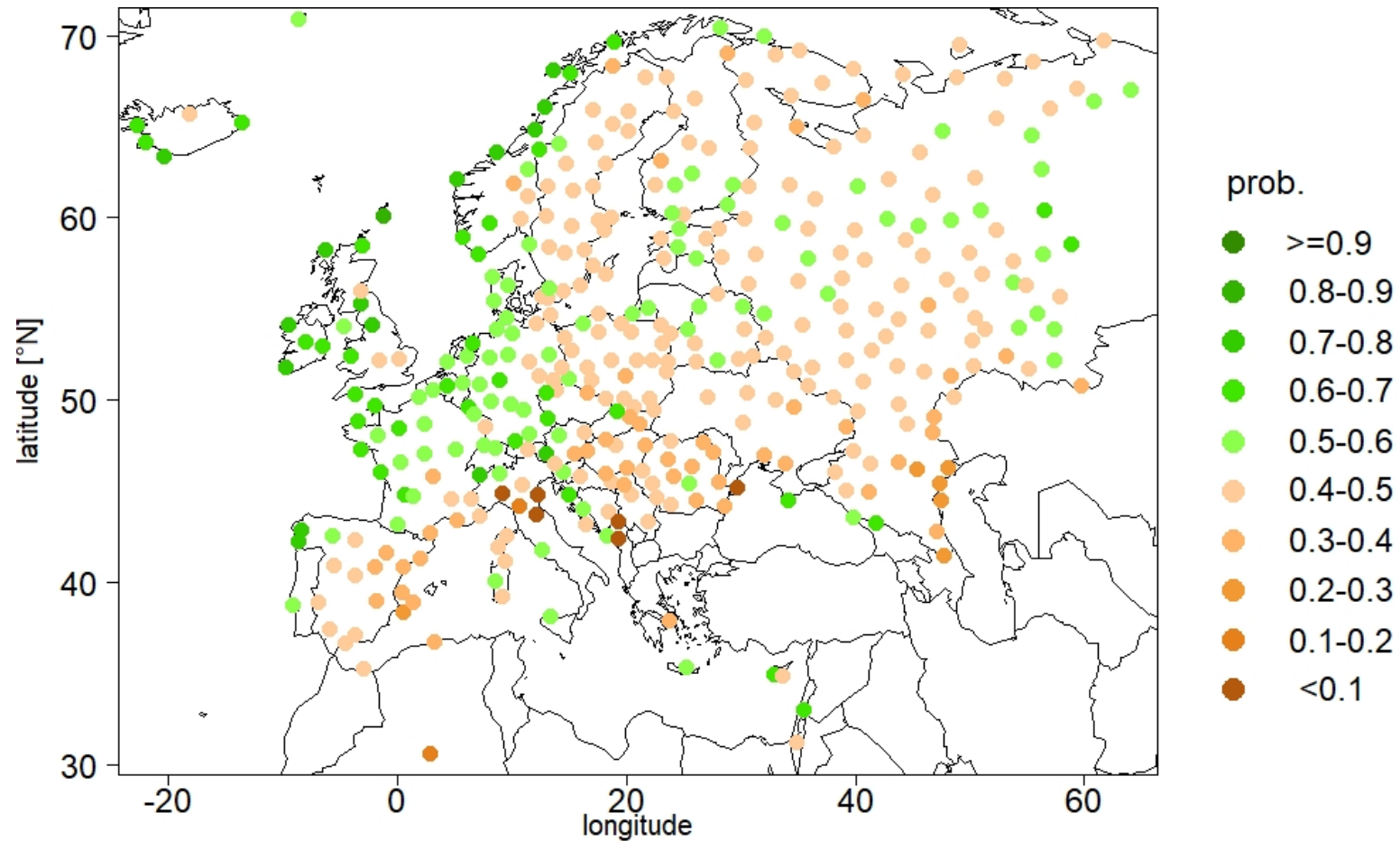
Prob. (P)	rain	no rain
rain	0.4	0.6
no rain	0.2	0.8

Row sum up to 1

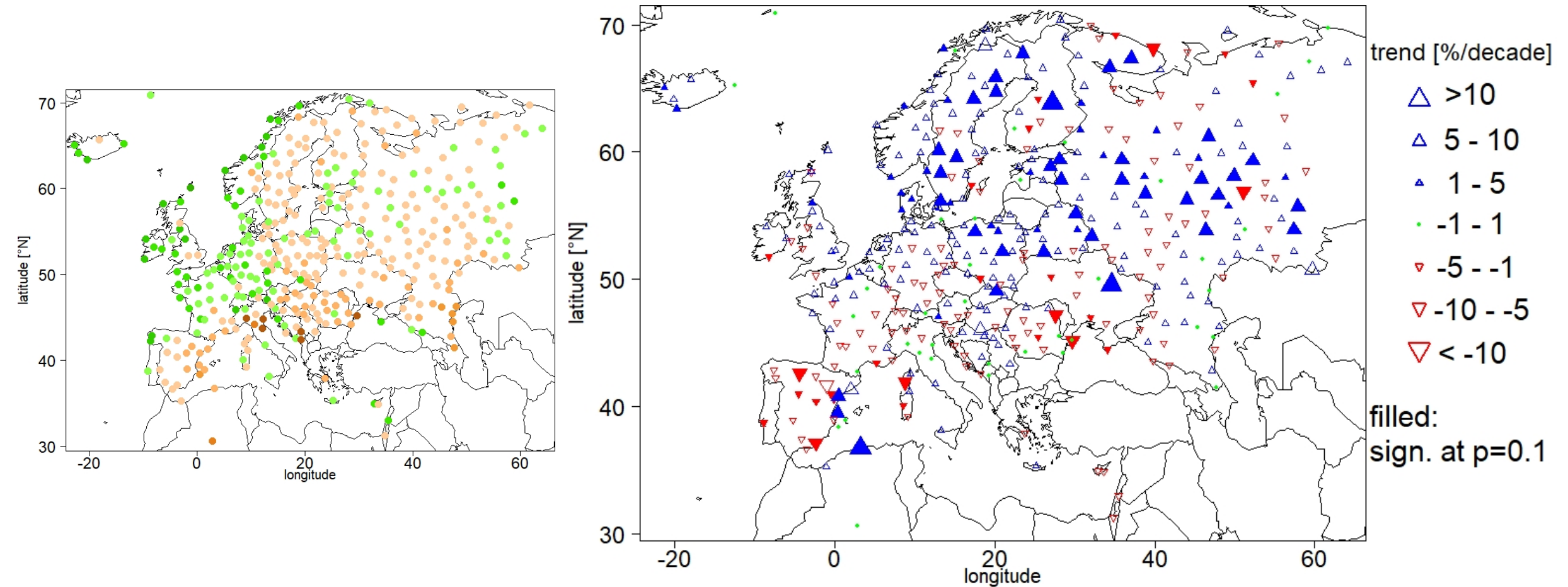


# wet-to-wet transition probability winter (DJF)

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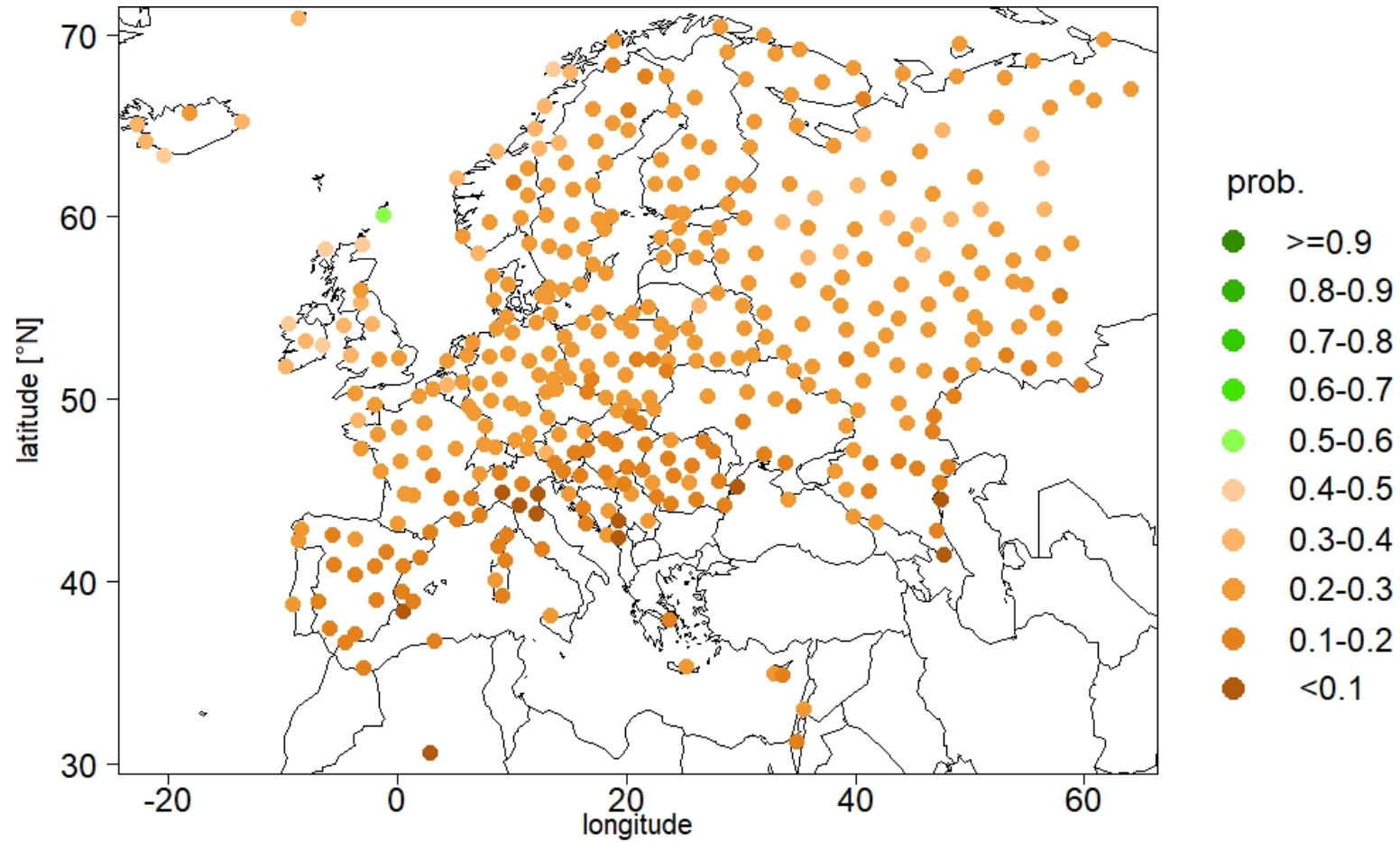


# Trend of wet-to-wet transition winter (DJF)

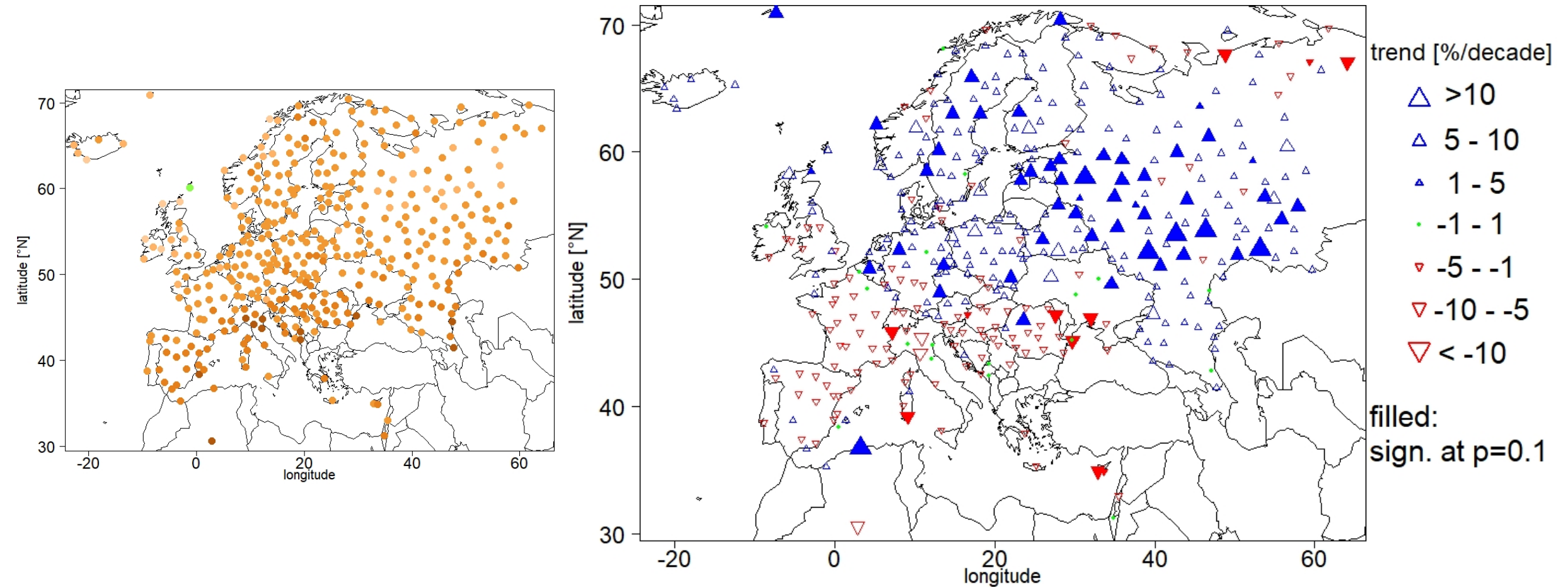


# dry-to-wet transition probability winter (DJF)

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# Trend of dry-to-wet transition winter (DJF)



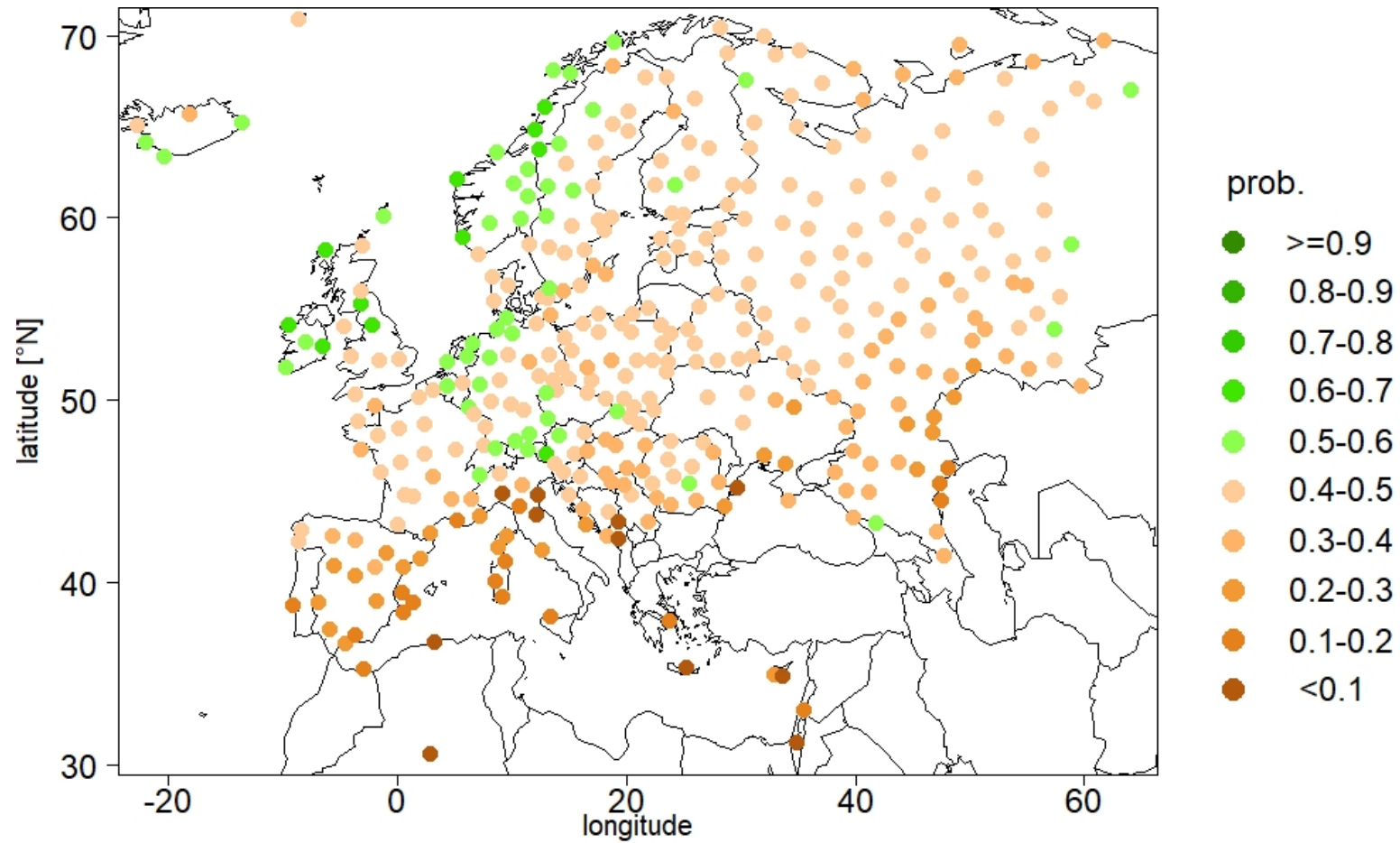
# Transition probabilities in winter

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- The highest wet-to-wet probabilities are around 60-70%, and they are in the British Isles, Western Europe and the coastal areas.
- Dry-to-wet probabilities are low throughout Europe, on average it is 20%
- Positive statistically significant trends dominate in the northern half of Europe and negative trends in the south

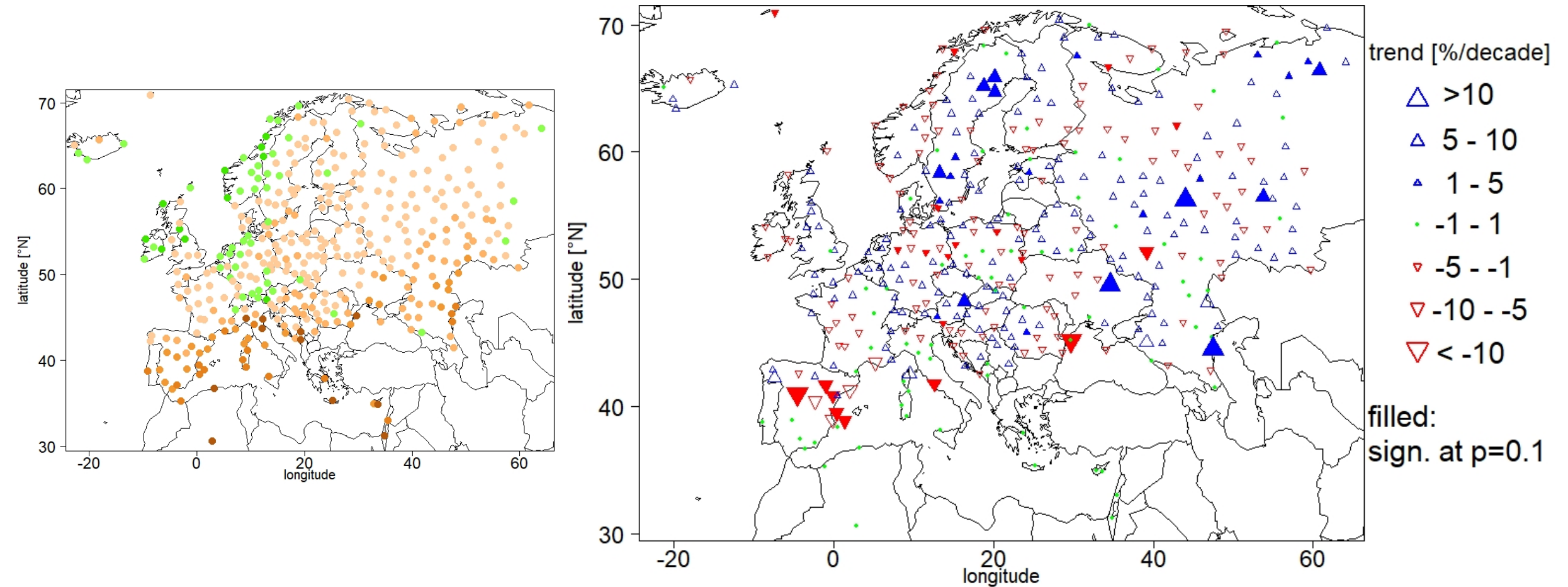
# wet-to-wet transition probability summer (JJA)

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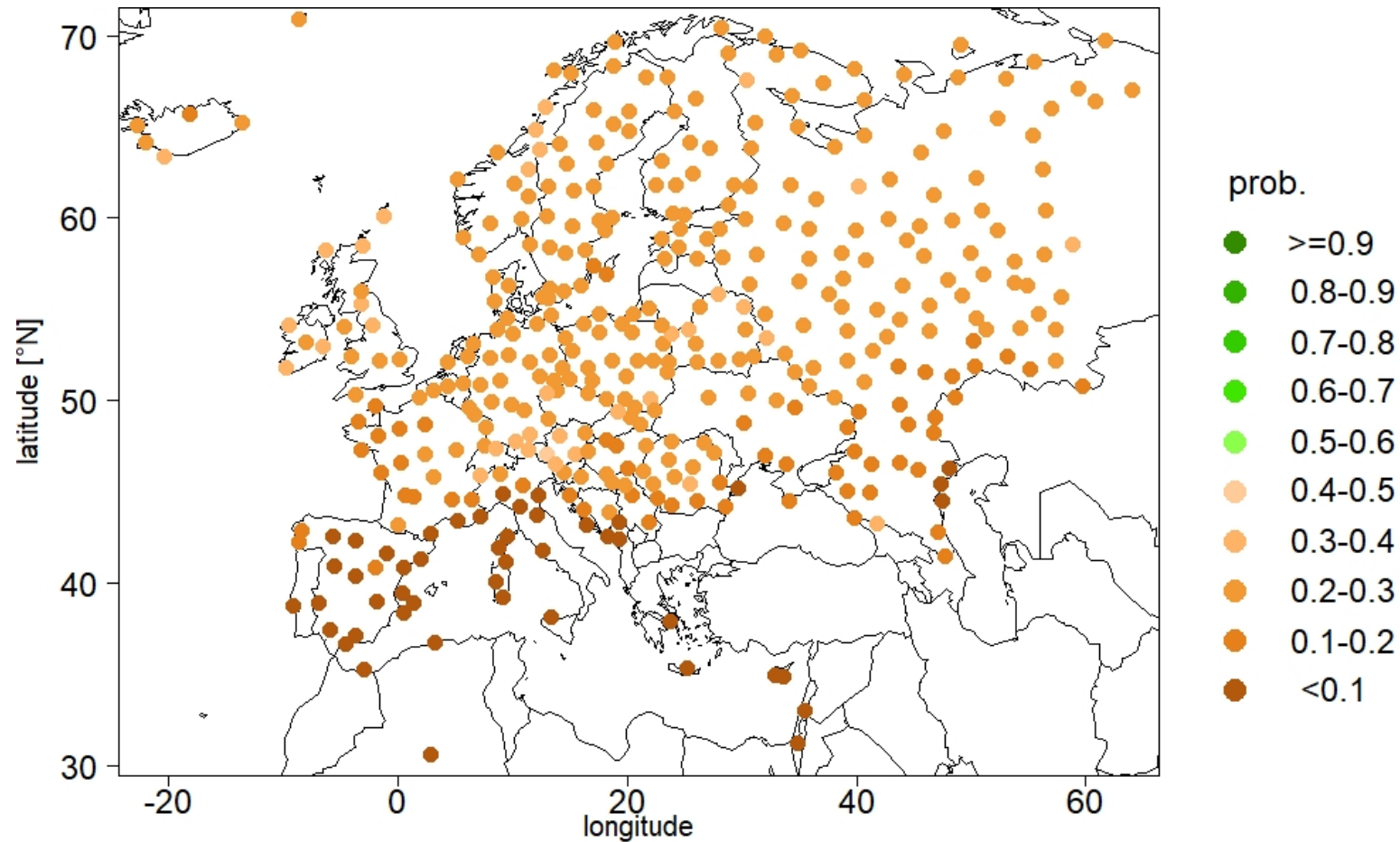


# Trend of wet-to-wet transition summer (JJA)

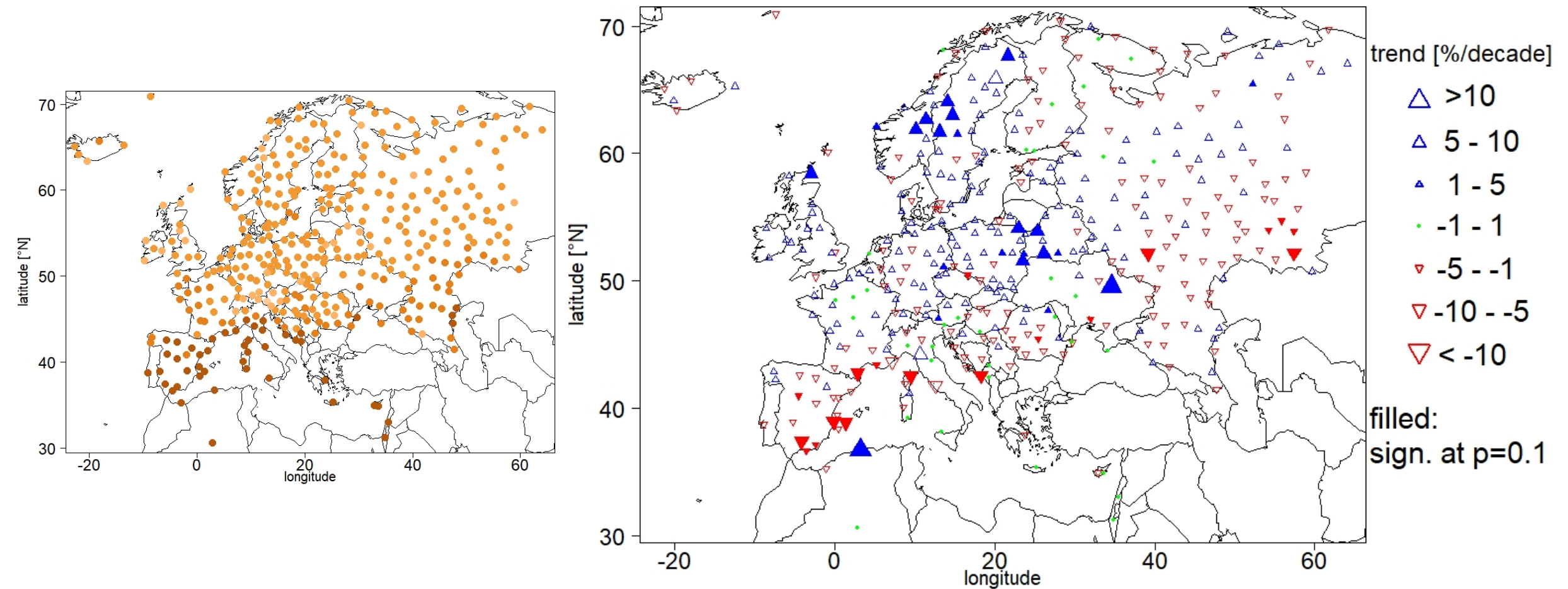




# dry-to-wet transition probability summer (JJA)



# Trend of dry-to-wet transition summer (JJA)



# Transition probabilities in summer

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- Summer wet-to-wet and dry-to-wet transition probabilities have a similar geographical distribution as in winter, but are generally smaller
- Trends are significant at only a few stations