



Insights into GSP properties in Europe

Koninklijk Meteorologisch Instituut

Institut Royal Météorologique

Königliches Meteorologisches Institut

Royal Meteorological Institute

Dieter Poelman Hannes Kohlmann Wolfgang Schulz

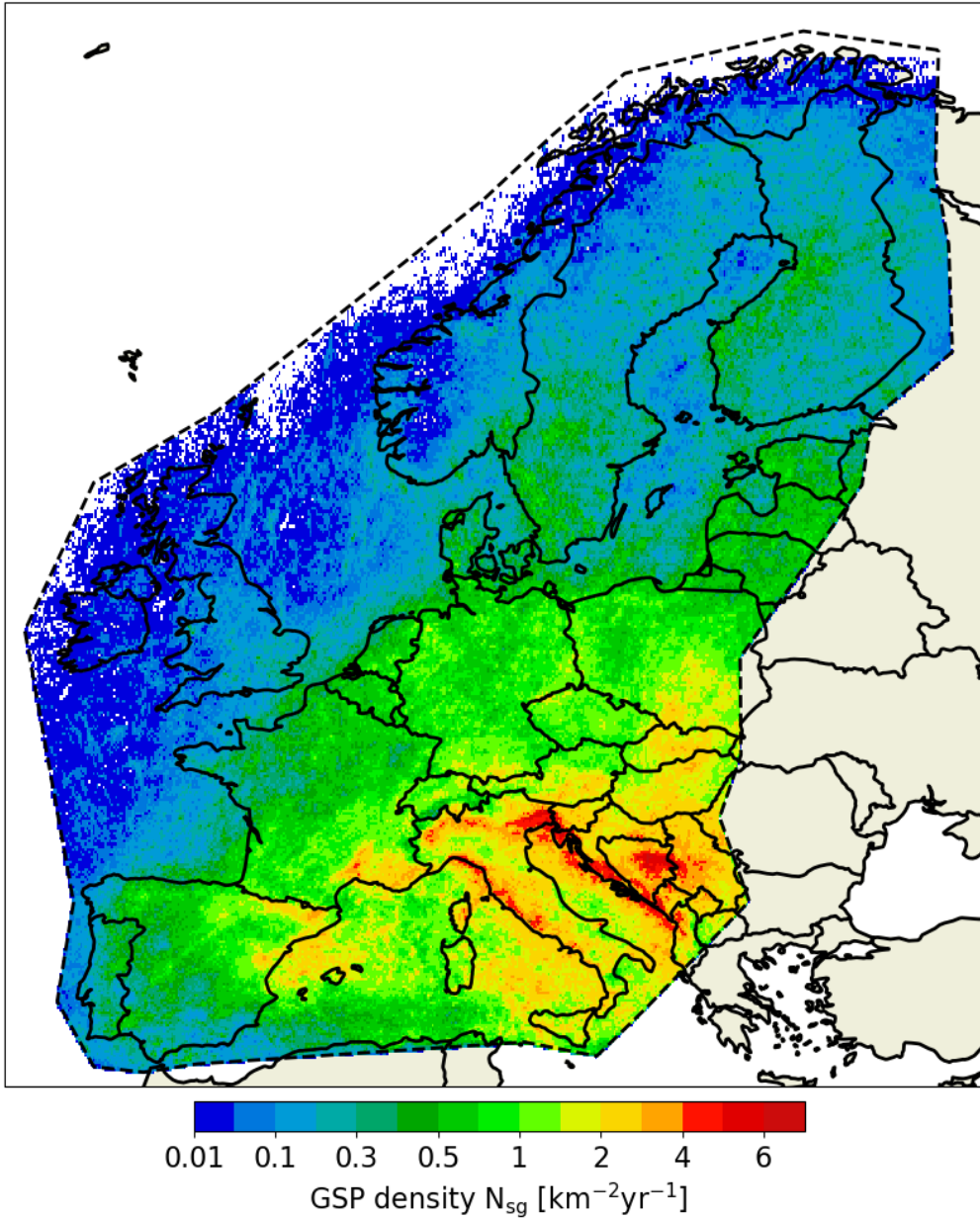
Introduction

- * In order to evaluate the lightning risk to a particular structure, it is common practice to use the guidelines set out in IEC 62305-2.
- * A key parameter that has a big impact on the outcome of the lightning risk calculation is the flash density N_g .
- * A flash has, per definition, only 1 ground termination point. However, high-speed camera observations have proven that flashes have on average more than 1 ground termination point.
- * We apply a GSP algorithm to data observed by the European Cooperation for Lightning Detection (EUCLID) network to retrieve spatial and temporal behavior of GSPs in Europe.

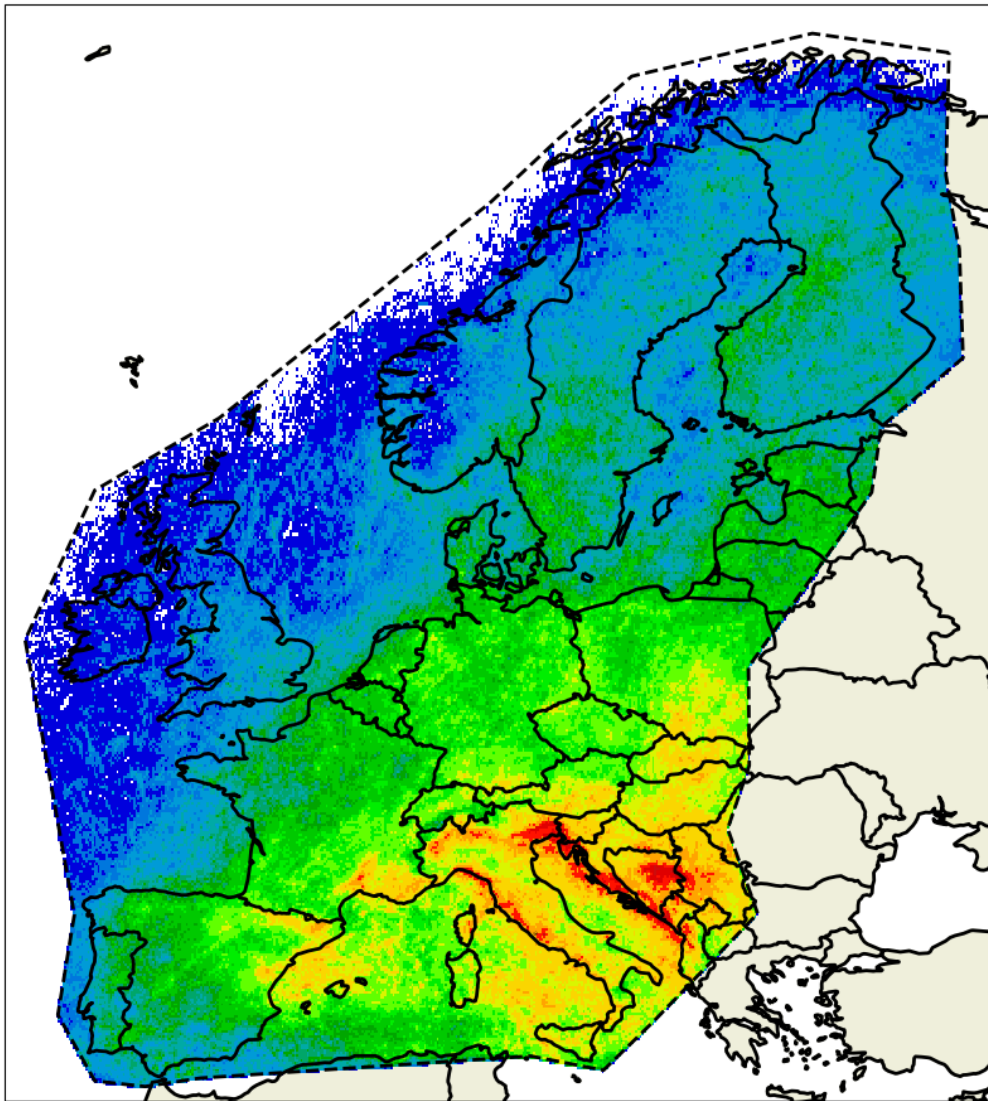
EUCLID



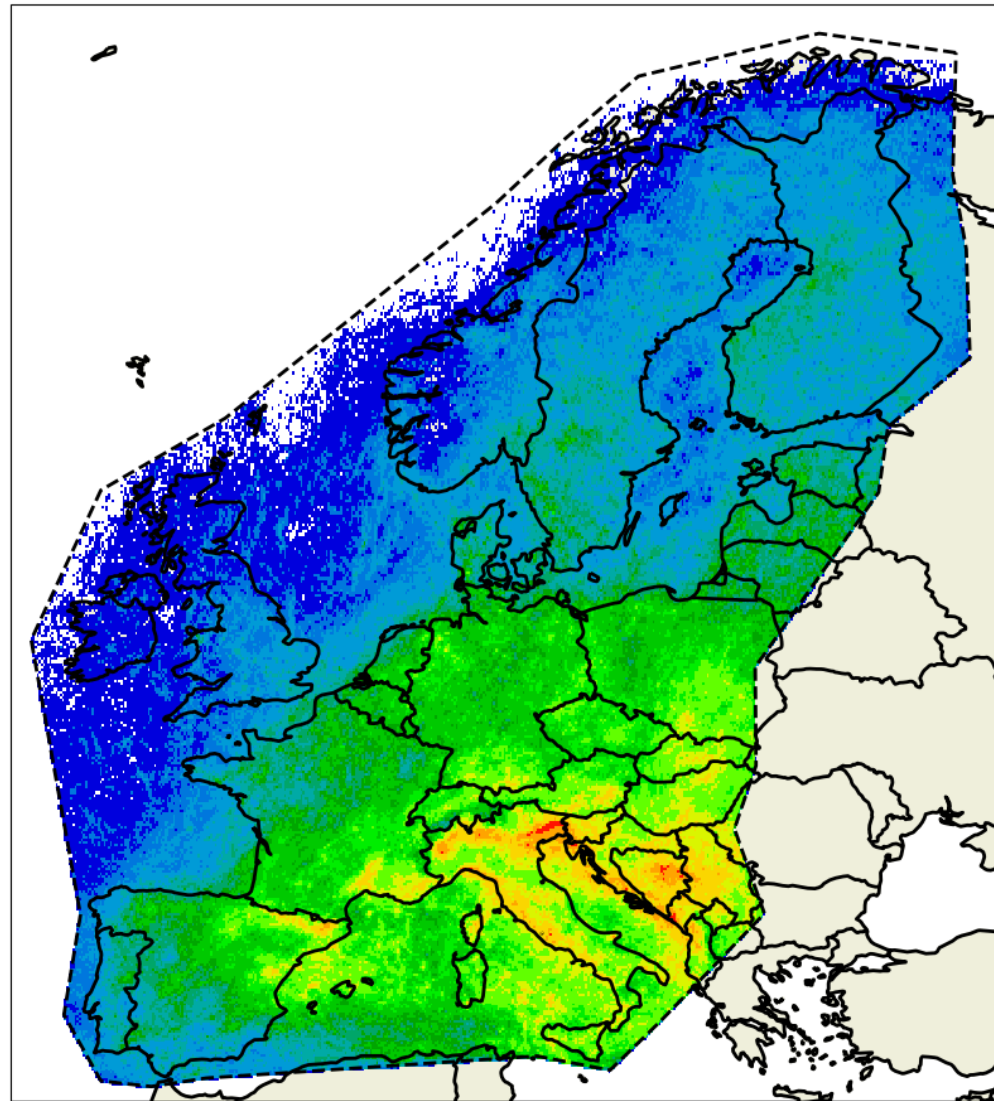
Spatial characteristics



Spatial characteristics

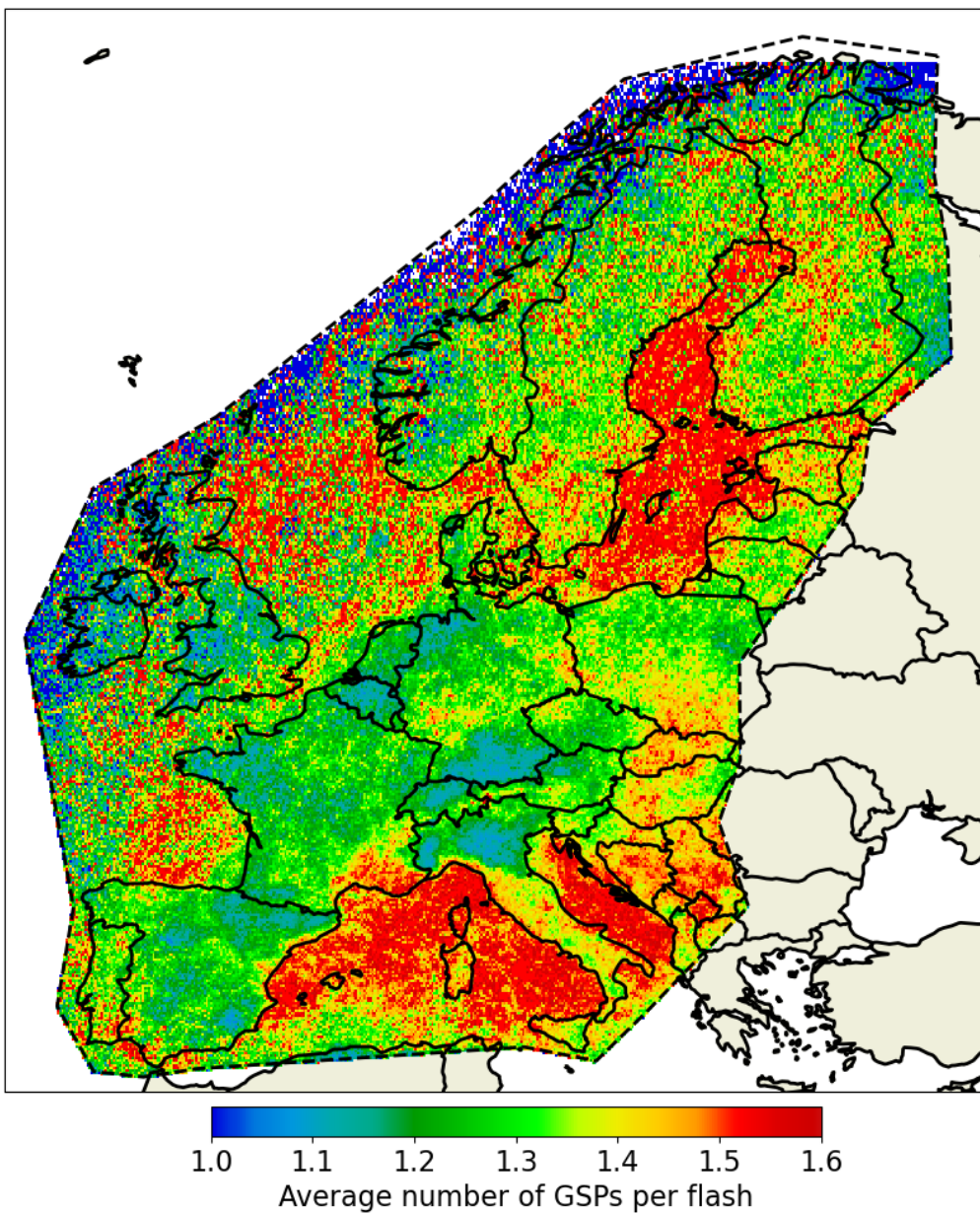


0.01 0.1 0.3 0.5 1 2 4 6
GSP density N_{sg} [$\text{km}^{-2}\text{yr}^{-1}$]

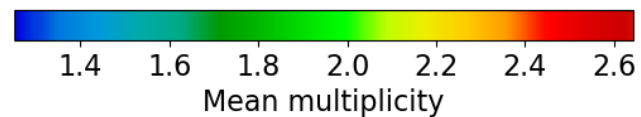
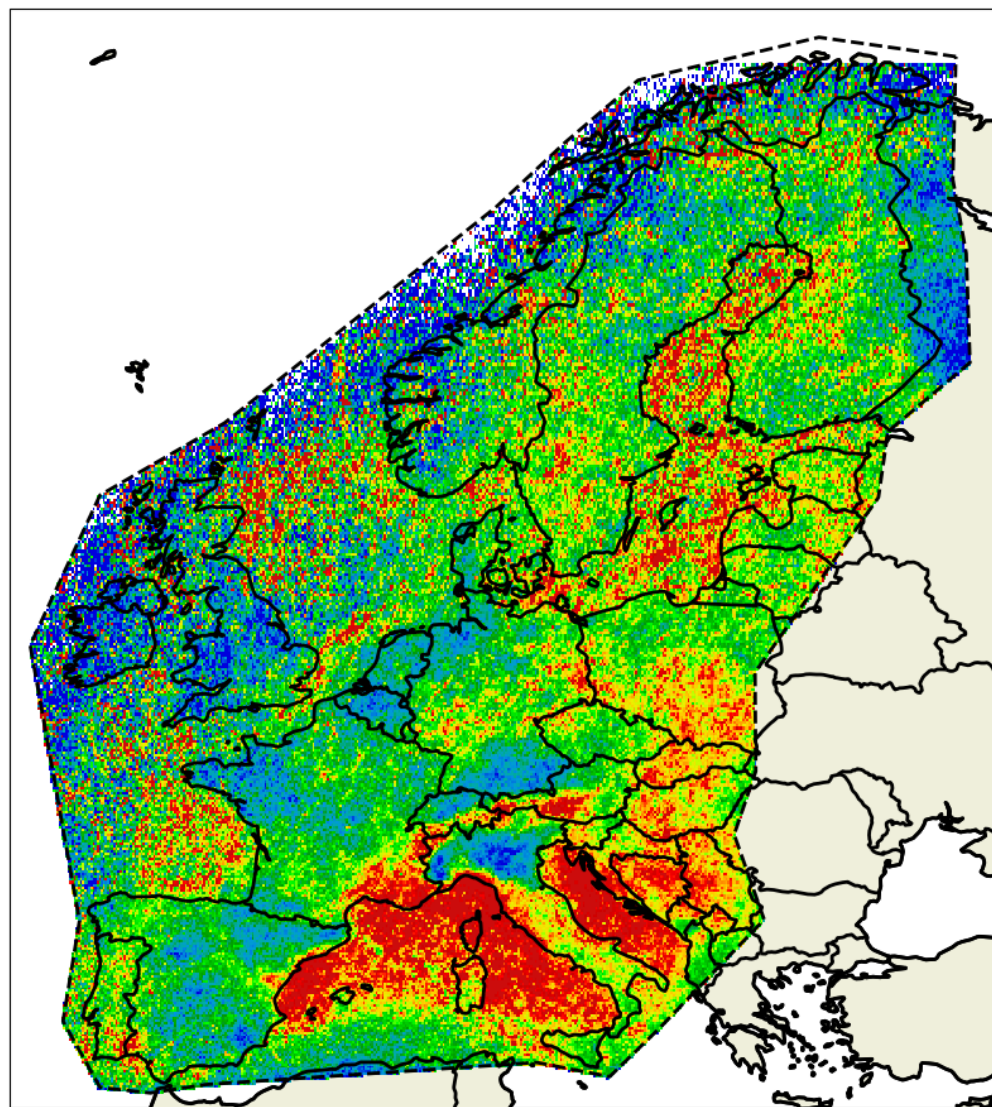
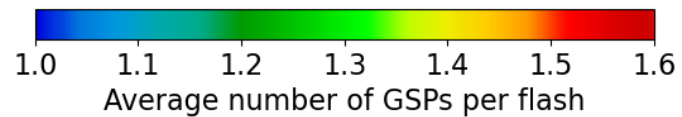
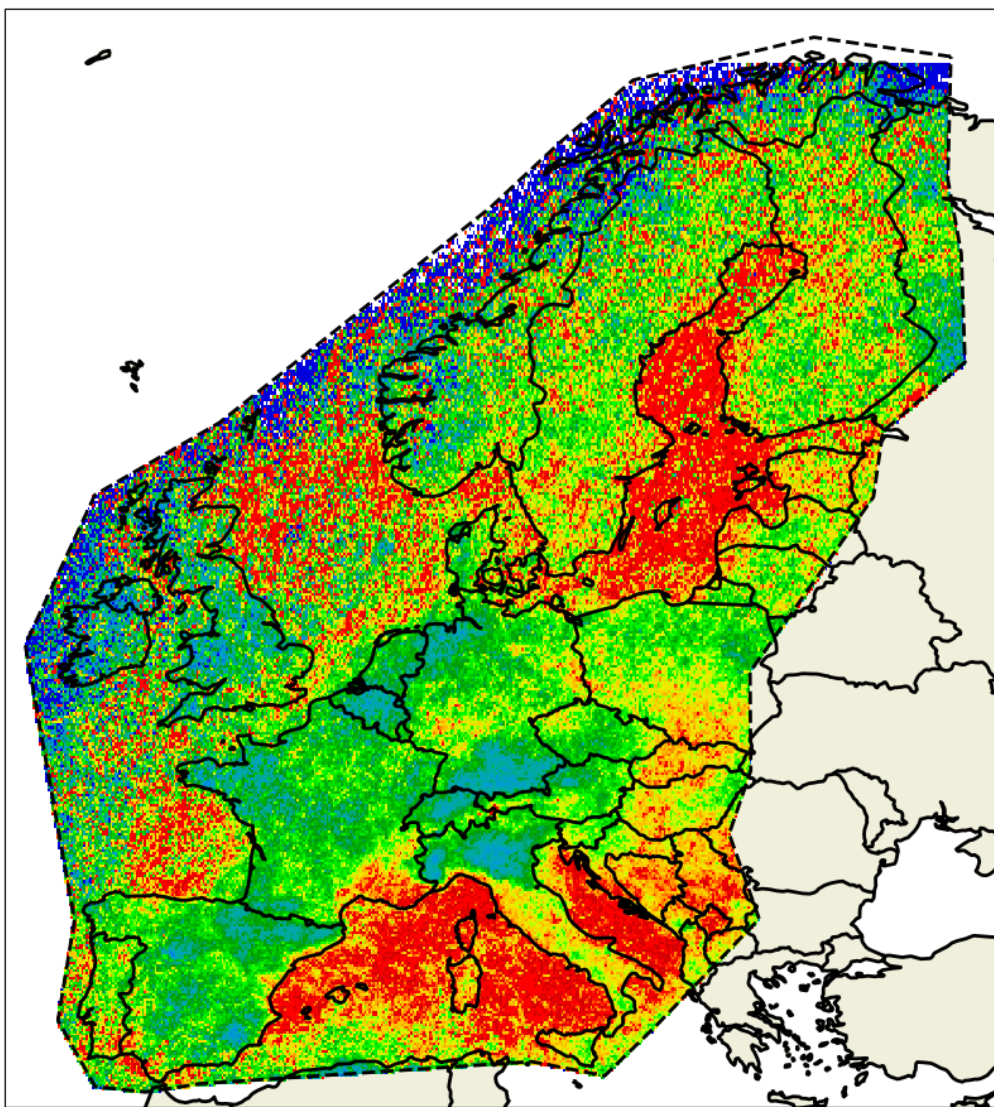


0.01 0.1 0.3 0.5 1 2 4 6
GSP density N_g [$\text{km}^{-2}\text{yr}^{-1}$]

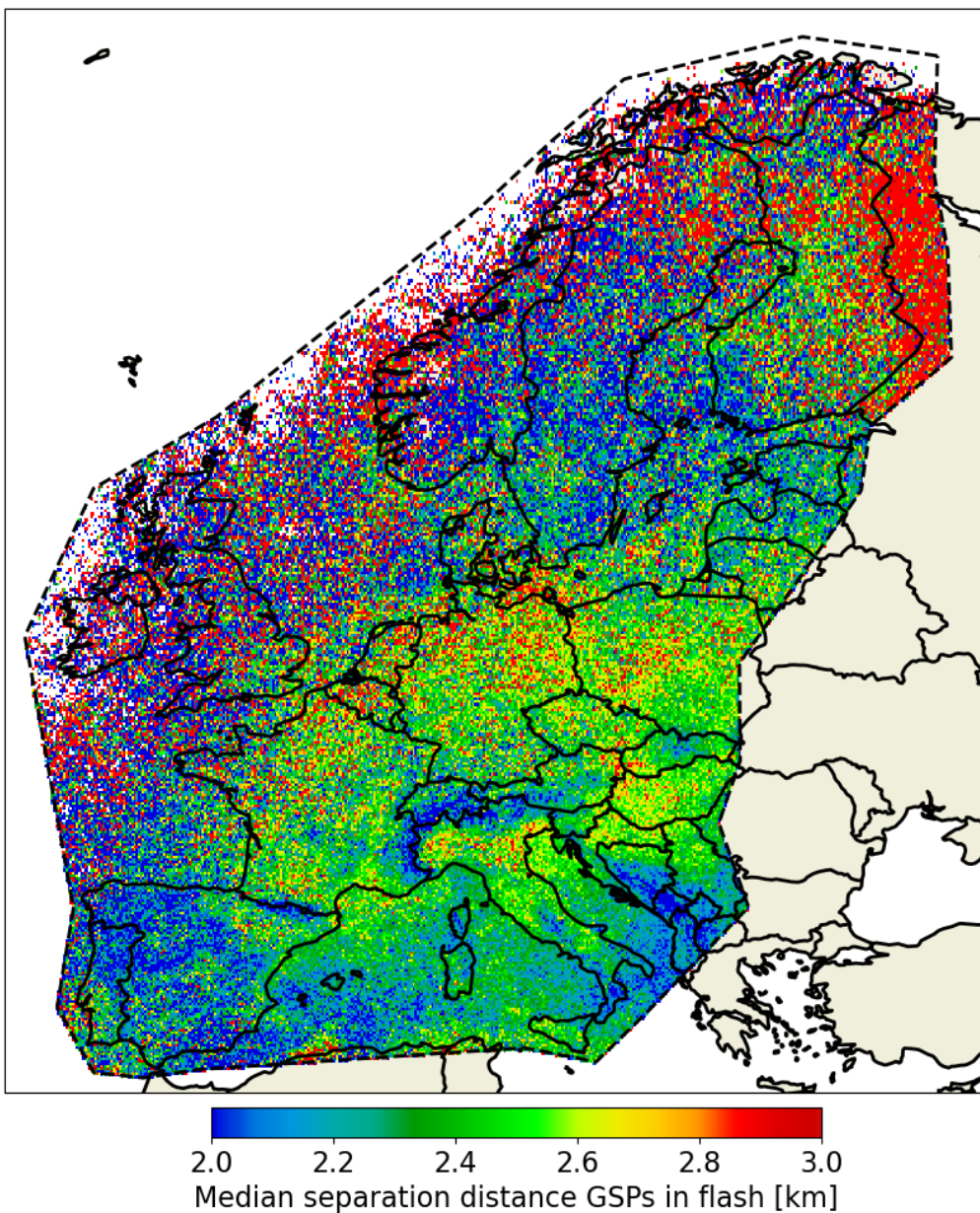
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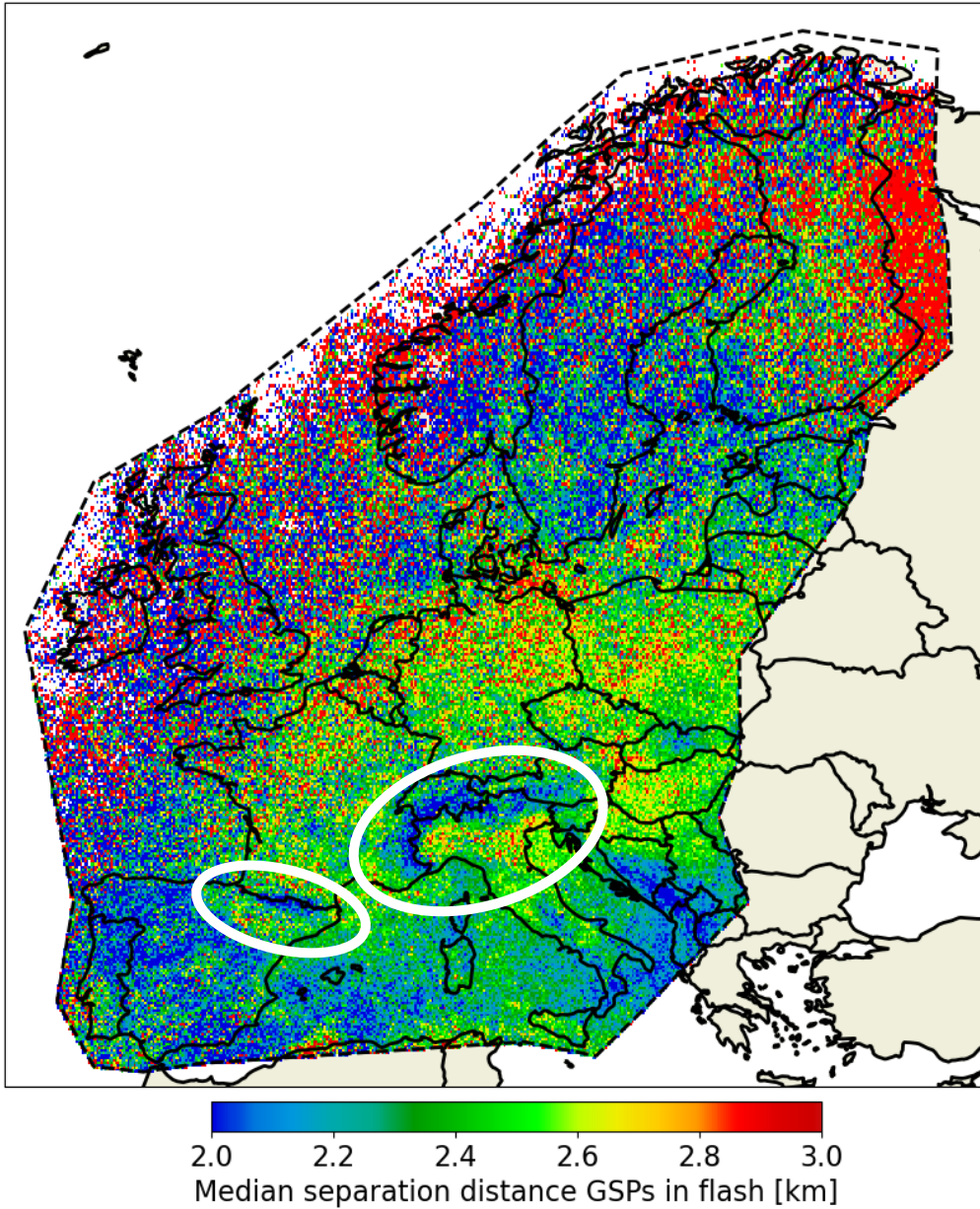
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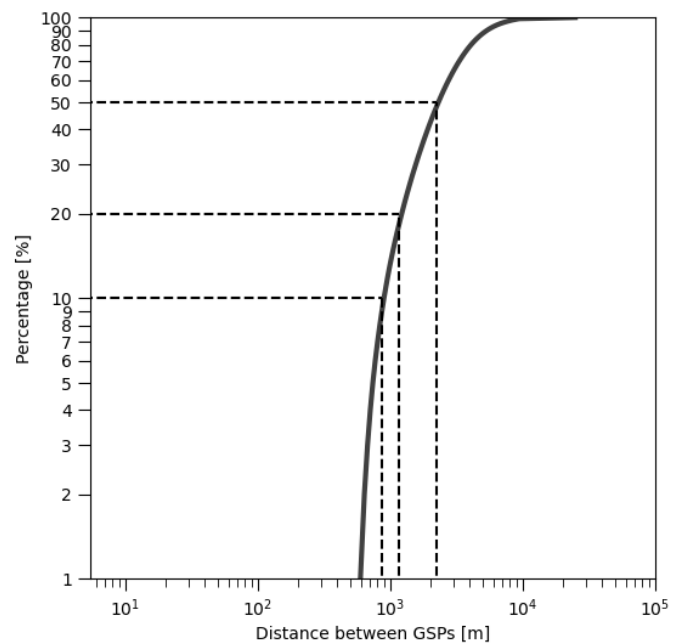
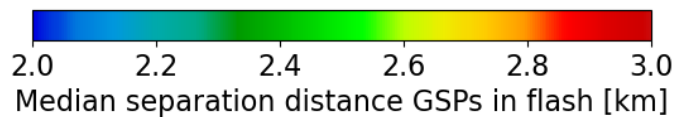
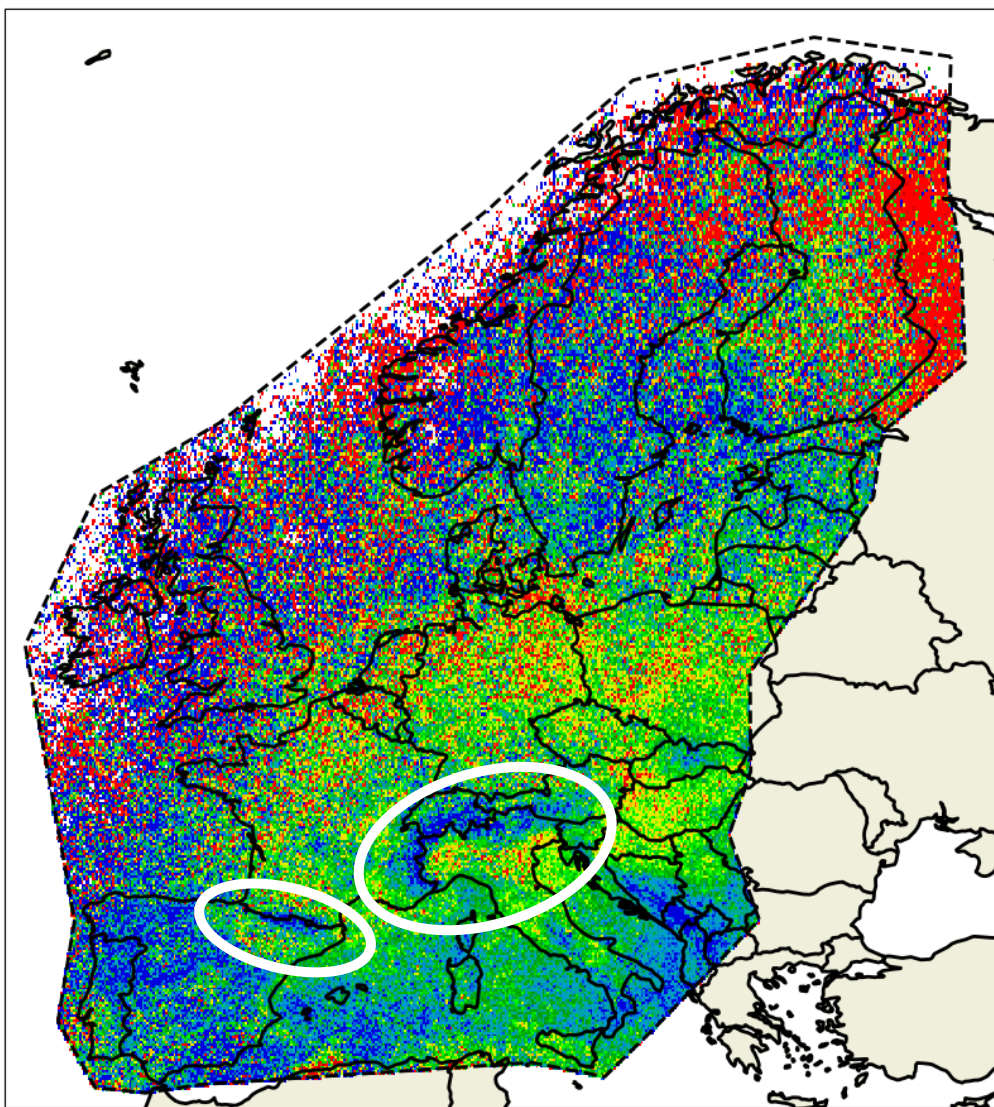
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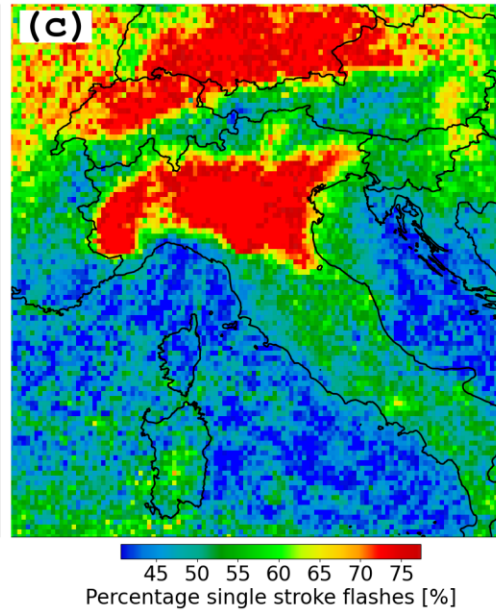
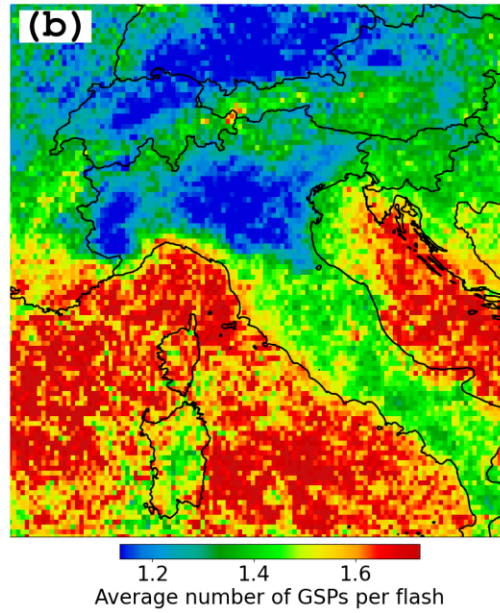
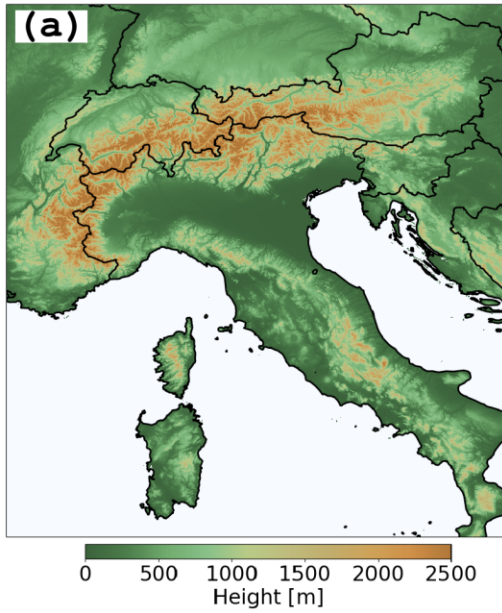
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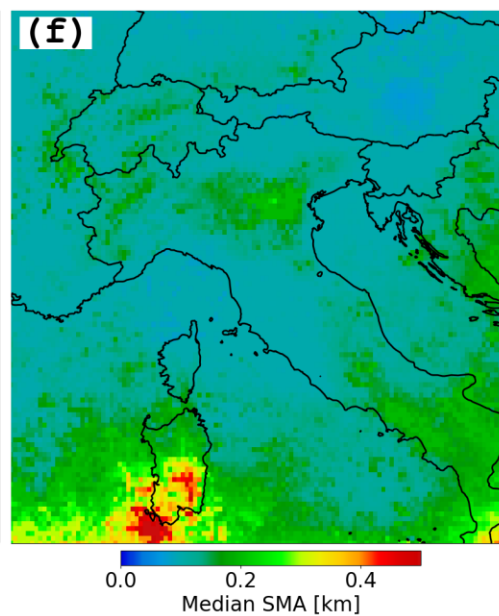
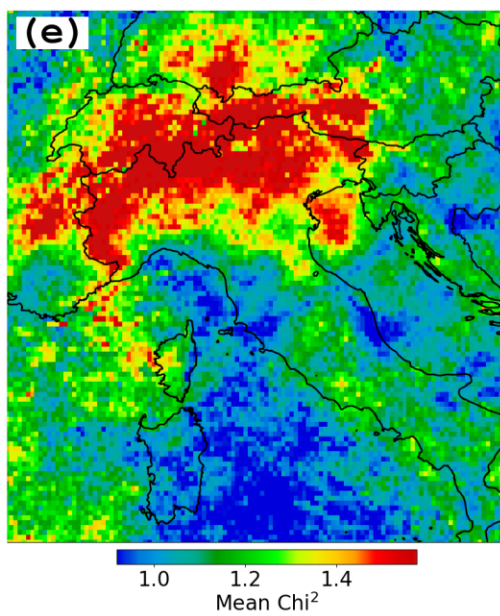
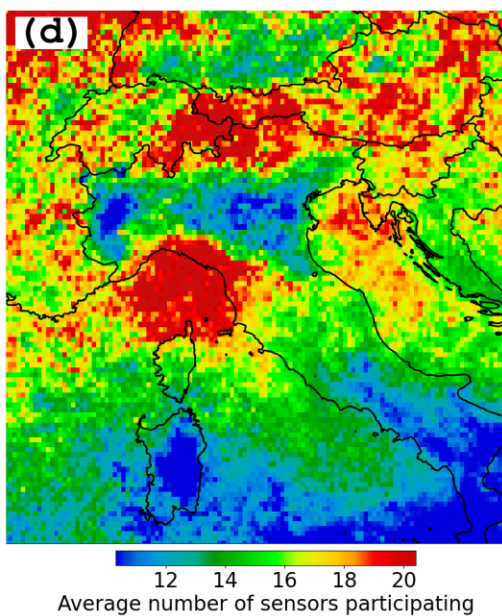
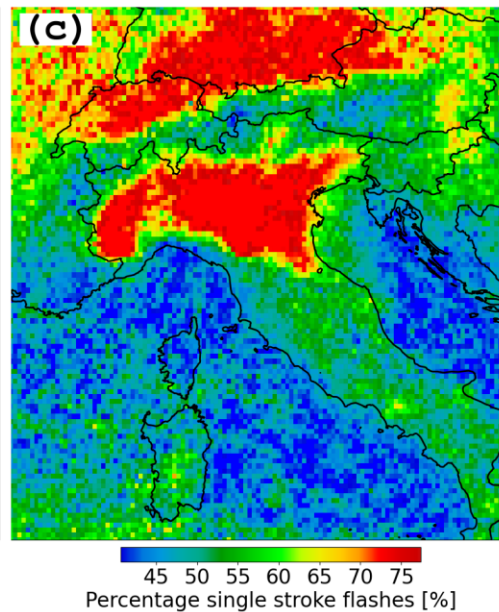
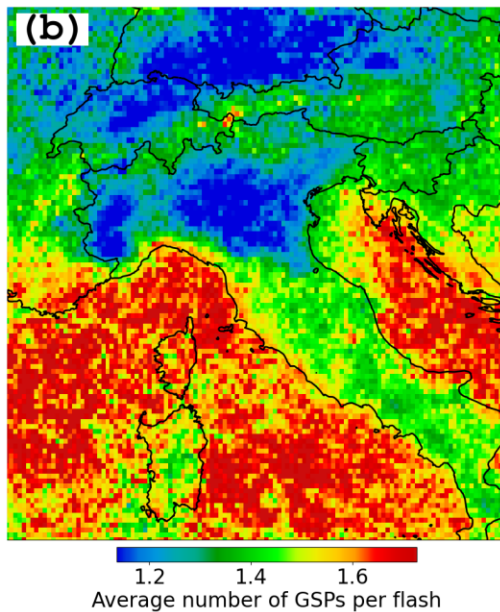
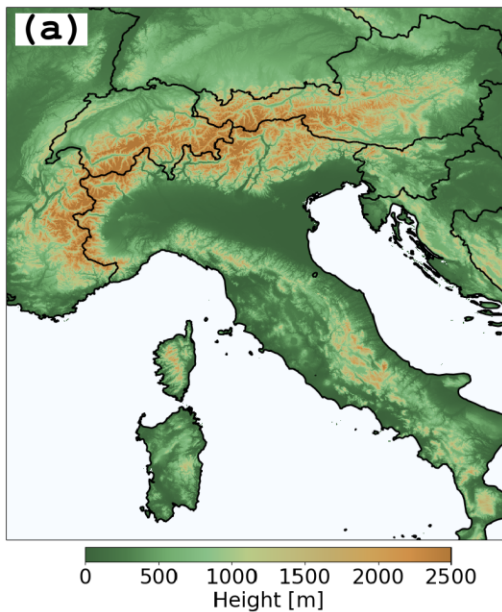
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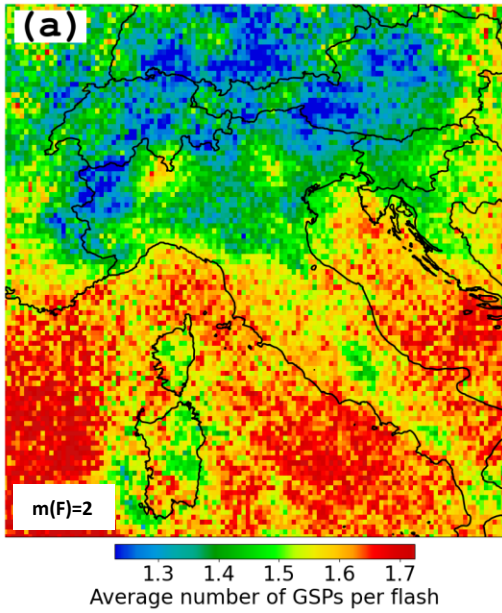
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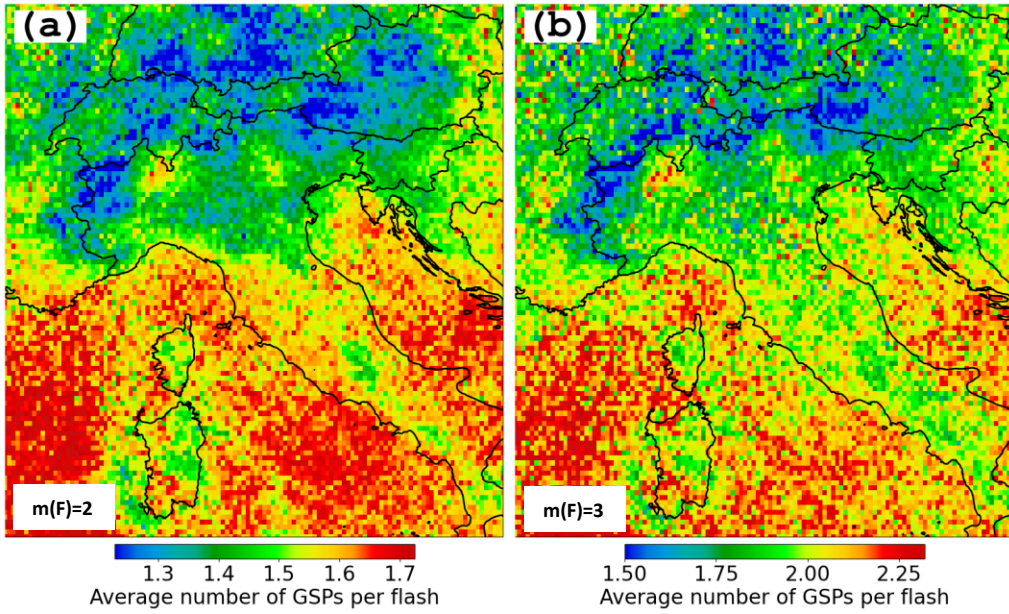
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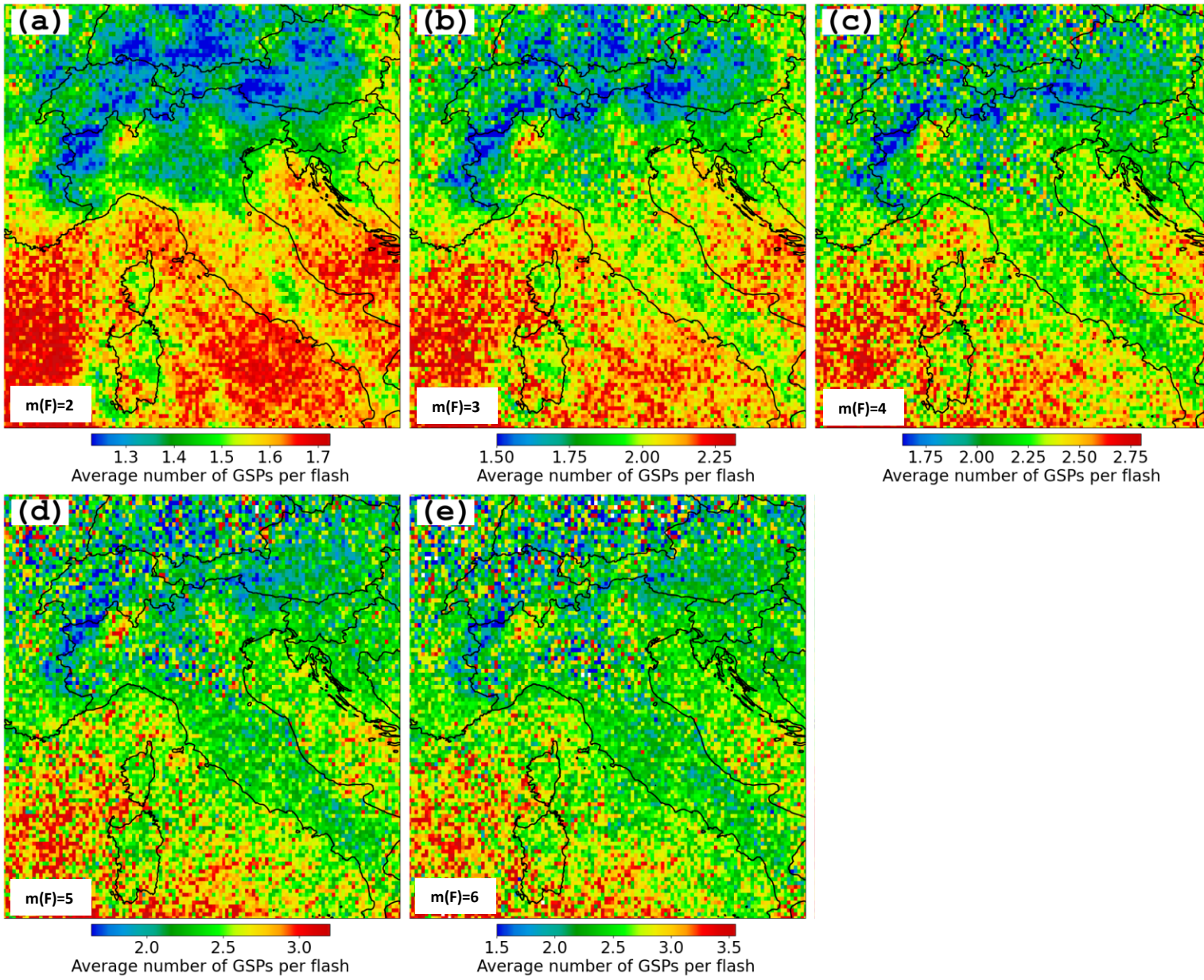
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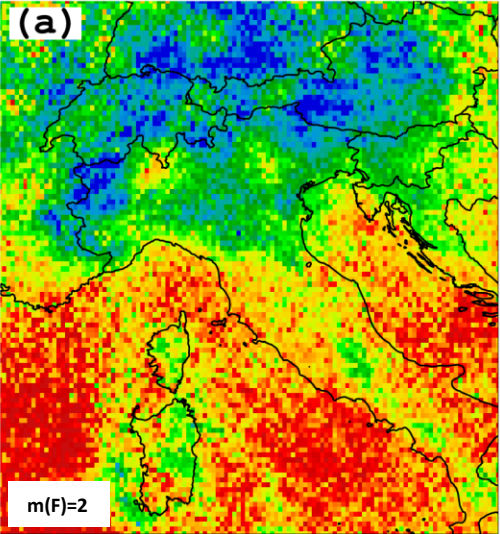
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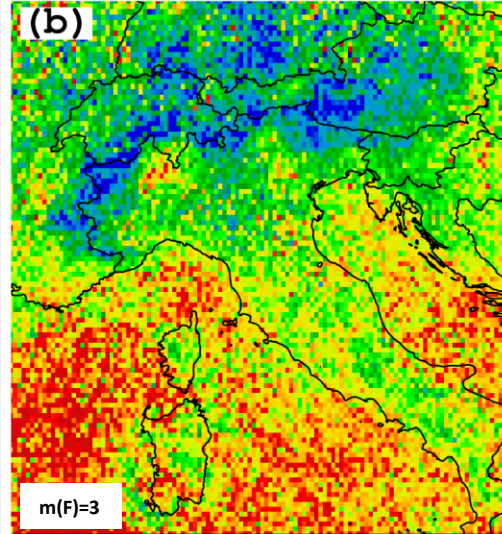
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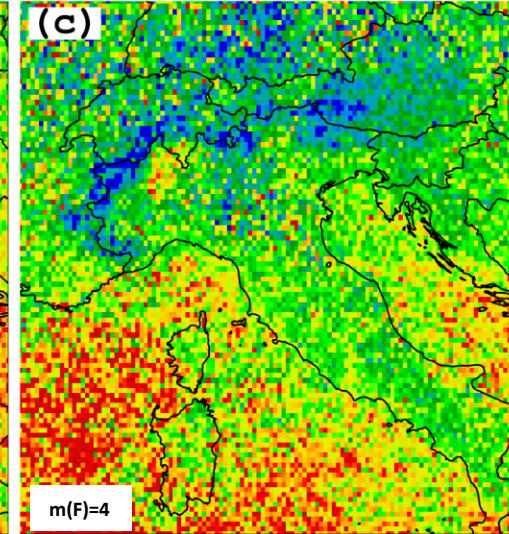
Spatial characteristics



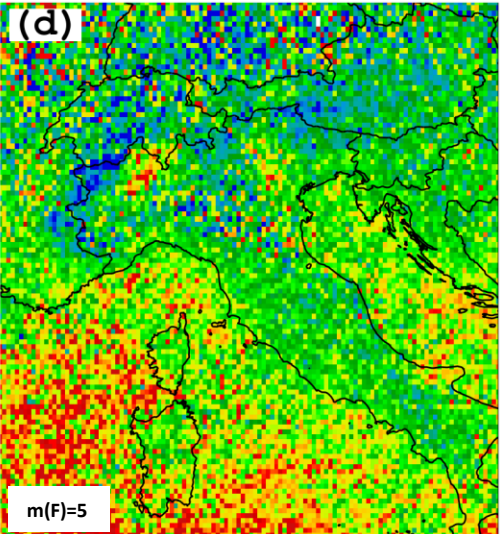
1.3 1.4 1.5 1.6 1.7
Average number of GSPs per flash



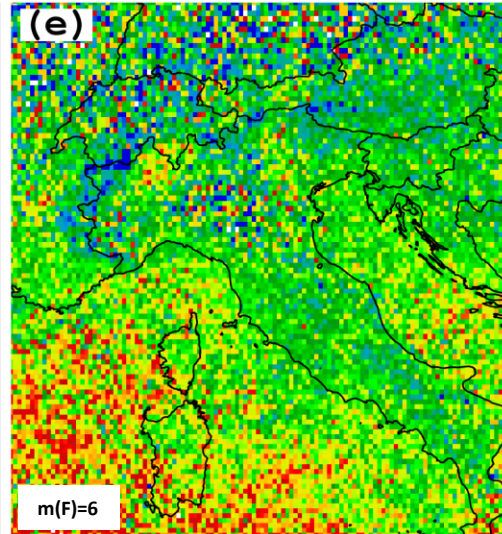
1.50 1.75 2.00 2.25
Average number of GSPs per flash



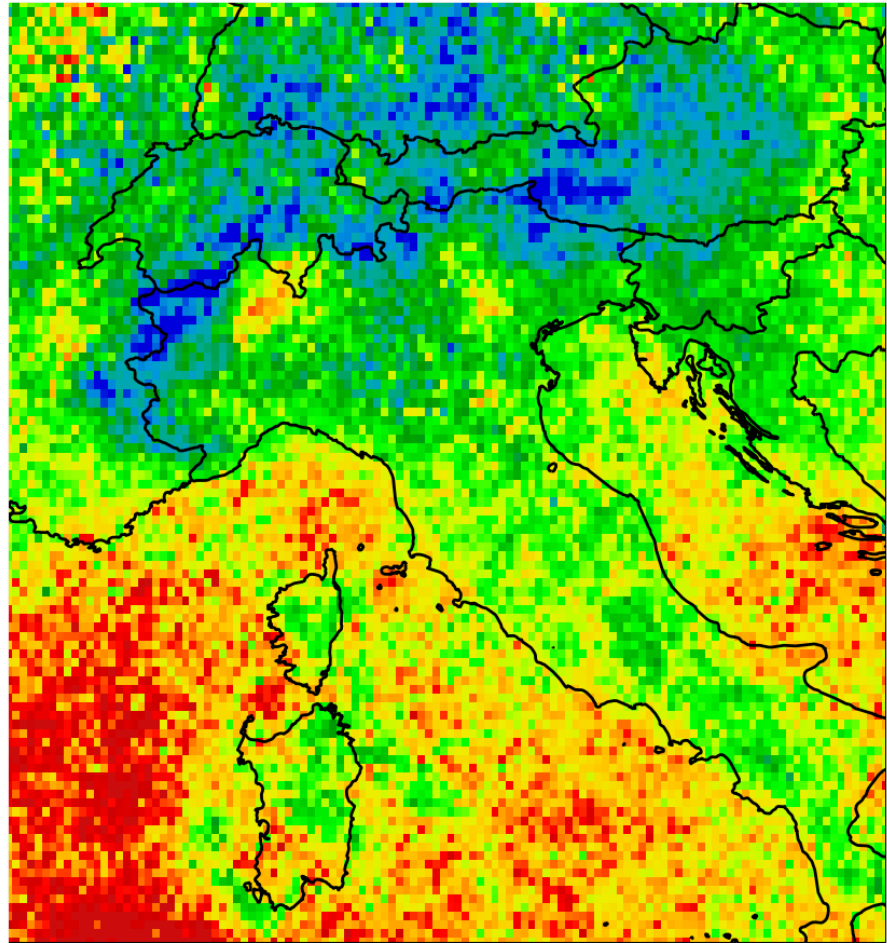
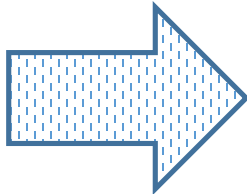
1.75 2.00 2.25 2.50 2.75
Average number of GSPs per flash



2.0 2.5 3.0
Average number of GSPs per flash

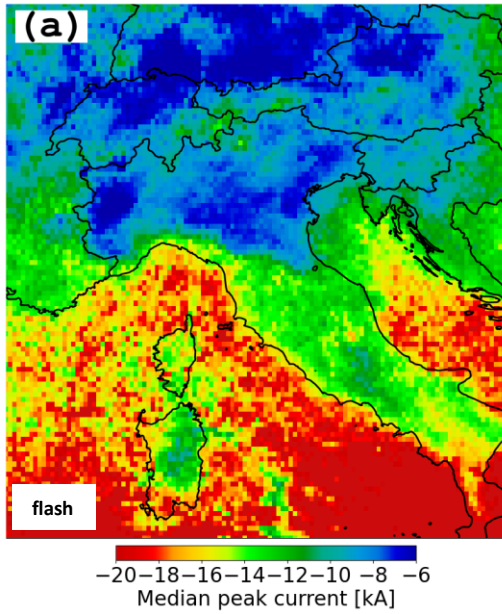


1.5 2.0 2.5 3.0 3.5
Average number of GSPs per flash

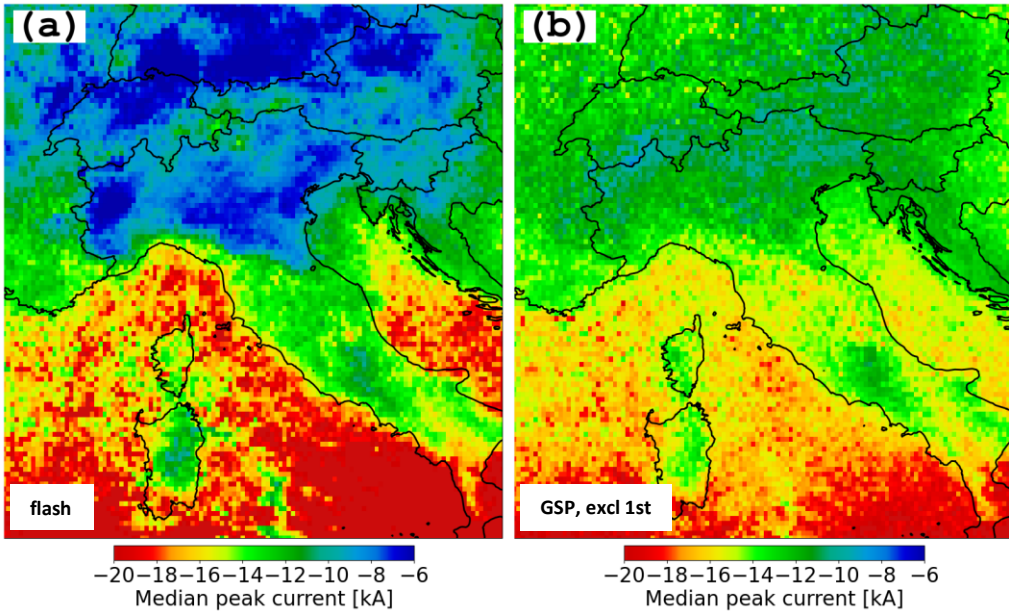


0.0 0.2 0.4 0.6 0.8 1.0
Normalized number of GSPs per flash

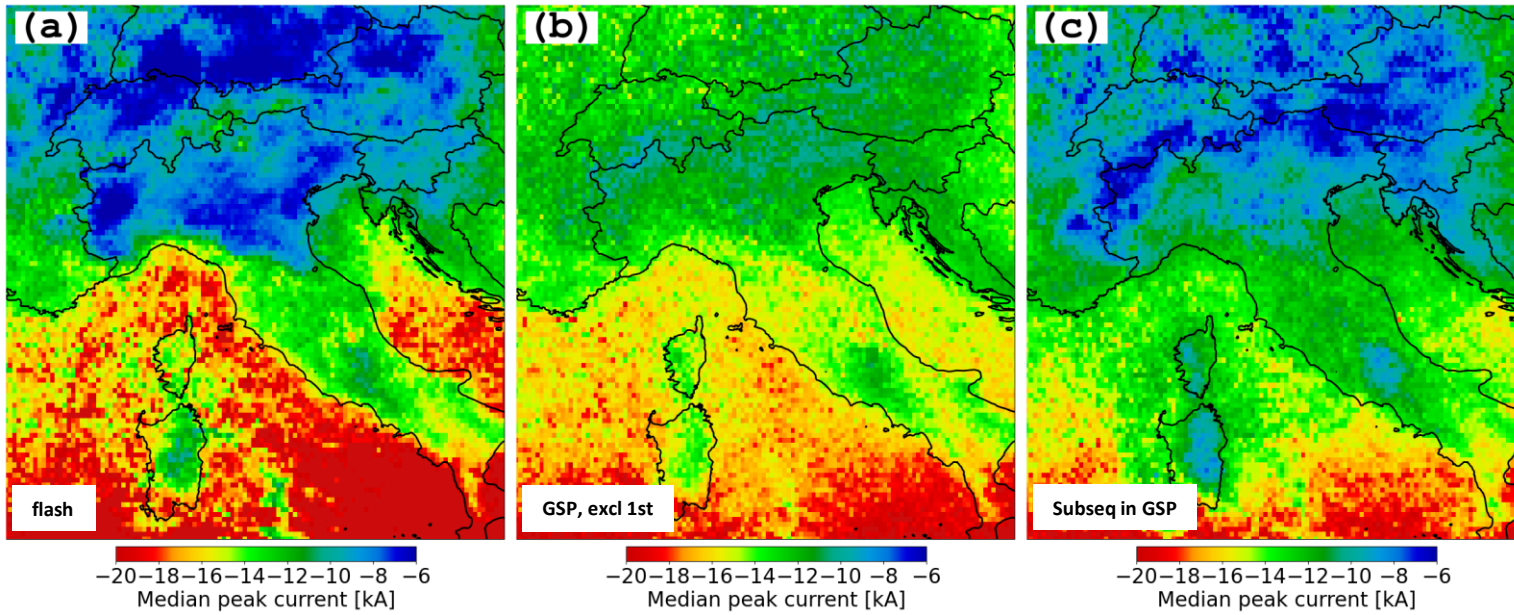
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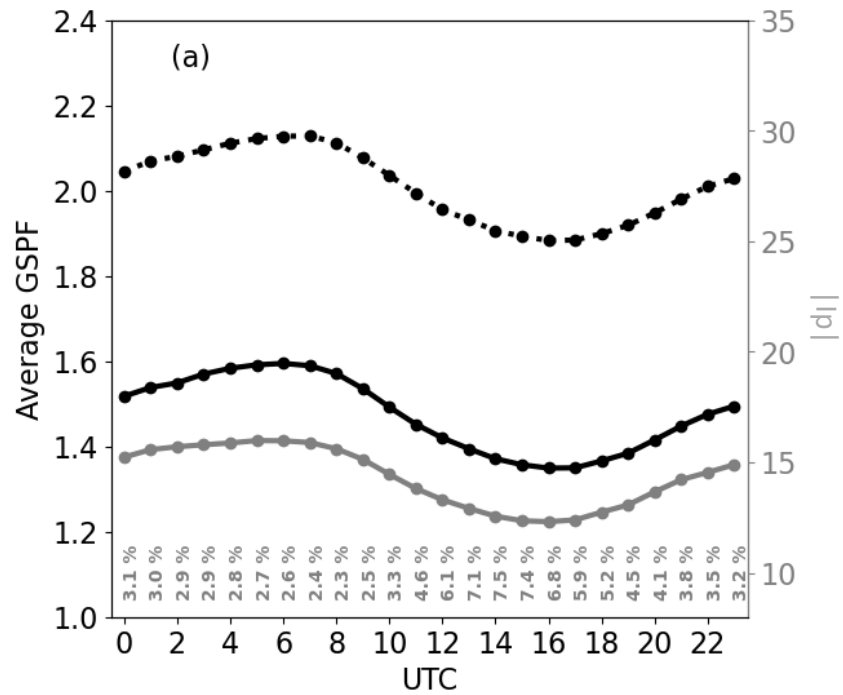
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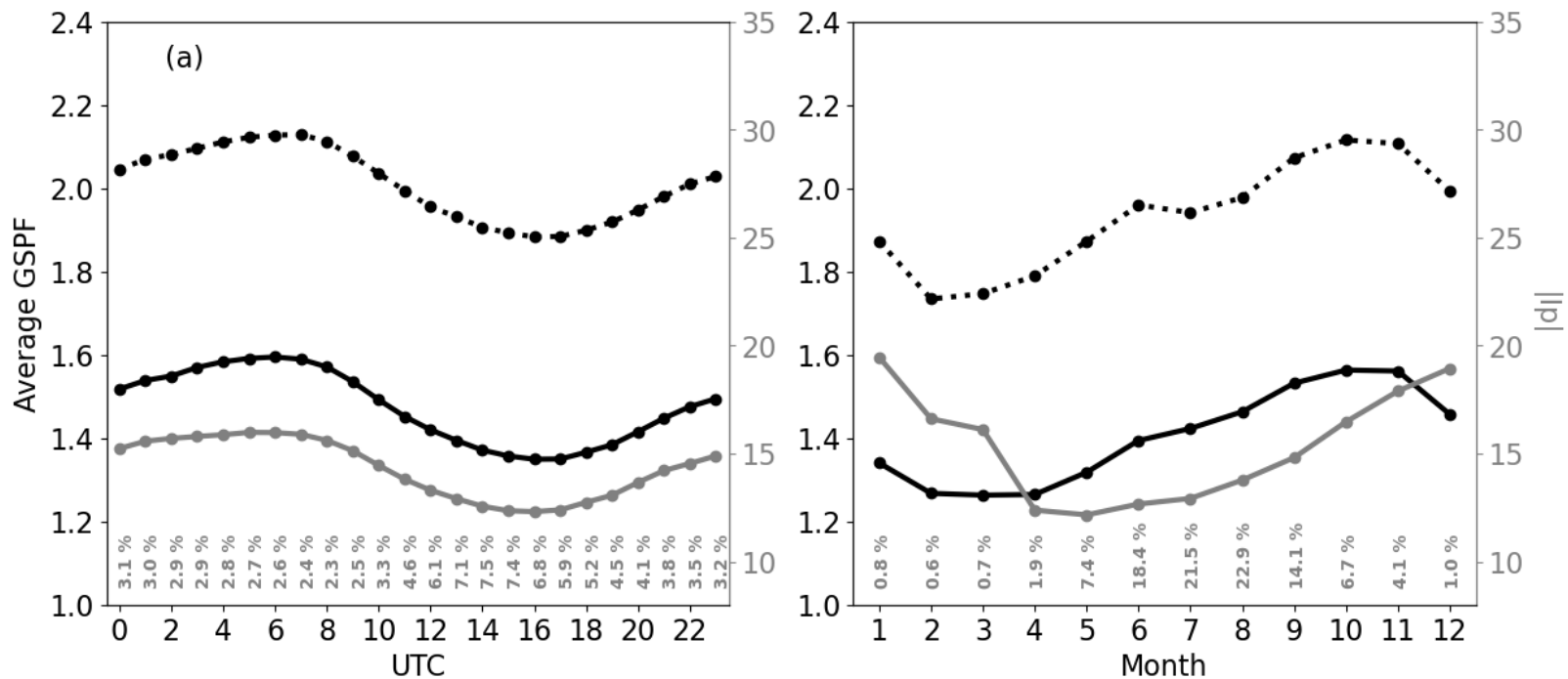
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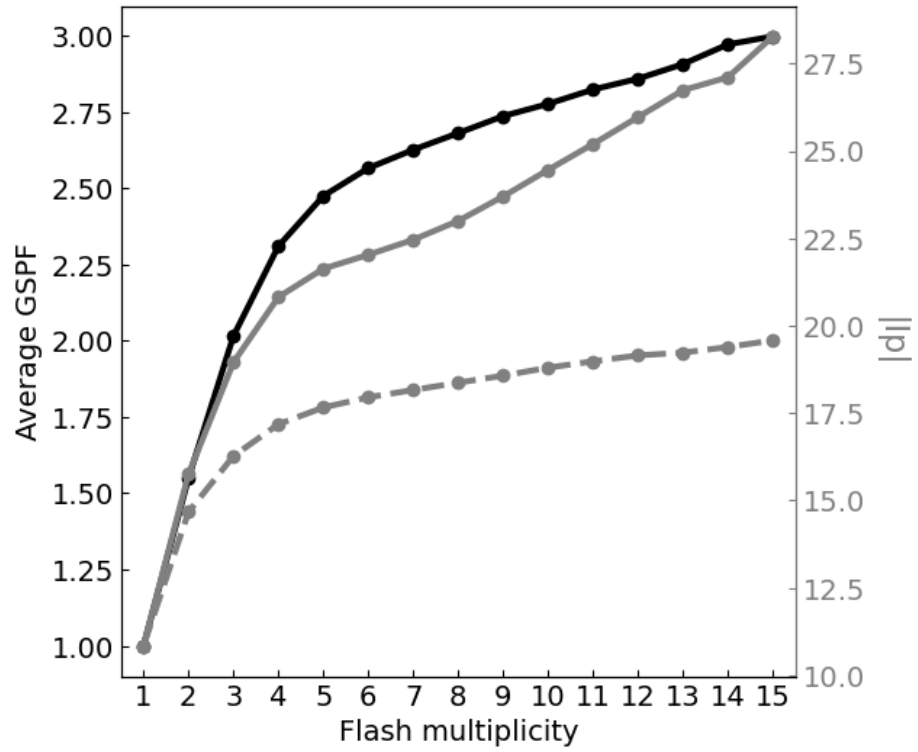
Temporal characteristics



Temporal characteristics



Additional characteristics



Summary

- * On average more than 1 GSP is observed per flash, hence the use of N_G in risk calculation of lightning protection leads to an underestimation of the hazard.
- * Ingesting LLS observations in GSP algorithms provide a means to study GSP characteristics on a larger temporal and spatial scale.
- * $GSPF_{sea} > GSPF_{land}$
- * $I_p \Leftrightarrow GSPF$
- * Presence of Alps has an impact on GSP behavior, resulting in low GSPF and GSP Δd