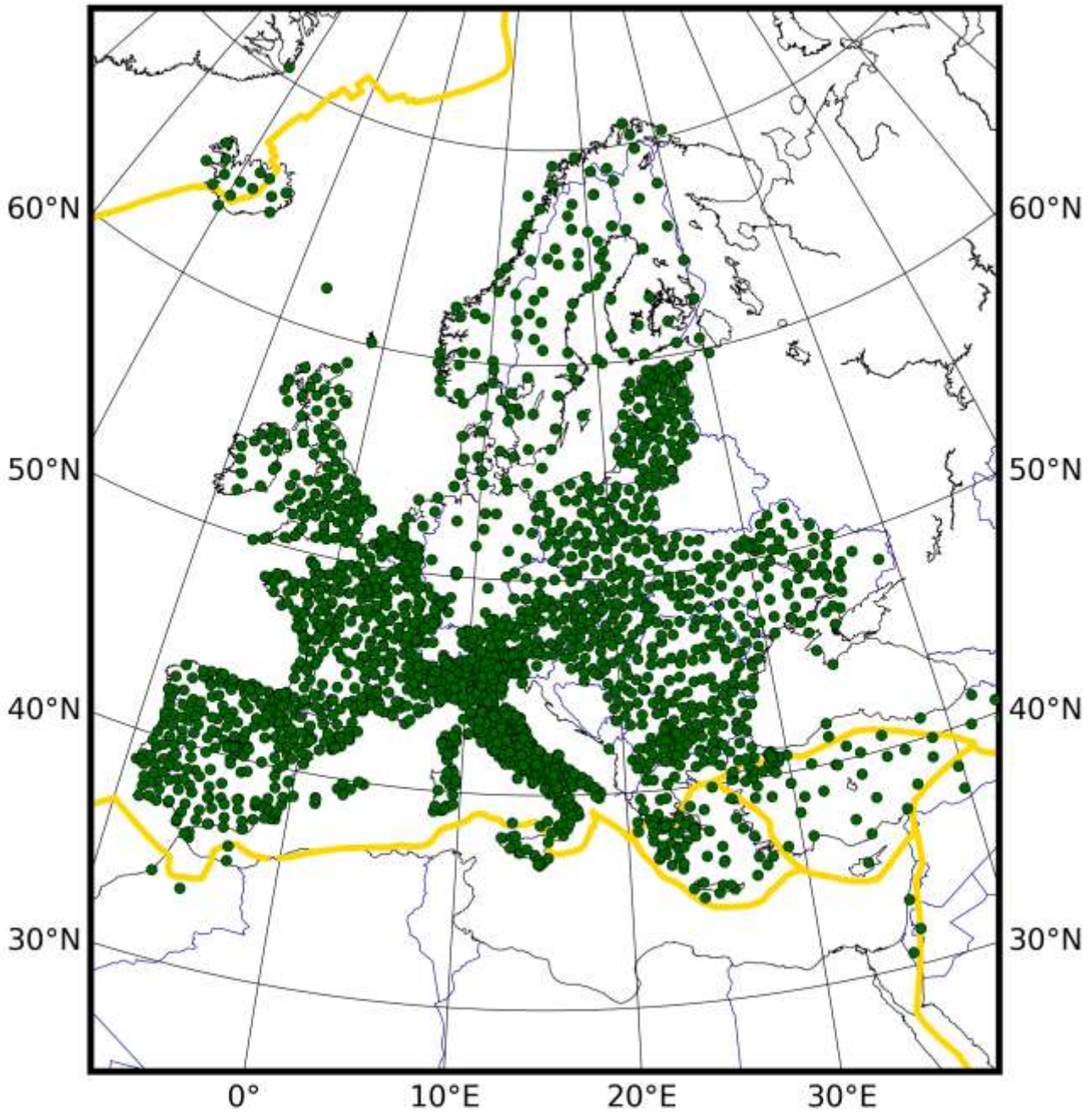
EUVEM2021 – A VELOCITY MODEL FOR EUROPE: APPLICATION OF LEAST-SQUARES COLLOCATION

REBEKKA STEFFEN, HOLGER STEFFEN, AMBRUS KENYERES, MARTIN LIDBERG

LANTMÄTERIET

INTRODUCTION

- Dataset by Ambrus Kenyeres from January 2021 is used: "EPND_D2100_E2000NEU.VEL" (https://epnd.sgo-penc.hu/)
- Outliers have been removed



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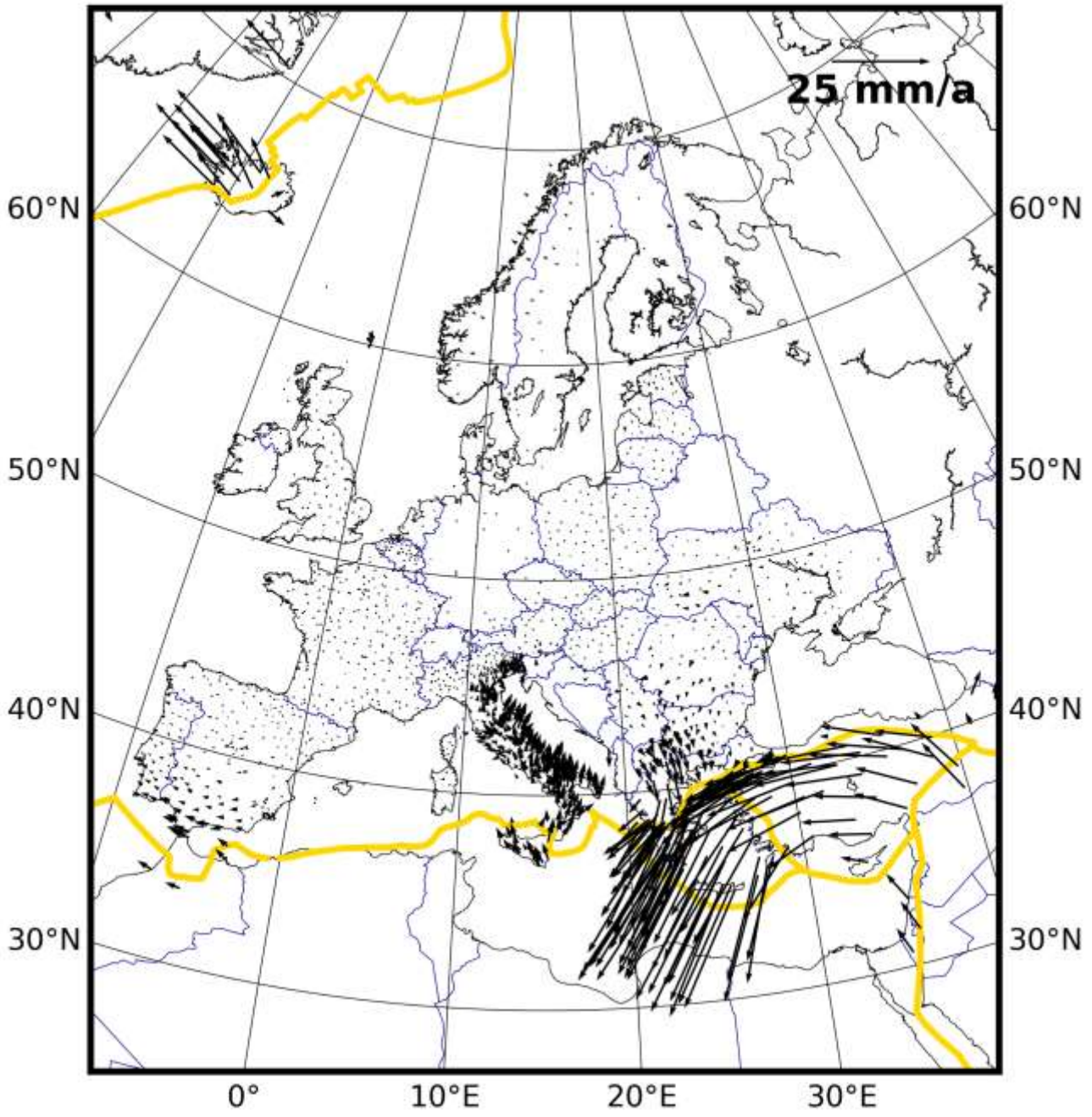
- Dataset by Ambrus Kenyeres from January 2021 is used: "EPND_D2100_E2000NEU.VEL" (https://epnd.sgo-penc.hu/)
- Outliers have been removed
- Observational uncertainties based on HECTOR are used



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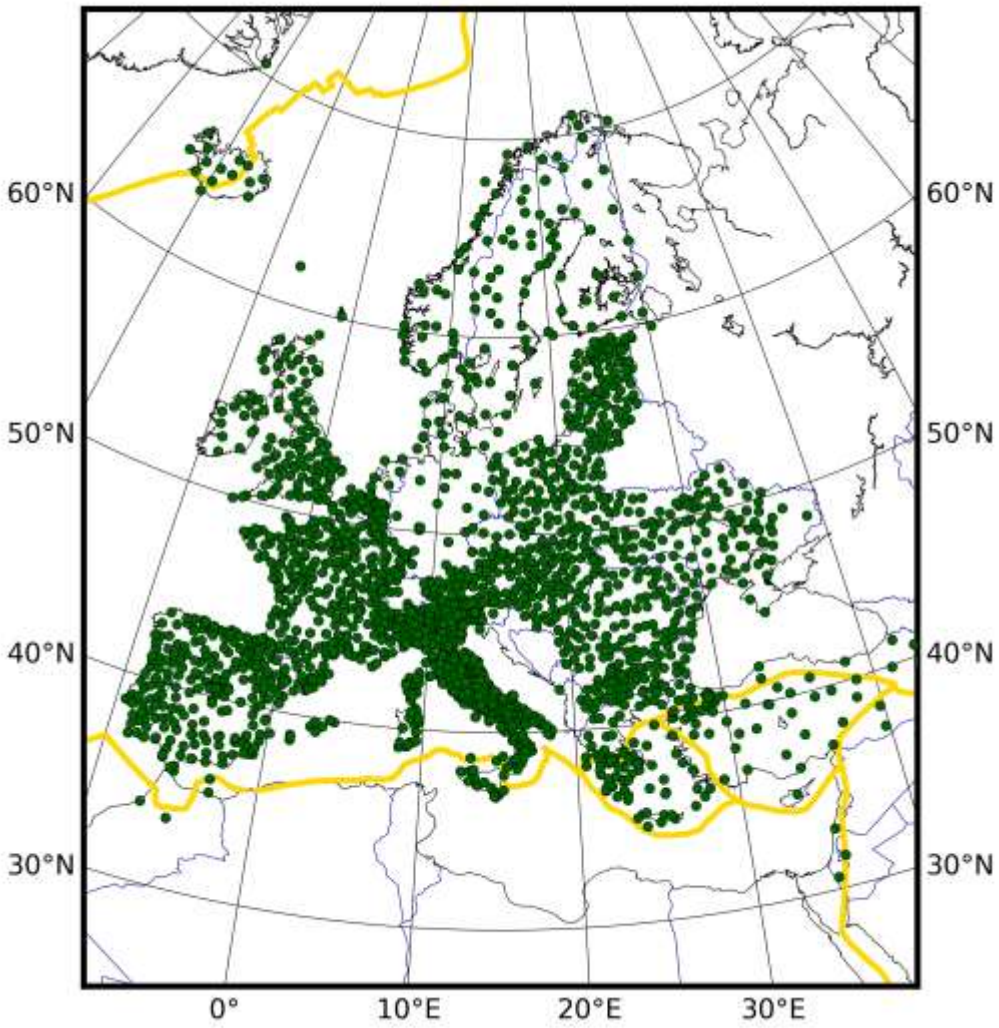

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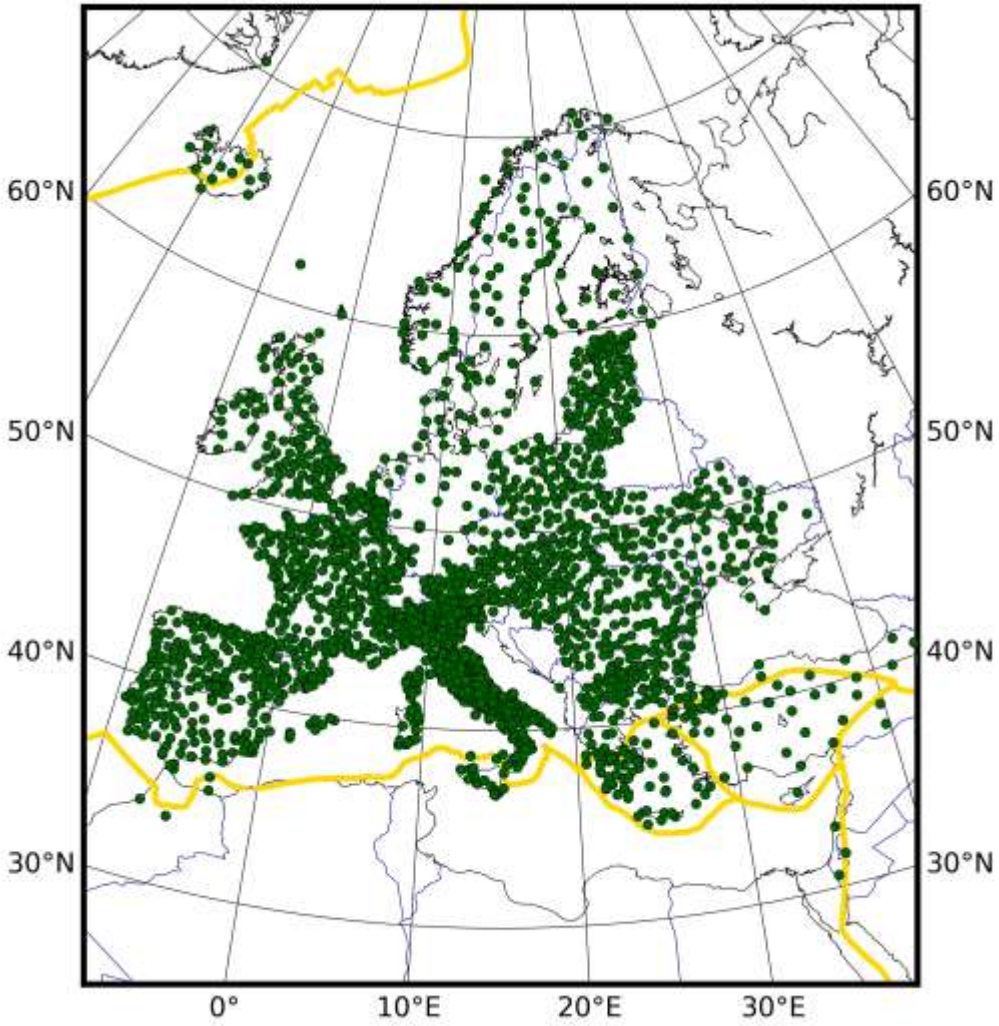
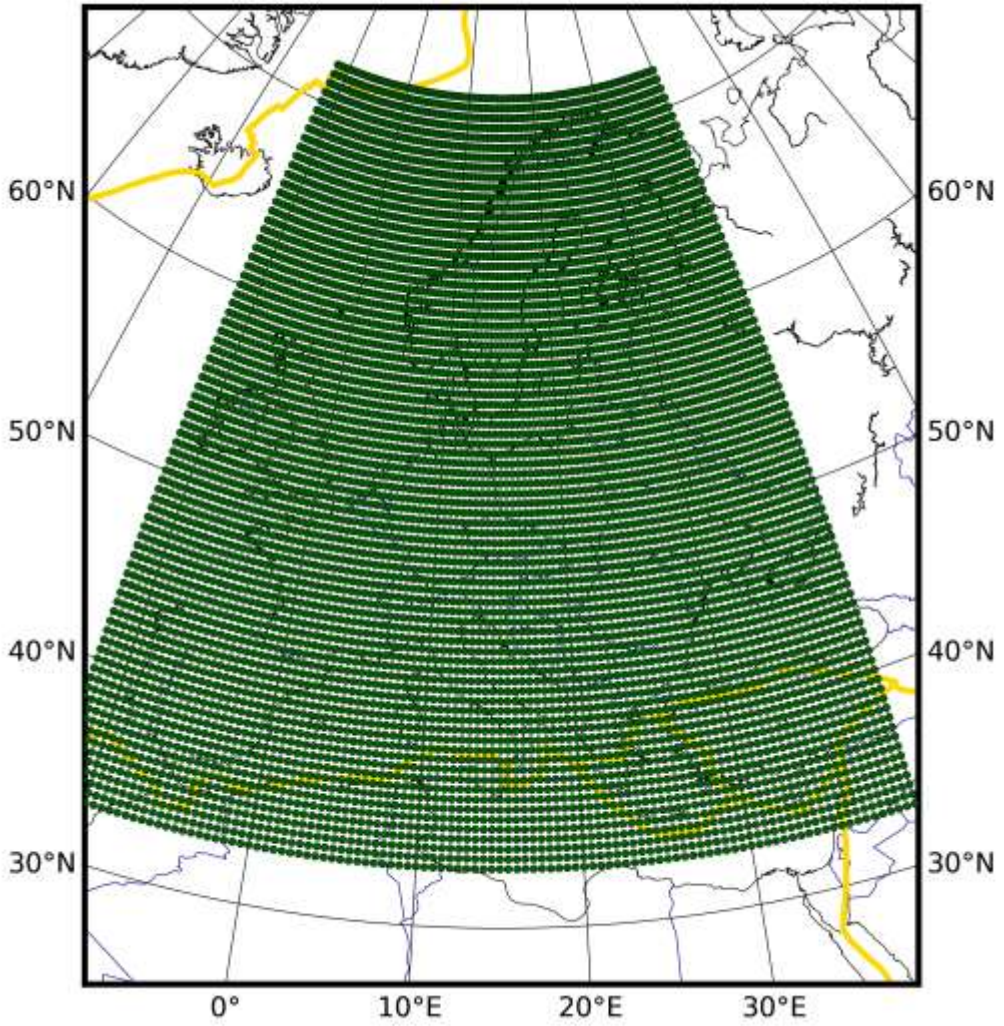


Interpolation to high-resolution grid



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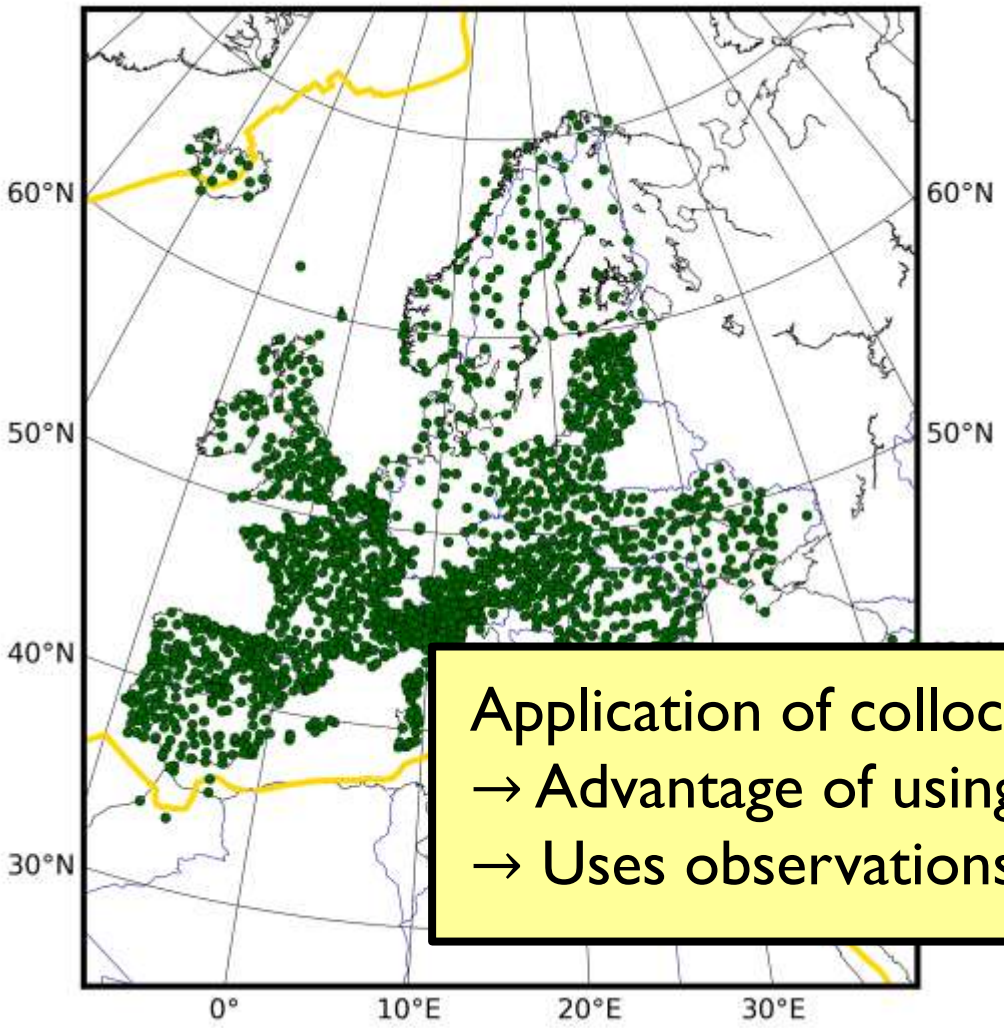

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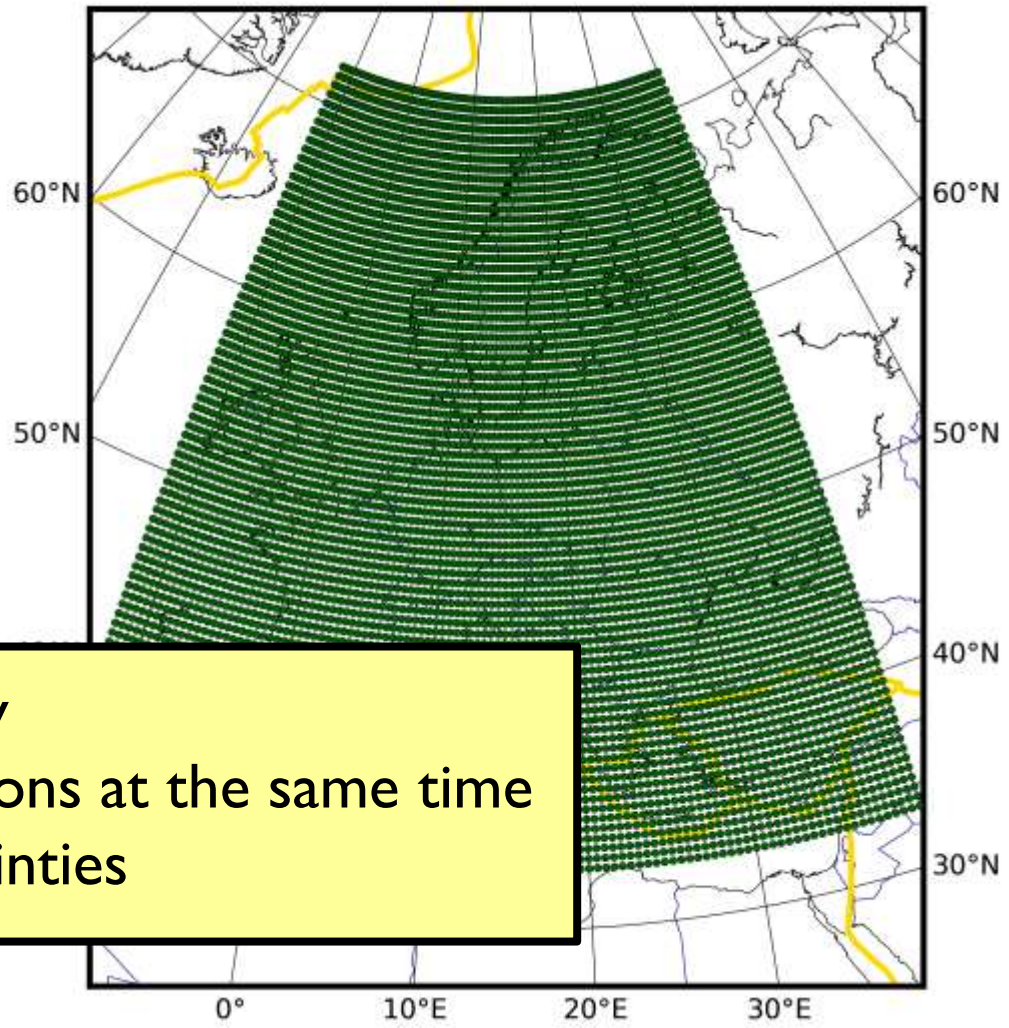


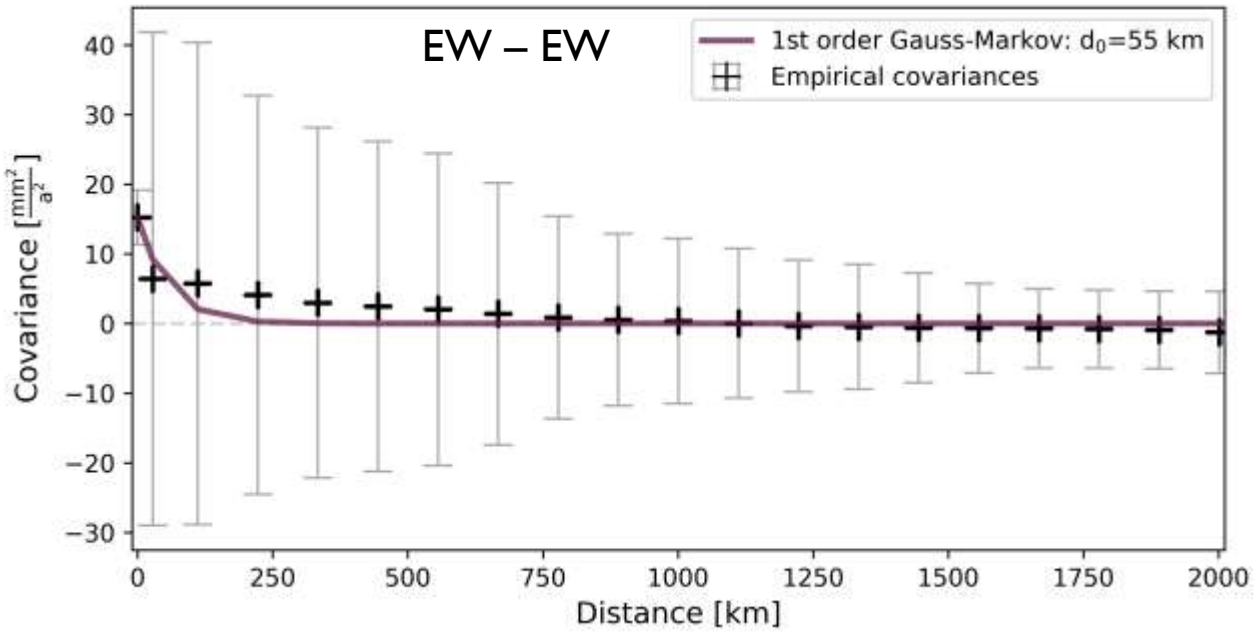
Application of collocation methodology
→ Advantage of using several observations at the same time
→ Uses observations including uncertainties

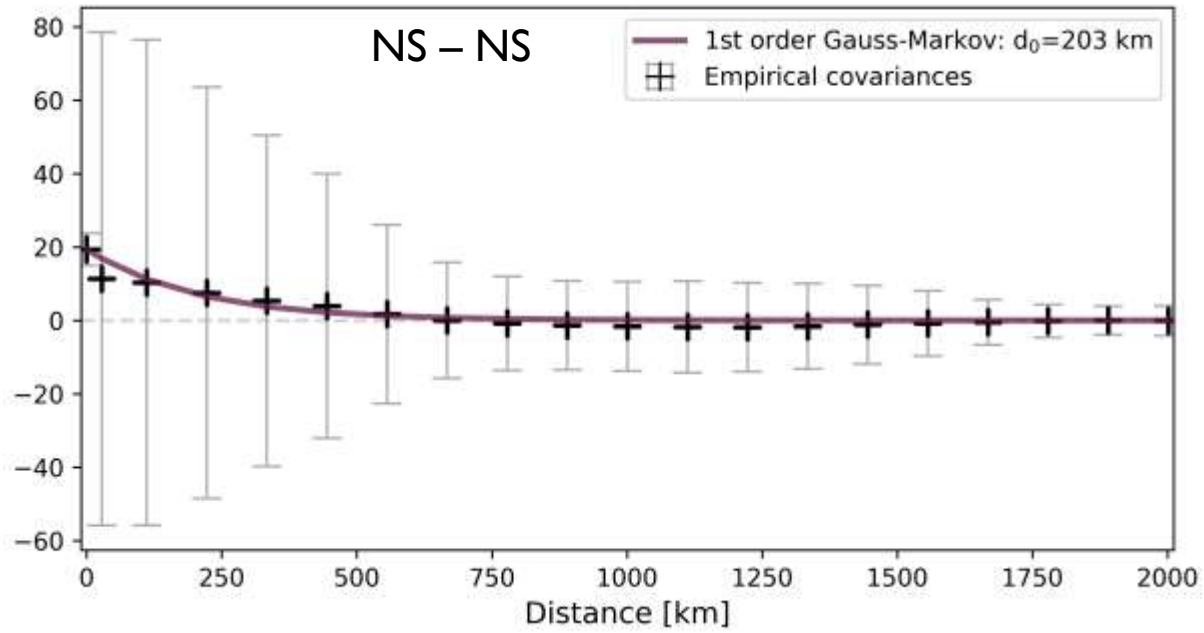
COLLOCATION (SHORT SUMMARY)

- Velocity data are filtered and interpolated (prediction) using least-squares collocation (LSC, based on Moritz, 1980)
- Collocation is done for the east-west and north-south component at the same time as well as considering the correlation between the components (following Legrand, 2007, and Steffen et al., to be submitted): HV-LSC
- Plate-boundary constraints are used as well (HV-LSC-ex)
- Interpolation is done on a 0.1° x 0.1° grid
- Collocation depends on the distance between the points and the choice of the covariance function → C_0 (signal covariance) and d_0 (correlation length) need to be determined

COVARIANCE FUNCTION

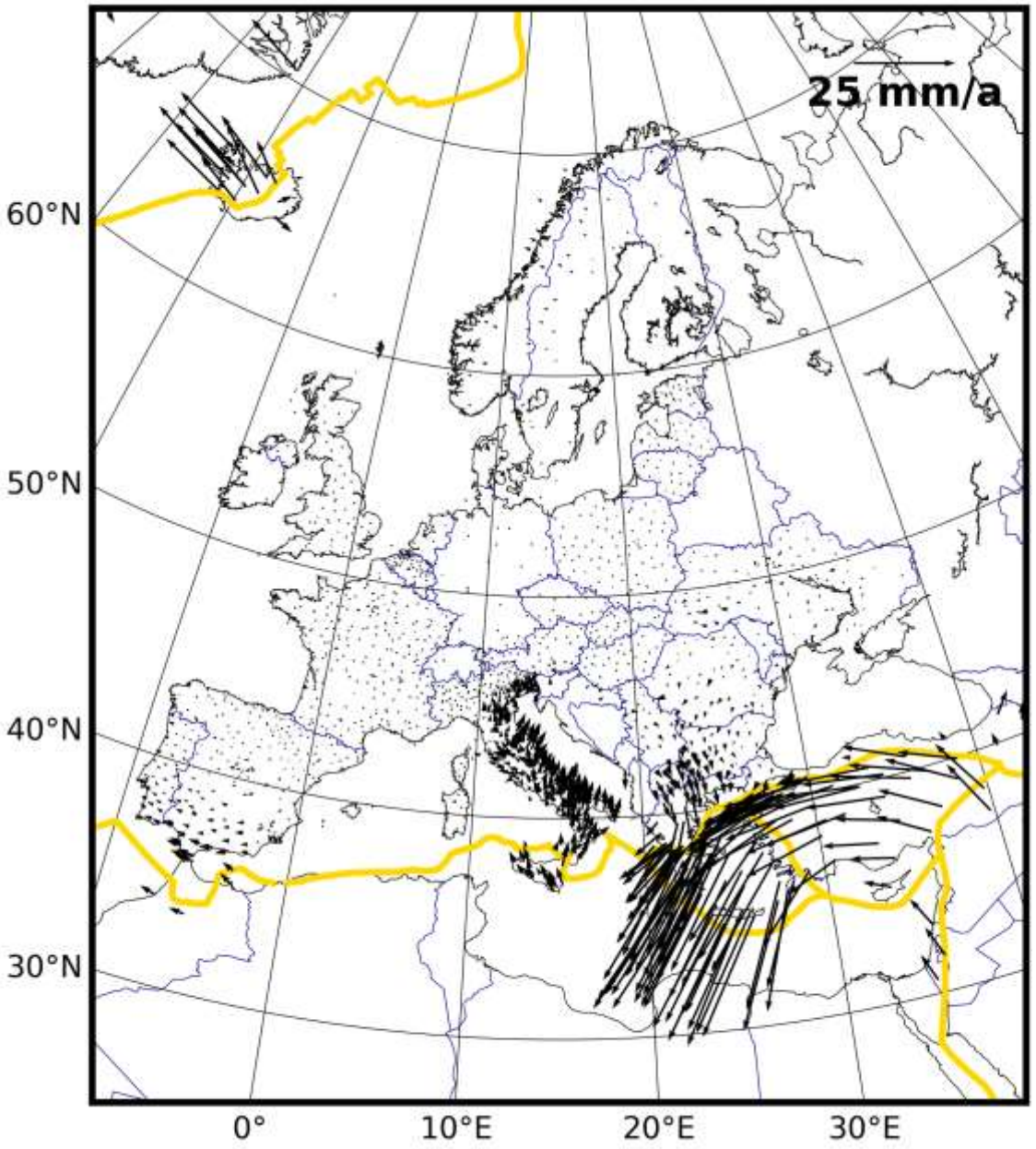
Gauss-Markov 1st order used: $K(d) = C_0 \cdot e^{-d/d_0}$



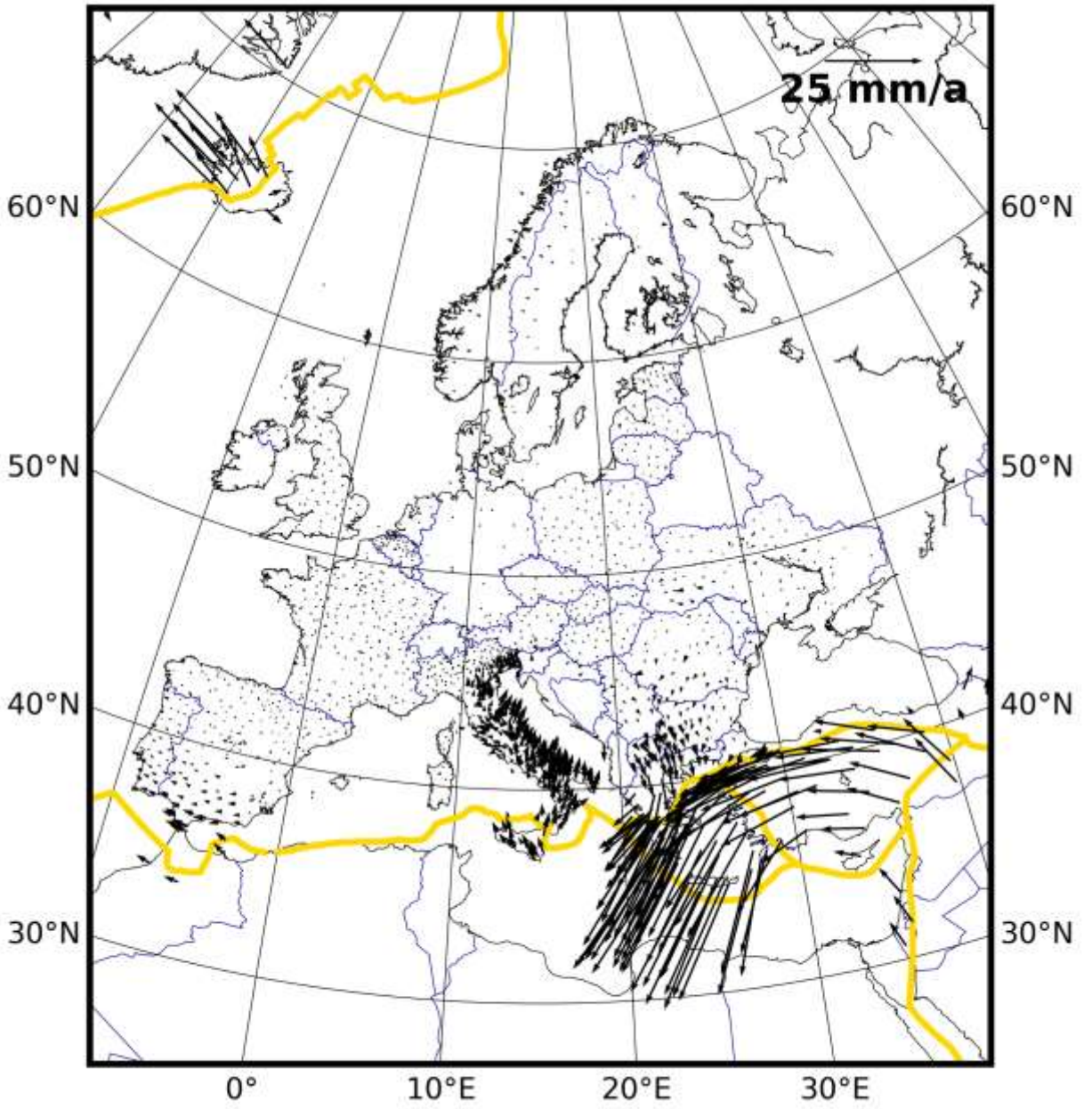


	$C_0\ [mm^2/a^2]$	$d_0\ [km]$
EW – EW	15.234	55 ± 19
NS – NS	19.360	203 ± 20
Final	**17.297**	**129**

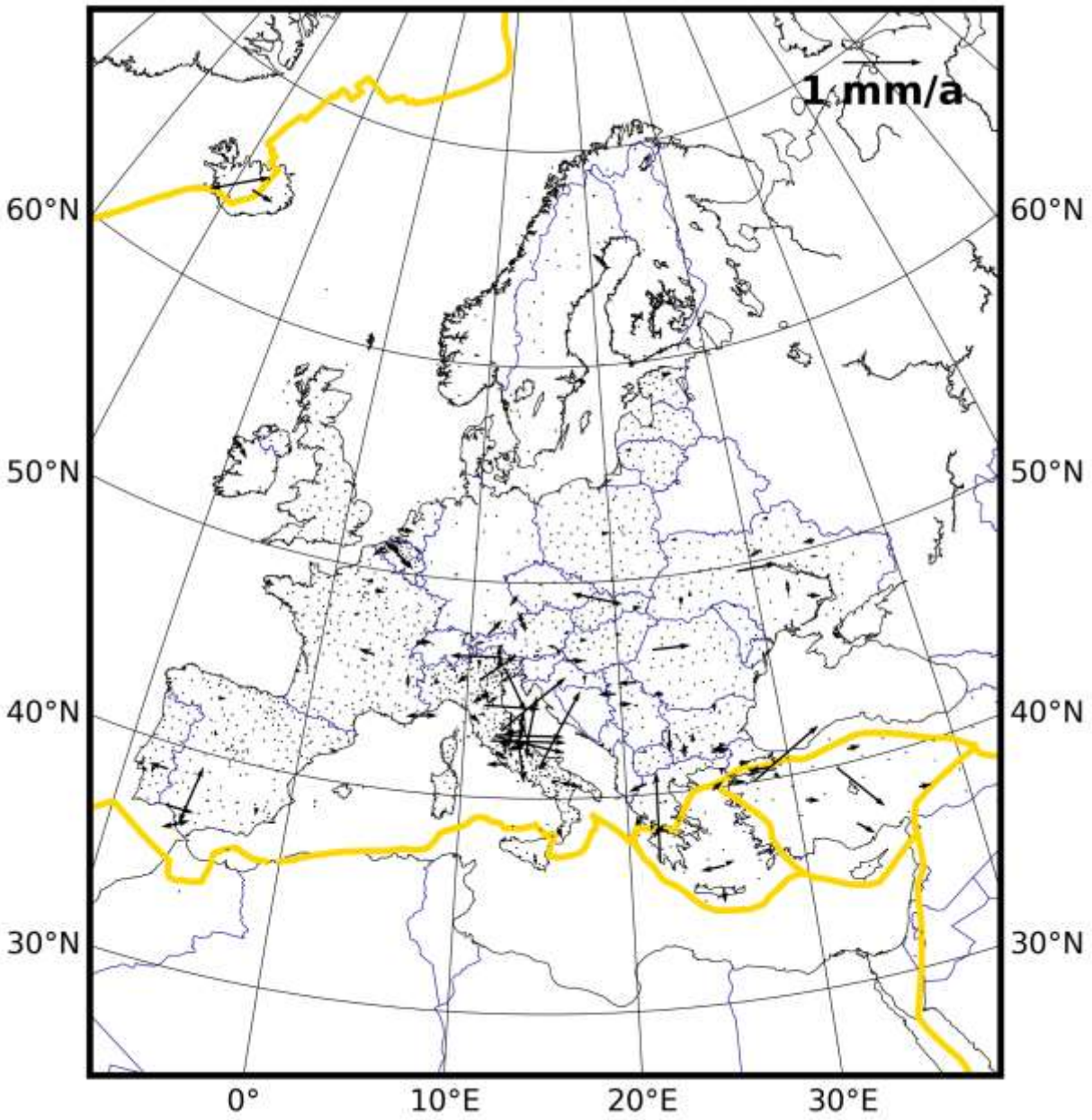
Original velocity field

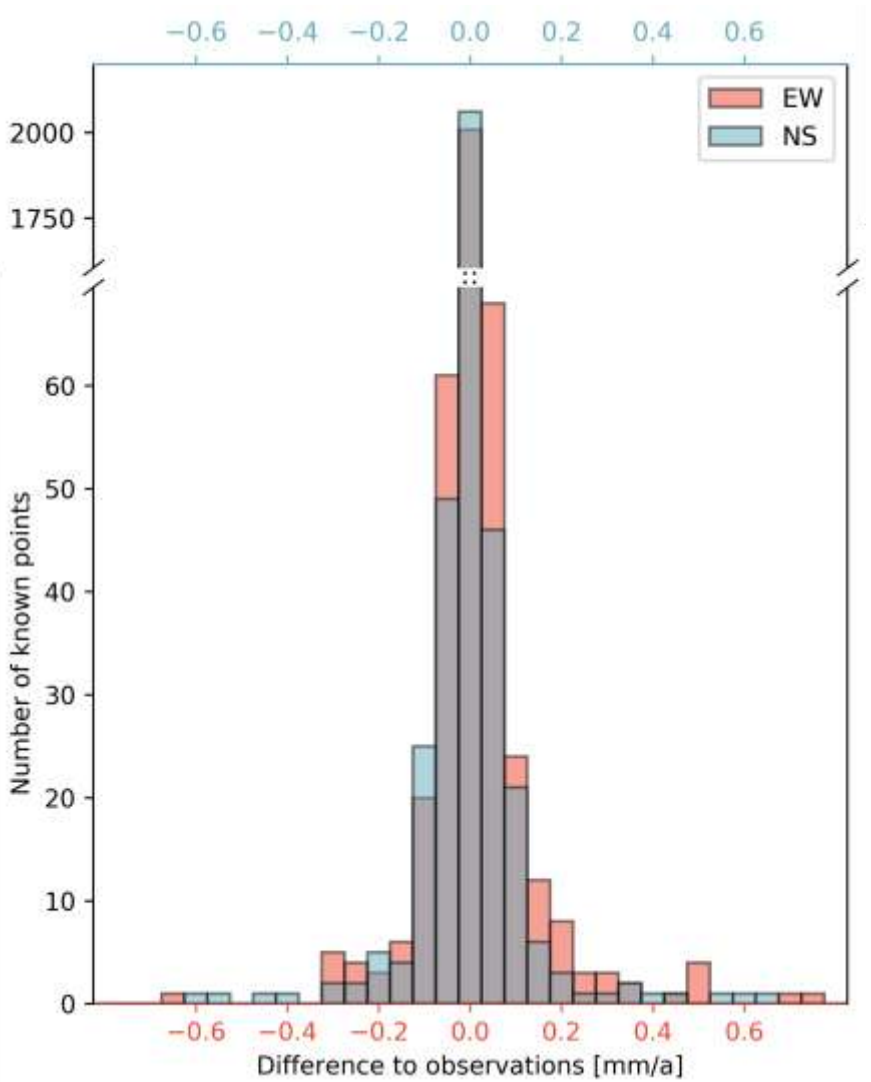


Filtered velocity field from HV-LSC-ex

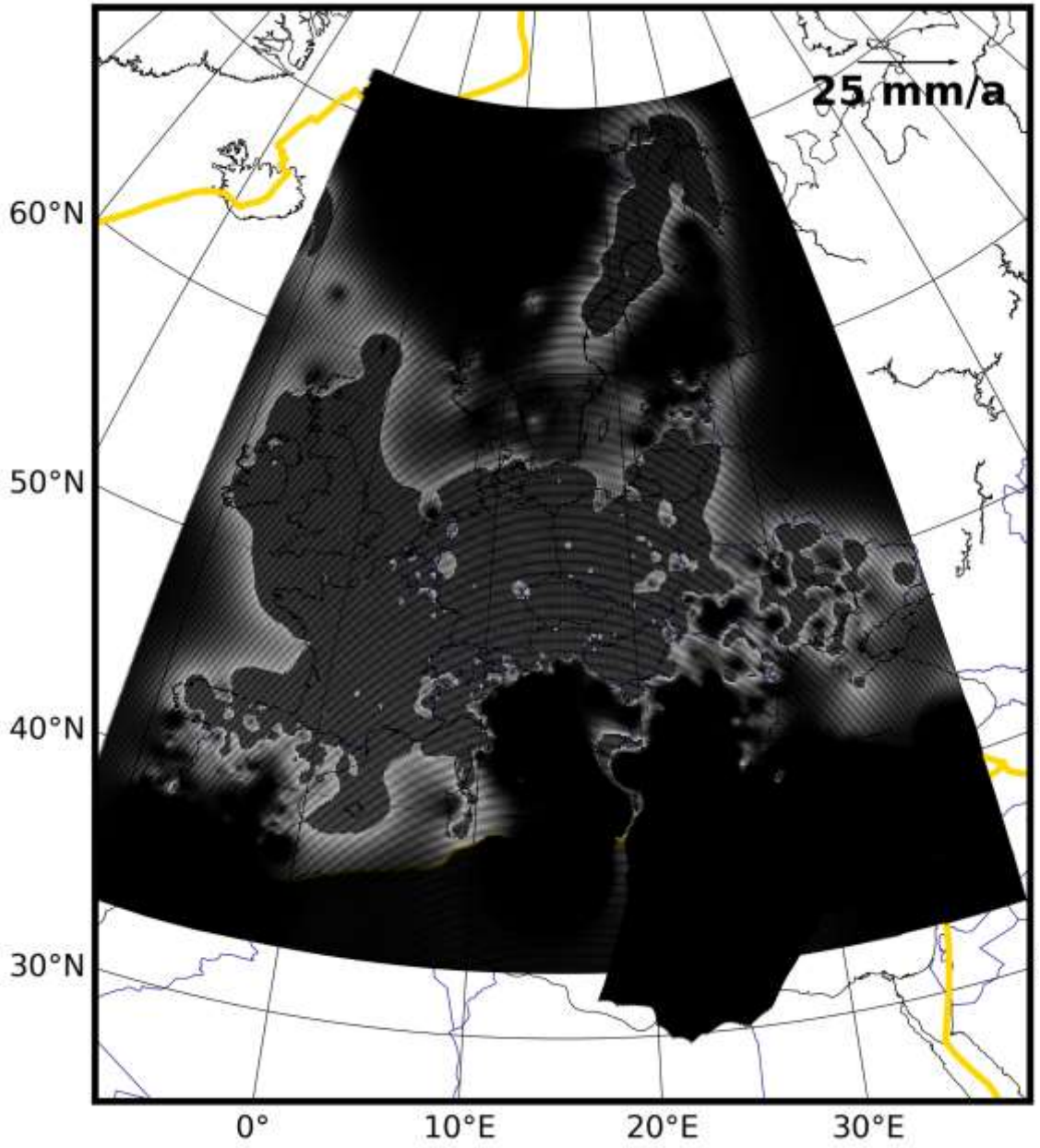


Difference

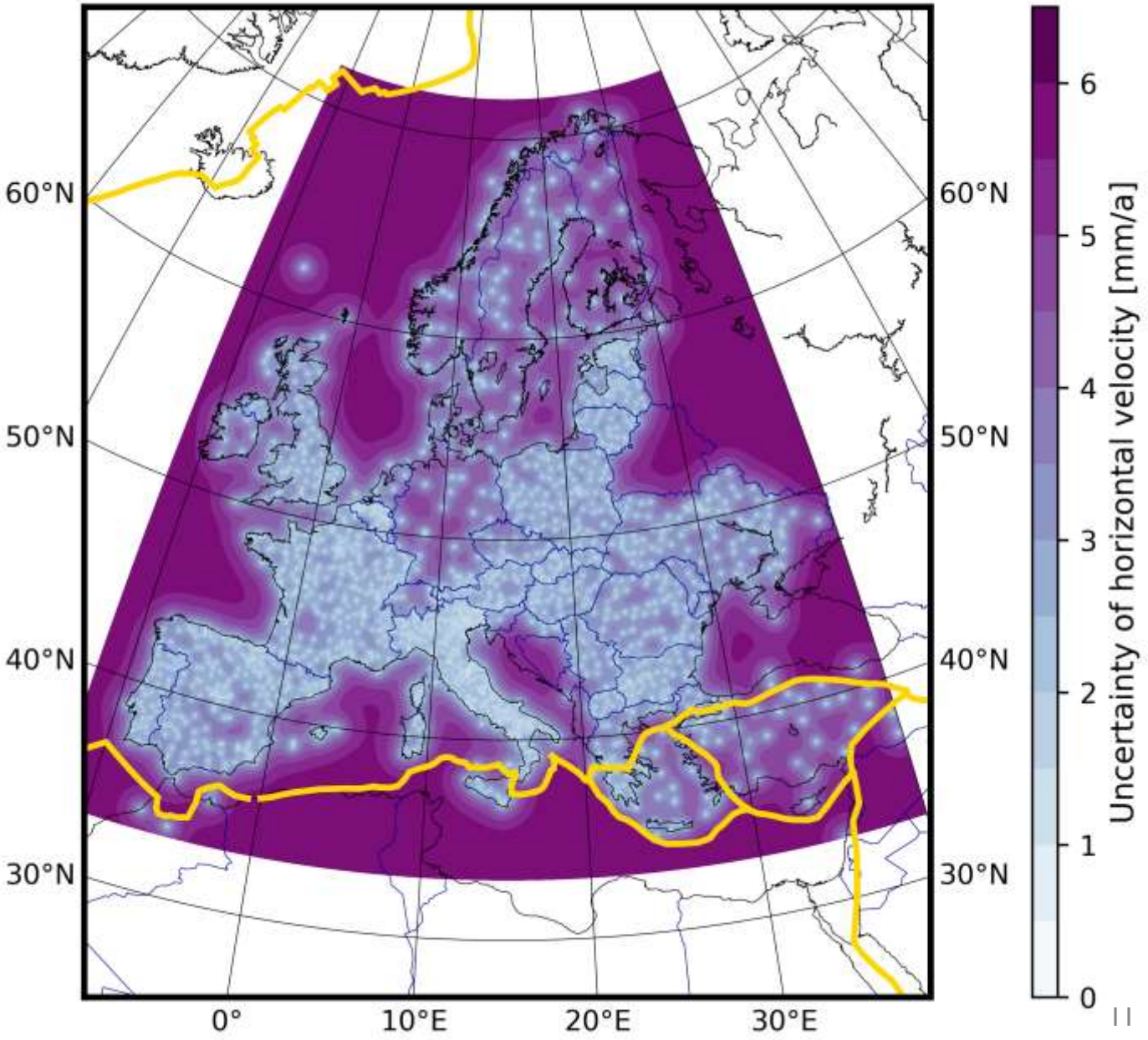

1 mm/a
60°N
50°N
40°N
30°N
0°
10°E
20°E
30°E


EW
NS
Number of known points
Difference to observations [mm/a]

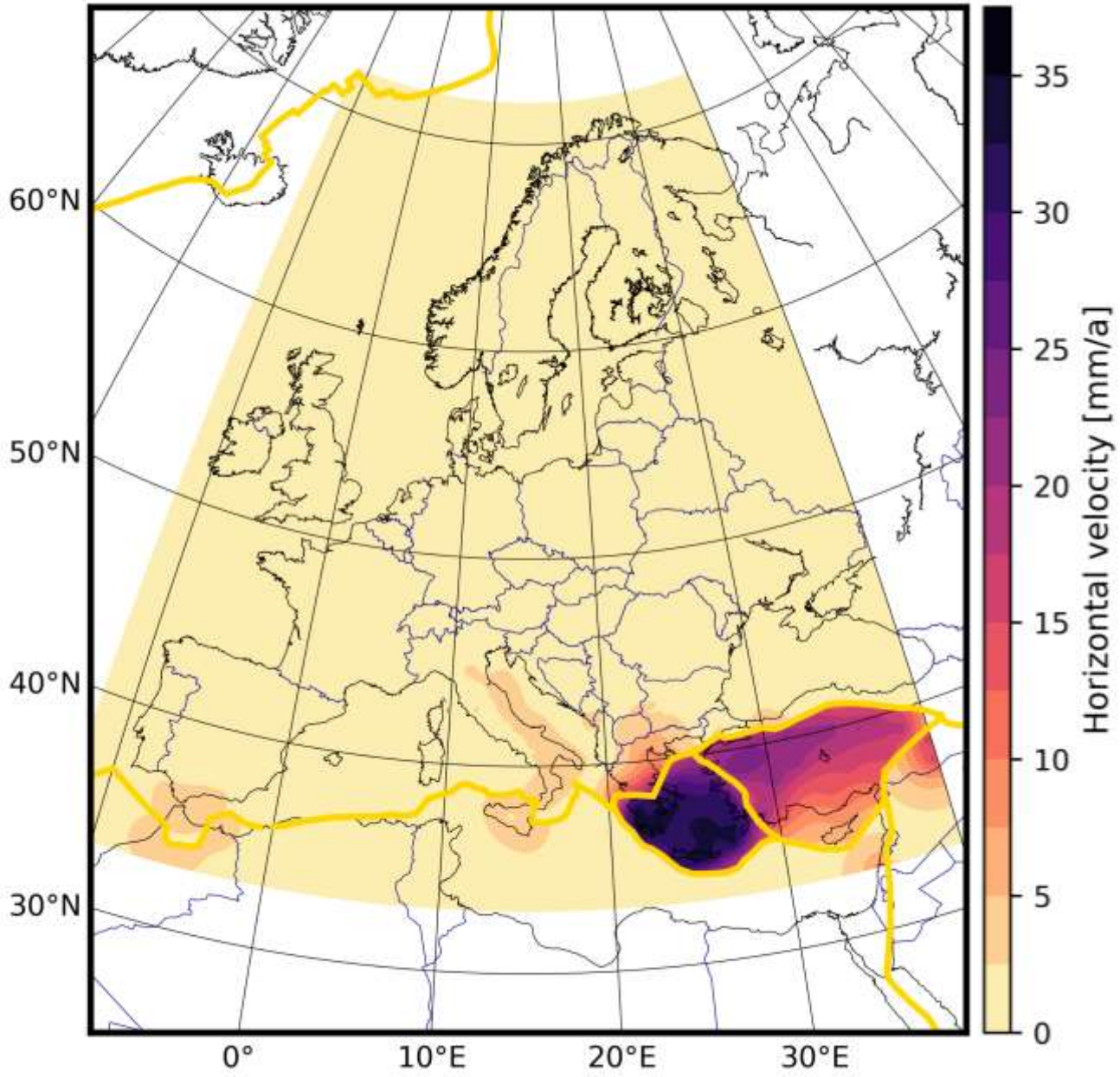
Interpolated velocity field using HV-LSC-ex



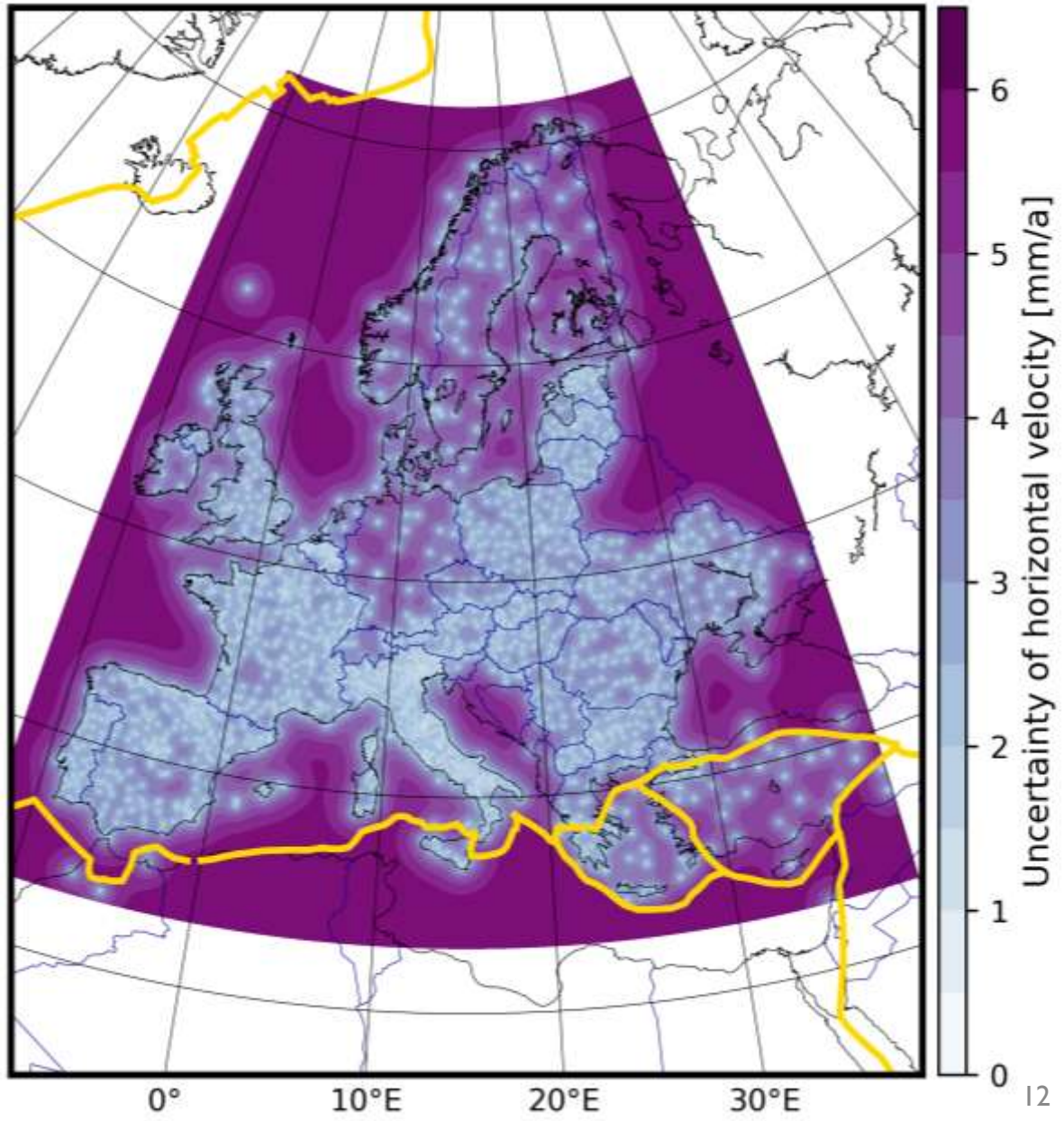
Uncertainty using HV-LSC-ex



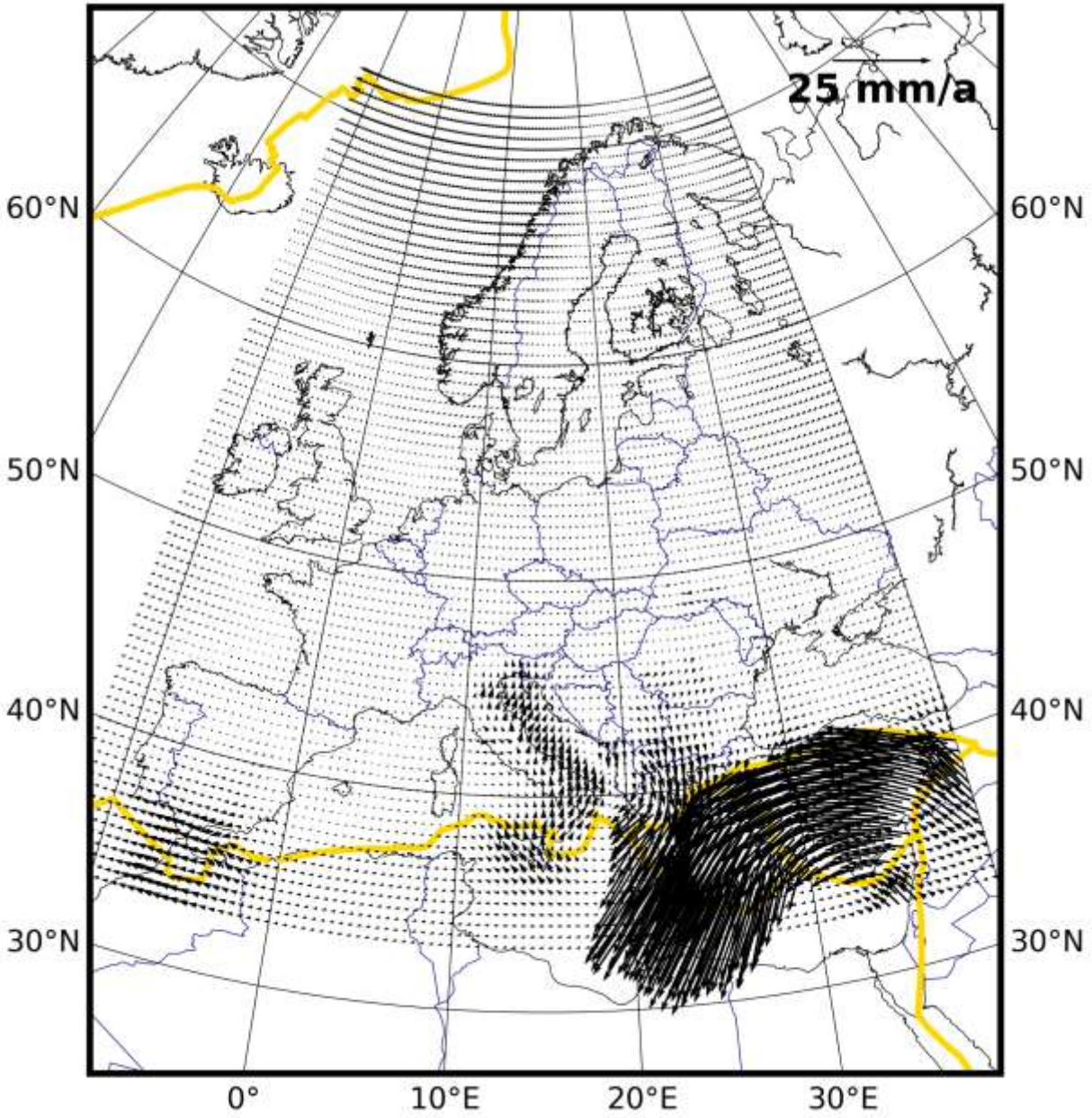
Interpolated velocity field using HV-LSC-ex



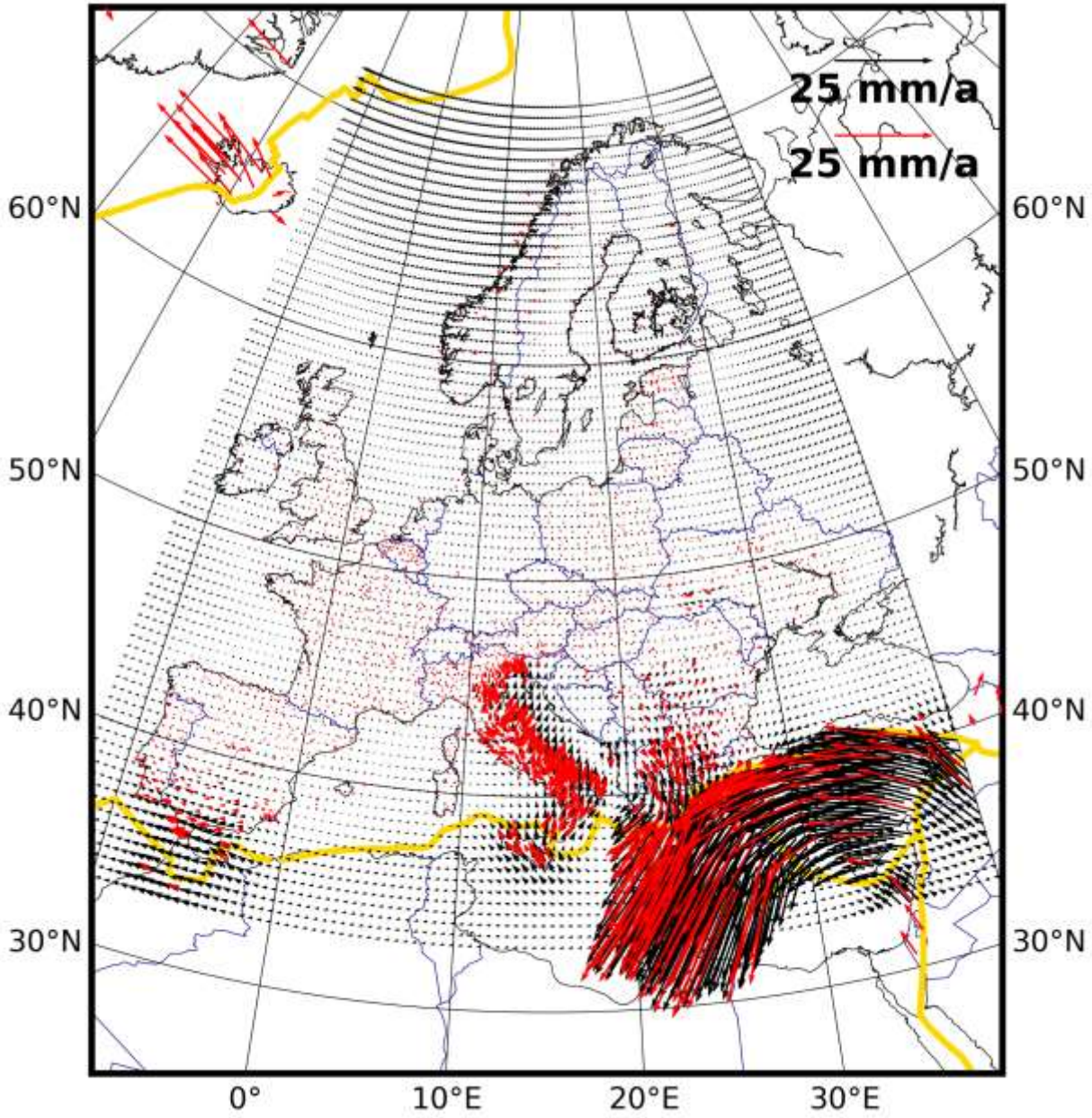
Uncertainty using HV-LSC-ex



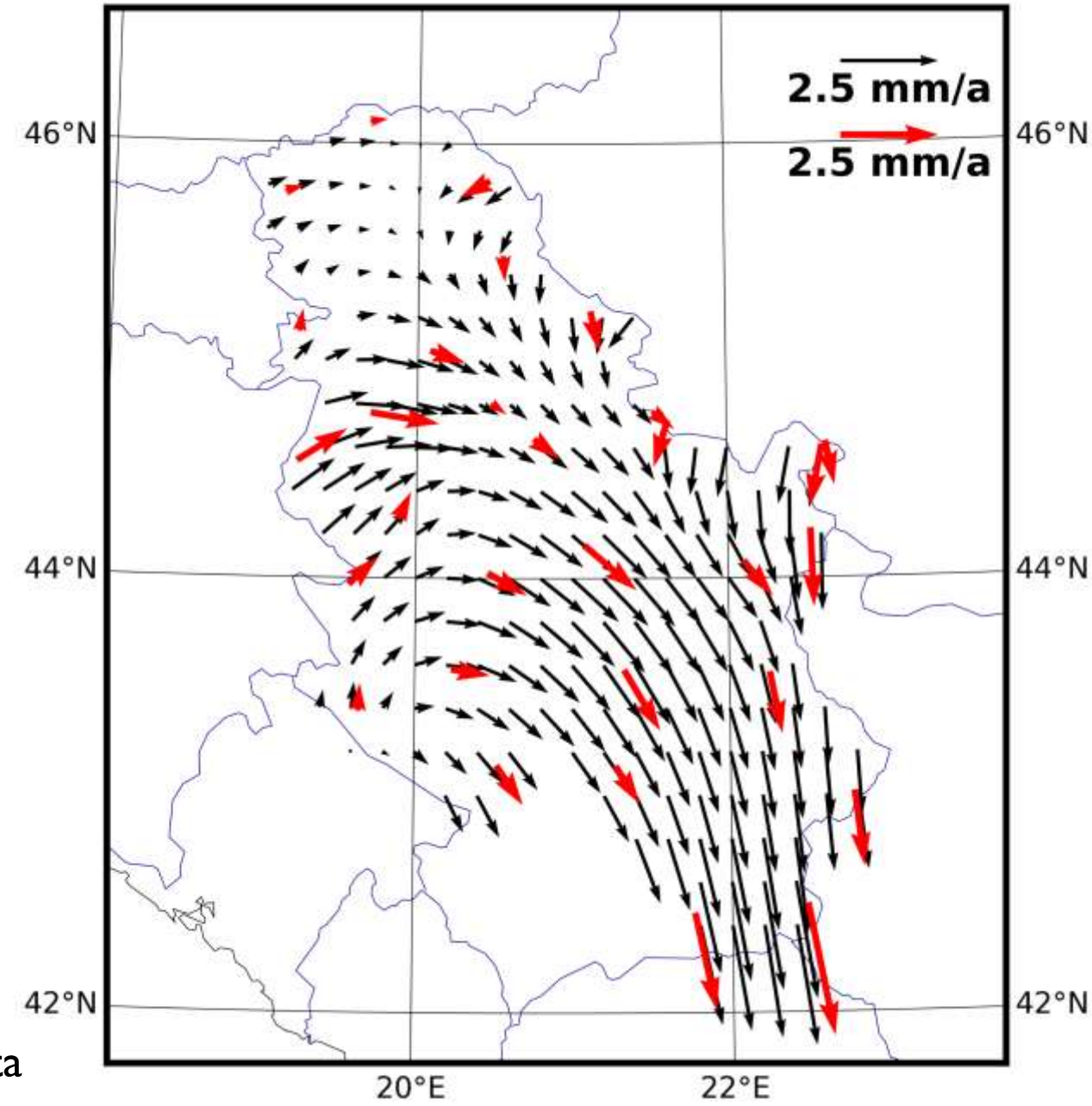
Lower resolution of 0.5° x 0.5°



Comparison to observations (in red)



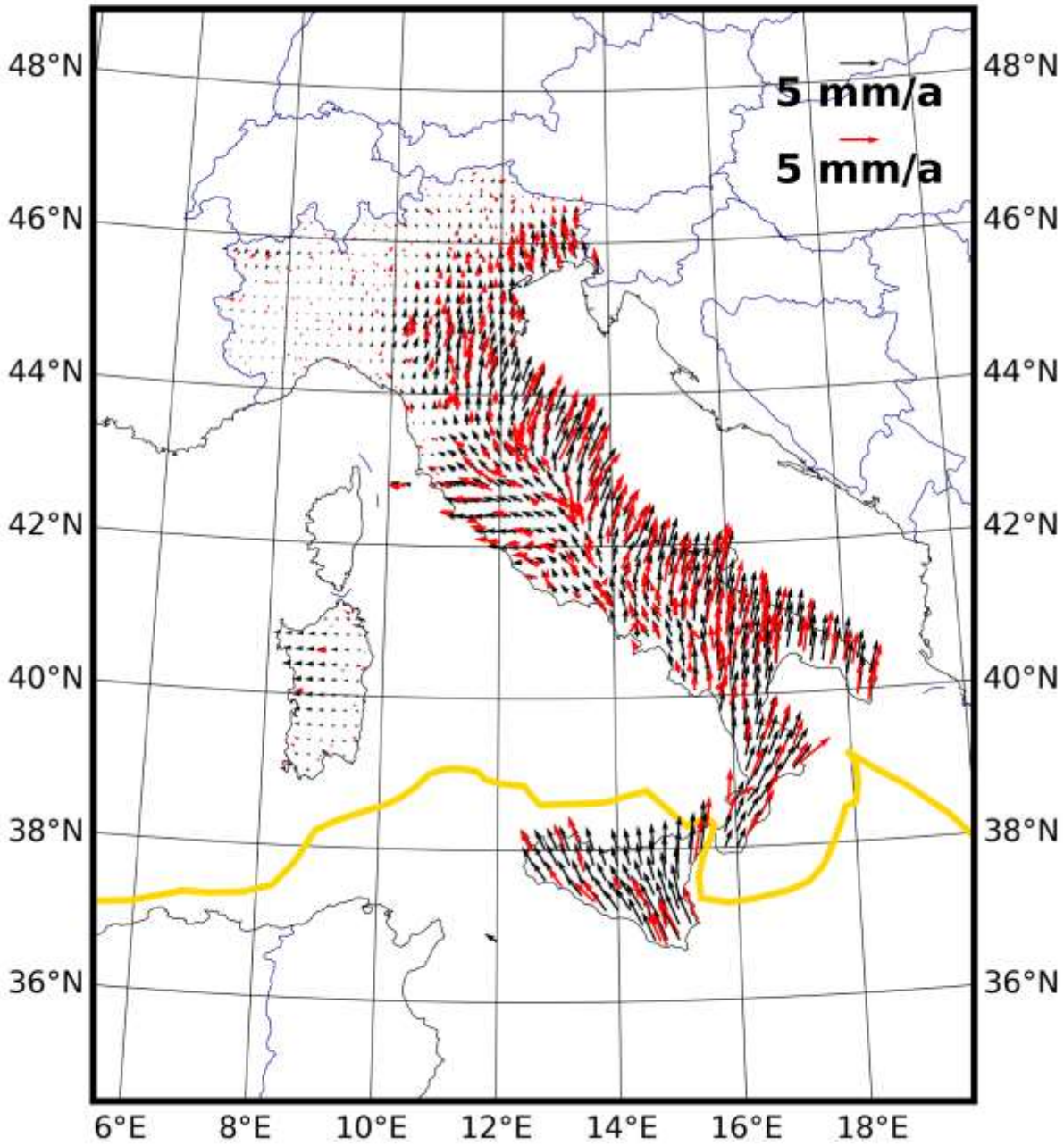
A FEW EXAMPLES - SERBIA



Red – original data

Black – collocated data

A FEW EXAMPLES - ITALY



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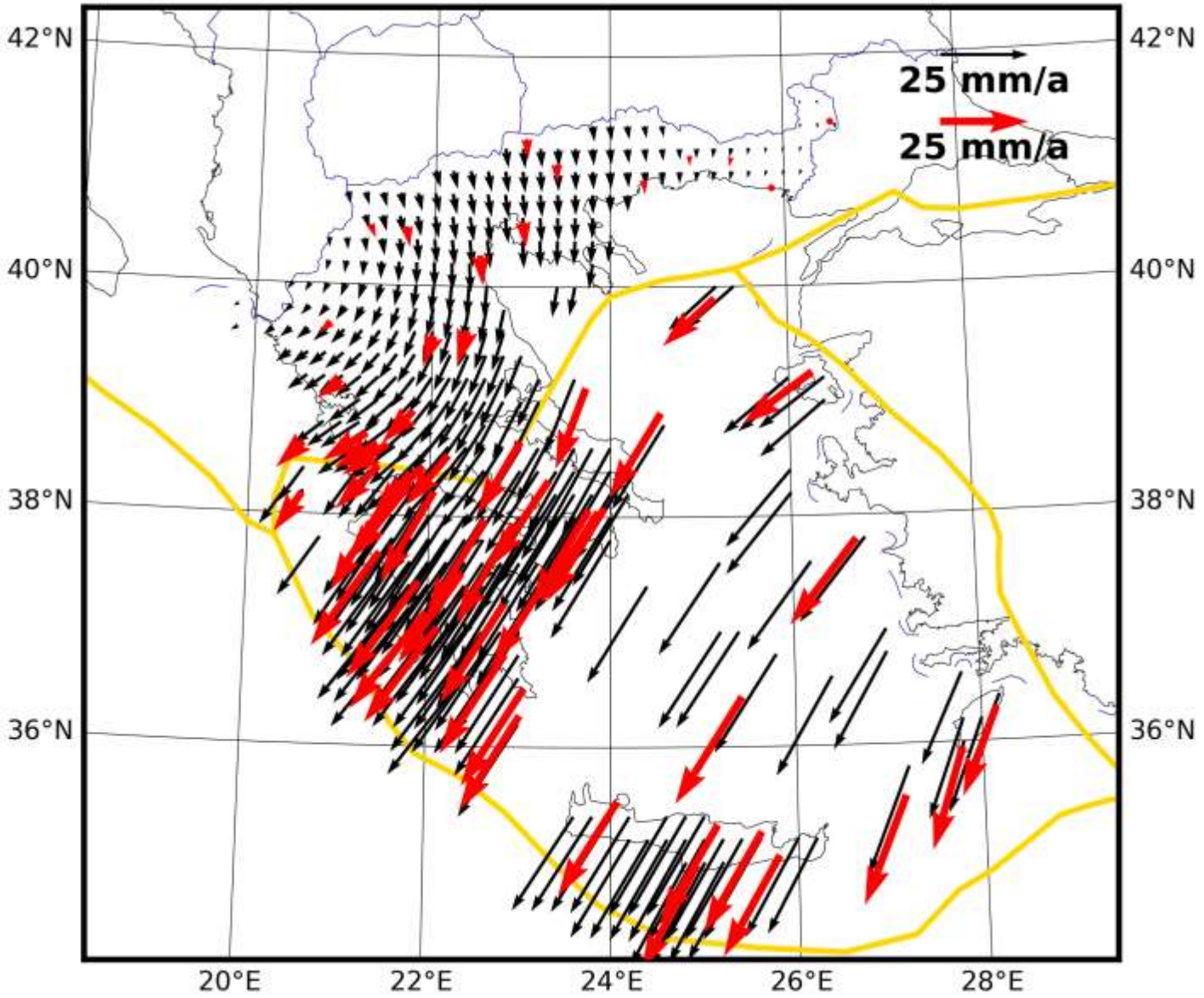
A FEW EXAMPLES - GREECE



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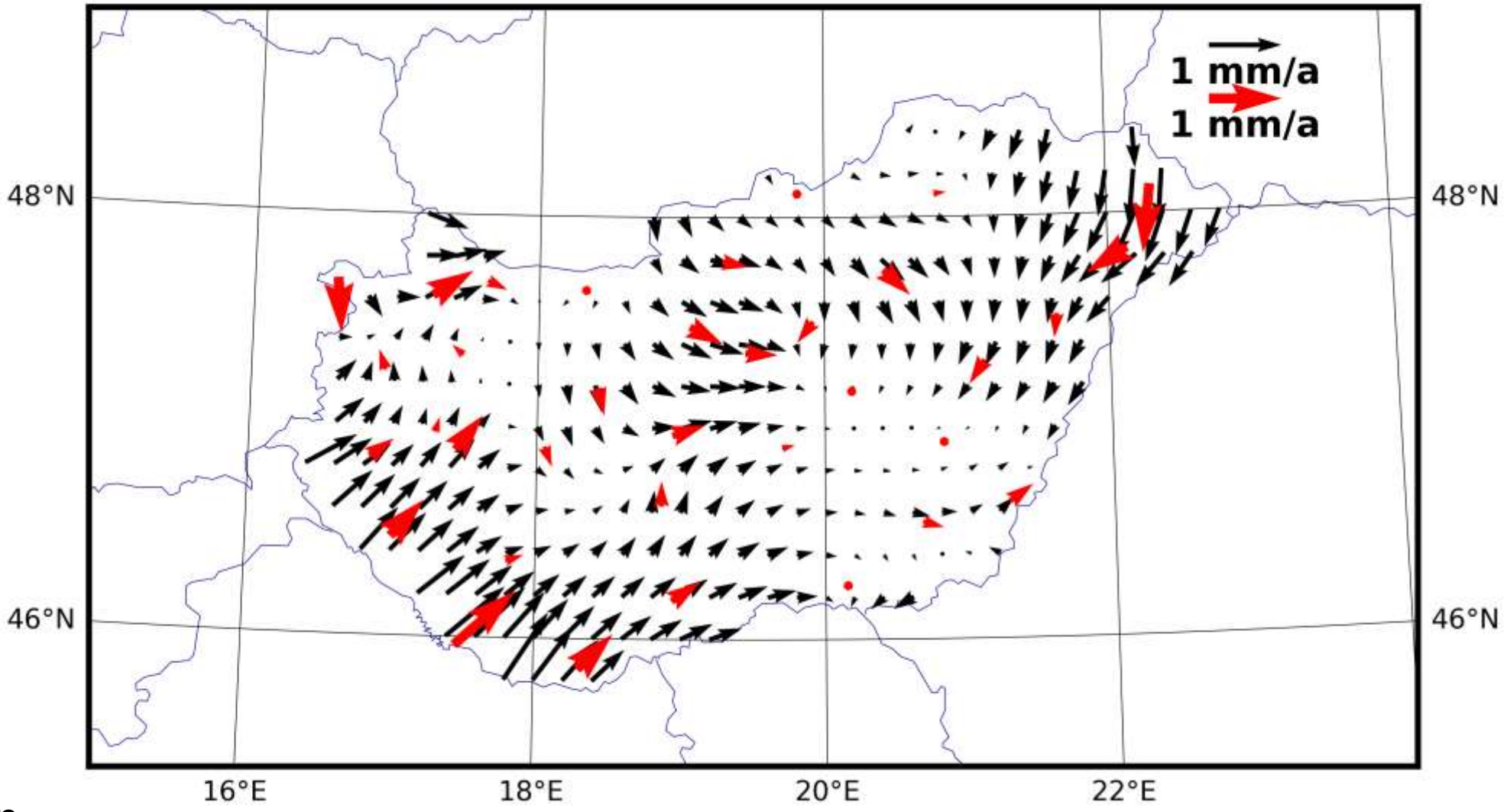
A FEW EXAMPLES - HUNGARY



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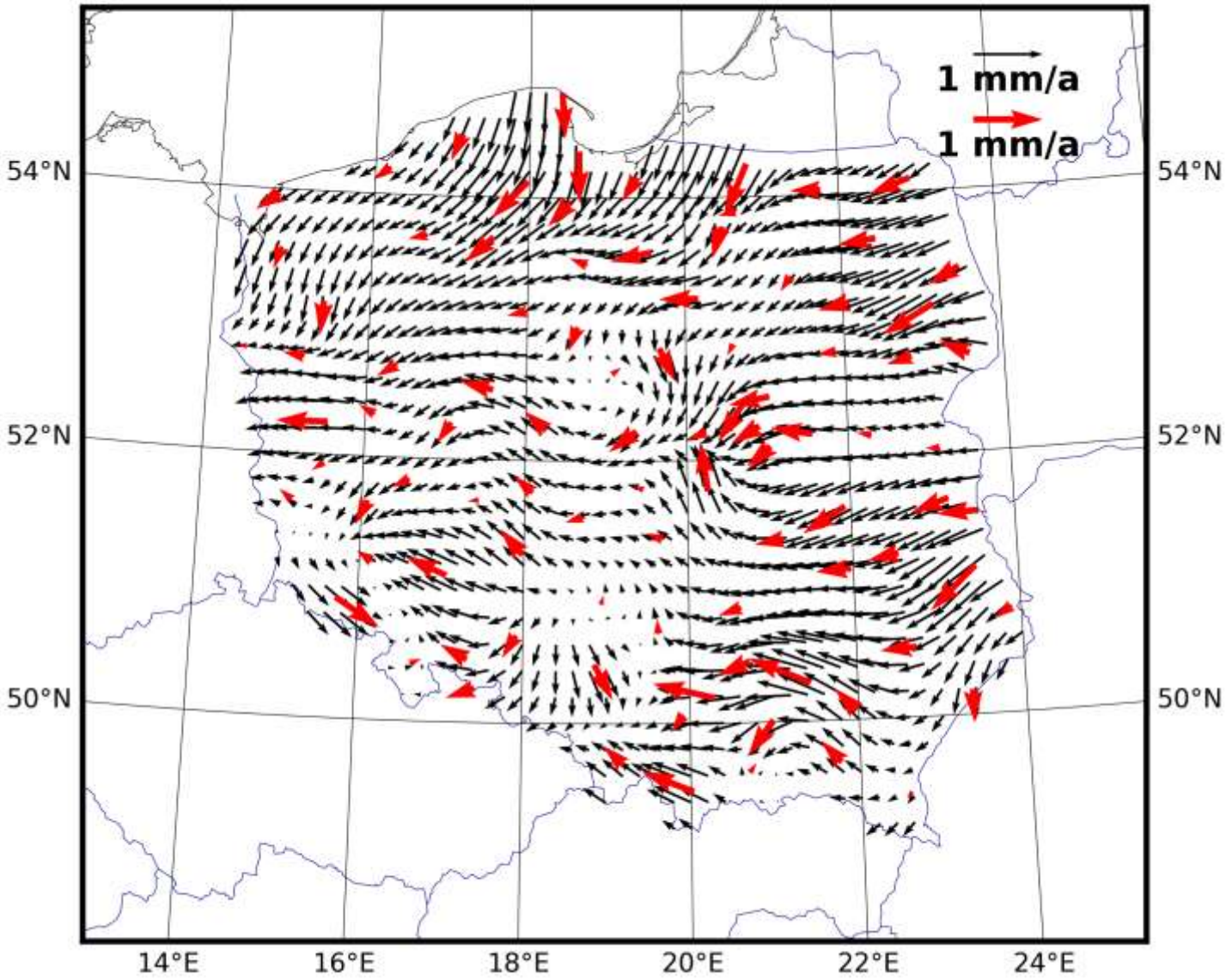
A FEW EXAMPLES - POLAND



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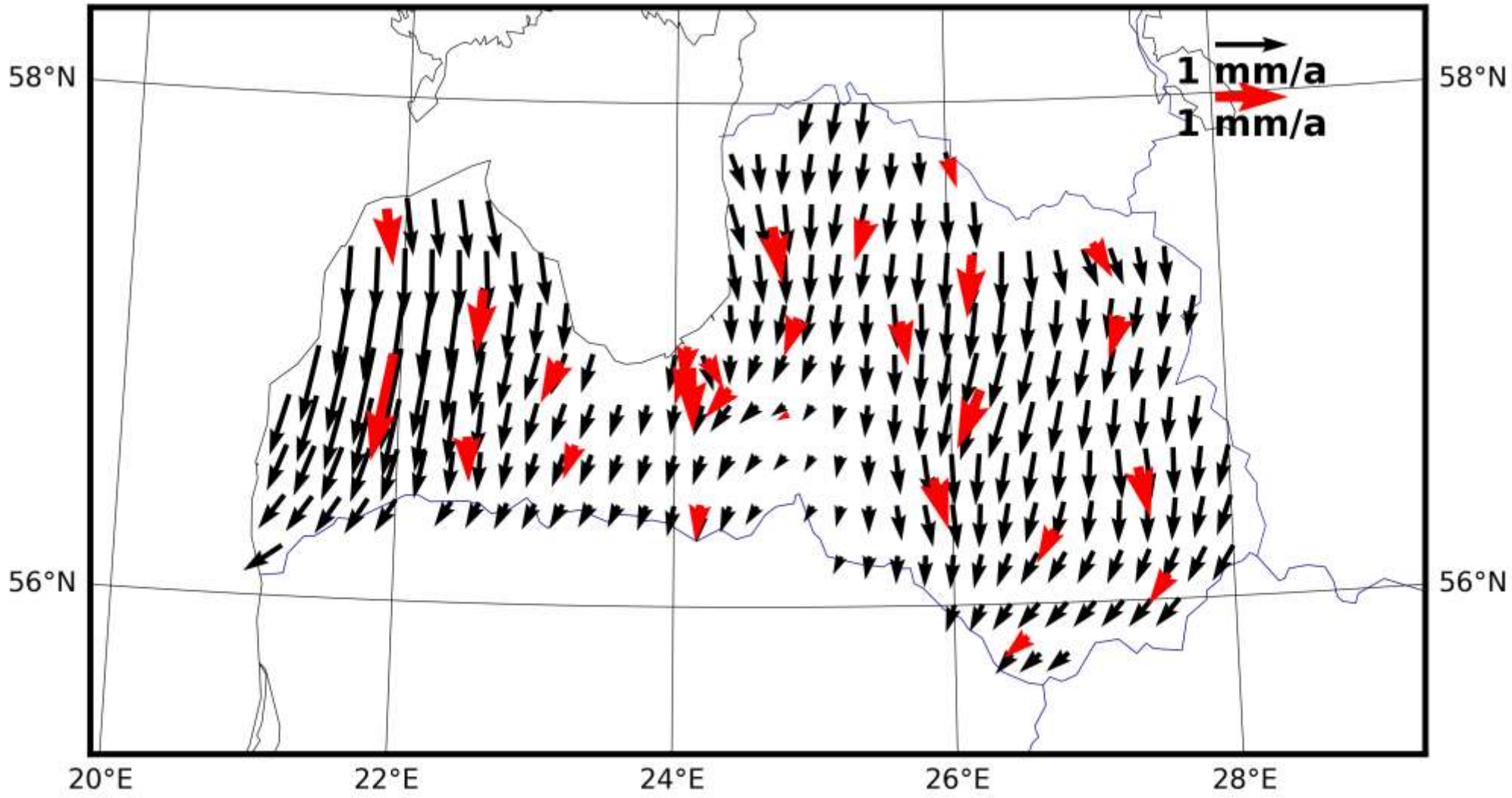
A FEW EXAMPLES - LATVIA



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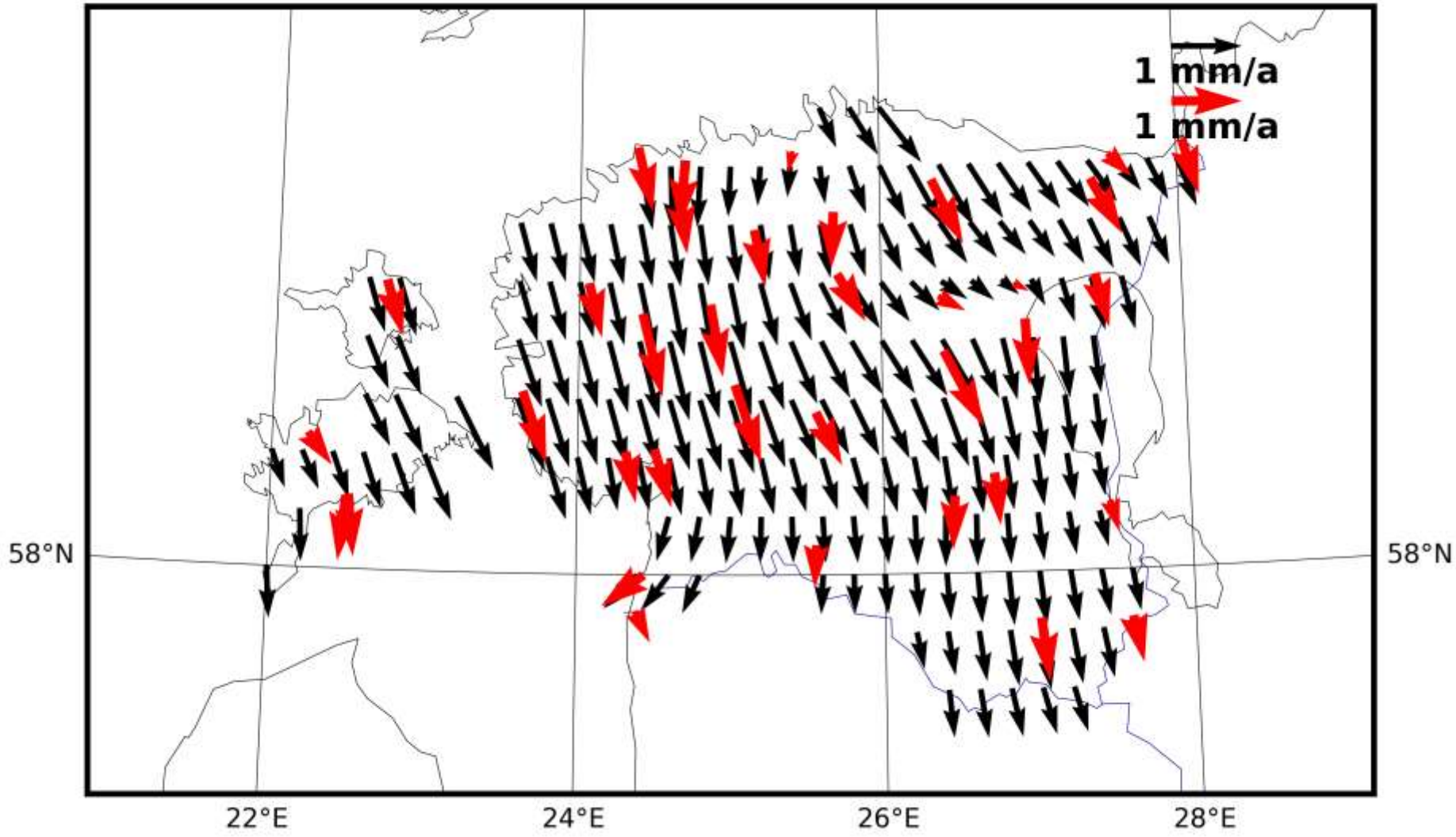
A FEW EXAMPLES - ESTONIA



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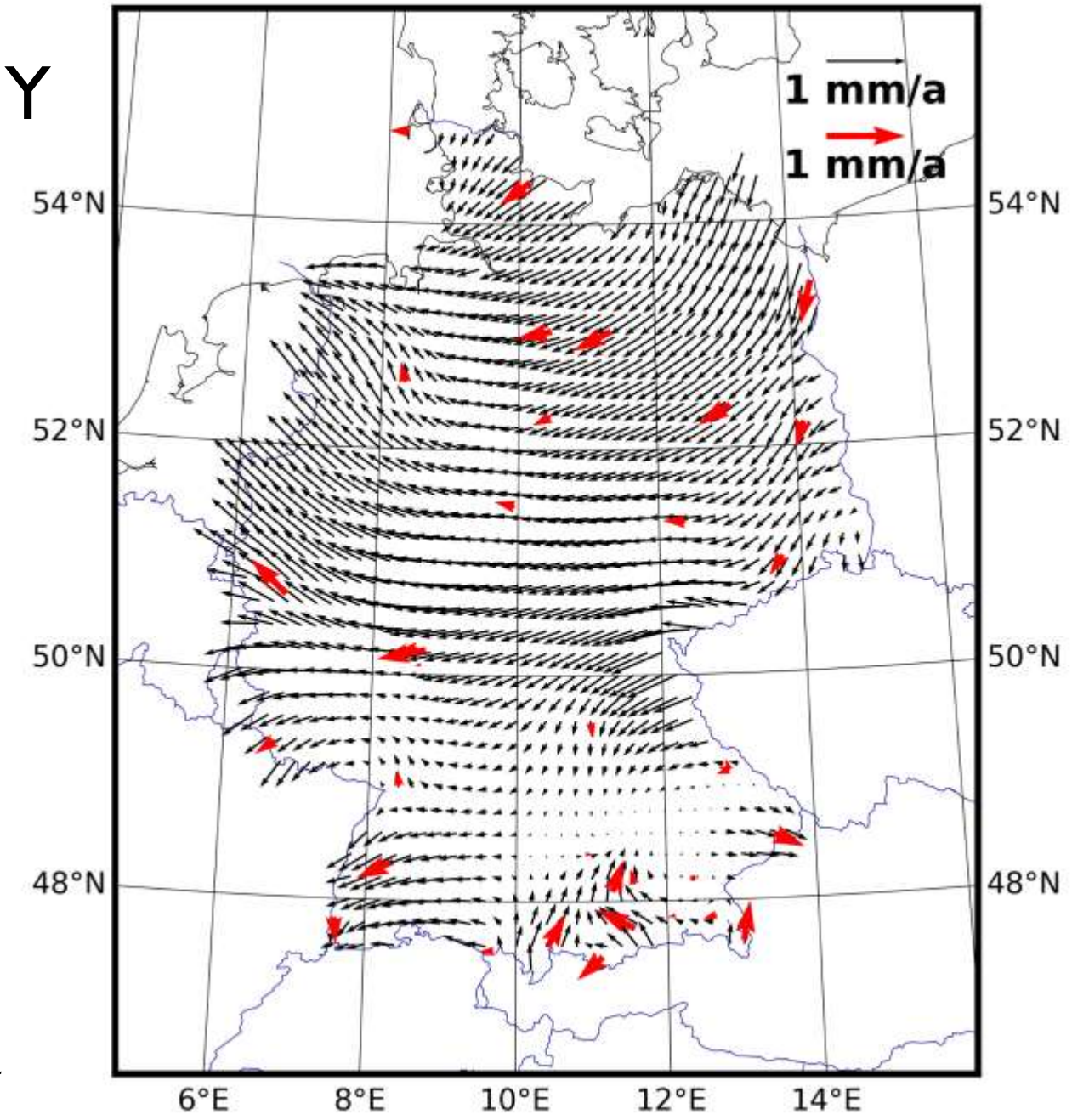

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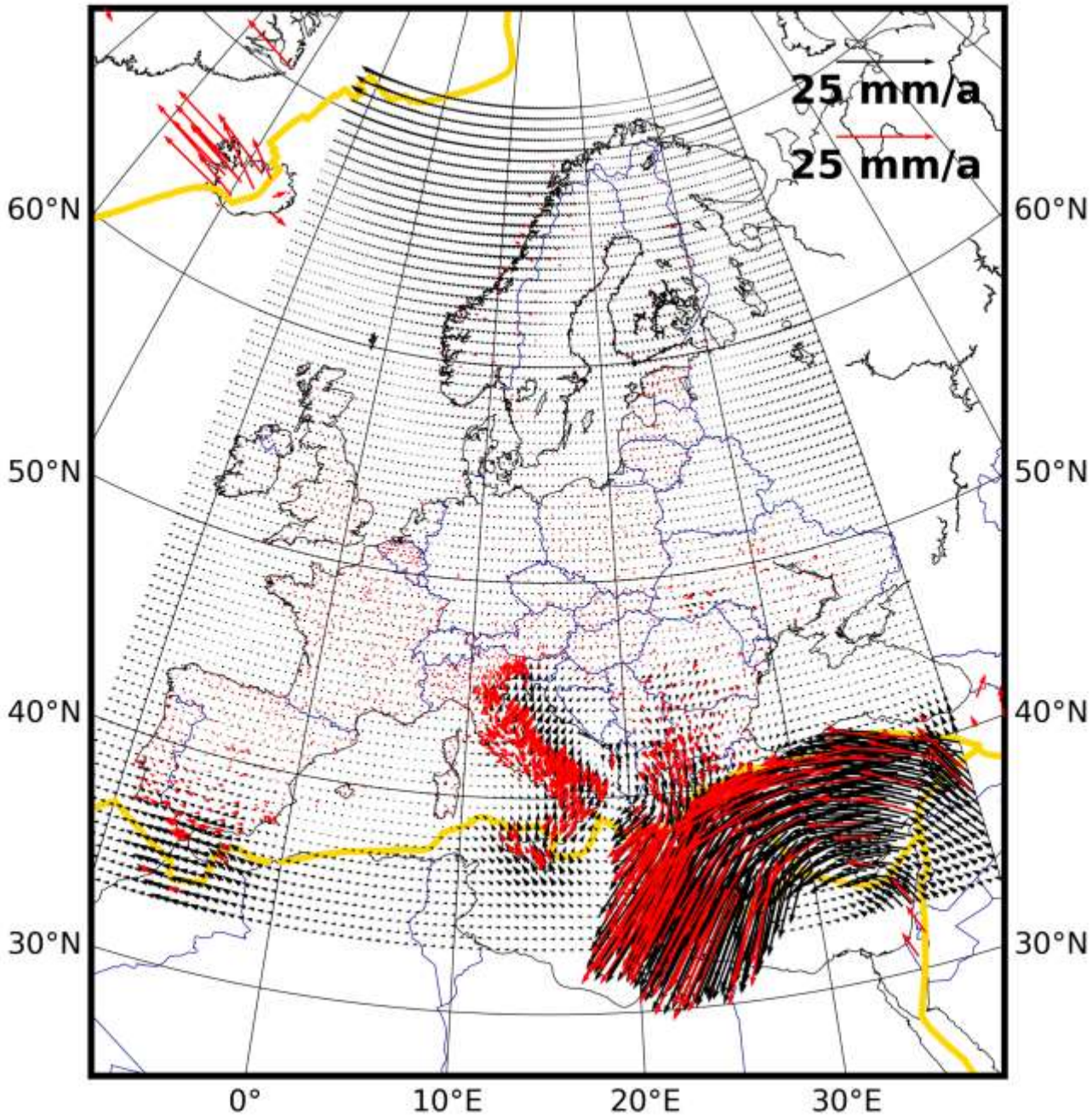
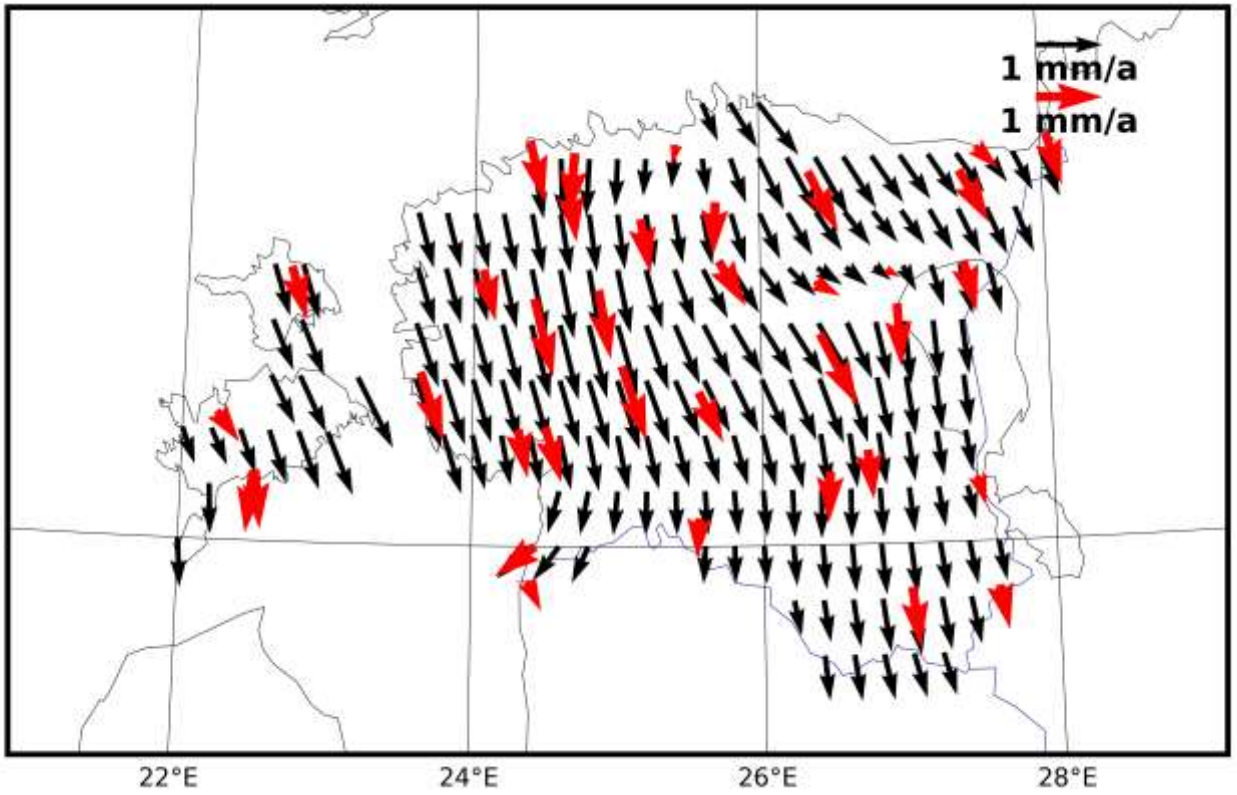
OUTLOOK

- Problem of non-stationarity exists in collocation method
  - → development of a new approach: HV-LSC-ex^2
    - → moving variance
    - → resulting model is smoother

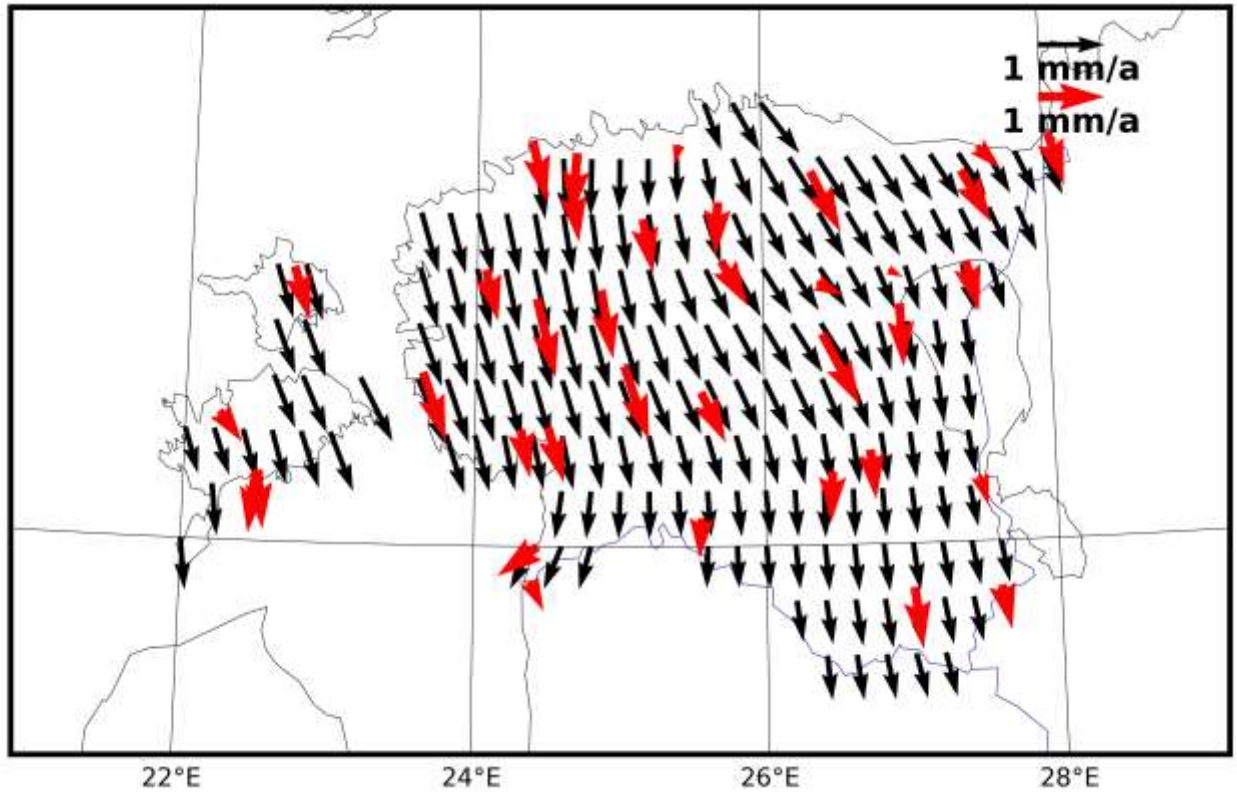


A FEW EXAMPLES - ESTONIA

Without moving variance (HV-LSC-ex)



With moving variance (HV-LSC-ex^2)



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A FEW EXAMPLES - LATVIA

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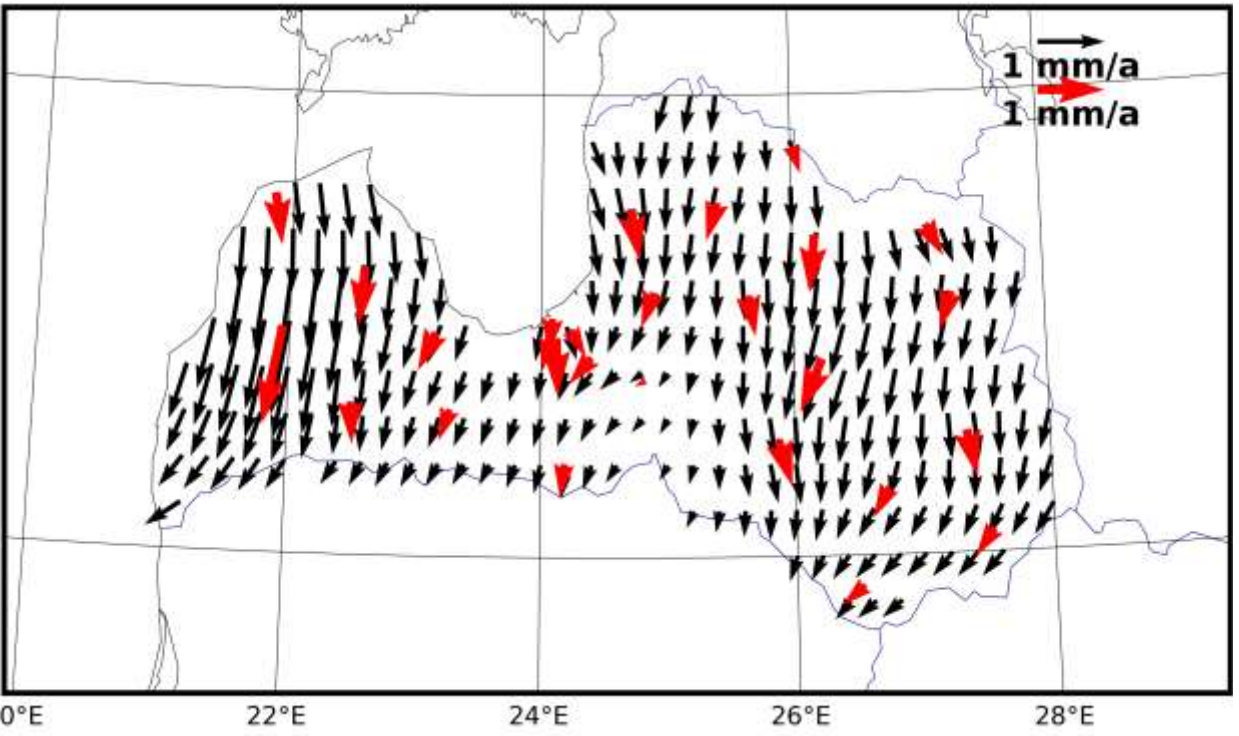
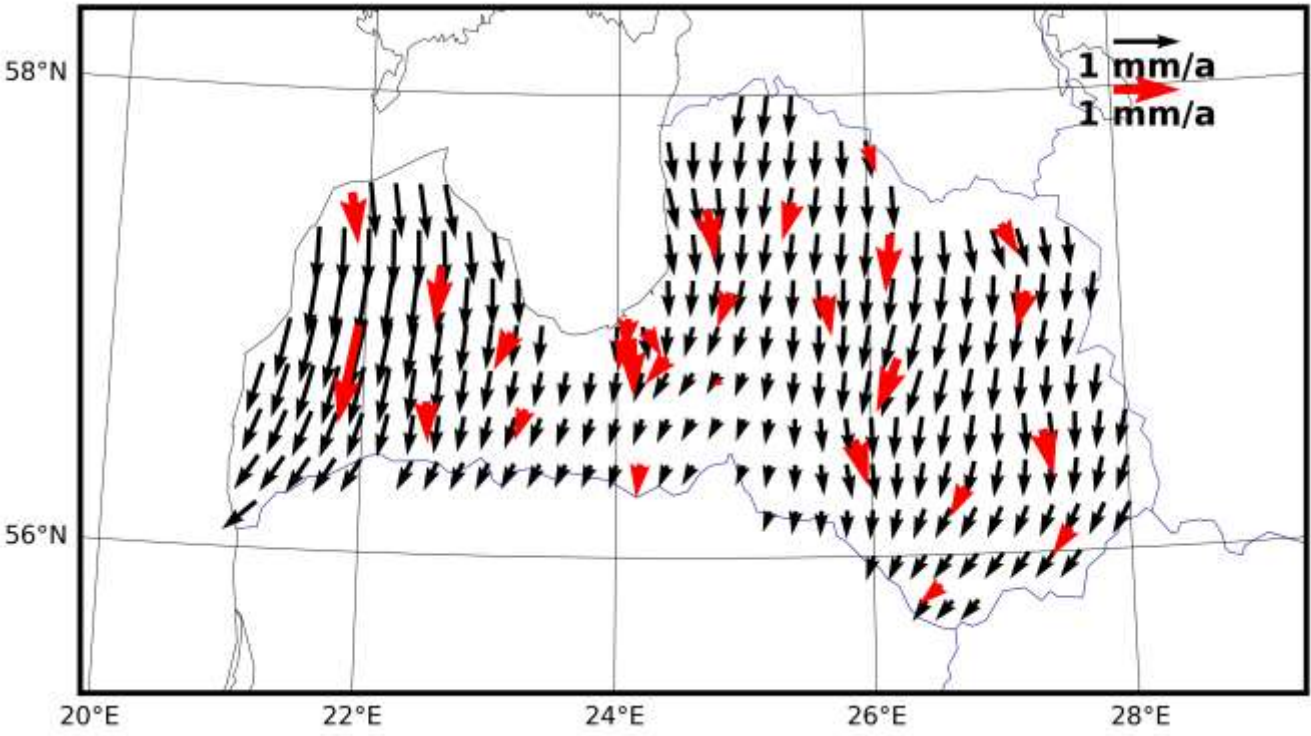


With moving variance (HV-LSC-ex^2)



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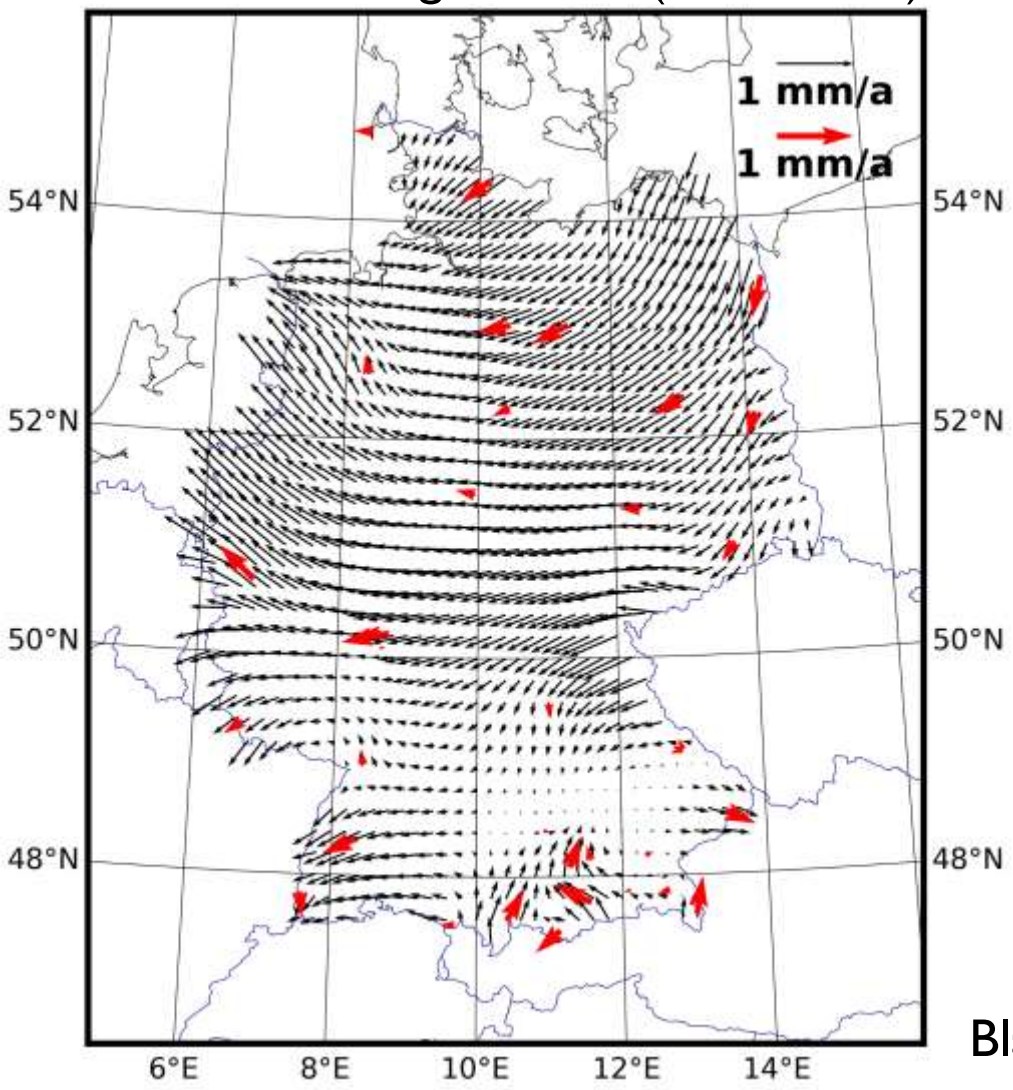

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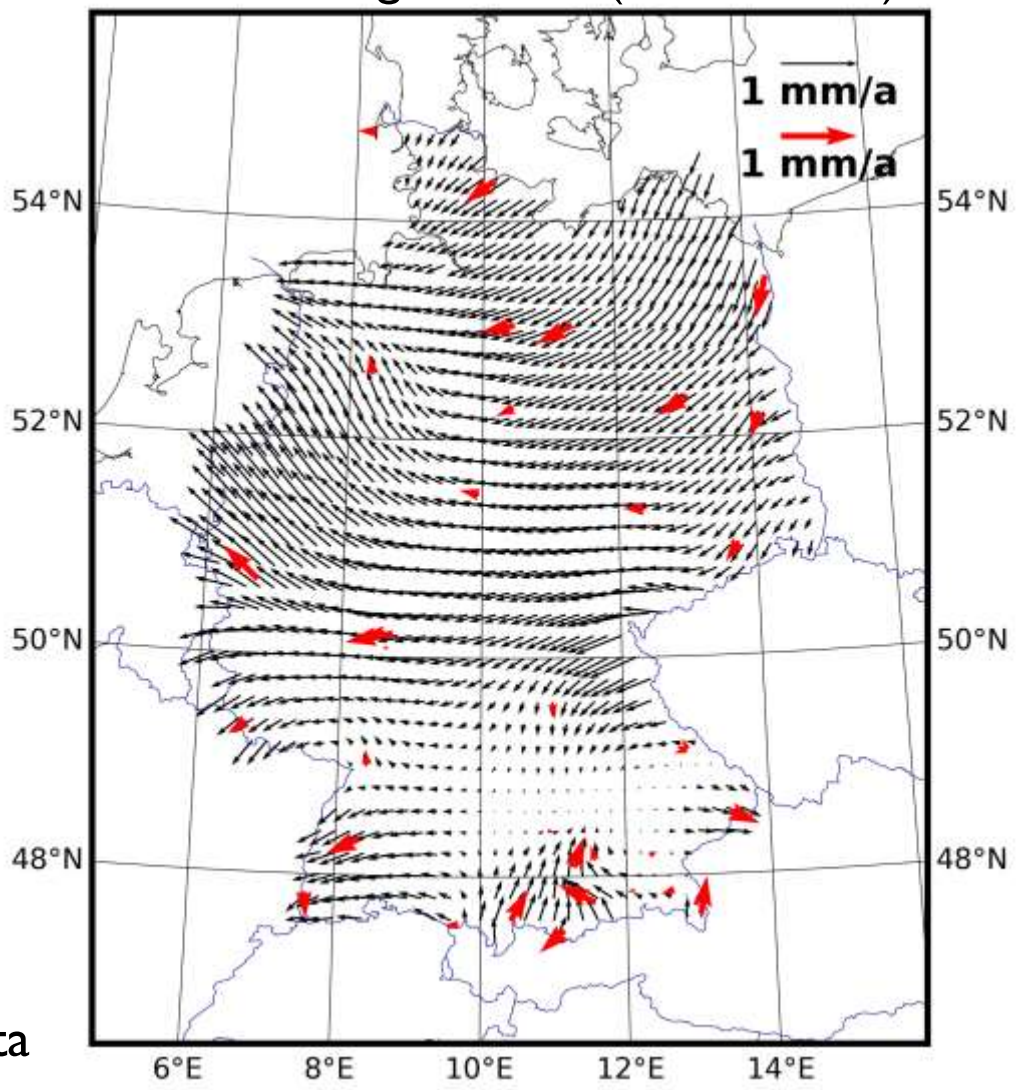

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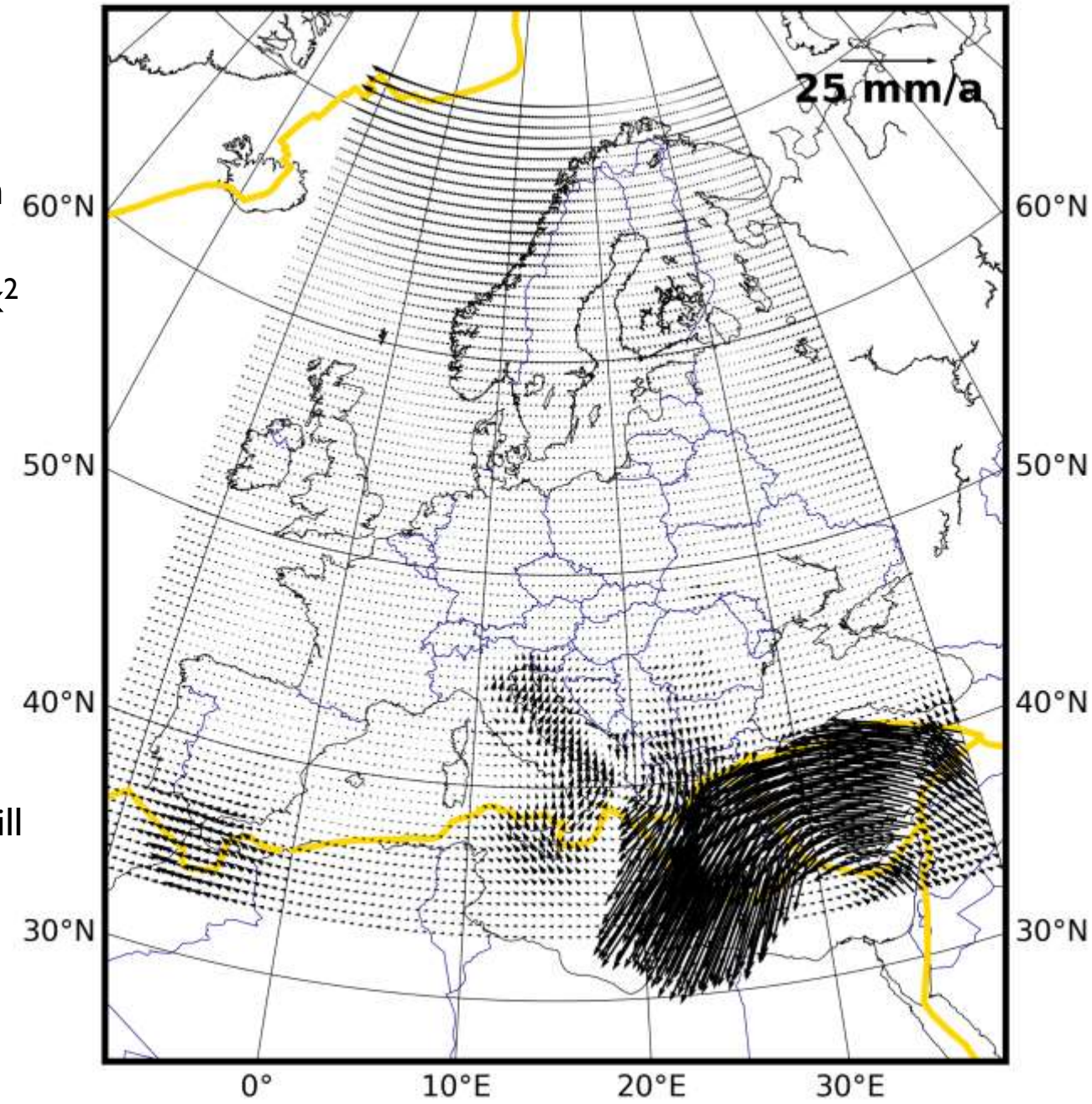
- Problem of non-stationarity exists in collocation method
  - → development of a new approach : HV-LSC-ex^2
    - → moving variance
    - → resulting model is smoother

- Next steps:
  - Verifying the applied correlation length via a test of several values and leave-one-out-cross-validations
  - External validation of the model via a Jackknife resampling
  - Method article is currently in preparation and will be submitted soon
  - EuVeM2021 (with and without moving-variance approach) will be released as ASCII and grid file soon



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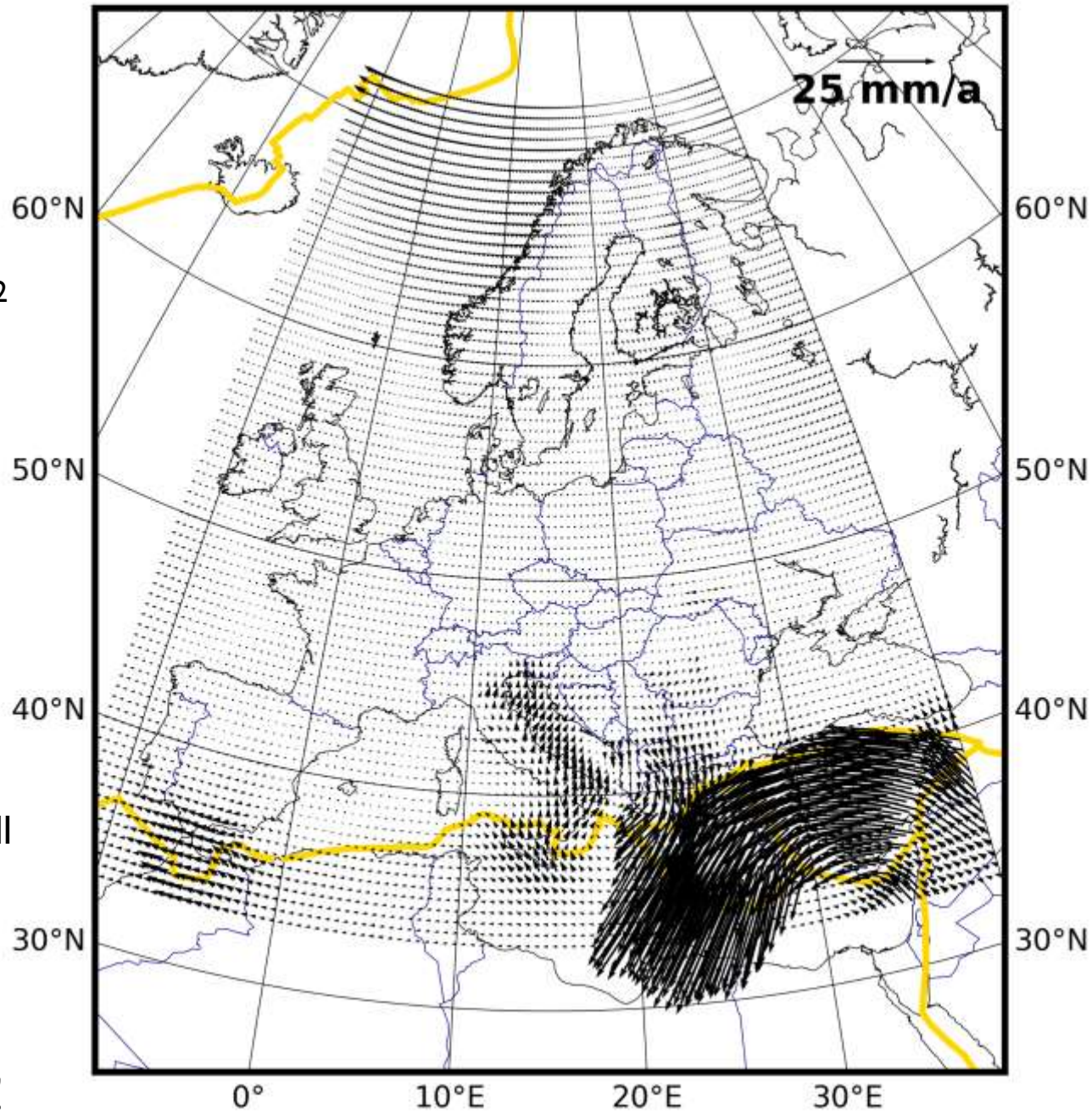

THANK YOU FOR YOUR ATTENTION!