submitted to *Geophys. J. Int.*

Supplement material (Part 1) for "EuVeM2022 - A European GNSS Velocity Model based on Least-Squares Collocation"

Rebekka Steffen[1⋆], Holger Steffen[1], Ambrus Kenyeres[2], Tobias Nilsson[1], Martin Lidberg[1]

[1] *Lantmäteriet, Gävle, Sweden*

[2] *LTK Satellite Geodetic Observatory, Hungary*

Content of the supplement (Part 1)

The supplementary material (Part 1) contains additional figures supporting the choice of the correlation length.

- Supplementary figure showing a map of Europe with names of the countries, named areas and tectonic plates
- Supplementary figures of the covariance analysis for various δ values
- Supplementary figures of the correlation analysis for various δ values

S1 SUPPLEMENTARY FIGURE WITH GEOGRAPHICAL NAMES

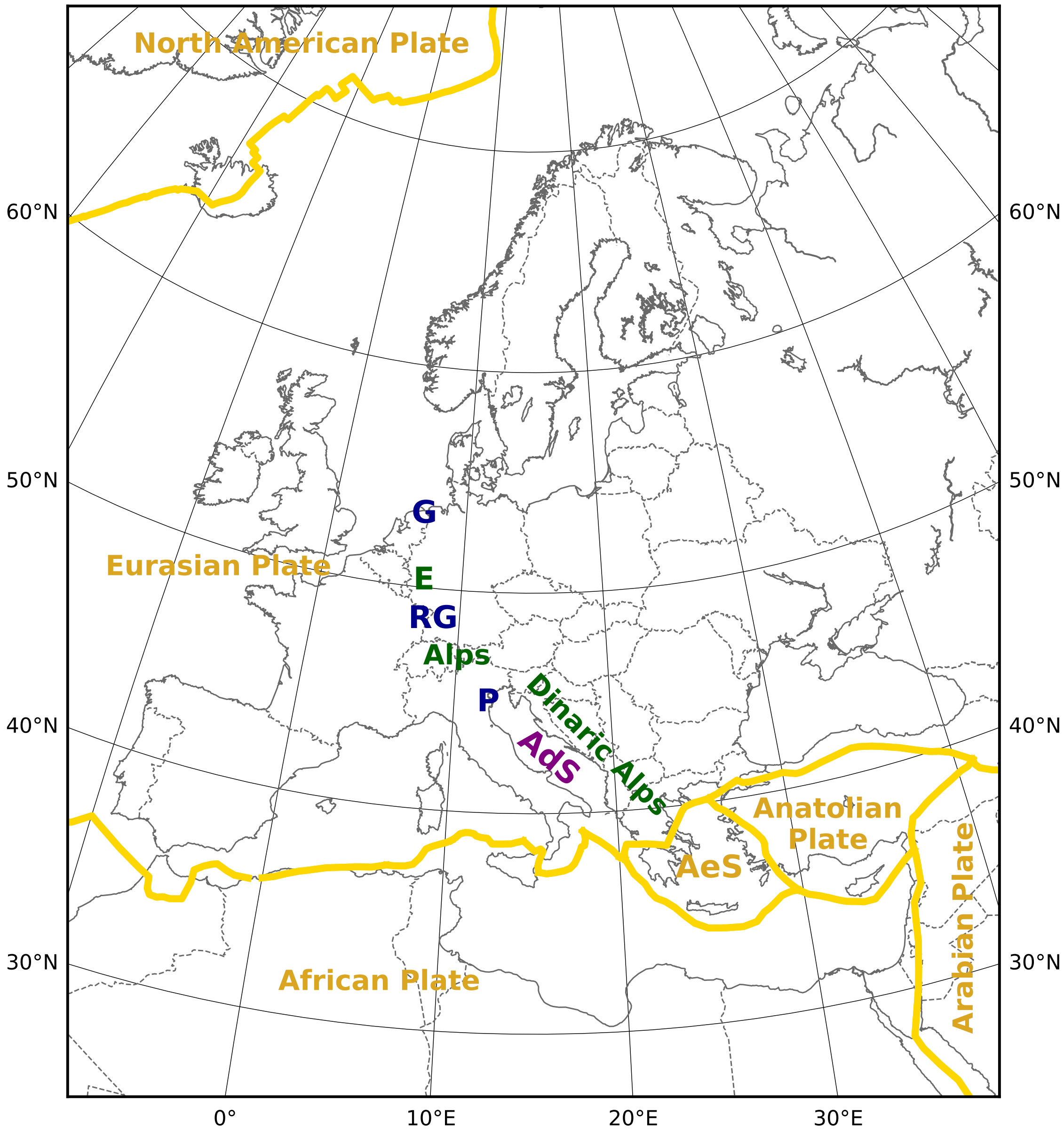

Figure S1. Geographical map of Europe with names of tectonic plates and areas specifically named in the text. Abbreviations are as follows: AdS - Adriatic Sea, AeS - Aegean Sea Plate, E - Eifel, G - Groningen, P - Po plain, RG - Upper Rhine Graben. Tectonic plate boundaries and names are after Bird (2003).

S2 SUPPLEMENTARY FIGURES OF THE COVARIANCE ANALYSIS FOR VARIOUS δ VALUES

This section shows the results of the covariance analysis using δ values between 0.25° and 4.0°. The correlation length is estimated by fitting a covariance function to the empirical covariances. Five covariance functions are used, which depend on the covariance C_0 and the correlation length d_0.
The following covariance functions are used:

- Function of the first-order Gauss-Markov process: $K(d) = C_0 \cdot e^{\frac{-d}{d_0}}$,
- Function of the second-order Gauss-Markov process: $K(d) = C_0 \cdot e^{\frac{-d^2}{d_0^2}}$,
- Hirvonen function: $K(d) = C_0 \frac{d_0^2}{d_0^2 + d^2}$,
- Function of the 1st order Markov model: $K(d) = C_0 \left(1 + \frac{d}{d_0}\right) e^{\frac{-d}{d_0}}$,
- Function of the 2nd order Markov model: $K(d) = C_0 \left(1 + \frac{d}{d_0} + \frac{d^2}{3\,d_0^2}\right) e^{\frac{-d}{d_0}}$.

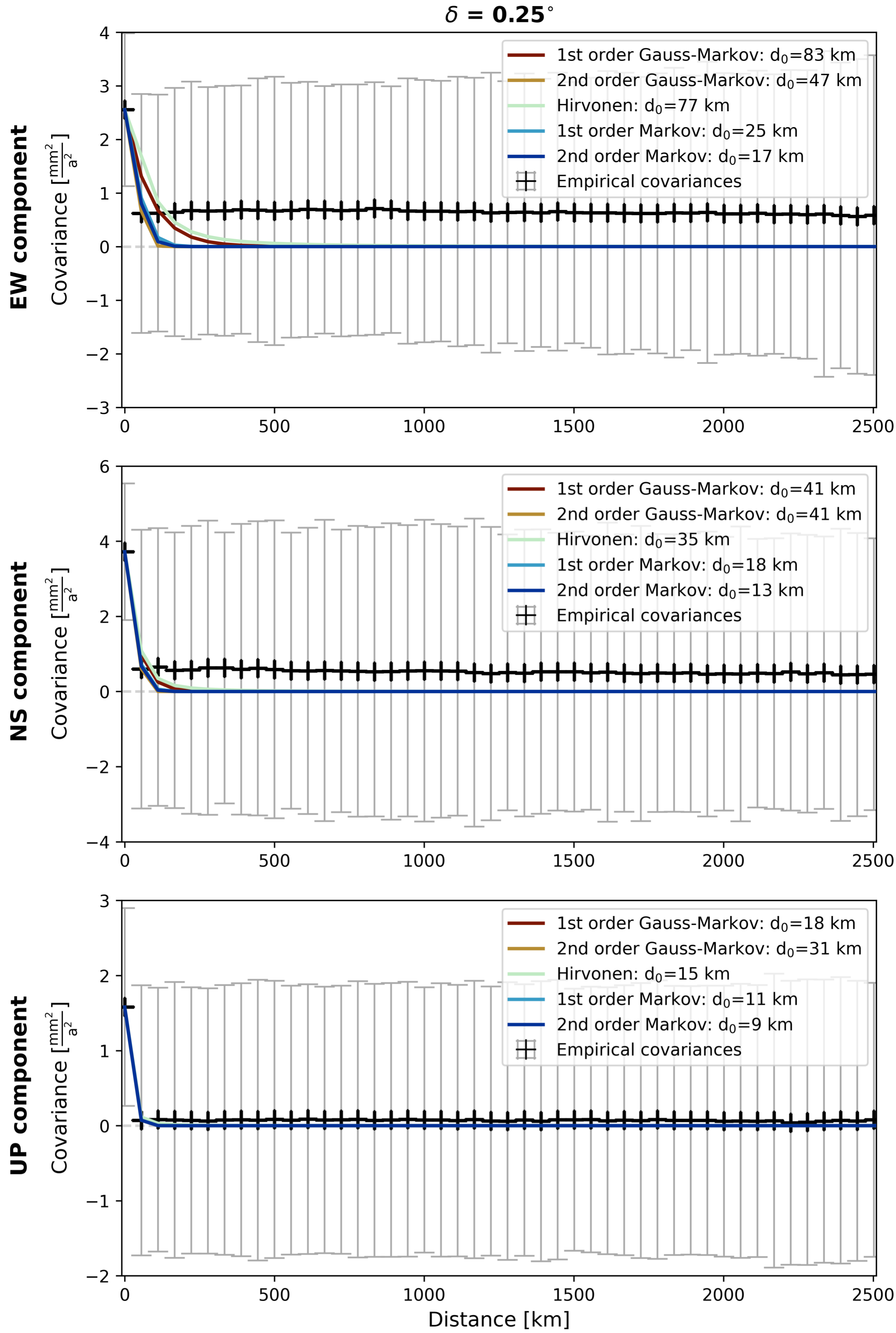

Figure S2. Results of the covariance analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 0.25°. The empirical covariances are shown as black crosses with their standard deviation in grey. The calculated curves for five different covariance functions are shown as solid, coloured lines, and the estimated correlation length is given together with the function in the legend. Most covariance functions provide similar curve progressions; thus, not all curves are clearly visible.

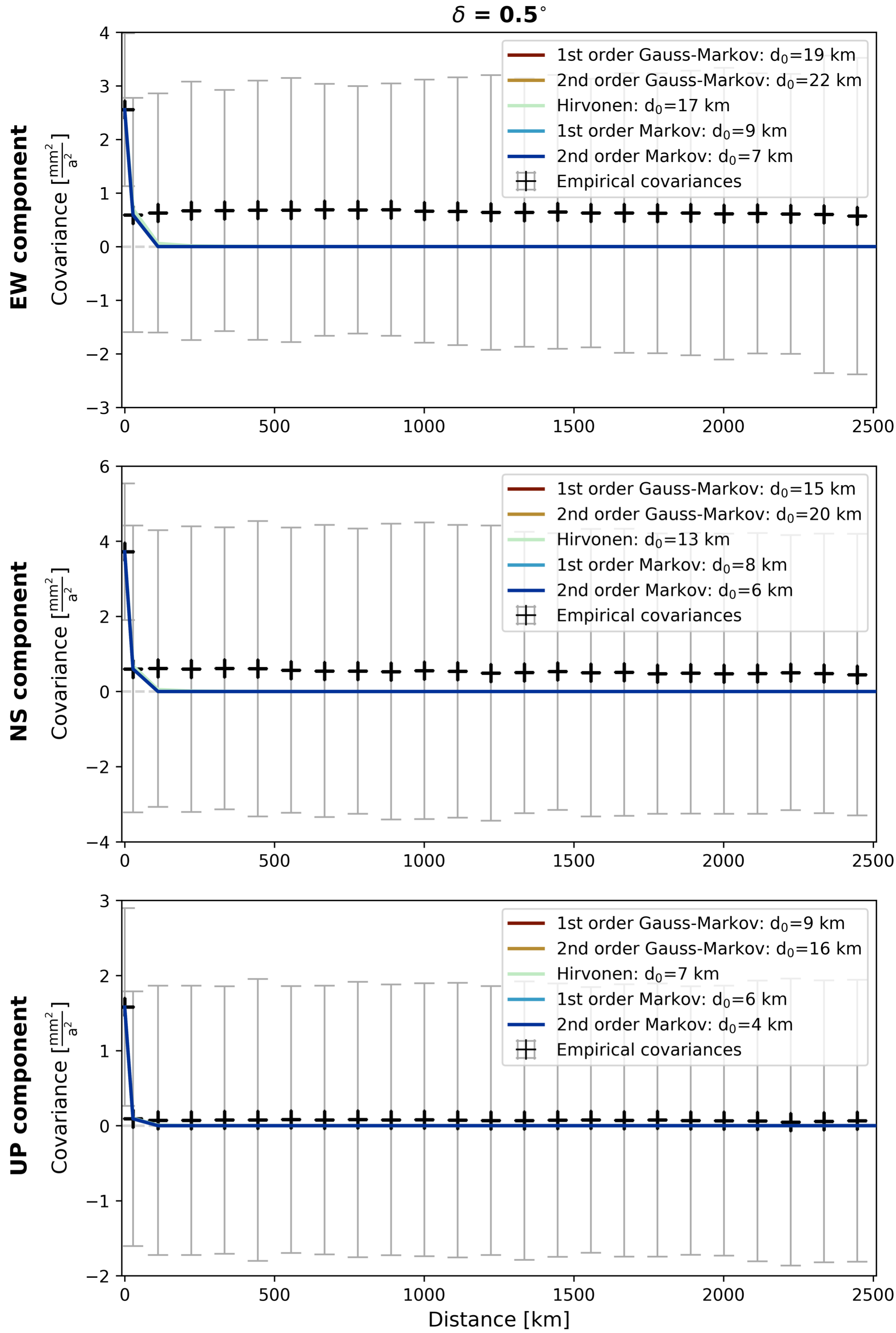

Figure S3. Results of the covariance analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of $0.5°$. Lines and symbols as in Fig. S1

.

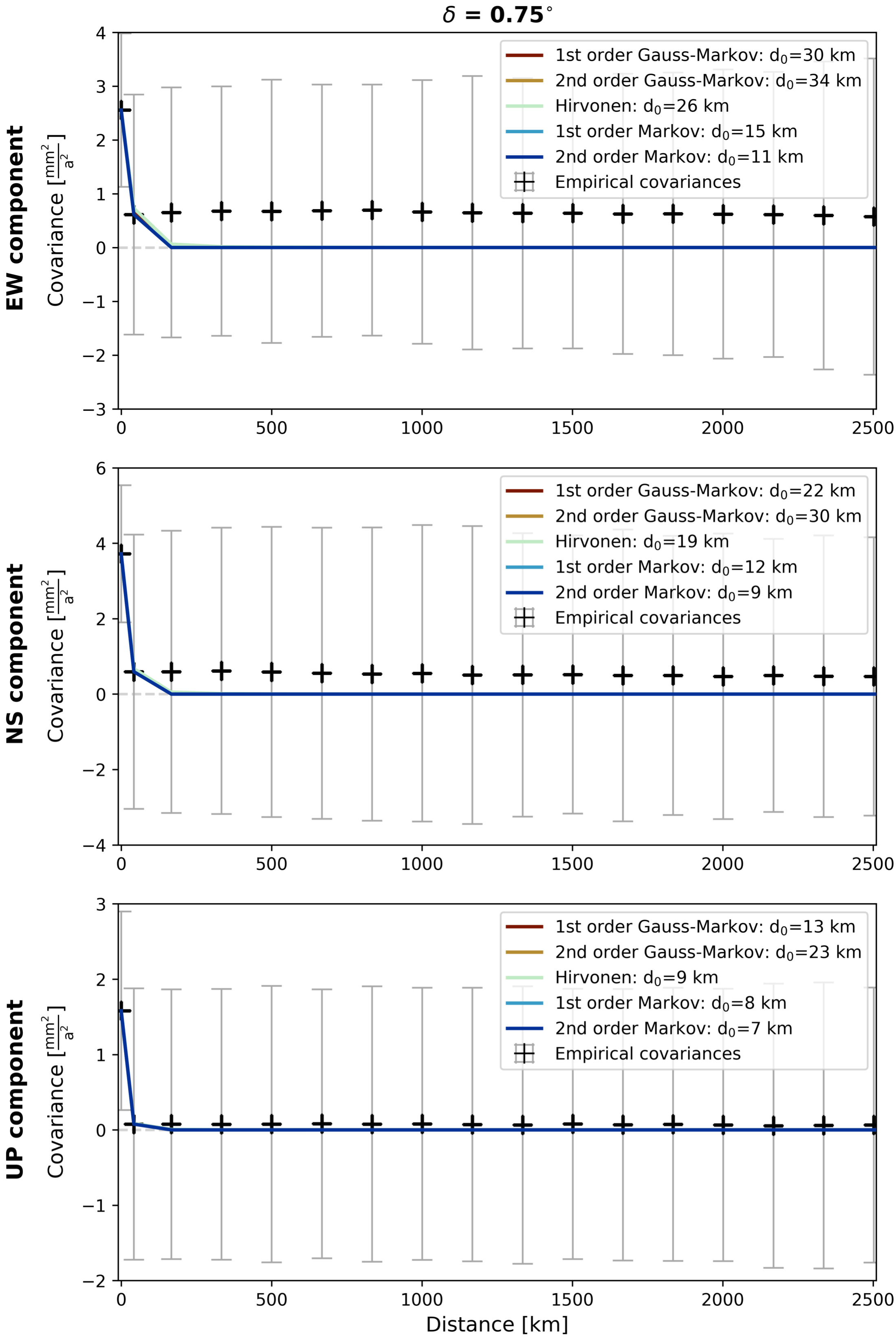

Figure S4. Results of the covariance analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 0.75°. Lines and symbols as in Fig. S1

.

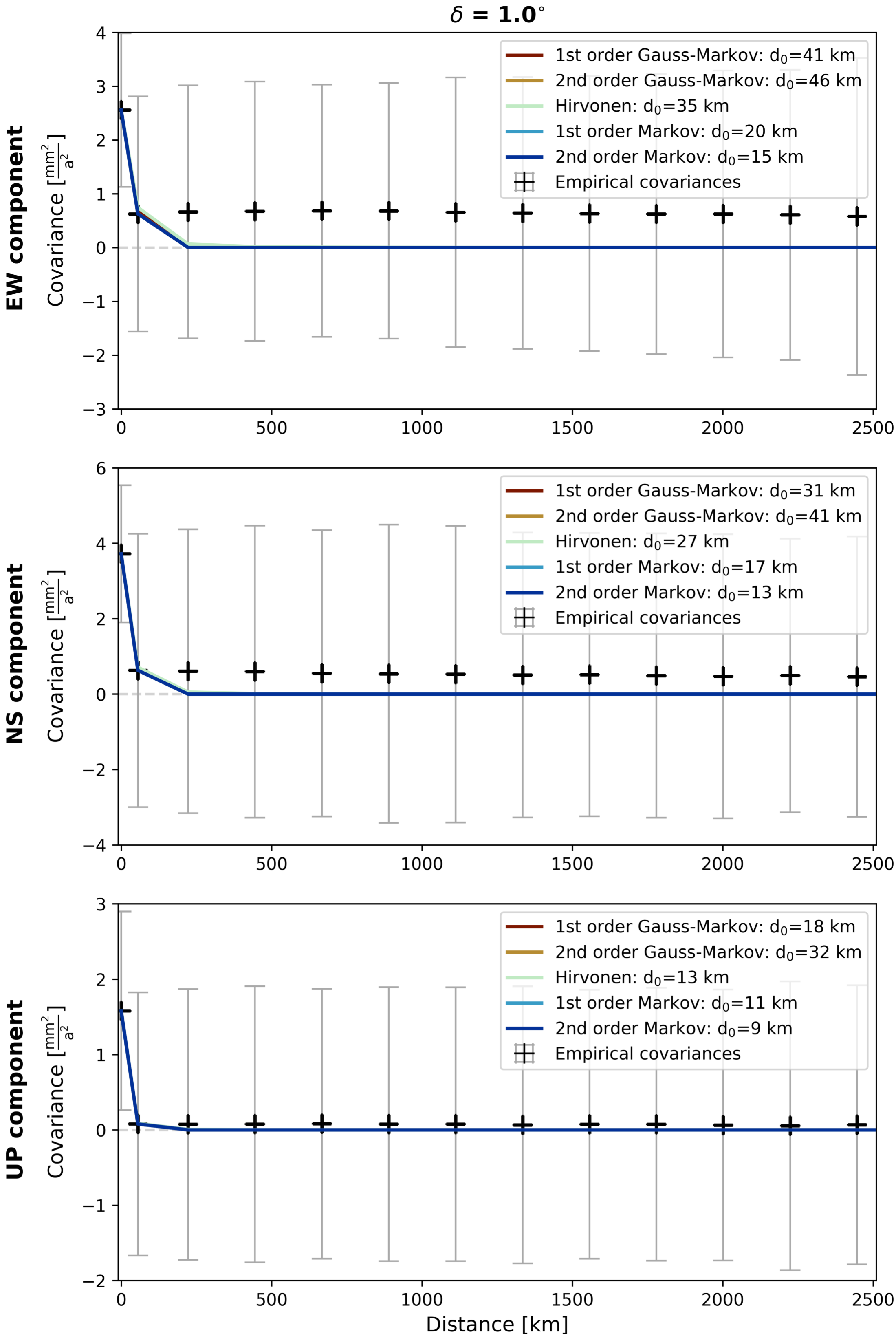

Figure S5. Results of the covariance analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 1.0°. Lines and symbols as in Fig. S1

.

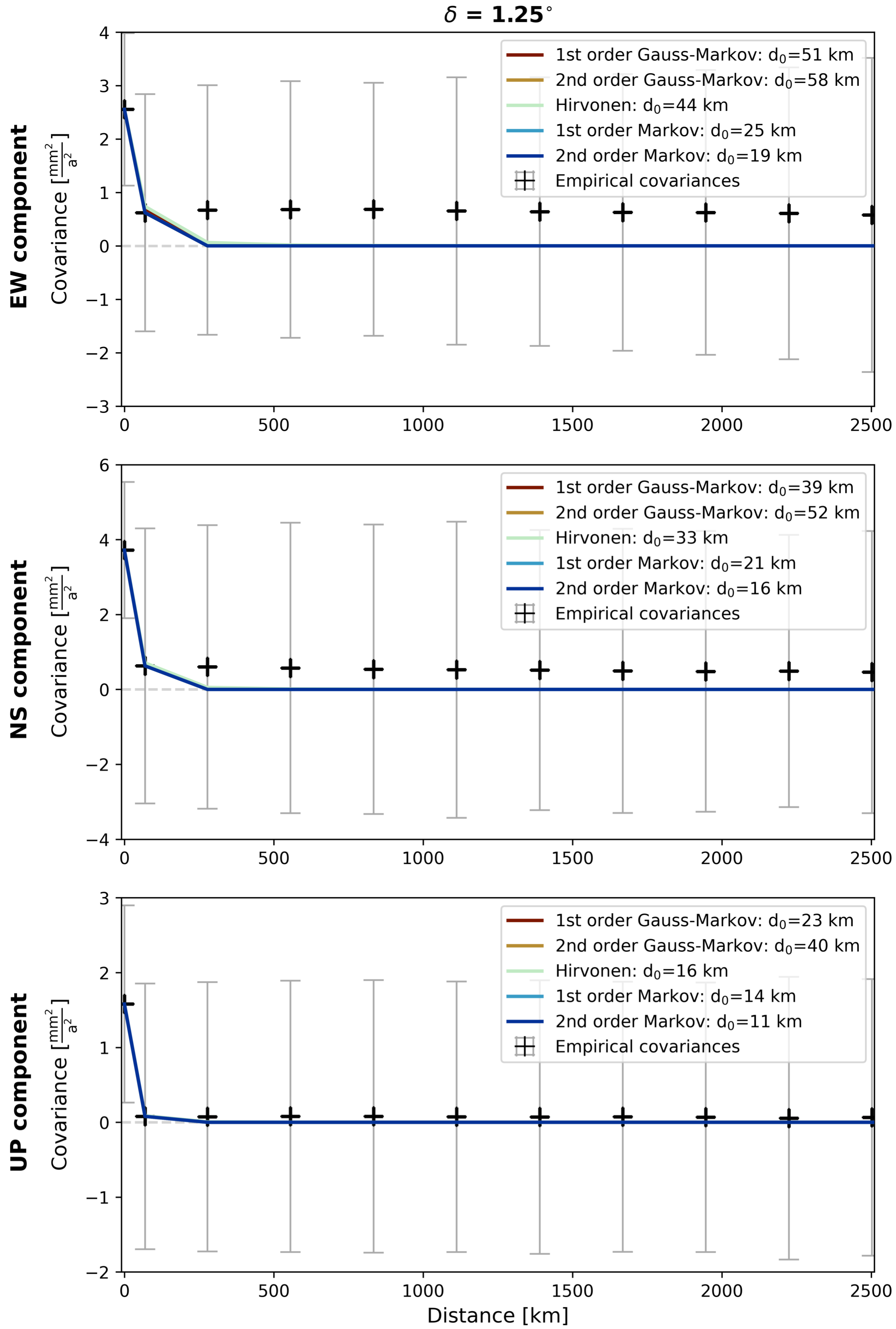

Figure S6. Results of the covariance analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 1.25°. Lines and symbols as in Fig. S1

.

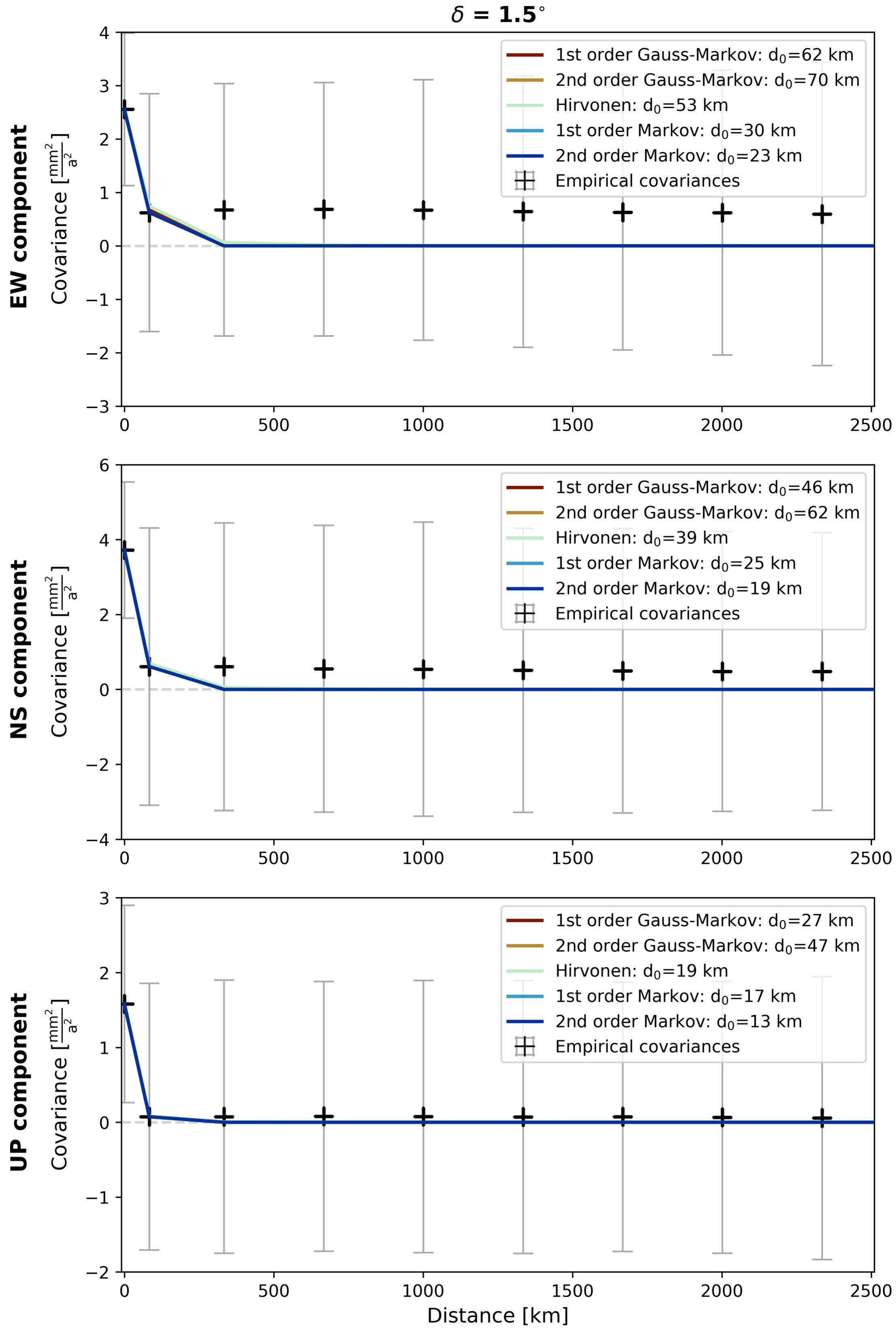

Figure S7. Results of the covariance analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 1.5°. Lines and symbols as in Fig. S1

.

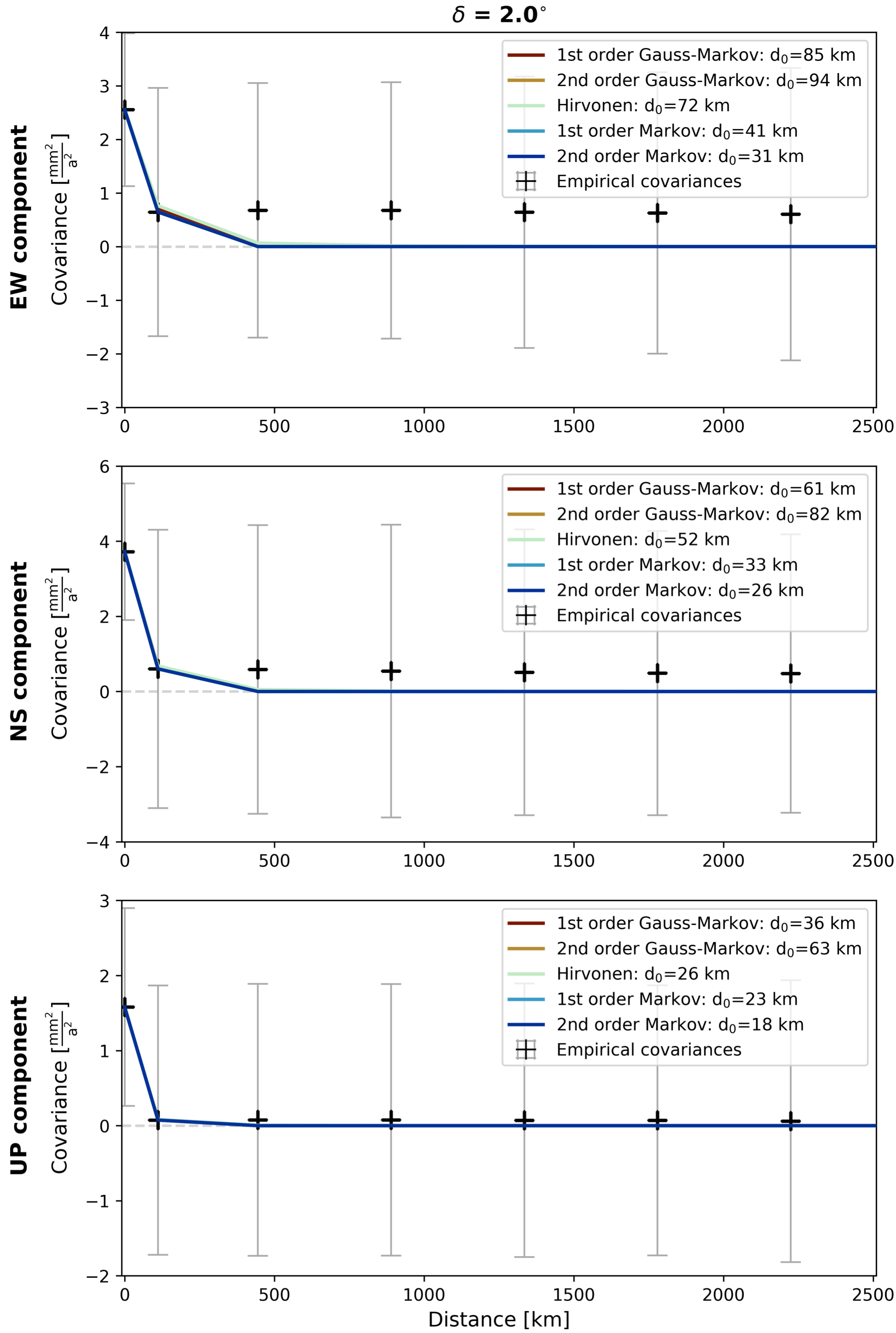

Figure S8. Results of the covariance analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 2.0°. Lines and symbols as in Fig. S1

.

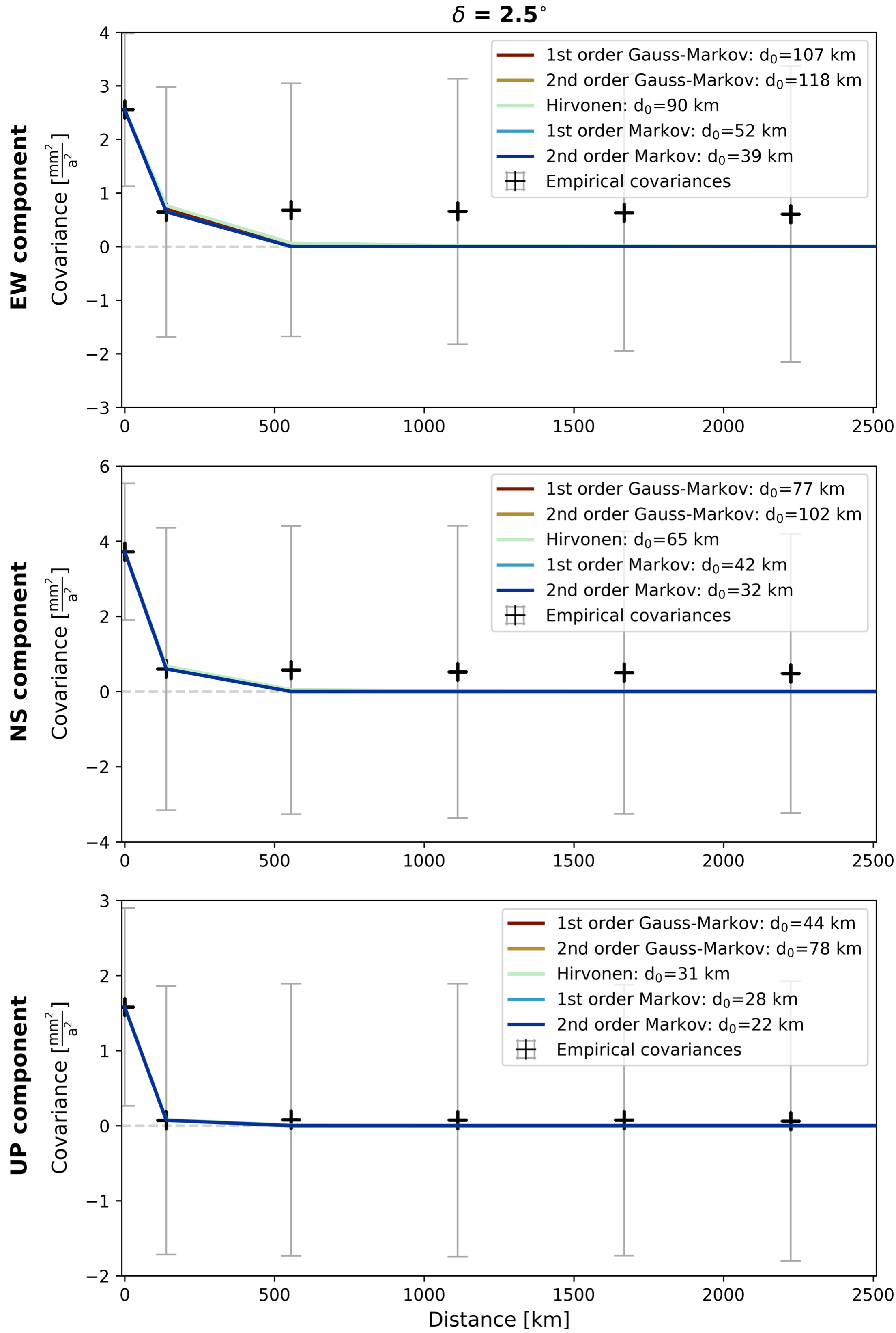

Figure S9. Results of the covariance analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 2.5°. Lines and symbols as in Fig. S1

.

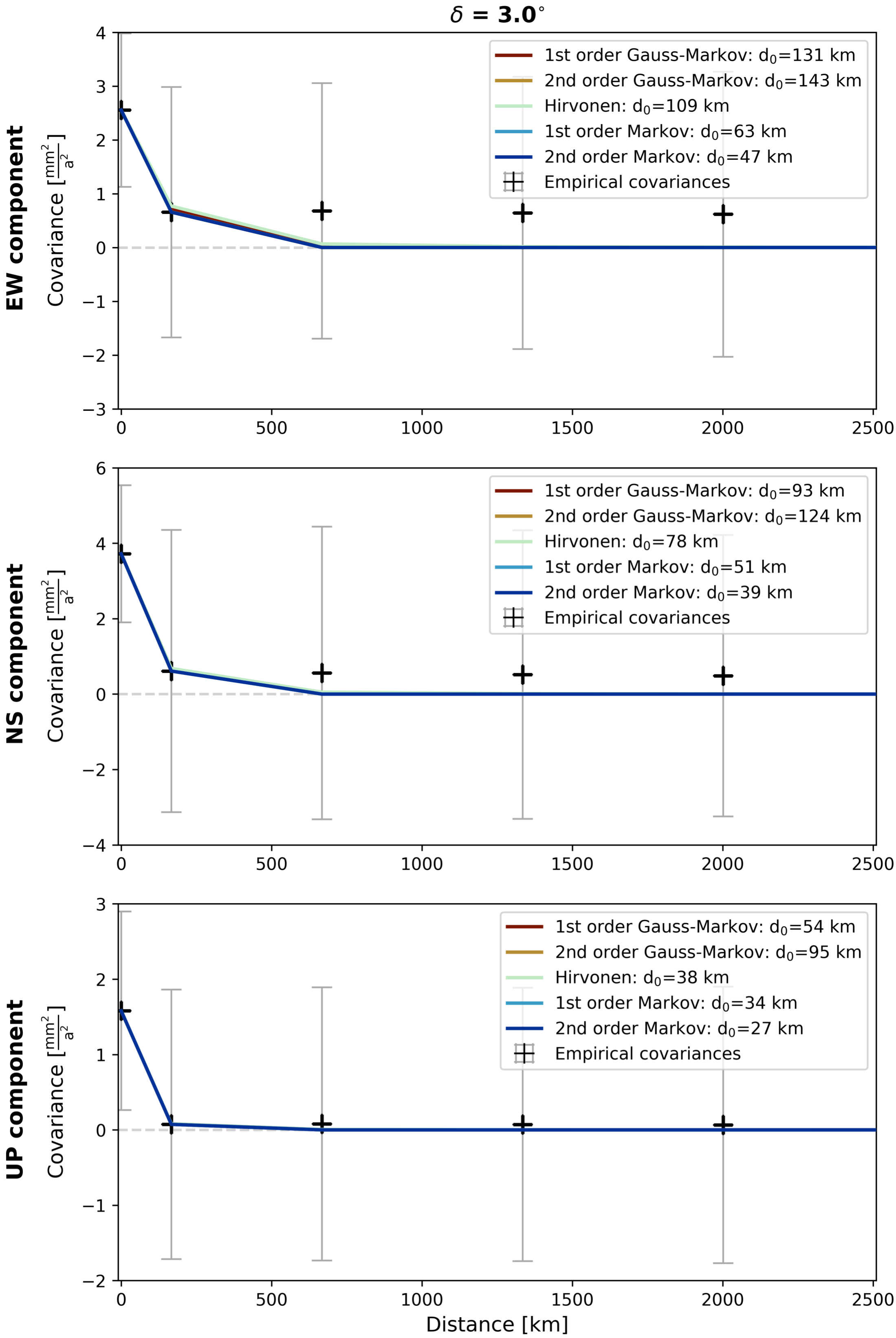

Figure S10. Results of the covariance analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 3.0°. Lines and symbols as in Fig. S1

.

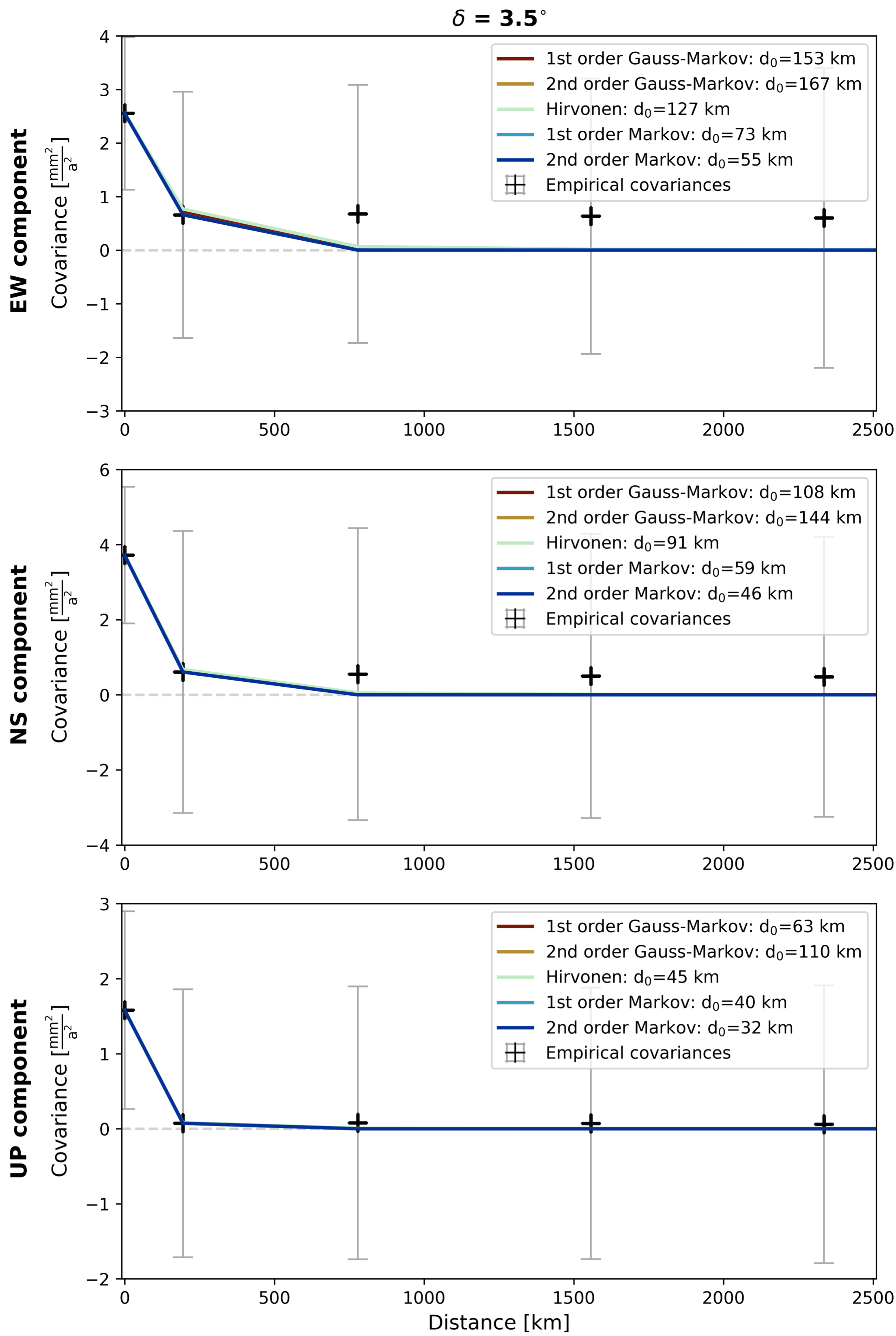

Figure S11. Results of the covariance analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 3.5°. Lines and symbols as in Fig. S1

.

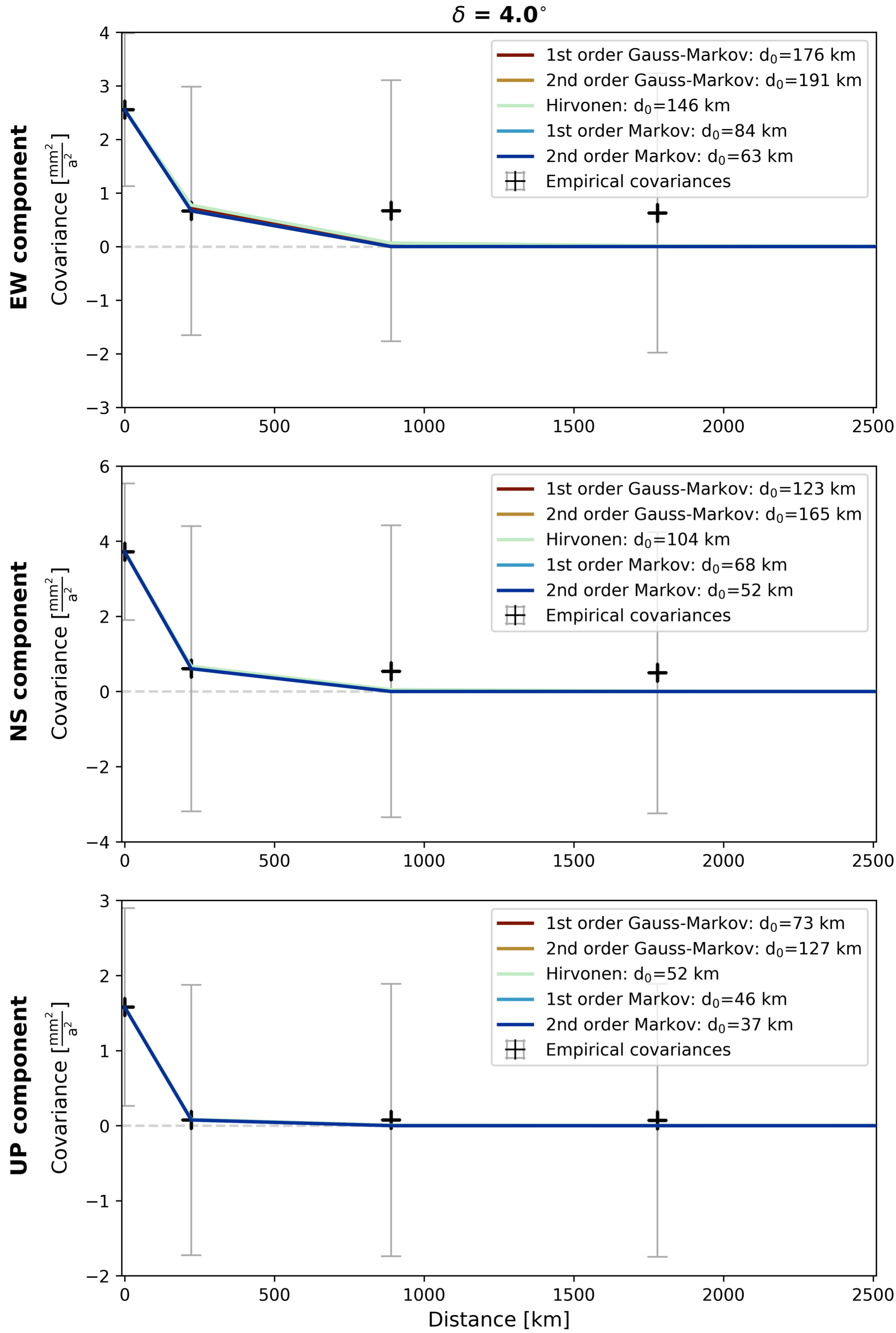

Figure S12. Results of the covariance analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 4.0°. Lines and symbols as in Fig. S1

.

S3 SUPPLEMENTARY FIGURES OF THE CORRELATION ANALYSIS FOR VARIOUS δ VALUES

This section shows the results of the correlation analysis using δ values between 0.25° and 4.0°. The correlation length is estimated by fitting a correlation function to the empirical correlations. Five correlation functions are used, which depend on the correlation ρ_0 and the correlation length d_0.
The following correlation functions are used:

- Function of the first-order Gauss-Markov process: $r(d) = \rho_0 \cdot e^{\frac{-d}{d_0}}$,
- Function of the second-order Gauss-Markov process: $r(d) = \rho_0 \cdot e^{\frac{-d^2}{d_0^2}}$,
- Hirvonen function: $r(d) = \rho_0 \frac{d_0^2}{d_0^2 + d^2}$,
- Function of the 1st order Markov model: $r(d) = \rho_0 \left(1 + \frac{d}{d_0}\right) e^{\frac{-d}{d_0}}$,
- Function of the 2nd order Markov model: $r(d) = \rho_0 \left(1 + \frac{d}{d_0} + \frac{d^2}{3\,d_0^2}\right) e^{\frac{-d}{d_0}}$.

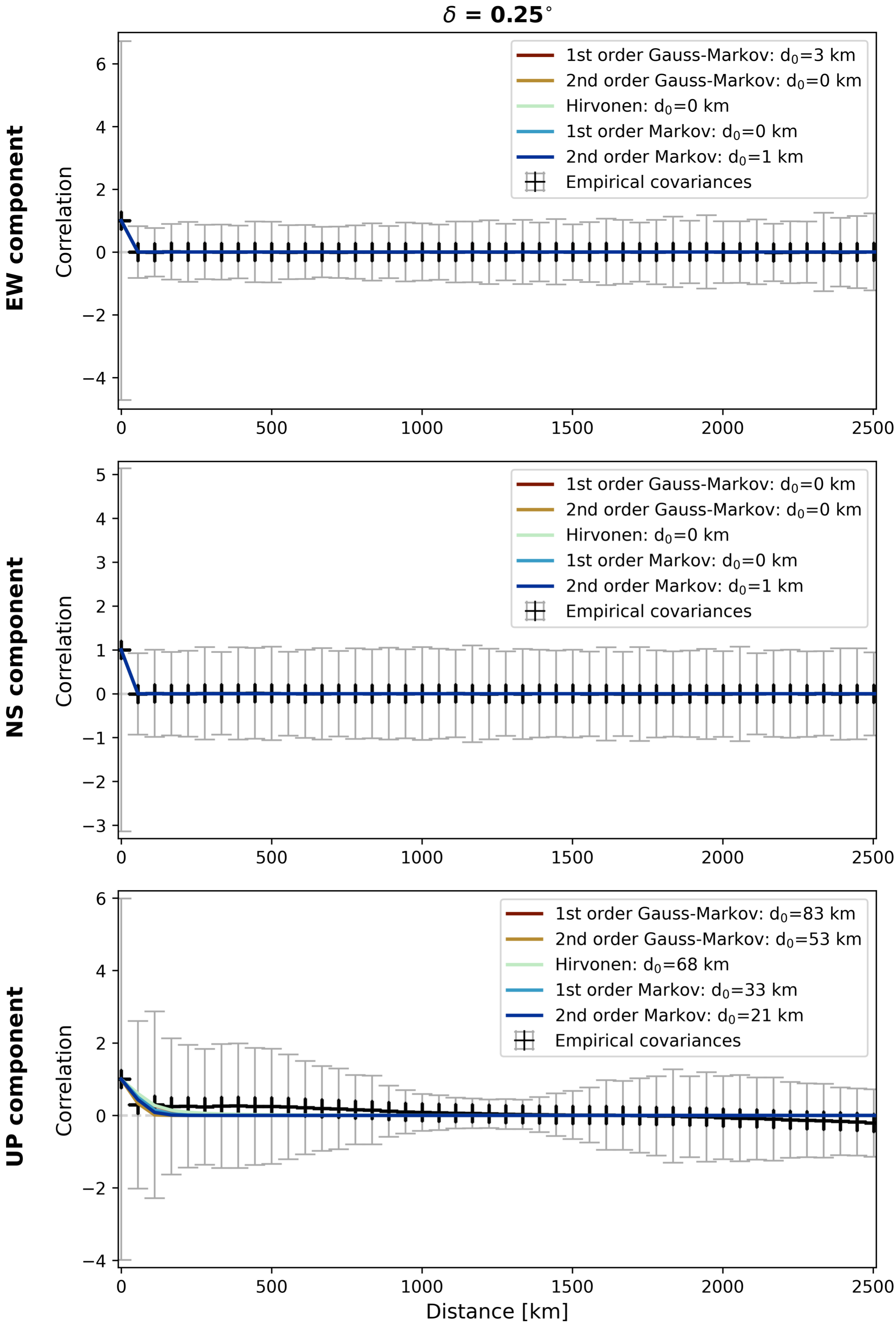

Figure S13. Results of the correlation analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 0.25°. The empirical correlations are shown as black crosses with their standard deviation in grey. The calculated curves for five different correlation functions are shown as solid, coloured lines, and the estimated correlation length is given together with the function in the legend. Most correlation functions provide similar curve progressions; thus, not all curves are clearly visible.

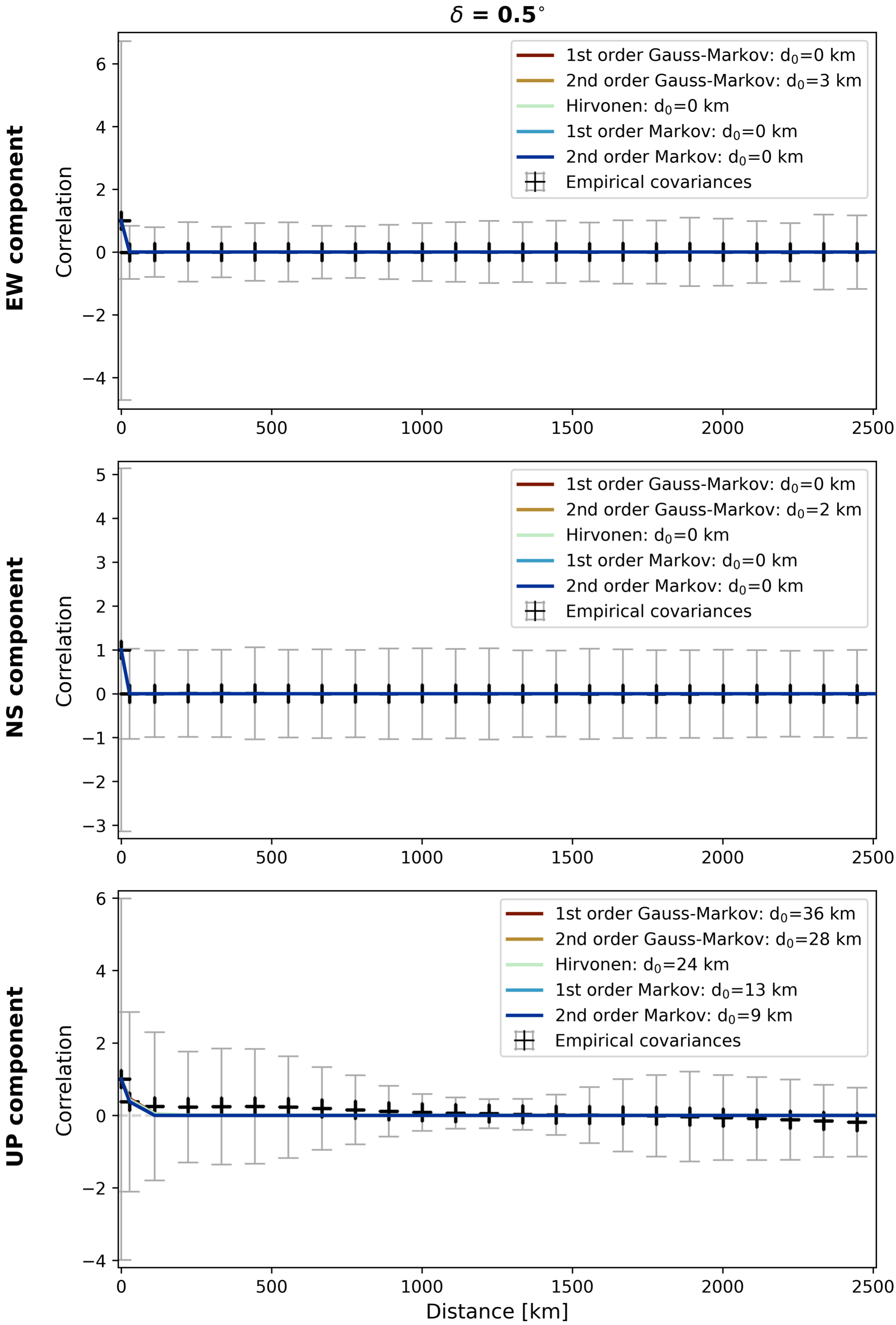

Figure S14. Results of the correlation analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 0.5°. Lines and symbols as in Fig. S12

.

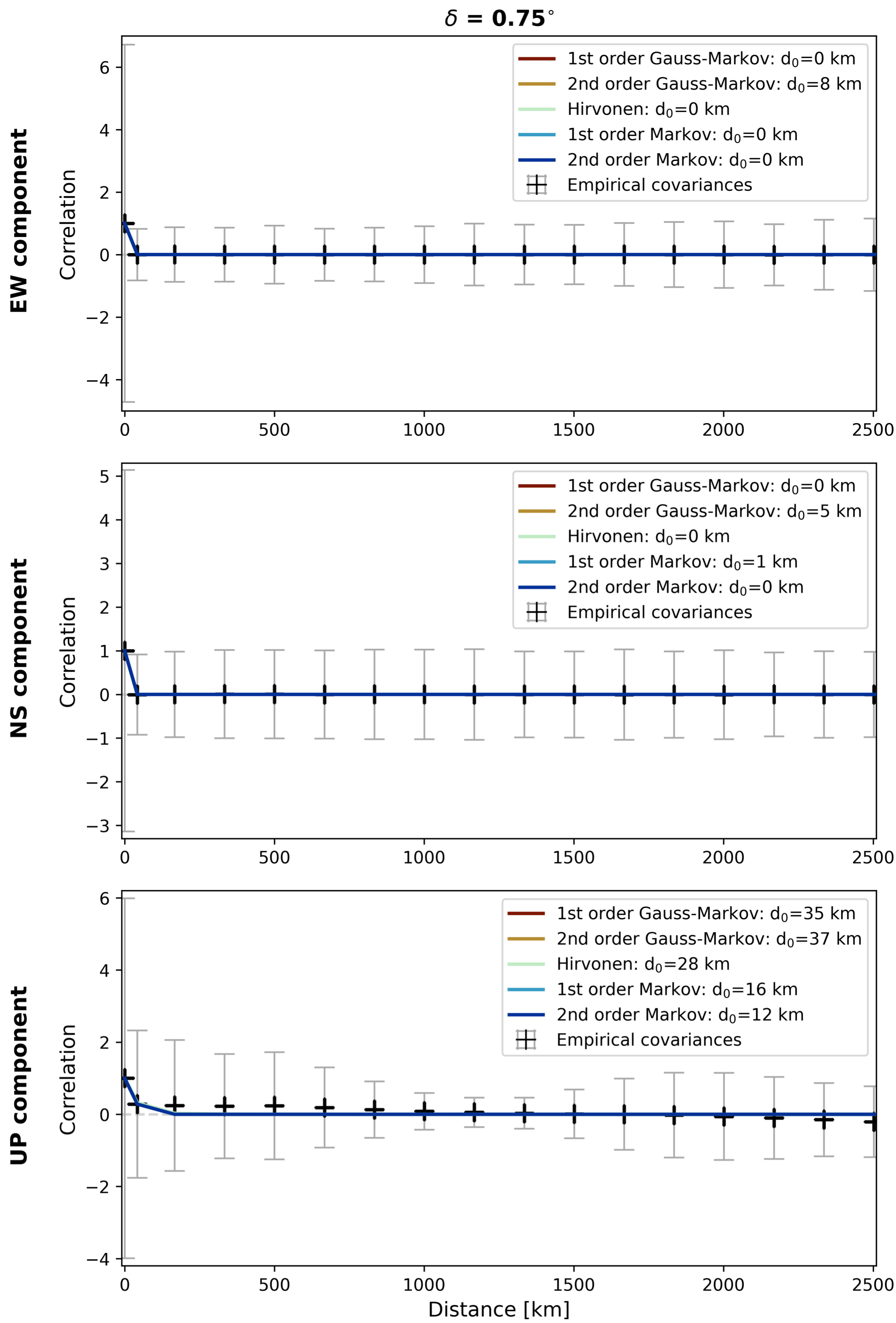

Figure S15. Results of the correlation analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 0.75°. Lines and symbols as in Fig. S12

.

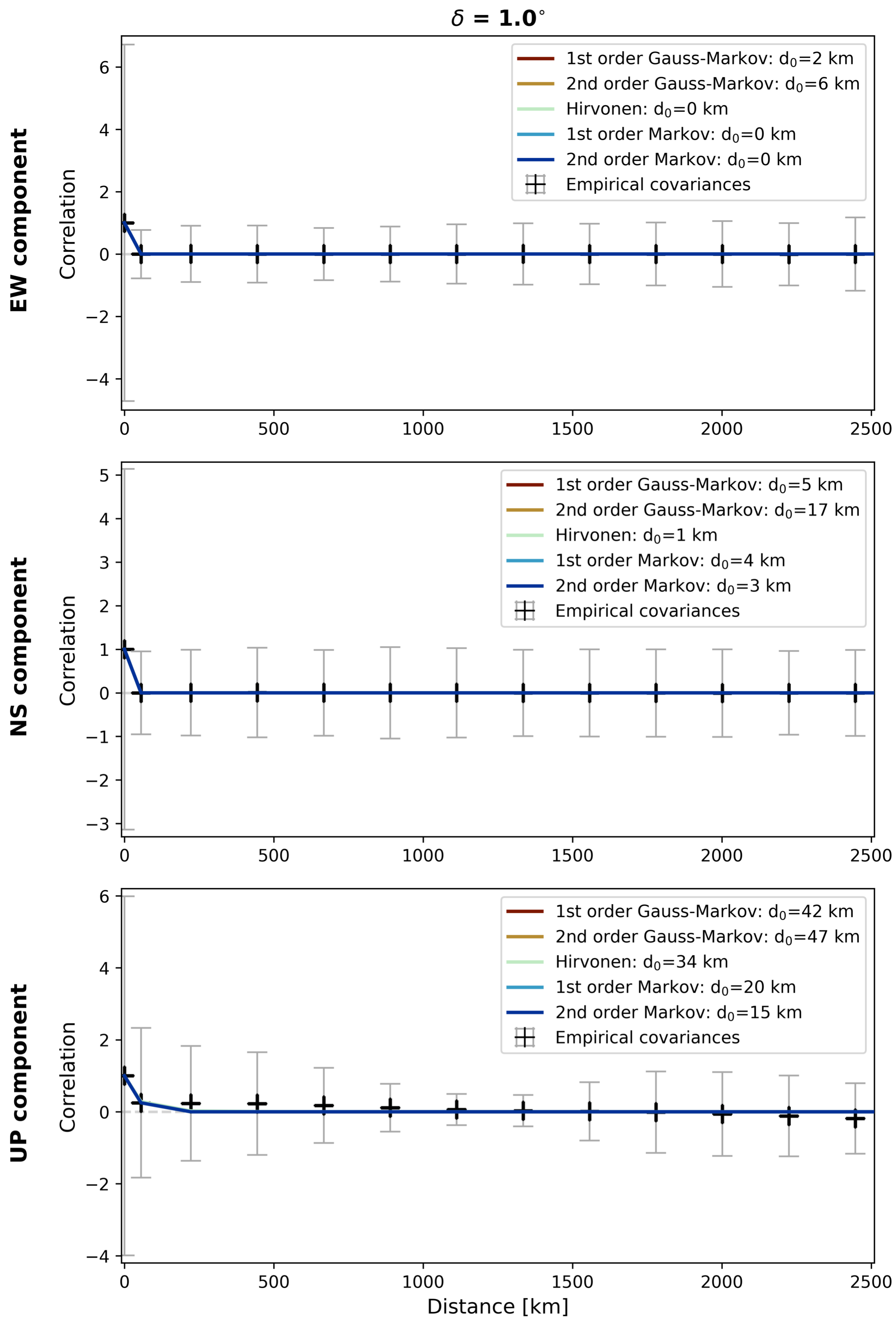

Figure S16. Results of the correlation analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 1.0°. Lines and symbols as in Fig. S12

.

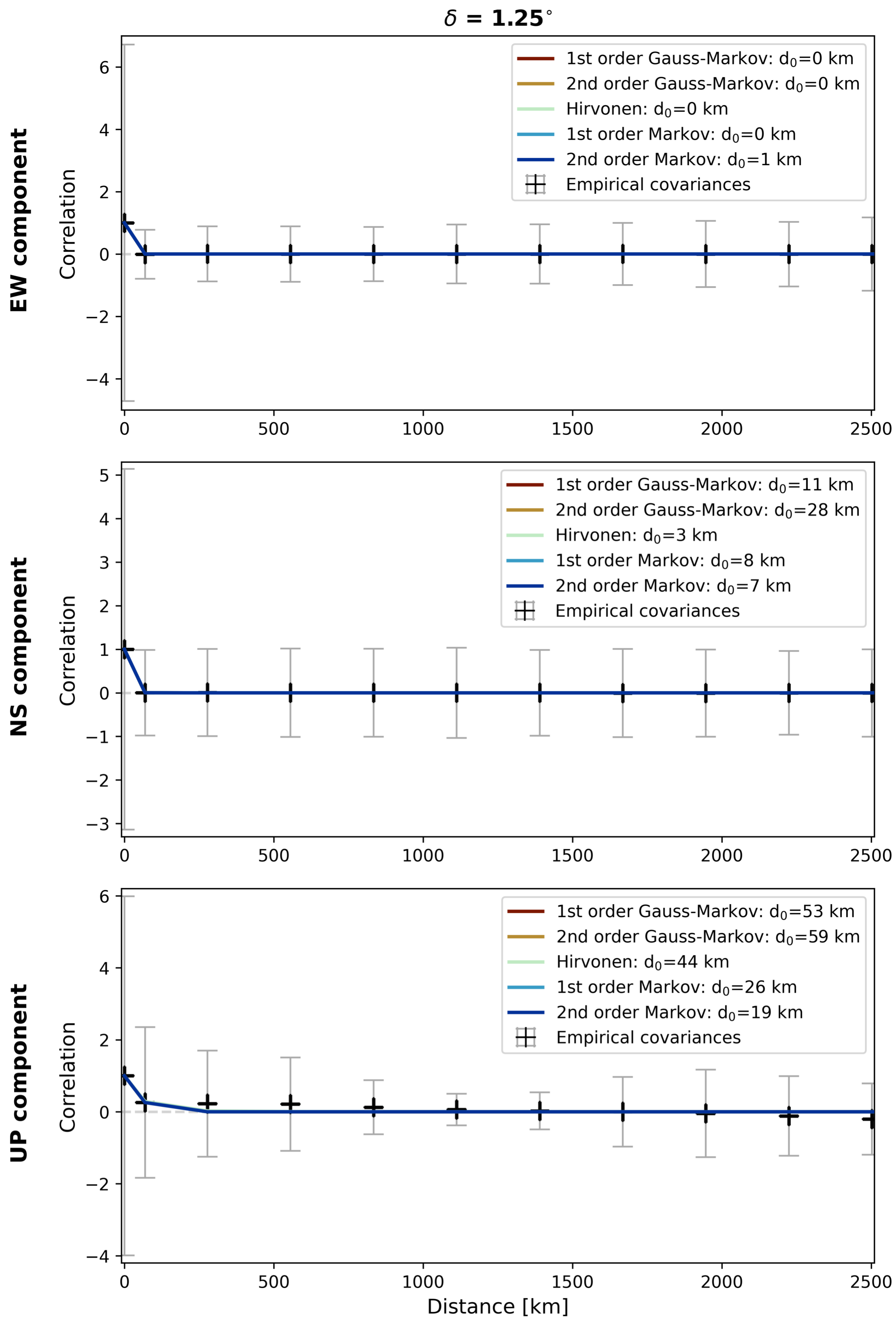

Figure S17. Results of the correlation analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 1.25°. Lines and symbols as in Fig. S12

.

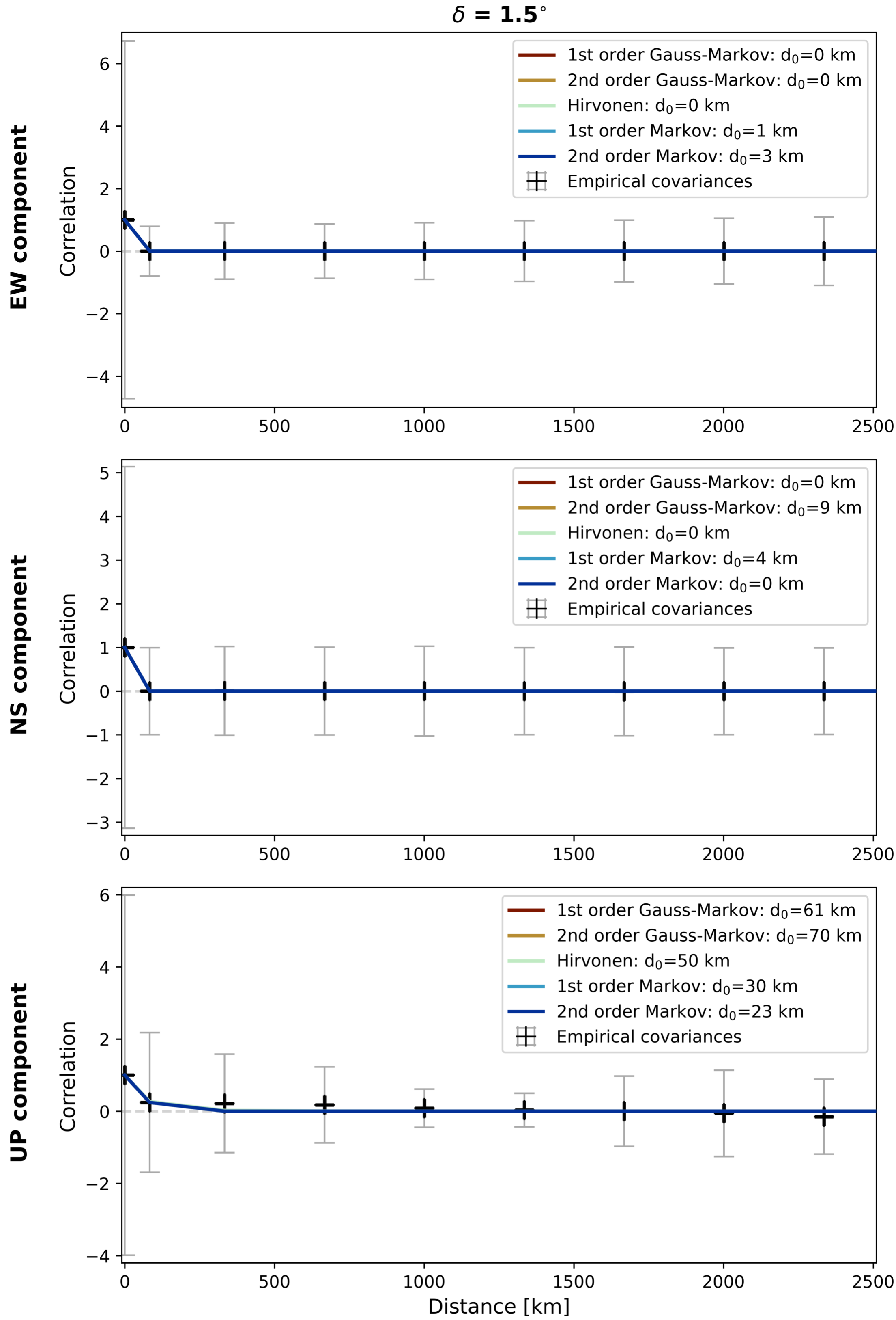

Figure S18. Results of the correlation analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 1.5°. Lines and symbols as in Fig. S12

.

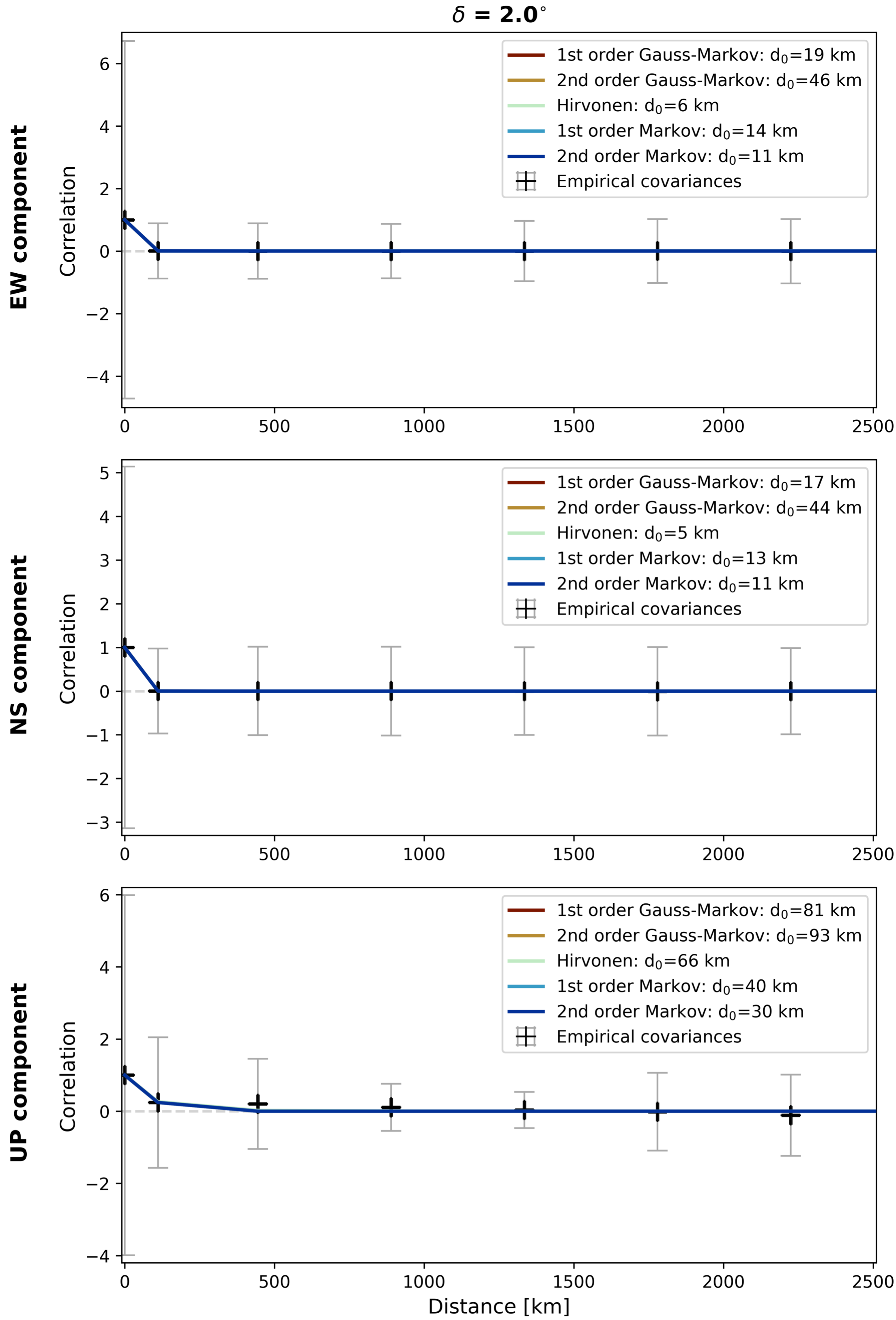

Figure S19. Results of the correlation analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 2.0°. Lines and symbols as in Fig. S12

.

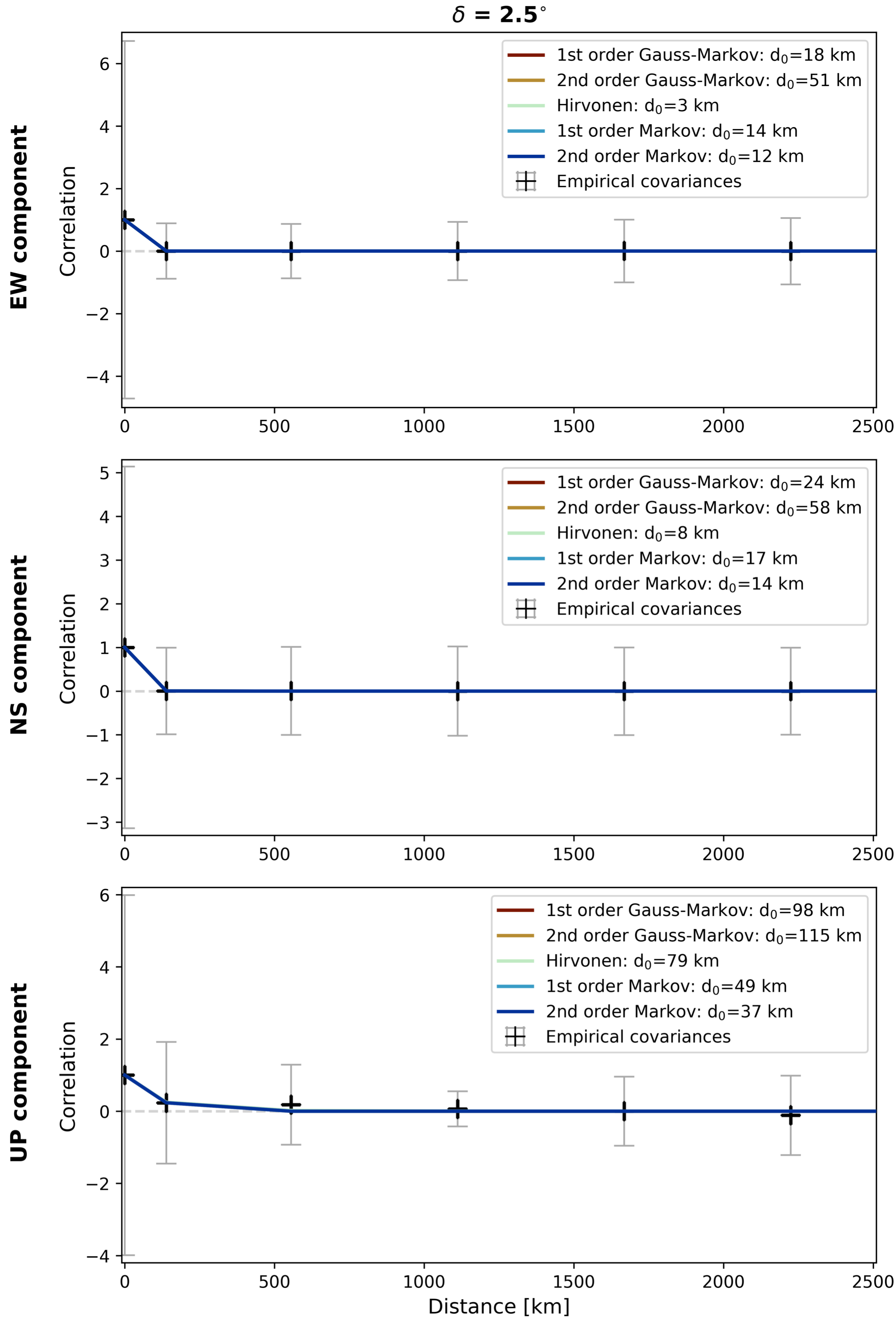

Figure S20. Results of the correlation analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 2.5°. Lines and symbols as in Fig. S12

.

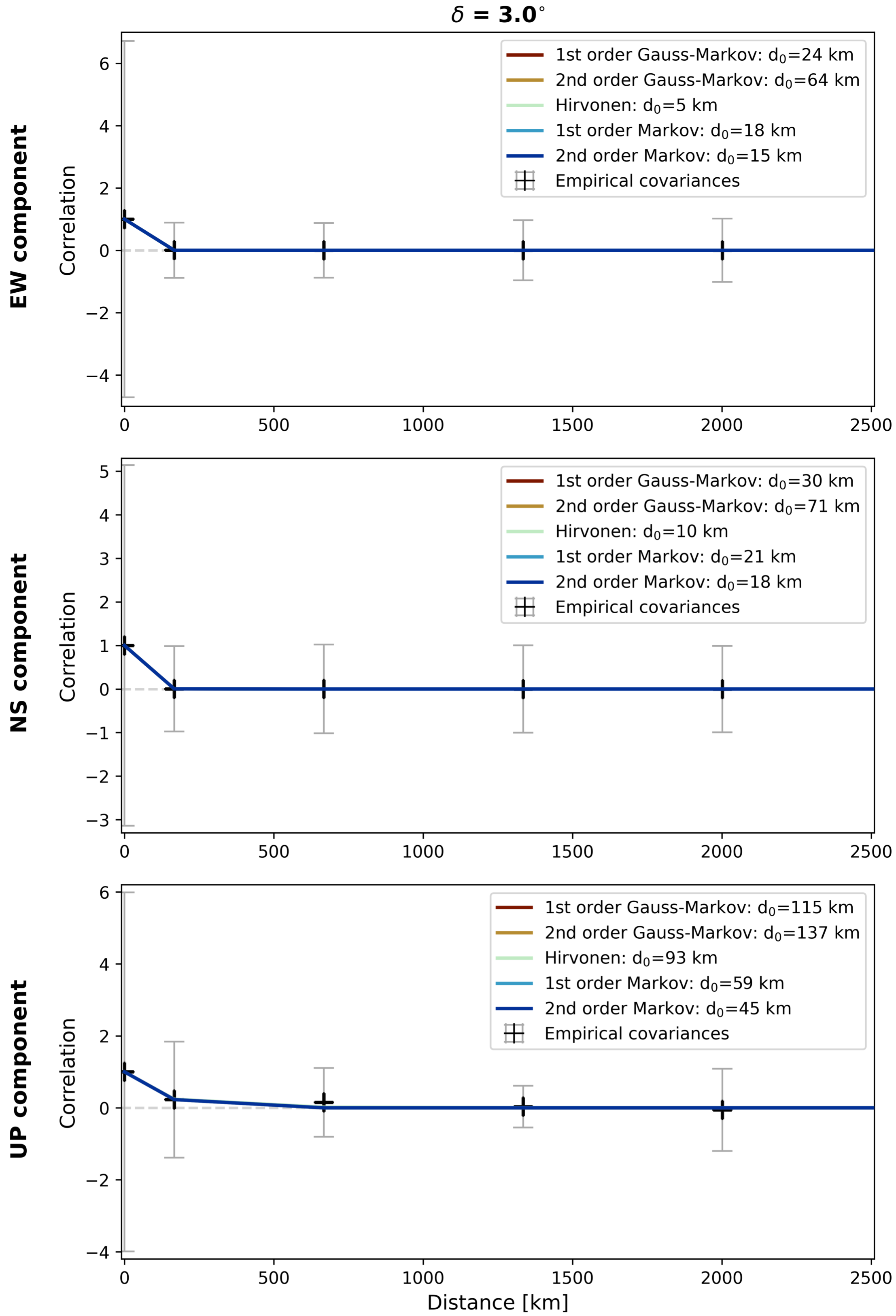

Figure S21. Results of the correlation analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 3.0°. Lines and symbols as in Fig. S12

.

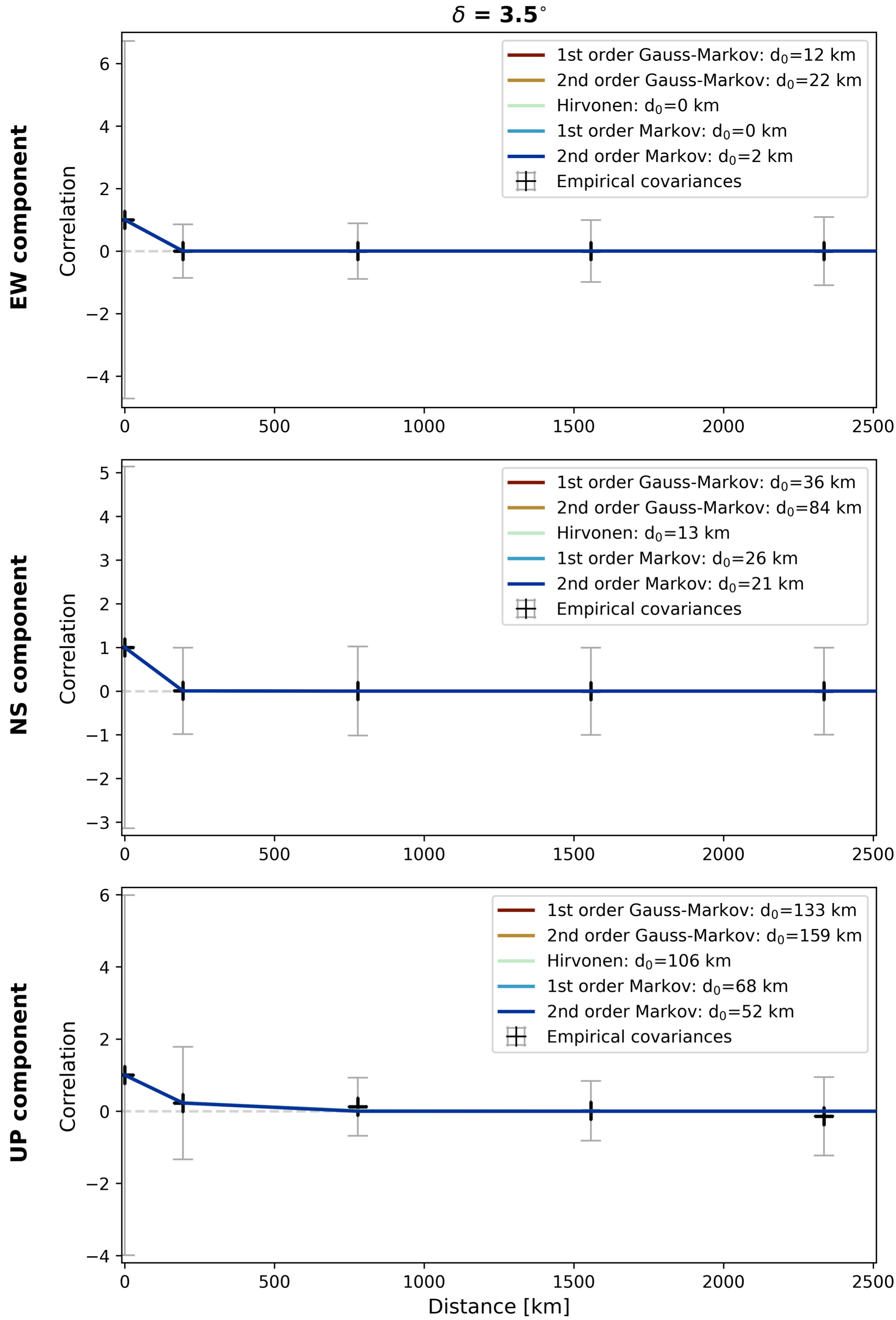

Figure S22. Results of the correlation analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 3.5°. Lines and symbols as in Fig. S12

.

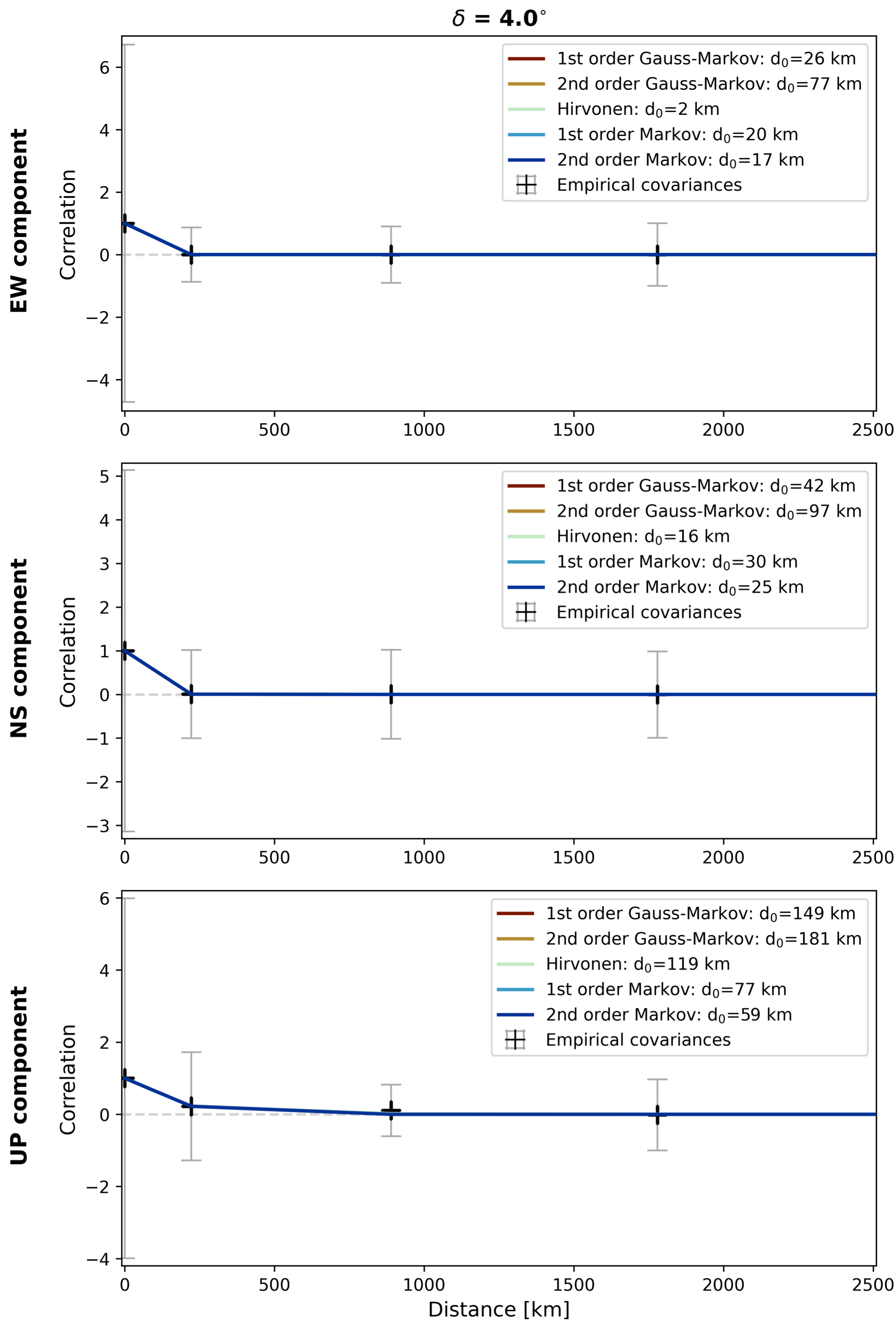

Figure S23. Results of the correlation analysis for all three velocity components (EW: east-west; NS: north-south; UP: vertical) for a δ of 4.0°. Lines and symbols as in Fig. S12

.