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Session G1.1 – EGU22-3605

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Impact of offsets on assessing the low-frequency stochastic properties of geodetic time series

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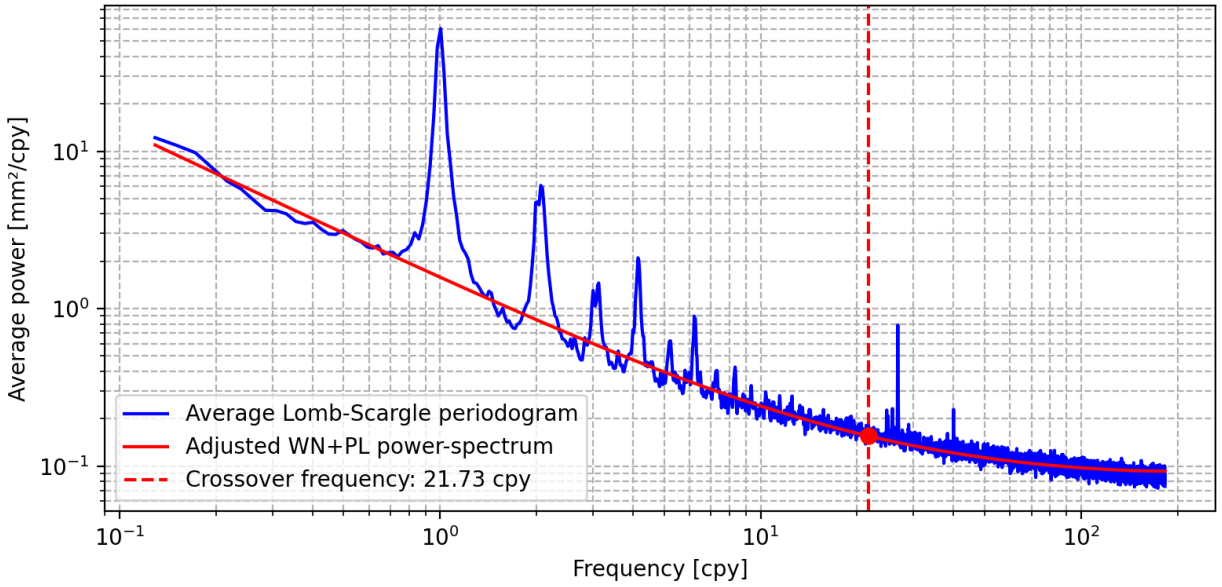
Stochastic model of GNSS position time series

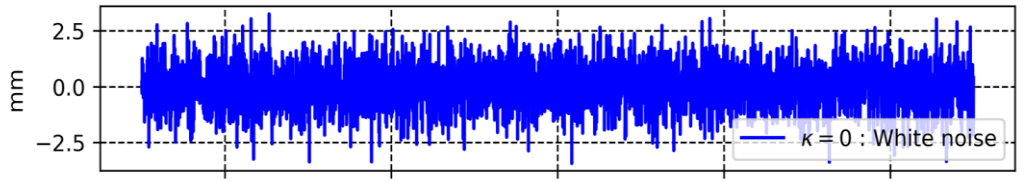
Average power spectrum of GNSS time series (corrected for trends and offsets)



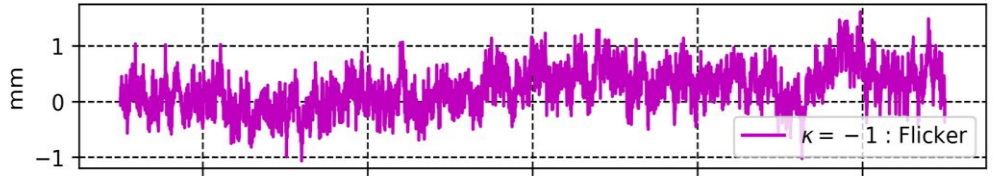
ULR repro3 – Gravelle, Gobron, Woppelmann et al., (2022) – In prep.

In general: **WN+FL model**

White noise (WN)



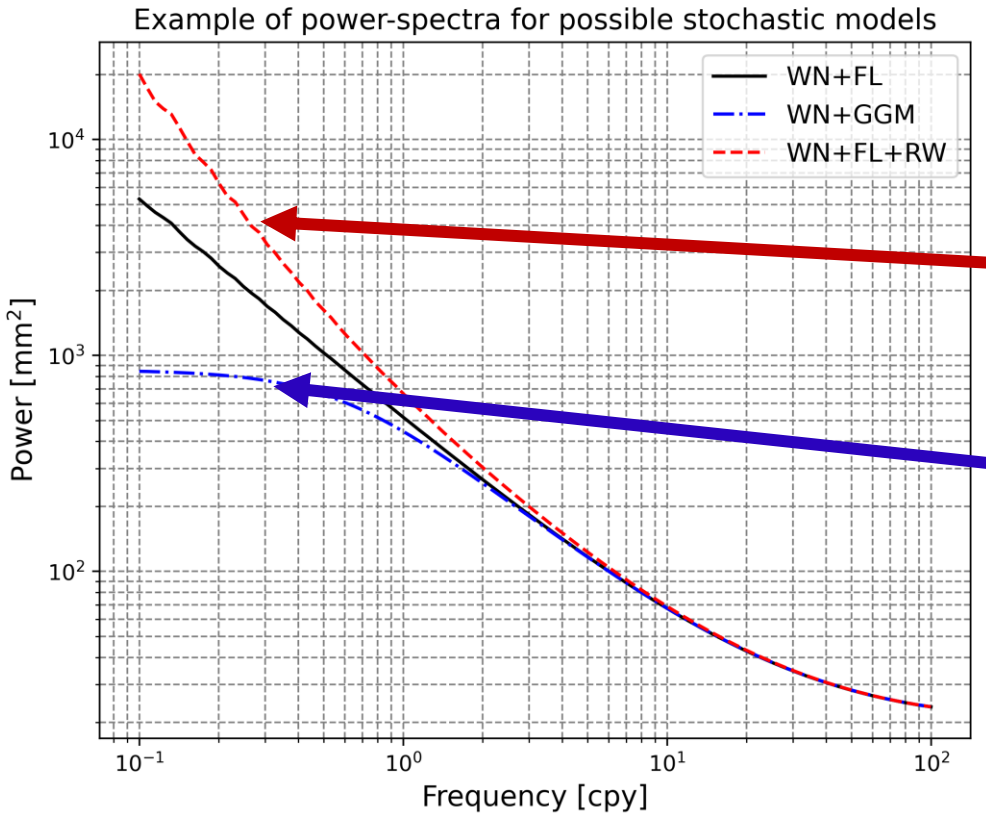
+ Flicker noise process (FL)



Estimated using a VCE method

Low-frequency scenarios

Two main alternatives proposed in the literature



WN+FL: Usual scenario

WN+FL+RW : Low frequency increase
(Not discussed here)

WN+GGM : Low frequency flattening
(Discussed here)

Mis-identification of stochastic model may undermine the estimation of the precision of parameters of interest, e.g., station velocities.

Motivations

Traditional MLE method is biased toward WN+GGM models in the presence of offsets.

JGR Solid Earth

RESEARCH ARTICLE
10.1029/2020JB019541

Chameleonic Noise in GPS Position Time Series

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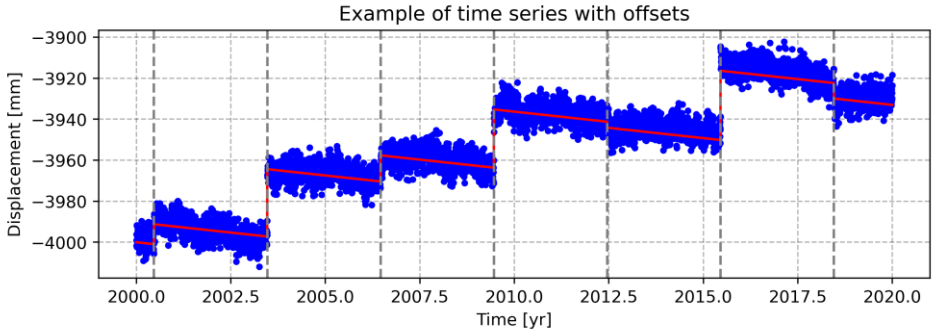
Key Points:

- Position offsets attenuate most of the power spectrum at long periods and severely impact velocity estimates

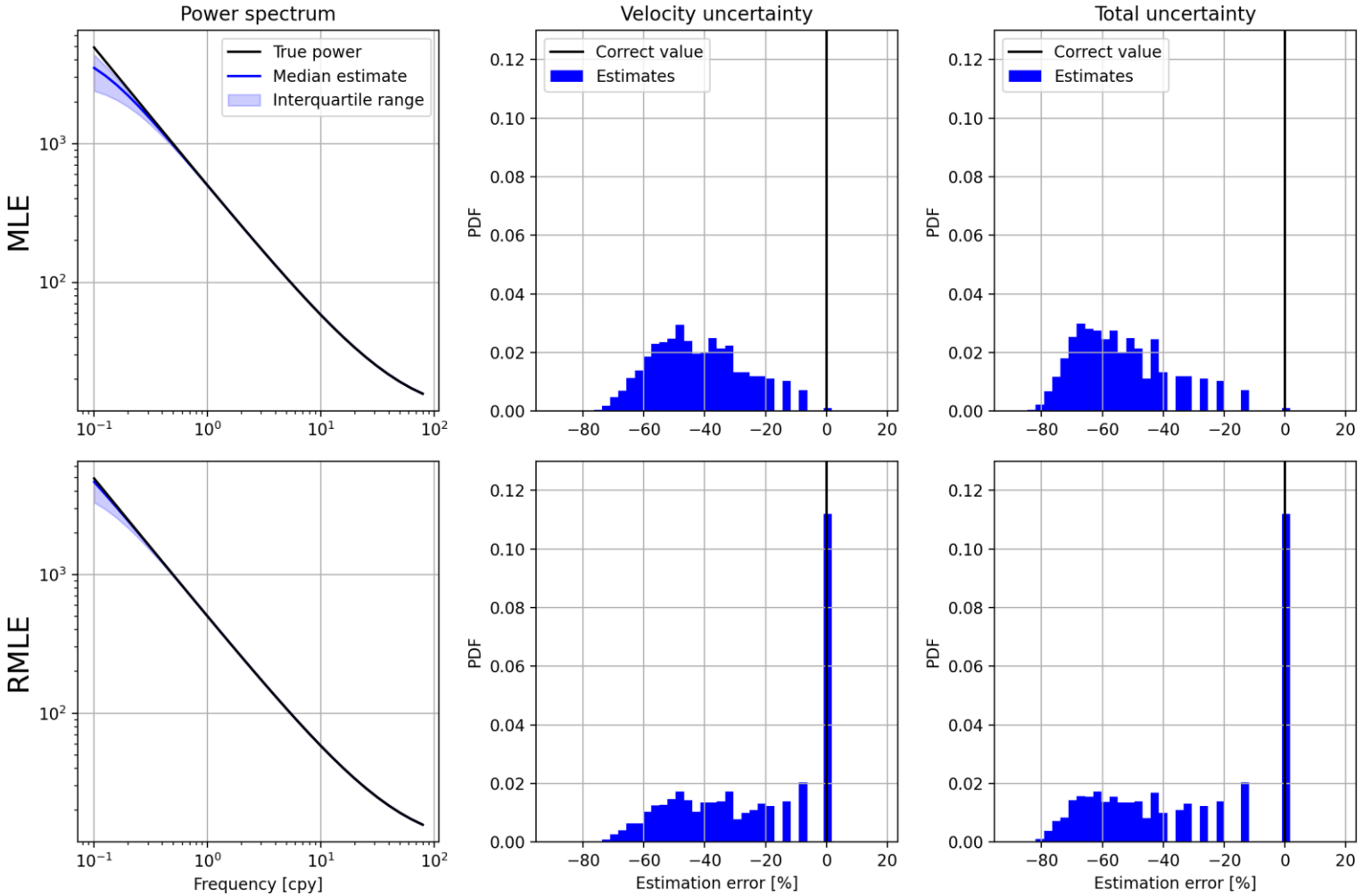


What about the RMLE method?

- **RMLE** is known to be **better than MLE for VCE** since **1971** (Patterson and Thompson, 1971).
- **RMLE** simply adds an **additional corrective term** to the likelihood function.
- This term accounts for the **variance absorbed by functional parameters**, which MLE neglects.
- **RMLE** is unbiased and minimum-variance
- **Easy to implement** in existing software.

Comparison of MLE and RMLE

10,000 synthetic series with a span of 20 years following a WN+FL model

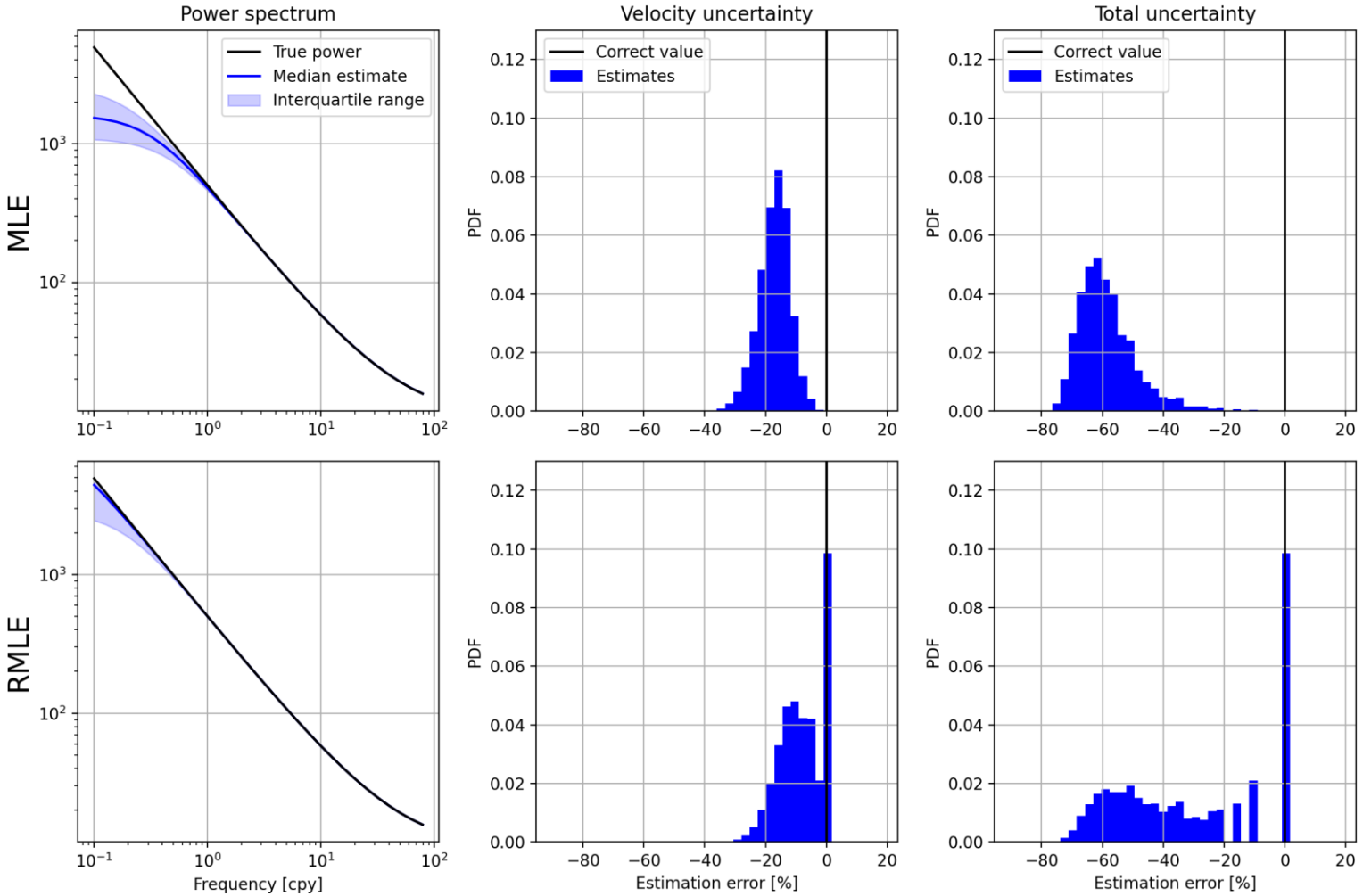


WN+GGM with a **linear trend only**

- **MLE** underestimates the low-frequency power
- **MLE** underestimates parameter uncertainties
- **RMLE** better estimates each quantities

Comparison of MLE and RMLE

10,000 synthetic series with a span of 20 years following a WN+FL model

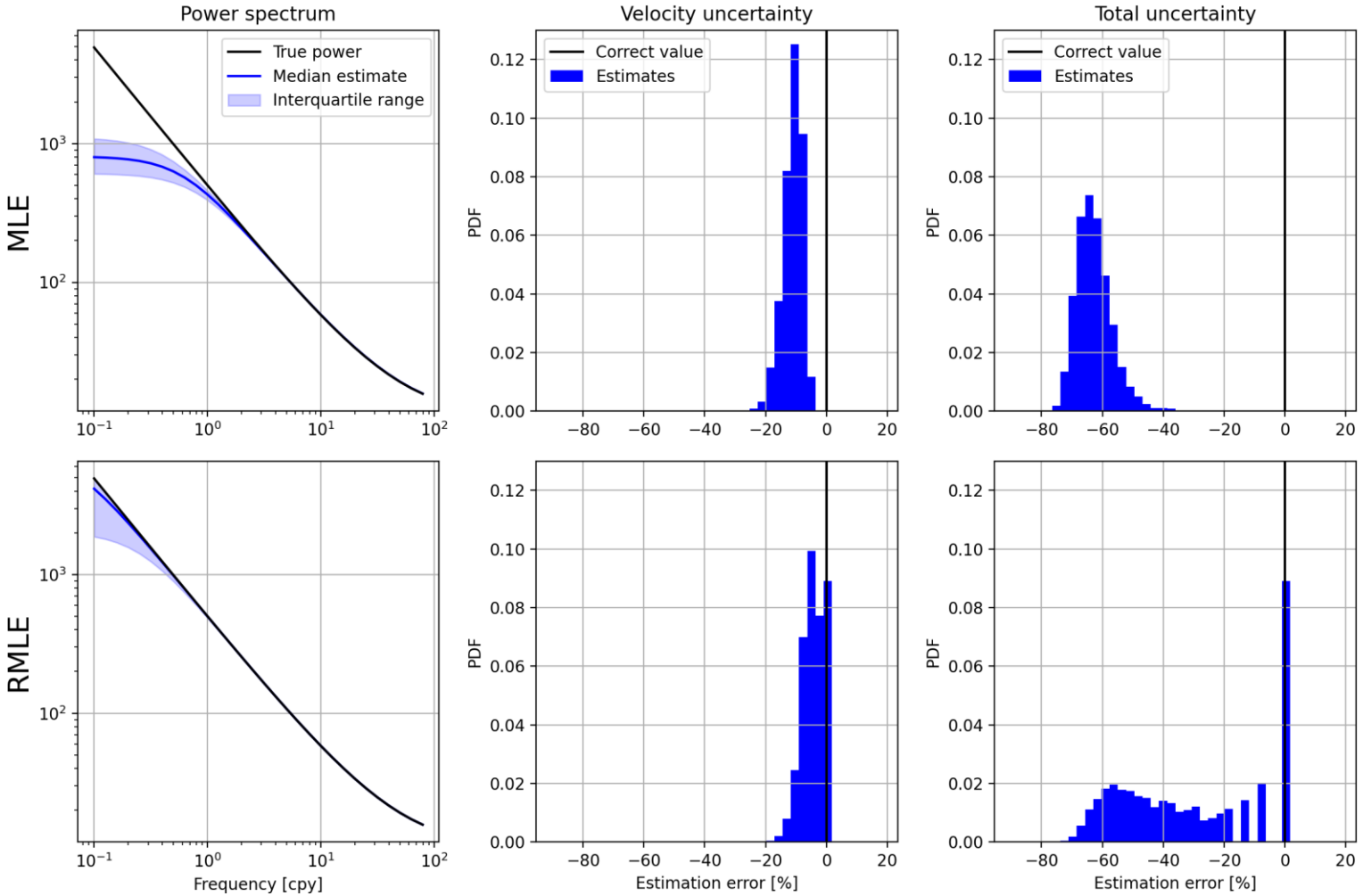


WN+GGM with a
linear trend + 7 offsets

- **MLE** underestimates the low-frequency power
- **MLE** underestimates parameter uncertainties
- **MLE** bias amplified with 7 offsets
- **RMLE** better estimates each quantities

Comparison of MLE and RMLE

10,000 synthetic series with a span of 20 years following a WN+FL model



WN+GGM with a
linear trend + 14 offsets

- **MLE** underestimates the low-frequency power
- **MLE** underestimates parameter uncertainties
- **MLE** bias amplified with 14 offsets
- **RMLE** better estimates each quantities

Conclusion

Keypoints

- MLE biases are **not negligible.**
- They have consequences on the **estimated precision of parameters of interest**, e.g., station velocities.
- One should use the **RMLE method** (or equivalent) for noise analyses.

More infos

- Questions?
- Paper submitted to **Journal of Geodesy**; preprint available on demand.

Thank you!