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Localized Radar-Based Nowcasting of Convective Rainfall

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Introduction

Accurate **rainfall nowcasts** are crucial for early warnings of extreme precipitation. However, traditional nowcasting techniques often struggle to predict the development and dissipation of **convective storms** effectively.

To address these limitations, methods like STEPS [1,2], ANVIL [3], and SPROG-LOC [3] have been developed. These methods involve **spectral decomposition** of **precipitation** or **Vertically Integrated Liquid (VIL)**, **autoregressive (AR)** or **autoregressive integrated (ARI) model**, **localization**, and **stochastic perturbations** to improve the accuracy of rainfall forecasts.

Building on these methods, we present a novel approach, Short Term Autoregressive Nowcasting (**STAN**). Its **deterministic** method is termed **SLANVIL** (or SLANPRE) for SPROG Localized Autoregressive Nowcasting using VIL (or PREcipitation), and its **probabilistic** extension with stochastic noise is called **STANVIL** for STEPS Localized ANVIL.

Case study Belgium – July 4th, 2021

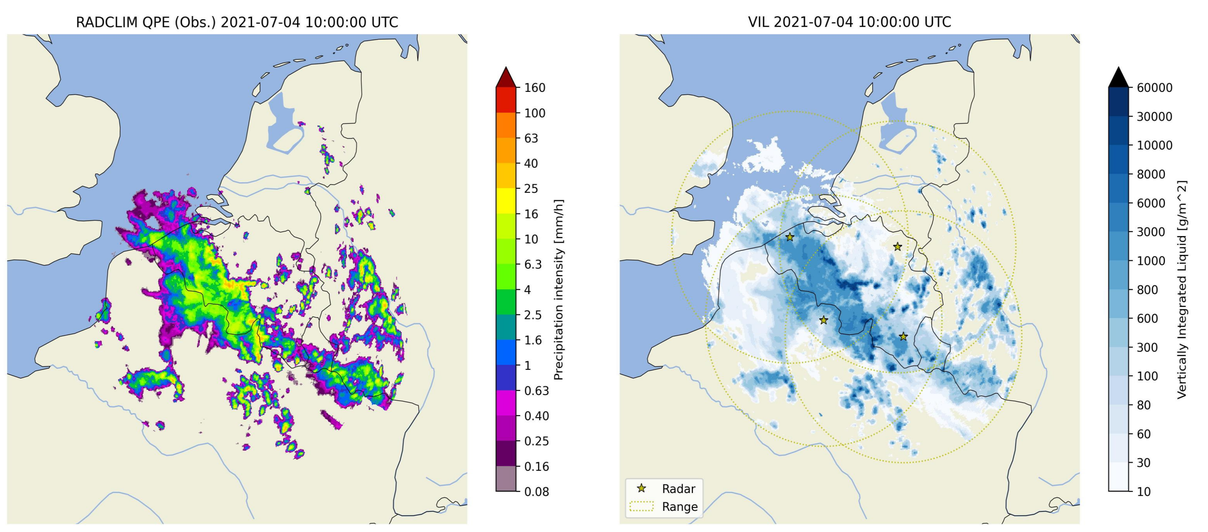

Figure 1. RADCLIM QPE product from RMI and computed VIL at 10 am.

Methodology

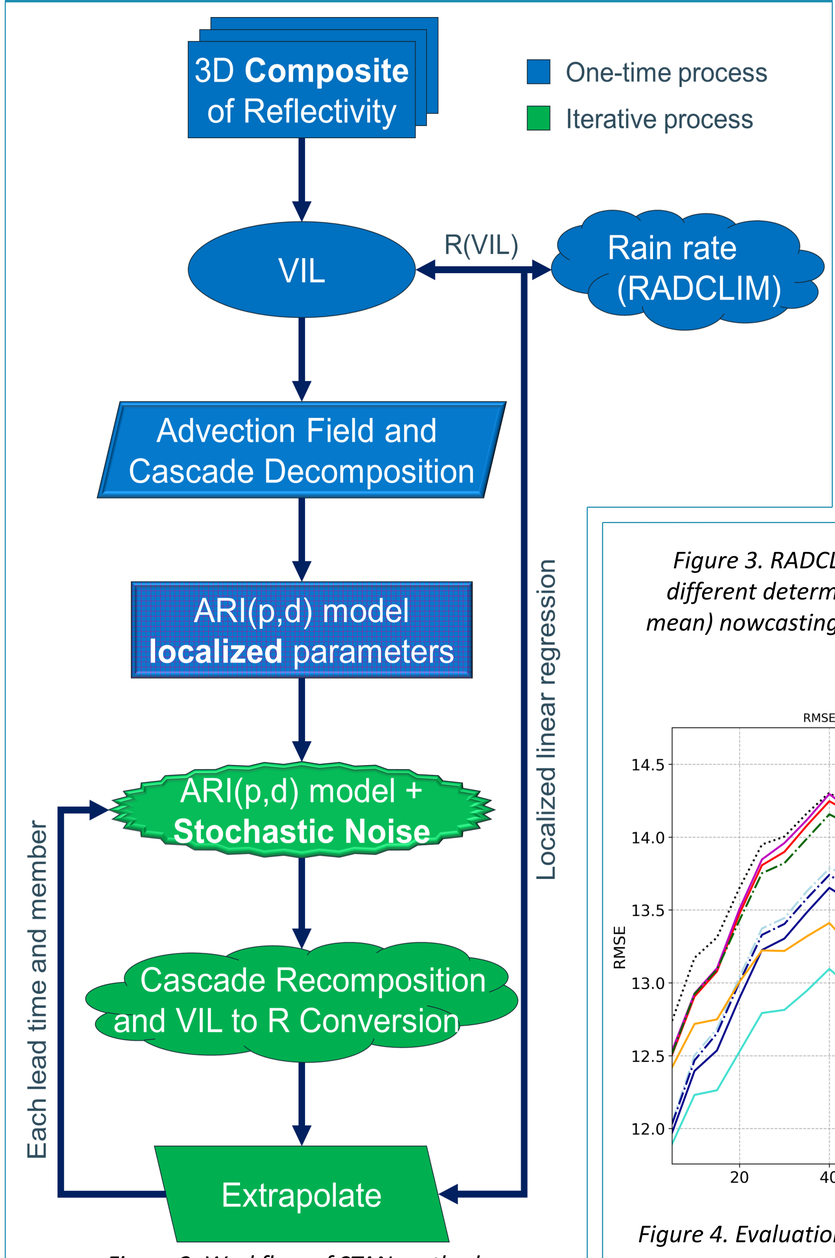

Figure 2. Workflow of STAN method.

Preliminary Results

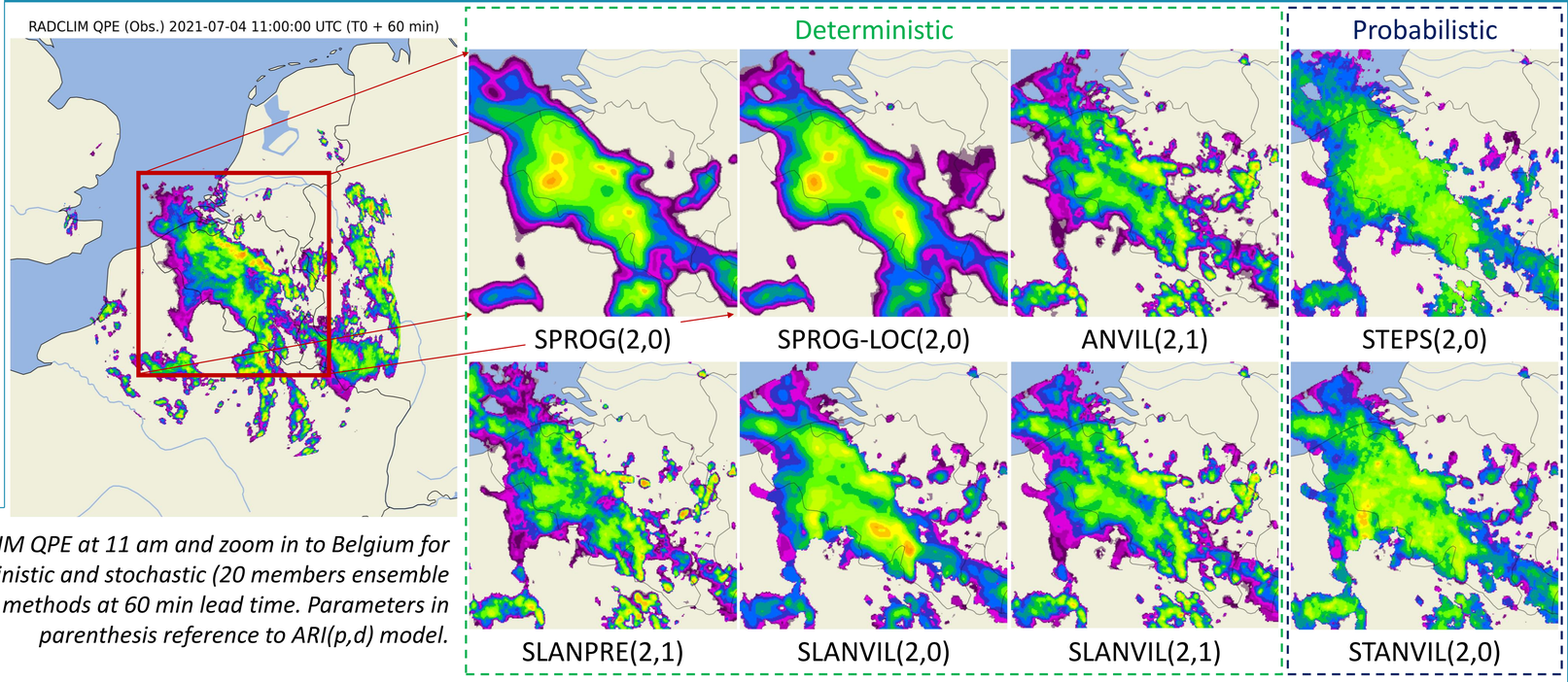

Figure 3. RADCLIM QPE at 11 am and zoom in to Belgium for different deterministic and stochastic (20 members ensemble mean) nowcasting methods at 60 min lead time. Parameters in parenthesis reference to ARI(p,d) model.

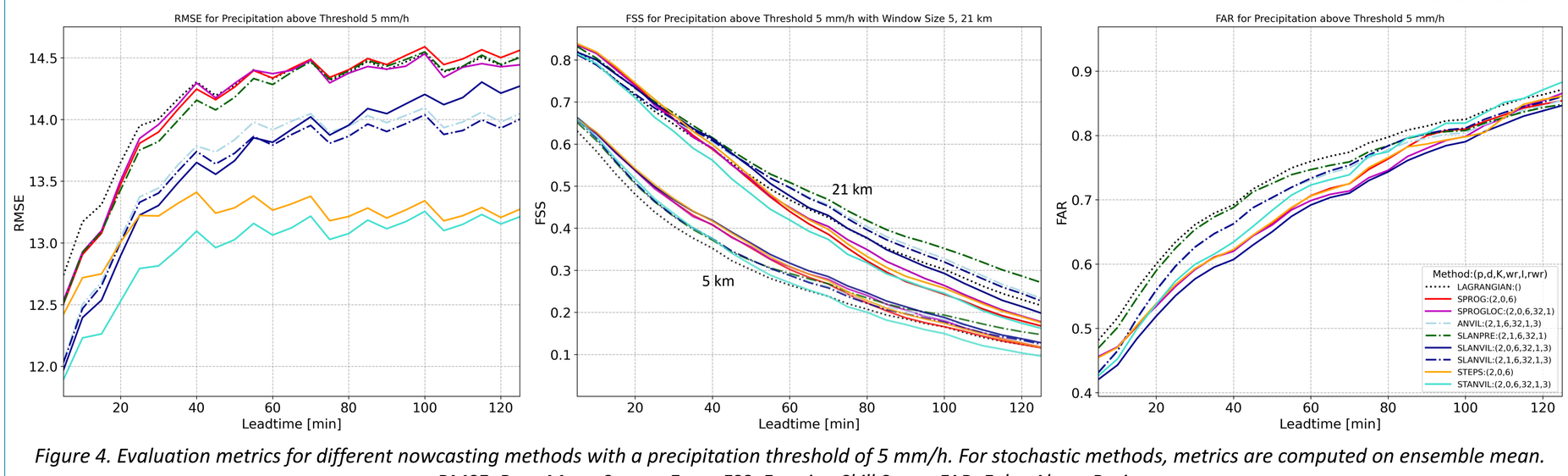

Figure 4. Evaluation metrics for different nowcasting methods with a precipitation threshold of 5 mm/h. For stochastic methods, metrics are computed on ensemble mean. RMSE: Root Mean Square Error, FSS: Fraction Skill Score, FAR: False Alarm Ratio.

Conclusions

- Including the VIL into the nowcasts yields better results for RMSE and FAR for precipitation thresholds of 0.1 and 5 mm/h but increases the BIAS for 5 mm/h compared to the same methods without it.
- Methods using ARI(2,1) model improve FSS but increase FAR at higher thresholds.
- Adding stochastic noise improves RMSE performance but reduces FSS and FAR performance for ensemble mean using methods with ARI(2,0) model.

Perspectives

- Find optimal configuration and model parameters for all nowcasting methods and compare them.
- Run and evaluate nowcasting methods for multiple rainfall events.
- Evaluate stochastic methods with probabilistic statistical metrics.
- Fix small bugs in Python script and incorporate STAN method into pySTEPS library.

References

[1] Seed, A. W., C. E. Pierce, and K. Norman (2013), Formulation and evaluation of a scale decomposition-based stochastic precipitation nowcast scheme, *Water Resour. Res., vol.* 49, pp. 6624–6641.
[2] Pulkkinen, S., Nerini, D., Pérez Hortal, A. A., Velasco-Forero, C., Seed, A., Germann, U., and Foresti, L. (2019), Pysteps: an open-source Python library for probabilistic precipitation nowcasting (v1.0), *Geosci. Model Dev.*, vol. 12, pp. 4185–4219.
[3] S. Pulkkinen, V. Chandrasekar, A. von Lerber and A. -M. Harri (2020), Nowcasting of Convective Rainfall Using Volumetric Radar Observations, *IEEE Transactions on Geoscience and Remote Sensing*, vol. 58, no. 11, pp. 7845-7859.
[4] R. Reinoso-Rondinel, M. Rempel, M. Schultze and S. Trömel (2022), Nationwide Radar-Based Precipitation Nowcasting—A Localization Filtering Approach and its Application for Germany, *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 15, pp. 1670-1691.