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Radar rainfall nowcasting for short-term hydrological forecasting

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4th workshop Dutch-German-French knowledge exchange

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The need for better short-term rainfall forecasts

- Need for accurate and timely short-term rainfall forecasts to ensure early flood warning
- Numerical Weather Prediction (NWP) often not sufficient on the short term:
 - Update frequency of issued forecasts is too low, especially for convective events
 - Events are forecast, but not at the right location



Torrential rains sweep away houses and roads, and 21 people are reported missing

The Guardian, Oct 4, 2020



A tool you probably use every day!



Source: https://www.dwd.de/DE/leistungen/radarbild_film/radarbild_film.html



• Step 1: derive the motion of the rainfall fields



Source: Pulkkinen et al., Geosci. Model. Dev., 2019

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A short introduction to nowcasting

• (Possible) step 2: what can we do with the development of the rainfall field over time?

STEPS (Short-Term Ensemble Prediction System): Decompose the precipitation field into a multiplicative cascade, each level denoting a different spatial scale and treating each level differently

Towards an ensemble:

- Temporal evolution of rainfall field with 2nd order auto-regressive process.
- Perturbations with correlated Gaussian random fields to take into account uncertainty.



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A short introduction to nowcasting – The nowcast chain







14 March 2021 18:35 UTC

Observations

Nowcast



15 March 2021 00:45 UTC

Observations

Nowcast

How skillful is nowcasting for rainfall and hydrological predictability?

What skill can we expect?



What skill can we expect? – Some conclusions based on a study with >1500 rainfall events

Skill was found to depend on:

1) **Event type and duration:** Increasing for longer events, Max. skilfull lead times range from 25 min (1-h events) to 116 min (24-h)

2) Season: Decreasing skill towards summer

3) Location: Increasing in the downwind direction

4) Catchment size: Increasing with larger catchment size



Consistency of the discharge peak forecast



Operational implementations and possible applications

Operational Delft-FEWS system for the Regge and Dinkel, the Netherlands



Loas

Application in Delft-FEWS by Environment Agency, UK



Regional flood warnings in Switzerland based on nowcasting



Warning level	Frequency distribution of the ensemble
2	3% > HQ100
2	10% > HQ10 und 30% > HQ2
2	10% > HQ5 und 40% > HQ2
2	25% > HQ5 und 50% > HQ2
2	60% > HQ2
3	15% > HQ100
3	50% > HQ10 und 75% > HQ5
3	25% > HQ30 und 100% > HQ5
3	75% > HQ10
4	50% > HQ30 und 75% > HQ20
4	25% > HQ100 und 100% > HQ20
4	75% > HQ30
5	50% > HQ100 und 75%
5	25% > HQ200 und 100% > HQ65
5	75% > HQ100

Towards better rainfall and hydrological forecasts up to 6 hours in advance

Blending ensemble nowcasts with Numerical Weather Prediction models

A study together with Royal Meteorological Institute, Belgium and Bureau of Meteorology, Australia

Why we have to try to get the best out of both forecasting methods (nowcasting and NWP)



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Blending with NWP

Linear blending: the easiest implementation





Blending with NWP

STEPS blending in the open-source pySTEPS package

- Blending per cascade level (spatial scale)
- Blending weights based on initial skill of radar rainfall nowcast and NWP at issue time forecast





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Blending in the open-source pySTEPS package: planning

Implementation of linear blending

Implementation of original STEPS blending scheme

Utilities for operational implementation

Blending multiple NWP models with the nowcast

Working – Final checks in progress

Lagged ensembles

Fix edge effects at radar domain boundaries

Possibly: relocate wrongly located NWP rainfall fields prior to blending

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Finalization end of 2021; followed by a test case and a paper

Blending with NWP

Nowcasting products by DWD

- KONRAD (KONvektive Entwicklung in RADarprodukten): a nowcasting system that is especially suited for thunderstorms
- Recent blending product SINFONY (Seamless INtegrated FOrecastiNg sYstem)

Open challenges

- Ensemble nowcasting for impact-based decision making
 - How do we go from (ensemble) nowcasts to impact?
 - How to deal with the probabilities in the ensemble?
- Where to put thresholds and warning levels in the early warning system?
- Real-time water level control based on nowcasts
- Biases in the radar composite
- Would it be useful for people on site during (potential) flood conditions to get direct and frequent updates of forecast rainfall, discharge and water levels? Who should provide this information?

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Blending can improve the forecast skill



Extra info



Extra info



Extra info

