Rainfall nowcasting for flood early warning

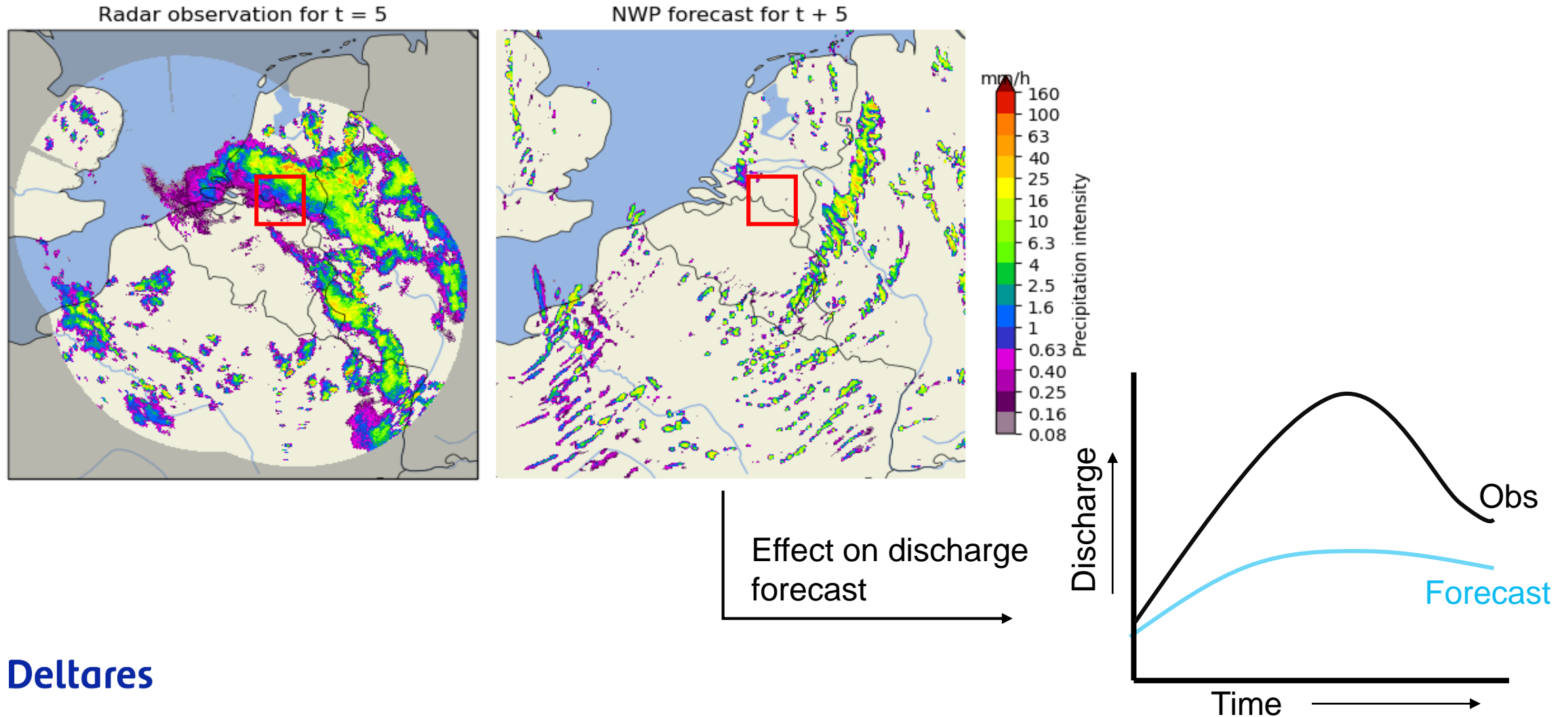**Deltares**

Ruben Imhoff

enabling delta life

Contents

- What is nowcasting?

- The value of nowcasting for rainfall and discharge forecasting

- Seamless forecasting with blending

- Operational water management applications

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Numerical weather prediction models not sufficient on short lead times for flood early warning

Radar observation for t = 5

NWP forecast for t + 5

mm/h
160
100
63
40
25
16
10
6.3
4
2.5
1.6
1
0.63
0.40
0.25
0.16
0.08

Precipitation intensity

Effect on discharge forecast
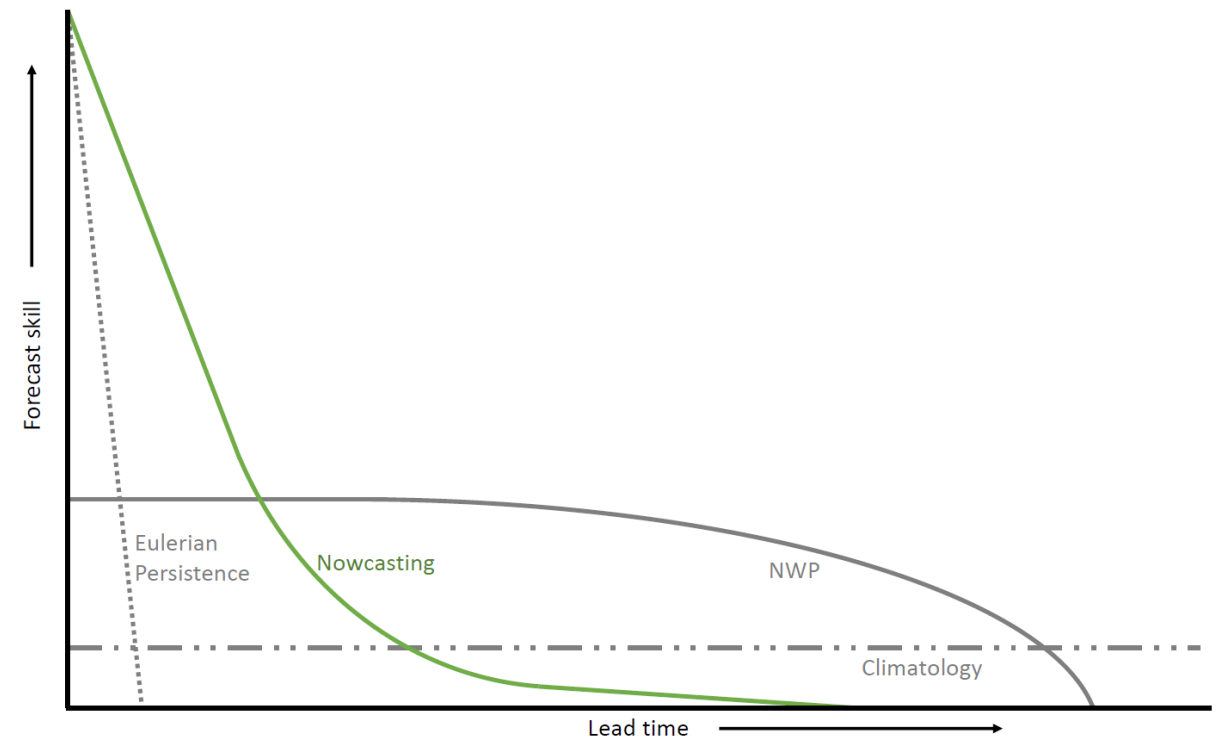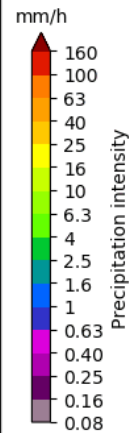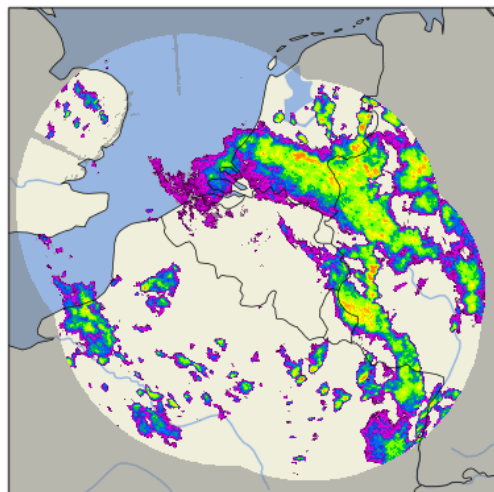
Discharge

Time

Obs

Forecast

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Possible solution for flood early warning: nowcasting

Radar observation for t = 0

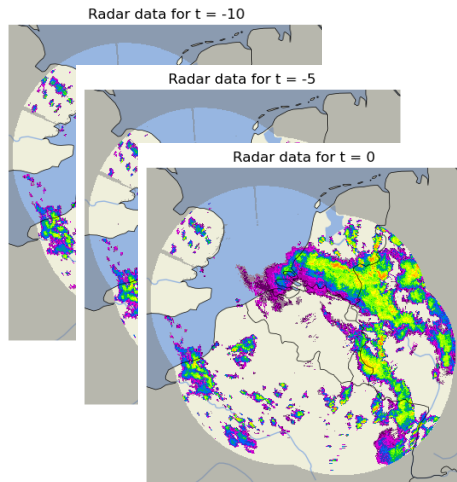NWP forecast for t + 5
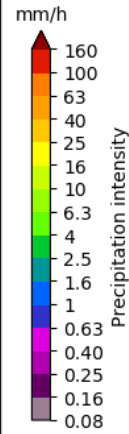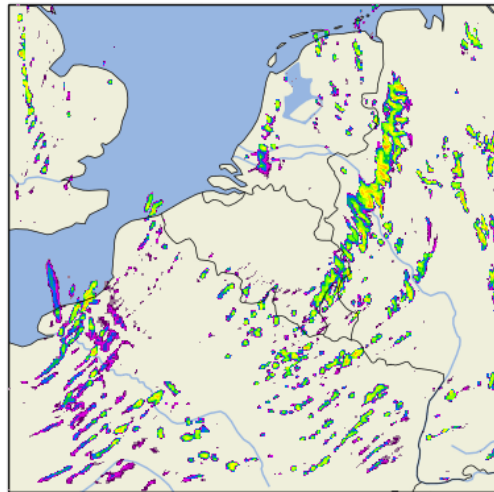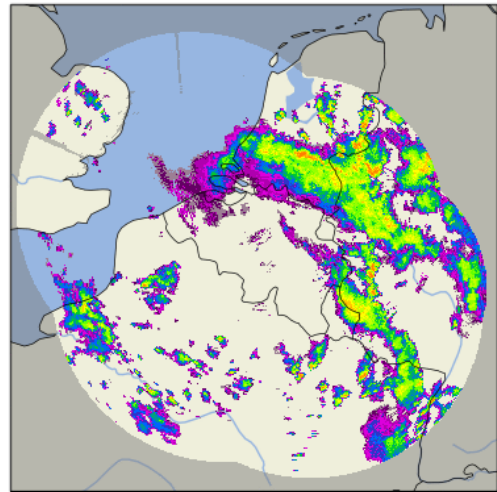
Nowcast for t + 5

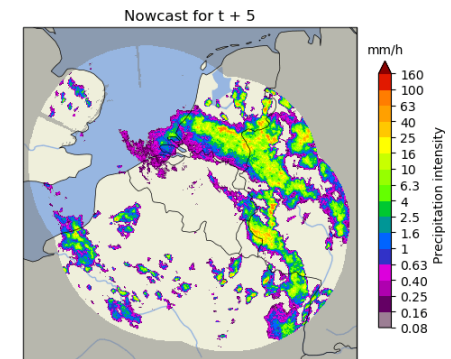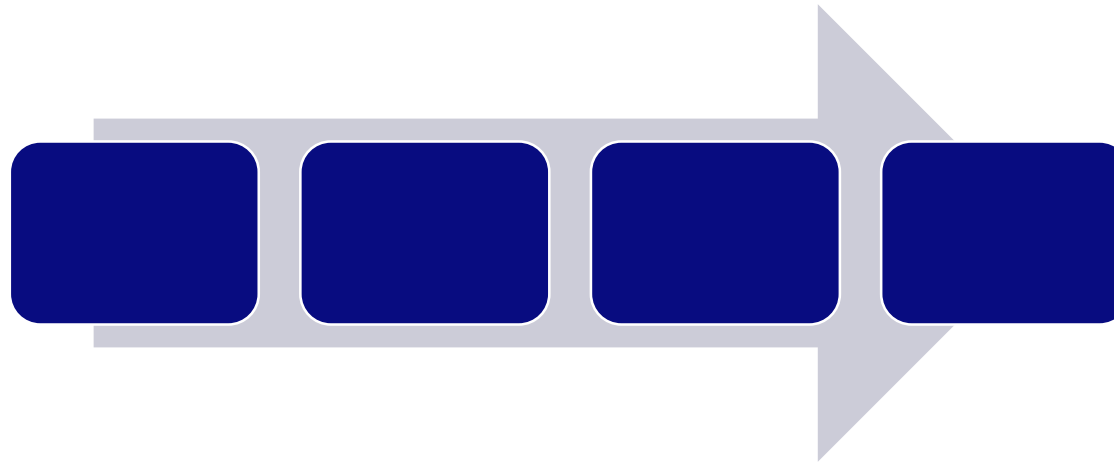Observation-based forecasts

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What is nowcasting?

Statistical extrapolation	Fast!	But no physics involved..

From most recent weather radar observations

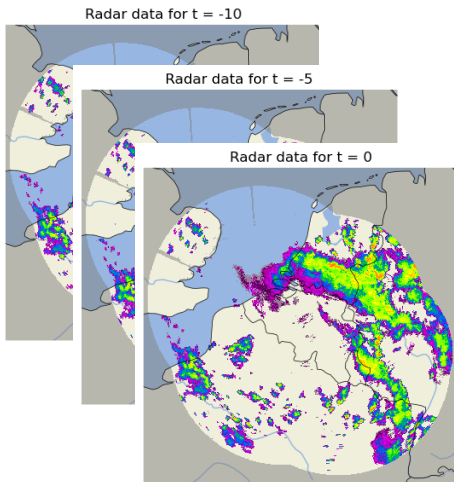To rainfall forecast up to 6 hr ahead

What is nowcasting?

Statistical extrapolation

Fast!

But no physics involved..

Radar data for t = -10

Radar data for t = -5

Radar data for t = 0

Determine movement of rainfall fields

Rainrate [mm h]

6.3
4
2.5
1.6
1
0.3
0.1
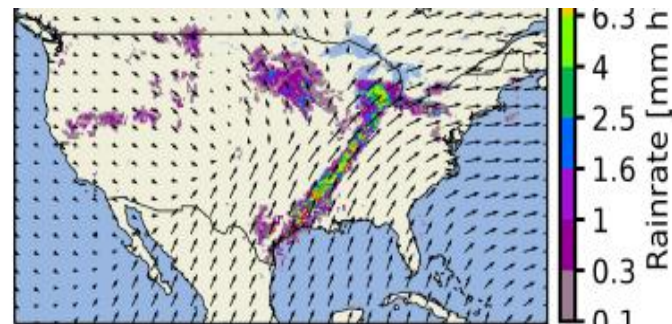
Source: Pulkkinen et al., Geosci. Model. Dev., 2019

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What is nowcasting?

Statistical extrapolation · Fast! · But no physics involved..

Radar data for t = -10

Radar data for t = -5

Radar data for t = 0

Determine movement of rainfall fields · Development of rainfall field

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What is nowcasting?

Statistical extrapolation

Fast!

But no physics involved..

Radar data for t = -10

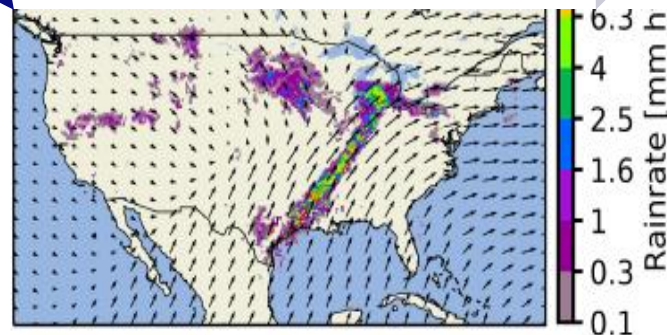Radar data for t = -5
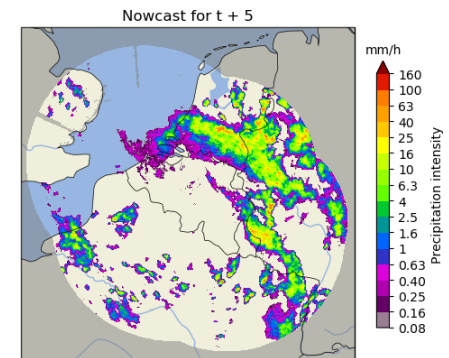
Radar data for t = 0

Nowcast for t + 5
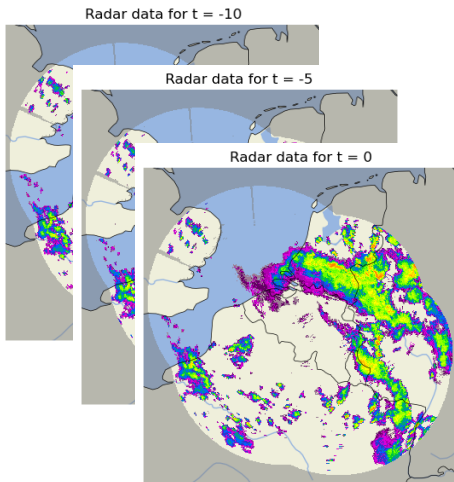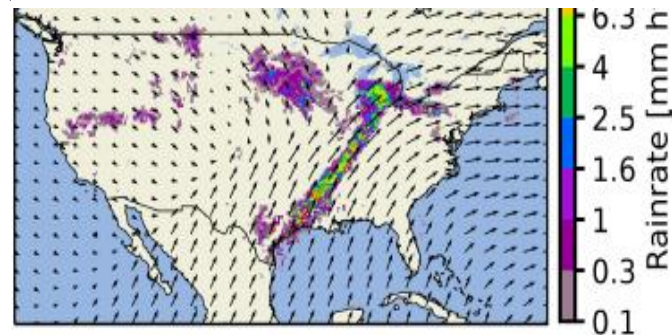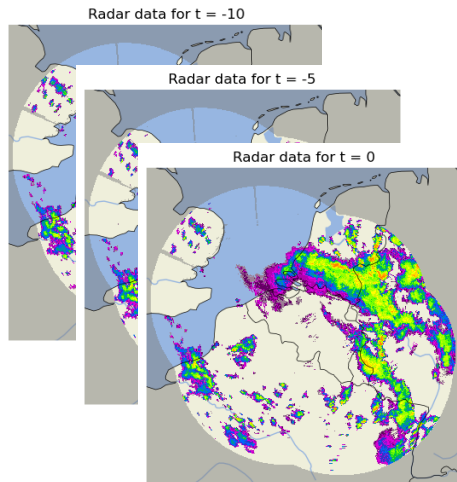
Determine movement of rainfall fields

Development of rainfall field

Extrapolate to future

Map on 2D grid

The skill of nowcasting
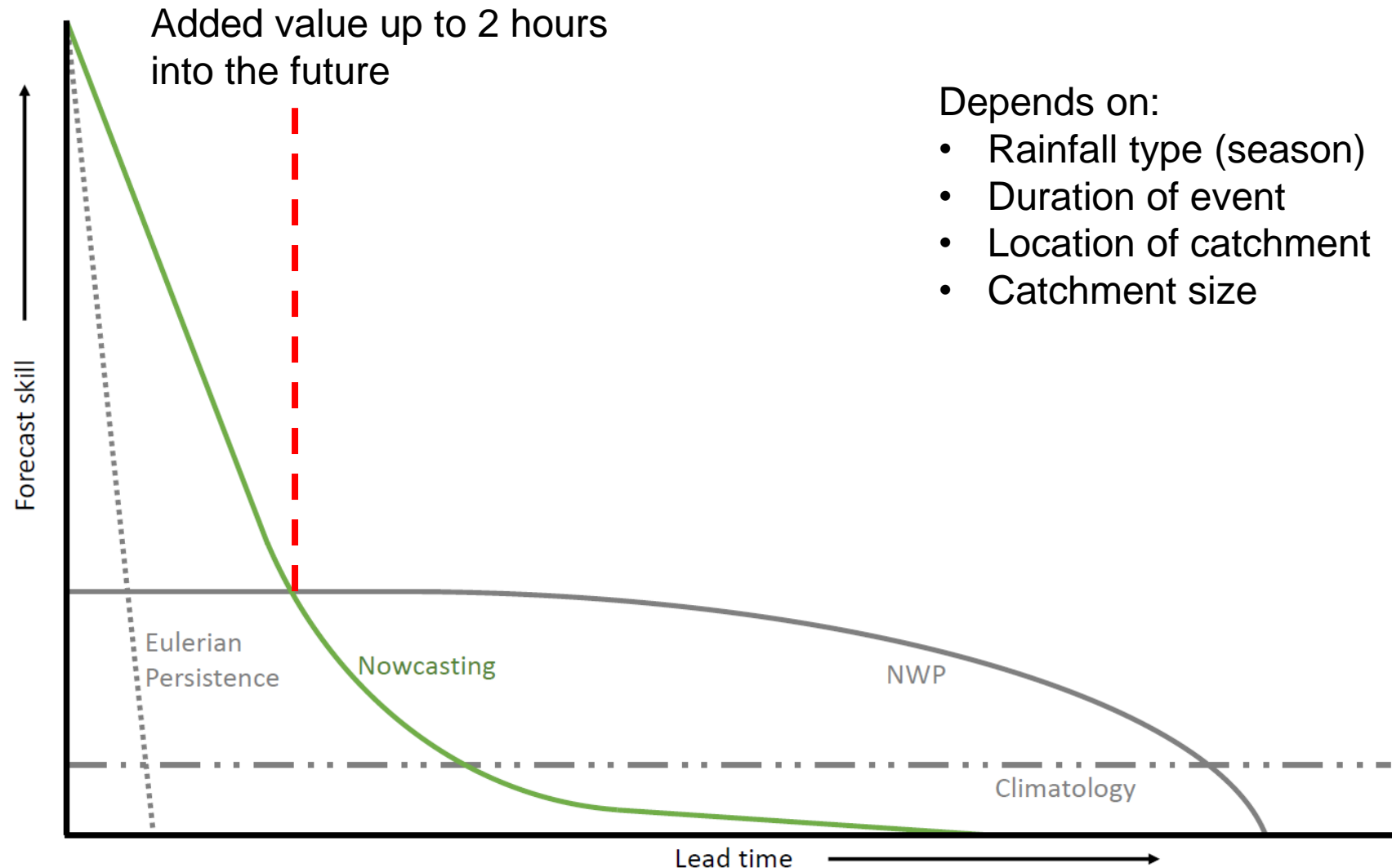
Added value up to 2 hours into the future

Depends on:
- Rainfall type (season)
- Duration of event
- Location of catchment
- Catchment size

Forecast skill

Eulerian Persistence

Nowcasting

NWP

Climatology

Lead time

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Resulting discharge forecasts

Geul catchment, July 14, 2021 – issue time 07:00 UTC

Resulting discharge forecasts
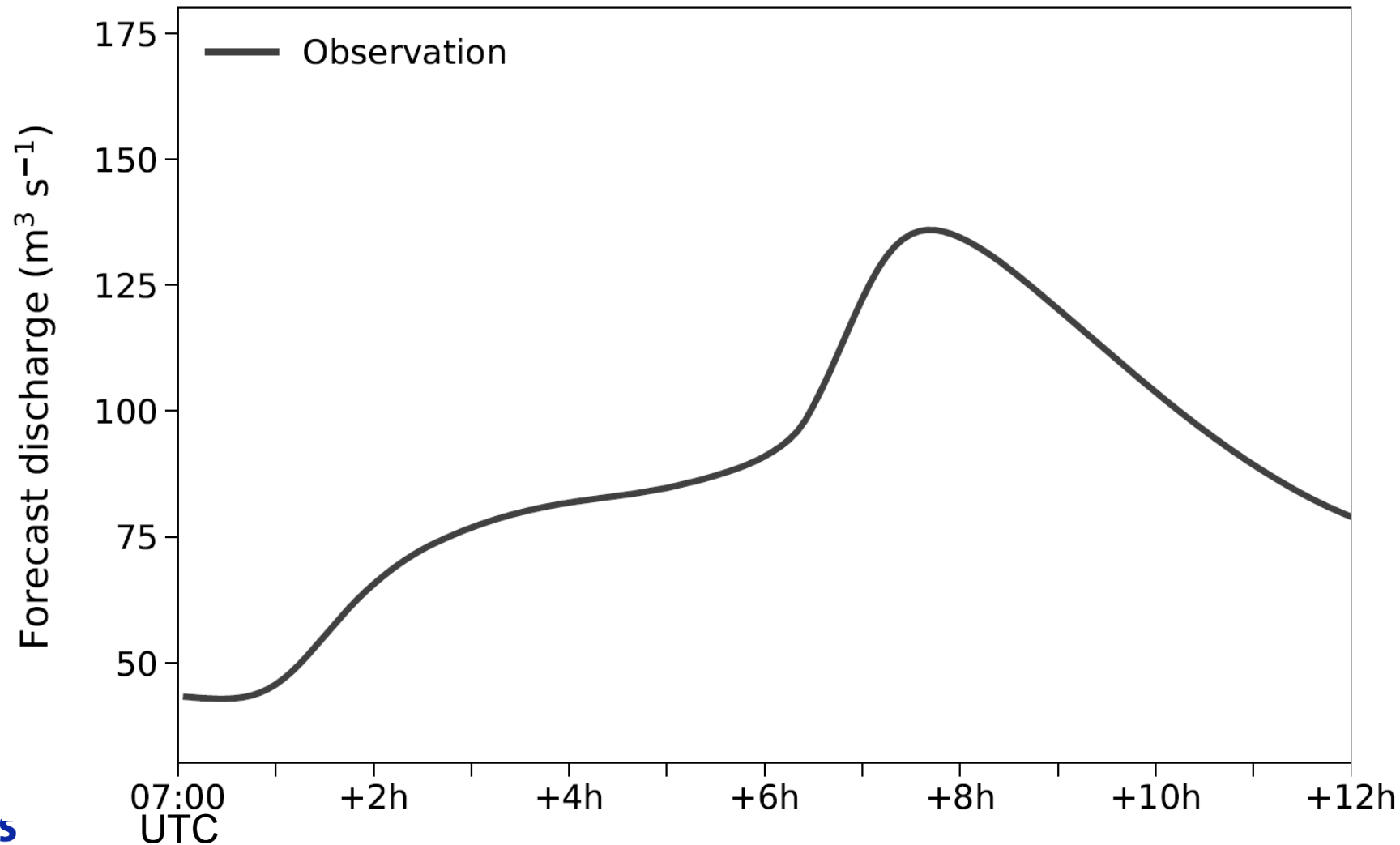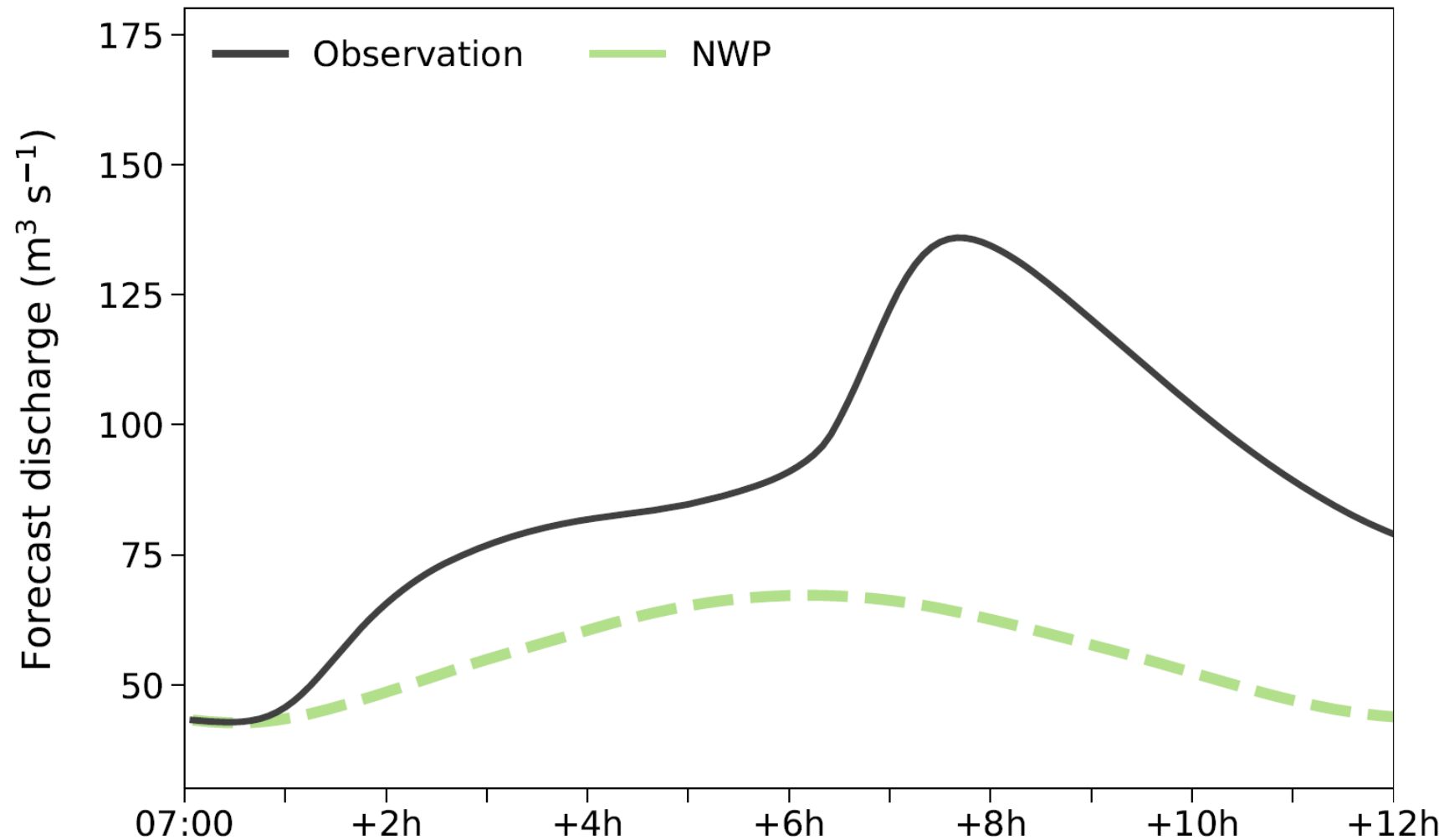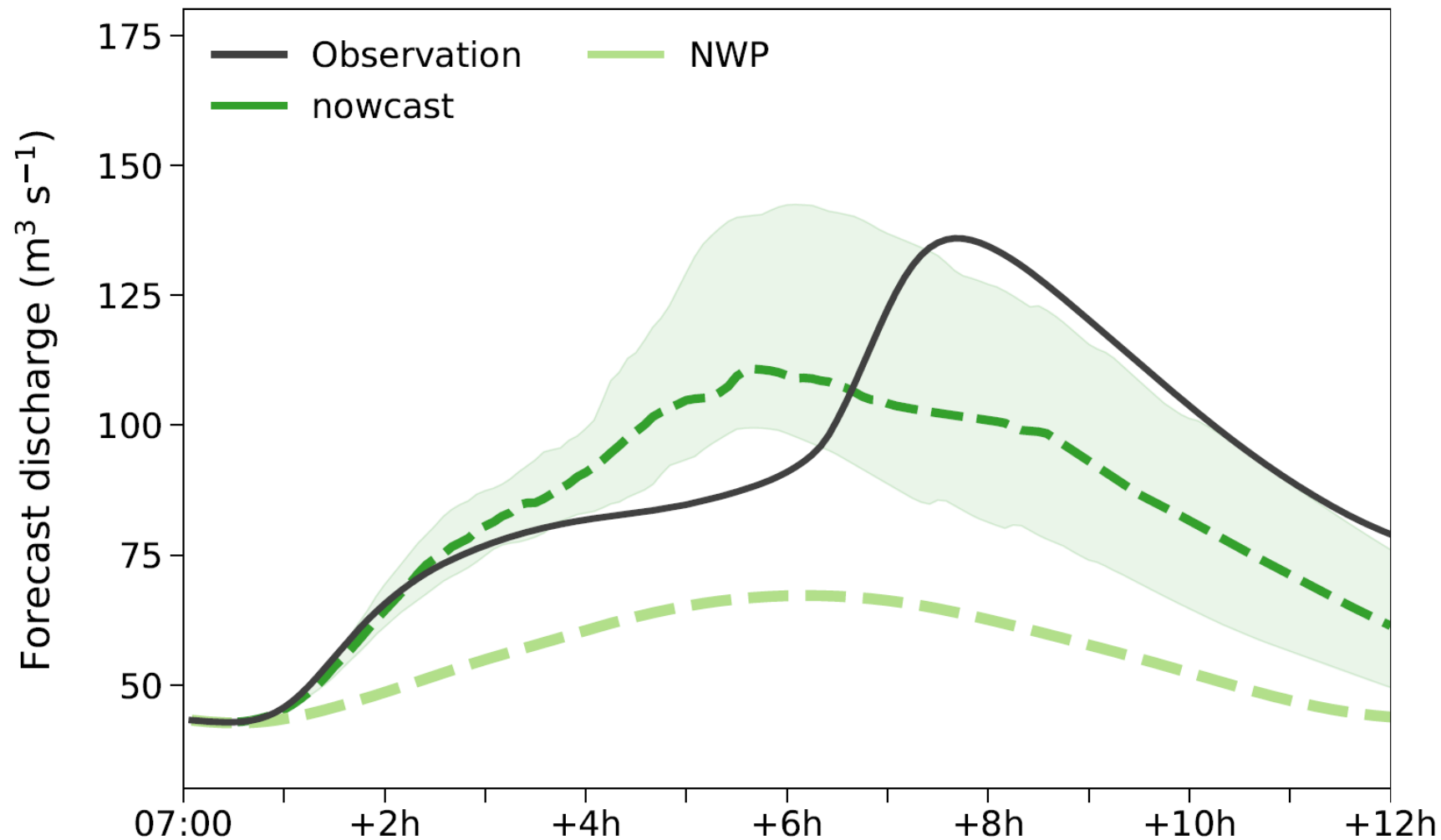
Geul catchment, July 14, 2021 – issue time 07:00 UTC

Resulting discharge forecasts

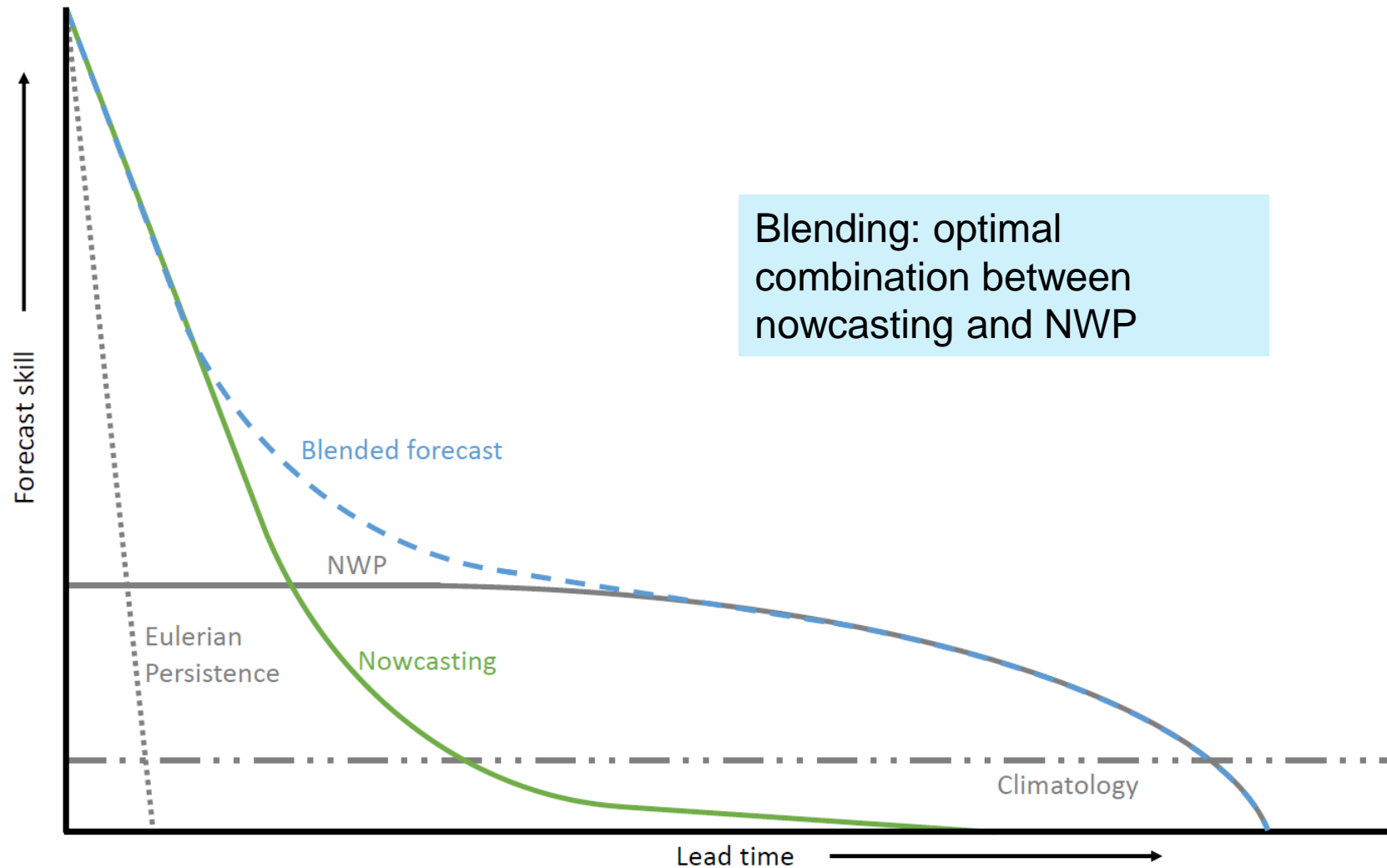Geul catchment, July 14, 2021 – issue time 07:00 UTC

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Can we even go a step further?

Blending: optimal combination between nowcasting and NWP

Forecast skill

Blended forecast

NWP

Eulerian Persistence

Nowcasting

Climatology

Lead time

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Simple linear blending?

Linear blending weights

Nowcast for t + 5

NWP forecast for t + 5

How to combine
a case like this?

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An advanced blending method (STEPS) – included in the open-source pysteps framework

Blending per spatial scale:

Per ensemble member:

Weights depend on initial skill and expected future skill

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An advanced blending method

Nowcast for t + 5

NWP forecast for t + 5

Blended forecast for t + 5
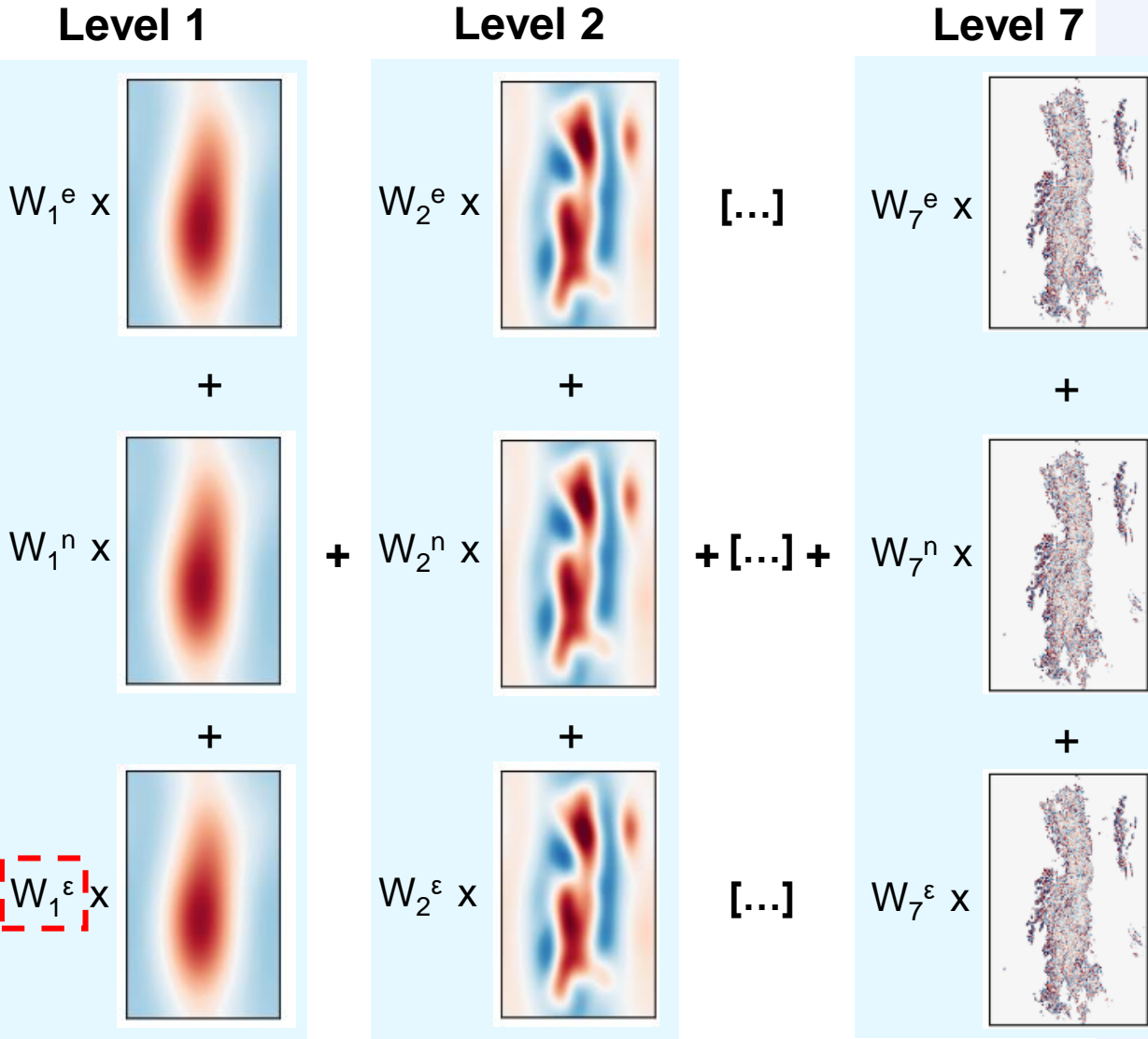
Project together with Royal Meteorological Institute, Belgium
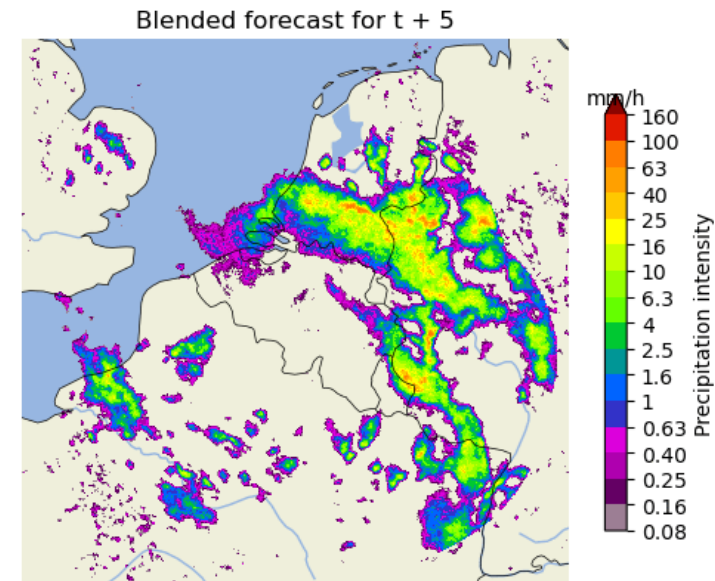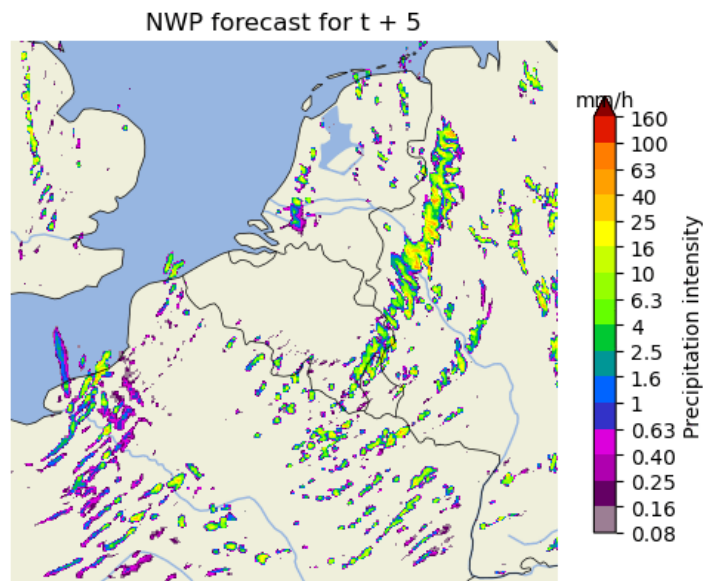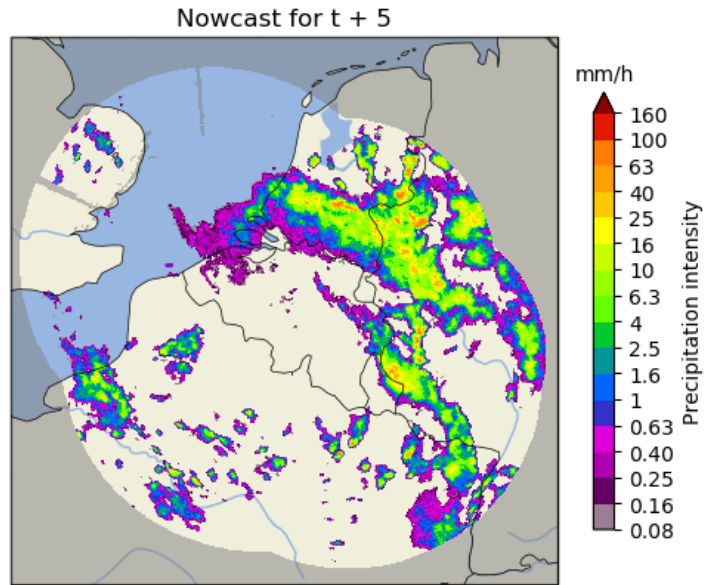
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Resulting discharge forecasts

Geul catchment, July 14, 2021 – issue time 07:00 UTC
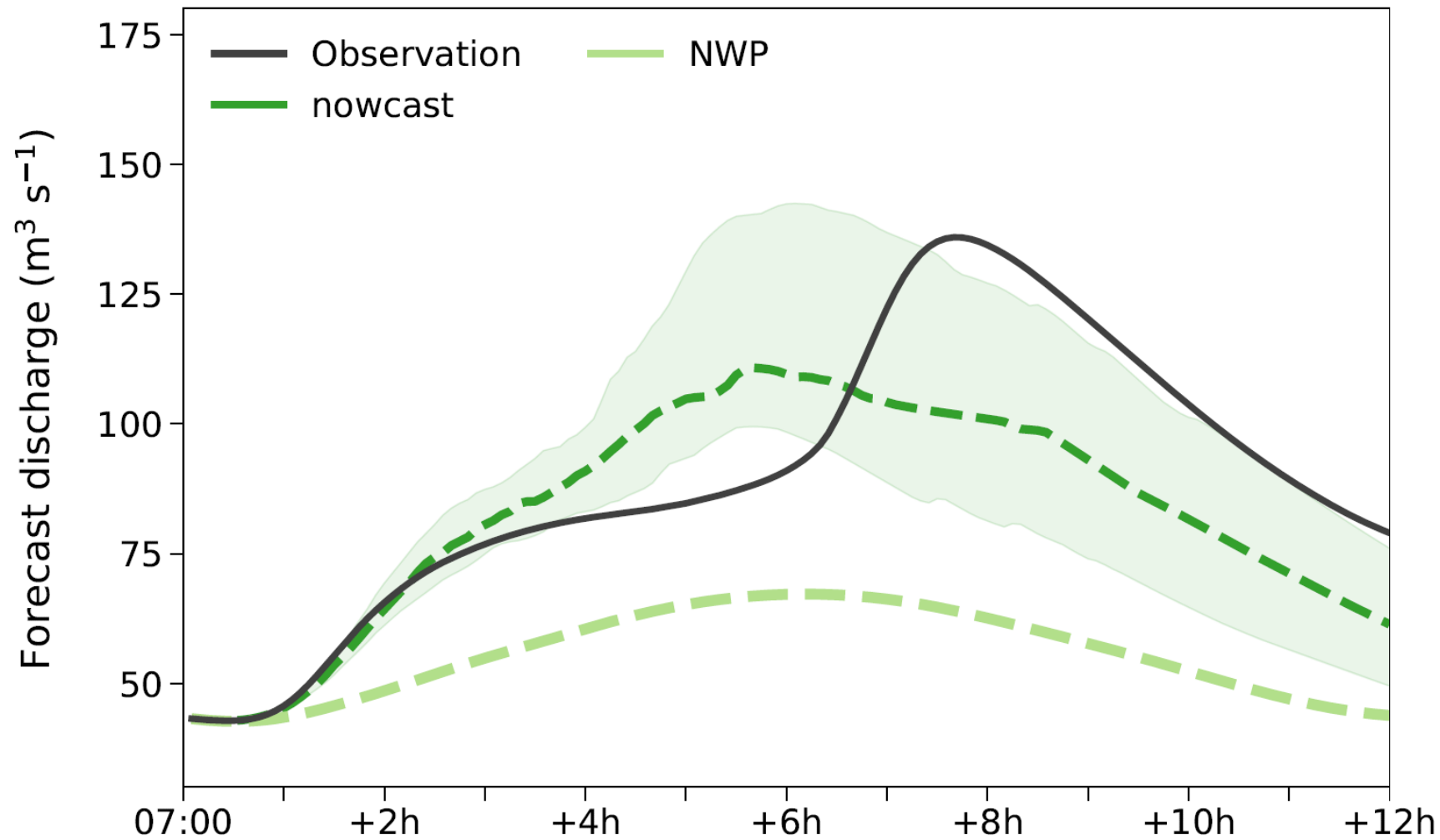
Resulting discharge forecasts

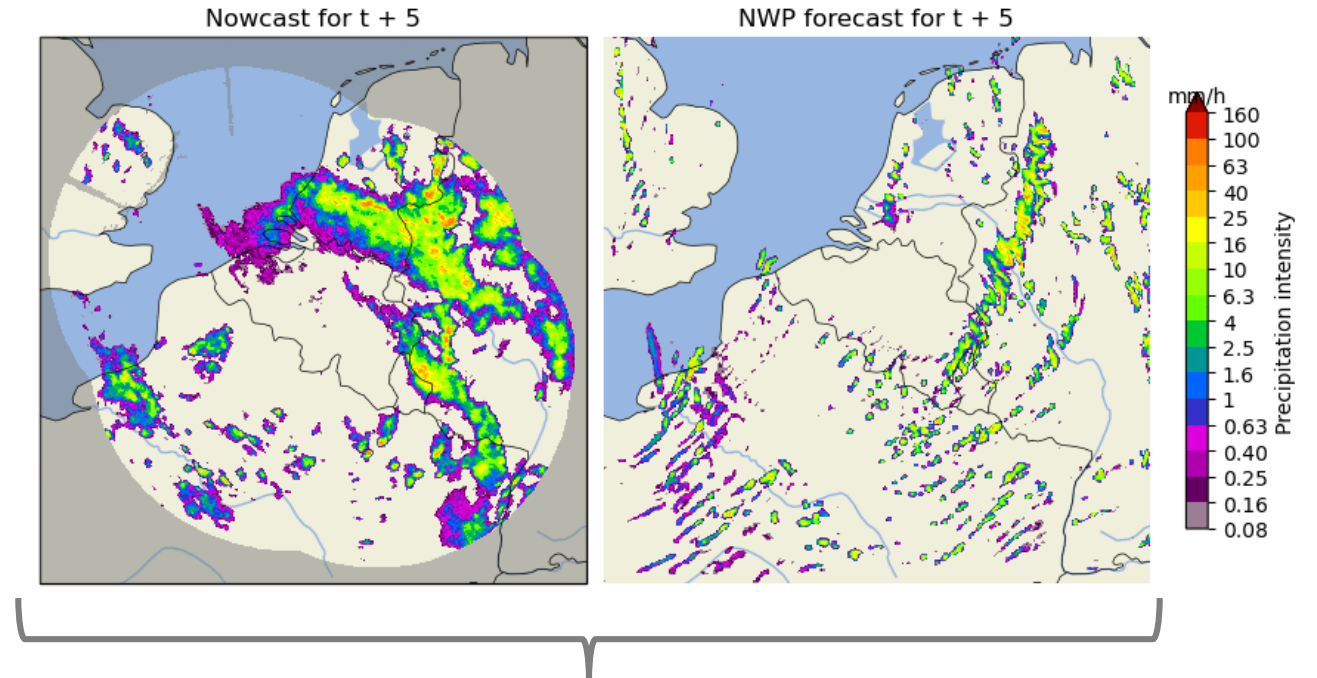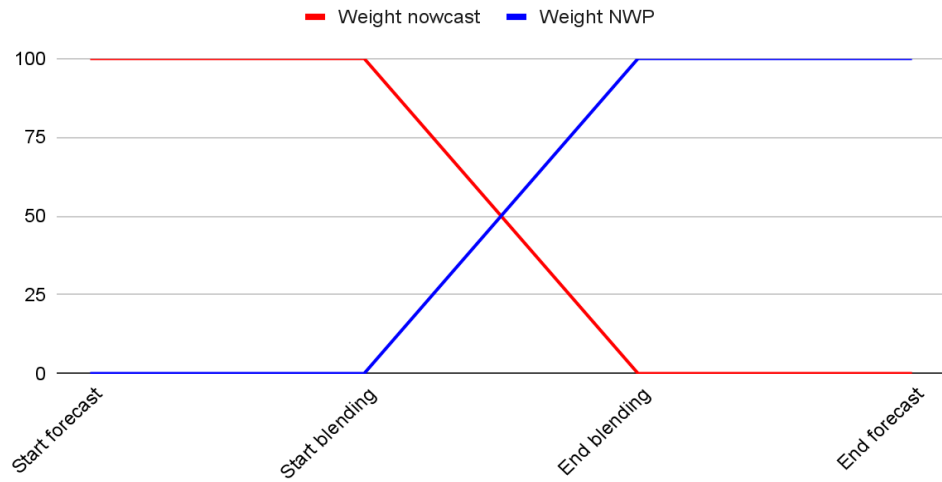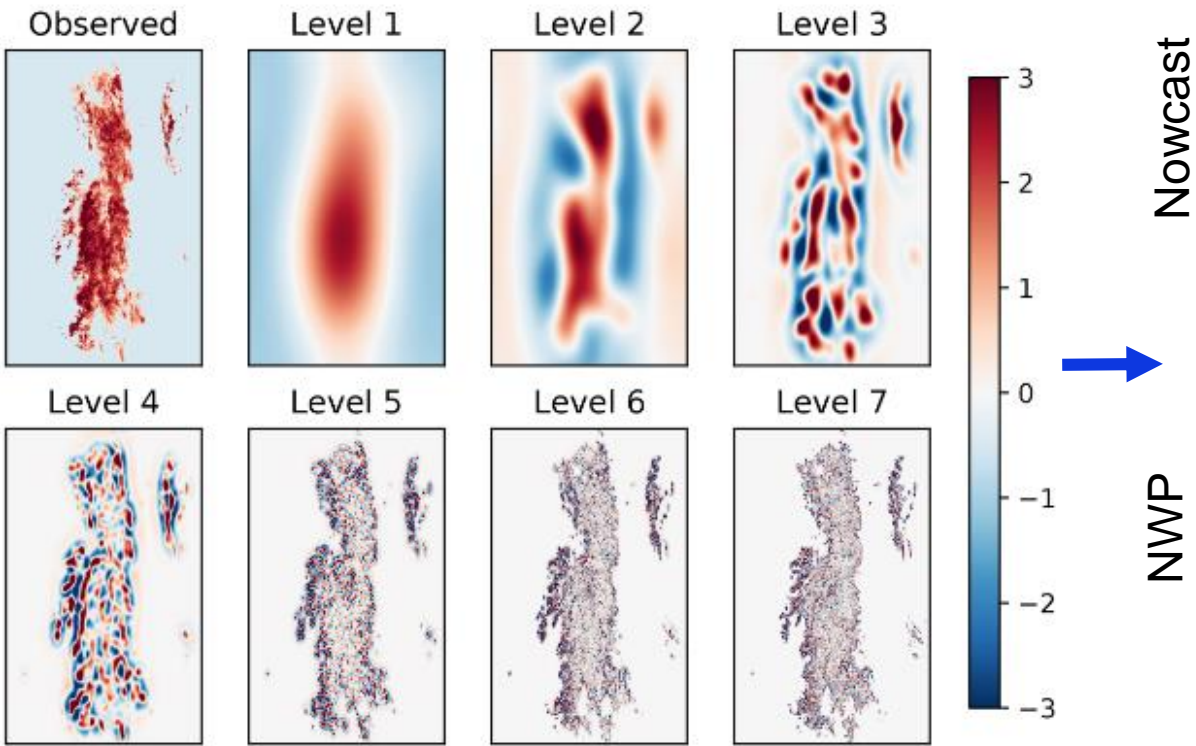Geul catchment, July 14, 2021 – issue time 07:00 UTC

Open-source pysteps nowcast runs through Delft-FEWS

March 15, 2021 00:45 UTC

Observation

Nowcast

Dwarsdiep (Water board Noorderzijlvest)

+15 hours ahead
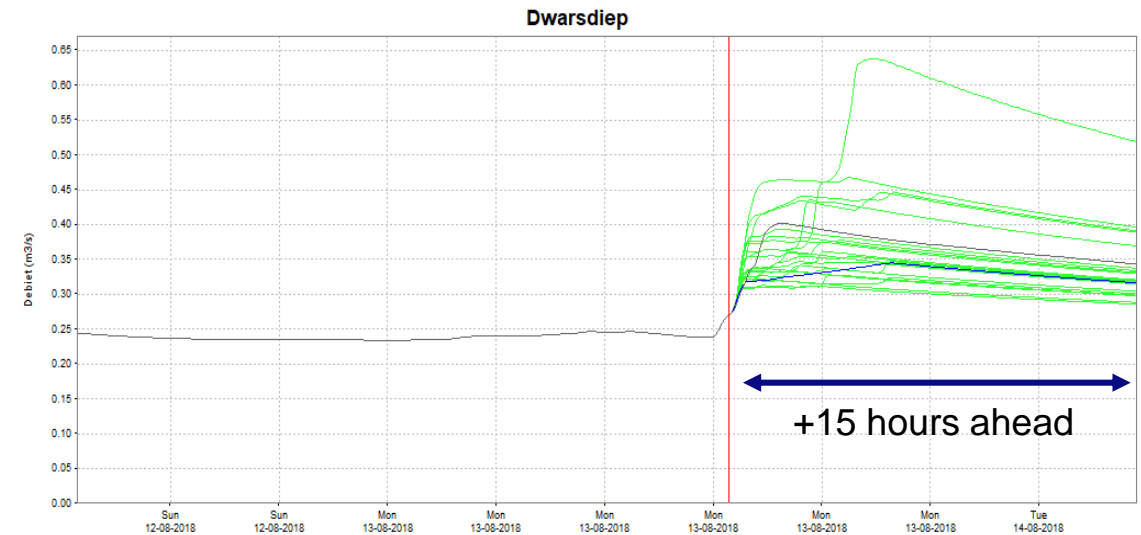
A glance at the forecasting chain

Radar QPE

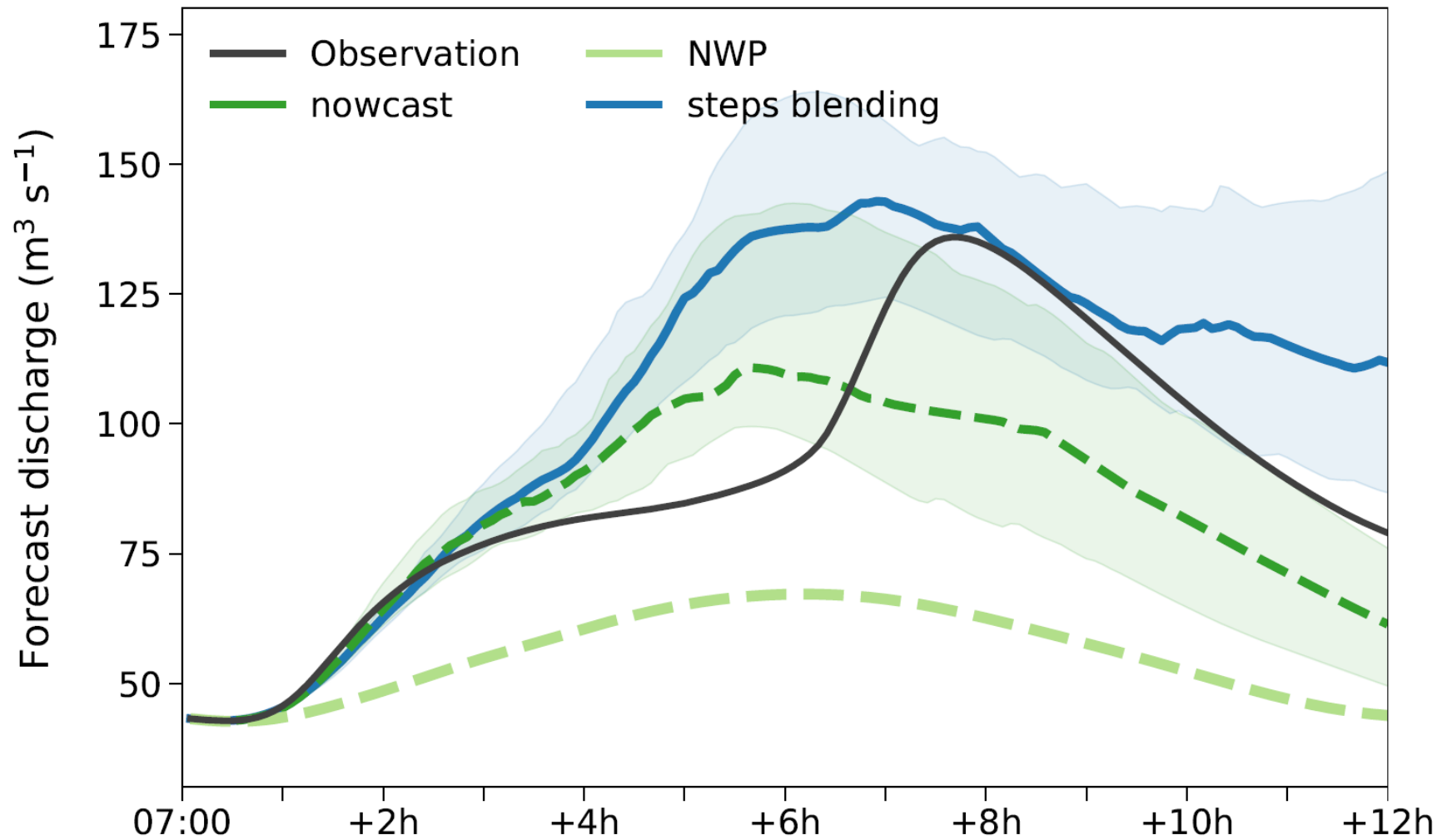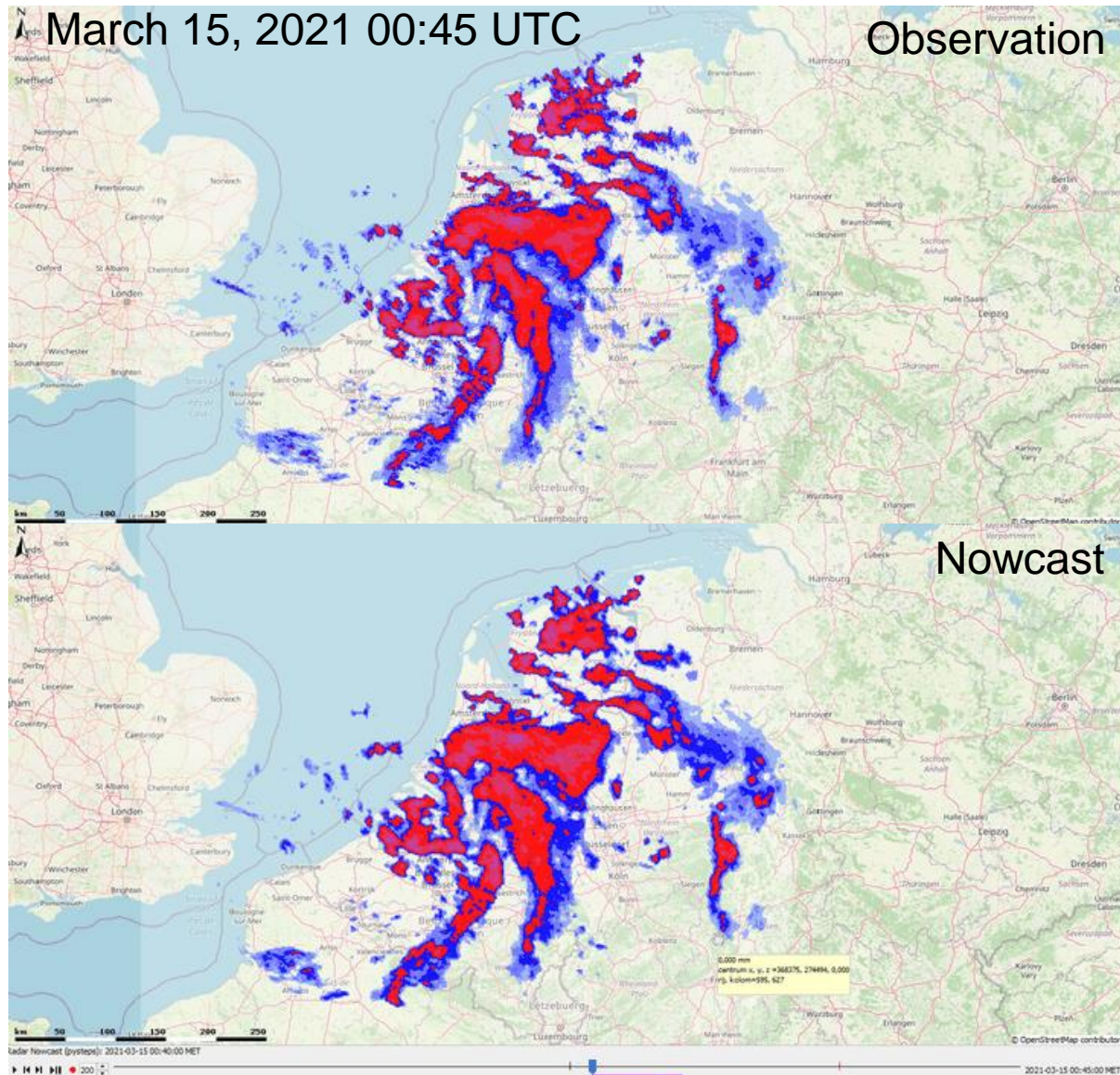- Availability of weather radar observations
- Bias correction of QPE
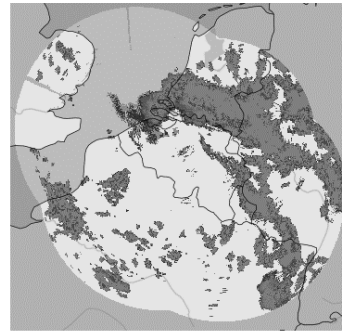
Rainfall forecasting

- Nowcasting with (corrected) QPE product
- Blending method to optimally combine nowcasting and NWP

Flood forecasting

- Improvement with nowcasting for first hours
- Blending often best of both worlds

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Source weather radar image: https://en.wikipedia.org/wiki/ARMOR_Doppler_Weather_Radar

Requirements to apply nowcasting

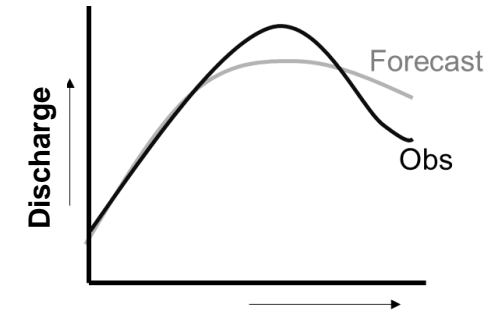| Nowcasting	Seamless forecasting
	Blending between nowcasts and (multi-model /ensemble) NWP forecast
• QPE from radar or other source on 2D (/3D) grid • Rain gauge observations to bias adjust QPE • Nowcasting algorithm, for instance pysteps	• Same as for nowcasting • High-resolution NWP forecasts in time (ideally same frequency as radar) • Even better: high update frequency of NWP forecast

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Focus areas that could profit from a nowcasting system

Local rain showers (missed by NWP)

Still challenging to forecast severe thunderstorms well..

The smaller the spatial and temporal scale, the bigger the advantage of nowcasting

Urban catchments

Quickly responding and mountainous catchments

Real-time control opportunities

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Thanks!

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