IMPROVING LONG-TERM HYDROPOWER INFLOW FORECASTS BY ASSIMILATING SNOW DATA

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[1] Statkraft, [2] NVE/Statkraft, [3] NORCE

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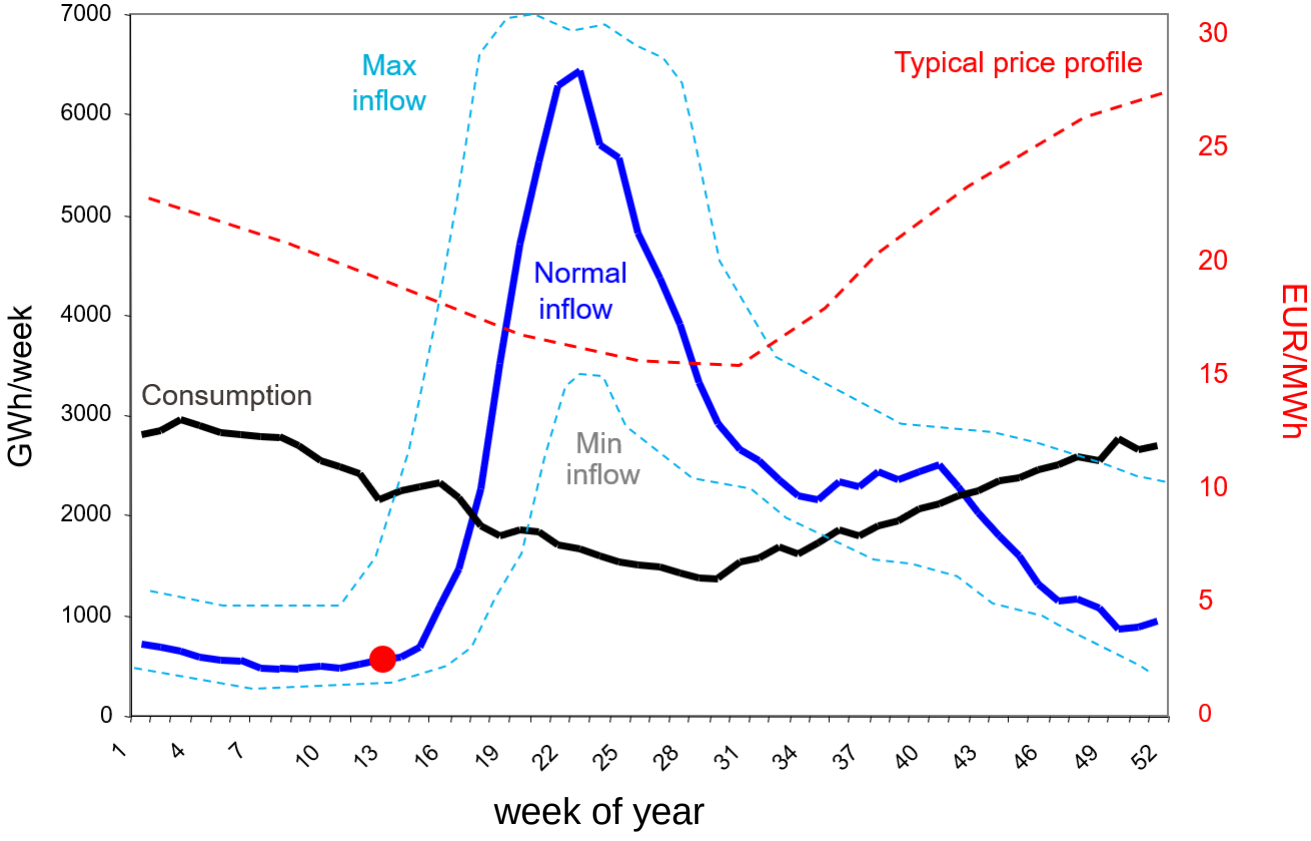
The basic challange



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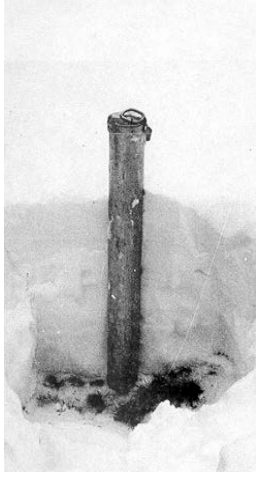
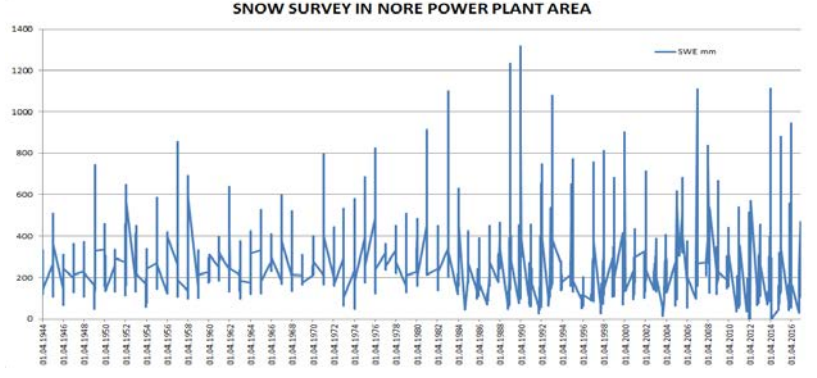
Long historical snow surveys in Statkraft





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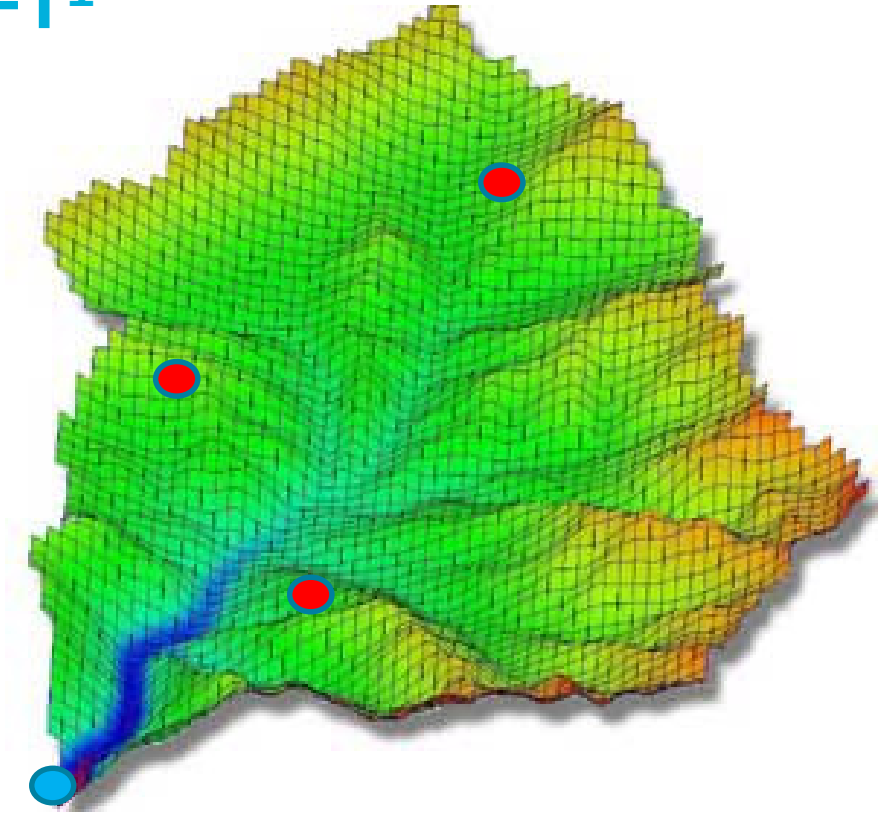
Hydrological model – SHYFT[1]

- Distributed hydrologic modelling
- Air temperature and precipitation input
- Temperature-index snow model
- Routing and water balance scheme



[1] www.gitlab.com/shyft-os

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Problem description

We have

- Model estimates (uncertain!) of snow across catchment
- Few measurements of snow (uncertain!)
- Runoff observations

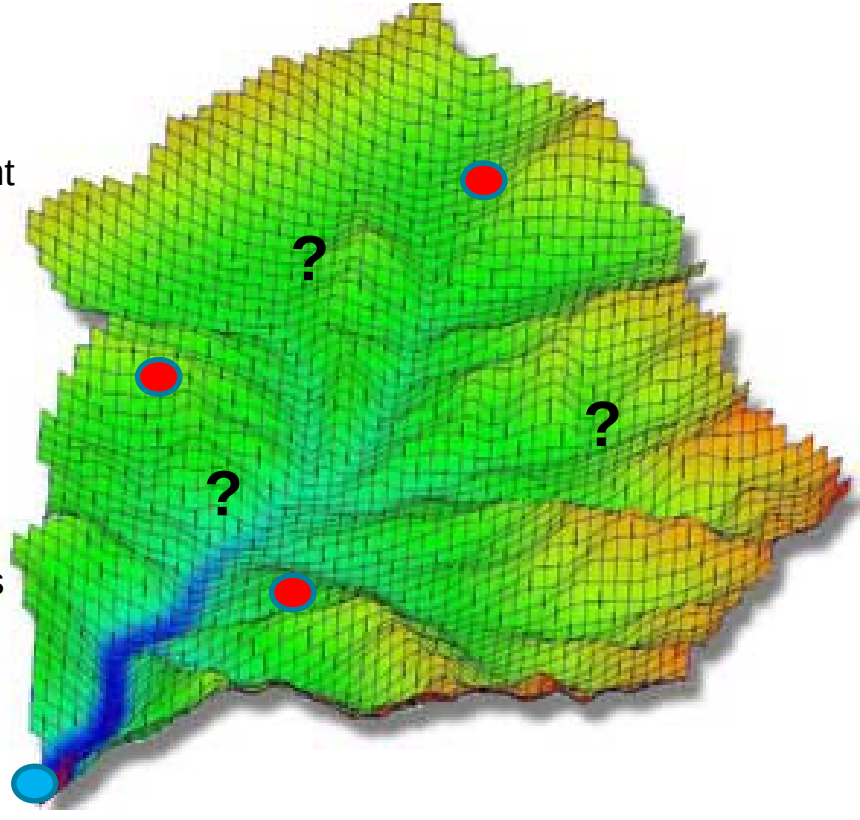
We want

- Improve model snow state, and hopefully get better inflow forecast

We need

- Method to improve snow state at unobserved locations taking into account:
- **Modelled and measured snow**
- **uncertainties in modelled and measured snow**
- **relationships between model grid points**

EnKF



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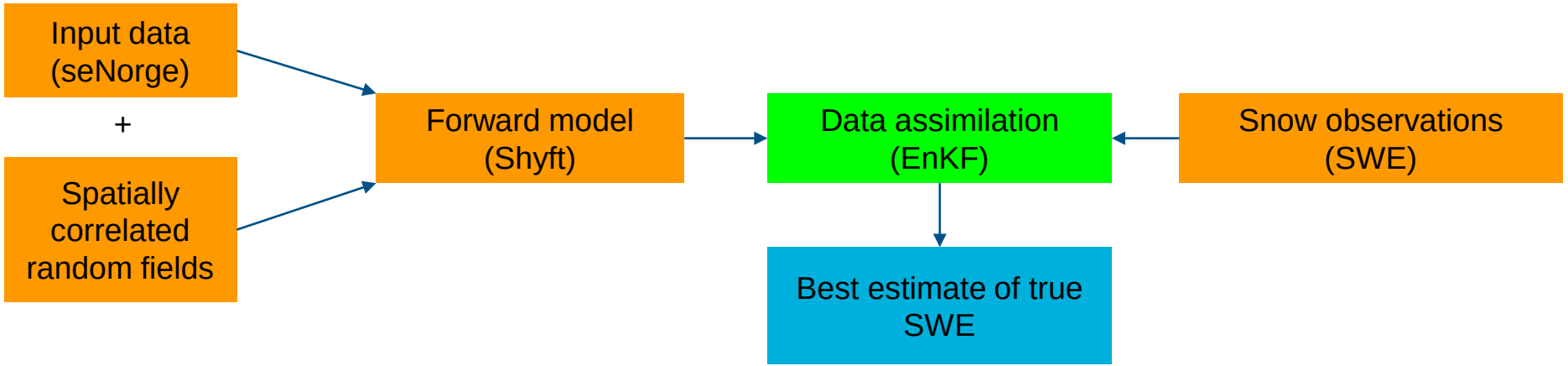
Data assimilation algorithm

Ensemble simulations
- simulate snow across the catchment
- establish relationship between grid points
- get uncertainty estimates

Combine all information objectively

Measurements with uncertainties

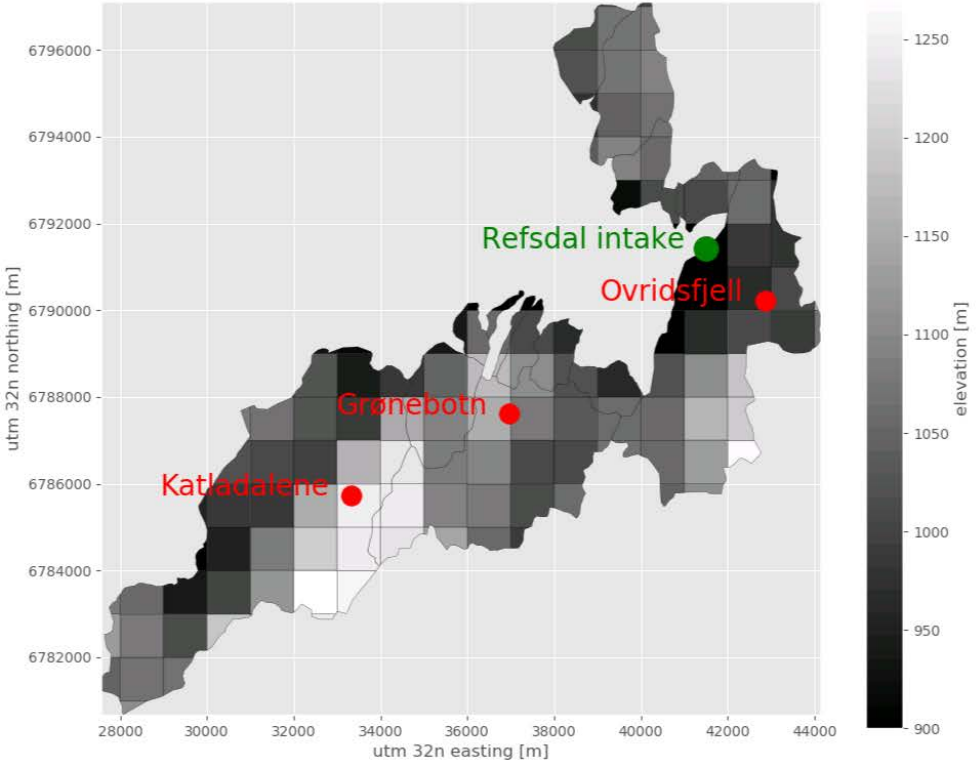


6 *Magnusson, J., D. Gustafsson, F. Hüsler, and T. Jonas (2014), Assimilation of point SWE data into a distribute model comparing two contrasting methods, Water Resour. Res., 50, doi:10.1002/2014WR015302.*

Study area and data

Refsdal catchment

- 74 km^2
- 530 to 1276 m.a.s.l.
- Mean annual precipitation 2200 mm (50 % falls as snow)
- 15 snow melt seasons (2000-2016)



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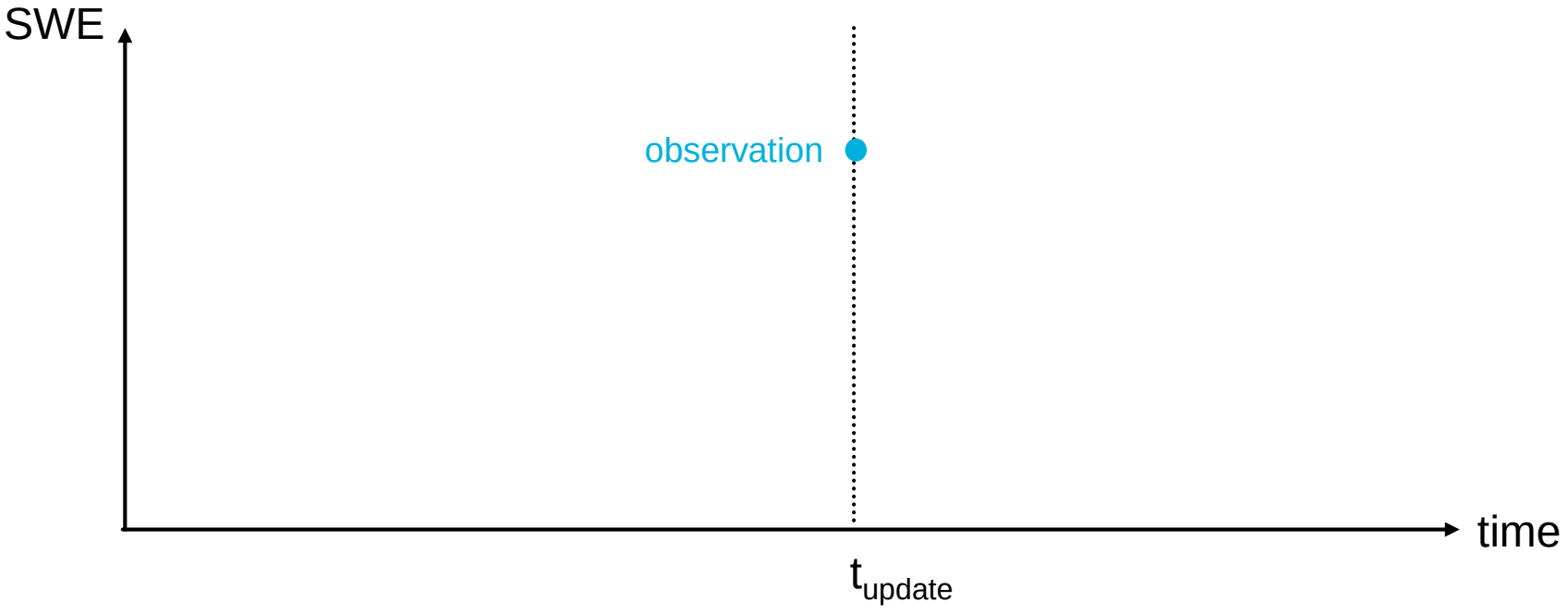
Experiments



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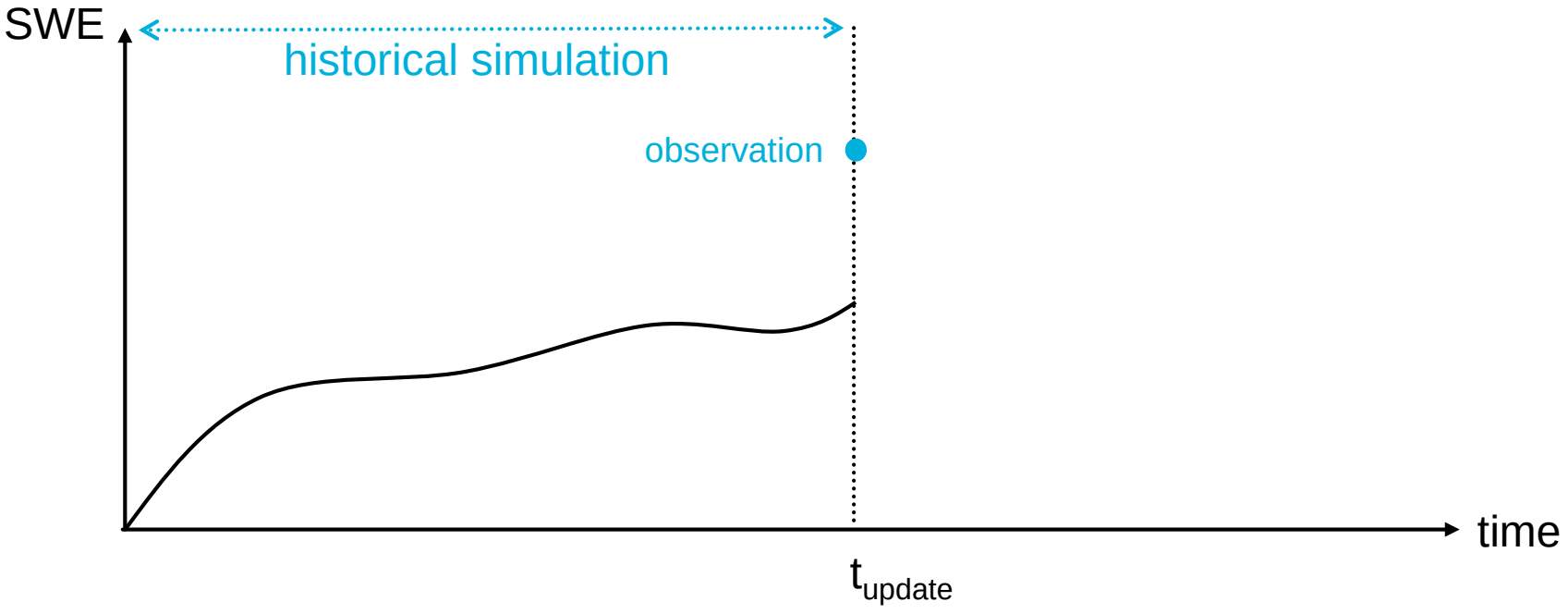

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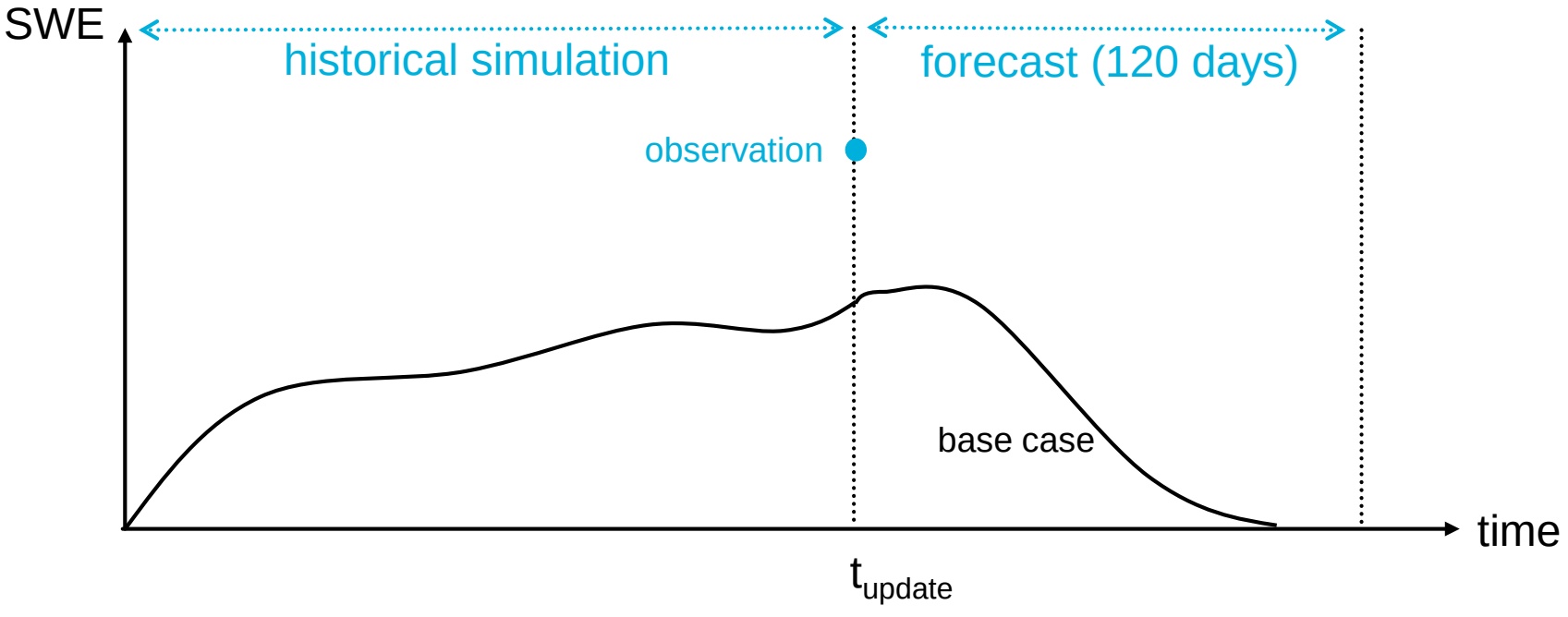

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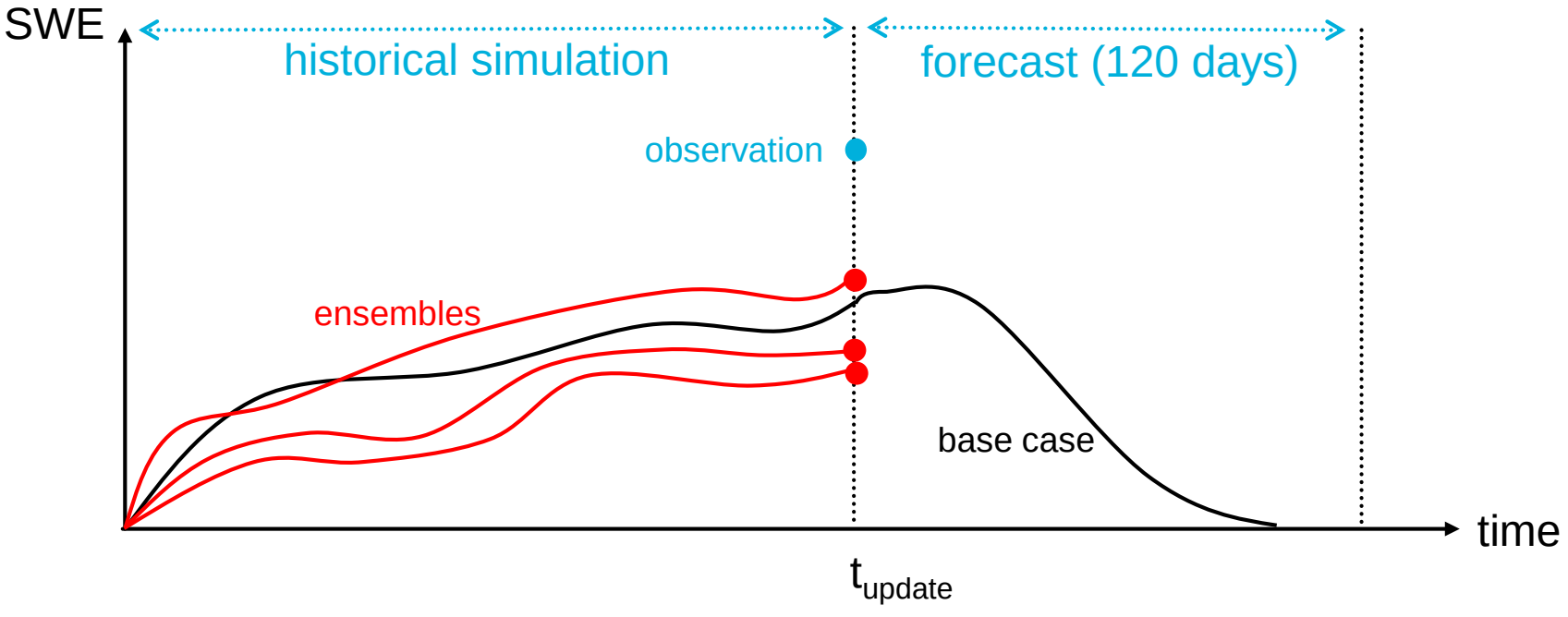

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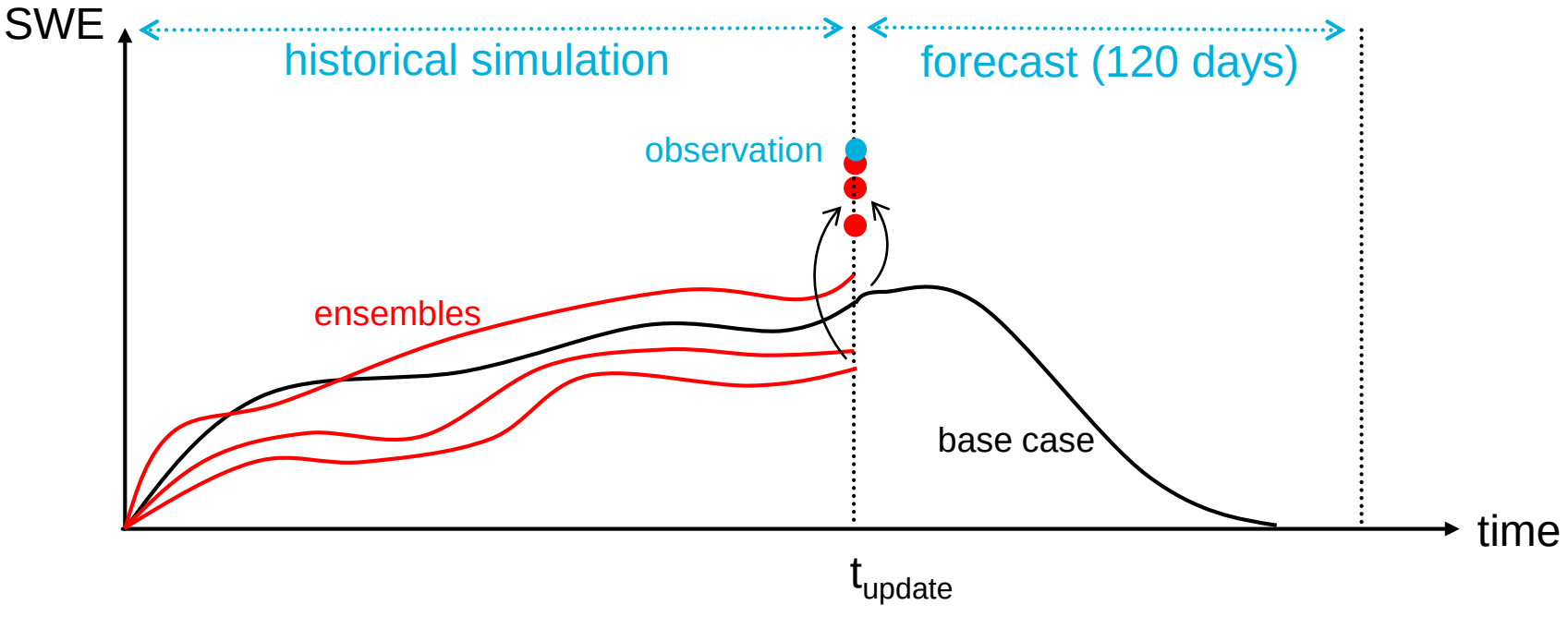

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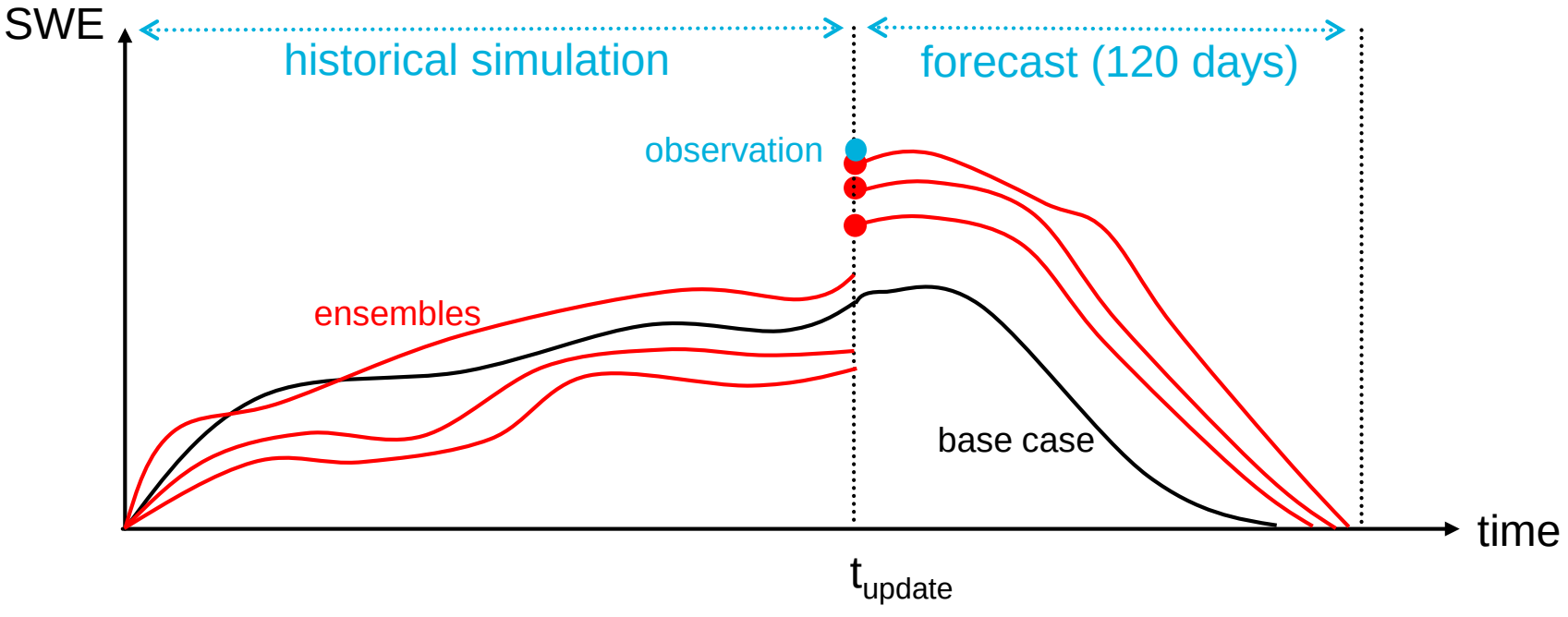

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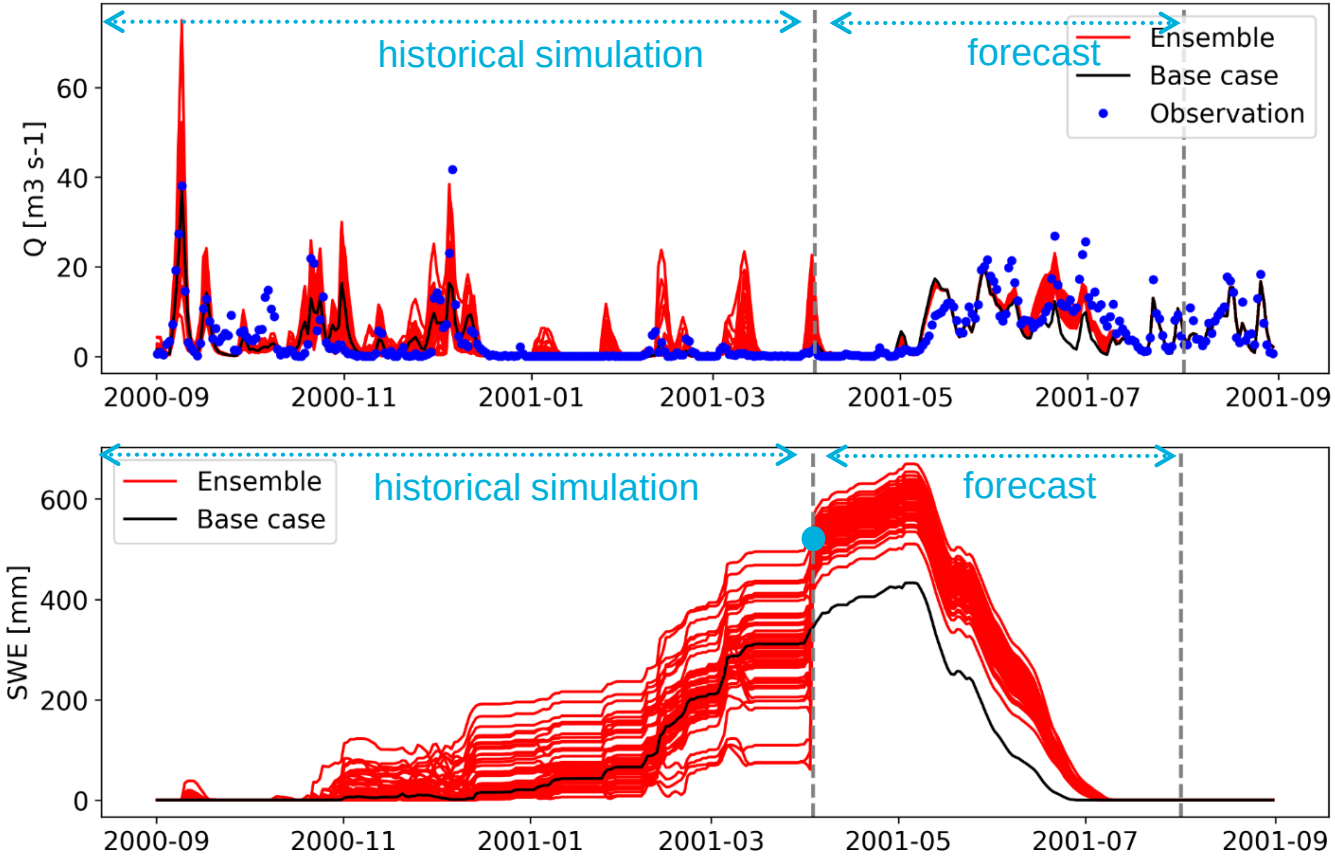
Results



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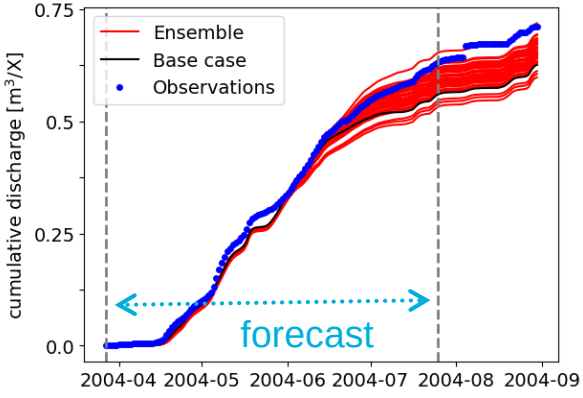

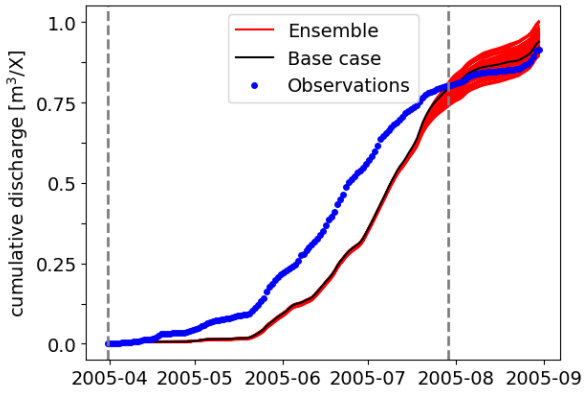

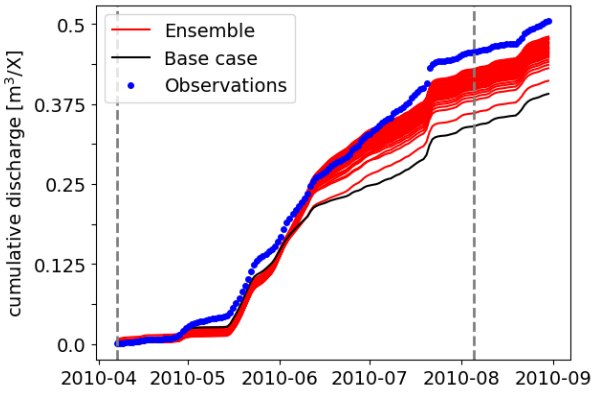

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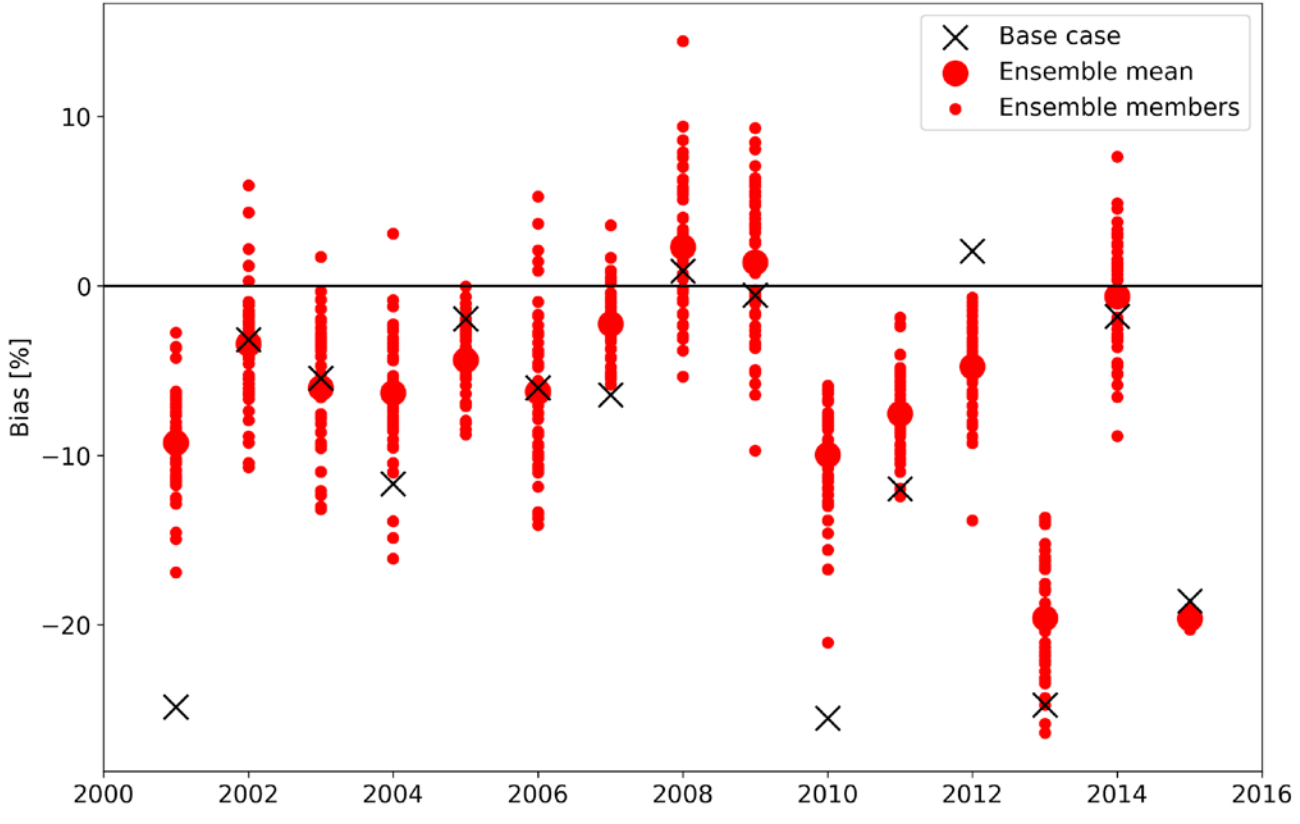

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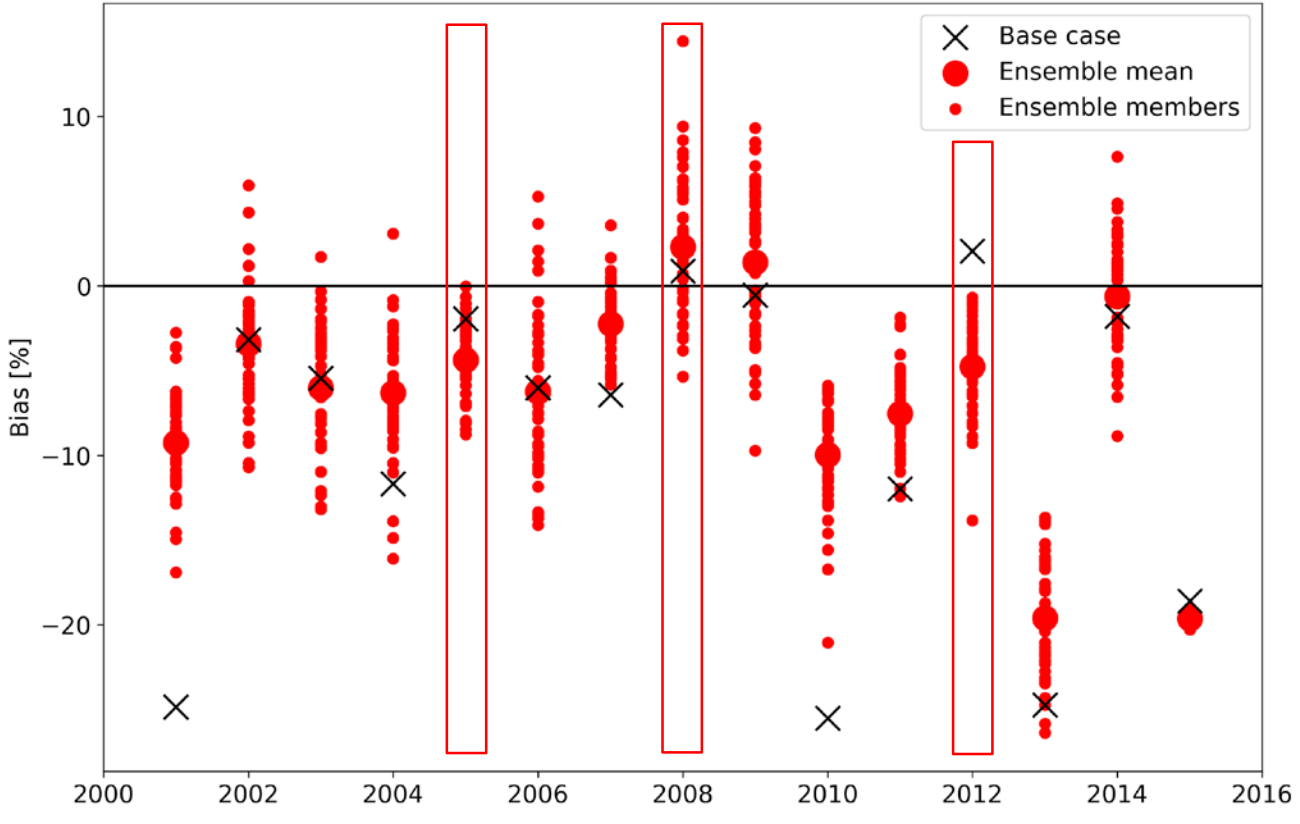

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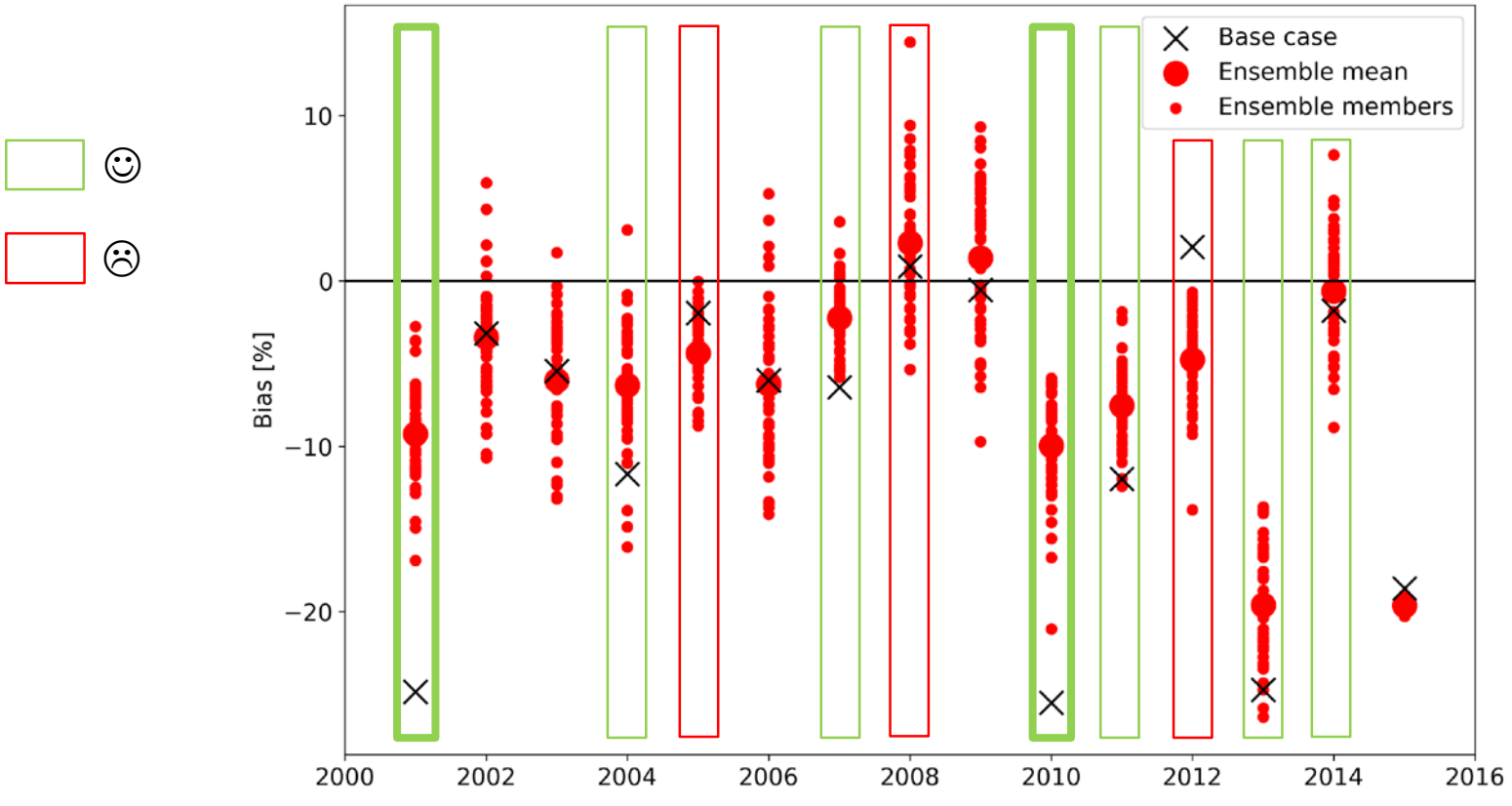
Base case
Ensemble mean
Ensemble members
Bias [%]
10
0
−10
−20
2000
2002
2004
2006
2008
2010
2012
2014
2016

Results

Grønebotn	Katladalene	Ovridsfjell	MAE [%]
			10
X			7
	X		6
		X	15
X	X		6
X		X	8
	X	X	8
X	X	X	7

Summary

- Performance of updating algorithm tested by comparing simulated to observed discharge in a 120 days forecast period and 15 snow seasons
- Benchmark against basecase without updating
- 7 years show improvements, 2 of which notably
- 3 years show small decrease in model performance
- Data from one measurement location tended to degrade the forecast

THANK YOU

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