Deltares

Dealing with various sources of uncertainty in the operational control of water systems using ensemble based MPC with convex optimization

Acknowledgements:
Funded by the Rijkswaterstaat Corporate Innovation Programme 2019

K. Horváth, M. Smoorenburg, D. Vreeken, R. Sinnige, R. Alvarado, T. Piovesan

HS3.3 is scheduled for a live chat on
Thursday, 07 May 2020, 08:30-10:15.

HS4.4

Ensemble and probabilistic hydro-meteorological forecasts: predictive uncertainty, verification and decision making

Convener: Albrecht Weerts | Co-conveners: Shaun Harrigan[ECS], Schalk Jan van Andel, Fredrik Wetterhall, Jan Verkade, Kolbjorn Engeland

Displays

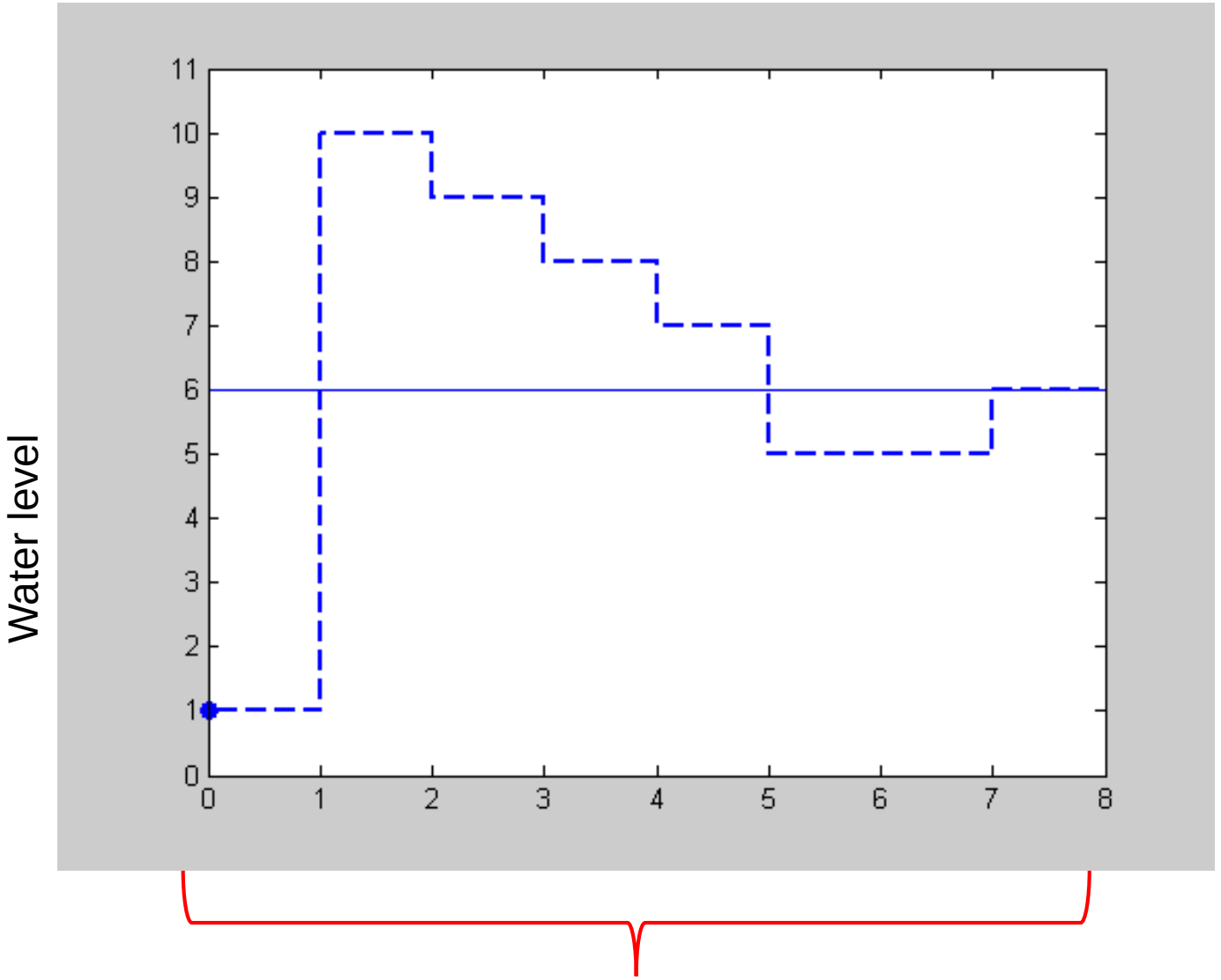
| Chat Fri, 08 May, 08:30–12:30

EGU2020-19132

Comparison of model predictive control methods that can account for uncertainties in forecasts of flood discharge and storm surge; case study Volkerak-Zoommeer, the Netherlands by Maarten Smoorenburg et al.

Deltares

Predictive Control



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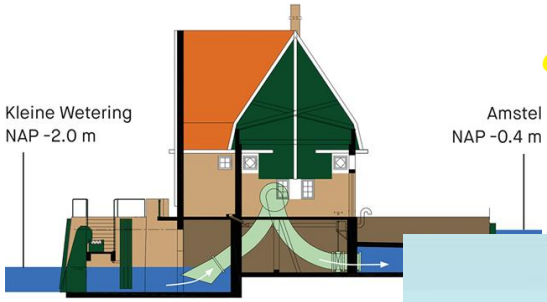
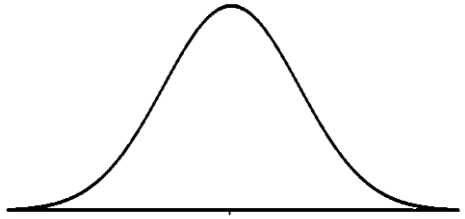
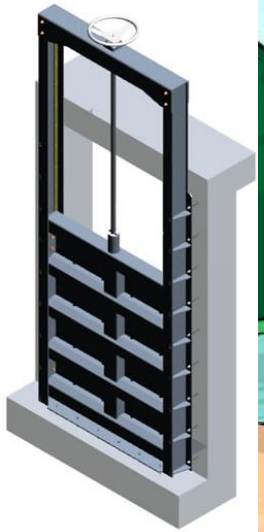
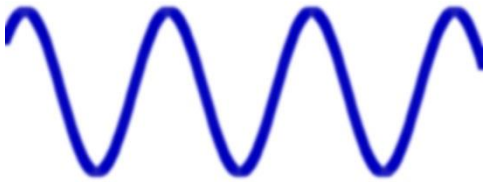
Water system



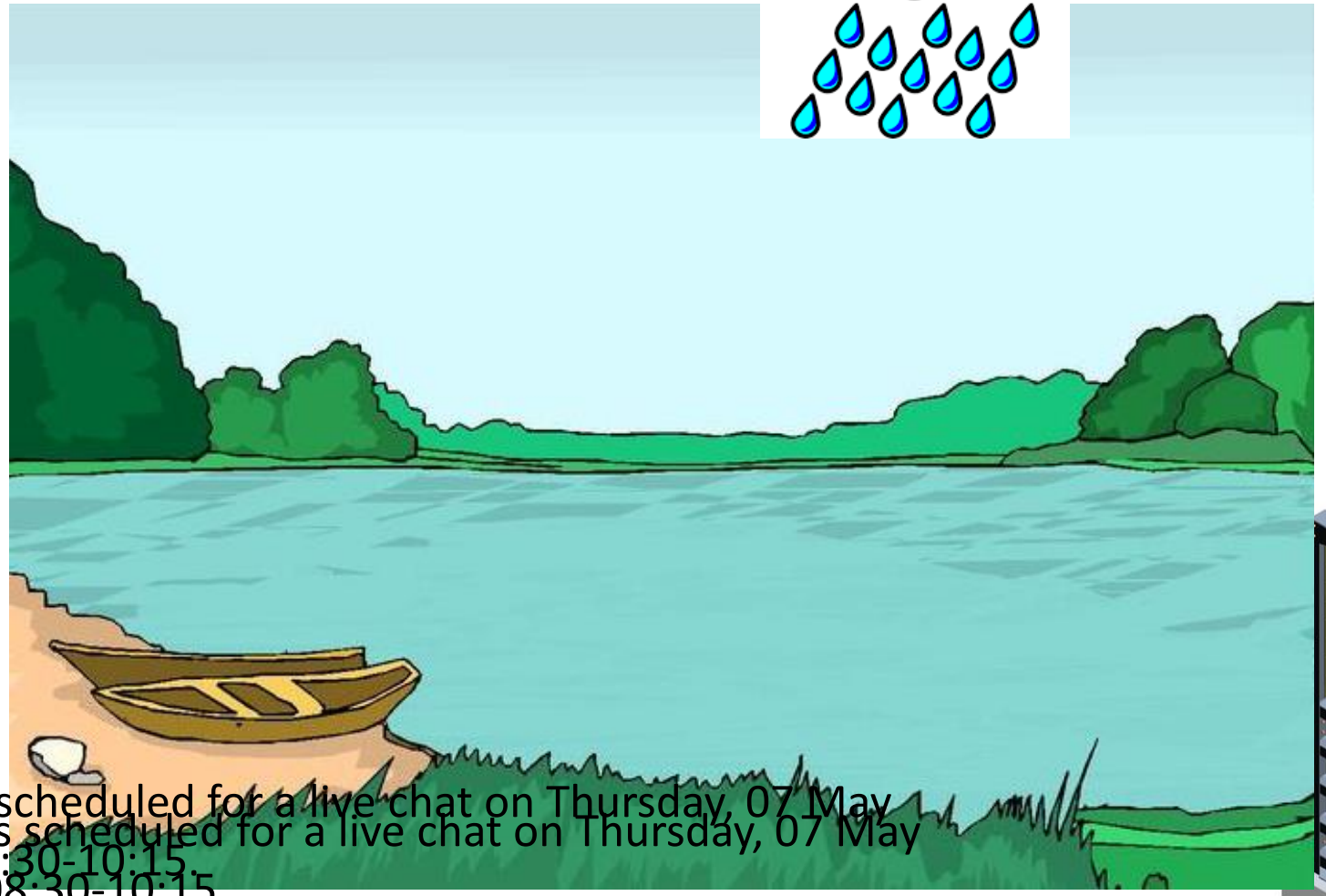


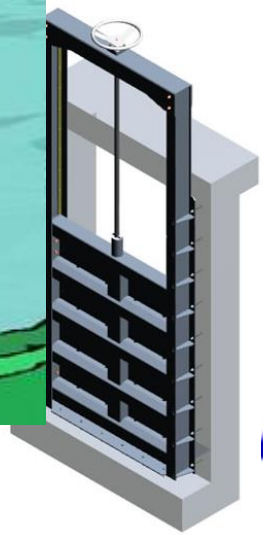




Deltares

Water system





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Deltares

$$\frac{V(k+1)-V(k)}{\Delta t} = Q_{in}(k+1) - Q_{out}(k+1)$$

k=0,..., λ

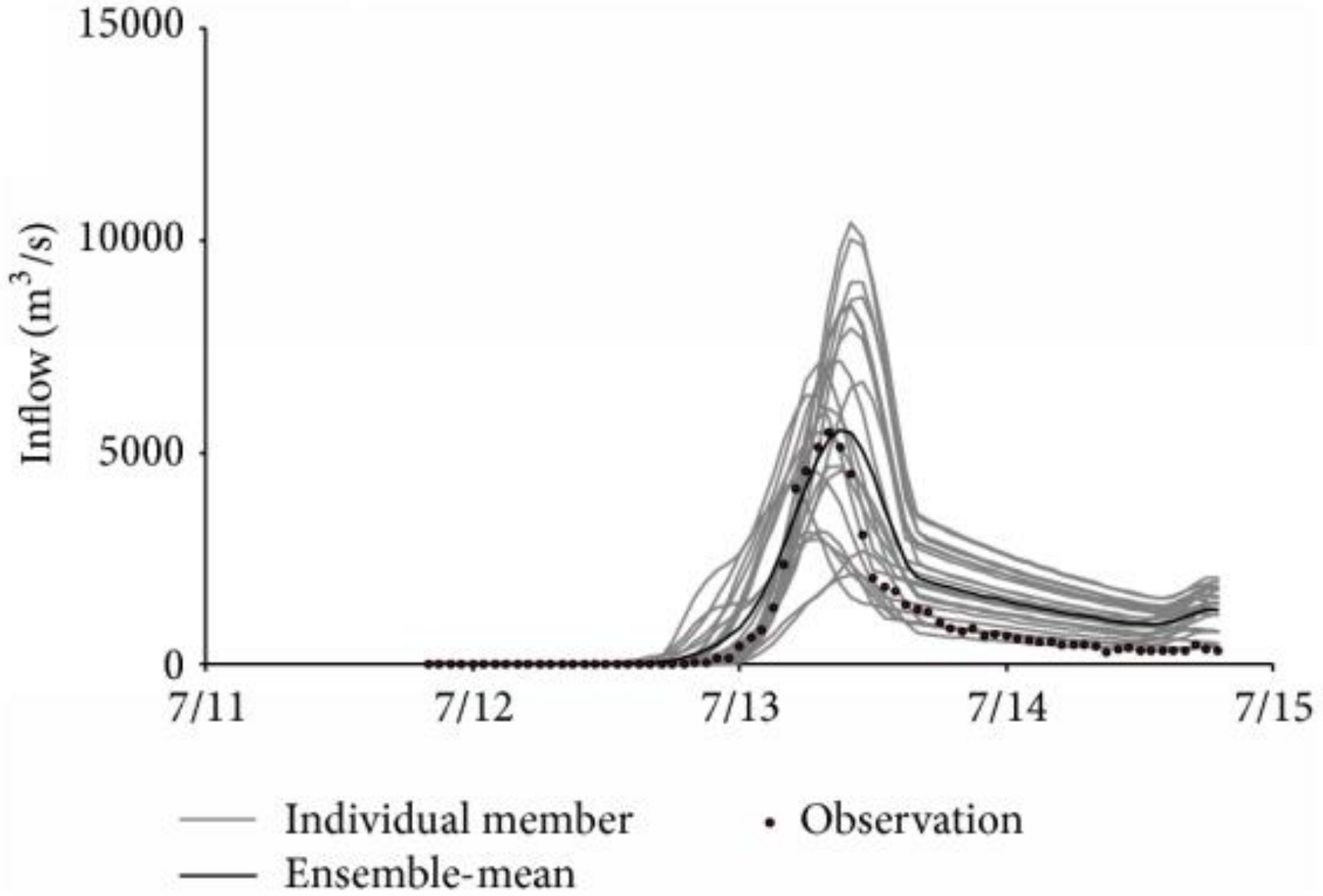
V(0) inital condition

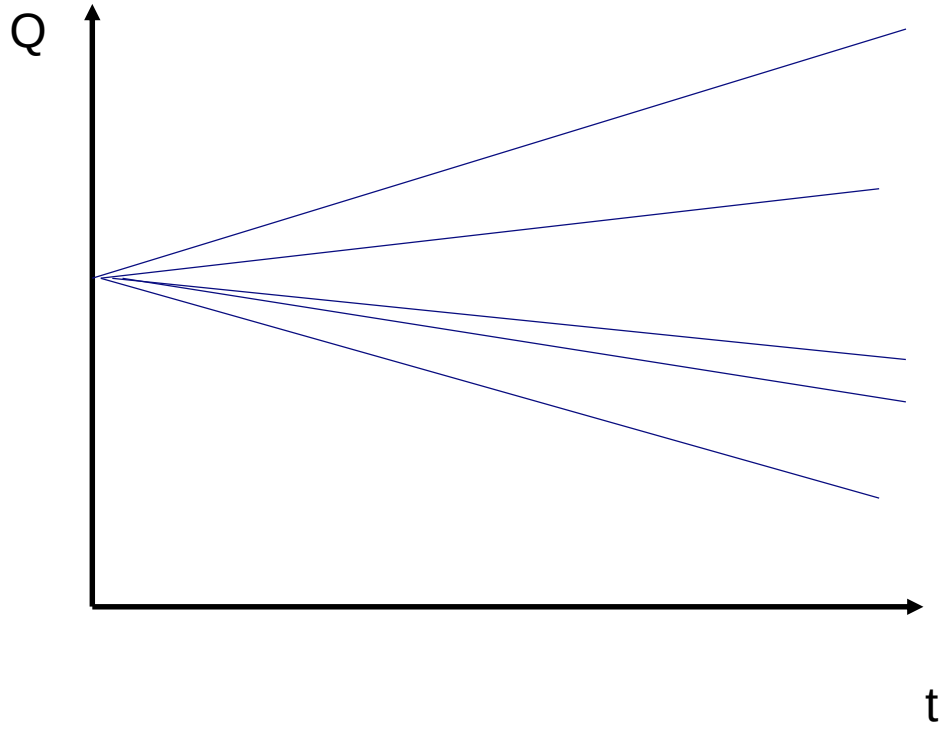
Qin(k): boundary condition

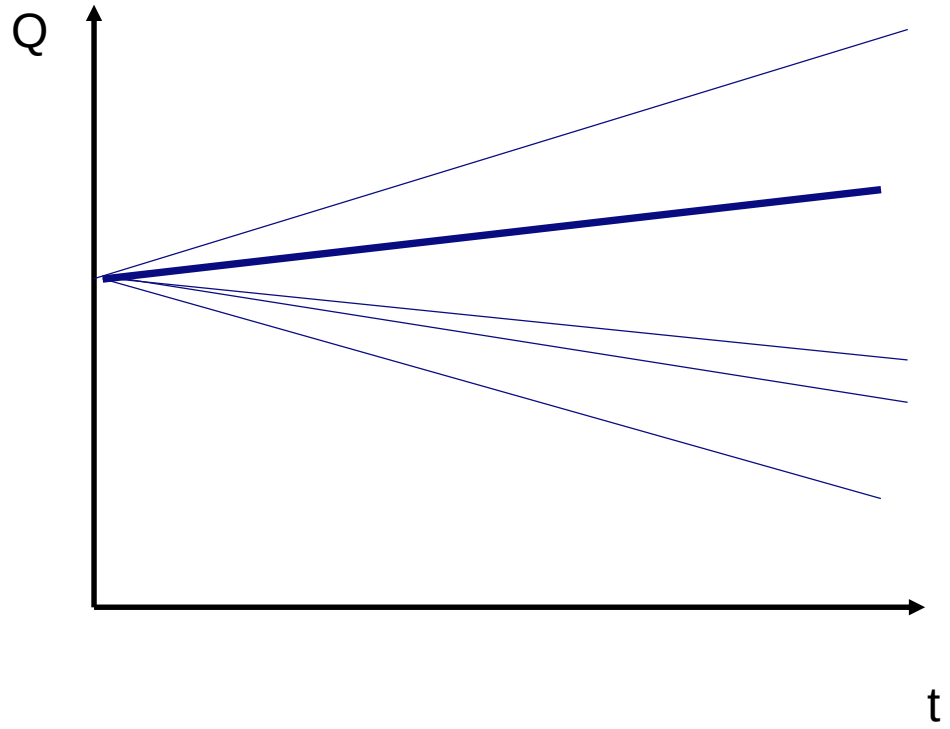
Qout(k): ?

$V_{min} < V(k) < V_{max}$

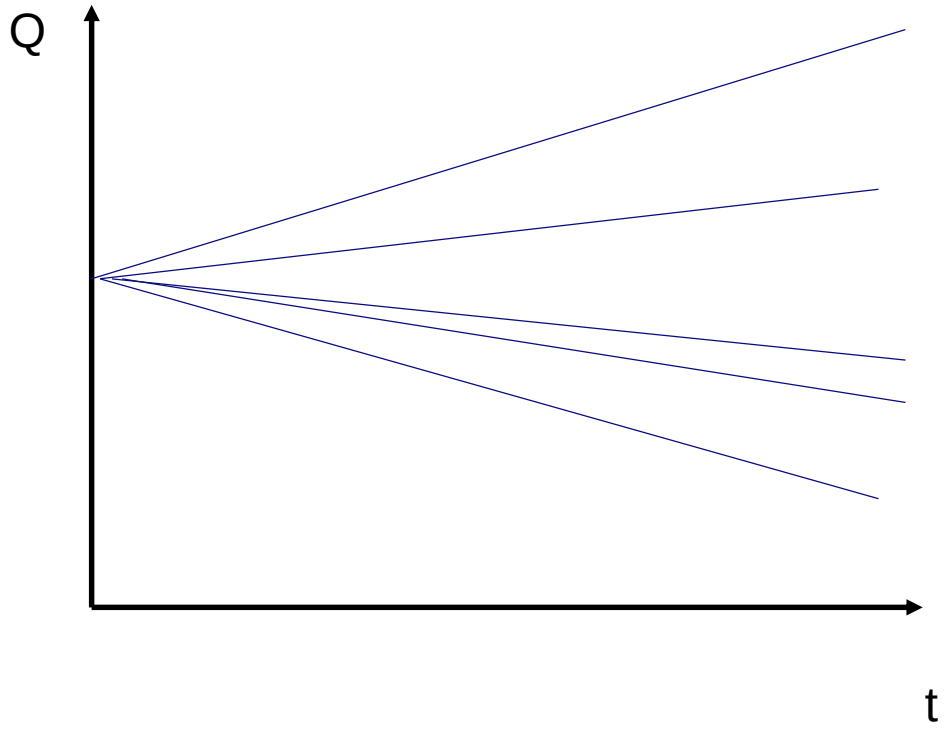
Deltares

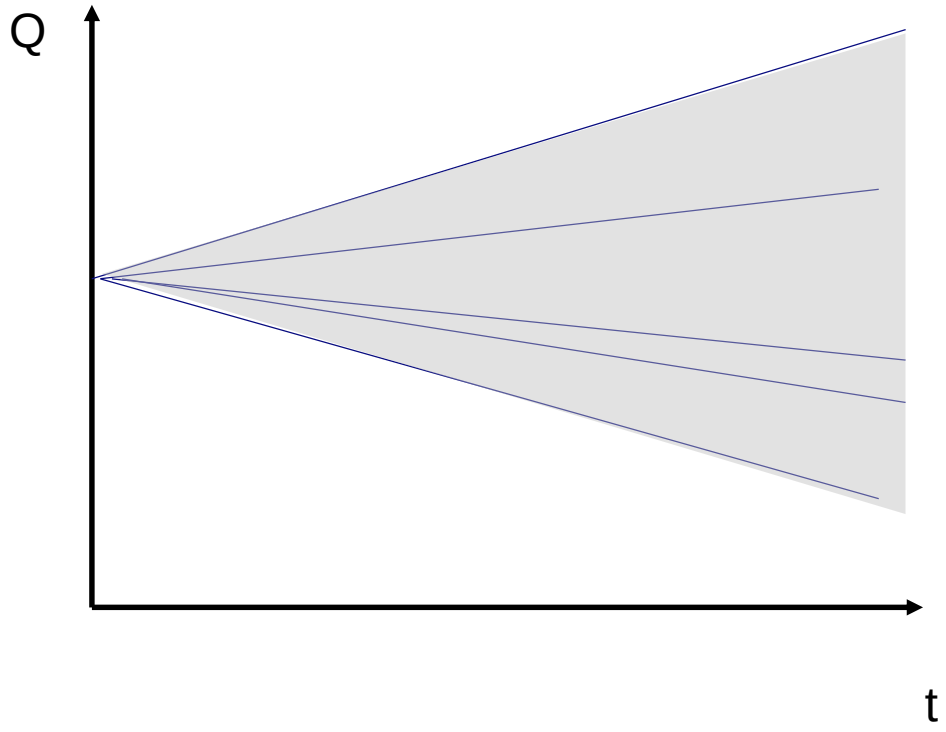

15000
10000
5000
0
Inflow (m^3/s)
7/11
7/12
7/13
7/14
7/15
Individual member
Ensemble-mean
Observation





Deltares





Deltares

$$\frac{V(k+1)-V(k)}{\Delta t} = Q_{in}(k+1) - Q_{out}(k+1)$$

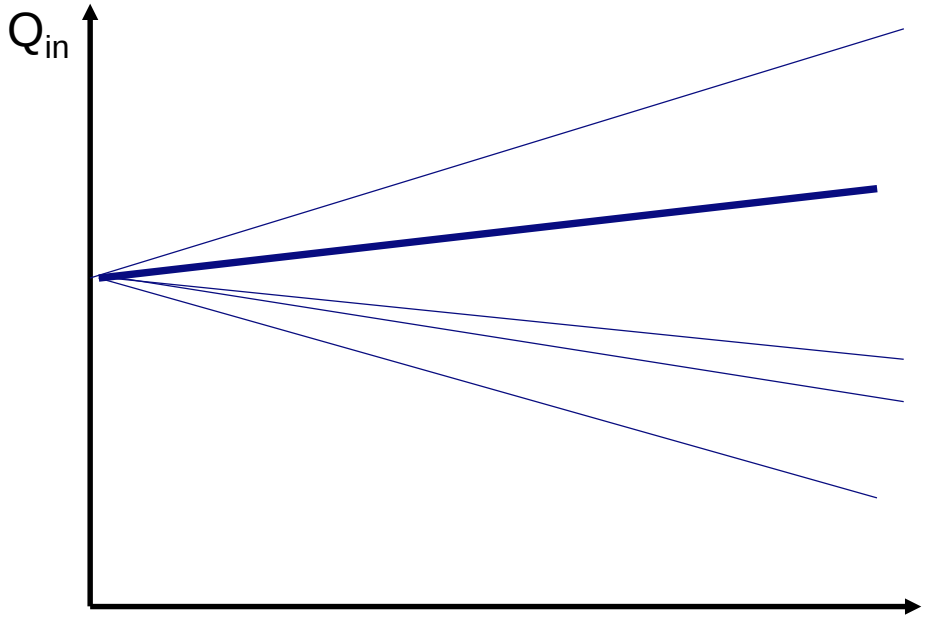
k=0,..., λ

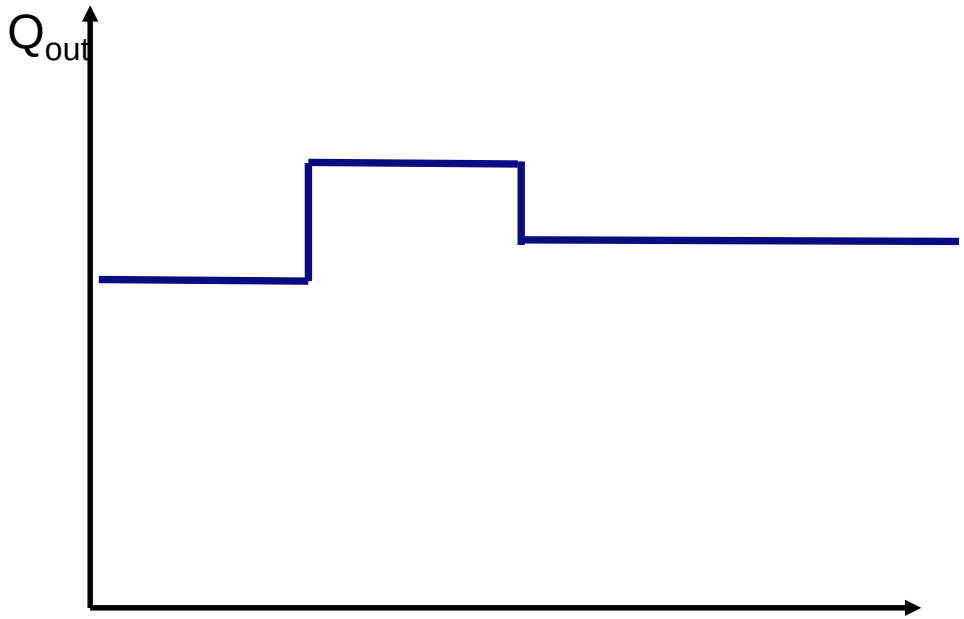
V(0) inital condition

Qin(k): boundary condition

Qout(k): ?

$V_{min} < V(k) < V_{max}$





Deltares

$$\frac{V(k+1)-V(k)}{\Delta t} = Q_{in}(k+1) - Q_{out}(k+1)$$

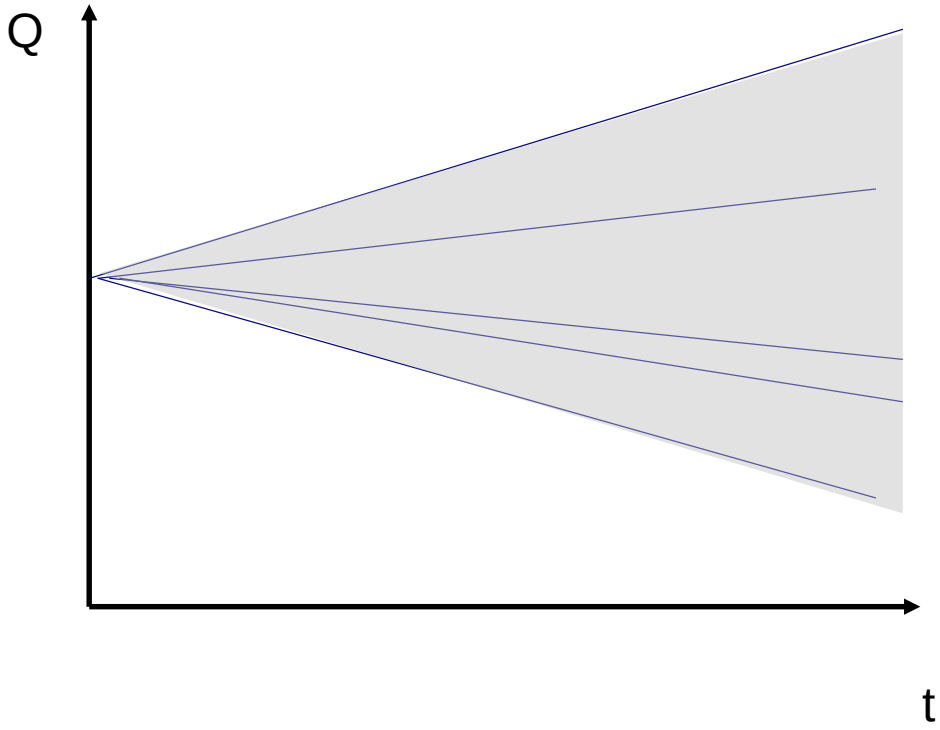
k=0,..., λ

V(0) inital condition

Qin(k): boundary condition

Qout(k): ?

$V_{min}<V(k)<V_{max}$



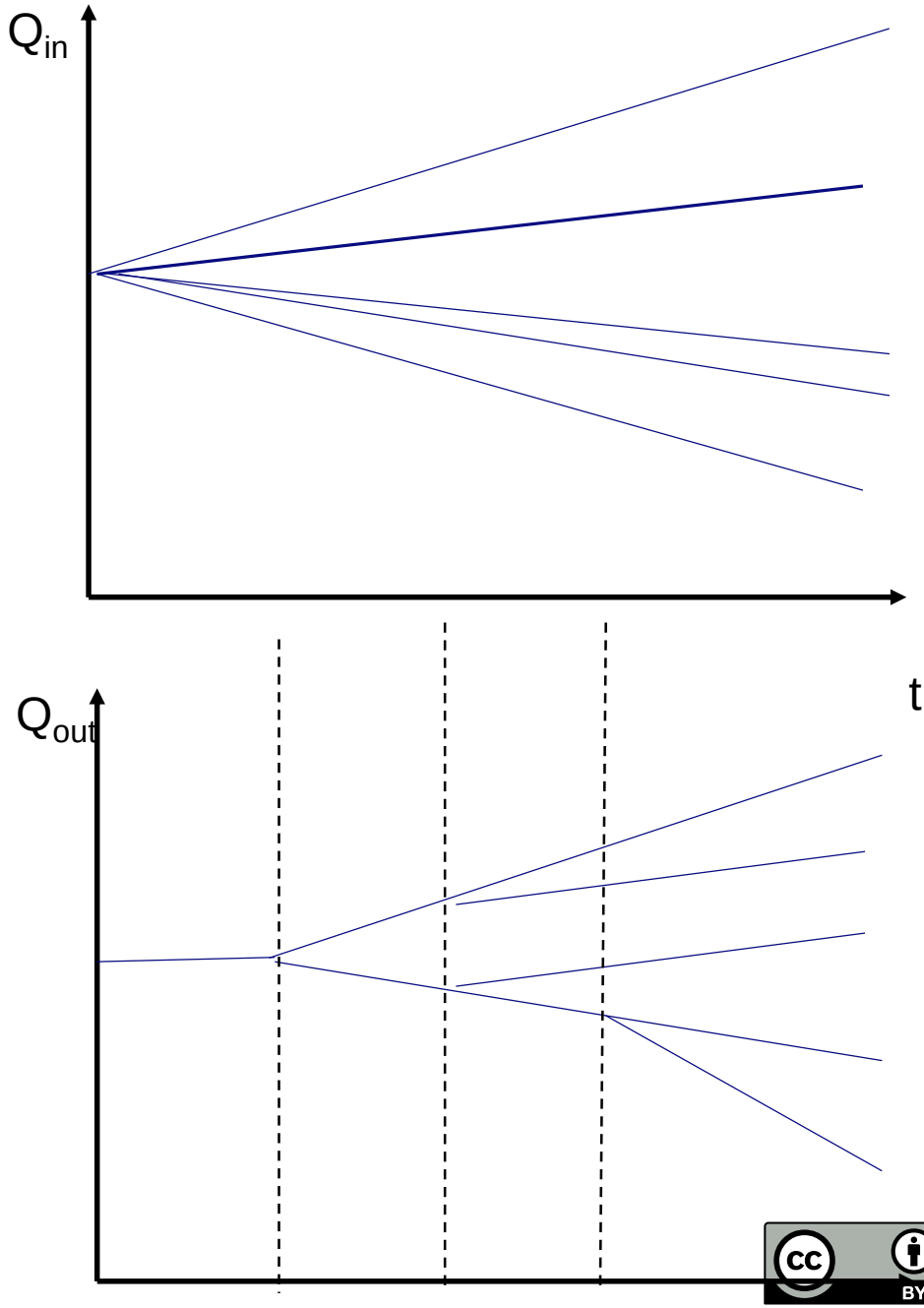
$$\frac{V^{e1}(k+1)-V^{e1}(k)}{\Delta t} = Q_{in}^{e1}(k+1) - Q_{out}(k+1)$$

$V_{min}<V^{e1}(k)<V_{max}$

Number of equations: e x λ x 3

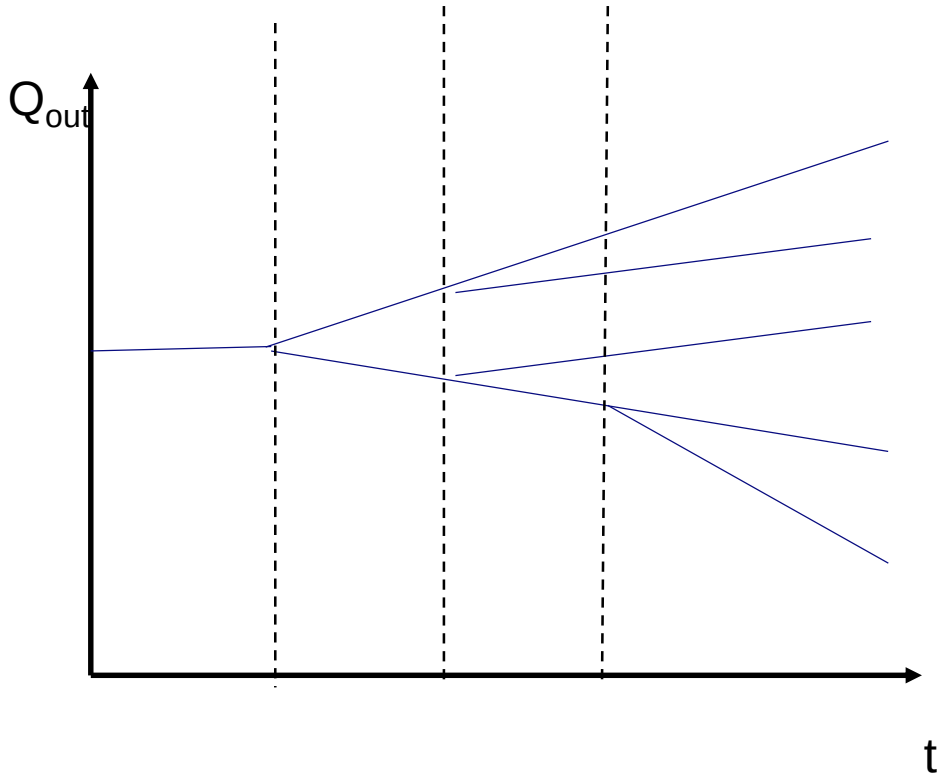
Ensemble: e1, e2, ..., ee

Deltares



Raso, Luciano, et al. "Tree-scenario based model predictive control." *EGU General Assembly Conference Abstracts*. Vol. 12. 2010.

Raso, Luciano. "Optimal control of water systems under forecast uncertainty: robust, proactive, and integrated." (2013).



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Raso, Luciano. "Optimal control of water systems under forecast uncertainty: robust, proactive, and integrated." (2013).

Deltares

$$\frac{V^{e1}(k+1)-V^{e1}(k)}{\Delta t}=Q_{in}^{e1}(k+1)-Q_{out}^{e1}(k+1)$$

$V_{min}<V^{e1}(k)<V_{max}$

$$Q_{out}^{e1}(1)=Q_{out}^{e2}(1)$$

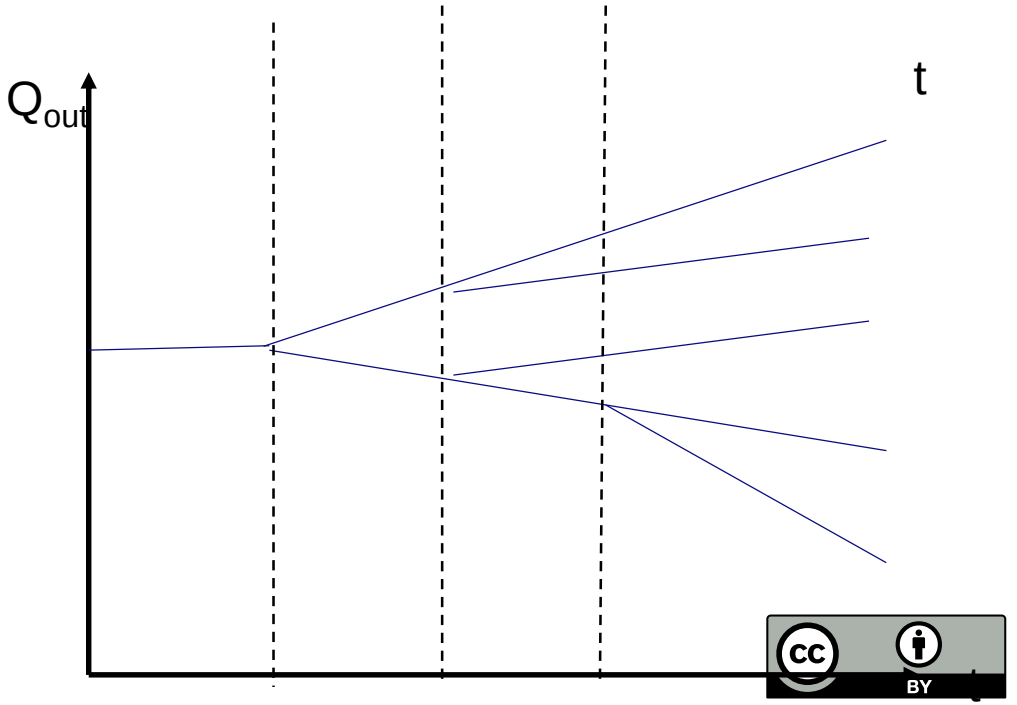
k=0,..., λ

V(0) inital condition

Qin(k): boundary condition

Qout(k): ?

$V_{min}<V(k)<V_{max}$



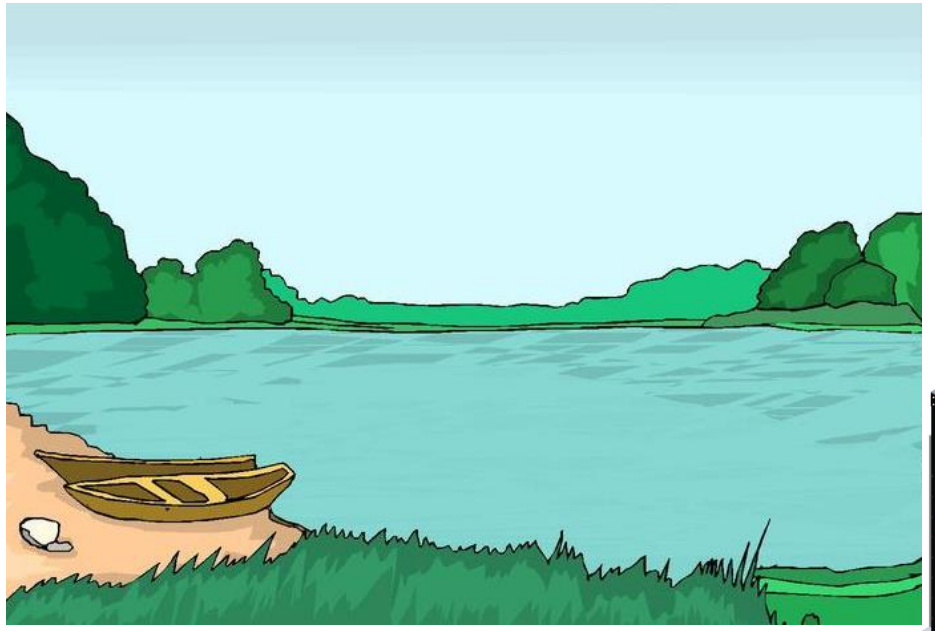
12 time steps

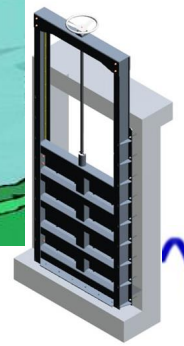
10 ensemble members

Mixed integer problem: open or close the gates

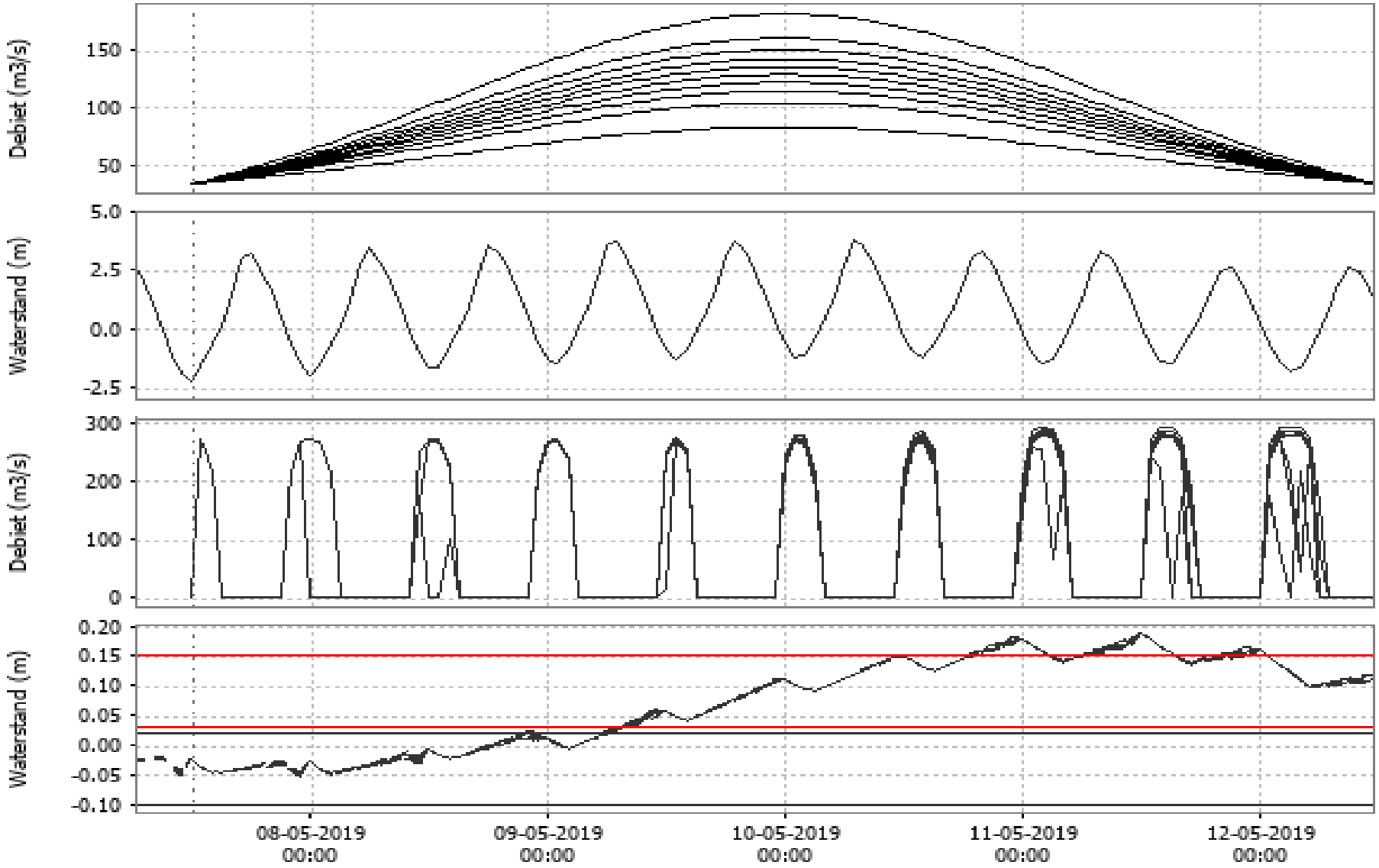
Closed-loop test: control model and test model is different!

Two inputs as ensembles





Deltares RTC-Tools



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MPC using ensembles

Deltares RTC-Tools

www.deltares.nl

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