

Impact of time displaced precipitation estimates for online updated models

Uncertainty and adaptive estimation in storm- and wastewater system modelling

Morten Borup

DTU Environment & Krüger A/S, Veolia VWS Denmark

Morten Grum

Krüger A/S, Veolia VWS Denmark

Peter Steen Mikkelsen

DTU Environment

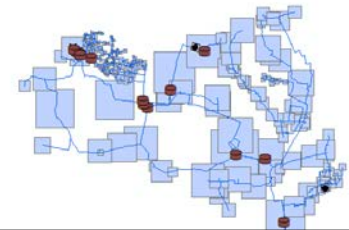
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Department of Environmental Engineering



Rain detection for runoff modelling

- **Gauges:** No Movement, no spatial distribution. Accurate.
- **Radar:** Movement, Spatial distribution. Inaccurate.

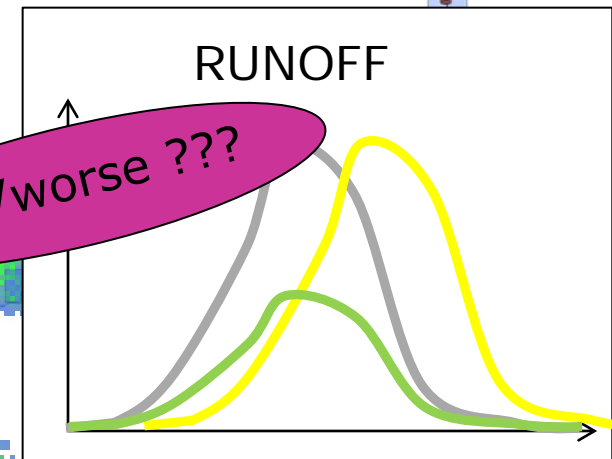


Rain detection method affect nature of model errors

GAUGES: Time displacements

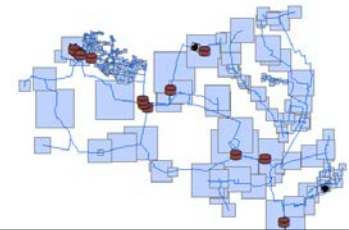
RADAR: Scaling

Best/worse ???



Rain detection for runoff modelling

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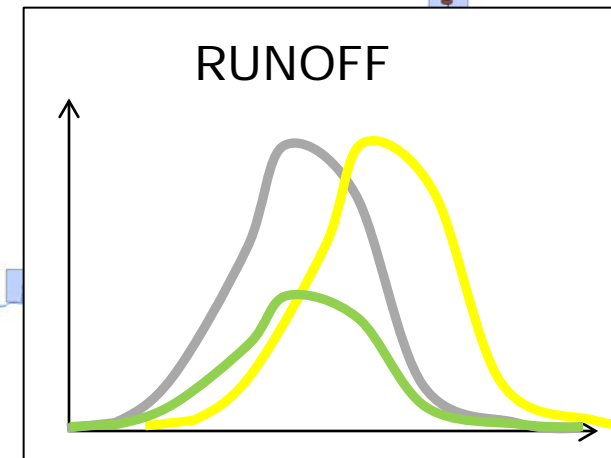
Updated online models

Can not distinguish time shifts from magnitude errors.

Updating: Synchronization issues.

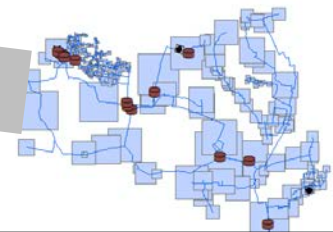
Objective:

Compare impact of time displaced rain data with that of scaled rain data for online updated models.

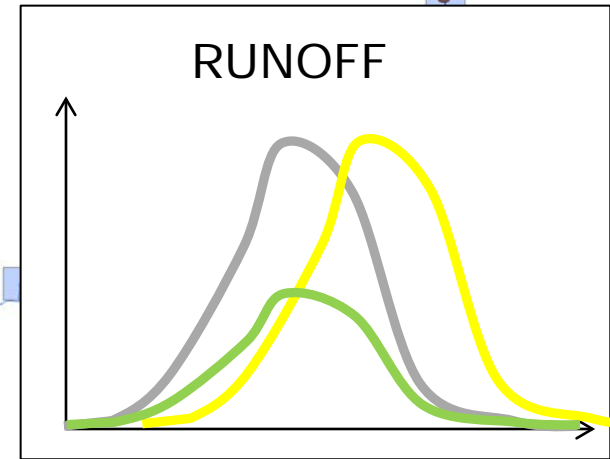


Simplification/assumptions

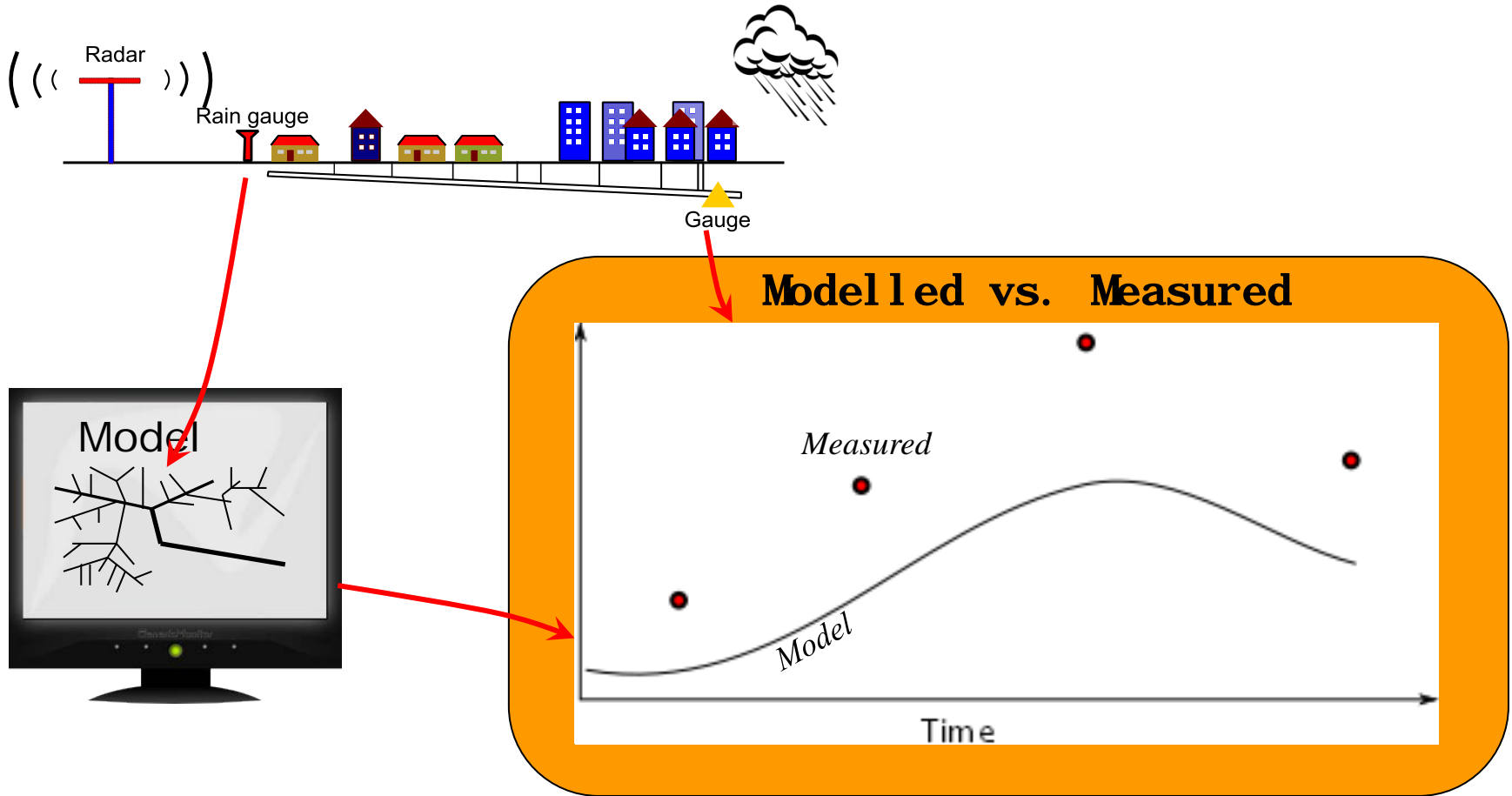
- Gauges: **BAD TIMING** ~~no spatial distribution~~ **Accurate.**
- Radar: **CORRECT TIMING** ~~spatial distribution~~ **Mis-scaled**



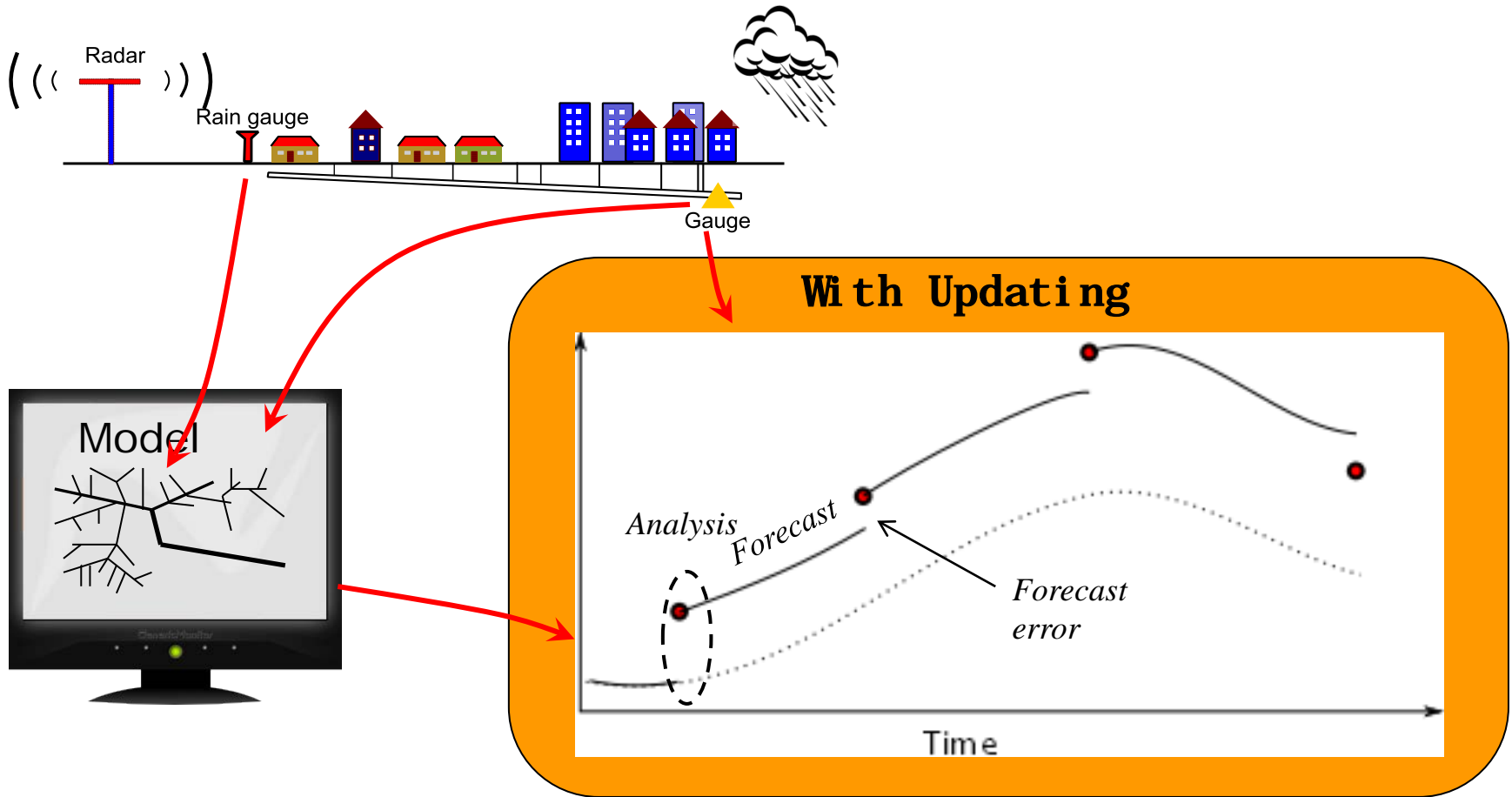
1d setup
 Movement = time displacement



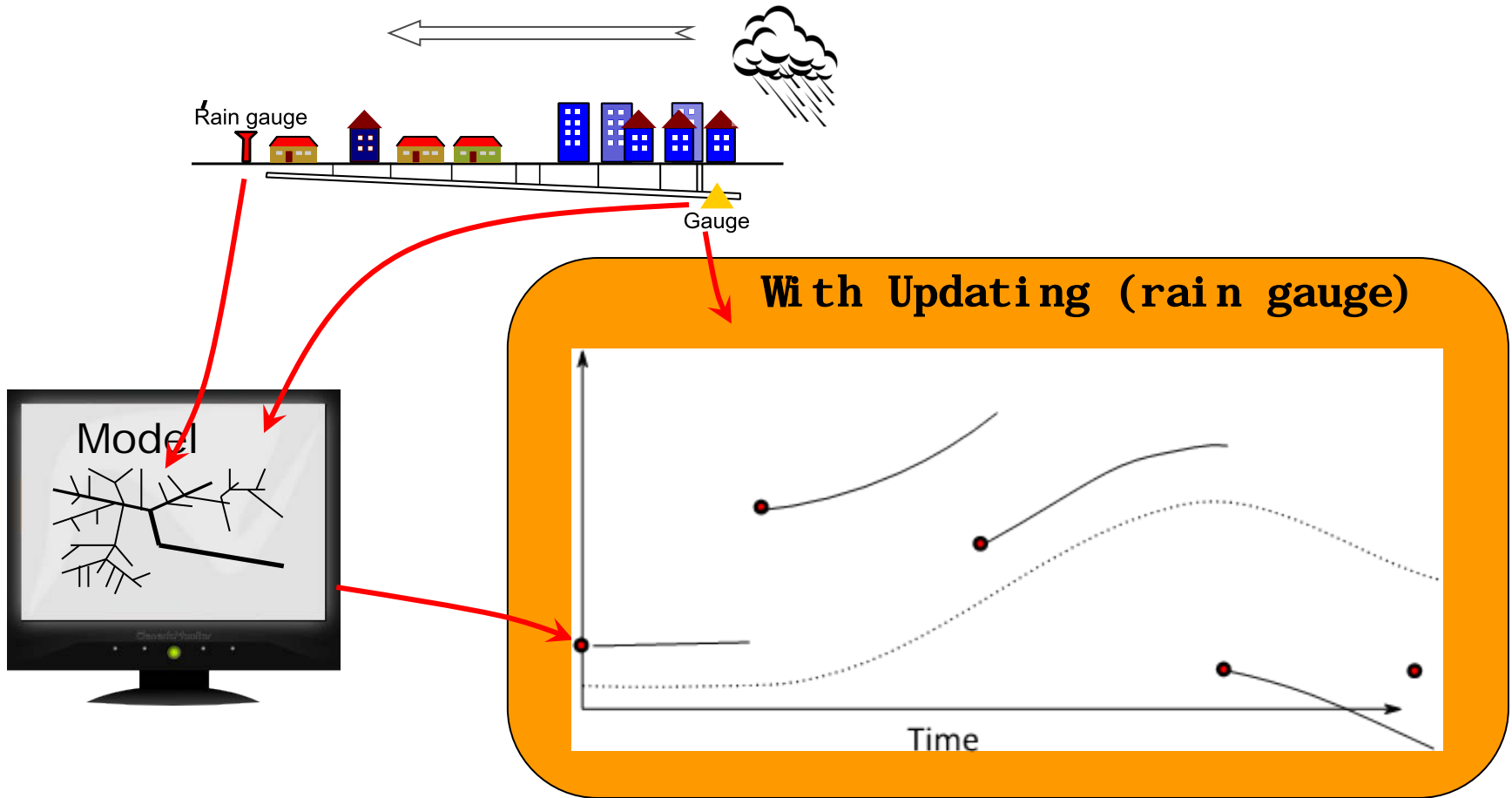
Online storm water model



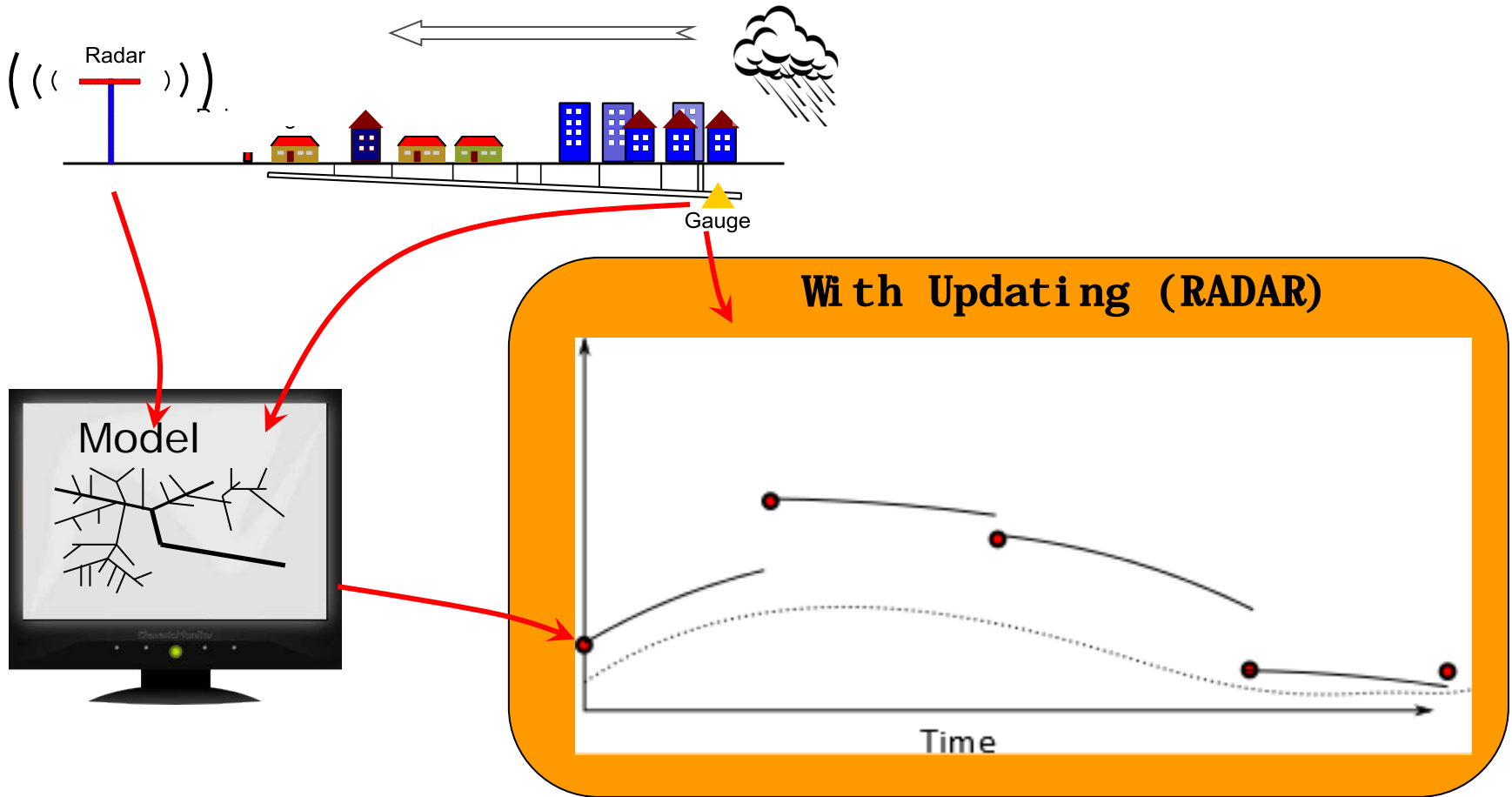
Online storm water model



Online storm water model

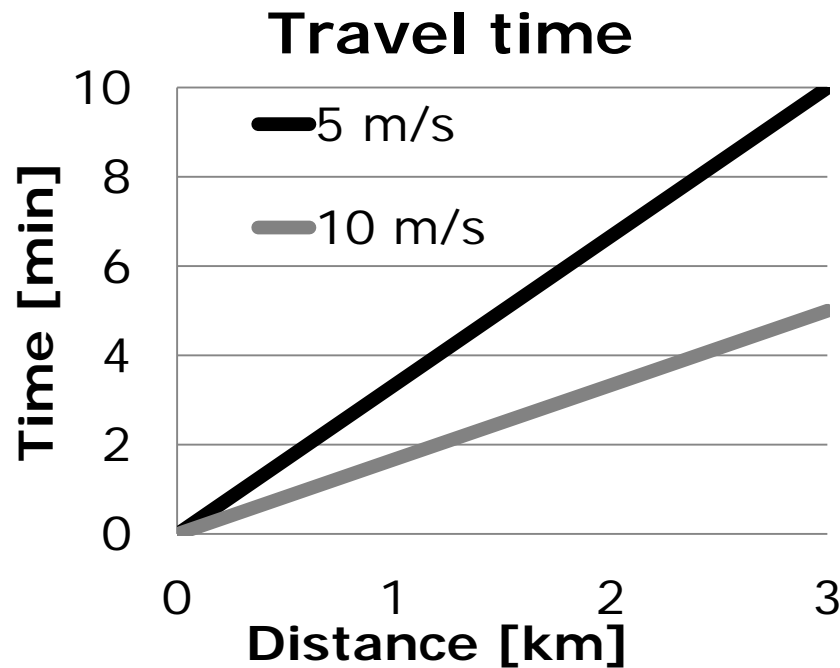


Online storm water model

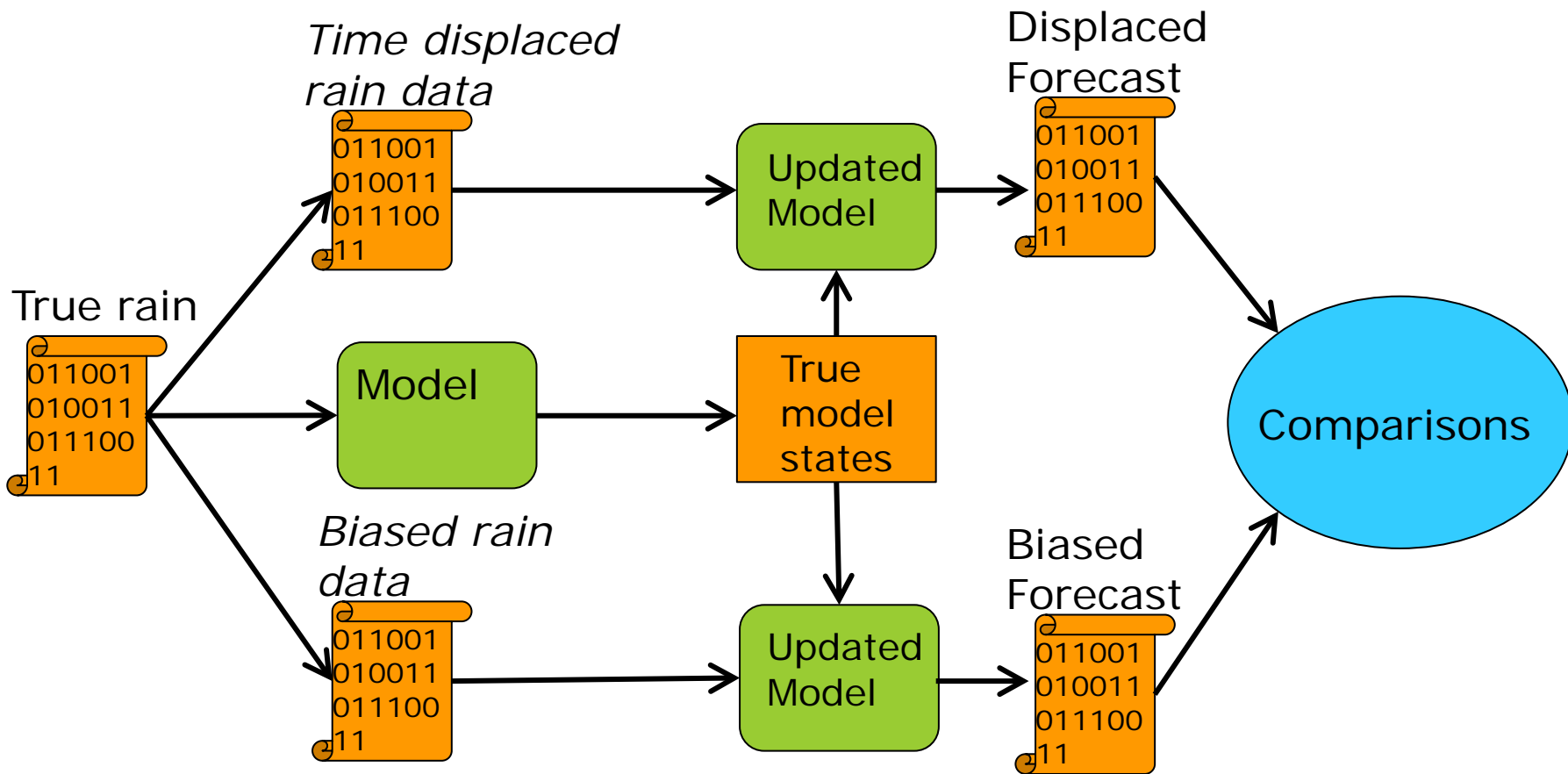


Size of displacements

- **Average** rain cell velocity in northern Europe 10 m/s
- 5 m/s not unusual



Methodology



Rain data

- Precipitation truth

$$P_{true} = SvK 28184 (1995 - 2005)$$

- Displaced rain data (rain gauge)

$$P_{disp}(t) = P_{true}(t - a)$$

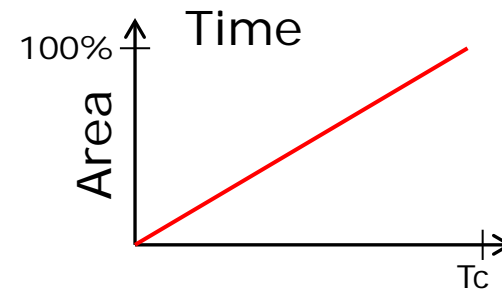
- Biased rain

$$P_{bias}(t) = c \cdot P_{true}(t), \quad c = 1 \pm \frac{bias}{100}$$

Model

- Time Area model

$$Q(t) = \frac{A}{T_c} \sum_{i=t-T_c}^t P(i)$$



- Observation (true runoff)

$$Q_{obs}(t) = \frac{A}{T_c} \sum_{i=t-T_c}^t P_{true}(i)$$

- Updated forecast model (x min. forecast)

$$Q_x(t) = \frac{A}{T_c} \left(\sum_{i=t-T_c}^{t-x-1} P_{true}(i) + \sum_{i=t-x}^t P_f(i) \right), \quad \text{for } x < T_c$$

Error quantification

- Forecast error

$$e(t) = Q_{obs}(t) - Q_x(t) = \frac{A}{Tc} \left(\sum_{i=t-Tc}^t P_{true}(i) - \sum_{i=t-Tc}^{t-x-1} P_{true}(i) - \sum_{i=t-x}^t P_f(i) \right)$$

$$= \frac{A}{Tc} \sum_{i=t-x}^t (P_{true}(i) - P_f(i)) \quad \text{for } x < Tc$$

Catchment
specific

Rain estimation
error

- SS_{err}

$$\sum_{i=1}^n e(i)^2 = \left(\frac{A}{Tc} \right)^2 \sum_{j=1}^n \left(\sum_{i=t-x}^t (P_{true}(i) - P_f(i)) \right)^2$$

Convenient properties

- $SS_{err}(disp)/SS_{err}(bias)$ independent of catchment:

$$\frac{SS_{err}(disp)}{SS_{err}(bias)} = \frac{\left(\frac{A}{Tc}\right)^2 \sum_{j=1}^n \left(\sum_{i=t-x}^t (P_{true}(i) - P_{true}(i-a)) \right)^2}{\left(\frac{A}{Tc}\right)^2 \sum_{j=1}^n \left(\sum_{i=t-x}^t (P_{true}(i) - c \cdot P_f(i)) \right)^2}$$

- Direction of time displacement without importance:

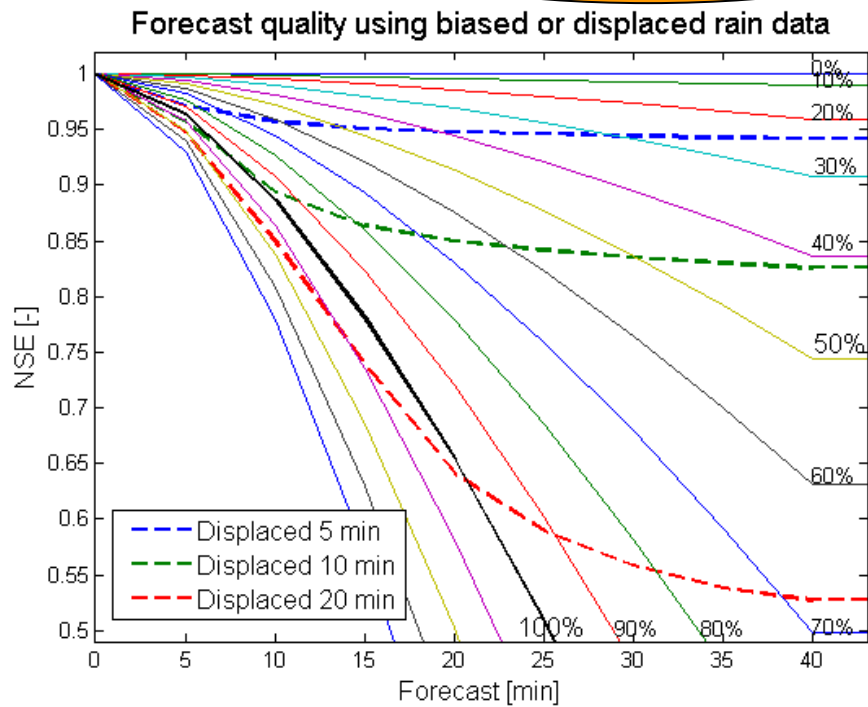
$$\sum_n |a_n - a_{n-c}| = \sum_n |a_n - a_{n+c}|$$

- No importance if bias is negative or positive:

$$\sum_n |P - P * 0.90| = \sum_n |P - P * 1.10|$$

Results

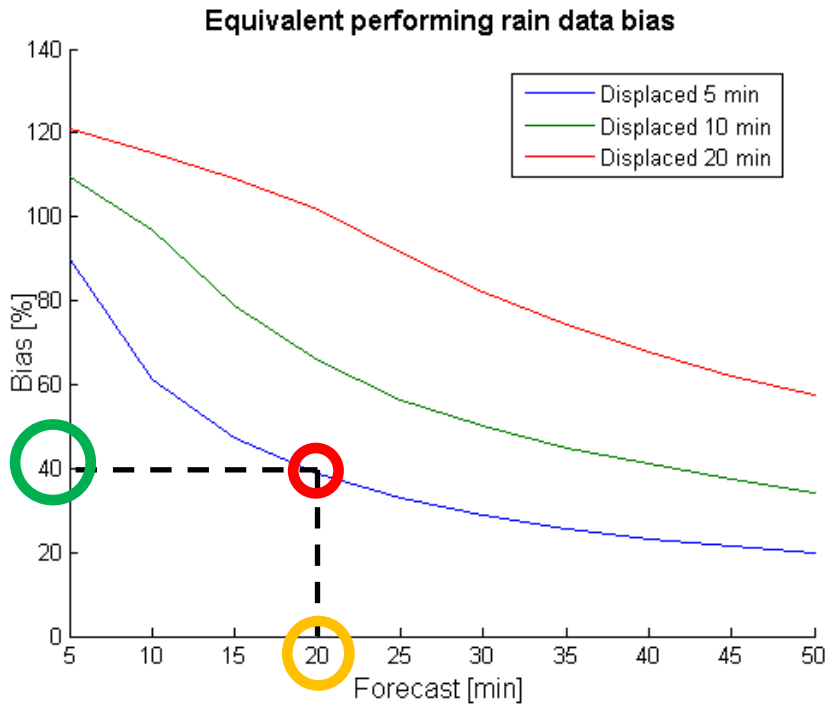
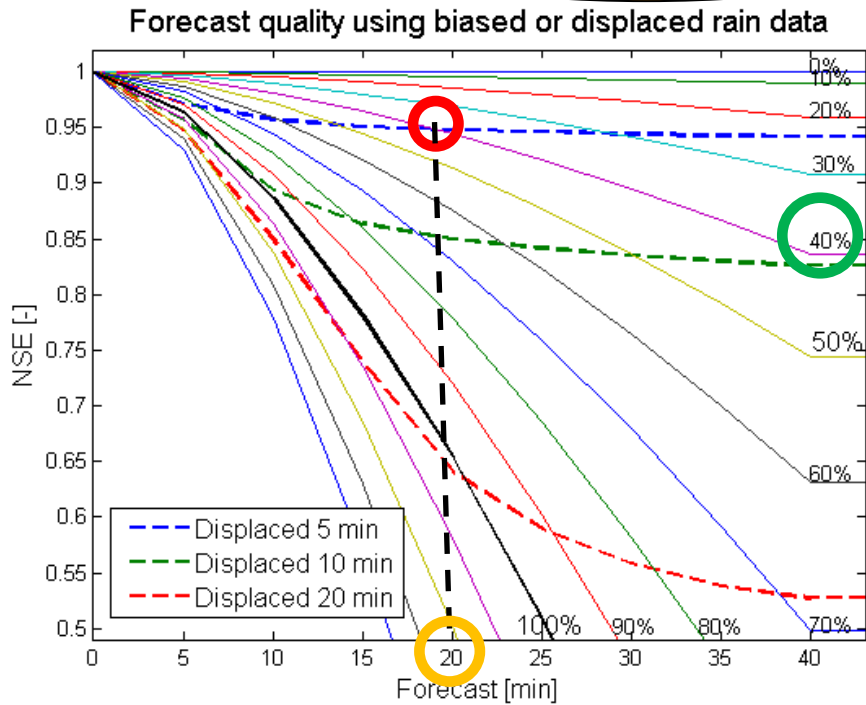
$T_c = 40$ minutes



Results

$T_c = 40$ minutes

$SS_{err}(disp.) = SS_{err}(bias)$
Any T_c



Conclusion

- Rain data requirements are different for updated models.

Independent of T_c :

- Frequent updating/short term forecasts:
 - Correct timing essential ->
 - (1) Radar better than gauges.
 - (2) Many bad gauges better than few good gauges.
- Infrequent updating/long forecasts:
 - Accuracy the more important.

Questions?



Spildevandscenter Avedøre



aarhusvand



AALBORG UNIVERSITY
DENMARK

KRÜGER



Lynettefællesskabet I/S