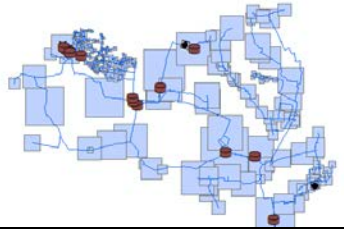
Impact of time displaced precipitation estimates for online updated models

Morten Borup
DTU Environment & Krüger A/S, Veolia VWS Denmark

Morten Grum
Krüger A/S, Veolia VWS Denmark
Peter Steen Mikkelsen
DTU Environment

Rain detection for runoff modelling

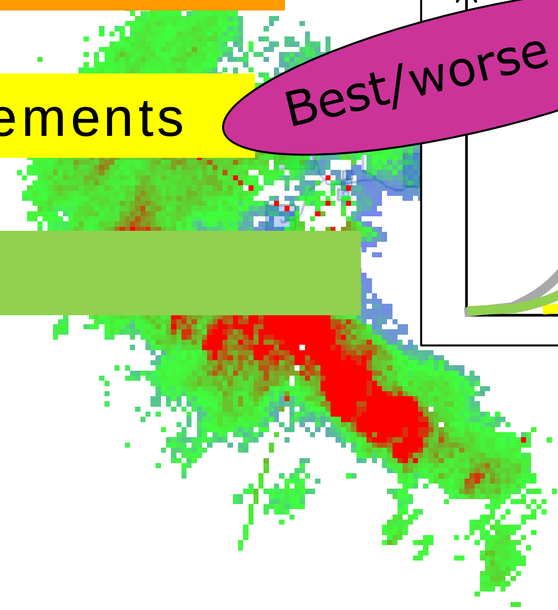
- **Gauges**: No Movement, no spatial distribution. Accurate.
- **Radar**: Movement, Spatial distribution. Inaccurate.

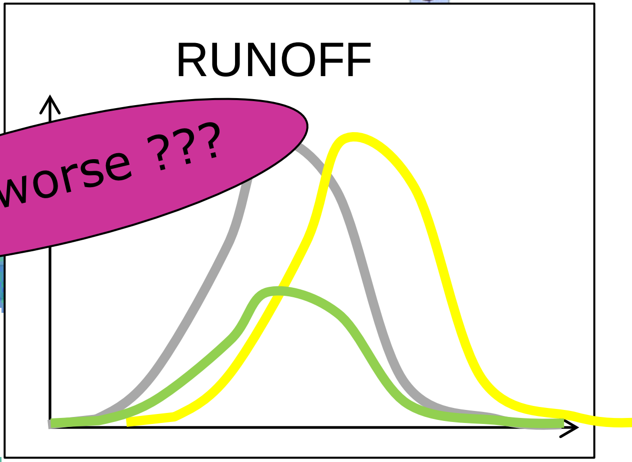


Rain detection method affect nature of model errors

GAUGES: Time displacements

RADAR: Scaling





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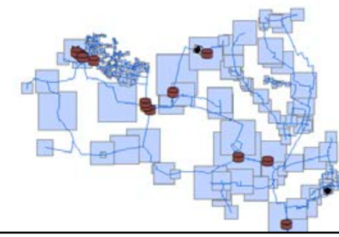


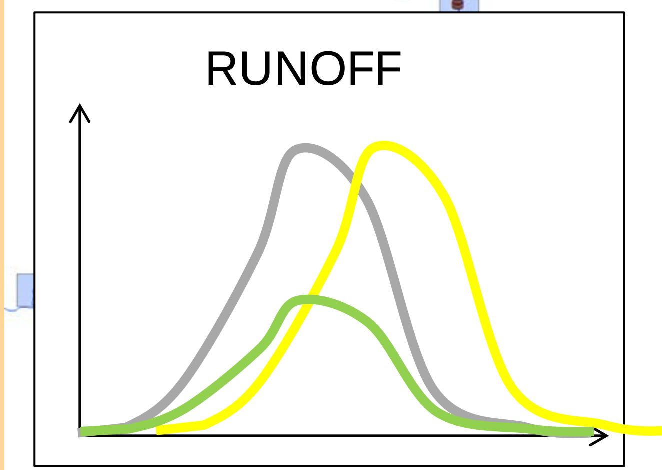
<u>Updated online models</u>

Can not distinguish time shifts from magnitude errors.

Updating: Synchronization issues.

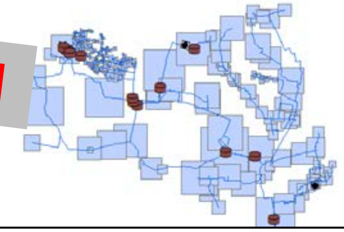
Objective:

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



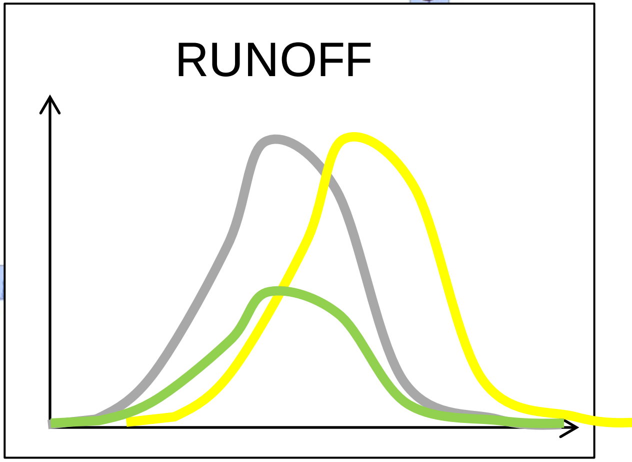
Simplification / assumptions

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

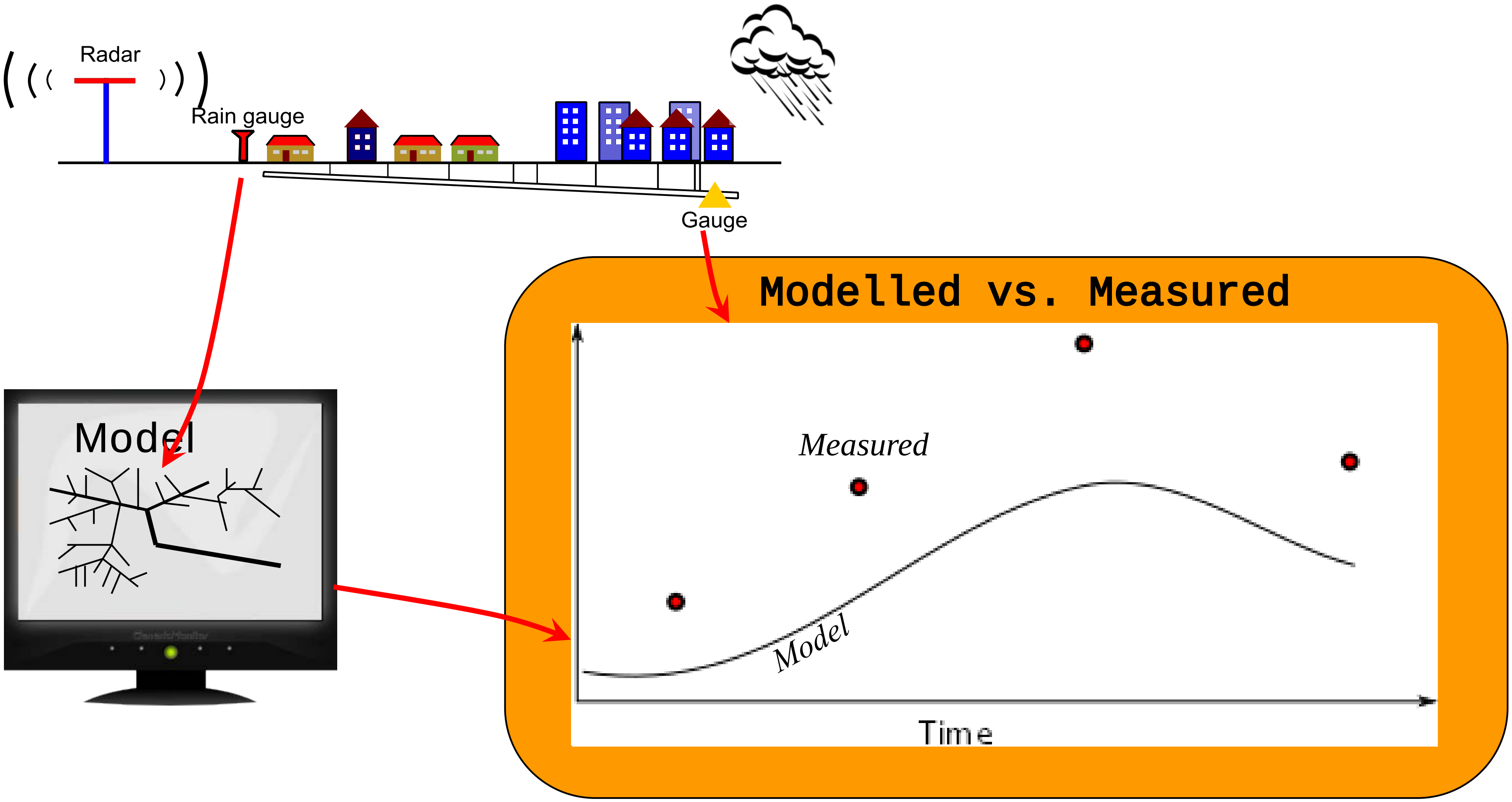


1d setup

Movement = time displacement



Online storm water model



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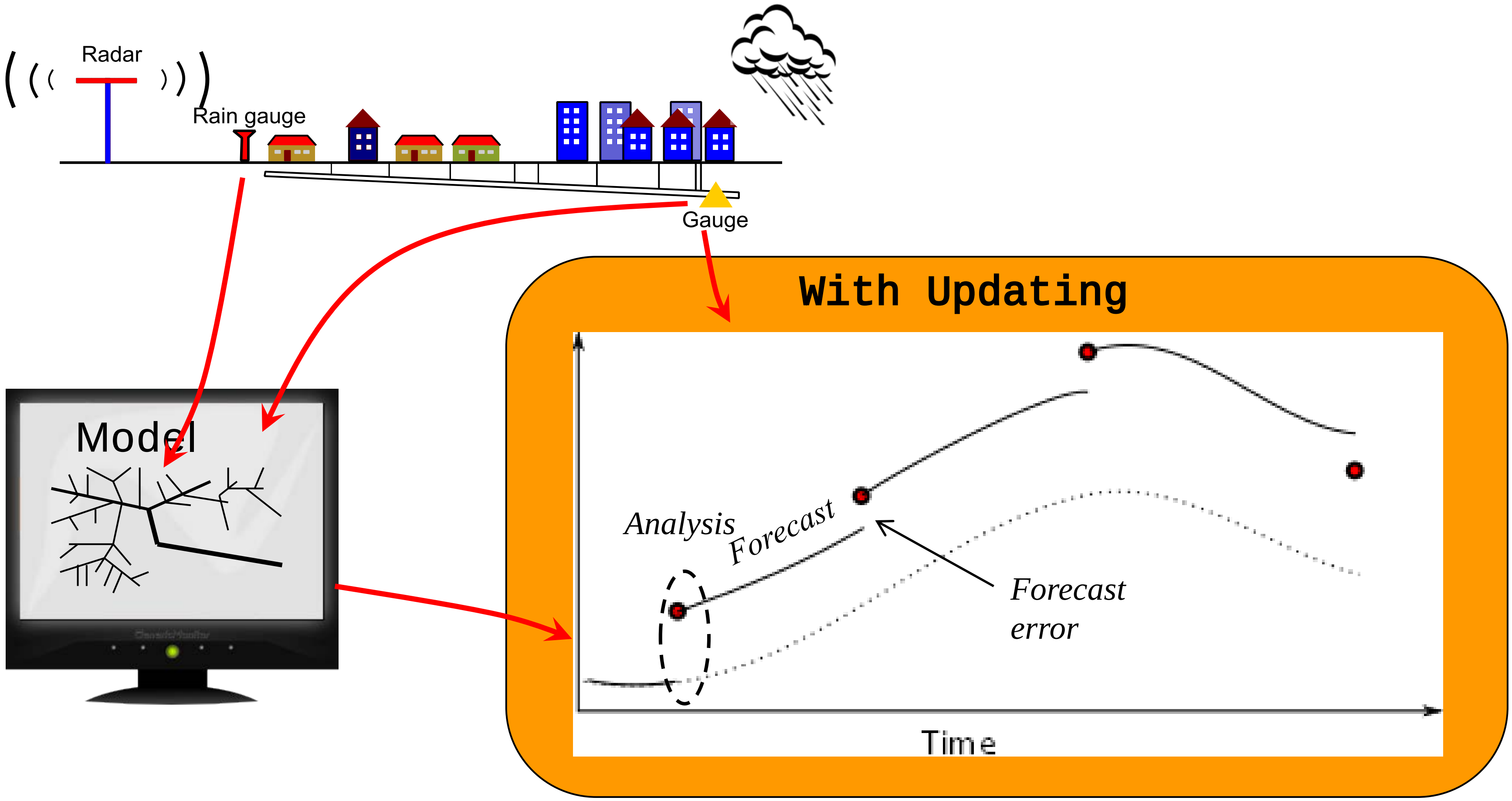

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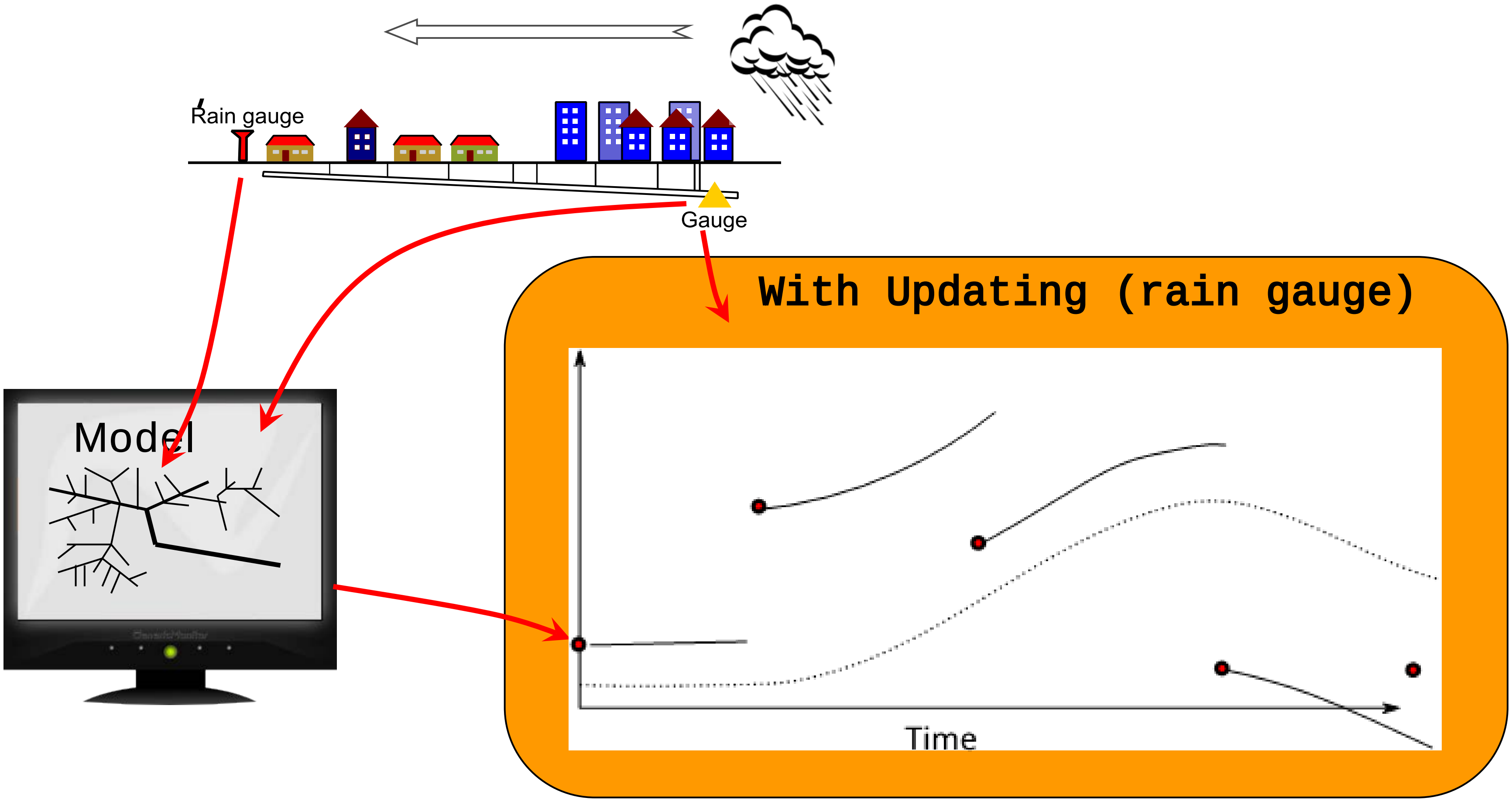

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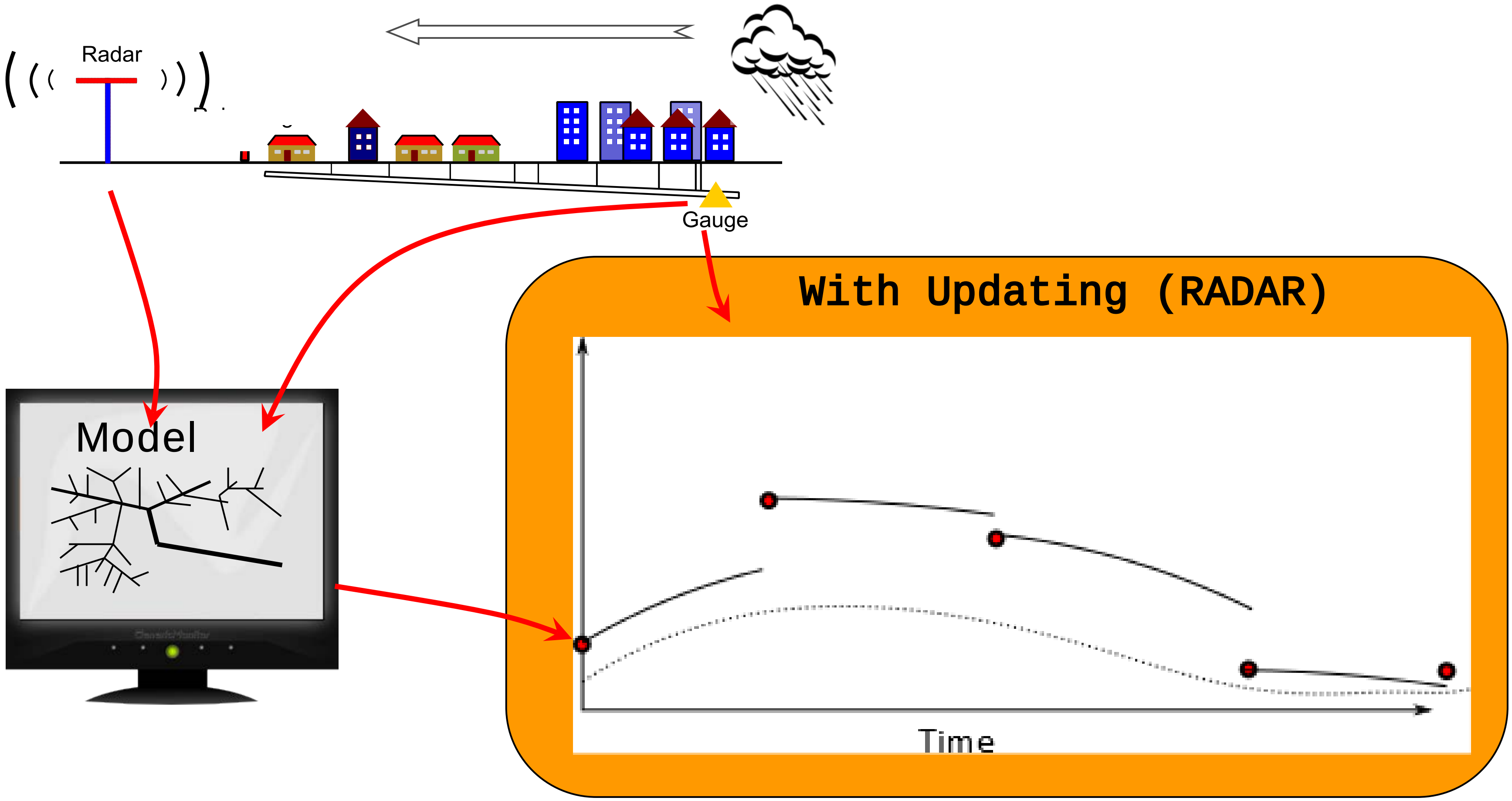
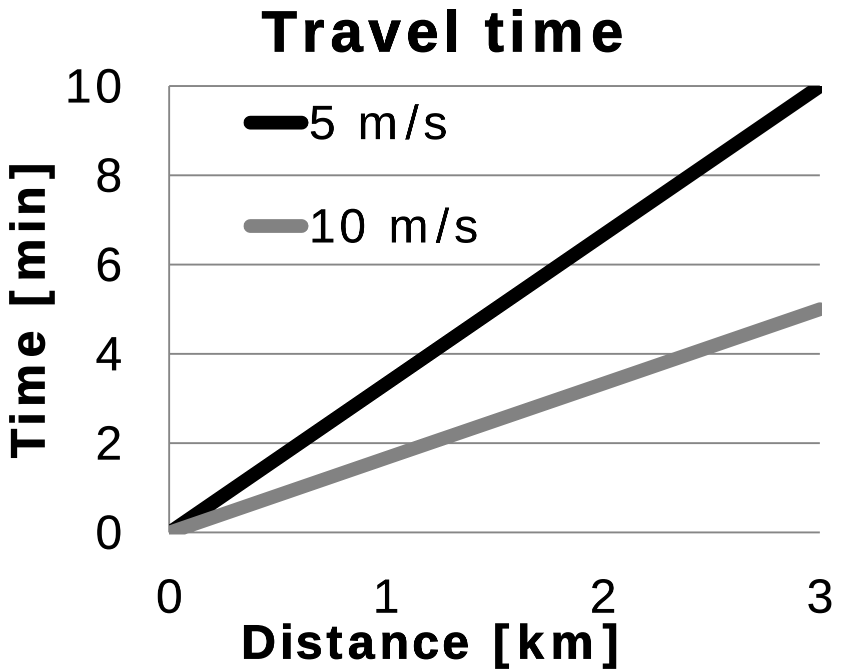
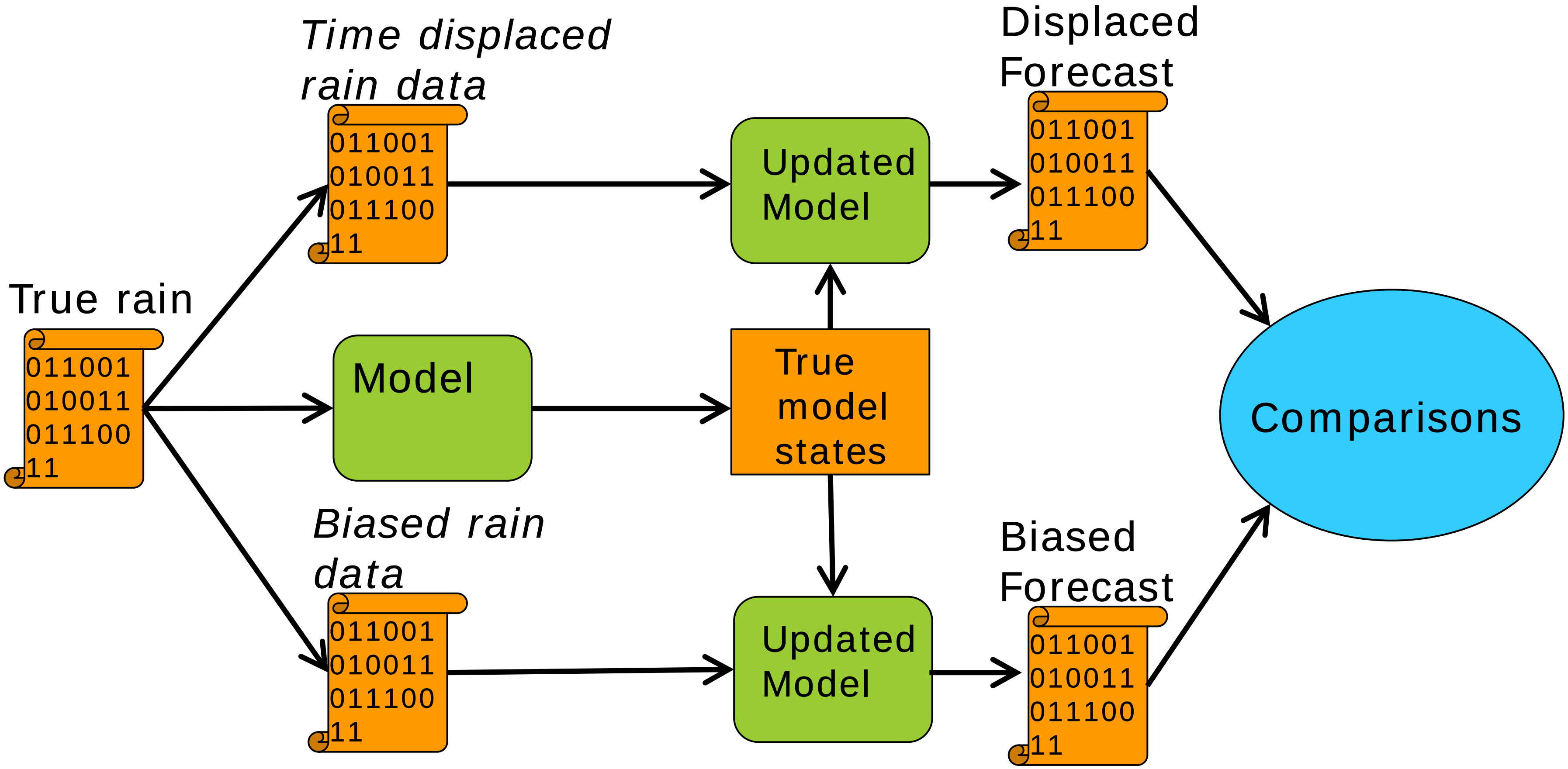


Size of displacements

- **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)

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

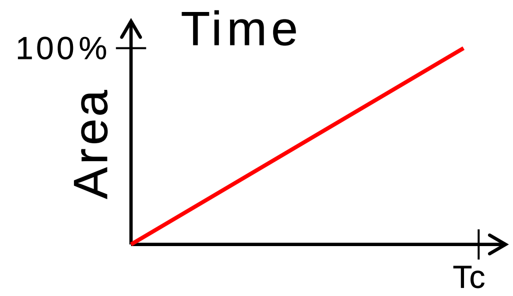
- Biased rain

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

Model

- Time Area model

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



- Observation (true runoff)

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

- Updated forecast model (x min. forecast)

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

Error quantification

- Forecast error

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

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

Catchment specific

Rain estimation error

- SS_{err}

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

Convenient properties

- SS$_{err}$(disp)/SS$_{err}$(bias) **independent of catchment**:

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

- Direction of time displacement without importance:

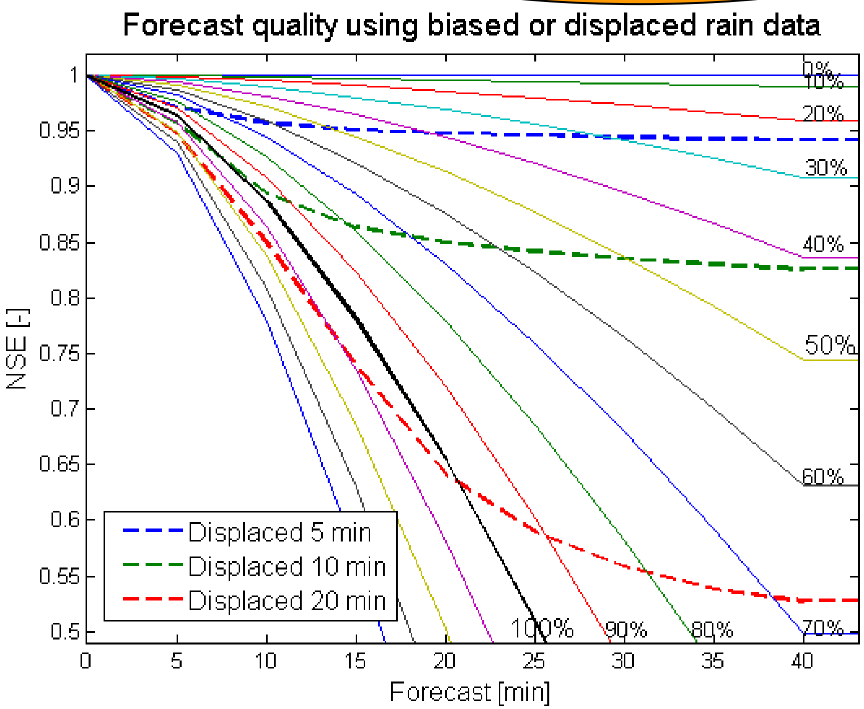
$$\sum_{n}^{\infty} \left| a_n - a_{n-c} \right| = \sum_{n}^{\infty} \left| a_n - a_{n+c} \right|$$

- No importance if bias is negative or positive:

$$\sum_{n}^{\infty} \left| P - P * 0.90 \right| = \sum_{n}^{\infty} \left| P - P * 1.10 \right|$$

Results

Tc = 40 minutes

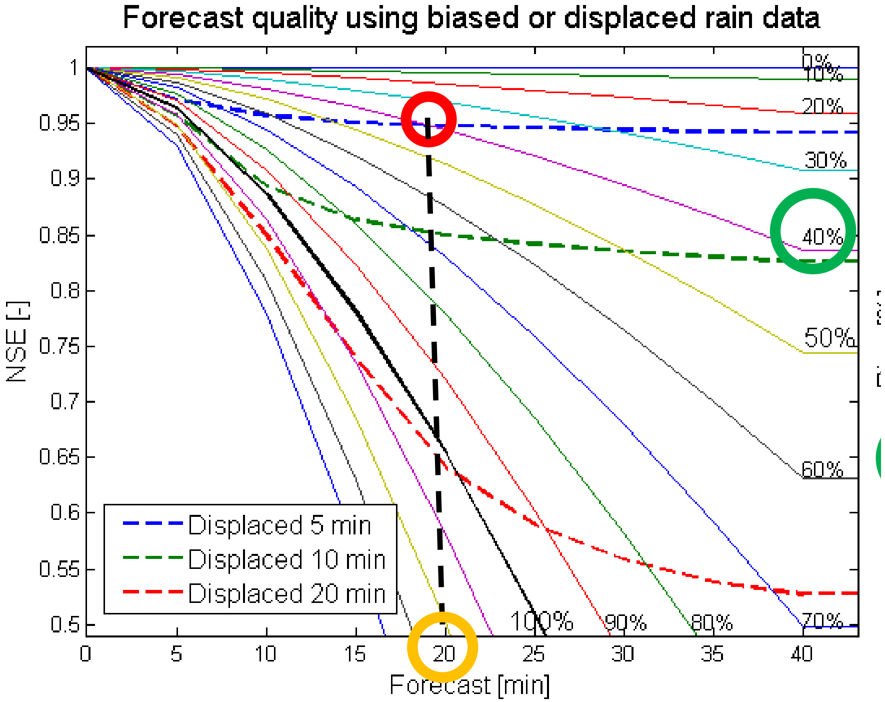


Results

Tc = 40 minutes

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

Any Tc



Conclusion

- Rain data requirements are different for updated models.

Independent of Tc:

- 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.

- Infrequent updating: Accurate more important.

Questions?