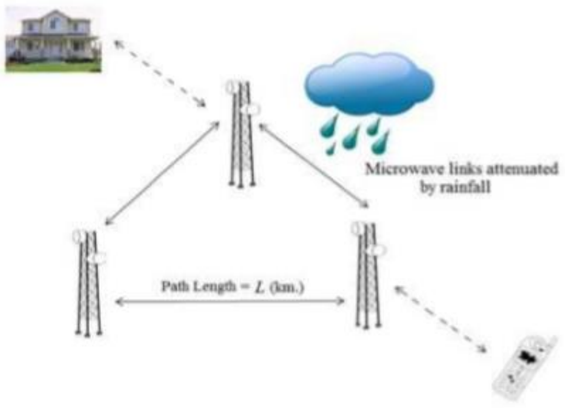
Rainfall Dynamics Estimation followed by Rainfall Monitoring using Microwave Link Measurements

Venkat Roy

Delft University of Technology, Delft, the Netherlands

1. Motivation & Introduction

• Attenuation measurements (dB/km) from commercial microwave links are related to the path averaged rainfall rate (mm/hr) over the link.



Main Relation: $y = ar^b \times L$,
y: dB, r: mm/hr, and L: km
a, b : depends on,

- Frequency
- Drop size distribution (DSD)
- Temperature
- Link length

$f \sim 35$ GHz: $y \approx r \times L$
[*Olsen et al., 1978*]
[*Jameson, 1995*]

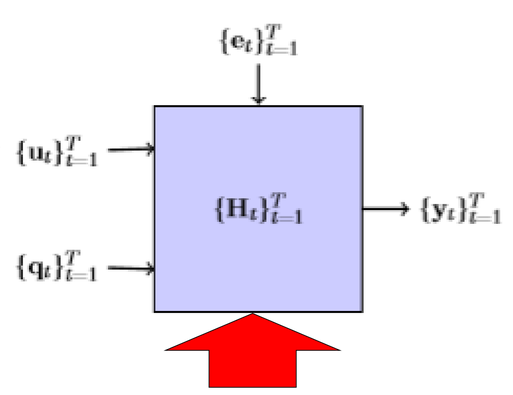
• For prediction, the state model for rainfall incorporates physical phenomena behind rainfall.
• **If the state model is unknown**, it can be estimated using the available ground truth.
•**If the ground truth is unavailable**, it can be estimated using the measurements and some assumptions on the structure of **the state transition matrix…**

- **Gaussian kernel assumption**
- **System identification tools**
- **Bayesian estimation methods**

2. Measurement and process model

$$\mathbf{y}_t = \Phi_t(\mathbf{u}_t) + \mathbf{e}_t$$
$$\mathbf{u}_t = \mathbf{H}_t\mathbf{u}_{t-1} + \mathbf{q}_t;$$

Rainfall intensity

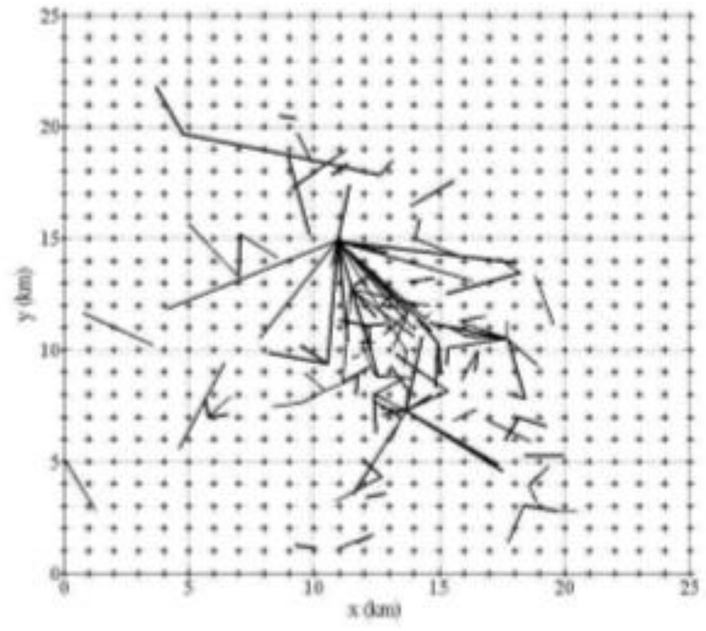


Unknown

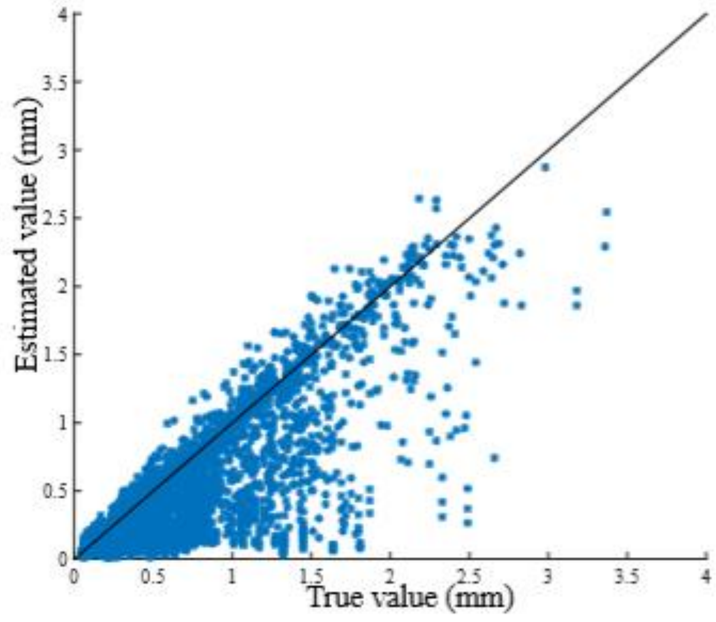
$$[\mathbf{H}_t]_{ij} = \alpha \exp[-(\mathbf{x}_i - \mathbf{x}_j - \mathbf{w}_t)^T \mathbf{D}^{-1}(\mathbf{x}_i - \mathbf{x}_j - \mathbf{w}_t)]$$

Gaussian kernel assumption

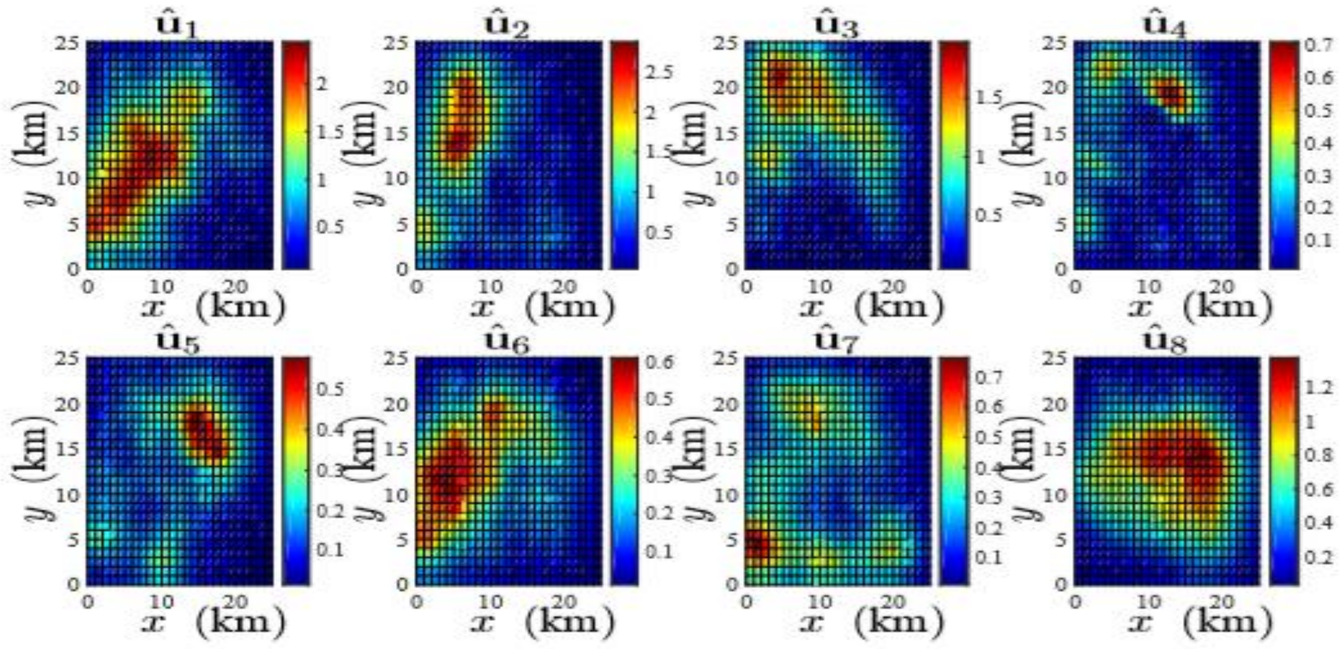
3. Performance analysis



Measurement grid : 155 links and 625 pixels
Operating frequency : 15 GHz
Temperature : 20^o C
a = 3.28 x 10^{-2} ; b = 1.173 [*Olsen et al.*]



Comparison of the ground truth and the estimated value



Rainfall map using the estimated state transition matrix

Data source: KNMI