

# Measurements for water

A.M.J. Coenders

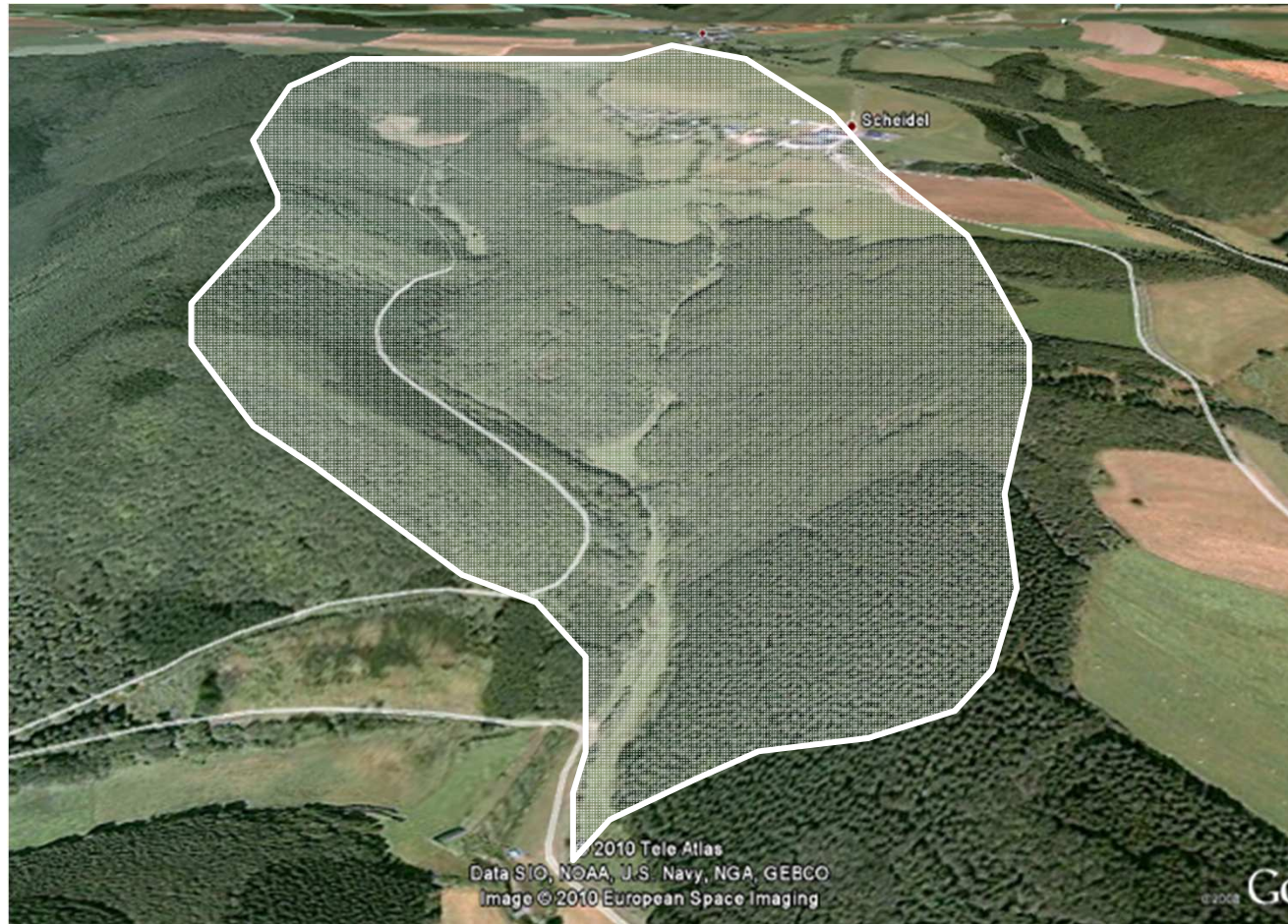
Waterbalans: Rainfall



# Rainfall measurements

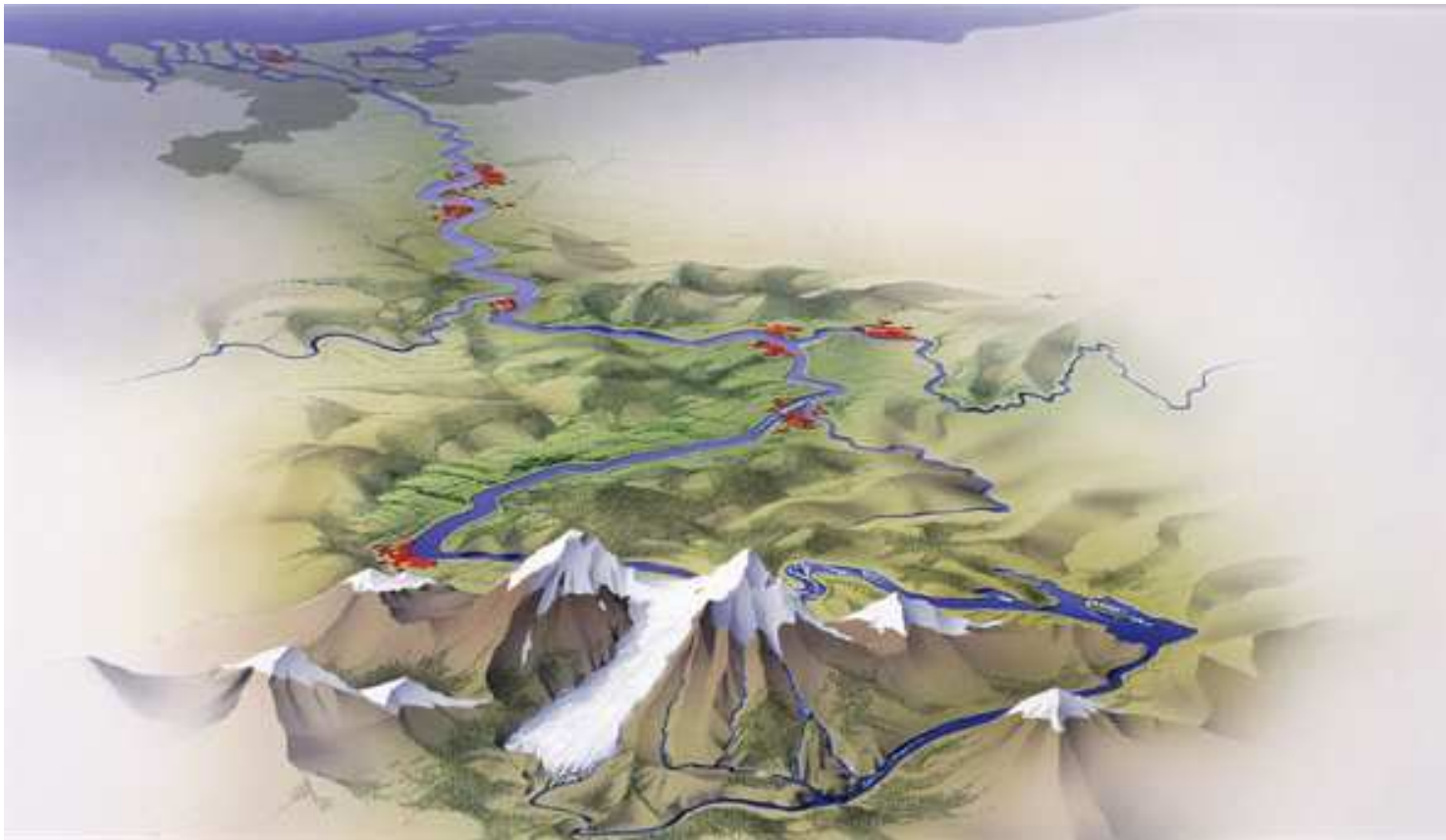


# How to measure rainfall?



Maisbich: 1.17 km<sup>2</sup>

# How to measure rainfall?



Rhine: 185 000 km<sup>2</sup>

# Measuring rainfall

## Options:

1. Point scale:
  - Accurate
  - Small scale ( $\Delta x$ ,  $\Delta t$ )
2. Areal:
  - Less accurate
  - Large scale ( $\Delta x$ ,  $\Delta t$ )
  - Often free downloadable

## Considerations:

- Objective
- Available money
- Available labour
- Accessibility site
- Scale

# Point observations



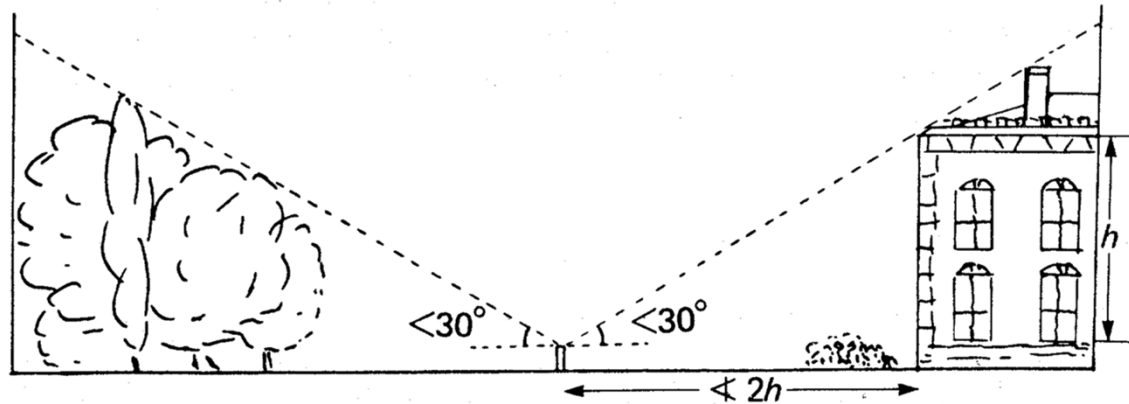
# Measuring rainfall at point scale

## Considerations:

- Location
- Height
- Sample interval
- Spatial distribution
- Rain gauge type



# Location and Height

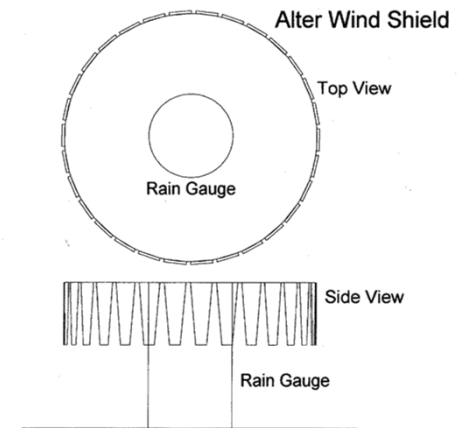


- Reduction:
  - at 1.50m from ground level 84-96%
  - at 0,40m from ground level 93-97%
- Solutions:
  - screens
  - turf wall



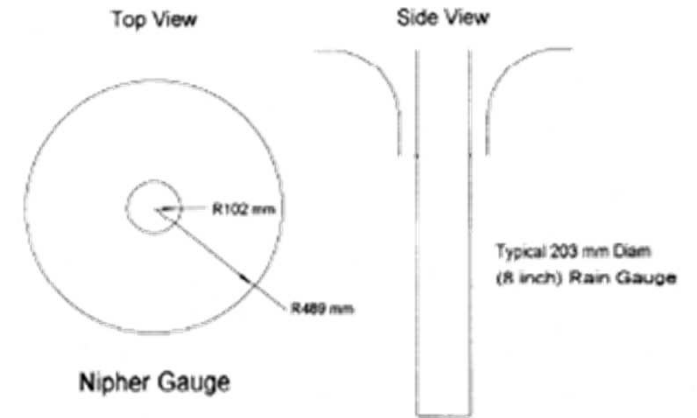
# Screens

- Alter wind shields

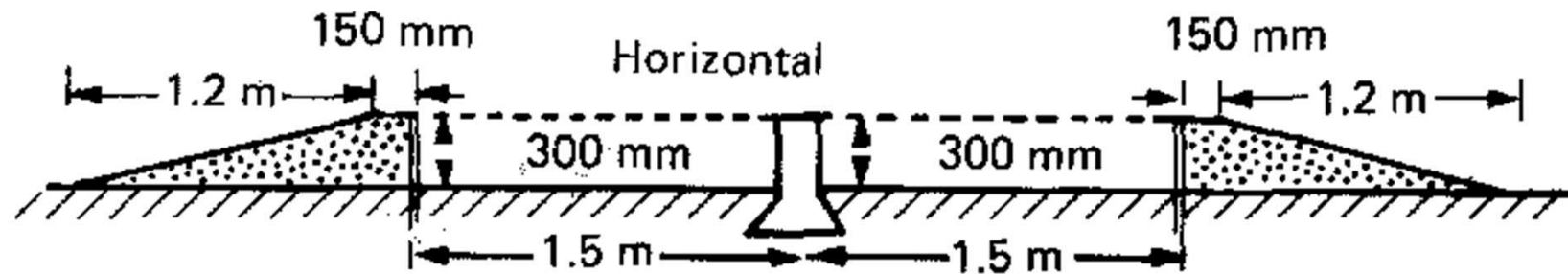


# Screens

- Nipher screen



# Turf wall

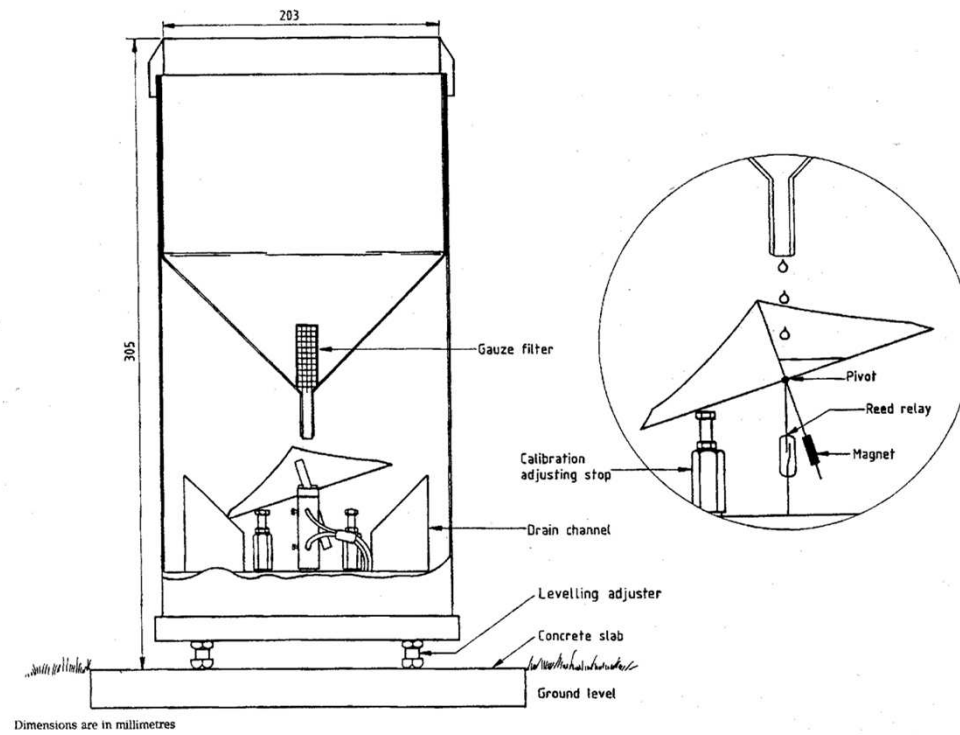


# Rain gauges types:

## Manual rainfall collector

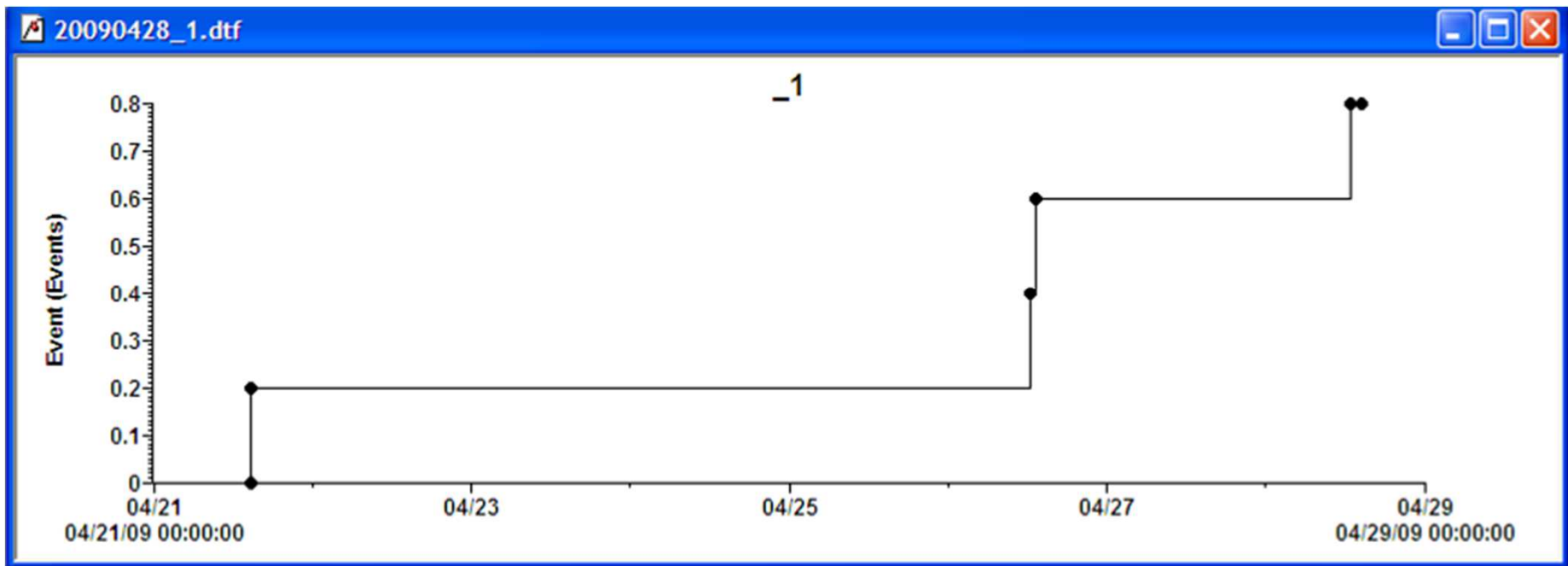


# Rain gauges types: Tipping bucket

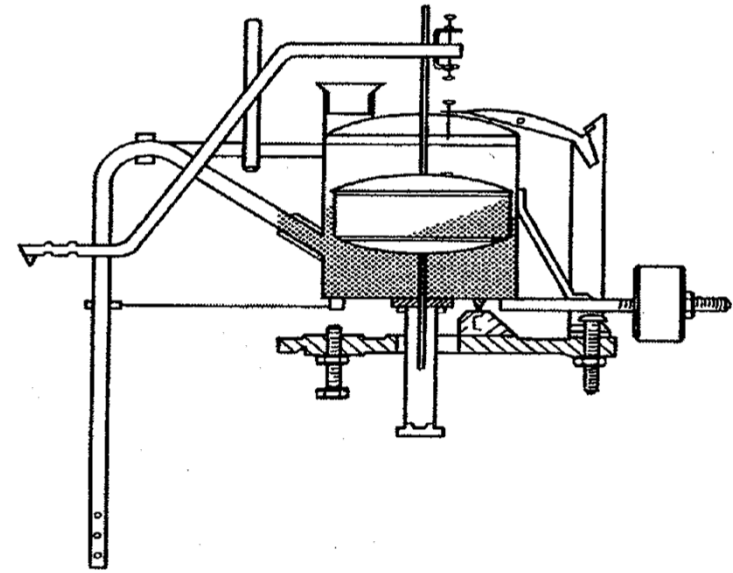


# Rain gauges types: Tipping bucket

- Data example

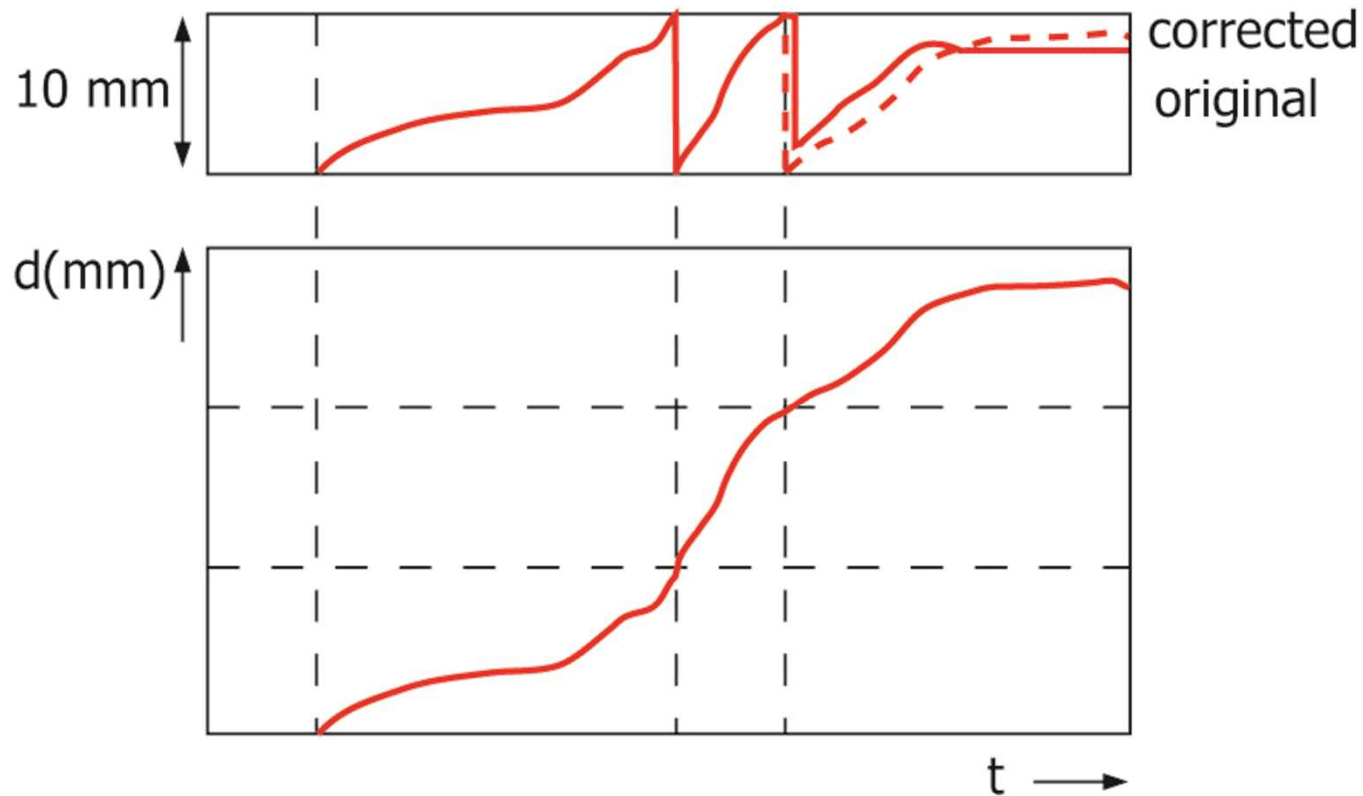


# Rain gauges types: Tilting siphon



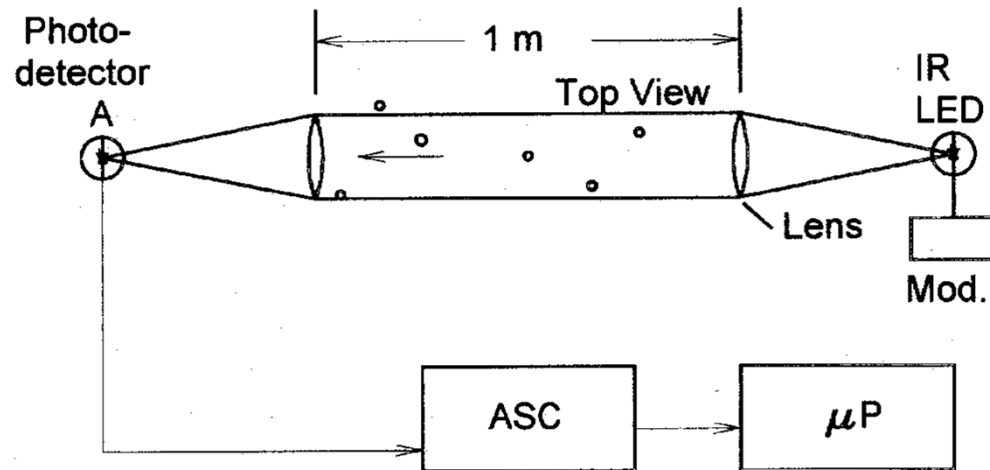
# Rain gauges types: Tilting siphon

- Data example





# Rain gauges types: Optical



# Rain gauges types: Heated and weighing



⇒ Snow

# Rain gauges types: Acoustic

- Disdrometer





# Areal observations

# Areal rainfall: Radar

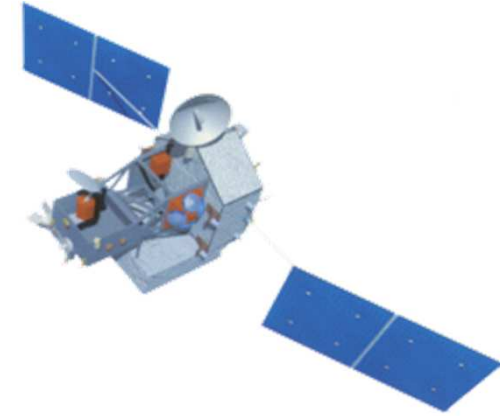
- Different frequencies & pulses
- Nowadays: pulse-Doppler radars (+ motion)



- Inaccuracies due to:
  - Curvature earth
  - Light rainfall no response
  - Shielding



# Areal rainfall: Remote Sensing



- **Thermal Infra Red** (Meteosat, MSG, GOES)
  - Cold cloud duration:  $T_{\text{cloud top}} < -40 \text{ }^\circ\text{C} \Rightarrow \text{rain}$
  - Suitable for:
    - Convergence & convective storms (semi-arid regions)
- **Microwave imagers** (SSM/I, AMSU-B, TMI, AMSR-E)
  - Scattering (quantity & ice particle size)
  - Emission of brightness temperature (water vapour)
  - Non-suitable for:
    - Orographic lifting & shallow convective storms (warm particles)

# Areal rainfall:

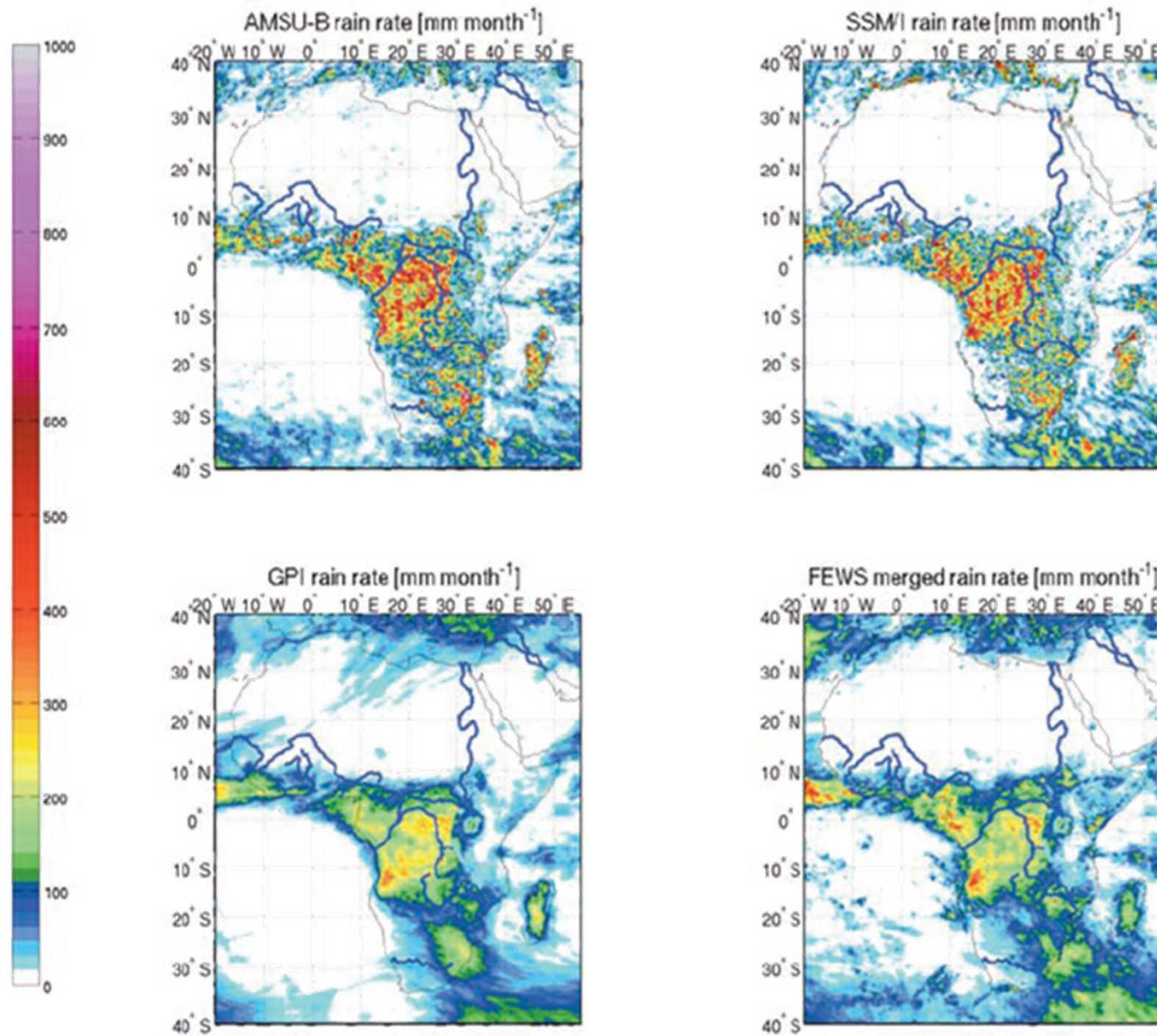
## Some recent rainfall algorithms

- **FEWS RFE 2.0**

- METEOSAT Infrared (IR) satellite data
- Special Sensor Microwave/Imager (SSM/I)
- AMSU-B
- Ground stations

- **Tropical Rainfall Measuring Mission (TRMM)**

- On board sensors (microwave, IR, Radar)
- External microwave sensors (AMSU-B, SSM/I, AMSR-E)
- External IR
- Ground stations



Winsemius, 2009



# Concluding...

- ⇒ RS is a great source, but you still need ground stations
- ⇒ In 2 weeks, exercise on accuracy of ground stations