

Hydrological Measurements

Miriam Coenders

5. Interception Measurement



Interception measurements



CT4440: Hydrological Measurements

Miriam Gerrits

www.interception.citg.tudelft.nl



Centre de Recherche Public
Gabriel Lippmann

**TU Delft**

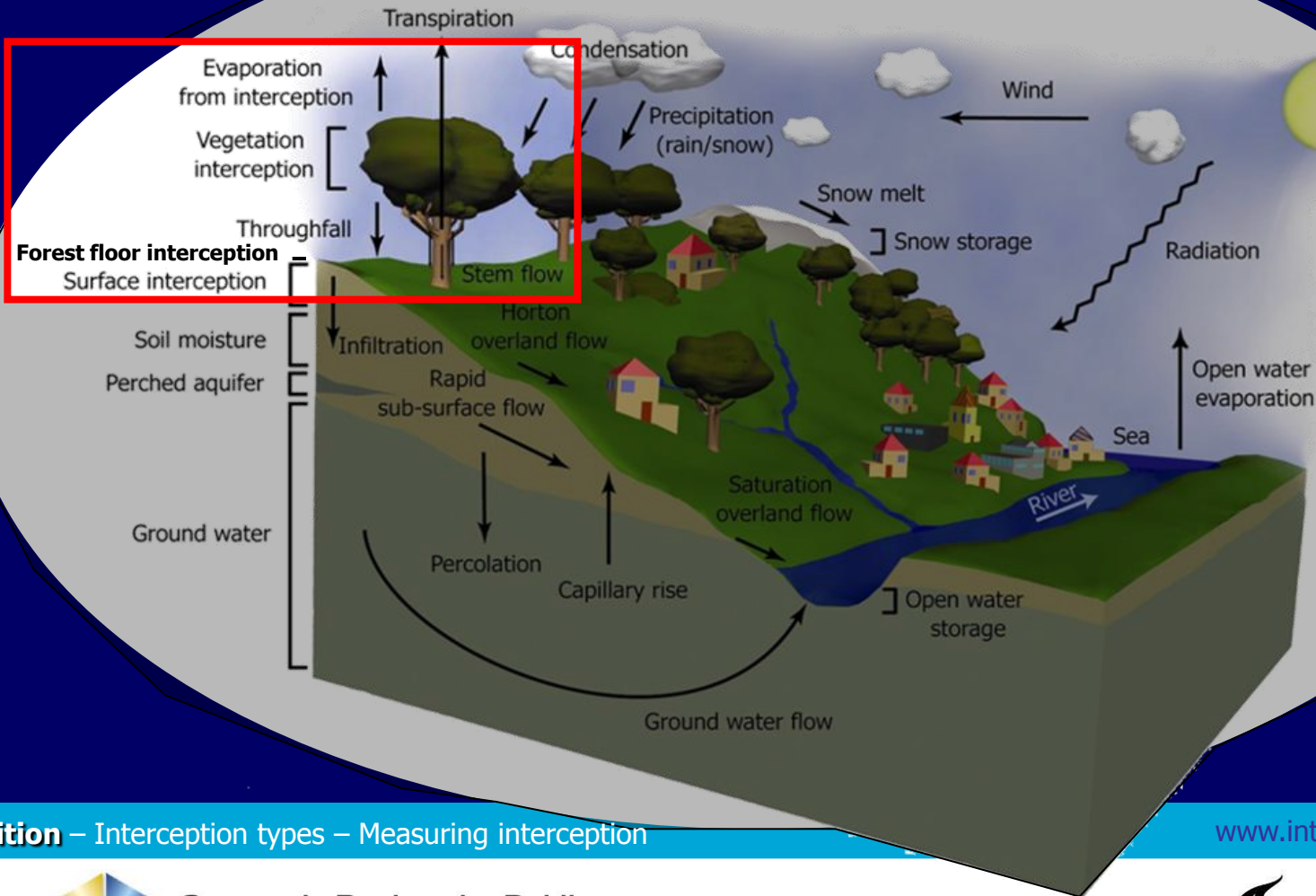
Delft University of Technology

Outline

- Theory
 - Definition of interception
 - Interception types
 - How to measure interception?
 - Canopy interception
 - Forest floor interception
- Discussion
- Excursion Botanical Garden



In the hydrological context:



Source Unknown

Definition – Interception types – Measuring interception

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After a rainfall event...



Source Unknown

...everything is wet

Definition – Interception types – Measuring interception

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Definition of interception

Temporarily **storage** of rainfall,
and the successive **evaporation** from this storage,
resulting in a reduction of infiltration.

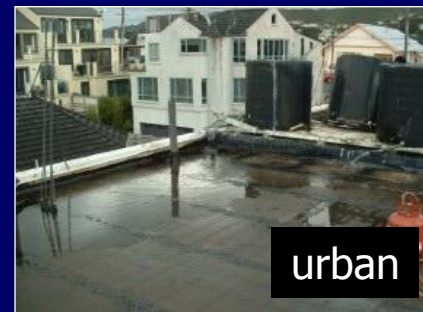
$$I = \underbrace{\frac{dS_{\text{int}}}{dt}}_{\text{process}} + \underbrace{E_{\text{int}}}_{\text{flux}}$$

stock

Where can water be temporarily stored?

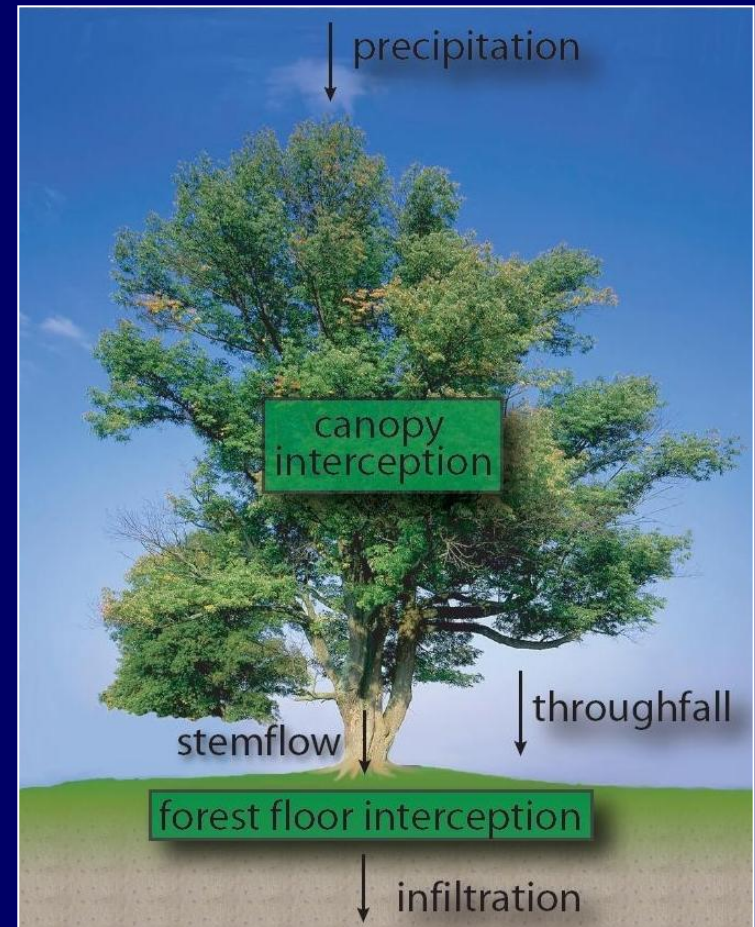
- Canopy interception
- Forest floor interception
- Snow interception
- Fog interception
- Urban interception
- ...

And can be combined



Interception types

- **Canopy interception**
- **Forest floor interception**
- Snow interception
- Fog interception
- Urban interception
- ...

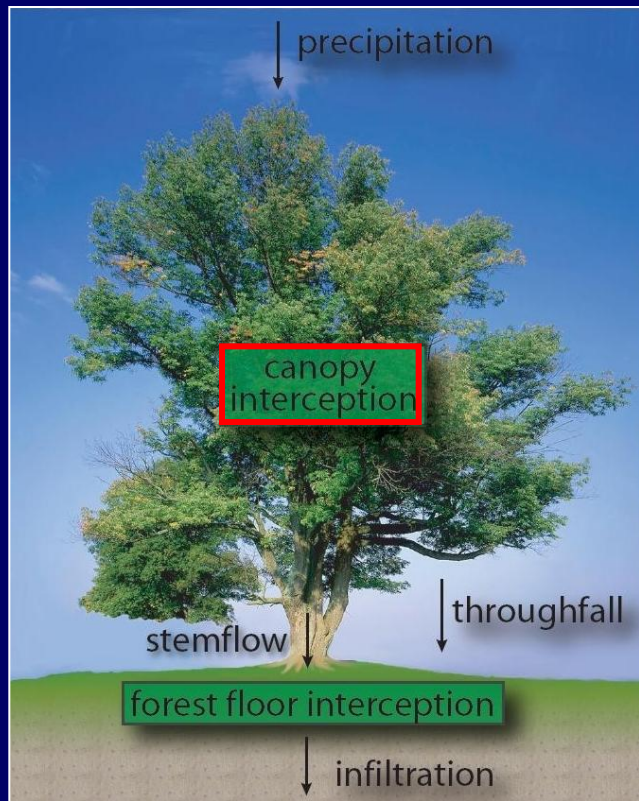


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How to measure interception?



Canopy interception: ways of measuring



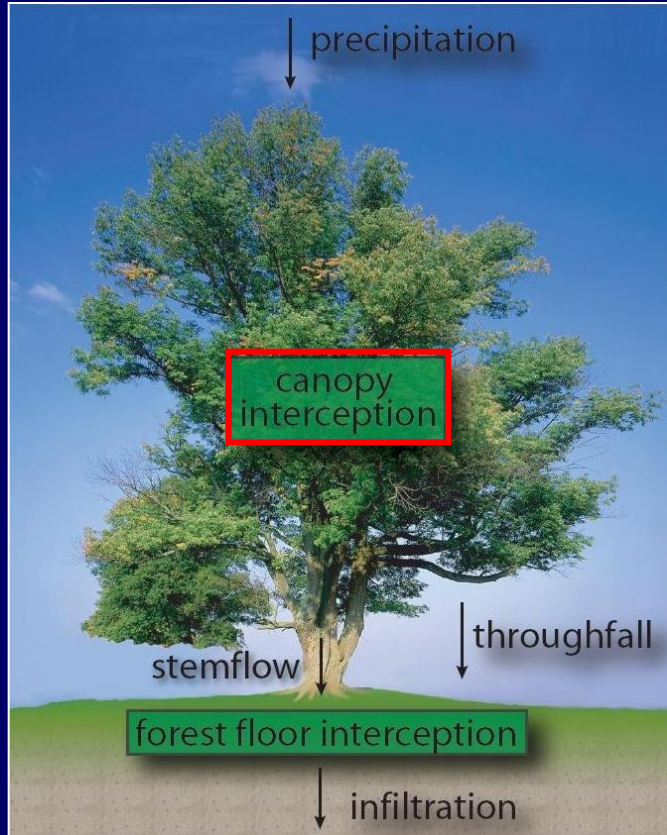
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Techniques based on:

- Water balance
- Attenuation
- Mechanics



Canopy interception: water balance approach



Source Unknown

$$I_{canopy} = P - T_f - S_f$$

But how to measure
throughfall and stemflow?

Throughfall



Throughfall



Stemflow



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Definition – Interception types – **Measuring interception**

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Canopy interception: attenuation

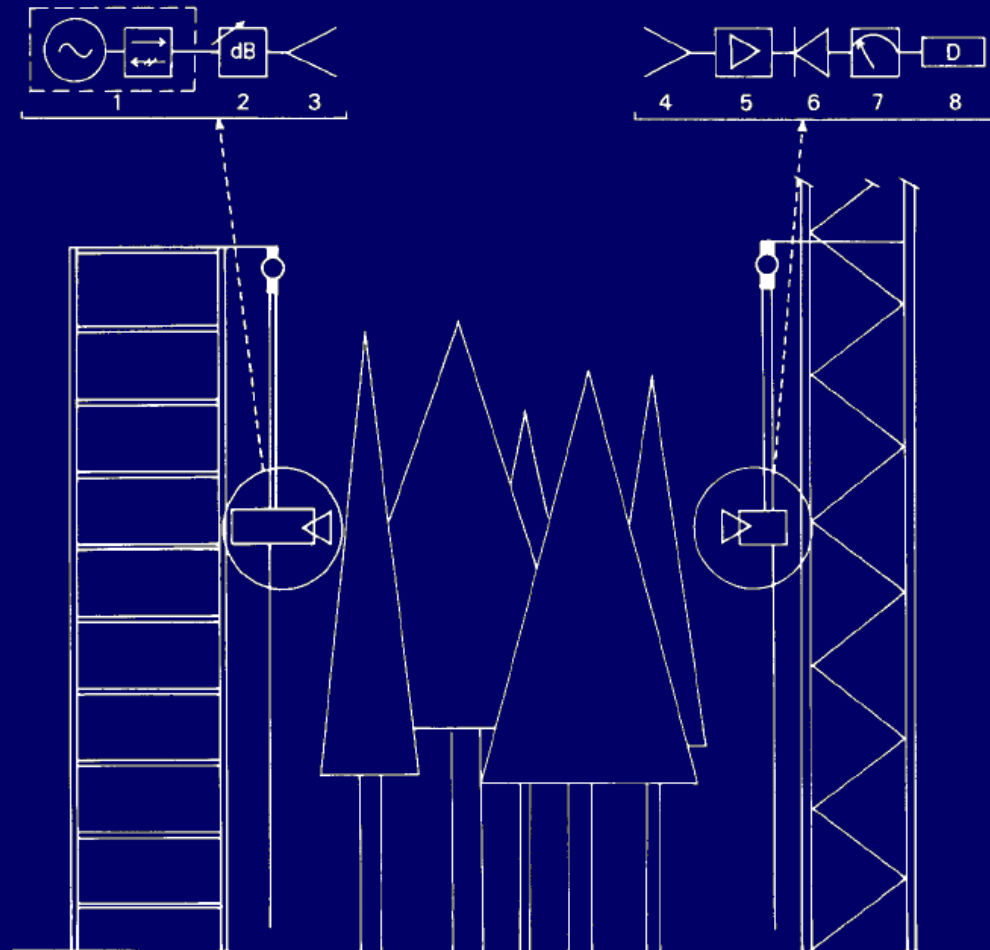
Radiation absorption and scattering by water inside and on trees

- Gamma ray attenuation

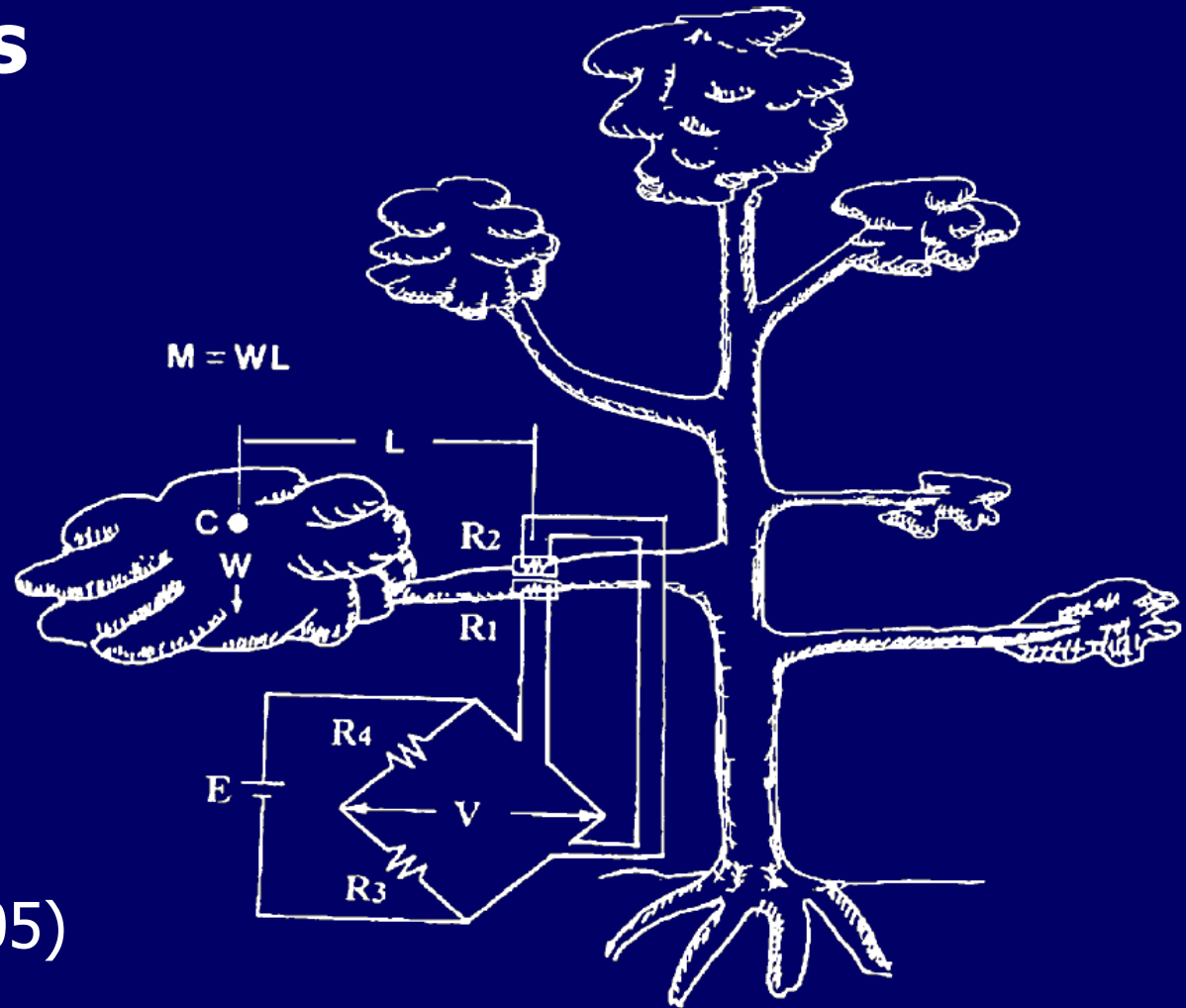
(Calder & Wright, 1986)

- Microwave attenuation

(Bouten et al, 1991)



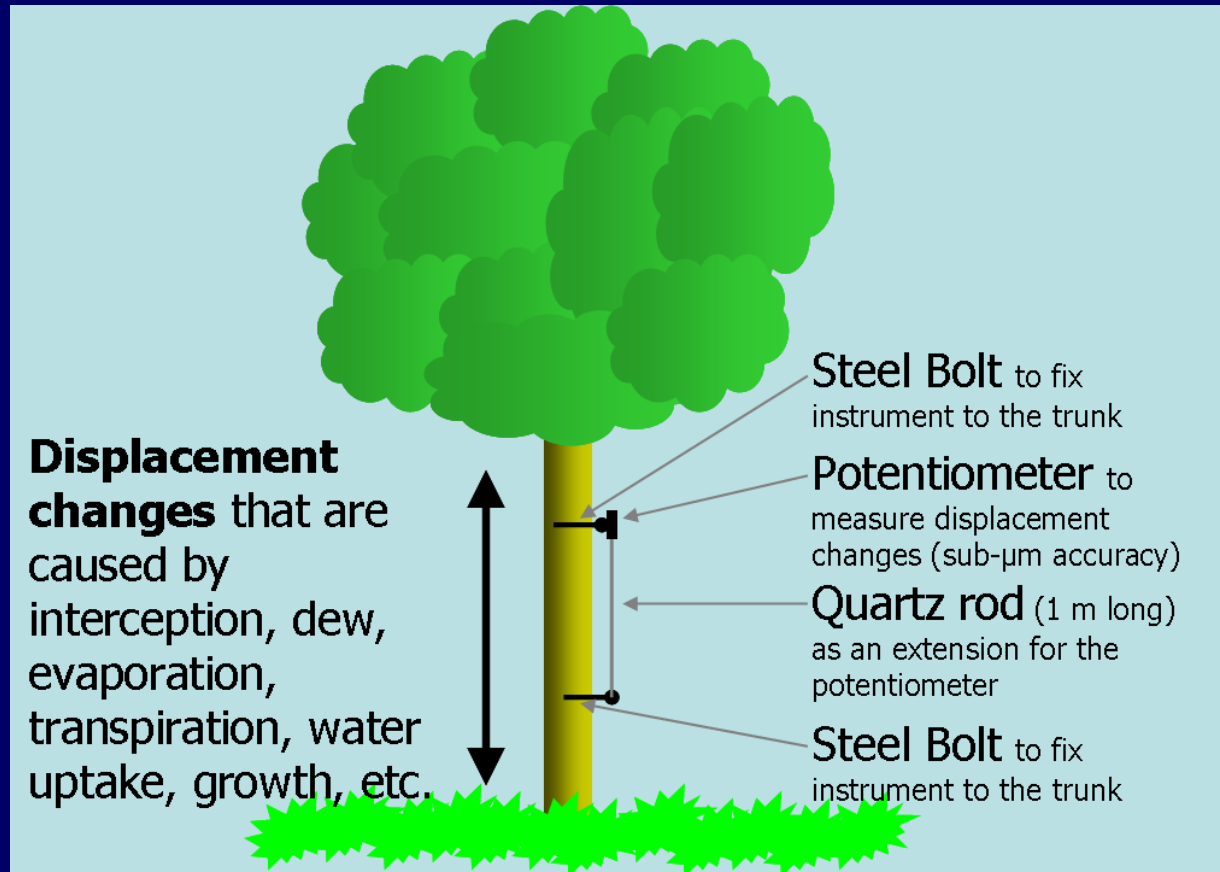
Canopy interception: mechanics



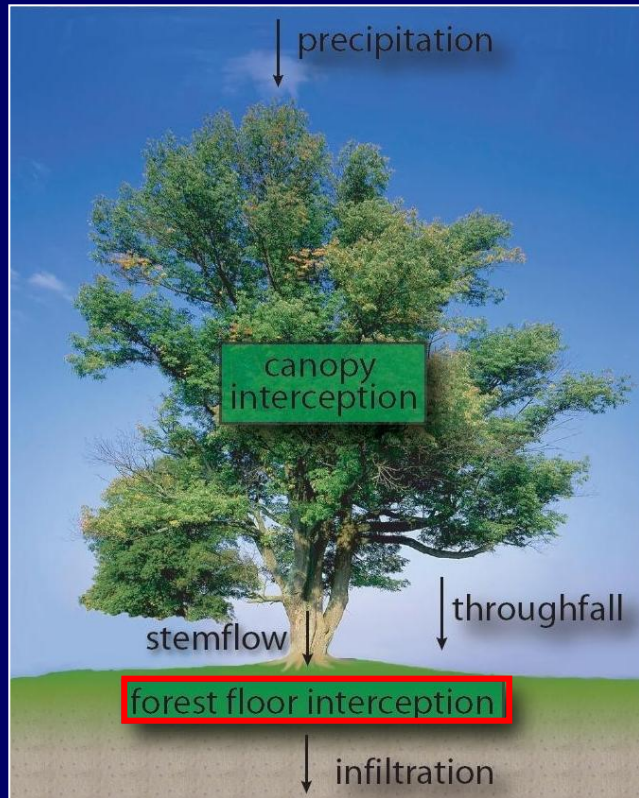
Huang et al (2005)

Canopy interception: mechanics

Jan Friesen
WRR 2008



Forest floor interception



Source Unknown

Techniques based on:

- Water balance

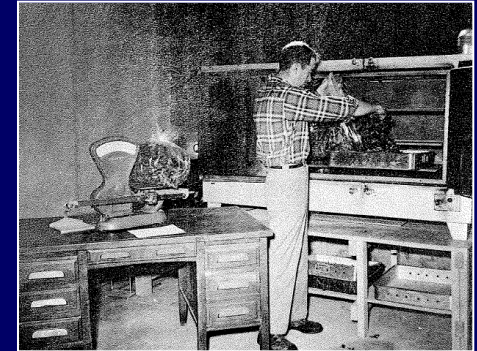
But a distinction between lab (disturbed) and field (undisturbed) experiments

Forest floor interception

Lab methods

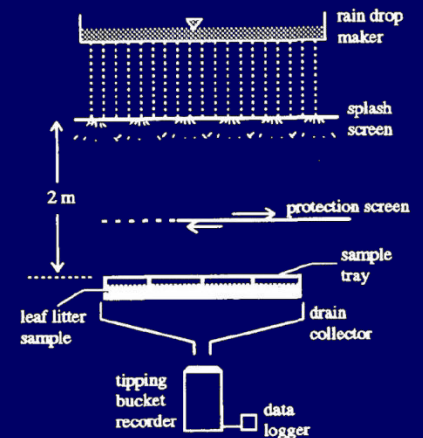
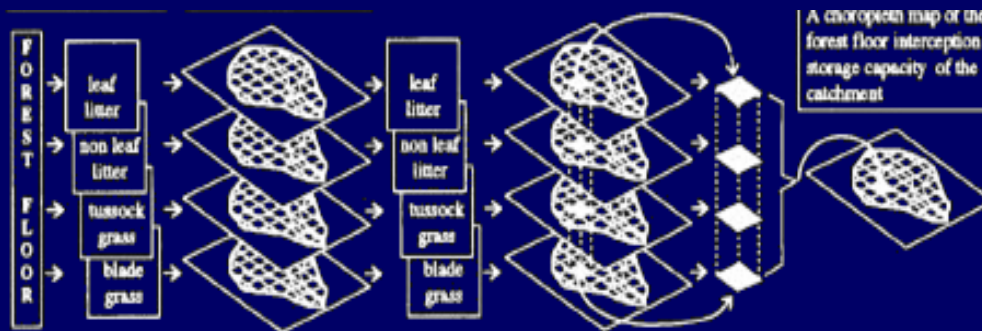
- **Drainage experiment**

(Helvey, 1964)



- **Rainfall simulator**

(Putuhen and Cordery, 1996)



Definition – Interception types – Measuring interception

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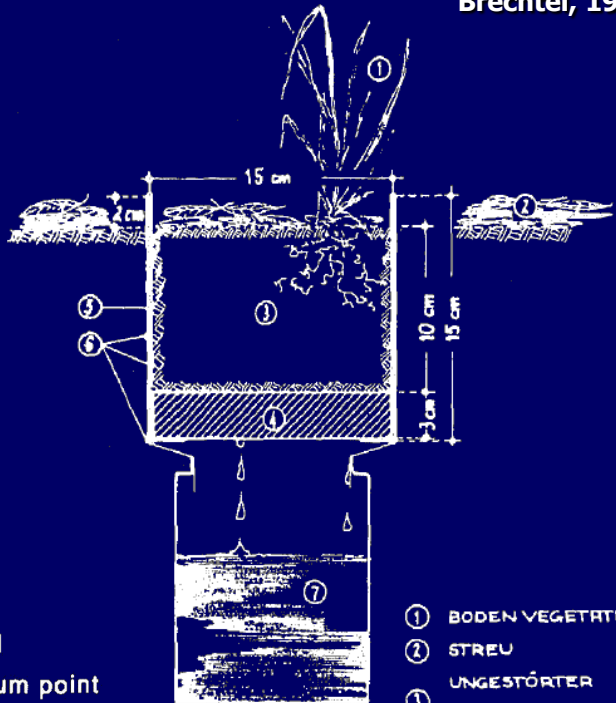
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Forest floor interception

Field methods

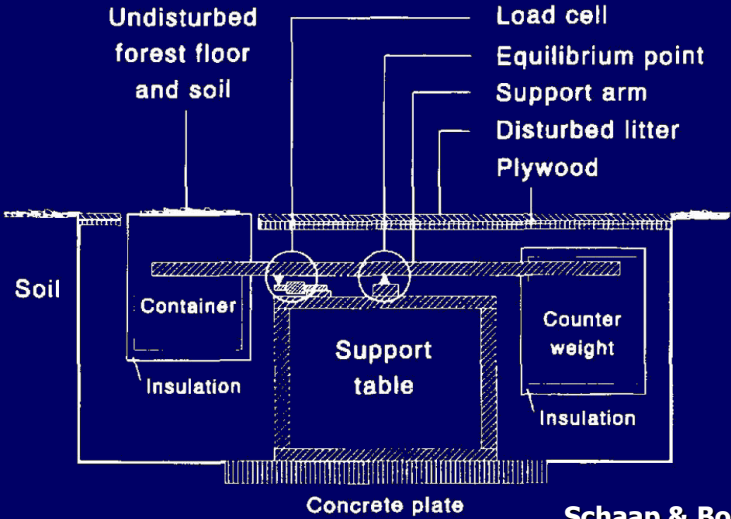
- Weighing trays (*Pathak et al., 1985*)
- Pebble mulch meter (*Li et al., 2000*)
- Small lysimeter (*Brechtel, 1969*)
- Lysimeter (*Schaap and Bouten, 1997*)



- ① BODEN VEGETATION
- ② STREU
- ③ UNGESTÖRTER
- ④ BODENKÖRPER
- ⑤ SICKEPLATTE 15 / 15 / 3
- ⑥ BLECHKASTEN 15 / 15 / 15
- ⑦ PLASTIKFOLIE SCHLAUCHFORM
- ⑧ SICKEWASSER-RUFFANG-BEHÄLTER

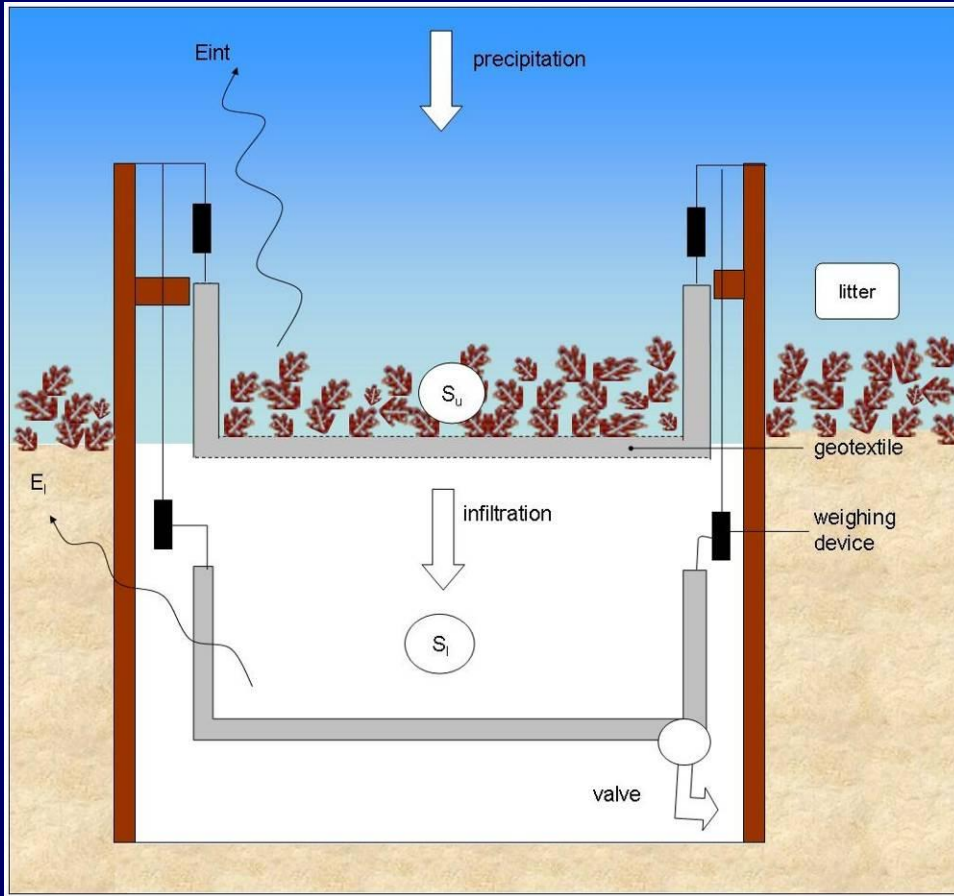


Li et al., 2000



Schaap & Bouten, 1997

Measuring forest floor interception



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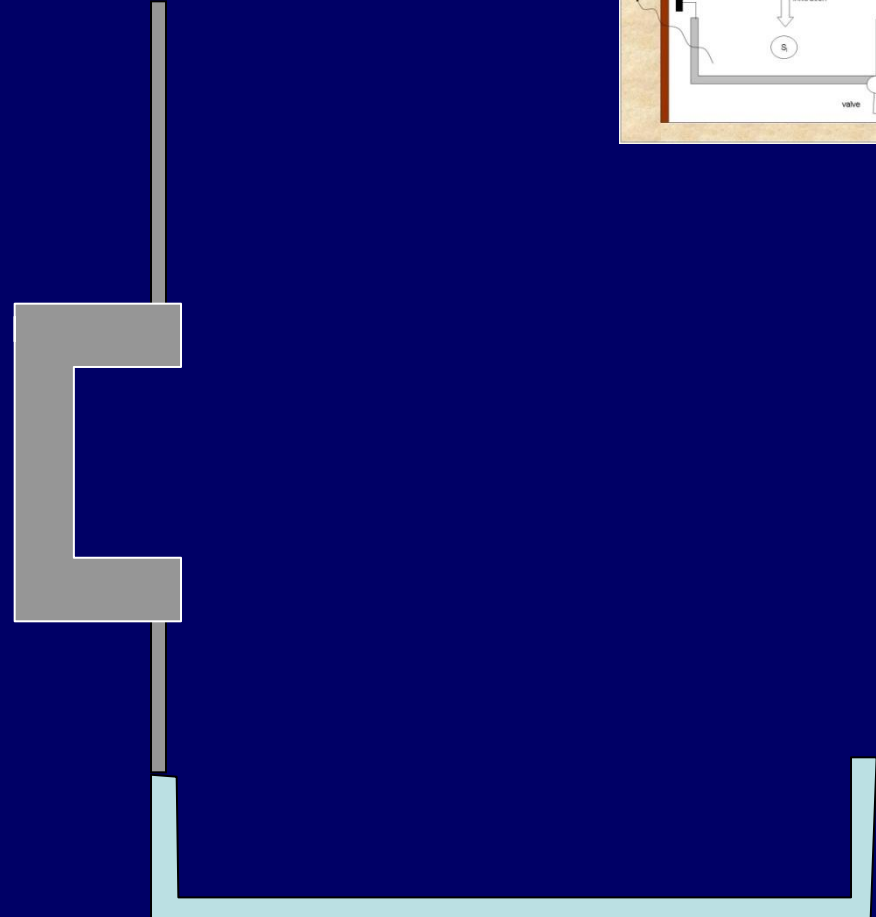
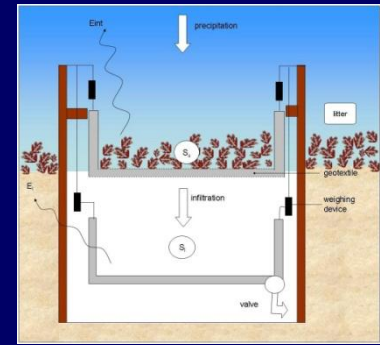
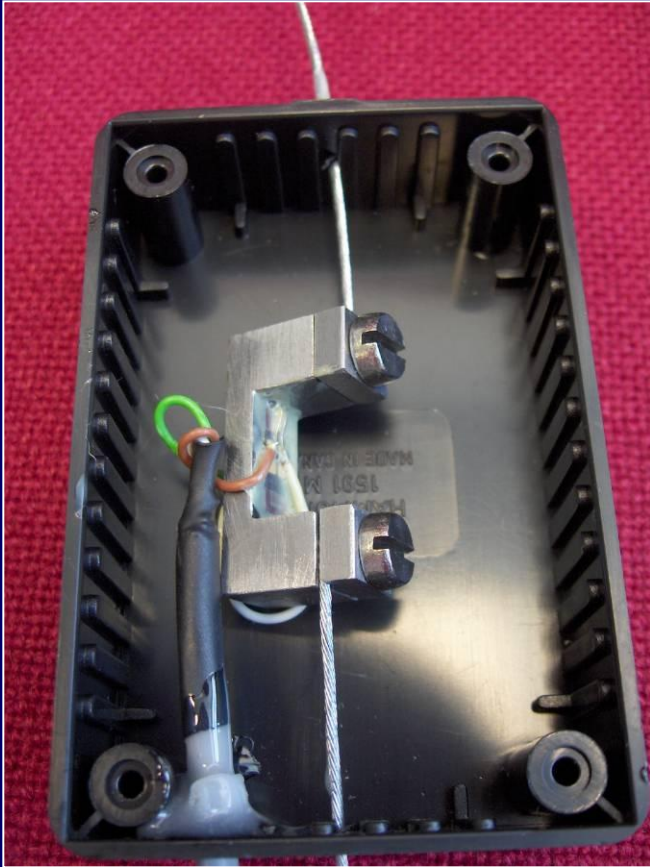
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$$E_{int} = P_{net} - \left(\frac{dS_{upper}}{dt} + \frac{dS_{lower}}{dt} \right)$$

Definition – Interception types – Measuring interception

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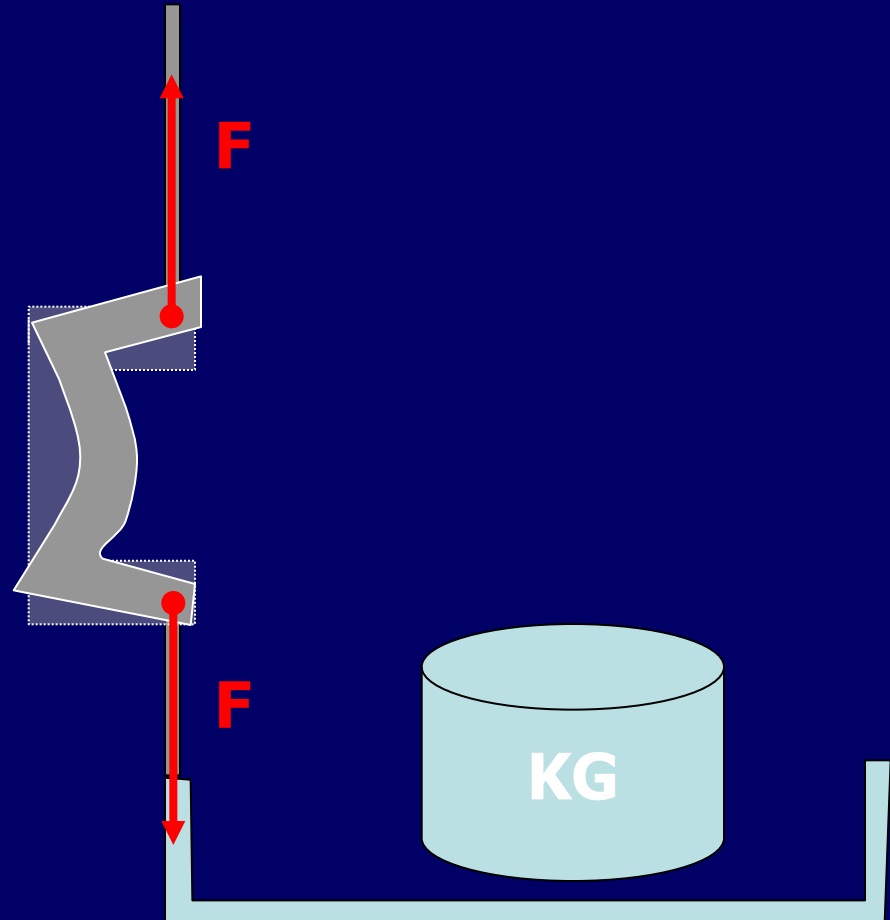
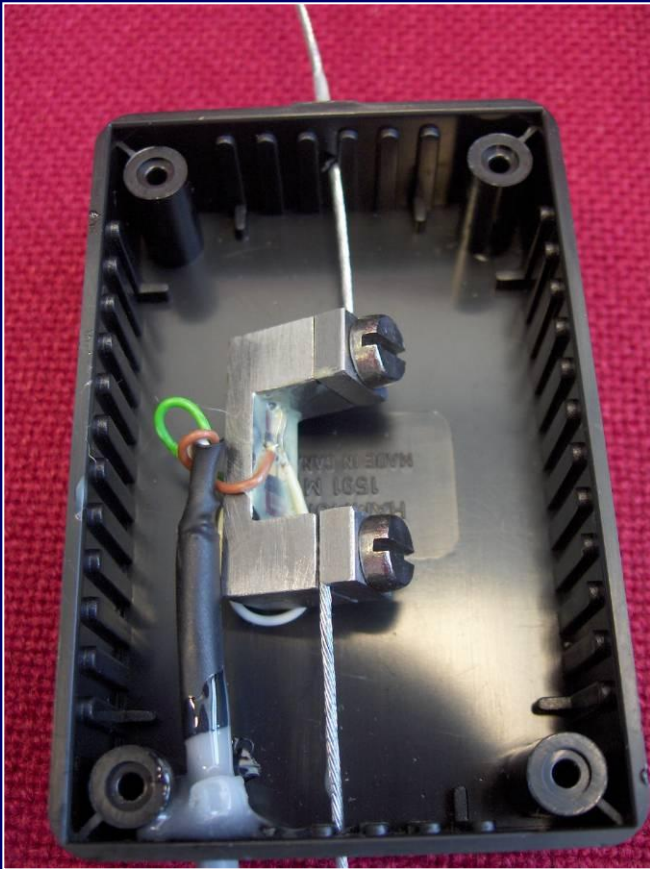
Weighing with strain gauges



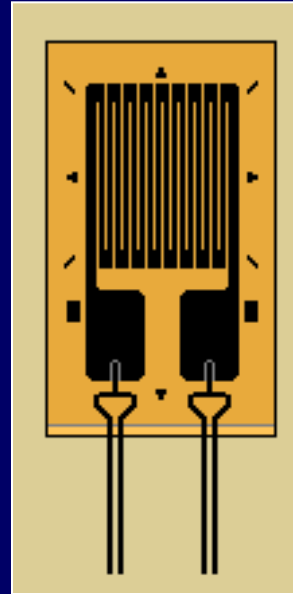
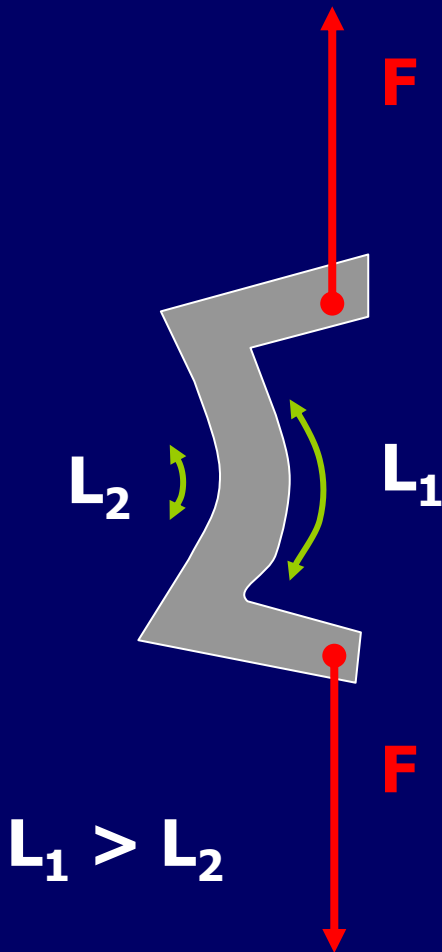
Definition – Interception types – **Measuring interception**

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Weighing with strain gauges

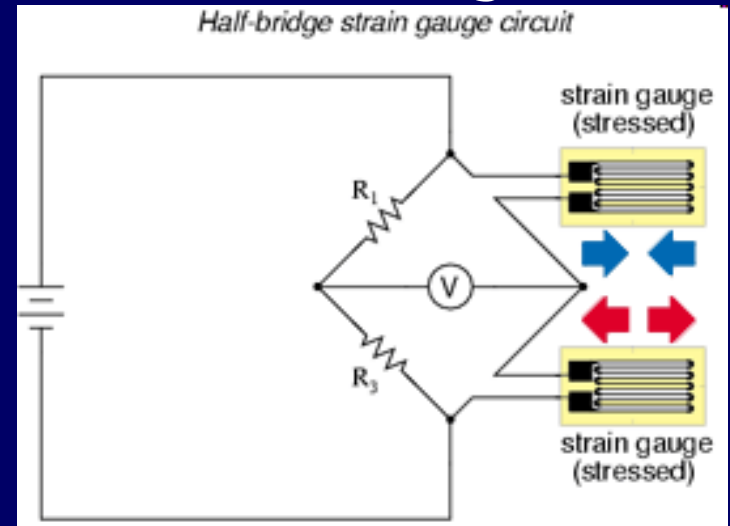


Weighing with strain gauges

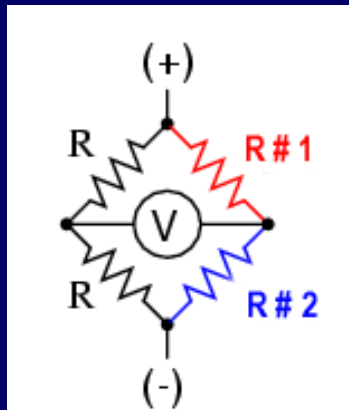
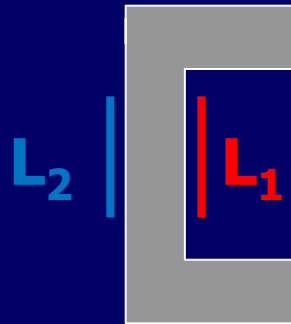


Strain gauge:
Resistance is a function of length

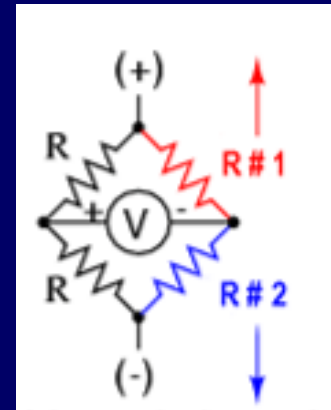
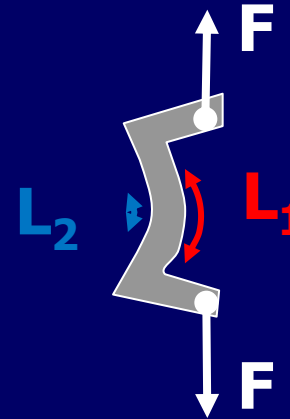
Wheatstone bridge:



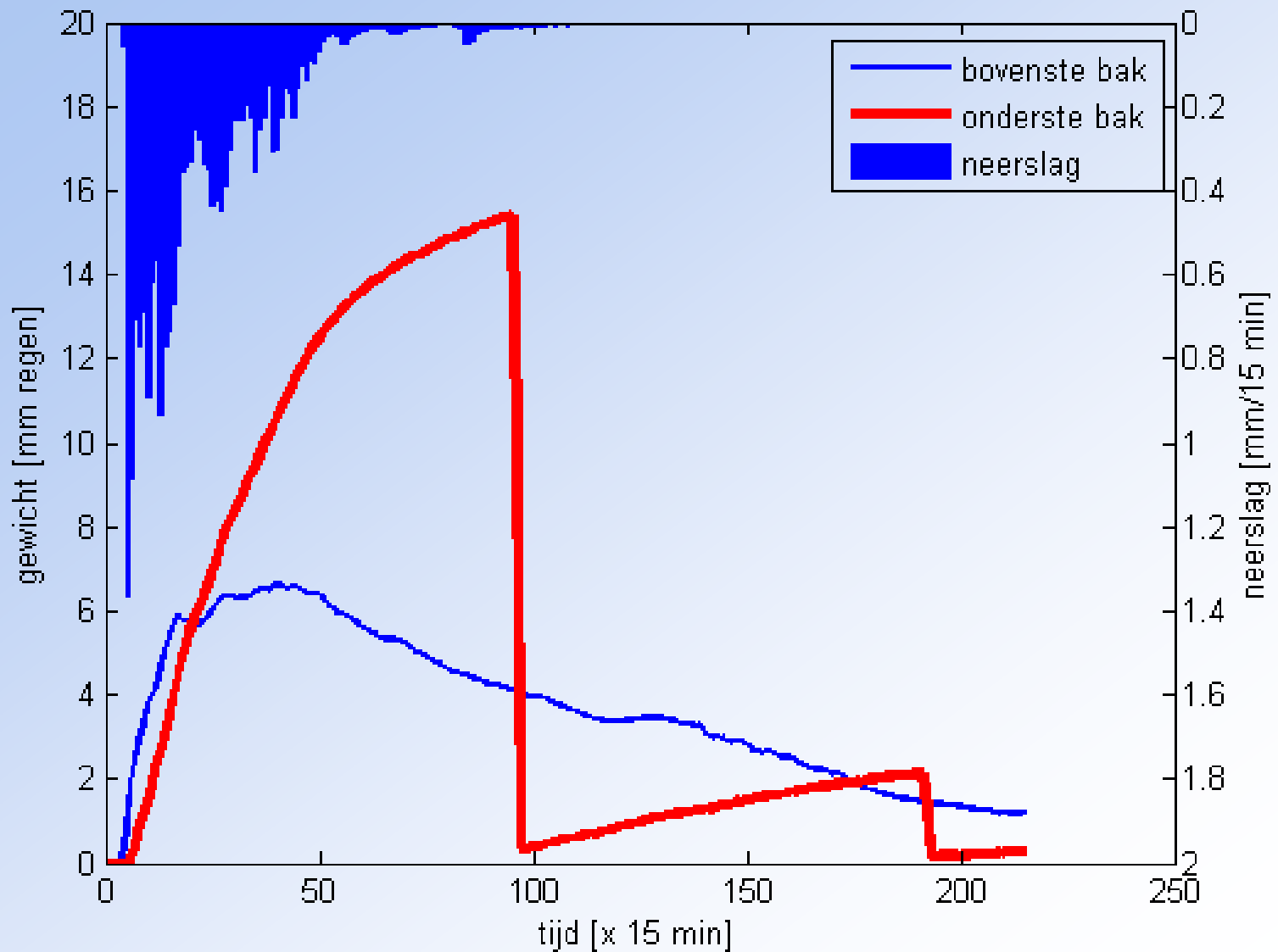
Weighing with strain gauges



Bridge balanced

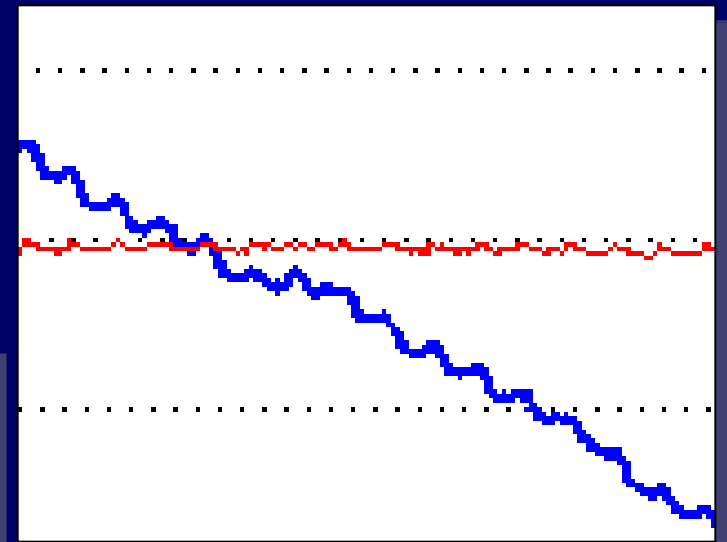
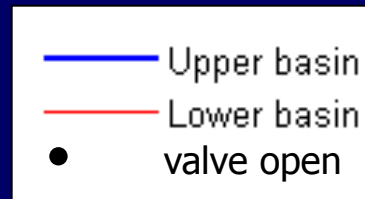


Bridge unbalanced



Temperature influence

Not only interception evaporation is influenced by temperature...



Measuring forest floor interception

Types of forest floors

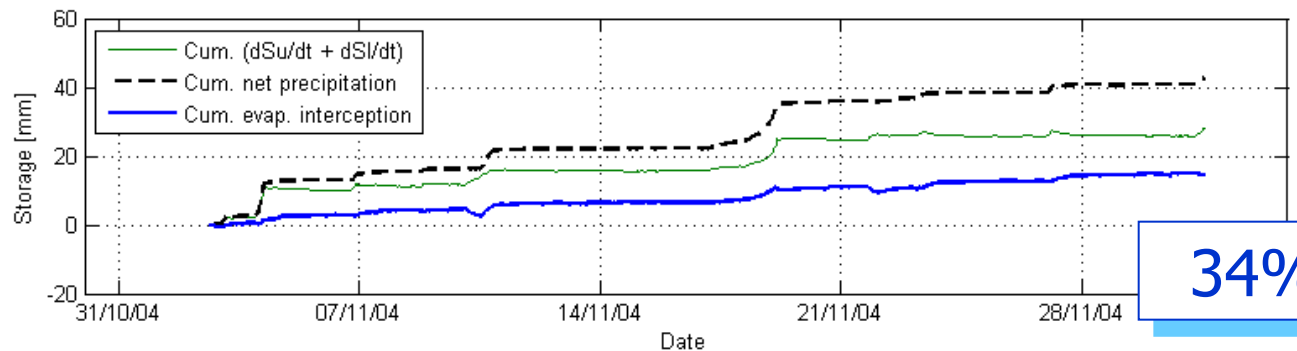
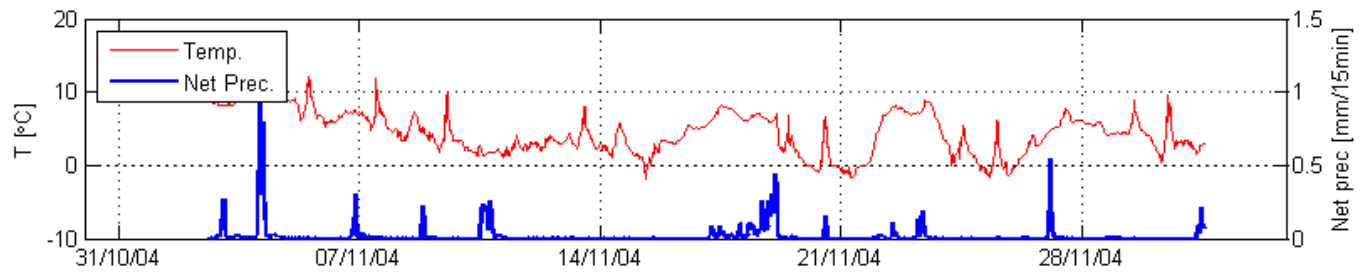
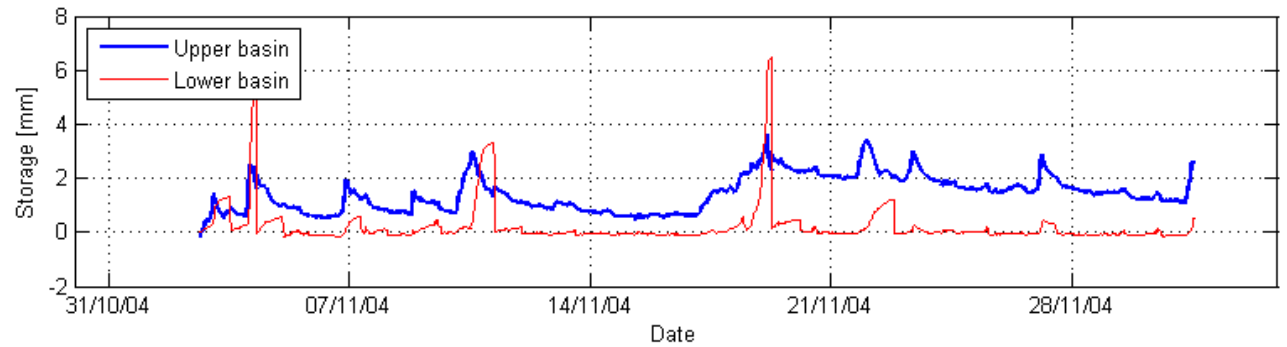


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Definition – Interception types – **Measuring interception**

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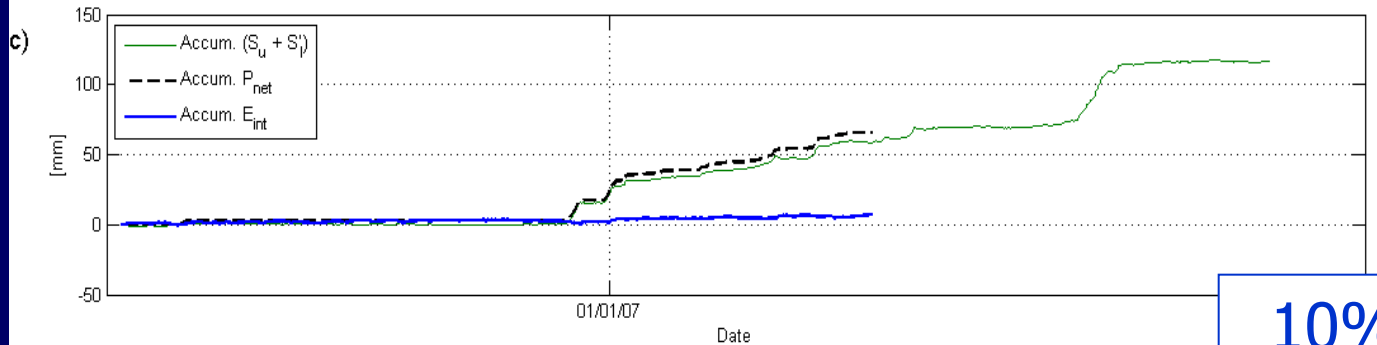
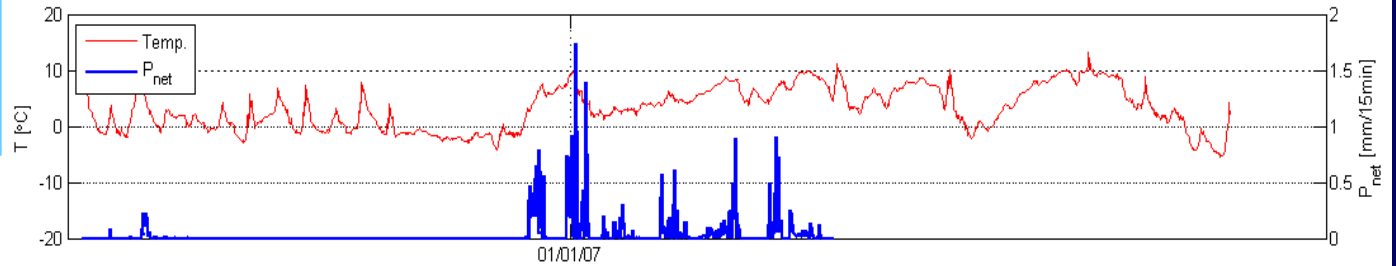
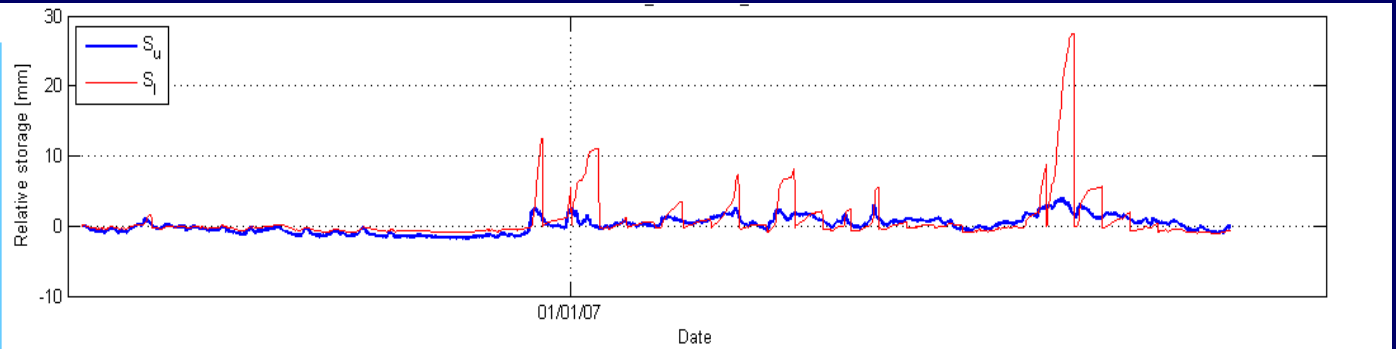
Huewelerbach litter interception



November

34%

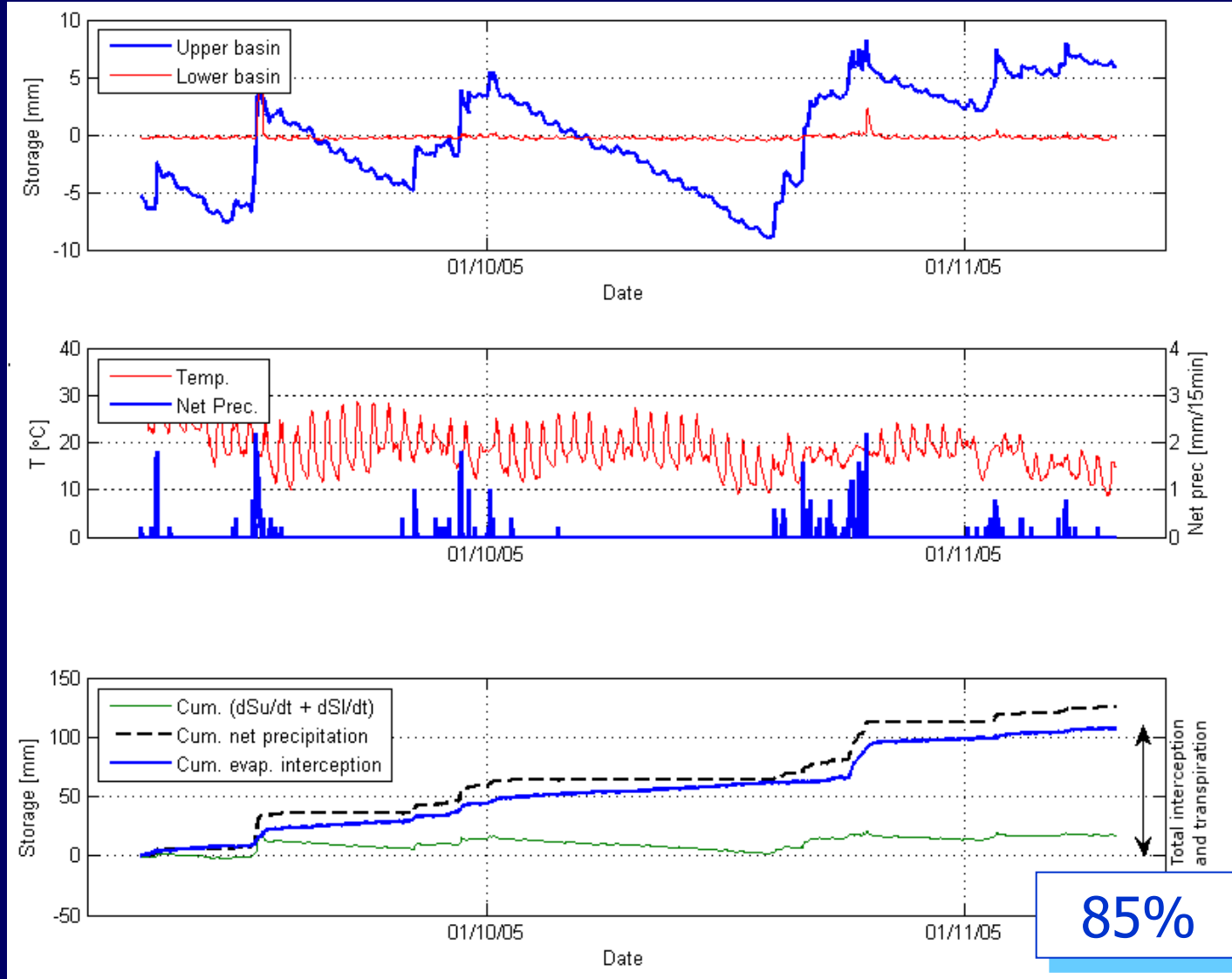
Huewelerbach *litter interception*



December

10%

Westerbork short vegetation interception



85%

Summary

- Interception = storage + evaporation
- Several types of interception exist and can be superposed
- Showed several ways to measure interception
 - Different approaches
 - Water balance
 - Attenuation
 - Mechanics
 - Pro's and con's

Introduction to 1st proposition

Interception data

Canopy:

- Beech: 0.5 – 1.5 mm
- Pine: 1.0 – 2.0 mm
- Oak: 1.5 mm (summer)

Forest floor:

- Beech: 1.8 mm
- Pine: 0.3 - 2.7 mm
- Grass: 2.5 mm

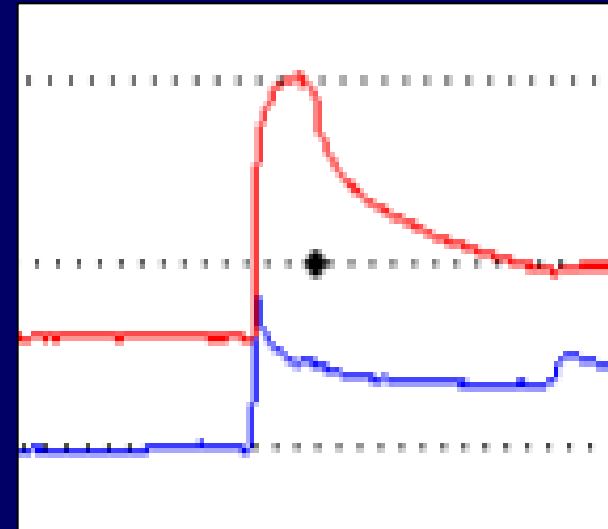
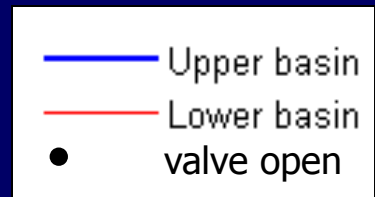
Data November 2009 Delft (KNMI):

Rain sum: 137 mm/month

Problems 1/78

Congestion of valve, which caused leakage

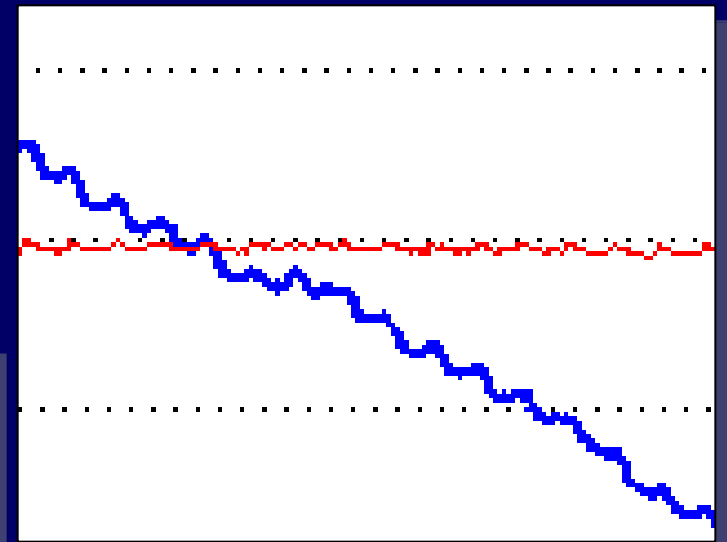
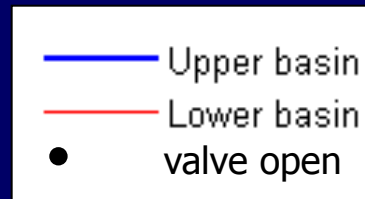
- ⇒ Filter in front of valve entrance
- ⇒ Bigger valve diameter
- ⇒ Backup: barrel to collect discharged water



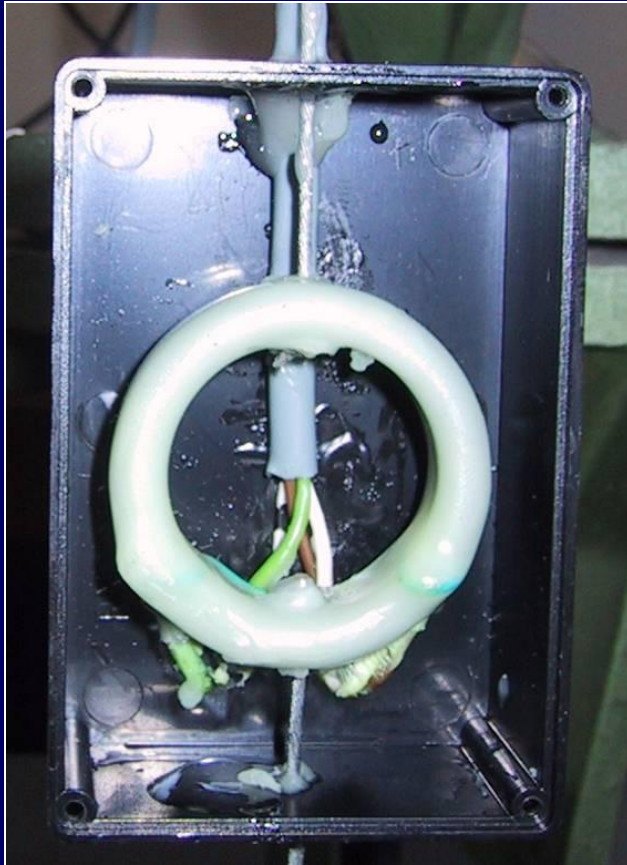
Problems 2/78

Temperature influence:

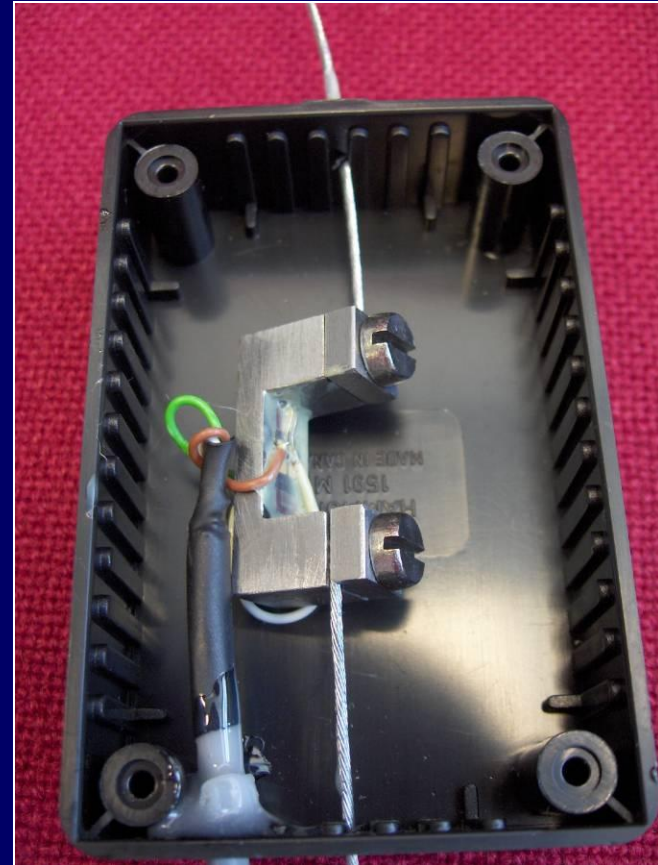
⇒ Less temperature sensitive sensor configuration



Strain gauges



version 1 *Source Unknown*



version 2 *Source Unknown*

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Problems 2/78

Temperature influence:

- ⇒ Less temperature sensitive sensor configuration
- ⇒ Dummy



Problems 3/78

Power failures:

- Battery empty
- Corroded plugs

- ⇒ Spare battery
- ⇒ Waterproof boxes
- ⇒ OR-wiring



Source Unknown

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Problems 4/78

Unknown forces:

- Eaten cables
- Bended supporting structures
- Collapsed basins

Source Unknown



Source Unknown

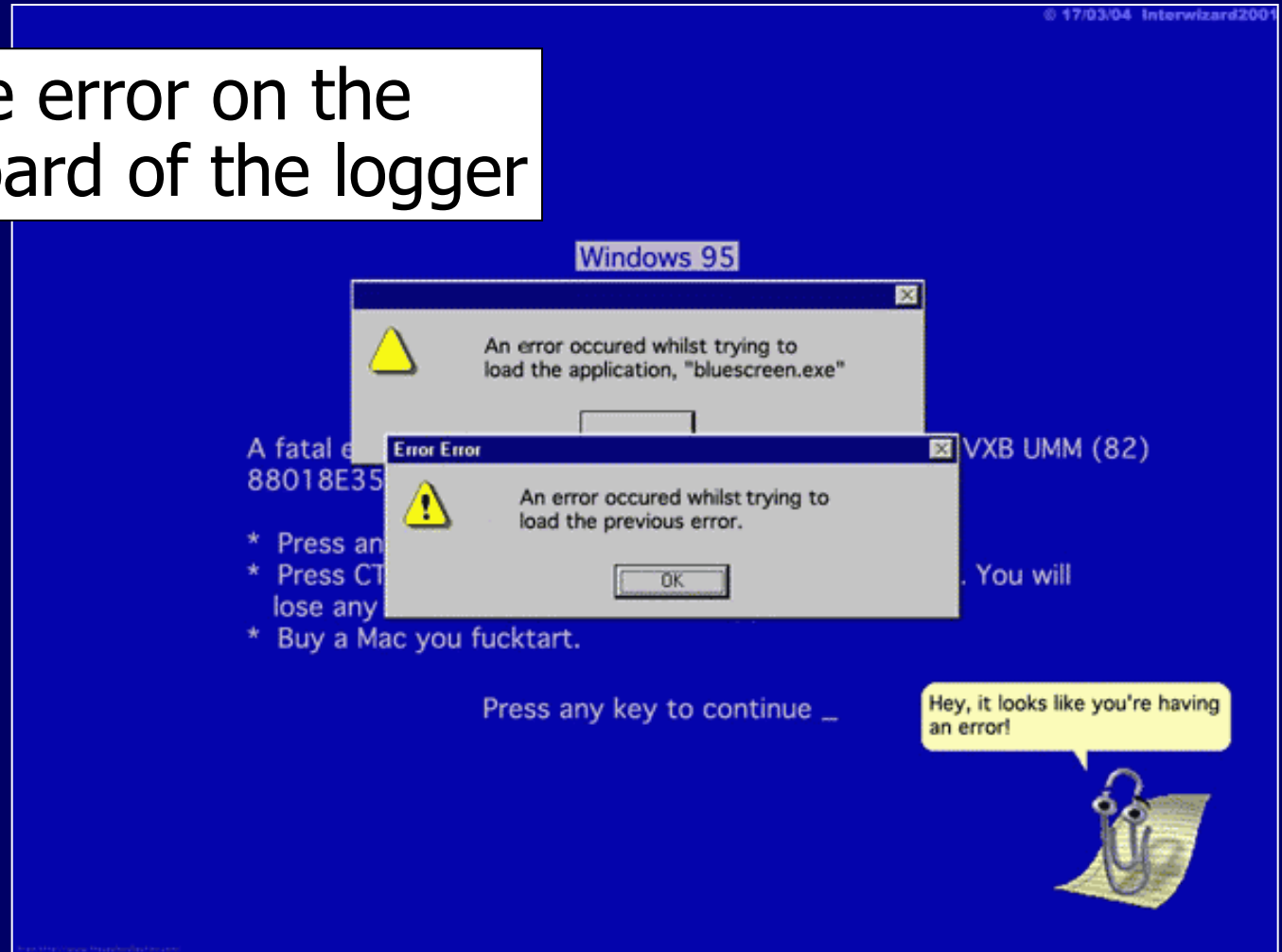


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Problems 5/78

© 17/03/04 Interwizard2001

Hardware error on the printing board of the logger



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