Energy balance measurements of forest floor interception
Huewelerbach catchment, Luxembourg

April 7th 2011
Miriam Gerrits, Venneker, Savenije, and Pfister
Motive for this study

- Evaporation is a major component of the water cycle

- Current focus often on transpiration

Evaporation:
- Transpiration
- Interception
  - Canopy
  - Forest floor
- Soil evaporation
- Open water evaporation
Interception in forests
Importance of interception: example of a beech forest

Gerrits, et al. 2010 (Hydrological Processes)

<table>
<thead>
<tr>
<th></th>
<th>2004-2010</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Canopy</td>
<td>Forest floor</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td><strong>Beech</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td>15%</td>
<td>19% (22% of Tf)</td>
<td>34%</td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td>7%</td>
<td>20% (22% of Tf)</td>
<td>27%</td>
<td></td>
</tr>
</tbody>
</table>
Challenge:
From plot to basin scale

Possible solution direction:

- Developments in Remote Sensing products:
  - Radiation
  - Rainfall
  - Surface Temperature
  - NDVI
  - ...

ENERGY BALANCE
Challenge:
From plot to basin scale

On the plot scale:
Find relation between the water and the energy balance
The interception plot

Huwelerbach catchment

Legend
DEM a.m.s.l.
- High: 402 m
- Low: 289 m
- Interception plot
- Meteorological station
- Stream

http://www.interception.citg.tudelft.nl
Water balance: Canopy interception equipment

3 gutters (2 m) $\Rightarrow$ tipping bucket
81 pluviometers $\Rightarrow$ manual (2-4 weeks)
Water balance:
Forest floor interception equipment

\[ E_{i,f} = P_{net} - \left( \frac{dS_u}{dt} + \frac{dS_l}{dt} \right) \]

Gerrits, et al. 2007 (HESS)
Energy balance: the parameters

- RH + temp
- wind
- RH + temp
- $2 \times R_S$
- $R_L \downarrow$ (http://landsaf.meteo.pt)

10 m

~ 5 m
Energy balance: the model

\[ C_v \frac{dT_{sk}}{dt} = R_N - H - \lambda E - G \]

\[ H = f(T_{sk}, T_{10}, g_a) \]

\[ \lambda E = f(q_{sk}^*, q_{10}, g_a) \]

\[ G = f(T_{sk}, T_l) \]

De Ridder and Schayes, 1997 (Am. Meteo. Soc.)
Results... Winter... Summer
Winter

RH (z=10) and T (z=10) over the period 06-Mar-2008 until 31-Mar-2008.


Observed precipitation (18 mm, 21%) and modelled precipitation (12 mm, 13%).

http://www.interception.citg.tudelft.nl

accum. $P_{\text{net}}$ [mm]

cum. $E_{i,f}$ (modelled)

cum. $E_{i,f}$ (observed)

Winter

30/03/08
31/03/08
02/04/08
03/04/08

0
20
40
60
80

[mm]

$E_{i,f}$ (modelled)

$E_{i,f}$ (observed)

0
0.5
1

0
0.5
1
1.5
2
2.5

Observed $E_{i,f}$ [mm/d]

Simulated $E_{i,f}$ [mm/d]

Simulated accum. $E_{i,f}$ [mm]

Observed accum. $E_{i,f}$ [mm]

$\lambda E$ [W/m$^2$]

$P_{\text{net}}$ [mm/5 min]

$P_{\text{net}}$ [mm/d]

Winter
Obs: 5 mm (18%)
Mod: 5 mm (19%)
Conclusions

- Energy balance model shows reasonable results, however:
  - Extreme weather conditions (snow, thunder)
  - Temperature sensitivity of observations

- Future:
  - Including canopy and coupling
  - Using more RS products
  - Upscaling

The authors would like to thank:
- Jean Francois Iffly, Cyrille Tailliez, Wim Luxemburg, and Hessel Winsemius;
- Fonds National de la Recherche Luxembourg, and Delft Cluster (the Netherlands)