Forest Hydrology: Lect. 6
Interception

If precipitation falls on a surface other than bare soil, it is considered to be intercepted and is subject to evaporation or sublimation

Objectives:

- Understand what factors affect interception amounts
- Learn how to measure interception
- Understand the differences in interception of snow and rainfall
- Understand how interception may offset transpiration
- Understand how interception can affect water quality

Interception……

First, the falling precipitation may be *intercepted* by the vegetation in an area.

It is typically either distributed as runoff or evaporated back to the atmosphere.

The leafy surface matter may also intercept precipitation

http://www.weather.gov/iao/InternationalHydrologyCourseCD1/johnson/wmo_2003/lectures/oct_2003_wmo_course.ppt

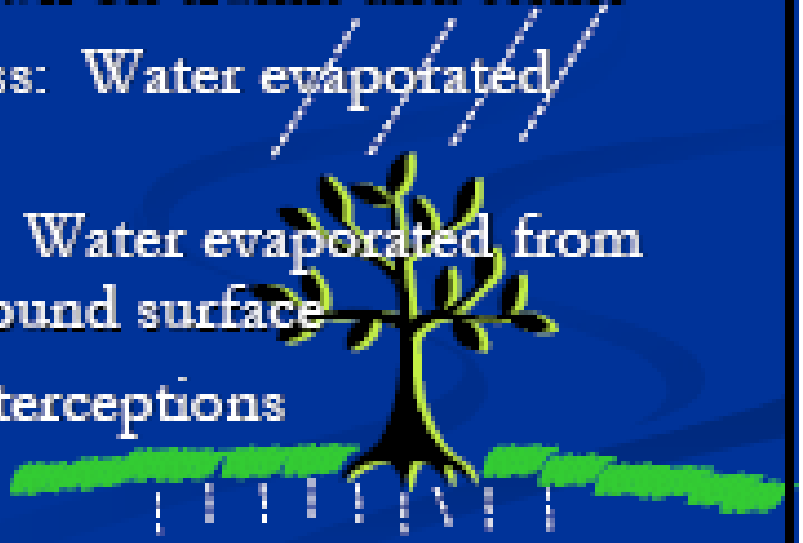
Interception…the point

- The point of the interception is that the precipitation is temporarily **stored** before the next process begins.
- The intercepted/stored precipitation may not reach the ground to contribute to runoff.
- Interception may be referred to as a loss, i.e. it does not contribute to runoff or soil moisture
- This is also true for snowfall which may sublimate and leave the watershed!

http://www.weather.gov/iao/InternationalHydrologyCourseCD1/johnson/wmo_2003/lectures/oct_2003_wmo_course.ppt

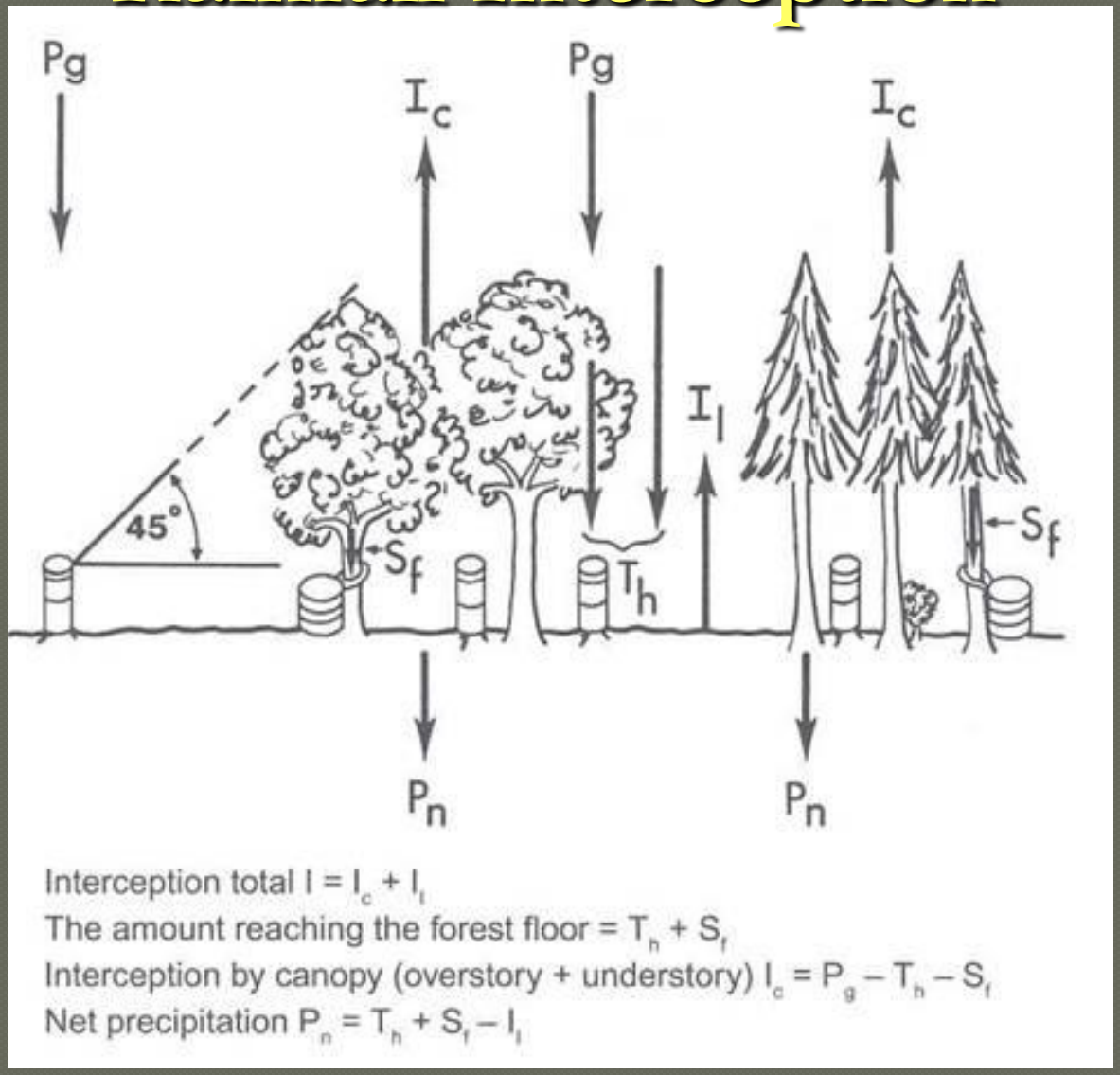
Interception

- Gross rainfall: Measured in open
- Throughfall: Through vegetative canopy and dripping out
- Stemflow: Running down on trunks and stems
- Canopy interception loss: Water evapotated from the canopy
- Litter interception loss: Water evaporated from the ground and near ground surface
- Net rainfall: Gross - interceptions

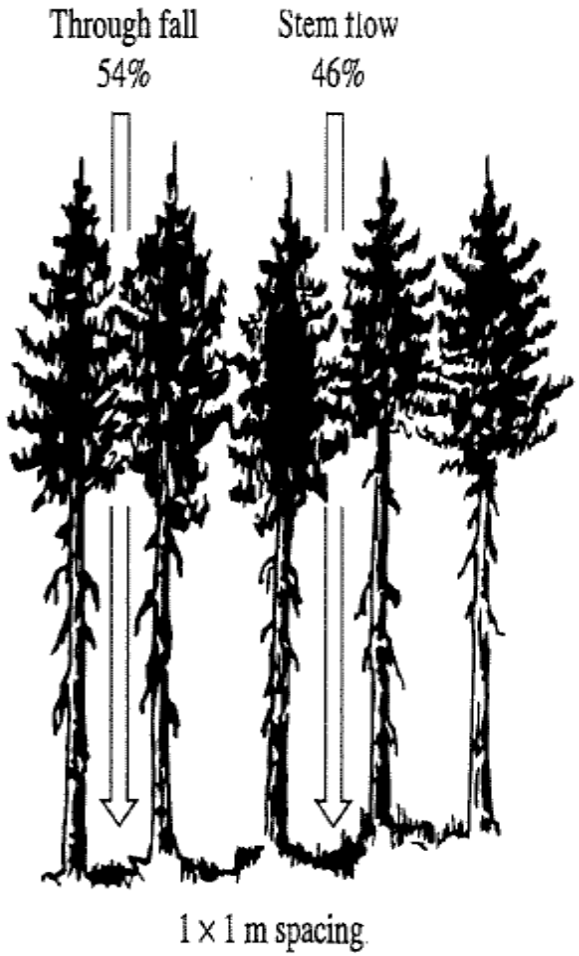


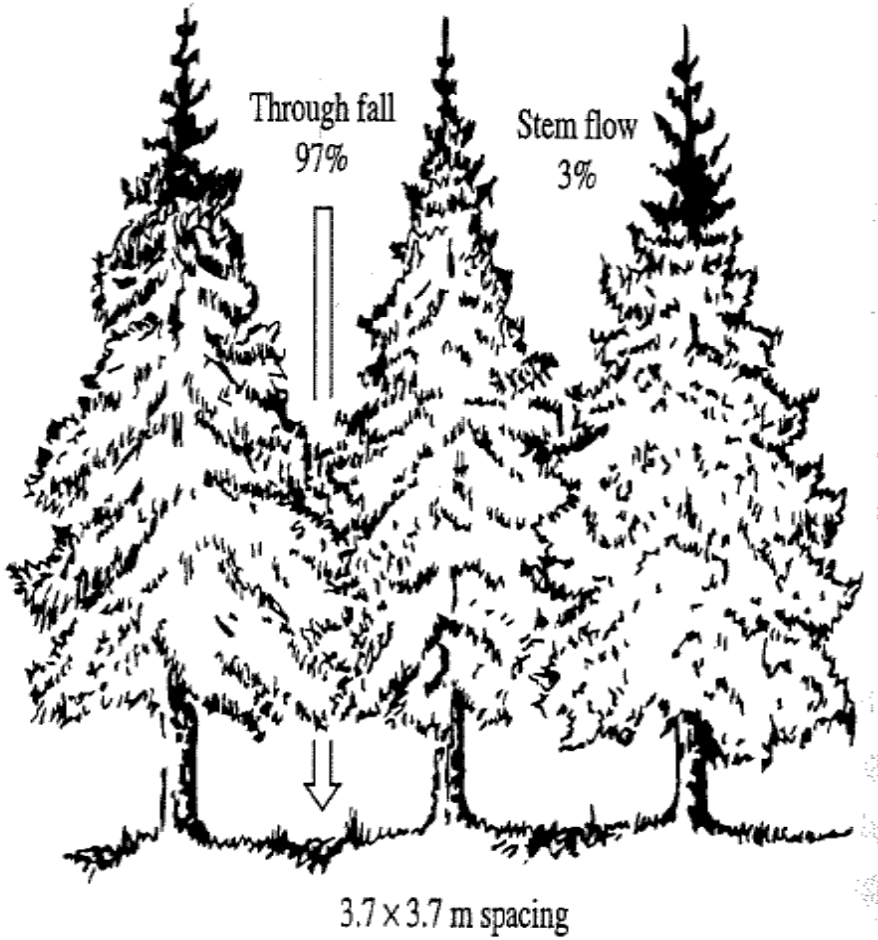
http://www.harbor2.umb.edu/zhou/egs295_files/lecture_27.pdf

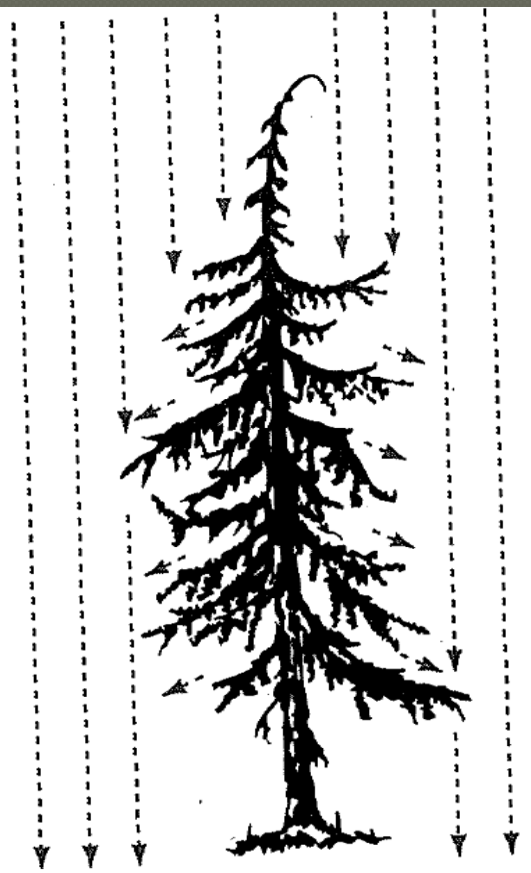
Rainfall Interception



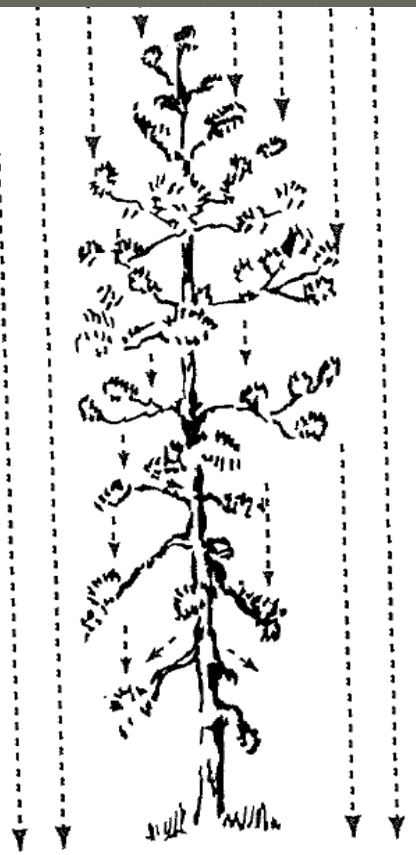
What factors control interception losses and throughfall ?


Through fall
54%
Stem flow
46%
1 × 1 m spacing

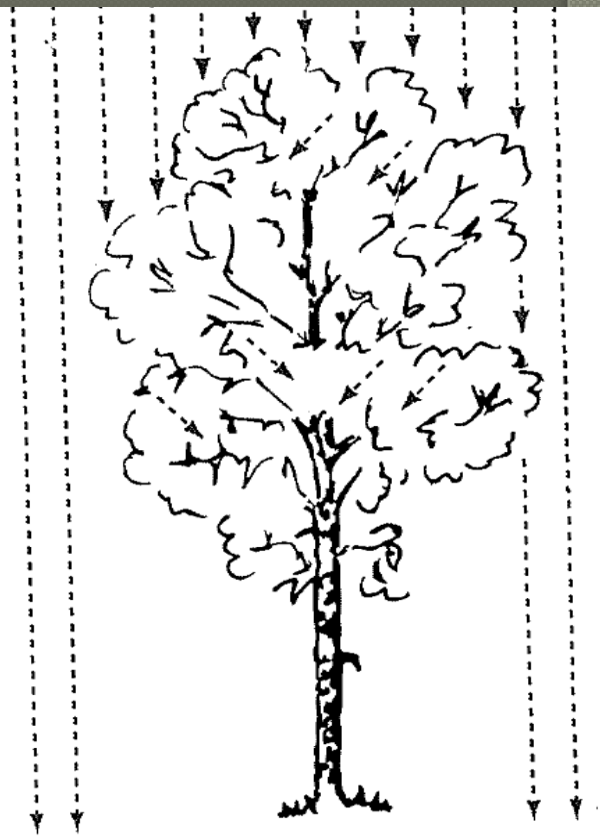

Through fall
97%
Stem flow
3%
3.7 × 3.7 m spacing



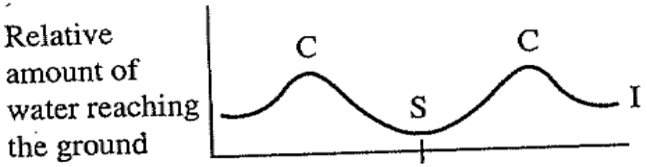
1
Western Hemlock



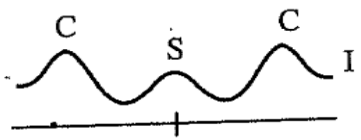
2
Pine



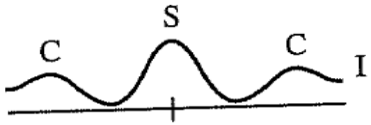
3
Bitter cherry
or Red flow



I = incident precipitation



C = canopy edge drip



S = stem flow

Controls on Interception Losses and Throughfall

- Storms size and frequency
- Hardwoods vs conifers
- Growing vs dormant seasons
- Snow vs rain
- Stand density
- Energy availability
- Position under canopy

Interception: $I_c = P_g - T_h - S_f$

Rainfall Interception

- New Hampshire mixed hardwoods I = 13%
- N. Carolina 60 year old white pine I = 9%
- NW U.S. White pine and hemlock I = 21%
- NW U.S. mature Douglas fir I = 34%
- Natural teak forests in Thailand I = 65%
- Is influenced by rain:
  - amount,
  - duration,
  - intensity,
  - and pattern

www.ctahr.hawaii.edu/faresa/courses/nrem662/08-31%20**Lecture**.**ppt** -

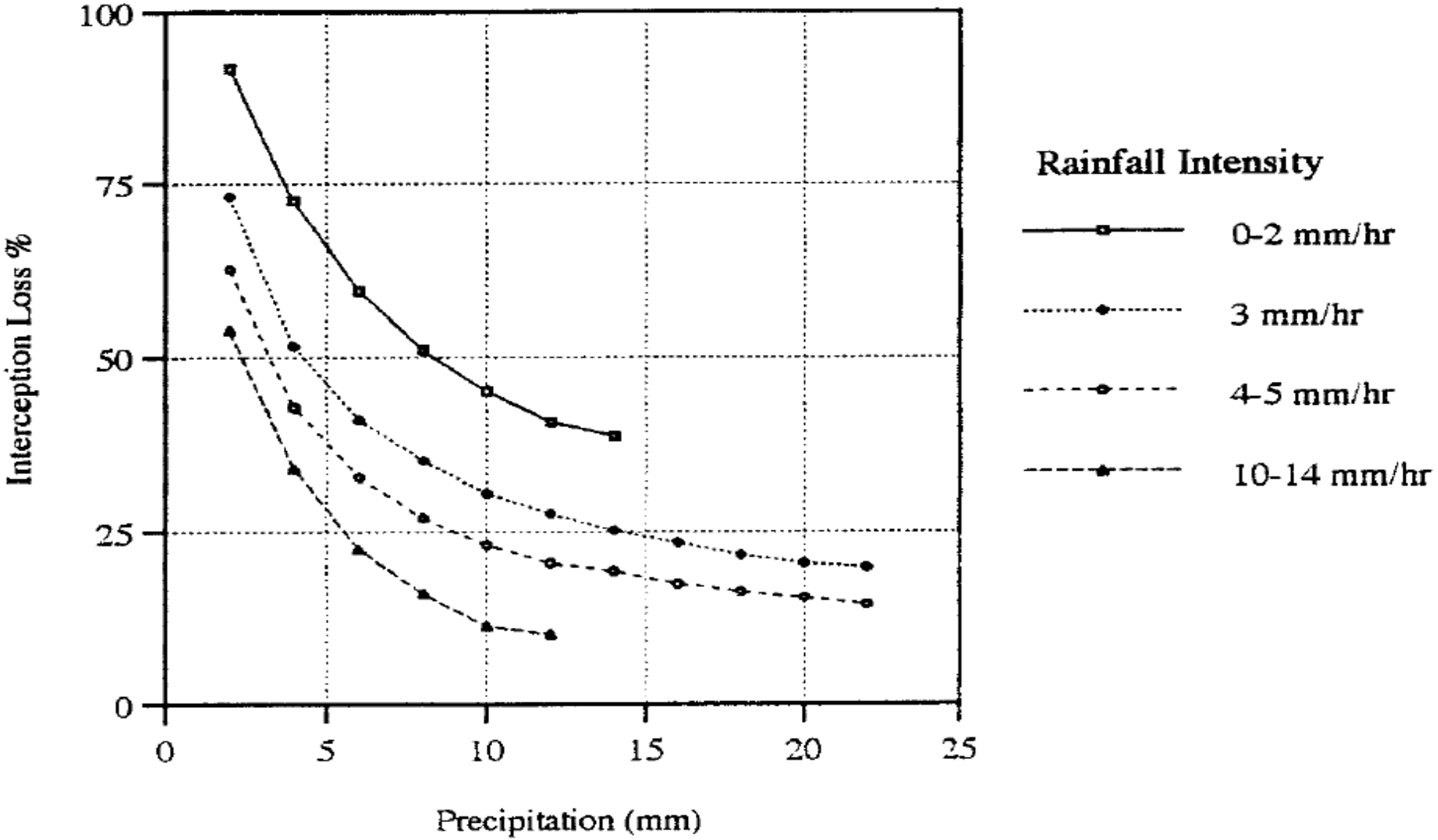
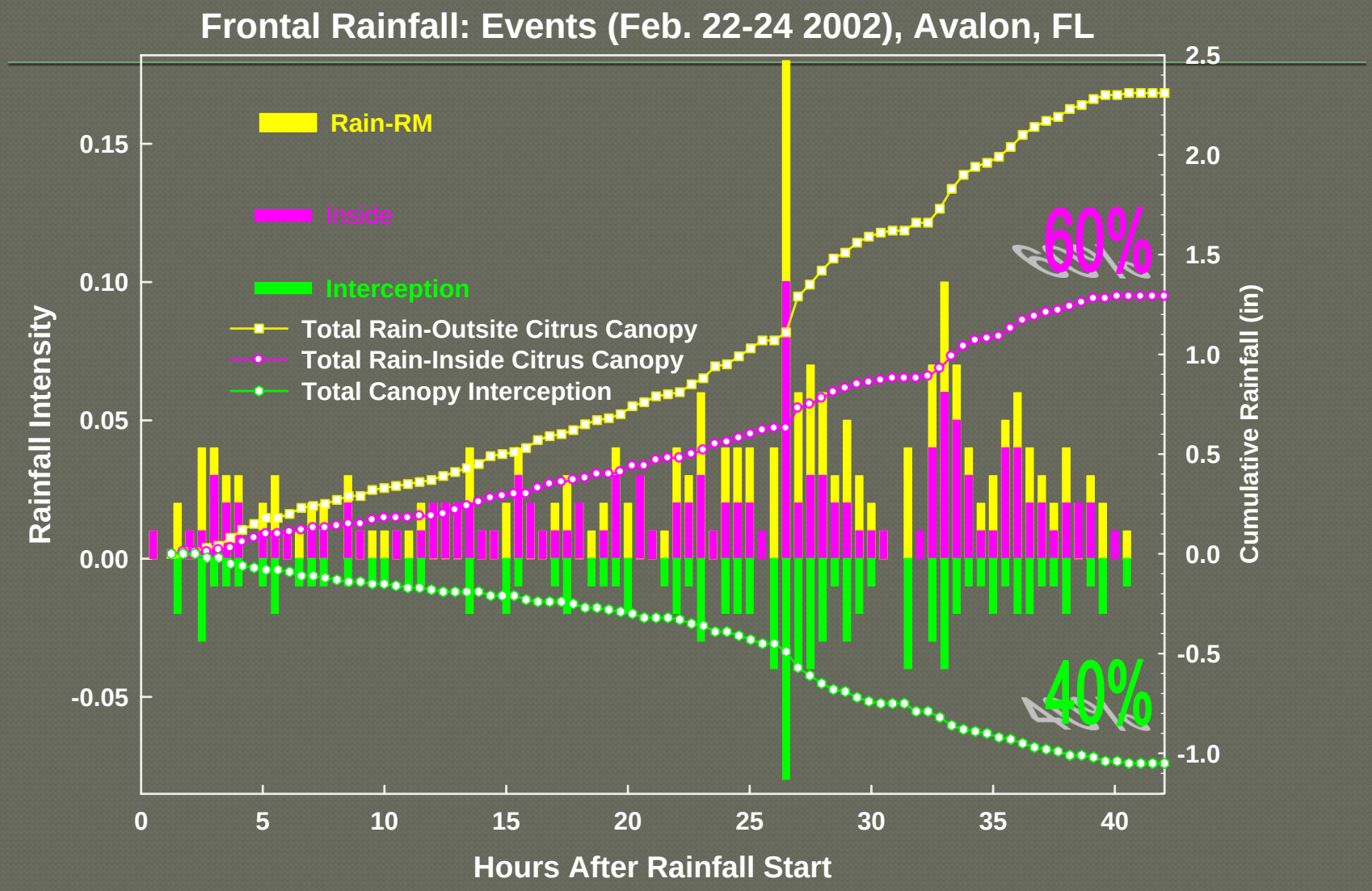


FIG. 1. Plot of percentage interception vs rainfall depth under varying intensities (adopted from Wells and Blake 1972).

Canopy…(or lack of)

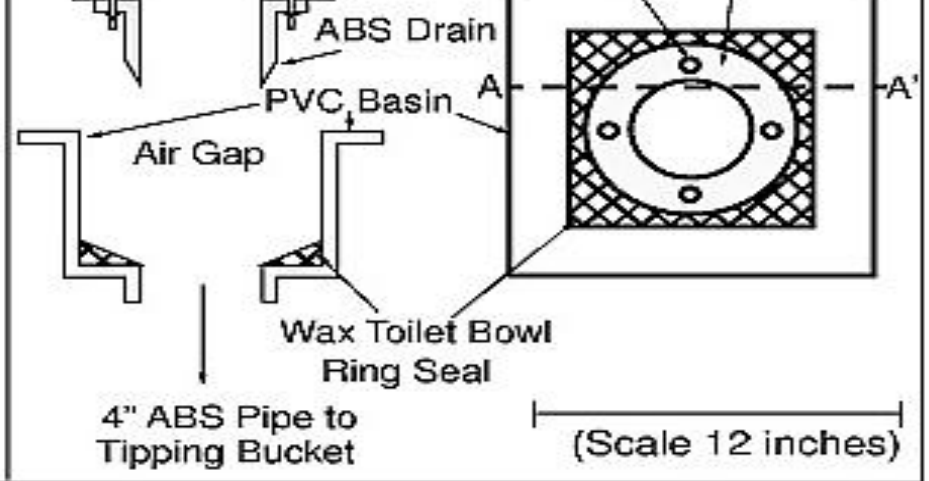
http://www.weather.gov/iao/InternationalHydrologyCourseCD1/johnson/wmo_2003/lectures/oct_2003_wmo_course.ppt

Rainfall Canopy Interception



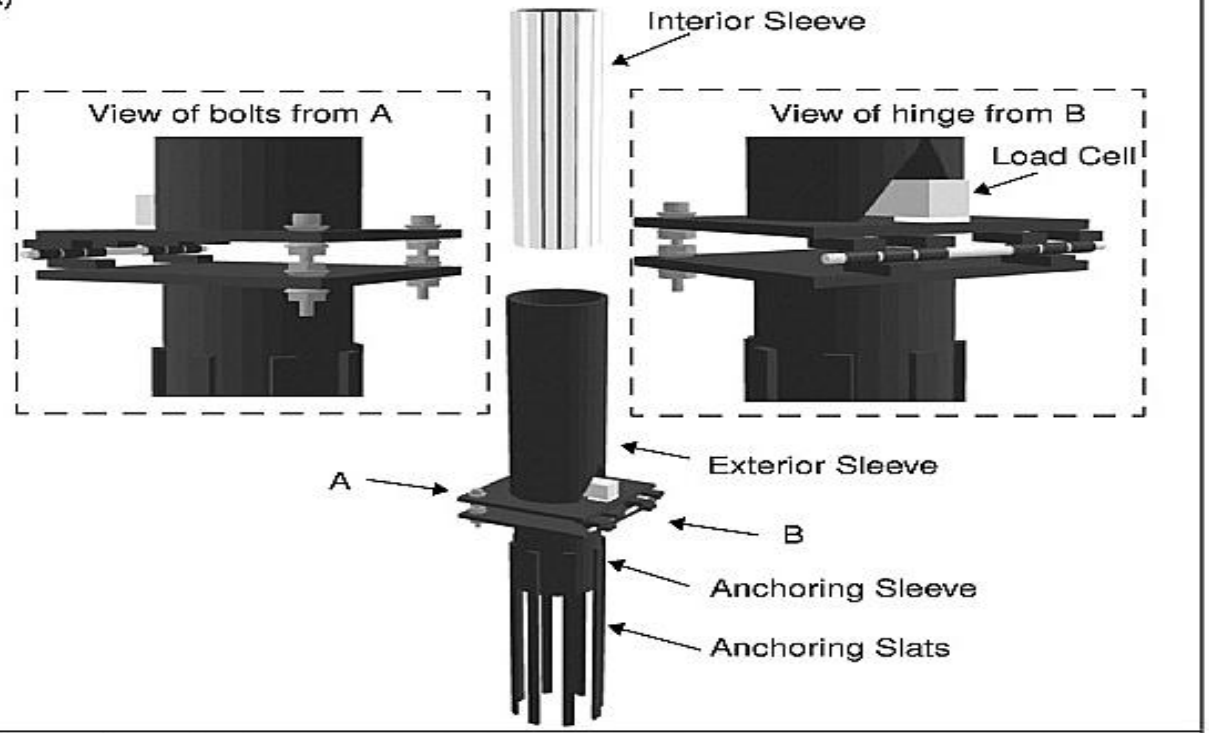
Snowfall interception

- Snow can stack up on surfaces, more depth intercepted than precipitation
- Study in Oregon showed about 60% of snowfall intercepted (snow water equivalent) up to about 40 mm of water
- Rainfall amounts ~ 1mm hardwood,
  ~2 mm conifers

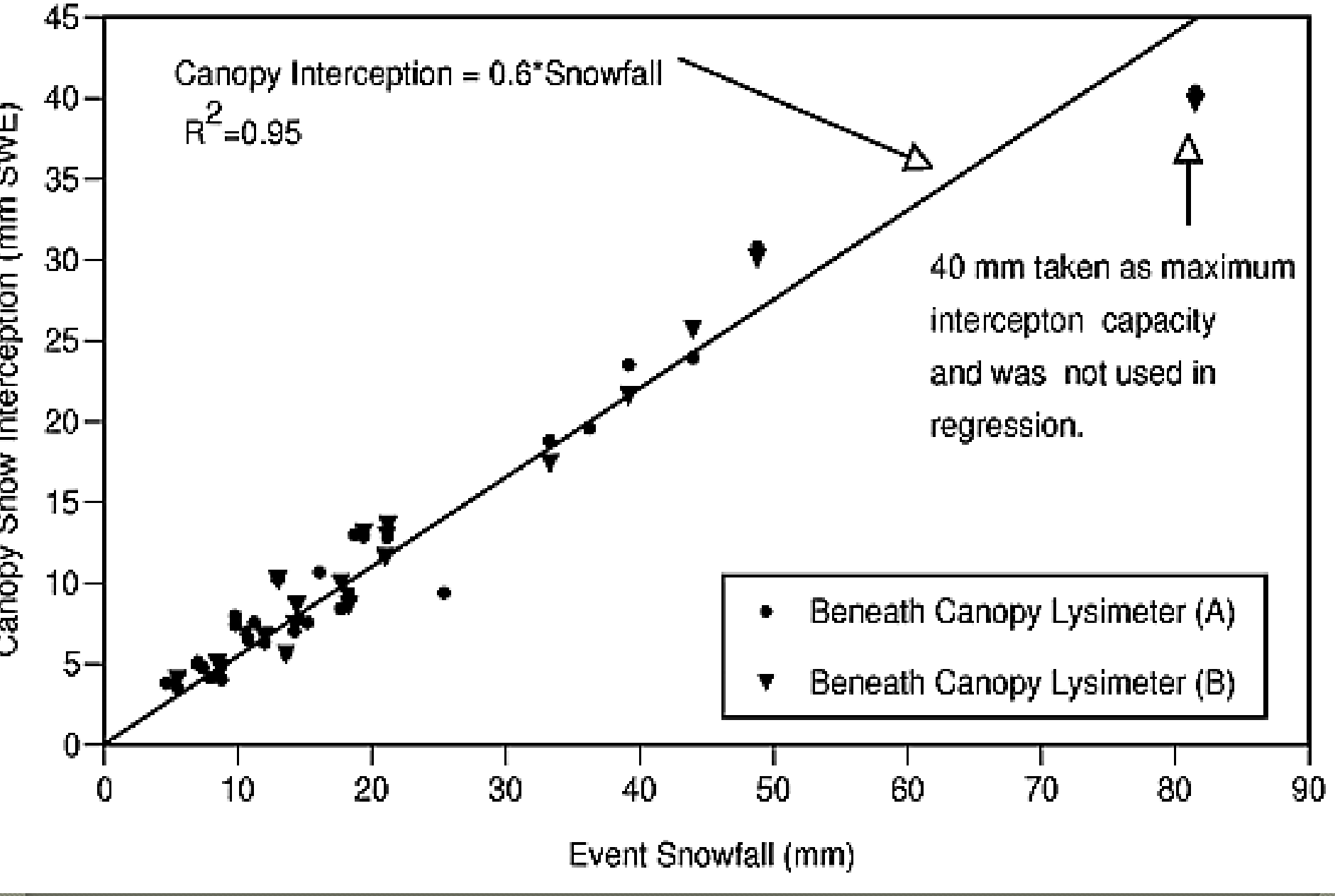

ABS Drain
A
A'
PVC Basin
Air Gap
Wax Toilet Bowl
Ring Seal
4" ABS Pipe to
Tipping Bucket
(Scale 12 inches)

c)

a)


Interior Sleeve
View of bolts from A
View of hinge from B
Load Cell
Exterior Sleeve
A
B
Anchoring Sleeve
Anchoring Slats

b)


Canopy Interception = 0.6*Snowfall
R2=0.95
40 mm taken as maximum intercepton capacity and was not used in regression.
Beneath Canopy Lysimeter (A)
Beneath Canopy Lysimeter (B)
Canopy Snow Interception (mm SWE)
Event Snowfall (mm)
0
5
10
15
20
25
30
35
40
45
0
10
20
30
40
50
60
70
80
90

Leafy Matter also intercepts…

Very thick ground litter layers can hold as much as 0.5 inches!

http://www.weather.gov/iao/InternationalHydrologyCourseCD1
/johnson/wmo_2003/lectures/oct_2003_wmo_course.ppt

Is it a loss?

- Studies indicate interception can be 10-40% of precipitation in some communities
- In dormant season, probably is a net loss
- In growing season, may be offset by reduction in transpiration
- Due to wind turbulence in forests, a greater loss than in grasslands where interception is largely balanced by decreased transpiration

Water quality effects of interception

- Decreases energy of raindrop impact, thus reducing erosion forces
- Chemistry of throughfall is different than precipitation- dissolves dry deposition on leaves and stems
- Hubbard Brook studies show much higher concentrations of calcium, potassium, sulfates, chlorides, organic carbon, and all forms of nitrogen in throughfall

Significance of interception

- Usually results in a net loss of water available for runoff and soil moisture
- Reduces raindrop impact which can decrease erosion
- Alters water chemistry
- Loss of trees may affect fog drip and thus total precipitation

- Throughfall less variable in larger storms

Table 1 Range of selected throughfall inputs under diverse wooded ecosystems in tropical, temperate, and semi-arid regions

Cover type	Throughfall (% of Pg)	Reference
Subtropical rainforest	91.6	Lin *et al.*, 2000
Bornean rainforest	81.0	Burghouts *et al.*, 1998
African rainforest	96.6	Chuyong *et al.*, 2004
Pinus caribaea plantation	75.0–85.0	Lilienfein and Wilcke, 2004
Oak-hickory forest	80.0–96.1	Peterson and Rolfe, 1979
Temperate deciduous forest	77.5	Price and Carlyle-Moses, 2003
Evergreen broadleaved forest	64.9–73.1	Masukata *et al.*, 1990
Black spruce forest	75.8	Price *et al.*, 1997
Semi-arid shrubs	27.0–79.3	Návar and Bryan, 1990
Thornscrub community	78.1	Návar *et al.*, 1999
Mediterranean holm oak forest	72.1–75.5	Rodrigo and Àvila, 2001

Inputs of selected nutrient-ions in throughfall of tropical, temperate, boreal, and semi-arid forests (kg/ha/year)

Forest cover type	Throughfall			Reference
	K	Mg2	NO3	
Tropical montane cloud forest	63.2	7.6	---	Cavelier *et al.*, 1997
Tropical montane cloud forest	54.7	4.1	0.8	Hölscher *et al.*, 2003
African rainforest	122.4	12.3	---	Chuyong *et al.*, 2004
Lodgepole pine	1.6	0.7	0.0	Fahey *et al.*, 1988
Black spruce	5.9	1.4	1.0	Morris *et al.*, 2003
Sitka spruce	23.1	13.0	---	Reynolds *et al.*, 2000
Mediterranean holm oak forest	12.3	1.7	0.9	Bellot *et al.*, 1999
Mediterranean holm oak forest	19.0	3.1	2.7	Bellot *et al.*, 1999

Conceptualization of abiotic and biotic factors affecting the event-scale temporal and spatial variability of throughfall

	Variability	
	Temporal	Spatial
Abiotic	Event magnitude (mm)	Event magnitude (mm)
	Event duration (h)	Event duration (h)
	Event intensity (mm/h)	Event intensity (mm/h)
	Wind speed (m/s)	Wind speed (m/s)
	Wind direction (°)	Wind direction (°)
Biotic	Interception storage (l/m2)	Species composition
	Plant area index (m2/m2)	Interception storage (l/m2)
		Canopy hydrophobicity
		3-D canopy structure
		Plant area index (m2 m2)a

Variability of throughfall volume and solute inputs in wooded ecosystems

Progress in Physical Geography 2006 30: 605
Delphis F. Levia, Jr. and Ethan E. Frost
http://ppg.sagepub.com/content/30/5/605