Evaluating the Drought Code Using *In Situ* Drying Timelags of Feathermoss Duff in Interior Alaska

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What is the DC?

- $S = S_0 + P - E_{act}$
- $E_{act} = E_{pot} * S_0/S_{max}$
- E_{pot} referenced to an evaporimeter
- E_{act} causes negative exponential drying
- E_{act} implies a soil is present
- All we know about the soil is its hydrological properties, water storage capacity, S_{max}, and its drying timelag, τ
- Soil properties cannot be precisely known

What is the “DC Equivalent Soil”?

- We know its water storage capacity, S_{max}
- Soil parameters are free to vary in fixing S_{max}
- Empirically determine soil attributes from known soils

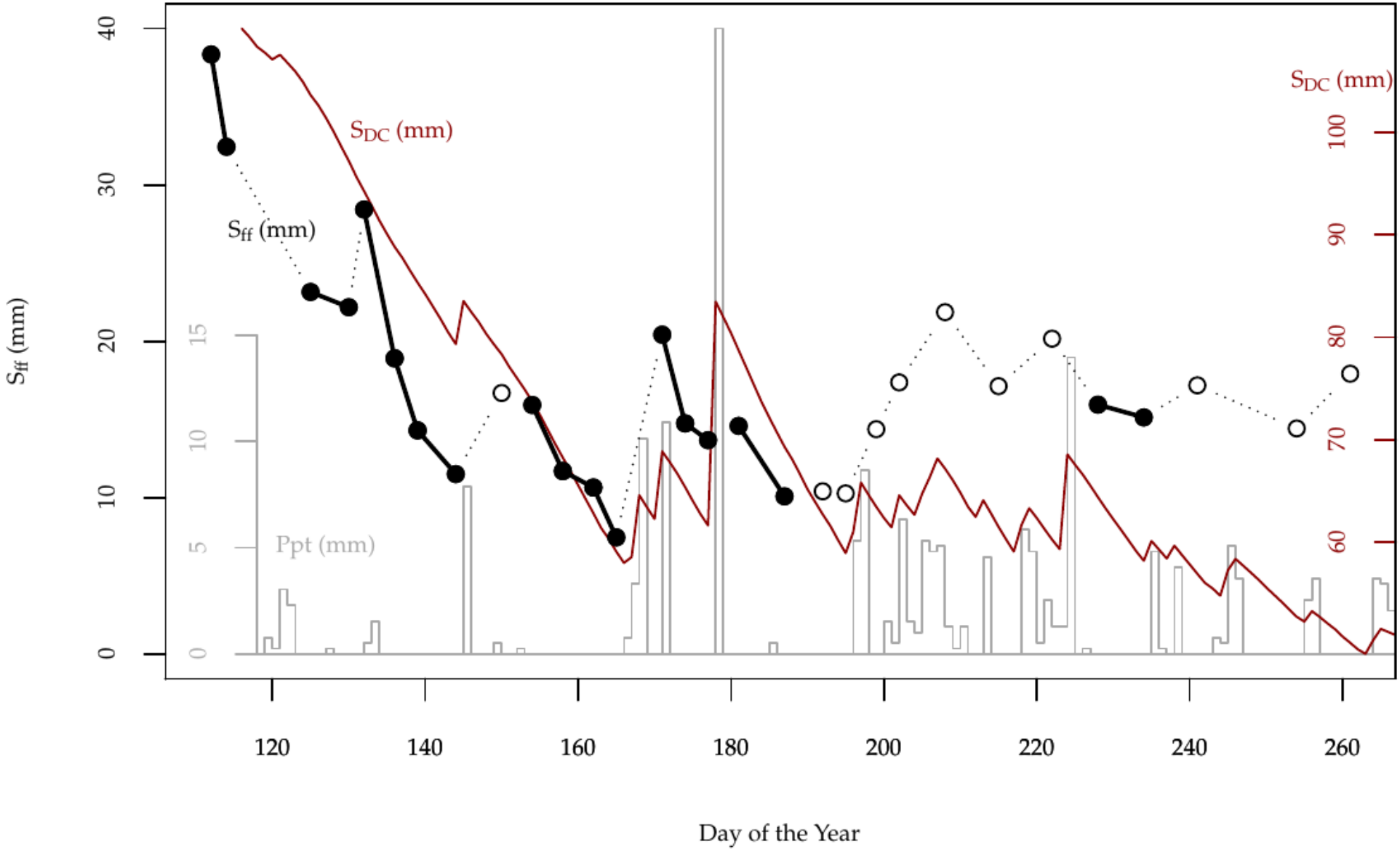
$$S_{max} = \frac{M_{g,max}}{100\%} \rho \delta$$

What is the “DC Equivalent Soil”?

- How can we know the “DC Equivalent Soil”?
- Equate the timelag, τ, in a forest floor to that of the DC
- $\tau_{ff} = \tau_{DC}$
- Requires a time series of volumetric moisture content measurements

Wilmore

- Wilmore thesis: “Duff moisture dynamics in black spruce feather moss stands and their relation to the Canadian Forest Fire Danger Rating System”
- 1999 Brenda Wilmore measured MC in a black spruce-feathermoss stand on Fort Wainwright


S_{ff} (mm)
S_{DC} (mm)
S_{ff} (mm)
Ppt (mm)
S_{DC} (mm)
0
10
20
30
40
0
5
10
15
60
70
80
90
100
120
140
160
180
200
220
240
260
Day of the Year

Results

- Timelag
- Duff = 28 days
- DC = 60 days

- S_{max}
- Duff = 31 mm
- DC = 203 mm

“DC Equivalent Soil”

- Duff timelag = 28 d and DC timelag = 60 d
- How do we equate timelags to know the properties of the “DC equivalent soil”
- For a negative exponential function:
- Translate between water balances:
  - Duff
  - DC water balance model
  - “DC equivalent soil”

$$\tau = \frac{S_{max}}{E_{pot}} = \frac{S_0}{E_{act}}$$

Pot. Evap in the Forest

$$\tau_{ff} = \frac{S_{max,ff}}{E_{pot,ff}}$$

$$28 = \frac{31}{E_{pot,ff}}$$

$$E_{pot,ff} = 1.1 \text{ mm}$$

Compare to Epot at an open evaporimeter

$$E_{pot,open} = 3.3 \text{ mm}$$

Actual Evap in the Forest

Heijmans et al measured 0.3 and 0.9 for closed and open PIMA stands.

$$\tau_{ff} = \frac{S_{0,ff}}{E_{act,ff}}$$

$$28 = \frac{17}{E_{act,ff}}$$

$$E_{act,ff} = 0.60 \text{ mm}$$

Heijmans, Arp, Chapin. 2004. Controls on moss evaporation in a boreal black spruce forest. Global Biogeochem. Cycles 18(2):1-8. DOI 10.1029/2003GB002128

S_{max} of “DC Equivalent” Soil

$$\tau_{DC} = \frac{S_{max,DCeq}}{E_{pot,ff}}$$

$$60 = \frac{S_{max,DCeq}}{1.1}$$

$$S_{max,DCeq} = 66 \text{ mm}$$

What is the depth of the DC_{eq} Soil?

$$S_{max,DCeq} = \frac{M_{g,max}}{100\,\%}\rho_s\,\delta$$

$$66 = \frac{29\,\%}{100\,\%}0.62\,\delta$$

$$\delta = 374 \text{ mm}$$

* $M_{g,max}$ = 29% and ρ_s=0.62 because they includes mineral soil

What is the DC equivalent soil?

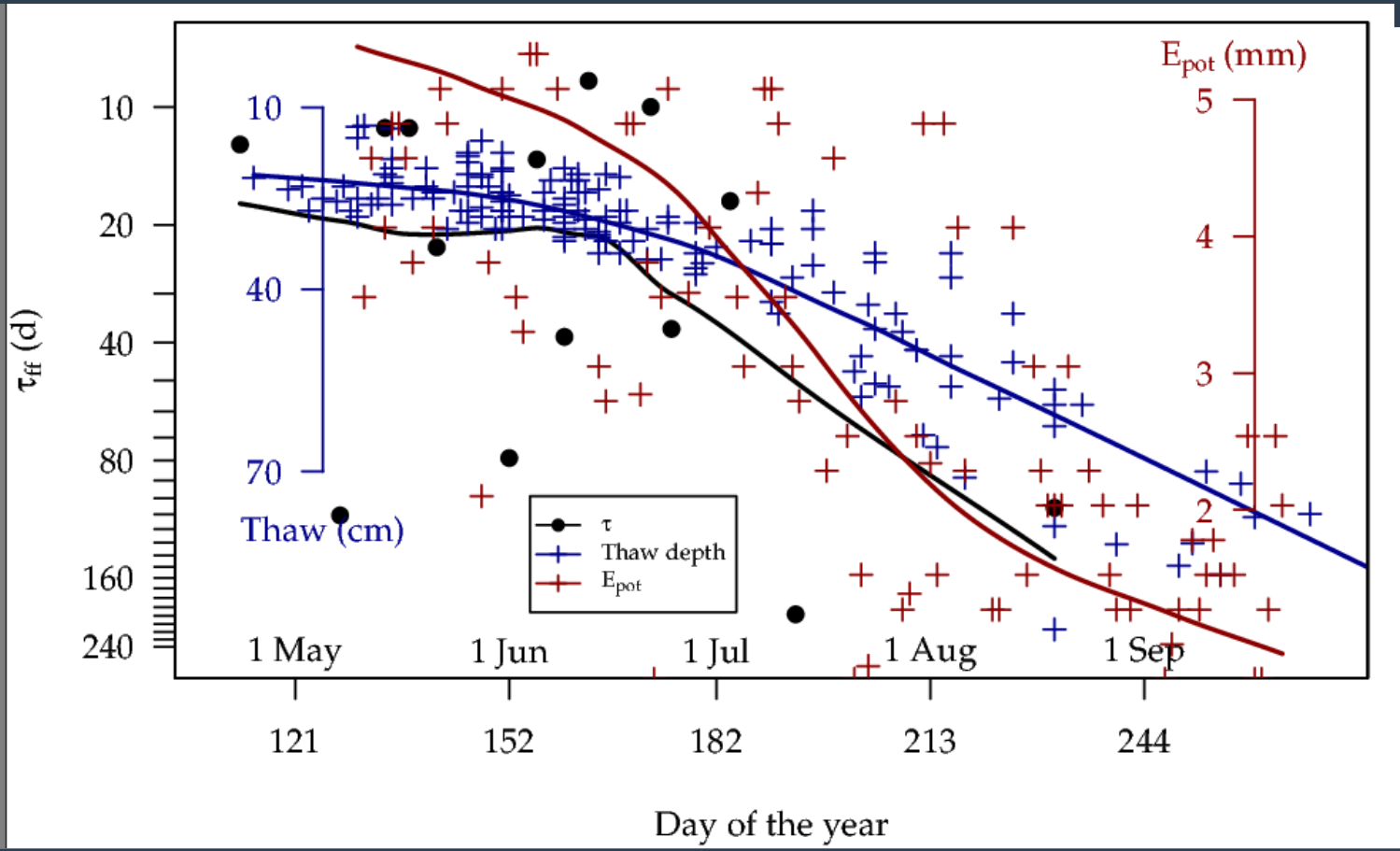
- “DC equivalent soil” is 37 cm deep
- 46% mineral soil by depth!
- 95% mineral soil by weight!
- Does not represent “burnable” fuel
- Solely a fire danger rating index

Permafrost

- DC equivalent soil is 37 cm deep
- Thaw depth reaches 37 cm on 5 July
- E_{pot} peaks in June

$$\tau = \frac{S_{max}}{E_{pot}} = \frac{Low}{High} = Short\ \tau$$

Permafrost



$$\tau = \frac{S_{max}}{E_{pot}}$$

Cross-walk to FWI

Horizon	Thickness	Moisture Code
Live Moss	0-3 cm	FFMC
Dead Moss	3-8	DMC
Upper Duff	8-15	DC
Lower Duff	15-20	
Mineral Soil	20+	

Profile	Thickness	Moisture Code
Live Moss-Mineral Soil	0-37 cm	DC