Index of late frost risk

Basis

Calculation of the index IS for the late frost risk of trees according to Czajkowski and Bolte (2006) is described. There is no direct impact of late frost events on tree growth in 4C. The index is an indicator of late frost and can be used to analyse changes in late frost risk under climate change. The index is calculated for a time span of several years. The calculation is implemented in the Fortran file: calc_climdriv.f.

Five variables are calculated:

- Ind1: **mean number of days** with late frost since beginning of the vegetation period (T>10°) or
- Ind1_sp **mean number of days** with late frost since bud burst of the simulated tree species
- Ind2: mean minimum May temperature
- Ind3: absolute minimum May temperature of the period
- Ind4: mean date of the last late frost event
- Ind5: date of the last late frost event of the period

Table 1 Classification into 6 levels

Risk	Level IS	Ind1[d]	Ind2 [°C]	Ind3 [°C]	Ind4 [date/DOY]	Ind5 [date/ DOY]
very low	1	until 2.5	until -1.5	until -5	< 10.5/130	< 5.6./156
low	2	2.6-3.5	-1.6- -2.0	until -6	< 15.5/135	<10.6./161
medium	3	3.6-4.5	-2.1 - -2.5	until -6	16.-20.5/135-140	11.-15.6./162-166
moderately high	4	4.6 -5.0	-2.6- 3.0	until -7	21.-25.5/141-145	16.-20.6/167-171
high	5	5.1-5.5	-3.1- -3.5	until -8	21.5.-25.5141-145	21.-25.6./172-176
very high	6	>5.5	<-3.5	< -8	> 25.5/145	>25.6./176

Calculation of the total index **IS** or **IS_sp**:

- combination of Ind1 – Ind5 with logical ‘and’
- realised:: averaging Ind1-Ind5 (IS), and. Ind1_sp-Ind5 (IS_sp)

Two additional Indices are calculated as following according to (Riek et al., 2013), see http://www.forstliche-umweltkontrolle-bb.de/r3_klima.php:

- ANZDLF: number of days with minimum temperature < 0°C from April until June
- SUMTLF: temperature sum of minimum temperature <0°C from April until June

Estimation of a further late frost risk index $\mathbf{LFI_{sp}}$ for decidous tree species from model variables during a simulation time of N years:

1. calculation of variable LFJ_{sp} per year i und per tree species sp:

$$LFJ_{sp}(i) = \begin{cases} 1 & daybb_{sp}(i) < date\_lft(i) \\ 0 & else \end{cases}$$

2. calculation of the index for the simulation period:

$$LFI_{sp} = \frac{\sum_{i=1}^{N} LFJ_{sp}(i)}{N}$$

References

Czajkowski, T. and Bolte, A., 2006. Frosttoleranz deutscher und polnischer Herkünfte der Buche (Fagus sylvatica L.) und ihre Beeinflussung durch Trockenheit. Archiv f. Forstwesen u. Landsch.ökol., 40(3): 119-126.

Riek, W., Kallweit, R. and Russ, A., 2013. Analyse der Hauptkomponenten des Wärmehaushalts brandenburgischer Wälderauf der Grundlage regionaler Klimaszenarien – Abgrenzung von Risikogebieten und Schlussfolgerungen für ein Klima-Monitoring. Waldökologie, Landschaftsforschung und Naturschutz(13): 17-32.