M68 index

Description

The $M68$ index was developed by Käse (1969) in East Germany based on the Nesterov index in order to predict fire danger in pure pine stands.

The $M68$ is used by the German meteorological service (DWD) for fire danger forecast throughout Germany.

The $M68$ requires daily air temperature and vapour pressure deficit at 13:00 as input data. This index is cumulative, the index values being daily added from the 15th of February until the 30th of September. Two correction factors are included in spring, late summer and fall: one taking into account vegetation condition and another taking into account rain and snow (Käse 1969).

Formula

The $M68$ index is based on following principle (Käse 1969):

$$\sum_{15Febr}^{30Sept} (T_{13} + 10) \cdot \Delta e_{13}$$

where T_{13} is air temperature [°C], and Δe_{13} vapor pressure deficit [mm of mercury] at 13:00. The index calculation should start on the 15th of Februrar, or after snowmelt, and finish on the 30th of September, or at the end of the fire season. If T ≤ -9.9 °C, then the $M68$ equals zero.

The value is daily corrected for precipitation, snow cover and finally for vegetation condition. Only values corrected for precipitation and snow cover are used for the calculation of the next day's index.

The precipitation corrected index $pM68$ index is calculated as follows (Käse 1969, DWD):

$$pM68_t = k_1 \cdot pM68_{t-1} + max\left[0,\ k_2 (T_{13_t} + 10) \cdot \Delta e_{13_t}\right]$$

for t between 15 Febr. and 30 Sept., and $pM68 = 0$ for t = 14 Febr.

and the final index $M68$ (corrected also for vegetation condition) :

$$M68_t = k_3 \cdot pM68_t$$

with

$$k_1 = \begin{cases} 1, & \text{if } P_t < 1 \\ 0.5, & \text{if } 1 \leqslant P_t < 5 \ \text{ or } Snowcover \geqslant 1\,cm \text{ since } t \\ 0.25, & \text{if } 5 \leqslant P_t < 10 \ \text{ or } Snowcover \geqslant 1\,cm \text{ since } t-1 \\ 0, & \text{if } P_t \geqslant 10 \ \text{ or } Snowcover \geqslant 1\,cm \text{ since } t-2 \end{cases}$$

$$k_2 = \begin{cases} 0, & \text{if } P_t \geqslant 20 \ \text{ or } Snowcover \geqslant 1\,cm \text{ since } t-2 \\ 0.5, & \text{if } P_t < 20 \text{ and } (P_{t-1},\ P_{t-2} \text{ or } P_{t-3}) \geqslant 20 \\ 1, & \text{if } P_t,\ P_{t-1},\ P_{t-2} \text{ and } P_{t-3} < 20 \end{cases}$$

$$k_3 = \begin{cases} 3, & \text{for } t < t_1 \\ 2, & \text{for } t_1 \leqslant t \leqslant t_2 \\ 1, & \text{for } t_2 < t < t_3 \\ 0.5, & \text{for } t \geqslant t_3 \end{cases} \quad with \quad \begin{array}{l} t_1 \text{, phenological phase "Birch, first leaves"} \\ t_2 \text{, first occurrence of rainfall } \geqslant \text{ 5mm after the start of the phenological phase "Robinia, first blossom"} \\ t_3 \text{, first occurrence of rainfall } \geqslant \text{ 5mm after 14th of August, at the latest 1 September} \end{array}$$

The $M68$ is supposed to be calculated on a daily basis. The meteorological data used for its calculation have to be recorded at 1 pm.

The index calculation has to be started on the 15 of February, or once the snow has melt. No particular starting value is stipulated.

Index interpretation

The $M68$ is interpreted as follows (Käse 1969):

Index values	Fire danger class	Interpretation
$M68 \leq 500$	0	Probablity for fire occurrence < 3%
$500 < M68 \leq 2000$	1	Probablity for fire occurrence < 20%
$2000 < M68 \leq 4000$	2	Probablity for fire occurrence ≥ 20% and < 40%
$4000 < M68 \leq 7000$	3	Probablity for fire occurrence ≥ 40% and < 60%
$M68 > 7000$	4	Probablity for fire occurrence ≥ 60%

Modifications

The DWD uses a modified formula and the values of vapour pressure deficit in hektoPascals [hPa] instead of mm Hg.

$$pM68_t = k_1 \cdot pM68_{t-1} + max\left[0,\, k_2 \cdot \frac{T_{13_t} + k_4}{10} \cdot \Delta e_{13_t}\right]$$

with

$$k_4 = \begin{cases} 10, & \text{if } H_{13_t} \leqslant 26 \\ 20, & \text{if } 26 < H_{13_t} \leqslant 66 \\ 30, & \text{if } H_{13_t} > 66 \end{cases}$$

It therefore uses other values for the fire danger classes, also considering wind speed and spatial differences in fire susceptibility (A, B and C):

Index values	Wind speed					
	<=8 m/s			>8 m/s		
	Fire danger class					
	A	B	C	A	B	C
≤ 50	-	-	-	-	-	-
51 - 100	-	-	-	1	1	-
101 - 150	1	-	-	1	1	1
151 - 200	1	1	1	2	1	1
201 - 300	1	1	1	2	2	1
301 - 500	2	2	1	3	3	2
501 - 700	3	2	2	3	3	3
> 700	4	3	3	4	4	4

References