Factor analysis micrometeorology variable on a middle taiga peatland of North-East European part of Russia

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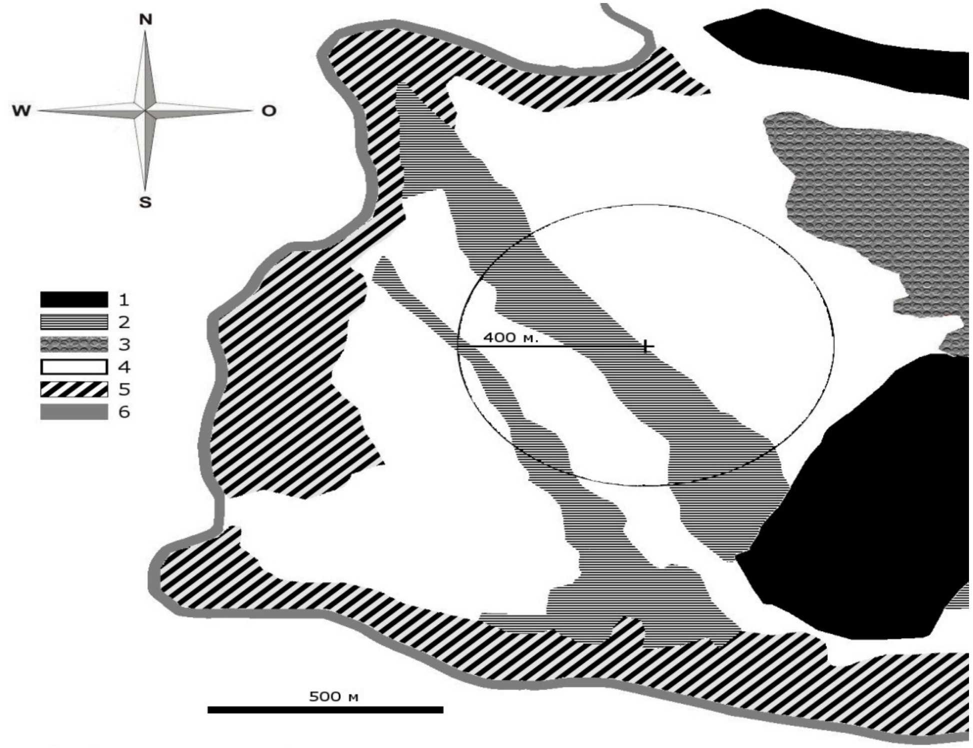

Fig.1. The Ust-Pojeg mire complex. 1 – mineral forest island, 2 –meso-eutrophic grass-mosses flow fen; 3 – oligotrophic pine-shrub-cotton grass-sphagnum communities; 4 – mesotrophic shrub-grass-sphagnum communities; 5 – edge fen; 6 – border of the peatland.

Object and method measurement

- The study site is a typical river valley peatland of North-West part of the European Russia and called Ust-Pojeg or Medla-Pev-Nijur (in komi language) mire complex ($61^0$56’ N, $50^0$13’ E, 119 m a.s.). It is situated in the middle taiga region of the Komi Republic. The Komi Republic is the eastern edge of European Russia and has a humid continental climate with warm summers and consistently cold winter temperatures with continuous snow cover. The mean annual rainfall of Syktyvkar, capital of the Komi Republic (50km southeast of the field site) is 525 mm (mean value of 1888-2012 years), and the mean annual temperature is 1.1^{0}C. (RTHMI-WDC, 2013). The peatland is widely investigated (Avagyan et al. 2015; Gažovič et al., 2010; Lapina et al., 2015; Schneider et al., 2016).
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- The EC measuring system consists of the sonic anemometer (CSAT3, Campbell Scientific Inc, USA) and the open-path gas analyzer (Li-7500A, Li-Cor Inc., USA). Sampling of air was made at the height of 3.93m. Data recording was made with a frequency of 10Hz. Microclimate parameters (air and soil temperature, PAR, solar radiation etc) were registered by the automatic meteorological station using the micrologger CR3000 (Campbell Scientific Inc., USA). Temperature and volume humidity of the soil were measured at depths of 25 cm(depth1, variable Ts1) and 15 см (depth2)
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Data

- The methane measurements started from June 14^{th} 2012, so the data for analysis was taken from June 15^{th} 2012 to October 20^{th} 2012 and from April 16^{th} 2013 to November 8^{th} 2013 when the last day with the mean diurnal temperature more than +5 ^{0}C.

- The data absent during the period from August 22^{nd} to September 9^{th}. Into these periods the days with the mean diurnal temperature less than +5 ^{0}C appeared. Separately were taken “daily” (when PAR was more than 20 mmol (m^{-2} s)) and “night” data points.

- The data averaged by half-hour intervals was used for analysis.

- The data logger of incoming shortwave radiation was broken in 2013, so the data of net radiation was uncorrected and excluded from further analysis. That is why the analysis was made separately for 2012 and 2013 years

Analyze data

- 48 variables are used.
- - concentration of methane (mmol m^{-3}),
- concentration of carbon dioxide (mmol m^{-3}),
- concentration of water vapor (mmol m^{-3}) ,
- air temperature (ºC),
- components of a vector of speed Ux, Uy, Uz (m/c),
- atmospheric pressure,
- squares of pulsations a speed component
- Vertical fluxes of the pulsation streams of heat, methane, carbon dioxide, water vapor,
- derivatives of concentration of methane, carbon dioxide, water vapor, temperature,
- CH_4CO_2
- H_2O T
- KETP
- L – Monin-Obuchov Scale,
- PAR
- Albedo
- Ts1,Ts2 –soil temperature
- Hs1,Hs2 – ssoil humidityt
- U_*
- And others

Correlation coefficient 2012

Пере-менная	CH_4			CO_2			H_2O		
	В целом	день	ночь	В целом	День	Ночь	В целом	День	Ночь
T	0.10	0.42	0.10	-0.28	-0.19	-0,28	-0.24	0.08	-0.27
U_*	-0.18	-0.24	-0,18	-0.07	-0.18	-0.07	-0.07	-0.17	-0.07
KET	-0.17	-0.23	-0.16	-0.09	-0.20	-0.08	-0.07	=-.07	-0.07
KETP	-0.10	-0.12	-0.10	-	-		-		
ФАР	-	0.09	-0.07	-0,13		-0.13	-0.12	-0.17	-0.10
T_{s1}	0.51	0.57	0.54	0.13	0.19		0.11	0,14	0.14
T_{s2}	0.39	0.42	0.43	-	-0.16		-	0.12	
H_{s1}	0.37	0.32	0.41	0.15	0.08	0.19	0.14		0.18
H_{s2}	-0.09			0.13	0.07	0.13	0.08	-0.1	0.11
P	0.26	0.20	0.3	0.18	0.12	0.23	0.12		0.18
CH_4CO_2	0.80	0.70	0.81	0.9	0.88	0.90	0.79	0.74	0.79
H_2O T	0.38	0.42	0.39	0.41	0.32	0.47	0.45	0.64	0.48
Humidity		-0.30		0.26	0.20	0.25	0.18	0.14	0.18
rldownwell		0.35		-0.29	-0.25	-0.29	-0.23		-0.27

2013

Пере-менная	CH_4			CO_2			H_2O		
	В целом	день	ночь	В целом	День	Ночь	В целом	День	Ночь
T	-0.15	-0.21	-0.07	-0.28	-0.25	-0.25	-0.06	0.18	-0.10
U_*	-0.27	-0.24	-0.30	-0.30	-0.31	-0.26	-0.20	-0.18	-0.19
KET	-0.19	-0.12	-0.28	-0.25	-0.20	-0.28	-0.18	-0.19	-0.2
KETP	-0.10	-0.18	-0.09	-0.10	-0.27	-0.05	-0.08	-0.22	-0.04
ФАР	-0.11	-0.14		-0.19	-0.19		-0.13	-0.13	
T_{s1}			0.14	0.14		0.24	0.29	0.39	0.29
T_{s2}		-0.12	0.15		-0.12	0.09	0.19	0.31	0.18
H_{s1}			0.15	0.12	0.24		0.23	0.311	0.24
H_{s2}	0.09	0.10	0.1		0.12	0.047			
P	0.12		0.18	0.14	0.12	0.19		-0.06	0.1
CH_4CO_2	0.88	0.92	0.83	0.76	0.80	0.76	0.52	0.50	0.58
H_2O T	0.09		0.16	0.31	0.212	0.44	0.62	0.73	0.69
Humidity	0.14	0.18	0.06	0.32	0.32	0.29	0.29	0.30	0.24

Correlation between dynamics concentration and environment parameters in 2012 year

Пере-менная									
	В целом	день	ночь	В целом	День	Ночь	В целом	День	Ночь
CH_4		-0.12			-0.24	0.06	0	-0.18	
CO_2		-0.25			-0.72		-0.20	-0.73	-0.09
H_2O		-0.29		0.14	-0.53	0.18	-0.08	-0.66	
dCH_4	1	1	1	0.14	0.11	0.15	0.09	0.17	0.09
dCO_2	0.15	0.11	0.15	1	1	1	0.35	0.8	0.28
dH_2O	0.09	0.17	0.09	0.35	0.8	0.28	1	1	1
T	-			-	0.16	-0.05	-	0.14	
dT	-0.05	0.1	-0.079	-0.13	-0.22	-0.116	-0.11	-0.08	-0.117
U_*	-	0.05		-	0.16		-	0.11	
KET					0.12			0.07	
KETP		-0.09							
ФАР									

T_{s1}									
T_{s2}					0.15			0.10	
H_{s1}									
H_{s2}									
P									
CH_4CO_2		-0.26			-0.64	0.064	-0.12	-0.62	-0.068
H_2O T		-0.15			-0.21	0.12	-0.13	-0.27	-0.08

For the description of concentration of greenhouse gases can be included in system of the differential equations nonlinear composed by CH4CO2 and H2O

The system of the differential equations for the description concentration is nonlinear. .

Factorial loadings of some parameters

Параметры				**2013**		
	В целом	«дневные»	«ночные»	В целом	«дневные»	«ночные»
T	0.855 (F1)	0.953(F1)	0.905 (F1)	-0.818 (F1)	-0.908 (F1)	0.940 (F1)
P	-0.829 (F12)	0.760 (F4)	-0.858 (F14)	-0.603 (F8)	-0.379 (F4)	0.584 (F6)
CH_4CO_2	-0.897 (F4)	-0.855(F2)	-0.887 (F4)	-0.802 (F5)	0.808 (F2)	-0,790 (F2)
H_2OT	0.620(F1)	0.732 (F1)	-0.613 (F4)	-0,767 (F5)	-0.844 (F1)	0.649 (F1)
Отн. Влажность	-0.701 (F5)	-0.58 (F1)	-0.582 (F12)	0.812 (F2)	0.623 (F4)	-0.828 (F13)
T_{s1}	0.741 (F1)	0.679 (F1)	0.728 (F1)	-0.878 (F1)	-0.859 (F1)	0.798 (F1)
T_{s2}	0.947 (F1)	0.949 (F1)	0.926 (F1)	-0,941 (F1)	-0.937 (F1)	0.892 (F1)
H_{s1}	-0.600 (F11)	-0.630 (F11)	0.594 (F11)	-0.711(F1)	-0.732(F1)	0.540 (F1)
H_{s2}	-0.734 (F11)	-0.516(F1)	0.753 (F11)	-0.436 (F8)		
ФАР	0.891 (F5)	0.742 (F8)	-0.932 (F5)	-0.905 (F2)	-0.906 (F4)	0.936 (F7)
U_*	-0.848 (F2)		-0.823(F2)	0.805 (F10)	-0.761(F9)	0.838(F3)
KETP	-0.890(F2)	0.489 (F3)	-0.894 (F2)	0,849 (F10)	-0.858 (F9)	0.908 (F3)
L (масштаб Монина-Обухова)	0.375 (F2)	0.991 (F15)	0.385 (F2)	-0,972 (F17)	0.876 (F13)	

Conclusions

- Key parameters

- air temperature
- soil temperature
- dynamic speed u_*
- volume humidity of the soil
- CH_4CO_2, H_2O T
- Humidity
- PAR
- Long-wave radiation
- Concentration CH_4, CO_2, H_2O

Conclusions

- It wasn't succeeded to reveal as significant LINEAR communications between derivatives of concentration of greenhouse gases and characteristics of the environment. Therefore, on this time scale of concentration of greenhouse gases can't pee the pants the differential equations with constant coefficients on time. It makes sense to do the monthly analysis.

- Не удалось выявить сколь значимых ЛИНЕЙНЫХ связей между производными концентраций парниковых газов и характеристиками среды. Следовательно, на данном масштабе времени концентрации парниковых газов не могут описаться дифференциальными уравнениями с постоянными коэффициентами по времени. Имеет смысл делать помесячный анализ, Estimated type of the differential equations system

- $$\frac{dCH_4}{dt} = a_{11}CH_4 + a_{12}CO_2 + a_{13}H_20 + \gamma_{11}CH_4CO_2 + \gamma_{12}H_2O\,T + f_1(T, T_{s1}, T_{s2}, PAR, u_*)$$

$$\frac{dCO_2}{dt} = a_{21}CH_4 + a_{22}CO_2 + a_{23}H_20 + \gamma_{21}CH_4CO_2 + \gamma_{22}H_2O\,T + f_2(T, T_{s1}, T_{s2}, PAR, u_*)$$

$$\frac{dH_2O}{dt} = a_{31}CH_4 + a_{32}CO_2 + a_{33}H_20 + \gamma_{31}CH_4CO_2 + \gamma_{32}H_2O\,T + f_3(T, T_{s1}, T_{s2}, PAR, u_*)$$

- **Thank you very much for your attention!**

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