G.J. Heij and J.W. Erisman (Editors). Acid Rain Research: Do we have enough answers?

THE RESPONSE OF PEAT WETLAND METHANE EMISSIONS TO TEMPERATURE, WATER TABLE AND SULPHATE DEPOSITION

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Sixty peat monoliths, each 30 cm in diameter and 40 cm deep, collected in the blanket bogs of Sutherland were installed in open-top chambers at ITE. A dynamic CH_4 flux measuring system capable of measuring emission or deposition over 15 to 30 minute periods using a flame ionisation detector was developed and installed at the site.

The initial fluxes showed a clear positive response to temperatures of the peat in the surface 10 cm (temperatures were continuously monitored at 6 depths in the peat down to 40 cm at which the surface diurnal cycle in temperature was not detectable). Following the initial measurements a systematic study of the temperature response of 24 monoliths, using the natural changes in temperature of the peat with changing season and weather took place during the spring and summer of 1993. The monoliths were divided between pools (water table maintained at the surface), lawns (water table maintained 2 cm below the surface) and hummocks (water table maintained 15 cm below the surface).

The temperature responses of the pool monoliths range from 3.6 to 14.9 μmol m^{-2} h^{-1} °C^{-1} with fluxes (normalised to 15°C) ranging from 42.7 to 183.5 μmol m^{-2} h^{-1} with the largest fluxes from monoliths with the largest leaf area of higher plants. An example of the quasi-linear temperature response for one of the pool monoliths is presented as Figure 1 and is typical of the pool monoliths studied.

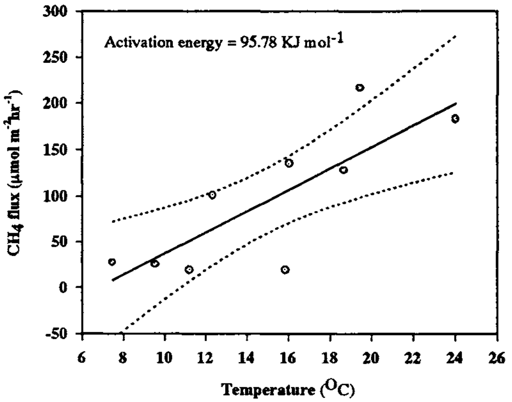

Figure 1: Effect of temperature on methane emission from a pool core

Emissions of methane from the hummock monoliths were an order of magnitude smaller than those of the pool and lawn monoliths (Table 1). This was attributed to water table depth, hummock monoliths having a water table depth of approximately 15 cm, providing an oxidising layer through which the methane has to pass before reaching the atmosphere. The effects of water table and temperature fluctuations have important consequences for the response of methane flux to climate change and any feedback mechanisms that may occur.

	n	Temperature response μmol $m^{-2}h^{-1}$	SD	Mean Flux (15°C)	SD	Q_{10} between 5°C and 15°C	SD
Pool	8	8.91	3.7	111.21	32.3	3.90	1.68
Lawn	6	11.52	3.8	103.18	38.1	6.90	5.12
Hummock	5	6.48	5.4	8.48	9.3	1.82	1.62

Table 1: Effect of temperature and water table on methane emission

More detailed and precise studies of the temperature response of CH_4 emissions are provided by work in controlled environment chambers (CONVIRONS). The same monoliths as those used above were used to obtain temperature responses of CH_4 emission with constant light, water table and relative humidity over long and short periods. Mean fluxes (normalised to 15°C) compare well with the fluxes from the peat monoliths in the OTC's. The results above show a clear exponential response with Q_{10} values in the range 2.10 - 2.82 and activation energies in the range 51.8 - 72.8 in good agreement with values in the literature.

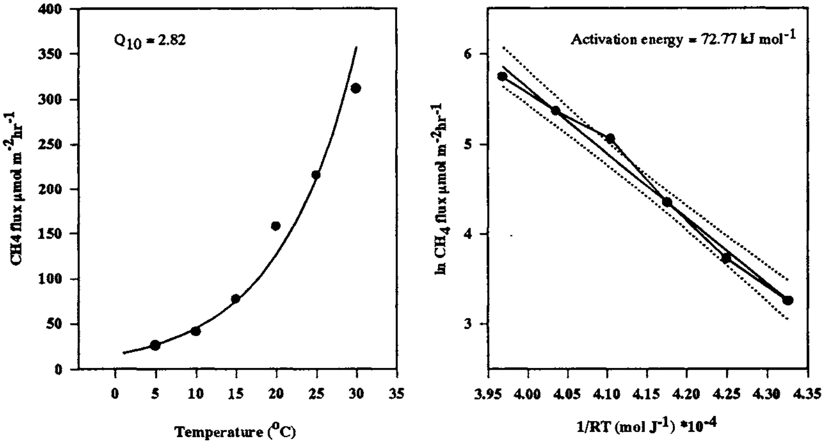

Figure 2: Temperature response of methane emissions from monoliths maintained in CONVIRONS

THE RESPONSE OF METHANE EMISSIONS TO INPUTS OF SULPHUR

Large areas of European and North American peat wetlands receive inputs of sulphur as a consequence of the long range transport of the products of fossil fuel combustion in industrialised countries. These inputs may influence the emission of methane by providing alternative electron acceptors for the microorganisms and an increase in the redox potential in the surface layers of the peat. The effect of atmospheric inputs were simulated by applying a 'wet deposition' equivalent to 100 kg ha^{-1} sulphur in an aqueous solution of $(NH_4)_2SO_4$ and Na_2SO_4. An equivalent amount of deionised water was added to the controls and the methane flux was monitored using static and dynamic methods. The inputs used in this study were large and at the upper range of the atmospheric input of sulphur in the U.K. However it is an appropriate amount for an initial study since a substantial fraction of the annual deposit may occur on a single day.

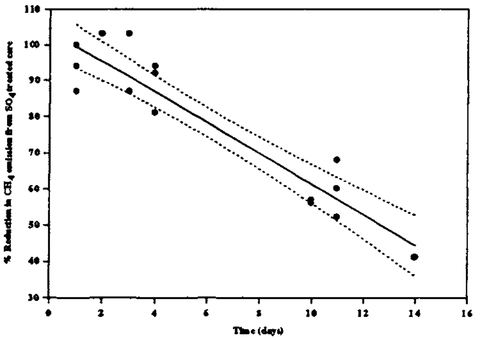

Figure 3: Effect of sulphate application on methane emission in an open top chamber

Following the simulated input of sulphur the emission of methane declined by approximately 50% within two weeks (Figure 3). It is intriguing that the reduction in flux should be 50% as it has been shown that > 80% of the methane flux is produced by the layers within 20 cm of the surface. One explanation could be the prescence of methanogens which utilise non-competitive substrates and are therefore not affected by the increased activity of the sulphur reducing bacteria.

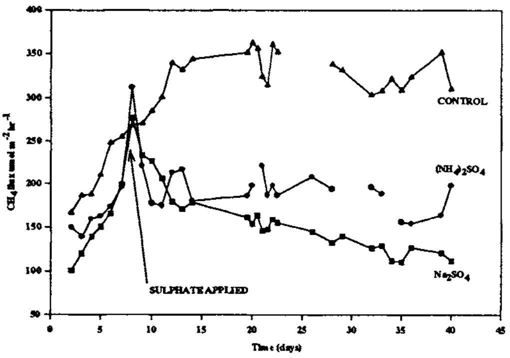

Figure 4: Effect of sulphate application on methane emission in a CONVIRON