FOREST MICROCLIMATE VARIABILITY DATA AND ITS USE IN TESTING A 1D MODEL

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INTRODUCTION

In Great Britain recent policy documents are endorsing the increase of within stand structural diversity by introducing alternative silvicultural systems to patch clear-felling (Peterken, 1996). For example, the United Kingdom Woodland Assurance scheme (UKWAS, 2000) expects managers to increasingly adopt ‘lower impact silvicultural systems’, such as continuous cover forestry, in windfirm conifer plantations that were created primarily to provide wood for industry. To achieve this goal in a cost effective way will require much greater use of natural regeneration than at present, (Malcolm et al, 2001). Understanding the microclimatic conditions influencing the survival of naturally regenerated seedlings is important in determining conditions necessary for growth and the ability to model these conditions based on stand level parameters will aid management policies in the transformation of plantation forests.

The aim of this study is to characterise the variability in microclimate close to the forest floor in coniferous plantations and to provide high quality data for model validation.

MATERIALS AND METHODS

The site location (55°12.5’N, 2°0.2’W) is Harwood Forest, NE England, 30 km inland from the North Sea at an elevation of 260 m. It is generally flat with a gentle NW-SE slope (~2°) and has a cool moist climate (950mm rainfall per year). The forest contains Sitka spruce (*Picea sitchensis* Bong. Carr*)* of 32 years old with a stocking density of 2000 stems per hectare. There is very little ground vegetation as the dense plantations cast too much shade. Soils are fine loamy, slowly permeable, seasonally waterlogged usually with a clayey subsoil.

One stationary and one roaming two metre mast measuring the undercanopy microclimate were deployed at Harwood between May 2001 and January 2002. These measured temperature (using thermistors), relative humidity and windspeed (using cup anemometers) at 4 heights (0.29 m; 0.53 m; 1.05 m and 2.13 m). Also photosynthetically active radiation, net radiation, soil temperature and soil heat flux. A 25 m mast collected the same data simultaneously above the canopy. The stationary 2 m mast was sited in dense stand (site 1) with 95% canopy cover. The roaming mast was located in sites ranging from a similarly dense location to an open clearfell site as follows: Site 2: dense, 95% canopy cover, 5 m from mast 1, 30 m from tall mast; Site 3: small opening, 85 % canopy cover, 10 m from stationary mast, 40 m from tall mast; Site 4: linear gap below tall mast, 80% canopy cover, 30 m from mast 1, 8 m from tall mast; Site 5: open clearfell, 3 km from both stationary mast and tall mast.

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RESULTS AND DISCUSSION

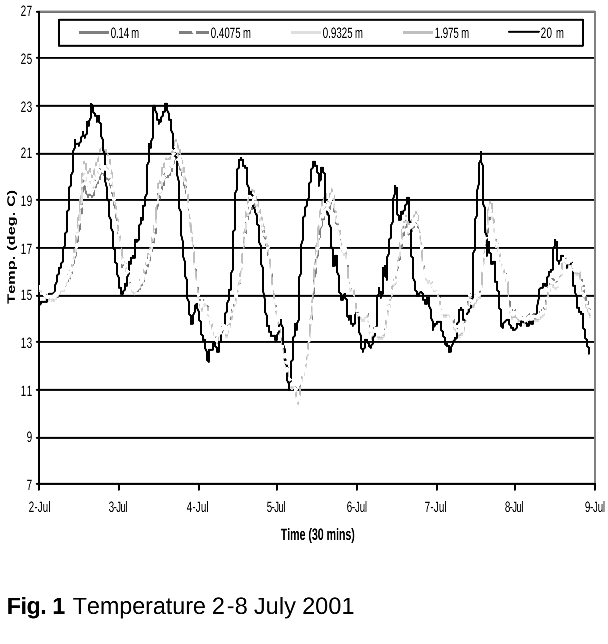

Fig. 1 Temperature 2-8 July 2001

Fig. 1 shows the temperature time lag that occurs from the top of the canopy down to the top of the stationary mast (site 1). Cross correlation showed the lag time to be on average 3 hours. Comparatively the temperatures over which the daily fluctuations occur is similar (for 2-8th July 01: 12 °C for tall mast and 10°C for small mast). Peak daily temperatures inside the forest never reach as high as outside and calculation of gradients confirms this observation – in the same amount of time (from 03:00 to 16:00) the air temperature measured at the top of the tall mast heats up approximately 2 °C more than near the forest floor.

During the same week differences between temperature at heights on the 2 m mast varied at most 1°C at the warmest part of the day. The top sensor (1.98) reaches the highest temps, the two middle sensors (0.41 and 0.98 m) record very similar temperatures and the bottom sensor (0.14 m) is the coldest. This could be due to radiation penetration and also greater windspeeds occur at 0.41 m causing more mixing. Soil temp is lower than air temperature all the time – the difference between the two varying between 0.2 and 0.6°C.

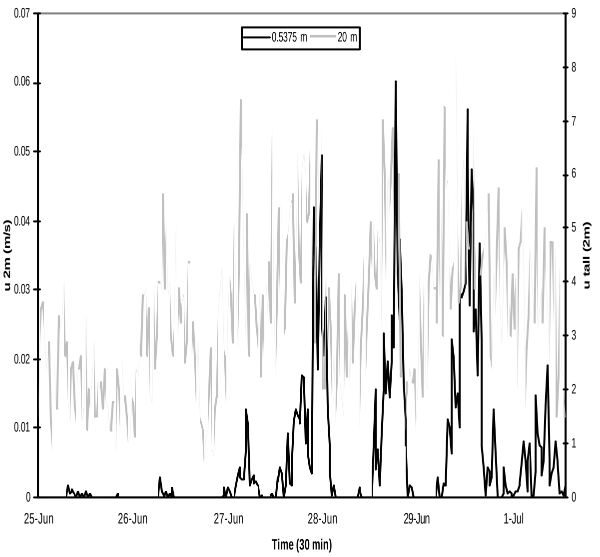

Fig 2. Wind 2–1 July 2001

Fig 2 shows that it is never completely still above the canopy with wind speeds ranging from 0.6 to 8.13 m/s. Below the canopy the range is much smaller (0 to 0.12 m/s) with the greatest speeds at 0.53 m (a wind speed sub-maxima occurring in the trunk space). This has the highest average wind speed for the week of 0.01 m/s. After this average wind speeds drop by 50% for the 1.06 and 2.1 m anemometers. The lowest wind speeds were recorded at 0.41 m with an average of only 0.002 m/s. Peak wind speeds occur at the same time each day. For 0.54 m wind speeds of greater than 0.02 m/s were occurring between 09:00 and 10:30 then staying above 0.02 m/s till between 19:00 and 20:30. Comparative to the tall mast peak wind speeds occur from 15:00 to 20:00.

A comparison of the four locations to the stationary mast reveals that microclimate characteristics were very similar when comparing in the dense stand (sites 1 and 2) and the dense (site 1) with the small opening (site 3). For the latter comparison during the time period 17-24 Nov. 01, temperatures varied diurnally from 2 to 12 °C, humidities 80-100%, wind speeds up to 3 m/s and soil temperatures by 6-10°C. PAR levels between the two were different (dense: <7 micromol/m2/sec; small opening: <60 micromol/m2/sec) but not enough to cause any obvious microclimatic differences. Temperatures in the linear gap (site 4) are also comparable to the dense location but with a different pattern of wind speed reaching approx 3 m/s higher than the dense. Soil temp in the linear gap tended to reduce to 2.5°C lower but then remain 1.5°C lower than the dense at peak temperatures. The clearfell site (site 5) showed much greater range in temperatures, especially below 0°C, than the dense (range –2 to 8°C compared to -7.5 to 10°C over the same time span). The open site experienced lower humidities and much greater winds of up to 4.8 m/s with a clear decrease towards the ground surface compared to a max of 0.12 m/s in the canopy. Again the soil temperature showed a greater range but of lower temperatures, 0.5 to 3.7°C as compared to 2 to 5°C in the dense.

The data shows the considerable variation in microclimate caused by variations in the overstorey. Further detailed analysis of this, and additional data currently being collected from Cloich forest 30 miles SE of Edinburgh with different canopy spacings (of 4, 6, and 8 m), will enable greater microclimate characterisation to be made of different forest densities, and provide data to validate a forest canopy model.

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