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General Description of the Climate and Vegetation at the BIPHOREP Measurement Sites

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Introduction

According to the BIPHOREP project plan, two intensive measurement campaigns were conducted in the boreal vegetation zone in Finland during the summers of 1996 and 1997. In this article we present a short overview of the climate and vegetation of the measurement sites. Also some general information on the climate and vegetation of these parts of the boreal zone are given

Campaign sites

The campaign sites were situated in the northern and eastern Finland (Figure 1). The 1996 measurement campaign was conducted in the northern boreal subzone in the vicinity of the Pallas-Ounastunturi National Park in northern Finland (68°N, 24°E). The 1997 measurement campaign was conducted around the border between the southern and middle boreal subzones in eastern Finland near the Mekrijärvi Research Station of the University of Joensuu (63°N, 31°E). The Finnish Meteorological Institute (FMI) also conducted a series of cuvette measurements of emission rates 20 km north of Helsinki, in the Ruotsinkylä research station of the Finnish Forest Research Institute (60°22'N, 24°59'E, 52 m a.s.l.). The Stockholm University (MISU) conducted additional emission measurements in Asa (57°22'N 12°10'E) in Southern Sweden and at the NOPEX site (60°10'N 17°05'E) near Uppsala in Sweden.

The synoptic weather stations closest to the Mekrijärvi and Pallas areas are Ilomantsi and Muonio, respectively. The more detailed climatological characterisation of the measurement areas is thus based on the statistics at these weather stations (FMI, 1991). For comparison,

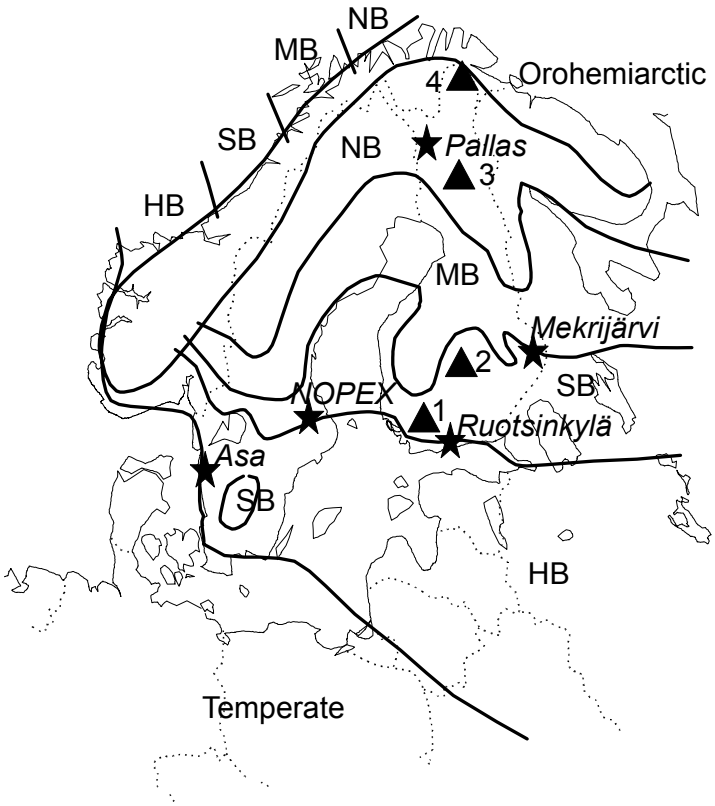

Figure 1. *The European boreal zone. The two letter codes indicate the boreal subzones: HB: hemiboreal; SB: South boreal; MB: Middle boreal; and NB: North boreal (Ahti et al., 1968; Hämet-Ahti, 1981, and Solantie, 1990). The BIPHOREP measurement sites in the boreal vegetation zone are indicated by stars (Pallas, Mekrijärvi) and the SYNOP stations used in this work by triangles (1: Jokioinen; 2: Jyväskylä; 3: Sodankylä; 4: Utsjoki Kevo).*

also data from the Jokioinen observatory in southern Finland is presented. The routine radiation measurements referred to in this article are conducted at six stations in Finland which cover the country from south to north (FMI, 1993).

A part of the measurements of the Sodankylä-Pallas GAW station are conducted in the Pallas area on a fell top (67°58'N, 24°07'E, 566 m a.s.l.). These include the monitoring of atmospheric trace gases like ozone, carbon dioxide and VOCs. The micrometeorological measurements in Pallas were conducted at the Kenttärova (67°58'N, 24°14'E, 330 m a.s.l.).

The seasonal ambient air VOC concentration measurements were conducted near the Mekrijärvi Research Station at Pötsönvaara (63°07'N, 31°04'E, 254 m a.s.l.). The micrometeoro-

logical measurements in the Mekrijärvi area were conducted at Huhus (62°52'N, 30°49'E, 180 m a.s.l.).

Climate

The climate in Northern Europe is warm compared to other areas in the same latitudes. Finland covers the latitudes from 60°N to 70°N, which corresponds to the location of Alaska or Southern Greenland. The mild climate is due to the warming effect of the Gulf Stream in the North Atlantic Ocean.

Cold snowy winters and moderately warm summers, and moderate rainfall through the year characterize the climate in Finland. In the Köppen (1928) classification Finland belongs to the class "Moist Continental Mid-latitude Climates, wet all seasons" (Df). This climate class covers large areas in northern Eurasia and America.

Another characteristic feature in the climate of Finland are the midlatitude cyclones arriving, often in the occluded stage, from the North Atlantic. The cyclones bring wind, clouds and rain with them, and result in the variability of the weather. The extreme weather conditions, very cold spells in winter or the warm weather in summer, are often observed in connection with continental air masses, arriving from the easterly direction.

The radiation conditions are characterized by large differences between winter and summer. During winter the day is short and the solar elevation low even in the midday. In summer the day is long but the solar angle is still relatively low. In the northern Finland these differences culminate to polar winter, sun being below horizon 24 hours a day, and polar summer, sun never setting.

The monthly mean values of the midday global radiation at four measurement sites are shown in Figure 2. As the photosynthetic photon flux density (PPFD) is very closely correlated with the global radiation an estimate of the mean PPFD [$\mu molm^{-2}s^{-1}$] values can be obtained by multiplying the global radiation [Wm^{-2}] by 1.8. In Figure 3 we present the diurnal variation of global radiation in July. As can be seen in Figure 3 the midsummer global radiation in northern Finland is about 20 % lower than that in southern Finland. At Sodankylä and Utsjoki Kevo the

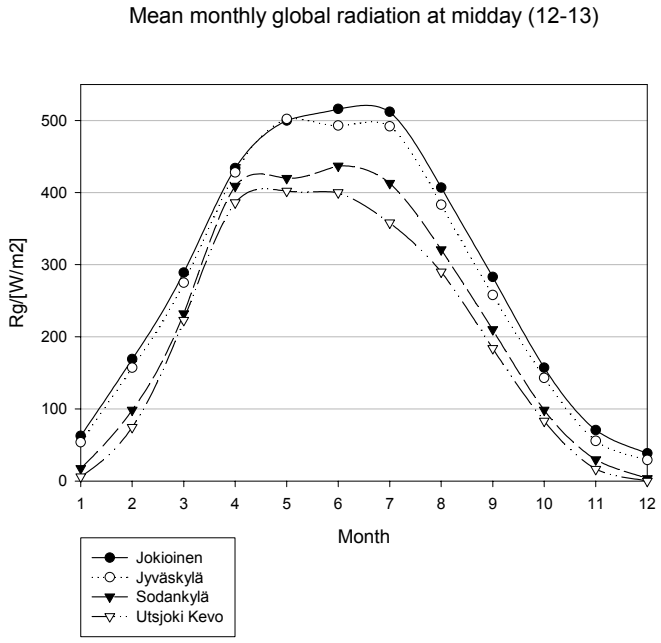

Figure 2*. Mean monthly global radiation at midday (12.00-13.00) at four measurement stations in Finland.*

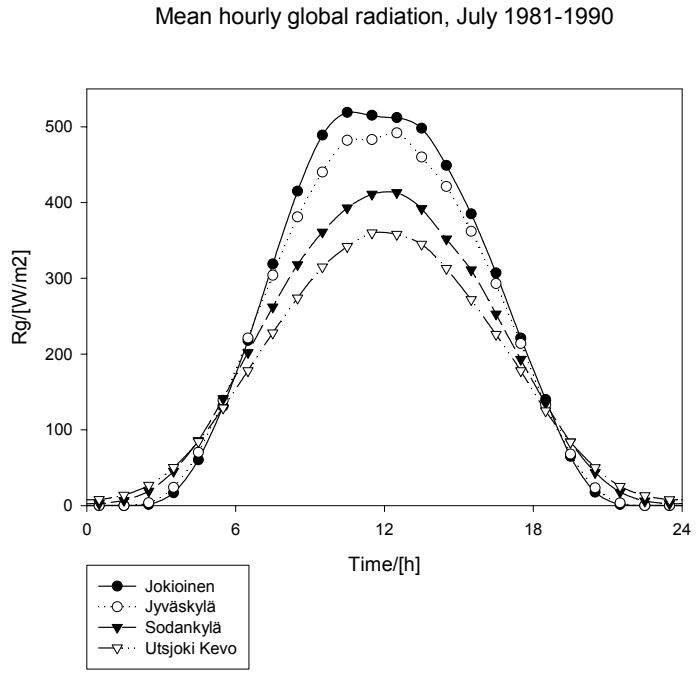

Figure 3. *Diurnal cycle of mean hourly global radiation at four measurement stations in July.*

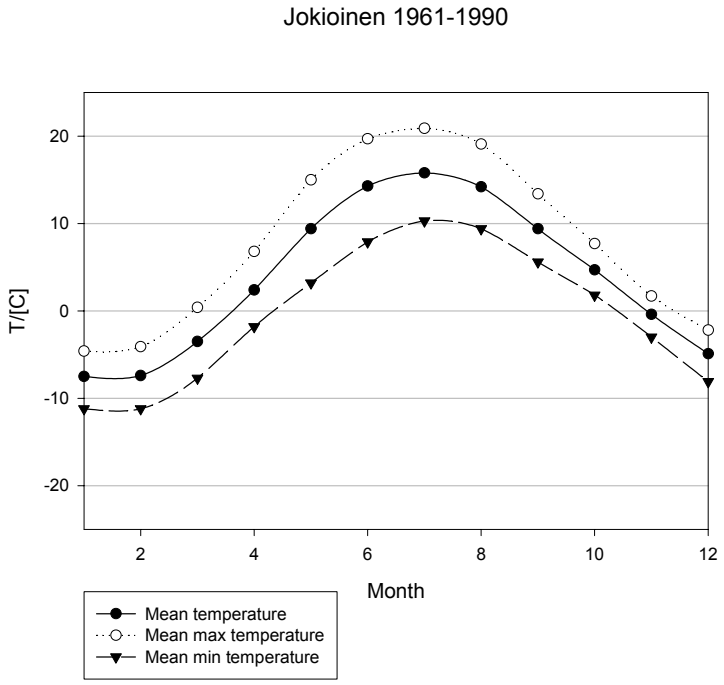

Figure 4. *Mean temperature and average of daily maximum and minimum temperatures at the Jokioinen observatory in southern Finland.*

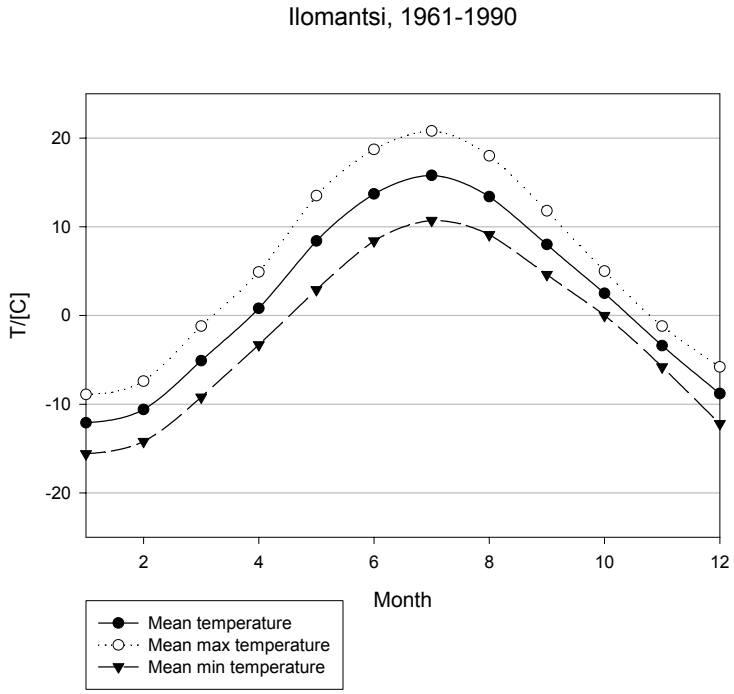

Figure 5. *Mean temperature and average of daily maximum and minimum temperatures at the Ilomantsi synoptic weather station near the Mekrijärvi Research Station.*

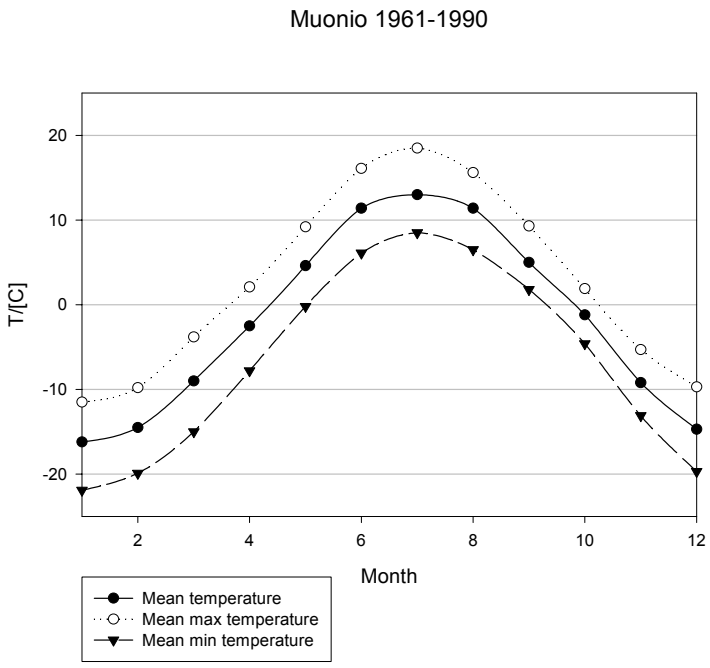

Figure 6. *Mean temperature and average of daily maximum and minimum temperatures at the Muonio synoptic weather station near the Pallas-Ounastunturi National Park.*

sun is above horizon for 24 hours a day around midsummer, but because of the low elevation angle the global radiation reaching the horizontal plane is low. (FMI, 1993). In winter the solar radiation is very low, resulting in cold temperatures.

The monthly average temperatures at the Jokioinen, Ilomantsi and Muonio weather stations during normal period of 1961-1990 are presented in Figures 4, 5 and 6. The temperatures at the Pallas area are colder due to its high latitude. Compared to the temperatures in Jokioinen especially the winter months are colder (FMI, 1991). The summer temperatures, however, do not differ that much. The mean annual absolute temperature maximum is generally a degree or two below 30°C in the continental parts of Finland (NBS, 1987).

The length of the growing season varies between 100 and 180 days. The effective temperature sum (ETS), defined as the accumulated daily average temperature over 5°C during the growing season, varies between 400 and 1300 degree-days. The average length of the growing season is 150 days at the Mekrijärvi area and 120 days at the Pallas area. The ETSs are 1000 and 700 degree-days at Mekrijärvi and Pallas, respectively (NBS, 1987).

The average yearly rainfall in Finland varies between 450 and 750 mm of which one third to a half falls as snow. The rainfall is relatively evenly distributed throughout the year, allthough the late summer and autumn are slightly wetter than the rest of the year (NBS, 1987). The summer is dryer in the hemiboreal and southern boreal regions of Finland than in the northern parts. The water storage remains, however, large enough to support the forests (Solantie, 1990).

Vegetation

The boreal zone covers an area of 18 Mkm^2 (Monserud et al., 1993) and it is one of the worlds major vegetation zones. It is characterized by coniferous forests. In Europe the coniferous boreal forests cover large areas of Sweden, Finland and northern Russia (Hämet-Ahti, 1981).

Almost all of Finland belongs to the boreal zone and forests cover three fourths of the country's land area. The most common tree species are coniferous: Scots pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*). The most common deciduous trees are birches (*Betula* sp.) (FFRI, 1996).

Finland has been divided into 15 forestry centres for forestry management purposes. The forestry information of FFRI (1997) is generally presented on the basis of this division. The Mekrijärvi area belongs to the Forestry Centre of Northern Carelia (Pohjois-Karjala) and the Pallas area is in southern Lapland (Lappi). The forest information of Lapland is divided into southern and northern parts, the latter being the so-called fjell Lapland.

The 1996 campaign area is situated in the northern boreal zone. The northern timberline of Norway spruce, which runs through the Pallas-Ounastunturi National Park, was about 50 km north from the Pallas measurement area. The subspecies of Norway spruce growing in these northern areas is known as the Siberian spruce (*Picea abies* subsp. *obovata*). The common subspecies of downy birch in northern Finland is the mountain birch (*Betula pubescens* subsp. *czerepanovii*) (Hämet-Ahti et al., 1992). In the southern part of Lapland, the Scots pine, the Norway spruce and the birches make up 58 %, 34 % and 17 % of the growing stock volume, respectively (FFRI, 1997).

Table 1. *Forest parameters at the Kenttärova micrometeorological site near Pallas.*

	Stems (1/ha)	**Growing stock volume** (m^3/ha)	**Leaf dry biomass** (10^3 kg/ha)	**Leaf area** (10^3 m^2/ha)
Total	1460	86	5.1	50
Pinus sylvestris	118	22	0.51	2.9
Picea abies subsp. *obovata*	623	24	2.8	16
Betula pubescens subps. *czerepanovii*	679	37	1.6	29
Others (*Salix caprea*)	39	3	0.13	2.4

Table 2. *Forest parameters at the Huhus micrometeorological site near Mekrijärvi.*

	Stems (1/ha)	**Growing stock volume** (m^3/ha)	**Leaf dry biomass** (10^3 kg/ha)	**Leaf area** (10^3 m^2/ha)
Total	4509	103	4.0	23.4
Pinus sylvestris	1176	100	3.6	20.1
Picea abies	14	0.12	0.022	0.12
Betula pendula	120	1.4	0.058	1.1
Betula pubenscens	108	1.0	0.040	0.74
Other broad-leaf (*Populus tremula, Alnus* sp.)	65	0.046	0.0031	0.057
Juniperus communis	3026		0.26	1.4

The forest at the Kenttärova micrometeorological site is a mixed Siberian spruce - mountain birch forest (Table 1). Half of the foliage biomass of the forest is spruce and one third is birch. According to the Finnish forest classification (Cajander, 1909, 1926) this site is classified as an Empetrum-Vaccinium type forest (EVT).

The 1997 campaign area is on the border between the southern and middle boreal zones. According to Solantie (1990) this area is also on the border between the grain and grass

cultivating zones. In Northern Carelia, the Scots pine, the Norway spruce and the birches make up 50 %, 33 % and 14 % of the total growing stock volume, respectively (FFRI, 1997).

The forest at the Huhus micrometeorological site is a very pure Scots pine forest (Table 2). In the western parts of the site the common juniper (*Juniperus communis*) is, however, quite abundant. As there is no standard method for the quantification of juniper growing stock volumes and leaf biomasses, these parameters are not presented. According to the Finnish forest classification, the site is classified as a Vaccinium type forest (VT).

The abundance of Scots pine in Finland is due to the forest management. The typical climax tree species in many areas of Finland, especially in the middle and southern parts of the country, is the Norway spruce.

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