Supplementary

Suppl. S1.

Interior Siberia is noteworthy from the view point of the conifer species that sharply changes from evergreen conifers (*Pinus sibirica, P. sylvestris, Abies sibirica, Picea obovata*) dominating west of the Yenisei River to deciduous conifers (*Larix gmelinii* and *L. cajanderi*) east of the Yenisei. *L. gmelinii* and *L. cajanderi* were named by Bobrov (1972) respectively after the western and the eastern geographical races of their parental species *L. dahurica*. *L. gmelinii* and *L. cajanderi* form the largest larch biome on the Earth, distributed on the continuous permafrost of the northeastern Eurasia. *Larix sibirica* grows only on non-permafrost and may be admixed to evergreen conifers. This species is outcompeted by evergreen conifers and may dominate only at sites unfavorable for evergreen conifers.

L. gmelinii is the main component of the forests in central Siberia, evolutionally well-adapted to grow on permafrost and in harsh climates with low air temperature, low precipitation, low air humidity and a thin snow pack. The water that thaws from the permafrost in the summer provides necessary moisture for the forest growth in this dry environment; otherwise, steppe or potentially semi-desert would exist (Shumilova 1962). Gmelin larch also performs well on the shallow soils atop it due to a superficial root system, 70-100% of the fine root tips are in the organic and upper (0-20 cm) mineral soil horizons; and the adventitious roots at the lower stem which have resulted from the thaw-freeze processes (Pozdnyakov 1986; Abaimov et al. 1998; Prokushkin et al. 2002; Kajimoto 2010). In comparison, to adapt to occasionally dry periods *P. sylvestris* growing on the non-permafrost sandy soils can develop an anchor root to reach a water table at a depth of 2.5-3 m (Prokushkin 1982). Может какую-нибудь пару предложений оставить только для напоминаний

Suppl. S2.

The 20 m tall flux towers at Tura (our larch forest) and was equipped with an eddy covariance (EC) system installed at 20 m and consisted of a sonic anemometer-thermometer (Gill Instruments, Lymington, UK) and an open-path infrared CO_2–H_2O analyzer (IRGA) LI7500A (Li-COR Inc. Lincoln, Nebraska, USA). The EC system measured and recorded the zonal, meridional and vertical wind velocity components (u, v, and w in m s-1), and the mixing ratios of CO2 (c in µmol mol-1), and water vapour (q in mmol mole-1) at a sampling frequency of 10 Hz. Five sets of multicomponent weather sensors WXT520 (Vaisala, Finland) measuring air temperature (Tair), pressure, relative humidity (RH), precipitation, wind speed, and direction every minute were mounted at 20 m. A four-component net radiometer CNR4 (Kipp and Zonen Inc., Delft, the Netherlands) was installed at 20 m to measure the incoming and outgoing components of net radiation (RSW(in), RSW(out), RLW(in), and RLW(out) in W m_2) every minute. All supporting meteorological data were stored in a CR5000 and CR10X dataloggers (Campbell ScientiBc, Logan, Utah, USA).Eddy covariance fluxes of sensible heat, water vapor, and CO_2 were calculated for every 30 minute period. Quality-control procedures designed by FFPRI FluxNet software (Ohtani et al. 2005) [00] were used for the raw eddy data. First, graph charts of the raw eddy time-series data for every 30-min interval were inspected, and data with noises due to wetting on the sensor surfaces were excluded from flux calculations. Second, within each half-hour of the raw data, spikes and outliers of plausible physical ranges were checked and excluded and then interpolated using procedures that were proposed by Vickers and Mahrt (1997) [00]. Finally, half-hourly fluxes with numbers of spikes and values outside the range exceeding 5% of the total raw data number were excluded. Coordinate axes for the wind field were rotated twice so that the mean lateral and vertical velocities were zero (McMillen 1988) [00]. The linear trends in vertical wind, virtual temperature, water vapor density, and CO_2 density were removed. A humidity correction was applied to the sonic temperature. Water vapor and CO_2 fluxes were corrected for density effects (Webb et al. 1980) [00]. After flux calculations, half-hourly fluxes with absolute angles of principal wind flow against a horizon >10º and the fluxes with precipitation were excluded. Additionally a daily quality control file was generated along with the fluxes, containing statistical parameters and flags for stationarity and well developed turbulence tests for the calculated fluxes (Foken et al. 2004) [00].

The 20 m tall flux towers in the Gmelin larch forest was installed at Tura and was equipped with an eddy covariance (EC) system installed at 20 m and consisted of a sonic anemometer-thermometer (Gill Instruments, Lymington, UK) and an open-path infrared CO_2–H_2O analyzer (IRGA) LI7500A (Li-COR Inc. Lincoln, Nebraska, USA). The EC system measured and recorded the zonal, meridional and vertical wind velocity components (u, v, and w in m s^{-1}), and the mixing ratios of CO_2 (c in µmol mol^{-1}), and water vapour (q in mmol $mole^{-1}$) at a sampling frequency of 10 Hz. Five sets of multicomponent weather sensors WXT520 (Vaisala, Finland) measuring air temperature (T_{air}), pressure, relative humidity (RH), precipitation, wind speed, and direction every minute were mounted at 20 m. A four-component net radiometer CNR4 (Kipp and Zonen Inc., Delft, the Netherlands) was installed at 20 m to measure the incoming and outgoing components of net radiation (RSW(in), RSW(out), RLW(in), and RLW(out) in W m_2) every minute. All supporting meteorological data were stored in a CR5000 and CR10X dataloggers (Campbell ScientiBc, Logan, Utah, USA).

The 27 m tall flux tower in the Scots pine forest at Zotino was inslalled and was equipped with an eddy covariance (EC) system installed about 5 m above the average tree height. The measurement system consisted of a triaxial sonic anemometer (model Solent R3, Gill instruments Lumington,UK) and a fast response CO2/H2O non-dispersive infrared gas analiser (model 6262-3, LiCor Inc., Lincoln, NB, USA). The air was drawn from an inlet at the top of the tower, 10 cm below the sonic measurement height through BEV-A-Line tubing (29 m length) and two aerol filters) ACRO 50 PTEE, 1 μm pore-size, Gelman Ann Arbor, MI, USA) at a flow rate of 5.8 min^{-1} (pump unit KNF Neuberger, Germany). The outputs from from the sonic anemometer and infrered gas analyser were red at 20 Hz through RS- portsonto 386-class computer, and data were stored for subsequent anaylises. Pressure in the infrared analuser was about 10 mbar above ambient air measured by the internal pressure sensor of the infrared gas analyser and was accounted for by internal software.

Frequency losses to daming in the tube and analyser response were corrected using the approach by Eugster and Senn (1995). Water vapour dilution corections were made with internal software of the LiCor 6262, and corrections of differences in air pressure in the sampling cell and in the atmosphere were calculated automatically with a built-in pressure transducer. Coordinate rotation as in McMillen (188) was applied.

Supporting meteorological instruments. Radiative flux measurements included total downward and upward radiation using a pyradiometer (LXG055) and shorwave downward and upward radiation using a Kipp and Zonen pyrranometer(C, M14, Kipp and Zonen, Delft, Holland) Additional measurements included air temperature (HMP35D, Vaisala, Helsinki, Finland), air humidity (HMP35D, Vaisala, Helsinki, Finland) and wind velocity (A100R, Vecotr Instruments). At ground level a rian gauge was installed 9#52203, Young Instruments, TraverseCity, MI, USA). Soil heat fluxe plates (RIMCO HP3/CN3) were installed at 0.05 m. For measuring soil temperature at 0.05. 0.10, 0.15 .50 and 1.0 m platimun resistance thermometers were installed. Environmental data were collected and every 10 sec and stored as 10-min averages on dataloggers (Campbell CR21X and D130000, Delts-T, Burwell, UK). For comparison with half-hourly eddy- flux data , 30-min averages of environmental data were subsequently calculated.

Suppl. S3.

Table S1. General climatology for the growing season (May-September) of two study sites: Tura and Zotino

Climatic Variable	Tura Station Larch Forest	Sym Station Pine Forest
Mean air temperature annual/January/July	−9.5/−6.7/16.3	−3.4/−23.3/17.8
Conrad continentality index	93.7	74.0
Dates of crossing 0°C (spring/autumn)	7 May/ 2 October	26 April/ 10 October
Length of the period with t < 0°C, days	218	200
Length of the period with t > 0°C, days	147	165
Length of the period with t > 5°C, days	115	132
Light hours during the period with t > 0°C, hour	2630	2720
Light hours during May-September	2700	2500
Cumulative negative degree-days, <0 °C	-4915	-3050
Growing degree-days, 5 °C	845	1070
Mean soil temperature at surface for May-September	12.4	14.4
Mean soil temperature at depth 40 cm for May-September	6.7	9.4
Precipitation: annual/growing season, mm	322/225	458/280
Max snow pack, cm	40	60
Length of the period with snow pack	210	207
Mean vapor pressure for May-September, mbar	8.8	9.7
Mean vapor pressure deficit for May-September, mbar	4.9	6.0

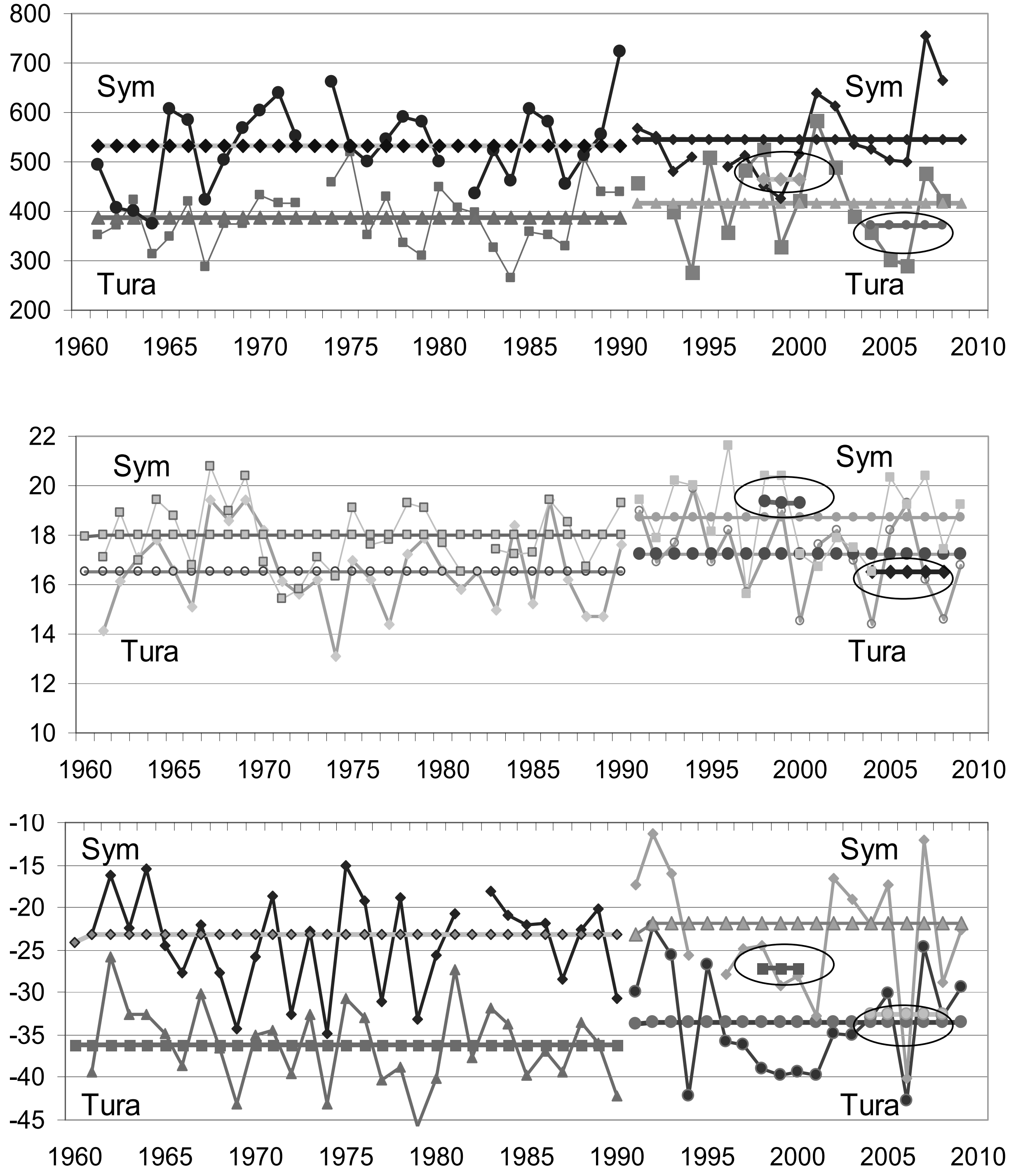

Figure S1. Time series of annual precipitation (upper), July temperature (middle) and January temperature (lower) averaged for the 1960-1990 and 1991-2009 periods for two weather station Sym (upper in each figure) and Tura (lower in each figure). Means for both periods are horizontal and means for the periods of eddy-covariance observations are circled.

Suppl. S4. Conclusions

Two different forest ecosystems growing in contrasting habitats in interior Siberia were studied: a *Pinus sylvestris* forest growing on warm sandy soils and a *Larix gemilii* forest growing on permafrost soils with a shallow active layer depth. These forest ecosystems differ distinctively in their structure (age, height and diameter, LAI, stem density, etc). The most impressive was the difference between the accumulated dry phytomass which was one order of the magnitude higher in the mature pine forest, 10.7 vs 1.1 kg m^{-2} in the larch forest.

Two site habitats where the ecosystems grew differed as well. Located as far as 650 km north-east of the pine forest, the larch forest's habitat was a severe environment with a one month shorter growing season, one month longer and 14 °C colder winters, lower annual and seasonal precipitation, and a thinner snow cover. Interior Siberia's harsh climate helps support relic permafrost – the critical environment-forming factor. The principal habitat contrast between our sites was initiated by underlying permafrost that forms soil conditions. The permafrost plays a double role: on one hand, it supports the forest existence in a dry climate over East Siberia delivering additional water from thawing permafrost; and on the other hand, much available energy, up to 30–50%, is consumed in thawing ice. Thus less energy remains for sensible heat and latent heat flux, warming the soil and ambient air and for physiological processes in ecosystems.

Net radiation was 2-2.5 fold greater in the pine forest than in the larch forest due to a 2.5 week longer growing season. Sensible and latent heat partitioned from R_n and expressed by the Bowen ratio showed that β remained at 1-2 for the growing season when the pine forest was physiologically active and increased up to 8-10 when it was not.

Precipitation and evaporation in the pine forest was 30-50% greater than in the larch forest. In both ecosystems, the water balance was positive for the growing season; however, the monthly and cumulative daily water balances were often negative. These ecosystems developed different strategies to compensate for occasional negative water balance in the dry environment: the pine developed an anchor root to get water from a deep water table and the larches developed the surface root system to survive on permafrost and get thawed water.

Daily maximal half-hourly CO_2 fluxes were about the same in both ecosystems ~−10 μmol m^{-2} s^{-1} However, averaged daily CO_2 fluxes in the pine forest were three times larger than the fluxes in the larch forest which resulted in 228 g C m^{-2} $season^{-1}$ of vs 83 g C m^{-2} $season^{-1}$ respectively. The NEP patterns in both ecosystems exposed a strong signal of them being a C-sink for the growing season and year-round. The seasonal NEP in our Gmelin larch ecosystem on permafrost with low ALD appeared to be the weakest among Siberian boreal ecosystems and other boreal forest ecosystems reported in the literature. Both R_{eco} and GPP were 2-3 fold lower in our Gmelin larch.

Water use efficiency (GPP/E) of the pine ecosystem appeared to be on average 2 times greater: 11 vs 6 mg CO_2 $g^{-1}H_2O$ in the larch ecosystem. Thus the water cost per unit C-assimilation was twice greater in the permafrost larch ecosystem.