Exchange of CO_2 in Arctic tundra: impacts of meteorological variations and biological disturbance (Supplementary material)

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S1 Flux partitioning equations

The separation of NEE into its two main components (GPP and R_{eco}) was achieved applying two approaches: (1) the REddyProc partitioning tool (Reichstein and Moffat, 2014) and (2) a light response curve (LRC) approach (Lindroth et al., 2007; Lund et al., 2012). REddyProc uses the measured night-time NEE as R_{eco}, assuming GPP close to zero. This partitioning is based on the exponential regression of night-time respiration with temperature using the Lloyd-Taylor-Function (Lloyd and Taylor, 1994):

$$R_{eco}(t) = R_{ref}(t)e^{E_0(1/(T_{ref}-T_0)-(1/(T_{air}(t)-T_0))} \quad (1)$$

where R_{ref} (µmol m^{-2} s^{-1}) is the based respiration at the reference temperature (set here to 10°C), E_o (°C) is the temperature sensitivity, T_{air} (°C) is the air temperature and T_0 is kept constant at -46.02°C as in Lloyd and Taylor (1994). A combined threshold of current solar radiation and potential radiation (based on exact solar time, latitude and longitude) selects night-time. REddyProc estimates temperature sensitivity E_0 from short-term periods, and the reference temperature R_{ref} based on this short-term temperature sensitivity for successive periods across the dataset. These estimates are then used to calculate the R_{eco} during day-time and night-time. GPP is calculated from the difference between NEE and R_{eco}.

On the other hand, LRC uses the Misterlich function (Falge et al., 2001):

$$NEE = -(F_{csat} + R_d)(1 - e^{(-\alpha(PAR)/(F_{csat}+R_d))}) + R_d \quad (2)$$

where F_{csat} is the CO_2 uptake at light saturation (µmol m^{-2} s^{-1}), R_d is dark respiration (µmol m^{-2} s^{-1}), α is the initial slope of the light response curve (µmol µmol^{-1}) and PAR is the photosynthetic active radiation, (µmol m^{-2} s^{-1}). NEE and PAR feeds a 6 days moving window (time step: 1 day) to estimate a set of F_{csat}, R_d and α per day (as a response to changes in vegetation characteristics). The parameterization of the LRC was considered significant when F_{csat}, R_d and α were significantly different from zero ($p<0.05$)(Lund et al., 2012). From the equation (2), 30 min GPP is calculated from the subtraction of R_d.

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Lloyd, J., and Taylor, J. A.: On the Temperature Dependence of Soil Respiration, Functional Ecology, 8, 315-323, 10.2307/2389824, 1994.

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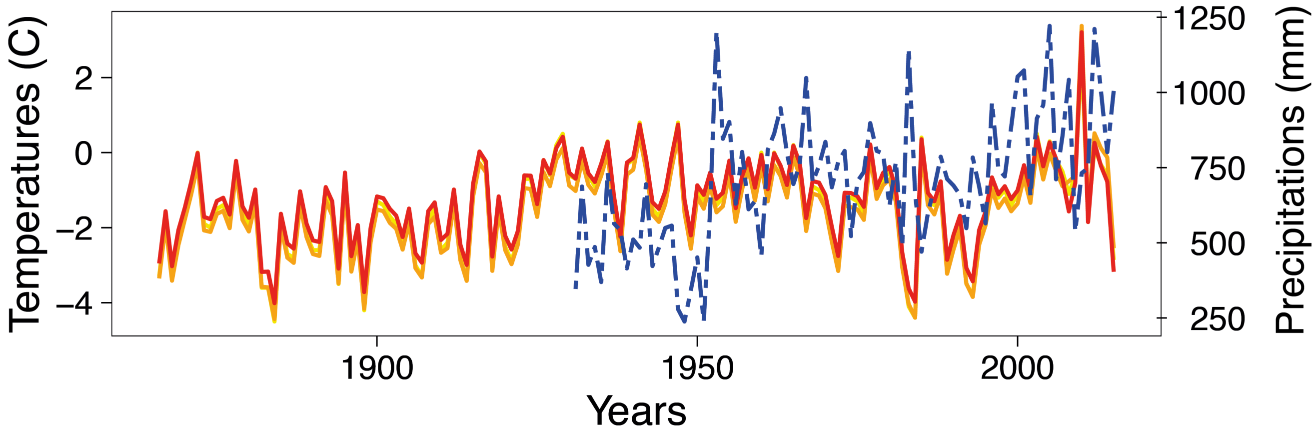

Figure S2: Time series for temperatures (1866-2015) from Nuuk, Kobbefjord-Fen and Kobbefjord-weather station (solid yellow, red and orange line respectively); and precipitations (1931-2015) from Nuuk (dashed blue line).

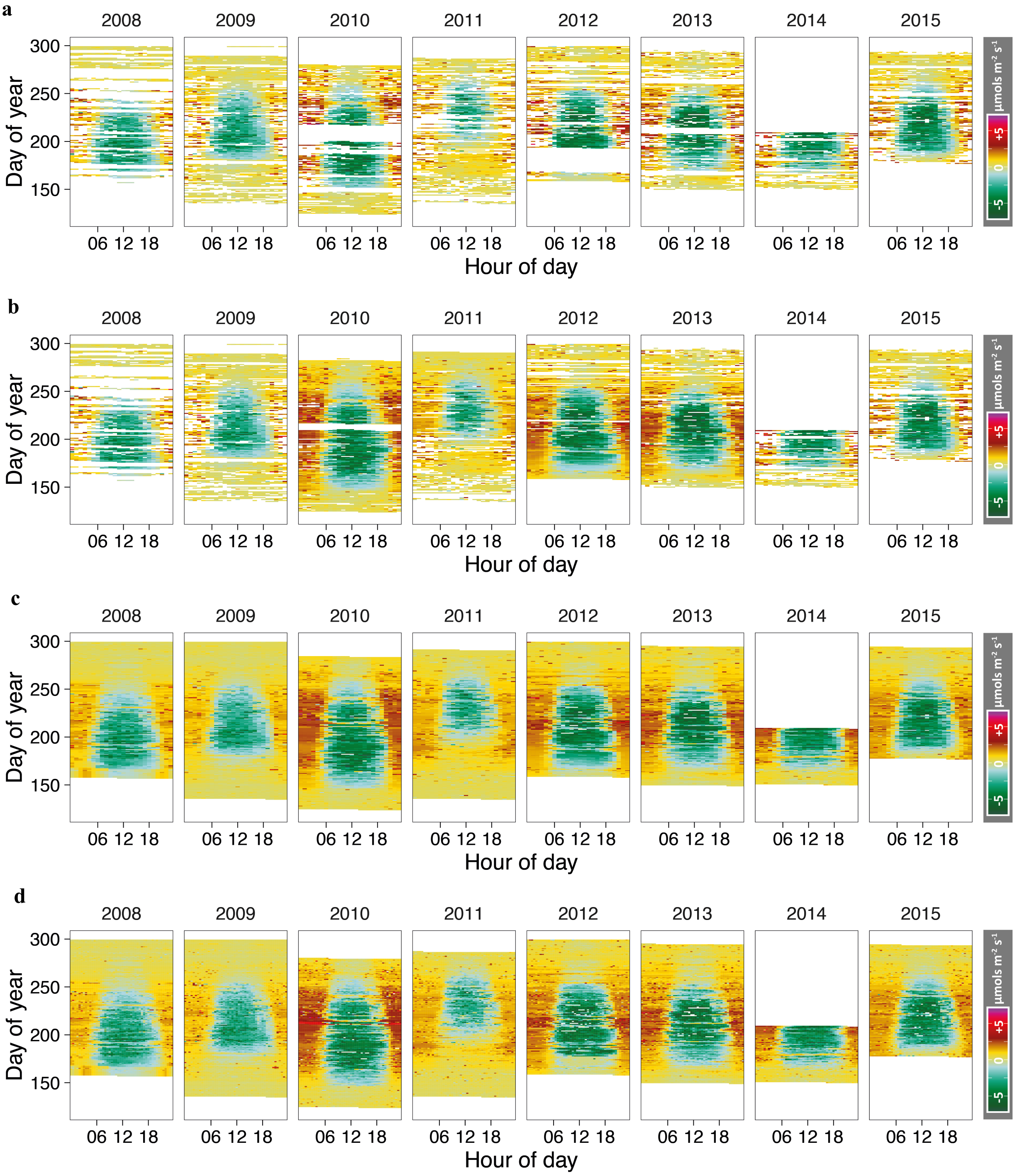

Figure S3: (a) Original NEE EC data, (b) gap-filled NEE based on auto-chamber data, (c) gap-filled product combining auto-chamber data and the MDS algorithm and (d) gap-filled product using only the MDS algorithm.

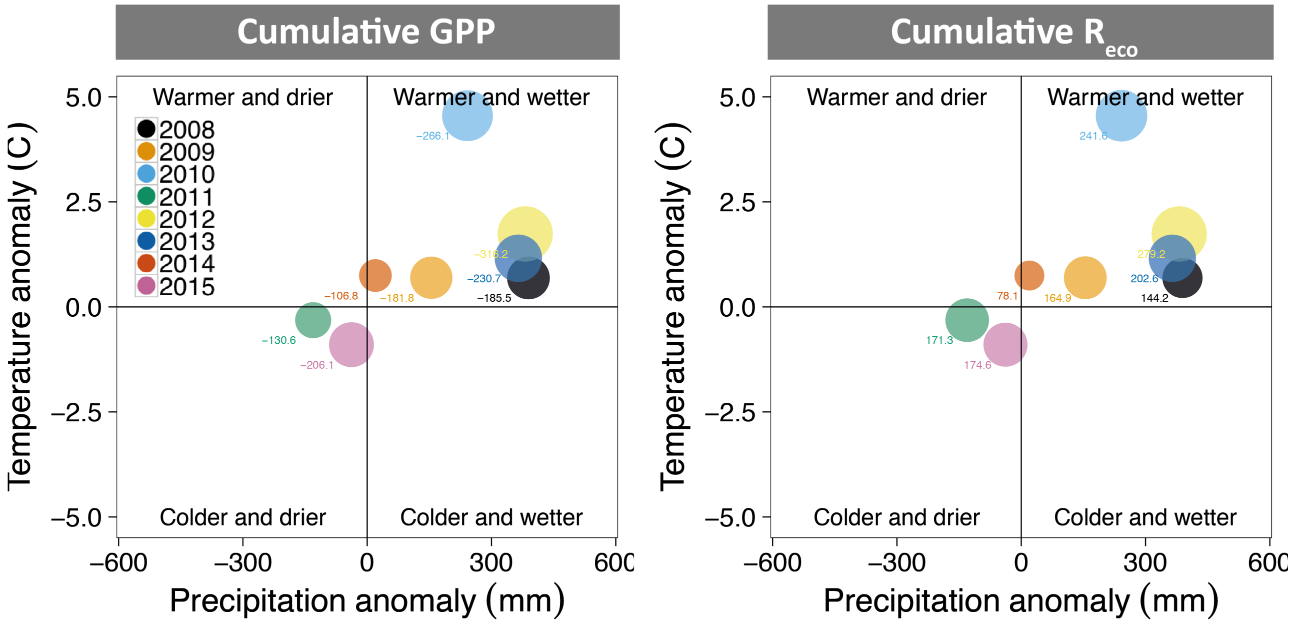

Figure S4: Annual cumulative GPP and R_{eco} defined by annual temperature and precipitation anomalies (2008-2015). The flux size is categorized depending on the flux magnitude (g C m^{-2}), i.e. larger diameters with greater fluxes.

Table S1: Temporal scale, time aggregation, sample size and n° of random forests utilized in the Random Forest analysis.

Figure	Temporal scale	Time aggregation	Sample size	N° of random forests (per variable and per flux)
7	Hourly	Hourly	24426	1
	Daily	Daily	1006	1
	Weekly	Weekly	118	1
	Monthly	Monthly	29	1
8	Diurnal	Hourly	24426	24
	Seasonal	Hourly	24426	37
	Annual	Hourly	24426	8

Table S2: Importance (%) of hourly aggregated variables (PAR, VPD, T_{air} and Prec) from Random Forest analysis based on all day data and day-time (11-14hr) / night-time (00-03hr) data.

	Flux	PAR	VPD	Tair	Prec
All day data	NEE	62.18	13.66	23.40	0.76
	GPP	60.16	12.51	26.70	0.62
	R_{eco}	9.99	17.28	70.95	1.77
Day-/Night-time data	NEE	64.59	12.09	22.58	0.74
	Day-time NEE	54.09	17.15	27.75	1.00
	Night-time NEE	10.55	24.79	61.80	2.86