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Exchange of CO_2 in Arctic tundra: impacts of meteorological variations and biological disturbance

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Equations S1: Flux partitioning

The separation of NEE into its two main components (GPP and R_{eco}) was achieved applying two approaches: (1) the REddyProc partitioning tool (Reichstein et al., 2016) 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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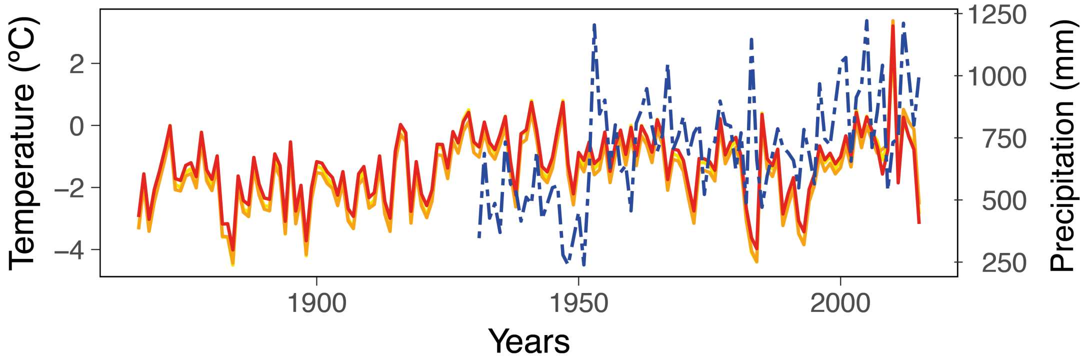

Figure S1. Time series for temperatures (1866-2015) from Nuuk, Kobbefjord-Fen and Kobbefjord-weather station (solid yellow, red and orange line respectively); and precipitations (1931-2015) from Nuuk (dashed blue line).

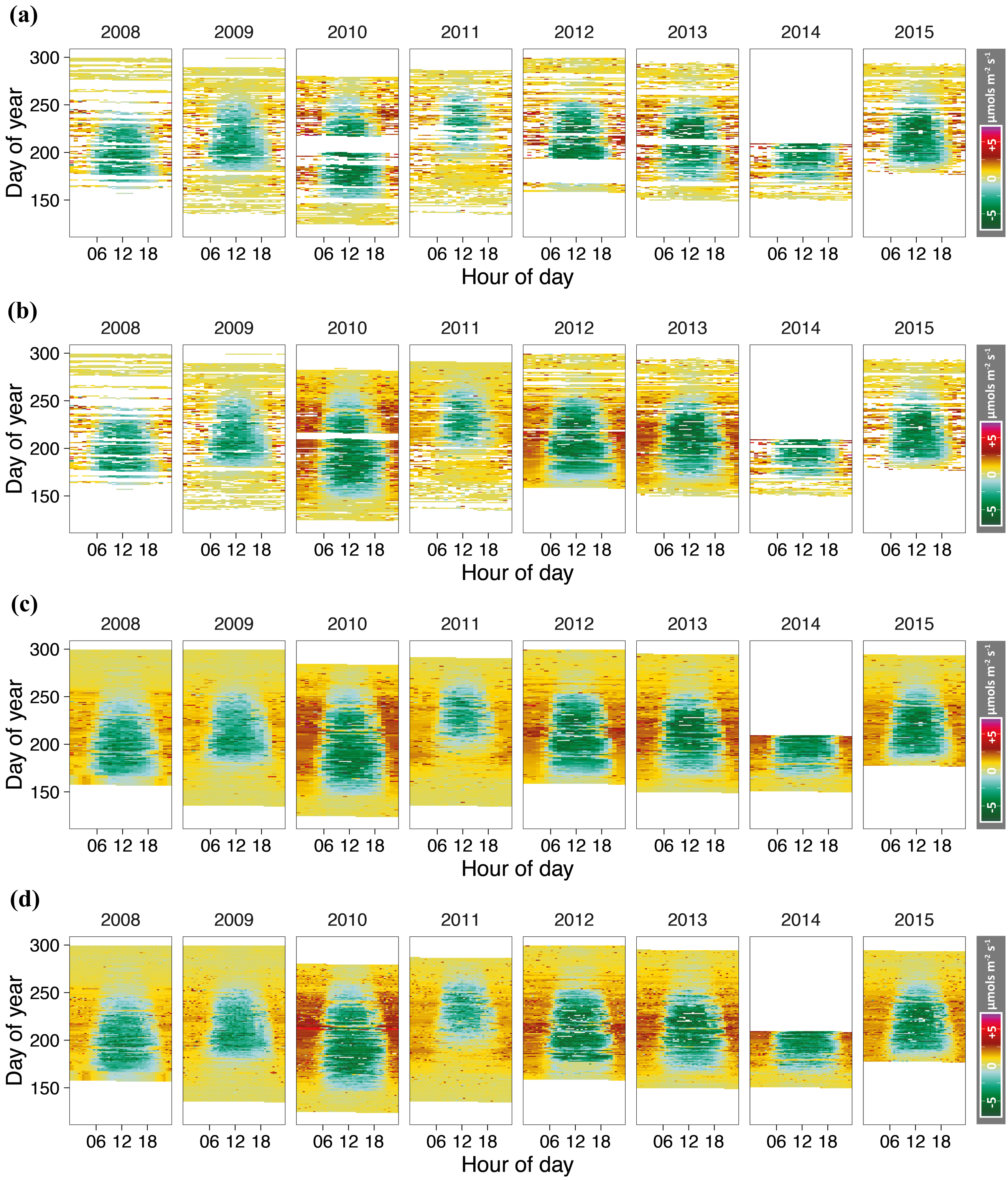

Figure S2. (a) Original NEE EC data, **(b)** gap-filled NEE based on auto-chamber data, **(c)** gap-filled product combining auto-chamber data and the MDS algorithm and **(d)** gap-filled product using only the MDS algorithm.

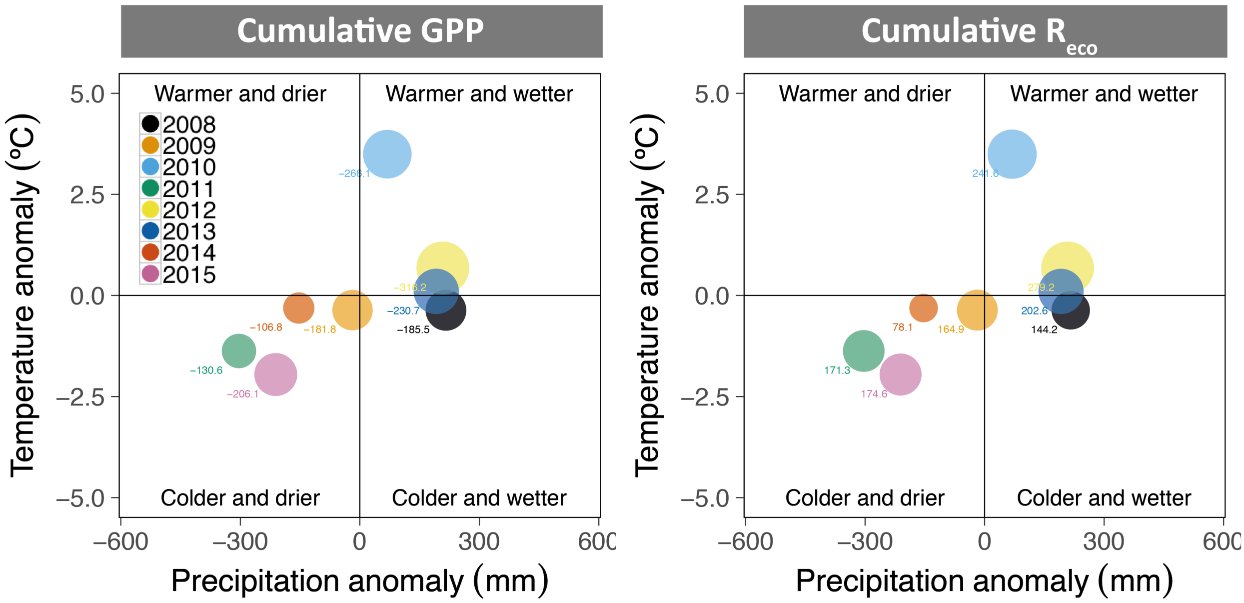

Figure S3. Annual cumulative GPP and R_{eco} defined by annual temperature and precipitation anomalies (2008-2015). The flux size is categorized depending on the flux magnitude (g C m^{-2}), i.e. larger diameters with greater fluxes.

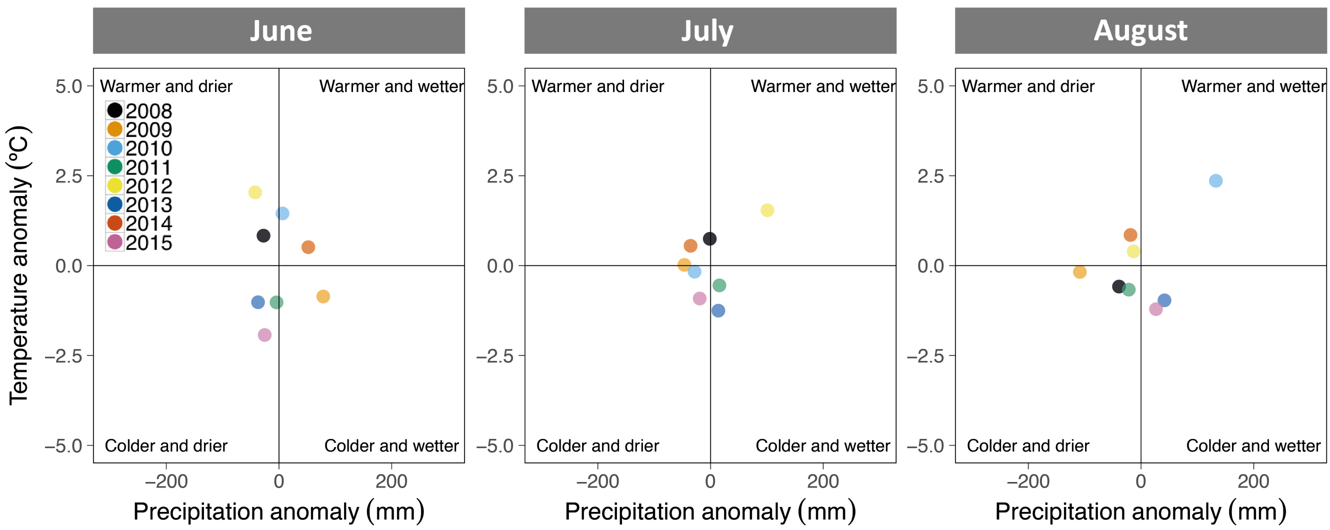

Figure S4. Temperature (°C) and precipitation (mm) anomalies in June, July and August of the analysed years (2008-2015).

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

Figure	Temporal scale	Time aggregation	Sample size	Number 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