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Greenhouse gas fluxes at a continental tundra site in NE Siberia and radiative forcing of advancing of the growing season

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Carbon dioxide and methane fluxes were measured at a tundra site near Chokurdakh, in the lowlands of the Indigirka river in north-east Siberia. This site is one of the few stations on Russian tundra and it is different from most other tundra flux stations in its continentality. A suite of methods was applied to determine the fluxes of NEE, GPP, R_{eco} and methane, including eddy covariance, chambers and leaf cuvettes. Net carbon dioxide fluxes were high compared with other tundra sites, with NEE=-92 g C m^{-2} yr^{-1}, which is composed of an R_{eco}=+141 g C m^{-2} yr^{-1} and GPP=-232 g C m^{-2} yr^{-1}. This large carbon dioxide sink may be explained by the continental climate, that is reflected in low winter soil temperatures (-14˚C), reducing the respiration rates, and short, relatively warm summers, stimulating high photosynthesis rates. Interannual variability in GPP was dominated by the frequency of light limitation (R_g <200 W m^{-2}), whereas R_{eco} depends most directly on soil temperature and time in the growing season, which serves as a proxy of the combined effects of active layer depth, leaf area index, soil moisture and substrate availability. The methane flux, in units of global warming potential, was +28 g C-CO_2e m^{-2} yr^{-1}, so that the greenhouse gas balance was -64 g C-CO_2e m^{-2} yr^{-1}. Methane fluxes depended only slightly on soil temperature and were highly sensitive to hydrological conditions and vegetation composition.

Using the full 29 year record of satellite microwave radiation, a time series of snow

depth was derived, showing that at the site, the growing season advanced 7 days in the spring, and between 3 and 10 days in the fall. As the growing season advances relative to the solar cycle, this has impacts on the albedo and reflected radiation, as well as on photosynthesis rates, whereas it may be argued that the impact on R_{eco} and f_{CH4} is negligible. It is shown that the albedo feedback is 10^2 times stronger than the photosynthesis feedback, annually averaged over the globe, even if the snow-albedo feedback is only limited to a short period and a small area. This puts greenhouse gas feedbacks to climate change in the shadow of snow-albedo feedbacks.