S1 Figures from site level simulations

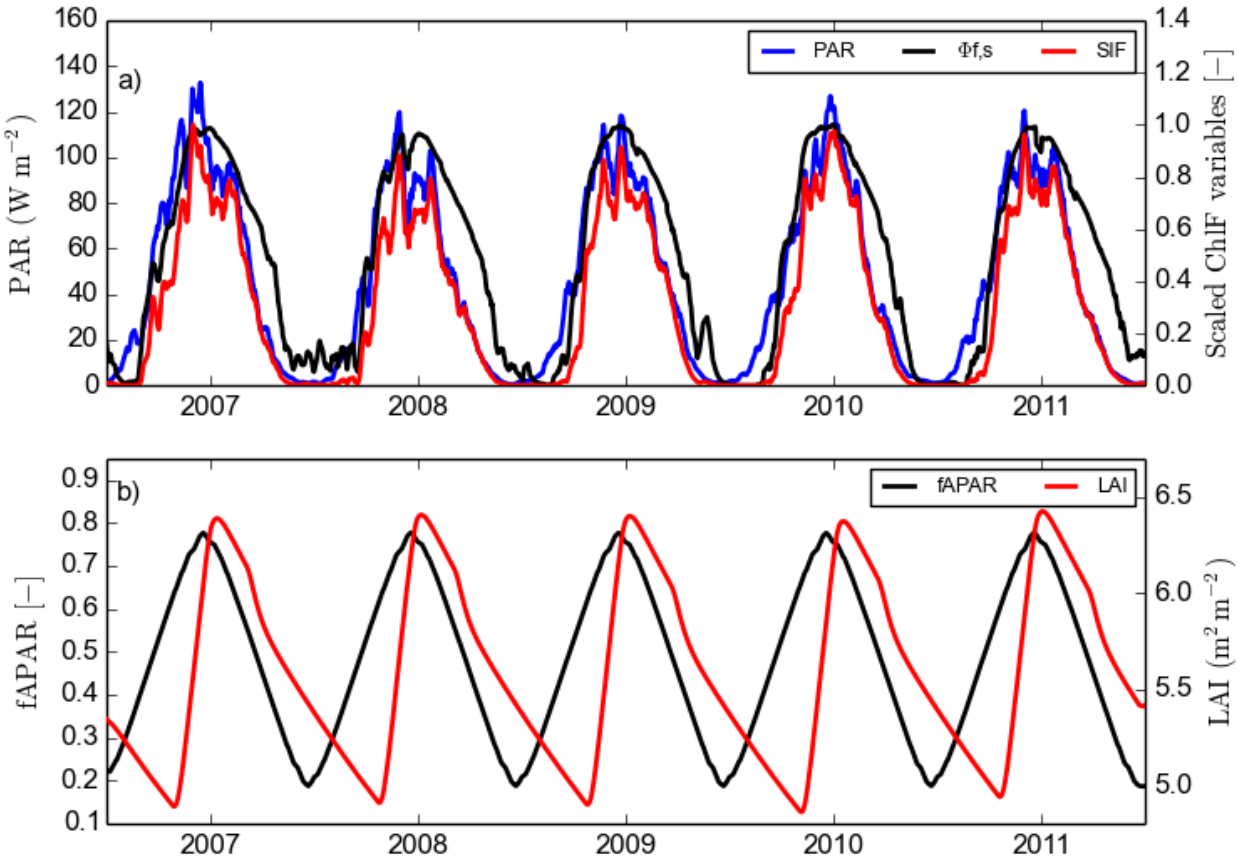

Fig. S1. (a) Five years of incoming photosynthetically active radiation (PAR) (blue line), modelled quantum yield of fluorescence (Φ_f)(black line) and sun-induced chlorophyll fluorescence (SIF) (red line) and (b) modelled fraction of absorbed photosynthetic active radiation by vegetation (fAPAR) (black line) and leaf area index (LAI) (red line). The daily values have been smoothed by a moving 10-day window.

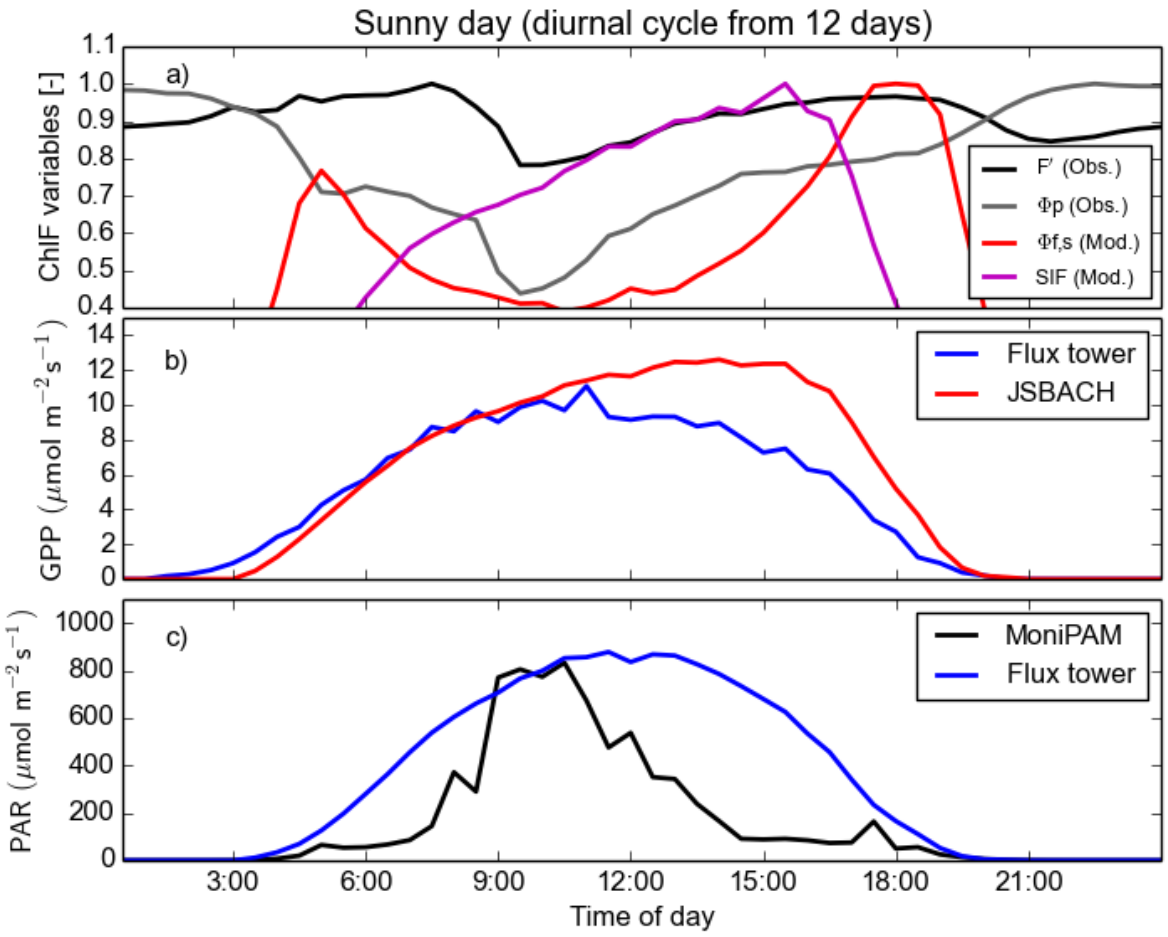

Fig. S2. (a) The diurnal cycles of observed prevailing fluorescence signal as measured with PAM fluorometry (F') and quantum yield of photochemistry in PSII (Φp) from MONI-PAM and modelled quantum yield of fluorescence (Φf) and sun-induced chlorophyll fluorescence (SIF) as averaged from 12 sunny days during the growing season, (b) the gross primary production (GPP) as measured from the flux tower (blue line) and GPP simulated by JSBACH (red line), (c) photosynthetically active radiation (PAR) observation from the flux tower (blue line) and from the MONI-PAM observation place in the canopy (black line).

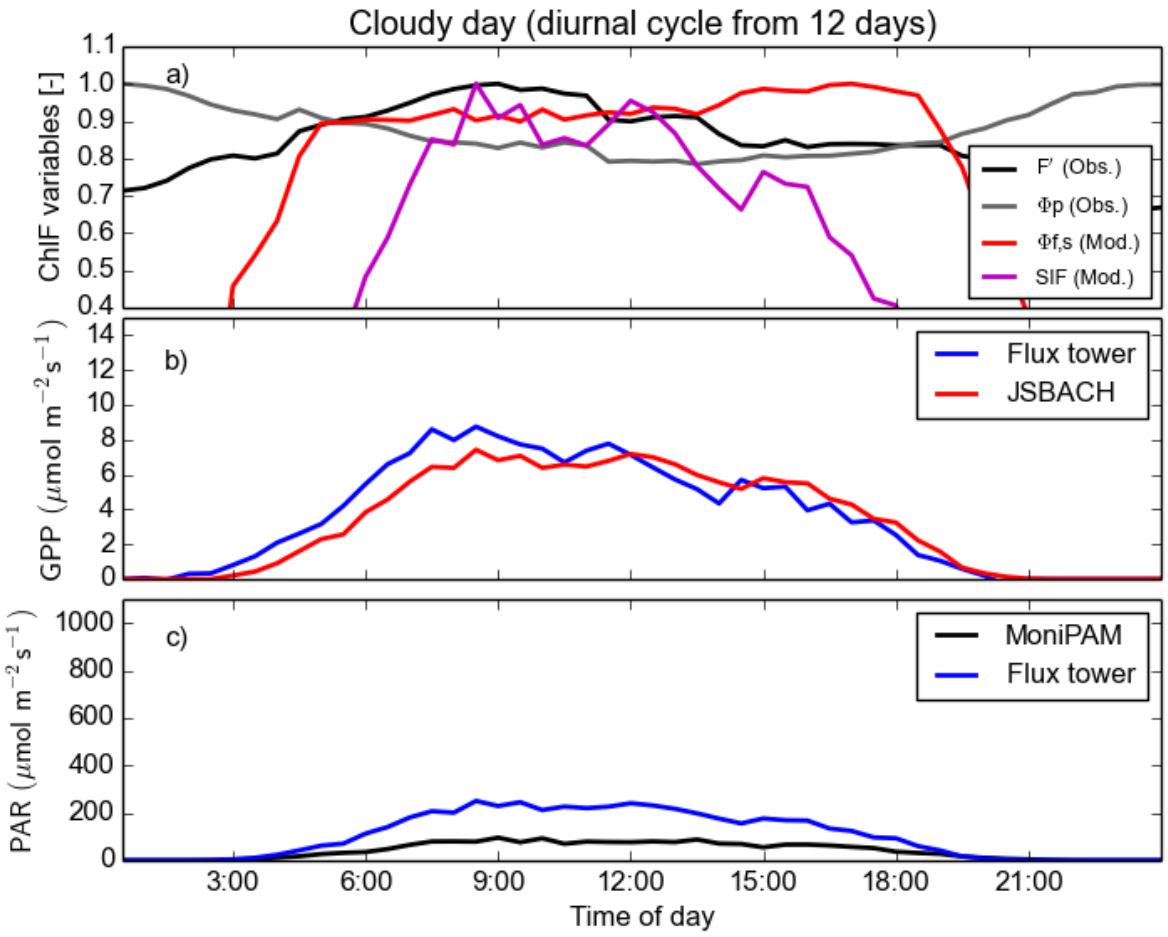

Fig. S3. (a) The diurnal cycles of observed prevailing fluorescence signal as measured with PAM fluorometry (F') and quantum yield of photochemistry in PSII (Φp) from MONI-PAM and modelled quantum yield of fluorescence (Φf) and sun-induced chlorophyll fluorescence (SIF) as averaged from 12 cloudy days during the growing season, (b) the gross primary production (GPP) as measured from the flux tower (blue line) and GPP simulated by JSBACH (red line), (c) photosynthetically active radiation (PAR) observation from the flux tower (blue line) and from the MONI-PAM observation place in the canopy (black line).

S2 Additional satellite observations

In order to assess whether the late winter/early spring behavior of the SIF signal from GOME-2 was caused by an instrument specific artifact, we examined data from two other satellite missions. The SCIAMACHY (SCanning Imaging Absorption SpectroMeter for Atmospheric CHartographY) spectrometer on ENVISAT (ENVIronmental SATellite) satellite (Köhler et al., 2015) has been observing since February 2002 and the OCO-2 (Orbiting Carbon Observatory) is a more recent mission that was launched in July 2014 and provides a smaller ground-pixel size compared to earlier missions that observed SIF (Frankenberg et al., 2014).

At FI-Ken the SCIAMACHY data from 2007-2011 was not free from the early increase of the SIF signal that was also seen in the GOME-2 data (Fig. B1). Unexpectedly high values during spring are more pronounced when the SCIAMACHY SIF is used.

The seasonal cycle of SCIAMACHY SIF at different latitudes is fairly similar to GOME-2 (Fig. B2a). The SCIAMACHY values indicate a lower level of SIF compared to the GOME-2 values. Some differences exist, e.g., the maximum value in 2011 occurred one month later in the 58-62° latitude region in the SCIAMACHY data. In the two northern latitudinal regions, the early increase and subsequent lowering of the SIF signal before the growing season was also present in the SCIAMACHY data.

The OCO-2 data in 2015 showed higher values in April for the two northernmost regions (Fig. 2b). The April value was not surpassed in the > 66° latitude region even during the summer. In 2016, the increase in the SIF signal in the two northernmost regions started in June (Fig. 2c), later than in 2015. Therefore, the more recent OCO-2 data also suffers from the same disturbance on these northern regions in Fenno-Scandinavia (at least in 2015) than the other missions. This effect might be caused by instrument noise.

References

Frankenberg, C., O'Dell, C., Berry, J., Guanter, L., Joiner, J., Köhler, P., Pollock, R. and T.E. Taylor, 2014. Prospects for chlorophyll fluorescence remote sensing from the Orbiting Carbon Obervatory-2. Remote Sensing of Environment, 147, 1-12.

Köhler, P., Guanter, L., and Joiner, J., 2015. A linear method for the retrieval of sun-induced chlorophyll fluorescence from GOME-2 and SCIAMACHY data, Atmos. Meas. Tech., 8, 2589-2608, doi:10.5194/amt-8-2589-2015.

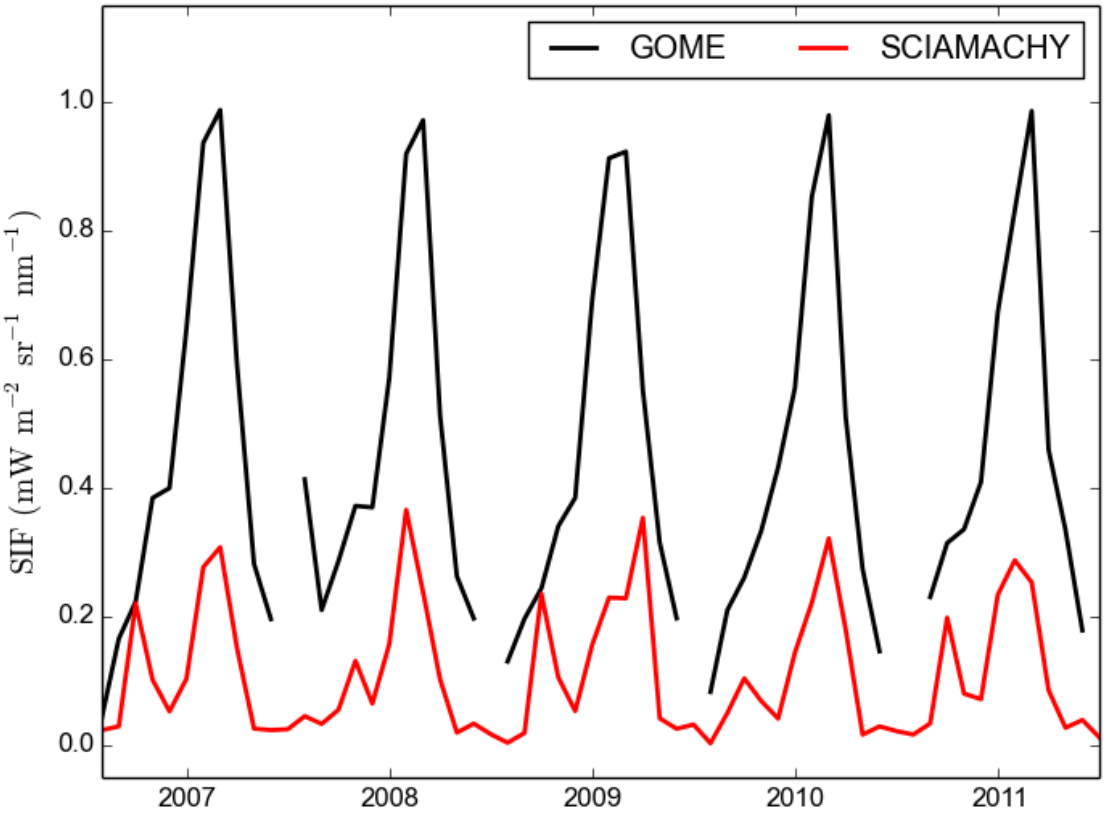

Fig. S4. Monthly sun-induced chlorophyll fluorescence (SIF) observations at FI-Ken (averaged over 2° x 2° area) from GOME-2 and SCIAMACHY for 2007-2011.

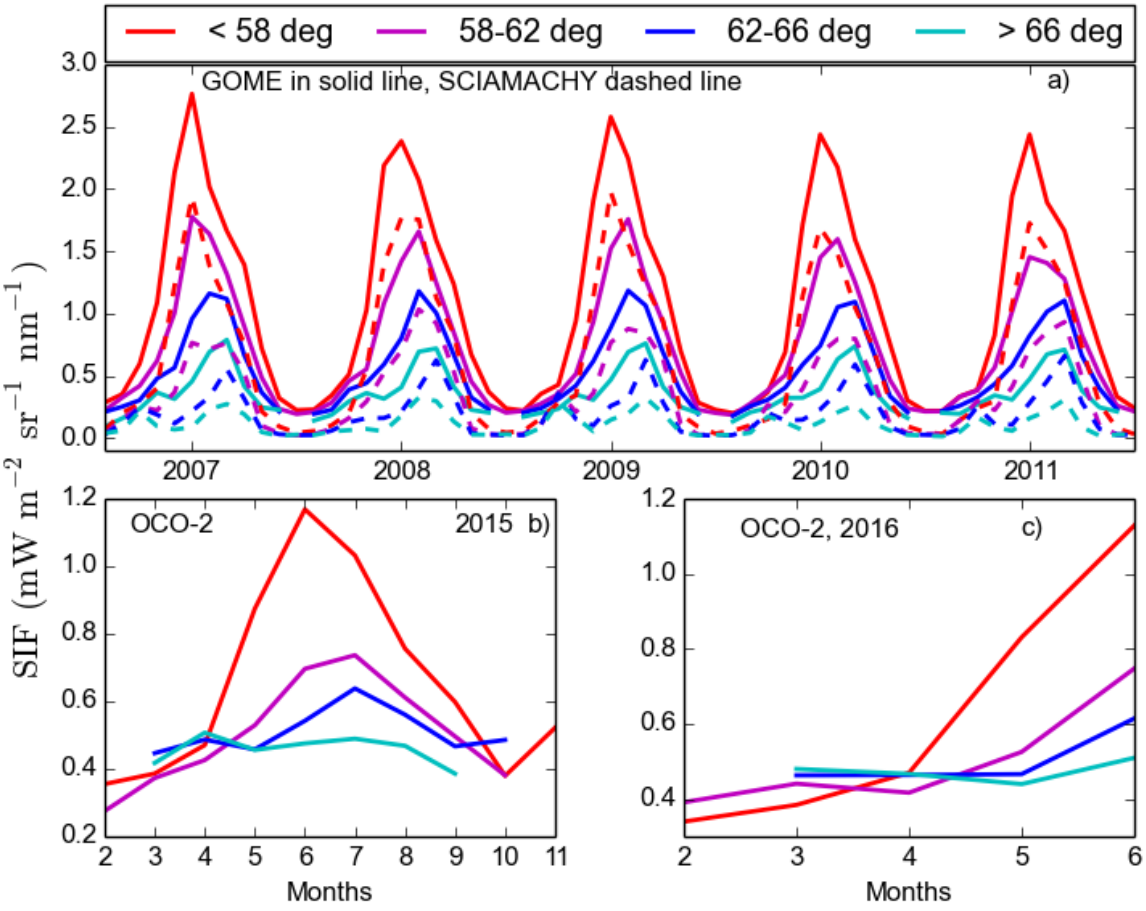

Fig. S5. (a) Monthly values in 2007-2011 for different latitudinal regions from GOME-2 (solid lines) and SCIAMACHY (dashed lines), (b) for 2015 from OCO-2 and (c) the first half of 2016 from OCO-2.