Supplementary Material for: **Carbon stocks and fluxes in the high latitudes: Using site-level data to evaluate Earth system models.**

| | Abisko | Bayelva | Kytalyk | Samoylov | Zackenberg |
|---|---|---|---|---|---|
| Snow depth | 2005-2012 | 1998-2009 | 2011-2013 | 2002-2013 | 1997-2010 |
| Soil temperature | 2005-2012 | 1998-2009 | 2011-2013 | 2002-2005 | 1995-2010 |
| Soil moisture | 2015 | 2009-2013 | - | 2002-2005 | 2006-2013 |
| $CO_2$ flux | 2012-2013 | 2008-2009 | 2003-2013 | 2002-2013 | 2000-2008 |

**Table S1** | Years for which observational data were used for mean annual cycles.

| | Abisko | Bayelva | Kytalyk | Samoylov | Zackenberg |
|---|---|---|---|---|---|
| JSBACH | 12.4 | 8.2 | 16.9 | 16.9 | 29.4 |
| JULES | 26.7 | 0.05 | 3.2 | 3.6 | 1.2 |
| JULES fixed veg | 35.0 | 4.9 | 12.9 | 13.1 | 5.5 |
| ORCHIDEE | 8.9 | 1.0 | 7.5 | 14.8 | 0.05 |
| ORCHIDEE no mixing | 12.6 | 1.6 | 10.1 | 17.4 | 0.0 |
| Observations | **39** | **8** | **29** | **24** | **13** |

**Table S2** | Total soil carbon in top 1m ($kgm^{-3}$). Observations are based on the flux tower footprint areas. Models are averaged for 1990-2013 inclusive (note they do not change substantially over the simulation period).

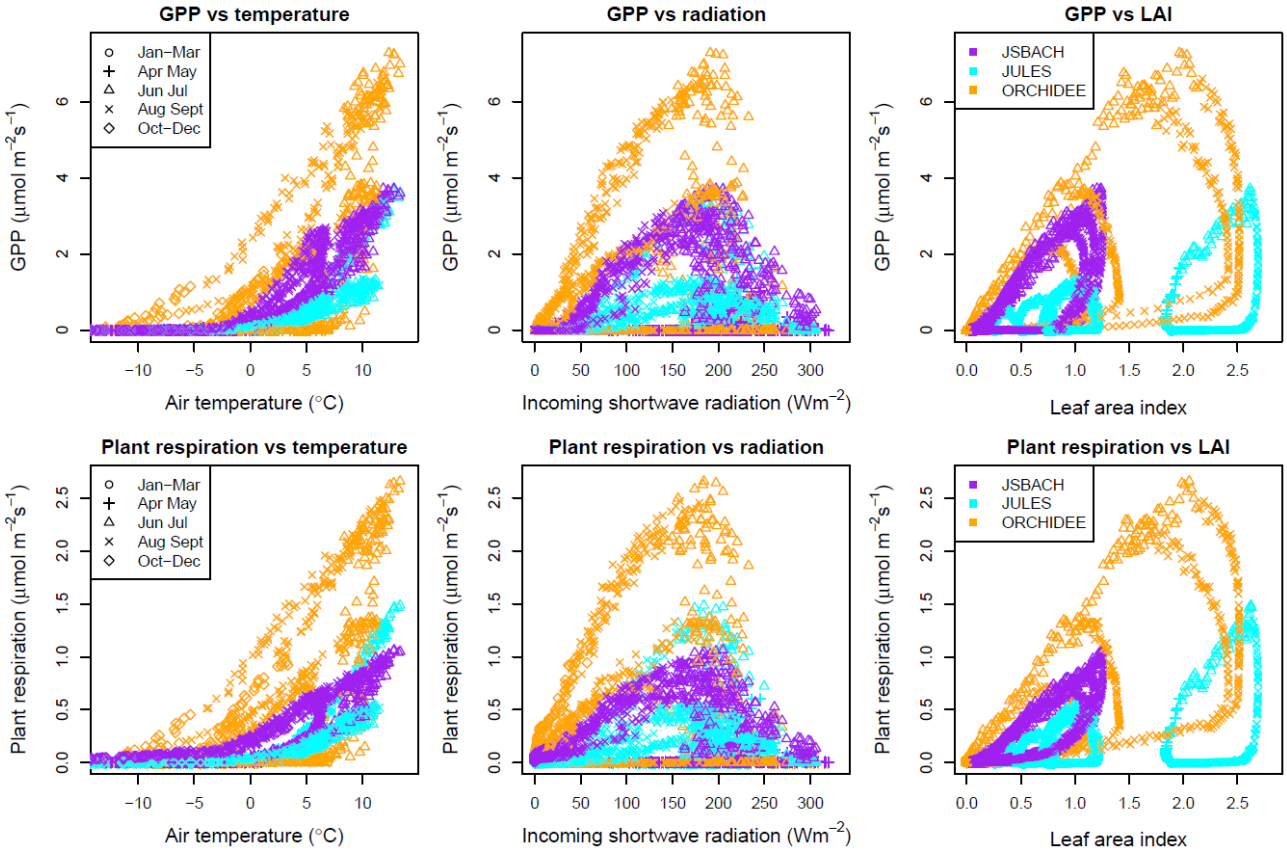


**Figure S1** | Relationship of modelled GPP and plant respiration with different variables: Air temperature, incoming shortwave radiation and LAI. All sites are included on each plot. Shapes of points correspond to different parts of the season.

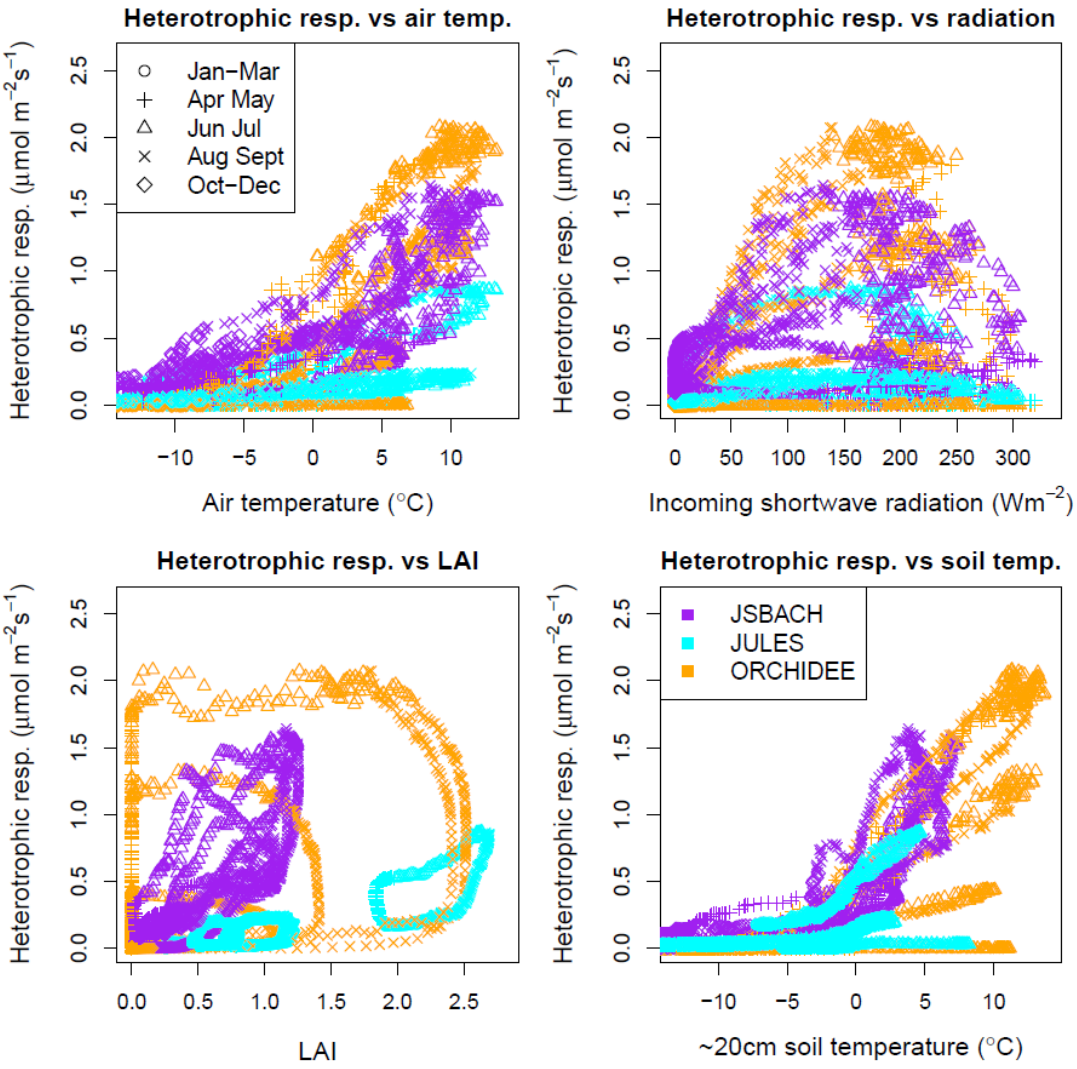


**Figure S2** | Relationship of modelled soil respiration with different variables: Air temperature, incoming shortwave radiation, LAI and 20cm soil temperature. All sites are included on each plot. Shapes of points correspond to different parts of the season.

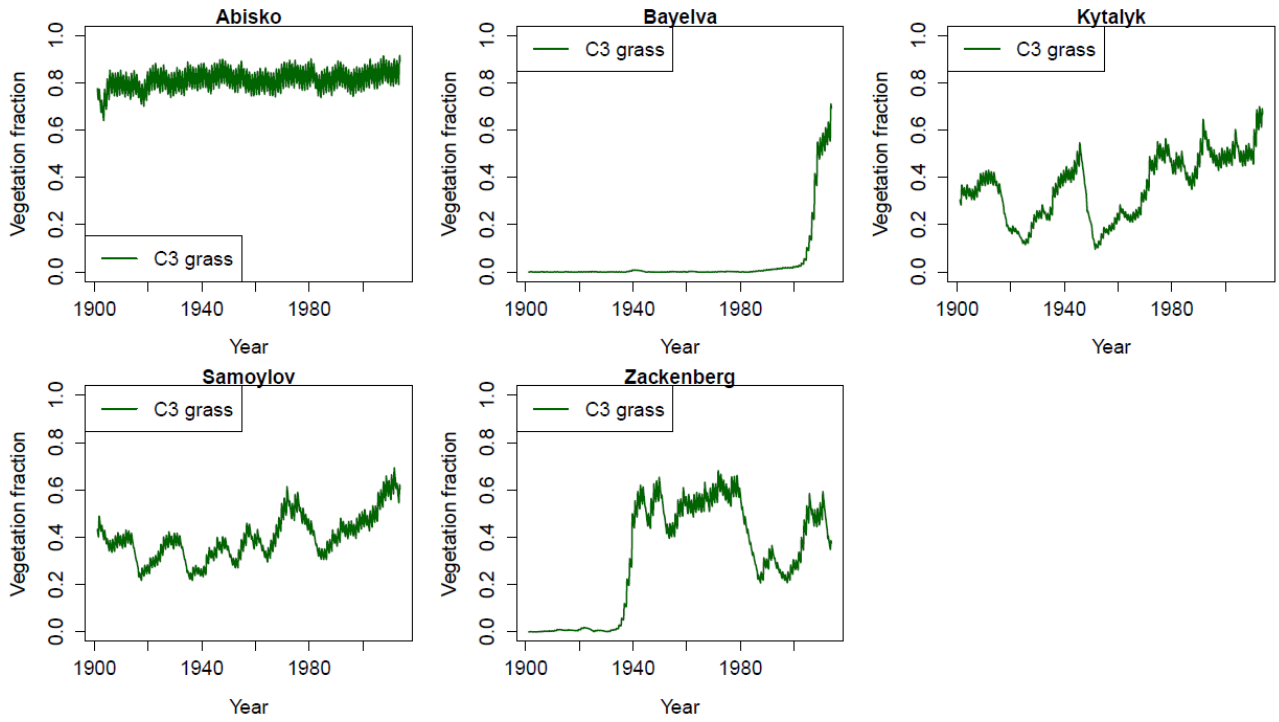


**Figure S3 |** Vegetation fractions in JULES as simulated by the dynamic vegetation model, TRIFFID. There are 9 PFT's that can potentially grow, but only C3 grass is able to grow at these sites.

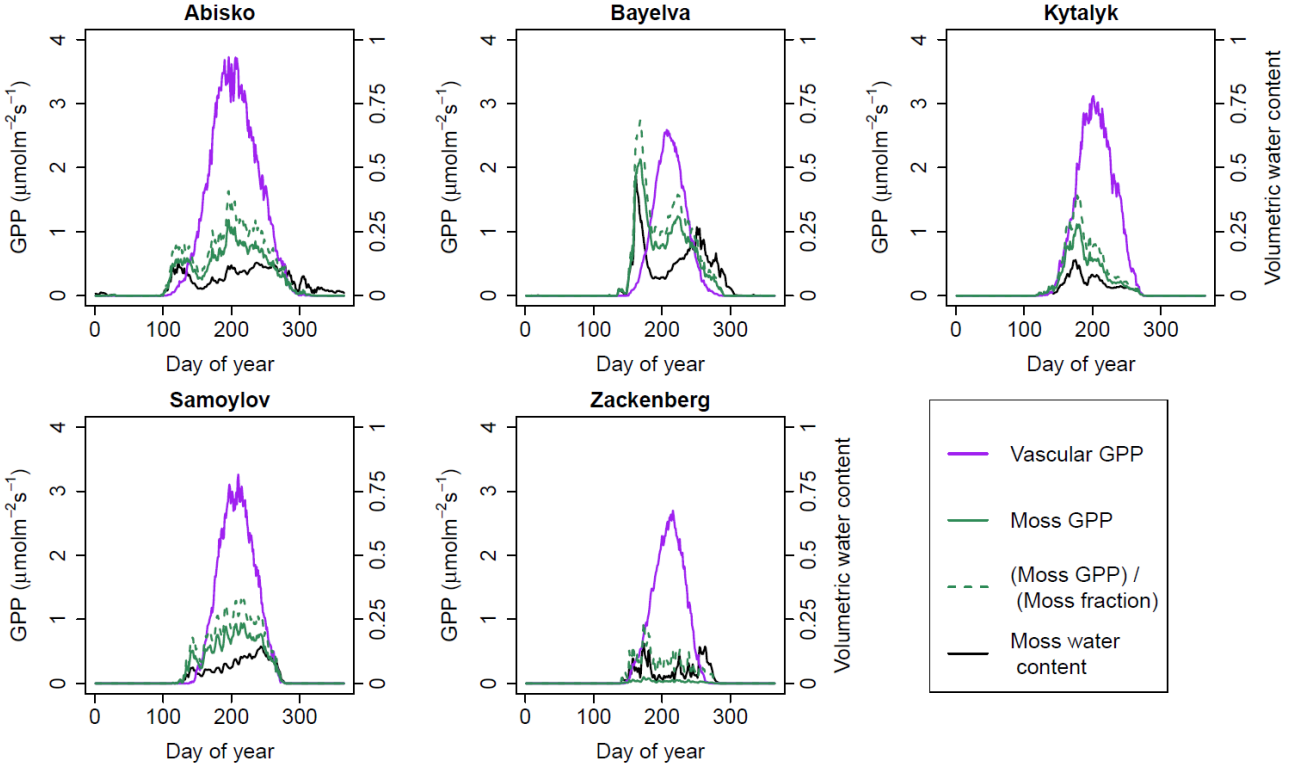


**Figure S4 |** Annual cycle of moss GPP and vascular plant GPP in JSBACH, showing the difference in their seasonal cycles. The moss moisture content is also shown to demonstrate the link between moss GPP and water content.