Supplementary online information for Reichstein et al.: On linking plant and ecosystem functional biogeography

Recent databases exploitable for functional biogeography from organismic to ecosystem level

Today considerable progress has been made to establish observing systems and databases to characterize the geographical variation of functioning at both organismic and ecosystem level. At the organismic level plant traits measurable at the individual plant (1), reflect the outcome of evolutionary processes in the context of abiotic and biotic environmental constraints. There have been initiatives to integrate and standardize different datasets, but these initiatives were focused on specific regions (e.g. LEDA, 2) or trait spectra (e.g. GLOPNET, 3), culminating in the TRY initiative (4) in 2007, aiming to develop a global database of plant traits for refining plant functional types (www.try-db.org). Based on the integration of 150 datasets the TRY database has achieved an unprecedented coverage of about 3 million trait entries for 721 different plant traits and about 70000 plant species at global scale (Figure S1).

The eddy covariance (EC) technique is the preferred method to measure flux densities of trace gases between the biosphere and the atmosphere (5). The method allows us to directly observe fluxes in situ, in a non-destructive manner without invasive artifacts at a spatial scale of hundreds of meters and on time scales spanning hours, days and years. Consequently the eddy covariance based ecosystem observation sites have been deployed since the mid-1990s almost in parallel in several regional to continental networks worldwide; it's strength and shortcomings are well-known, including the potential loss of fluxes, difficult application under complex terrain and the inability to monitor fast fluxes (e.g. from fire) (6). Hence, it is valuable to complement the eddy covariance method with other approaches, e.g. inventories. The current global network of sites includes more than 500 stations spanning from tropical to arctic climate regions and different ecosystems and disturbance levels. A series of efforts to combine and synthesize the observations from the different regional networks participating in FLUXNET has resulted in a global standardized data set with more than 930 site-years from more than 250 sites (Figure S1). Released in 2007 (www.fluxdata.org), it forms an unprecedented basis for research on global ecosystem functioning, capturing most variation in climate and vegetation structure (measured at fraction of absorbed photosynthetically active radiation fAPAR).

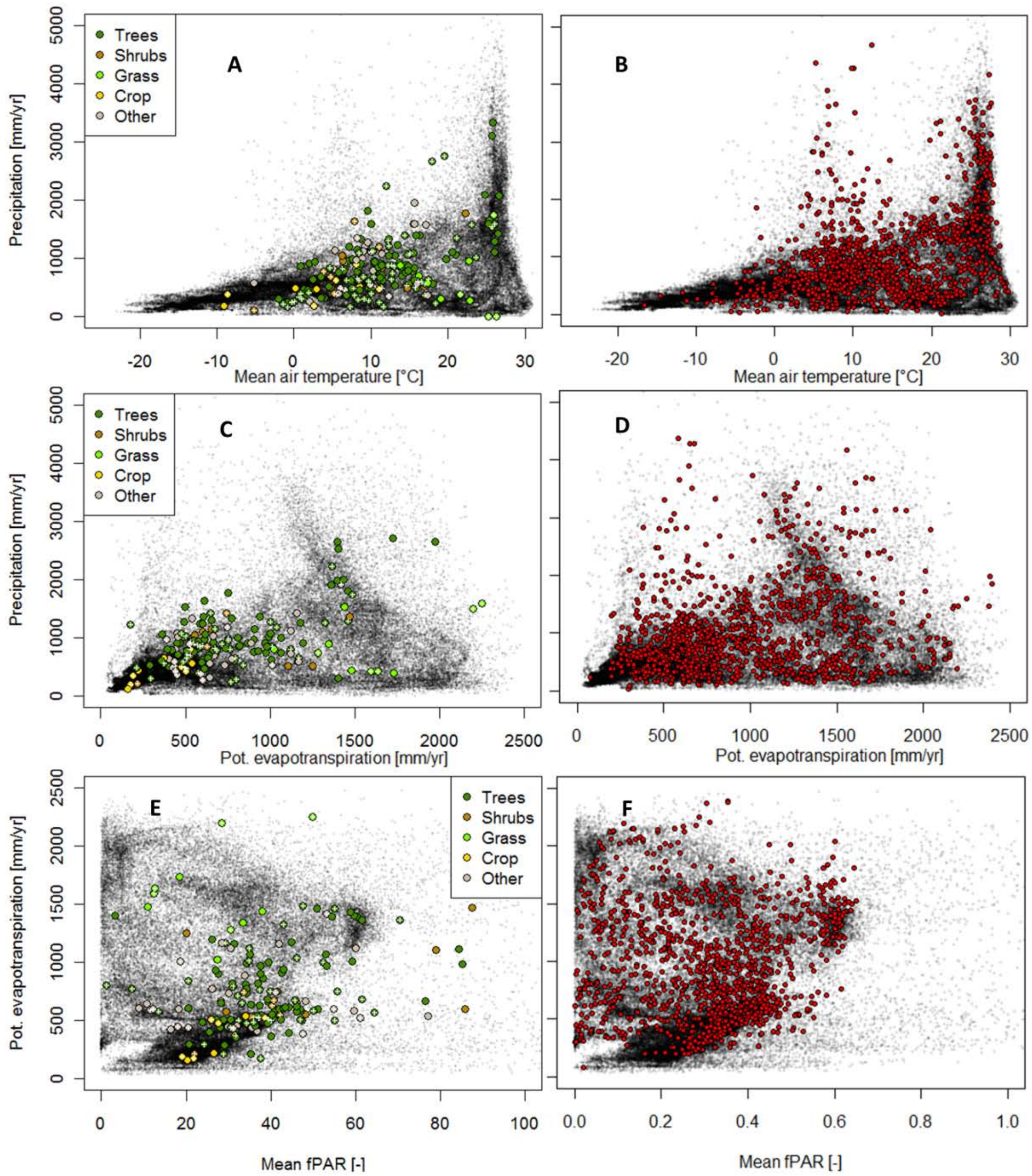

Figure S1: The distribution of FLUXNET (a,c,e) and TRY (b,d,f) observation sites in ecological spaces spanned by variable mean annual temperature and precipitation (a, b), potential evapotranspiration (PET) and precipitation (c, d) and fPAR and PET. The gray dots indicate all terrestrial landsurface pixels at 0.5°x0.5° and are derived from 7 for climate variables and 8 for fPAR.

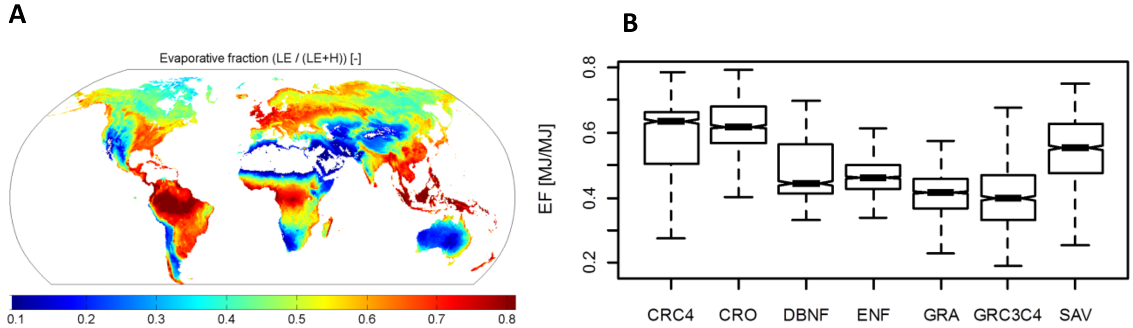

Figure S2: Global distribution of the ecosystem functional property evaporative fraction derived from integrating FLUXNET, remote sensing and climate data (A) and their within and between-vegetation type variation for selected vegetation types (B). Computed from Jung et al. (2011). CRO: Cropland, CRC4: C4 crops, DBNF: Deciduous broad leaved and needle leaved forests; ENF: Evergreen needle leaved forest, GRA: C3 grassland, GRC3C4: C3-C4 mixed grassland, SAV: savannah.

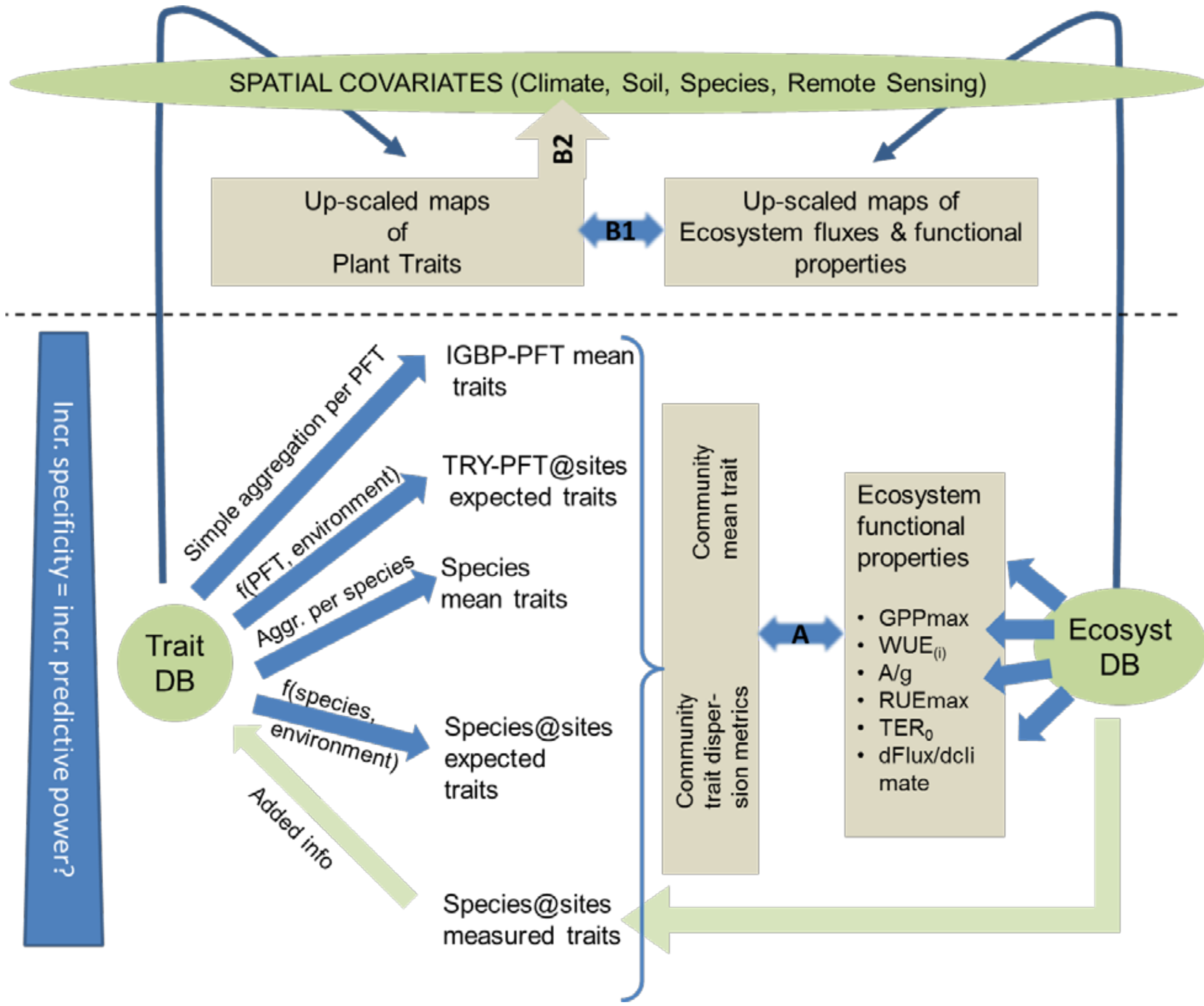

Figure S3: Conceptual scheme for linking trait and flux databases across different scales: A) Ecosystem scale (lower right part of the figure), B1) Continental to global scale (via comparing up-scaled fields of traits versus ecosystem properties), B2) By using up-scaled traits as spatial covariates to improve up-scaling (arrow).

Explanation of Figure 2a in main manuscript:

For Figure 2a, light response curve parameters from Lasslop et al. (2010) have been analysed. Lasslop et al. (2010) derive light-response parameters for consecutive 4-day periods, hence yielding a time series of parameters such as the light-saturated gross carbon uptake. For each year of the record the 90th percentile has been calculated (GPPsat_90) and plotted against the observed NEP for that year.

An ANCOVA reveals highly significant effects of GPPsat_90 on annual NEP and highly significant site effects, but no interaction between the two factors, indicating there is no significant difference in the NEP versus GPPsat_90 slopes between the site, but rather a general relation:

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                   Df  Sum Sq Mean Sq  F value    Pr(>F)
GPPsat_90.          1  602330  602330 116.6002 7.677e-13 ***
SiteID              6 1366192  227699  44.0784 3.865e-15 ***
GPPsat_90:SiteID    6   53065    8844   1.7121    0.1464
Residuals          36  185968    5166
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
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(Analysis has been performed in R (9) with the “aov” function)

Table S1: Overview of the sites used in Figure 2a. The labels are the standardized FLUXNET labels as documented at www.fluxdata.org. More site-information can be found there.

Site label in Fig. 2	Site name	Vegetation type	Dominant species	Country of location
DE-Hai	Hainich	Temperate deciduous broadleaf forest	Fagus sylvatica L.	Germany
DE-Tha	Tharandt	Temperate evergreen needle-leaf forest	Picea abies L-	Germany
FR-Hes	Hesse	Temperate deciduous broadleaf forest	Fagus sylvatica L.	France
FR-Pue	Puéchabon	Mediterranean evergreen broadleaf forest	Quercus ilex L.	France
NL-Loo	Loobos	Temperate evergreen needle leaf forest	Pinus sylvestris L.	Netherlands
DK-Sor	Soroe	Temperate deciduous broadleaf forest	Fagus sylvatica L.	France
FI-Hyy	Hyytiälä	Boreal evergreen needle leaf forest	Pinus sylvestris L.	Finnland

References cited in supplementary information:

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2. Kleyer M, et al. (2008) The LEDA Traitbase: a database of life-history traits of the Northwest European flora. *Journal of Ecology* 96(6): 1266-1274.
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4. Kattge J, et al. (2011) TRY - a global database of plant traits. *Global Change Biology* 17: 2905-2935.
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9. R_Development_Core_Team (2010) *R: A language and environment for statistical computing. R Foundation for Statistical Computing*, ISBN 3-900051-07-0, URL http://www.R-project.org/, Vienna, Austria).