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TERRECO

Gap-filling strategy for daytime net ecosystem exchange of carbon dioxide at a fast-growing cropland in South Korea

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Introduction

- Data acquisition by eddy-covariance technique only covers averagely 65% of the whole year due to system failures and data rejection (Falge et al., 2001).
- The major gap-filling strategies do not work well for fast-developing ecosystems or fast-growing croplands.
- We developed a multi-step filter procedure to gain good-quality data as input for the different parameterizations.
- We tested several gap-filling strategies based on nonlinear regression (NLR) method for daytime NEE obtained from the long-term campaign during the complex TERrain and ECOlogical Heterogeneity (TERRECO) program in 2010.

Data basis

- Site: a potato cropland in a mountainous region
- NEE acquisition:
  eddy-covariance + TK2 (Mauder and Foken, 2004).
- Footprint analysis
- New multi-step filter procedure:
  - Consistency check
  - Quantile and standard deviation filter
  - Instrument-error check
  - TK2 quality-flag check

Models

Our 7 NLR model approaches (Tab. 1) are based on the light-response function (Eqn.1). F_d is the half hourly daytime NEE, R_g is the global radiation, α is the initial slope of the curve, β is the saturated NEE, γ is the offset standing for the respiration rate.

- Model 1, 3, 4 classify data with temperature bins (**T**);
- Model 2, 7: uses a day binning (**D**);
- Model 5, 6 use vapour pressure deficit (VPD) bins (**Vb**);
- Model 3 to 7: a leaf area index (LAI) was introduced (**L**);
- Model 4, 6, 7: a VPD factor was introduced (**Vf**).

Each data group were used for individual fitting of α, β, γ.

Conclusions

- The presently mostly used **temperature classification approach** does not influence the model performance.
- The **day-binning routine** could obviously improve the simulation.
- The **vapor-pressure deficit (VPD) effect** seems also to improve the simulation esp. during the morning hours.
- Adding a **LAI factor** to capture both the diurnal cycle and seasonal vegetation development, we obtained an index of agreement close to 1, and mean square error close to the observation.
- Applying the LAI (fast growing plants) and VDP factor (Model 4 or 5), we are now able to fill the large gaps between observation periods when other models cannot be used.

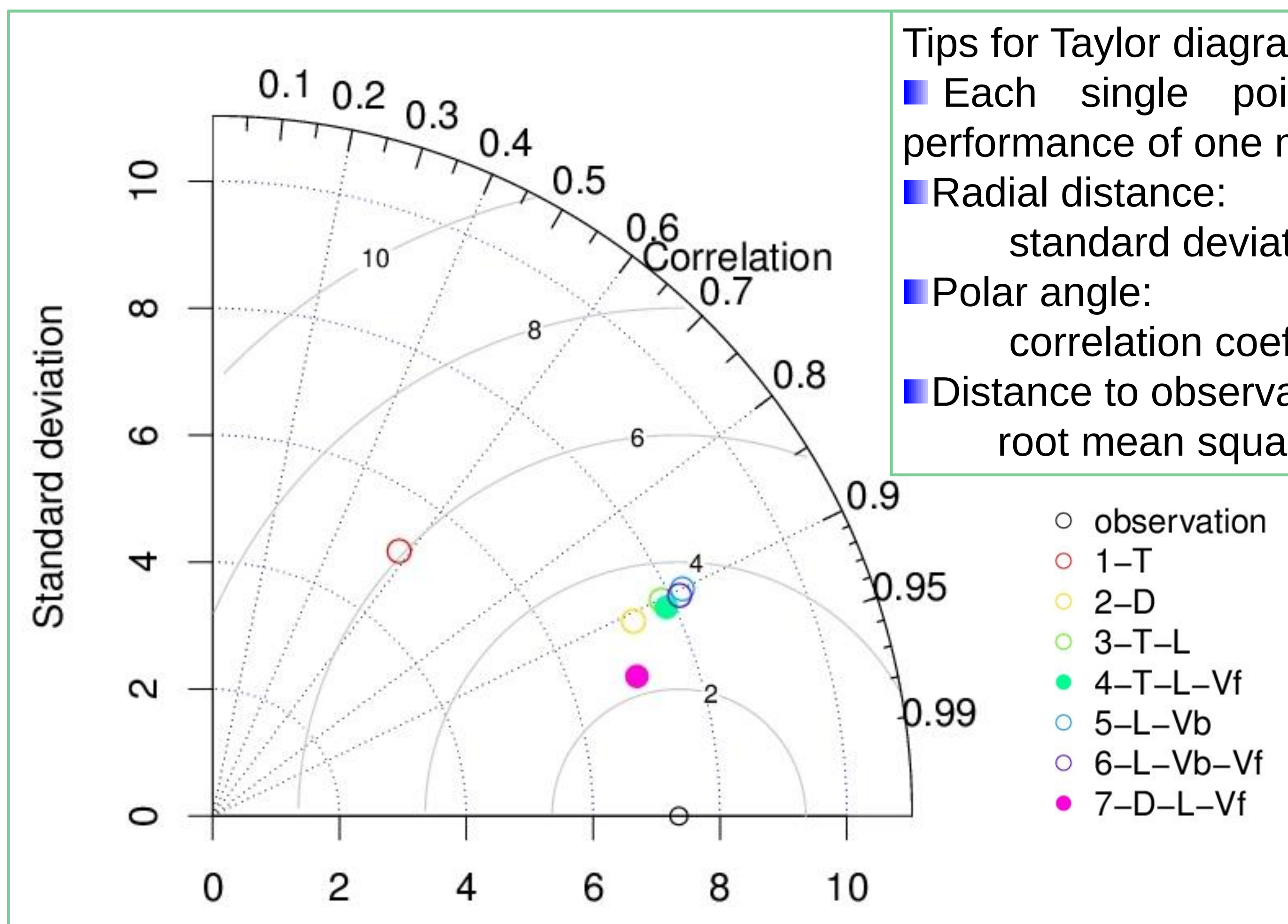
$$F_d = \frac{\alpha R_g \beta}{\alpha R_g + \beta} + \gamma \qquad \text{(Eqn. 1)}$$

$$\beta^* = \begin{cases} \beta_0^* e^{-k(\mathrm{VPD} - 10\ \mathrm{hPa})}, & \mathrm{VPD} > 10\ \mathrm{hPa} \\ \beta_0^*, & \mathrm{VPD} \leq 10\ \mathrm{hPa} \end{cases} \qquad \text{(Eqn. 2)}$$

Tab. 1. Approaches included in each model

Models	Temperature bins	LAI factor*	Day bins	VPD bins	VPD factor**
1-T	Yes	No	No	No	No
2-D	No	No	Yes	No	No
3-T-L	Yes	Yes	No	No	No
4-T-L-Vf	Yes	Yes	No	No	Yes
5-L-Vb	No	Yes	No	Yes	No
6-L-Vb-Vf	No	Yes	No	Yes	Yes
7-D-L-Vf	No	Yes	Yes	No	Yes

* F_d in Eqn. (1) was replaced with $F_d^* = F_d$ / LAI
** An exponential function (Eqn. 2, Lasslop, 2010) was introduced.



Tips for Taylor diagram:
- Each single point specify the performance of one model.
- Radial distance:
  standard deviation (sd),
- Polar angle:
  correlation coefficient (R),
- Distance to observation point (○):
  root mean square error (RMSE).

Fig. 1. Taylor diagram (a polar plot) of the model performances

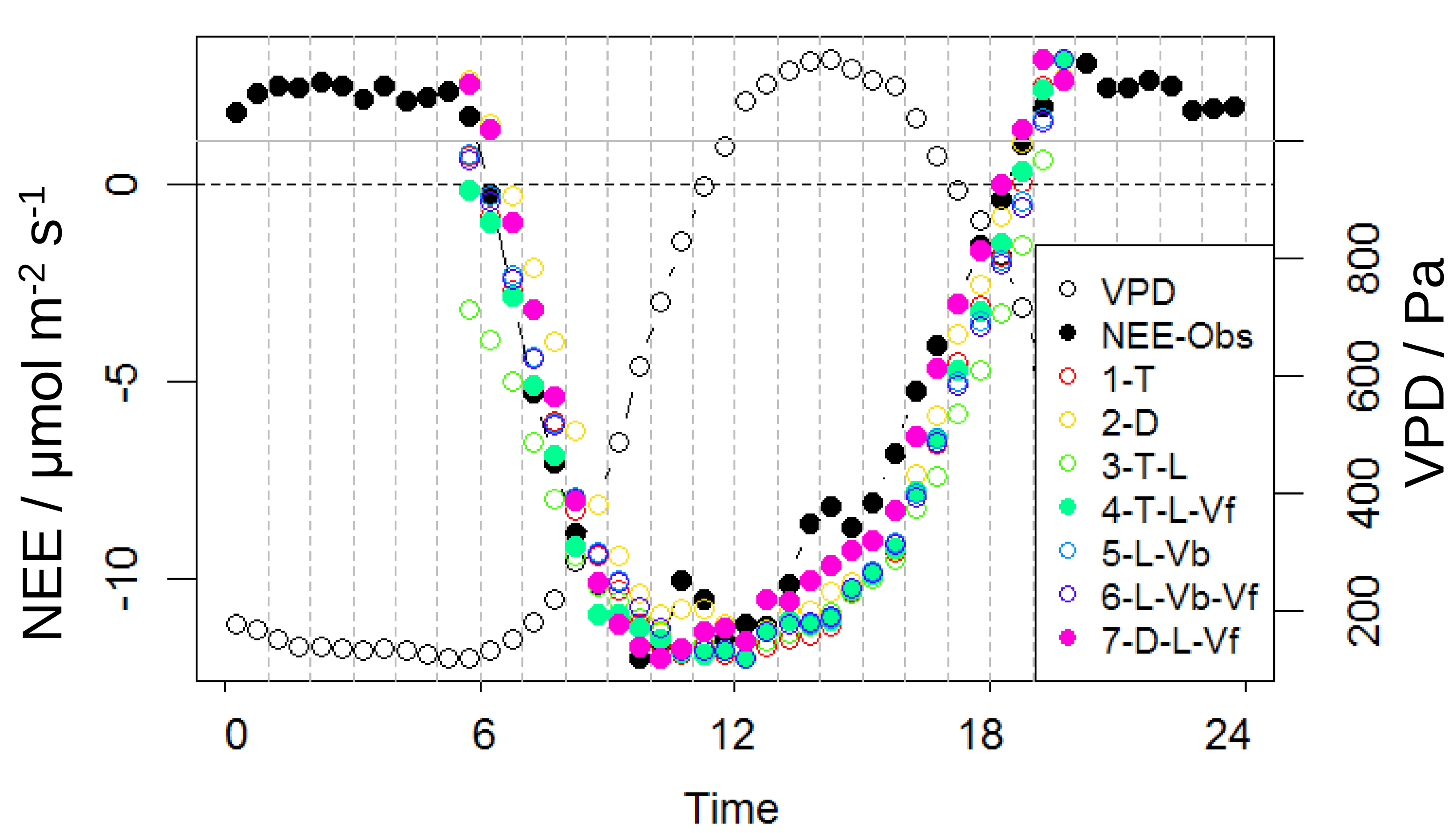


Fig. 2. Mean diurnal cycle of VPD, observed and simulated NEE

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