3rd iLEAPS, Science Conference
Garmisch-Partenkirchen, September 18th-23rd 2011

UNIVERSITÄT BAYREUTH

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TERRECO

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

Selected results of the research on energy and matter exchange over a complex terrain in 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.

Results

- The presently mostly used **temperature classification approach** does not influence the model performance.
- The **day-binning routine** could obviously improve the simulation.
- The **vapour-pressure deficit (VPD) effect** seems also to improve the simulation esp. during the morning hours.
- Adding a **LAI factor** to capture both the daily course 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.

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

$$\beta^* = \begin{cases} \beta_0^* e^{-k(\mathrm{VPD} - \mathrm{VPD}_0)}, & \mathrm{VPD} > 10\ \mathrm{hPa} \\ \beta_0^*, & \mathrm{VPD} \le 10\ \mathrm{hPa} \end{cases} \qquad \text{(Eqn. 2)}$$

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.

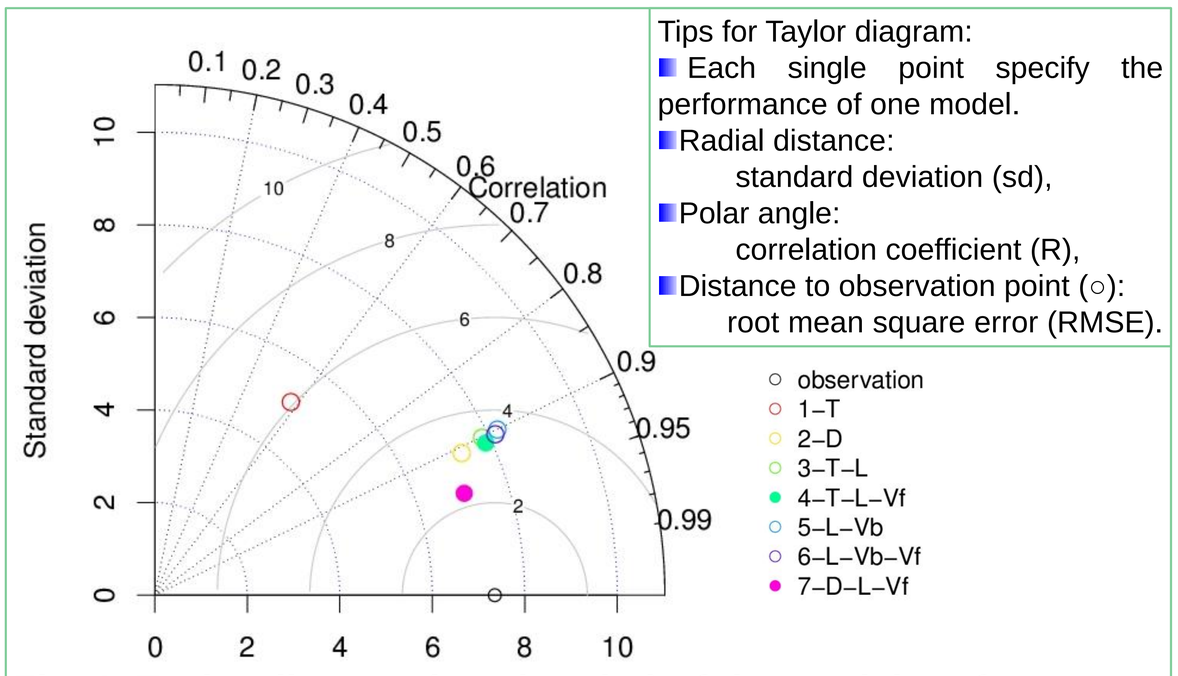

Fig. 1. Taylor diagram (a polar plot) of the model performances

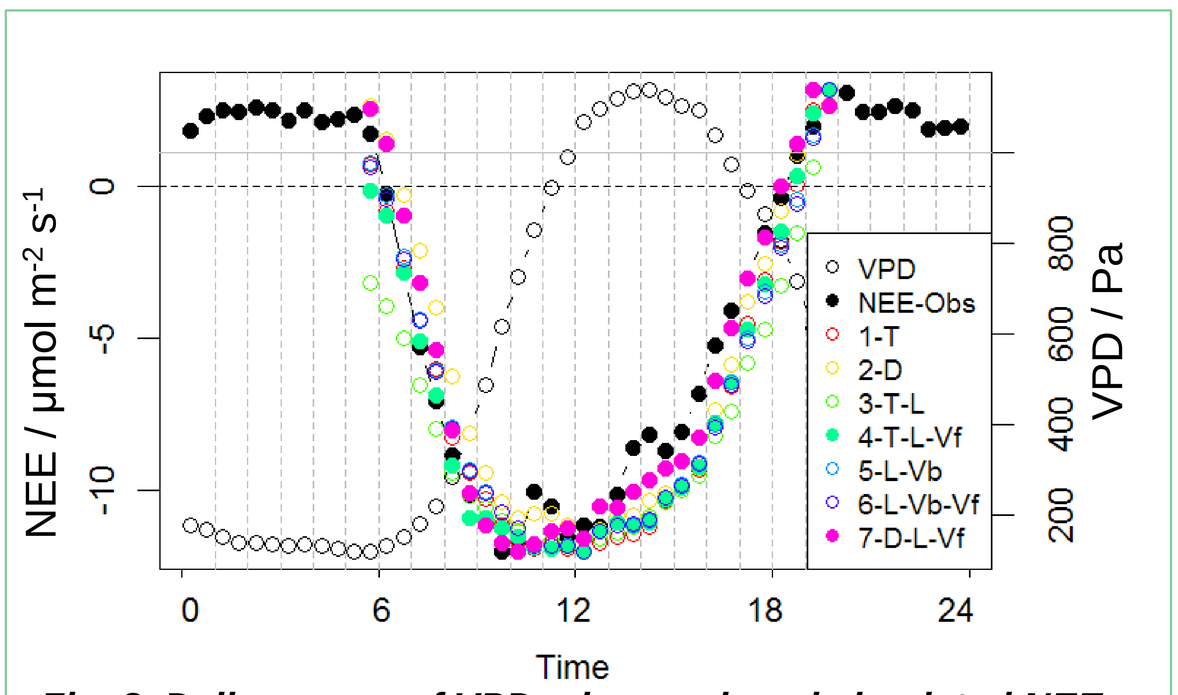

Fig. 2. Daily course of VPD, observed and simulated NEE

Acknowledgements

This study was carried out as part of the International Research Training Group TERRECO (GRK 1565/1) funded by the Deutsche Forschungsgemeinschaft (DFG) at the University of Bayreuth, Germany and the Korean Research Foundation (KRF) at Kangwon National University, Chuncheon, S. Korea.

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