SUPPLEMENTARY MATERIAL RELEVANT FOR THE FOLLOWING PAPER

Quantifying the constraint of biospheric process parameters by CO_2 concentration and flux measurement networks through a carbon cycle data assimilation system

Ernest Koffi[1*], Peter Rayner[2], Marko Scholze[3], Frederic Chevallier[1], Thomas Kaminski[4]

[1]Laboratoire des Sciences du Climat et de l'Environnement (LSCE), UMR 8212, Ormes des merisiers, 91191 Gif-sur-Yvette, France[2] School of Earth Sciences, University of Melbourne, Australia

[3]School of Earth Sciences, University of Bristol, Queen's Road, Bristol BS8 1RJ, United Kingdom

[4]FastOpt, Hamburg, Germany

*Now at the European Commission Joint Research Centre, Institute for Environment and Sustainability, 21027 Ispra (Va), Italy

Corresponding e-mail: *ernest.koffi@jrc.eu.europa.eu*

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Note

BETHY NEE diurnal variations against observations

1. Introduction

The above mentioned paper investigates the sensitivity of the process parameters of the biosphere model BETHY (Knorr, 2000) to choices of atmospheric concentration network, high frequency terrestrial fluxes, and the choice of flux measurement network by using a carbon cycle data assimilation system. For the flux measurements, we used BETHY generated fluxes as a proxy of the observations. To ensure that BETHY fluxes are reasonable, this note aims to compare BETHY net flux (NEE) to observations obtained from some selected sites of the FLUXNET network (e.g., Baldocchi, 2003 and Papale et al., 2006; see the dedicated website: http://www.fluxnet.ornl.gov). In fact, to infer the uncertainties in the model process parameters, we use the classical linear error propagation via the Jacobian of the model. This does not require the use of either real or synthetic data, but the uncertainties in these data.

2. Methodology

BETHY simulates only a diurnal variation of NEE for each month of the year. To compare these simulations to the observations, we first derived a mean diurnal cycle (hourly basis) from FLUXNET semi-hourly NEE data having a ‘Free Fair Use” data policy (see http://www.fluxdata.org). We selected 20 sites that are located in a great part of the globe (Figure A1). The details (station names, ID, and coordinates (longitude/latitude)) of these sites are given in the Table A1. The comparisons of BETHY NEE to the FLUXNET observations are made mainly for the year 2001.

3. Results

This note does not intend to discuss the sources of the differences between the observations and the modeled fluxes, but to give only the main differences between the two data sets. Overall, BETHY NEEs confronted to the observations obtained from the 20 selected FLUXNET sites do show 5 main characteristics (see Figures A2 to A8):

- The phasing of the diurnal cycle of modeled NEE is generally in a fairly good agreement with the ones derived from the observations
- The amplitudes of the modeled NEE are larger than the observed ones for most of the selected cases during spring and summer seasons
- The use of the optimized parameters of BETHY as performed in Koffi et al. (2012), when using only CO_2 concentrations to constrain the process parameters of BETHY, decreases the amplitudes of modeled NEE at some sites. Moreover, as expected, in some cases, the optimized parameters improve the fitting of the modeled fluxes to the observations (e.g., cases of AU-Thum and BE-Vie (Fig. A2), SE-Fla (Fig.A6), US-Los (Fig. A7), and US-SP2 (Fig.A8))
- The simulated onset of the growing season is delayed at most of the sites (e.g., FR-Pue and IT-Ro1 (Fig. A5), SE-Fla (Fig. A6), and UK-Gri (Fig. A7)).
- Finally, in general the model seems to perform equally for the different selected PFTs

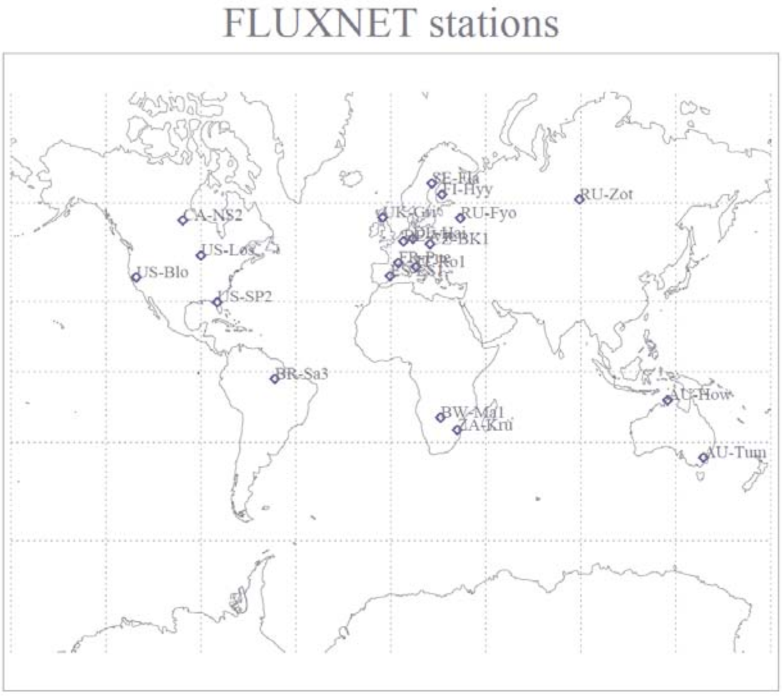
These results are encouraging and can be expected to be significantly improved. Indeed, in the present study, the BETHY fluxes are obtained by using daily meteorological, phenological, and soil data averaged over a large grid cell (2x2 degrees latitude/longitude) and also this cell can contain only up to 3 PFTs. Consequently, by using fine meteorological, phonological, and soil data measured at each of these sites would undoubtedly improve the results.

4. Conclusions

BETHY fluxes compare quite well to the observations, hence the use of these simulated fluxes as a proxy of the measurements is reasonable. The modeled fluxes are generally found to be larger than the observed ones, hence the uncertainties in the flux as characterized in this work can be overestimated in some cases and then render the conclusions of the work enough robust. Indeed, we have considered the uncertainties in flux to be 25% and 75% of the modeled fluxes. For more details, see the manuscript of the paper.

Table A1: The names, IDs, and the coordinates (longitude and latitude) of 20 selected FLUXNET sites are given. The dominant PFT in the cell of BETHY that encompasses the FLUXNET site together with their percentage of coverage relative to the total area of the cell are also reported. The PFTs of BETHY are defined in Figure 2 of the paper.

FLUXNET				BETHY	
Station Name	**Station ID**	**Longitude (o)**	**Latitude (o)**	**Dominant PFT of BETHY cell**	**Percentage of coverage of the dominant PFT**
Howard Springs	AU-How	131.152	-12.494	10	0.54
Tumbarumba	AU-Tum	148.152	-35.656	9	0.60
Vielsalm	BE-Vie	5.997	50.306	13	0.54
Santarem-Km83-Logged Forest	BR-Sa3	-54.971	-3.018	1	0.9
Maun- Mopane Woodland	BW-Ma1	23.56	-19.916	10	0.49
UCI-1930 burn site	CA-NS2	-98.524	55.906	5	0.9
Bily Kriz- Beskidy Mountains	CZ-BK1	18.538	49.503	9	0.72
Hainich	DE-Hai	10.452	51.079	13	0.60
El Saler	ES-ES1	-0.319	39.346	9	0.39
Hyytiala	FI-Hyy	24.295	61.847	5	0.46
Puechabon	FR-Pue	3.596	43.741	9	0.44
Roccarespampani 1	IT-Ro1	11.93	42.408	9	0.38
Fyodorovskoye wet spruce stand	RU-Fyo	32.923	56.461	4	0.40
Zotino	RU-Zot	89.350	60.800	5	0.77
Flakaliden	SE-Fla	19.457	64.113	5	0.65
Griffin- Aberfeldy-Scotland	UK-Gri	-3.798	56.607	13	0.55
CA - Blodgett Forest	US-Blo	-120.633	38.895	4	0.42
WI - Lost Creek	US-Los	-89.979	46.083	4	0.65
FL - Slashpine-Mize-clearcut-3yr,regen	US-SP2	-82.245	29.765	4	0.52
Skukuza- Kruger National Park	ZA-Kru	31.497	-25.02	10	0.47



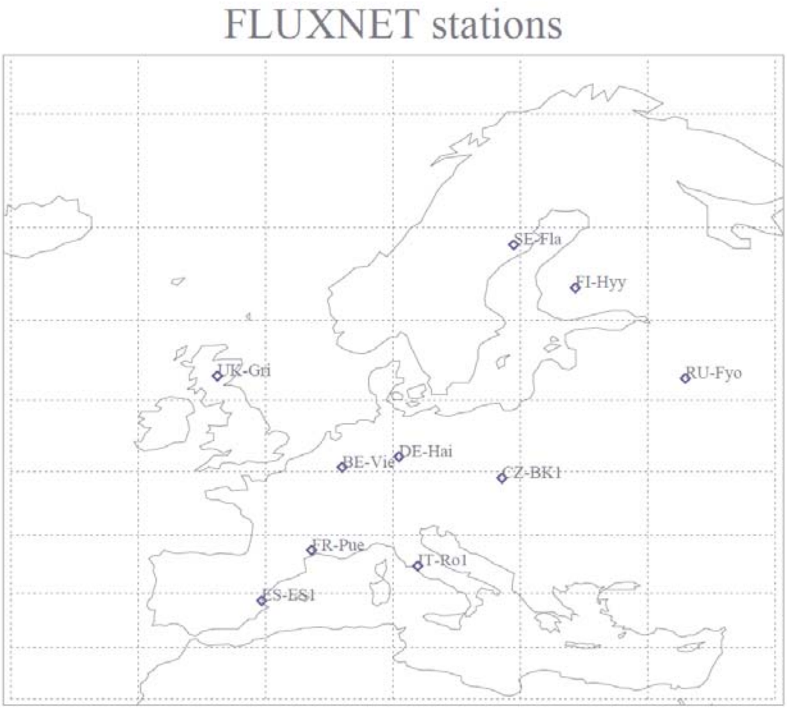


Figure A1: Locations of the selected 20 FLUXNET sites used for the comparison. The stations' IDs are shown. The station names together with the coordinates are described in the Table A1.

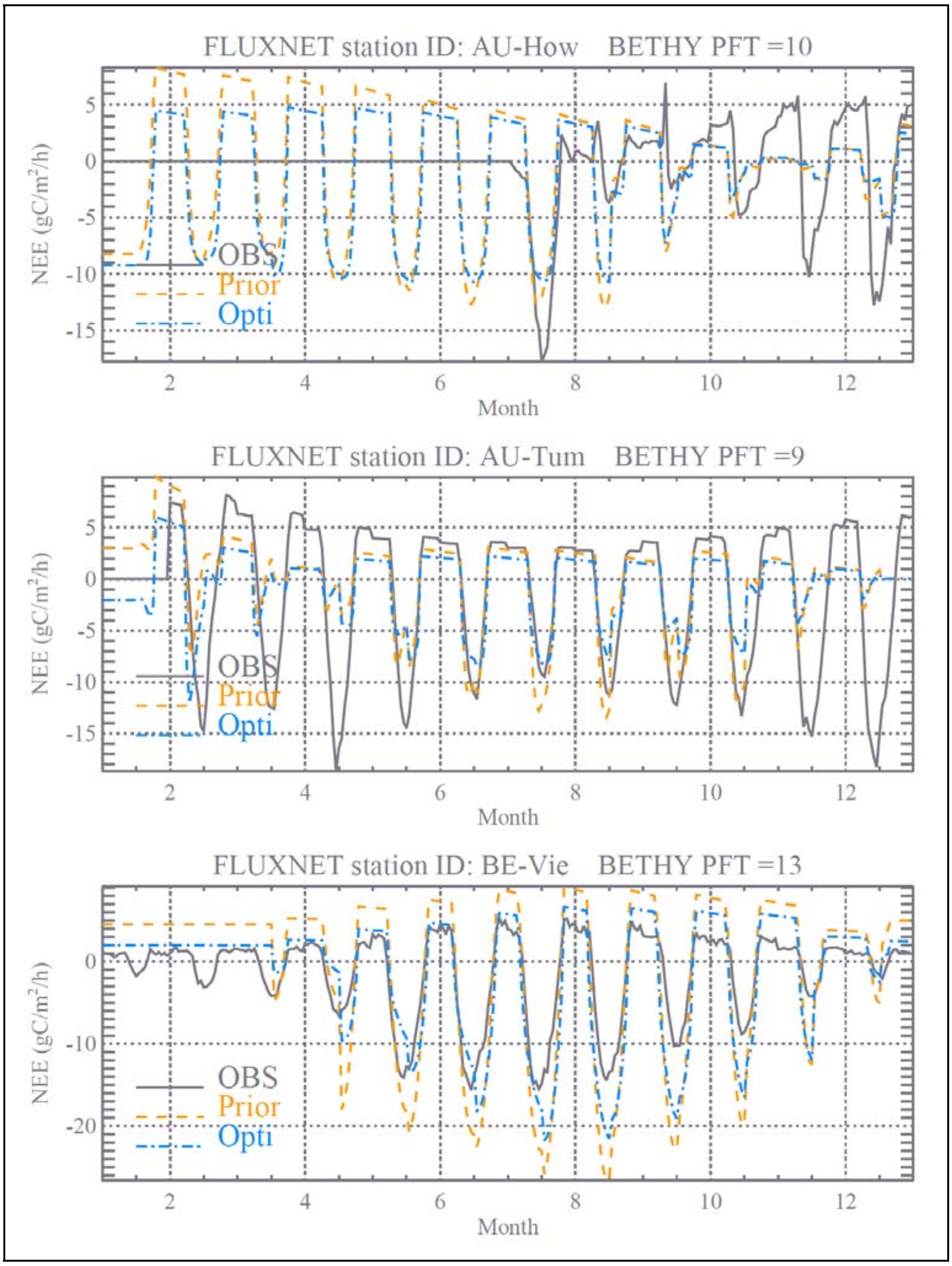


Figure A2: Mean diurnal variations of NEE at some selected FLUXNET sites. The observed NEE (black solid line), the BETHY simulations by using the prior values (orange dashed line) and optimized values (blue dashed dot line) obtained by using only observed CO_2 concentrations (Koffi et al., 2012) of the process parameters are shown. The FLUXNET station details (i.e., station name, ID, and location latitude and longitude) are described in the Table A1. The FLUXNET station ID and the PFT of BETHY that encompasses the FLUXNET site are given. The year 2001 is considered.

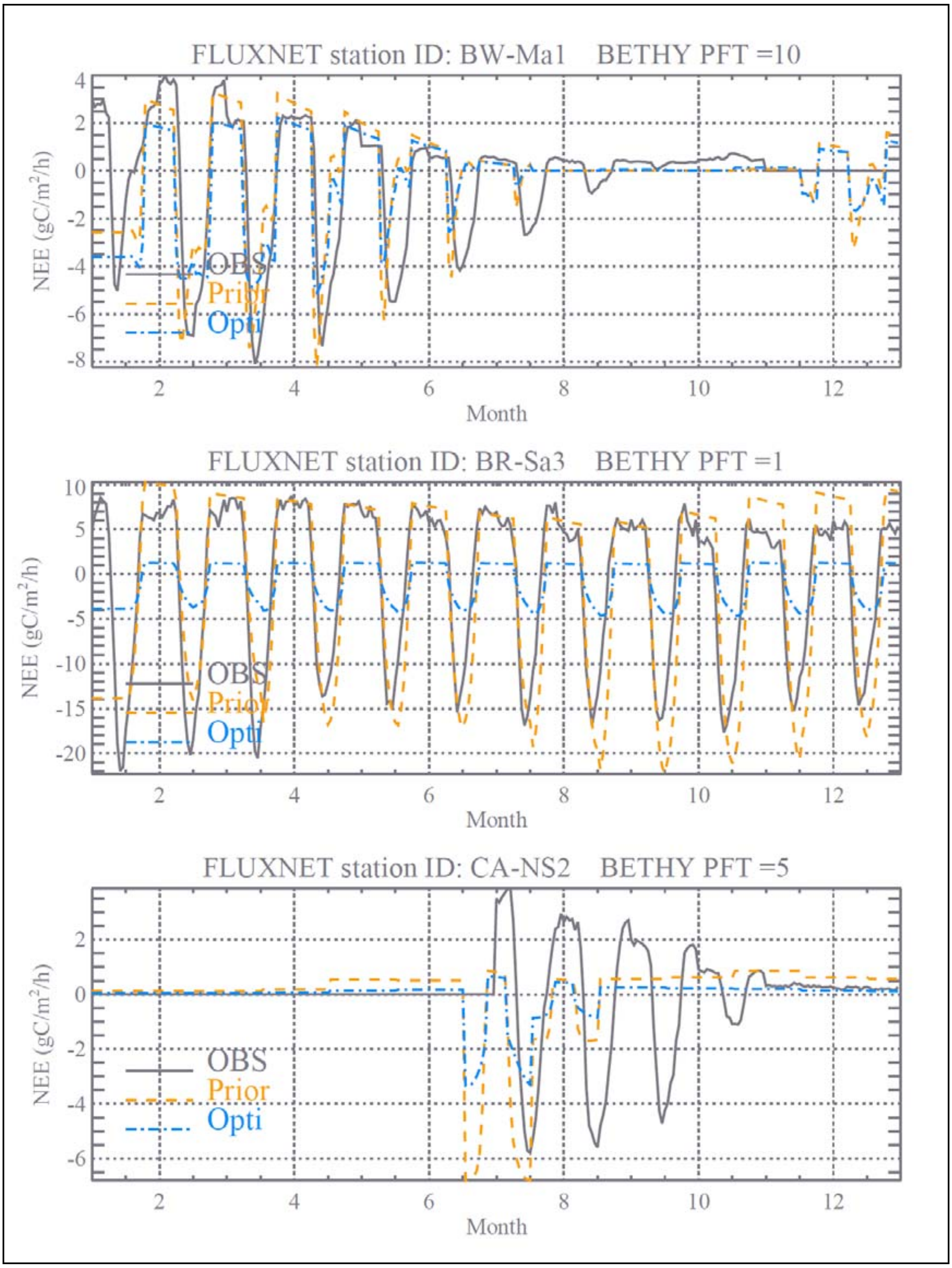


Figure A3: As Figure A2, but for other stations.

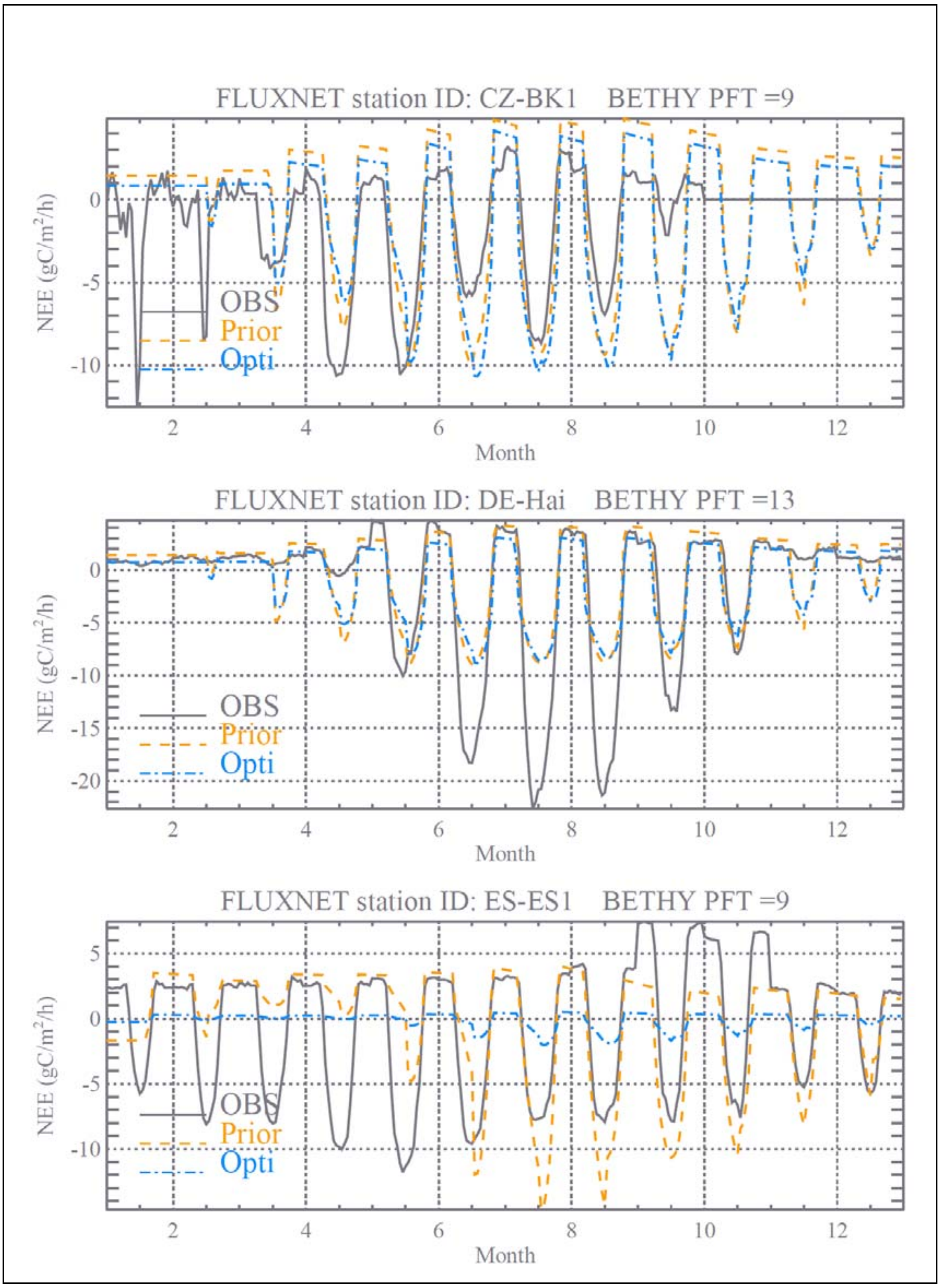


Figure A4: As Figure A2, but for other stations.

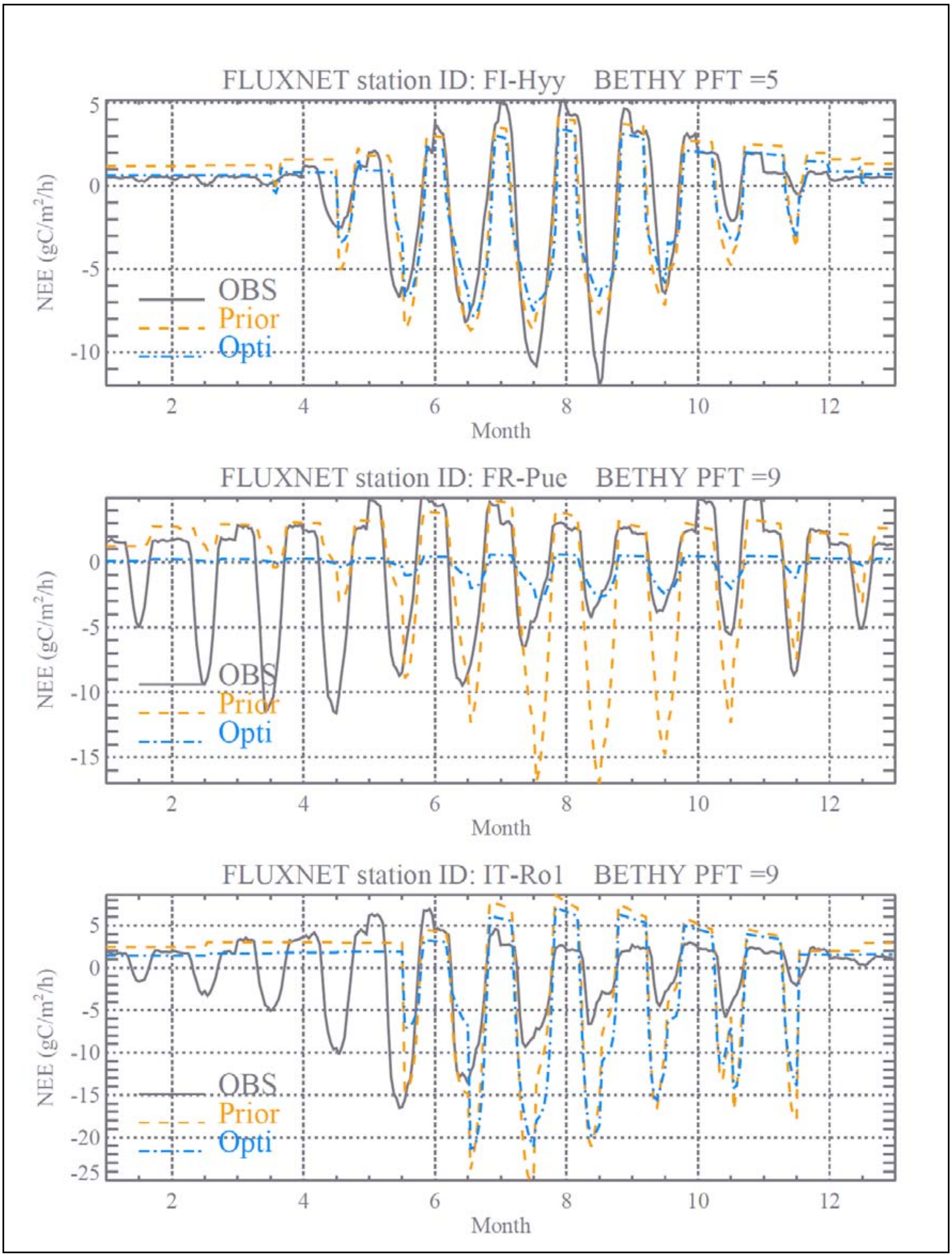


Figure A5: As Figure A2, but for other stations.

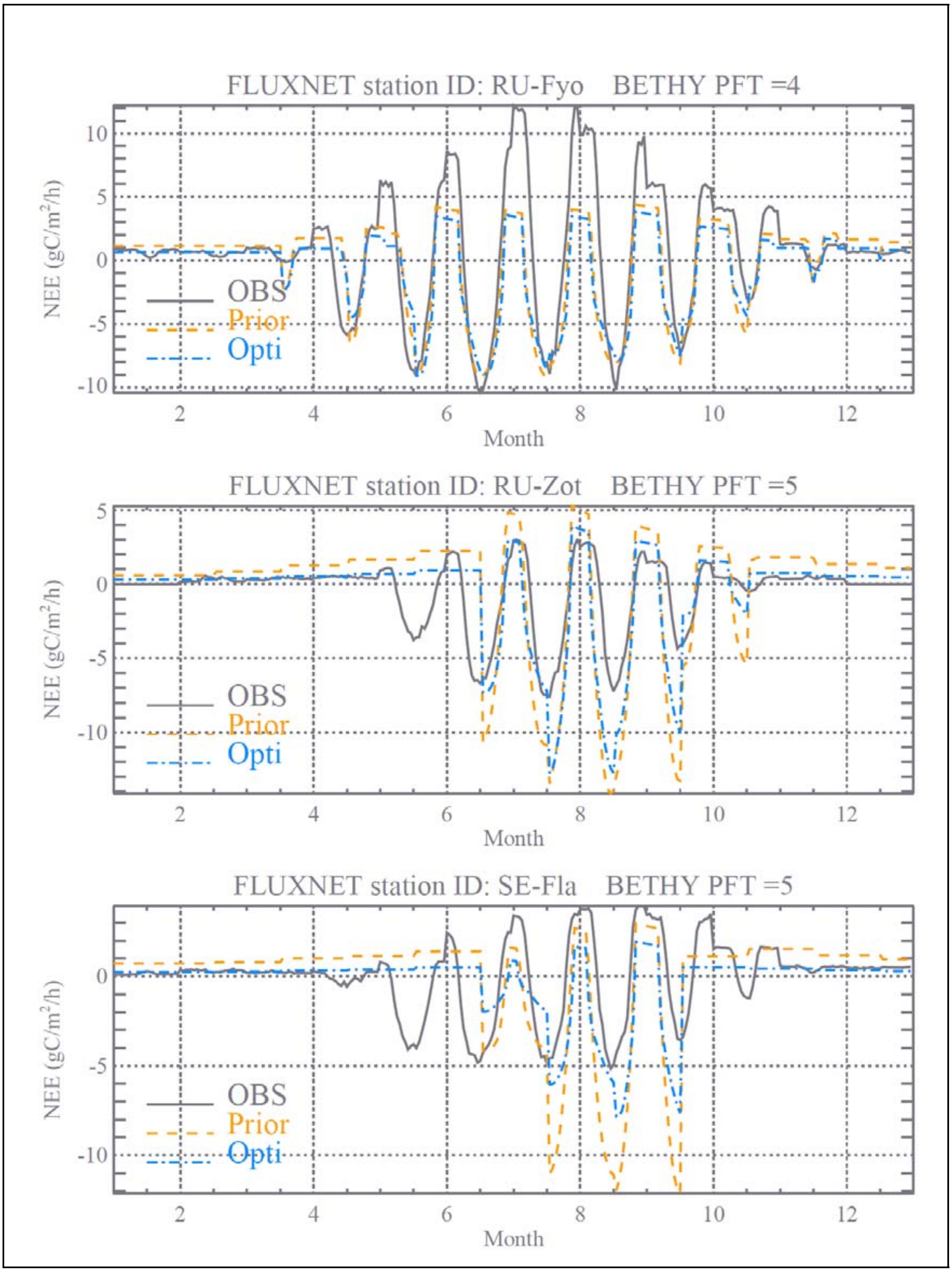


Figure A6: As Figure A2, but for other stations. Data for RU-Zot are for 2002.

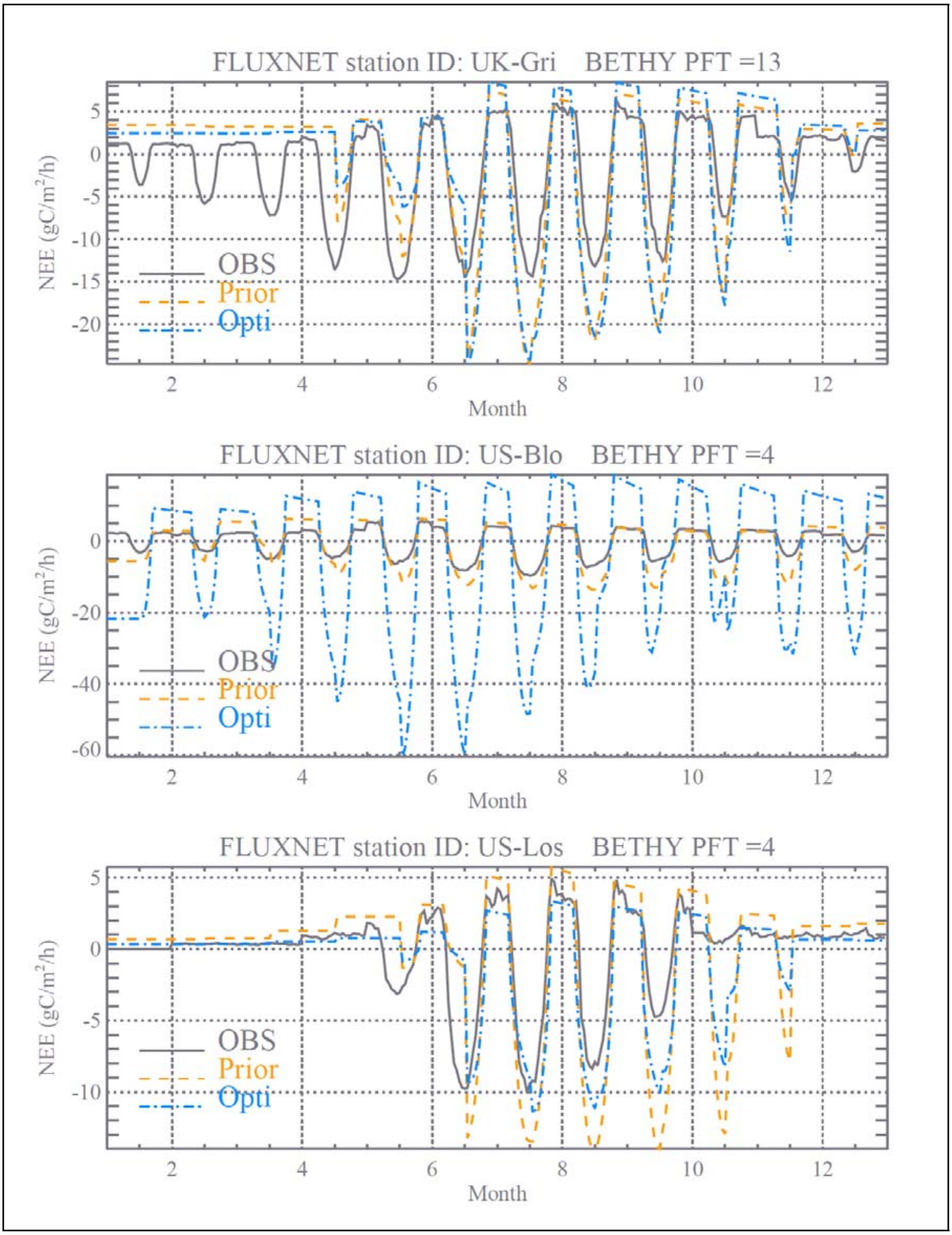


Figure A7: As Figure A2, but for other stations.

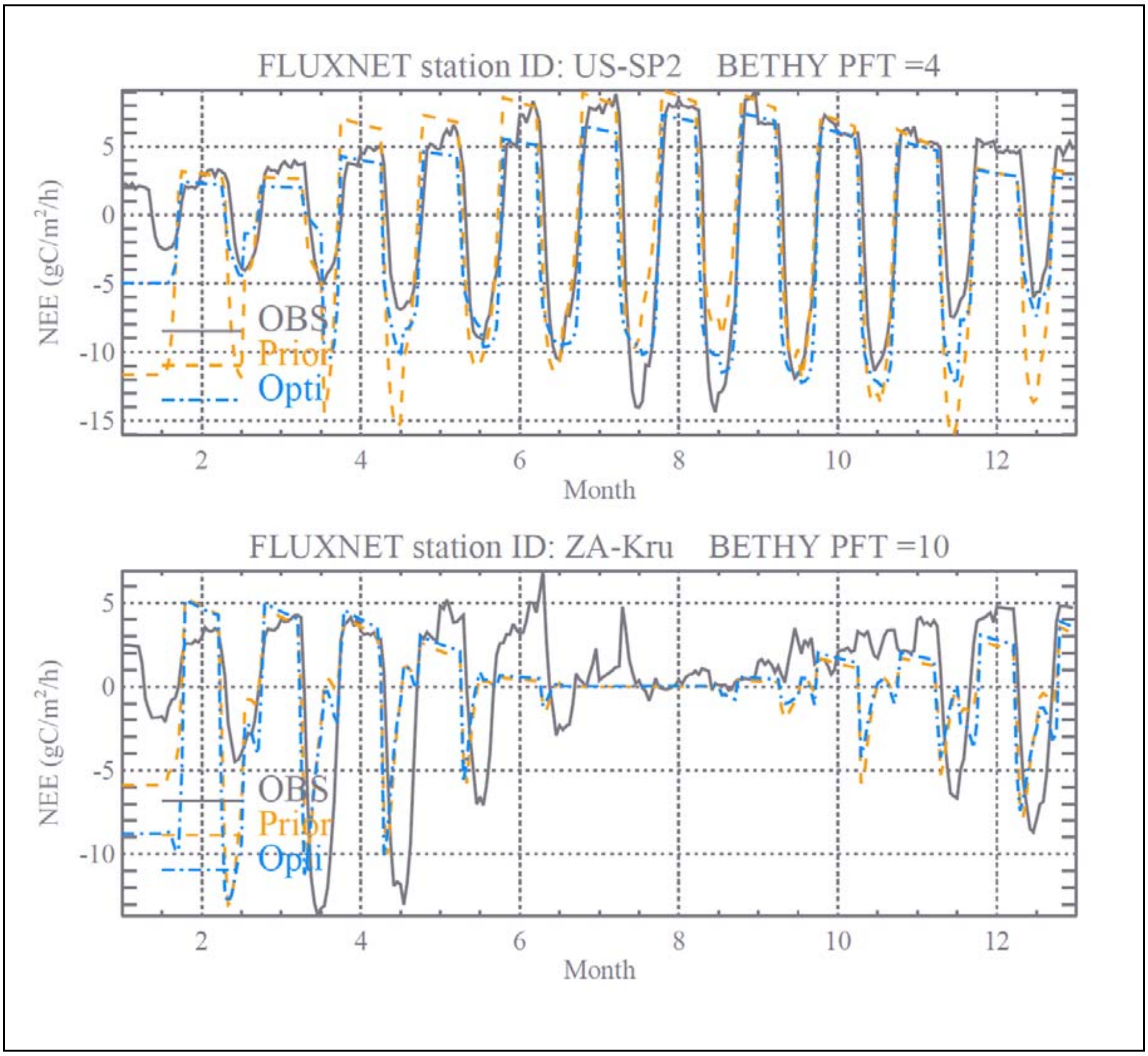


Figure A8: As Figure A2, but for other stations.

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