

**A Training Course on CO<sub>2</sub> Eddy Flux Data Analysis and Modeling**

# **Gap Filling & Flux Partitioning: Practice**

**Katherine Owen  
John Tenhunen  
Xiangming Xiao**

Institute of Geography and Natural Resources, Chinese Academy of Sciences,  
Beijing, China

Institute for the Study of Earth, Oceans and Space, University of New Hampshire, USA  
Department of Plant Ecology, University of Bayreuth, Germany

The Institute of Geography and Natural Resources, CAS,  
Beijing, China

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# Practice: Flux Partitioning & Gap Filling

**Many available methods. I will show:**

- Short term exponential flux partitioning
- Marginal distribution sampling gap filling

both from Reichstein et al. 2005, Global Change Biology

## **Outline**

1. Inputs: data preparation
2. Running the program and potential problems
3. Outputs and potential problems

## Practice: Flux Partitioning & Gap Filling

### Inputs: Data preparation

- Variable names in input file & program must be the same (no more than one column!) (Fc vs. NEE, Ta vs. Tair, Pa vs. Press)
- Latitude (& longitude) calculate sunrise & sunset
- Watch out for missing **half hours** of data!

Missing Variables? Some can be calculated

- VPD calculation 
$$VPD = \left(1 - \frac{rH}{100}\right) 0.6108 \cdot e^{\frac{17.27T_{air}}{T_{air} + 237.3}}$$
- PPFD calculation 
$$PPFD = 2.24R_g$$

GR2004.txt - Notepad

Day	Hour	qCNEE	NEE	qCLE	LE
--	--	--	umolm-2s-1	--	--
1	0.5	Z	-9999	Z	-9999
1	1	Z	-9999	Z	-9999
1	1.5	Z	-9999	Z	-9999
1	2	Z	-9999	Z	-9999
1	2.5	Z	-9999	Z	-9999
1	3	Z	-9999	Z	-9999
1	3.5	Z	-9999	Z	-9999
1	4	Z	-9999	Z	-9999
1	4.5	Z	-9999	Z	-9999
1	5	Z	-9999	Z	-9999
1	5.5	Z	-9999	Z	-9999
1	6	Z	-9999	Z	-9999
1	6.5	Z	-9999	Z	-9999
1	7	Z	-9999	Z	-9999
1	7.5	Z	-9999	Z	-9999
1	8	Z	-9999	Z	-9999
1	8.5	Z	-9999	Z	-9999
1	9	Z	-9999	Z	-9999
1	9.5	Z	-9999	Z	-9999
1	10	Z	-9999	Z	-9999
1	10.5	Z	-9999	Z	-9999
1	11	Z	-9999	Z	-9999
1	11.5	Z	-9999	Z	-9999
1	12	Z	-9999	Z	-9999
1	12.5	Z	-9999	Z	-9999
1	13	Z	-9999	Z	-9999
1	13.5	Z	-9999	Z	-9999

# INPUT FILE SET-UP

- Column delimitation (tab space , ;)
  - Any order of columns is OK
  - 1st row = variable name
  - 2nd row = unit (if no unit --)
- Can set up in excel and save as .txt
- Date & time 324 24.0 or 20/05/1996 24:00 - others possible, but change program
- End of day 01/05 0:00 or 30/04 24:00
- Missing values -9999
- Be consistent (same number of rows)
- No letters except in rows 1 & 2

CEIP\_EC\_L2\_Flx\_FRHes\_1996\_v01.txt - Notepad

Day;Month;Year;Hour;Minute;CO2;ZL;FC;H;LE;ust
--;--;--;--;--;umolmol-1;--;umolm-2s-1;wm-2;wm
19/05/1996,24:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,00:30,-9999,-9999,-9999,-9999,-9999
20/05/1996,01:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,01:30,-9999,-9999,-9999,-9999,-9999
20/05/1996,02:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,02:30,-9999,-9999,-9999,-9999,-9999
20/05/1996,03:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,03:30,-9999,-9999,-9999,-9999,-9999
20/05/1996,04:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,04:30,-9999,-9999,-9999,-9999,-9999
20/05/1996,05:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,05:30,-9999,-9999,-9999,-9999,-9999
20/05/1996,06:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,06:30,-9999,-9999,-9999,-9999,-9999
20/05/1996,07:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,07:30,-9999,-9999,-9999,-9999,-9999
20/05/1996,08:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,08:30,-9999,-9999,-9999,-9999,-9999
20/05/1996,09:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,09:30,-9999,-9999,-9999,-9999,-9999
20/05/1996,10:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,10:30,-9999,-9999,-9999,-9999,-9999
20/05/1996,11:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,11:30,-9999,-9999,-9999,-9999,-9999
20/05/1996,12:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,12:30,-9999,-9999,-9999,-9999,-9999
20/05/1996,13:00,-9999,-9999,-9999,-9999,-9999
20/05/1996,13:30,-9999,-9999,-9999,-9999,-9999

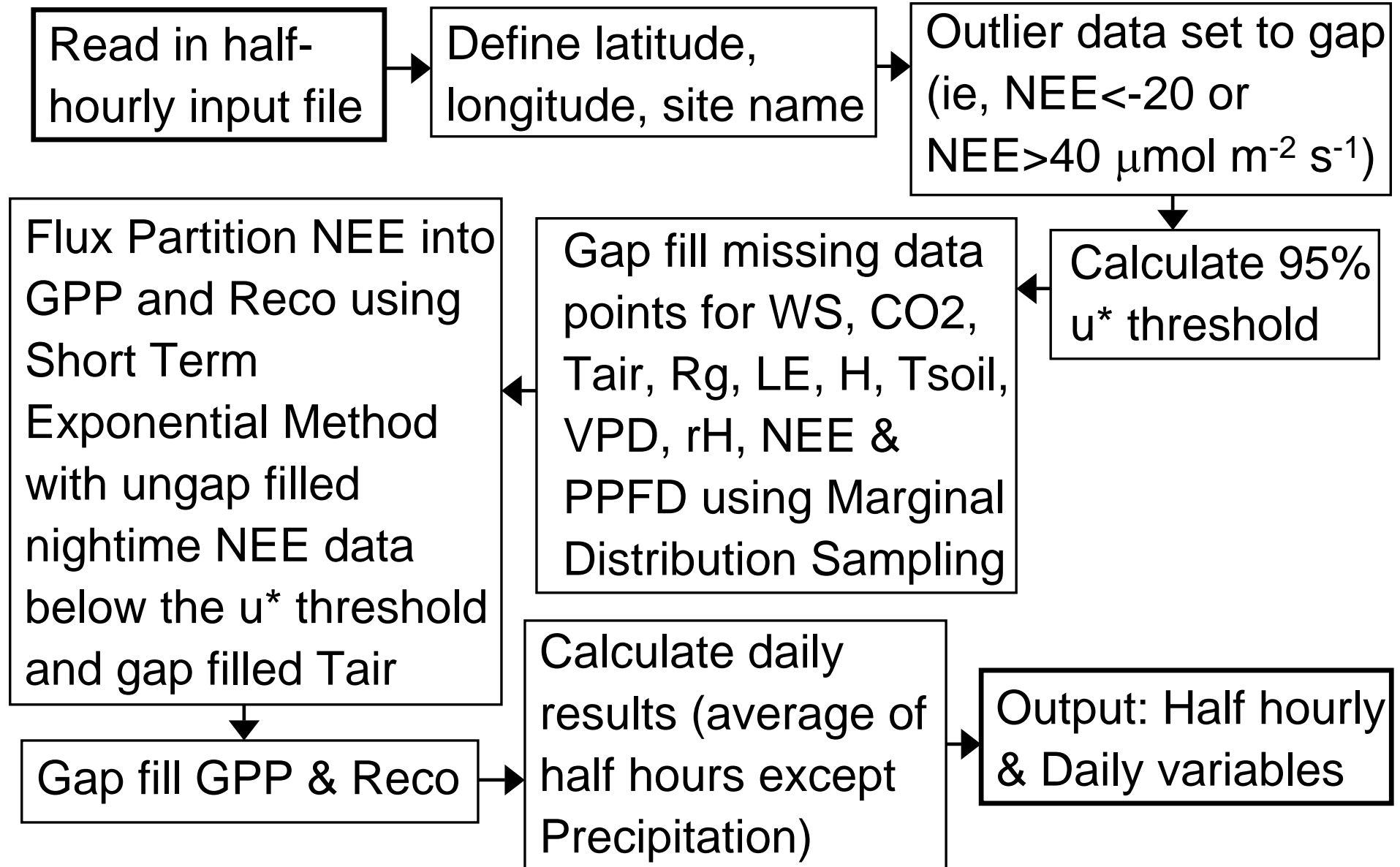
## Practice: Flux Partitioning & Gap Filling

### Potential problems in running the program

- No or too few measurements of:  $u^*$ ,  $Q_c U^*$ , NEE,  $Q_c NEE$ ,  $T_{air}$
- $Q_c NEE$  is 1 or 2 - all data is “poor quality”
- Missing half hours of data (including at end of year)
- Letters instead of numbers in input file (except headings & units)
- Many low  $u^*$  values ( $< 0.1$  m/s)

# Practice: Flux Partitioning & Gap Filling

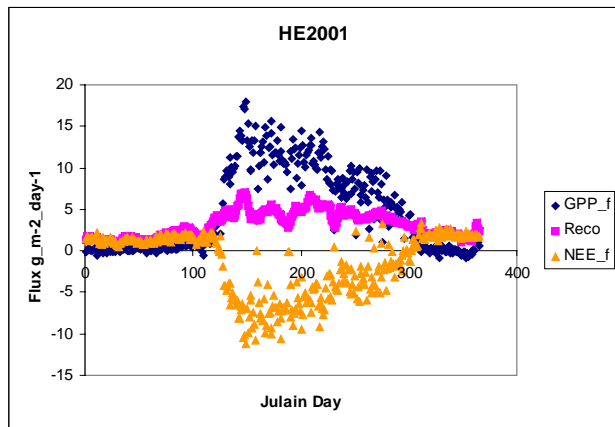
## How the program works



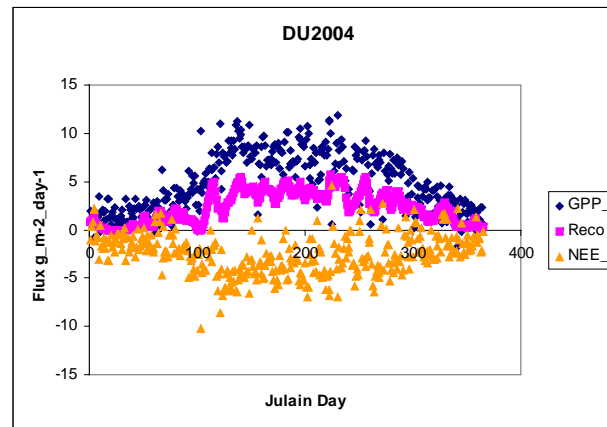
# Practice: Flux Partitioning & Gap Filling

## Outputs

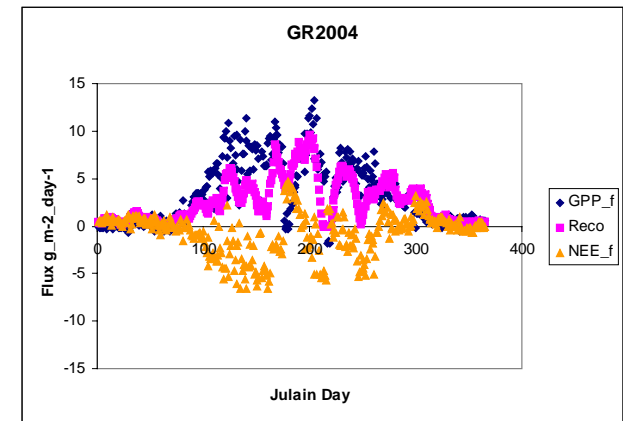
Daily & half hourly files with original, gap filled & flux partitioned data



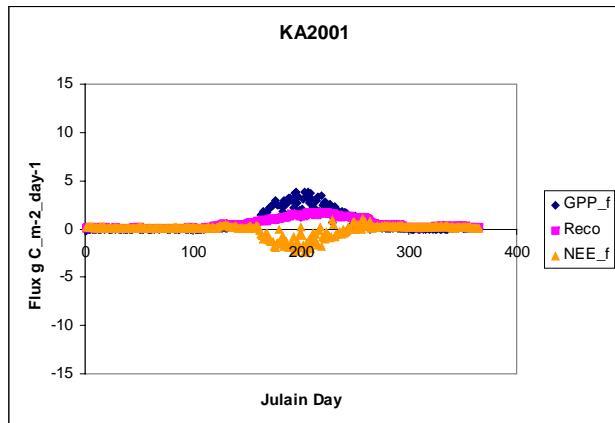
Hesse, France  
Deciduous Beech Forest



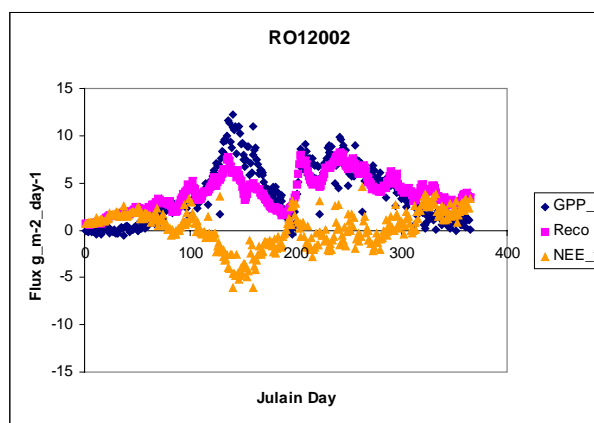
Duke Forest, NC, USA  
Evergreen Pine Forest



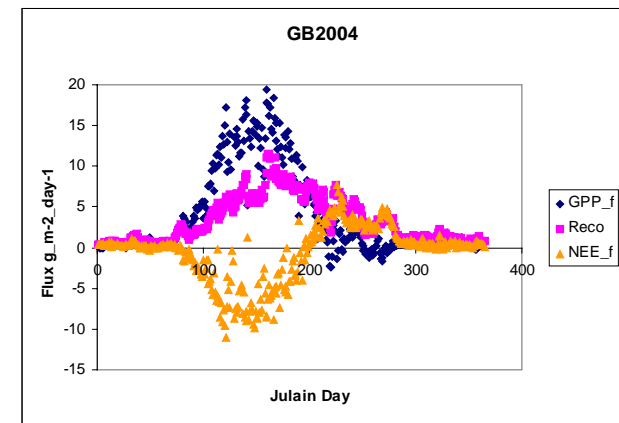
Grillenburg, Germany  
Grassland (3x cut)



Kaamanen, Finland  
Wetland



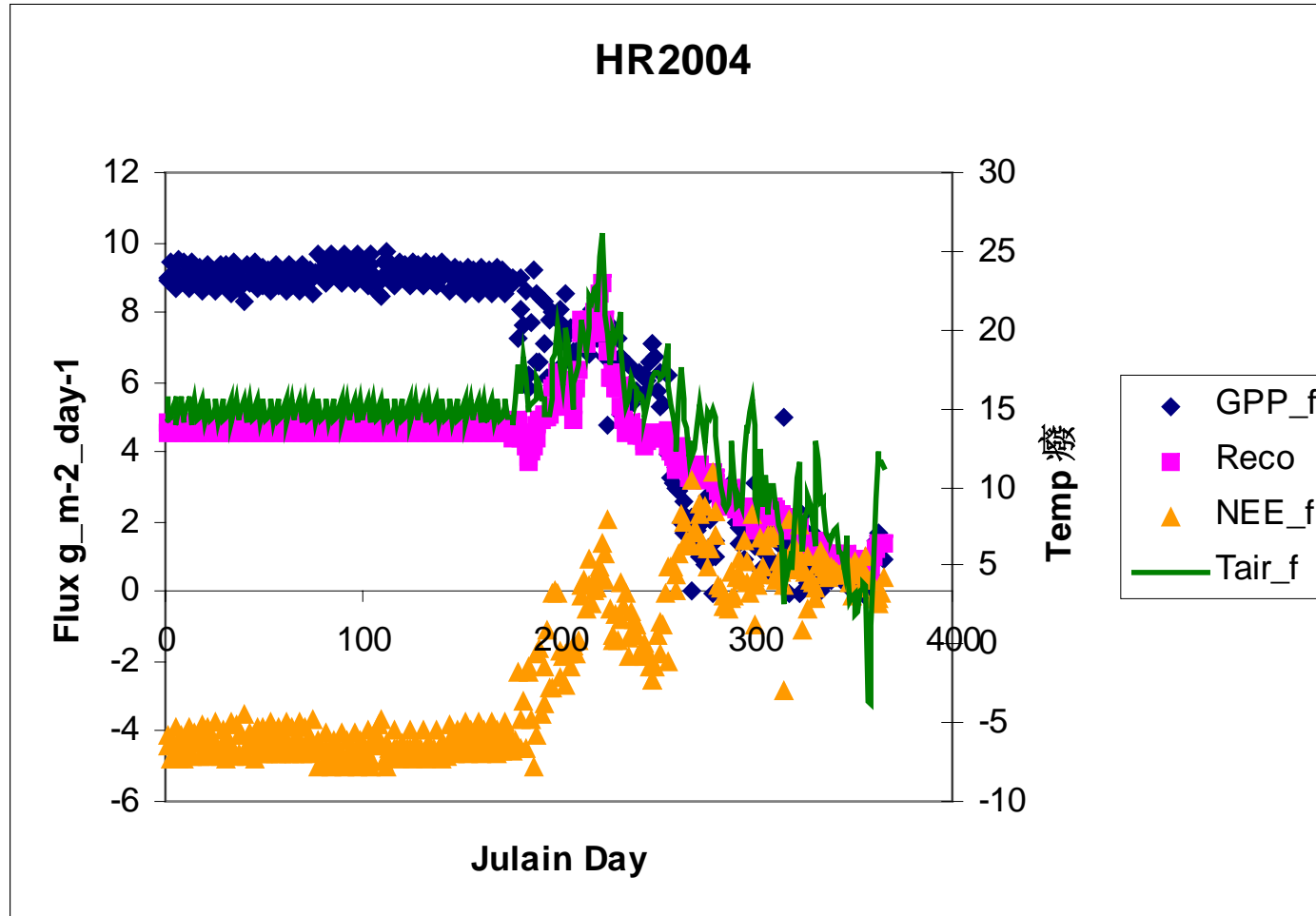
Roccorespampani, Italy  
Deciduous Oak Forest



Gebesee, Germany  
Cropland - Rapeseed

# Practice: Flux Partitioning & Gap Filling

## Outputs & Potential Problems

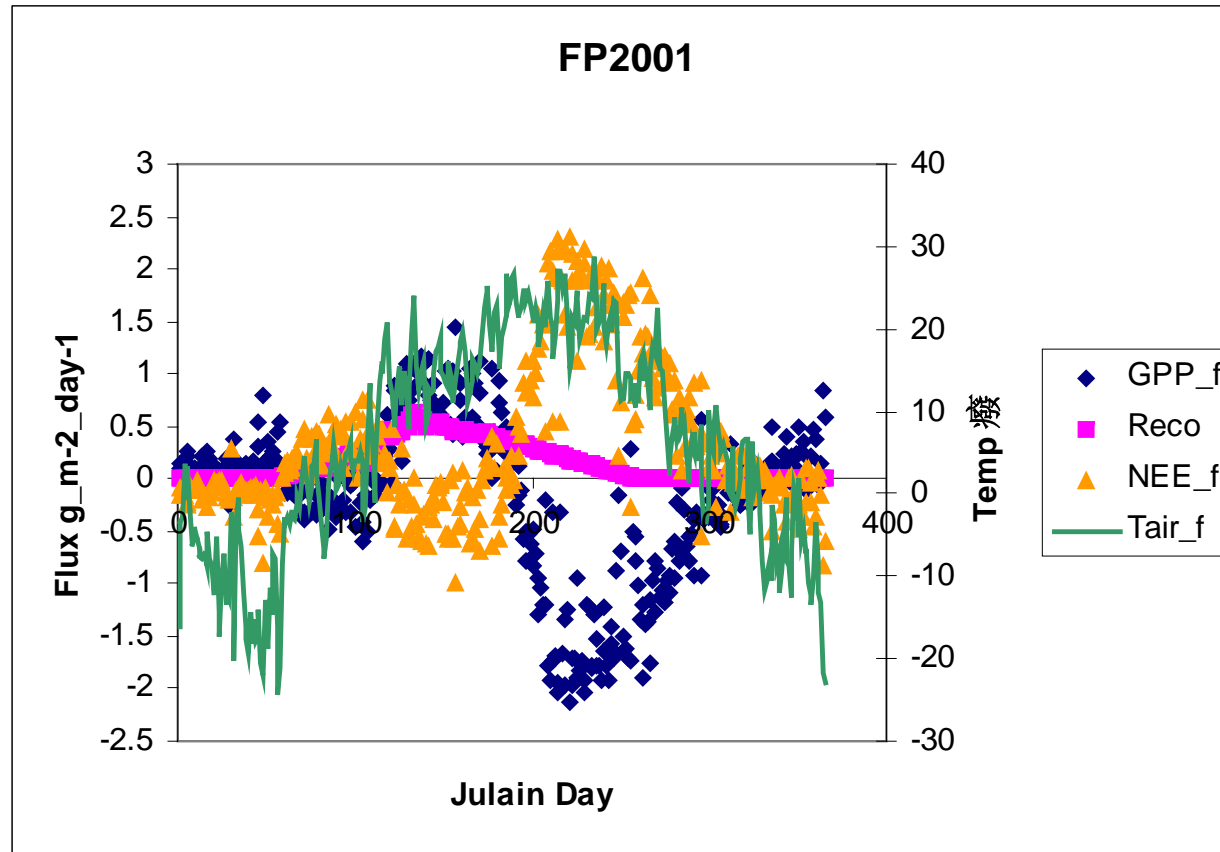


Missing Tair values for 1st half of year. Tair gap filled with summer values --- then affects gap filled NEE.



# Practice: Flux Partitioning & Gap Filling

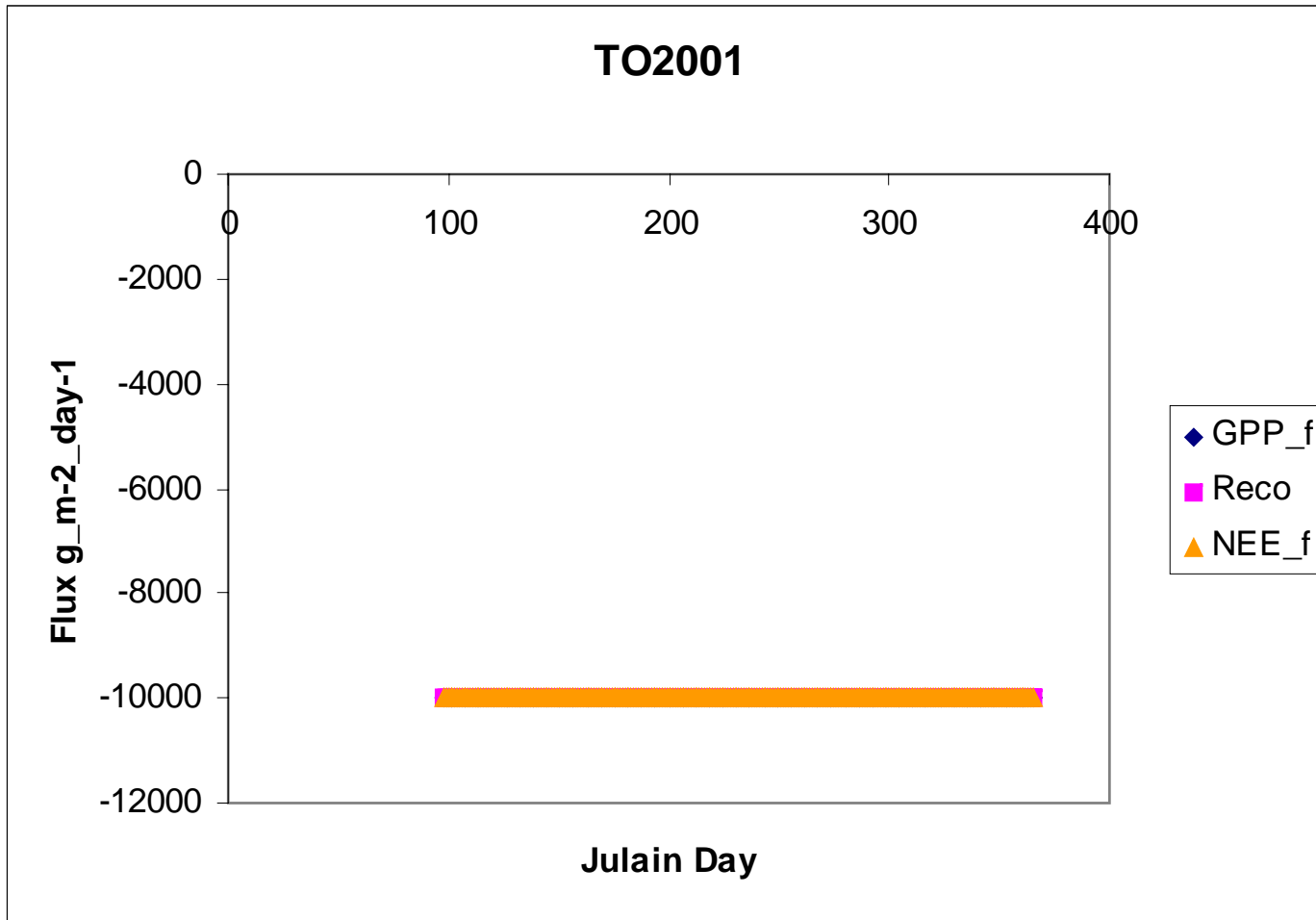
## Outputs & Potential Problems



Too many gaps in NEE measurements (gaps during Julian days 0-39, 51-95, 133-265)

$u^*$  too low at end of year  $\rightarrow$  Reco=0  $\rightarrow$  negative GPP

# Practice: Flux Partitioning & Gap Filling Outputs & Potential Problems



Too many values of QcNEE of 1 or 2 → Too many values of NEE set as gaps → Not enough data to gap fill

# Practice: Flux Partitioning & Gap Filling

## Examples: Hesse, France

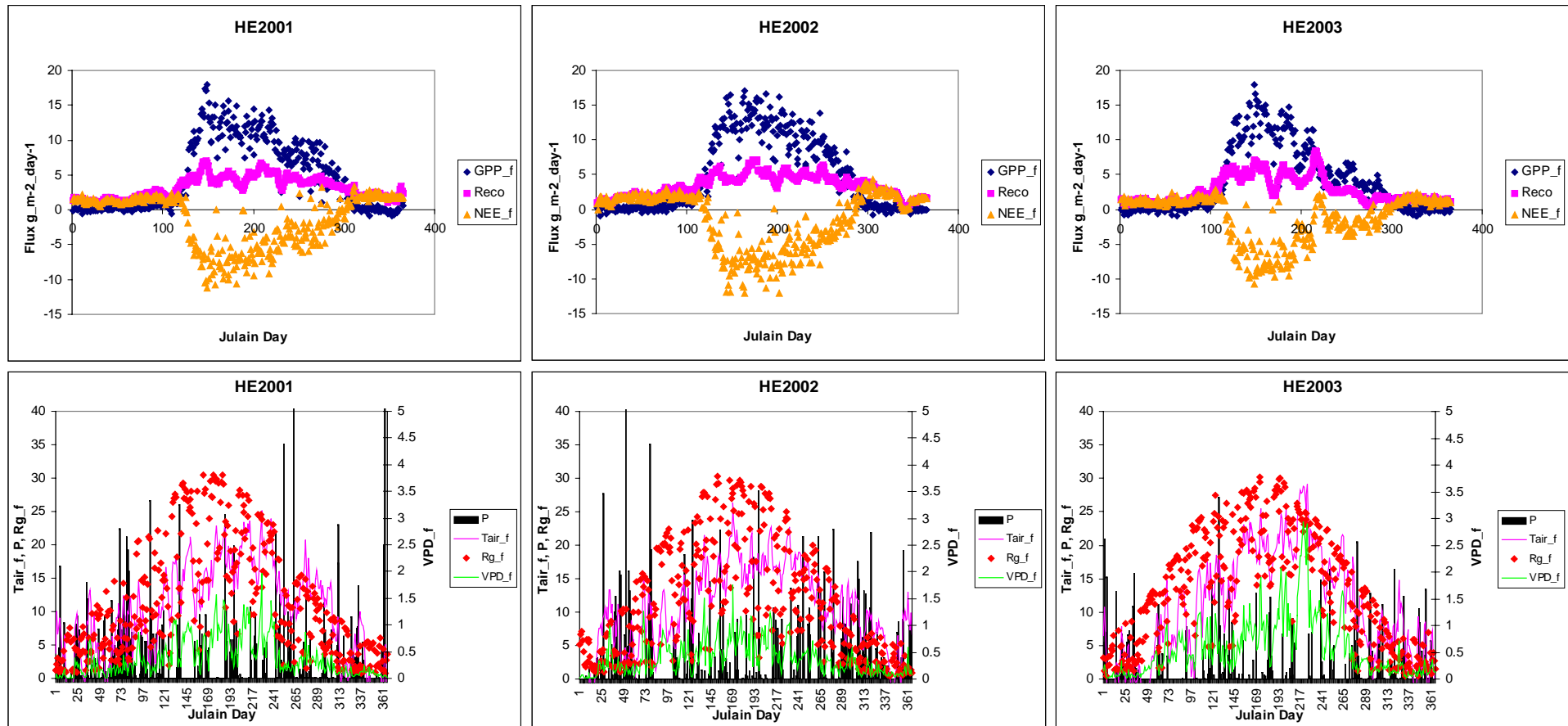


Hesse, France

- Deciduous Beech Forest
- *Fagus sylvatica*
- experienced drought in 2003

# Practice: Flux Partitioning & Gap Filling

## Examples: Hesse, France



Hesse, France  
Deciduous Beech Forest

# Practice: Flux Partitioning & Gap Filling

## Examples: Takayama, Japan



July 1994



November 1994



Takayama, Japan

- Mountain Deciduous Forest

- *Quercus crispula*

Blume, *Betula ermanii*

Cham., *Betula*

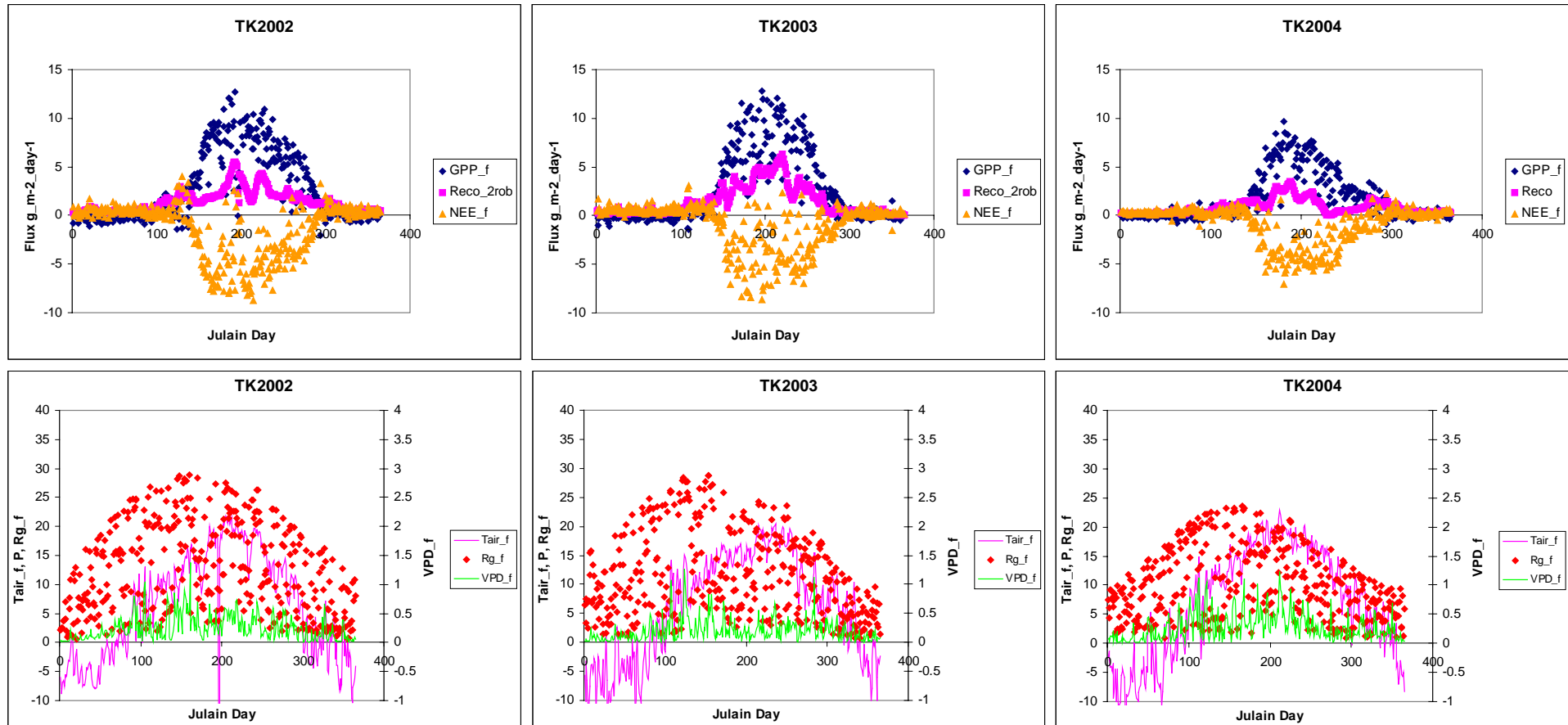
*platyphylla* Sukatchev

var. *japonica* Hara

- Storm damage in 2004

# Practice: Flux Partitioning & Gap Filling

## Examples: Takayama, Japan

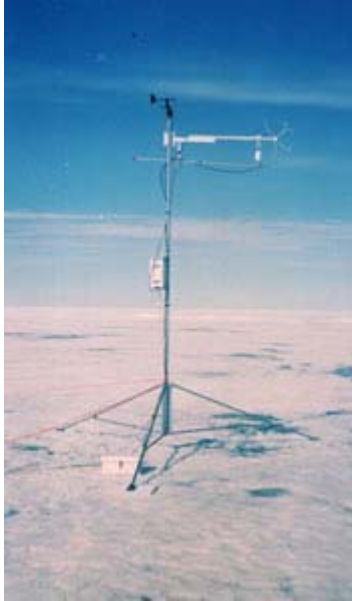


Takayama, Japan

Mountain Deciduous Forest

## Practice: Flux Partitioning & Gap Filling

### Examples: Barrow, Alaska, USA



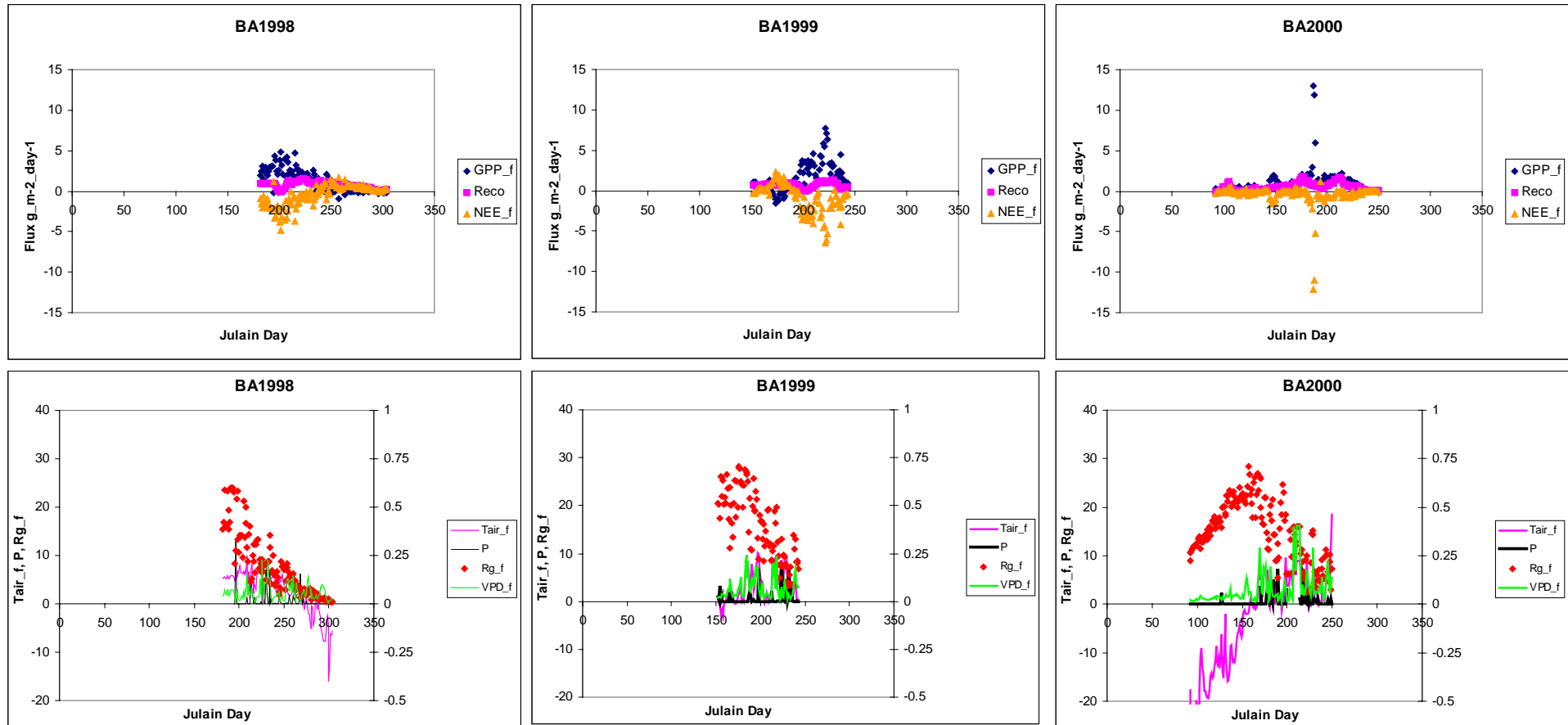
Barrow, Alaska, USA

- Tundra

- Carex aquatilis* spp.  
*Stans*, *Eriophorum*  
*angustifolium*, *Dupontia*  
*fisheri*, *Poa artica*

# Practice: Flux Partitioning & Gap Filling

## Examples: Barrow, Alaska, USA



Barrow, Alaska, USA  
Tundra



## Practice: Flux Partitioning & Gap Filling

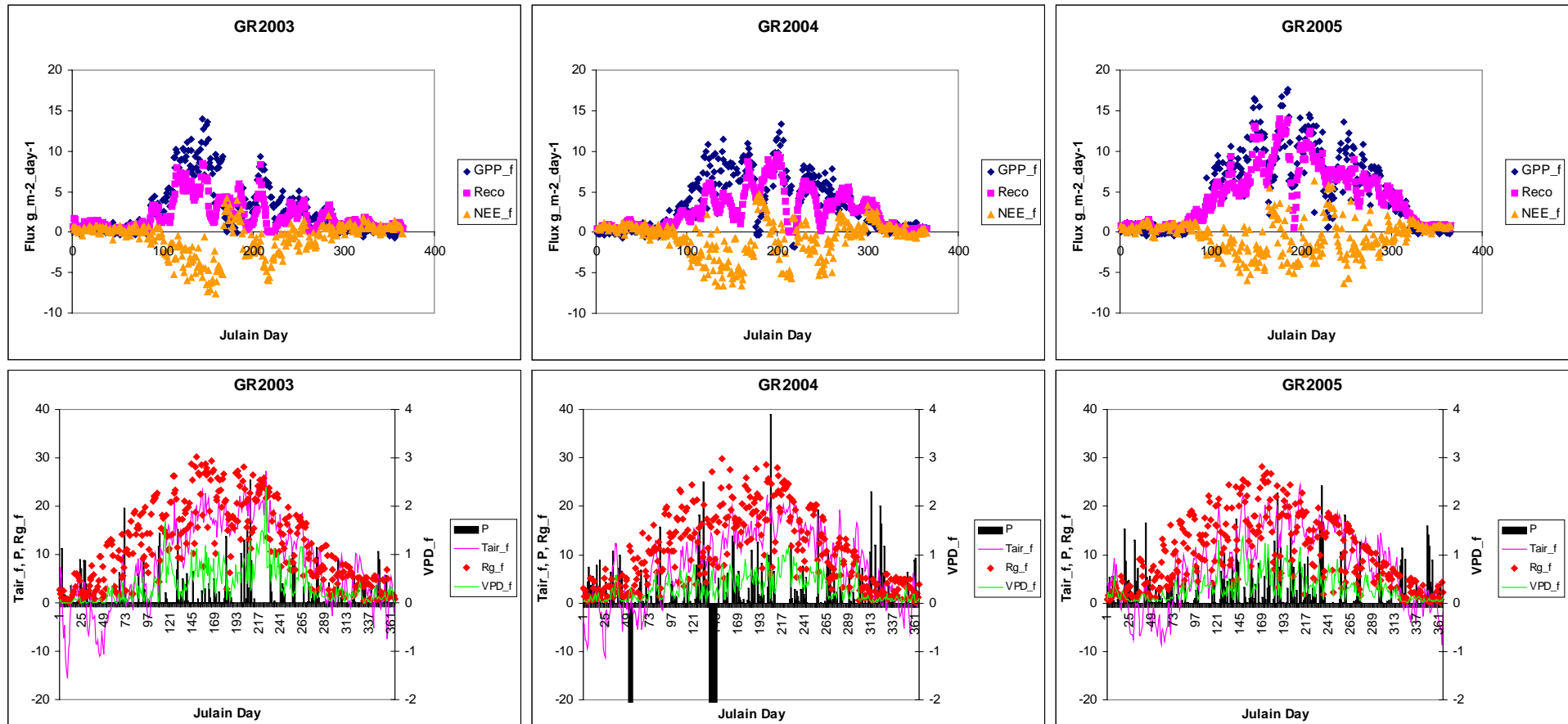
### Examples: Grillenburg, Germany

Grillenburg,  
Germany

- Grassland
- *Festuca pratensis*,  
*Alopecurus  
pratensis*, *Phleum  
pratensis*
- Cut 2 or 3 times  
per year
- No grazing
- experienced  
drought in 2003

# Practice: Flux Partitioning & Gap Filling

## Examples: Grillenburg, Germany



Grillenburg, Germany  
Grassland