



Terrestrial Ecosystem Demo Project of GTOS/FAO

Report on

Evaluation of Remote Sensing and In-situ Datasets for Carbon Accounting for the Ecosystem Productivity Project of GTOS

(Markus Reichstein)

(PSA contract from 27-12-2002)

Attached to this report: Data-CD with programs,
ancillary information and data base of currently registered sites.

Dr Markus Reichstein
Guest Scientist
Potsdam Institute for Climate Impact Research
Telegrafenberg C4
D-14412 Potsdam
+49 331 2882550

Home:
Schlüterstraße 3
D-14558 Bergholz-Rehbrücke

1. Development of methodology for extracting MODIS time series at arbitrary sites

The extraction of MODIS time-series involves the steps depicted in Figure 1. There, the steps within the blue box are automated through a sequence of procedures implemented in the Interactive Data Language (IDL), subsequently called 'cutoutsystem'. The process can be started from the command line, e.g. if the site X with the geographical coordinates 39.566667 N, 2.9 E should be cutout with 101x101 pixels around the center, for the year 2003 and the MODIS FPAR/LAI product the following command has to be entered:

```
cutFromGeo, sitename='X', lat=39.566667D, lon=2.900000D,  
extent=101., product='MOD15A2', year=2003, ver='004'
```

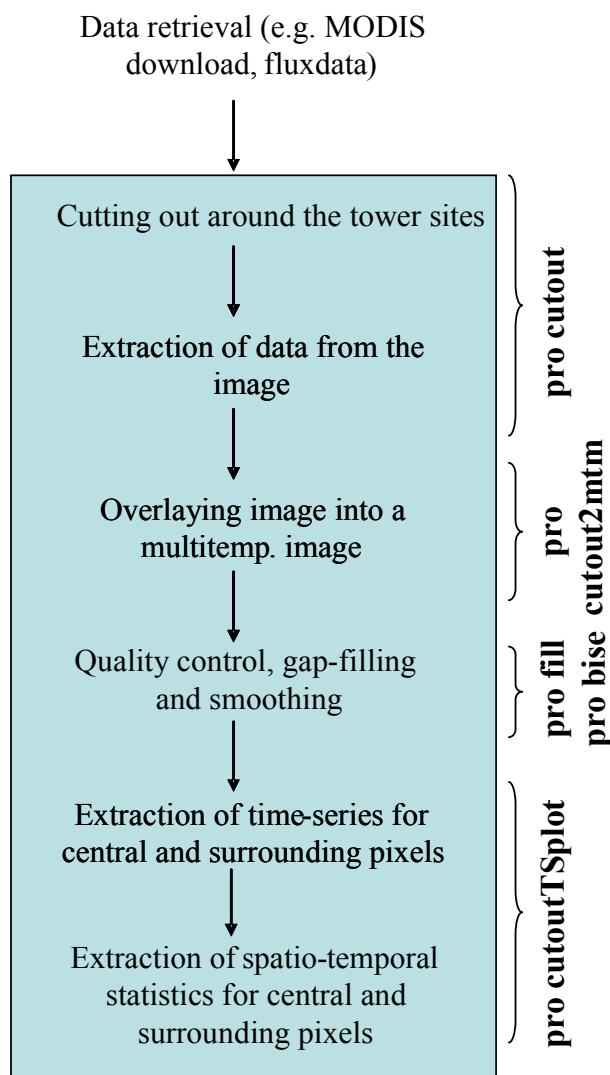


Figure 1: Flow chart for the extraction of spatio-temporal subsets from the MODIS data stream for comparison with flux time series from ground observation. On the right hand side the IDL procedures that perform the respective tasks are indicated. The IDL programs are found in the file cutoutsystem.zip on the accompanying CD.

The code and ancillary descriptions can be found on the accompanying CD within the file cutoutsystem.zip. The cutoutsystem produces as output multitemporal images in IDL format and as binary files, as well as ASCII files with time series of the central, and 5x5 surrounding pixels and summary time series about the whole cutout. The information is summarized graphically as a figure (cf. Figure 2).

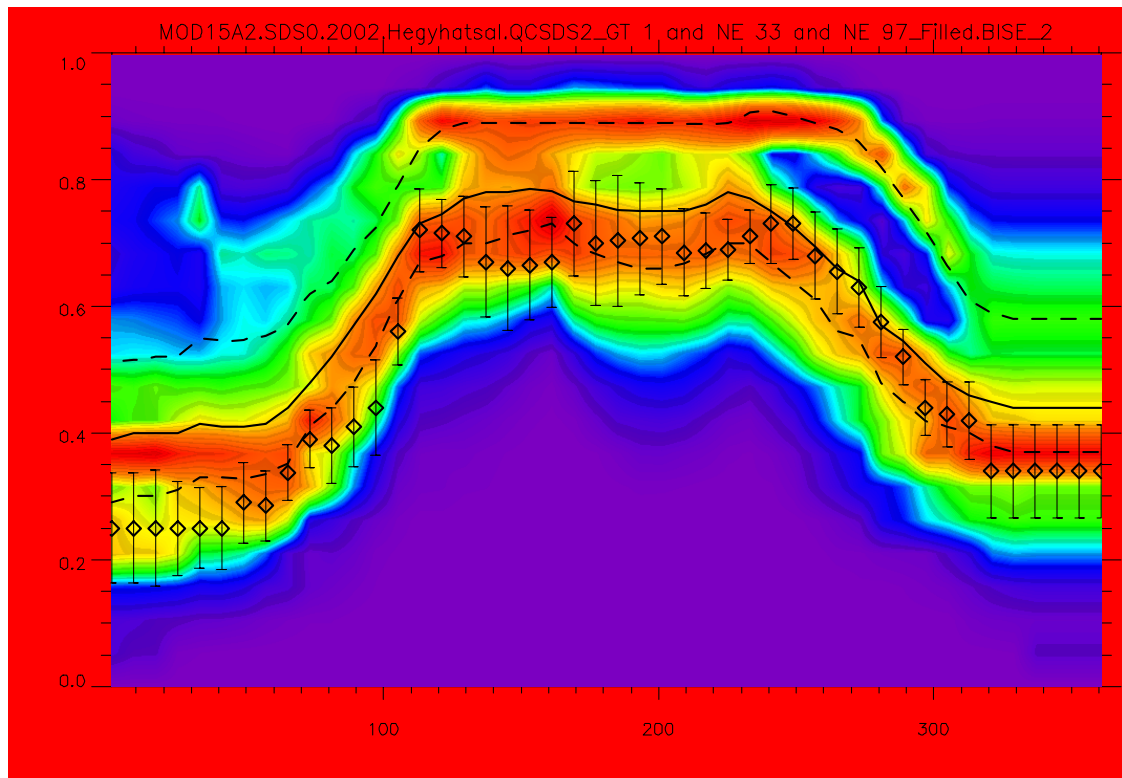


Figure 2: Graphical summary of the processed cutout of the CEE site Hegyhatsal 2002. x-axis: julian day; y-axis: fPAR. Dots: fPAR at central pixel; error bars: standard deviation of 3x3 pixels around central pixel; solid line: median fPAR for total cutout region; dashed lines: lower/upper quartile; colors: code density of fPAR (i.e. two dimensional histogram).

2. Application to CEE and Asian site data

The methodology for comparison of remote sensing and in-situ data of ecosystem productivity is currently being applied to available Central-Eastern European and Asian flux sites. This activity has been commenced by Steffen Gruenler (University of Jena) within a volunteer-ship at FAO during 2003 and is now being continued as Diploma-thesis under supervision of Prof. Christiane Schmullius and Dr. Markus Reichstein. The sites that have provided data for this activity are indicated in Figure 3. The MODIS data retrieval and the extraction of the MODIS time series at the sites has been finished, while the eddy covariance data is currently being processed to allow the comparison. A first comparison is shown for the Cherskii site.

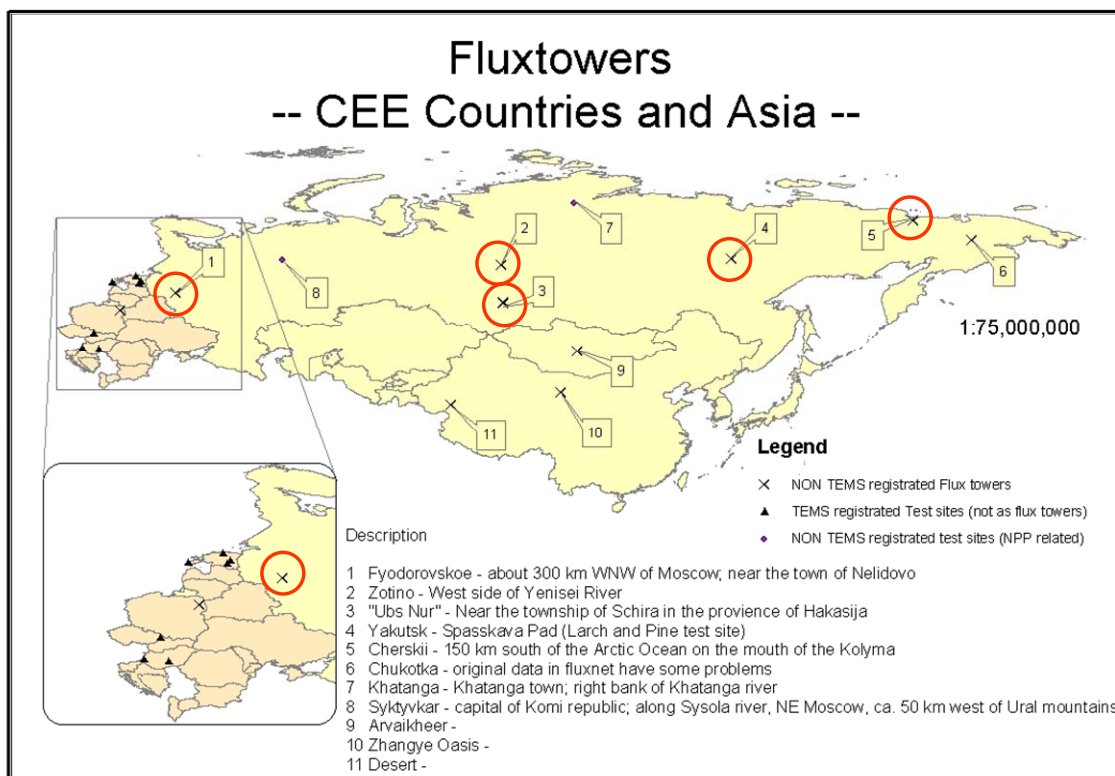


Figure 3: Central-Eastern European and Asian sites where a comparison of MODIS GPP estimates with ground-based flux estimates is currently performed. The sites with a red circle provide data within 2001-2003.

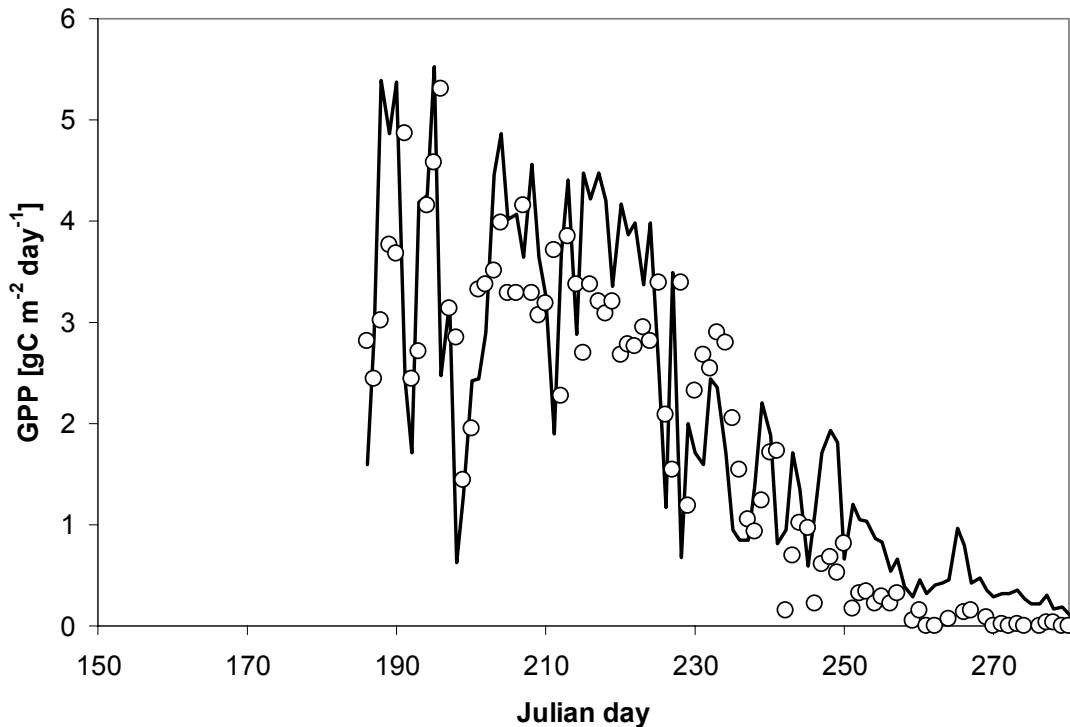


Figure 4: First estimates of modelled (line) and observed (circles) GPP for the Cherskii site 2002.

3. Extension of GTOS NPP/TEMS site data base

3.1. Questionnaire

To allow for a standardized registration of new sites to the GTOS NPP demo projects an online registration interface organized as a questionnaire was developed in consultation with representatives from FLUXNET, the MODLAND team and the BigFoot project. The questionnaire consists of three parts: 1) basic information about the site and the contact person is collected, 2) information on which parts of the MODIS data stream are of interest for the research currently carried out at the site, 3) information about the ground observations executed at the site (cf. Figure 5). Technically, after submission the content of the form is processed with a perl script and sent via e-mail to markus.reichstein@web.de for further processing and analysis (see below). After registration a confirmation is sent to the browser from which the registration was submitted (Figure 6). The form and the programs for processing the form submissions are found on the accompanying CD.

The form has been distributed via the contact points of the NPP Demo Project initiative, the ILTER mailing list, FLUXNET, regional flux networks and personal contacts.

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http://btb4x3.bio.uni-bayreuth.de/~markusr/GTOS/NPPdemo_quest.html

GTOS NPP Demonstration project

Questionnaire to site PIs / site managers

1. Basic information:

Site name:

Contact person's name:

Contact person's e-mail:

We are interested in (further) participation in the GTOS NPP Demonstration project: yes, no

Site is already registered in TEMS data base: yes, no, unknown

Site already participates in the following networks:

Site location (central point):

Latitude:* ° ' " N Source of information:

Longitude:* ° ' " E State of information:

Major vegetation type(s): (view [Definitions](#))

----- Please select (IGBP type) -----

- Evergreen needle leaf forest
- Evergreen broadleaf forest
- Deciduous needle leaf forest
- Deciduous broadleaf forest
- Mixed forest
- Closed shrublands

(multiple selections allowed, e.g., if vegetation mosaic. Press CTRL+click for multiple selections)

* you can enter either nautical (deg, min, sec) or decimal coordinates. For decimal coordinates just fill in the °-field with a decimal number and leave others empty. Use - (minus) to enter western or southern coordinates. If geo-location accuracy is less than 10 seconds, please enter 'preliminary' in the 'State-of-information-field' on the right.

Figure 5: Questionnaire for registration of new sites to the NPP Demonstration project. The questionnaire is currently installed at http://btb4x3.bio.uni-bayreuth.de/~markusr/GTOS/NPPdemo_quest.html

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http://btb4x3.bio.uni-bayreuth.de/~markusr/GTOS/NPPdemo_quest.html

2. Your interest in products from the MODIS data stream for your site:

We are interested in receiving cutouts from the MODIS data stream of the following products:

Spectral reflectances (MOD09): yes, no

Landcover classification (MOD12): yes, no

Vegetation indices (MOD13): yes, no

LAI and fAPAR estimates (MOD15): yes, no

Gross and net primary productivity estimates (MOD17): yes, no

The spatial extent of the spatial subset around the central location should be at the order of

Spatial subsets with the following spatial resolution (pixel size) will be useful for us:

larger than 1 km yes, no

1km yes, no

500 m yes, no

250 m (only two bands available) yes, no

Figure 5 (continued)

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3. Observations currently performed at the site, that can be connected with the GTOS NPP demonstration project:

At our site, we are currently observing:

Variables	is observed?	Frequency?	Continuity?	Duration (e.g. 1995-2000 or 1996-ongoing)	Remarks
Net primary productivity (inventory based methods)	<input type="radio"/> yes, <input type="radio"/> no	Please select	Please select		
Soil/litter carbon stocks	<input type="radio"/> yes, <input type="radio"/> no	Please select	Please select		
Leaf area index	<input type="radio"/> yes, <input type="radio"/> no	Please select	Please select		
Ecosystem gas exchange (eddy covariance)	<input type="radio"/> yes, <input type="radio"/> no	Please select	Please select		
Ecosystem gas exchange (bowen ratio)	<input type="radio"/> yes, <input type="radio"/> no	Please select	Please select		
Meteorological conditions	<input type="radio"/> yes, <input type="radio"/> no	Please select	Please select		
Soil carbon fluxes	<input type="radio"/> yes, <input type="radio"/> no	Please select	Please select		
Other variables: Which? <input type="text"/>	<input type="radio"/> yes, <input type="radio"/> no	Please select	Please select		
Other variables: Which? <input type="text"/>	<input type="radio"/> yes, <input type="radio"/> no	Please select	Please select		
Other variables: Which? <input type="text"/>	<input type="radio"/> yes, <input type="radio"/> no	Please select	Please select		

General comments:

Thanks for your cooperation!

Please report problems directly via e-mail to markus.reichstein@web.de.

Figure 5 (continued)

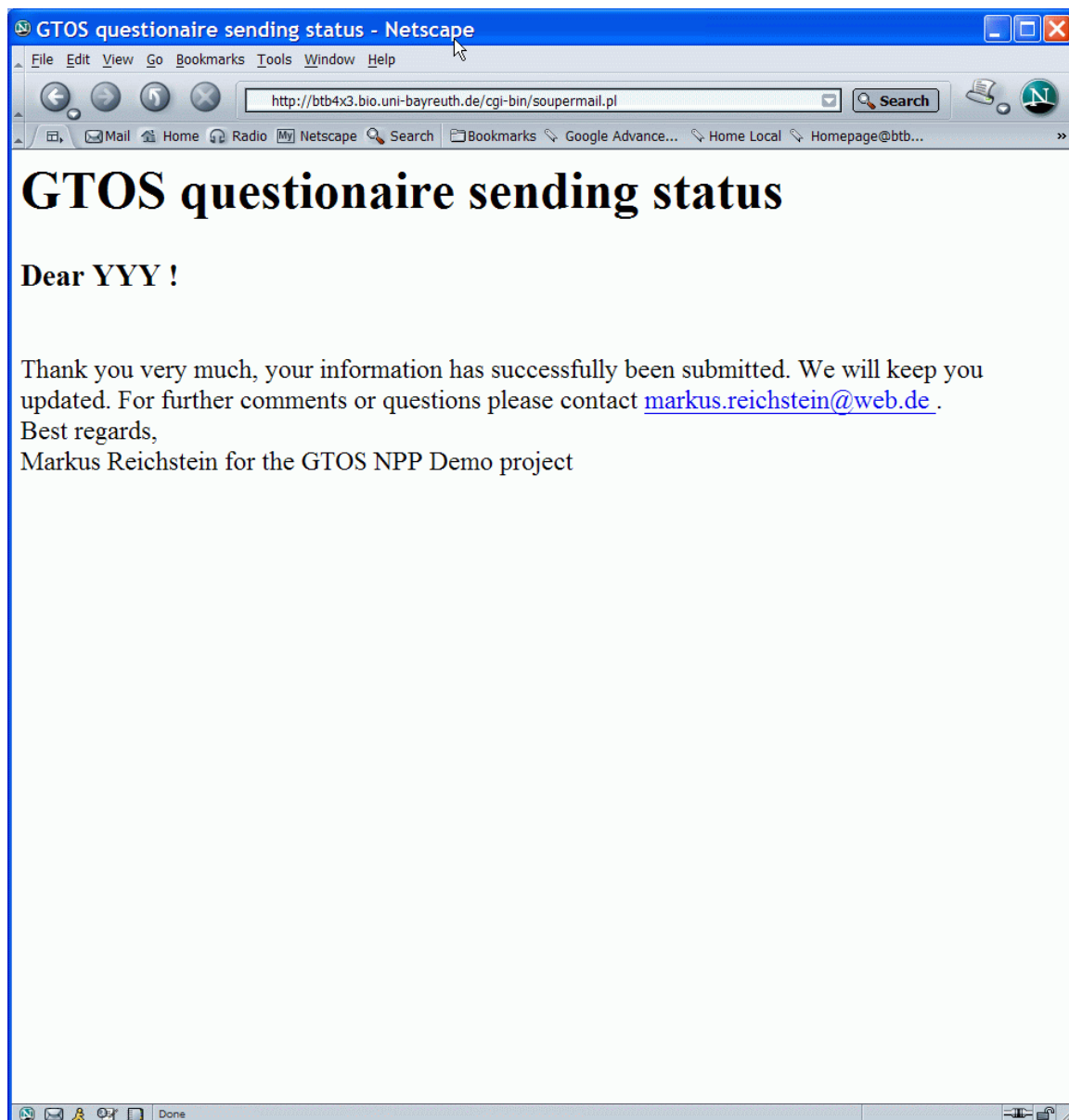


Figure 6: Status response after submitting site information to the questionnaire. In this case ‘YYY’ was entered as the name of the contact person.

3.2. Registered sites

At this point 58 sites registered via the online questionnaire. The full registration information can be found in the SiteTable.xls file on the accompanying CD. Here, a brief summary about the sites registered so far is given. Table 1 shows the most important properties of the registered sites.

Table 1: Overview of sites currently registered via the online questionnaire with selected properties. The total table is in the file SiteTable.xls on the CD.

Site name	Contact person	email	VegType	NPP	NPPcon	NPPfreq	Eddy	Eddycon	TEMS
Alinya	Maria-Jose Sanz	mjose@ceam.es	GRA	no	unselected	unselected	yes	continuous	no
Ansai resarch station of soil and water conservation,CAS Beijing Forest Ecosystem Research Station	Guobin Liu	gbliu@ms.iswc.ac.cn	MOS	yes	continuous	annual	no	unselected	unknown
borgo ciofi	Weiguo Sang	swg@ns.ibcas.ac.cn	DBF,MF,CSH	yes	campaign three	annual	no	unselected	yes
Bugac	enzo magliulo	v.magliulo@ispaim.na.cnr.it	CRO	yes	continuous campaign	month	yes	continuous	unknown
Changbai Mountain Forest	Zoltan Nagy	nagyz@spike.fa.gau.hu	GRA	yes	two	season	yes	continuous near	yes
Changwu Agro-ecological Experiment Station on the Loess Plateau, Chinese Academy of Sciences	Han Shijie	hansj@iae.ac.cn	MF	yes	several	lessfrequent	yes	continuous	unknown
CocoFlux	Wenzhao Liu Olivier	wzliu@ms.iswc.ac.cn	MOS	yes	campaign one near	annual	no	unselected	unknown
Collelongo	Roupsard Giorgio	roupsard@cirad.fr	CRO	no	continuous near	month	no	continuous near	no
Coweeta LTER Site	Matteucci	macchia@unitus.it	DBF	yes	continuous	lessfrequent	yes	continuous	yes
Dongshan Village, Longguang District, Shenzhen 518121, P. R. CHINA	Paul Bolstad	pbolstad@umn.edu	DBF	yes	several	lessfrequent	no	unselected	unknown
El Saler	Prof. Dr. You-Shao WANG	yswang@scsio.ac.cn	ENF	yes	continuous	season	n.a.	unselected	unknown
Espirra , Portugal	Maria-Jose Sanz	mjose@ceam.es	ENF	no	unselected campaign	unselected	yes	continuous	no
Gobabeb HAILUN AGRO-ECOLOGICAL EXPERIMENTAL STATION, CHINESE ACADEMY OF SCIENCES	Gabriel Pita	gabrielpita@ist.utl.pt	EBF	yes	one campaign	annual	yes	continuous	no
Hegyhatsal	Joh Henschel	jhenschel@drfn.org.na	n.a.	yes	one	annual	no	unselected	yes
	Song Chunyu	cys@mail.hrb.hl.cninfo.net	CRO	no	unselected	unselected	no	unselected	unknown
	Zoltan BARCZA	bzoli@caesar.elte.hu	MOS	no	unselected	unselected	yes	continuous	unknown

Heshan Hilly Land interdisciplinary experimental station, Chinese Academy of Sciences	Zhengfeng Wang	wzf@scib.ac.cn	ENF,EBF,GRA,CRO,URB	yes	several	annual	yes	one	no
Inner Mongolia Grassland Ecosystem Research Station, the Chinese Academy of Sciences	Qingmin Pan	pqm@ns.ibcas.ac.cn	GRA	yes	continuous campaign	month	no	unselected near	unknown
Konza Prairie Biological Station	John M. Blair	jblair@ksu.edu	GRA	yes	one campaign	annual	yes	continuous	yes
Las Majadas Lize Inland River Basin Comprehensive research station, CERN	Maria-Jose Sanz	mjose@ceam.es	SAV	yes	one	annual	yes	continuous	no
Lize Interland River Basin Comprehensive research station, CERN	Wen Zhi, Zhao	zhaowz@ns.lzb.ac.cn	MOS	yes	continuous	annual	yes	continuous	unknown
Lize Interland River Basin Comprehensive research station, CERN	n.a.	n.a.	n.a.	n.a.	unselected	unselected	n.a.	unselected	n.a.
Luancheng Agricultural Ecosystem Experimental Station, CAS	Wen Zhi, Zhao	zhaowz@ns.lzb.ac.cn	MOS	yes	continuous	annual	yes	continuous	unknown
Maoxian Mountain Ecosystem Research Station, Chinese Academy of Sciences	Hu Chunsheng	cshu@ms.sjziam.ac.cn	CRO	yes	continuous	season	yes	near continuous	yes
Matra Naiman Desertification Research Station in Horqin Sandy Land	Liuqing	liuqing@cib.ac.cn	MF	yes	one campaign	lessfrequent	no	unselected	unknown
Neustift	Zoltan Nagy	nagy@spike.fg.gau.hu	GRA	yes	two	season	yes	continuous	yes
Nonantola, Italy	Xueyong Zhao	bmzhaoy@public.hh.nm.cn	GRA	yes	near continuous	annual	no	unselected	unknown
Norunda	Alexander Cernusca	Alexander.Cernusca@uibk.ac.at	GRA	yes	several	month	yes	continuous	yes
Oensingen	Marianna Nardino	M.Nardino@ibimet.cnr.it	DBF,MF	no	unselected campaign	unselected	yes	continuous	unknown
	Anders Lindroth	Anders.Lindroth@nateko.lu.se	ENF	yes	one	annual	yes	continuous	unknown
	Nina	nina.buchmann@ipw.agrl.ethz.ch,	CRO	no	unselected	unselected	yes	continuous	no

Agriculture	Buchmann, Werner Eugster	werner.eugster@ipw.agrl.ethz.ch							
Ordos Sandland Ecological Research Station (OSERS), Chinese Academy of Sciences	Zhenying HUANG	zhenying@ns.ibcas.ac.cn	OSH	no	unselected	unselected	no	unselected	no
Orgovany	Miklos Kertesz	n.a.	MOS	no	unselected campaign	unselected	no	unselected	yes
RENON/RITTEN	Stefano Minerbi	stefano.minerbi@provincz.bz.it	ENF	yes	one	annual	yes	continuous	unknown
Rocca	Sabina Dore Guenther Seufert	dore@unitus.it	EBF, DNF	n.a.	unselected	unselected	n.a.	unselected	unknown
San Rossore Sanjiang Plain Marsh Ecological Experiment Station, P.R.C China Shapotou Desert Research & Experiment Station, Chinese Academy of Sciences	SONG Chanchun	songcc@mail.neigae.ac.cn	GRA, CRO	yes	continuous	unselected	yes	continuous	no
Shenyang Experimental Station of Ecology, CAS	Dr. Li Xin-Rong	Lxinrong@ns.lzb.ac.cn	OSH	yes	continuous	annual	no	unselected	unknown
Skukuza	Wenju Liang	liangwj@iea.ac.cn	CRO	yes	continuous	annual	no	unselected near continuous	unknown yes
Sky Oaks New Stand Taihu Laboratory for Lake Ecosystem Research	Dr Bob Scholes Hongyan Luo, Joe Verfaillie	bscholes@csir.co.za luo@sunstroke.sdsu.edu; josephv@sunstroke.sdsu.edu	SAV	no	several	annual	yes	continuous	yes
Tonzi Ranch (Ione, CA)	Weiping Hu	wphu@niglas.ac.cn	OSH	no	unselected	unselected	yes	continuous	no
Tumbarumba Viote del MOnTe Bondone	Dennis Baldocchi Ray Leuning and Helen Cleugh Damiano Gianelle	baldocchi@nature.berkeley.edu	SAV	n.a.	unselected	unselected	yes	continuous	no
Virginia Coast Reserve Long-Term Ecological Research Project	Ray Leuning@csiro.au, Helen.Cleugh@csiro.au		EBF	yes	near continuous campaign	month	yes	continuous	unknown
Vordemwald (LWF)	Gianelle	gianelle@cealp.it	GRA	yes	three	season	yes	continuous	no
	John Porter Norbert Kraeuchi	jhp7e@virginia.edu	ENF, DBF, MF, CS H, OSH, GRA, CRO	yes	campaign one	annual	no	unselected	yes
	Kraeuchi	kraeuchi@wsl.ch	MF	no	several	lessfrequent	yes	unselected	yes

WLEF Tower Site Xishuangbanna Tropical Rainforest Ecosystem Station	Paul Bolstad	pbolstad@umn.edu	MF	yes	several	annual	yes	continuous	unknown
Yanting Agro- ecological Experimental Station of Purple Soil, Chinese Academy of Sciences	Tang Jianwei	tangjw@xtbg.org.cn	EBF	yes	one	annual	yes	continuous	unknown
Zerbolo'-Parco Ticino	zhu Bo Guenther Seufert You-Shao	bzhu@imde.ac.cn,gmr@imde.ac.cn	MF	no	unselected	unselected	no	unselected	yes
n.a.	WANG	yswang@scsio.ac.cn	n.a.	n.a.	unselected	unselected	n.a.	unselected	yes

A clear majority of the registered sites is from the northern hemisphere (Figure 7), where Europe and North America are well represented. Asia is mostly represented by sites from China, while from Korea/Japan where flux sites are present no registration was recorded. Moreover tropical sites are underrepresented. IGBP-landcover types are relatively evenly distributed, except that evergreen broadleaf forest and no deciduous needle leaf forest are absent (Figure 8).

Around three fourth of the site managers would be interested in relatively small MODIS cutouts around the sites ($\leq 10\text{km} \times 10\text{km}$), while the minority would also be interested in landscape-level information (Figure 9).

From most of the sites information on each, primary production, leaf area index, and fluxes via eddy covariance and soil respiration chambers are available (Figure 10, Figure 11). About half of the sites have had already registered to the TEMS database.

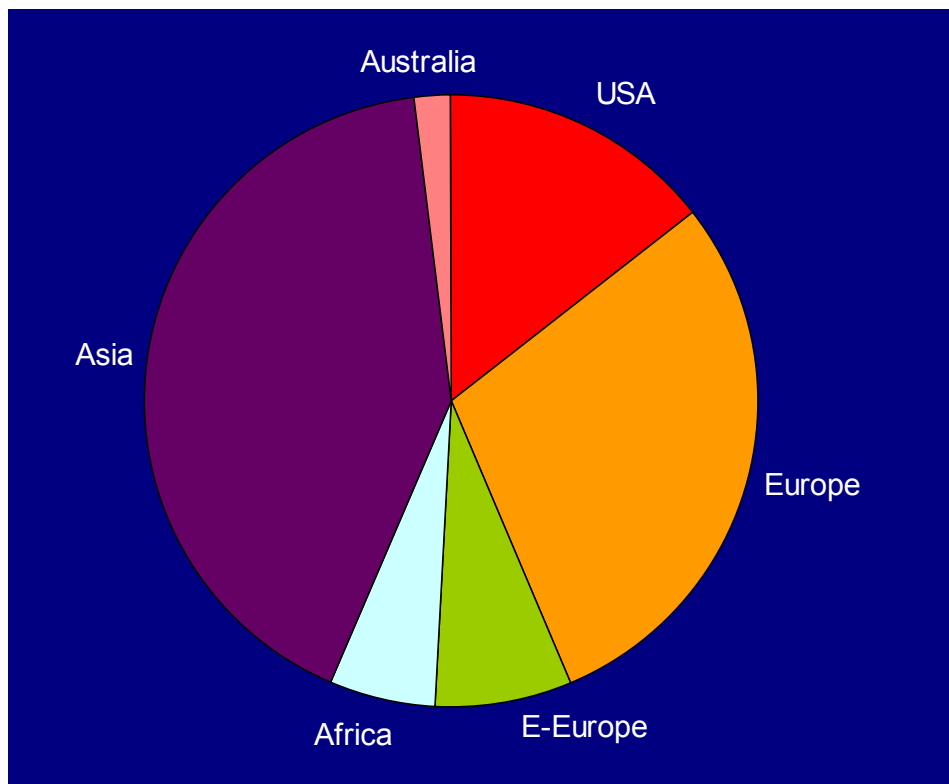


Figure 7: Regional distribution of sites registered so far.

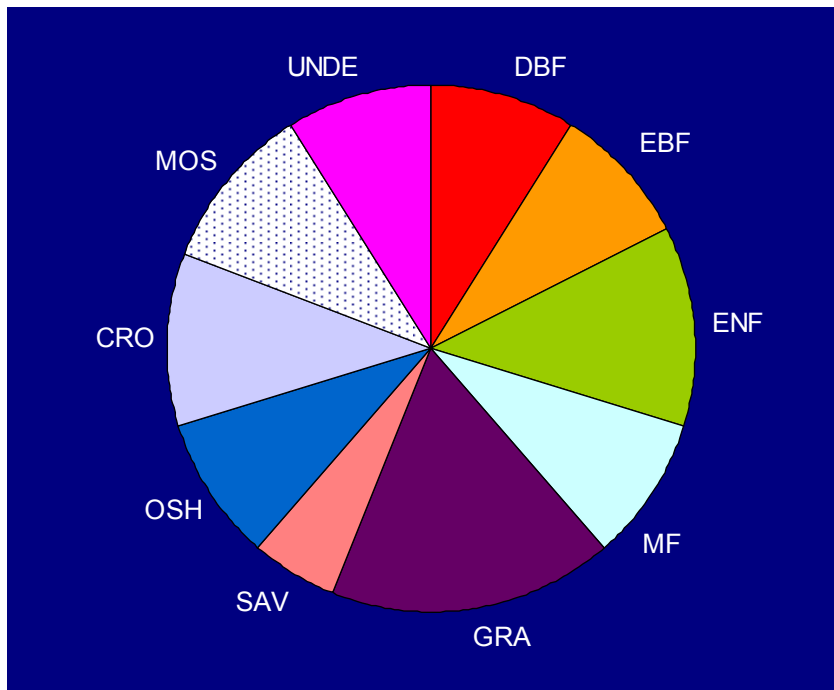


Figure 8: Distribution of landcover types (IGBP classes) among registered sites. 'UNDE' abbreviates undefined (i.e. was not selected by the registering person).

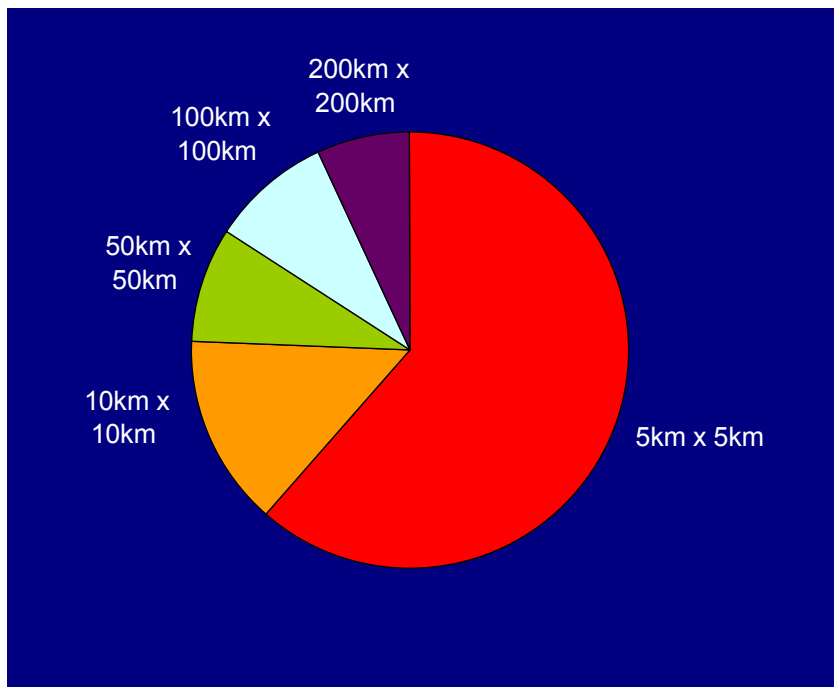


Figure 9: Preference of site managers concerning the spatial extent of MODIS cutouts

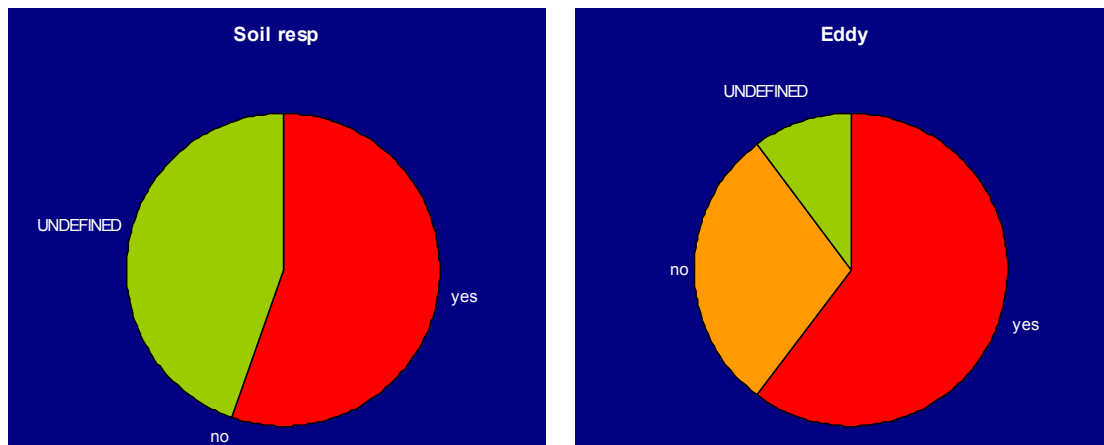


Figure 10: Responses to the question if soil respiration (left) or eddy covariance measurements (right) are performed at the registered sites.

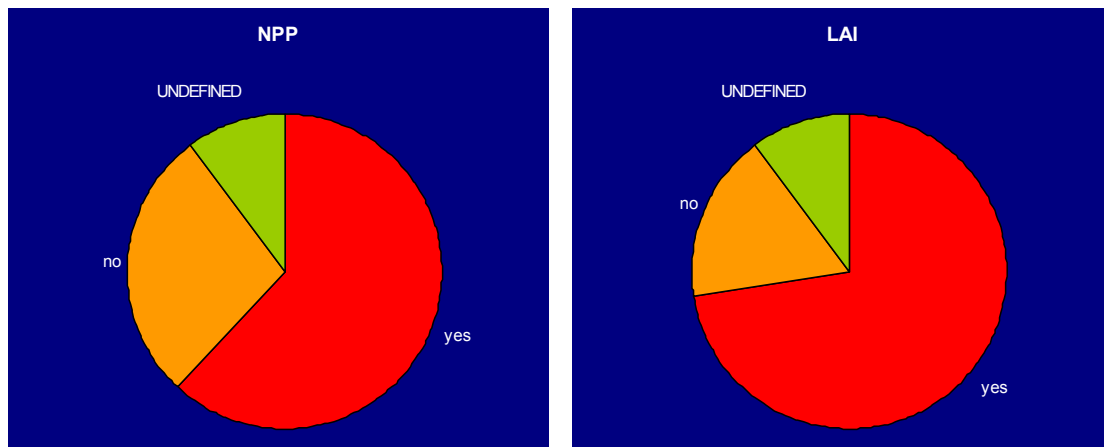


Figure 11: Responses to the question if net primary production (left) or leaf area index measurements (right) are performed at the registered sites.

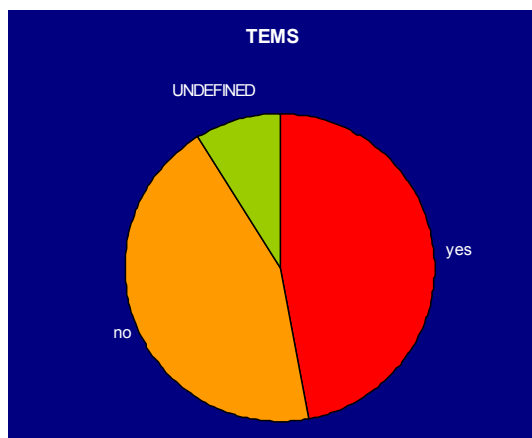


Figure 12: Responses to the question if sites are already registered in TEMS.

4. Problems and further steps

Currently the major problem remains the submission of sites from tropical, East Asian and southern hemisphere regions. As discussed at FAO in January 2004 a number of measures should be taken to increase the visibility of the GTOS NPP Demo projects and to provide further incentives for site registration:

- Putting the link to the questionnaire on a top-level of the GTOS web-site
- Distribution of e-mails concerning the questionnaire from an FAO address (instead of my personal)
- Direct contact of site and project managers from particular sites and small networks
- A clear statement that this a supra-national effort (might overcome hesitations from East Asian sites)
- Offering a data analysis tool for eddy covariance data for those sites who register to the NPP Demo project. The development of such a tool has been commenced and could be further developed during a continuation of the activity.

Furthermore, in the context of the Central and Eastern Europe (CEE) initiative the methodology of comparing remote-sensing and in-situ datasets will be applied to available sites and results be presented at the CEE workshop in summer. This activity will be amended in the context of the supervision of Steffen Gruenler's thesis on Russian and Asian flux sites.