CPTEC
Centro de Previsão de Tempo e Estudos Climáticos

MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

The LBA Data-Model Intercomparison Project

Recent Progress
and
Site Level Results

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And many, many more...

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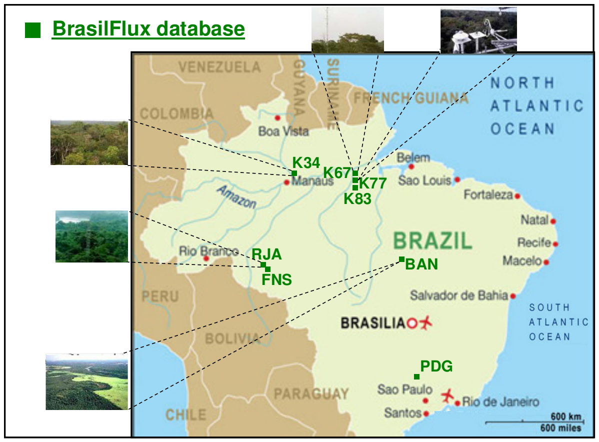
Motivating Scientific Questions

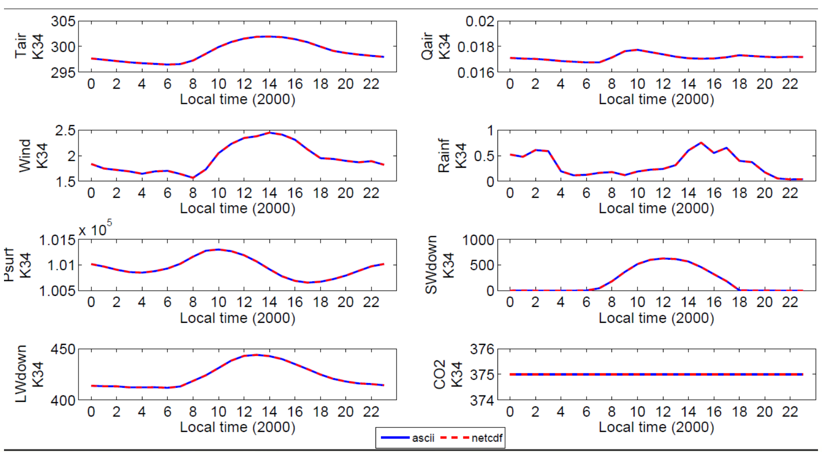
1. *When do different LSMs produce better simulations when subject to the same drivers?*
2. *How models with different complexities reproduce diurnal, seasonality and annual cycles of surface fluxes? What are the magnitudes of uncertainties?*
3. *How are the land surface process controlled by water, energy and carbon fluxes.*
4. *What is the partitioning, variance, spatial distribution, and interannual variability of water and energy fluxes in response to atmospheric drivers?*
5. *What are the links between soil processes and drier climate over Amazon?*
6. *What can we learn from LSMs simulations about the interactions among water, energy and carbon in the forest-savannah-pasture ecosystem?*

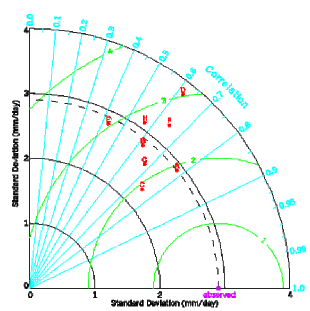
Sites Design, Observational Datasets and Metrics

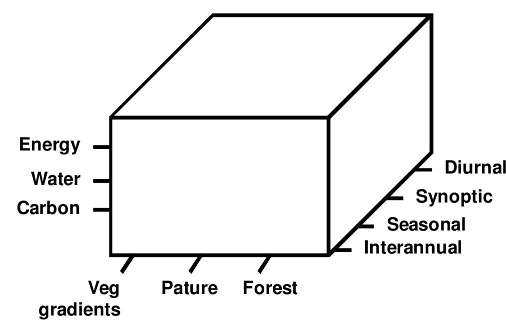
Multiple sites analysis, drivers, data precision and gap filling, QC, UTC preferred, Metrics for intercomparison modeling analysis etc.



ID	Short Code	Site Name	Longitude [deg]	Latitude [deg]	Local time (from UTC) [hh:mm]	Elev. [m]	Tower Ht [m]	Biome Type	IGBP Link
1	BAN	Javaes River - Bananal Island	-50.159111	-09.824417	-03:00	120	40	Forest-Savanna	4
2	K34	Manaus Km34	-60.209297	-02.609097	-04:00	130	50	Tropical rainforest	2
3	K67	Santarém Km67	-54.958889	-02.856667	-04:00	130	63	Tropical rainforest	2
4	K77	Santarém Km77	-54.894357	-03.019833	-04:00	130	18	Pasture-Agriculture	12
5	K83	Santarém Km83	-54.971435	-03.018029	-04:00	130	64	Selectively logged tropical rainforest	2
6	RJA	Reserva Jarú	-61.930903	-10.083194	-04:00	191	60	Tropical dry forest	2
7	FNS	Fazenda Nossa Senhora	-62.357222	-10.761806	-04:00	306	8.5	Pasture	12
8	PDG	Reserva Pe-de-Gigante	-47.649889	-21.619472	-03:00	690	21	Savanna	9







Interacting with other similar initiatives

The North American Carbon Program – Synthesis Analysis

Exchange methods and ideas with NACP collaborators

Advantages (and disadvantages) LBA/DMIP vs NACP protocols (revise and compare)

Effort to bring together NACP Synthesis and LBA-MIP participants into a common framework, additions and changes were made to both protocols.

Table 4A. General energy balance components: [PROTOCOL LBA/MIP]

MIP						NACP					
Variable	Description	Definition	Units	Positive Dir. (Traditional)		Variable	Description	Definition	Units	Positive Dir. (Traditional)	Component
SWnet	Net shortwave radiation	Incoming solar radiation less the simulated outgoing shortwave radiation, averaged over a grid cell	W/m^2	Downward		=	=	=	=	=	Energy Flux
LWnet	Net long wave radiation	Incident long wave radiation less the simulated outgoing long wave radiation, averaged over a grid cell	W/m^2	Downward		=	=	=	=	=	Energy Flux
Qle	Latent heat flux	Energy of evaporation, averaged over a grid cell	W/m^2	Upward		=	=	Latent heat flux out of canopy top, averaged over grid cell	=	=	Energy Flux
Qh	Sensible heat flux	Sensible energy, averaged over a grid cell	W/m^2	Upward		=	=	=	=	=	Energy Flux

Table 4A. General energy balance components:

Variable	Description	Definition	Units	Positive Dir. (Traditional)	Priority	NetCDF Dimensions	NACP code	NACP Category
SWnet	Net shortwave radiation	Incoming solar radiation less the simulated outgoing shortwave radiation, averaged over a grid cell	W/m^2	Downward	Mandatory	time	E6**	Energy Flux
LWnet	Net long wave radiation	Incoming longwave radiation less the simulated outgoing longwave radiation averaged over grid cell	W/m^2	Downward	Mandatory	time	E2**	Energy Flux
Qle	Latent heat flux	Energy of evaporation, averaged over a grid cell	W/m^2	Upward	Mandatory	time	E5**	Energy Flux
Qh	Sensible heat flux	Sensible energy, averaged over a grid cell	W/m^2	Upward	Mandatory	time	E4**	Energy Flux
Qg	Ground heat flux	Heat flux into the ground, averaged over a grid cell	W/m^2	Downward	Mandatory	time	E3**	Energy Flux
DelCanHeat	Change in canopy heat storage	Change in canopy heat storage	J/m^2	Increase	Mandatory	time	*	*

The LBA-DMIP Recent Progress

Some challenges involving producing the best available site level datasets

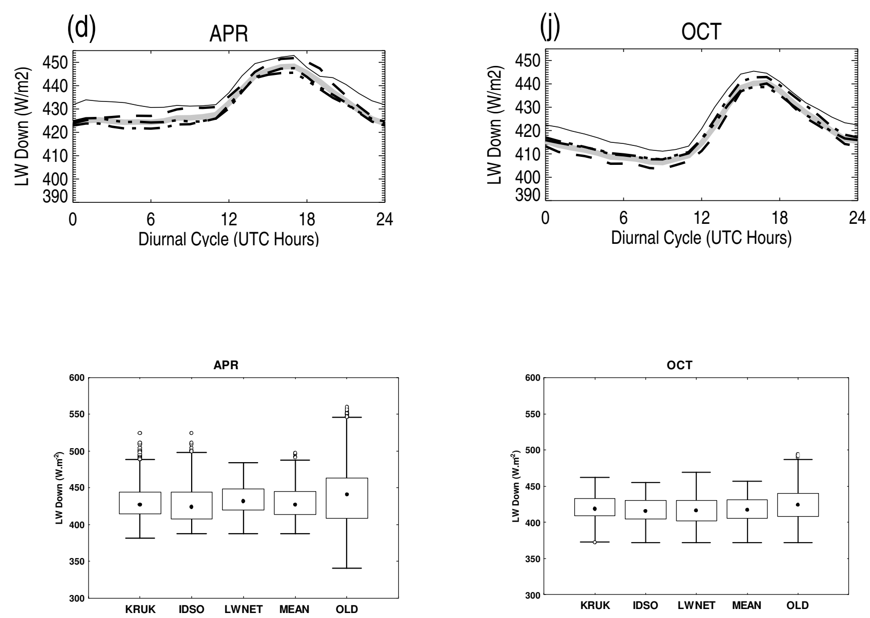
Three different methods for downward longwave radiation (LWdown) calculations were tested for observations gap-filling:

Kruk et al (2009) use Stefan-Boltzmann law, but there are differences between clear sky conditions and cloud cover, which is calculated through observed downward shortwave radiation.

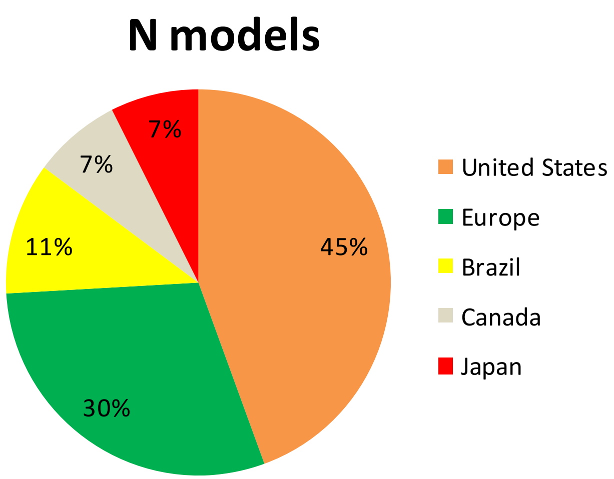
Idso (1981) also uses the Stefan-Boltzmann law. There is a special consideration to BAN and K67, where there are missing measurements.

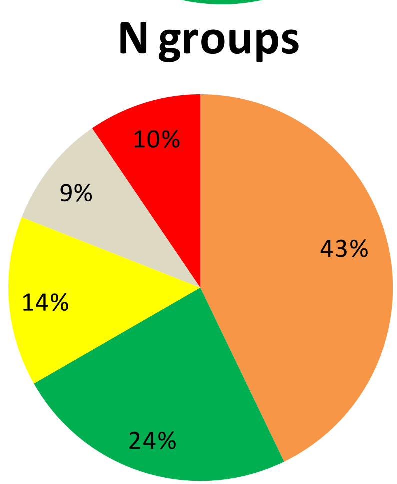
LWnet is based on net LW (incoming LW minus outgoing LW) observations through small changes on LWnet daily cycle from day to day at each of the sites. This method resulted of a complex and intelligent algorithm as procedure to calculate LW, which has been implemented and proposed in the LBA-MIP.

K34



Mapping out models and participants





n	Model	Affiliation
1	lpj.c1d	Swiss Federal Research Institute WSL, Switzerland
2	lpj.c1p	Swiss Federal Research Institute WSL, Switzerland
3	lpj.c2d	Swiss Federal Research Institute WSL, Switzerland
4	lpj.c2p	Swiss Federal Research Institute WSL, Switzerland
5	ED2.met	Harvard University, United States
6	IBIS.c1	UFV, Brazil
7	ORCHIDEE.c1	Ghent U, Belgium
8	DLEM.c	Auburn U, United States
9	SSiB2.c1	UCLA, CA, United States
10	SSiB2.c2	UCLA, CA, United States
11	SSiB2.c3	UCLA, CA, United States
12	SiB2.c1	UFSM, Brazil
13	modified SiB2	USP, Brazil
14	SIB3	Colorado State U, United States
15	Biome-BGC.c	Fukushima U, Japan
16	CN-CLASS	Mcmaster U, Canada
17	HTESSEL	Eldas (The Netherlands)
18	Fisher	JPL, United States
19	LEAFHYDRO	U Santiago de Compostela/Rutgers U, New Jersey
20	SiBCASA	U Colorado at Boulder, United States
21	CLM4CN	U Texas at Austin, United States
22	ISAM	U Illinois, United States
23	JULES	Oxford U, United Kingdom
24	CLM3	U Arizona, United States
25	CLMDVGM	U Arizona, United States
26	CLASS	U Alberta, Canada
27	VISIT	National Institute for Environmental Studies, Japan

Level 0 check

1) Files in NetCDF

- Need to format each model (different variables present and not present) each site (different years and periods) in files .txt for to convert them.
- Some models have different dimensions (e.g, SoilMoist (nsoil, time), Carb CarbPools (npool, time).
- Customized programs are not easy to make.

2) To check whether all required variables were included in the files or not.

3) To check variable names and/or dimensions. E.g. most of groups used BaresoilT instead of BareSoilT as required

Level 0 check

4) Compare reported (modeled) drivers with the original forcing datasets to ensure the correct version was used.

5) To check the diurnal cycle of energy variables.

6) To compare annual values of all variables.

7) To check the energy and water budgets.

8) To check the appropriate units: NetCDF or ASCII output files

9) To check the appropriate units: expected numerical order of magnitude and range.

Metrics and Analysis Methods

BIAS

$$\text{bias}_{\alpha} = \frac{1}{n}\sum_{i=0}^{n} x_{i\ \alpha} - \bar{x}_{i\ ensamble}$$

where α is each model,
n is sample size.

negative to positive

Standardized RMS

$$S.RMS_{\alpha} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(\frac{x_i - \bar{x}_{ensemble}}{\sigma_{\text{ensemble}}}\right)^2}$$

where α is each model,
n is sample size.

null to positive

Correlation

$$\text{correlation}_{\alpha} = \frac{\sum_{i=1}^{n}(x_{\alpha} - \bar{x}_{\alpha}).(x_{ensemble} - \bar{x}_{ensemble})}{\sqrt{\sum_{i=1}^{n}(x_{\alpha} - \bar{x}_{\alpha})^2 . \sum_{i=1}^{n}(x_{ensemble} - \bar{x}_{ensemble})^2}}$$

-1 to 1

Reproducibility

$$\text{Re}\ producibity = \frac{\sigma^2_{ensemble}}{\sigma^2_{noise}}$$

$$\frac{\text{Variance from average of the models}}{\text{Variance average from models}}$$

> 0

0

Brier score

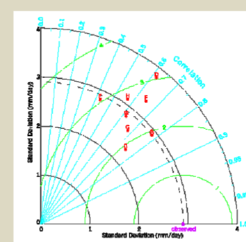
$$\overline{\text{B}s} = \frac{1}{n}\sum_{i=1}^{n}(1 - CS_i)^2.(0 - IS_i)^2$$

2 total disagreement with observation

0 perfect score

Space-time diagram (Taylor diagram)

synthesize information about skill



Example of Energy Analysis and Intercomparison

For each site, we looked at monthly means of:

a) Net Radiation,

b) Sensible Heat Flux,

c) Latent Heat Flux,

d) Ground Heat Flux,

and computed the following statistics (Taylor, 2001):

1. Linear correlation (R) between each model and observations at the eddy flux towers
2. Normalized standard deviations (Sn): simulated standard deviations of the monthly means divided by the observed standard deviations.

$$S_n = \frac{[simulated\ standard\ deviation]}{[Observed\ standard\ deviation]}$$

3. Root Mean Square Error (RMSE)
4. Mean Bias (MB): Differences in mean values

The LBA-DMIP Recent Progress

Models Used

	BAN	K34	K67	K77	K83	RJA	FNS	PDG
ed2.met	x		x			x	x	x
ibis.c1	x	x	x	x	x	x	x	x
LEAFHYDRO.nwt	x	x	x	x	x	x	x	x
LEAFHYDRO.wt	x	x	x	x	x	x	x	x
SiBCASA.c1	x	x	x	x	x	x	x	x
sib2.c1	x	x	x	x	x	x	x	x
htessel.nc1	x	x	x	x	x	x	x	x
ORCHIDEE.c1	x	x	x	x	x	x	x	x
SiB3.c	x	x	x	x	x	x	x	x
ssib2.c1	x	x	x	x	x	x	x	x
ssib2.c2	x	x	x	x	x	x	x	x
ssib2.c3	x	x	x	x	x	x	x	x
cnclass.code	x	x	x	x	x	x	x	x
modified Sib2	x	x	x	x	x	x	x	x
clm3.5.nc	x	x	x	x	x	x	x	x
clm3.5-DGVM.c	x	x	x		x	x		x

-16 (not all) models are compared in this analysis, due to the availability of the model outputs and/or simulated variables at the time we downloaded the data.
- One or several variables are occasionally dropped from analysis due to obvious errors from either simulations/format conversions/data aggregation.