Comparison between regional drivers and station data on temporal multi-scales in the Amazonian region

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Introduction

The main goal of the Large-Scale Biosphere-Atmosphere Experiment in Amazonia – Data-Model Intercomparison Project (LBA-DMIP) funded by the NASA Terrestrial Ecology program (NNH08ZDA001N-TE) is to understand how the different land-surface models (LSM) produce better simulations in the Amazon when subject to the same atmospheric drivers. This project consist of two phases, being that the first takes advantage of measurements of unique ecosystems made during LBA at eight flux tower sites across the Amazon and central Brazil. This work presents the progresses towards the second phase of the LBA-DMIP, where gridded regional simulations will be performed in order to investigate the exchange of carbon, heat and water between surface and atmosphere considering the Amazon as a whole region. Progress in modeling the biogeophiysical processes in the Amazon can be previously inhibited by the lack of adequate drivers for model parameterization, such as precipitation and surface variables. The confidence in regional simulation depends on how well the drivers used represent the region of interest. There are several regional driver datasets that incorporate models, satellite estimates and gauges, the former wherever it is available. Nonetheless, for initial comparison with the flux tower sites we have chosen two datasets (hereafter called regional drivers): the South America Land Dates Assimilation System (SALDAS) produced in collaboration between NASA/GSFC Hydrological Sciences Branch and the Centro de Previsao do Tempo e Estudos Climaticos (CPTEC-Brazilian Center it goes Weather Forecast and Climate Studies) and the other dataset the Climatic Research Unit (CRU) of Global Princeton Forcing based on Observational-Reanalysis hybrid of Princeton University. To the present proposed, we compared the regional drivers with the stations located nearby the tower sites through linear interpolation.

Forcing Data Specifics

SALDAS: 3-Hourly files; 1/8th Degree (~12.5 km) over Equator; GRIB format; C-shell scripts, Fortran programs used to automatically generate and archive forcing; Quality controlled, adjusted for terrain height; 15 Model and observation-based fields; GOES-CPTEC PAR (not implemented yet); GOES-CPTEC skin temperature (not implemented yet)

BrasilFlux Database

Drivers are observations over unique ecosystems made during LBA at eight flux tower sites across the Amazon.

The datasets are available for periods from 1999 to 2006 (multi-year) in UTC time.

The drivers comprise air temperature, specific humidity, module of wind speed downward long wave radiation at the surface, surface pressure, precipitation, shortwave downward radiation at the surface and CO2 will be set to 375 ppm.

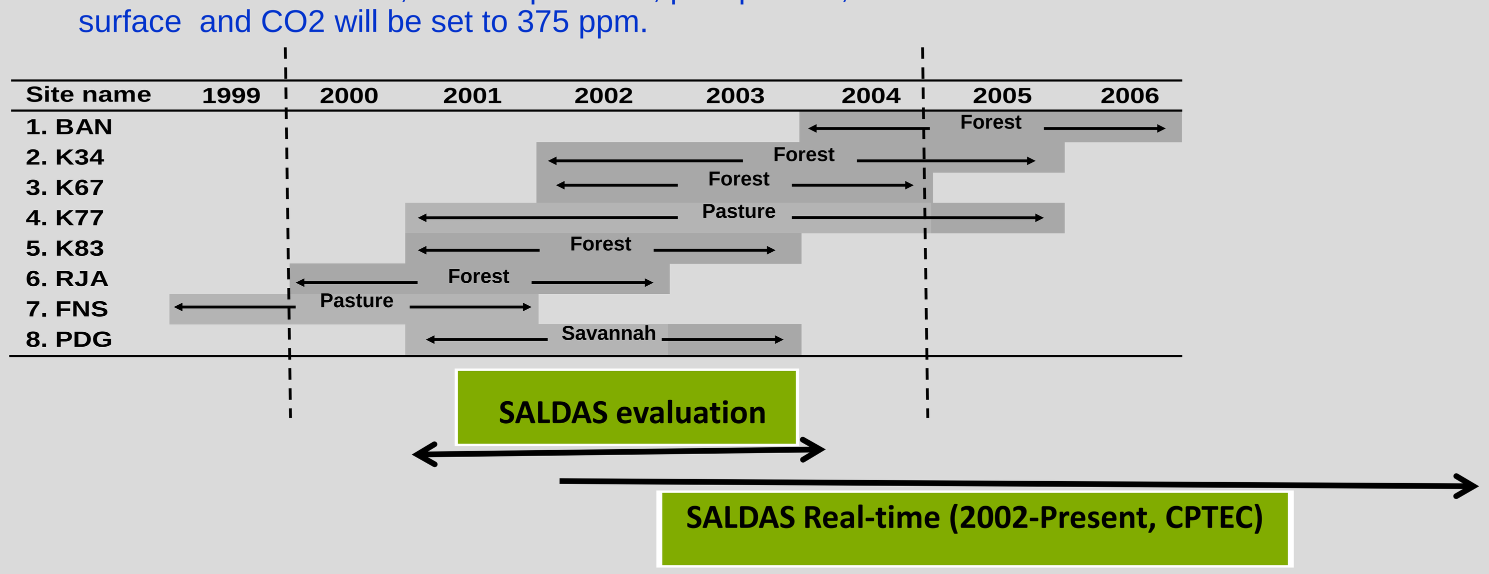

Figure 1. Site-specific availability of continuously filled driver data and your respective biome type.

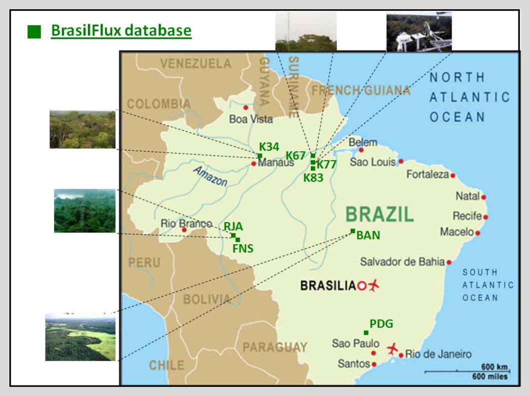

Figure 2. BrasilFluz Database

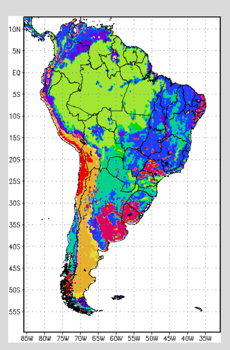

Figure 3. SALDAS domain.

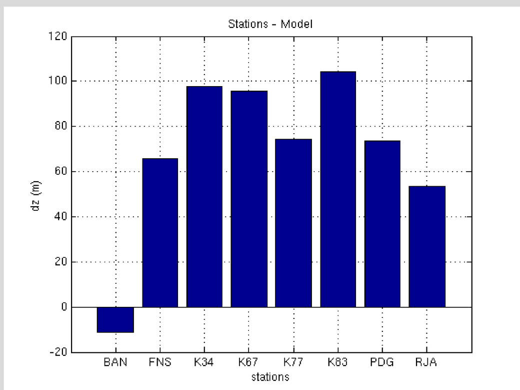

Figure 4. SALDAS and LBA sites difference of altitude.

Dataset the Climatic Research Unit (CRU)
Global Princeton Forcing based on Observational-Reanalysis hybrid of Princeton University.

Jan-1948 – present period; 3-hourly times (daily precipitation); Global coverage; 1.0-degree resolution; Latitude-longitude grid;

Observational-Reanalysis hybrid type; http://hydrology.princeton.edu/data/index.html site;

Sheffield, J., G. Goteti, and E. F. Wood, Development of a 50-yr high-resolution global dataset of Meteorological forcings for land surface modeling, J. Climate, 19 (13), 3088-3111.

Variables: Precipitation (prcp); Air temperature at 2m above ground (tas); Downward longwave at surface (dlwrf); Downward shortwave at surface (dswrf); Surface pressure (pres); Specific humidity (shum); Windspeed (wind)

Precipitation Evaluation

The SALDAS and CRU were investigated comparing with eight LBA sites and regarding their annual to hourly variability. Differences between drivers and sites are around of 10% of total precipitation. We can identify the wet season being six months more rainy for each site and year. SALDAS shows an under-estimate of relative differences during wet season, while CRU shows differences varying next to zero (Fig. 7). But the standard deviation of differences is similar for both drivers.

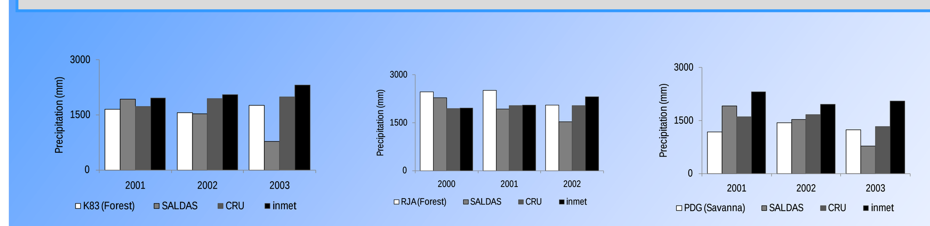

Fig. 6. Annual precipitation to three LBA sites comparing with SALDAS, CRU and INMET

Monthly Precipitation: Wet and Dry Season

Sites and Multi-years / Month

site	year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
K34 (Forest)	2002	330	400	281	388	258	178	103	83	264	244	123	155
K34 (Forest)	2003	14	254	254	345	290	183	100	100	135	59	181	138
K34 (Forest)	2004	273	321	463	443	238	59	127	126	155	111	72	101
K67 (Forest)	2002	237	193	252	440	143	69	58	7	13	29	155	81
K67 (Forest)	2003	27	225	162	56	241	105	62	62	65	44	161	76
K67 (Forest)	2004	373	391	237	209	226	56	109	49	69	39	5	65
K77 (Pasture)	2001	288	200	177	388	129	176	31	13	40	18	76	60
K77 (Pasture)	2002	268	201	205	269	139	165	64	5	5	12	112	104
K77 (Pasture)	2003	49	264	181	297	160	164	73	93	107	122	98	43
K77 (Pasture)	2004	288	200	213	348	138	167	31	13	41	17	76	60
K83 (Forest)	2001	318	291	195	338	181	144	34	21	47	9	49	32
K83 (Forest)	2002	227	159	164	281	170	163	67	2	2	8	216	101
K83 (Forest)	2003	62	271	181	287	233	139	81	83	134	83	108	97
RJA (Forest)	2000	481	173	506	269	90	2	9	13	149	172	377	228
RJA (Forest)	2001	497	343	208	166	130	41	35	0	85	284	338	385
RJA (Forest)	2002	517	173	182	281	77	8	24	35	46	144	293	267
FNS (Pasture)	2000	265	250	67	153	36	30	35	86	183	249	198	227
FNS (Pasture)	2001	347	285	165	115	120	39	7	26	200	38	224	219
PDG (Savanna)	2001	140	82	115	25	82	3	5	18	104	122	262	212
PDG (Savanna)	2002	334	197	105	22	47	0	5	74	69	80	213	299
PDG (Savanna)	2003	424	160	130	54	78	8	10	12	21	87	201	55
BAN (Forest)	2004	266	350	377	105	52	5	1	11	33	89	195	197

Fig. 7. Monthly precipitation to LBA sites and multi-years in each month.

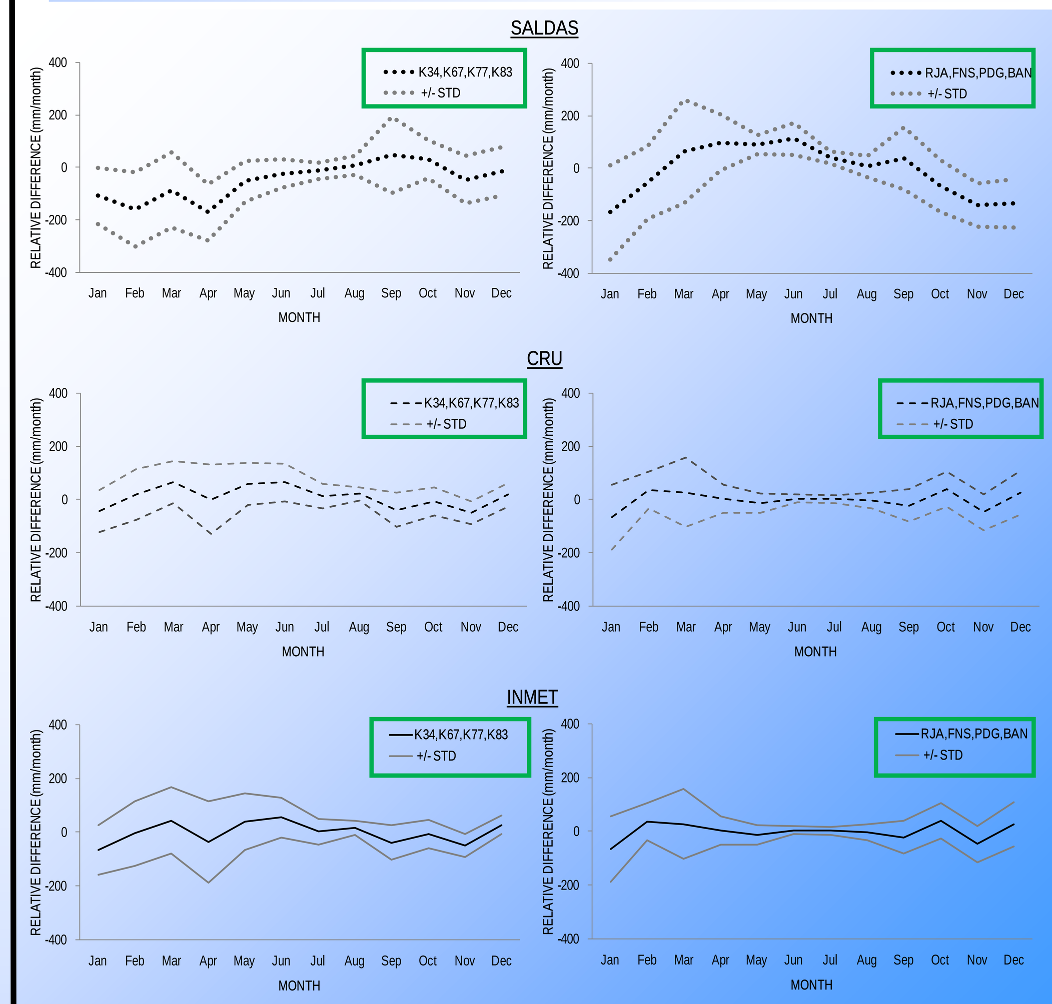

Fig. 7. Monthly relative difference between LBA sites and regional drivers (and INMET) to multi-years in each site.

Rainfall Probability of Detection (POD)

POD of daily precipitation in each month were investigated using threshold 5, 25, 50, 75 and 95% (~0,1,3,10,30 mm/day respectively, Gamma distribution). POD is given by the number of rainy days correctly identified by regional drivers divided by the sum of the number of rainy days, using as reference LBA sites. This was computed in each range of agreement with the threshold of rain. The CRU has better skill during wet season on K34,K67,K77,K83 for all threshold, except 30mm/day or more (Fig. 8). SALDAS showed lesser seasonal variation, whereas SALDAS is better during dry season for all threshold.

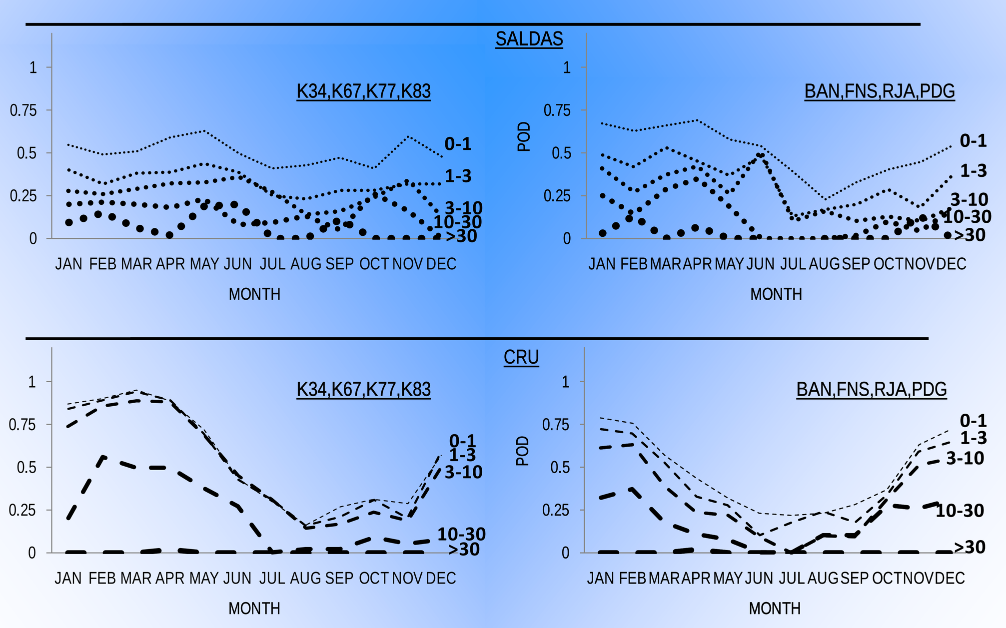

Fig. 8. Statistical index Probability of Detection (POD) for daily precipitation of SALDAS and CRU using as reference LBA/MIP sites for different threshold and computed for the whole month.

Rainfall False Alarm

FAR of daily precipitation is given by the number of rainy days that are incorrectly identified for the regional drivers, divided by sum of not rainy days using as reference LBA sites. FAR is very similar for both regional drivers regarding all rainfall range. We noted larger FAR during dry season, suggesting that errors occurred more when rain is sparse.

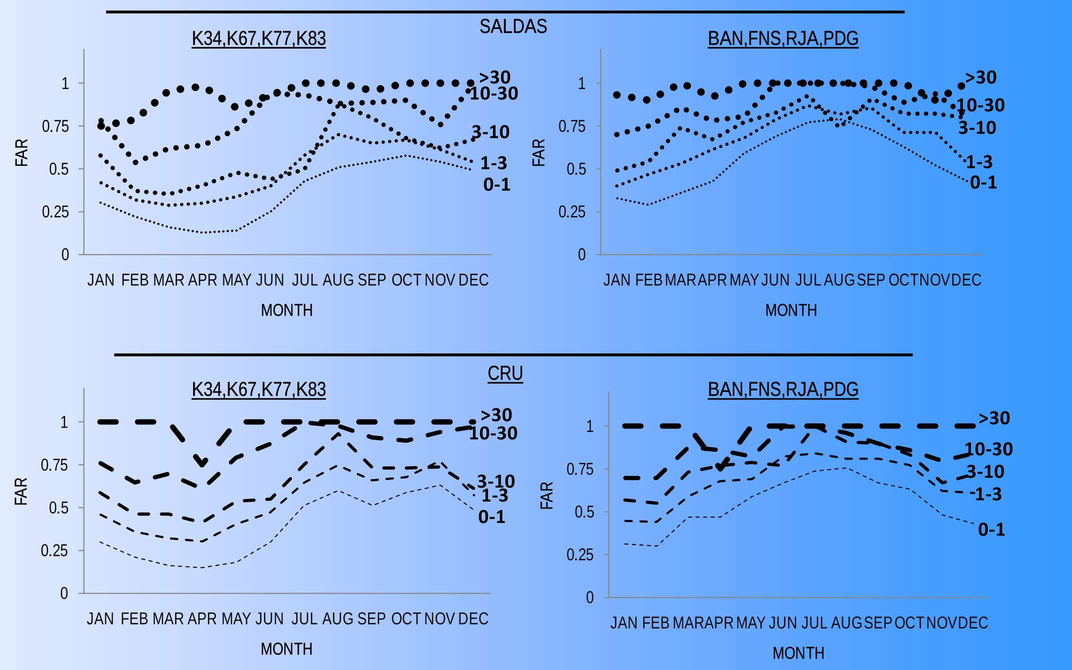

Fig. 9. Statistical index False Alarm (FAR) for daily precipitation of SALDAS and CRU using as reference LBA/MIP sites for different threshold and computed for the whole month.

3-Hourly precipitation

Here, we evaluation only 3-hourly SALDAS precipitation (CRU is only made available on daily precipitation) using as reference K34,K67,K77,K83 sites in the same temporal resolution, but only during wet season. The proposal is investigate the capability of SALDAS to reproduce the daily variability of the rain on the diurnal cycle. We noted the lightly better POD and lower FAR during the day, comparing with nightly precipitation. It is interesting to note that, the higher thresholds of precipitation shows higher POD and FAR, indicating that the SALDAS have the better results regarding the higher thresholds, but it has more incorrect outputs for these thresholds.

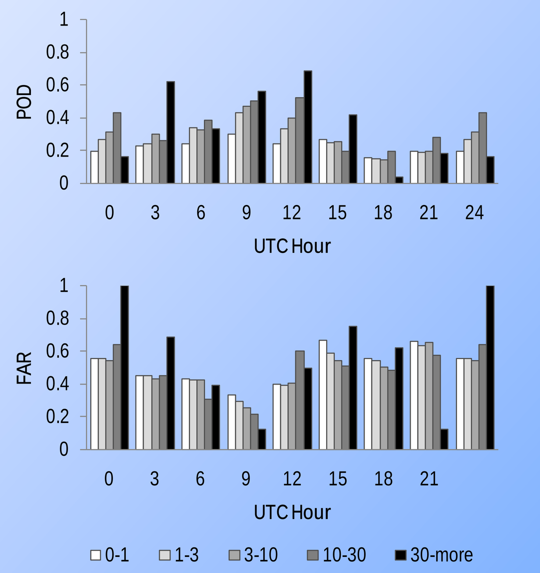

Fig. 10. Statistical index Probability of detection (POD) and False Alarm (FAR) for 3-hourly precipitation of SALDAS and CRU using as reference LBA/MIP sites for different threshold and computed for each hour.

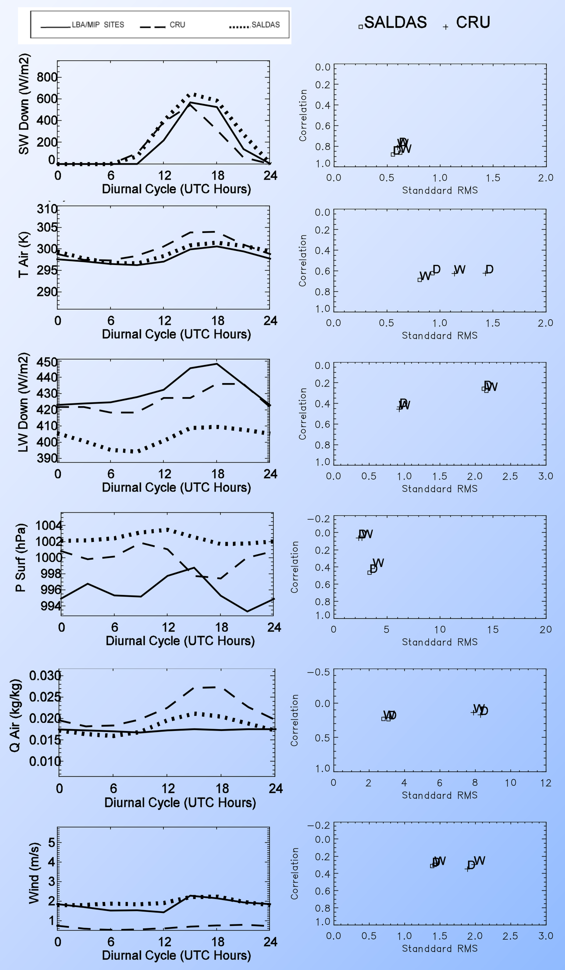

Fig. 11. Diurnal cycle (left), correlation vs standardized RMS for SALDAS and CRU surface variables regarding as reference LBA sites.

Surface variables: Diurnal Cycle and uncertainly about regional drivers

Cycle diurnal for short wave and temperature is similar to LBA sites. The correlation is relatively high for both regional drivers. But for temperature, CRU has RMS larger than SALDAS. However, long wave shows differences on diurnal cycle for both regional drivers, that is a surface variable very important as forcing of models. The CRU shows a diurnal cycle for long wave closer to LBA sites than SALDAS, but the variation is not correct. Then, CRU has RMS lesser than SALDAS and correlation is lightly higher.

Surface pressure and specific humidity have poor consistence with LBA sites, but this is related with model parameterizations associated to rain. CRU shows under-estimative for wind around 1 m/s and RMS larger than SALDAS, but correlation is similar for both.

Here, we show some uncertain about surface variables through comparison on LBA site, that is a severe analysis, because is done on site, but it showed where or how far are the regional drivers from observation data.

Summary

The SALDAS and CRU regional drivers were compared with LBA/DMIP data on site resolution in multi-years (Fig.7). To compare the two sources of data, linear interpolations were computed on closer in each site. The regional drivers temperature, pressure, humidity specifies and atmospheric radiative fluxes, that have a 3-h time step, exhibit correlations with distinct characteristics for each variable. In general, regional drivers show dynamic aspects of the large scale of agreement with previous studies. Then, monthly and annual relative differences to LBA sites are smaller than 1%. To precipitation, low to high frequency timescales were evaluable through of annual, monthly, daily, 3-hourly average. We showed that the precipitation is the most critical regional driver. We found that inconsistency with LBA/DMIP site is as larger as comparison between sites and closer INMET station. The CRU precipitation showed better than SALDAS during wet season in relation the probability of detection to daily precipitation, although SALDAS has better spatial resolution than CRU. The CRU was more rainy while SALDAS showed an under estimate of rainfall in same period. But, the both regional drivers had same results regarding false alarm of rainfall. SALDAS have the advantage of 3-hourly precipitation and evaluating on this temporal resolution, we found indication that SALDAS detected better the rainfall on day than at night. However, the results indicated that higher rainfall thresholds investigated here also were detected. This can be associated with the mesoscale dynamics, which may significantly contribute to the seasonal to daily total precipitation and is present in SALDAS product. The most of the precipitation events here investigated are convective and thus relatively short lived for a given point. This is proven when we compared the precipitation between near stations and flux tower sites. That is, differences of precipitation between regional drivers and flux tower sites had resulted similar for differences between near stations and flux tower sites.

Acknowledgments

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