Centro de Previsão de Tempo e Estudos Climáticos

CPTEC / INPE

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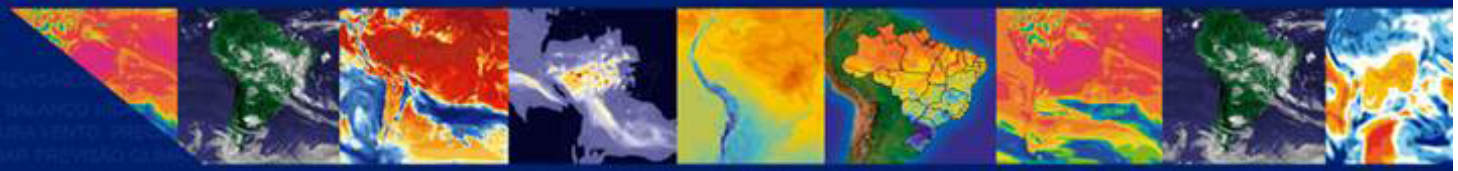
Ground Validation Activities at CPTEC/INPE: How GPM constellation can retrieve diurnal cycle over Brazilian territory?

Daniel Vila (presenter)

2019 PMM Science Team Meeting

Ciência e Tecnologia a serviço da sociedade



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INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

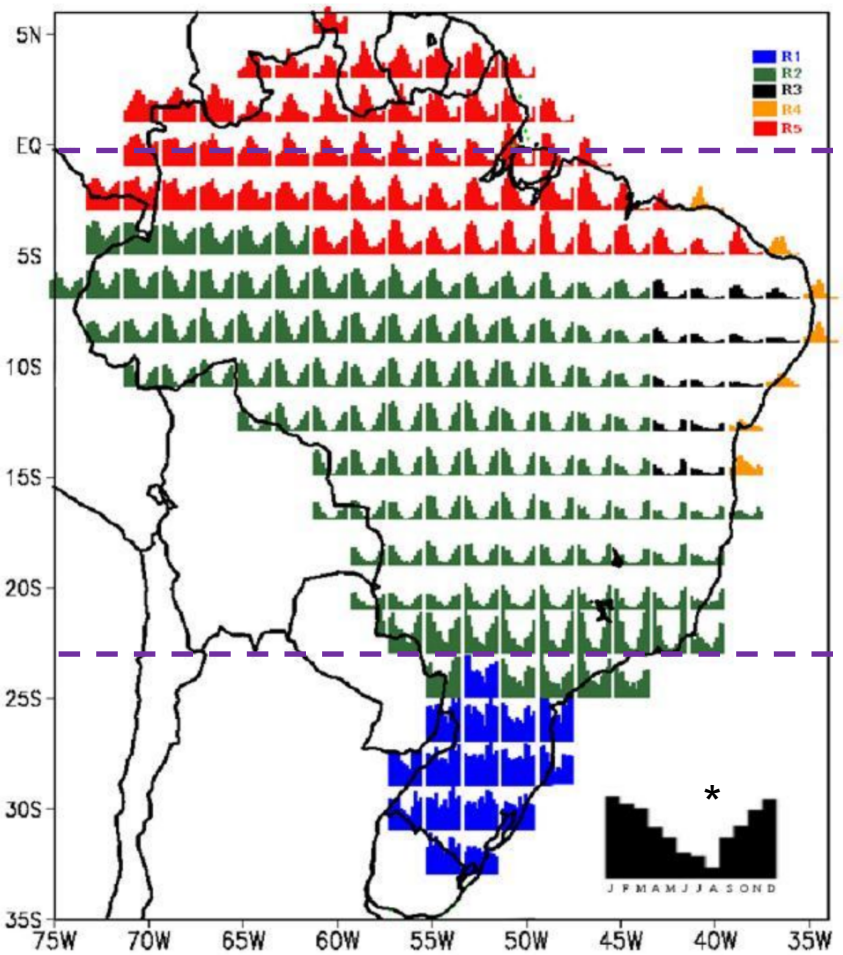
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES

PÁTRIA AMADA BRASIL GOVERNO FEDERAL

Outline

- GPM constellation algorithms and diurnal cycle over tropical region during the rainy season.
- Can daily bias-correction techniques improve the diurnal cycle retrieval. The SHM portal.
- GPM data applications: How well known algorithms can retrieve extreme events – Preliminary results from FROGS database.

Diurnal Cycle



Spatial distribution of precipitation climatology (1998–2016) based on daily bias-corrected data

Period: 2014-2018 (GPM era)

Area: Equator – 23.5˚ S

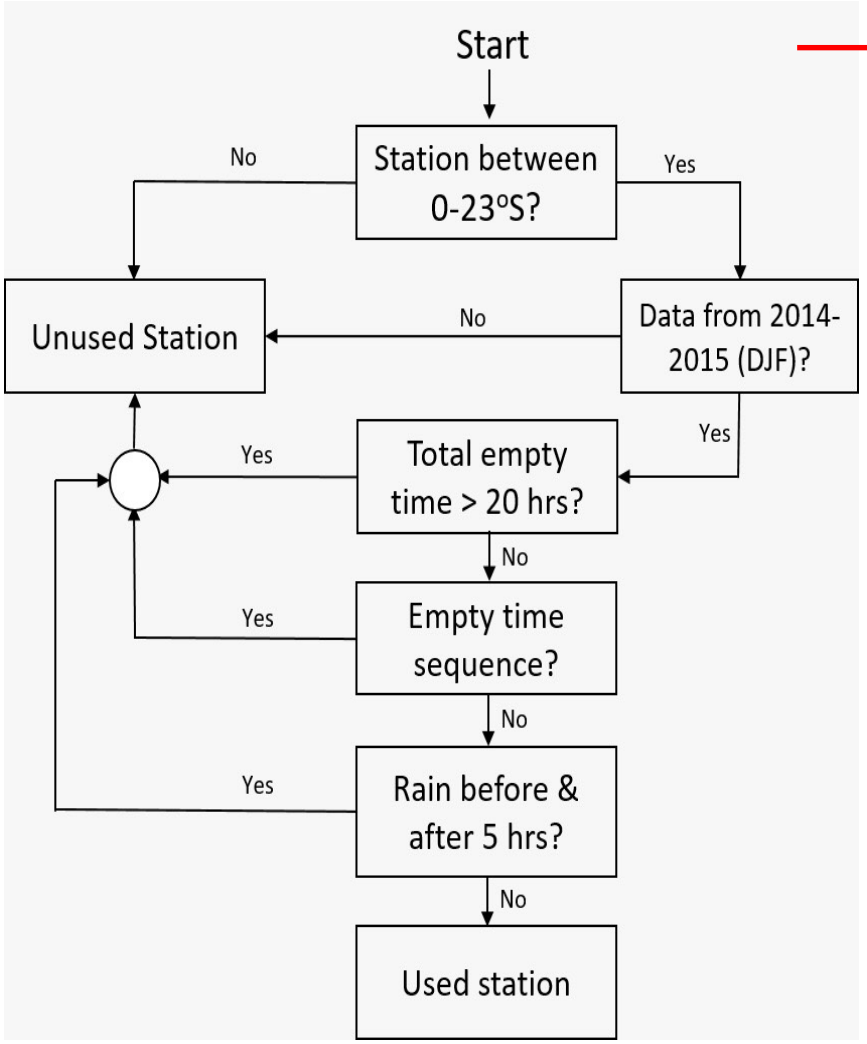
Rainy season: DJF*

Ground truth: Hourly gauge data (automatic stations) – 402 gauges in the tropics, no QC.

GPM algorithms: CMORPH (no gauges), IMERG-late (no gauge), IMERG-Final – 1 hour accumulation

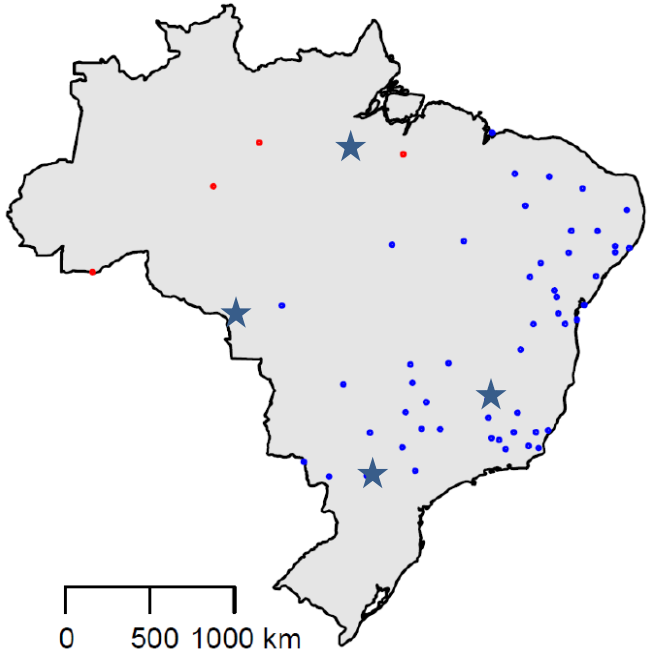
Validation metrics: bias, RMSE, correlation coeficient, standard deviation (Taylor diagram) and hourly pdf for different regions (individual stations)

Diurnal Cycle



402 gauge stations over the tropics

54 valid stations after QC



# of available gagues per region

Midwest: 8
Northeast: 23
North: 6
Southeast: 19
South: 1

Diurnal Cycle

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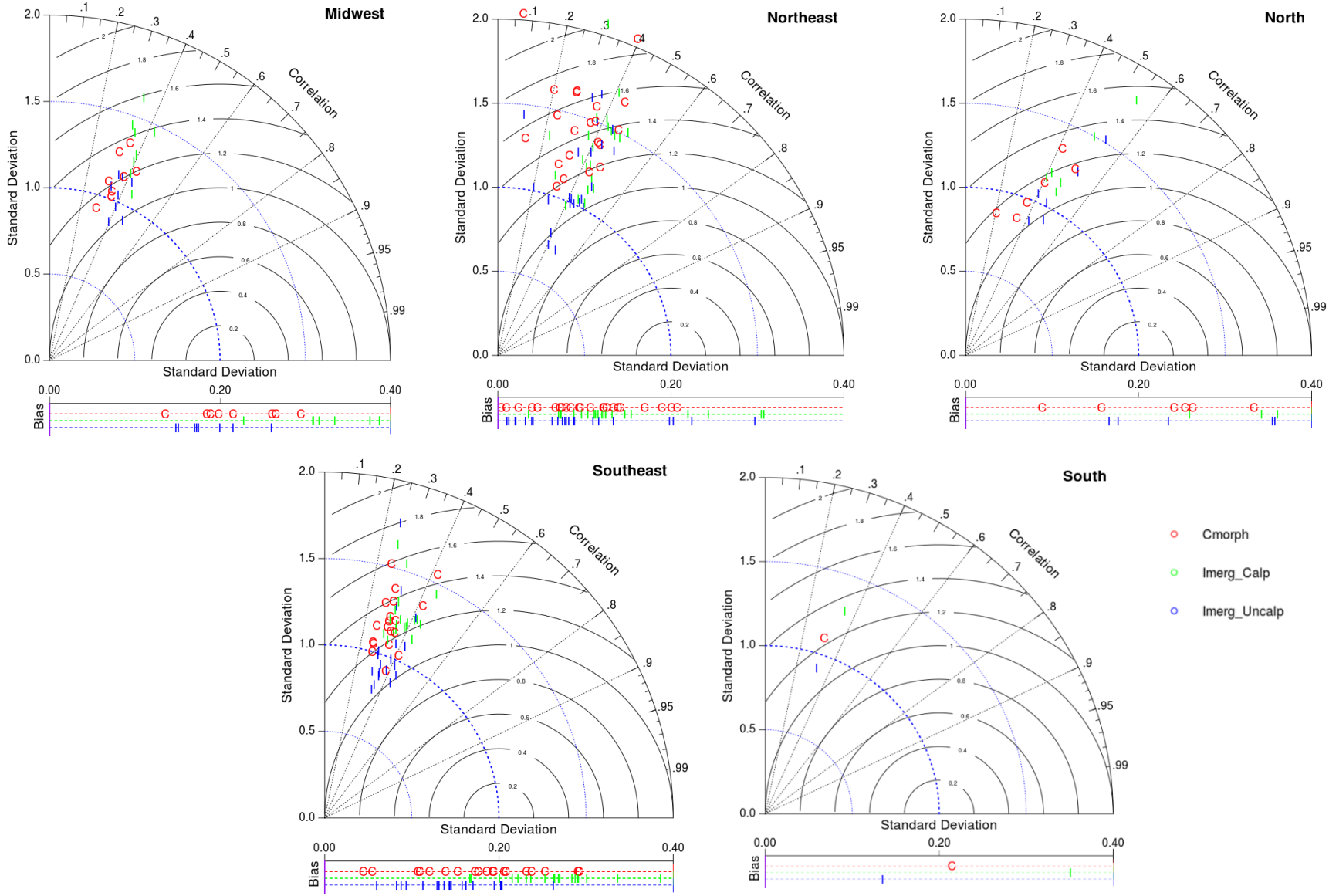
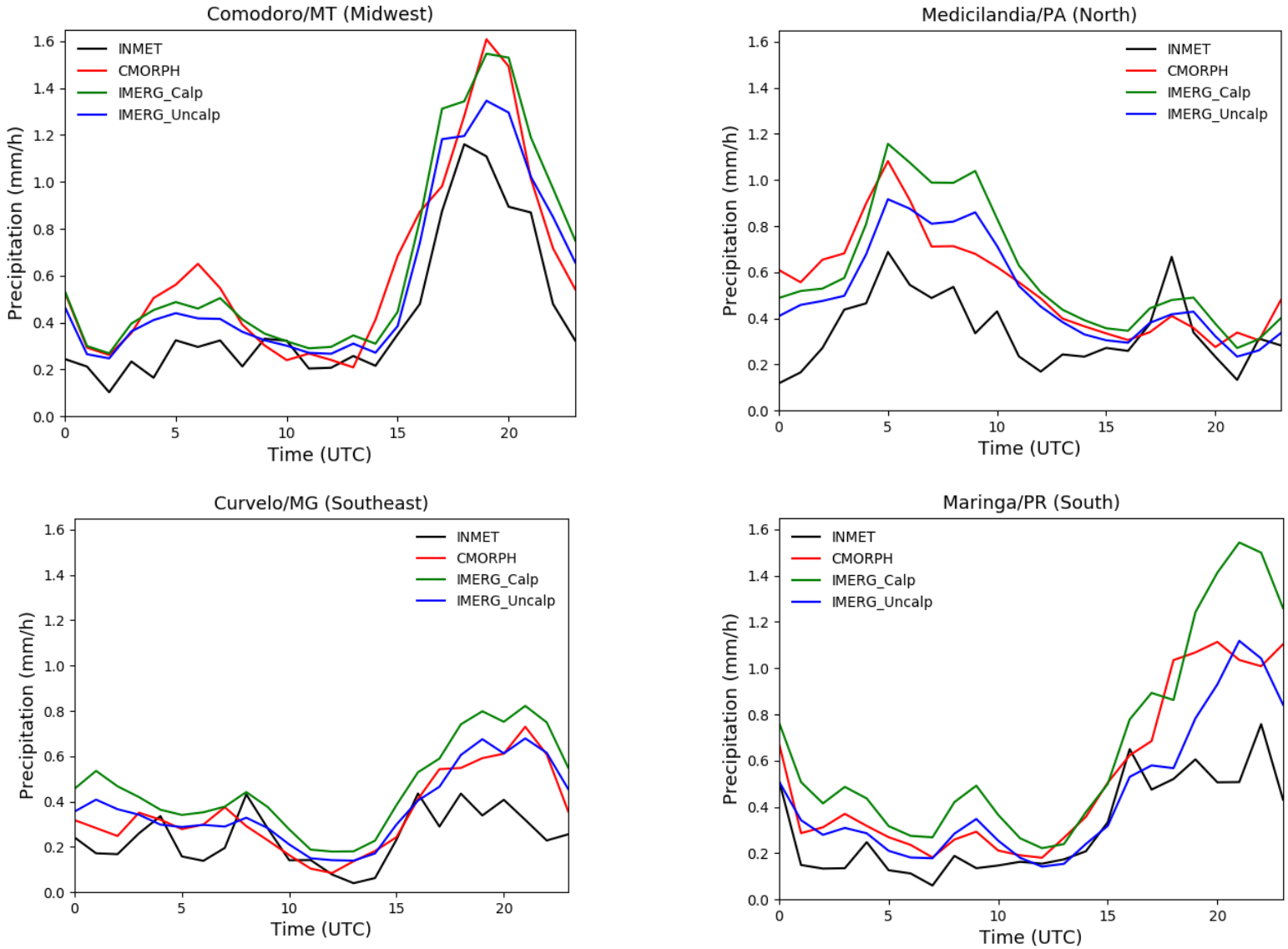
REGION	AUTOMATIC STATION	CMORPH			IMERG_Calp			IMERG_Uncalp		
		Bias	R	Sd	Bias	R	Sd	Bias	R	Sd
MIDWEST	GOIANIA	0.2947797	0.3520109	1.344947	0.334282	0.3924784	1.296205	0.1993533	0.3861595	1.040088
MIDWEST	MORRINHOS	0.1887768	0.3503081	1.045725	0.375373	0.4202201	1.457496	0.2151491	0.4240173	1.138634
MIDWEST	PONTA PORA	0.2607877	0.4218977	1.208777	0.3087605	0.3531683	1.410403	0.1719271	0.3729213	1.144332
MIDWEST	TRES LAGOAS	0.1843902	0.3768791	1.150648	0.309238	0.3348617	1.447777	0.1701322	0.3360307	1.071305
MIDWEST	ITAQUIRAI	0.2153136	0.321901	1.27507	0.3159983	0.3402333	1.619678	0.1482334	0.3520337	1.148235
MIDWEST	COMODORO	0.19869	0.3539426	1.018555	0.227807	0.447559	1.075336	0.1505948	0.4641391	0.9168883
MIDWEST	NOVA MARINGA	0.1359949	0.2943152	0.927402	0.3864582	0.4001636	1.183764	0.1742229	0.3957082	0.8738405
MIDWEST	ALTO TAQUARI	0.2658076	0.318278	1.094968	0.4418012	0.3930058	1.255481	0.2602858	0.398428	0.9677353
NORTHEAST	MACEIO *	0.003871307	0.3600585	1.589939	0.07160088	0.4073447	1.711247	0.06261923	0.2836754	2.340284
NORTHEAST	PALMEIRA DOS INDIOS	0.03886473	0.1214543	1.304142	0.07224019	0.2212913	1.340445	0.04057722	0.1992539	1.020961
NORTHEAST	ARAPIRACA	0.02365362	0.07175991	2.041238	0.06994125	0.1202111	2.27663	0.03148257	0.1028087	1.442644
NORTHEAST	SALVADOR *	0.08442267	0.2789912	1.639654	0.1320225	0.3733477	1.525159	0.1332581	0.3603308	1.668
NORTHEAST	ITIRUÇU	0.1254481	0.4607718	1.511953	0.112771	0.4647035	1.111666	0.01248719	0.4662989	0.7098146
NORTHEAST	ITABERABA	0.2004373	0.3943889	2.050578	0.1199575	0.4568339	1.186198	0.06912708	0.4580156	1.025531
NORTHEAST	MACAJUBA	0.1333068	0.437086	1.677391	0.111101	0.3699423	1.407678	0.07823753	0.3590167	1.294133
NORTHEAST	IRECÊ	0.1385152	0.2665343	2.340747	0.1453011	0.4099168	1.538384	0.1164055	0.4062795	1.323908
NORTHEAST	BRUMADO	0.1696065	0.4667487	1.266873	0.1463158	0.4874067	1.134891	0.1095545	0.4866195	1.010187
NORTHEAST	UAUA	0.09341851	0.3129311	1.408708	0.0871729	0.4034128	1.353708	0.08734753	0.3804665	1.503941
NORTHEAST	MARAÚ *	0.00953705	0.2332558	1.469213	0.1034044	0.2951387	1.123328	0.03844344	0.2978331	0.9672515
NORTHEAST	DELFINO	0.1213713	0.3753867	1.504558	0.09594691	0.4477727	1.037674	0.0883241	0.435396	1.003662
NORTHEAST	IPIAU	0.07362408	0.41601	1.395361	0.1240114	0.3853768	1.263528	0.02008391	0.383428	0.7917101
NORTHEAST	CRATEUS	0.09489762	0.4256414	1.384592	0.1217245	0.4774043	1.472601	0.07699827	0.4731475	1.13864
NORTHEAST	JAGUARIBE	0.1419391	0.3017142	2.650832	0.1539898	0.3070668	2.073897	0.08774735	0.3333385	1.627426
NORTHEAST	SAO LUIS *	0.07919114	0.3388729	1.11594	0.219107	0.4835437	1.036183	0.2235129	0.4608551	1.04744
NORTHEAST	ALTO PARNAIBA	0.207513	0.3181284	1.061757	0.3039052	0.4158521	1.232471	0.202336	0.4018606	1.025096
NORTHEAST	CAMPINA GRANDE	0.07158333	0.2002367	1.614933	0.07260203	0.4570162	1.46956	0.01984164	0.4179508	0.9941338
NORTHEAST	CABROBÓ	0.1066862	0.3607072	1.486937	0.1151392	0.424588	1.252371	0.07408541	0.4132641	1.025046
NORTHEAST	IBIMIRIM	0.06672726	0.4342765	1.211807	0.1196544	0.491622	1.52373	0.0815277	0.4819657	1.387401
NORTHEAST	TERESINA	0.1895819	0.3271644	1.259354	0.3068064	0.4409287	1.486266	0.2964424	0.4414581	1.500833
NORTHEAST	OEIRAS	0.1227398	0.2939289	1.192739	0.2427479	0.4246801	1.500545	0.1980601	0.4303074	1.389624
NORTHEAST	ITABAIANINHA	0.0459873	0.278804	1.632152	0.03487131	0.4008523	0.9743228	0.0101265	0.4022866	0.7203816
NORTH	MEDICILANDIA	0.08880817	0.203382	0.8649892	0.2588097	0.4714964	1.103906	0.1652042	0.4839648	0.922592
NORTH	SANTANA DO ARAGUAIA	0.2535754	0.3613261	0.977234	0.3419976	0.4707668	1.165761	0.2341999	0.4594393	1.019002
SOUTHEAST	ALFREDO CHAVES	0.05497622	0.2680811	1.050062	0.1665541	0.3028286	1.116619	0.1123755	0.3077106	0.9899913
SOUTHEAST	ALEGRE	0.1766155	0.2926394	1.388512	0.2364917	0.304699	1.543193	0.1617634	0.3191264	1.291488
SOUTHEAST	BARBACENA	0.231444	0.3337013	1.213421	0.2832737	0.3533889	1.223543	0.1427207	0.3362007	0.9450222
SOUTHEAST	UBERLÂNDIA	0.252681	0.3078085	1.195232	0.3361124	0.3443536	1.190401	0.1701557	0.3463255	0.8970669
SOUTHEAST	VICOSA	0.1089679	0.3819882	0.9217336	0.2528093	0.4392723	1.245272	0.08259314	0.432671	0.8649761
SOUTHEAST	TIMÓTEO	0.152912	0.3078626	1.22503	0.2314056	0.320274	1.320398	0.09320279	0.3042948	1.014381
SOUTHEAST	SAO JOAO DEL REI	0.1387678	0.263821	1.055285	0.2635174	0.3445801	1.137796	0.08714381	0.342044	0.8203823
SOUTHEAST	JUIZ DE FORA	0.2907687	0.4169002	1.351092	0.269542	0.3883709	1.199216	0.2023997	0.374169	1.084615
SOUTHEAST	CAMPINA VERDE	0.2376941	0.3113712	1.165377	0.2906078	0.3510482	1.165797	0.1308651	0.3491431	0.8777278
SOUTHEAST	FLORESTAL	0.1200098	0.3455228	1.069064	0.2152933	0.3316486	1.088703	0.05938412	0.3364459	0.7922106
SOUTHEAST	CURVELO	0.1070017	0.4099618	1.0305	0.221356	0.4369106	1.146259	0.1288683	0.4444701	0.9200689
SOUTHEAST	UNAÍ	0.1860104	0.3000963	1.312858	0.2631173	0.4108534	1.251454	0.1436864	0.4151749	0.9667957
SOUTHEAST	RIO PARDO DE MINAS	0.17288	0.4184139	1.550416	0.1999557	0.4441218	1.442735	0.1369943	0.4103654	1.269872
SOUTHEAST	CAMBUCI	0.1941048	0.2516481	1.517811	0.2683348	0.2565579	1.637271	0.2623797	0.2459495	1.760979
SOUTHEAST	CAMPOS DOS GOYTACAZES	0.04394287	0.2747197	0.9991936	0.1674549	0.3177863	1.268951	0.1941043	0.3163111	1.385279
SOUTHEAST	FRANCA	0.2922613	0.2597508	1.150772	0.38552	0.3109068	1.209024	0.2014154	0.3049835	0.8885718
SOUTHEAST	AVARÉ	0.1923817	0.3496542	1.146464	0.2869956	0.3820771	1.191103	0.1446157	0.3798878	0.9235173
SOUTHEAST	LINS	0.2078913	0.3306261	1.146114	0.3002095	0.4180494	1.26185	0.2028105	0.4195202	1.091139
SOUTHEAST	BARRETOS	0.2054018	0.2702444	1.293514	0.2902509	0.3868407	1.221131	0.1572765	0.3829615	0.9920944
SOUTH	MARINGA	0.214477	0.3092989	1.101543	0.3503001	0.3549053	1.288594	0.1347715	0.3203094	0.9146157
NORTH	EPITACIOLANDIA	0.333044	0.4068843	1.124636	0.3604845	0.4145219	1.193057	0.1757712	0.4143158	0.8790615
NORTH	ITACOATIARA	0.2412372	0.4156146	1.35254	0.4514385	0.495939	1.497281	0.3575152	0.510154	1.268082
NORTH	MANICORE	0.1568442	0.3399849	0.8691216	0.4408186	0.4026901	1.155905	0.3544992	0.3993319	1.048382
NORTH	TUCURUI	0.2626339	0.4978025	1.277233	0.678046	0.5440396	1.811473	0.5577403	0.5340722	1.515823

Diurnal Cycle



Diurnal Cycle



Diurnal Cycle

Some VERY preliminary conclusions…

- Diurnal cycle phase is well represented by all analyzed algorithms.

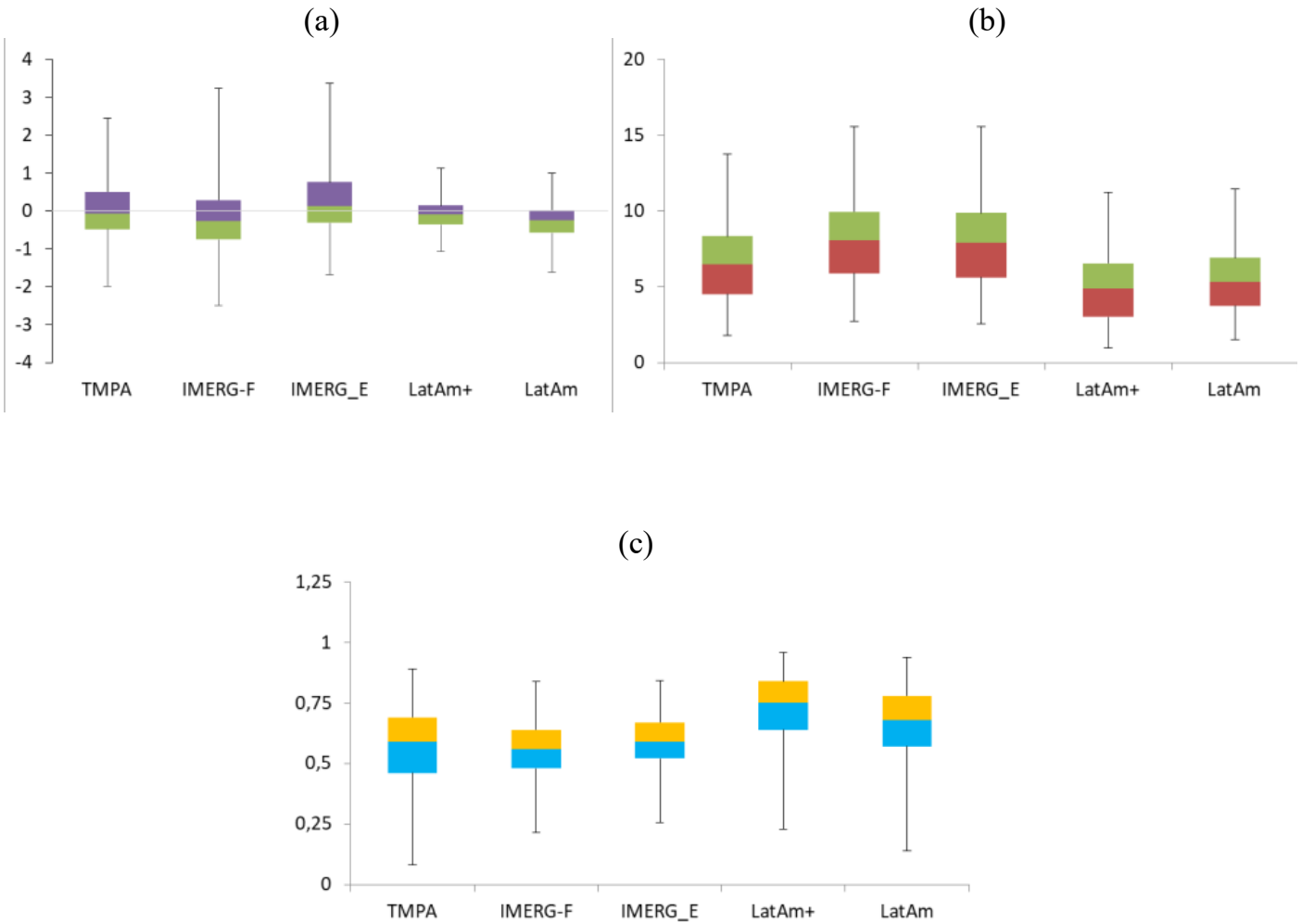
- However the precipitation is underestimated in almost all times and regions.

- Monthly bias-corrected algorithms (IMERG-Final) improves marginally the correlation coefficient but the bias is larger when compared with satellite-only algorithms (IMERG, CMORPH)

Outline

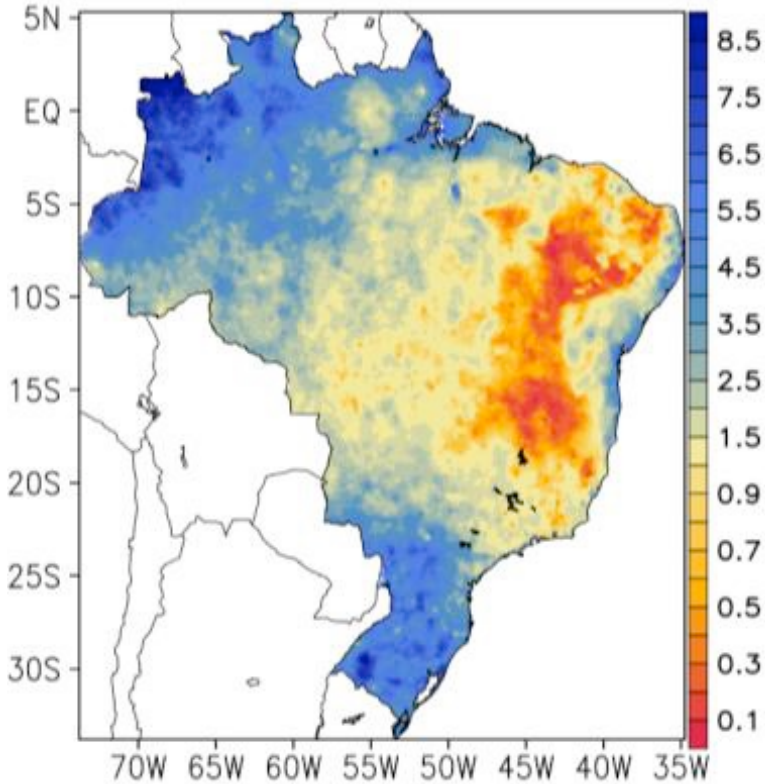
- GPM constellation algorithms and diurnal cycle over tropical region during the rainy season.
- Can daily bias-correction techniques improve the diurnal cycle retrieval ? The SHM portal
- GPM data applications: How well known algorithms can retrieve extreme events – Preliminary results from FROGS database

SIGMA SMH

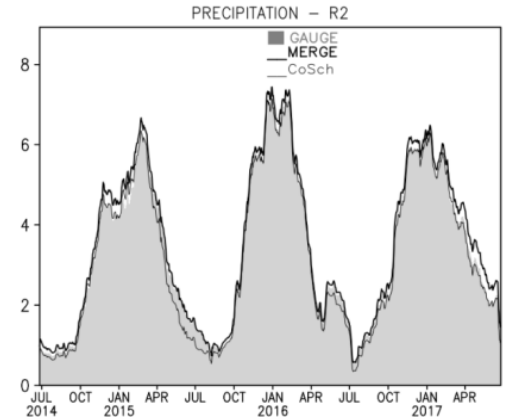


(a) Bias, (b) Root Mean Square Error (RMSE) and (c) Correlation for TMPA, IMERG-F, IMERG-E, LatAm+ (IMERG + daily gauges) and LatAm (TMPA + gauges)

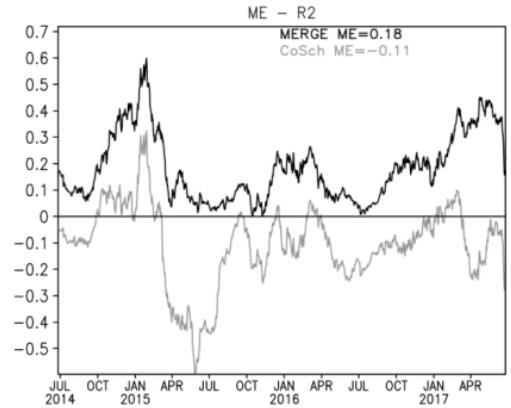
SIGMA SMH



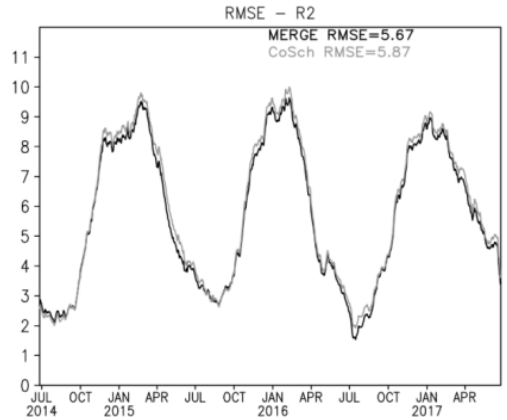
Spatial distribution of the mean precipitation (2014-2018)



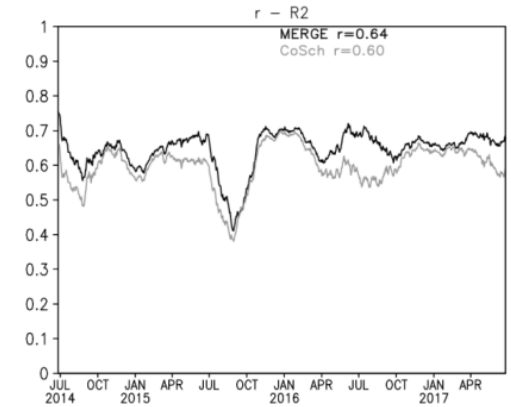
(a)



(b)



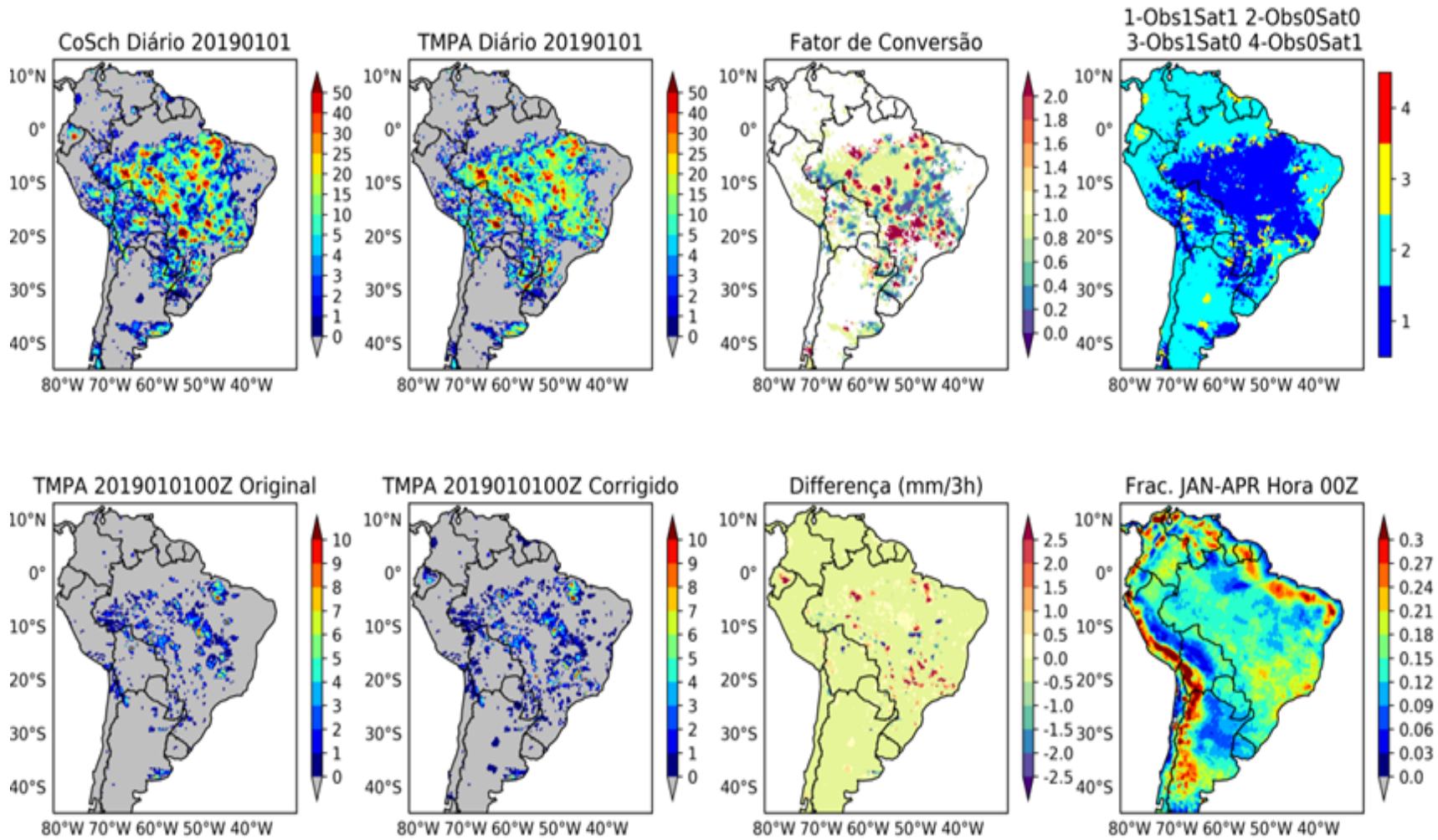
(c)



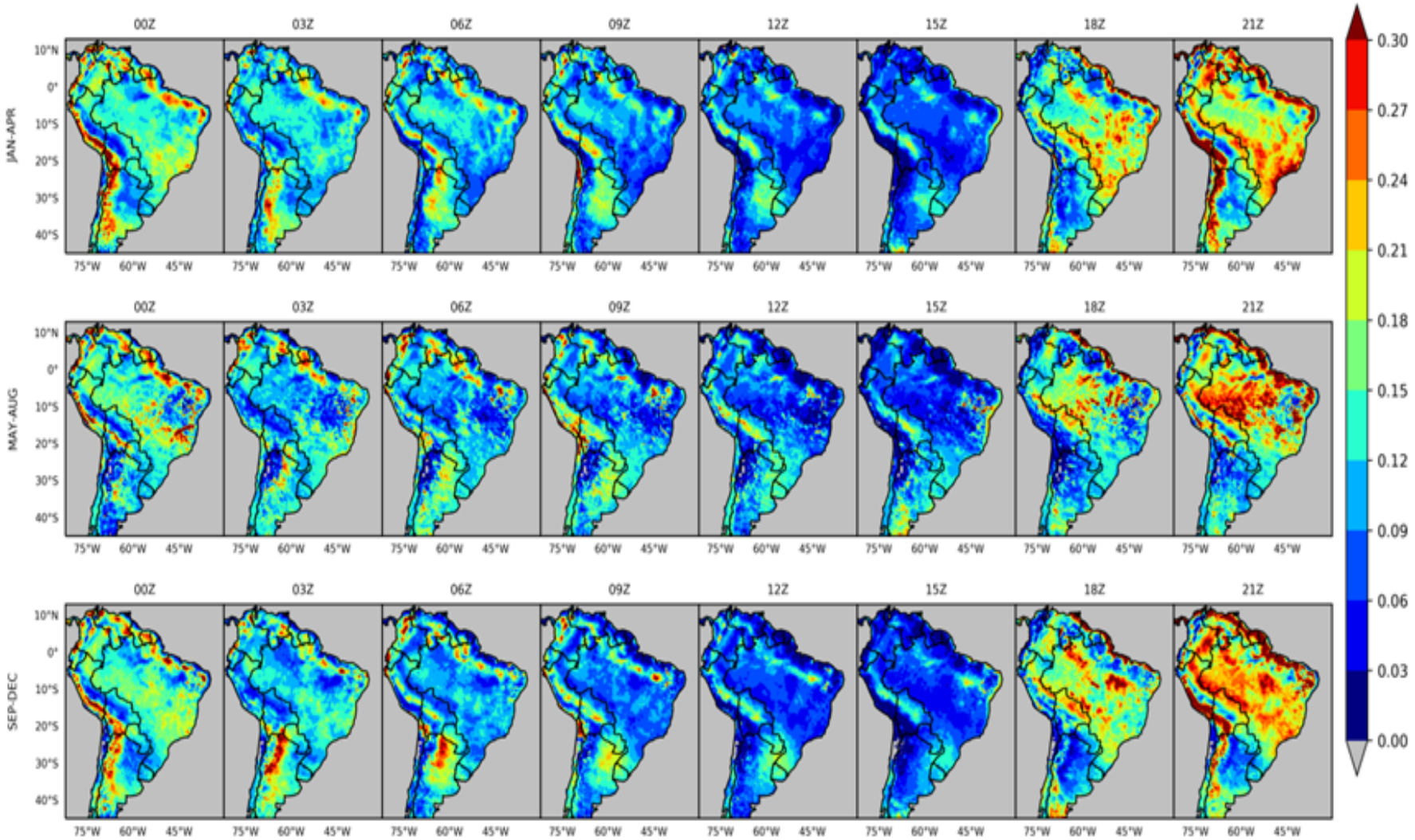
(d)

IMERGE-Early + **daily** rain gauges (>2000)

SIGMA SMH


CoSch Diário 20190101
TMPA Diário 20190101
Fator de Conversão
1-Obs1Sat1 2-Obs0Sat0
3-Obs1Sat0 4-Obs0Sat1
TMPA 2019010100Z Original
TMPA 2019010100Z Corrigido
Differença (mm/3h)
Frac. JAN-APR Hora 00Z
10°N
0°
10°S
20°S
30°S
40°S
80°W 70°W 60°W 50°W 40°W

SIGMA SMH


00Z
03Z
06Z
09Z
12Z
15Z
18Z
21Z
JAN-APR
MAY-AUG
SEP-DEC
10°N
0°
10°S
20°S
30°S
40°S
75°W
60°W
45°W
0.30
0.27
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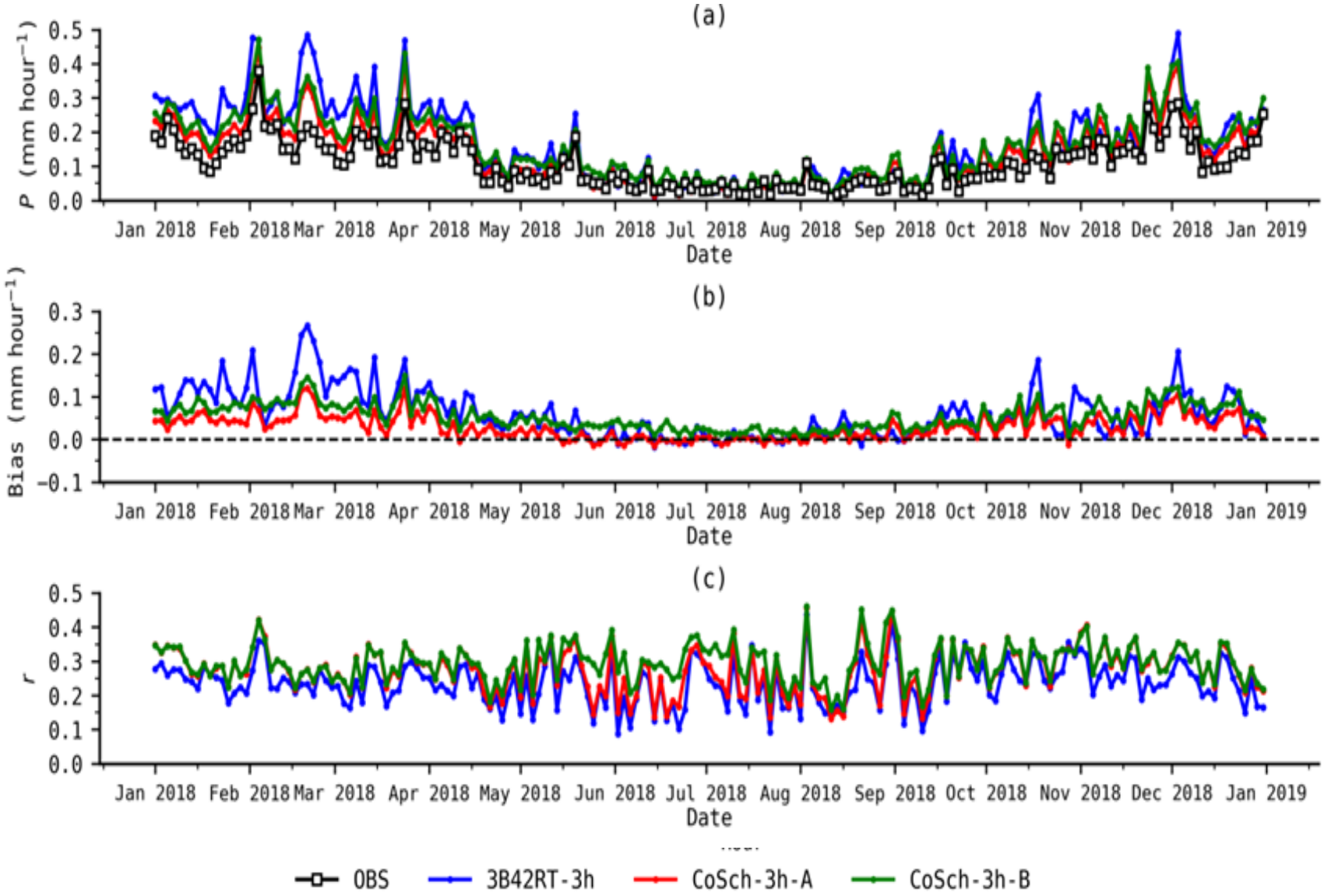
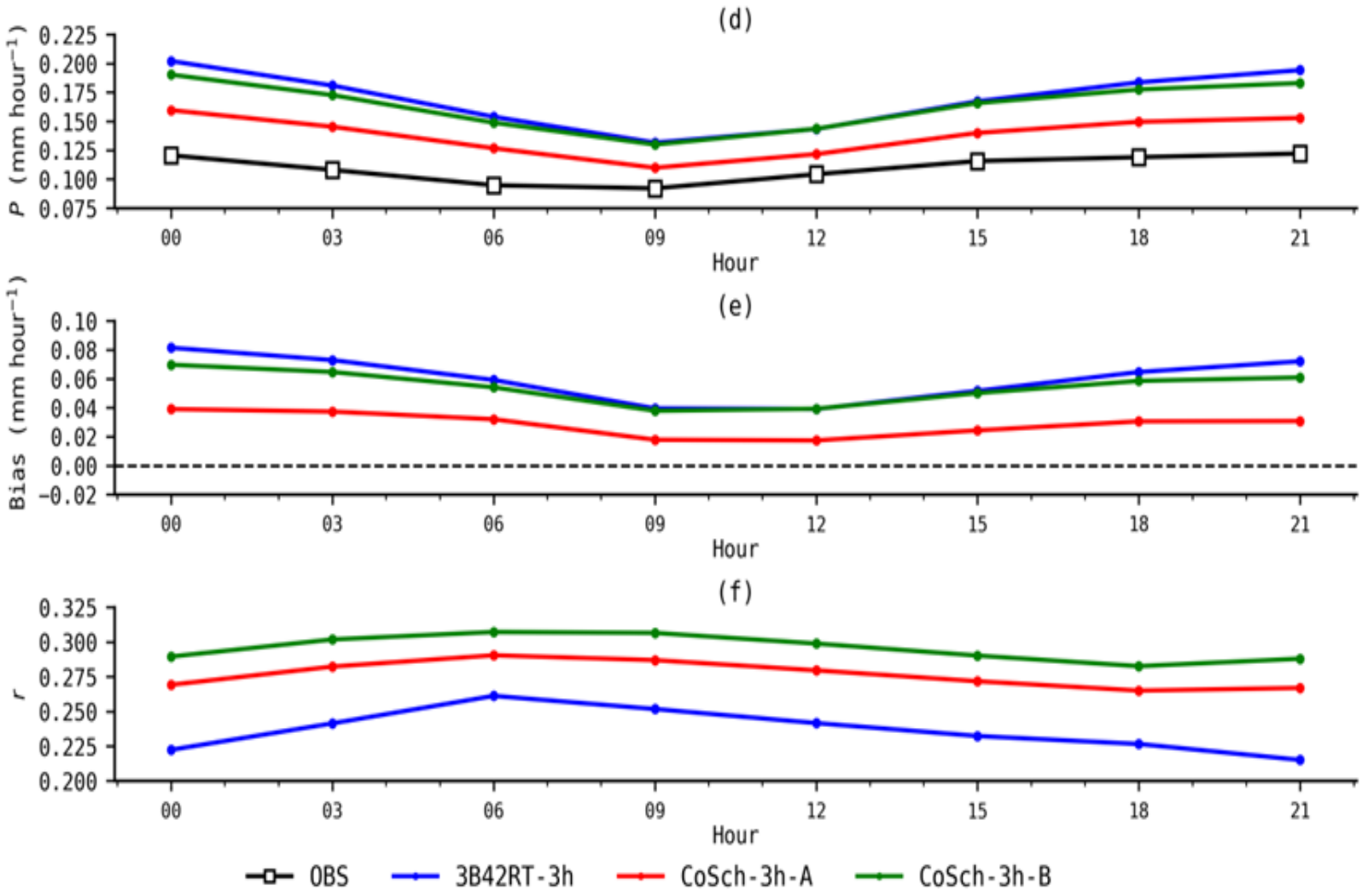
0.00

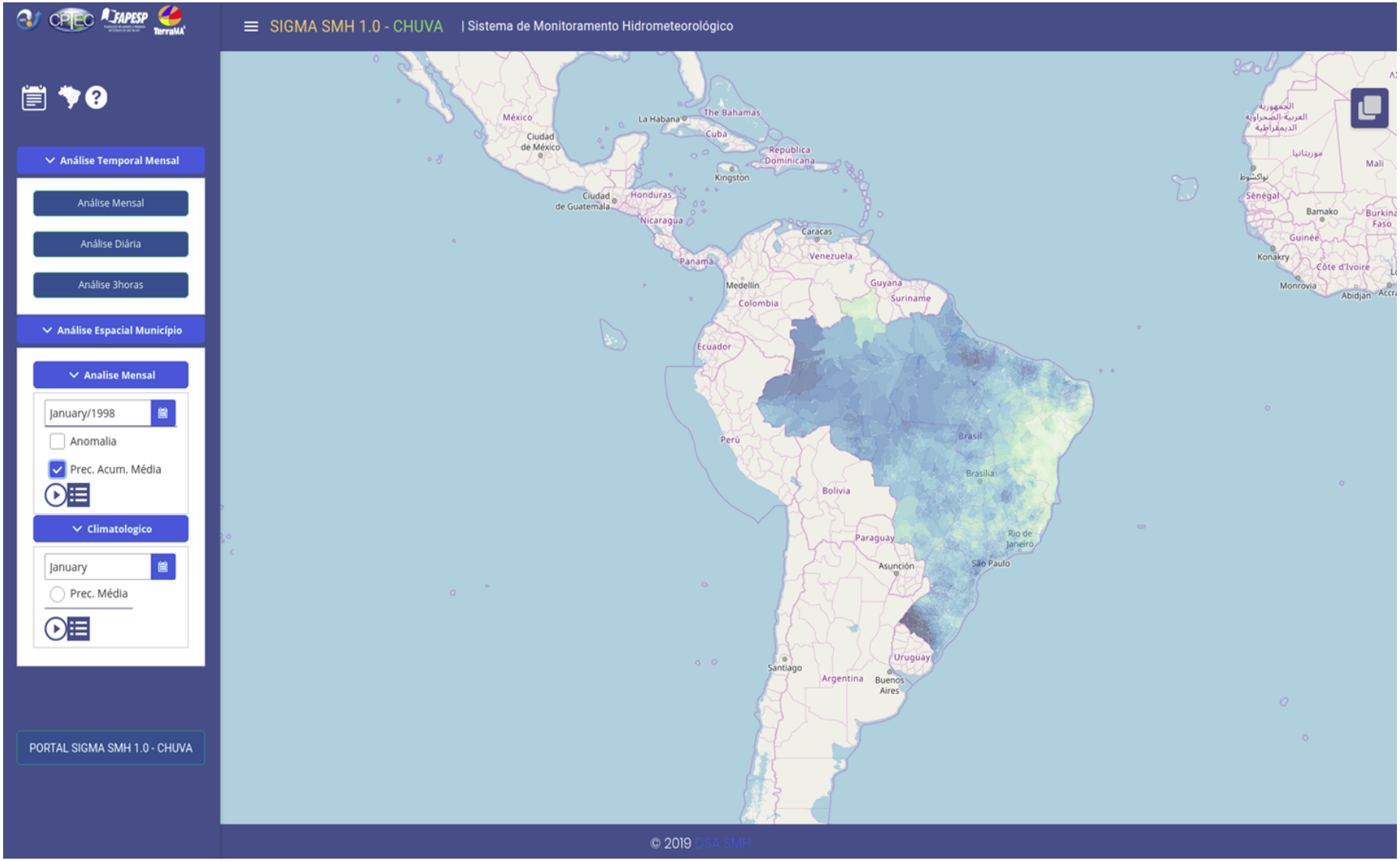
SIGMA SMH


(a)
P (mm hour⁻¹)
0.5
0.4
0.3
0.2
0.1
0.0
Jan 2018 Feb 2018 Mar 2018 Apr 2018 May 2018 Jun 2018 Jul 2018 Aug 2018 Sep 2018 Oct 2018 Nov 2018 Dec 2018 Jan 2019
Date
(b)
Bias (mm hour⁻¹)
0.3
0.2
0.1
0.0
-0.1
Jan 2018 Feb 2018 Mar 2018 Apr 2018 May 2018 Jun 2018 Jul 2018 Aug 2018 Sep 2018 Oct 2018 Nov 2018 Dec 2018 Jan 2019
Date
(c)
r
0.5
0.4
0.3
0.2
0.1
0.0
Jan 2018 Feb 2018 Mar 2018 Apr 2018 May 2018 Jun 2018 Jul 2018 Aug 2018 Sep 2018 Oct 2018 Nov 2018 Dec 2018 Jan 2019
Date
OBS
3B42RT-3h
CoSch-3h-A
CoSch-3h-B

SIGMA SMH


(d)
P (mm hour⁻¹)
0.225
0.200
0.175
0.150
0.125
0.100
0.075
00
03
06
09
12
15
18
21
Hour
(e)
Bias (mm hour⁻¹)
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
Hour
(f)
r
0.325
0.300
0.275
0.250
0.225
0.200
Hour
OBS
3B42RT-3h
CoSch-3h-A
CoSch-3h-B

SIGMA SMH


SIGMA SMH 1.0 - CHUVA
| Sistema de Monitoramento Hidrometeorológico
Análise Temporal Mensal
Análise Mensal
Análise Diária
Análise 3horas
Análise Espacial Município
Analise Mensal
January/1998
Anomalia
Prec. Acum. Média
Climatologico
January
Prec. Média
PORTAL SIGMA SMH 1.0 - CHUVA
México
Ciudad de México
La Habana
The Bahamas
Cuba
República Dominicana
Kingston
Ciudad de Guatemala
Honduras
Nicaragua
Caracas
Venezuela
Panamá
Medellín
Colombia
Guyana
Suriname
Ecuador
Perú
Brasil
Brasília
Bolivia
Paraguay
Asunción
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Uruguay
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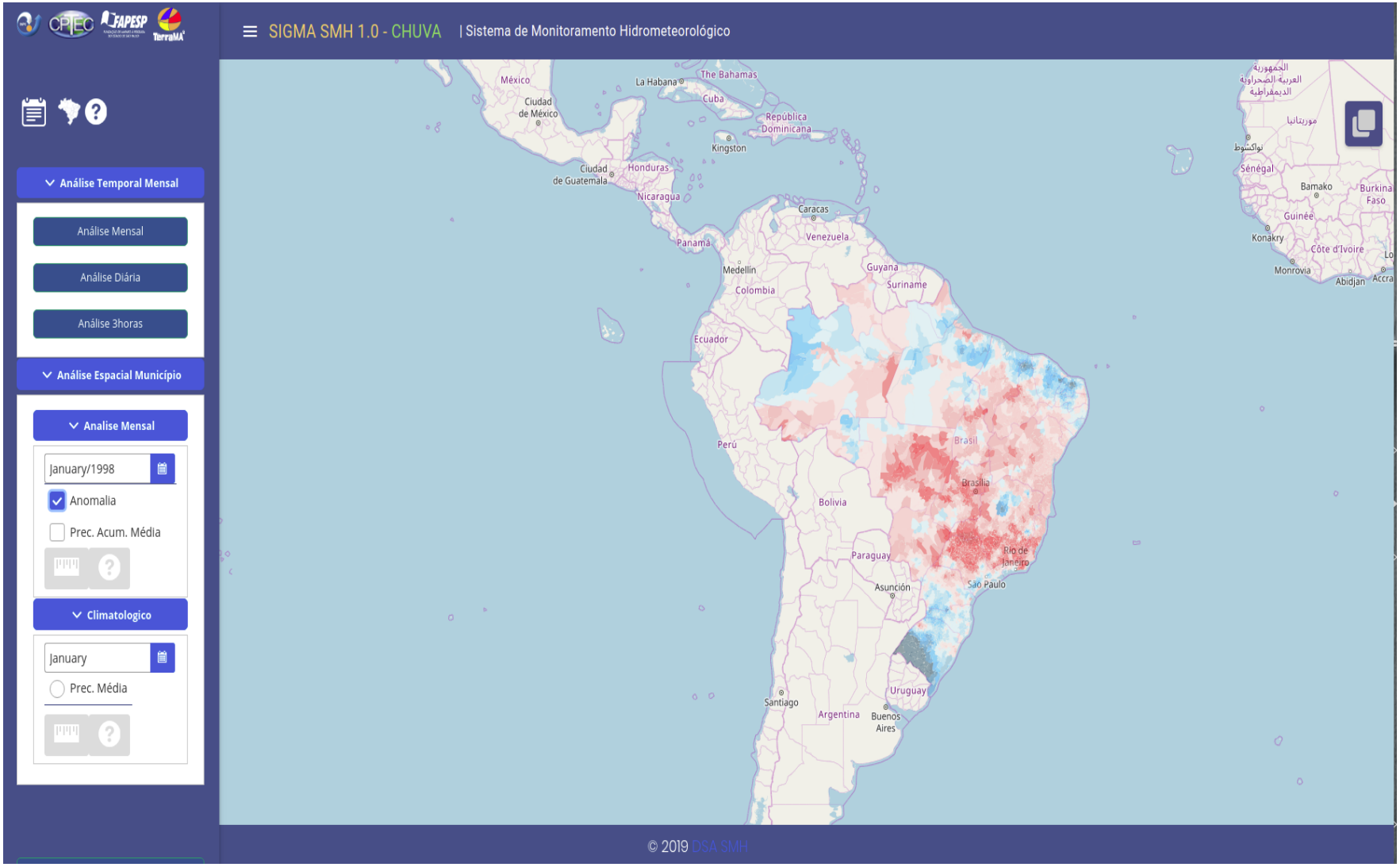
SIGMA SMH 1.0 - CHUVA
| Sistema de Monitoramento Hidrometeorológico
Análise Temporal Mensal
Análise Mensal
Análise Diária
Análise 3horas
Análise Espacial Município
Analise Mensal
January/1998
Anomalia
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Climatologico
January
Prec. Média
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La Habana
The Bahamas
Cuba
República Dominicana
Kingston
Ciudad de Guatemala
Honduras
Nicaragua
Caracas
Venezuela
Panamá
Medellín
Colombia
Guyana
Suriname
Ecuador
Perú
Brasil
Brasília
Bolivia
Paraguay
Asunción
Rio de Janeiro
São Paulo
Uruguay
Santiago
Argentina
Buenos Aires
Sénégal
Bamako
Burkina Faso
Guinée
Konakry
Côte d'Ivoire
Monrovia
Abidjan
Accra
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Análise Mensal Dados Climatológico!

Busca de Dados

Data Inicial:

January/1998

Data Final:

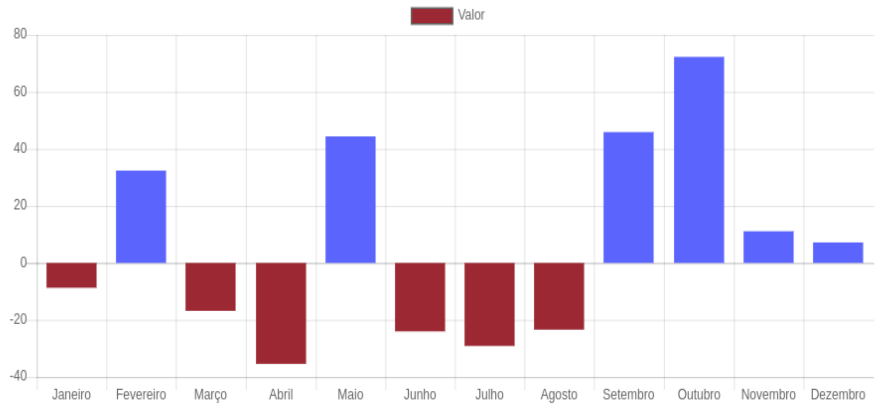
December/1998

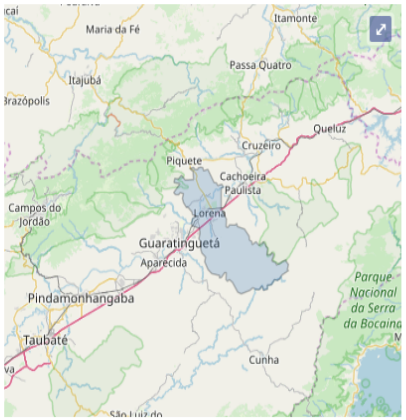
Anomalia

SP

Lorena

Buscar Fechar





MÊS	Valor Anomalia	Municipio
Janeiro	-8.7	Lorena
Fevereiro	32.4	Lorena
Março	-16.8	Lorena
Abril	-35.4	Lorena
Maio	44.4	Lorena
Junho	-24	Lorena
Julho	-29.1	Lorena
Agosto	-23.4	Lorena
Setembro	45.9	Lorena
Outubro	72.3	Lorena
Novembro	11.1	Lorena

Outline

- GPM constellation algorithms and diurnal cycle over tropical region during the rainy season.
- Can daily bias-correction techniques improve the diurnal cycle retrieval. The SHM portal
- GPM data applications: How well known algorithms can retrieve extreme events – Preliminary results from FROGS database

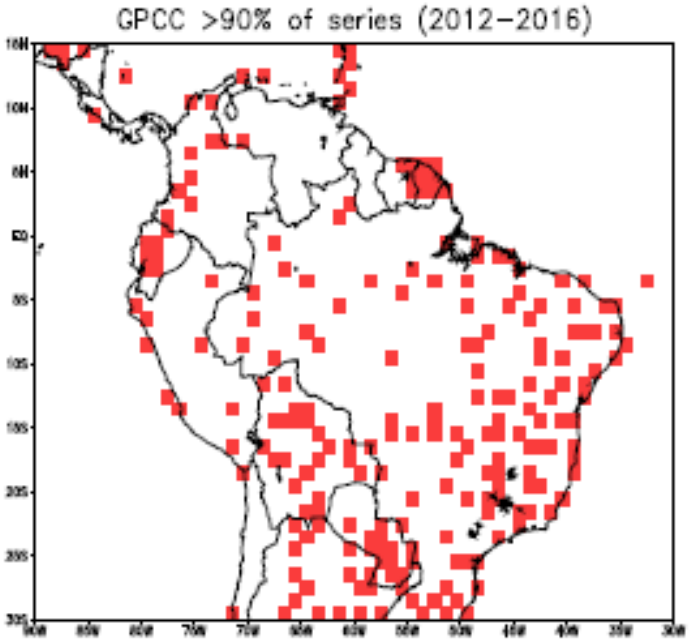
FROGS : A 1DD Rainfall Database

Frequent Rainfall Observations on GridS is a new dataset composed by daily precipitation gridded products that include satellite, ground-based and reanalysis products gridded to a common 1°x1° daily resolution. The database is formed by 32 products where the files are produced within netCDF-4 format and 83 contains information as longitude, latitude, time and rain.

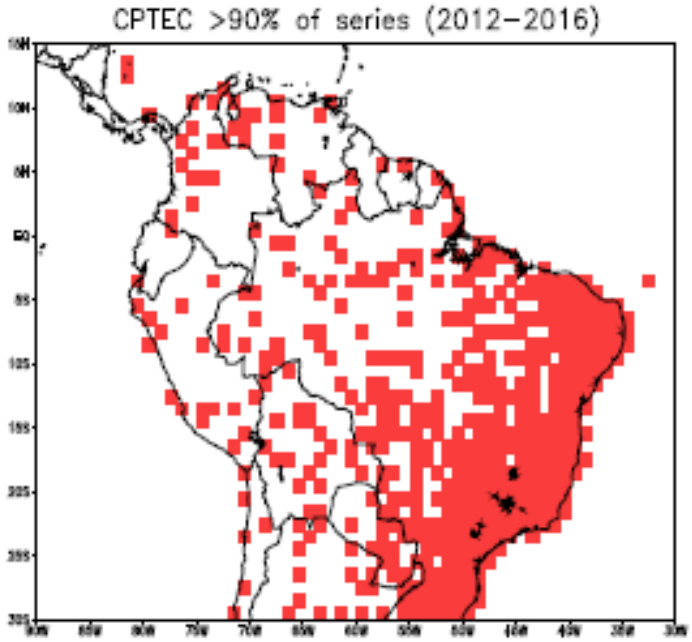
Table 1. Description table of satellite products (adapted from Roca at al 2018)

Satellite product version	Spacial coverage	Use rain gauges	Use IR sensor	Use MW sensor	References
CHIRP v2.0	50S-50N 180W-180E Land only	No	Yes	No	(Funk et al. 2015)
CHIRPS v2.0	50S-50N 180W-180E Land only	Yes	Yes	No	(Funk et al. 2015)
PERSIANN CDR v1 r1	50S-50N 180W-180E	Yes	Yes	No	(Ashouri et al., 2015) (Sorooshian et al., 2014)
3B42 RT v7.0 uncalibrated	50S-50N 180W-180E	No	Yes	Yes	(Huffman et al. 2009)
3B42 RT v7.0	50S-50N 180W-180E	Yes	Yes	Yes	(Huffman et al. 2009)
GSMAP-NRT-no gauges v6.0	50S-50N 180W-180E	Yes	Yes	Yes	(Kubota et al., 2007)
GSMAP-NRT-gauges v6.0	50S-50N 180W-180E	Yes	Yes	Yes	(Kubota et al., 2007)
CMORPH V1.0, RAW	60S-60N 180W-180E	No	Yes	Yes	(Xie et al., 2017)
CMORPH V1.0, CRT	60S-60N 180W-180E	No	Yes	Yes	(Xie et al., 2017)
TAPEER v1.5	30s-30n 180W-180E	No	Yes	Yes	(Roca et al, 2018)
COSCH	60s-33n 120w-30w Land only	Yes	Yes	Yes	(Vila et al., 2009)

Extreme Events



(a)



(b)

G + IR + MW	IR + MW	Reference
$3B42_g$	3B42	CPTEC
$GSMAP_g$	GSMAP	
$CMORPH_g$	CMORPH	
$COSCH_g$	TAPEER	
G + IR	**IR**	
$CHIRPS_g$	CHIRPS	
$PERSIANN_g$		

Extreme Events

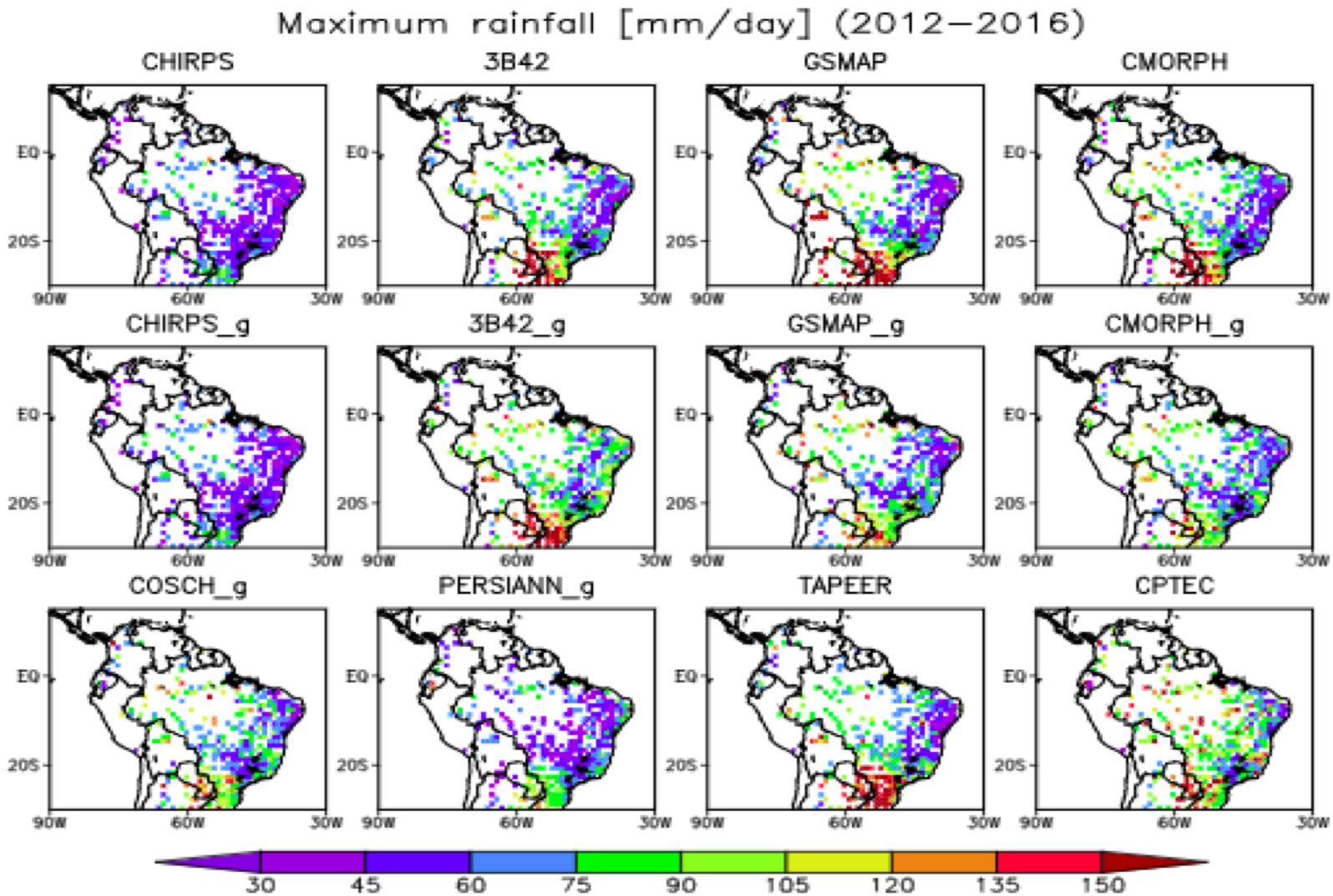
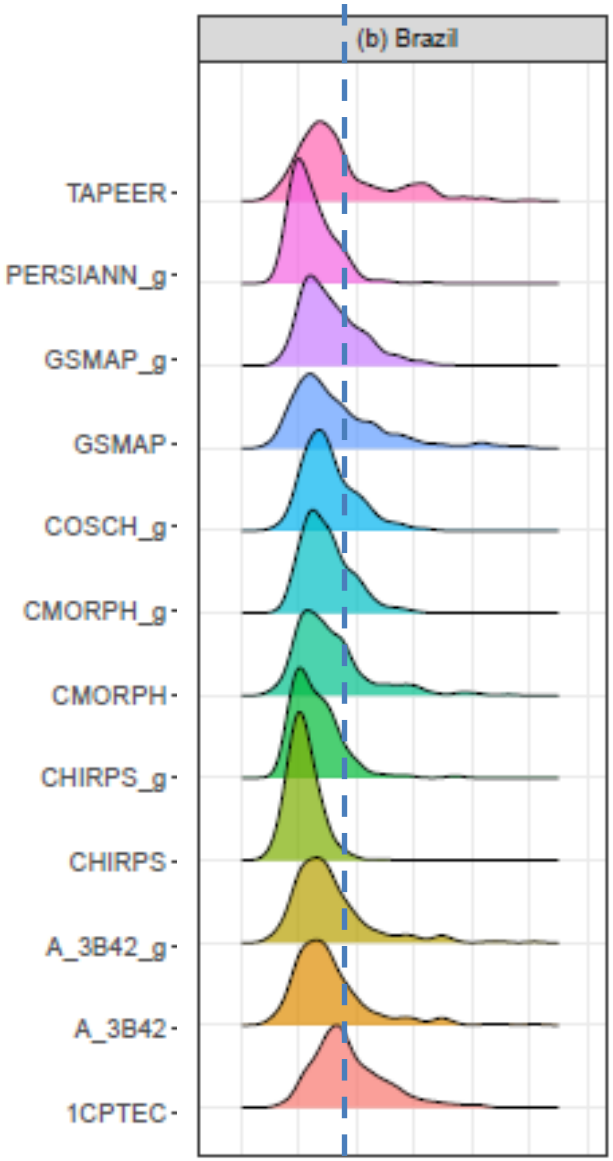
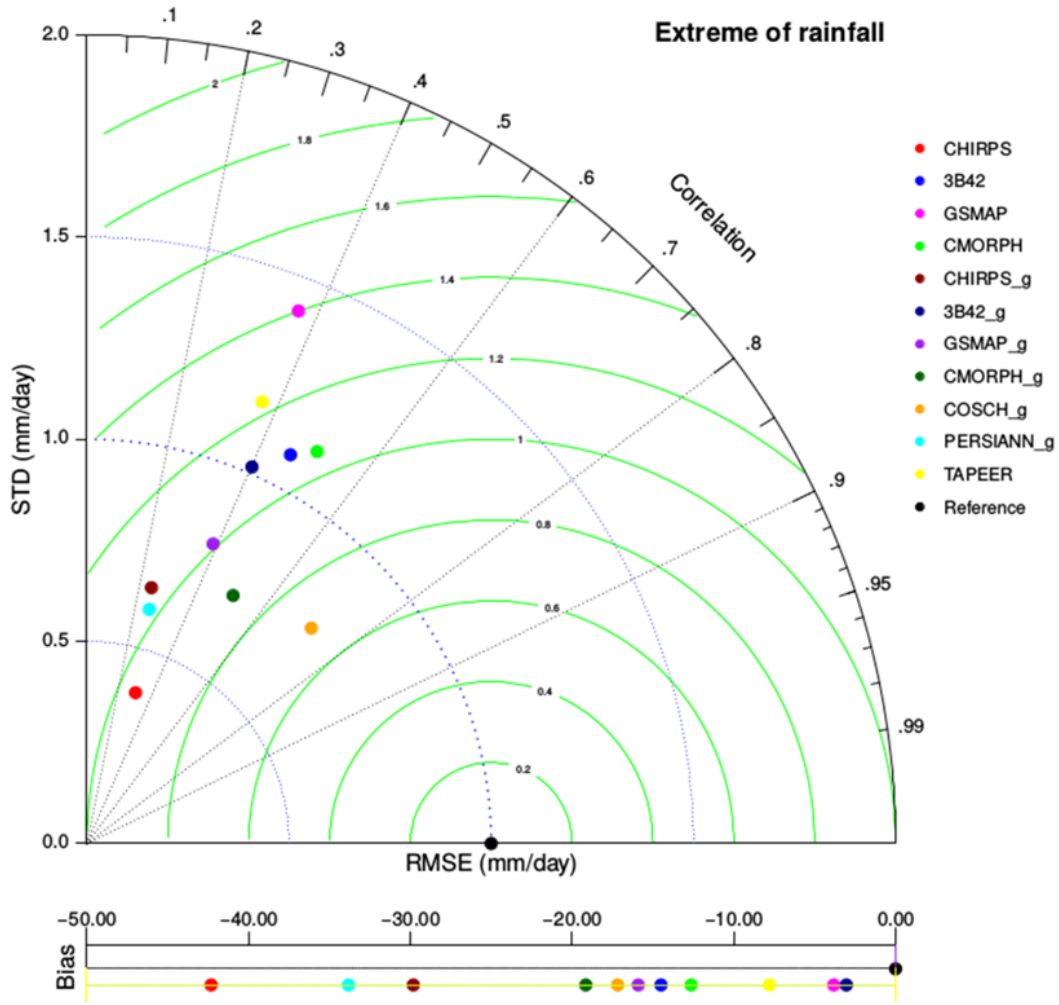


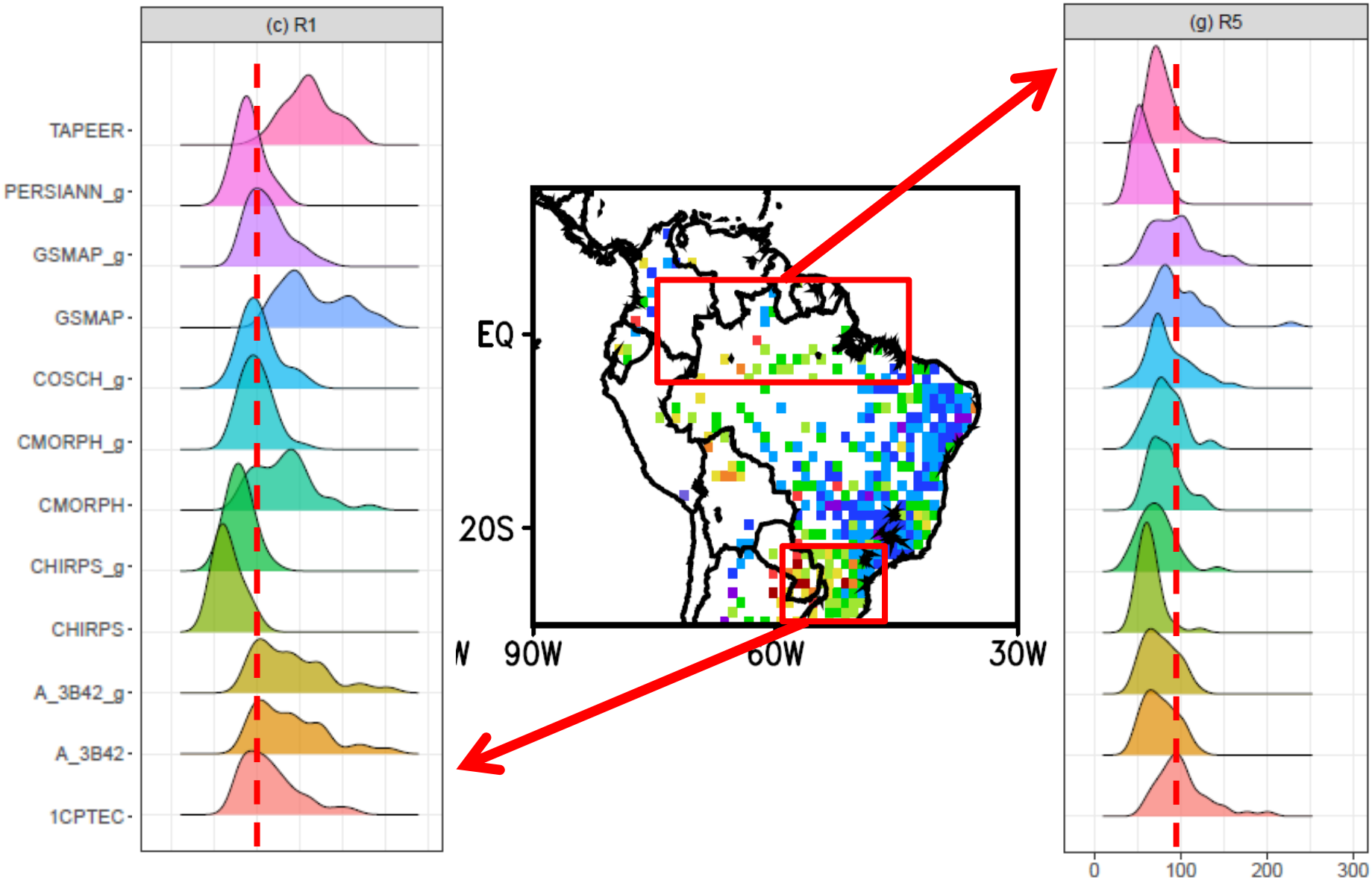
Figure 3. Spacial distribution of maximum rainfall [mm/day] of satellite products.

Extreme Events





Extreme Events



Centro de Previsão de Tempo e Estudos Climáticos

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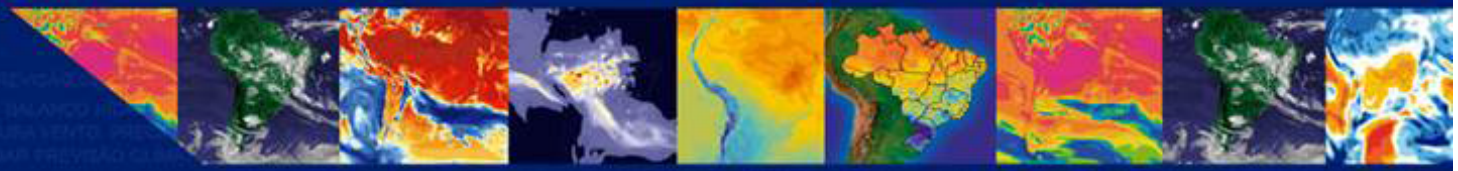
Thank you!

daniel.vila@inpe.br

2019 PMM Science Team Meeting

Ciência e Tecnologia a serviço da sociedade



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INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

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