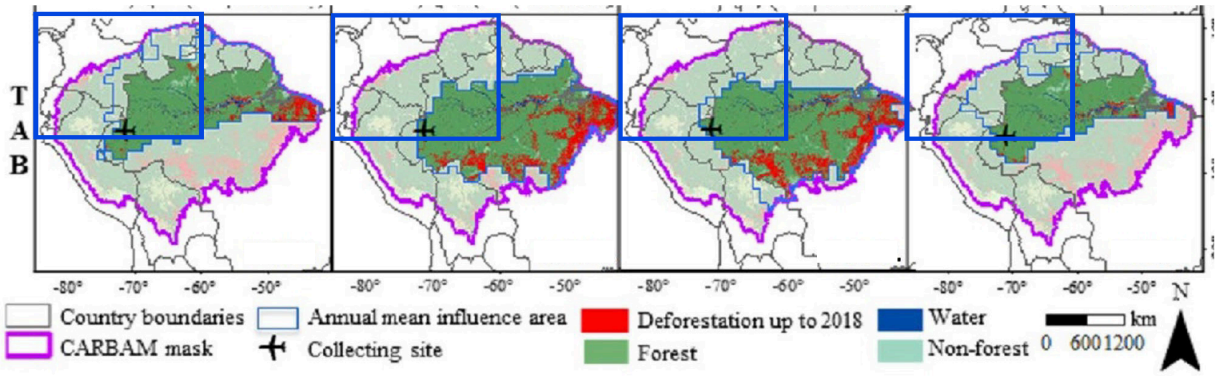

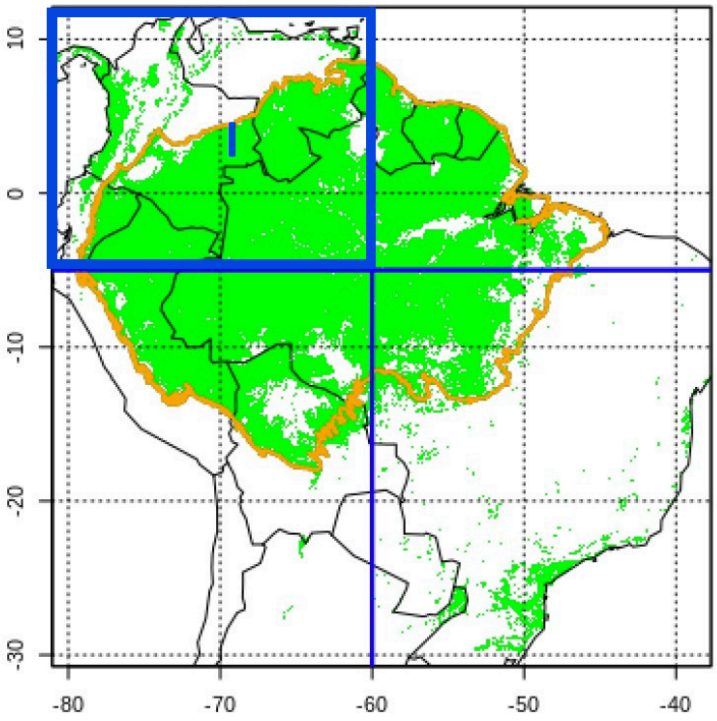

Figure S1. **Special treatment of evergreen broadleaf class in Amazon basin.** (Top) Figure adapted from Gatti et al. (2021) showing deforestation extent through 2018 (red). Deforestation in interior/western Amazon basin (blue quadrant) is significantly less. (Bottom) EBLF classes in blue quadrant calibrated with K34 Interior Amazon eddy flux measurements to reflect carbon exchange in a more ecologically intact rainforest.

Table S1. **WRFv3.8.1 model configuration details**.

Option	Description
Land-surface	Noah land-surface model with MM5 Monin-Obukov surface layer
PBL package	Yongsei University (YSU) scheme
LW radiation	RRTMG
SW radiation	RRTMG
Microphysics	Lin et al.
Convection	Grell-Freitas
Nesting	One-way
Nudging	u,v,T,q at all levels above PBL in d01; u,v in PBL in d01; every 6 h; 1 h relaxation time
Time stepping	3rd order Runge-Kutta; 4 short time steps per long time step
Advection	5th order horizontal, 3rd order vertical positive definite advection for moisture and scalars
Diffusion	2nd order horizontal diffusion using Smagorinsky first-order closure
Damping	No upper level or vertical velocity damping; default values for divergence and external model damping

Table S2. Calibration parameters for ecosystem classes represented by eddy flux sites in VPRM domain. Values and standard deviation provided for each parameter from NLS fitting to non-gapfilled observational data. VPRM model version shown as one of TRA, TRG, SIF, SIFg. For Br-K67, results from seasonal fitting are also provided, as blue font (wet season) and brown font (dry season).

		Eddy Flux Site Used in VPRM Calibration				
		Br-CST	**Br-FNS**	**Br-K34**	**Br-K67**	**Br-PDG**
λ (σ)	**TRA**	0.047 (0.00)	0.067 (0.01)	0.052 (0.01)	0.106 (0.00) 0.138 (0.00) 0.087 (0.00)	0.037 (0.00)
	TRG	0.067 (0.01)	0.082 (0.01)	0.051 (0.01)	0.116 (0.00) 0.160 (0.00) 0.088 (0.00)	0.044 (0.00)
	SIF	0.019 (0.00)	0.029 (0.00)	0.024 (0.00)	0.034 (0.00) 0.033 (0.00) 0.032 (0.00)	0.016 (0.00)
	SIFg	0.033 (0.00)	0.032 (0.00)	0.023 (0.00)	0.038 (0.00) 0.041 (0.00) 0.032 (0.00)	0.019 (0.00)
PAR_0 (σ)	**TRA**	4608 (1380)	2427 (628)	1818 (489)	733 (21) 731 (30) 886 (29)	1996 (328)
	TRG	2377 (434)	1841 (405)	1994 (542)	701 (17) 655 (23) 900 (28)	1572 (238)
	SIF	2295 (379)	1256 (127)	1443 (351)	802 (18) 888 (40) 854 (30)	1296 (151)
	SIFg	1085 (109)	1118 (107)	1675 (405)	745 (15) 747 (27) 863 (29)	1058 (122)
α (σ)	**TRA**	-0.095 (0.02)	-0.050 (0.05)	-0.820 (0.07)	0.678 (0.03) 0.688 (0.03) 0.644 (0.04)	0.015 (0.02)
	TRG	-0.095 (0.02)	0.082 (0.06)	-0.823 (0.07)	0.586 (0.02) 0.823 (0.04) 0.629 (0.03)	0.035 (0.02)
	SIF	-0.0519 (0.02)	0.504 (0.05)	-0.693 (0.07)	0.616 (0.02) 0.409 (0.04) 0.677 (0.03)	0.107 (0.02)
	SIFg	-0.023 (0.01)	0.634 (0.05)	-0.792 (0.06)	0.709 (0.02) 0.737 (0.04) 0.673 (0.03)	0.134 (0.02)
β (σ)	**TRA**	3.15 (0.42)	3.10 (1.3)	28.0 (2.0)	-10.0 (0.64) -8.92 (1.1) -9.29 (0.71)	0.571 (0.42)
	TRG	0.179 (0.45)	-5.96 (2.6)	9.13 (4.1)	-20.8 (0.62) -25.8 (1.1) -21.6 (0.77)	-2.87 (0.89)
	SIF	2.37 (0.39)	-6.72 (1.1)	23.7 (1.8)	-7.74 (0.53) -2.47 (1.1) -9.70 (0.79)	-0.290 (0.42)
	SIFg	-0.092 (0.37)	-13.2 (1.8)	5.41 (2.7)	-21.6 (0.55) -23.3 (1.1) -17.8 (0.88)	-2.07 (0.63)
γ (σ)	**TRA**	--	--	--	--	--
	TRG	14.5 (0.91)	14.3 (3.6)	37.1 (7.1)	29.0 (0.49) 34.6 (0.88) 24.7 (0.72)	7.62 (1.7)
	SIF	--	--	--	--	--
	SIFg	7.33 (0.28)	3.05 (0.67)	18.4 (2.1)	8.59 (0.15) 10.0 (0.22) 5.79 (0.31)	1.71 (0.45)

Table S3. Respiration bias by ecosystem type. Italicized font is used for validation sites. Bold values indicate overestimate of respiration relative to observations; normal font is underestimated relative to observations.

Respiration Bias			Median Model-Obs Bias (μmol $CO_2/m_2/s$)			
Site	**IGBP**	**Season**	**TRA**	**TRG**	**SIF**	**SIFg**
Br-BAN	*Woody Sav*	*Ann*	*-3.5*	*-1.1*	*-0.20*	***0.82***
		Wet	*-3.2*	*-0.94*	*-0.17*	***0.83***
		Dry	*-6.0*	*-2.5*	*-1.5*	*-1.3*
Br-CST	Woody Sav	Ann	-0.47	-0.57	-0.16	-0.19
		Wet	-1.8	-0.60	-1.4	**0.64**
		Dry	-0.058	-0.56	**0.23**	-0.46
Br-K77	*Grasslands*	*Ann*	***0.36***	***0.93***	*-0.047*	*-0.45*
		Wet	*-0.74*	*-0.20*	*-0.82*	*-0.98*
		Dry	***0.78***	***2.1***	***0.71***	***0.50***
Br-FNS	Grasslands	Ann	-3.1	-3.2	-0.80	-0.43
		Wet	-4.8	-3.6	-1.8	-0.64
		Dry	-2.5	-2.8	-0.13	-0.11
Br-PDGa	*Savannas*	*Ann*	*-0.16*	***0.17***	***1.1***	***1.5***
		Wet	*-0.23*	***0.57***	***1.1***	***1.9***
		Dry	*-0.13*	***0.078***	***1.1***	***1.3***
Br-PDGb	Savannas	Ann	-0.96	-0.43	**0.51**	**0.92**
		Wet	-2.0	-1.1	**0.42**	**0.48**
		Dry	-0.54	-0.32	**0.88**	**1.0**
Br-K83	*Evergreen Bdlf*	*Ann*	*-1.4*	*-1.5*	*-0.86*	*-0.22*
		Wet	*-2.3*	*-3.4*	*-1.9*	*-1.4*
		Dry	***0.55***	***2.3***	***1.4***	***2.7***
Br-K67	Evergreen Bdlf	Ann	-1.4	-0.39	-1.0	**0.019**
		Wet	-2.8	-3.7	-2.1	-1.3
		Dry	-0.17	**2.4**	**0.54**	**1.8**
Br-K34	Evergreen Bdlf	Ann	-1.2	-1.1	-1.6	-2.1
		Wet	-3.9	-4.6	-4.8	-4.5
		Dry	-1.2	-0.61	-1.5	-1.1

Table S4. Diurnal mean bias for ecosystem classes represented by eddy flux sites in VPRM domain. Italicized font is used for validation sites.

			Diurnal Mean Bias (μmol $CO_2/m_2/s$)			
Site	**IGBP**	**Season**	**TRA**	**TRG**	**SIF**	**SIFg**
Br-BAN	*Woody Sav*	*Ann*	*-3.3*	*-0.76*	*-1.5*	*-1.2*
		Wet	*-2.2*	*0.05*	*-0.49*	*-0.45*
		Dry	*-7.7*	*-5.3*	*-7.0*	*-6.5*
Br-CST	Woody Sav	Ann	-0.19	-0.07	-0.09	0.13
		Wet	-1.1	-0.22	-1.1	0.21
		Dry	0.33	-0.09	0.58	-0.09
Br-K77	*Grasslands*	*Ann*	*-5.1*	*-4.9*	*0.14*	*0.03*
		Wet	*-3.7*	*-4.0*	*0.38*	*0.23*
		Dry	*-6.5*	*-5.8*	*0.01*	*-0.07*
Br-FNS	Grasslands	Ann	-0.92	-0.55	0.51	0.71
		Wet	-2.2	-1.2	-0.34	0.33
		Dry	-0.53	-0.65	0.62	0.40
Br-PDGa	*Savannas*	*Ann*	*-0.81*	*-0.69*	*-0.06*	*0.097*
		Wet	*-0.25*	*0.14*	*0.42*	*0.79*
		Dry	*-1.2*	*-1.3*	*-0.34*	*-0.33*
Br-PDGb	Savannas	Ann	-0.80	-0.53	-0.31	-0.072
		Wet	-1.1	-0.51	-0.41	-0.047
		Dry	-0.52	-0.55	-0.12	-0.13
Br-K83	*Evergreen Bdlf*	*Ann*	*0.15*	*-0.31*	*0.10*	*0.26*
		Wet	*0.73*	*-0.82*	*0.02*	*-0.08*
		Dry	*-0.30*	*0.49*	*0.42*	*0.88*
Br-K67	Evergreen Bdlf	Ann	-0.43	-0.27	-0.071	-0.089
		Wet	0.36	-0.98	-0.049	-0.35
		Dry	-0.84	0.36	-0.044	0.22
Br-K34	Evergreen Bdlf	Ann	0.18	0.15	-0.38	0.044
		Wet	2.1	0.52	0.88	0.43
		Dry	-0.34	-0.22	-0.83	-0.33

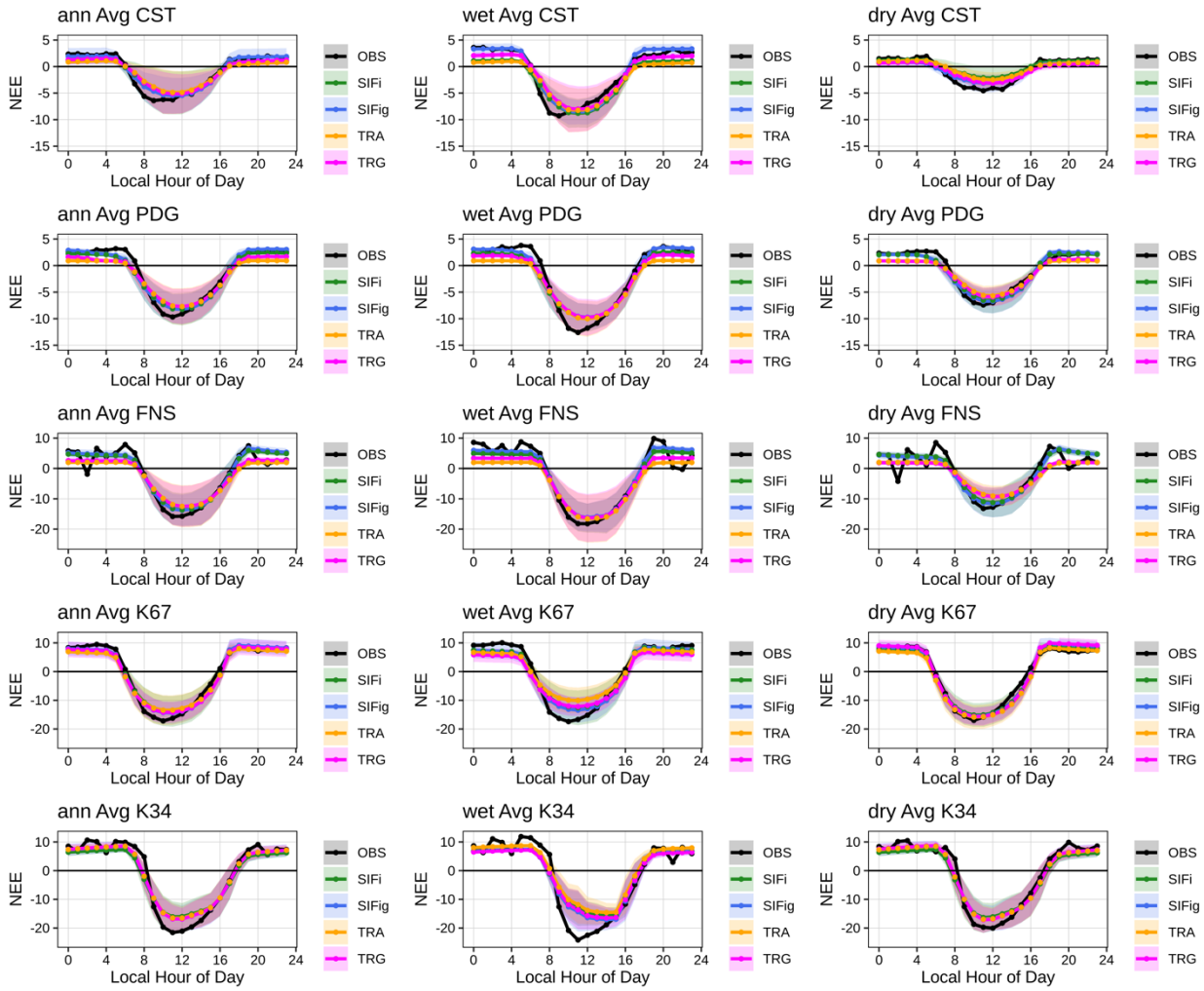

Figure S2. Diurnal results, calibration sites.

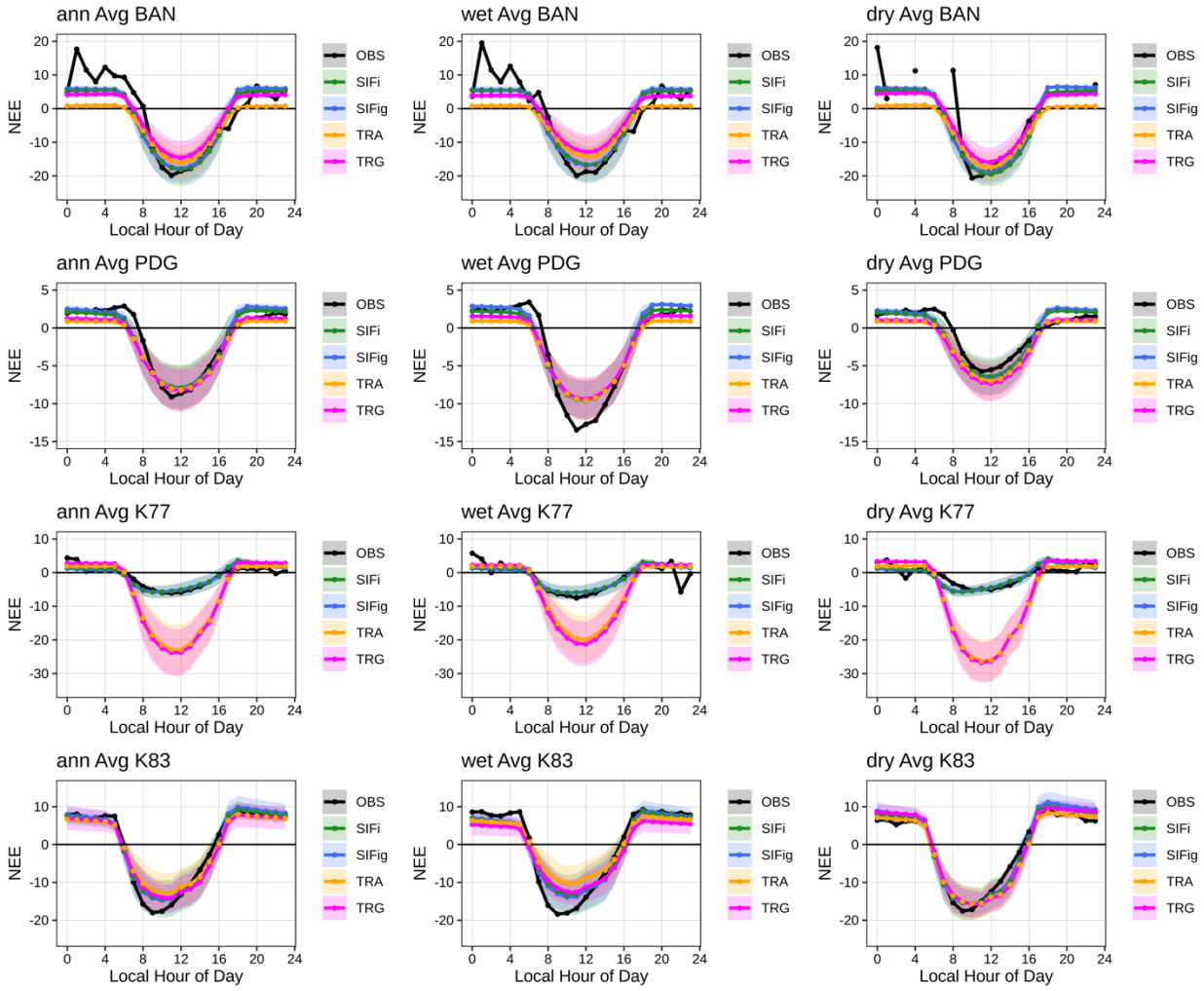

Figure S3. Diurnal results, validation sites.

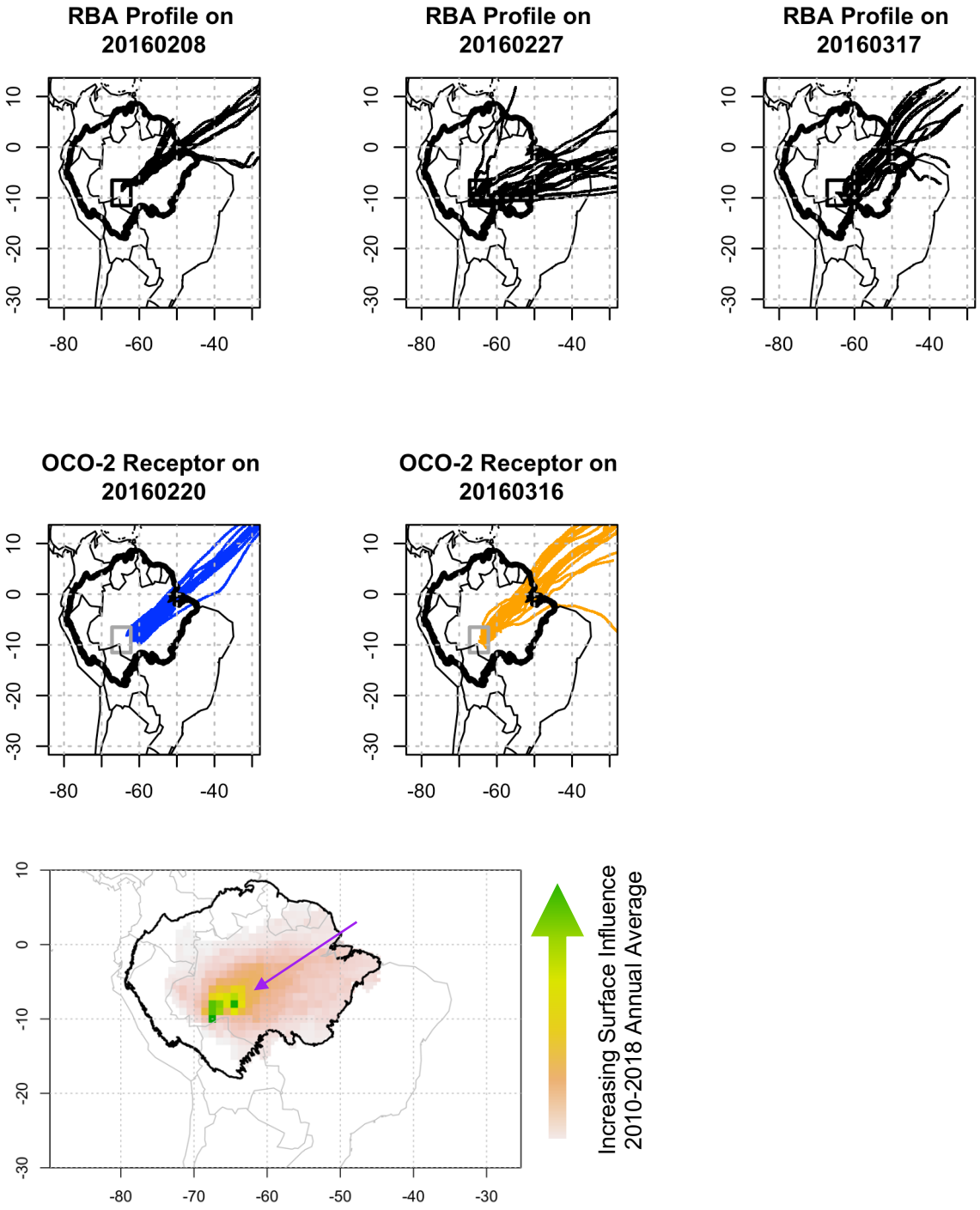

Figure S4. NOAA HYSPLIT 10-day back trajectories in 5x5degree bounding box surrounding RBA, representing influences for a typical 2016 wet season month. (Top Row) Back trajectories corresponding to dates, times, and locations of actual aircraft vertical profiles. (Middle Row) Back trajectories corresponding to dates, times, and location of available and representative OCO-2 receptors. (Bottom Row) Weighted annual influences (2010 to 2018) from Gatti et al. (2021) generally track prevailing wet season 2016 wind direction.

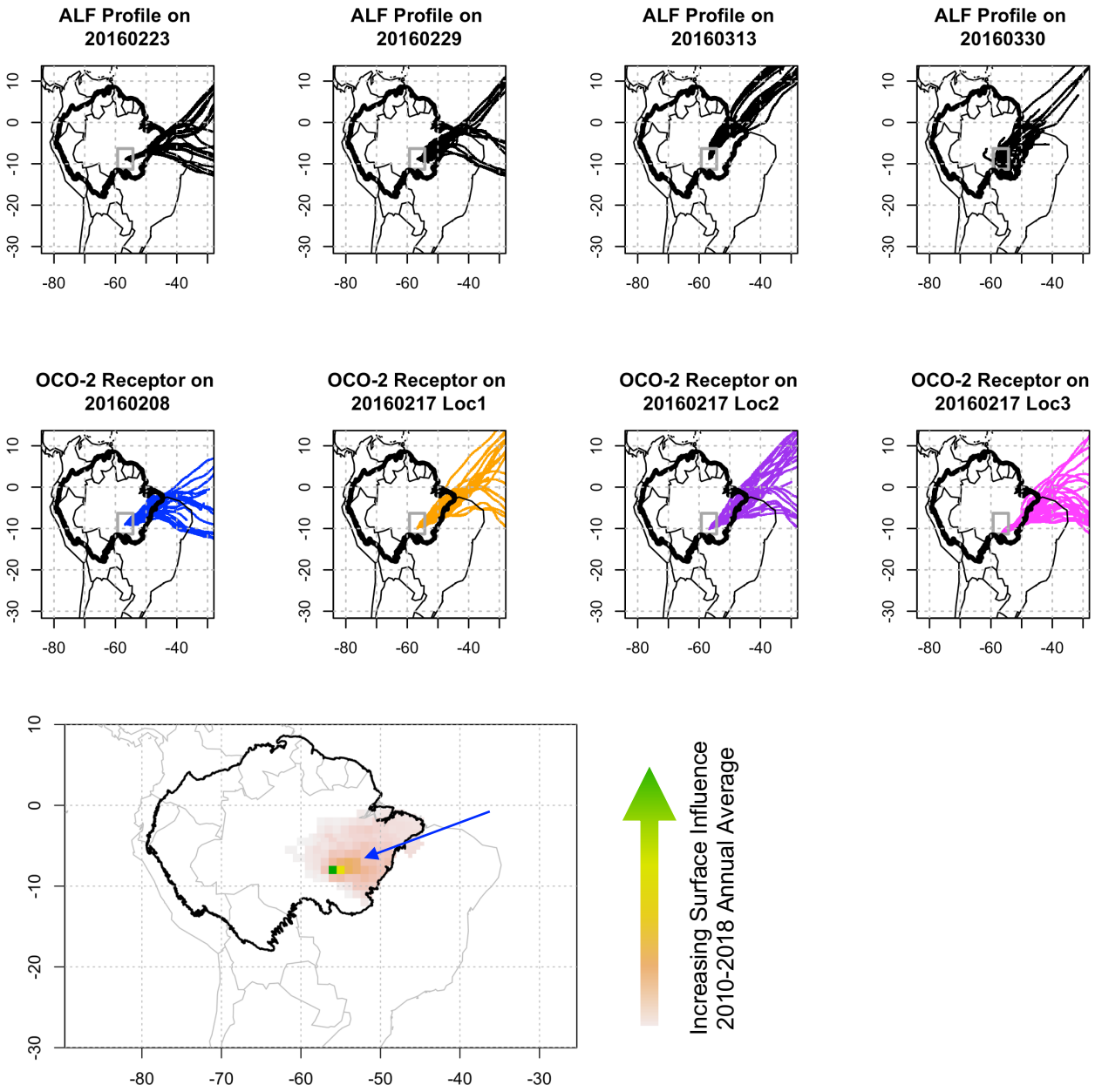

Figure S5. NOAA HYSPLIT 10-day back trajectories in 5x5degree bounding box surrounding ALF, representing influences for a typical 2016 wet season month. (Top Row) Back trajectories corresponding to dates, times, and locations of actual aircraft vertical profiles. (Bottom Row) Back trajectories corresponding to dates, times, and location of available and representative OCO-2 receptors. (Bottom Row) Weighted annual influences (2010 to 2018) from Gatti et al. (2021) generally track prevailing wet season 2016 wind direction.

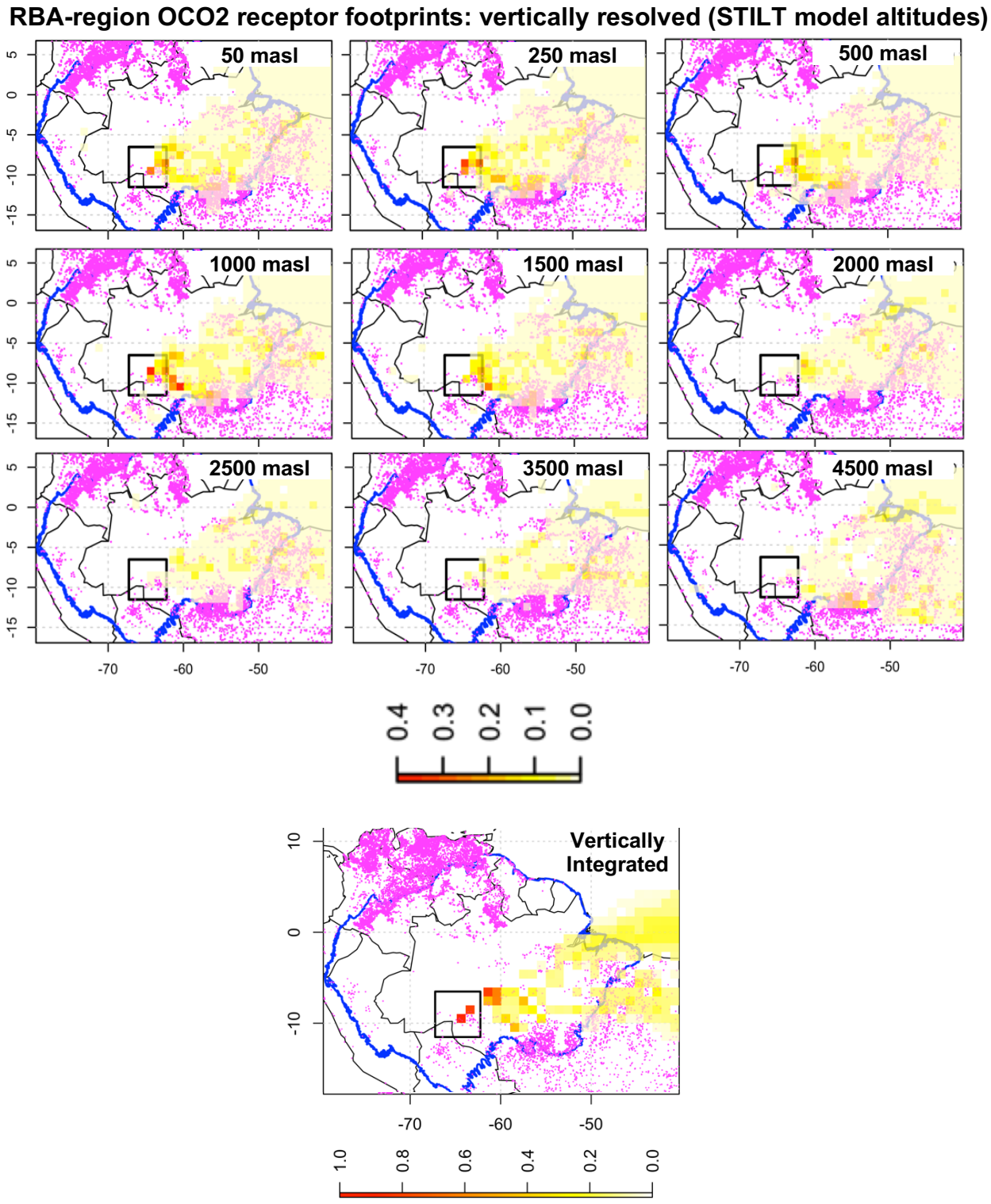

Figure S6. Vertically resolved footprints at RBA used in vertical profile simulation. Magenta points are fire locations identified between February and March 2016.

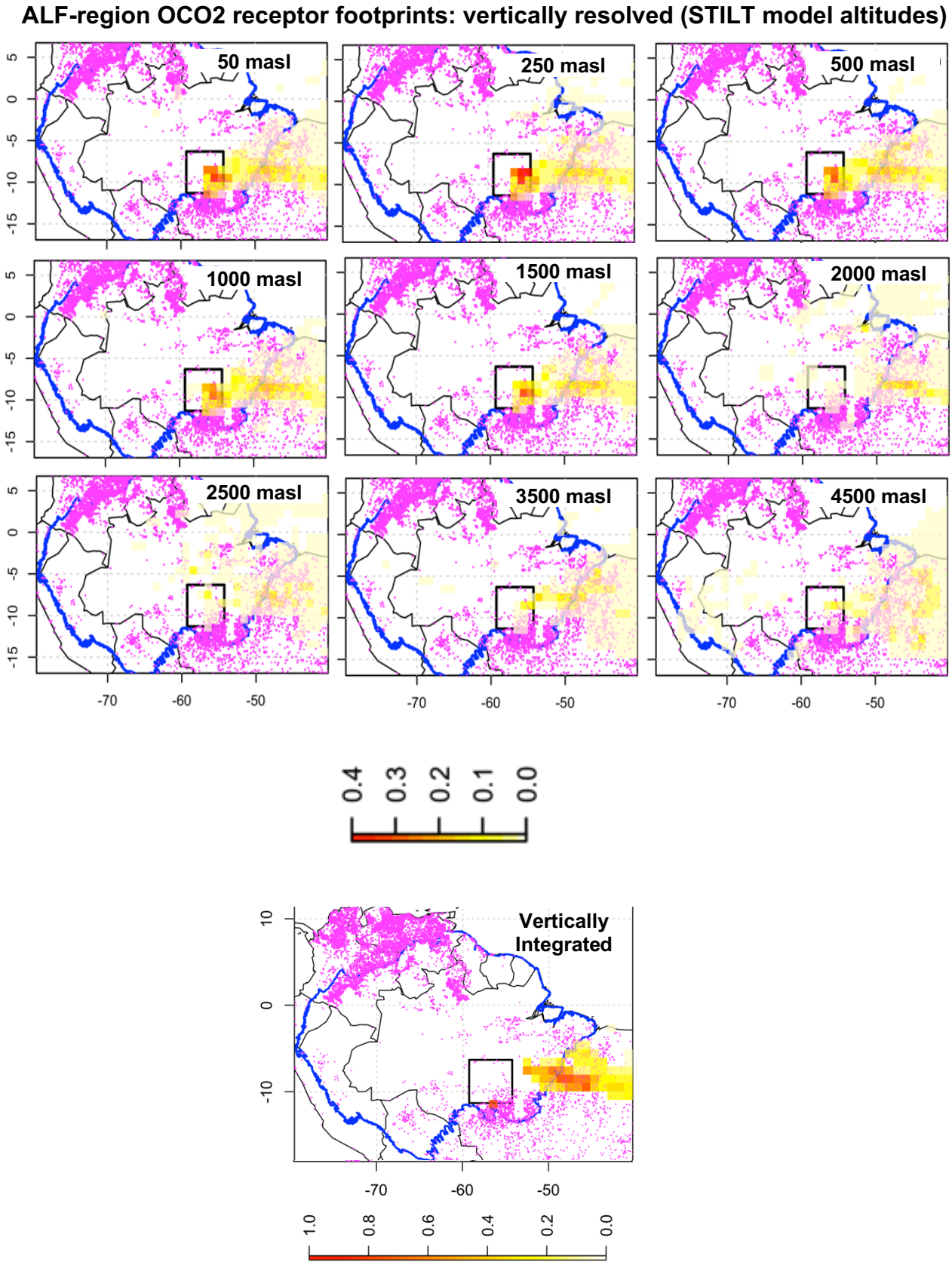

Figure S7. Vertically resolved footprints at ALF used in vertical profile simulation. Magenta points are fire locations identified between February and March 2016.