Relationship between Amazon burning aerosols and rainfall over La Plata Basin

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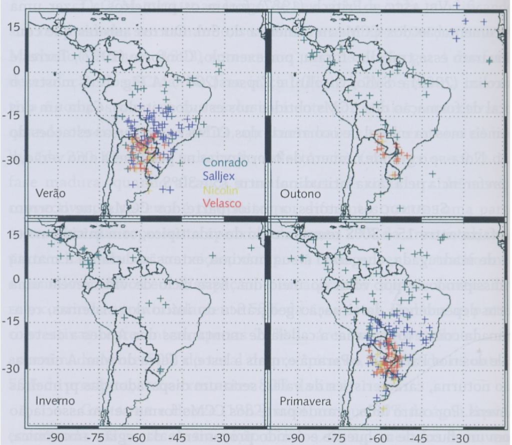
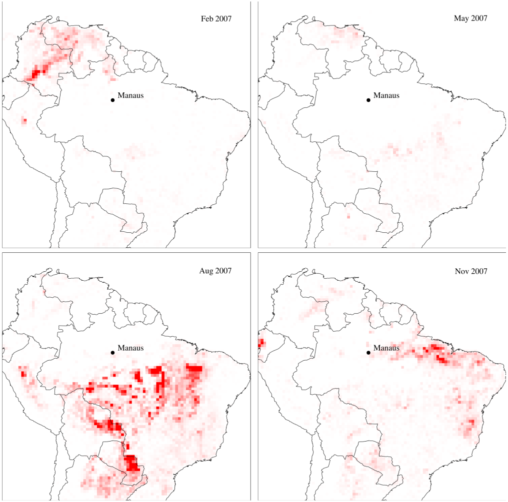
Climatological distribution



Silva Dias et al. (2009)

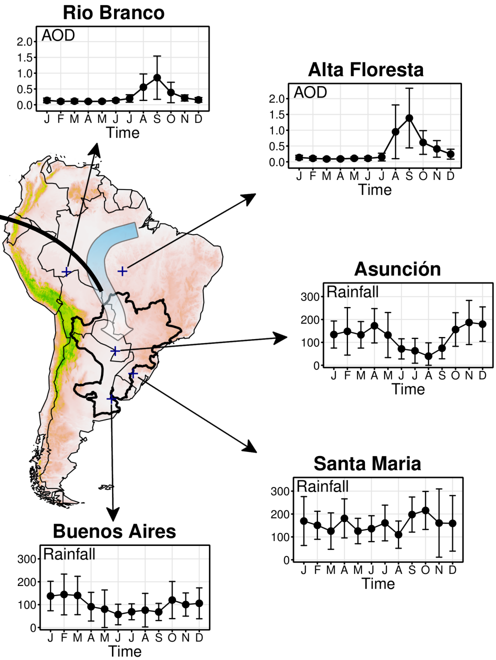
Biomass burning



Martin et al. (2006)

Freitas et al. (2005)

Aerosols from biomass burning in Amazon and Central Brazil are advected via LLJ to La Plata Basin in the dry season.



Objective

Investigate the relationship between the aerosols, that come from biomass burning of Amazon region and central of Brazil, and rainfall over the La Plata Basin for September, October, November and December.

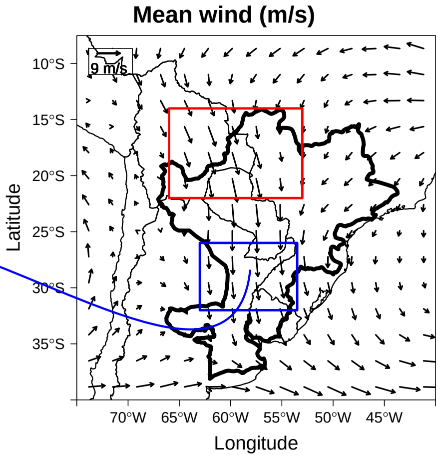
Data

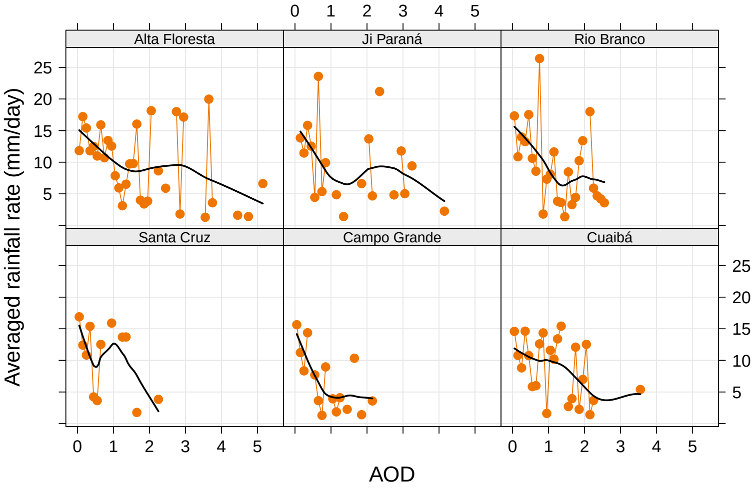
- Precipitation (mm/h) from TRMM-3B42 between 1999 and 2012 (0.25°x0.25° - 3h);
- Daily AOD (440 nm) from AERONET;
  - Alta Floresta (1999 - 2012);
  - Ji Paraná (2006 - 2012);
  - Rio Branco (2000 - 2012);
  - Santa Cruz (1999 - 2012);
  - Campo Grande (2003 - 2012);
  - Cuiabá - Miranda (2001 - 2011).
- Reanalyses 2 from NCEP/DOE (1999 - 2012).

Filtering

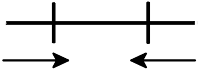
- Keep cases with north wind over the blue rectangle;
- Keep cases with minimum rainfall over red rectangle (avoid cleaning up the airmass during the path);

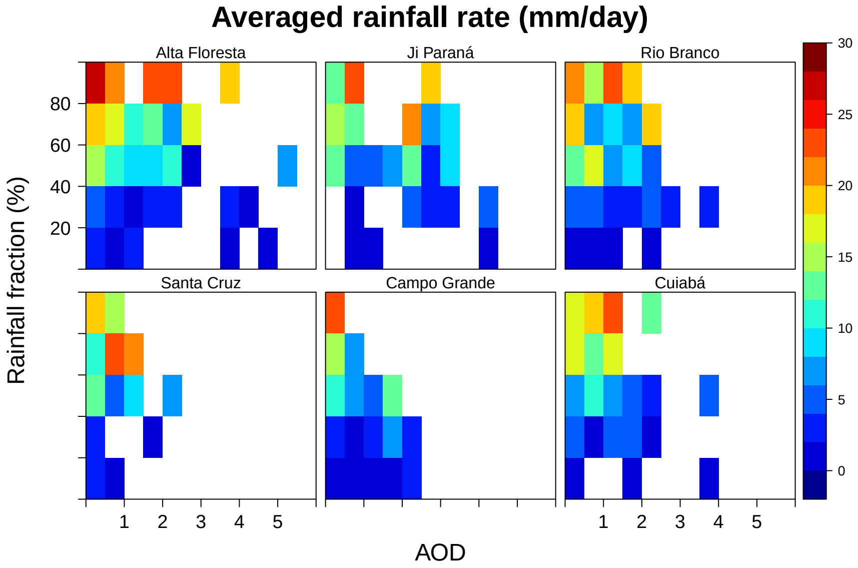
Averaged rainfall rate (mm/day)




Alta Floresta
Ji Paraná
Rio Branco
Santa Cruz
Campo Grande
Cuaibá
Averaged rainfall rate (mm/day)
AOD
0 1 2 3 4 5
5 10 15 20 25

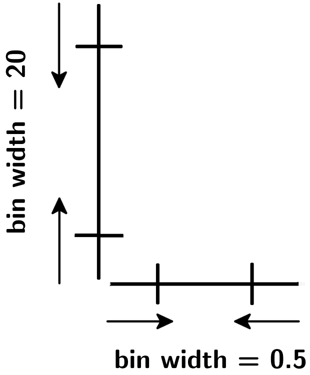
bin width = 0.1

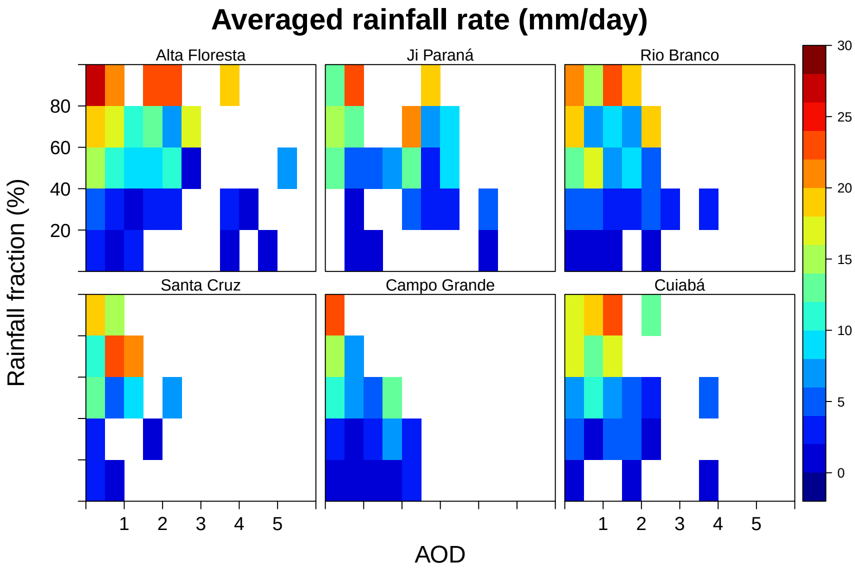



Averaged rainfall rate (mm/day)
Alta Floresta
Ji Paraná
Rio Branco
Santa Cruz
Campo Grande
Cuiabá
Rainfall fraction (%)
80
60
40
20
1
2
3
4
5
AOD
30
25
20
15
10
5
0

Rainfall fraction = % of rainy grid points

$$\textbf{Rainfall fraction} = \frac{number\ of\ rainy\ grid\ points}{all\ grid\ points} \times 100\%$$

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Alta Floresta
Ji Paraná
Rio Branco
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Rainfall fraction (%)
80
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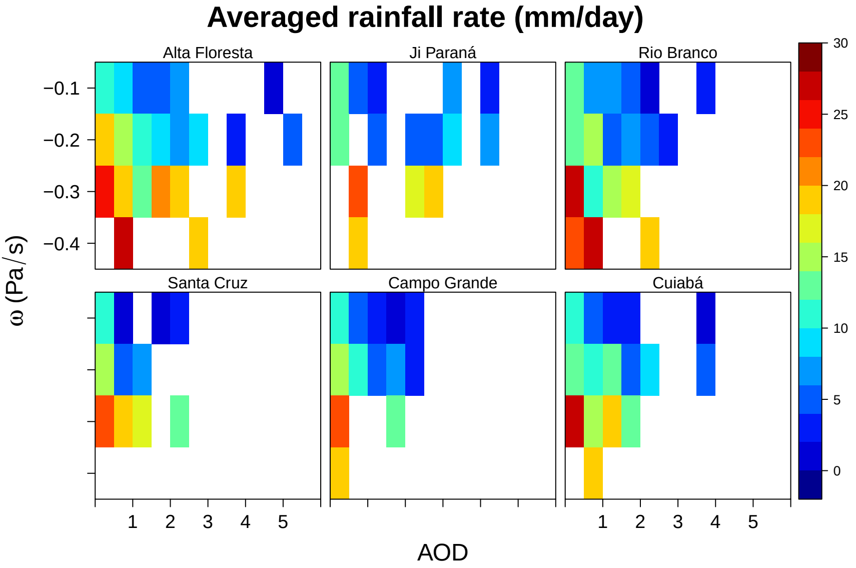
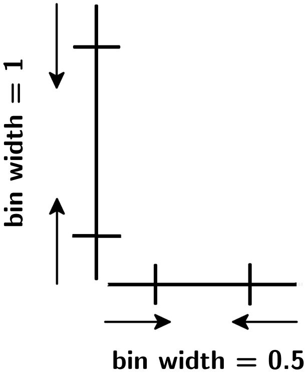
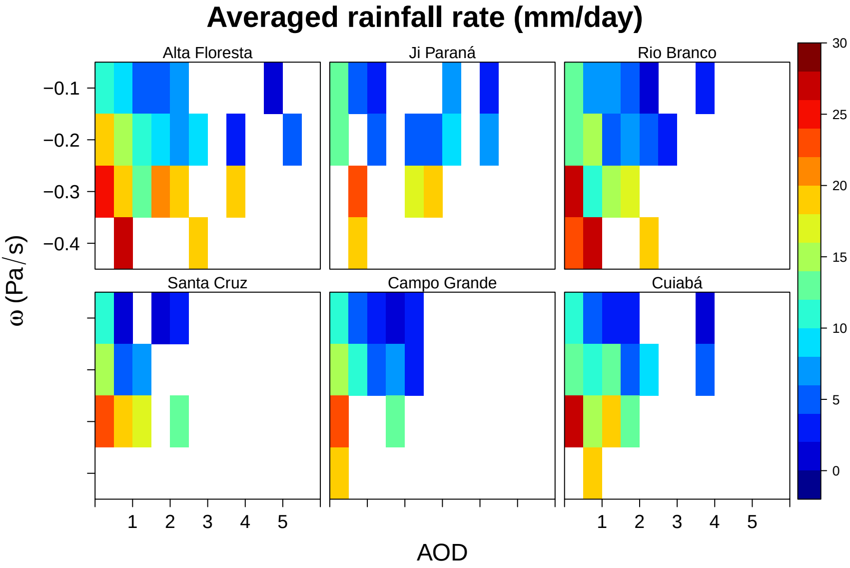

Averaged rainfall rate (mm/day)
Alta Floresta
Ji Paraná
Rio Branco
Santa Cruz
Campo Grande
Cuiabá
ω (Pa/s)
−0.1
−0.2
−0.3
−0.4
1
2
3
4
5
AOD
30
25
20
15
10
5
0

ω = average over blue rectangle at 500 hPa




Averaged rainfall rate (mm/day)
Alta Floresta
Ji Paraná
Rio Branco
Santa Cruz
Campo Grande
Cuiabá
−0.1
−0.2
−0.3
−0.4
ω (Pa/s)
1
2
3
4
5
AOD
30
25
20
15
10
5
0

Combined EOF

- Filtered data (north wind);
- Only cases with rainfall fraction $> 40\%$.

$$\begin{bmatrix} AOD_1 & ARR_1 & \omega_1 & RH_1 \\ AOD_2 & ARR_2 & \omega_2 & RH_2 \\ \vdots & \vdots & \vdots & \vdots \\ AOD_n & ARR_n & \omega_n & RH_n \end{bmatrix}$$

RH = mean relative humidity between 700 and 500 hPa averaged over the blue rectangle

Combined EOF

Variance explained

	$R_1^2(\%)$	$R_2^2(\%)$	$R_1^2 + R_2^2$
Alta Floresta	41	31	72
Ji Paraná	43	30	73
Rio Branco	42	34	76
Santa Cruz	45	30	75
Campo Grande	41	31	72
Cuiabá	43	30	73

Combined EOF

Perturbation values around average

Alta Floresta

	AOD	ARR	ω	RH
e1	0.0	-0.5	0.7	-0.6
e2	0.8	-0.6	-0.1	0.3

Santa Cruz

	AOD	ARR	ω	RH
e1	0.1	0.5	-0.7	0.6
e2	0.9	-0.5	-0.2	0.0

Ji Paraná

	AOD	ARR	ω	RH
e1	-0.2	0.7	-0.5	0.5
e2	0.8	-0.1	-0.5	0.2

Campo Grande

	AOD	ARR	ω	RH
e1	-0.1	0.5	-0.7	0.5
e2	0.8	-0.5	-0.2	0.4

Rio Branco

	AOD	ARR	ω	RH
e1	0.3	0.2	-0.7	0.6
e2	0.6	-0.7	0.2	0.2

Cuiabá

	AOD	ARR	ω	RH
e1	0.0	0.6	-0.6	0.5
e2	0.9	-0.3	-0.3	0.2

Conclusions

Bin analyses

- Aerosols effect is detected for rainfall fraction $> 40\%$;
- For weak ω, large AOD loads tend to suppress rainfall.

Combined EOF

- 1st EOF explains $\sim$40% of variance $\longrightarrow$ dynamic forcing;
- 2nd EOF explains $\sim$30% of variance $\longrightarrow$ aerosol forcing suppress rainfall.

What next?

Use numerical modeling to understand the effect of advected aerosol on the rainfall of MCS over La Plata Basin.

- Radiative effect;
- Microphysic effect.

Thank you!