Biomass Burning in the Cuiabá-Santarém Area and Precipitation

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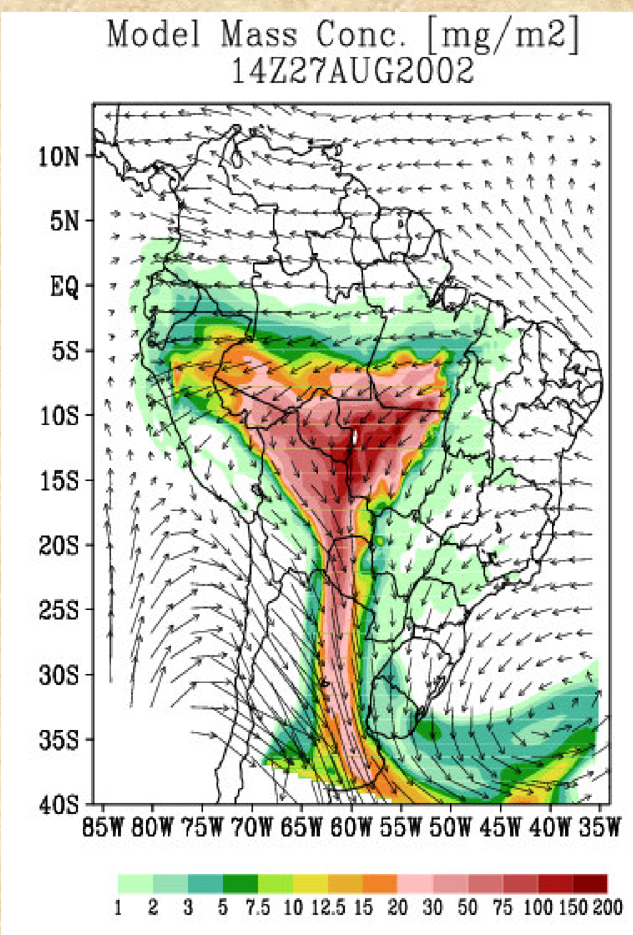
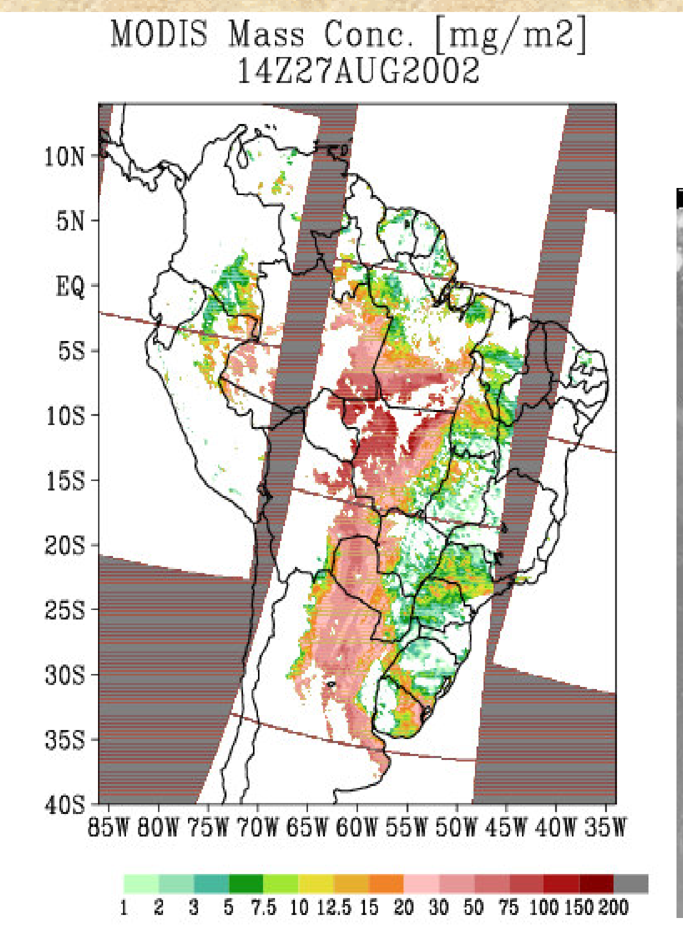
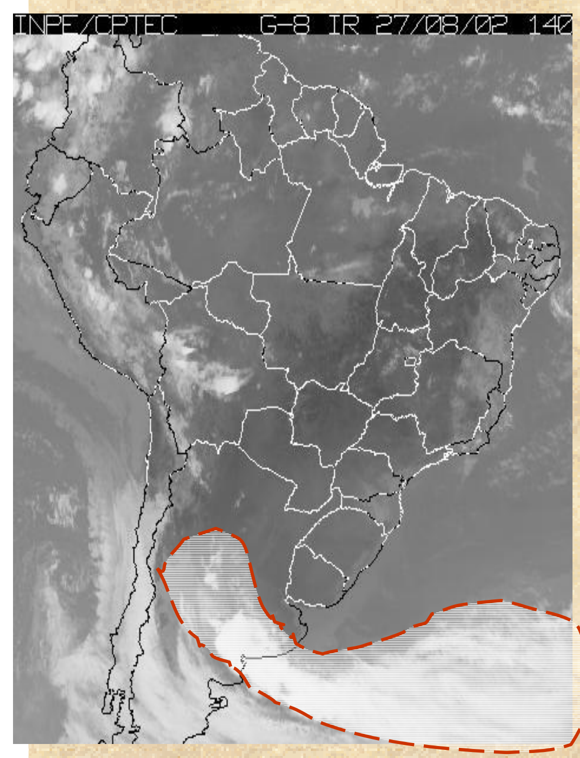
Motivation

- Biomass burning and precipitation:
  - Radiative impact – cooling at the surface due to reduction of SW rad. , warming above due to absorption of SW
    - However: literature does not show consistent results
  - Cloud microphysics: larger number of CCN's tend to decrease but may also have a significant impact in ice concentration, leading to precip. increase

Mass Concentration (mg/m²)
MODEL x MODIS
at 1400Z27AUG2002



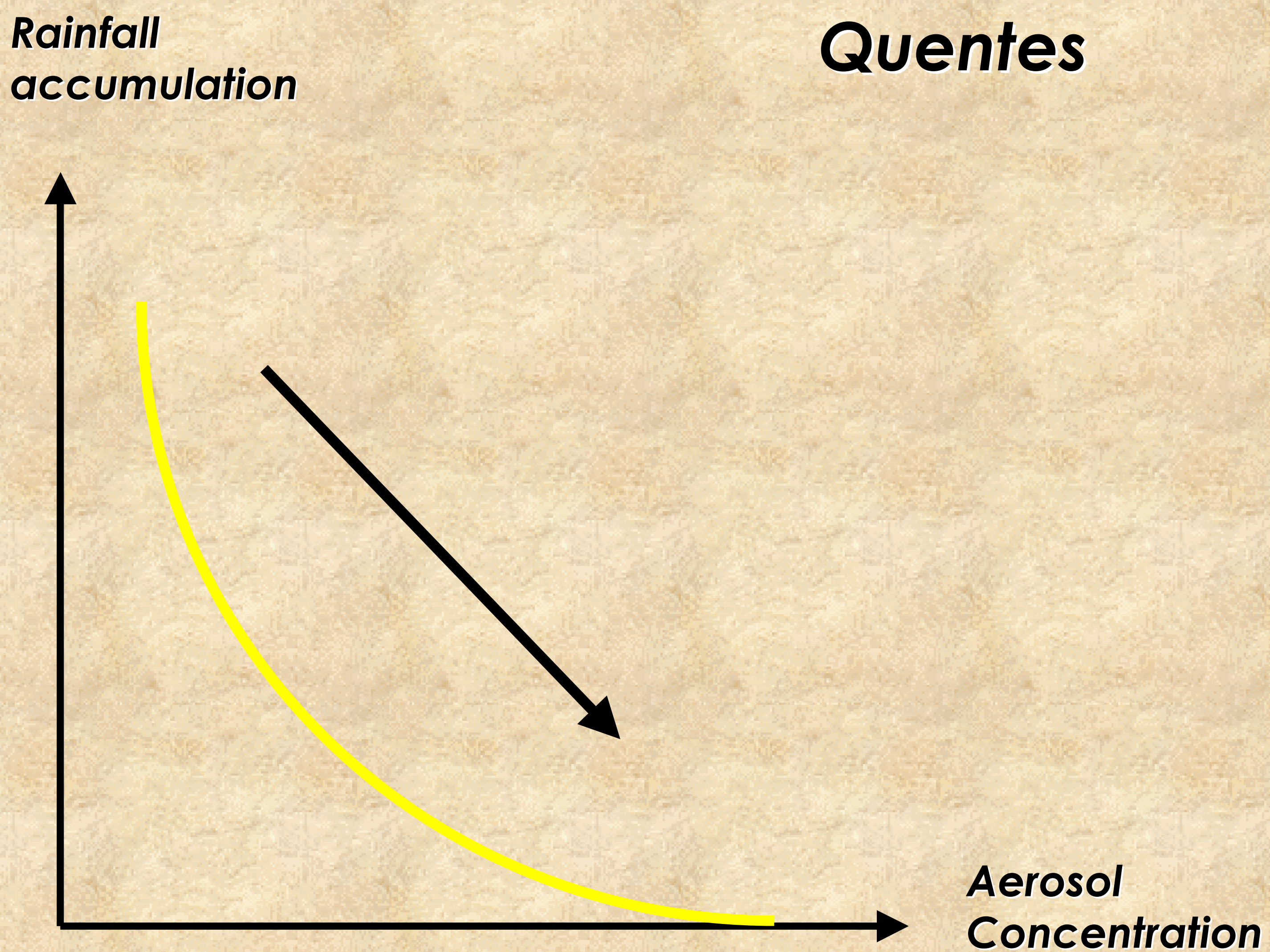




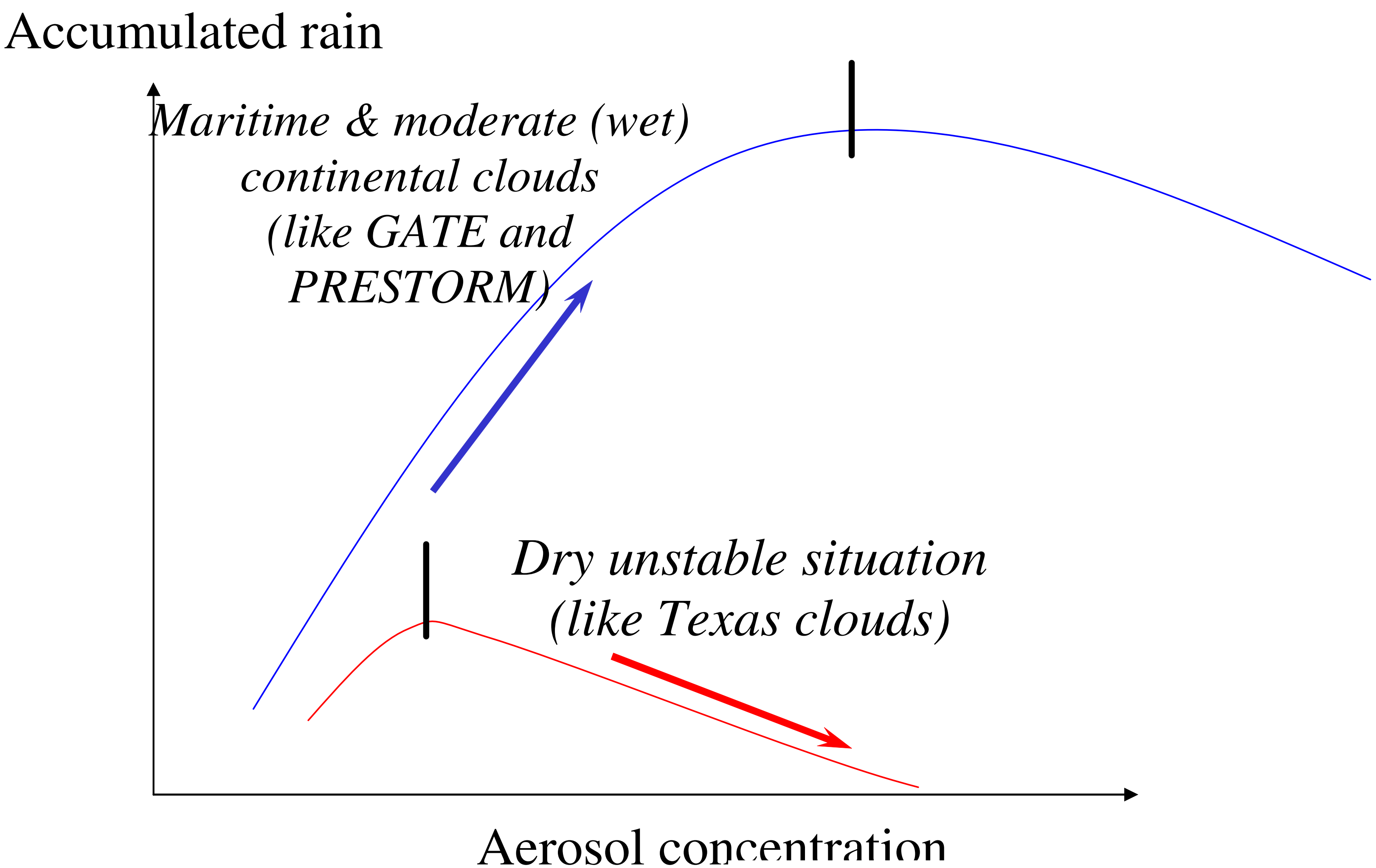
GOES 8 IR 1400Z

Longo et al. 2004

Nuvens Quentes



Scheme of aerosol effects on precipitation



Khain & Rosenfeld, 2003

Modeling the aerosol impact in the Amazon precipitation

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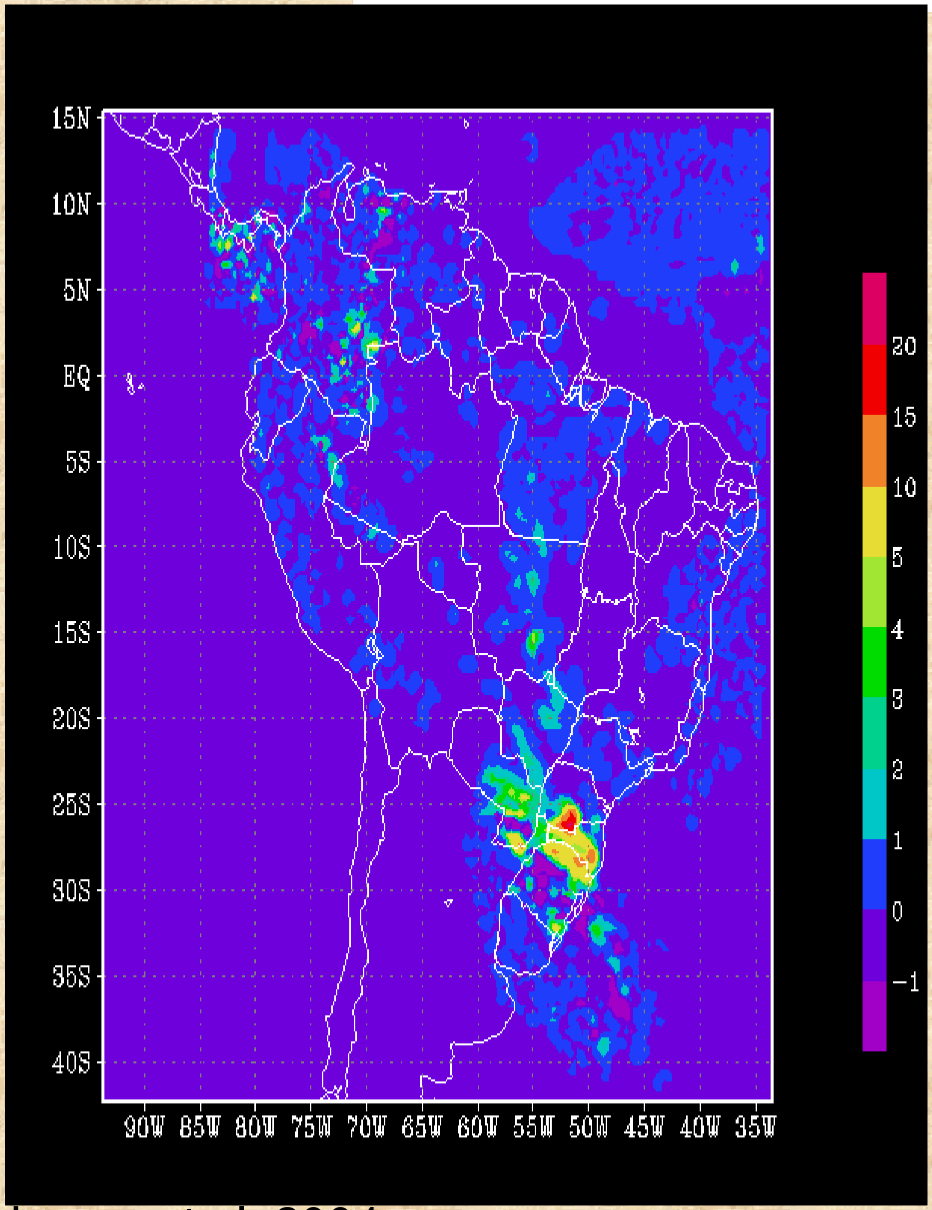
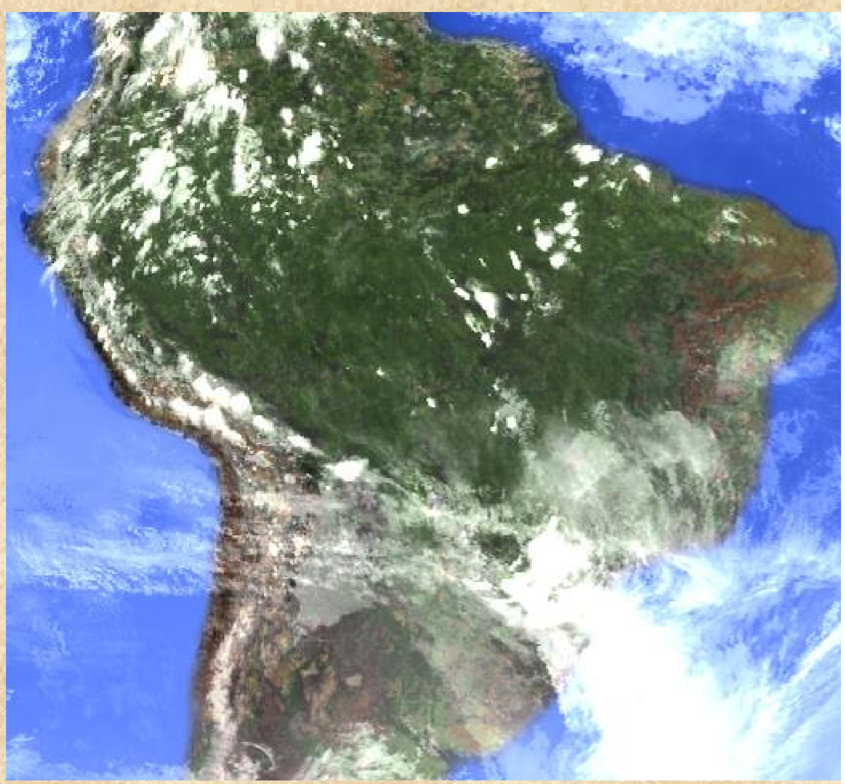
Conclusion

- Aerosol effect on microphysics in the transition season in the Amazon provides a good test for new developments
- Preliminary results indicate that aerosol and radiation effects combined change horizontal distribution of precipitation in a regional sense.

Reduction on the Convective precipitation (mm)

$$\Delta P = (P - P_{aer})$$





Radiative effect only

Longo et al. 2004

However, precipitation response in other cases not always consistent!

Any other mechanism??

- **BRAMS-2.0 model (www.cptec.inpe.br/brams) with emission and transport module for gases and particulate matter (Freitas, 1999; Vendrasco, 2005), and a complex model for solving the radiative process (CARMA – Toon et al. 1988).**
- **Test case: Cuiabá/Santarém**
- **Nested grids: 40 and 10km resolution**
- **Observed fires**

Experiment Number	1	2	3	4	5	6	7	8*
Start Time	10/05 2002	10/05 2002	10/12 2002	10/12 2003	10/12 2004	10/12 2004	10/12 2005	10/05 2002
Nudging and Boundary Condition	CPTEC	NCEP	CPTEC	CPTEC	CPTEC	NCEP	NCEP	CPTEC

Experiment 8 differs from Exp 1 by the emission rate (4X) larger.

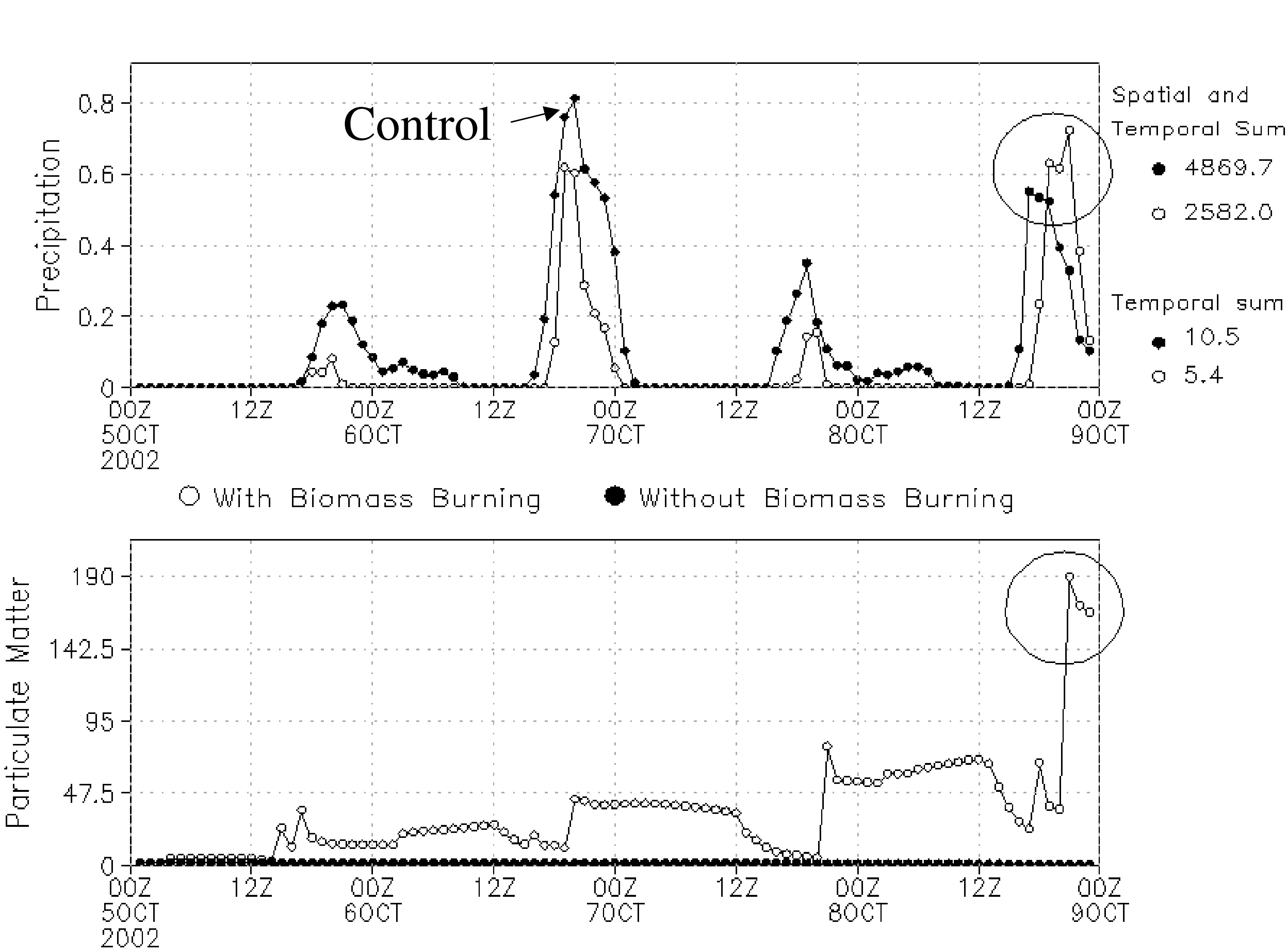


Figure 1: Mean precipitation for simulations with and without biomass burning emission (upper) and particulate matter concentration (lower). Precipitation in $mm.h^{-1}$ and Particulate matter concentration in $\mu g.m^{-3}$.

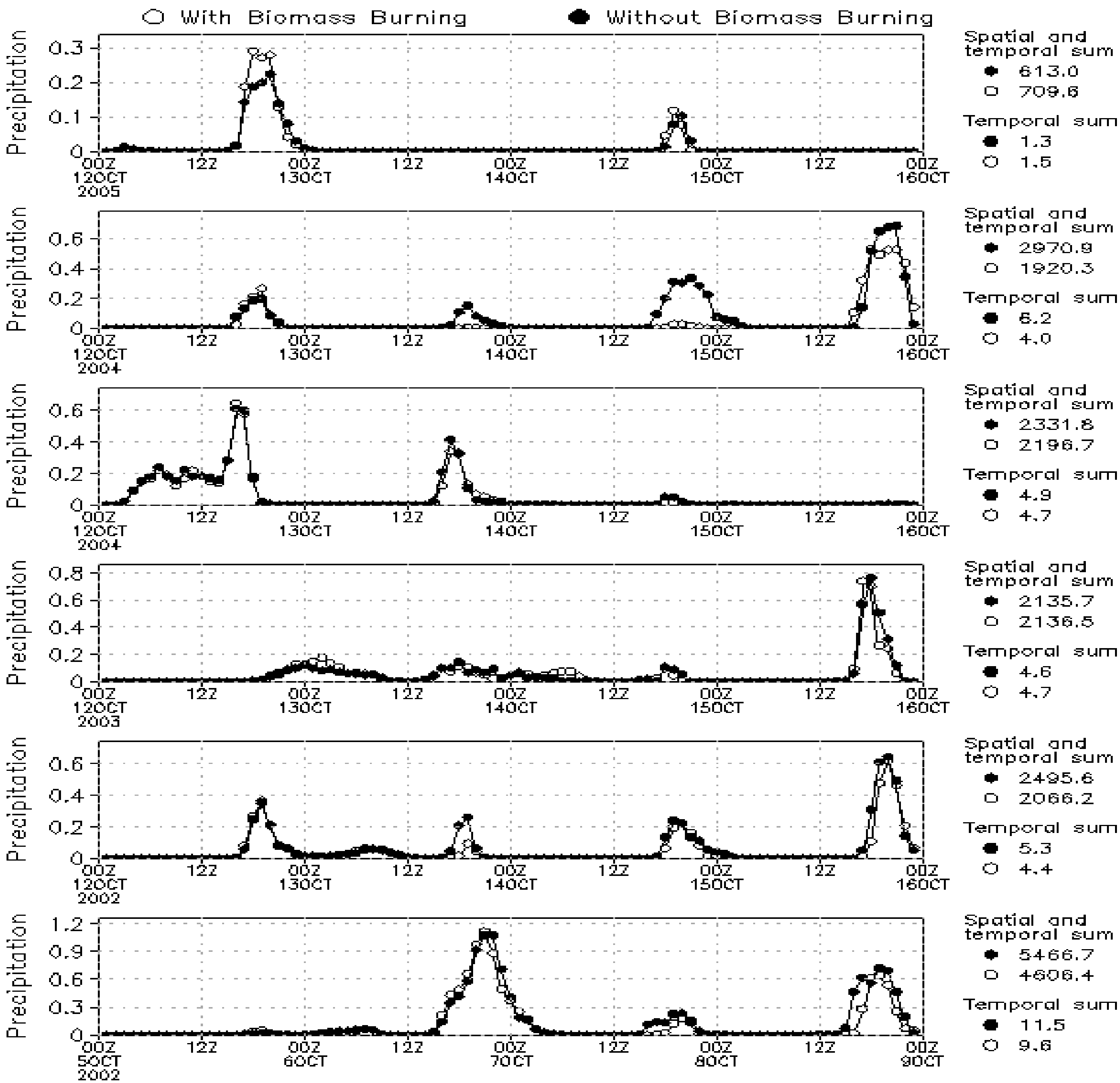
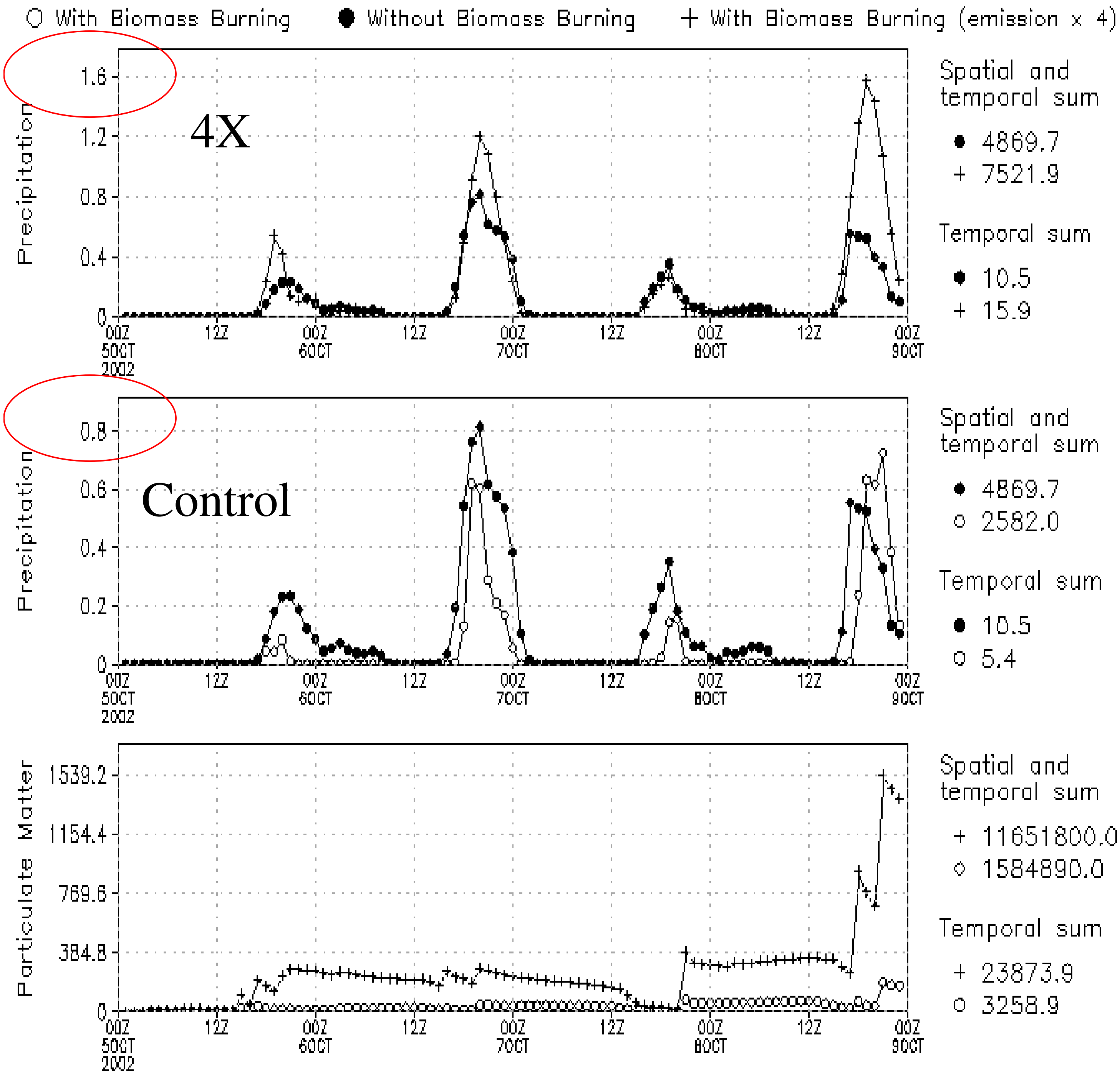
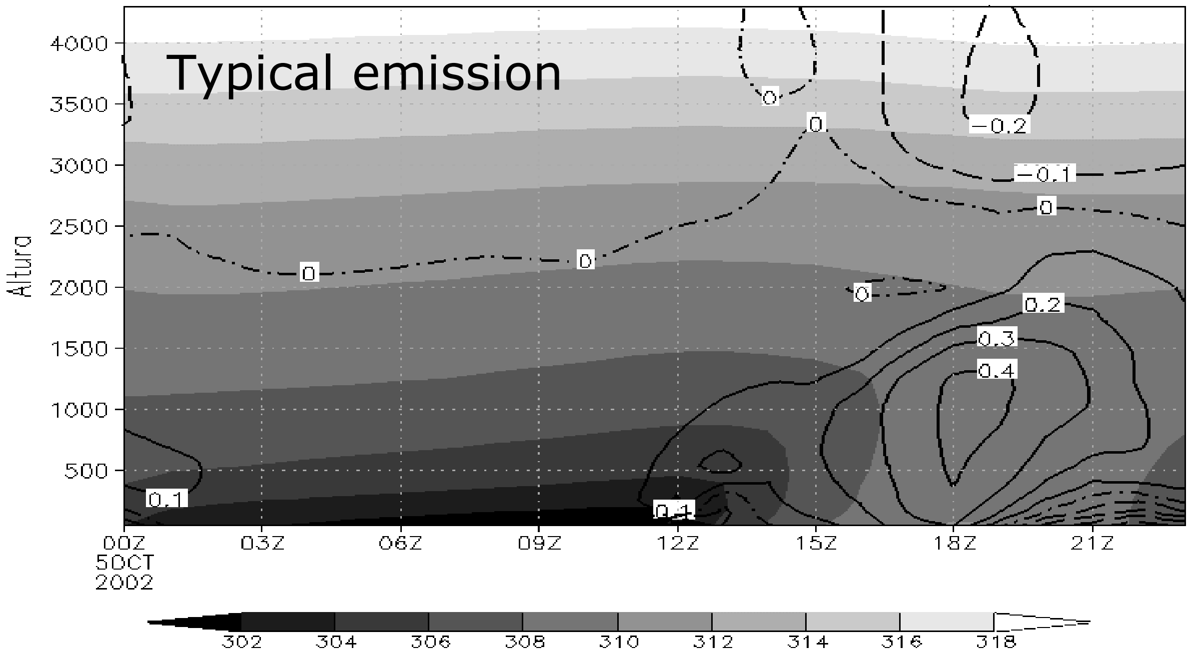


Figure 2: Mean precipitation for simulations with and without biomass burning emission for all simulations, starting in simulation 2 (lower) and ending in simulation 7 (upper). Precipitation in $mm.h^{-1}$.



O With Biomass Burning
Without Biomass Burning
+ With Biomass Burning (emission x 4)
4X
Control
Precipitation
Particulate Matter
Spatial and temporal sum
4869.7
+ 7521.9
Temporal sum
10.5
+ 15.9
Spatial and temporal sum
4869.7
o 2582.0
Temporal sum
10.5
o 5.4
Spatial and temporal sum
+ 11651800.0
◇ 1584890.0
Temporal sum
+ 23873.9
o 3258.9
00Z 5OCT 2002
12Z
00Z 6OCT
00Z 7OCT
00Z 8OCT
00Z 9OCT



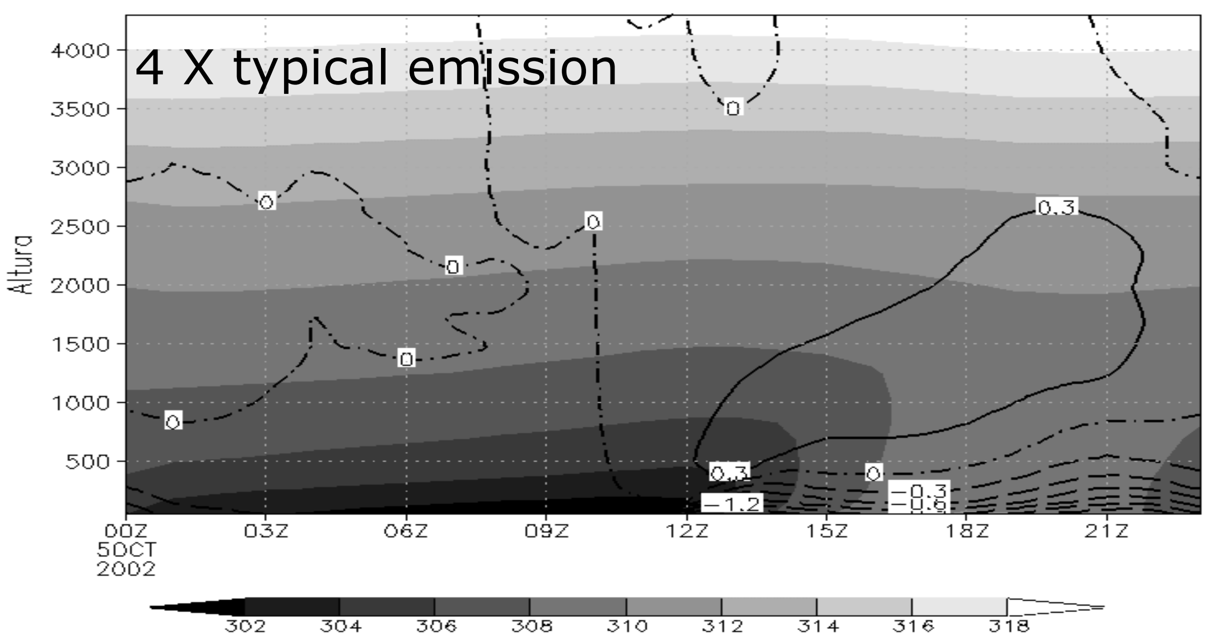


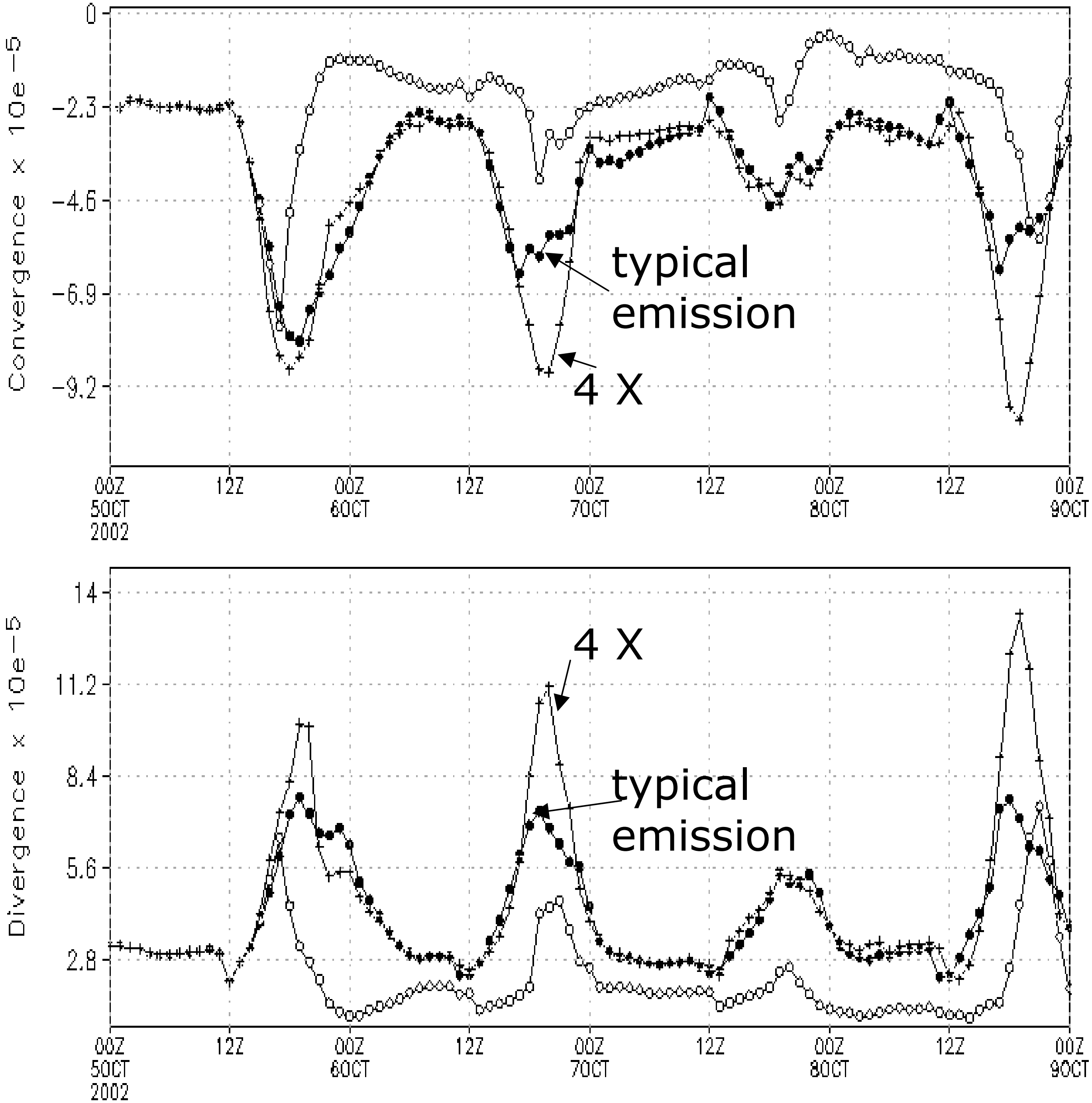
Figure 4: Potential temperature for simulation 1 without biomass burning (shaded). Difference between potential temperature in the cases with and without biomass burning (contour).

Partial conclusions:

- Radiative impact: can either increase or decrease precipitation
- Experiments indicate that precipitation changes is non-linearly related to PM emission

- Possible mechanism?????

Local circulations induced by horizontal thermal gradients caused by localized smoke plumes???



Mean wind divergence and convergence for 3 simulations. Without emission (closed circle), with typical emission (open circle), and with 4 times the typical emission (plus signal).

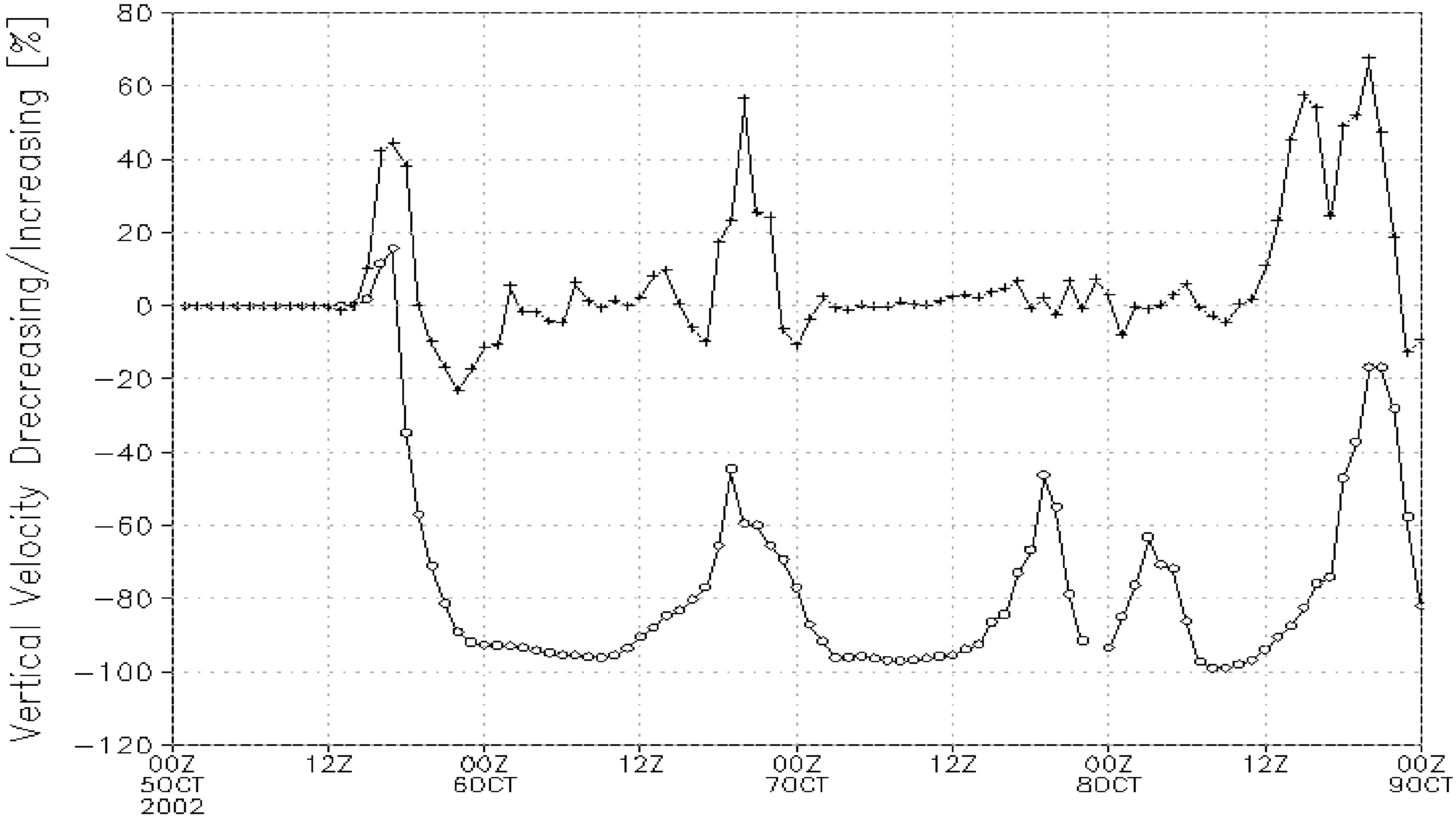


Figure 6: Mean vertical velocity increasing or decreasing due to the biomass burning. Simulation 1 (open circle) and simulation 8 (plus sign).

Conclusions

In the mean, the biomass burning radiative forcing tends to decrease the precipitation: thermodynamical effect dominates.

However, very large concentrations of aerosols may lead to an increase in the precipitation due to the dynamical forcing associated to the horizontal pressure gradients.

Thermodynamical versus dynamical forcing → decrease or increase

Dynamical forcing is similar to a local breeze effect caused by the smoke plumes