Scenarios of Deforestation and their Impact on the Amazon Basin Hidrometeorology

Cenarios de Desmatamento e seu Impacto na Hidrometeorologia da Amazonia

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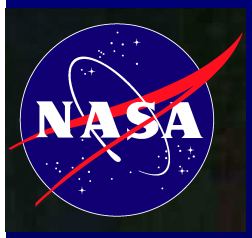
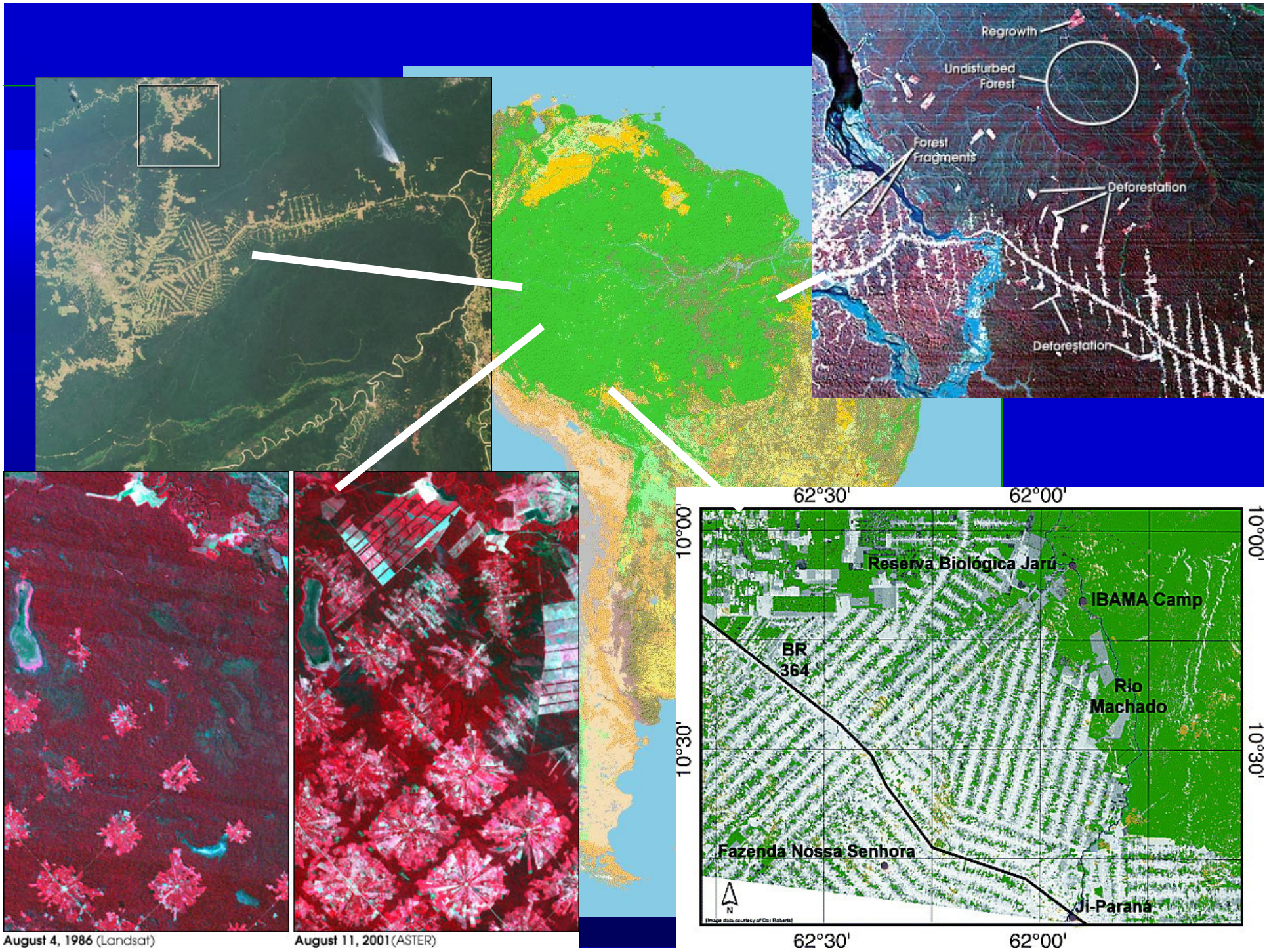
Duke University



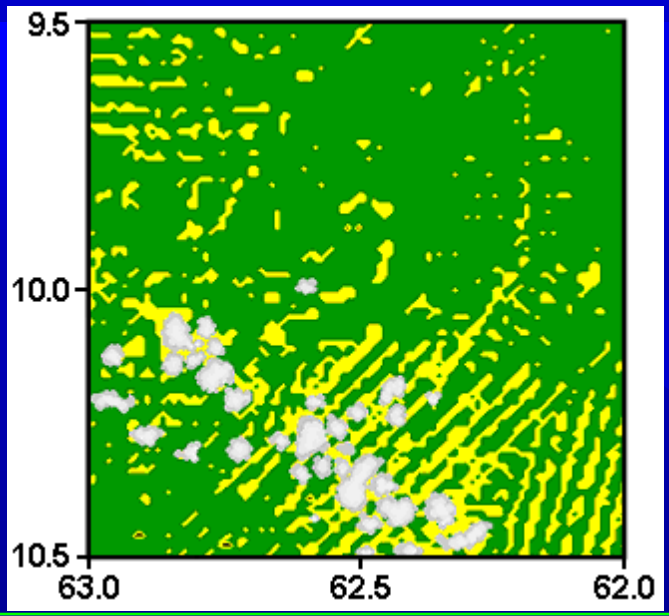
04 October 2006


Regrowth
Undisturbed Forest
Forest Fragments
Deforestation
Deforestation
62°30'
62°00'
10°00'
10°30'
Reserva Biológica Jarú
IBAMA Camp
BR 364
Rio Machado
Fazenda Nossa Senhora
Ji-Paraná
N
August 4, 1986 (Landsat)
August 11, 2001 (ASTER)

Amazonian drought October 2005

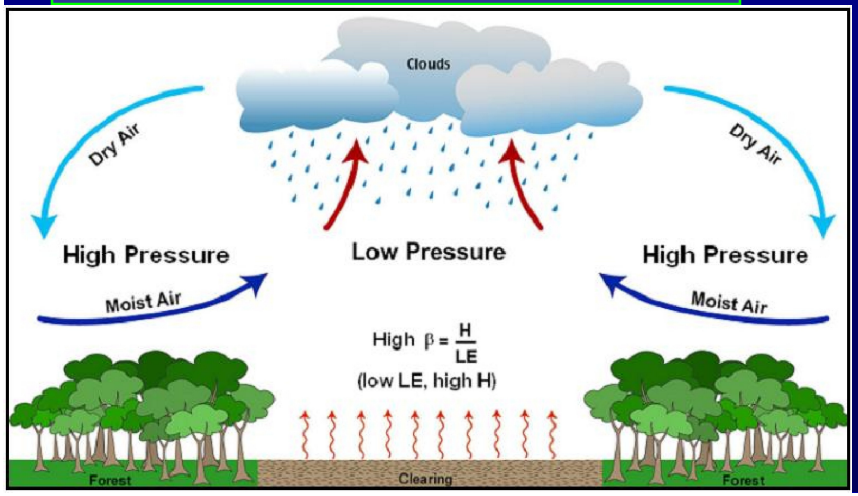
Source: Greenpeace 2005

Impacts of Deforestation in the Amazon Basin as seeing from models & observations



GOES Satellite 17 August 1994

Baidya Roy and Avissar, 2002



Global Models > rainfall decreases
Werth & Avissar 2002
Nobre et al. 1991

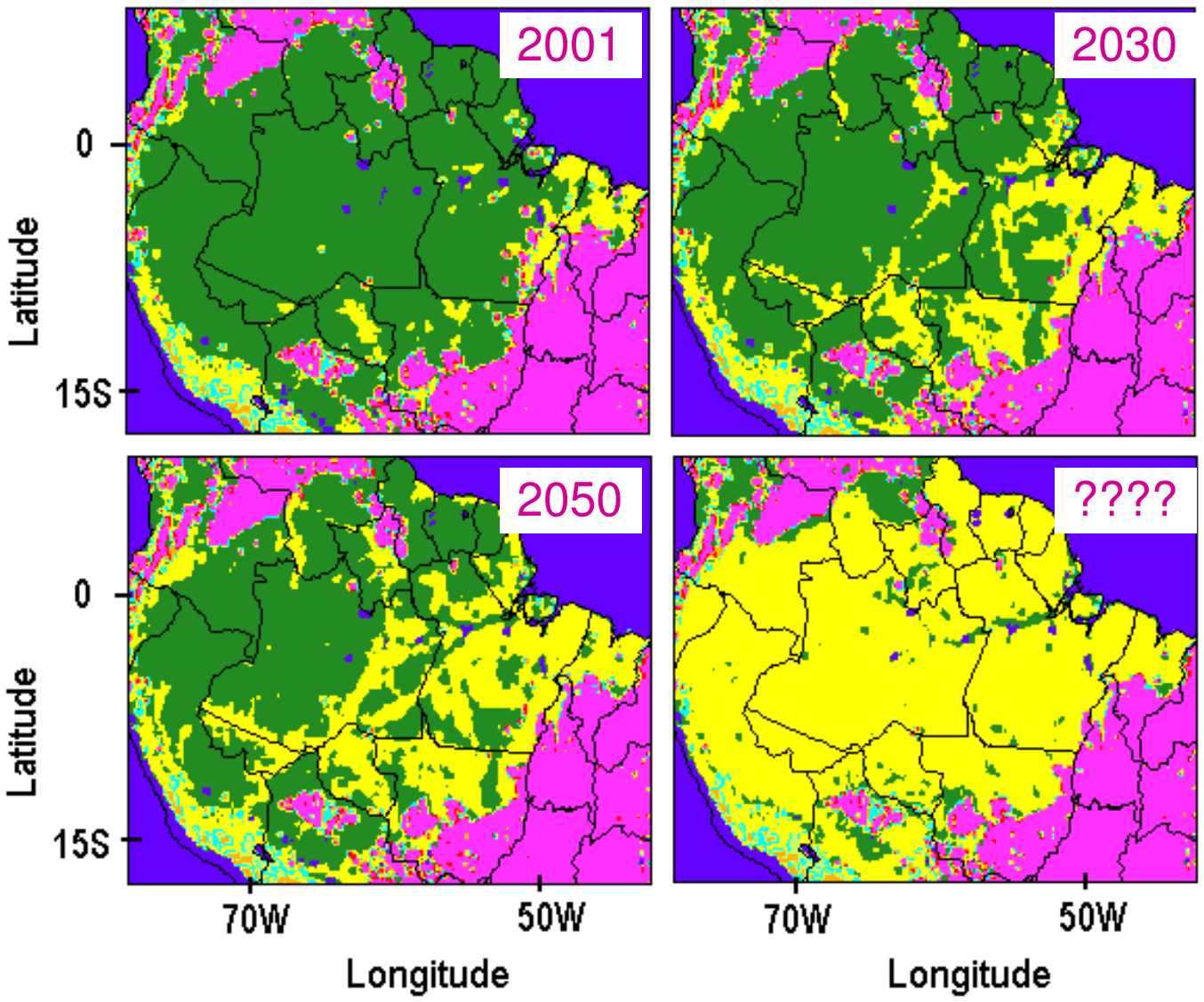
Regional models > Convection increase
Baidya Roy and Avissar, 2002
Souza et al. 2001
Wang et al. 2000
Silva Dias et al. 2002
Gandu et al. 2004

Satellite > Cumulus increase
Cutrim et al. 1995
Negri et al. 2004
Changnon et al. 2004
Durieux et al. 2003

Rainfall OBS > not noticeable change
Richney et al. 1989
Yadvinder et al. 2004

Scenarios of deforestation

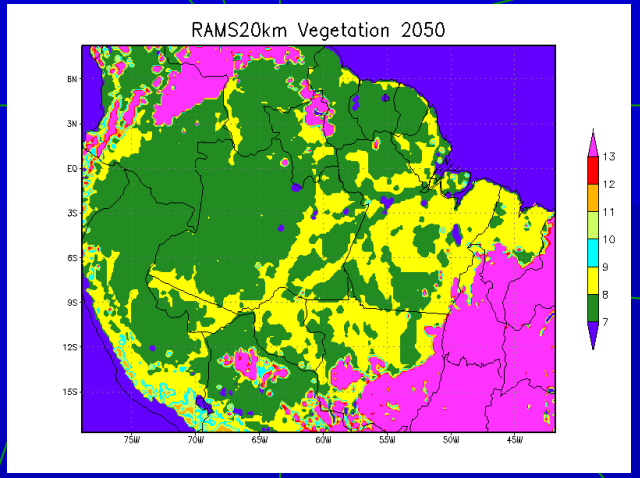
RAMS model scenarios of deforestation



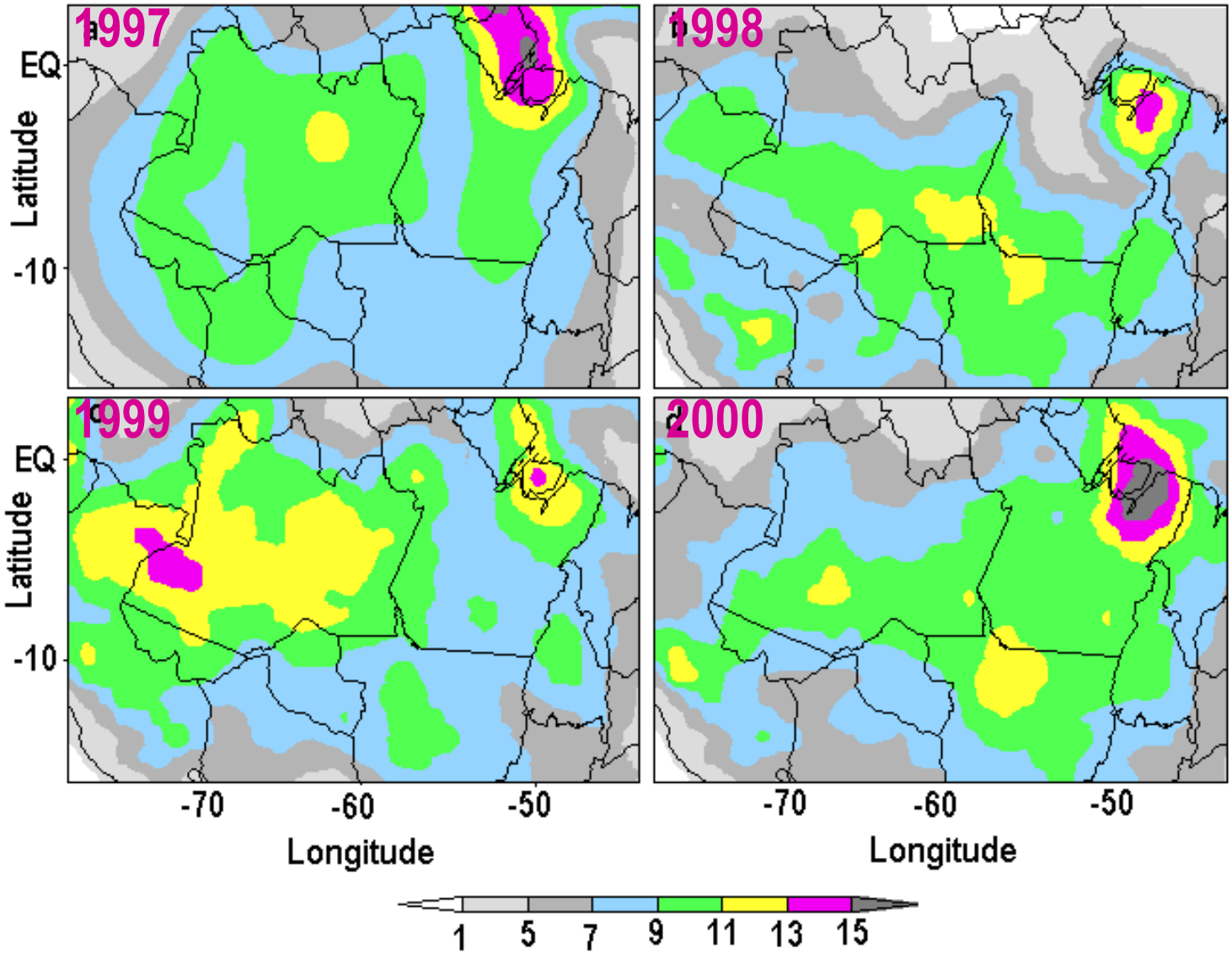
RAMS Amazon rainforest vegetation parameters:

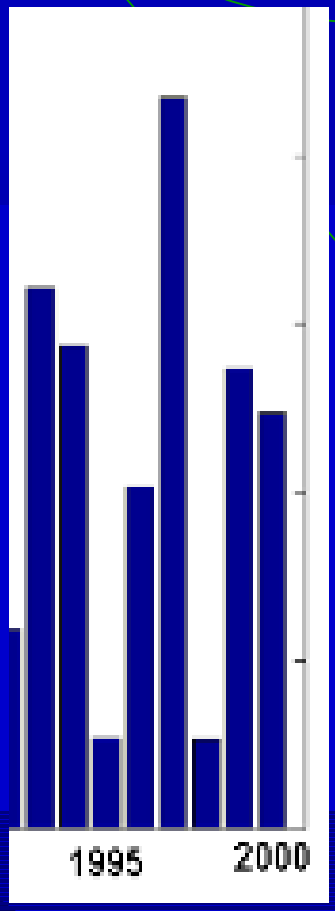
Parameter	Forest	Pasture
Albedo	.13	.18
Emissivity	.95	.96
Leaf Area Index	5.0	2.0
Vegetation Fraction	.98	.80
Height (m)	35.	0.2
Root Depth (m)	4.0	1.0
Maximum Stomatal Conductance (m/s)	.0035	.01

Gash and Nobre, 1997 ABRACOS campaign

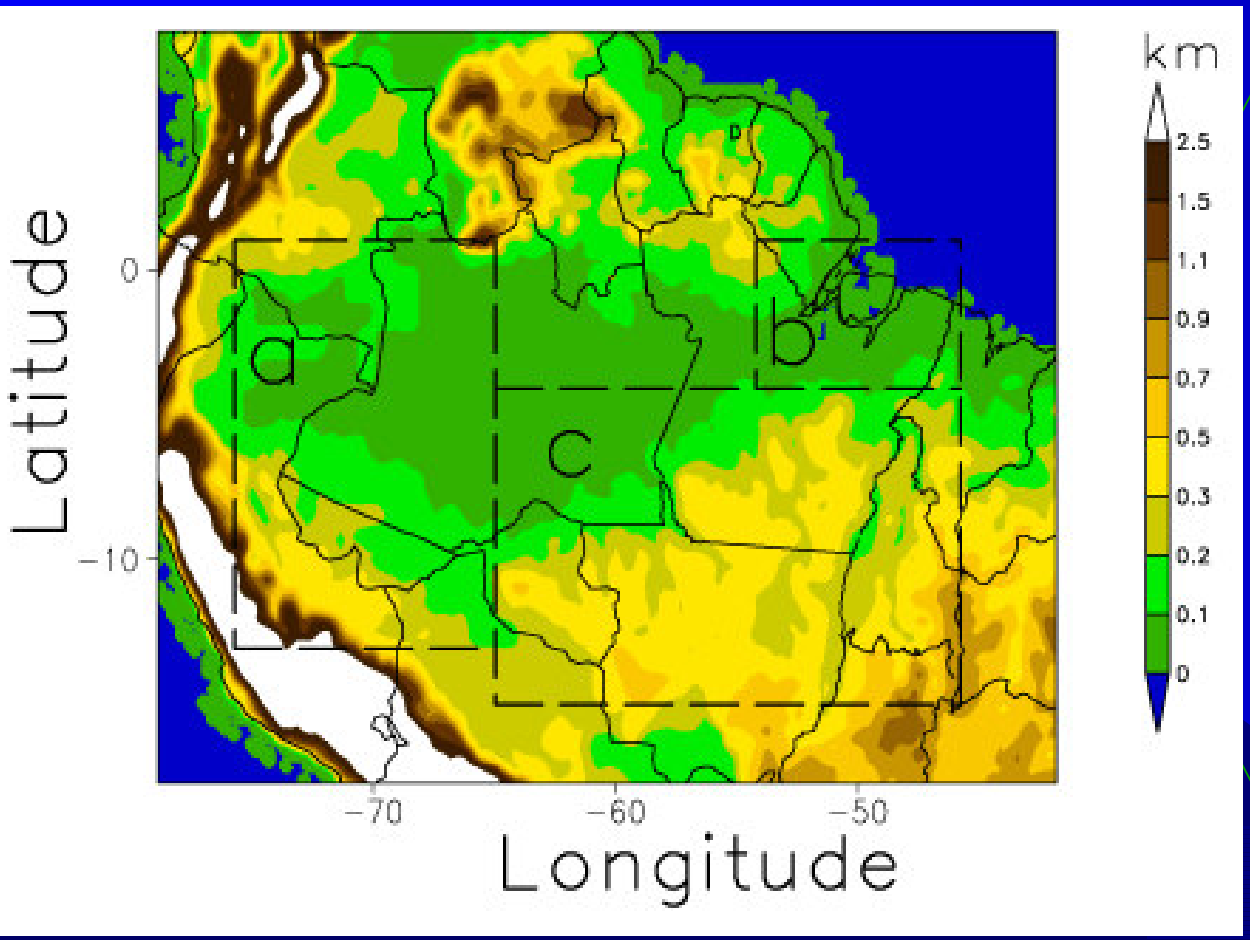


January-February mean accumulated precipitation (mm/day)





RAMS model domain & experiment design



dx=20km (210)

dy=20km (150)

top=25km (50)

soil=4m (12)

Kain-Fritsch cumulus

60-day

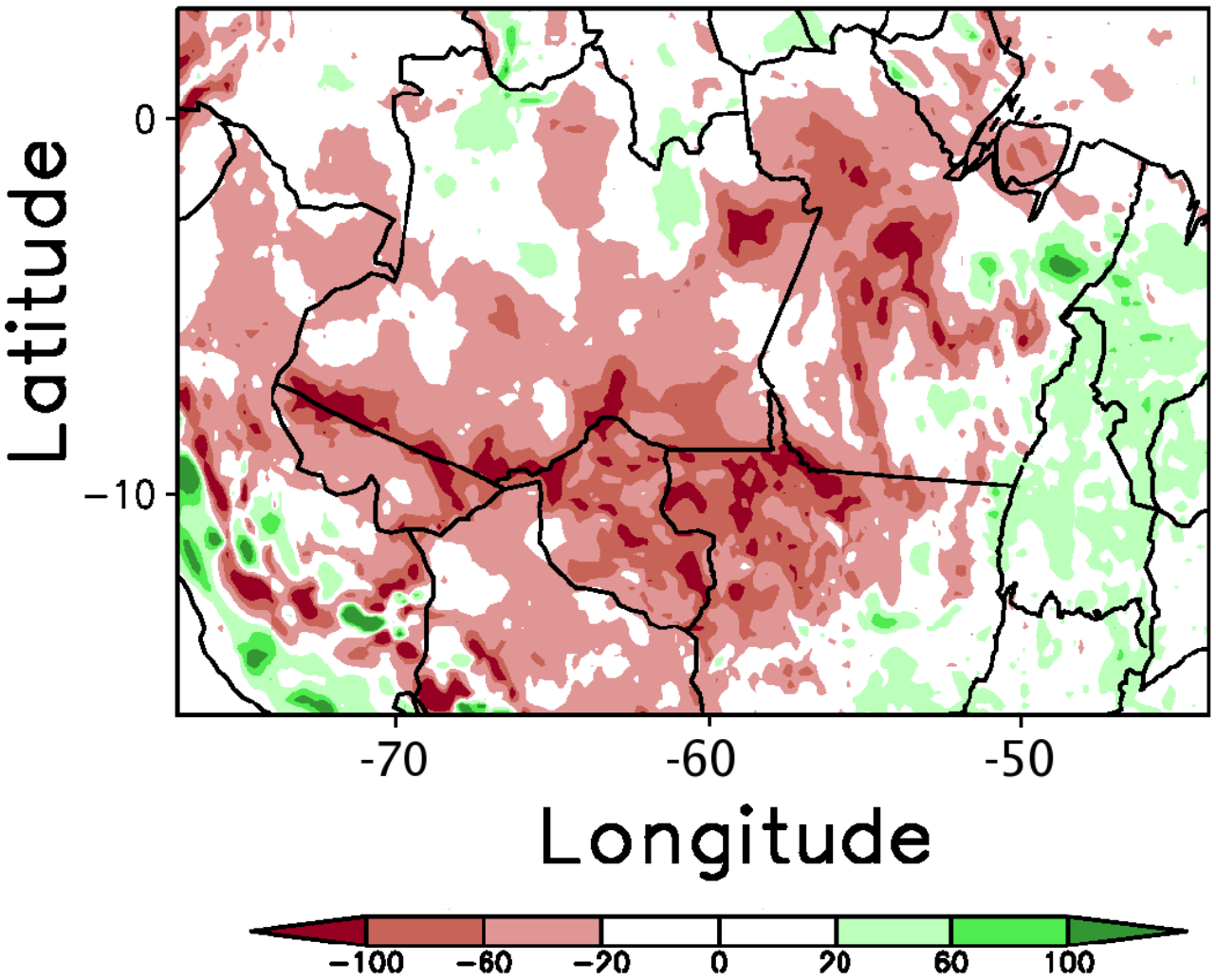
NCEP-reanalysis

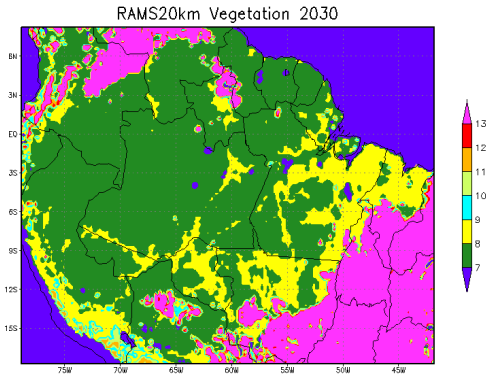
NOAA – Weekly SST

Jan. Feb.

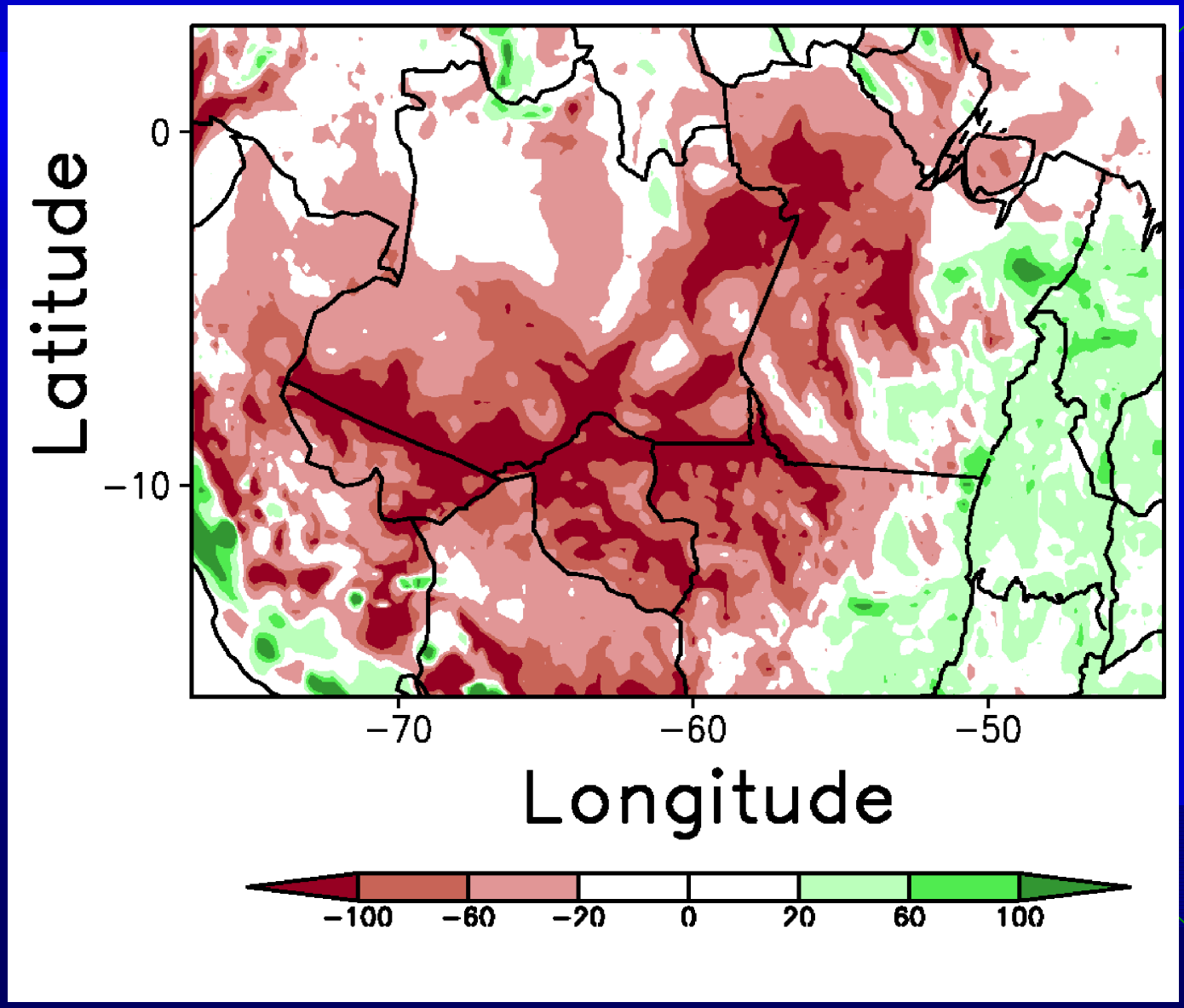
1997-98-99-00

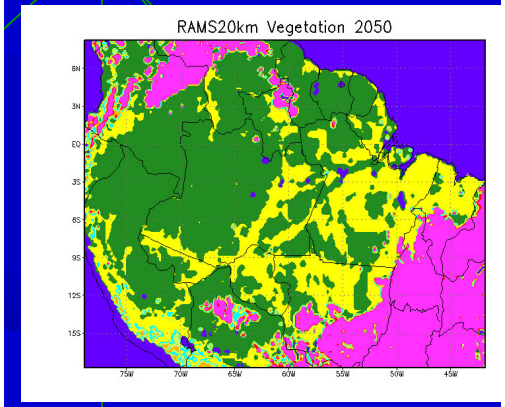
RAMS Impacts of deforestation / rainfall 2030



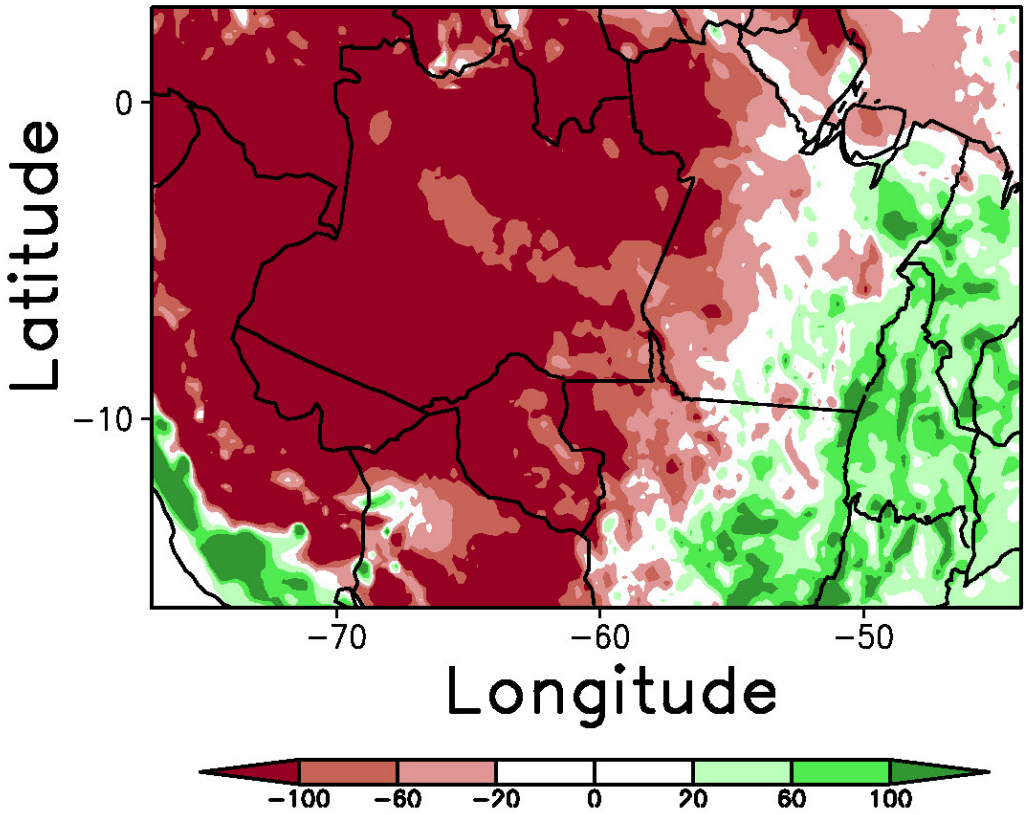


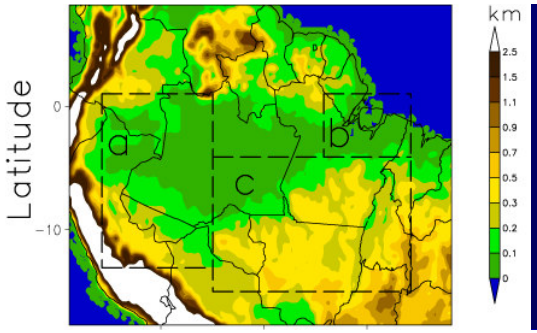
RAMS Impacts of deforestation / rainfall 2050



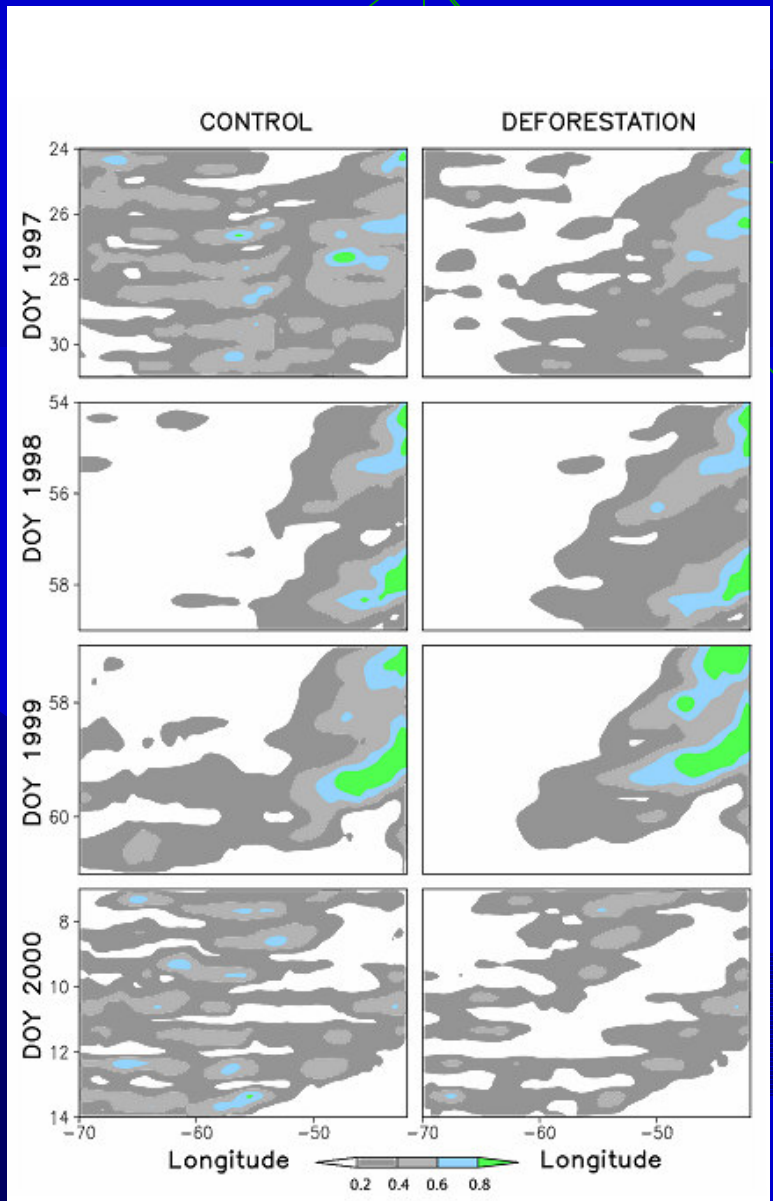


RAMS Impacts of total deforestation on rainfall

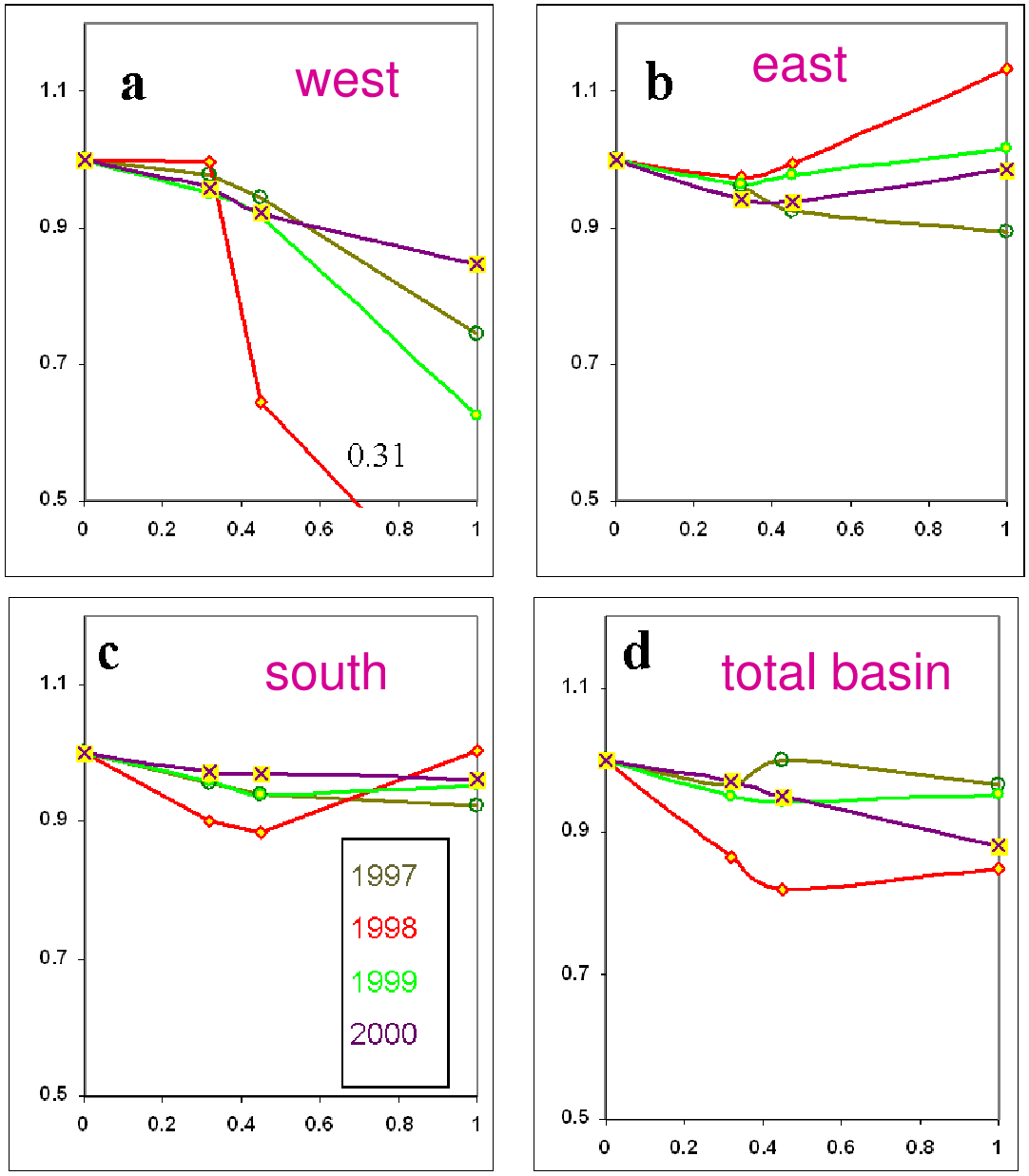


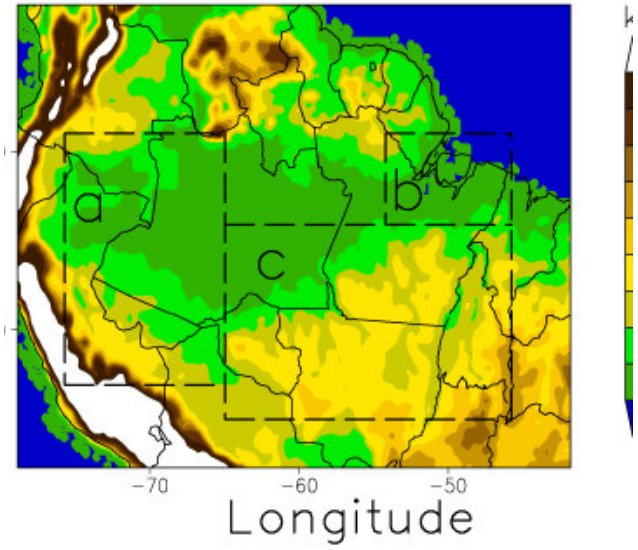


RAMS Impacts of total deforestation on cloud cover



RAMS regional impacts of deforestation on rainfall





Amazon: Clouds have marine characteristics; "The Green Ocean"

Low density of big droplets (50-100 cm^{-3})

(Tokai et al. 2002)

Clean atmosphere [low CCN]

(Roberts et al. 2001)

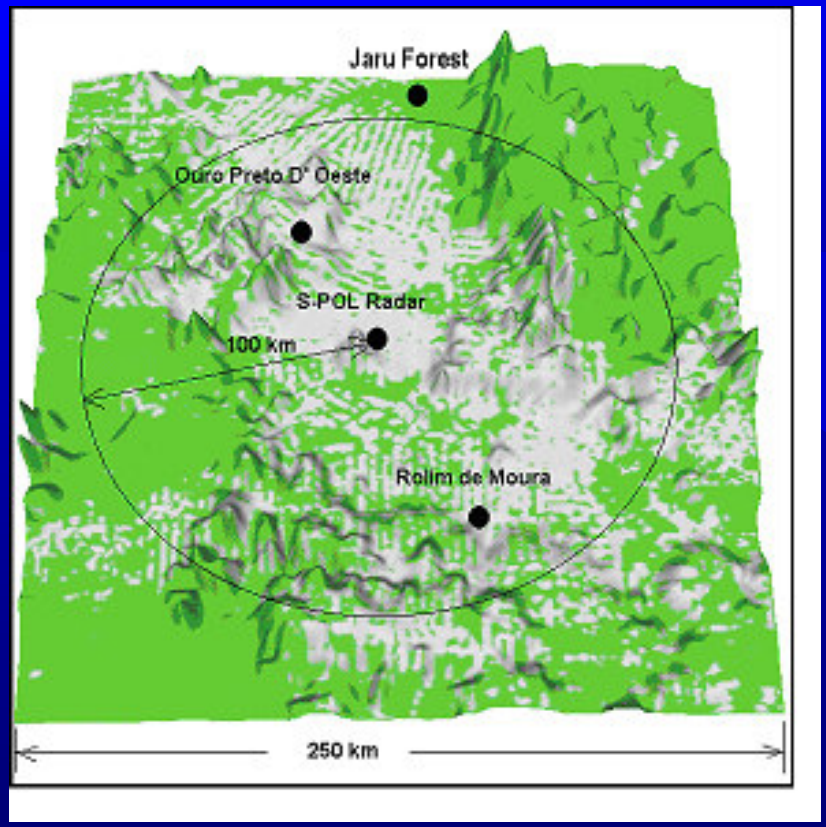
Large presence of light stratiform rainfall

(Halverson et al. 2002)

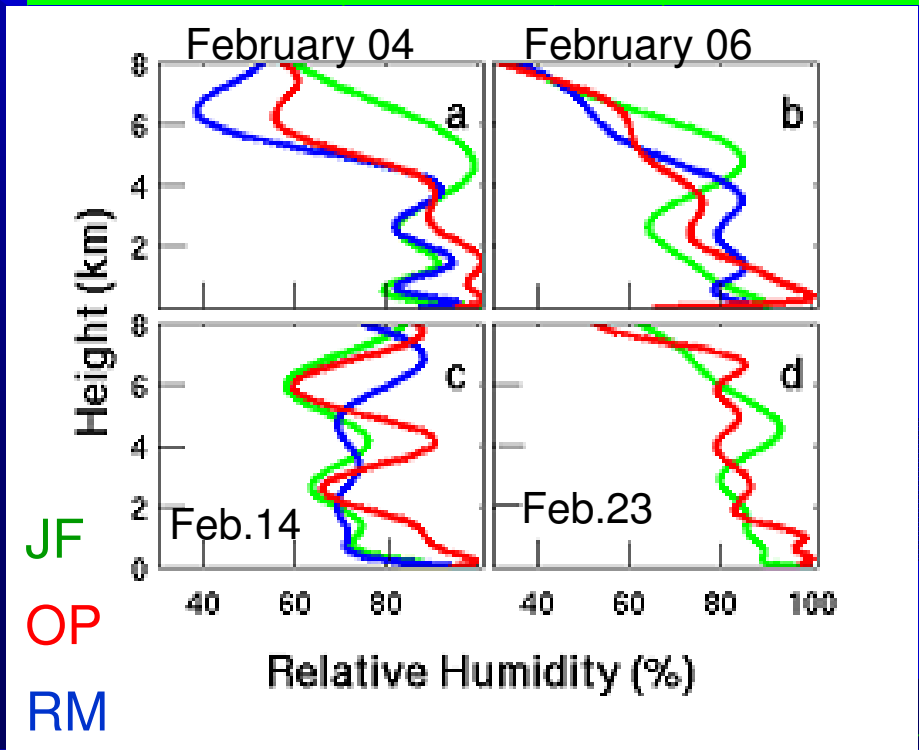
Low frequency of lightning

(Williams et al. 2002)

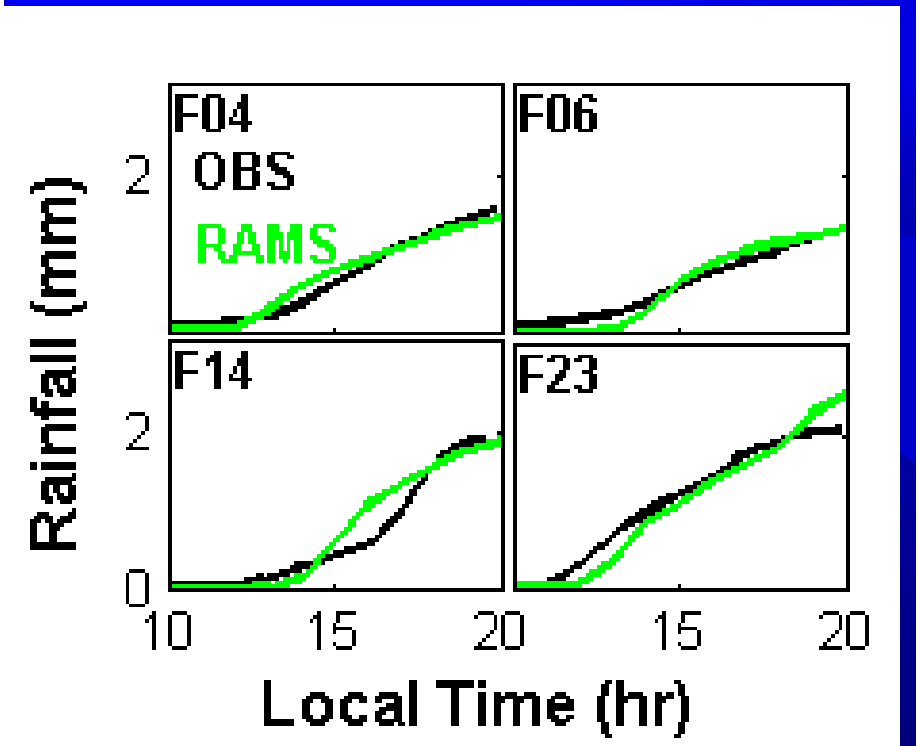
RAMS model domain & design

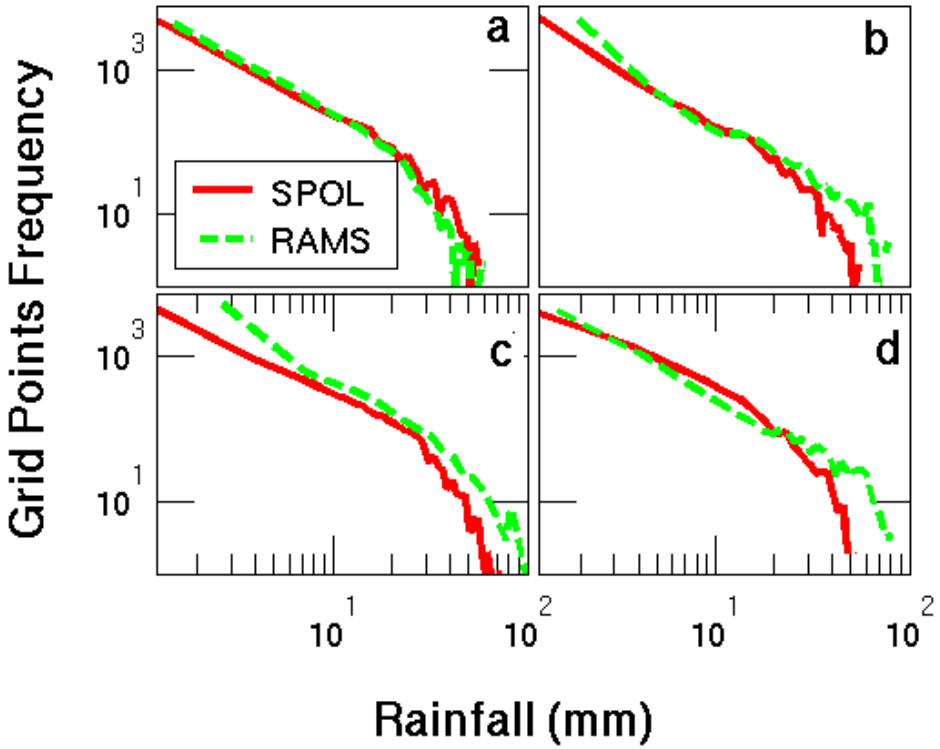


Parameter	Option/Dimension
Horizontal Grid Points	250 x 250
Vertical Grid Points	50
Horizontal Resolution	1000 m
Soil Layers	12
Time step	5.0 seconds
Time of integration	12 hours
Initial Condition	Radiosounding



RAMS results compared with observations from the SPOL radar

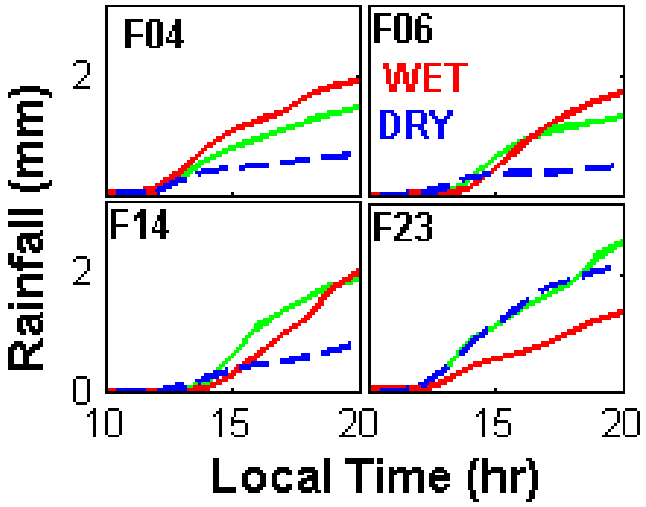




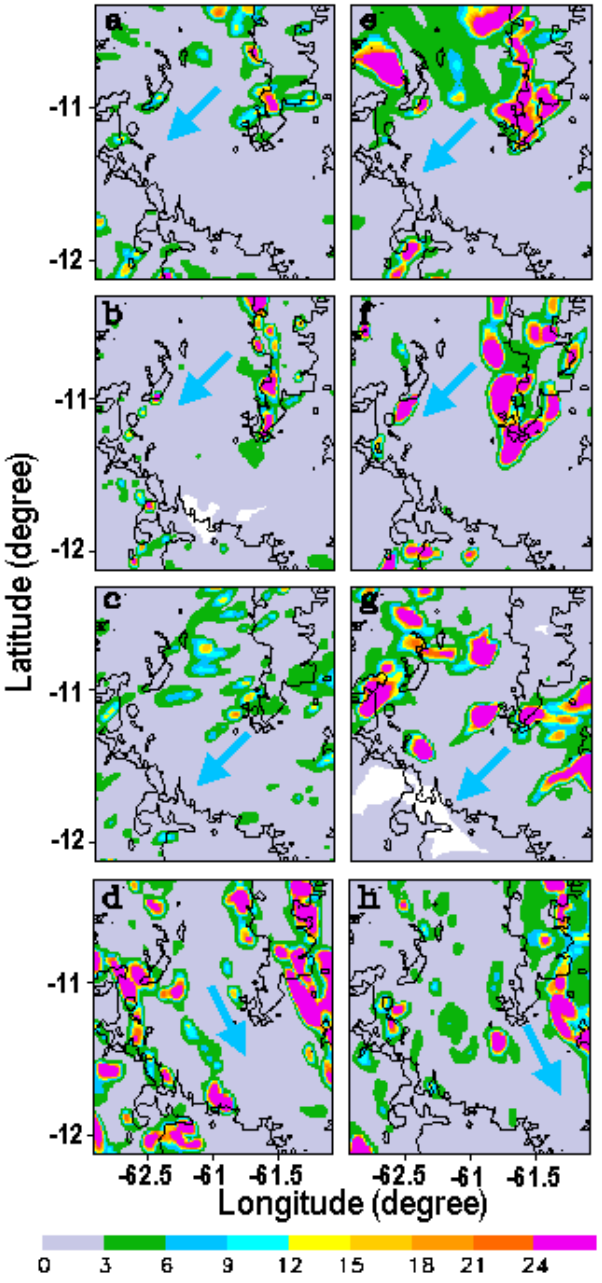
RAMS

Umidade de solo:

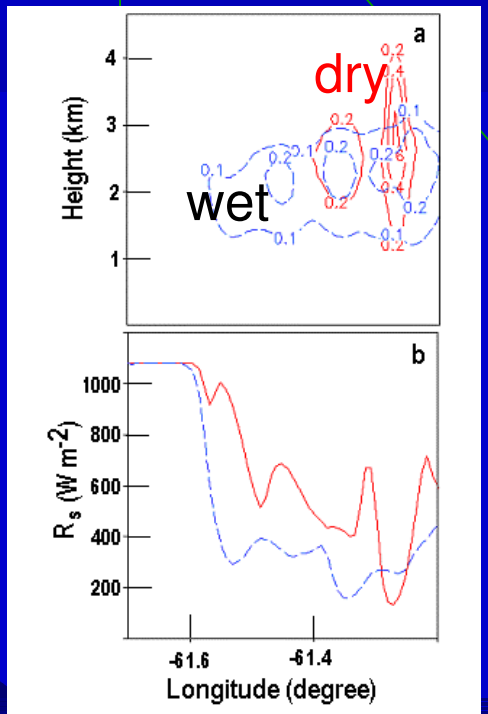
Testes de sensitividade



SM -15% SM +15%



Rain mixing ratio (g/kg) at 10.8S Noon Feb.23



Downward solar radiation at the surface

Amazon: Clouds have marine characteristics; "The Green Ocean"

Low density of big droplets (50-100 cm^{-3})

(Tokai et al. 2002)

Clean atmosphere [low CCN, 267 cm^{-3}]

(Roberts et al. 2001)

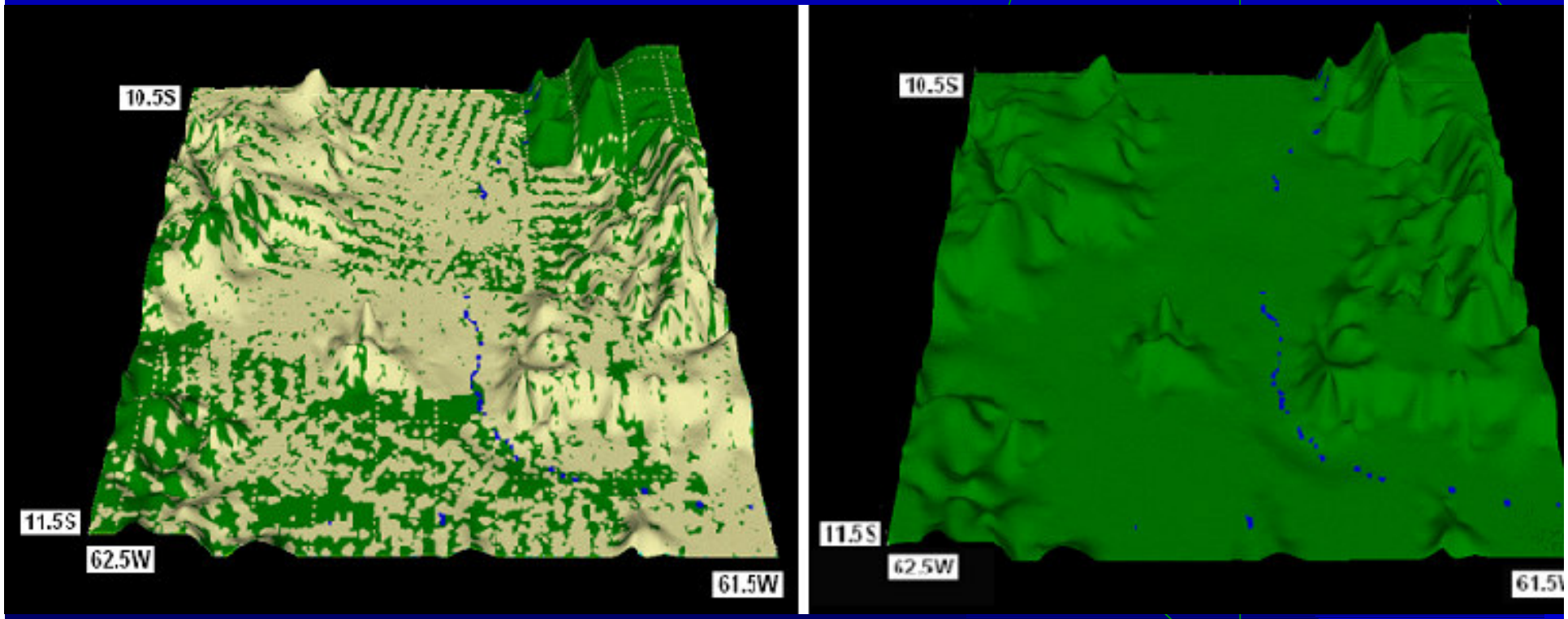
Large presence of light stratiform rainfall

(Halverson et al. 2002)

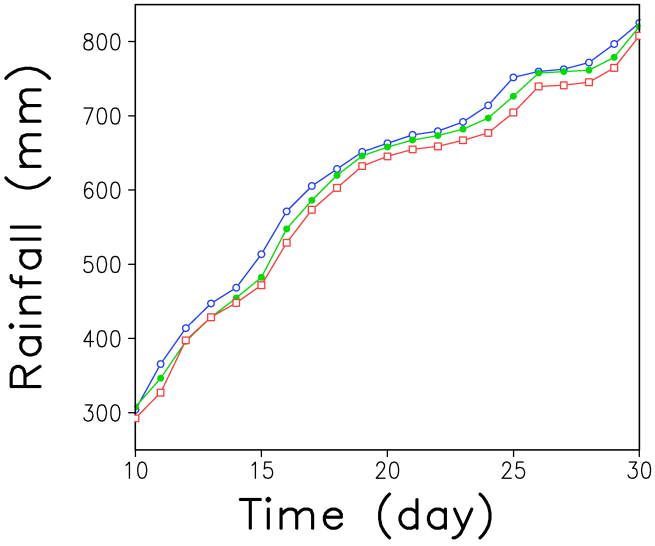
Low frequency of lightning

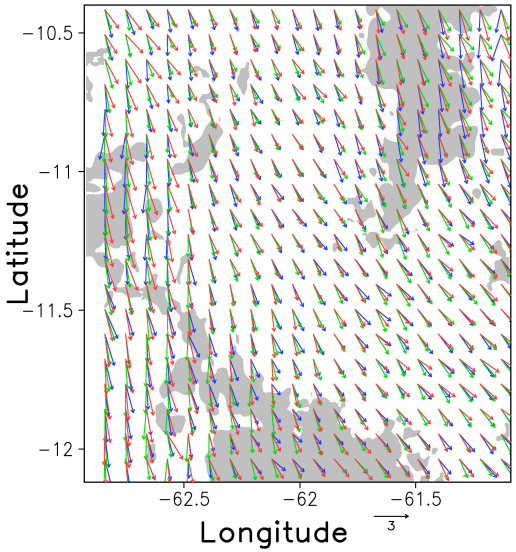
(Williams et al. 2002)

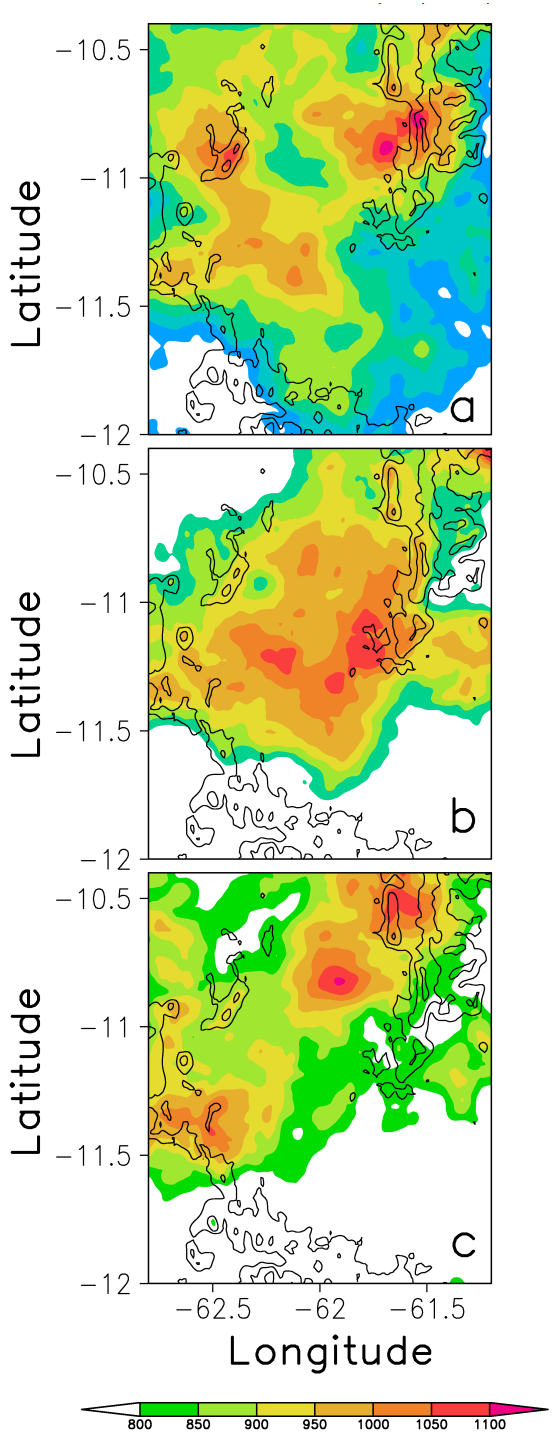
RAMS - Impacts of Deforestation on Hydrological Processes (Case Studies) Hydroclimatology (January 1999)



RAMS Impacts of deforestation on rainfall





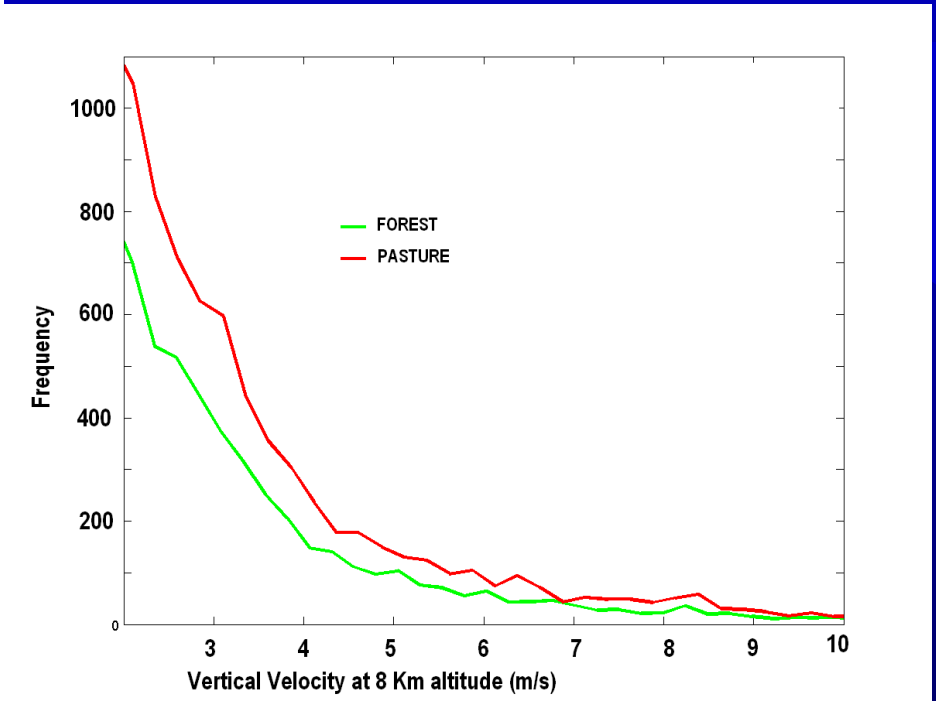


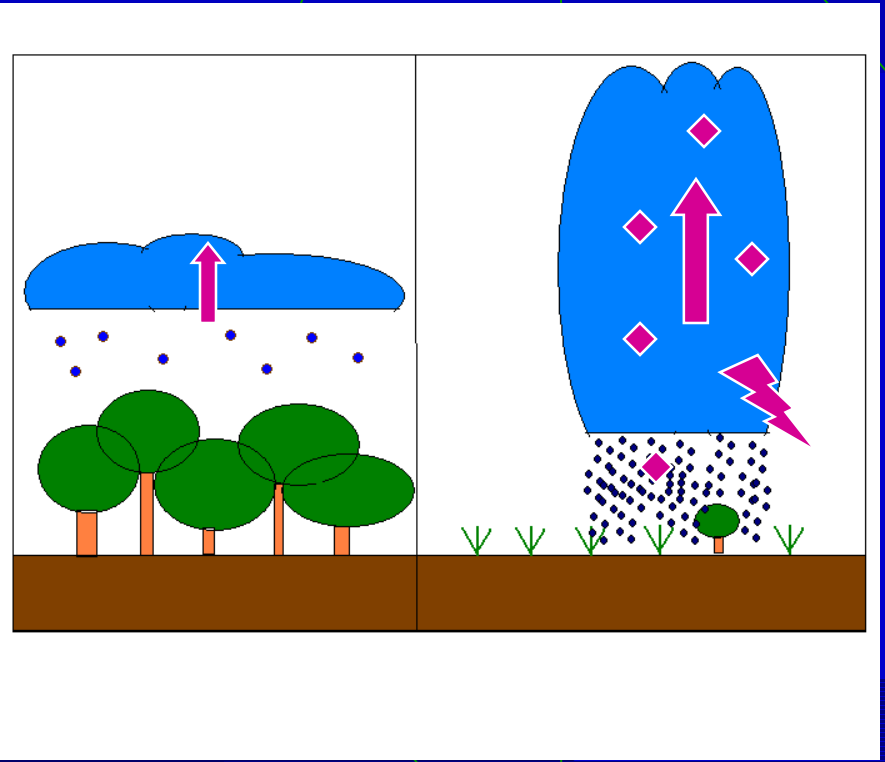
Current Vegetation

Forest

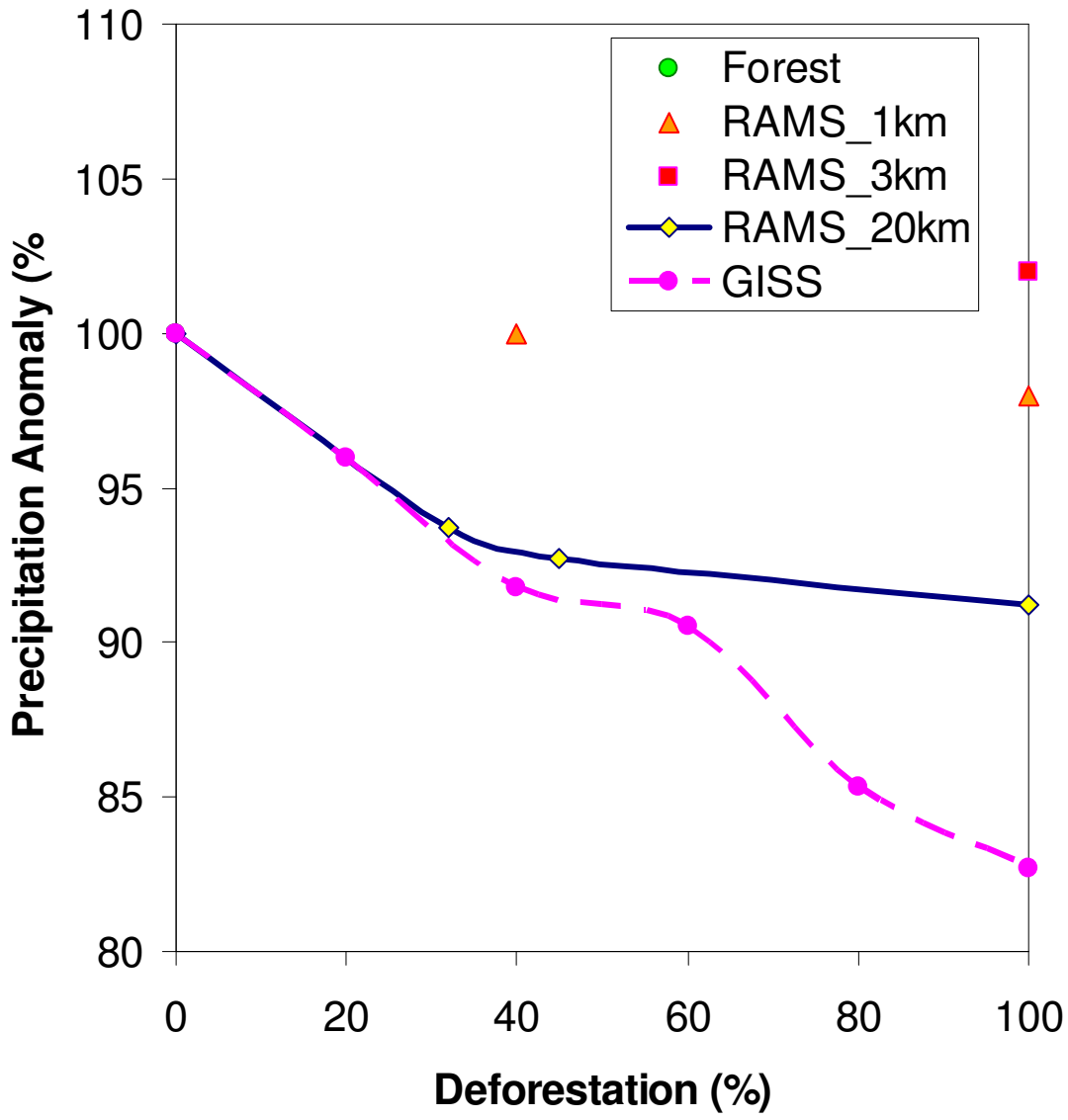
Pasture

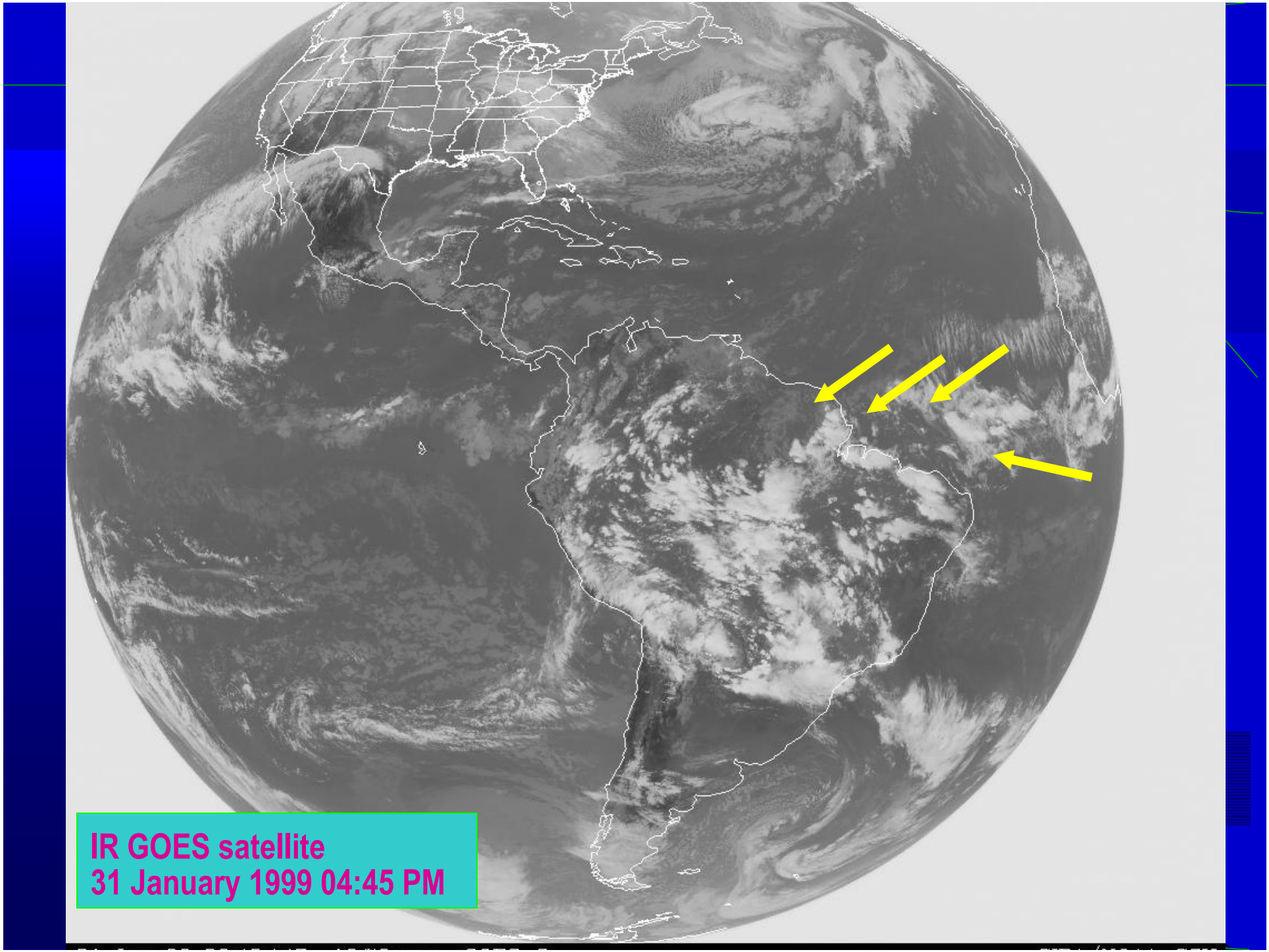
The END of the "GREEN OCEAN"



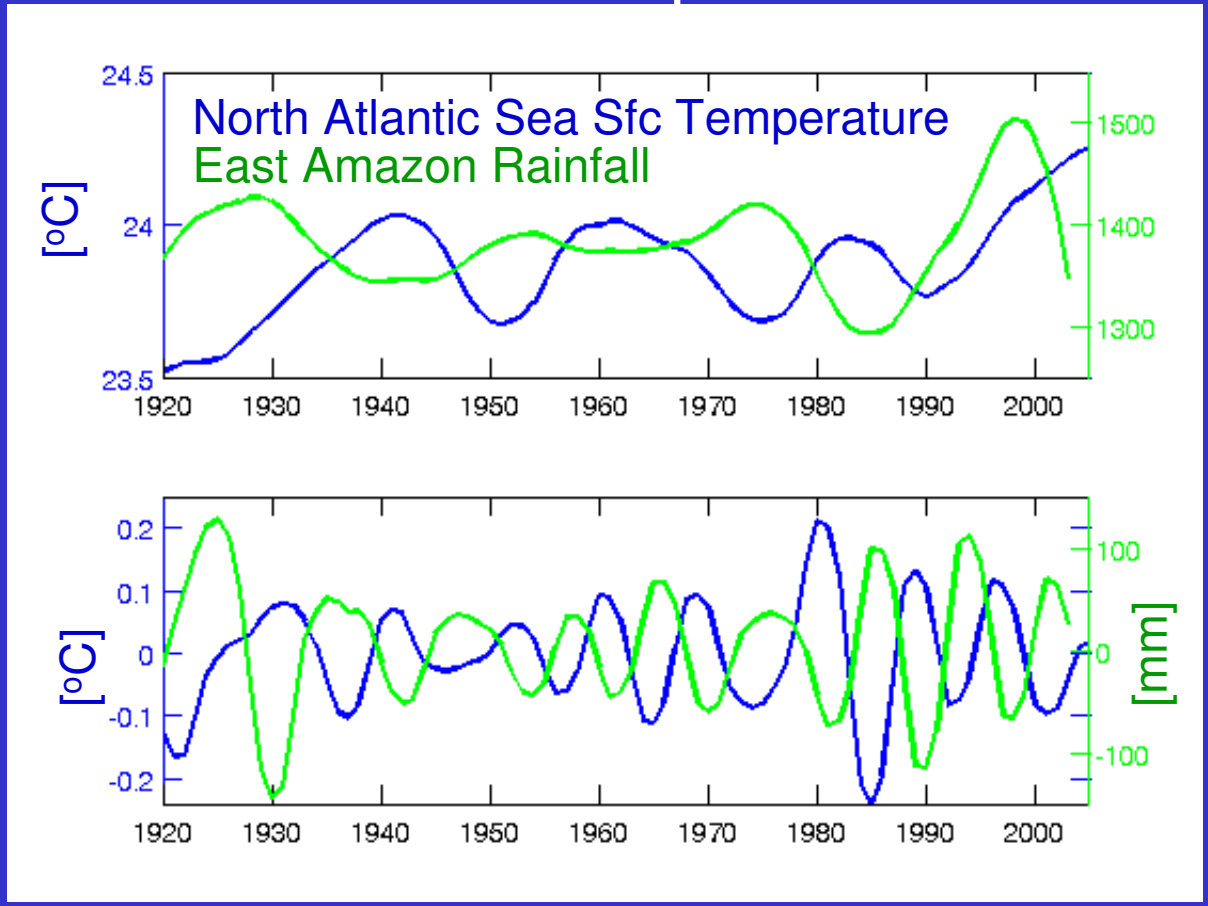


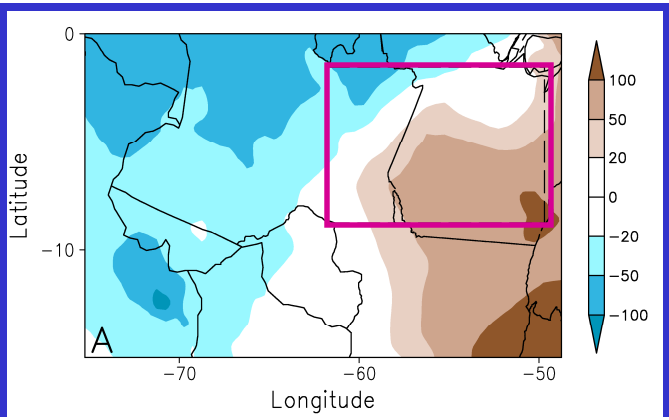
Amazonian Deforestation




IR GOES satellite
31 January 1999 04:45 PM

Wavelet decomposition



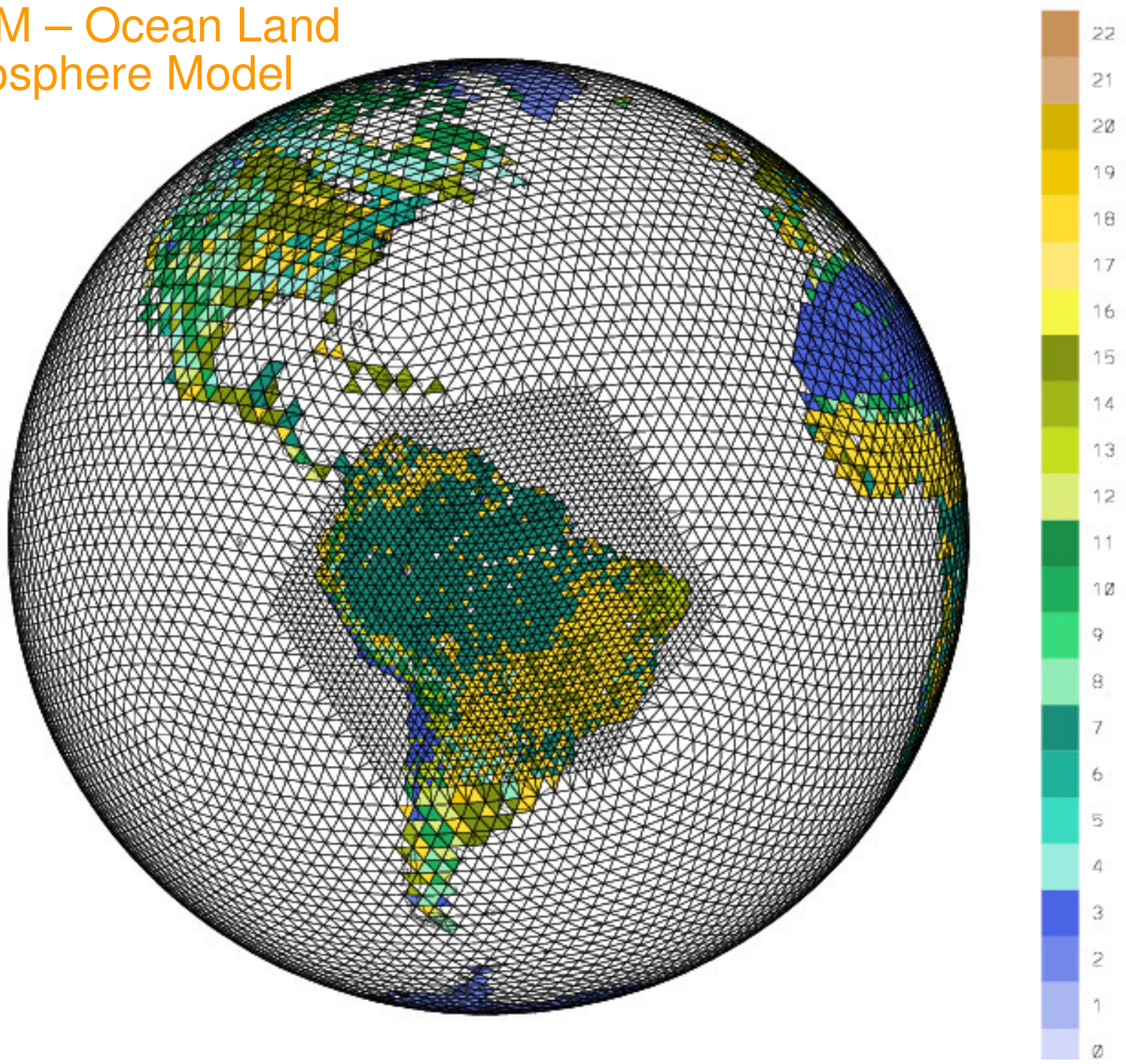


Correlation Coefficients

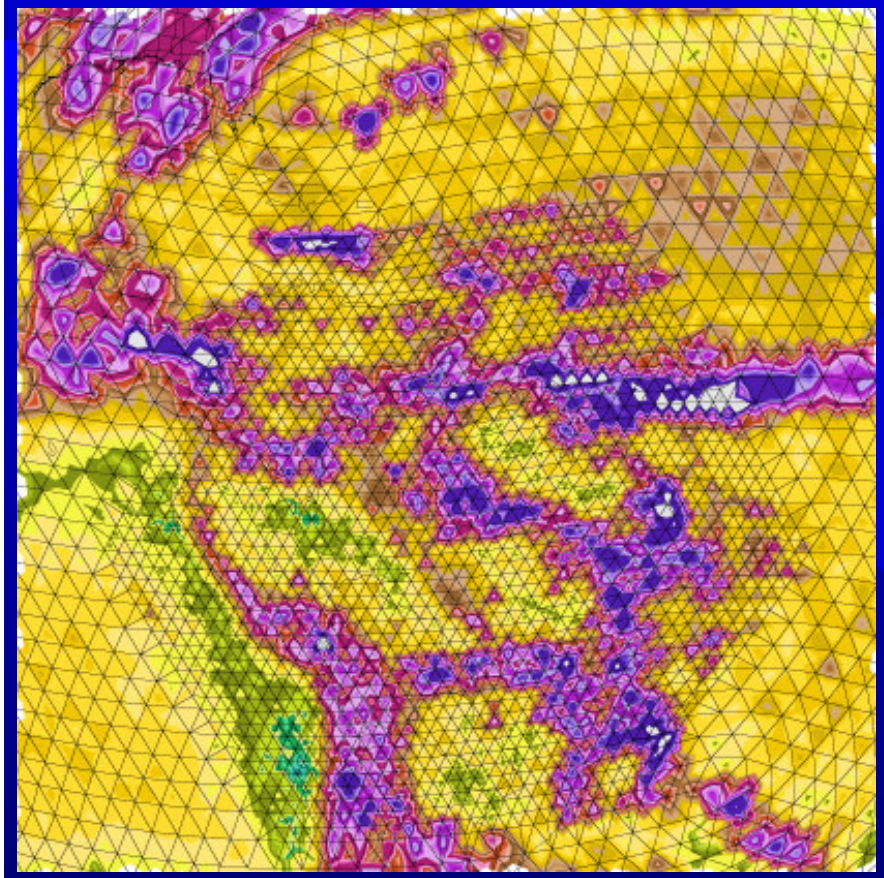
SST & Rainfall
[1920-1975]
(R=-0.80)

SST & Rainfall
[1920-2003]
(R=-0.64)

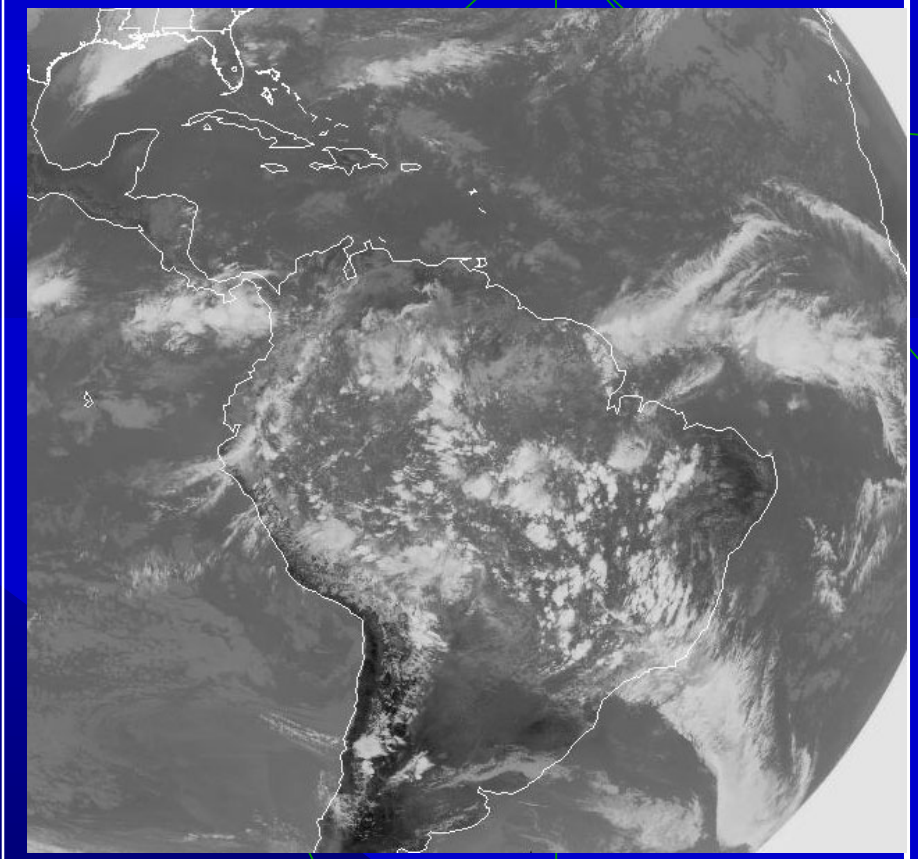
OLAM – Ocean Land Atmosphere Model



OLAM – preliminary results



OLAM rainfall
accumulated in 48 hs
01-03/January/1999



GOES satellite image
02 January 1999

Conclusions

Impacts of deforestation may depend on the prevailing climate regime and the geographical location

Expected deforestation produces less rainfall in the west of the basin because the easterly propagating squall-lines weakens before reaching the west of the basin (ENSO like pattern)

Locally deforestation produces about the same rainfall accumulation, but induces to less stratiform rainfall and more convective rainfall (and hail) “The End of the Green Ocean”.

A model approach that addresses the overall hydro-meteorological processes in the Amazon is necessary to fully represent the impacts of deforestation (OLAM)