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

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
RAMS model scenarios of deforestation

2001

2030

2050

????
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Forest</th>
<th>Pasture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albedo</td>
<td>0.13</td>
<td>0.18</td>
</tr>
<tr>
<td>Emissivity</td>
<td>0.95</td>
<td>0.96</td>
</tr>
<tr>
<td>Leaf Area Index</td>
<td>5.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Vegetation Fraction</td>
<td>0.98</td>
<td>0.80</td>
</tr>
<tr>
<td>Height (m)</td>
<td>35.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Root Depth (m)</td>
<td>4.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Maximum Stomatal Conductance (m/s)</td>
<td>0.0035</td>
<td>0.01</td>
</tr>
</tbody>
</table>

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
1997-98-99-00
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**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Option/Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Grid Points</td>
<td>250 x 250</td>
</tr>
<tr>
<td>Vertical Grid Points</td>
<td>50</td>
</tr>
<tr>
<td>Horizontal Resolution</td>
<td>1000 m</td>
</tr>
<tr>
<td>Soil Layers</td>
<td>12</td>
</tr>
<tr>
<td>Time step</td>
<td>5.0 seconds</td>
</tr>
<tr>
<td>Time of integration</td>
<td>12 hours</td>
</tr>
<tr>
<td>Initial Condition</td>
<td>Radiosounding</td>
</tr>
</tbody>
</table>

- **February 04**
  - JF
  - OP
  - RM

- **February 06**
  - JF
  - OP
  - RM

- February 14
- February 23
RAMS results compared with observations from the SPOL radar

![Graphs comparing RAMS results and SPOL radar observations](image-url)
RAMS
Umidade de solo:
Testes de sensitividade

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”
Wavelet decomposition

Correlation Coefficients

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

SST & Rainfall [1920-2003] (R=-0.64)
OLAM – Ocean Land Atmosphere Model
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 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).