Simulation of the West African Monsoon using the MIT Regional Climate Model

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### New Features

<table>
<thead>
<tr>
<th>Coupling of Integrated Biosphere Simuylator (IBIS) Land Surface Scheme</th>
<th>Winter et al. (2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New surface albedo assignment</td>
<td>Marcella (2012), Marcella and Eltahir (2012)</td>
</tr>
<tr>
<td>New convective cloud scheme</td>
<td>Gianotti (2012), Gianotti and Eltahir (2013a)</td>
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<tr>
<td>New convective rainfall autoconversion scheme</td>
<td>Gianotti (2012), Gianotti and Eltahir (2013b)</td>
</tr>
<tr>
<td>Modified boundary layer height and boundary layer cloud scheme</td>
<td>Gianotti (2012), Gianotti and Eltahir (2013c)</td>
</tr>
</tbody>
</table>

### Poster Session

- **Gianotti and Eltahir**: Improving simulation of the feedback between radiation, convective clouds and rainfall over the Maritime Continent
- **Eltahir et al**: Introducing the MIT Regional Climate Model (MRCM)
### Experiments Design

<table>
<thead>
<tr>
<th></th>
<th>Land surface scheme</th>
<th>Convection scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IGF</strong></td>
<td>IBIS</td>
<td>Grell FC</td>
</tr>
<tr>
<td><strong>BSE</strong></td>
<td>BATS</td>
<td>Standard Emanuel</td>
</tr>
<tr>
<td><strong>ISE</strong></td>
<td>IBIS</td>
<td>Standard Emanuel</td>
</tr>
<tr>
<td><strong>IME</strong></td>
<td>IBIS</td>
<td>Modified Emanuel</td>
</tr>
</tbody>
</table>

**MIT Regional Climate Model (MRCM)**
Model Configuration

- Resolution: 50km
- Integration Period: 1989-2008 (20yr)
- Initial & Boundary Condition: ERAInterim (1.5deg)
- Sub-domain for area-average validation
  - A: Guinea Coast
  - B: Sahel
  - C: Northern Africa
JJA Rainfall Spatial Pattern

- 20-YR Climatology (1989-2008)

- Bias with CRU (1989-2008, 20yr)

- Bias with TRMM (1998-2008, 11yr)

BATS vs. IBIS
Standard vs. Modified
Steiner et al. (2009)

This improvement is comparable with results using RegCM3 coupled with the Community Land Model Version 3 (CLM3).
Latitude-Time Cross-section of Rainfall

- IGF
- BSE
- ISE
- IME

CRU
Latitude-Time Cross-section of Net Radiation

IGF

BSE

ISE

IME

SRB
Steiner et al. (2009) also noted that the surface albedo was too low in their simulation using BATS, and attributed this result to higher soil moisture. Since wetter soils further reduce the soil albedo, this can cause an enhanced feedback to absorbed solar radiation, leading to excessive net radiation.
Wind Vector at 850 & 200 hPa

850 hPa Wind

200 hPa Wind
Temperature [10W-10E/May-Oct]
Specific Humidity [10W-10E/May-Oct]

BSE

IME

ERAI

BSE-ERAI

IME-ERAI

Time:05
The simulation of the WAM exhibits strong sensitivity to the choice of both land surface scheme and convection scheme.

The improvement in the spatial and temporal distribution of rainfall in simulations using IBIS, rather than the default BATS scheme, is significant.

In addition, the modifications incorporated within MRCM with respect to convective cloud cover, autoconversion and boundary layer characteristics significantly improved the simulation of rainfall.

The MRCM represents a significant improvement over previous versions of this model that attempted to simulate the West African Monsoon.

The MRCM is capable of reproducing the major features of the rainfall and dynamics of the West African monsoon.
Thank you for your attention!!
The IGF exhibits more extensive cloud cover in the lowest 100 mb of the atmosphere than the other simulations, but less cloud cover throughout the rest of the vertical column. This reflects the weaker convective activity. The weak vertical transport results in little high cloud cover.

In contrast, the simulations using the Emanuel scheme show less low-level cloud cover but more extensive cloud cover throughout the vertical column and especially at high altitudes. This results from the strong convective mass flux generated by this convection scheme, which transports large volumes of moisture vertically through the atmosphere and produces large anvil clouds aloft.

The IME exhibits a cloud profile that appears shifted vertically compared to the other simulations, with very little cloud cover in the lowest 100 mb and more cloud cover within the top 100 mb. The representation of large-scale cloud cover within the PBL was modified such that cloud could only form within the mixed PBL if its entire depth was saturated. This was found to remove unrealistic dense cloud cover close to the surface over land and improve the model performance compared to the ISCCP observations.
Zonal Wind & Omega [10W-10E/May-Oct]