RUTGERS

Measured and Modeled Cloud and Radiation Interactions over West Africa

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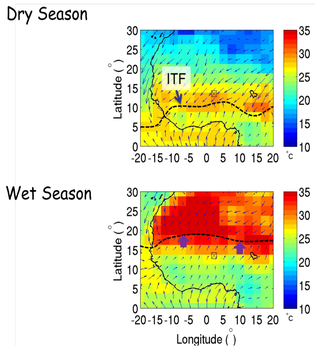
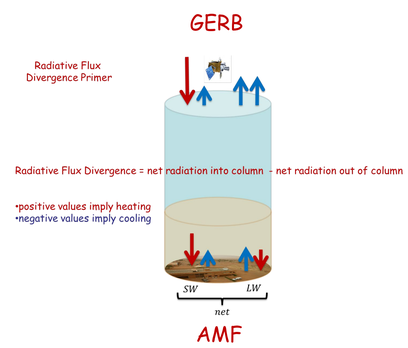
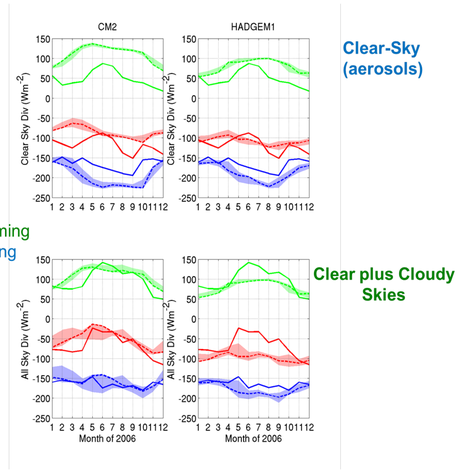
Objectives

(1) Measure the cross-atmosphere radiation flux divergence in the Sahel Region of West Africa
(2) Measure the impacts of clouds upon this divergence
(3) Determine if two GCMs are able to reproduce these impacts.

Miller, M.A., V.P. Ghate, R. Zahn (2012), The radiation budget of the West African Sahel and its controls: a perspective from observations and global climate models, *J. Climate, 25,* DOI: 10.1175/JCLI-D-11-00072.1

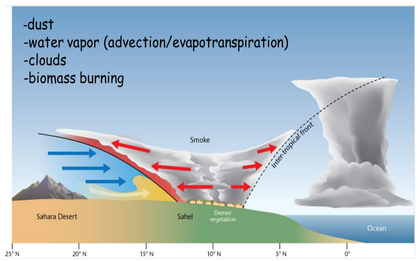




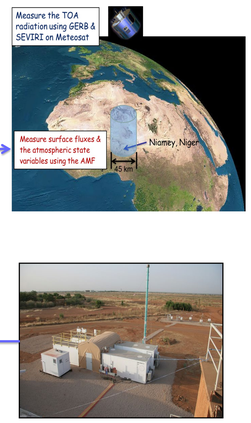


Experiment Design

Factors that may control the TOA, surface, and total column radiative divergences in SW and LW:

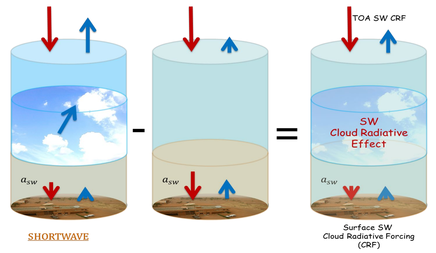


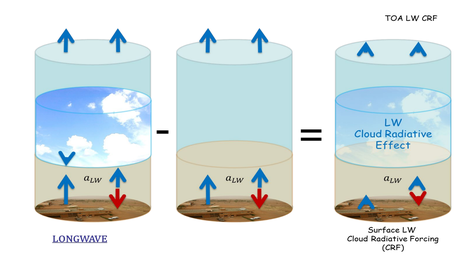
Haywood et al., JGR, 2008

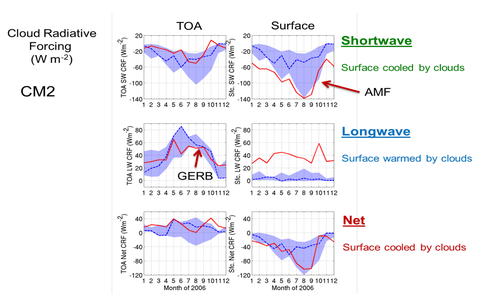


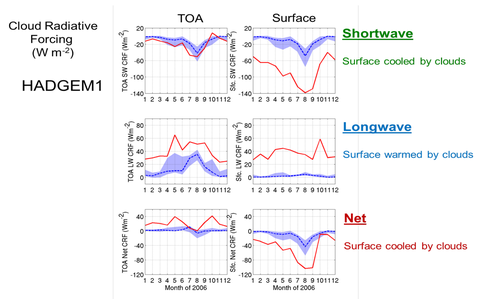
Department of Energy's Atmospheric Radiation Measurement Facility (AMF)

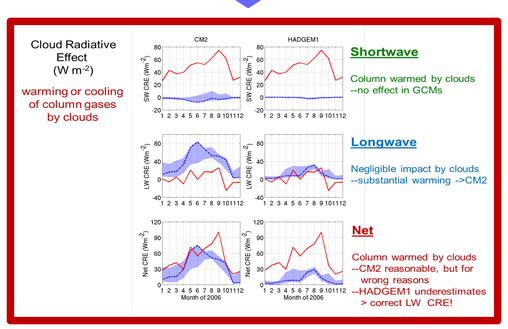
Cloud Radiative Forcing: Radiative Impacts of Clouds at the Surface and the Top-of-Atmosphere











Global Climate Models

Clouds and Radiation

HADGEM1

UK Met Office Hadley Center
Experiment ID = 1% per year CO2 increase experiment (to doubling), run 2
Single Level Grid Size = 1.25 Latitude by 1.875 Longitude (145 by 192 grid)
Multi Level Grid Size = 1.25 Latitude by 1.875 Longitude by 16 Pressure Levels

AM2.1 (CM2.1)

NOAA Geophysical Fluid Dynamics Laboratory
Experiment ID = 1% per year CO2 increase experiment (to doubling), run 1
Grid Size = 2 Latitude by 2.5 Longitude by 17 Pressure Levels

Precipitation

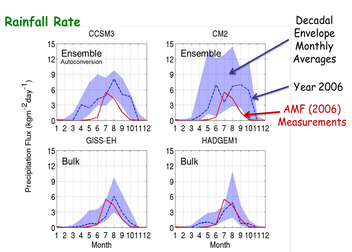
GISS Model E

NASA Goddard Institute for Space Studies
Experiment ID = 1% per year CO2 increase experiment (to doubling), run 1
Single Level Grid Size = 3 Latitude by 5 Longitude
Multi-Level Grid Size = 4 Latitude by 5 Longitude by 17 Pressure Levels

CAM3 (CCSM3.0)

National Center for Atmospheric Research
Experiment ID = 720ppm Stabilization Experiment (SRESA1B), run 1
Single Level Grid Size = 1.4 Latitude by 1.4 Longitude

How to Read the Plots



For this column in the West African Sahel Region:

Measurements

- There is a positive SW CRE accentuated in the rainy season (warming due to absorption by H_2O and dust?).
- There is a negligible LW CRE.
- The dominance of the SW CRE leads to positive net CRE through the year 2006.

Global Climate Models

CM2

- Clouds don't cool the surface enough in the SW and don't warm the surface enough in the LW
- Canceling errors allow CM2 to accurately predict the net surface CRF

HADGEM1

- Clouds emit too little LW radiation to space, but SW CRF is dominant → net TOA CRF not too bad.
- Clouds don't cool the surface enough in the SW and don't warm the surface enough in the LW
- Clouds don't produce enough net cooling at the surface.