Radiative Atmospheric Divergence using ARM Mobile Facility GERB data and AMMA STations

ARM STM, Norfolk VA 2008

# Comparing Observations and Calculations of Radiation During the RADAGAST Experiment


Nazim Bharmal, Anthony Slingo, Jeff Settle, Gary Robinson, Helen White

Environmental Systems Science Centre, University of Reading

*nab@mail.nerc-essc.ac.uk*


NATURAL ENVIRONMENT RESEARCH COUNCIL
ENVIRONMENTAL SYSTEMS SCIENCE CENTRE

Imperial College London

Met Office

## Introduction

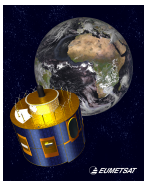


*Fig. 1: Geostationary Earth Radiation Budget instrument aboard Meteosat-8*

*Fig. 2: ARM Mobile Facility instrument field at Niamey airport, Niger (2.17E 13.47N).*

- Using the Edwards-Slingo RT code (ES), the radiation measured at TOA by GERB and at the surface from the AMF during its Nigerien deployment is compared with calculations during Nov-Dec 2006.
- Satellite data is also used to scale surface properties and provide a cloud mask. Surface aerosol loadings in the SW are from the AERONET station at Niamey.
- Estimates of the broadband atmospheric flux divergence for one diurnal time can then be calculated from the measured and calculated flux components.

## Longwave comparisons

- Used 'sonde launches between November and December 2006, at 06, 11, 17, & 23 UT to create RT input profiles.
- Launch times chosen to be cloud free via satellite (NOWSAF SEVIRI) and surface (in-house) cloud masks.
- Aerosol loading for RT profiles is empirically derived from calculation of surface direct effect. (Measured LW flux less calculated pristine flux).
- Comparisons with IR retrievals indicate approach is reasonable, although may be some positive bias at 11 UT.
- Resulting downwelling surface flux matches the AMF values to ±0.5 $Wm^{-2}$, as expected.
- Surface emissivity is 0.93 & surface temperatures are scaled using MODIS retrievals across the GERB area (ARG product, ~50km x 50km).
- Net surface flux is -4.7 ±1.8 $Wm^{-2}$; surface temperature scaling leads to primary difference at 11 UT.
- At TOA, radiance differences are constant with UT, but the fluxes have a variation:
  - Error in emissivity may account for the radiance difference.
  - Error in GERB radiance-to-flux conversion would cause disparity between radiance and flux differences.

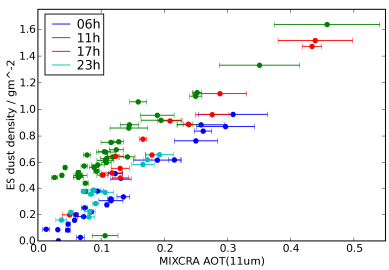



*Fig. 3: Comparison of derived dust loading with MIXCRA AOT retrievals. (D Turner, in preparation, 2008).*

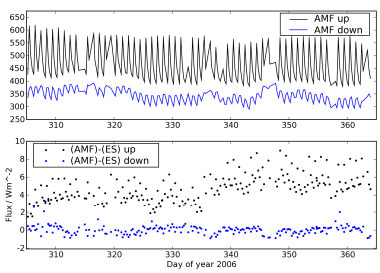



*Fig. 4: Upwelling and downwelling surface LW fluxes from the AMF (top) and the difference from RT calculations (bottom).*

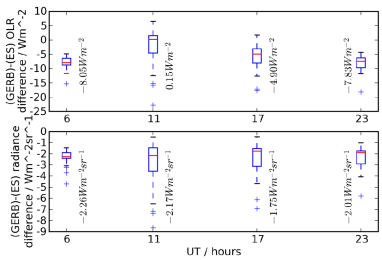



*Fig. 5: Difference of GERB from RT calculations; OLR (top) and TOA radiance (bottom). Red bars represent medians, whose values are stated.*

## Shortwave comparisons

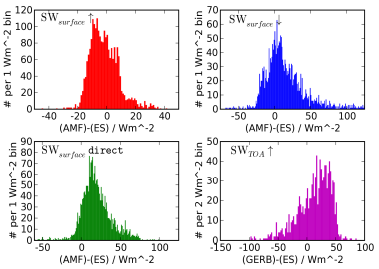



*Fig. 6: Distributions of measured less calculated SW fluxes for the surface upwelling, downwelling, & direct beam, and TOA reflected.*

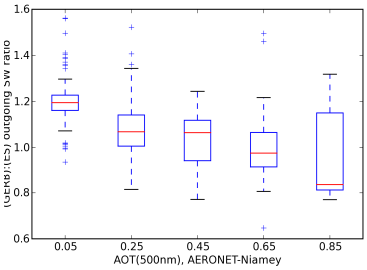



*Fig. 7: Measured (GERB) to calculated (ES) SW TOA reflected flux for several AOT bins.*

- Merged profiles with AERONET AOT(500nm) retrievals allow RT calculations of SW flux at 10 min time resolution.
- Aerosol optical properties are from DABEX (Jan-Feb 2006) aircraft campaign, fixed with only dust present.
- Largest discrepancy for reflected TOA comparison; ratio of (GERB):(RT calculation) shows correlation with AOT.
- Similar analysis with surface downwelling flux shows significant ratio change only for AOT > 1.

## Radiative Divergences

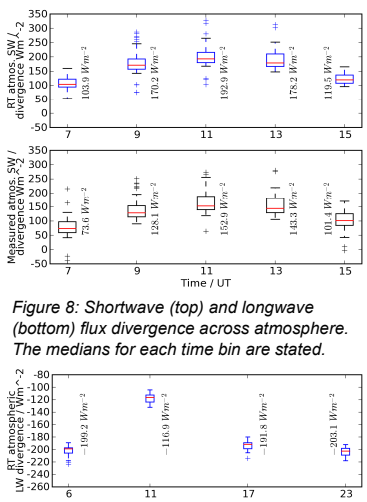



*Figure 8: Shortwave (top) and longwave (bottom) flux divergence across atmosphere. The medians for each time bin are stated.*

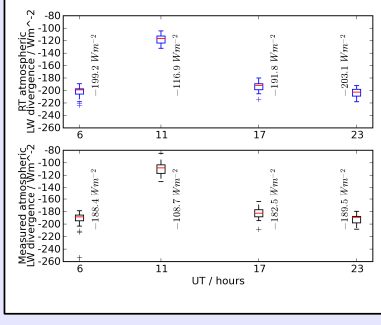
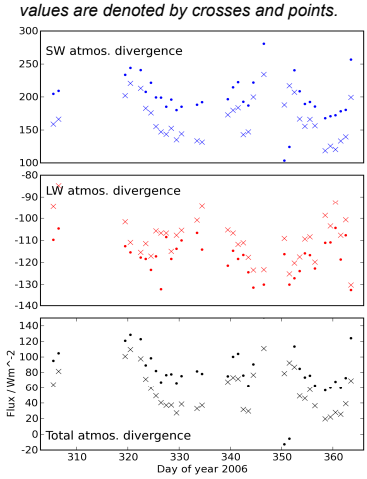



*Figure 9: 11 UT flux divergence across the atmosphere. Measuremed & RT-derived values are denoted by crosses and points.*




- From the results at TOA and the surface, and LW & SW, flux divergence across atmosphere can be calculated.
- The measured and calculated values have significant difference.
- Future work: investigate the TOA comparisons to eliminate seen biases.


**Acknowledgements:** AMF data from ARM archive; GERB data from GGSPS & RMIB; AERONET level 2 data courtesy Rick Wagener, BNL; DABEX data from Ben Johnson, UK MetOffice; MIXCRA AOT retrievals from Dave Turner, Uni. Wisconsin-Madison; NOWSAF SEVIRI cloud mask via Gary Robinson.