Second stage of the longwave ICRCCM3: InterComparison of Radiation Codes in Climate Models for clouds in the longwave

Robert G. Ellingson, Jiujing Gu, Ezra E. Takara, and George Kablick III
Dept. of Meteorology, Florida State University, Tallahassee, FL 32306

Introduction

In 1991 Ellingson et. al. published results from ICRCCM1, an intercomparison of climate models, focused on clear sky cases. In 2000 Barker et. al. completed ICRCCM3, with realistic cloudiness in the shortwave.

This study extends ICRCCM3 into the longwave. Here, we present results for one of Barker's cases, ATEX - a broken 1km thick stratocumulus layer over a 6.8kmX6.8km region. The horizontal resolution is 100m with vertical resolution ranging from 20 to 40m.

Methodology and Results

We use a backwards Monte Carlo (MC) code as a benchmark.

- The code uses the correlated k-distributions from RRTM.
- 1,000 photon bundles for each k – 256,000 per cell/face.

Fluxes above and below the layer and heating rates within the layer were computed.

- The direct computation of heating rates was validated for clear skies by comparing to LBLRTM; the MC error estimate simulated the absolute difference between LBL and MC.
- The maximum estimated ATEX heating error is 0.51Wm^{-3}.
- The surface fluxes show both 3D and CLOWD effects; the upward fluxes show the shielding effect of clouds.

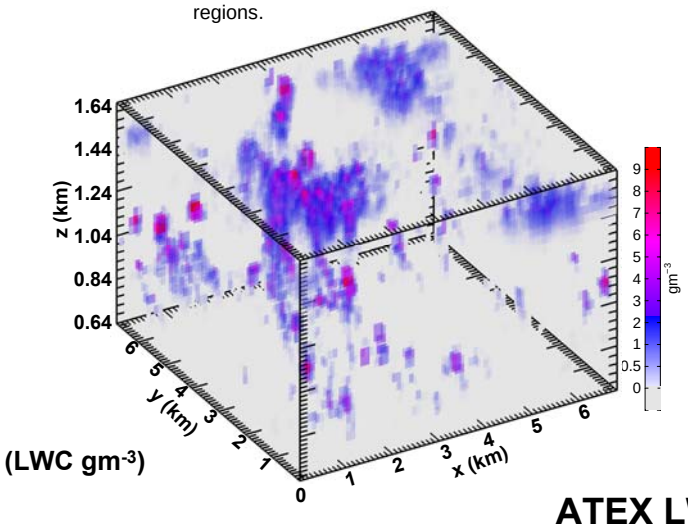
Your participation

We invite your participation in the intercomparison and your input regarding the results to be generated and cases to be used. For example:

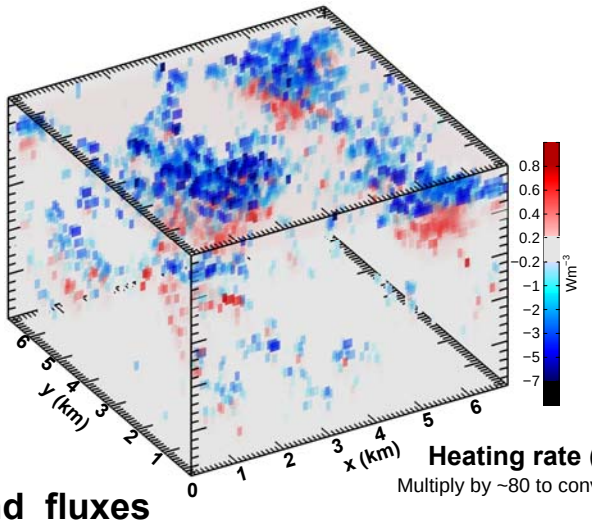
- What is the desired horizontal and vertical spatial resolution of the results?
- Are there longwave cases that are of particular interest for climate models?
- Is there interest in isolating the effect of specific gases/components as in Ellingson et. al.?
- Are there cases to be run after Barker et. al.?

ATEX liquid water content and heating rates

These figures show the ATEX 3D distributions of liquid water content (LWC) and heating rate. The largest heating/cooling coincides with LWC. Most cooling occurs at the high LWC regions at the top of the layer. Heating is dispersed below liquid regions.



(LWC gm^{-3})



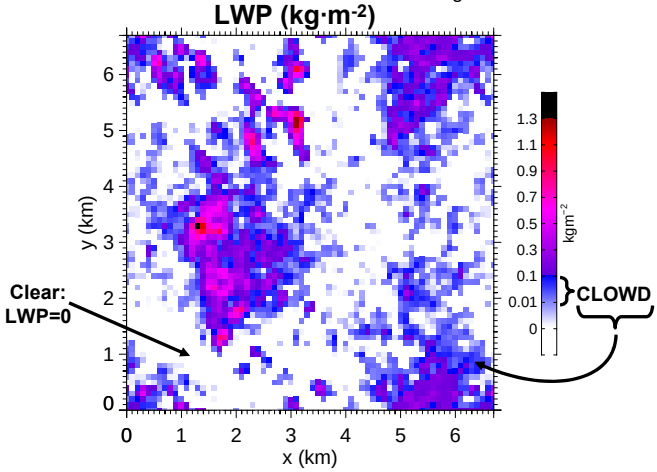
Heating rate (Wm^{-3})

Multiply by ~80 to convert to K/day

ATEX LWP and fluxes

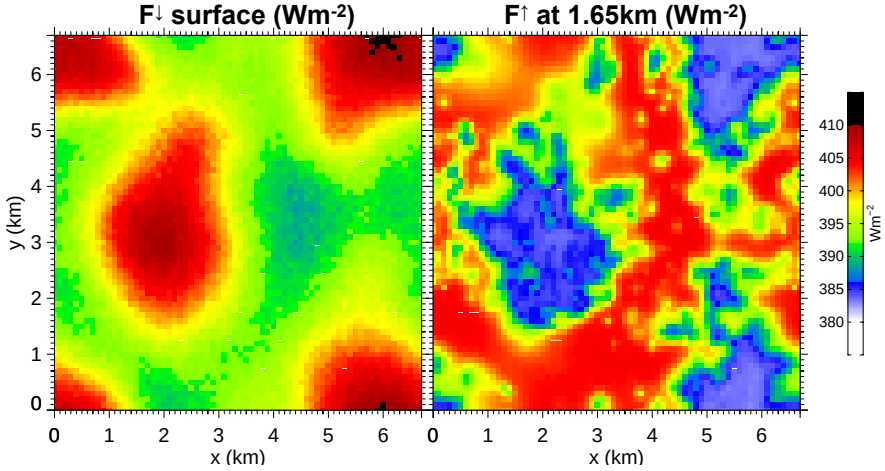
These figures show the liquid water path (LWP), surface downward flux, and the upward flux above the cloud layer. Areas of interest are marked in the LWP figure. The clear area has a surface downward flux ~395Wm^{-2}, 25Wm^{-2} more than the plane parallel clear sky flux (PPCSF). This can be attributed to 3D effects. The CLOWD area is 35Wm^{-2} above PPCSF. The upward flux shows the cloud shielding effect. Fluxes above large LWP are 385Wm^{-2}, 20Wm^{-2} less than PPCSF. Even the CLOWD areas show some shielding.

LWP (kg·m^{-2})



F↓ surface (Wm^{-2})

F↑ at 1.65km (Wm^{-2})



Corresponding author: Ezra Takara
etakara@met.fsu.edu
850-644-3340 FAX 850-644-9642