Monthly Technical Report

PROJECT TITLE	Development and Evaluation of an Interactive Sub-Grid Cloud Framework for the CAMx Photochemical Model	**PROJECT #**	14-025
PROJECT PARTICIPANTS	ENVIRON International Corporation Texas A&M University	**DATE SUBMITTED**	10/2/14
REPORTING PERIOD	**From:** 9/1/2014 **To:** 9/30/2014	**REPORT #**	4

A Financial Status Report (FSR) and Invoice will be submitted separately from each of the Project Participants reflecting charges for this Reporting Period. I understand that the FSR and Invoice are due to the AQRP by the 15th of the month following the reporting period shown above.

Detailed Accomplishments by Task

This project was initiated on May 21, 2014. This report documents progress during the month of September 2014.

Task 1: Preparation and Software Design

This task was completed in August.

Task 2: Implementation of a Sub-Grid Convective Model in CAMx

WRF version 3.6.1 was modified to pass additional entrainment/detrainment fluxes and precipitation water profiles from the Kain-Fritsch (K-F) scheme to the variable output registry. Modifications were completed for the WRFCAMx interface program to read new WRF K-F output fields and to process them as new variables in the CAMx cloud/rain input file. Functional testing on a sample set of WRF K-F data was completed, as described below. Programming of the convective transport matrix solver subroutine for CAMx was completed.

Preliminary Analysis

ENVIRON undertook basic functional testing of the WRFCAMx interface program. WRF version 3.6.1 was run for a week-long period in June 2013 using an existing model configuration from previous projects conducted for TCEQ. A single 36 km grid was run with the modified K-F algorithm. WRFCAMx was run in 3 modes: (1) only resolved cloud data were processed to generate cloud fields for CAMx; (2) the original approach to diagnose sub-grid clouds was used

to generate total cloud field inputs for CAMx; (3) the new K-F sub-grid cloud option was used to generate separate resolved and sub-grid cloud inputs for CAMx. Both sub-grid cloud cases included the diagnosis of sub-grid stratiform clouds according to the original approach in WRFCAMx.

Quality assurance (QA) procedures were conducted to ensure that new code was correctly implemented and was properly processing new cloud data and generating the CAMx data files. These QA steps revealed certain aspects of the technique that required slight modifications to a few details, and also revealed issues in the original diagnostic option that led us to improve the robustness of that approach as well. WRFCAMx speed was not impacted by the additional of the K-F option or by any subsequent modifications from the QA procedures.

Figure 1 shows the GOES-East visible image of the eastern US at 2215 UTC (4:15 CST) on June 22, 2013. Figure 2 displays resulting CAMx-ready input total cloud fields, expressed as vertically-integrated cloud opacity (i.e., optical depth), for the three test cases at 4 PM CST. The resolved cloud case clearly lacks cloud coverage. The sub-grid cloud cases exhibit a more expected cloud pattern and coverage that agrees better with the satellite image. The diagnosed and K-F cloud fields are mostly similar than different, although the diagnosed case exhibits slightly more cloud coverage, particularly over the Atlantic where K-F agrees better with satellite image. The QA review confirmed that these differences are the direct result of the different methodologies as opposed to coding errors.

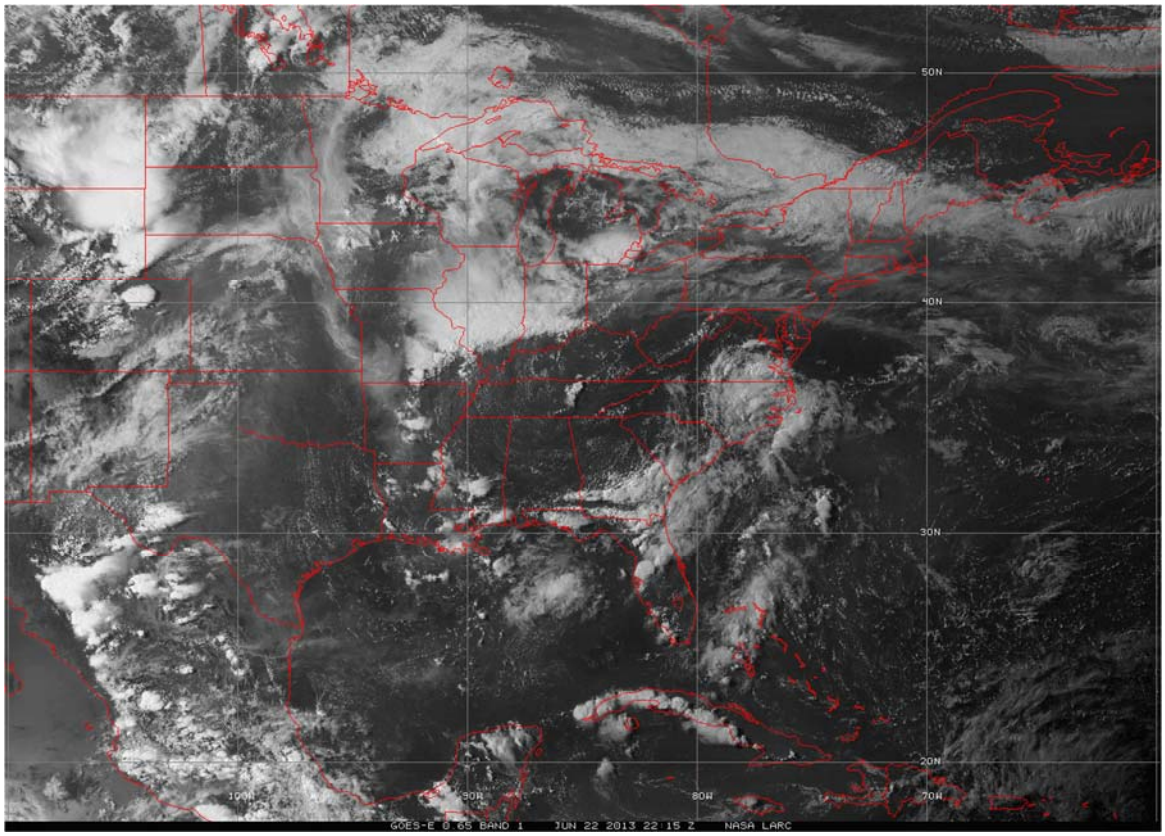

Figure 1. GOES-East visible satellite image of the eastern US at 2215 UTC (4:15 CST) on June 22, 2013.

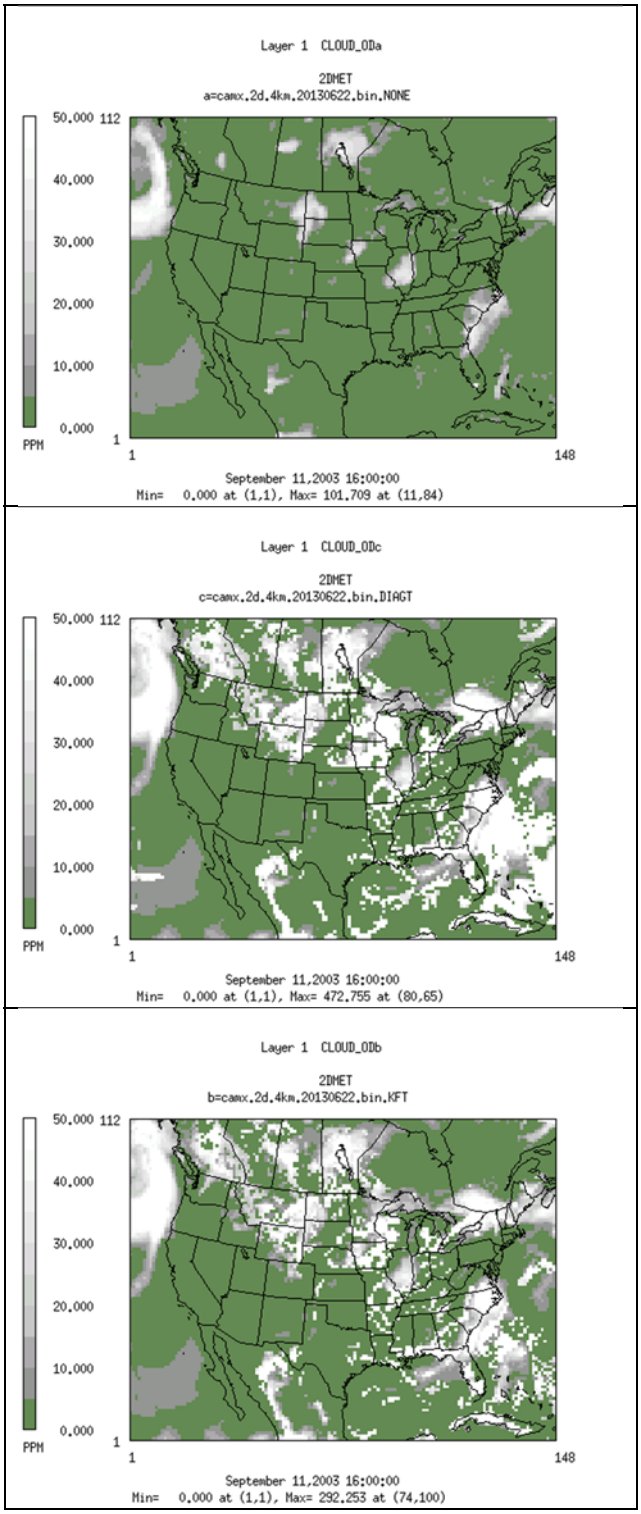

Figure 2. CAMx-ready input total cloud fields (expressed as optical depth) for three test cases at 4 PM CST on June 22, 2013. (Top) resolved clouds only; (middle) resolved plus diagnosed sub-

grid clouds; (bottom): resolved plus K-F sub-grid clouds. Note that the date/time and PPM legend units are incorrect.

Data Collected

No additional data were collected during the reporting period. A contract was established with Texas A&M in September, so collection of field study measurements from DISOVER-AQ and START08 is anticipated over the next couple of months.

Identify Problems or Issues Encountered and Proposed Solutions or Adjustments

No problems or issues were encountered during the reporting period.

Goals and Anticipated Issues for the Succeeding Reporting Period

We anticipate continuing work under Task 2 during October, which includes integrating the convective mixing algorithm into CAMx and basic process testing. Task 3 will commence, to include adding aqueous chemistry and wet deposition modules into the sub-grid cloud algorithm. Field study data acquisition will commence. We do not anticipate any major technical, budget or schedule issues.

Detailed Analysis of the Progress of the Task Order to Date

Progress on Task 1 (software design) was completed in August. Task 2 (implementation of a sub-grid convective model in CAMx) was started in August and continued through September. Tasks 3 (implementation of chemistry and wet deposition) is anticipated to begin in October. Task 4 (model evaluation) is expected to begin this fall in accordance with the Work Plan schedule.

The project remains on schedule and budget for completion and delivery of the final AQRP-reviewed report by the AQRP contract end date of June 30, 2015.

Submitted to AQRP by: _Chris Emery_____

Principal Investigator: __Chris Emery_____