

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	7/7/14
REPORTING PERIOD	From: 6/1/2014 To: 6/30/2014	REPORT #	1

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 AQR by the 15th of the month following the reporting period shown above.

Detailed Accomplishments by Task

This project was initiated on May 21, 2014.

Task 1: Preparation and Software Design

The team has commenced modeling database setup and measurement data acquisition. We have coordinated with Dr. Alapaty's group at EPA to obtain the latest WRF model source code and have discussed via e-mail correspondence to define the specific Kain-Fritsch (K-F) cumulus variables available to support the CAMx cloud model framework. From this we have begun to refine details of the methodology to incorporate a sub-grid cloud model in CAMx.

The interactive sub-grid cloud framework in CAMx will address shallow mixing, deep convective transport, gas and aqueous chemistry, and wet scavenging. All processes will be driven by specific data obtained from output fields generated by the WRF K-F scheme. The CAMx sub-grid cloud model framework will operate separately from the normal grid processes in a manner similar to the Plume-in-Grid (PiG) model. This "cloud-in-grid" (CiG) approach will define at each hour the physical attributes of a multi-layer cloud "reactor" according to the hourly cloud data provided by WRF. Each CiG reactor configuration would be unique to each grid column (or entirely absent from it) and characterize a steady-state sub-grid cloud environment between each meteorological update time. Fractions of pollutant vertical mass profiles from each host grid column will be allocated to each CiG reactor layer, which would then operate on that mass to include vertical transport, entrainment/ detrainment with the ambient grid column, chemistry, and wet removal.

NCAR released WRF v3.6 code on April 18, with a patch issued on May 7, which includes the Alapaty interactions between convection (K-F) and radiation (RRTMG) algorithms. Output variables needed for use with CAMx include deep and shallow cloud fractions (CLDFRA_DP and CLDFRA_SH, respectively) and the K-F liquid and ice condensates (QC_CU and QI_CU, respectively). When the KF-RRTMG interaction is enabled:

1. CLDFRA is the total adjusted cloud fraction; i.e., it includes the CLDFRA_DP and CLDFRA_SH contributions to the cloudiness and is the sum of the resolved cloud fractions and the subgrid-scale cloud fractions while incorporating the effects of Cu punch-through of a resolved cloud deck, and
2. QCLOUD and QICE represent only the resolved cloud condensates; subgrid condensates QC_CU and QI_CU are only temporarily used to adjust the resolved condensates for the calls to the radiation routines, but kept separate on output.

These cloud fraction and condensate variables are all 3-D in space, so vertical profiles per grid column are available. Actual mass fluxes among in-cloud layers and entrainment with the ambient environment are not output. Also, none of these variables are time-averaged (they are instantaneous output at the top of each hour), but time averaging may be done by Alapaty's group in the future depending on need. Additional updates to K-F (such as the dynamic relaxation time scale, entrainment modifications, etc.) to make the parameterization multi-scale are currently under development and thus, have not been included in the WRF v3.6 release. This "scale-aware" version will be useful in reducing wet bias at higher resolutions (e.g., 12 km or finer). Such beta-tested updates are expected to be available from EPA in July.

Work on Tasks 2 through 5 has not yet commenced.

Preliminary Analysis

Preliminary analyses are not yet available.

Data Collected

WRF version 3.6 (with May 7 patch) has been downloaded and installed at ENVIRON.

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 completing work under Task 1 (refining of the convective model design), to be described in the next monthly progress report.

Detailed Analysis of the Progress of the Task Order to Date

Progress on the project is ongoing.

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

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