Monthly Technical Report

(Due to AQRP Project Manager on the 8th day of the month following the last day of the reporting period.)

PROJECT TITLE	Targeted Improvements in the Fire INventory from NCAR (FINN) Model for Texas Air Quality Planning	**PROJECT #**	14-011
PROJECT PARTICIPANTS **(Enter all institutions with Task Orders for this Project)**	The University of Texas at Austin ENVIRON International Corporation	**DATE SUBMITTED**	5/7/15
REPORTING PERIOD	**From:** April 1, 2015 **To:** April 30, 2015	**REPORT #**	9

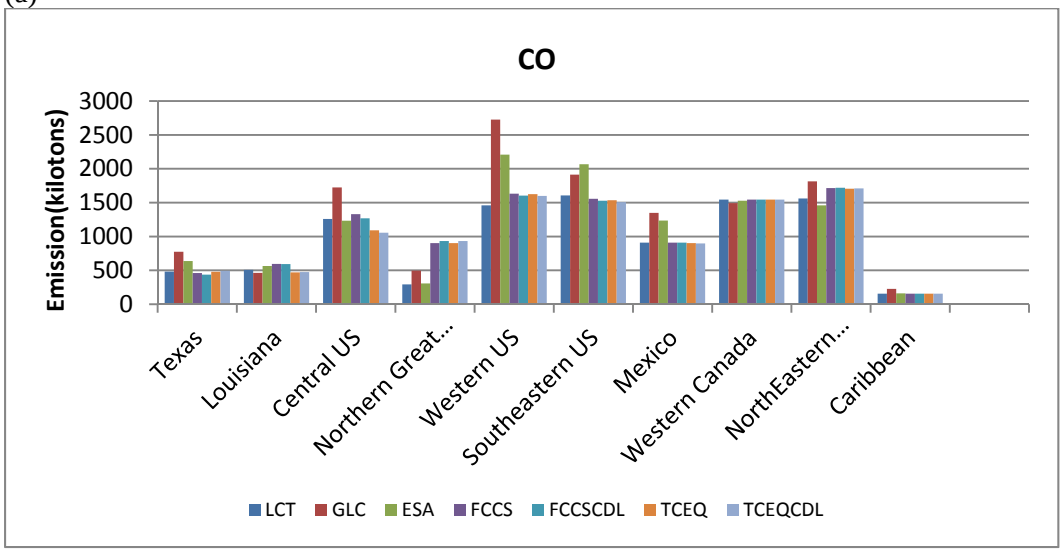
A Financial Status Report (FSR) and Invoice will be submitted separately from each of the Project Participants reflecting charges for this Reporting Period. I understand that the FSR and Invoice are due to the AQRP by the 15th of the month following the reporting period shown above.

Detailed Accomplishments by Task

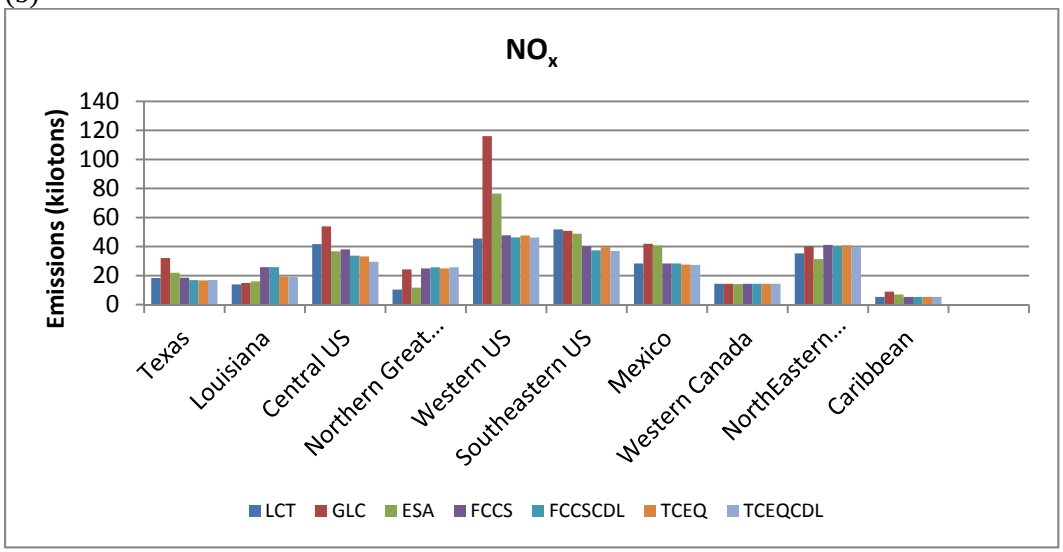
Task 1. Regional Land Cover Characterization

Simulations with the next generation of the FINN processor have been completed for seven land cover scenarios. Emission estimates for carbon monoxide (CO), nitrogen oxides (NO_x), and fine particulate matter ($PM_{2.5}$) are shown in Figure 1 below. These results are preliminary and subject to change as we continue to review the FINN algorithms. We are also currently processing the recently released MODIS Vegetation Continuous Fields (VCF) product for 2012 (version 5.1), which contains proportional estimates for vegetative cover types: woody vegetation, herbaceous vegetation, and bare ground. MODIS VCF data has been used in FINN to identify the density of the vegetation at active fire locations. We anticipate incorporating this year-specific data into the FINN algorithms for our analyses.

(a)



(b)



(c)

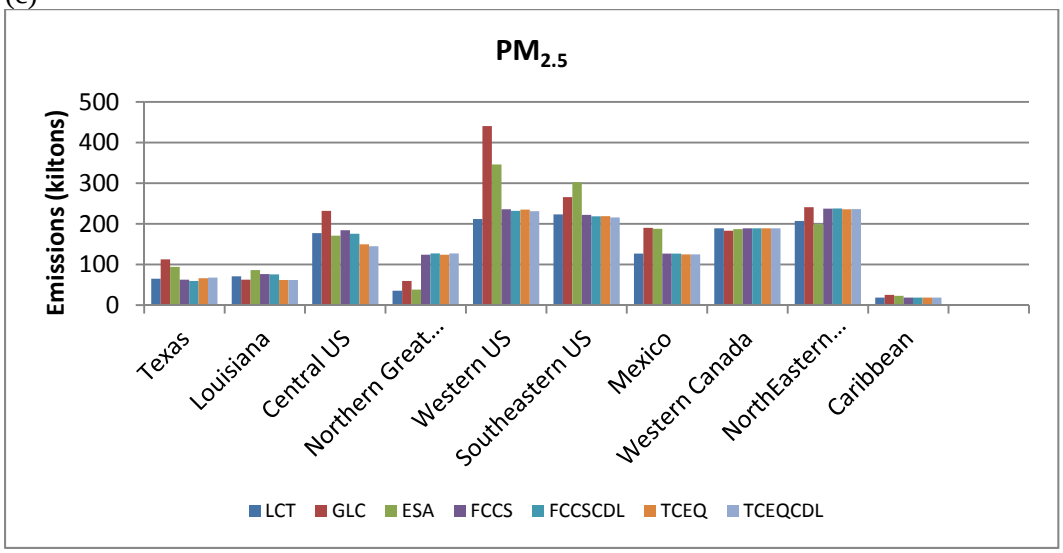


Figure 1. Preliminary annual total (a) CO, (b) NO_x, and (c) $PM_{2.5}$ emissions (ktons) from fire events in 2012 obtained from the newly modified FINN processor shown by land cover data source: ***(1)*** MODIS Land Cover Type (LCT) product; ***(2)*** Global Land Cover (GLC) - SHARE product from the United Nations Food and Agriculture Organization; ***(3)*** the Climate Change Initiative Land Cover product from the European Space Agency (ESA); ***(4)*** the Fuel Characteristic Classification System (FCCS); ***(5)*** the FCCS with cropland characterized by the National Agricultural Statistical Service Cropland Data Layer (CDL); ***(6)*** the FCCS-CDL replaced with regional land cover in Texas and surrounding states developed by Popescu et al. (2011) for the Texas Commission on Environment Quality (TCEQ); ***(7)*** the TCEQ database with cropland characterization by the CDL.

Task 2. Mapping of Croplands Data
Cropland data processing has been completed; crop-specific emission factors have been incorporated in FINN as described in earlier reports.

Task 3. Estimation of Burned Area
Development of the algorithms and ArcGIS tools used for processing of the MODIS Rapid Response fire detection records, quantifying burned area, and characterizing the underlying land cover has been completed.

Task 4. Sub-grid scale Partitioning of NO_x Emissions to NO_z in Fire Plumes
ENVIRON conducted a literature review of various field studies and modeling approaches upon which to base NOx partitioning into aged NOz forms (HNO_3 and PAN) during EPS3 processing of the FINN emission estimates. Based on Alvarado et al. (2010) and Fischer et al. (2014), the GEOS-Chem model apportions 40% NOx to PAN and 20% NOx to HNO_3, leaving 40% as NO. These factors were derived from ARCTAS-B aircraft measurements within North American boreal fire plumes and were considered adequate for the 3-hour emission time scales applied in GEOS-Chem. In regulatory ozone modeling for the State of Louisiana using a 2010 FINN v1 inventory, ENVIRON and ERG (2013) apportioned 20% NOx to PAN and 10% NOx to HNO_3 and reduced remaining NOx to 20% of the original FINN value (a net reduction in total fire nitrogen of 50%). The NOx reduction was applied to align NOx:CO values closer to Alvarado et al (2010). Hecobian et al. (2011) evaluated ARCTAS measurements within numerous fire plumes throughout North American and Asia. Their results will be evaluated and compared to the NOz:NOx values from Alvarado et al. (2010) to assess consistency. More recently, Alvarado et al. (2013) developed look-up tables of NOz:NOx emission ratios as functions of vegetation type, temperature, and solar angle. Such tables would be ideal for incorporation into air quality models, as long as vegetation types could be adequately mapped to the land cover classification schemes used in the models. However, the availability of these data is unclear and such an approach is beyond the simpler methodology intended for this project. Look-up tables may be a good direction for future work.

ENVIRON reviewed the EPS3 fire emissions processing chain and developed a straw-man approach to incorporate re-speciation of FINN NOx to NOz compounds as a function of fire size relative to grid resolution and fire plume rise. The general approach is to maximize NOz:NOx ratios for small fires relative to grid size and for fires with higher plume rise to account for longer aging times occurring during rise and dilution to grid scale. Conversely, NOz:NOx ratios would be minimized (or zero) for large fires relative to grid size and for fires with lower plume rise, in which case grid model chemistry would be a more appropriate mechanism to age the NOx. The approach will also consider diurnal PAN:NOx profiles to account for the fact that PAN is a photochemically-derived product.

Task 5. Comprehensive Air Quality Model with Extensions (CAMx) Sensitivity Studies
The TCEQ has provided its 2012 CAMx episode in its entirety. Our base case simulation has been run at the Texas Advanced Computing Center (TACC). We have benchmarked our output for the base case against that of the TCEQ. Emissions estimates from fire events developed by the TCEQ for its 2012 CAMx base case have been summarized; these will be compared with estimates from the newly modified FINN processor using the default land cover database (MODIS LCT) as well as those obtained using other land cover products described above.

Data Collected *(Include raw and refine data.)*
As described above.

Identify Problems or Issues Encountered and Proposed Solutions or Adjustments
None this period.

Goals and Anticipated Issues for the Succeeding Reporting Period
Priorities for next month include completing sensitivity analyses in FINN to produce fire emission estimates; conducting comparisons to fire emissions estimates currently being used by the TCEQ in their 2012 CAMx episode to the extent possible; starting updates to the EPS3 system for NOx-to-NOz conversion, and preparing for the AQRP data workshop in June.

Detailed Analysis of the Progress of the Task Order to Date *(Discuss the Task Order schedule, progress being made toward goals of the Work Plan, explanation for any delays in completing tasks and/or project goals. Provide justification for any milestones completed more than one (1) month later than projected.)*
Ongoing.

Submitted to AQRP by:

Principal Investigator: Elena McDonald-Buller