Improving NAQFC O₃ Predictions over remote sensing-derived chemical regimes

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Goal: Improved ground-level O₃ predictions

- Various global/regional chemical transport models including Community Multiscale Air Quality Modeling System (CMAQ) overpredict summer daytime O₃ over the eastern US. Peak concentrations predicted by CMAQ are routinely 5-10 ppbv higher than surface EPA Air Quality System (AQS) observations.

Approach: Integrate the National Air Quality Forecasting Capability (NAQFC) system with satellite resources

- The NAQFC system produces 48 hour forecasts of surface O₃ and PM2.5 concentrations over the CONUS. The NAQFC numerical modeling system couples the National Centers for Environmental Prediction (NCEP) Weather Research and Forecasting Non-hydrostatic Mesoscale Model (WRF-NMM) with CMAQ (12km spatial resolution).
- NAQFC setups:
  - NAQFC: operational forecasting system based on CMAQ4.6
  - NAQFC_2: updating Monin-Obukhov equation using NOAA land surface model variables and implement satellite canopy heights (aerodynamic resistance, Ra update)
  - NAQFC_3: updating wet cuticle resistance (canopy resistance, Rc update) from NAQFC_2
  - NAQFC_4: CMAQ4.7 with satellite canopy heights
- Satellite measurements: providing canopy heights and chemical regimes

Accomplishments:

1. Identification of chemical regimes using satellite (category 1=NOx-saturated regime; category 2= Mixed regime; category 3= NOx-sensitive regime) over the CONUS

2. Improved O₃ daily predictions over three chemical regimes in CONUS (applicable to other global/regional models)

3. Improved weekly anomaly predictions (including “Weekend effects” over category 1) of O₃ in NAQFC over chemical regimes of the CONUS

Indicators of success:

- Manuscripts in preparation:
  - Choi, et al., The impact of satellite-observed canopy heights on improving surface O₃ simulations over the eastern US, will be submitted to Geophysical Research Letters, 2011
  - Choi, et al., Weekly variations of the surface NOx and O₃ over the USGS LULC regions and GOME-2 derived chemical regimes of the US: CMAQ4.7 model evaluation and analysis, Atmospheric Chemistry and Physics, 2011, in preparation
  - Choi et al., Modeled O₃ and PM2.5 from CMAQ4.6 and CMAQ4.7 over satellite-derived chemical regimes over the US, Atmospheric Environment, 2011, in preparation

- Serving the satellite and modeling communities as the science team member of NASA TES project and as a scientific advisory committee of US-Korea geostationary satellite project, GEMS

Collaborators/Partners:

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<tr>
<th>Institute/Group</th>
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<td>OCO-3, TES, and MBR Groups</td>
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Future direction:

- Update NAQFC forecasting system with improved physics and chemistry
- Evaluate current bottom-up emissions inventory using top-down approach (using satellite observations)
- Utilize the data from the forecasting system to establish a long-term monitoring system with corresponding satellite measurements:
  - Column O₃, NO₂, BrO, OClO from GOME and GOME-2
  - Column O₃, HCHO and NO₂ from SCIAMACHY
  - Column O₃, HCHO and NO₂ from OMI
  - CO profiles from MLS
  - CO and CO profiles, CO₂, H₂O, and CH₄ from TES
  - Temperature and CO₂ at 8km from AIRS; CO profiles from MAPS
  - CO profiles, CO column, CH₄ column from MOPITT

Cloud top height and aerosol optical depth from MODIS

DEDICATION:

This presentation is dedicated to the memory of ARL Air Quality Group Lead Dr. Daewon Byun (1955-2011), whose leadership and pursuit of scientific excellence continue to inspire us.

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