Introduction

- Modeling dry deposition in Comprehensive Air Quality Model with extensions (CAMx) and similar photochemical grid models.
- Available satellite remote sensing land use/land characterization (LULC) data to describe surface characteristics for dry deposition modeling.
- Evaluate impact of changed LULC on predicted ozone concentrations in the Houston-Galveston-Beaumont-Port Arthur Area (HGBPA).
- The goal of the work is not only to provide reliable LULC data for air quality modeling, but also to assess the overall sensitivity of model predictions to land cover data and to provide recommendations regarding the frequency and methodology for future updates.

Dry Deposition

- The most physical important mechanism for air pollutants during the summer season in Texas.
- Dependent on reactivity, stability, and diffusivity of gases, particle size, meteorological conditions and surface characteristics.

LULC Data for Dry Deposition Modeling in CAMx

- Base Case - USGS National Land Cover Database based on Landsat thematic mapper imagery, aerial photography, and supplemental data. Currently used by State of Texas likely to mid 1970’s vintage.
- International Geosphere-Biosphere Program (IGBP) classification from AVHRR - Advanced Very High Resolution Radiometer (1992 at 1km resolution).
- IGBP classification from MODIS - Moderate Resolution Imaging Spectroradiometer (2001 at 1km resolution).
- New Eastern Texas Land Cover Dataset developed by the University of Texas Center for Space Research (CSR)* (1999-2003 at 30m resolution).

LULC Products

- AVHRR - Data set includes Normalized Difference Vegetation Index derived from AVHRR 10-day composites collected from April 1992 to March 1993 and ecosystem data.
- MODIS - Algorithm based on surface reflectance, vegetation index and surface temperature.
- Data collected by the Terra satellite over a period of 96 days in 2001.
- CSR - Includes image data for three time periods [Spring (Jan. – Mar.), Leaf-on (Apr. – Aug.), Leaf-off (Sep. – Dec.)], collected between 1999 and 2003 by Landsat 7 Enhanced Thematic Mapper-Plus sensor.

Differences in Land Cover Data Sets

- The MODIS and AVHRR data sets have grid cells with higher fractions of urban coverage within the Houston area. The MODIS and CSR data sets show a larger spatial extent for the urban area when compared to the base case and particularly the AVHRR data set.
- AVHRR, MODIS, and CSR data sets show increased agricultural coverage in the western area of the HGBPA region.
- AVHRR data processing and classification methods identify most forest coverage as coniferous rather than deciduous or mixed forest as in the MODIS and CSR datasets.

Comparison of Predicted Ozone

- In general, scatter plots of predicted ozone concentrations in urban and agricultural areas between the base case and test cases show good agreement with some noted differences.
- Changes in characterization of urban areas can lead to changes in predicted air quality in these populated areas. For example, during the afternoon of August 25, 2000, the MODIS data set shows an average of 0.5 ppb lower in the Houston urban area for the MODIS data set as much as 0.6 ppb higher in peak hours than the base case and 1.3 ppb higher for the CSR data set.
- Predicted Ozone concentrations were lower west of Houston due to increased stomatal uptake by increased agricultural land coverages in the new data sets.

Comparison to Previous LULC Updates

- McDonald-Buller et al. (2001) compared the base case model to the previous, 1970’s vintage USGS LULC data set used to model dry deposition.
  - Predicted 1-hr averaged ozone concentrations were as much as 11 ppb higher and 6 ppb lower than the USGS dataset. These large differences were primarily due to the urban spread that occurred during the time span between the USGS dataset and the base case.
  - The use of more detailed data on vegetation within urban areas resulted in smaller changes, approximately 2 ppb in peak ozone concentrations.
  - The differences between the CSR or MODIS datasets compared to the base case are small when compared to the effect of not updating land cover for long periods of time. Periodic updates are necessary to capture urban growth and land use changes.

Conclusions

- Three LULC data sets show general agreement but some differences in spatial extent of urban areas and classification of land cover exist.
- Periodic updates of land cover are necessary to capture changes due to urban development, reforestation programs, and other changing land use patterns because of their impact on pollutant concentrations.
- Satellite-derived LULC products can provide timely representations of land characteristics and identify changes in land cover but must be used in conjunction with other data and ground truthing, particularly in the areas of transition.
- The largest differences in predicted ozone concentrations were due to differences in land classification.
- A MODIS-derived land cover classification developed specifically for Texas and the surrounding region would provide an accurate and easily updated land cover source for modeling dry deposition in CAMx.

References


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- Texas Commission on Environmental Quality’s (TCEQ) New Technology Research and Development Program (NTRD).

Application of Satellite Remote Sensing Data for Estimating Dry Deposition in Southeastern Texas

Comparison of Predicted Ozone

- Predicted 1-HR Average Ozone for Houston-Galveston Area.
- Predicted 1-HR Average Ozone for Agricultural Area.

Comparison of Predicted Ozone for Houston-Galveston Area for the MODIS and AVHRR data sets.

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