DEVELOPING MODELING TOOLS TO ASSESS EMISSION REDUCTION STRATEGIES FOR BOGOTA, COLOMBIA

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INTRODUCTION
- Bogotá, Colombia’s capital, is the main financial center with a GDP of 1005BN and an economic growth of 4.6% from 2000-2012 (DANE).
- Emissions from the industrial and transportation sector have increased with the economy, with a consequent deterioration in the air quality.
- In 2006, PM10 annual average concentration in Bogotá was 70 ug/m³ (PM annual standard 50 ug/m³). In 2002, PM10 decreased to 48 ug/m³. However, some parts of the city still show concentrations above the standard.
- In 2010, a ten-year abatement pollution plan was put in place to meet the PM10 standard everywhere in the city by 2020 and prevent other pollutants to exceed the standard.
- Air quality planning tools to assess the most effective emission reduction strategies in Bogotá are necessary in order to reach the 2020 goal.
- The Bogota’s Environmental Authority is implementing model3 (SMOKE-WRF-CMAQ) with the objective to test emission reduction strategies for mobile, point and area sources.

METHODS

1. Updating of Emission Inventories
Emission from mobile, point, and area sources were updated from the base year (2008) to the modeling year (2012).

2. Temporal and Spatial disaggregation
Emissions were disaggregated hourly to 1x1 km in a inner domain of 54x54 km including Bogota and surroundings.

3. Selection of modeling episode
Based on the analysis of air quality records, two modeling periods were chosen: Feb. 15 (±10 days for dry period) and Oct. 15 (±10 days for wet period).

4. Implementation of Models-3
Based on the analysis of air quality records, two modeling periods were chosen: Feb. 15 (±10 days for dry period) and Oct. 15 (±10 days for wet period).

5. Emission reduction strategies
Emission reduction strategies in 2020 are currently tested for mobile, point and area sources to identify the most cost-effective program.

RESULTS

1. Fleet composition, vehicle type and model, AADTs
   - Traffic counts, road size & length, land use

2. Fuel type & consumption, control devices
   - Fuel type, fuel & meat consumption, schedule

3. Fuel distribution, storage capacity, Land cover, land use, meteorology, emission factors
   - Paved and unpaved roads, traffic counts, road size & length, vehicle type and weight, building and road construction

4. Diagnostics Implementation for dry/wet seasons in 2012
   - SMOKE vs CMAQ
   - Diagnostics pollutant concentrations for Bogota urban area

5. Emission reduction strategies
   - Use of PM control devices in heavy trucks
   - Implementation of the Integrated Transportation System
   - Use of PM control devices in buses
   - Hybrid and electric vehicle fleet introduction
   - Diesel to natural gas fleet replacement
   - Use of control devices in industrial stacks
     - Coal conversion to natural gas in Industries
     - Charcoal conversion to natural gas in restaurants
   - VOCs recovery in gas stations and gas storage
     - Pavement of unpaved roads
     - Street sweeping and washing

CONCLUSION
- Tools were developed to estimate, update and prepare emission inventories for modeling purposes.
- A modeling episode was chosen based on air quality and meteorological records.
- Models-3 (SMOKE, WRF, CMAQ) has been implemented for the first time in Bogota.
- Emission reduction strategies were defined and will be tested for their impact on air quality concentrations.

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References:
- Air Quality modeling over Bogotá is a challenging endeavor. Representing atmospheric processes, and pollutants’ fate over complex terrains for their accurate assessment requires the employment of comprehensive models with high performance. In order to overcome the challenges in air quality modeling, the Modeling Air Quality in Complex Terrain (MACT) project was implemented by the US-Canada-INAF team.

- The WRF-Chem model was developed by the National Center for Atmospheric Research (NCAR) and is currently used in a wide range of applications, from weather forecasting to air quality simulations. The model is designed to simulate the transport, dispersion, and transformation of atmospheric pollutants, providing valuable insights into air quality trends and their impact on human health.

- CMAQ is a community model for air quality assessment, widely used in research and regulatory applications. It is capable of simulating the transport, transformation, and deposition of various air pollutants, including fine particulate matter (PM2.5) and ozone (O3).

- SMOKE is a modular model suite developed for the purpose of simulating the transport and transformation of various air pollutants. It is particularly useful in the context of air quality modeling, as it allows for the detailed analysis of emission sources and their impact on air quality.

- GloBEIS is a software tool designed for the analysis and visualization of atmospheric models, facilitating the interpretation of complex atmospheric phenomena and the assessment of air quality impacts on human health.

- The GloBEIS platform provides a comprehensive visualization of atmospheric models' outputs, offering a detailed view of air pollution patterns and their evolution over time and space.

- Emission reduction strategies were defined and will be tested for their impact on air quality concentrations.