Using satellite remote sensing for air pollution epidemiology

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February 16, 2007
Remote sensing and air pollution epidemiology

- Air pollution epidemiology
  - primary goals are to estimate effects of air pollutants on health outcomes
    - pollutants: particulate matter, ozone, air toxics
    - health outcomes: death, heart disease/attacks/stroke, lung disease
  - estimating exposure to pollution is difficult because of limited monitoring

- Data needs:
  - Highly-resolved (spatially or temporally or both) estimates of pollution exposure
  - Ground-level pollution information

- Primary current research direction is to use satellite aerosol optical depth (AOD) observations as proxy for PM$_{2.5}$
AOD has been shown to be correlated with ground-level PM$_{2.5}$.
AOD complements PM$_{2.5}$ monitors: higher spatial resolution outside of urban areas.
but... AOD is a noisy and biased proxy for PM$_{2.5}$ (AOD reflects entire vertical column).
AOD observations often missing due to cloud cover and surface reflectance.
Estimating monthly PM in the eastern US

- Goal: estimate monthly average PM$_{2.5}$ in the eastern U.S. for 2000-2006
  - produce a standard data product useful for multiple air pollution epidemiology studies
  - include estimates of uncertainty in estimates

- Data sources:
  - PM data: EPA and state monitors
  - AOD observations:
    - GOES: 4 km resolution, half-hourly during daytime, poorest quality
    - MODIS: 10 km resolution, once per 2-3 days, medium quality
    - MISR: 17.6 km resolution, once per 4-9 days, highest quality
  - GIS-derived variables (distance to major roads, population density) and meteorological variables that may be correlated with PM$_{2.5}$

- work in collaboration with Yang Liu and Steve Melly, Exposure, Epidemiology and Risk Program, Department of Environmental Health, Harvard School of Public Health
Statistical modelling

- calibrate AOD to PM$_{2.5}$ at the daily level based on spatial location, time of year, planetary boundary layer and relative humidity
- at the monthly level, statistically predict PM$_{2.5}$ monthly spatial surfaces using PM$_{2.5}$ data and calibrated AOD
- modelling involves dealing with spatial grid mismatch of observations and temporal mismatch
- exploration of usefulness of GOES AOD and of CMAQ PM$_{2.5}$ model-derived predictions