REGIONAL AND LONG TERM VARIATIONS OF AIR POLLUTANTS ON AIR QUALITY OVER THE MISSISSIPPI GULF OF MEXICO REGION, AND RELATED HEALTH IMPACTS

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Abstract

Industries and transportation are some of the important sources of pollutants to the atmosphere, and the most important are particulate matter (2.5 micron: PM2.5), sulphur dioxide, nitrogen oxides, and ozone. These emissions can contribute to the environmental issues like climate variability due to elevated levels of greenhouse gases, or acidic rainfall. Climate change affects living beings – people, plants, and animals. In human beings, health related diseases like asthma are of much concern in addition to climate sensitive diseases such as malaria and smog. It is important to investigate and understand the interplay between industrial pollutants, climate change and health. In the present study, we present a detailed study of the long term variations of PM2.5 for over 10 years (2001 – 2010) in selected regions of Mississippi – Northern, Central, and Southern. For each of these regions, a few locations will be selected to study the seasonal variations of PM2.5 to account for the observed scenarios or episodes. The three regions are selected because of their air quality and associated characteristic weather patterns. The Northern region of Mississippi exhibits Northerly winds and high pressures systems, while Southern region shows Southerly winds with low pressure systems. The PM2.5 seasonal variations are expected to manifest the influence of the weather patterns. The observed air pollutant scenarios in Mississippi will be accounted in relation to the air pollutant sources – Industrial and Transportation, and air dispersion. Physical mechanisms will be drawn to interpret the observed air quality episodes of PM2.5 in the seasonal trends, and the associated health effects. The results will help to understand the role of pollutants on environmental issues and health effects.

Key words: Criteria Air Pollutants, Wind Speed, Wind Directions, Statistical Modeling, Environmental modeling, Health Impacts

MOTIVATION: AIR POLLUTANTS AND EFFECTS ON HEALTH

- associations between the levels of particulate matter/ozone in the air and adverse respiratory and cardiovascular effects in people
- (e.g., increases in daily mortality, illness, hospital admissions and emergency room visits).
- even at relatively low ambient levels that are prevalent in the U.S. and Western Europe.
  - better understand the nature of the relationship between the pollutant and disease - especially how PM affects human health
  - Dependence on weather, human interference, other pollutants

Factors Influencing Health and Symptoms

- PM is a complex mixture of solid and liquid particles that are suspended in air typically consist of a mixture of inorganic and organic chemicals, including carbon, sulfates, nitrates, metals, acids, and semi-volatile compounds.
- PM Size Classification:
  - coarse (10 to 2.5 µm), fine (2.5 µm or smaller), and ultrafine (0.1 µm or smaller).
- Why Size is Important
  - Particles deposit in the respiratory tract and affect human health.
  - Coarse particles are deposited almost exclusively in the nose and throat;

Factors
- size and composition of the particles
- the level and duration of exposure
- age and sensitivity of the exposed person.
- Age
  - Elderly people
  - Children

Symptoms
- sore throat,
- persistent cough,
- burning eyes,
- wheezing,
- shortness of breath, tightness of chest, and chest pain.
- PM may also trigger asthma

Sources of PM

Natural Processes

Dust and soil; Sea salt; Forest fire smoke; Pollen, spores, mold; Livestock

Transportation

Automobiles; Buses; Boats; Trucks; Airplanes

Human Made Activities

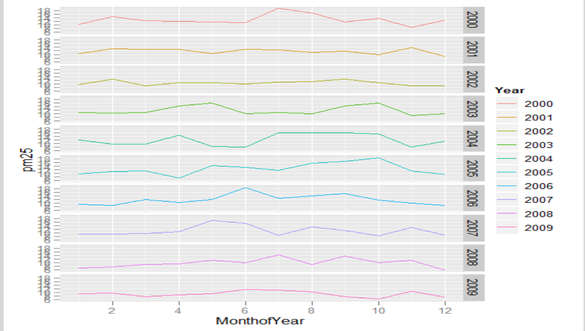
Construction Equipment; Lawn mowers, snow blowers; Heating furnaces; Factories; Incinerators; Power plants; Mining; Tobacco smoke; Cooking smoke

EPA Standards

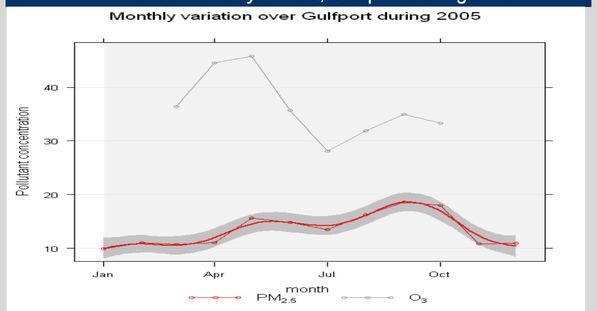
- Ozone
  - The 8-hour standard in 2008 of 75 ppb.
- PM2.5
  - annual averages does not exceed 15.0 micrograms per cubic meter (µg/m3); the 24-hour average standard: does not exceed 35 micrograms per cubic meter (µg/m3).
- *coarse* particles (PM_{10})
  - EPA also retained the existing national 24-hour PM_{10} standard of 150 $\mu g/m^3$; however, it revoked the annual PM_{10} standard.

Results and Discussion

Gulfport , Mississippi during 2000 - 2009

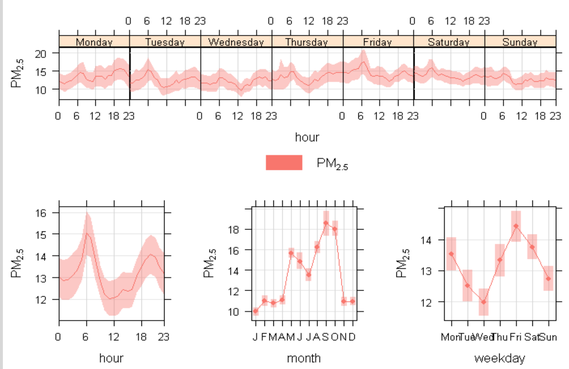


PM and O3 monthly trends, Gulfport during 2005

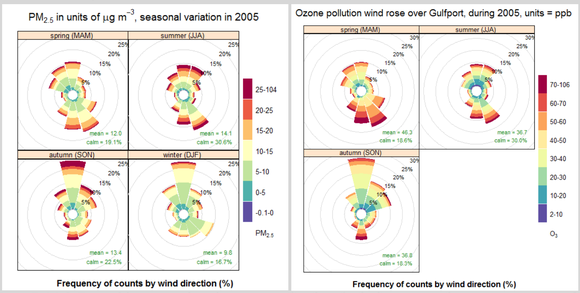


- PM peaking during Aug, Sep pronounced
- Ozone has max peak during summer primarily by photochemical mechanism; has a weak peak during winter due to atmospheric chemistry

PM over Gulfport , Mississippi during 2005



- Pronounced peak during rush hours, low concentrations during weekends, week days variation fluctuating – highest on Friday, seasonal – not clear, max during Fall
- Diurnal cycle; Annual cycle

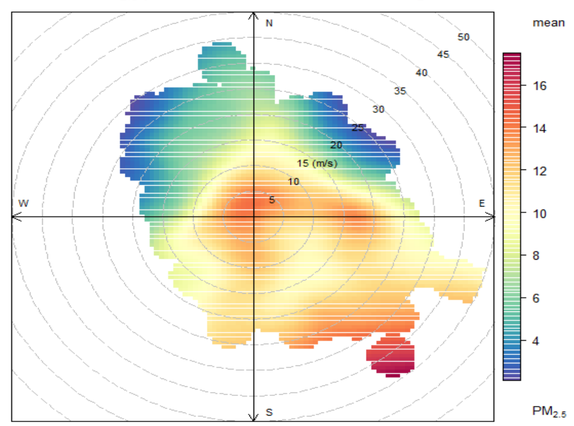


- P M 2.5 peaking may be due to southerly winds because they occur most of the time
  - In summer, the winds are from S/SE about 17% of the time and PM concentrations in the region of above 25 ug/m3 occur about 3% of the time a little seasonal lag
  - Winter – northerly winds but PM 2.5 concentrations are relatively lower
- Ozone data for winter not available
  - Summer – southerly; Winter - northerly

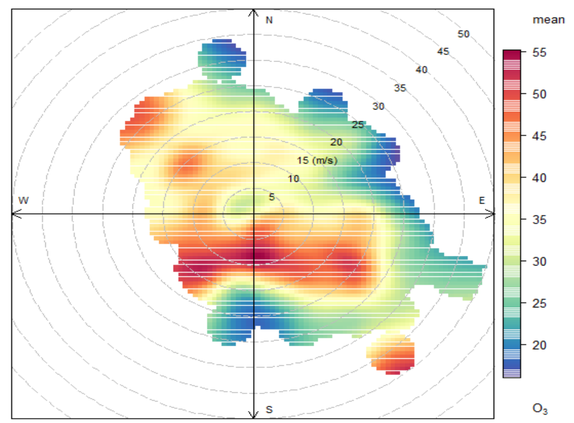
Pollutant Sources Identification

- PM2.5 sources
  - Low wind – ground level
  - High wind – stack emissions
  - Wind-blown sources e.g. particle suspension
  - Source at farther distance, affecting the site at larger speeds
  - Dominance of Southernly, and South Easterly winds controlling the overall mean of PM2.5
- Ozone sources
  - Mostly ground level; Evidence of a source in S and SW
  - Low winds
    - Contributed by the PM2.5 emissions
    - Sources of pollution
      - Mostly by Refineries to the South and SE of the location
      - Industries – Southern of LA, Alabama; Northern of Memphis

$PM_{2.5}$ polar distibution over Gulf, during 2005



Ozone polar distibution over Gulf, during 2005



Summary

Long term trends – 3 to five year oscillation

Decreasing – national and regional trends by Increased regulation standards

Regional - Annual variation of particulate matter

Skewed normal distribution, peaking Aug, Sep

Risk factor for health – greater

May be due to south westerly winds in the Gulf

Transporting pollutants from the neighboring states

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