GeoMedStat: An Integrated Spatial Surveillance System

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Purpose

Purpose of this project was to develop a real-time surveillance system which can assist in timely intervention and providing efficient healthcare.

Introduction

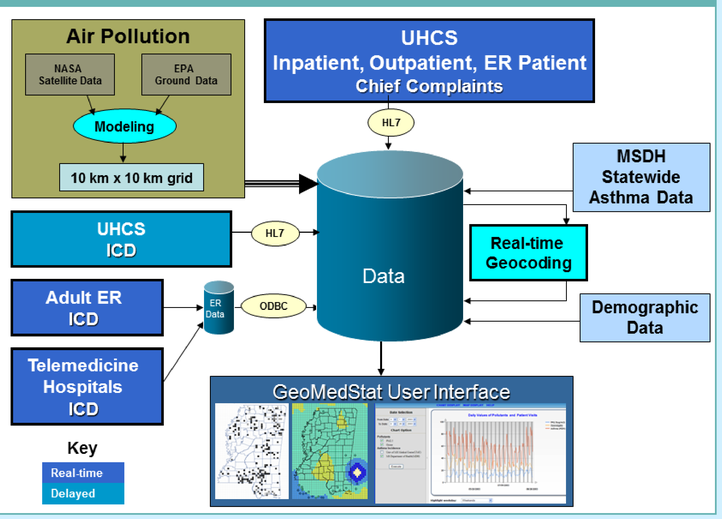
Real-time surveillance of hospital admission information can help in better healthcare preparation, identifying potential outbreaks, and public health awareness when necessary. When such patient surveillance systems are integrated with tracking environmental pollutants associated with certain types of admission that may even help more effective interventions.

At UMMC, we have developed GeoMedStat, an integrated spatial surveillance system capable of tracking and mapping both real-time and historical patient encounters along with air pollution data. GeoMedStat has links to hospital information systems allowing real-time access to both Chief Complaint and ICD of patient encounters. The currently tracked healthcare events are daily: a) real-time asthma hospitalization from the UMMC hospital system and b) historical statewide asthma hospitalization from the MSDH.

Environmental air quality has a major impact on human health. $PM_{2.5}$ and ozone (O_3) are known to exacerbate asthma and other health problems. GeoMedStat utilizes NASA satellite data and EPA ground-monitored data as inputs for surface modeling of $PM_{2.5}$ and O_3.

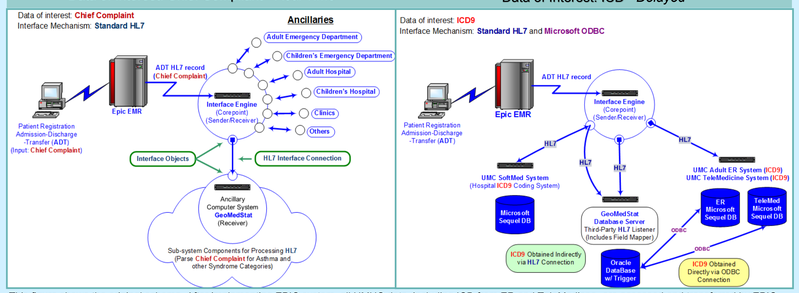
Implementation of real-time or near real-time integrated surveillance system is a challenge due to: a) disparate sources of data, b) different types of data, c) data incompatibility and d) lack of standardized technological components. In addition, accessing and utilizing health data that are considered as PHI, requiring stringent protocols, have to be supported by the system. This presentation aims to illustrate the development of GeoMedStat, its components and functionality.

Major Components of GeoMedStat– Overview



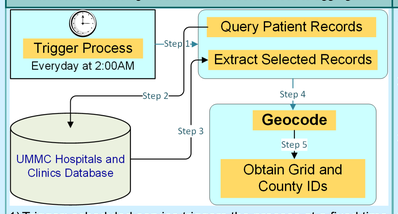
Methods

University of Mississippi Health Care (UMHC) System Data Interface Architecture with GeoMedStat



This figure shows the original schema. After implementing EPIC system, all UMHC data, including ICD from ER and TeleMedicne, are accessed and transferred by EPIC.

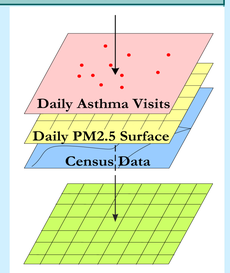
Automated Geocoding Process: from street address to aggregated



1) Trigger: scheduled service triggers the process at a fixed time
2) Identify required data: query patient records from the hospital database based on ICD and Chief Complaints
3) Extract records: extract selected patient records
4) Geocode: conduct geocoding, first street-level and then at ZIP code level for the remaining unmatched records
5) De-identify: by overlaying geocoded points, obtain grid ID and county FIPS. The GeoMedStat database thus stores the grid ID and county code instead of any address or point location

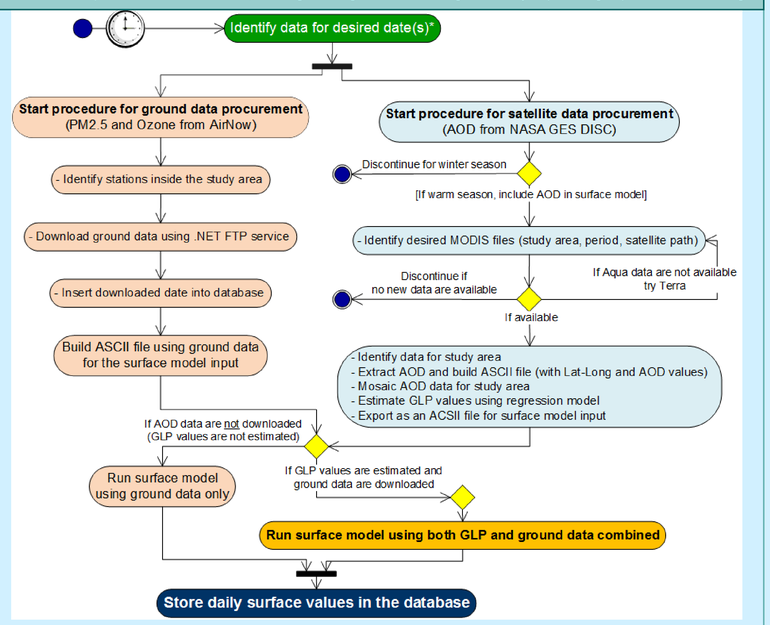
Data Resolving into One Common Scale

1) GeoMedStat prepares daily $PM_{2.5}$ surface values at 10 km x 10 km
2) GeoMedStat prepares daily O_3 surface values at 10 km x 10 km
3) Patient data are aggregated into same size grid by spatial overlay operation
4) Block group demographic data are interpolated into 10 km x 10 km grid resolution



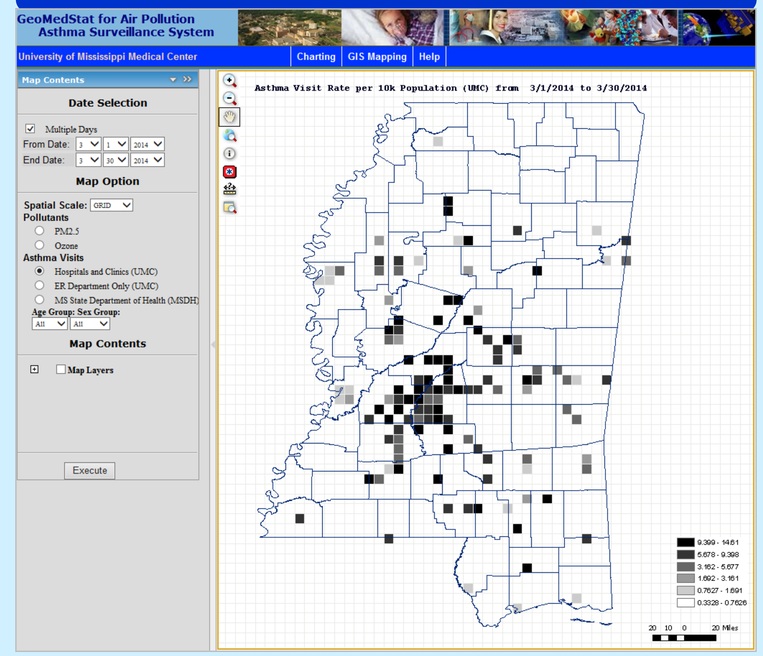
Data Integration into a common resolution is essential for the effective use of this system.

Pollutant Data Acquisition from NASA and EPA , Modeling and Integration: Process diagram for daily air pollutant geospatial surface modeling

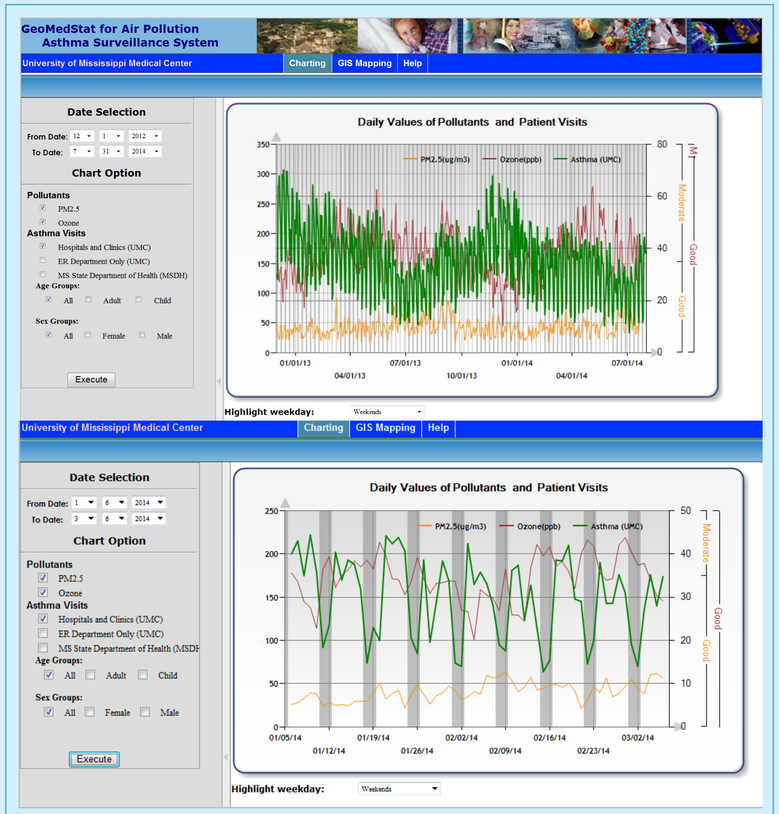


1. Develop automated data downloading service from NASA and EPA for daily pollutants
2. Download daily Aerosol Optical Depth (AOD) data from NASA website at a scheduled time
3. Download daily $PM_{2.5}$ and O_3 data from EPA website at a scheduled time
4. Run a regression model to estimate Ground Level Particulates (GLP) for $PM_{2.5}$ using NASA's AOD and EPA's ground-measured $PM_{2.5}$ data
5. Build spatial surface with estimated Ground Level Particulates (GLP) for $PM_{2.5}$ and ground $PM_{2.5}$ data using B-spline method for the entire state of Mississippi
6. Build spatial surface with EPA's ground-measured O_3 data using B-spline method for the entire state of Mississippi

Results



User Interface: Number of admissions per 10K population, $PM_{2.5}$ and O_3 within the10 km x10 km grids for a given day or for a range can be displayed as maps



User Interface: Number of admissions per 10K population, $PM_{2.5}$ and O_3 within the10 km x10 km grids for a given day or for a range can be graphed as charts individually or together