Adding GIS and Earth Observations to Syndromic Surveillance

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Objective

This paper describes an integrated modeling, sensing, and information system for forecasting atmospheric dust episodes and monitoring $PM_{2.5}$ and PM_{10} concentrations that aggravate respiratory diseases in the American southwest.

Background

There are several reasons why public health communities do not use information from Earth observations routinely in syndromic surveillance systems [1]. Most notable are: (a) they need assurance that these exotic inputs have been verified, validated, and benchmarked for their statistical and economic benefits; and, (b) mechanisms do not yet exist that deliver such information on demand and quickly in a work environment that is already overloaded. To address these issues, at least in context of respiratory diseases, a regional atmospheric dust model has been nested within the national operational weather forecasting model to enhance public health awareness of pending dust episodes and concentrations in the Southwest. Outputs from the nested model are being used to create web-based services that augment syndromic surveillance systems currently being designed and implemented by health care providers and public health agencies in the region.

Methods

NOAA's National Weather Service (NWS) uses a model developed by its National Centers for Environmental Prediction (NCEP) to produce weather forecasts. Under a 5-year agreement with NASA, the Public Health Applications in Remote Sensing (PHAiRS) project team has nested within NCEP the Dust Regional Atmospheric Model (DREAM) to add a dust forecasting capability [2]. The process includes: (a) verifying and validating nested model outputs against ground-based weather and air quality reporting stations; (b) validating statistically the reliability and quality of model outputs using a running 3-year history of EPA air quality data from 2003; (c) adopting an experimental design measuring the improvements achieved by replacing static DREAM parameters with satellite data sets; and (d), testing the combined model and web-based information delivery system.

Results

The baseline nested model has been run for two recorded dust storms that occurred over New Mexico and west Texas on December 8-10 and December 15-16, 2003. Model results compare favorably with recorded ground-based weather parameters (e.g., wind speed, wind direction, and temperature), and dust concentrations ($PM_{2.5}$ and PM_{10}). Six parameters were selected for replacement. Each was prepared for assimilation taking into consideration x,y,z,t resolution, file formats, geographic projection, compatibility of measurement units and other attributes. Initial model runs *after* data replacements showed modest, but encouraging, improvements in the surface dust model forecast, without disturbing the performance of other atmospheric parameters, especially those characterizing the upper atmosphere. Also evident in the results is that certain combinations of parameter replacements actually degrade model performance.

The team has developed a prototype web-based interface that can be accessed by syndromic surveillance professionals to provide a broader geographical context for medical data (e.g. chief complaints, diagnoses) in decision making.

Conclusions

Results from the baseline model runs indicated that DREAM's performance could be improved if some of its static parameters were replaced by direct satellite observations of surface parameters. After data assimilation both the atmospheric simulator and airborne dust simulator were more dynamic and timely; but it is also evident that replacing combinations of parameter exhibit non-linearities that must be better understood.

With further development and testing, health care professionals should be able to increase substantially the spatial dimension of syndromic surveillance at local, regional, and global scales. Initial results from this system confirm that web-based service technology can provide rapid synthesis of data from a variety of distributed, interoperable databases. A beta-test effort will be implemented to engage interested health care and syndromic surveillance professionals to optimize this systems utility.

References

[1] Morain, S. and A.M. Budge, 2006. Science data products for public health decision support. In: *IGARSS, 2006*, Denver, CO, July 30-Aug.2.

[2] Morain, S. and W. Sprigg. 2005. Initial Benchmark Report for Public Health. NASA Cooperative Agreement NNS04AA19A. Sep. 30. 36 pages.