Solutions Network Formulation Report

Quantifying Airborne Allergen Levels Before and After Rain Events Using TRMM/GPM and Ground-Sampled Data

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1. Candidate Solution Constituents

a. Title: Quantifying Airborne Allergen Levels Before and After Rain Events Using TRMM/GPM and Ground-Sampled Data

b. Author: Randy M. Stewart, Science Systems and Applications, Inc., John C. Stennis Space Center

c. Identified Partners: CDC (Centers for Disease Control and Prevention); American Academy of Allergy, Asthma and Immunology; Tulane University & Ochsner Foundation; U.S. Environmental Protection Agency

d. Specific DST/DSS: CDC Environmental Public Health Tracking Network

e. Alignment with National Application: Public Health; Air Quality; Disaster Management

f. NASA Research Results – Table 1:

Missions	Sensors/Models	Data Product
TRMM (Tropical Rainfall Measuring Mission)	Precipitation Radar and TRMM Microwave Imager	Rain Rate, Drop Size, Duration
GPM (Global Precipitation Measurement)	Dual-frequency Precipitation Radar & GPM Microwave Imager	Rain Rate, Drop Size, Duration

g. Benefit to Society: Improved asthma warnings; improved hazardous cloud mitigation; better understanding of rain effects on air quality

2. Abstract

Allergies affect millions of Americans, increasing health risks and also increasing absenteeism and reducing productivity in the workplace. Outdoor allergens, such as airborne pollens and mold spores, commonly trigger respiratory distress symptoms, but rainfall reduces the quantity of allergens in the air (EPA, 2003). The current NASA Tropical Rainfall Measuring Mission provides accurate information related to rain events. These capabilities will be further enhanced with the future Global Precipitation Measurement mission. This report examines the effectiveness of combining these NASA resources with established ground-based allergen/spore sampling systems to better understand the benefits that rain provides in removing allergens and spores from the air.

3. Detailed Description of Candidate Solution

a. Purpose/Scope

This report examines use of NASA's current TRMM (Tropical Rainfall Measuring Mission) and future GPM (Global Precipitation Measurement) data in conjunction with ground-based airborne

allergen data to quantify the effects of rain on removing allergens from the air. The AAAAI (American Academy of Allergy, Asthma and Immunology) estimates that allergies affect roughly 40 to 50 million Americans (AAAAI, 2005). In addition to dangers presented to persons suffering from asthma and other respiratory conditions, allergies create a significant national economic impact. In 1998, increased absenteeism and reduced productivity due to allergies were estimated to cost U.S. companies more than $250 million (Hewitt Associates LLC, 1998). Airborne pollens and mold spores are outdoor allergens that commonly trigger respiratory distress symptoms (AAAAI, 2006). Rain events reduce the quantity of allergens in the air (EPA, 2003). Requirements exist for the EPA (U.S. Environmental Protection Agency) to set standards to protect susceptible populations, such as asthmatics. To this end, the EPA Office of Research and Development conducts coordinated research efforts to study environmental influences on respiratory conditions (EPA, 2002). Additionally, in response to a January 2001 Pew Environmental Health Commission report that described the lack of a national system of health tracking, the CDC (Centers for Disease Control and Prevention) developed a plan for a national Environmental Public Health Tracking Network, or EPHTN (CDC et al., 2006).

b. Identified Partners

Several opportunities exist for partnerships with this project:

Centers for Disease Control and Prevention: The CDC has established a formal agreement with NASA and with other federal agencies, such as the EPA (CDC et al., 2006) to conduct research relevant to tracking public health threats and to assist with developing methodologies that can be used in tracking. Congressional funding in 2001 provided for a national system of health tracking to be developed by the CDC known as the National EPHTN. The EPHTN is intended to improve the state of information concerning environmental contaminants, human exposure to hazards, and potentially related health outcomes. The EPHTN is developing infrastructure to integrate environmental and public health information systems and to improve access to information from those systems (CDC et al., 2006). The EPHTN will be a national early warning system for the rapid identification of health threats, such as toxic chemical releases. The EPHTN also will establish the long-term collection of information on harmful exposures to be used in future studies of new environment-disease correlations. Earth science results will provide new information on the environmental contribution to chronic disease and predictive value based on coupled Earth system-chronic disease models (Haynes and Venezia, 2005). The concept described in this formulation report meets the intent of the type of information required by the EPHTN system.

American Academy of Allergy, Asthma and Immunology: The mission of the AAAAI is the advancement of the knowledge and practice of allergy, asthma, and immunology. The AAAAI establishes certification for allergen sampling stations nationwide. This concept directly relates to the interests of the AAAAI.

Tulane University & Ochsner Foundation: Dr. Edward Davis, Allergy and Immunology, Ochsner Clinic Foundation, heads an AAAAI-certified allergen sampling station in New Orleans. In association with Tulane University, Dr. Davis provides training related to operating certificated allergen sampling stations.

EPA: The EPA researches outdoor allergens, spores, and biological pollutants in addition to general air quality.

c. NASA Earth-science Research Results

NASA's TRMM was launched on November 28, 1997. The new technology onboard the satellite enabled new insights about global rainfall and allowed researchers to study rain events on a level never before possible. TRMM was originally scheduled for an operational life of 3 years, but on September 28, 2005, NASA officially approved the extension of TRMM science operations through fiscal year 2009 (JAXA, 2005).

Data from TRMM's rainfall sensors are used to study the Earth's hydrological cycle. The PR (Precipitation Radar) onboard TRMM is the first spaceborne instrument designed to provide 3-dimensional maps of storm structure (NASA, 2006a). Additionally, the TMI (TRMM Microwave Imager) provides quantitative rainfall information over a wide swath using a passive microwave sensor. Products from these NASA assets, combined with the data from certified allergen/spore sampling stations, can address such questions as the manner in which rain rate, duration of rain, and size of rain drops affect the air quality and the rate of allergen level rebound.

d. Proposed Configuration's Measurements and Models

NASA has developed atmospheric models using TRMM rainfall data, such as the 2B-31 model that combines data from the PR and from the 9-channel passive TMI. This algorithm estimates the 3-dimensional structure of the particle size distribution within the PR swath (NASA, 1998). Table 2 describes a hypothetical scenario in which data from ground-based spore monitoring systems has been merged with specific rain-event data derived via models from TRMM.

GPM, which is the follow-on to TRMM, is currently scheduled for launch in late 2010 (NASA, 2006b). The GPM program will build upon the success of TRMM, incorporating improvements in many areas (NASA, 2006c). Instruments on GPM will include the DPR (Dual-frequency Precipitation Radar) and the GMI (GPM Microwave Imager). GPM will include multiple platforms compared to TRMM's single satellite. GPM will also provide expanded coverage, increased radiometer range, better vertical resolution, and improved temporal sampling compared to TRMM.

Table 2. Hypothetical data.

Date	Pre-Rain Spore Count (Spores/m^3)	Rain Rate (in/hr)	Rain Drop Size (mm)	Rain Event Duration (Minutes)	Post-Rain Spore Count (Spores/m^3)
5/11/06	25,000	0.4	1.5	34	17,000
5/28/06	32,000	2.5	4.2	17	90

The anticipated outcome from this project would be datasets that provide evidence of specific effects of rain parameters on airborne allergen/spore counts. New understanding of rain's role in cleaning the air could lead to improved decisions regarding asthma warnings and hazardous cloud mitigation.

This candidate solution would begin by accumulating data from TRMM and coincident allergen/spore samples from a certified allergen/spore sampling station located in the same geographic location. Data from TRMM observations would supply required inputs to models that would in turn generate rain-event products. These products would be merged with appropriate allergen data before and after the rain event. A subsequent Rapid Prototyping Capability study would include investigation as to the utility of using this data for supporting the EPHTN and/or the CMAQ (Community Multi-scale Air Quality) modeling system.

4. Programmatic and Societal Benefits

Public Health: By combining the detailed rain data provided by NASA satellites with pre- and post-rain-event allergen sampling data, quantitative results can be generated to provide an improved understanding of how this natural process reduces these harmful elements. This information would be valuable to millions of individuals who are sensitive to allergens and could lead to methods for minimizing airborne allergens.

Air Quality: Knowledge gained from this study would be directly applicable to general air quality programs and tools, such as the CMAQ modeling system. CMAQ has been designed to approach air quality as a whole by including state-of-the-science capabilities for modeling multiple air quality

issues, including tropospheric ozone, fine particles, toxics, acid deposition, and visibility degradation (NASA, 2006d).

Homeland Security & Disaster Response: A better understanding of rain's effects on allergens/spores could be applied to airborne biological attack and accidental airborne hazard release. This information could provide vital new ideas for mitigation and evacuation decision-making.

5. References

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