Task Number: HE-09-02a
Task Title: Aerosol Impacts on Health and Environment: Research, Monitoring and Prediction

Overarching Task*:* Monitoring and Prediction Systems for Health
Area: HEALTH
Related Community of Practice: Air Quality & Health and Atmospheric Chemistry
Relevant Committee*: TBD*
Related Targets: *(to be included in 2009)*

Task Definition *(as given in the 2009-2011 Work Plan):*

Facilitate research and development activities that lead to the delivery of new services related to monitoring of the atmospheric cycles of various aerosols and their improved forecast in operational numerical models of the atmosphere. The proposed approach is consistent with GEO goals and philosophy and seen to combine observations and a variety of diverse research and modelling effort into a system of systems. The key activities include: (1) Reducing risks due to aerosol influences on health and public safety and assess aerosol effects on marine and terrestrial ecosystems. (2) Supporting the WMO international initiative - the Sand and Dust Storm Warning Advisory and Alert System (SDS-WAS) in developing dust storm warning system and assessments. (3) Assessing and links between dust and human health. (4) Reviewing current developments in modeling and observation of bioaerosol transport/deposition. (5) Increasing present understanding of impacts of the atmospheric deposition of dust (iron, phosphorus) to the ecosystem.

Leads *(GEO Member or PO, Entity carrying out the work, Contact: e-mail)*:
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Motivation/Background
This task is proposed in order to improve monitoring and predictive capabilities on predicting aerosol impacts on health and environment. The expected societal benefits are reduction of risks of the negative impacts of aerosols to humane health and improved knowledge on aerosol influence on environment.

Prediction of dust aerosol is based on mathematical modelling of the atmospheric dust cycle. Most of the current models are advanced, being capable to predict major dust storms, but still unable to predict small scale atmospheric phenomena (e.g. downburst of cold air, squall-line circulation) which are often major drivers of the dust process. Models for bioaerosol (pollen, spores, microorganisms) are on the other hand still used only in research mode; their operational implementation is limited by unsatisfactory specification of sources of various bioaerosols. Models for iron/phosphorus transport are too coarse to provide better analysis and understanding of the process of Fe/P deposition to marine/terrestrial environment and its role to the geo-biochemistry. In general, there is a lack of required specification/observation of aerosol features (sources, vertical profiles, deposition) necessary for model initialization and validation.

Outputs

- Finalized SDS-WAS Implementation (in 2009).
- Scientific Plan for assessing possible links between dusty weather conditions an the meningitis outbreaks in Africa; establishing a corresponding project with GEO, WWRP-THORPEX, the Spanish Regional SDS Centre and WHO
- Scientific assessment of chemical inputs to the ocean and environmental and climate impacts (2010 or 2011)
- Reviewing current scientific knowledge of the bioaerosol transport processes, from the emission to the deposition stage; recommendation to establish international cooperation in research and application of the bioaerosl science

Activities

Following the GEO strategic approach to ensure the coordinated development and implementation of Earth observing systems including variety of observations, as well as transition of research systems into operational systems, five themes in the field of analysis and prediction of aerosol affecting the human health and the environment elaborated below are proposed. Coordinated cooperation between GEO and WMO is envisaged as a pre-condition to secure their implementation and capacity building in order to reduce risks of negative influence of aerosols to humane health.

SDS-WAS project

In late 2007, the WMO/GEO Expert Meeting on an International Sand and Dust Storm Warning System was held in Barcelona, Spain, to discuss and recommend actions needed to develop global sand and dust storm warning advisory and assessment system (SDS-WAS) based on integrating numerical SDS predictions and observations. At the meeting, the participants evaluated opportunities for providing SDS-WS products capable of contributing to the reduction of risks from SDS through effective cooperation between the research community, data producers and users. GEO was a co-sponsor of the meeting in Barcelona. As an outcome of this activity, two regional SDS-WAS centres have been established in 2008 (in China and Spain) and these centres will provide improved SDS-WAS observational and prediction products through extensive regional cooperation, data exchange and dissemination, as defined by the developing project implementation plan for the 2008-2012 period.

In the forthcoming period, the following major ***activities*** are planned:

- Enhanced use of the remote and ground-based observations of parameters relevant for the dust process, especially a new generation of the satellite products such as NASA CALIPSO and ESA MSG. The observations will be used mainly for the models validation and for assimilation of data in dust forecasting systems.
- Assessing regional climate features of the atmospheric dust process by performing re-analysis dust model simulations
- Building capacities in developing countries adversely affected by dust, in order to be able to routinely perform dust-relevant observations with new instruments planned to install
- Training NHMSs synoptic engineers to use and interpret the new services based on dust predictions and observations
- Transition from research into operational products and services
- In late 2009 or early 2010, the second Expert Meeting on an International Sand and Dust Storm Warning System is planned to review the developments within SDS-WAS since the first meeting.

Impacts of dusty weather conditions on meningitis in Africa

In September 2007, the GEO Meningitis Environmental Risk (MERIT) Consultative Meeting was held to find a common platform between relevant communities to discuss issues of meningitis epidemics in Africa and to help focus research efforts towards the effective enhancement of epidemic meningitis control strategies in Africa. The meeting gathered participants from the WHO, the Health and Climate Foundation, the International Research Institute for Climate and Society, WMO, and GEO, which was the host of the meeting.

The following WMO ***activities*** as a contribution to MERIT from SDS-WAS are envisaged:

- providing data from the SDS-WAS 45-year of dust model re-analysis,
- cooperation with the medical community (WHO), to assess possible links between dusty weather conditions (e.g., low humidity) and meningitis outbreaks in the Sahel region (the “Meningitis Belt”) (using the reanalysis SDS data together with outbreak statistics for epidemiological studies to be followed on by investigating real-time links).
- Within WMO, links between the WWRP-THORPEX African initiative and SDS-WAS will be enhanced in order to achieve scientific priorities related to development of dust modelling and observation products that to support the socio-economic measures to better predict environmental conditions for meningitis outbreaks.

Meningitis belt in Africa

Deposition of aerosol chemicals and impacts on marine environment

The atmospheric deposition of chemicals to the ocean is a critical nutrient input to the marine environment. It is recognised that much of the oceanic iron, which is a nutrient in many areas of the ocean, originates from the atmospheric dust. In addition to oceanic iron, the critical nutrient phosphorus (also existing in mineral dust) represents a co-limiting nutrient in some marine areas. Within GESAMP (GESAMP – UN Group of Experts on the Scientific Aspects of Marine Environmental Protection), WMO is leading the working group of experts "The Atmospheric Input of Chemicals to the Ocean" with the objective to assess the impacts of deposition of minerals in natural dust (including iron and phosphorus in dust) to the marine environment. This GESAMP activity is strongly linked with the SDS-WAS programme. The first meeting of the GESAMP WG was held in December 2008.

The identified ***activities*** concerning impacts of the chemical input to the global ocean are:

- Exploring how to establish effective international cooperation for better estimates and impacts of dust and chemical input to the ocean.
- Evaluating current understanding of iron, phosphorus and nitrogen atmospheric inputs to the ocean.
- Providing an input for preparing a scientific report and a public information addressed to policy makers on the mentioned critical issues.

The societal impacts of bioaerosols

There is evidence on presence and transport of the bioaerosol (a biological aerosol) Negative impacts of bioaerosol movement includes the transport of toxins, spores and pathogenic microorganisms (bacteria and viruses). The following examples illustrate impact of bioaerosol to the human health and environment:
Valley fever, a disease of the lungs common in the southwestern United States and northwestern Mexico is caused by a fungus that becomes airborne when the soil is disturbed by winds. People's and animals' infection occurs when a spore is inhaled. Diseases caused by *pollen* in the respiratory system are increasing in many countries. The adverse health effects of allergens can be reduced by preemptive medical measures.

However, their planning requires appropriate measurements and reliable forecasts of pollen concentrations.

US southwest regions affected by valley fever

Asian soybean rust is one of the most serious diseases of soybean in many regions worldwide. The cause of this disease is fungal spores which under favorable weather conditions may rapidly develop and damage soybean yields up to 50%. The soybean rust caused a major concern to the soybean industry when identified for the first time in the USA in 2004 and 2005, and in response, the United States has established a system for surveillance, prediction, and management of soybean rust. For most of the bioaerosol, there are ongoing but still preliminary activities to establish measurements and modelling/predictions of various bioaerosol processes.

WMO ***activities*** will relate to:

- Investigating current scientific status in monitoring and modelling of different bioaerosol within atmospheric research and operational modeling systems.
- Evaluating possibilities of routine detection and prediction of the bioaerosol process
- Exploring developing socio-economic applications to support decision-making communities, through establishing an international cooperation between modelling, observation, medical and user communities

Microbial growth on a sample filter collected during an African dust event in the US Virgin Islands (From Griffin et al., 2003)

Resources

(1) Support and sponsorship from GEO: (1) Co-sponsoring the Second WMO/GEO SDS-WAS Expert Meeting; (2) Co-sponsoring a meeting on 'Bioaerosol and Health'

(2) GESAMP Trust Fund for GESAMP Working Group activities

(3) Regular WMO budget and THORPEX Trust fund in support of dust-related activities

(4) Spanish Trust fund in support of SDS-WAS for improvement of observation capabilities in North Africa

Capacity Building Component

One of outcomes of this task is building capacity of the SDS-WAS regional nodes to provide dust forecasting and monitoring products. The expected end-users of the products are meteorological services, medical community and civil protection organizations, for which a training courses on use of the dust related products will be organized in 2009 and 2010.

There is also an ongoing initiative to improve the real-time warning system for dust and sand storms in the Maghreb. A network of 3 real-time observations of atmospheric aerosols in Egypt, Tunisia and Morocco will be realized in 2009 and training of the local staff will be organized.

User Engagement Component

All activities elaborated above are user-oriented. Within SDS-WAS, user community is one of the project key component. In the GESAMP global assessment of chemical input to the ocean, a fishery industry is one of potential end users. Finally, for the bioaerosol monitoring and prediction tasks, there is potential interest of the medical community and pharmaceutical industry.

Science and Technology (S&T) Component

1) Please briefly describe the elements of scientific research or technological development contained in this Task

2) In relation to the S&T component(s) of this task, please describe gaps, priorities, continuity needs, barriers, scientific expertise and additional resource needs (this information will be used for developing a gaps and needs assessment in Task ST-09-01)

Members and POs' Contributions to Outputs and Activities above:

(Input is optional. This section gives the chance to Members and POs to provide more details (3-5 lines) on their individual activities, making a clear connection with the Outputs and Activities outlined above).

Greece

Atmospheric Modeling and Weather Forecasting Group (AM&WFG), University of Athens: Fluxes of naturally-produced aerosols (desert dust, sea-salt particles) are simulated operationally. In an attempt to link exposure to dust particles and human health, the group has recently developed a methodology by determining the inhaled human dose (see Mitsakou et al., ACP, 2008).

Institute for Environmental Research and Sustainable Development, NOA: Within the research activities of IERSD/NOA we operate a aerosol station at urban-background environment (Athens suburbs) and an Atmospheric Chemistry Laboratory for physical/optical and chemical characterisation of aerosols, for use on impacts on health and the climate.

National Observatory of Athens (NOA): Contribution from the Atmospheric Research Team (ART) at National Observatory of Athens. ART is active in the field of atmospheric aerosols mainly with many experimental measurements and publications. The experience from such an activity will be passed onto the GEO specific task.

Univerity of Athens, Department of Geology and Geoenvironment, Laboratory of Climatology and Atmospheric Environment: Contribution to the understanding of the relationship between air pollution-weather variability and human health (cardiovascular and respiratory diseases) using multivariate statistical methods. More specifically, the impact of particulate matter (enhanced by Saharan dust episodes) in human health is the objective of the research of our team.

Japan

JAMSTEC: By constructing network for simultaneous observation of air pollutants (ozone and its precursors) and aerosols in East Asia and Russia, establishment of long term detection system of change in diurnal cycle of vertical profiles of these species is aimed in addition to perform validation of satellite data.

Norway
Norwegian Institute for Air Research: COST633: Particulate matter: Properties related to health effects

Portugal
Institute of Mediterranean Agricultural Sciences - ICAM (Univ. Evora): Contributions will be related with bioaerosol research, monitoring and prediction. The envisaged output is the "application of bioaerosol science". The main envisaged activity is the "societal impacts of bioaerosols" namely in what concern the impacts of airborne pollen and the adverse health effects of aeroallergens.

ECMWF
Contribution through EC funded project GEMS (see http://gems.ecmwf.int/). This EU funded project is developing comprehensive data analysis and modelling systems for monitoring the global distributions of atmospheric constituents important for climate, air quality and UV radiation.

ISPRS
ISPRS WGVIII-2: Contribute to preparation of reports.

Participation

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