



MEETING OF THE WMO SDS-WAS REGIONAL STEERING GROUP (RSG) FOR N AFRICA – MIDDLE EAST – EUROPE (NA-ME-E) REPORT

25-26 November 2011, Antalya, Turkey
Host: Turkish State Meteorological Service (TSMS)¹

1. Welcoming; introduction of participants

RSG Chair and Representatives of WMO and SDS-WAS NA-ME-E Regional Centre welcomed the participants' attendance to the meeting².

The meeting participation evidence is as follows:

RSG Members: José Maria Baldasano, Emilio Cuevas-Agullo, George Kallos, Michael Schulz (Chair),

Invited experts: Humaid Albadi, Cihan Dundar, Goran Pejanovic, Nicolas Huneus, Enric Terradellas, David Walters

WMO Secretariat: Slobodan Nickovic

Members not present: Ina Tegen, Moncef Rajhi, Olivier Boucher, Jean-Jacques Morcrette, Carlos Perez

2. Adoption of the Agenda

RSG has adopted the agenda (attached as ANNEX 1)

3. Activities since the last RSG meeting

a. Summary of activities (Michael Schulz)

As a reminder, *objectives* of the SDS-WAS and its *research foci* as specified in the Scientific and Implementation Plan were listed:

- Improved dust source specification and parameterization
- Influence of local and mesoscale atmospheric processes on dust storm generation
- Advanced methods in observing the SDS, including surface-based, aircraft and satellite methods
- 4-D assimilation of dust-related observations

² See photos from the Meeting at the end of this document

- Studying direct and indirect radiative forcing effects of dust in atmospheric weather and climate models
- The role of dust as ice nuclei affecting storm development and precipitation
- Dust impact on high impact Hydrometeorological and environmental phenomena (e.g. monsoons, tropical cyclones, mesoscale convective systems, flooding and droughts)
- Developing ensemble systems for SDS prediction
- Dust and health issues
- Photochemical effects of dust and its impact on atmospheric ozone and other oxidants
- Impact of dust on marine productivity
- SDS reanalysis studies producing dust climatologies SDS model validation and model intercomparisons

Overview of *achievements/activities* since 2008:

- Formulation, revision and updates of the SDS-WAS Scientific Implementation Plan
- Formulation of working group tasks (via wiki page)
- Establishment of Regional Center at BSC with dedicated staff support from AEMET
- SDS WAS web portal with multiple freely available products and information; → Pooling of information relevant for SDS
- Efforts to increase the observational capacity for mineral dust (Sun photometer deployment, PM in Spain, Fennec campaign, Satellite retrieval over Northern Africa, BSC-DREAM8b vertical profiles, dust benchmark compilation, visibility data usage)
- 2 SDS-WAS Training Courses (2010, 2011)
- ESA/SDS-WAS workshop on the potential of satellite products for SDS (Nov 2009)
- SDS-WAS/GESAMP workshop « Impact of Dust on Marine Biogeochemistry », March 2011
- Dust workshop in Athens September 2011
- Proposals for forecast model usage, as well as a joint model intercomparison and evaluation have been circulated

- Preliminary 3hourly dust forecast model data from BSC, ECMWF, LSCE are transferred on routine basis to regional center at BSC, pilot visualisation with common colour code achieved
- NRT evaluation of dust and aerosol model products is done at BSC, ECMWF and MetNo
- Cooperation and contacts established to
 - Asian node of SDS-WAS
 - MACC Monitoring Atmospheric Composition and Climate EU project
 - ICAP International Cooperative for Aerosol Prediction
 - AeroCom Aerosol Model Intercomparison Initiative
 - WMO CAS/CBS; see Slobodan's presentation
 - MERIT Meningitis Environmental Risk Information Technologies
 - GESAMP Group of Experts on Scientific Aspects of Marine Environmental Protection
 - GAW Global Atmospheric Watch (GALION lidar network, SAG)
 - WWRP Verification Research WG

SDS WAS *implementation plan* for next years (to be elaborated in discussions)

- enhancing NRT effective cooperation between partners in regional nodes, that will include exchanging of agreed observations and model products (2011-2013)
- Developing and implementing a common routine verification system for all dust models available. (2012-2014)
- strengthening cooperation with organizations/networks/projects providing SDS-related observations (NASA, ESA, EUMETSAT, GALION, AEONET, EMEP, GAW etc. (continuous)
- proposing Trust Fund establishment (2011)
- models inter-comparisons (2012-)
- dust reanalysis (2012-)
- ensemble forecasting (2014-)
- Considering establishing new nodes and/or sub-nodes (Americas, SW Asia, Australia) (2012-)
- Establishing RDP/FDP projects (continuous)

- Supporting field campaigns, to be used for a better understanding of the SDS process, to evaluate of model performance.
- Data assimilation (2011-)
- Establishing user-oriented studies (e.g. case studies of events affecting air/ground transport; studies linking public health and dust, etc.) (continuous)
- Studies on emission process (continuous)
- Mineral dust fractions; impact of deposited dust on environment (continuous)
- New SDS data flow with retour for partners:
 - accessibility to long-term data archives
 - accessibility to near-real time model outputs (numeric information) among participants
- Implement a historical dust-data archive of satellite data
- Share observations for near real time dust monitoring, researches and model verification
 - Including surface wind near dust sources?
 - Provide dust sources of different models
 - Encourage the availability of quantitative dust data (i.e. AOD) from MSG-Seviri, Modis, MISR and CALIOP
 - Extraction of fine and coarse mode AOD for operational model verification
 - Use of aerosol supersites (Global GAW and EUSAAR/ACTRIS) for sophisticated point model verification/validation (i.e..size distribution validation)

b. NA-ME-E Node (Enric Terradellas)*

The Regional Center for Northern Africa, Middle East and Europe of the WMO SDS-WAS programme is jointly managed by two Spanish institutions: AEMET, which is the National Meteorological Service, and the Barcelona Supercomputing Center (BSC-CNS).

The objectives of the Center are:

* Detailed report is attached as ANNEX 2

- To lead the implementation and operation of an integrated system of observation and prediction.
- To facilitate user access to information
- To build capacity of countries to use the provided products.

The web page (<http://sds-was.aemet.es>) provides access to different dust-related resources:

- Observational systems (in-situ measurements, indirect observations, sun-photometric stations, satellite products, ...)
- Dust model outputs
- Products of model intercomparison and validation
- Time-averaged products
- News, materials and other sources of information

The Regional Center has organized and participated in different capacity building events: training courses in Barcelona (2010), technical workshop in Barcelona (2011) and training courses in Istanbul and Antalya (2011).

c. Secretariat report (Slobodan Nickovic)

A report was made on how the process of approval for the SDS-WAS was made over several years by the WMO governing bodies. The major steps of the process were:

- **CAS (Commission of Atmospheric Sciences) 2009:** recommended
 - forming an ad-hoc joint task team with representatives from the CBS (Commission of Basic Systems) and CAS to prepare an amendment to the GDPFS Manual covering the various operational aspects of the SDS-WAS
 - SDS-WAS regional Nodes to adopt common standards for data exchange formats, graphical presentation of forecasts and data exchange.
 - to develop sand and dust forecast verification and assessment tools to evaluate model performance using near-real-time observations. Urged to interact with the Working Group on Forecast Verification Research for the preparation of reference material on verification
- **WWRP JSC, 2011 recommended:**

- To make Inventory of recent scientific papers published by the SDS-WAS partners.
 - Secretariat to finalize operational procedures to designate appropriate SDS-WAS partners performing operational dust forecasting who are capable of providing sustained operations as RSMC centres.
 - SDS-WAS to collaborate with the WWRP Verification WG to improve dust forecast verification.
- **16th WMO Congress, 2011 recommended:**
 - Supported CAS and CBS efforts to specify an optimal concept of transferring research on numerical dust forecasting to operational activity where possible.
 - Encouraged participation of SDS-WAS in the interdisciplinary project “Meningitis Environmental Risk Information Technologies” (MERIT) in providing information to MERIT partners on dusty weather conditions which are considered to be correlated to meningitis epidemics in the Sahel.
- **CAS Management Group, November 2011**
 - MG gave its support to the establishment of the CBS GDPFS SDS Specialized Centre in Spain (AEMET and BSC).
 - Noted that biomass burning is an important issue; to concrete plans on how CAS/GAW/WWR should address this issue. The example of SDS-WAS could be used.

Discussion

- *To establish in the future joint activities/projects, gathering more SDS partners*
- *To make public available as much as possible:*
 - *observation data available to modelers*
 - *reanalysis*
 - *Mineralogy data*
 - *AOD from satellites*

- *Heterogeneous main goals concerning SDS activities within WMO: CAS (more SDS research) Vs CBS (operational SDS products within an operational regional SDS forecasting center)*

4. Activities relevant for SDS-WAS

Emilio Cuevas (AEMET)

Presented SDS activities carried out at the Izaña Atmospheric Research Center (AEMET) in 2011 as partner of the Regional Center. These activities covered different aspects: 1) Observational capacity (use of visibility data for dust concentration estimation and further model data assimilation, implementation of AERONET stations in Northern Africa, use of new generation ceilometers for operational Saharan Air Layer detection); 2) Validation of the NMMb/BSC-Dust model reanalysis with very satisfactory results; 3) Research in dust transport monitoring and Saharan Air Layer characterization over the North Atlantic and the Sahara; 4) activities related with impact of dust on marine productivity (analysis of outstanding likely dust-caused algae blooms in the North Atlantic and contribution to GESAMP); 5) investigation on mineral dust & anthropogenic pollution mixture processes in Northern Africa (effects of refineries and gas flares emissions on dust analysis; 6) impact of dust on tropospheric ozone destruction over North Atlantic; 7) research in dust optical properties (in the free troposphere) and dust radiative effects (radiative forcing of dust in global, direct and diffuse radiation); 8) investigations on health and dust issues (impact of dust on cardiovascular diseases), and 8) new instrumental developments (new Lunar Cimel for aerosol observations during night period).

Discussion

- *Lack of data in Northern Africa near dust sources*
- *PM10 data required*
- *Cooperation between NHMS and Universities/research centers is required*
- *NHMS could house field campaigns an long-term observation programs carried out by Universities/research centers*
- *A survey concerning observational dust-related data availability in Europe and Northern Africa is needed. Michael Schulz, Emilio Cuevas and Enric Terradellas will draft a document with this information, summarizing the situation at country-level. It will be initialized in parallel thorough WMO (AREP official letter through the PR's of NMHS), and with a letter of the SDS WAS Regional Center SG*

addressed to Universities, research Centers and air quality agencies. The draft should also contain recommended actions

Jose Baldasano (BSC-CNS)

The Earth Sciences Department of Barcelona Supercomputer Center-Centro Nacional de Supercomputación (BSC-CNS, www.bsc.es) maintains mineral dust forecast operations with the BSC-DREAM8b model (Pérez et al., 2006a,b) and conducts modelling research and developments for short-term prediction. BSC-DREAM8b has been delivering operational desert dust 72 h forecast over Northern Africa, Middle East, Europe and Asia since May 2009 (www.bsc.es/projects/earthscience/DREAM). The operational resolution is $1/3^\circ \times 1/3^\circ$ and 24 vertical layers up to 15 km in the vertical. Daily evaluation with near-real time (NRT) observations is conducted using observations from the European Lidar Network (EARLINET; www.earlinet.org), the AErosol RObotic NETwork (AERONET; <http://aeronet.gsfc.nasa.gov/>), satellite and ground level PM levels, outline the good skills of BSC-DREAM8b concerning both the horizontal and vertical extent of the dust plume in particular dust events in the Mediterranean Basin (e.g. Pérez et al., 2006a; Amiridis et al., 2009; Papanastasiou et al., 2010). Additionally, the model has been validated and tested against measurements at source regions from the experimental data of Saharan Mineral Dust Experiment (SAMUM; Haustein et al., 2009) and Bodélé Dust Experiment (BoDEX; Todd et al., 2008) campaigns.

Also, in order to improve dust forecasts works in collaboration with the Centro de Investigación Atmosférica de Izaña from Spanish Weather Service (AEMET; www.izaña.org) and Institute of Environmental Assessment and Water Research (IDÆA) from the Spanish National Research council (CSIC). Currently, the evaluation system includes satellites (MSG and MODIS) and sunphotometers (AERONET). Ongoing activities involve the inclusion of lidars, visibility reports and surface concentration measurements to the evaluation system.

Since 2008, one of the most important efforts are made in the development of a new generation atmospheric mineral dust model NMMb/BSC-Dust (Pérez et al., 2011; Haustein et al., 2011) as well aerosol global and gas-phase chemistry NMMb/BSC-CHEM (Jorba et al., 2010) coupled on-line to the new generation unified meteorological core of the Non-hydrostatic Multiscale Model on the Arakawa B grid model NMMb (Janjic, 2005; Janjic and Black, 2007) of the National Centers for Environmental Prediction

(NCEP). The new NMMb/BSC-CTM modelling system (Pérez et al., 2011a) is intended to be a powerful tool for research and to provide efficient global and regional chemical weather forecasts at sub-synoptic and mesoscale resolutions including a physically-based dust emission scheme taking into account the effects of saltation and sandblasting, soil moisture and viscous diffusion close to the ground.

NMMb/BSC-Dust provides a good description of the horizontal distribution and temporal variability of the dust. At a global scale the model lies within the top range of the dust global models participating in the AeroCom project (<http://dataipsl.jussieu.fr/AEROCOM/>; Huneeus et al., 2011) in terms of performance statistics for surface concentration, deposition and AOD. At regional domain at high resolution (without dust data assimilation) covering Northern Africa, Middle East and Europe, the NMMb/BSC-Dust is capable to reproduce the main source regions in the Sahara as well as the column dust loading, its spatial distribution and the vertical extension of the dust plume as shown in the results recently presented in Haustein et al. (2011) and Pérez et al. (2011).

Discussion

- *BSC-DREAM8b and/or NMMb/BSC-Dust reanalysis available at the SDS WAS RC*
- *NRT model outputs available among participants*

Nicolas Huneeus (ISCE, France)

A case study Project proposal

As a contribution to the activities of the SDS-WAS NAMEE node we intend to complement its effort by conducting a case study where different dust forecast models are compared against observations for a given dust event, which occurred in April 2011. We are interested in exploring the differences between the models to simulate different datasets and identify whether this is due to vertical profile, optics, size distribution, removal fluxes, wind fields or other model characteristics or processes. Studying a specific dust event allows to also investigate on higher time frequency of a few hours the capacity of the models to predict the approach of a dust event.

As a first step, we have compared the AERONET AOD at these stations to ECMWF model output using the 24, 48 and 72 hours forecast time steps from three consecutive forecasts run by the experimental ECMWF MACC model version running in

assimilation mode. The different forecasts reproduce the onset and duration of the event at each AERONET station. The largest bias with respect to the observations appears in days when the dust cloud passed the Aeronet sites. All forecasts have difficulties to reproduce the magnitude during the event and the discrepancy increases for a larger forecast time step. We will extend this analysis to in-situ measurements of surface concentration (PM), satellite retrieved AOD (e.g MODIS) and vertical profiles of aerosol extinction (Caliop).

Objectives

- (i) To make necessary simultaneous measurements of aerosols, cloud microphysics and large-scale meteorological conditions to document and understand the pathways through which aerosols interact with clouds and influence precipitation over continental Indian monsoon region.
- (ii) To quantify the efficacy of seeding in precipitation enhancement over a suitable location in India.

To achieve these objectives, it has been planned to carry out CAIPEEX in three phases. As India is characterized by existence of diverse climate conditions across the country and the seasonal cycle is very large, the Phase-I of CAIPEEX aimed at collecting simultaneous aerosols and cloud microphysics data from a number of locations across the country.

Phase I

With this background, Phase I was conducted during May – September 2009 from six base locations, namely Pune, Pathankot, Hyderabad, Bareilly, Bengaluru and Guwahati. A Piper Cheyenne model PA-31 T instrumented aircraft was utilized in the program. Total 219 hours of flying was done during the period.

Phase II

The objective of Phase-II is to quantify the efficacy of seeding in precipitation enhancement. It is proposed to use two instrumented aircraft, one for seeding and one for cloud microphysics measurements. Based on preliminary results of Phase-I, Hyderabad was considered as the base station for Phase-II experiment. Hyderabad is located in the rain shadow region during south-west monsoon on eastern side of the Western Ghat Mountains and the region around it is vulnerable to local droughts. In order to be able to delineate contribution of seeding from naturally occurring precipitation,

sample size need to be sufficiently large. As a result, it was proposed to conduct the Phase-II experiment at least for two monsoon seasons.

First year of Phase-II was conducted in the year 2010. S-band radar from IMD, located at Hyderabad and a C-band radar located at Sholapur, were used to monitor the clouds. Simultaneous with the aircraft flights, balloon flights were conducted for measurement of large scale winds, humidity and temperatures. Total 13 seeding trial flights were conducted during the period. Phase-II Second year program is in operation in the monsoon and post monsoon seasons of 2011. It is planned to conduct 250 hours of flying during the experiment. To supplement aircraft observations, ground observations from variety of instruments are carried out from Integrated Ground Observational Campaign (IGOC) station located at Palamur (Mahabubnagar).

Many national organizations viz India Meteorological Department (IMD), National Center for Medium Range Weather Forecasting(NCMRWF), National Balloon Facility-Tata Institute of Fundamental Research (NBF TIFR), Vikram Sarabhai Space Center (VSSC), National Aerospace Laboratory (NAL), Indian Institute of Science (IISc) and Universities are participating in the experiment.

Phase III consists of detailed analysis of the data for preparation of guidelines for operational cloud seeding program and parameterization of cloud microphysical processes for numerical weather models for improvement of weather and climate forecasts. (see ANNEX 3 – the draft project proposal)

Discussion

- *Over time, to study more than one case*
- *Question: to use operational or special model setup? More practical if a special setup is used. Resolution/domain should be a choice of each participating group*
- *Important to define evaluation protocol; what statistics to be used*

Benjamin Lamptey (Regional Maritime University, Ghana)[♦]

"Weather and Meningitis in Ghana"

The Google Foundation funded Project on Weather and Meningitis in West Africa is using the Kasena-Nankana District (KND) in the Upper East Region of Ghana for pilot studies. The project is lead by the University Corporation for Atmospheric Research (UCAR) in Boulder Colorado, USA. It involves scientists from other institutions in the

[♦] See ppt presentation on <http://sds-was.aemet.es/materials/meeting-of-the-regional-steering-group>

USA as well as Ghana. The goals of the project are to (a) minimize meningitis incidence by providing 1-14 day weather forecasts to target dissemination of scarce vaccine, (b) contribute to better understanding of disease transmission with a focus on intervenable factors. The KND was chosen because of initial work by and available district level data at the Navrongo Health Research Institute in the Upper East region of Ghana.

UCAR currently has a statistical model for predicting the probability of occurrence of meningitis within season. The model uses the Thorpex Interactive Global Grand Ensemble (TIGGE) data. A relationship between humidity (RH and Vapor pressure) and meningitis has been observed.

In Ghana, the Weather Research and Forecast (WRF) model is to (i) be installed and customized for the West African Region, (ii) be used to generate higher resolution data than the TIGGE data to study relation between weather variables and meningitis for comparison with the study done using TIGGE data, (iii) be run in a semi-operational mode and output data used as input to UCAR statistical data. In parallel, available dust observation and model data is to be analyzed to explore the contribution of dust to meningitis. Eventually, a dust model may be run as stand-alone or incorporated into the atmospheric model. Also some climate change related work has started.

Discussion

- *Meningitis data availability: not yet solved*

Michael Schulz (MetNo):

Presented was a preliminary evaluation of dust model output from four models (BSC-DREAM, INCA, GEMS, NMMB-dust). Reanalysis simulations were performed for the year 2006 and coarse aerosol optical thickness from Aeronet was used over North Africa to evaluate the simulations. All models showed capacity to simulate dust events. Coarse mode AOD is shown to be a potential good parameter to be used for dust model evaluation. Clarification is needed and has been identified with respect to the AOD data, which include non-dust AOD contributions, to the impact of assimilation on the GEMS model result and to missing diagnostics on the dust budget. The presentation was meant to introduce and propose a joint research project for a reanalysis period which is well studied also under other international projects such as AeroCom.

Discussion

- *Repeat the 2006 exercise including other new dust models??*
- *Include surface wind validation (against station observations) in desert areas??*

Johannes Kaiser (ECMWF) Joint Working Group on Forecast Verification Research♦

The focus of the activities of Joint Working Group on Forecast Verification Research (JWGFVR, http://www.wmo.int/pages/prog/arep/wwrp/new/Forecast_Verification.html) is development and promotion of new verification methods relevant for the end users, as well as training aimed at raising the profile of verification as integral part of the forecasting/research process and at encouraging capacity building in developing societies. The members of the group work in either research or operational centres on different aspect of verification. JWGFVR has collaborated with various WMO working groups and has initiated or participated in international projects. Recently, the group has organised a workshop on verification methods in Melbourne (Australia). The future focus of the group will be working on spatial methods for verifying ensemble predictions and working on a concept for seamless verification, i.e. verification tools/methodologies that can consistently verify across a range of time scales.

Johannes Kaiser (ECMWF)

The MACC(-II) projects are producing daily analyses and 5-day forecasts of the global aerosol distribution in real time in preparation of the operational GMES atmospheric service. The analyses are constrained by the assimilation of MODIS AOD observation with the 4D-Var system of ECMWF's Integrated Forecasting System (IFS). Eight years of aerosol daily analyses (2003-2010) followed by 5-day forecasts have also been produced. All these are publicly available on request, see <http://gmes-atmosphere.eu>. Over the last six years, the development, validation and pre-operational provision of aerosol analyses and forecasts by the IFS have relied heavily on the satellite data provided by MODIS and the surface measurements at the AERONET stations. CALIPSO measurements are the next measurements to be assimilated in the near future. SEVIRI is also considered for the future. These products are being refined through further aerosol and model developments.

♦ See ppt presentation on <http://sds-was.aemet.es/materials/meeting-of-the-regional-steering-group>

The continued service provision depends on the near-real time provision of satellite (and surface) measurements, for example the provision of a homogeneous land/sea aerosol product in real time from Sentinel-3. Unfortunately, ESA does not plan to deliver this.

Besides the WMO-SDS, intensive collaborations in, e.g., ICAP and AEROCOM have been very helpful. Any SDS-WAS contribution towards NRT verification of the participating models would be particularly welcome.

Discussion

- *Concentrate on coarse AOD only to remove causes are not dust related, and study the contribution of other components to coarse AOD (i.e. sea salt)*
- *Review dust life time*
- *Run non-assimilated ECMWF model version to know the impact of dust assimilation*
- *Investigate model behavior on annual basis*
- *Assimilation of visibility observations?: high cost –computing impact*

David Walters (The UK Met Office)

Unified Model (MetUM) is a flexible atmospheric model used by the UK Met Office and its collaborators in the UK and abroad for a wide variety of applications; these range from its use in coupled Earth system models performing climate projections through to Numerical Weather Prediction (NWP) in global, regional and convection permitting configurations. One advantage of a unified model is that it is relatively simple to pull through science developed for one application for use in another. The MetUM's dust scheme was originally developed for use in global climate projections but has since been applied to dust storm prediction in both global and regional NWP models. In July 2011 the Met Office introduced a dust forecast component to its operational deterministic global NWP model, which routinely runs forecasts at N512 (~25km) horizontal resolution out to 7 days ahead. From the end of 2011, the Met Office plans to provide forecast plots over North Africa and Europe from this model for use in the NA-ME-E node of the WMO SDS-WAS.

The dust scheme is based on Woodward (2001) and has been continually developed over recent years. The version currently used in the global NWP model is similar to that described in Woodward (2011) with the simplification that the vertical flux,

transport and deposition of dust uses only 2 size divisions covering radii of 0.1-2 and 2-10 microns. The radiation scheme is currently still using a 6 bin dust climatology derived from 20 years of a long MetUM climate integration. We plan to use the prognostic dust scheme in the radiation scheme in the coming 12-18 months.

Performance of the model so far has been satisfactory with biases and skill-scores over the area of the operational limited area model improved for dust events with $AOD < 0.5$, which we believe is at least partly due to the advection of dust from sources outside the limited area model's domain. The skill scores and biases for larger dust events are degraded, showing either that a higher resolution model or a parametrisation of sub-grid variability in the model's friction velocity is required to forecast high AOD events more accurately. Model developments currently being worked on include the lifting of dust from areas of seasonal vegetation and the assimilation of dust observations from SEVERI and MODIS AOD products.

Discussion

- *Met Office dust forecasting in SDS WAS from December 2011*
- *Dust-radiation feedback*
- *Availability of AOD raw data from UKMO ? for AERONET validation and comparison with model outputs*

G. Kallos (University of Athens)

with contribution from S. Solomos, C. Spyrou, C. Mitsakou, C. Kalogeri, J. Kushta, P. Athanasiadis

University of Athens, School of Physics, Atmospheric Modeling and Weather Forecasting Group – AM&WFG.

The Desert Dust and its Impacts: General Considerations

Airborne particles of anthropogenic and/or natural origin have certain direct and indirect effects in the atmosphere. Aerosols interact strongly with solar and terrestrial radiation in several ways. By absorbing and scattering the solar radiation aerosols reduce the amount of energy reaching the surface. Aerosols enhance the greenhouse effect by absorbing and emitting outgoing long wave radiation. Forcing by dust and other natural aerosols exhibit large regional and temporal variations due to their short lifetime and diverse optical properties.

At the Atmospheric Modeling and Weather Forecasting Group of University of Athens there are organized activities concerning the atmospheric model development and applications

related to direct and indirect effects of dust and other kind of aerosols. Two modeling systems have been developed and are in use namely SKIRON and RAMS/ICLAMS.

The SKIRON system development started on 1995 and has as main purpose the study of dust producing mechanism and the related direct effects. It has been applied in the Mediterranean and North Africa, Atlantic Ocean Middle East and Arabian Peninsula as well as Central Asia.

The RAMS/ICLAMS is a relatively new development with the main purpose to study aerosol radiation cloud interactions and study of indirect effects. The development is based on RAMS model and has some unique capabilities such as two-way interactive nesting, explicit cloud microphysics etc. At this model the dust and sea salt submodels have been added. In addition, the modeling system has gas and aqueous phase chemistry, gas to particle conversion and thermodynamic equilibrium, treatment of cloud condensation nuclei (CCN) and ice nuclei (IN) as predictive quantities etc.

Aerosols can serve as CCN and IN. The amount of particles that will nucleate and form cloud droplets depends on number concentration, size distribution and chemical composition. Changes in the partitioning between hygroscopic and non-hygroscopic particles can affect the cloud cover, radiative properties and precipitation. Moreover, several other environmental parameters such as atmospheric conditions and surface properties play an important role on cloud processes.

Modeling such processes and interactions require explicit resolving physical, chemical and dynamical processes at very high resolution. The RAMS/ICLAMS new modeling tool has been applied in the Mediterranean Region to study the impacts of aerosols on radiation transfer, cloud and precipitation. As it was found, increased concentrations of particles delayed the initiation of precipitation and limited the rainfall heights. The size distribution of the particles was also found to be important. Adding GCCN to polluted clouds promoted early-stage rain while adding GCCN to pristine clouds had no significant effect on precipitation. The role of dust and soot as IN and the competition between homogeneous and heterogeneous ice formation mechanisms has been also investigated for various types of clouds. Comparison of model results with surface observations of precipitation indicated a strong link between dust concentrations and rainfall amounts. Despite these advances in

understanding these processes intense combined modeling and observational surveys are needed to reduce the uncertainty on these mechanisms and to improve our knowledge on atmospheric chemistry and meteorology interactions.

A recent study of the dust production mechanisms is related to the role of density currents. Density currents are mesoscale phenomena that lead in both uplifting of existing dust and production high amounts due to intense turbulent activity in the head and the cool part of it. Because of the high productivity of dust these phenomena must be considered as a separate dust source and treated on an accurate way.

Discussion

- *Proposal to reproduce some “strong different case studies” related with convective systems (i.e. Habbobs) and density currents (downdrafts currents)*
-
- *Focus on meso-beta/gamma mechanisms of dust production.*

Humaid Albadi (National Weather Service Oman)

Summary Points of CoE-Muscat report for RSG SDS meeting

➤ Although Middle East is the second most dust emitter area in the world after Sahara and despite the effort from scientific community in the last decade over the Sahara desert, China and Australia, less attention has been raised in Middle East constraining the processes that operate in key source areas of dust production. Therefore it worthwhile to draw attention of various organizations and academic institutes to put efforts in this direction.

Meteorologist in the Middle East region are more concerned about the progress of scientific research effort in answering some of the fundamental questions such as the affect of dust in the rain process, Reduction or increment of rain amount ? How much is the change of Dust load affect NWP performance in North Indian Region?

➤ Discussing how to extend the Scope of the Center of Excellence–Muscat to be a Regional Training & Research Centre for SDS-WAS. What facilities the centre has. The Oman representative to investigate the needs of holding the next 3rd Training course on WMO SDS-WAS in CoE-Muscat in 2012.

Goran Pejanovic (National Weather Service, Serbia)*

See presentation here

<http://sds-was.aemet.es/materials/meeting-of-the-regional-steering-group>

5. SDS-WAS Implementation

Updating the research implementation agenda; Defining joint research project

6. RSG Membership

The following three members are not re-appointed since they moved to new organizations/projects: Dr Carlos Perez, Dr Vincent-Henri Peuch and Mr Moncef Rajhi (representing originally BSC, MeteoFrance and Tunisian Meteorological Service, respectively).

The following two new members are appointed: Mr Goran Pejanovic (Serbian Meteorological Service) and Mr Humaid Albadi (Omani Meteorological Service).

Decision on possible membership of Mr Hamza Mohamed Hamza (Meteorological Service Egypt) is postponed in order to gain information about his scientific background for which his CV will be requested, and the official support from his RP will be also required.

7. Any other business

8. Closing

Summary of meeting actions/recommendations

The meeting participants had an open discussion on possible next steps and actions based on the input and achievements shown during the meeting. These are summarized here in abbreviated form:

A) SDS "infrastructure"

SDS web Portal: Several further possible improvements are suggested:

- 1) Links to available dust observations, benchmark data sets
- 2) Link to dust source mappings, usable as input for models
- 3) A link to the dust related publication list held at WMO
- 4) Presentations from RSG meeting shall be accessible on web with password protection
- 5) Feedback by portal users should be encouraged through eg a feedback button

Forecast model field display and NRT verification on BSC portal:

It is recommended to add further statistical parameters on the comparisons

Further feedback from modellers shall be sought

At this moment it shall be accessible with no public link to modeling partners

The public display is envisaged after agreement from contributors

Forecast model data server

A user server making accessible the model data to contributing modelling partners and joint research project contributors (via user/password). An agreement among model contributors is required. A data policy for model data exchange is to be proposed by Michael Schulz and discussed by means of email discussion.

Reanalysis BSC

The provision of the dust model field reanalysis for the period 1984-2008 by NMMB model and period 1980-2010 by BSC-Dream model, provided at BSC server shall be explored.

Observational data for SDS

To increase the observational capacity an attempt is suggested to survey and assess per country in the Mediterranean the available instrumentation, site operation and future plans for dust monitoring (survey draft : Schulz/Cuevas/Terradellas); Parameters of interest for SDS model evaluation are PM10, size distribution, Sun photometer (automated and handheld) retrieved optical parameters, lidar retrieved backscatter and extinction, ceilometer retrieved backscatter, dust deposition, visibility.

Survey shall be sent by two means:

Questionnaire from WMO to MetOffices (Nickovic)

Supplementary Open review to universities and environmental agencies

Future meetings

1) A training course is proposed to be held in Oman in 2012 or 2013 depending on funding from WMO, EUMETSAT and host institution

2) A training course for PhD students and postdocs from Mediterranean region is suggested to be developed for purpose of cooperation among SDS partners and research project development (funding requires exploration, eg towards EU-ACTRIS)

3) A contribution and report to the Joint Research Committee of WMO in April/March 2012 shall be prepared through the report from this meeting and a follow-up preparatory telecon meeting. Representation is assured by chairman of SDS NAMEE.

Dust field data transfer to Meningitis project

Lamprey is supposed to specify the needs of the Meningitis project with respect to the technical and scientific aspects of dust data to the RSG and BSC;

Cooperation with CBS

Based on the previous experience at the BSC and within the RSG, the operational forecast of AOD, PM10 fields and AOD verification seems to be possible. It is suggested to seek also in the future advise from the SDS-WAS RSG with respect to the quality of dust forecasts.

Development of international cooperations

Cooperation to ICAP was found very useful and it was suggested to also invite a representative to future SDS meetings. Also further cooperation to the JWWRP verification group was encouraged.

Dust in the Middle East was recognised as an important research subject. A Regional Training Center for Sand and Dust Storming Warning and Advisories should be considered as proposed in Oman. More information on these activities shall be made available via the SDS portal. RSG NAMEE understands the need for coordinated SDS activities in the region and supports WMO considering establishment of a new node for the Middle East.

B) Joint research projects

It has been agreed that joint research projects need to be developed. The subjects shall be made available via a password protected part of the SDS web portal. Elaborated proposals need to be prepared for the JRC March meeting. The status of the projects shall be revisited in January.

Proposed/Planned projects:

1. Case study for April 2011 case, (Hunneus)
2. Other typical cases for dust crossing the Mediterranean, Eastern/Mid/Western Med
3. Procedure and scope of NRT data evaluation of data arriving at BSC server (Baldasano)
4. Reanalysis of 2006, exploration of coarse AOD for dust evaluation (Schulz)
5. Using visibility for dust model evaluation (Cuevas)
6. Discussion of skill scores for dust model evaluation (Hunneus)
7. The value of an ensemble dust forecast model (TBD)
8. Form and structure of aerosol alerts (TBD)
9. Prescribed emission fluxes introduced in one model (TBD)
10. Mesoscale dust source production processes (TBC)

Note: Presentations from the meeting are posted on:

<http://sds-was.aemet.es/materials/meeting-of-the-regional-steering-group>

ANNEX 1



MEETING OF THE WMO SDS-WAS REGIONAL STEERING GROUP (RSG) FOR N AFRICA – MIDDLE EAST – EUROPE (NA-ME-E)

25 November (14:00-17:30) - 26 November (09:00-16:30) 2011, Antalya, Turkey
Host: Turkish State Meteorological Service (TSMS)

AGENDA

26 November 2011

14:00-15:30

1. Welcoming; introduction of participants
2. Adoption of the Agenda
3. Activities since last RSG meeting
 - a. Summary of activities (Michael)
 - b. NA-ME-E Node (Emilio/Jose)
 - c. Secretariat Report

16:45-17:30

Discussion (Joint research)

26 November 2011

09:00-10:30

4. Activities relevant for SDS-WAS

11:00-12:30

Activities relevant for SDS-WAS (continued)

14:00-15:30

5. SDS-WAS Implementation
 - Updating the research implementation agenda
 - Defining joint research project

15:30-16:30

6. Membership in RSG
7. Any other business
8. Closing meeting

ANNEX 2



REGIONAL CENTER FOR NORTHERN AFRICA, MIDDLE EAST AND EUROPE OF THE WMO SDS-WAS PROGRAMME

Activity Report 2010-2011

Enric Terradellas (AEMET), José M. Baldasano (BSC-CNS)

Barcelona, 9 January 2012

Index

- 1. Background.**
- 2. Design and implementation of the web portal**
- 3. Joint visualization and evaluation of dust model outputs**
- 4. Coordination of capacity building activities**
- 5. Participation in WMO meetings**
- 6. Partners of the Regional Node**

Background

In May 2007, the 14th WMO Congress endorsed the launching of the SDS-WAS programme. It also welcomed the strong support of Spain to host the Regional Centre (RC) for Northern Africa, Middle East and Europe and to play a lead role in implementation.

The Secretary-General of WMO in a letter to the Permanent Representative (PR) in Spain with WMO, dated January 29, 2007, formally requested Spain to lead the SDS-WAS node for Europe, Africa and Middle East. The PR in Spain accepted the offer in a letter dated March 1, 2007.

In November 2008, the first meeting of the Regional Steering Group (RSG) for Northern Africa, Middle East and Europe was held in Tunis-Carthage (Tunisia).

On April 26, 2010, the State Meteorological Agency (AEMET) and the Barcelona Supercomputing Center - National Supercomputing Center (BSC-CNS) signed the agreement to create the Regional Center.

Design and implementation of the web portal

The web portal of the R. C. (<http://sds-was.aemet.es>) was designed to allow the user to access observational and forecast products, as well as sources of basic information. In particular, the portal was designed to provide National Meteorological and Hydrological Services (NMHS) with the necessary information to issue warning advisories related to the dust content in the atmosphere. The site was first released in November 2009 and became fully operational in early 2010. It is managed using the software Plone 4.x and hosted by a server with the following technical characteristics:

- 8 processors Intel Xeon at 2.8 GHz
- 12 GB of RAM memory
- 1 TeraByte of hard disk

Efforts have been aimed at increasing the quantity and quality of the products that are distributed, with special emphasis on observational data. A global observational network is crucial to any forecast and early warning system for real-time monitoring, for validation and verification of forecast products, and for data assimilation systems that may be developed in the future. The main data sources are in-situ aerosol measurements, indirect measurements (visibility), ground-based remote sensing (lidar and radiometers) and satellite products.

Direct measurements of aerosol content are common in Europe but very scarce and intermittent in Africa, near the main dust sources. Air-quality monitoring stations usually yield concentrations of total suspended particles (TSP) or particulate matter with aerodynamical diameter less than 10 or 2.5 μm (PM10, PM2.5). This information is very important to monitor dust events. However, it is necessary to note that stations measure concentration of all particles, not just dust. Moreover, it is important to bear in mind the location of the stations, since the abundance of anthropogenic particles near large cities, industrial complexes and roads can mask the presence of mineral dust.

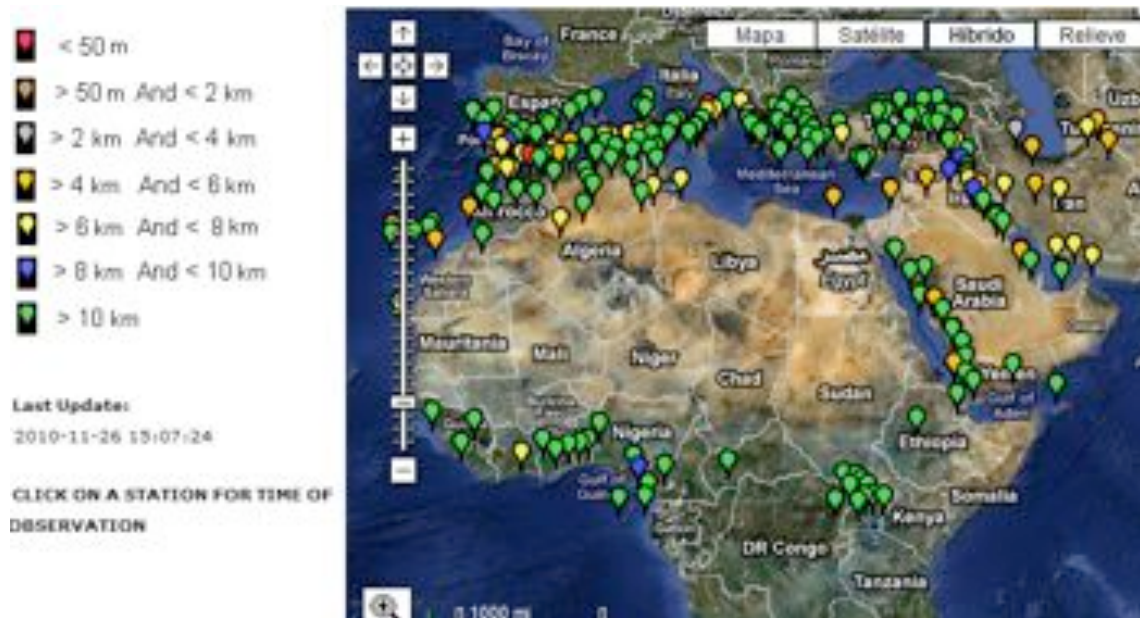
The reference method to measure particle concentration is based on gravimetric sampling techniques, whose results take days or weeks to be available and reflect the average conditions over a long time period, usually 24 hours. Automated devices can continuously estimate the particle concentration, but it is necessary to introduce correction factors in the measurements. Data from 13 stations are currently available and refreshed 3 times daily.



Air-quality monitoring stations continuously yielding PM data

This information is complemented by the backtrajectories, which allow investigating the origin of the air mass present over a particular site. They are computed using the 'Hybrid Single Particle Lagrangian Integrated Trajectory' (HYSPLIT) model, developed by NOAA - Air Resources Laboratory (ARL). The product presented is a 60-hour back trajectory ending at 12 UTC at 400 m above each station. It is based on the most recent integration of the NCEP Global Forecast System.

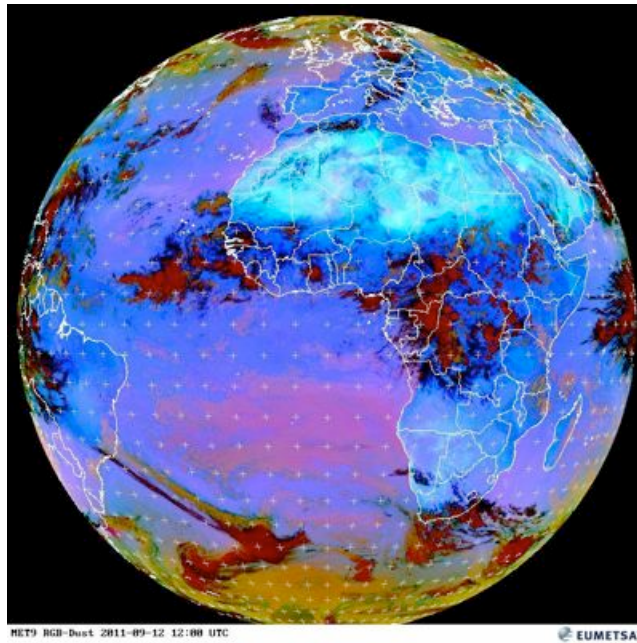
Indirect information in real time, even qualitative, can be found in the reports issued by aerodromes and synoptic weather stations. A 'Google Maps'-based tool has been developed to display visibility and present weather from METAR aviation weather reports. It provides real-time information from a large number of airfields in Southern Europe, Northern Africa and Middle East.



Visibility and present weather from METAR reports

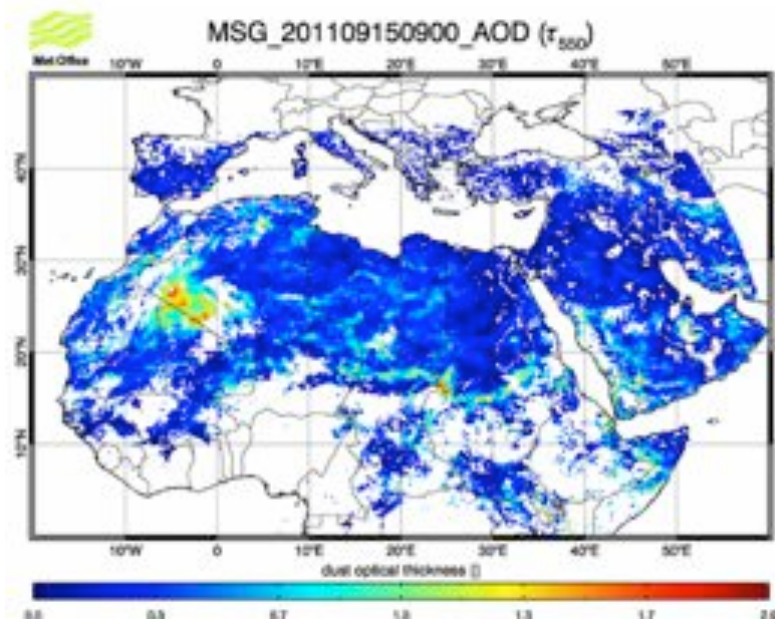
The AERONET (AERosol RObotic NETwork) program is a federation of networks for ground-based remote sensing of aerosol led by NASA and the French consortium PHOTONS. It provides public access to a database with optical, microphysical and radiative properties of atmospheric aerosol, retrieved from sun photometer measurements.

The EUMETSAT RGB-dust product consists of a combination of three different infrared channels of the SEVIRI radiometer travelling onboard the Meteorat Second Generation satellites. It is designed to follow day and night the evolution of the dust plumes both over land and ocean. It makes use of the different emissivity of the atmospheric dust and the desert surface. Daytime, it also exploits the temperature difference between the hot desert surface and the colder dust cloud. Dust appears with a pinkish or magenta color whereas the dry land surface (desert) presents a light bluish color daytime and light greenish at night. The portal presents hourly images and 24-hour animations. rior consulta.



EUMETSAT RGB-dust product

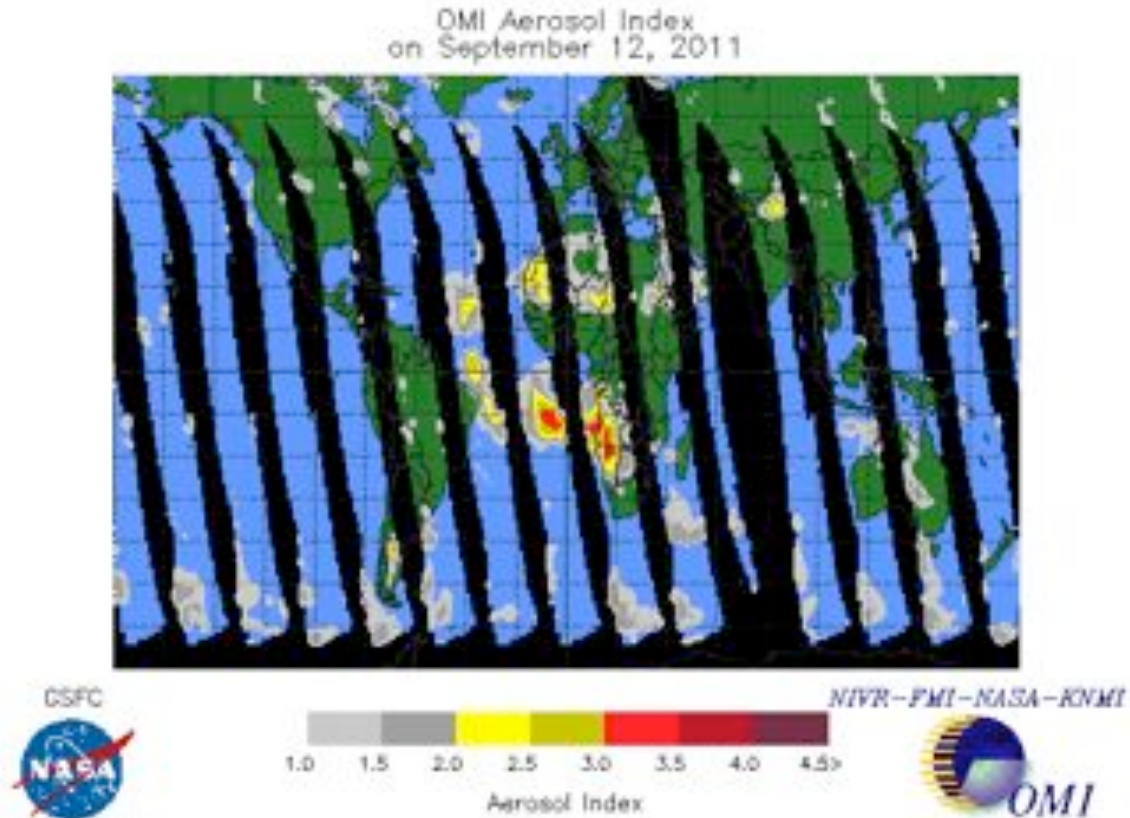
The U.K. Met Office produces a quantitative retrieval of dust AOD over land from SEVIRI. It is based on empirical relationships between the radiance measured by the SEVIRI infrared channels and the dust AOD at 550 nm.



U. K. Met Office dust product

The OMI instrument onboard of Aura platform can distinguish between aerosol types, such as smoke, dust, and sulphates. The OMI aerosol index is a measure of how much the wavelength dependence of backscattered UV radiation from an atmosphere

containing aerosols (Mie scattering, Rayleigh scattering, and absorption) differs from that of a pure molecular atmosphere (pure Rayleigh scattering). The aerosol index map, available with a two-day delay, is daily downloaded.



OMI aerosol index

PARASOL is a French-built Earth observing research satellite. PARASOL stands for "Polarization and Anisotropy of Reflectances for Atmospheric Sciences coupled with Observations from a Lidar". It carries a wide-field imaging radiometer/polarimeter called POLDER that is designed to improve our knowledge of the radiative and microphysical properties of clouds and aerosols by measuring the directionality and polarization of light reflected by the Earth-atmosphere system. The products available at ICARE are daily posted on the R. C. web portal.

Most products are archived. A system to access historical information has been implemented. Archived products currently available online are:

- In-situ measurements from air-quality monitoring stations. Monthly plots of PM10 and PM2.5 are available since June 2011 at <http://sds-was.aemet.es/forecast-products/dust-observations/in-situ-measurements>
- Back-trajectories are also available for most stations since June 2011: <http://sds-was.aemet.es/forecast-products/dust-observations/in-situ-measurements>
- EUMETSAT RGB-Dust product. Hourly images and 24-hour animations since August 2010 are available at <http://sds-was.aemet.es/forecast-products/dust-observations/msg-2013-eumetsat>

- U. K. Met Office product of dust concentration based on SEVIRI. Hourly images and 24-hour animations are available since August 2010: <http://sds-was.aemet.es/forecast-products/dust-observations/msg-2013-u.k.-met-office>

A Newsletter service has been created to periodically distribute information on ongoing actions in the framework of the WMO SDS-WAS programme. Four mailing lists have been created:

- Steering Group.
- Partners
- Students
- Public newsletter

Joint visualization and evaluation of dust model outputs

The exchange of forecast model products is recognized as a core part of the Implementation Plan of the WMO SDS-WAS programme and as a basis for the joint near real-time evaluation activities.

The area of interest is 30°W to 70°E in longitude and 0° to 70°N in latitude (see map below). It is called “Reference Area” (RA). This is intended to cover the main source areas for North Africa, Europe and Middle East and the whole region, as well as the main transport routes and deposition zones from the equator to the Scandinavian Peninsula. The action will consider forecasts of up to 72h with a 3-hour frequency.

The displayed variables are:

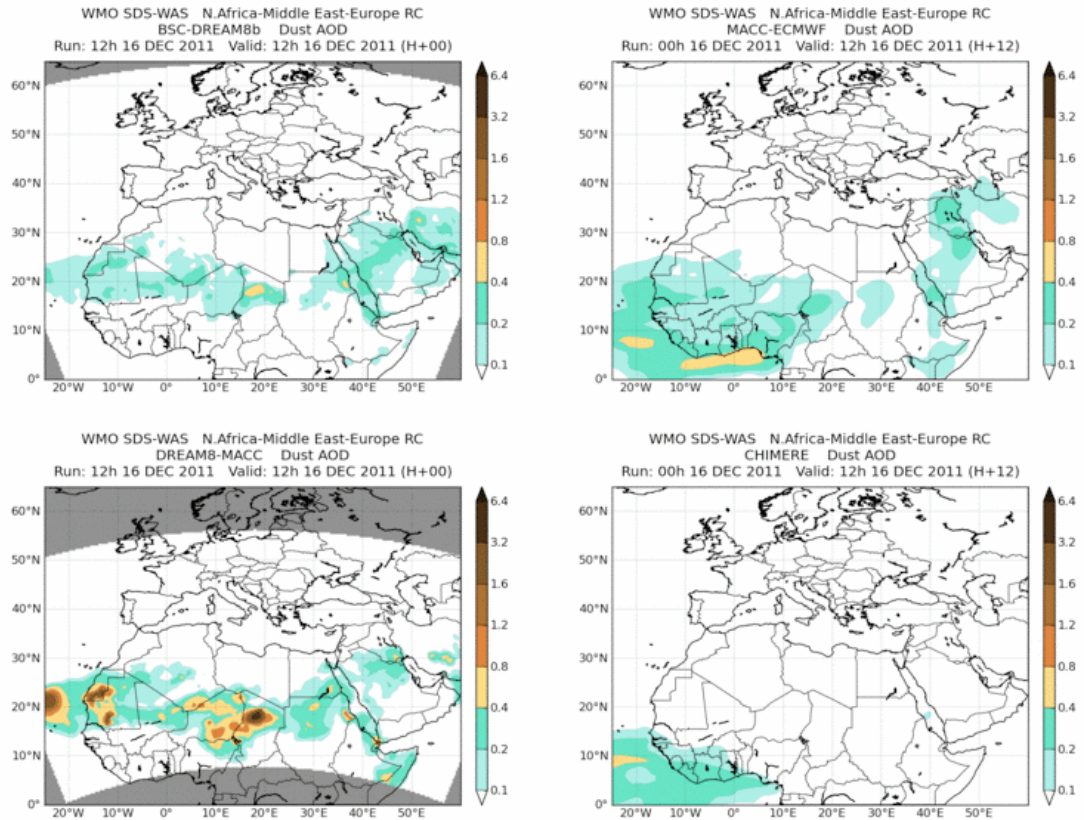
- Dust concentration at surface (SCONC_DUST)
- Dust optical depth at 550 nm (AOD550_DUST)

The format for data exchange is NetCDF, which allows compression of data fields while preserving characteristics of the numerical values like those of aerosol distribution that have a very large dynamical range.

There are currently 5 models participating in the exercise:

- BSC-DREAM8b (regional), run by the BSC-CNS
- MACC (global), run by the ECMWF
- LMDzT-INCA (global), run by the LSCE
- DREAM8-MACC (regional), run by the SEEVCCC
- CHIMERE (regional), run by the LMD

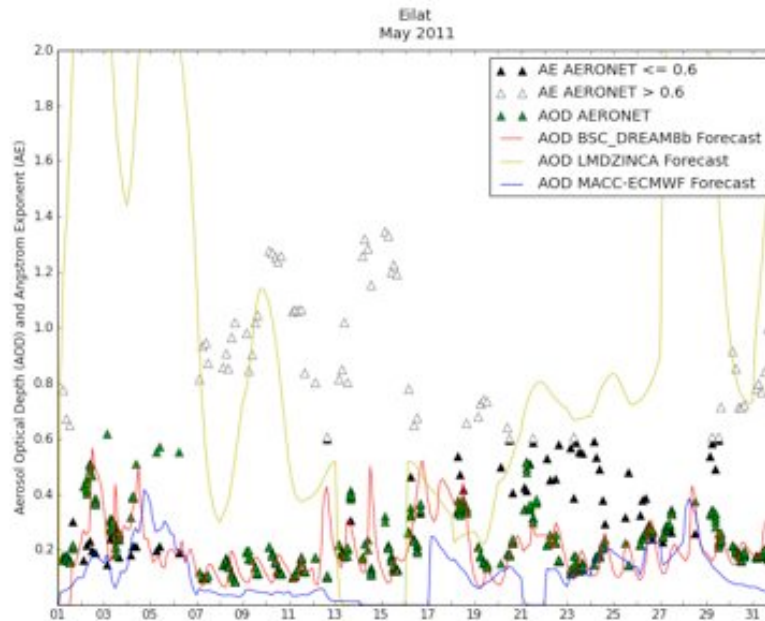
Model outputs are represented using a common color palette. This palette is built by combining brownish and greenish colors. The brownish tones highlight the areas with high contents of mineral dust whereas the greenish tones allow emphasizing the thresholds set by European Union directives on air quality.



Dust AOD forecast by different models for 12 UTC 16 December 2011.

The product is archived and historical plots are available online at: <http://sds-was.aemet.es/forecast-products/compared-dust-forecasts>

A common evaluation system has been implemented in order to have information about the quality of the different forecasts. Predictions of dust optical depth at 550 nm issued by the models are compared with measurements of aerosol optical thickness from a set of AERONET stations that often present high concentrations of dust. Monthly plots are generated and automatically archived: <http://sds-was.aemet.es/forecast-products/forecast-evaluation>



Dust AOD forecast by different models compared with aerosol AOD

The AERONET network measures the overall aerosol concentration. The Ångström exponent (α) is included in the graphs in order to discriminate the contribution of mineral dust. The exponent usually presents lower values for mineral dust than for other types of aerosol.

Data with quality level 1.5, that is, after removing observations with cloudy sky, are used.

Coordination of capacity building activities

The Regional Center coordinates with partners and National Meteorological and Hydrological Services (NMHS) in the region different actions aimed to strengthen the capacity of countries to use the observational and forecast products distributed in the framework of the WMO SDS-WAS programme.

In 2010, the Regional Center organized two training courses and a technical seminar:

- Training Week on Satellite Meteorology, held in Barcelona, Spain, 7-12 November 2010. It was jointly organized and financed by the Spanish State Meteorological Agency (AEMET), the Barcelona Supercomputing Center (BSC-CNS), EUMETSAT and the World Meteorological Organization (WMO). Although it was not a specific course on mineral dust, there were several lectures on satellite detection of dust. 14 representatives of African NMHS (Morocco, Algeria, Mali, Mauritania, Burkina Faso, Niger, Senegal, Guinea, Guinea Bissau, Ivory Coast, Benin, Cape Verde, Liberia and Ghana) and a representative of

ACMAD participated in the course. There was a technical visit to the AEMET Center in Barcelona



Participants in the Training Week on Satellite Meteorology

- Training Week on WMO SDS-WAS Products, held in Barcelona, Spain, 15-19 November 2010. It was also jointly organized and financed by AEMET, BSC-CNS, EUMETSAT and the WMO. 14 representatives of African and Middle-Eastern NMHS (Morocco, Algeria, Mali, Mauritania, Burkina Faso, Niger, Nigeria, Iran, Iraq, Saudi Arabia, Oman and Turkey), a representative of ACMAD and a researcher from the University of Milano participated in the course. In addition to lectures and practical sessions, there were technical visits to an EARLINET lidar, an AERONET station, an air-quality monitoring station and to the MareNostrum supercomputer.



Participants in the Training Week on WMO SDS-WAS Products

- Lectures on Atmospheric Mineral Dust and its Impact on Human Health, Environment and Economy was a technical seminar organized by the Regional Center and jointly financed by AEMET, BSC-CNS, EUMETSAT and the WMO. It was held in Barcelona on 13 November 2011. The lecturers were Dr. Leonard Barrie (WMO), Dr. José Prieto (EUMETSAT), Dr. Emilio Cuevas (AEMET), Dr. Michael Schulz (Norwegian Met. Institute, chair of the WMO SDS-WAS Regional Steering Group for Northern Africa, Middle East and Europe), Dr. José M. Baldasano (BSC-CNS), Dr. Benjamin Lamptey (Regional Maritime University, Accra, Ghana) and Dr. Xavier Querol (Spanish Scientific Research Council).



Opening of 'Lectures on Atmospheric Mineral Dust and its Impact on Human Health, Environment and Economy'

In 2011, the Regional Center has participated in two training courses. In addition, it has coordinated the '2nd. Training Course on WMO SDS-WAS Products'

- Meteorological Services, Sand and Dust Storm (SDS), Forecasting and Early Warning System. The course was held in Istanbul, Turkey, 22-26 February. It was organized and funded by the Turkish State Meteorological Service. The course was conducted in English, Turkish and Arabic, with simultaneous translation. It run in parallel with another course entitled 'Erosion preventing Techniques and Controlling Methods and Forestry', with several common lectures. There was participation from several Middle-Eastern countries: Turkey, Iraq, Iran, Syria, Lebanon, Jordan and Saudi Arabia.



Participants in the training course on Meteorological Services, Sand and Dust Storm (SDS), Forecasting and Early Warning System

- 2ND. Training course on WMO SDS-WAS (satellite and ground observation and modelling of atmospheric dust). The course was held in Antalya, Turkey, 21-25 November. It was organized and funded by the Turkish State Meteorological Service, EUMETSAT and the WMO with collaboration of AEMET and BSC-CNS and coordinated by the R. C. There were 23 participants from 16 different countries: Saudi Arabia, Algeria, Burkina Faso, Cape Verde, Chad, Egypt, Ethiopia, Iraq, Jordan, Kuwait, Morocco, Senegal, Sudan, Tunisia, Turkey, and Yemen.



Participants in the 2nd Training Course on WMO SDS-WAS

Participation in WMO meetings

The R. C. has participated in the side event of the XVI WMO Congress entitled 'Sand and Dust Research', held in Geneva, Switzerland, on 25 May 2011. The event was organized to present the SDS-WAS to the different NMHSs and to show the undertaken efforts aimed to better understand and predict the release, transport and deposition of mineral dust. The program was:

- Nickovic, S.: Sand and Dust Storm Research. Global Overview.
- Zhang, X., S.-U. Park y Y. Chun: Review of SDS Activities in Asia
- Terradellas, E., J. M. Baldasano y E. Cuevas: WMO SDS-WAS programme. Regional Center for Northern Africa, Middle East and Europe

The R. C. has also participated in the meeting of the Regional Steering Group held in Antalya, Turkey, 25-26 November 2011. The most relevant actions carried out both by the R. C. and by the different partners since the last RSG meeting were reviewed and the agenda for coming years was updated.



Meeting of the Regional Steering Group

Partners of the Regional Node

The WMO SDS-WAS program is structured as a federation of partners. The term federation implies an organization with a minimum of general rules of operation. This approach allows the presence of a wide range of participants (research and operational institutions, weather services, etc.) that can cooperate and mutually benefit without changes in its structure.

The institutions that actively participate in the program are the following:

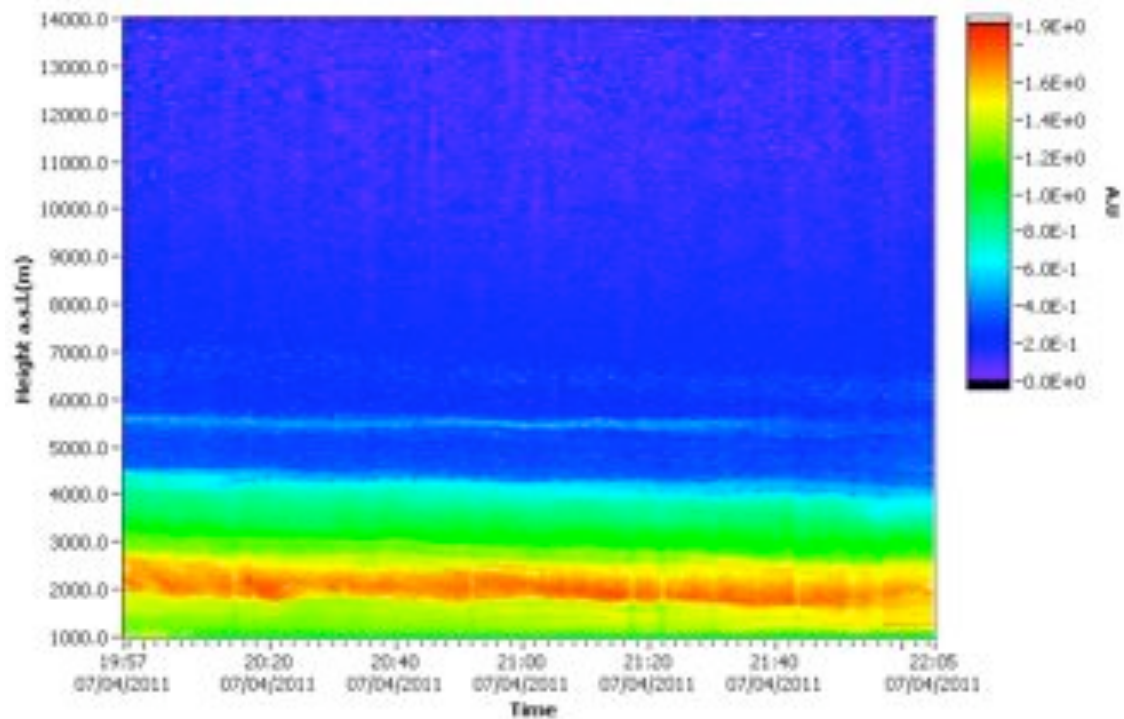
- AFRICAN CENTER FOR METEOROLOGICAL APPLICATIONS TO DEVELOPMENT (ACMAD). The Regional Center regularly supplies 10-day averages of dust surface concentration and total dust load from model

simulations. The maps are published by ACMAD in its 'Climate and Health' bulletins.



'Climate and Health Bulletin' issued by ACMAD.

- AGENCIA ESTATAL DE METEOROLOGÍA (AEMET). AEMET is one of the host institutions of the Regional Center. It provides observational data from Spanish EMEP and AERONET stations and has had active participation in the SDS-WAS capacity building activities.
- BARCELONA SUPERCOMPUTING CENTER – NATIONAL SUPERCOMPUTING CENTER (BSC-CNS). The BSC-CNS is one of the host institutions of the Regional Center. It provides dust forecasts of the BSC-DREAM8b model. It supports with its servers the activities of the R. C. and provides developments, which are used in the generation of SDS-WAS products. It participates in capacity building activities.
- DIRECTION DE LA MÉTÉOROLOGIE NATIONALE DU MAROC (DMN). Following the agreement reached, the DMN will provide the CR with data from the air quality monitoring stations of Essaouira and Agadir.
- EUMETSAT. It provides the RGB dust product, one of the most widely used for dust monitoring. There is important cooperation on capacity building: EUMETSAT has been one of the institutions organizing and funding training activities on mineral dust.
- EUROPEAN AEROSOL RESEARCH LIDAR NETWORK (EARLINET). EARLINET does not generate operational products. However, it has facilitated access to their observations for the study of particular events.



Dust cloud observed by the lidar station at the Granada University on 7 April 2011.

- EUROPEAN CENTER FOR MEDIUM RANGE WEATHER FORECAST (ECMWF). The R. C. has participated in the MACC project. Designated products were posted at <http://sds-was.aemet.es/projects-research/macc-project>. The R. C. will also participate in the MACC-II Project. On the other hand, the ECMWF provides dust forecasts of the MACC model.
- EUROPEAN ENVIRONMENT AGENCY (EEA). The EEA supplies data on concentration of particulate matter (PM₁₀ and PM_{2.5}) from several European rural background stations.
- EUROPEAN SPACE AGENCY (ESA). On 8-9 September 2009, the ESA, in cooperation with the WMO, organized a consultation meeting on mineral dust in Barcelona. The ESA reported a future call for funding of projects related to mineral dust observation worth € 1 million.
- GENERALITAT DE CATALUNYA. It provides PM values from the air-quality monitoring station of Bellver de Cerdanya.
- CANARY ISLANDS GOVERNMENT. It provides PM values from the air-quality monitoring stations of Granadilla and Costa Teguisse.
- ICARE. ICARE provides products derived from PARASOL satellite images.
- ISTANBUL TECHNICAL UNIVERSITY (ITU). The ITU has collaborated in the field of capacity building, providing lecturers for training courses.

- LABORATOIRE DE METEOROLOGIE DYNAMIQUE (LMD) - ECOLE POLYTECHNIQUE. The LMD provides dust forecasts from the CHIMERE model that are used in the joint visualization and in the model evaluation.
- LABORATOIRE DES SCIENCES DU CLIMAT ET DE L'ENVIRONNEMENT (LSCE). The LSCE provides dust forecasts from the INCA-LMDzT model that are used in the joint visualization and in the model evaluation.
- MALTA ENVIRONMENT AND PLANNING AUTHORITY (MEPA). The MEPA provides PM data from the rural background of Gharb, in the island of Gozo.
- SOUTH EAST EUROPEAN VIRTUAL CLIMATE CHANGE CENTER (SEEVCCC). The SEEVCCC provides dust forecasts of the DREAM8-MACC model and participates in capacity building activities
- SPANISH NATIONAL RESEARCH COUNCIL (CSIC). The CSIC has been active in the field of capacity building, providing lecturers for training courses.
- TECHNICAL UNIVERSITY OF CATALONIA (UPC). The UPC provides data from different ground remote-sensing systems: an AERONET station, a Raman lidar and a micro-pulse lidar.



Sun photometer managed by the UPC integrated in the AERONET network

- TURKISH STATE METEOROLOGICAL SERVICE (TSMS). In 2011, the TSMS has organized two training courses on mineral dust. The R. C. participated in both and coordinated the '2nd. Training Course on WMO SDS-WAS'.
- U. K. MET OFFICE (UKMO). The UKMO provides quantitative satellite retrievals of dust AOD from SEVIRI. It started providing dust forecasts to be posted on the R. C. web portal.
- UNIVERSITY OF LEEDS. It has provided lecturers for training courses.

- MALTA ENVIRONMENT AND PLANNING AUTHORITY (MEPA). The MEPA provides PM data from the rural background of Gharb, in the island of Gozo.
- NOAA AIR RESOURCES LABORATORY (ARL). The ARL has authorized and facilitated the use of the HYSPLIT model to compute backtrajectories. This product allows better interpretation of PM data from air-quality monitoring networks.

ANNEX 3

Dust forecast model intercomparison: Case study of the Dust Cloud of April 2011

Proposal for a joint study in the framework of the SDS-NAMEE node

Nicolas Huneus, Michael Schulz October 2011

Contact: Nicolas Huneus - nicolas.huneus@lsce.ipsl.fr

Motivation

Mineral aerosols play an important role not only in the climate system but also for regional air quality in different parts of the globe (Kim et al., 2001; Ozer et al., 2007; Jimenez-Guerrero et al., 2008). To improve the capabilities to forecast sand and dust storms the World Meteorological Organization (WMO) created the Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). A specific task in this framework concerns the evaluation of dust forecast models with observations. Such evaluation can be done on several time scales. Within the SDS-WAS node on Northern Africa-Middle East-Europe (NAMEE) several attempts are underway to perform model evaluation and intercomparison between different models contributing to the SDS activities.

As a contribution to the activities of the SDS-WAS NAMEE node we intend to complement its effort by conducting a case study where different dust forecast models are compared against observations for a given dust event, which occurred in April 2011. We are interested in exploring the differences between the models to simulate different datasets and identify whether this is due to vertical profile, optics, size distribution, removal fluxes, wind fields or other model characteristics or processes. Studying a specific dust event allows to also investigate on higher time frequency of a few hours the capacity of the models to predict the approach of a dust event.

The ability of models to reproduce the onset and durations but not the magnitude of a given dust events has already been documented by Uno et al. (2006). The authors in this paper compared multiple regional dust models over Asia in connection to specific dust events and among the results are that even though the models were able to reproduce surface measurements, large differences existed among them in processes such as emissions, transport and deposition. Similar results were presented by Todd et al. (2008). The authors conducted an intercomparison with five regional models for a 3-day dust event over the Bodélé depression. Yet none of these studies considered forecast outputs nor did they compared the effect of increasing forecast time step in the performance to reproduce the observations associated to a given dust event.

Intercomparison

The selected dust event corresponds to the one which occurred between the 5th and 7th of April of 2011. Dust was blown out over Morocco and Algeria on the 5th of April and reached the coast of Portugal the next day. The dust cloud continued to be transported to the northeast reaching Scandinavia on April the 10th (Figure 1). Multiple AERONET stations in Spain showed an increase in aerosol optical depth (AOD) at 550 nm between the 6th and the 9th of April (Figure 2). The dust cloud was observed by multiple satellites and red rain in Northern Scandinavia could be traced back to this cloud.

As a first step, we have compared the AERONET AOD at these stations to ECMWF model output using the 24, 48 and 72 hours forecast time steps from three consecutive forecasts run by the experimental ECMWF MACC model version running in assimilation mode (Figure 2). The different forecasts reproduce the onset and duration of the event at each AERONET station. The largest bias with respect to the observations appears in days when the dust cloud passed the Aeronet sites. All forecasts have

difficulties to reproduce the magnitude during the event and the discrepancy increases for a larger forecast time step.

We will extend this analysis to AERONET stations affected by this dust event outside of Spain. Furthermore, we will also compare each forecast output to in-situ measurements of surface concentration (PM) and satellite retrieved AOD (MODIS, MISR, PARASOL) and vertical profiles of aerosol extinction (Caliop). In addition we intend to explore the application of statistical skill scores to evaluate model performance. The use of skills is widely used in the Numerical Weather Prediction (NWP) community and Regional Air quality and it might be useful to apply some of these skills to the forecast of dust events.

The evaluation of several models and eventual different model versions is crucial to better understand the reason of individual model performance for a big event like the one proposed to be studied here. Model groups who are interested to join this study are asked to consider if model data for the period of April 2011 can be made available.

Variables of interest and file convention for model data intended to contribute to the study

For the above proposed analysis we make use of the tools developed in the framework of the AeroCom project. To facilitate the intercomparison and application of the above mentioned tool, the data have to follow the AeroCom conventions. The format of the data files has to be NetCDF and each variable has to be saved in a different file. The output frequency has to be 3 hourly and except for the emission fluxes all variables have to be instantaneous with the units as indicated in parenthesis next to each variable in the list below. The emission fluxes have to be accumulated within the 3-hour period. For practical reasons we ask for the entire month of April of 2011 and the forecast has to be up to 72 hours starting each day at 00UTC. Each daily forecast shall be contained in one file.

Models which may not provide all diagnostics are kindly asked to contact Nicolas Huneeus.

The files for each variable have to be named according to the following guideline: {Model_Name}.3hourly.{Variable_Name}.{Year}.{Day}.nc

The variables of interest and variable names in parentheses are:

- 2D Total AOD@550nm (od550aer)
- 2D Dust AOD, total and fine mode (<1um) or per bin (od550dust, od550lt1dust)
- 3D aerosol and dust extinction @550nm (ec5503daer, ec5503ddust)
- Surface wind (zonal and meridional) [m/s] (uas,vas)
- 3D wind field [m/s] (uas,vas)
- 2D Surface dust concentration, total and fine mode or per bin. [g/m³] (sconcdust,sconclt1dust)
- 2D Total aerosol load [kg/m²] (loaddust)
- 3D Dust mixing ratio for all dust tracers in model [kg/kg] (mmrdust01...04) (accompanied by ascii readme file on how to recompute aerosol size)
- 2D Emission fluxes, both total and per bin/mode [kg/m²/s]
- 3D Temperature, Relative humidity and Pressure fields at surface and 500 hPa.

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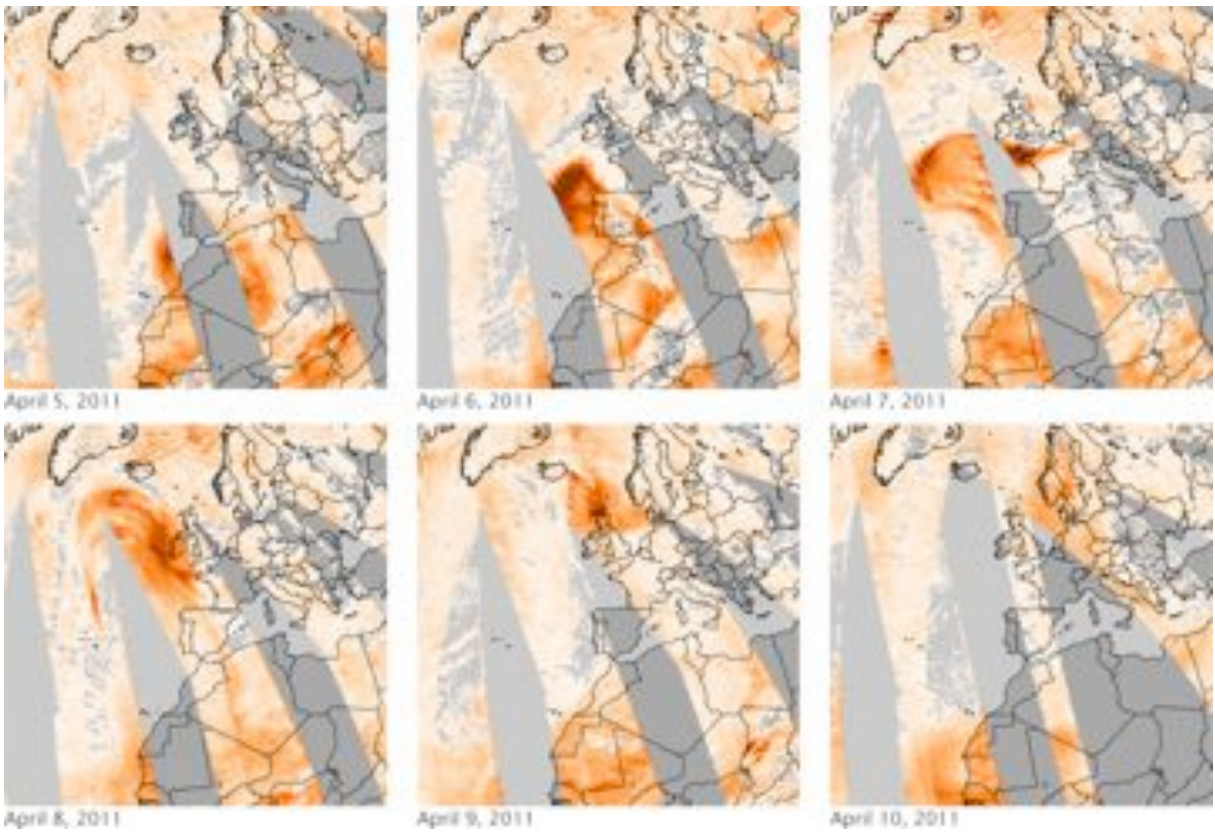


Figure 1: OMI Aerosol Index images between 5 and 10 of April 2011.

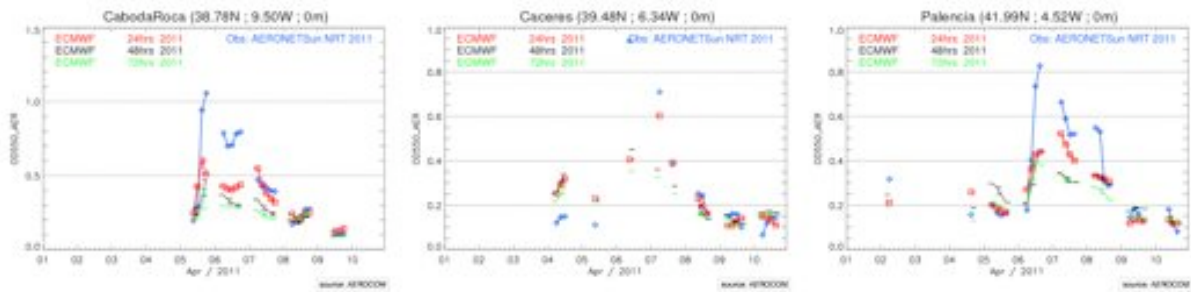


Figure 2: Aerosol optical depth (AOD) at 550 nm between the 1st and 10th of April 2011 at Spanish AERONET stations. AERONET AOD (blue) and model output at 24 (red), 48 (black) and 72 (green) hours forecast.

ANNEX 3

Photos from the meeting





