1. **Objectives**

The major objective of the Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) is to develop, refine and provide a basis for distributing the global products useful in reducing the adverse impacts of SDS and to assess impacts of the SDS process on society and environment. Specific objectives include: research projects addressed to improving dust observations and modelling; provision of near-real-time forecasts, models validation and models inter-comparison; training on use of the SDS-WAS research outcomes; participating in international multi-disciplinary research initiatives.

The SDS-WAS activities are realized through three regional nodes: North Africa-Middle East-Europe - NAMEE; Asia; Pan-America, with initiative to establish another activity node for the West Asian region. A continuing objective is to knit these nodes, and potentially others, into a seamless global system. The SDS-WAS activities were focused on performing several research studies/projects, on continuing systematic validation of quasi-operational dust model products, and on increasing capacities of interested WMO Members to better monitor, predict and reduce negative impacts from SDS.

2. **Key highlights in the last year**

*Management*

Following the 66th WMO Executive Council Resolution 13, SDS-WAS established in October 2015 the SDS-WAS Steering Committee (SC). The SC is formed to effect global research coordination of regional activities. The SC is composed of members delegated by the regional activity nodes. An SDS-WAS trust fund has been established to secure funding of the SDS-WAS activities. During the last year, WWRP published the SDS-WAS Science and Implementation plan: 2015-2020.

The EC66 acknowledged the initiative to designate another SDS-WAS regional node in Beijing, China, as a component of the RSMC-ASDF for the region consisting of Asia and the Central Pacific. SDS-WAS encourages CMA to proceed with preparations to establish the new component and the administrative guidelines for coordination across the RSMC-ASDF. The Asian Regional Science Group (RSG) recognizes that all member countries in the Asian node agree that the Beijing Asian-RC (regional centre) hosted by CMA should represent the Asian node, which would include the future RSMC-ASDF.

The Caribbean Institute for Meteorology and Hydrology in Barbados is the new host Centre for the Pan-American SDS-WAS node. The Centre is preparing staff and facilities to expand forecast operations for trans-Atlantic dust. The Pan-Am Center's focus will be dust impacts on health, following the WMO/WHO-coordinated activities for better monitoring of these impacts.

*Publications*

SDS-WAS published the paper "Airborne dust, a hazard to human health, environment and economy" in the WMO Bulletin Nov 2015 issue.


The SDS-WAS Pan-America Centre is represented on the American Meteorological Society’s Board on Environment and Health and co-authored the AMS peer-reviewed and

The following peer-reviewed publications are outcomes of two SDS-WAS studies performed during 2014-2015:


Two peer-reviewed publications from research projects led from the Pan-America Centre:


A technical SDS-WAS Report *Dust/sand storms over Libya: spatial distribution, frequency and seasonality* by Ali Salem Eddenjal was published in 2015.

"WMO/WWRP SDS-WAS Technical Report on Asian Regional Centre" has been published in March 2015, presenting in details the research and experimental near-real time monitoring (dust modelling and observations) in the region.

**Conferences and Meetings**

SDS-WAS organized, participated in and/or presented its activities at following events:

- 1st Africa/Middle-East Expert Meeting and Workshop on the Health Impact of Airborne Dust, Amman, Jordan, 2-5 November 2015 (dust impacts on health; international collaboration with WHO, UNEP)

- Kick-off meeting of the SDS-WAS Steering Committee, Amman, Jordan, 6-8 November 2015 (establishment of the Committee; next year SDS-WAS plans)


- International Cooperative for Aerosol Prediction (ICAP/AEROCAST) Meeting on Assimilation: June 16-19, 2015, Barcelona, Spain (assessing the current status of the aerosol assimilation)

- AGU 2014 Fall Meeting. Session on ‘Remote Sensing and Modeling of Dust Storms and Atmospheric Pollution’ 14-18 Dec, San Francisco

- "The fourth meeting of the WMO SDS-WAS Regional Steering Group (RSG) for Asia", Beijing, China, 10-11 March 2015.
“A Symposium Celebrating Fifty Years of Climate Research on Barbados;” Husbands, St. James, Barbados, West Indies, 16-17 October 2015
“Conference on Airborne Dust, Climate Change, and Human Health;” Miami, Florida, 19-21 May 2015

Scientific Progress

Model validation.

NAMEE Centre (BSC) continued with on-line NRT model validation of 8 models against the AERONET aerosol optical depth observations, producing daily, monthly, seasonal and annual validation scores.

The Asian SDS-WAS Centre portal started daily exchange of model and some observation data. The Asia Centre plans to establish a validation exercise in the first half of 2016. The output of model forecasts are shared within the Asian-RC and have a joint visualization and evaluation initiative. A near real time SDS observation data sharing list has been approved among KMA, JMA and CMA. The list includes PM10 data at 17 stations, Aerosol Optical Depth (AOD) data at some stations, satellite AO data and SDS weather and visibility report data.

Dust-atmosphere feedbacks

Several research groups in the SDS-WAS community are advancing parameterizations of dust-atmosphere feedback effects in their models:
- direct effects: e.g. ECMWF; CMA; BSC
- indirect CCN, ice nucleation: Serbian HyMet Service (RHMSS) and IMAA-CNR (Potenza);

COSMO consortium and Leibniz Institute for Tropospheric Research.

Dust-related data assimilation

CMA: the CUACE/Dust model uses near real-time measurements of dust aerosols (concentrations and visibility) at ground stations, vertical profiles from lidar and spatial coverage from the Chinese geostationary FY-2C satellite (Hu et al. 2008) to perform 3D-Var data assimilation system in experimental mode.

Japan Meteorological Agency (JMA): MASINGAR mk-2 global model tests a data assimilation technique (LETKF). Studies on assimilation of ground-based Asian lidar-network data are also conducted.

ECMWF: MODIS AOD data assimilation in the experimental NRT MACC system

RHMSS and National Observatory of Athens (NOA): initial encouraging experiments to assimilate MSG/SEVIRI AOD provided by the UK Met Office.

Dust-related observation issues

AEMET funds maintenance and calibration of the 4 AEMET stations in Africa. AEMET plans to put more instruments in Tamanrasset (the only real station inside Sahara), possibly a ceilometer. For the NAMEE node, GAW AOD data have limited use because there is only one GAW station (Izana) in the area of interest that can be used for the models validation.

The Secretariat confirms that the Aerosol SAG and Total deposition SAG may wish to include dust observations within GAW. A meeting of SDS-WAS and SAGs is proposed. It remains to be resolved how data may be exchanged with GAW, as, for example, KMA observations of composition (not NRT).

Other research

New ECMWF “interim” dust reanalysis from 2003-2014 (Benedetti, Flemming and Inness, unpublished)
More fundamental research. Peter Knippertz and the group at the University of Leeds: Dust emission diurnal cycle and parameterizations; COSMO-MUSCAT Leipzig modelling group (I. Tegen, B. Heinold, K. Schepanski): size-resolved distribution of Saharan dust including radiative effects and feedbacks. Dust interaction with the tropical storm Chantal; Influence of particle non-sphericity on dust deposition fluxes; the role of the nocturnal low level jet for Saharan dust production, supported by Meteosat SEVIRI dust index data.

3. Links to WGs, Projects, International initiatives

**CBS:** Part of the SDS-WAS research products having achieved sufficient maturity were transferred to the first CBS-coordinated Regional Specialized Meteorological Centre with activity specialization in Atmospheric Sand and Dust storm Forecasts (RSMC-ASDF) for Northern Africa, Middle East and Europe. RSMC-ASDF is hosted by the Barcelona Dust Forecast Center (the cooperative efforts of AEMET, the Barcelona Supercomputing Center and WMO), which provides operational dust forecasts on GTS.

**ICAP:** The International Cooperative for Aerosol Prediction (ICAP) (an international forum for aerosol forecast centers, remote sensing data providers, and lead systems developers to share best practices) and SDS-WAS collaborate on producing dust multi-model ensembles built from the following systems: ECMWF MACC, JMA MASINGAR, NASA GSFC/GMAO, FNMOC/NRL NAAPS, NOAA NGAC, BSC NMMB/BSC-CTM and Met Office UM. The NAMEE web pages show side-by-side the mean and the standard deviation of dust optical depth at 550 nm yield by multi-model systems for a common domain.

**GAW:** SDS-WAS extensively uses data from the GAW-affiliated AERONET AOD network for model validation. Another particularly important source of aerosol data is the GAW GALION network composed by EARLINET (a European research network), NDACC, ADNET in Asia and MPLNET, mainly used for model validations and case studies. The SDS-WAS SC emphasized in tir kick-off meeting (Nov 2015) need for more collaboration with GAW, especially with the Aerosol SAG and Total deposition SAG.

**Forecast Verification WG:** A SDS-WAS representative participated in the SERA WWRP/WG 2015 meeting in order to establish cooperation between the two in more sophisticated evaluation of dust predictions.

**GESAMP** (The Group of Experts on Scientific Aspects of Marine Environmental Protection): SDS-WAS has a membership in the GESAMP Atmospheric Input of Chemicals to the Ocean working group, supporting research of dust impacts on marine environment.

**WHO, UNEP, EUMETSAT:** cosponsored with WMO the 1st Africa/Middle-East Expert Meeting and Workshop on the health impact of airborne dust (Amman, Jordan, 2-5 November 2015)

3. Next year planning

SDS-WAS will follow its research priorities and adjust them as much as possible to the WWRP new Implementation Plan. The following is planned for the next year:

- Second SDS-WAS SC meeting (second half of 2016)
- Establish experimental transatlantic dust forecasts and initiate first steps in a global Dust/Health Early Warning System (Pan-America node)
- Finalize the ongoing project - the Tehran 2014 small-scale dust storm case by downscaling models to bellow 5km
- Re-submit to COST Action program the SDS-WAS proposal *European Network for Use of Information on Atmospheric Dust Monitoring and Forecasting* with the
objective to make atmospheric desert dust observations and forecasts tailored to a wide variety of users
- Include experimental prediction of ice formed due to dust-cloud interactions
- Continue with dust data assimilation research efforts with the aim to achieve future operational implementation

4. Other elements

- Membership in the Steering Committee (new body established in November 2015)
  Enric Terradellas Chair (AEMET), Slobodan Nickovic (Serbian Met Service), Angela Benedetti (ECMWF), Zhang XiaoYe (CMA), Joowan Cha (KMA), William A Sprigg (USA), David Farrell (Barbados)
- Fund raising
  SDS-WAS Trust Fund established in 2015; WMO Members have been invited to contribute

Meeting plan table

<table>
<thead>
<tr>
<th>Date</th>
<th>Meeting title</th>
<th>Venue</th>
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<tr>
<td>12-17 June 2016</td>
<td>2nd International Conference on atmospheric dust (DUST2016)</td>
<td>Castellaneta Marina, Italy</td>
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<tr>
<td>1st to 4th May 2016</td>
<td>8th International Workshop on Sand/Duststorms and Associated Dustfall</td>
<td>Lisbon, Portugal</td>
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<tr>
<td>09-11 Dec, 2015</td>
<td>International Aerosol Modeling Algorithms Conference</td>
<td>UC Davis, CA, USA</td>
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<td>14, 2015 - Dec 18, 2015</td>
<td>AGU Fall Meeting</td>
<td>San Francisco, CA, USA</td>
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<tr>
<td>March, 2016</td>
<td>The first International Conference on Dust</td>
<td>Ahvaz, Iran</td>
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<tr>
<td>Jun 20, 2016</td>
<td>24th International Conference on Modelling, Monitoring and Management of Air Pollution</td>
<td>Crete, Greece</td>
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<td>July 2016</td>
<td>ICAP annual meeting</td>
<td>Maryland, USA</td>
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<tr>
<td>Oct/Nov 2016</td>
<td>Meeting of the Asian node</td>
<td>Seoul</td>
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<tr>
<td>Jun 26, 2016</td>
<td>2016 Goldschmidt Conference</td>
<td>Yokohama, Japan</td>
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