



GLOBAL  
ATMOSPHERE  
WATCH



WEATHER CLIMATE WATER  
TEMPS CLIMAT EAU

# WMO GAW and ICAP joint research areas and collaboration

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WMO OMM

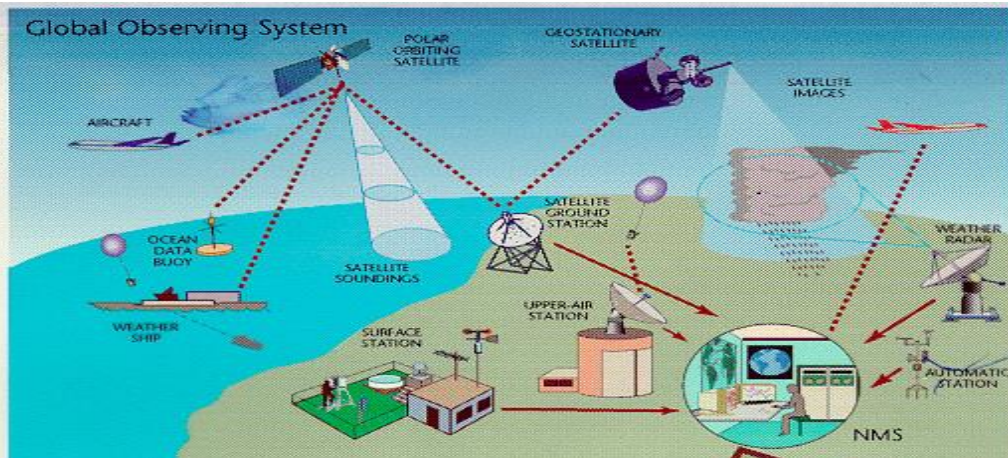
World Meteorological Organization  
Organisation météorologique mondiale

International Cooperative for Aerosol  
Prediction (ICAP)

11th working group meeting  
22 - 24 July 2019, Tsukuba City, Ibaraki,  
Japan

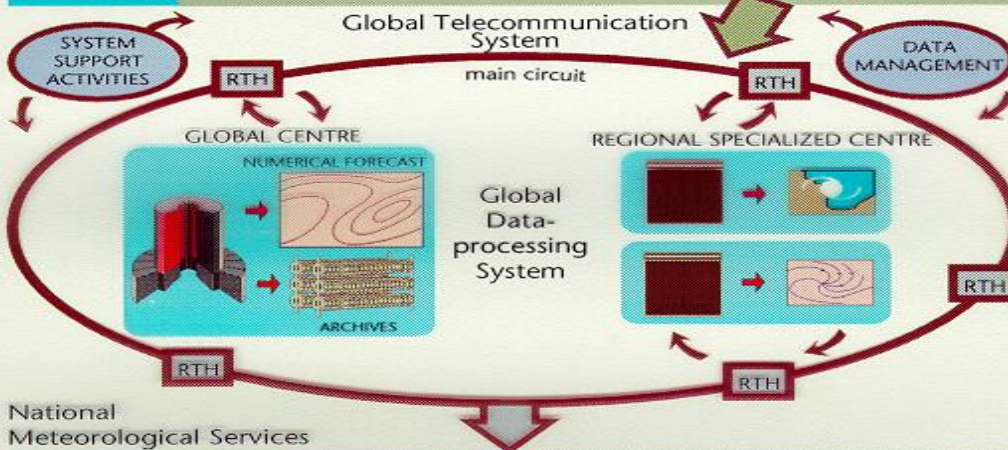
# WMO operational networks

WIGOS



193 NMHSs: satellites, land, ships, buoys, and aircraft contribute to Global Observing every day (incl. GAW)

WIS



Global Telecom with Regional Hubs – becoming the WMO Information System

GDPFS



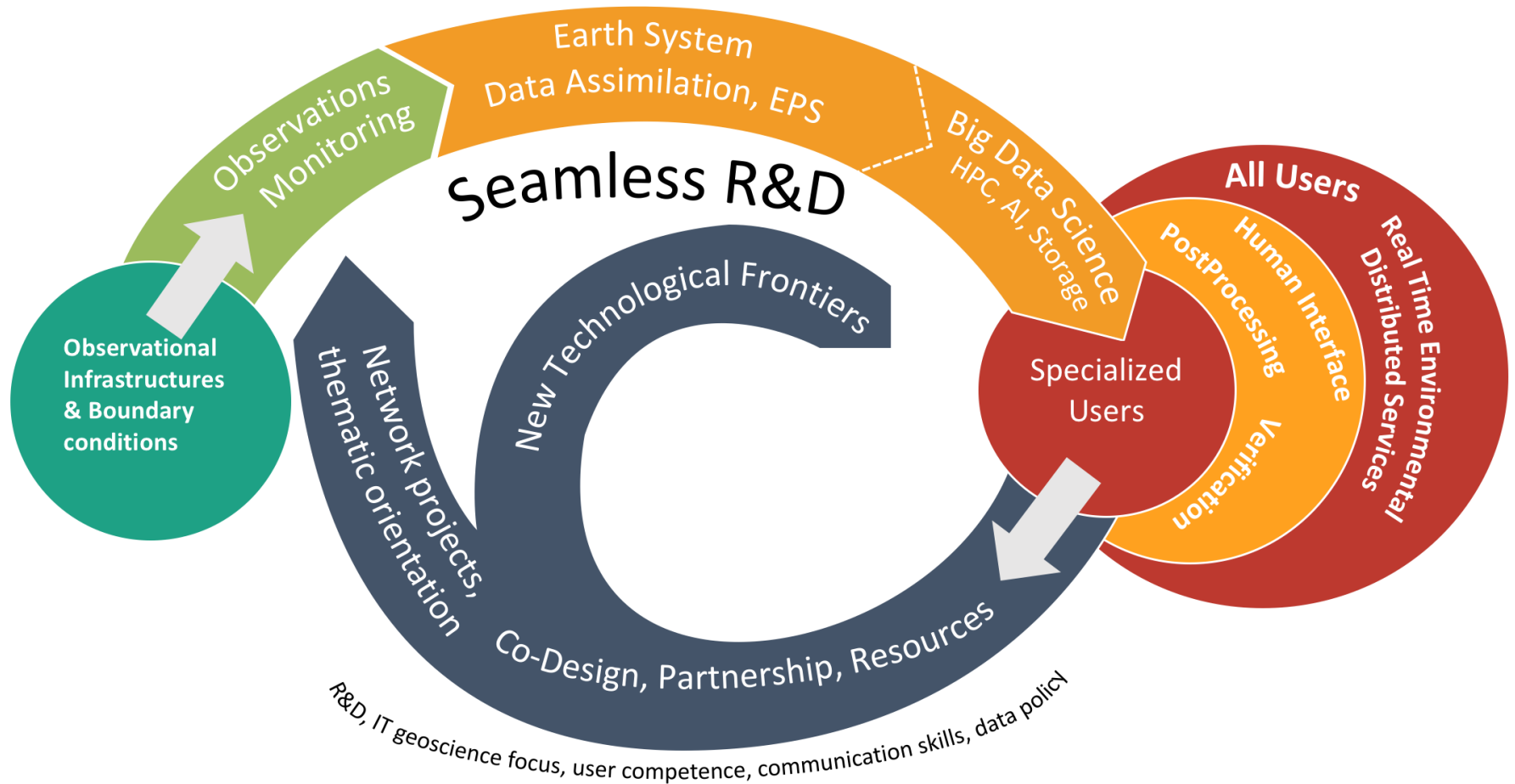
**Global Data-Processing & Forecasting System (GDPFS):** Global, Regional Specialized Met. Centres (RSMC, RCC), and National Centres

Service delivery

NMHSs deliver analyses, forecast and early warning services

# SEAMLESS SCIENCE FOR SERVICES JOURNEY

- Quality, Relevance and Impact:
- User Interactions forces exploration of “What works”
- Seamless Earth system modelling across weather, water, environment, ocean, climate; interoperable observation systems of ES components



# WMO Commission for Atmospheric Science (CAS)

## AEROSOLS - One of six CAS PRIORITIES

### **Aerosols: Impacts on air quality, weather and climate**

– The monitoring and modelling of aerosols is a significant challenge – many stations needed to measure a wide variety of variables.

CAS stressed the need to plan for an **integrated global aerosols observation system**.



**GAW**



WMO OMM

# Global Atmosphere Watch (GAW) Programme



**GAW@30**

Provides international leadership in research and capacity development in atmospheric composition observations and analysis through:

- *maintaining and applying long-term systematic observations of the chemical composition and related physical characteristics of the atmosphere,*
- *emphasizing quality assurance and quality control,*
- *delivering integrated products and services related to atmospheric composition of relevance to society.*

GAW builds on partnerships involving contributors from **100** countries (*including many contributions from research community*)

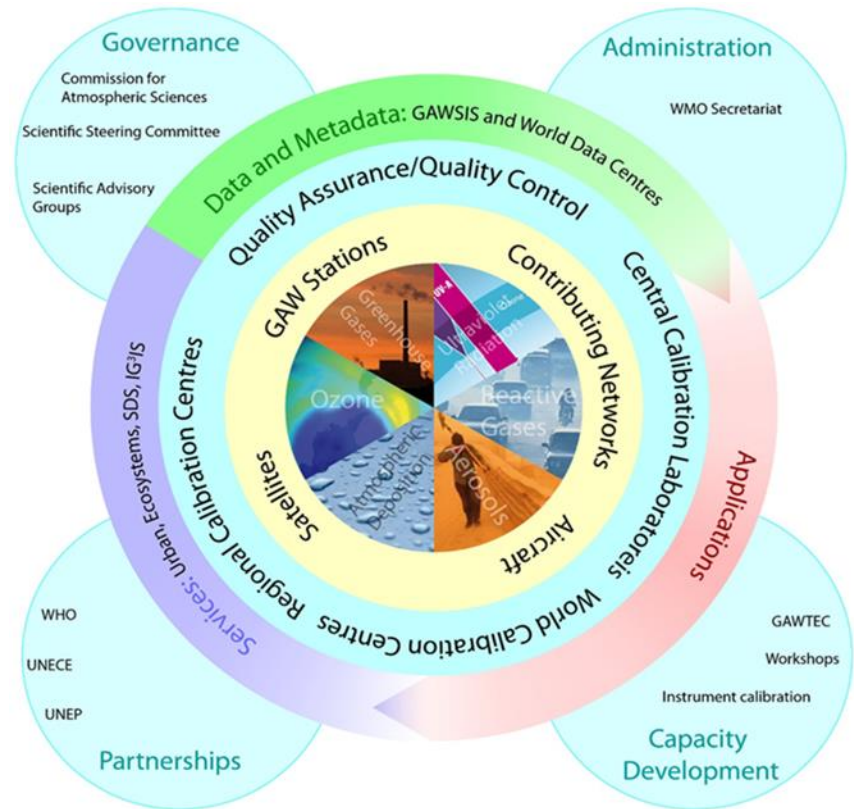


GAW division chief O. Tarasova



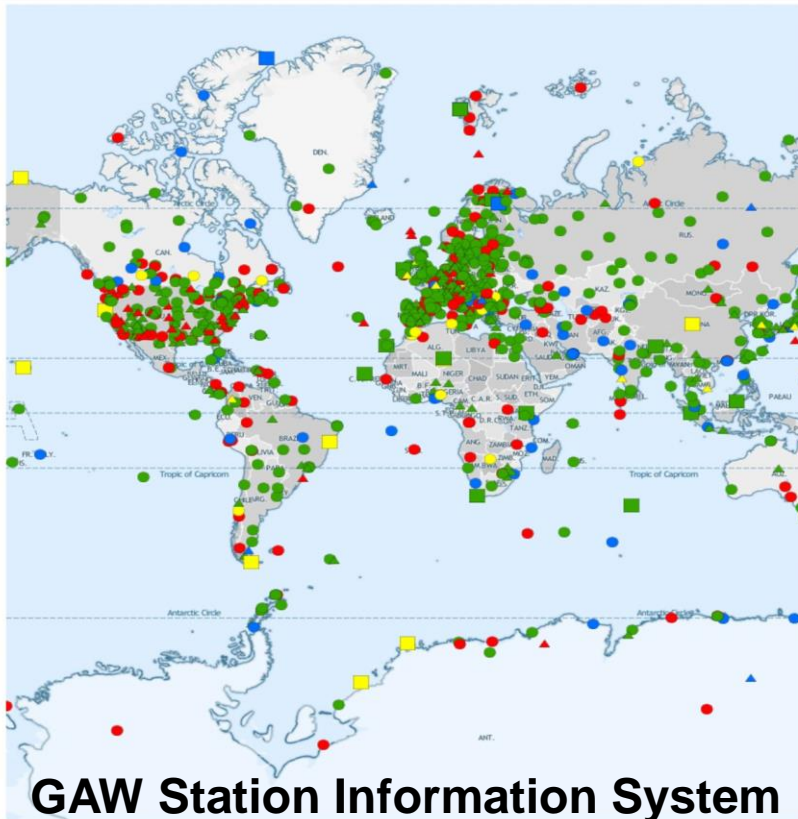
# Elements integrated in GAW

- Observations
- Quality assurance
- Data management
- Modeling and analysis
- Joint research
- Capacity building
- Outreach and communications



*Promote a “value chain” from observations to services*

# GAW observational network



**GAW Station Information System (GAWSIS)**



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra  
  
Federal Department of Home Affairs FDHA  
Federal Office of Meteorology and Climatology MeteoSwiss

Global	■	Reporting	●
Regional	■	Partly Reporting	●
Contributing	■	Non-reporting	●
Local	■	Closed	●
	▲	Planned	●
	★	Pre-operational	●

**GAW has >800 stations in >100 countries and works with >100 variables!**



**WMO OMM**

GAW observational network comprises:

- Global stations (31)
- Regional stations
- Local stations
- Mobile platform
- Contributing networks (10)
- GAW Lidar Observation Network (GALION)

**5 contributing networks joined GAW:**

MPLNET, AD-NET, LALINET, CASTNET, and aircraft-based network (IAGOS) during inter-sessional period.

Expanding the connections and capabilities in satellite based atmospheric composition observations (RRR process, WIGOS, SCOPE-Nowcasting, VASAG/VAAC) GAW/GCOS Task Team on Atmospheric Composition Observational Requirements – Chair R. Eckman (NASA)

# GAW – enhancing modeling



GAW

The broad “atmospheric chemistry” application area was substituted with more specific application areas:

- “atmospheric composition forecasting”,
- “atmospheric composition analysis and monitoring”
- “urban services”.



Expand GAW’s role in enhancing **predictive capabilities** (atmospheric composition and its uses)

- ☑ urban air quality forecasting (AQF) capabilities through GURME,
- ☑ Modelling Applications SAG (“Apps”) – usefulness exchanging chemical observational data in NRT and AQF
- ☑ expanding collaborations with WWRP/WCRP/WGNE and others



WMO OMM



# GAW SAG-APPs Work Streams

## (1) Assessments (Dentener, Hegglin)

- Health, Climate Change, Ecosystems

## (2) Improving emissions (Sofiev, Zhou)

- Up-to-Date, Weather-dependent, Inverse

## (3) Further developments of NRT systems (Hort, Peuch)

- Ensembles, enable set-up applications worldwide

## (4) Data aspects (Da Silva, Tanaka)

- Identify gaps (limb sounding...), common skill scores, Use of WIS

## (5) Developing scientific activities (Makar, Grell)

- interactive chemistry/radiation for improving NWP forecasts (up to seasonal), identify gaps in knowledge

## (6) Outreach

- Summer schools, webinars, “Year of Air Quality” initiative?



Co-chairs: F. Dentener (JRC) & V.-H. Peuch (CAMS)

# Applications in GAW to supports Members



**Observations and reanalysis:** direct support of conventions (LRTAP, Montreal Protocol)

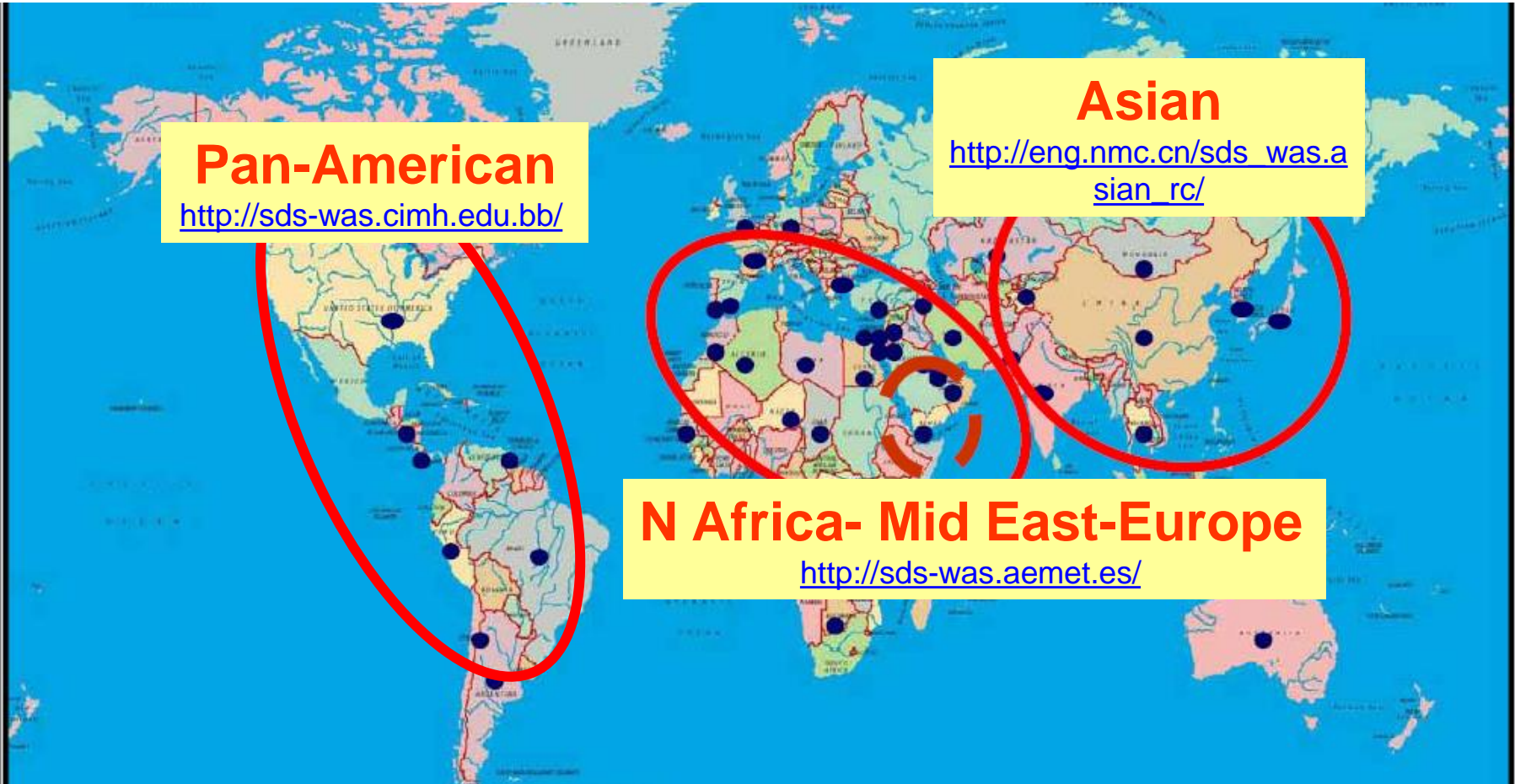
## **Specific service oriented applications:**

- *Support of climate negotiations:* IG<sup>3</sup>IS
- *Ecosystem services:* Analysis of total deposition, nitrogen cycle, deposition to the oceans/marine geoengineering
- *Health:* Regional (MAP-AQ) and Urban air quality (GURME)
- *Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)*
- *Vegetation Fire and Smoke Pollution Warning and Advisory System (VFSP-WAS)*
- *Food security:* Atmospheric composition and agriculture
- *Transport security:* Volcanic ash forecasting
- *Weather forecasting:* aerosol effects on NWP, high impact weather



# Sand & Dust Storm Warning Advisory & Assessment System (SDS-WAS)

- 3 Regional Nodes, 15 organizations providing forecast
- WMO WWRP/GAW Global Coordination: Steering Committee and Trust Fund
- Regional coordination through regional activity nodes
- SDS-WAS Science & Implementation Plan

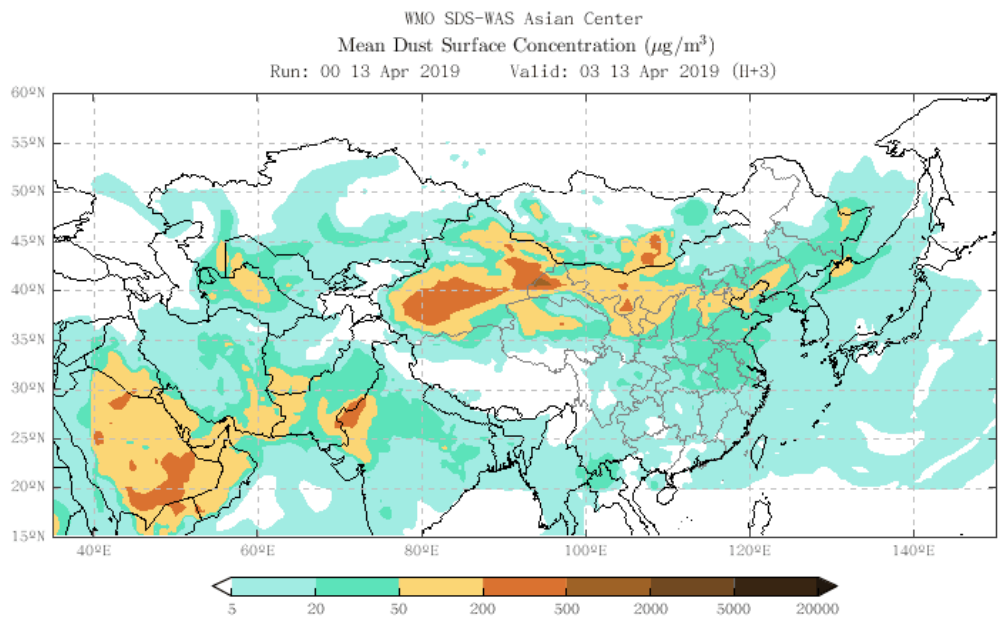
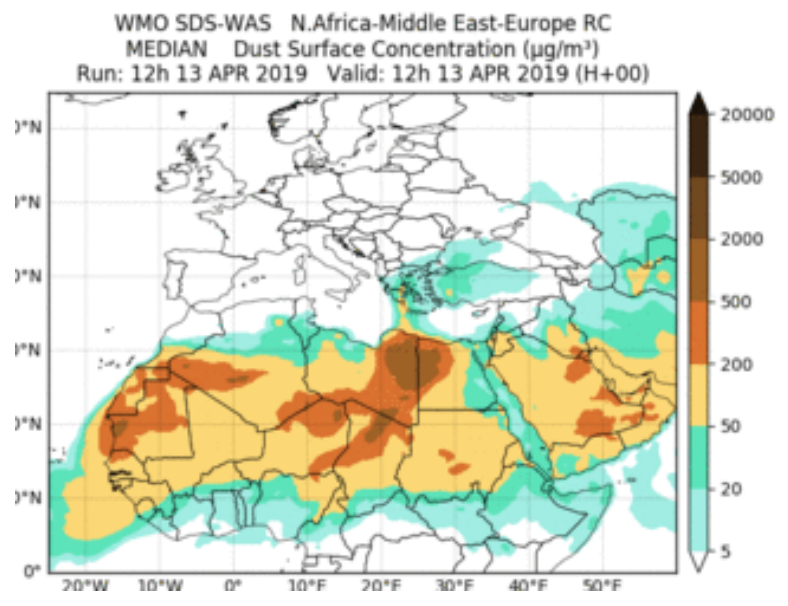


**Pan-American**  
<http://sds-was.cimh.edu.bb/>

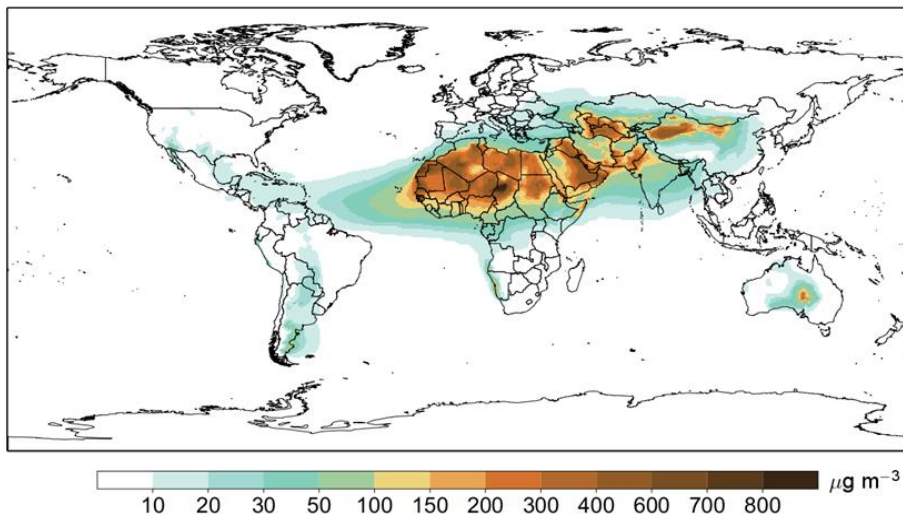
**Asian**  
[http://eng.nmc.cn/sds\\_was.asian\\_rc/](http://eng.nmc.cn/sds_was.asian_rc/)

**N Africa- Mid East-Europe**  
<http://sds-was.aemet.es/>

# 72 hours SDS Forecasting by SDS-WAS Regional Centers

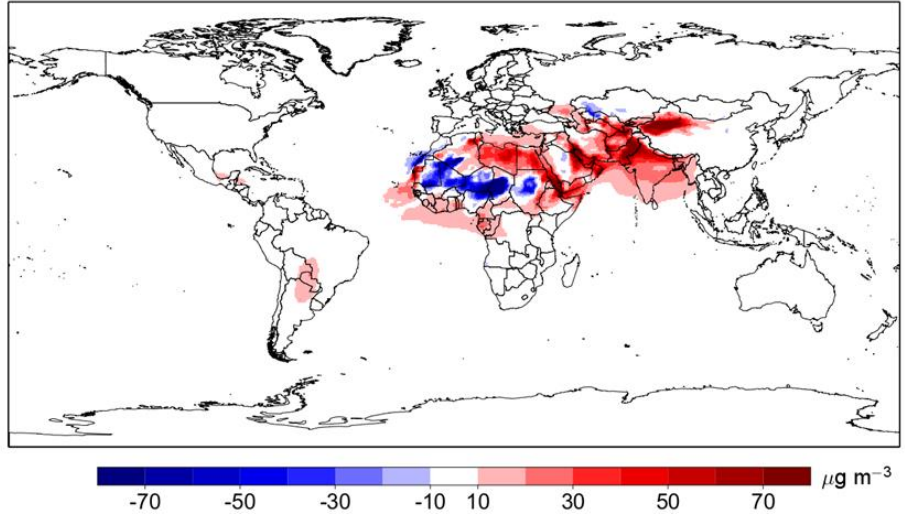


## Multi-year SDS Assessments and Long-term Trends



Annual mean surface concentration of mineral dust in 2018.

WMO Dust Bulletin, #3, 2019



Anomaly of the annual mean surface concentration of dust in 2018 relative to mean of 1981-2010

# Numerical models contributing to WMO SDS-WAS

Model	Institution	Domain
BSC-DREAM8b_v2	Barcelona Supercomputing Center, Spain	Regional
CAMS	European center for Medium-Range Weather Forecast, U. K.	Global
DREAM-NMME-MACC	South east European Climate Change Center, Serbia	Regional
NMMB/BSC-Dust	Barcelona Supercomputing Center, Spain	Regional
MetUM	Met Office, U. K.	Global
GEOS-5	National Aeronautics and space Administration, U. S.	Global
NGAC	National Centers for Environmental Prediction, U. S.	Global
EMA REG CM4	Egyptian Meteorological Authority, Egypt	Regional
DREAMABOL	National Research Council, Italy	Regional
WRF-CHEM	National Observatory of Athens, Greece	Regional
SILAM	Finnish Meteorological Institute, Finland	Regional
CUACE/Dust	China Meteorological administration, China	Regional
MASINGAR	Japan Meteorological Agency, Japan	Global
ADAM	Korea Meteorological Administration, Korea	Regional

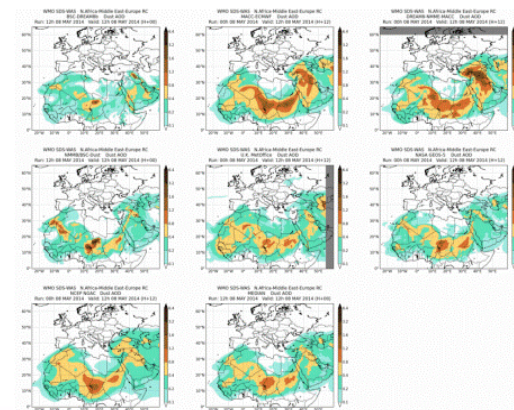
**7 global models**

**11 regional models**

**15 organizations**

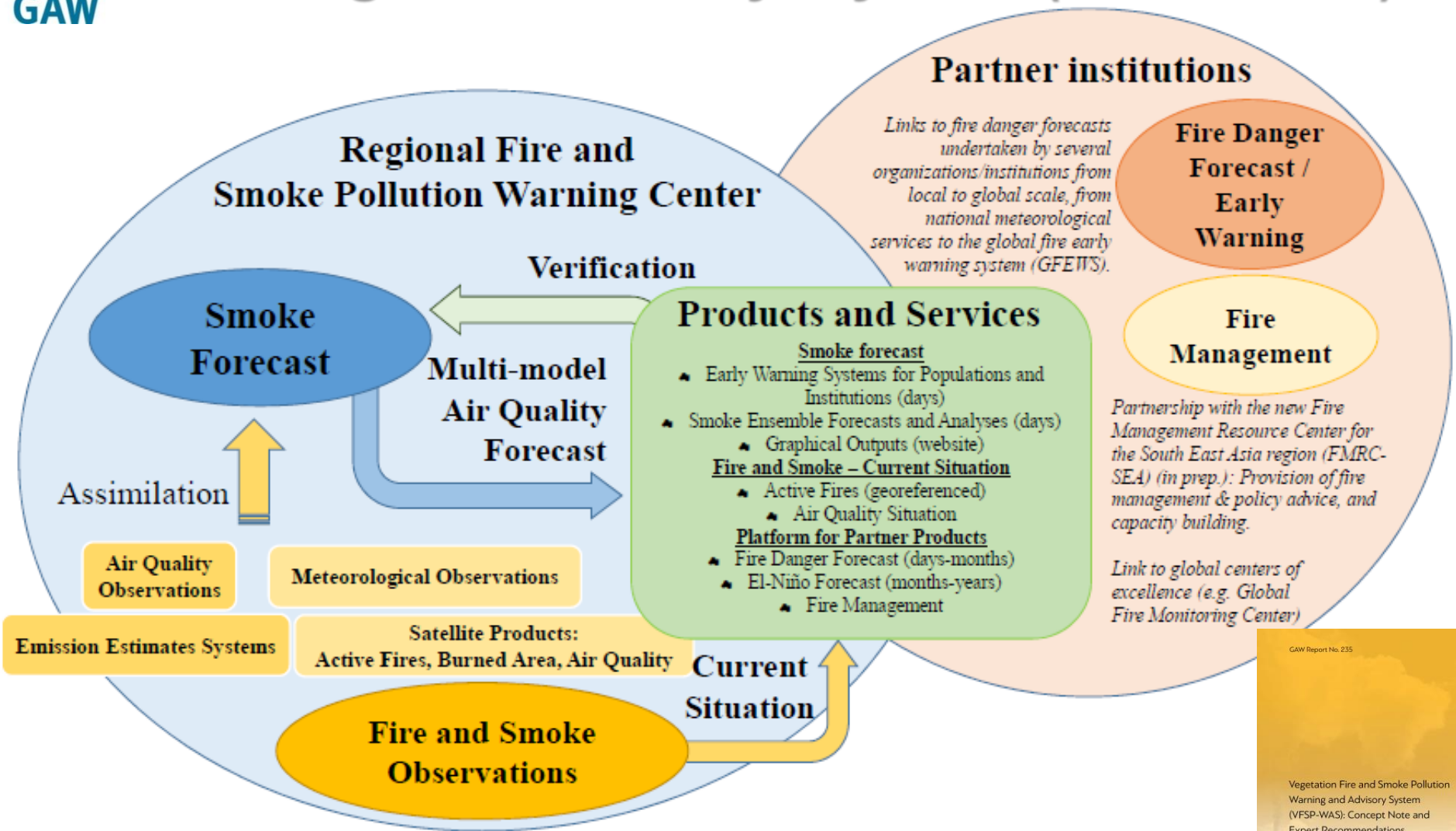
**3 regional nodes  
(NAMEE, Asia,  
Americas)**

**2 regional operational  
centers (Barcelona,  
Beijing)**





# Regional Vegetation Fire and Smoke Pollution Warning and Advisory System (VFSP-WAS)



GAW Report No. 235

Vegetation Fire and Smoke Pollution Warning and Advisory System (VFSP-WAS): Concept Note and Expert Recommendations



**Interested countries are welcome ! Weather**





Smoke Forecasts

Multi-Model Ensemble

ICAP Ensemble

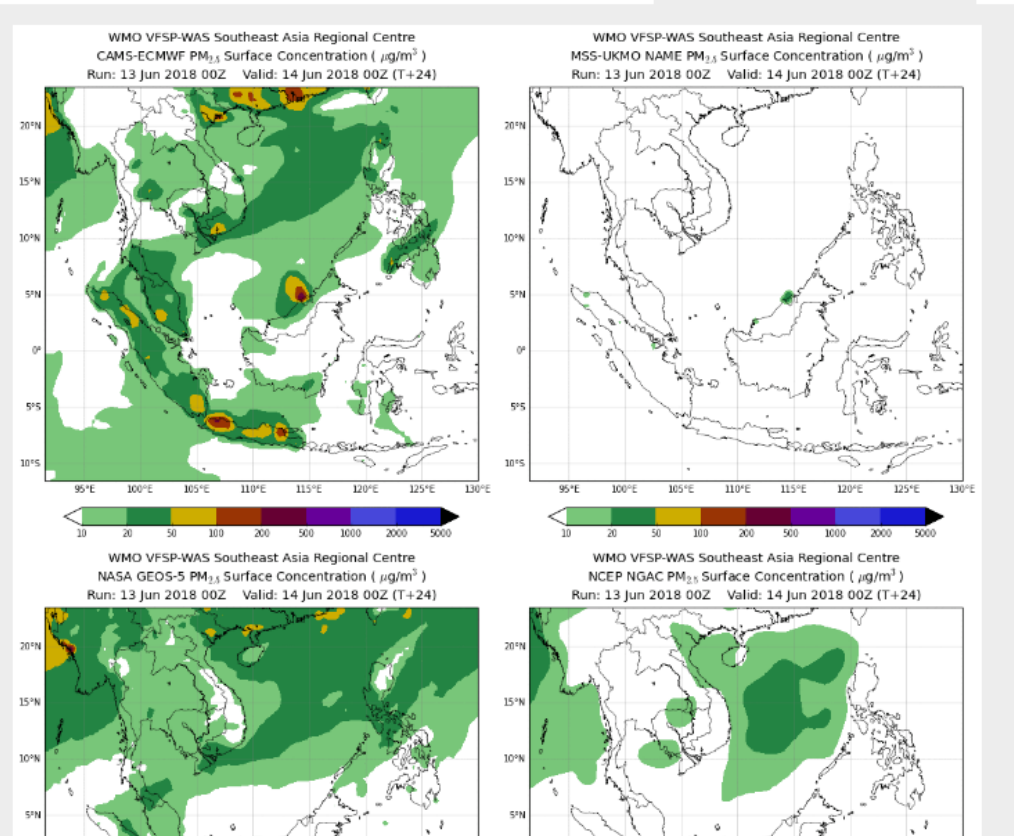
Forecast Evaluation

NWP Forecasts

S2S Outlook

### Smoke Forecasts Comparison

Smoke Aerosol Optical Depth PM<sub>10</sub> Surface Concentration PM<sub>2.5</sub> Surface Concentration





# Towards Integrated Air Quality Forecast Systems

(MAP-AQ: develop and implement forecast system for air quality with downscaling capability for Africa, Asia, L. America, selected countries, cities)

World Meteorological Organisation (WMO)  
Global Atmosphere Watch (GAW)

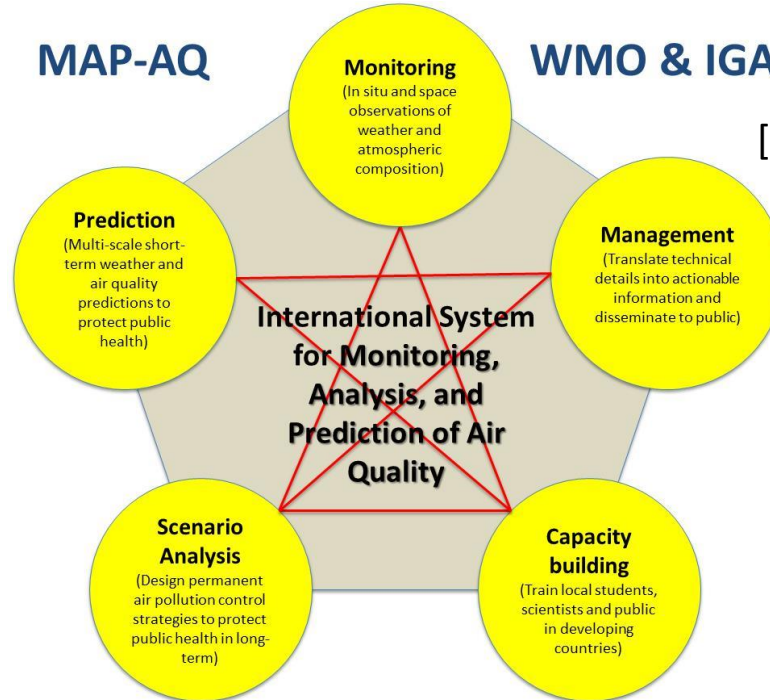
South African Weather Service  
Department of Environmental and Forestry Affairs

WMO Report on International Workshop  
"Seamless Prediction of Air Pollution for Africa: from Regional to Urban"

March 2018

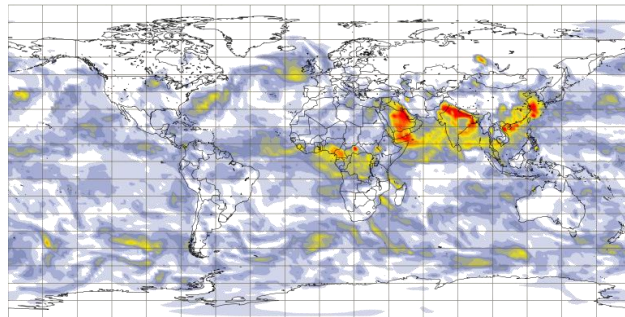
MAP-AQ

WMO & IGAC



[Kumar et al., Nature, 2018]

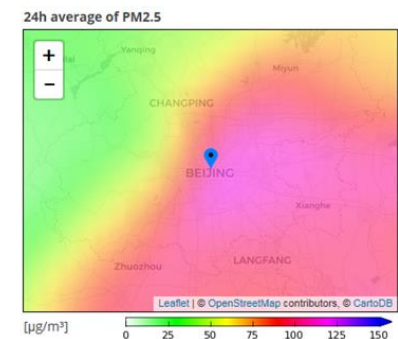
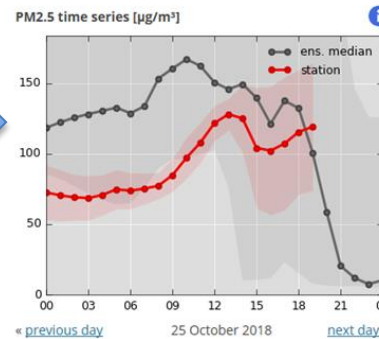
**A potential pilot project for future Global Data Processing and Forecasting System (GDPFS)**



CAMS global forecast



Air Quality Forecast for Beijing



MAP-AQ project forecast for China cities:

<http://www.marcopolo-panda.eu/forecast/>



# Global Air Quality Forecasting Services potentially part of GDPFS

**USERS**

Health sector  
Eco-systems  
Food security

Operationalization and user interface

QA/QC, verification

Good implementation practices

**MAP -AQ**

Regional demonstrations, experimental (research mode) implementation

Urban pilot projects

attribution

Improved processes description, data assimilation, model performance scores

**App & GURME  
SAGs  
SDS-WAS  
WWRP  
WGNE**

Community mobilization, basic science and field experiments

**IGAC**

(observation and modeling)

Science block



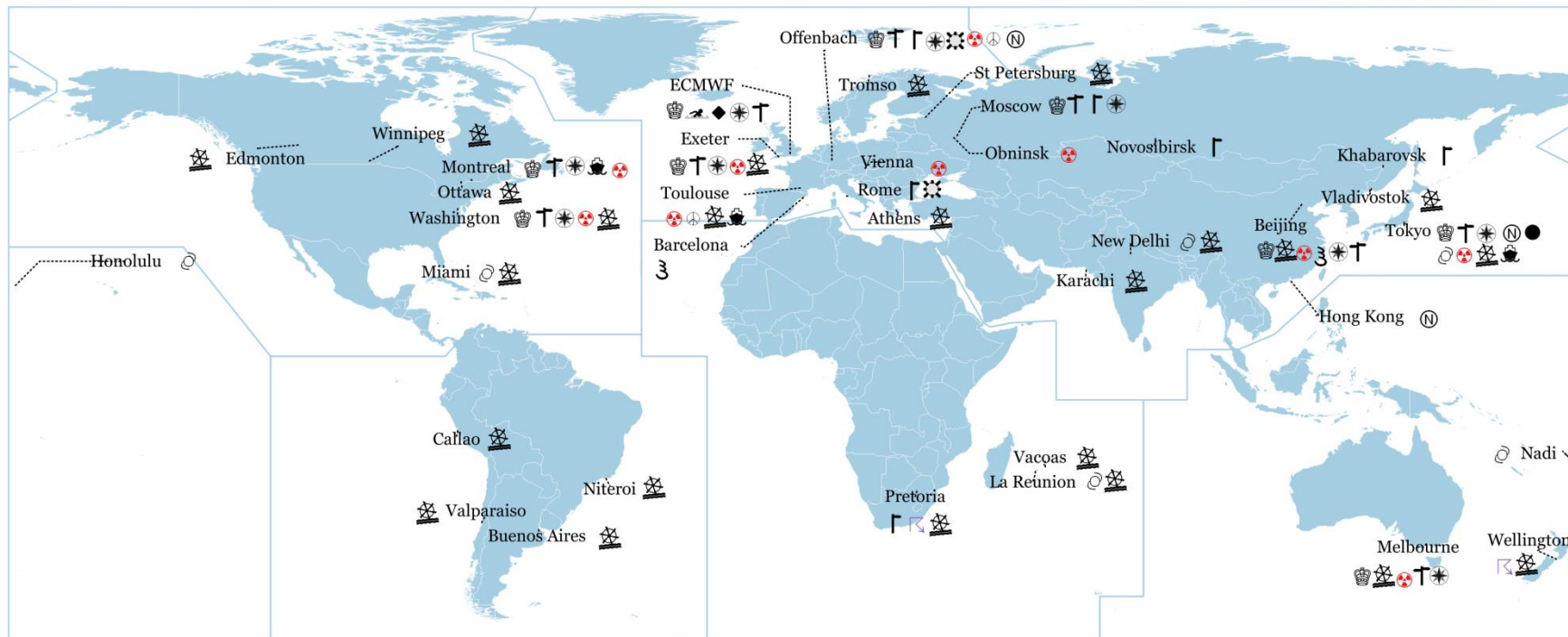
WMO OMM

# Members should have access to high-quality forecast products

## WMO Designated Global Data-processing and Forecasting System Centres

- Nowcasting and Weather Forecasting (upto 30 days)

Updated on 26 September 2018



### Legend

- |  |  |  |
|--|--|--|
| 👑 World Meteorological Centres (WMCs)* (9)                           | 🌊 RSMCs TC (6)                               | Ⓝ RSMCs Nowcasting (3)                     |
| 🌊 RSMCs(NRT***) Lead Centre for Coordination of Wave Forecast (1)    | 🌊 RSMCs Marine Meteorological Services (24)  | ⚡ RSMCs Limited Area Ensemble NWP (2)      |
| ● RSMCs(NRT***) Lead Centre for Coordination of EPS Verification (1) | ☢ RSMCs Nuclear Emergency Response** (10)    | ⚡ RSMCs Global Ensemble NWP (9)            |
| ◆ RSMCs(NRT***) Lead Centre for Coordination of DNV (1)              | ☮ RSMCs Non-Nuclear Emergency Response** (2) | ⌋ RSMCs Limited Area Deterministic NWP (6) |
| 🌊 RSMCs Numerical Ocean Wave Prediction (3)                          | ☸ RSMCs Sand Dust (2)                        | ⌋ RSMCs Global Deterministic NWP (9)       |
| 🌊 RSMCs Severe Weather Forecasting (2)                               |  |  |

\* World Meteorological Centres are also Global Producing Centres for a) Deterministic Numerical Weather Prediction, b) Ensemble Numerical Weather Prediction, and c) Long-Range Forecasts.

\*\* RSMC for nuclear and non-nuclear emergency response have Atmospheric Transport and Dispersion Modelling (ATDM) capabilities.

\*\*\* NRT stands for Non-Real-Time

### DESIGNATIONS USED

The depiction and use of boundaries, geographic names and related data shown on maps and included in lists, tables, documents, and databases on this web site are not warranted to be error free nor do they necessarily imply official endorsement or acceptance by the WMO.

## **Suggestion to establish and maintain cooperation related to matters of common interest, in particular:**

- *for the global and regional atmospheric composition (aerosol) observation and modelling, and*
- *for using observation data for model evaluation and data assimilation for aerosol forecasting and their applications.*
- *Forms of collaboration: informal, joint meetings, MoU, ... ??*

# Possible topics for cooperation with ICAP:

- **GAW observations and satellite data for evaluation and assimilation for ICAP modelling community;**
- **ICAP global ensemble (and members) for 193 WMO Member countries and territories: research and operational applications within the Global Air Quality Forecasting (GAQS) system;**
- **Contribution to SDS-WAS, VFSP-WAS, WGNE, VASAG and GAW APP with global dust, volcanic ash, BB smog and other atmospheric aerosols forecasts;**
- **Hosting a global center and/or training facility for GAQS, SDS-WAS and other relevant applications;**
- **Other GAW application areas for 193 Member countries and in support of Conventions;**
- **Promoting scientific collaboration between the research groups supporting the ICAP and WMO/GAW and facilitate exchange of data and other relevant information between ICAP and WMO/GAW communities;**
- **Organizing joint events and undertaking capacity building activities for global aerosol observation and forecasting and their potential applications.**



# Thank you!

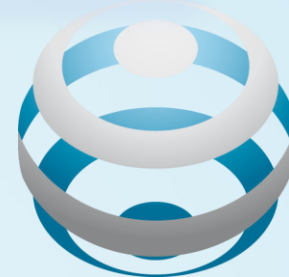
## ICAP is welcome for cooperation with WMO GAW

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