



## The 2nd Phase of the WGNE Aerosol project: Evaluating the impact of aerosols on Numerical Weather and Subseasonal Prediction



### A joint collaboration between WGNE, S2S and GAW

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## *The First Phase of the WGNE-Aerosol Project*

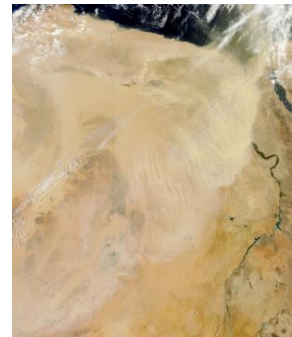
### *Goals*

#### *Identify:*

- the importance of aerosols for the predictability of the atmosphere*
- the atmospheric model quality for air quality forecasting*

*Analyse capabilities of NWP models to simulate the impact of aerosols on weather prediction*

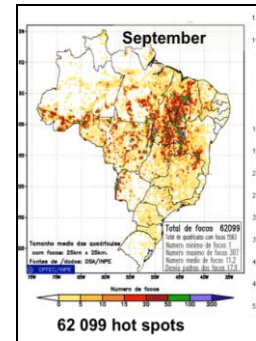
### Case Studies



Dust over Egypt:  
4/2012



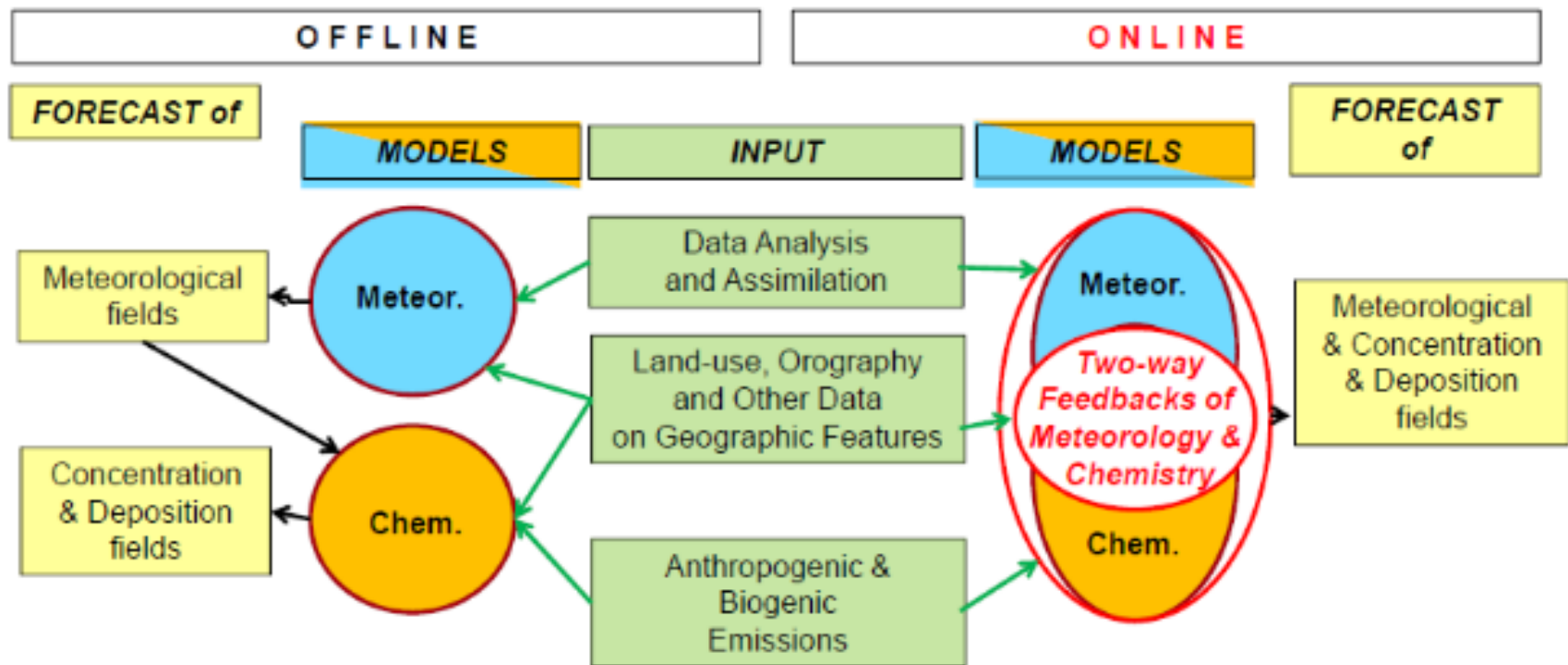
Pollution in China:  
1/2013



Smoke in Brazil:  
9/2012



## Direction of advances

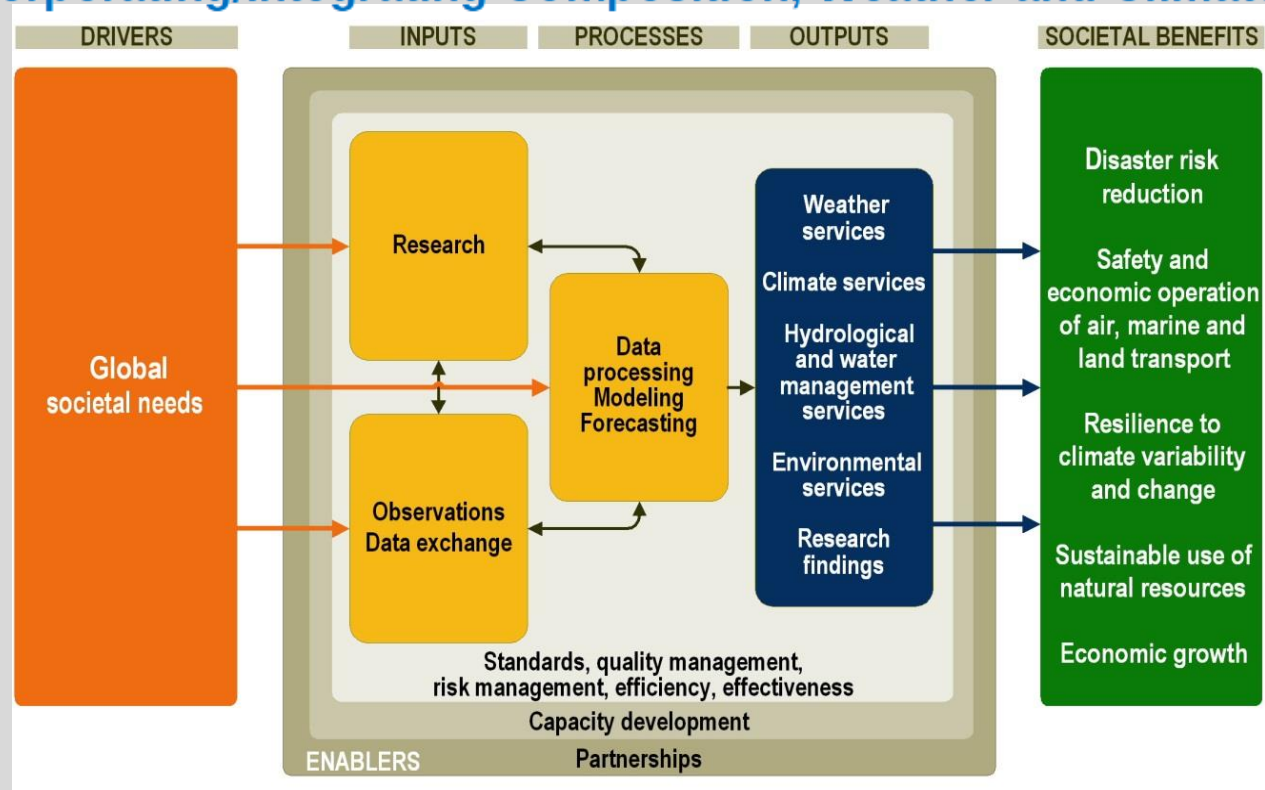




# The Second Phase of the Aerosol Project: a WGNE-S2S-GAW initiative

**Overarching Objective - Improve Prediction Capabilities via Incorporating/Integrating Composition, Weather and Climate**

**Common Research Objective**



Source: Carmichael & Tarasova, 2019, APP-SAG/ MAP-AQ meeting)

Across relevant temporal and spatial scales



## Are operational centres able to run fully integrated NWP systems?

- Few operational meteorological centres are able to run a weather/chemistry NWP system with interactive aerosols
- Less centres are able to run fully coupled modelling systems for longer timescales, like S2S
- All the operational S2S models contributing to the S2S WWRP–WCRP joint research project database use climatological aerosols



### **S2S WWRP–WCRP project recognizes the importance of aerosols on S2S timescales**

The incorporation of interactive aerosols on S2S models:

- *Opportunity to improve the skill of models*
- *Contribute to support policy makers and end-users providing skillful air quality forecasts*



# Importance of aerosols for S2S predictability

May-June 2003-2015

11 ensemble members

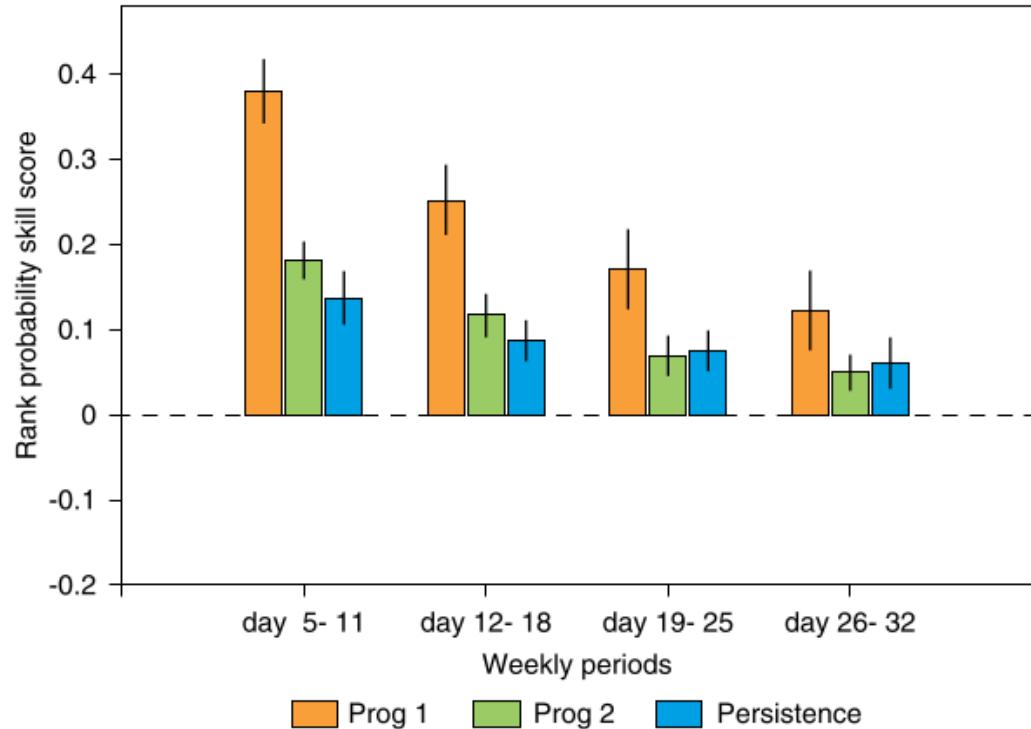
4 experiments:

→ Two different climatologies

→ Prognostic aerosols initialized using the time-varying CAMSira

→ Prognostic aerosols initialized using a fixed climatology (based on a CAMS experiments without data assimilation) –PROG2

***Only direct effect was considered***



RPSS for experiments PROG1 (orange) and PROG2 (green) with respect to a persistence forecast (blue) of dust optical depth for the tropics

Benedetti and Vitart (2018, MWR)



## *The Second Phase of the Aerosol Project: a WGNE-S2S-GAW initiative*

**Identify and quantify the importance of aerosols** for the predictability of the atmosphere at **short-range and subseasonal** time scales

*Update the **knowledge about the current capabilities** of modelling groups to simulate the impact of aerosols on short-range and subseasonal time scales*

**Identify and quantify the skill of air quality forecasting, especially on subseasonal time scale for impact purposes**



# ***The WGNE-S2S-GAW Aerosol Project protocol***

## ***Systematic NWP (Medium-range) experiment***

Confirm results from the first phase considering a big sample size in order to obtain statistical significance for differences

## ***S2S experiments***

Subseasonal re-forecasting experiments based on ensemble approach on a global scale in order to address the importance of interactive aerosols on subseasonal predictability





## Limited area domain (focus on NWP)

**Proposed years:** 2016-2018  
**Forecast length:** 72h from 00:00 UTC

**Time resolution:** 3h  
**Configuration:** as in operation

<b>Event</b>	<b>Period</b>	<b>Domain</b>	<b>Center of domain</b>	<b>Effects to be analysed</b>
Dust in Egypt	Mar-Apr-May	from Eq. to 50°N, Eq. to 60°E	30°E, 25°N	Direct Indirect* Climatological
BB S. America	Aug-Sep-Oct	32°W to 76°W 33°S to 6°N	60°W, 10°S	Direct Indirect* Climatological
BB S. Africa	Aug-Sep-Oct	0°E to 60°E 40°S to 10°N	30°E, 15°S	Direct Indirect* Climatological
Dust and anthropogenic pollution in East Asia	Feb-Mar-Apr	80°E to 120°E 20°N to 50°N	100°E, 35°N	Direct Indirect* Climatological

**\*Optional**



## S2S Re-forecast Experiments 2003-2018

- ***Dust***
  - Minimum requirement: **1<sup>st</sup> May start date**
  - Recommended additional start dates: 1<sup>st</sup> April and 1<sup>st</sup> June
- ***Biomass burning smoke***
  - Minimum requirement: **1<sup>st</sup> September start date**
  - Recommended additional start dates: 1<sup>st</sup> Aug and 1<sup>st</sup> Oct
- Minimum 5-member ensemble
- At least 32-day long simulations from 00:00 UTC
- Time resolution: 6 hours
- Climatological aerosols (emissions) vs prognostic aerosols (prescribed observed emissions)
- Initialized by own analysis/re-analysis
- Aerosol direct effect (indirect effect is optional)
- Centres interested to join: **ECMWF, NOAA, NASA, JMA, ECCC**



**Storage data:** at CPTEC (10TB available), format: netcdf

## ***Forecast verification (contribution from JWGFVR)***

<b>Regional</b>	<b>S2S</b>	<b>Air Quality/optical properties</b>
RMSE	Bias of the ensemble mean	Time series – F x O
Bias	Correlation between ensemble mean and obs anomalies	Bias
Contingency table scores	MSSS	
Scorecards	Standard deviation ratio	
	Fair CRPS	
	Scorecards	



# *Forecast verification*

- Database for model evaluation
  - Aerosol properties: CAMS and/or MERRAero  
AERONET
  - Weather variables: SYNOP  
ERA5 reanalysis



## *Data delivery*

- Grid:
  - lat/lon grid at a grid space of  $1^\circ \times 1^\circ$  of lat/lon for global experiments
  - lat/lon grid at a grid space of  $0.20^\circ \times 0.20^\circ$  of lat/lon for regional experiments
- Format: NetCDF
- File name:
  - Interactive aerosol:  
<CENT>\_<EVENT>\_INT\_<YYYYMMDD>00\_<hh>
  - No interactive aerosol:  
<CENT>\_<EVENT>\_NOINT\_<YYYYMMDD>00\_<hh>



# *Data delivery*

Metadata: A document describing additional information about model data should be provided

- Dynamical core
- Initialization (soil moisture, sea surface temperature, snow etc), data assimilation
- Vertical coordinate system
- Grid-spacing, vertical resolution, model top
- Physical parameterizations (aerosol complexity)
- Model spin-up (atmospheric composition spin-up)
- Emission sources

## Timeline

Limited-area experiment: from October to December 2019

S2S experiment: 2-years (2020–2021)



## *Data delivery*

The description about the algorithm used to interpolate data from the model native grid to the regular lat/lon grid should be provided

The procedure adopted to upload model data and metadata will be provided personally. Please contact Ariane Frassoni (ariane.frassoni@inpe.br with a copy to afrassoni@gmail.com) to receive more information about data delivery



# Acknowledgements



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**INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS**





Thanks for your attention!