



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

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## WGNE - Working Group on Numerical Experimentation



fostering the **development of atmospheric circulation models** for use in weather prediction and climate studies on **all time scales**, and **diagnosing and resolving shortcomings**.

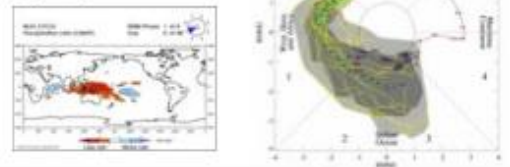
*Objectives are achieved through*

- Identification of **systematic errors** common to many models.
- Sharing **diagnostic tools and techniques** to get to the root of the error.
- Sharing knowledge around **sensitivity of errors to model formulation** (parametrizations, dynamical core, etc.).
- Work with other groups (e.g. GASS & GLASS) to **develop solutions**.

*Cases of strong or persistent events of aerosol pollution studied by the WGNE Aerosols project*



*MJO - Task Force: Real time MJO Index forecast activity using 20 forecast models*



ICSU

International Council for Science



WORLD METEOROLOGICAL ORGANIZATION





## ***The First Phase of the WGNE-Aerosol Project (WGNE-Aer I)***

- 1) Identify the importance of aerosols for the predictability of the atmosphere*
- 2) Identify the importance of atmospheric model quality for air quality forecasting*
- 3) Analyse capabilities of NWP models to simulate aerosol impacts on weather prediction*



# Evaluating Aerosols Impacts on Numerical Weather and Subseasonal Prediction

## WGNE Aer Phase 1 - Participating Models

Institution Model	Domain Resolution	Aerosol Species	A & BB Emissions	Aerosol Physics	Cloud Physics	Aerosol Assim.
CPTEC BRAMS	Regional 20 km	BC, Sea-Salt, OC, SO <sub>4</sub>	EDGAR 4. 3BEM	bulk	2-mom	no
JMA MASINGAR	Global TL319L40	Dust, Sea-Salt, BC, OC, SO <sub>4</sub>	MACCity GFAS 1.0	2-mom	2-mom	no
ECMWF Global	Global T511L60			Bulk	Bulk	yes
Météo-France ALADIN + ORILAM	Regional 7.5 km	Dust	DEAD model	3-mom log-no normal	Bulk	no
ESRL/NOAA WRF-Chem	Regional cloud res.	(many)	EDGAR 4. 3BEM	Bulk and Modal	2-mom	no
NASA/GSFC GEOS-5+GOCART	Global 25 km	Dust, Sea-Salt, BC, OC, SO <sub>4</sub>	EDGAR 4.1 QFED 2.4	Bulk	Bulk or 2-mom	yes
NCEP NGAC+GOCART	Global T126	Dust, Sea-Salt, BC, OC, SO <sub>4</sub>	Climatological Aerosols	Bulk	Bulk	no
Barcelona SC	regional	dust	BSC-dust model	8 dust size bins	Same as in WRF	no

Courtesy: Saulo Freitas



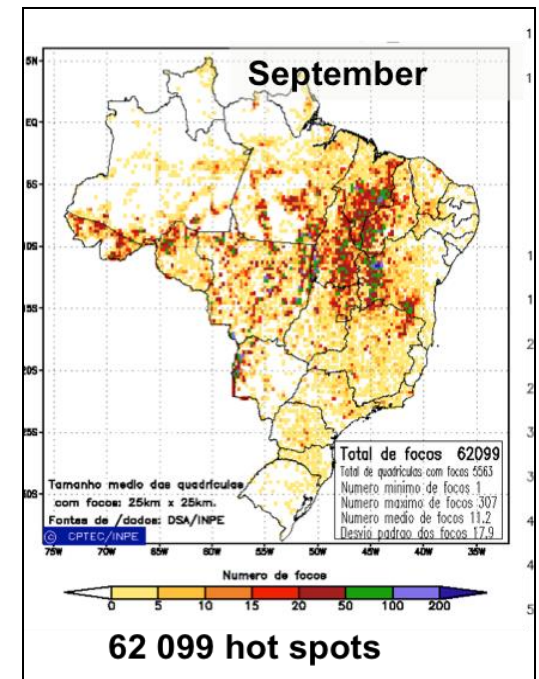
## Case Studies



Dust over Egypt: 4/2012



Pollution in China:  
1/2013



Smoke in Brazil:  
9/2012





## Main results

Large discrepancies among centers

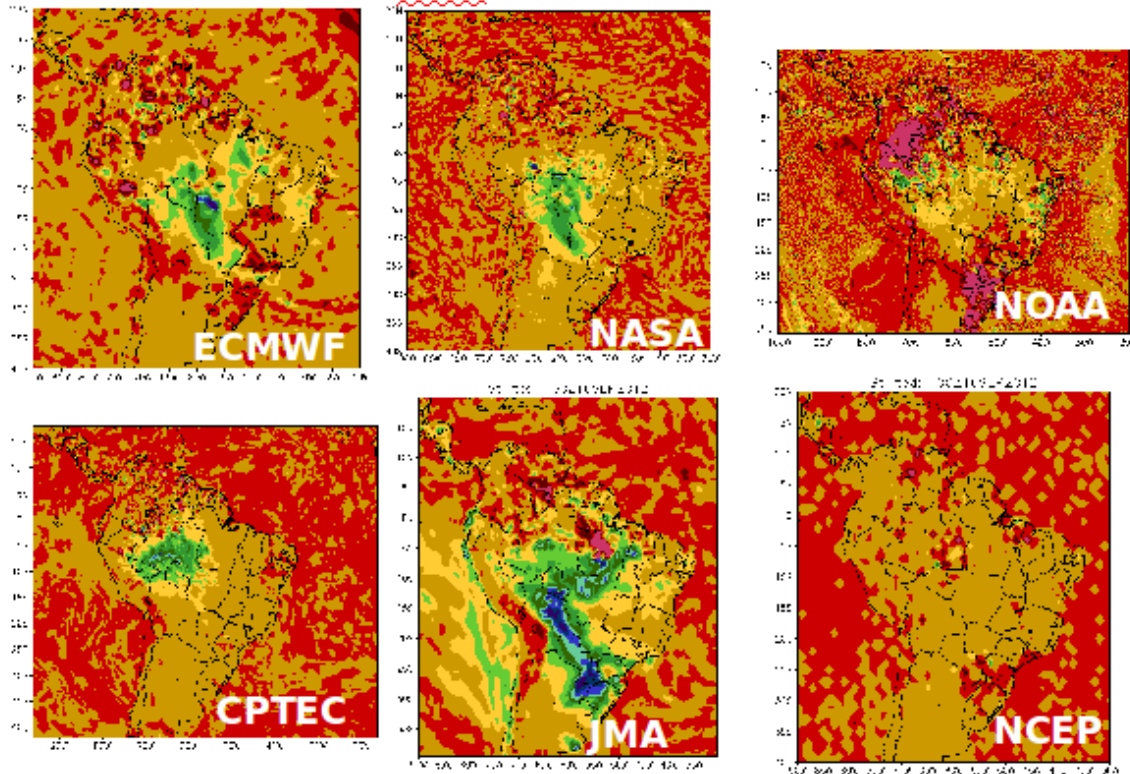
Decrease in Radiative shortwave flux at surface and air temperature at 2m

Direct effect is important: improvements on NWP skill considering interactive aerosols

Miss-representation of intense cases using climatological aerosols

Lack on statistical significance

2-m temp forecast for  
15UTC11SEP  
Init.:00UTC10SEP

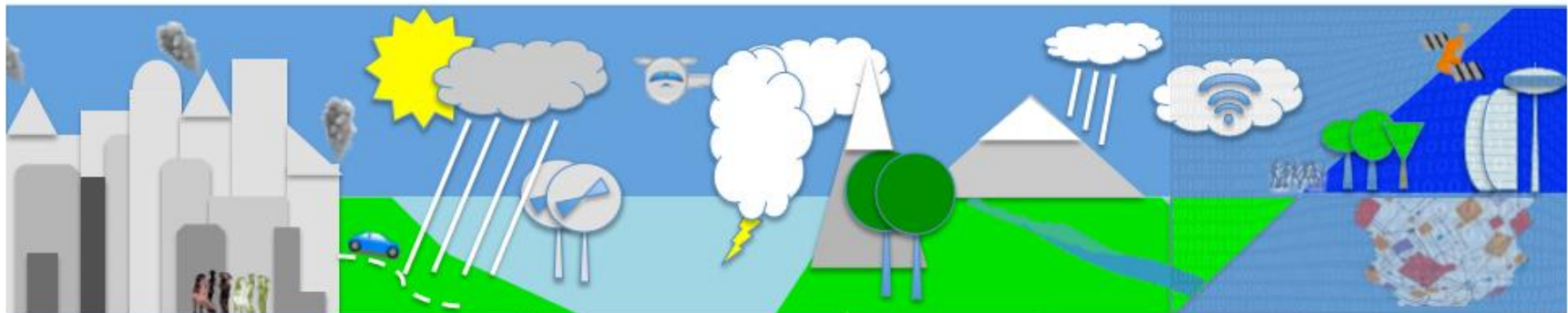




"The best possible science serves society in the best possible way" **WMO**

Weather science advances to a "seamless" prediction

## Addressing six Societal Challenges



**URBANIZATION**  
Research and services for megacities and large urban complexes

**Integrated GHG Information System:**  
Serving society and supporting policy

**HIGH IMPACT WEATHER**  
and its socio-economic effects in the context of global change

**WATER**  
Modelling and predicting the water cycle for improved DRR and resource management

**AEROSOLS**  
Impacts on air quality, weather and climate

**EVOLVING TECHNOLOGIES**  
Their impact on science and its use



## ***The Second Phase of the WGNE-Aerosol Project (WGNE-Aer II)***

**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 NWP models to simulate aerosol impacts on weather and subseasonal prediction*

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





# ***The Second Phase of the WGNE-Aerosol Project (WGNE-AerII)***

## ***Systematic NWP experiment***

Confirm results from WGNE-Aer I considering a big sample size in order to obtain statistical significances for differences

## ***S2S experiments***

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



## Protocol: limited area domain (focus on NWP)

**Proposed years:** 2016-2018

**Forecast length:** 72h from 00:00 UTC

**Time resolution:** 3h

**Configuration:** as in operation

**Variables:** see the list

<b><i>Event</i></b>	<b><i>Period</i></b>	<b><i>Domain</i></b>	<b><i>Center of domain</i></b>	<b><i>Effects to be analysed</i></b>
Dust in Egypt	Mar-Apr-May	from Eq. to 50°N, Eq. to 60°E	30°E, 25°N	Direct Indirect (optional) No Aer
BB S. America	Aug-Sep-Oct	32°W to 76°W 33°S to 6°N	60°W, 10°S	Direct Indirect (optional) No Aer
BB S. Africa	Aug-Sep-Oct	0°E to 60°E 40°S to 10°N	30°E, 15°S	Direct Indirect (optional) No Aer



## S2S Re-forecast Experiments

### Experiment 1: Dust prediction and impact

- Starting dates 1<sup>st</sup> March/1<sup>st</sup> April/1<sup>st</sup> May 2003-2018
- Minimum 5-member ensemble
- At least 32-day long simulations
- Climatological aerosols vs prognostic aerosols (dust only)
- Initialized by own analysis/re-analysis
- Aerosol direct effect (indirect effect is optional)



## S2S Re-forecast Experiments

### Experiment 2: Biomass burning

- Starting dates 1<sup>st</sup> Aug/1<sup>st</sup> Sept/1<sup>st</sup> Oct 2003-2018
- Minimum 5-member ensemble
- At least 32-day long simulations
- Climatological emissions vs prescribed observed emissions
- Initialized by own analysis/re-analysis
- Aerosol direct effect (indirect effect is optional)



## Protocol

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

**Forecast verification (contribution from JWGFVR)**

### Regional experiments:

- Root mean Square Error (RMSE)

- Bias (Forecast-Observation: F-O)

- Contingency table scores (ETS, Bias, POD, FAR)

### S2S experiments:

- Bias of the ensemble mean

- Correlation between ensemble mean anomalies and corresponding observations

- Mean squared error skill score (MSSS)

- Standard deviation ratio (ratio of the predicted ensemble mean anomaly standard deviation and the observed anomaly standard deviation)

Scorecards for both experiments





## Open tasks

- Define a reference database for model evaluation
- Define specific statistical scores for air quality and optical properties evaluation – ***possible JWGFVR contribution***
- Define a time-line of the experiments
- Possibility: consider other regional domains



## Acknowledgements



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Thanks for your attention!