Evaluating aerosols impacts on Numerical Weather Prediction: Summary

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Goals of the Exercise

• This project aimed to improve our understanding about the following questions:

• How important are aerosols for predicting the physical system (NWP, seasonal, climate) as distinct from predicting the aerosols themselves?

• How important is atmospheric model quality for air quality forecasting?

• What are the current capabilities of NWP models to simulate aerosol impacts on weather prediction?
## Participating Models

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CPTEC BRAMS</td>
<td>Regional 10 km</td>
<td>BC, Sea-Salt, OC, SO4</td>
<td>EDGAR 4. 3BEM</td>
<td>bulk</td>
<td>2-mom</td>
<td>no</td>
</tr>
<tr>
<td>JMA MASINGAR</td>
<td>Global TL319L40</td>
<td>Dust, Sea-Salt, BC, OC, SO4</td>
<td>MACCity GFAS 1.0</td>
<td>2-mom</td>
<td>2-mom</td>
<td>no</td>
</tr>
<tr>
<td>ECMWF Global</td>
<td>Global T511L60</td>
<td>Dust</td>
<td>DEAD model</td>
<td>Bulk</td>
<td>Bulk</td>
<td>yes</td>
</tr>
<tr>
<td>Météo-France ALADIN + ORILAM</td>
<td>Regional 7.5 km</td>
<td>Dust</td>
<td>DEAD model</td>
<td>Bulk</td>
<td>Bulk</td>
<td>no</td>
</tr>
<tr>
<td>ESRL/NOAA WRF-Chem</td>
<td>Regional cloud res.</td>
<td>(many)</td>
<td>EDGAR 4. 3BEM</td>
<td>Bulk and Modal</td>
<td>2-mom</td>
<td>no</td>
</tr>
<tr>
<td>NASA/GSFC GEOS-5+GOCART</td>
<td>Global 25 km</td>
<td>Dust, Sea-Salt, BC, OC, SO4</td>
<td>EDGAR 4.1 QFED 2.4</td>
<td>Bulk</td>
<td>Bulk or 2-mom</td>
<td>yes</td>
</tr>
<tr>
<td>NCEP NGAC+GOCART</td>
<td>Global T126</td>
<td>Dust, Sea-Salt, BC, OC, SO4</td>
<td>Climatological Aerosols</td>
<td>Bulk</td>
<td>Bulk</td>
<td>no</td>
</tr>
<tr>
<td>Barcelona SC</td>
<td>regional</td>
<td>dust</td>
<td>BSC-dust model</td>
<td>8 dust size bins</td>
<td>Same as in WRF</td>
<td>no</td>
</tr>
</tbody>
</table>
## Protocol: Experiments

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Direct Effect</th>
<th>Indirect Effect</th>
<th>No aerosol Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Case Studies

1) Dust over Egypt: 4/2012
2) Pollution in China: 1/2013
3) Smoke in Brazil: 9/2012
Case 1: Dust Plume over Egypt

Diff of Temp @ 2m
Aer-NoAer
12 UTC
Fct: 18Apr2012
Init: 00UTC17Apr2012

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

Large discrepancies among centers
Case 3: Persistent Smoke in South America

Low effect with climatological aerosol

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

Large discrepancies among centers

2-m temp forecast for 15UTC11SEP
Init.: 00UTC10SEP
General overview of impacts on the prediction skill – case 3

<table>
<thead>
<tr>
<th>Variable</th>
<th>ECMWF</th>
<th>JMA</th>
<th>NASA</th>
<th>NCEP</th>
<th>NOAA</th>
<th>CPTEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skill score</td>
<td>RMSE</td>
<td>BIAS</td>
<td>RMSE</td>
<td>BIAS</td>
<td>RMSE</td>
<td>BIAS</td>
</tr>
<tr>
<td>2-m temp</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>10-m wind speed</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>✔</td>
<td>X</td>
</tr>
<tr>
<td>10-m wind direction</td>
<td>✔</td>
<td>✔</td>
<td>X</td>
<td>✔</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>rainfall</td>
<td>✔</td>
<td>✔</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>✔</td>
</tr>
</tbody>
</table>

- ✔ Significant impact
- X Negligible impact
- Skill is degraded
- Skill is improved
- Mixed improvement/degradation

**Domain of Evaluation**

**ECMWF**

**temp2m (K)**

**RMSE**

**BIAS**

**Forecast time (h)**
CPTEC operational NWP

RMSE 2-m temperature 01/09 – 30/09/2014
Synoptic and METAR data - 72h forecast

Biomass burning spots
September 2014

Mean error
2.36
1.96
CPTEC operational NWP

RMSE 2-m temperature 01/04 – 30/04/2014
Synoptic and METAR data - 72h forecast

Biomass burning spots
April 2014
Questions

How important are aerosols for predicting the physical system?

Direct effect is important - improvements on NWP skill considering Aerosols

How important is atmospheric model quality for air quality forecasting?

Important (Ex: JMA and ECMWF lower errors) - more investigation is needed

What are the current capabilities of NWP models to simulate aerosol impacts on weather prediction? To be discussed
Projetc webpage:
http://meioambiente.cptec.inpe.br/wgne-aerosols/

Thanks for your attention!