Evaluating aerosols impacts on Numerical Weather Prediction: Summary

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Pan-WCRP Modelling Groups Meeting
Exeter - Oct 2017

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?

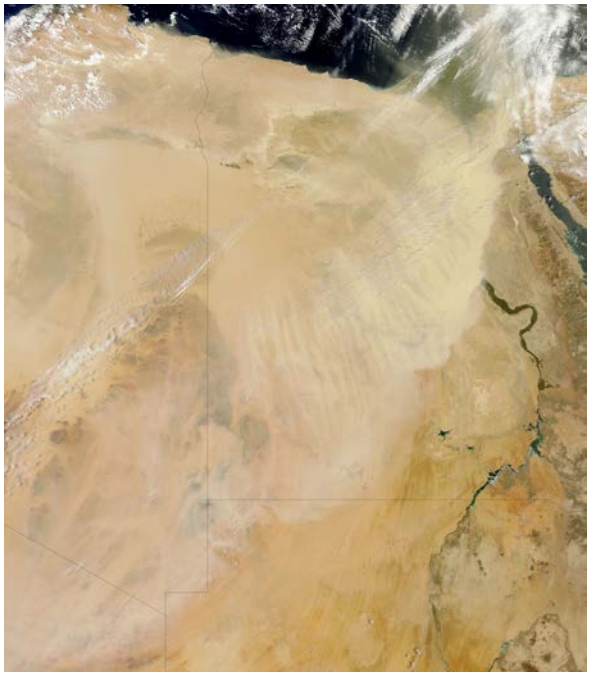
Participating Models

Institution Model	Domain Resolution	Aerosol Species	A & BB Emissions	Aerosol Physics	Cloud Physics	Aerosol Assim.
CPTEC BRAMS	Regional 10 km	BC, Sea-Salt, OC, SO4	EDGAR 4. 3BEM	bulk	2-mom	no
JMA MASINGAR	Global TL319L40	Dust, Sea-Salt, BC, OC, SO4	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, SO4	EDGAR 4.1 QFED 2.4	Bulk	Bulk or 2-mom	yes
NCEP NGAC+GOCART	Global T126	Dust, Sea-Salt, BC, OC, SO4	Climatological Aerosols	Bulk	Bulk	no
Barcelona SC	regional	dust	BSC-dust model	8 dust size bins	Same as in WRF	no

Protocol: Experiments

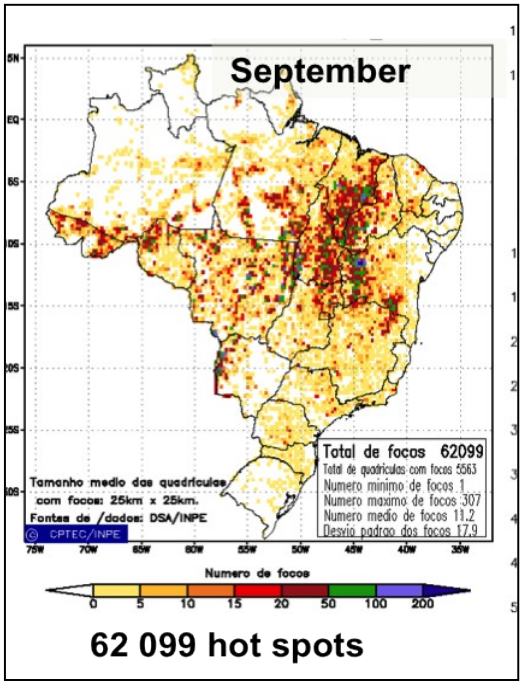
Experiment	Direct Effect	Indirect Effect	No aerosol Interaction
1	X		
2		X	
3	X	X	
4			X

Case Studies



1) Dust over Egypt: 4/2012

2) Pollution in China: 1/2013



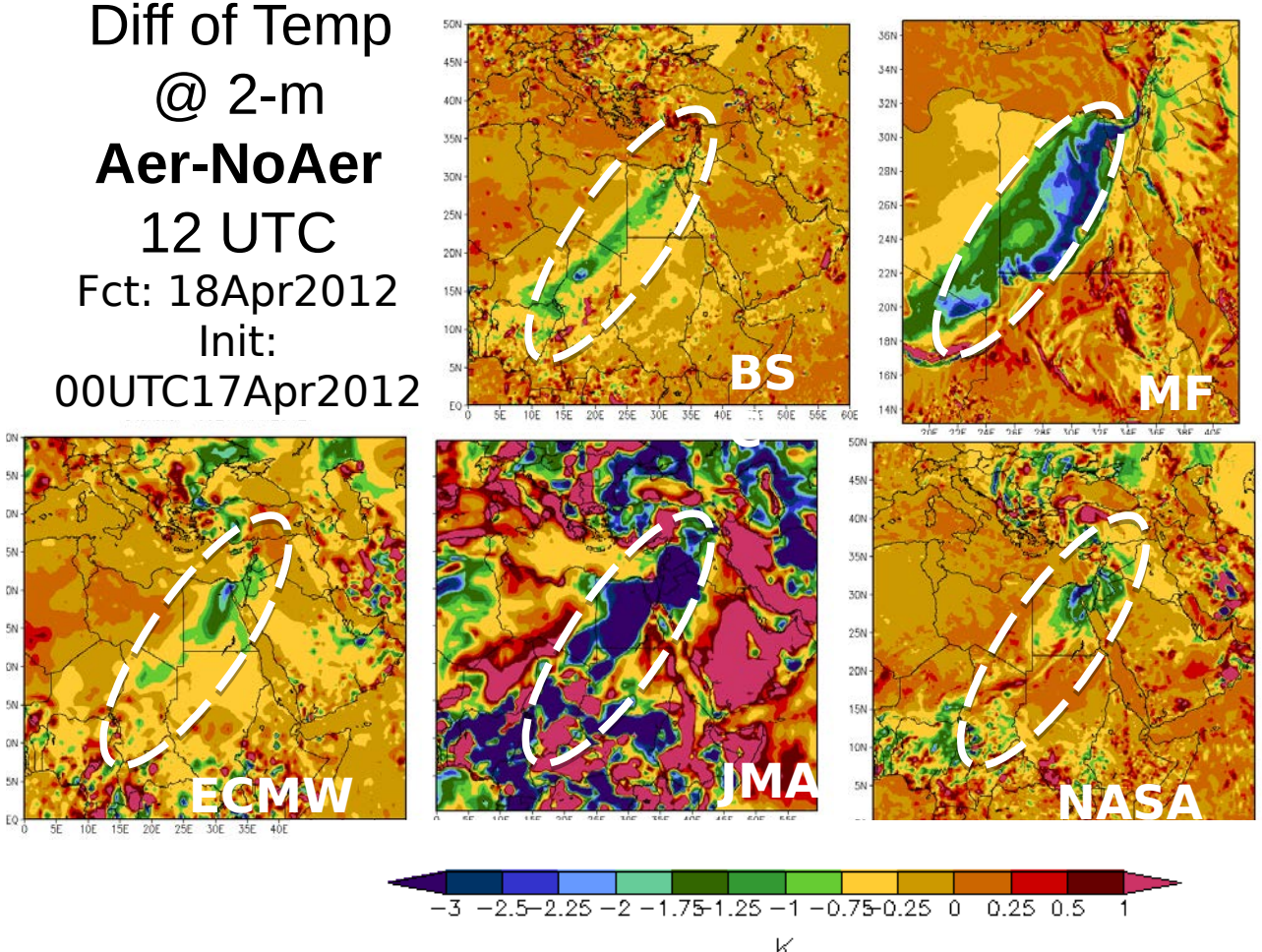
3) Smoke in Brazil: 9/2012

Case 1: Dust Plume over Egypt

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

Large discrepancies among centers

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



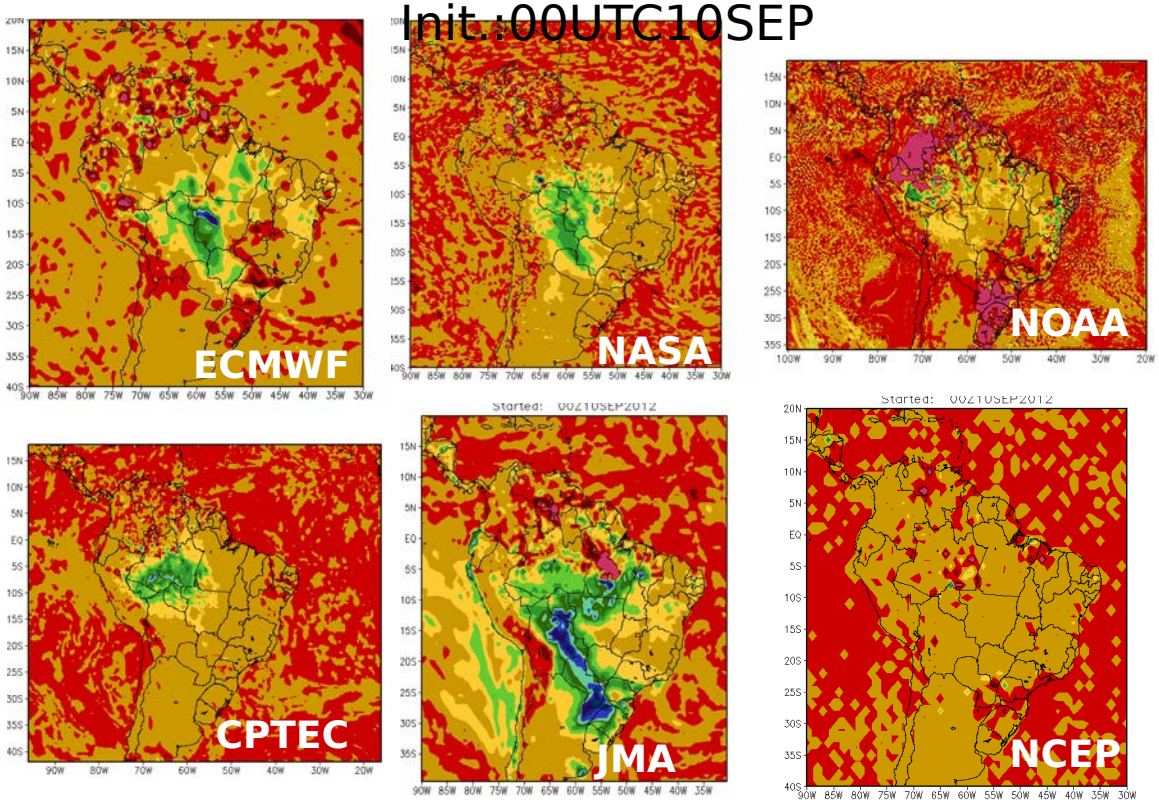
Case 3: Persistent Smoke in South America

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

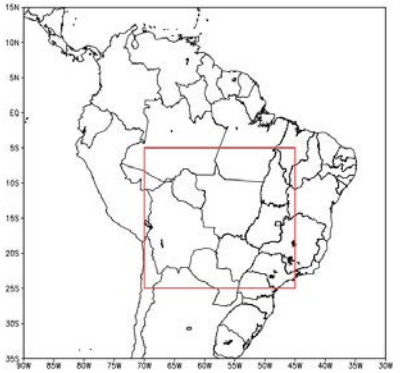


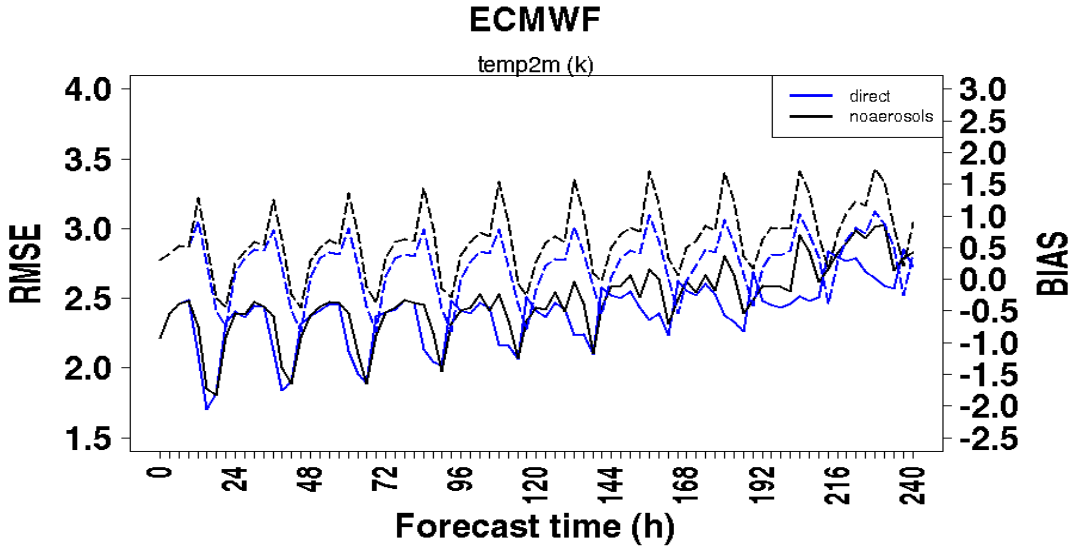
General overview of impacts on the prediction skill – case 3

Variable	ECMWF		JMA		NASA		NCEP		NOAA		CPTEC	
Skill score	RMSE	BIAS	RMSE	BIAS	RMSE	BIAS	RMSE	BIAS	RMSE	BIAS	RMSE	BIAS
2-m temp	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10-m wind speed	✗	✗	✗	✗	✓	✓	✗	✗	✓	✓	✓	✓
10-m wind direction	✓	✓	✗	✓	✗	✓	✗	✗	✗	✓	✓	✓
rainfall	✓	✓			✗	✗	✗	✗	✓	✗	✓	✓

✗	Negligible impact
✓	Significant impact
	Skill is degraded
	Skill is improved
	Mixed improvement/degradation

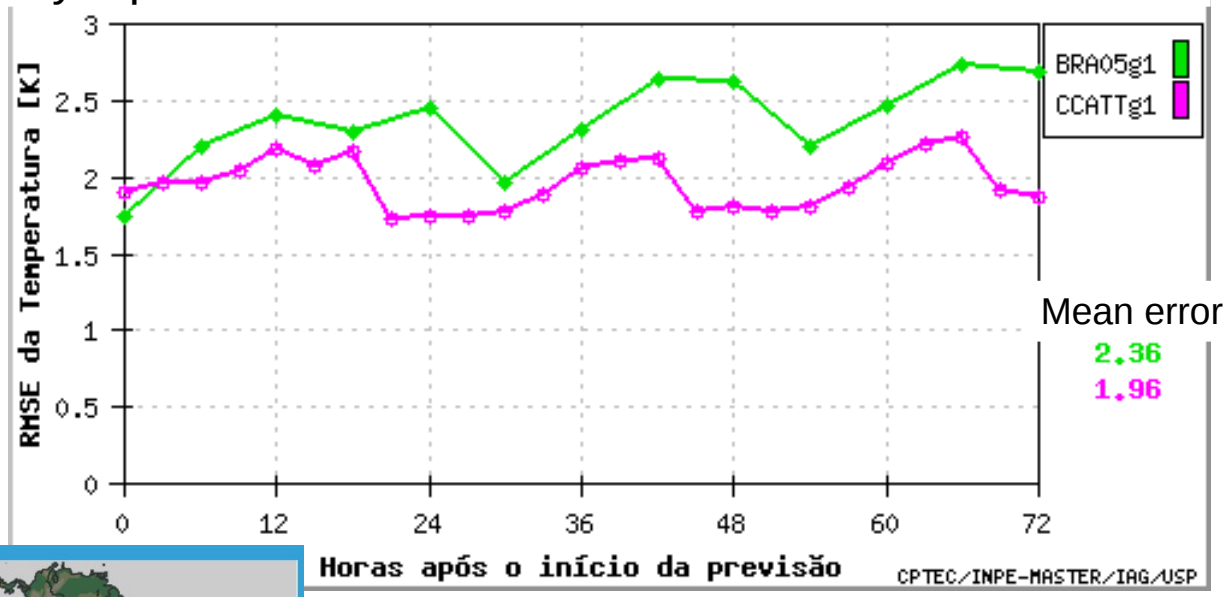
DOMAIN of EVALUATION

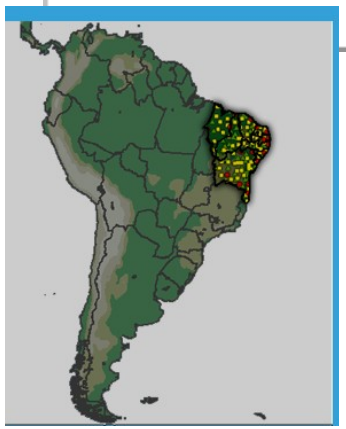




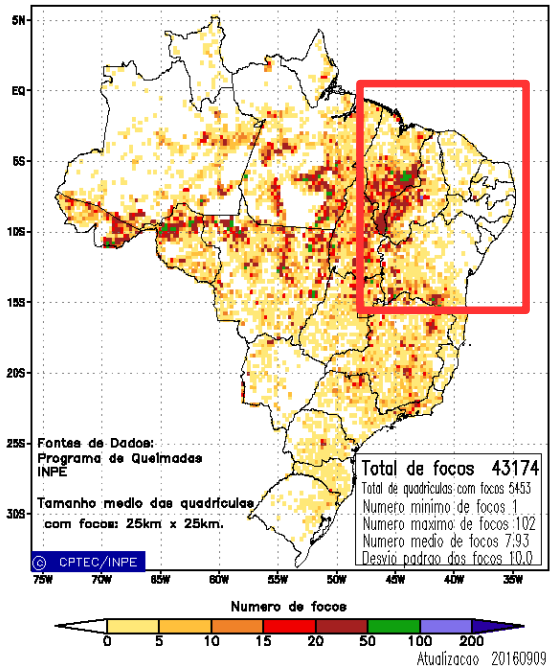
CPTEC operational NWP

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



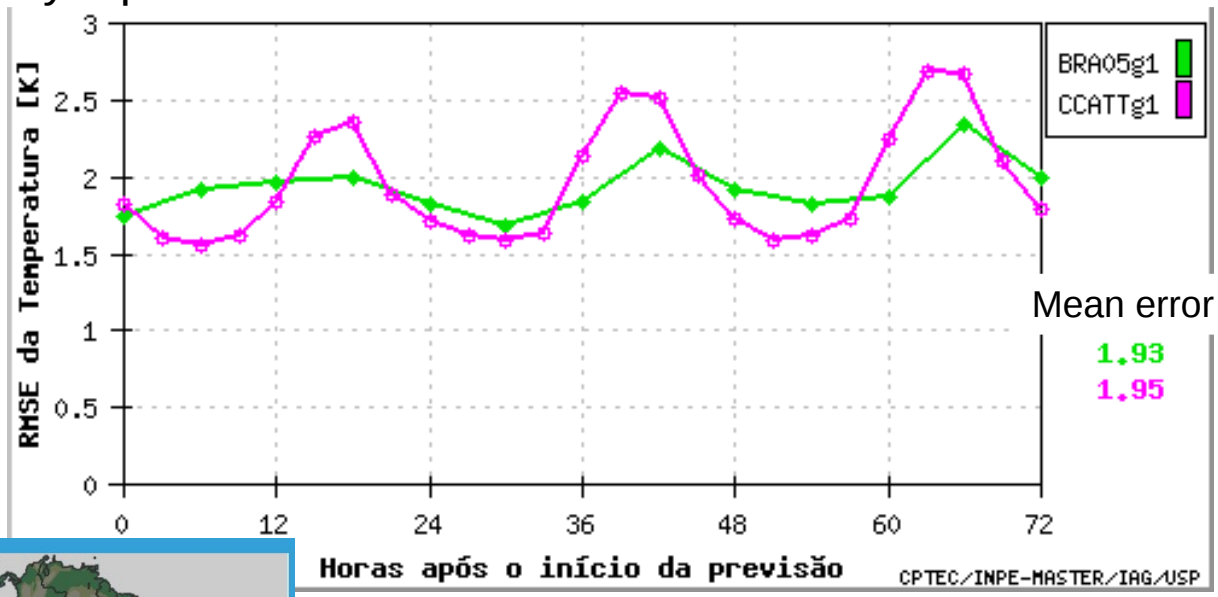


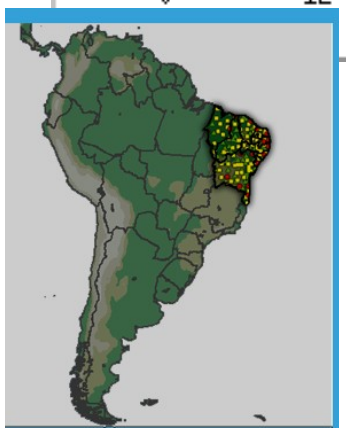
Biomass burning spots
September 2014



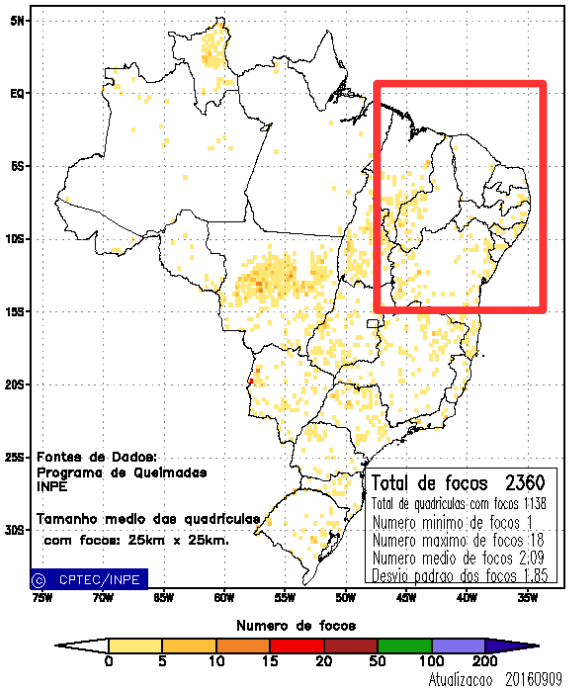
CPTEC operational NWP

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 erros) - 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!