Action 10: Evaluating aerosols impacts on Numerical Weather and Subseasonal Prediction

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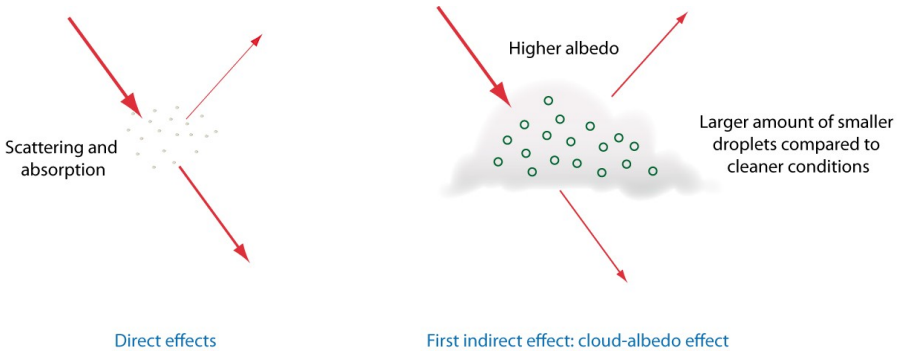
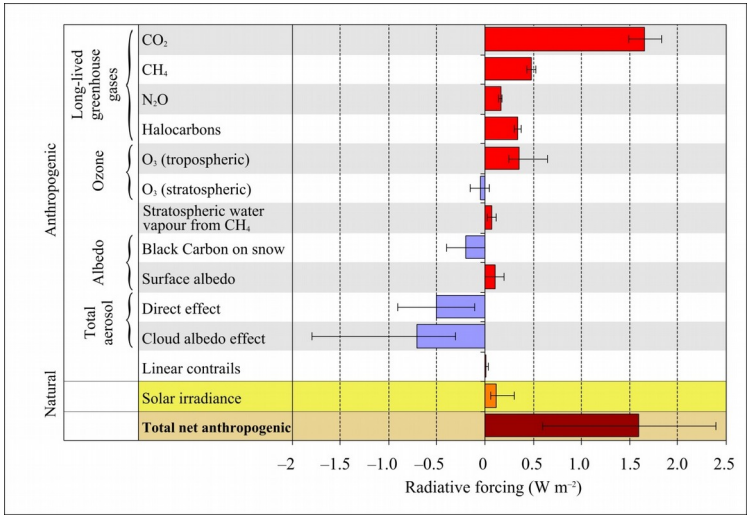
Evaluating Aerosols Impacts on Numerical Weather and Subseasonal Prediction

Importance of aerosols





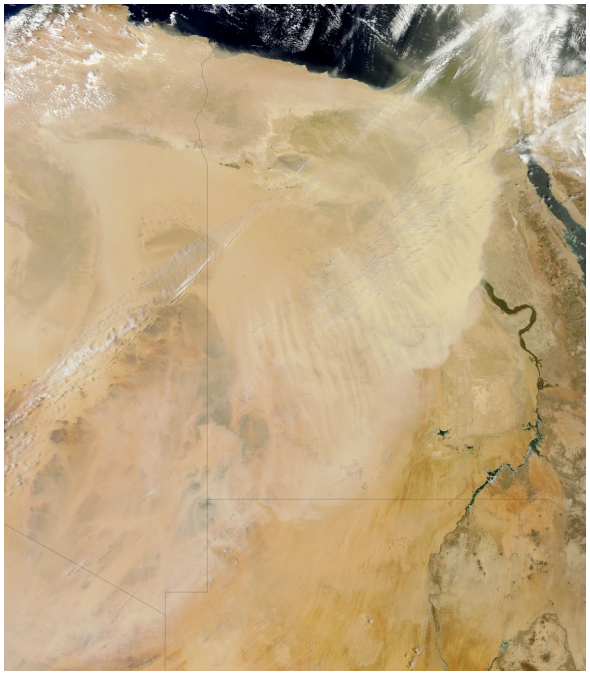
Health impacts

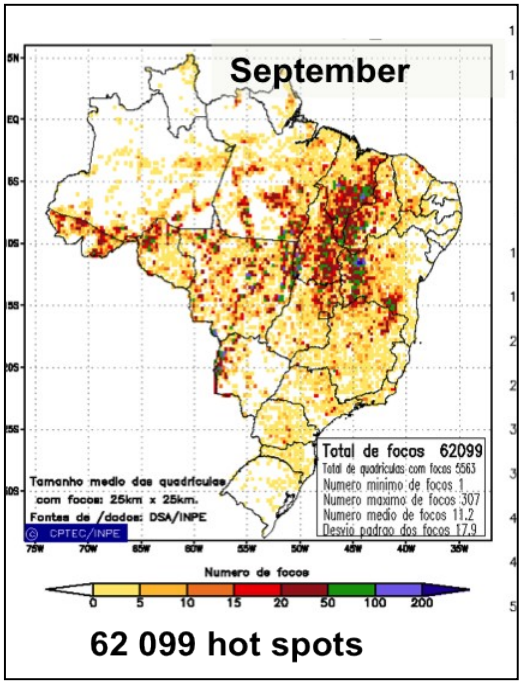
https://www.nature.com/articles/d41586-018-06150-5

WGNE Aer Phase 1 - 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

Case Studies





1) Dust over Egypt:
2) 4/2012

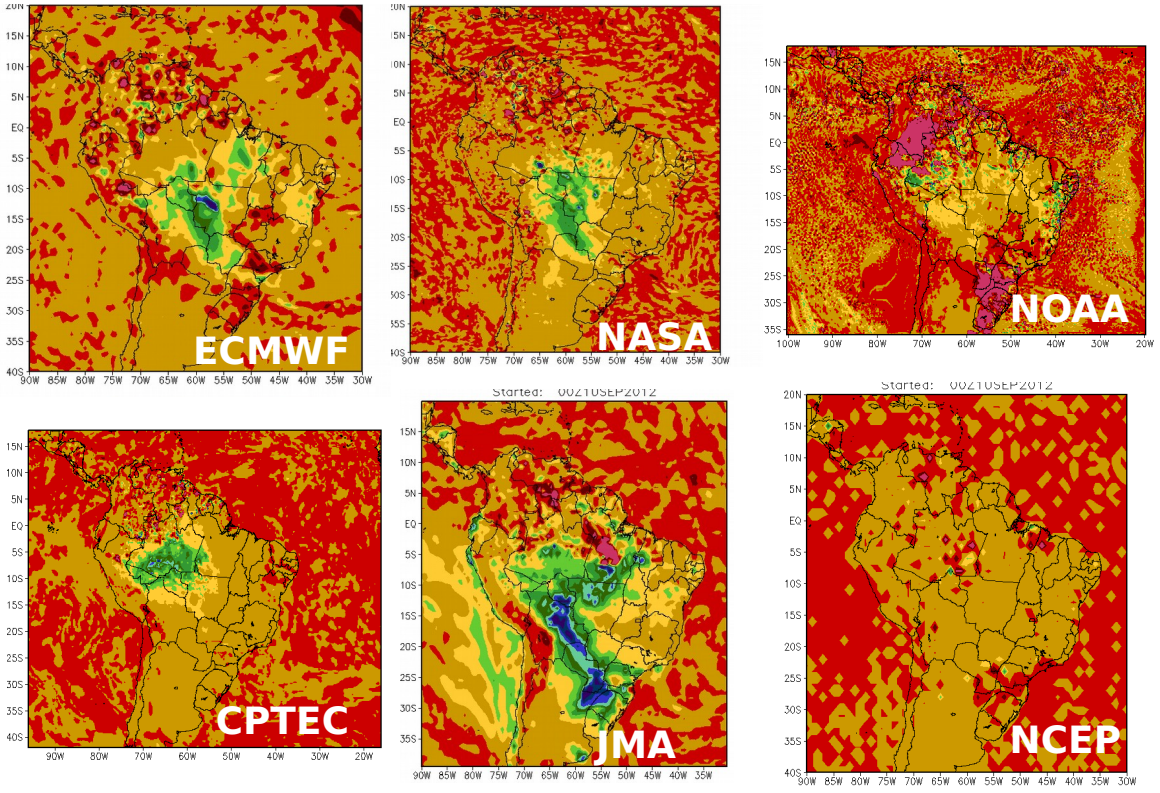
2) Pollution in China: 1/2013

3) Smoke in Brazil: 9/2012

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

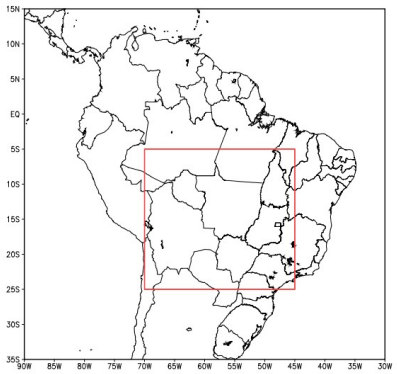
2-m temp forecast for
15UTC11SEP
Init.:00UTC10SEP



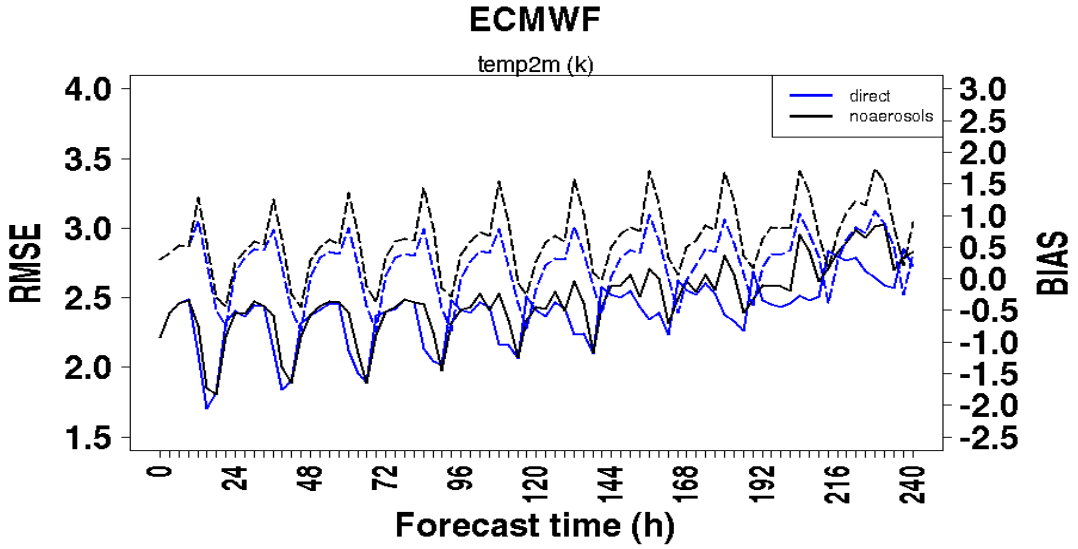
General overview of impacts on the prediction skill – case 3

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	✓	✓			✗	✗	✗	✗	✓	✗	✓	✓

DOMAIN of EVALUATION



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



Phase 1 - 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

The Second Phase of the WGNE-Aerosol Project (WGNE-Aer2)

Systematic NWP experiment

Higher resolution regional configurations in order to address the importance of interactive aerosols on weather predictability

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

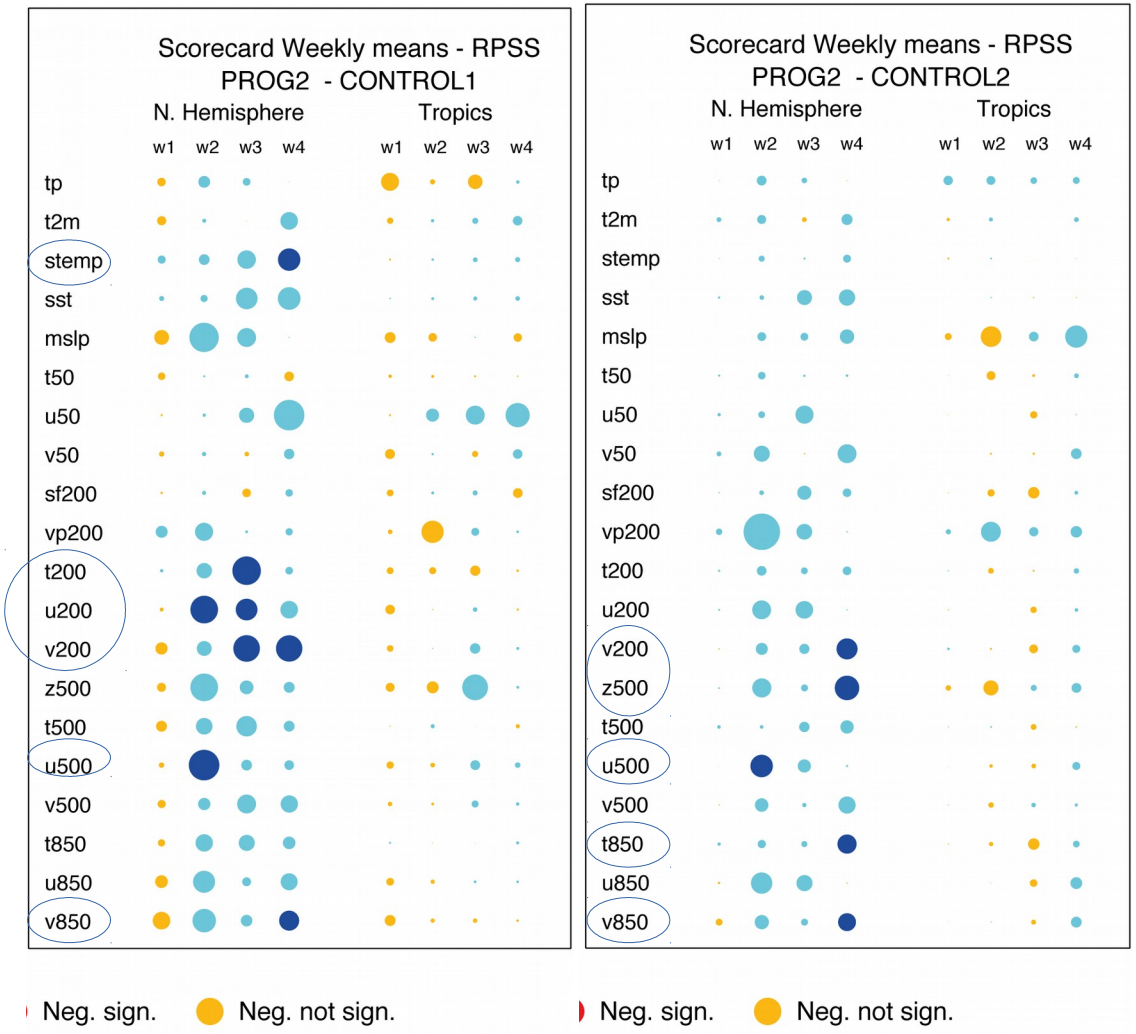
Importance of aerosols on S2S predictability

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



Benedetti and Vivart (2018, submitted)

Goals of the Project

- This project aims to improve our understanding about the following questions:

- How important are aerosols for predicting the physical system (at short-range, medium range and S2S time scales) as distinct from predicting the aerosols themselves?

- What are the current capabilities of NWP models to simulate aerosol impacts on weather and subseasonal prediction?

- How important is forecast skill (in the atmospheric sense) for air quality forecasting?

- Are the S2S air quality forecasts useful for impacts purposes?

S2S possible Re-forecast Experiments

Experiment 1: Dust prediction and impact

- Starting dates 1st March/1st April/1st 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 possible Re-forecast Experiments

Experiment 2: Biomass burning

- Starting dates 1st Aug/1st Sept/1st 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)

Limited area domain (focus on weather predictability)

Proposed years: 2016-2018
Forecast lenght: 72h from 00:00 UTC
Time resolution: 3h

Configuration: as in operation
Variables: see table

Event	Period	Domain	Center of domain	Effects to be analysed
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

Open tasks

● Define a reference database for model evaluation

● Verify reanalysis availability, like MACC and MERRAero (how is the access to such data and how feasible is the comparison considering different model configurations?)

- Verify availability of data from field campaigns (e.g. Oracles) and convert into data base suitable for model assimilation and verification

● Define specific statistical scores – mostly deterministic for the limited-area predictions at short-range time-scales and mostly probabilistic for the global forecasts at subseasonal time-scales

● Consider the evaluation of concentrations among models (important for local applications) and define specific statistical scores

● Define storage of data, format and delivery

Suggestions from the teleconference held September 14th

- Include North America in the regional experiments
- Evaluate emissions generated by each center using data from ORACLES over South Africa
- Increase the number of air quality variables
- Increase the forecast length to 5 days (120 hours)
- Define a time-line of the experiments

Thanks for your attention!