

SDS-WAS: ENSEMBLE PREDICTION OF AIRBORNE DUST

Gerardo GARCÍA-CASTRILLO Alfons Callado
Enric Terradellas

International Workshop on Middle East (Regional) Dust Sources and
Their Impacts
Istanbul Oct 23th-25th



Outline

- 1 **SDS-WAS Regional Center**

- 2 **Observations and Forecasts**

- 3 **Results**
 - Aerosol Optical Depth
 - Surface Concentration

- 4 **Conclusions and open issues**
 - Conclusions
 - Value Products

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SDS-WAS (NA-ME-E) Regional Center



NORTHERN AFRICA-MIDDLE EAST-EUROPE (NA-ME-E) REGIONAL CENTER
WASO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)

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Latest News

Severe sandstorms hit Central China
Jan 15, 2011

Service down for maintenance
27:08 GMT
Jan 16, 2011

Saniter dust over the U. S.
Jan 25, 2011

Upcoming Events

Chemistry-Climate Model (Global) Workshop
Jan 18, 2011

DUST 2011 International Conference on Atmospheric Dust
Jan 18, 2011

2011 Meeting of the SDS-WAS Regional Steering Group

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To be informed about our activities, news and events related to dust, frequency is almost monthly.

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Global Dust Forecasts

Forecast Station

Dust observations

sds-was.aemet.es



**Barcelona
Supercomputing
Center**

Centro Nacional de Supercomputación

Dust model inter-comparison



MODEL	RUN TIME	DOMAIN	DATA ASSIMILATION
CHIMERE	00	Global	No
LM DzT-INCA	00	Regional	No
CAMS-ECMWF	00	Global	MODIS AOD
BSC-DREAM8B V2.0	12	Regional	No
DREAM8-NMME	00	Regional	CAMS analysis
NMMB/BSC-DUST	12	Regional	No
MetUM	00	Global	MODIS AOD
GEOS-5	00	Global	MODIS reflectances
NGAC	00	Global	No
EMA REG CM4	00	Regional	No
DREAMABOL	00	Regional	No
NOA WRF-CHEM	12	Regional	No
FMI-SILAM	00	Global	No
LOTOS-EURO	00	Regional	MODIS AOD

Dust model inter-comparison

Dust Optical Depth 550 nm. Models runtime: 2 May 2016

Poor Man Ensemble

Dust Optical Depth 550 nm. Models runtime: 14 Oct 2017

The Objective

Toolboxes

- HARMONIE Verification Monitor - Deterministic
- HARP (Hirlam Aladdin R-based package) - Probabilistic



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Observations

Aerosol Optical Depth

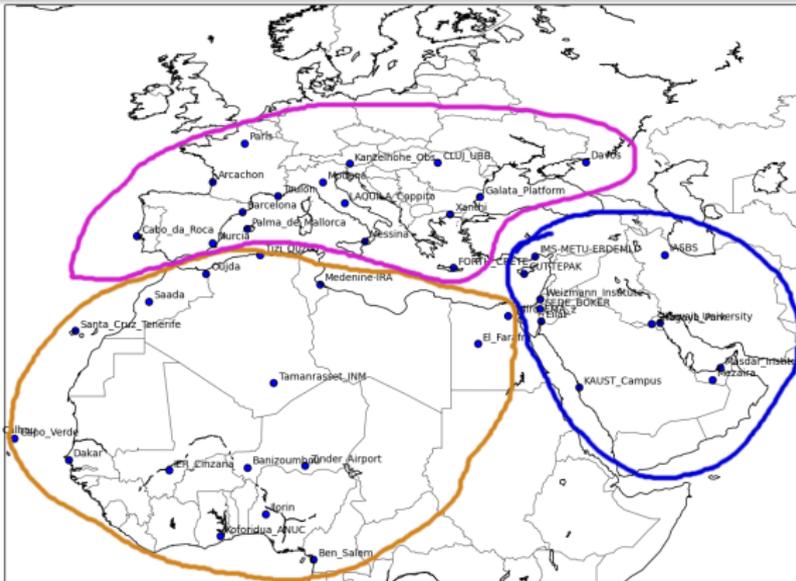
- April 2016 from Aerosol Robotic Network (AERONET)
- Thresholds 0.5, 1 and 2
- Daily Maximum, version 3 and level 1.5



Observations

Aerosol Optical Depth

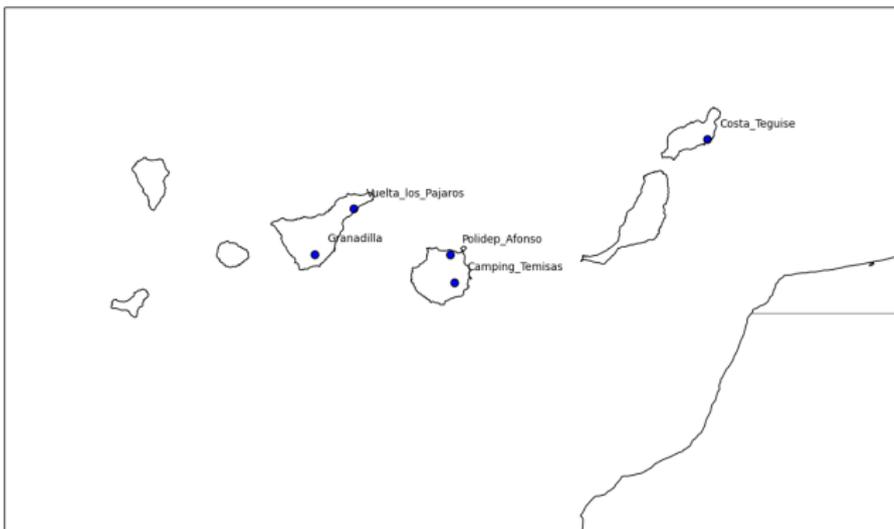
- April 2016 from Aerosol Robotic Network (AERONET)
- Thresholds 0.5, 1 and 2
- Daily Maximum, version 3 and level 1.5



Observations

Surface Concentration

- December 2014 AQMS from Canary Government
- Thresholds 50 and 90 $\mu\text{g}/\text{m}^3$
- Daily Maximum



Observations

Surface Concentration

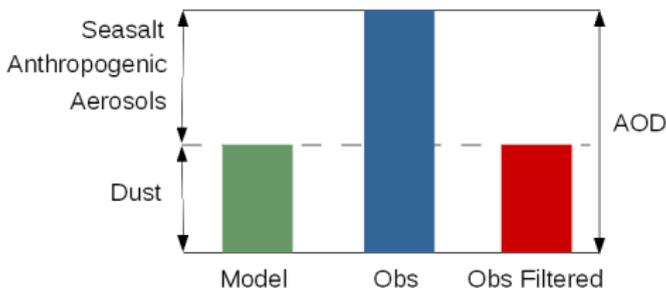
- December 2014 AQMS from Canary Government
- Thresholds 50 and 90 $\mu\text{g}/\text{m}^3$
- Daily Maximum



Dust optical depth

Previous concepts

- AOD_{550} can be dust, sea-salt, anthropogenic particles...



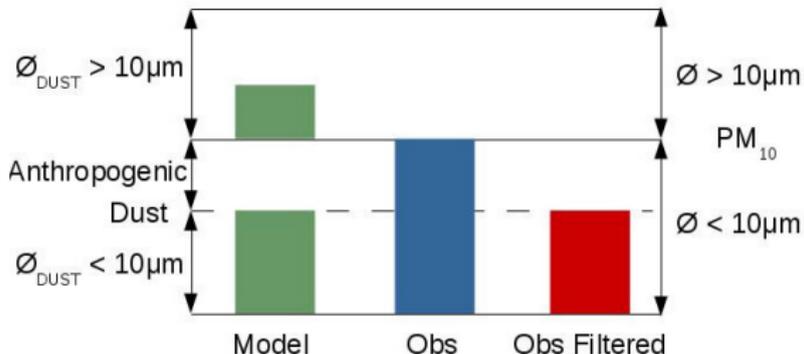
Methods

- NoFilter : Raw Observation
- Filter06 : Ångström exponent less than 0.6
- Coarse : AOD Coarse_fraction from AERONET
- Filter06_12 : Ångström exponent:
 - more than 1.2, AOD = 0
 - less than 0.6 (Filter06)

Dust surface concentration

Previous concepts

- Not all PM₁₀ is dust
- Models could include dust particles with a diameter larger than 10 μm



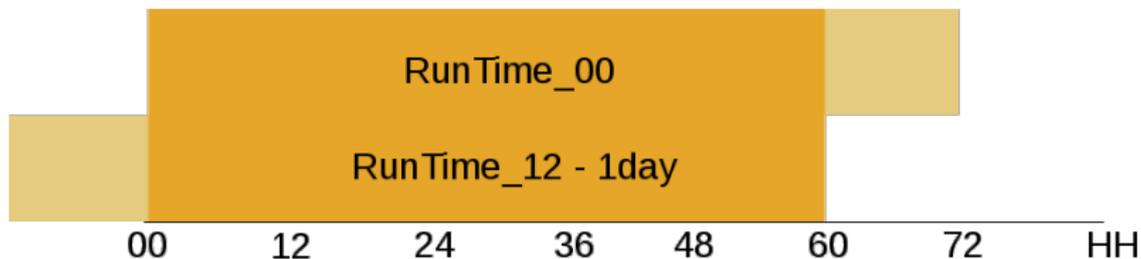
Methods

- NoFilter : Raw Observation
- PMcoarse : PM₁₀ - PM_{2.5}

Model Availability

Run Time

- 00 UTC - CAMS, GEOS-5, NGAC and so on.
- 12 UTC - BSC-DREAM8Bv2.0, MNNB/BSC-DUST and NOA WRF-CHEM



Verification Day: 04-04-2016

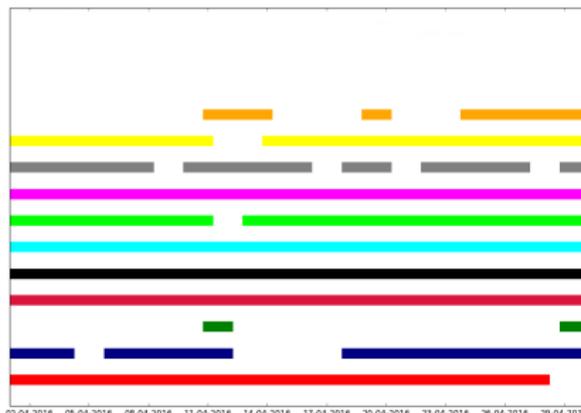
00 UTC 04-04-2016

12 UTC 03-04-2016

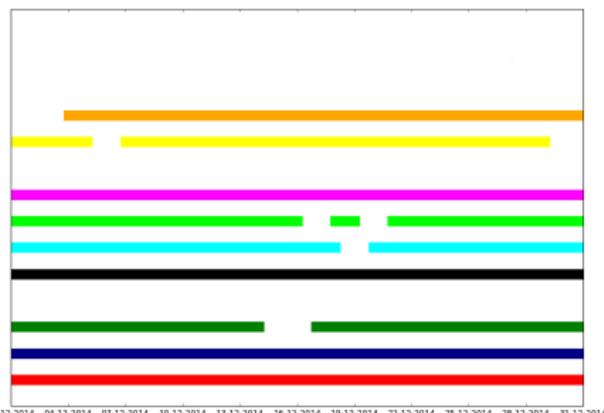
Model Availability

Run Time

- 00 UTC - CAMS, GEOS-5, NGAC and so on.
- 12 UTC - BSC-DREAM8Bv2.0, MNNB/BSC-DUST and NOA WRF-CHEM



April 2016



December 2014

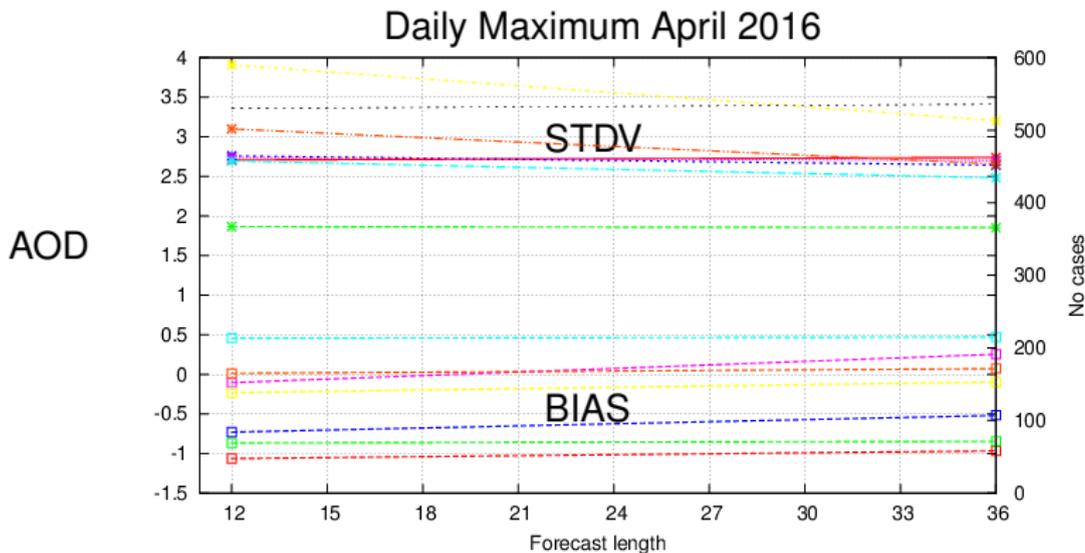
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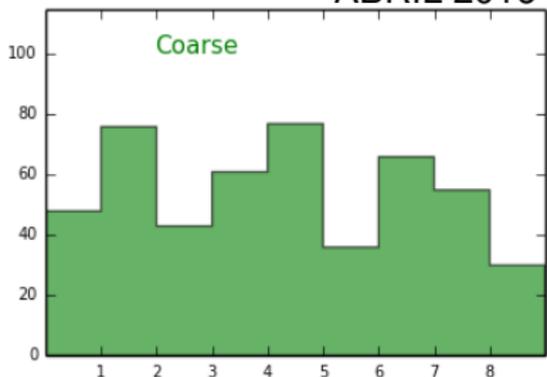
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Deterministic Verification

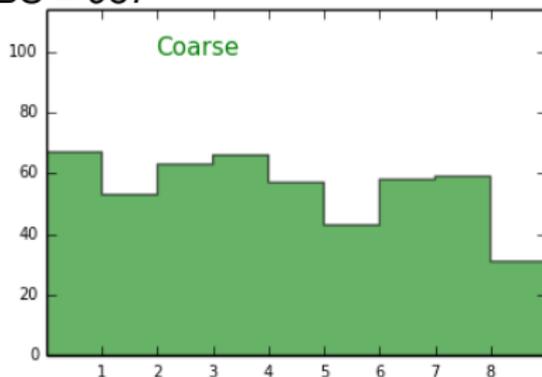


Probabilistic Verification : Rank Histogram (Talam)

AOD Daily Maximun
ABRIL 2016 NOBS = 987



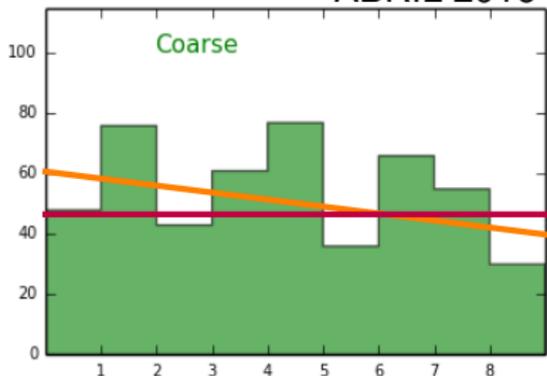
Leadtime = 12h



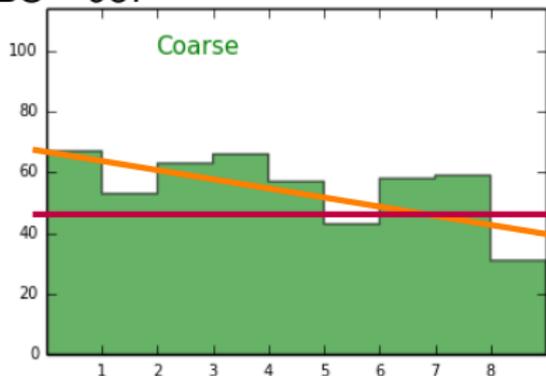
Leadtime = 36h

Probabilistic Verification : Rank Histogram (Talamam)

AOD Daily Maximun
ABRIL 2016 NOBS = 987



Leadtime = 12h



Leadtime = 36h

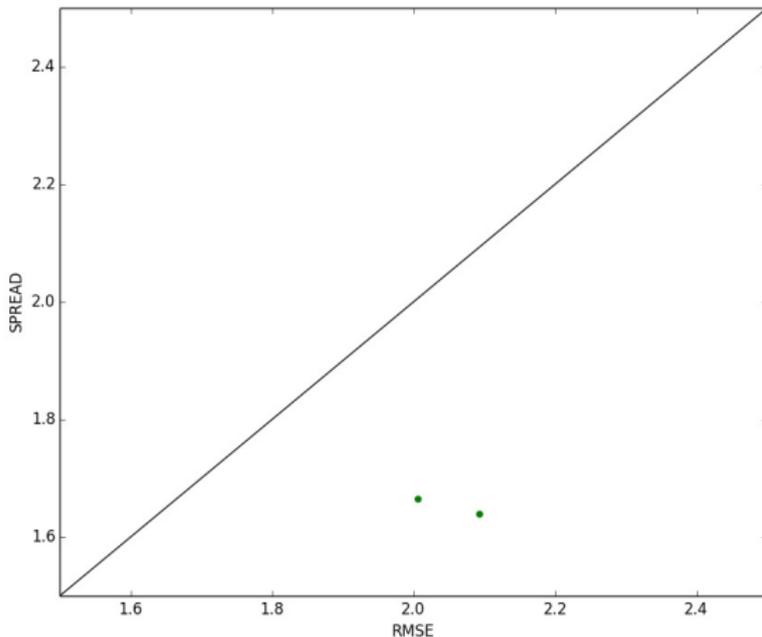
Ideal or Ensemble SPREAD about right to represent forecast

+ BIAS

NECESSARY BUT NOT SUFFICIENT TO KNOW ABOUT EPS
CONSISTENCY

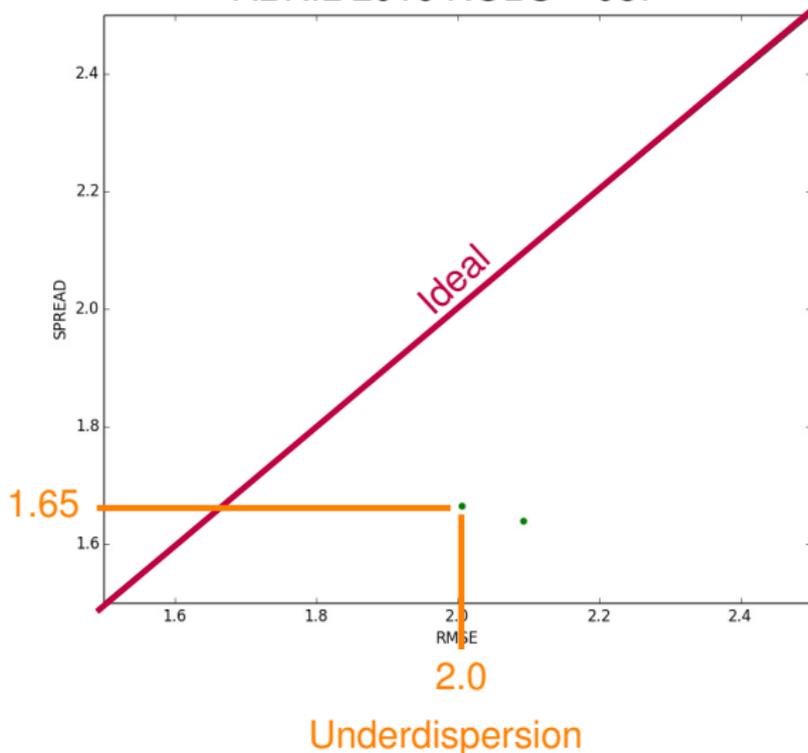
Probabilistic Verification : RMSE - SPREAD

AOD Daily Maximun
ABRIL 2016 NOBS = 987



Probabilistic Verification : RMSE - SPREAD

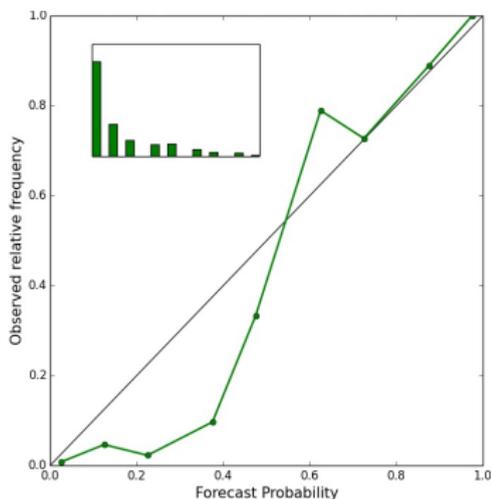
AOD Daily Maximun
ABRIL 2016 NOBS = 987



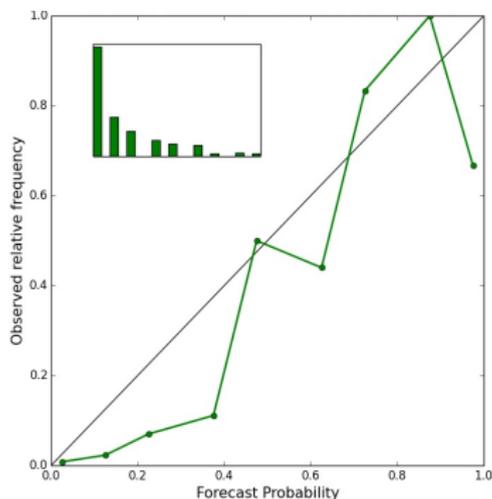
Probabilistic Verification : Reliability Diagram

AOD Daily Maximun
 ABRIL 2016 NOBS = 987
 Threshold = 0.5

Leadtime = 12h



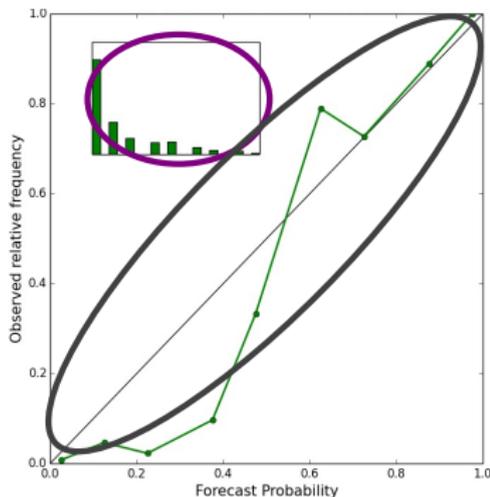
Leadtime = 36h



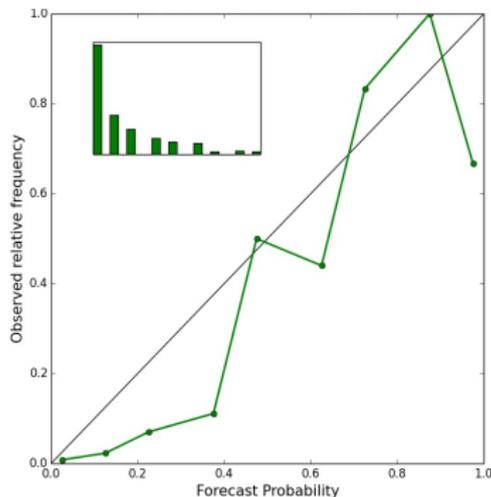
Probabilistic Verification : Reliability Diagram

AOD Daily Maximun
 ABRIL 2016 NOBS = 987
 Threshold = 0.5

Leadtime = 12h



Leadtime = 36h



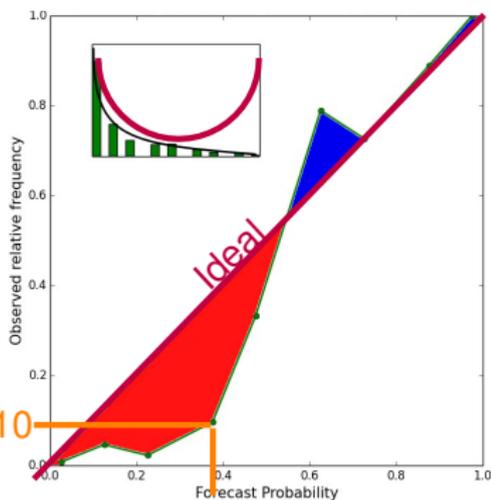
Sharpness - Tendency of the forecast to predict extreme values.

Reliability - The average agreement between the forecast and observation

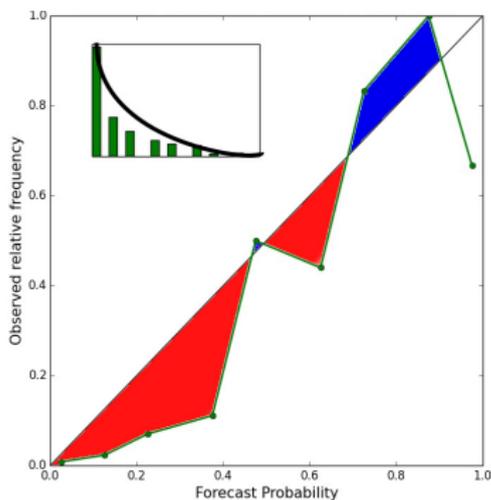
Probabilistic Verification : Reliability Diagram

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ABRIL 2016 NOBS = 987
Threshold = 0.5

Leadtime = 12h



Leadtime = 36h

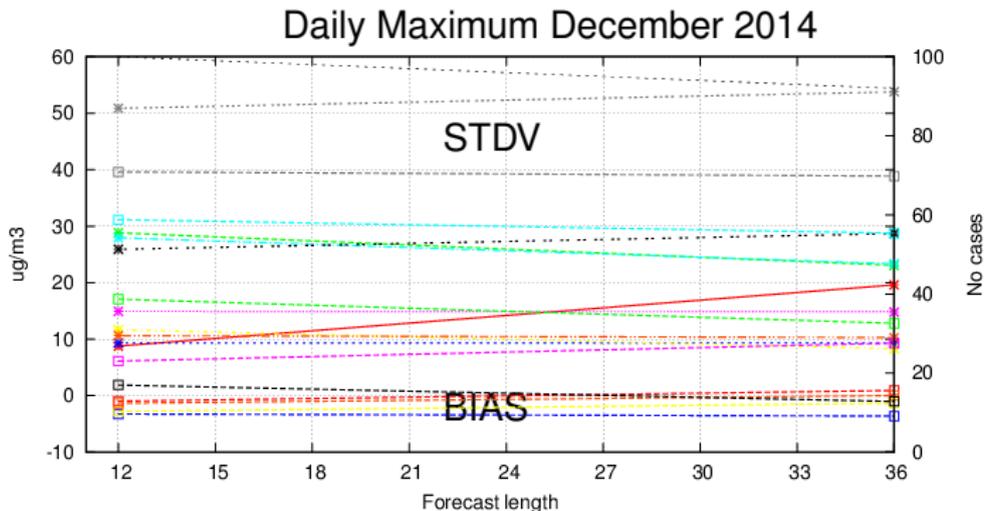


Overforecasting or + BIAS
Underforecasting or - BIAS
Typical Sharpness

Outline

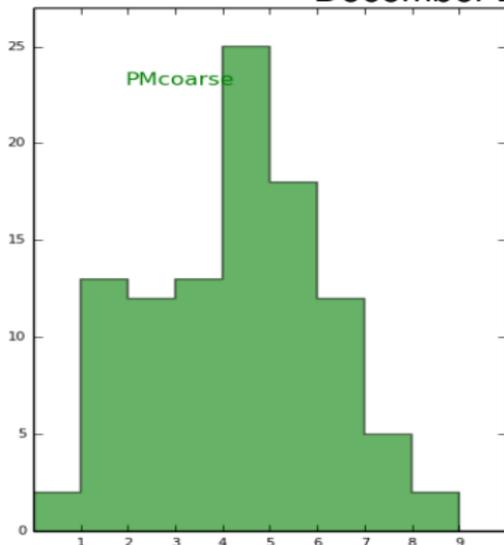
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Deterministic Verification

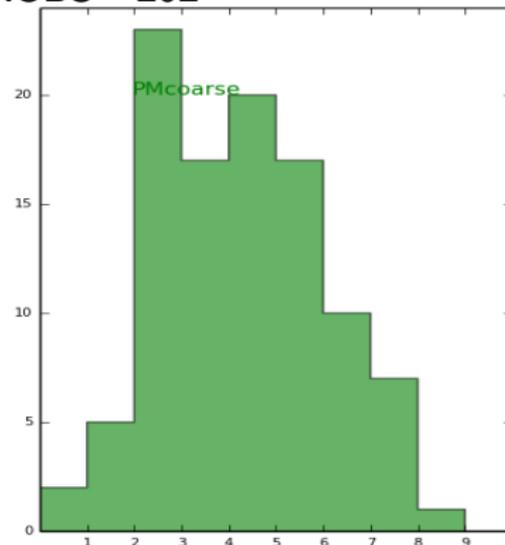


Probabilistic Verification : Rank Histogram (Talagram)

PM10 Daily Maximum December 2014 NOBS = 202



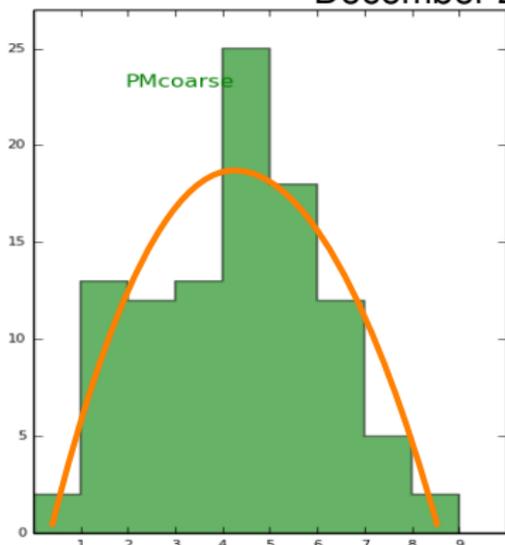
Leadtime = 12h



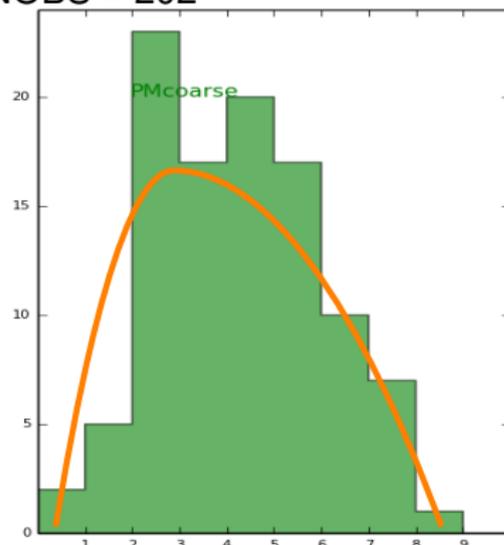
Leadtime = 36h

Probabilistic Verification : Rank Histogram (Talam)

PM10 Daily Maximum December 2014 NOBS = 202



Leadtime = 12h

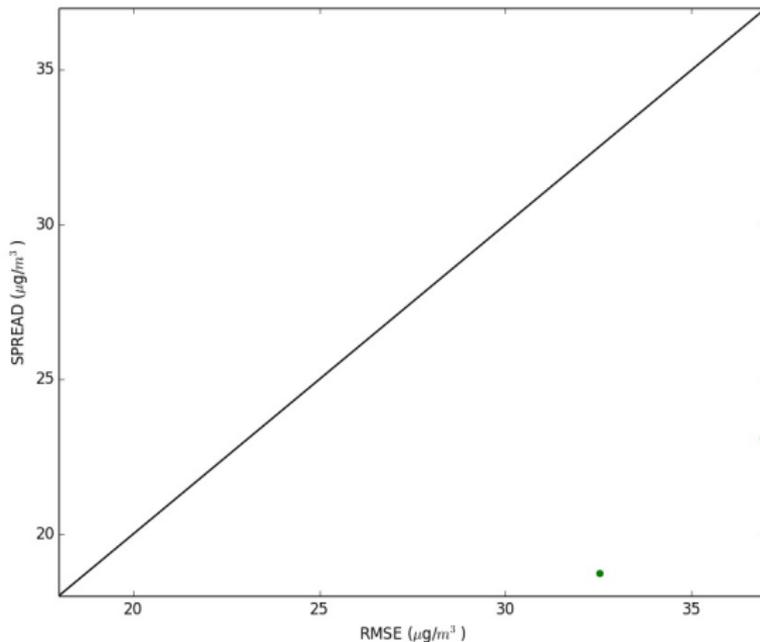


Leadtime = 36h

SPREAD TOO LARGE -> Models are very different
NECESSARY BUT NOT SUFFICIENT TO KNOW ABOUT EPS
CONSISTENCY

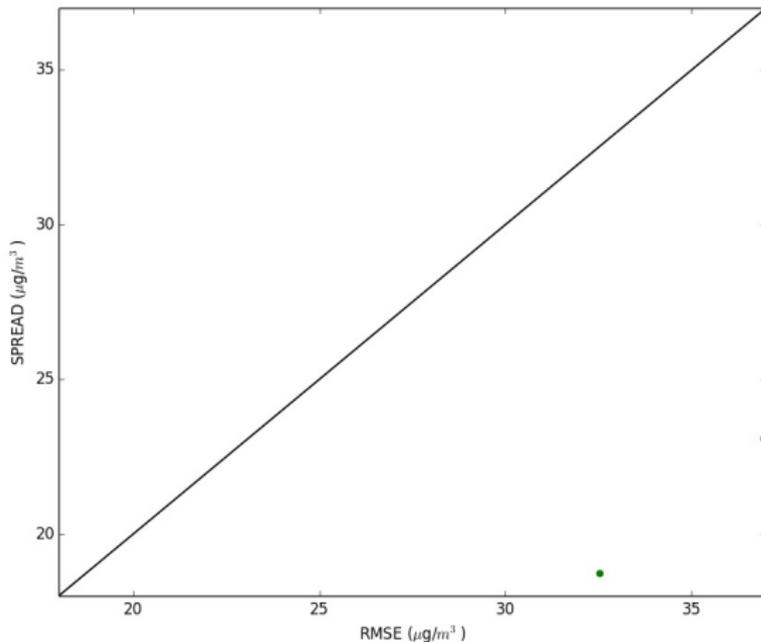
Probabilistic Verification : RMSE - SPREAD

PM10 Daily Maximum
December 2014 NOBS = 202



Probabilistic Verification : RMSE - SPREAD

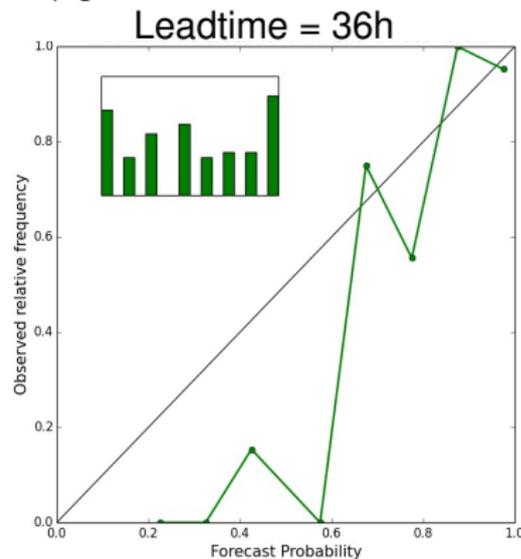
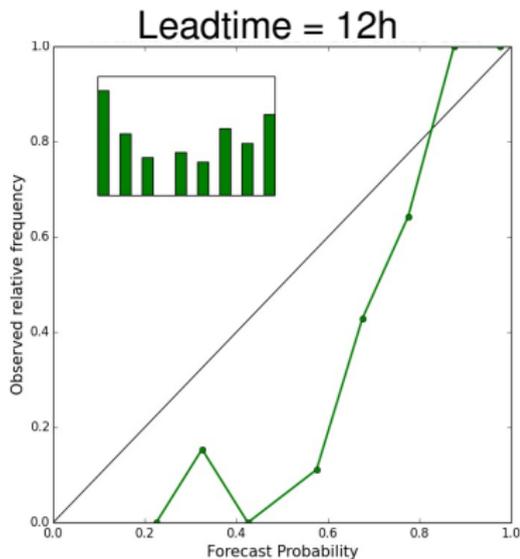
PM10 Daily Maximum
December 2014 NOBS = 202



Underdispersion

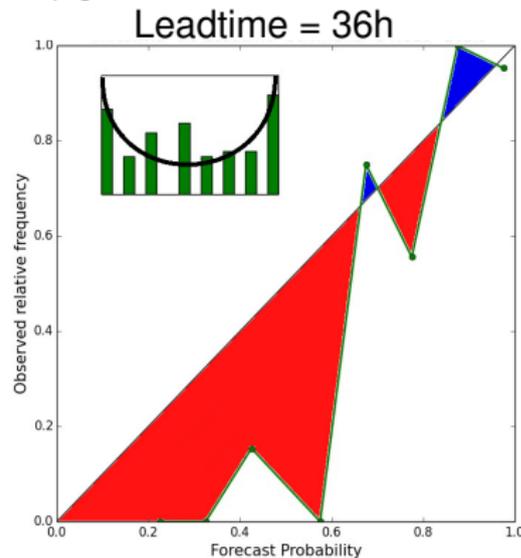
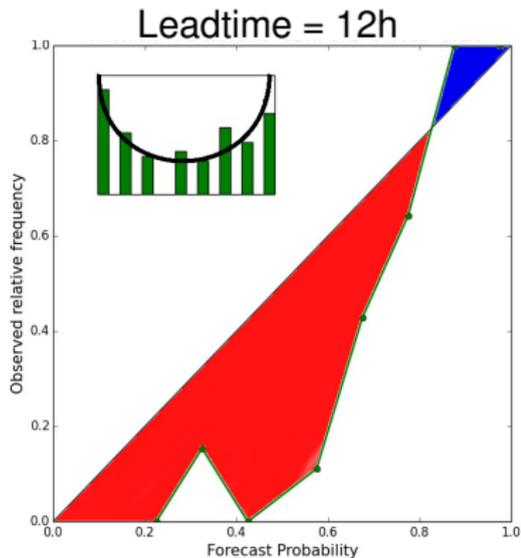
Probabilistic Verification : Reliability Diagram

PM10 Daily Maximum
December 2014 NOBS = 202
Threshold = $50 \mu\text{g}/\text{m}^3$



Probabilistic Verification : Reliability Diagram

PM10 Daily Maximum
December 2014 NOBS = 202
Threshold = $50 \mu\text{g}/\text{m}^3$



Overforecasting or + BIAS
Underforecasting or - BIAS
Poor Sharpness

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Conclusions

AOD

- Coarse, APRIL 2016 for NA-ME-E, ~ 45 stations
- + BIAS and SPREAD close to ideal
- Underdispersion (RMSE higher than SPREAD)
- Typical Sharpness
- Overforecasting in median-low probabilities and Underforecasting in high probabilities
- REGULAR CONSISTENCY -> BETTER WITH CALIBRATION?

Conclusions

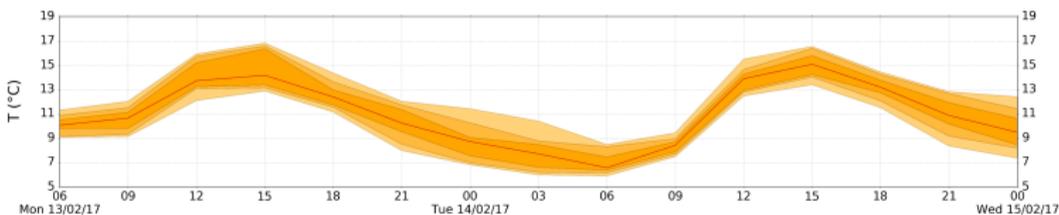
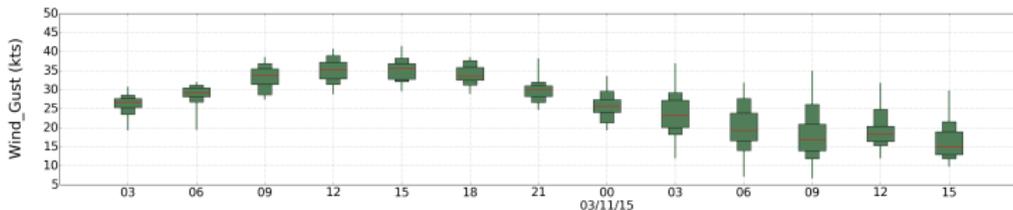
SFC

- PMcoarse, December 2014 for Canary Island, 5 stations
- SPREAD too large
- Underdispersion (RMSE higher than SPREAD)
- Poor Sharpness
- Overforecasting in high-median-low probabilities and Underforecasting in very high probabilities
- **BAD CONSISTENCY -> CALIBRATION**

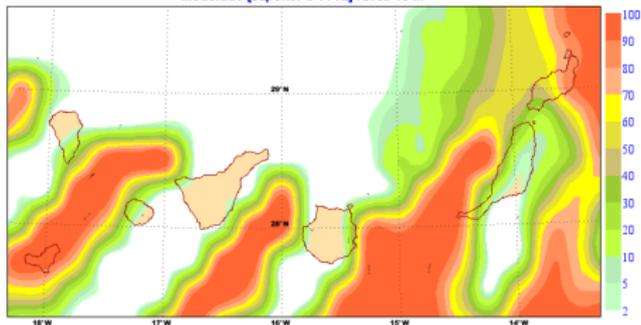
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Value Products



EPS (0.25°) 20170928 a 00 UTC. H+018. Validez: jueves, 28 de septiembre de 2017, a 18 UTC.
Probabilidad viento superior a umbrales
moderado [superior a 11 Kt] Nivel: 10 M



Thank you for your attention

<http://sds-was.aemet.es>

NORTHERN AFRICA-MIDDLE EAST-EUROPE (NA-ME-E) REGIONAL CENTER
WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)

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10 subsides on atmospheric mineral dust

Revised evaluation
Compared dust trends

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Water data and satellite
Aug 16, 2012

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EAC 2012
Sep 12, 2012 - Sep 17, 2012 - [View details](#)

2012 AIRS/ATM Interdisciplinary Scientific Conference
Sep 18, 2012 - Sep 21, 2012 - [View details](#)

8th International Symposium on Transboundary Pollution

Dust Forecasts

Compared Dust Forecasts
Revised Evaluation

Dust Observations

sdswas@aemet.es

Çok teşekkür ederim

