FAIRMODE
Forum for air quality modelling in Europe

CAMS – FAIRMODE WG8 Joint evaluation exercise
Natural Dust contribution to exceedances of limit values

Contribution from Malta

by Ruth Borg & Ariana Schembri.

Atmosphere Monitoring

7th CAMS policy user workshop

04 October 2023

Copernicus Europe's eyes on Earth

European Commission

ERA Environment & Resources Authority

Atmosphere Monitoring

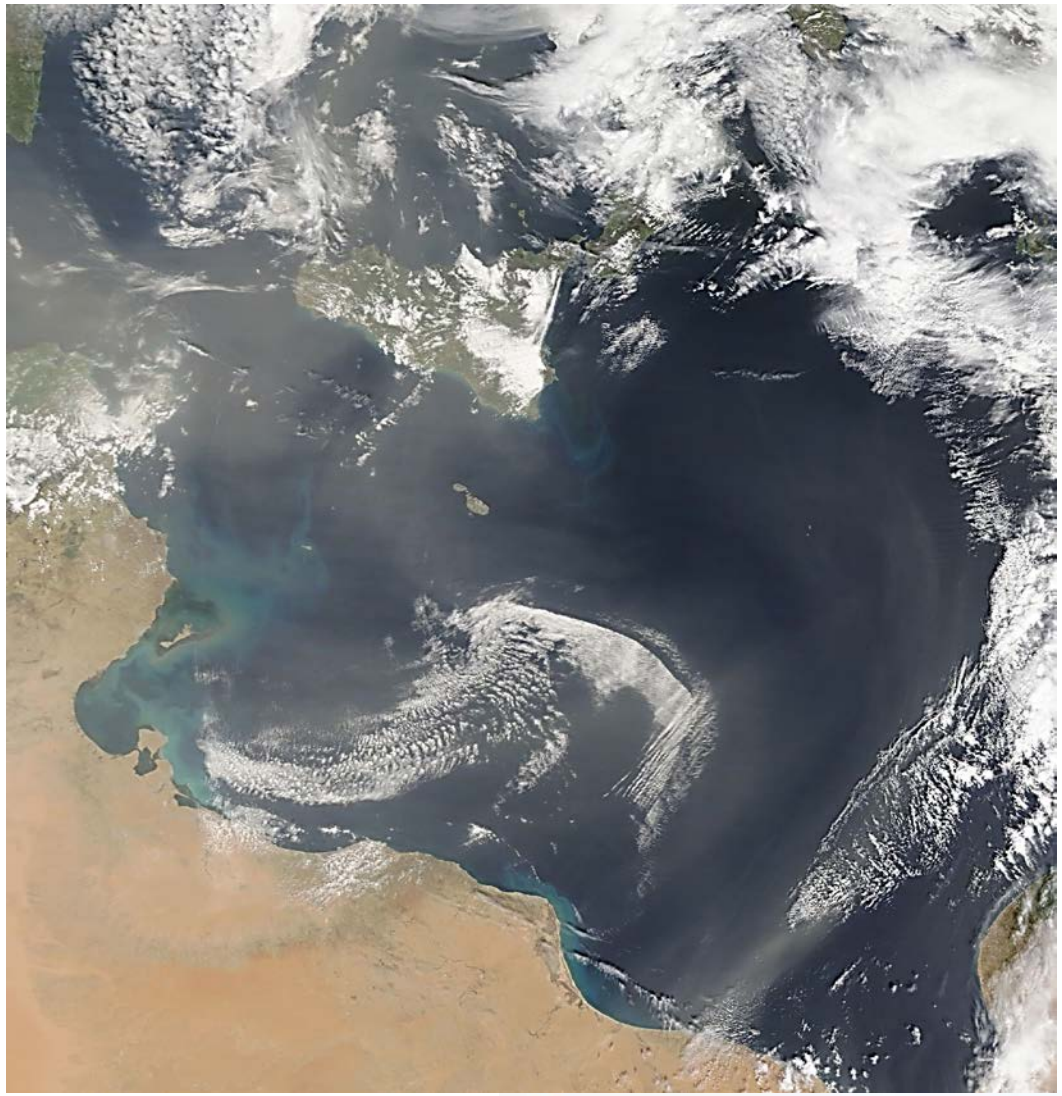
Episode selected and methods used

Episode period: 28th - 31st March 2022

- As discussed during the April session, several MS opted to analyse this episode since this was a common episode amongst many, including Malta.

- Currently methodology used: in accordance with the COMMISSION STAFF WORKING PAPER establishing guidelines for demonstration and subtraction of exceedances attributable to natural sources under the AAQD

- Testing CAMS dust products:
  - E1a - Interim re-analysis DUST/PM_{10}
  - E1a - Forecast DUST/PM_{10}
  } Daily means
  - CAMS Global Dust
  - CAMS Regional forecast dust
  - CAMS Regional Re-analysis for PM_{10} Dust Fraction
  - CAMs Regional PM_{10} Re-analysis



FAIRMODE Forum for air quality modelling in Europe

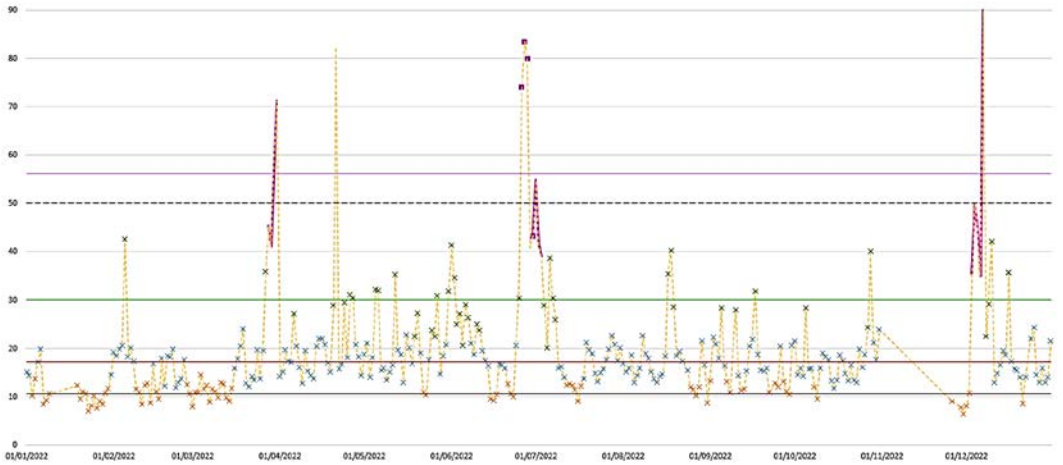
Copernicus Europe's eyes on Earth

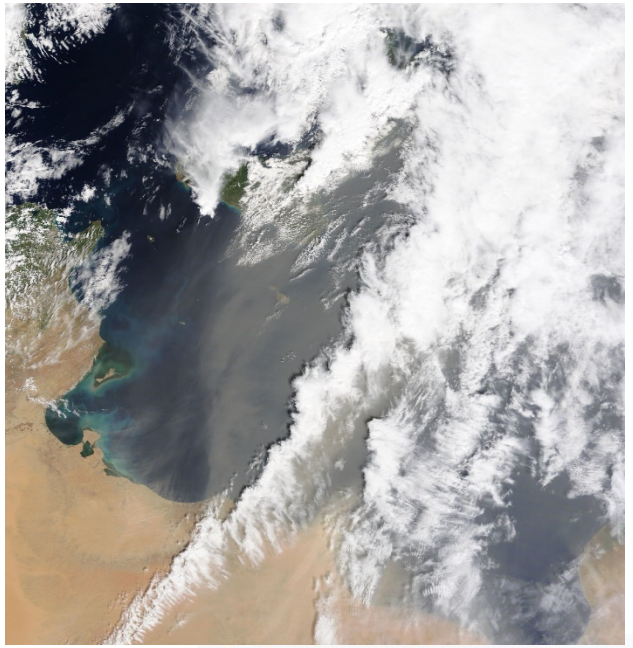
European Commission

Natural Dust contribution – Current method

Atmosphere Monitoring

- After verification, the PM_{10} daily averages measured in our rural background station in Gharb and our traffic station in Msida are plotted;
- Due to the homogeneity of the two datasets we analyse the highest concentrations monitored at both stations;
- The identification of Saharan episode is then confirmed by using the method described by ***Gómez – Losada et al (2016),*** which uses ***Hidden Markov Models*;**
- PM_{10} concentration regimes are determined by this model which are attributed to different sources or groups of sources;
- The PM_{10} values grouped by these regimes are plotted accordingly and those which exceed the daily limit value are further analysed using ***NASA Worldview Snapshot***, ***NOAA HYSPLIT single-particle backward trajectories*** and ***Ensemble Forecasts*** provided by the Barcelona Dust Regional Centre.





FAIRMODE
Forum for air quality modelling in Europe

Copernicus
Europe's eyes on Earth

European Commission

Atmosphere Monitoring

Natural Dust contribution – Current method

- As described in the CION working paper, the regional and temporary background concentration is determined by averaging the background measurements approximately 15 days before and after each particular episode;
- The resulting surplus is then subtracted from the respective episode values of Gharb station and Msida station;
- Sea salt is also deducted from the PM_{10} value without Saharan dust

Dates	PM_{10} value before correction (µg/m³)	Calculated PM_{10} dust contribution – Current method (µg/m³)	PM_{10} value after deduction of dust contribution (µg/m³)	PM_{10} value without natural contribution (µg/m³) (sea salt and Sahara dust)
28/03/2022	67.5	28.12	39.38	35.4
29/03/2022	53.8	23.82	29.98	27.8
30/03/2022	66.8	43.32	23.48	16
31/03/2022	99	54.02	44.98	40.89

Zejtun urban background station data

Copernicus Europe's eyes on Earth

European Commission

Natural Dust contribution – CAMS method

Atmosphere Monitoring

Atmosphere Monitoring

Malta has applied three different methodologies:

1) Assumption that the DUST data is made up of Saharan dust only without the inclusion of anthropogenic dust (resuspension), agricultural dust, etc.

$$PM_{NDD} = PM_{10}total - PM_{10}DUST$$

2) Estimating the share of natural dust in the FC and IRA using actual monitored Saharan dust fractions by dividing the monitored Saharan dust by Malta's monitored total $PM_{10,}$ apply that % share to the IRA/FC PM_{10}_total and subtracting the estimated Saharan dust fraction.

$$PM_{ratio} = (MT_{Sahara}/MT\_PM_{10}\,total)$$

$$PM_{NDD} = PM_{10}total - PM_{ratio}$$

3) Calculating a bias between Malta monitored data vs PM_{10}_total and deducting that same bias from the PM_{10}_total.

$$PM_{BIAS} = MT\_PM_{10}total - PM_{10}total$$

$$PM_{NDD} = PM_{10}total - PM_{BIAS}$$

FAIRMODE
Forum for air quality modelling in Europe

Copernicus Europe's eyes on Earth

European Commission

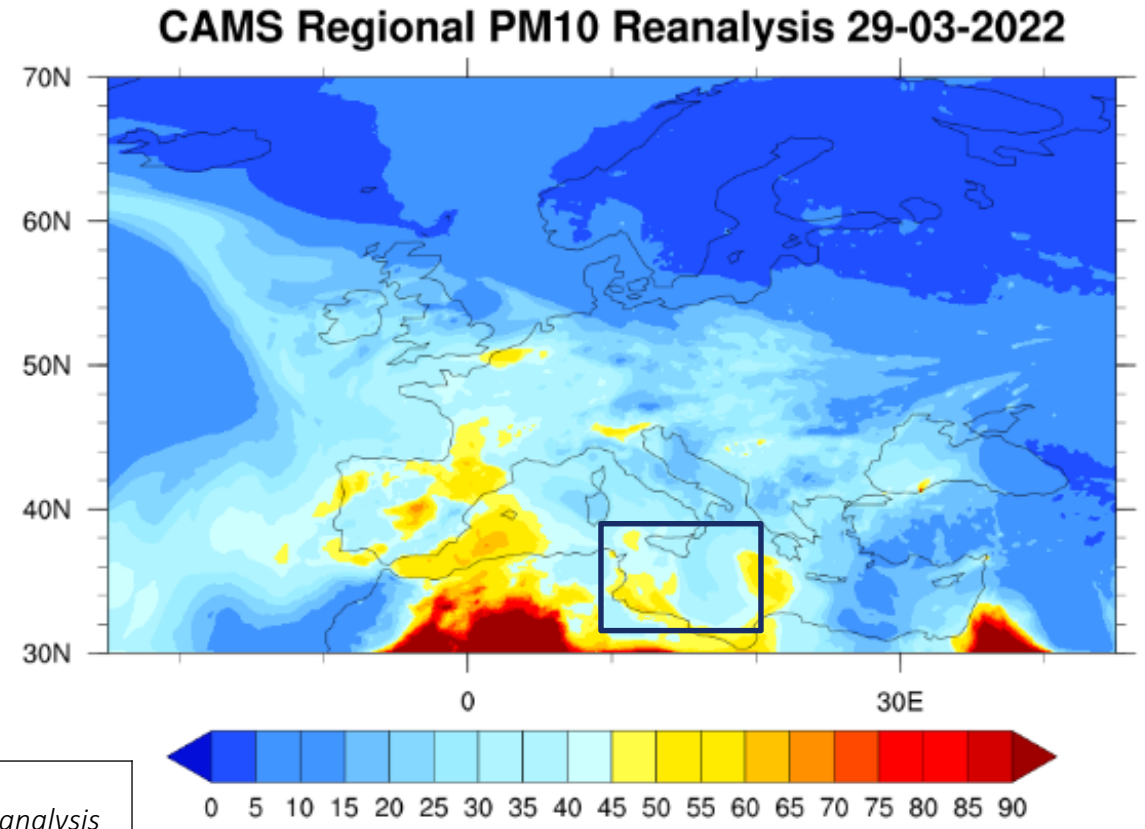
Method number	Date	PM10 value before correction			Calculated PM10 dust contribution – «Current method»	Calculated PM10 dust contribution – «CAMS based method»		PM10 Concentration with NDD		
		FC	*IRA*	*MT*		*FC*	*IRA*	*FC*	*IRA*	*MT*
1	28/03	56.1	48.9	58.6	28.12	38.4	32.6	17.7	16.3	39.38
	29/03	55.5	41.3	59.1	23.82	32.6	20.3	22.9	21.0	29.98
	30/03	86.1	52.6	81.8	43.32	61.1	35.8	25.0	16.8	23.48
	31/03	92.0	81.8	77.0	54.02	75.7	69.6	16.2	12.3	44.98
2	28/03	56.1	48.9	58.6	28.12	23.4	20.4	21.3	18.5	39.38
	29/03	55.5	41.3	59.1	23.82	24.6	18.3	23.3	17.3	29.98
	30/03	86.1	52.6	81.8	43.32	55.8	34.1	24.5	14.9	23.48
	31/03	92.0	81.8	77.0	54.02	50.2	44.7	22.2	19.7	44.98
3	28/03	56.1	48.9	58.6	28.12	11.4	18.6	44.7	30.2	39.38
	29/03	55.5	41.3	59.1	23.82	-1.7	12.5	53.8	53.8	29.98
	30/03	86.1	52.6	81.8	43.32	-19.3	14.2	66.8	66.8	23.48
	31/03	92.0	81.8	77.0	54.02	7.0	17.2	85.0	64.7	44.98

Main questions to be discussed

Atmosphere Monitoring

- The resolution for the CAMS PM_{10} Natural Dust Viewer is not optimal for Malta:
  - To include the boundary for Malta at this resolution
  - Provide better resolution – zooming in function would be ideal

- At this extent we can only observe ranges since colours overlap where we believe MT to be.



Date	*MT official Data*	*Regional Forecast Dust*	*Global Dust*	*Regional Reanalysis for PM10 Dust Fraction*	*Regional PM10 Reanalysis*
28/03/22	45.3	40-50	20-30	50-55	65-75
29/03/22	41	40-45	55-65	30-40	35-45
30/03/22	60.5	60-65	45-55	25-30	50-60
31/03/22	71.2	70-80	85-90+	65-75	75-90+

Data from Msida traffic station

FAIRMODE
Forum for air quality modelling in Europe

Copernicus
Europe's eyes on Earth

European Commission

Atmosphere Monitoring

Lessons learned, limitations and next steps

- The ***second*** methodology was determined to be the most appropriate out of all three. However, the main reason for this is because we are applying the actual monitored Sahara dust to PM_{10} ratio and deducting it from the PM_{10} total of both IRA and FC;
- DUST portion includes all types of dust so without knowing the actual $\%^{age}$ share, other methodologies have to be used;
- Modelling might provide over/under estimates if it takes into consideration gridded regional background;
- Comparisons with modelled CAMS concentrations (not-verified) are being analysed against verified monitored data.
- Malta is not visible on the viewer, so a zooming in option (which can enlarge the extent) would be more appropriate for us to compare with CAMS data.

Next steps

- Review other MS methodologies and potentially make use of these methods and compare.

Thank you!

Copernicus
Europe's eyes on Earth

European Commission

FAIRMODE
Forum for air quality modelling in Europe