Bioclimatologia humana – 24.04.2023

Qualidade do ar e saúde humana. Aspetos gerais. O caso das intrusões de poeiras.

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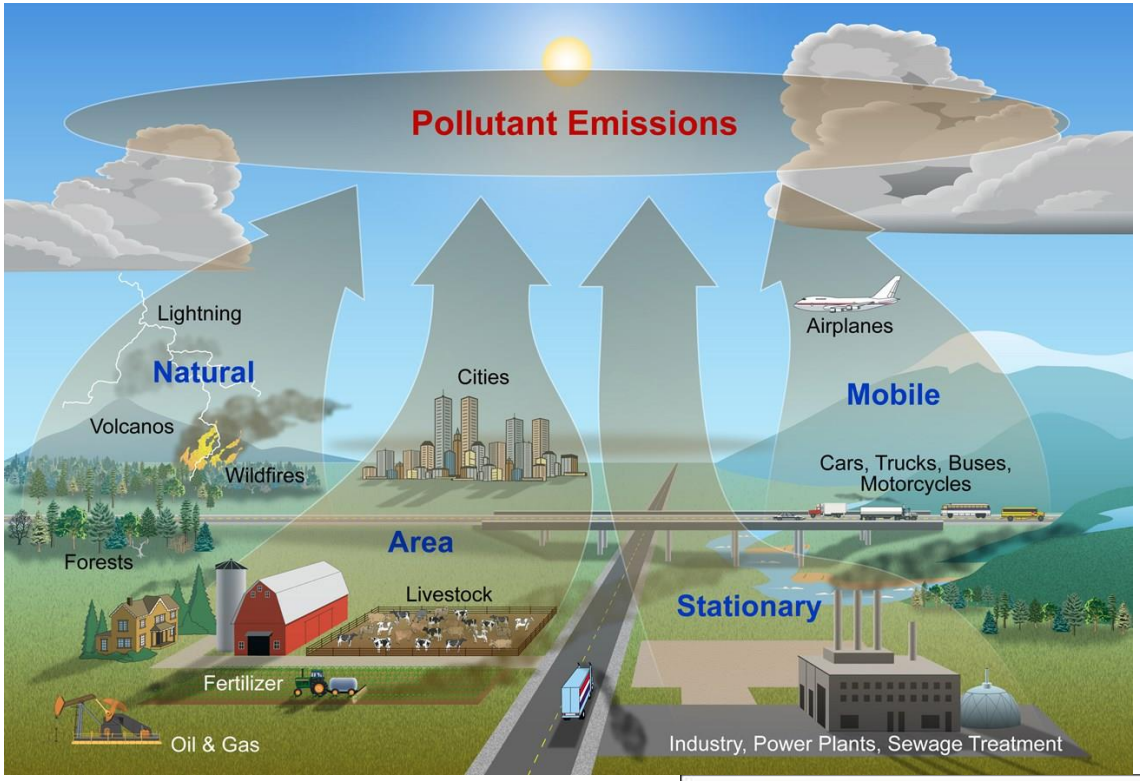
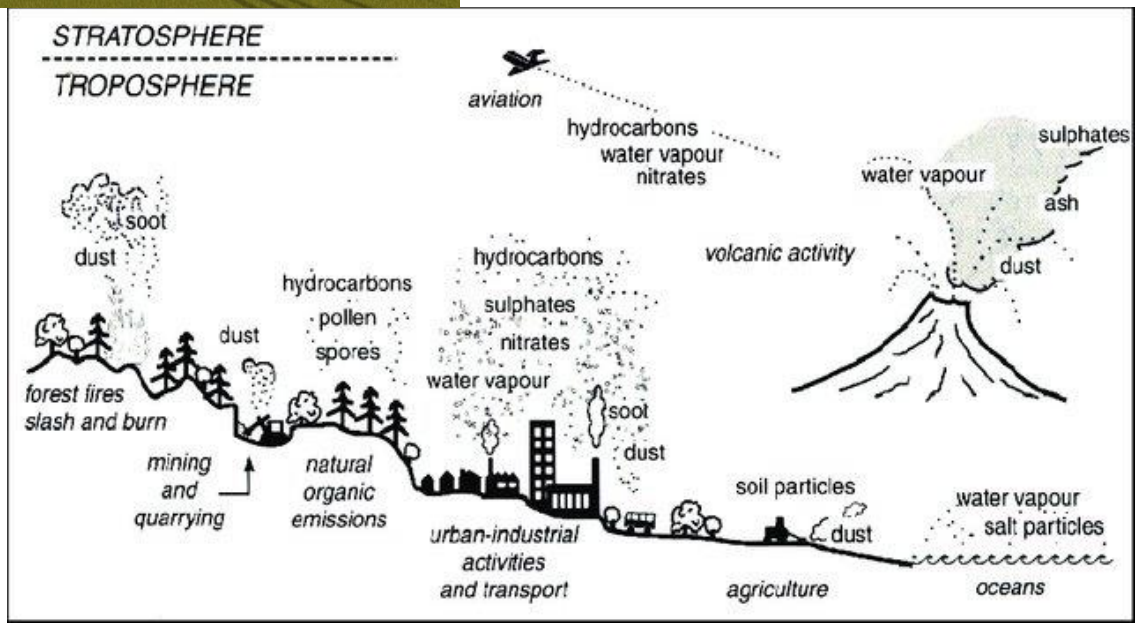
4. Impactos da poluição atmosférica na saúde
5. As intrusões de poeiras norte-africanas e os seus impactos na saúde: o caso do Sul de Portugal

Introdução

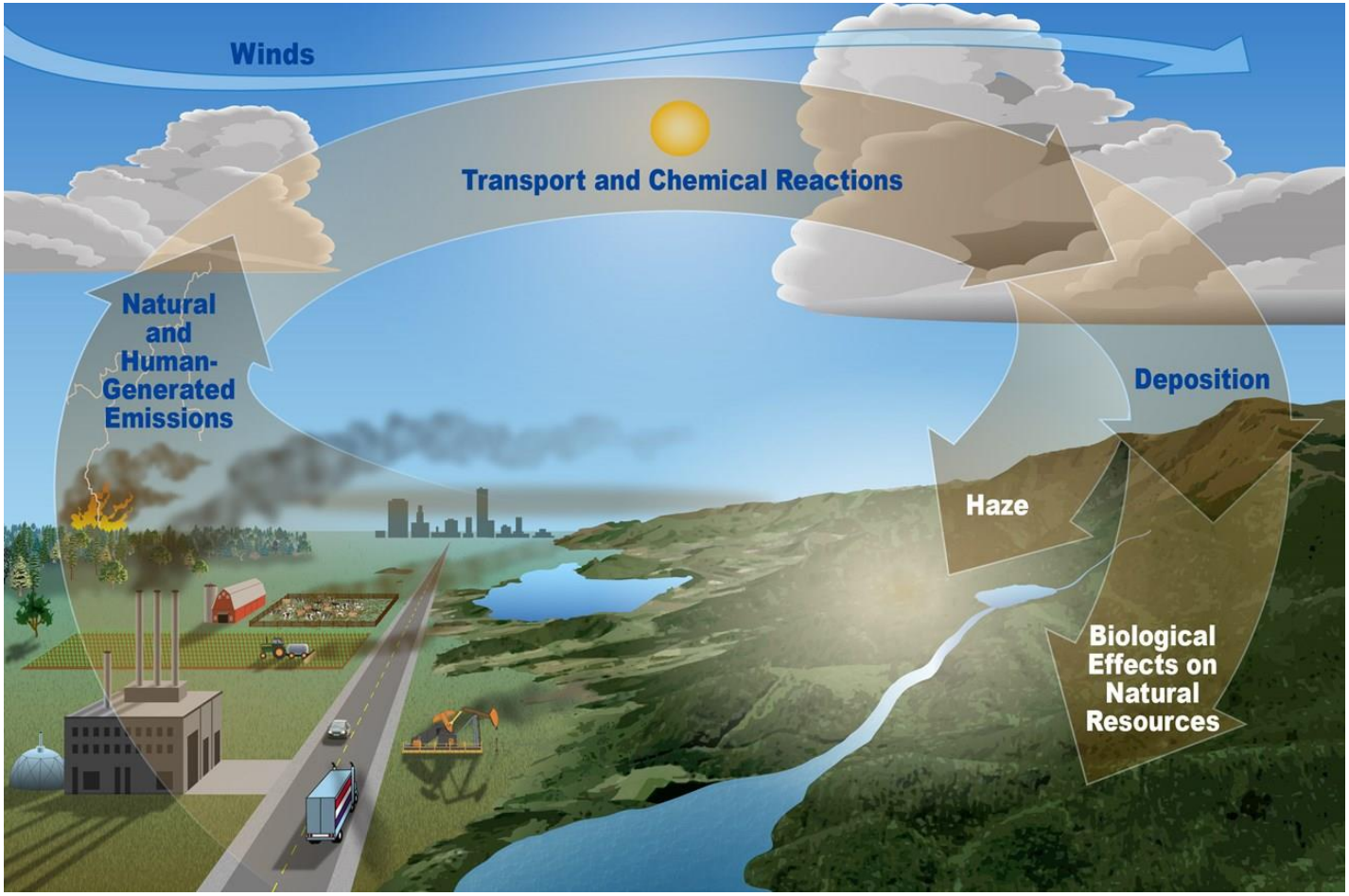
Fontes emissoras



Fonte: https://www.nps.gov/subjects/air/sources.htm

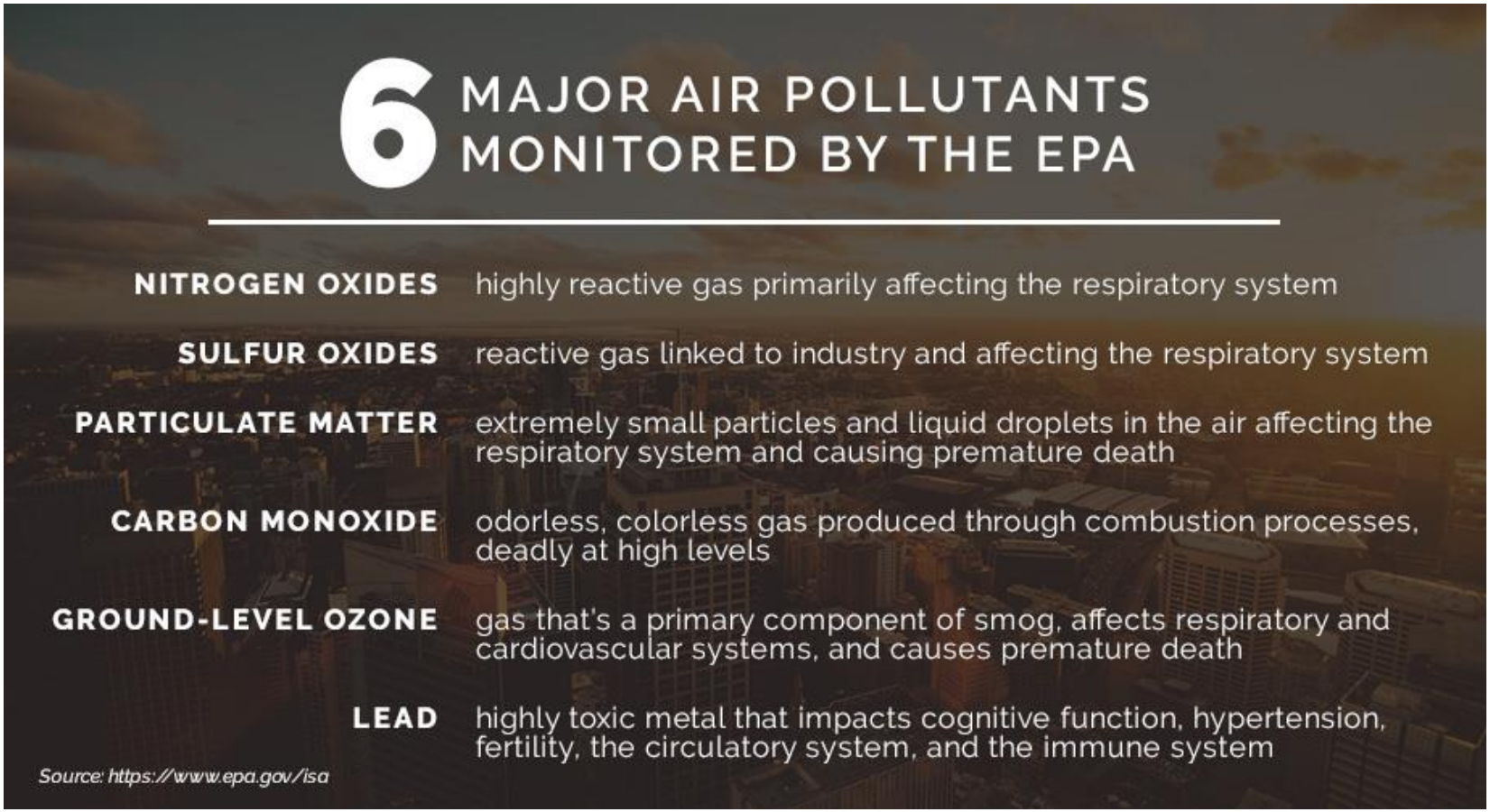


Fonte: Kemp (2004)



Fonte: https://www.nps.gov/subjects/air/sources.htm

Principais poluentes atmosféricos



Partículas (matéria particulada)

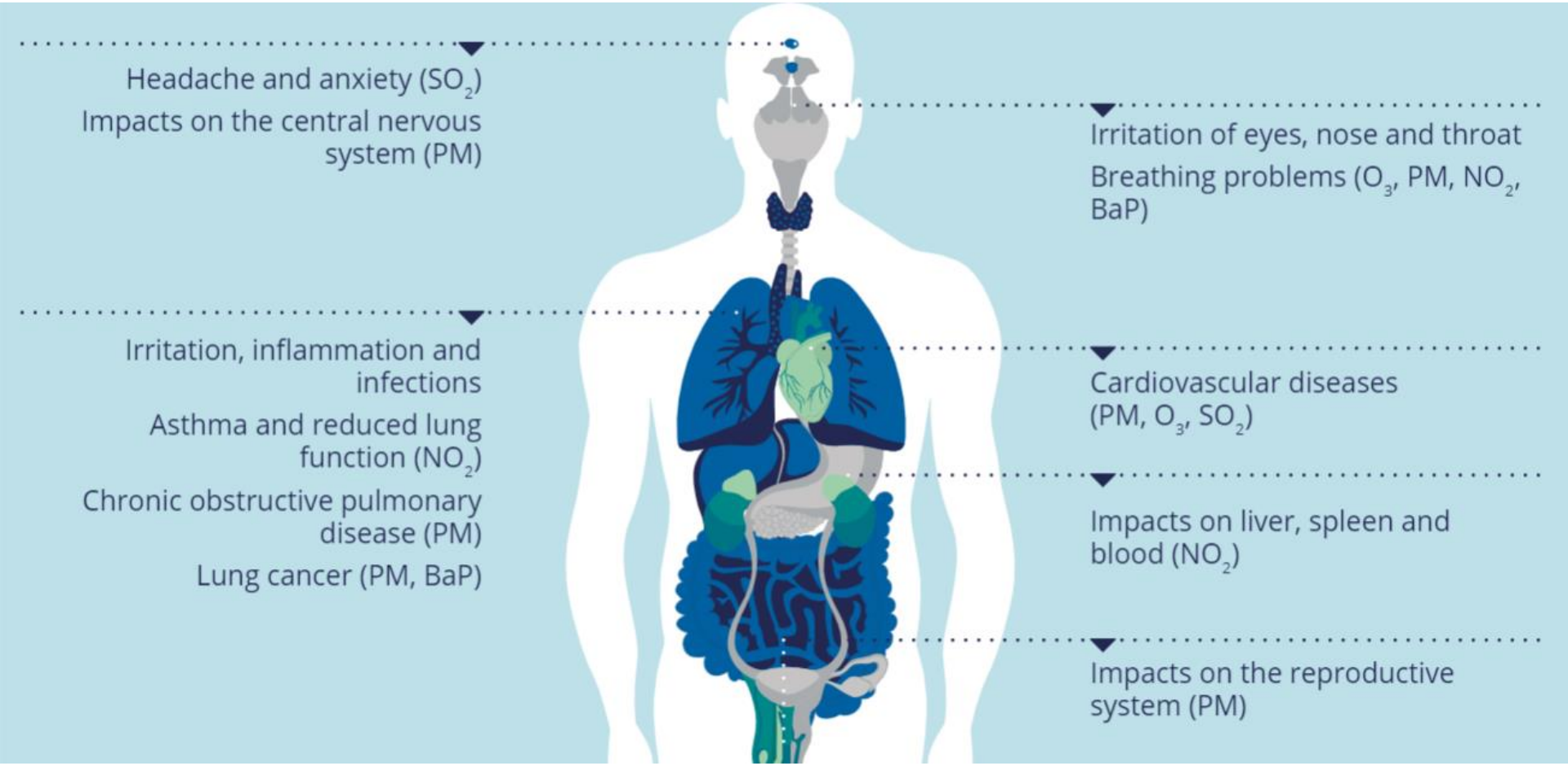
Particle size	Penetration degree in human respiratory system
>11 μm	Passage into nostrils and upper respiratory tract
7–11 μm	Passage into nasal cavity
4.7–7 μm	Passage into larynx
3.3–4.7 μm	Passage into trachea-bronchial area
2.1–3.3 μm	Secondary bronchial area passage
1.1–2.1 μm	Terminal bronchial area passage
0.65–1.1 μm	Bronchioles penetrability
0.43–0.65 μm	Alveolar penetrability

Fonte: Manisalidis *et al.,* (2020)

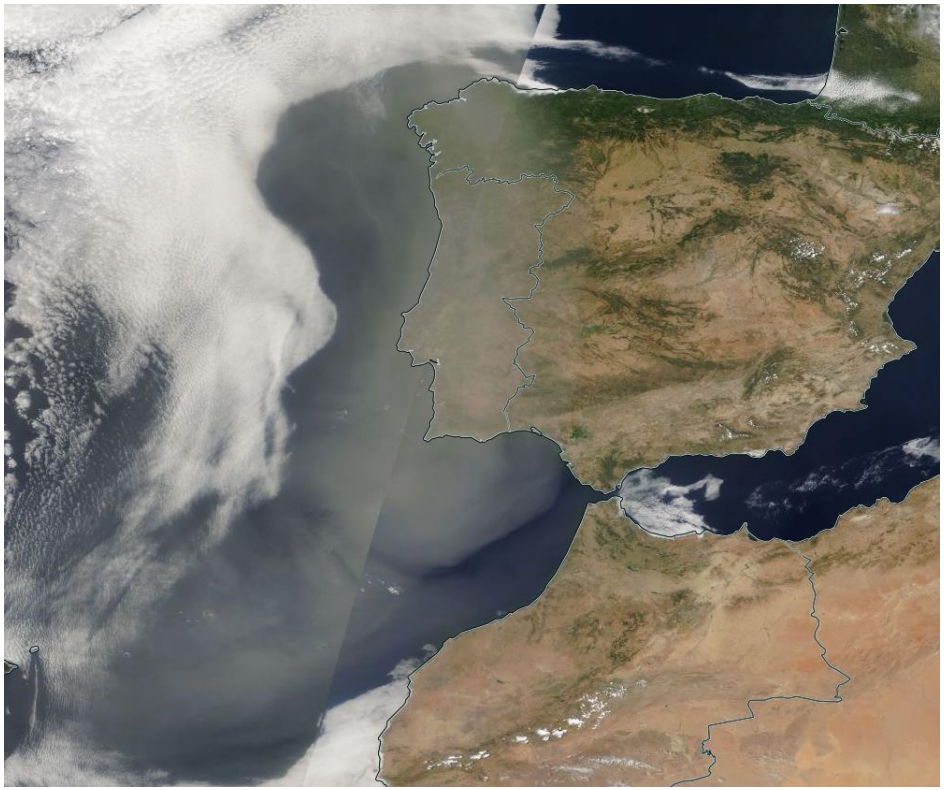
Type		PM diameter [μm]
Particulate contaminants	Smog	0.01–1
	Soot	0.01–0.8
	Tobacco smoke	0.01–1
	Fly ash	1–100
	Cement Dust	8–100
Biological Contaminants	Bacteria and bacterial spores	0.7–10
	Viruses	0.01–1
	Fungi and molds	2–12
	Allergens (dogs, cats, pollen, household dust)	0.1–100
Types of Dust	Atmospheric dust	0.01–1
	Heavy dust	100–1000
	Settling dust	1–100
Gases	Different gaseous contaminants	0.0001–0.01

Fonte: Manisalidis *et al.,* (2020)

Impactos na saúde da poluição do ar



Fonte: EEA, "Healthy environment, healthy lives ," 2019



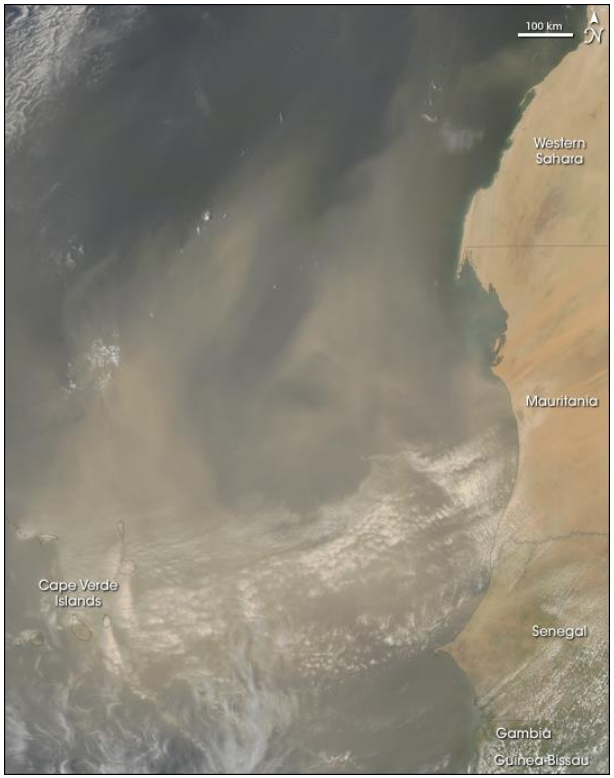
5. As intrusões de poeiras norte-africanas e os seus impactos na saúde: o caso do Sul de Portugal

5.1. Introdução

Tempestades de poeiras

materiais de tamanho **siltoso** ou **argiloso**) são mobilizados e transportados na atmosfera ao longo de grandes distâncias.

eventos integram três fases: a **emissão** dos materiais da superfície, o seu **transporte** e a **deposição**.



Fonte: https://archive.org/details/WestAfrica.A2005200

Dust cycle

(Shao et al., 2011)

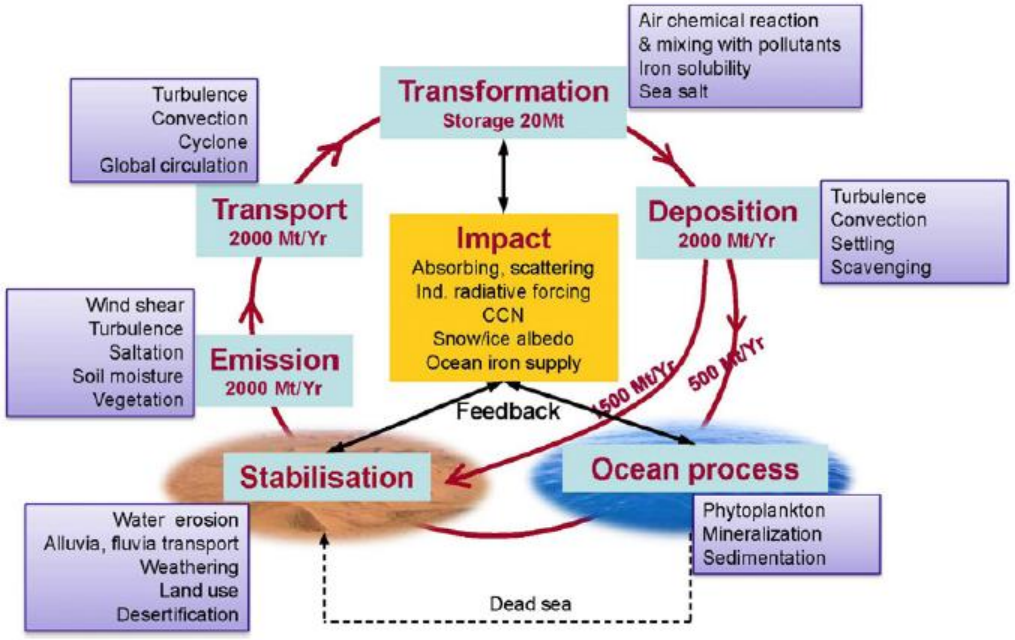
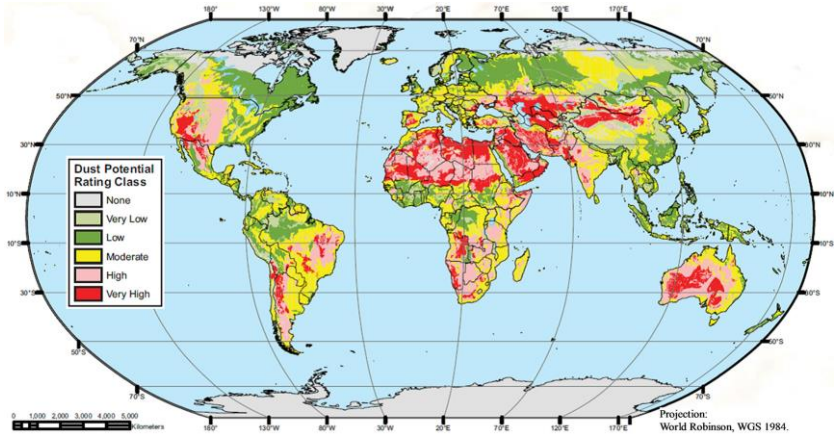


Fig. 2. An illustration of the dust cycle in the Earth system and the main processes in which dust plays an important role.

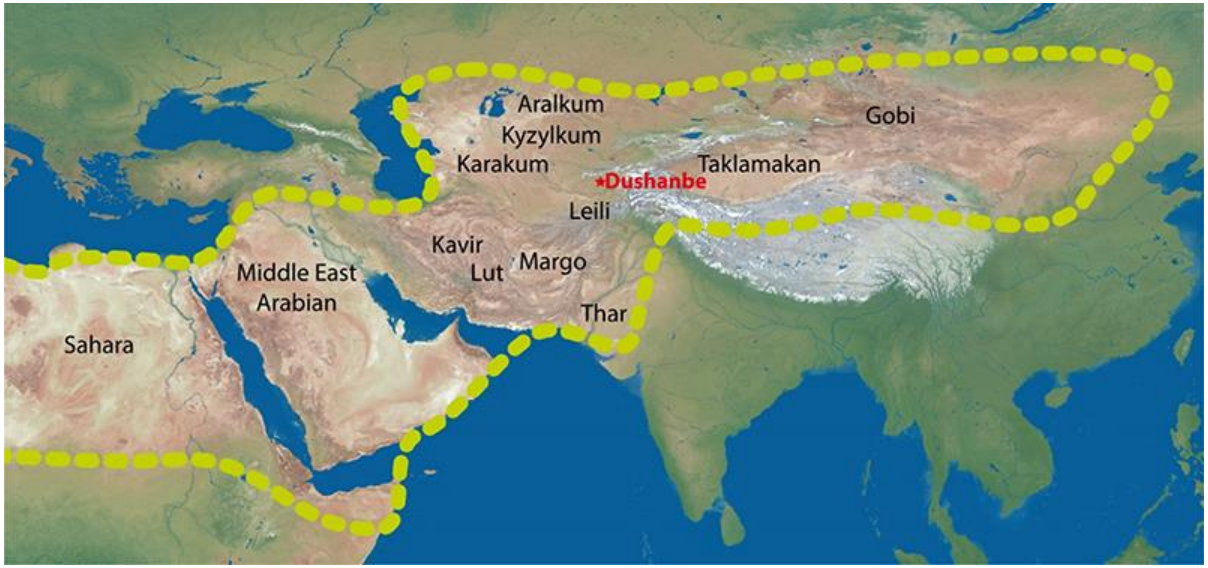
Dust emission: arid and semidry regions



Fonte: DTF - Integrated Desert Terrain Forecasting for Military Operations (2013).

- Maior extensão de áreas no hemisfério norte
- Sáara: cerca de 50% da emissão mundial de poeiras

Dust emission: “Dust belt”



FONTE: Hofer, J., Althausen, D., Abdullaev, S. F., Makhmudov, A. N., Nazarov, B. I., Schettler, G., Engelmann, R., Baars, H., Fomba, K. W., Müller, K., Heinold, B., Kandler, K., and Ansmann, A.: Long-term profiling of mineral dust and pollution aerosol with multiwavelength polarization Raman lidar at the Central Asian site of Dushanbe, Tajikistan: case studies, Atmos. Chem. Phys., 17, 14559–14577, https://doi.org/10.5194/acp-17-14559-2017, 2017

Dust emission:

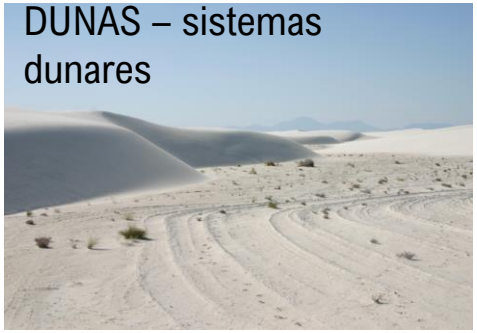
Antigos lagos secos - Bodelé

WADIS – vales secos

CHOTTS – depressões salinas

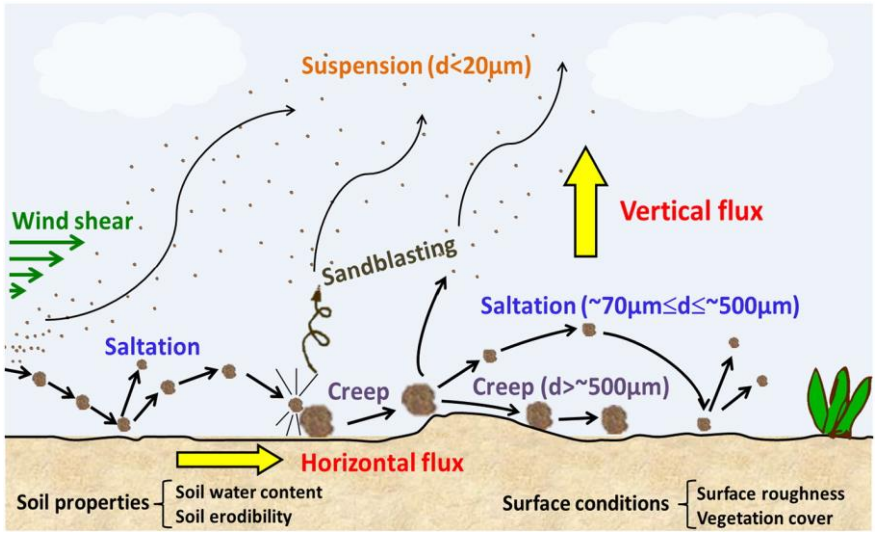
Depósitos de loess

DUNAS – sistemas dunares



Dust transport:

Creeping, Saltation, Sandblasting, Suspension



Fonte: Gherboudj *et al*., (2016)

Dust transport:

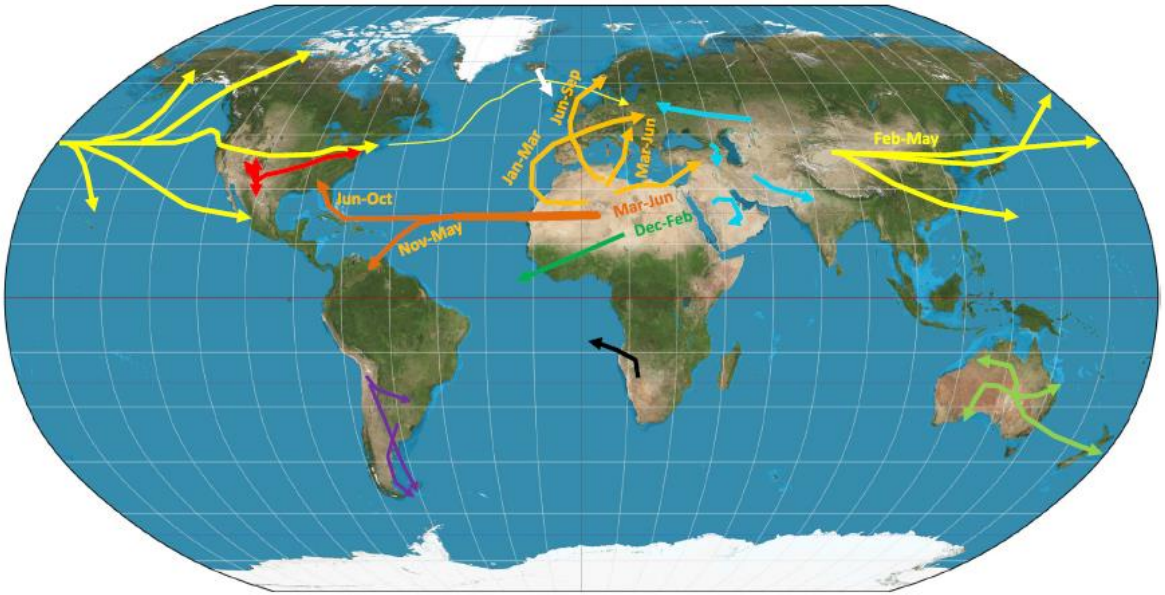
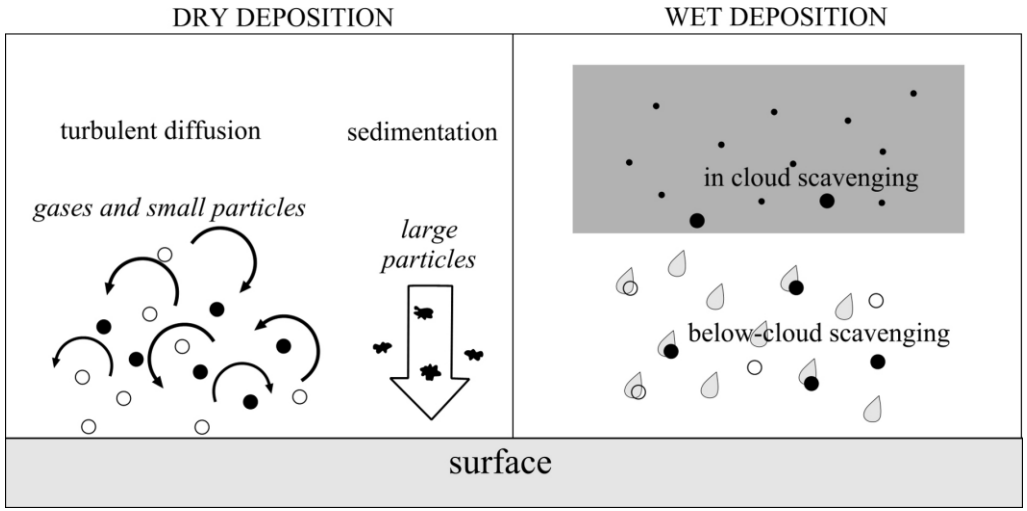


Fig. 2. Major desert dust transport fluxes, modified from Griffin (2007).

Fonte: Kellogg & Griffin (2006)

Dust deposition:

Gravidade (deposição seca): poeiras de maior dimensão
A deposição seca diminui com a distância à origem.
Precipitação (deposição húmida): poeiras de menor dimensão

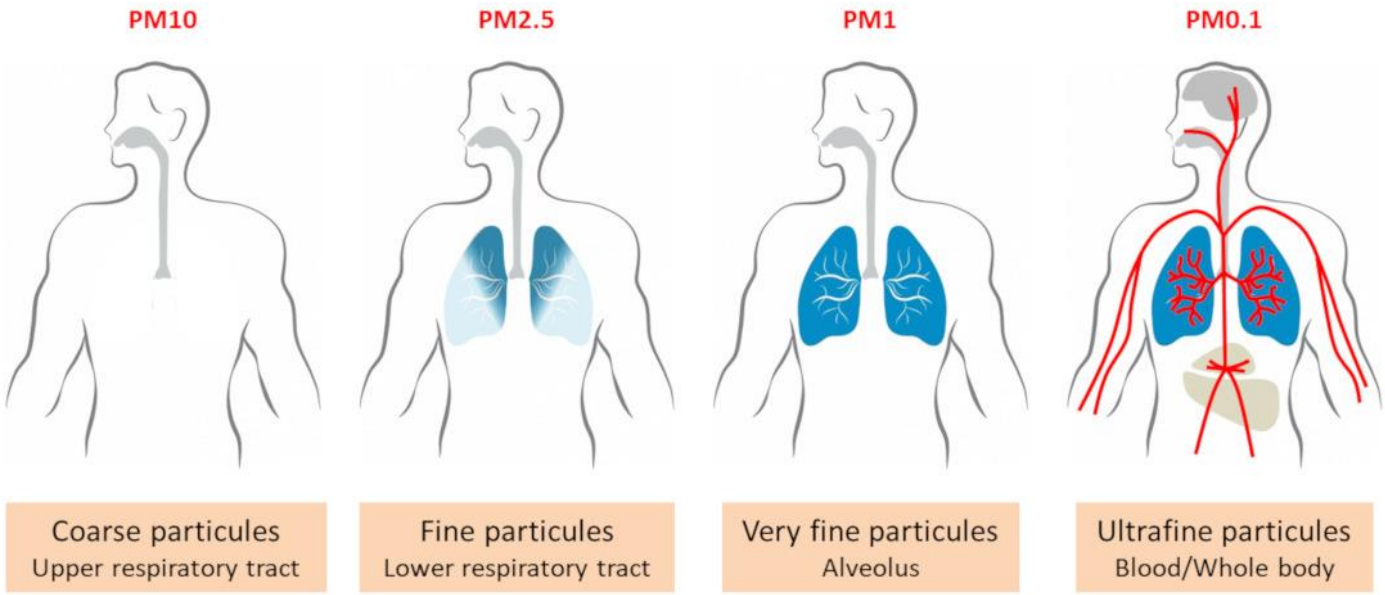


Fonte: Leelossy et al (2014)

5.2. Efeitos das poeiras na saúde humana

- Forma de poluição que mais pessoas afeta
- Depois de inaladas, as poeiras são uma grave ameaça à saúde sobretudo se a exposição for prolongada, frequente ou mesmo permanente.
- PM10: diâmetro aerodinâmico igual ou menor a 10 µm ou 0,01 mm
- PM2.5: diâmetro aerodinâmico igual ou menor a 2.5 µm ou 0,0025 mm
- Mistura de substâncias sólidas e líquidas de origem orgânica ou não orgânica que se encontram suspensas no ar

Fonte: PrevQualar - http://www.prevqualar.org/content.action?cid=contentInformation



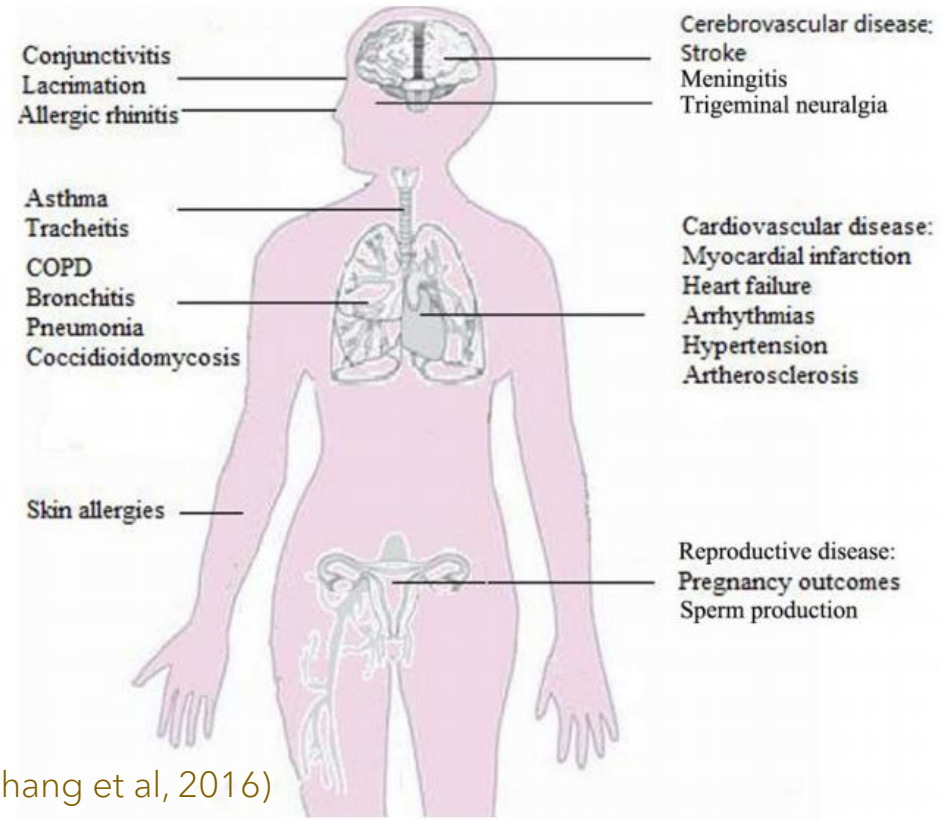
perigosas, se o contacto for prolongado

mais danosas alcançam os brônquios e os branquíolos

muito danosas podem alcançar os alvéolos

penetram na circulação sanguínea

Doenças mais associadas aos efeitos das poeiras



(Zhang et al, 2016)

Doenças respiratórias

Doenças cardiovasculares

+

Coccidioimicose (Valley fever)

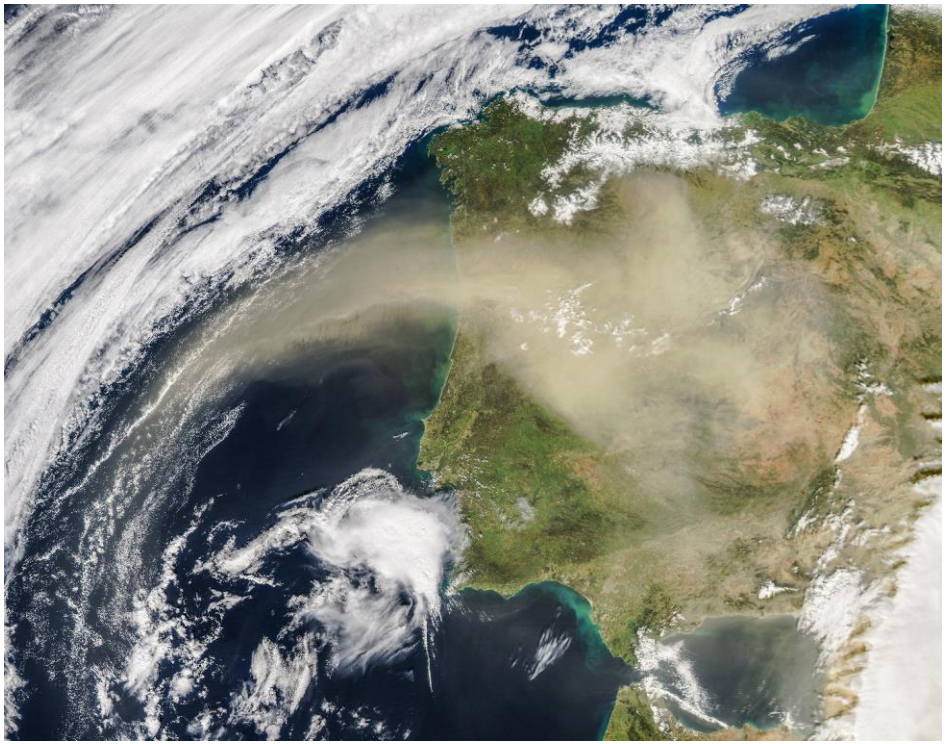
Pneumoconiose

Meningites meningócicas

Conjuntivites

Doenças dermatológicas

5.3. Dust intrusions in Portugal



21 Fev 2016

http://eoimages.gsfc.nasa.gov/images/imagerecords/87000/87566/iberianpeninsula_amo_2016052_lrg.jpg

5.3. Dust intrusions in Portugal

2005: monitorização regular pela APA e a FCT-UNL e publicação de relatórios anuais de "Identificação de eventos naturais"

Atualmente a APA divulga previsões destes eventos no seu site (https://qualar.apambiente.pt/node/eventos_naturais)

Limites legais para a saúde humana*:

https://eur-lex.europa.eu/legal-content/PT/TXT/PDF/?uri=CELEX:02008L0050-20150918&from=EN

5.3. Dust intrusions in Portugal

Limites legais para a saúde humana*:

- concentrações médias diárias PM10 – 50 μg m^{-3}
- concentrações médias diárias PM2.5 – 25 μg m^{-3}

*https://eur-lex.europa.eu/legal-content/PT/TXT/PDF/?uri=CELEX:02008L0050-20150918&from=EN

atmosphere

MDPI

Article

Assessing Heatwaves and Their Association with North African Dust Intrusions in the Algarve (Portugal)

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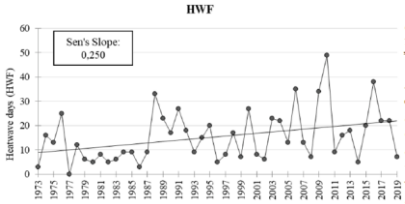
Abstract: Heatwaves are an extreme meteorological event in which affected populations may also be exposed to deteriorated air quality conditions due to the increase in air pollutant concentrations, such as PM_{10} (particulate matter < 10 μg/m^3). In order to identify heatwaves (1973–2019) in the region of Faro (Algarve) during the hot season (April–September), the *Excess Heat Factor* (EHF) index was applied. The Mann–Kendall test revealed an upward trend in three heatwave metrics in Faro, and the trend of accumulated heat load (EHF load) was also positive as would be expected, but its signal was not statistically significant. An inventory of North African dust events (2006–2019) was made, and their simultaneous occurrence with heatwaves was assessed, pointing to only 20% of dust events of the Sahara occurring simultaneously with heatwave days. A cluster analysis was conducted on daily geopotential height fields at 850 hPa level over the 2006–2019 period, and four distinct patterns were identified as the most prominent synoptic circulations promoting both heatwave conditions and North African dust over the Algarve.

Keywords: atmospheric patterns; cluster analysis; *Excess Heat Factor*; PM_{10}; Saharan dust events

Citation: Fernandes, R.; Fragoso, M. Assessing Heatwaves and Their



+2,5 heatwave days per decade (period 1973-2019)

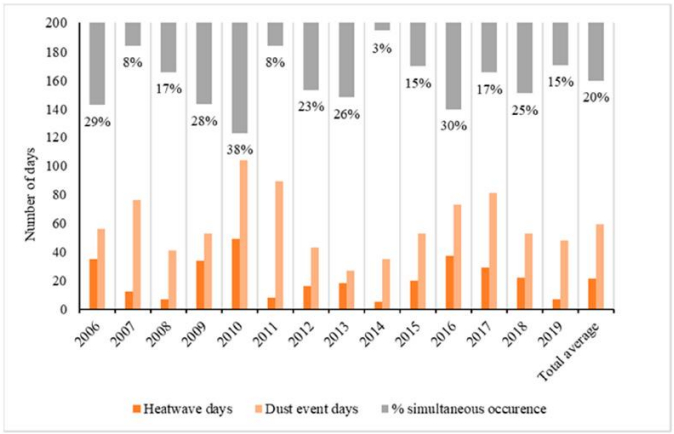


Figure 7. Interannual distribution of heatwaves and SD days and their simultane between 2006 and 2019.

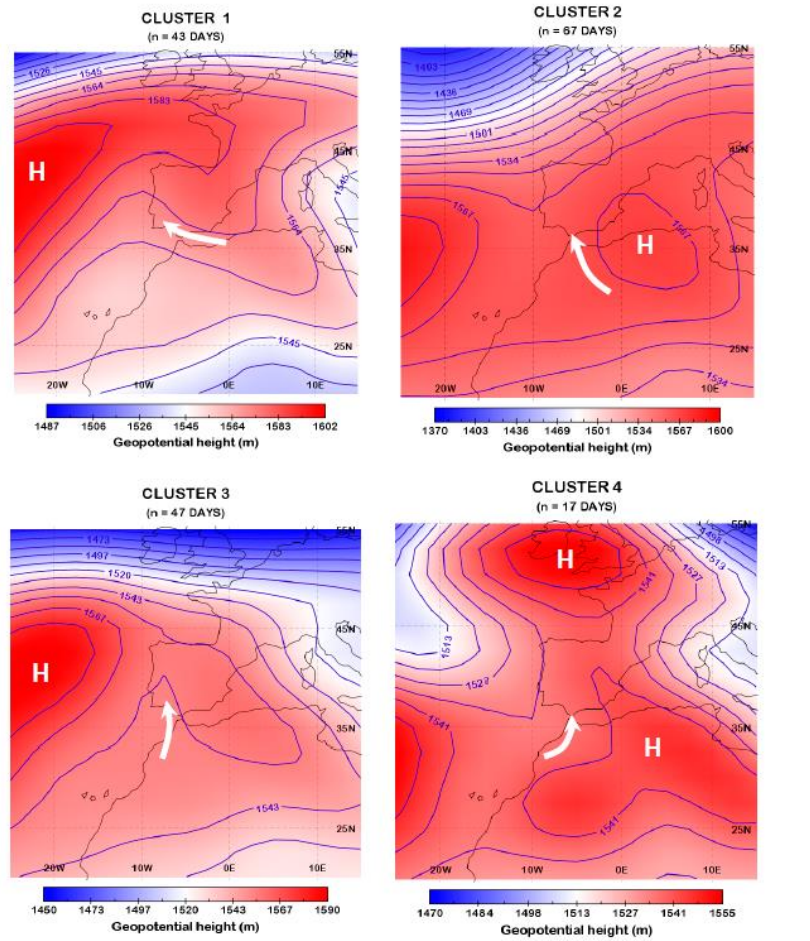
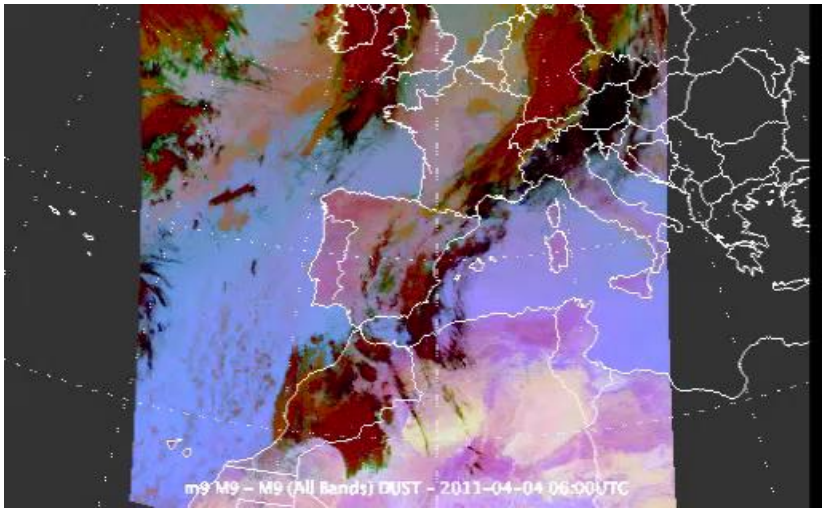


Figure 8. Atmospheric patterns (850 hPa geopotential height) related to the clusters of heatwave and SD days (2006–2019 period). The arrows indicate the direction of the airflow and "H" letters indicate the position of main high-pressure cores.



Evento extremo de 4 – 9 abril 2011

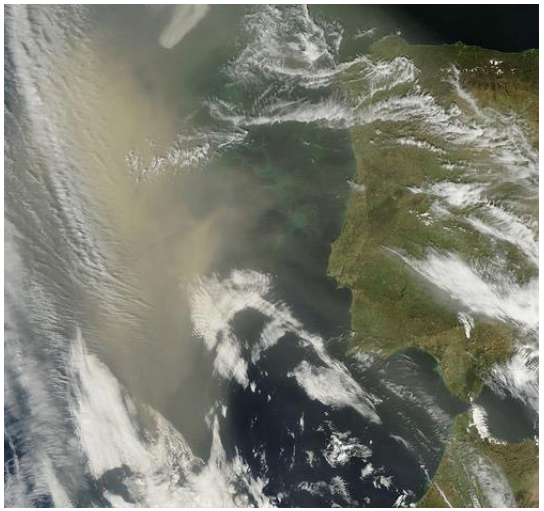


Imagem de satélite do dia 6 de Abril de 2011 (fonte: NASA EARTH OBSERVATORY).

MONTEIRO, A., FERNANDES, A.P., GAMA, C., BORREGO, C., TCHEPEL, O. (2015). Assessing the mineral dust from North Africa over Portugal region. *Atmospheric Pollution Research* 6, 70-81.

Atmospheric Pollution Research

www.atmospolres.com

Assessing the mineral dust from North Africa over Portugal region using BSC–DREAM8b model

Alexandra Monteiro [1], Ana Patricia Fernandes [1], Carla Gama [1], Carlos Borrego [1], Oxana Tchepel [2]

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How a mesoscale cyclonic vortex over Sahara leads to a dust outbreak in South-western Iberia

Flavio Tiago Couto[a,*], Eduardo Henrique Chaves Cardoso[a], Maria João Costa[b], Rui Salgado[b], Juan Luis Guerrero-Rascado[c], Vanda Salgueiro[a]

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[c] Instituto de Investigación del Sistema Tierra en Andalucía (IISTA-CEAMA). Universidad de Granada, Departamento de Física Aplicada, Granada, Spain

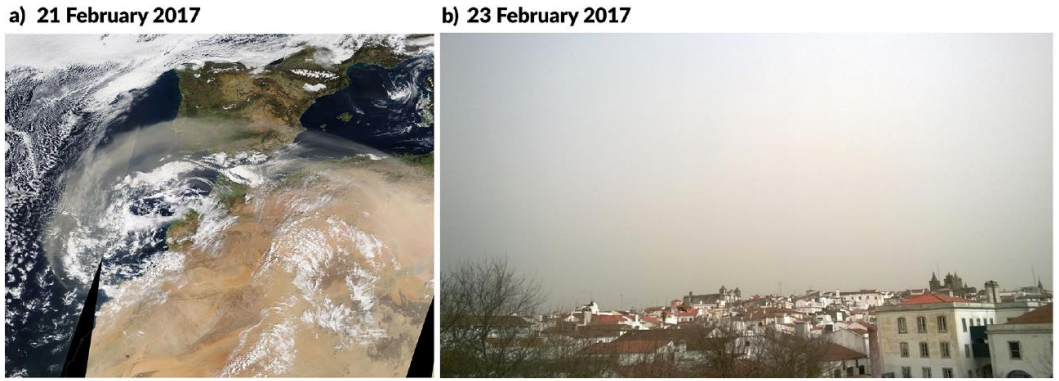


Fig. 3. a) MODIS Corrected Reflectance image on 21st February 2017. Source: https://worldview.earthdata.nasa.gov/; b) Picture of the dusty sky at Évora on 23rd February 2017 at 1115 UTC.

Couto et al, 2021

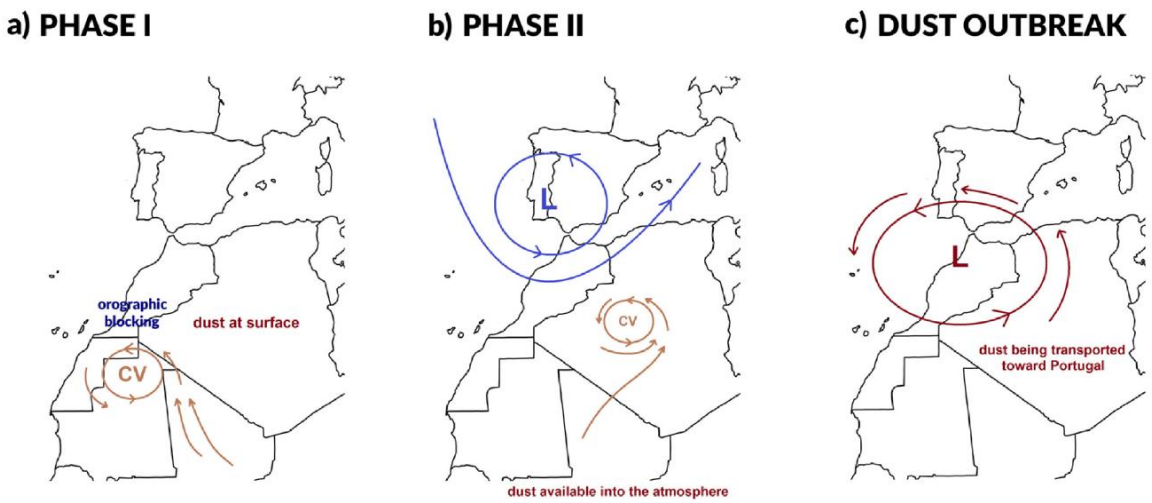
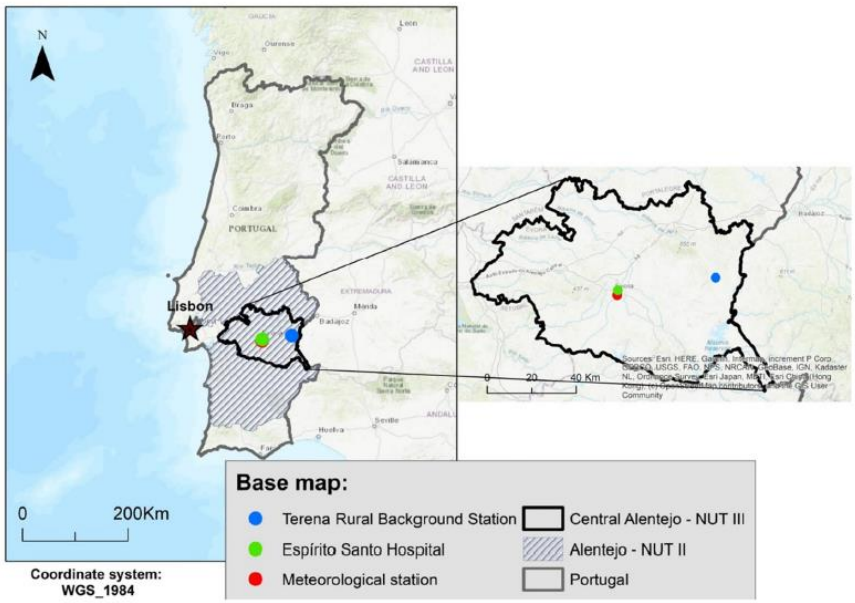


Fig. 14. Schematic representation of the main atmospheric configurations leading to the exceptional desert dust outbreak: a) PHASE I represents the early stage when dust is still found at surface, as well as the first stage of a cyclonic vortex (CV) development, b) PHASE II represents the stage when mineral dust has already been mobilized and dispersed into the atmosphere by the cyclonic vortex (CV) dynamics, and the approaching of a middle latitude low pressure system (L) from North, c) Dust outbreak stage shows the instant when the circulation associated with the low pressure system (L) already merged with the atmospheric circulation around the Atlas Mountains induced the transport of mineral dust toward Portugal.

Couto et al, 2021

Intrusões de poeiras no Alentejo (Alentejo Central) e a sua relação com internamentos hospitalares por doenças respiratórias (Silva et al, 2021)

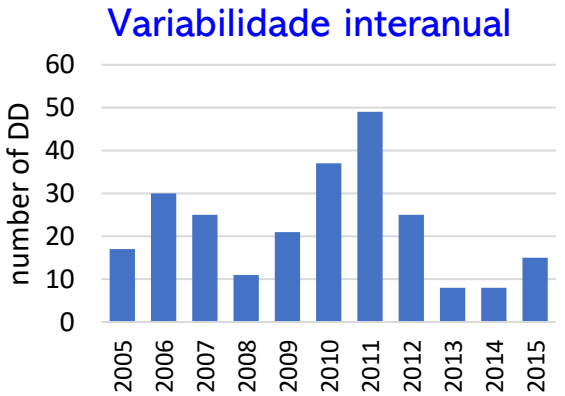


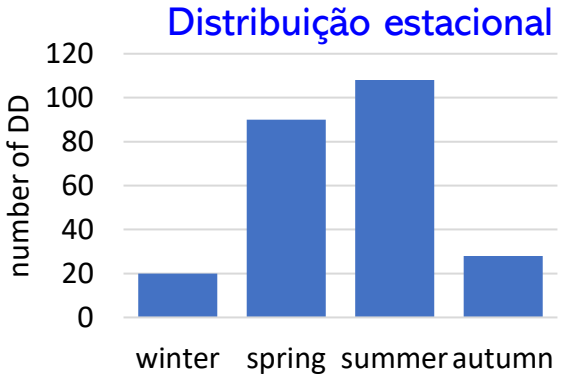
Silva et al (2021)

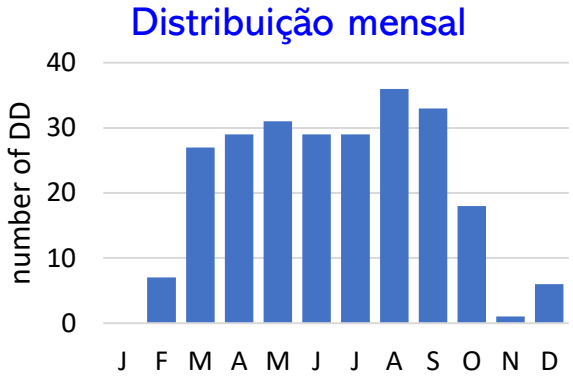
- Inventários APA (2006-2015): 825 dias IPNA no Alentejo
  - 246 dias IPNA no Alentejo Central
- Imagens de satélite (MODIS)
- Dados meteorológicos Évora/Geofísico
- Concentrações PM10 e PM2.5 da estação de Terena
- Internamentos hospitalares urgentes no Hospital Espírito Santo (Évora) por patologias respiratórias

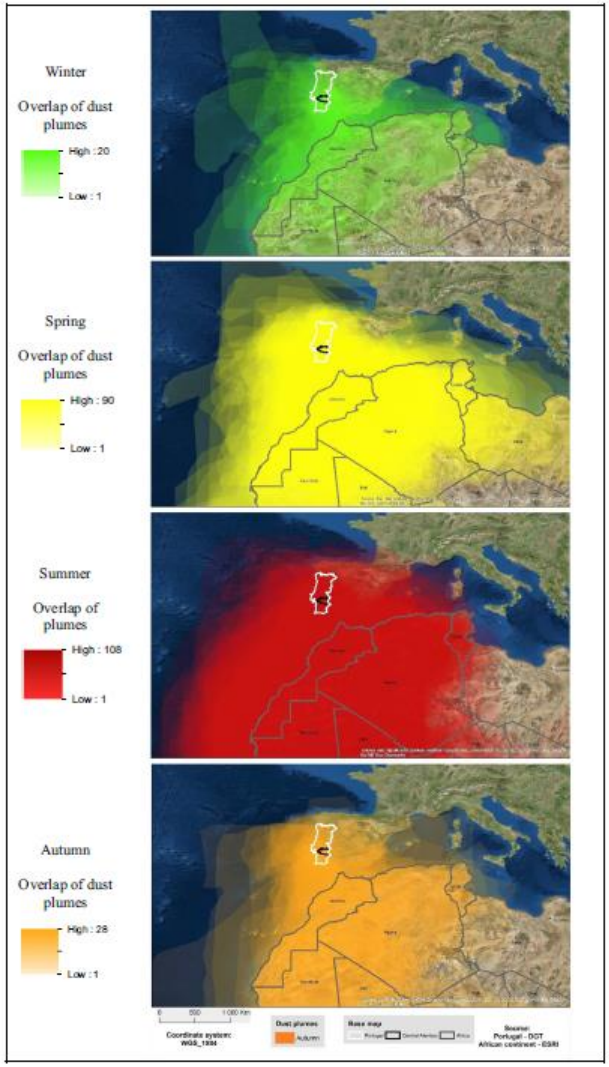
246 dias IPNA

- Forte variabilidade interannual (8 a 49 dias/ano)
- Frequência maior no Verão e na Primavera (76% dias no semestre quente, Abril- Setembro)
- Agosto e Setembro são os meses com mais dias IPNA



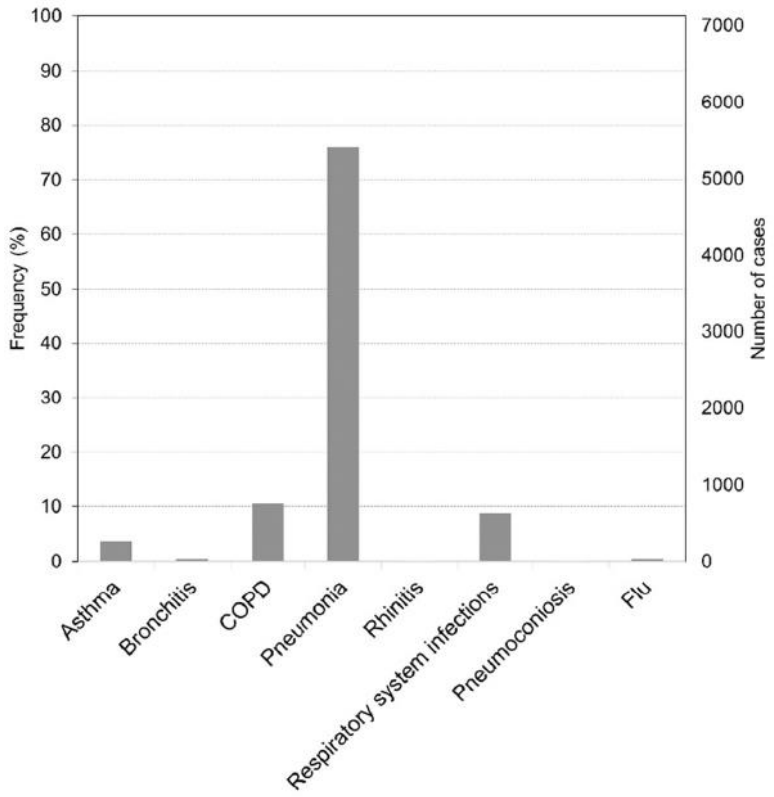






- Delimitação das plumas e determinação da sua extensão espacial
- Maior extensão espacial das plumas no Verão (6x superior à superfície média das plumas de Inverno)
- Menos eventos, plumas menos extensas no Inverno; mas é no Inverno que os dias IPNA registam maior frequência de dias com excedência dos limites legais de concentração de poluentes PM10 e PM2.5

Silva et al (2021)



Internamentos:

- Forte prevalência de internamentos por pneumonia

- Outras causas importantes:
- Infeções respiratórias
- DPOC e asma

- Maior frequência de internamentos no Inverno (37%), seguindo-se a Primavera (28%)

- Mais internamentos em dias IPNA que em dias sem poeiras

Silva et al (2021)

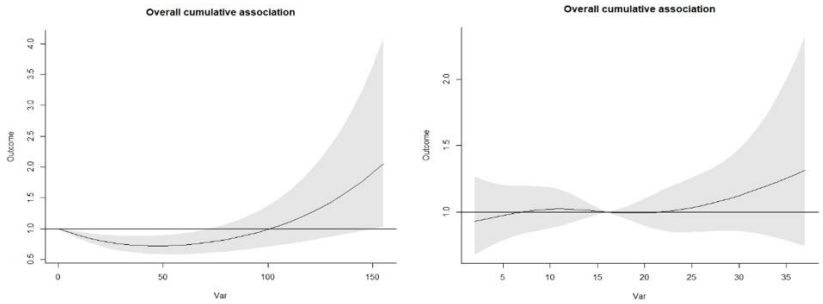
** Distributed Lag Non-linear Models*

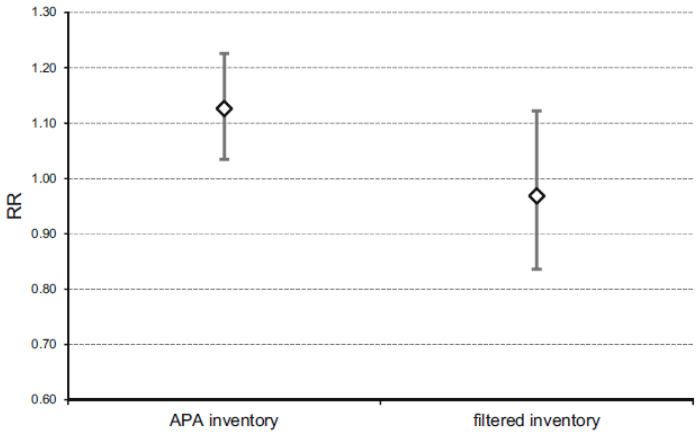
Modelação DLNM* das hospitalizações por causas respiratórias com determinantes ambientais
(variáveis climáticas, de qualidade do ar e presença/ausência de poeiras em circulação)

- Modelo final integrou a temperatura média e a concentração média diária PM10, além da presença/ausência de poeiras

- Risco relativo de internamento é 12% mais elevado nos dias com poeiras (amostra APA) que nos dias sem poeiras

Silva et al (2021)





Referências:

Fernandes, R.; Fragoso, M. (2021) Assessing Heatwaves and Their Association with North African Dust Intrusions in the Algarve (Portugal). *Atmosphere*, 12, 1090. https://doi.org/10.3390/atmos12091090

Hofer, J., Althausen, D., Abdullaev, S. F., Makhmudov, A. N., Nazarov, B. I., Schettler, G., Engelmann, R., Baars, H., Fomba, K. W., Müller, K., Heinold, B., Kandler, K., and Ansmann, A.: Long-term profiling of mineral dust and pollution aerosol with multiwavelength polarization Raman lidar at the Central Asian site of Dushanbe, Tajikistan: case studies, *Atmos. Chem. Phys*., 17, 14559–14577, https://doi.org/10.5194/acp-17-14559-2017, 2017

Manisalidis I., Stavropoulou E., Stavropoulos A., Bezirtzoglou E. (2020) Environmental and Health Impacts of Air Pollution: A Review, *Frontiers in Public Health*, 8, DOI=10.3389/fpubh.2020.00014

Shao, Y., Wyrwoll, K-H., Chappell, A., Huang, J., Lin, Z., McTainsh, G., Mikami, M., Tanaka, T., Wang, X., Yoon, S. (2011) Dust cycle: An emerging core theme in Earth system science, *Aeolian Research*, Vol. 2, Issue 4, 181-204,

Silva T, Fragoso M, Almendra R, Vasconcelos J, Lopes A, Faleh A (2021) North African dust intrusions and increased risk of respiratory diseases in Southern Portugal Submitted to *International Journal of Biometeorology.* https://doi.org/10.1007/s00484-021-02132-x

Silva, T. (2019) – Intrusão de poeiras Norte Africanas no Alentejo Central: relação com internamentos e mortalidade. Dissertação de mestrado em Geografia Física e Ordenamento do território , IGOT-Universidade de Lisboa, 146 p.

Zhang, X.; Zhao, L.; Tong, D.Q.; Wu, G.; Dan, M.; Teng, B. (2016) A Systematic Review of Global Desert Dust and Associated Human Health Effects. *Atmosphere* 2016, 7, 158.