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First Continuous Aerosol Measurements at Testa Grigia at 3480 m a.s.l.: Aerosol Populations and Dust Transport Dynamics in the Southern European Alps

Stefania Gilardoni et al.

Correspondence to: Stefania Gilardoni (stefania.gilardoni@cnr.it)

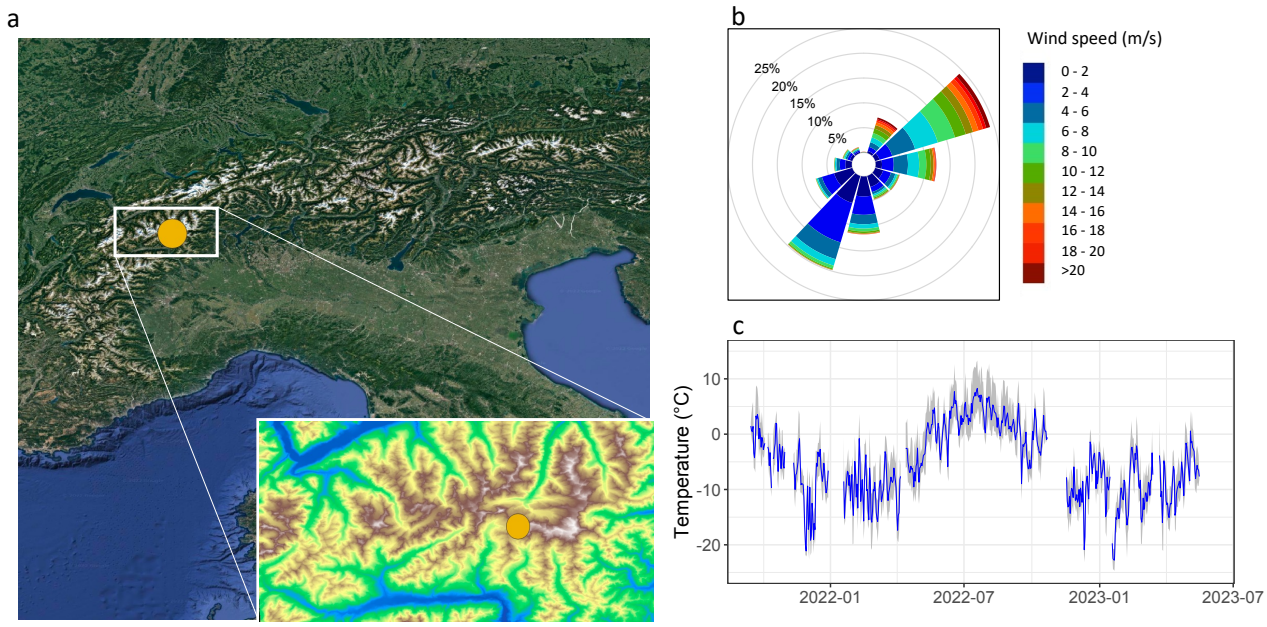

Figure S1. Map showing the location of the Testa Grigia Observatory, in the Western Italian Alps, and the topography of the area surrounding the observatory (panel a), wind rose from 1-minute time resolution data recorded during the investigated period (panel b), and time trend of daily average temperature in blue and diurnal temperature range in gray (panel c). Map is from Imagery ©Landsat / Copernicus, Data SIO, NOAA, U.S. Navy, NGA, GEBCO, Map data ©2026 Google. Topography is from Continental Europe Digital Terrain Model, distributed by OpenTopography. https://doi.org/10.5069/G99021ZF. Accessed 2026-01-07.

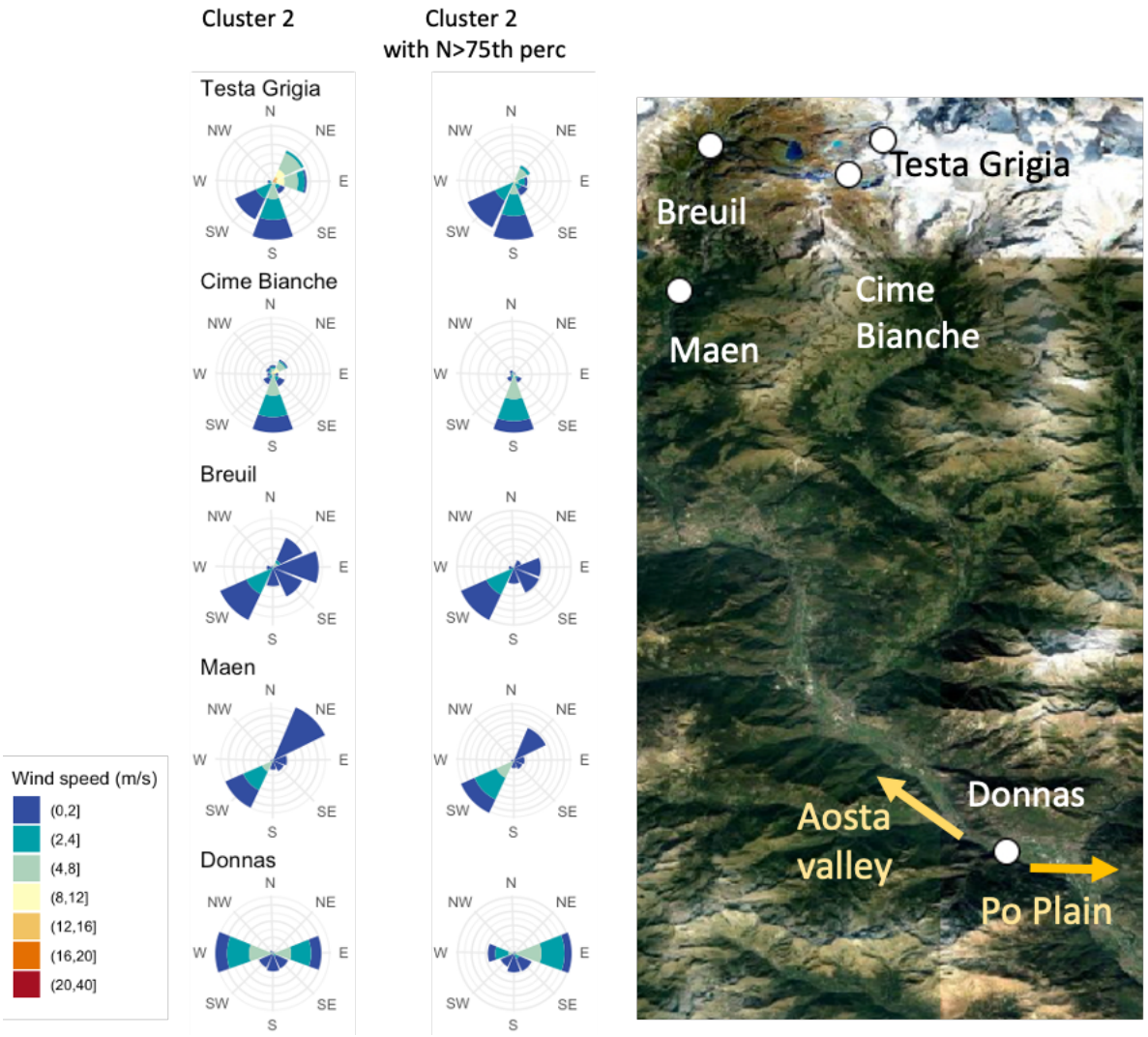

Figure S2. Windrose for cluster 2 periods during the entire campaign (left column) and when particle number concentration exceeded the 75th percentile (right column); each wind rose corresponds to wind direction measurements at a different location along the Valley that connects Testa Grigia to the Po Plain, as illustrated in the map on the right. Map is from Imagery ©2026 Airbus, Google, ©swisstopo, Map data ©2026 Google.

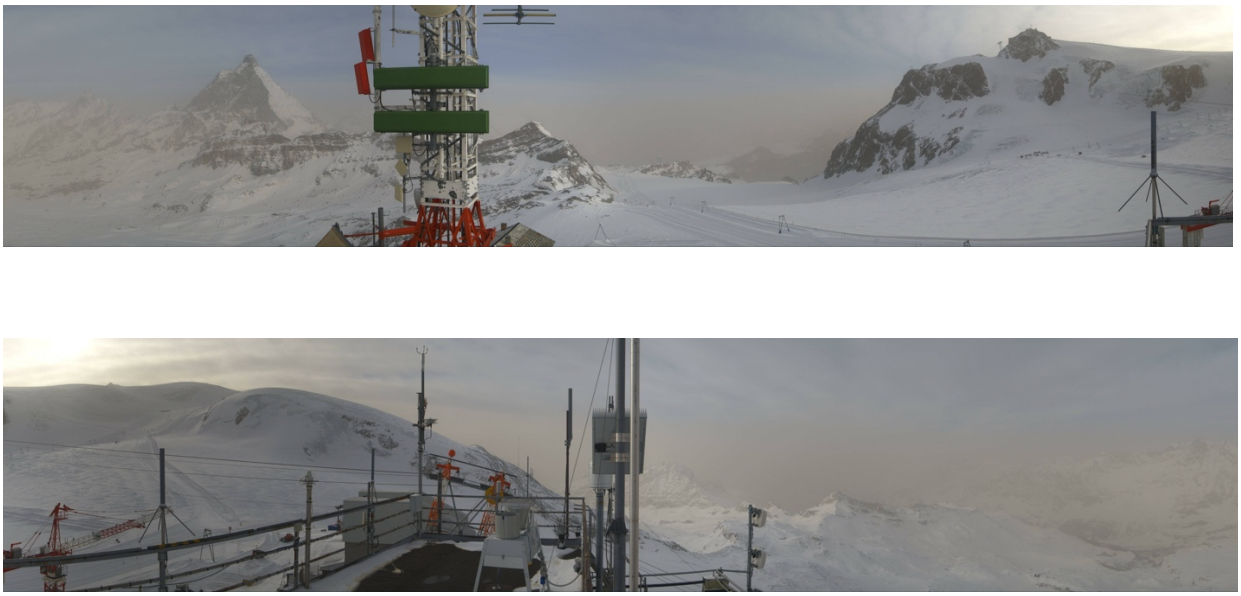

Figure S3. Webcam images taken from the PANOMAX webcam installed at Plateau Rosa, near the Testa Grigia Observatory, on March 16, during an intense Saharan Dust Episode that reached Europe in spring 2022. Curtesy PANOMAX and Cervino SpA.

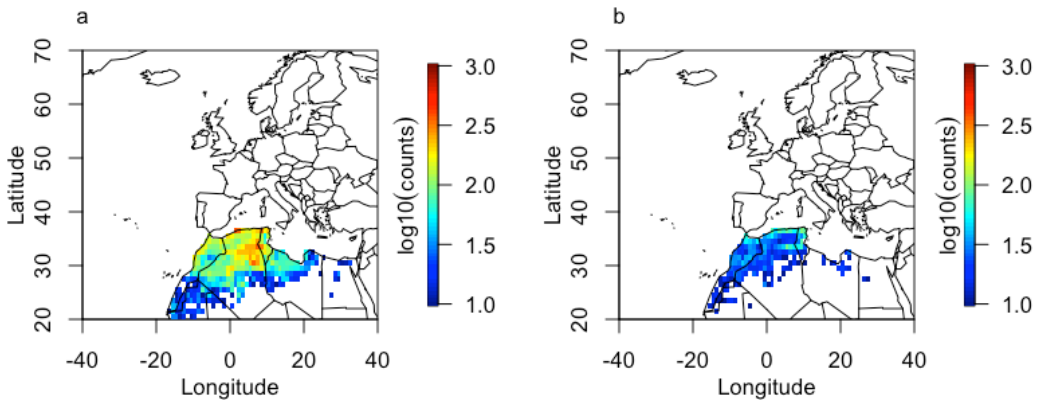

Figure S4. Residence time maps over the Sahara region of back trajectories associated with aerosol population corresponding to cluster 1 during March, May, and June in panel a, and during October and November in panel b.

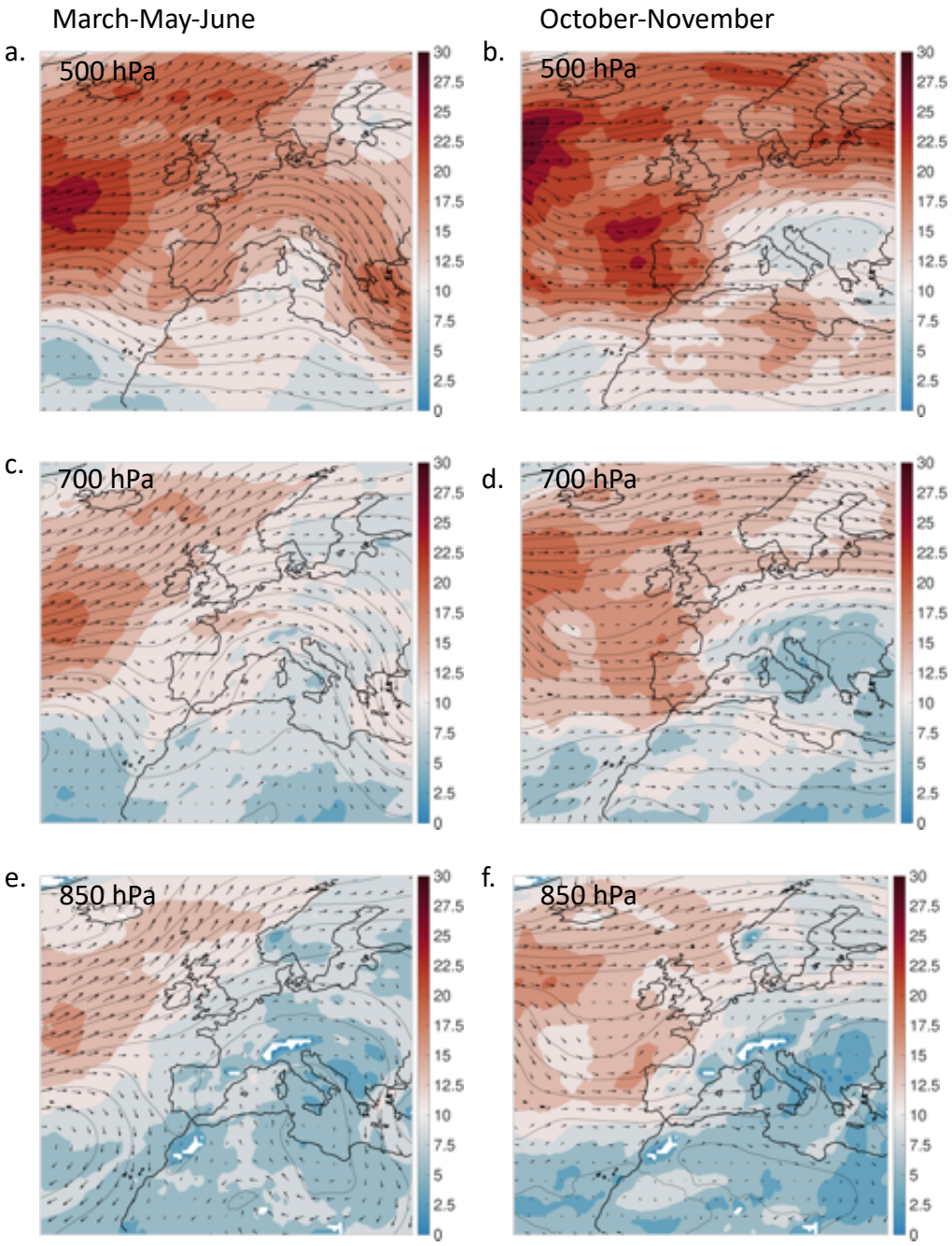

Figure S5. Maps of average geopotential heights and wind speeds over Europe and north Africa during SDE periods in March, May, and June (panels a, c, and e) and in October and November (panels b, d, and f) at 500 hPa (a and b), 700 hPa (c and d) and 850 hPa (e and f).

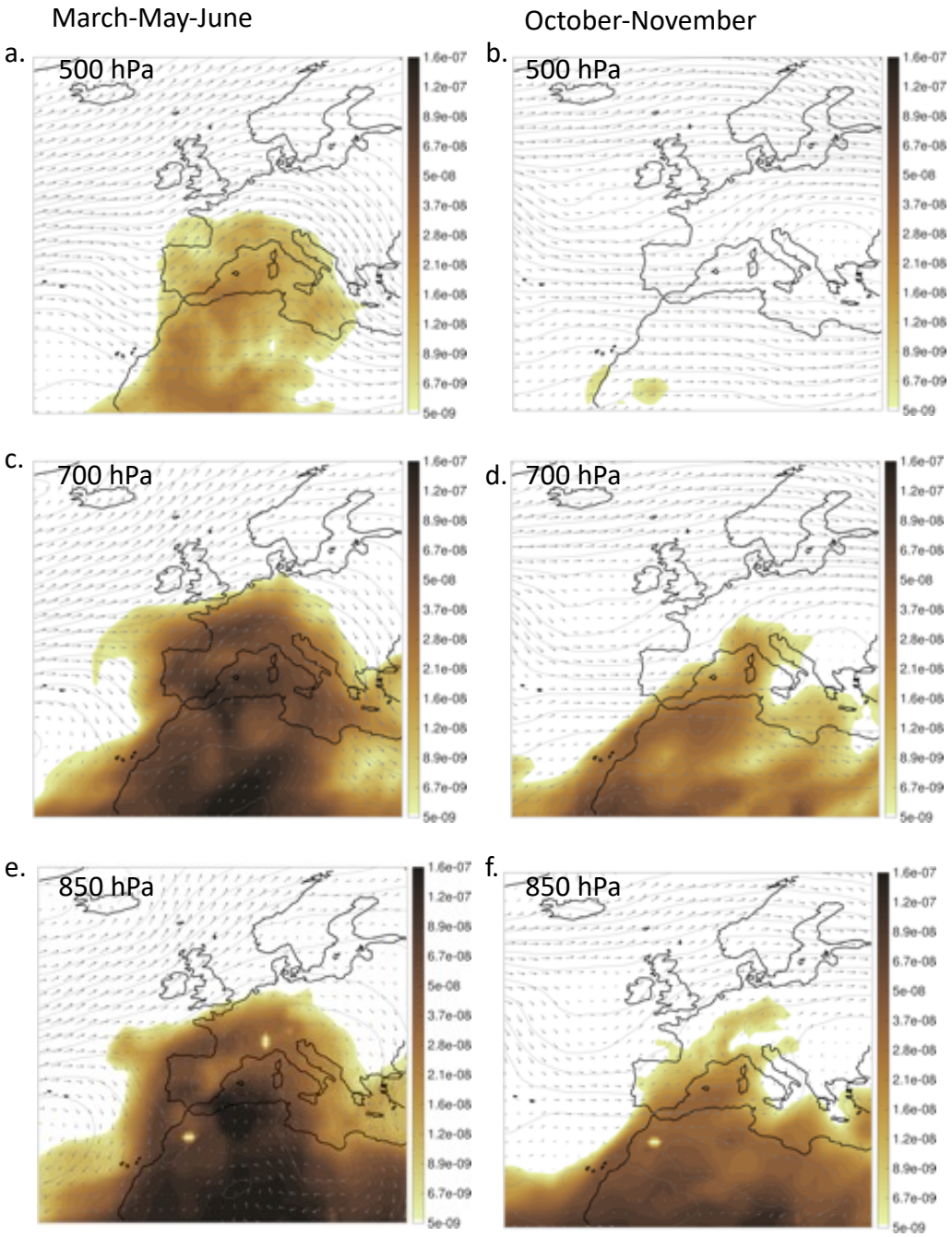

Figure S6. Maps of average dust concentrations from CAMS reanalysis (color; 10^{-9} kg/kg), geopotential (contour lines; every 20 dam) and averaged wind arrows over Europe and north Africa during SDE periods in March, May, and June (panels a, c, and e) and in October and November (panels b, d, and f) at 500 hPa (a and b), 700 hPa (c and d) and 850 hPa (e and f).

	$N_{>250nm}$ (cm^{-3})	N_{fine} (cm^{-3})	N_{coarse} (cm^{-3})
All data	Mean 16.30 5th perc 0.33 25th perc 1.27 50th perc 4.53 75th perc 18.34 95th perc 71.13	Mean 16.14 5th perc 0.32 25th perc 1.24 50th perc 4.46 75th perc 18.05 95th perc 70.60	Mean 0.15 5th perc 0.00 25th perc 0.01 50th perc 0.03 75th perc 0.09 95^{th} perc 0.56
Winter	Mean 2.98 5th perc 0.20 25th perc 0.64 50^{th} perc 1.31 75th perc 2.94 95th perc 10.77	Mean 2.94 5th perc 0.19 25th perc 0.63 50^{th} perc 1.29 75th perc 2.90 95th perc 10.70	Mean 0.04 5th perc 0.00 25th perc 0.01 50^{th} perc 0.01 75th perc 0.03 95th perc 0.11
Spring	Mean 18.84 5th perc 0.49 25th perc 2.75 50^{th} perc 8.48 75th perc 25.04 95th perc 70.70	Mean 18.57 5th perc 0.45 25th perc 2.71 50^{th} perc 8.39 75^{th} perc 24.75 95^{th} 69.52	Mean 0.27 5th perc 0.00 25th perc 0.02 50^{th} perc 0.05 75th perc 0.12 95th perc 0.86
Summer	Mean 44.37 5th perc 2.64 25th perc 12.95 50^{th} perc 31.08 75th perc 62.35 95th perc 132.49	Mean 44.11 5th perc 2.60 25^{th} perc 12.70 50^{th} perc 30.68 75^{th} perc 62.08 95^{th} perc 132.25	Mean 0.26 5th perc 0.01 25th perc 0.05 50^{th} perc 0.10 75th perc 0.24 95th perc 1.26
Fall	Mean 10.38 5th perc 0.33 25th perc 1.17 50^{th} perc 3.88 75th perc 11.21 95th perc 42.80	Mean 10.29 5th perc 0.31 25th perc 1.12 50^{th} perc 3.82 75th perc 11.13 95ht perc 42.63	Mean 0.09 5th perc 0.00 25th perc 0.01 50^{th} perc 0.02 75th perc 0.06 95th perc 0.38

Table S1. Seasonal statistics of particle number concentration corresponding to all particles measured by the OPC ($N_{>250}$: particles with optical diameter larger than 250 nm), fine particles (N_{fine}: particles with optical diameter smaller than 1 μm) and coarse particles (N_{coarse}: particles with optical diameter larger than 1 μm and smaller than 10 μm).

Station	Coordinates	Altitude	Network
Cime Bianche	45.9182°N, 7.69146°E	3100 m	Centro Funzionale Valle d'Aosta
Breuil	45.9314°N, 7.62623°E	1998 m	Centro Funzionale Valle d'Aosta
Maen	45.8626°N, 7.61112°E	1310 m	Centro Funzionale Valle d'Aosta
Donnas	45.5966°N, 7.76643°E	318 m	Regional Environmental Protection Agency

Table S2. Location of the meteorological stations.