Identification of key aerosol types in Athens based on long-term in situ optical and chemical properties

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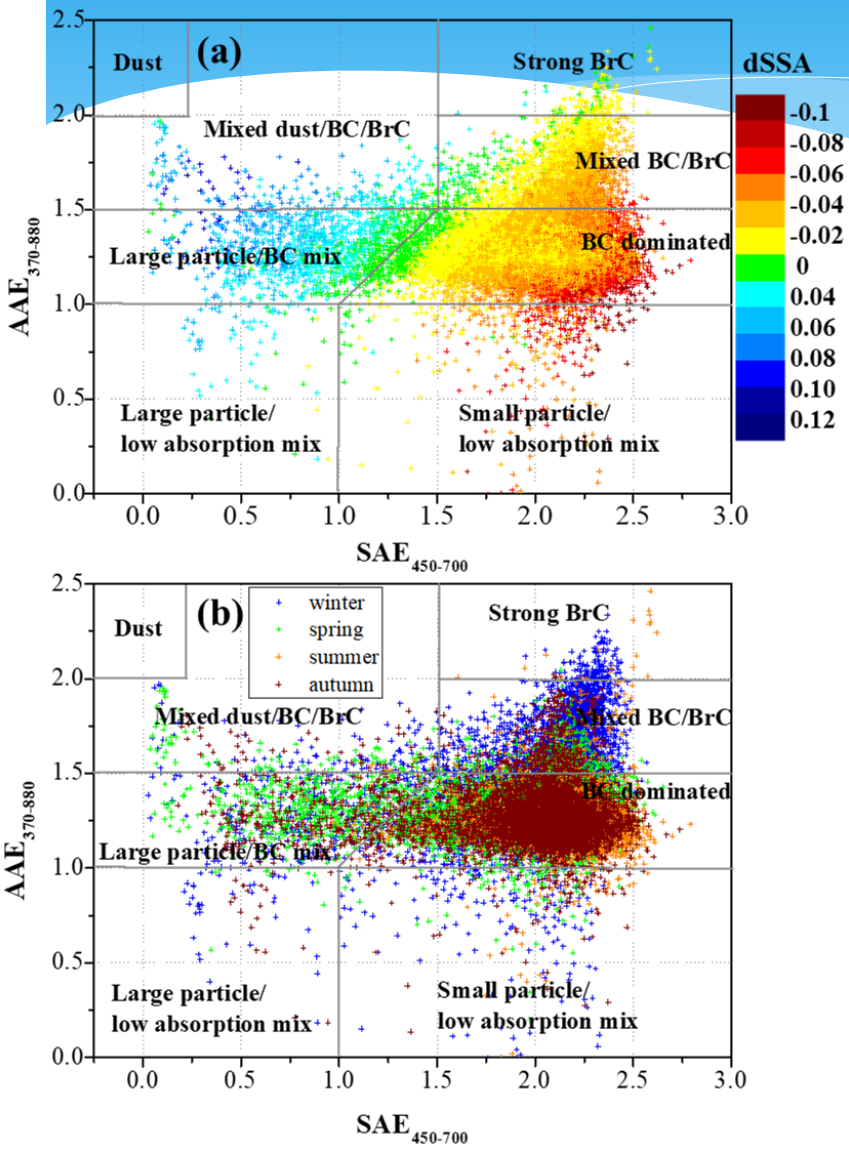
Scope and objectives

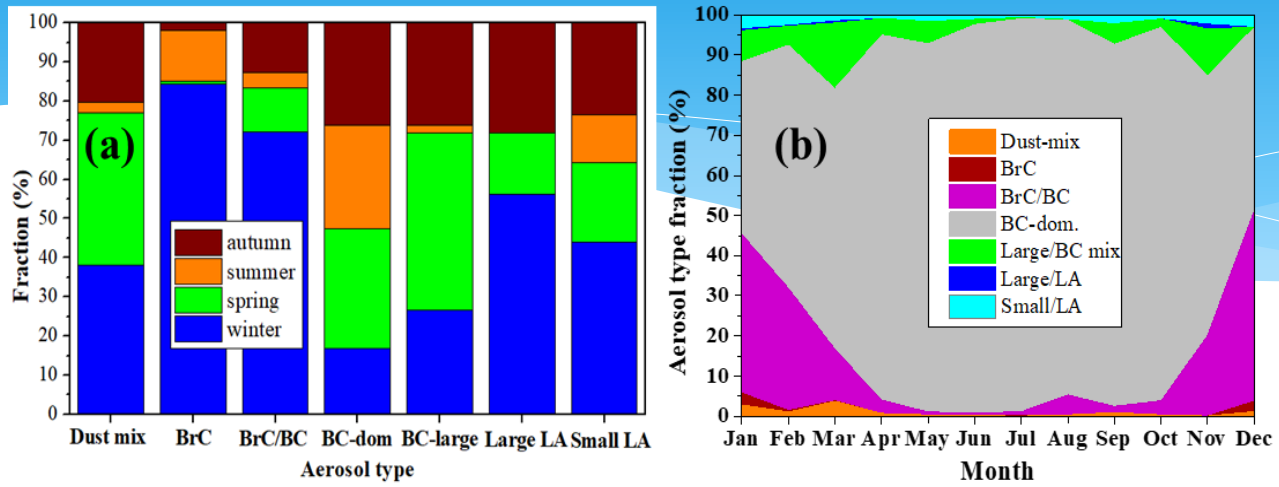
* Classification of key aerosol types in Athens based on in situ measurements (Thissio station)
* 3-year data (Oct. 2016-Sep. 2019) from Nephelometer, Aethalometer, along with available ACSM, meteorological observations, PM10 concentrations and trace gases (NOx, O3, CO). [hourly-averaged datasets]
* Classification matrix based on SAE vs. AAE (Cappa et al., 2016, ACP)
* Seasonality of types, monthly fractions, diurnal patterns, optical properties, chemical composition, sources and linkages with meteorology

Aerosol types

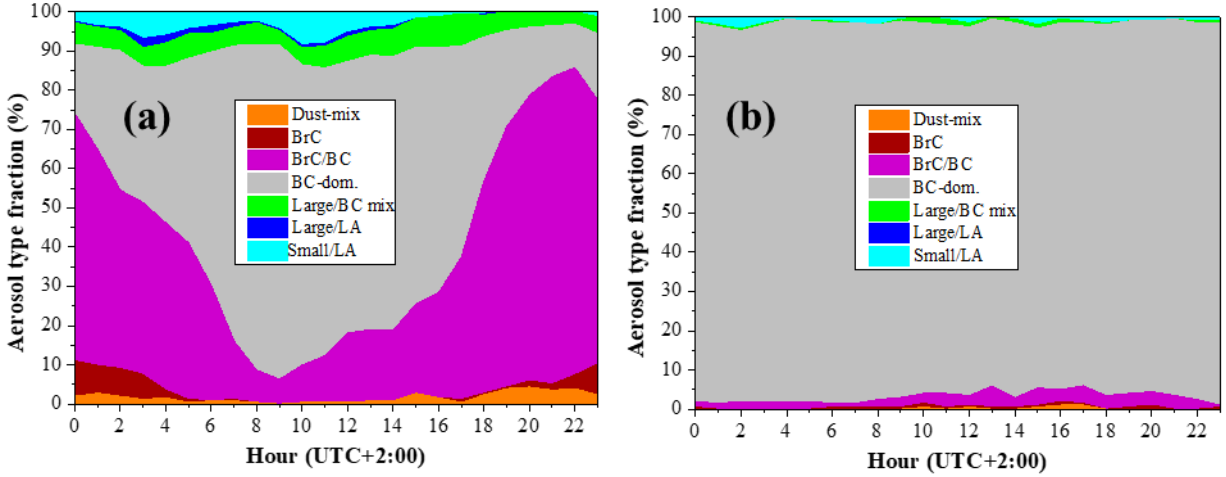


* The classification scheme $SAE_{450-700}$ vs. $AAE_{370-880}$ [Cappa et al. 2016] for identification of aerosol types in Athens, color-coded by $dSSA_{470/660}$ (a) and season (b).
* "BC-dominated" (76.3%), "BrC/BC" (14.3%), "large/BC mix" (5.3%), "BrC" (0.65%), "dust-mix" (1.2%), small particles with low absorption efficiency (1.9%), large particles with low absorbing efficiency (0.32%).

Seasonality and diurnal cycles

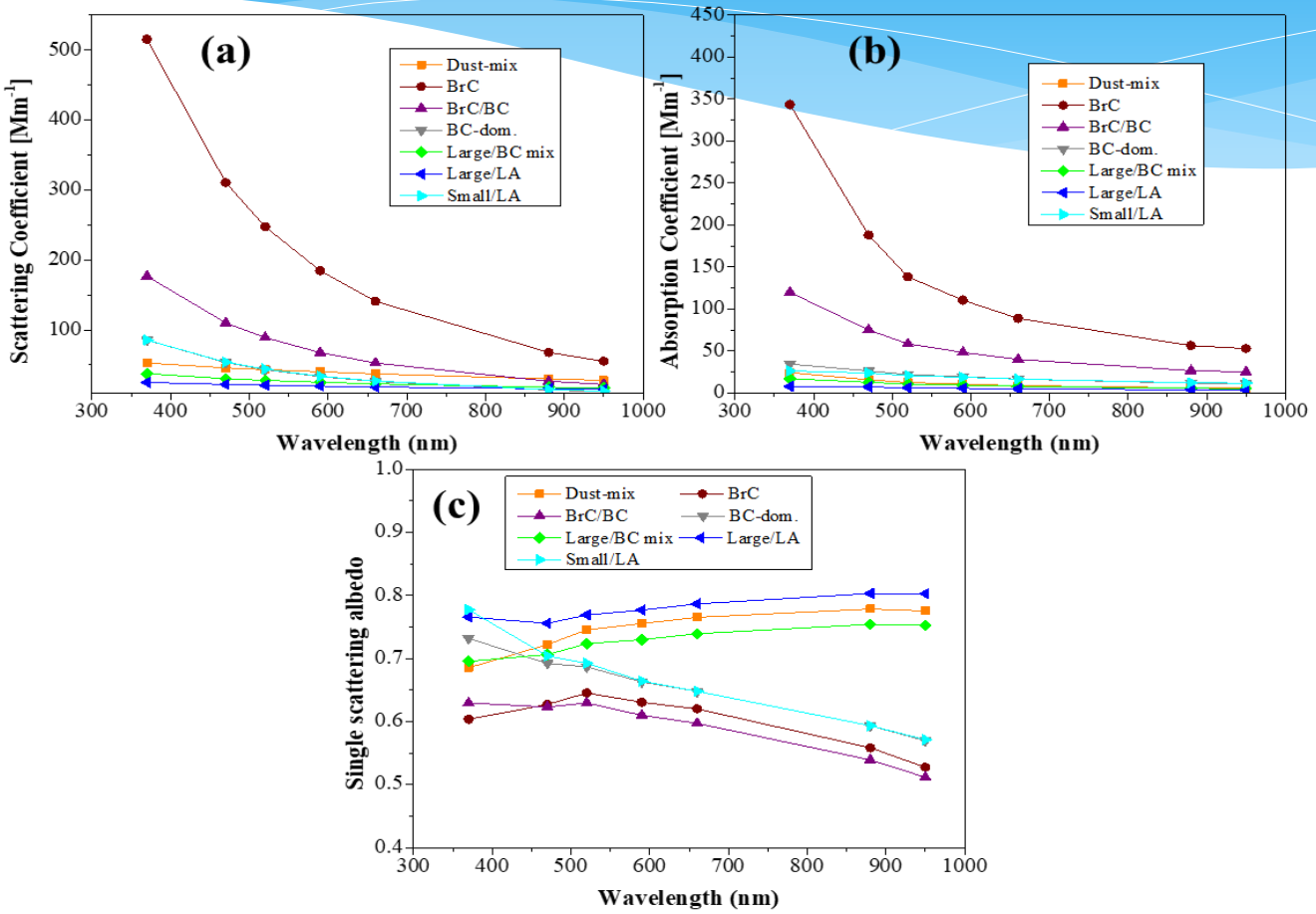


Seasonal fractions of occurrence for each aerosol type (a) and monthly variation of the cumulative percentage frequency of each aerosol type (b).



Diurnal variation of the cumulative percentage frequency for each aerosol type during winter (left) and summer (right).

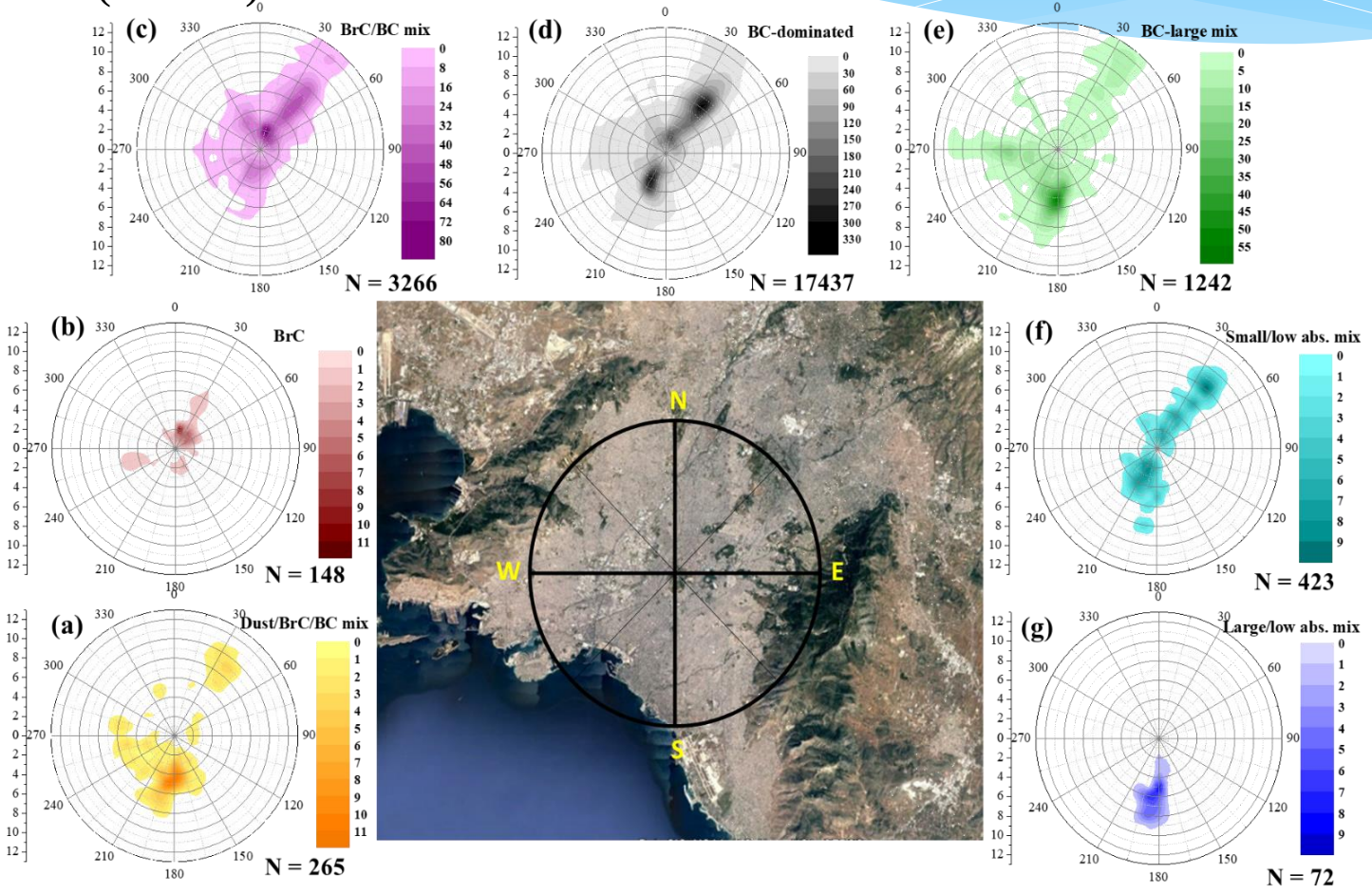
Optical properties of aerosol types



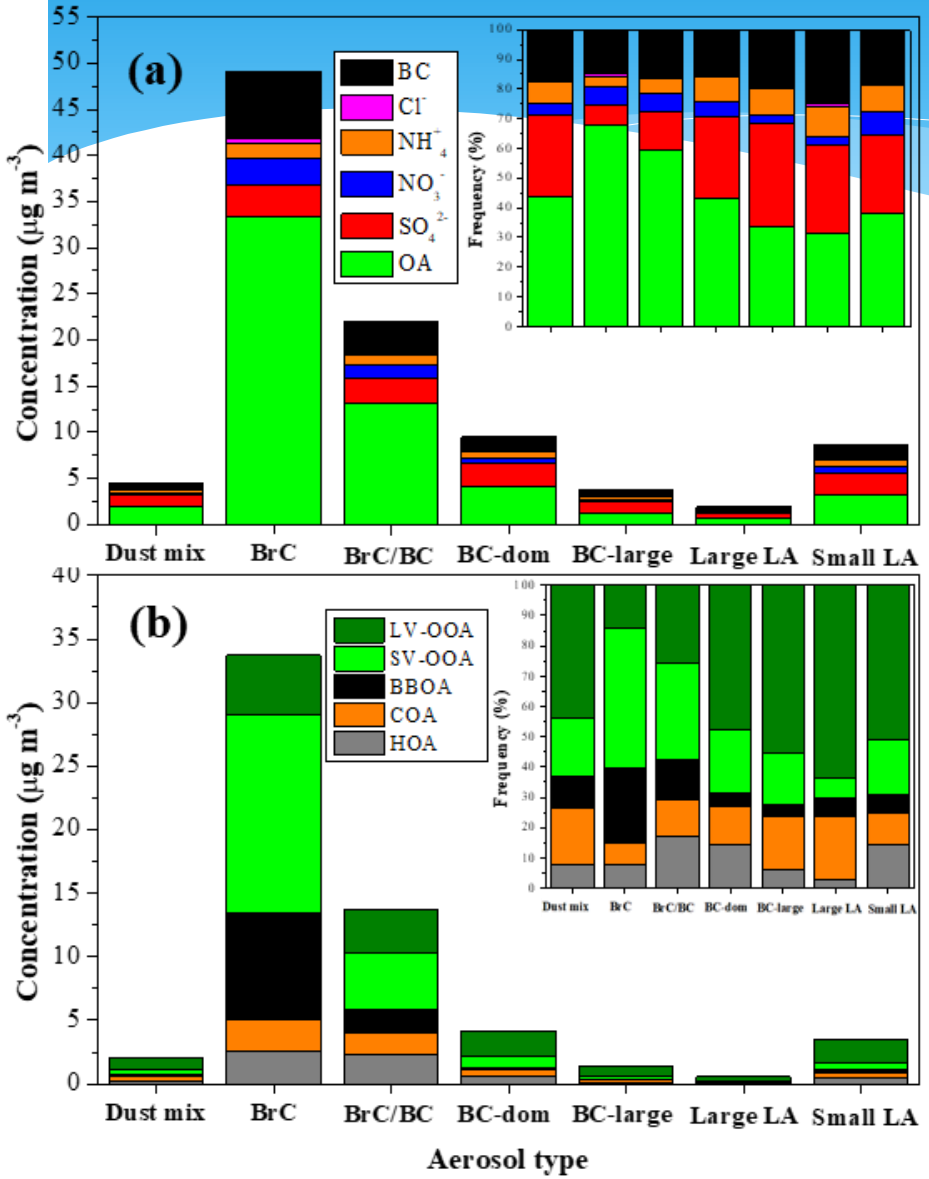
Spectral variation of the single scattering albedo, scattering and absorption coefficients for the seven identified aerosol types.

Sources and influence of meteorology

Wind roses for the frequency of occurrence of each aerosol type in Athens. The map of the greater Athens area is shown with the centre in the monitoring site (Thissio).

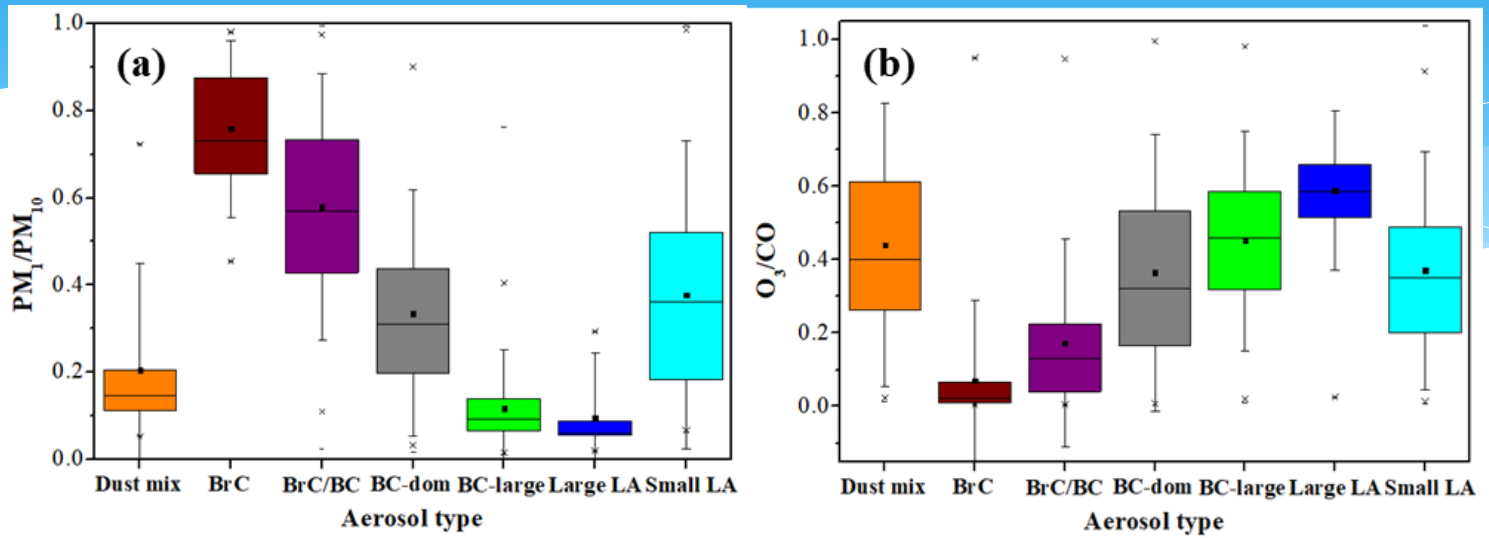


Chemical composition of aerosol types



* Chemical profiles (a) and organic aerosol source apportionment (b) for the identified aerosol types. The insert graphs correspond to the (%) contribution of each chemical component to the total concentration.
* Large organic content for "BrC", "BrC/BC"
* Processed types ("large/BC mix", "large/LA" with high LV-OOA fractions)

Chemical composition of aerosol types



* Box-whisker plots of PM1/PM10 (a), and O3/CO (b) for the various identified aerosol types in Athens. PM1 equals the ACSM mass plus BC.
* "BrC", "BrC/BC" correspond to fine aerosols.
* Local fresh emissions for "BrC", "BrC/BC" (low O3/CO), atmospheric aging for "large/BC mix", "large/LA", "dust-mix" (high O3/CO).

Conclusions

Main characteristics of the aerosol types

BC-dominated" aerosol (76.3%): Moderate levels of scattering and absorption, low SSA (0.69), fine-mode aerosols. Mainly from fossil-fuel combustion and photo-chemical processes. Composed by organics (43%), sulfate (27%) and BC (16%).

"BrC/BC" (14.3%): Dominant in winter nights, large wood burning content mixed with BC from fossil fuels. High organic content (60%).

"BrC" (0.65%): High turbid conditions, winter nights, calm winds, intense residential wood burning.

"large/BC mix" (5.3%): More frequent in spring, reflects aged processed BC mixed with coarse particles.

"dust-mix" (1.2%): Mixture of transported dust with urban pollution, dominant in spring, high PM10 levels, low absorption.

"small/LA" (1.9%): Urban aerosols with enhanced presence of sulfate and nitrate, fine aerosols, processed organics (AAE< 1).

"large/LA" (0.32%): Clean conditions, strong winds, weak influence of local combustion sources. High possibility to carry marine aerosols.

Acknowledgments

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