Spatiotemporal variability and representativeness of aerosol and clouds over the PANhellenic GEophysical observatory of Antikythera

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Abstract: The PANhellenic GEophysical observatory of Antikythera, PANGEA, located in the centre of the Eastern Mediterranean basin, at the island of Antikythera is influenced by natural aerosol sources and combinations of all distinct aerosol types and a large variability of cloud systems. The atmospheric homogeneity in terms of aerosols and clouds is presented in the broader area around PANGEA, for a radius up to 100 km away, using the climatological LIVAS and CLOUSAT dataset. The climatological aerosol and cloud statistics over PANGEA are presented. The majority of the detected layers (up to 68%) are attributed to clean continental and marine particles. Additionally, high clouds (high) prevail also during all months at altitudes higher than 6 km, except for July and August. Nimbostratus (Ns), altostratus (As) and deep clouds are observed at all levels up to 13km.

1. Introduction

The PANhellenic GEophysical observatory of Antikythera, PANGEA, located in the centre of the Eastern Mediterranean basin, at the island of Antikythera (35.86 N, 23.81 E, elevation: 110 m a.s.l.) in Greece is the main station of the National Observatory of Athens (NOA) for atmospheric monitoring. PANGEA is a remote site, located in a hot-spot region in terms of climate change. PANGEA is representative of the broader region, receiving significant amounts of dust layers originating from deserts or semiarid areas in Africa up to 12 km [1], smoke particles from wildfires, sea-salt aerosols, biogenic aerosols, volcanic ash from Etna eruptions [2] and continental aerosols consisting of mixtures of anthropogenic pollution and particles from natural sources. Given that PANGEA is influenced by combinations of all distinct aerosol types and is characterized by a large variability of cloud systems, it is an ideal site for Cal/Val activities. Since June 2018 the aerosol remote sensing facility of NOA has been operating continuously an instrumental suite that fulfills the optimum requirements of the ACTRIS RI, including a 24/7 multi-wavelength lidar and a NASA-AERONET sunphotometer. Since June 2023 PANGEA station is part of the Global Atmosphere Watch Programme (GAW).

2. Methodology and Results

The study of Gkikas [3] presented the atmospheric homogeneity in the broader area around PANGEA, for a radius up to 100 km away, using climatological MODIS Aqua AOD (Aerosol Optical Depth) measurements as a homogeneity tracer. In this study, we show that the total Aerosol Mean Extinction coefficient profiles at 532 nm from the LIVAS climatology [4] remains almost constant for different radii around PANGEA site, for the period June 2006 to December 2021 (Figure 1a). Additionally, the spatial total AOD and Dust Optical Depth (DOD) remain almost constant at PANGEA, revealing a horizontal homogeneity of the aerosol and dust load in the broader area (Figure 1b). We conclude that a radius of 100 km is representative for PANGEA.

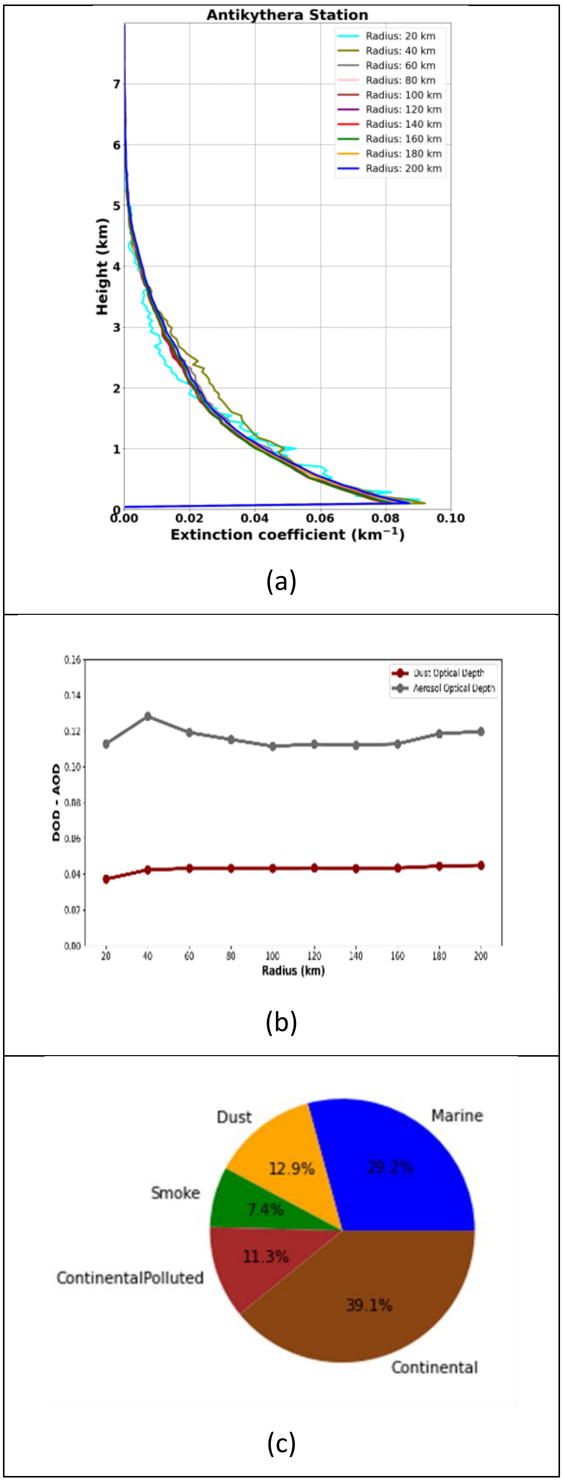

Figure 1. Total Aerosol Mean Extinction coefficient profiles at 532 nm (a) and AOD and DOD (b) for different radii around PANGEA site for the period between June 2006 and December 2021, using LIVAS dataset. Percentages of the detected aerosol layer types over PANGEA from 1 year of lidar measurements (c).

Figure 1c presents the percentages of the typed detected layers into the defined aerosol classes with NATALI [5] during 1 year of PollyXT measurements in PANGEA. The majority of the detected layers (up to 68%) are attributed to the Clean Continental and the Marine category. The Dust (pure and mixtures) cluster comes next with an occurrence ratio of 13%. Highly or medium absorbing particles (i.e., Smoke and Continental polluted category) remote sources (e.g., wildfires and agricultural fires) are also observed.

The cloud statistics for the radius of 100 km around PANGEA is then used for the decadal analysis from CloudSat [6]. The cloud homogeneity considering different radii centered at Antikythera island is also confirmed by the CloudSat dataset (not show here).

We herein analyze the data record collected between January 2007 and December 2007 to characterize the cloud properties over PANGEA, processing the 2B - GEOPROF (R05) radar reflectivity product and the 2B - CLDCLASS (R05) cloud type product. We only use reflectivities associated with a “CPR_cloud_mask” value more than 30, a value indicative of high confidence in the retrieval. CloudSat algorithm classifies clouds into eight categories: stratus (St), stratocumulus (Sc), cumulus (Cu), nimbostratus (Ns), altocumulus (Ac), altostratus (As), deep convective clouds (deep), and high-level clouds (high).

The monthly variability of the 8 classes of clouds is presented (Figure 2a), along with their presence per height (Figure 2b). Maximum cloudiness conditions are observed during the winter months (>70%), while minimum conditions are observed during the summer period (<10%). High clouds (high) prevail also during all months at altitudes higher than 6 km, except for July and August above PANGEA. Nimbostratus (Ns), altostratus (As) and deep clouds are observed at all levels up to 13km.

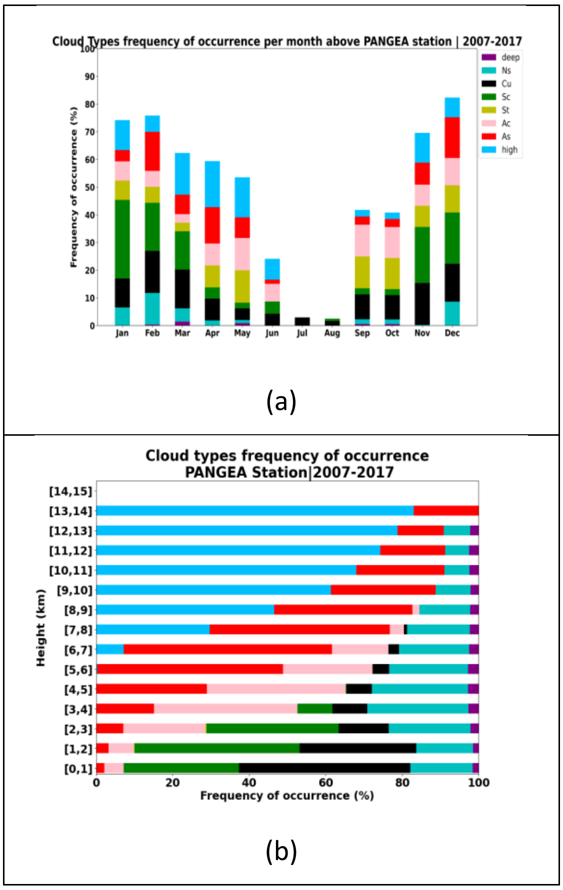

Figure 2. Frequency of cloud type occurrence (a) per month, and (b) per height from CloudSat for the period 2007 to 2017.

3. Conclusions

The atmospheric homogeneity in terms of aerosols and clouds in the broader area around the PANhellenic GEophysical observatory of Antikythera, PANGEA is presented in this study. We conclude that PANGEA is ideal for Cal/Val activities given that the location is representative of a wider region within the Mediterranean.

4. Acknowledgements

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5. References

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