Multi-year measurements of columnar aerosol properties at an Alpine EuroSkyRad Station

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1. Introduction

A Prede POM-02 sun/sky aerosol photometer has been measuring sun and sky radiation in the Saint-Christophe (Aosta Valley, Italy, see Fig. 1) site for almost 5 years, in order to retrieve columnar aerosol optical properties. The peculiar position in an Alpine valley makes this site particularly significant for both assessing aerosols radiative impact on the high-sensitivity mountain climate and for tracing long-range transport of aerosol within the Mediterranean basin. Due to the limited local sources, this site acts as a background air pollution station to study aerosol-rich air masses advections from the near Po Valley (one of the most polluted areas in Europe) and their interactions with such a complex environment.

Fig. 1(a): Site location (Saint-Christophe, 45.74°N, 7.36°E, 570 m a.s.l) is near a small city (<50k inhabitants) in an alpine valley.
(b): The Prede POM-02 sun/sky photometer at ARPA Valle d’Aosta (ARPA VdA), measuring at 12 wavelengths, from 315 to 2200 nm.

2. Methods

- In accordance with the EuroSkyRad (ESR, www.eurosyrad.net) network procedures, the SUNRAD [1] and SKYRAD [2] inversion algorithms have been used to determine aerosol parameters from the photometer’s direct and diffuse radiative fluxes, respectively. In Fig. 2 we show that the AOD data elaborated with a standard Sunrad configuration appear lognormally distributed, as it has been found in a previous work [3].
- To assess the sensitivity of the aerosol optical depth (AOD) retrievals to atmospheric pressure (P) and columnar ozone (O3), the Sunrad dataset has been reprocessed using available P and O3 measurements.
- Skyrad AOD dataset was filtered with the Cloud Screening of Skyrad data (CSSR, [4]) algorithm, using global radiation data from a co-located pyranometer, to identify cloud contamination.
- An optical particle counter (OPC) and a lidar-ceilometer helped understanding the evolution of both the particle size distribution (PSD) at the surface and the optical depth for some of the most significant episodes of advection of polluted air masses coming from the Po Valley. These advections are usually associated with a peculiar wind regime, an up-valley breeze blowing from East to West (~90°N) during the afternoon.

3. Results

AOD sensitivity tests

For the Skyrad AOD (500 nm) dataset, applying the CSSR algorithm with pyranometer data (level 2.2) causes the geometric std. deviation to decrease, while the geometric mean gets slightly increased (within the uncertainty [5]). As shown in Fig. 3(a-b), this correction has been implemented only when pyranometer data were available. On the other hand, correcting the Sunrad series drives to a change in the average AOD values of -2.6 and -3.1% respectively for P only and P+O3 corrections, for the 340 nm wavelength (most sensitive to Rayleigh and O3 scattering effects).

Advections identification

It is possible to clearly identify the advection of polluted air masses by studying optical (AOD, α) and physical (volume distribution) aerosol parameters from the photometer together with wind velocity and OPC data collected at ground (see e.g. Fig. 4) due to the optimal agreement between (1) the breeze/no breeze wind regime and the AOD sudden increase and (2) the particle volume distributions as measured by the OPC and retrieved by the POM-02 diffuse radiation flux.

Fig. 2: Statistics for AOD at 500 nm, based on the entire May 2012 - April 2017 dataset of Sunrad retrievals, with superimposed a best-fit lognormal probability density function (PDF) with geometric mean μ=0.075 and standard deviation σ=2.13.

References


Conclusion and perspectives

Results from Fig. 3(a-b) demonstrate the need of implementing within the ESR network a processing for both cloudscreening and to include ancillary measurements (e.g. pyranometers, pressure and ozone) to further improve aerosol data quality. These datasets will be used to evaluate aerosol radiative forcing effects on the Aosta Valley climate.

This study is also preparatory to the ongoing R&D work for the “USR GASA for Technology Transfer”, a project co-funded by the European Regional Development Fund (ERDF) Investment and Growth Program 2014/20, CUP B36150022/0006.