Stage de recherche au LACy

Laboratoire de l'Atmosphère et des Cyclones

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Titre du stage : **Multiwavelength lidar tropo-strato time series of aerosol extinction profiles over La Réunion.**

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Sujet du stage :

Aerosols contribute the largest uncertainty to estimates and interpretations of the Earth's changing energy budget [1]. Aerosols are therefore essential climate variables that need to be observed at a global scale to monitor the evolution of the atmospheric composition and potential climate impacts.

The south-western Indian Ocean (SWIO) can be considered as a pristine region [2,3], where land and human activities have so far had little impact, where sea salt aerosols are dominant, and where changes in the aerosol concentration can give rise to unexpected results. Actually, the SWIO is strongly impacted by long range atmospheric transport pathways connecting South America, Southern Africa, Australia and South-East Asia to this part of the world [4-7]. These source regions are yearly submitted to the Southern Hemisphere (SH) biomass burning (BB) season, and show records of extreme wildfires (e.g. the 2020 Australian wildfires, [8]). Wildfires emit large quantities of gases and aerosols into the troposphere [9] and, through the tremendous amount of heat they release (pyroconvection), even directly into the stratosphere (e.g. [8]). The increasing frequency of extreme wildfires events occurring in response to global and regional warming trends (e.g. [10]) urges assessment of their climate-altering potential. Moreover, volcanic eruptions can significantly impact the composition of the troposphere and stratosphere. Several events were recorded over the SWIO [11,12], and their radiative impact still needs to be inferred.

As a matter of fact, the SWIO exhibits a low yet highly variable aerosol burden [3,7], which makes it a region difficult to monitor from spaceborne instruments (measurements performed with a small signal to noise ratio) [3,13-18], and makes the global climate models struggling to simulate the related aerosol optical depth (AOD) in this part of the world [19,21]. Field experiments and ground-based observations provide then the most accurate and comprehensive analysis of aerosol properties, especially in such low AOD conditions characterizing the SWIO [7].

La Réunion (21°S, 55°E) is an island located in the subtropical SWIO at the crossroads of the long-range transport pathways bringing air masses from South America, Southern Africa, Australia and South-East Asia. It hosts the Observatory of Atmospheric Physics of La Réunion (OPAR), which is a world-class permanent station for long term atmospheric observations: dynamic and chemistry of the low and middle atmospheres in the context of Climate Change in the South Hemisphere. It is a French Instrumented Site and provides data for international monitoring networks (such as Global Atmospheric Watch – GAW and the Network for the Detection of Atmospheric Composition Change – NDACC), European Research Infrastructures (such as the Integrated Carbon Observing System – ICOS and the Aerosols, Clouds, and Trace Gases Research Infrastructure – ACTRIS), scientific research, and satellite validation (https://opar.univ-reunion.fr/). OPAR is one of the few ground-based observation points in the Indian Ocean and its range of instruments gives potential to fully characterize aerosol loading, microphysical, optical and radiative properties as well as vertical distribution, which are the comprehensive set of parameters to assess their impact on climate [21,22]. The location of OPAR makes it a hot spot for the study of BB aerosol plumes crossing the SWIO and originating from ones of the areas which are the most intensely submitted to BB activity [23], as well as an important validation point for the next spaceborne aerosol lidar mission EarthCARE (Earth Clouds, Aerosols and Radiation Explorer) of the European Space Agency (ESA). However, up to now, the influence of pollution plumes on the tropical atmospheric composition of La Réunion has been only determined by analyzing trace gases measurements [6,24-31].

OPAR performs regular observations of aerosols through tropospheric and stratospheric multiwavelength lidar measurements since 2014. The goal of this proposed internship is twofold: i) generate time series (2014-2022) of tropo-strato aerosol extinction profiles using OPAR multiwavelength lidar measurements through Raman and/or sun/moon-photometer synergy ; ii) geophysically interpret these time series to gain insights into the vertical distribution of BB and volcanic aerosol plumes and their properties to quantify their impact on the SWIO tropospheric and lower stratospheric composition and radiative balance at seasonal and interannual scales.

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