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MINERAL DUST IN SAHELIAN AFRICA: (II) OBSERVATIONS DURING THE AMMA FIELD EXPERIMENT

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The major role played by mineral dust in the chemistry and the dynamics of the atmosphere of Western Africa has been described in a related contribution.

In this poster, we will now illustrate the observational/modelling strategy that we will deploy during AMMA and expected scientific outcomes. Observations will be conducted during the SOP and EOP field phases. EOP measurements have been designed to document the annual and inter-annual variability of the dust cycle, and will be performed at three ground-based stations located along the main pathway of dust outflow towards the Atlantic (13°N, in Niger, Mali and Senegal). SOP measurements have been conceived to investigate the emission processes, to document the physico-chemical and optical characteristics, and to estimate the radiative and geochemical impacts of mineral dust. These observations will be performed at the ground and on aircraft platforms during the SOP0/SOPA and SOP1/SOPB1-B2 periods.

Dust is a difficult subject of study, because of the remoteness and the harshness of the source regions, and because of the experimental challenges imposed by its intrinsic properties. As an example, to date, the extent of the size distribution of mineral dust, ranging from fractions to tenths of microns, as well as the associated variability in its mineralogy, are not fully documented, especially in the proximity of source regions.

Content

Our observations of mineral dust during the AMMA experiment serve a triple objective: 1) estimating the seasonal and interannual variability of the mineral dust cycle over western Africa; 2) studying the mechanism of the emission process so to constrain the emission fluxes by number and by mass; and 3) looking at the physico-chemical and optical properties of mineral dust to estimate their impact on the solar and terrestrial budgets.

To do, we are establishing three long-term stations in Niger, Mali and Senegal, to be operational during the EOP period. The station in Niger will be enforced during the SOPs periods. The observational strategy is completed and complementary to modelling of the mineral dust

cycle and radiative impact. The experimental set up, as well as the complementary with modelling, is described hereafter.

1) EOP stations

The annual and inter-annual variability of the mineral dust cycle is monitored at three stations along the main pathway of dust outflow towards the Atlantic, around approx. 13°N. These are Banizoumbou (13N, 2E), Cinzana (13N, 5W), and M'Bour (14N, 16W) in Niger, Mali and Senegal, respectively. Due to variations in the altitude of dust transport, monitoring the surface concentration or the total integrated amount only is not sufficient to constrain the long-term variations of the mineral dust cycle. To date, data on mineral dust are still sparse, especially in the proximity of source regions, which are difficult to access, and are characterised by extreme environmental conditions, such as elevated temperature, dustiness and isolated intense rainfall episodes following extreme convective events. These factors impose serious logistical constraint for long-term good-quality measurements.

In order to achieve a long-term data series representative of the mineral dust cycle, we therefore choose to monitor few parameters by the means of robust instrumentation, namely

- Mass concentrations at the surface level measured by a TEOM (Tapered Element Oscillating Microbalance) for PM10 particles
- Column integrated aerosol optical depth measured by a CIMEL sun/sky photometer
- Vertical resolved aerosol backscatter profile measured by a micro-lidar (ISAC/CNR)
- Dry/wet deposition measured by a passive device
- Basic meteorological parameters by the means of weather station

These measurements will allow determining the aerosol content along the vertical as a function of time. They will serve as validation points for the simulations of the emission-transport model CHIMERE-DUST which is being developed at the LISA/LMD. Over western Africa, the model simulates the dust concentration fields at a 1 x 1° horizontal resolution for multiannual periods based on a physical parameterisation of the dust emission process. In turn, simulations will thus serve to interpolate the point measurements at the three stations to the continental scale.

2) SOP stations

During SOP0-A1-A2-A3 and SOP1-B1-B2, the measurements at Banizoumbou will be enforced and intensified.

The SOP0-A1-A2-A3 campaigns in the dry season aim to constraining the direct radiative effect of mineral dust and biomass burning particles, and their mixing. SOP0-A2 is also dedicated to studying the deposition and outflow of mineral dust to the Atlantic Ocean. Both these phenomena are related to the microphysical properties of mineral dust, that is, their size distribution and mineralogical composition. The size distribution of mineral dust varies from fraction to tenths of microns, the largest mass fraction being in the super-micron fraction. Particles in this size range are responsible for most of the deposition fluxes and for affecting the terrestrial radiation budget. Particles up to few microns are the most effective in interacting with the solar radiation. The mineralogy of dust particles also varies with size, and with source region. This needs to be determined as it has a large impact on the radiative impact, particularly in the terrestrial spectrum. Furthermore, the mineralogical composition of mineral dust may be altered due to mixing with concurrent aerosol components. In conclusion, to

achieve the SOP0-A1-A2-A3 objectives, measurements of micro-physical and optical properties as a function of particle size are necessary.

The SOP1-B1-B2 campaigns in the wet season aim to study the contribution to dust emissions of particular convective events, the squall lines, which have been shown to be able to put dust into suspension by eroding disturbed soils. The question is whether this dust remains in the atmosphere or it is abated by the heavy rains. To do so, measurements of the emission fluxes of mineral dust by mass are necessary. Simultaneous measurements of the emission fluxes by number would allow relating emissions to radiative impact, as well as providing experimental validation to the physical emission scheme. The summer campaign will also provide data on the microphysical properties of dust emitted from the Sahelian region.

During both field phases, the observational strategy combines ground-based and airborne observations. Various aerosol parameters (size spectrum, mass and number concentrations, optical properties) should be measured over the largest size range and under controlled conditions. To do so, both at the ground and on the French ATR42 aircraft, we have conceived sampling chambers allowing multiple and simultaneous sampling. In addition to the EOP measurements mentioned above, the Banizoumbou station will host measurement of number size distribution (GRIMM OPC), spectral scattering and absorption coefficients (TSI Inc néphélomètre and Magee Sci. aethalometer), and bulk and size-segregated mineralogy. The same set of instruments will be available on the French ATR-42 aircraft. The coupling between the two measurement sets will be done by overflying the station and sampling at various altitudes. In the wet season, flights will be scheduled before and after the convective events.

LES POUSSIERES MINERALES EN AFRIQUE SAHELIENNE : (II) STRATEGIE D'OBSERVATIONS DANS LE CADRE DE LA CAMPAGNE AMMA

Le rôle majeur joué par les poussières minérales dans la chimie et la dynamique de l'atmosphère en Afrique de l'Ouest est décrit dans la présentation orale associée.

Dans ce poster, la stratégie d'observation et de modélisation déployée dans le cadre de AMMA et les avancées scientifiques attendues seront illustrées. Des observations dédiées seront conduites durant les phases SOP et EOP. Les mesures EOP ont vocation à documenter la variabilité annuelle et interannuelle du cycle des poussières minérales et seront réalisés sur trois stations sols localisées sur le trajet principal de transport de poussière vers l'Atlantique Nord-tropical (13°N, au Niger, Mali et Sénégal). Les mesures SOP ont été conçues pour étudier les processus d'émission, documenter les propriétés physico-chimiques et optiques des poussières minérales et d'estimer leur forçage radiatif et leurs impacts géochimiques. Ces observations seront réalisées au sol et sur des plateformes aéroportées au cours des SOP0/SOPA 1à 3 des SOP1/SOPB1-B2.

Les poussières minérales sont un sujet d'étude difficile en raison de la localisation éloignées et des conditions particulièrement sévères des zones sources et par les difficultés expérimentales imposées par leurs propriétés intrinsèques. Ainsi, par exemple, il n'existe pas de description complète de la distribution granulométrique des poussières minérales, depuis la fraction jusqu'à la dizaine de micron, et des variations de composition minéralogique associées, en particulier à proximité des zones sources.

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Afrikanske Monsun : Multidisiplinaere Analyser
Analisi Multidisciplinare per il Monsone Africano
Analisis Multidiciplinar de los Monzones Africanos
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Extended abstracts

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Convective wind system with aerosols, named "haboob", Hombori in Mali, West Africa.