DEVELOPMENT OF A NOVEL ALGORITHM TO CALCULATE THE OPTIC PROPERTIES OF TEMPORAL AEROSOLS THROUGH REMOTE SENSING DATA MEASUREMENTS: PROSPECTIVE STUDY

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ABSTRACT

Satellite' sensors as well as ground-based sun photometers instruments surface are utilized gather data about the quantitative composition of components in the Earth's atmosphere. The relationships among these components produce effects in different phenomena, like regional climate change. Aerosols, consisting of particles from 0.01 to 10 μm, are atmosphere components, whose effects are still poorly understood. Through Remote Sensing, it is possible to classify them and gain information about their role in different atmospheric processes: low visibility, solar energy balance, cloud formation and increases or decreases of the quantity of precipitation. This paper describes how the study and analysis of satellite-based and ground-based measurements can be used to develop and validate a novel procedure to calculate the optical properties of temporal aerosols found in and around Guadalajara, based on previous algorithms:, to determine the aerosol size distribution function, scattering phase function, single scattering albedo, complex refractive index and asymmetry parameter. The quantifiable knowledge about the temporal and regional aerosols' optical properties will contribute to future investigations related to their quantitative effects on atmospheric processes in this region. These effects include: alteration of weather and climate, change of the tropospheric temperature, contribution to environmental ills, the formation and properties of the clouds, effects on the ecosystems, local solar energy balance, and the impacts on human health.

Index Terms— Photometry, Remote Sensing, aerosols, aerosol´s optical properties, NASA satellite data inter comparison, algorithm development.

I.INTRODUCTION

In the last 30 years, researchers have identified and classified different types of aerosols, and investigated their spatial and temporal distribution. It is important to characterize the influence of aerosol parameters vertical distribution, optical properties on local ground-level temperatures. Also, it is necessary to accurately understand

the sizes of the direct and indirect effects of naturally-occurring aerosols when they combine with anthropogenic aerosols, and the ways in which atmospheric conditions define their effects, both in

urban and rural settings, on such processes as radiative forcing and precipitation. To gain this understanding, we will make use of remote-sensing measurements from both spaceborne (e.g. CALIPSO) and ground-based (e.g. the ITESM "SHADE" sun photometer) instruments, in combination with newly developed algorithms and mathematical models based on the previous algorithms, which we adapt to be suitable to the Guadalajara geographic zone.

II.VERIFICATION PROTOCOLS

Taking time and space collocated measurements from the SHADE Sun Photometer, the CIIMEL Sun Photometer and several satellite data/retrievals, correlations will be made amongst these data sets in order to derive multiple aerosol optical properties.

At the time of writing, the measurements done with the MIMS Sun Photometer were taken from November 2010 to March 2012, were only suitable for calculating Aerosol Optical Thickness and the Angstrom Coefficient. The extended goal is to use the SHADE Sun Photometer to make an extended study on the aerosols of the Metropolitan Area of Guadalajara.

The calculations done for Aerosol optical thickness was doing by using the following formula:

$$\tau_{\lambda A} = \frac{[\ln(V_o / R^2) - \ln(V - V_{dark}) - a_R(p / p_o)m]}{m}$$

Where $\tau_{\lambda A}$ is the aerosol optical thickness made by aerosols, V_o is the calibration constant of MIMS Sun Photometer, R is the Earth-sun distance expressed in

astronomical units (AU), a_R is the contribution to optical thickness of molecular Raleigh scattering of light in the atmosphere. For the red channel is a_R is about 0.05793 and for the green channel a_G is about 0.13813, p is the barometric pressure, p_o is the standard sea level atmospheric pressure (1013.25 millibars) and m is the relative air mass.

The calculation of aerosol's percent transmission "Solar Intensity" as show in the figure 1 was done by expressed the percent of sunlight at a particular wavelength:

$$\% \; Transmission = 100 \, e^{-\tau}$$

In the figure 1, we have a relation between the aerosols optical thickness measurements in a different time with the perceptual of transmission solar intensity for two different types of aerosols 505nm and 625 nm. The graph shows how the transmission of the solar intensity is more reduce with the aerosols of 505 nm.
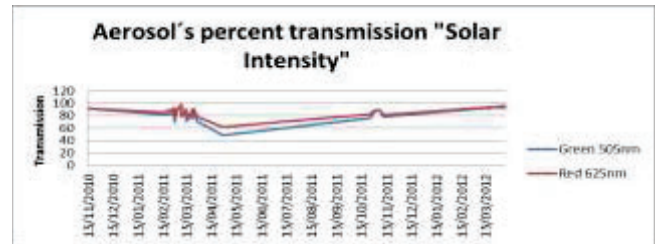

Figure 1 Shows the Aerosol's (550nm, 625nm) percent transmission "Solar Intensity" in Guadalajara, Jalisco México.

As we mention with the measurements done other calculations was possible is the Angstrom Coefficient that gives some information regarding the size distribution of the particles.

Angstrom Exponent: $\alpha = \dfrac{\ln(\tau_2 \div \tau_1)}{\ln(\lambda_1 \div \lambda_2)}$

Where α It is the Angstrom Coefficient, τ aerosol optical thickness, λ it is the wavelength of incident light.
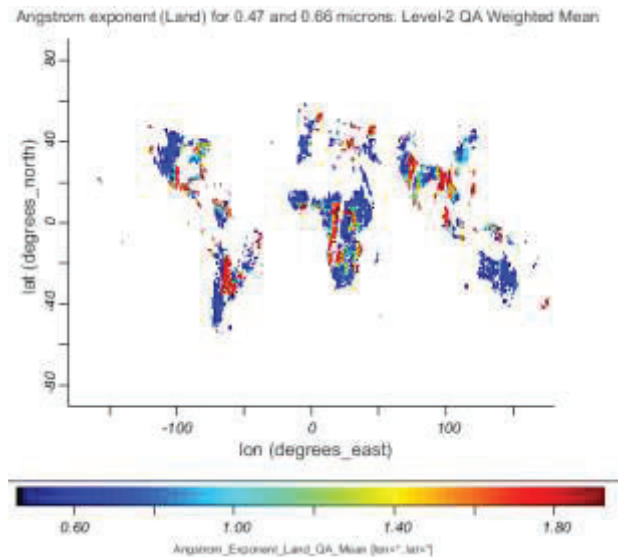

Figure 2. Angstrom Exponent

The previous image is a two dimensional plot of the Angstrom exponent for April 8th, 2011, retrieved from the Giovanni portal for the TERRA - MODIS instrument. The Angstrom exponent is typically defined as the relationship between aerosol optical extinction and wavelength. There is a relationship between the Angstrom exponent and the size distribution of the aerosols. Usually, larger particles have a lower Angstrom exponent, and vice versa. This is because larger particles tend to be more spectrally flat. A study will be carried out to determine the amount of correlation between the Angstrom Exponent calculated for the SHADE instrument, and the Angstrom exponent derived from the TERRA - MODIS instrument.

As mentioned previously, collocated data will be acquired from satellite and ground-based sun photometer measurements, made at three different sites within the Guadalajara geographic zone. This information will be the basis for the development and validation of a novel procedure to calculate the optical properties of temporal aerosols based on previous algorithm.

This is a columnar aerosol size distribution equation:

IV.CONCLUSION

The results of this research will give a quantifiable knowledge about the temporal and regional aerosols' optical properties existing in and around Guadalajara. At this moment we just quantify aerosols optical thickness of wavelength of 525nm and 625nm, and their final intensity in Guadalajara city. We will identify the aerosol size distribution function, scattering phase function, single scattering albedo, complex refractive index and asymmetry parameter of these particles during 5 months. In addition, these results will be the basis of future investigations related to environmental and atmospheric processes of the in this region.

V. REFERENCES

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