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DETECTION OF SMALL ATMOSPHERIC PARTICULATE MATTER BY SATELLITE MEASUREMENTS

Abstract

Particulate Matter (PM) is a general term used for a complex mixture of organic and inorganic non-gaseous particles (aerosols), of both natural (volcanic eruptions, sea spray, desert dust, vegetable material, soil erosion, fires etc) and non-natural (combustion processes, transport, industrial and extraction activity, building sites...) origin, which, due to their small mass, remain temporarily suspended in the Earth's atmosphere (and in particular in the low troposphere) in solid, liquid or both physical states. An important classification of PM is that based upon its sizes: ultra-coarse particulate refers to particles with aerodynamic diameter dA greater than 10 micron, coarse particulate (PM10) to particles with dA ¡ 10 micron, fine particulate (PM2.5) to dA ¡ 2.5 micron, ultra-fine particulate (PM0.1) to dA ¡ 0.1 micron. Another basic distinction is between primary and secondary PM. Primary refers to aerosols emitted directly into the atmosphere through man-made and natural processes, while secondary particles are those formed in the atmosphere by chemical reactions involving gaseous pollutants as nitrogen oxides and sulphur dioxide. The harmful effects on health caused by the presence of non-natural origin particulate, depending on its chemical composition, are inversely correlated to the size of the particles and different kinds of aerosols are discriminated. Previous studies on the matter demonstrated the feasibility to estimate the atmospheric particulate content by satellite-based remote sensing, using different temporal MODIS data.

The PM is monitored by satellite, evaluating the variations in radiance that reaches the sensor due to the effect of the aerosols, both in the reflective and in the thermal infrared part of the electromagnetic spectrum (in the thermal infrared region, the radiance variations can be related to changes of the estimated values of surface brightness temperature); these variations are linked to the value of Aerosol Optical Thickness and interpreted to allow an estimate of particulate concentration, different solar illumination and atmospheric conditions are taken into account since temporal series of satellite images have been used. The concentration of water vapour, strongly influenced by seasonal effects have been evaluated.

In this paper, the results obtained, using a broad range of numerical simulations along with satellite measurements, show the possibility of monitoring the presence of small atmospheric particles. Since the secondary PM are mainly composed of fine and ultra-fine particles, the proposed methodology is particularly suitable to isolate the secondary particulate presence, far away from emission sources of particulate.