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Enhancing weak transient signals in SEVIRI false colour imagery: application to dust source detection in southern Africa

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Understanding the processes governing the availability and entrainment of mineral dust into the atmosphere requires dust sources to be identified and the evolution of dust events to be monitored. To achieve this aim a wide range of approaches have been developed utilising observations from a variety of different satellite sensors. Global maps of source regions and their relative strengths have been derived from instruments in low Earth orbit (e.g. Total Ozone Monitoring Spectrometer (TOMS) (Prospero et al., 2002), MODerate resolution Imaging Spectrometer (MODIS) (Ginoux et al., 2012)). Instruments such as MODIS can also be used to improve precise source location (Baddock et al., 2009) but the information available is restricted to the satellite overpass times which may not be coincident with active dust emission from the source. Hence, at a regional scale, some of the more successful approaches used to characterise the activity of different sources use high temporal resolution data available from instruments in geostationary orbit. For example, the widely used red-green-blue (RGB) dust scheme developed by Lensky and Rosenfeld (2008) (hereafter LR2008) makes use of observations from selected thermal channels of the Spinning Enhanced Visible and InfraRed Imager (SEVIRI) in a false colour rendering scheme in which dust appears pink. This scheme has provided the basis for numerous studies of north African dust sources and factors governing their activation (e.g. Schepanski et al., 2007, 2009, 2012).

However, the LR2008 imagery can fail to identify dust events due to the effects of atmospheric moisture, variations in dust layer height and optical properties, and surface conditions (Brindley et al., 2012). Here we introduce a new method designed to circumvent some of these issues and enhance the signature of dust events using observations from SEVIRI. The approach involves the derivation of a composite clear-sky signal for selected channels on an individual time-step and pixel basis. These composite signals are subtracted from each observation in the relevant channels to enhance weak transient signals associated with low levels of dust emission. Different channel combinations are then rendered in false colour imagery to better identify dust source locations and activity. We have applied this new clear-sky difference (CSD) algorithm over three key source regions in southern Africa: the Makgadikgadi Basin, Etosha Pan, and the Namibian and western South African coast. Case studies indicate that advantages associated with the CSD approach include an improved ability to detect dust and distinguish multiple sources, the observation of source activation earlier in the diurnal cycle, and an improved ability to pinpoint dust source locations. These advantages are confirmed by a survey of four-years of data, comparing the results obtained using the CSD technique with those derived from LR2008 dust imagery. On average the new algorithm more than doubles the number of dust events identified, with the greatest improvement for the Makgadigkadi Basin and coastal regions. We anticipate exploiting this new activation record derived using the CSD approach to better understand the surface and meteorological conditions controlling dust uplift and subsequent atmospheric transport.