The Promise of Hyperspatial Remote Sensing for Understanding Aeolian Processes:

An Example Using PlanetScope at “The Dustiest Place on Earth” (And Elsewhere)

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Introduction

- Mineral aerosol (dust) plays a key role in directly and indirectly influencing Earth’s climate[1,2].
- Understanding the activity of dust sources is critical to determining dust’s impact in the Earth system, as accurate simulation of dust uplift (emission) is essential for skilful modelling of the global aeolian dust cycle[3].
- Source regions, where emission occurs, determine dust’s varied environmental impacts, exerting a fundamental control on dust properties (particle size, mineralogy, biogeochemical potential)[4].
- Sources are also ‘launch pads’ for the large-scale coupling of environmental systems that are linked by long-distance dust transport in the atmosphere.
- Despite recent advances in establishing the first globally-comprehensive dust source inventories using satellite data[5,6], remote sensing data resolution has remained at a space/time scale below which specific small-scale processes driving dust uplift become apparent. This is a factor which leads to significant differences between modelled and observed atmospheric dust loadings[2].

Data and Methods

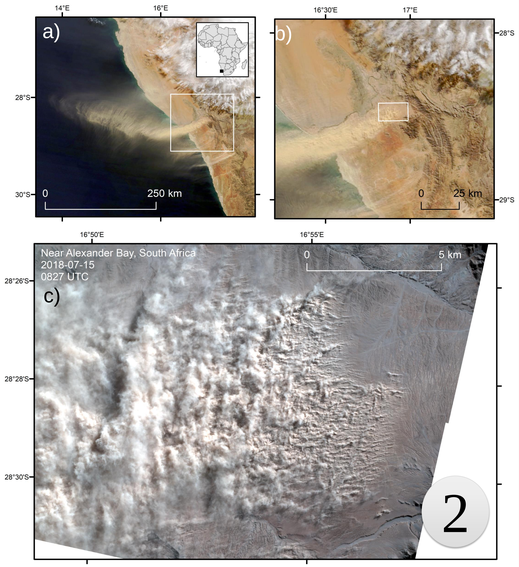
- Recent advances in satellite technology have led to the creation of miniaturised, multi-platform constellations[7].
- These constellations allow extremely high spatial resolution Earth observation on a daily basis.
- Planet Lab’s suite of Dove satellites equipped with the PlanetScope sensor is one such constellation. Presently, ~175 Dove platforms are in orbit, each with an orthorectified spatial resolution of ~3 m.
- As part of an effort to re-assess processes occurring within dust sources at a global scale using these data, we present three example case studies.
- Systematic interrogation of PlanetScope data has - for the first time - allowed insights from dust sources at space (m) and time scales (<1 day) which allow direct comparison with both *in situ* data and moderate resolution dust climatologies.

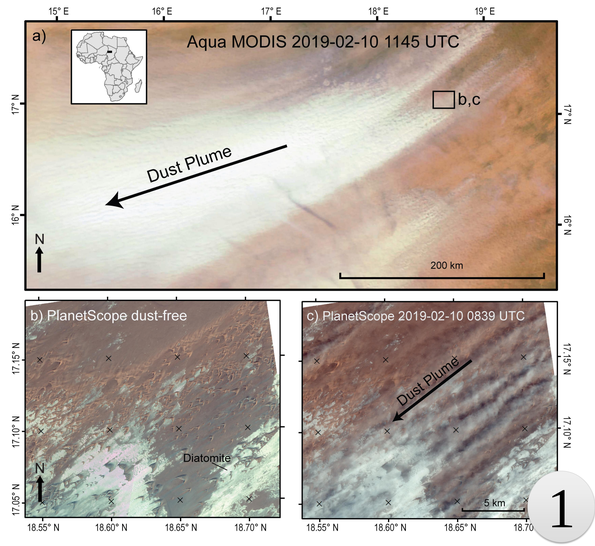
Results

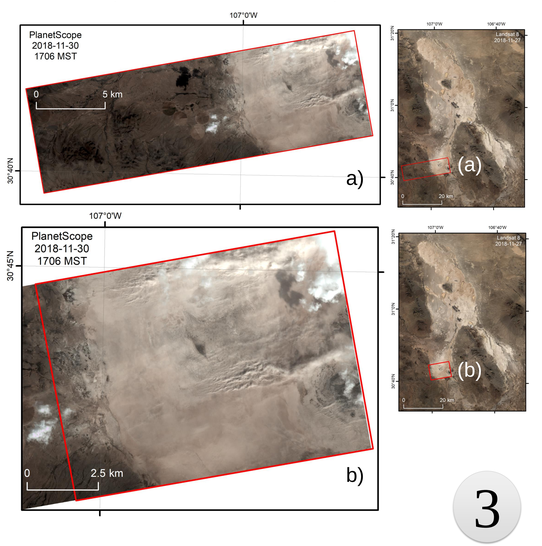
1 **Bodélé Depression**, **Chad**. MODIS data (a) depict typical dust plumes at this location, described as the “dustiest place on Earth”[8]. PlanetScope imagery (b) of a dust-free source area, and (c) the same regions under dust emission conditions. These allow rapid investigation of (i) the relationship between mobile saltating quartz sand and sand-sized diatomite aggregates of the barchan dunes, with their associated saltation flux over the underlying diatomite surfaces, and (ii) the mapping of individual plumes to candidate emission surfaces.

2 **Alexander Bay, southern Namibia**. MODIS data allow us to locate a consolidated dust plume travelling into the S. Atlantic, and upwind determination of the (approximate) location of the source region (images a and b). Again, PlanetScope (c) allows us to map individual plumes in great detail for the first time, and provides insights regarding the *actual* location of dust emitting surfaces – in this case a large area of fluvial/alluvial wash.

3 **Paleolake Palomas Basin, Chihuahua**, **Mexico.** Two extremely detailed PlanetScope views (a and b) depict heterogeneous dust uplift of plumes from sub-basins within the playa and from nearby irrigated agricultural land.







Conclusions

- By pointing out the potential of novel high-resolution imagery for dust source observation, we highlight that such data permit visualization of emissions at a scale which will significantly enhance our ability to monitor, understand and model aeolian dust entrainment.
- PlanetScope data offer spatial and temporal resolution that enables direct links to be made between field observations of dust emission, and large scale global inventories of dust flux.
- Taking advantage of their exceptional detail and global coverage, we call for future, systematic evaluations of dust sources using constellation-based, high-spatial resolution imagery.
- These data promise a new impetus for remote sensing data to better inform our understanding of the spatio-temporal distribution of aeolian processes and emission drivers in the global dust cycle.

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