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Simulated deposition of aeolian dust on the Australian continental shelf: Preliminary results

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Abstract: Australia is the driest inhabited continent and one of the major sources of aeolian dust in the Southern Hemisphere (De Deckker 2019). The suspended dust particles have a capacity to travel great distances across the whole continent and beyond, in extreme cases reaching Antarctica and New Zealand (Nguyen et al. 2019). When accumulated in large quantities such particles can have an adverse environmental, economical, and human health impacts. To shed more light on these issues, a number of studies have been conducted recently aiming, in particular, at better understanding the provenance and pathways of aeolian dust over the Australian continent (McGowan and Clark 2008; Petherick et al. 2009; O'Loingsigh et al. 2017; Yang et al. 2021; Shaylor et al. 2022). Most of these studies have been investigating the dispersion of particles in atmosphere.

In our study we employ a particle-tracking model (GlobuSed) to simulate pathways of the dust particles across the coupled atmosphere, ocean, and sediment environments. The transport in atmosphere is driven by 3 hourly ERA5 winds (Hersbach et al. 2023), ocean currents are approximated by a wind-driven Eckman spiral combined with tidal currents, the transport in sediments is represented by a 1D vertical diffusion. Diffusion in atmosphere, ocean, and sediments is represented by the Brownian motion with the diffusion coefficients varying across environments. Two classes of particles with the settling velocities in atmosphere of 1 and 0.1 cm/s are simulated. Particles are released at a constant rate into the atmosphere from the Lake Eyre Basin (approximated by a square region). Simulations are carried out for two dry years 2017 and 2018, and one more year 2020 representing an onset of the La Nina conditions.

Despite relatively simple model, simulated distribution of the dust particles over the Australian shelf is consistent with the general understanding of the dust movements over the Australian continent. According to the model, over the simulation period up to 10% of the total amount of particles eroded from Lake Eyre Basin has been deposited over the GBR region. The study highlights the role of sand storms capable of moving large quantities of dust to the ocean. It also suggests the critical role of the subtropical-ridge anticyclonic winds in delivering dust particles to southern GBR.

Further progress in understanding the distribution of the aeolian dust particles over the Australian shelf must be based on more advanced data for ocean currents and improved representation of the dust processes. Understanding the biological responses of the ocean to the dust input requires an application of an advanced biogeochemical model.

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