**Real-time prediction of desert dust melting in aircraft engines**

Melted volcanic ash in jet engines remains as an aviation safety issue over several decades. Because the current generation of aero turbines increased operating temperatures to 1300C or more, desert dust with its melting temperatures lower than combustion temperatures can also adversely affect engines and degrade aircraft performances. Standard dust tests samples are usually used to examine in laboratory conditions the harmful influence of particles to aircraft engines. Although this approach in general mimics effects of volcanic ash or simulates dust storm conditions, it cannot completely represent real-time conditions. To complement such studies, we here propose a methodology which assesses the probability of mineral melts in turbines when aircrafts pass through dust clouds using a numerical model for predicting spatial-temporal distribution of major minerals in atmospheric dust. We parameterize the melting temperature of the mineral mixture using (a) the predicted dust concentrations, (b) the estimated melting temperatures of composing minerals, (c) fractions of considered minerals, and (d) the exposure time of dust to high turbine temperatures. Our model prediction results of dust effects on aircrafts are generally consistent with the evidence that the aviation experienced problems with turbines during a recent Middle East heavy dust storm. The proposed aviation-tailored forecast system if executed in operational m

* Walsh: The combination of extreme temperature and residenceime can lead to sand even melting inside the turbine component. With increasing temperatures of gas turbine engines and the development of new cooling designs, it is critical to evaluate the effects of ingested sand particles.
* Zhao: Since the surfaces of components in future engines are likely to be cyclically exposed to temperatures of 1250 °C and above
* Singh: Metal temperatures were shown to be the most important parameter for particle deposition. At temperatures above 1000 oC, sand particles started melting and promoted blocking of cooling holes. Particle ingestion is excessive while takeoff and landing when engines are in ground proximity and running at full power[1]; According to studies by Edwards and Rouse[7], high sand ingestion can reduce engine stability by eroding blade profiles and lowering the compressor efficiency, as a result of which the line of operation is closer to the surge line.
* *Taltavull,* It is increasingly clear that gas turbines, particularly aeroengines, are susceptible to damage caused by ingested particulate, such as sand, fly ash and volcanic ash, often referred to generically as calcia-magnesia-alumina-silica (CMAS). Such particles may melt, or at least soften, in flight, making it more likely that, if they strike solid surfaces within the turbine, they will adhere to them on impact. Ongoing increases in turbine entry temperature clearly raise the danger of this happening and

Atmospheric mineral dusts are inorganic particles of rock and soil

that have been lifted into the atmosphere, predominantly from arid

regions such as the Sahara9

Although atmospheric dust concentrations and mineralogy

vary spatially and temporally9,13 (Supplementary Fig. 1), a large

fraction of observed atmospheric dust mass around the world is made

up of just a few minerals.

Paola

parameterization

* Singh Figure 5.4 shows the probability of sticking for sandparticles based on viscosity*visc P* with temperature. Sticking probability rises exponentially as the

particle approaches softening temperature.

Melting points