SMALL LINEAR WIND TUNNEL SALTATION EXPERIMENTS: SOME EXPERIENCES

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Since the wind tunnels proposed to be used for the Space Station Planetology Experiments are of a rather limited size, some experience and techniques used for saltation experiments in a small linear wind tunnel may be of interest. Three experiences will be presented. The first concerns a length effect of saltation mass flux in which the size of the wind tunnel exaggerates the physical process taking place. A second experience concerns a non-optical technique that does not interfere with flow and by which momentum flux to the floor may be measured. The technique may also be used to calculate saltation flux (using appropriate assumptions). The third experience concerns the use of the momentum equation to estimate momentum fluxes by difference.

1. A length effect exaggerated by wind tunnel dimensions.

A feedback mechanism that increases mass flux of saltating particles with distance exists for sufficiently fast moving air passing from a smooth floor to a surface of erodible sand. Absorption of momentum by sand starting to move in saltation increases the apparent aerodynamic roughness height. This increase of roughness height corresponds with increased momentum flux from the air which makes a larger saltation mass flux possible. P.R. Owen theoretically showed this feedback mechanism to be exaggerated by the presence of a wind tunnel cieling. His theory agrees quite well with experimental results of a small cross section linear wind tunnel.

2. An approximate method for fast response measurement of saltation particle flux.

A fast time response sensor may be used to count the number of impacts on an area of floor as well as measure the momentum flux from impacts. It has the capability of furnishing data to a method by which the horizontal flux of mass moving in saltation for monodisperse particles can be estimated. The sensor has a large advantage in that it does not interfere with the flow in the wind tunnel. A disadvantage of the estimation method is that it must assume a relationship of saltation trajectories to convert the signal into mass flux information. The method uses the assumption for monodisperse particles that saltation length is proportional to particle speed at impact with the surface. The mean particle speed at impact with the surface is assumed to be proportional to the momentum flux divided by the mass flux. It is assumed that mass flux is proportional to number of impacts times the mass of each particle.

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The method giving a fast response mass flux for saltating particles shows for a typical run a rapid increase of particle mass flux corresponding to increase of air speed after turning on the wind tunnel fan, followed by a period of steady mass flux, followed by a decay of mass flux as the particles are depleted from the wind tunnel.

3. An attempt to use a direct momentum flux measuring device to evaluate momentum fluxes by using the momentum equation.

By measuring several terms of the momentum equation, momentum fluxes may be estimated by evaluating all but one of the terms of the momentum equation; the difference of terms is the quantity estimated. For example, the momentum equation was used to estimate the momentum flux to the floor of a rectangular wind tunnel as follows: Floor stress = upwind wind momentum flux - downwind wind momentum flux - cieling stress + pressure differential integrated over the wind tunnel cross section - downwind particle momentum flux. In the example, downwind particle momentum flux was measured using a direct momentum integration device. The method suffered, however in that the difference, the floor stress, was a small difference of large quantities all having experimental errors. Results show that the method is unreliable for distances smaller than 150 cm in a linear wind tunnel and that the estimate has large error limits. It was concluded that direct measurements were preferable where they can possibly be made.