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# 氷上に発生するカタバ風の流速分布

**Velocity distribution of katabatic wind flowing on the ice floor**

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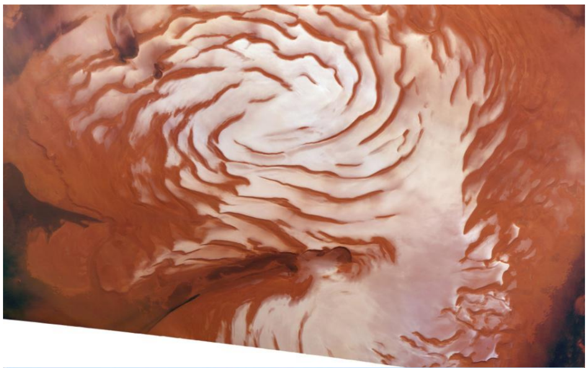
## 1. Introduction

Katabatic wind , also called downslope wind, or gravity wind, It's a kind of wind that blows down a slope because of gravity.

The form of katabatic winds: Most katabatic winds are more or less the result of air in contact with upper level ground is cooled by radiation, increases in density, and flows downhill and along the valley bottom.

Two typical examples of katabatic wind are the cyclic steps on mars and Blizzard in Antarctica



Pic.1Spiral troughs on the polar ice caps of Mars (Credit: ESA/DLR/FU-Berlin/Ralf Jaumann) pic.2 Blizzard in Antarctica (Credit: JOHN GOODGE)

Spiral troughs on the polar ice caps of Mars have been interpreted to be cyclic steps formed by katabatic wind blowing over ice. Cyclic steps are relatives of upstream-migrating antidunes. Cyclic step formation on ice is not only a mechanical but also a thermodynamic process. It change the surface of mars.

Because the flow of katabatic winds and it's impact is not fully understood.Study the velocity of katabatic wind is neccesary.

## 2. Experimental

### (1) Experimental apparatus

The experiments were conducted in an aluminum tank. The surface can be cooled to a temperature down to －20◦C. It conducted eight cases of experiments by the use of an experimental apparatus consist of a tank, a cooling system for the flume, and a circulating system.

In this experiment, because it is hard to get the velocity data directly, a method called visualization of the density flow(created by katabatic winds) is realized by using insense's smoke. By taking photos of the smoke motion at different places of the flume, we can aquire the flow velocity changes of katabatic winds in former research.

This year a new measurement method called PIV (Particle image velocimetry) has been used.

PIV apparatus consists of a camera (normally a digital camera with a CCD chip in modern systems), a laser with an optical arrangement to limit the physical region illuminated (normally a lens to convert a light beam to a line), a synchronizer to act as an external trigger for control of the camera and laser, the seeding particles and the fluid under investigation. PIV software is used to post-process the optical images.

### (2) Experimental condition

The experiments were conduct in the laboratory of Hokkaido university.

By cooling the tank, there would be ice forming on the surface of tank.

In this reserch, I choosed three locations on the tank. 40cm ,90 cm and 150cm from the upstream to down stream. The flow of the small particals above the ice are illuminated in the target area with a light sheet. The camera lens images the target area onto the sensor array of a digital camera. The camera is able to capture each light pulse in separate image frames.

### 3. Analysis method

By using PIV, I found out the flow of the katabatic wind is a kind of flow called inclined wall plume. The characteristics of the inclined wall plume are investigated by the k-ε turbulence model.

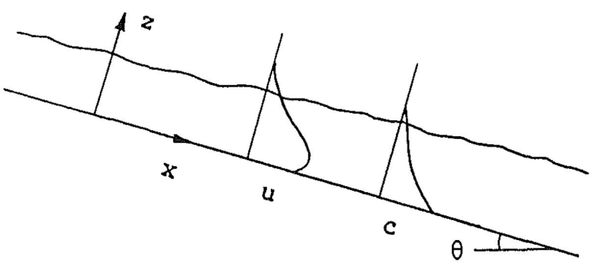



**Fig. 1 Definition sketch of inclined wall plume**

The equation of continuity, the momentum equations in the x and z direction, and the equation of quantity causes the density difference become,

$$\frac{\partial u}{\partial x} + \frac{\partial w}{\partial z} = 0 \qquad (1)$$

$$u\frac{\partial u}{\partial x} + w\frac{\partial u}{\partial z} = \frac{\rho}{\rho_0} g \sin\theta - g\cos\theta \frac{\partial}{\partial x}\int_z^h Rc\, dz - \frac{\partial}{\partial z}(\overline{u'w'}) \qquad (2)$$

$$u\frac{\partial c}{\partial x} + w\frac{\partial c}{\partial z} = -\frac{\partial}{\partial z}(\overline{c'w'}) \qquad (3)$$

where u and w are the velocity components in the flow direction x and in the lateral direction z, respectively, g is the gravitational acceleration, $\theta$ is the slope angle of the wall.

And the velocity u can be interpret as,

$$u = \frac{\partial \psi}{\partial z} = \frac{\partial}{\partial z}\{bx^m F(\eta)\} = bx^m \frac{\partial \eta}{\partial z} F' = abx^{m-l} F'$$

### 5. Conclusion

In this research, we would like to know the velocity distribution on the ice cap. By cooling the tank with a circulating system using ethanol. We can observe the ice formation and the air flow above it surface. PIV system give me a chance to get the precise data of the movement of small particals in the air flow. And by using analysis method, we can get the distribution of the velocity .

In my research so far, I found out the velocity would increase with the height above the surface on the tank before a critical value. After the critical value , velocity would decrease sharply with the vertical axis.

### 6. Future Works

In order to understand the katabatic wind better, I will do more experiments using PIV system and aluminum tank. Some variable quantity will be considered in my future work. Such as the angle of the inclined tank surface, the temperature of the environment and the surface of the tank. By analyzing and comparing these different conditions, the flow of the katabatic wind can be understood better.

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