

LASER ALTIMETRY MEASUREMENTS OF OKHOTSK SEA ICE FROM AN AIRPLANE

Mitsuo ISHIZU, Tetsuro AOKI, Kohei MIZUTANI,
Masao TAKABE, Tosikazu ITABE
Communications Research Laboratory,
Ministry of Posts and Telecommunications
4-2-1 Nukui-Kitamachi, Koganei, Tokyo 184, Japan
Phone: 81-423-27-6831 Facsimile: 81-423-27-6667

1. Introduction

Laser altimetry from space has been studied intensively to realize accurate and high-density land mapping which will be very useful to know global environmental changes.⁽¹⁾ We are developing an airborne

laser altimeter to acquire a basic technology of laser altimetry for future plan of a space lidar.

We present here the construction our altimeter and a result of observations in 1993-1994 on Okhotsk sea ice at the northern coast in Hokkaido.

2. Construction of a laser altimeter

The optical block of the altimeter is constructed in a small(50x50x80cm) package made of aluminum honeycomb boards. The system consists of a diode-pumped Nd:YAG laser (Laser Diode Inc., LDP150-2), and transmitting and receiving telescopes. The laser pulse of 10mJ is frequency doubled by KTP crystal to yield 2mJ green power. The diameters of transmitting and receiving telescopes are 8cm and 20cm, respectively. An interference and neutral density filters are accompanied for noise reduction and intensity adjustment.

In order to measure the pulse delay time precisely, pulse peaks of signals from a monitor photodiode and from a photomultiplier tube are detected by two constant fluctuation discriminators. The received pulse also triggers a digital oscilloscope and the wave form as well as the delay time was recorded in a laptop computer.

The accuracy of the system was measured by ground test. A TV broadcasting tower at 4.3km distance from our building was used as a target. The standard deviation of the measured distance was 6cm per pulse, which agreed with an error estimation from receiving photon numbers.

Table 1 summarizes specifications of our system.

3. Observation of sea ice

Height distributions of sea ice were observed by the altimeter installed in a small airplane(Cesna Caravan) at periods of March 1993 and February 1994 near the coast of Abashiri city in Hokkaido. Sea ice was chosen as a target because of the resemblance to the polar ice sheets.

Figure 1 shows a trace of the height records and simultaneously monitored photographs of sea ice. As is shown in the photographs, the flight pass was along the sea region covered with thin to thicker ice. The average height of the airplane was 425.6m, and the fluctuation of the average height is due to the variation of the flight height and attitudes of the airplane.

Although each height record scatters around the average heights, a rectangular distribution of the records can be clearly seen in the later half of the pass. In this distribution the bottom boundary are thought to be by the echo from sea water or small ice surfaces and the top boundary to be by the echo from the board ice. Thus the height of the board ice from sea level is concluded to be 80cm in thick ice region.

4. Conclusion

The sea ice height from sea level was measured by the airborne laser altimeter to be 80cm for board ice. We will improve the altimeter to measure absolute heights of the ground by incorporating a navigation system.

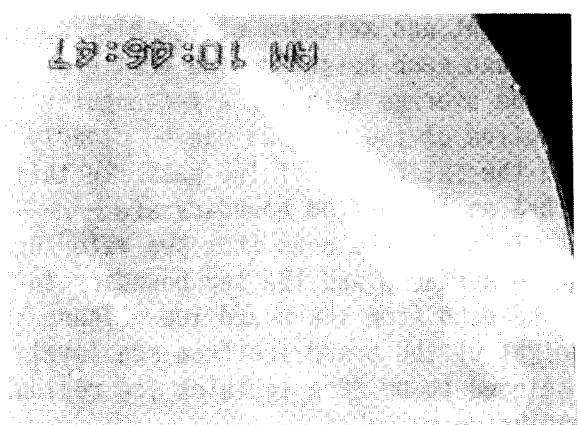
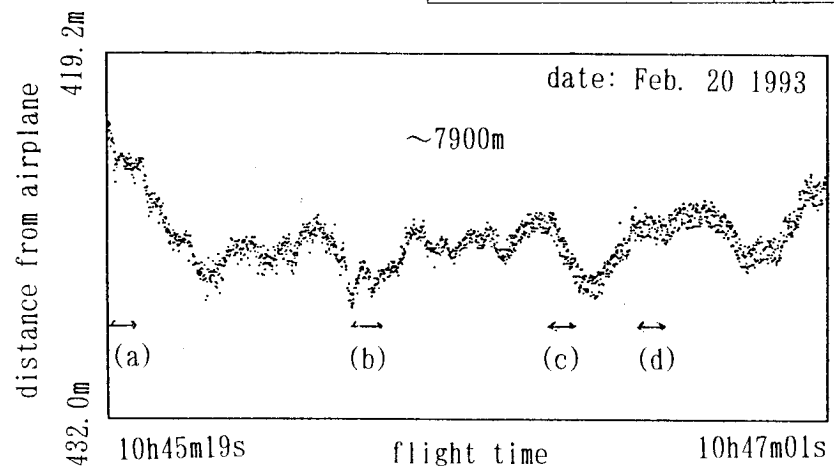
This work was partly supported by Science and Technology Agency of Japan and National Space Development Agency of Japan.

References

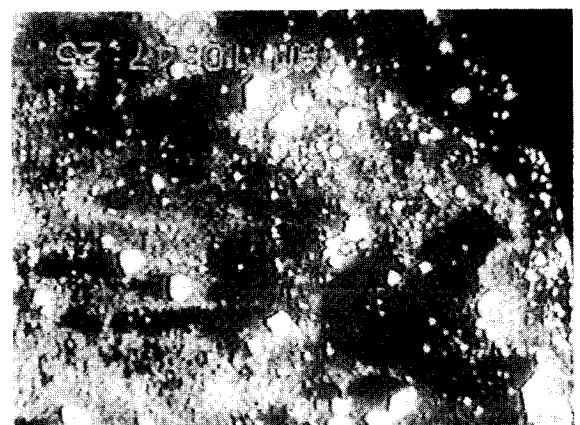
- (1) J.L. Bufton, "Laser altimetry measurements from aircraft and spacecraft", Proc. IEEE, 77, 463-477, 1989.

wavelength	532nm
pulse width	7nsec
pulse energy	2mJ(@532nm)
pulse rate	20pps
transmitting telescope	Newton D=8cm
laser beam divergence	0.1mrad
receiving telescope	Cassegrain D=20cm
photomultiplier	$\mu=8\%$, $Tr=150psec$
digital OSC	2GSample/sec, 8bit
weight of optics	20kg
size of optics	50x50x80cm

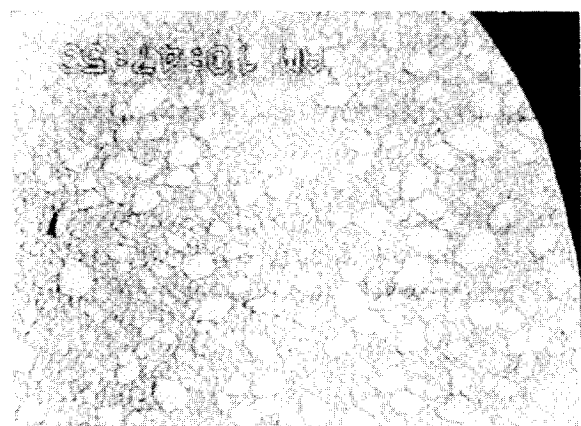
Table 1. Specifications of laser altimeter.



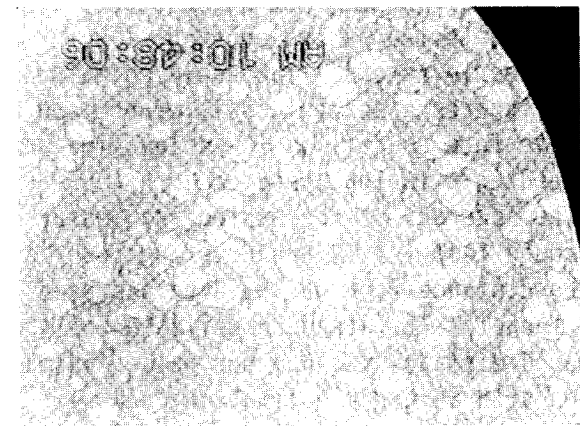
(a) grease ice



(b) scattered small ice



(c) gathered board ice



(d) gathered board ice

Figure 1. Height map of sea ice along the flight pass.