

Structure and Maintenance Process of Stationary Snowfall System along Coast in the Hokuriku District, Japan

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Introduction

During winter season, when the outbreaks of cold air mass from Siberia occur, many convective clouds develop over the Sea of Japan.

Snowfall Patterns in the Outbreaks

- Mountain-snowfall Type
- Plain-snowfall Type

Past Studies about Snowfall in Coastal Regions

- Land breeze produced or intensified echoes of snow clouds around the coastal regions in Hokuriku and the western part of the Hokkaido Island.

But stationary snow clouds around coasts have not been reported.

We observed a stationary snowfall system by X-band Doppler radar.

Purpose

- To clarify the structure and maintenance process of the stationary snowfall system.

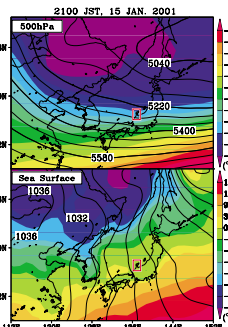
Observation and Data

- Data :
- X-band Doppler radar data (Oshimizu radar)
 - C-band dual-polarization radar data (Goishigamine radar)

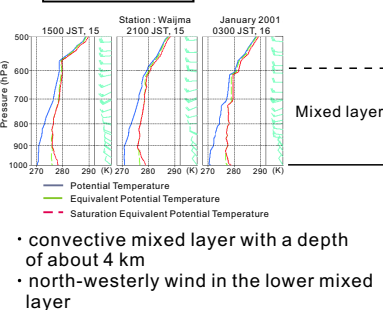
Analysis Period in this study :
from 15 to 16 January 2001

Synoptic Situation

weather map



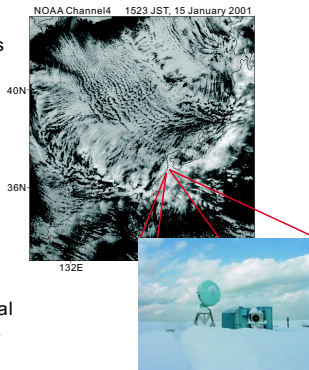
sounding profile



- convective mixed layer with a depth of about 4 km
- north-westerly wind in the lower mixed layer

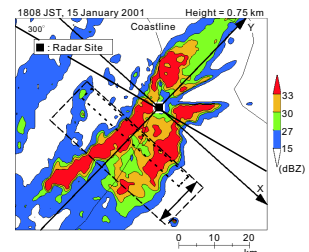
- 500 hPa : cold air mass less than -33 °C over Hokuriku
- Surface : isobars running in the south-north direction in the Sea of Japan

satellite imagery



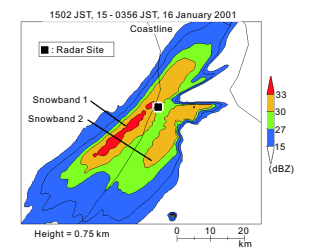
Radar Echo Structure

snap shot

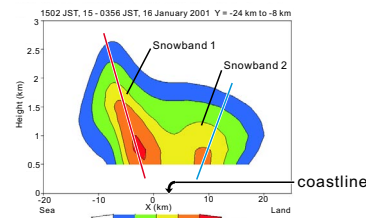


- a snowfall system along the coast

time-averaged patterns



- two maximum echo bands : "Snowband 1" and "Snowband 2"
- difference of intensities

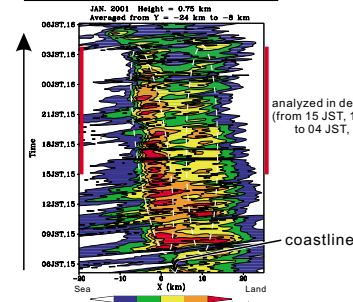


- difference of echo-tops
- difference of tilts

Airflow Structure

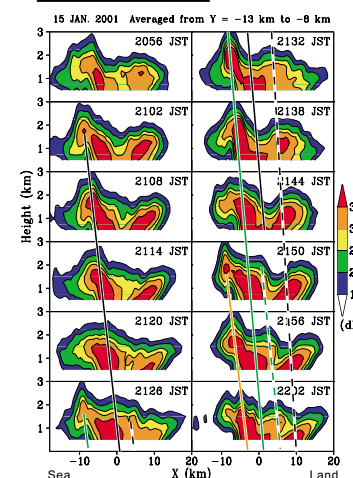
time-height cross section of horizontal wind over the Doppler radar

time-distance cross section

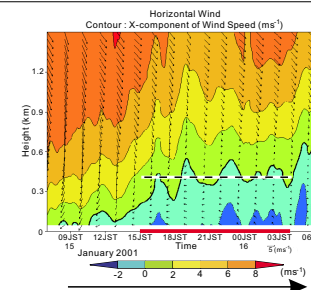


- The system was maintained for over 20 hours.
- stationary two echo maximum regions

sequential pattern

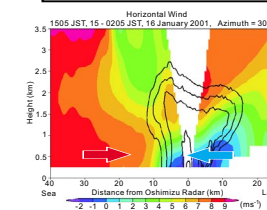


- After echoes of Snowband 1 had descended, echoes of Snowband 2 developed in the side of the land.
- repetition

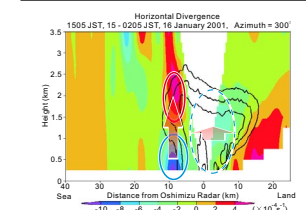


- development of land breeze with a depth of about 400 m

averaged horizontal wind



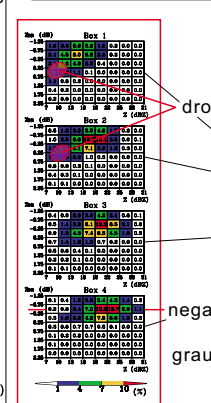
averaged horizontal divergence



- strong convergence between monsoon wind and land breeze
- divergence over the strong convergence region
- weak convergence in the middle layer of the snowfall system

Microphysical Structure

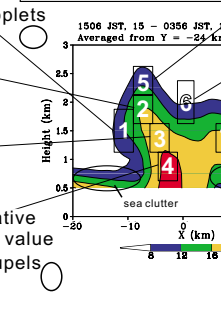
Z-ZDR distributions



vertically oriented ex.: graupels
round
horizontally oriented ex.: platelike crystals, droplets

platelike crystals

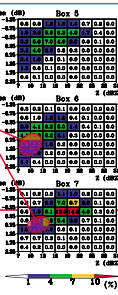
0 dB



droplets

negative value graupels

snow aggregates



Conclusions

A snowfall system stayed for over 20 hours along the coast in Hokuriku.

- The convergence between land breeze and monsoon wind maintained the system.
- The snowfall system had two snowbands : Snowband 1 and Snowband 2.

Snowband 1

strong convergence
strong updraft
high echo-top
riming process
strong reflectivity

Snowband 2

weak convergence
weak updraft
low echo-top
aggregation process
deposition process
weak reflectivity

- The strong divergence in Snowband 1 contributed to the weak convergence in Snowband 2.
- The particles formed in Snowband 1 composed a part of aggregates in Snowband 2.

Acknowledgments

We thank Hokuriku Electric Power Company, for supplying us with the dual-polarization radar data. This work was supported by CREST of JST.

conceptual model

