Case Study on the Formation of Snowfall in a Basin Covered by the Stratiformed Precipitation System with an Extratropic Cyclone in Winter

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1. Introduction

In winter, a stratiformed precipitation system associated with an extratropical cyclone moving on the Pacific coast of Japanese archipelago often covers on Japan, which brings rainfall and snowfall widely.

However, discriminant of snowfall and rainfall don't depend on such cold and warm regions in a simplistic form.
To enable the discriminant of snowfall or rainfall, we need the knowledge of the formation of snowfall brought by the stratiformed precipitation system.

One of the regions where rainfall and snowfall are brought by the system…

Kofu Basin … Snowfall
Coastal region at Shizuoka … Rainfall } covered by one large precipitating system

Snowfall or Rainfall?
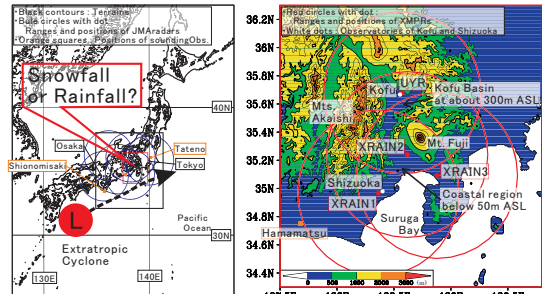
Weather condition with passing an extratropic cyclone at Kofu and Shizuoka meteorological observatories of the JMA from December on 2012 to February on 2013.

	2012						2013						
	4 Dec.	6 Dec.	16 Dec.	22 Dec.	28 Dec.	30 Dec.	14 Jan.	22 Jan.	2 Feb.	4 Feb.	6 Feb.	13 Feb.	18 Feb.
Kofu	●	●	☃	✳ 1cm	✳ 5cm	●	✳ 10cm	●	●	●	●	✳ 2cm	✳ 0cm
Shizuoka	●	●	●	●	●	●	●	●	●	●	●	●	●

✳: Show with maximum snow depth   ☃: Sleet   ●: Rain

Purpose
· Description of the characteristics of precipitation in a basin and on the coastal region associated with the stratiformed precipitating system
· Discussion of the formation of snowfall in a basin
Using the case of the observation on Kofu Basin and the coastal region at Shizuoka on 14 January 2013.

2. Observation and Data

· X-band multi-parameter radar (X-MPR)
 1) UYR: X-MPR of University of Yamanashi installed on Kofu Basin
 2) XRAIN: X-MPR of Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
  XRAIN1: Shizuokakita, XRAIN2: Fujinomiya, XRAIN3: Kanukiyama
 3) Z_H : Radar Reflectivity (Horizontal), DV : Doppler Velocity, ρ_{HV} : Correlation coefficient, Z_{DR} : Differential reflectivity, K_{DP} : Specific Differential Phase
 4) Three-dimentional grid data with the resolution of 500 m every 5 minites
· C-band meteorological radars of Japan Meteorological Agency (JMAradar)
 1) Rainfall intensity derived by radar reflectivity
 2) Composite grid data with the resolution of 1 km at 2 km ASL every 5 minutes
· Weather charts published by the JMA
· Sounding observation
 1) Shionimisaki and Tateno by the JMA
 2) Hamamatsu by Japan Self-Defense Forces
· Surface observation at the meteorological observatories of the JMA
 1) Rainfall amount, temperature, wind, water vapor mixing ratio and snowfall depth
 2) The observatories in basins surrounded by mountains and on plains
※ Local Standard Time (LST) = UTC + 9 hours

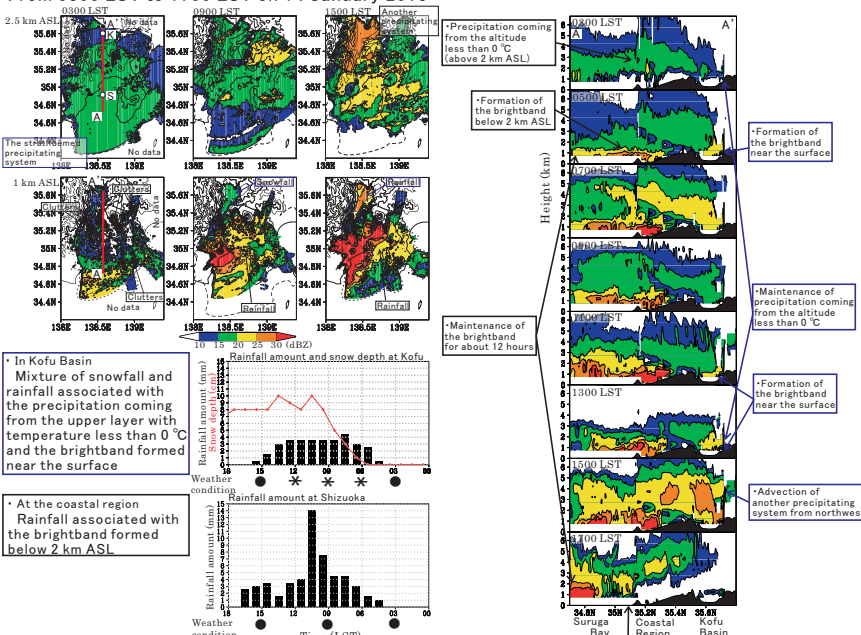## 3. Overview of the stratiformed precipitating system with the extratropic cyclone

Descriptions of observation data at 0900 LST on 14 January 2013
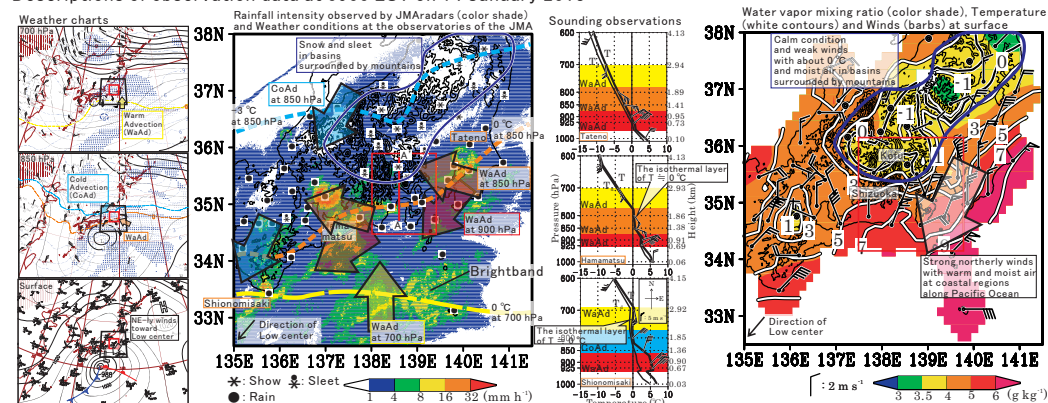
4. Temporal variation of the stratiformed precipitating system
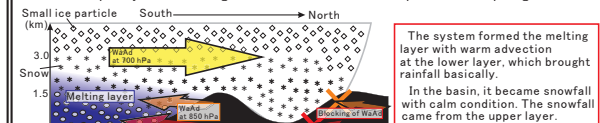
Composite radar reflectivity observed by X-MPRs
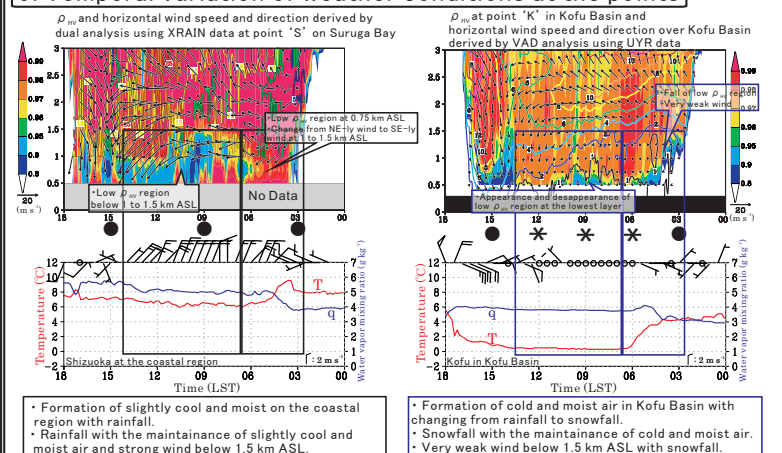From 0300 LST to 1700 LST on 14 January 2013

· In Kofu Basin
Mixture of snowfall and rainfall associated with the precipitation coming from the upper layer with temperature less than 0 ℃ and the brightband formed near the surface

· At the coastal region
Rainfall associated with the brightband formed below 2 km ASL

5. Temporal variation of weather conditions at the points

ρ_{HV} and horizontal wind speed and direction derived by dual analysis using XRAIN data at point 'S' on Suruga Bay

ρ_{HV} at point 'K' in Kofu Basin and horizontal wind speed and direction over Kofu Basin derived by VAD analysis using UYR data

· Formation of slightly cool and moist on the coastal region with rainfall.
· Rainfall with the maintainance of slightly cool and moist air and strong wind below 1.5 km ASL.

· Formation of cold and moist air in Kofu Basin with changing from rainfall to snowfall.
· Snowfall with the maintainance of cold and moist air.
· Very weak wind below 1.5 km ASL with snowfall.

6. Condition in Kofu Basin

Temporal variations of surface temperature and wind speed at routine surface observation points of the JMA in Kofu Basin

· Formation of the isothermal layer of T ≒ 0 ℃
· Cold air with stgationary in Kofu Basin

7. Discussion and Summary

· Precipitation brought by the stratiformed precipitating system associated with the extratropic cyclone moving on the Pasific coast of Japanese archipelago in winter

The system formed the melting layer with warm advection at the lower layer, which brought rainfall basically.
In the basin, it became snowfall with calm condition. The snowfall came from the upper layer.

· Formation of snowfall in the basin

Melting and sublimation of snow and evaporation of rain melting from snow cooled and humidified the slightly cool and dry air in the basin.
Then, the cold air was formed by the evaporation of raindrops and the melting of snowflakes and fell to the basin, which contributed to snowfall from the upper layer without melting.