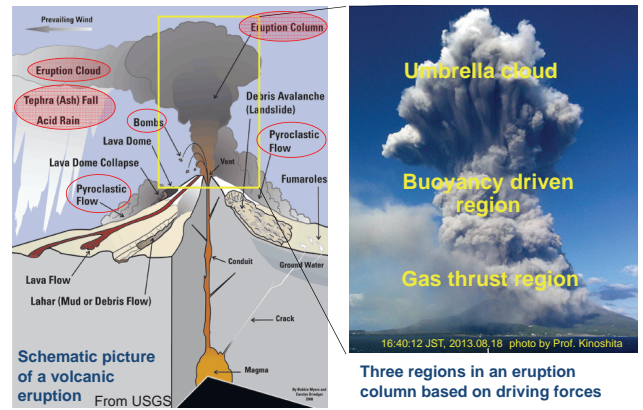


# WEATHER RADAR OBSERVATIONS OF SAKURAJIMA VOLCANIC SMOKE

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<sup>4</sup> Tohoku Univ.

# TARGET OF WEATHER RADAR



Three regions in an eruption column based on driving forces

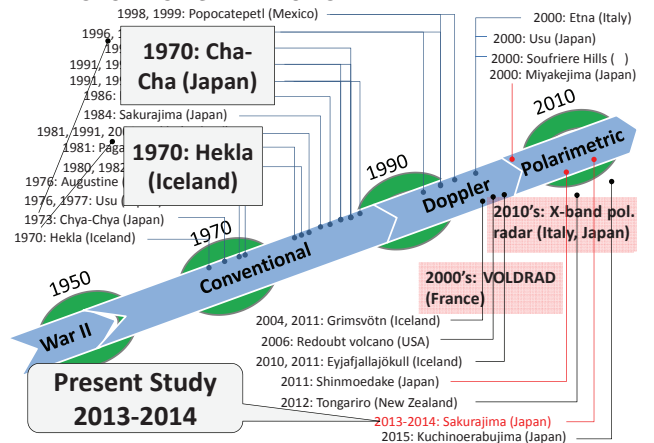
## BACKGROUND

- Passive methods
- Weather radar can detect volcanic smoke
- Usage of weather radar for ash forecasting

## PURPOSE

- What information can weather radar retrieve ?
- Structures of eruption columns and ash clouds

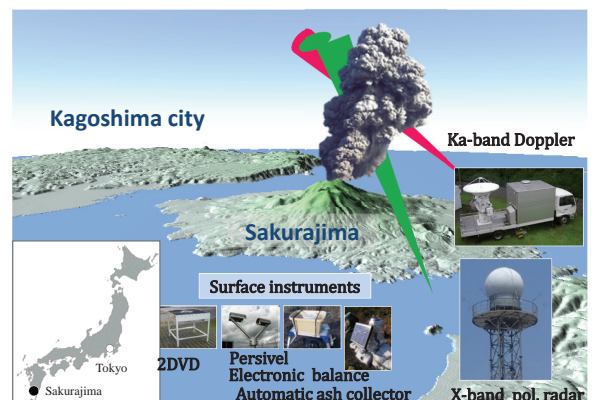
## VOLCANIC ASH DETECTION BY WEATHER RADAR



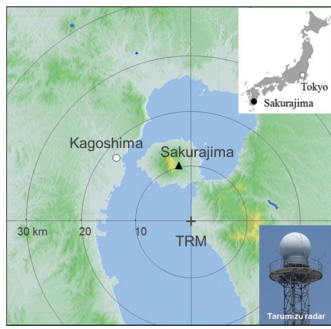
## OUTLINE

- Historical review
- Observations of Sakurajima volcano
- Results of two case studies
- Conclusions and future plan

## Collaborative Observation of Sakurajima Volcanic Ash



## Operational X-band Polarimetric Radar

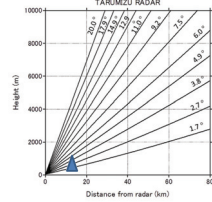


Location and observation area of X-band polarimetric radar of MLIT.

### Main specification of radar

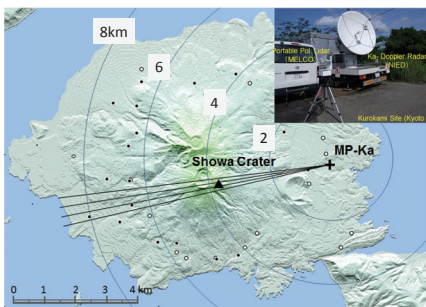
Radar(Name)	TRM (Tarumizu)
Antenna	Size: 2.2 m Beam width: 1.0° Gain: 44.7 dB (H), 45.1 dB (V) Speed: 1-4 rpm Scan angle (PPH): 1.7°-20.0° (12 tilts)
Transmitter	Frequency: 9770 MHz Power: 200 W PRF: 1500/2000 pps Pulse width: 1.0 μs
Receiver	Smin: -109.5 dBm
Measured radar parameters	$Z_h, Z_v, Z_{oh}, \Phi_{DP}, \rho_{hv}, V_d, \sigma$
Resolution	Range: 150 m Azimuth: 1.0°

### Antenna scan strategy



## RESULTS

## Ka-band Doppler Radar (NIED)



Location and observation area of Ka-band Doppler radar of NIED.

### Main specification of radar.

	specification
Frequency	35.35 GHz
Antenna Type	Cassegrain, 2.1 mφ
Scan Rate	(AZ) Full Circle: $\leq 24 \text{ deg/s}$ (EL) -2 to +182: $\leq 12 \text{ deg/s}$
Antenna Gain	54.0 dB
Beam Width	0.3°
Transmitter	Magnetron
Peak Power	100 W
Pulse Length	0.5 μs
PRF	400/4,000 Hz
Polarization	Horizontal
Noise Figure	3.5 dB
Max. Range	30 km
Outputs	$Z_h, V, W$

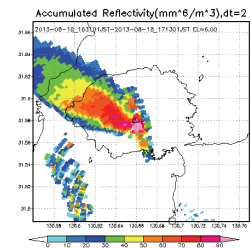
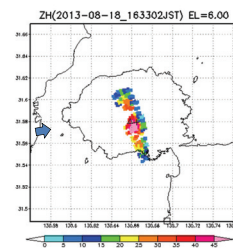


Ka-band Doppler radar.

## CASE 1



**Sakurajima**  
**2013/08/18/16:31 JST**  
**Echo top : 5000m (from vent)**  
**TIME: 1631-1713 JST**



## DATA AND ANALYSIS METHOD

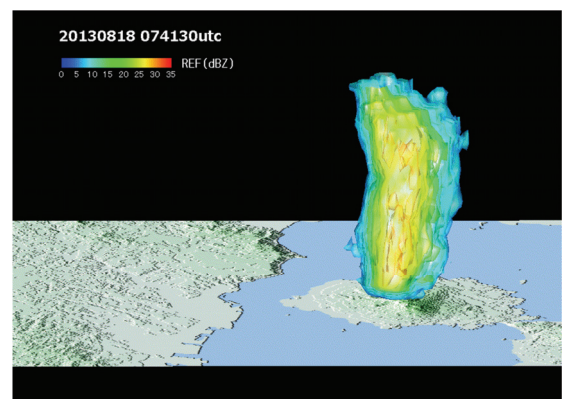
### DATA

- Case 1: Aug. 18, 2013  
Volume scan data of X-band polarimetric radar
- Case 2: May 10, 2014  
Volume scan data of X-band polarimetric radar  
RHI and PPI data of Ka-band Doppler radar

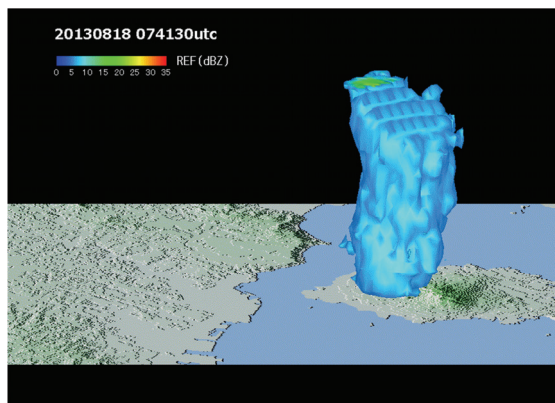
### ANALYSIS METHOD

THREE-DIMENSIONAL RADAR DATA ANALYSIS TOOLS OF VOLCANIC by *Maki et al.*, *IUGG 2015, Poster VS17p-104*

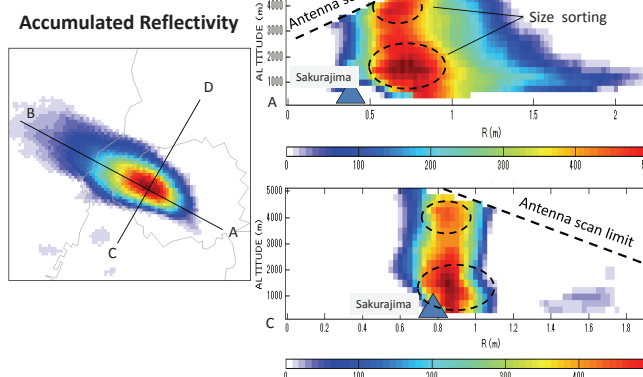
## BIRD'S EYE VIEW



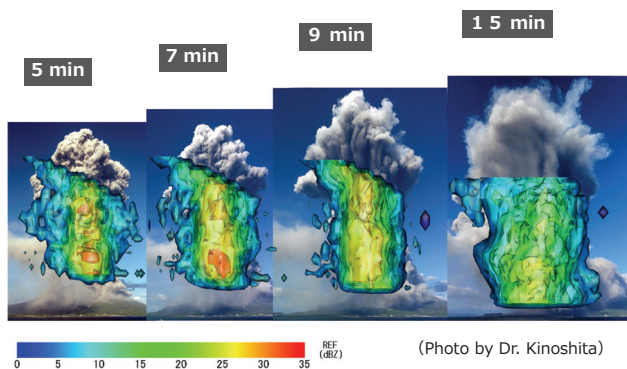
### ➤ CT SCAN (Vertical, Horizontal)



### Case 1 Aug. 18, 2013 16:32-17:30

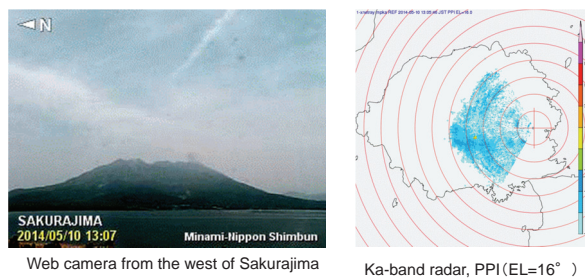


### ➤ INNER STRUCTURE 2013/08/18/16:31 JST



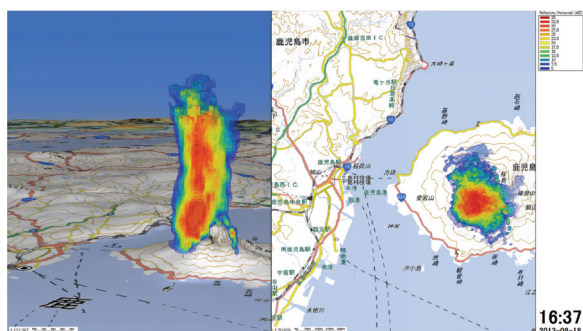
### CASE 2: SAKURAJIMA, MAY 10, 2014

Ash column height: 4500 m from vent

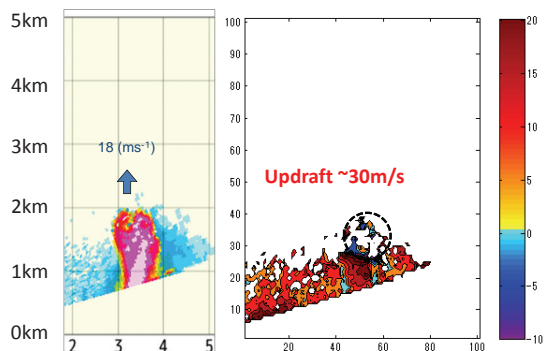


Report from JMA  
Explosive Eruption at 13:07 JST, May10,2014  
Ash column height 4500m from the crater  
Air shocks, Volcanic rocks (the 3<sup>rd</sup> uphill)

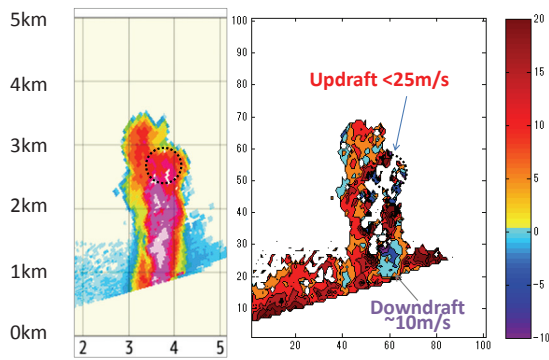
### ➤ TIME CHANGE



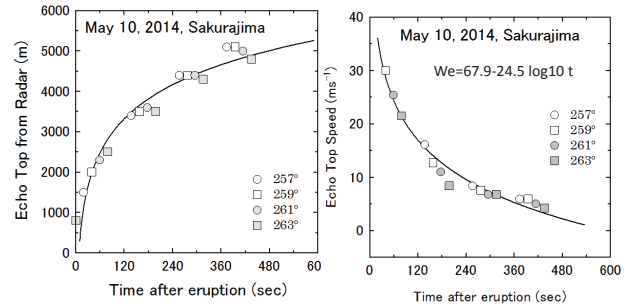
### 2 minute after eruption



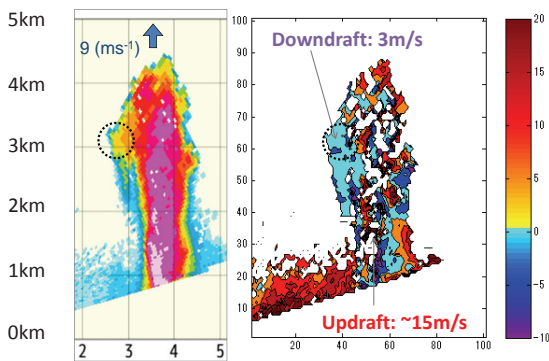
### 4 minute after eruption



### ECHO TOP HEIGHT AND SPEED



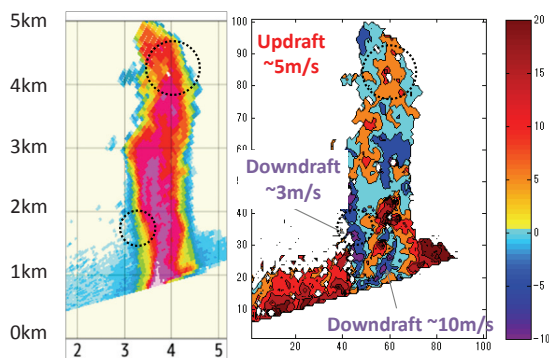
### 6 minute after eruption



### COMPARISON OF TWO EVENTS

	CASE 1 (AUG 18, 2013)	CASE 2 (MAY 10, 2014)
Eruption Type	Explosive	Explosive
Ash column height	5000m (from vent)	4500m
Ash cloud life time	58 min	40 min
Ash fall area dimension	20 km(length) x 6 km (width)	5.5 km (length) x 6 km (width)
Ash fall area	184 km <sup>2</sup> (tentative)	55km <sup>2</sup> (tentative)
Ash fall volume	available	available
Max ash accumulation	5km downwind from vent at 1500m height	1.5km downwind from vent at 1000m height
Upward speed (m/s)	unknown	max. 30m/s (from Ka-band)

### 8 minute after eruption



### CONCLUSIONS AND FUTURE WORK

#### Conclusions:

- Weather radar data of two explosive eruptions are analyzed.
- Weather radar can give us useful information on structure of ash column.
- Ka-band Doppler radar give us information with high spatiotemporal resolution.

#### Future work:

- More quantitative analysis.
- Statistical analysis by 31 eruption cases in 2013.
- Potential of polarimetric parameters.