Volcanic Ash Fall Forecasts (VAFF) of Japan Meteorological Agency

VAAC Tokyo
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Shinmoedake (Kirishimayama), 26 January, 2011

Quantitative VAFF (under development)

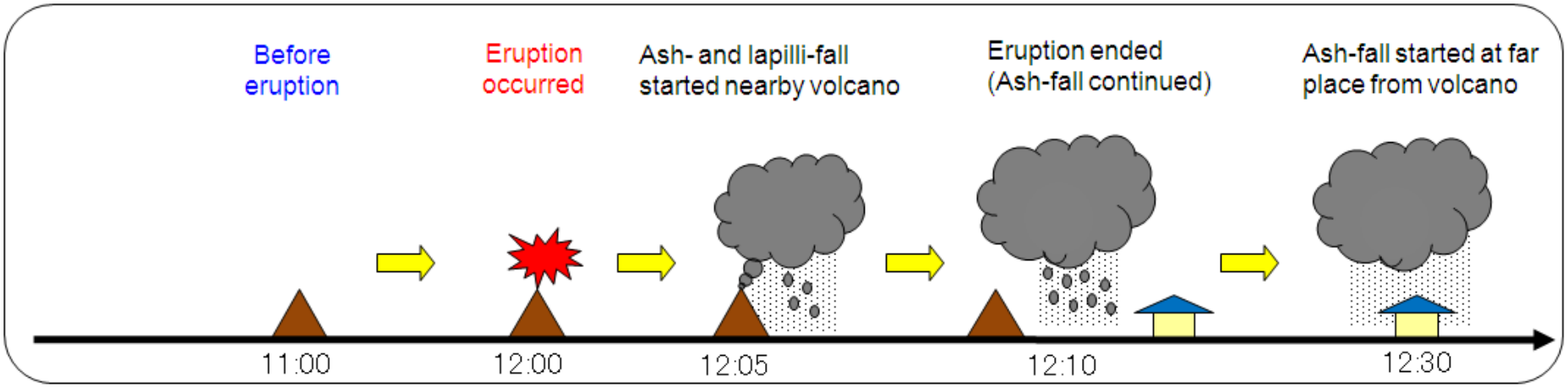
Category Table of Ash Quantity for new VAFF

Category Table of Ash Quantity for Volcanic Ash Fall Forecasts

Category (categorized according to quantity)	Contents			Effects, Action and Preparedness		Other effects
	Ash thickness【Keyword for action】	Ashfall condition※1		People	Driver	
		Ash on roads	Visibility			
Much	≧ 1 mm 【Stay Indoors】	Covered completely 	Poor (Heavy ashfall) 	Stay Indoors Ash worsen symptoms of chronic asthma or pulmonary emphysema, and may cause trouble of eyes, nose, throat or respiratory organs of some healthy people.	Keep off driving Closure of roads or limitation of speed for vehicles are needed due to poor visibility by ashfall or blown-up ash.	Insulator coated by ash has a risk of power failure. Water quality may be deteriorated and water supply may be forced to suspend
Moderate	≧ 0.1 mm and < 1 mm 【Attention】	Road markings nearly obscured 	A little low (Visible ashfall) 	Put on mask Ash may worsen symptoms of chronic asthma or pulmonary emphysema.	Drive slowly Visibility may be reduced when intense ashfall in short time is observed. Road markings may be obscured.	Crops as rice may be damaged.※2 Railway service may be suspended due to point failure.
Little	< 0.1 mm	Thin deposit 	Normal (Slightly visible ashfall)	Close windows Ash adhere to one's clothing or body. Ash in the eyes makes some pain.	Clean up windshield Adherence of ash to car's windshield may cause reduction of visibility.	Flight operation is suspended※2

※1 Photo by JMA, Kagoshima Prefecture and Minami-Nippon Shimbun (corp.).
※2 the Mt. Fuji Hazard Map Examination Committee (2004)

Information System of VAFF



	Wind Information above Volcano	Observation Report on Eruption	-	Volcanic Ash Fall Forecast (VAFF, only Area)
			5～10min	20～30min
	Volcanic Ash Fall Information before Eruption	**Observation Report on Eruption**	**Volcanic Ash fall Early Forecast (VAEF)**	**Volcanic Ash Fall Forecast (VAFF, including Quantity)**
	This information is issued regularly (e.g. 3 hourly) and informs an area of assuming eruption where volcanic ash and lapilli may fall.	This is reported as soon as an eruption occurs and informs the eruption start time and plume height.	VAEF informs ash-fall area, quantity and lapilli-fall area within an hour after the eruption. In order to issue quickly, we have prepared the predictions of several assumed eruptive conditions beforehand and use a prediction which is most suitable condition to the eruption for the VAEF.	VAFF informs ash-fall area and quantity predicted on the most reliable eruption data.

VAFF will be issued within 30 minutes after eruption

Example of VAFF

Eruption at 10:22
Issuance at 10:52

Ash-fall area
- yellow: ‘moderate’
- grey: ‘little’

Municipalities to be affected
- bold line

(Forecast of cumulative ash fall from eruption)

サンプル

火山名　桜島　降灰予報

平成25年5月15日10時52分
気象庁地震火山部発表

１５日１０時２２分に桜島（昭和火口）で噴火が発生し、噴煙は火口縁上２８００ｍまで上がりました。
１５日１６時までに鹿児島市（桜島）ではやや多量の降灰があり、降灰は以下の図で示した範囲に予想されます。

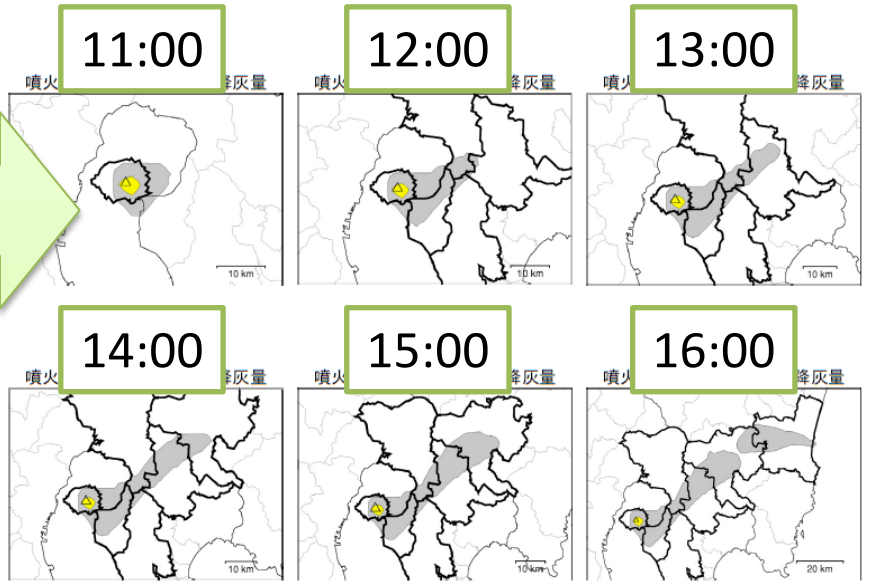
予想される降灰量は各市町村の多いところで次のとおりです。
やや多量　鹿児島県：鹿児島市
少量　宮崎県：宮崎市、都城市
鹿児島県：鹿屋市、垂水市、曽於市、霧島市

予想される各市町村の降灰開始時刻は次のとおりです。
１１時まで　鹿児島県：鹿児島市
１２時まで　鹿児島県：鹿屋市、垂水市、曽於市、霧島市
１４時まで　宮崎県：都城市
１６時まで　宮崎県：宮崎市

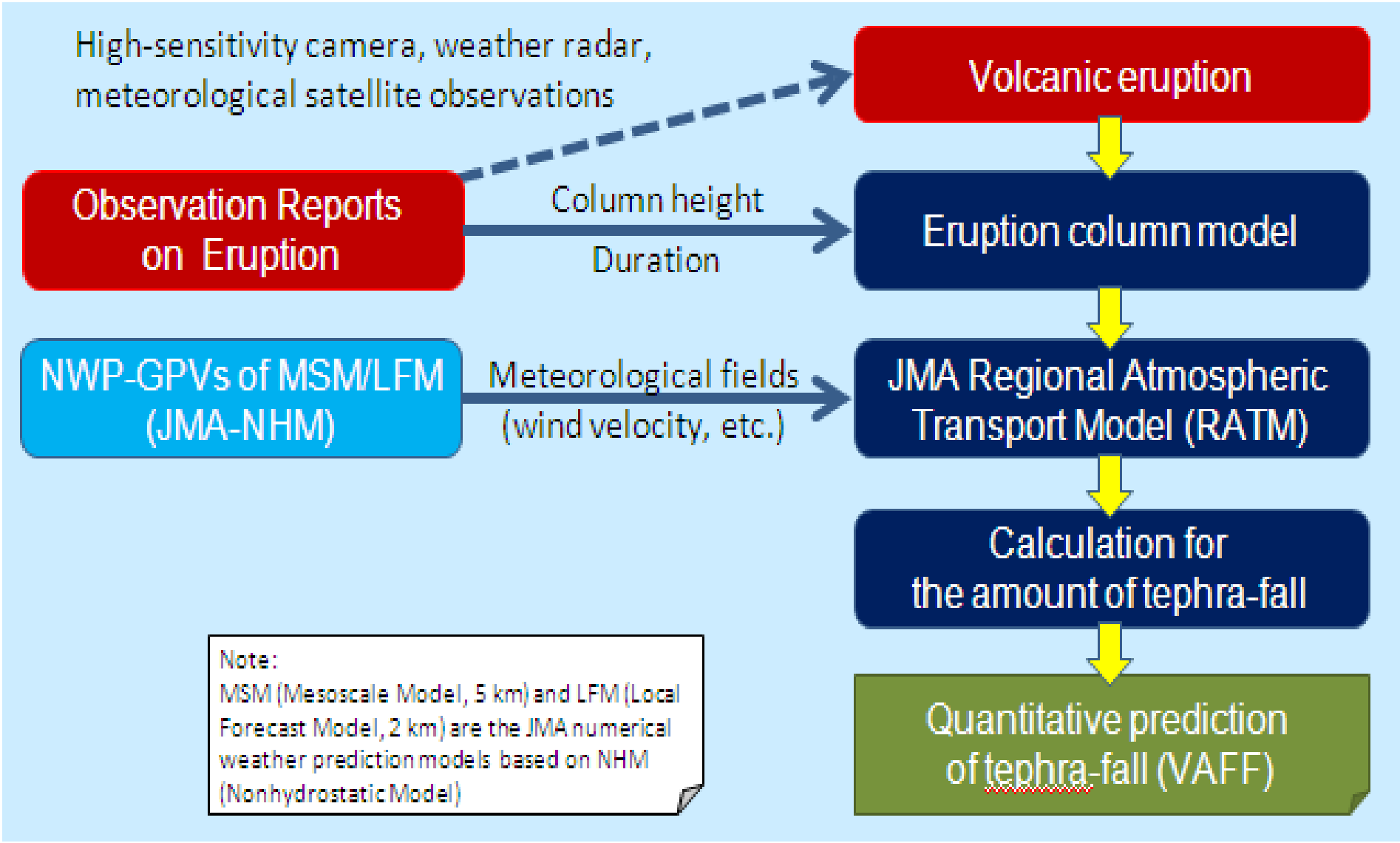
やや多量の降灰が予想される範囲内にいる場合は、傘をさしたりマスクをする等防灰対策をしてください。また、車を運転されている方は道路の白線が見えなくなるおそれがありますので、徐行運転を心掛けてください。

＊＊（参考：降灰量の階級の説明）＊＊
【多量（１mm以上）】：地面が火山灰で完全に覆われる。不要な外出、車の運転を避ける必要がある。
【やや多量（０．１mm～１mm）】：降灰により道路の路面表示が見えにくくなる。マスク等で防灰対策を行い、運転中の場合は徐行運転をする必要がある。
【少量（０．１mm未満）】：地面に火山灰がうっすら積もる。

：やや多量の降灰
：少量の降灰
太線：降灰が予想される市町村



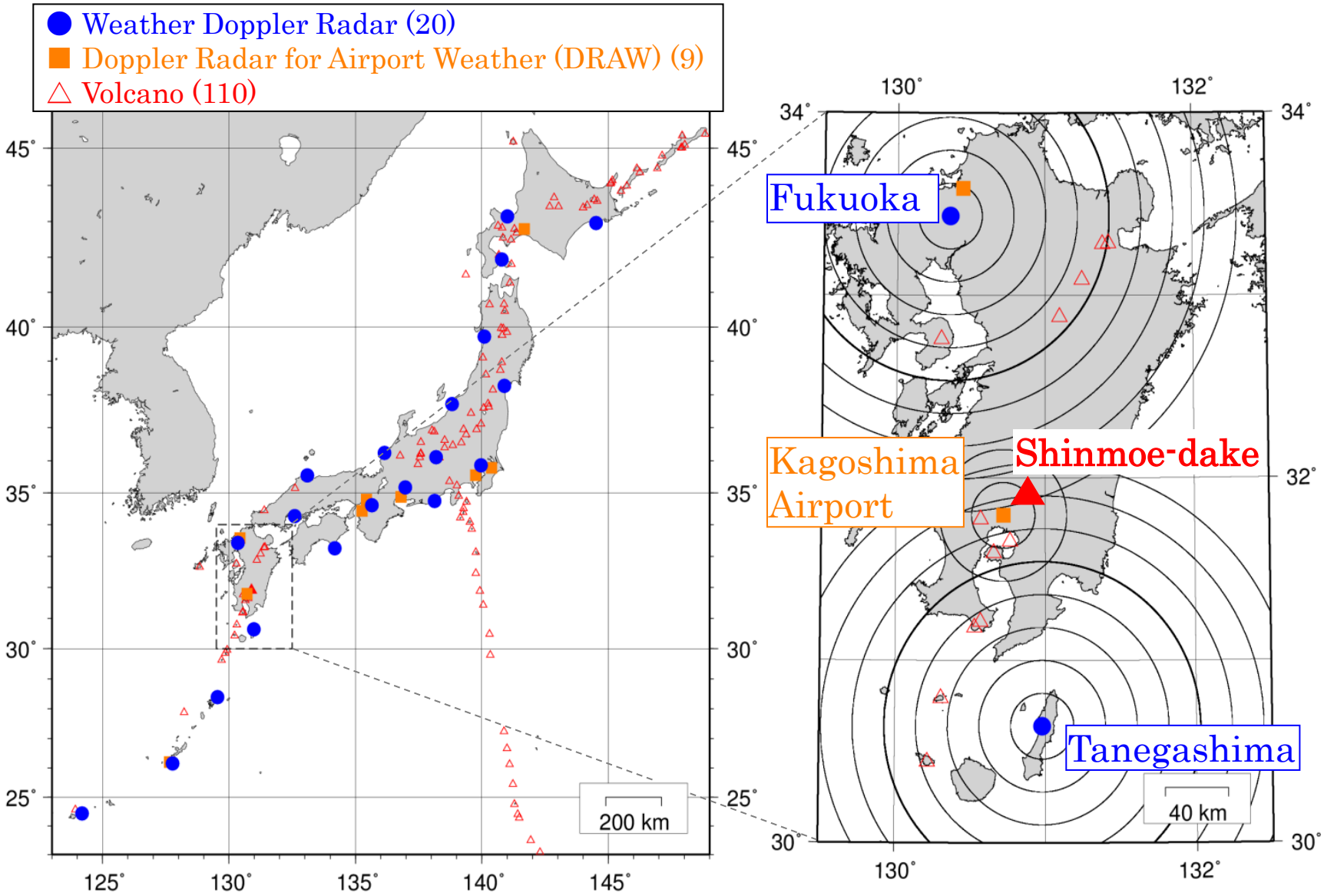
Quantitative VAFF Method



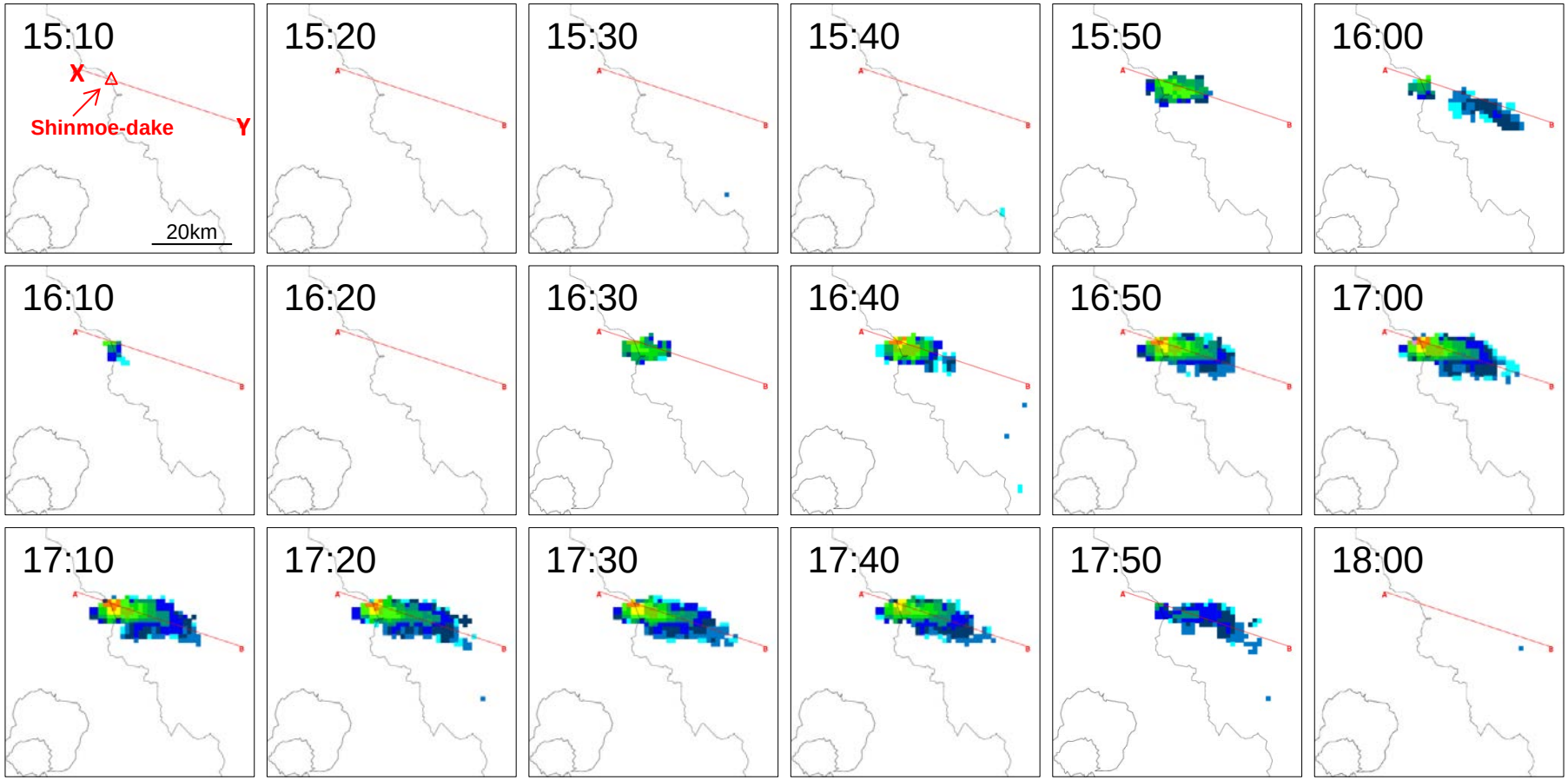
Estimation of the Height of Ash Cloud from Radar Echo

Sub-Plinian Eruption of Shinmoedake (Kirishimayama)

The JMA Weather Radar Network

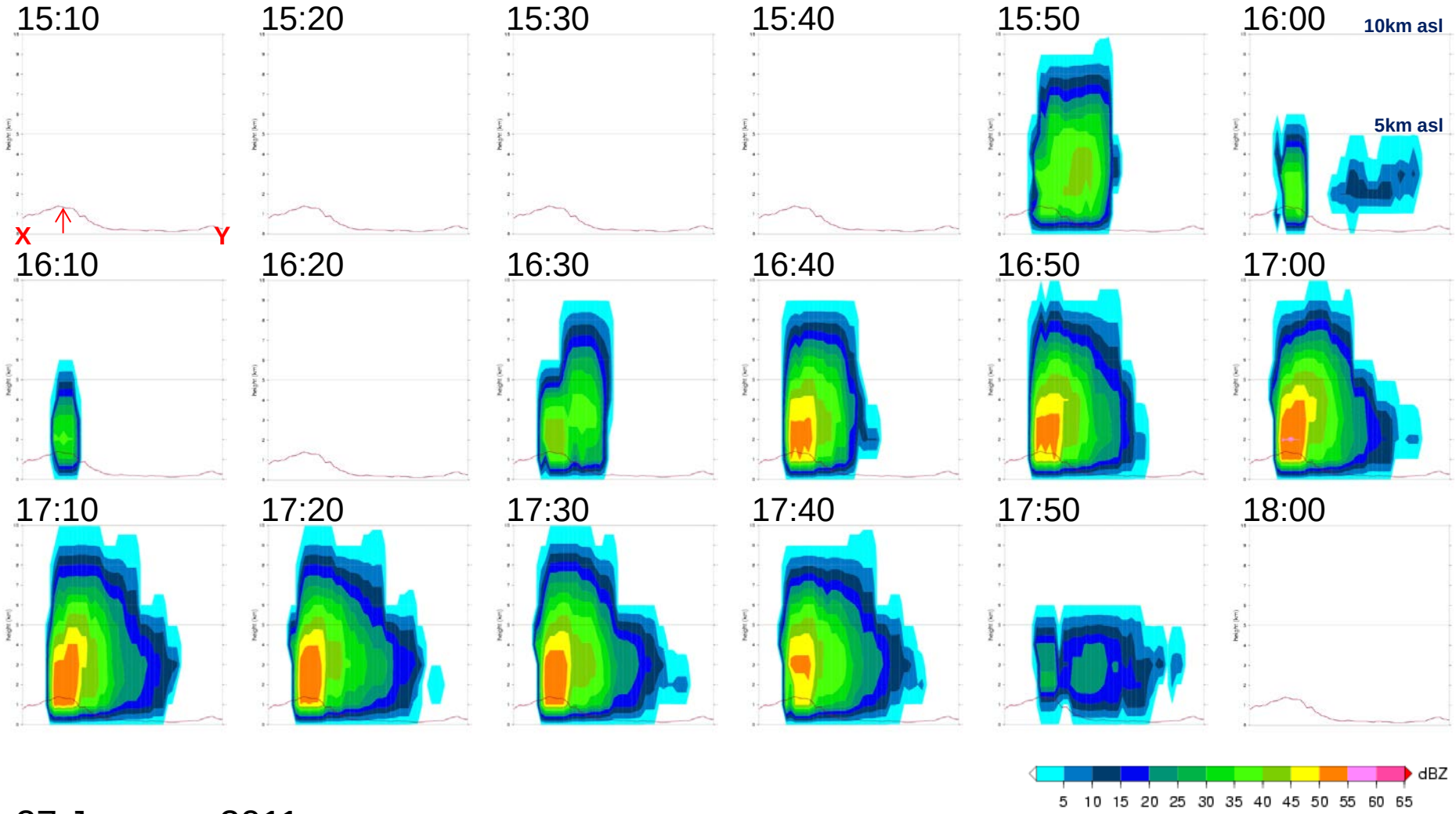


CAPPI images at 2 km height



27 January, 2011

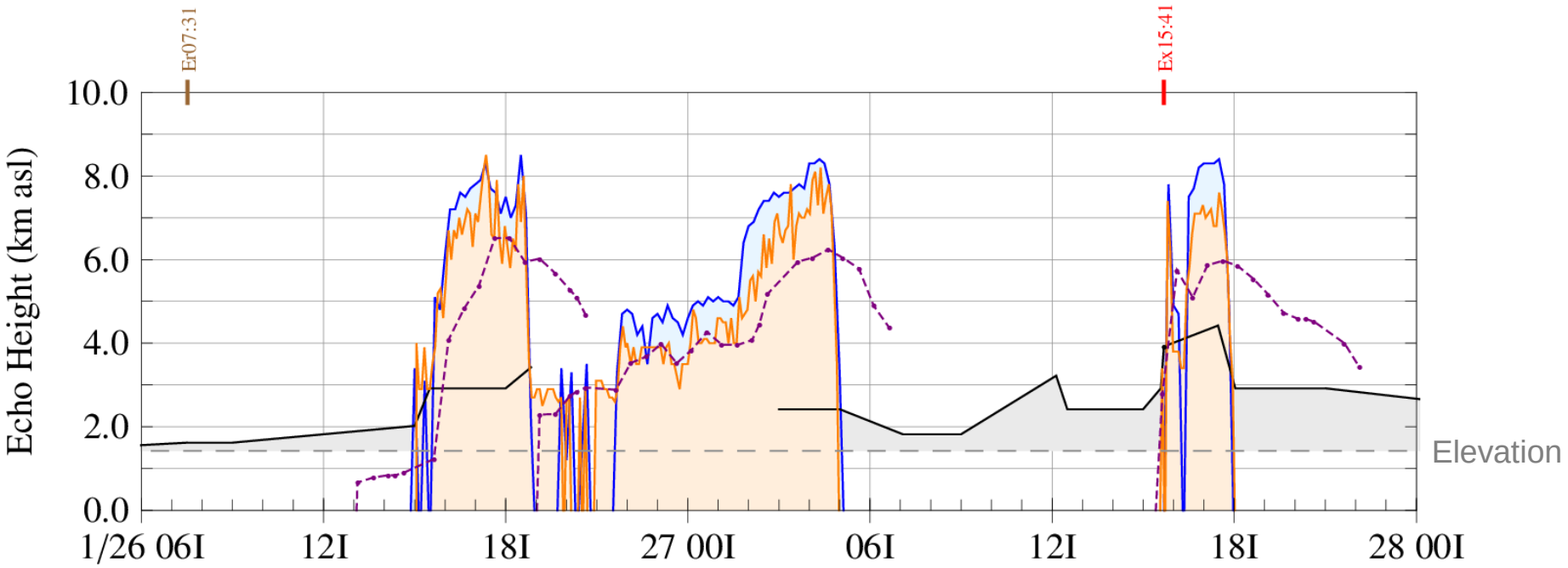
Vertical cross sections along the X-Y line



27 January, 2011

Time-series Variation of the Height of Ash Cloud

—Tanegashima & Fukuoka weather Doppler radars (composite)
—Kagoshima DRAW
- - MTSAT-2 (brightness temperature)
—Camera (installed at about 7.6 km south of the volcano)



Quantitative Tephra Fall Prediction

JMA Regional Atmospheric Transport Model (RATM)

Time evolution of tracer particles during the time step Δt

- $x(t+\Delta t) = x(t) + \overline{u(t)}\Delta t + u'(t)\,\Delta t$
- $y(t+\Delta t) = y(t) + \overline{v(t)}\Delta t + v'(t)\,\Delta t$
- $z(t+\Delta t) = z(t) + \overline{w(t)}\Delta t + w'(t)\Delta t - V_t\Delta t$

Diffusion

Gravitational settling

$(\bar{u}, \bar{v}, \bar{w})$: Mean wind velocity (GPV of JMA-NHM)

Initial Condition of JMA RATM

1. Shape of eruption column

   Fan-shaped upward with entrainment coefficient 0.198

2. Total mass of eruption column

   $6.95\times10^{5}H^{4}T$ (Morton *et al.*, 1956)

   T: Duration of eruption

3. Grain-size distribution

   Log-normal with median diameter 0.25mm and standard deviation 1.0

4. Diffusion time

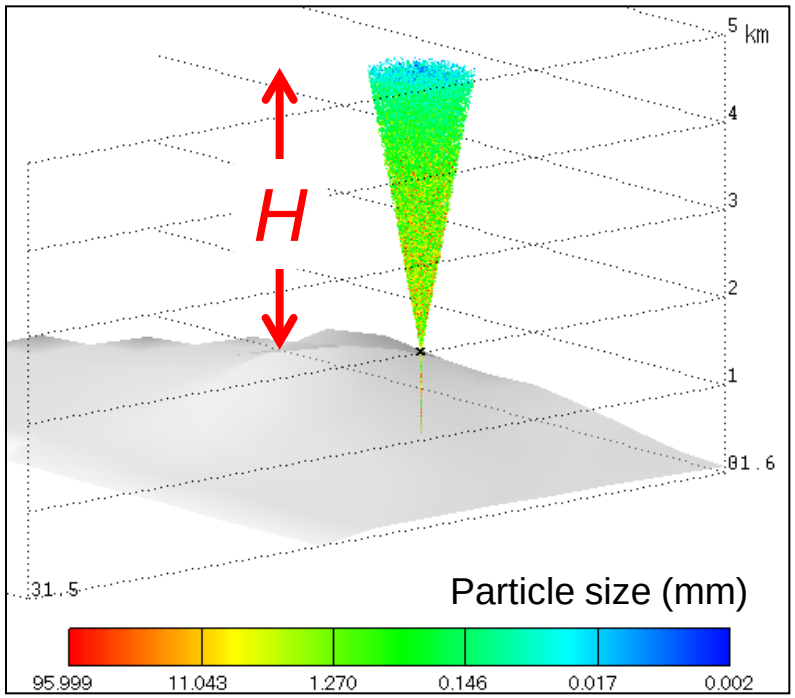
   $4\times10^{-2}t^{3/2}$

   t: Elapsed time

5. Rising velocity

   Linear with respect to height

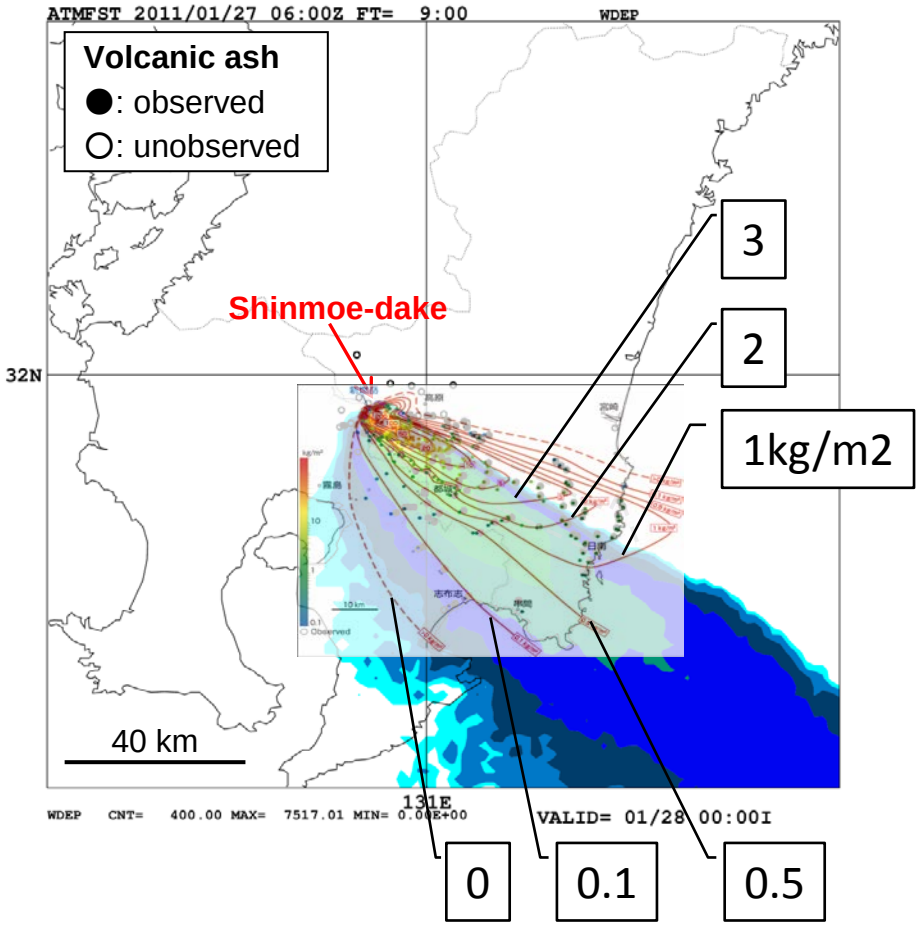
Initial Distribution of Tracer Particles

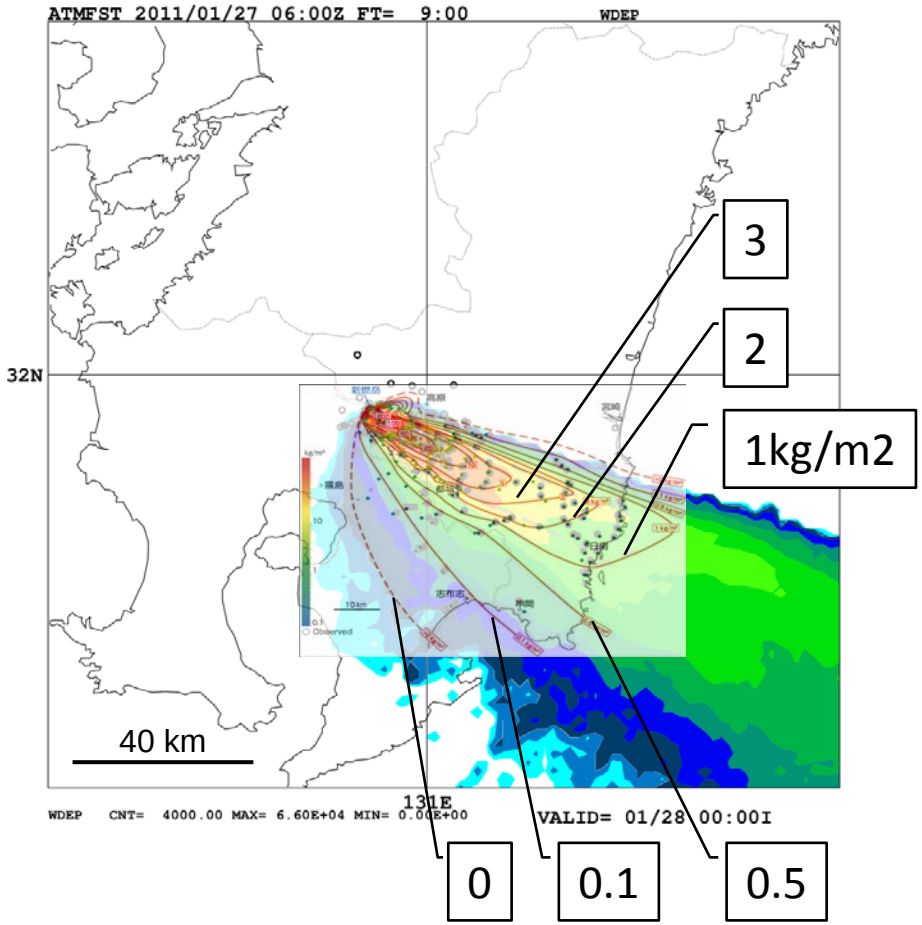


Verification of Model Output (1)

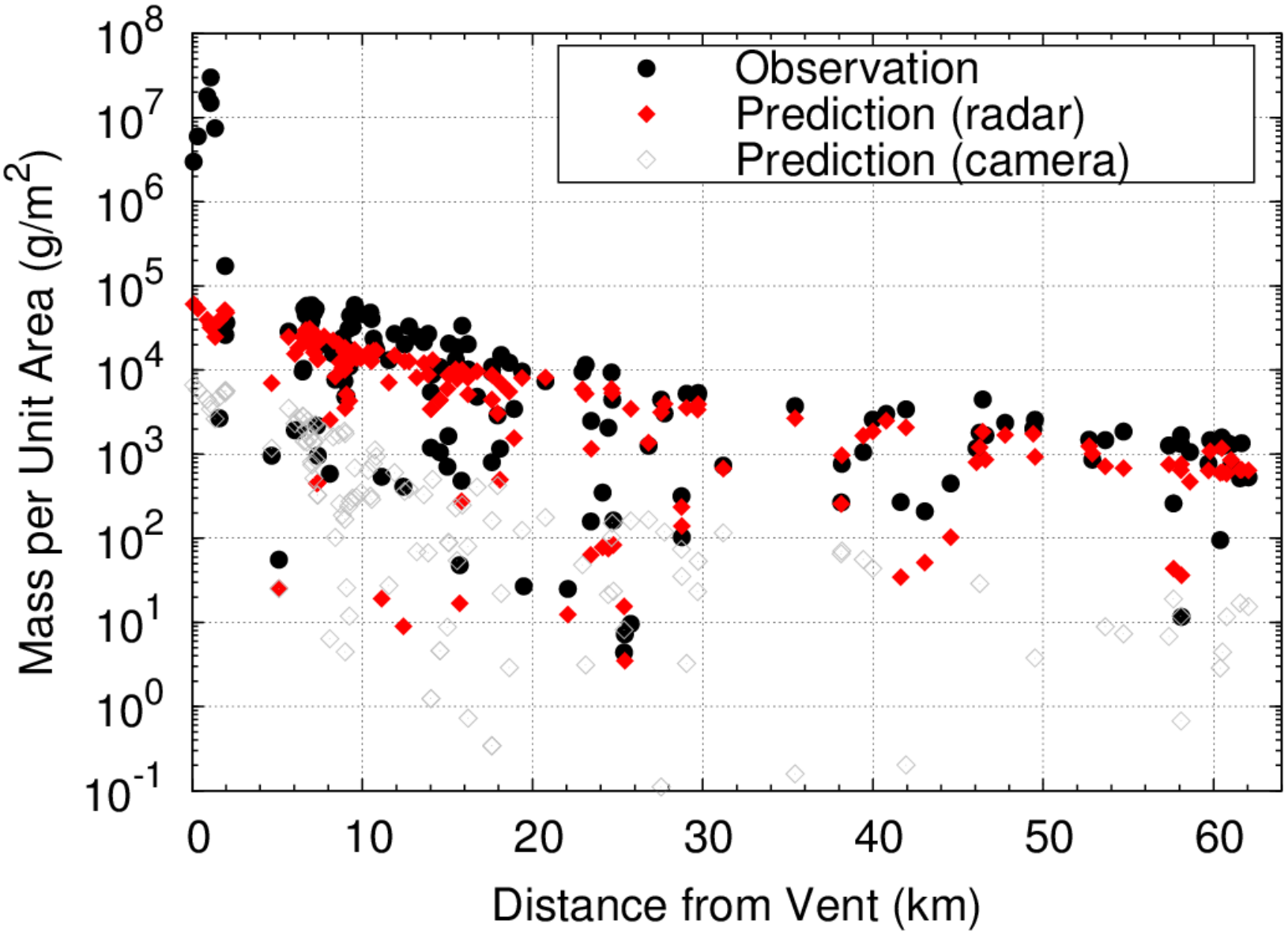
Initial height estimated from Camera data

Initial height estimated from Radar data





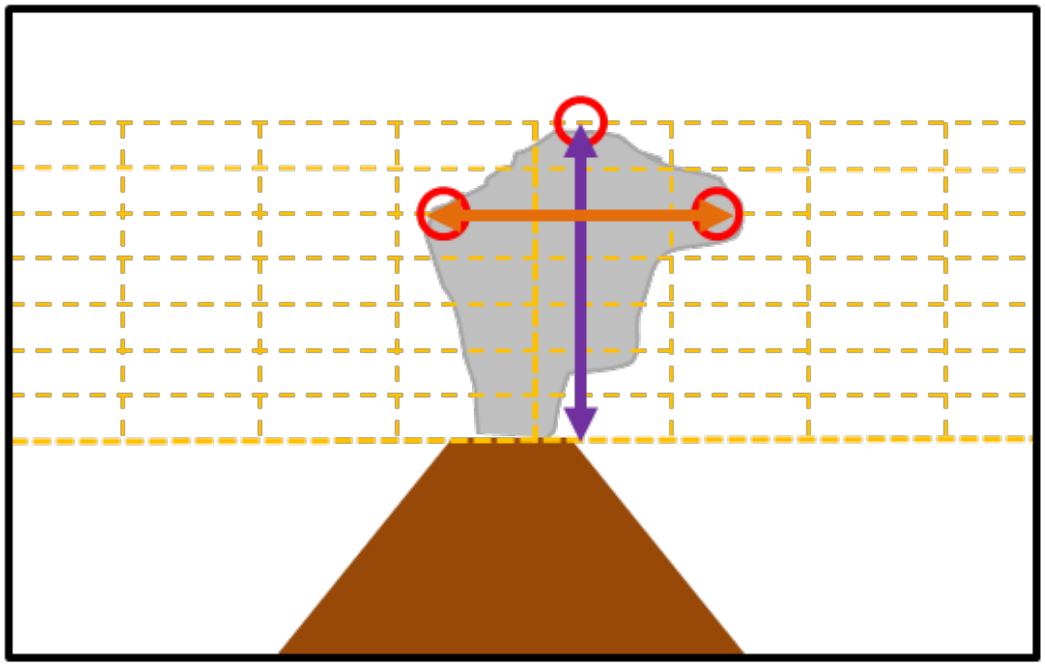
Verification of Model Output (2)



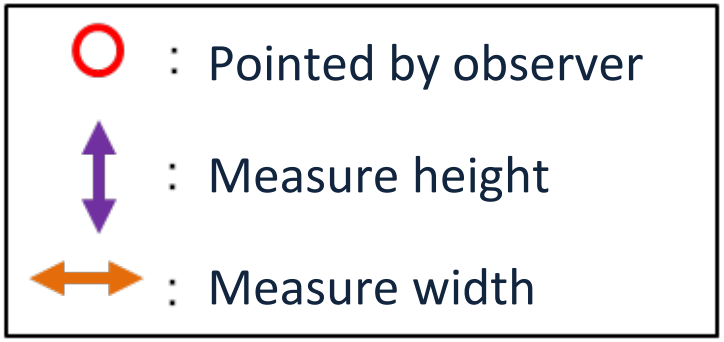
3-D Measurement System using Camera Image (under development by Asia Air Survey Co., Ltd)

Volcano with One Camera

3-D Measurement System enables observer to measure height and width of ash column objectively by pointing screen.

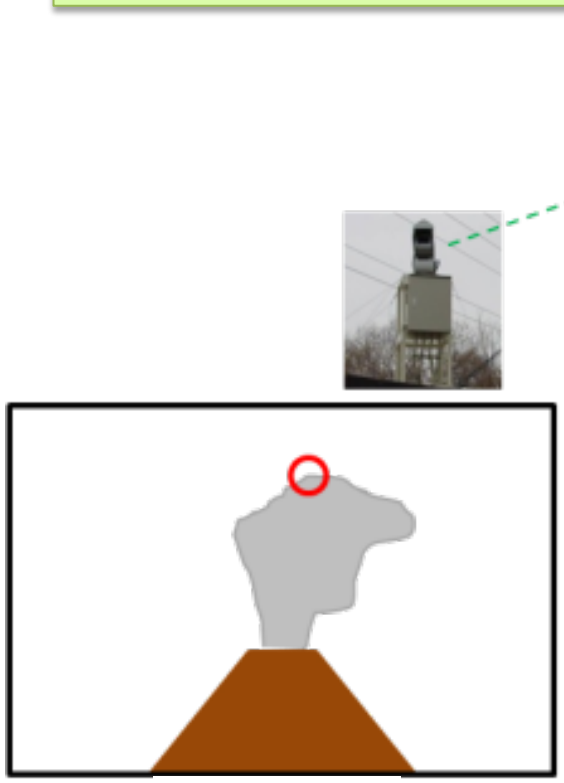


Screen that displays camera image

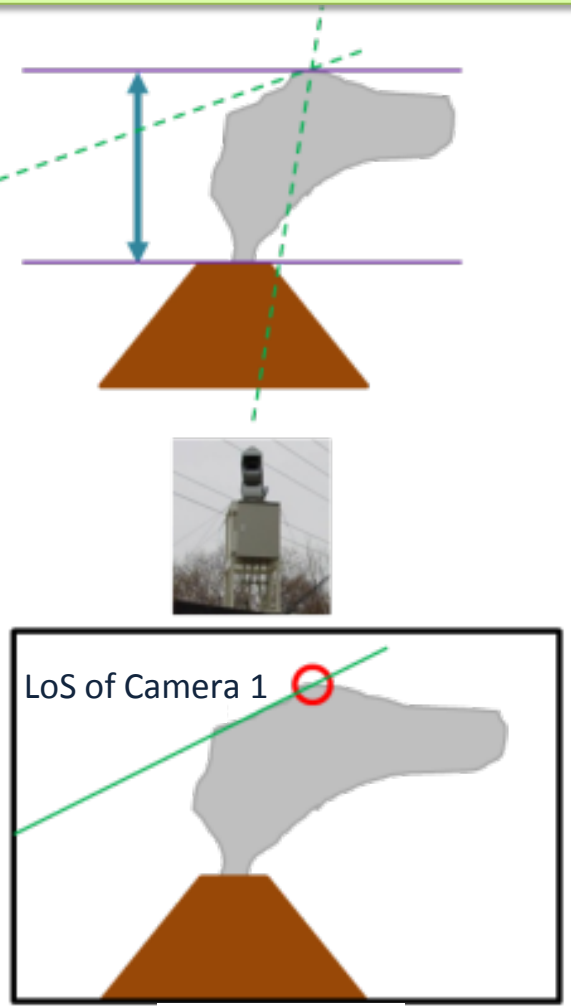


Volcano with Two or More Cameras

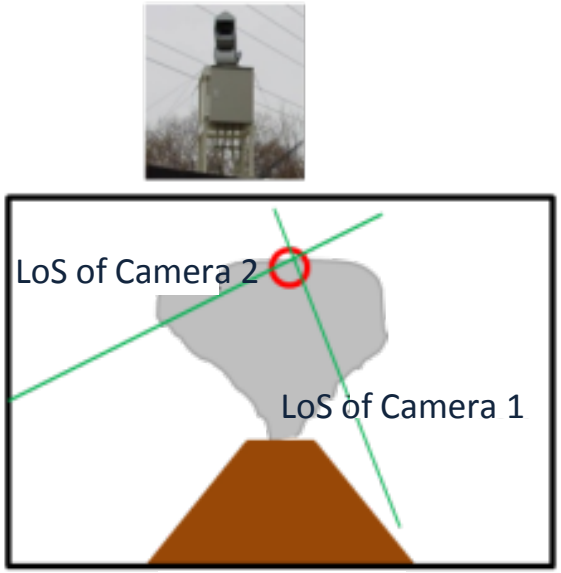
3-D coordinate of the intersection of two cameras' lines of sight (LoS) is calculated, and height and width are measured thereby.



Camera 1



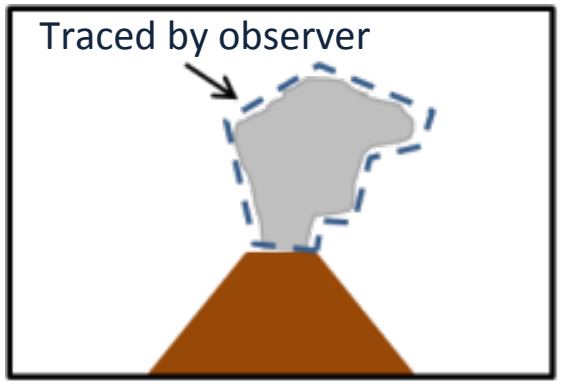
Camera 2



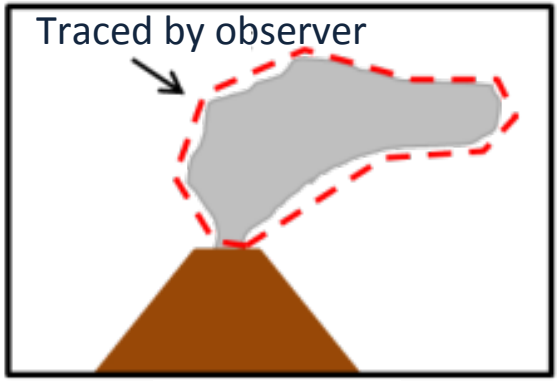
Camera 3

Volcano with Three or More Cameras

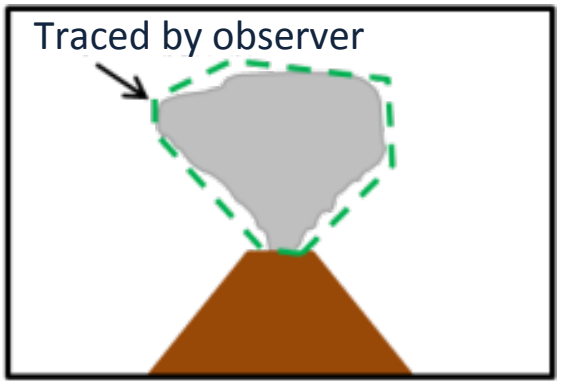
Observer can trace the outlines of ash cloud on each screen, and then shape and volume are calculated thereby.



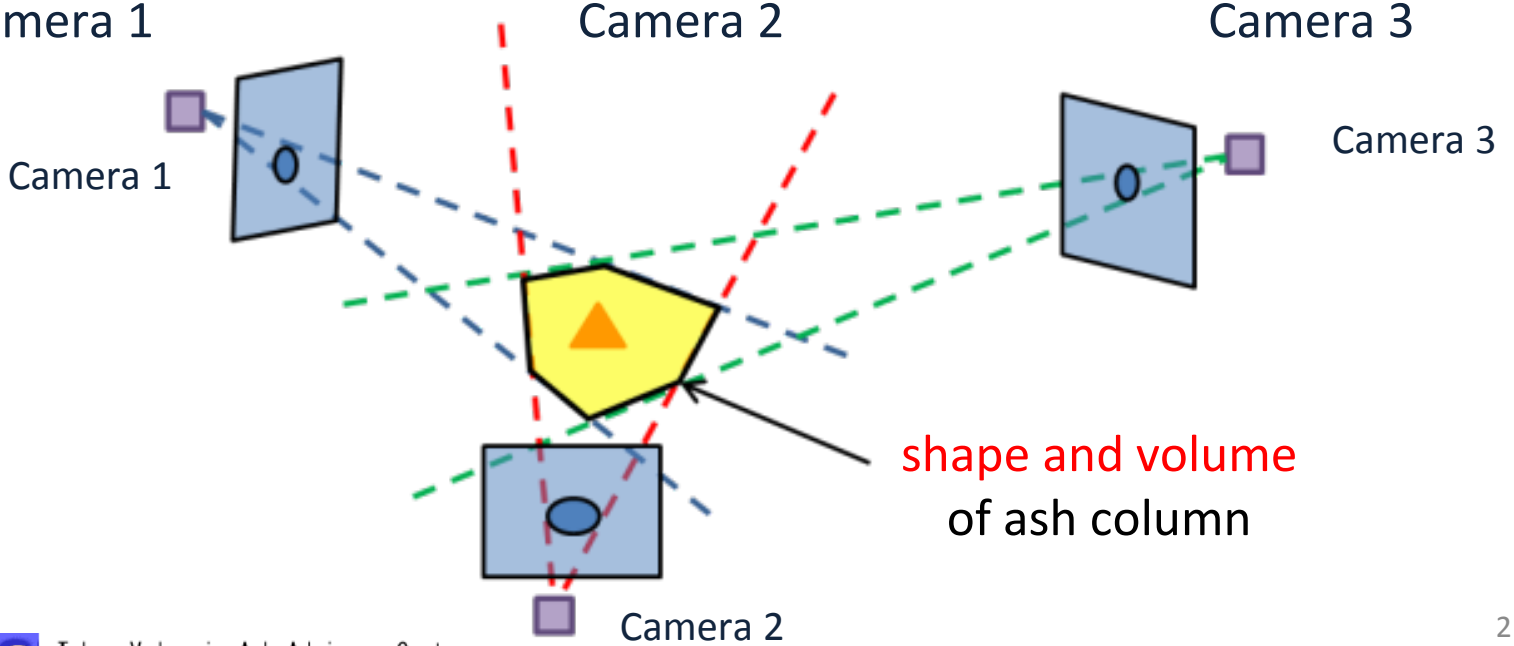
Camera 1



Camera 2



Camera 3



Summary

Summary

- Prompt provision of quantitative VAFF is socially required
- Estimated height of ash cloud is key input to JMA-RATM
- Estimation using radar data improved the model output
- 3-D measurement system would allow for estimation of the volume of eruption column


Thank you!