Crater lake monitoring by sound speed and turbidity measurement of lake water

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Crater lakes are generally part of the volcanic hydrothermal system. Because the chemical compositions of lake water reflect the activity of the volcano, the monitoring of active crater lakes is important to understand the local hydrothermal system and prevent disaster.
Through the study of Lakes Nyos and Monoun in Cameroon, we developed a convenient method of CO_2 monitoring using sound speed of lake water. Furthermore, we found stratification with dense suspended solid particles by turbidity measurement with an under-water camera. This stratification had not been detected by chemical analysis of sampled water. We are elaborating a plan for crater lake monitoring using these new methods. In our presentation, we introduce these new methods and the future plan.
Concerning the CO_2 measurement, we expected that $CO_{2\ (aq)}$ could change the sound speed of dissolved water even though CO_2 is a nonpolar molecule, and confirmed it through laboratory experiments [1]. We used a parameter Fwhich is the difference between the observed sound speed in the lake and the sound speed in pure water at the same temperature and pressure. Through sound speed, depth profile measurements at Lakes Nyos and Monoun with an underwater data logger equipped with a sound speed sensor, we found that the value of Δv has good linear correlation with total CO_2 concentration which mainly consists of HCO_3^- and $CO_{2(aq)}$ [2].
At Lakes Nyos and Monoun, we measured the turbidity depth profile of lake water using an underwater camera. At Lake Nyos there is a chemocline layer in which CO_2 concentration rapidly increases with depth. We found that the turbidity increases in only upper part of chemocline layer, and rapidly decreases at the middle of the layer. Using this result, we made a new Fe ion transport model with precipitates around the chemocline layer.
Using these methods, we are now planning crater lake monitoring project in Japan. Our target will be Lake Ikeda (Kagoshima, 233m deep) and Lake Unagi-ike (Kagoshima, 57m deep), where convection of lake water may stop because of the increase of mean atmospheric temperature. And there is a possibility that volcanic gas compositions started to accumulate in bottom of the lake because geothermal activity around the lake is high. In addition to these lakes, Lake Towada (Aomori & Akita, 327m deep), Lake Mashu (Hokkaido, 211m deep), Lake Toya (Hokkaido, 180m deep), and Lake Kuttara (Hokkaido, 148m deep) will be our second priority targets where we may detect a sign of volcanic activity because there are eruptions within these 5000 years.
References:
[1]Sanemasa et al.(2015) *Geochemistry and Geophysics of Active Volcanic Lakes*
[2]Saiki et al.(2016) *Geochemistry and Geophysics of Active Volcanic Lakes*

Keywords: crater lake, carbon dioxide, turbidity

A Climatological and Modelling Study of Ash Dispersal and Fallout over the Sakurajima Volcano

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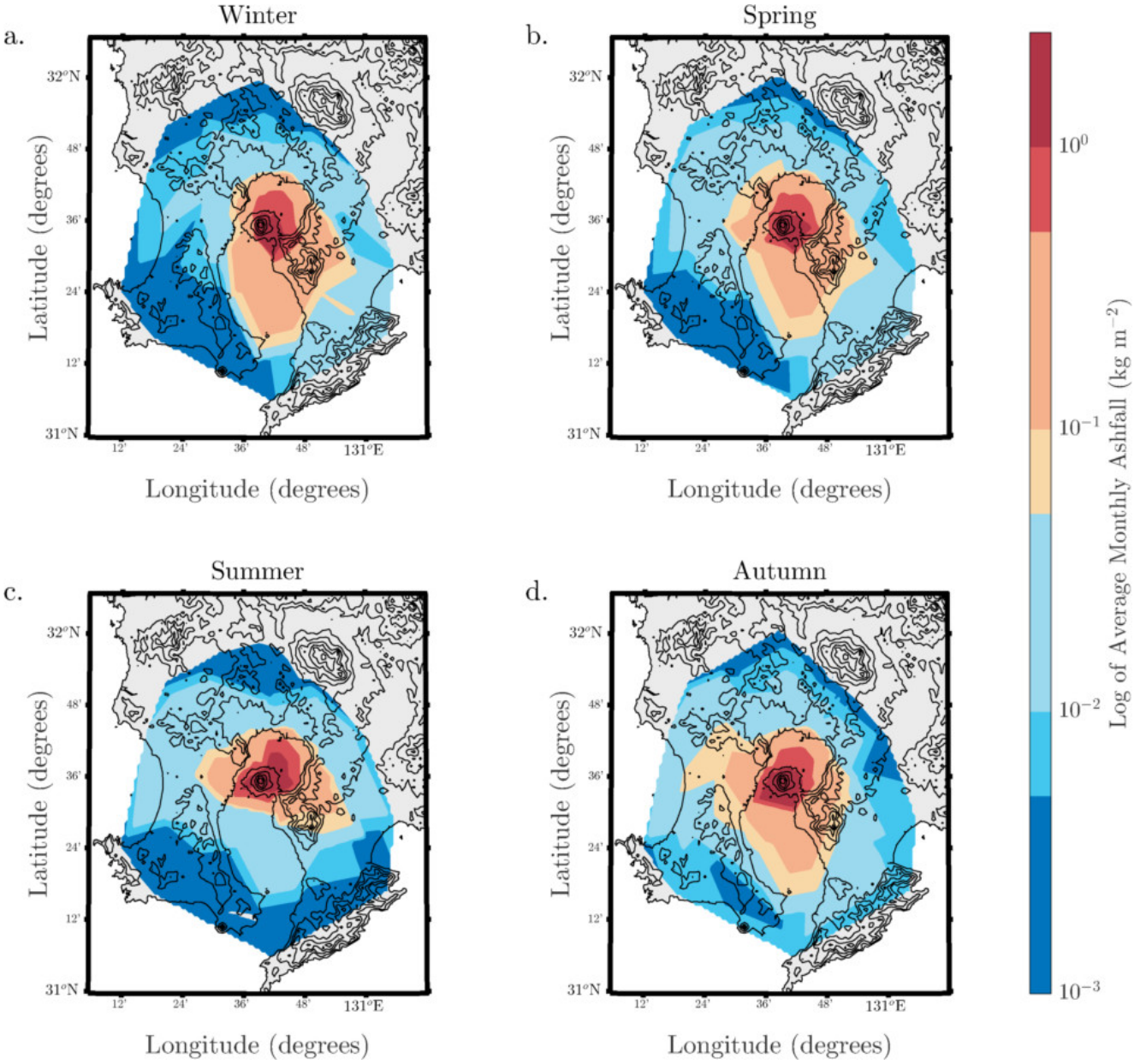
(Introduction) This study deals with ash dispersal at the Sakurajima volcano, an active volcano in southern Kyushu monitored by the Sakurajima Observatory (SO) of Kyoto University. Volcanic ash affects a range of spatial and temporal scales. It impacts lives and livelihoods: from international air traffic to the destruction of property and increased mortality. It can interact with clouds, causing acid rain and directly affecting agriculture and there is an established link between volcanic emissions and the wellbeing of the communities surrounding the Sakurajima volcano. The Sakurajima volcano is a very active volcano with approximately 700 eruptions per year since the southern crater was formed in 2009, however on average these are relatively weak eruptions. This makes the transport and deposition of volcanic ash more susceptible to localised topographical effects, unresolvable in the most commonly used Volcanic Ash Transport and Dispersion (VATD) models. The Weather and Research Forecast (WRF) model, a mesoscale numerical weather prediction model capable of resolving these effects was used to provide simulations for ash dispersal at a fine horizontal resolution (down to 1 km). Results from the analysis of six years of observational data will be presented along with preliminary results from the WRF model simulations.
(Observations and modelling) Databases for the eruptions and ashfall are kept by the Japanese Meteorological Agency (JMA) and the SO, respectively. JMA records eruption time, VEI, plume height, and plume dispersal among other characteristics, while the SO has 59 ashfall measuring stations (mainly monthly), creating a high-resolution network in the Kagoshima prefecture. Atmospheric sounding data are available twice per day at Kagoshima (archived by the University of Wyoming), and JMA also maintains a large network of 30 rainfall measuring stations in the area. The WRF model is used to provide high-resolution simulation data for specific months of eruptions. The WRF model is unique in VATD models as it follows an “online” approach when it comes to physics and chemistry –interactions between the plume and meteorological conditions are resolved in real time, while also resolving the fine-scale meteorological circulation, leading to more accurate predictions. The setup used for the simulations presented has 4 domains, with the finest domain centred over the Kagoshima prefecture with a horizontal grid resolution of 1 km.
(Preliminary results) Analysis of the observational data reveals a strong influence of the local meteorology, with some seasonal characteristics (Fig. 1). Wind direction has the most significant role in the distribution of heavy ash close to the volcano, with the majority of ashfall over 1 kg m^{-2} aligned to the average wind depending on the season. However lighter ash stays airborne for longer periods of time and is more susceptible to topographic effects such as flow splitting (mainly seen over the Satsuma peninsula, SW of the volcano; Fig. 1a-c). Wet deposition due to rainfall is also suspected to have a large role in ash deposition during the wet season, resulting to an overall narrower ashfall distribution (Fig. 1c). The role of the topography and wet deposition will be further examined with numerical simulations.
(Conclusions) The Sakurajima volcano is an active, closely monitored volcano located in Southern Kyushu. Due to the combination of unusually high activity and an unusually high spatial resolution of observational data it provides an excellent location for studying the role of topography in the transport and deposition of volcanic ash, a major atmospheric hazard affecting the lives and livelihoods of people living in the area. Observational data are analysed for the 6 years of

eruptive activity (2009-2014), complemented with computational modelling using the WRF model, a high-resolution numerical weather prediction model.

Keywords: Ash dispersal, Sakurajima, WRF



Reinterpretation of wind effects on volcanic ash transport process with Hoei eruption of Mt Fuji by using unsteady numerical simulation

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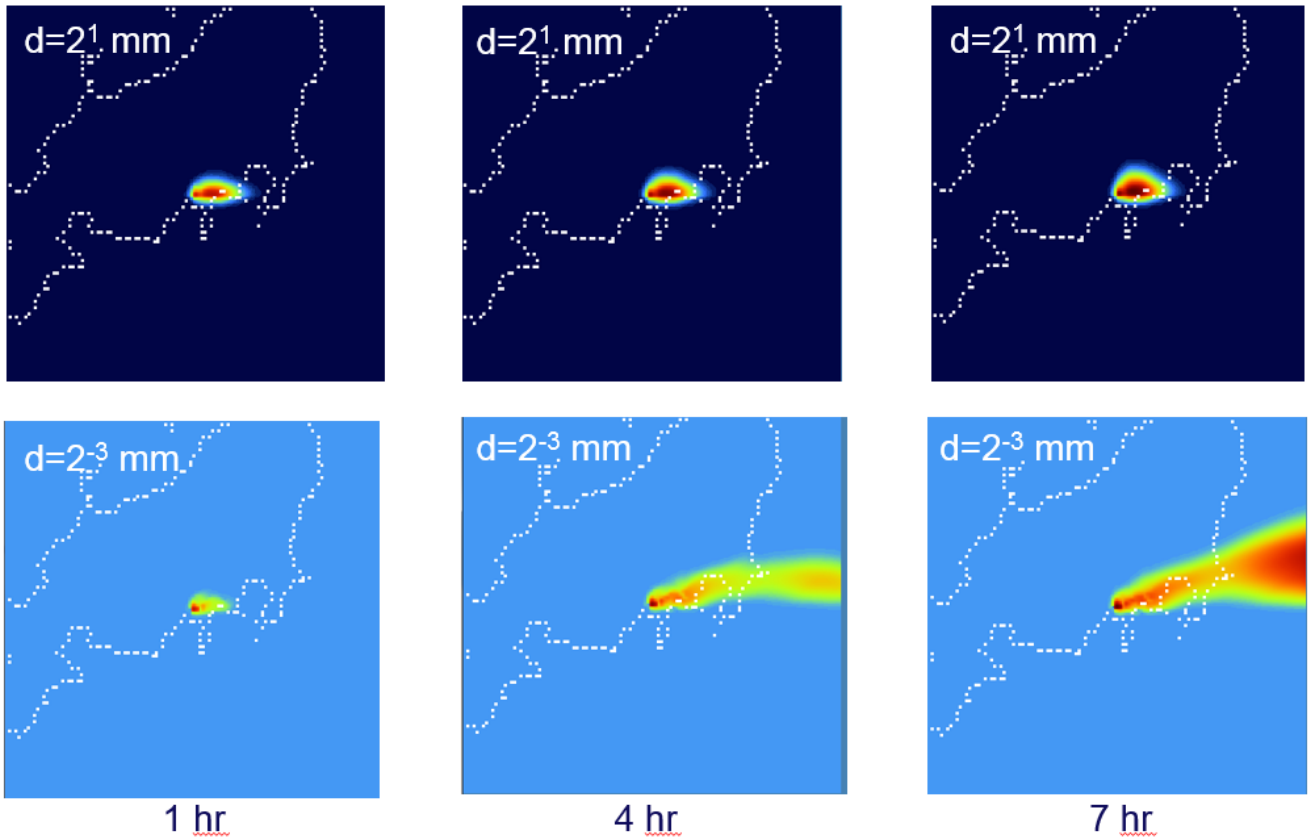
We performed numerical simulations for transport processes of volcanic ash with eruptions of Mt Fuji, especially paying attention to the effects of unsteady wind fields.
We used a three-dimensional Eulerian model for transport and deposition of volcanic ashes, FALL3D (Costa et al. 2006) with the volcanic inputs, corresponding to the stage1 of AD1707 Hoei eruption of Mt Fuji, i.e., the eruption column height is approximately 20 km with the erupted mass of 10^11 - 10^12 kg during 6 hr (Miyaji et al. 2011, Magill et al. 2015). The meteorological inputs were set with the 53 years reanalysis meteorological dataset, CRIEPI-RCM-Era2, which has temporal- and spatial-resolutions of 1 hr and 5km, and a weather forecasting and analysis system, NuWFAS (Hashimoto et al. 2011, Hashimoto et al. 2013). The typical wind profiles in the vertical direction at the vent for winter (DJF) were selected with clustering analysis of CRIEPI-RCM-Era2, and the four dimensional meteorological dataset were reproduced with NuWFAS.
After confirming the agreement of tephra thickness isopaches between the present numerical simulation and previous studies (e.g. Miyaji 1984, Miyaji et al. 2011, Magill et al. 2015), we discussed temporal change in the ground concentration and the deposition of volcanic ash. The increase in concentration at Tokyo was observed after 2 hr of the eruption, which also agree well with previous studies (Miyaji et al. 2011, Magill et al. 2015), indicating that the traveling time of volcanic ash from Mt. Fuji mainly depends on the wind speed in the atmospheric boundary layer (ABL). The temporal change in wind direction in the ABL yielded the skewed p.d.f. (probability density functions) of grains size along the principal axis of the tephra thickness isopaches, which is reported by previous studies (Miyaji 1984, Ui et al. 2002). This was because that the traveling time of the volcanic ash also depends on the diameter of ash (Fig. time-series of tephra thickness isopaches for diameter class of 2^1 and 2^(-3) mm); the setting velocities are functions of the diameter.
More details will be presented in the presentation, and we believe that our study oust be helpful to comprehend essential characteristics of volcanic ash transport process with AD1707 Hoei eruption.

Keywords: tephra, ash transport- and deposition-model, numerical weather prediction, grain size distribution, isopach map



The influence of topographic grid size on lava flow simulation-Using the example of the Kenmarubi lava flow of Mount Fuji-

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The hazard map of Mount Fuji regarding volcanic disasters was published in 2004. This map shows the prospective affected area of lava flows, pyroclastic flows, lahars due to snow melt, and volcanic ashes based on the results of numerical simulations. At that time, the resolution of the Digital Elevation Model (DEM) used for simulations was 200m square. It has been 10 years since the first hazard map was published, and we have since produced higher resolution map using the laser scan of the topography. In this study, we used the higher resolution DEMs and simulated the Kenmarubi lava flow (AD1000) with the LavaSIM simulation software. The simulation results run with the finer grid size of the DEM produced a faster lava flow, and reached the foot of the mountain faster than the lava flow with the coarse grid DEM. Even though we ran the simulation with the same duration of lava flow, the lava flow spread over wider area and became thinner when the grid size of the DEM was coarse. Thus, the simulated lava flow properties (i.e. flow area and duration) strongly depends on the grid size of the DEM. In conclusion, we should use the appropriate grid size for the numerical simulations depending on the types of flows, and understand that there are some errors related to the grid size of the DEM when we construct and use hazard maps of volcanic eruptions.

Keywords: topographic grid size , Numerical simulation, Lava flow, Mount Fuji

Information of volcanic activities with scientific uncertainly in a view of science communication

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Japan Meteorological Agency (JMA) introduced a “special alert” on August 30, 2014. Ministry of Land, Infrastructure and Transport (MLIT) has published “a way of disaster prevention and mitigation that corresponds to a new stage,” on January 20, 2015. The style of Disaster information is developping. In this report, Information of volcanic activities with scientific uncertainly and the wide range of time and space was focused in a view of science communication. In particular, after the Great East Japan Earthquake, the concept of “uncertainty of science” and “science in action (developing),” became an issue to examine the calling and the receiving side of the case in Japan. The cace of the crater peripheral danger alarm of Mt. Zao April 2015 as the example of low freqency volcanic activity and the rapid evacuation in the eruption of Mt. Kuchinoerabu in August 2014 and May 2015, as the example of high freqency volcanic activity were selected.
On May 29, 2015 volcano eruption occurs in Shindake crater of Mt. Kuchinoerabu, for the first time of the special alarm (eruption alert level 5) was announced in Japan's volcano, evacuation of the island outside has done. Interviews were conducted in July and October 2015. The main target of hearing investigation are staffes of Yakushima Town Hall (Miyanoura branch, Kuchinoerabu Branch), staffs of fire brigade, heads of wards in Kuchinoerabujima. Topics of hearing are “the volcano disaster prevention awareness befor August 2014,” the volcano disaster prevention awareness after August 2014,” “judgment and situation of evacuation in May 2015” and“opinions towards the back home”. As reslts it is important to transport between citizen not but governors with specialist.
After April 7 in 2015, the volcanic seismisity near the volcano Zao Okama increased, and the alart (around the crater danger) was announced on the 13th. At the end of the volcanic tremor on May 17th, passed in a small state of the earthquake, it has been released on June 16. It was the first of the volcano, which was activated after a disaster at the Utaki. Through the news April 14, a tourist government officials commented “a projecting part of spring tour was foiled ,” “We did not have recognitions of active volcano for Mt. Zao”. After the release of alert, many supoting projects have been carried out with a focus on tourist assistance from prefectures Miyagi and Yamagata. The effect of these project was interviewed from tourism-related business owners in both Prefecture Yamagata Miyagi. As results no recognitions of active volcano for Mt. Zao is in the majority, the gap of the time scale of life and geological phenomenon, present situation that is preventing the understanding of the measures have been suggested.

Keywords: Science communication, Information of Volcanic Activities, scientific uncertainly

Trend analysis for Japanese newspaper coverage associated with volcanic disaster

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Mass-media is one of primary tools in the transmission of scientific and technological information from experts to (Japanese) public. Generally, there are two types of scientific and technological news; One is strongly tied to political and economic issues, and the other is a research outcome, leading to the broader public interest in the cultural/scientific topics. In the Earth and Planetary Sciences, the former largely includes the risk or mitigation information of natural disasters, such as global warming, earthquake and volcanic eruption. Various kinds of risk information are currently delivered via mass-media to the public, so that they can help shape the public perspective to potential natural hazards and prompt the social involvement in disaster reduction activities. The exposure to the risk information may change the public attitudes and opinions. While at a same time, in most cases, the communication between non-experts (the public) and experts is also mediated by journalists. Therefore it is important in the process of the science communication to reveal how issues of natural disaster are intensively covered by mass media (journalists). Our goal is to build the fundamental knowledge required for considering the smoother communication between journalists and experts.

In Japan, there are many kinds of active volcanoes and it is essential to implementing the volcanic disaster mitigation at all time. Volcano research has been indeed powerfully promoted at universities and government agencies and some disaster prevention schemes have been made on the base of a lot of volcanological studies. Because these have an influence on the civic living through the disaster prevention education and public work projects to a certain extent, to which projects is the higher priority assigned is basically dependent on public deliberation. Without the national consensus, effective and coherent policymaking could not be realized. Then it requires the public to have primary volcanological knowledge when advancing countermeasures to reduce the negative impact of volcano eruption. As the prime means of communication between government agencies, volcanological experts, and non-experts, mass-media plays a significant role. From this view point, it is crucial to comprehend how volcanic disaster is portrayed in mass-media coverages.

This study forces on the Asahi Shimbun, Mainichi Shimbun, and Yomiuri Shimbun. They are the typical national newspapers in Japan, which are often called three major newspapers, and they have a circulation of several million. Almost all news articles published by these newspaper companies have been recorded, classified and indexed separately from the 1990s onward. This enables to obtain the reproducible results. The newspaper articles with the word “eruption” published from January 1990 to August 2015 were collected through these databases. The research methodology is the quantitative analysis with the use of the LDA (Latent Dirichlet Allocation) which is a way of automatically extracting topics that texts contain. All samples about volcanic disaster are categorized in line with discovered topics to allow an examination of the amount and type of subject matter covered. In this presentation, the author is going to show how news issues of volcanic disaster are framed by the newspaper media.

Keywords: volcanic disaster, LDA, media study

