Chapter 6 Conclusion

There was an annual total of 227 volcanic eruptions at 75 volcanoes during the period from 1977 through 1985 in the field of view of GMS. Eruptions that sent eruption clouds higher than 4 km in altitude and were expected to be detected in GMS images numbered 51 annual volcanic events at 30 volcanoes in total. The eruptions at which eruption clouds were actually detected in GMS images numbered 31 annual events from 23 volcanoes in total during the period from late-1977 through 1985 when GMS images were provided. And the detection rate of eruption clouds by GMS images against the total volcanic eruptions during late-1977 - 1985 was about 13.7 %. This low detection rate was mainly due to disturbances of surrounding atmospheric clouds over the volcanoes. The lower limits of altitude and dimensions of eruption clouds detected in GMS image were about 5 km and 30 km, respectively. All big eruptions, however, accompanied by wide and high eruption clouds higher than 10 km cloud be well detected, but the occurrence-time of an eruption was almost impossible to determine owing to limitations of the GMS's image-taking intervals and the low altitude and small domain of rising eruption clouds immediately after the occurrence of an eruption.

Many photograph images of detected eruption clouds are compiled in this paper for the sake of understanding the detectability and spreading sequences of eruption clouds by GMS images. The largest number of eruption cloud images was obtained during the 1982 Galunggung Eruption and the second largest during the 1981 Alaid Eruption. The best sequences from the rising cloud through its dispersion were obtained during the 1981 Pagan Eruption. It was confirmed that the sequences of eruptions could be well monitored by observations of eruption cloud in GMS images. The decay, the cessation or end and the resumption of volcanic eruption could be observed by monitoring the time variations of the top altitude and horizontal length of the eruption cloud and judging whether the eruption cloud came continuously out of the location of the volcano or detached from the volcano. Especially, the end or decay of volcanic eruption could be well judged by inspections of decreases of top altitude and isothermal domains of the highest portions of the eruption clouds.

Fundamental analyses were conducted concerning the behavior of eruption clouds in the atmosphere. According to their results, the horizontal moving velocity of a spreading eruption cloud several m/sec faster than the surrounding wind speed and a large horizontal eddy diffusivity higher than 10^{9-10} cm^2/s were obtained in several cases of eruption clouds. However, these results are somewhat problematic because of limitations of ground resolution of GMS image as well as errors in determining the precise edge of eruption clouds. There were several interesting cases where the highest or near-highest portion of an eruption cloud kept its altitude and also the eruption cloud that had spread increased its top altitude or increased its horizontal dimensions even several hours after the end of the eruption. These phenomena may suggest that the spreading eruption cloud can still expand in the atmosphere by its own heat-source within after the cessation of the eruption.

To distinguish eruption clouds from atmospheric clouds in GMS images based on temperature and albedo data was difficult. However, there were tendencies that eruption clouds show lower albedo values, compared with those of atmospheric clouds which have the same altitudes as those of eruption clouds. There were noticed larger differences between the estimated results of the top altitudes of eruption clouds based on temperature data by GMS and air-temperature profiles by radio-sounding data and the results by visual ground observations. However, in several cases, there were good coincidence between the estimated top altitudes and the visual observation values by aircraft. To study these disagreements, we should further accumulate observed results and advance theoretical investigations. Thermal energy releases by eruption clouds were estimated by assuming the spreading eruption clouds as plume-risings and the results could fairly well evaluate the intensities of volcanic eruptions. Still better methods to estimate the accurate thermal energy releases by satellite image data of eruption clouds are strongly required.

According to analyses of the Sakurajima eruption clouds taken by LANDSAT MSS images, eruption clouds showed almost the same physical characteristics as atmospheric clouds. This result indicates that the bulk volume of ejected materials borne within eruption clouds spreading in the atmosphere can be appropriately estimated by substitution of measurement results on particle sizes, their distributions and the concetrations of atmospheric clouds.

The monitoring of eruption clouds by GMS images will be provide a useful technique for surveillance of volcanic eruptions, observation of their sequences, forecasts of ejecta-fall areas, estimation of the total volume of ejected materials and warning for safe navigations of aircraft. For these purposes, further improvements of the satellite system including the performance of detectors, image-taking frequencies, and convenient data processing systems are required. Furthermore, not only theoretical and experimental investigations of the dynamics of rising and spreading of eruption clouds, but also accurate observations of the actual sequences of volcanic eruptions and eruption clouds are strongly demanded.

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