

Analysis of Historical Meteor and Meteor shower Records: Korea, China and Japan

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Abstract. We have compiled and analyzed historical meteor and meteor shower records in Korean, Chinese, and Japanese chronicles. We have confirmed the peaks of Perseids and an excess due to the mixture of Orionids, north-Taurids, or Leonids through the Monte-Carlo test from the Korean records. The peaks persist for almost one thousand years. We have also analyzed seasonal variation of sporadic meteors from Korean records. Major features in Chinese meteor shower records are quite consistent with those of Korean records, particularly for the last millennium. Japanese records also show Perseids feature and Orionids/north-Taurids/Leonids feature, although they are less prominent compared to those of Korean or Chinese records.

Keywords. meteors, meteor showers, historical records

We have compiled and analyzed the meteor and meteor shower records in official Korean history books (Kim *et al.* 1145; Kim *et al.* 1451; Chunchugwan 1392-1863) dating from 57 B.C. to A.D. 1910, covering the Three Kingdoms period (from 57 B.C. to A.D. 918), Goryeo dynasty (from A.D. 918 to A.D. 1392), and Joseon dynasty (from A.D. 1392 to A.D. 1910). The books contain only a small number of meteor shower records in contrast to abundant meteor records.

The earliest records during the Three Kingdoms period are too few and have mostly year and month information only. However, the meteor records during Goryeo and Joseon dynasties, spanning roughly one thousand years, show several statistically significant features when rearranged in sidereal years. Most prominent is the peak of the number of records at the day 220, which coincides with the modern major periodic meteor shower, Perseids. The peak persists from Goryeo dynasty to Joseon dynasty, almost one thousand years. This implies that the comet 109P/Swift-Tuttle, the parent comet of Perseids, has been active for more than one thousand years without significant perturbation on its orbit. The change in the number of records for Perseids during Goryeo and Joseon dynasties suggests that the activity of Perseids has decreased over the same period. Another collection of peaks appear around the day 300, which can be associated with Orionids, north-Taurids, or Leonids. These peaks also suggest the activities of some of these major periodic meteor showers have increased over the last millennium.

We also find the evidence of seasonal variation of sporadic meteors in Korean records. According to Yrjola & Jenniskens (1998), the activity of sporadic meteors is expected to peak at the Autumnal equinox and to be lowest at the Vernal equinox in the northern hemisphere. We confirm the seasonal variation of sporadic meteors from the records of Joseon dynasty, with the maximum number roughly 1.7 times the minimum. The least-square sinusoidal fit shows a phase shift of 15 days, toward winter, with respect to the simple geometrical expectation. We can think of two possible causes for the marginally detected phase difference. One factor could be the residual contamination by meteor

showers. Another is the real innate seasonal variation of sporadic meteors. It is possible for the debris of each comet not to completely dissipate in a few years, resulting in excess of sporadic meteors near periodic meteor shower. In fact, there are many periodic meteor shower events in the winter, and the scattered meteoroids related with the meteor showers may have shifted the peak of the seasonal variation of sporadic meteors towards the winter.

We also analyzed Chinese and Japanese meteor shower and meteor records in their compilation books (Beijing Obs. 1988; Kanda 1935; Kanda 1936; Ohsaki 1994) for the same periods like Korea. The major features in the distribution of Chinese meteor shower records are quite consistent with those in Korean meteor records for the last one thousand years. Chinese records also suggest decrease in Perseids activity and increase in Orionids/north-Taurids/Leonids activity as the Korean records do. Japanese records also show Perseids feature and Orionids/north-Taurids-Leonids feature, although they are less prominent compared to Korean or Chinese records. One of the modern major periodic meteor shower, eta-Aquarids, which is one of the pair remnant of the comet Halley, does not have any corresponding feature in Korean, Chinese, and Japanese records while another pair remnant of Halley, Orionids, appears somewhat strongly at the day 295. This may suggest eta-Aquarids has been active only recently.

Babadzhanov (1994) has suggested five stages in the evolution of meteoroid stream. At its final stage, meteor stream becomes almost indistinguishable from the sporadic background. Evolution of the stream left by a comet depends on the condition of the comet. However, bright meteors decrease year by year after the comet passes. According to Wu (2002), Leonid showers would never be seen for more than about four consecutive years. Yeomans (1981) on the other hand has suggested that significant Leonid meteor showers were maintained for roughly 2500 days. We have looked for this kind of change in meteor activity in Korean records, wishing to estimate the evolution time of identified periodic meteor showers. For example, 231 records associated with Perseids are folded by using its period of 135 years, and distribution of the number of records as a function of phase is constructed. We have found no significant change of activity over cycles.

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