

# The Lunar Atmospheric Tide at Trivandrum and Agustria

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Chapman and co-workers<sup>1,2,3</sup> have given determinations of the lunar atmospheric tide at a large number of stations, and the author and co-workers<sup>4,5</sup> for 3 stations in India. The present paper gives the lunar atmospheric tide at Trivandrum and Agustria.

2. Trivandrum Observatory (lat.  $8^{\circ} 31' 32''$  N, long.  $76^{\circ} 59' E$ ) was situated on the summit of a small hill 195 ft. above M.S.L. and about 4 miles from the sea. For a site for an observatory which "should be built at as great a height as possible and as near as possible to Trivandrum," Agustria peak was the obvious choice. Amongst the rugged peaks of Western Ghats seen from Trivandrum, one is conspicuous for its height and its isolation; two thousand feet in the line of the range it rises apart in the form of a sharply pointed cone. Its peak is isolated and there is no plateau nearby. The Agustria Observatory was situated on this peak (lat.  $8^{\circ} 37' N$ , long.  $77^{\circ} 19' E$ ) at a height of 6200 ft. above M.S.L. and about 25 miles from Trivandrum.

3. The data for Trivandrum consist of hourly eye observations of the barometer (Newman Barometer for  $1\frac{1}{2}$  years and Adie Barometer for the rest of the period) except on Sundays for the periods 1853-1855 and 1856-1864. The data for the two periods have been analysed separately as the observations were taken 3 minutes past the hour, local mean time, during the first period, and at 3 minutes past the half hour during the latter period. The data for Agustria consist of hourly eye observations of the barometer (Adie Barometer or Newman Barometer) except on Sundays for the period January 1856 to September 1858 and June to December 1864. The hourly observations were taken at 33 minutes past the hour. There were some days at the two stations on which complete observations were not available, and the data for a few of these

days, on which the necessary values for even hours could not be obtained suitably by interpolation, were rejected.

4. The data were analysed by the Chapman-Miller<sup>6</sup> method to determine the lunar atmospheric tide at these two places. Although hourly readings were available, the work was based on the two-hourly readings neglecting the alternate hourly values. The material was analysed with the aid of Hollerith punching, sorting and tabulating machines.

5. Only the mean annual tide was determined from the data of Agustria and data for 1853-55 of Trivandrum as the periods were short. The mean annual tide and the three seasonal values, (J—June Solstice—May to August, E—Equinoxes—March, April, September, October, and D—December Solstice—November to February) were, however, determined from the data for 1856—1864 of Trivandrum.

6. Only the second component of the lunar atmospheric tide was determined in the form:

$$C_2 \sin(2t + \theta_2)$$

where  $t$  denotes time reckoned from the local hour of mean lunar transit, at the rate of  $360^{\circ}$  per lunar day. The amplitude  $C_2$  has been given in microbars,  $33.86 \times 10^3$  microbars being equivalent to one inch of mercury. A phase correction had to be made on account of use of Greenwich times of lunar transit instead of local times, and as the observations had not been taken at full hours, local mean time. The number of days of data used is given by  $N$ .

7. The probable errors (P.E.) of the results have been evaluated and are given with the corresponding lunar determinations. If  $C_2$  exceeds the corresponding P.E. by more than 3 times, the determinations can be considered as successful.

8. Table 1 gives the mean annual atmospheric tide at Trivandrum and Agustria.

TABLE 1.

| Station.                         | N    | C <sub>2</sub> | θ <sub>2</sub> | P.E. |
|----------------------------------|------|----------------|----------------|------|
| Trivandrum (1853-55)             | 938  | 40.0           | 70.2°          | ±6.5 |
| Trivandrum (1856-65)             | 2815 | 54.2           | 74.1°          | ±6.1 |
| Trivandrum (1853-55 and 1856-65) | 3753 | 50.7           | 73.1°          | ±6.2 |
| Agustia                          | 914  | 49.3           | 75.2°          | ±7.2 |

TABLE 2.

| Station.         | Height above M.S.L. (ft.) | C <sub>2</sub> | θ <sub>2</sub> | Table 2 (contd.) |          |            |         |
|------------------|---------------------------|----------------|----------------|------------------|----------|------------|---------|
|                  |                           |                |                | La Moline        | Huancayo | Trivandrum | Agustia |
|                  |                           |                |                | 823              | 47.5     | 73.0°      |         |
|                  |                           |                |                | 11000            | 39.0     | 74.1°      |         |
|                  |                           |                |                | 195              | 50.7     | 73.1°      |         |
|                  |                           |                |                | 6200             | 49.3     | 75.2°      |         |
| Periyakulam      | 944                       | 52.0           | 62°            |                  |          |            |         |
| Kodaikanal       | 7688                      | 52.0           | 68°            |                  |          |            |         |
| San Francisco    | 155                       | 14.7           | 57.9°          |                  |          |            |         |
| Lick Observatory | 4213                      | 10.9           | 67.7°          |                  |          |            |         |
| San Diego        | 87                        | 23.2           | 68.8°          |                  |          |            |         |
| Mount Wilson     | 5848                      | 15.9           | 75.5°          |                  |          |            |         |

TABLE 3.

| Season | N   | C <sub>2</sub> | θ <sub>2</sub> | P.E.  |
|--------|-----|----------------|----------------|-------|
|        |     |                |                |       |
| E      | 943 | 53.4           | 71.7°          | ±10.5 |
| D      | 925 | 63.8           | 47.2°          | ±11.9 |

TABLE 4.

| Station.     | J              |                | E              |                | D              |                |
|--------------|----------------|----------------|----------------|----------------|----------------|----------------|
|              | C <sub>2</sub> | θ <sub>2</sub> | C <sub>2</sub> | θ <sub>2</sub> | C <sub>2</sub> | θ <sub>2</sub> |
| Batavia      | 94             | 72°            | 77             | 77°            | 81             | 54°            |
| Trivandrum   | 61.0           | 104.5°         | 53.4           | 71.7°          | 63.8           | 47.2°          |
| Periyakulam  | 47             | 65°            | 63             | 68°            | 36             | 39°            |
| Madras       | 62             | 68°            | 51             | 58°            | 49             | 39°            |
| Manila       | 13.1           | 87.7°          | 12.5           | 87.3°          | 11.6           | 19.9°          |
| Bombay       | 57             | 90°            | 54             | 92°            | 43             | 55°            |
| Hongkong     | 73             | 69°            | 56             | 73°            | 60             | 35°            |
| San Fernando | 35.4           | 90.7°          | 26.9           | 83.7°          | 23.2           | 50.9°          |
| Coimbra      | 20.3           | 84.5°          | 18.7           | 73.0°          | 14.0           | 49.9°          |
| Lisbon       | 22.3           | 74.5°          | 23.2           | 68.3°          | 23.1           | 40.0°          |
| Toronto      | 39             | 89°            | 29             | 70°            | 21             | 71°            |

9. It has been pointed out previously<sup>3,5</sup> that of two stations close by at considerably different heights, the amplitude of lunar tide at the higher station is generally less and the phase angle greater than at the lower station. The amplitude at Agustia is less and the phase angle greater than at Trivandrum. The lunar tide at four pairs of adjacent stations at considerably different heights along with that at Trivandrum and Agustia is given in Table 2.

10. Table 3 gives the lunar tide at the separate seasons J, E and D at Trivandrum (1856-64).

11. At Trivandrum the phase angle for the December solstice is less than for the other two seasons as at other stations, but the amplitude is greater. The lunar tide at different seasons at some places and at Trivandrum are given in Table 4.

## REFERENCES.

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