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Site characteristics of The Indian Astronomical Observatory, Hanle

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Abstract. A brief summary of site characteristics of Indian Astronomical Observatory, Hanle, Ladakh (altitude 4500 m), is presented based on a survey being carried out since the last four years.

Keywords : astronomical sites, site characterization, astronomical seeing

1. Introduction

The Indian Institute of Astrophysics, Bangalore, has been characterizing the high-altitude site at Hanle (GPS coordinates : Long : 78°57′51″ .2 E; Lat : 32°46′46″.5 N; Alt : 4467 m – Krishna Mohan et al., 1997) over the last four years. Early results of site survey were presented by HIROT Team (1996). An automated weather station was installed at the highest peak in the Digpa-ratsa Ri Range (since named as Mt. Saraswati), in July 1996. A seeing monitor in the form of a twin-aperture differential image motion monitor using a 12-inch telescope and thermo-electrically cooled CCD (SBIG ST4) was installed at the summit in July 1998. We present here the characteristics of Hanle based on these studies.

2. Results

The number of spectroscopic nights over the calendar years 1995-1998 were 253, 256, 211 and 285, and photometric nights 182, 180, 150 and 234. The rms variaton over these years is thus 10% for spectroscopic and 16% for the photometric nights. The useful nights are generally clustered together. For example, 60% of photometric nights are in stretches of 5 or more contiguous nights and 33% are in 10 or more contiguous nights.

Sapru et al. (1998) have evaluated Hanle among other sites in the country based on satellite imagery obtained in V band at 0830 and 1130 hours. Averaging the cloudiness at these times over a region of 100 km diameter centred on the coordinates of Hanle within 50 km accuracy, these authors conclude that Hanle region was clear for 46% of the time during the sampled periods in 1989-90 and 1992-94. Comparing with the in-situ measurements made at similar time of the day, over a period of 49 overlapping days, Sapru et al. find a 73% chance of

correctly identifying a clear or cloudy epoch. The satellite imagery thus serves as an indicator limited by (a) spatial and temporal resolution, and (b) temporal sampling. Continuous in-situ measurements are essential for further characterization.

The automated weather station measures air and ground temperatures, ambient relative humidity, solar radiation, wind speed and direction every minute and records at the end of each hour the minimum and maximum values, during that hour, of the temperatures, relative humidity, wind speed and direction. Also recorded are the mean vector wind speed and direction, mean solar radiation, and integrated rainfall during that hour. The records show that Hanle is an extremely cold and dry site with the minimum relative humidity reaching a few per cent and minimum air temperature reaching – 25°C. Climatographs show it is never hot and humid. The total annual rainfall was 5-6 cm during the years 1995-98, a significant fraction of which was at the limit of sensitivity of the detector (0.125 mm per hour). The ambient temperature and relative humidity suggests that the median precipitable water vapour above Hanle is 1.9 mm. The measured values (HIROT Team 1996, and 220 GHz radiometry carried out by S. Yamamoto and colleagues from University of Tokyo) in Hanle in particular, and in Ladakh in general (Chandersekhar, Sahu and Desai 1983) suggest that the actual values may be lower.

The wind speed shows diurnal pattern similar to Chajnantor, picking up during the day and subsiding in the evening. The maximum observed wind speed of 32 m/s out of samples taken every minute over a 3 year period is similar to the other high-altitude sites. However, the median wind speed (3 m/s considering day and night data) is lower than the value at Mauna Kea (4.5 m/s) or Chajnantor (5.5 m/s) (Holdaway et al. 1996).

The seeing monitor of Wood et al. (1995) design is described in some detail by Manoj & Ravindra (1998) who presented the early observations. In brief, the seeing monitor employs a 12-inch aperture telescope in front of which a mask is placed containing two apertures of 60 mm diameter each, separated by 275 mm. An 80 arcsec prism is placed in front of one of the apertures, thus creating two images of the star being monitored. Based on images recorded with 20 ms integration on an ST-4 CCD camera of pixel size 13.75 × 16μm, the centroids and their rms motion are estimated. At the image scale of 1 arcsec/pixel at the *f*/10 Cassegrain focus, each aperture provides a diffraction limited image with full width at zero intensity of 4.4 pixels. This oversampling helps in estimating the rms motion of the centroids to an accuracy much better than 1 arcsec. The theory of seeing estimation from rms separation of such images is discussed by Sarazin & Roddier (1990).

The median seeing based on data recorded over a total of 16 nights spread over the months of July, August and December 1998 is 0.96 arcsec in the V band. This value is an upper limit due to the following reasons :

(a) The rms centroid motion has an instrumental component which needs to be subtracted from the measurements (Sarazin & Roddier 1990).

(b) The measurements were made only two meters above ground and seeing would be better at greater heights from the ground.

3. Summary

The characteristics of Hanle are summarized below :

Good accessibility round the year

Number of spectroscopic nights : 251±26 per year

Number of photometric nights : 186 ± 30 per year

Precipitable water vapour : ≤ 2 mm

Annual precipitation (rain+snow) : < 7 cm

Extinction in V band : ~ 0.1 mag/ airmass

Sky brightness : μv=21.5 mag / arcsec^2

Median Seeing : < 1.0 arcsec

Right Ascension Advantage : Uniform distribution of useful nights round the year

Longitudinal Advantage (79° E) : Canary Islands (20° W); Eastern Australia (157° E)

Low ambient temperature : Median –2° C at night

Low relative humidity : Median 30% at night

Low wind speed : Median 2.2 m/s (8 kmph) at night

Constant wind direction : Prevailing south-south-westerly

No pollution (electromagnetic, air)

Low seismicity

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