Analysis of Atmospheric Seeing Measurements

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Abstract

I have been given access to time series of measurements taken at different locations worldwide, covering multiple years of observations from GONG. I performed some statistical analysis on those time series to characterize the overall quality of the different sites. My primary data set consists of H-alpha observations. Three parameters from these images were extracted and investigated. For this project I mainly focused on the sharpness parameter, which can be used as a proxy for atmospheric seeing. Based on my analysis I was able to rank the six different sites in terms of their overall sky quality. The results from this project is relevant in planning for future sites survey.
Method of Analysis

• GONG H-alpha data were acquired spanning a 10-year period from 2011 to 2020.
• Each fits data file contained parameters illustrative of seeing quality.
• There are three parameters I used: RMS, Skybrite, and Sharpness.
**Sharpness**
1. The center-disk 128x128 pixels are extracted. These pixels form the Region of Interest (ROI).
2. A boxcar filter (9x9 kernel) is run over the ROI to create a blurred version of the original data.
3. The original data is divided by the blurred data.
4. The **sharpness** is the standard deviation of the ratio data computed in step 3.
   Sharpness ranges in values from 0 (very bad) to 1 (very good).

**RMS:**
Using the above ROI, compute the RMS of the original data.

**SkyBrite:**
Using the 320x320 pixels in each corner of the image, compute the average.
H-alpha images from Mauna Loa (Mh), left and Big Bear (Bh), right.

Atmospheric seeing has smeared features in both images, but less so for Big Bear. This is reflected in the higher ‘sharpness’ value for Big Bear, 0.01588 vs 0.01224 for the Mauna Loa data.
Converting Sharpness to Arc Seconds

• Using GONG H-alpha and seeing monitor data acquired almost simultaneously in Tucson between 10/22/2013 and 2/10/2014

• Correlation of 1/sharpness vs seeing data.
Overall seeing quality of all six GONG sites for the 10-year period.
Bi-annual variation of seeing quality for two sites. Note: Considerable changes at Big Bear over the years.
Conclusions

Preliminary ranking

<table>
<thead>
<tr>
<th></th>
<th>Big Bear (California)</th>
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<tbody>
<tr>
<td>2</td>
<td>Cerro Tololo (Chile)</td>
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<tr>
<td>3</td>
<td>Learmonth (Australia)</td>
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<tr>
<td>4</td>
<td>Mauna Loa (Hawaii)</td>
<td></td>
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<tr>
<td>5</td>
<td>Teide (Canary Islands, Spain)</td>
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<td>6</td>
<td>Udaipur (India)</td>
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