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VII Workshop on Robotic Autonomous Observatories (October 16-20, 2023)
Editors: Maria Gritsevich, Alberto J. Castro-Tirado, Petr Kubánek, Shashi B. Pandey, and David Hiriart - DOI: https://doi.org/10.22201/ia.14052059p.2025.59.13

ZERO POINT MAGNITUDES OF ALL-SKY IMAGES FOR DETERMINING CLOUD CONDITIONS

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RESUMEN

Brevemente explicamos el método del punto cero para determinar el porcentaje de nubes, comparando las imágenes obtenidas con las que se esperarían en condiciones de cielo despejado, proporcionando valores del porcentaje cubierto por cada sector del cielo.

ABSTRACT

We briefly explain the zero-point method of determining cloud cover, by comparing recent all-sky images with what would be expected in cloudless conditions, obtaining values for the cloudiness of each sky sector.

Key Words: All-sky image — Zero point data — Cloud condition detection

1. INTRODUCTION

Why do we need to know the sky conditions? When operating autonomously we need to ensure that we do not proceed with observing if the target is obscured by heavy cloud.

Traditional cloud sensors provide a single value for the cloudiness of the sky. They are subject to degradation over time, eventually returning erroneous values.

We would like a more reliable solution that reports how much cloud there is in each part of the sky.

Our method compares recent all-sky images with what would be expected in cloudless conditions, obtaining values for the cloudiness of each sky sector.

2. METHOD

2.1. *Using the zero-point magnitude*

We make use of the zero-point magnitude, considering that the zero-point magnitude is the magnitude of a star that would result in one count per second measured by the detector for a given system so it is direct measurement of the efficiency (or throughput) of a system.

In other words for a higher throughput system (e.g. a larger aperture, fewer lossy optics, or a more sensitive detector) the zero-point magnitude will be a larger value.

If the throughput of the system remains constant the next biggest contributor to a change in the counts per second measured by the detector would be losses through the atmosphere (e.g thin clouds).

2.2. *Determining the reference zero-point*

We use all-sky images and zero-point magnitudes provided by the all-sky camera of the Asteroid Terrestrial-impact Last Alert System (ATLAS)[3] at our Sutherland site.

ATLAS does full astrometric and photometric calibration of each night-time image.

We first determined a "reference" zero-point map of the sky taking all archival zero-point data where the sky was clear and the seeing was recorded to be below 1.2 arcseconds (the median seeing at Sutherland is about 1.5 arcseconds).

We then divide the sky into segments and obtain a reference zero-point value for each segment.

2.3. *Mapping the cloud cover*

From the calibrated all-sky image we can obtain a live zero-point map. We then compare this live zero-point map to the reference map.

If no live zero-point data is available in a segment (e.g no stars detected) or the difference between live and reference values is above 0.5 we flag that segment as "bad". If not, the segment is flagged as "good".

This leads to a table of good/bad values, describing the current state of each sky segment.

If more than a predetermined number of segments is bad, we abort ongoing observations and close the dome until conditions improve.

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[3]`https://atlas.fallingstar.com/`

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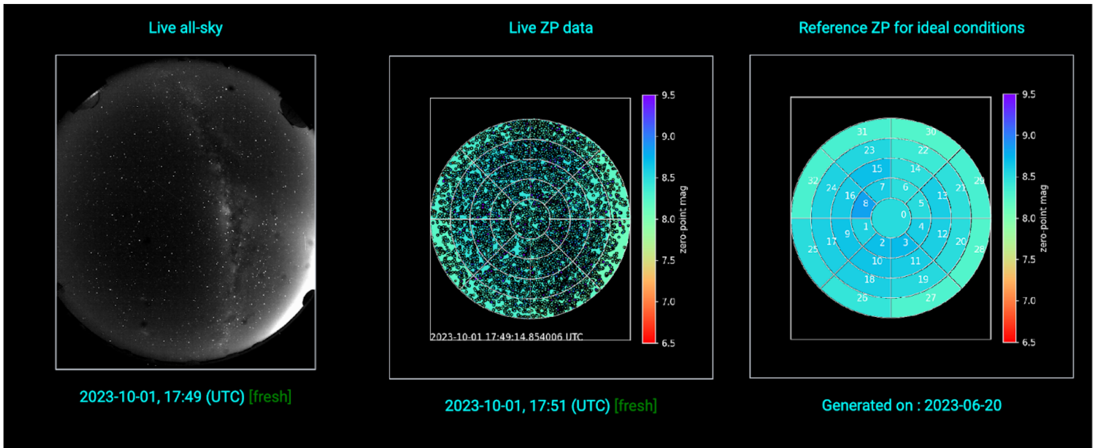
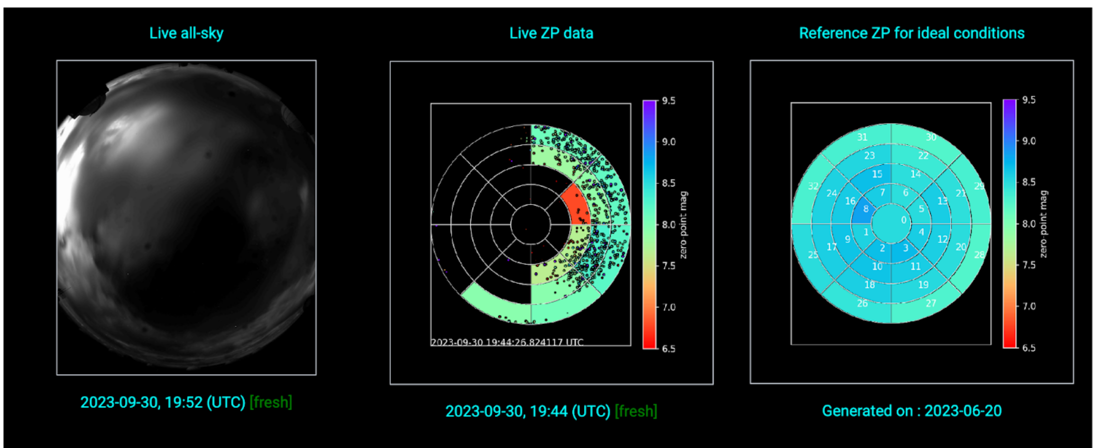


Segment No:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Ref ZP:	8.49	8.54	8.56	8.51	8.5	8.49	8.5	8.52	8.54	8.57	8.58	8.51	8.52	8.5	8.51	8.51	8.56
Difference:	0.13	0.1	0.12	0.17	-0.01	0.05	0.1	0.06	0.17	0.12	0.16	0.12	0.03	0.12	0.04	0.02	0.12
Flag: [fresh]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Segment No:	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Ref ZP:	8.54	8.56	8.47	8.43	8.44	8.43	8.46	8.49	8.36	8.41	8.3	8.22	8.25	8.28	8.27	8.29
Difference:	0.1	0.15	0.1	0.07	0.11	-0.06	-0.03	0.04	0.15	0.12	0.1	0.12	0.05	0.01	-0.05	-0.0
Flag: [fresh]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig. 1. Example of GOOD sky-conditions.



Segment No:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Ref ZP:	8.49	8.54	8.56	8.51	8.5	8.49	8.5	8.52	8.54	8.57	8.58	8.51	8.52	8.5	8.51	8.51	8.56
Difference:	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	0.86	0.85	1.71	nan	nan	nan
Flag: [fresh]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Segment No:	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Ref ZP:	8.54	8.56	8.47	8.43	8.44	8.43	8.46	8.49	8.36	8.41	8.3	8.22	8.25	8.28	8.27	8.29
Difference:	nan	nan	0.53	0.14	0.55	0.63	nan	nan	nan	0.48	0.23	0.01	0.08	0.17	nan	nan
Flag: [fresh]	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	1

Fig. 2. Example of BAD sky-conditions.

3. CONCLUSIONS AND FUTURE WORK

We show our zero-point method of determining cloud cover, by comparing recent all-sky images with what would be expected in cloudless conditions, obtaining values for the cloudiness of each sky sector.

Currently we use the zero-point data to make a simple do/dont observe decision. However, data is available for each segment of the sky. We could refine this to decide which part of the sky is clear enough for observing, and constrain the system to accept only observation requests for this part of the sky.