SkyProbe

Monitoring the absolute atmospheric transmission in the optical (to optimize science operations)

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Five years of MegaCam observing statistics

CFHT’s MegaPrime Observing Statistics
Starting June 2003, with 6 to 7 runs per semester since (m01->m06/7)
"A" semesters = February to July / "B" semesters = August to January
The night length varies from 8.7 hr (June) to 11.2 hr (December)

Mauna Kea: 25% of the night time is lost to weather
Fraction of MegaCam data gathered in photometric conditions

CFHT’s MegaPrime - Fraction of photometric exposures
Starting Jan. 2003, with 6 to 7 runs per semester since (m01->m06/7)
"A" semesters = February to July / "B" semesters = August to January

25% of observed time is affected by cirrus: 68 nights per year
All in all, Mauna Kea offers ~200 "clear" nights per year
CFHTLS (Legacy Survey): a 500 nights program from 2003 to 2008

<table>
<thead>
<tr>
<th>Survey</th>
<th>Area (sq. deg.)</th>
<th>Location</th>
<th>$u^*$</th>
<th>$g'$</th>
<th>$r'$</th>
<th>$i'$</th>
<th>$z'$</th>
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</thead>
<tbody>
<tr>
<td>SNLS</td>
<td>4</td>
<td>D1/2/3/4</td>
<td>28.7</td>
<td>28.9</td>
<td>28.5</td>
<td>28.4</td>
<td>27.0</td>
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<tr>
<td>Wide</td>
<td>170</td>
<td>W1/2/3/4</td>
<td>26.4</td>
<td>26.6</td>
<td>25.9</td>
<td>25.5</td>
<td>24.8</td>
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<tr>
<td>Very Wide</td>
<td>410</td>
<td>On ecliptic</td>
<td>25.5</td>
<td>25.0</td>
<td>24.4</td>
<td></td>
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Cuillandre et al., SPIE 4844, p.501, 2002

Developed as a full-time observatory facility

Calibration & Standardization of large Surveys - 2012 Fermilab
SkyProbe field of view and 30 sec. exposure depth

MegaCam footprint
18000x18000 pixels
1 sq. degree
0.19 arcsec per pixel

7x5 sq. degrees for a 765x510 CCD -- 35 arcsec. per pixel!
Uses a Nikon 50mm lens (f/1.8)
Reaches V=12 mag. in 30 seconds

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SkyProbe in a nutshell

Limitations of standard approaches:

- All-sky IR (10um) cameras provide only a low resolution (but important) map of the cloud distribution
- Satellite imagery can only be used as a warning tool

SkyProbe specifications:

- Low cost (<$3K for hardware) & very high reliability
- Provides an absolute zero point in the V band
- Stable response, few percents photometry accuracy
- Field of view encompassing the telescope science field
- Frequent measurements (every minute)
- Maintenance free system over 10 yrs (~1.5 million exposures)

Key developments:

- Low-cost reliable CCD cameras from the amateur astronomy
- Full sky precision photometry catalog: Tycho2 from Hipparcos
- Elixir: CFHT’s optical imaging data pipeline (12K, MegaCam)
Photometry challenges

Mag-Mag diagram: scatter
  - sampling
  - de-focusing

CCD design:
  - transparent gate
  - sub-pixel response
User’s interface

Standalone mode (www) & CFHT Service Observing weather central

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MegaCam g’ zero points from CFHTLS Deep/SNLS fields
Sets of 5 exposures taken over 30mn on different nights
Red circled sequence: ref, -0.001, -0.008, -0.005, -0.001 mag.
Extinction from particulates varies above Mauna Kea from 1 to 2% on timescale of minutes, pure clear sky is very rare!
Interfacing with the infrared all-sky camera (ASIVA)

Photometric SkyProbe pointing

Sky Region

SkyProbe FOV

Sky Region

Current Conditions

Thick Clouds

Cirrus

Attenuation Baseline

Radiance Baseline

Diff Stdev=21.84

Radiance:0.034451

The spectral radiance is calculated per mid IR image with calibration data. Per pixel, and area means, a value < 0.1 can imply photometric conditions, up to 0.3 can imply cirrus conditions, and a value near 1.0 is very thick opaque clouds.

From a three minute bin of data, the standard deviation of the subtraction of the first mid IR image from the last is a factor that can be used for photometric determination. Values < 26.0 can imply photometric conditions. For SkyProbe FOV, we use a 50x50 pixel window.
Interfacing with the infrared all-sky camera (ASIVA)

nonPhotometric SkyProbe pointing

Sky Region

SkyProbe FOV

Current Conditions

Thick Clouds

Mid IR 9.5μ-12.5μ Filter (1s) (SkyIRVIS)

Radiance Baseline

Attenuation Baseline

Diff Stdev Baseline

From a three minute bin of data, the standard deviation of the subtraction of the first mid IR image from the last is a factor that can be used for photometric determination. Values < 26.0 can imply photometric conditions. For SkyProbe FOV, we use a 50x50 pixel window.

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CFHT’s CloudCam: a nighttime color webcam

Awesome Canon technology!

Sturdy housing

CMOS imaging (IR blocking filter removed)
Image shows airglow (strong I-band contribution)
An upcoming dual-channel system: SkyProbeBV

SkyProbeBV & SkyProbe at CFHT SkyProbeBV filters bandwidth

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