Status of Astronomy on Ellesmere Island

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National Research Council Canada

SCAR Astronomy and Astrophysics from Antarctica Third Workshop
Kilauea, Hawai'i

7-10 August 2015

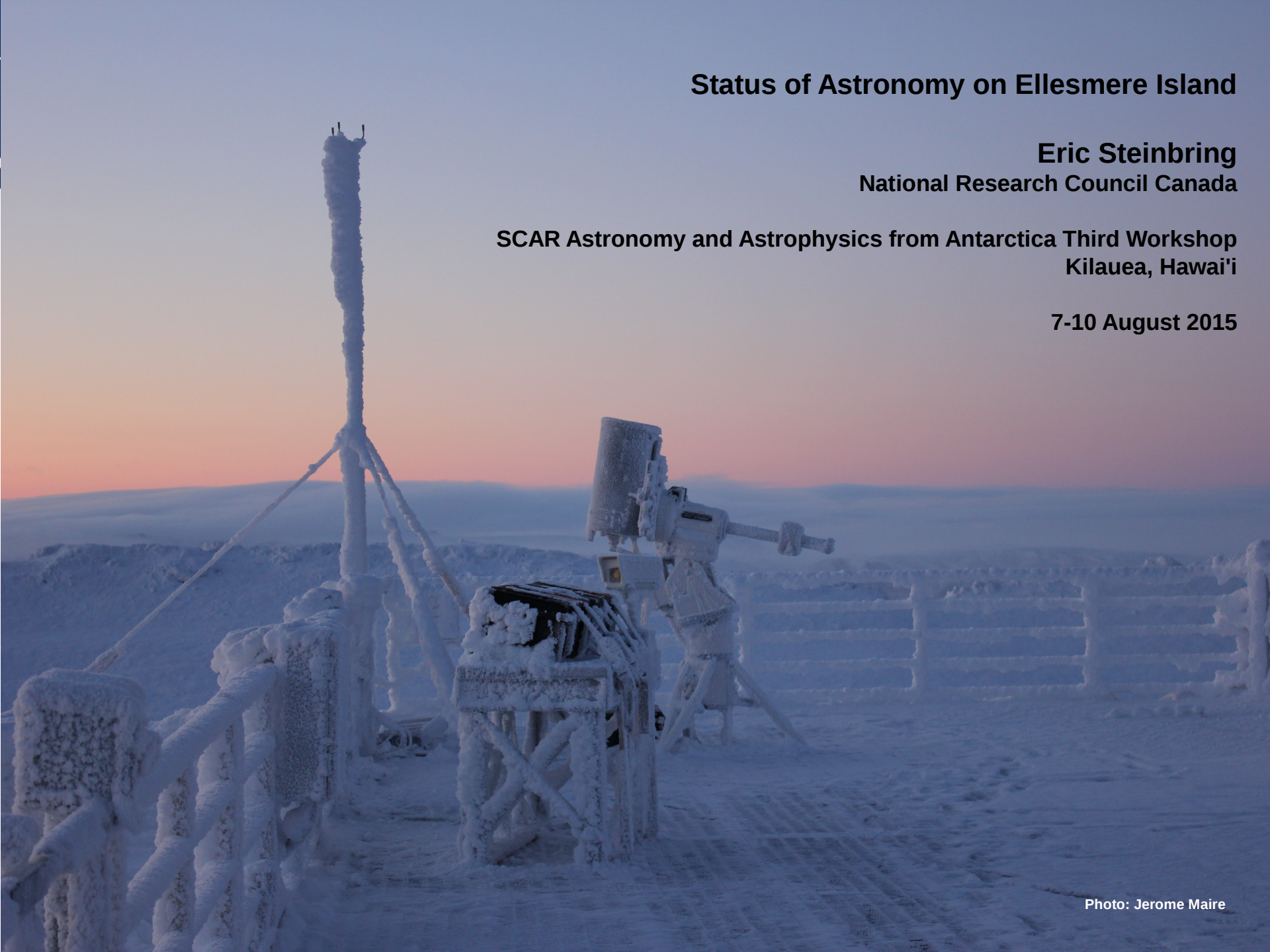


Photo: Jerome Maire

Composite images from Earthcam

Eureka

Summit

Dome C

Dome A

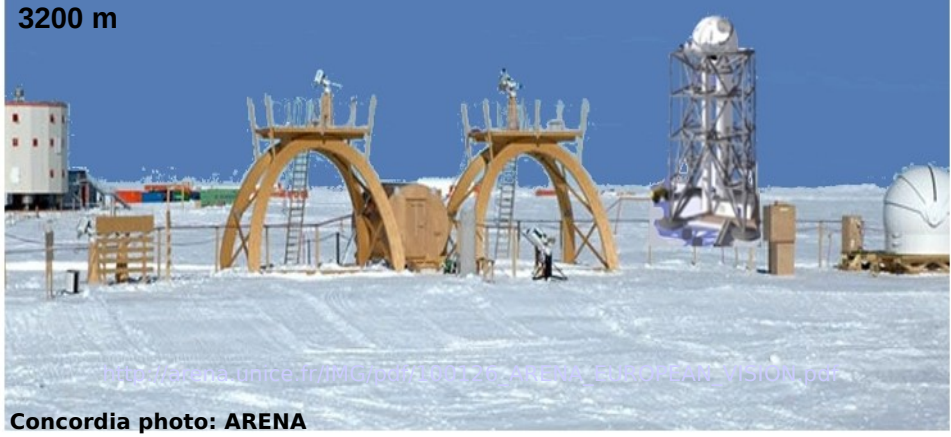
South Pole

Dome F

Eureka, 80N, Ellesmere Island, Canada
Polar Environment Atmospheric Research Laboratory (PEARL)
600 m

PEARL photo: CANDAC

Dome C, 76S, Antarctica
Concordia Station
3200 m



Concordia photo: ARENA

Clarity

Usable sky (V<2 mag): 86%
Clear sky (V<0.5 mag): 68%
Photometric sky: 48%
[MK: 80%, 70%, 50%][1]
Steinbring et al., 2012, PASP, 124, 185

Opacity

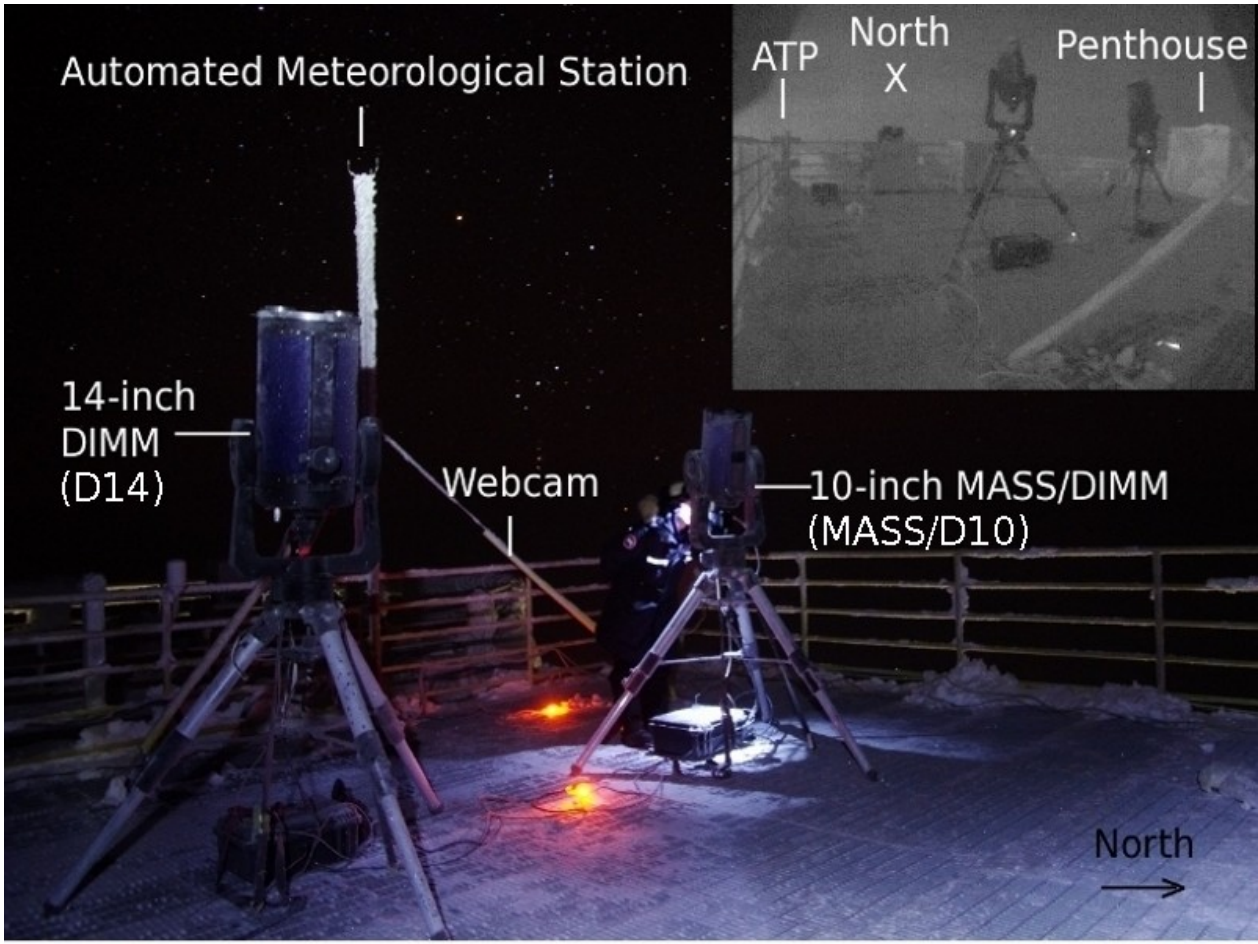
Median tau (225 GHz): 0.14
Modal tau (225 GHz): 0.09
[ALMA: 0.08, South Pole: 0.06][2]
Matsushita et al., 2013, IAU, 124, 185, 204
Asada et al., 2012, SPIE, 8444, 1

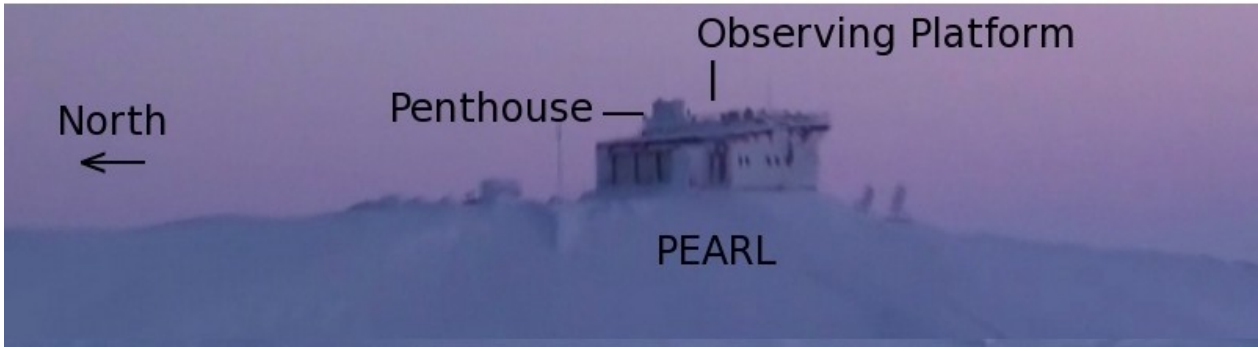
Brightness

Grey (V): 19.7 mag/sq-arcsec
[MK: 19.5, Dome C: 19.8][3]
Dark (V): 20.7 mag/sq-arcsec
Infrared (J): 15.8 mag/sq-arcsec
Steinbring et al., 2012, PASP, 124, 185
Sivanandam et al., 2012, SPIE, 8446, 43

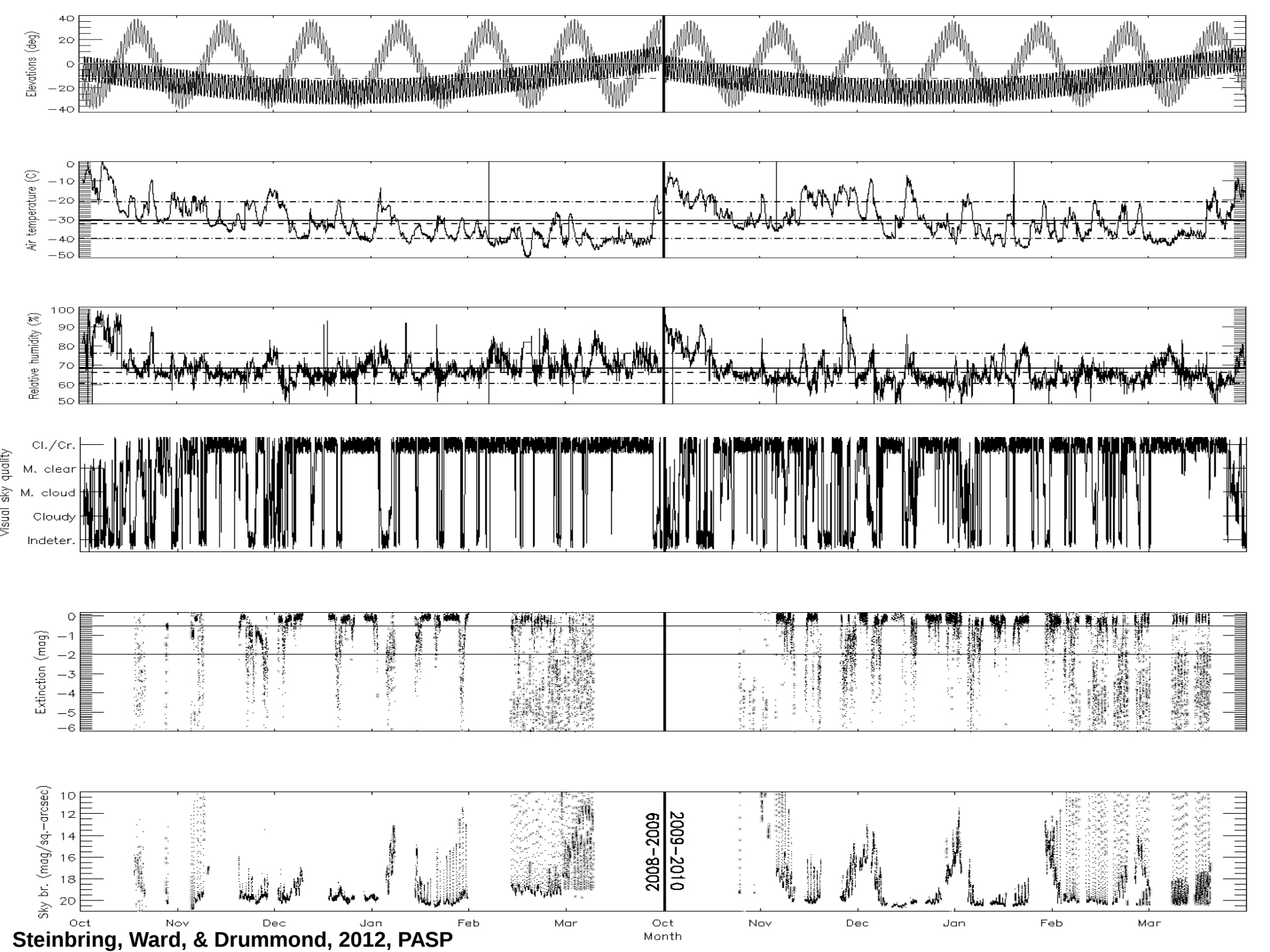
Seeing

Median total (V): 0.76 arcsec
Median free (V): 0.50 arcsec
[MK: 0.75, 0.33; CTIO: 0.79, 0.50]
Modal free (V): 0.23 arcsec
Steinbring et al., 2013, PASP, 125, 866
Hickson et al., 2013, MNRAS, 433, 307
Hickson et al., 2010, SPIE, 7733, 53





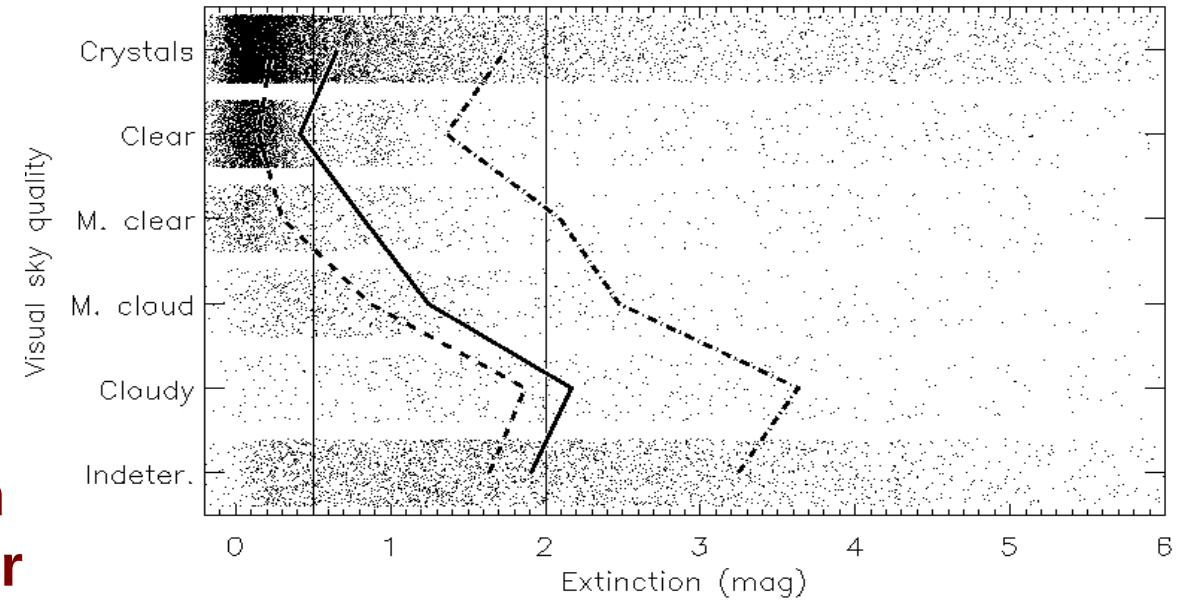
1: Gemini usable, clear, and photometric fractions, 2: Yearly means, 3: Median of 12 degree twilight

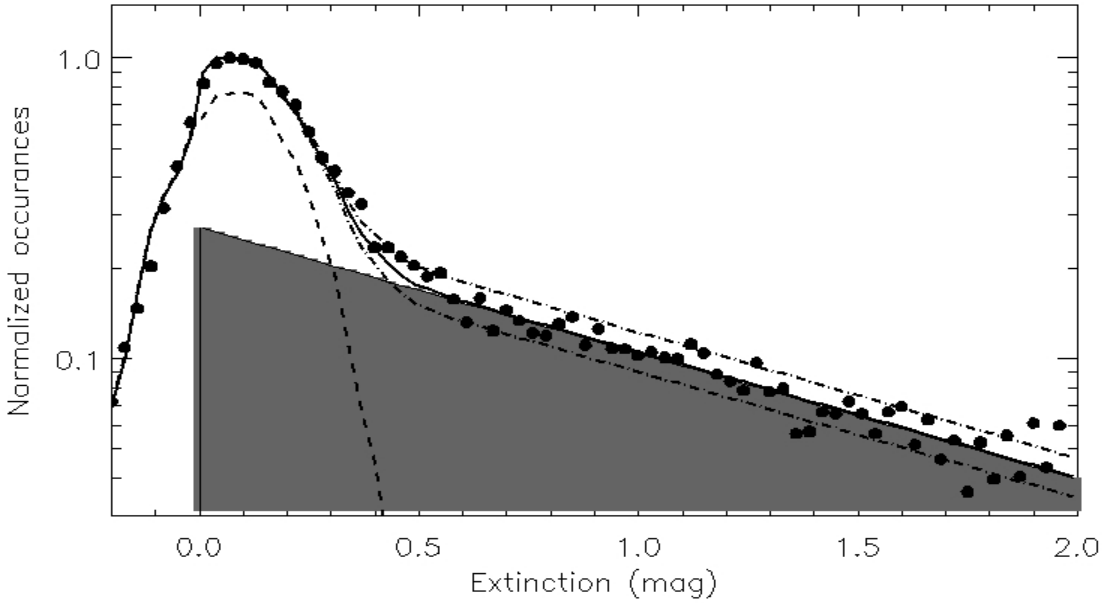


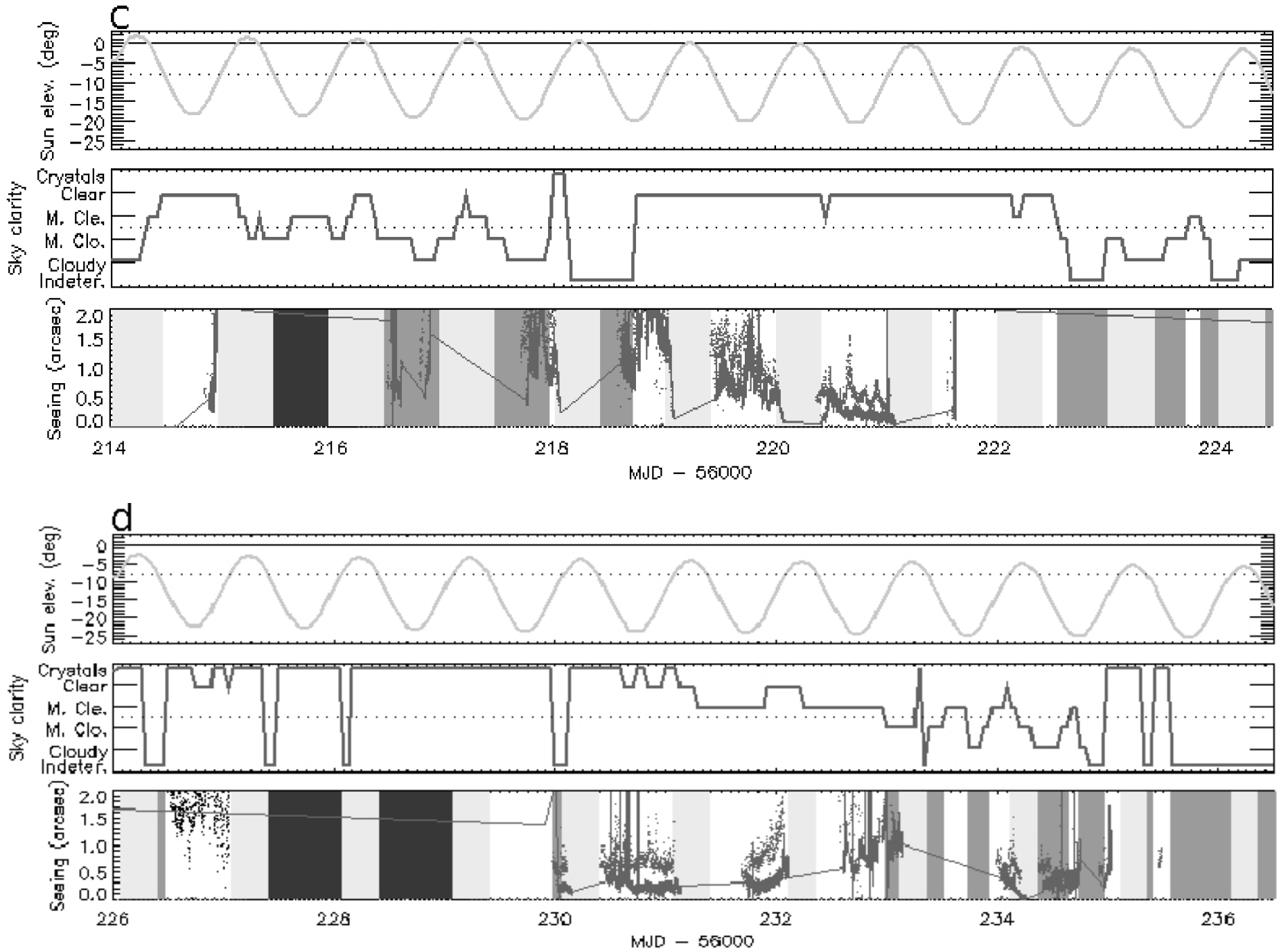
Steinbring, Ward, & Drummond, 2012, PASP

PASI All-Sky Imager shows PEARL sky usable 84% of time, clear 68% of time, can be continuously so for 100 hours or more; truly photometric 48% of time, and better from higher terrain

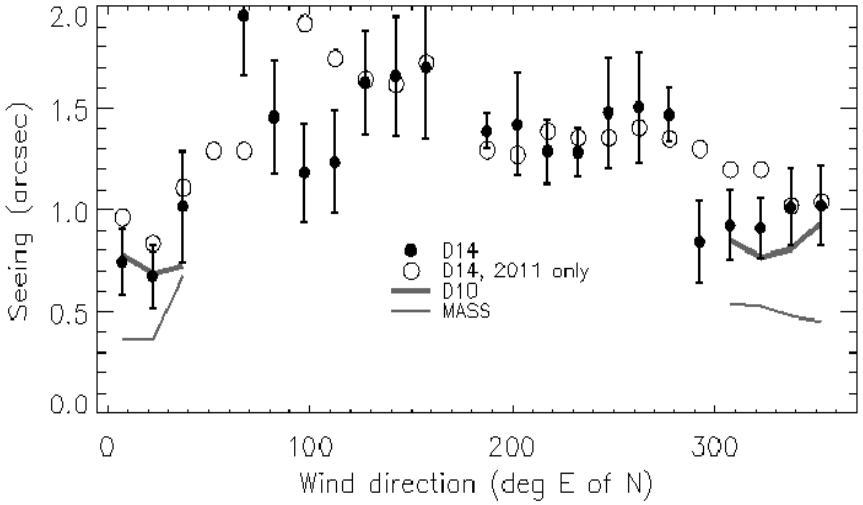
Steinbring, Ward, & Drummond, 2012, PASP

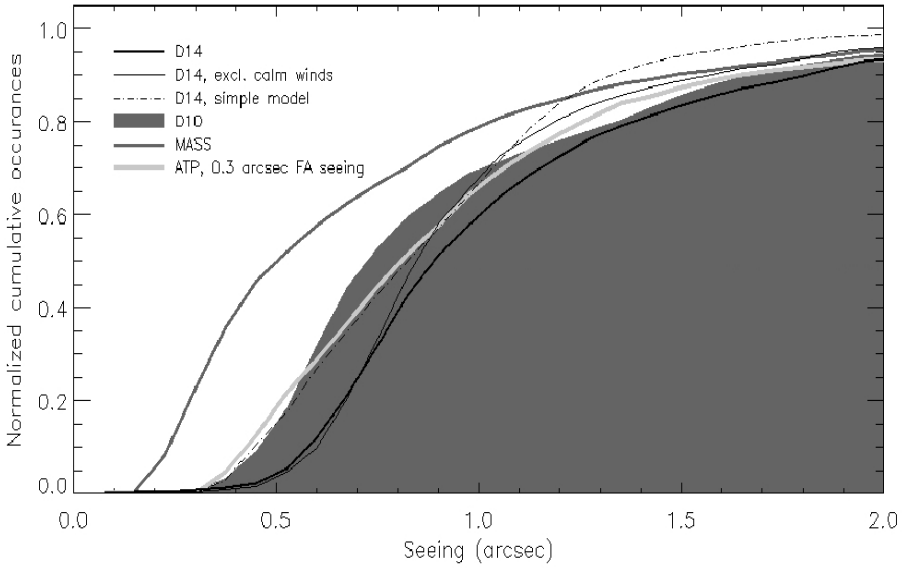


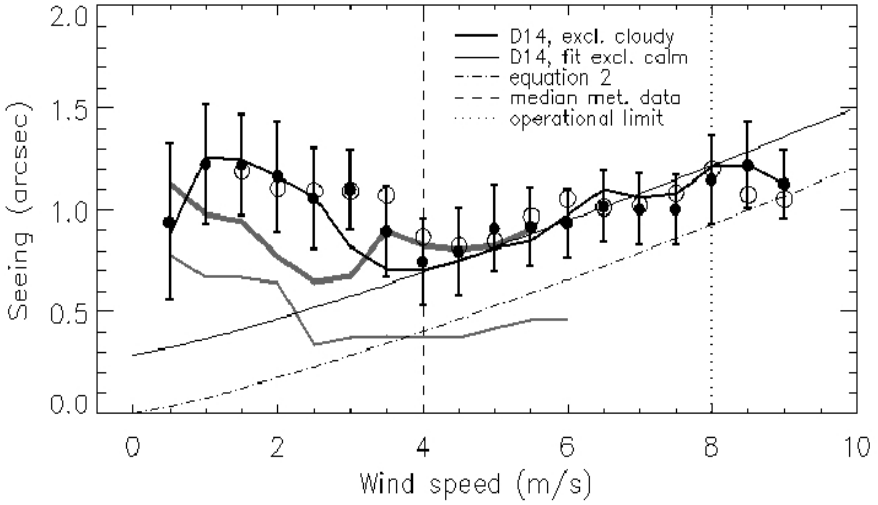




Steinbring et al., 2013, PASP







MASS/DIMM V-band seeing is 0.76 arcsec or better at 8-m elevation; best 20 percentile 0.54 arcsec with typically 0.30 arcsec from free atmosphere - in agreement with ATP profiles

Steinbring et al., 2013, PASP

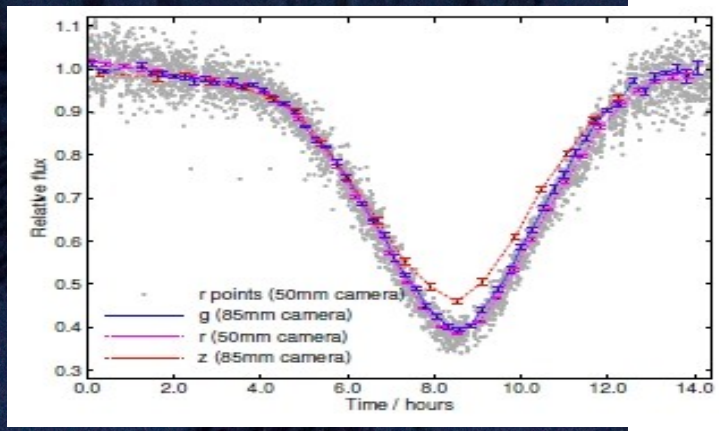
Arctic Wide-Field Cameras (AWCams)

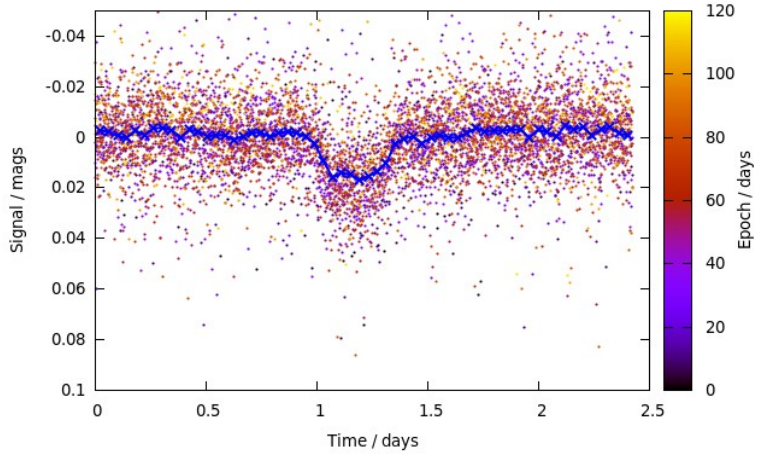
TABLE 1
THE SPECIFICATIONS OF THE AWCAM SYSTEMS

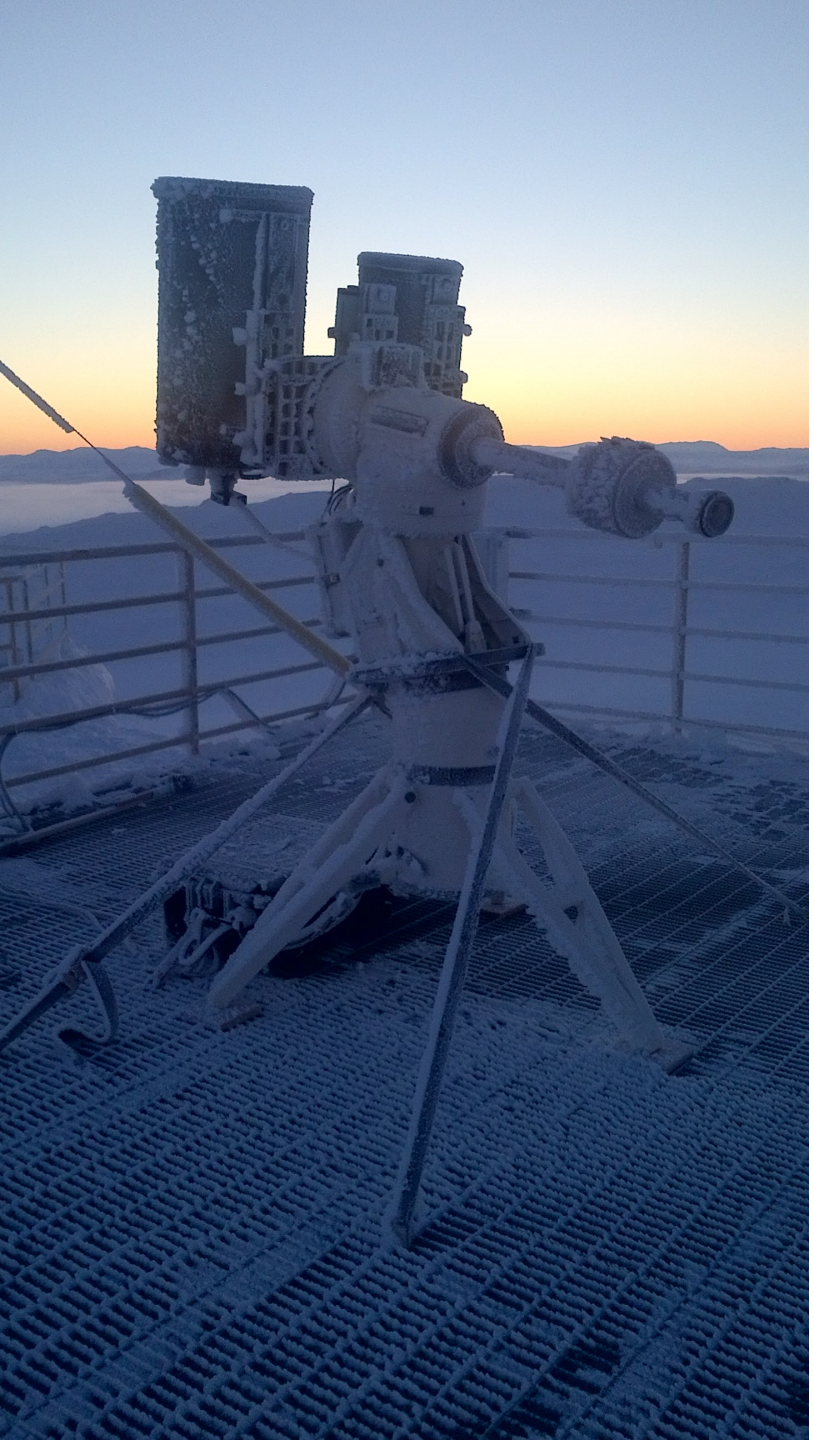
Survey characteristics	
Pointing	North Celestial Pole
Survey dates	14 February 2012 – 21 February 2012
Survey length (total)	152 hours
Survey length (dark and clear)	98 hours
Data collected	44,583 images (1.36 TB)
CCD Hardware	
CCD	4096^2 front-illuminated (KAF-16803)
Peak CCD Quantum Efficiency	59%
Pixel size	9μm
Readout time	4 seconds
85mm camera	
Camera lens	Canon EF 85mm f/1.2L II USM
Field dimensions	25.4 × 25.4 degrees
Continuous-coverage field	504 square degrees
Pixel scale	22.3"/pixel
Image quality	2-5 pixel FWHM over entire field
Filters	Clear, g, r, i, z
50mm camera	
Camera lens	Canon EC 50mm f/1.2L USM
Field dimensions	40.8 × 40.8 degrees
Continuous-coverage field	1295 square degrees
Pixel scale	35.9"/pixel
Image quality	2-5 pixel FWHM over entire field
Filters	Clear, g, r, i, z

Millimag photometry demonstrated over clear periods lasting days, over complete dark periods

Law et al., 2014, SPIE, 91450
Law et al., 2013, AJ, 145, 58
Law et al., 2012, SPIE, 8444, 5







Autonomous Site-Testing Telescope (Ukaliq)

- Meade RC f/8 “sealed” OTAs with corrector plates
- Custom aluminum tripod for 80 deg latitude
- Sturdy mounting to rooftop reduces vibration
- Astro-Physics 3600 GTO Arctic-hardened mount
- Mechanical limit switches replaced with proximity
- Dedicated swappable guiding telescope
- All off-the-shelf cameras: SBIG and Moravian
- No enclosure; defrosting OTAs with “parking box”
- Up to two other mounting locations on mount
- Large, easy-to-release clamps
- Pre-focussed OTAs swappable back in cold
- All electronics in a single warmbox on roof
- Shutdown at 8 m/s wind, or from east or west

Adapting a seeing monitor for autonomous operation at PEARL has taught some lessons for future high-precision photometric studies

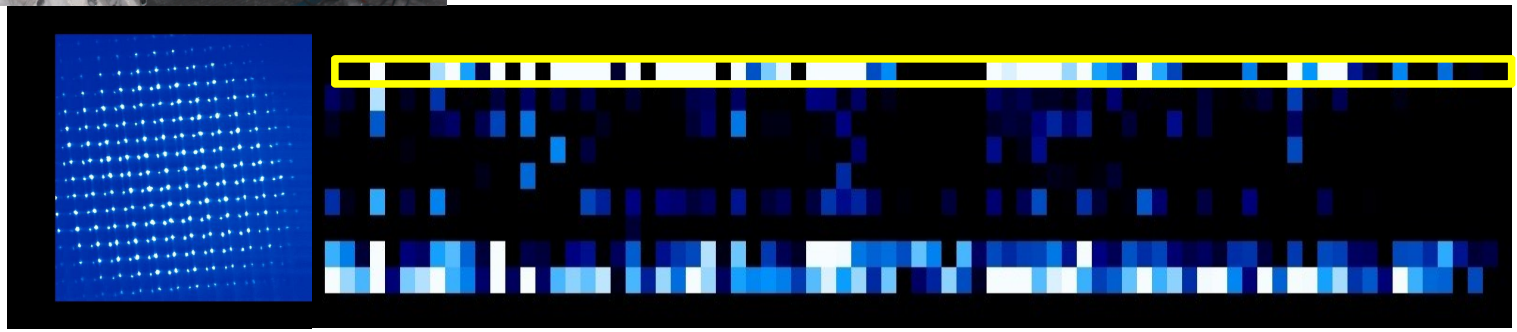
Steinbring et al., JPhCS, 595, 10234

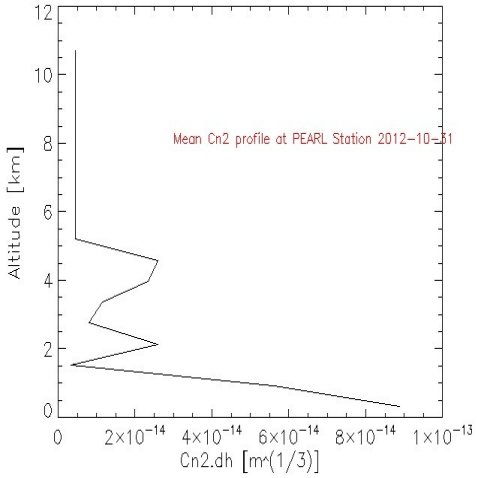
Photo: David R. Gray, Canadian Museum of Nature

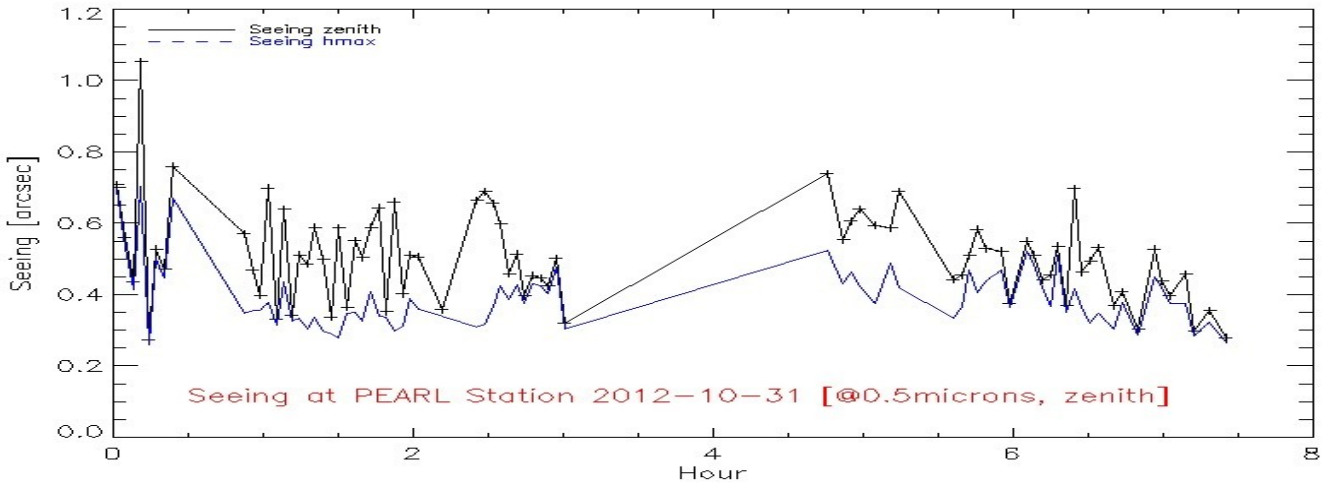
Slope Detection and Ranging (SLODAR)

Detection of discrete, low-altitude turbulent layers over a few nights observation

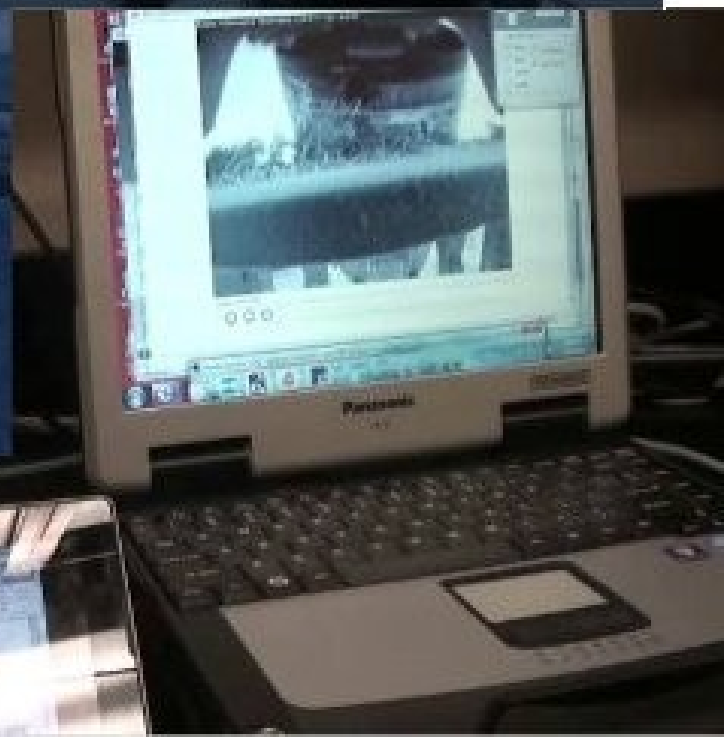
Maire et al., 2014, SPIE, 91453
Mieda et al., 2014, SPIE, 91453



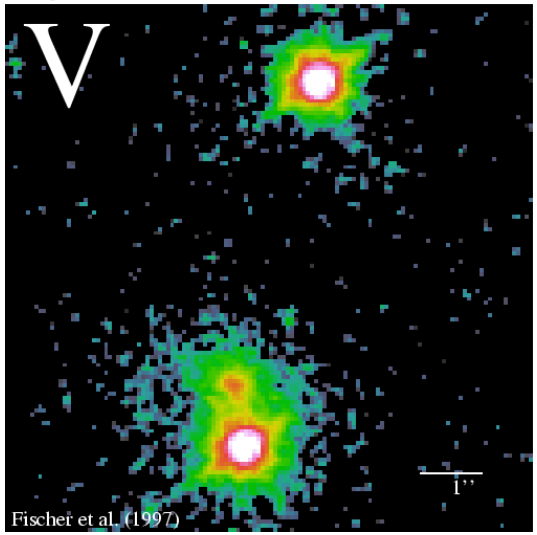


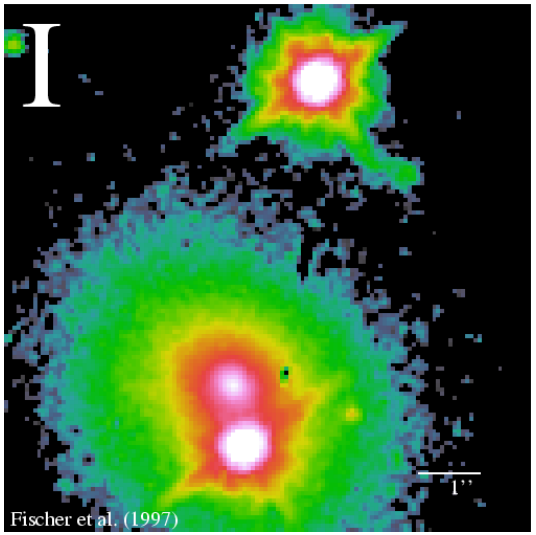


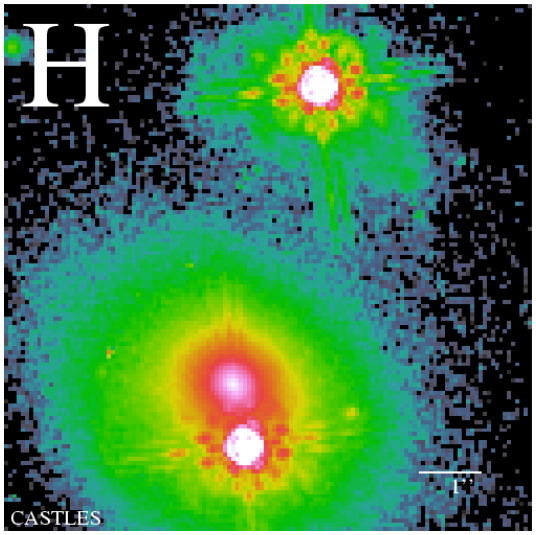
Ukaliq Warmbox and Parking Box

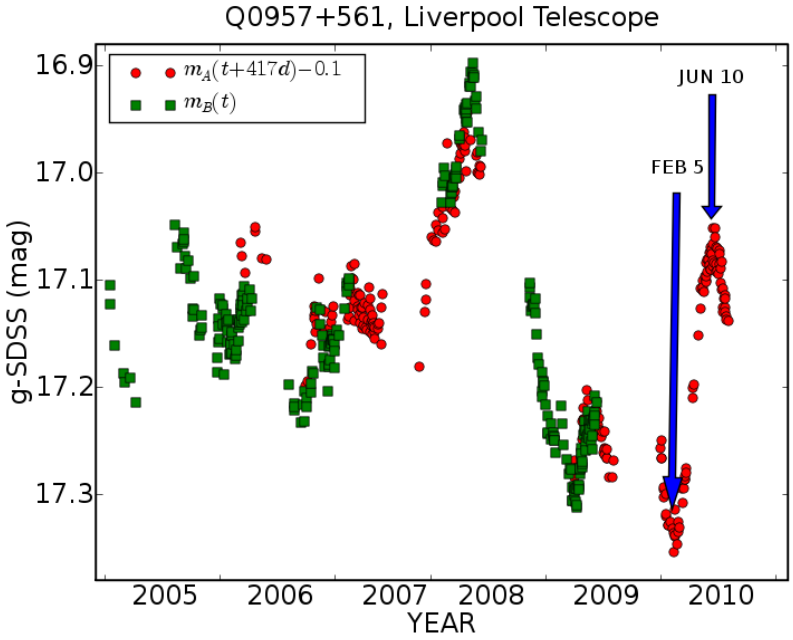


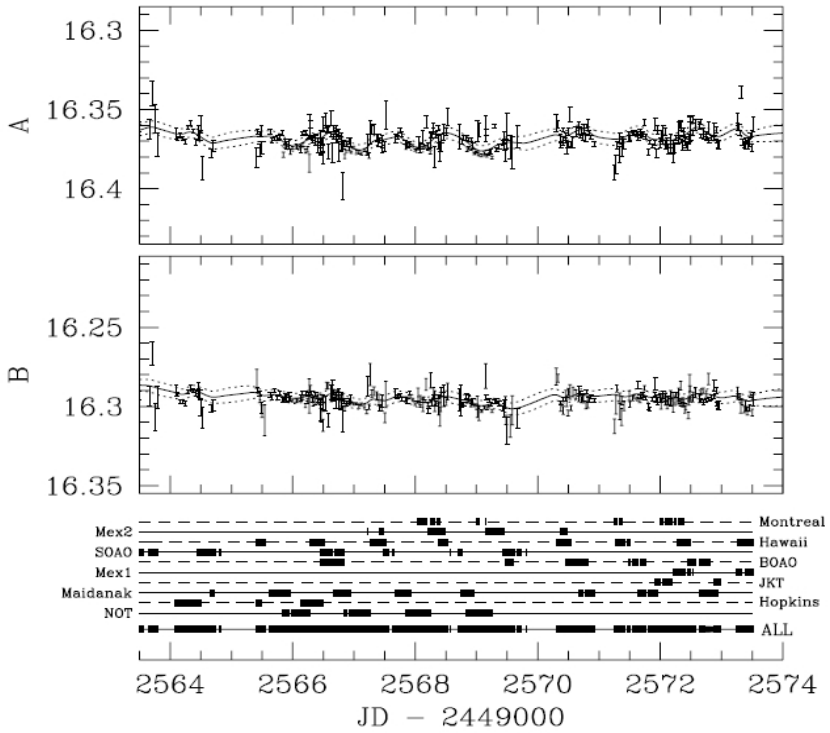
Q0957+561 A, B

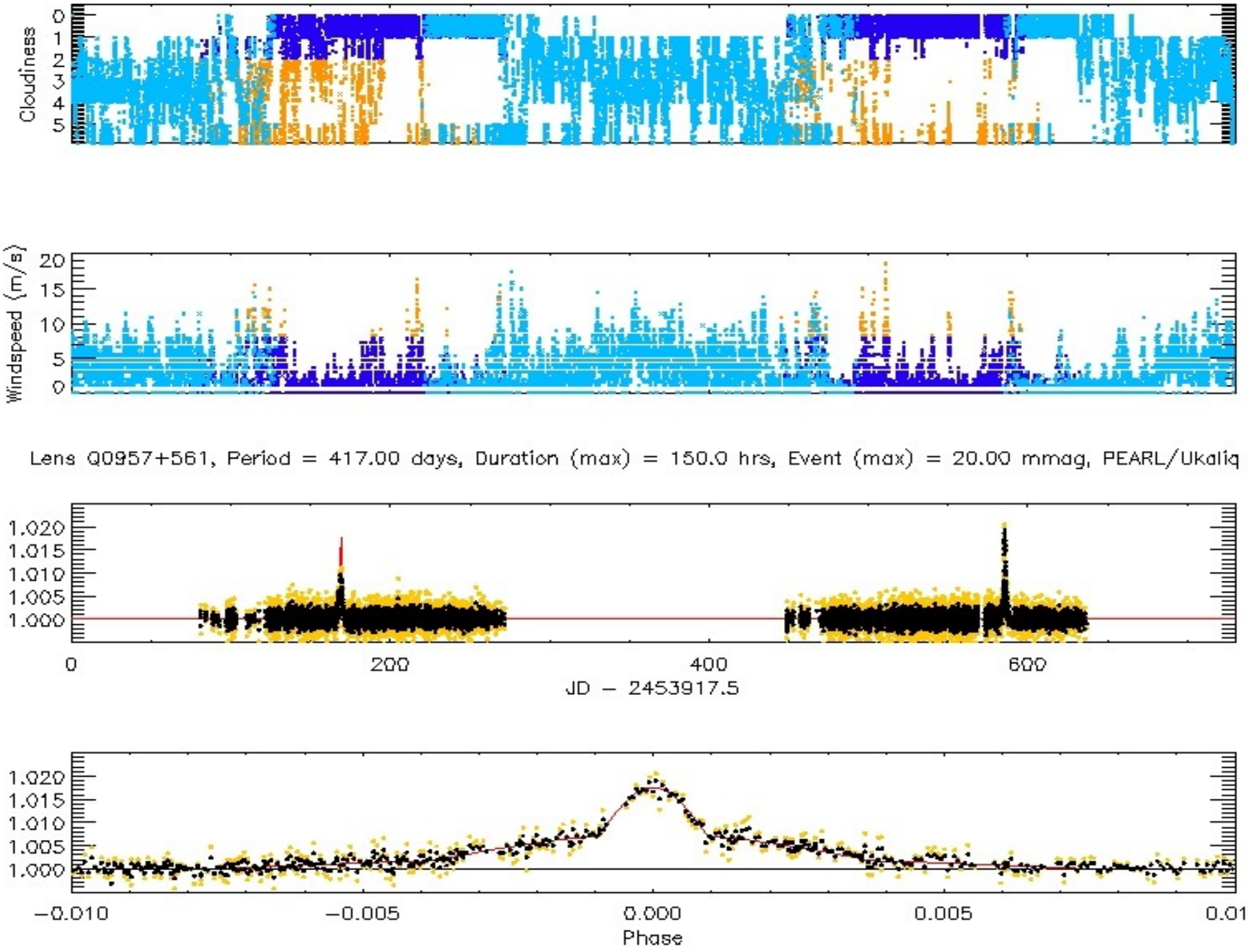

V
1''
Fischer et al. (1997)


I
1''
Fischer et al. (1997)


H
1''
CASTLES


Q0957+561, Liverpool Telescope
$m_A(t+417d)-0.1$
$m_B(t)$
JUN 10
FEB 5
g-SDSS (mag)
16.9
17.0
17.1
17.2
17.3
2005
2006
2007
2008
2009
2010
YEAR


A
16.3
16.35
16.4
B
16.25
16.3
16.35
Mex2
SOAO
Mex1
Maidanak
NOT
Montreal
Hawaii
BOAO
JKT
Hopkins
ALL
2564
2566
2568
2570
2572
2574
JD − 2449000


Cloudiness
0
1
2
3
4
5
Windspeed (m/s)
20
15
10
5
0
Lens Q0957+561, Period = 417.00 days, Duration (max) = 150.0 hrs, Event (max) = 20.00 mmag, PEARL/Ukaliq
Relative flux
1.020
1.015
1.010
1.005
1.000
0
200
400
600
JD − 2453917.5
Relative flux
1.020
1.015
1.010
1.005
1.000
−0.010
−0.005
0.000
0.005
0.010
Phase

- Readily duplicated unit-system clones
- Ship by sea, carried by pickup to summit
- Drive and electronics ship in its own warmbox
- Uses existing roof of PEARL “observatory”
- Setup by 2 or 3 people over 2 days
- Power is ~10W operating, ~110W max per unit
- Communication via PEARL ethernet
- Remote controlled; local shutdown by AWS
- Supports DIMM, MASS, SloDAR, etc.
- Could support up to 0.5 m aperture each
- Simple tip-tilt allows uniform sub-1” images
- Up to 6 clones practical on current rooftop
- If one fails, carry on with others; fix in the spring
- Total effective system aperture ~1 m

Photo: Emily McCullough/CANDAC