All-Sky Mid-Infrared Imagery

to Characterize Sky Conditions and Improve STELLA's Observational Performance

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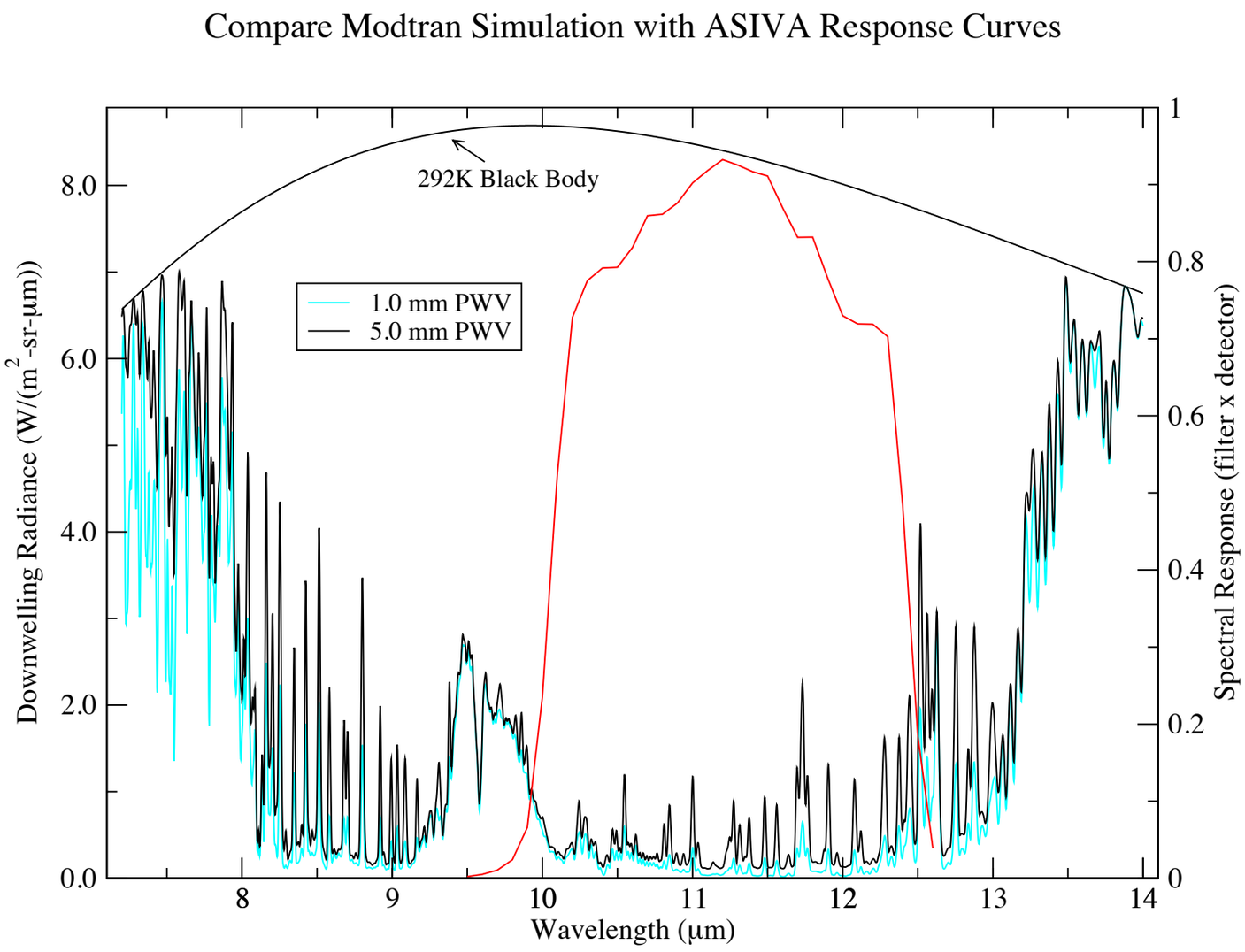
Location

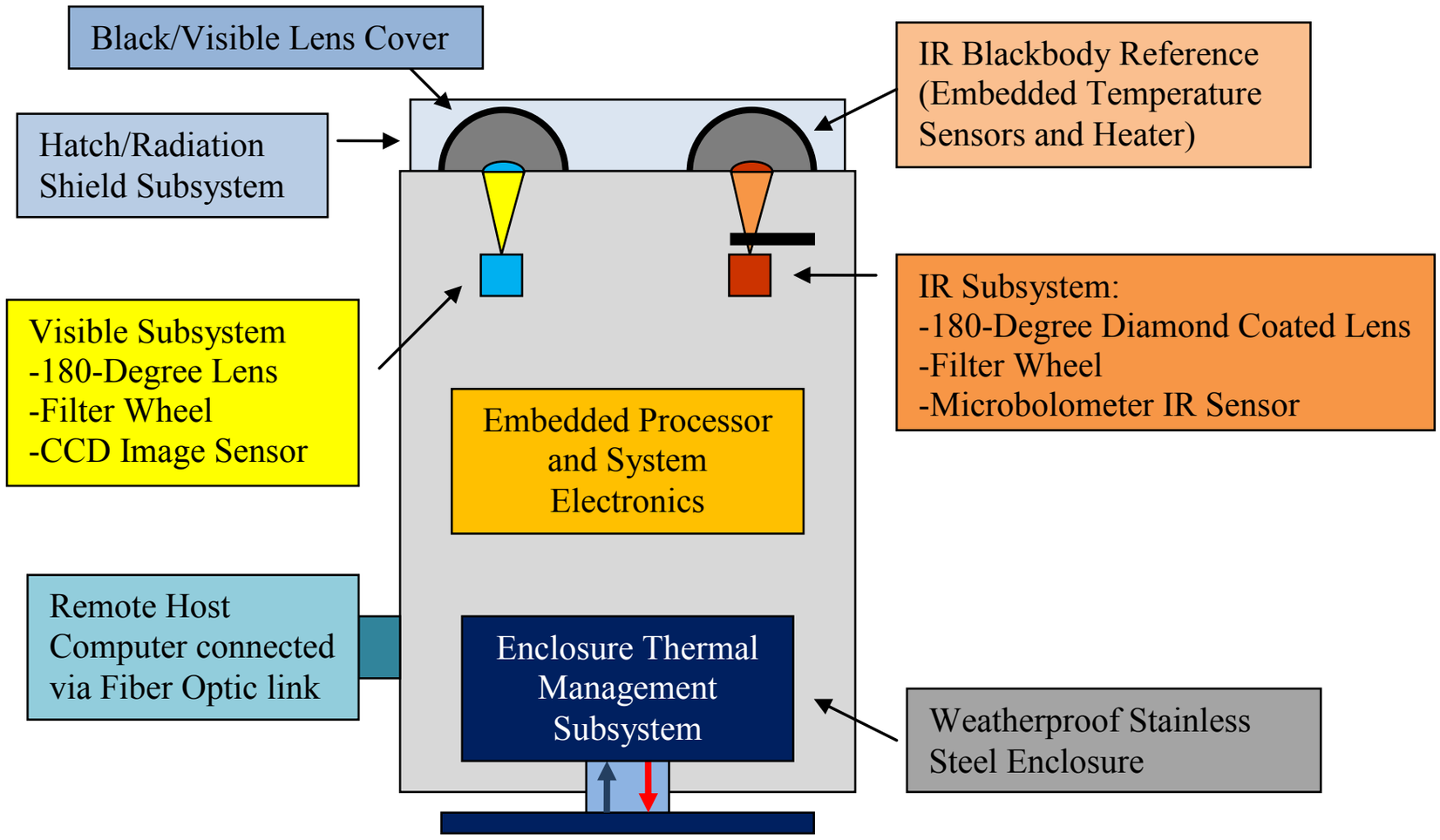
- All Sky Infrared Visible Analyzer (ASIVA)
- Part of STELLA at Teide observatory, Tenerife, 16°30′35” W 28°18′00”N, 2400m altitude
- Purpose is to provide cloud cover information for automatic scheduler

Introduction



- Using mid-IR to detect clouds does not suffer from moon or sun
- Window from 10.2 to 12.2μm least dominated by water vapor & Carbon dioxide
- use of a custom 10.2-12.2μm filter to increase the cloud contrast in radiometrically calibrated images

ASIVA


Black/Visible Lens Cover
Hatch/Radiation Shield Subsystem
IR Blackbody Reference (Embedded Temperature Sensors and Heater)
IR Subsystem:
-180-Degree Diamond Coated Lens
-Filter Wheel
-Microbolometer IR Sensor
Visible Subsystem
-180-Degree Lens
-Filter Wheel
-CCD Image Sensor
Embedded Processor and System Electronics
Remote Host Computer connected via Fiber Optic link
Enclosure Thermal Management Subsystem
Weatherproof Stainless Steel Enclosure

ASIVA data products

One set of observations every 5 minutes

- Each observation is a set of several (currently 8) images contained in one FITS data cube for each filter
- Pairs of IR observations are done:one on a black body reference with the hatch closed, one on sky with the hatch open
- Visual observations in all available filters are stored along the IR observations

Calibration sets

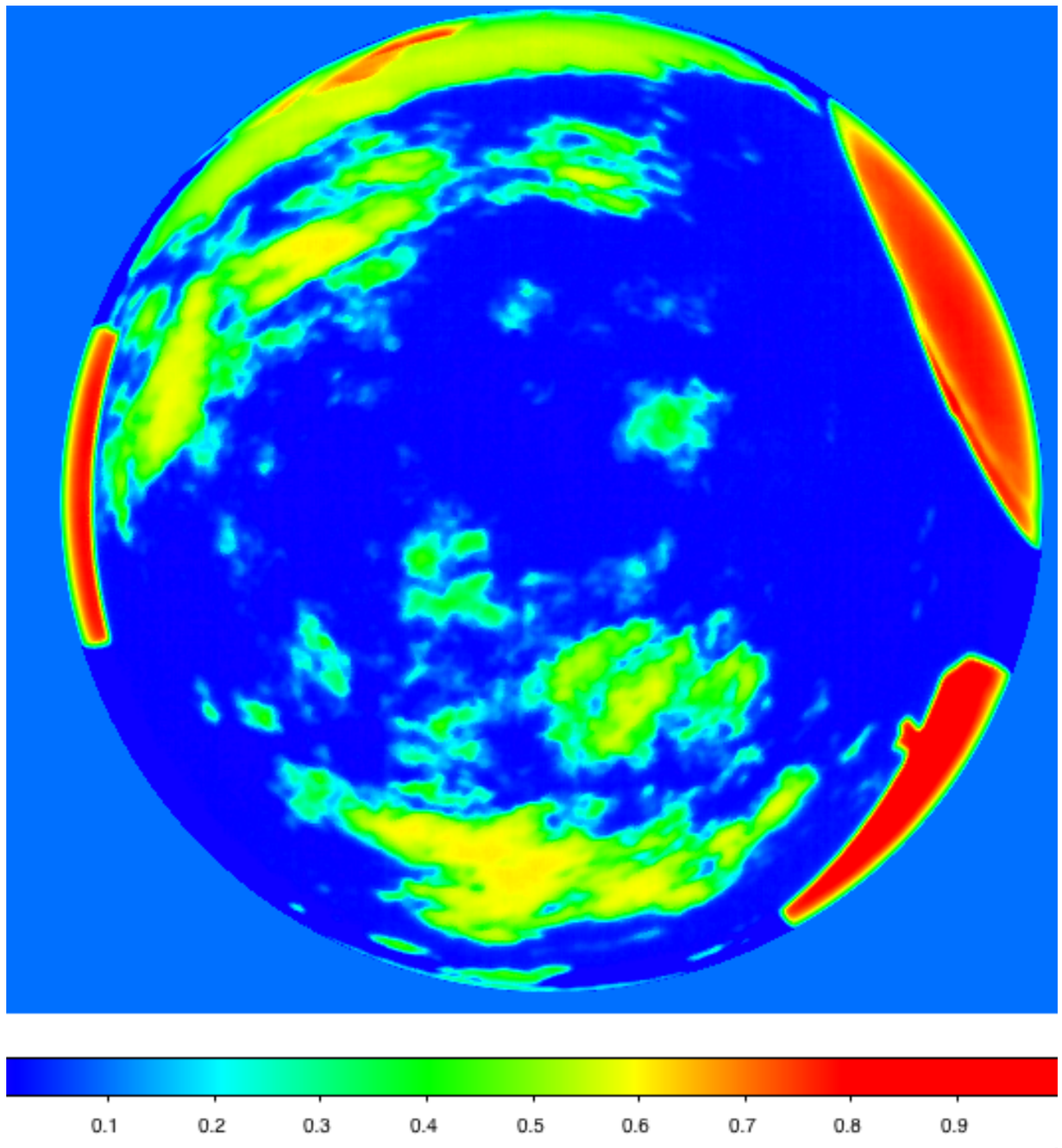
- The black body reference can be heated. One heats it up to the max possible temperature (depending on wind and outside temperature, approximately 70°C)
- Sets of observations with the hatch closed are done every 5 minutes
- From these images the response functions using each filter are determined

ASIVA data products

Derived products

- spectral radiance calibrated images (using the respective BB reference)
- temporal standard deviation - using the 8 individual observations
- spatial standard deviation - using difference of first and last image per cube, then doing the standard deviation
- from these three, a sky quality metric image (with pixel values from 0 to 1) is derived
- recently, the algorithm was extended to use a clear-sky subtracted radiance calibrated image. This makes the sky-quality measure more robust and will be implemented in a software update later this year.

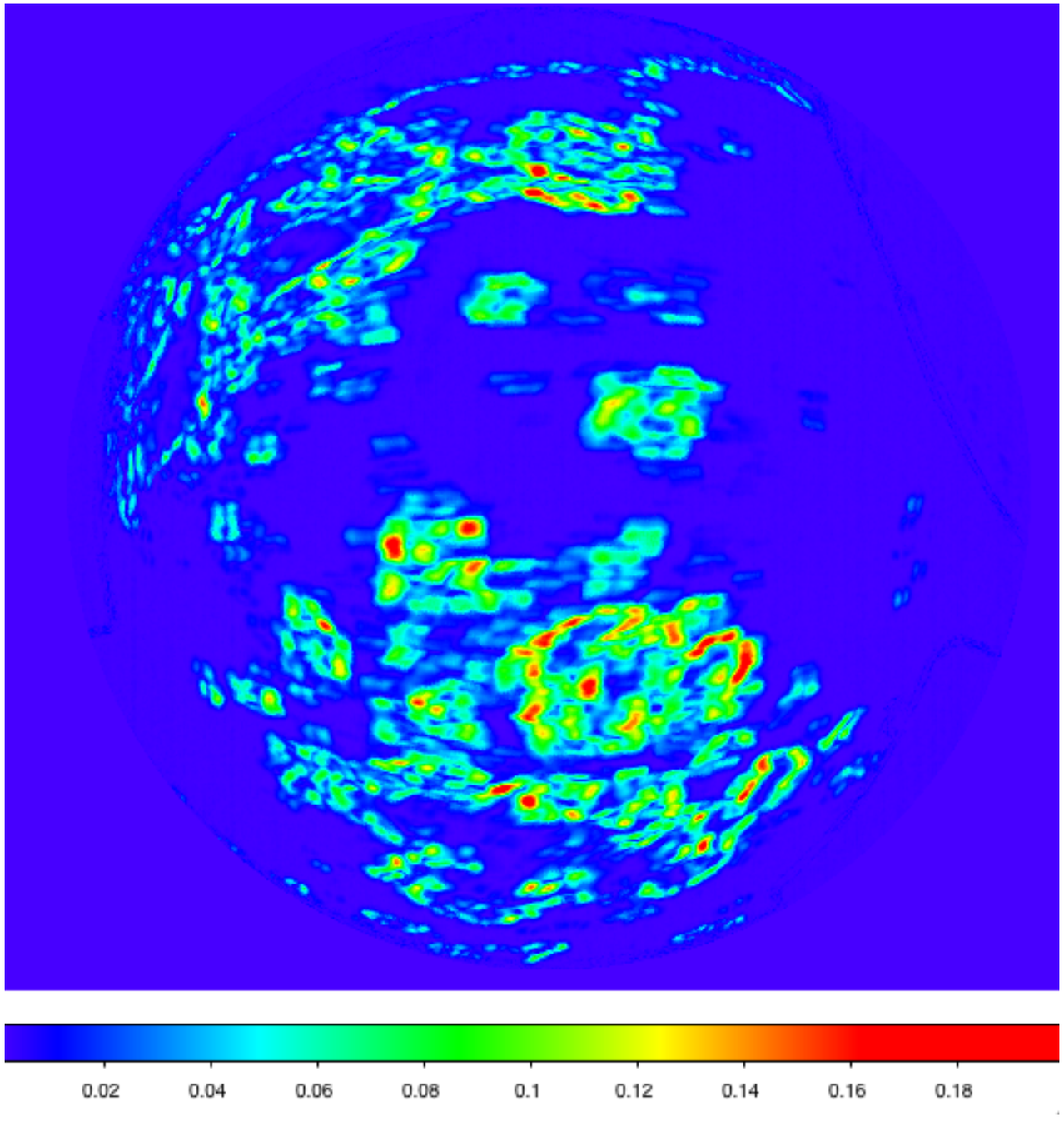
ASIVA data products



Example images from Klebe at al. 2012 taken with another ASIVA instrument in New Mexcio.

- clear-sky subtracted normalized radiance image
- Temporal standard deviation image
- Spatial standard deviation image
- combined sky quality image

ASIVA data products



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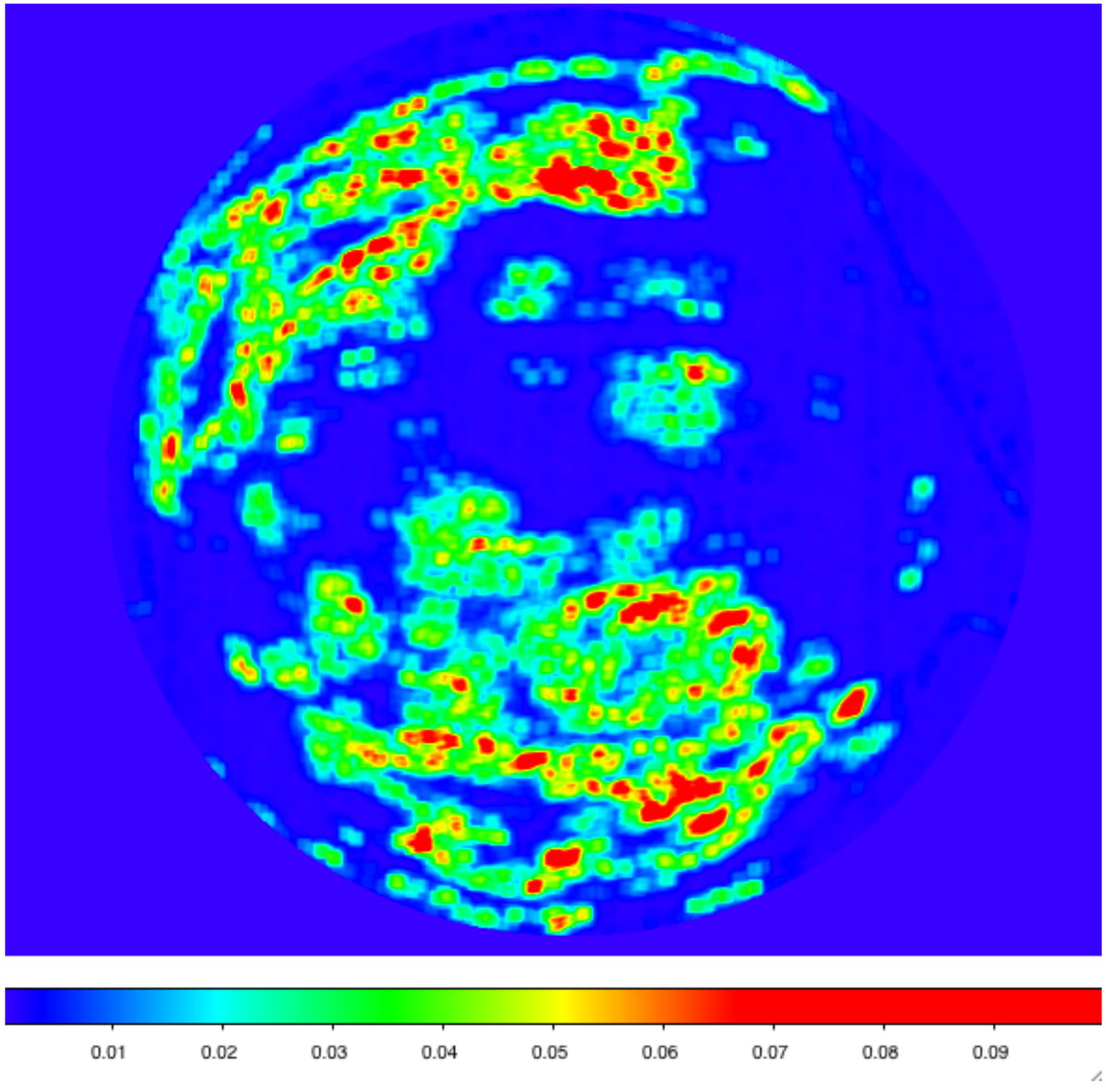

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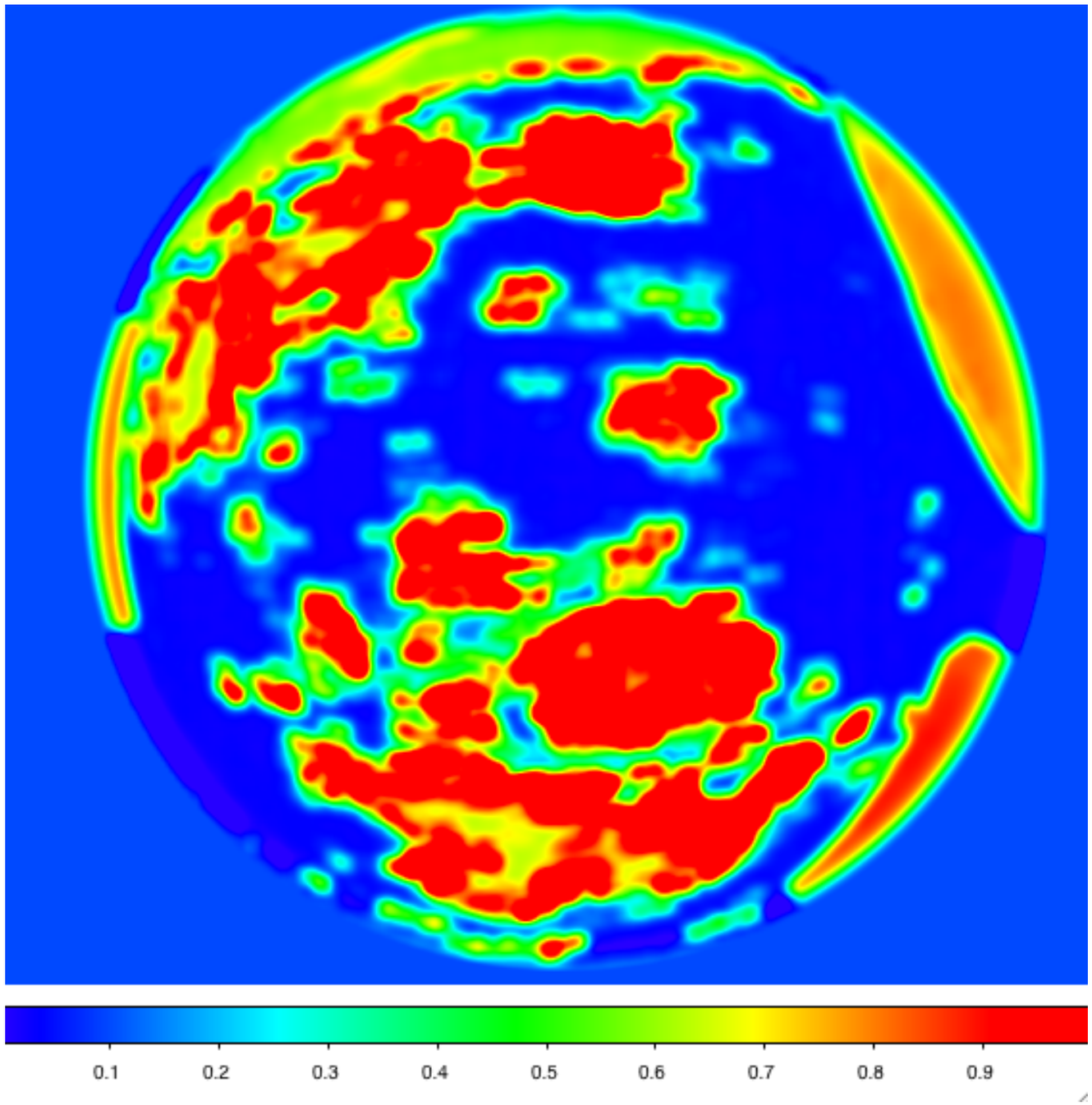

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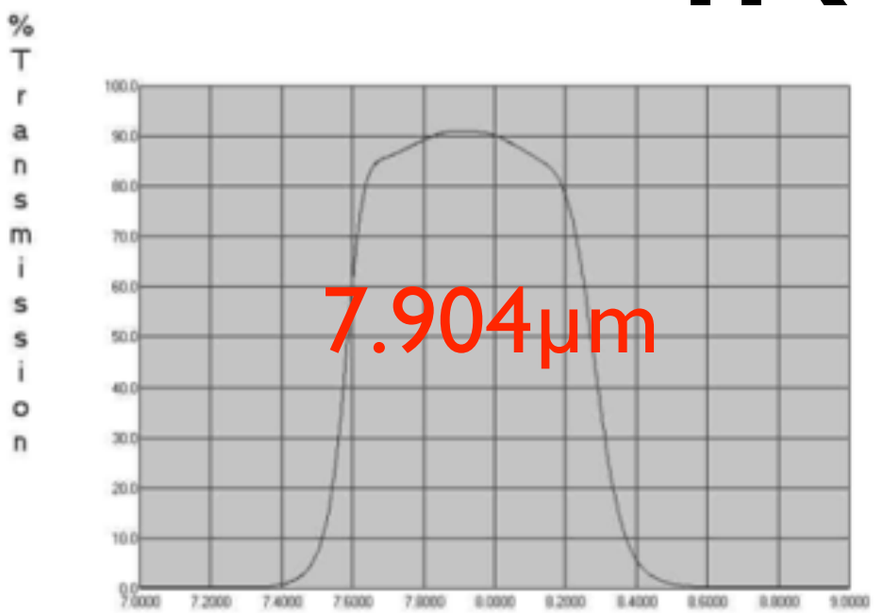
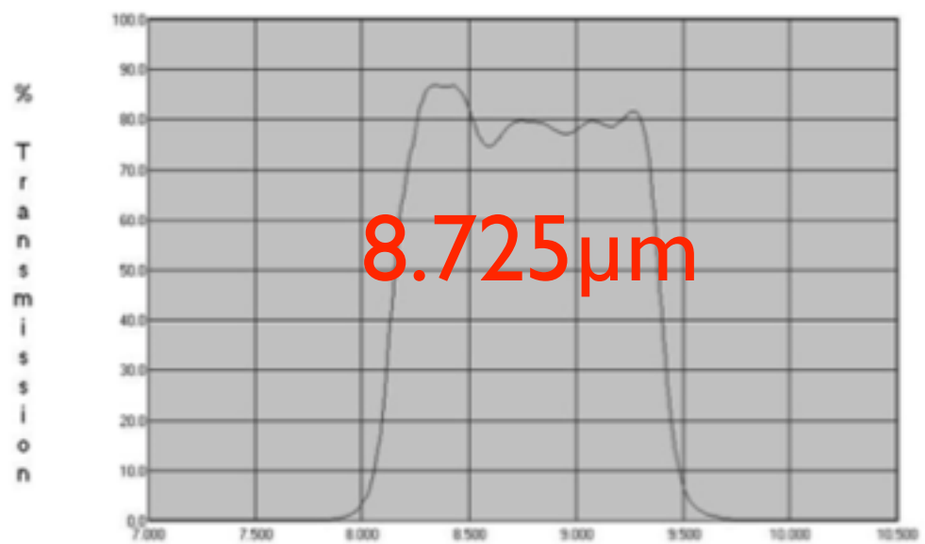
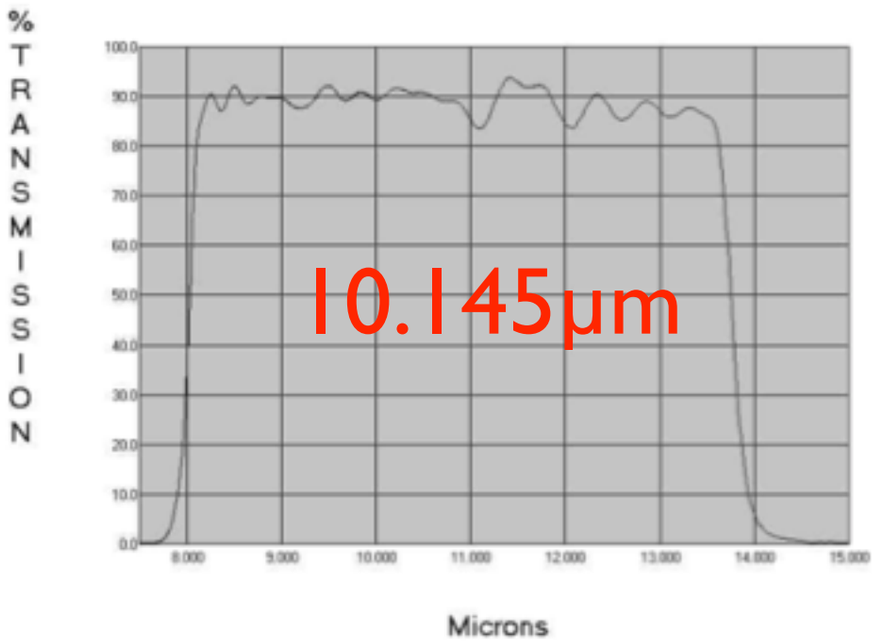
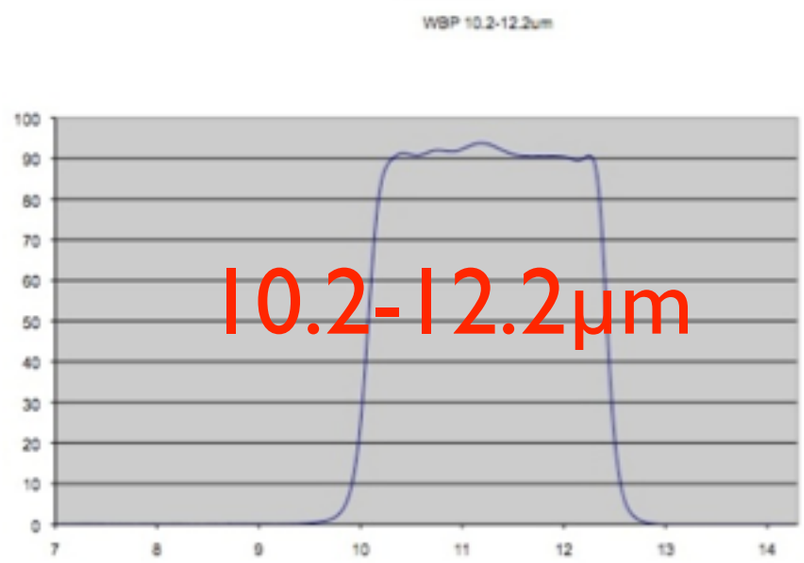
IR Filters



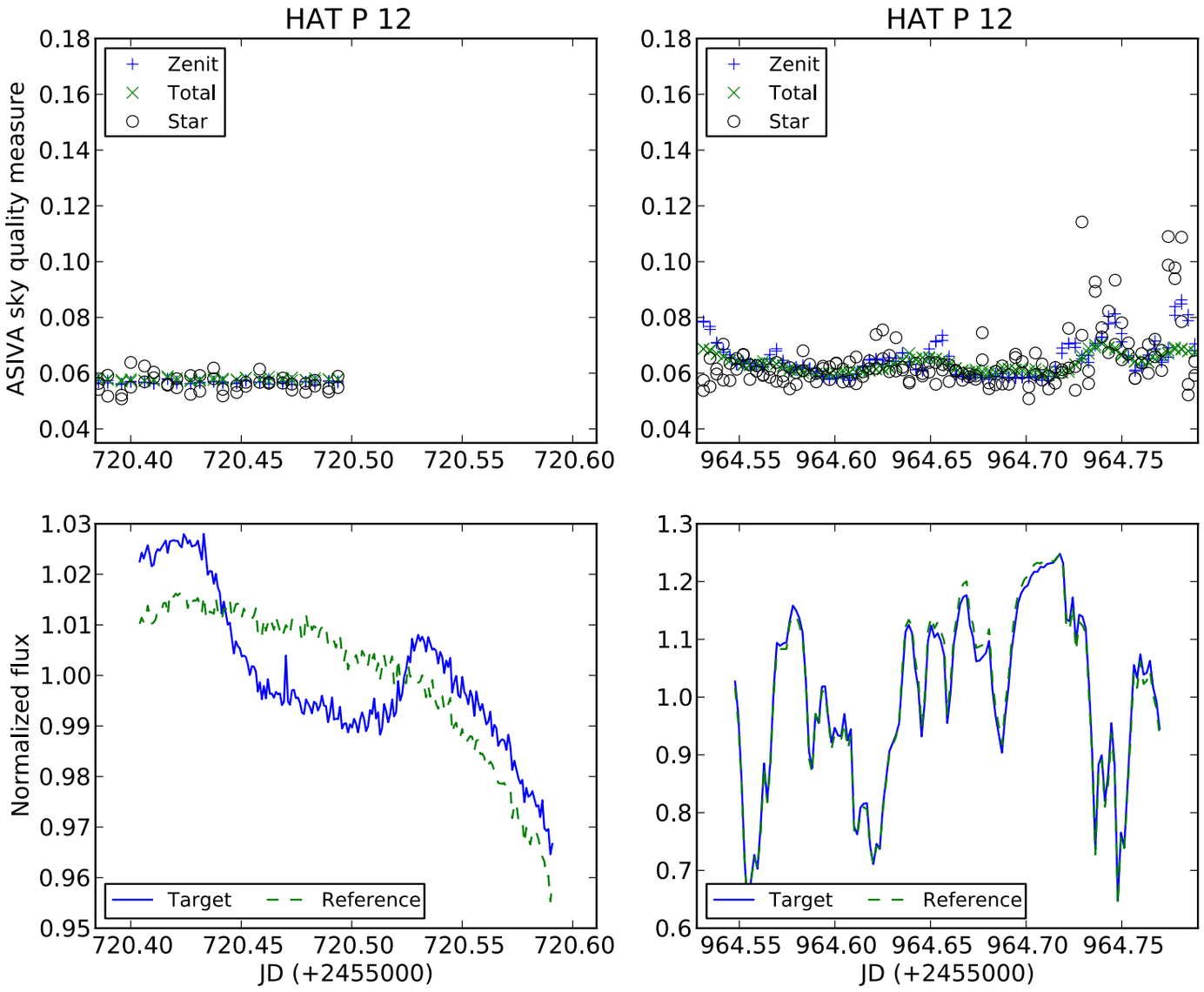






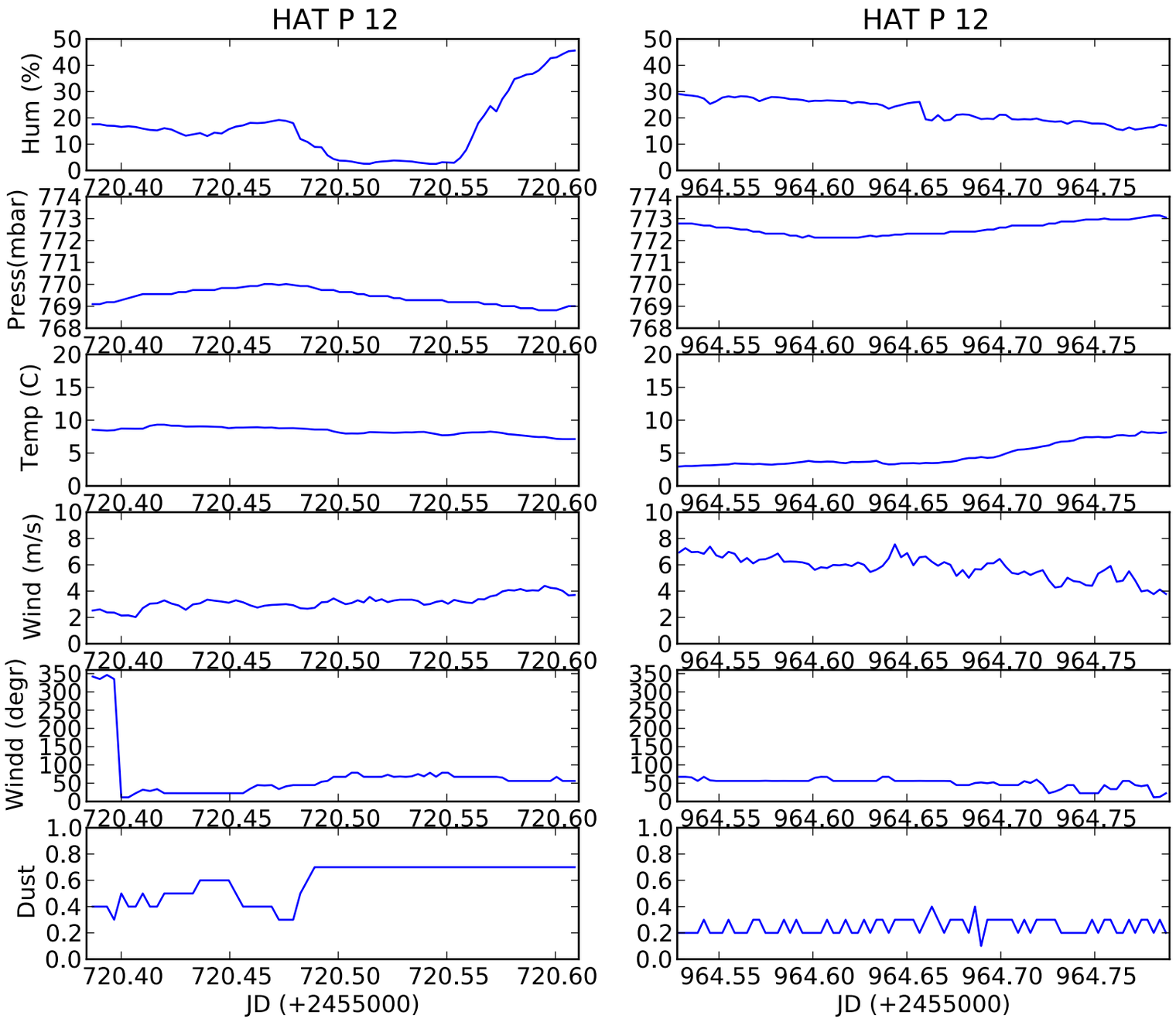
Data using this custom filter is used throughout this talk

Application: Photometry



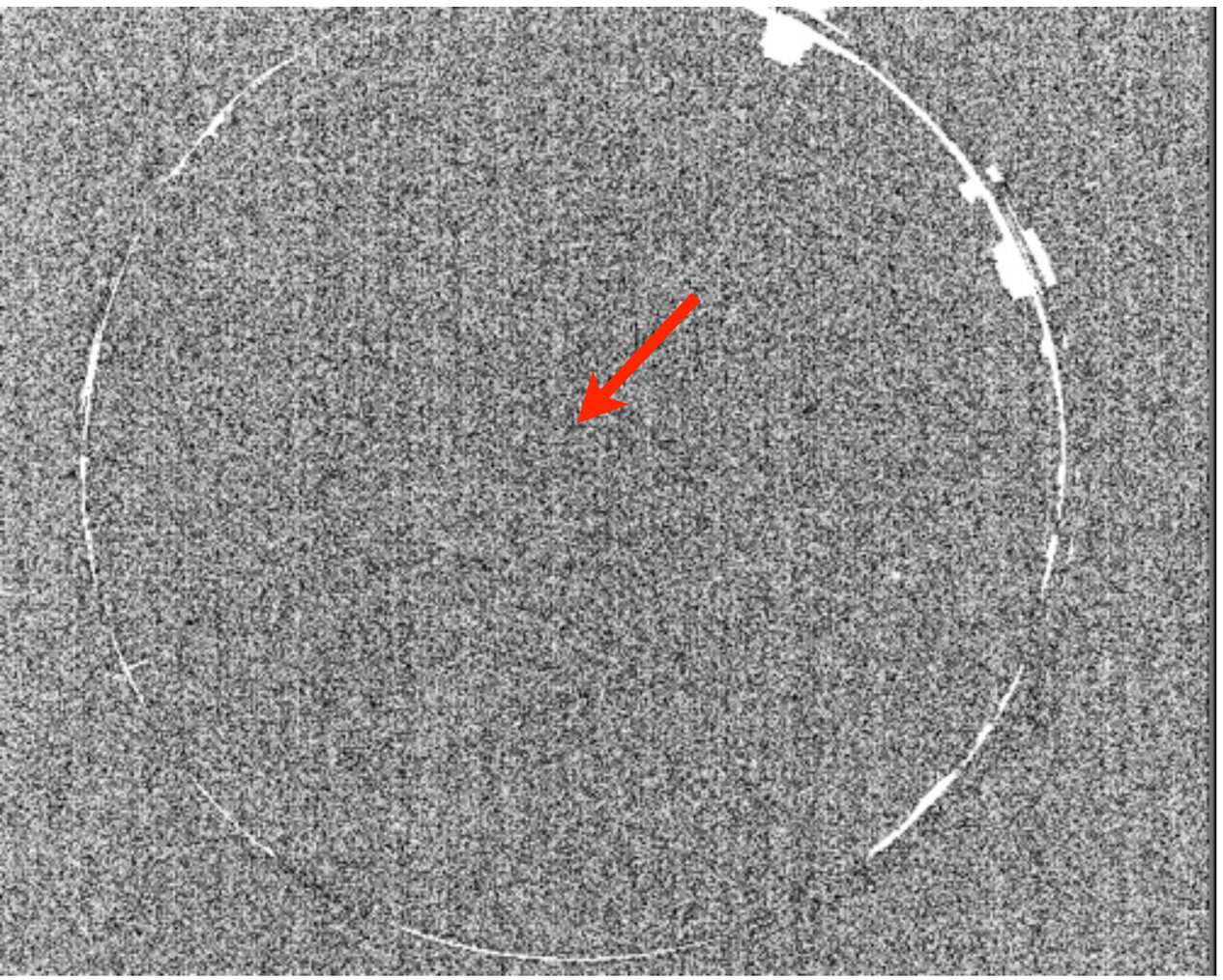
- 2 data sets of HAT P 12 transit observations with simultaneous ASIVA data
- top panel shows the ASIVA sky quality data for the Zenit, the total value, and the position of the star
- bottom panel shows normalized raw counts of the target and the comparison stars
- left: perfect conditions
- right: OK conditions, but not photometric

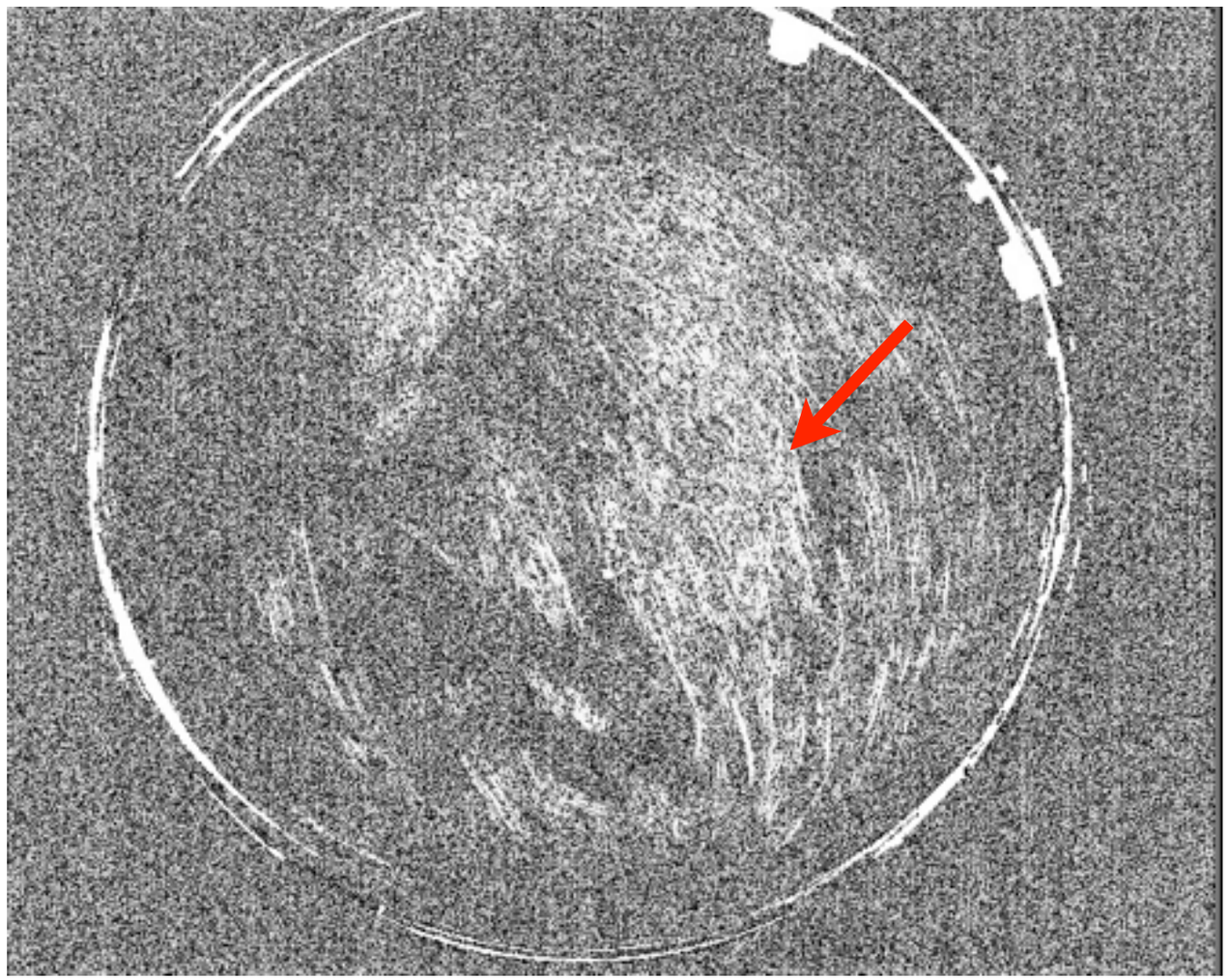
Weather readings



- comparison of the standard environmental data of these two observations show no obvious sign of bad conditions during the second run
- Just looking at these readings, the second run looks better (less dust, higher pressure)

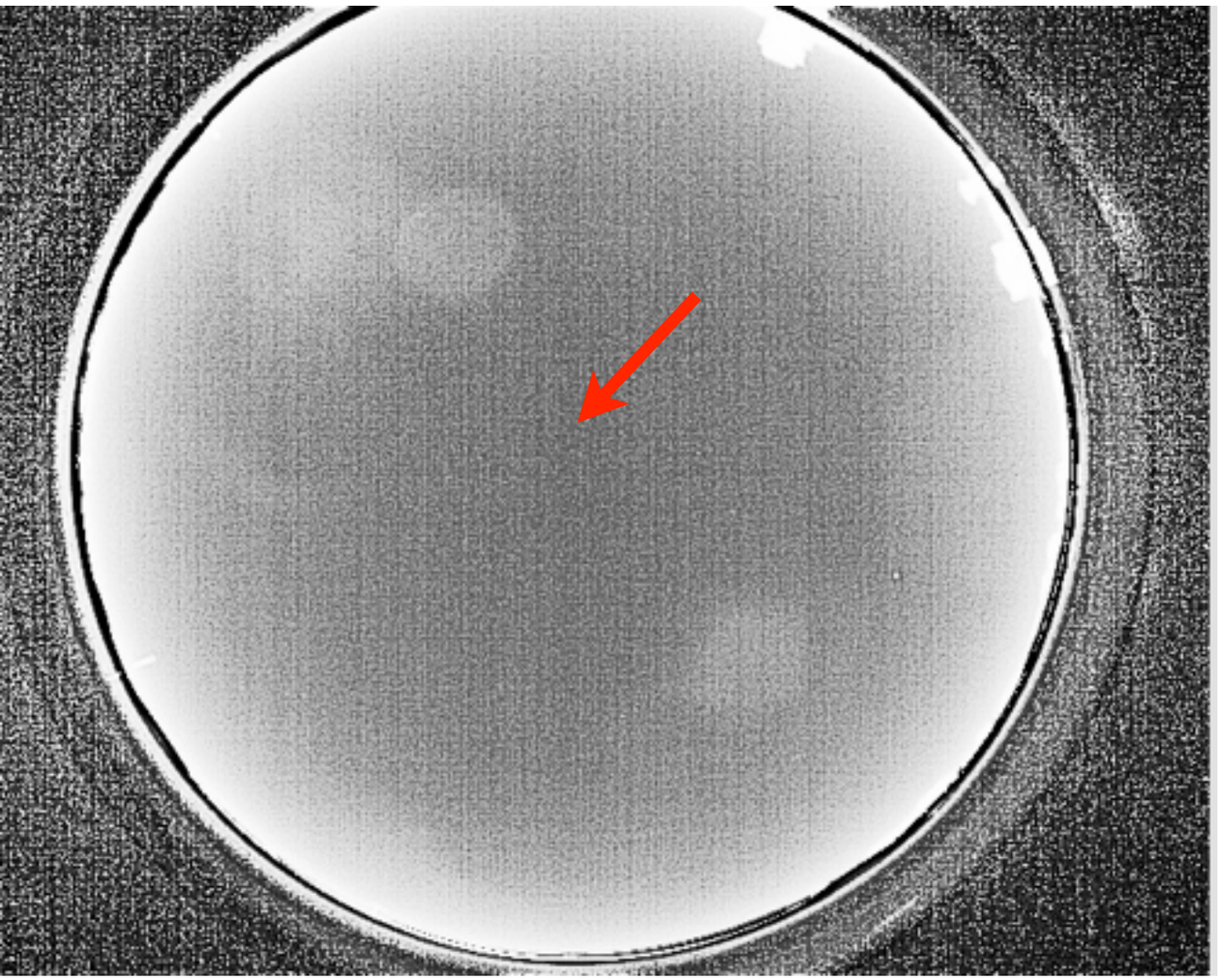
Sky quality

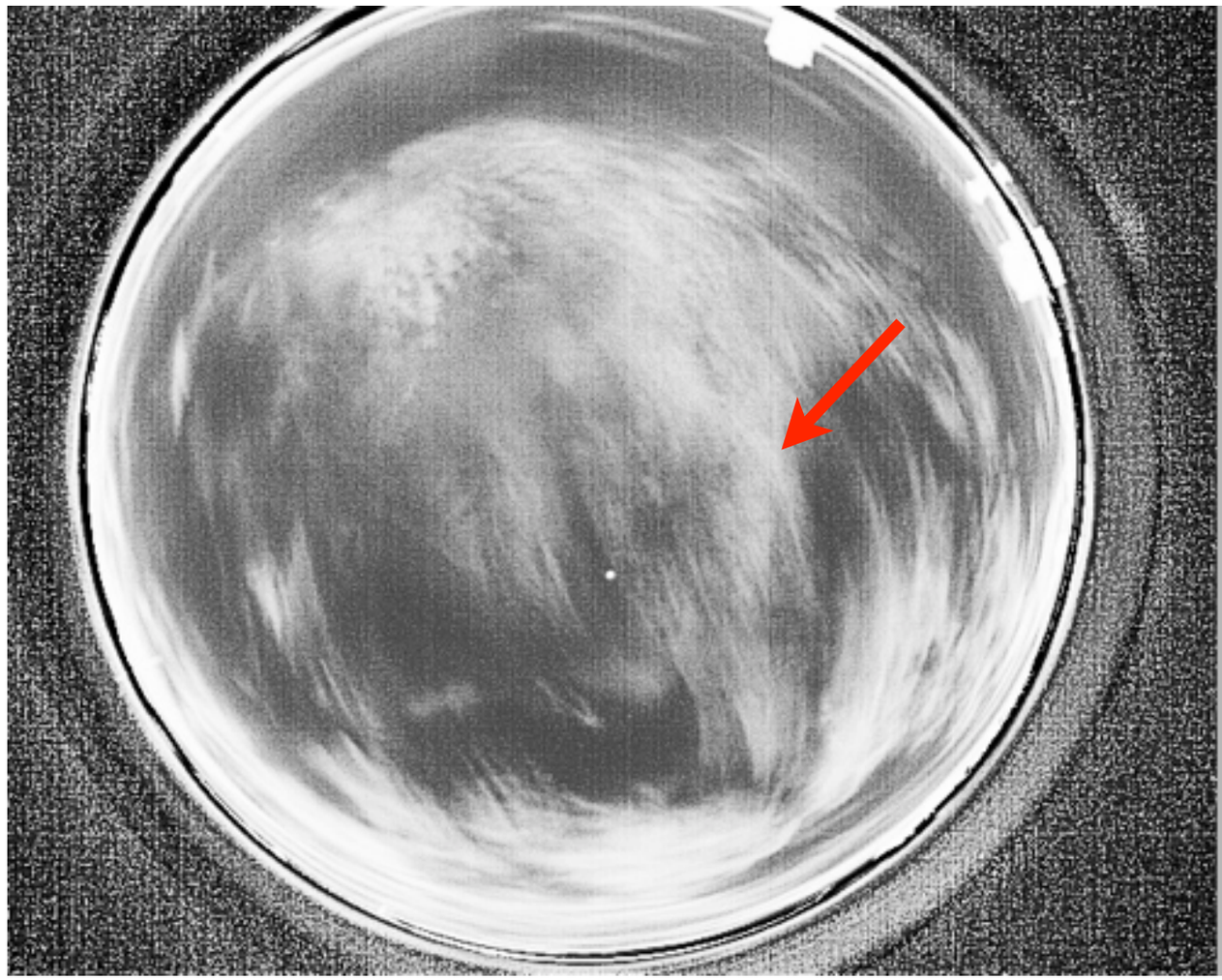




Sky quality movies during the two observing blocks. The arrows mark the approximate position at the beginning of the observations.

Radiance





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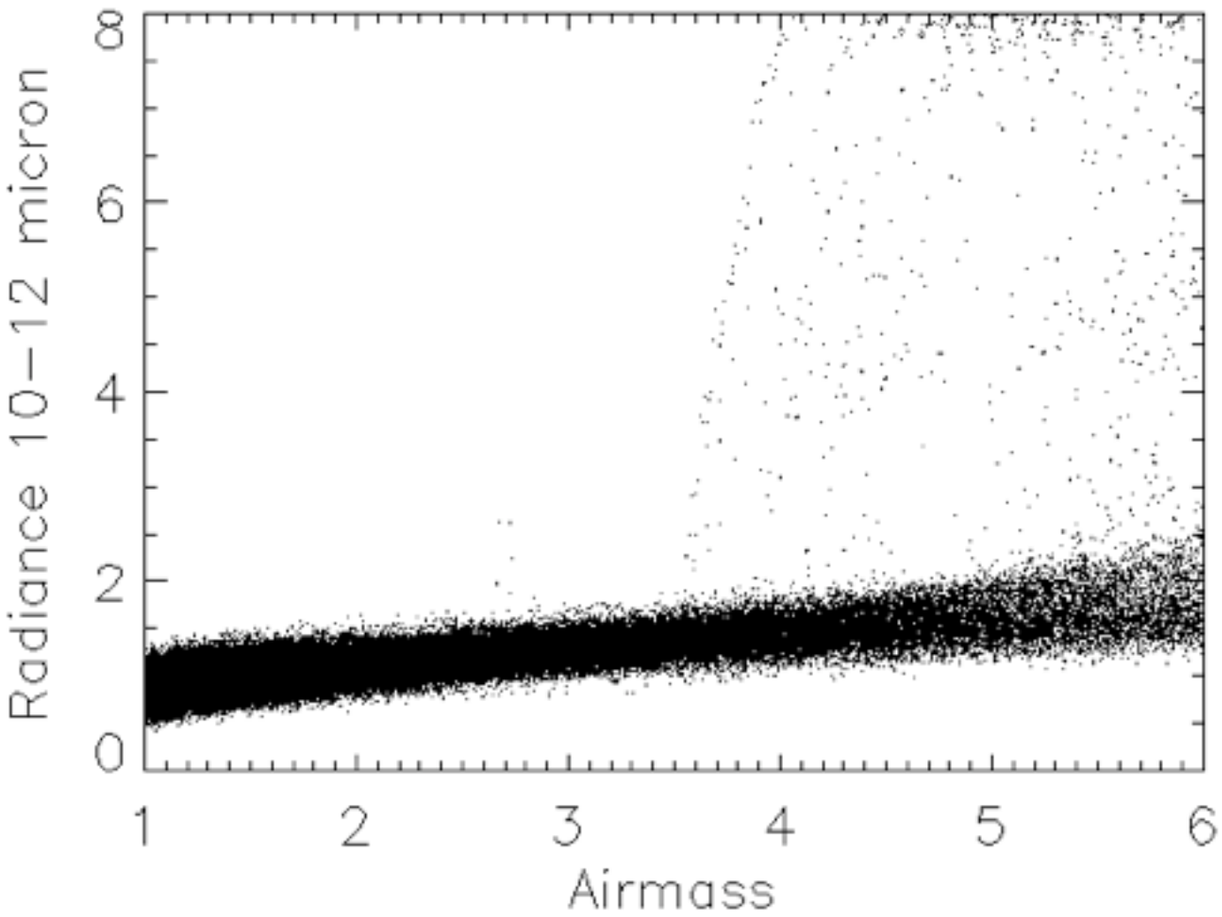
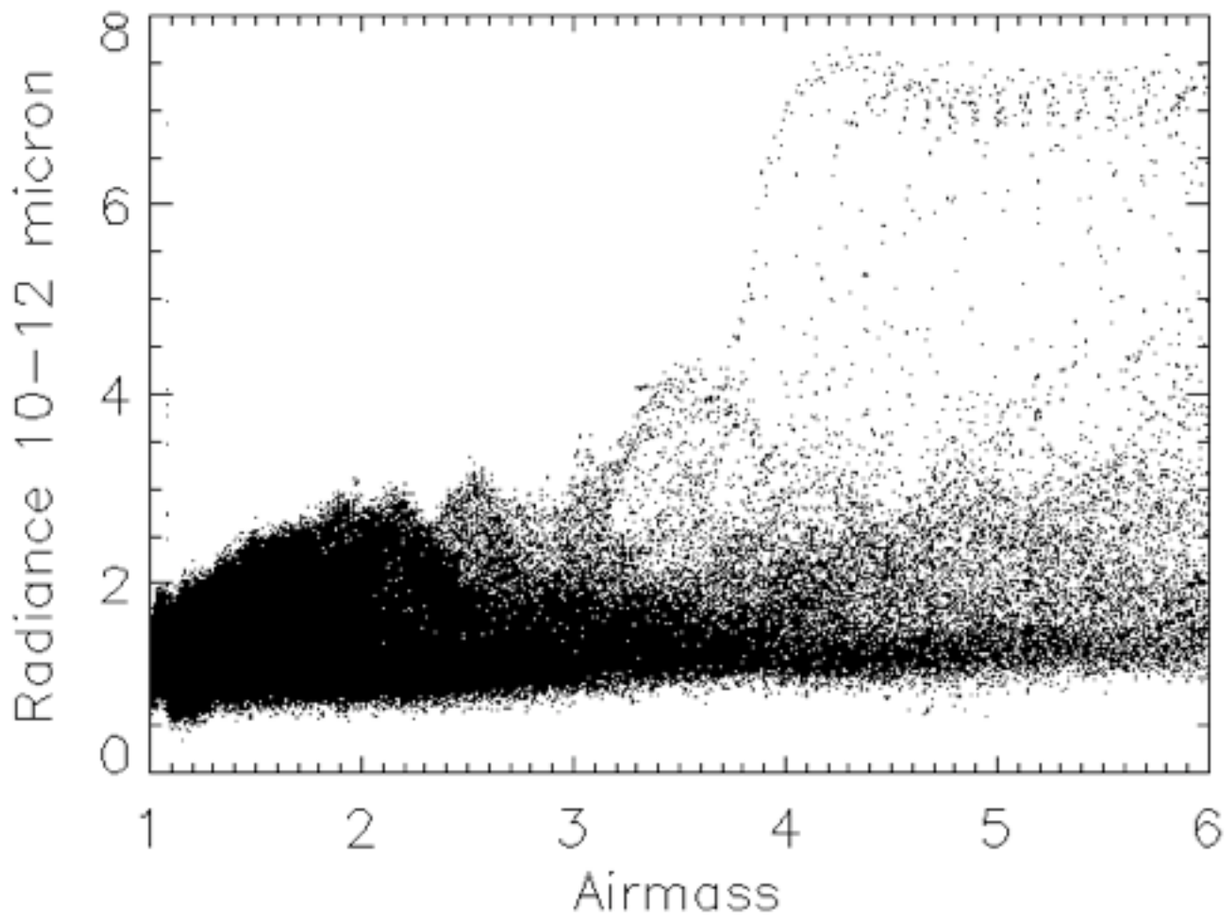
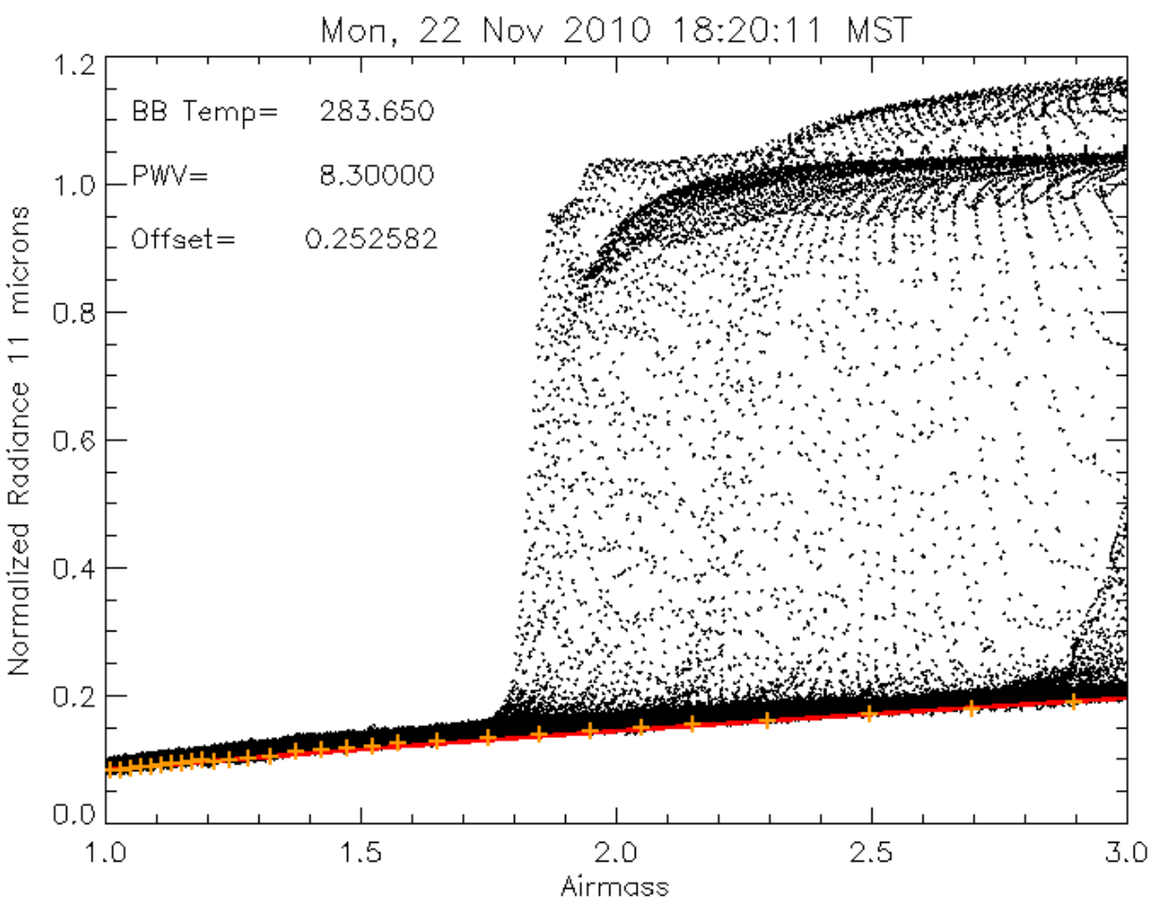
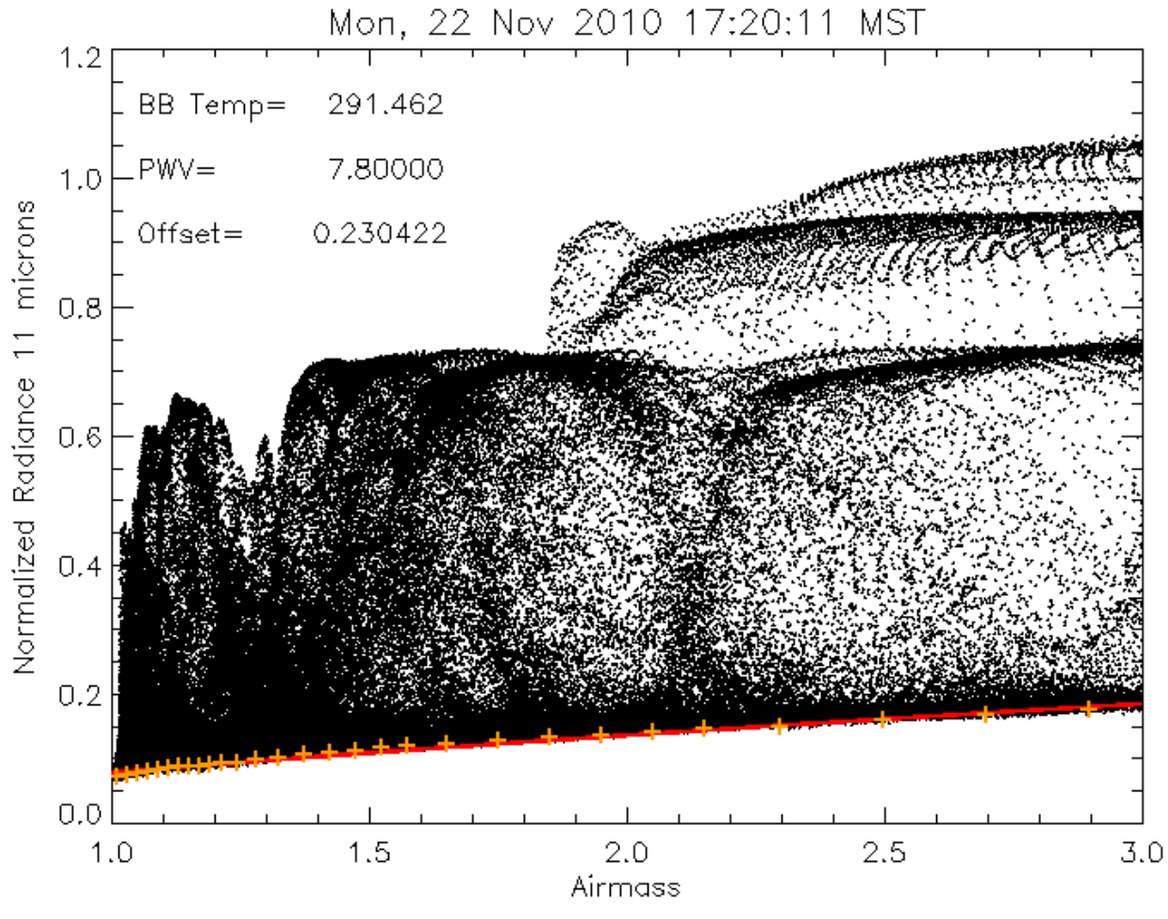




Radiance vs. airmass for the two images shown before. The high scatter of the lower envelope in the left (clear sky) image is a sign that the instrument needed re-calibration. Since then the calibration has been re-done, but the archival data still needs to be processed.

Radiance





For comparison: Radiance vs. airmass for newly calibrated data from a different ASIVA instrument using an updated data reduction scheme (from Klebe et al. 2012)

Summary

Current status

- Sky quality image done every 5 minutes
- Overall value is visible to the scheduler
- Current use is only for overcast skies (sq=1), where we do not try to observe

Near future (this year)

- Update of the image analysis software and re-reduction of the archival data
- We will make the spatial and temporary resolved information visible to the scheduler
- programs can make use of this to restrict observations to good weather (mmag photometry)
- information will be written into the FITS headers, and will be available in our environmental-data archive

Summary

Science fiction (next year)

- cloud and sky quality forecasts will be made available to the scheduler
- the instruments will try observe at clear spots in the sky in case the conditions are variable
- predictions will be used to observe the targets in the right order, i.e. at the time when the clouds are NOT in the line of sight