Calibrating instrument response and atmospheric transmission with celestial sources

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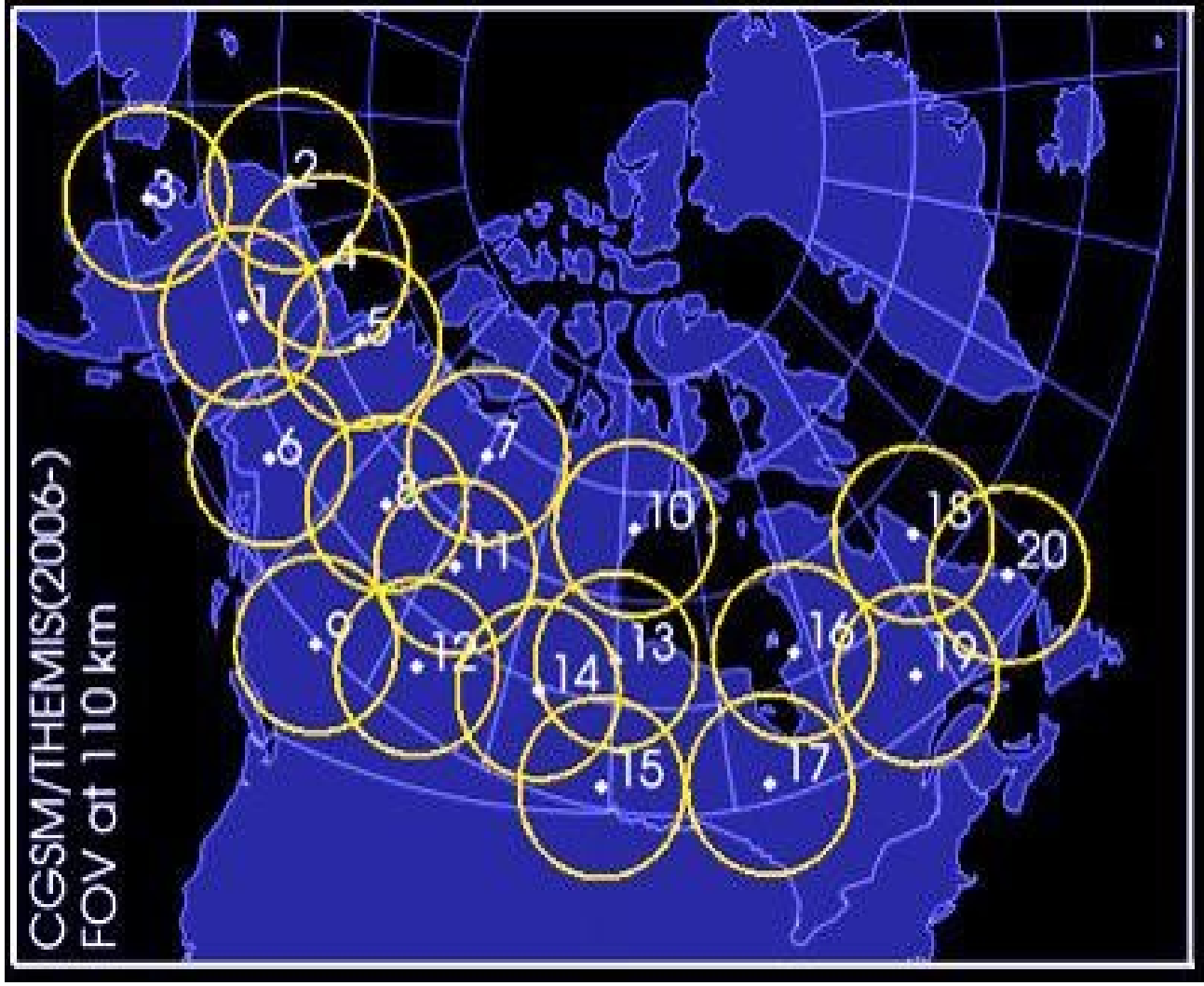
Spectral photometric calibration requires several resources that have recently become easier to obtain

- **Geometric calibration**
- **Calibrated sources**
- **Computation**

Future progress depends on robust automation in order to produce calibrated data in real-time.

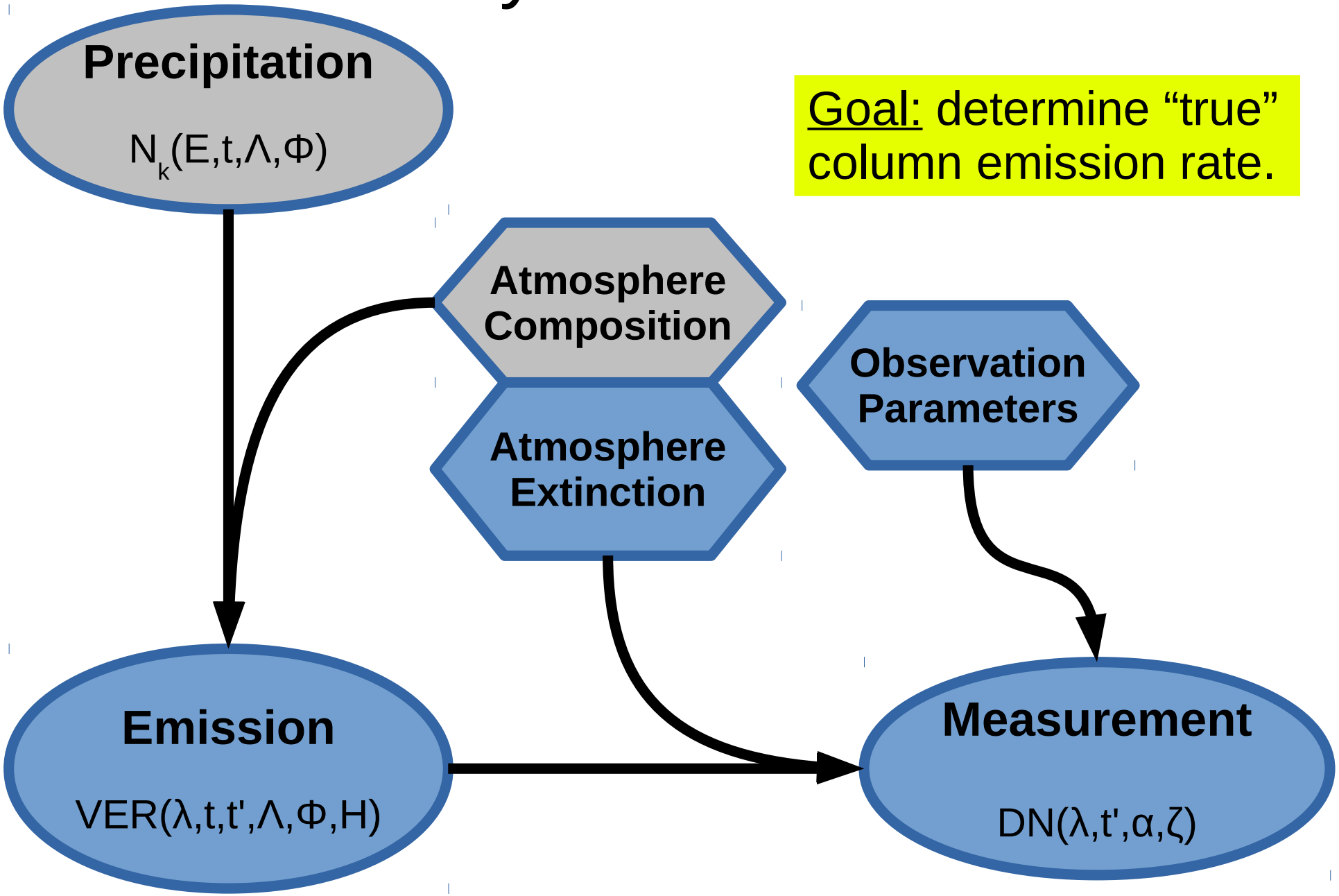
This is essential for global scale science and space weather applications.

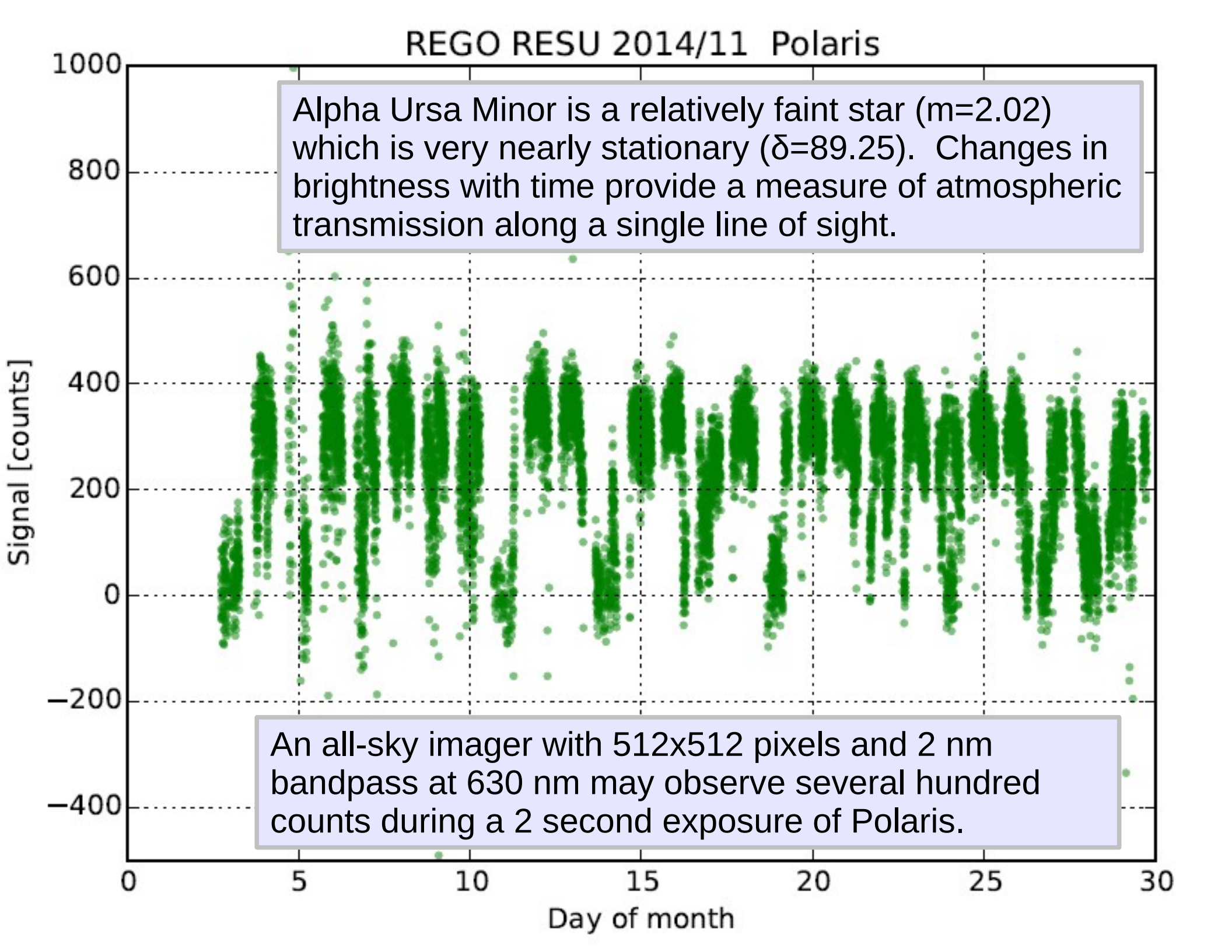


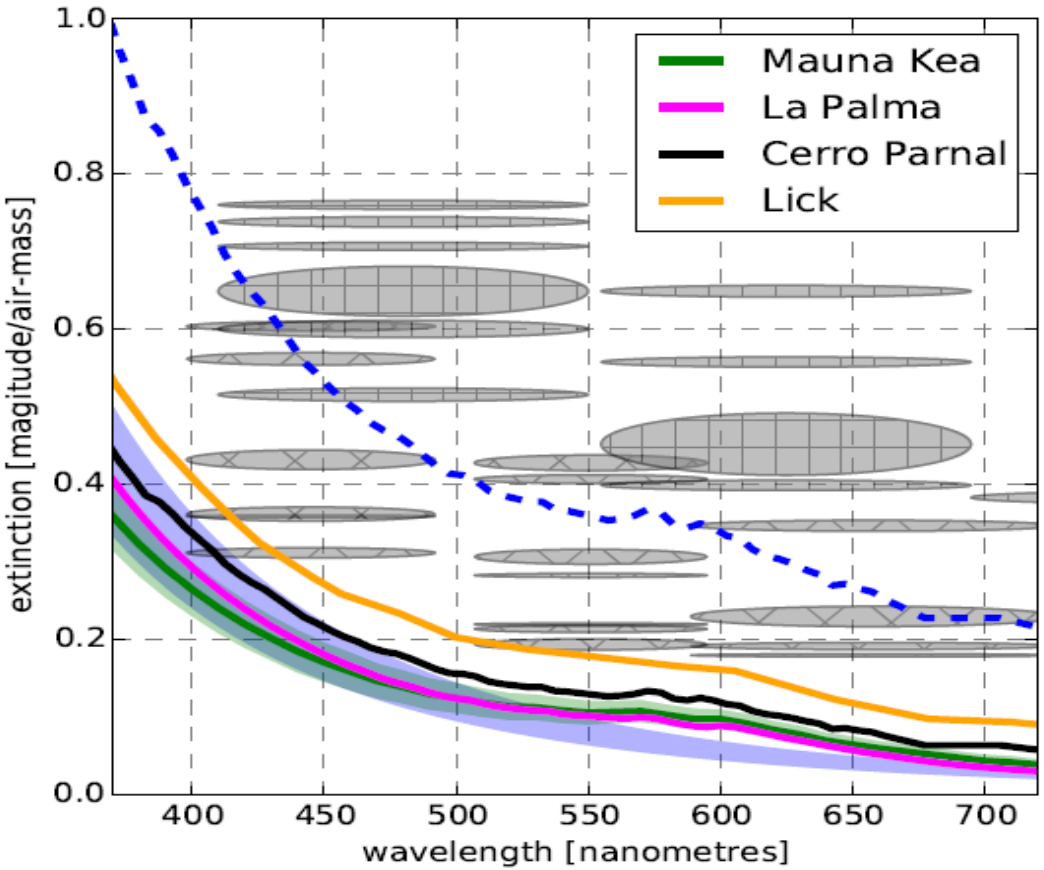
These topics are occasionally alluded to in the literature, but rarely with sufficient detail.

Hopefully new journals such as Geoscientific Instrumentation, Methods and Data Systems will provide a venue for public discussion and dissemination.

Physical model




REGO RESU 2014/11 Polaris
Alpha Ursa Minor is a relatively faint star (m=2.02) which is very nearly stationary (δ=89.25). Changes in brightness with time provide a measure of atmospheric transmission along a single line of sight.
An all-sky imager with 512x512 pixels and 2 nm bandpass at 630 nm may observe several hundred counts during a 2 second exposure of Polaris.
Signal [counts]
1000
800
600
400
200
0
−200
−400
0
5
10
15
20
25
30
Day of month



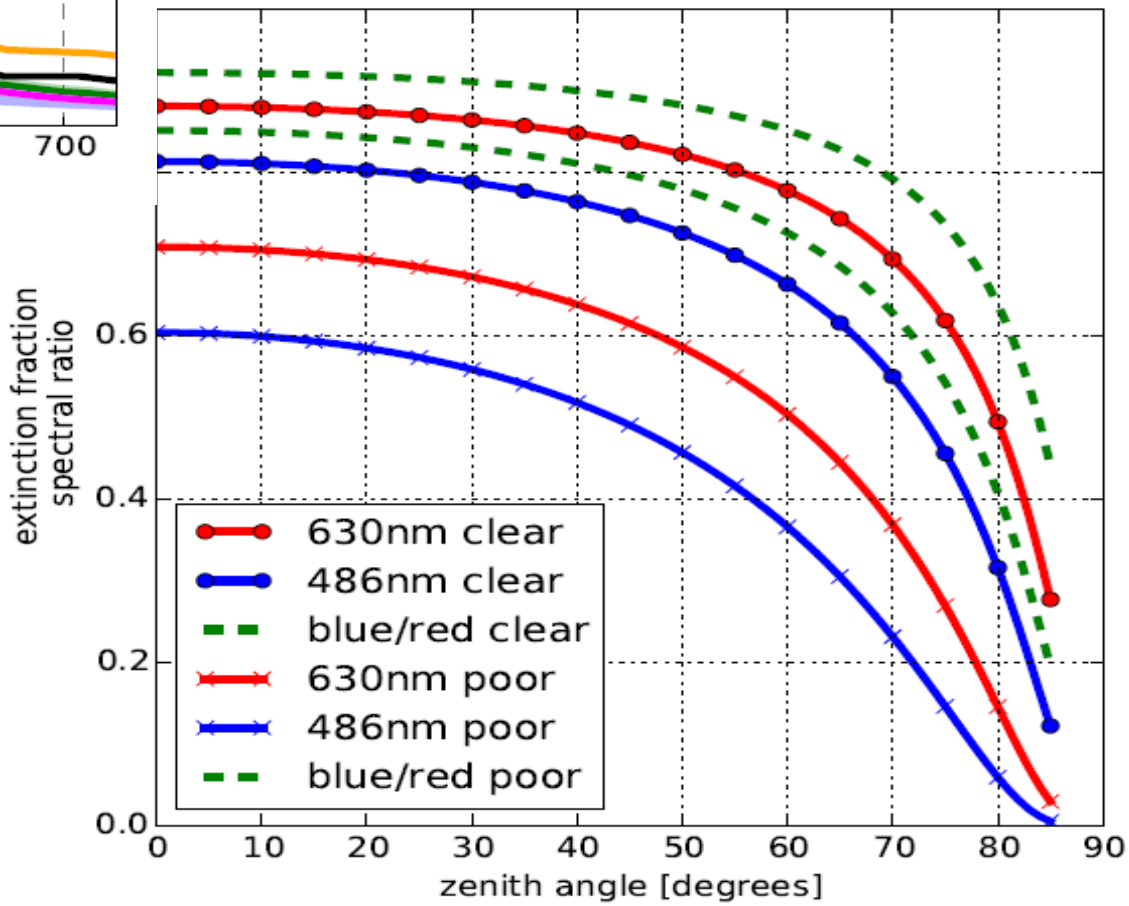
Atmospheric attenuation observations and models are available from several high altitude observatories.

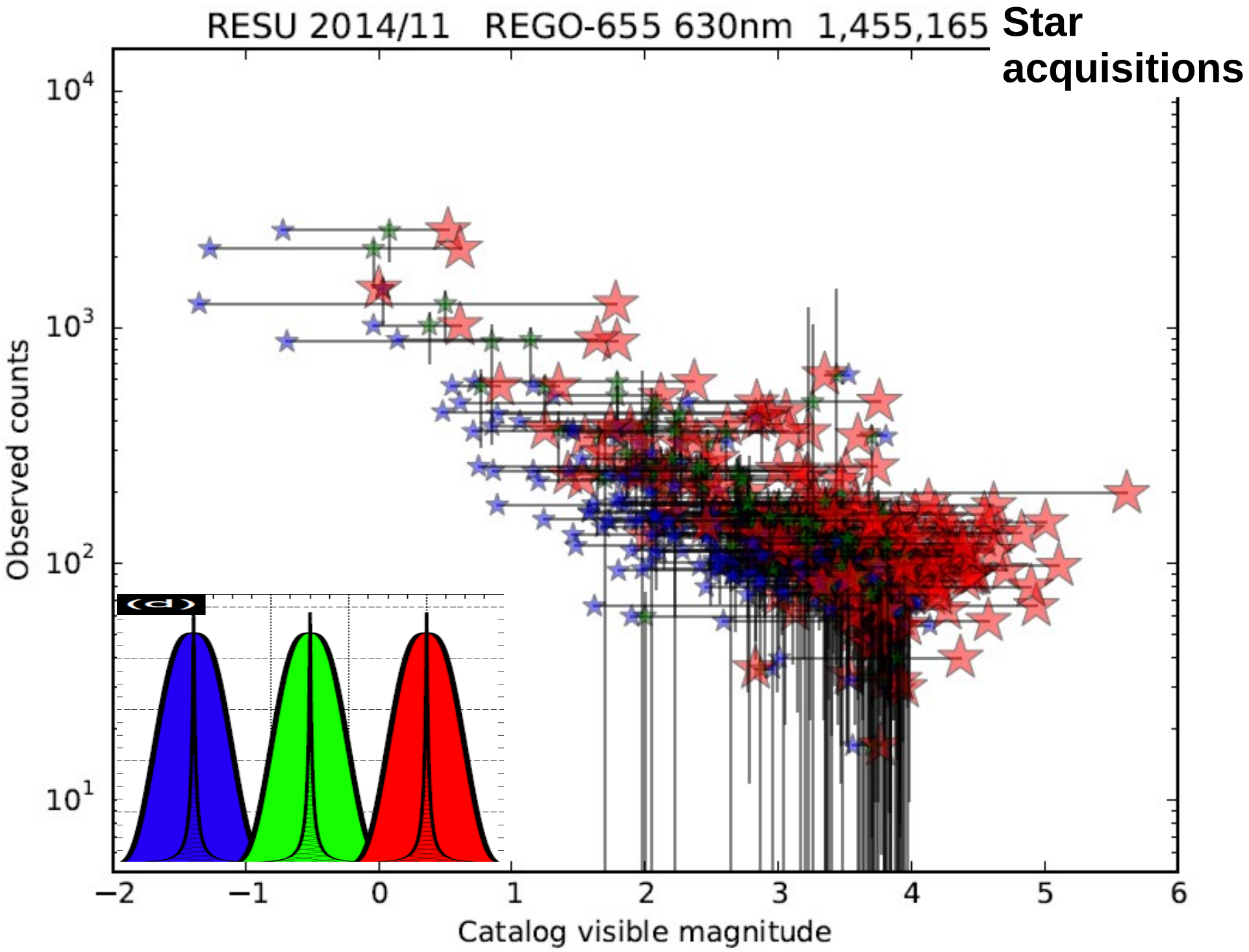
Low altitude conditions are highly variable. A local monitor is required.

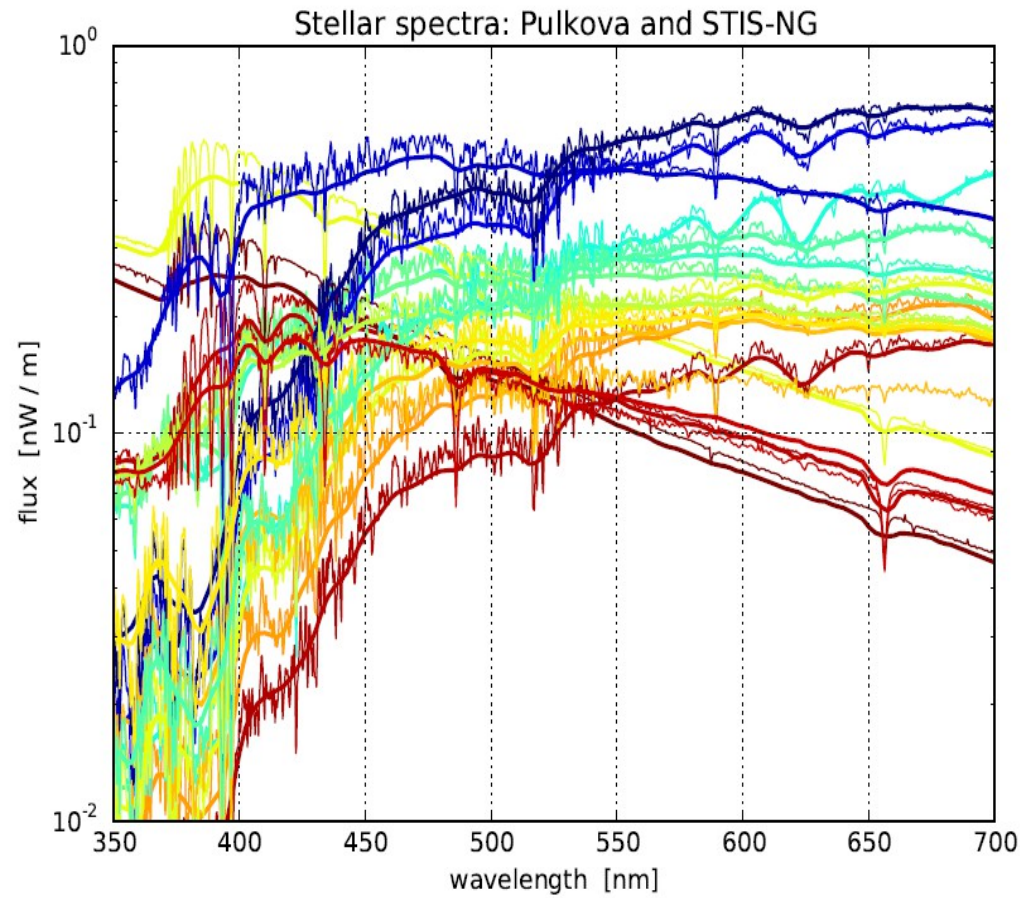
Clear-sky zenith ~10/20% red/blue attenuation.

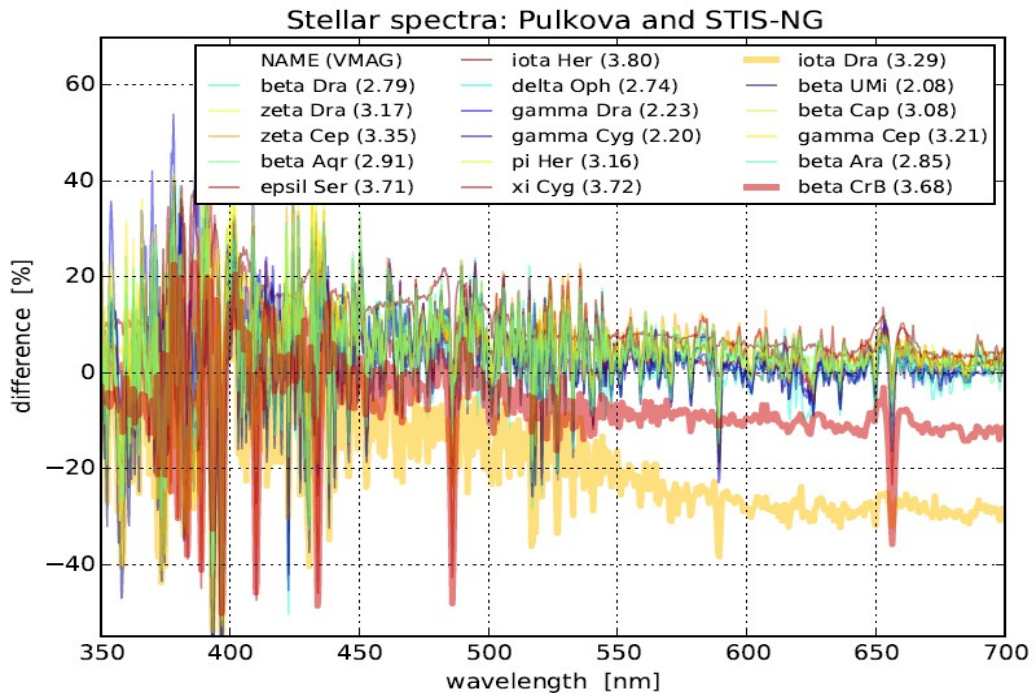
Haze at zenith changes ratio ~10%.

Haze at horizon: unusable.




RESU 2014/11 REGO-655 630nm 1,455,165
Star acquisitions
Observed counts
Catalog visible magnitude
(d)





Absolute calibration requires stellar spectral flux in physical units.

Astronomers also require absolutely calibrated reference stars, but generally for m=8-12.

Some data are available for relatively bright stars (m<4). Common sources from two large data sets

- **Pulkovo Spectrophotometric Catalog (1996)**
- **STIS Next Generation Spectral Library Version 2 (2010)**

are consistent to 10% or better.

Conclusions

✔ Optical auroral observations are more useful when geometrically and photometrically calibrated

✔ Continuous in-field calibration can be accomplished using astronomical sources

✔ Orientation < 0.1 degree,

absolute sensitivity < 10%

✗ Atmospheric variability is dominant error source

✗ Difficult to distinguish between ASI vignetting and uniform atmospheric extinction

✗ Difficult to distinguish between scattering and absorption