Estimating fractional sky cover from spectral radiation measurements

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Fractional Sky Cover:

Variations of cloud cover have significantly contributed to contemporary climatic changes

The impact of greenhouse warming on cloud amount through climate feedback will have significant changes on the global radiative energy balance.

---it is crucial to accurately monitor fractional sky cover of clouds globally.

Current monitoring of fractional sky cover in ARM:

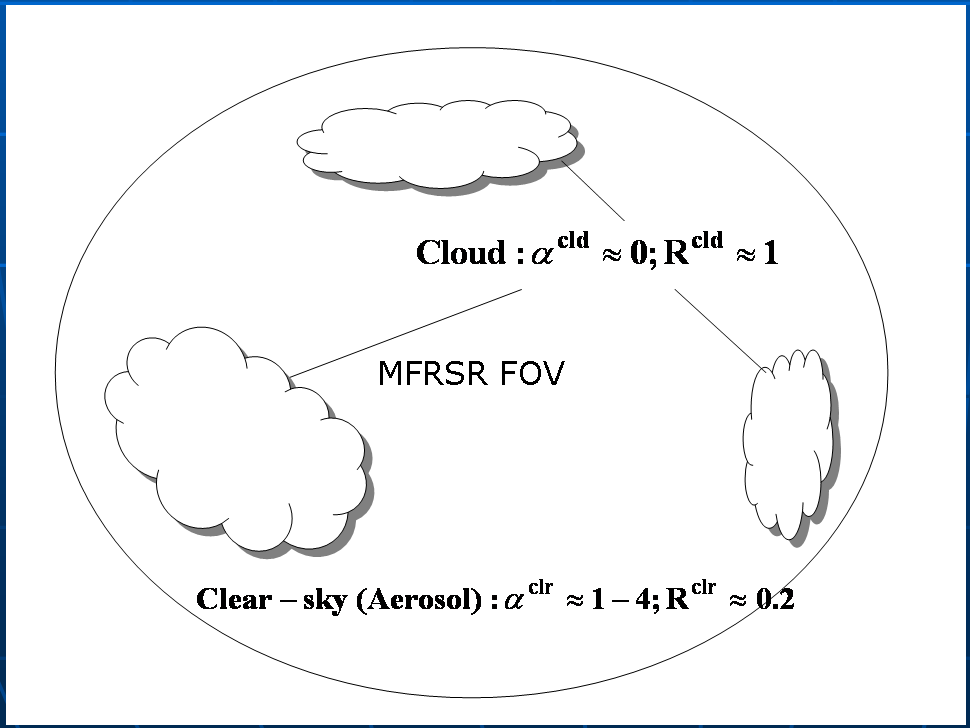
- TSI (pixel color)
- SW (based on TSI)
- Time series (Cloud occurrence, from Radar, Lidar, and radiation)

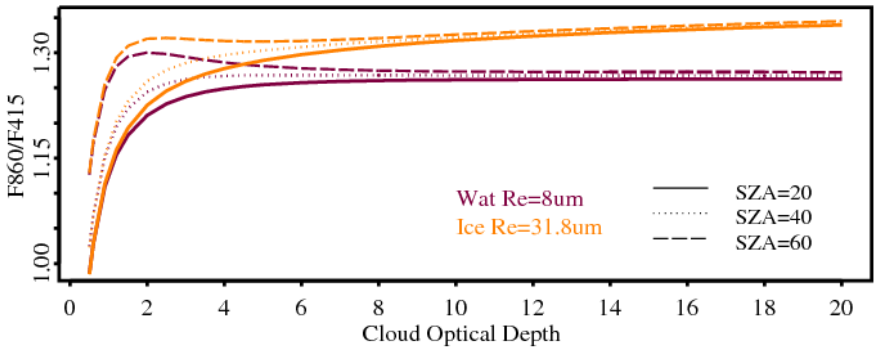
Fractional Sky Cover:

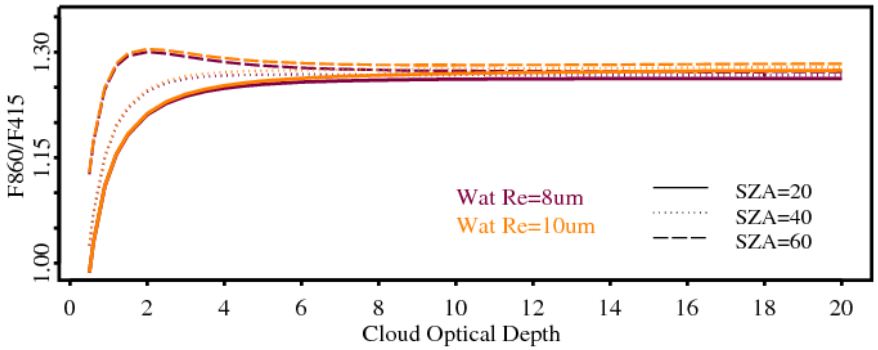
What is the clear-sky (or cloudy sky)?

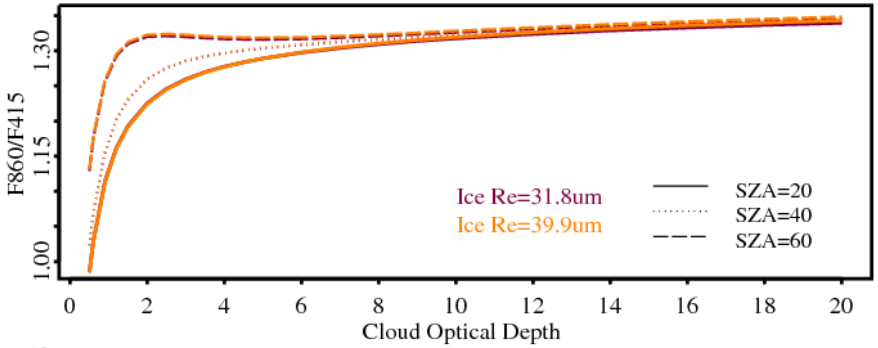
The spectral dependence of optical depth of atmospheric scatterers generally follows Angstrom's empirical relationship

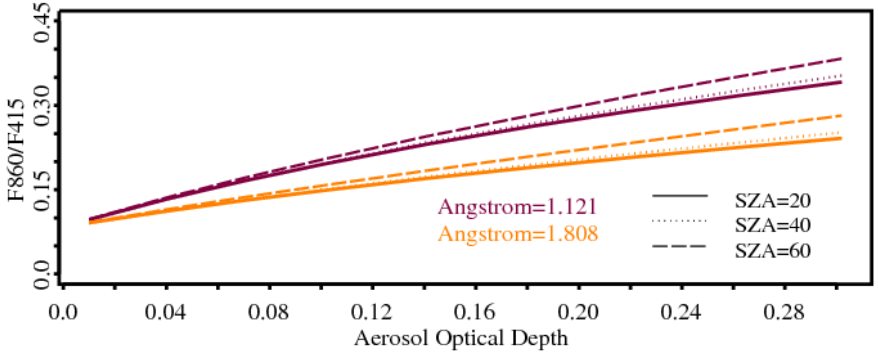
$$\tau_{sca}(\lambda) = \beta\lambda^{-\alpha}$$











Spectral transmittance at 415 and 860 nm have big difference at clear and cloudy sky and thus have different partition between cloud and aerosol.

OVERCAST SKY

SZA and Re have minor effect on (F860/F415) value .

CLEAR SKY

SZA and Angstrom Coefficient also have minor effect on (F860/F415) value

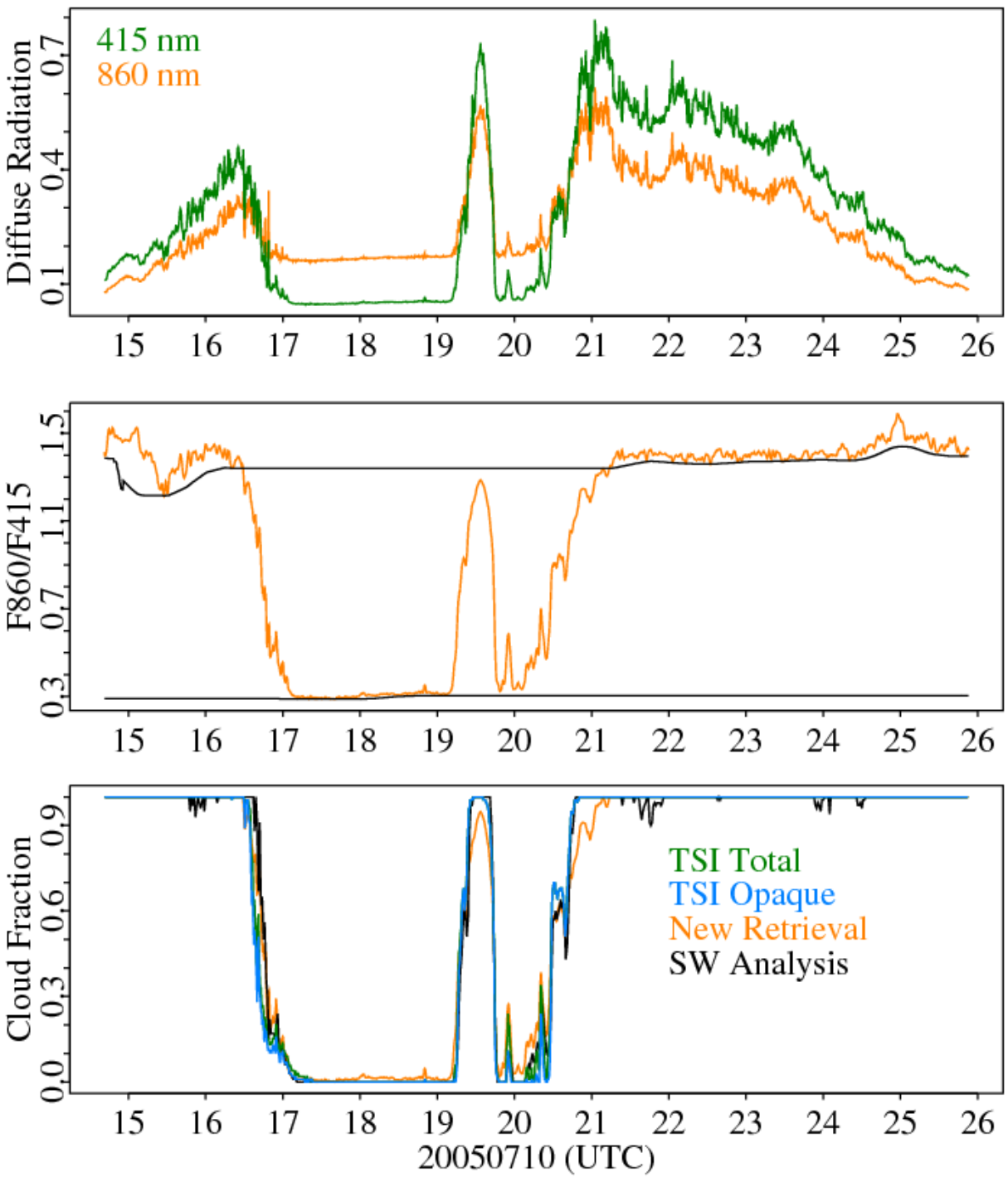
Fractional Sky Cover:

$$R = (1-\alpha)R^{clr} + \alpha R^{cld}$$

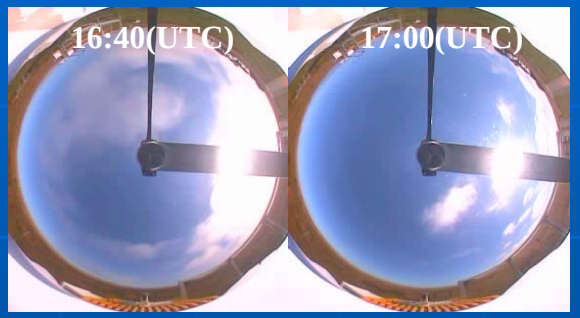
$$\alpha = \frac{R - R^{clr}}{R^{cld} - R^{clr}}$$

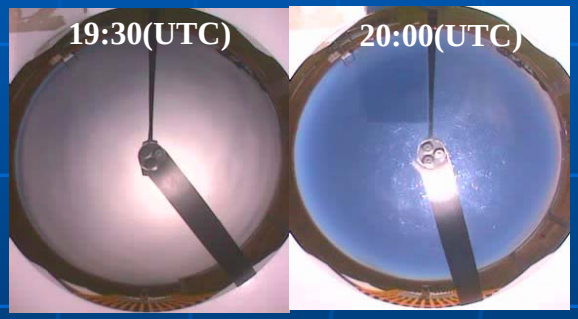
Where $R^{cld} \sim 1.25 \pm 0.05$; $R^{clr} \sim 0.2 \pm 0.05$. Therefore $\Delta\alpha \approx 0.1$ or 10%

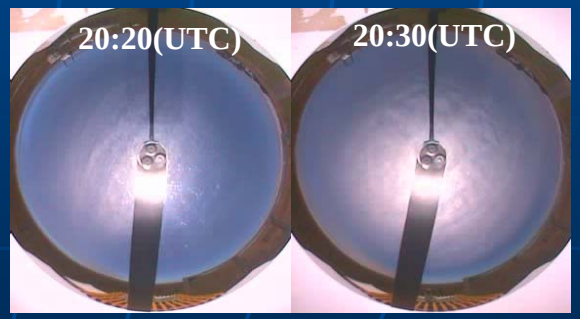
If using localized R^{cld} and R^{clr}, the uncertainty of α will further reduced to about 5%

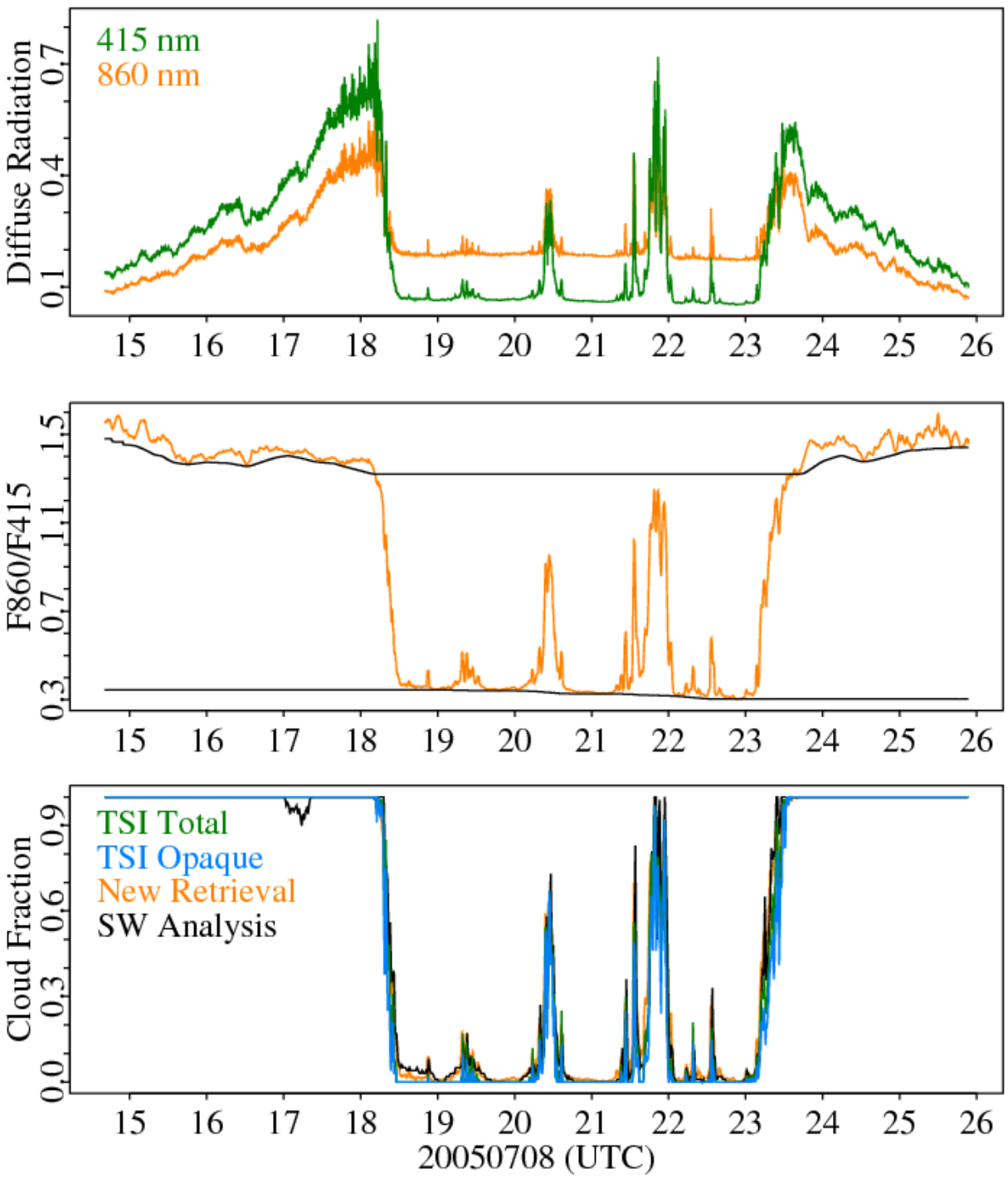


Good Case
Jul 10, 2005









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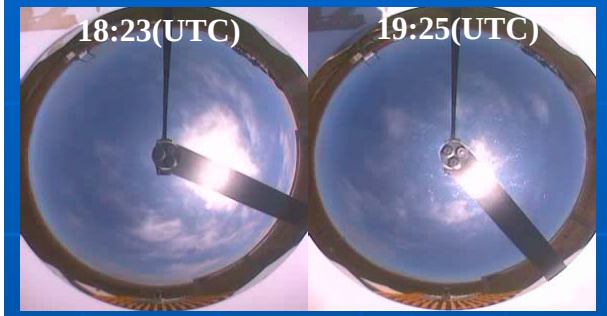
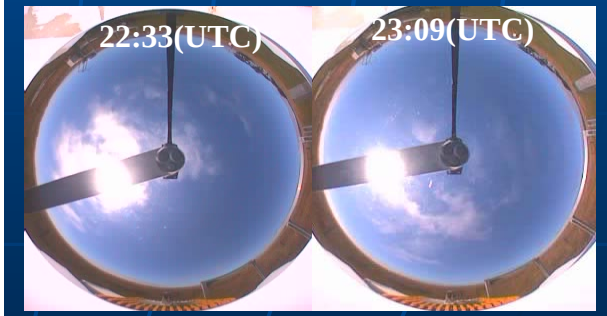
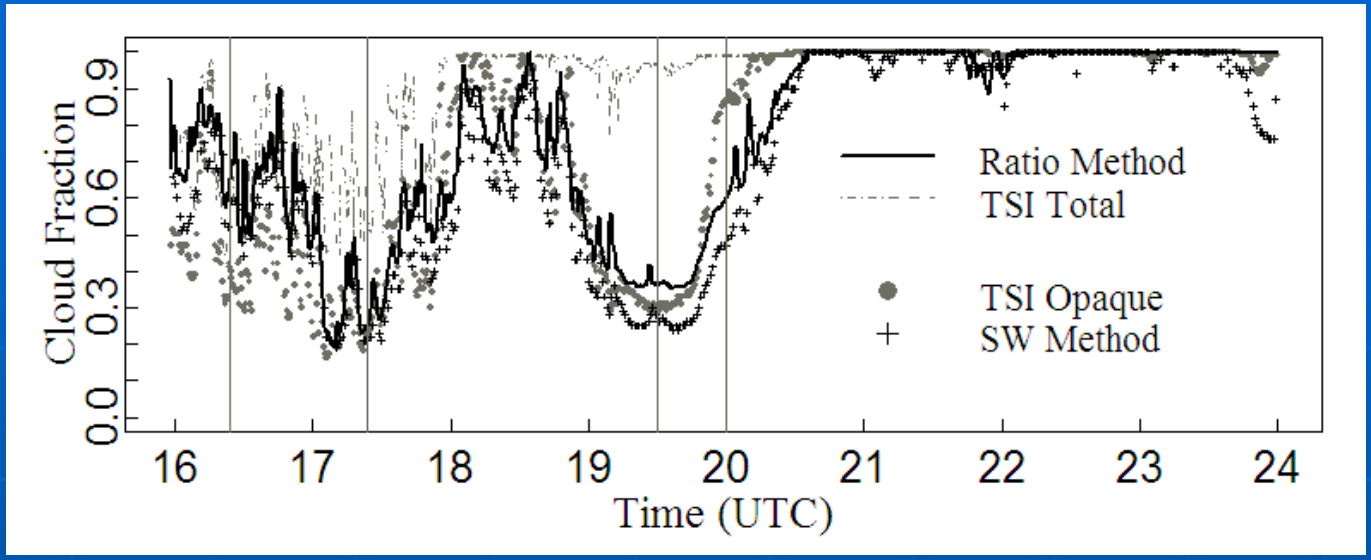
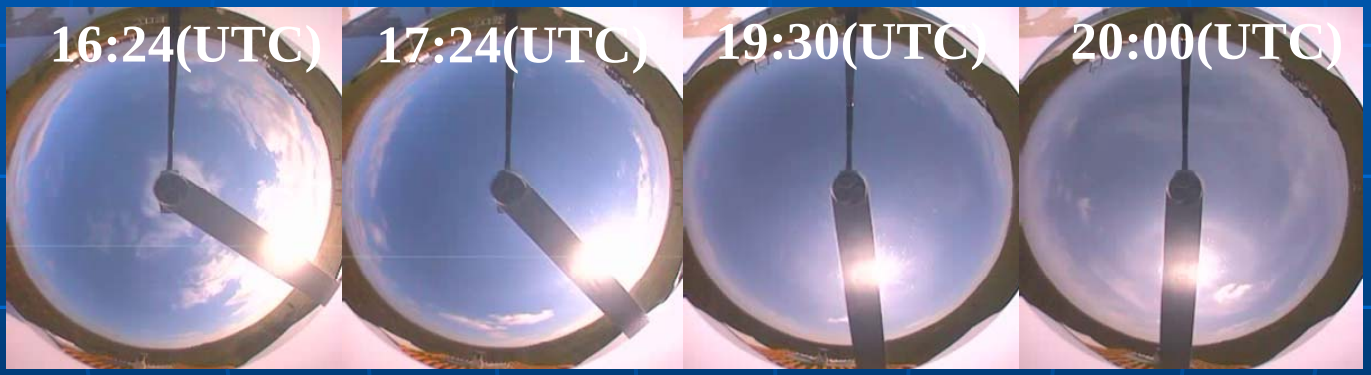




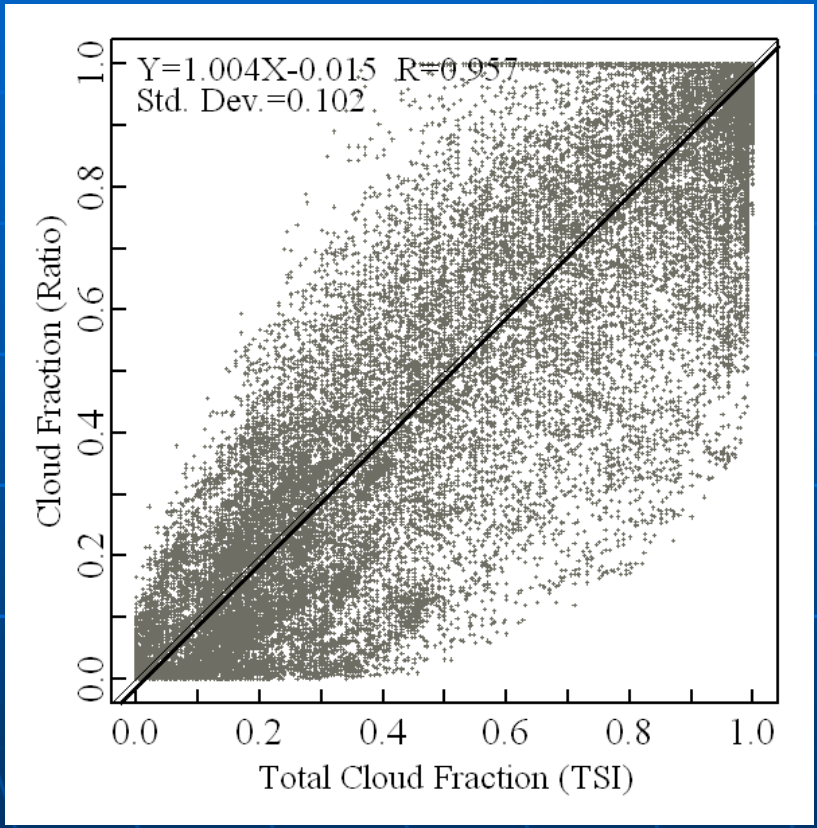


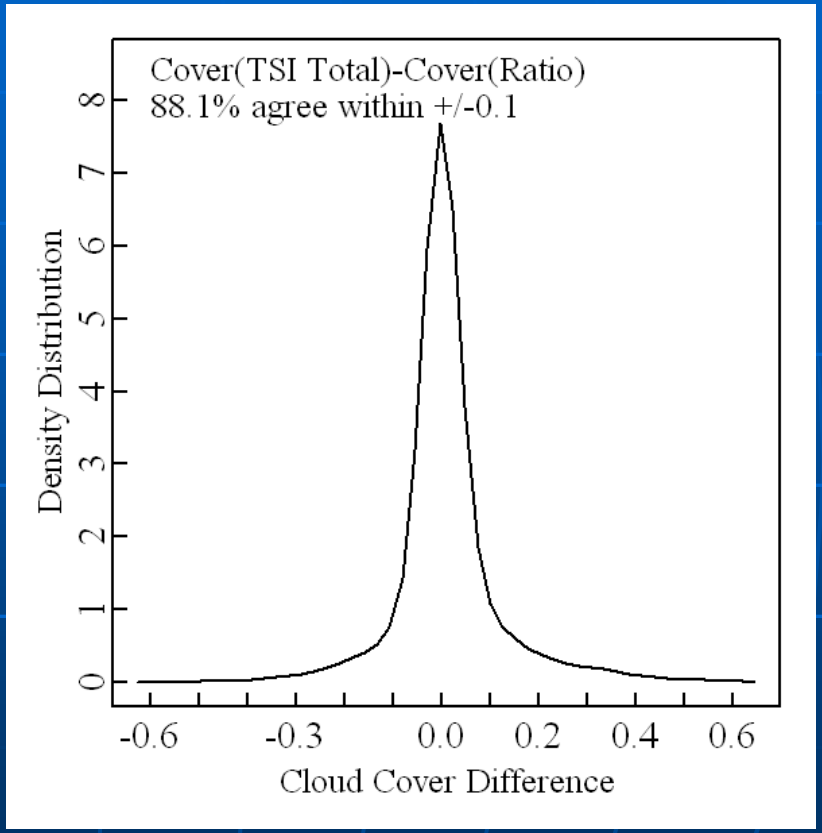


Threshold issues: thin and opaque clouds
Effective fields of view: different for three instruments

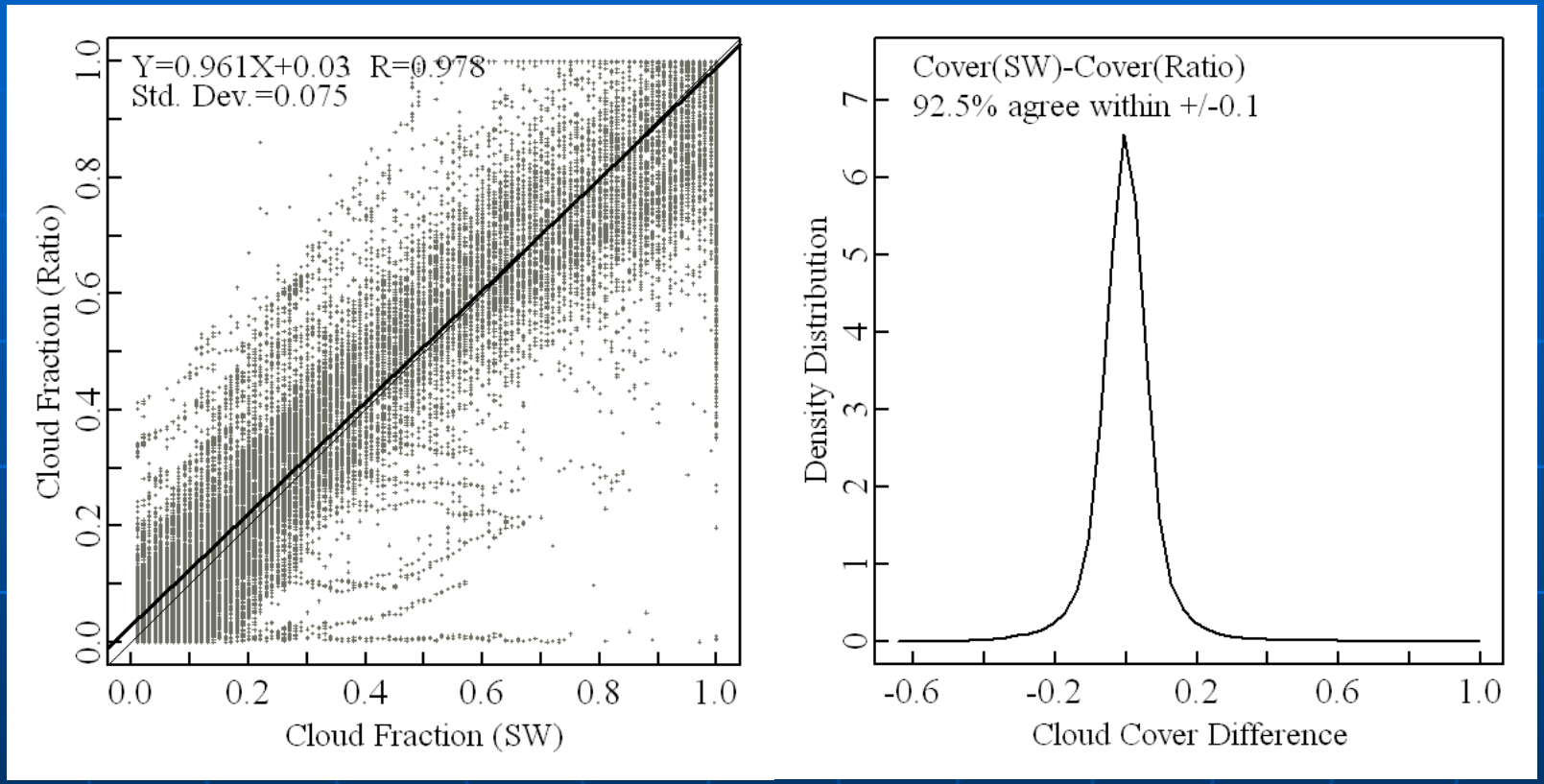
TSI: individual camera behavior and characteristics effectively make the clear/thin threshold less robust than the classification of obviously clear skies and opaque clouds

Ratio method & TSI Observation





Ratio method & SW Analysis



Conclusion:

A method for estimating fractional sky cover from spectral measurements has been developed.

As illustrated in our sensitivity study and demonstrated in real measurements, the transmittance ratio at selected wavelengths is insensitive to solar zenith angle and major atmospheric gaseous absorption.

With a localized baseline procedure, retrievals of this ratio method are independent of absolute calibration and weakly sensitive to changes in cloud and aerosol optical properties.

The uncertainty of this method, estimated through the sensitivity study and intercomparison, is less than 10%.

Ratio method & TSI Opaque