Cloud information from Oxygen A-band Spectrometer

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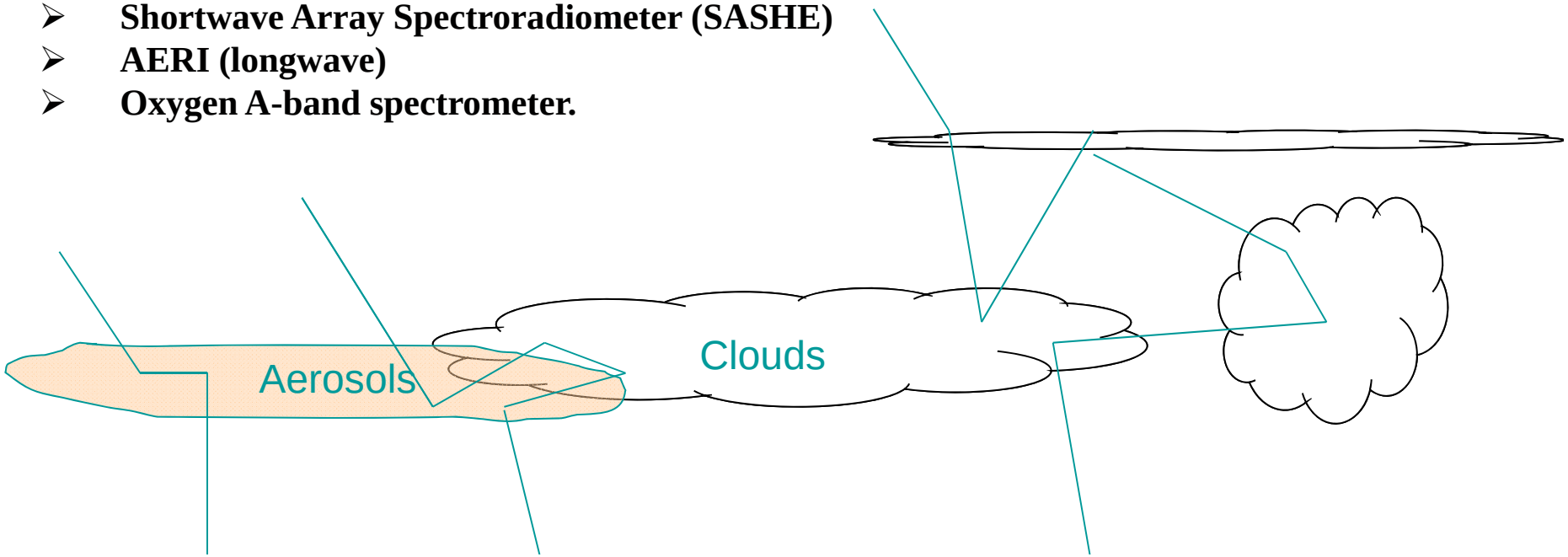
Spectral radiation closure / Radiative impacts of aerosol-to-cloud transition

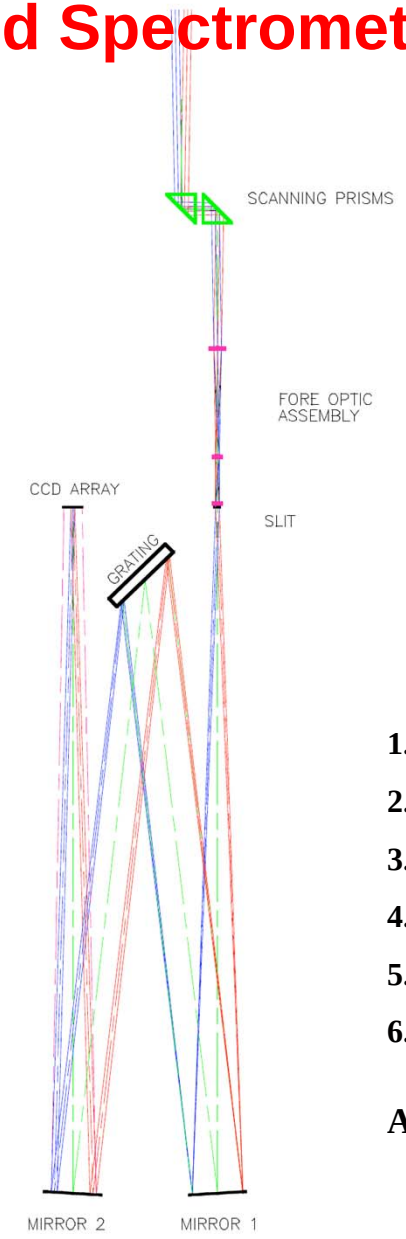
- **Aerosol optical properties/Cloud optical properties → 1D effect**
- **Aerosol-cloud microphysical interaction/transition →3D effects**
- **Cloud layering / Cloud overlap (GCM) → 3D effects**
- **Radiation closure (surface or TOA) vs. the accuracy of heating rate profile**

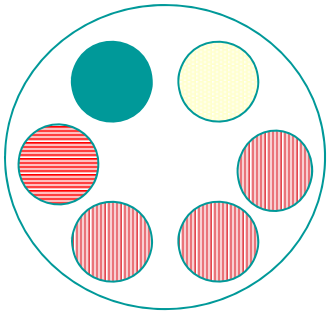
Measurement capability

- **Scanning radars/lidar**
- **Shortwave Array Spectroradiometer (SASHE)**
- **AERI (longwave)**
- **Oxygen A-band spectrometer.**



High Resolution Oxygen A-band Spectrometer (HABS)



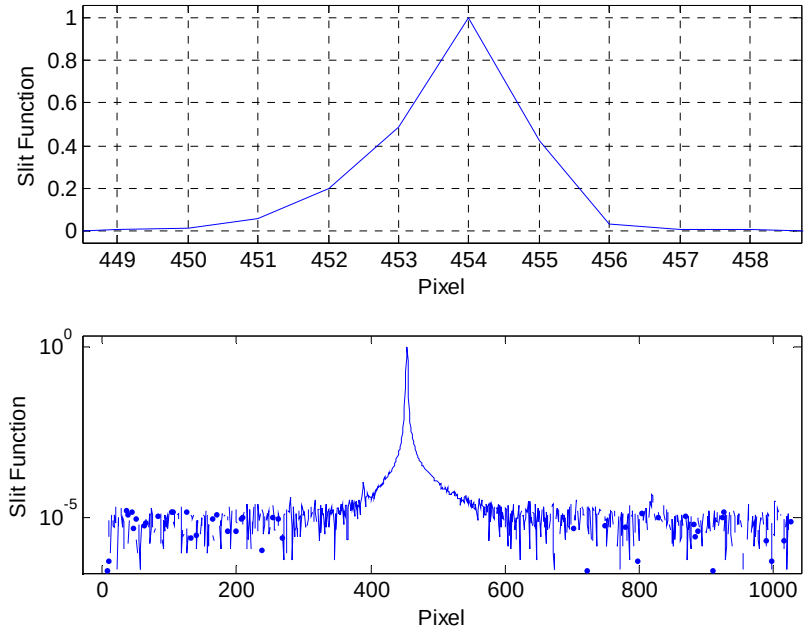


1. **Open**
2. **0-Polarization**
3. **45-Polarization**
4. **90-Polarization**
5. **135-polarization**
6. **Diffusor**

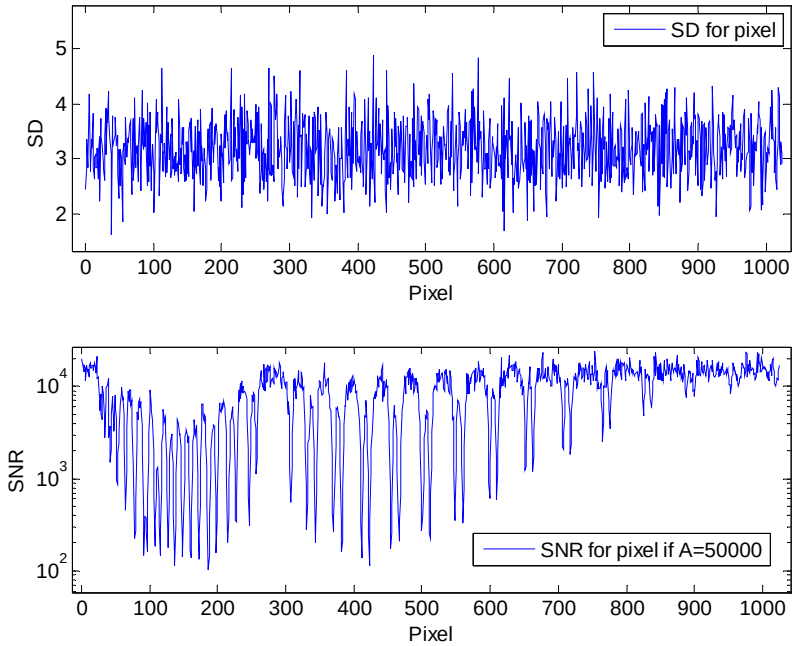
A field of view of 2.7° .

High Resolution Oxygen A-band Spectrometer (HABS)

Slit Function:



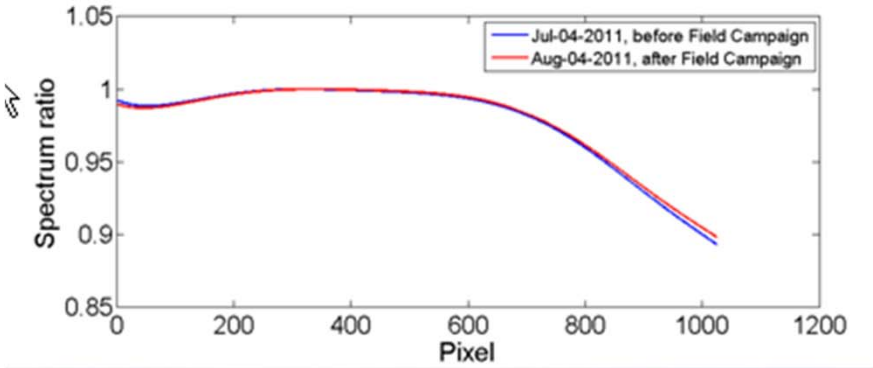
SNR:

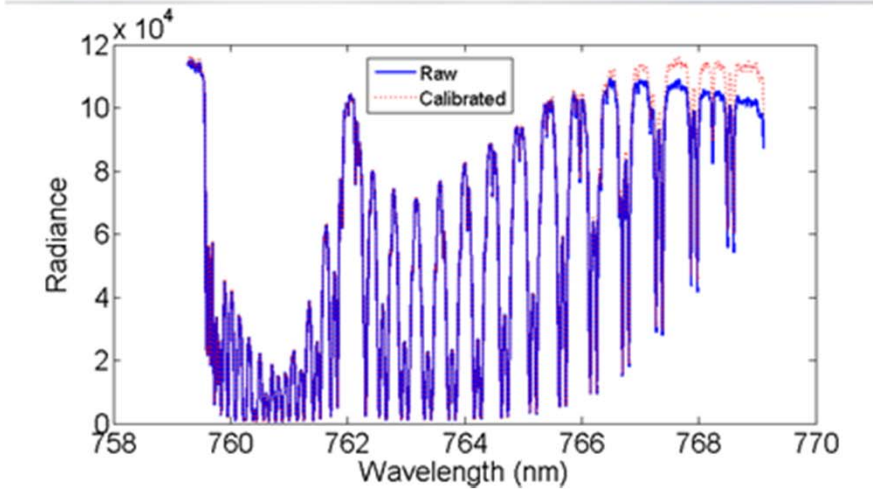


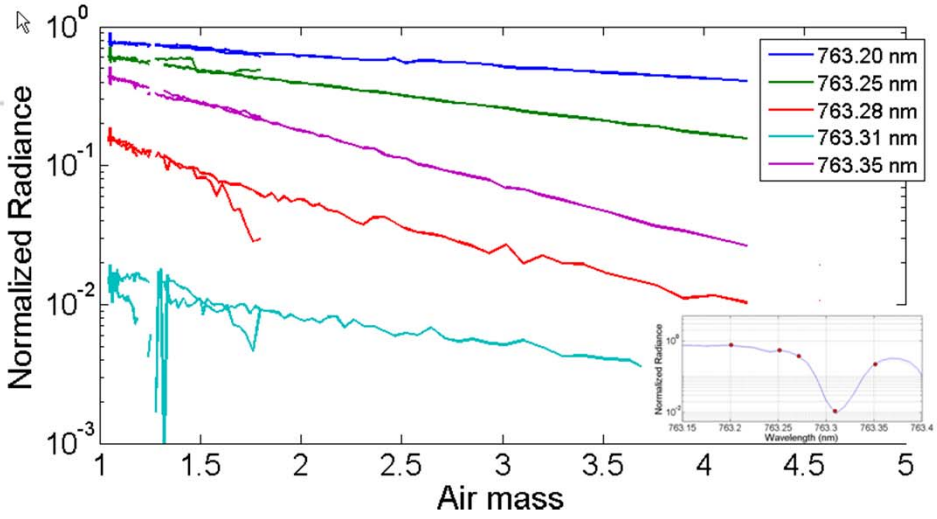
- **The FWHM is about 1.85 pixels or 0.019 nm, which is better than 1/3 of wavenumber.**
- **The out of band rejection of the HABS is 10-5, better than the requirement.**
- **SNR is over 100 even for the darkest pxiels**

High Resolution Oxygen A-band Spectrometer (HABS)

--- DISCOVER-AQ field campaign







Oxygen A-band measurements and applications:

- Validating GCM cloud overlap schemes
- 3D radiative effects

Equivalence Theorem: [Irvine, 1964]

$$I_\nu(\mu,\phi;\mu_0,\phi_0) = I_0(\mu,\phi;\mu_0,\phi_0)\int_0^\infty p(l,\mu,\phi;\mu_0,\phi_0)e^{-\kappa_\nu l}dl$$

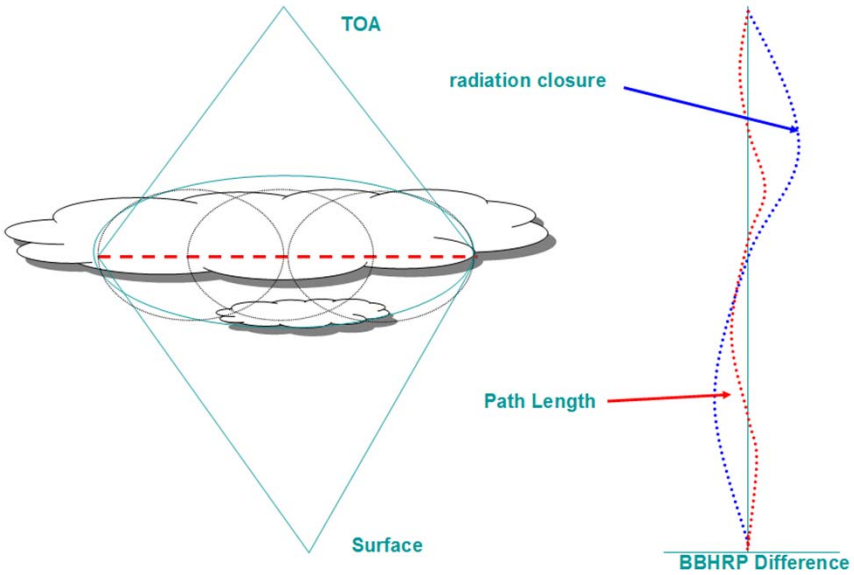
Where *p(l)* is photon path length distribution with path length *l*

K_v is gaseous absorption coefficient

$I_0(\mu,\phi;\mu_0,\phi_0) \Rightarrow$ **cloud optical properties**

$p(l,\mu,\phi;\mu_0,\phi_0) \Rightarrow$ **cloud geometry**

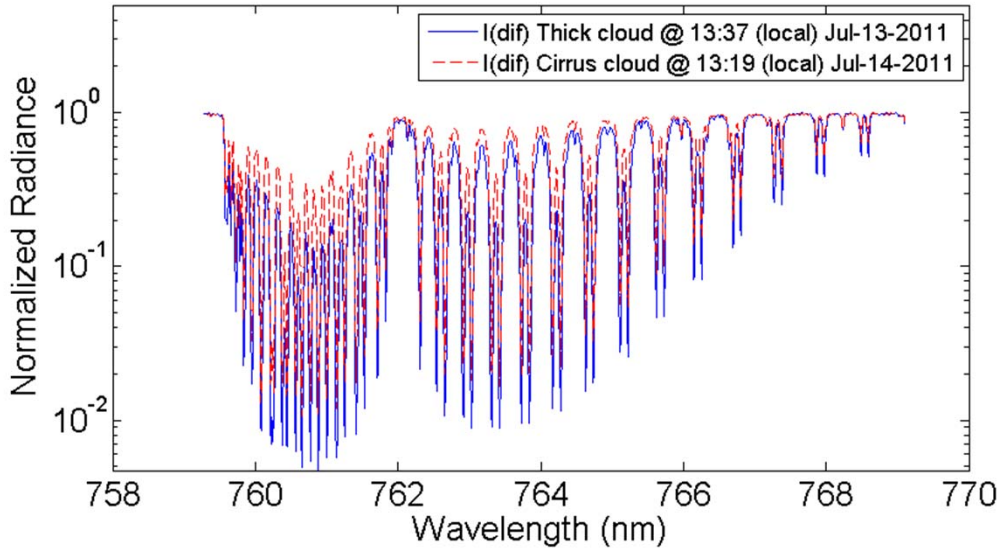
$\Rightarrow$ **Radiation field**

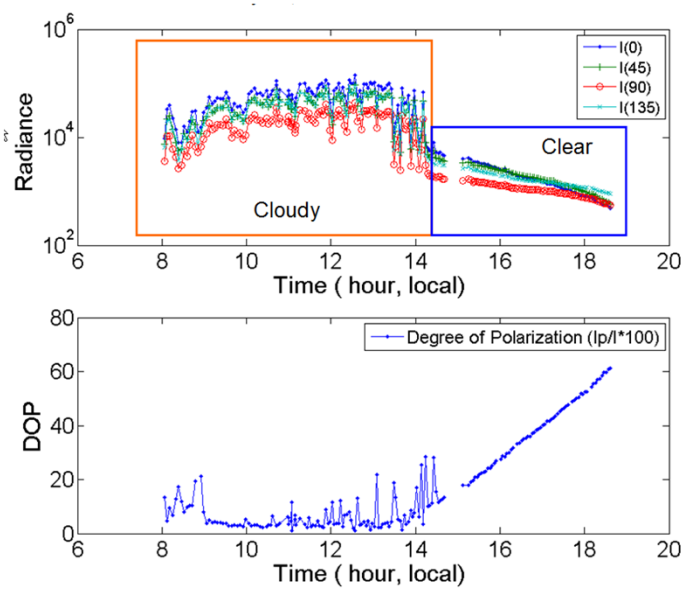


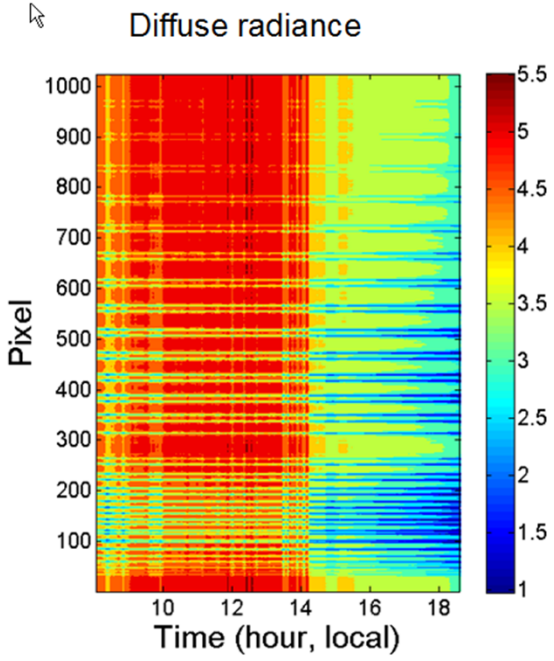
- Mean path length to ensues the radiation closure at the surface and TOA
- Higher moments to ensure the accuracy of heating profiles

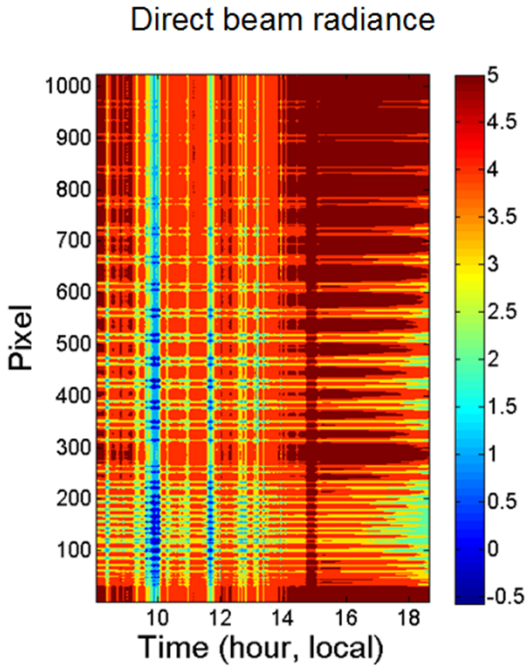
Oxygen A-band measurements and applications:

- **Radiative impacts of aerosol-cloud transition**



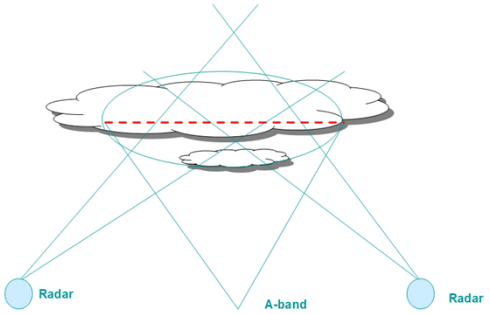




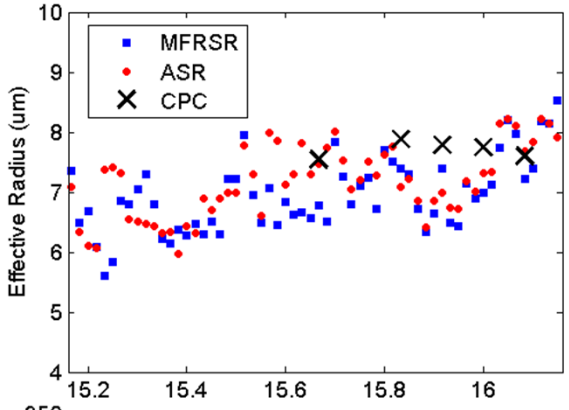


Oxygen A-band measurements and applications:

Synergetic retrievals of cloud optical properties from Radar



$$LWP(\text{model}) \propto D^3 \Leftarrow \begin{matrix} R(\text{Radar}) \propto D^6 \\ T(\text{A-band}) \propto D^2 \end{matrix}$$



- Better constraints on cloud drop size distribution and multi-layer clouds

Comparison of Radar (CPC, Mace) and Spectrometer-Radar (ASR)