



Inferring Optical Depth of Broken Clouds above Green Vegetation using Aircraft-based Radiometric Measurements (Interpreting RACORO Measurements)

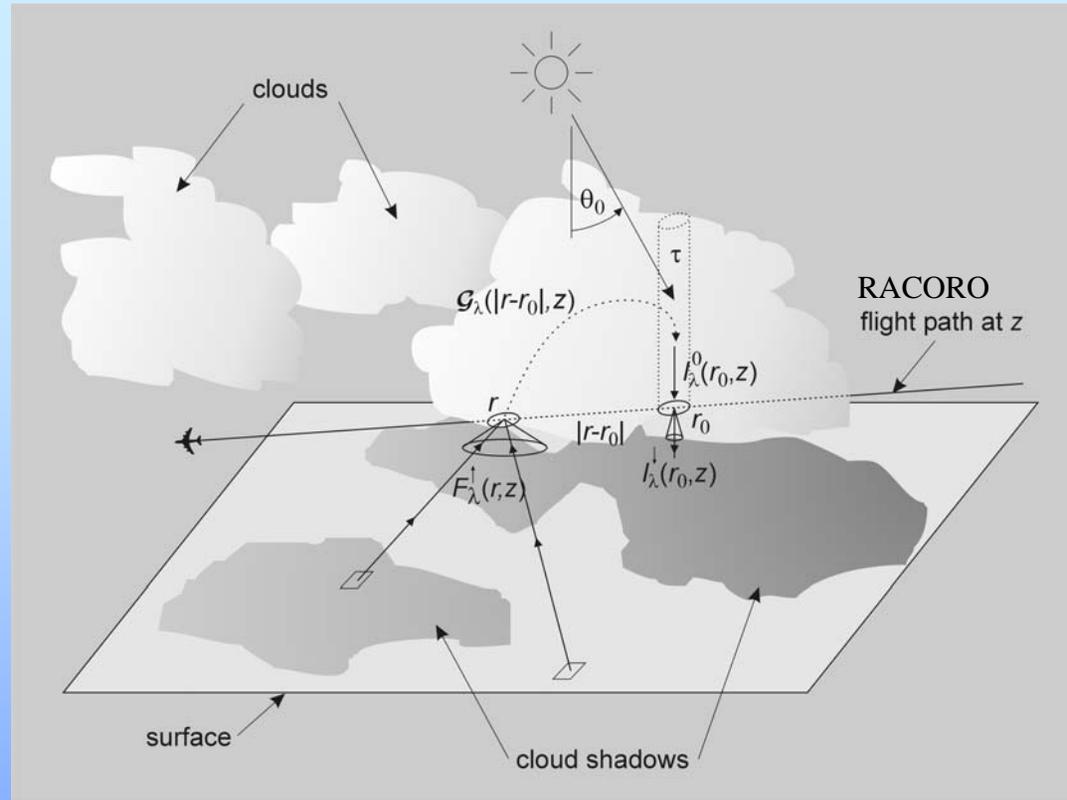
Howard Barker and Alexander Marshak

"An aircraft flying in the vicinity of cloud base ... moves quickly relative to cloud advection and evolution and, with a down-facing pyranometer, can measure upwelling flux directly over any surface type. Moreover, cloud and aerosol present beneath the aircraft are, in principle, not problematic. The primary drawbacks to the aircraft method are cost and limited application. ... Obviously the aircraft method will be used only during relevant field experiments."

Barker, H., A. Marshak, W. Szyrmer, A. Trishchenko, and J. Blanchet, 2002: Inference of cloud optical properties from aircraft-based solar radiometric measurements. *J. Atmos. Sci.*, **59**, 2093-2111.



Schematics and main equation



Downwelling
radiance

Downwelling
radiance for a
"black" surface

Upwelling flux Green's function

$$I_{\lambda}^{\downarrow}(r_0; z) = I_{\lambda}^0(r_0; z) + \int_{\mathcal{R}} F_{\lambda}^{\uparrow}(r; z) \mathcal{G}_{\lambda}(|r_0 - r|; z) dr,$$



Observations

Observations are made at two wavelength λ_1 and λ_2 such that:

- optical properties above z are very *similar* at λ_1 and λ_2
- optical properties below z *differ* at λ_1 and λ_2
- satisfied for green vegetation at $\lambda_1=0.65$ and $\lambda_2=0.86$

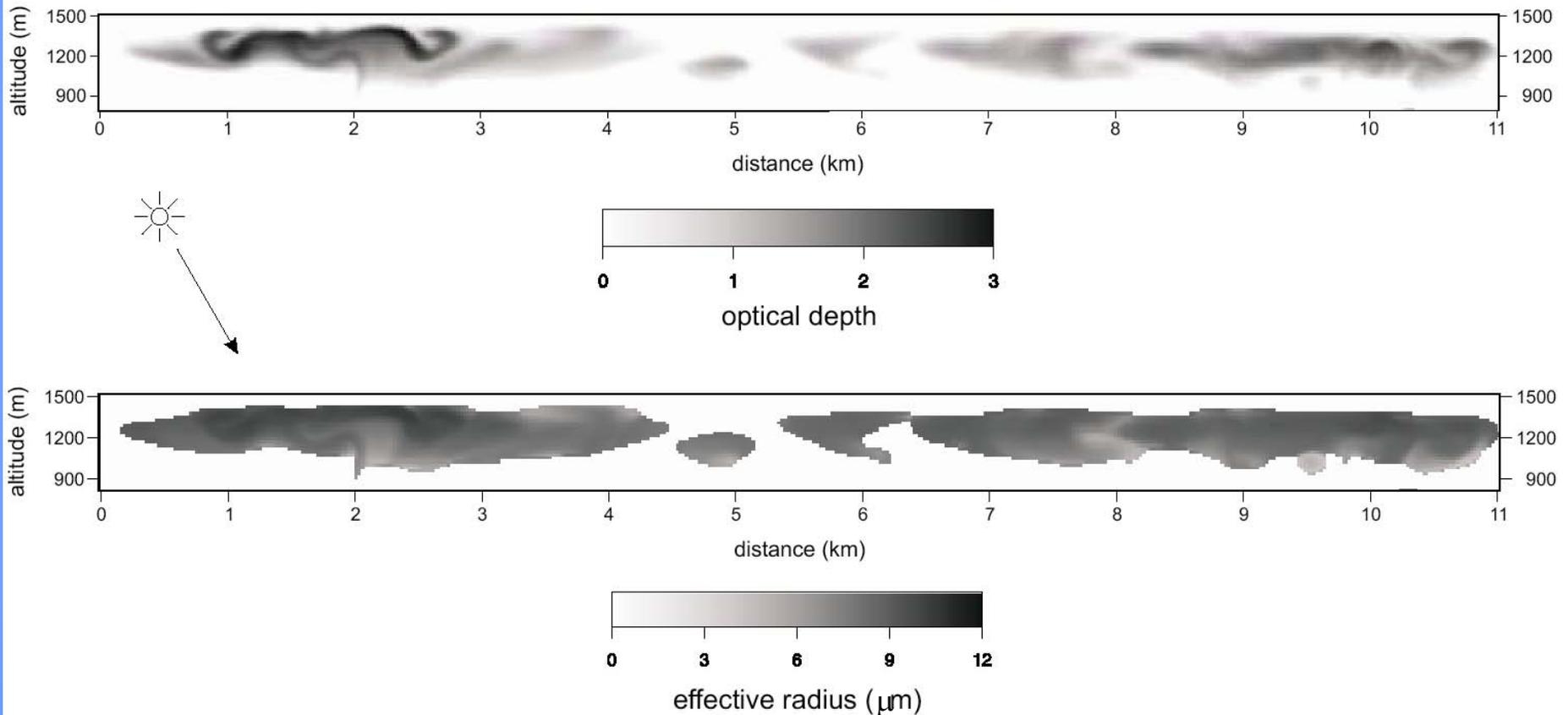
Based on these assumptions,

$$\rho_{z,z_{top}}(\tau) \approx \frac{I_{\lambda_2}^{\downarrow}(r_0, z) - I_{\lambda_1}^{\downarrow}(r_0, z)}{\int_{\mathcal{R}} \left[F_{\lambda_2}^{\uparrow}(r, z) - F_{\lambda_1}^{\uparrow}(r, z) \right] \mathcal{H}(|r_0 - r|, z) dr}$$



Experimental setup: cloud field

- simulated by 2D CRM
- spatial resolution of droplet size spectra
- 25 m resolution, 100 km domain



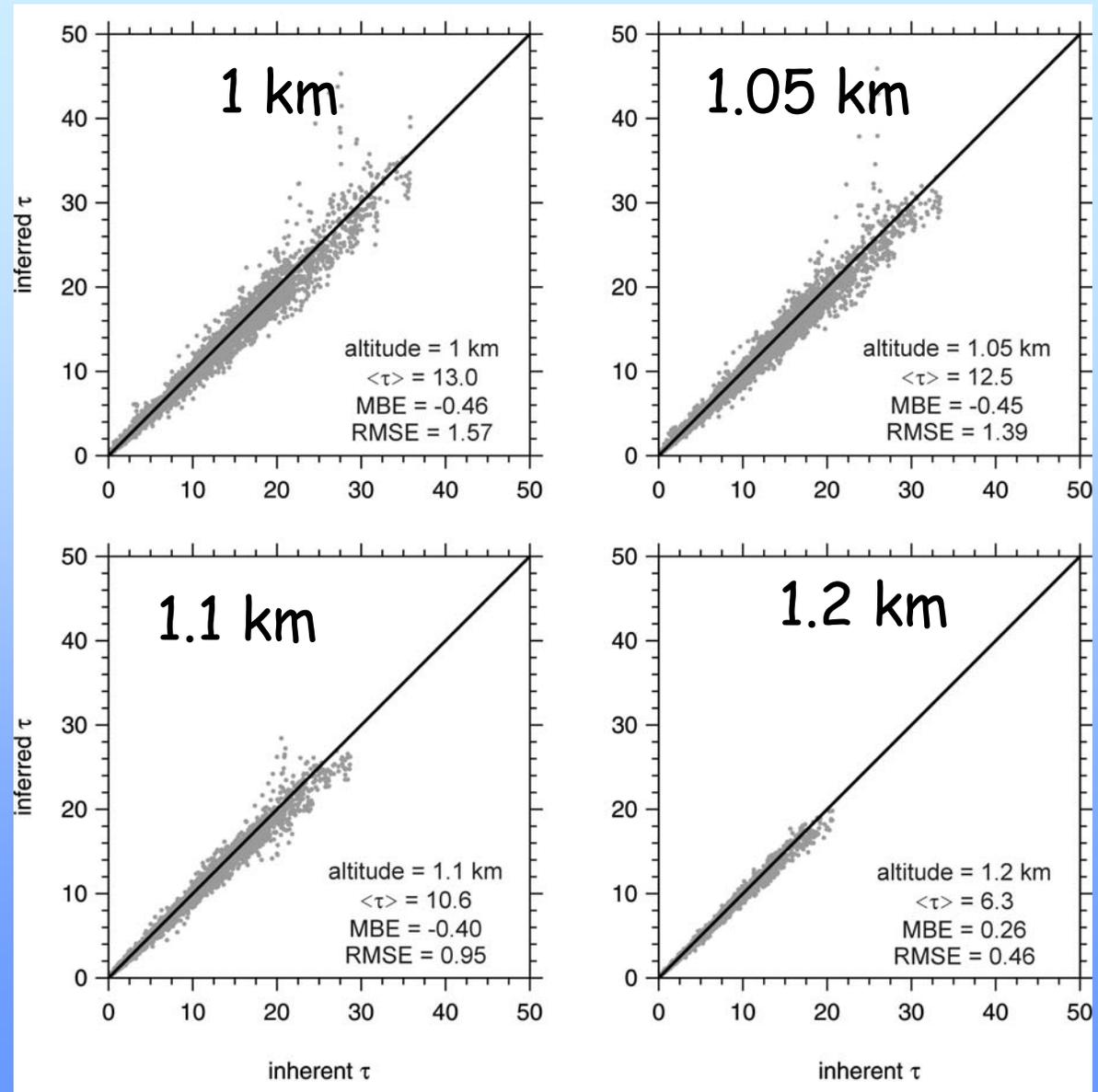


Results

Scatter plots of inferred vs. inherent τ for an aircraft at various z .

Gamma distr. for the Green's function has been used.

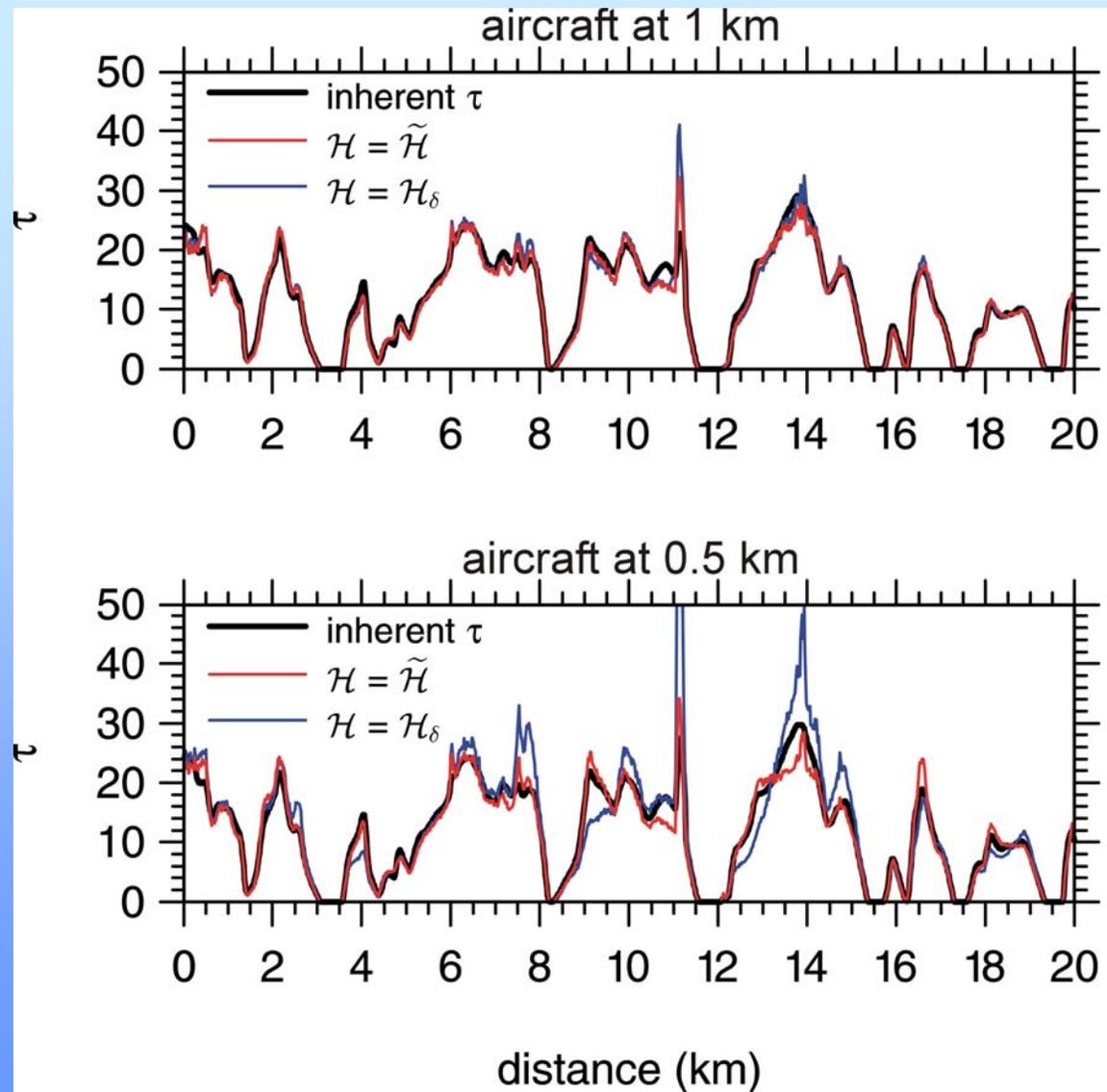
(MBE=mean bias error)





Results (cont.)

A 20 km transect shows inherent and retrieved τ from the aircraft at 1 and 0.5 km resp. using both approx. to the Green's function





Summary

Main Idea and Assumptions

- use both zenith radiance and flux at two λ s;
- assumed that atm. optical properties at both λ s are *similar* above the aircraft but *differ* below it;
- seems like appropriate for the interpretation of RACORO measurements over vegetated surface.