Calculation of TOA and surface albedo over the Antarctic using in-situ BRDF measurements

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Radiative transfer model

- 32 bands covering CERES SW band;
- monochromatic calculations performed by DISORT;
- accounts for Rayleigh scattering;
- gas absorption (correlated-*k*, HITRAN);
- clouds and aerosol scattering and absorption (if any);
- surface elevation;
- accurate bottom boundary condition.

BRDF: $$\rho(\theta_0,\theta_v,\varphi)=\frac{I_r(\theta_0,\theta_v,\varphi)}{F_0(\theta_0)}=\alpha(\theta_0)R(\theta_0,\theta_v,\varphi)/\pi$$

where $\alpha(\theta_0)$ – black sky albedo, cannot be measured due to Rayleigh scattering, has to be modeled; $R(\theta_0, \theta_v, \phi)$ – anisotropic reflection factor (ARF), measurable(?), an attempt to clean out directional distribution of the incident light in measurements under clear sky.

$$R(\theta_0,\theta_v,\varphi)=\frac{\pi I_r(\theta_0,\theta_v,\varphi)}{\int_0^{2\pi} d\varphi \int_0^{\pi/2} d\theta_v \sin\theta_v \cos\theta_v I_r(\theta_0,\theta_v,\varphi)}$$

Experiment and parameterization of ARF: Dome C, austral summers of 2003 – 2004 and 2004 – 2005, SVD (Hudson et al 2006 JGR)

Modeling black sky albedo

Snowpack was modeled as 2 layers of ice spheres. Original model: top layer is 0.25 mm thick consisting of 40 μm (radius) spheres, bottom layer is infinite of 90 μm spheres. Current model: particle size (top/bottom layer) – 70/120 μm, optical thicness 2.1.

Update of the snow albedo LUT: two layer model, top layer sizes 50 μm, 100 μm, 200 μm, 500 μm, 1000 μm, 2000 μm with corresponding bottom layer sizes related to the top layer ones as 12/7. Optical thicknesses are 2.1 and 10000.

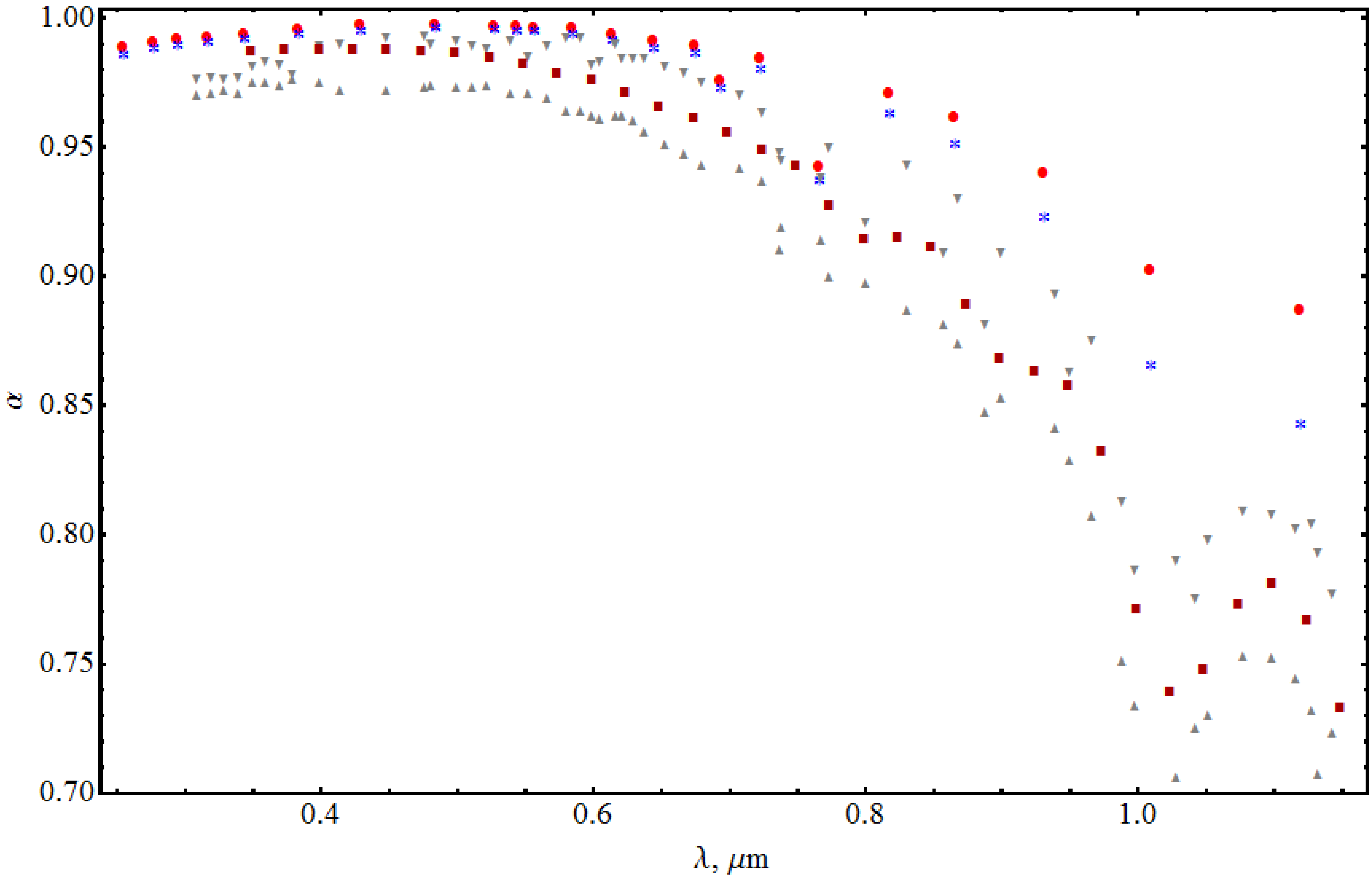

Figure 1. Spectral white sky albedo. Red circles – 40/90 μm model, blue asterisks – 70/120 μm model (both bands 1 – 23), dark red squares – Dome C measurements (Hudson et al. 2006), gray triangles – 1σ confidence interval for several data sets (Grenfell et al. 1994)

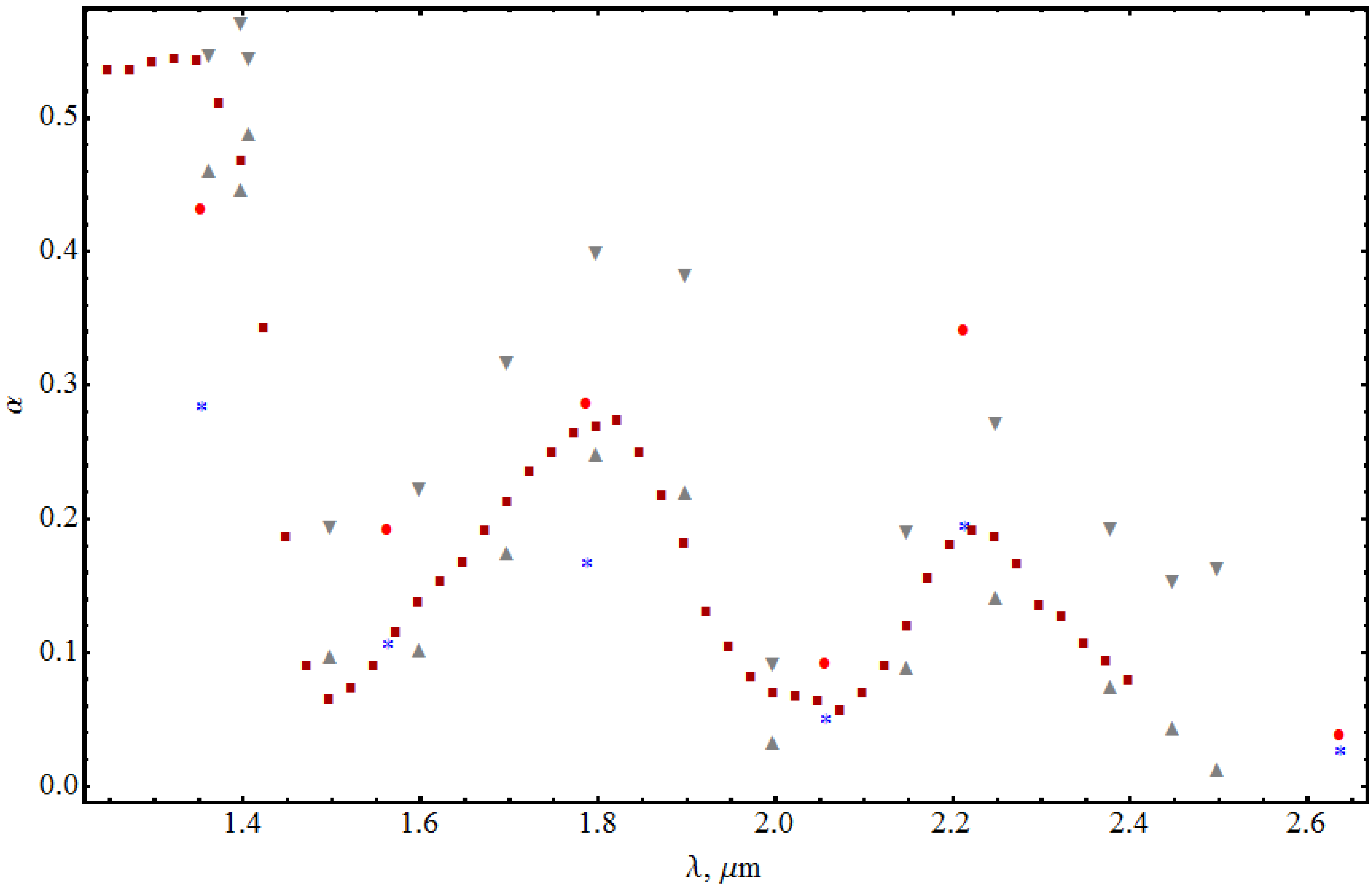

Figure 2. Spectral white sky albedo. Red circles – 40/90 μm model, blue asterisks – 70/120 μm model (both bands 24 – 29), dark red squares – Dome C measurements (Hudson et al. 2006), gray triangles – 1σ confidence interval for several data sets (Grenfell et al. 1994)

TOA albedo over Dome C

Table 1. variation of TOA albedo with solar zenith angle and atmospheric profile, first two days of 2004/01

Profile, ddhh / SZA, deg	0100	0106	0112	0118	0200	0206	0212	0218
57	0.744	0.745	0.744	0.747	0.745	0.742	0.742	0.744
63	0.744	0.745	0.744	0.747	0.744	0.742	0.742	0.744
69	0.743	0.744	0.743	0.746	0.743	0.741	0.741	0.743
75	0.740	0.741	0.740	0.743	0.741	0.738	0.738	0.740
81	0.730	0.731	0.730	0.734	0.731	0.727	0.728	0.730

Atmospheric profiles were read and interpolated from MOA files. Calculations with standard subarctic summer and winter profiles give albedo of 0.719 (57 deg), 0.717 (63 deg) and 0.733 (57 deg), 0.732 (63 deg), respectively. CERES albedo is ~ 0.67.

Future plans

- Debugging RT code for variation of snow grain size;
- Accounting for soot in the surface black sky albedo calculations;
- Selection of hemispherical clear sky scenes and comparison of CERES measurements (including NPP) and model TOA radiance and albedo.