

# Albedo Measurements in SURFRAD and ARM

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# Measurements at the Table Mountain Test Facility, Boulder, Colorado

- Installed in March 2008
- MFRSR wavelengths (415, 500, 615, 673, 870, and 940 nm plus PAR and UVB)
- Undisturbed grassland just north of usual SURFRAD measurements
- Info needed for retrieving SSA, useful for satellite AOD retrievals
- Drought monitoring

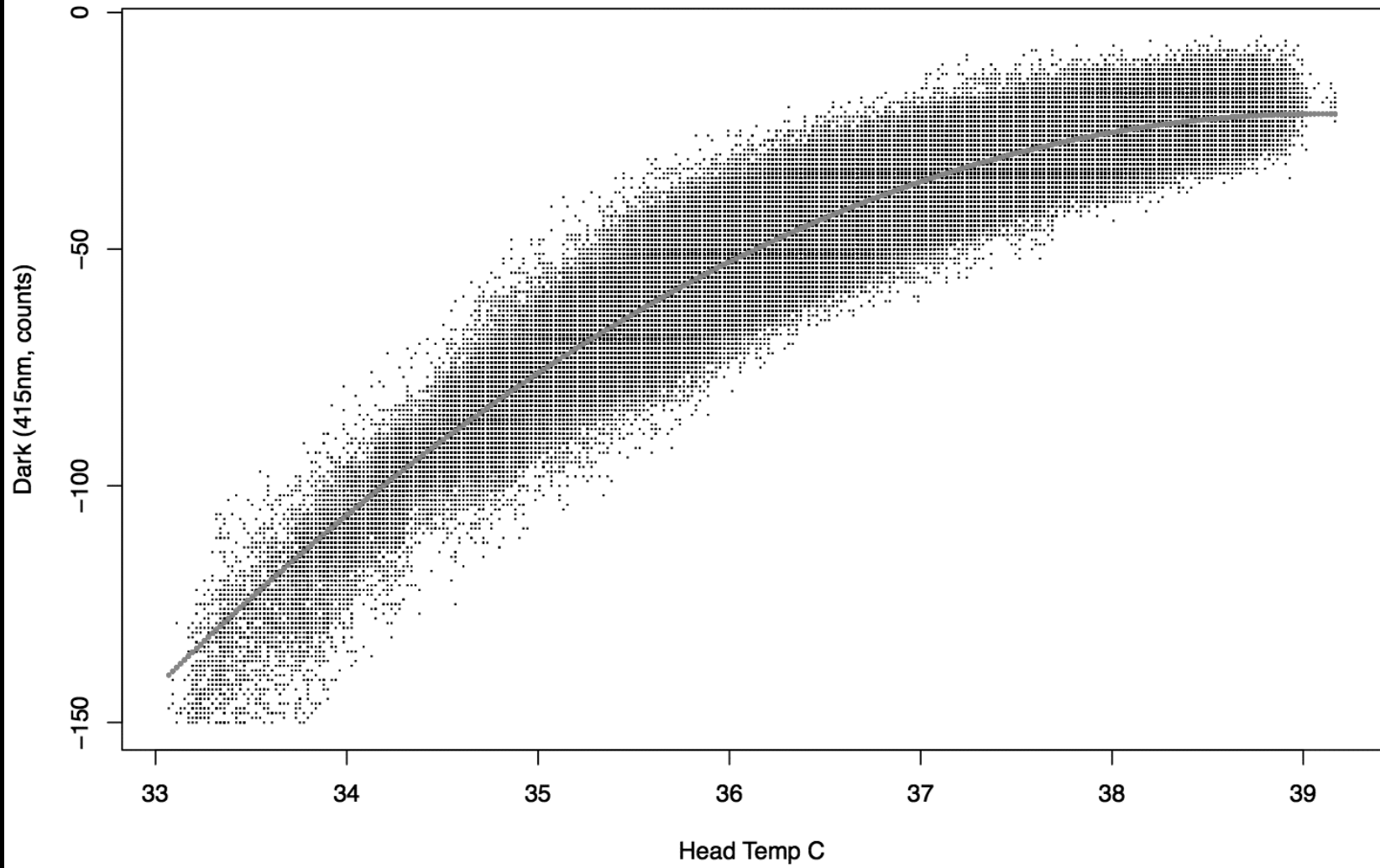




# Topics Addressed

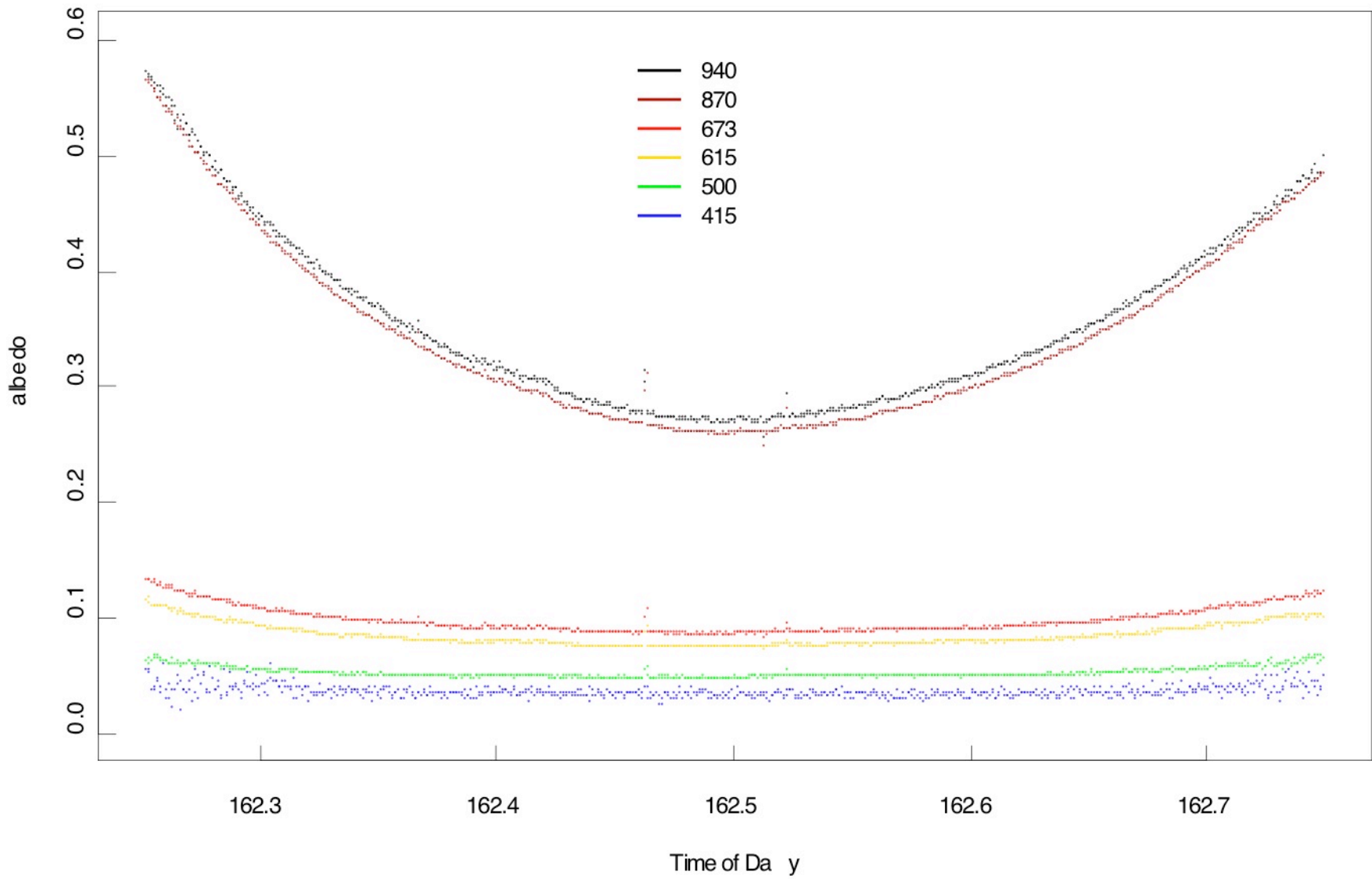
- Why did we start this? (Cloud retrievals)
- How to do this correctly? How is it done now?
- Spectral behavior: vegetation, dry grass, snow
- Solar-zenith angle behavior
- There is much to do? Including bringing ARM sites up to stuff.

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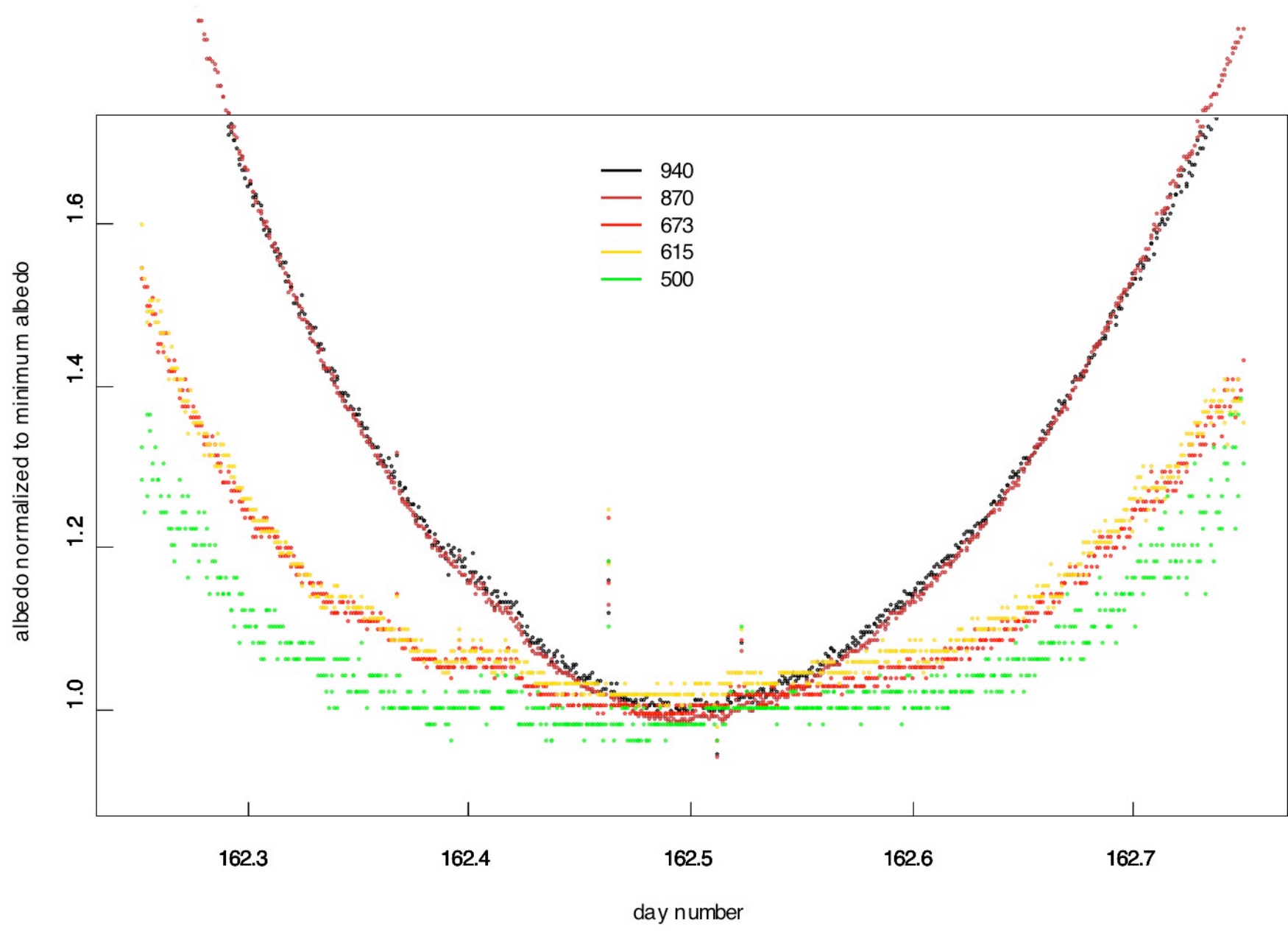


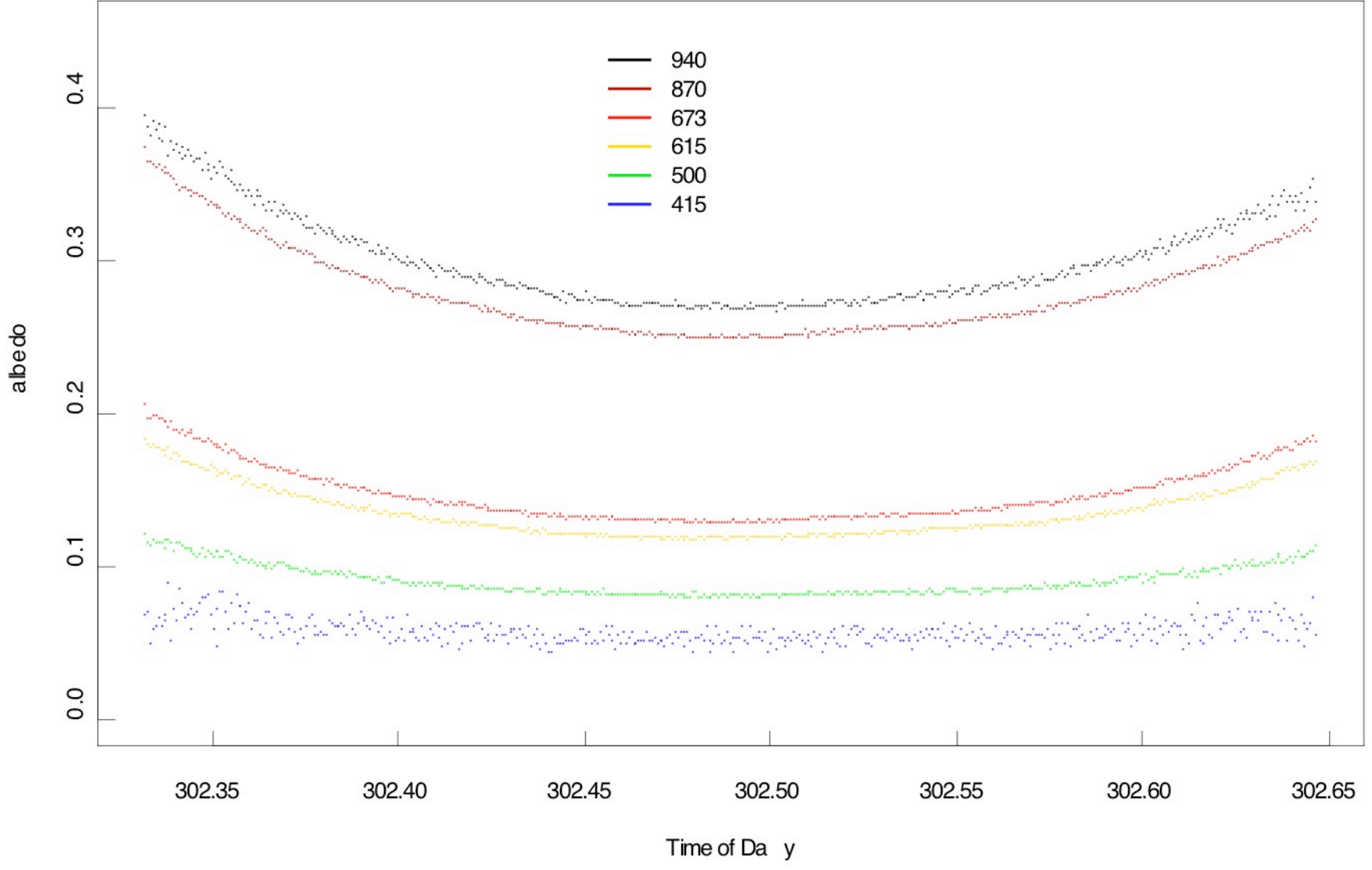
# Quality Control Issues

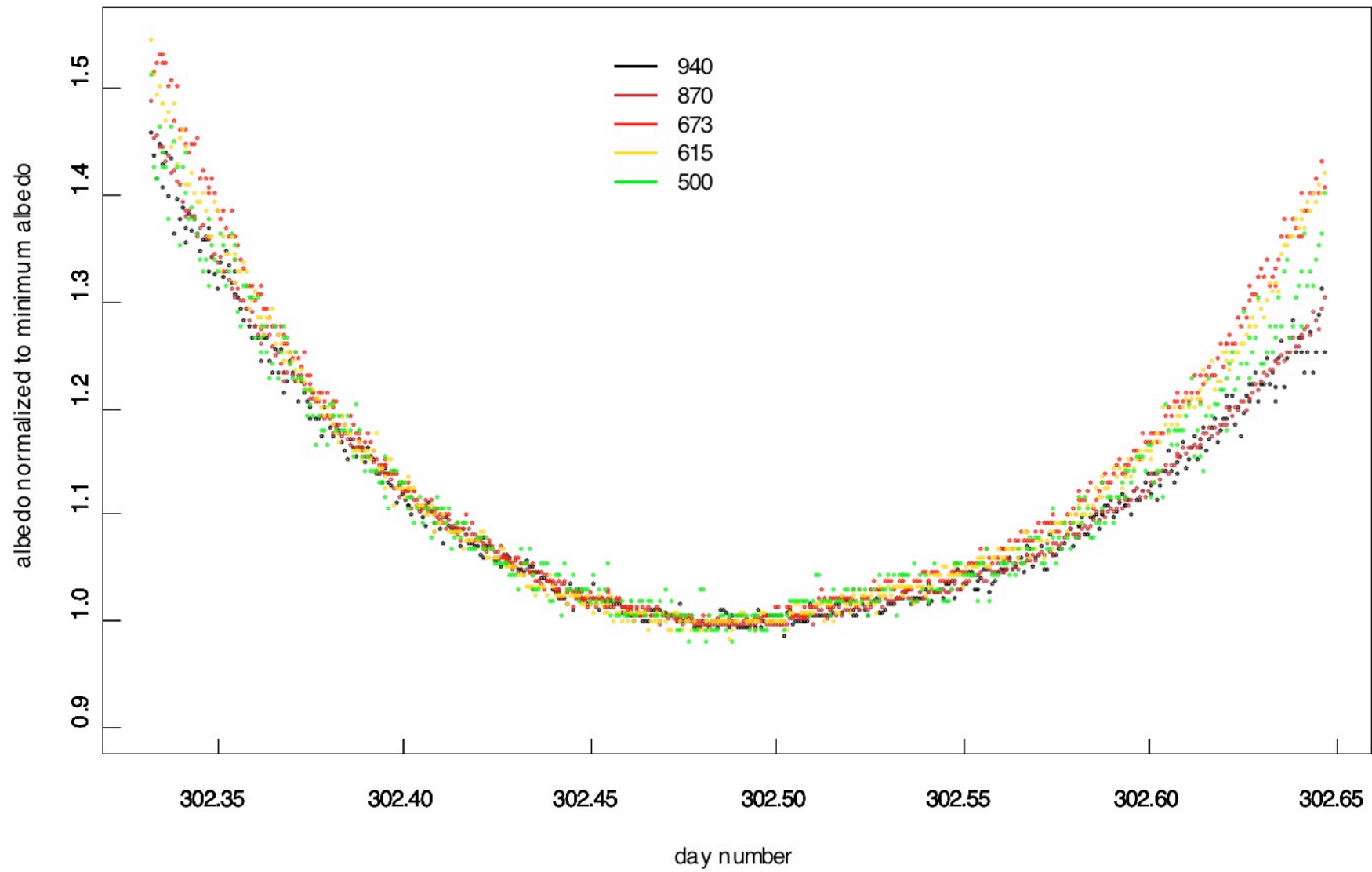
- Offset corrected
- Cosine corrections to direct, diffuse, upwelling
- Frequent calibrations

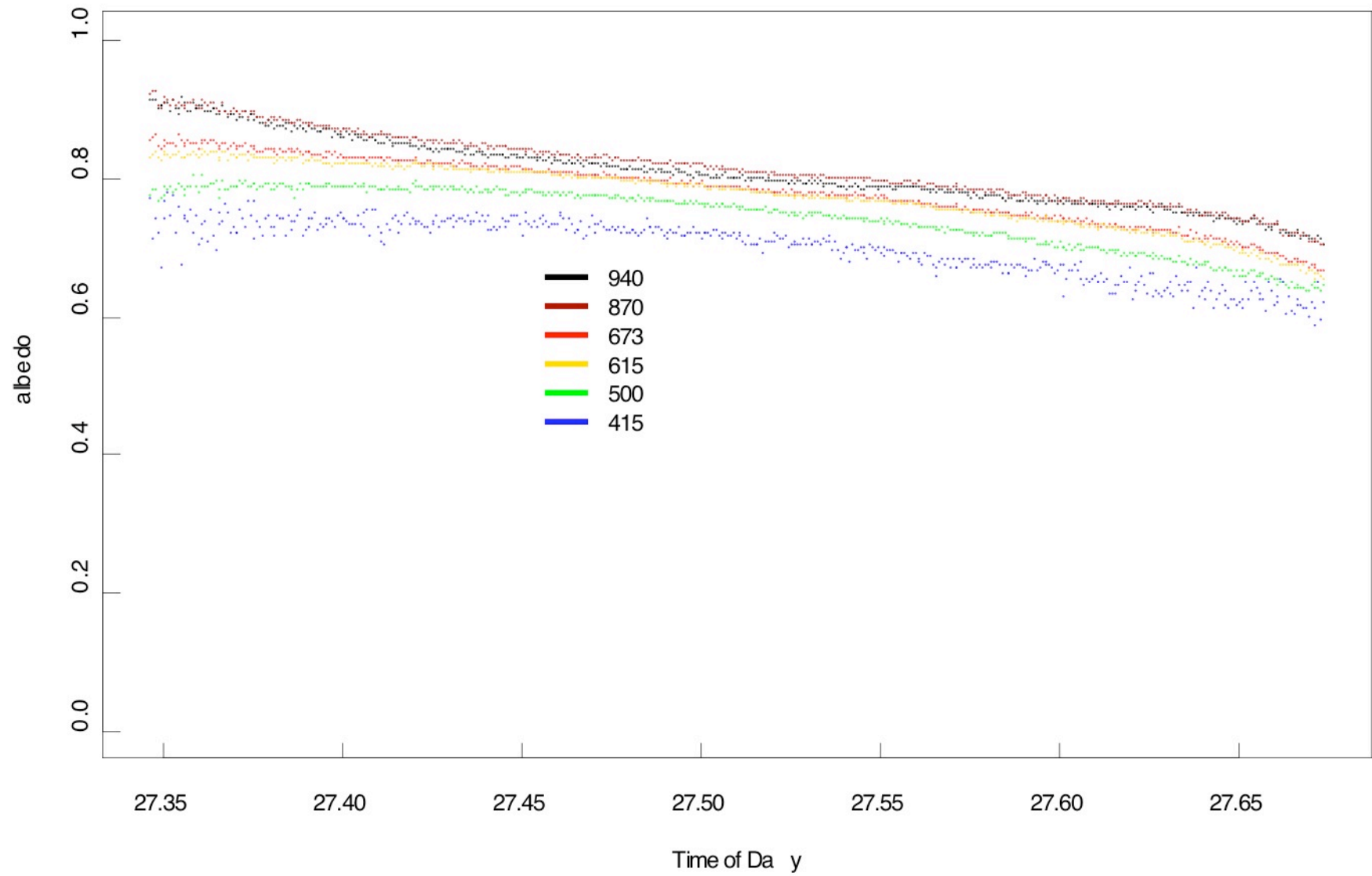


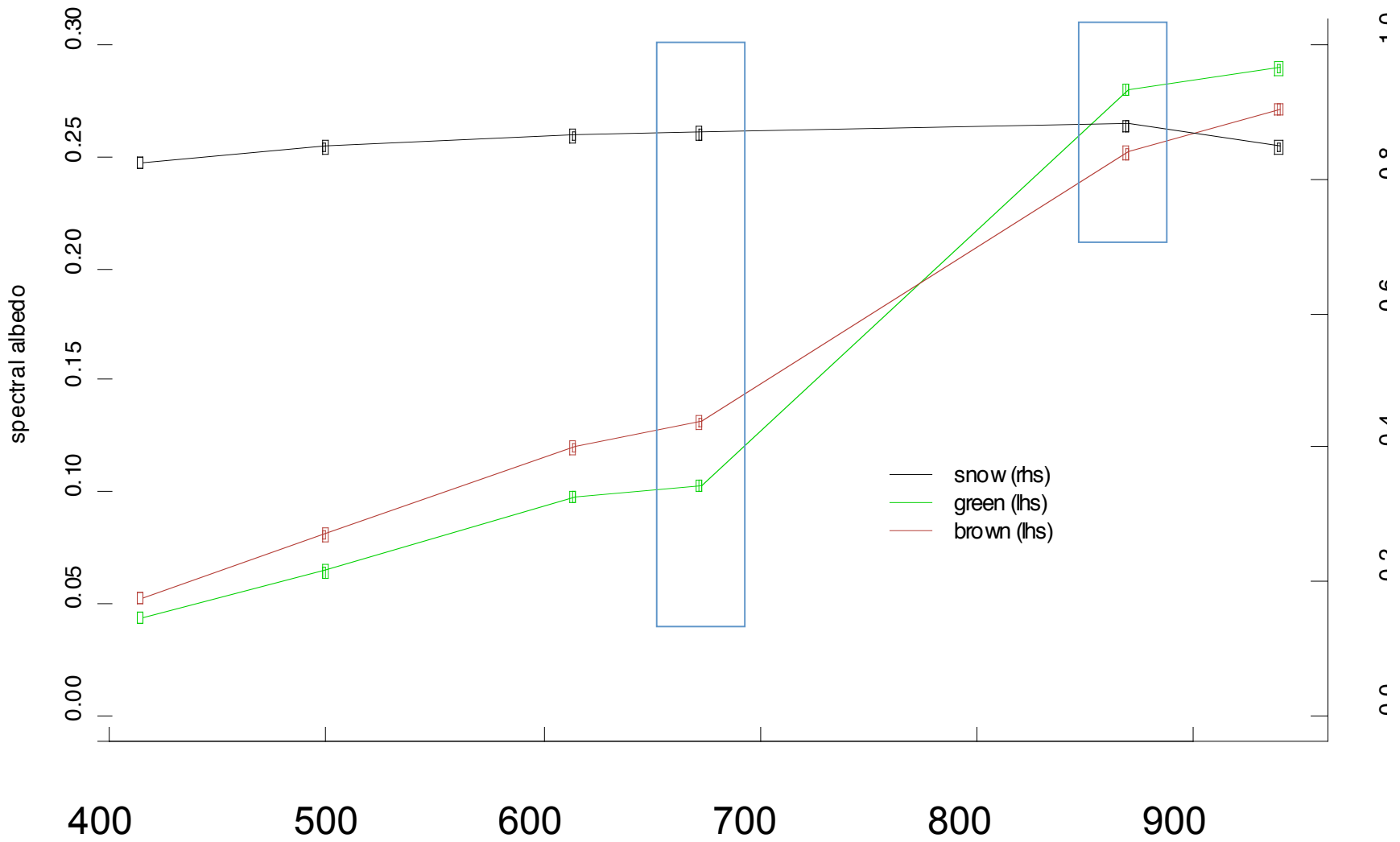






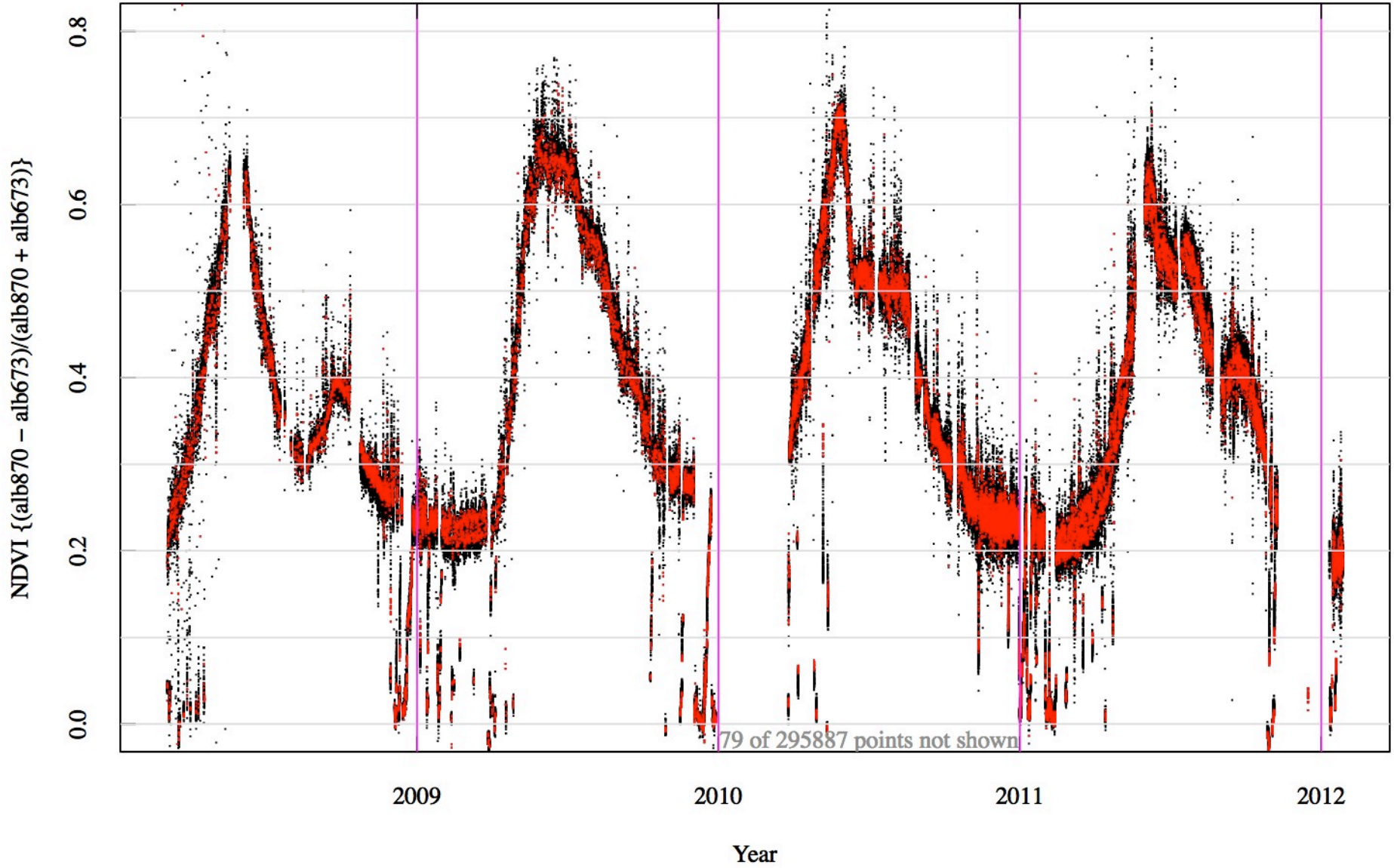






$$\text{NDVI} = (A_{870} - A_{673}) / (A_{870} + A_{673})$$

**Table Mtn Test Facility (40.1249 N; 105.2368 W)**

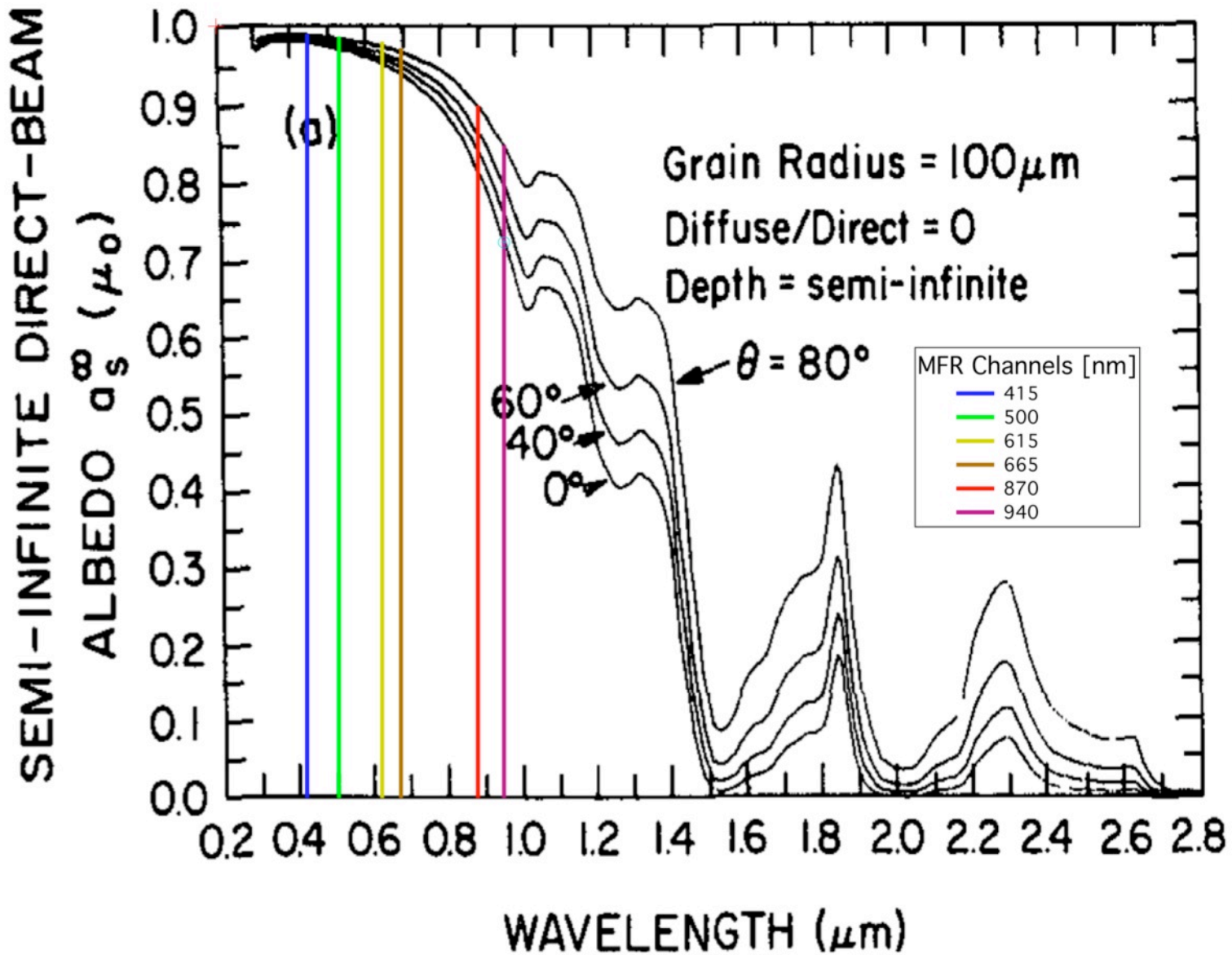


# Snow Albedos

- For the rest of the talk will focus on snow
- Reflectance as a function of wavelength
- Reflectance as a function of solar-zenith angle

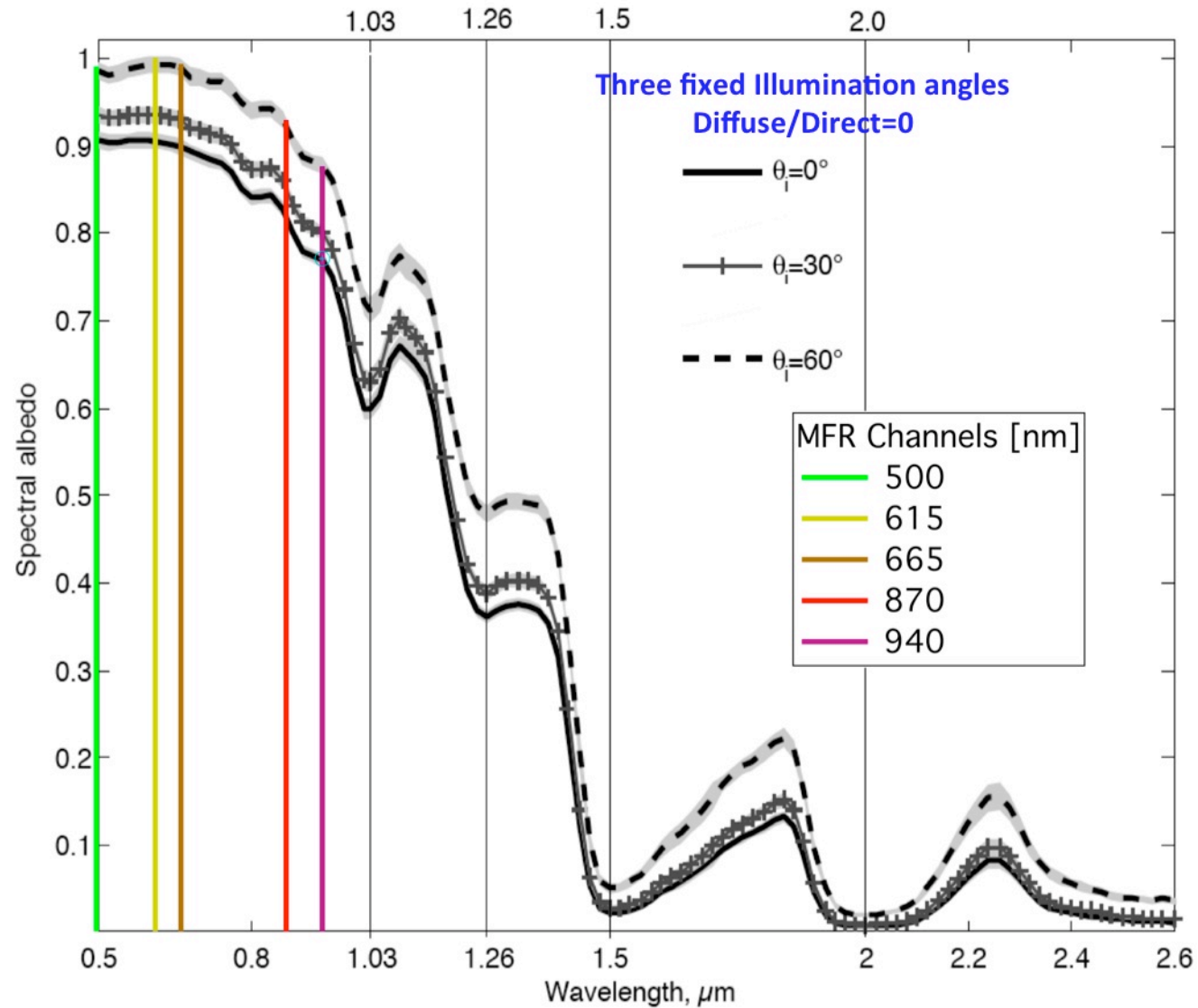


Snow Spectral Albedo Calculated from Model (Mie Scattering)



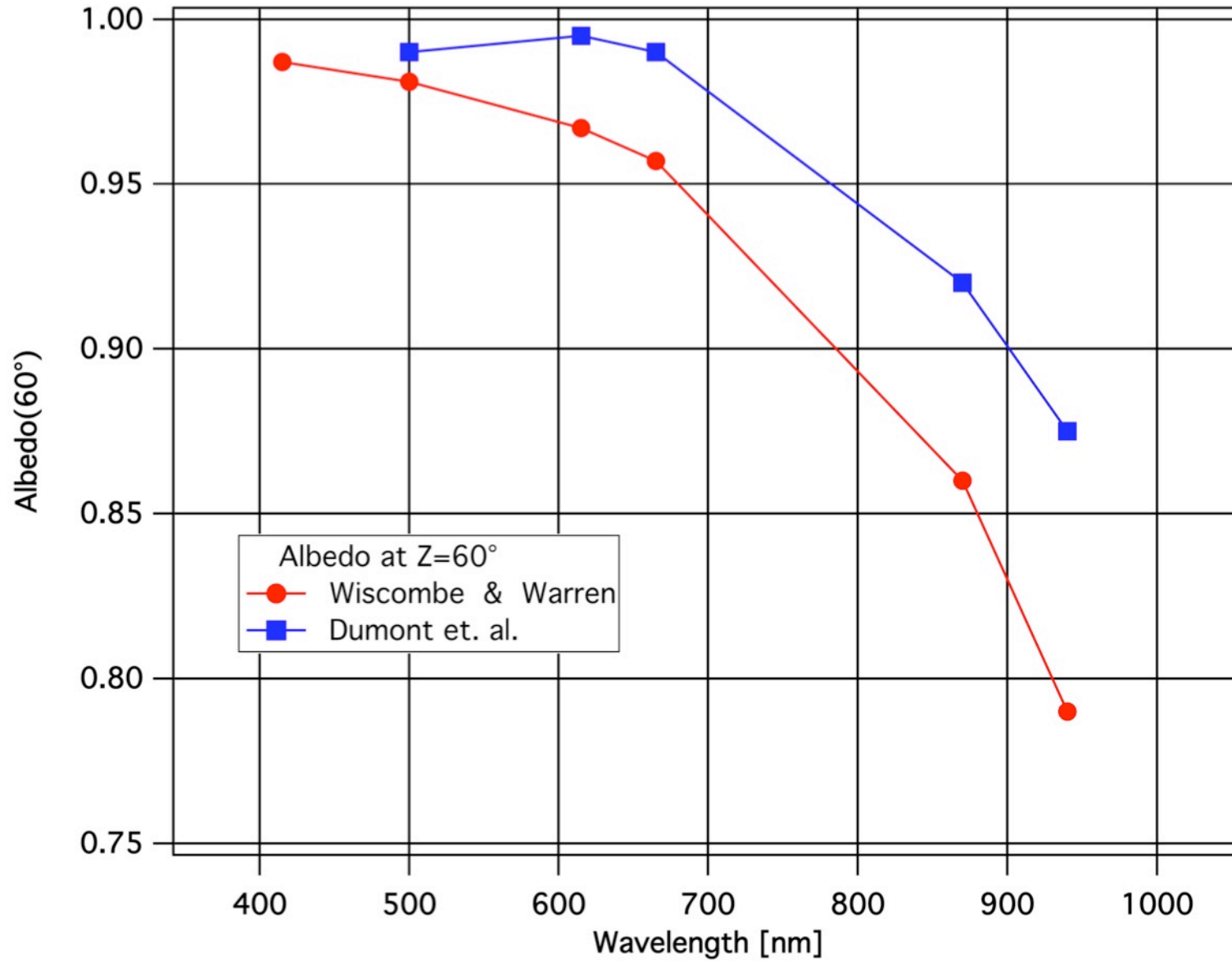
Wiscombe and Warren., *J. Atmos. Sc.*, **37**, 2712-2733, [1980](#), **Figure 11a**

## Snow Spectral Albedo Calculated from Measured (goniometric) BRDF



Dumont et al., *Atmos. Chem. Phys.*, **10**, 2507-2520, [2010](#), **Figure 2**

## Snow Spectral Albedo at Z=60° as Function of Wavelength



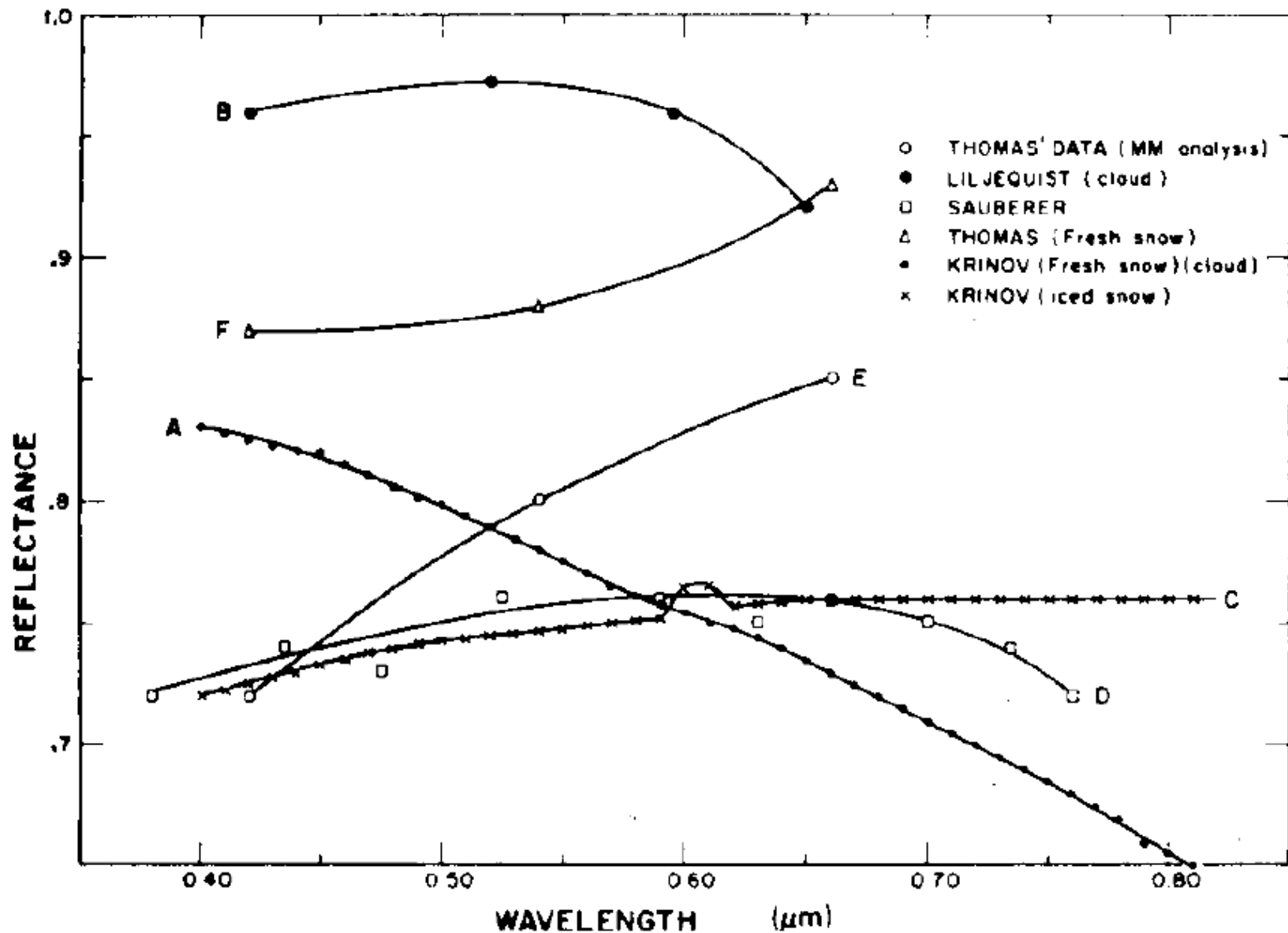
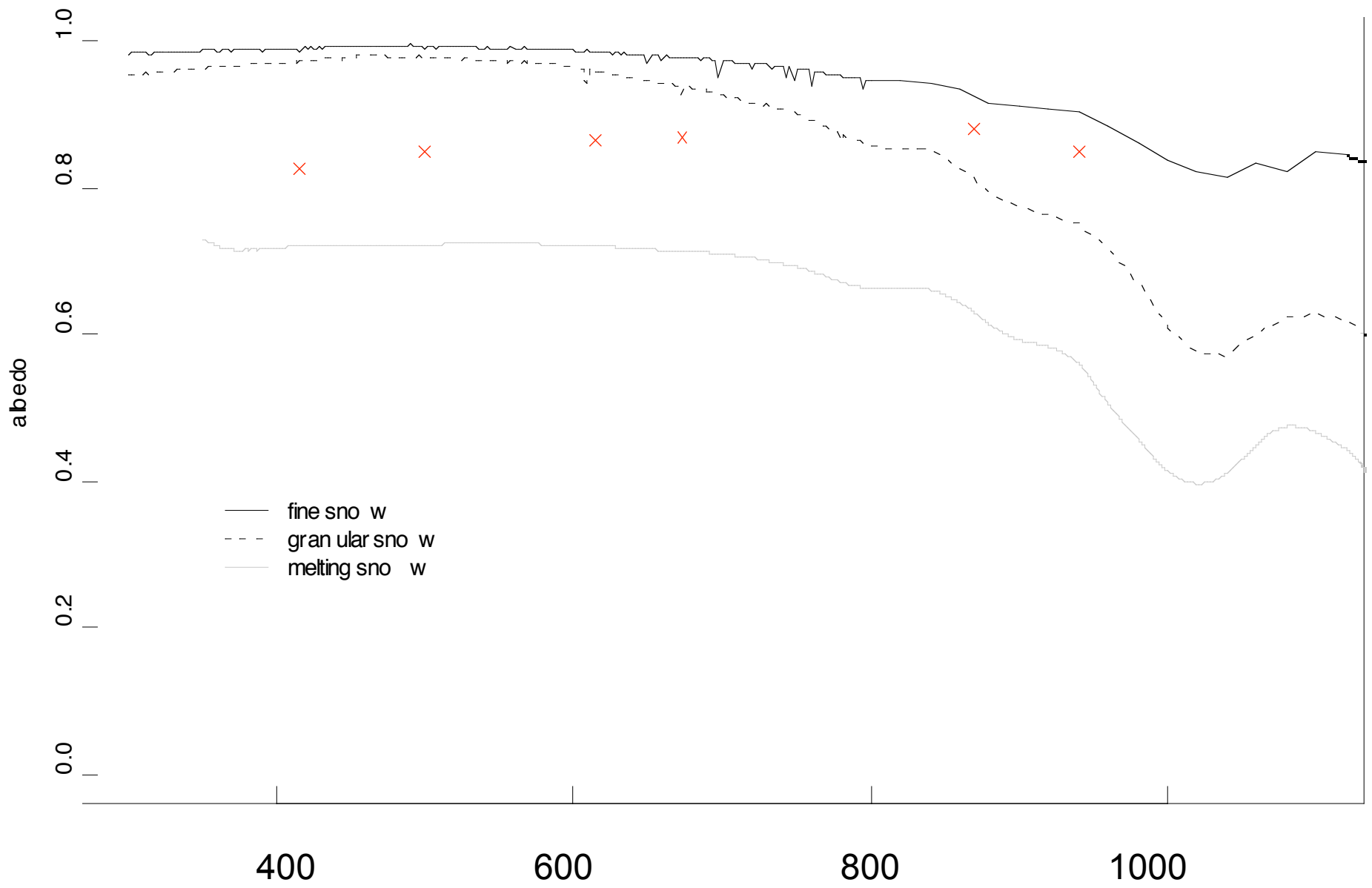
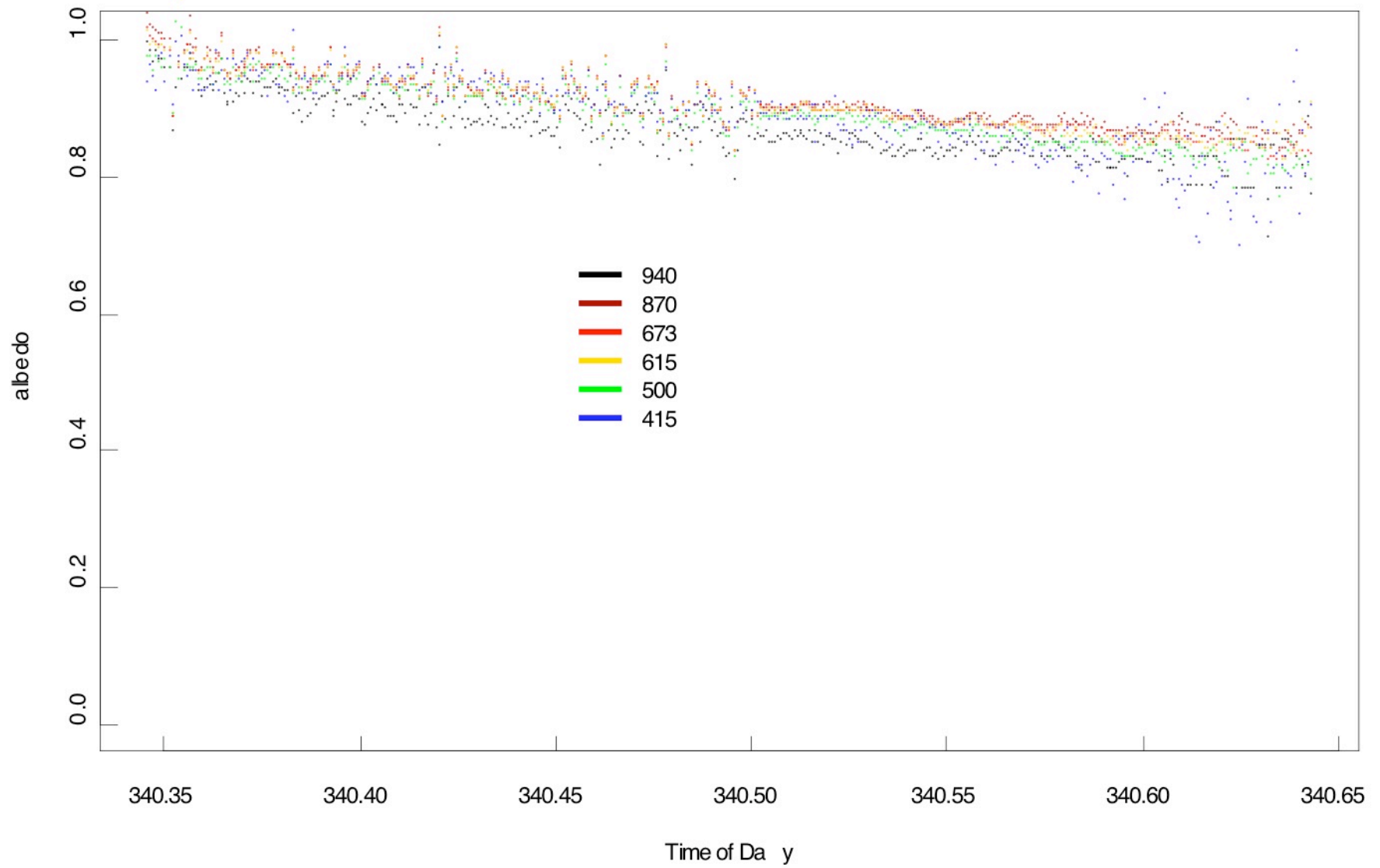


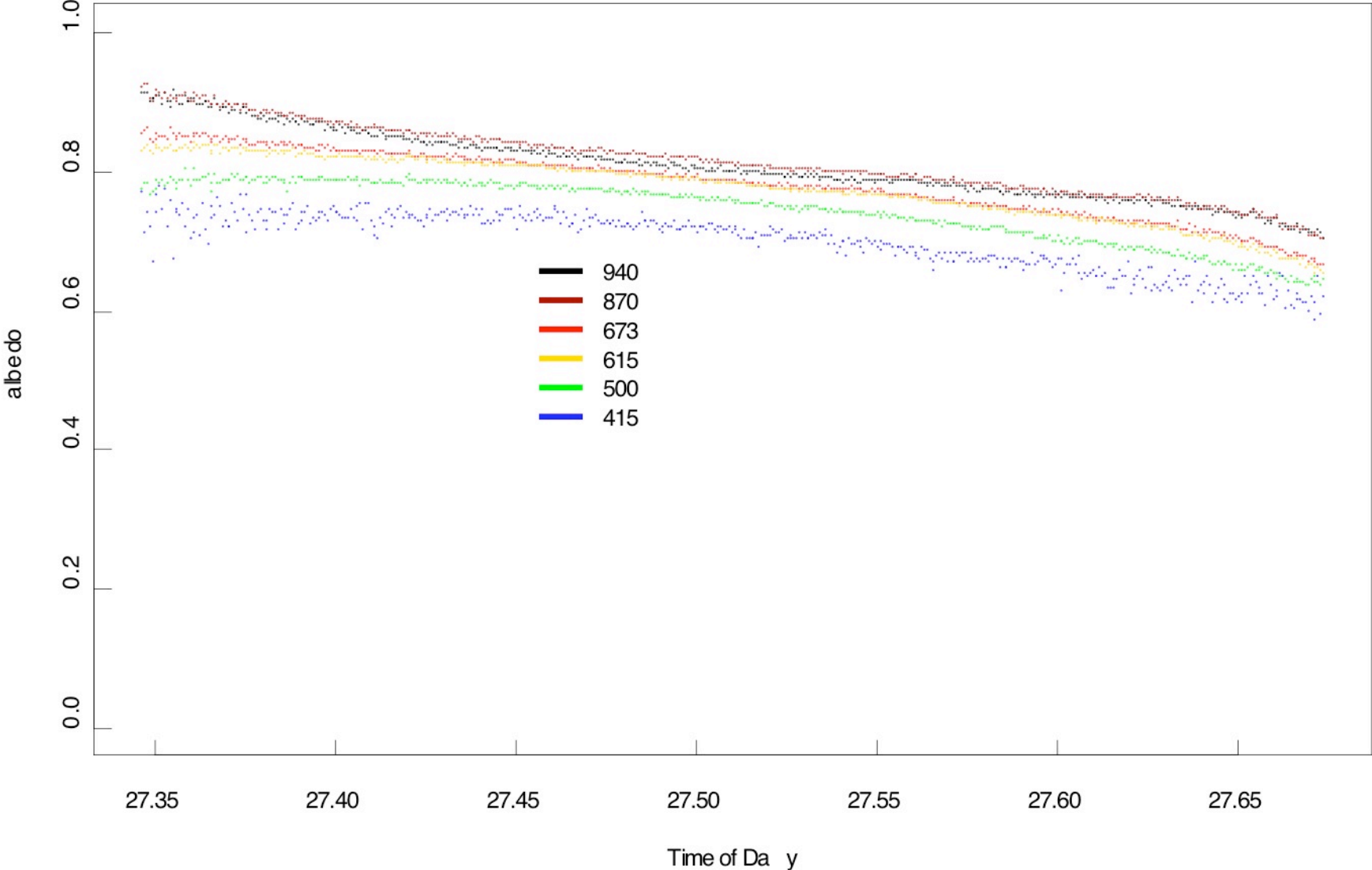
FIG. 16. Reflectance of snow as a function of wavelength in the visible, according to various investigators. From Mellor (1977).



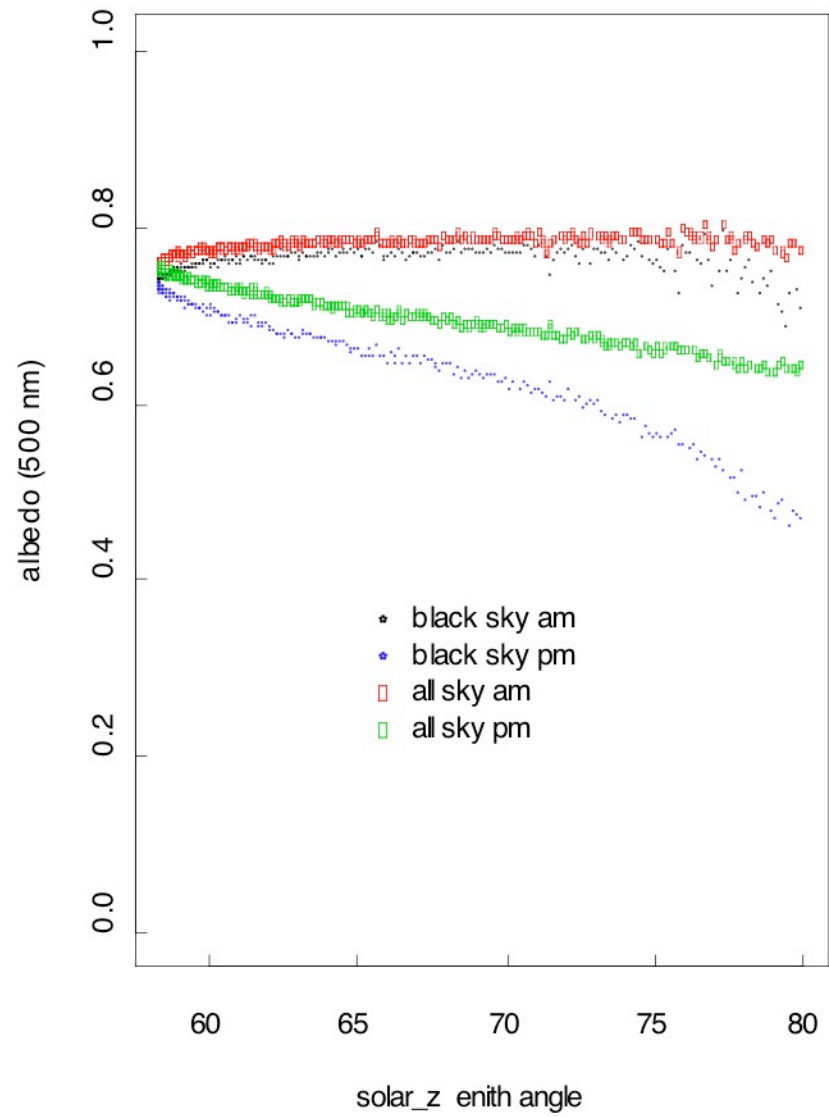
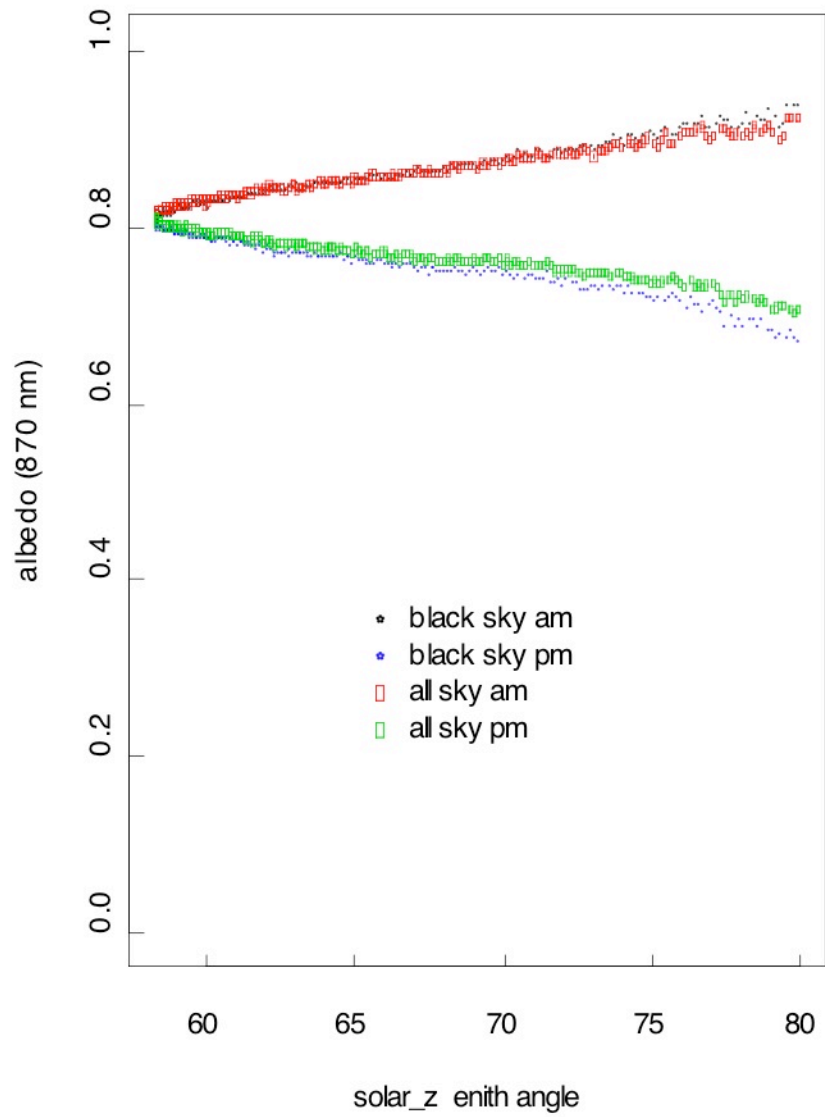
# Cloudy Day



# Clear Day

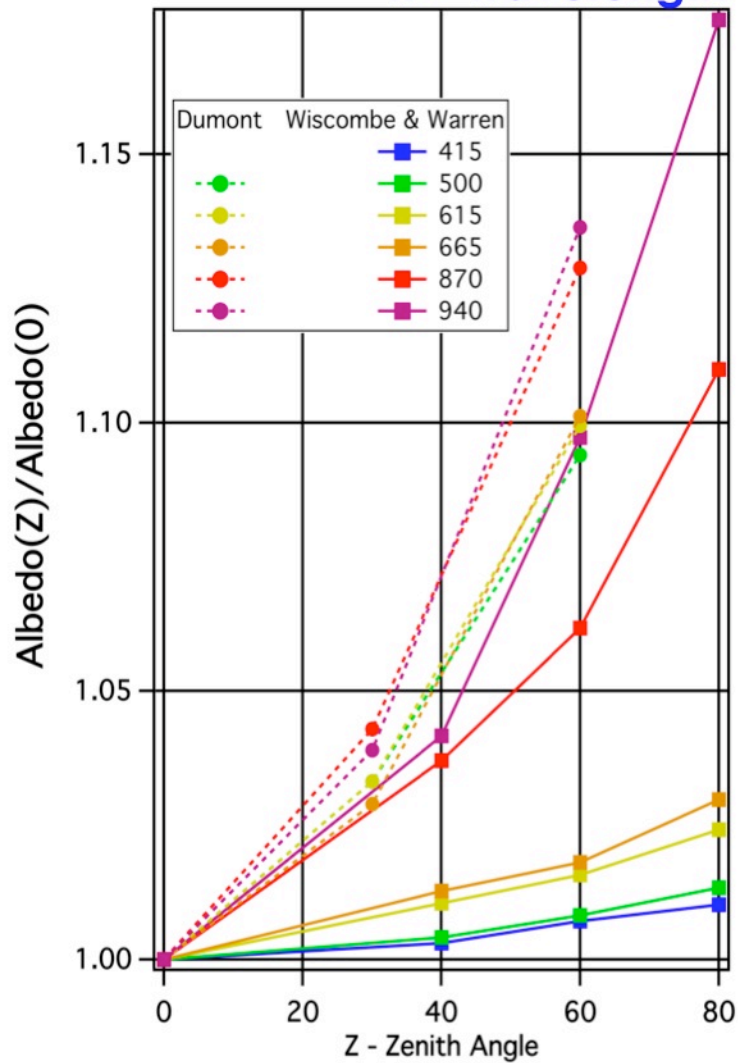


# Clear Day



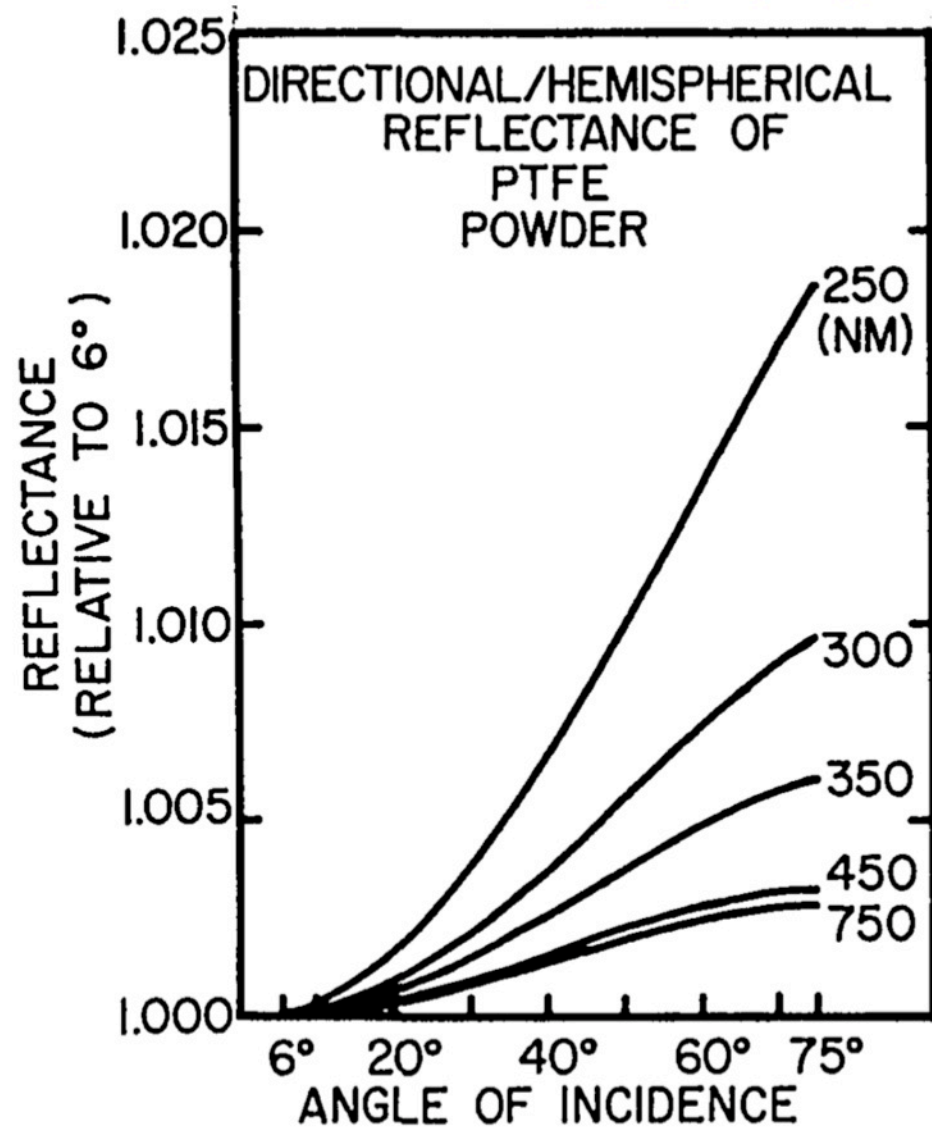


Snow :  $d[dA(Z,w)/dZ]dw > 0$   
 $w$  - wavelength

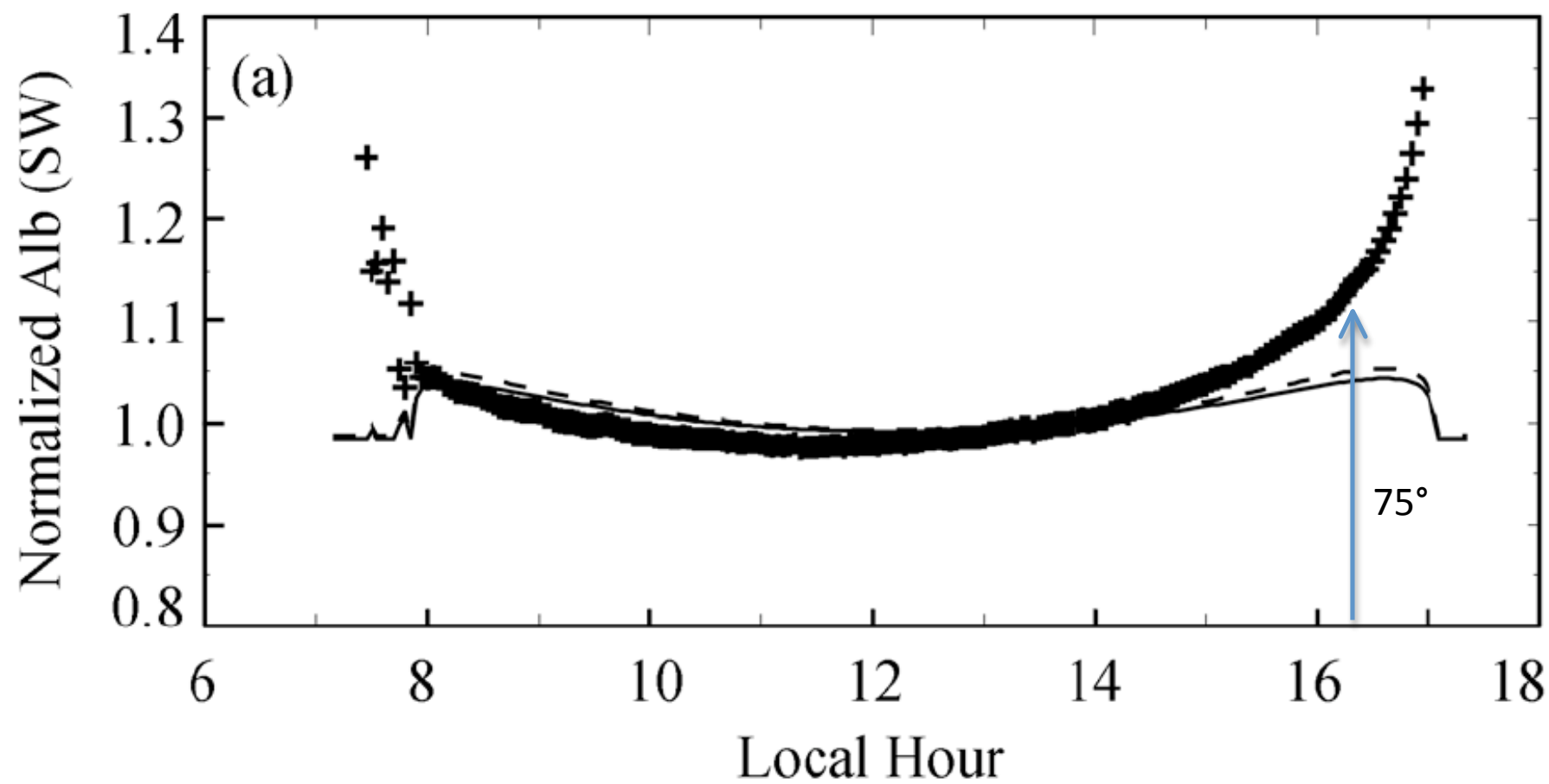


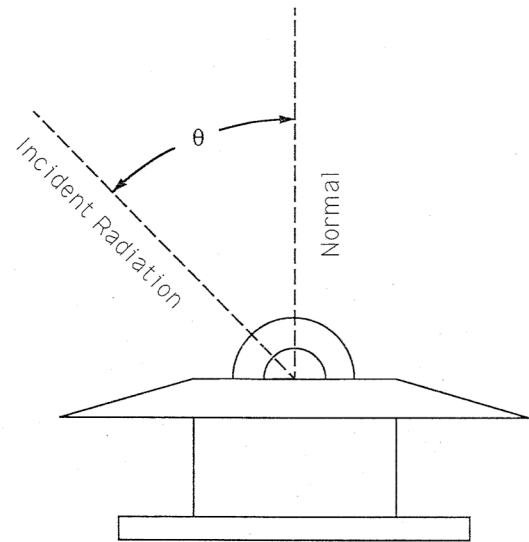
Albedo Relative to 0°

PTFE Powder :  $d[dA(Z,w)/dZ]dw < 0$

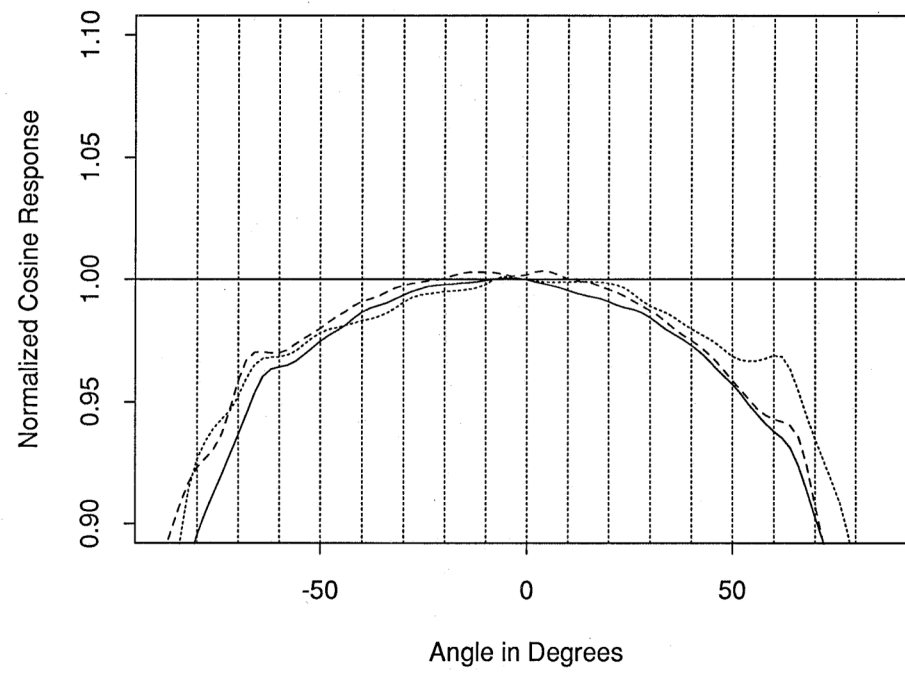


Weidner and Hsia, *J. Opt. Soc. Am.*,  
 71, 856-861, 1981, Figure 4

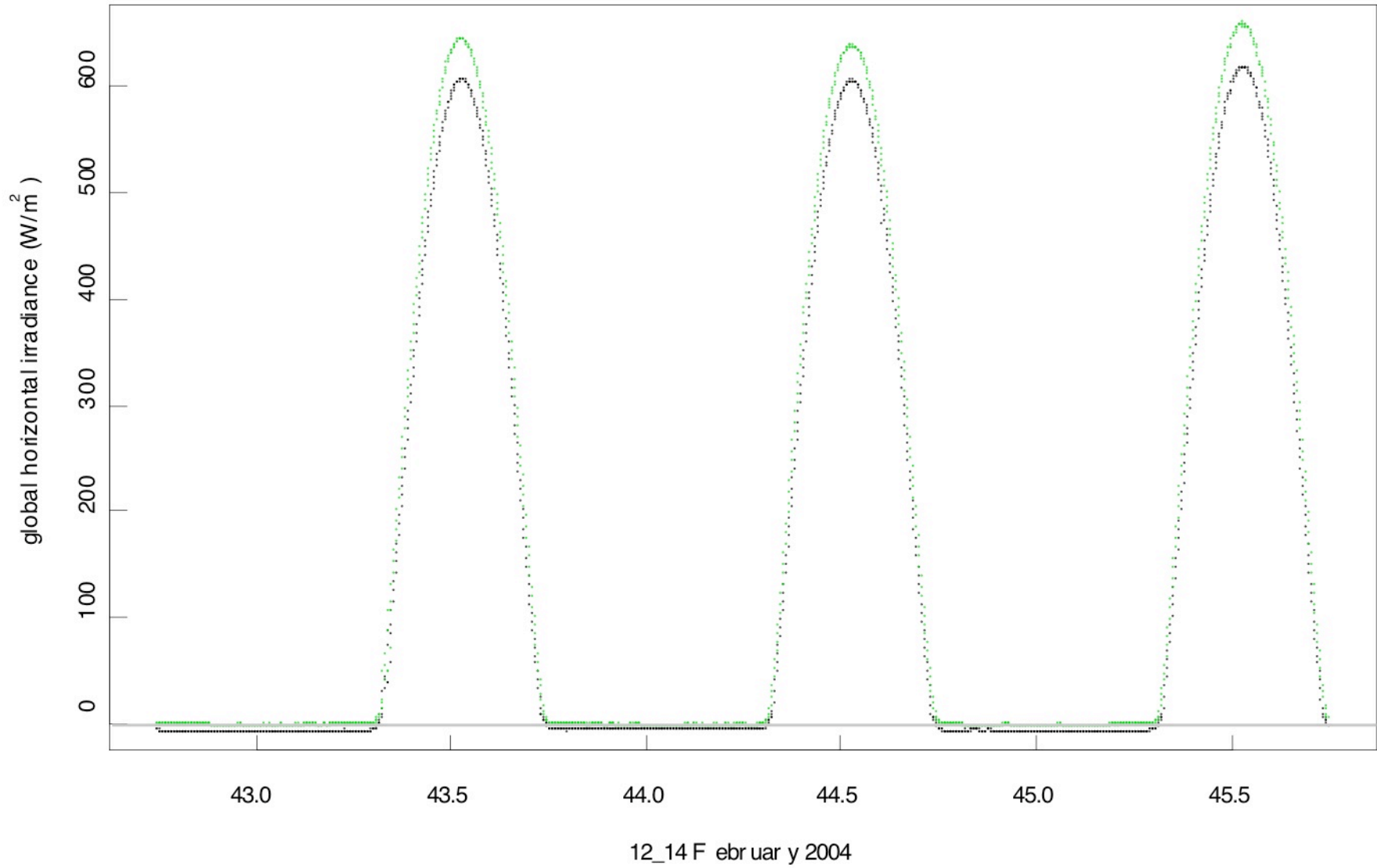




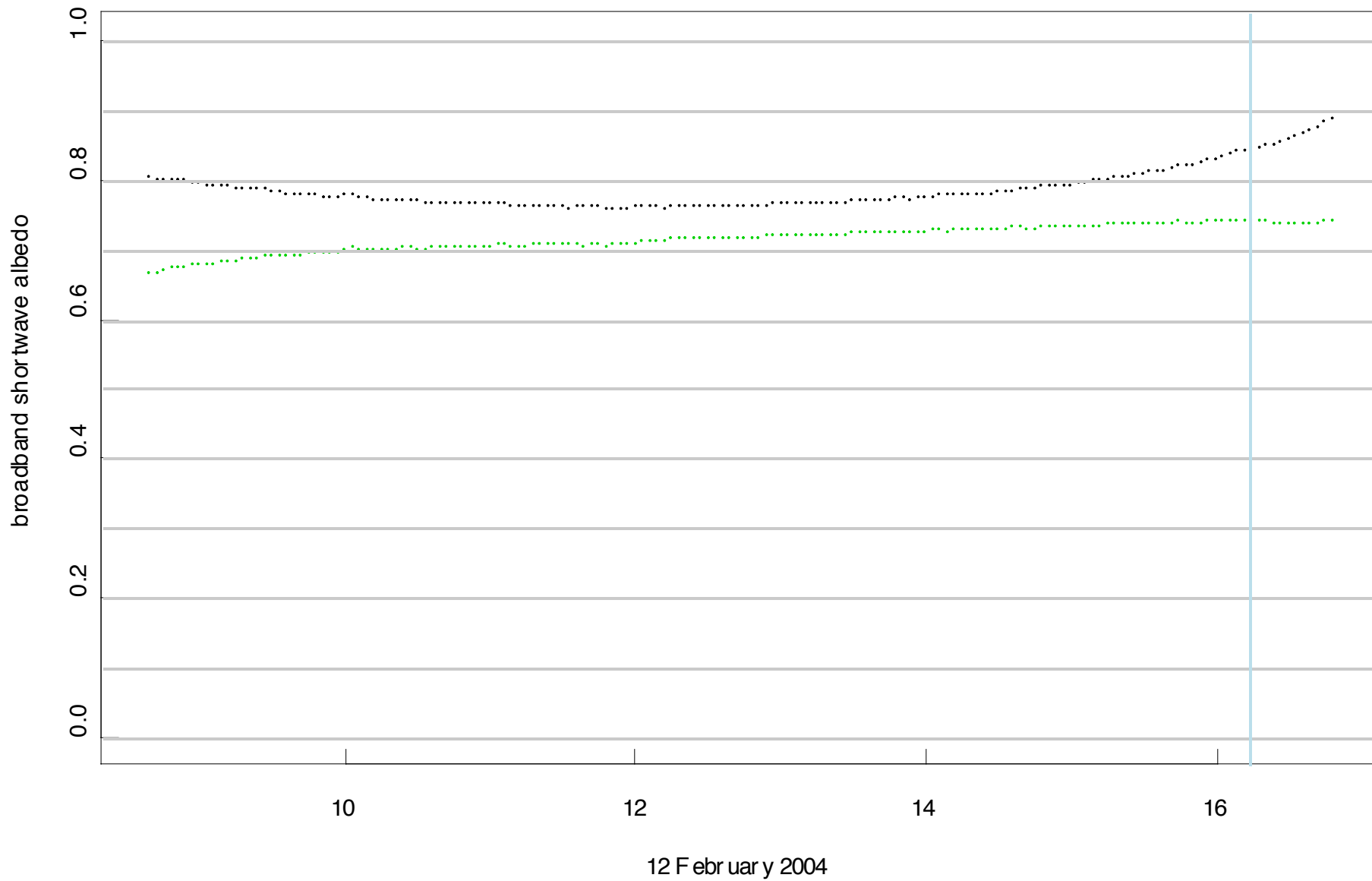
## PSP Pyranometers



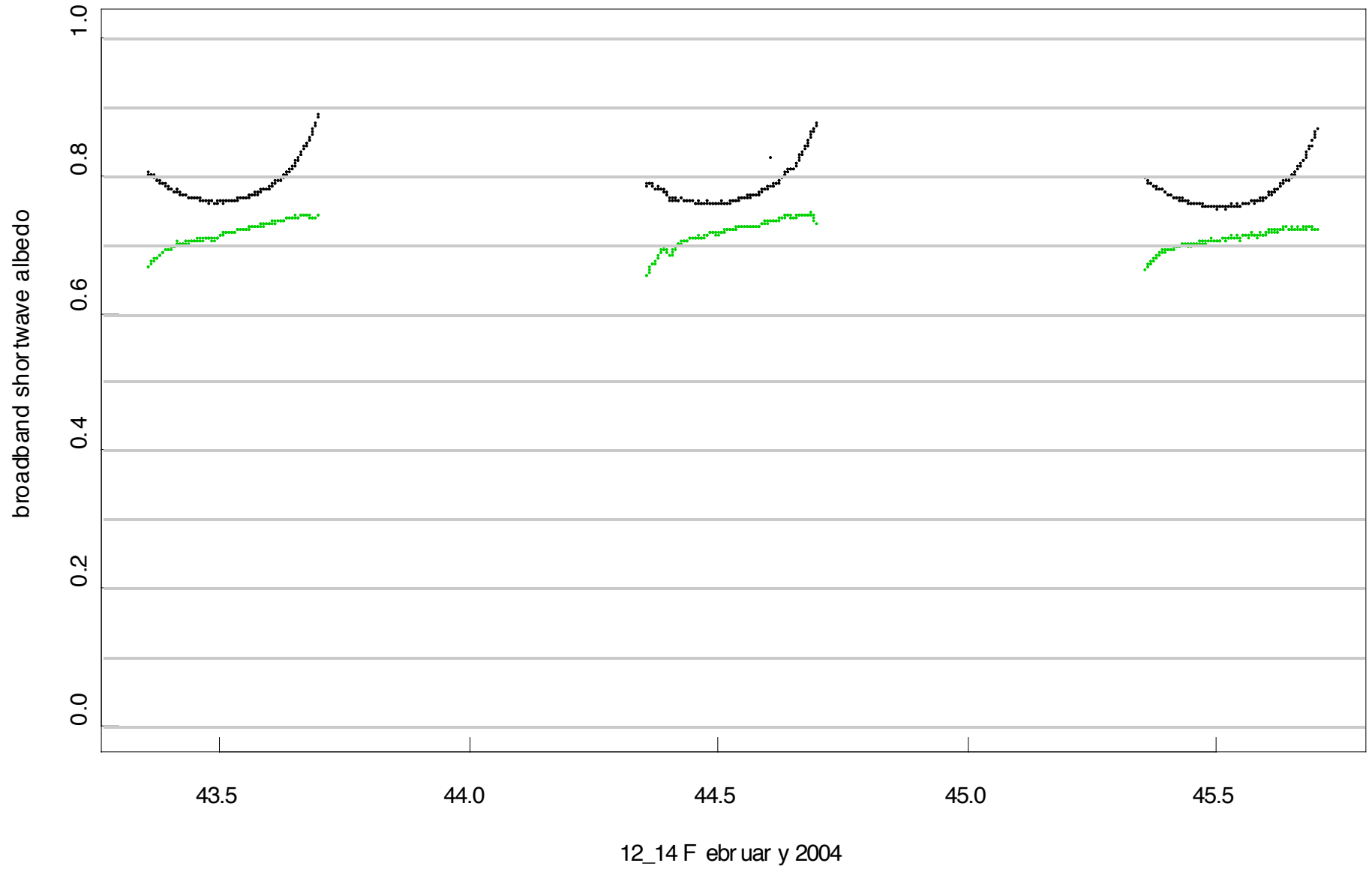
# Global Horizontal Irradiance – Two Ways



# Albedo – Calculated Two Ways



# Three Consecutive Clear Days



# Albedo on a Totally Overcast Day

