Calculating Surface Albedo with Aircraft-Based Instrument

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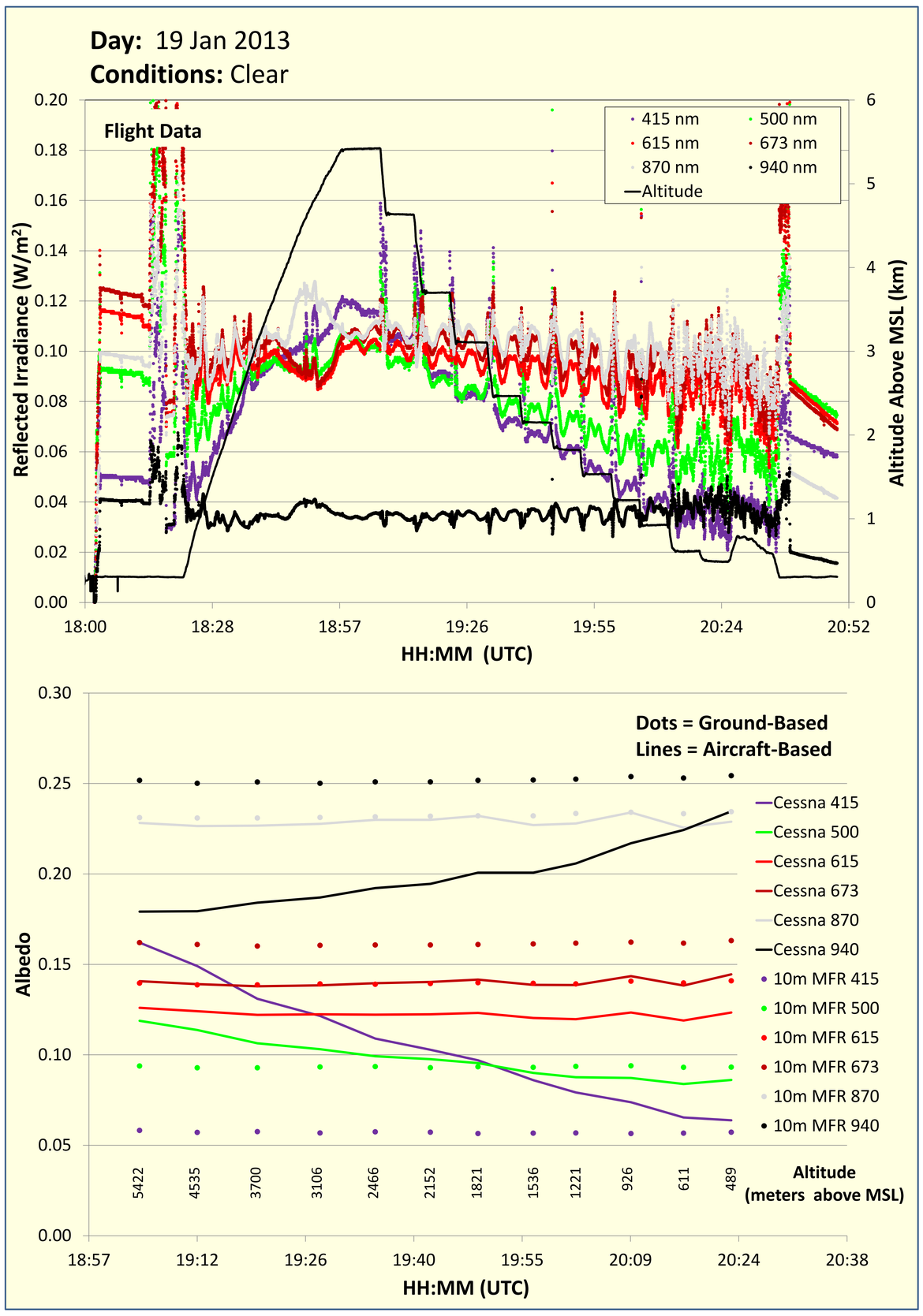
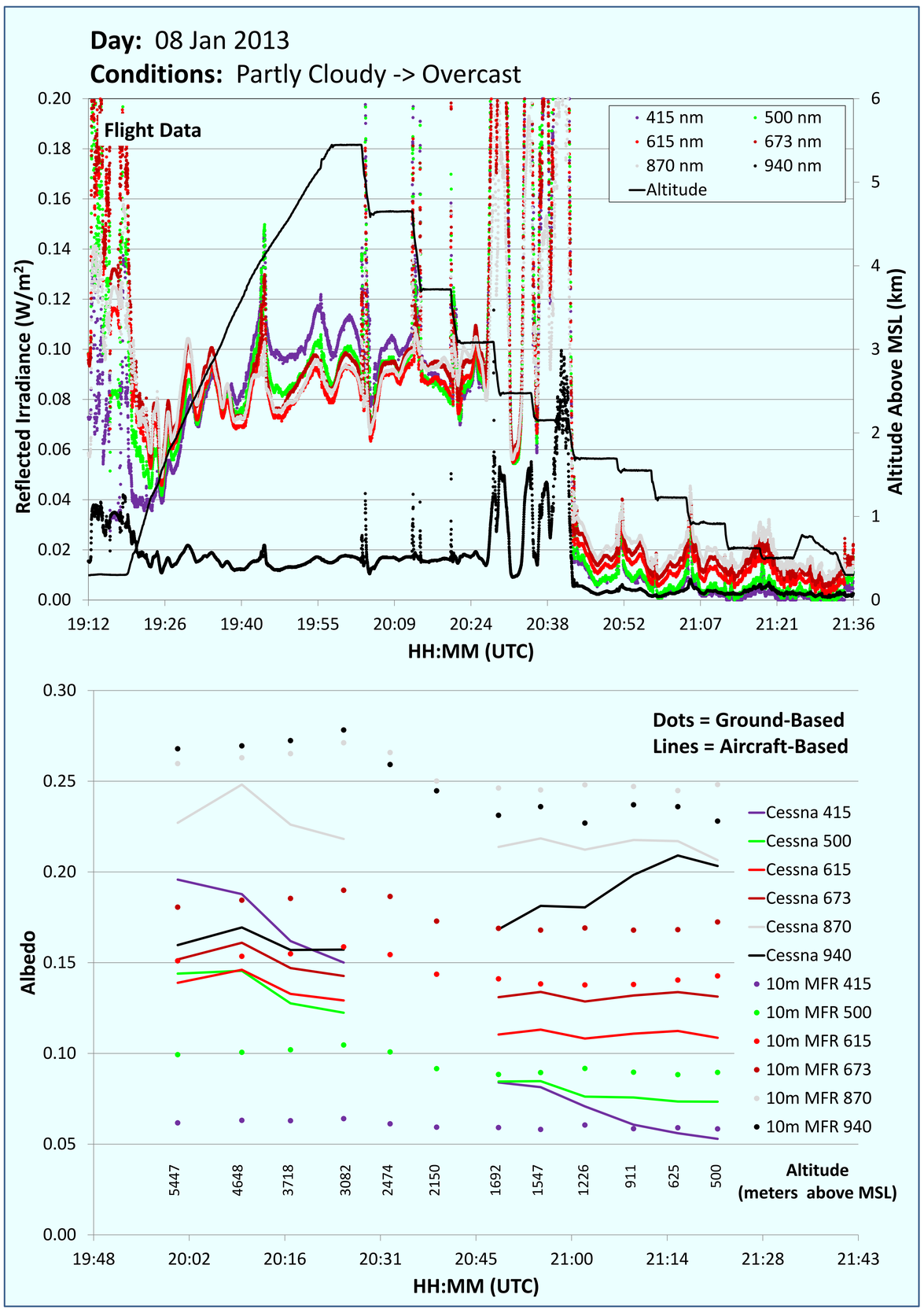
Purpose: Explore the feasibility of using the Multi-Filter Radiometer (MFR) mounted on the Cessna 206 for surface albedo measurements.

Procedure: Aircraft-based albedo is compared with ground-based albedo under clear, partly cloudy, and overcast conditions. For each flight transect across the SGP Central Facility, we average data points within 300 m of the MFR mounted on the 10 m tower. A typical set of twelve transects begins at ~5500 m above mean sea level (MSL) and finishes at ~500 m above MSL. Each transect is compared with ground-based data. The E13 Multi-Filter Rotating Shadowband Radiometer is used for the incoming irradiance data for both the aircraft- and ground-based albedo calculations.

Plots: Upper panels show flight data. Calibrated reflected spectral irradiance on the left axes, and altitude in kilometers above MSL on the right axes. The lower panels are comparisons of aircraft-based surface albedo with ground-based surface albedo. Lines are surface albedo calculated with the Cessna 206 mounted MFR, and dots are surface albedo calculated with the 10 m MFR corresponding with each transect. Altitude of each transect is noted just above the x-axis.





Discussion (left panels, clear conditions):
Flight and comparison data during very clear conditions on 19 Jan 2013. The flight progresses through takeoff up to a maximum altitude of ~5500 m above MSL. At that point the aircraft begins the transects across the Central Facility (CF). A normal flight consists of twelve transects at decreasing altitudes, culminating with the lowest pass at ~500 m above MSL. The CF surface is about 320 m above MSL, so the lowest transect is about 200 m above the surface. Albedo at 415 nm and 500 nm show a marked decrease with decreasing altitude. This is due to the diminishing contribution of Rayleigh scattering. The opposite behavior is seen with the 940 nm albedo. The increasing albedo with decreasing altitude owes to the reduction in attenuation of the reflected irradiance by water vapor. Albedo at 615, 673 and 870 nm remain essentially constant with decreasing altitude. Channels 500, 673 and 870 nm have a negative bias. A first order effort at dark offset corrections did improve the bias to what we see now. Bias that still exists may be further improved with a comprehensive dark offset determination as a function of temperature, as well as improvements in the lamp calibration once a sufficient calibration history is in place.

Discussion (right panels, partly cloudy -> overcast conditions):
The first transect of the 08 Jan 2013 flight begins under partly cloudy (PC) conditions. The PC conditions remain until just after 20:24 UTC when the transition to overcast (OC) conditions begins. By the start of the seventh transect at ~1700 m above MSL, sky conditions have become completely overcast. Albedos at 5500 m above MSL are bunched a bit tighter, and slightly greater, than under clear conditions. Under OC skies the spread is about the same as clear conditions, with albedos across all the channels slightly lower. Some of the differences between the clear and PC -> OC conditions may be the result of changing surface characteristics as there are 11 days between the two flights.