Multi-Year Comparisons of Summertime Cloud Characteristics at Barrow and Atqasuk

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Introduction

Barrow and Atqasuk were chosen as sites for Atmospheric Radiation Measurement's (ARM's) North Slope of Alaska studies because of expected contrasts in the cloud characteristics at coastal (Barrow) and inland (Atqasuk) sites. With the successful completion of several years of data acquisition with a common set of instruments at the two sites, it is now possible to assess how well this goal has been met. The cloud characteristics are different, although in somewhat surprising ways, and the differences show a feature that does not appear to be represented properly in current global models.

Data

For the analyses, data were used only for instruments available at both sites. They include:

- microwave radiometers (MWRs)
- multi-filter rotating shadowband radiometers (MFRSRs)
- ceilometers
- pyranometers.

Data from the warmer months (June-September) of 2001-2003 were used for this study.

Results

- For the time periods analyzed, the median liquid water paths (LWPs) at the two sites were virtually identical (0.048 mm at Barrow and 0.043 mm at Atqasuk.)

- During the snow-free season and for low-clouds (base heights <400 m), the magnitudes of the LWPs show a strong dependence on the directions of the ambient winds (Figure 1).

- The relative magnitudes of the LWPs also show a directional dependence. For onshore flows the LWPs at Atqasuk are larger than those at Barrow and vice versa for offshore flows (Figure 2).

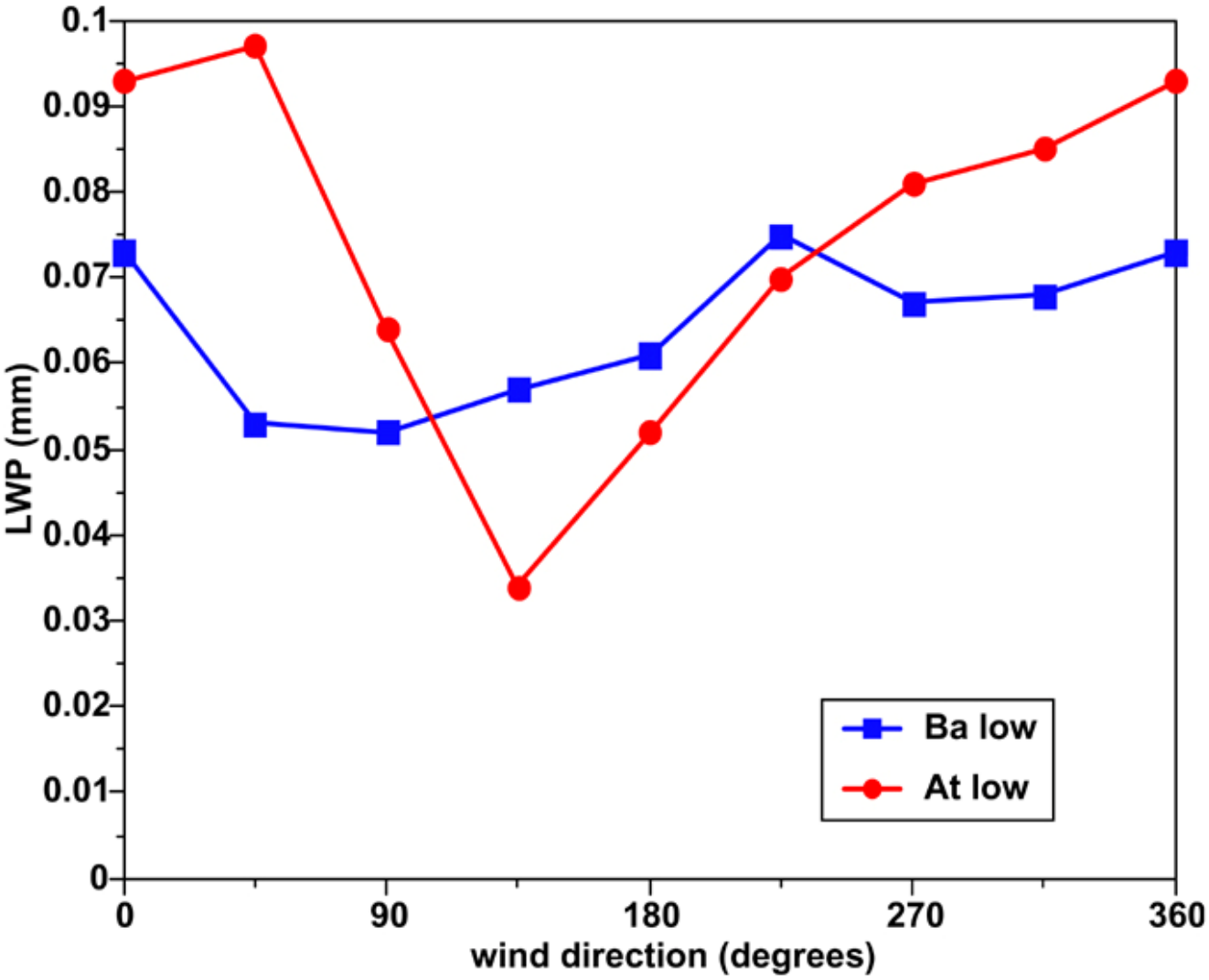

Figure 1. Variations of LWPs for low clouds at Barrow and Atqasuk as a function of wind direction.

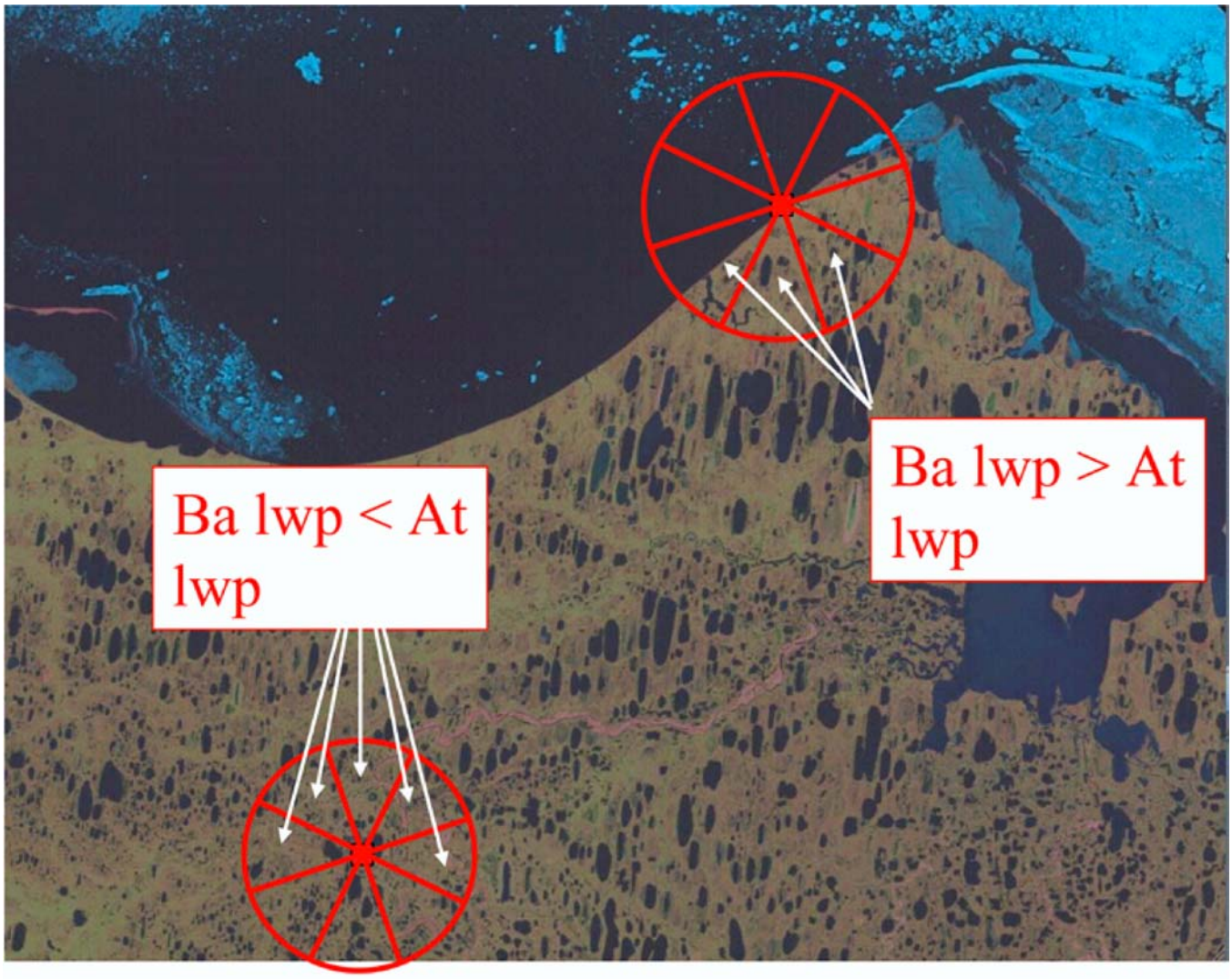

Figure 2. Variation of the magnitudes of the LWPs at Barrow and Atqasuk for onshore and offshore wind directions.

- This behavior suggests a significant influence of the surface heat and moisture fluxes on cloud formation and water content. Upwind fetches over the warmer lakes result in "wetter" clouds than fetches over the ocean or offshore ice.

- The European Centre for Medium-Range Weather Forecasts model tends to underestimate the LWPs at both sites, with a median simulated value approximately 64% of the observed value.

- Comparisons of the simulated and observed downward shortwave (SW) hemispherical radiation show good agreement in the mean but with considerable scatter (Figure3).

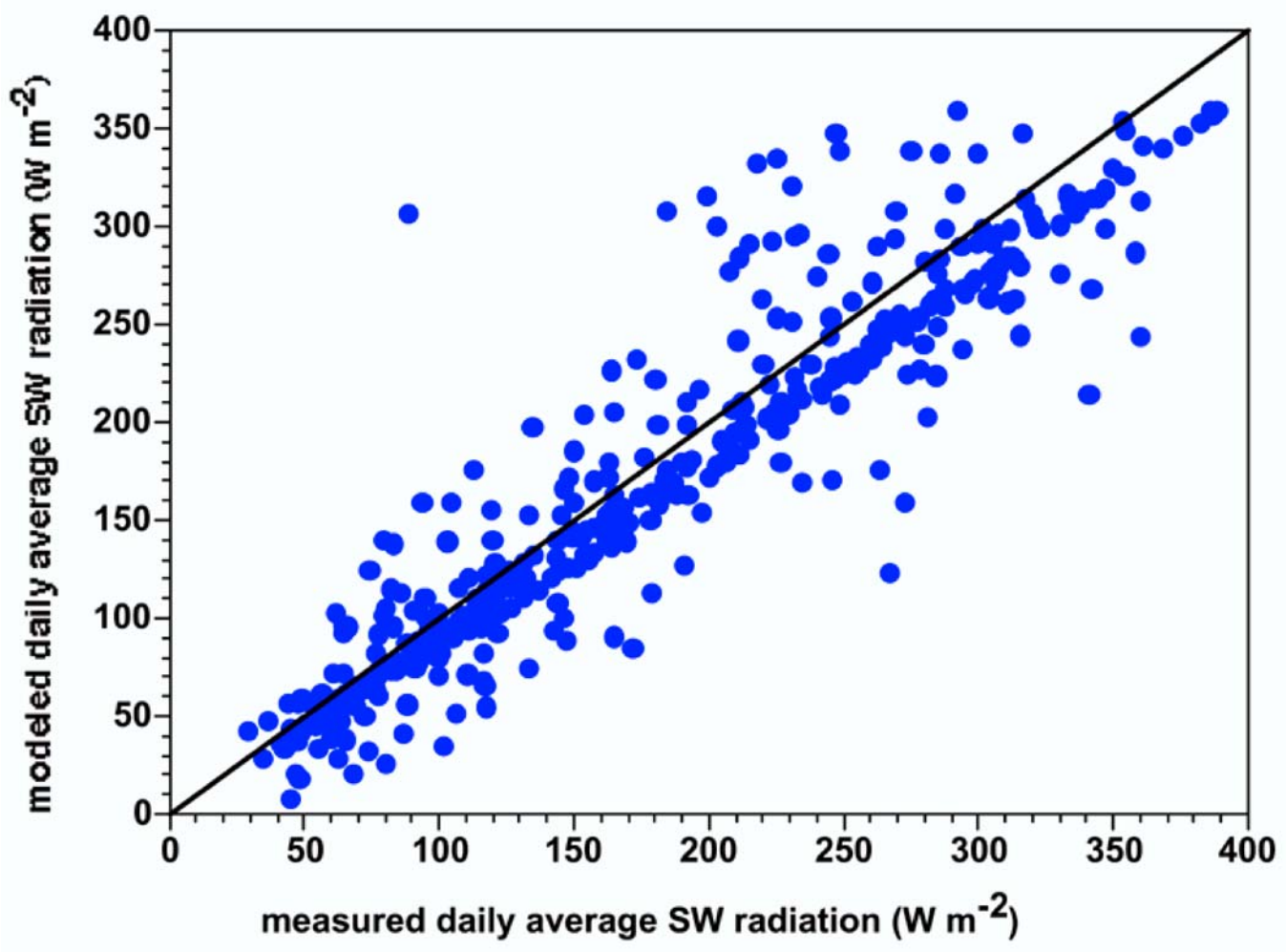

Figure 3. Comparison of modeled and measured daily averages of downwelling SW radiation.

Combining optical depth data from the MFRSRs with LWPs values from the MWRs allows estimates of the effective droplet radii of the clouds. Results for two years are given in Table 1.

Table 1. Optical Depths and Effective Cloud Droplet Radii at Barrow and Atqasuk for 2 Years

2003	Barrow	Atqasuk
τ	11.3	15.1
reff (μm)	11.3	9.4
2003		
τ	13.6	15.6
reff (μm)	8.9	9.7

Future Work

An IOP has been proposed for the summer of 2005. Radiosondes at Barrow and Atqasuk would be launched 5 to 6 times per day for a 4-week period. A mixing line analysis would from these data enable us to evaluate our hypothesis regarding the coupling of surface fluxes to the clouds.

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