Comments on "The Albedo of Water as a Function of Latitude"

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The article by Cogley, (1979) raises the question as to how much the albedo of the sea surface is reduced by the presence of scattered clouds. We found an example of this albedo reduction during the JASIN experiment (Joint Air Sea Interaction) which took place in the North Atlantic Ocean (~12°W, 59°N) in July, August and September 1978. Radiation measurements were made on the German research vessel *Meteor*. The instrumentation both for the global radiation and the reflected shortwave radiation were two Kipp and Zonen solarimeters, the downward-looking one being installed 10 m from the ship on a

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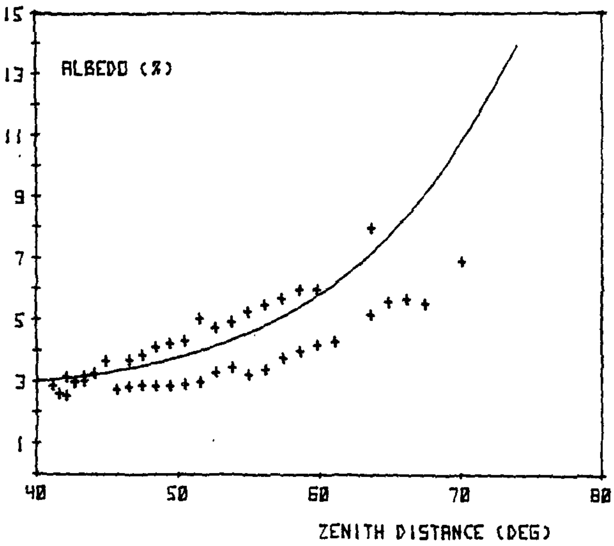

FIG. 1. Albedo on 30 July 1978 as a function of solar zenith distance: (+) measured values, (−) calculated clear-sky albedo.

boom. Ten-minute averages of the radiation fluxes were recorded.

The results of albedo calculations for 30 July 1978 are shown in Fig. 1, where only values for $K\downarrow \geq 0.6 S_0 \cos\theta$ are plotted to be sure that the sun was not obscured by clouds (Payne, 1972) [$K\downarrow$: global radiation, S_0: solar constant, θ: solar zenith distance]. The upper branch of the albedo curves corresponds to measurements in the morning, the lower one to those made in the afternoon and early evening of that day. The solid line represents clear-sky albedo at 50 km visibility, calculated according to

$$\rho = \rho_i I_0\downarrow/K_0\downarrow + \rho_d(1 - I_0\downarrow/K_0\downarrow), \qquad (1)$$

where

- ρ albedo
- ρ_i reflectance for direct radiation, according to Fresnel's law
- ρ_d reflectance for diffuse radiation (assumed to have the constant value of 0.055, determined from measurements for overcast conditions at JASIN)
- $I_0\downarrow$ direct portion of the global radiation at clear sky
- $K_0\downarrow$ global radiation at clear sky.

$I_0\downarrow$ and $K_0\downarrow$ are calculated after Schmetz and Raschke (1978).

The difference between the two measured albedo curves is significant for large solar zenith distances: At $\theta = 65°$ it is ~4%. All-sky photographs taken simultaneously reveal the differences in cloud cover that caused the albedo change: The high morning values represent clear-sky measurements with a great dependence on solar zenith distance due to the large portion of direct radiation being reflected approximately according to Fresnel's law. The afternoon albedo values are lower since scattered clouds (Sc, Cu) were present at that time. Due to reflection of light at the sides of the clouds the global radiation is as large as or even larger than at clear sky, i.e., the portion of diffuse radiation is relatively larger. Thus the dependence of albedo on solar zenith distance is less pronounced. A typical sky condition for the afternoon is shown in the all-sky photograph (Fig. 2).

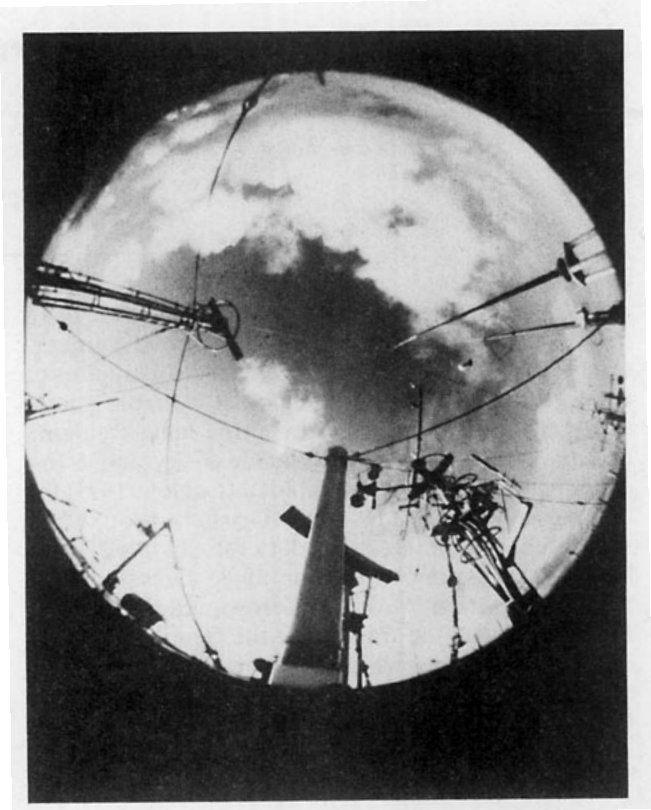

FIG. 2. All-sky photograph taken at 1820 GMT showing typical sky conditions during the afternoon and early evening of 30 July 1978.

Unfortunately, no more examples of this phenomenon can be presented by the JASIN data; no other day showed comparable sky conditions.

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