Effects of adjacent clouds to satellite fields of view on the measurements of the surface reflectivity

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In this paper we present multiple scattering effects in inhomogeneous atmospheres on estimating the surface reflectivity from space. It is well known that multiple scattering effects can not be negligible for accurate atmospheric corrections (Deschamps et al., 1983, Gordon et al., 1987). Extensive studies, therefore, have been undertaken on the radiative transfer simulations(Mitchell and O'brien, 1993, Hann et al.,1991, Gordon et al., 1997). These studies, however, assumed a plane-parallel atmosphere which is unlikely to occur in nature. Multiple scattering in highly inhomogeneous natural land surface and clouds lead to complicated problems to be solved for accurate atmospheric corrections, particularly for inhomogeneous surfaces (e.g. Kaufman and Sendra,1988). Radiation from surface areas adjacent to the target pixel enhances the radiance received at the satellite sensor by multiple-scattering processes, which is known to be so called adjacent effect (Reinersman and Carder, 1995). Similarly, scattered radiation from adjacent clouds, that is clouds in the vicinity of satellite field of view, enhances the radiance received at the satellite-borne sensor.

Clouds often appear to be broken on scales that defy high spatial resolution of recent satellite sensors. An assumption that the fields of view are over cast for cloud-contaminated field leads to bias in albedo (Coakley and Kobayashi,1989, Kobayashi, 1993). Even if the fields of view are cloud-free, clouds in the vicinity of the fields of view influence the atmospheric scattering. Radiation scattered from the adjacent clouds enhances radiance detected at satellite-borne sensor and therefore may lead to bias in the retrieval.

Here we estimate the influence of the adjacent clouds to target pixel on the retrieval of the surface reflectivity by using a 3-D radiative transfer model. The estimate of the adjacent clouds effects which often occur in satellite images, will lead to a significant increase in an understanding of atmospheric correction and consequently will improve the retrieval of the surface reflectivity.

A 3-D radiative transfer model used here is based on the Monte Carlo technique. The model allows for the atmospheric inhomogeneity as well the surface one for visible wavelength bands. The radiance received at a satellite sensor at a wavelength of 0.49 μm and at a altitude of 500km was simulated. The solar zenith angle is 30 degree. The atmospheric model consists of stratified atmosphere of molecule and aerosols with optical thickness of 0.4 and cuboidal-long bar clouds with optical thickness of 9. An atmosphere in the target is assumed to be clear, but clouds in the vicinity of the target exist (Fig. 1).

Figure 2 shows sensor radiance as a function of cloud distance which defined as a length between a side of the target area and that of cloud. Clouds adjacent to the target area lead to significant enhancement of the radiance received by satellite-borne sensor. The enhancement, however, disappear drastically as the clouds separate from the target. Almost no effects of the clouds are observed at the distance of 10km.

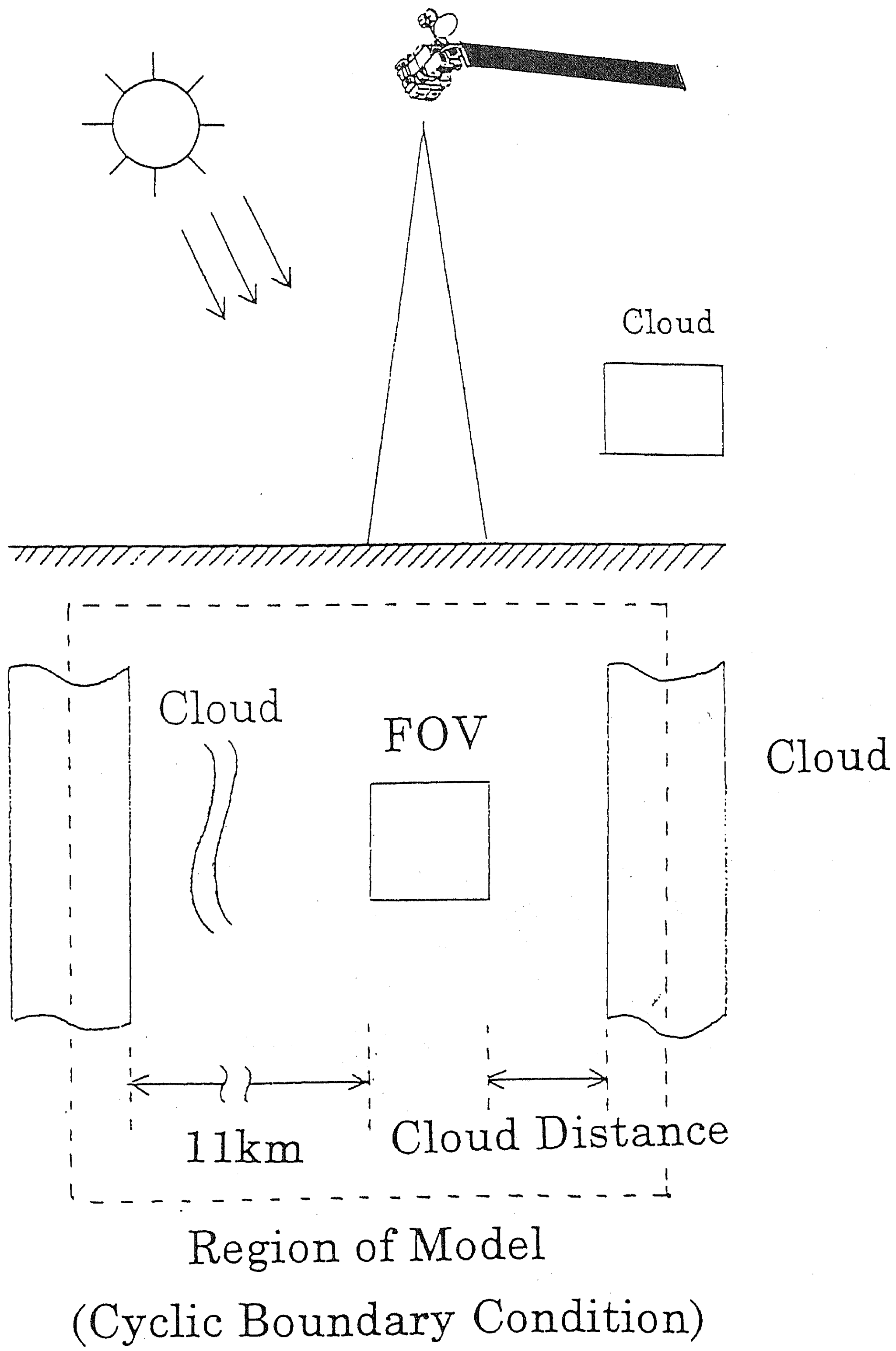

Fig.1 A schematic figure of model atmosphere. Side view (upper part) and top view (lower part) are plotted.

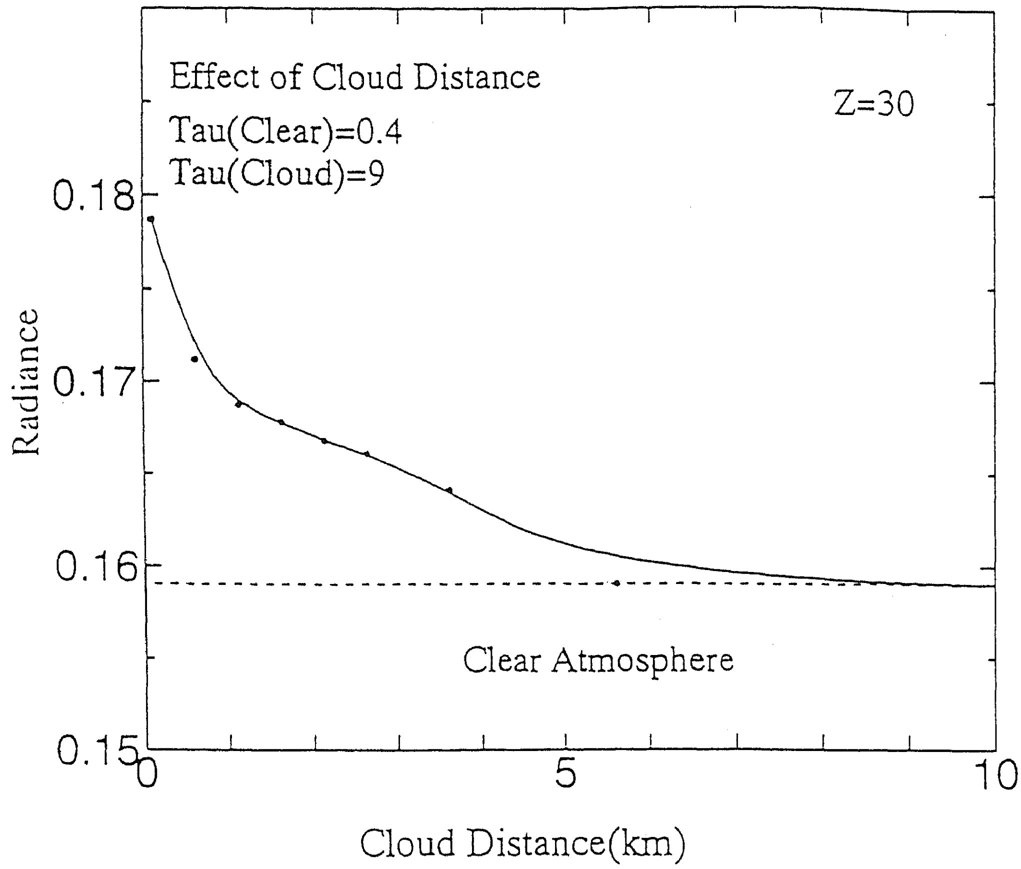

Fig.2 Radiance received at satellite-borne sensor as a function of the cloud distance.

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