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***Interactive comment on* “Effects of dust storms on microwave radiation based on satellite observation and model simulation over the Taklamakan desert” by J. Ge et al.**

J. Ge et al.

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Reviewer #1

We are very appreciative of the reviewer’s thorough review of the paper. The suggestions and comments give us some new and interesting ideals for our further study for the dust effects on microwave from theoretical basis.

Actually, using infrared and visible satellite observations can well detect mineral dust and volcanic ash over both oceans and lands. The reason we investigate the effects of dust on microwave using satellite observation and model simulation is due to the most common dust storms in East Asia are caused by strong winds behind a cold front and general coexist with cirrus. The visible-infrared radiance is primarily sensitive to

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the upper cirrus cloud layer and the visible-infrared dust detecting approach is nearly useless in cirrus over dust areas, while microwave can penetrate ice cloud and is not significantly scattered or absorbed by ice clouds. If we can validate those effects of dust aerosols on microwave, we can use microwave sensor to detect these dust aerosols which are below cirrus cloud.

The results of satellite observed data analysis clearly show that the brightness temperatures at high frequencies can be depressed by dust scattering, and dust particles also lead to weak depolarization of surface microwave emission. If we use a threshold of -5K for SCAT which is defined in the paper, we could separate most dusty pixels from clear-sky pixels over the Taklamakan desert.

Because of lacking of accurate dust dielectric constant for each channel of AMSR-E and limitation of the model, we have to use Mie theory and do some simple assumptions to simulate dust effects on microwave at this moment. The comparison between dusty and clear condition also shows that dust aerosols could depress microwave radiation at high frequency of AMSR-E and have a weak depolarization of surface emission.

We have recognized that some new and interesting works about triboelectric effects of dust and scattering of non-sphere dust aerosols have been done. We have added a statement with some references for these important issues in the discussion section. We will also consider triboelectric effects of dust and scattering of non-sphere dust aerosols in our further research work. The temperature, humidity and dust cloud profiles are taken from NCEP re-analysis data. All of the referred typographical, grammatical, and spelling errors have been corrected.

The following are our point-by-point responses to the reviewer's comments:

Comment1: The presentation makes the assumption that the only source term is the thermodynamic emission by the dust. This is not necessarily so! Triboelectric effects may charge the dust particles so that they may emit microwave radiation from corona. I could not access the ref-

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erence Yang (2003). Dust storms on Mars have generated intense microwave radiation, see <http://www.lpi.usra.edu/meetings/sixthmars2003/pdf/3191.pdf> <http://www.cosis.net/abstracts/EAE03/04710/EAE03-J-04710.pdf>. Terrestrial atmospheric pressure is higher than that on Mars and wind speeds on Mars may be greater than on Earth, so that the effect may be smaller on Earth than on Mars. None the less, triboelectric effects have been observed on Earth and microwave radiation may be produced by charged dust particles. It would be extremely interesting if this study were to shed light on that question.

Response: Yes, the phenomenons of charged dust particles in dust storms have been observed on earth and we agree that it is a new and very interesting research area. We have pointed out this new founding at the end of this paper. We plan to further study on this issue in our future works. The reference Yang (2003) is a book, which introduces detail properties of Asian dust, published in Chinese Meteorological Press.

Comment2: A unique aspect of particles in dust storms is that triboelectric effects generate electrical fields that align non-spherical dust particles, see <http://www.atmos-chem-phys.org/7/6161/2007/acp-7-6161-2007.pdf>. This suggests that the use of Mie theory is inappropriate, and that Rayleigh-Gans theory, Atlas, Kerker and Hitschfeld (1953) J. Atm. Terrest. Phys., 3, 108, or the Discrete Dipole Approximation may be better suited to describe the scattering and absorption properties of the particles. This should not present a serious problem for the authors's radiative transfer model because Dr. Weng has developed a vector model that should accommodate the off diagonal terms of the scattering matrix and the vector albedo for single scattering.

Response: Although dust particles are non-spheres and have been confirmed by some research works, these theoretical work are too early to be applied in our study. We have added a statement for this important issue at the end of the paper and given some related references.

Comment3: The authors assume that the dielectric constant is 5.5 at all frequencies.

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On what do they base that assumption? Even a casual perusal of Microwave Remote Sensing, by Ulaby, Moore and Fung, Table E-4, pp 2083-4 shows that the real part of the dielectric constant of minerals at 35 GHz varies between 5 and 9.6, and the imaginary part may be significant. The model results shown in Fig. 8 of the manuscript should present error bars that show the effect of this mineralogical variability. Or do the authors know the mineral that comprises the dust? They have not stated that.

Response: The dusty dielectric constants for the six AMSR-E frequencies may be different from each others. Because of lacking accurate dielectric constant values from laboratory or measurement, we have to do a simple assumption for dielectric constant in a reasonable range. We agree that the imaginary part of dielectric constant have significant effects on dusty extinction. Actually, there is no related information of the dust particles mineral component over the Taklamakan desert, but we did the model test for dielectric constant with different imaginary part and the results are quite different. When the dielectric constant is $5.52-0.024i$, the results of simulation and observation show a best consistence.

Comment4: In any case, the authors should present the attenuation, k , and reflectivity, ϵ , as a function of M , the mass density, with error estimates.

Response: It is not impossible to create the M function of k and ϵ ; since there is not any related observation so far.

Comment5: What temperature, humidity and dust cloud profiles were used in the model?

Response: The temperature, humidity and pressure profiles in the model are from NCEP re-analysis data. Dust properties such as concentration, particle size, et al. are from related references.

Comment6: The model results need validation, even if it is only rudimentary. Rather than showing just a single result of the model, it would be useful to present a map

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of the extent of the dust, based on this microwave model, and to compare that result with dust distributions obtained from the UV observation of the same outbreaks. A map of retrieved vertical dust loading (gm/m^2) would be even better. Were lidar or sun-photometer measurements of the optical thickness available?

Response: Yes, this is a good suggestion. We like to validate model results but there is really not any available lidar or sun-photometer measurement of the optical thickness over Takalamakan desert region. We will have field observation campaign in 2010 and hopefully got the quality data to validate our results after this campaign.

Comment7: Some minor typographical, grammatical, and spelling errors need correction. P. 3 The author is Rosenfeld. Do they mean stack up instead of sack up? Accumulate would be a better choice. P.6 the brightness temperature spectrum displays; or spectra display; P. 16, 17, and 18 The order of presentation of the references is not alphabetical.

Response: All of the typographical, grammatical, and spelling errors above have been corrected.

Comment8: Fig. 1 From what location are those data obtained? A map of the horizontal distribution of the various brightness temperatures would have been helpful.

Response: The data are from the region of case 5 in table 1. We did not show the plots of brightness temperatures distribution because the variation of brightness temperatures in the dust case region is very small (less than 1 k) especially at low frequency.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 7931, 2008.

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