Summary of the Final Report of Research Results

1) Title of the proposed research

Cloud remote sensing using GOSAT instruments

2) Principal Investigator (PI) and Co-Investigators (Co-Is)

PI:

Dr. Alexander Kokhanovsky

3) PI's affiliation

The University of Bremen

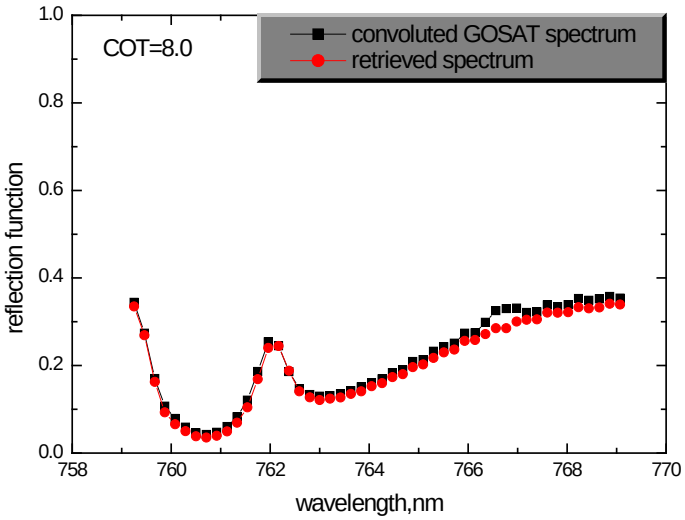
4) Summary of the Final Report of Research Results

The work has been composed of two separate work packages. The first one was centered around the inter-comparison of the radiative transfer models used in the solution of the inverse problems. The results are given by Kokhanovsky et al. (2010). The following algorithms have been inter-compared: SCIATRAN (University of Bremen, Bremen, Germany), PSTAR (National Institute of Environmental Studies, Tsukuba, Japan), RAY (Institute of Physics, Minsk, Belarus), MYSTIC (University of Munich, Munich, Germany), SOSVRT(Institute of Atmospheric Physics, Beijing, China), 3DMCPOL (Lille University, Lille, France), MVDOM (Power Engineering Institute, Moscow, Russia). We have found a high accuracy of all above – mentioned algorithms as far as the first three Stokes parameters are of concern. The inter-comparisons have been performed for aerosol, cloud and Rayleigh phase functions for the case of black underlying surface.The second work package was aimed at the application of the semi-analytical cloud retrieval algorithm SACURA developed at University of Bremen to the FTS data. In particular, we have applied SACURA to the TANSO-FTS observations in the oxygen A-band absorption spectral range. The task was to derive cloud optical thickness (COT) and cloud bottom/top heights (CBH/CTH). The TANSO-FTS performs measurements at about 1000 wavelengths in the oxygen A-band with the FWHM (at each wavelength in the oxygen A-band) equal to 0.022nm. Such detailed measurements are needed to derive the trace gas concentrations. However, fine spectral resolution is not needed to derive just three parameters of clouds (CBH, CTH, COT). Therefore, the spectral observations of the TANSO-FTS were degraded to that of SCIAMACHY (FWHM=0.48nm) flown on board ENVISAT(March 1, 2002 - April 8, 2012) and then the retrievals have been performed. This also enables fast retrievals needed for the processing of large satellite datasets.

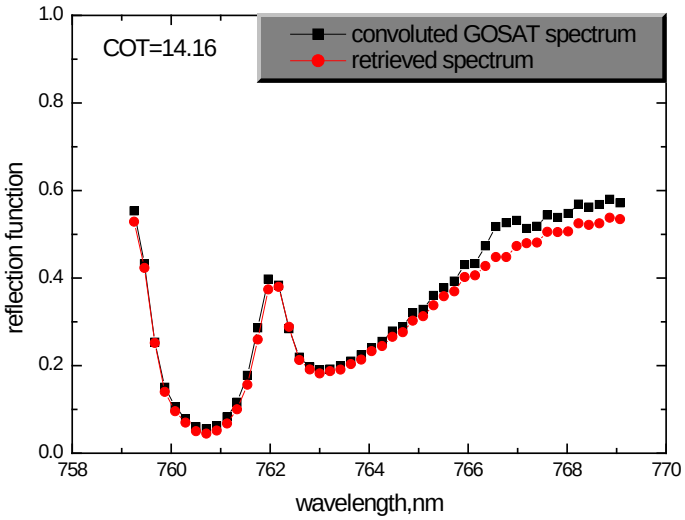
The top of atmosphere reflectance was calculated as

$$R = \frac{\pi(I_s + I_p)}{2\mu_0 E_0}. \quad (1)$$

Here μ_0 is the cosine of the solar zenith angle, I_s, I_p are the *s*- and *p*- components of the reflected light intensity as detected by the TANSO-FTS (Kuze et al., 2009). The solar irradiance E_0 was calculated as recommended by O'Dell (2012). The retrievals have been performed for the cloud scene located at 30.8946N, 161.5325E (case 1) 29.5398N, 161.2108E (case2). The measurements have been performed on April 23, 2009 from the GOSAT satellite. For the case 1, we have derived the cloud optical thickness of 8, CBH=0.54km, CTH=3.83km, cloud albedo 0.5. For the case 2, we have derived: COT=14.16, CBH=0.22km, CTH=1.53km, and cloud albedo of 0.63. The accuracy of fit is demonstrated in Fig. 1.



a)



b)

Figure 1. The accuracy of fits for the cases 1(a) and 2(b) as derived from GOSAT observations.

5) List of publications relating to the proposed research

A. A. Kokhanovsky, V. P. Budak, C. Cornet, M. Duan, C. Emde, I. L. Katsev, D. A. Klyukov, S. V. Korkin, L. C-Labonnote, B. Mayer, Q. Min, T. Nakajima, Y. Ota, A. S. Prikhach, V. V. Rozanov, T. Yokota, and E. P. Zege. Benchmark results in vector atmospheric radiative transfer. *J. Quant. Spectrosc. Radiat. Transfer*, 111(12-13):1931 - 1946, 2010.