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FRESCO v6: improvements in cloud detection and new applications

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FRESCO effective cloud fraction and cloud pressure are being used for cloud correction in trace gas retrievals from GOME, SCIAMACHY and GOME-2 measurements. The FRESCO v6 cloud algorithm is an improvement of FRESCO+ (or FRESCO v5) by using the MERIS surface albedo database and the HITRAN 2008 database for O_2 absorption. The cloud information from GOME, SCIAMACHY has been recently processed/reprocessed using FRESCO v6, in the same data format as FRESCO+. The FRESCO v6 data from GOME-2 will be processed later. Additionally, FRESCO v6 provides scene albedo, scene pressure and broadband surface solar irradiance for SCIAMCHY in HDF5 format through TEMIS web site.

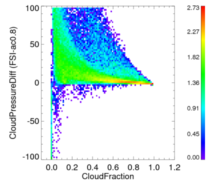

Figure 5*. Difference between scene pressure and cloud pressure as a function of effective cloud fraction for one day of SCIAMACHY data on 30 November 2005.*

1. Introduction

The FRESCO cloud algorithm retrieves cloud information from the O_2 A band. In the standard FRESCO retrieval, FRESCO retrieves effective cloud fraction and cloud pressure, assuming the cloud albedo to be 0.8 if no snow/ice on the surface. For the pixels with snow/ice, FRESCO retrieves scene albedo and scene pressure, assuming cloud fraction to be 1, which is called snow/ice mode. In FRESCO v6, the standard retrieval remains and the snow/ice mode is applied to all pixels. Broadband surface solar irradiances are derived from the effective cloud fractions, which is processed for SCIAMACHY measurements (Wang et al., 2011). The high resolution (0.25°x0.25°) MERIS surface albedo database (Popp et al., 2011) is used in FRESCO v6 instead of the 1°x1° surface albedo database derived from GOME (see Fig. 1). The O_2 absorption parameters are taken from the HITRAN 2008 database.

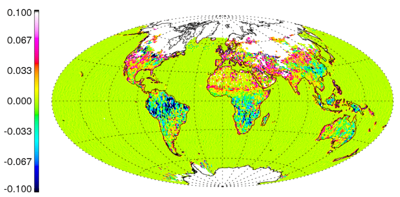

Figure 1. *Difference between the MERIS surface albedo and GOME surface albedo for January. Over ocean, the MERIS and GOME surface albedo data are the same.*

2. Effective cloud fraction and cloud pressure

The differences between FRESCO v6 and FRESCO+ effective cloud fraction are mainly caused by the MERIS surface albedo (Popp et al., 2011). The cloud pressure differences are due to the differences of O_2 absorption data in the HITRAN databases. Figs. 2 and 3 illustrate the differences between FRESCO v6 and FRESCO+ products.

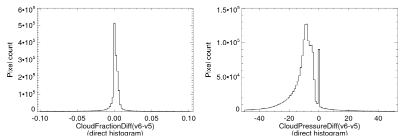

Figure 2. *(Left) Distribution of the effective cloud fraction differences for SCIAMACHY in January 2008. The mean difference (FRESCO v6 – FRESCO+) is* **$-6.0 \times 10^{-5} \pm 0.017$.** *(Right) Distribution of the cloud pressure differences. The mean difference is* **-12.1 ± 22.3 hPa.** *Pixels with snow/ice at the surface are excluded.*

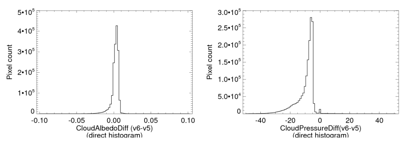

Figure 3. *(Left) Distribution of the scene albedo differences for SCIAMACHY in January 2008. The mean difference (FRESCO v6 – FRESCO+) is* **-0.002 ± 0.006.** *(Right) Distribution of the scene pressure differences. The mean difference is* **-9.8 ± 6.7 hPa.** *Only for snow/ice pixels.*

3. Scene albedo and scene pressure

The scene albedo and scene pressure retrieved from FRESCO snow/ice mode are consistent with the standard FRESCO retrievals. As shown in Fig. 4, the scene albedo can be converted into the effective cloud fraction properly if the surface albedo is known and the Rayleigh scattering contribution to the reflectance is small. The scene pressure is higher than the cloud pressure, because the scene pressure is a combination of the cloud pressure and surface pressure (see Fig. 5).

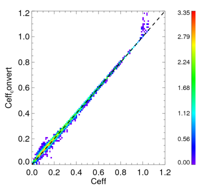

Figure 4. *Scatter density plot of the FRESCO v6 effective cloud fraction c and the effective cloud fraction converted from the scene albedo (Ac) using c=(Ac-As)/(0.8-As). As is surface albedo. The data are from GOME-2 FRESCO v6 in June and July 2010.*

4. Surface solar irradiance

In order to derive surface solar irradiance (SSI) from effective cloud fraction, FRESCO v6 retrieves effective cloud fraction by assuming the cloud albedo to be 0.95. Then the effective cloud fraction is converted to SSI using the Mesoscale Atmospheric Global Irradiance code (MAGIC, Mueller et al., 2004). An example of the FRESCO SSI map is shown in Fig. 6.

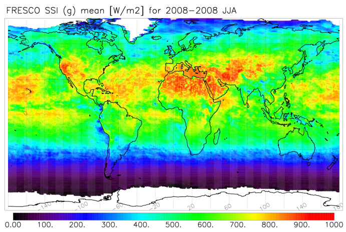

Figure 6*. Mean surface solar irradiance for June-July-August 2008 at SCIAMACHY overpass time (~10:00 Local Time).*

5. Conclusion

The FRESCO v6 effective cloud fraction is improved due to the use of the MERIS surface albedo database, particularly at coastlines and desert regions. The scene albedo and scene pressure could be used over snow/ice and bright surfaces like over desert. Probably the forced snow/ice mode gives better result than the standard FRESCO mode for desert dust cases. The surface solar irradiance is a new application of the effective cloud fraction and could be a contribution to the global solar irradiance databases.

References

Mueller, R. et al., Rethinking satellite based solar irradiance modelling. the SOLIS clear-sky module. Remote Sensing of the Environment, 91:160–174, 2004.
Popp, C., P. Wang, D. Brunner, P. Stammes, Y. Zhou, and M. Grzegorski, MERIS albedo climatology for FRESCO+ O2 A-band cloud retrieval, Atmos. Meas. Tech., 4, 463-483, 2011.
Wang, P., Stammes, P., and Mueller, R.: Surface solar irradiance from SCIAMACHY measurements: algorithm and validation, Atmos. Meas. Tech. Discuss., 4, 873-912, doi:10.5194/amtd-4-873-2011, 2011.

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FRESCO v6 data and the MERIS surface albedo data are available at www.temis.nl
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