AEROSOL OPTICAL DEPTH RETRIEVAL OVER LAND USING METEOSAT-8 SEVIRI DATA

Christoph Popp[1], Nando Foppa[1], Adrian Hauser[2] & Stefan Wunderle[1]
[1]Remote Sensing Research Group, University of Berne, Switzerland
[2]iTECH Engineering AG, Switzerland
Contact: popp@giub.unibe.ch
Further Information: http://saturn.unibe.ch/rsbern

UNIVERSITÄT BERN

INTRODUCTION

Atmospheric aerosol particles influence the Earth's radiation budget by reflecting, scattering, and absorbing solar electromagnetic radiation and by modifying cloud properties due to their role as cloud condensation nuclei (CCN). Their geographical, temporal, chemical, and physical high variability means a complex and challenging task in today's atmosphere and climate related science.

During the last decades, remote sensing has become a valuable complement to ground based measurements of aerosol parameters due to its capability of obtaining spatial homogeneous data. Current Earth observing sensors provide operational aerosol maps over ocean and land but most polar orbiting systems are limited to maximum cover a region once in the daytime. In contrary, up-to-date geostationary instruments like the Spinning Enhanced Visible and Infrared Imager (SEVIRI) on-board Meteosat-8 offer considerable prospects to enhance the frequency of aerosol mapping due to their high repetition rate.

The objective of this study is to present a multi-temporal method for the retrieval of aerosol optical depth from SEVIRI. The obtained results demonstrate the suitability and potential of SEVIRI for sensing atmospheric aerosol properties.

SEVIRI DATA

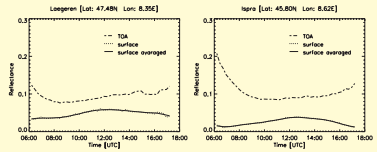
Geolocated and calibrated top of atmosphere reflectance (TOA) level1.5 SEVIRI data for the entire month of August, 2004 is used in this study. The considered daily observation time ranges from 6:12 to 17:12 UTC and the area of interest covers Switzerland and neighboring regions from 45.0N to 48.5N and 5.0E to 12.0E.

METHODOLOGY

The method for the retrieval of aerosol optical depth (AOD) over land is based on the analysis of multi-temporal 0.6 μm channel SEVIRI images similar to a method applied on Geostationary Observational Environmental Satellite (GOES) data (Knapp et al.).

AOD processing steps:

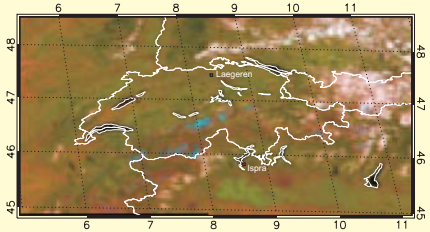
- Cloud and cloud shadow masking (Derrien and Le Gléau; Simpson and Stitt).
- Correcting TOA for gaseous absorption, Rayleigh scattering, and a background aerosol using meteorological auxiliary data.
- Background composite of the lowest reflectance for each daily observation time as surface reflectance estimate.
- Inversion of AOD at 0.55 μm using the radiative transfer code SMAC (Rahman and Dedieu).



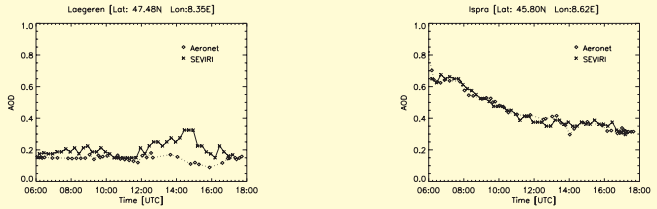
SEVIRI 0.66 μm channel raw and averaged estimated surface reflectance for the pixels located at the AERONET sites as a function of daytime. Also shown is the TOA reflectance for August 1, 2004.

VALIDATION WITH AERONET DATA

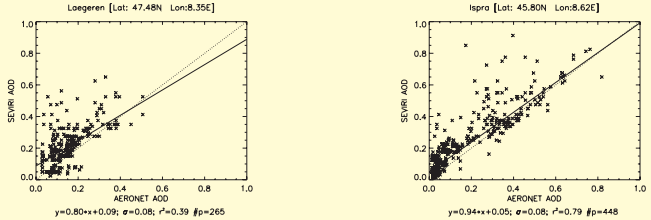
The validation of SEVIRI retrieved AODs is performed on comparisons to AERONET data, considering exclusively measurements from either source within a maximum time delay of +/- 15 minutes.



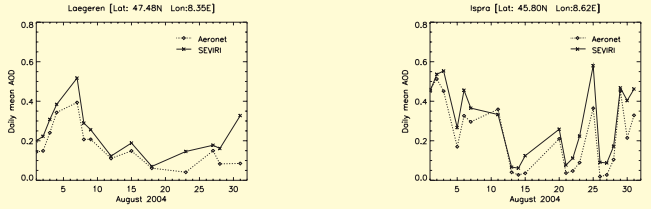
RGB composite of the study area for August 1, 2004.



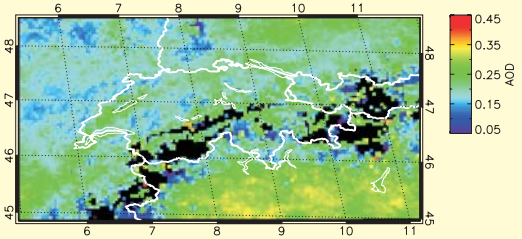
Daily trend of SEVIRI derived AODs and AERONET measured AODs.



Scatter plots of the total of retrieved AODs which intersect with AERONET measurements within a maximum time delay of +/- 15 minutes.



Monthly trend of daily averaged AODs from SEVIRI and AERONET.



AOD map over Switzerland for August 2004. The values represent averaged daily mean AODs. Black gaps indicate areas where no valid AOD could have been retrieved.

RESULTS AND CONCLUSION

First implementation of the proposed method on multi-temporal imagery revealed reasonable results:

- The derivation of daily and monthly trends of AOD from Meteosat-8 SEVIRI is possible.
- SEVIRI inversed AODs are within a standard deviation of 0.08 compared to AERONET measurements (0.06 for daily mean values).
- Correlations between SEVIRI and AERONET AODs are:
  r^2 for all values: 0.39 at Laegeren, 0.79 at Ispra.
  r^2 for daily mean AODs: 0.75 at Laegeren, 0.89 at Ispra.
- The monthly mean AOD map shows a dependence of retrieved AODs from altitude but not from surface types.
- Sources of errors: Inaccurate cloud and cloud shadow masking; sub-pixel clouds; topographic shadows; radiative transfer calculations; inaccurate or missing meteorological data; assumptions of stable surface characteristics; assumptions of the background aerosol amount; calibration inaccuracy.

OUTLOOK

- Improving of cloud shadow mask and incorporation of sub-pixel cloud masking.
- Extension of the study area.
- Further investigations on data from different seasons.
- Extended quantification of the single error sources.

ACKNOWLEDGMENTS

We would like to thank MeteoSwiss and NCEP for supplying data. SEVIRI data was freely provided by EUMETSAT. The authors also thank the AERONET PIs and their staff for establishing and maintaining the sites used in this study. This study has been funded by the Swiss Defense Procurement Agency.

REFERENCES

Knapp, K. R., Vonder Haar, T. H., and Kaufman, Y. J. (2002). Aerosol optical depth retrieval from GOES-8: Uncertainty study and retrieval validation over South America. Journal of Geophysical Research. 107(D7) 4055.

Derrien, M. and Le Gléau, H. (2003). SAFNWC/MSG SEVIRI cloud products. Proc. The 2002 EUMETSAT Meteorological Satellite Conference. Weimar, Germany. 191:198.

Simpson, J. J. and Stitt, J. R. (1998). A procedure for the detection and removal of cloud shadows from AVHRR data over land. IEEE Transactions on Geoscience and Remote Sensing. 36(3): 880-897.

Rahman, M. and Dedieu, G. (1994). SMAC: a simplified method for the atmospheric correction of satellite measurements in the solar spectrum. International Journal of Remote Sensing. 15 (1): 123-143.