SYNERGETIC USE OF MODIS AND AIRS: USE OF SPATIAL AND SPECTRAL RESPONSE IN COMBINATION WITH LEVEL-2 DATA

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1. INTRODUCTION

In the last decades, a large number of different atmospheric sounding and imaging instruments has gathered a lot of information about the atmosphere – most times by individual measurements and adapted retrievals. The A-train is a constellation of several platforms with different instruments and provides therefore the possibility of combination of instruments. Moreover, instruments on the same platform provide the unique opportunity of combining instruments by using accurate geolocation information to overcome possible drawbacks of a single instrument, resulting in a possible increase of information content of existing parameters [1] or even new parameters.

In this study, we combine the high-spatial-resolution imager MODIS (MODerate resolution Imaging Spectroradiometer) with the high-spectral-resolution sounder AIRS (Atmospheric Infrared Sounder), both mounted on the satellite platform Aqua. MODIS has a high spatial resolution of 1 km and less and several brad-band channels in the visible and infrared spectrum and provides e.g., high-resolution cloud observations with its Level 2 data. On the other side, AIRS has a high spectral resolution in the infrared but a relative coarse spatial resolution (13.5 km at nadir) and provides vertical resolution of e.g. the atmospheric temperature and water vapor content. The overlap in the infrared region provides the possibility of comparing the radiances of the instruments, which is done in this study by using accurate spectral and spatial information of both instruments and also in combination with the Level 2 data. The spatial information of the MODIS content within the field of view (FoV) is especially useful information for examining the spectral behavior of AIRS, which is done in this study by analysis of the empirical orthogonal functions (EOF) of the spectra.

2. SPECTRAL AND SPATIAL RESPONSE

When it comes to the spectral range, AIRS has 2378 channels between 3.7 and 15.4 μm, but has also several spectral gaps within this region, as indicated by the black line in Fig 1. Most of the MODIS-channels 20 to 36 fall in this spectral region, indicated by the spectral response functions in Fig 1. By using the broader spectral response of MODIS as a weighting function, the instruments can be compared for several channels.

When it comes to the spatial response of AIRS, a new feature was developed for the synergetic use of the instruments: by using pre-launch measurements of AIRS, a spatial response for every AIRS-channel was calculated, taking into account the truncation of the FoV, the rotation with increasing scan angle and a smearing of the response due to the movement of the instrument. The result can be seen in Fig 2 for two different channels. This specific spatial response for every channel can be used as a weighting function for the (150 or more) different MODIS- measurement-points within an AIRS-FoV.

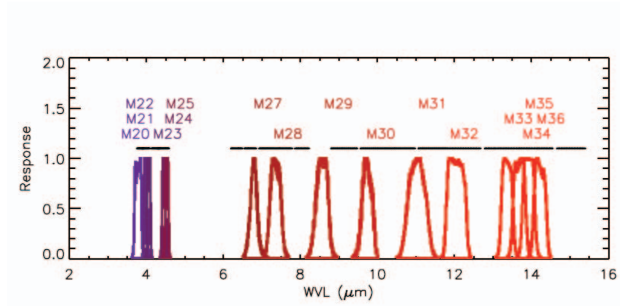

Fig 1 : Spectral area of AIRS and spectral responses of MODIS channels in this area.

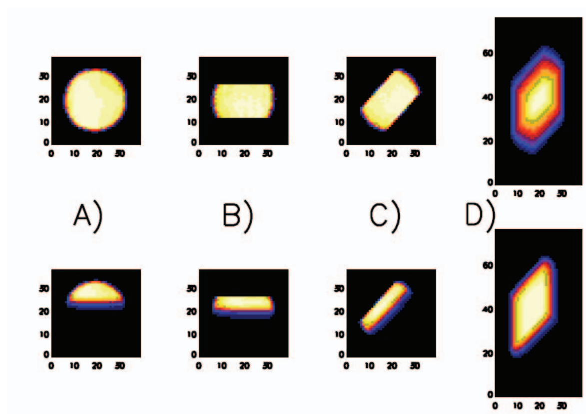

Fig 2 : Spatial response of AIRS (Ch 1 and 2265) A) prelaunch, B) truncated, C) rotated, D) smeared

3. COMPARISON OF AIRS AND MODIS BY INCLUDING SPATIAL RESPONSE AND LEVEL-2 DATA

3.1. Investigation of correlations of ΔT_b and atmospheric compositions

We investigated the difference in brightness temperatures between the two instuments (ΔT_b) under varying atmospheric conditions. This can be achieved by using the same instruments, because both instruments were designed to obtain different atmospheric and geophysical parameters. The combination of the instruments can help to improve the Level 2 products as long as the variation of ΔT_b with these parameters is weak. Furthermore, the Level 2 - products are informative in combination with the radiances, and additional information can be obtained as long as no correlation exists between ΔT_b and Level 2 products. Figure 3 shows an example of a correlation of $\boldsymbol{\Delta T_b}$ and the coverage of ice clouds within the AIRS-FoV, which was derived by MODIS - using the described spatial response information. The picture shows also dependence on the temperature lapse rate, which was derived by AIRS: A to E indicates and increasing lapse rate. The upper panel describes a comparison with usual MODIS spectral response functions, the lower one describes the same with shifted MODIS-response functions, as provided by [2]. In the upper panel, there is a strong correlation of $\boldsymbol{\Delta T_b}$ and the coverage of ice clouds, like e.g. channel 35 and 36. By using different lapse rates, as derived by AIRS, these correlations can be further investigated. The correlation seems to get stronger for certain channels, when the lapse rate is increasing. We will also show, as can be seen in the lower panel, that the spectral shift of certain MODIS-channels is able to reduce this correlation.

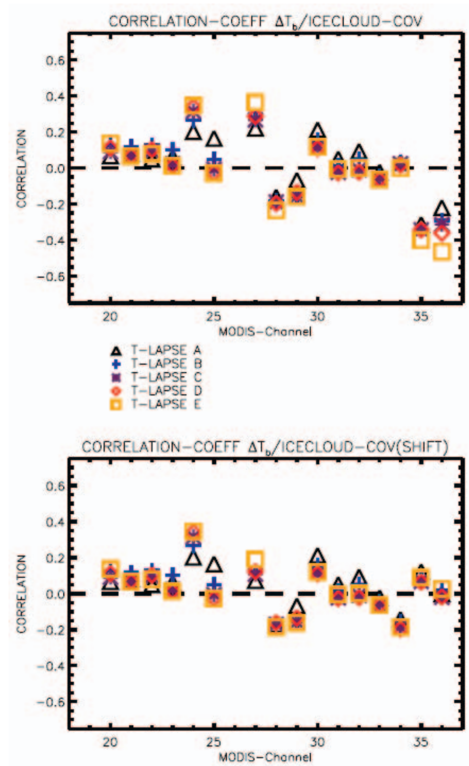

Fig 3: Correlation coefficients of $\boldsymbol{\Delta T_b}$ and coverage of ice clouds within an AIRS-FoV for different T-lapse rates.

3.2. Investigation of AIRS spectra for different cloud types and coverage

The accurate spatial response functions of AIRS in combination with MODIS are also useful to get a more exact knowledge of cloud coverage within an AIRS-FoV. This is helpful for investigating the spectral behavior of AIRS under cloudy conditions examining the AIRS spectrum. We did this by analyzing the different Empirical Orthogonal Functions (EOF) of the measured AIRS-spectrum, e.g. with different cloud coverage as derived by MODIS. Figure 4 shows an example of EOF 1, when the entire FoV of AIRS is covered by ice clouds compared to the whole area covered by water clouds. This is useful for the investigation of possible

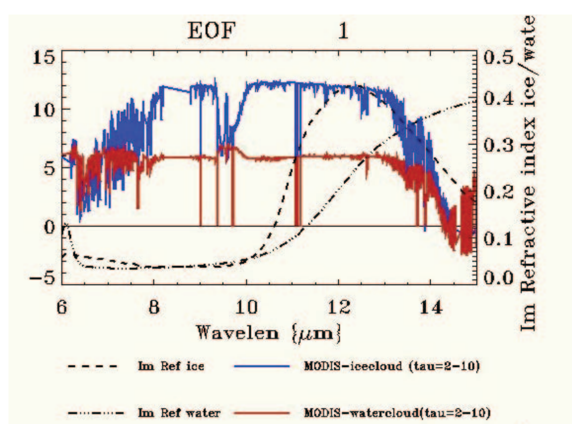

Fig 4: Empirical Orthogonal Function 1 for ice-(upper, blue) and water-clouds (lower, red) as derived by the AIRS spectrum analysis.

channels, which are sensitive to a certain cloud types - especially in the areas of CO_2-bands, which could become useful for developing combined algorithms of the instruments. We will present investigations of the spectra of AIRS by taking into account to e.g. cloud coverage as derived by MODIS within the FoV of AIRS. The accurate knowledge of the spatial response is necessary to investigate the amount of cloud coverage.

11. REFERENCES

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