EXTRACTION OF OZONE AND CHLOROPHYLL A FROM AVIRIS DATA

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Extraction of Ozone

Ozone absorbs particulary in the ultraviolet and visible range of the spectrum. Hence, spectrometry is expected to be a promising tool to extract the ozone contents in a given air column by using the correlation between cumulative trace gas amount and absorption strength in the sensor channels located in the absorption bands. Based on the huge POLLUMET data, the AVIRIS specifications and MODTRAN2 simulations, investigations to detect tropospheric ozone in the Chappuis-Band (500 - 700 nm) were initiated.

Today, the abundance of water vapor from imaging spectrometry data is usually determined by ratio methods [Frouin, 1990; Bruegge, 1990]. Two or more channels are combined to yield the total column water vapor abundance. The same process can be applied to ozone abundances.

First the best channels within the Chappuis-Band have to be determined. It must be discriminated between 'Reference channels' which should not be affected by any absorbing gas included ozone and on the other hand 'Measurement channels' which should be sensitive to the change of ozone amount and not be disturbed by other absorbing gases. An empirical comparision of MODTRAN2 transmissions calculations in the AVIRIS channels yielded a number of suitable AVIRIS ozone channels:

Measurement channel numbers:	22 (608nm), 23 (618 nm) ,17 (558 nm), 16 (549 nm)
Reference channel numbers:	1-12(< 515 nm), 28 (667 nm), 29 (677 nm), 40 (746 nm)

These selected channels could be combinated both by three known splitting window techniques and by new approaches. To date, the used methods are: Ratio of two channels [King, 1992], continuurm interpolated band ratio (CIBR) using 2 reference channels [Bruegge, 1990] and the Narrow/Wide technique [Frouin, 1990] with two channels of different bandwith centered at the same wavelength. Two new approaches are now introduced: The first is a quadratic interpolated band ratio (QIBR) analog to the CIBR but using three reference channels. The second is a statistical approach (TOTAL) by ratioing several measurement channels by the same number of reference channels. Each of these five methodes can be tested with different channel combinations, using the predefined channels.

From radiosonde data and other POLLUMET in-situ measurements a reference atmosphere for July 5th (1991) was created, consisting in a complete description of pressure, temperature, water vapor and ozone. The total column ozone in the atmospheric layers was integrated with height and compared to standard atmospheric profiles. None of them represented the tropospheric ozone amounts satisfying; the ozone column was nearly double as high as guessed by the tropical or the midlatidude summer model. This shows, that tropospheric ozone has a bigger influence on the total ozone signal than assumed.

To evaluate the methods and submethods, the influence of disturbing factors and the sensitivity to changing ozone amounts was investigated. For this purpose the amounts of the respective elements (aerosols, water vapor and ozone itself) were varied systematically in the atmospheric reference profiles. MODTRAN2 allows to simulate the influenced radiance at the sensor channels and all the methods could be applied to the simulated radiance. Good sensitivity to ozone staggering show the CIBR, the channel ratio and the TOTAL methods. The Narrow/Wide technique is only half as sensitive to ozone. Changing visibility goes ahead with the aerosol contents and affects especially the TOTAL and some of the CIBR-Methods. Narrow/Wide and QIBR methods aren't disturbed as much. If humidity is doubled in the atmosphere, the influence on all investigated methods is only about a fivth of the change due to variing aerosol optical thickness. After this evaluation step most of the methods could be eliminated.

The remaining methods were quantificated using the ozone variation procedure described above. An absolute quantification was only possible for one CIBR (channels 10,28 and 22) and one Narrow/Wide ratio (channels 10, 28, 17 and 22). All the others yielded irrealistic high or little ozone contents. Finally the CIBR was selected because of its higher sensitivity to ozone staggering. It's application to the AVIRIS-Scene (Figure ???) was only possible over water, due to the high response to changing underground and the very little absorption in the Chappuis Band. The error, which must be taken into account considering the disturbing factors is about +/- 30% .

Figure Captions

Figure 1:

Comparison of the raw AVIRIS data and the geocoded image to the right.