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针对SCIAMACHY探测器问题的CO柱浓度反演算法改进与地基验证

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An improvement of retrieving carbon monoxide from SCIAMACHY Part I: with respect to the instrumental issues

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摘要

搭载于ENVISAT卫星上的SCIAMACHY是目前唯一采用近红外波段观测大气温室气体(CO_2,CH_4,CO)的高光谱传感器.与其它热红外卫星传感器如AIRS、MOPITT、IASI等相比,SCIAMACHY用于CO探测的近红外波段对与人类活动密切相关的底层大气具有更高的敏感性.但无论从光谱角度(该波段CO吸收强度较弱,且存在很强的CH_4和H_2O重叠吸收),还是从SCIAMACHY仪器问题的角度(近红外波段探测器容易出现结冰现象),都给CO反演带来很大的挑战.由于探测器结冰问题造成SCIMACHY CO反演误差高达100%,并且该误差随时间和空间而变化.多个研究机构发展了各种不同的算法用于该误差的校正,但校正结果的时间一致性较差.本文基于IMAP-DOAS的CO反演算法,发展了一种针对SCIAMACHY探测器结冰问题的新校正算法,校正后的CO柱浓度反演误差以及时间一致性都比较理想,并与不同地基FTIR观测结果进行了对比,对比结果表明该校正算法的CO反演结果与地基观测一致性较好,相对偏差由校正前的60%减小到了5%,能够准确地获得CO的时空变化信息.经过校正后的CO柱浓度结果不仅可以用于准确获得CO排放源与汇的时空分布信息,还可以为政府部门制定碳减排相关政策提供重要参考,有效控制全球温室效应.

关键词 一氧化碳, IMAP-DOAS, SCIAMACHY, FTIR

Abstract:

SCIAMACHY on board the European ENVISAT satellite is the only one spectrometer, which could quantitatively determine the total column densities of the greenhouse gases CO_2, CH_4, as well as of CO from near-infrared spectral band. Compared to other thermal infrared satellite (MOPITT, IASI, AIRS, etc.), SCIAMACHY is more sensitive to low atmosphere where the strong source are located. However, the CO retrieval turned out not only to be a challenging task from a spectroscopic point of view, but also complicated by a serious instrument issue: the ice layer deposit on the SCIAMACHY near-infrared channels. This deposit ice layer yields systematic biases on SCIAMACHY CO VCD measurements, which are up to 100% and not only depend on location, but also vary with time. The accurate correction is essential, since inaccurate corrections will lead to a wrong interpretation of the results. Currently, there are several correction methods developed by different groups, but no consistent time series could be retrieved so far. In this paper, similar correction procedures are developed and validated at first. In addition to the existing correction methods, a completely new correction method is then developed. To validate the new SCIAMACHY CO product, we compare it with the independent ground based FTIR measurements. After the correction, the agreement of the seasonal patterns greatly improves; the relative differences between the two dataset reduce from 60% to less than 5%, which make the precisely satellite measurements possible. The results not only could improve our knowledge of the sources and sinks, but most importantly, also could help government formulate carbon reduction rules, effectively reduce the greenhouse effect.

Keywords Carbon monoxide, IMAP-DOAS, SCIAMACHY, FTIR

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