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CO_2 and CH_4 total column retrievals: The study of co-registration errors in multiband IR spectroscopes in support of future satellite missions

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Measuring atmospheric composition is a central objective for monitoring climate change and understanding human impact on the environment. One of the targets of future Earth observing satellite missions is quantifying natural and anthropogenic sources and sinks of Carbon Dioxide (CO_2) and Methane (CH_4). These missions, like CarbonSat, Sentinel-5 and its precursor S5-P, use a multi-band retrieval approach to characterize atmospheric scattering by aerosols and cirrus. The measurements from a grating spectrometer in which different optical modules measure different spectral bands may typically suffer from co-registration errors, due to a spatial mis-alignement of the different optical channels. Here, we study the effect that a mis-alignement of the different spectral bands would have on the retrieval performance for a space-borne multiband spectroscope collecting solar backscatter absorption spectra in the near and shortwave infrared. We only take into account retrieval errors due to spatial heterogeneity of cirrus clouds. Since cloudy scenes are commonly filtered out, the remaining co-registration errors in the retrieved CO_2 and CH_4 are expected to arise mostly from differing cirrus optical depth between different bands. This may cause an incorrect fit of the aerosol size distribution. To study the impact of this error on the retrieval accuracy of CO_2 and CH_4, we performed retrieval simulations for an ensemble of synthetic scenarios covering a typical range of cirrus configurations, derived from LIDAR observations. Our study in particular aims at supporting the best selection of instrument properties of new sensors such as Sentinel-5, S5-P and the CarbonSat mission and provides insight into critical aspects to be considered in the design of future satellite missions.