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Global Observations of SO_2 and HCHO Using an Innovative Algorithm based on Principal Component Analysis of Satellite Radiance Data

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We report on the latest progress in the development and application of a new trace gas retrieval algorithm for spaceborne UV-VIS spectrometers. Developed at NASA Goddard Space Flight Center, this algorithm utilizes the principal component analysis (PCA) technique to extract a series of spectral features (principal components or PCs) explaining the variance of measured reflectance spectra. For a species of interests that has no or very small background signals such as SO_2 or HCHO, the leading PCs (that explain the most variance) obtained over the clean areas are generally associated with various physical processes (e.g., ozone absorption, rotational Raman scattering) and measurement details (e.g., wavelength shift) other than the signals of interests. By fitting these PCs and pre-computed Jacobians for the target species to a measured radiance spectrum, we can then estimate its atmospheric loading. The PCA algorithm has been operationally implemented to produce the new generation NASA Aura/OMI standard planetary boundary layer (PBL) SO_2 product. Comparison with the previous OMI PBL SO_2 product indicates that the PCA algorithm reduces the retrieval noise by a factor of two and greatly improves the data quality, allowing detection of smaller point SO_2 pollution sources that have not been previously measured from space. We have also demonstrated the algorithm for SO_2 retrievals using the new NASA/NOAA S-NPP/OMPS UV spectrometer. For HCHO, the new algorithm shows great promise as evidenced by results obtained from both OMI and OMPS. Finally, we discuss the most recent progress in the algorithm development, including the implementation of a new Jacobians lookup table to more appropriately account for the sensitivity of satellite sensors to various measurement conditions (e.g., viewing geometry, surface reflectance and cloudiness).