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Simultaneous retrieval of tropospheric CO_2 and CH_4 in the tropics: almost two years from IASI hyperspectral infrared observations.

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Coupled observations from the Infrared Atmospheric Sounding Interferometer (IASI) and from the Advanced Microwave Sounding Unit (AMSU), launched together onboard the European MetOp platform in October 2006, are used to retrieve mid-to-upper tropospheric contents of carbon dioxide (CO_2) and methane (CH_4) in clear-sky conditions, in the tropics, since the first month of operation of MetOp (July 2007). In April, 20 months will be available. With its very high spectral resolution, IASI provides a few channels located either in the 15 μm band or in the 7.7 μm band highly sensitive to, respectively, CO_2 and CH_4, with reduced sensitivities to other atmospheric variables. These channels, sensitive to both temperature and either CO_2 or CH_4, are used in conjunction with AMSU channels, only sensitive to temperature, to decorrelate both signals through a non-linear inference scheme based on neural networks. A key point of this approach is that no use is made of prior information in terms of gas seasonality, trend, or geographical patterns. The accuracy of the retrieval is estimated to be about 2 ppmv (less than 1%) for CO_2 and 16 pbbv ($\sim$0.9%) for CH_4. Features of the retrieved methane space-time distribution include: (1) a strong seasonal cycle in the northern tropics, and a lower seasonal cycle in the southern tropics, in agreement with in-situ measurements; (2) a latitudinal decrease from 20°N to 20°S lower than what is observed at the surface but in excellent agreement with tropospheric aircraft measurements; (3) geographical patterns in good agreement with simulations from atmospheric transport and chemistry models, but with a higher variability; (4) signatures of CO_2/CH_4 emissions transported to the troposphere such as a large plume of elevated tropospheric methane south of the Asian continent, which might be due to Asian emissions from rice paddies uplifted by deep convection during the monsoon period and then transported towards Indonesia. In addition to bringing a greatly improved view of CO_2 and CH_4 distribution, these results from IASI should provide a means to observe and understand atmospheric transport pathways of these two greenhouse gases from the surface to the upper troposphere.