PERSPECTIVES ON POLAR-ORBITING INFRARED SOUNDERS FOR APPLICATION IN REGIONAL AIR QUALITY MONITORING

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Recent advances in hyperspectral infrared (IR) sounders extend their capability to the measurement of a continuous spectrum—654 to 2760 cm^{-1} (or 3.6 to 15.3μm)—at a resolution of 0.25cm^{-1}. This is evident in the Infrared Atmospheric Sounding Interferometer (IASI) and a number of studies have shown that this allows trace gas concentrations to be retrieved at a higher accuracy than was previously possible.

IASI was launced in 2006 on the METOP-A satellite which is the first of a series of European polar orbiting satellites dedicated to operational atmospheric monitoring. It has a sun synchronous orbit with a 9h30 equator local crossing time. At present, the IASI retrieval algorithm is developed to retrieve total column concentrations for ozone (O_3), carbon monoxide (CO), carbon dioxice (CO_2) and methane (CH_4) at a global scale, with spatial sampling of 250 km (or 4 x 4 pixels at nadir) and three hour operational dissemination since March 2008. In this paper, we hypothesize that it is possible to improve on such global retrieval algorithms and thereby extend the application of polar-orbiting IR sounding measurements to air quality monitoring at a regional scale.

Trace gases strongly linked to pollution events, e.g. CO and CH_4, typically have weak absorption in the IR range (with mixing ratios in the parts per million range) and have their highest concentrations at the boundary layer. Their accurate retrieval, therefore, remains a challenge despite the 0.25cm^{-1} spectral resolution of IASI, since IR sounders are known to be weakly sensitive to temperature contrasts at or near the Earth's surface.

The hypothesis presented here is based on the fact that each region has a unique set of surface characteristics and by developing retrieval parameters to reflect these, it becomes possible to improve on gobal retrieval statistics. We will demonstrate this for CO total column concetration retrieval over Southern Africa. In this region, for example, boundary layer inversions are restricted to nighttime only with air well mixed during the day even in Winter. This is an effect mostly due to the region having such a narrow landmass with respect to the ocean surrounding it. In addition, Southern Africa has a high CO surface variability caused by vast areas of undeveloped land interrupted by seasonal biomass burning and coal mining. Compared to industrialized regions, such as Europe, this makes it easier to isolate pollution sources, but at the same time introduces large background errors to the retrieval equation. Results will be calibrated with in situ measurements and compared with data from past field campaigns, specifically SAFARI 2000. A comparison will also be drawn with global products generated from other polar-orbiting instruments, e.g. AIRS and MOPITT, for the same area.

We envisage that the information generated in this way could fill the information gap between fine-scale, but isolated, and global products. With the suite of infrared sounders in orbit today, it is possible to get daily night and day time measurements. In this way, exploring the potential of space-borne measuremets for regional-scale trace gas retrievals, we hope to lay the foundation for the development of a Southern African air quality monitoring system which will ultimately draw on information from a range of spatial and temporal scales for improved decision making.