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• **News & Views** •

A Step Forward toward Effectively Using Hyperspectral IR Sounding Information in NWP

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Satellite-based atmospheric sounding measurements with high spectral resolution or from hyperspectral infrared (IR) sounders are important global observations for improving weather forecasts through assimilating them into operational numerical weather prediction (NWP) systems. Advanced IR sounders, such as the Atmospheric Infrared Sounder (AIRS) (Chahine et al., 2006) onboard Aqua, the Infrared Atmospheric Sounding Interferometer (IASI) (Hilton et al., 2012) onboard Metop-A and -B, and the Crosstrack Infrared Sounder (CrIS) (Gambacorta et al., 2014) onboard SNPP (Suomi National Polar-orbiting Partnership), together with microwave sounders, have become the most important providers of observations for operational centers (Le Marshall et al., 2005, 2006a, 2006b; Cardinali, 2009). These advanced IR and microwave sounders have provided the largest impact on forecast skill amongst all satellite observations (Joo et al., 2013; Cucurull and Anthes, 2014). Although advanced IR sounders have played a critical role in NWP systems, only a few hundred of the channels are selected in for assimilation, instead of all available channels, due partly to the large amount of data. For example, AIRS has 2372 channels, IASI has 8461 channels, and CrIS has 1305 channels, but in each case only a subset of channels are assimilated in the NWP systems at the major operational centers.

Methodologies have been developed for selecting a subset of channels for NWP assimilation. For example, Li and Huang (1994) developed an approach based on a stepwise regression for AIRS channel selection; Collard (2007) selected channels for assimilation based on information content analysis along with some additional criteria; Rabier et al. (2002) studied channel selection based on the Jacobian matrix and iterative method for sequentially selecting channels with the largest information content; Ventress and Dudhia (2014) modified the standard algorithm to allow spectrally correlated errors to be properly modelled, and quantified, within the channel selection process; and Migliorini (ECMWF technical Memo no. 727, 2014) studied the optimal flow-dependent selection of channels in the presence of cloud. These methodologies are very useful for selecting a subset of channels presenting optimal information for radiance assimilation, especially when hyperspectral advanced sounder data are available from geostationary orbit; for example, the Geostationary Interferometric Infrared Sounder onboard the FengYun-4 series (Yang et al., 2017). In general, these methodologies are based on information content analysis, in which the linearization is used in the channel selection process. One limitation of information content analysis is the linear approach for selecting absorption channels that have high nonlinearity (e.g., the radiances of the water vapor absorption channels are more nonlinear to atmospheric water vapor than temperature). Another limitation of such methods stems from the fact that channels are selected at each absorption band independently from other absorption bands, resulting in a subjective channel selection caused by different weights between bands.

A new method has recently been developed (Noh et al., 2017) for refining the channel selection process. Using this method, channels are selected through calculation of the impact of the individually added channel on the improvement in the analysis outputs from a one-dimensional variational analysis. The channel score index (CSI) has been developed and used as a measure of success in the channel selection process, and 200 channels were systematically selected from 314 EUMETSAT channels of IASI by counting individual channels' CSI contributions. Impact study indicates improved forecasts of moisture in the upper troposphere, and the total precipitable water (reduced moisture bias), when using the newly selected channels, as compared with forecasts derived from the 183 channels used operationally by the UKMO's Unified Model. Compared with other methods, this method considers the nonlinearity in channel selection, especially for selecting moisture channels, which allows more moisture channels to be included. This is an important step forward toward the effective use of sounding information from hyperspectral IR

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sounders in NWP, especially moisture sounding information.

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