IWAQFR 2018 Abstract for Oral Presentation

Assimilating Phase Space Retrievals in WRF-Chem/DART: Comparison with Independent Observations, Extension to Assimilation of Truncated Retrieval Profiles, and Assimilation of Spectrally Truncated Phase Space Retrievals

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Chemical data assimilation (Chem-DA) is critical to the accuracy of chemical weather forecasting, but Chem-DA faces many challenges e.g., (i) scarcity of observations, (ii) remote observations with high volume and low information density, (iii) observation error correlations, and (iv) high computational/data storage costs. Mizzi et al. (2016) introduced compact phase space retrievals (CPSRs) to help address those challenges, specifically those related to the assimilation of satellite retrieval profiles of atmospheric composition. They showed that assimilation of MOPITT CO CPSR profiles ameliorated challenges (ii), (iii), and (iv) with improved model performance when compared to the assimilated observations.

Mizzi et al. (2018) performed similar experiments and compared their results against independent observations (IASI CO retrieval profiles and MOZAIC/IAGOS *in situ* CO profiles). They found skill improvements and computational cost reductions comparable to those of Mizzi et al. (2016). They also found that: (i) the near-surface improvement was not as large as expected, and (ii) the assimilation had introduced a positive bias in the upper-troposphere. Item (i) was unexpected because the MOPITT instrument was designed, and has been shown, to have sensitivity to CO in the lower -troposphere. Item (ii) was somewhat expected because other researchers had reported a positive bias for the MOPITT CO retrievals in the upper troposphere.

To address item (i), Mizzi et al. (2018) used the CPSR algorithm and a compositing analysis based on all the MOPITT CO terrestrial retrievals observed over the CONUS during their study period to show that following the CPSR compression transform the MOPITT averaging has strong sensitivity near the surface. However, after accounting for the error correlations with the CPSR rotation transform, that sensitivity weakens due to the magnitude of the near-surface observation errors.

To address item (ii), Mizzi et al. (2018) extended the CPSR algorithm to assimilation of truncated retrieval profiles (profiles where the biased retrievals were discarded). The extended algorithm is similar to the original approach except it is based on a rectangular averaging kernel matrix (as opposed to a square matrix) due to the discarded elements of the retrieval profile. They found that by applying the extended algorithm they could remove the upper-tropospheric bias. However, assimilation of the truncated retrievals had a negative impact in the middle and lower troposphere – it reduced the assimilation-based improvements in those regions. Again, Mizzi et al. (2018) used the CPSR algorithm and a compositing analysis to investigate their results. It showed that by discarding the upper-tropospheric retrievals they had: (i) disproportionately reduced to the total information content of the assimilated retrievals because most of the information was associated with the upper-tropospheric retrievals, and (ii) reduced the sensitivity of the fully transformed averaging kernel throughout the troposphere.

In this oral presentation, we will discuss an overview of WRF-Chem/DART and its recent advances and applications. We will focus on the results of Mizzi et al. (2018) and present preliminary results from our research on assimilation of truncated phase space retrievals.