Statistical inversions including regression-based retrievals are dominating in satellite remote sensing application, which can only extract the qualitative information from measurements. To improve these retrievals from qualitative to quantitative, we introduce a total least squares (TLS) method for satellite retrieval, which can extract information from individual pixel measurement using physical deterministic approach and we use sea surface temperature (SST) retrievals as a test bed. TLS implicitly determines the optimal regularization strength to be applied to the normal equations for 1st order Newtonian retrieval using all of the noise terms embedded in the residual vector. However, the standard TLS technique does not include any constraint to prevent noise enhancement in state space parameters from the existing noise in measurement space for an inversion with an ill-conditioned Jacobian. Hence, we introduce an additional empirical regularization proportional to the logarithm of the condition number of the Jacobian to ameliorate the noise propagation into the retrieval parameters, which we refer to as the modified total least square (MTLS) method.

The use of the MTLS method for SST retrievals from nadir viewing GOES-13 measurements will be discussed. We will also present a time series of retrieval results for three years satellite data collocated with buoy temperatures. Our results show a significant improvement (~50% reduction in root mean square error for validation against buoys) in the SST retrievals using MTLS algorithm over the operational regression-based products at the office of satellite product operations (OSPO, NOAA). We have also derived an analytic equation to calculate the total retrieval error that agrees well with the observational error. These calculated errors can serve as quality indicators for the individual retrievals.