In this study, we present that traditional spatial regridding methods applied to space-based observations tend to cause serious bias for retrieved data when subject to varying footprint pixel resolution in fine-scale comparisons between different satellite platforms, or even within single instrument. In order to resolve this issue, we designed a new spatial regridding method which performs (a) lossless fractional weighting using accurate polygon clipping algorithms, and (b) spatial reconstruction (or downscaling) based on fine-scale information using moving spatial weighting kernels. We first applied the method to a case for NO2 columns from the Global Ozone Monitoring Experiment-2 (GOME-2), the Ozone Monitoring Instrument (OMI) and the Community Multiscale Air Quality (CMAQ) model NO2 columns (4-km resolution) in 2008 southern California. The new method successfully produces fine scale satellite-derived NO2 columns, showing excellent agreement with CMAQ NO2 columns (R=0.96 for GOME-2 and R=0.93 for OMI in August 2008) and with surface NO2 concentrations from U.S. Environmental Protection Agency (EPA) Air Quality System (AQS) monitoring sites (R=0.91 for GOME-2 and R=0.80 for OMI in August 2008). Nonetheless, traditional methods show significant negative biases in highly urbanized regions or near active traffic activities. We further investigated bias dependency in raw data pixel resolution over urban cities in the Contiguous United States. While satellite measurement at nadir provides best resolution data (e.g. 13×24=312km2 for OMI), its actual coverage is extremely small; using 50% of available pixels (pixel size < 450 km2) results in only ~11% coverage. When bigger pixels are allowed, satellite's coverage increases (e.g. data coverage at 75% (<721 km2) and 100% (<1732 km2) are 24% and 60%, respectively) but it tends to underestimate column density over urban cities with traditional regridding method. The new spatial regridding method successfully removes pixel-dependent biases over urban cities and maximizes data coverage.