

Trends (2000-2022) from the TOAR II/HEGIFTOM Global Ground-based Tropospheric Ozone Measurements: A Reference Dataset for Satellite Products and Models

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Abstract

Tropospheric ozone trends among various models and satellites diverge widely, the former due to different emission and dynamical parameterizations, the latter due to varying spectral techniques or algorithms. Ground-based (GB) observations are required to verify models and satellites but GB network data themselves can display station biases and discontinuities over time. The TOAR-II Working Group, HEGIFTOM (Harmonization and Evaluation of Ground-based Instruments for Free-Tropospheric Ozone Measurements) used uniform procedures to “homogenize” data from 5 network instrument types: ozonesondes, IAGOS profiles, FTIR, Lidar, Dobson Umkehr. The data are at: <https://hegiftom.meteo.be/datasets>. Amounts and uncertainties for tropospheric ozone (nominally “total” column, surface to 300 hPa), free (FT) and lower (LT) tropospheric columns were calculated for each GB network over ~25 years. We report trends for the period 2000 to 2022 from the HEGIFTOM data based on Quantile Regression (QR) and Multiple Linear Regression (MLR) methods. The key findings: (1) For both statistical methods, pole-to-pole and across the full longitude range of observations, medians for all trends fall within +3 ppbv/decade to -3 ppbv/decade; (2) With many regions featuring negative and positive changes, “zonal-mean” ozone trends are often negligible and misleading. (3) Ozone over SE Asia and a few tropical stations exhibit the greatest increases but even in the tropics negative trends are observed. (4) Trends in total ozone may be greater or smaller than FT ozone, depending on whether pollution over a site is more concentrated near the surface or in the FT. In summary, the HEGIFTOM analyses show that multi-instrument, high-quality, harmonized data provide robust trends (2000-2022) across statistical methods: within ± 3 ppbv ozone/decade for the surface to 300 hPa column. The remarkably comprehensive HEGIFTOM dataset provides clear constraints for TOAR II global models and evolving tropospheric ozone satellite products for the 2000-2022 period.

Early Career Scientist

NO, I am not an early career scientist.

IGAC Activities

TOAR: Tropospheric Ozone Assessment Report