Variabilities in Surface Ozone at the Doon Valley of the Himalayan Foothills: Role of Different Chemical Processes

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South Asia is one of the most diverse regions, home to pristine Himalayan ranges and the most polluted regions, i.e., the Indo-Gangetic Plain (IGP). However, ground-based observations of trace species are highly limited in this region. Because of this, observations of surface ozone have been made at Dehradun (30.330°N, 78.04O°E, 700 a.m.s.l.), a valley site between the Himalayas foothills and the IGP region's proximity from August 2009 to September 2018. Diurnal variations at Dehradun show higher daytime levels than nighttime throughout the year, implying the photochemical production of surface ozone during the daytime. Further, an evening (8.5 ppbv/h) and morning (8.0 ppbv/h) time rate of change of ozone (dO^3/dt) at the site suggests a typical urban environment. A significant monthly variation was observed, with the maximum levels in late springtime (May; 45±15.5 ppbv) and the minimum in the summer/monsoon (July; 15±7.5 ppbv). Sometimes during springtime, the hourly levels exceed 100 ppbv levels, and a secondary maximum is also observed in late autumntime (November; 30±12.4 ppbv). These monthly variations were similar to the other northern Indian (Nainital; Pantnagar) sites. The springtime maxima revealed the role of strong photochemistry in the presence of excessive precursors under the shadow of strong solar radiation with some effect of small-scale dynamic processes. The monthly variation also suggests the influence of boundary level height and biomass burning during spring and autumn at Dehradun. The comparison of monthly surface ozone variability at Dehradun with other Indian subcontinent sites shows the region's heterogeneity in ozone distribution processes. The modeled (CAMs) and observational temporal variabilities are in good agreement at Dehradun except for Summer/Monsoon season, where model results overestimate (20-25 ppbv) the ozone levels than observations. The photochemical production regime of ozone production assesses through the ratio (H_2O_2/HNO_3) analysis for model results. These results are further reconfirmed by other ratio sensitivity indicators ($HCHO/NO_2$). Both hands are in good agreement and suggestion the NO_x-limited regime. A photochemical box model (NCAR-Master Mechanism) was also used to understand the photochemical ozone budget, sensitivity simulation and the role of different NMHC groups at Dehradun and suggest the dominant role of aromatics NMHCs in photochemical ozone production. More details will be presented during the conference.

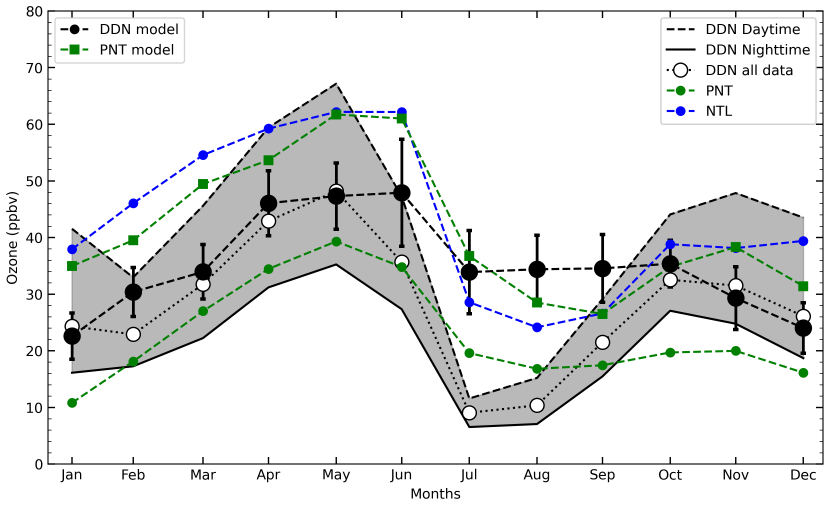

Figure 1. Comparison of Seasonal variations in monthly, daytime (1130–1630 h) and nighttime (0100–0300 h) average ozone at Dehradun with CAMs modeled dataset. Monthly average ozone mixing ratios are also shown at a nearby high-altitude site (Nainital) and a semi-urban site in Pantnagar.