The November 2023 severe pollution episode in Pakistan and Northern India

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South Asia, with its high population density supported by thriving industrial and agricultural sectors, is one of the most polluted region in the world. In early November 2023, the region along the Himalayas, the Indo-Gangetic Plain (IGP), experienced a severe air pollution episode that affected visibility over several thousand kilometers and impacted millions of inhabitants.

Here we use a variety of measurements and datasets to attempt to untangle the reasons behind the formation and the buildup of this pollution episode. Using IASI (Infrared Atmospheric Sounding Interferometer) measurements, embarked on board of the Metop satellites, we find exceptionnally high concentrations of carbon monoxide (CO) and ammonia (NH_3) in the Northwestern states of IGP. Fire satellite measurements from MODIS (Terra and Aqua) and VIIRS (Suomi-NPP and NOAA-20) show that CO is mainly emitted from agricultural waste burning, prevalent at the post-monsoon season. NH_3 primarily emanated from extensive applications of nitrogenous fertilizers, as well as fires, contributing to the formation of fine particulate matter (PM2.5) in the region and degrading the air quality as seen by local air quality stations. ERA5 reanalysis unveiled that these high concentrations of pollutants and their buildup was favored by meteorological conditions that resulted in air mass stagnation, facilitating the accumulation of pollutants in the region.

This study builds a framework to demonstrate the potential of using satellite instruments data, in situ measurements, and reanalysis combined to understand the formation and the progression of air pollution episodes in South Asia.