Synopsis Seminar

Seminar Title	: Interaction of aerosols with radiation, clouds, and precipitation during different meteorological scenarios over India and adjoining oceans
Speaker	: Ankan Sarkar (Rollno : 519er2002)
Supervisor	: Prof. Jagabandhu Panda
Venue	: Mining Engineering Seminar Hall
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Abstract

: Aerosols have emerged as a critical component in Earth&rsquos atmosphere due to their significant impact on the energy balance, cloud formation, circulation patterns, and precipitation processes. In general, they alter radiative budget and cloud properties through aerosol-radiation interaction (ARI) and aerosol-cloud interaction (ACI), introducing complex feedback with meteorological processes. The research works in the thesis explored aerosol variability and its impacts on radiation, clouds, and precipitation considering different meteorological scenarios, with a specific emphasis on extreme weather events in northern and central-east India. Analysis of aerosol trends during the COVID-19 lockdown periods revealed that despite the decline in anthropogenic emissions due to limitations in human activities, prevailing meteorological conditions and long-range transport of natural aerosols from elevated layers played a substantial role in altering the aerosol distribution. A long-term observational analysis indicated the dominance of negative semi-direct effect (SDE) of highly absorbing smoke and polluted dust, which increased low-level clouds over heavily polluted central and lower Indo-Gangetic Plain regions. WRF-Chem results further indicated that doubling the anthropogenic black carbon (BC) can lead to a significant reduction in surface fluxes, hindering further growth of the planetary boundary layer (PBL), consequently worsening the wintertime fog-haze situation through &lsquoaerosol-radiation-PBL&rsquo feedback. However, the most prominent mid-tropospheric heating of absorbing BC encouraged upward moisture transport and facilitated the enlarged production of ice clouds in the polluted environment. RegCM-simulated results showed that during the unprecedented scenario of consecutive dust storms in the 2018 pre-monsoon months, dust-induced nocturnal warming dominated over daytime cooling at the surface, creating widespread low-pressure areas and thereby encouraging moisture convergence toward the Indian subcontinent. Meanwhile, dust-induced mid-tropospheric heating strengthened the &lsquoelevated heat pump&rsquo effect, resulting in increased moisture transport and convective rainfall over the Arabian Sea and adjoining land areas. Numerical simulations regarding dust impacts on a &lsquodust-rain&rsquo storm illustrated that while ACI could partially offset the total effects, ARI remained dominant during the extreme event. A similar signature was also observed in the case of a super cyclone Amphan, where the ingestion of light-absorbing aerosols in the peripheral regions weakened the tropical cyclone through dominating ARI effects. Also, the observational analysis demonstrated the redistribution of aerosols during several TC cases, which became more prominent when they reached either their mature stage or approached the continents for landfall.