Changes in Surface $PM_{2.5}$ Spatial Distribution over Thailand during the ASIA-AQ Measurement Campaign

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Abstract

This study examines the spatial distribution of PM2.5 in Thailand during March 2024, focusing on a noticeable shift observed from March 19 onward. Typically, PM2.5 concentrations are higher in northern Thailand and decrease towards the south. However, this pattern changed, prompting an investigation into whether the cause was due to significant changes in emissions or synoptic meteorology, using the ARUN WRF-Chem forecasting system during the 2024 ASIA-AQ aircraft campaign. The ARUN WRF-Chem system employs the WRF-Chem model (v.4.3.1), optimized for Indochina with updated terrestrial data, the MYNN Level 3 planetary boundary layer scheme, and the latest anthropogenic emission inventories for northern Thailand. The model domain covers mainland Southeast Asia with a 9 km horizontal grid spacing. Initial and boundary conditions for meteorology were sourced from NCEP's GDAS/FNL and GFS, and for chemistry from CESM2 WACCM. Fire and biogenic emissions were included using FINNv2.5 and MEGAN. Analysis of the WRF-Chem forecast outputs initially focused on emission sources, particularly fire emissions, using forecasts initialized on different dates in March 2024. From March 13-18, emissions were consistent, but decreased after March 19 before gradually increasing again. Subsequent forecasts examined the advection of these emissions, showing a shift in prevailing winds from westerly to easterly on March 19. The change in wind patterns was linked to a moderate high-pressure system extending from China to upper Thailand and the South China Sea. This system, combined with hot weather in northern Thailand, led to mesoscale convective systems that caused thunderstorms and gusty winds. These conditions facilitated the transport of fire emissions from neighboring countries into central Thailand, including Bangkok. Vertical distribution analysis indicated that the high-pressure extension and mesoscale convective winds enabled the transport of PM2.5 from southern Laos and northern Cambodia to central Thailand, altering the typical PM2.5 distribution pattern during this period.

Early Career Scientist

NO, I am not an early career scientist.

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, BBURNED: Biomass Burning Uncertainty: ReactioNs, Emissions and Dynamics

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group