Topic: Study of Mercury Deposition Processes in Thailand Integrating Emission Source Characterization and Atmospheric Modeling

Name of student: Ms. Pham Thi Bich Thao **Student ID:** 52920112

Name of Supervisor: Assoc. Prof. Savitri Garivait

ABSTRACT

Mercury (Hg) is considered to be a Hazardous Air Pollutant (HAP), and its deposition results in adverse effects to both human health and the ecosystem. Recent global assessment of atmospheric Hg fate indicated a relatively high level of Hg deposition flux, which is directly linked to health risk in the Northern of Thailand. This observation raised questions about the emission-to-deposition processes. In this regard, it is necessary to investigate several involved factors, such as source characteristics, meteorological conditions, and chemical transformation driving deposition processes.

Thailand has various Hg anthropogenic atmospheric emissions sources, such as coal-fired power plants, cements, large scale gold mining. In this study, characteristics of anthropogenic atmospheric Hg emissions for the year 2010 were presented. The calculations were based mostly on the bottom up approach. The activity data were obtained from official sources including governmental reports and databases. The emission factors of Hg species were assessed from local sources or adapted from literature review with proper adjustments to well reflect emissions behaviors of various sources in Thailand. It was found that in year 2010, total atmospheric Hg emissions were 20,495.2 kg, which 79.0% from natural sources, 19.7% from anthropogenic sources, and 1.2% from biomass open burning. Within Hg speciation, Hg^0, Hg^{2+} and Hg^P accounted for 91.7 %, 6.5%, and 7.8 % respectively.

To better understand the mechanism of Hg deposition in the case of Thailand, a coupled model consisting of a meteorological model (i.e., MM5) and an air quality model (i.e., CAMx) was used. To access seasonal variation, 4 one-month simulations (here are March,

May, August, and November 2010) were performed. In general, all options captured the temporal variation of meteorological parameters in Thailand which are generally influenced by monsoon. The comparison with 3 hourly data with Thai Meteorological Department indicated that reasonable agreement was found. Among several sets of investigated physical options, the combination of Grell, MRF, Simple ice, Cloud radiation scheme, and Five layer soil model had better agreement with observation, compared to other options.

Emissions of Hg as well as other species, such as NO_X, CO, SO_2, NMVOC, NH_3, PM_{10}, $PM_{2.5}$, OC, and BC, from both anthropogenic natural sources, and biomass in interested domains (inside and outside Thailand) were accessed in the year 2010 and then processed to input into the CAMx. Emissions were high in March due to biomass burning activity, and generally high in May due to the peak in power generation in the country during the summer period. Simulations of different months (March, May, August, and November 2010) showed that relatively high Hg concentration, mostly located in the northern of Thailand, is found in March and November, 2010. Of note, output of this work was not directly performed by in pair comparing with observations because firstly, there was no record of Hg concentration or deposition in study domain. Monthly average total Hg concentrations ranged between 1.7-2.6 ng/m^3 which is not far from yearly average of 1.7-2.0 ng/m^3 as output from global model and from samplings of 2.04 – 2.43 ng/m^3 in the northern of Thailand during March and April, 2010. Monthly accumulated Hg deposition in the northern of Thailand was up to 2.4 g/km^2/month, which was approximately 30 g/km^2/year in range with 20-50g/km^2/year found in HTAP (2010).

Sensitivity test of Hg deposition on emissions by disable Hg emissions inside domain 2 indicated that most of Hg concentration and deposition inside Thailand domain caused in mass inflow. Inflow and out flow of Hg species were analyzed. Transport budget of Hg^0 is relatively small and positive for all simulation months, indicating net transport of Hg speciated emissions out of the domain while that of Hg^{2+} and Hg^P is relatively high and negative, indicating net removal within the domain.

Keywords: Mercury, emissions, deposition, modeling, Thailand