UNIVERSITY OF THE PHILIPPINES

Master of Science in Meteorology

Bhenjamin Jordan L. Ona

Experimental simulations of aerosol effect to landfalling tropical cyclones over Philippine coast: virtual seeding using WRF model

Thesis Adviser:

Gerry Bagtasa, Ph.D.

Institute of Environmental Science and Meteorology

University of the Philippines Diliman

Date of Submission

June 2017

Thesis Classification:

P

EXPERIMENTAL SIMULATIONS OF AEROSOL EFFECT TO LANDFALLING TROPICAL CYCLONES OVER PHILIPPINE COAST: VIRTUAL SEEDING USING WRF MODEL

Bhenjamin Jordan L. Ona
Institute of Environmental Science and Meteorology
University of the Philippines Diliman

Gerry Bagtasa, Ph.D.
Thesis Adviser

ABSTRACT

The influence of aerosols acting as cloud condensation nuclei (CCN) in the evolution of Typhoon Bopha (2012), Typhoon Hagupit (2014), and Typhoon Haima (2016) was investigated by conducting sensitivity experiments using Weather Research and Forecasting (WRF) model at cloud-resolved resolution with Thompson aerosol-aware microphysics module. This module can predict number concentration of cloud droplet (N_c), CCN number concentration (N_{wfa}), and ice nuclei number contration (N_{ifa}). There are initial N_{wfa} surface emissions for each model simulation per tropical cyclone (TC) with N_{wfa} maxima of 300 cm^{-3}, 2000 cm^{-3}, and 5000 cm^{-3} at different mean particle radius varying from 0.01 μm and 0.16 μm. The simulated TCs at different aerosol scenario manifest distinctive development patterns. CCN efficiency of small- (0.01 μm mean radius) and large-sized (0.16 μm mean radius) was investigated through microphysical processes on TC dynamics. The study showed that an increased N_{wfa} in TC invigorates convection, intensified cloud updraft, and affect precipitation efficiency. Small-sized aerosol generated large number of smaller cloud droplets, supercooled water, and ice crytals than large-sized aerosol. The presence of large number of ice precipitation triggers strong updraft velocity in the peripheral bands and low-level cooling through melting and evaporation that weakens convergence towards the center of TC. However, large-sized aerosol is more potent

CCN than small-sized aerosol in terms of their nucleating ability. Large amount of latent heat was released via droplet condensation after seeding high number of large-sized aerosol. This heat energy had energised TC and slowly weakened its intensity. The study concluded that large amount of small-sized aerosol noted a reduction in maximum wind speed by 10% to 22%, reformation of larger radius, and decreased in horizontal pressure gradient which indicate the deintensification of TC.