Vegetation Cloud Interaction in the Arctic Regions

Mee-Hyun Cho[1], Ah-Ryeon Yang[2], Eun-Hyuk Baek[1], Sarah M Kang[3], Su-Jong Jeong[4], Jin Young Kim[5], and Baek-Min Kim[1]

(1) Korea Polar Research Institute, Division of Climate Change, Incheon, South Korea,
(2) Seoul metropolitan office of meteorology, Suwon, South Korea,
(3) Ulsan National Institute of Science and Technology, Ulsan, South Korea,
(4) South University of Science and Technology of China, School of Environmental Science and Engineering, Shenzhen, China,
(5) KIST Korea Institute of Science andTechnology, Gangneung, South Korea,
(6) KOPRI Korea Polar Research Institute, Incheon, South Korea

This study investigates future changes in the Arctic region and vegetation-cloud feedbacks simulated by National Center for Atmospheric Research Community Atmosphere Model Version 3 (NCAR-CAM3) coupled to the mixed layer ocean model. Impacts of future greening of Arctic region are tested using altered surface boundary conditions for hypothetical vegetation distributions: 1) grasslands poleward of 60°N replaced by boreal forests (GtoBF) and 2) both grasslands and shrubs replaced by boreal forests (GStoBF). Surface energy budget analysis reveals that future greening induces considerable surface warming effect locally and the warming is largely driven by short wave radiation increase. Both upward and downward shortwave radiation contributed the surface warming positively: Upward shortwave radiation is decreased mainly due to the decreased surface albedo (a darker surface). Downward shortwave radiation is increased due to the reduced cloud cover. It is revealed that relatively smaller increase of water vapor compared to the large increase of low-level air temperature in the simulation reduces the relative humidity and results in the reduction of cloud cover. Therefore, vegetation-cloud feedbacks induced from the land cover change amplifies significant Arctic warming. On top of previously suggested feedback mechanisms, we suggest that the vegetation-cloud feedback should be considered as one of major components that give rise to the additional positive feedback to the Arctic amplification.