ForestSAT 2018
1-5 October 2018, College Park, Maryland

Using Landsat, Aerial Surveys, Weather Modeling, and Agent-based Models of Outbreak Insect Phenology and Migration to Explore the Topographic Concentration Hypothesis.

Matthew Garcia (matt.e.garcia@gmail.com)
University of Wisconsin–Madison, Madison, Wisconsin, USA
Brian Sturtevant
USDA Forest Service, Rhinelander, Wisconsin, USA
Jacques Régnière, Yan Boulanger, Rémi St-Amant, and Luc Guindon
Natural Resources Canada, Québec City, Québec, Canada
Barry Cooke
Natural Resources Canada, Sault Ste. Marie, Ontario, Canada
Gary L. Achtemeier
USDA Forest Service, Athens, Georgia, USA
Joseph J. Charney
USDA Forest Service, East Lansing, Michigan, USA
Philip A. Townsend
University of Wisconsin–Madison, Madison, Wisconsin, USA

Abstract

We present ongoing work investigating topographic effects on the concentration and spatiotemporal patterns of the growing eastern spruce budworm [*Choristoneura fumiferana* (Clem.)] outbreak in eastern Canada. Spruce budworm moths tend to migrate in discrete, but sometimes massive, nocturnal flight events over several weeks each summer. Moths from an outbreak area may supplement distant locations to boost endemic populations to outbreak levels the following spring. The spruce budworm outbreak event on the north shore of the Gulf of St. Lawrence in Quebec has recently crossed the Gulf to the south shore and now threatens forests in New Brunswick and Maine. Past work [Pedgley, 1990] and recent studies [Bouchard and Auger, 2014; Bouchard et al., 2017] suggest that outbreak epicenters are associated with topographic valleys. We hypothesize that night-migrating insects may become concentrated by near-surface wind patterns in topographic valleys, where egg deposition and favorable climate can lead to a persistent source of migrating insects along with host forest defoliation (and eventual mortality) in subsequent years. We are exploring the validity of this "topographic concentration hypothesis" using an agent-based model of insect phenology and migratory flights. Spatially explicit spruce budworm phenology is modeled using the BioSIM framework [Nealis and Régnière, 2014], where data regarding the likelihood of adult moth migration readiness are provided to an Atmospheric Transport Model (ATM) derived from prior work [Sturtevant et al., 2013]. This ATM component uses Weather Research and Forecasting (WRF) model results on a 1-km grid to simulate the flights of individual moths. We used high-performance and high-throughput computing systems at the University of Wisconsin–Madison to perform WRF and ATM simulations of migration flight events in July 2013 for calibration and validation against Val d'Irène weather radar observations in southern Québec [Boulanger et al., 2017]. We then

compared model-based maps of egg deposition during migration events in a given year with aerial surveys and Landsat-based analyses of host species defoliation and mortality in subsequent years. The fusion of these modeling methods and data sources provides insight into the patterns and dynamics of the current spruce budworm outbreak behavior in Québec and may be applicable to other species outbreaks in locations where such information is available.