



**ses**

school of environmental sciences

The MSc Thesis Examination for

**Jacob Lachapelle**

will be held on

**Friday, May 21, 2021**

At 1:00 p.m.

A microscale 3-D model of urban outdoor thermal exposure (TUF-Pedestrian):  
impacts of street tree configuration

**EXAMINATION COMMITTEE:**

Dr Susan Glasauer (Chair)  
Dr Scott Krayenhoff (Advisor)  
Dr Claudia Wagner-Riddle (Internal-External)  
Dr Jon Warland (Committee member)

**ADVISORY COMMITTEE:**

Scott Krayenhoff (Advisor)  
Dr Jon Warland (Committee member)  
Dr Ariane Middel (Committee member)

Everyone is welcome to attend.

## ABSTRACT

Street trees create shade and provide effective cooling to urban pedestrians during hot weather. However, existing simulation tools may not be sufficient to inform optimization of street tree placement for this purpose. A microscale three-dimensional (3-D) urban radiation and energy balance model, TUF-Pedestrian, is developed to simulate pedestrian radiant exposure and study urban tree placement. TUF-Pedestrian explicitly simulates the shortwave and longwave radiative impacts of trees on their surroundings. It also includes a pedestrian that absorbs radiation, permitting calculation of a summary metric of radiant exposure: the mean radiant temperature ( $T_{MRT}$ ). Model evaluation demonstrates that TUF-Pedestrian accurately simulates incoming directional shortwave and longwave radiation fluxes on pedestrians and associated  $T_{MRT}$  in urban environments with and without tree cover. Subsequently, the model is applied to understand the variation of pedestrian  $T_{MRT}$  as a function of different street tree configurations in hot weather. Results suggest it is important to consider street orientation and latitude (solar angle) in terms of the placement of street trees relative to pedestrian walkways. Importantly, additional radiant cooling of pedestrians during hot afternoons per unit addition of tree cover decreases modestly as existing tree cover increases. Optimizing street tree configuration in urban canyons for pedestrian thermal comfort is a complex task that can be supported with simulation tools such as TUF-Pedestrian.