# Adaptive Prediction of Local Disease Risk Indicators Using Multi-scale Weather, Land and Crop Data

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**Abstract**

The risk of fungal and bacterial diseases in a crop canopy can be predicted using disease risk models with specific environmental conditions (microclimate data such as temperature, relative humidity, solar radiation, wind speed, and surface wetness duration (SWD)). Unfortunately, the inconvenience and uncertainty associated with monitoring key variables such as SWD at the local leaf scale and the complexity of upscaling to the crop level prevent existing disease risk models from being used with reliability. Despite these difficulties, it is anticipated that the next 10-20 years will see a shift in the estimation of surface wetness from systems based on *in situ* sensors to those based on simulation models and remote sensing [Magarey et al., 2004]. A well-calibrated Surface Wetness Energy Balance (SWEB) model for predicting surface wetness at the plant scale has been developed and validated using an extensive dataset from four grape cultivars growing at the Climatological Reference Station in Geneva, New York [Magarey 1999]. Spatial modeling of surface wetness at the crop scale is essential to assess the impacts of alternative management policies on predictions of disease risk. As a result, the process-based SWEB model has been replicated using a suite of recurrent Artificial Neural Networks (ANNs) to estimate key environmental variables (specifically SWD) at local crop scales from local and regional weather station data and site specific sensing data. The selected ANN combines two statistical methods to accomplish this spatial mapping (a K-nearest means classifier and a Bayesian classifier), while the recurrent nature of the ANNs provide a means of forecasting in time. An important component of the adaptive monitoring and operation of the ANN system framework is a data assimilation technique (a simple data-driven Kalman filter) that integrates monitoring data and phenomenological modeling results to provide insightful analyses on SWD dynamics in both spatial and temporal dimensions. The model builds on the format of a raster-based geographic information system (GIS) that is used to store the spatially referenced remotely sensed data. The overall goal is the development of an adaptive, web-based Geographical Information System (GIS) software incorporating ANN models that ultimately can be combined with existing disease models to improve maps of disease risk at fine spatial and temporal scales.

Magarey, R. D. (1999). A theoretical standard for estimation of surface wetness duration in grape canopies., Ph.D. Dissertation, Cornell University, Ithaca, NY.

Magarey, R.D., J.M. Russo, and R.C. Seem, and D.M. Gadoury. (2004). Surface wetness duration under controlled environmental conditions. *Agric. For. Meteorol*.