**NASA DEVELOP National Program**

****NASA Langley Research Center

**Spring 2015**

**Northwest US Agriculture II**

*Evaluating suitability for apple cultivation based on accumulated chill hours and precipitation in Washington State from 2003 – 2065*

**Project Team:**

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**Past or Other Contributors:**

Northwest Agriculture I – LaRC Fall 2014

**Partner Organizations**

United States Department of Agriculture – Agriculture Research Service (USDA-ARS) Appalachian Fruit Research Station, POC: D. Michael Glenn, Ph.D.,

**Applied Sciences National Applications Addressed:**

Agriculture, Climate

**Study Area:** Washington, USA

**Study Period:** 2003 - 2065

**Earth Observations & Parameters**

Aqua and Terra, MODIS – Land Surface Temperature

Suomi NPP, VIIRS – Land Surface Temperature

**80-100 Word Objectives Overview**

The purpose of this project is to incorporate precipitation and temperature forecasts into methods of assessing possible shifts in ideal apple growing locations in the state of Washington. Accumulated chill hours and total precipitation are climatically controlled factors of a location’s suitability for growing apples. These factors may be influenced as climate changes; therefore, calculating current totals as well as forecasting these factors into the future will give apple growers a sense of how the suitability of their present lands may alter with coming climate change. Due to requirements for accumulated chill hours, rising temperatures may shift the location of ideal apple growing conditions northward. Additionally, climate change may modify demands for irrigation resources.

**Abstract**

The state of Washington is the top apple producer in the United States, contributing over half of the nation’s apples (USDA NASS, 2012). Currently, Washington’s climate is ideal for apple growth; however, as the climate continues to change, concerns are rising over the suitability of the region for continued apple cultivation. Apple trees require between 400 – 1000 hours between the temperatures of 1.4 – 12.5° C, known as chill hours, to enter dormancy and successfully bloom in the spring. The team partnered with the United States Department of Agriculture – Agriculture Research Service (USDA-ARS) who provided the connection and communication with apple growers in Washington. Accumulated chill hours and precipitation were identified as key factors contributing to the health and success of apple crops that may change due to climate fluctuations. Thus, understanding how climate change may affect these factors will provide apple producers with insights as to how their orchards may be affected in coming years. NASA Earth observations from Aqua and Terra Moderate Resolution Imaging Spectroradiometer (MODIS) and Suomi NPP Visible Infrared Imaging Radiometer Suite (VIIRS) were used. Accumulated chill hours were calculated for 2003 – 2013 using the Land Surface Temperature products from each sensor. Total annual precipitation was calculated for 2003 – 2013 using data from the National Oceanic and Atmospheric Administration (NOAA) Multisensor Precipitation Estimator (MPE). Next, future climate model outputs were used to project accumulated chill hours and precipitation to 2065. The resultant maps of current and forecasted accumulated chill hours, as well as maps of current and forecasted precipitation, will benefit orchard managers by detailing regions that are currently optimal for apple production and how those regions will shift with forecasted changes in climate.

**Community Concerns**

* With impending climate fluctuations, temperature and precipitation trends will change in the state of Washington, resulting in possible negative impacts on apple harvests.
* If winter temperatures rise there could be a reduction in accumulated chill hours for locations where apples are currently grown, which could negatively affect the apple trees’ dormancy and spring bloom.
* If summer temperatures increase, the demand for irrigation resources may expand, which could raise the cost of apple production.
* Precipitation trends may change, whereby altering the amount of available water for irrigation. Water availability, water rights allocations, and the cost of water all have the potential to raise production costs for apple growers, thus negatively impacting the industry in the state.

**Current Management Practices & Policies**

Apple growers currently use NOAA’s climate prediction center and the models used there, including those for the effects of El Niño Southern Oscillation, to determine future conditions for their fields. Potential evapotranspiration calculations are used to determine how much water will be required by the apple trees to keep them healthy and prevent sunburn. Water rights allocations may be restricted from junior water rights holders if there is not enough water in the reservoir system, which may affect irrigation capabilities of apple growers.

**Decision Support Tools**

* Methodology of calculating chill hours and precipitation for the current climate conditions and forecasted into the future
* Chill Hours Map
* Forecasted Chill Hours Map
* Total Precipitation Maps
* Forecasted Total Precipitation Maps

**Benefit to End-User:**

* Calculations of both accumulated chill hours and precipitation, for the current climate conditions and forecasted into the future, will give growers a better understanding of how apple production will be impacted by climate change.
* Forecasted trends in accumulated chill hours and precipitation can aid apple growers prepare for impending climate change by informing the growers of what to expect.

**Models Utilized**

* Utah Chill Hour Model
* Climate Model(s) – TBD after talking to Dr. Noel Baker (NASA) on Feb. 13, 2015

**Ancillary Datasets Utilized**

* NOAA Weather Station Data
* NOAA Multisensor Precipitation Estimator (MPE)- Daily rainfall data
* CMIP5 Air temperature and precipitation forecasts (RCPs)- moderate and unconstrained

**Software Utilized**

Python - data acquisition and processing, used for calculation of accumulated chill hours

R Scripting - statistical analysis of MODIS, VIIRS, and weather station data as well as comparison of fit for MODIS and Climate model data

ArcGIS - Raster Manipulation/Analysis, Image Enhancement and Map Creation of Landsat ETM+, NPP VIIRS, Aqua/Terra MODIS