**NASA DEVELOP National Program**

****Langley Research Center

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**Northwest US Agriculture II**

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

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**Partner Organizations**

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**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 extend the data developed to include precipitation and temperature forecasts in order to assess possible locations of change in apple production in the state of Washington. The calculation of accumulated chill hours and precipitation for both past and future climate conditions will improve comprehension of the impact of fluctuating climate on apple production. As climate continues to change, rising temperatures will shift ideal apple growing conditions northward as well as increase the demand for irrigation.

**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 0 – 7° C, known as chill hours, to enter dormancy and successfully bloom in the spring. Partnering with the United States Department of Agriculture – Agriculture Research Service (USDA-ARS), accumulated chill hours and precipitation were identified as key factors contributing to the health and success of apple crops that will change due to climate fluctuations. Thus, understanding how climate change will affect these factors will inform future production of this fruit. Using NASA Earth observations from Aqua and Terra Moderate Resolution Imaging Spectroradiometer (MODIS) and Suomi NPP Visible Infrared Imaging Radiometer Suite (VIIRS), specifically the Land Surface Temperature products from each, chill hour accumulations were calculated from 2003 – 2013, and then forecasted using a future climate model. With local weather station data and the National Oceanic and Atmospheric Administration (NOAA) Multisensor Precipitation Estimator (MPE), precipitation totals were calculated for 2003 – 2013, and then forecasted using a future climate model. Resultant maps of past and forecasted accumulated chill hours as well as maps of past and forecasted precipitation benefit orchard managers by detailing regions that have been optimal for apple production in the past and how those regions will shift with forecasted changes in climate.

**Community Concerns**

* Apples are a major contributor to the Washington state economy.
* Apple trees require a chill season for the trees to go into dormancy and then successfully blossom.
* Apples themselves do not have stomata as leaves do and thus are unable to cool through transpiration so the fruit must be sprayed with water to allow for evaporative cooling as a preventative measure against the fruit skin temperature reaching detrimentally high levels (prevention of apple sunburn).
* With impending climate fluctuations, temperature and precipitation trends will change in Washington, resulting in possible negative impacts on apple harvests when rising winter temperatures may cause a reduction in chill hours and increased summer temperatures may expand the demand for irrigation resources that may not necessarily be available.

**Current Management Practices & Policies**

Apple growers currently use NOAA’s climate prediction center and the models used there to determine future conditions for their fields. Models forecasting the effects of El Nino and La Nina are also used. 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 in the past 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, in the past 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, The Dynamic Model, or the Chill Hour Model
* Climate Model – TBD

**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