**NASA DEVELOP National Program**

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Langley Research Center

Hampton, VA

**Summer 2015**

**Short Title: Northwest U.S. Agriculture III**

**Subtitle:** Applying Future Climate Patterns to Project Suitable Apple Orchard Conditions in Washington State

**VPS Title:** Climatic Apple Turnover: Forecasting Ideal Growing Conditions for Apples in Washington State

**Project Team & Partners**

**Project Team:**

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**Partner Organizations**

United States Department of Agriculture - Agriculture Research Service (USDA-ARS), End-User and Collaborator, POC: Dr. Michael Glenn, Ph.D., Appalachian Fruit Research Station, Kearneysville, WV.

**Project Details**

**Applied Sciences National Applications Addressed:**

Agriculture, Climate

**Study Area:** Washington State, United States

**Study Period:** 2002-2100

**Earth Observations & Parameters**

* Aqua, MODIS - Land Surface Temperature

**Ancillary Datasets Utilized**

* USDA CropScape Dataset - Land cover

**Models Utilized**

* World Climate Research Programme (WCRP) Coordinated Regional Climate Downscaling Experiment (CORDEX) regional climate models: Canadian and EC-EARTH. Air temperature forecasts for the RCP 4.5 and RCP 8.5 Scenarios.

**Software Utilized**

Python - Manipulation of MODIS Data, & Calculation of temperature averages and Growing Degree Days

ArcGIS - Raster Manipulation/Analysis, Image Enhancement & Map Creation

**Project Overview**

**80-100 Word Objectives Overview**

Apple production is a major part of Washington’s economy; however, apple trees have very specific climatic requirements that must be met in order to ensure a good harvest.  Changes in regional climate due to global climate change could pose a threat to apple orchards as previously ideal conditions become unfavorable.  By modeling Washington’s climate up to the year 2100, the end-users will be provided with Plant Hardiness Zone (PHZ) maps for the coming decades.  The maps will help inform apple growers of the challenges they will face, as well as suitable locations for future orchards.

**Abstract**

Washington State produces 65% of the nation’s apples, adding 2.2 billion dollars to the nation’s economy. Washington’s warm, dry summers and cool, wet winters provide excellent conditions for apple growth. However, there is a strong likelihood that Washington’s suitability for apple farming could be altered by current and future climate change. Areas of optimal conditions were mapped out as Plant Hardiness Zones (PHZs), which are used by the USDA to determine which plants will thrive in a particular location. Apples grow best when climate conditions match zones 5 and 6. By creating maps of current and projected PHZs, apple growers will be able to decide if it would be beneficial to move apple orchards in the upcoming decades. Using Aqua MODIS Land Surface Temperature (LST) from 2002-2015, minimum temperatures per day and month were extracted to create a present-day PHZ map. Additionally, future climate model air temperature forecasts from the Coupled Model Intercomparison Project phase 5 (CMIP5) for 2020-2100 were used to determine future PHZs. Growing Degree Days (GDD) were also calculated to create orchard suitability maps. Since the ability of apple trees to thrive is dependent on GDDs, PHZs, and average growing season temperature, these maps provide further insight into which regions of Washington State may be suitable for apple orchards in the future. Final maps of current and forecasted PHZs allow stakeholders to identify regions that are currently optimal for apple production, and see how those regions may move with forecasted climate change.

**Community Concerns**

* For apples, ideal growing conditions can be found in Plant Hardiness Zones 5 and 6, which characterize all of the major apple growing regions, including Washington. However, future climate change will result in changing temperature and precipitation patterns and may shift the locations of these ideal growing conditions.
* If winter temperatures include more extreme lows, apple trees are at a higher risk of dying
* If overall temperatures increase - making apple trees reach their required number of Growing Degree Days earlier in the season - apple buds may be more at risk for spring frost

**Current Management Practices & Policies**

Apple growers currently rely on models provided by NOAA’s climate prediction center, including models which predict the effects of various teleconnections, such as the El Niño Southern Oscillation. Additionally, potential evapotranspiration calculations are used to determine how much water will be required by 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 & Benefits**

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| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Plant Hardiness Zone maps | Aqua MODIS- Land Surface Temperature (LST) data | Highlights current Plant Hardiness Zones in Washington State to have a baseline to compare to the USDA maps for accuracy assessment, and to see how PHZs change with future climate scenarios.  |
| Forecasted Plant Hardiness Zone maps | CMIP5 forecasts | Highlights regions suitable for future plant growth in order to help orchard owners prepare for the impact of climate change. |
| Orchard suitability maps | Aqua MODIS- Land Surface Temperature (LST) data | Highlights areas optimal for apple growth in Washington State with greater detail in order to have a baseline when comparing future regions of apple growth. |
| Forecasted orchard suitability maps | CMIP5 forecasts | Highlights regions suitable for future growth of apples with detail to help orchard owners prepare for the impact of climate change. |

**Project Imagery**

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**Caption:** [Insert Caption Here. Max of 25 words.] Image Credit: [Insert project short title] Team.

**Image:** File Name (Please submit your image as a separate .jpeg as well as inserting it in this document)