Monitoring Vineyard Water Use and Vine Water Status with Land Surface Temperature for Improved and Sustainable Water Management from Field to Regional Scales

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Presented by Kyle Knipper
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Monitoring Vineyard Water Use through Remote Sensing Techniques for Improved Water Management

Need

Irrigation is KEY for successful wine grape production.
- Represents 1 million acres valued at ~ 6 billion dollars (California)
- Reductions in water availability and increased water use interest
- Need for optimization of water management strategies to preserve water resources and maintain sustainable wine grape production

Status Quo

Irrigation management at E&J Gallo
- In situ observations
- FAO crop model using crop coefficients
- METRIC (adapted for vineyards)

Issues / Challenges

- Unable to reliably identify vine stress levels - techniques do not explicitly separate inter-row and vine row water use.
- In situ/FAO = point measurement; METRIC = only on Landsat dates
Objective

Evaluate and refine the Atmosphere Land Exchange Inverse (ALEXI) and its disaggregation algorithm (DisALEXI) remote sensing-based modeling system together with the data fusion package for evaluating daily ET of vineyards and eventually other high value and uniquely structured row crops in California.

Develop ET-toolkit that can be used to determine the appropriate timing to initiate irrigation in the spring and the amount of irrigation water to apply during the growing season to achieve grape production and wine quality objectives.
## Project Partners

<table>
<thead>
<tr>
<th>Role</th>
<th>Name(s)</th>
<th>Affiliation</th>
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<tbody>
<tr>
<td>Co-I</td>
<td>Martha Anderson, Joseph Alfieri, Feng Gao</td>
<td>USDA-ARS HRSL</td>
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<tr>
<td>Co-I</td>
<td>Christopher Hain</td>
<td>NASA-MSFC</td>
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<td>Co-I</td>
<td>Alfonso Torres-Rua, Mac McKee, Lawrence Hipps</td>
<td>USU</td>
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<td>Collaborator</td>
<td>John Prueger</td>
<td>USDA-ARS NLAE</td>
</tr>
<tr>
<td>Co-I/Partner</td>
<td>Nick Dokoozlian, Maria del Mar Alsina-Marti</td>
<td>E&amp;J Gallo Winery</td>
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## End-users / Stakeholders

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<tr>
<th>Role</th>
<th>Organization Name</th>
<th>Organization Type</th>
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<tbody>
<tr>
<td>Co-I/End-User</td>
<td>E&amp;J Gallo Winery</td>
<td>Private sector commercial</td>
</tr>
<tr>
<td>Stakeholder/Supporter</td>
<td>National Grape &amp; Wine Initiative</td>
<td>Private sector non-profit</td>
</tr>
<tr>
<td>Stakeholder/Supporter</td>
<td>Almond Board of California</td>
<td>Private sector commercial (Federal Marketing Order)</td>
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Schematic overview of the inputs and processing steps in the ET fusion package

**INPUTS**

<table>
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<th>Landsat 8 (30 m)</th>
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LST (Band 10) | LAI, Albedo |

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<tr>
<th>MODIS (1 km)</th>
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LST (MOD11_L2) | Geoloc (MOD03) |
LAI, (MCD15A3) | Albedo (MCD43 GF) |
NDVI (MOD13A2) |

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<th>ALEXI (4 km)</th>
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LST (GOES Imager) | LAI, (MCD15A3) |

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<tr>
<th>MET INPUTS (20 km)</th>
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NARR: Vapor pressure | Wind speed |
Air Temperature | NLDAS: Insolation |

**PREPROCESSING**

- Atmospheric corrections
- Sharpen LST to 30m: DMS
- Generate MODIS-consistent LAI
- Process gridded (LAI, NDVI, Albedo) and swath (LST)
- Gap-fill, remove outliers, apply spline interpolation
- Extract ALEXI ETd and met data for each sensor’s projection
- Compute daily reference ET

**DisALEXI**

- Disaggregate ALEXI ETd (4km) to 30 m
- Disaggregate ALEXI ETd (4km) to 1 km
- Gap-fill conserving fRET
- Resample to Landsat 30m UTM grid

**STARFM**

- Identify optimal MODIS/Landsat ETd pair for each prediction date between Landsat overpasses
- Run STARFM for each pair date and apply weighting to each MODIS image on prediction dates associated with pair

**OUTPUT**

- Daily ETd at 30 m resolution

Adaptive Reflectance Fusion Model (Gao et al., 2006)
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GRAPEX: Grape Remote sensing Atmospheric Profile and Evapotranspiration eXperiment

GRAPEX project began in 2013 with the objective of evaluating and refining TSEB, ALEXI/DisALEXI...

Two pinot noir vineyards
Lodi, CA

Micrometeorological, biophysical and remote sensing data from ground, airborne (including UAVs) and satellite platforms have been collected (2013 – present).
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ALEXI/DisALEXI + STARFM = Daily ET (30m) – 2013 (growing season)

TSEB + UAV Thermal Data = ET (~5m) – 5 days during 2013 growing season
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Site 1: 2015 Growing Season (July & Aug.)

Site 2: 2015 Growing Season (July & Aug.)

Factor: Much Stronger Advection at Site 1 vs. Site 2 both a measurement and modeling issue

*Figures created by Joe Alfieri (USDA-ARS HRSL)
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Next steps…merging of 30-m data fusion ET with sub-meter UAV imagery in detecting canopy level vine physiological conditions.

Compare DisALEXI/Fusion and METRIC Model ET estimates with TSEB/METRIC* applied to UAV high-resolution imagery.

Determine the potential synergy in UAV acquisitions in concert with data fusion for improving vine level management.

*A version of METRIC using UAV imagery has been developed by our USU partners.
Publications

Monitoring daily evapotranspiration over two California vineyards using Landsat 8 in a multi-sensor data fusion approach
Semmens, K., Anderson M.C., Kustas, W.P, Gao, F., Alfieri, J.G.

Mapping evapotranspiration with high-resolution aircraft imagery over vineyards using one- and two-source modeling schemes
Hydrology and Earth System Sciences (2016)

An intercomparison of evapotranspiration estimates derived using thermal-based satellite remote sensing for irrigation management in California
Irrigation Science (in review)