SDGE

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EDO Major Projects: Wind and PV Forecasting

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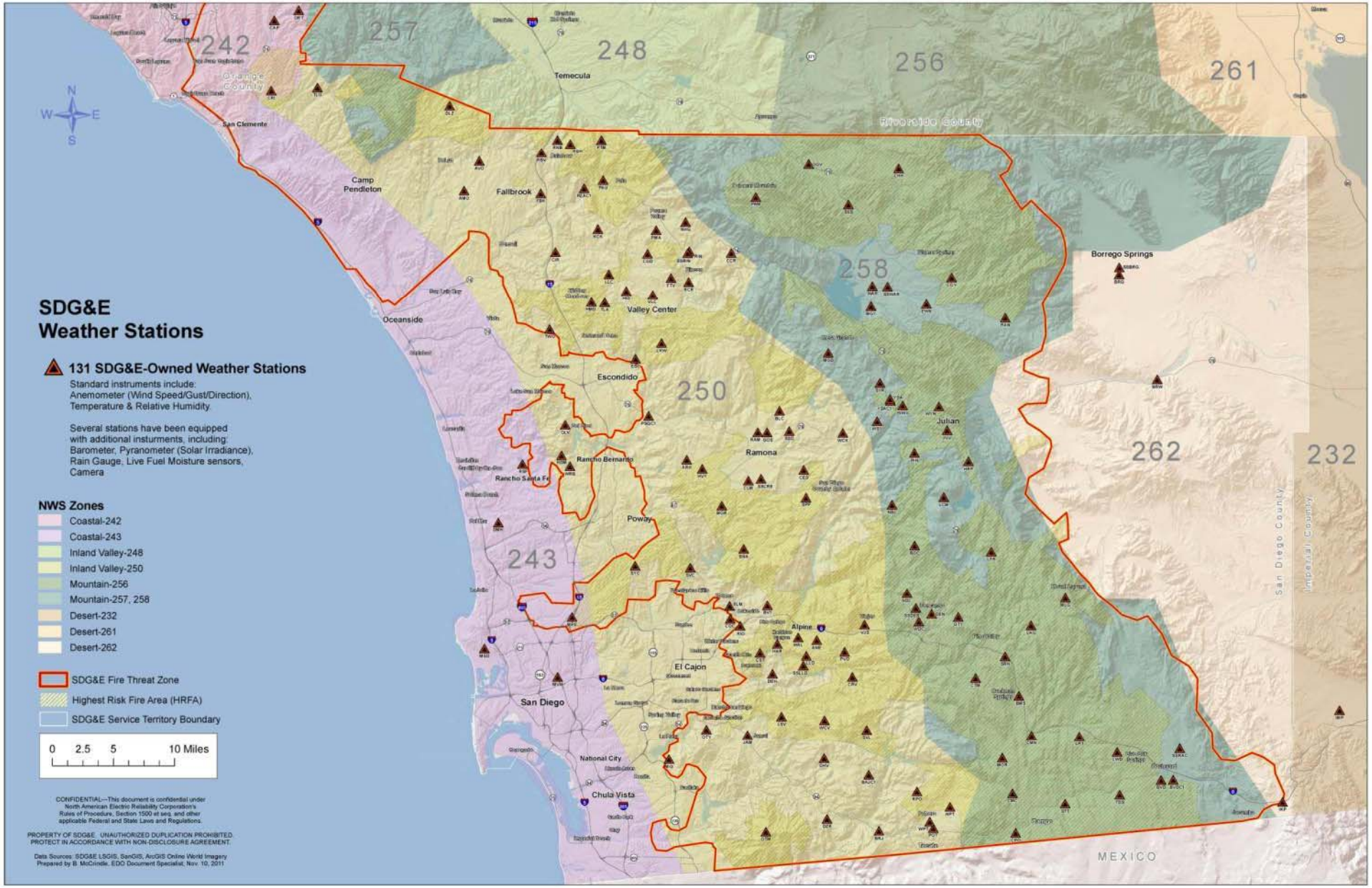
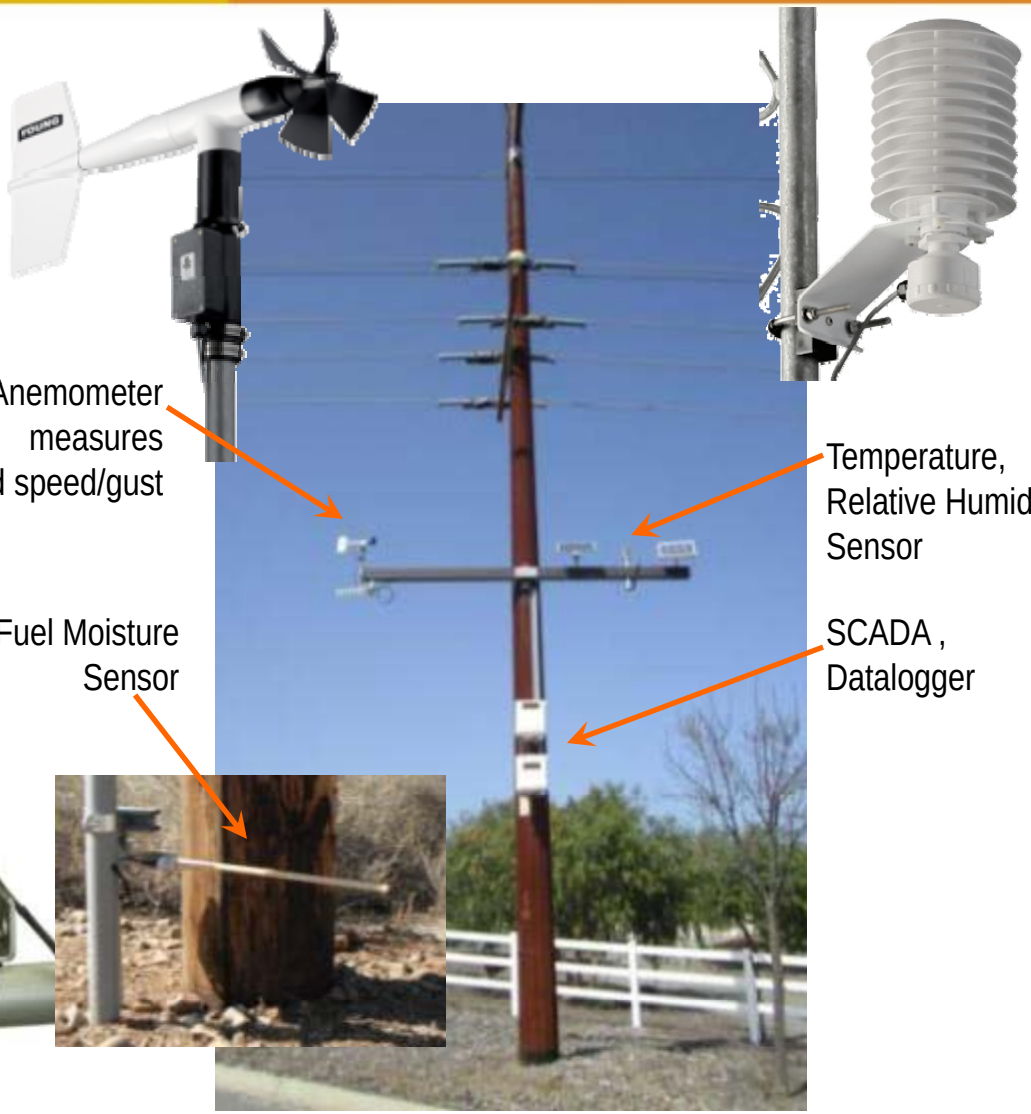
SDG&E Weather Network (MesoNet)



EDO Major Projects:
SDG&E Weather Station Network

- 3rd Largest, densest in nation: 131 SDG&E-owned stations
- Support operational decisions: Staging crews; enabling sensitive relays; reclosing settings via SCADA
- 43 Pyranometers on stations from coast to desert measure solar irradiance; support marine layer modeling, PV load forecasting



Current Forecasting Projects

- **Two Meteorologists on Staff**
- **Daily Forecasting Winds and Temperatures on a Micro Scale**
  - By Circuit
- **Modeling past 50 years for wind, solar radiation, temperature in conjunction with MeteoGroup**
  - Design of System
  - Hardening Projects
  - Support better understanding of Santa Ana Winds and Fire Potential
- **Next year begin forecasting winds in support of Wind Generation Projects**
- **Photovoltaic Power Generation Forecasting and Marine Layer Modeling**

1. Current operational solar capacity provided by SDG&E operations.
2. Approved and Pending CPUC Interconnection Requests, solar PV and solar thermal. October 2011.

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Solar Photovoltaic
Power Generation Forecasting

Project Objectives:

Advance SDG&E's understanding of long-term benefits, determine solar forecasting Integration requirements

Green Power Labs Pilot Project Deliverables:

Provide SDG&E with Day Ahead (DA) and Hour Ahead (HA) Solar Power Forecasting of 12 PV facilities

Our Current Operational Solar PV [1]: ~120MW
Our Current Approved and Pending Solar [2]: 1GW+

1. Current operational solar capacity provided by SDG&E operations.
2. Approved and Pending CPUC Interconnection Requests, solar PV and solar thermal. October 2011.

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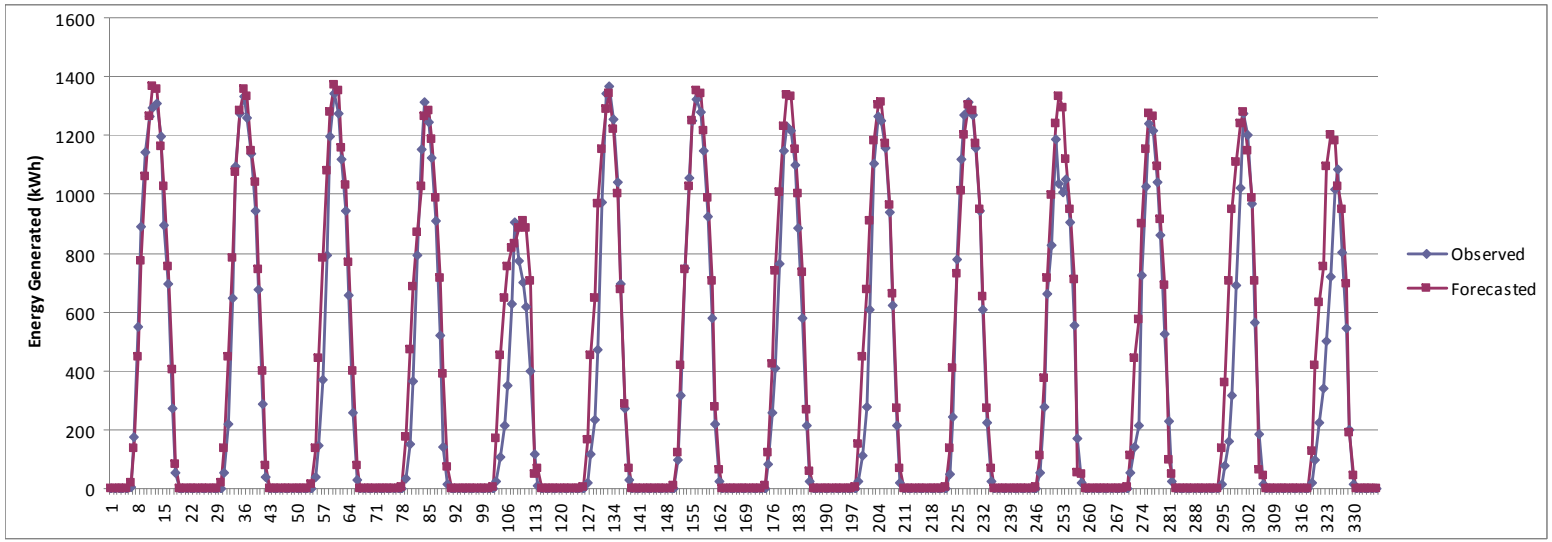
Project Achievements

- Average normalized RMSE for Hour Ahead forecast is 11% and 10% for Day Ahead.
- Most forecast errors originate from the early day hours; peak hours and afternoons are accurate, which is valuable for estimation of total daily generation.
- Coastal stations are the most erroneous and require special attention due to the effects of the marine layer.
- Further improvements to Hour Ahead forecasts are expected from better analysis of marine layer effects on the morning forecasts.



Aggregate forecast vs. observed data for 2 weeks in September 2011.

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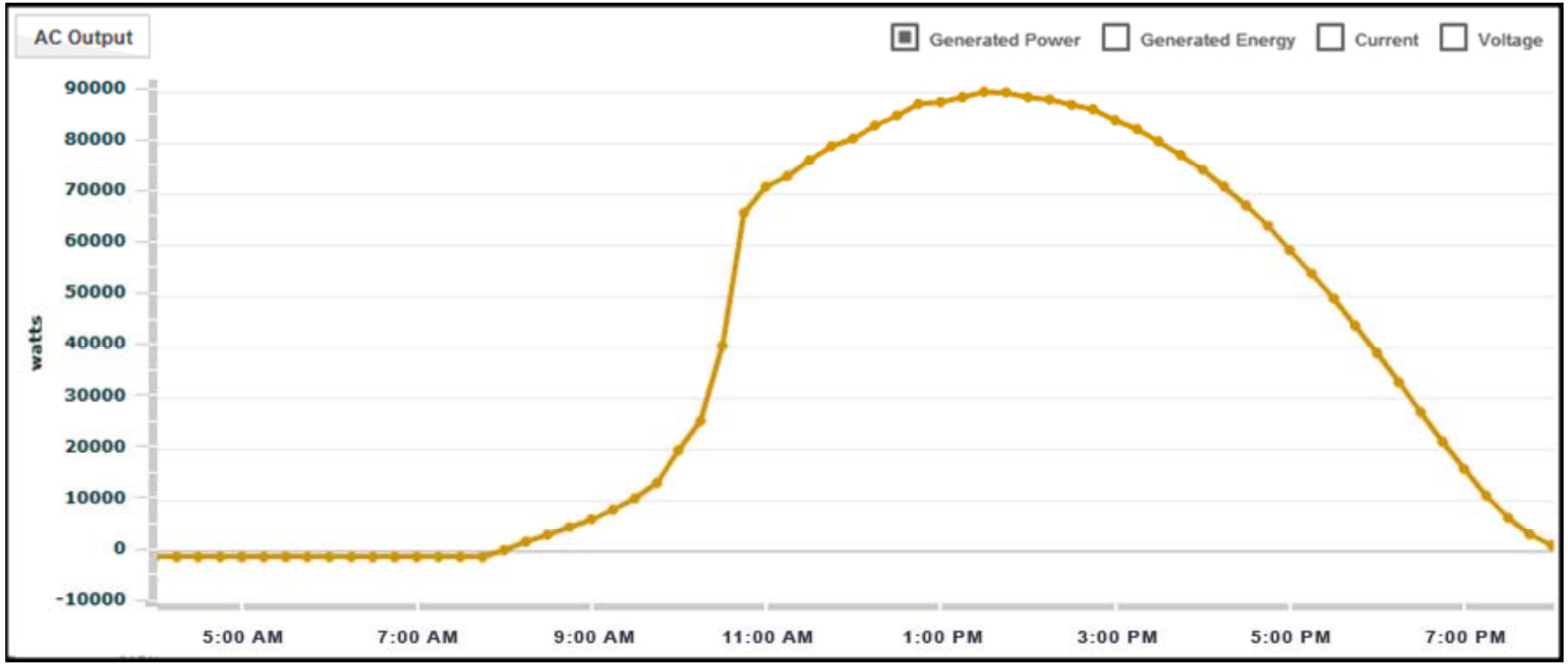
Future Expectations

Improved analysis through the integration of available live instrumentation data into the model



Marine Layer effects are the strongest in defining a difference between forecasted and observed values, particularly in the mornings.

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Next Steps

- Extensive work on modeling marine inversion layer will be integrated with GPL's forecasting in order to minimize morning errors.
- Real-time data will be integrated into statistical forecast verification through autoregressive models leading to better Hours Ahead prediction of solar power production.

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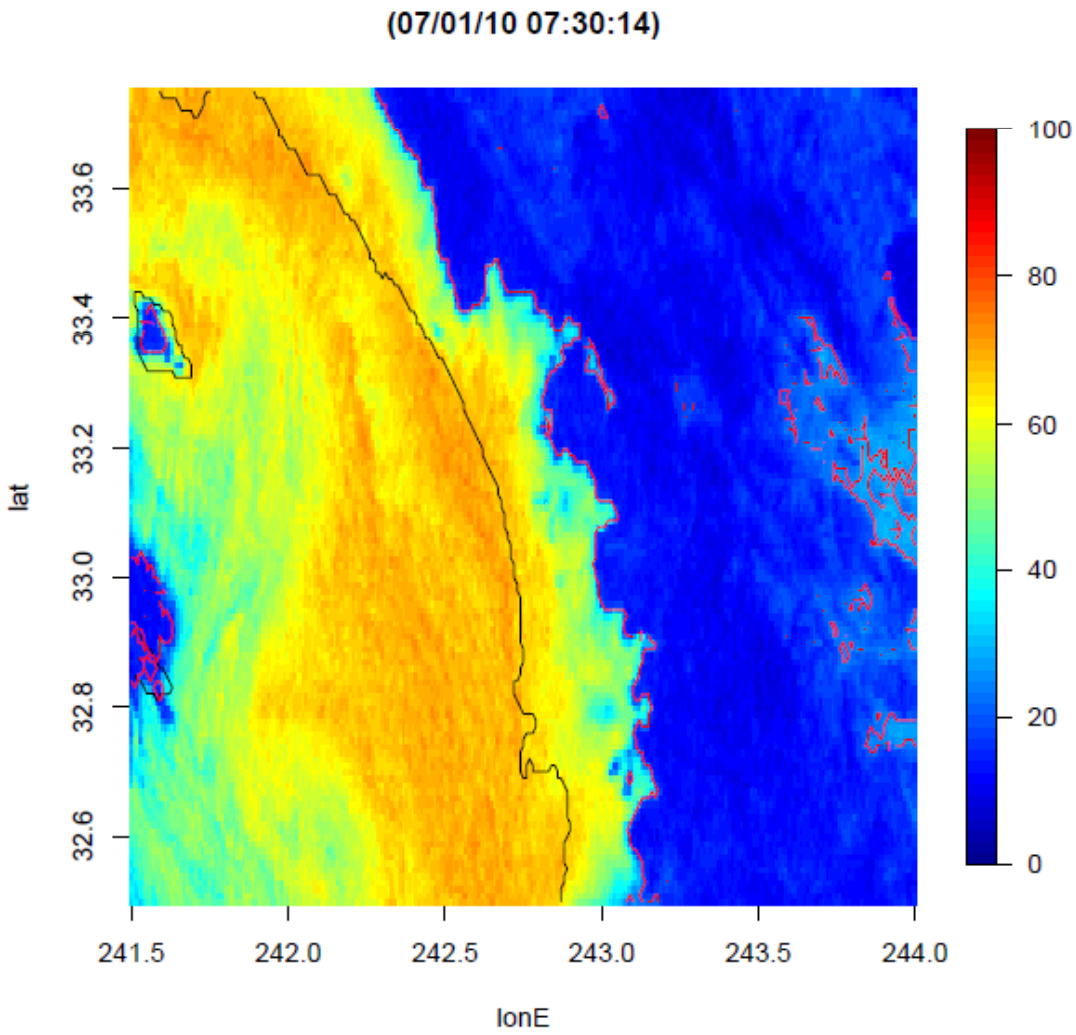
Coastal Marine Layer (CML) Forecasting

- Binary Logistic Regression Model
- Binary Classification — Cloudy or Clear
- Compartmentalize San Diego County into 1km grid, ~32,000 grid cells in region
- Before the CML spatial and inland extent can be studied, each grid cell must be quantitatively identified as cloudy or clear for each time step

Goes Satellite Data Channel 1
0730 hours



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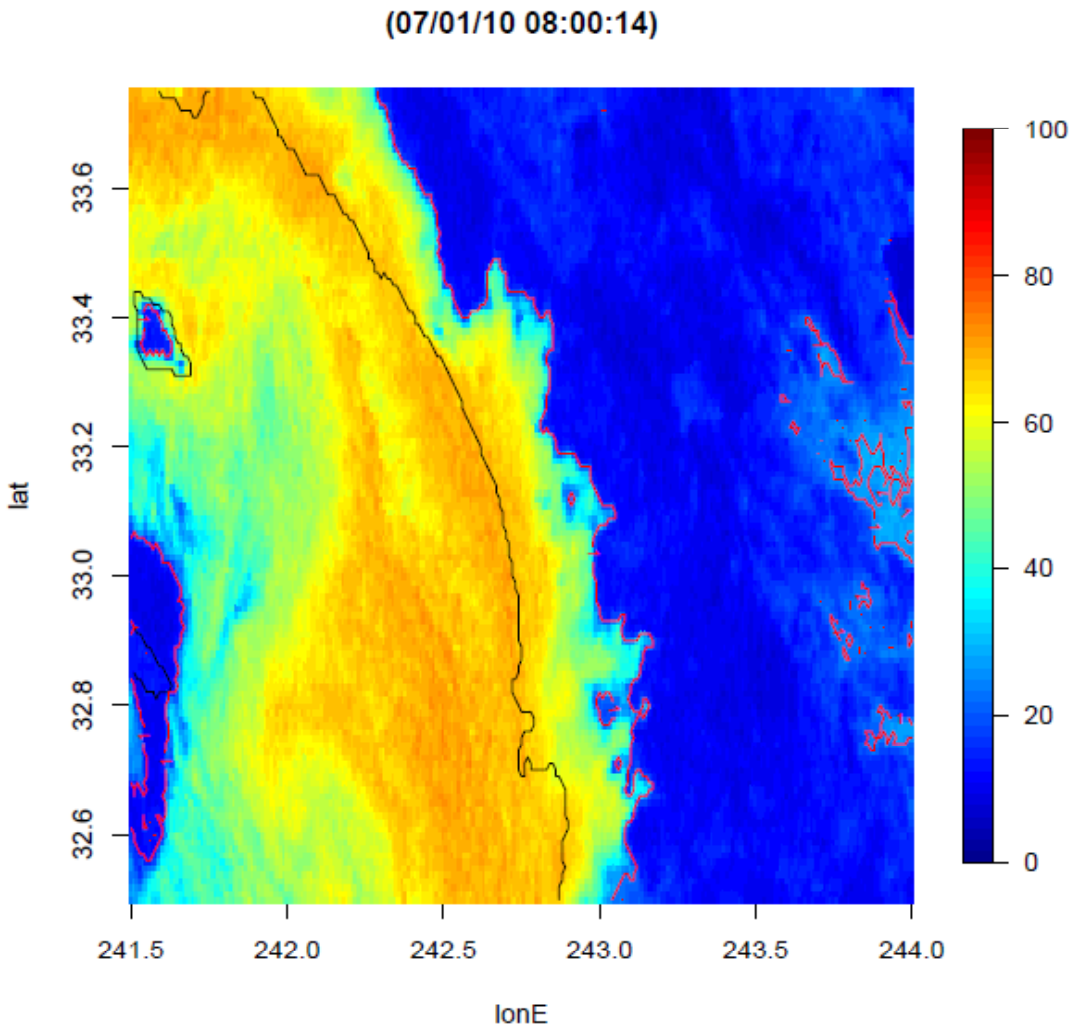
Goes Satellite Data Channel 1
0800 hours



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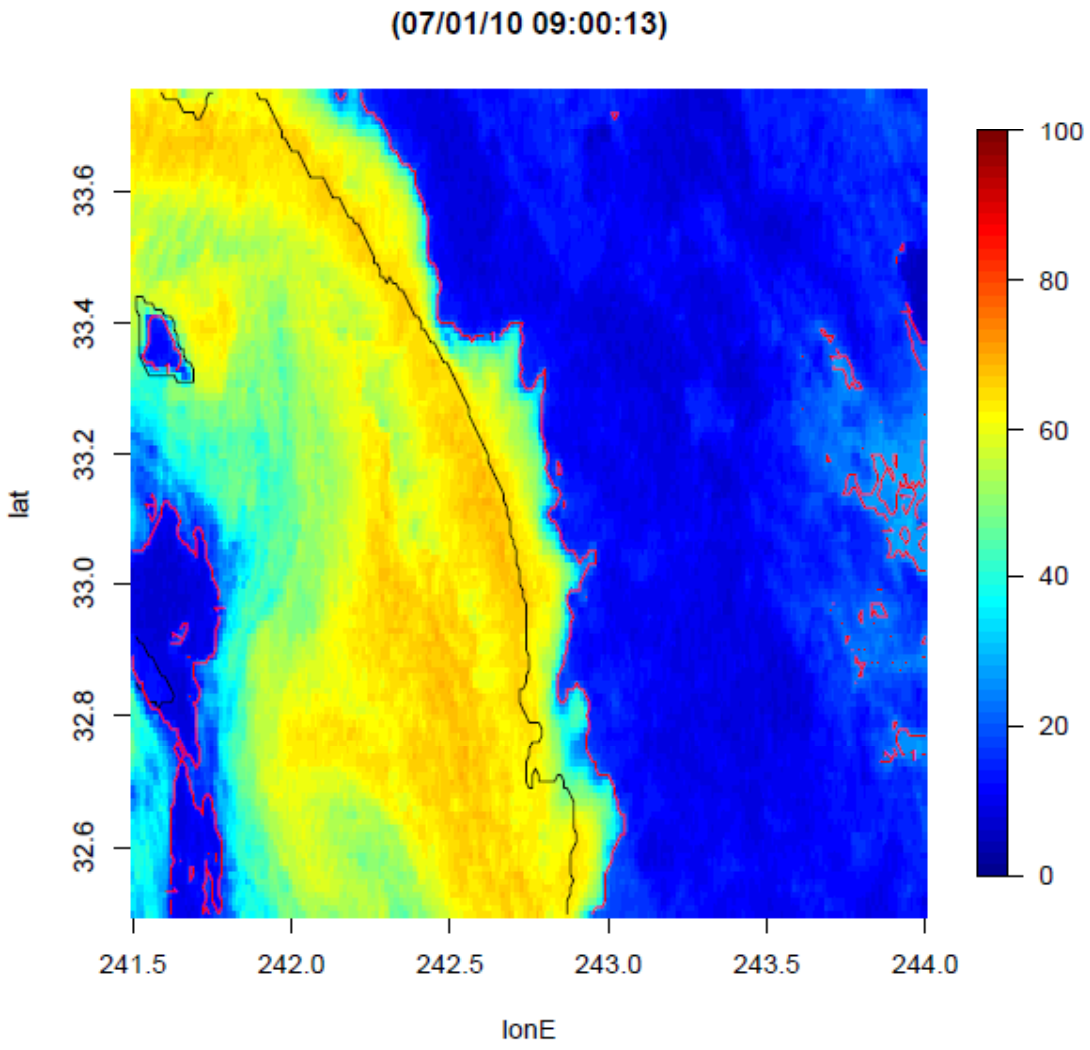
Goes Satellite Data Channel 1
0900 hours



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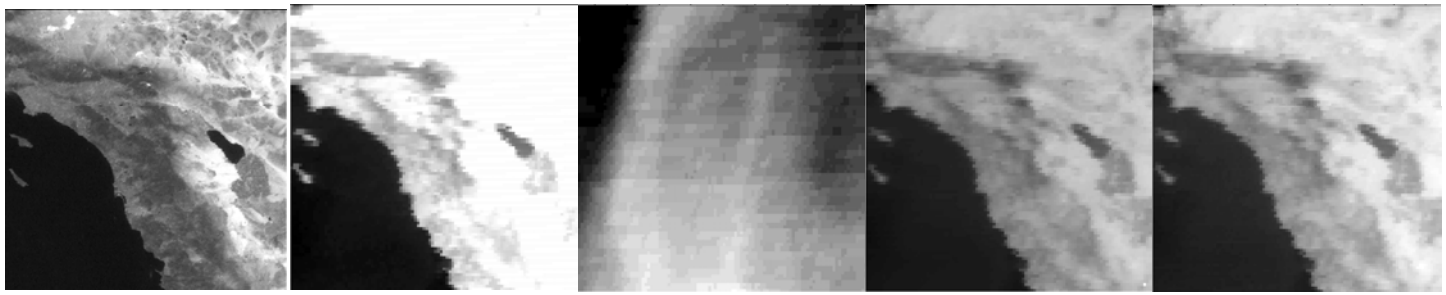
Expanded Results on Validation of Leading Edge

- Green Power Labs was hired to write an algorithm to separate marine layer from high altitude clouds based on the other available satellite channels
- For each 30 minute interval there are five images, corresponding to the five channels measured by GOES West Satellite: Visible, Shortwave, Water vapour, IR1 and IR2



Chanel 1: λ=0.65µm | Chanel 2: λ=3.9µm | Chanel 3: λ=6.8µm | Chanel 4: λ=10.7µm | Chanel 5: λ=12.0µm

- Difference between VIS and IR1 are the key to differentiation of low CML stratus from high altitude clouds

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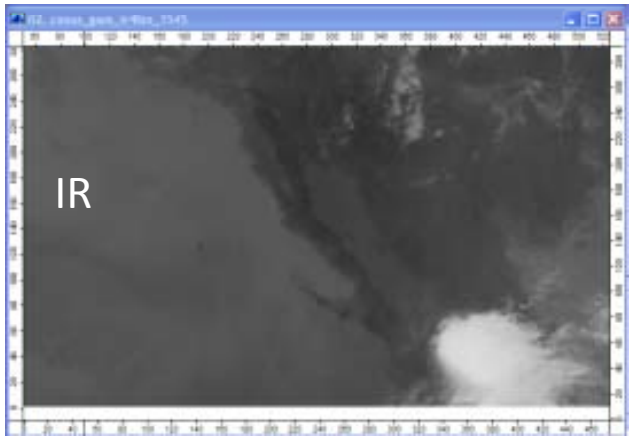
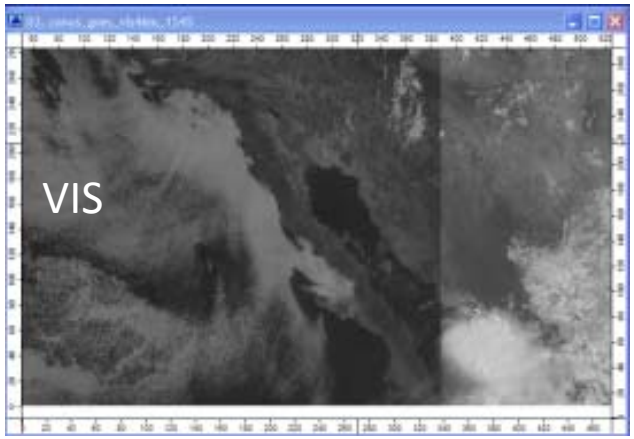
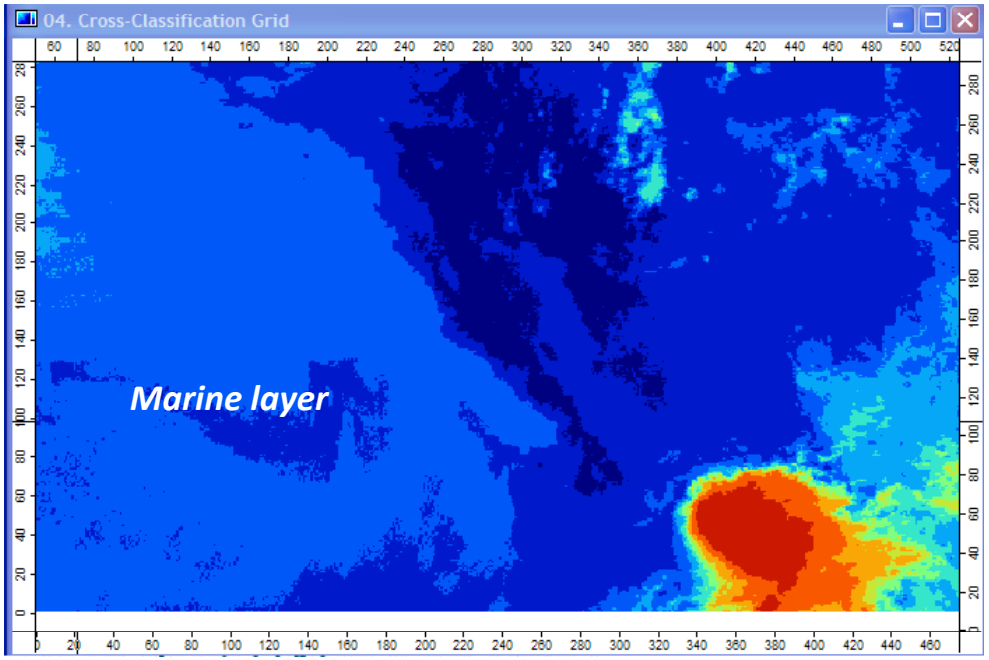
Algorithm for Differentiation of Marine Layer

This example demonstrates the process of extracting classification information on location of marine layer from pairs of images:







Result of Cross-classification: High altitude cumulus clouds are seen in the bottom right corner of both IR and VIS images (orange), while marine layer is distinctly defined as light blue class.

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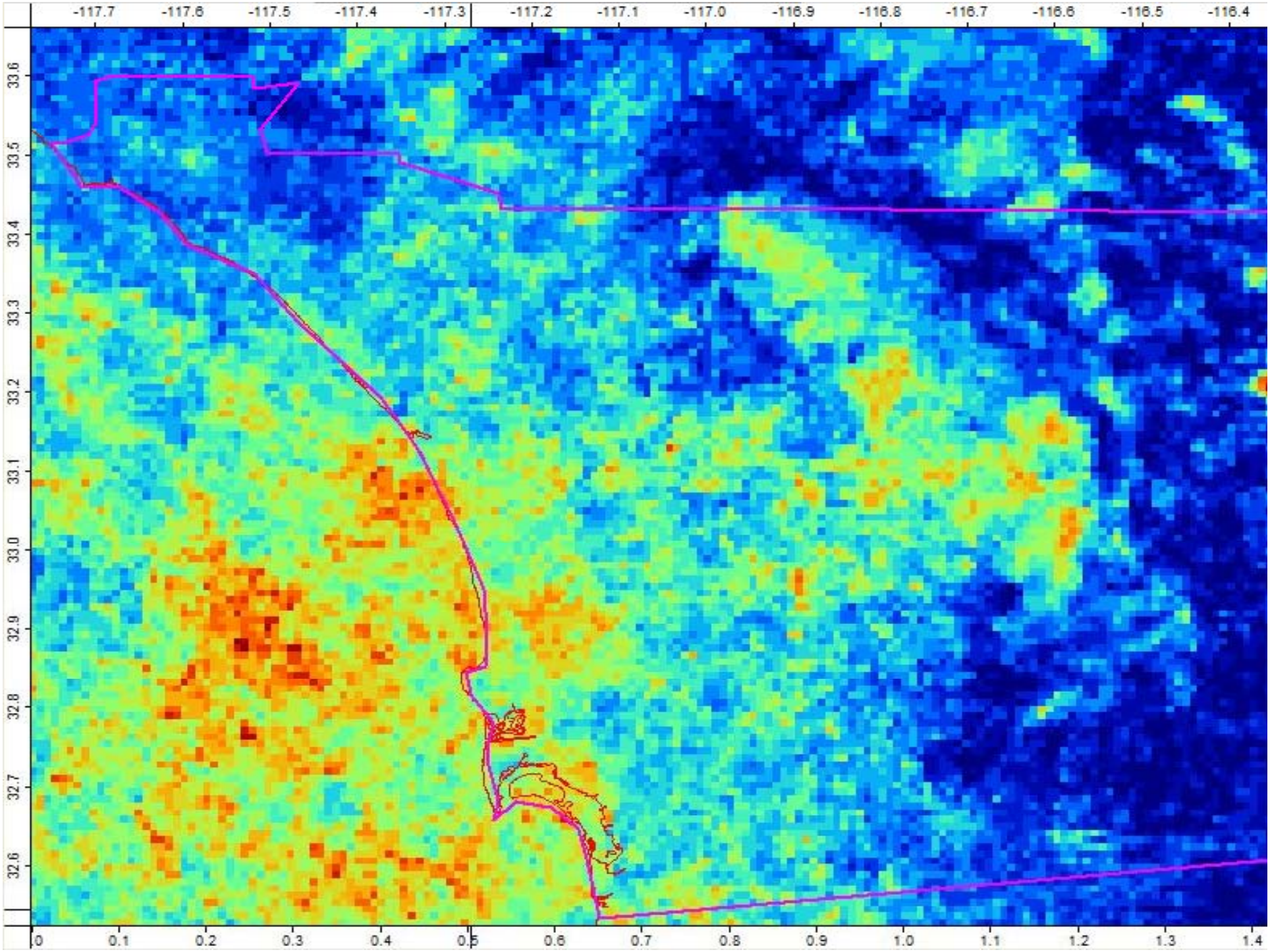
-117.7
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-117.0
-116.9
-116.8
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-116.6
-116.5
-116.4
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0.8
0.9
1.0
1.1
1.2
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1.4

Next Steps

- Acquire 10 years of historical Satellite data
- Run algorithms over the 10 years of data
- Overlay data onto 1km grid of San Diego
- Classify each 1 km grid cell as clear or cloudy over the 10 year period for every 30 minute time step
- Start building model with known relationships
- Run the model for each individual 1km grid cell