Data Analytics for Renewable Energy

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In collaboration with Dr. Duane Stevens, ATMO Dept.

Alumni:

- Christopher Foo (2014), ICS
- Anthony Chang (2014), ATMO
- Todd Taomae (2015), ICS
- Carlos Andrade (2016), ICS

Problem Statement

How can we analyze data in order to

- Inform renewable energy decisions, or
- Understand spatial and/or temporal trends or patterns, or
- Forecast energy load, renewable energy production, etc ?

There's a lot of data!

- Ground sensor data: wind, pressure, temperature, irradiance, ...
- Radiosonde, Doppler
- Mobile phones, cars, crowdsourced sensors (www.wunderground.com)
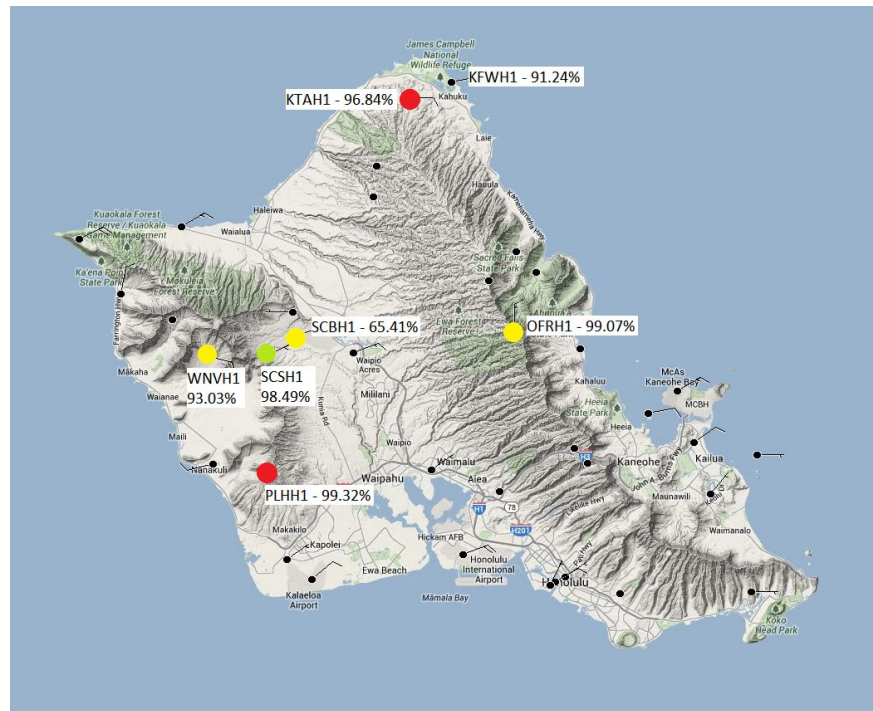
Analysis & Simulation Data Products

- Global Forecasting System (GFS) data from NCEP
- "Analysis" = forecast time zero. The system's best guess of the state of the atmosphere
- Many models
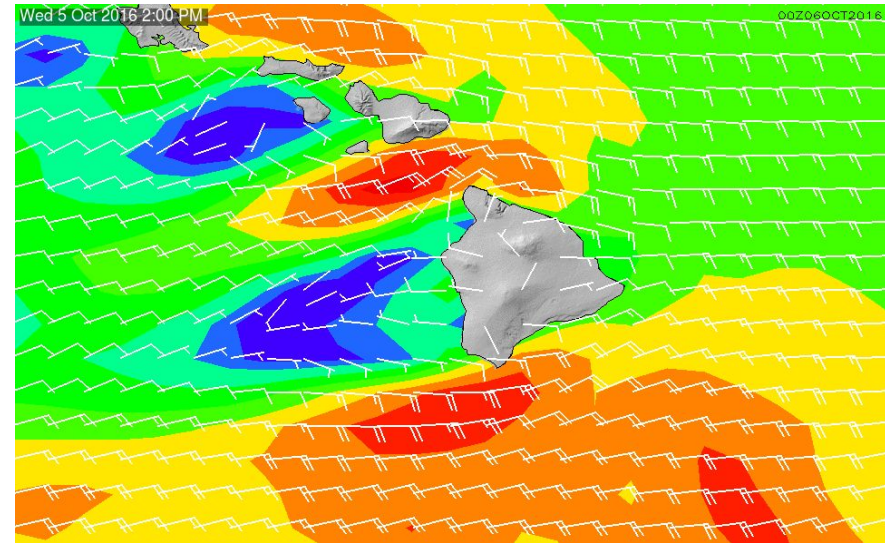
Satellite Data

- Geostationary Operational Environmental Satellite (GOES)
- Solar irradiance data derived from satellite data.
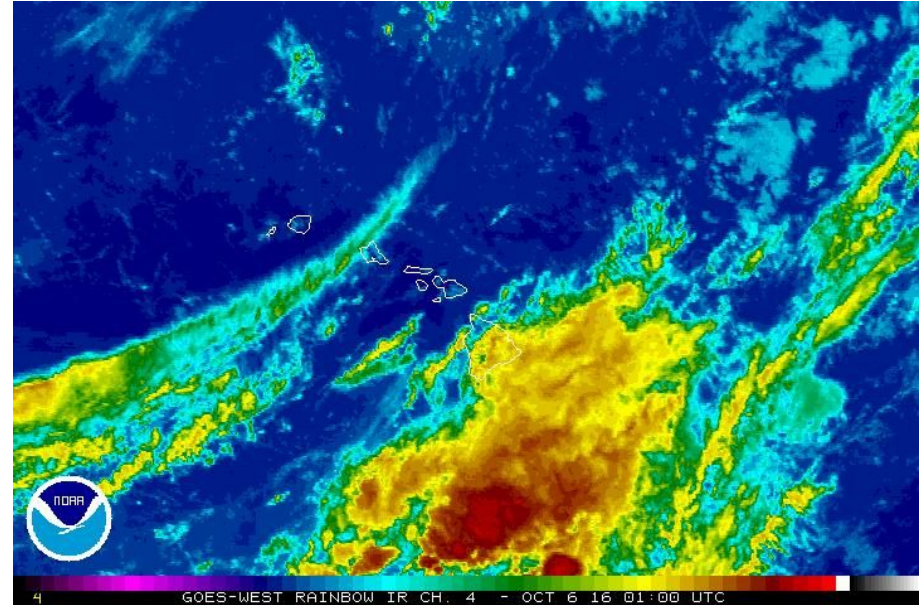
What we've done so far ...

- Point Forecast using weather station data:
  - Data mining techniques & other analysis (Chris Foo)
  - Probabilistic models (Carlos)
- Gridded Forecast:
  - Linear regression models using satellite derived solar irradiances (Todd)
- Outlier Analysis:
  - Identifying "rare" events using GFS analysis data

What next?

- Fusing these disparate data sources and discovering the relationships
- Identifying regimes from GFS data and correlating to cloud pattern on HI

Haar Wavelet Multi-Resolution 2
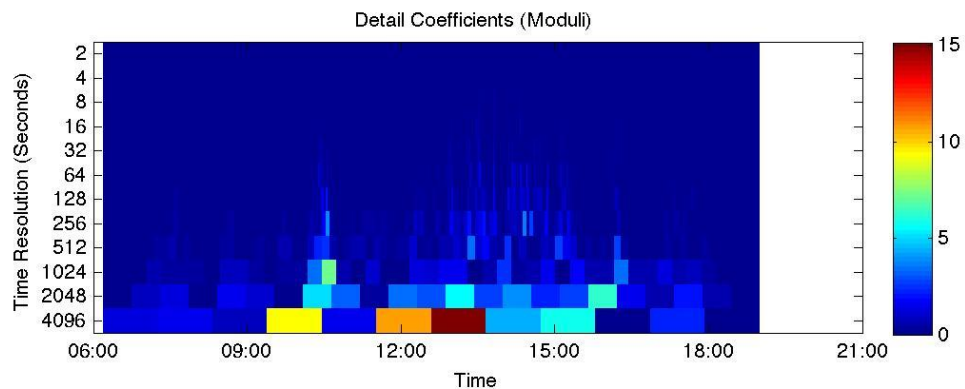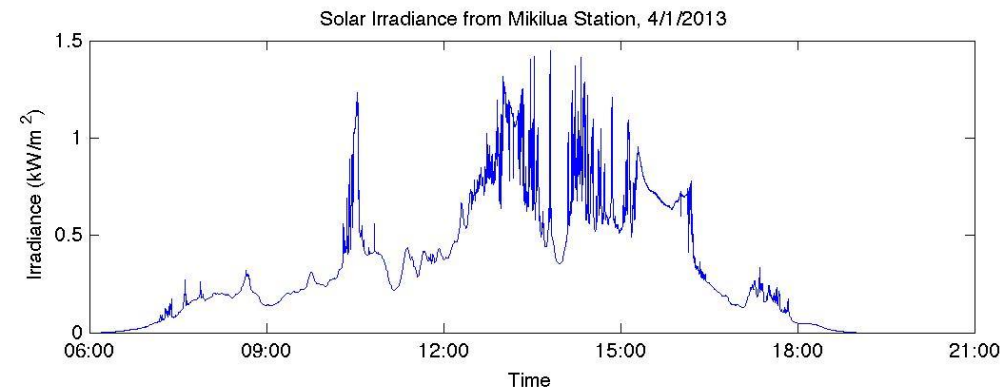
Haar Wavelet Multi-Resolution 3
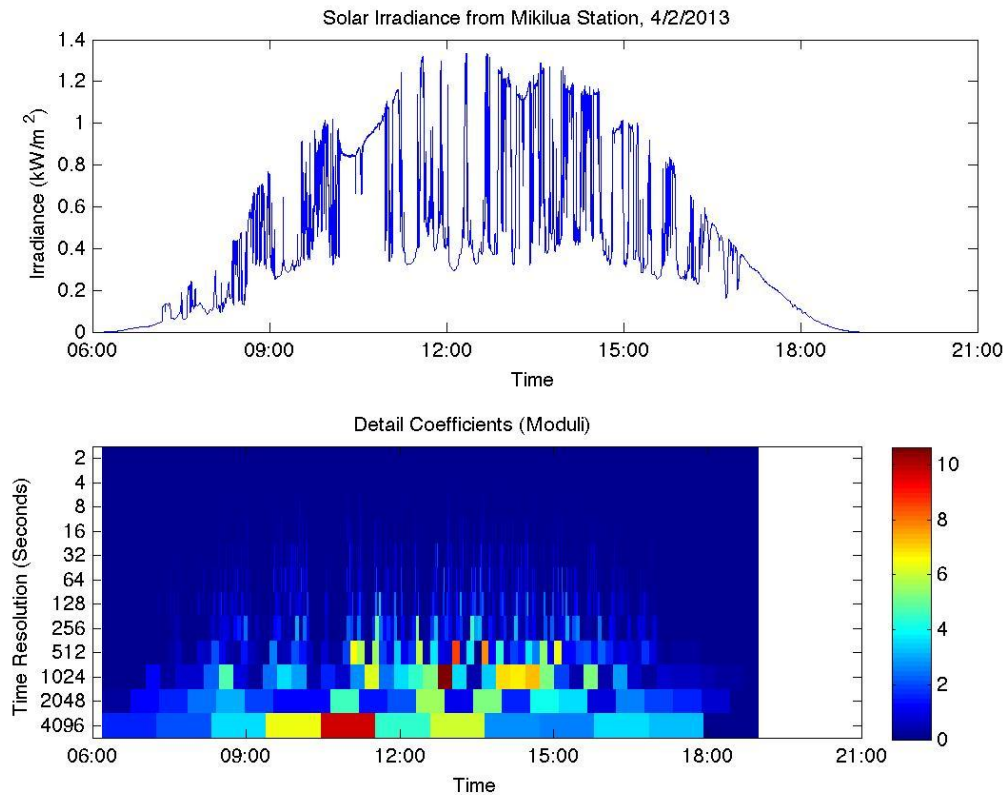
"Rare" Events

- Similar to outlier analysis
- Several possible definitions depending on how we model what is rare or NOT:
  - Infrequent events (phenomenological)
  - Events not predicted well by a given model (statistical or dynamical or both)
  - Events with high disagreement in an ensemble of models

GFS "Rare" Events
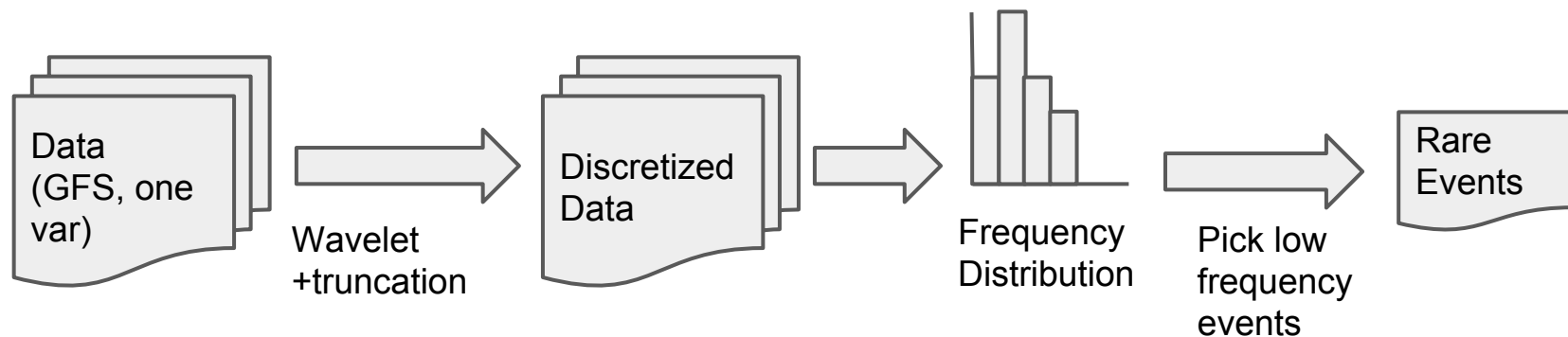
- Use GFS analysis data (forecast time zero)
- One "data point" per day (2pm Hawaii time)
- Variables: PWAT, VVEL, U V winds
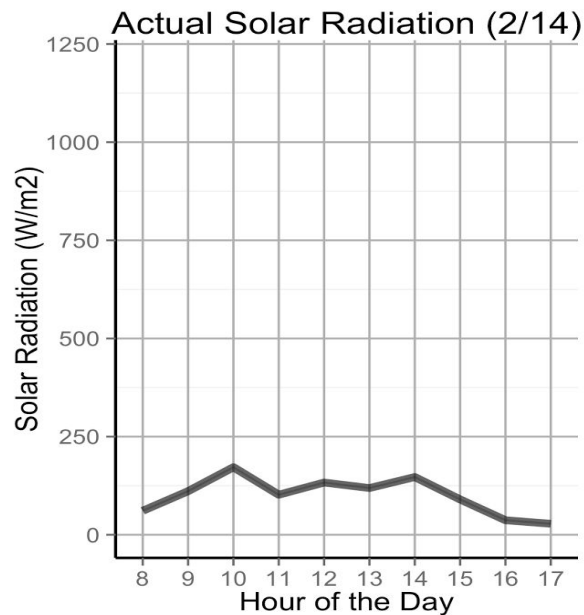- Future: sequences of 2-3 days

GFS Rare Day:
Feb 15 2014
(- 3 days)

GFS Rare Day: Feb 15 2014 (- 2 days)

Actual Solar Radiation (2/13)
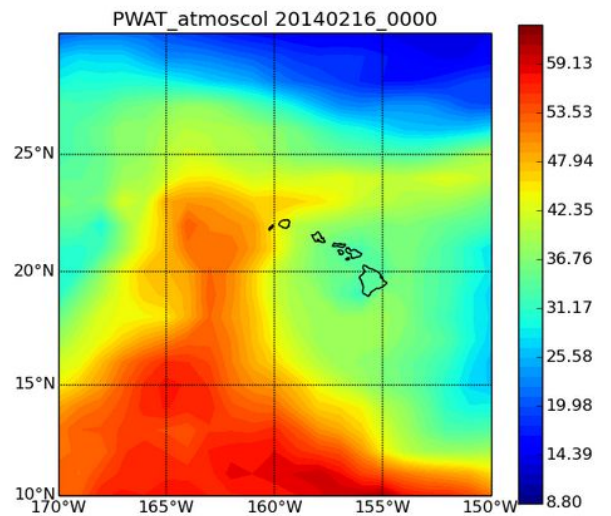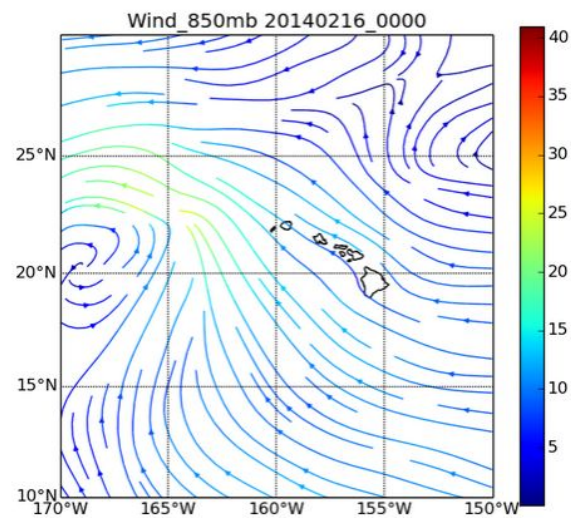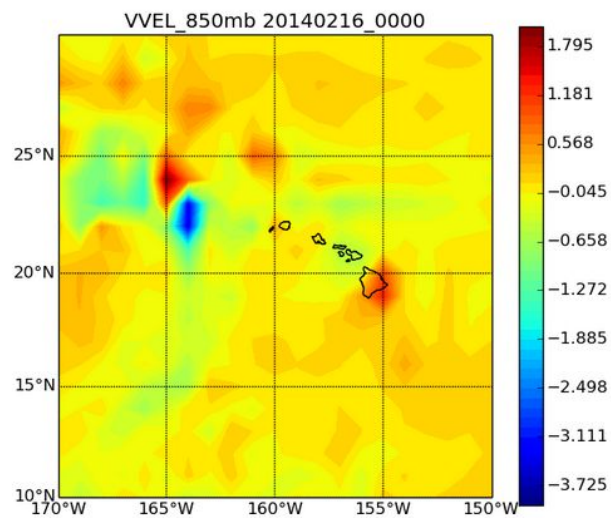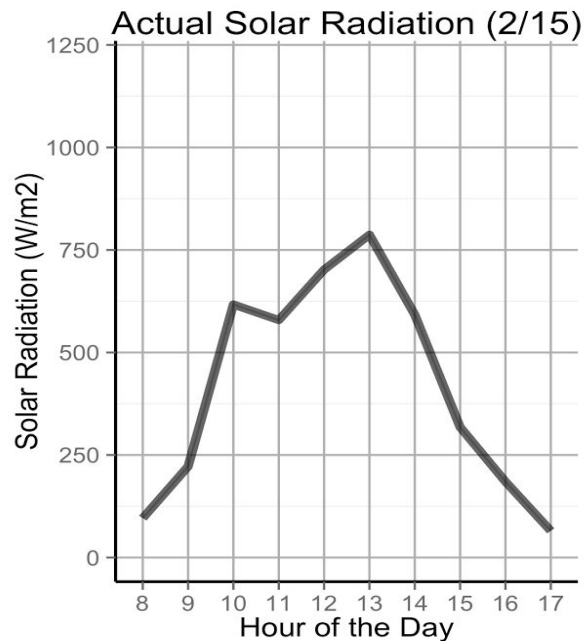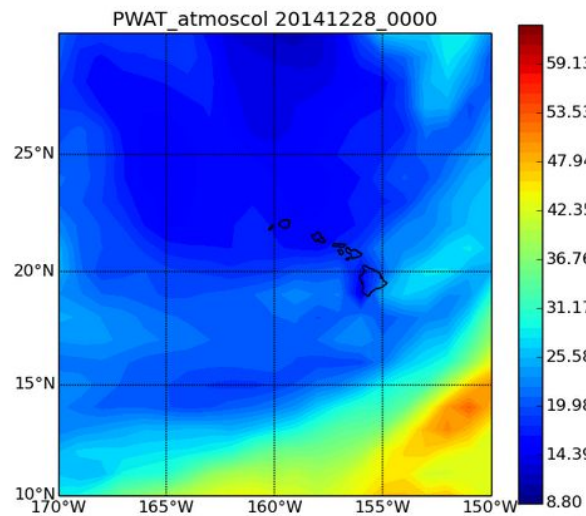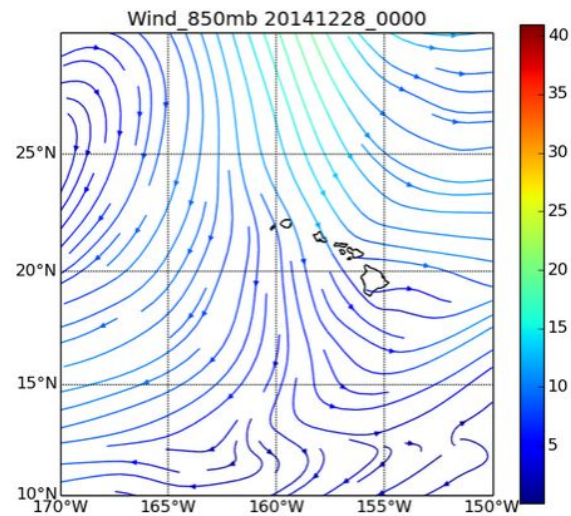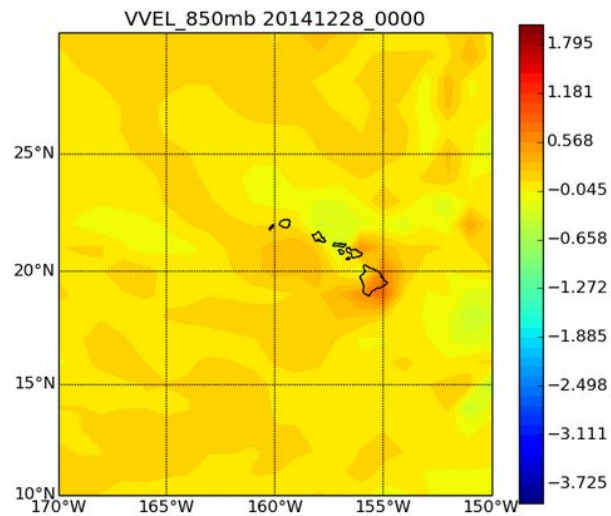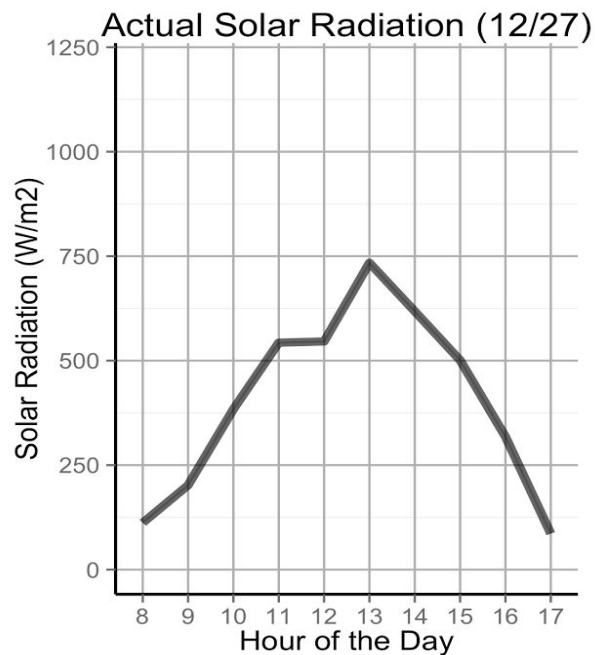
VVEL_850mb 20140214_0000

Wind_850mb 20140214_0000

PWAT_atmoscol 20140214_0000

GHI 20140214_0000
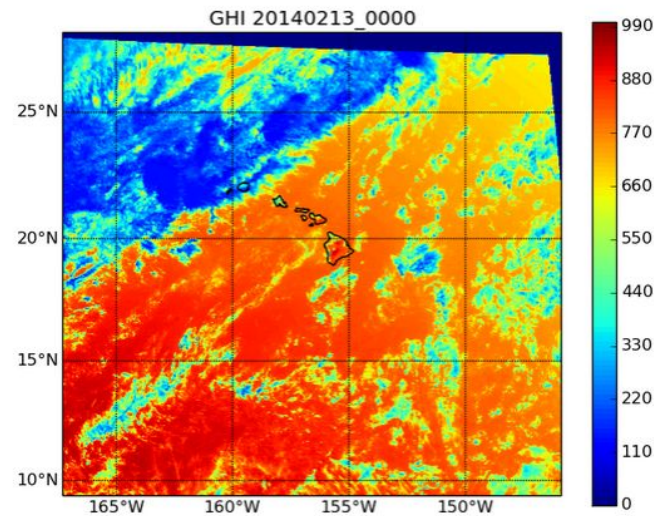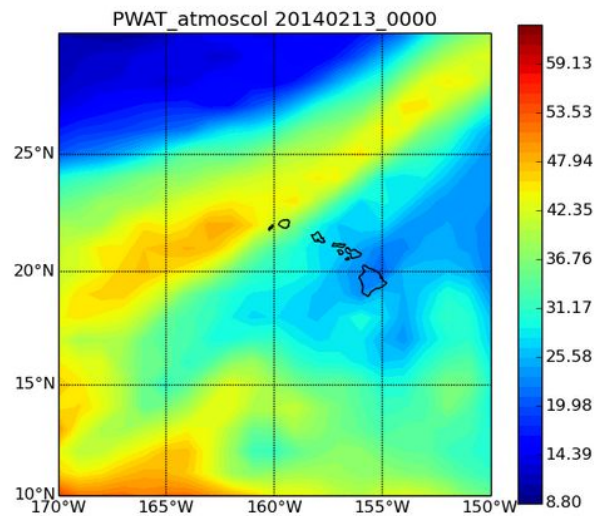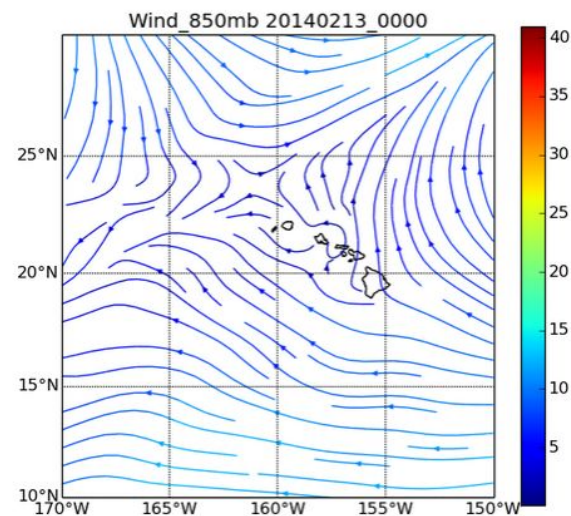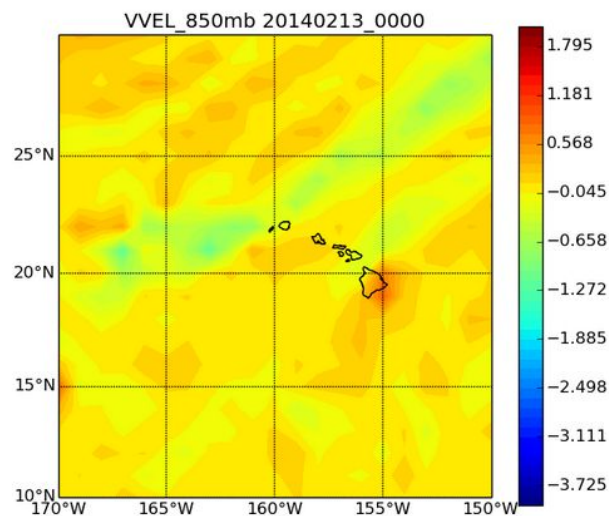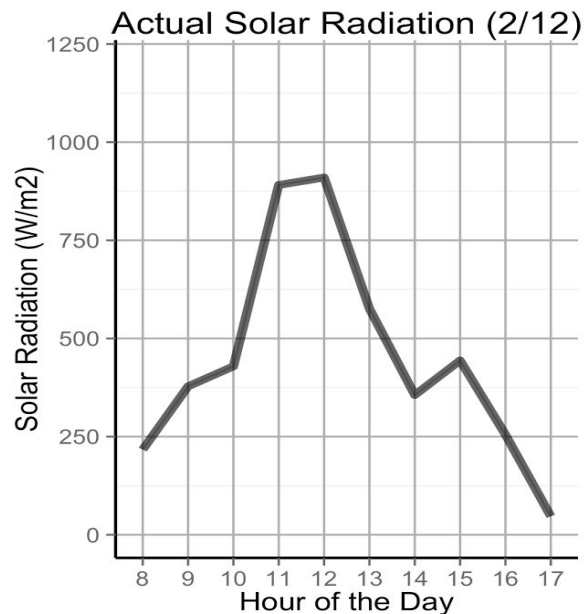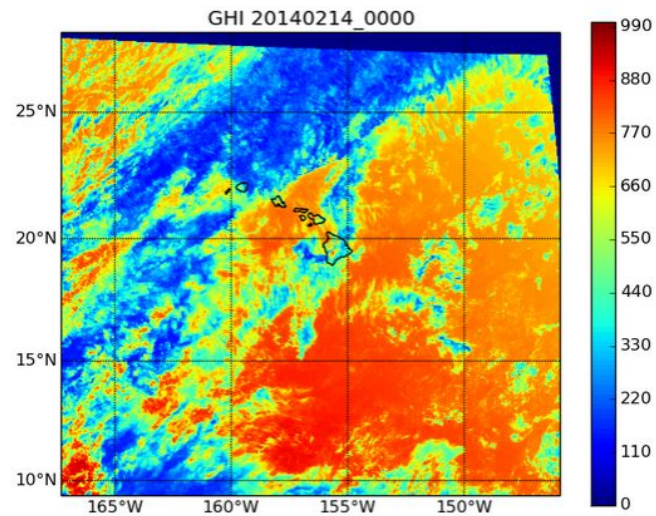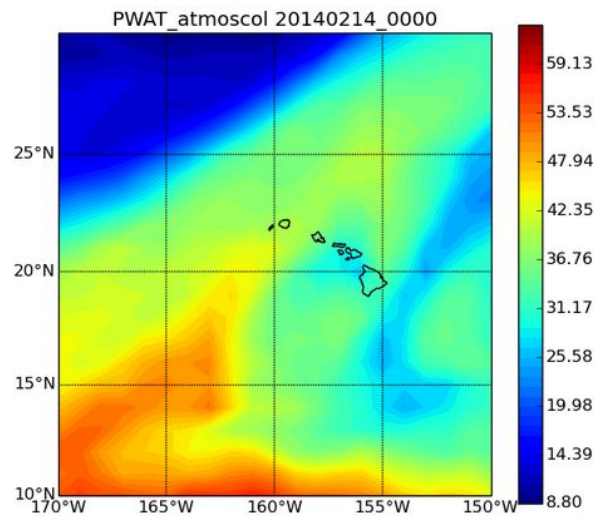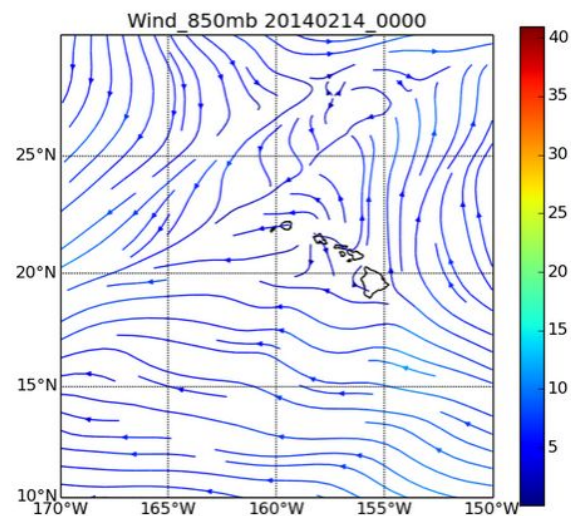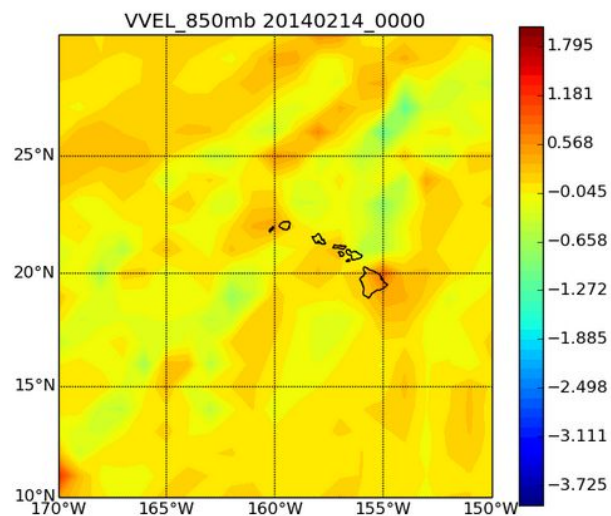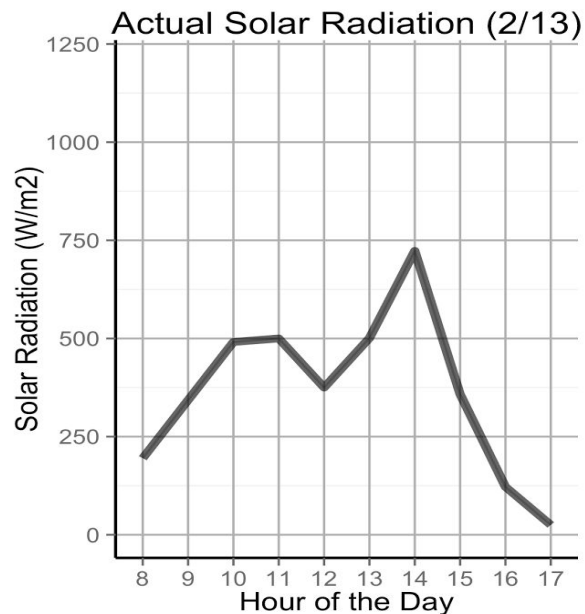
GFS Rare Day:
Feb 15 2014
(- 1 day)

GFS Rare Day:
Feb 15 2014
(- 0 days)

Actual Solar Radiation (2/15)

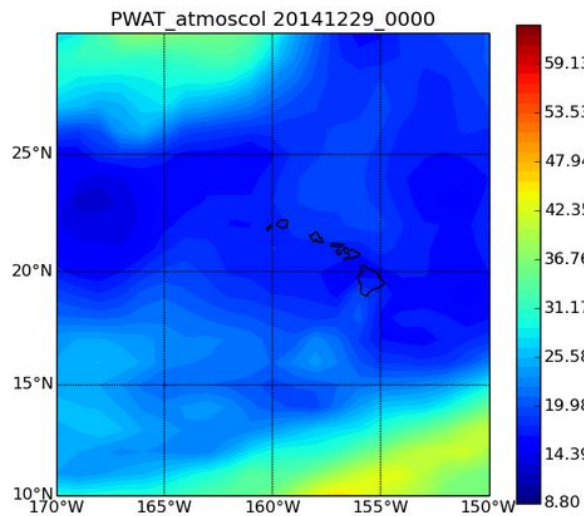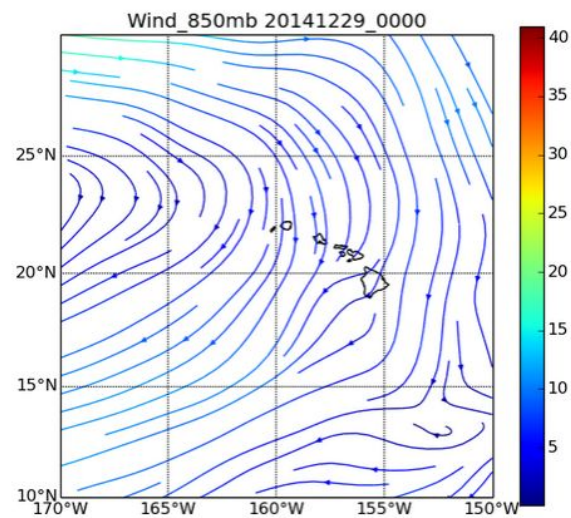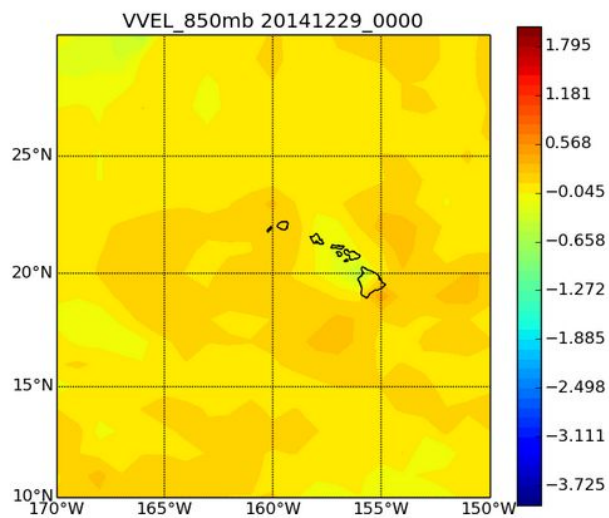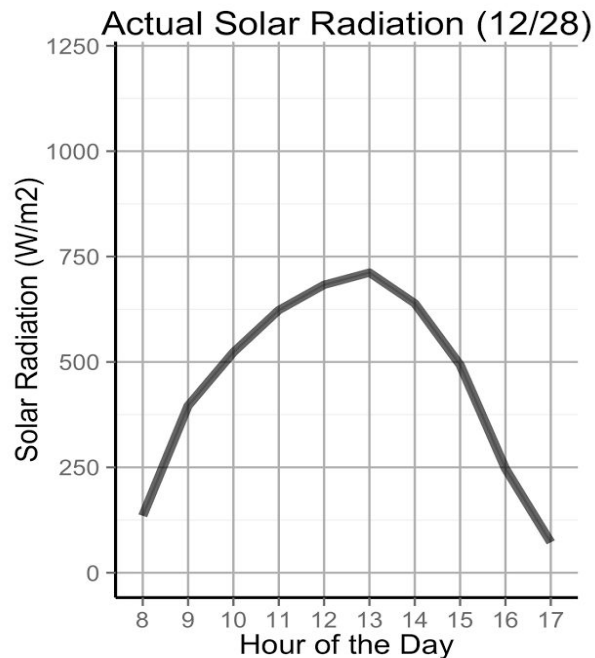VVEL_850mb 20140216_0000

Wind_850mb 20140216_0000

PWAT_atmoscol 20140216_0000

GHI 20140216_0000
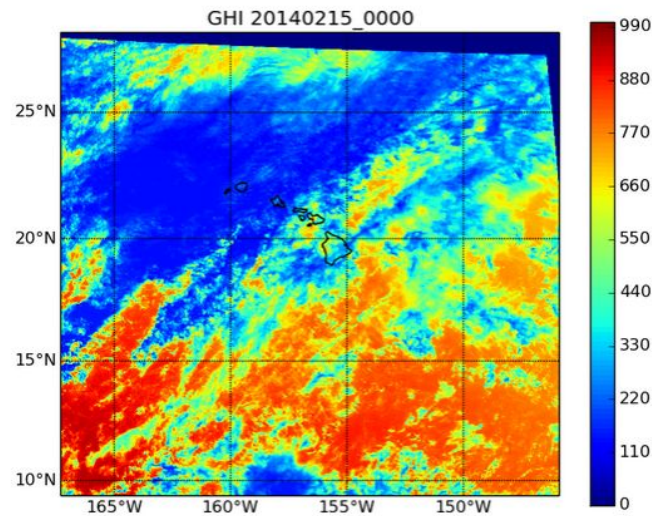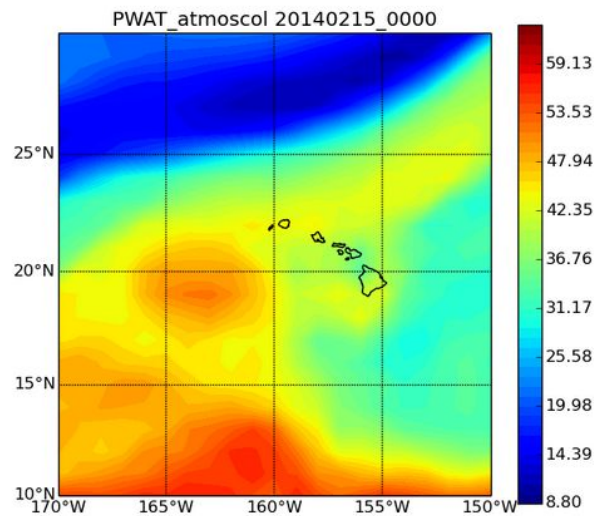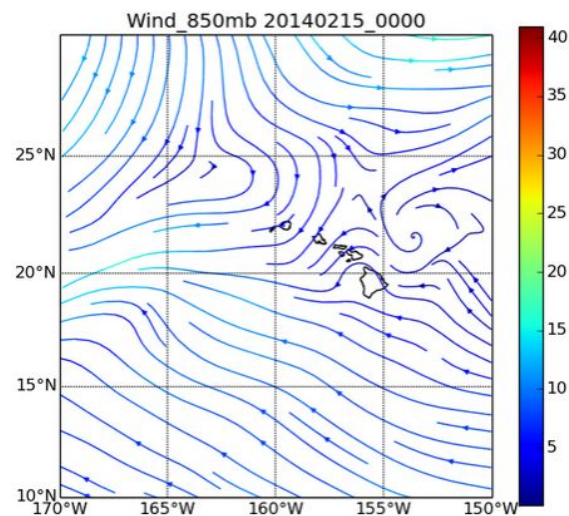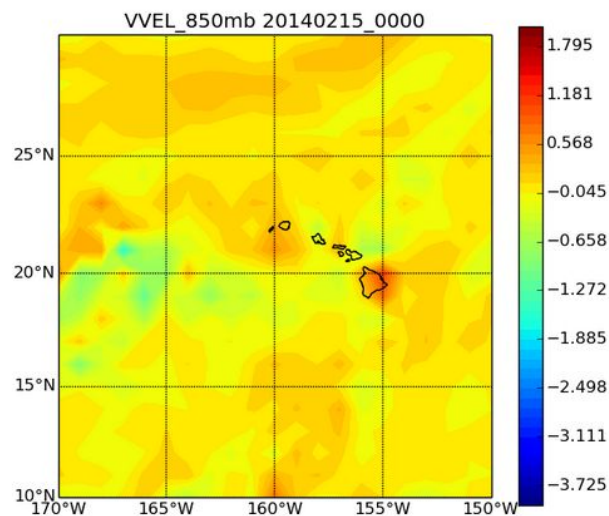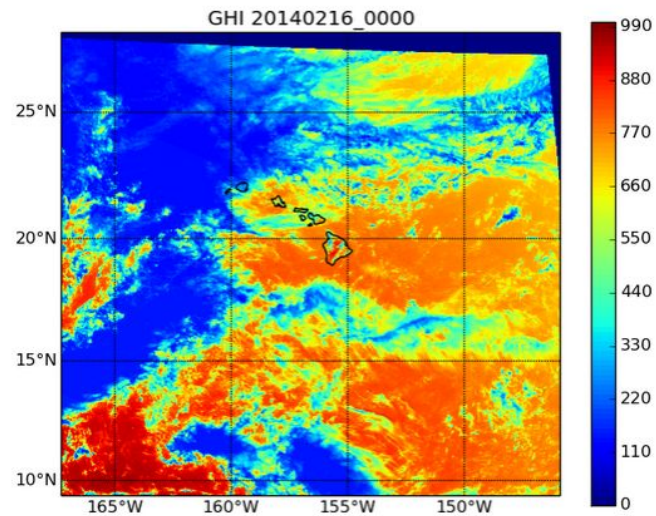
GFS Rare Day:
Dec 30, 2014
(- 3 days)
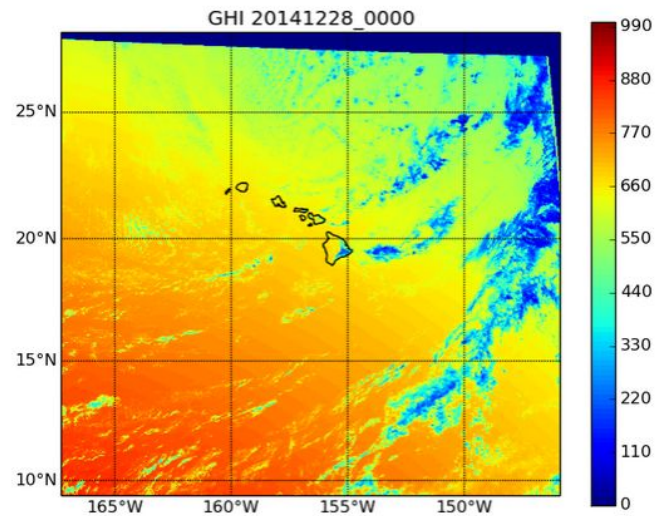
GFS Rare Day:
Dec 30, 2014
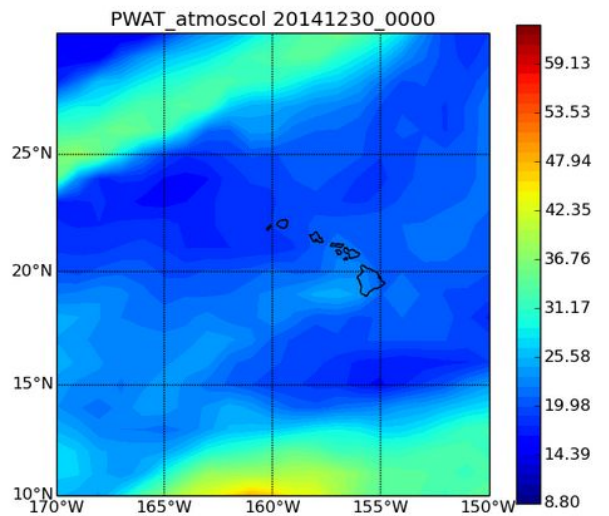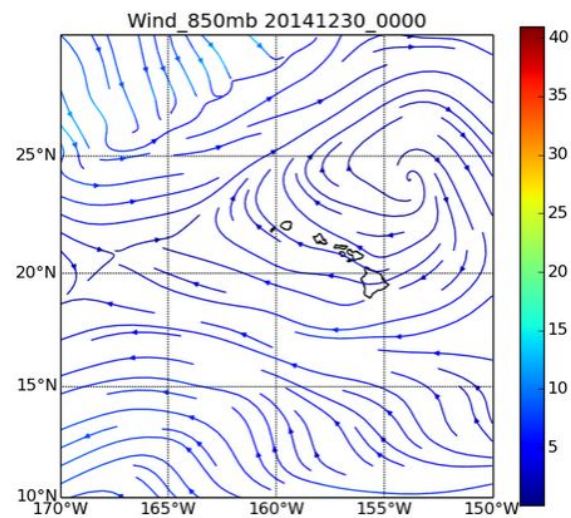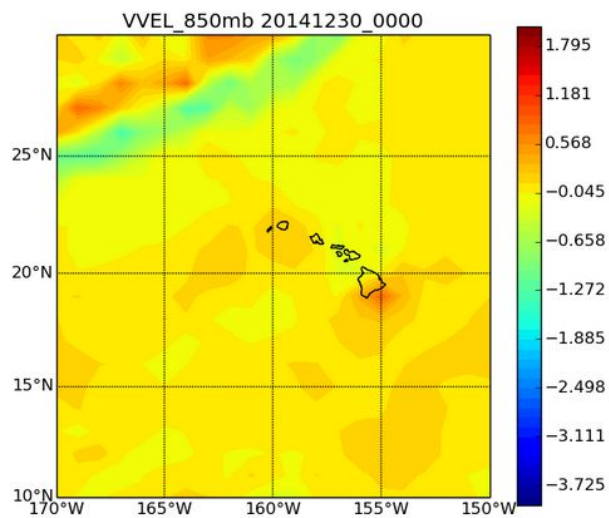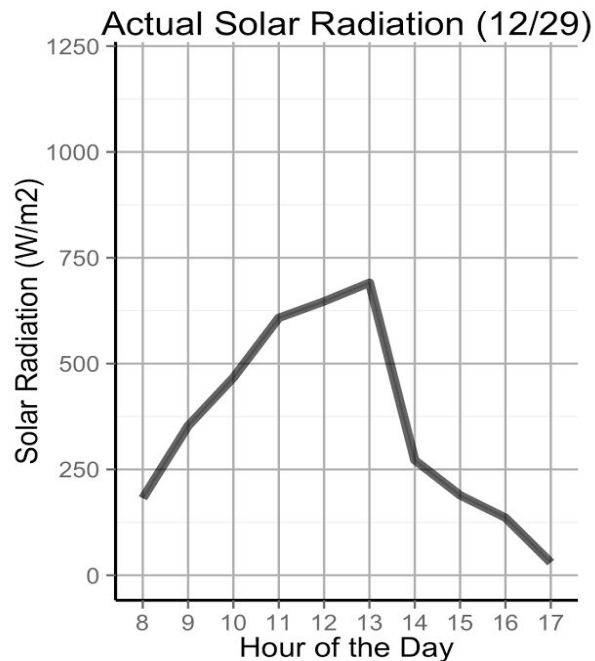(- 2 days)
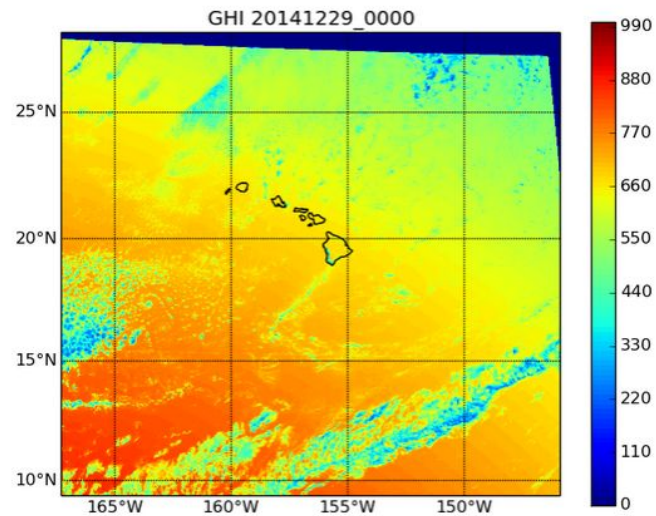
GFS Rare Day:
Dec 30, 2014
(- 1 day)

GFS Rare Day:
Dec 30, 2014
(- 0 days)