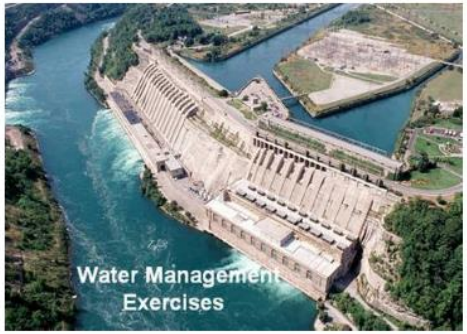
SUNYIT IITG Development of an Interactive Case Study

Chris Urban SUNYIT/CIS PI **Glenn Van Knowe (CO-PI)**

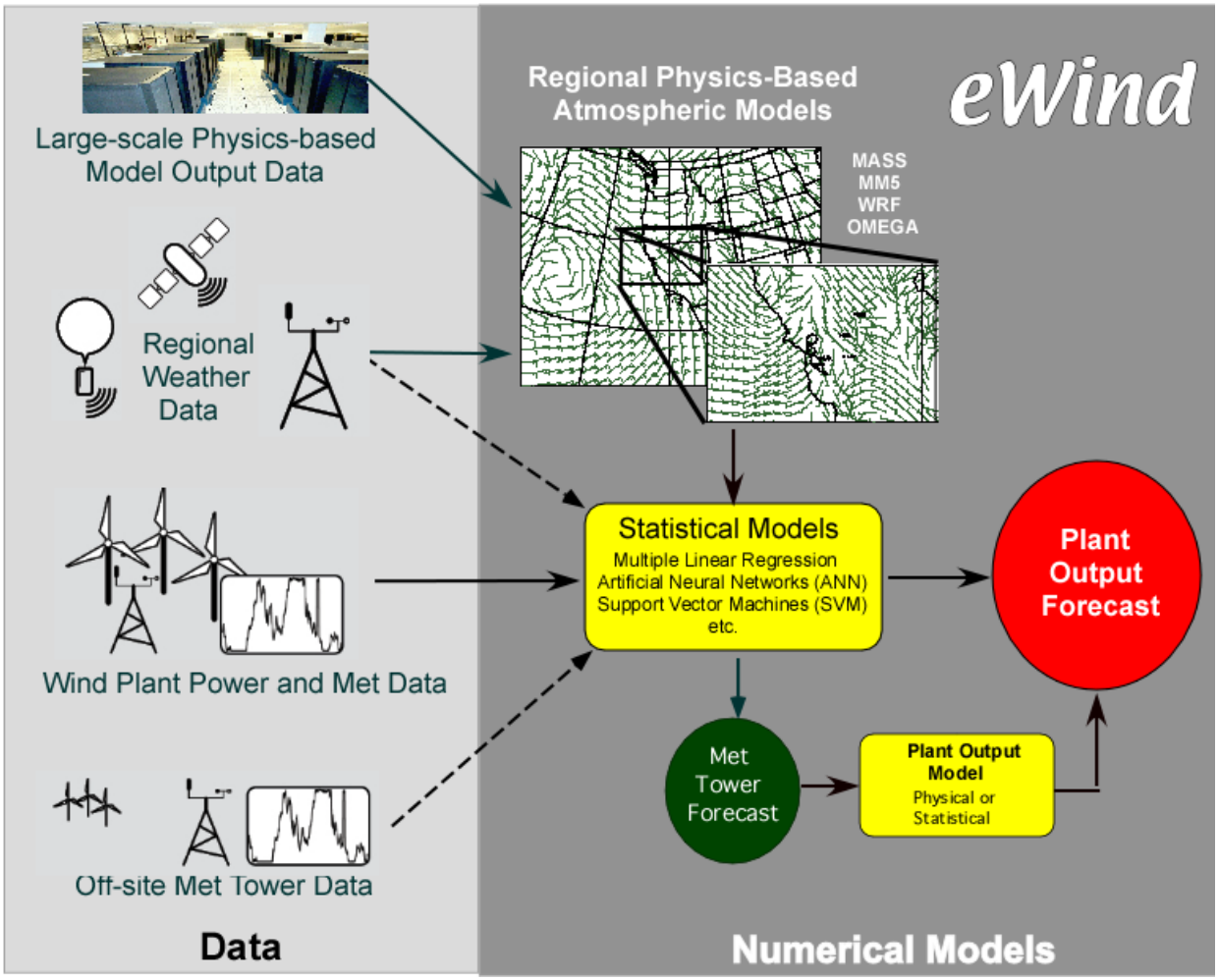
Bringing reality into the classroom



Trying to put learning in a real world context

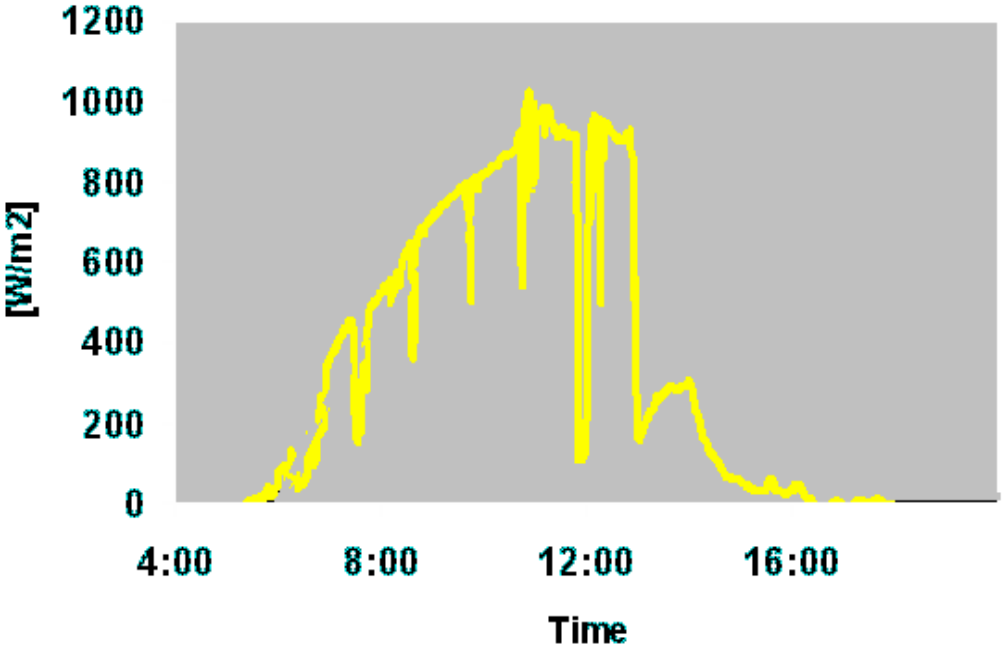
Numerical Modeling Capabilities

Input Data, Forecast Model Components and Data Flow for State-of-the-Art Forecast System



- We are model developers, not just model users, so we can modify our own (MASS) model for specific purposes
- We also use other popular "community" models: WRF, ARPS
- We can provide sophisticated atmospheric modeling

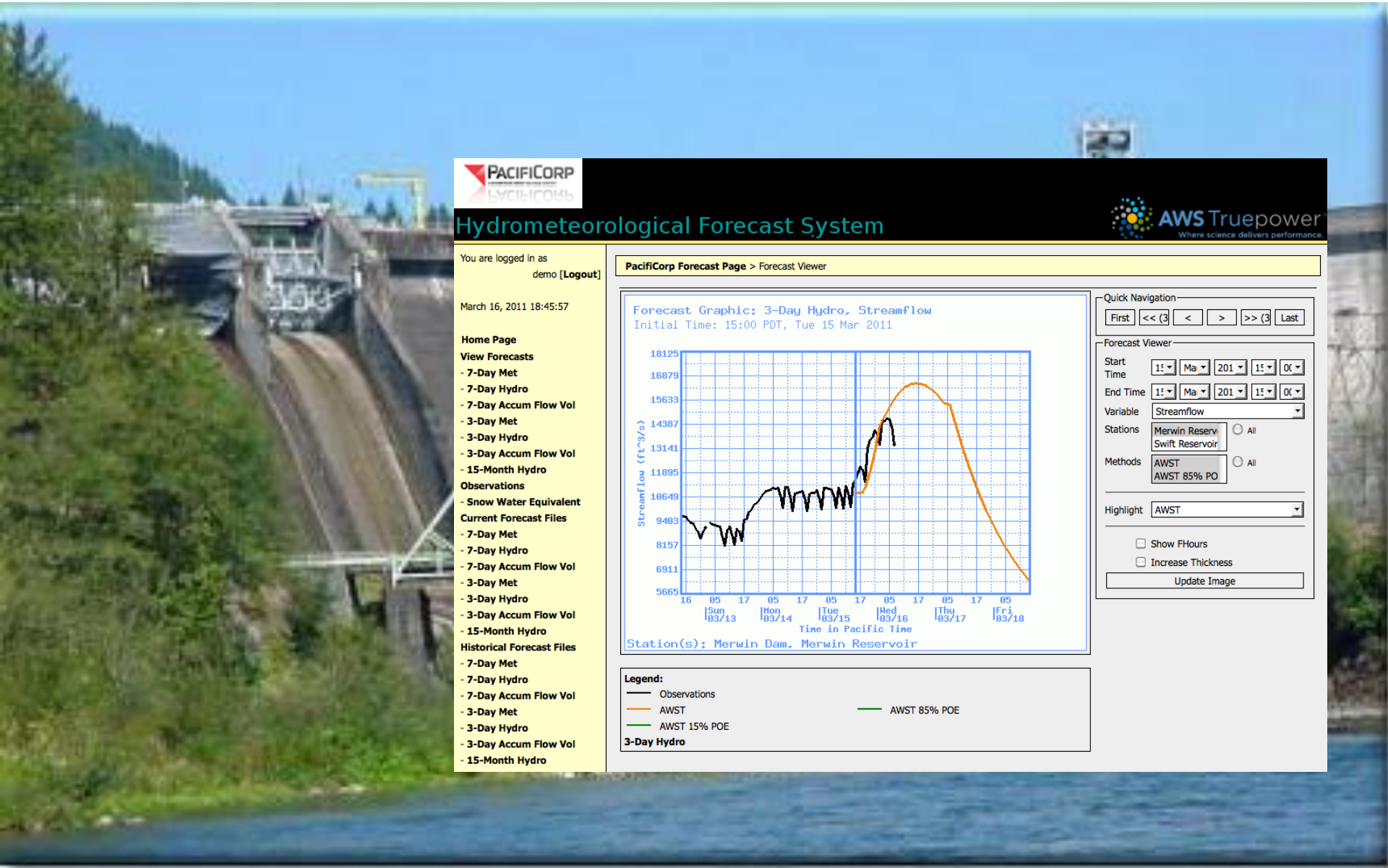
Solar Forecasting - Growing Need
Power Ramps Caused by Boundary Layer Clouds



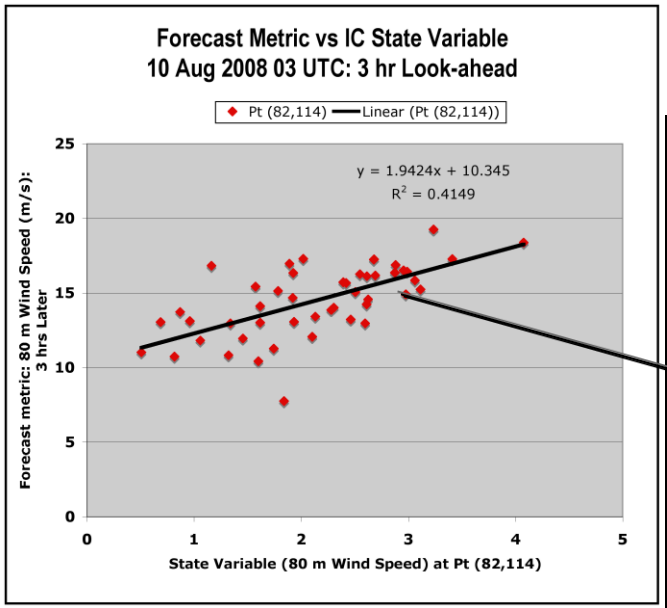
- Ramps caused by boundary clouds are most significant

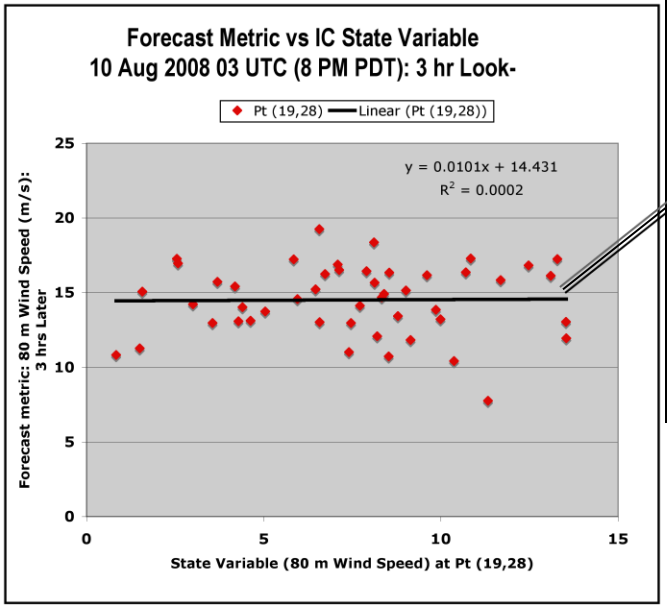
AWS Truepower™
Where science delivers performance.

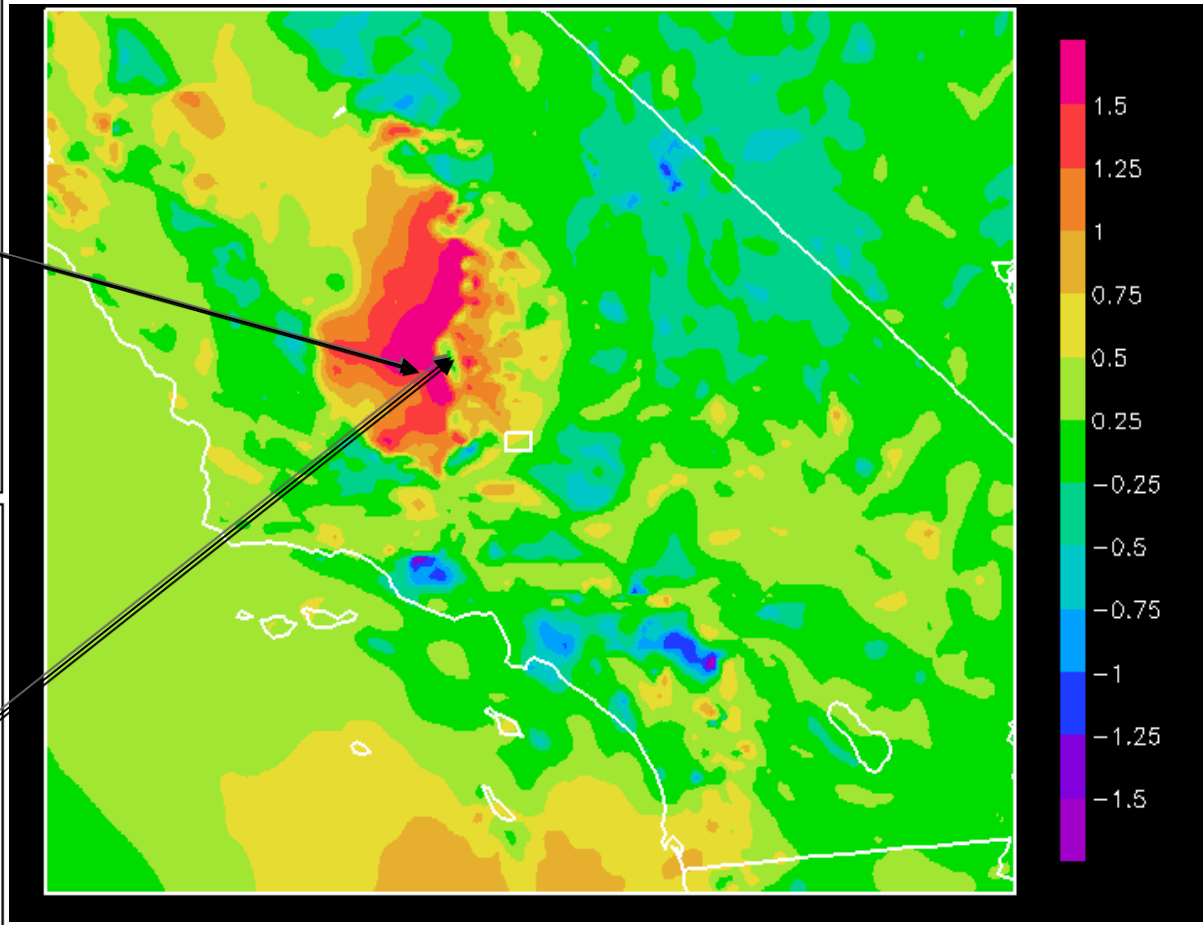
Hydro Power



LLNL ESA Obs Targeting





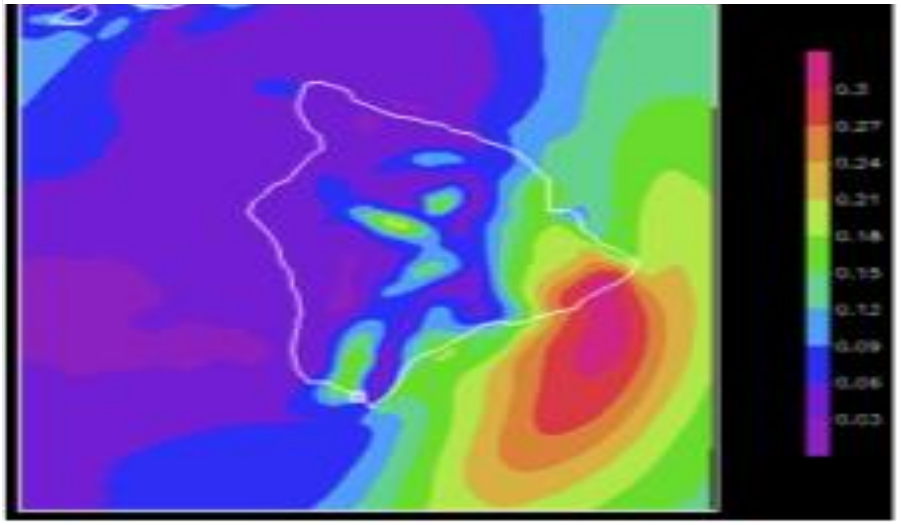


Hawaii WindNET

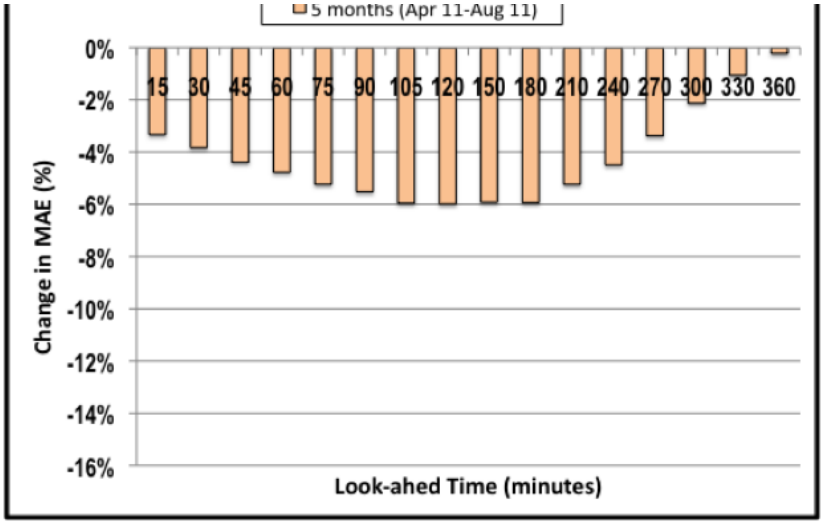
- Multi-year project sponsored by DOE and Hawaiian Electric Company (HECO)
- **Objective:** demonstrate value of targeted observations for short-term (0-6 hour ahead) wind forecast performance
- 9-month forecasting experiment on the Big Island of Hawaii
- Additional experiments now in progress in Maui and Oahu

Deploy Sensors at Target Locations

NWP-based Observation Targeting Study

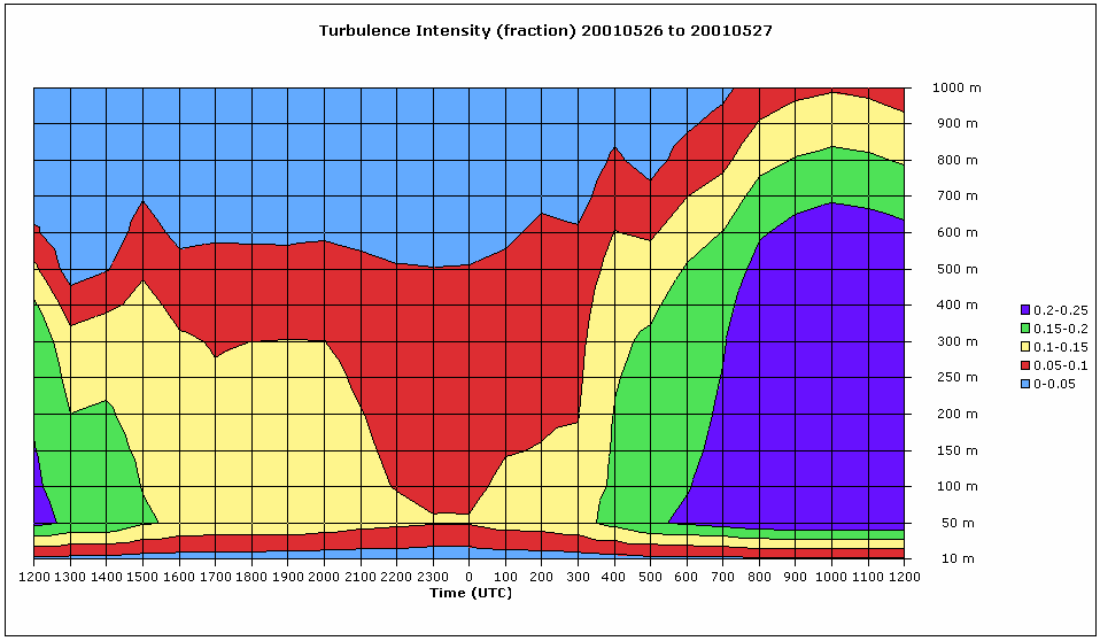


Assess Impact on Forecasts

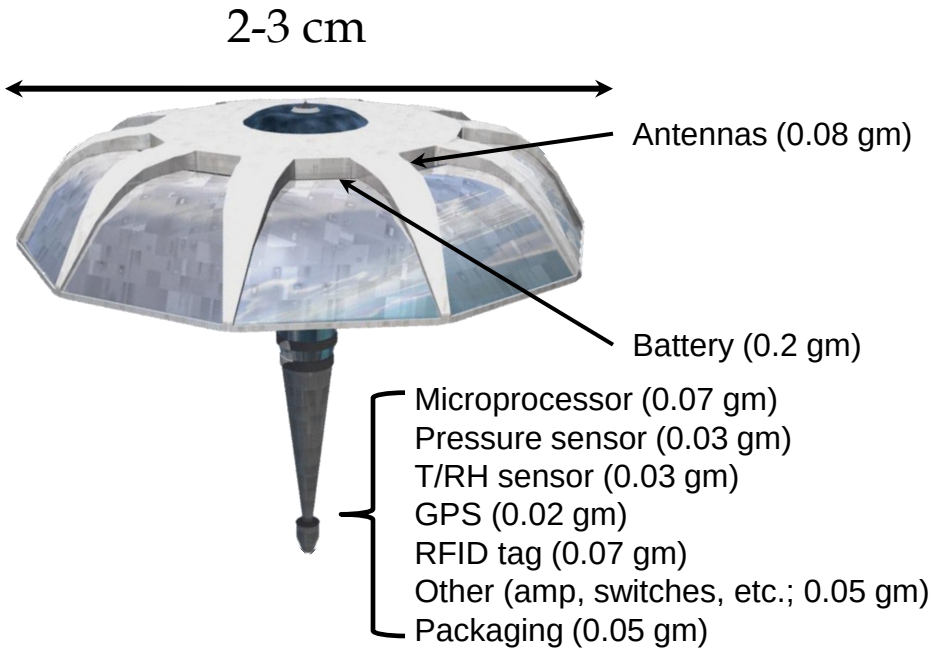


Dubai Skyscraper Study

- **Model study of wind and turbulence to support studies of building loads in Dubai**

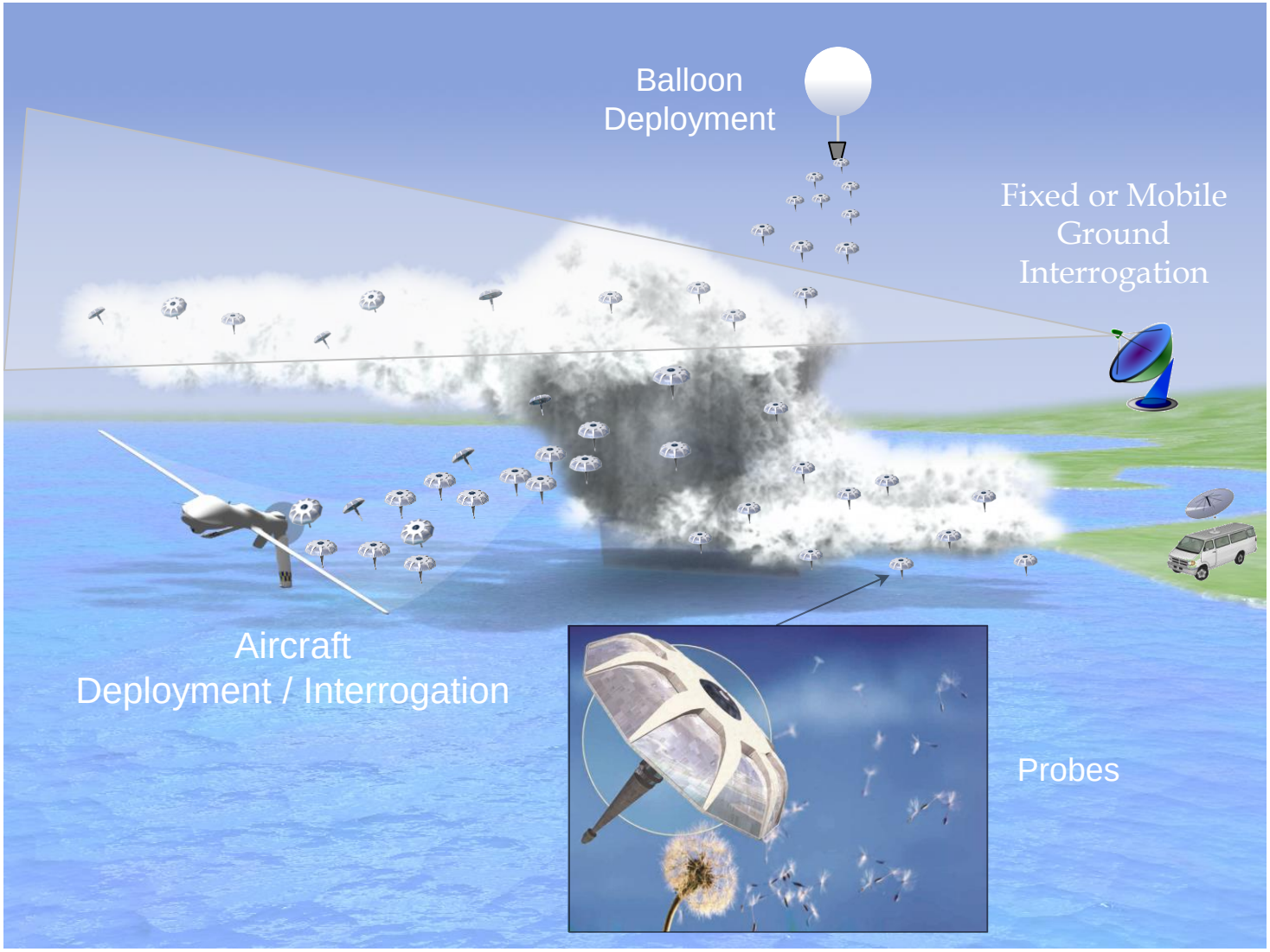


NSF/NASA|NOAA Project: Probe Design Specifications



Form factor: aerodynamic, passive drifter, bio inspired
Measurements: air P, T, RH, velocity
Accuracy: similar to dropsondes
Mass: 0.5 – 0.6 gm
Terminal velocity: 0.25 – 0.50 m/s
Cost :10 – 100 times < dropsonde
Functionality: minimize to meet specifications

Probe Systems Concept



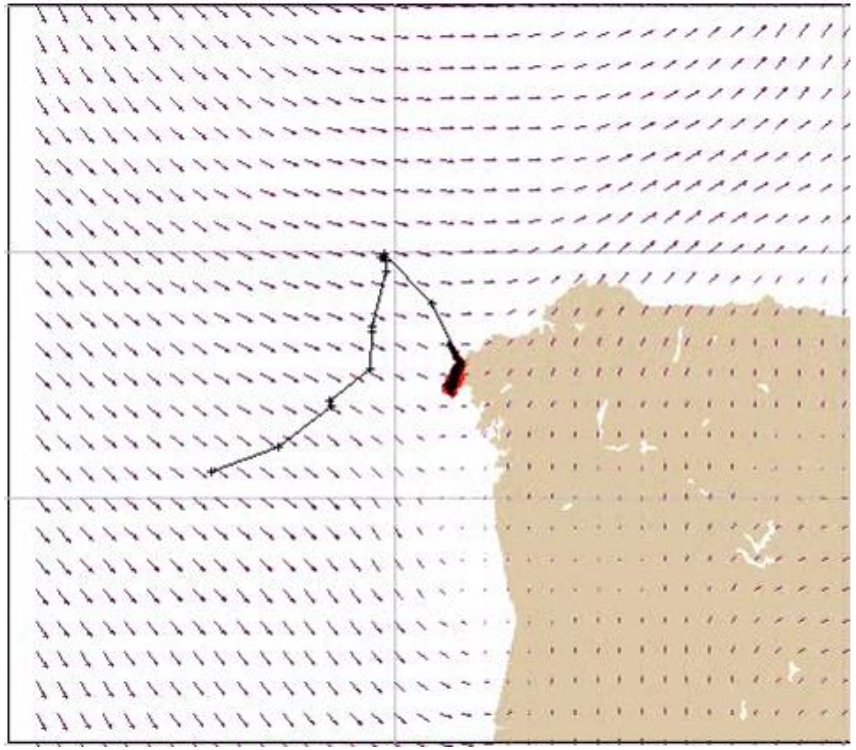
Prestige Oil Spill

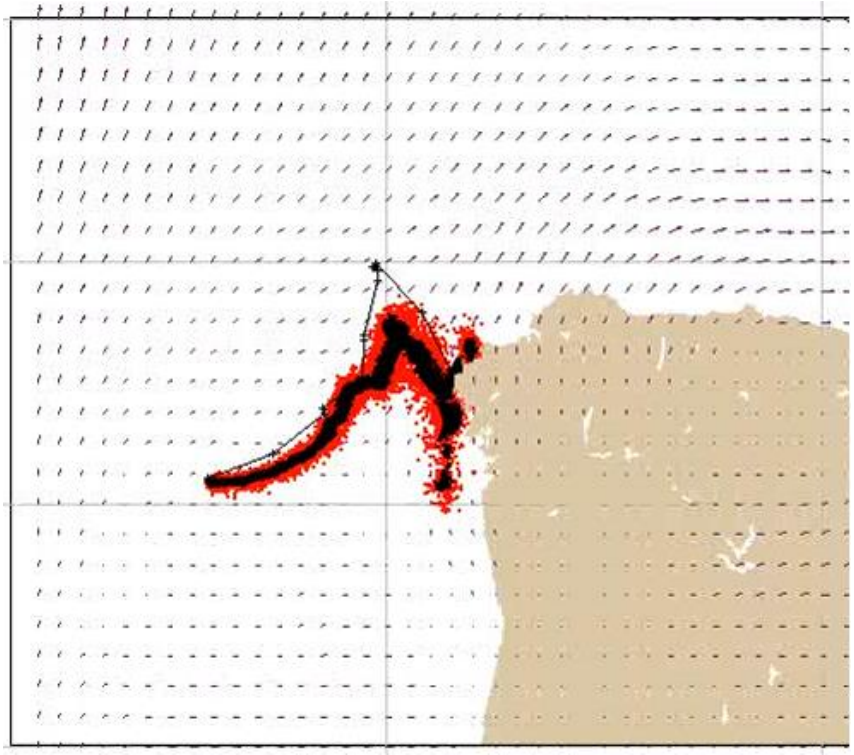
March, 2003

Prestige Oil Spill

March, 2003

- Oil Spill Simulation





Interactive Teaching Tools

Virtual Environment

Put Learner in real world role

Immersive learning strategies

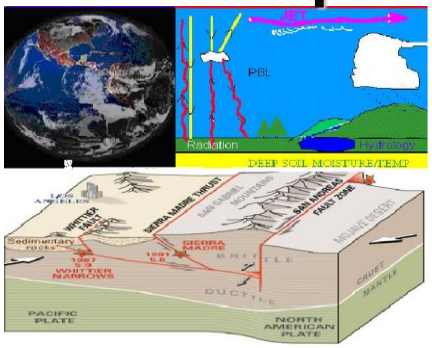
Interactive Case Studies (ICS)

- Prototype - in classroom testing

GEOpod Simulator

- Advanced Physics-based models, intuitive interfaces & analysis tools
- Virtual Earth Science Labs - Inquiry based investigation, what-if capability
- Still under construction

NSF: GEOpod

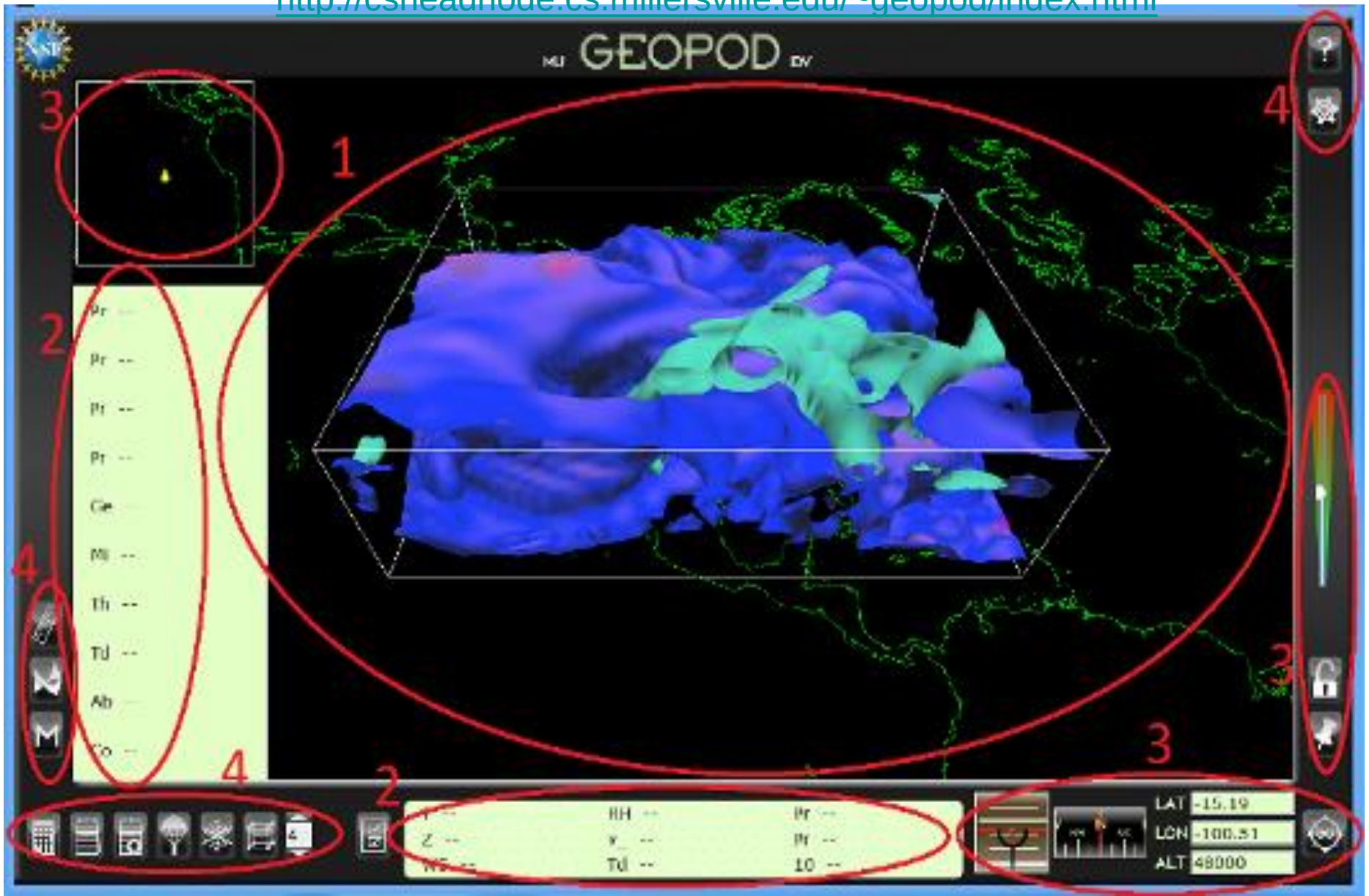


IITG: ICS

Glenn Van Knowe
Gevanknowe@meso.com

GEOPOD

[GEOPOD Home](#) [Geopod Demo (WMV)](#)
http://csheadnode.cs.millersville.edu/~geopod/index.html



GEOPOD

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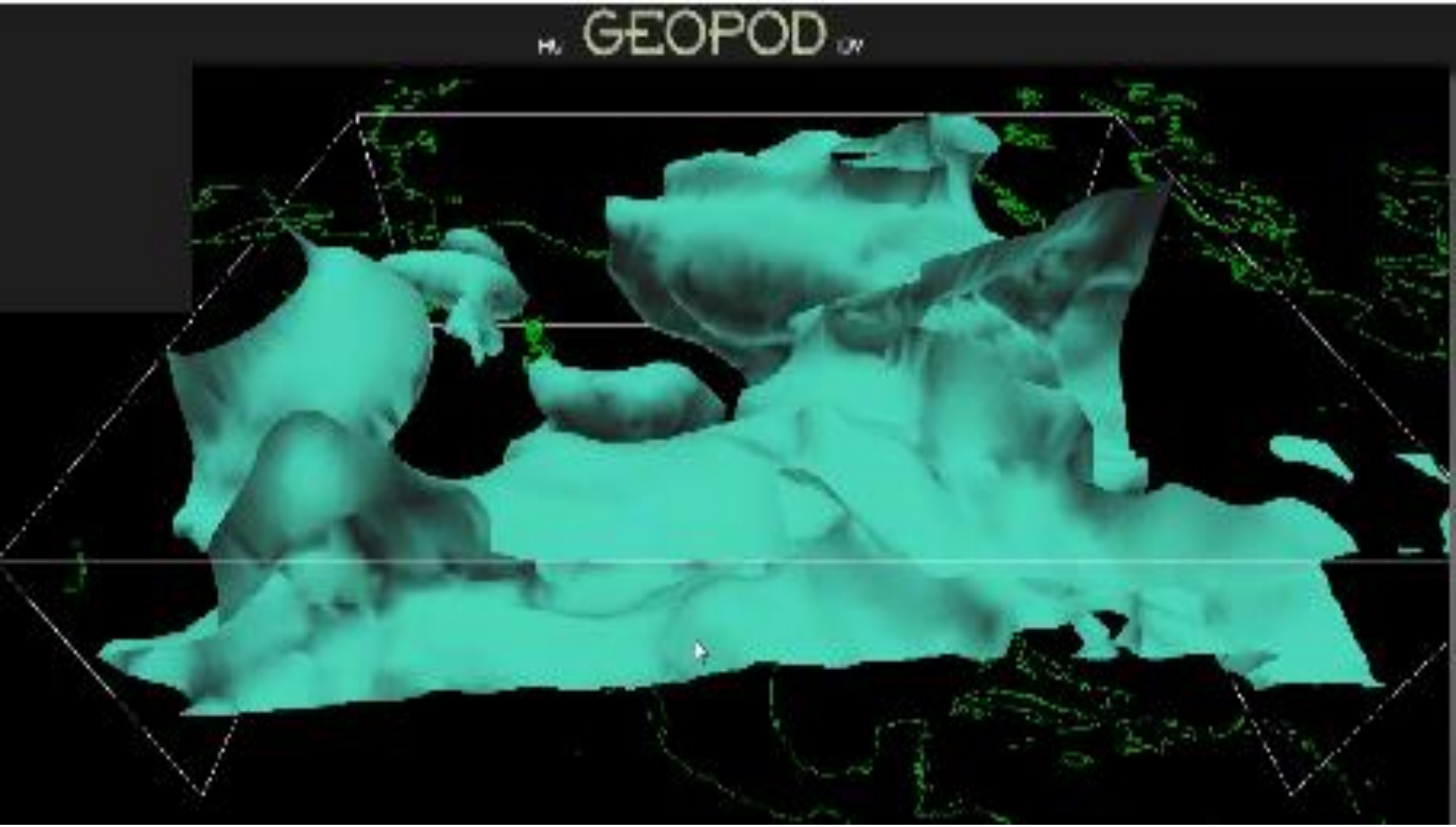

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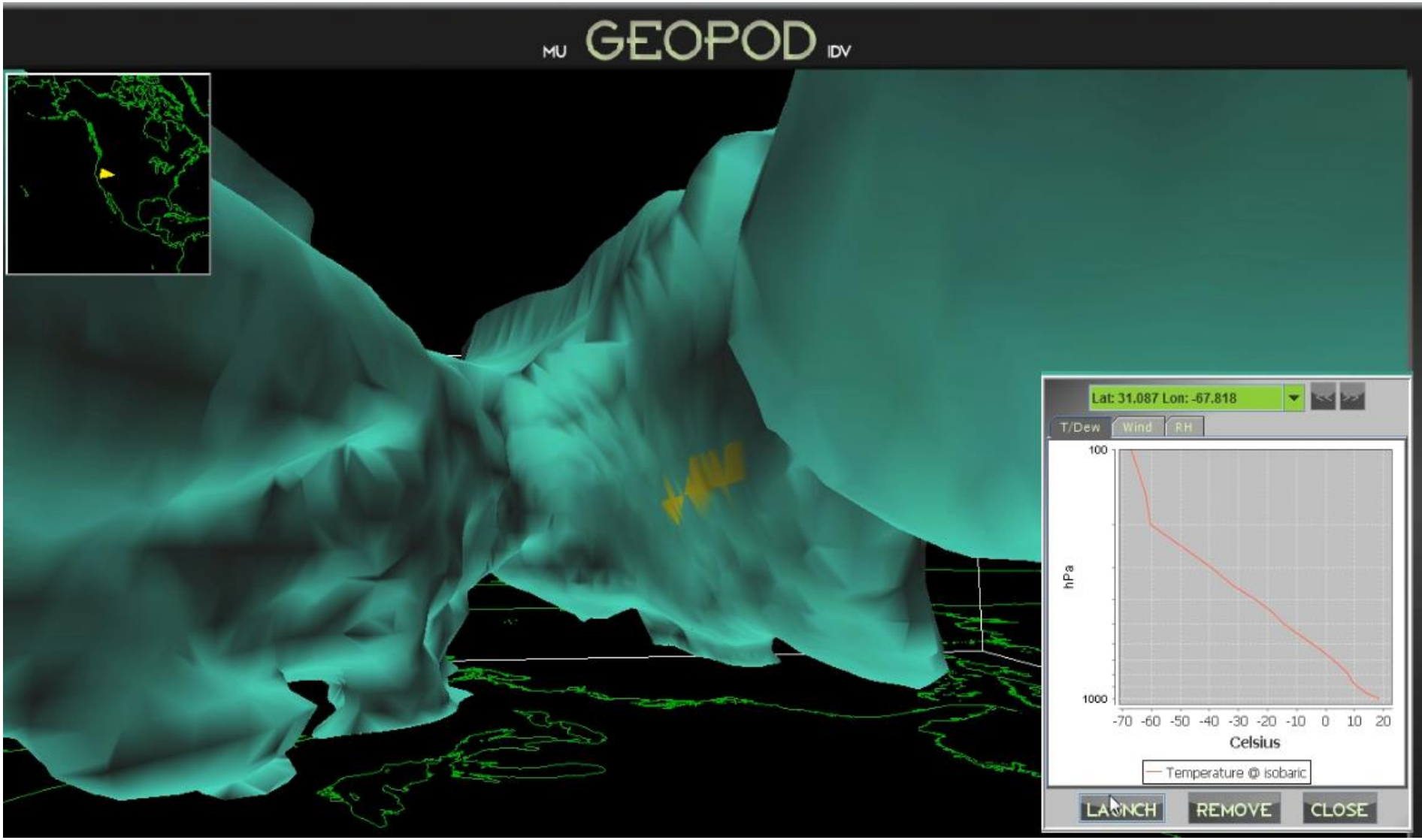
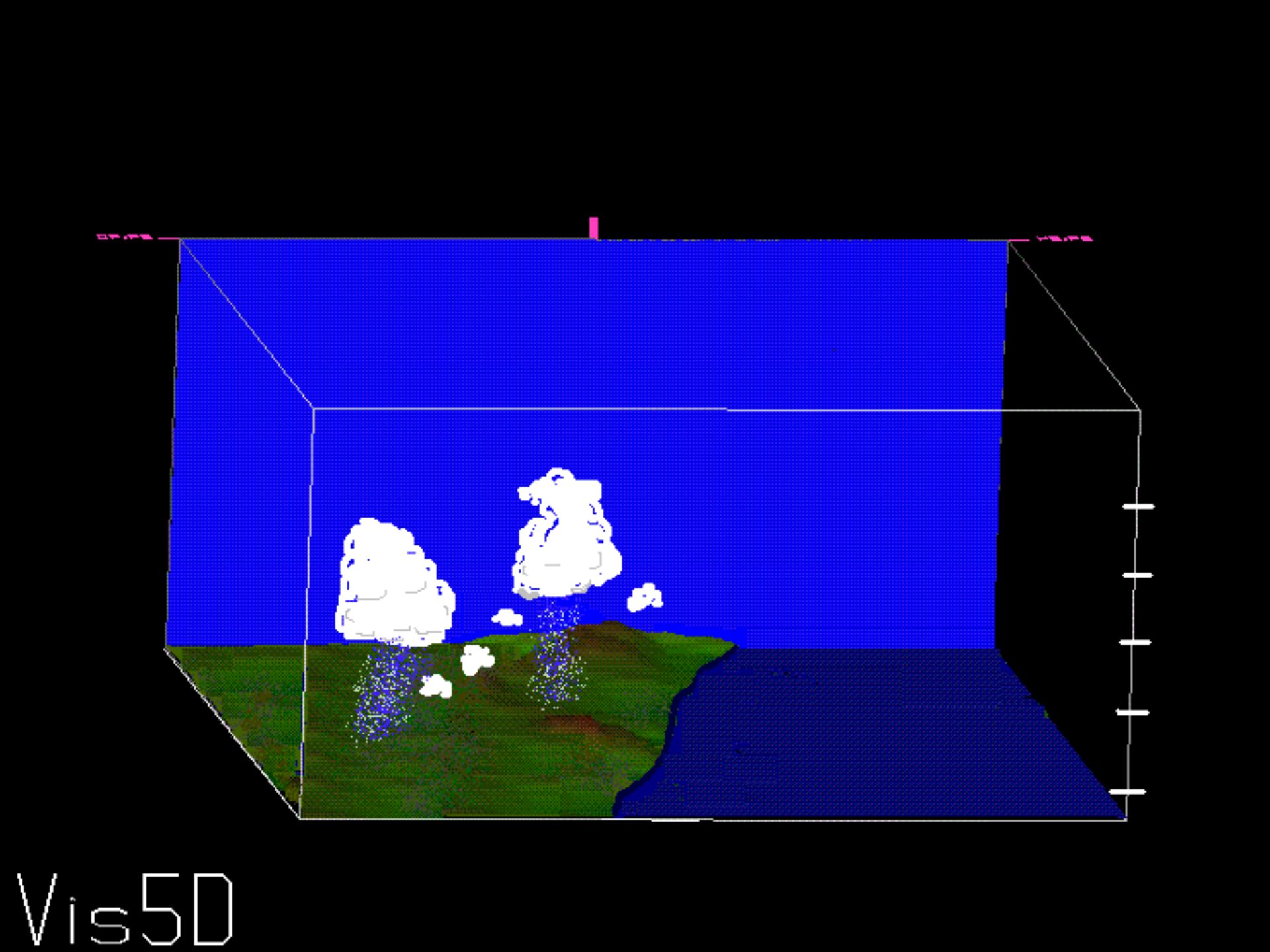



Vis5D


Vis5D

Saint Louis University

Student Experiments

Select Land/Water Distribution and Shape of Coastline:

All Water-0% Land
All Land-100% Land
Straight: West Half is Land
Straight: East Half is Land
Straight: North Half is Land
Straight: South Half is Land
Concave -50% Land
Convex -50% Land
"S" Shaped -50% Land
Water surrounding island -10% Land
Land surrounding lake - 90% Land

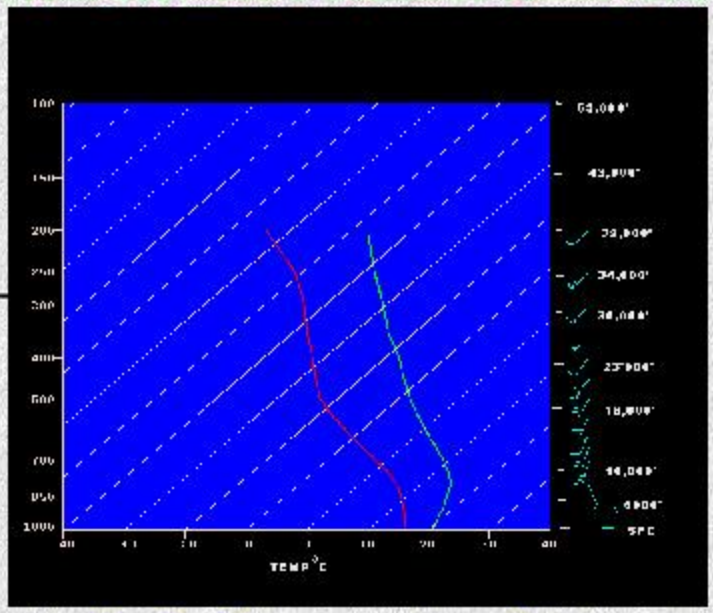
Select One

Select Land Usage:

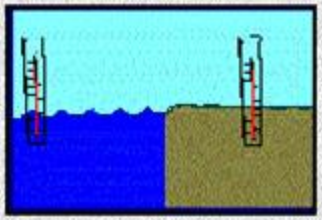
Forest
Agricultural
Urban

Select One

ATMOSPHERIC CHARACTERISTICS



Input Water Temperature (°C) : e.g., 18.0



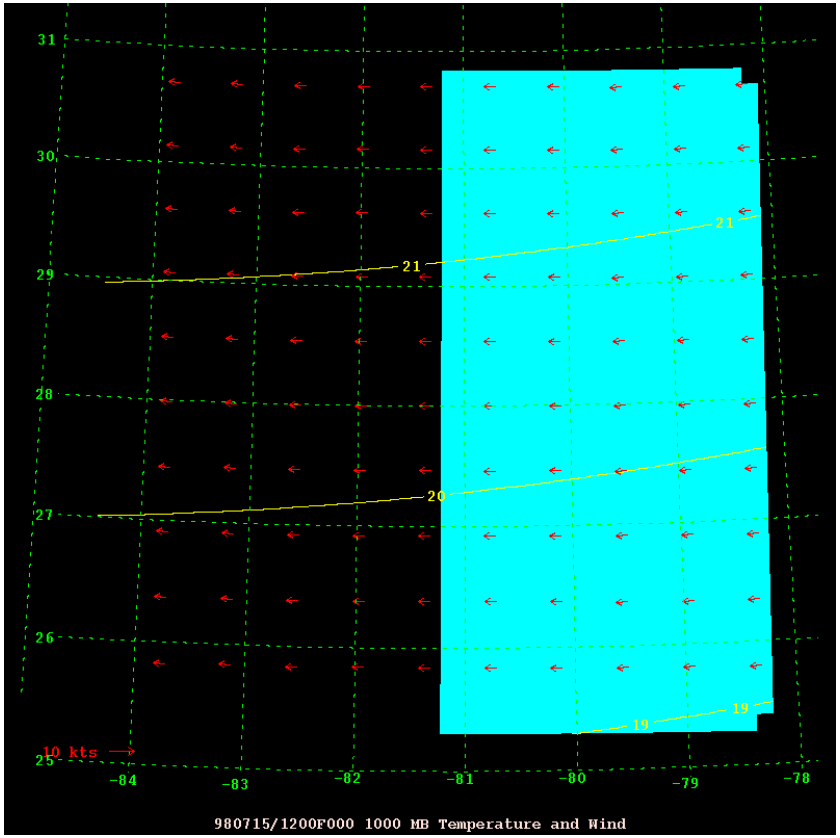
Enter the Water Temperature:

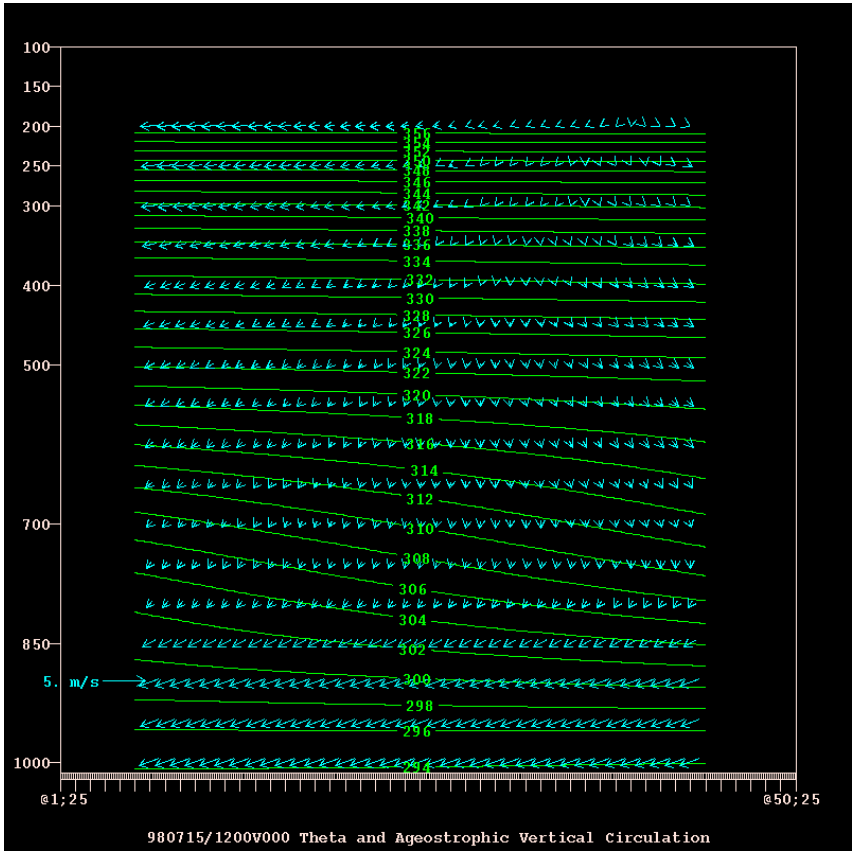
Input a low-level temperature adjustment:

0.0

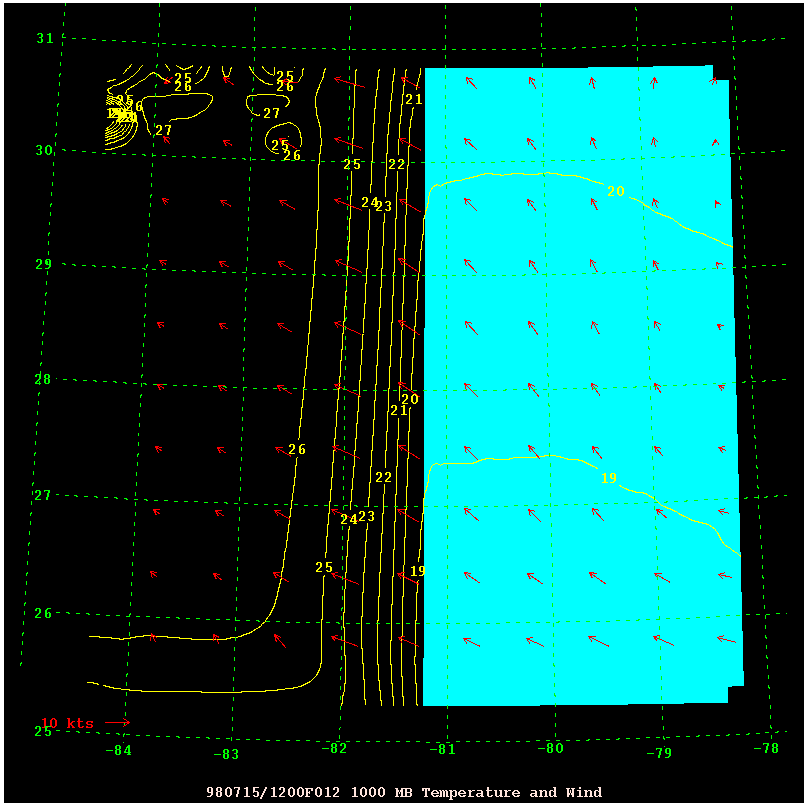
Select Low-level (900 mb) Inversion Strength:

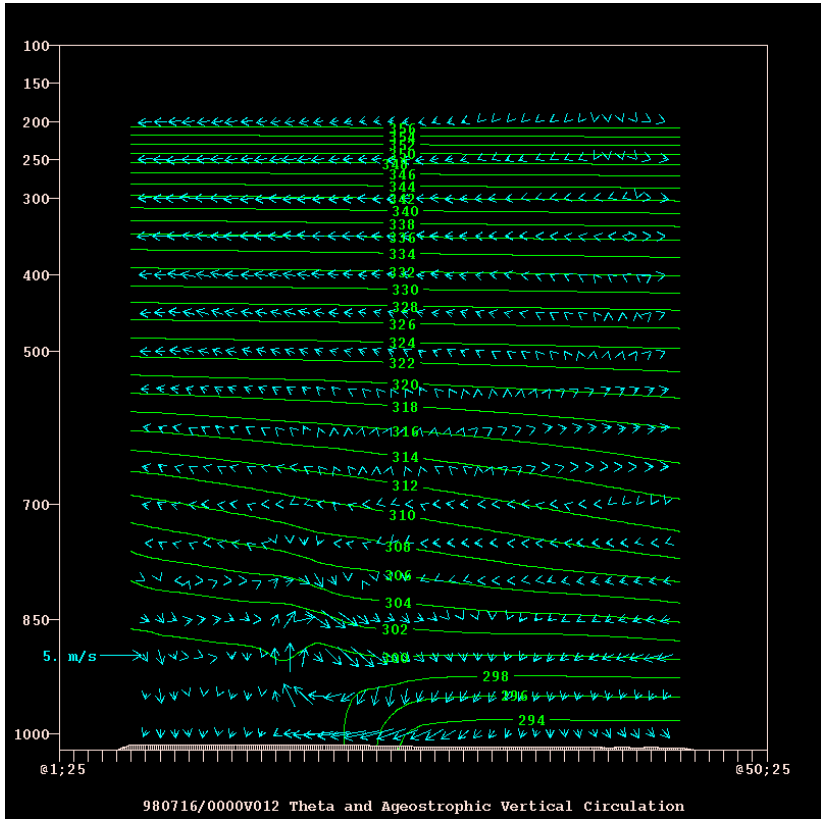
Initial conditions of temperature and wind



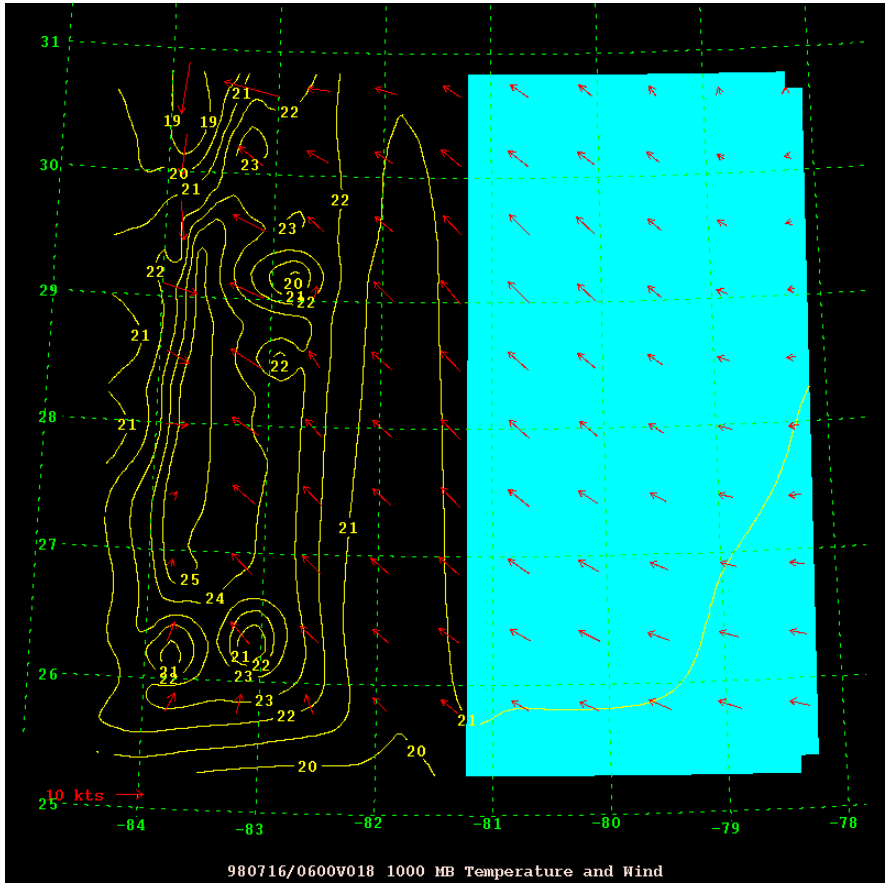


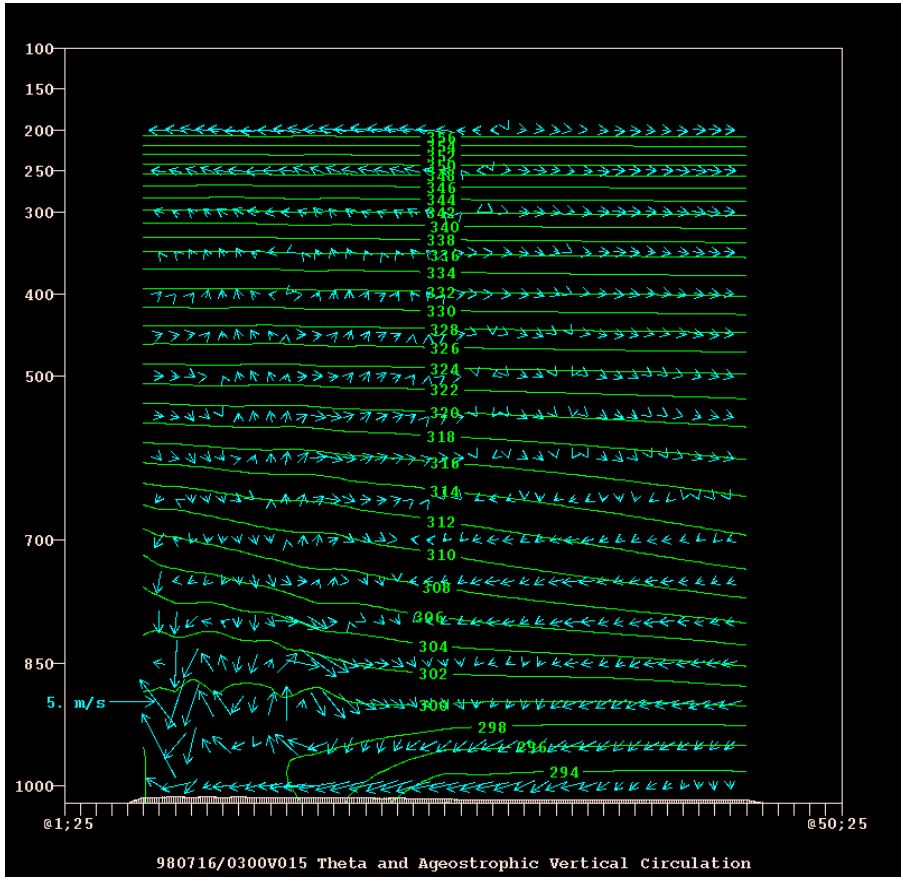
12 hours after the simulation start, late in the afternoon.



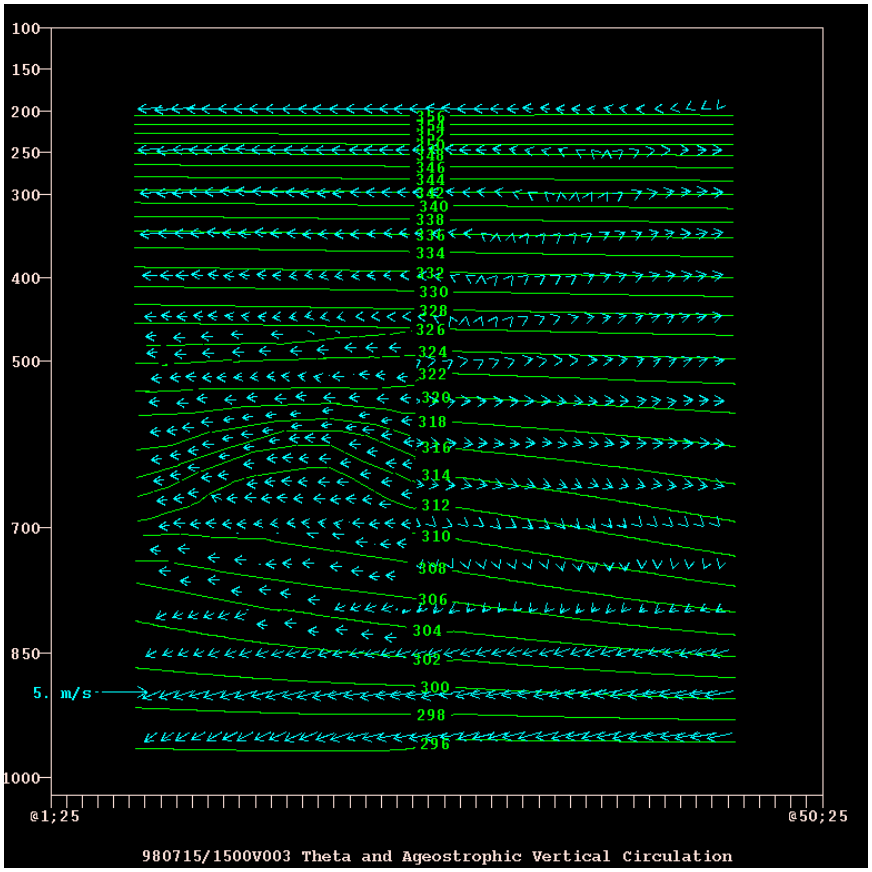


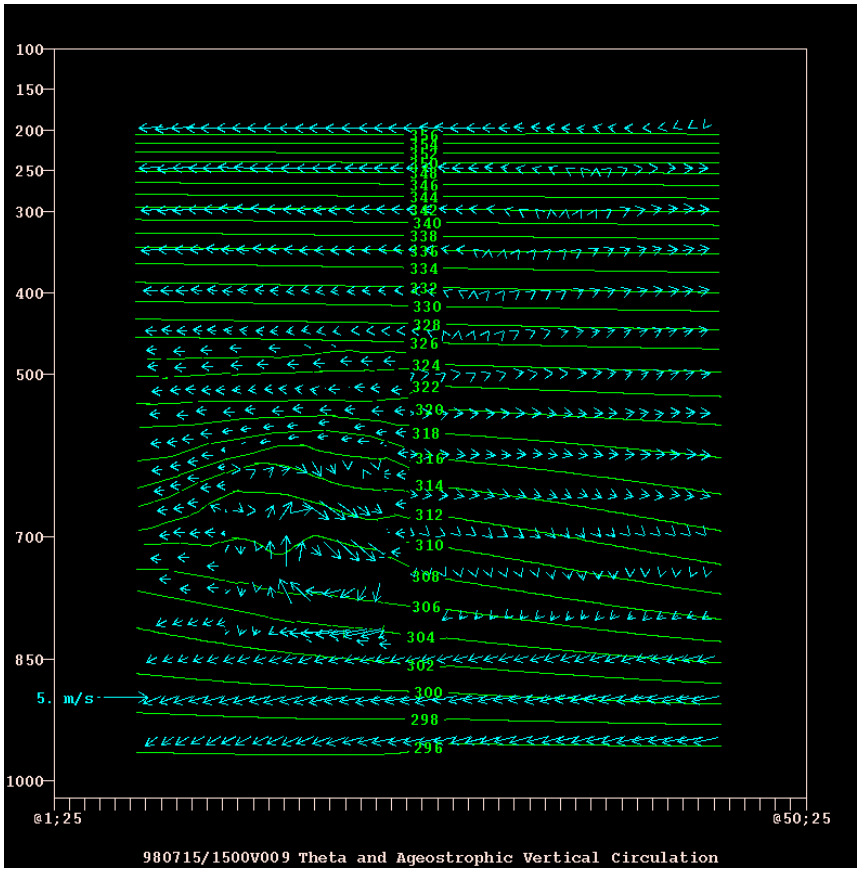
Conditions about 6 hours after sunset



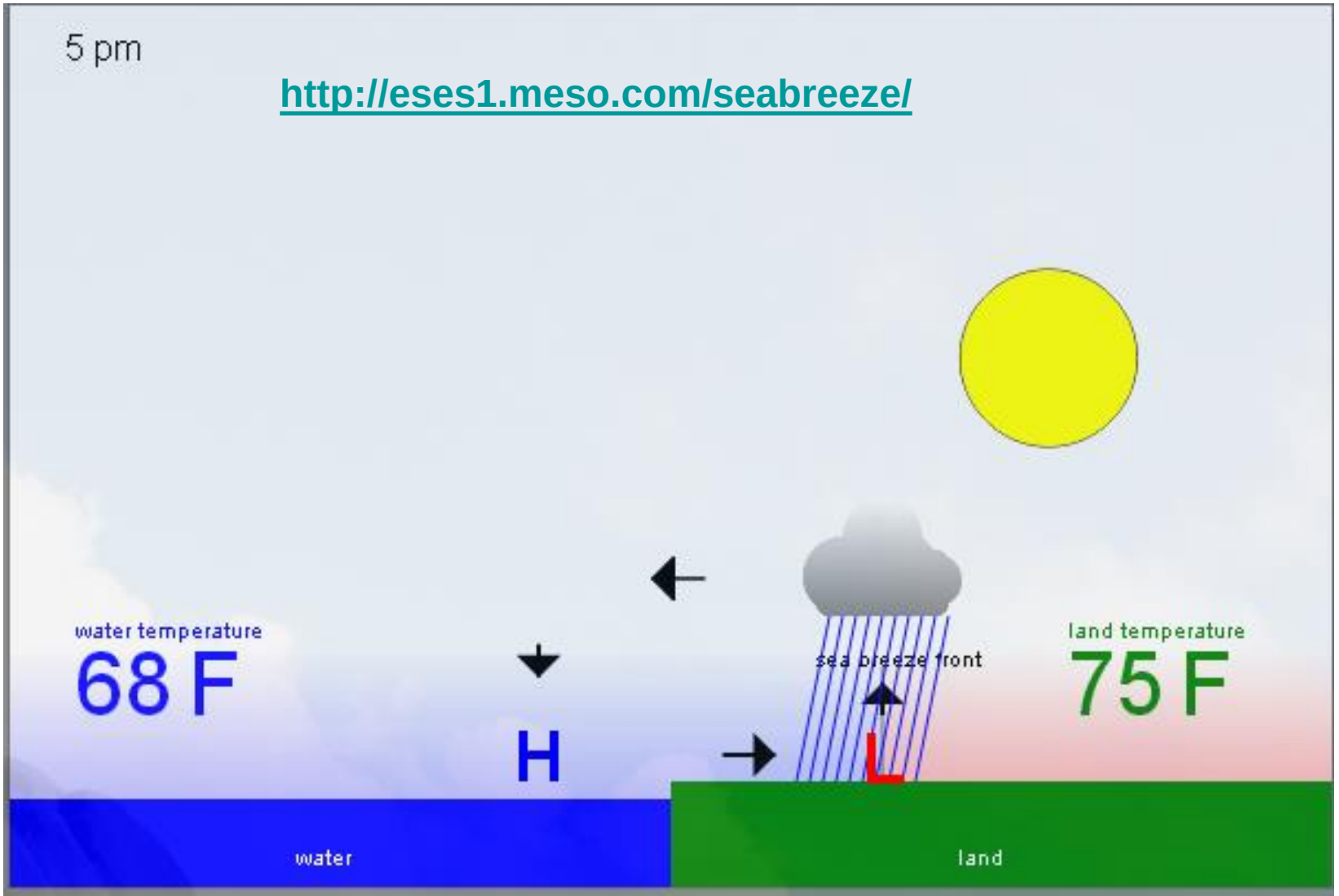


Direct thermal circulation caused by cold pocket aloft





Non Science Major Development
Thermal Circulation
Ex. Sea Breeze



http://eses1.meso.com/seabreeze/seabreeze-control.html

Sea Breeze Experiments

Experiment 1: Land and Water Temperatures

a. Make the initial LAND temperature cooler or warmer than the control run:

-10 F [0] +10 F **no change**

b. Make the initial WATER temperature cooler or warmer than the CONTROL run:

-10 F [0] +10 F **no change**

Would you expect these changes to result in a stronger or weaker sea breeze for this case?

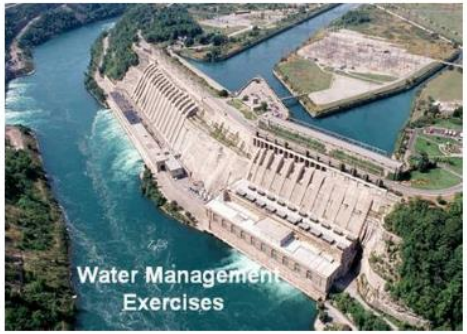
- stronger
- weaker
- not much change

Now submit your prediction and see how the sea breeze changes: Submit

SUNYIT IITG/ NSF SBIR - Development of an Interactive Case Study Capability

Glenn Van Knowe MESO Inc

Bringing reality into the classroom

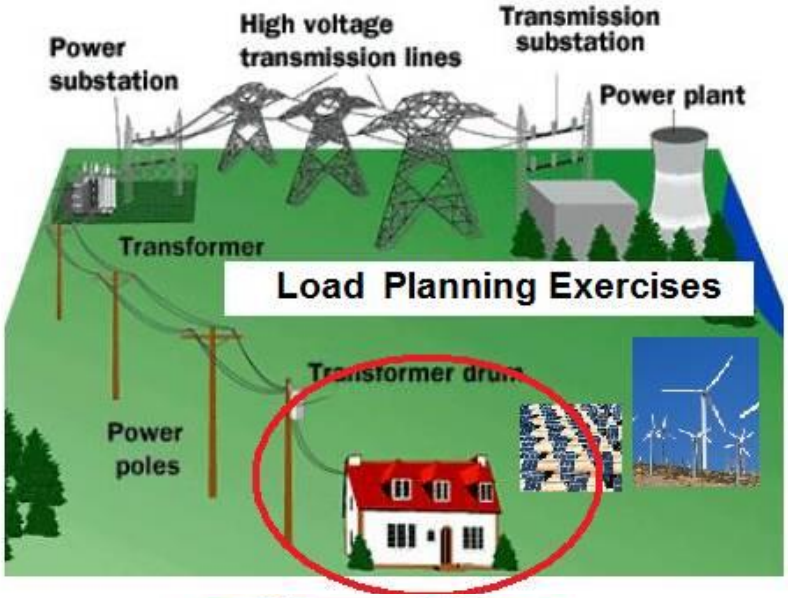


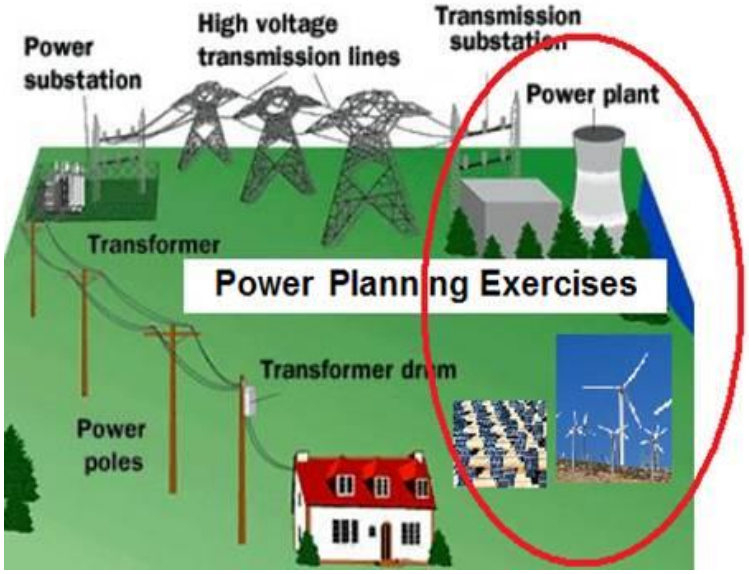
Trying to put learning in a real world context

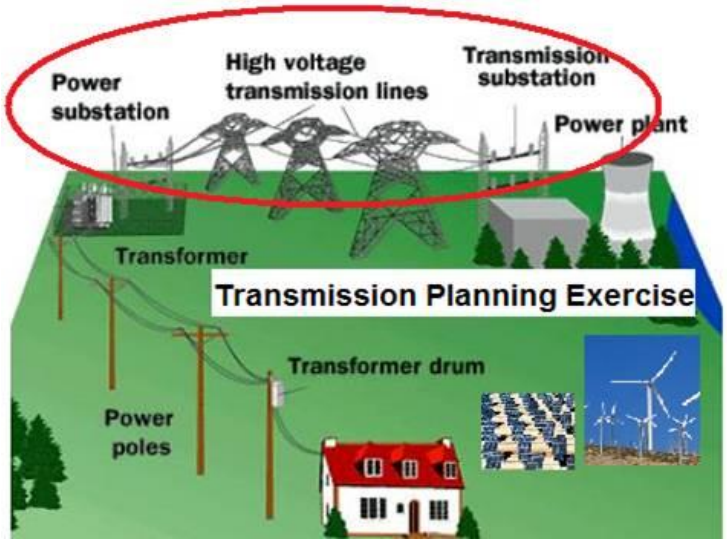
Need to start

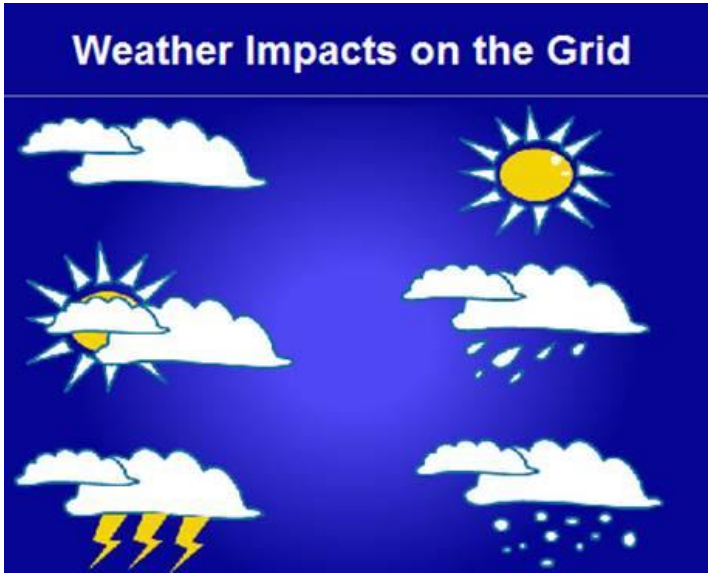
End 12:35 PM

Prep Modules for Grid Management Exercise









Home | About | Contact | Contest Info | For Teachers ▼ | Forecasting Sites

Grid Operator Case Study Exercise

About Case Studies Test Case Instructions

Design your city and power generation. Then be a grid operator for a day!
Avoid blackouts or damaged lines by calling up just the right amount of power.

Step 1: Enter a Name for Your Case or Community

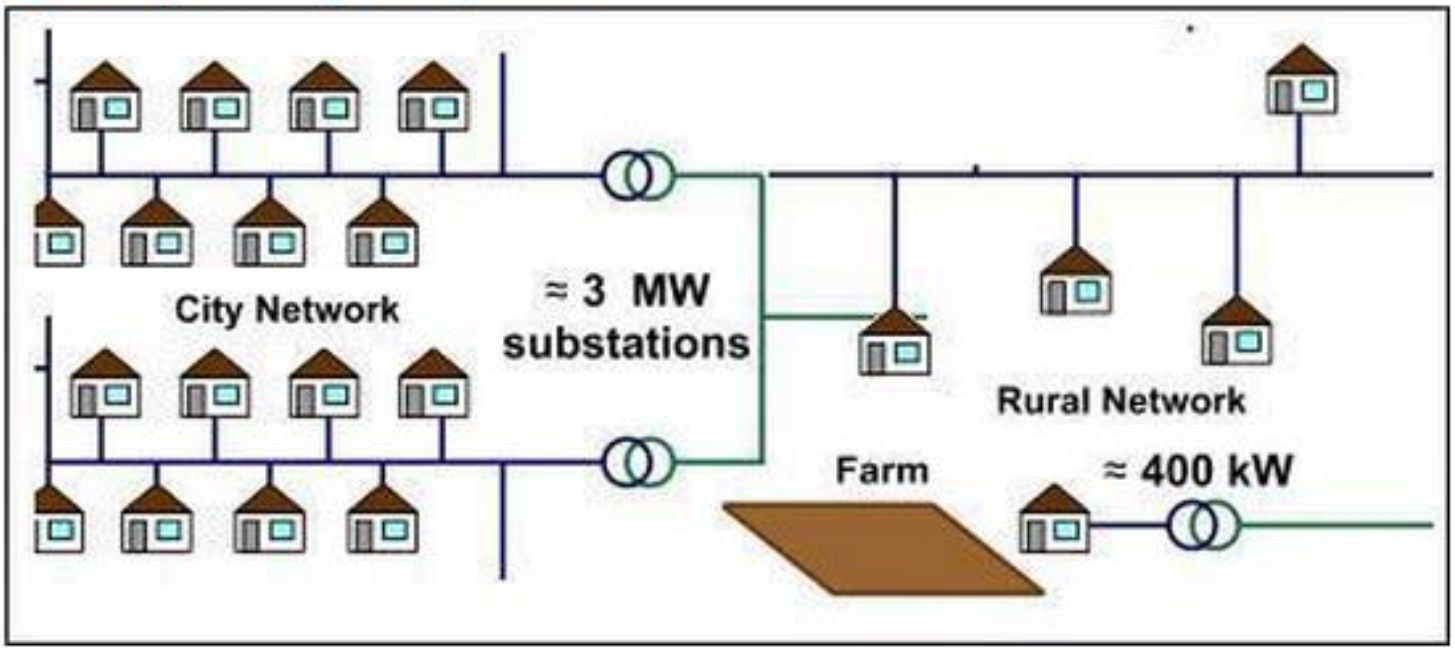
Name details

Step 2: Choose a Location for Your Case or Community

Albany, NY Location details

Step 3: Enter the Electrical Load of Your Community

Load planning background



Use **ONLY ONE** of these three options:

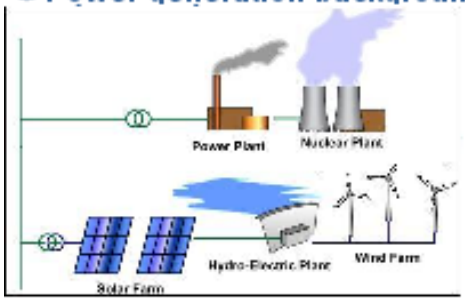
Choose a **type**: Choose a type of city

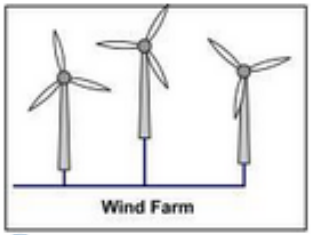
or an **actual** city: Choose an actual city

or enter a **base load** (MWh/day) directly: 1500

Step 4: Enter the Power Generation For Your Community

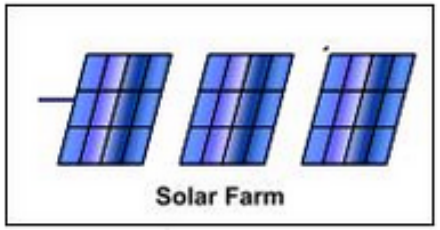
Power generation background





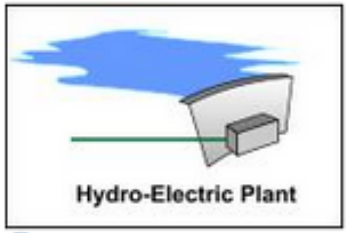
Select an option: No wind generation or enter a wind generation directly: 12 12

Wind Plant Details



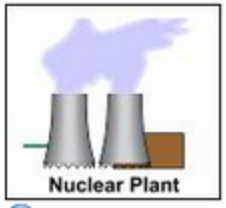
Select an option: No solar generation or enter a solar generation directly: 5 5

Solar Plant Details



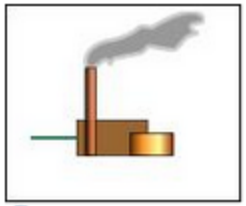
Select an option: No hydro generation or enter a hydro generation directly: 15 15

Hydro Plant Details



Select an option: --> No nuclear generation or enter a nuclear generation directly: 26 26

Nuclear Plant Details



Select an option: No conventional generation or enter a conventional generation directly: 80 80

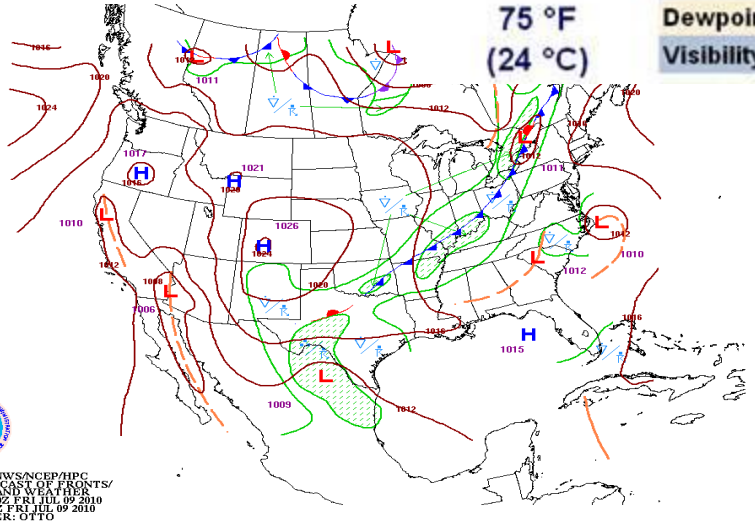
Power Plant Details

Select an option: No generation from other sources or enter generation from other sources directly: 1 1

Other Power Details

Weather Data & Maps

- http://www.hss-1.us/sunyit/solarcamp/cases/grid-op/wx-data-maps-grid-op-ex.htm



Step 5: Select a Case Study Date:

July 9, 2010 Date details

Step 6: Make a 24-Hour Weather Forecast for Your Case Study Date:

Weather forecasts are needed for both load planning and renewable power generation for your grid.
Your temperature forecasts are the most important factor in determining your load forecast.
Your wind, cloud and precipitation forecasts are the biggest factors in your renewable forecasts.

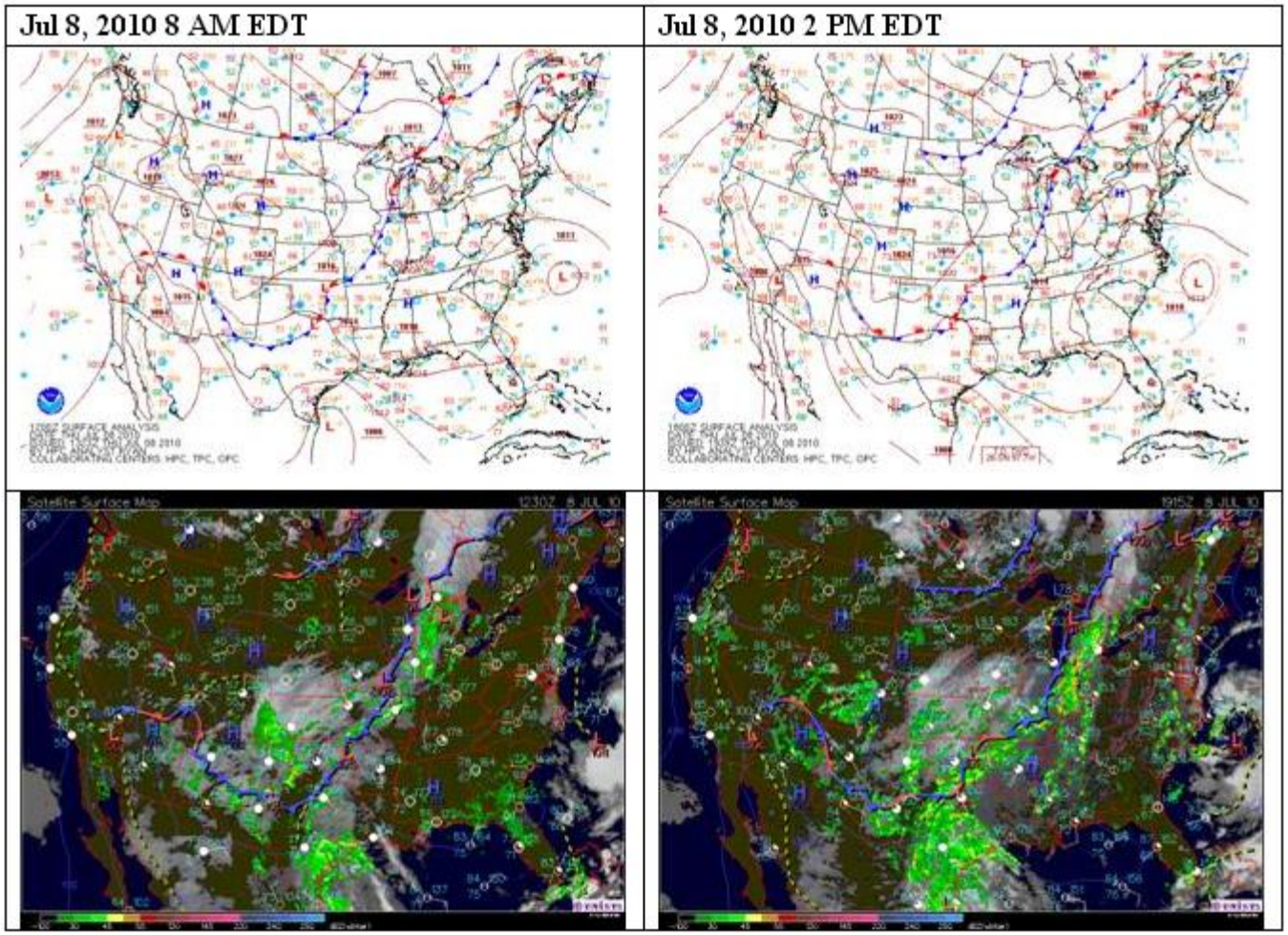
If you need help to know how to make a forecast, click on How to make a weather forecast
To view weather maps and data for the date you selected, click on a date link, such as July 9, 2010

How to make a weather forecast

Weather Data and Maps for Selected Dates:
July 9, 2010

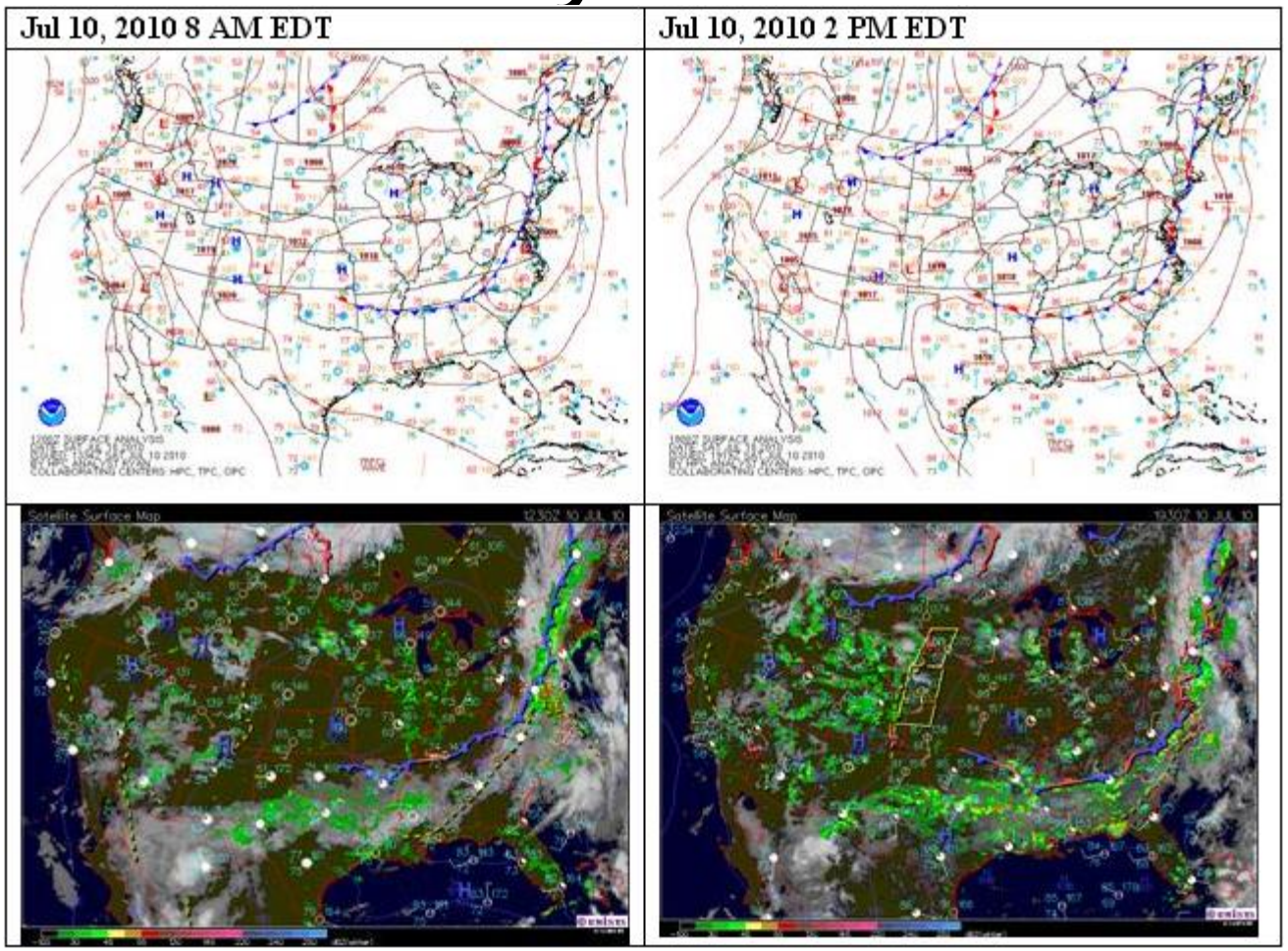
http://www.hss-1.us/fcst-cent/casestudies/grid-mang/info/weather-synop/8juy2010-uab.htm

Day before



http://www.hss-1.us/fcst-cent/casestudies/grid-mang/info/weather-synop/10juy2010-uab.htm

Day After



Step 7: Make and Enter a Weather Forecast for Your Case Study Date:

Entering forecast details

80 -100	Maximum temperature (F) (Range: -70 to 140, Example: 68)
65 - 80	Minimum temperature (F) (Range: -70 to 140, Example: 42)
5 -15	Mean wind speed (mph) (Range: 0 to 150, Example: 12)
30 - 80	Mean daytime cloud cover (%) (Range: 0 to 100, Example: 40)
0 1.00	Precipitation (inches) (Range: 0.00 to 20.00, Example: 0.25)

Initial Calculations

Example My weather forecasts

Step 7: Make and Enter a Weather Forecast for Your Case Study Date:

Entering forecast details

90	Maximum temperature (F) (Range: -70 to 140, Example: 68)
73	Minimum temperature (F) (Range: -70 to 140, Example: 42)
10	Mean wind speed (mph) (Range: 0 to 150, Example: 12)
50	Mean daytime cloud cover (%) (Range: 0 to 100, Example: 40)
.40	Precipitation (inches) (Range: 0.00 to 20.00, Example: 0.25)

Initial Calculations

Page 2

Grid Operator Exercise - continued

Base Load of Your City:

Base load: **1500** MWh/day
Modified forecasted load by student: **2037.5** MWh
Modified load details

Power Generation Capacities for Your City:

Wind Capacity: **12** MW
Solar Capacity: **5** MW
Hydro Capacity: **15** MW
Nuclear Capacity: **26** MW
Conventional Capacity: **80** MW
Other Generation Capacity: **1** MW
Total Capacity: **139** MW
Power generation details

Student-forecasted Energy Generation for 24-Hour Forecast Period:

Wind power: **72** MWh
Solar power: **30** MWh
Hydro power: **720** MWh

Nuclear power: **592.8** MWh
Power from other sources: **7.2** MWh
Student-forecasted energy generation details

Student-forecasted renewable power (wind + solar + hydro): **822** MWh
Student-forecasted predictable power (nuclear + other): **600** MWh
Student-forecasted non-conventional power (renewable + predictable): **1422** MWh

Modified forecasted load by student: **1975** MWh
Student-forecasted energy summary details

Enter Conventional Power Generation Needed:

Conventional power generation details

Conventional Capacity: **80** MW
24-hr Conventional Max Energy: **1536** MWh

625 Conventional power generation needed (MWh)

Final Calculations

Grid Operator Exercise - continued

Final Generation Analysis

Uh-oh! You have caused a blackout -- try again!

Weather Forecast Impact Analysis	Conventional Generation Analysis
Student total power forecast: Non-conventional power + conventional power called up: **2047** MWh Actual generation needed based upon observed: **1975** MWh Net total power forecast over or under actual power needed: **72** MWh **(want this to be as small as possible)**	Conventional generation called up by student: **625** MWh Conventional generation needed: **753.4** MWh Conventional power over or underproduced: **-128.4** MWh **(want this to be the lowest positive value)**

Details of Results

See further details below of the results of your weather and power forecasts.

Meteorological/Environmental Variables

Select one of the following to see how your forecast compared to the actual weather for the day:

Temperature

Wind

Cloud

Precip

Insolation

Load-Related (Generation Needed)

Load details

24-hr student load forecast: **2037.5** MWh
24-hr observed (actual) load: **1975** MWh

Power Forecasts

Power forecast details

Wind Generation

Student forecast wind power: **72** MWh
Observed (actual) wind power: **57.6** MWh

Temperature-related
Student max temperature: **90** F
Observed max temperature: **88** F
Student min temperature: **73** F
Observed min temperature: **70** F
Student average temperature: **81.5** F
Observed average temperature: **79** F
Student temperature load mod factor: **3.0375**
Observed temperature load mod factor: **2.975**

Wind-related
Student mean wind speed: **10** mph
Observed mean wind speed: **8** mph
Student wind power factor: **0.25**
Observed wind power factor: **0.2**

Final Generation Analysis

Yay! You have successfully met the needs of your city, and everybody has electricity!
But keep in mind that for every megawatt hour that you go over the needed amount, the electric bill goes up.
To see if you can get closer to zero, try again.

Weather Forecast Impact Analysis	Conventional Generation Analysis
Student total power forecast: Non-conventional power + conventional power called up: **2192** MWh Actual generation needed based upon observed: **1975** MWh Net total power forecast over or under actual power needed: **217** MWh **(want this to be as small as possible)**	Conventional generation called up by student: **770** MWh Conventional generation needed: **753.4** MWh Conventional power over or underproduced: **16.6** MWh **(want this to be the lowest positive value)**

Thank you for participating

vanknog@sunyit.edu

ESES/ICS Education Evaluation Home

UNIVERSITY AT ALBANY State University of New York	ENV 250 (GEO 250) Sustainable Dev: Energy and Resources	Dr Keesee
Millersville University SEIZE THE OPPORTUNITY	ESCI 245 - Environmental Science	Dr Yalda
Saint Louis University	Intro Class	Ms Cato
SUNY The State University of New York	CIT Workshop 5/22 8:30 - 945 AM	Dr Van Knowe

Dr Keesee's ESES/ICS Education Evaluation Home

Lesson Plan PPT	Lesson Plan PDF		
Answer Sheet Doc	Gen ICS Instructions	Exercise Instructions	Grid Mang Exercise
			drvanknowe@gmail.com

Go to and review answer sheet, instructions then the Grid Operator exercise

Answer Sheet Doc	Gen ICS Instructions	Exercise Instructions	Grid Mang Exercise

Case Instructions

For Dr Keessee's ENV (GEO) 250
- Environmental Science Course.

Text Case Instructions

General Instructions		**ESCI 245** Exercise
Read First		Complete this Exercise

Student Entry Example

Grid Operator Exercise

User login

Username: *

Password: *

Log in

- Request new password

Information Already Calculated

Base load: **920** MW
Wind Farm Max Capacity: **150** MW
Hydro Max Capacity: **50** MW
Solar Max Capacity: **10** MW
Max Irradiance: **610** ly/day

Be sure to look at the weather analysis material.

Step 1: Weather Forecast Entries (Forecasts)

	Maximum temperature (F)
	Minimum temperature (F)
	Mean wind speed (mph)
	Mean daytime cloud cover fraction
	Precipitation (inches)

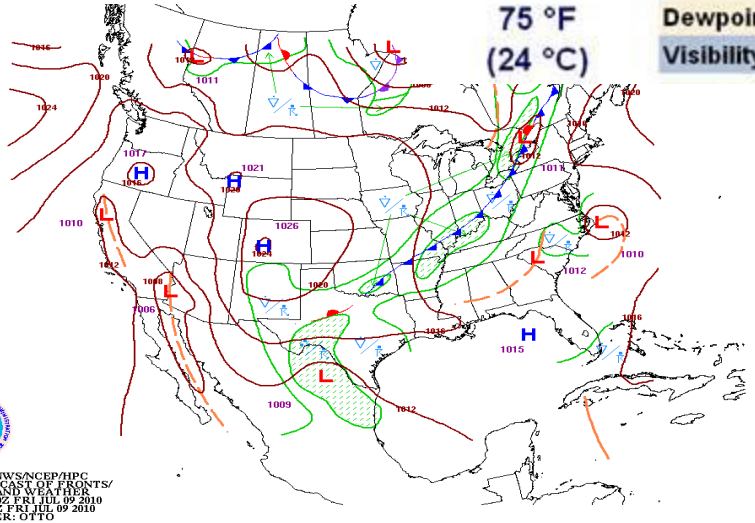
Initial Calculations

Energy Load Calculations Manual

Energy Production Calculations Manual

Weather Data & Maps

- http://www.hss-1.us/sunyit/solarcamp/cases/grid-op/wx-data-maps-grid-op-ex.htm



CIT Web Links

ICS Home	ESES Home	Hurricane Demo	Oil Spill Demo
Geopod Demo (WMV)	Sea Breeze Start	See Breeze Model	Grid Mang Exercise
All Wx Maps	CIT Wx Maps		drvanknowe@gmail.com

Answer Sheet Doc	Gen ICS Instructions	Exercise Instructions	Grid Mang Exercise