Renewable Energy and NOAA

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NOAA/Earth Systems Research Laboratory

The Twin Crises of our Times

Global Warming and Energy Sustainability

Solution: non-fossil fuel sources of energy, of which renewable energy will be the major component.

Can NOAA meaningfully contribute to the solutions to these two problems by helping grow renewable energy?

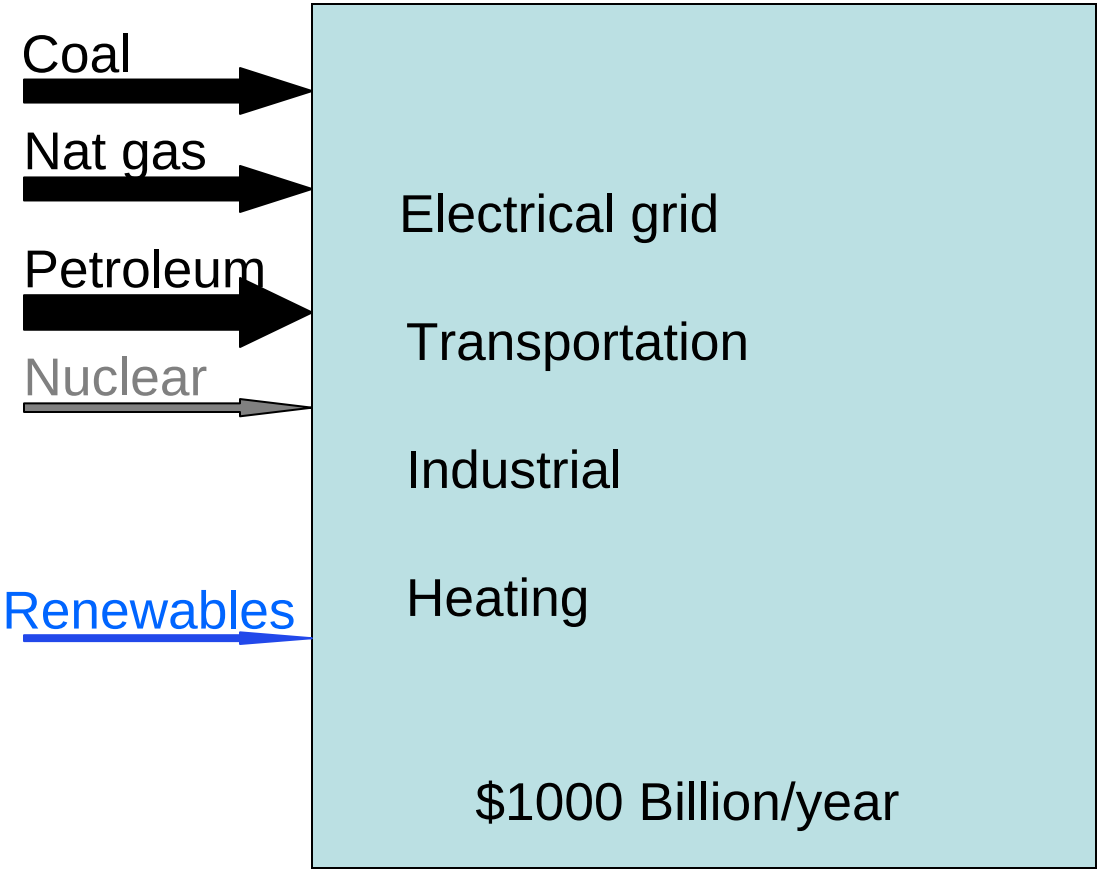
NOAA Scientist?

NREL Scientist?

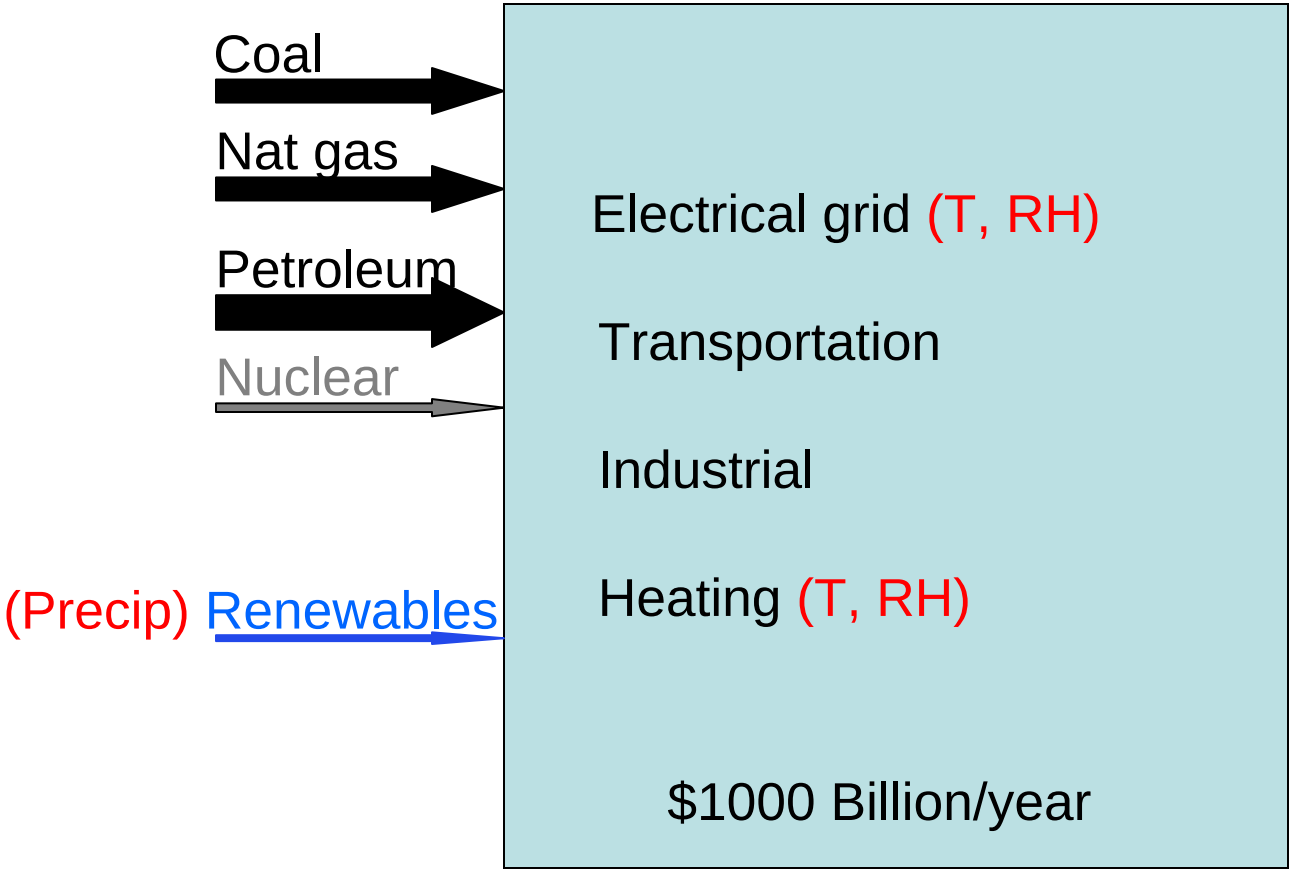
Outline

- What are the connections between NOAA and renewable energy?
- Specific wind energy example of energy/dollar/carbon savings from better wind forecasts.
- Highlight NOAA's expertise as it applies to renewable energy

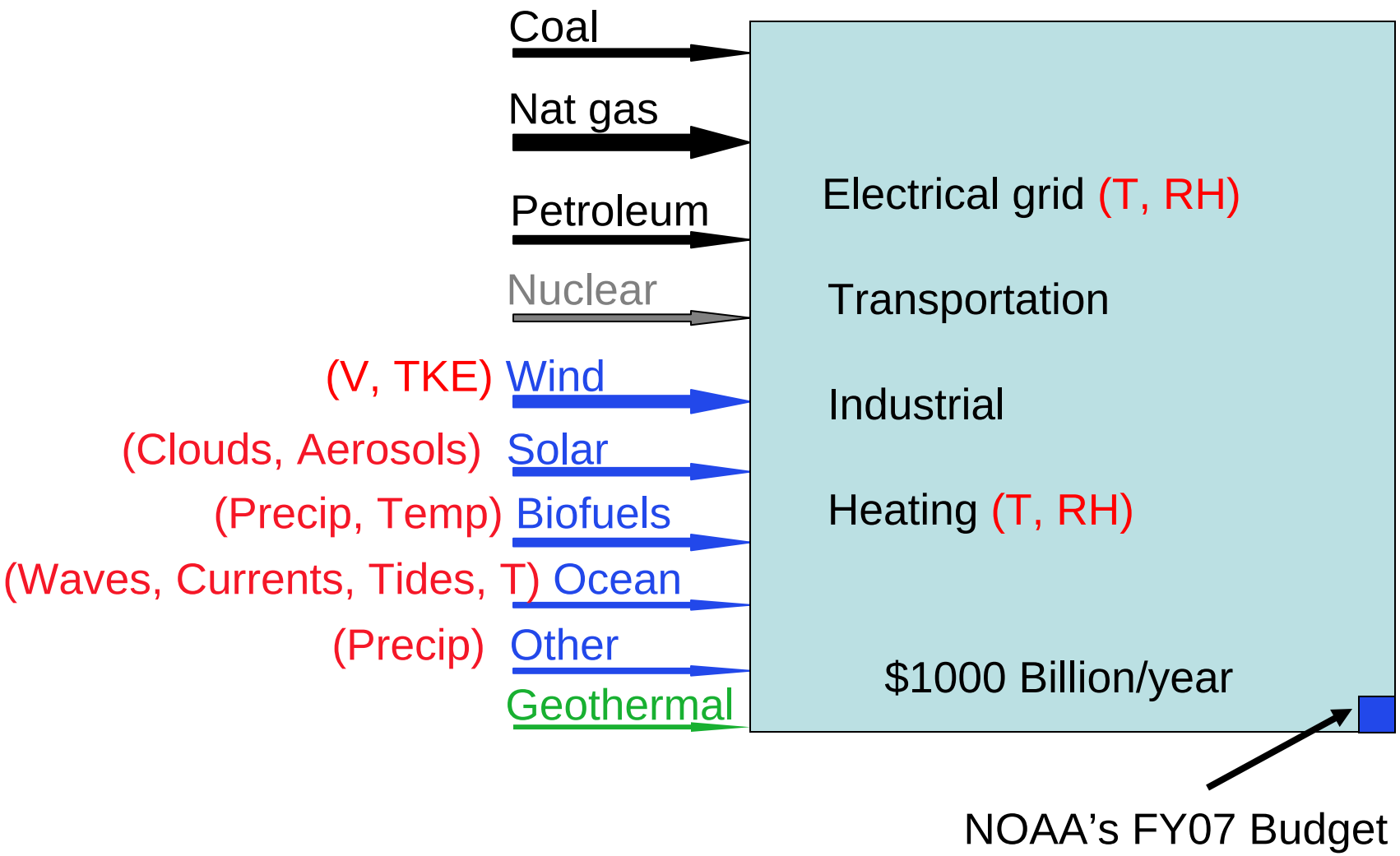
2007 US Energy Flows



2007 US Energy Flows



2030 US Energy Flows?



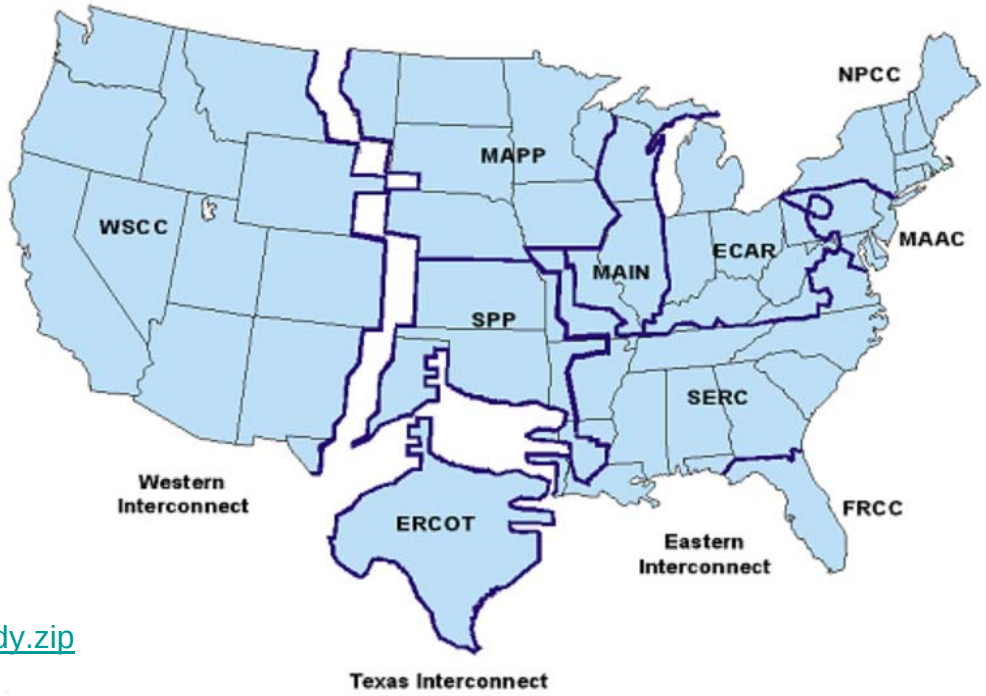
Can one quantify the energy/dollar/carbon savings from better atmospheric and oceanic information?

Let’s take a detailed look at one small part of the pie …

Impacts of Wind Forecasts on Electricity Generation

Can one estimate the energy/dollar/carbon value to the wind energy sector of improving wind forecasts nationwide?

- GE Study for the ERCOT (2008)[1]
- GE Analysis "Impact of Wind Forecasting", Gary Jordan, Utility Integration Group presentation, October, 2008



[1]"Analysis of Wind Generation Impact on ERCOT Ancillary Services Requirements" (March, 2008) Available: http://www.ercot.com/news/presentations/2008/Wind_Generation_Impact_on_Ancillary_Services_-_GE_Study.zip

- Assume 5K MW (current), 10K, and 15K of wind energy produced in Texas. At 15K MW, wind would produce ~17% of Texas annual electrical need.

- Use a meteorological model to simulate “actual winds” over a one year period.

- Statistically degrade the simulated “day-ahead” winds (18 to 42 h) to replicate the skill of a State-of-the-Art (SOA) meteorological model.

  - Use an energy production model (plant unit types, operating efficiencies, time-ramping characteristics, emissions) to calculate hour-by-hour electricity generation and cost.

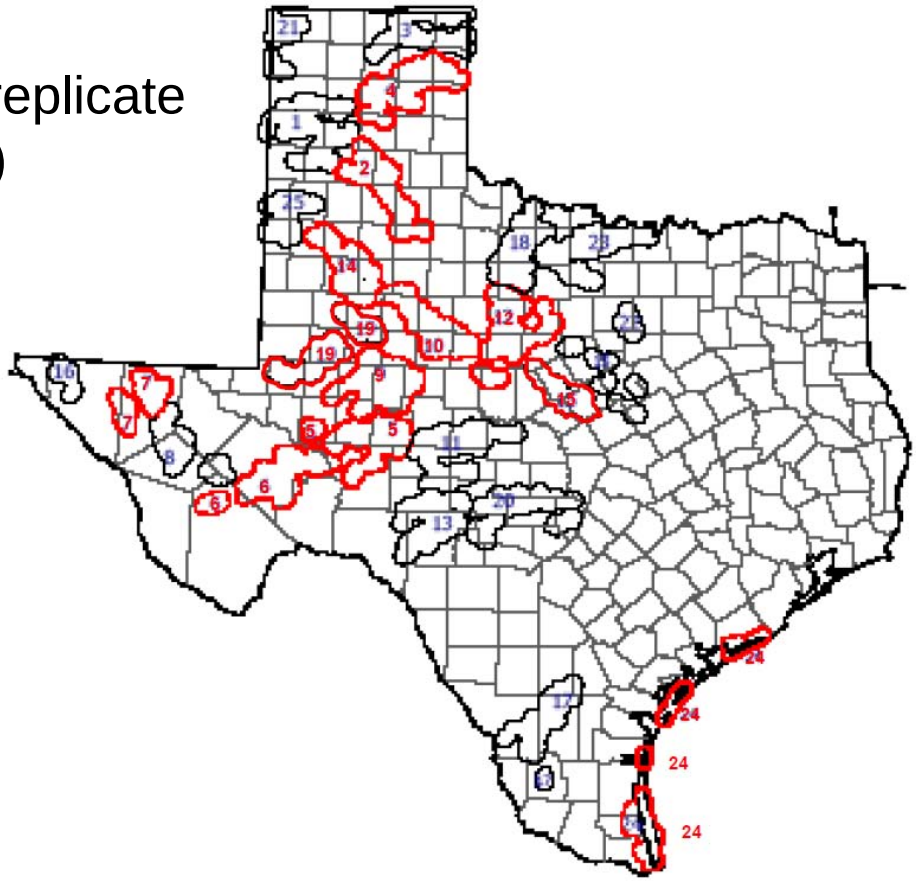
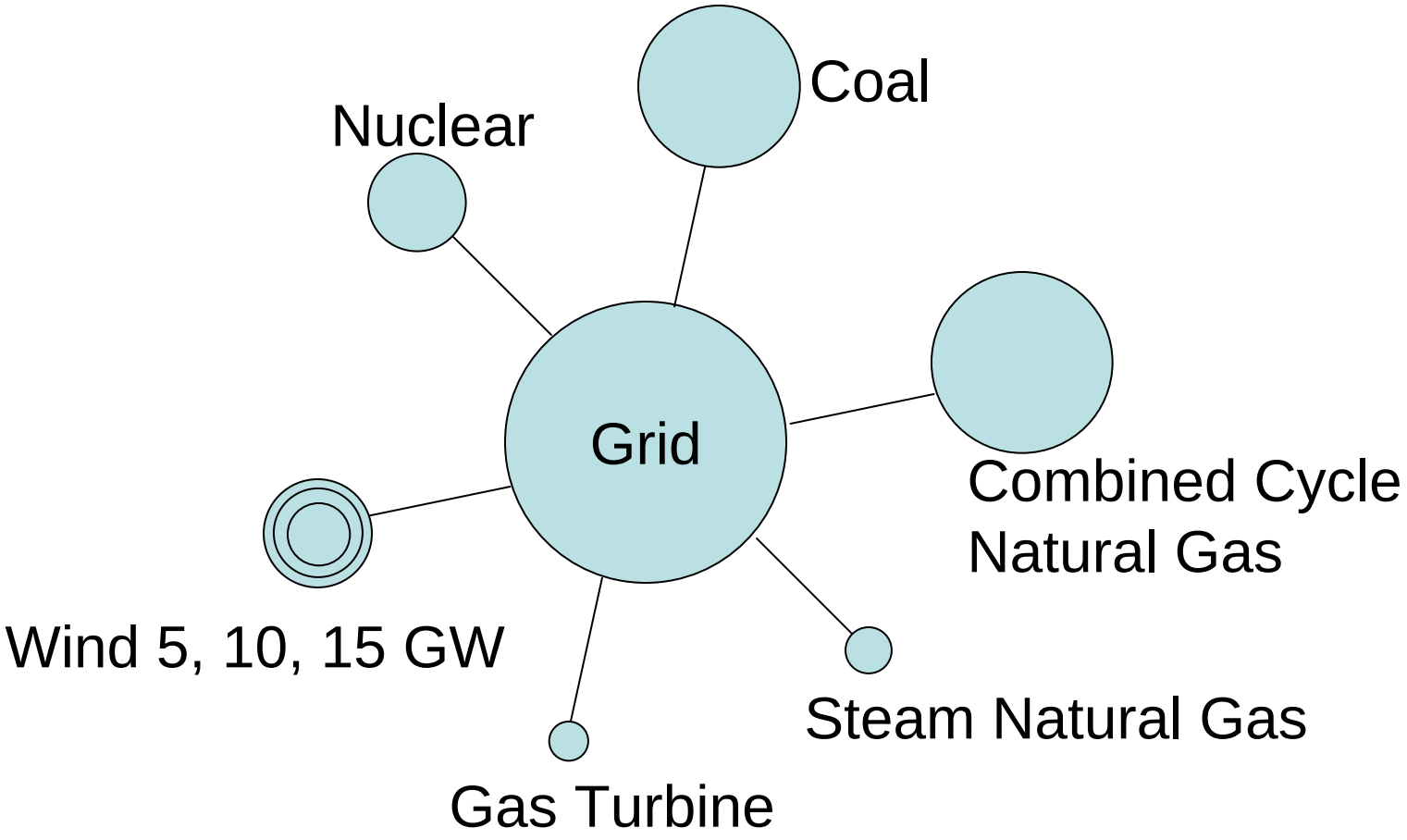


Figure 2-1 - CREZ map, zones included in the study are shown in red.

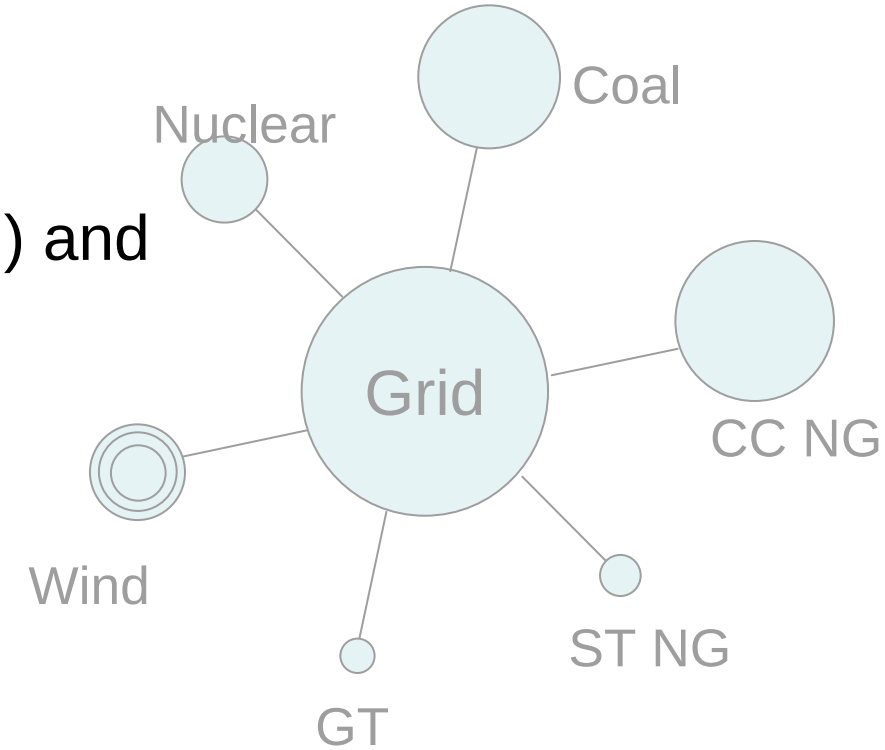
GE ERCOT Study

ERCOT (Texas) Electricity Production



Issues

Grid operators keep demand (load) and generation closely balanced

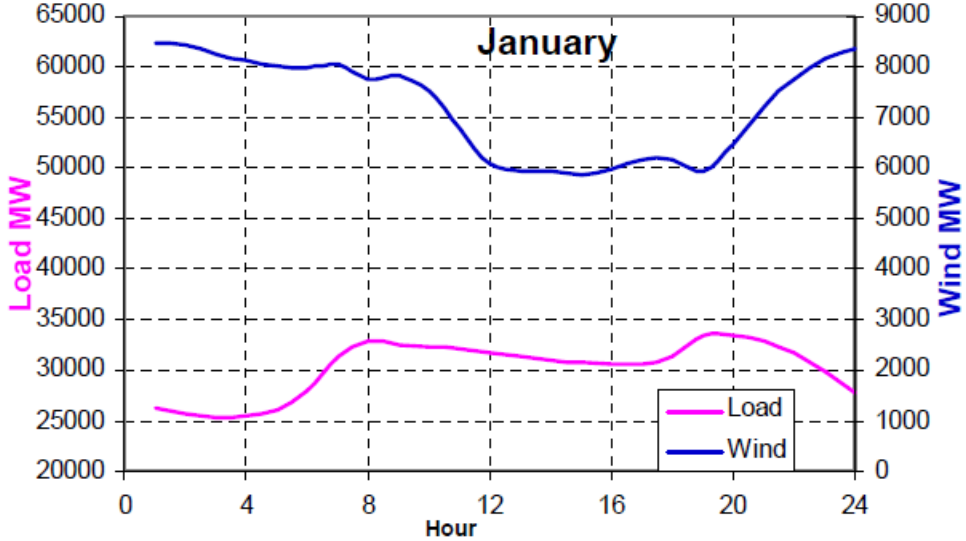


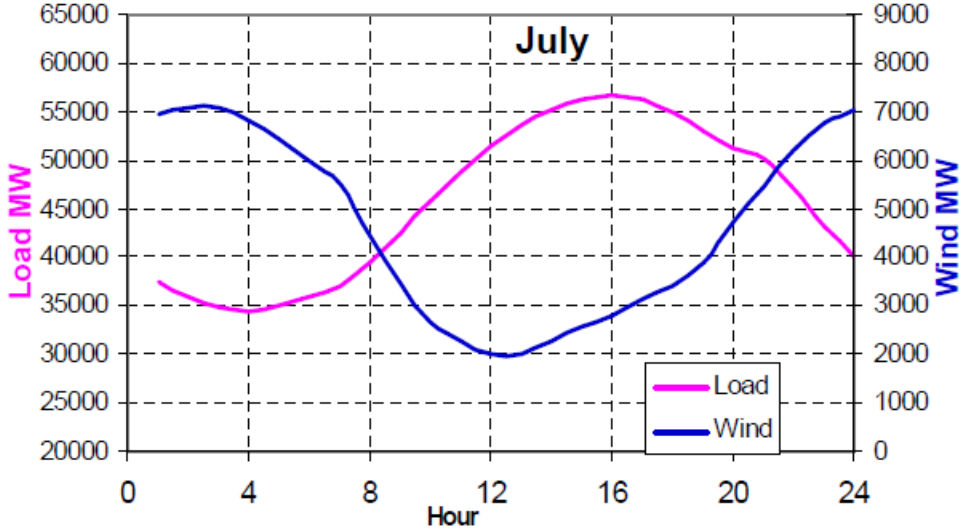
Balancing is done by 1) reducing output levels from plants, or
2) shutting off plants

Plants operating at reduced capacity are less efficient (~30 % lower efficiency for CC, 15 % for coal)

Because of start-up costs, don’t want to turn off plants for short periods of time:
Nuclear weeks, Coal and Steam Gas 24 h, CC 8 h, GT minutes.

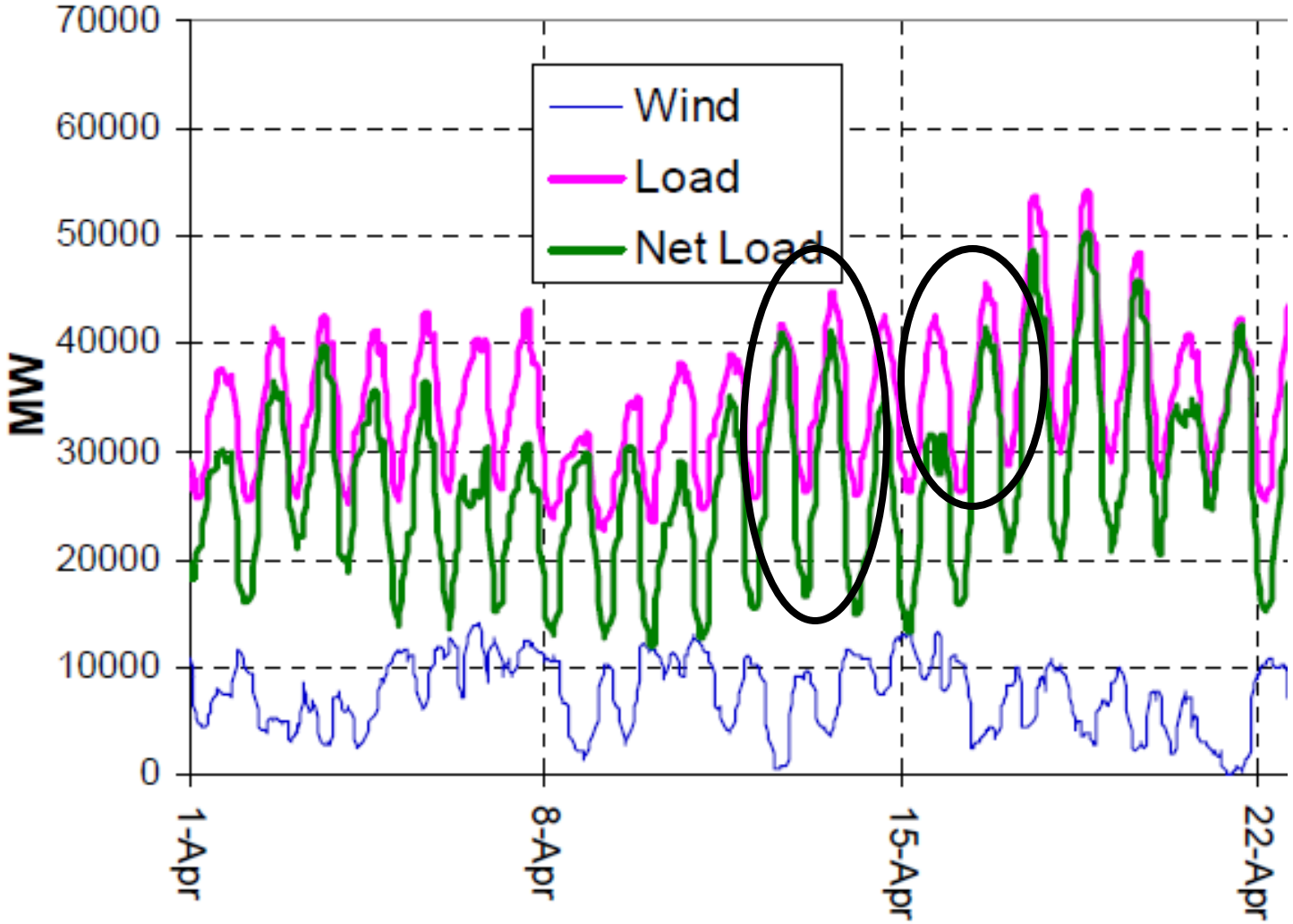
GE ERCOT Study



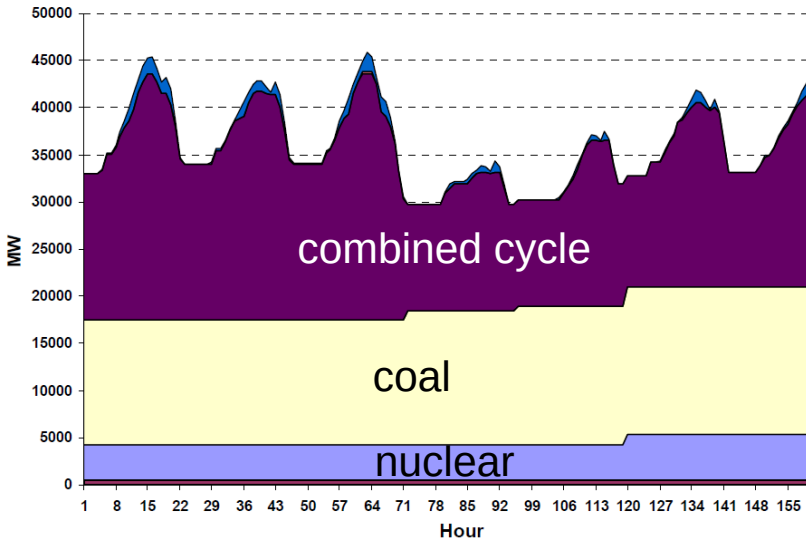


Average diurnal cycle of (winter and summer) load demand and wind energy production

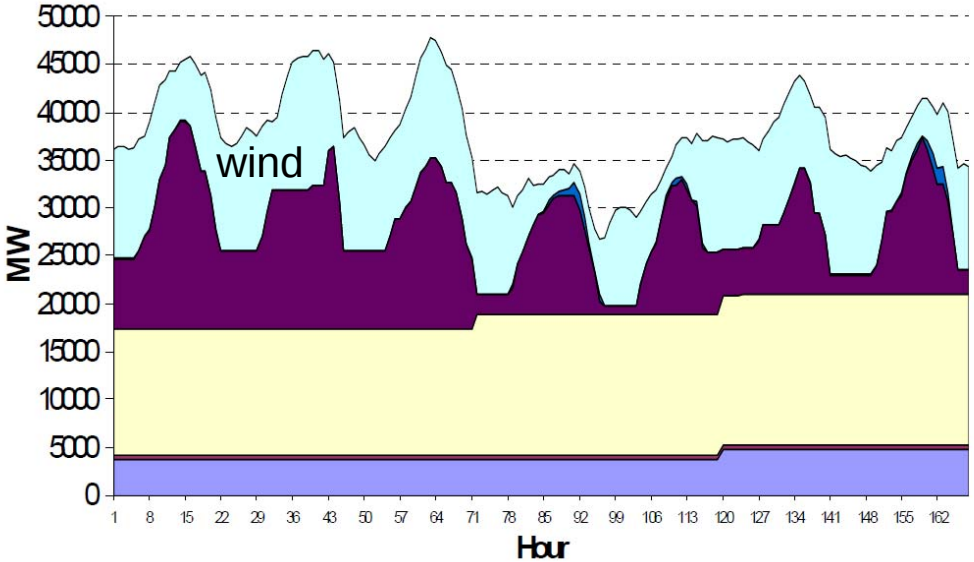
GE ERCOT Study



- Wind increases diurnal range of net load (load – wind)
- Wind increases variation of daily max net load

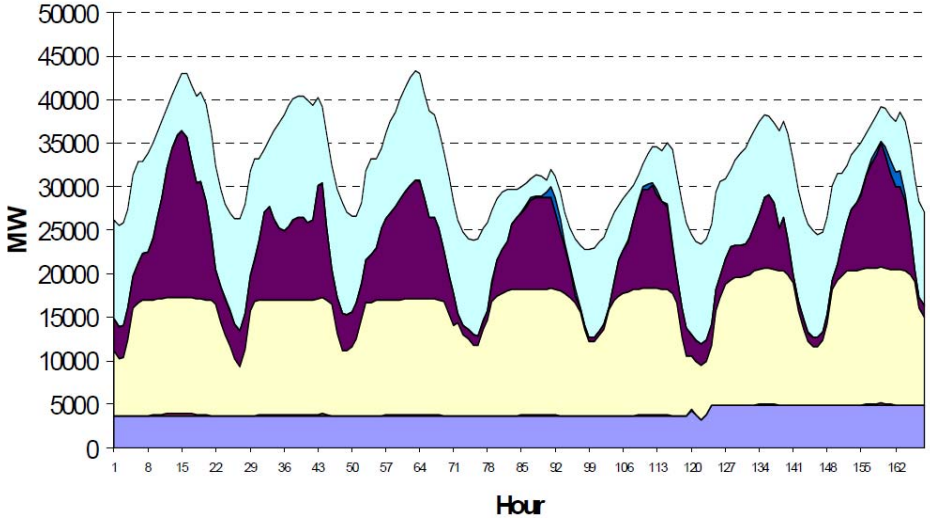


Day-ahead units committed,
No wind forecast



Day-ahead units committed,
with SOA wind forecast

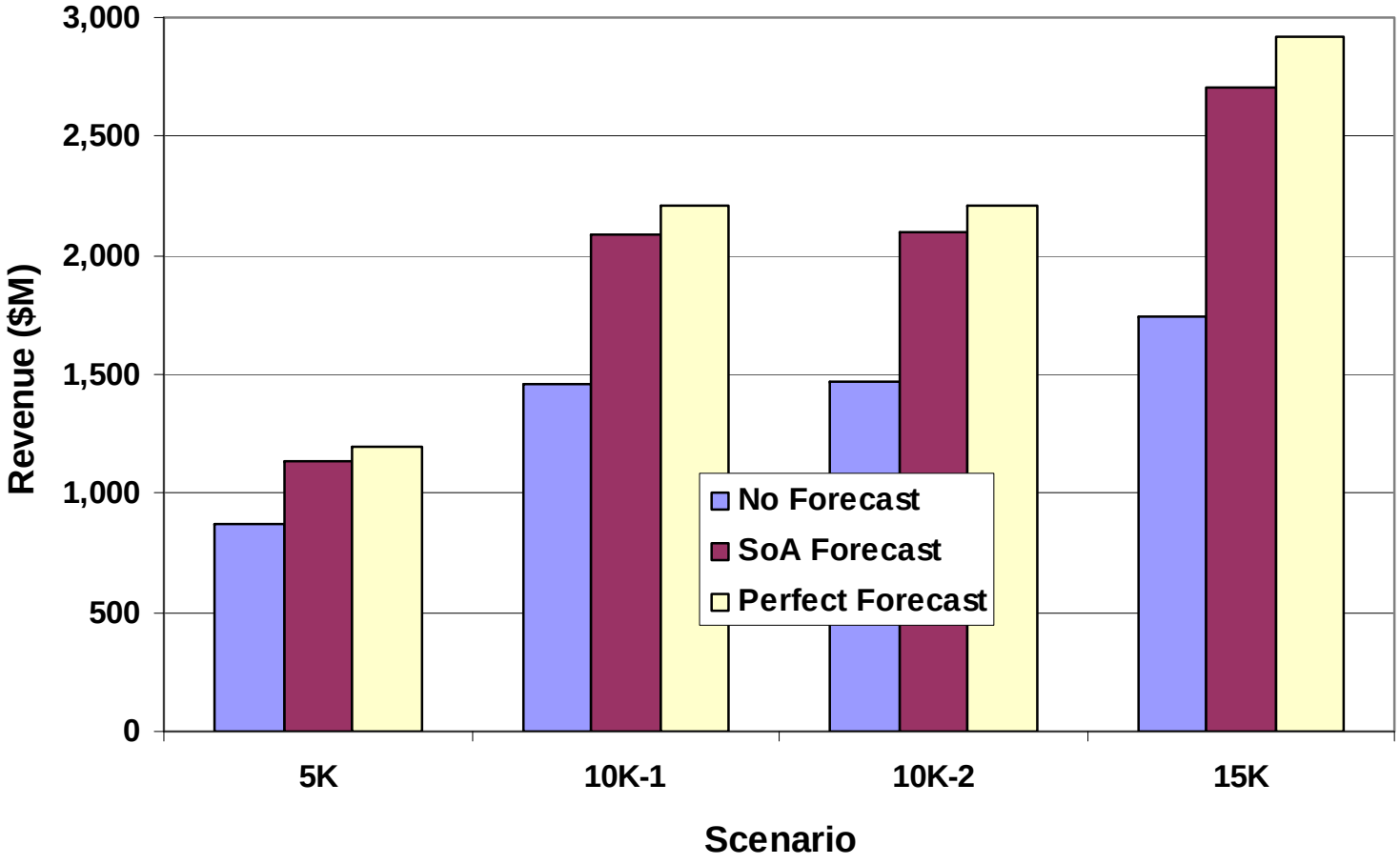
Peak wind week of year



Energy produced, with SOA wind forecast

GE ERCOT Study

Wind Generation Revenue ($M)

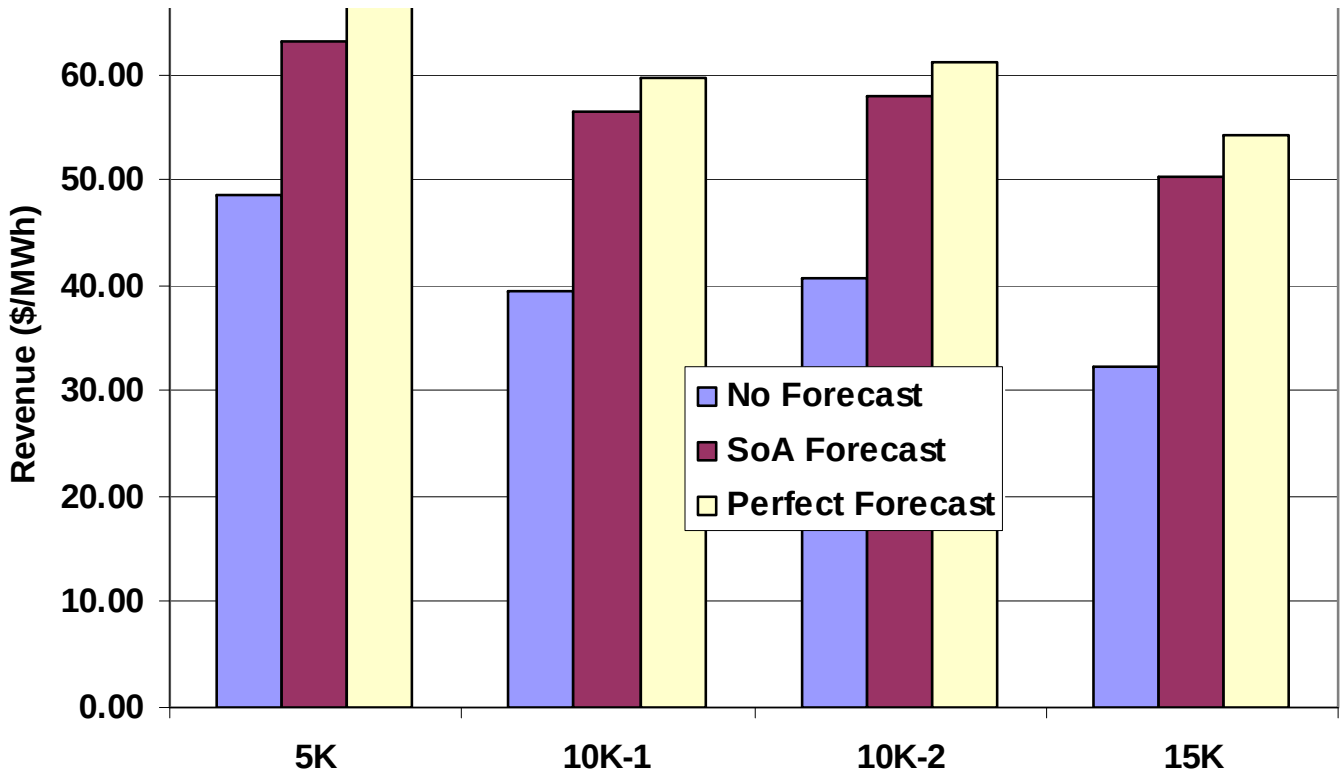


Gary Jordan, GE ERCOT Study

Gary Jordan, GE ERCOT Study

Impact of Forecasting on Wind Generation

Revenue ($/MWh of wind energy)



<u>Extrapolating GE ERCOT results to 20% US electricity production by wind in 2030:</u>

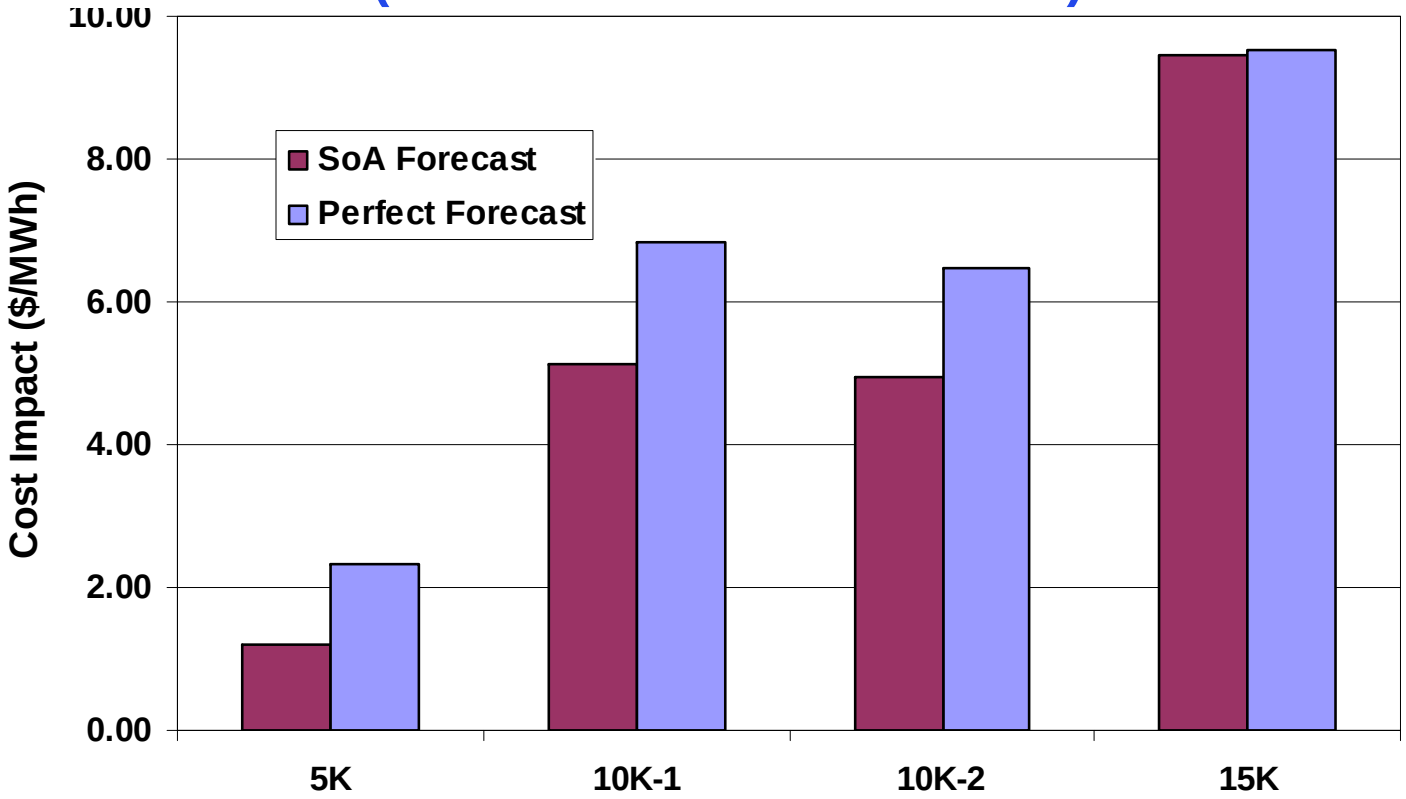
Value of SOA forecast: ~$16/MWh x 800 TWh = $13 B/year

Value of improving from SOA to perfect forecast: ~$2.4 B/year

Gary Jordan, GE ERCOT Study

Impact of Wind Forecasting on Fuel and Plant Costs

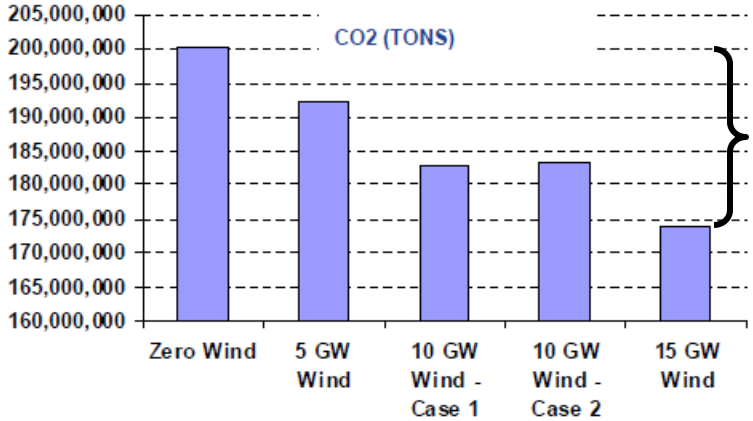
($/MWh of Wind Generation)



<u>Extrapolating GE ERCOT results to 20% US electricity production by wind in 2030:</u>

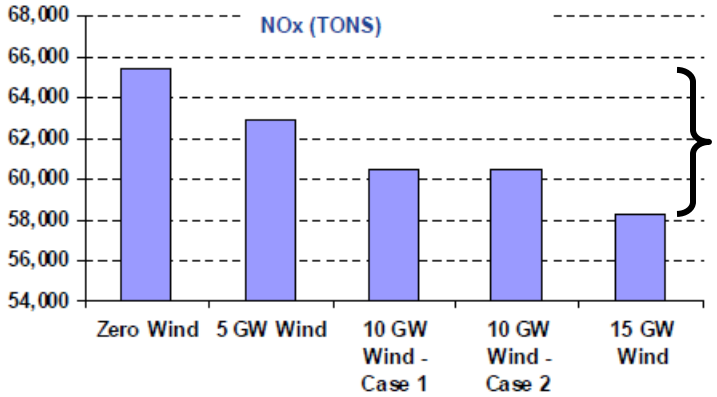
Value of SOA forecast: ~$5/MWh x 800 TWh = $4 B/year

Value of improving from SOA to perfect forecast: ~$800 M/year

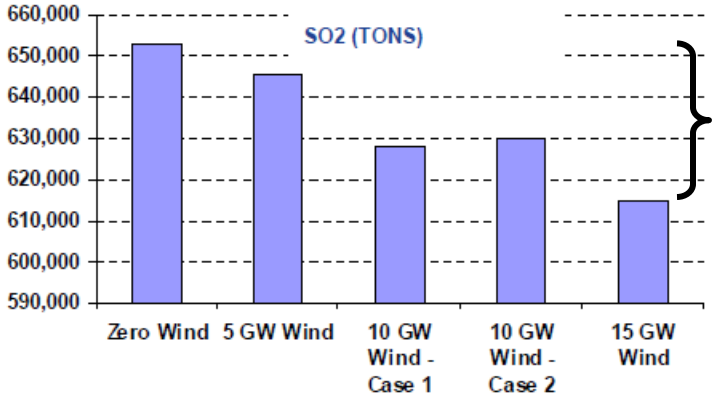


13% CO_2 reduction

Reductions in CO_2 and key pollutants with SOA wind forecasts.



11% NOx reduction

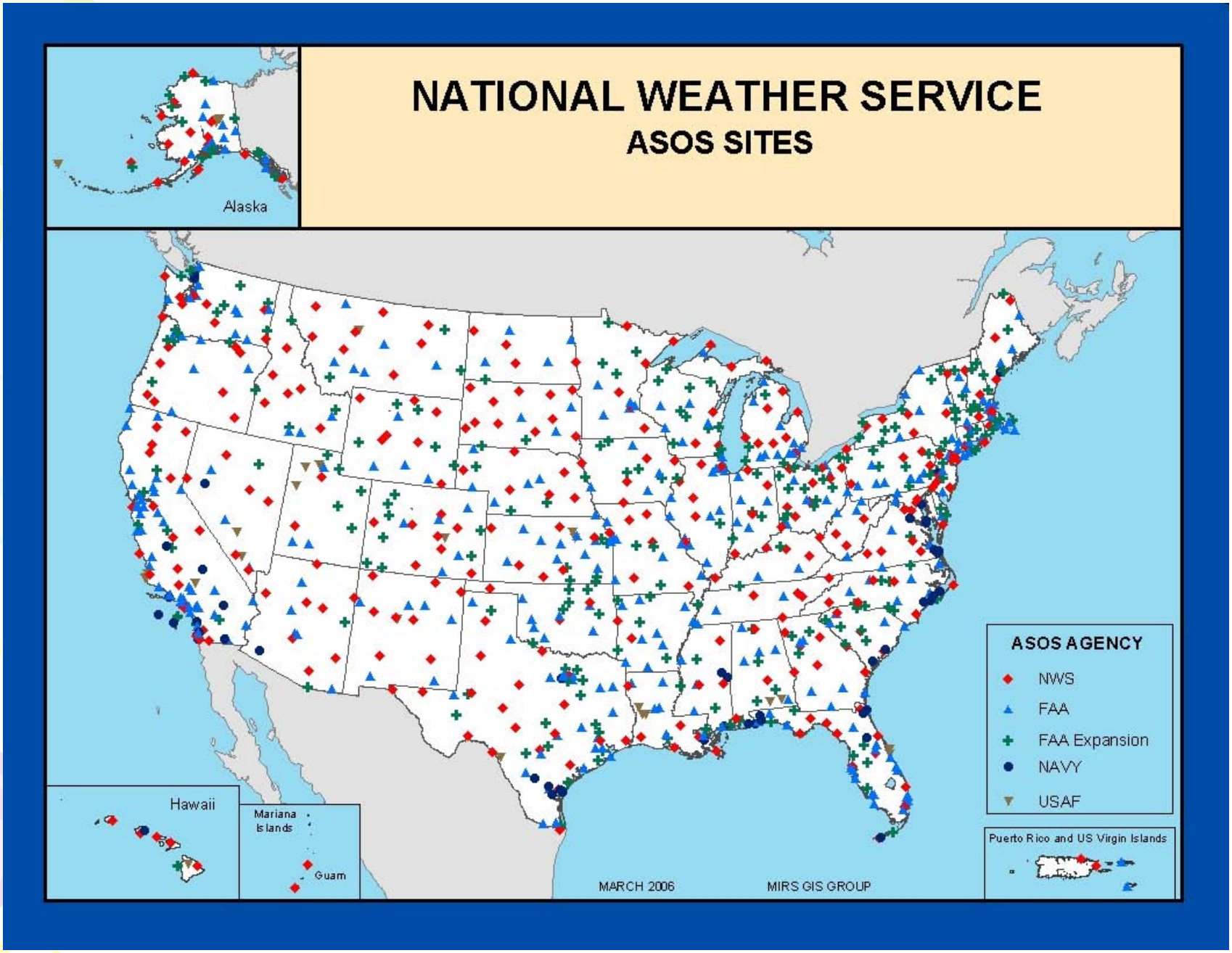


6% SO_2 reduction

Gary Jordan, GE ERCOT Study

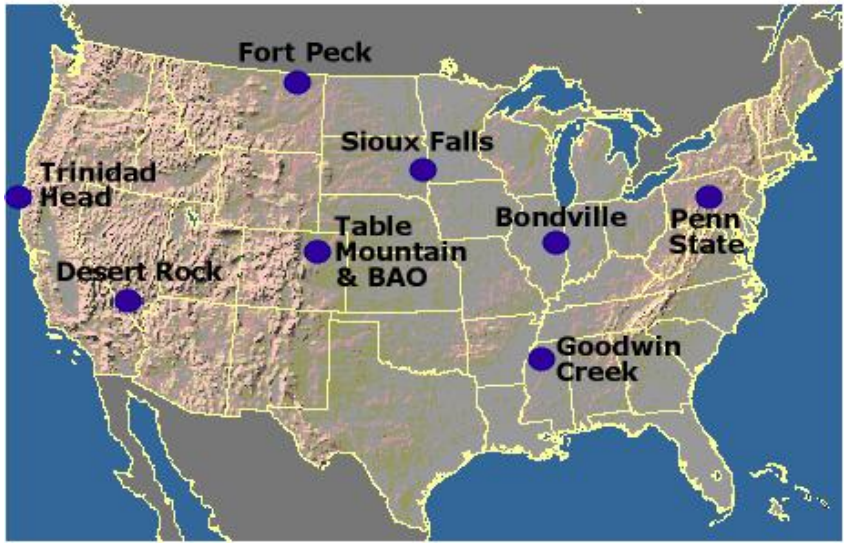
GE Texas Study Summary

- With good wind forecasts, wind can be integrated into the (Texas) grid, despite it's inherent difficulty
- Using good wind forecasts saves energy/dollars/carbon
- The dollar savings are enormous, even for this small piece of the renewable energy pie

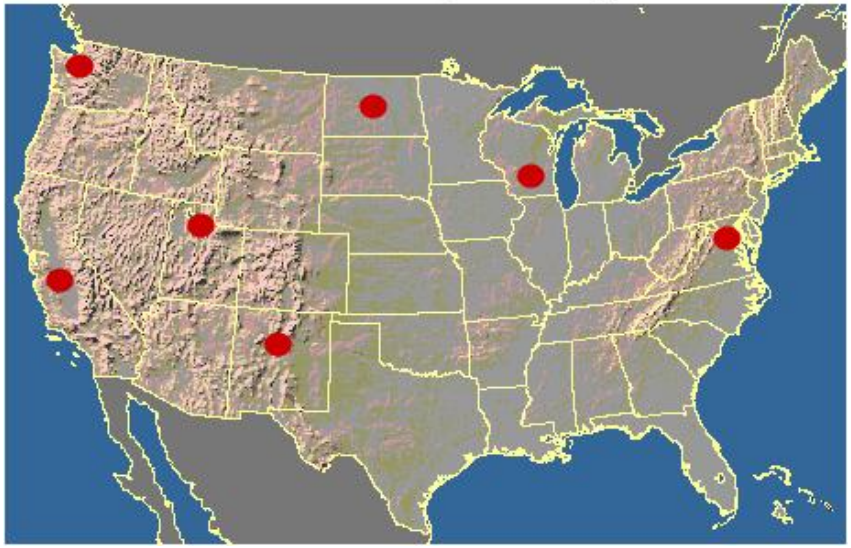

NATIONAL WEATHER SERVICE
ASOS SITES
Alaska
Hawaii
Mariana Islands
Guam
ASOS AGENCY
NWS
FAA
FAA Expansion
NAVY
USAF
Puerto Rico and US Virgin Islands
MARCH 2006
MIRS GIS GROUP

Current and Proposed NOAA Surface Solar Radiation Networks with Direct Beam

Current funded U.S. GMD surface radiation stations

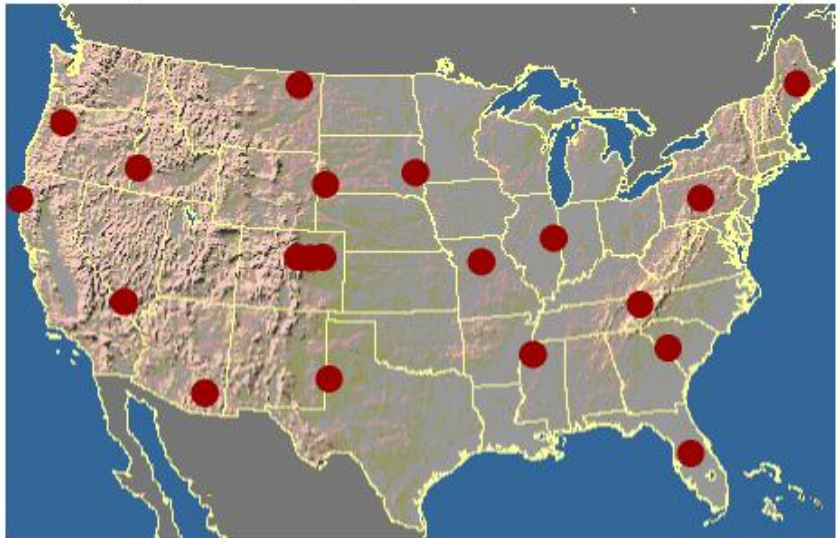


Current ISIS Network (solar only, unfunded)

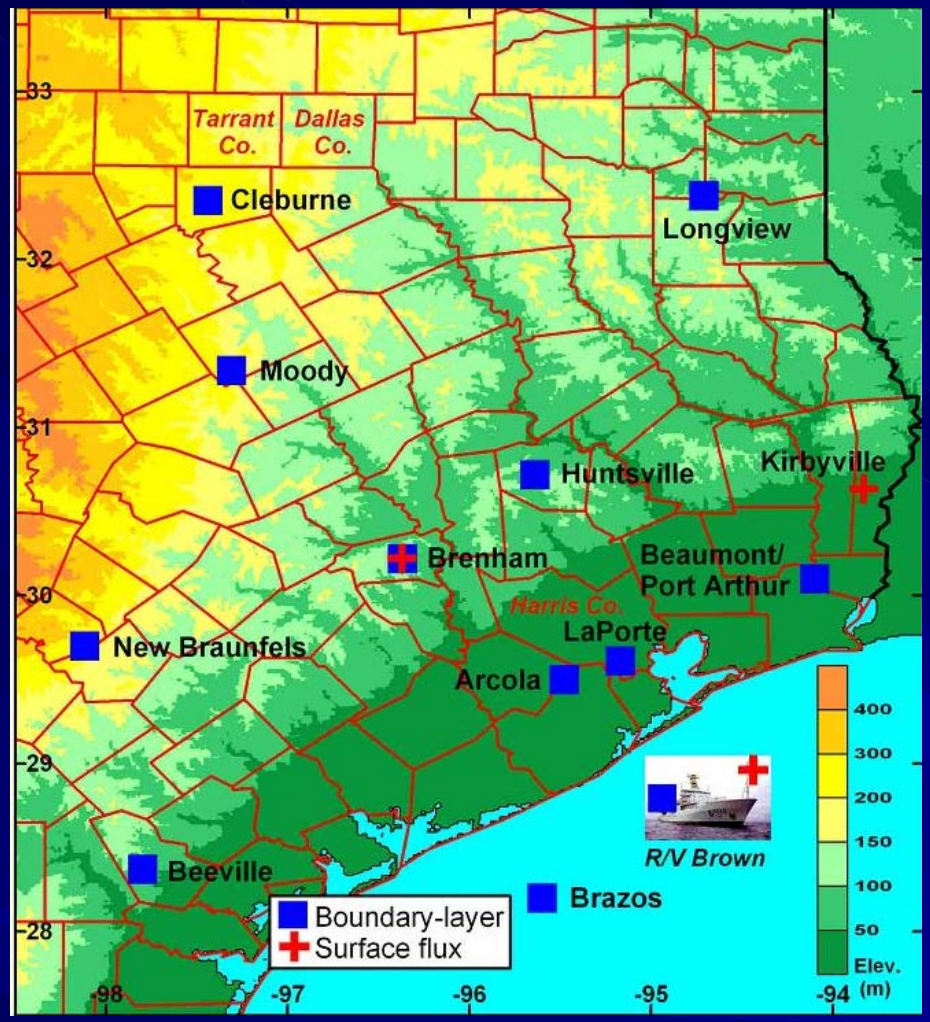


Proposed: SEBN (Surface Energy Budget Network), intended primarily for climate research applications. (CONUS portion only depicted)

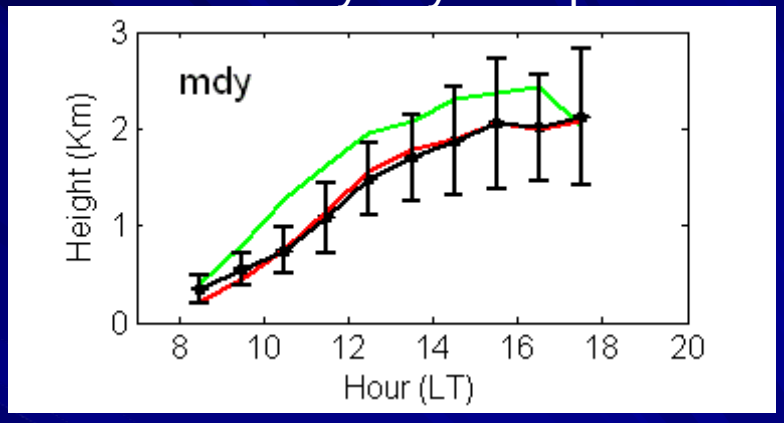
If resurrected, ISIS sites could be included. Some re-siting possible.

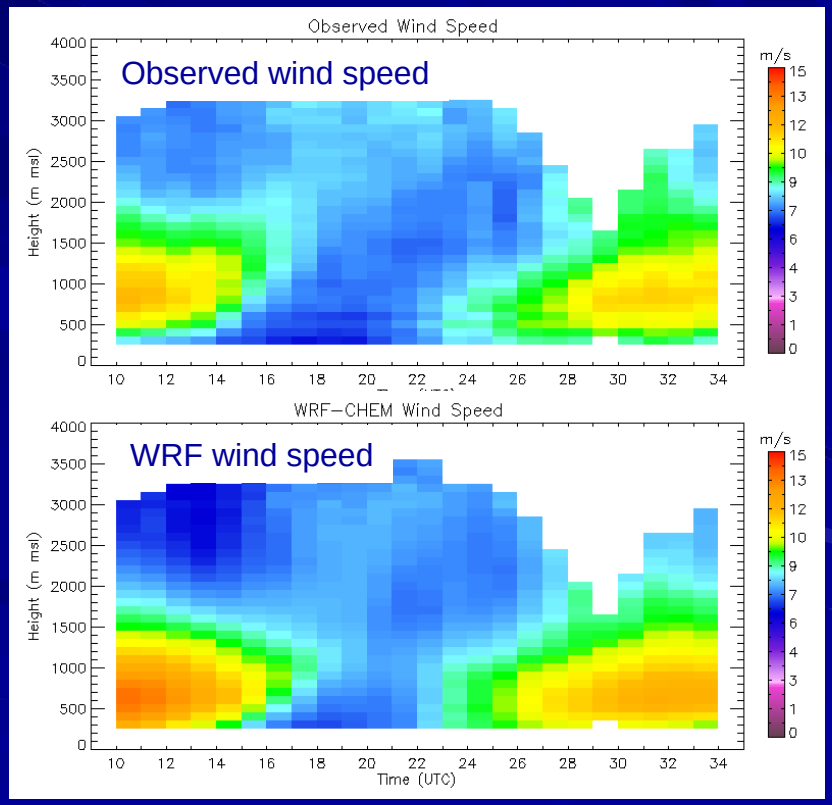


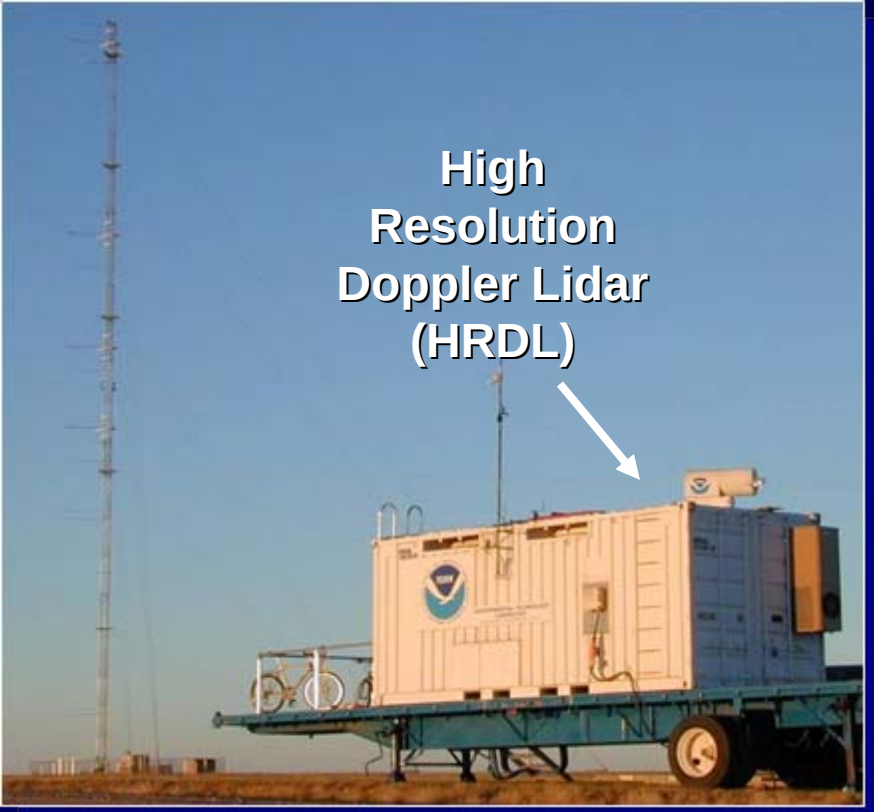
Boundary Layer Wind Profiler Networks

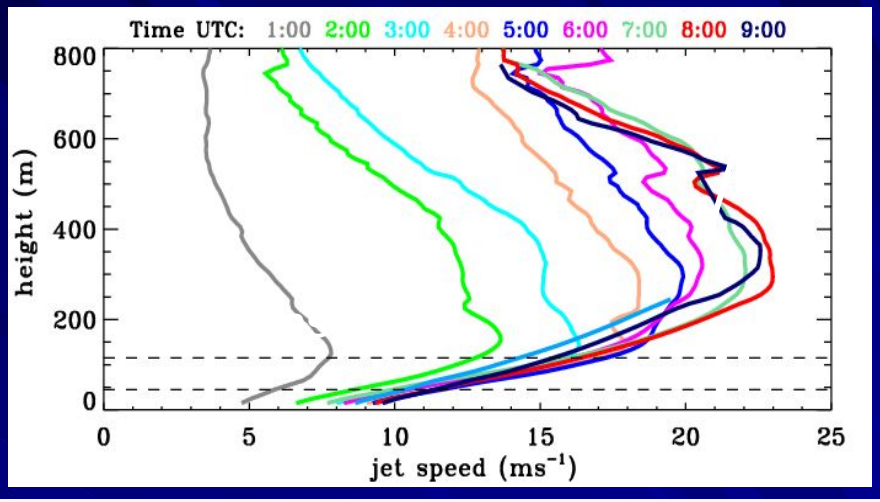


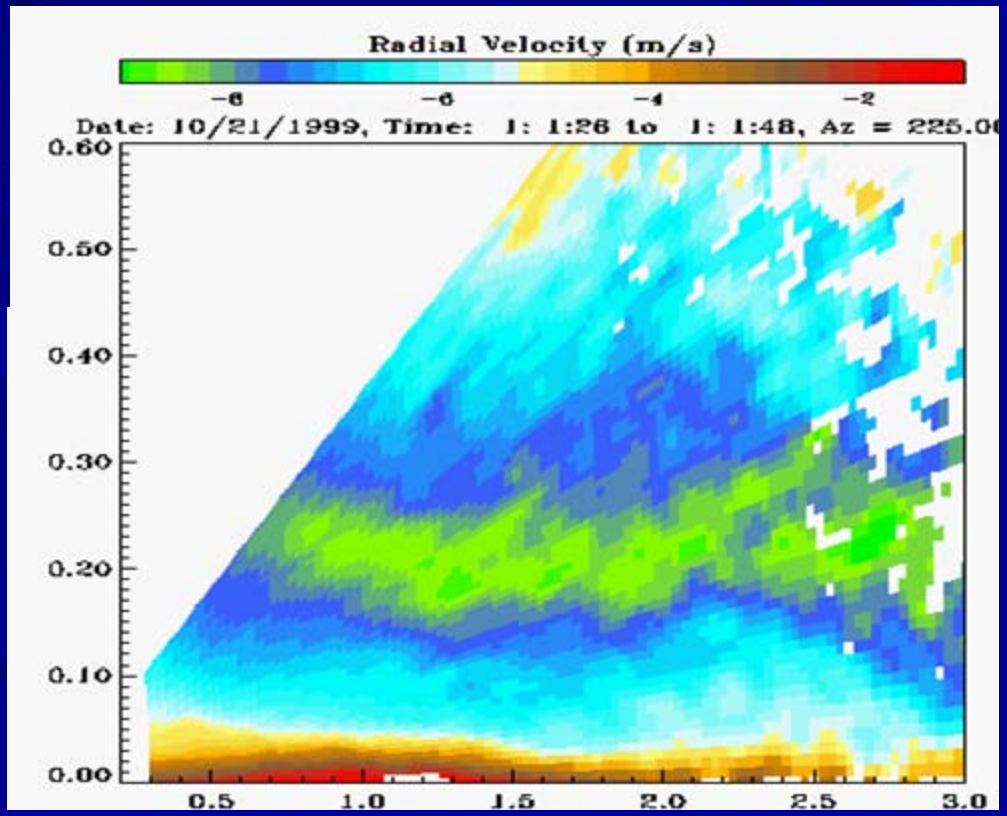
Boundary Layer Depth









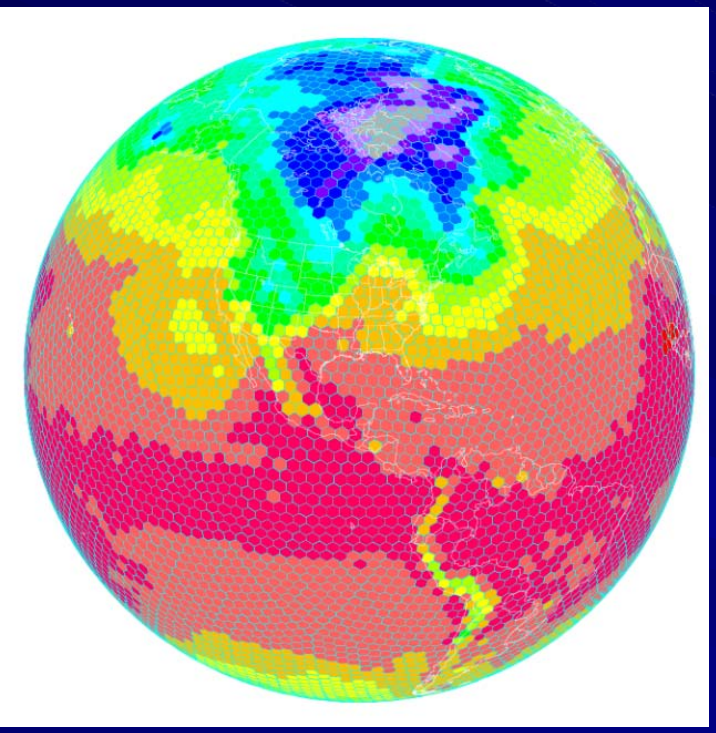


Height (km)

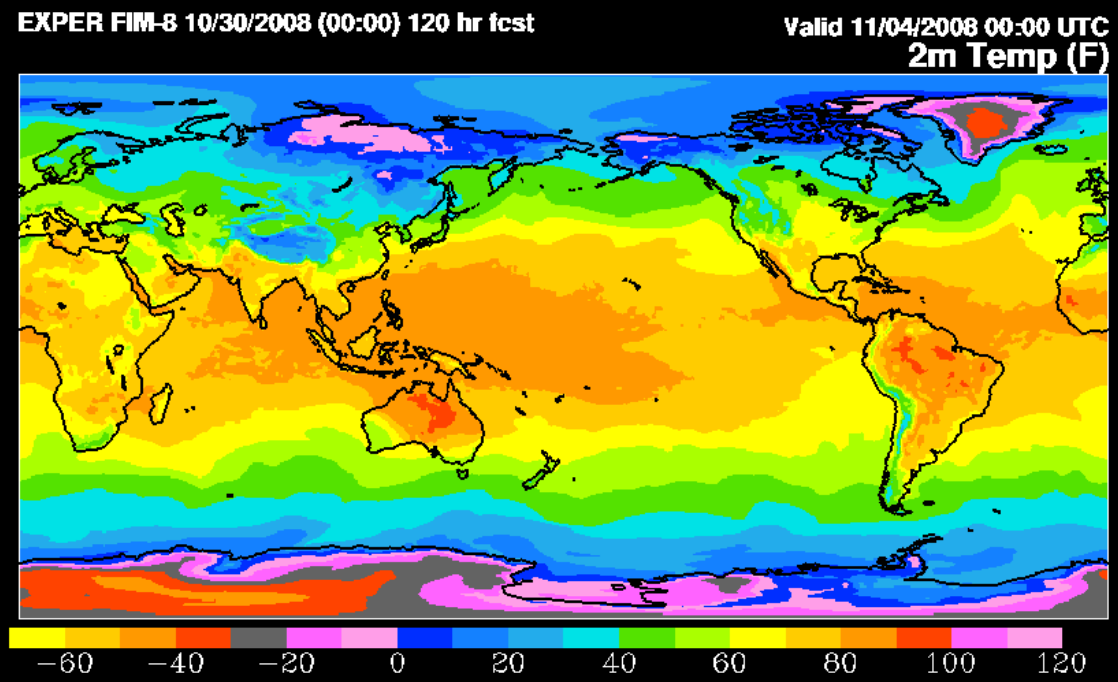
Distance (km)

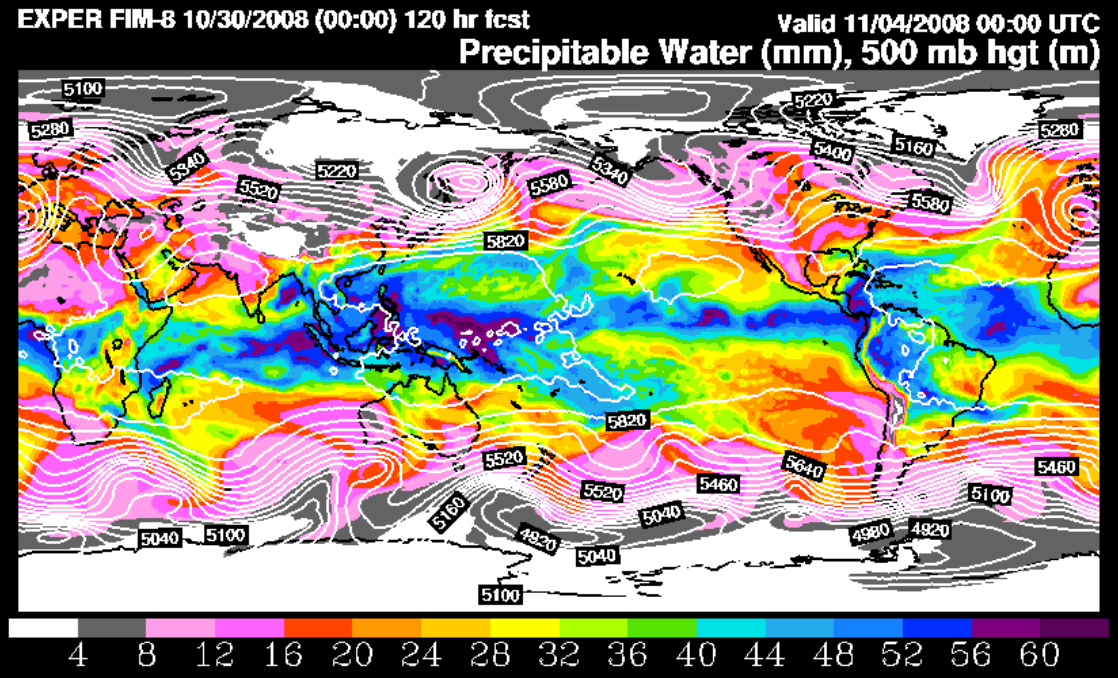
Over 30 scientific publications between NOAA and NREL using the Great Plains lidar data sets.

Global model development



Flow following finite volume Icosahedral Model (FIM)

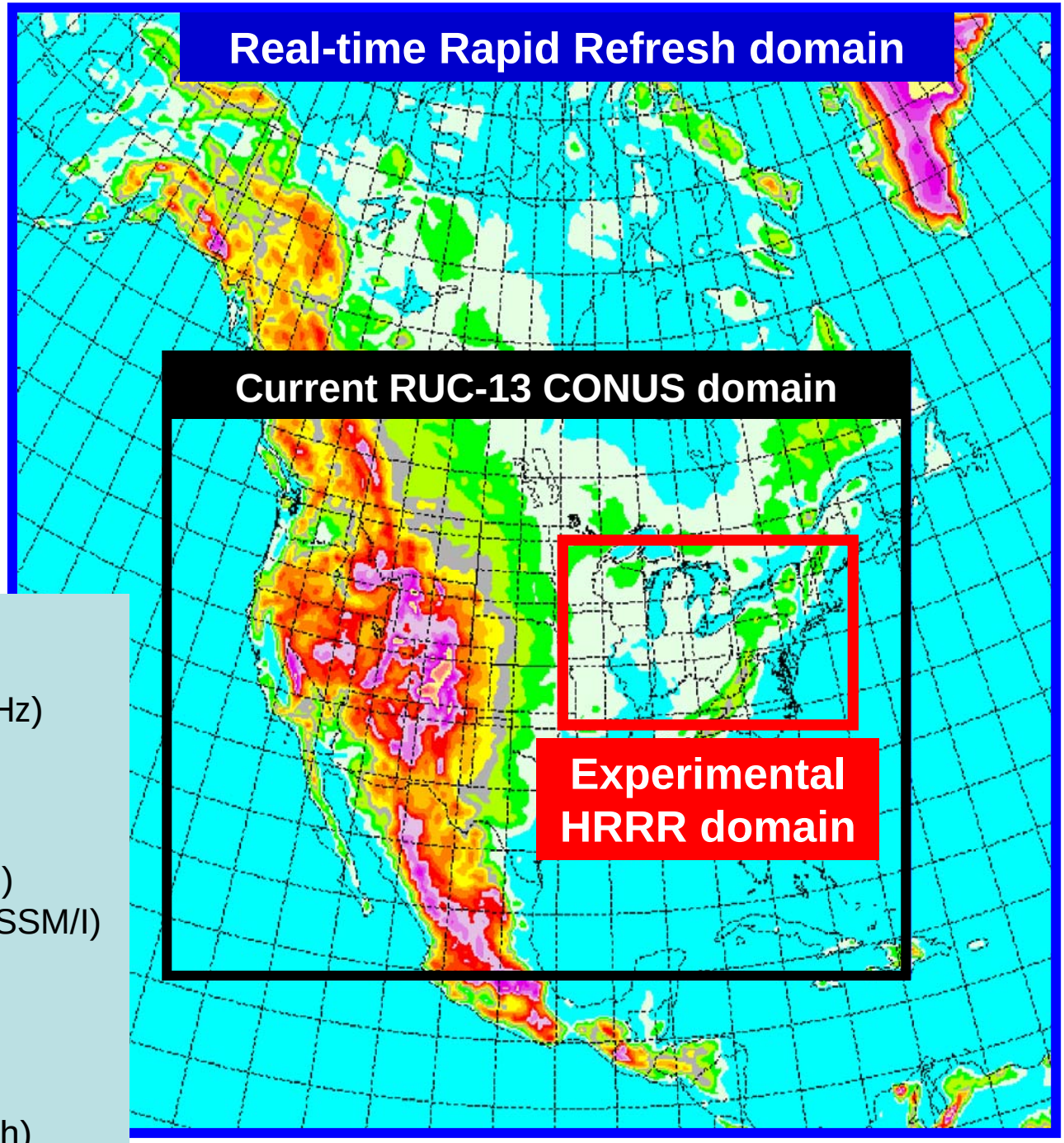




Hourly updated NCEP/NOAA 12h forecasts -RUC, Rapid Refresh and HRRR

RR – 2010 at NCEP

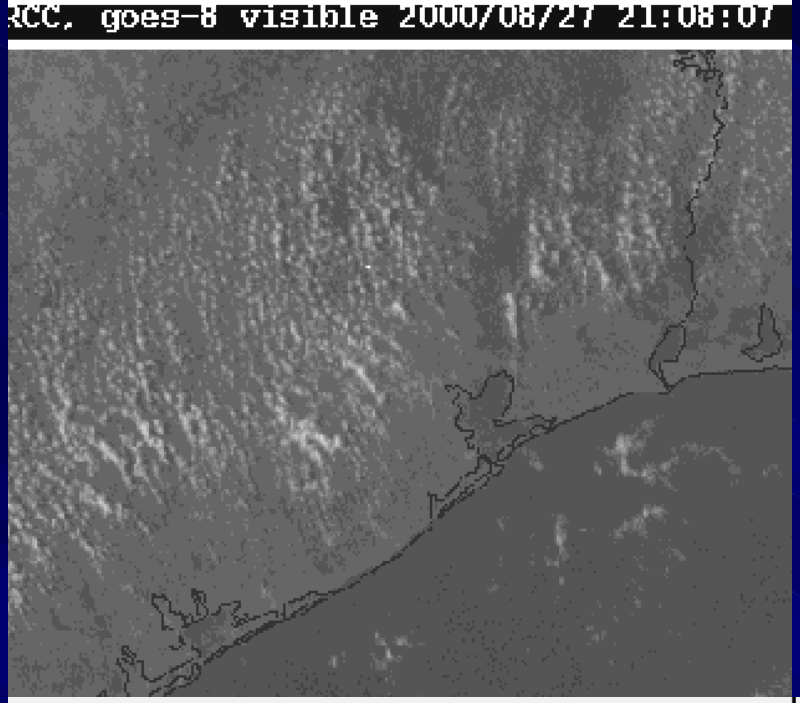
HRRR – 3km demo

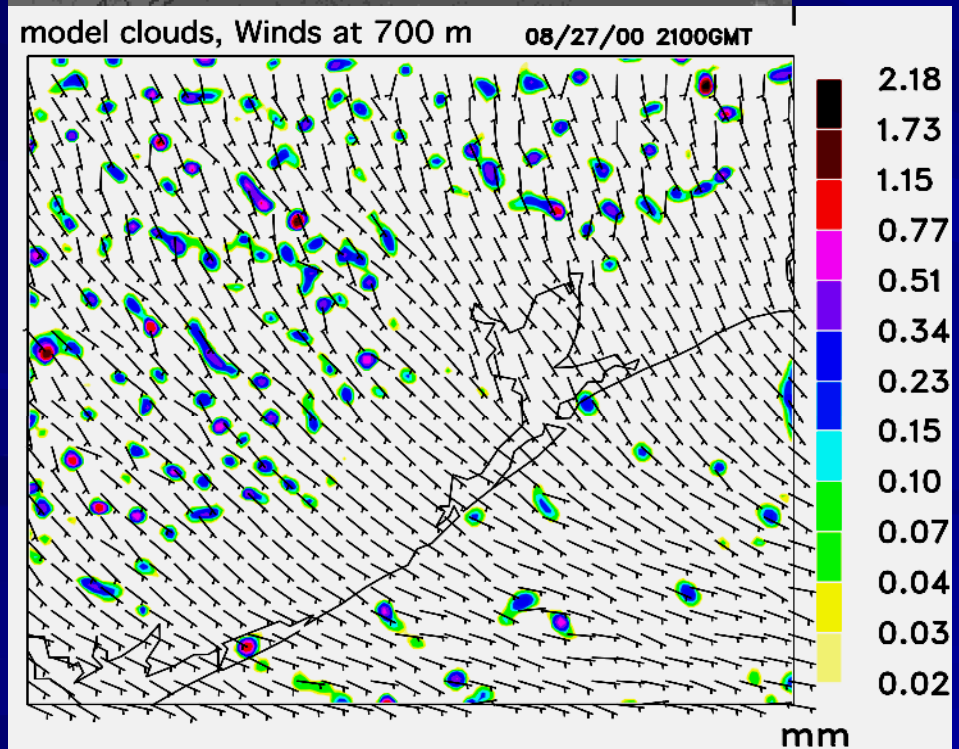


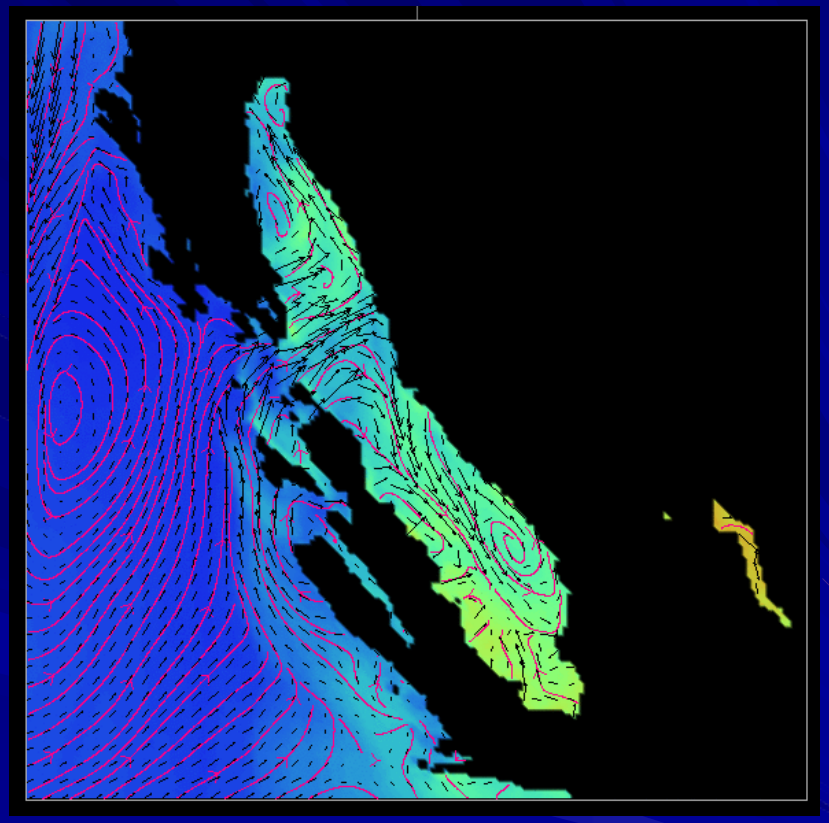
Data types used

Rawinsonde (balloons)
Wind Profilers (405 MHz, 915 MHz)
RASS virtual temperatures
VAD winds (WSR-88D radars)
Aircraft (ACARS, TAMDAR)
Surface (METAR, Buoy, Mesonet)
Precipitable water (GPS, GOES, SSM/I)
GOES cloud-drift winds
GOES cloud-top pressure/temp
Radar reflectivity, lightning
Ship reports/dropsondes
Satellite radiances (Rapid Refresh)

High resolution modeling

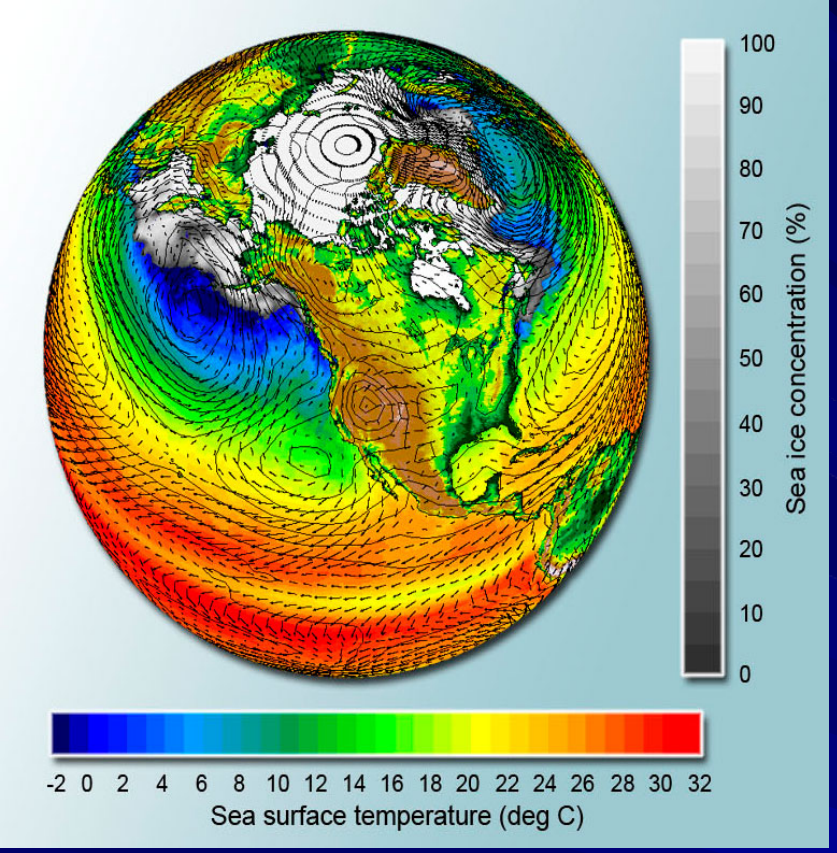


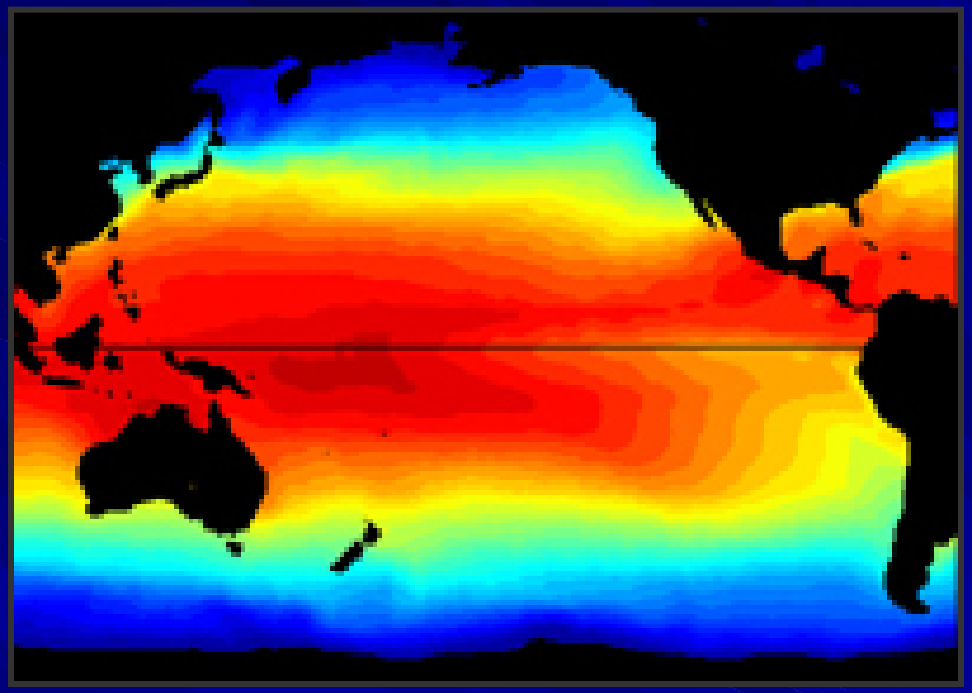




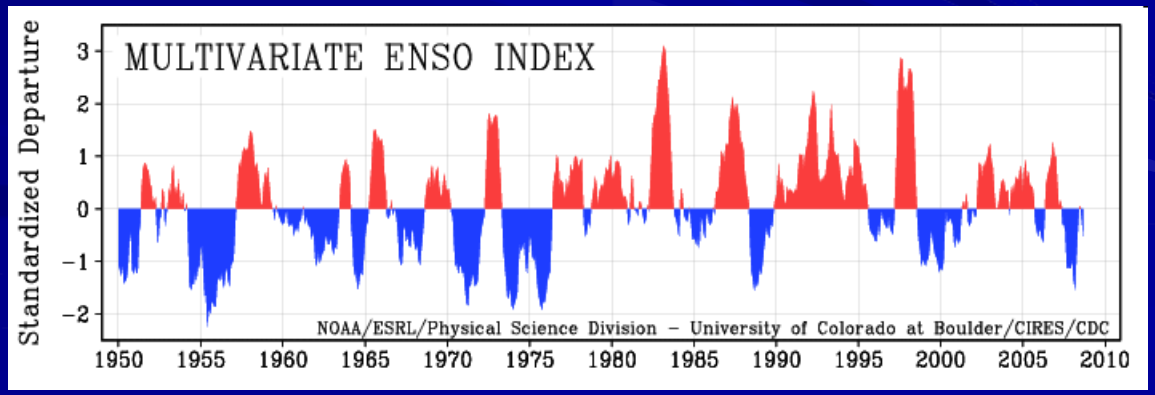
High resolution (4km) model simulation of low-level winds in California's Central Valley (Jian-Wen Bao, NOAA)

Climate modeling and Diagnosis

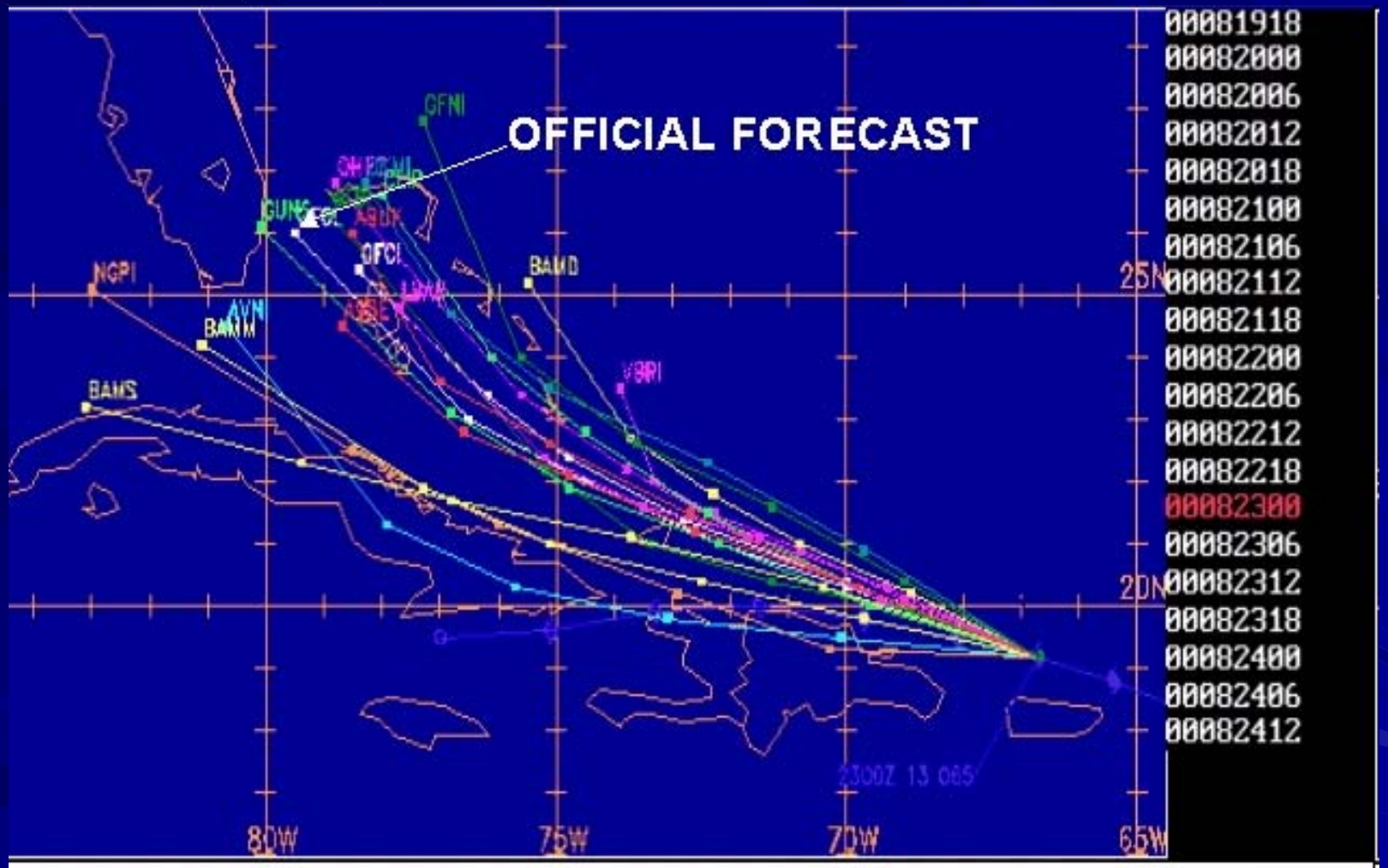




Climate model projection for Late Fall 2020



Ensemble Forecasting



HURRICANE DEBBY TRACK MODEL GUIDANCE

08/23/00 0000 UTC

Closing Points

- NOAA has tools and expertise that can be applied to renewable energy
- However, NOAA currently has no RE program that could mobilize its resources and expand them
- Chuck Kutscher: we’re well on the road towards a significant deployment of RE