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Application Of An Operational Mesoscale Modelling System For Industrial Plant Operations

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Anthony Praino (apraino@us.ibm.com), Lloyd Treinish (lloydt@us.ibm.com), David Pinckney and Robert Calio, IBM Thomas J. Watson Research Center, Yorktown Heights, NY, USA, http://www.research.ibm.com/weather/DT.html

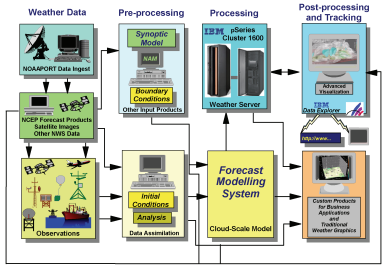
Background and Motivation

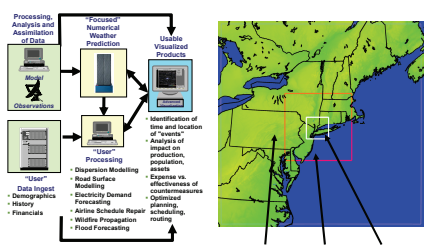
- Weather-sensitive business operations are primarily reactive to short-term, local conditions due to (real or perceived) unavailability of appropriate predicted data for
  - BMS systems - utility plant operation, site operations, energy conservation and generation, safety, …
- Mesoscale NWP has long shown "promise" as a potential enabler of proactive decision making for both economic and societal value
  - Can business and meteorological value be demonstrated beyond physical realism?
  - Can a practical and usable system be implemented at reasonable cost?
- It is not about weather but integrating forecasts into decision making to optimize facility operations
- Forecast for multiple IBM locations (Burlington, VT, East Fishkill, NY, Poughkeepsie, NY, Somers, Yorktown Heights, NY)
  - Operational infrastructure with focus on end-to-end process tailored to plant/facility operations
  - Applications with end users to address usability and effectiveness issues

Approach

- End-to-end integrated and automated, customizable forecasting system (user to meteorology)
- Optimized for good throughput on modest IBM Power/AIX hardware (i.e., <1 hour compute time per forecast day) to enable timely decisions
- User-driven not data-driven (start with user needs and work backwards)
- Modelling code derived from non-hydrostatic WRF-ARW
- NCEP data sources (e.g., NAM, RUC, GFS) used for lateral boundaries and background fields
- NOAA and other sources for data assimilation for initial conditions and analysis for verification
- Sophisticated, flexible visualization and dissemination
- Coupled to "user" and response processes & models
- Forecast for asset-based decisions to manage weather event, pre-stage resources and labor proactively

Architecture



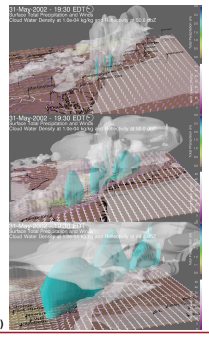


New York Area Forecast Domain

Issues to Consider for Facility Operations

- Predict specific events or combination of weather conditions that can affect heating and cooling systems (HVAC) with sufficient precision and lead time to enable proactive operation of central utility plant and other facilities for energy and resource optimization
- Migration from monitoring a storm to the ability to plan resources for optimal use and minimal impact to site operations
- Implement as a service tailored for the geographic, throughput and dissemination requirements of the facility and operations
- Predict conditions that can lead to site and facility operational impacts, thus allowing proactive planning

Custom Forecast Products



Nested to Cloud-Scale Models for Metropolitan Areas (16, 4 and 1 km)

Weather-Sensitive Industrial Site Operations

Building Energy Management

- Optimized use of electrical power, fuel sources and water
- Daily, accurate site-specific forecasts could ensure that all of the chillers and boilers are available and/or running before peak load
- Forecast of afternoon conditions could enable operations personnel to shut down unneeded equipment to conserve energy
- Accurate site forecast enables maximizing energy efficient operations by the use of free cooling and/or other types of heat exchangers
- Peak load shedding or avoidance strategies
- Smart Building Management System applications
- Potential for alternative energy generation and storage strategies

Site Operations

- Weather-sensitive manufacturing and development operations
- Outdoor events and grounds work affected by local weather conditions
- Site personnel scheduling (arrival, departure, remote access)
- Improved efficiency and effectiveness for cold season operations
- Reduction of cost and environmental impact
- Potential for improved supply chain management
- Enable more energy-efficient IT operations

Safety

- High winds/lightning can affect outdoor activities such as roof and scaffold work, window cleaning or general construction
- Heavy rain, ice, snow could contribute to accidents on site roads, parking lots and sidewalks

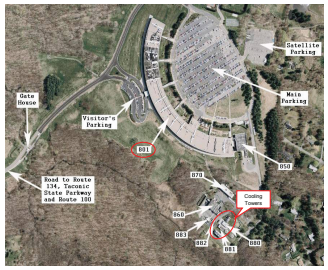
Security

- Infrastructure and asset protection may have weather sensitivities

Application Case Study

Site Forecasts for Free Cooling Operations

- One to three day forecast of wet bulb, dry bulb, dew point, etc.
- Numerical forecast data is integrated into chiller plant control loop to optimize free versus mechanical cooling
- Industrial scale chiller plant energy management



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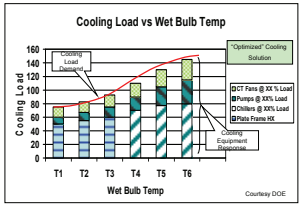
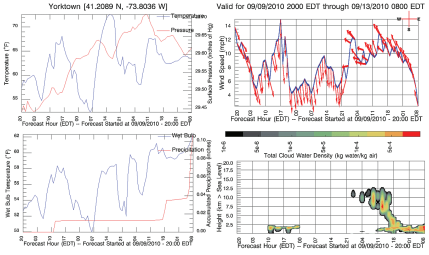
Yorktown Heights, NY

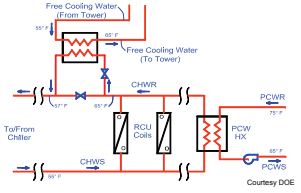




Site-Specific Forecast Plots for IBM Yorktown Including Wet and Dry Bulb Temperatures

Courtesy DOE

Cooling Towers



Free Cooling Loop Schematic

Automated, Customized, Integrated Products Generation

Site	Date	Time	Time Zone	Dry Bulb Temp (F)	Wet Bulb Temp (F)	Precip (in)	Pressure (in HG)	Wind Speed (mph)	Wind Direction (Degrees)	Dew Point (F)	Heat Index (F)	Wind Chill (F)	Snow (in)
Yorktown	9/9/2010	20:00	EDT	57	52	0	29.36	13.3	307	49	57	54	0
Yorktown	9/9/2010	20:10	EDT	57	52	0	29.34	8.2	303	49	57	55	0
Yorktown	9/9/2010	20:20	EDT	57	52	0	29.36	8.9	300	49	57	55	0
Yorktown	9/9/2010	20:30	EDT	57	52	0	29.33	9.2	301	48	57	55	0
Yorktown	9/9/2010	20:40	EDT	57	52	0	29.36	9.3	303	48	57	55	0
Yorktown	9/9/2010	20:50	EDT	58	53	0	29.36	10.8	300	48	58	56	0
Yorktown	9/9/2010	21:00	EDT	58	53	0	29.37	11.6	298	48	58	56	0
Yorktown	9/9/2010	21:10	EDT	59	53	0	29.38	11.5	299	48	59	56	0
Yorktown	9/9/2010	21:20	EDT	58	53	0	29.37	10.5	298	48	58	56	0
Yorktown	9/9/2010	21:30	EDT	58	53	0	29.37	10.1	297	48	58	56	0
Yorktown	9/9/2010	21:40	EDT	58	53	0	29.37	10.1	299	48	58	56	0
Yorktown	9/9/2010	21:50	EDT	58	53	0	29.37	10.3	298	48	58	56	0
Yorktown	9/9/2010	22:00	EDT	58	53	0	29.35	10.8	297	48	58	56	0
Yorktown	9/9/2010	22:10	EDT	58	53	0	29.36	10.6	296	48	58	56	0
Yorktown	9/9/2010	22:20	EDT	58	53	0	29.36	10.9	296	48	58	56	0
Yorktown	9/9/2010	22:30	EDT	58	53	0	29.38	11.1	297	49	58	56	0
Yorktown	9/9/2010	22:40	EDT	59	53	0	29.37	11.2	297	49	59	56	0
Yorktown	9/9/2010	22:50	EDT	59	53	0	29.39	11.7	299	49	59	56	0
Yorktown	9/9/2010	23:00	EDT	59	53	0	29.38	12.1	298	49	59	57	0

Site Operations Forecast Data – Tabular Format

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Site Operations Actions based upon Deep Thunder Forecast
Recommended Actions for Sunday - Friday Operations
Valid Date:201025300

Temperature is forecasted to be less than 60F for more than 2 hours
Run 1 chiller if CWR > 50F
Run 1 boiler before 8AM
Run 1 HW radiation pump before 6AM

Humidity is forecasted to be greater than 50 percent for more than 2 hours
Cooling Towers: Maintain CWR temperature
Air Handler: Disable Economizer

Forecast Statistics
High Temp: 75.25219
Low Temp: 55.15657
High Humidity: 99.74673
Low Humidity: 73.46073
Max Wind Speed: 12.607601
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Rule-Based Site Operations Actions Forecast