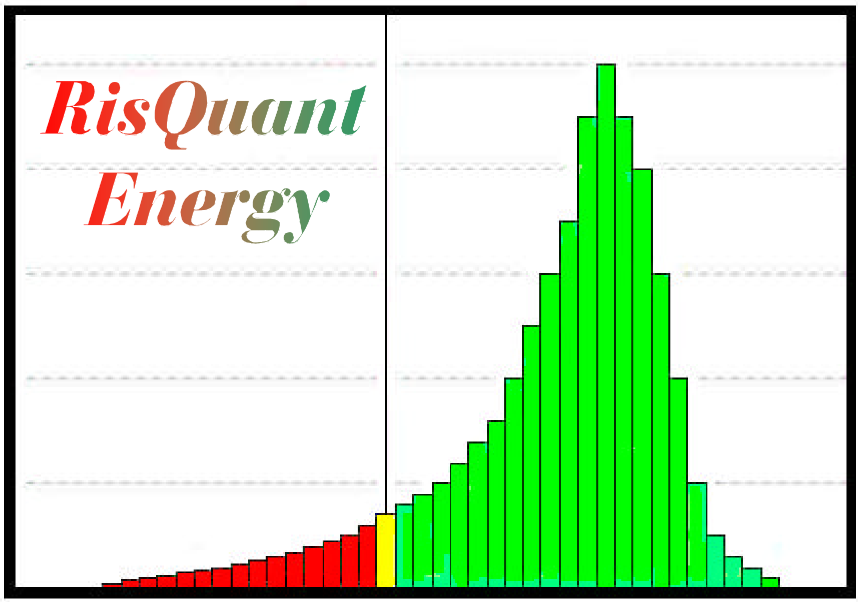
Weather Simulator as Component of Power Market Monte Carlo Simulator



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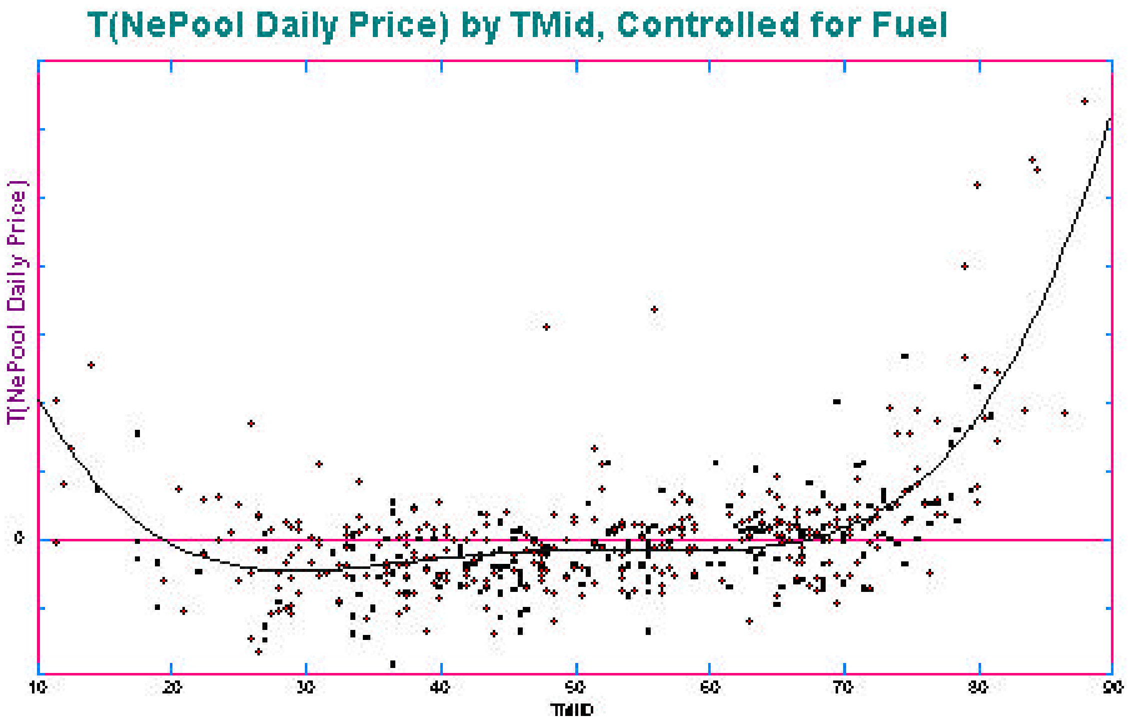
Weather and Price in NEPool (New England Power Pool)



X-Axis: TMid BOS, Average of daily high and low temperatures for Boston MA.

Y-Axis: Curvilinear Transformation of NEPool daily 5x16 prices, controlled for fuel cost.

Temperature strongly influences power prices.

No analytic solution to ascertain that influence.

Monte Carlo methods offer robust tools to examine that influence.

Model and Function Structure

NePool = f (TMid BOS, Fuel Costs …)

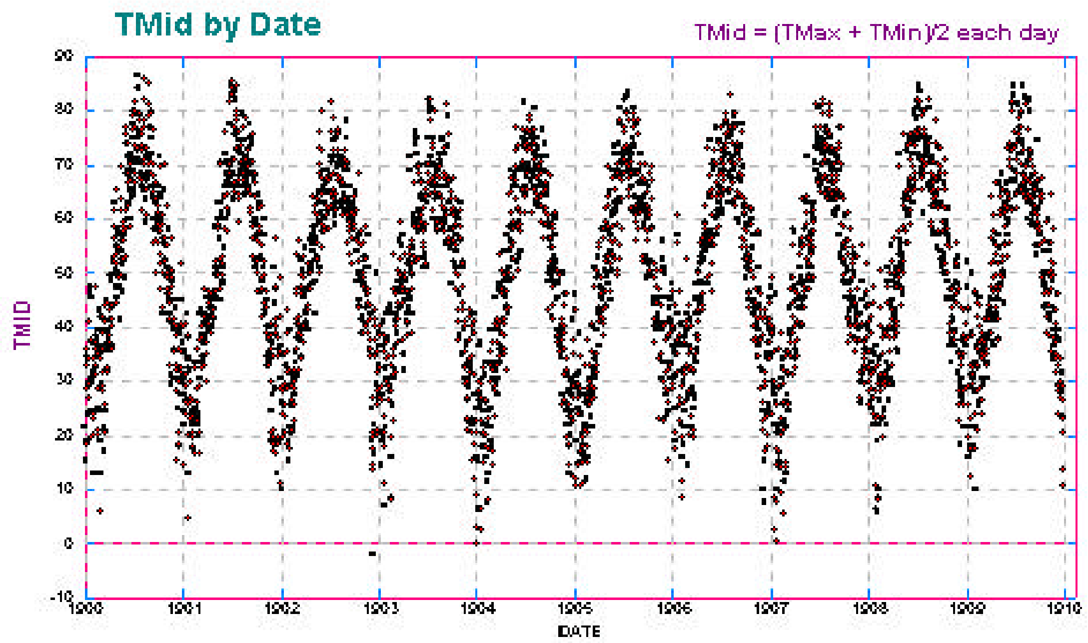
TMid BOS = f (AsOf Date
RAND()
TMid on Date - 1
TMid on Date - 2
TMid on Date - 3
TMid on Date - 4
TMid on Date - 5)

The Tmid BOS simulation function looks at the date to be simulated, the set of five recent deviations from the expectation whether simulated or actual, and applies a random quantity.
That result becomes an argument in the NEPool pricing simulation function.
The scope of the poster session is limited to the design of the Tmid BOS() function.

Purpose of Tmid Bos()

- Synthesize strands of weather data
- Statistically consistent with the one hundred year historical record
- Can be used as an argument in a pricing simulator

Temperature Exhibits Strong Annual Periodicity



X-Axis: Date from Jan 1, 1900 thru Dec 31, 1909.

Y-Axis: TMid (average of daily high and low) for each date in series for Boston MA.

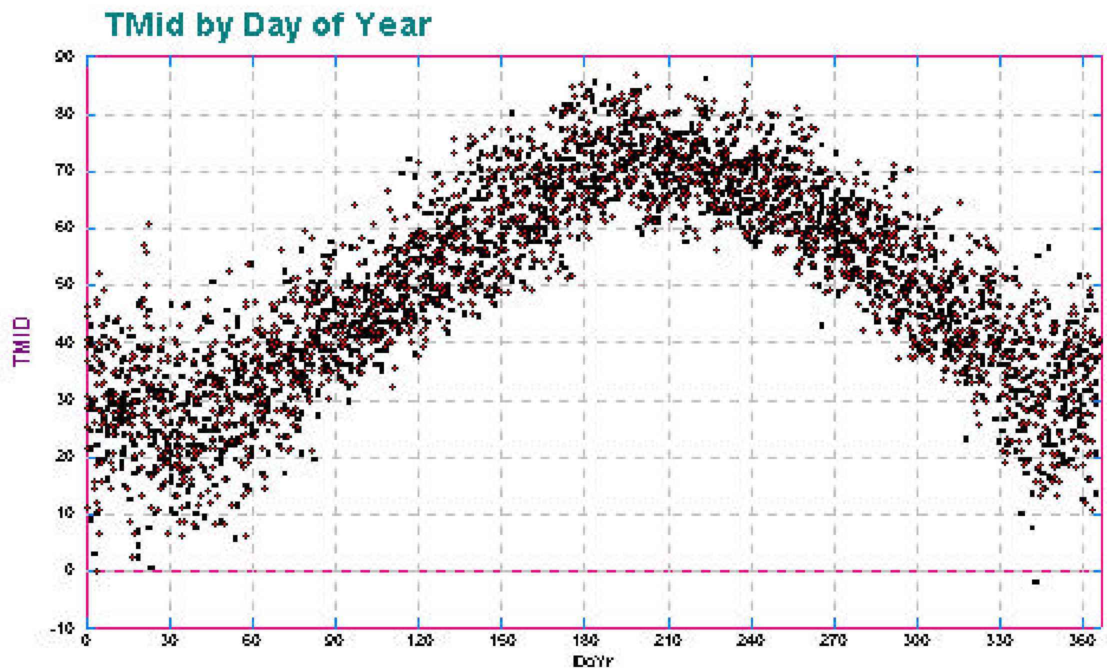
Locale: BOS, Boston Logan airport preceded by nearby military observations.

Series analyzed: Jan 1, 1900 thru Oct 31, 2001.

Number of TMid observations: 37,186

Model class: Sine wave.

Adjusting the Annual Phase



Correlation Matrix	
	T(TMid)
DoYr - 22	0.8966096
DoYr - 23	0.8971396
DoYr - 24	**0.8974042**
DoYr - 25	0.8974033
DoYr - 26	0.8971369

X-Axis: Day of year [1-365].

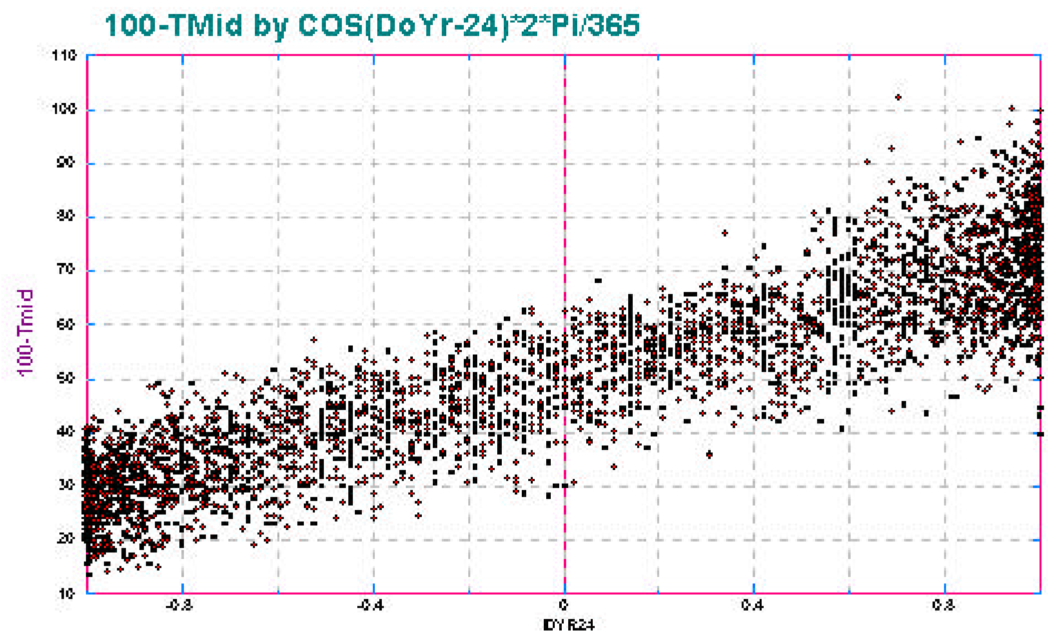
Y-Axis: Tmid for day of year.

Note that the low point of the series appears to be shortly after the first of the year.

Comparing the correlation of the transformed Tmid with various offsets of the Day of the Year indicates that the best fit is a twenty-four day offset.

Other locations have a different offset, typically seventeen days.

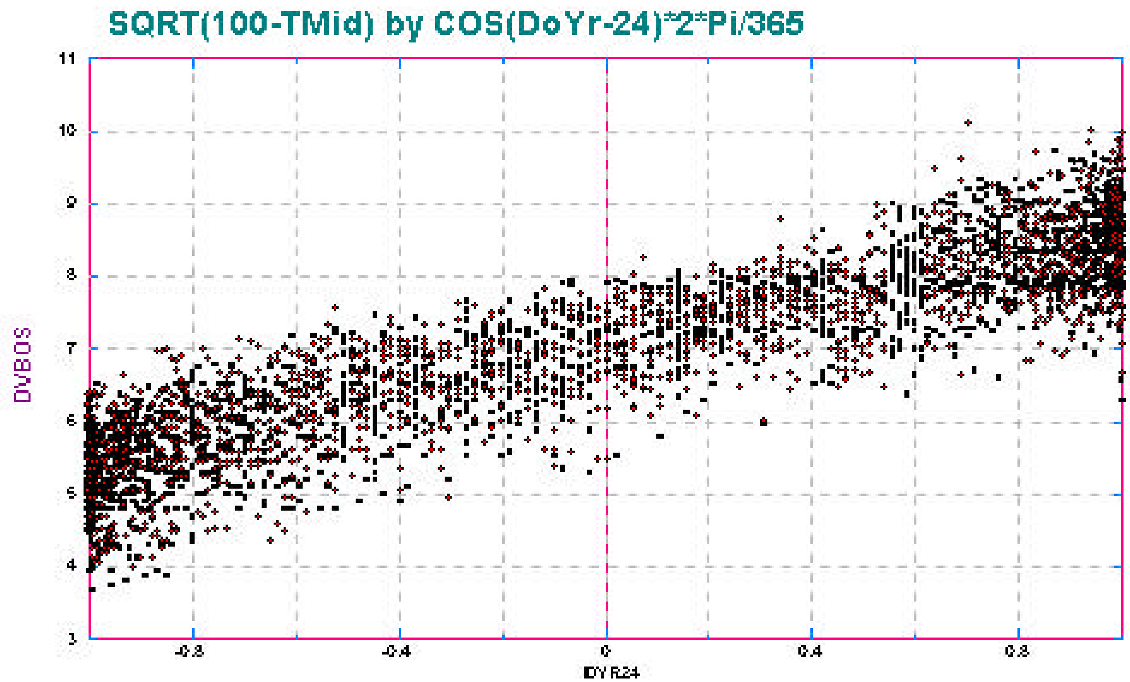
Cosine Transformation Achieves Linearity



X-Axis: COS(DoYr-24)x(2xPIx365)
Y-Axis: 100-TMid

The cosine transformation nicely extracts the periodicity.
The series remains heteroskedastic with winter, on the right, having roughly twice the variance of the summer, on the left.

Transformation to Achieve Homoskedasticity



X-Axis: COS(DoYr-24)x(2xPIx365)
Y-Axis: SQRT(100-Tmid)

The regression now appears to be both linear and homoskedastic.
However, the residuals exhibit considerable autocorrelation.

Residual Autocorrelations of the Periodic Model

Lag	ACF	Sig	PACF	Sig
1	0.6222	120.0	0.6222	120.0
2	0.2796	40.5	-0.1754	-33.8
3	0.1576	21.9	0.1048	20.2
4	0.1189	16.3	0.0103	2.0
5	0.1039	14.1	0.0351	6.8
6	0.0919	12.4	0.0173	3.3
7	0.0763	10.3	0.0108	2.1
8	0.0654	8.8	0.0156	3.0
9	0.0605	8.1	0.0143	2.8
10	0.0571	7.6	0.0122	2.4
11	0.0535	7.2	0.0112	2.2
12	0.0534	7.1	0.0160	3.1
13	0.0525	7.0	0.0104	2.0
14	0.0548	7.3	0.0187	3.6
15	0.0591	7.9	0.0173	3.3
16	0.0585	7.8	0.0109	2.1
17	0.0498	6.6	0.0021	0.4
18	0.0419	5.5	0.0065	1.3
19	0.0391	5.2	0.0077	1.5
20	0.0365	4.8	0.0038	0.7
21	0.0352	4.6	0.0072	1.4
22	0.0309	4.1	-0.0003	-0.1
23	0.0331	4.4	0.0143	2.8
24	0.0359	4.7	0.0059	1.1
25	0.0374	4.9	0.0094	1.8
26	0.0406	5.3	0.0123	2.4
27	0.0407	5.4	0.0060	1.2
28	0.0358	4.7	0.0020	0.4
29	0.0319	4.2	0.0050	1.0
30	0.0340	4.5	0.0107	2.1
31	0.0344	4.5	0.0033	0.6
32	0.0302	4.0	0.0009	0.2
33	0.0296	3.9	0.0086	1.7
34	0.0272	3.6	-0.0006	-0.1
35	0.0275	3.6	0.0084	1.6
36	0.0289	3.8	0.0047	0.9
37	0.0293	3.8	0.0055	1.1
38	0.0255	3.3	-0.0012	-0.2
39	0.0218	2.9	0.0020	0.4
40	0.0171	2.2	-0.0037	-0.7
41	0.0206	2.7	0.0116	2.2
42	0.0238	3.1	0.0013	0.3
43	0.0218	2.9	0.0006	0.1
44	0.0211	2.8	0.0051	1.0
45	0.0221	2.9	0.0039	0.8
46	0.0194	2.5	-0.0020	-0.4
47	0.0177	2.3	0.0034	0.6
48	0.0150	2.0	-0.0024	-0.5
49	0.0100	1.3	-0.0042	-0.8
50	0.0073	0.9	-0.0008	-0.2

ACF - Autocorrelation Function
PACF - Partial Autocorrelation Function

Final Model: Lags 1,2,3,4,5 were used.

Why limited to five?
- Adequate for this purpose
- Model is descriptive, not predictive

Final Model Diagnostics:
- Linearity achieved
- Homoskedastic errors
- Normally distributed errors
- Residual autocorrelations continue to exhibit some color.