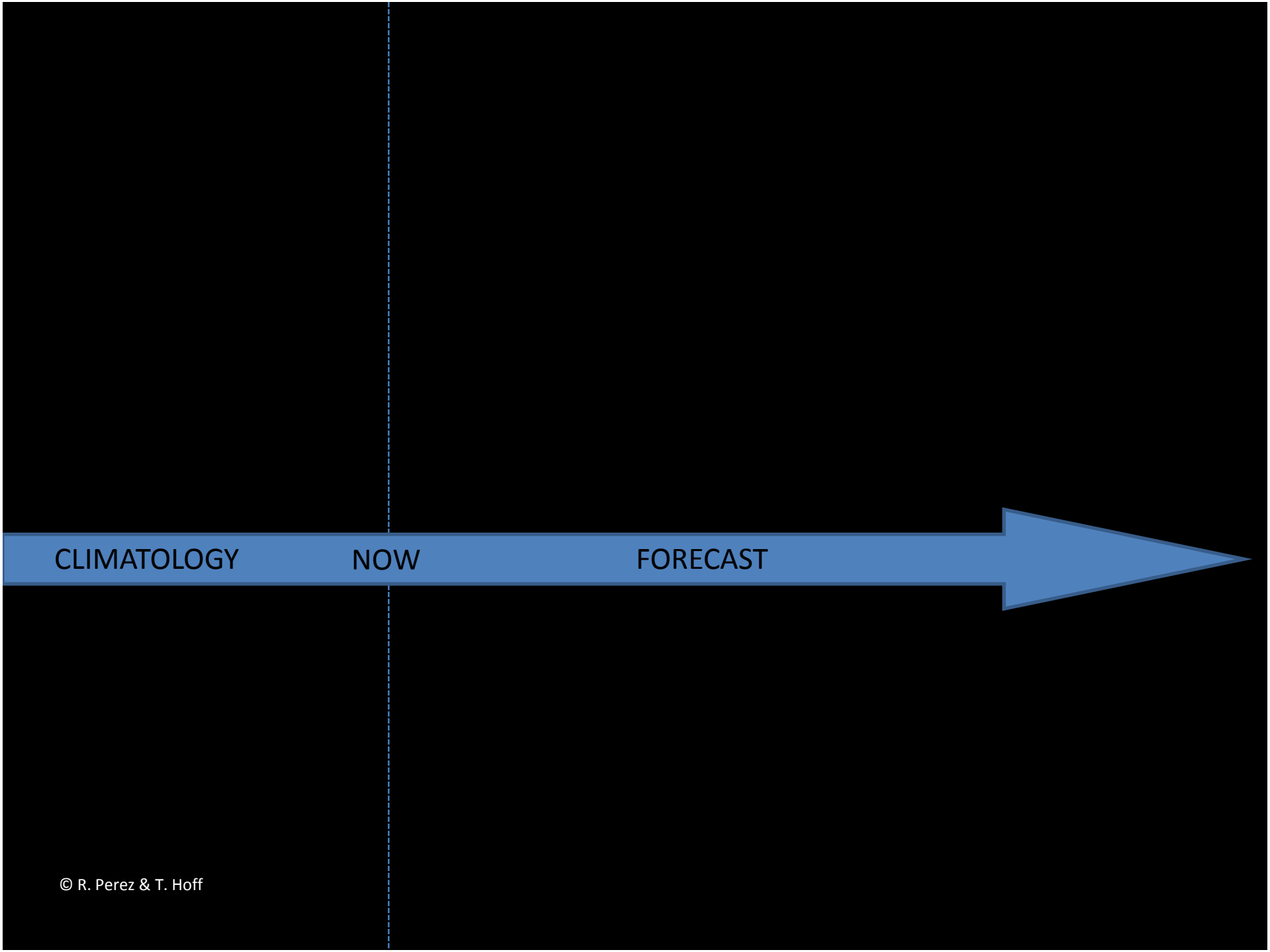
PV OUTPUT VARIABILITY MODELING

Richard Perez & Tom Hoff



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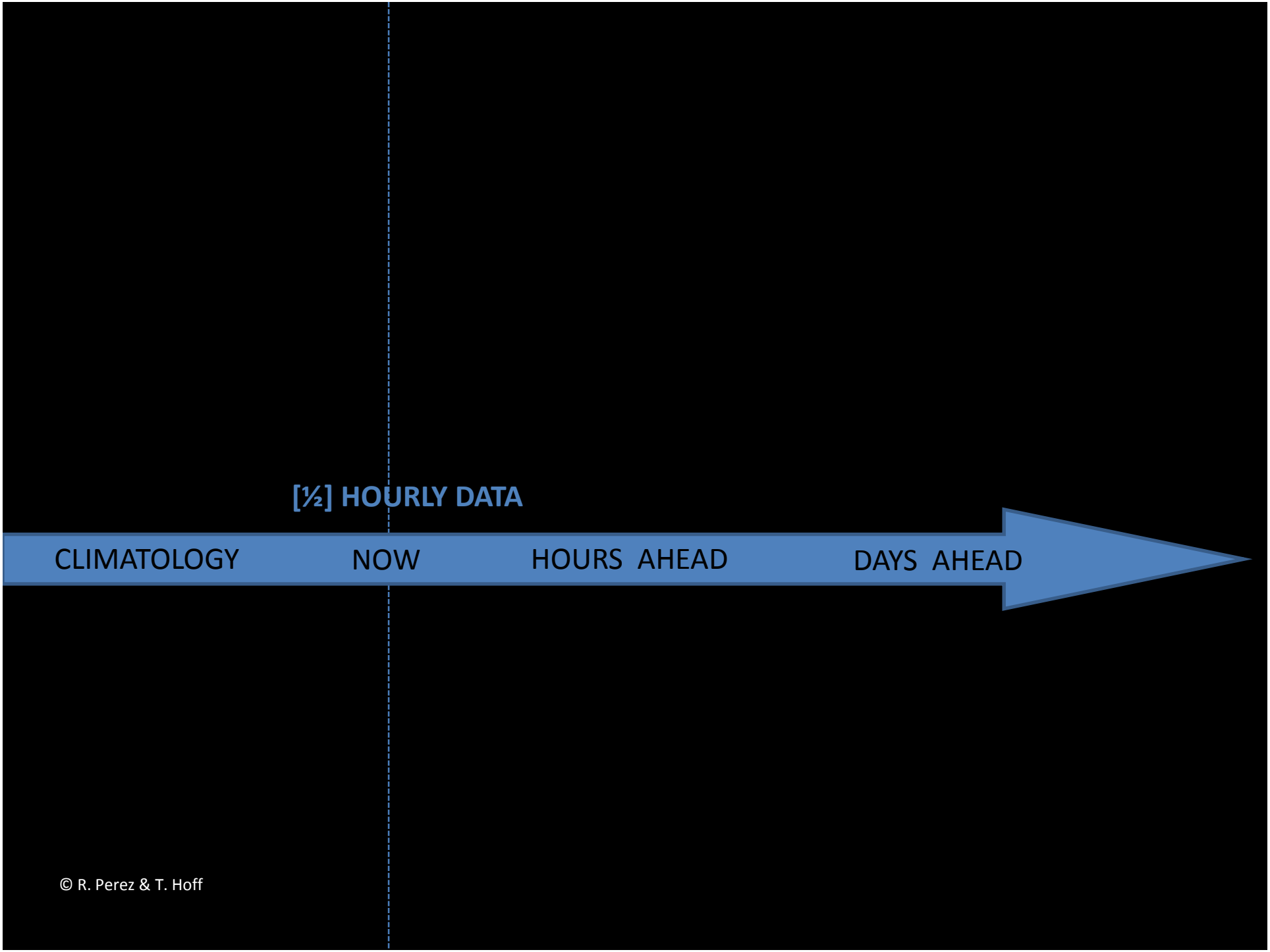

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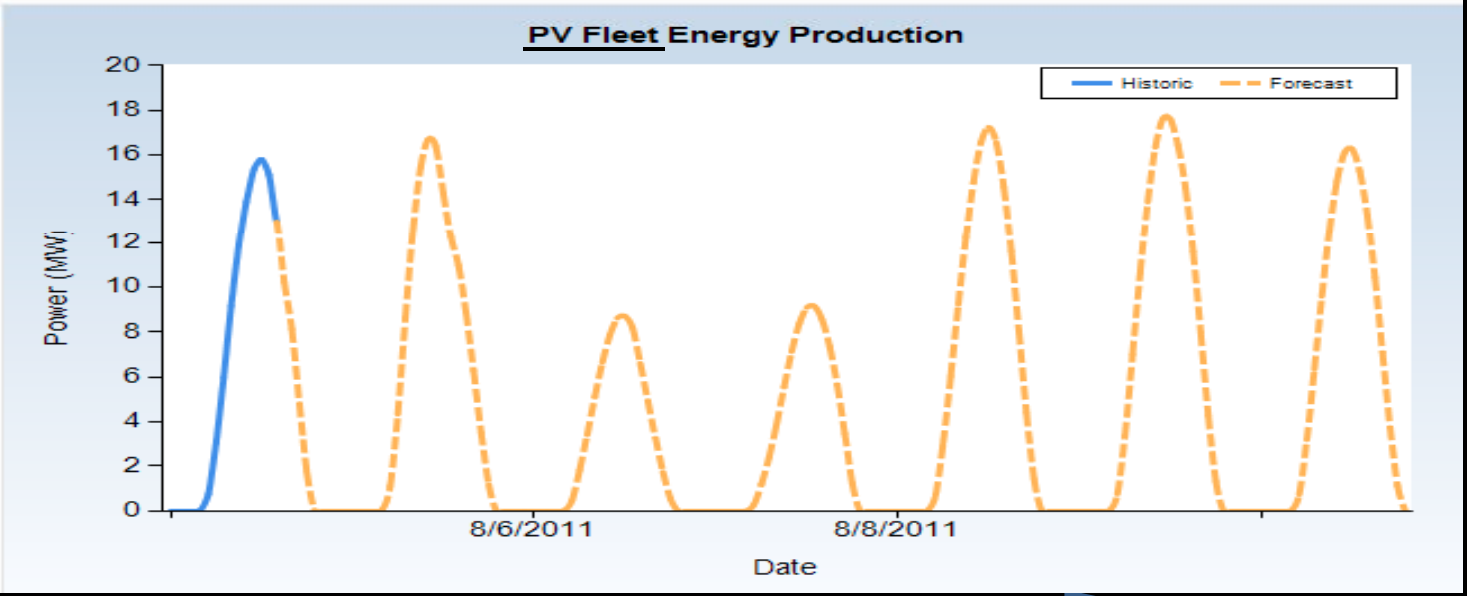

CLIMATOLOGY NOW HOURS AHEAD DAYS AHEAD

1998 → 6 days ahead

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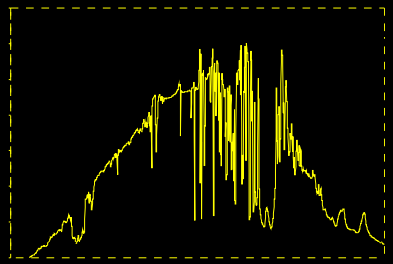
[½] HOURLY DATA

CLIMATOLOGY NOW HOURS AHEAD DAYS AHEAD

1 MINUTE DATA OR LESS



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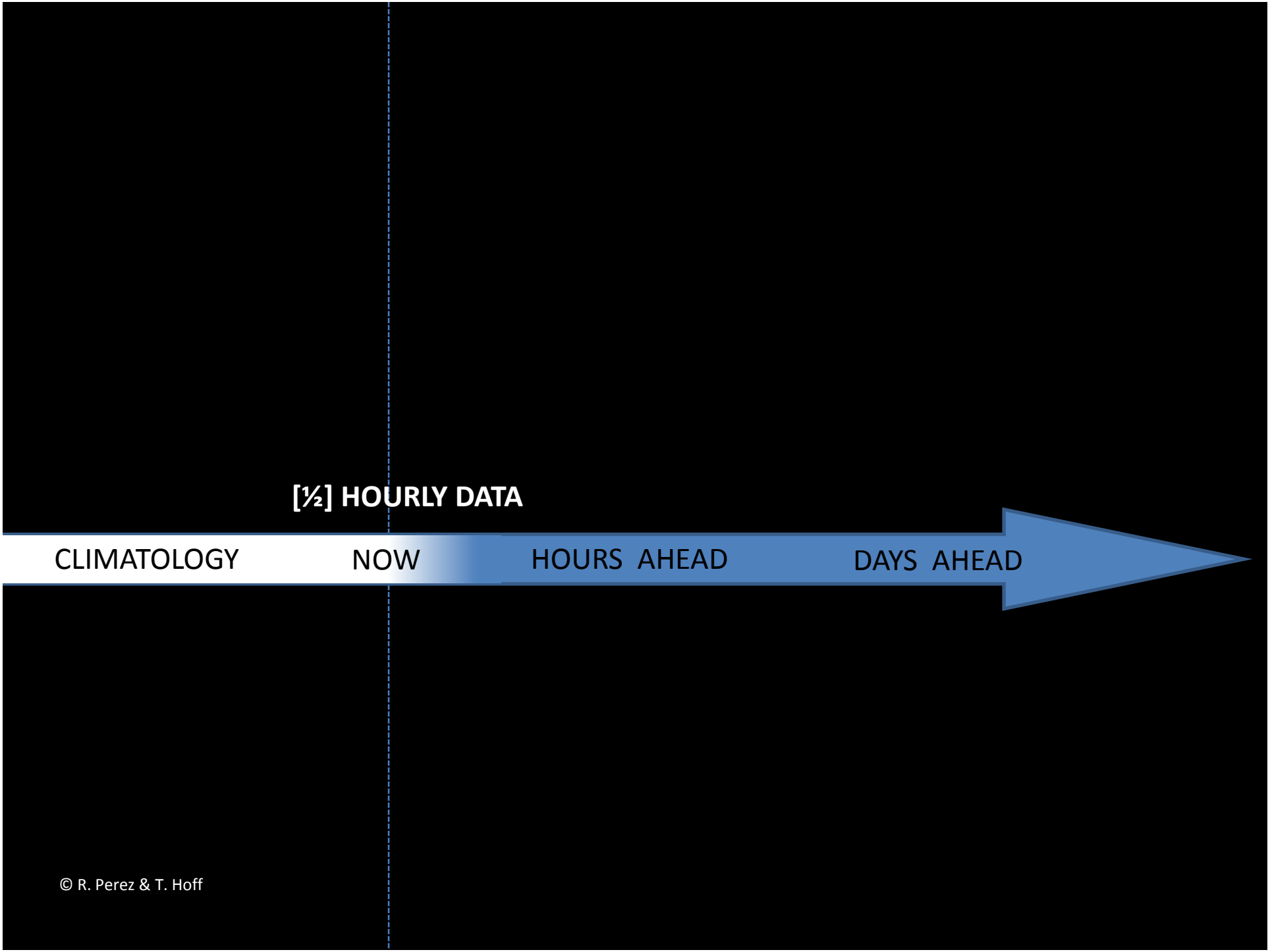

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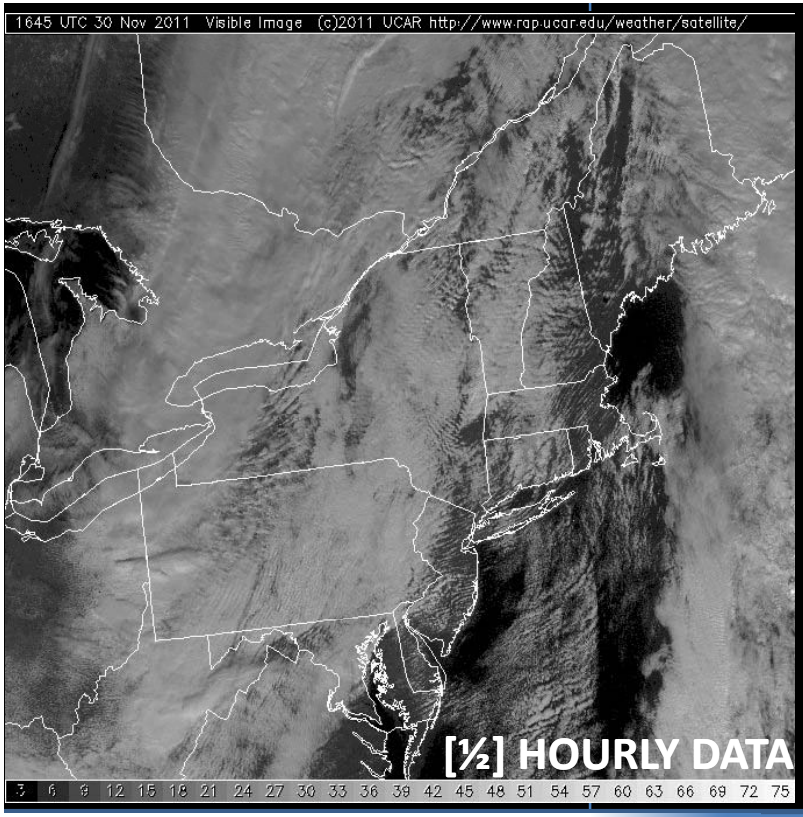
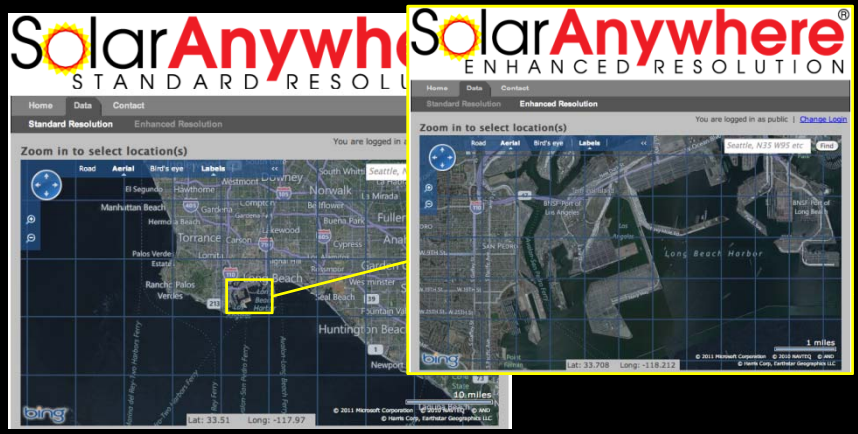


Started with 10km Hourly -- standard resolution

Now producing 1km ½ Hourly – enhanced resolution



CLIMATOLOGY | NOW | HOURS AHEAD | DAYS AHEAD

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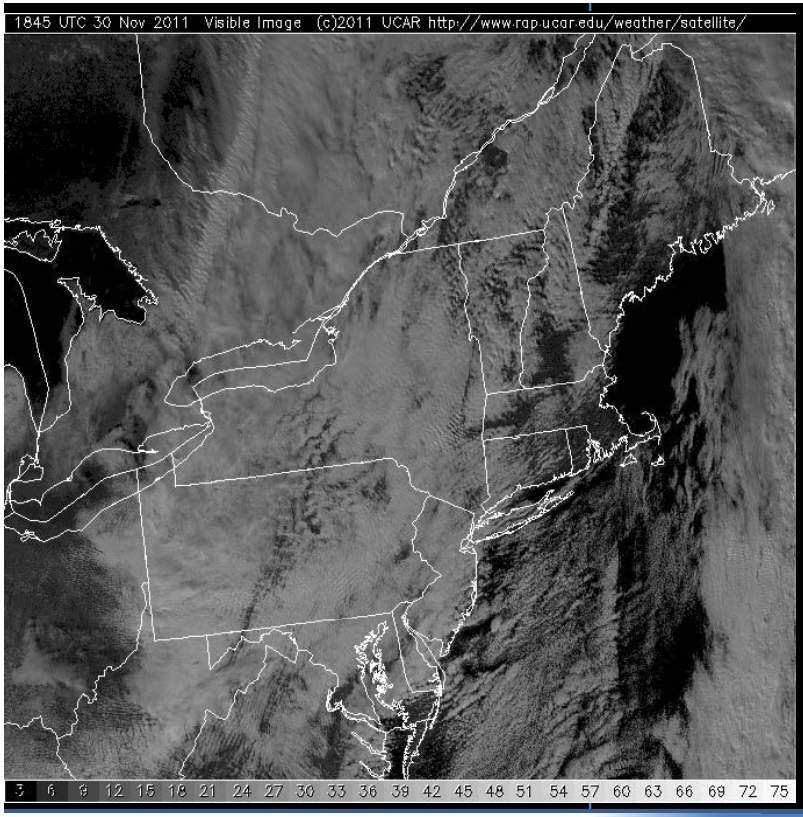

CLOUD MOTION

CLIMATOLOGY | NOW | HOURS AHEAD | DAYS AHEAD

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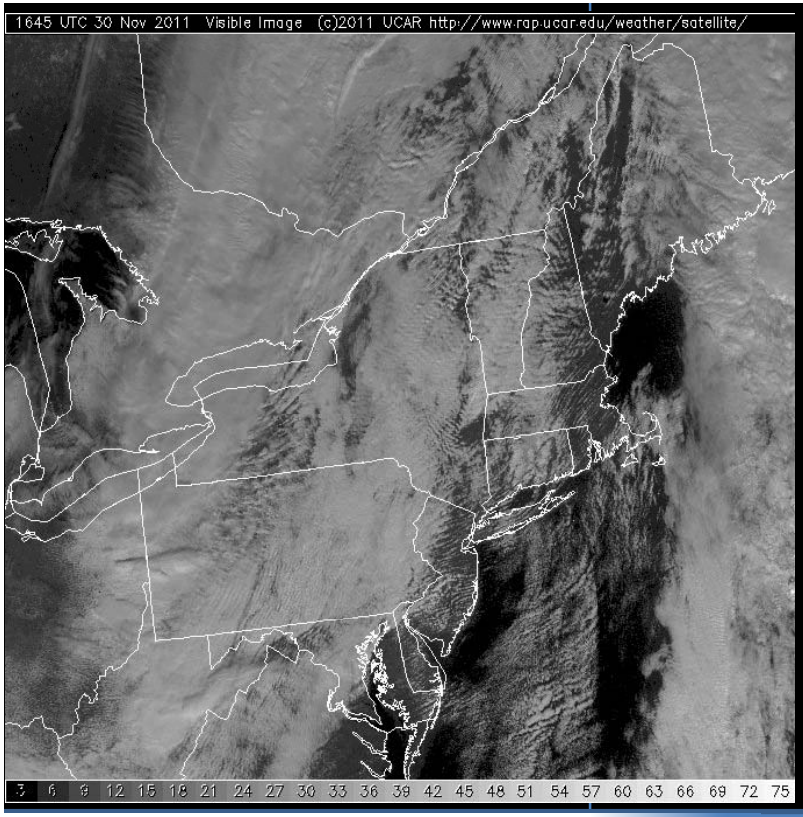

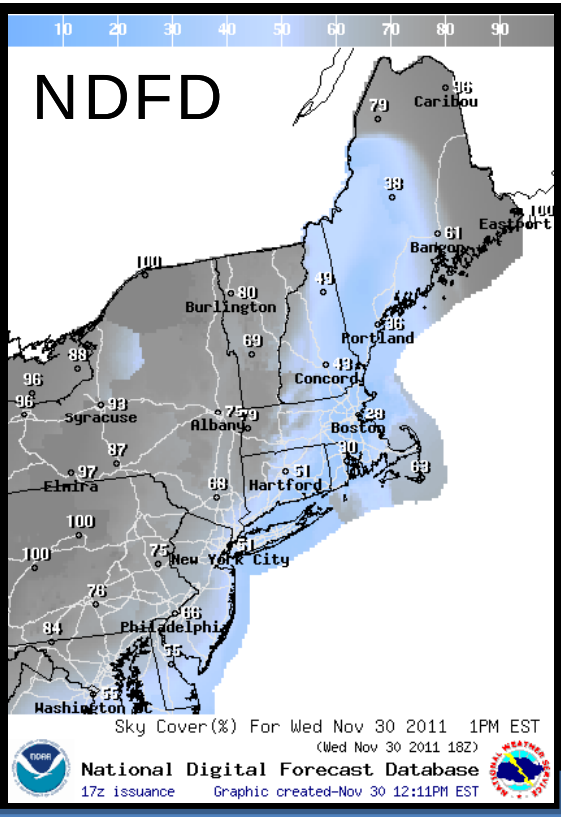

CLIMATOLOGY NOW HOURS AHEAD DAYS AHEAD

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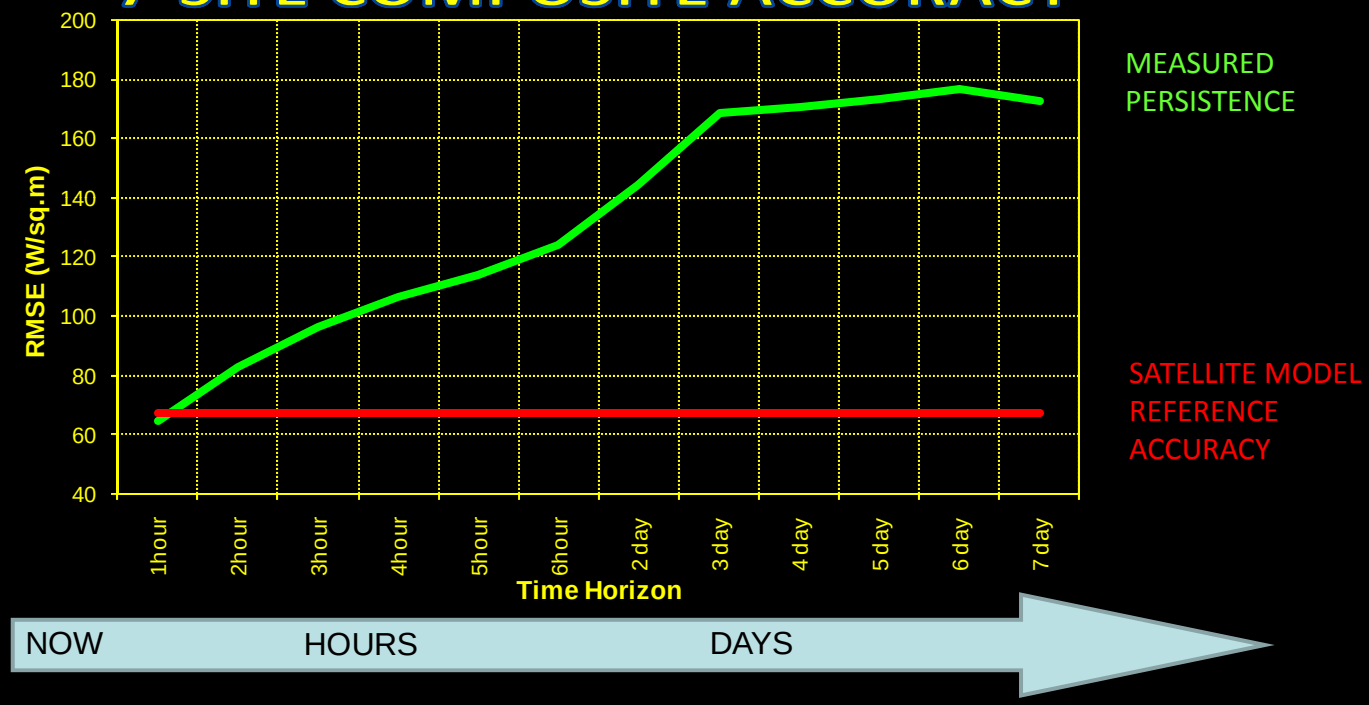
7-SITE COMPOSITE ACCURACY



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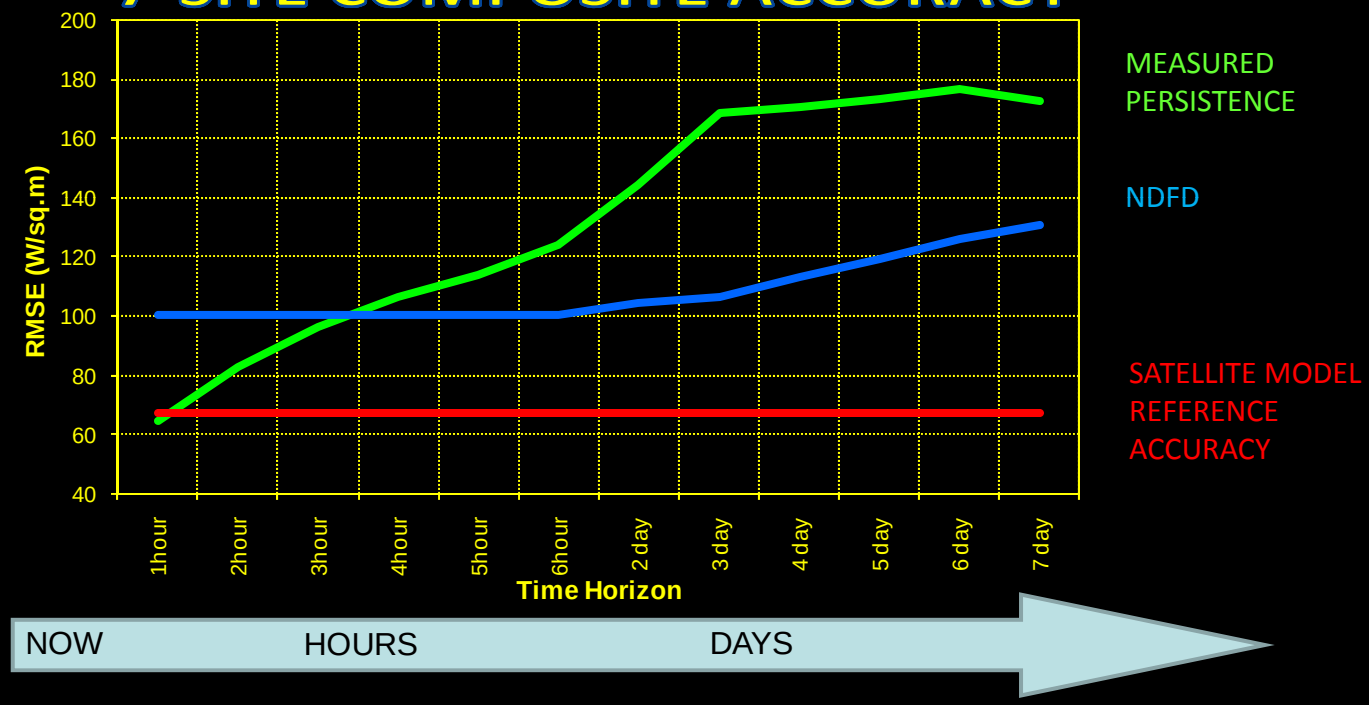
7-SITE COMPOSITE ACCURACY



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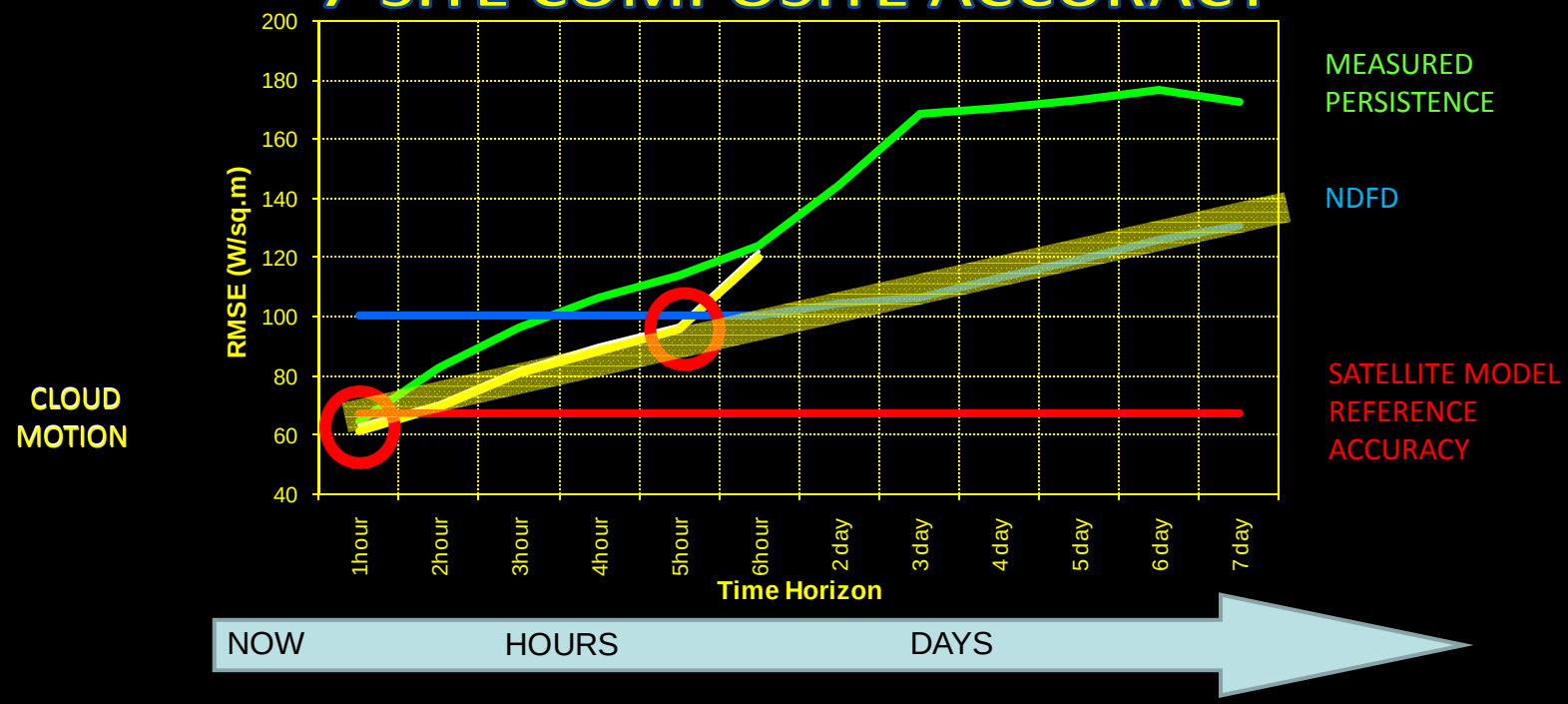
7-SITE COMPOSITE ACCURACY



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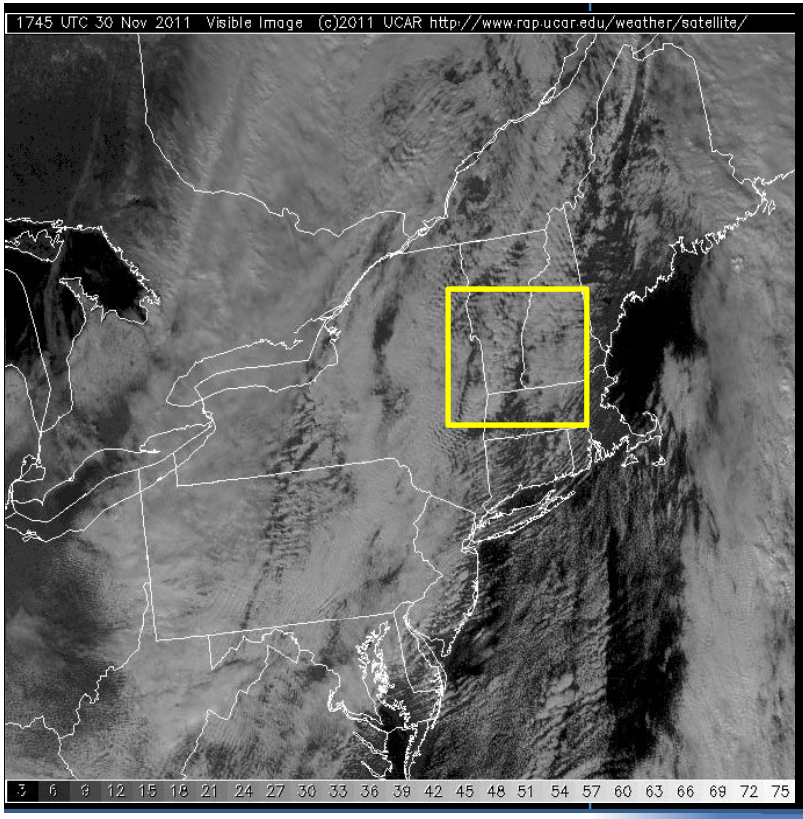
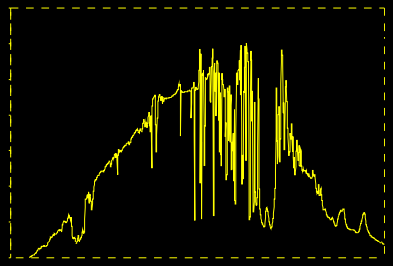


CLIMATOLOGY NOW HOURS AHEAD DAYS AHEAD

1 MINUTE DATA OR LESS



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CLIMATOLOGY NOW HOURS AHEAD DAYS AHEAD

1 MINUTE DATA OR LESS

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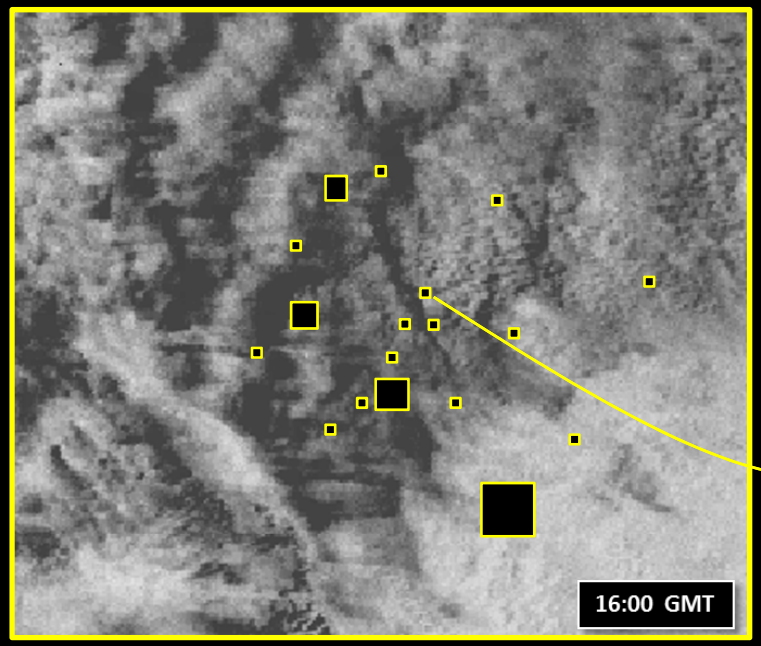

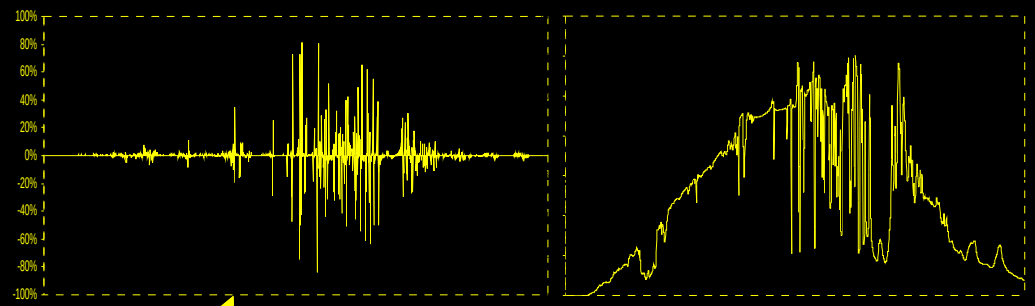

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FLEET OF SYSTEMS ?

CLIMATOLOGY NOW HOURS AHEAD DAYS AHEAD

1 MINUTE DATA OR LESS

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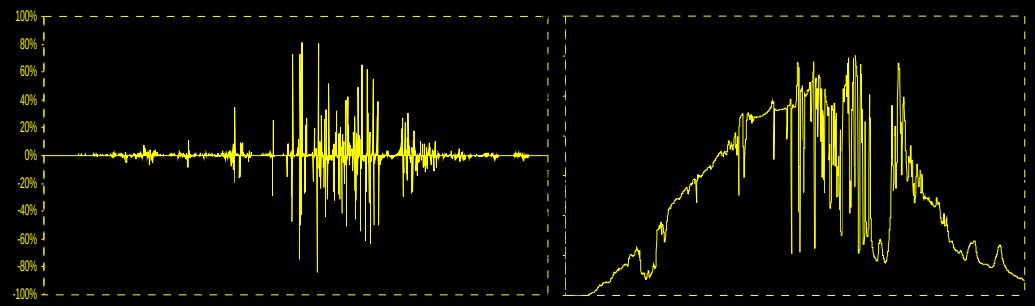
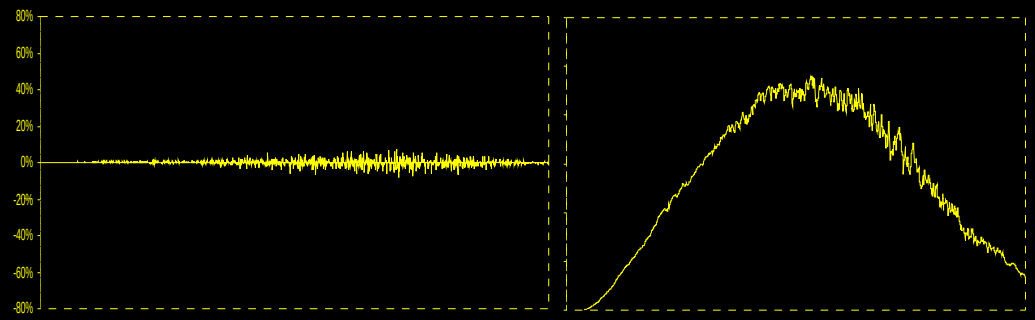
Variability = $\sigma(\Delta kt^*)$

Relative Variability = $\underline{1/\sqrt{N}}$
N locations



SINGLE LOCATION



20 UNCORRELATED LOCATIONS

How does correlation vary with distance and time scale ?

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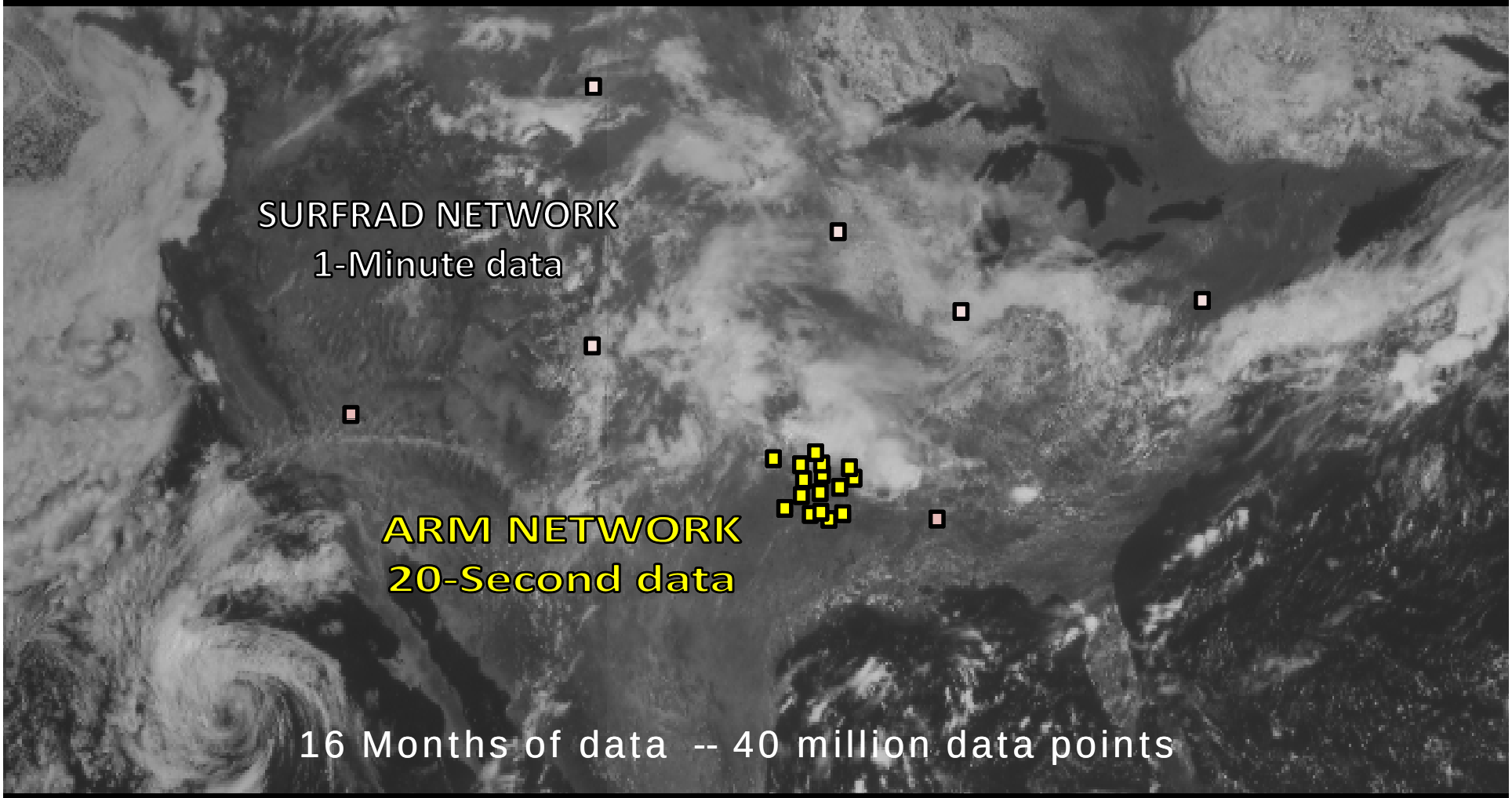

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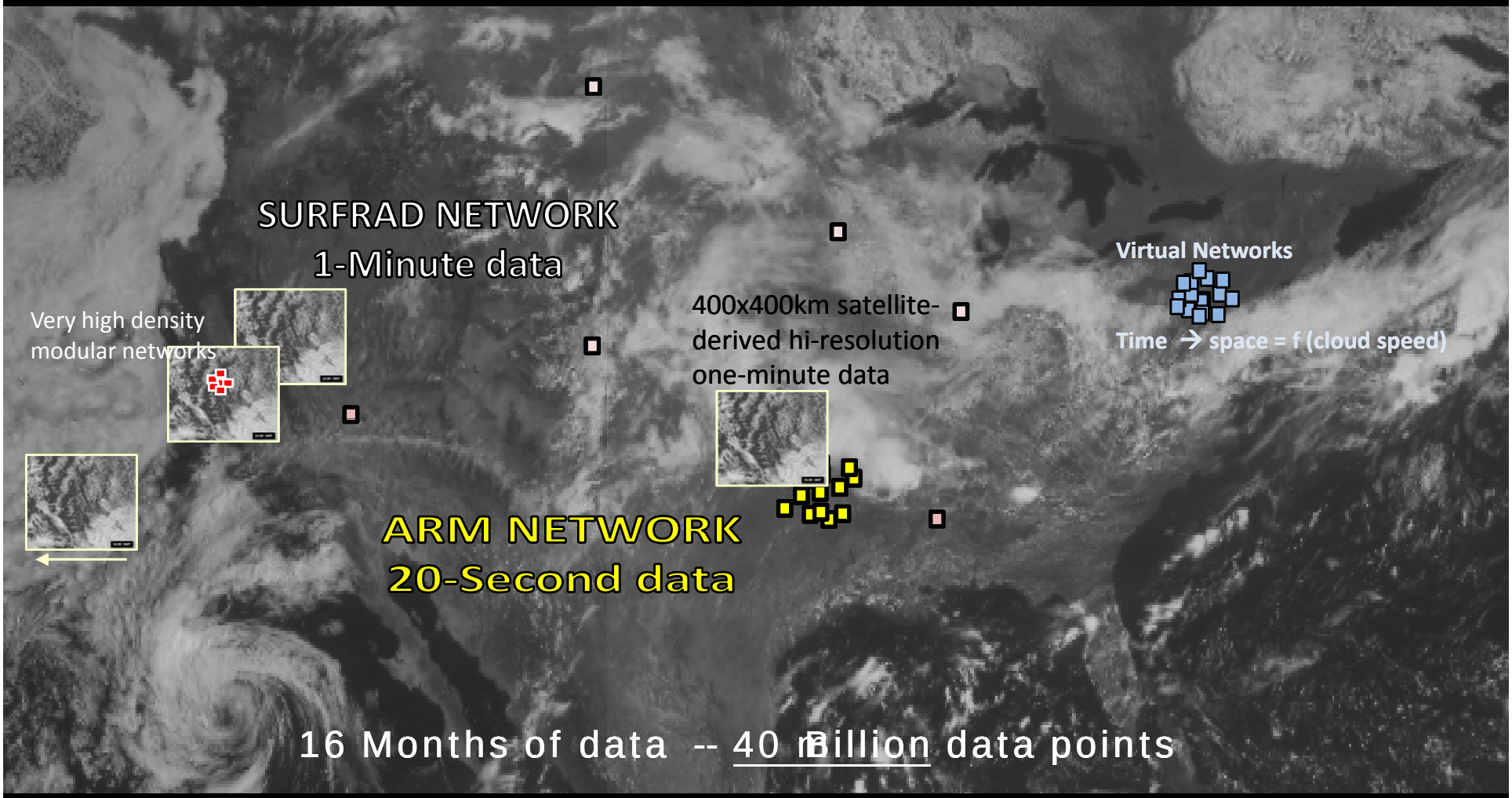

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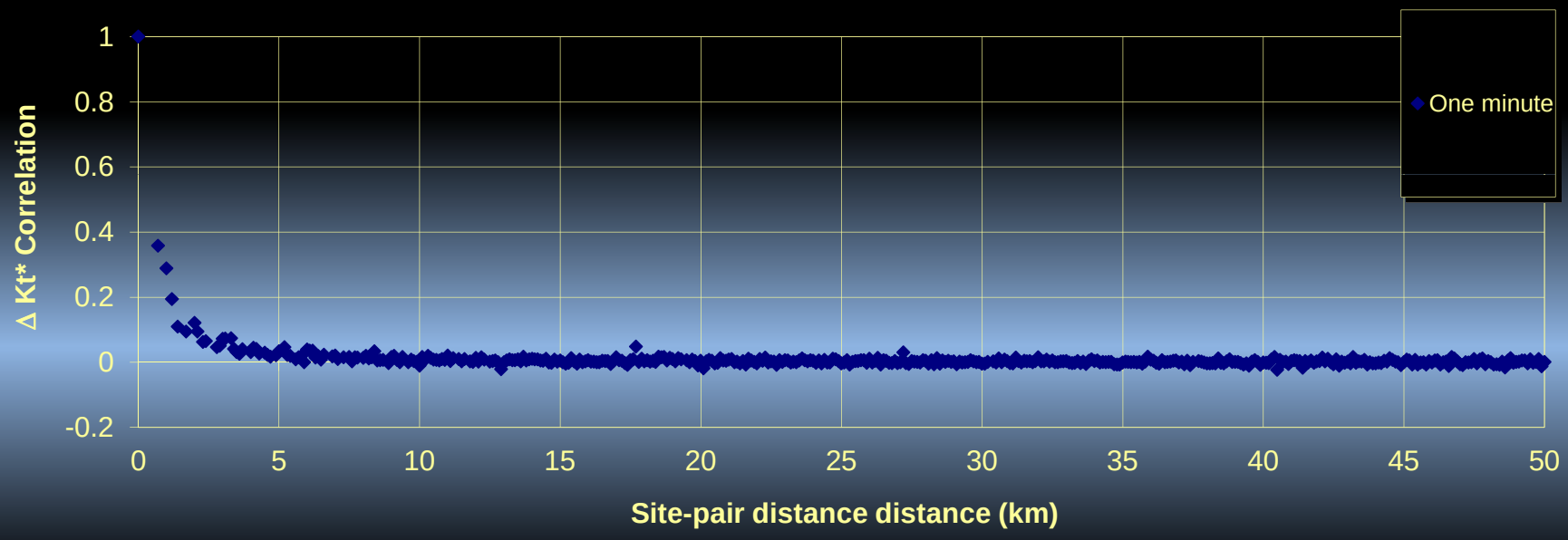

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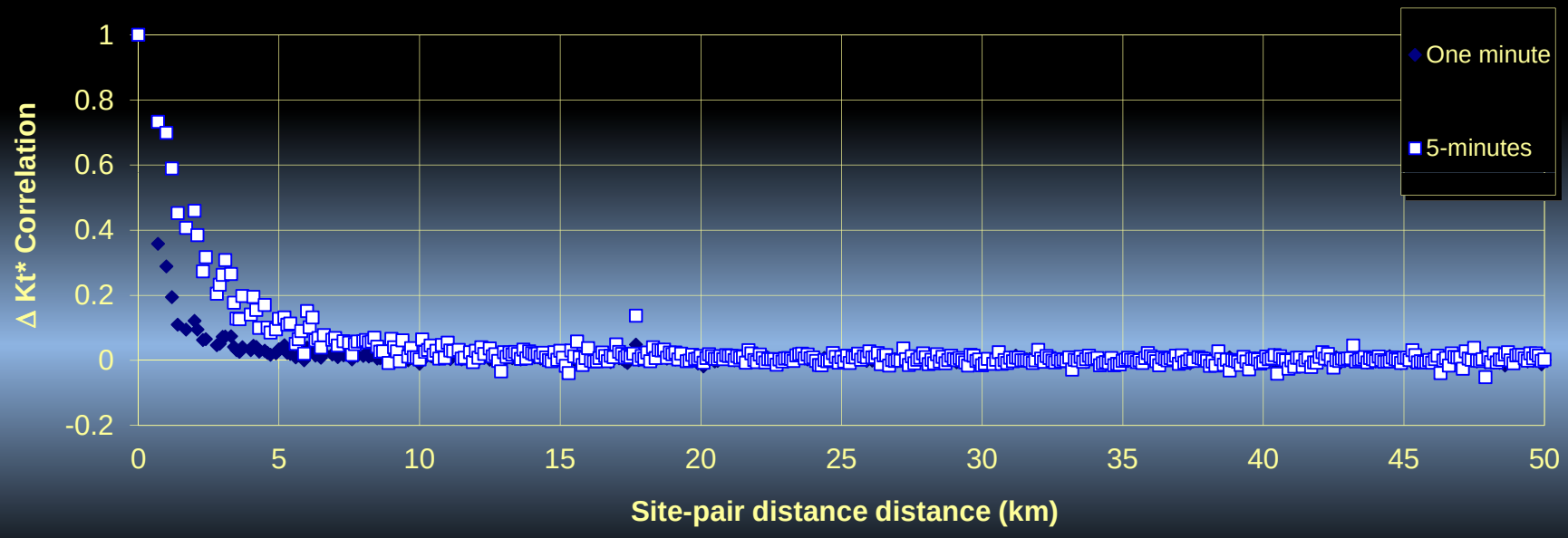

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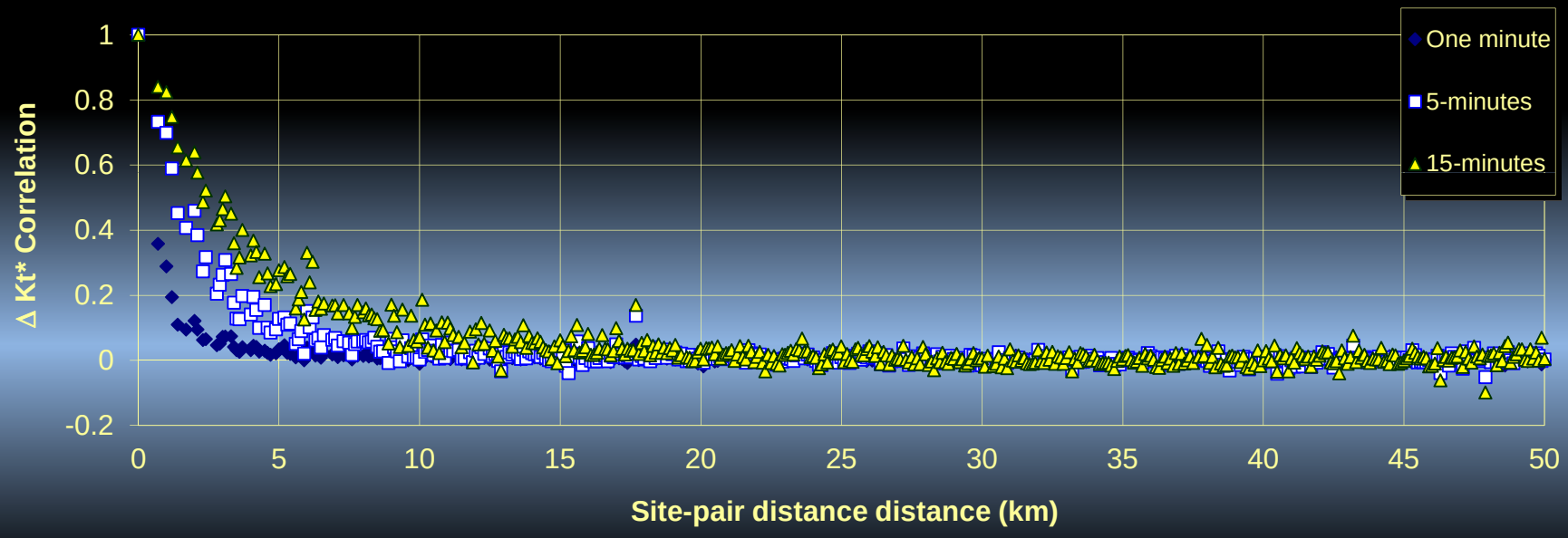

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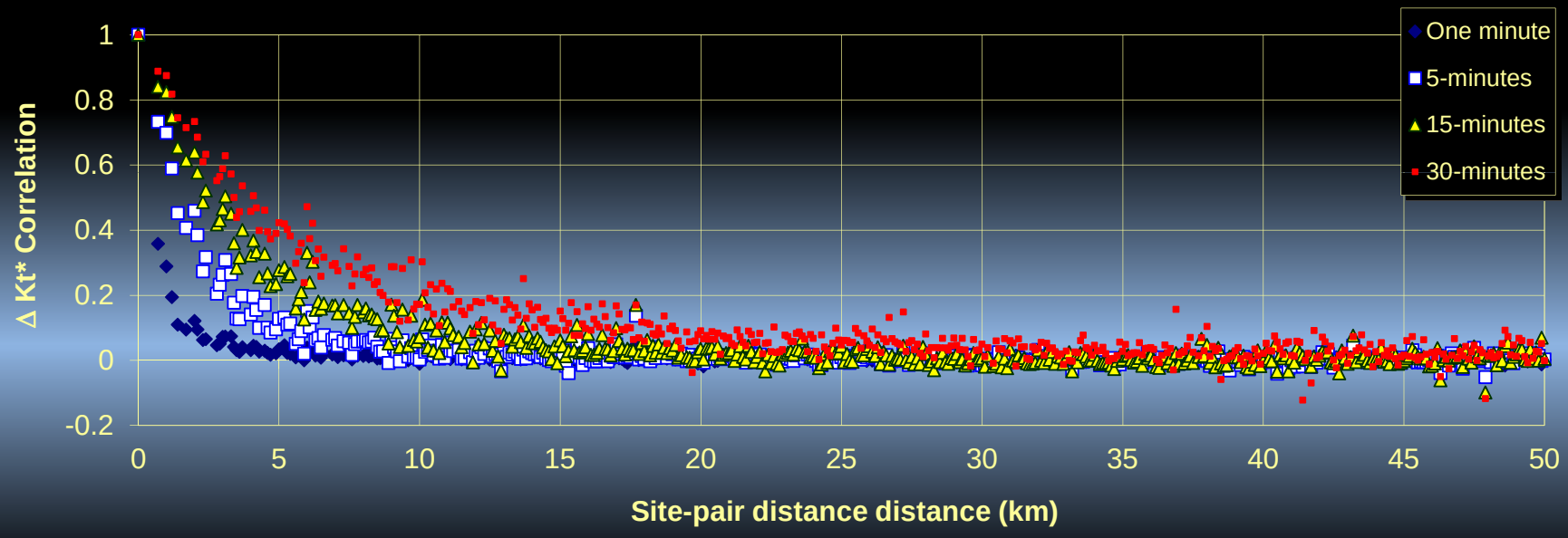

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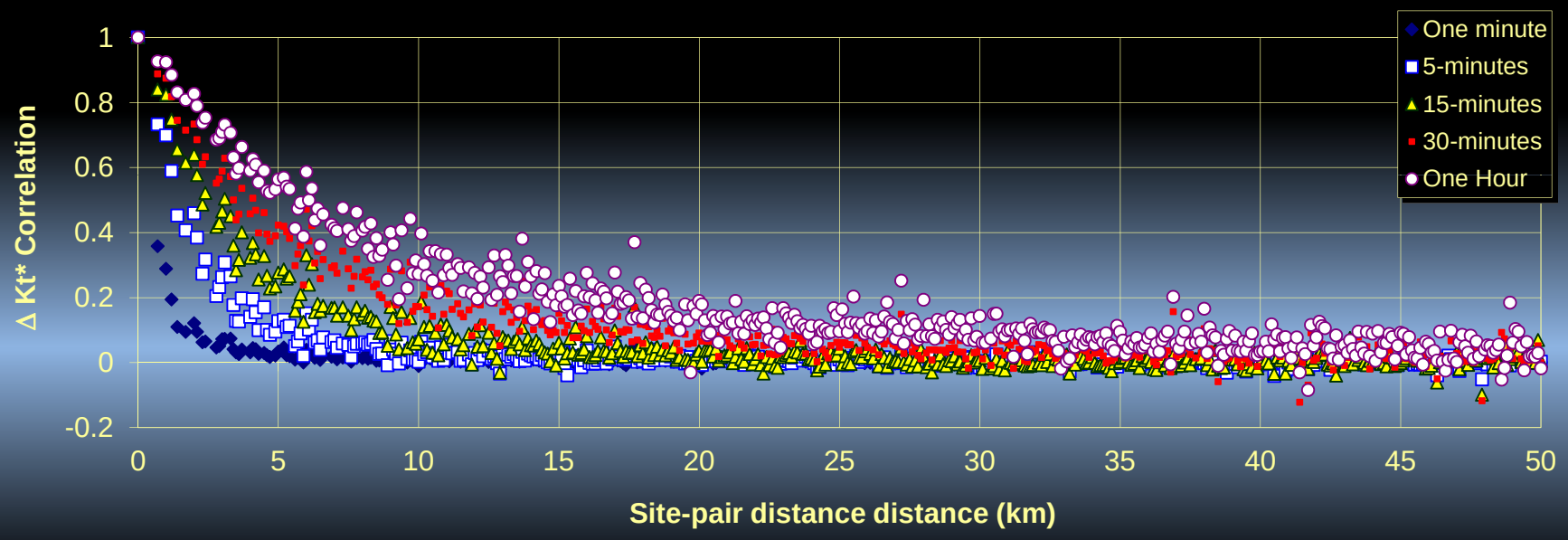
HAWAII LAND Nov 2011

CLOUD SPEED 13 km/h



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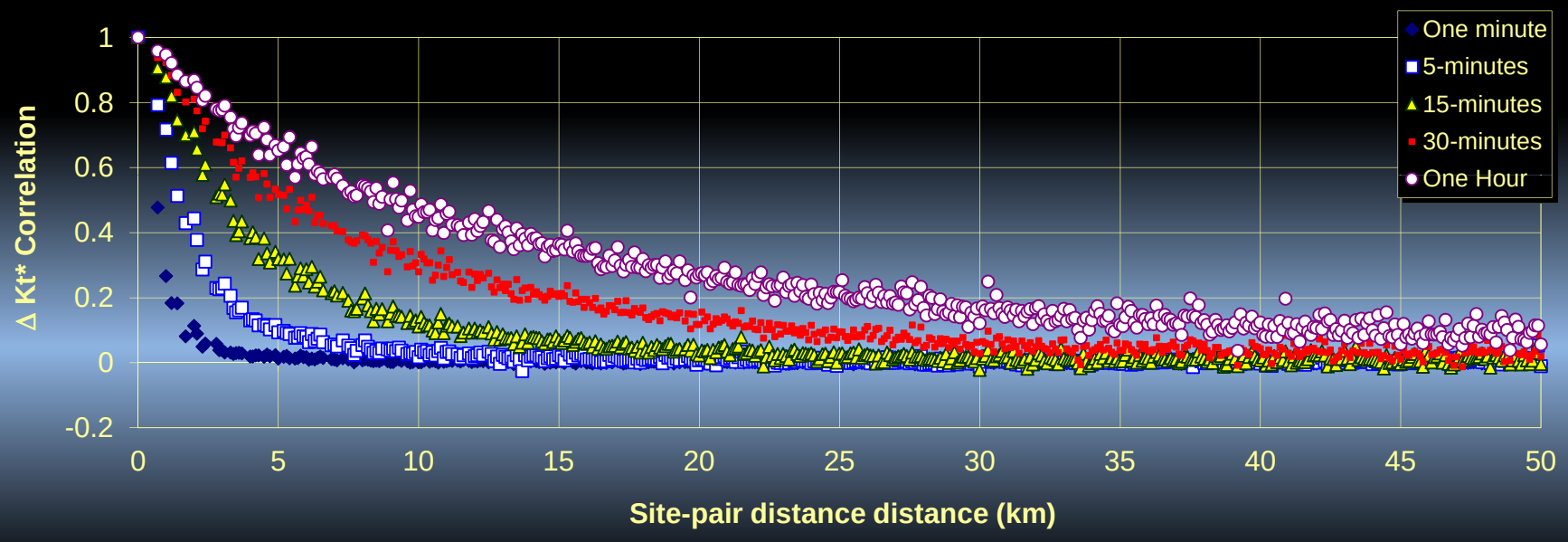
NEVADA Jun 1998

CLOUD SPEED 24 km/h



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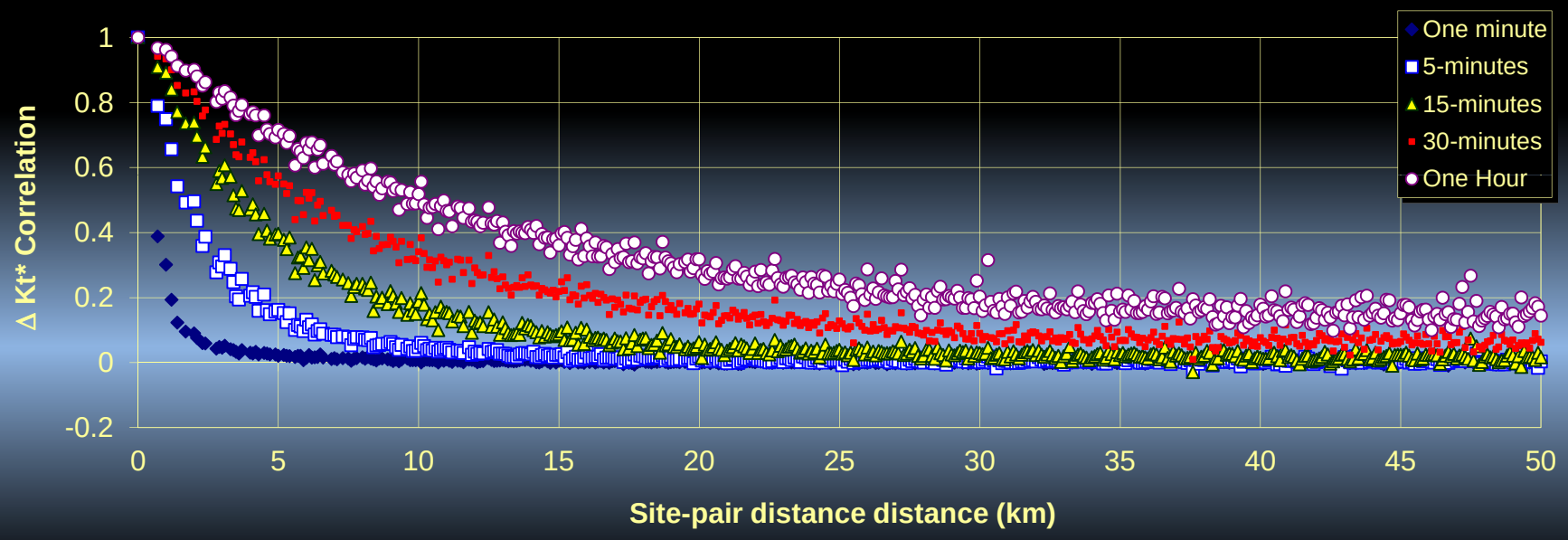
HAWAII Dec 2010

CLOUD SPEED 26 km/h



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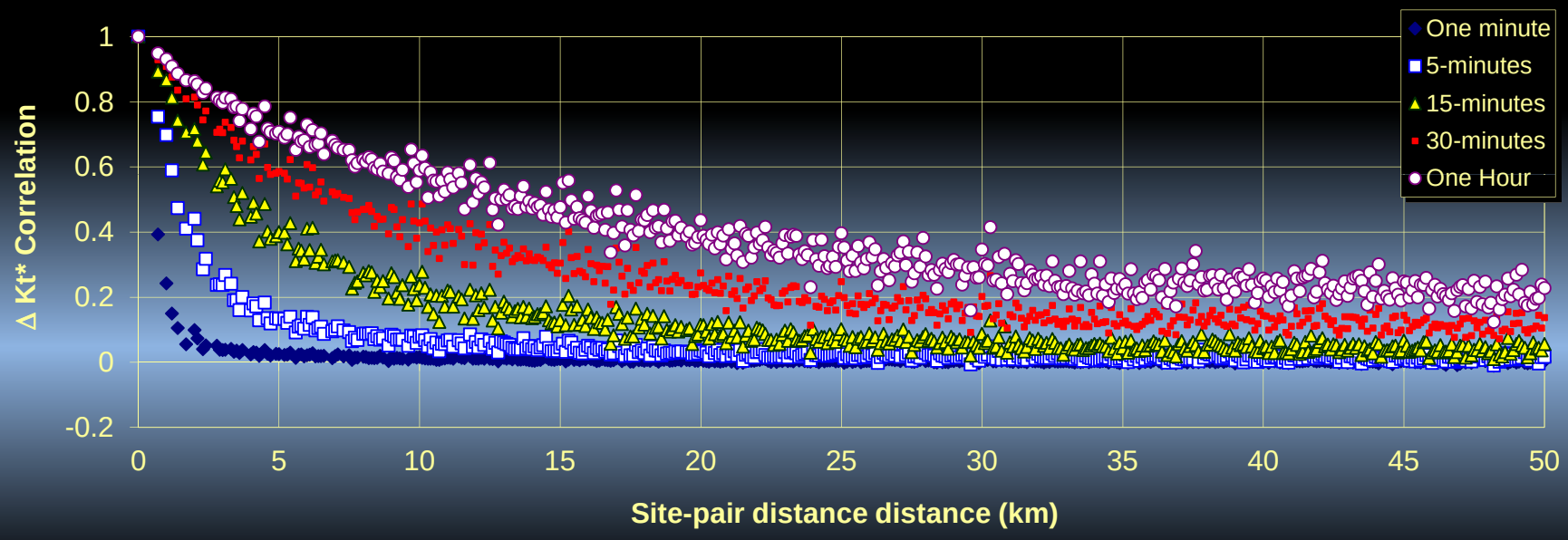
CENT. CALIFORNIA Mar 1998

CLOUD SPEED 30 km/h



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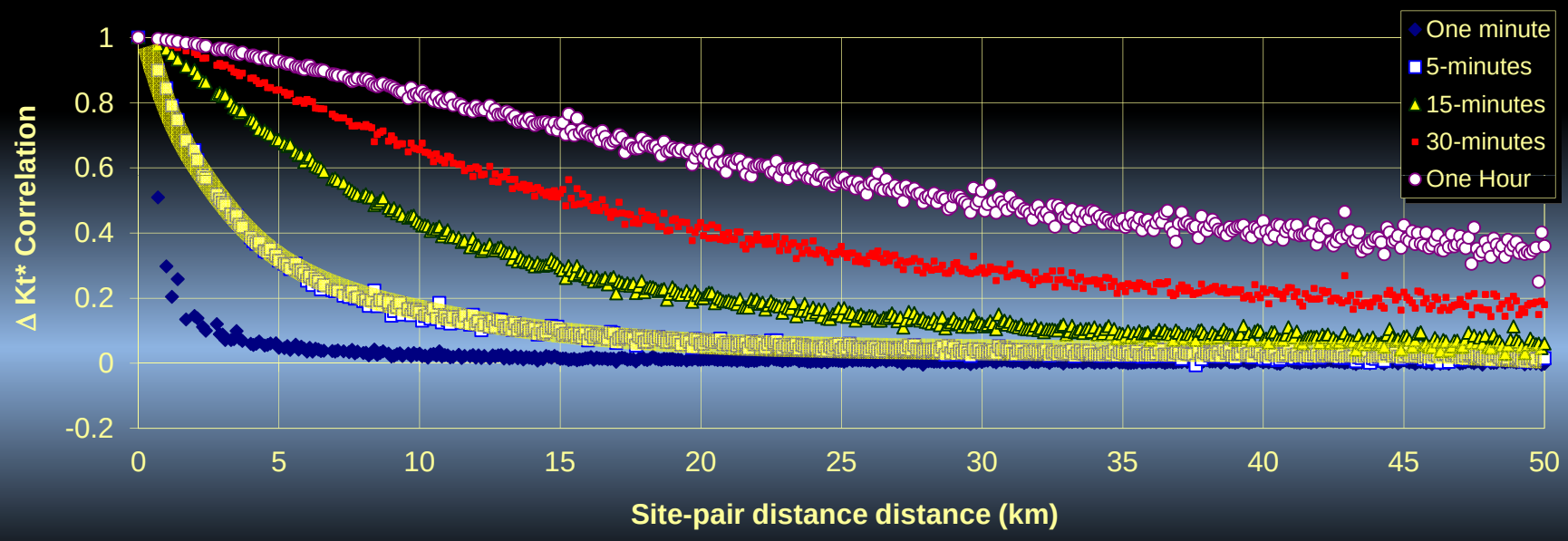
$$C_{pair} = e^{\frac{x \ln(0.2)}{1.5\,\Delta t\,CS}}$$

SOUTH GT. PLAINS Dec 2010

CLOUD SPEED 44 km/h



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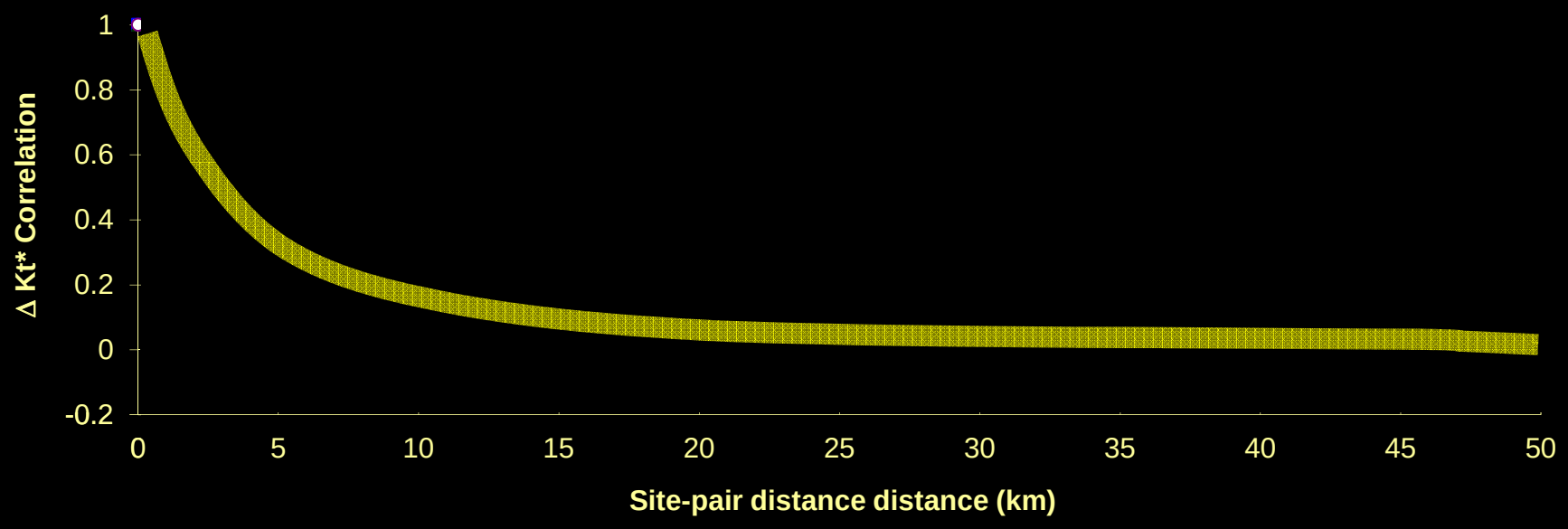
$$C_{pair} = e^{\frac{x \ln(0.2)}{1.5\, \Delta t\, CS}}$$



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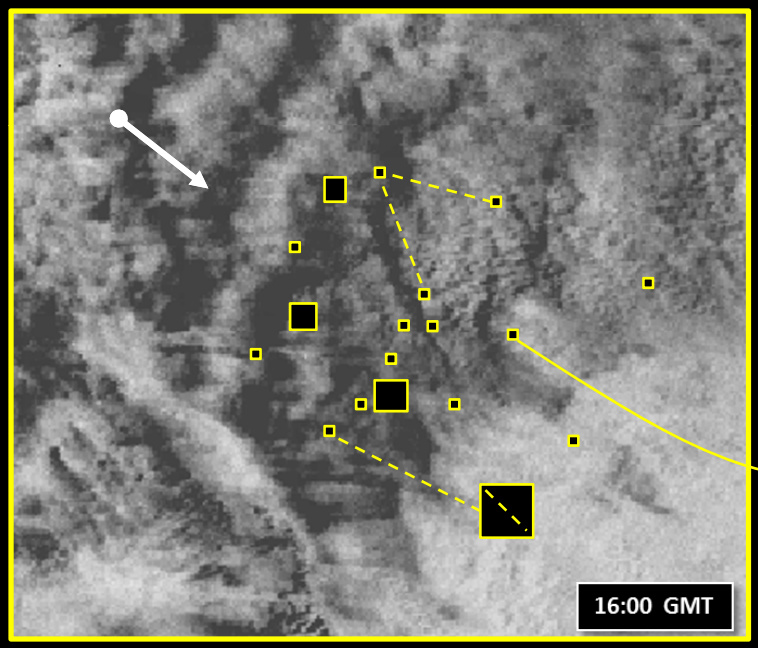
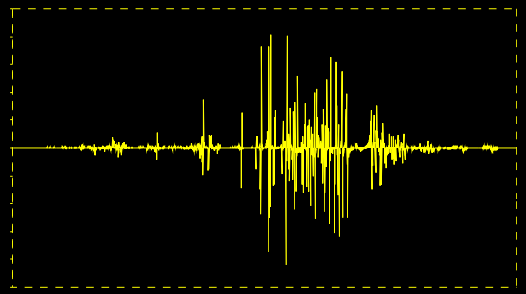
$$C_{pair} = e^{\frac{x \ln(0.2)}{1.5 \Delta t \, CS}}$$

CLOUD SPEED

ΔT

DISTANCES





CPR HI-RES HI-FREQUENCY PV FLEET MODELING

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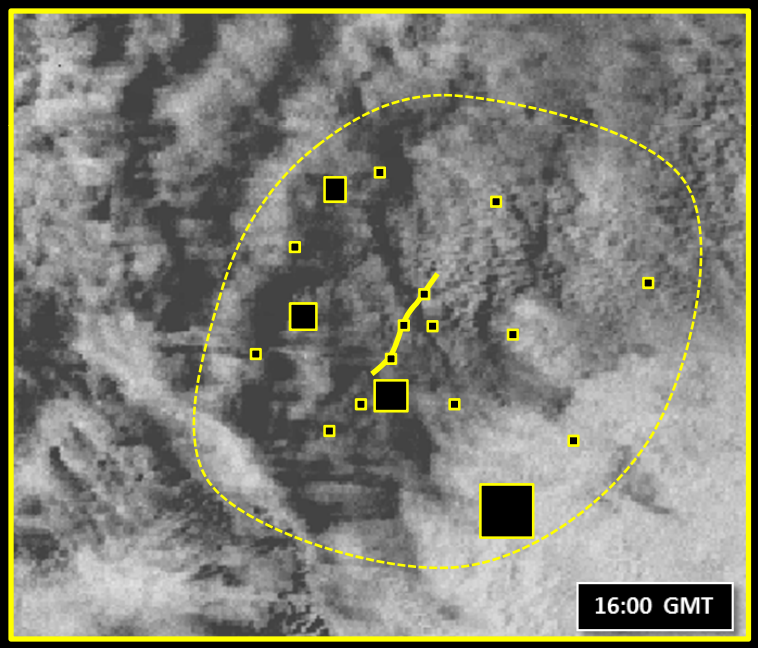
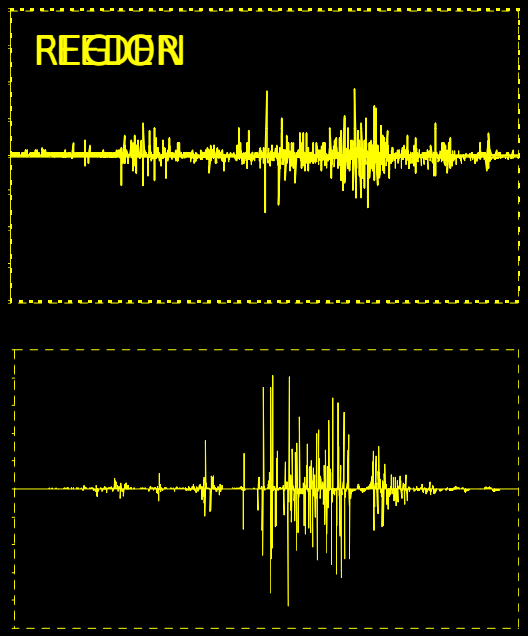
CORRELATION MATRICES





CPR HI-RES HI-FREQUENCY PV FLEET MODELING

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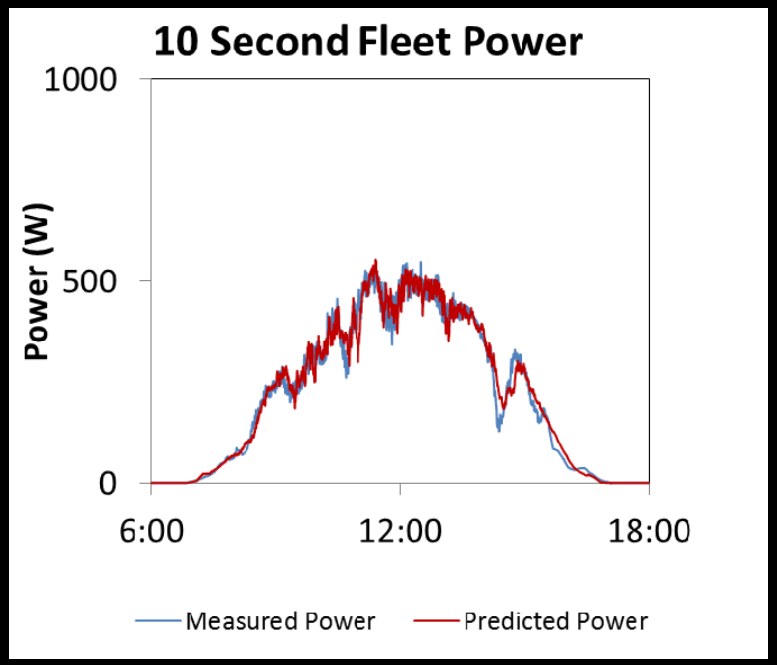
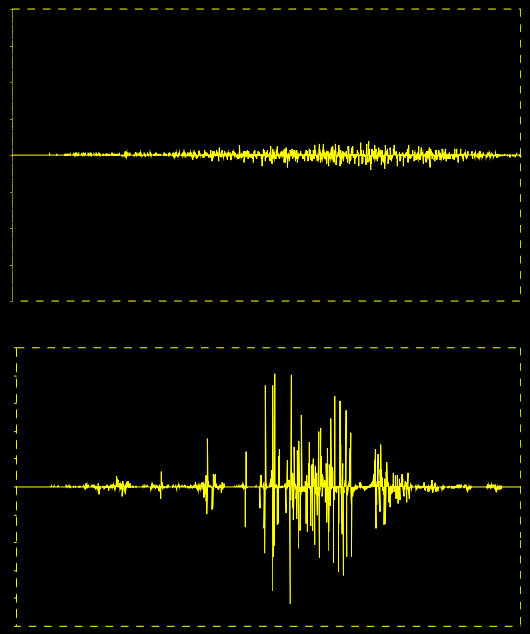
Measured and simulated 10 second data from 25 locations in a 4 km x 4 km grid in Napa on Nov. 21, 2010





CPR HI-RES HI-FREQUENCY PV FLEET MODELING

1998 Hour ahead

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