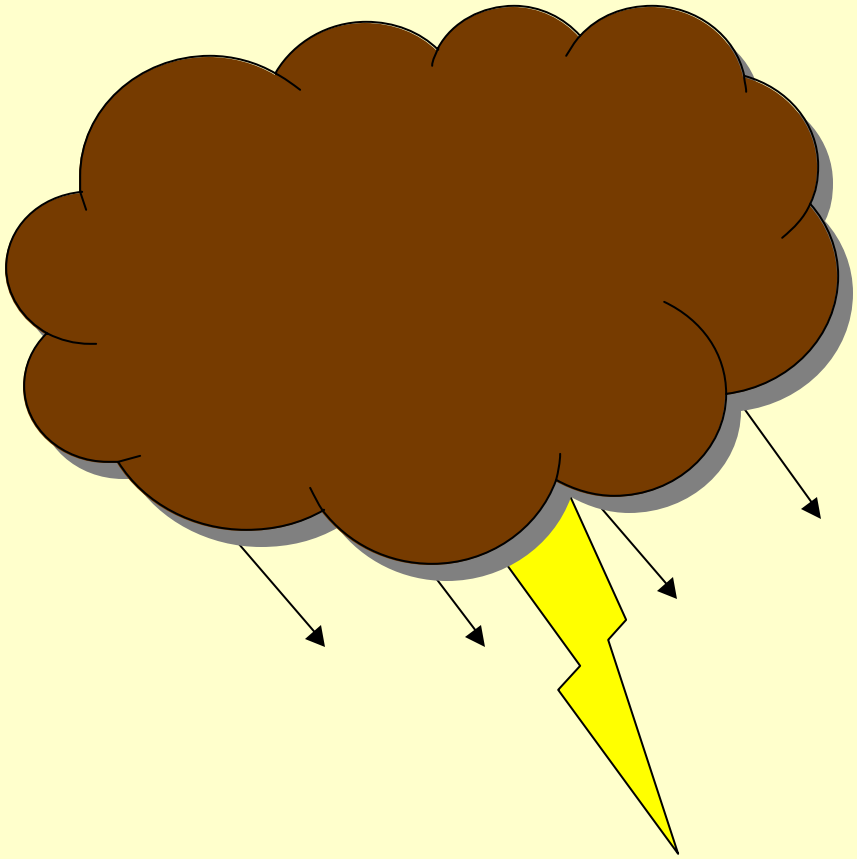
NE-RAMS Meteorological Modeling Project

VTAPCD NOAA/ARL



AD-HOC Met Modeling Meeting CHICAGO July 30 – 31 2002

NE-RAMS STUDY Summer 1999

"An Evaluation of an Operational Mesoscale Meteorological Model in Predicting Surface Wind Fields and Temperatures Over Complex Terrain and Coastal Regions of the Northeastern U.S."

Cooperative Study between NOAA-ARL & VTAPCD

Principals Involved:

Jeff McQueen	**NOAA-ARL(previously)**
Cliff Johnson	**NOAA-ARL**
Paul Wishinski	**VTAPCD**
Dan Riley	**VTAPCD**
Rich Poirot	**VTAPCD**

PURPOSE OF THE STUDY

DOES THE RAMS MODEL PRODUCE

"MORE REPRESENTATIVE" WIND FIELDS for NEW ENGLAND

THAN OTHER AVAILABLE 3-DIMENSIONAL WIND FIELDS?

HOW WELL DOES RAMS REPLICATE MEASURED METEOROLOGICAL PARAMETERS

AT THE SURFACE AND IN THE LOWER BOUNDARY LAYER?

HOW INTENSIVE AN EFFORT IS IT

TO CONFIGURE RAMS TO ROUTINELY GENERATE

HIGH RESOLUTION SPATIAL AND TEMPORAL WIND FIELDS

FOR THIS REGION?

Archived 3-D Fields could potentially be used for:

1. **REGIONAL AIR QUALITY MODEL INPUT**
2. **METEOROLOGICAL FIELDS for use in calculating**

   "local scale" AIR MASS BACK-TRAJECTORIES

OPERATIONAL SETTINGS for RAMS

RAMS-NE STUDY

RAMS OPERATIONAL RUN NUMERICS & PHYSICS

Table 2. RAMS operational run numerics and physics.

Model	**Option used**
Basic Equations	Compressible, non-hydrostatic
Numerics	
Time differencing	Forward-backward time-split
Space differencing	Second-order flux form
Horizontal coord.	Oblique stereographic
Vertical coord.	Terrain following Z'
Physics	
*Radiation	Harrington and Olson (1999) long/short wave
*Moist processes	Explicit microphysics for rain, cloud, Rain-rad=3 mm, Cloud ccn=9E+8
*Cumulus	None
X-Y diffusion	Deformation K (first-order)
PBL turbulence	Prognostic turbulent kinetic energy equation (level 2.5)
Surface layer	Louis (1979)
Surface model	Tremback-Kessler (1985) and LEAF-2 land-surface model
Boundary conditions	
Lateral boundaries	Davies Sponge blending (5 pts)
Top boundary	Nudging to EDAS above 16 km
Initialization	Isentropic Initialization
Input Meteorology	EDAS analysis at 00 and 12 UTC
Assimilation	EDAS 3 hr analysis at lateral boundaries
Input surface	30' resolution terrain, land-cover, constant soil type (sandy-clay-loam) * Initial soil wetness : 0.40
Seas	Ocean temperature : EDAS 32 km; Lake temperature : Poirot average

The * identifies parameters which were experimented with before final simulations were run.

RAMS OPERATIONAL RUN PARAMETERS : DOMAIN

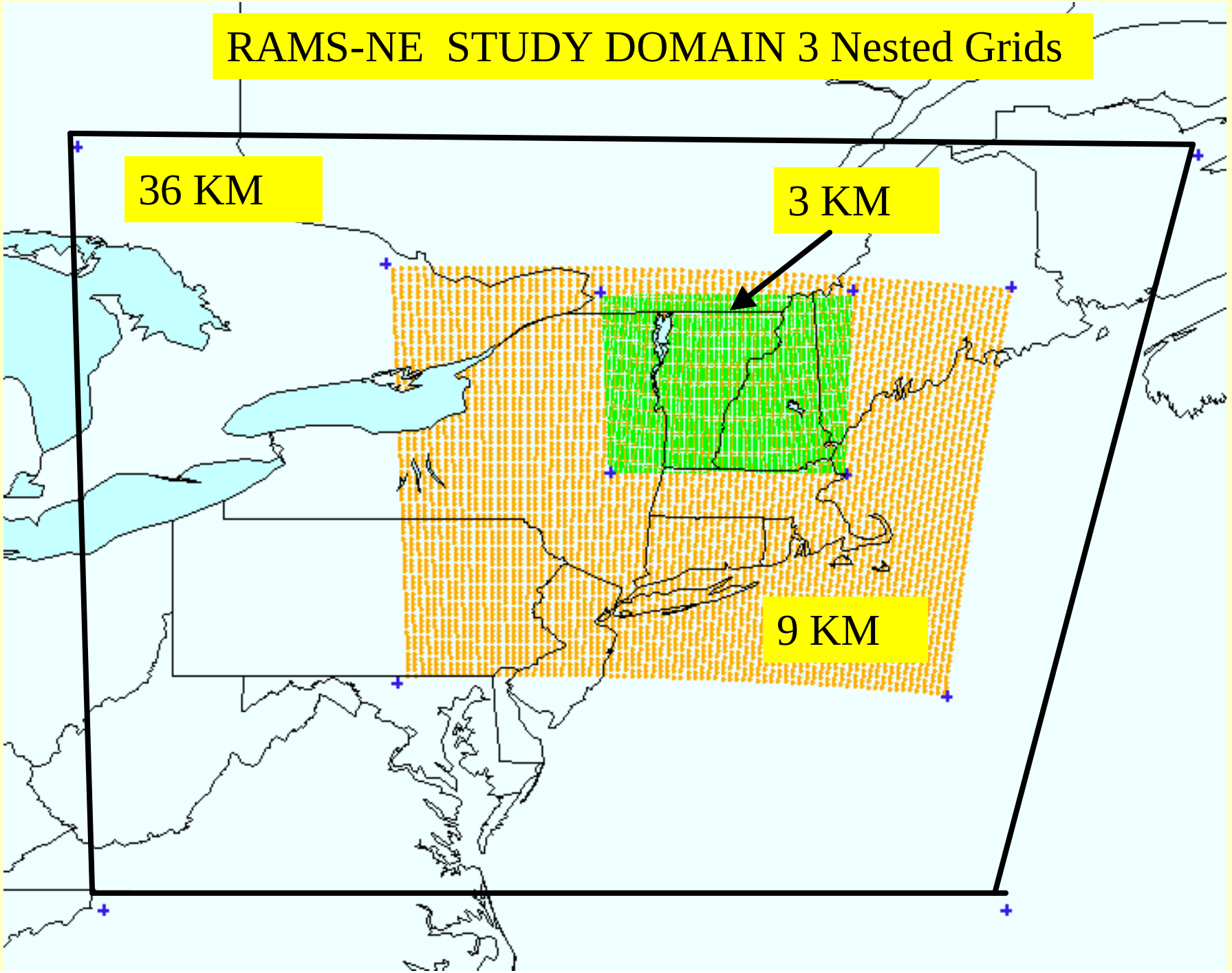
Table 3. RAMS operational run parameters.

Grid #	1	2	3
ΔX (km)	36	09	03
Δt (sec)	90	30	10
NX	37	78	96
NY	37	74	96
NZ	29	29	29
ΔZ_1	50 m	50 m	50 m
ΔZ Max	1350 m	1350 m	1350 m
Ztop	19. 3 km	19 3 km	19.3 km
Center lat	42.5 N	42.68 N	43.98 N
Center lon	72.5 W	73.19 W	72.30 W
SW Lat	36.31 N	39.62 N	42.68 N
SW Lon	81.51 W	77.18 W	74.05 W
K_h	1.0	1.0	1.0

ΔX is the model grid spacing, Δt is the model time step and NX, NY and NZ are the number of saved grid points in the X, Y and Z direction, respectively. ΔZ_1 is the depth of the first model layer closest to the ground and ΔZ Max is the depth of the coarsest model vertical layer. K_h is the horizontal diffusion coefficient used.

DOMAIN UTILIZED

RAMS-NE STUDY


RAMS-NE STUDY DOMAIN 3 Nested Grids
36 KM
3 KM
9 KM

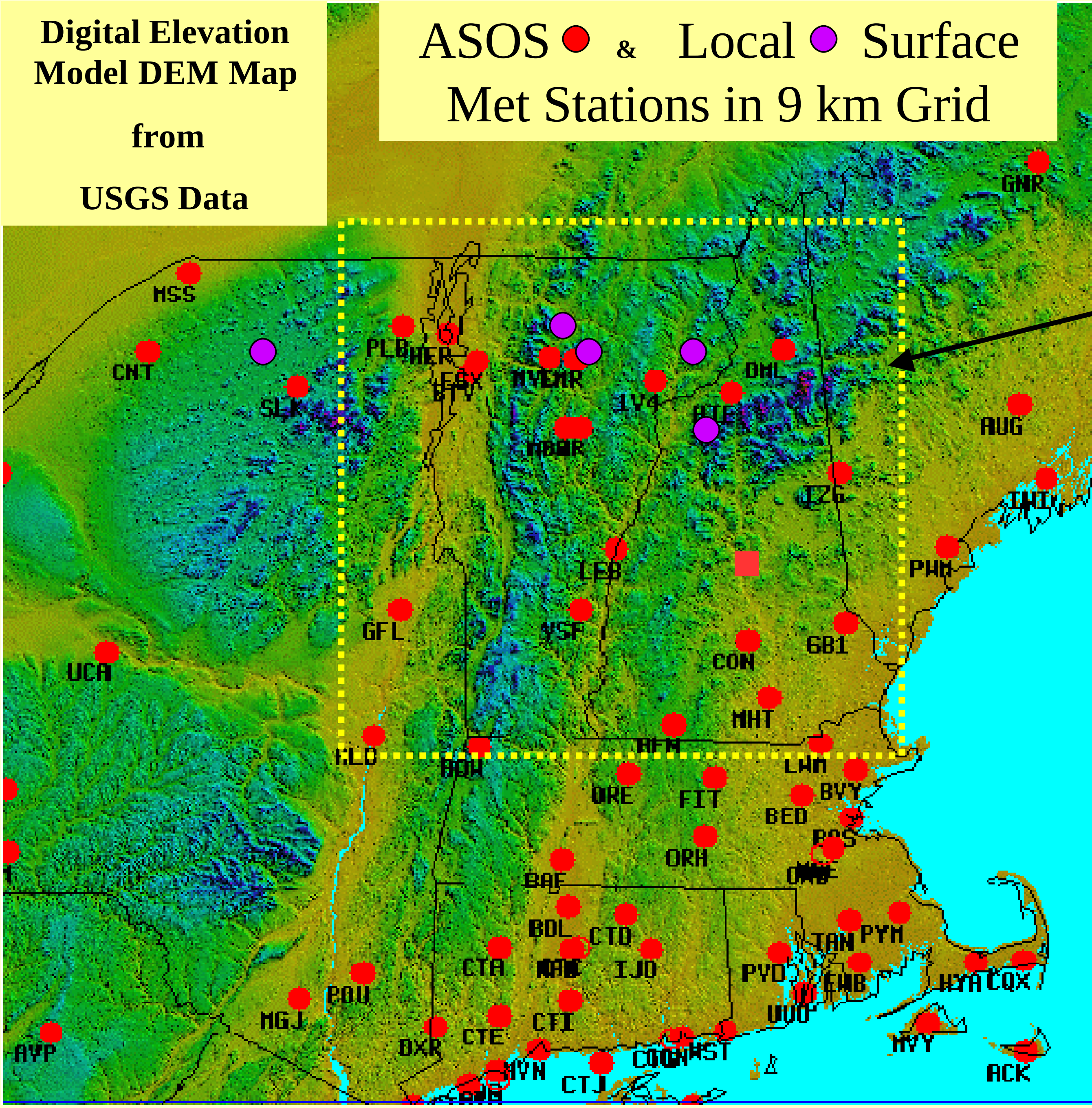
Digital Elevation Model DEM Map

from

USGS Data

ASOS ● & Local ● Surface Met Stations in 9 km Grid

3 Km Grid Domain



CHARACTERIZATION of SITES and METEOROLOGY for STATISTICAL ANALYSIS in RAMS NE STUDY

METEOROLOGICAL OBSERVATION-SITE CHARACTERIZATION

1) **Plain or Broad Valley** – Where **terrain higher than 500 meters is generally greater than 10 km. distant**. Less than 10 km distant the terrain is most generally defined as gently rolling.

2) **Complex Terrain (Valley)** - The site may be generally defined as in a local valley of sufficient depth and steepness of slope that atmospheric valley characteristics such as **local inversions occur and the site is well sheltered from prevailing winds**.

3) **Complex Terrain (High Elevation)** – The site may be generally defined as a **"hilltop" or "ridgeline" location** where horizontal wind-flow reaching the site is generally unimpeded by other terrain features.

4) **Complex Terrain (Other)** – All other sites where 2 or 3 are not satisfied with a 'significant amount of steep terrain' higher than the ASOS site elevation (e.g. a site **on a mountainside, or in proximity to steep terrain with insufficient vertical extent to have valley characteristics**).

5) **Coastal Regime** – Where site is **less than 10 km. from a coastline**.

NOTE: Specific definitions of "hilltop" and "ridgeline" were used but these are not included here for brevity.

12 CRITERIA for Hrly METEOROLOGICAL CATEGORIZATION

Table 1. Criteria for Meteorological Categories.

Category	Wind Speeds (knts)	Thermal Stability*	Dewpoint Temperature(F)
1	<4	0	
2	>4	0	
3	<5	1	
4	>5	1	
5	<5	2	<58
6	<5	3	<58
7	<5	2	>58
8	<5	3	>58
9	>5	2	<58
10	>5	3	<58
11	>5	2	>58
12	>5	3	>58

*- Thermal Stability

0 - Surface Temperature <= 850 mb Temperature

1 - The difference between the surface and the 850 mb temp is between 0 and 7.5 C.

2 - The difference between the surface and the 850 mb temp is between 7.5 and 15 C.

3 - The difference between the surface and the 850 mb temp is greater than 15 C.

DESCRIPTION OF 7 METEOROLOGICAL REGIMES EXAMINED

(Based on Measurements at ASOS locations)

Table 1. Criteria for Meteorological Categories.

Category	Wind Speeds (knts)	Thermal Stability*	Dewpoint Temperature(F)
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7	<5	2	>58
8	<5	3	>58
9	>5	2	<58
10	>5	3	<58
11	>5	2	>58
12	>5	3	>58

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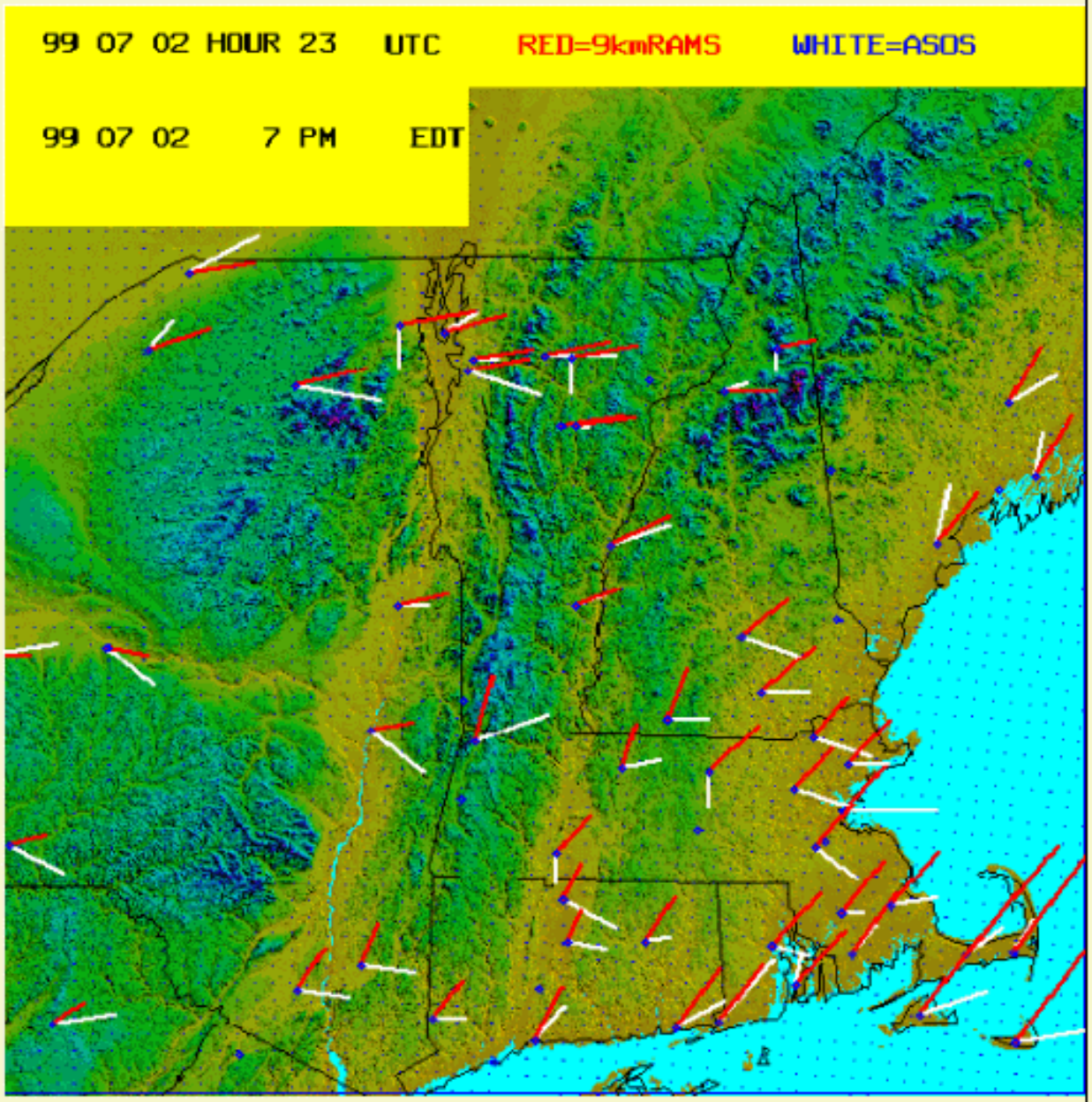
1. **LOW WIND SPEED: Hrly met criteria 1, 3, 5, 6, 7, 8**
2. **HIGH WIND SPEED: Hrly met criteria 2, 4, 9, 10, 11, 12**
3. **STABLE CONDITIONS: Hrly met criteria 1, 2, 3, 4**
4. **"Conditionally" UNSTABLE: Hrly met criteria 1, 5, 7, 9, 11**
5. **UNSTABLE CONDITIONS: Hrly met criteria 6, 8, 10, 12**
6. **POLAR CONTINENTAL: Hrly met criteria 5, 6, 9, 10**
7. **TROPICAL MARITIME: Hrly met criteria 7, 8, 11, 12**

WINDS

HOUR by HOUR

GRAPHICAL COMPARISON of RAMS Hourly WIND predictions

to ASOS (and LOCAL) surface measurements



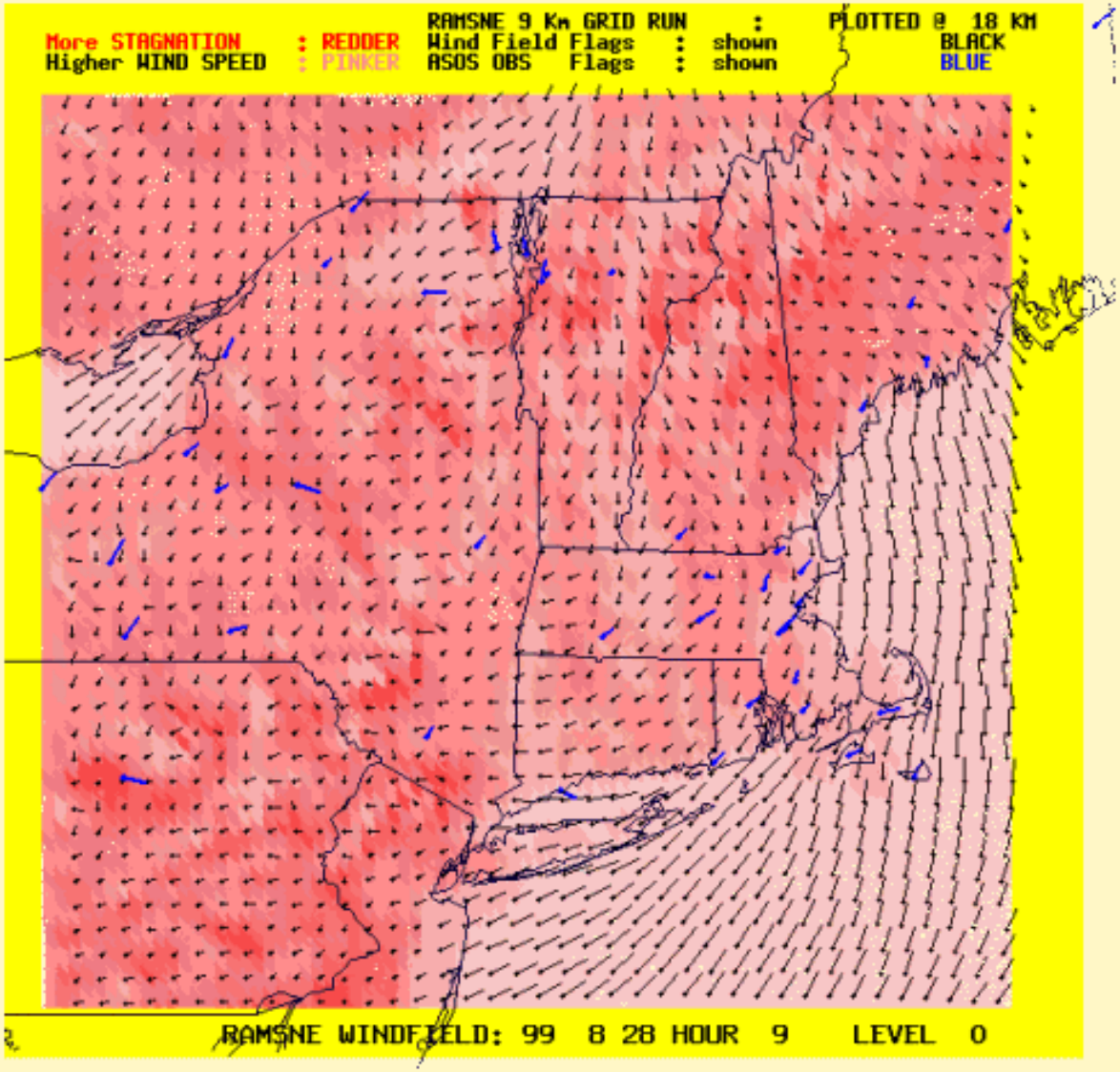
Hrly Comparison of Wind Speed & Direction

Shown as a "flag" at each measurement site

RAMS winds determined by vector average of the 2, 3, or 4 field grid point predictions nearest to measurement for that hour.

ASOS value is a

three-minute vector average wind at top of the hour



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Shown as a "flag" at each measurement site

RAMS winds determined by vector average of the 2, 3, or 4 field grid point predictions nearest to measurement for that hour.

ASOS value is a

three-minute vector average wind at top of the hour

Play Cape-Cod July
99 Movie of Surface
Winds

WINDS

HOUR by HOUR

STATISTICAL COMPARISON of RAMS Hourly WIND predictions to ASOS Surface Measurements

showing

Comparative "Improvement" seen over 80 Km EDAS Archived Field representation

Table 5 Comparison Between NERAMS 03 Km Grid and EDAS 80 Km Archive

Site CATEGORY # 4 COMPLEX TERRAIN (OTHER)

Met Category	WERR 03 Grid	**WDBIAS** 03 Grid	WSBIAS 03 Grid	WERR 80 Grid	**WDBIAS** 80 Grid	WSBIAS 80 Grid	Site-Hours
Low Wind Speed	2.08	5.3	0.3	2.25	4.6	0.6	1150
High Wind Speed	2.6	9.2	-1.0	2.53	**14.5**	-0.4	1675
Stable Conditions	2.04	**7.9**	-0.2	2.14	1.6	0.2	1350
Conditionally Unstable	2.42	6.6	-0.5	2.43	**12.6**	-0.1	1550
Unstable Conditions	2.74	12.4	-0.8	2.95	**17.5**	-0.1	310
Polar Continental	2.69	4.3	-1.0	2.61	**19.5**	-0.4	760
Tropical Maritime	2.69	10.5	-0.5	2.75	**18**	-0.1	725

Highlighted values are for wind direction bias over the domain which are significantly higher for one meteorological grid prediction than the other. Direction bias "WDBIAS" is in degrees. Positive values imply clockwise directional bias.

Site-Hours is only a representative value which is approximately the average number of Site-Hours for both grids compared.

WERR = SQRT { (Umodeled – Umeasured) **2 + (Vmodeled – Vmeasured) **2 }

WDBIAS = Average scalar difference between Modeled and Measured Wind Angle in Degrees

WSBIAS = Average scalar difference between Modeled and Measured Wind Speed in m/sec

NOTE: Values are averaged over all matched hours examined

Table 5.(cont) Comparison Between NERAMS 03 Km Grid and EDAS 80 Km Archive

Site CATEGORY # 1 PLAIN OR BROAD VALLEY

Met Category	WERR 03 Grid	**WDBIAS** 03 Grid	WSBIAS 03 Grid	WERR 80 Grid	**WDBIAS** 80 Grid	WSBIAS 80 Grid	Site-Hours
Low Wind Speed	2.09	-0.6	0.6	2.17	**-7.0**	0.5	1500
High Wind Speed	2.89	5.8	-1.1	2.75	5.8	-0.9	2100
Stable Conditions	2.14	-1.7	0.0	2.14	**-7.1**	0.0	1625
Conditionally Unstable	2.58	4.7	-0.5	2.66	2.0	-0.4	2000
Unstable Conditions	3.22	2.5	-0.9	2.98	3.1	-0.6	365
Polar Continental	2.76	3.7	-0.7	2.74	**7.5**	-0.6	1225
Tropical Maritime	3.03	**11.7**	-0.8	2.97	5.8	-0.6	775

Site CATEGORY # 2 COMPLEX TERRAIN (VALLEY)

Met Category	WERR 03 Grid	**WDBIAS** 03 Grid	WSBIAS 03 Grid	WERR 80 Grid	**WDBIAS** 80 Grid	WSBIAS 80 Grid	Site-Hours
Low Wind Speed	2.42	-2.3	0.4	2.69	**8.1**	0.8	825
High Wind Speed	2.67	4.6	-1.1	2.66	**10.3**	-0.5	1075
Stable Conditions	2.36	-2.9	-0.3	2.63	-3.4	0.3	625
Conditionally Unstable	2.62	0.8	-0.5	2.67	**14.1**	-0.1	1100
Unstable Conditions	2.73	14.3	-0.7	2.82	**19.2**	0.1	195
Polar Continental	2.63	0.4	-0.5	2.62	**15.4**	-0.1	775
Tropical Maritime	2.71	9.3	-0.5	2.82	**16.2**	0.0	475

Highlighted values are for wind direction bias over the domain which are significantly higher for one meteorological grid prediction than the other. Direction bias "WDBIAS" is in degrees. Positive values imply clockwise directional bias.

Site-Hours is only a representative value which is approximately the average number of Site-Hours for both grids compared.

Table 6. Comparison Between NERAMS 09 Km Grid and EDAS 80 Km Archive

Site CATEGORY # 1 PLAIN OR BROAD VALLEY

Met Category	WERR 09 Grid	WDBIAS 09 Grid	WSBIAS 09 Grid	WERR 80 Grid	WDBIAS 80 Grid	WSBIAS 80 Grid	Site-Hours
Low Wind Speed	2.01	-2.9	0.2	2.16	-4.3	0.5	2750
High Wind Speed	2.75	3.8	-1.3	2.58	**8.4**	-0.7	6500
Stable Conditions	2.22	-3.1	-0.5	2.1	-5.1	0.0	3700
Conditionally Unstable	2.57	2.2	-0.9	2.56	**7.1**	-0.5	4800
Unstable Conditions	2.96	7.0	-1.2	3.0	**16**	-0.5	1200
Polar Continental	2.7	1.3	-1.2	2.61	**11.2**	-0.7	2850
Tropical Maritime	2.73	8.3	-1.0	2.8	11.3	-0.4	2750

Site CATEGORY # 2 COMPLEX TERRAIN (VALLEY)

Met Category	WERR 09 Grid	WDBIAS 09 Grid	WSBIAS 09 Grid	WERR 80 Grid	WDBIAS 80 Grid	WSBIAS 80 Grid	Site-Hours
Low Wind Speed	2.49	8.8	0.5	2.53	5.4	0.7	1300
High Wind Speed	2.65	4.3	-1.0	2.59	**10.1**	-0.5	2075
Stable Conditions	2.47	0.1	-0.2	2.47	-3.5	0.2	1150
Conditionally Unstable	2.62	7.5	-0.5	2.59	**13.5**	-0.2	1850
Unstable Conditions	2.65	14.5	-0.8	2.72	15.5	-0.1	410
Polar Continental	2.58	5.6	-0.6	2.5	**13.5**	-0.3	1275
Tropical Maritime	2.73	13.4	-0.5	2.77	16.2	-0.2	975

Highlighted values are for wind direction bias over the domain which are significantly higher for one meteorological grid prediction than the other. Direction bias "WDBIAS" is in degrees. Positive values imply clockwise directional bias.

Site-Hours is only a representative value which is approximately the average number of Site-Hours for both grids compared.

Table 6 (cont) Comparison Between NERAMS 09 Km Grid and EDAS 80 Km Archive

Site CATEGORY # 5 COASTAL REGIME

Met Category	WERR 09-Grid	WDBIAS 09 Grid	WSBIAS 09 Grid	WERR 80 Grid	WDBIAS 80 Grid	WSBIAS 80 Grid	Site-Hours
Low Wind Speed	2.26	14.9	0.6	2.51	14.2	1.1	1350
High Wind Speed	3.06	12.7	-1	2.86	12.9	-0.3	6400
Stable Conditions	2.6	11.4	-0.3	2.49	9.7	0.4	3075
Conditionally Unstable	3.02	13.6	-0.9	2.85	13.8	-0.3	3775
Unstable Conditions	3.48	15.7	-1.1	3.59	**21.4**	-0.1	940
Polar Continental	3.17	12.1	-1.4	3	16.2	-0.7	1650
Tropical Maritime	3.1	15.4	-0.7	3.01	14.9	-0.1	3000

Highlighted values are for wind direction bias over the domain which are significantly higher for one meteorological grid prediction than the other. Direction bias "WDBIAS" is in degrees. Positive values imply clockwise directional bias.

Site-Hours is only a representative value which is approximately the average number of Site-Hours for both grids compared.

WERR = SQRT { (Umodeled – Umeasured) **2 + (Vmodeled – Vmeasured) **2 }

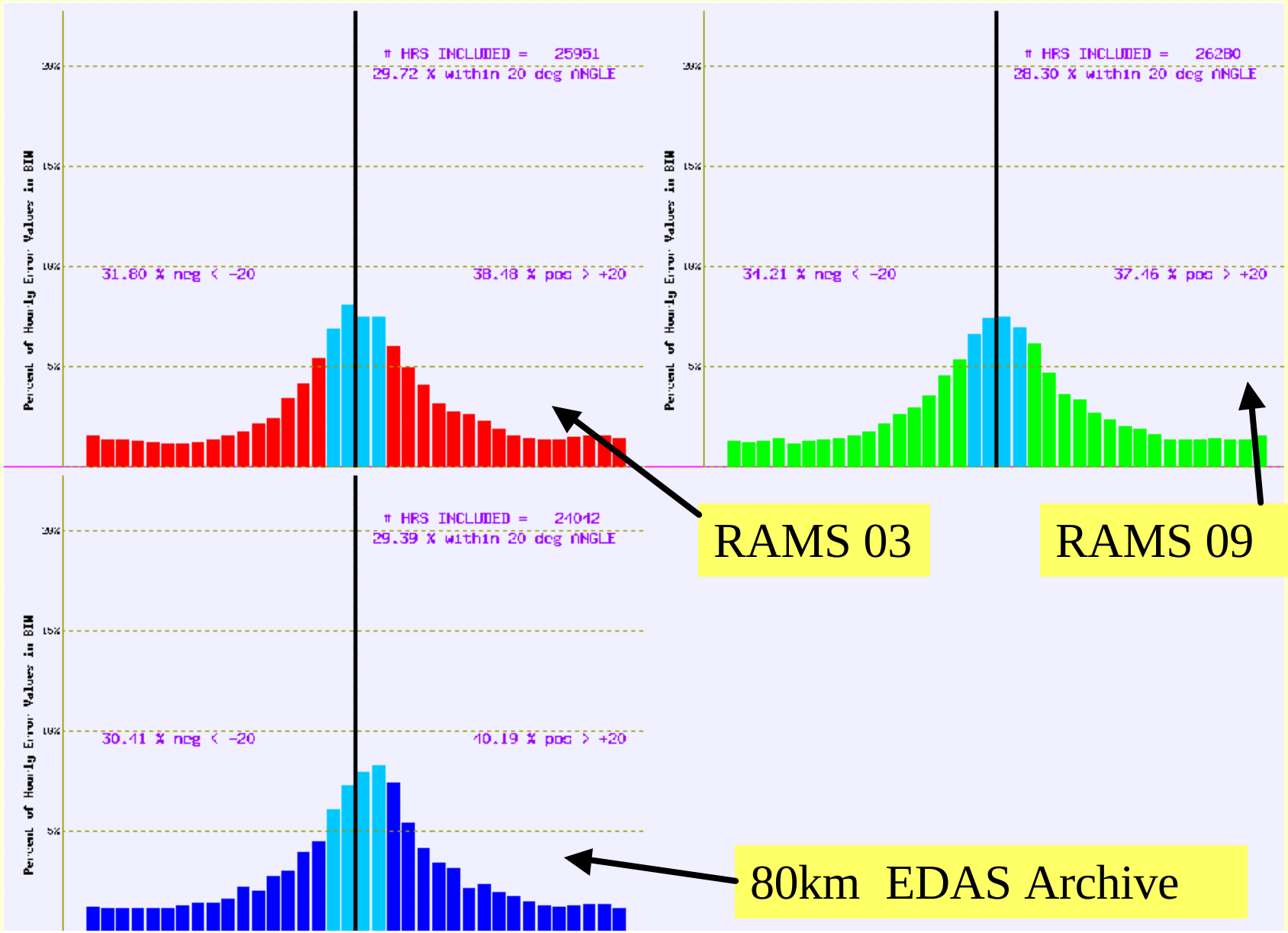
WDBIAS = Average scalar difference between Modeled and Measured Wind Angle in Degrees

WSBIAS = Average scalar difference between Modeled and Measured Wind Speed in m/sec

NOTE: Values are averaged over all matched hours examined

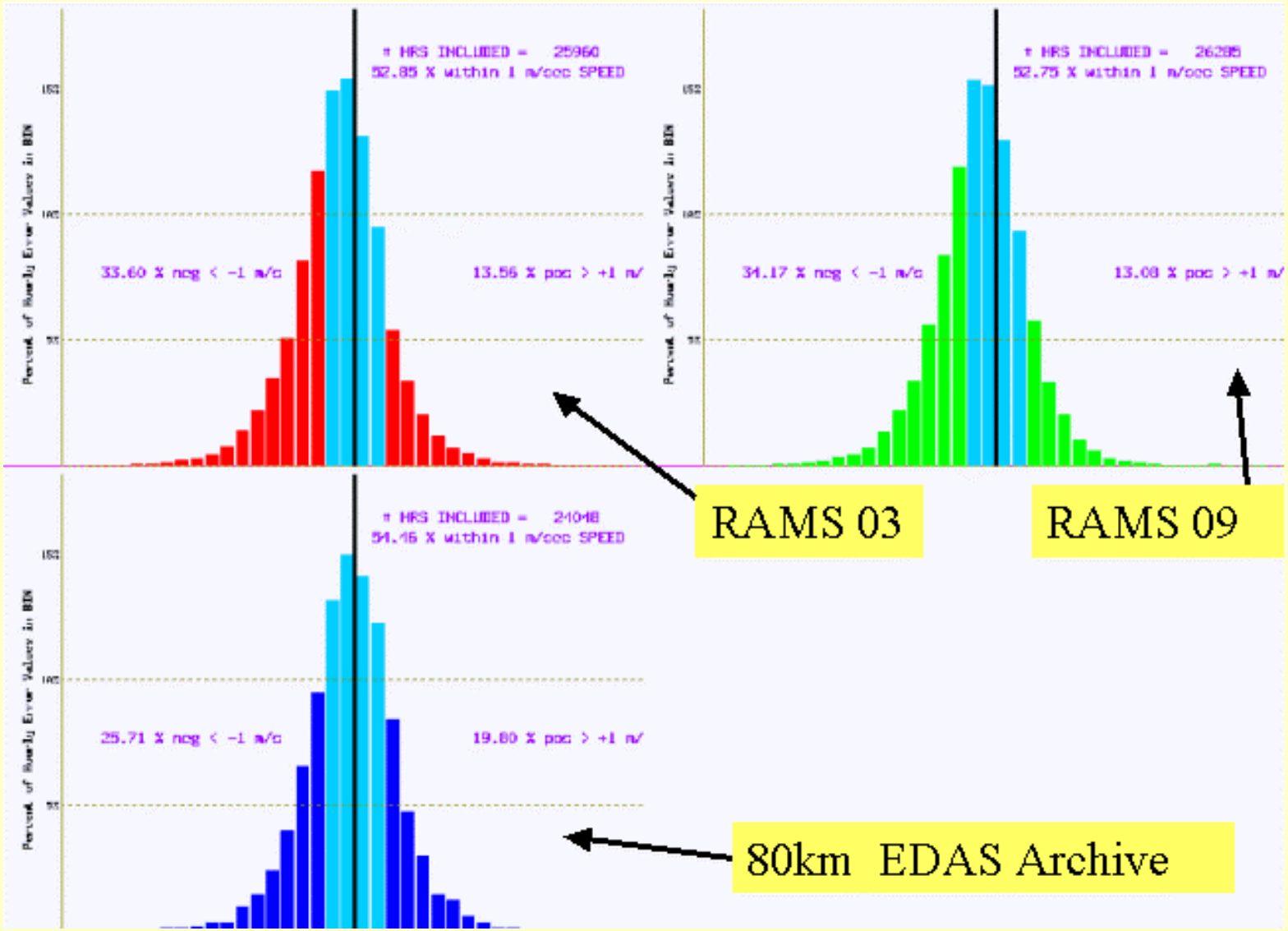
Domain-wide Wind-Direction Error Distributions

All met conditions @ 20 Sites within 03 Grid



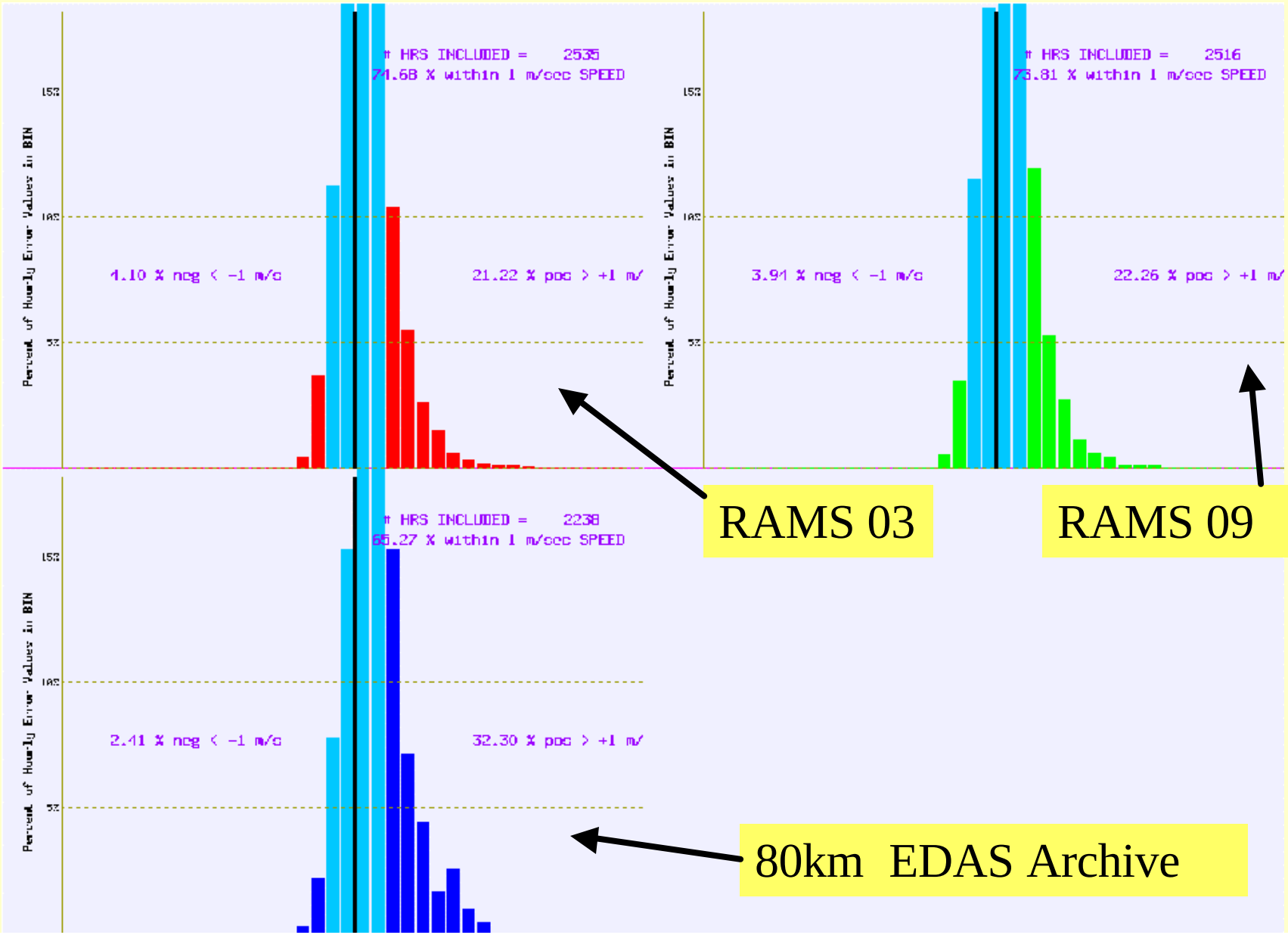
Domain-wide Wind-Direction Error Distributions

All met conditions @ 20 Sites within 03 Grid



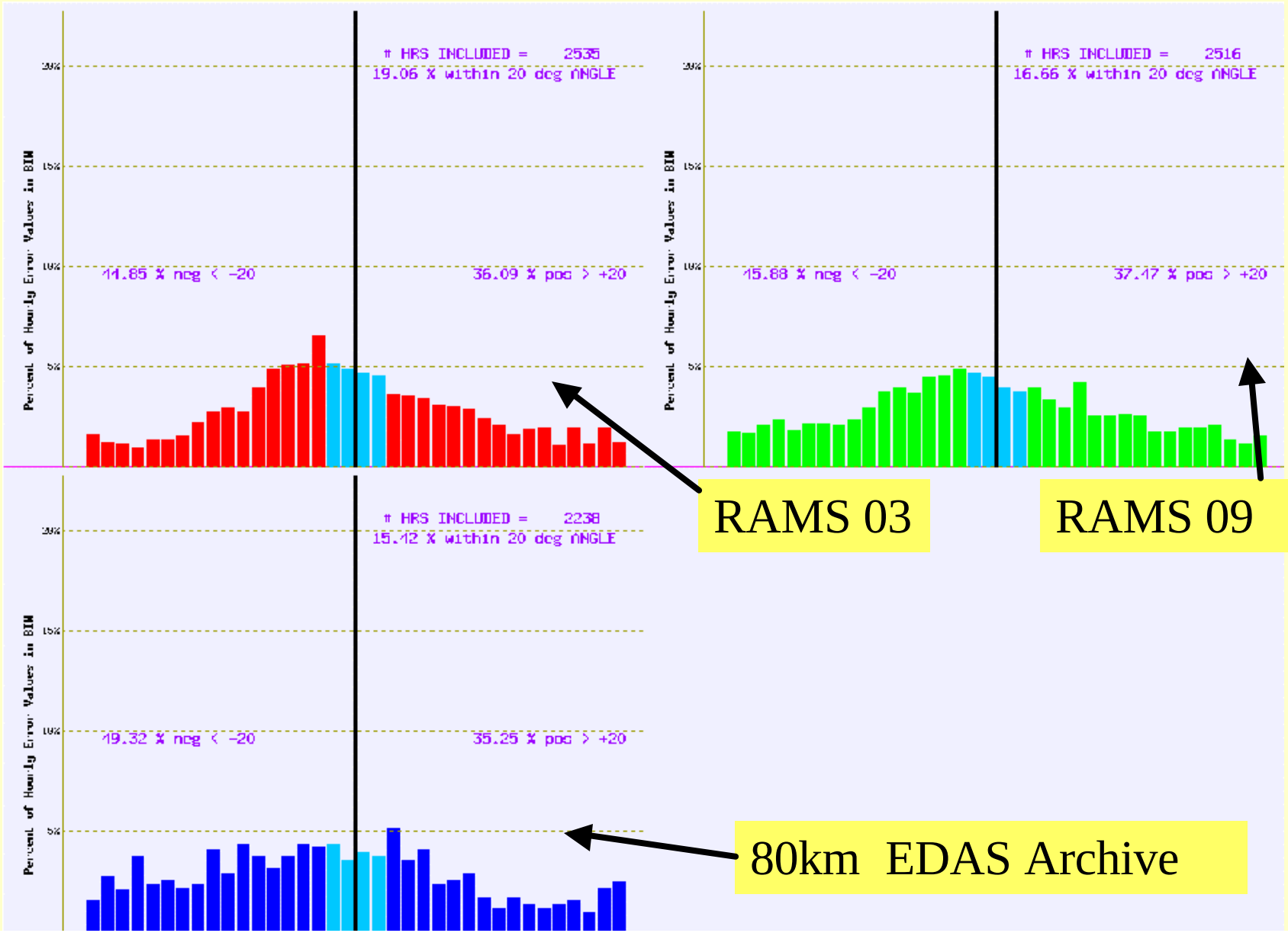
Domain-wide Hourly **Wind-Speed Error Distributions** STABLE Conditions:

WS<4Knts Surf T <= 850mb T @ 20 Sites within 03 Grid



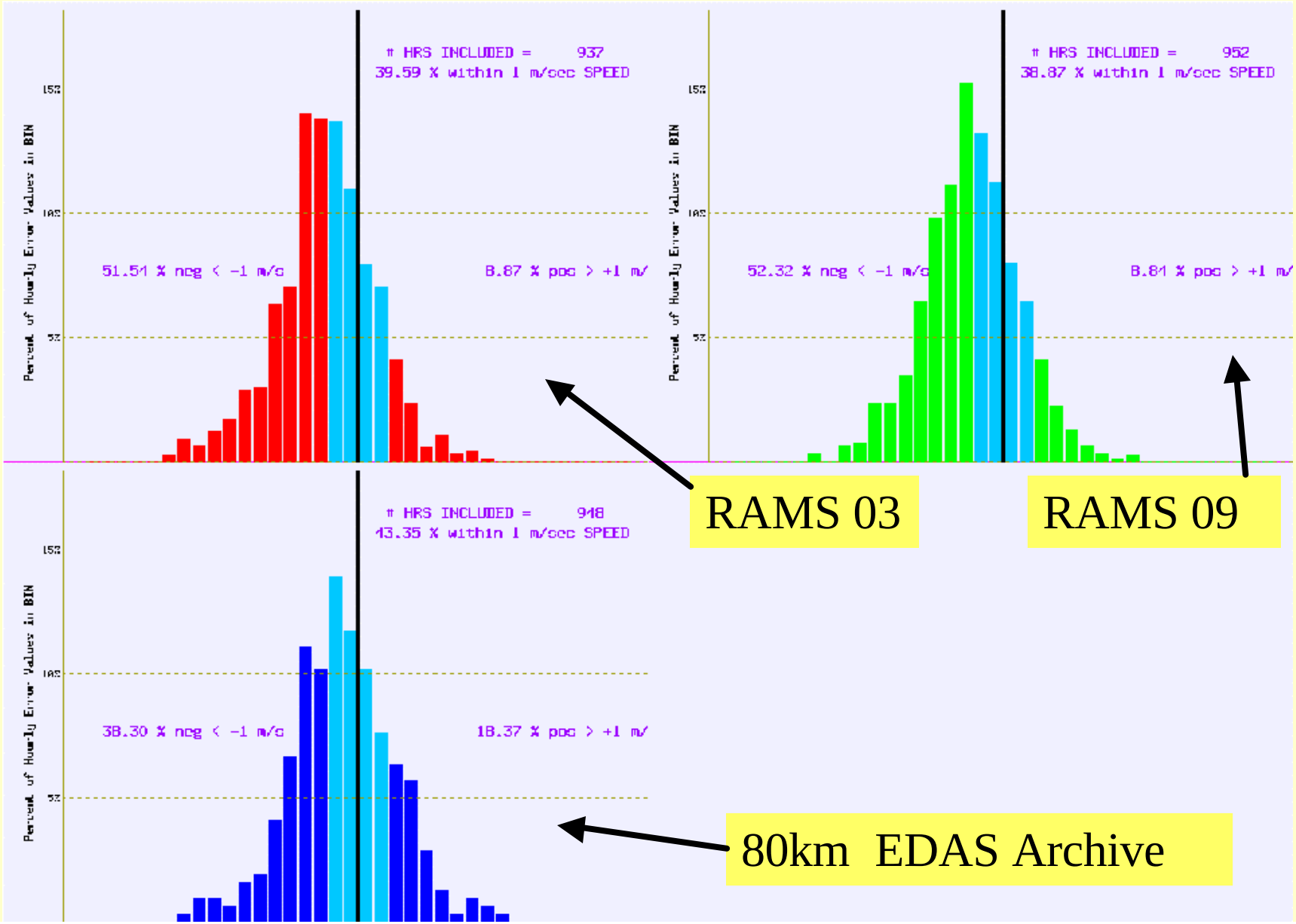
Domain-wide Hourly **Wind-Direction Error Distributions** STABLE Conditions:

WS<4Knts Surf T <= 850mb T @ 20 Sites within 03 Grid



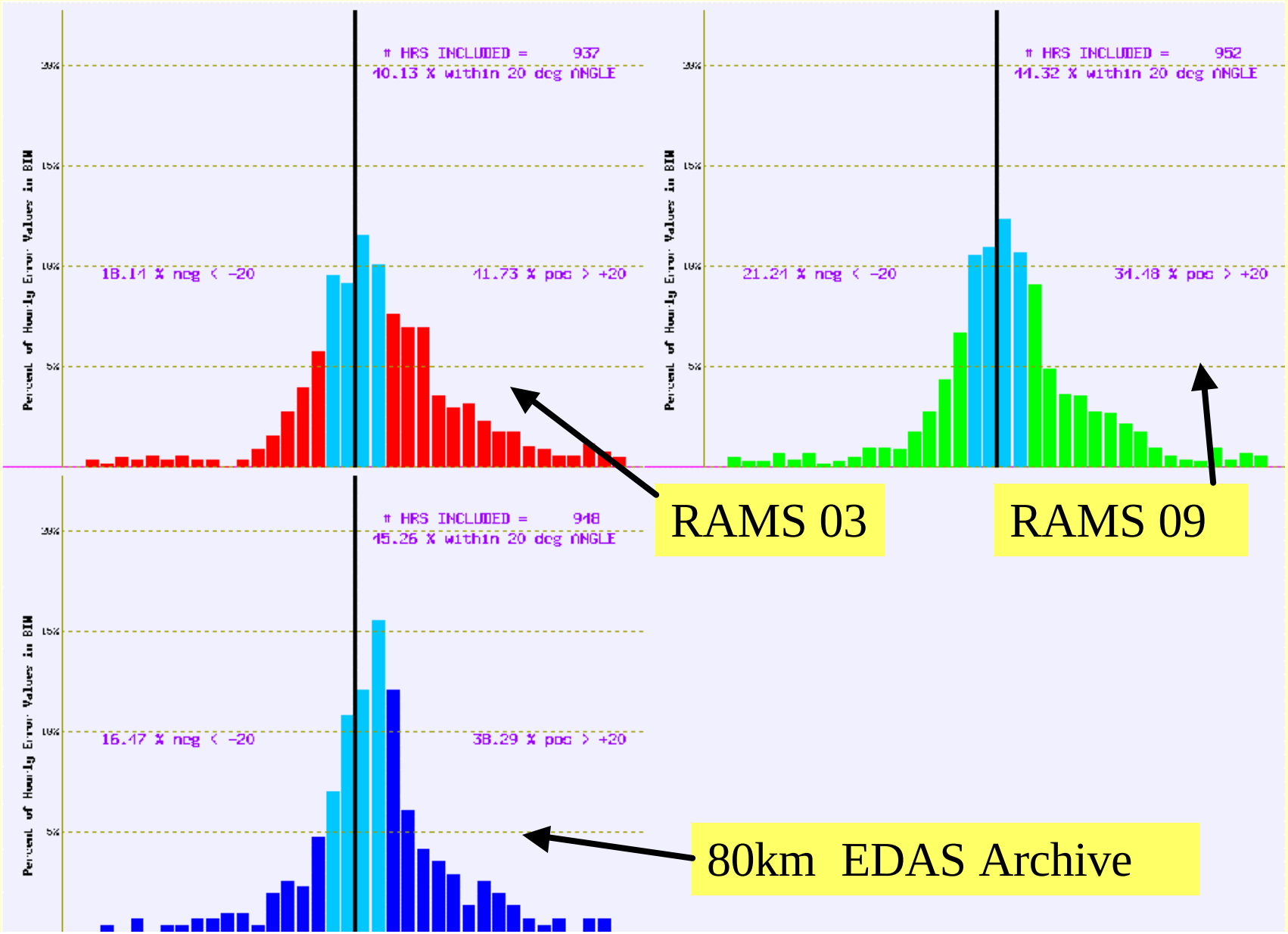
Domain-wide Hourly **Wind-Speed Error Distributions** UNSTABLE:

WS>5Knts Surf T > 850mb T by >15C Dewpoint T > 58 F @ 20 Sites



Domain-wide Hourly **Wind-Direction Error Distributions** UNSTABLE:

WS>5Knts Surf T > 850mb T by >15C Dewpoint T > 58 F @ 20 Sites



"CLIMATOLOGICAL"

3-Month Wind Direction & Speed Binning

GRAPHICAL COMPARISONS of RAMS "WIND-ROSE"

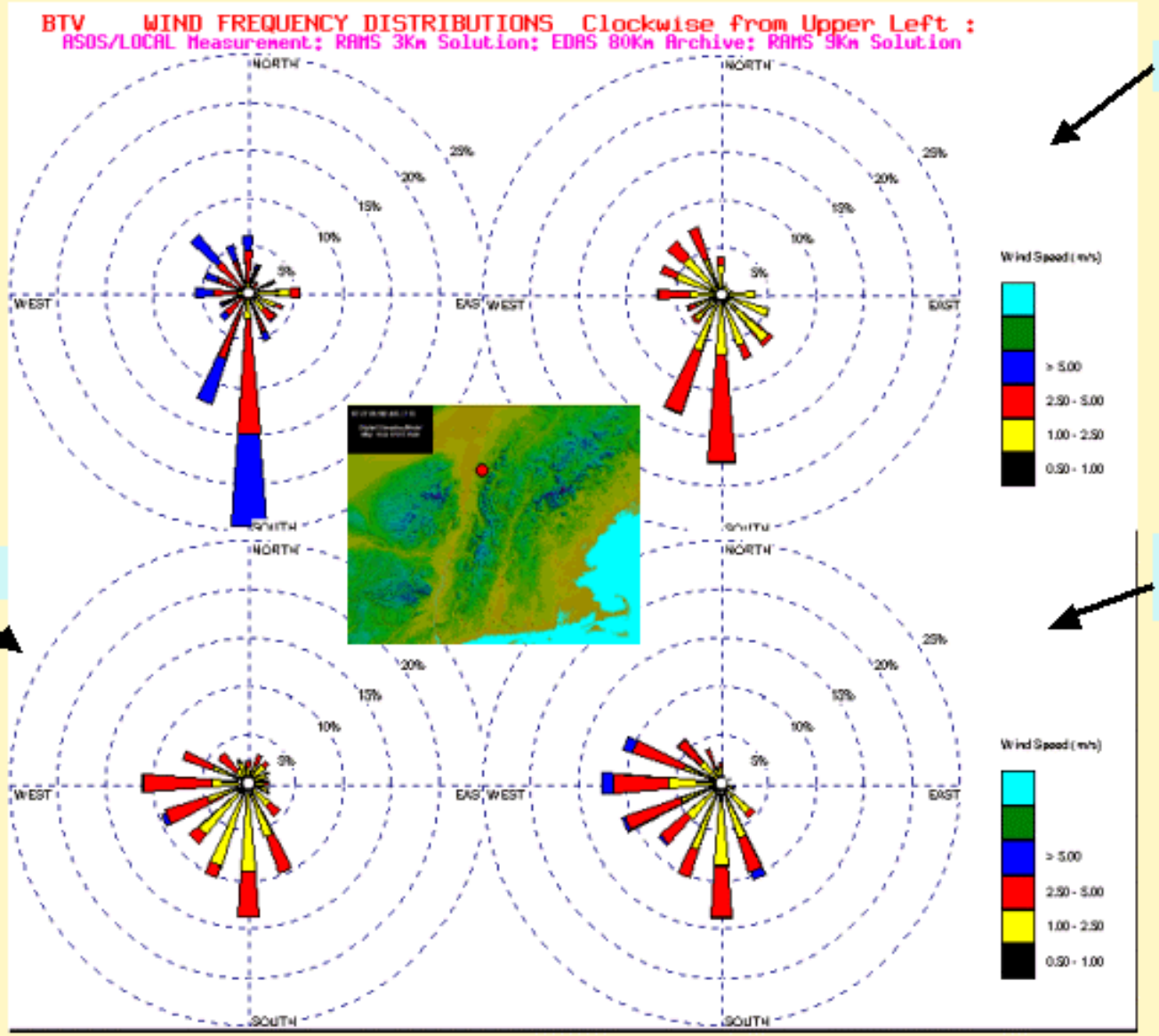
to ASOS (or LOCAL) "WIND-ROSE"

Also showing

"Improvement" over 80 Km EDAS Archived Data "WIND-ROSE"

For a few of the ASOS sites

Burlington, VT June/July/Aug 1999 Wind frequency plots for ASOS & 3 Re-Analyses



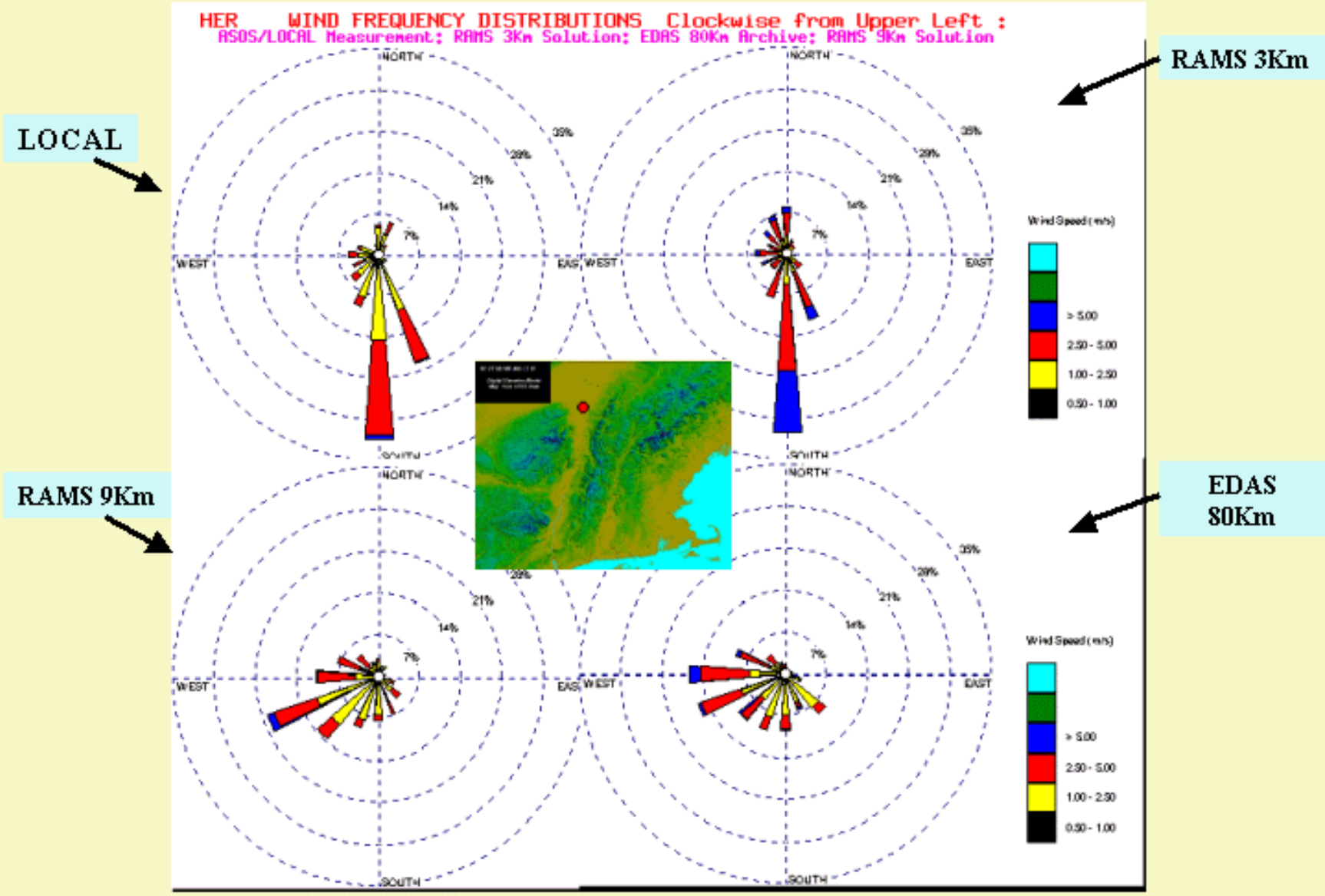
ASOS

RAMS 3Km

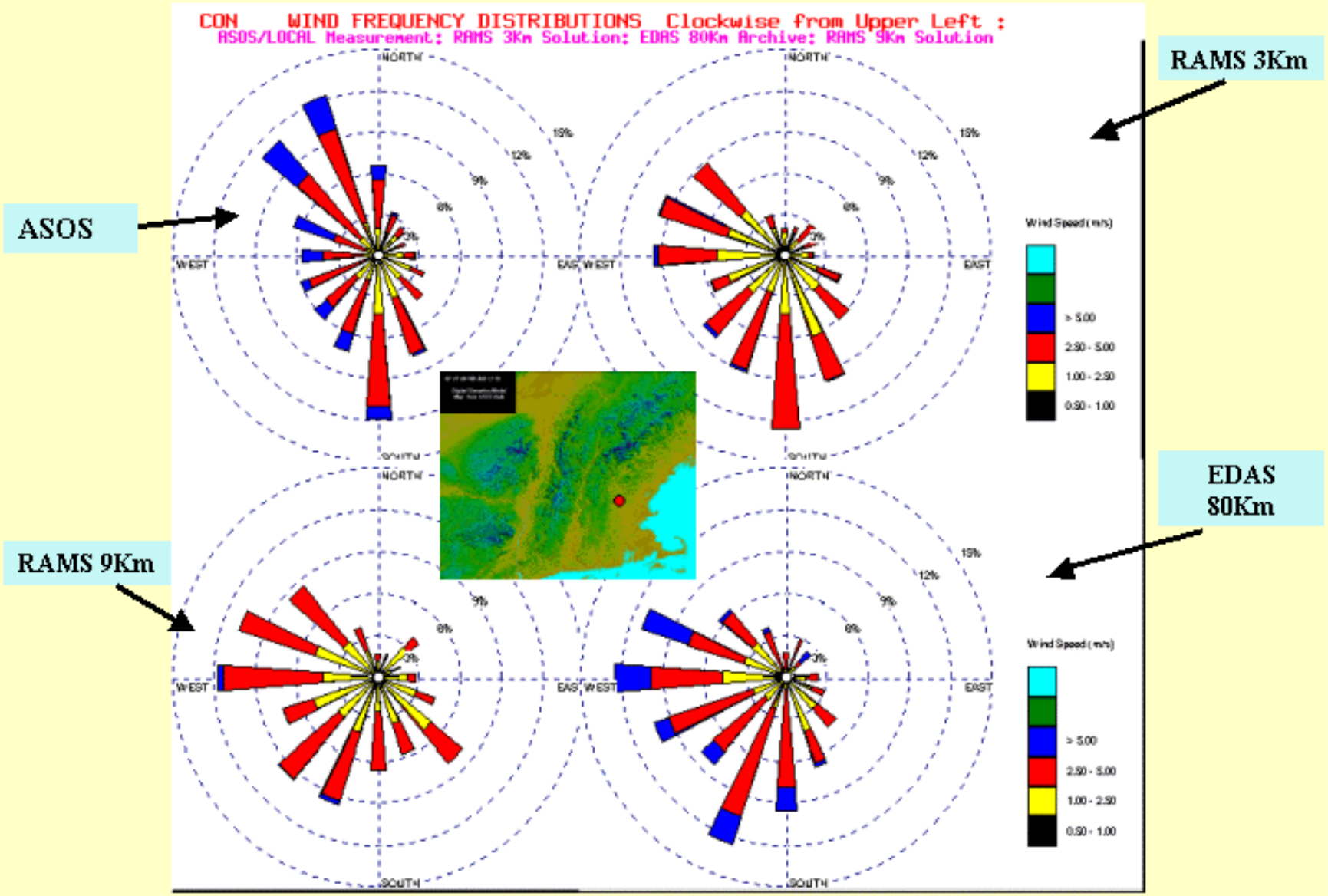
RAMS 9Km

EDAS 80Km

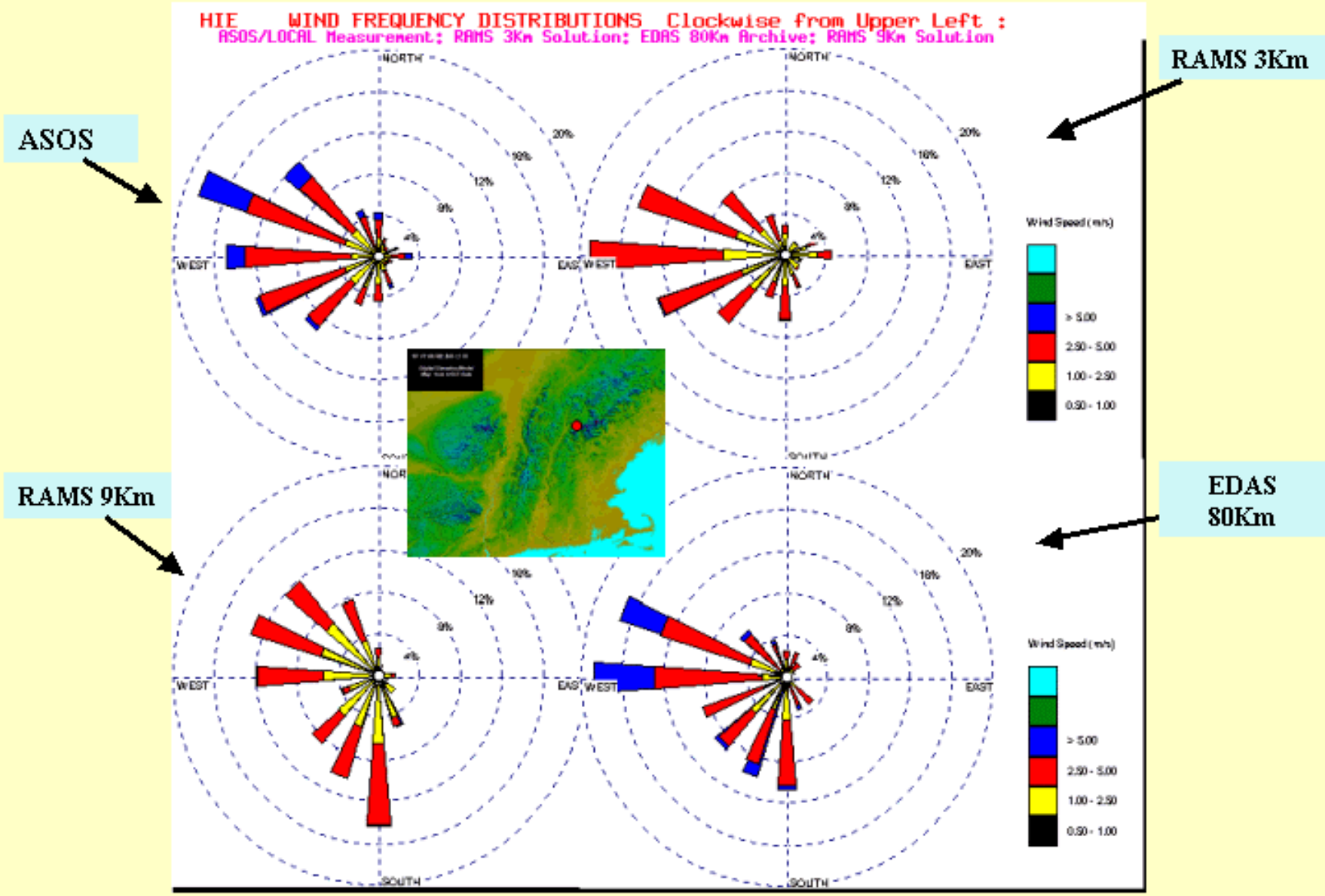
S. Hero, VT June/July/Aug 1999 Wind frequency plots for ASOS & 3 Re-Analyses



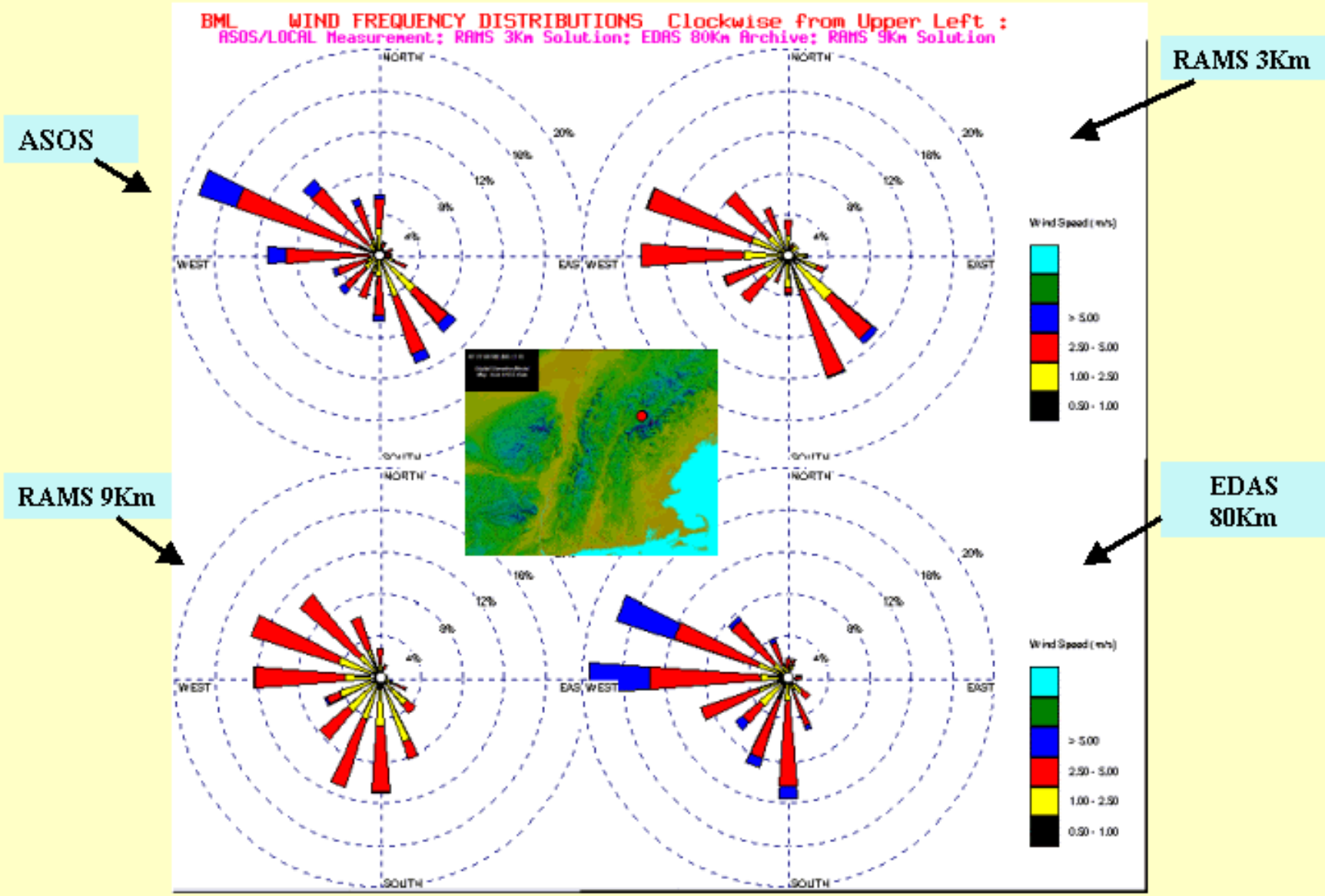
Concord, NH June/July/Aug 1999 Wind frequency plots for ASOS & 3 Re-Analyses



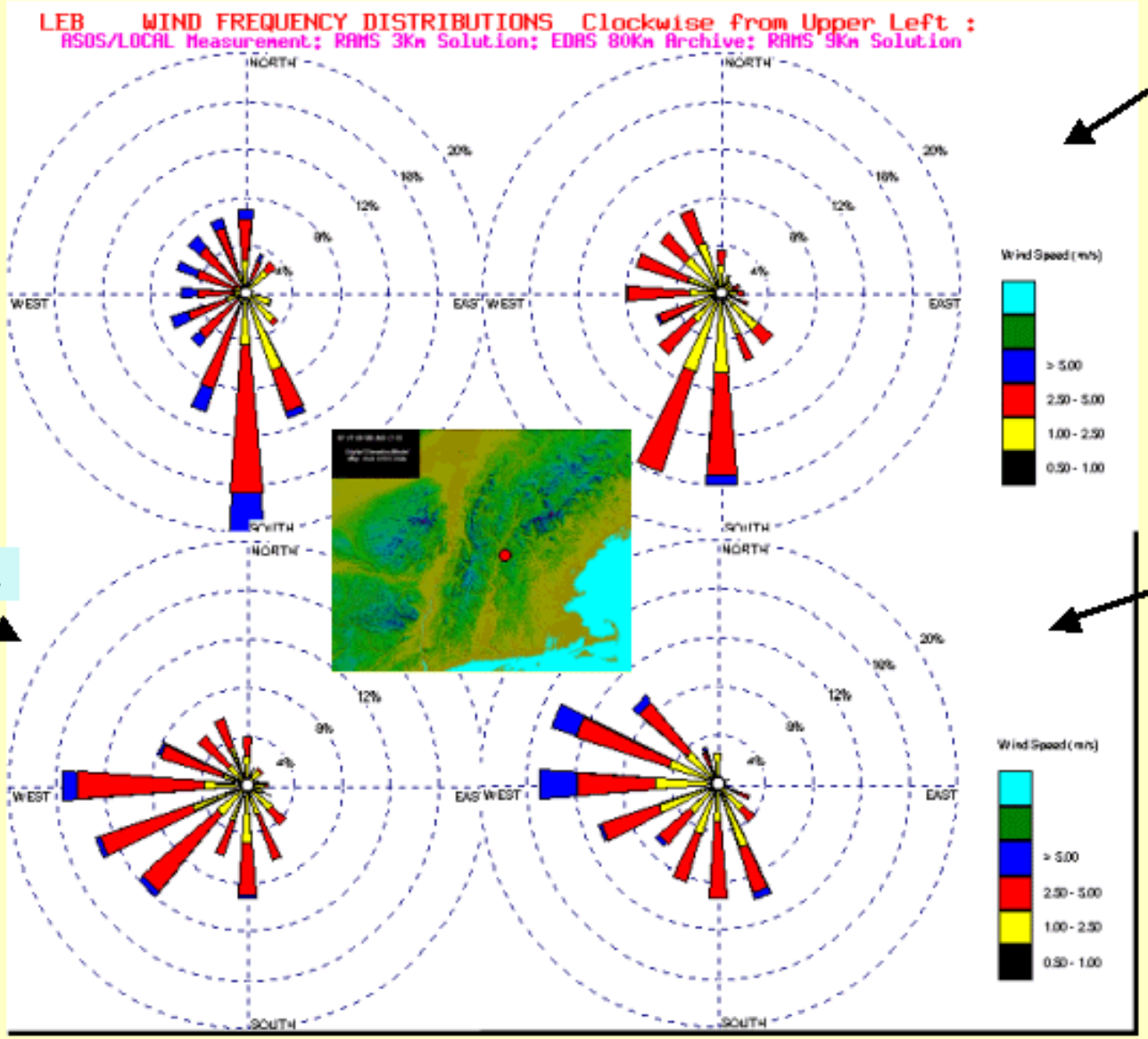
Whitefield, NH June/July/Aug 1999 Wind frequency plots for ASOS & 3 Re-Analyses



Berlin, NH June/July/Aug 1999 Wind frequency plots for ASOS & 3 Re-Analyses



Lebanon, NH June/July/Aug 1999 Wind frequency plots for ASOS & 3 Re-Analyses



TEMPERATURE & PRESSURE

HOUR by HOUR

GRAPHICAL Depictions of RAMS Predicted Hourly

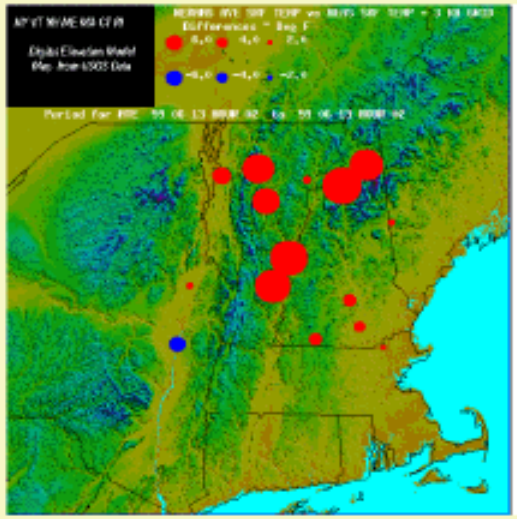
Surface TEMPERATURES

Surface PRESSURES

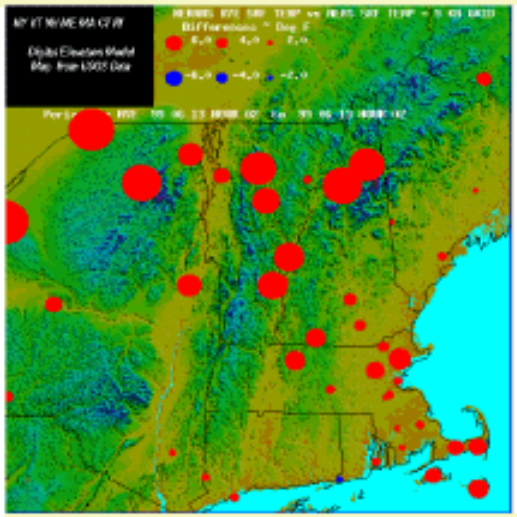
Compared to ASOS Measurements

RAMS Surface Temperature Prediction error ~ Deg F for Particular Hrs

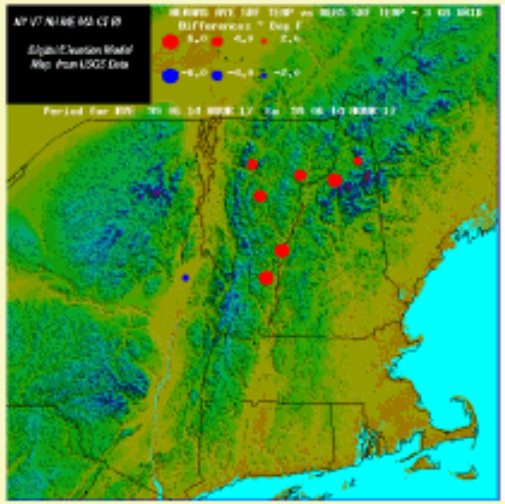
June 12 11 pm Local EDT 3Km Grid



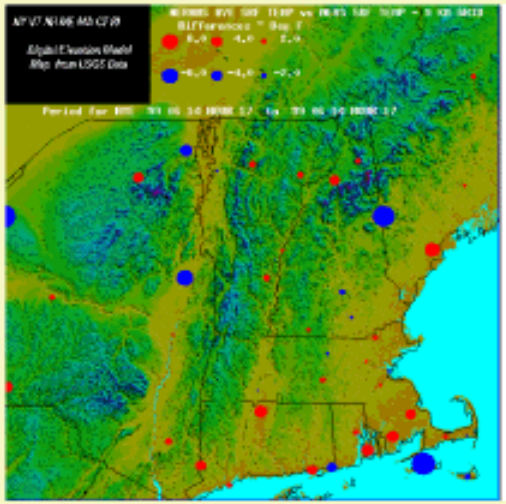
June 12 11 pm Local EDT 9Km Grid



June 14 4 pm Local EDT 3Km Grid



June 14 4 pm Local EDT 9Km Grid



On this DATE/HR

Predicts too Warm at Night

+15 Deg F

+ 3 Deg F

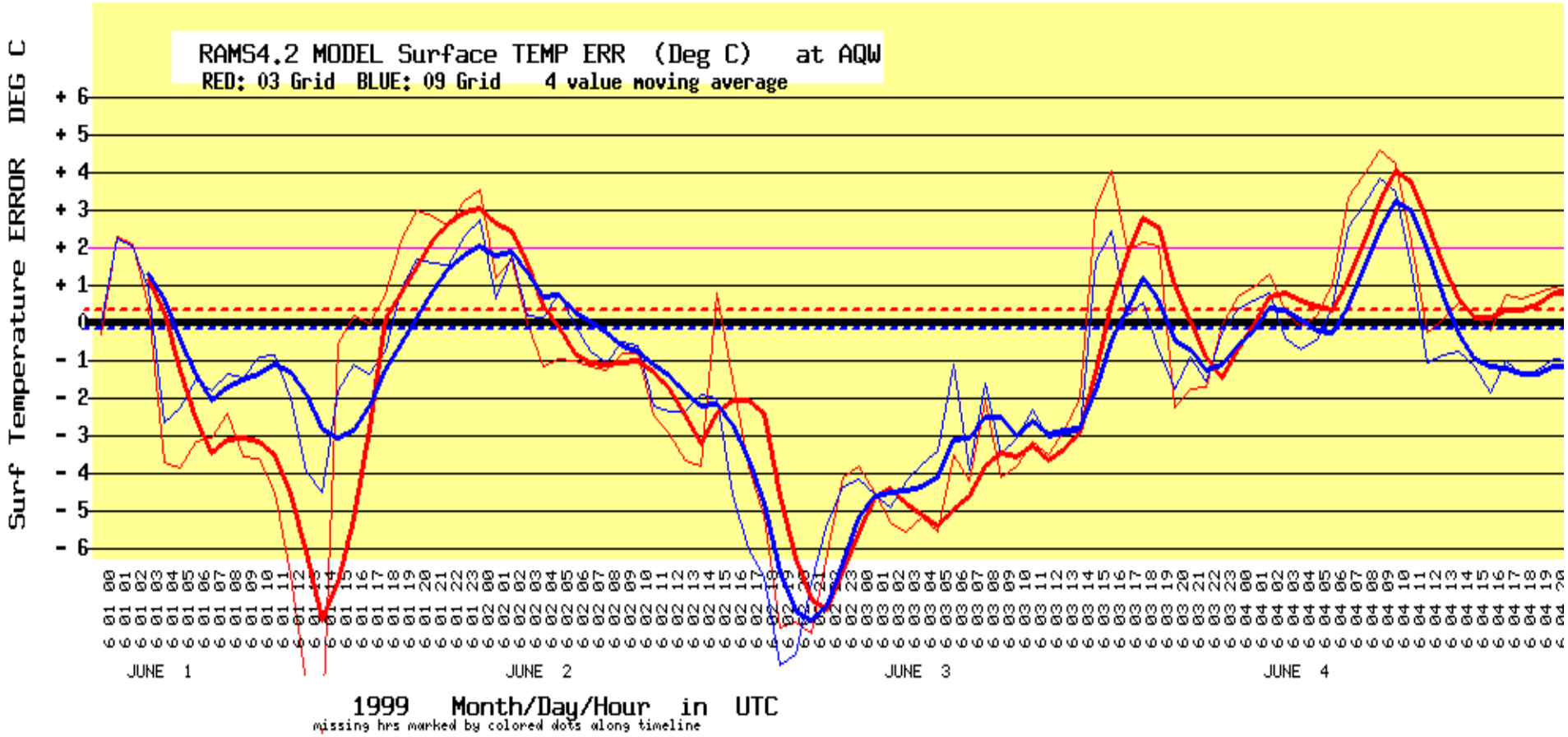
On this DATE/HR predicts quite well during Daytime

- 3 Deg F

+ 3 Deg F

Time Series for part of summer 1999 North Adams MA

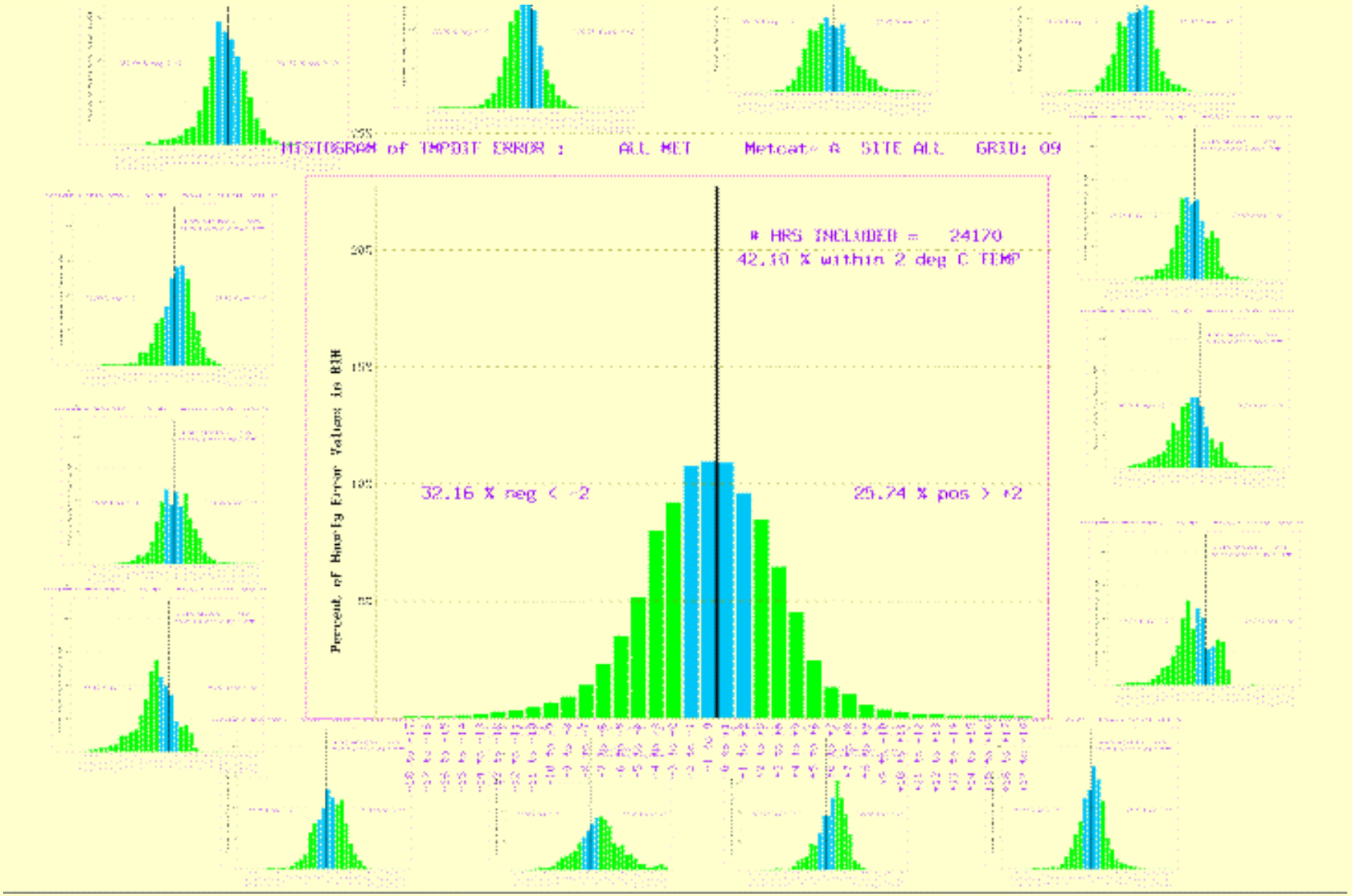
Surface Temperature Error in Degrees C



Play Temperature
Difference Movie

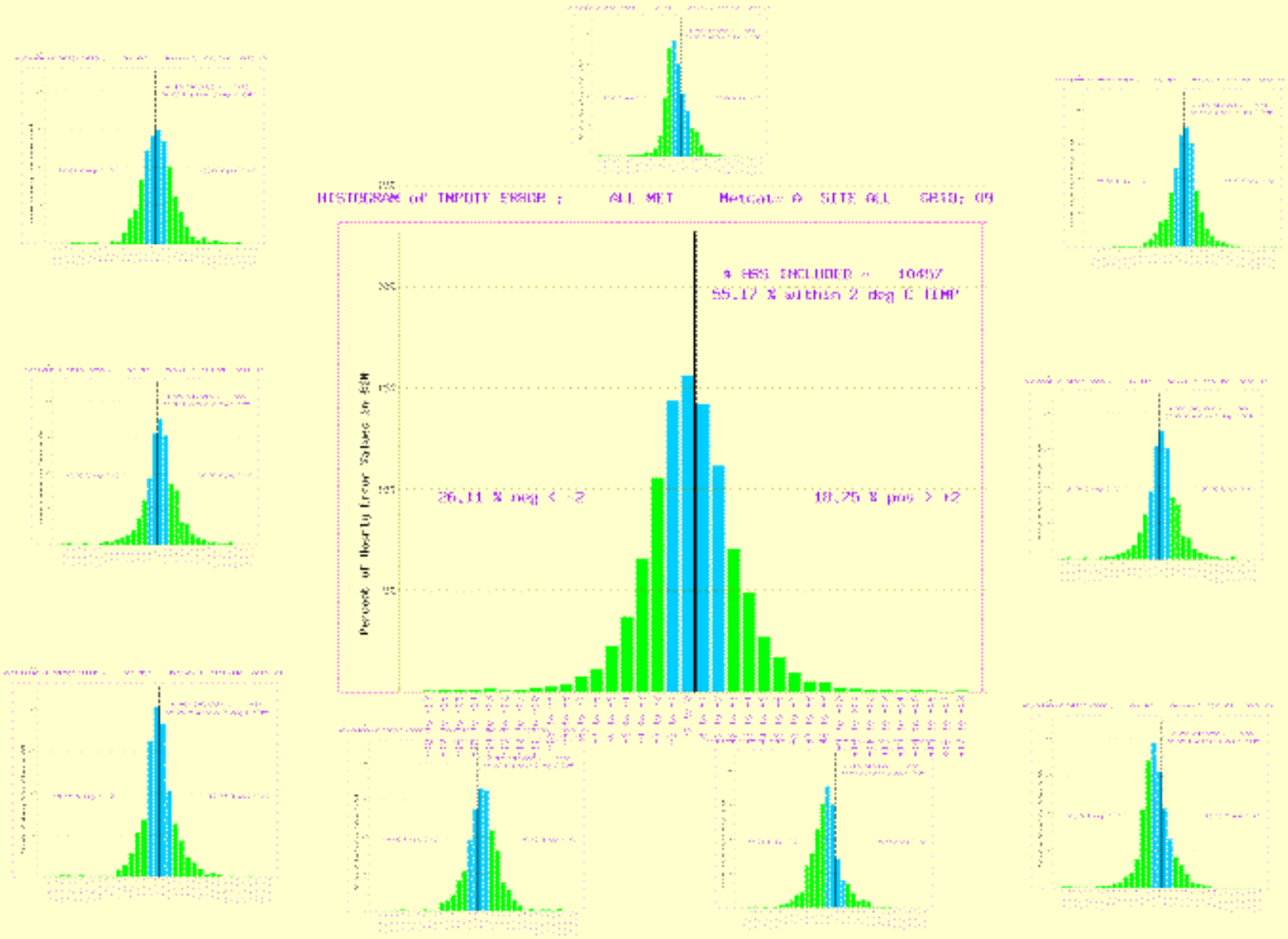
TEMPERATURE Error Distributions for 14 COASTAL Sites on RAMS 09 Grid

Distribution for ALL sites together shown large in center



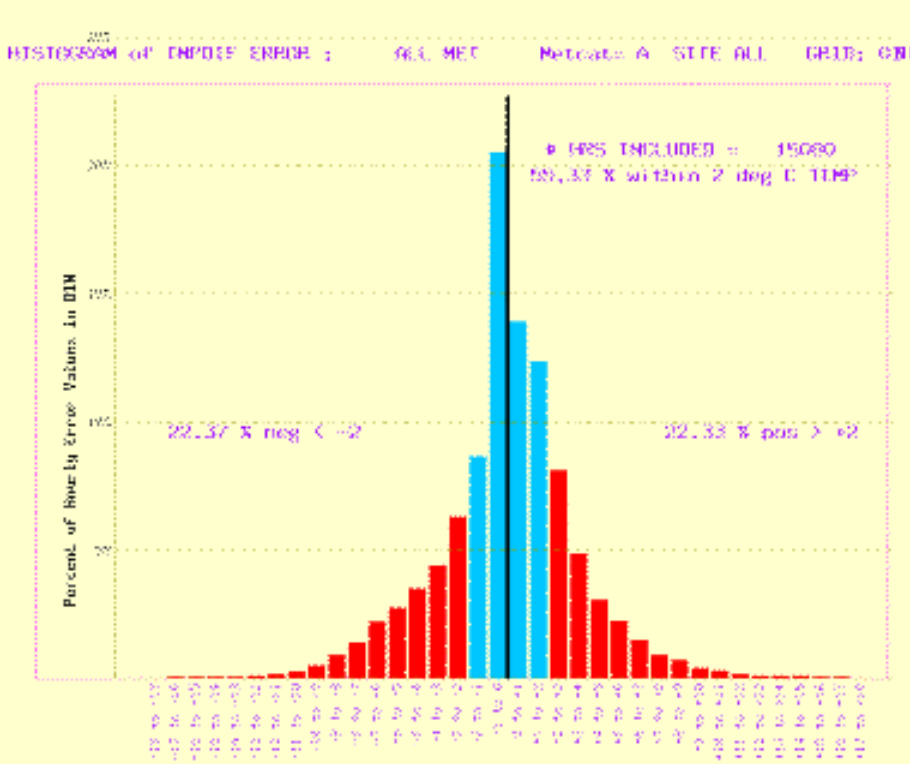
TEMPERATURE Error Distributions for 9 VALLEY Sites on RAMS 09 Grid

Distribution for ALL sites together shown large in center



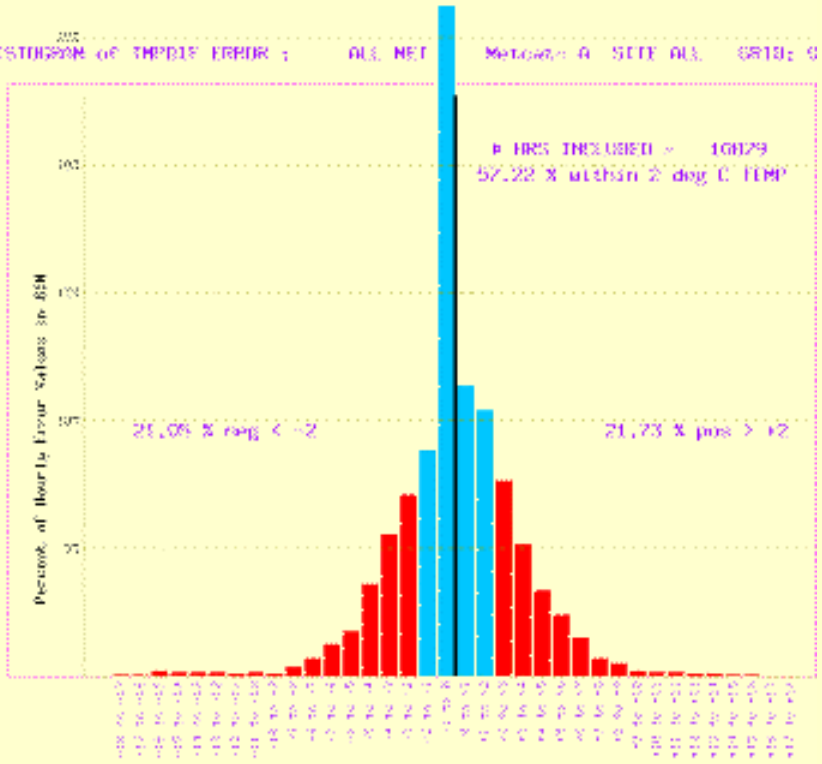
RAMS 03 Grid **Day-time**

Temperature (deg C) Error Distribution



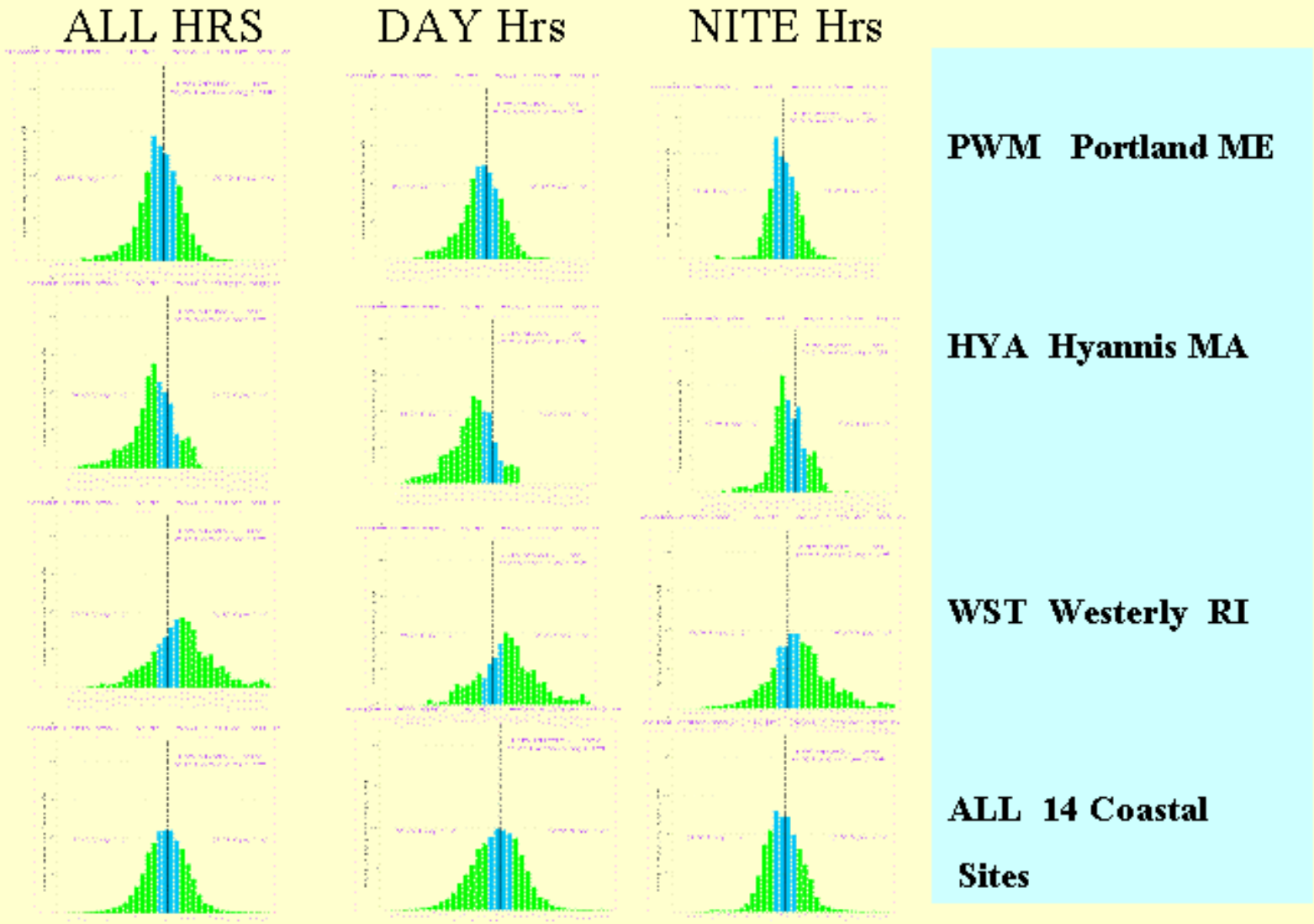
RAMS 03 Grid **Night-time**

Temperature (deg C) Error Distribution



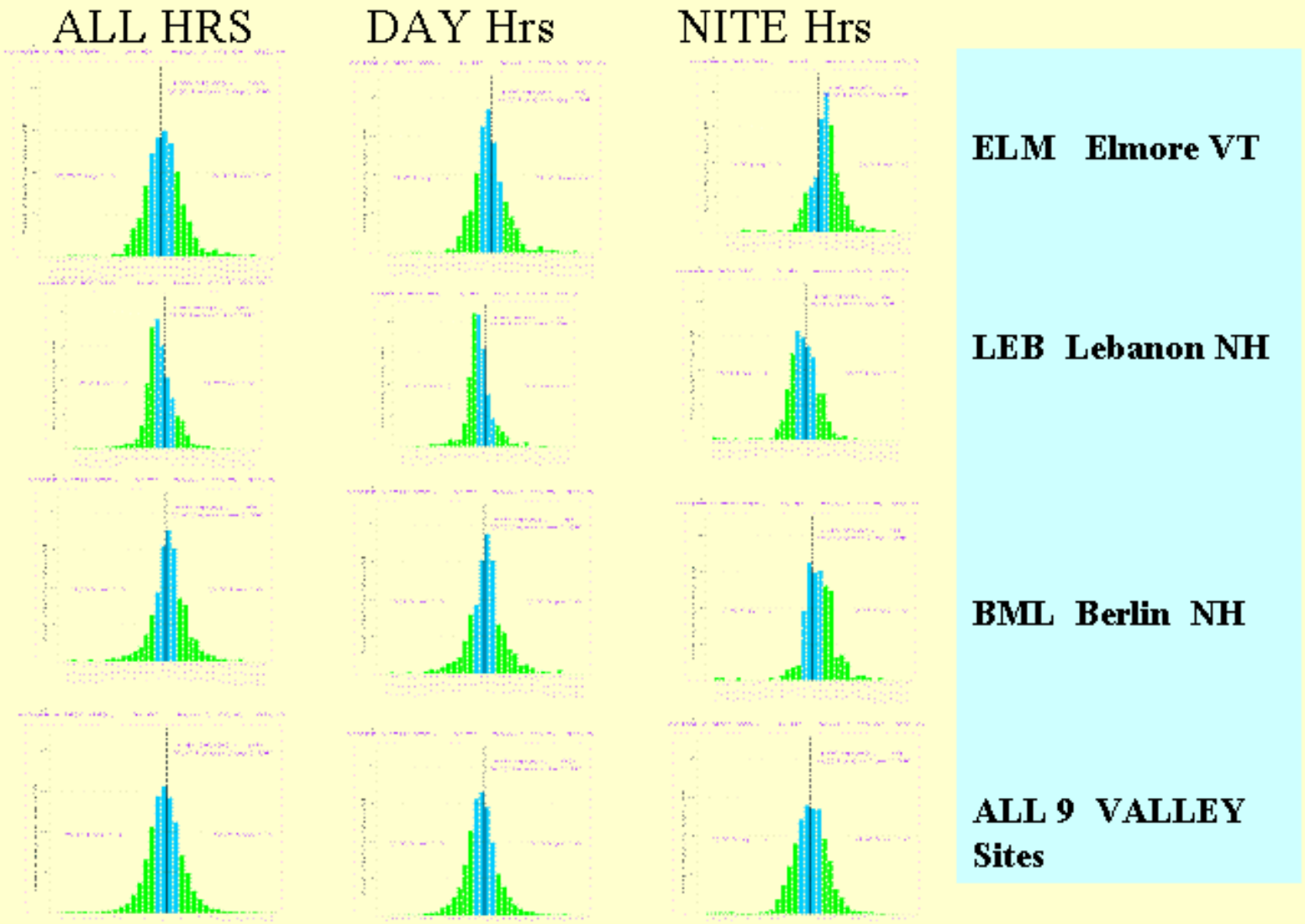
TEMPERATURE Error Distributions for 3 COASTAL Sites on RAMS 09 Grid

Distributions for ALL 14 COASTAL sites together shown as bottom row



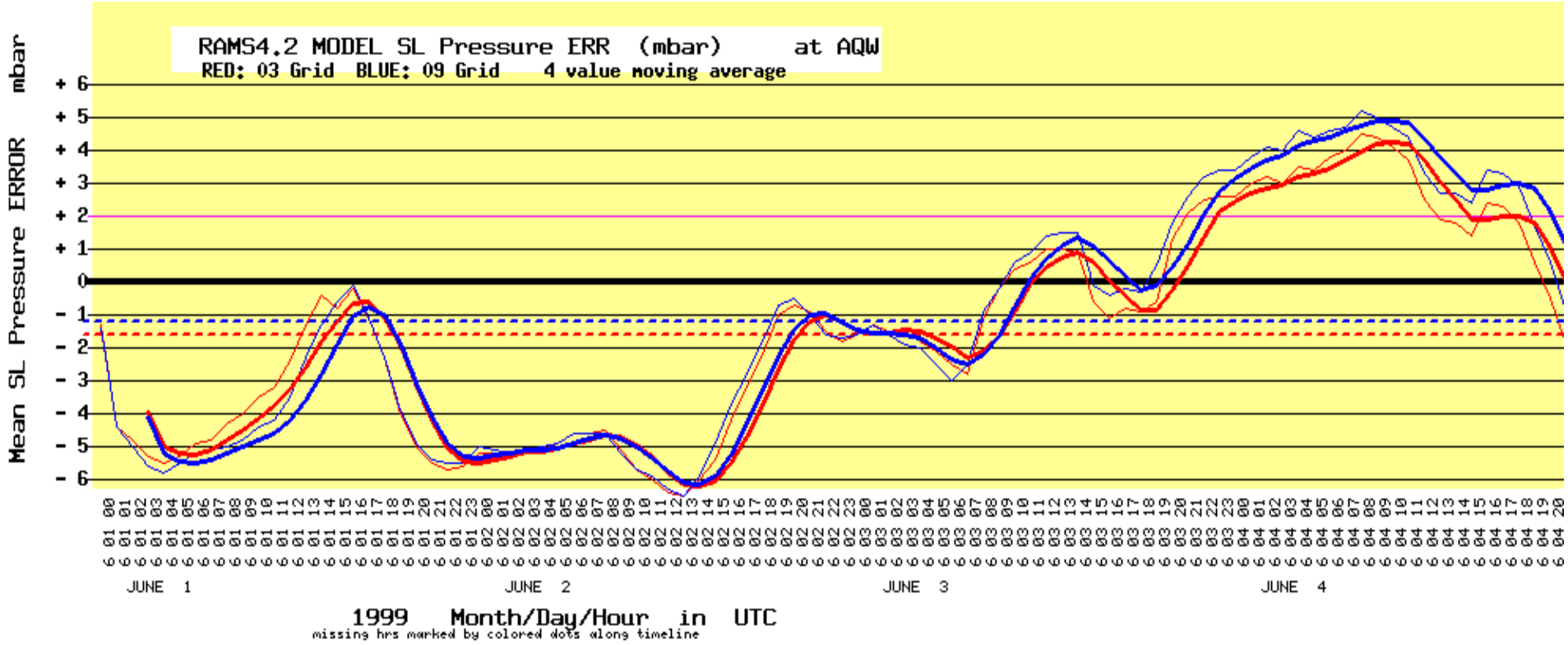
TEMPERATURE Error Distributions for 3 VALLEY Sites on RAMS 09 Grid

Distributions for ALL 9 VALLEY sites together shown as bottom row



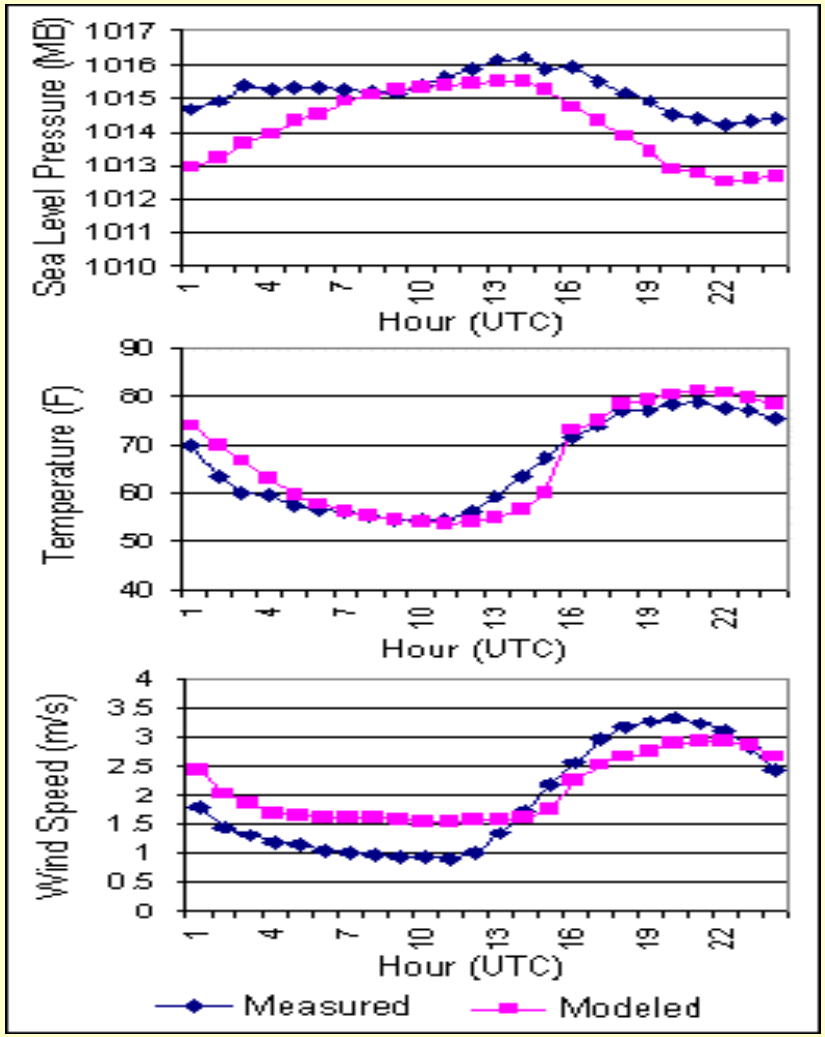
Time Series for part of summer 1999 North Adams MA

Sea Level Pressure Error in Millibars



Domain-wide Ave Diurnal Variations in 3 RAMS Surface Parameters

Compared to measurement for all Met Conditions : all sites

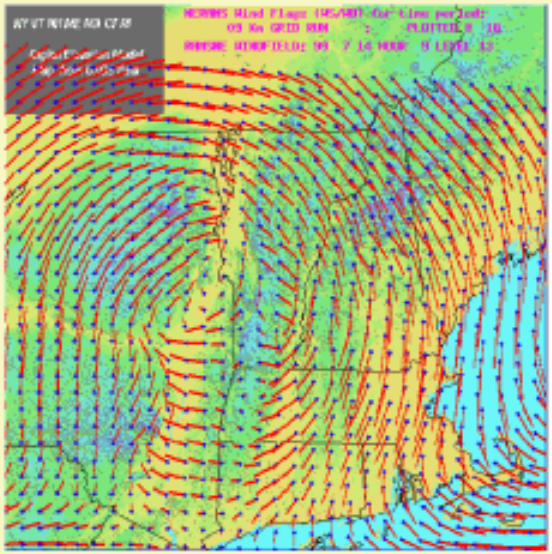


WINDS ALOFT

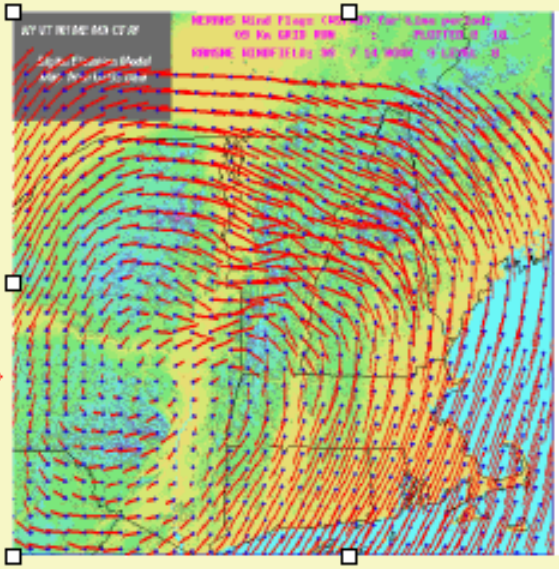
HOUR by HOUR

GRAPHICAL Depictions of RAMS Hourly UPPER-LEVEL WINDS

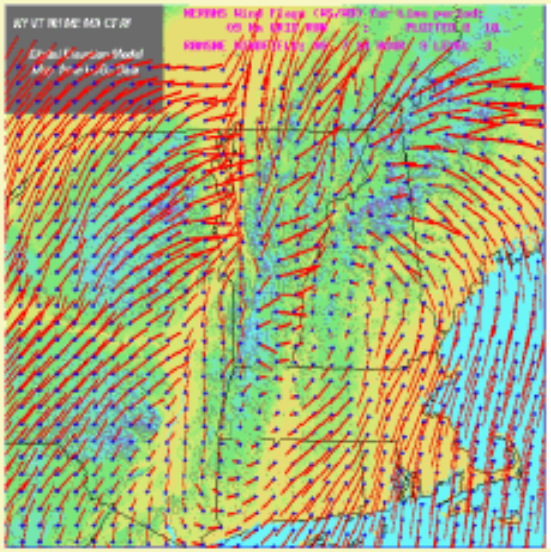
July 14, 1999 9 Hrs UTC RAMS 9 km Winds @ 4 Levels



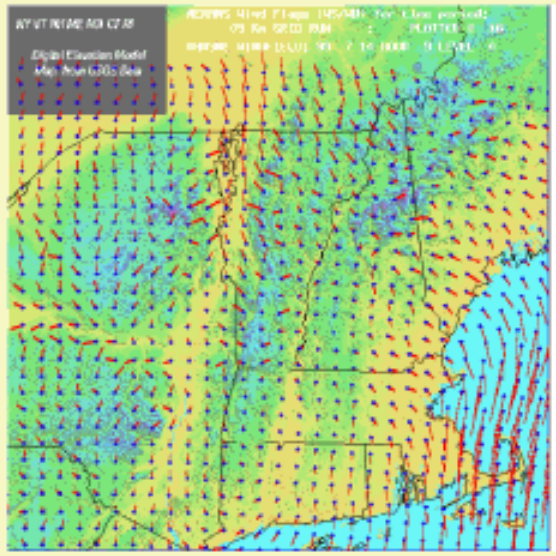
← 1785m AGL



568m AGL ->



← 79m AGL



10m AGL ->

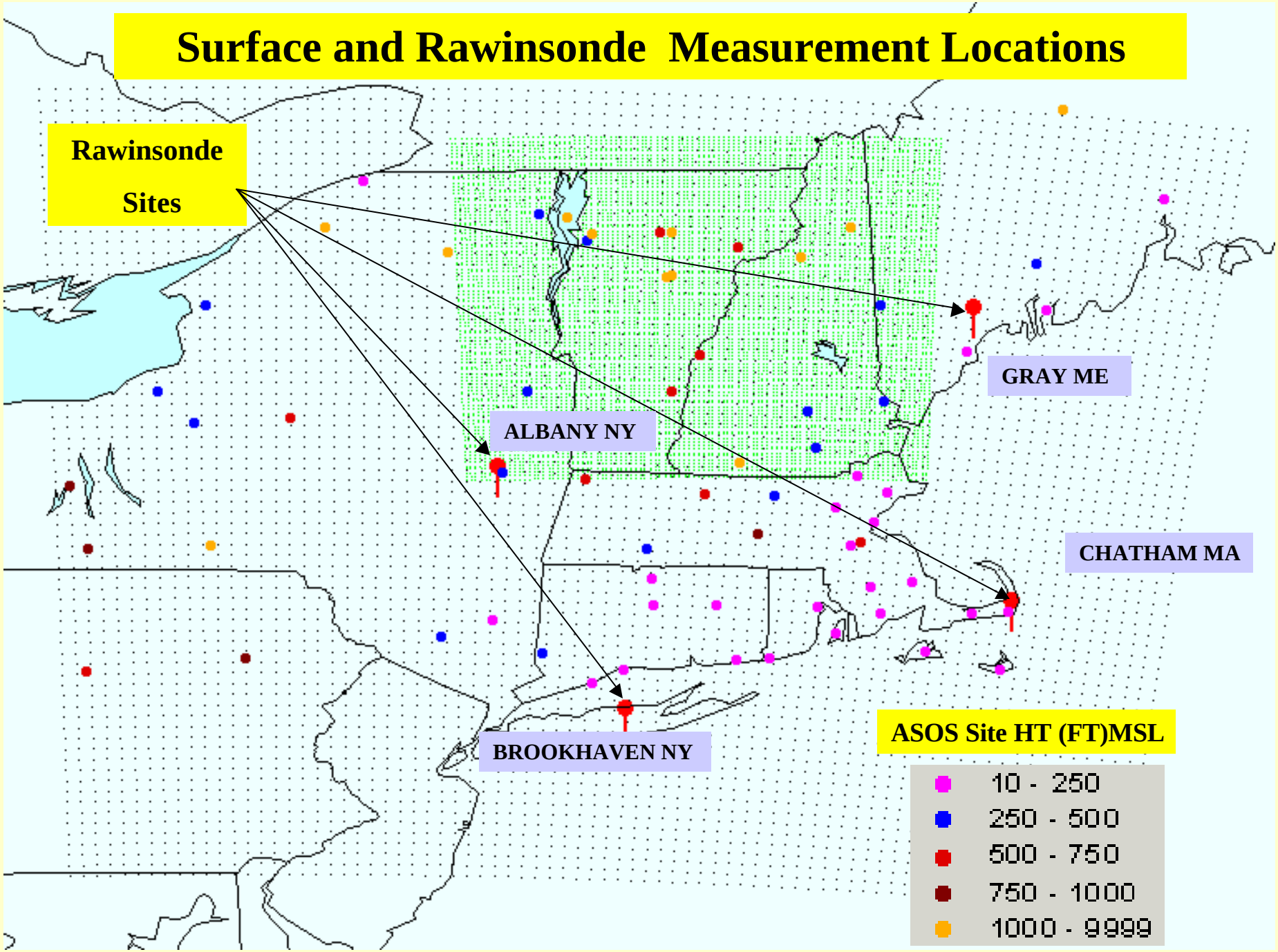
WINDS ALOFT

COMPARISON of RAMS Predicted UPPER-LEVEL WINDS

To RAWINSONDE measurements

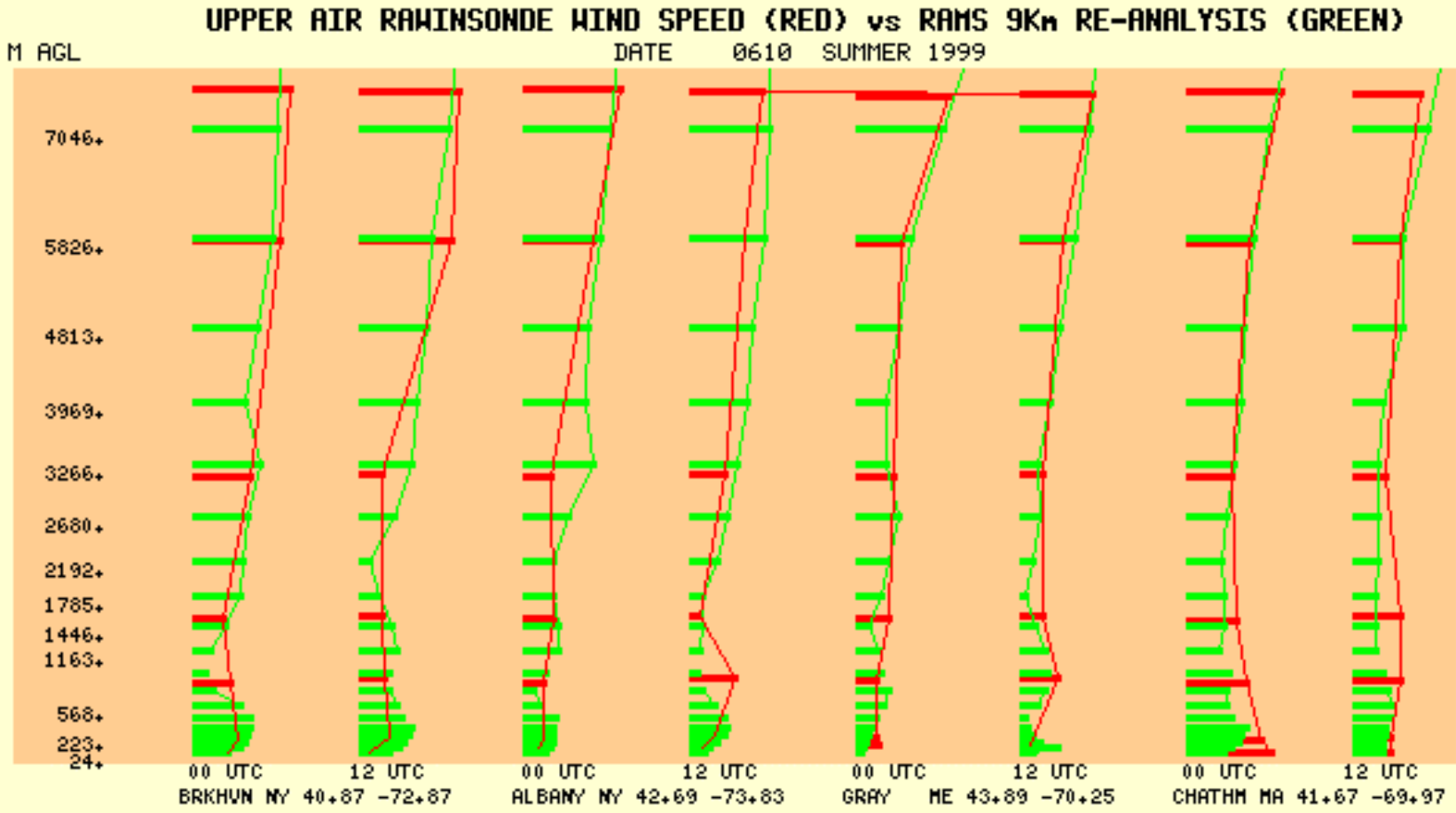
For 4 Locations on 9 KM grid

Surface and Rawinsonde Measurement Locations



June 10 1999 0Z and 12Z Upper Air Comparison

Wind Speed (Green = RAMS Red = Rawinsonde)

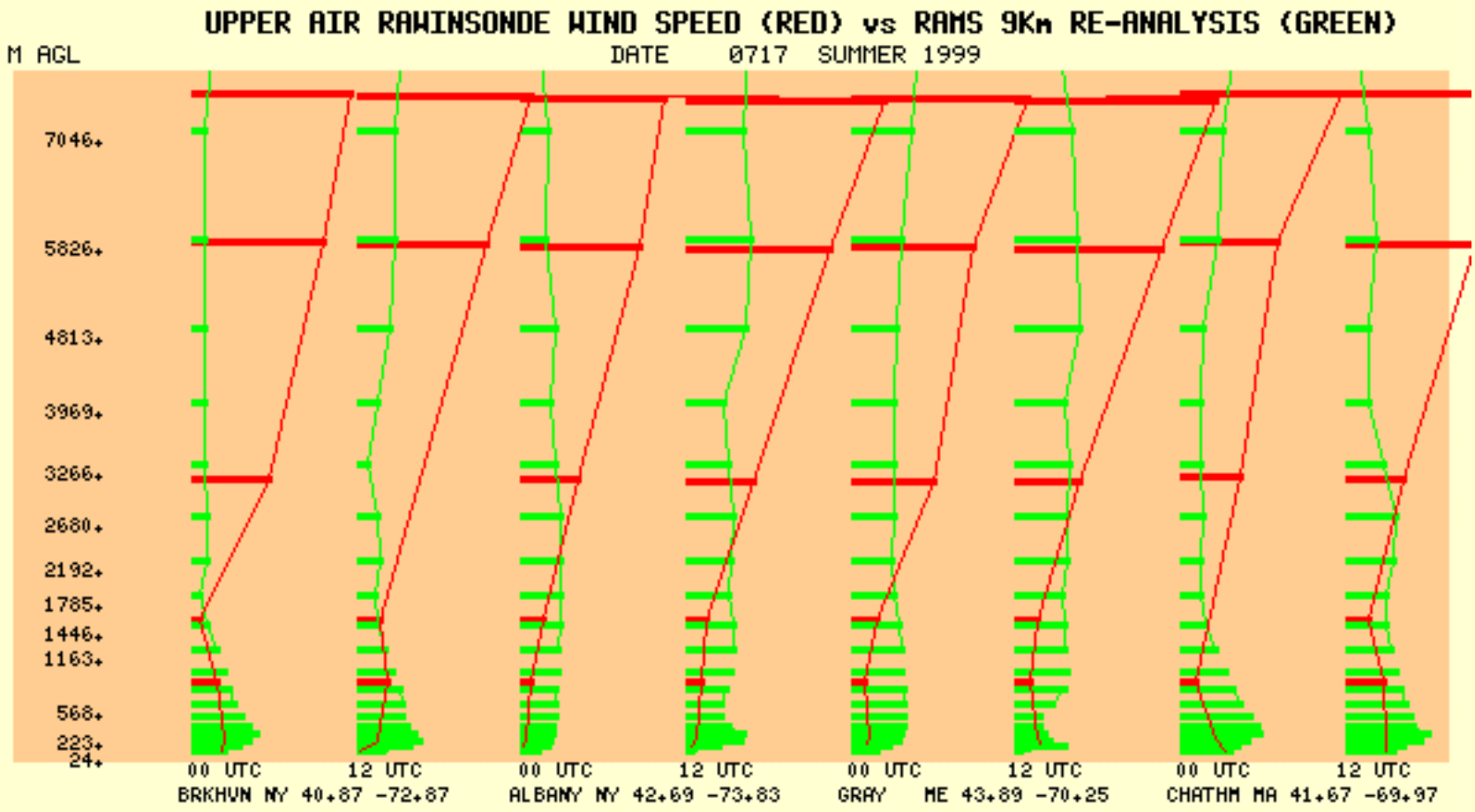


BROOKHAVEN NY **ALBANY NY** **GRAY ME** **CHATHAM MA**

For each PAIR: Left is 0Z Right is 12Z

July 17 1999 0Z and 12Z Upper Air Comparison

Wind Speed (Green = RAMS Red = Rawinsonde)



BROOKHAVEN NY **ALBANY NY** **GRAY ME** **CHATHAM MA**

For each PAIR: Left is 0Z Right is 12Z

COMPARISON STATISTICS for RAMS 9 KM WIND FIELD

COMPARED TO WINDS AT 7 UPPER LEVELS (Combined) at 4 RAWINSONDES

RAWINSONDE LOCATION	AVERAGE DIRECTIONAL BIAS DEGREES	HOURS	AVERAGE POSITIVE ERROR DEG	HOURS	AVERAGE NEGATIVE ERROR DEG	HOURS
94703_OKX	- 6.1	1023	+ 54	443	- 53	580
54775_ALY	- 0.4	1116	+ 56	520	- 50	596
54762_GYX	- 1.1	1185	+ 55	542	- 49	643
14684_CHH	- 9.1	1210	+ 52	521	- 56	689
RAWINSONDE LOCATION	AVERAGE WIND SPEED BIAS METERS/SEC	HOURS	AVERAGE POSITIVE ERROR M/SEC	HOURS	AVERAGE NEGATIVE ERROR M/SEC	HOURS
94703_OKX	+ 1.2	1023	+ 5.6	542	- 3.9	481
54775_ALY	+ 3.0	1116	+ 7.1	719	- 4.3	397
54762_GYX	+ 3.9	1185	+ 8.6	768	- 4.7	417
14684_CHH	+ 2.1	1210	+ 7.3	666	- 4.3	544

CONCLUSIONS (re: WIND-FIELDS)

1. **RAMS 9 KM & 3 KM RE-ANALYSIS WIND FIELDS DO SEEM MORE REPRESENTATIVE OF MEASUREMENT DATA THAN AVAILABLE EDAS 80 KM ARCHIVED WIND FIELDS (both on an hr-by-hr basis and climatologically) at many sites.**

2. **AS CONFIGURED AT PRESENT, RAMS DOES SHOW SOME WEAKNESSES: (comparing to ASOS & Rawinsonde measurements)**

   a) SURFACE WIND SPEEDS AVERAGE LOWER THAN CORRESPONDING ASOS MEASUREMENTS

   b) UPPER LEVEL WIND SPEEDS AVERAGE HIGHER THAN CORRESPONDING RAWINSONDE MEASUREMENTS

3. **DOMAIN-WIDE BIAS IN SURFACE WIND DIRECTION IS LESS FOR THE RAMS 3 KM & 9 KM RE-ANALYSIS THAN FOR THE EDAS ARCHIVED DATA. Whether BIAS is direction specific or not and the REASONS for it have not yet been determined.**

Initial Findings re: TEMPERATURE PREDICTIONS

SURFACE TEMPERATURES ARE PREDICTED SOMEWHAT BETTER INLAND THAN AT LOCATIONS ALONG THE COAST

50-60% of PREDICTED HRly SURFACE TEMPERATURES ARE WITHIN ABOUT 2 DEGREES C OF MEASURED on 03 GRID (slightly better prediction during night-time hrs than daytime)

On average, over the entire domain, RAMS under-predicts surface Temperatures (by up to 20 Deg F during the night/day transition period from 8am to 10am local time

CAPE-COD & COASTAL ISLAND SITES BEHAVE DIFFERENTLY

(Some of these findings need to be confirmed over the full summer period)

CONTINUING FUTURE WORK with RAMS 1999 DATA

Analysis:

More work on Upper Level Wind-Fields could be done

Additional work comparing Temperature Fields needs to be done

More analysis of coastal performance needs to be done

Air Quality Modeling:

USING RAMS WIND-FIELDS FOR SUMMER 1999 in BACK-TRAJECTORY SOURCE/RECEPTOR STUDIES

COMPARING CALPUFF MODEL RUNS DRIVEN BY RAMS-03 & RAMS-09 WIND-FIELDS to

CALPUFF MODEL RUNS using CALMET DERIVED WIND-FIELDS @ various grid resolution FOR THE SAME DOMAIN