



# Practical Use of Meteorological Models and Visualization Tools for Soaring Forecasts

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- \* Retired NWS Meteorologist 42 years*
- \* Manager / CWSU Aviation Support*
- \* Contest Forecaster – Discus 2A: 4000 hours*
- \* Barron Hilton Cup – West U.S. Winner 2008*
- \* WGC Uvalde 2012 Technical Support Met*





# What We Will Talk About Today...

- Atmospheric Soundings for Soaring – How to Visualize Thermal Layer (PBL)
  - Radiosonde Balloons; Profilers & Aircraft
  - Numerical Models and Forecast Soundings
- Software Tools For Soundings – How To ...
  - What About DrJack.net and XCSkies.com?
  - ESRL SKEW-T, BUFKIT and RAOB.com
- Where Is U.S. NOAA Numerical Modeling Efforts Headed?
- What About Weather in the Cockpit?



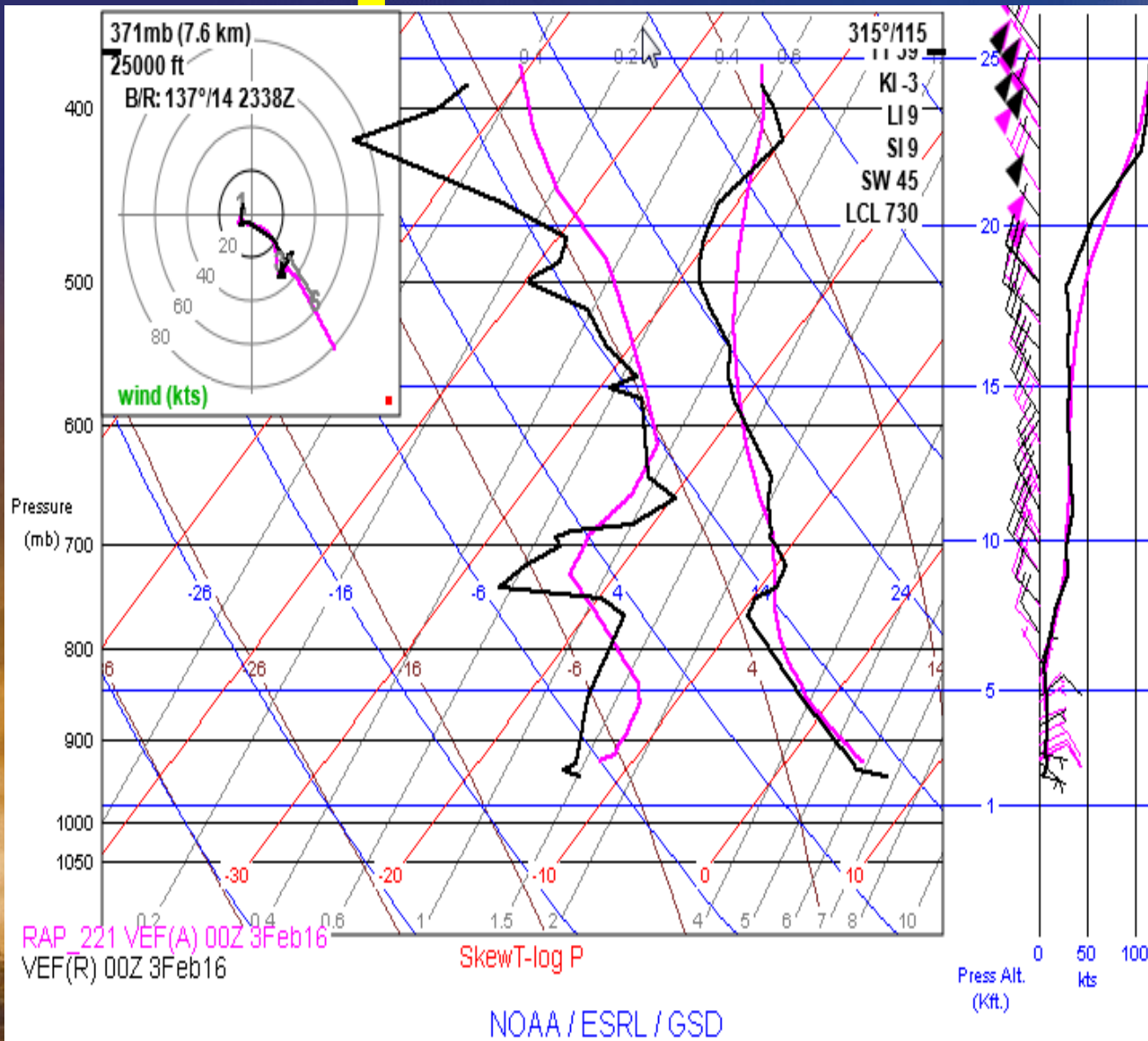
# Radiosonde - Legacy Obs

- Radiosonde Obs

- Twice/day - 12Z 00Z
- Approx 800 world wide; 92 U.S.
- Detailed vertical temp, wind and rh data
- Several 100's km separation from soaring forecast location
- Not a good soaring forecast solution - Good for analyses



# Typical Radiosonde Ob Compared to Model Sounding

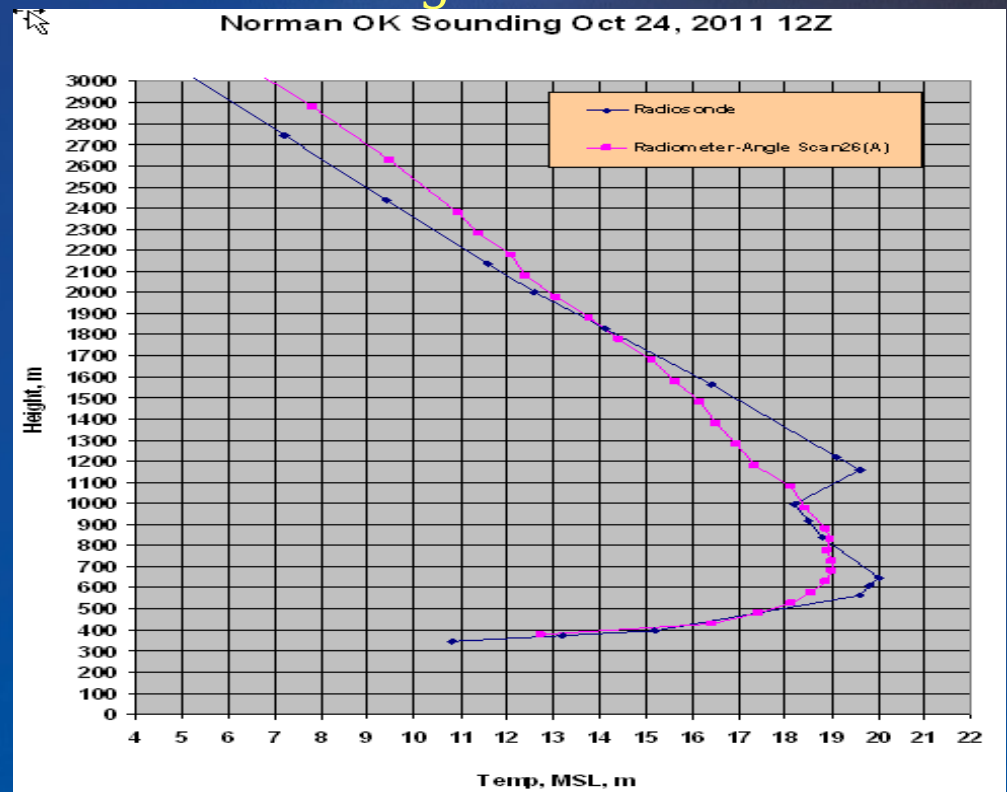


- Black – Las Vegas Raob
- Temp DewPt
- Valid 4pm PST
- Sharp boundaries at top Thermal Layer
- Purple – Model RAP Sounding
- Notice smoothing of features



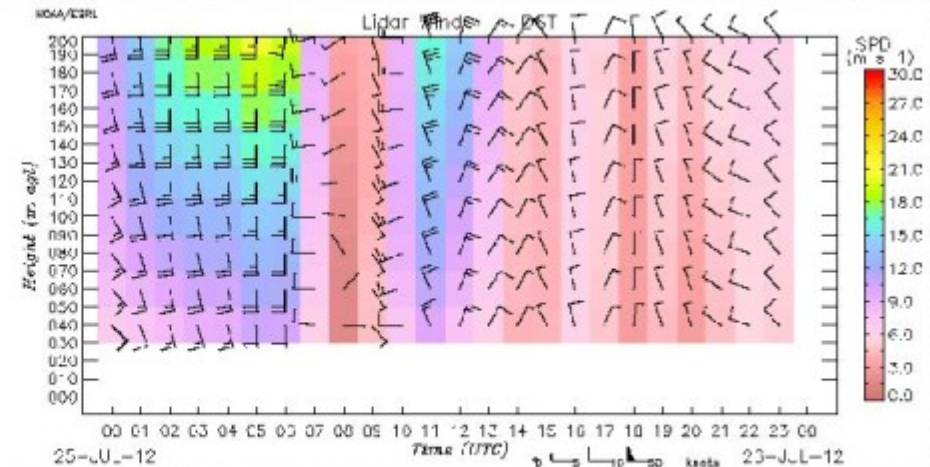
# Observing Thermal Layer - Remote Soundings

- Radiometers - Detects temperature moisture profiles; No Wind info. Accuracy depends on nearby sounding and historical statistical data
- Radiometric.com is a leaders in the field. There are now over 300 of their MP-300 instruments around world. Far less expensive to operate than Radiosondes. One of founders is Mike Exner - long time Boulder Soaring Assoc member



# Observing Thermal Layer – Remote Soundings

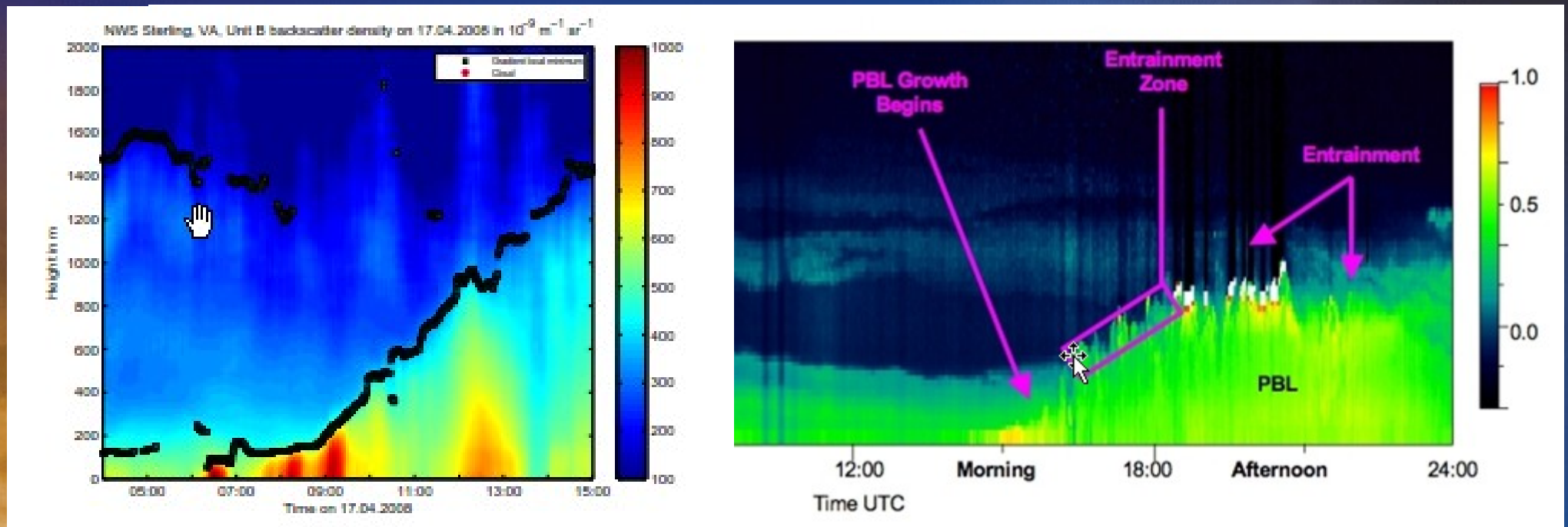
- Radar Wind Profiler/RASS – Delivers wind temp profiles except in extremely clear air





# Observing Thermal Layer – Remote Soundings

- Lidar Profiler/Ceilometer – Used in NWS ASOS can detect thermal layers – But... not operationally available





# Observing Thermal Layer – Remote Soundings

- In Short... Remote Soundings are NOT PRACTICAL because of cost or operational status for soaring forecasts
- Sometimes... like WGS-2012 Uvalde... one is able to get access to these systems. Radiometrics provided one of their radiometers during the World Soaring Championships



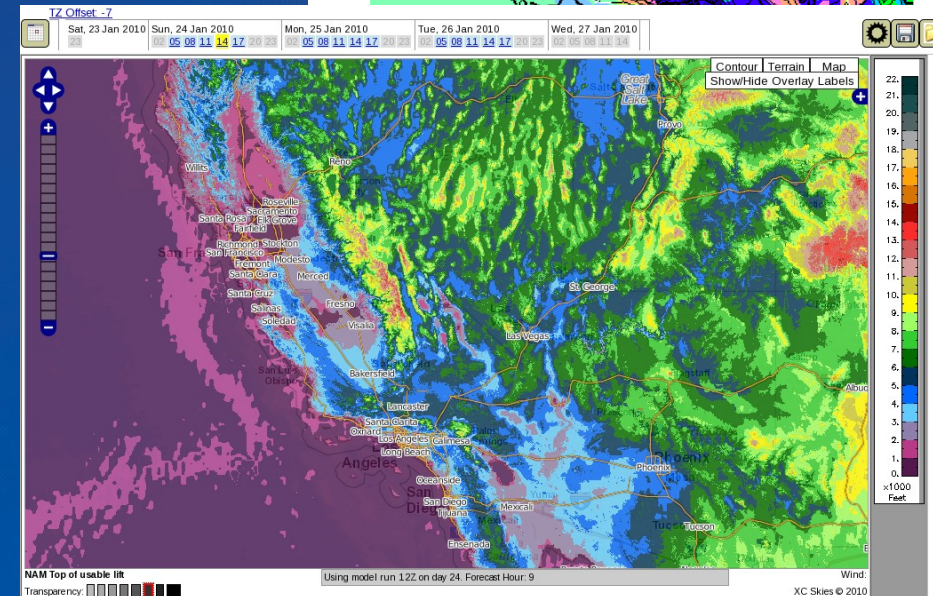
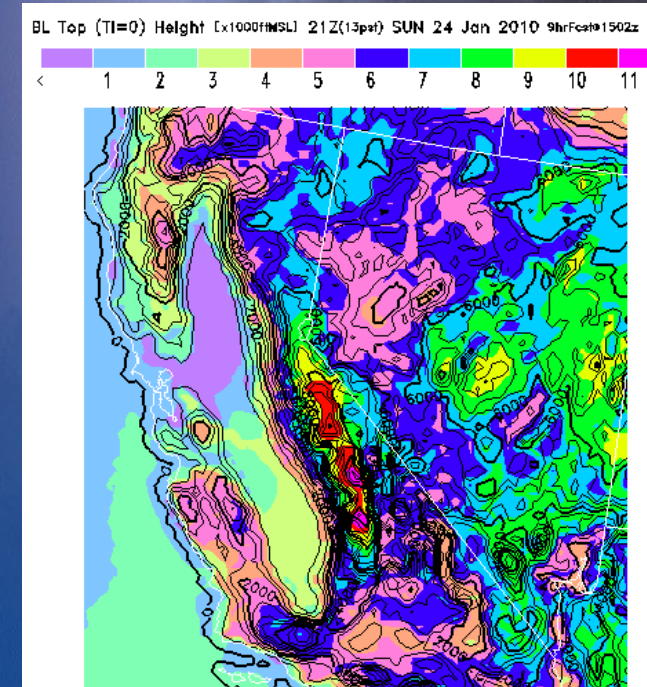




# Software Tools For Soundings

## *What About DrJack.net and XCSkies?*

- Both still provide ***solid value*** and are more than sufficient for 1-3 day flight planning
- DrJack BLIMAP - Stable; No Development; only Maintenance
- XCSkies - Unchanged since around 2009; Stable and valuable resource
- Both sites no longer display radiosonde obs or Interactive NOAA Skew-T through the java plugin
- What's the future? ....
  - Good Question? ...
  - RAP, HRRR, NAM and GFS Gridded Formats may change in 2019... as NOAA converts to “Ensembles” of 20 runs





# Software Tools For Soundings

## *Numerical Model Forecasts*

- Models have complex simulation of surface energy budgets and physics of the atmosphere boundary layer
- Vertical number of layers is sufficient to resolve evolution of the PBL (thermal layer)... and performance of the physical simulation keeps improving
- In the U.S. ... Gridded Data at 3km to 13km resolution and Binary Model Soundings for hundreds of locations are freely available
- Currently ... as of early 2016... HRRR (3km) runs hourly to 15hrs; NAM (13km) 6hourly to 84hrs; NAM4km (4km) 6hourly to 60 hrs.

*So.... What's needed are visualization tools for accesing these soundings!*





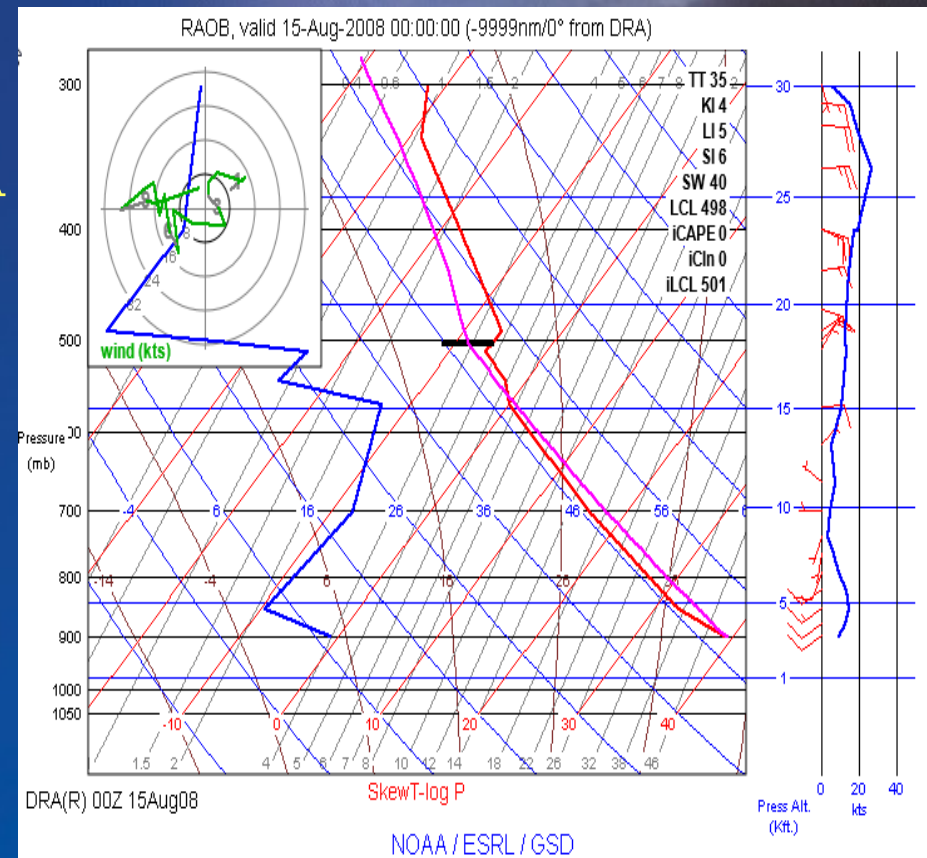
# Sounding Visualization Tools

## *Here's What I Use...*

TOOL	EASE OF USE	COST	COMMENTS	PROGRAM ENVIRON
ESRL Interactive Skew-T	Easy to use Fast to Learn	Free	RAOBS, RAP, NAM,GFS Any Lat/Lon or 3-4 letter ID	Browser HTML5
BUFKIT	Moderate Highly interactive once learned	Free	All Operational Models; Only discrete 600+ model sounding points BUFKIT files; Skew-T and Time Series Plots	Visual Basic Windows OS
RAOB.com	Steep Curve; Once learned lots of UI Action; Must be scripted for operational use  Dedicated Professional Users	\$100 Basic Soaring Diagram; \$170 Extra for Time Series Graphics	“Kitchen Sink” of Sounding Plots and Analyses; Beautiful Time Series Thermal Plots; Foreground Batch Cmds; RAOBs, Many model formats	Visual Basic Windows OS

# ESRL Interactive Skew-T

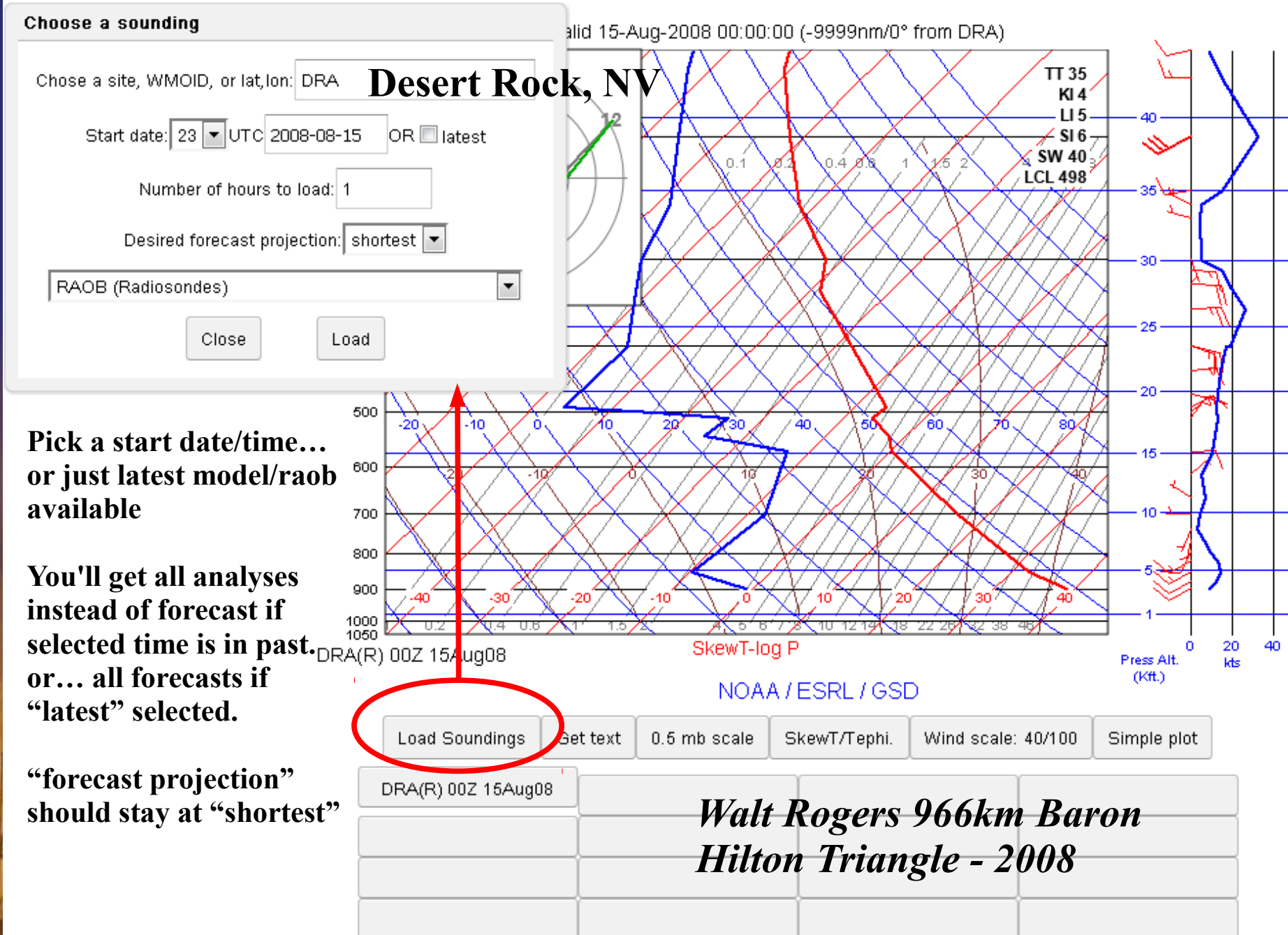
- My recommendation for ease of use
- Written by Bill Moninger at NOAA Boulder Earth System Research Lab (ESRL) GSD
- Great access to Radiosonde historical obs up to about 8yrs ago
- Originally developed to use Java Plugin - Now uses HTML5 requiring no browser plugin ... works in Ipad



<http://rucsoundings.noaa.gov/gwt/>



# ESRL Interactive Skew-T



# ESRL Interactive Skew-T

## Choose a sounding

Chose a site, WMOID, or lat,lon:

Start date:  UTC  OR ☐ latest

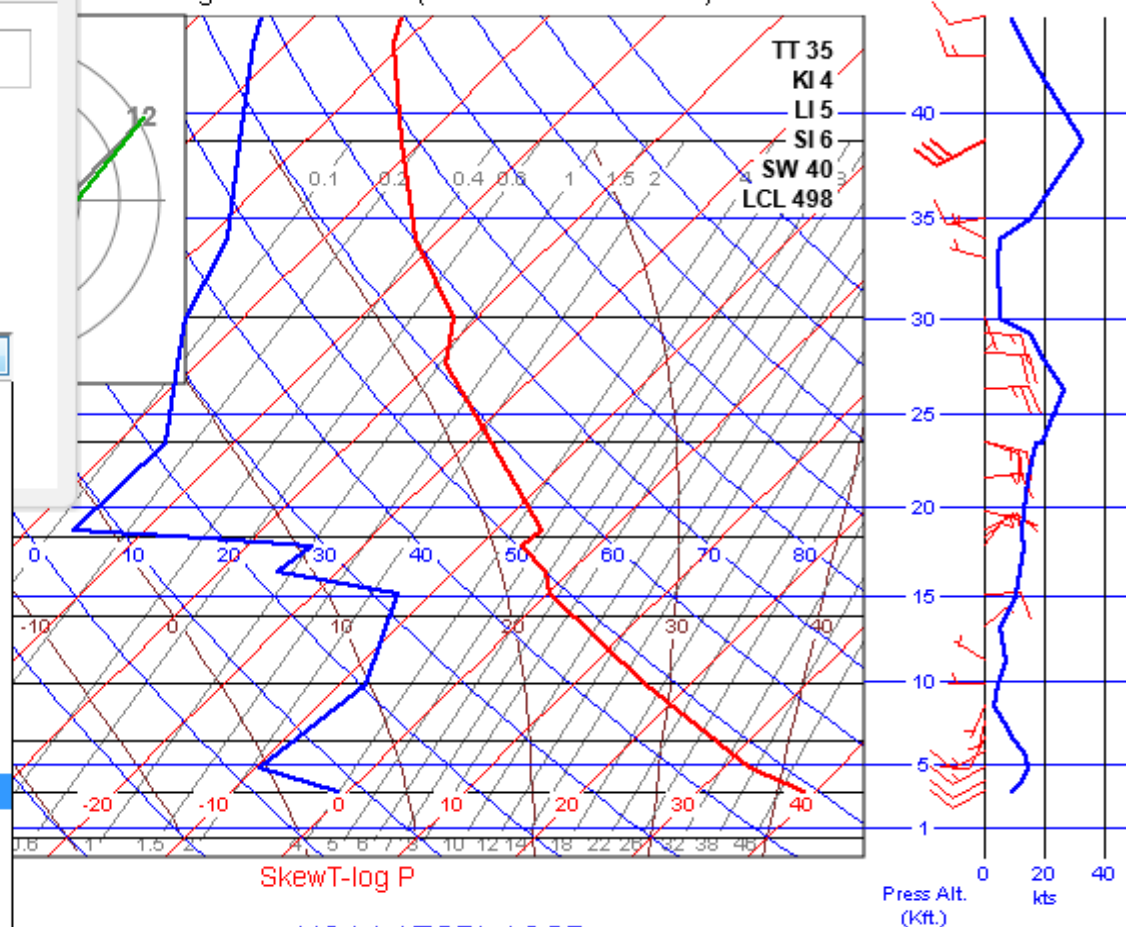
Number of hours to load:

Desired forecast projection:

RAOB (Radiosondes)

- RAP\_130 (GSD CONUS 13km)
- RAP\_OPS\_130 (NCEP CONUS 13km)
- RAP (full RAP domain at RAOB times, else RAP\_130)
- Op40 (RAP\_OPS\_236 CONUS 40km FAST LOAD)
- RAP\_221 (GSD RAP entire domain 32 km)
- Bak40 (to 48h. GSD RAP at 40km – formerly 'MAPS')
- Bak13 (RAP archival analyses and 3h forecasts)
- HRRR (3km CONUS)
- FIM (to 5 days)
- GFS (to 5 days)
- NAM (to 15 hrs)
- RAOB (Radiosondes)**
- PROF (Profilers)
- RADIO (Radiometers)
- ACARS (Aircraft-restricted)
- FIM\_prs (FIM on isobaric levels)
- RETRO (Special restores)
- for all models check 'latest' to get most recent –
- other runs (if any) are in alphabetical order –

valid 15-Aug-2008 00:00:00 (-9999nm/0° from DRA)



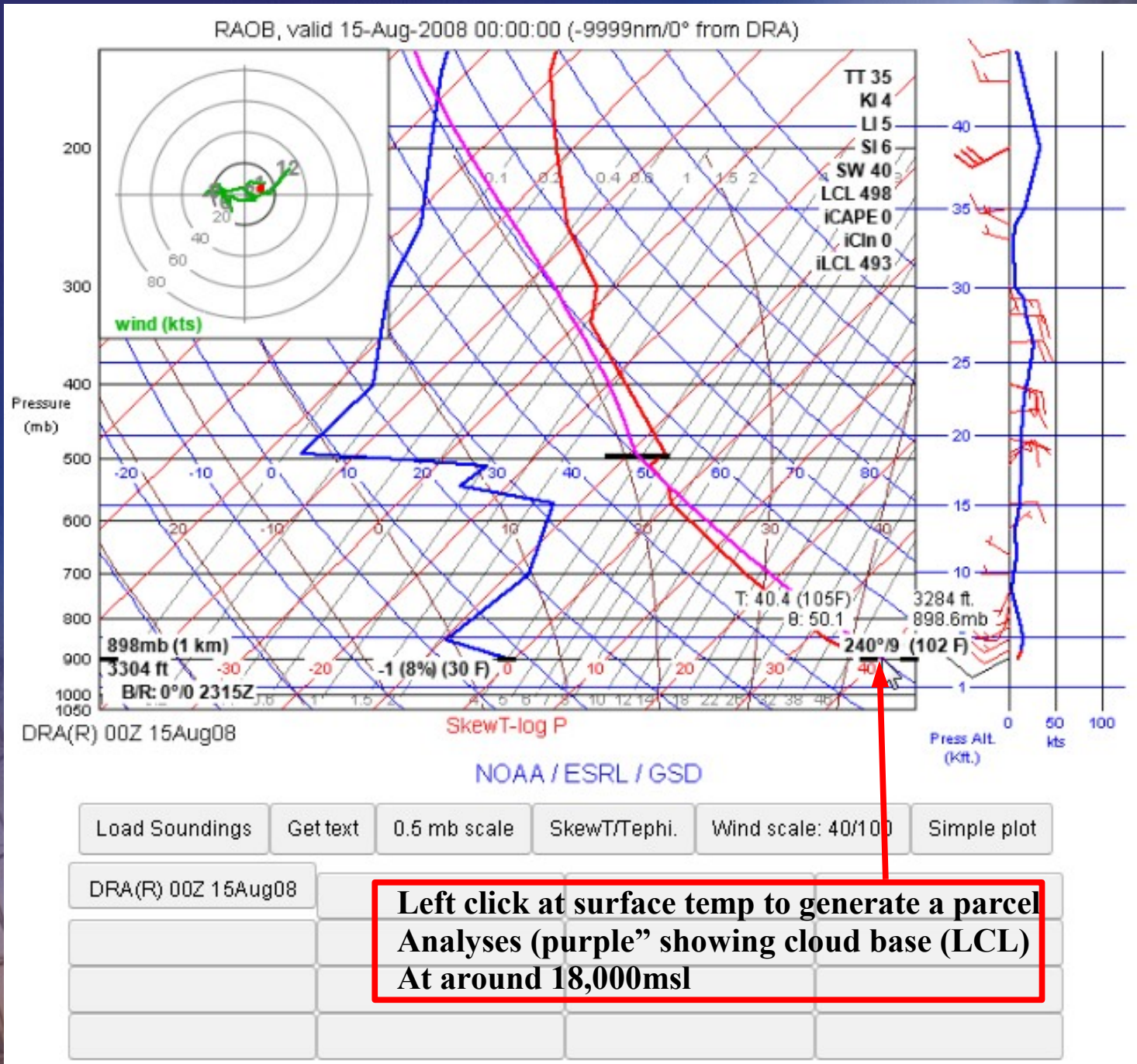
NOAA / ESRL / GSD

Get text 0.5 mb scale SkewT/Tephi. Wind scale: 40/100 Simple plot

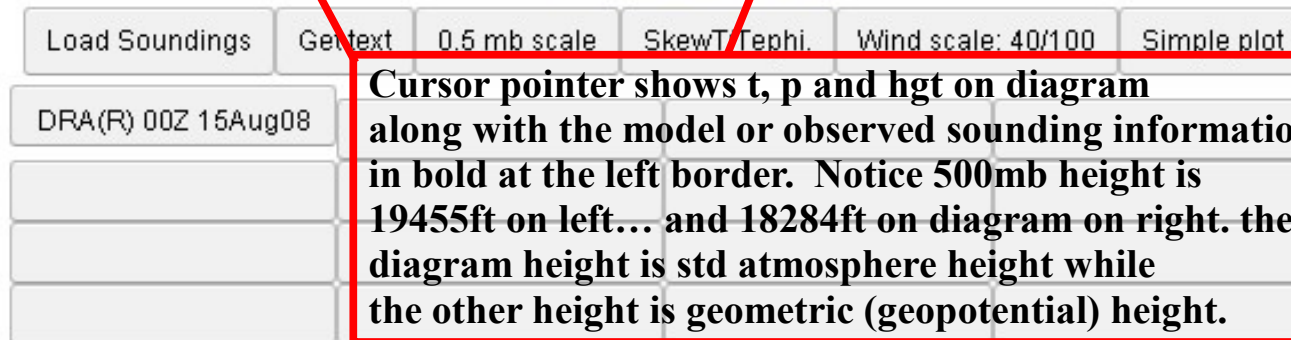
DRA(R) 00Z 15Aug08



# ESRL Interactive Skew-T









# ESRL Interactive Skew-T

- Here's how to interpret sounding data types
- Only two RAP model runs (Exp & Ops – different grids)
- ***Yes it is confusing!***

RAP\_130 (GSD CONUS 13km)

RAP\_130 (GSD CONUS 13km)

RAP\_OPS\_130 (NCEP CONUS 13km)

RAP (full RAP domain at RAOB times, else RAP\_130)

Op40 (RAP\_OPS\_236 CONUS 40km FAST LOAD)

RAP\_221 (GSD RAP entire domain 32 km)

Bak40 (to 48h. GSD RAP at 40km – formerly 'MAPS')

Bak13 (RAP archival analyses and 3h forecasts)

HRRR (3km CONUS) ← Inop as of early 2016

FIM (to 5 days)

GFS (to 5 days)

NAM (to 15 hrs)

RAOB (Radiosondes) ← Good for raobs back 8yrs

PROF (Profilers)

RADIO (Radiometers)

ACARS (Aircraft-restricted)

FIM\_prs (FIM on isobaric levels)

RETRO (Special restores)

– for all models check 'latest' to get most recent –

– other runs (if any) are in alphabetical order –

**RAP OPS means NWS Operational Model  
RAP GSD or BAK means experimental RAP  
Run at ESRL NOAA Boulder**

**RAP\_130 GSD – 13km grid version –  
slow access displaying data. Experimental  
Version**

**RAP\_OPS\_130 - 13km grid version -  
Slow access displaying data. Operational  
Version**

**Bak40 – 40km grid version RAP**

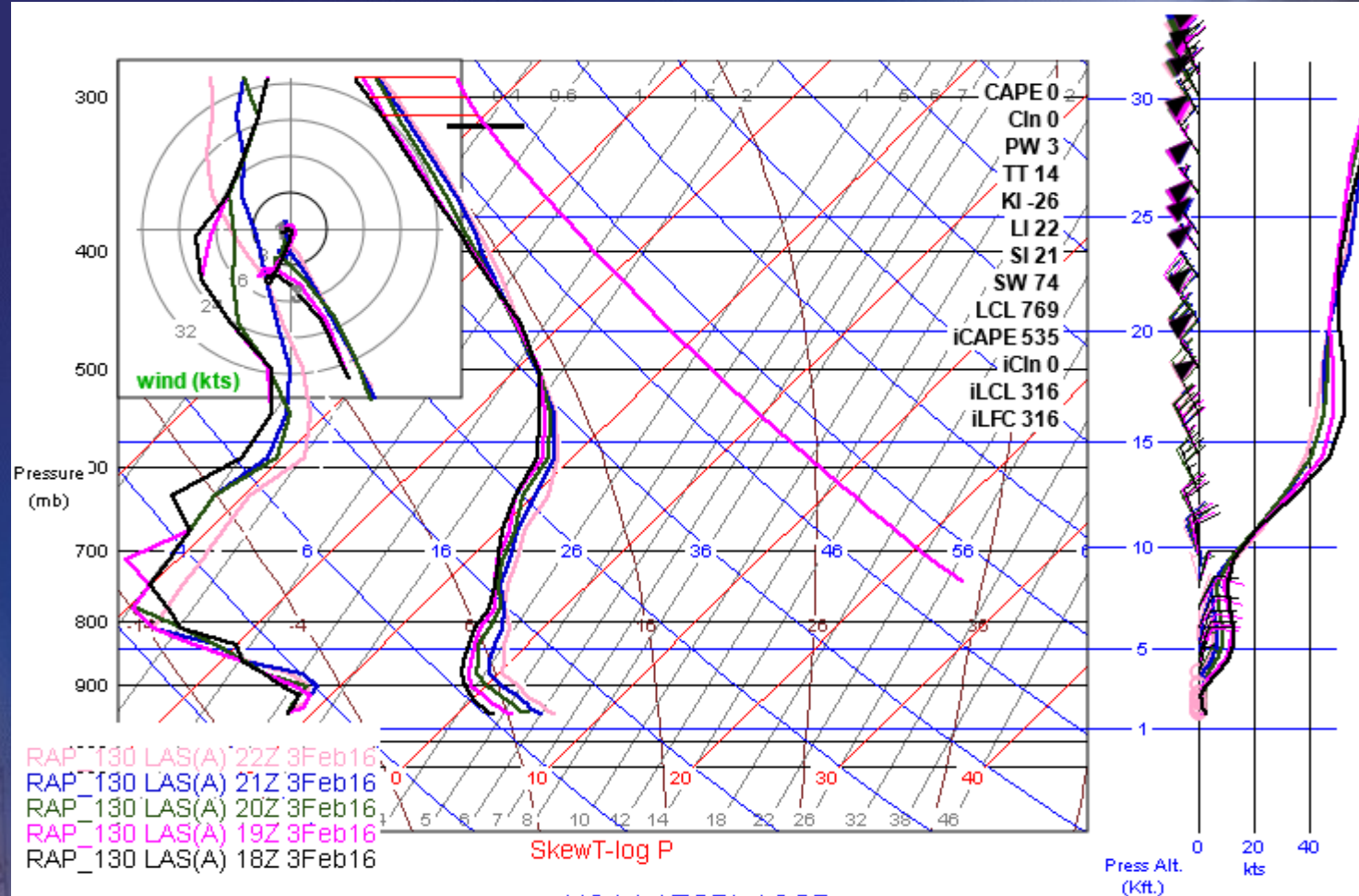
**Experimental. Display access fast**

**Op40 - 40km grid version RAP. Operational  
Version. Display access fast**

**RAP\_221 – 32km grid version Experimental  
About same as RAP\_130**

***For fast access use OP40 or BAK40 RAP...  
Slower access higher resolution use  
RAP\_OPS\_130 or RAP\_130 GSD***

# ESRL Interactive Skew-T



Load Soundings

Get text

150mb scale

SkewT/Tephi.

Wind scale: 40/100

Simple plot

LAS(A) 23Z 3Feb16

LAS(A) 22Z 3Feb16

LAS(A) 21Z 3Feb16

LAS(A) 20Z 3Feb16

LAS(A) 19Z 3Feb16

LAS(A) 18Z 3Feb16





# ESRL Interactive Skew-T

- Select the "Instructions" link for more documentation
- To find 3-4 letter IDs that work... select METARs link to browse for a city or airport name that will work in the locations field
- These 2 minute mp4 videos below shows interactive use of the ESRL NOAA Skew-T

***Video Demo Skew-T RAOB -***

***Web Access: [bit.ly/1Sc60mn](http://bit.ly/1Sc60mn)***

***Local File***

***Video Demo Skew-T RAP -***

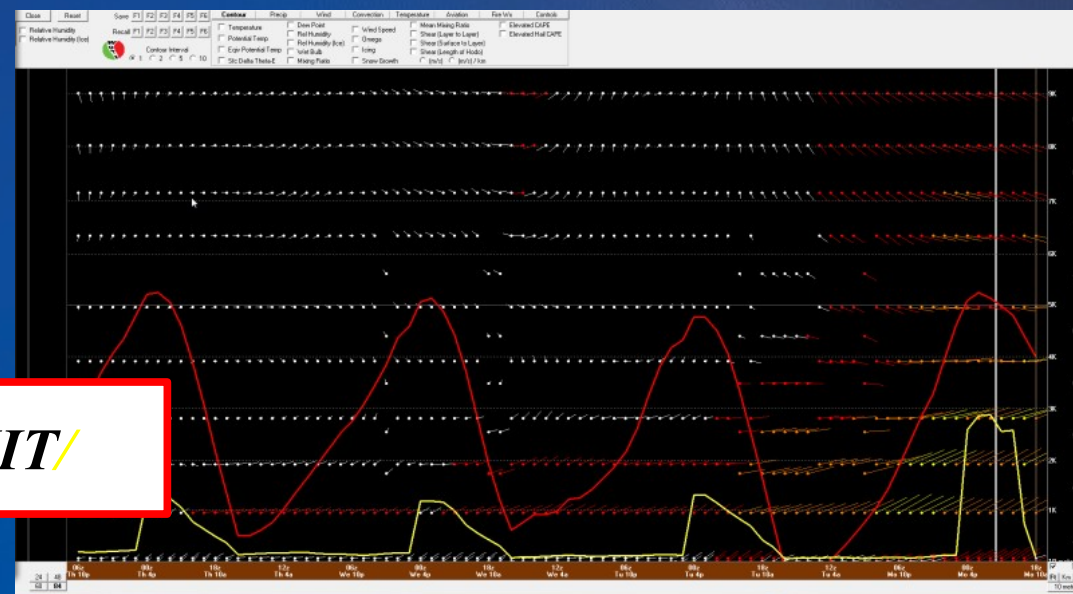
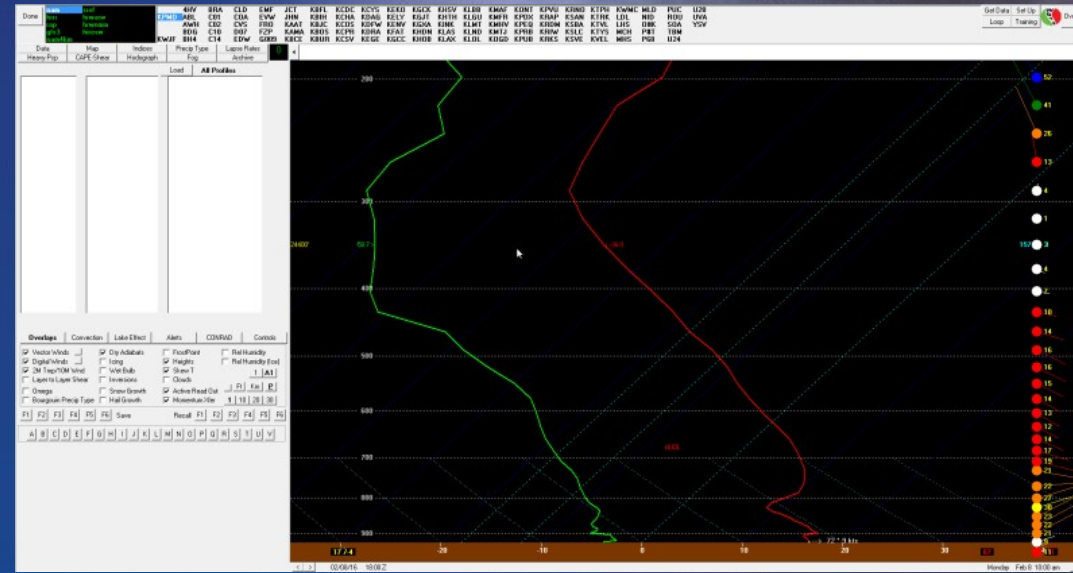
***Web Access: [bit.ly/1PxGhPm](http://bit.ly/1PxGhPm)***

***Local File***



# BUFKIT Sounding Viewer

- High resolution model soundings NAM, RAP, HRRR, GFS, NAM4KM
- Two Windows - PROFILE view and OVERVIEW Time Series cross section. Browse Skew-T interactively
- Uses specially encoded model sounding binary (BUFR) files - decoded into BUFKIT text format... 600+ discrete locations
- Easily browse through 15hr (HRRR) to 180hr (GFS) time series
- Mixed Layer (thermal) Height; T, Td, RH, Winds, Precip



<http://www.wdtdb.noaa.gov/tools/BUFKIT/>

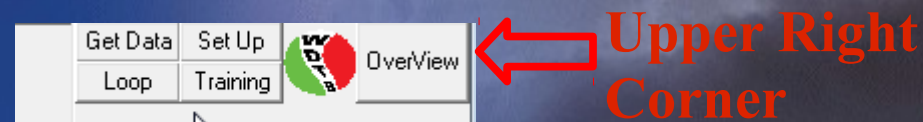




# BUFKIT Sounding Viewer

## Getting Started

- Program freely available - Visual Basic (need Windows to run)
- Settings - Set download directory
- GetData - Download BUFKIT files with BufGet app
- Training - Lots of Help Videos
- PROFILE is main Skew-T Window
- OVERVIEW opens 2<sup>nd</sup> Window... best if you have two monitors



**Bufkit Set Up**

Specify where the Bufkit profiles are located

Directory that Contains the Bufkit profiles:

Directory that Contains the Archive Bufkit profiles (the profiles with a data prepended to the filename):

Specify how the clock on your computer is set up:

Is your PC on Local or Z time  
☒ The Computer is on Local time  
☐ The Computer is on Z time (set to UTC)

Standard Time Zone in which your PC is located  
 Pacific Mountain Central Eastern  
 West by 6 Hours

Savings Time  
☐ DST in effect

Specify Up to 18 Model Types (Examples: NAM NAMM GFS3 RUC ARW NMM)

nam	gfs3	hrrarw			
hrrr	nam4km	hrrnmm			
rap	sref	hiresw			

Specify the Site IDs Layout

These profiles will be listed first on the available site list:

KPMD	NID	KLAX			
KWJF	EDW				
KMHV	KBUR				

Max Site IDs or Models Types in a Column  
 5

Directory to save screen captured snapshots:

Advanced Options  
☐ The Pietrycha Timeline Anomaly  
☐ The Zubrick Overview Scale Extension

Directory to save exported profiles:

Optimize for Linux  
☐ Running on a Linux PC

Save Cancel

Saved changes will take effect the next time you start Bufkit

**BUFKIT**  
**Five-Minute University**

Buf Forecast Profile ToolKit Version 15.11.2 The Warning Decision Training Division

Bufkit 11  
 Bufkit 10  
 Getting Started With Bufkit

Bufkit 9 Introduction	Requirements	Configuring Bufkit	Running Under Linux
Getting Data	Using Bufget	Bufkit Profile Sites	

Profile Knobology

The Profile Screen Layout	Selecting a Model and Profile	Zoom In and Out	Display Options
Convective Options	The Map Display	Using Nomograms	My Favorite Layouts



# BUFKIT Sounding Viewer

## *Getting Data*

- Penn State has most reliable BUFKIT data
- Click on dot to manually DL file
- ..Or.. capture URL into BufGet which allows scripting to DL many at once
- Bufrgruven - Perl script fetches & converts to BUFKIT - Linux.. run in a VM - Advantage of capturing earlier model runs

CONUS  
[Northeast U.S.](#)  
[Southeast U.S.](#)  
[Northcentral U.S.](#)  
[Southcentral U.S.](#)  
[Northwest U.S.](#)  
[Southwest U.S.](#)  
[Alaska](#)  
[Hawaii](#)  
[Canada](#)  
[Central America](#)  
[Domain](#)

[00Z NAM](#)  
[06Z NAM](#)  
[12Z NAM](#)  
[18Z NAM](#)

[00Z NAM4KM](#)  
[06Z NAM4KM](#)  
[12Z NAM4KM](#)  
[18Z NAM4KM](#)

[00Z GFS](#)  
[06Z GFS](#)  
[12Z GFS](#)  
[18Z GFS](#)

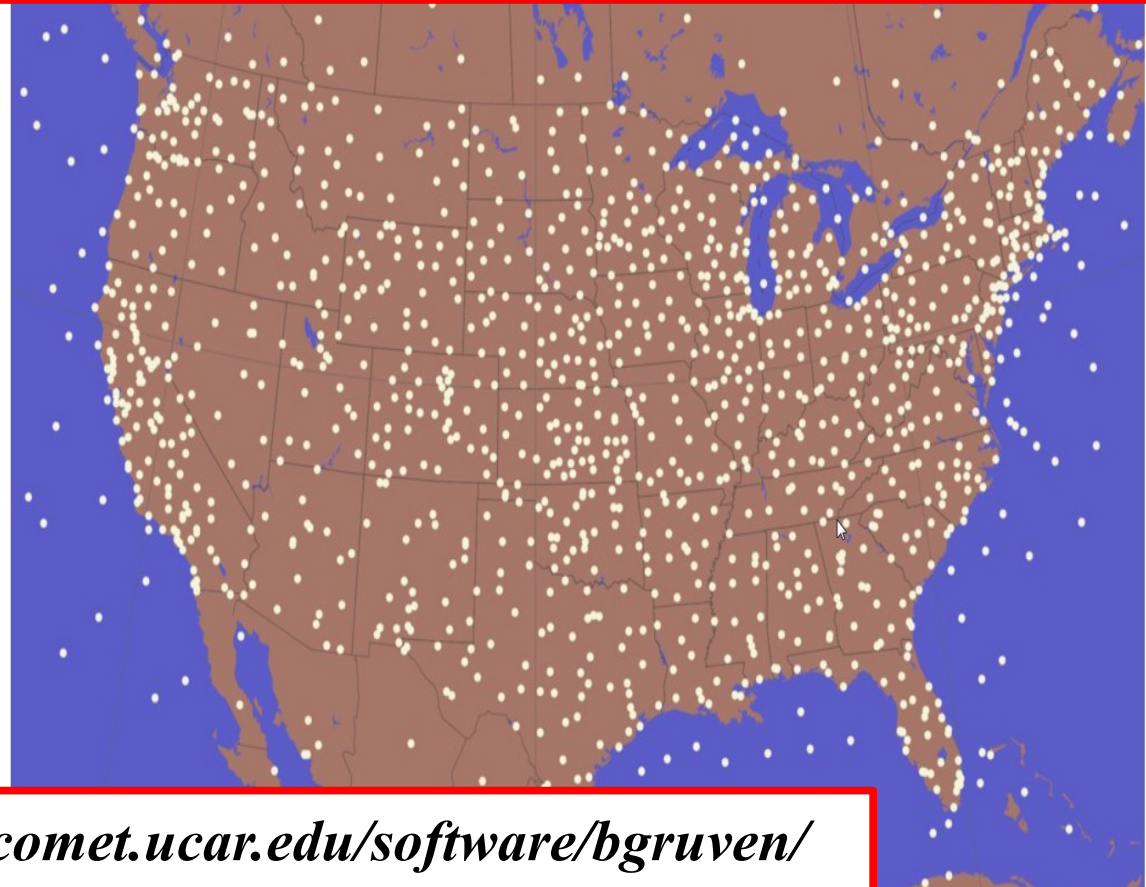
[03Z SREF](#)  
[09Z SREF](#)  
[15Z SREF](#)  
[21Z SREF](#)

[00Z RAP](#)  
[01Z RAP](#)  
[02Z RAP](#)  
[03Z RAP](#)  
[04Z RAP](#)  
[05Z RAP](#)  
[06Z RAP](#)  
[07Z RAP](#)  
[08Z RAP](#)  
[09Z RAP](#)  
[10Z RAP](#)  
[11Z RAP](#)  
[12Z RAP](#)  
[13Z RAP](#)



## Bufkit Data Distribution System

[www.meteo.psu.edu/bufkit/CONUS\\_NAM\\_18.html](http://www.meteo.psu.edu/bufkit/CONUS_NAM_18.html)



[strc.comet.ucar.edu/software/bgruven/](http://strc.comet.ucar.edu/software/bgruven/)

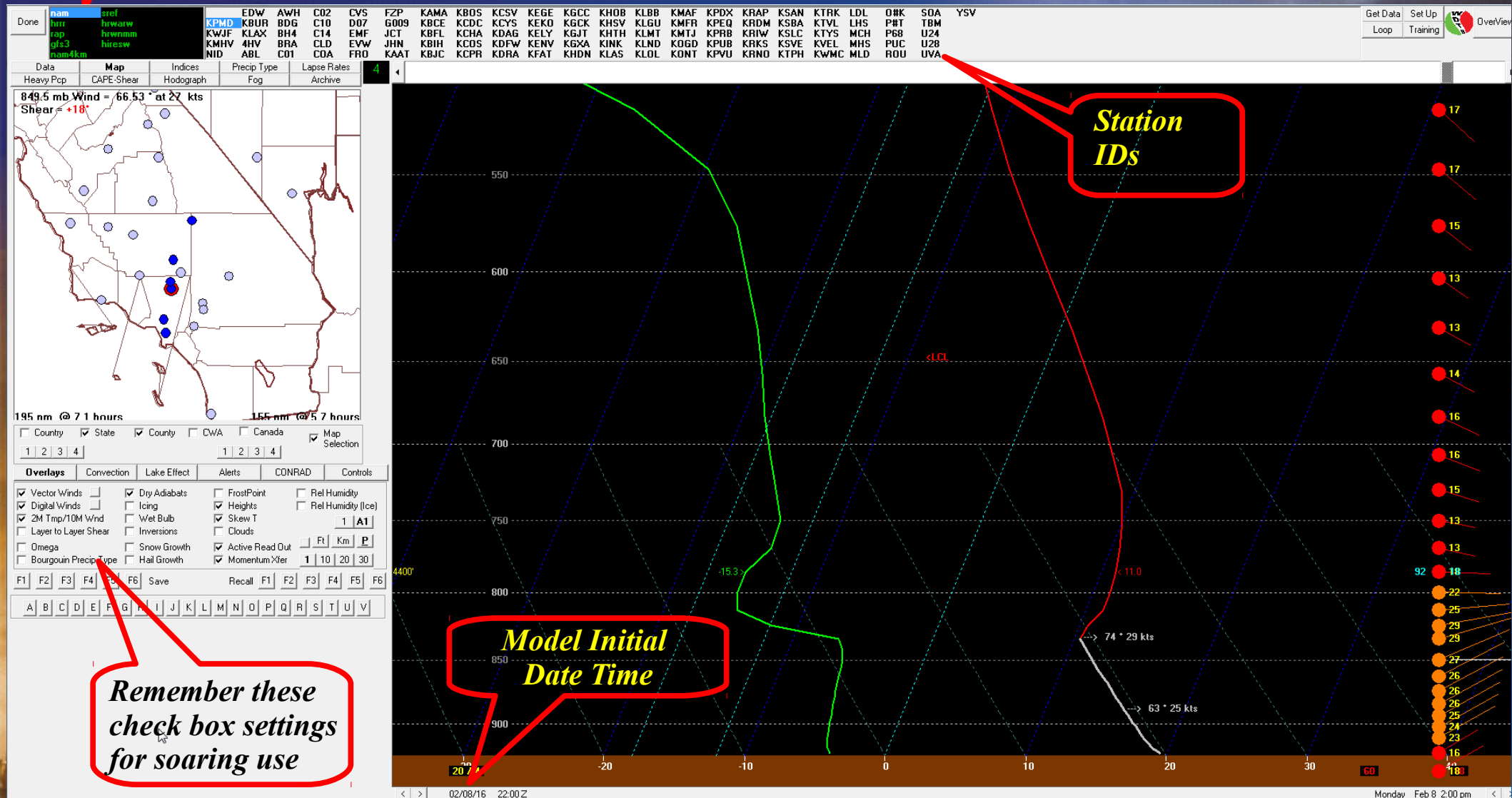




# BUFKIT Sounding Viewer

## Profile View

Select Models





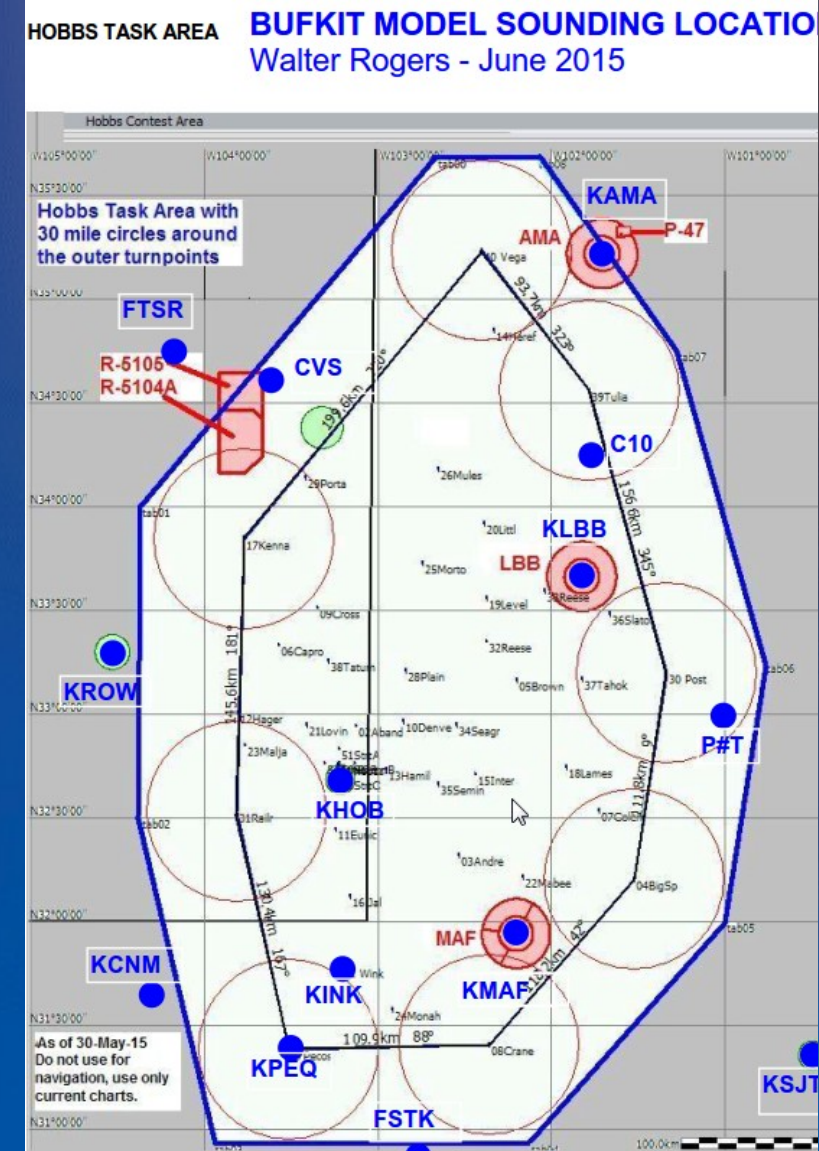




# BUFKIT Sounding Viewer

## Summary

- Really a Great Program! ... for Quickly browsing model soundings...
  - Thermal Heights
  - Wind, Temp and Dew point
  - RH Cross Sections
  - Checking for Surface Winds affecting Runway Configuration
- Limitations
  - You can only use one of the 600+ sites
  - You cannot script it for automatic generation of graphics
  - Thermal Heights are in AGL... requires mentally converting to MSL
  - Two step process.. first get soundings .. then view





# BUFKIT Sounding Viewer *Summary*

*Check out these Video Demos:*

***BUFKIT PROFILE:***

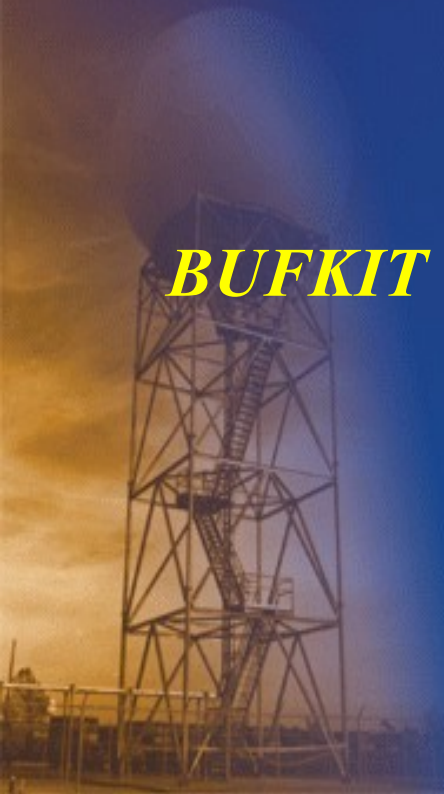
*[bit.ly/1TReY80](http://bit.ly/1TReY80)*

*Local File*

***BUFKIT TIME SERIES:***

*[bit.ly/1Q82zNt](http://bit.ly/1Q82zNt)*

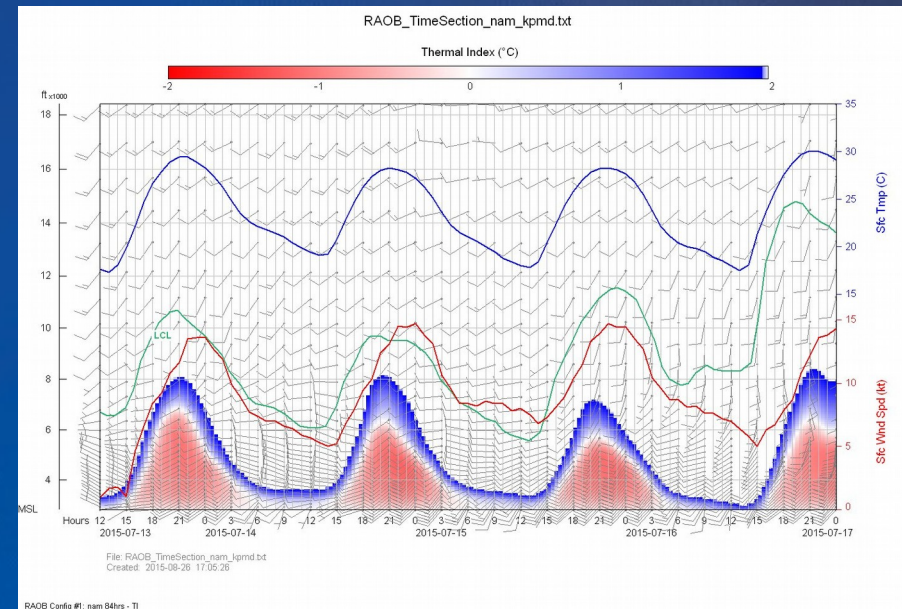
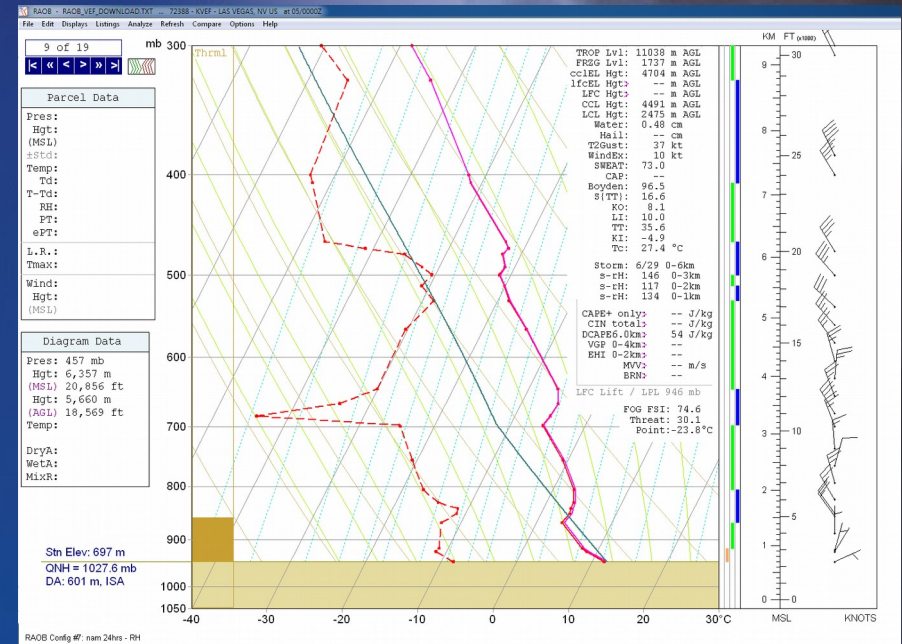
*Local File*





# RAOB.com

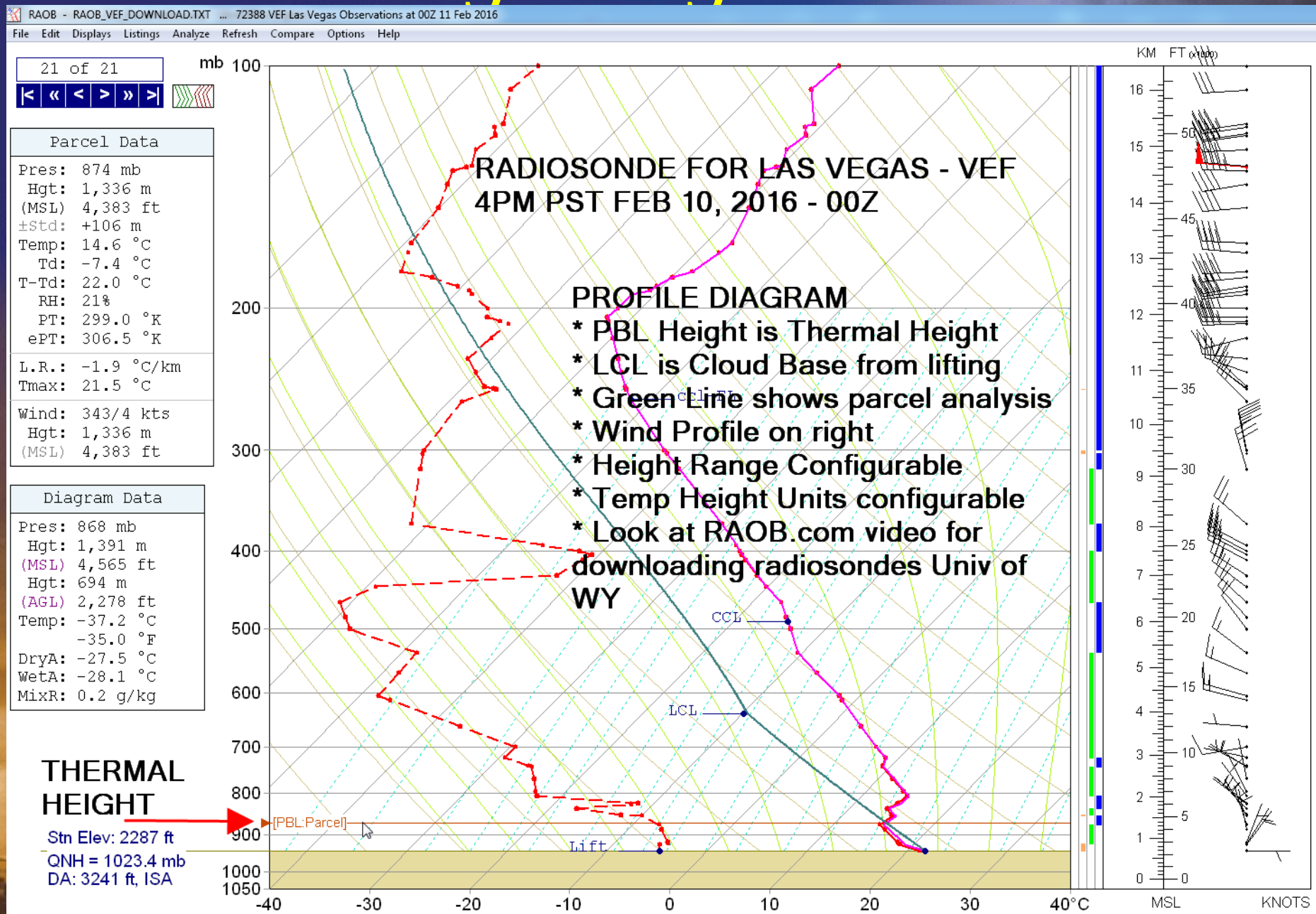
- Most complex RAOB sounding analysis tool available
  - Can analyze decode practically any type of sounder or data format available
- Produces beautiful time series thermal plot graphics
- Commercial product
- Outstanding technical support
- Basic Program - \$100; Analytic Module - \$50; Cross Section Module - \$120 - Total \$270
- Steep learning curve
- Batch commands - semi-automatic production of graphics





# RAOB.com

## Sounding Diagram Window

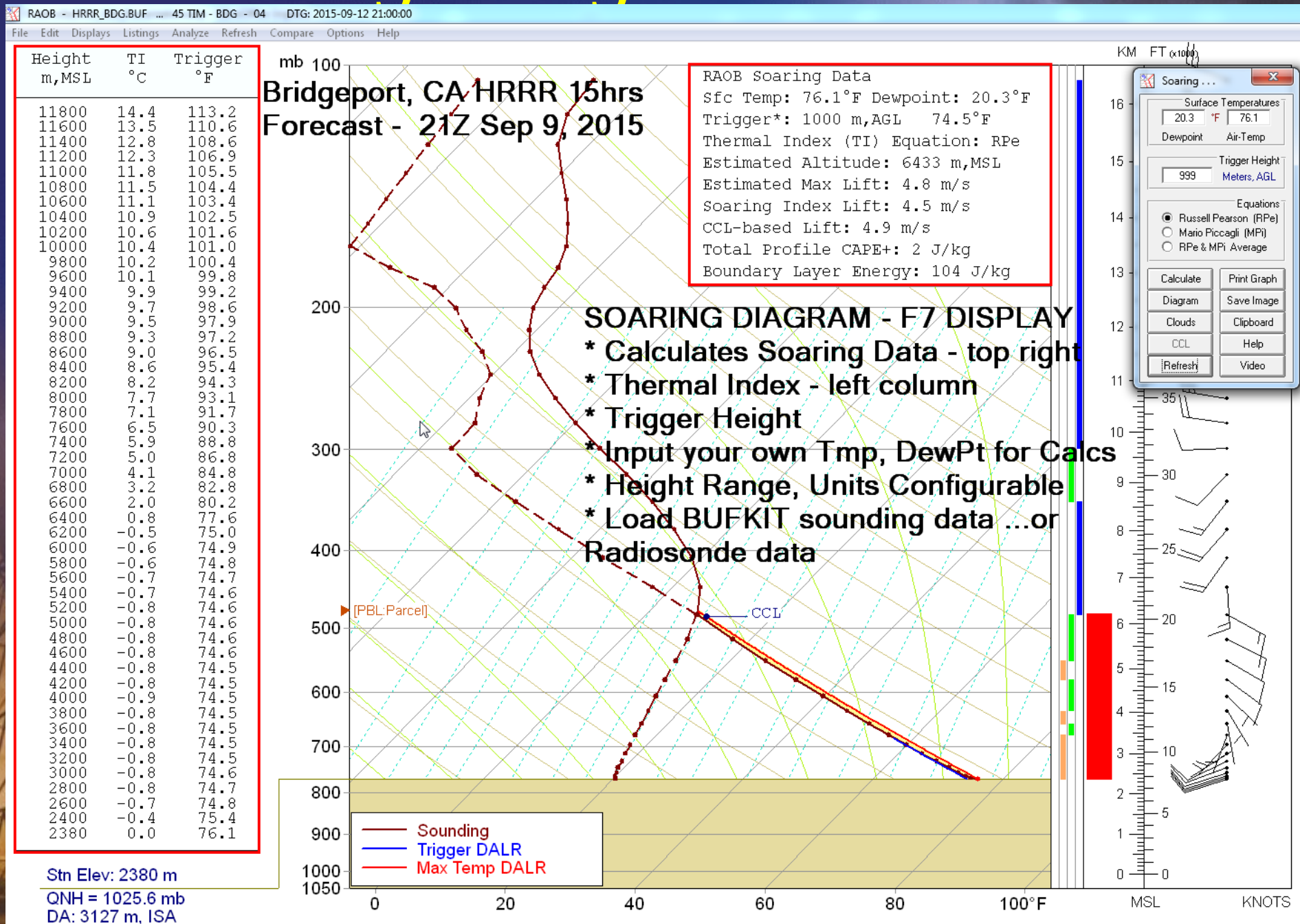






# RAOB.com

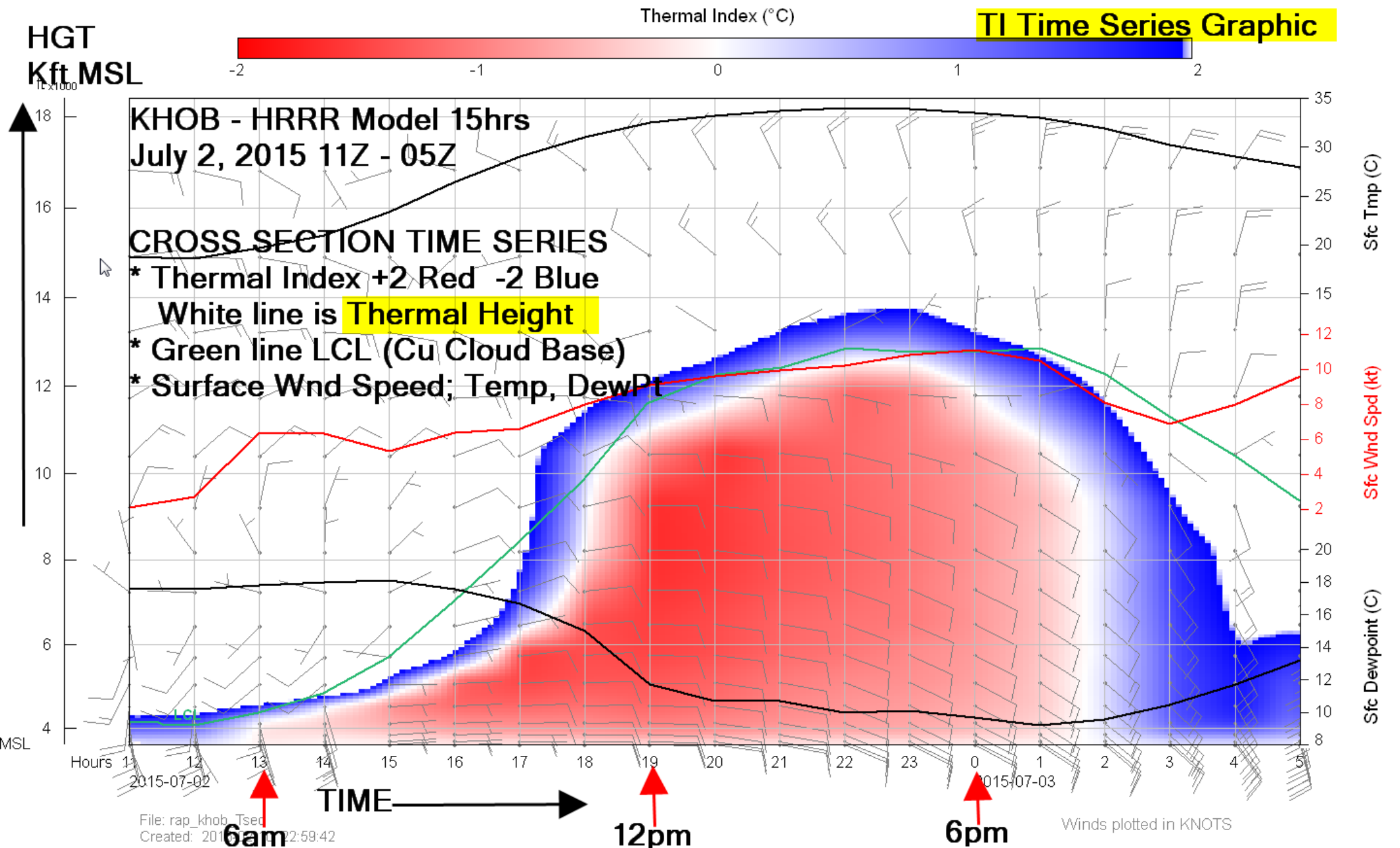
## Soaring Diagram Window





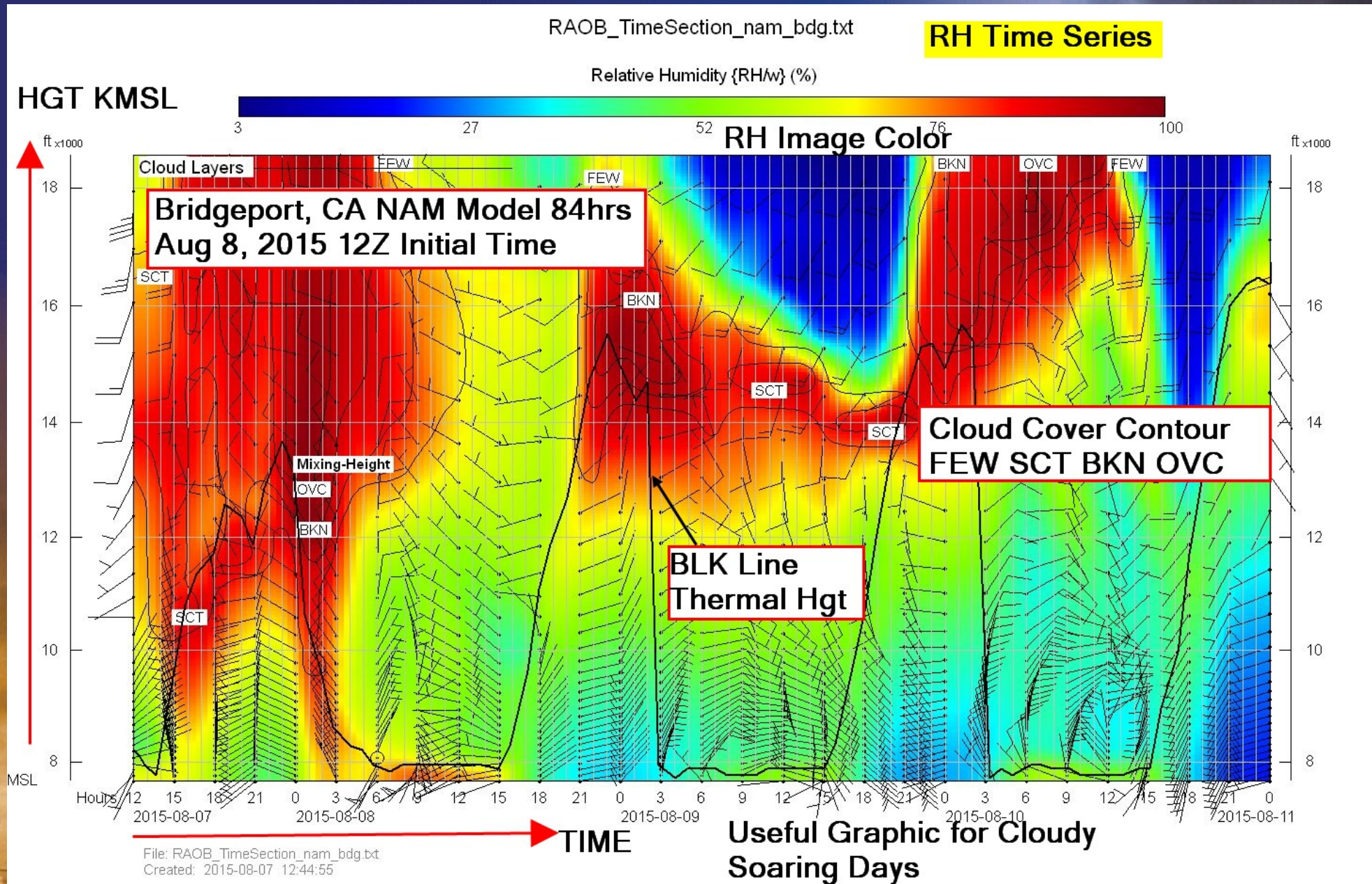
# RAOB.com

## Time Series Thermal Plot





## Time Series Thermal Plot







# RAOB.com Summary

- Analyzing individual profiles is too time consuming using PROFILE DIAGRAM ... or SOARING DIAGRAM
- My preferred method is to use Time Series Graphics
  - RAOB allows 1-8 configuration profiles for each graphic type
  - Batch Commands ... a RAOB feature ... greatly speeds up the graphic creation
  - By using a custom bash script, I can generate 20 or 30 graphics from a command line selecting model type, station name and Config number for graphic (TI or RH)

*There are numerous training videos on RAOB.com to get you started.  
Here's one video demo I've created that shows creation steps for:  
Sounding Screen and Time Series Graphics Scripted*

***RAOB has a Steep Learning Curve! It's for the PROFESSIONAL SOARING FORECASTERS \$\$\$ :) Not the casual user!***





# Where Is U.S. NOAA Numerical Modeling Efforts Headed?

- These are Operational Models for Soaring Community... HRRR (3km), RAP (13km), NAM (13km) and GFS (0.25Deg)
- Currently for NWS Operational Community... Already have HIRSW (3km), NAM CONUS NEST (4km)
- Soon... there will be an Hourly Updated NAMRR (4km) ... for NAM Rapid Refresh
- Plans for Future...ALL REGIONAL MODELS MOVING TO ENSEMBLES – Sometime in 2018. Parallel “members” or model runs
  - SREF -12km; 24-84 hr forecasts – hourly for short range
  - HREF – 3km; 24 hr forecast – periodically 36-60hrs
- Legacy Models “Deterministic” RAP, HRRR, NAM and NAMRR will be “sunset” somewhere in 2019
- Improved Boundary Layer physics... Land Surface Models ... Initialization - probably most helpful to soaring community

# What are ENSEMBLES?

## *And What Does This Mean for Us?*

*A set of different forecasts all valid at the same forecast time(s).  
The differences between the forecasts can provide information on the probability distribution of the predicted variables. The forecasts in the ensemble may have different initial conditions, boundary conditions, parameter settings, or may even be from entirely independent NWP models.*

*For Soaring this means  
we'll see "probability"*

*Of given parameters*

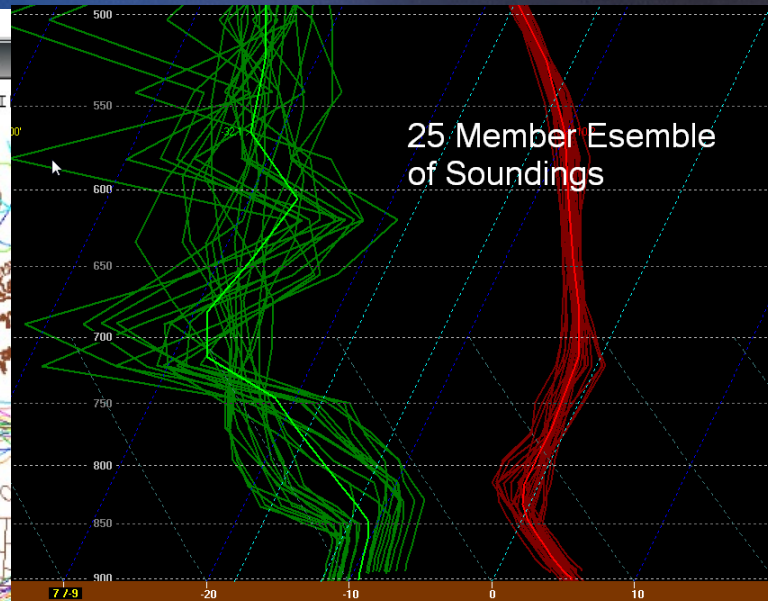
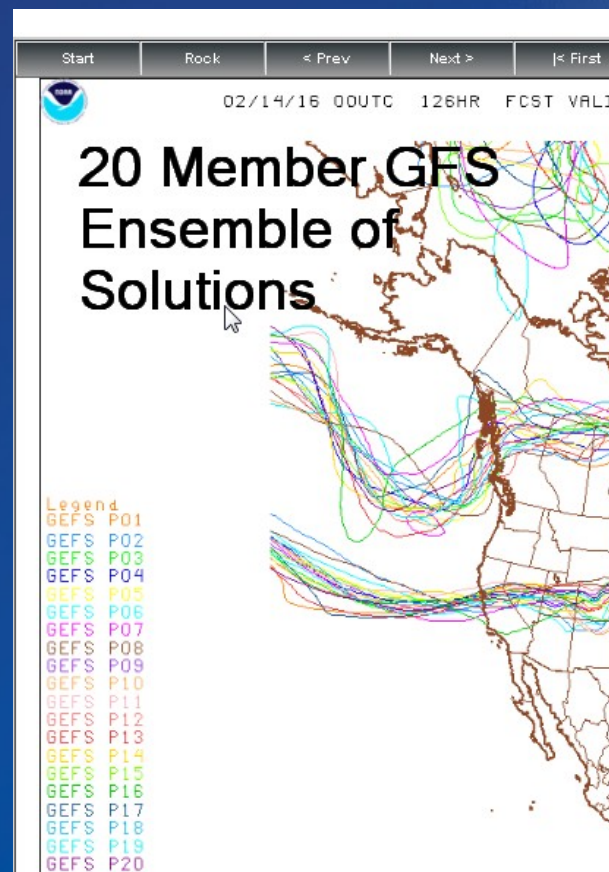
*\* Thermal Height*

*\* Thermal Strength*

*\* Thunderstorm to  
occur*

*\* Given Thunderstorm  
strength*

*XCSkies and DrJack  
will have to be updated*







# Weather In The Cockpit

## *Data Sources, Availability and Modeling*

### *These are what I think are important...*

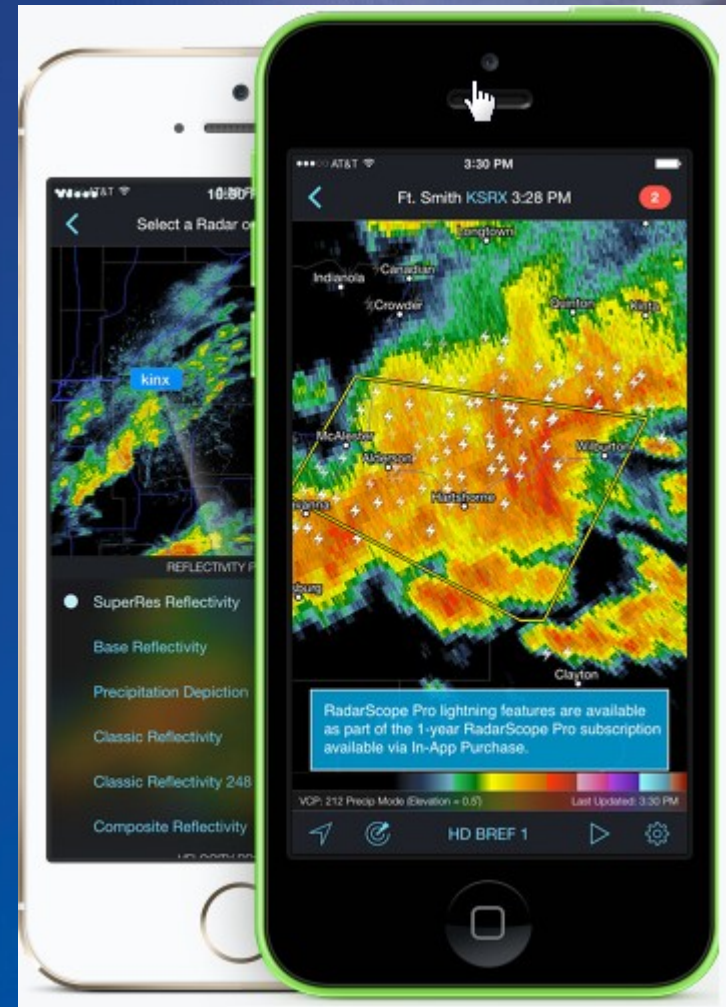
- NEXRAD Radar – RADAR SCOPE – Raw Data High Resolution (Iphone/Ipad Android Commercial App)
  - Shows finest detail clear air mode, outflow boundaries, convective cells and convergence lines
- GOES-R – New Family of geo-stationary weather satellites
  - 5 minute (optionally 1min) updates versus 15min
  - 0.5km Resolution versus 1km for Visible
  - Many more infrared, visible channels and lightning mapper
- IDV (Integrated Data Viewer) – Great Program for 2D/3D visualization of Modeling Data, Radar, Satellite and Any Kinds of Point Data
  - A Tool for Researchers or Professional Forecaster Looking to Create Custom Soaring Graphics
  - Great at geo-referencing all data sets... including contest airspace



# Weather In The Cockpit

## *RadarScope - A PDA App*

- NEXRAD U.S. Radar Network
- Professional fine detail access
- No smoothed images...native radar data rendered in its original radial format for a high level of detail
- Very fast processing - low latency. <1 minute
- All official NEXRAD products, Echo Top, super res, all elev angles, precip types, etc
- PRO VERSION - \$10/yr adds
  - Lightning
  - 20 frame super res animation
- IOS Android - \$10 initial purchase

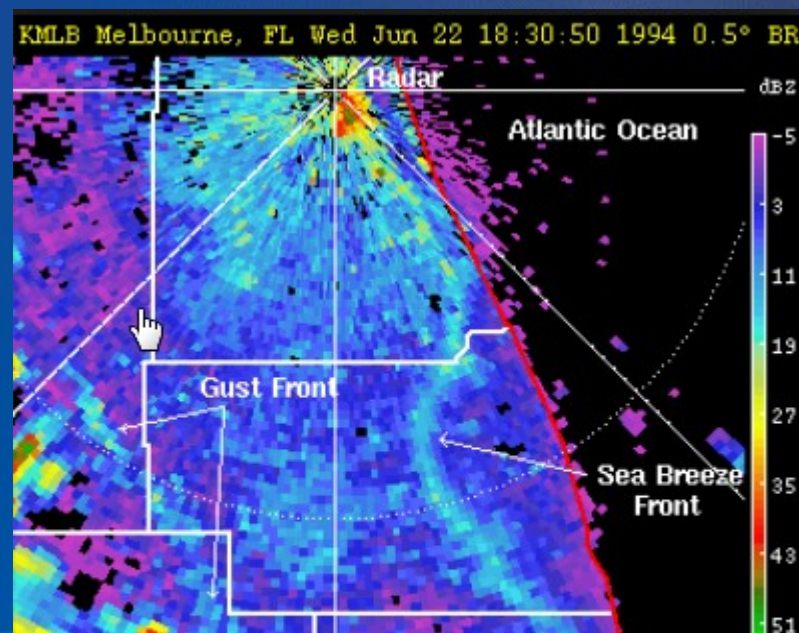
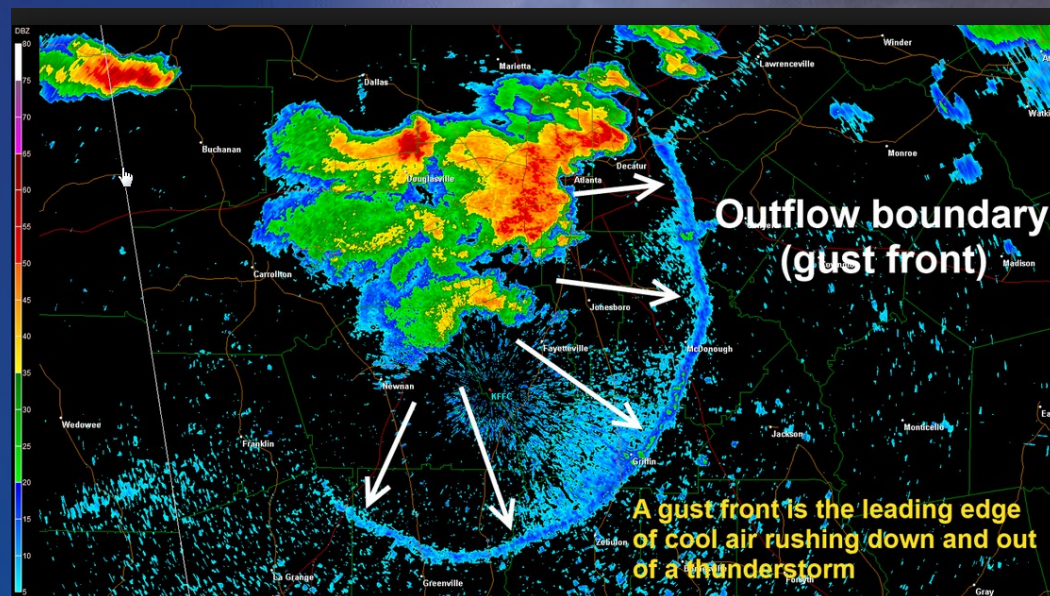




# Weather In The Cockpit

## *What's So Special About RADARSCOPE?*

- Low Latency High Res Data!
- You can see clear air outflow boundaries, sea breeze front ... and sometimes shear lines
- Precip hydrometeor types including hail
- Lightning data animation... not very common on other PDA radar apps
- Shows NWS warning polygons
- Great tool for after landing... Decide on "boxing it up"



*In my opinion, RADARSCOPE is the best PDA app for gliding. It holds promise for "In the Cockpit Use" ... especially if they Add GOES-R 5minute 0.5km imagery!*

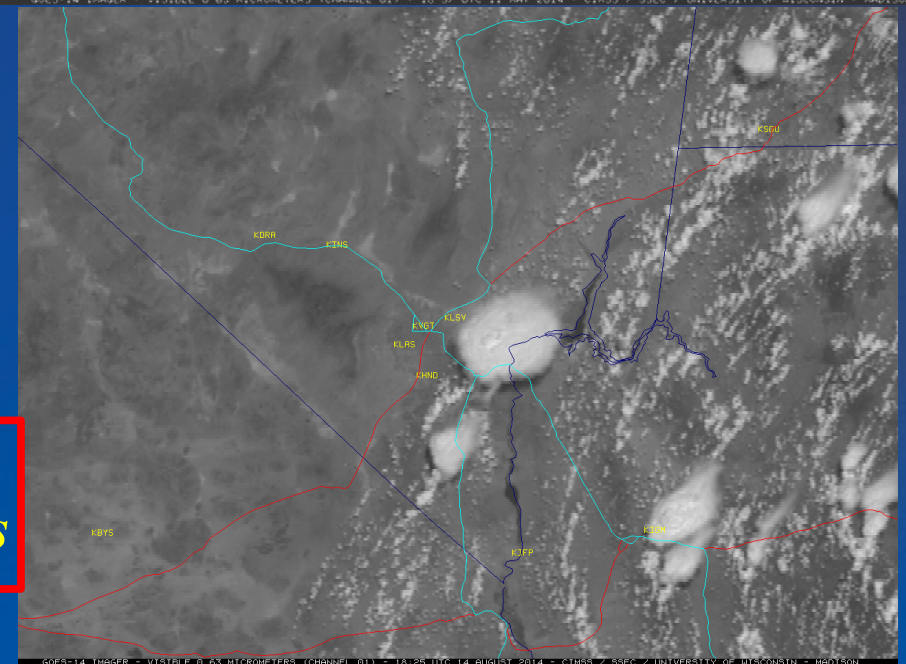
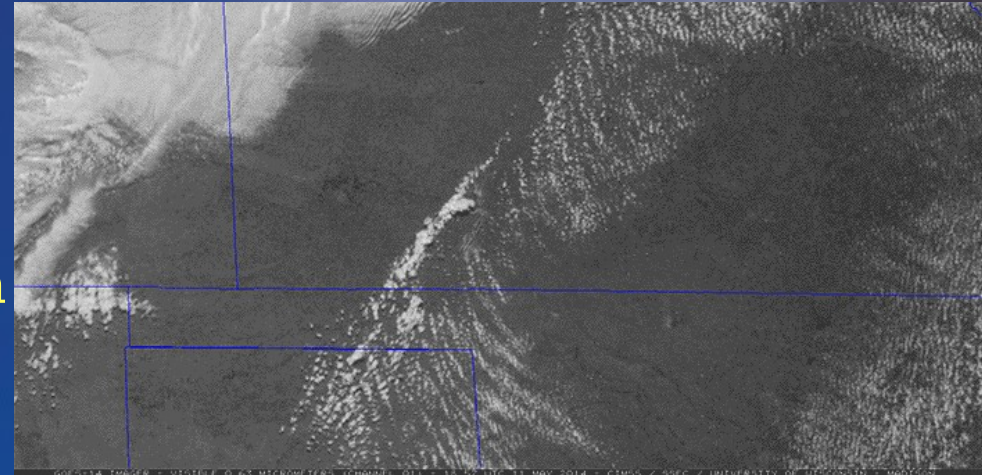


# Weather In The Cockpit

## *GOES-R Higher Res Imagery*

- Next Generation NOAA Geo-Stationary Satellite with Advanced Imager
- Twice line resolution vis - 0.5km
- Three times update rate - 5min vs 15min currently
- More Infrared channels
- Much improved sensitivity dynamic range
- Lightning Mapper
- Launches March 2016 - Operational in 2017

*Great Tool for tracking isolated cu and low Coverage cloud cover marking cloud streets*





# Weather In The Cockpit

## IDV 2D 3D Viewer

- Integrated Data Viewer (IDV) visualizing and analyzing atmosphere & geosciences
- Free supported software (Java any platform)
- interactively slice, dice, and probe the data to create cross-sections, profiles, animations and value read-outs of multi-dimensional data sets
- ***You don't have to do DL gigabyte sized data sets to see High Res Model Data!***
- Can customize model calculations to PBL, Convergence Zones, MW Lift for soaring graphics
- Could be used as a server to generate "Cockpit Weather" for gliding

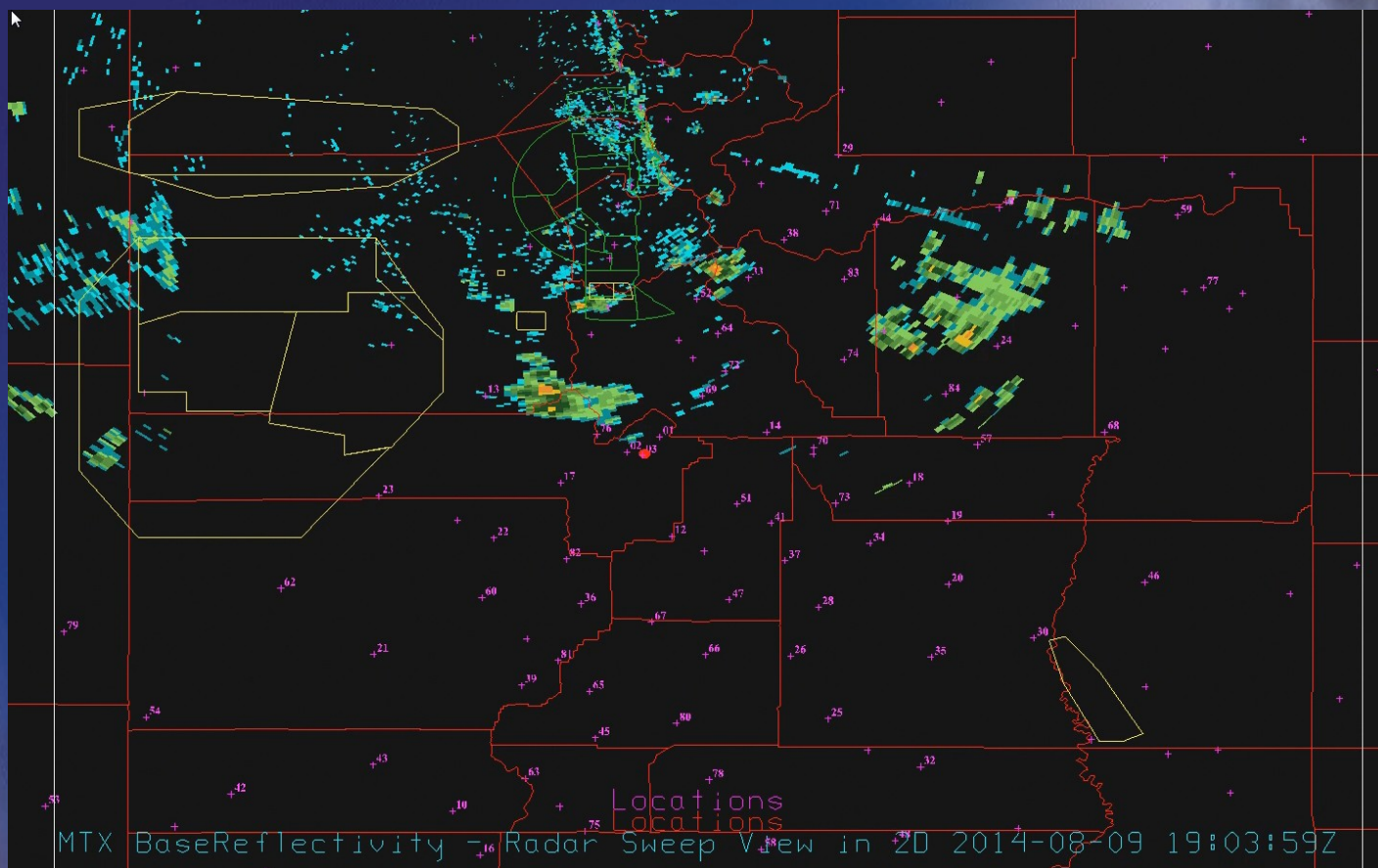


***Avenal – Central California Shear Lines moving into San Joaquin Valley. HRRR model hourly data 3-7pm PDT 09/10/2015***



# Weather In The Cockpit

## *Radar Example - IDV*

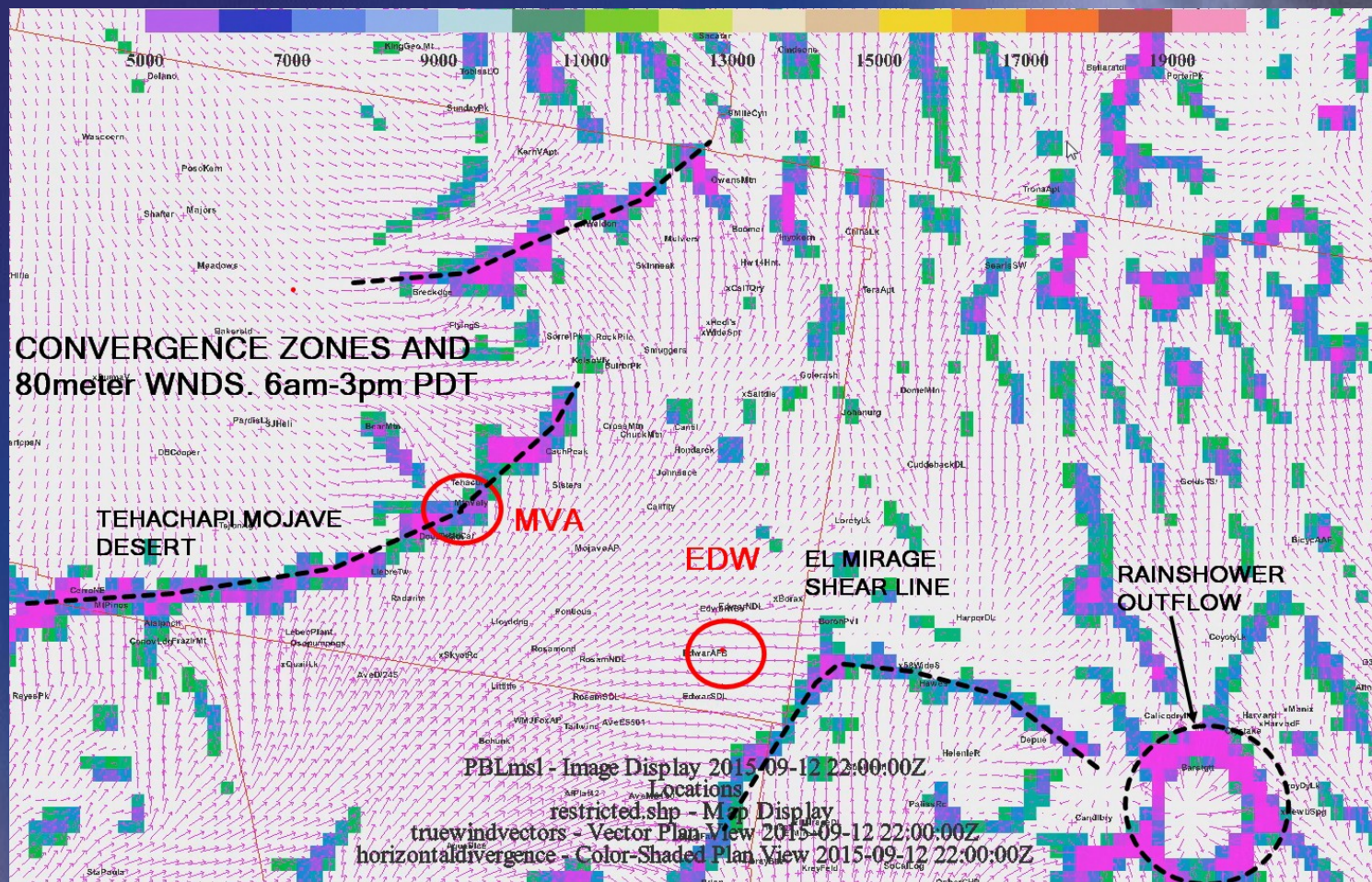


**Base Reflectivity Lowest Elevation Angle for Nephi 2014 ... the “famous downburst day” Aug 9<sup>th</sup>. IDV allowed overlaying airspace and all turnpoints in the task area**



# Weather In The Cockpit

## *HRRR Model Shear Lines*

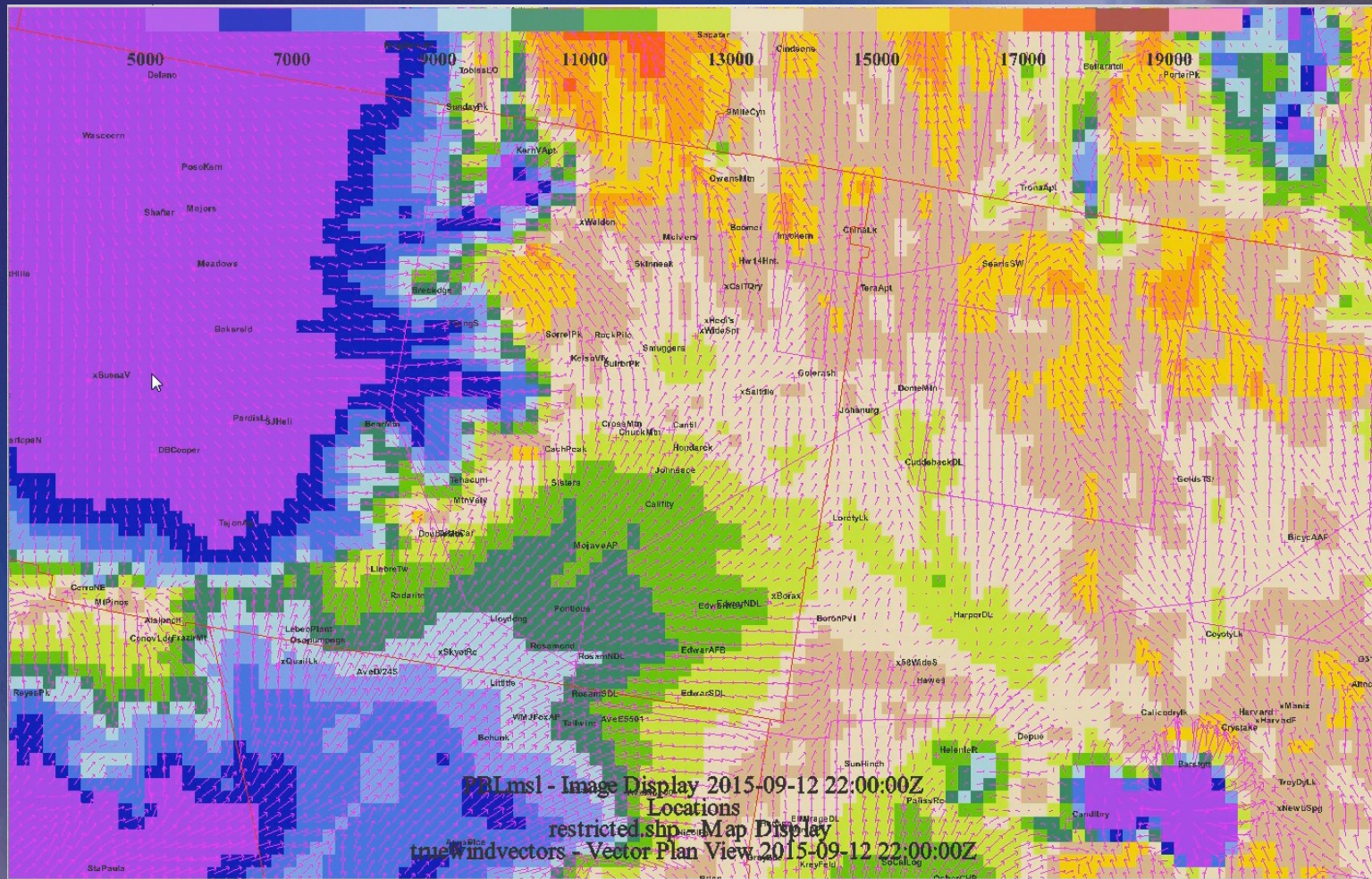


**HRRR Model Convergence zones based on 80m AGL winds at 3km resolution. IDV allows view of finest details on model forecasts.**



# Weather In The Cockpit

## *HRRR Model Thermal Height*



**HRRR Thermal Height – Top Color Bar 1000s ft MSL. Creation of CU cloud cover with colored base level is also available from IDV.**





# Weather In The Cockpit

- If... **The Big If**... Cockpit Displays can integrate high res radar, satellite... maybe rapid update model data ... **Then**... in some (probably small) cases, weather-in-cockpit data would give a significant competitive edge for flight decisions
  - High Bandwidth Internet needs to be available
  - Cockpit big screen displays need to integrate data... data formats different in different parts of the world
  - There's no way that this WON'T be distracting...
  - Mitigation for safety and fairness...
    - Two Place Gliders? Open Class Gliders? Rely on ground Weather Dispatcher to Relay info verbally or via low bandwidth graphics?
    - Contest Rules Prohibit Devices in Cockpit
  - Going to be an Open Source - non-profitable project. Probably only attempted by "**Techno Nerds**"... unless there is overlap with a commercially available product ... like RADARSCOPE for PDAs



# Weather In The Cockpit

## *My Take on this...*

- Allow Weather in the cockpit – You can't really prevent it especially when PDA Phones and Tablets are so prevalent
  - Not because it will transform racing... instead it will bring on innovation
  - Technology nerds will equip... but their “heads will be down” too much... impacting competitiveness
  - Allow ground flight dispatcher/weather “team flying”... this might add a significant boost to the “social aspects” of the sport.
  - This “Team Flying” approach to competition will better prepare U.S. pilots for World Competitions
  - Gary Itner will still probably “whip our xxx” anyway regardless of how we equip :)





# The End... Spectacular Soaring!

*Thank you...*

*Walter Rogers  
wrogerswx@gmail.com*

*Posted Presentation:  
Ssa.org → Member Resources  
→ Weather → News  
→ Tutorials*





# Request for Met Assistant

## *Nephi 2016 Nats*

- I will be flying the Standard Class Nats in my Discus 2A “WX”
- .... and... also doing contest weather support with briefings
- I am looking for someone interested and committed to assist me with preparing briefings in real-time... and learning the “software tools” and/or techniques of soaring forecasts
- You must be able and willing to work with me well before hand so as to coordinate the tasks at hand
- You do not have to be at Nephi... we can collaborate remotely
- Good computer skills necessary... and strong interest needed
- Available daily during contest for 1-2 hours at a fixed time early to assist in preparation

*Contact me at: [wrogerswx@gmail.com](mailto:wrogerswx@gmail.com)*

*If interested...*