Continuous Thermodynamic and Wind Profiling for High-Impact Weather Forecasting

2018 AMS Annual Meeting

Eighth Conference on Research to Operations

Commercial and Institute Activities Enabling R2O

Tuesday, 9 January 2018

9:30 AM, Hilton Room 16AB

Tim Wilfong

Radiometrics Corporation

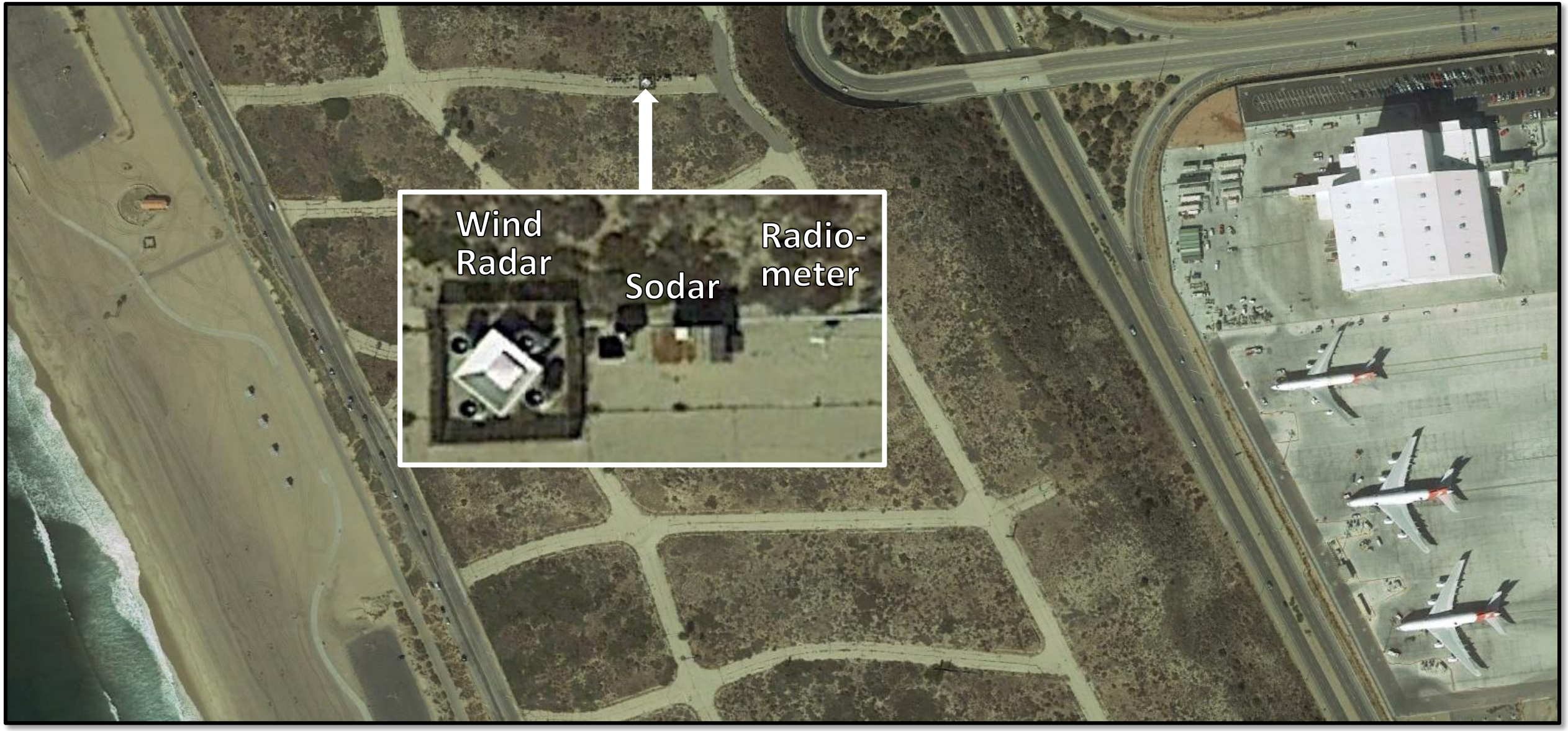
Certified Consulting Meteorologist / Engineer

R. Ware[1,2], D. Berchoff[3,4], M. Beauharnois[5], L. Blanchette[6], K. Brewster[7], J. Brotzge[5], F. Carr[7], W. Conway[8], B. Demoz[9], J. Freedman[5], N. Gasperoni[7], I. Gultepe[10], K. Knupp[11], E. Lau[1], D. Holland[12], E. Joseph[5], C. MacDonald[13], M. Mahaffey[14], S. McLaughlin[1], R. Parmentier[15], K. Reed[1,2], P. Roller[16], N. Sette[16], C. Thorncroft[5], S. Vanderburg[17], Denis Voytenko[12], P. Wiker[18], **T. Wilfong**[1]

[1]Radiometrics (Boulder, CO), [2]NCAR (Boulder, CO), [3]TruWeather Solutions (Reston, VA), [4]TempoQuest (Las Vegas, NV), [5]New York State U. (Albany, NY), [6]U.K. Met Office (Bermuda) [7]University of Oklahoma (Norman, OK), [8]Weather Decision Support Systems (Norman, OK), [9]U. Maryland (College Park, MD), [10]Environment Canada (Toronto, CANADA), [11]U. Alabama (Huntsville, AL),[12]New York U. (New York, NY), [13]Sonoma Technology (Petaluma, CA), [14]Quijanza (Lafayette, CO), [15]Leosphere, Inc. (Paris, FRANCE), [16]So. California Edison (Monrovia, CA), [17]San Diego Gas & Electric (San Diego, CA), [18]Clark County Air Quality (Las Vegas, NV)

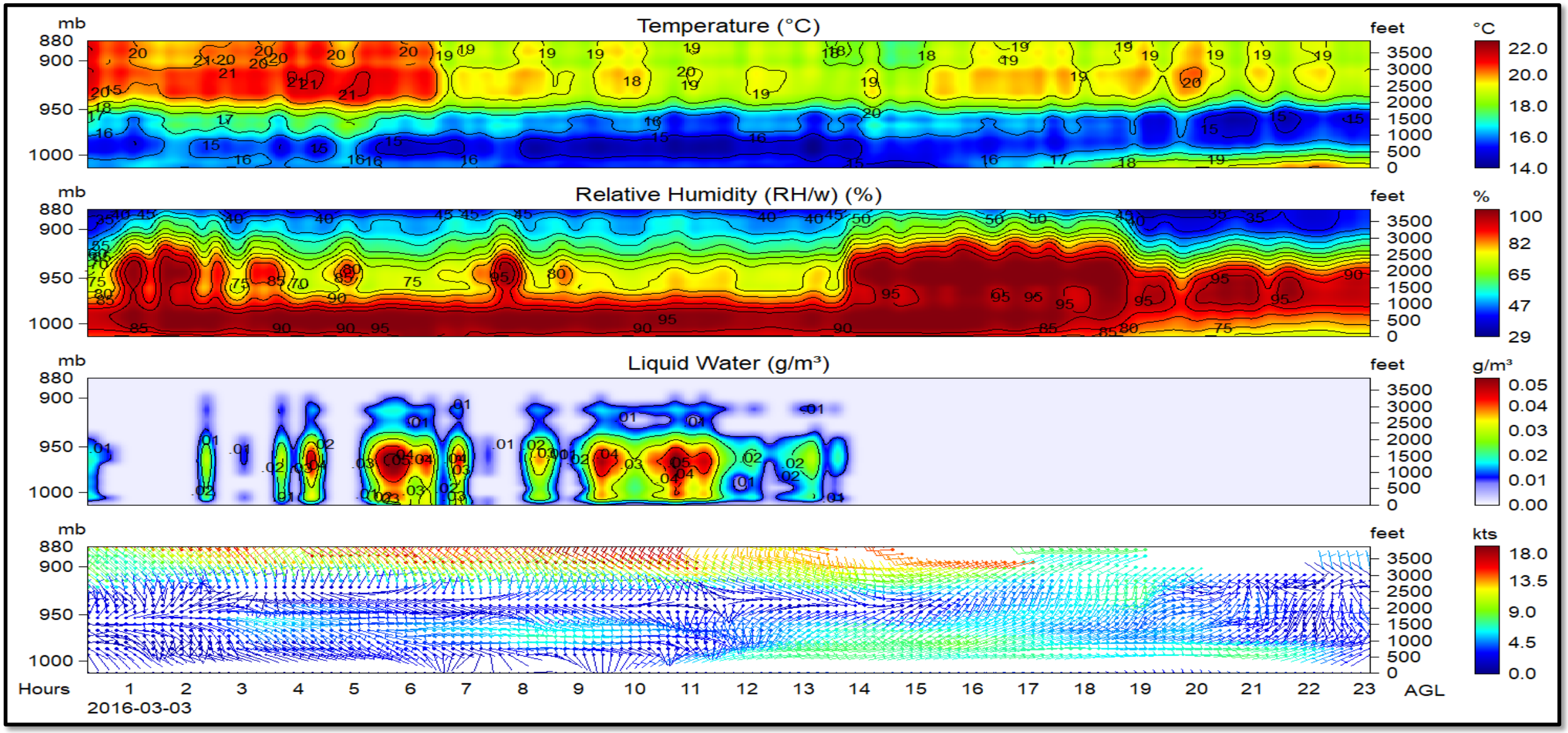
Outline

- Integrated Thermodynamic and Wind Soundings
  - Fog, Sea Breeze, Cross-Wind and Wind Shear (Los Angeles International Airport)
  - Precipitating Cold Front (Colorado)
  - Winter Cold Front (New York State Mesonet)
- Launch Weather, Hurricane and Tornado
  - Launch Vehicle Maximum Dynamic Stress (Max-Q)
  - Hurricane Matthew (2016)
  - Moore Tornado (2013)

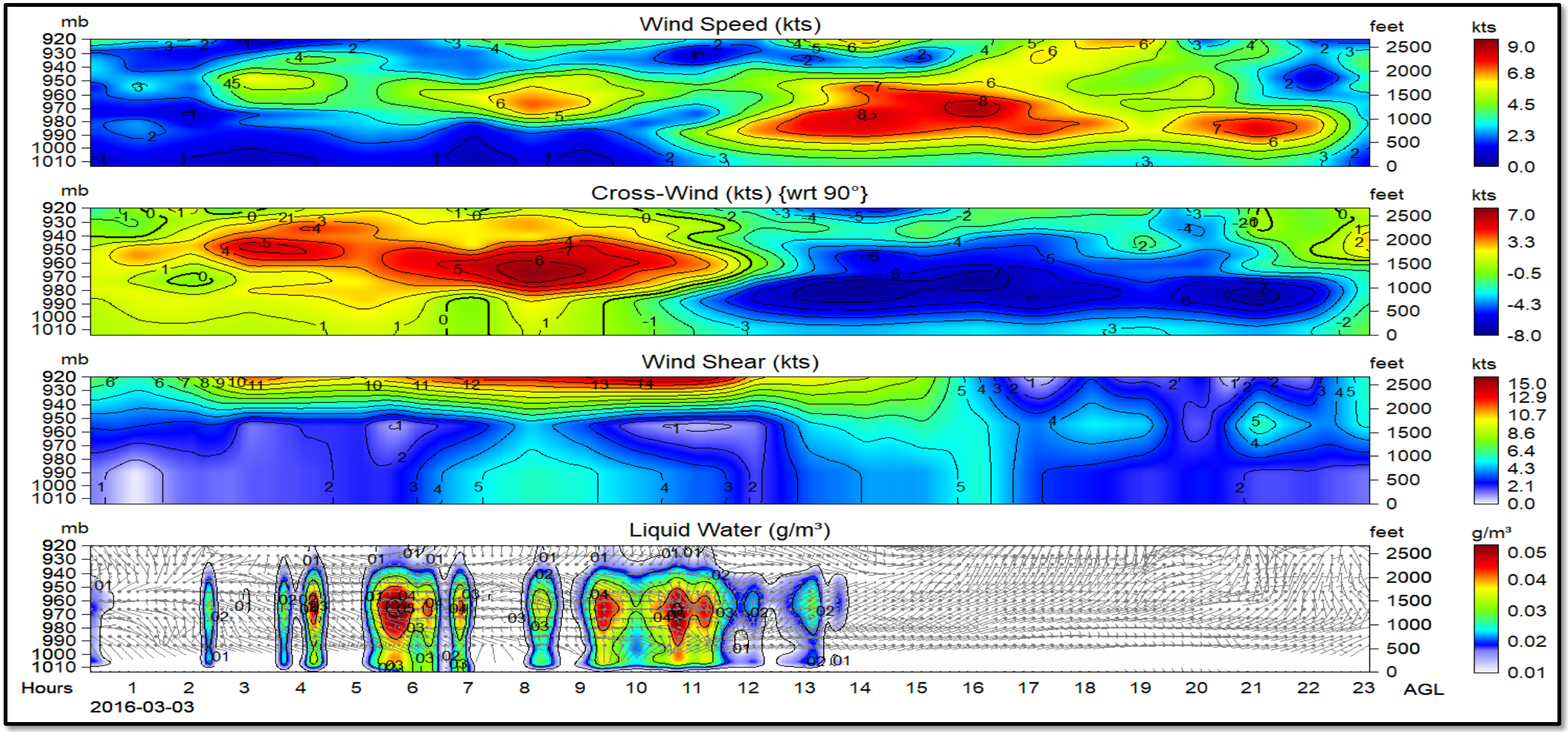


Thermodynamic and wind profilers at LAX

Microwave profiler at LAX

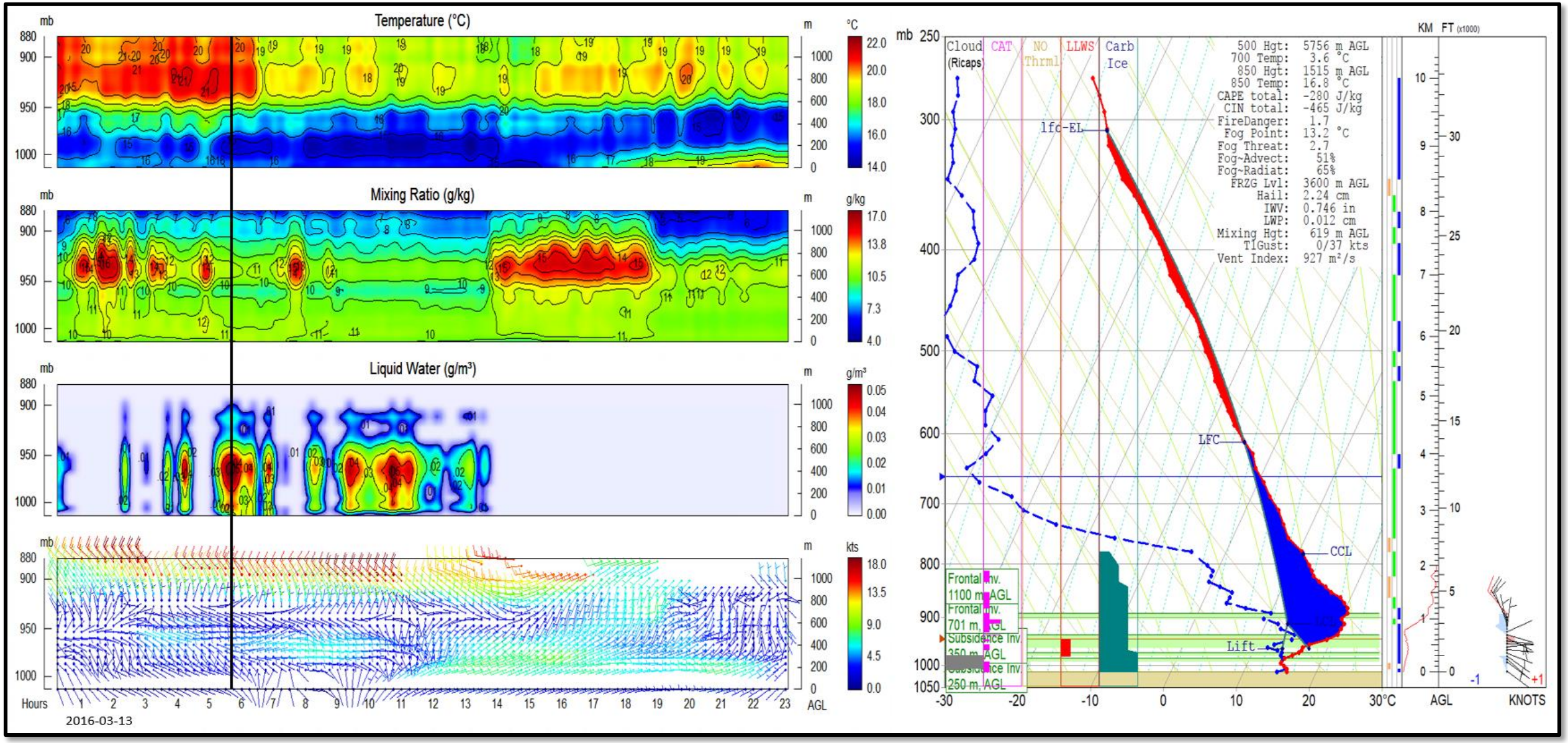


Sea breeze and fog at LAX -- thermodynamic and wind signatures

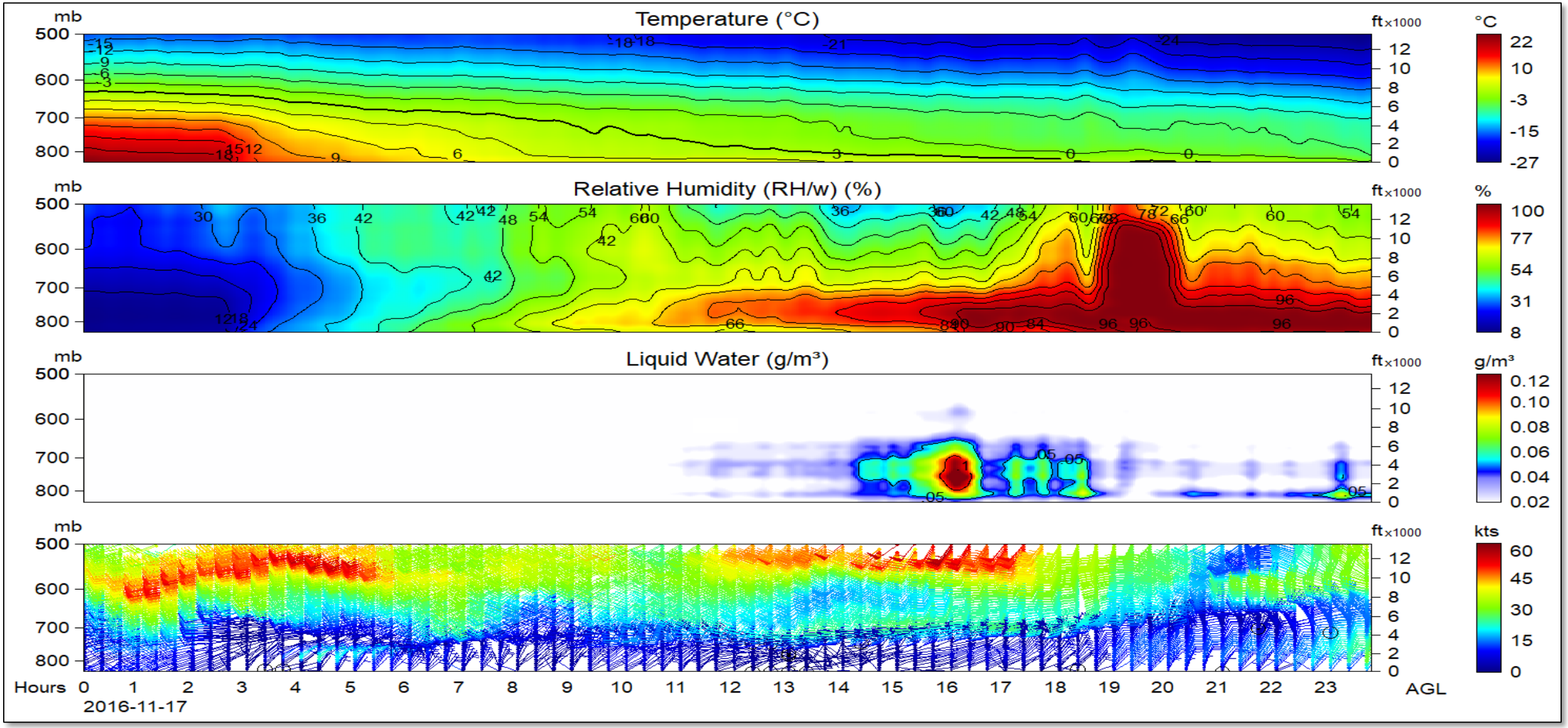


Airport winds and fog signatures at LAX

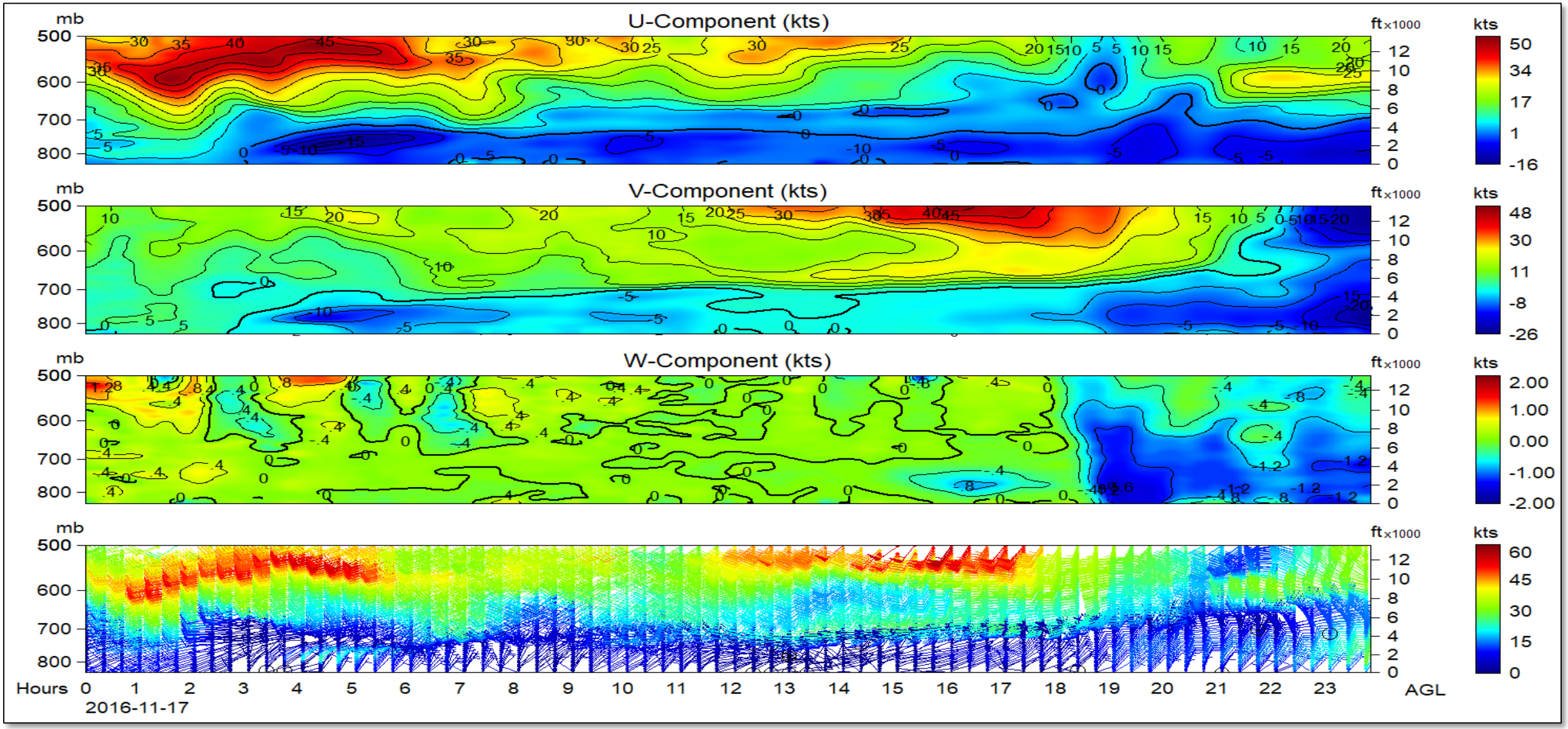
radiometrics
Ahead of the Weather®



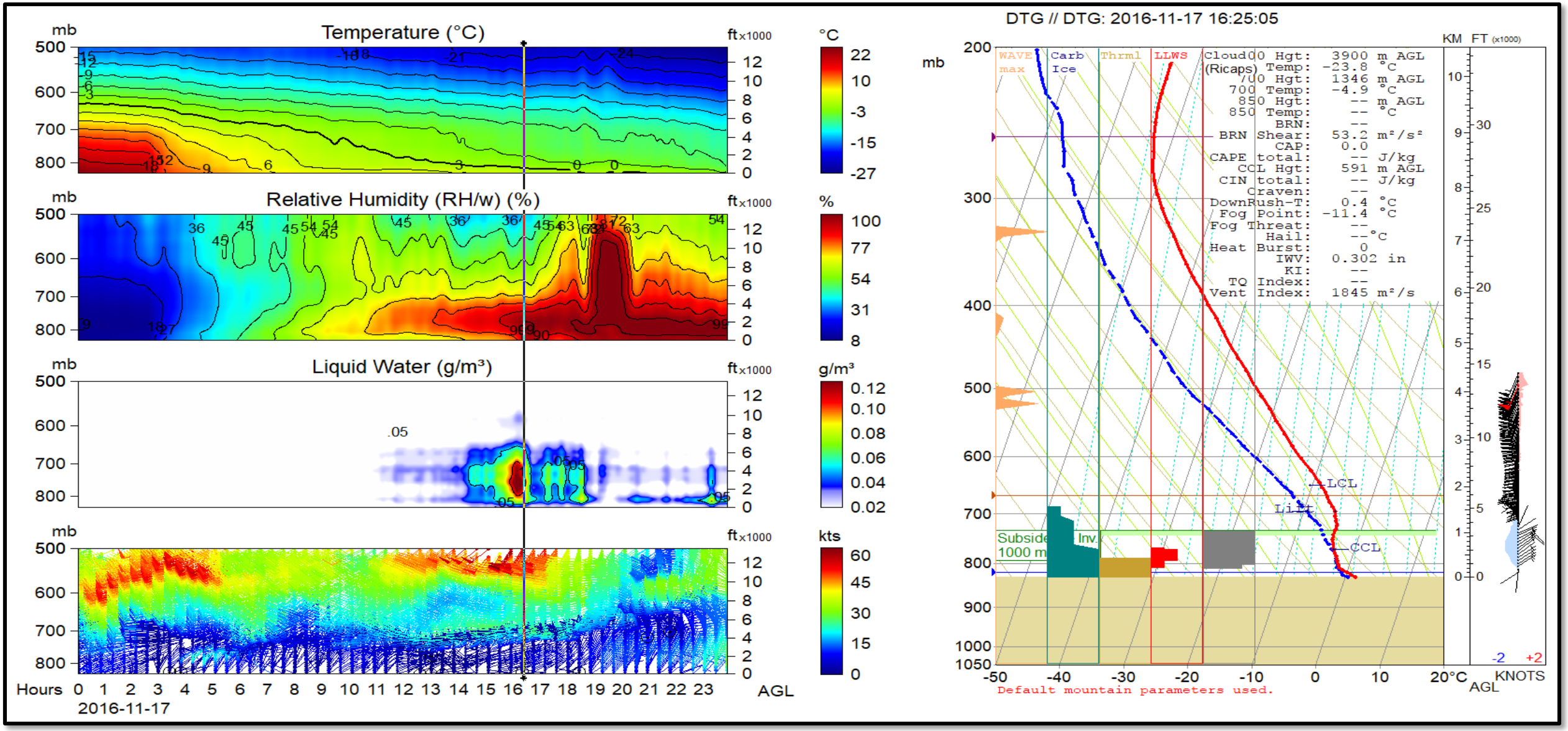
Forecast index time series – weather surveillance and Nowcasting tools



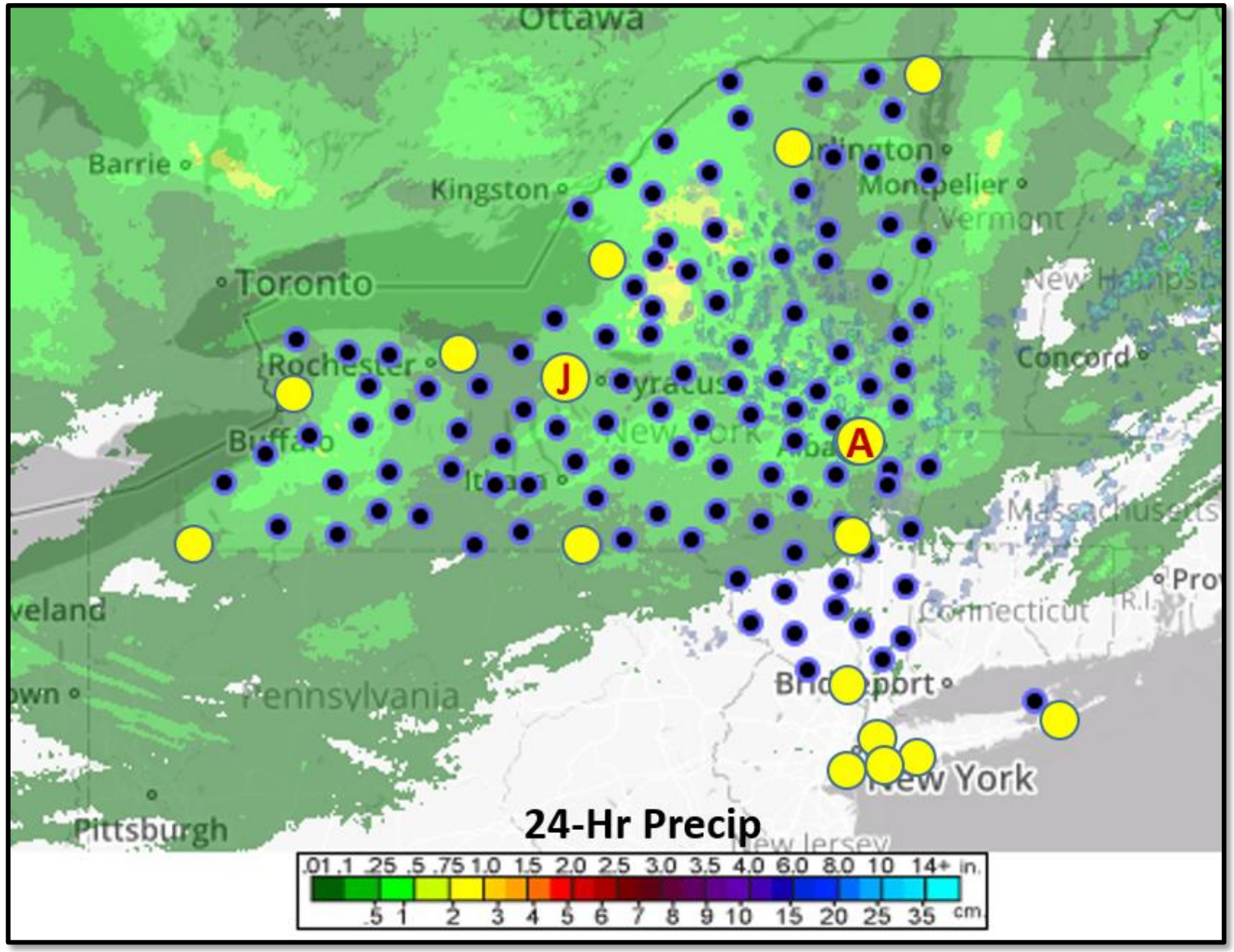
Colorado cold front with rain and snow -- thermodynamic and wind signatures.



Colorado cold front with rain and snow -- wind signatures



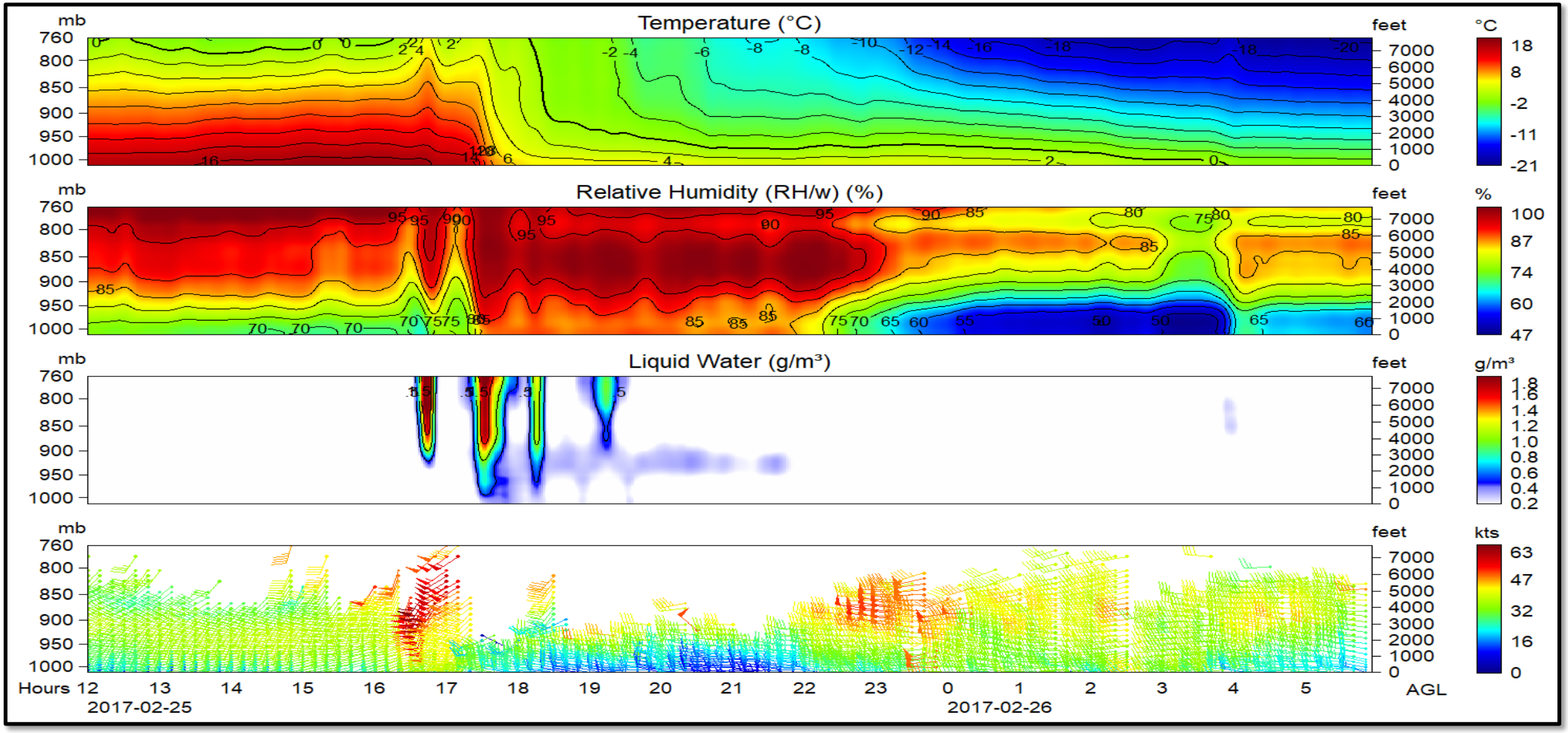
Forecast index time series – weather surveillance and Nowcasting tools



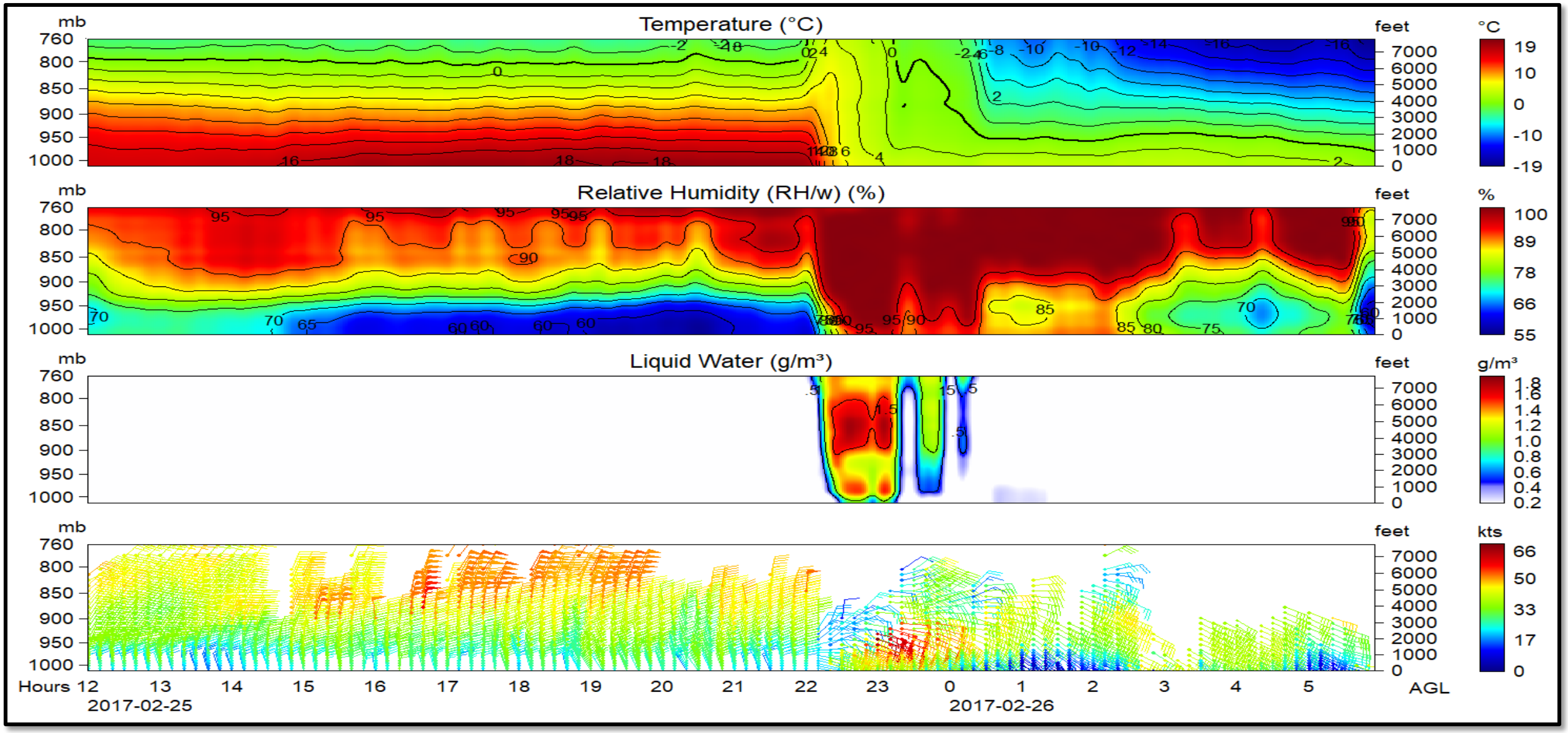
NY Mesonet Sites

- Weather (125)
- Thermodynamic & Wind Profiler (17)

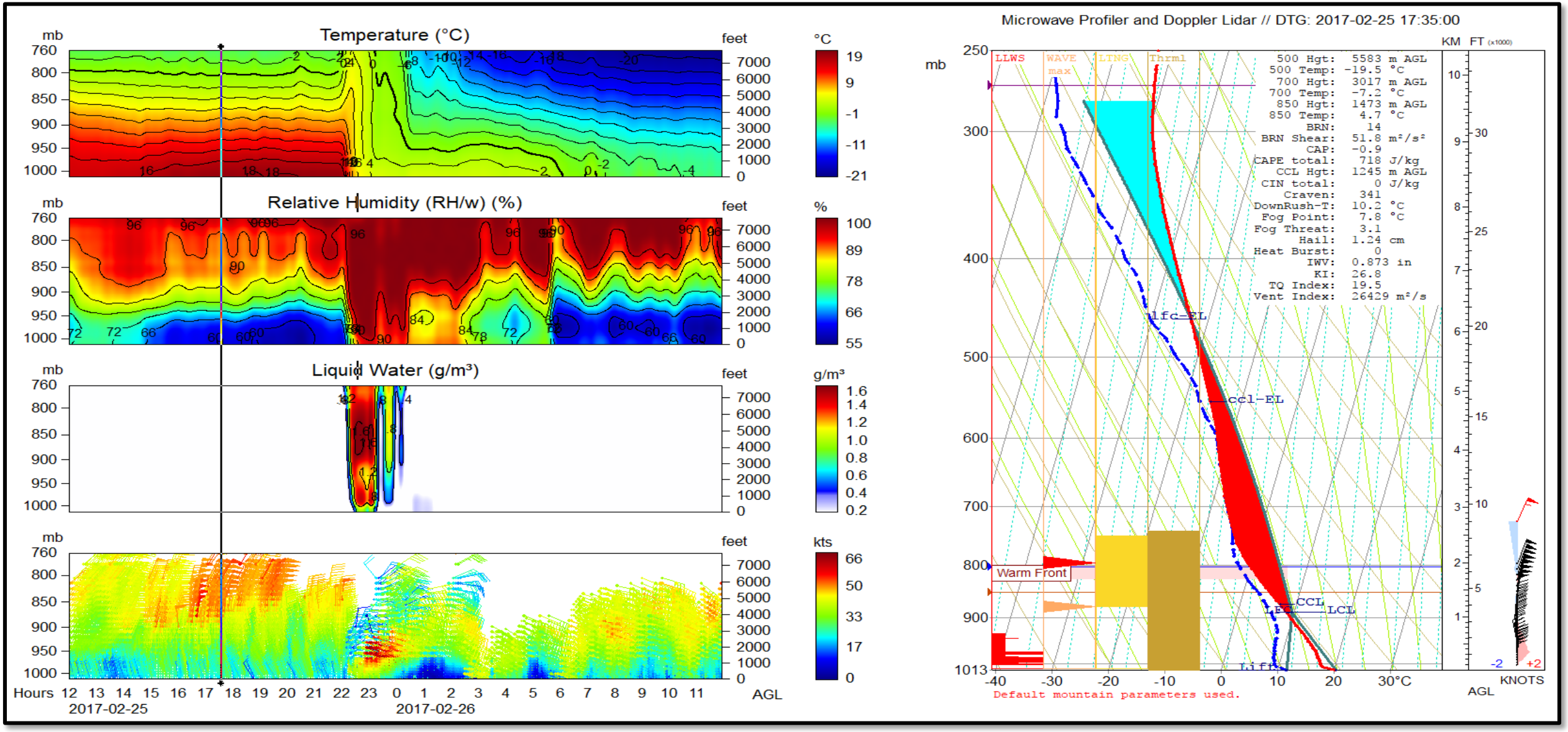
- J Jordan
- A Albany



Cold front with rain -- thermodynamic and wind signatures at Jordan



Cold front with rain -- thermodynamic and wind signatures at Albany



Thermodynamic and wind signatures at Albany including frontal passage

radiometrics Ahead of the Weather®

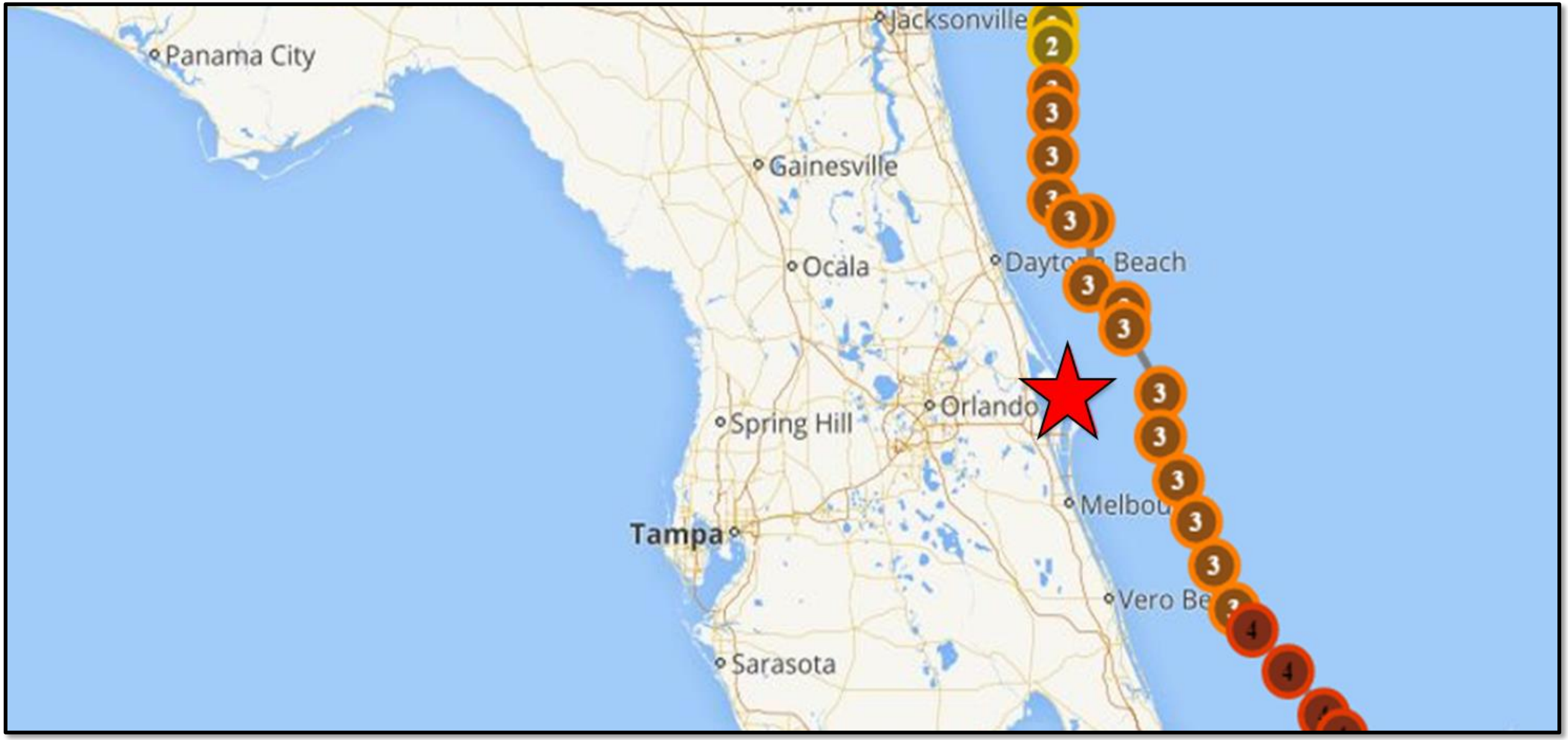
Launch Weather Decision Support System

- Launch vehicle maximum mechanical stress (Max-Q) occurs near 14 km (46,000 ft) altitude
- Max-Q is a function of wind and air density
  - NASA measures wind speed and direction at Cape Kennedy with a Stratospheric Wind Radar
  - Air Density Profiler under development by RDX and OU CAPS (NASA STTR contract)

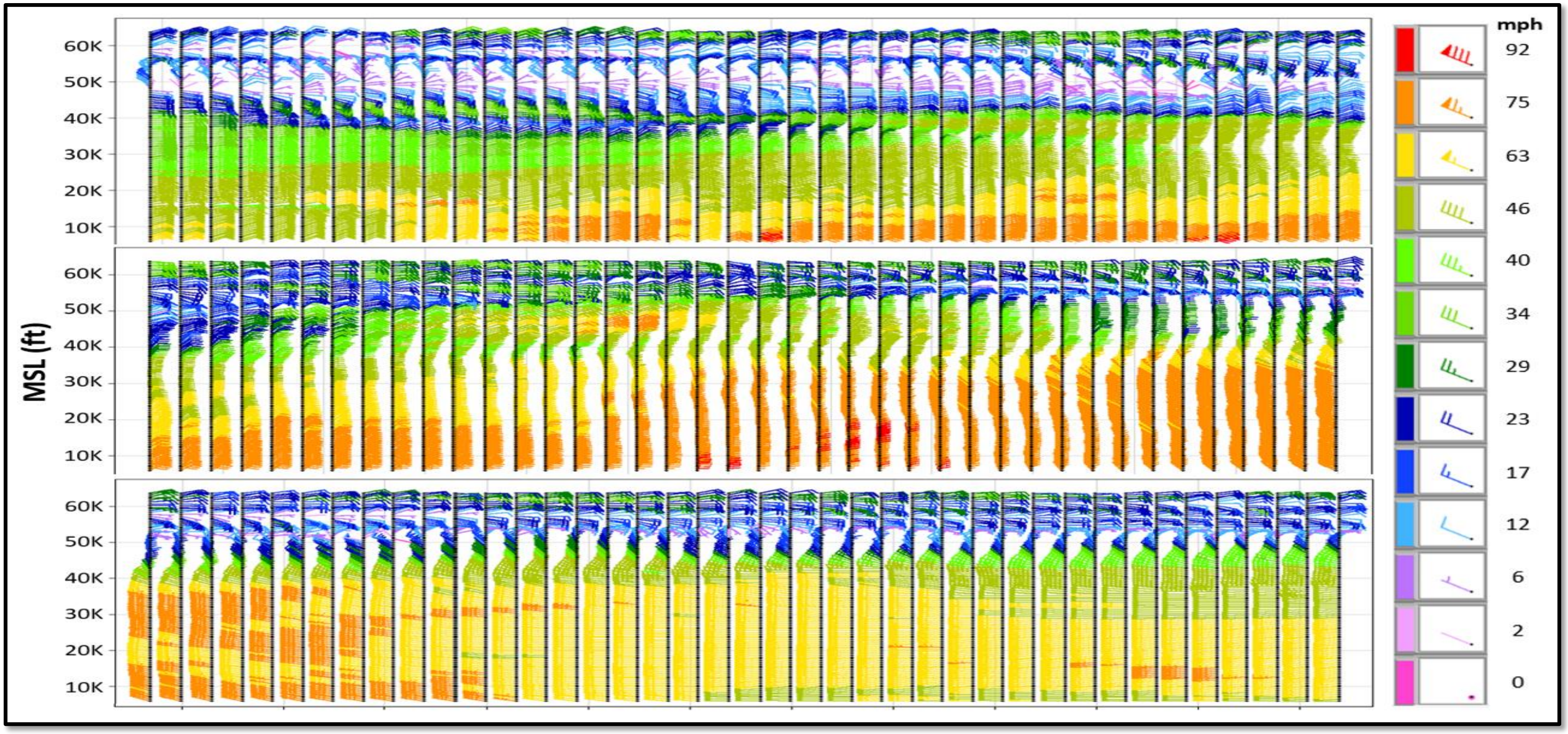
NASA Stratospheric Wind Radar at Cape Kennedy

Example Wind Profiles

- Hurricane Matthew eyewall passage 15 km from NASA stratospheric wind profiler
- Wind vectors observed to altitudes greater than 60,000 ft (18.3 km)
- Wind speed >92 mph (Category 3)



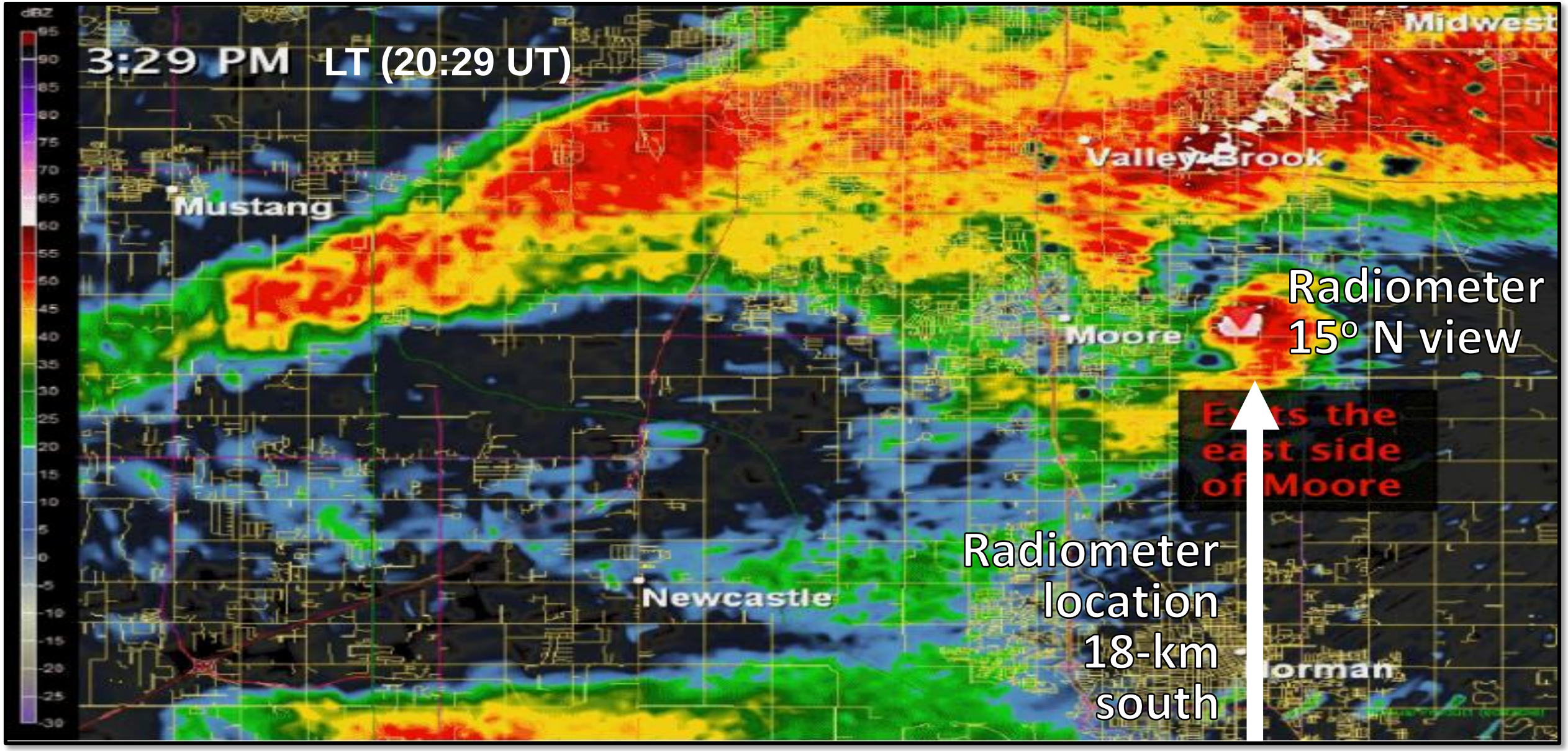
Hurricane Matthew path and intensity, NASA stratospheric wind radar location ★



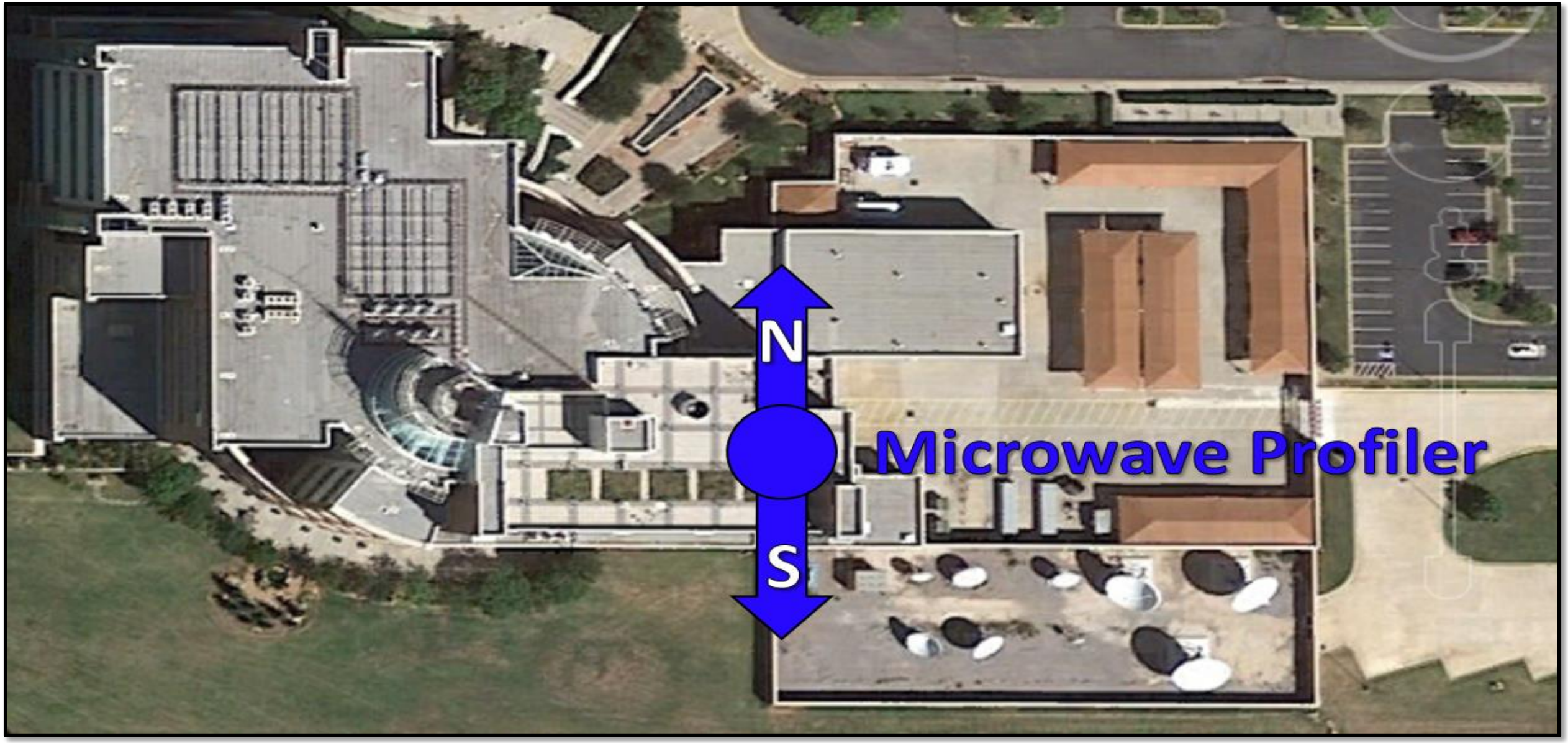
Wind radar observations of Hurricane Matthew, 06-17Z 7 Oct 2016

Moore Tornado

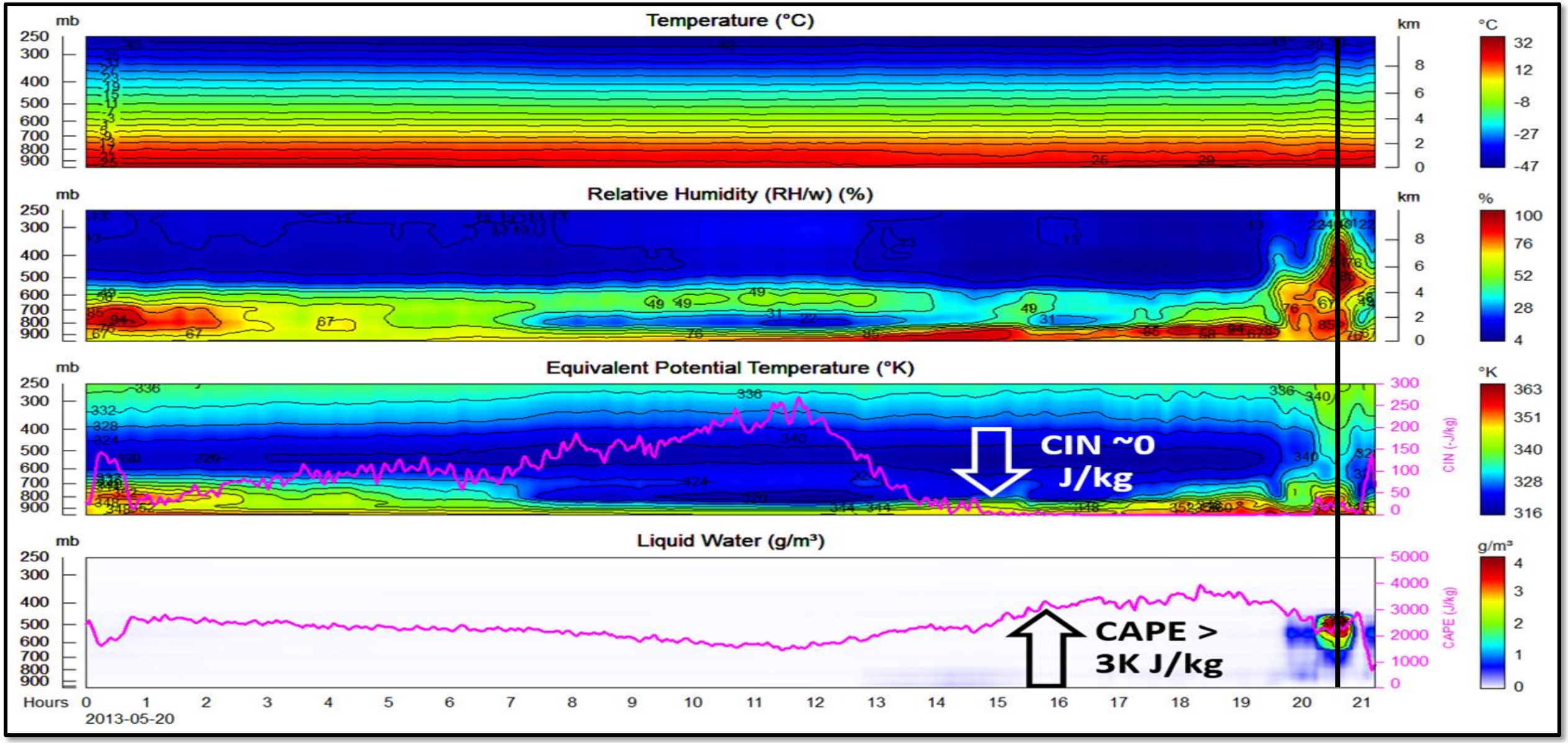
- Intense and destructive tornado struck Moore, Oklahoma, 20 May 2013
- The tornado vortex traversed the 15 deg north elevation field-of-view of a microwave radiometer
- CAPE >3,000 & CIN ~0 (J/kg) hours before tornado touchdown



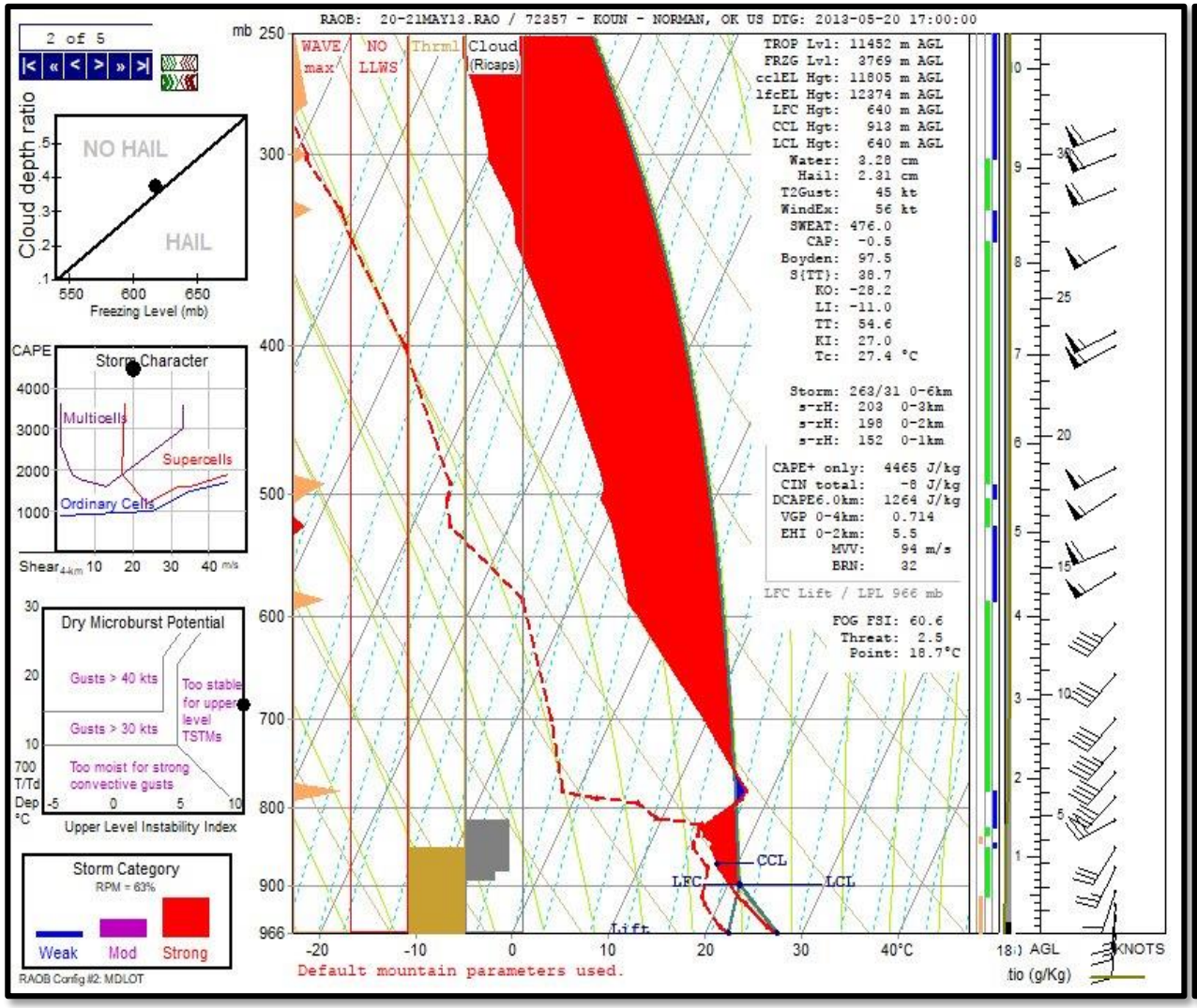
Tornado vortex traversing radiometer field-of-view at 3:29 pm LT (20:39 UT)

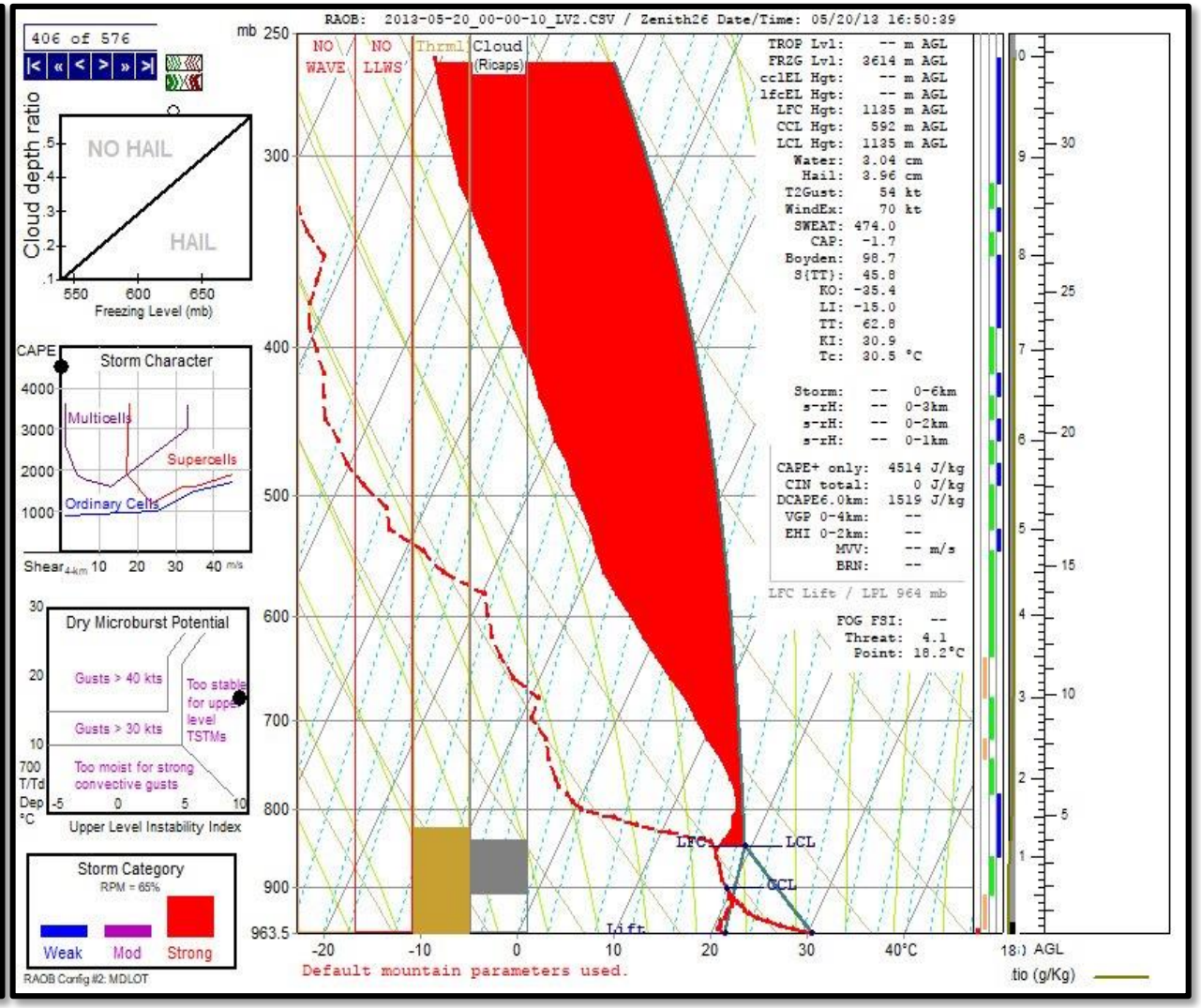


N-S viewing directions from National Weather Center rooftop 18-km south of tornado path



CAPE >3,000 J/kg, CIN ~0 J/kg, more than 4-hr before radiometer vortex observation (black line)

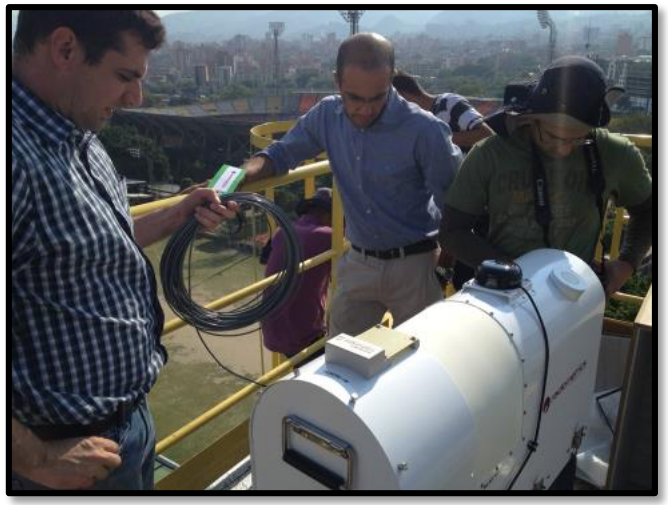




Radiosonde (left) and radiometer (right) three hours before tornado touchdown







Thermodynamic and wind profiling for local high impact weather forecasting

Final Comments

- Continuous upper air soundings are needed to improve high impact weather forecasting
- Example soundings were shown at airport and launch ranges, for networks, and for high impact weather cases
- Widespread assimilation of such soundings into numerical weather models can improve high impact weather forecast accuracy