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Understanding Temperature Inversions and the Kansas Mesonet Inversion Monitor Webpage

Chip Redmond - Mesonet Manager
Mary Knapp - Assistant Climatologist

"The computer says I need to upgrade my brain to be compatible with the new software."

Hourly Data Availability

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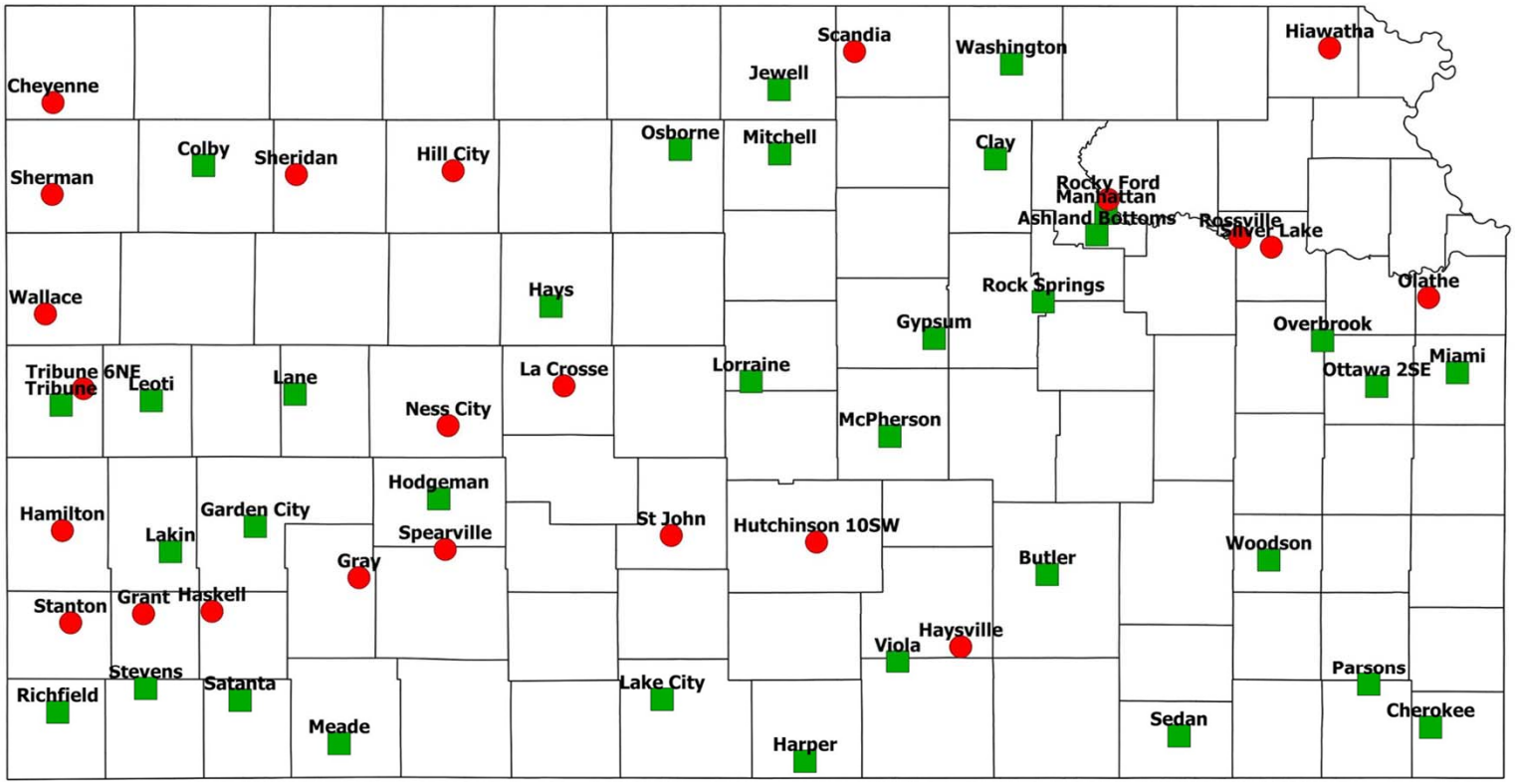
2017 K-State Kansas Mesonet (9/26/17)



Station Type
- 10ft Tripod
- 30' Tower

0 50 100 miles

North

Kansas State University Weather Data Llibrary (WDL) Weather Station Mesonet
As of: 9/26/17
Created by: Christopher Redmond - WDL Manager
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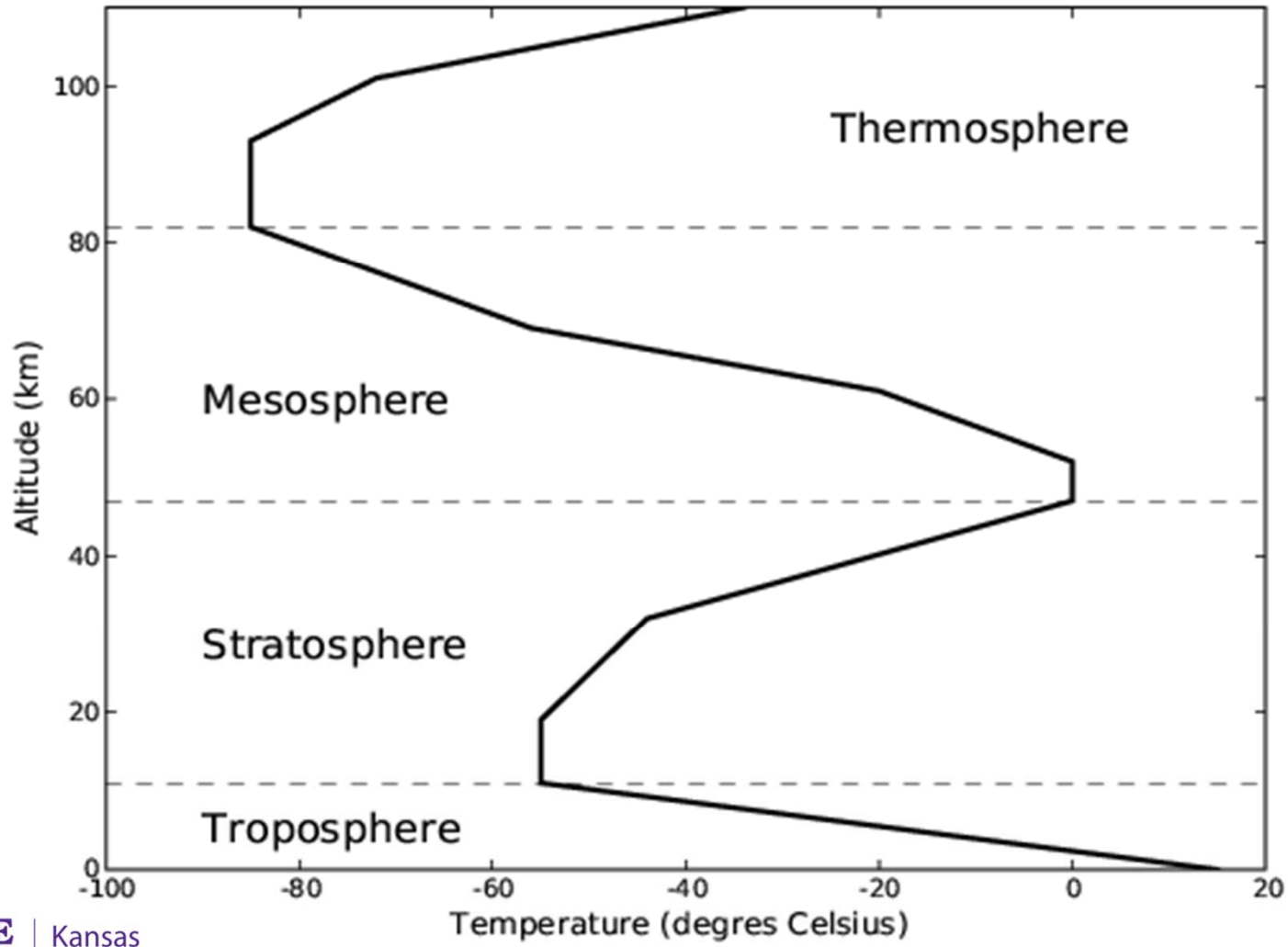

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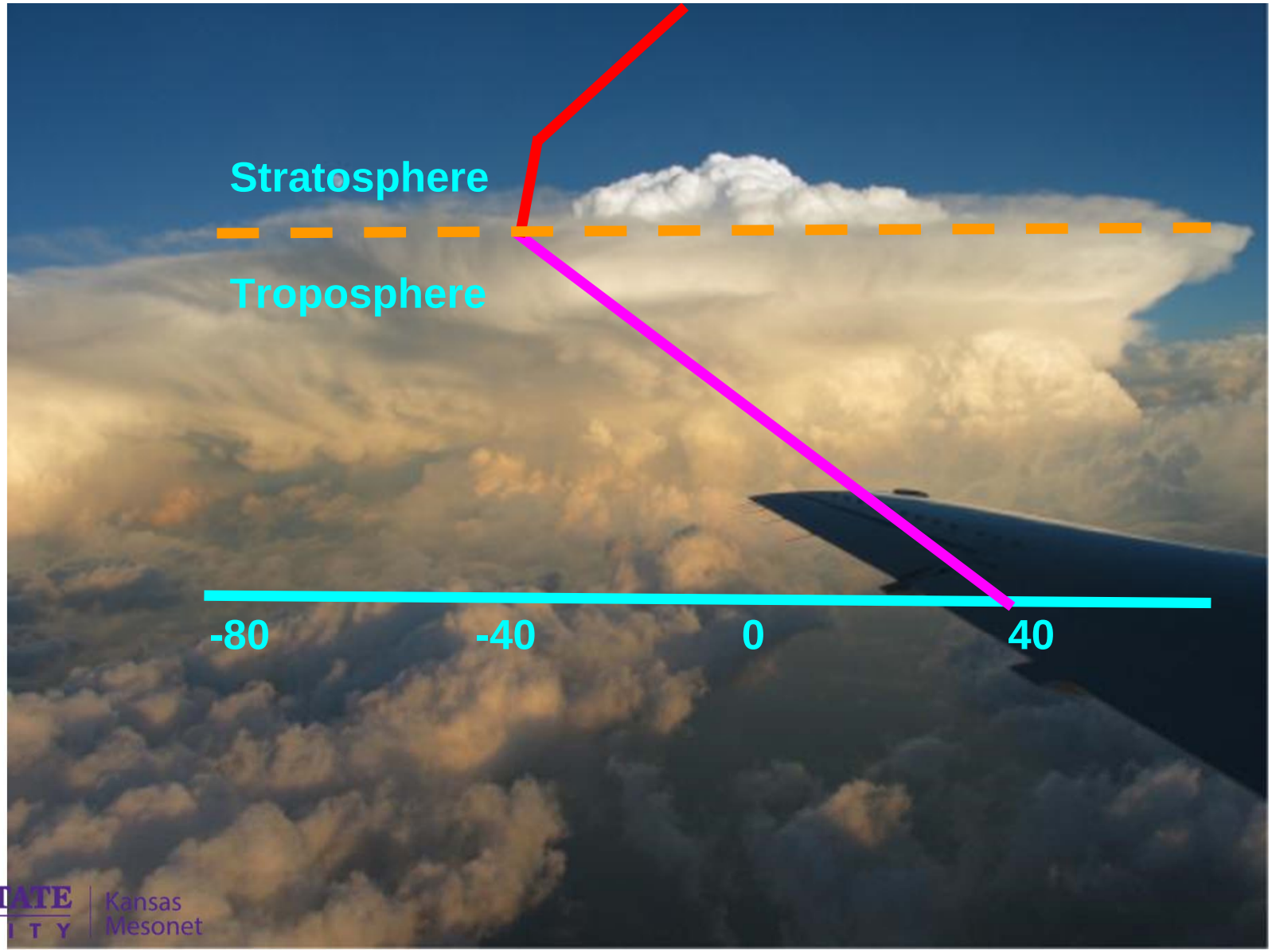

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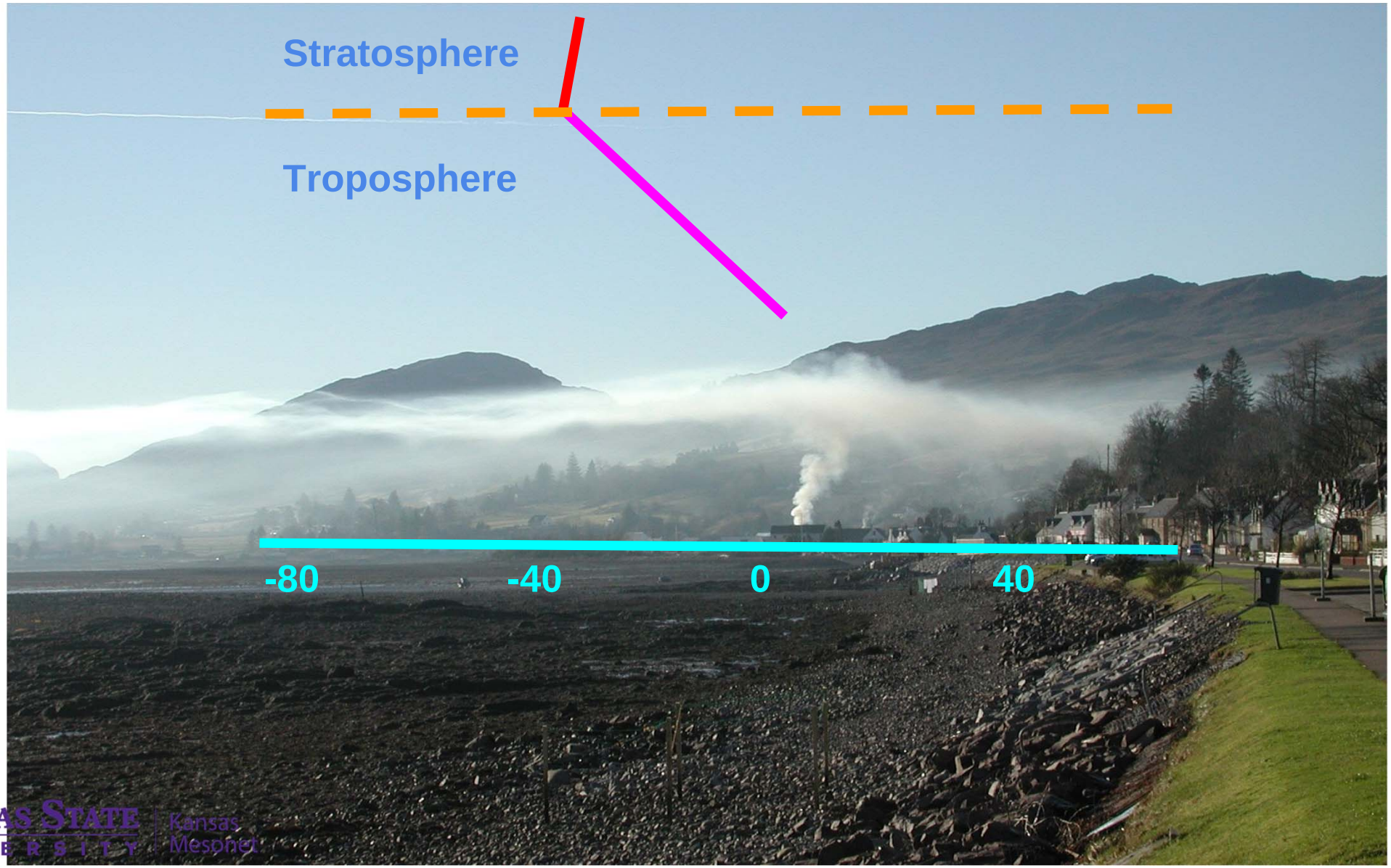
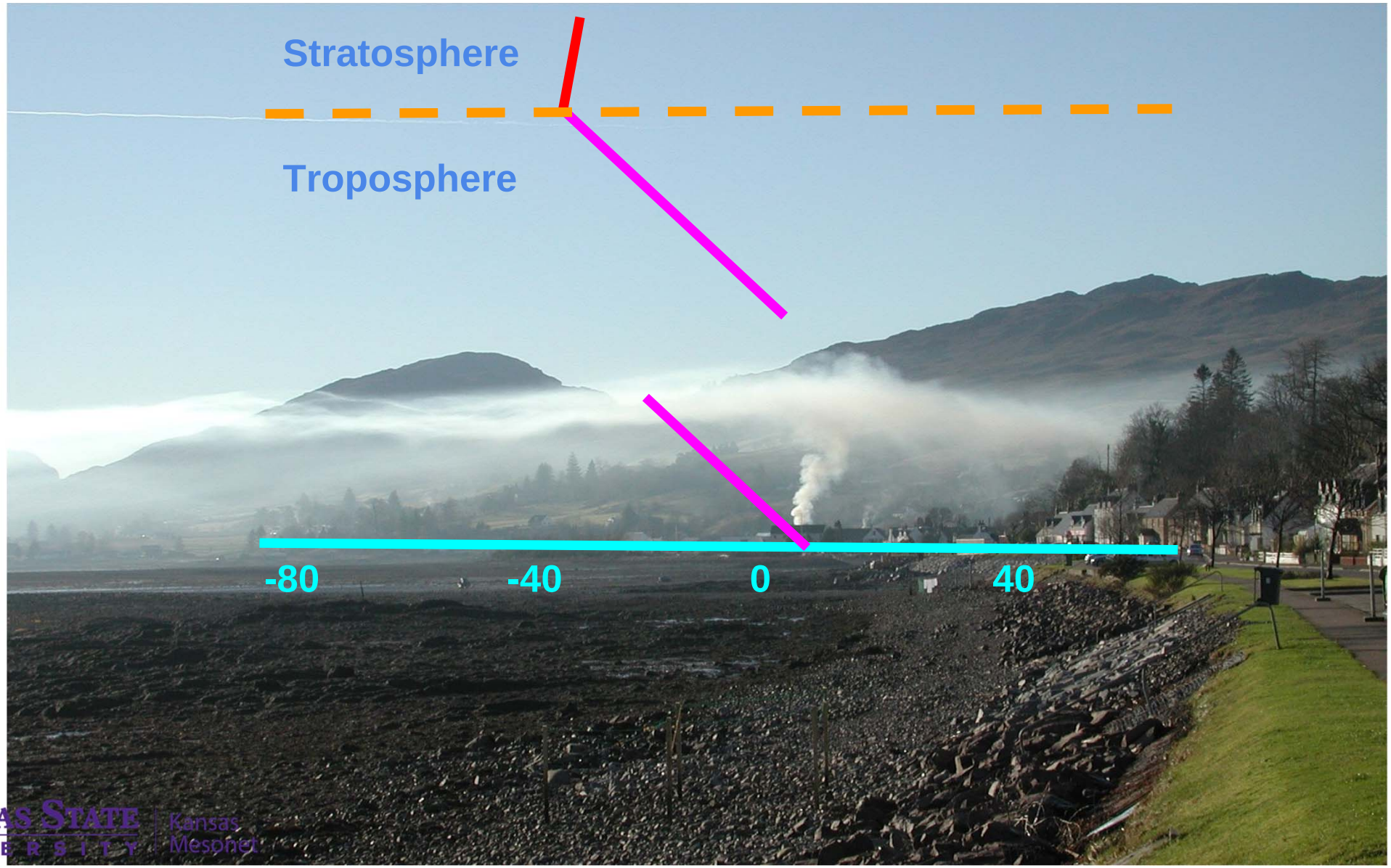
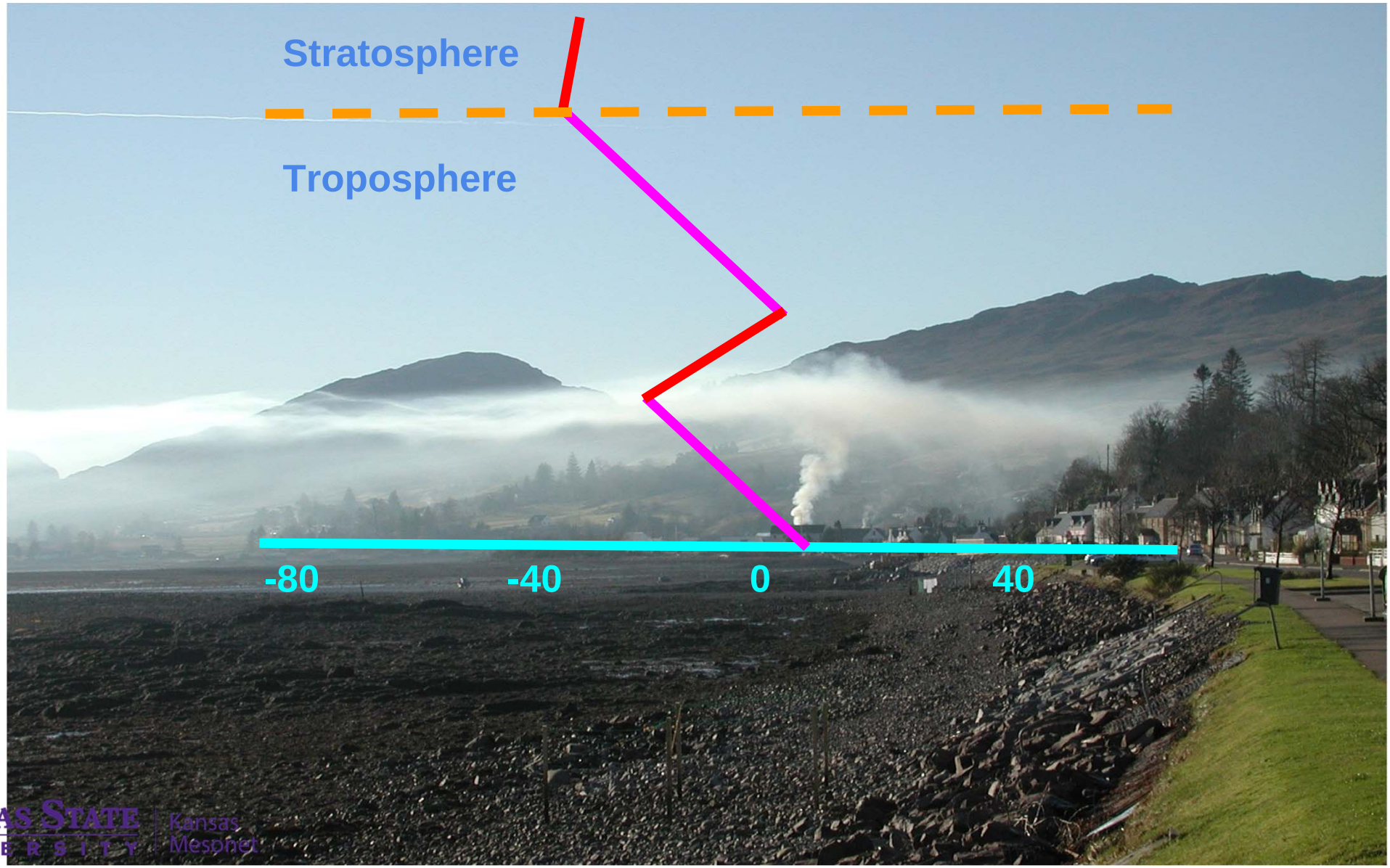
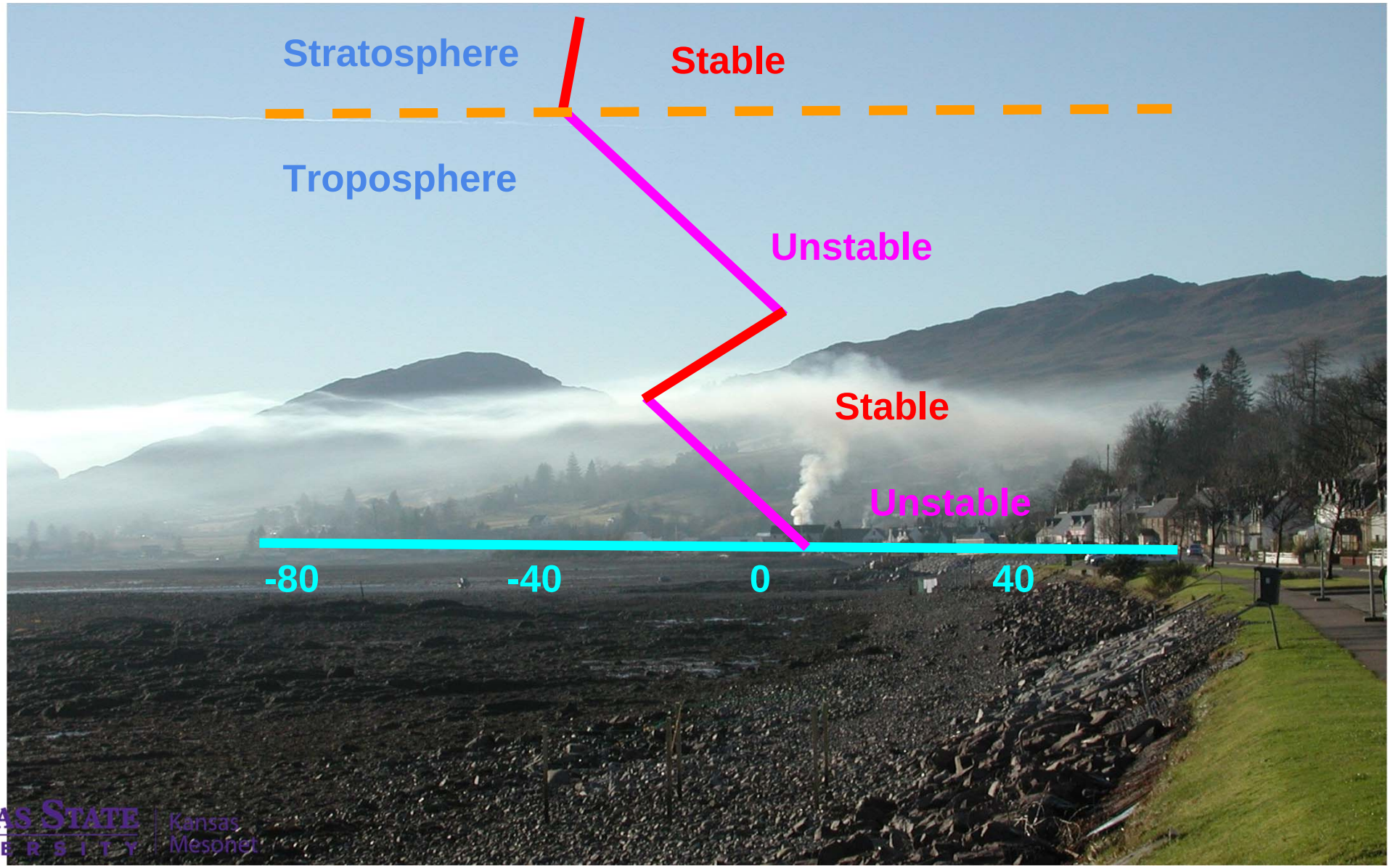
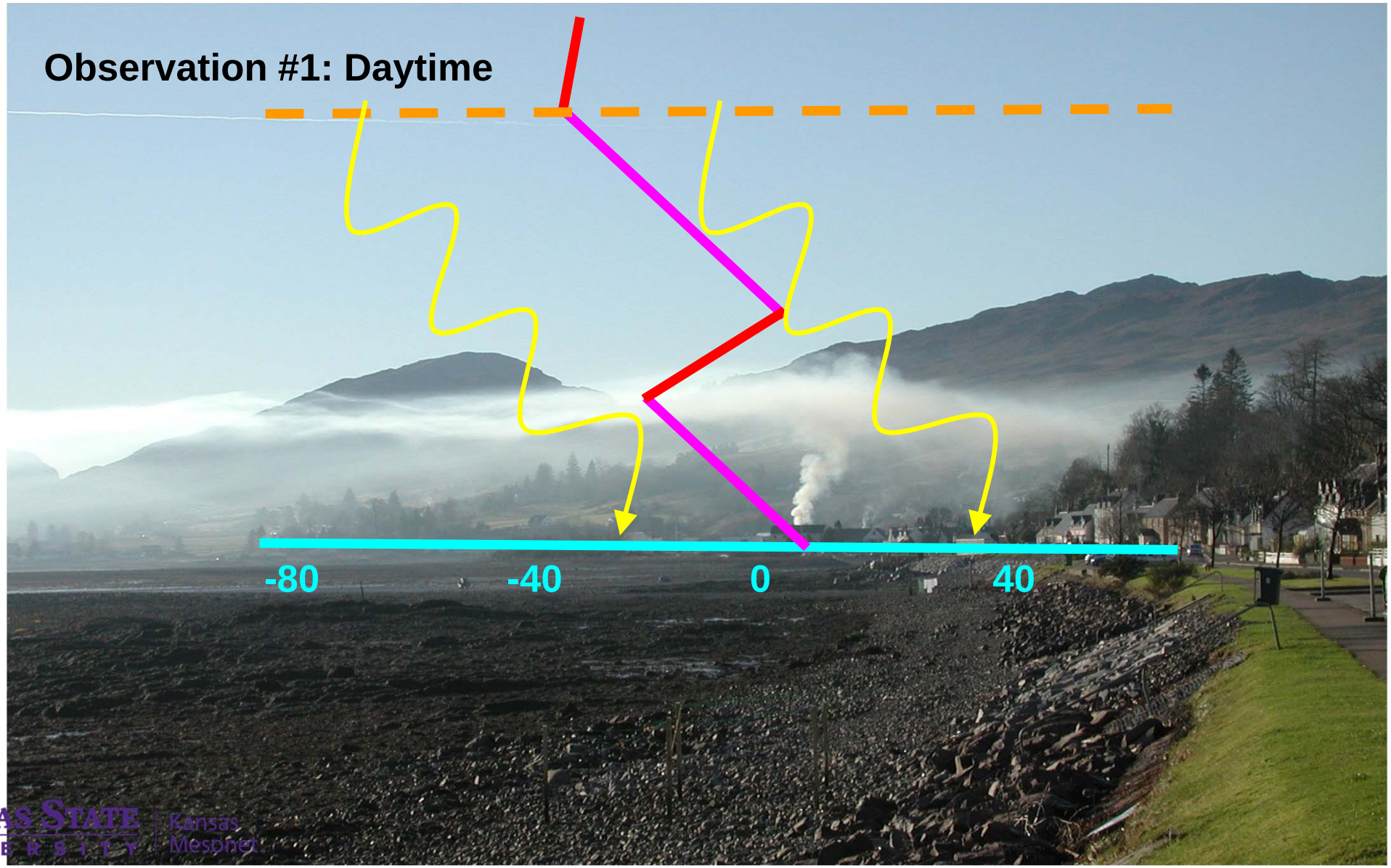

Stratosphere
Troposphere
-80
-40
0
40


Stratosphere
Troposphere
-80
-40
0
40


Stratosphere
Troposphere
-80
-40
0
40


Stratosphere
Stable
Troposphere
Unstable
Stable
Unstable
-80
-40
0
40



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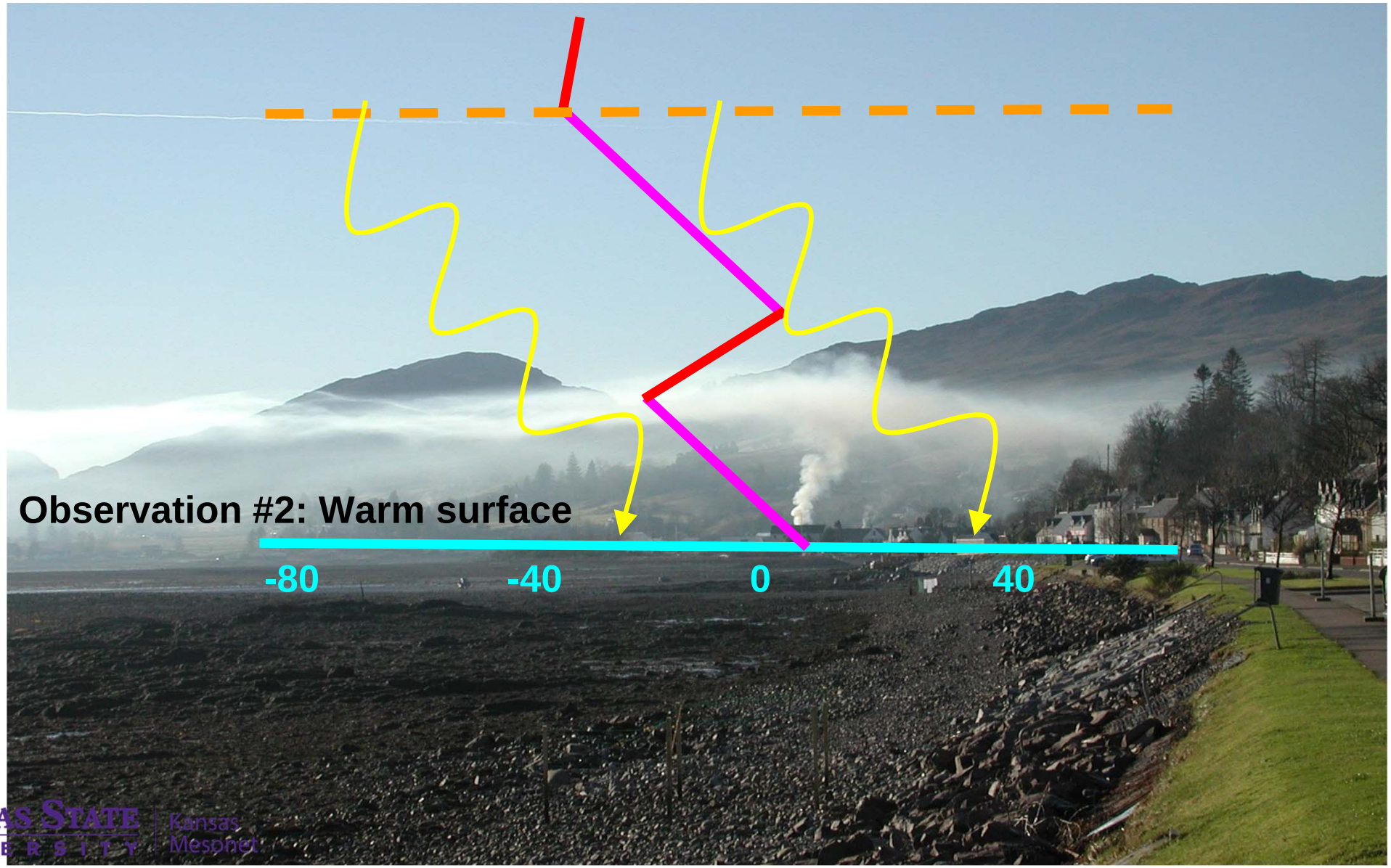
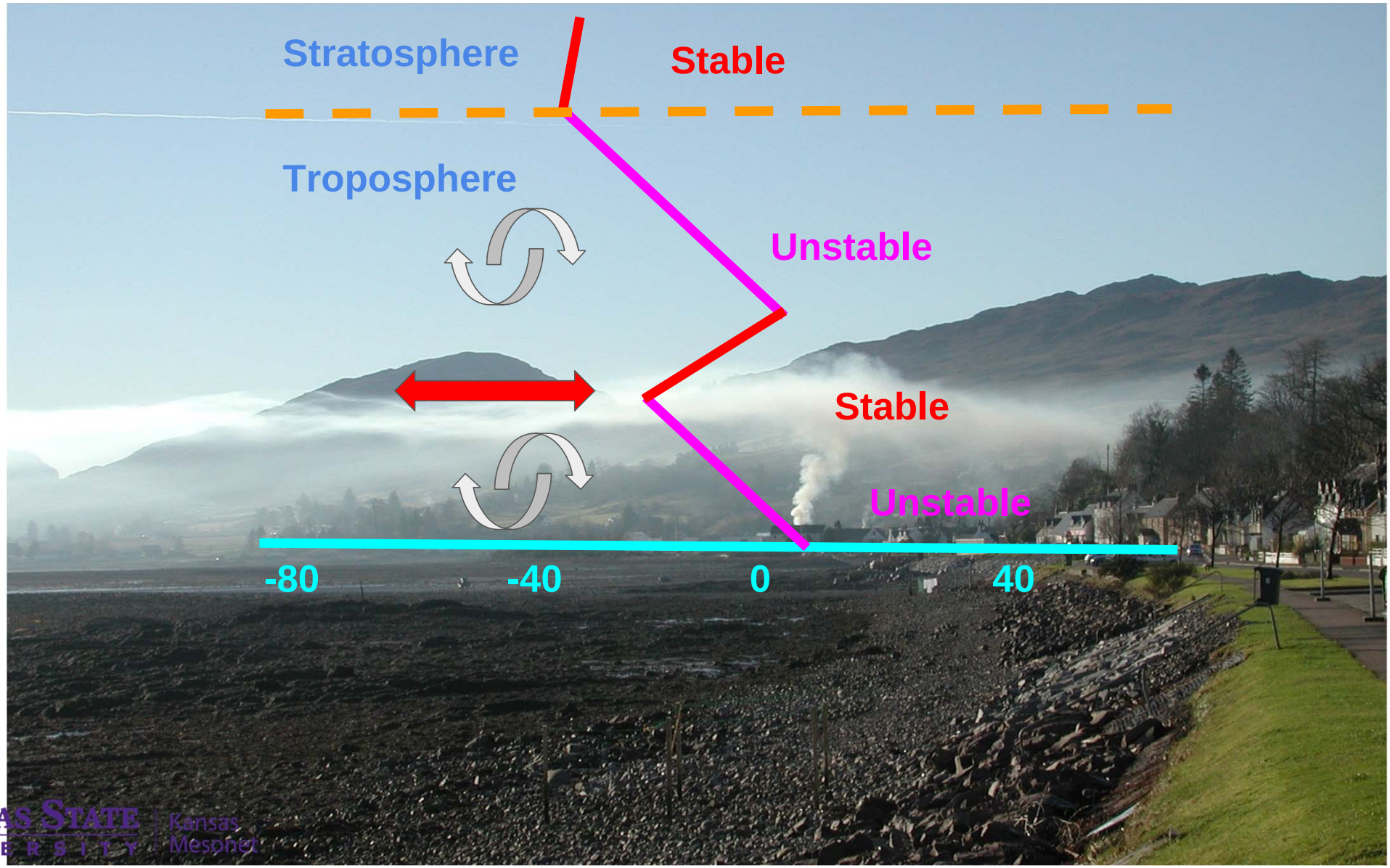
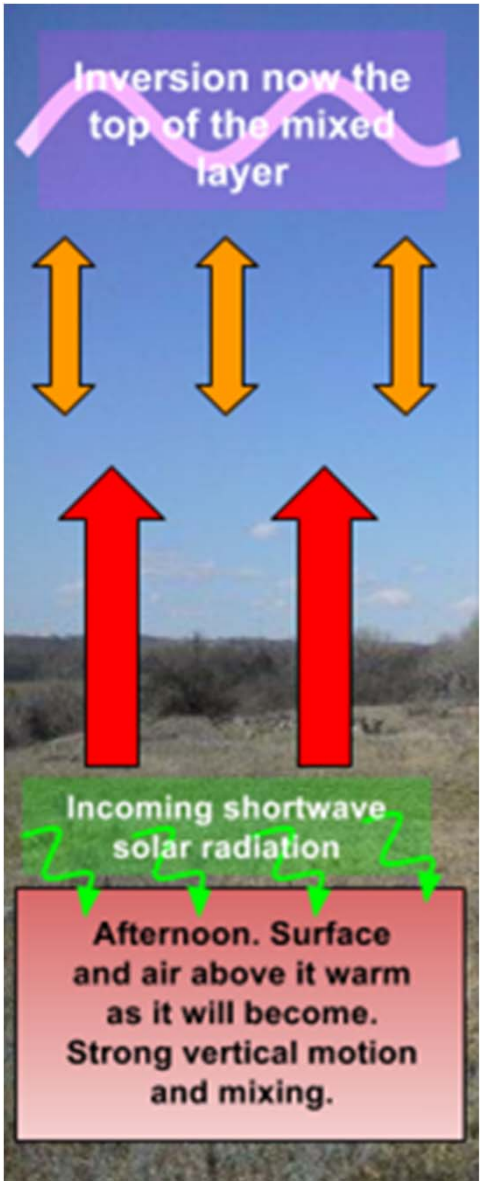

Observation #2: Warm surface
-80
-40
0
40


Stratosphere
Stable
Troposphere
Unstable
Stable
Unstable
-80
-40
0
40

- Temperature typically decreases with height
- Warm air rises when cooler than environment (unstable)
- Unstable = increased winds and good vertical mixing
- Stable = poor dispersion and little wind
- Inversion is anytime warm air exists atop cooler air (stable)



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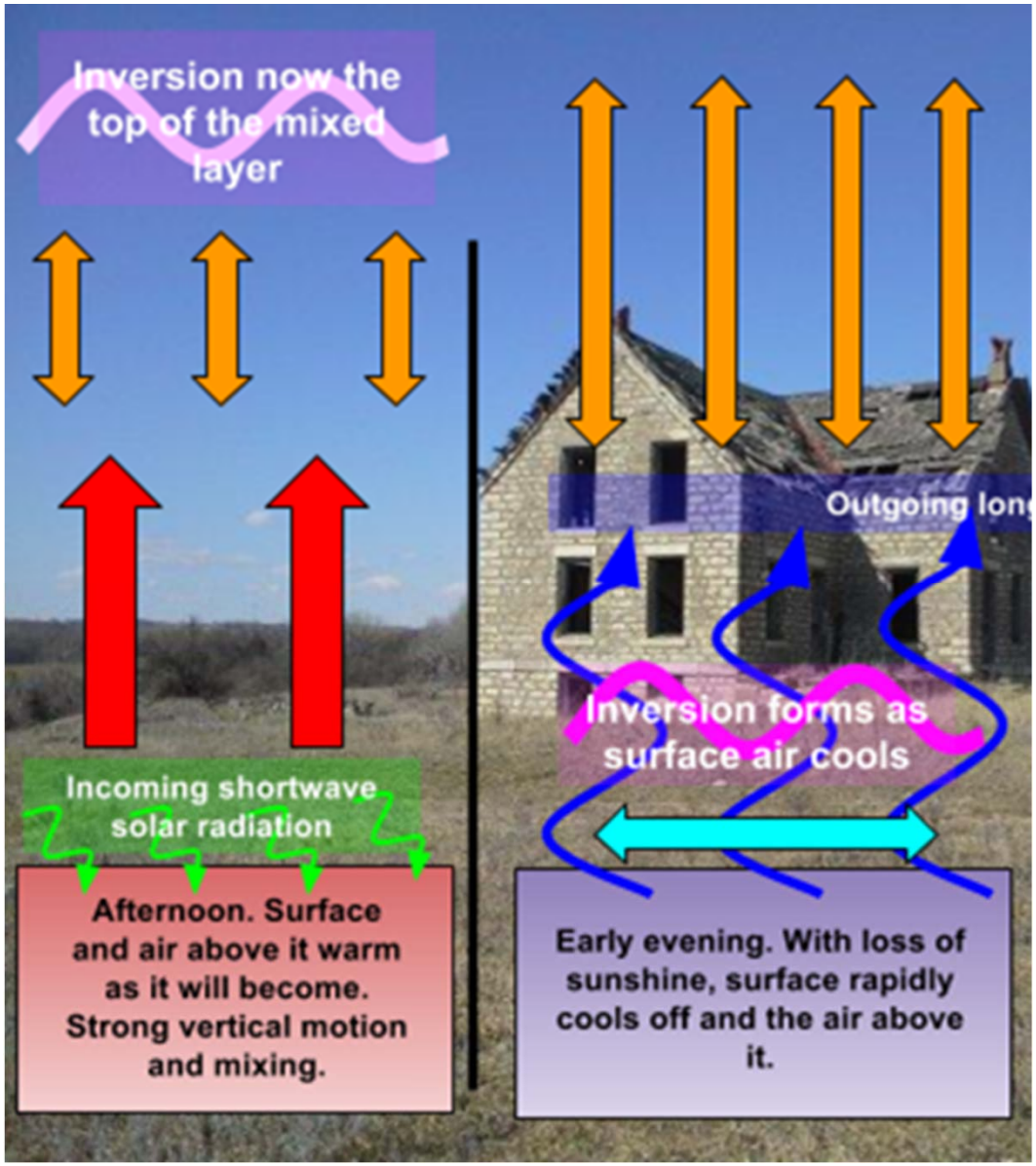

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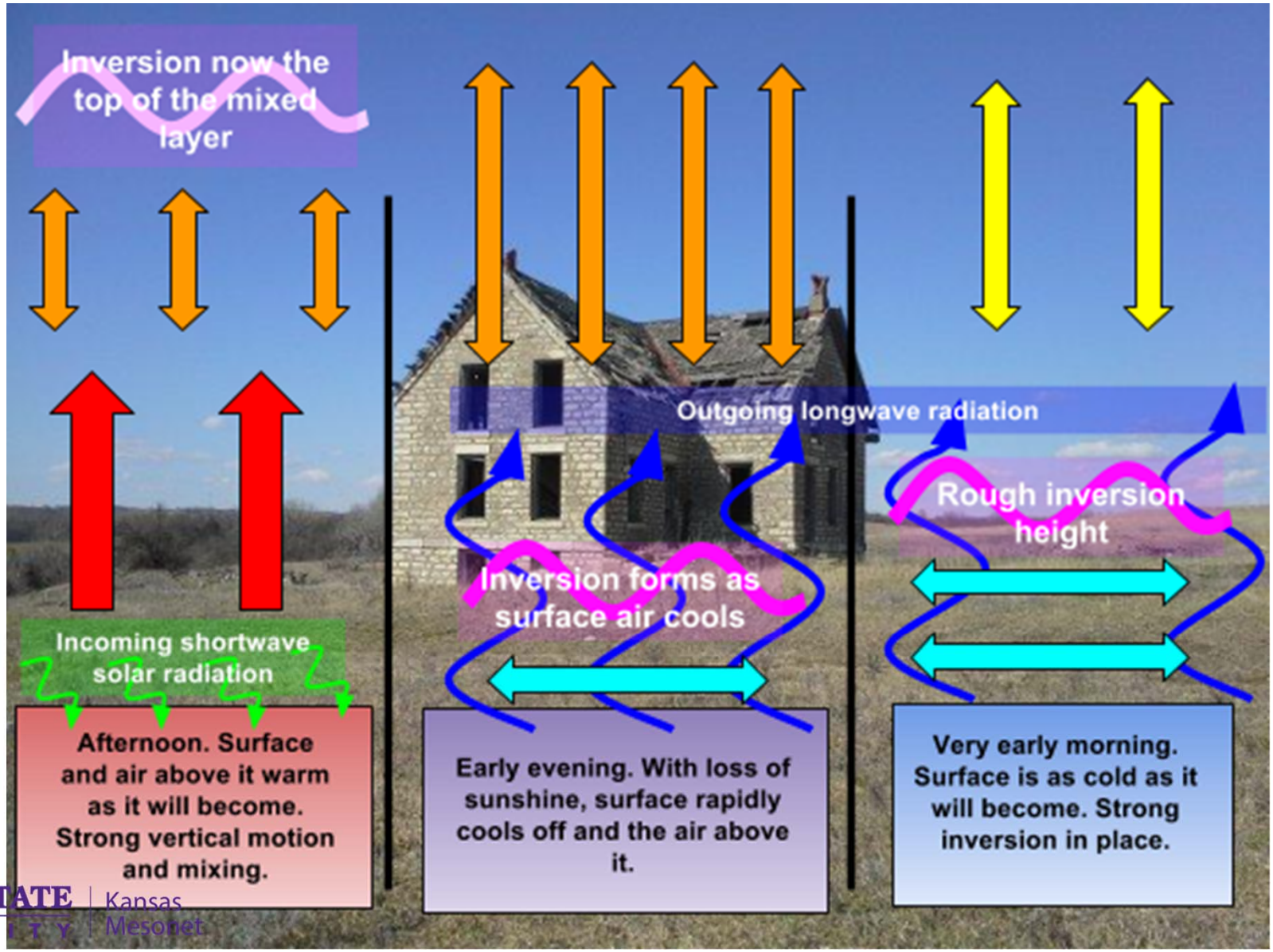
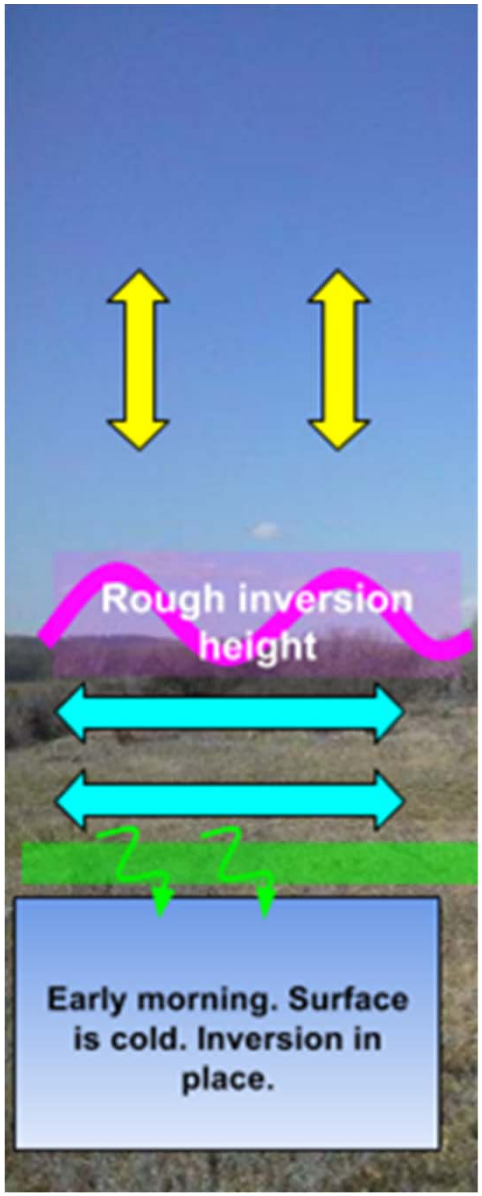

Inversion now the top of the mixed layer
Outgoing longwave radiation
Rough inversion height
Inversion forms as surface air cools
Incoming shortwave solar radiation
Afternoon. Surface and air above it warm as it will become. Strong vertical motion and mixing.
Early evening. With loss of sunshine, surface rapidly cools off and the air above it.
Very early morning. Surface is as cold as it will become. Strong inversion in place.



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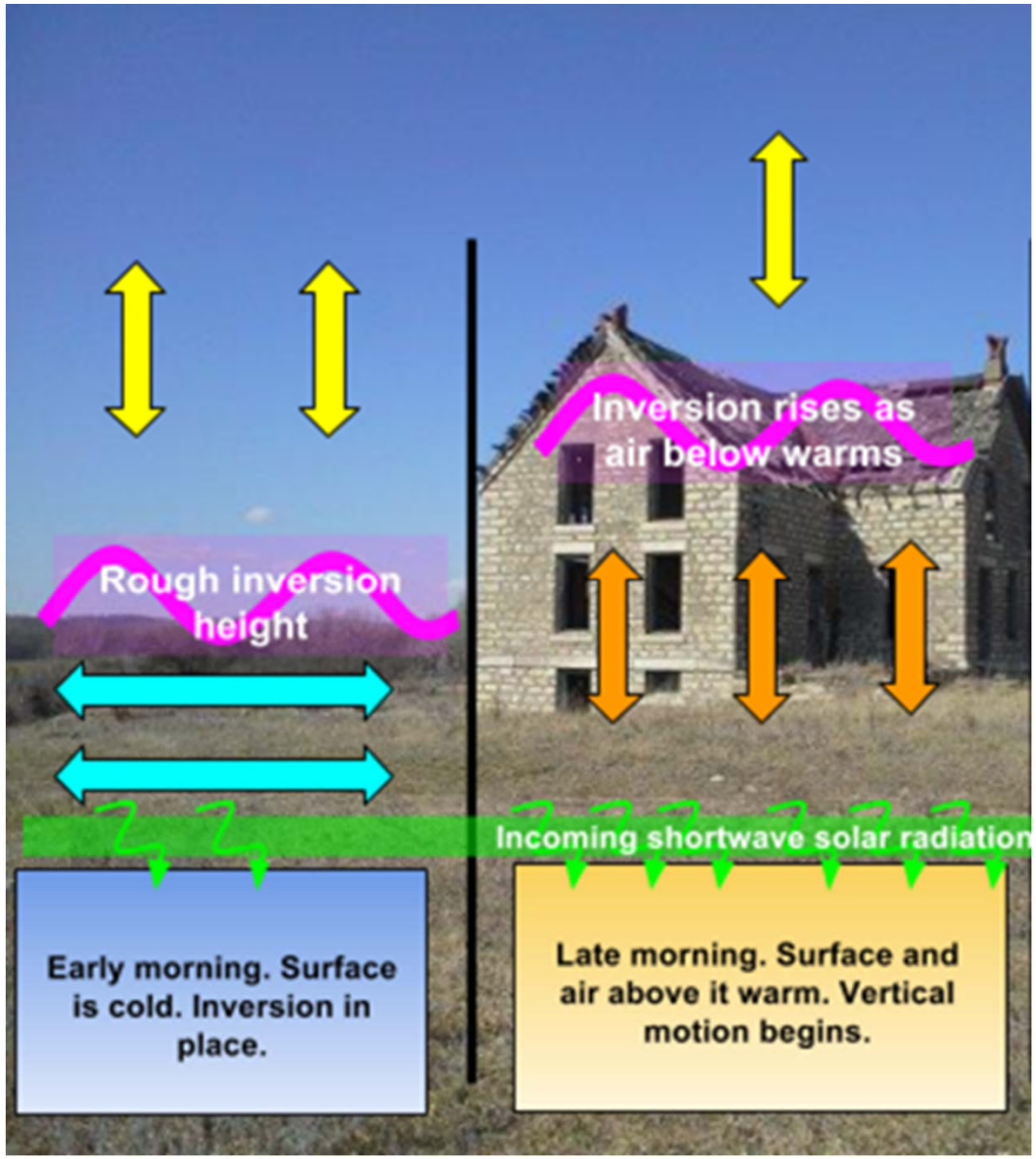

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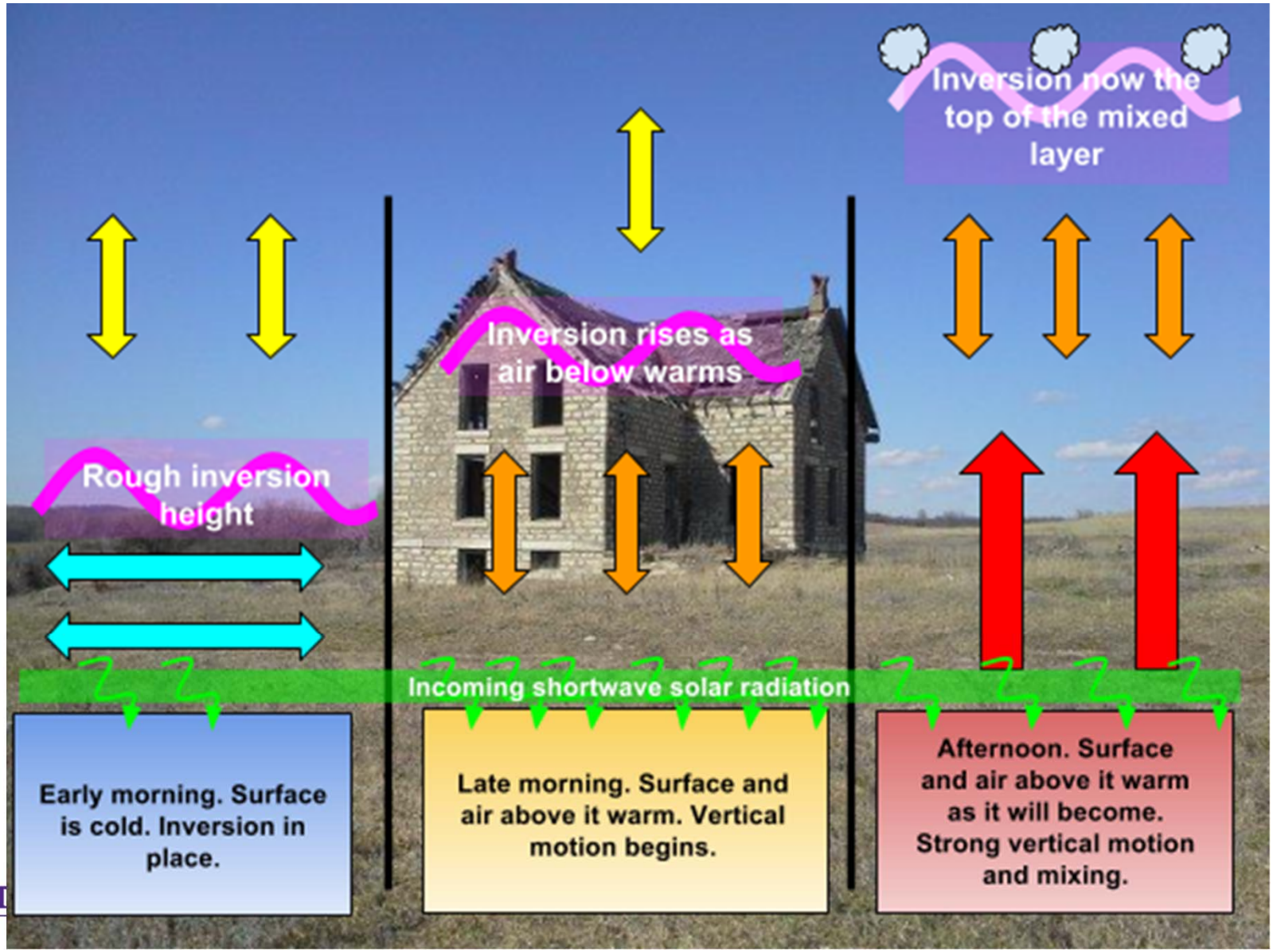


- Surface inversions are typically a nightly occurrence
- Onset is usually near/before sunset
- Diminish in the mid-morning after sunrise
- Afternoon cumulus a good sign that inversion is dissipated
- Optimized under clear, low wind conditions

3C, 37F

4C, 39F

-5

0

5

1400 Hrs

(30’ Temperature - 6’ Temperature)

-2 No Inversion

1700 Hrs

-2 No Inversion

3C, 37F

1C, 35F

2000 Hrs

+2 Inversion

-5 0 5

3C, 37F

0C, 32F

-5

0

5

2100 Hrs

+5 Inversion

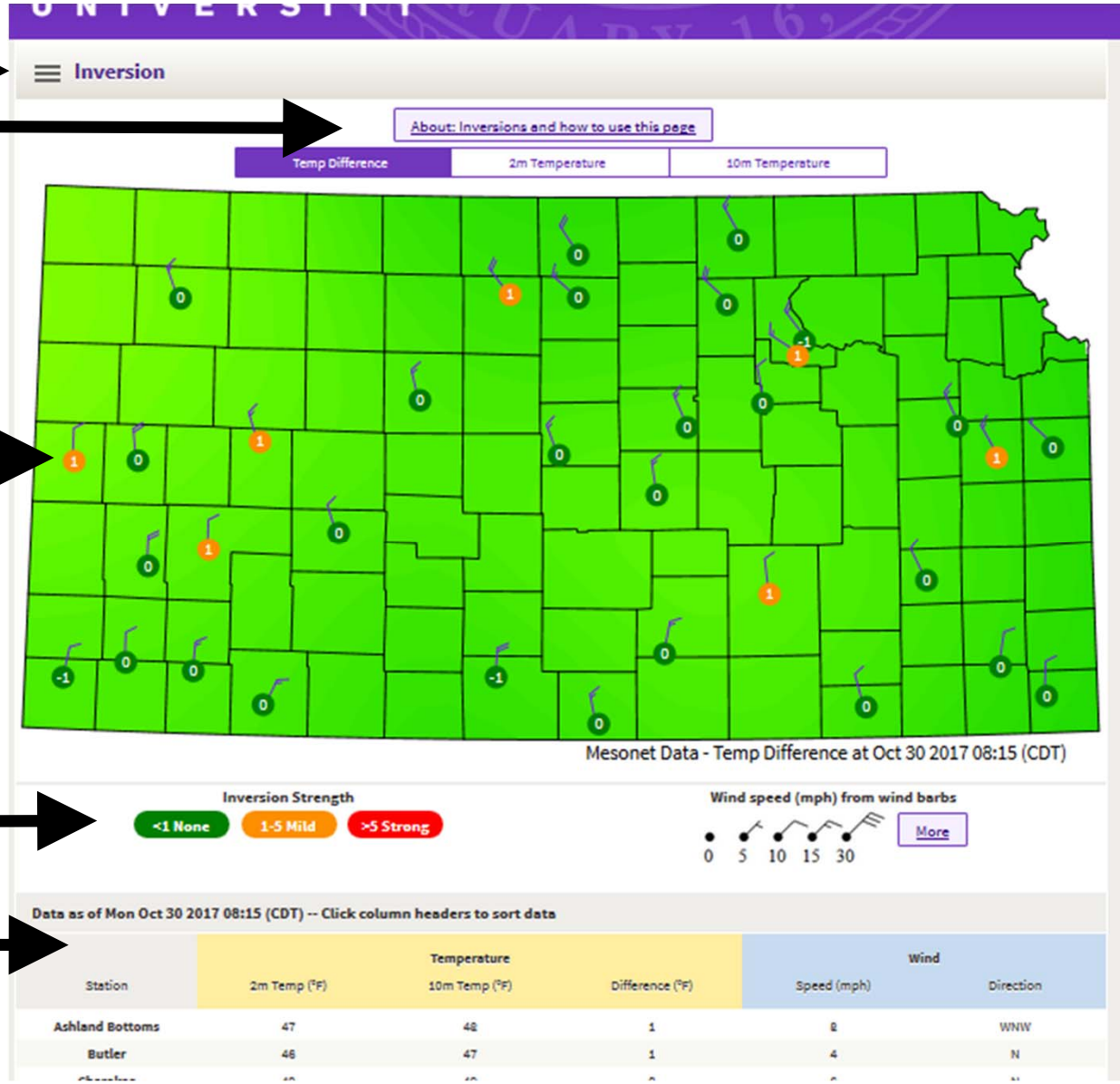
Navigate

Educate

Disseminate

Interpret

Download



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Miami	51	50	-1	3	WNW
Mitchell	48	47	-1	15	NW
Osborne	48	47	-1	20	NW
Ottawa 2SE	51	50	-1	13	NNW
Overbrook	49	48	-1	15	NW
Parsons	51	51	0	9	N
Richfield	44	43	-1	12	NNE
Rock Springs	50	50	0	10	NNW
Satanta	47	45	-2	14	N
Sedan	52	52	0	7	N
Stevens	46	45	-1	13	N
Tribune	40	41	1	9	NNW
Viola	52	51	-1	14	N
Washington	48	46	-2	14	NW
Woodson	50	49	-1	10	NNW

CSV Data | PNG Image

Download

1 inversion.csv

```
STATION,TEMP2MAVG,TEMP10MAVG,TEMPDIFF,WDIR2M,WSPD2MAVG,TIMEST
Ashland Bottoms,49.0,49.0,0,272,12,2017-10-30 12:35:00 CST
Butler,50.0,50.0,0,340,5,2017-10-30 12:35:00 CST
Cherokee,52.0,51.0,-1,5,5,2017-10-30 12:35:00 CST
Clay,50.0,48.0,-2,296,17,2017-10-30 12:35:00 CST
Colby,44.0,42.0,-2,340,16,2017-10-30 12:35:00 CST
Garden City,43.0,44.0,1,351,12,2017-10-30 12:35:00 CST
Gypsum,52.0,50.0,-2,323,19,2017-10-30 12:35:00 CST
Harper,54.0,53.0,-1,7,14,2017-10-30 12:35:00 CST
Hays,48.0,47.0,-1,341,14,2017-10-30 12:35:00 CST
Hodgeman,47.0,46.0,-1,327,8,2017-10-30 12:35:00 CST
Jewell,47.0,45.0,-2,328,20,2017-10-30 12:35:00 CST
Lake City,51.0,50.0,-1,12,12,2017-10-30 12:30:00 CST
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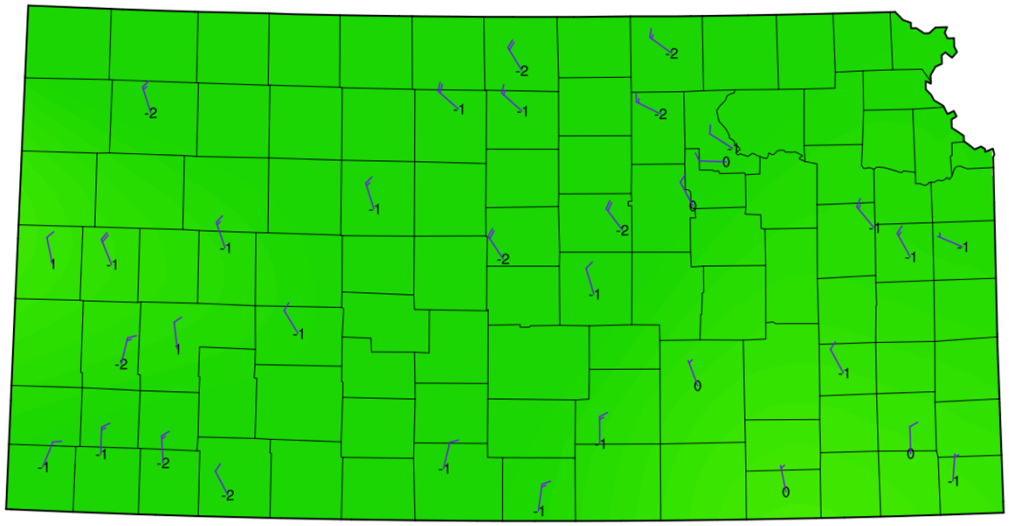

Kansas Mesonet - 2m - 10m Air Temp Difference at 2017-10-30 12:40

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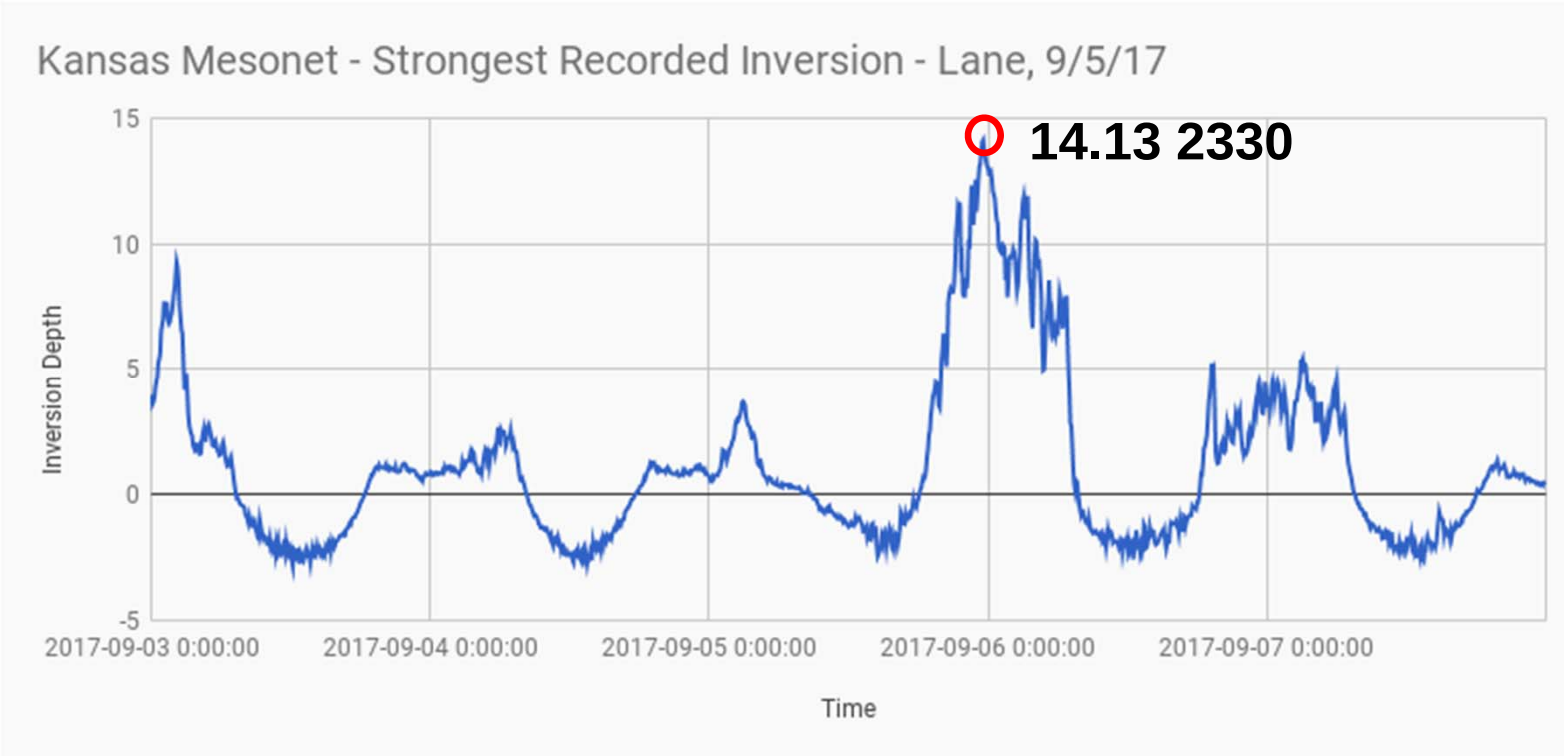
- Inversion data is provided as guidance, not a decision tool
- Nothing beats in the field measurements
- Provides a base-line for future spray studies

- Mesonet inversion monitor measures temperature at 30’ & 6’
- Onset of inversions may initially go undetected
- Nocturnal inversions cool from the ground up
- Tool considers >=5F a “strong” inversion
- Data available real-time online with options to sort/download

mesonet.ksu.edu/agriculture/inversion/pastdata

What constitutes an inversion?

- Instruments installed at the beginning of summer (May/June)
- Inversion = Temperature difference >=1 until it reaches <=0
- Focused on mostly nocturnal inversions



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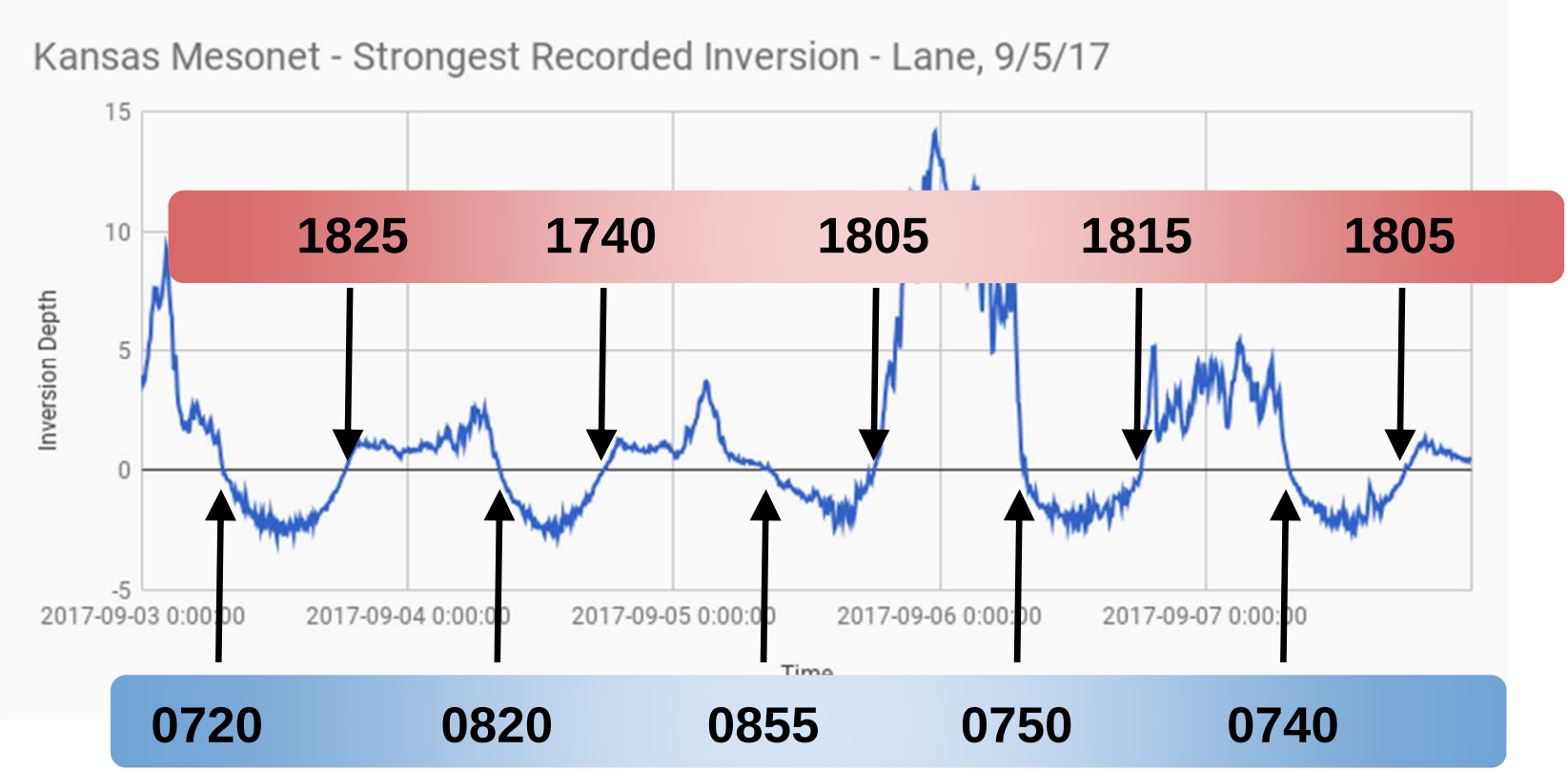

Average End Time: 0801 (0715 sunrise)
Average Start Time: 1806 (2004 sunset)

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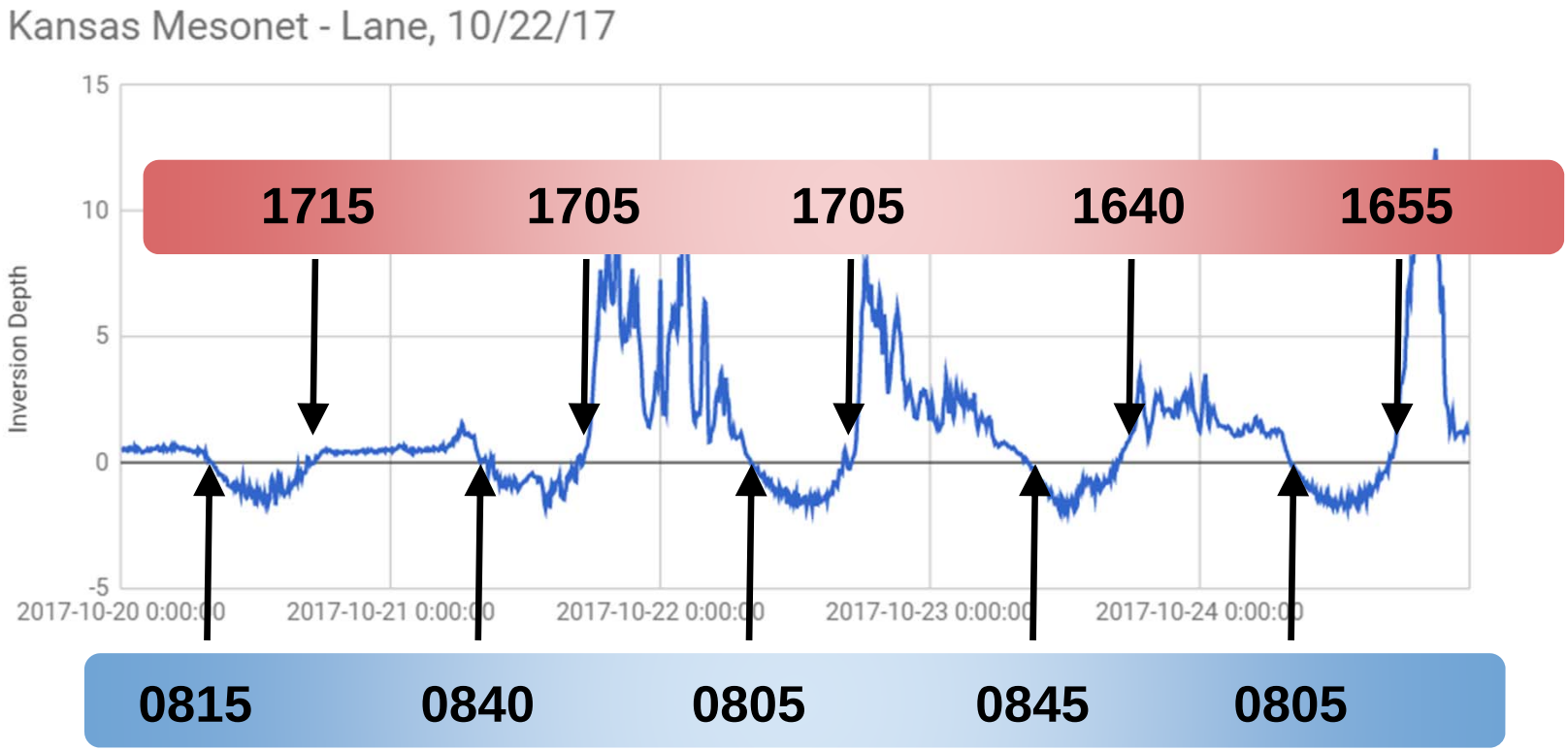

Average End Time: 0822 (0758 sunrise)
Average Start Time: 1700 (1853 sunset)

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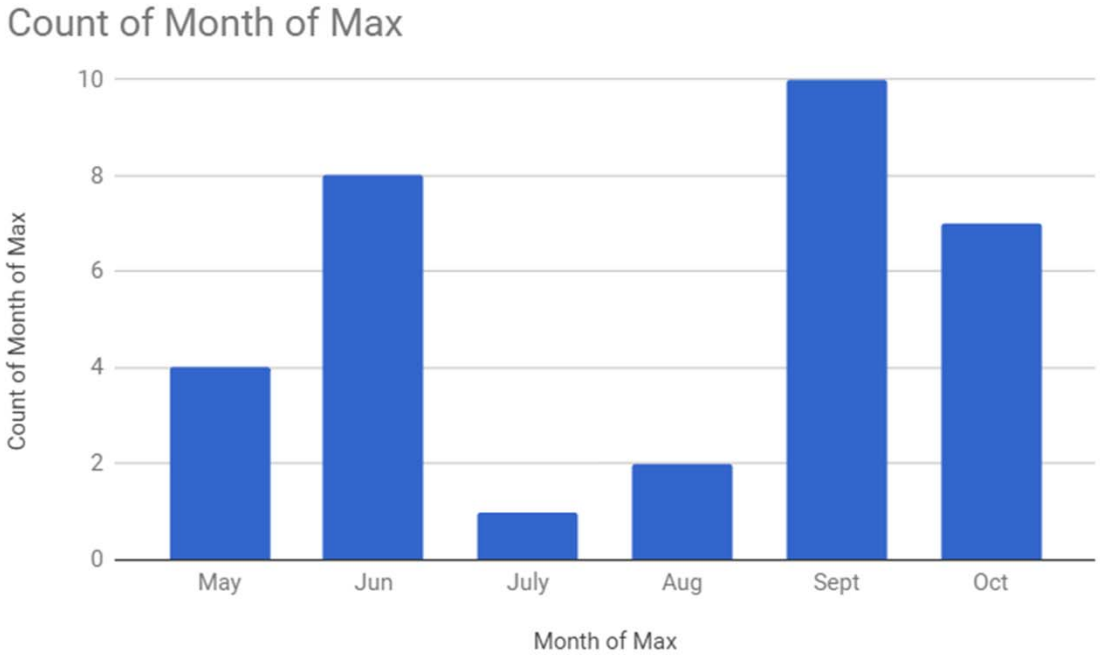

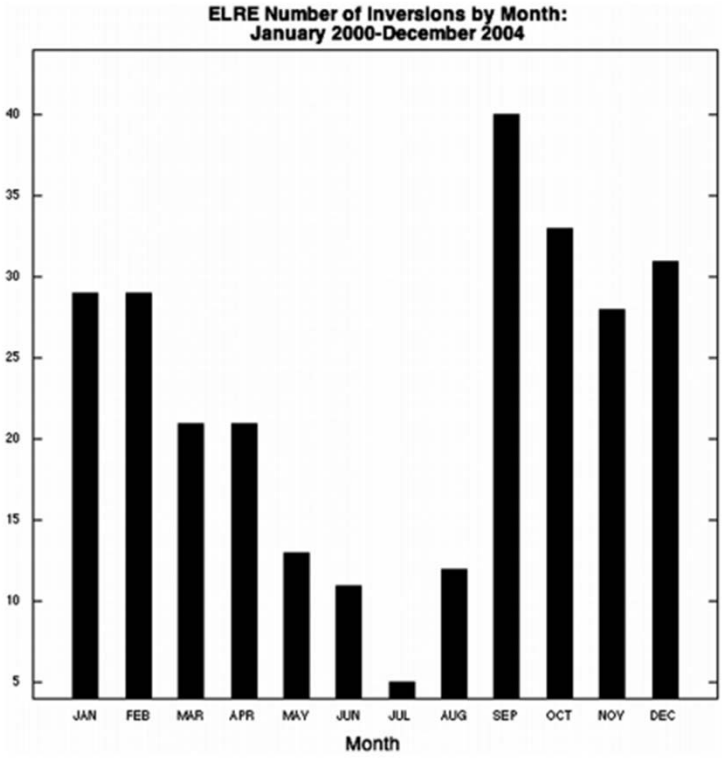

FIG. 3. Number of significant inversions by month at ELRE from January 2000 to December 2004.

(Hunt, E.D., Basara, J.B., Morgan, C.R. 2007)

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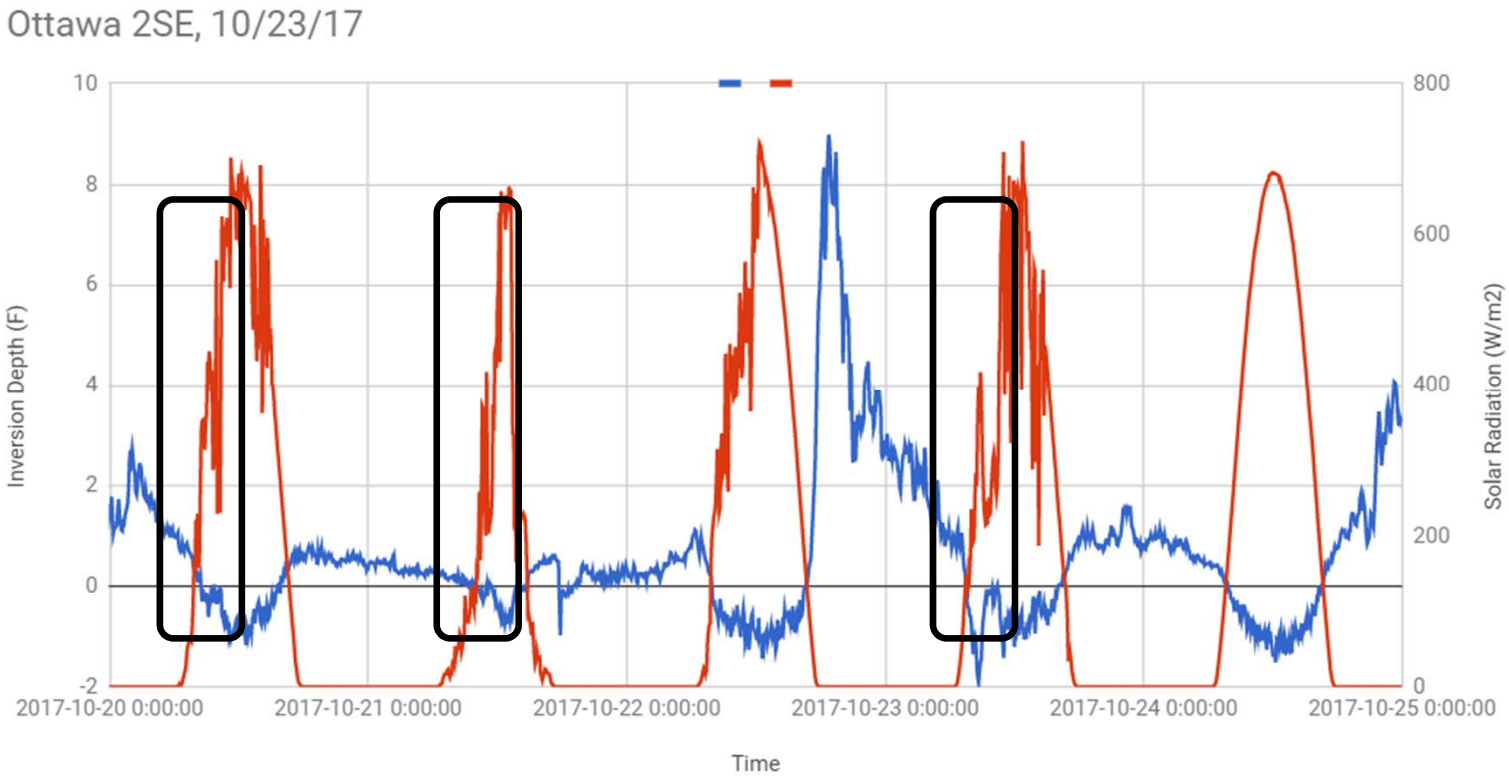

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"STRONG WIND TODAY?"

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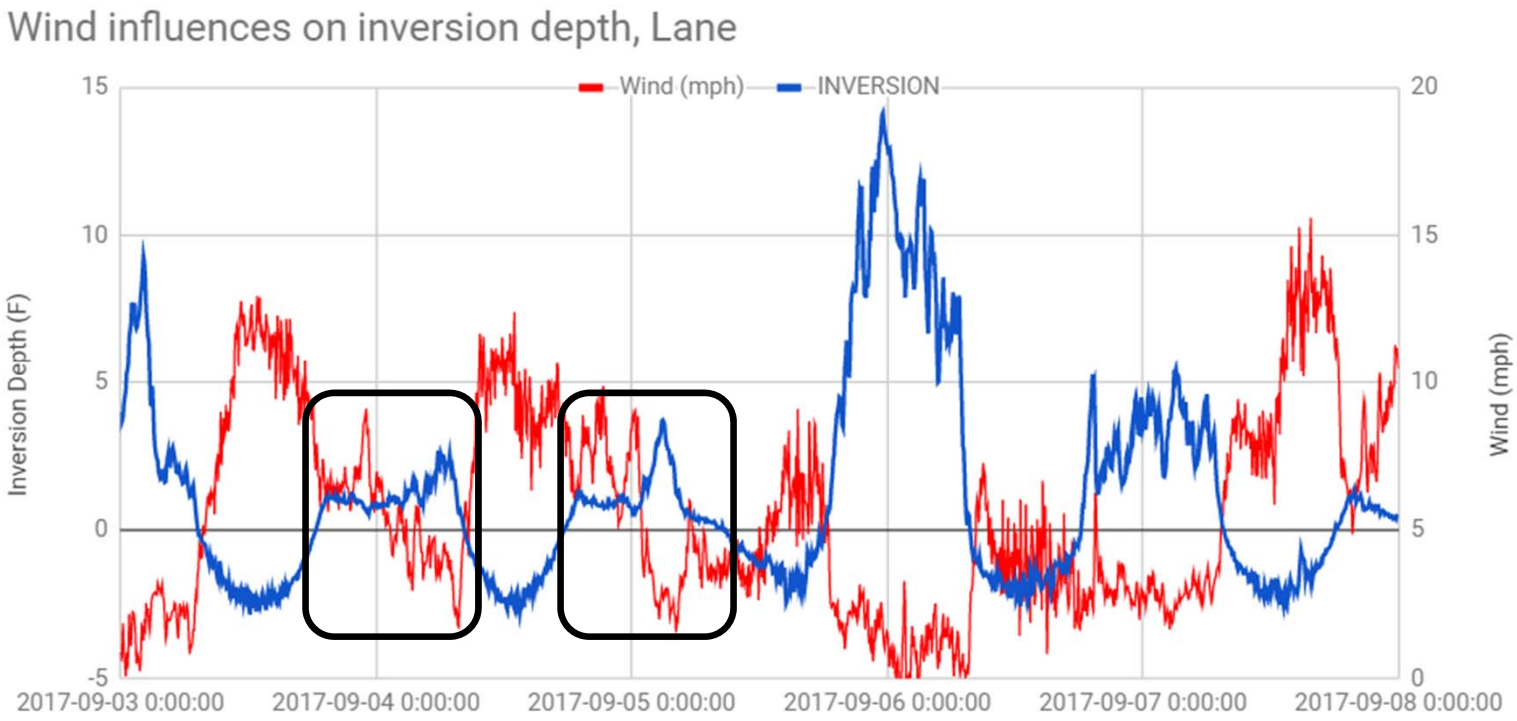

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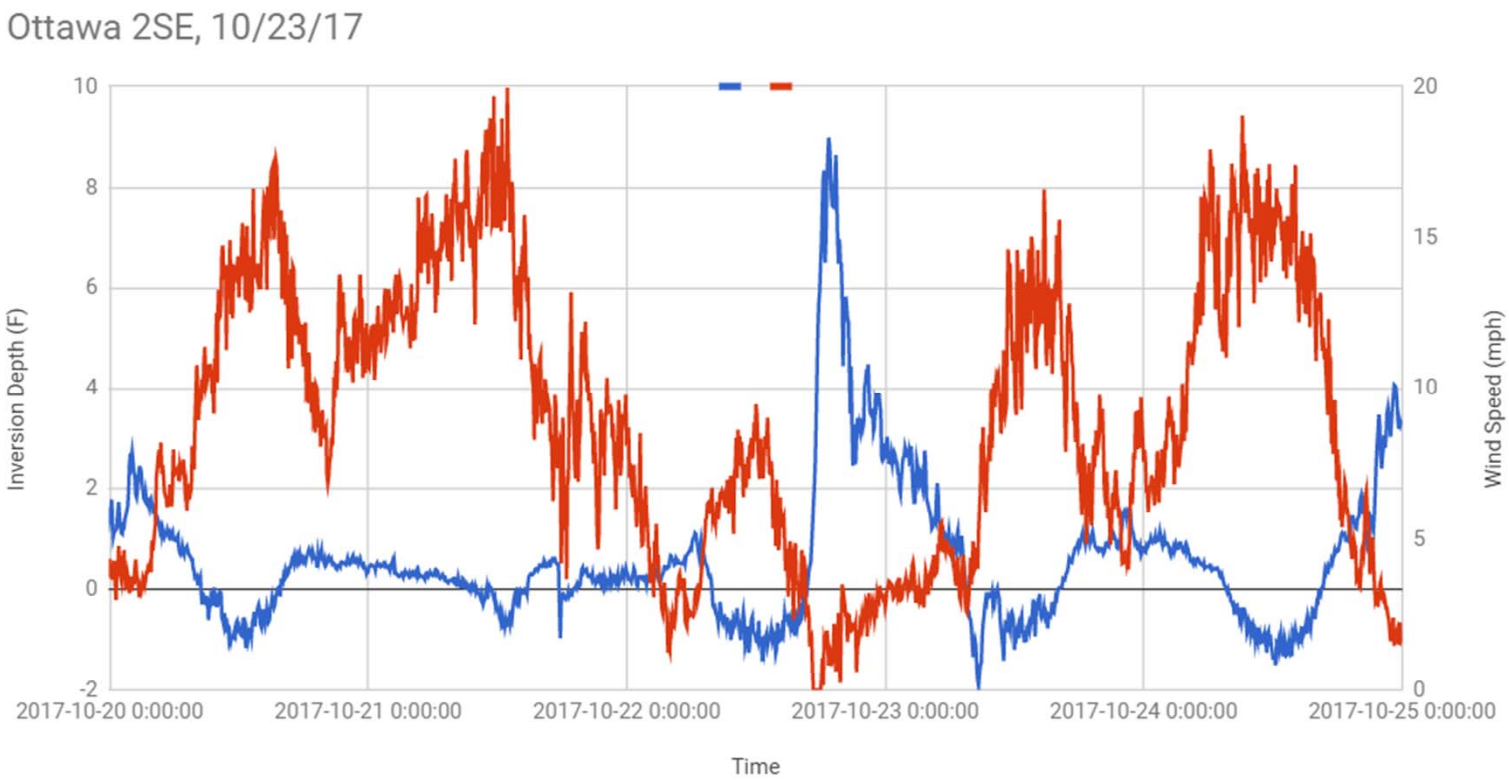

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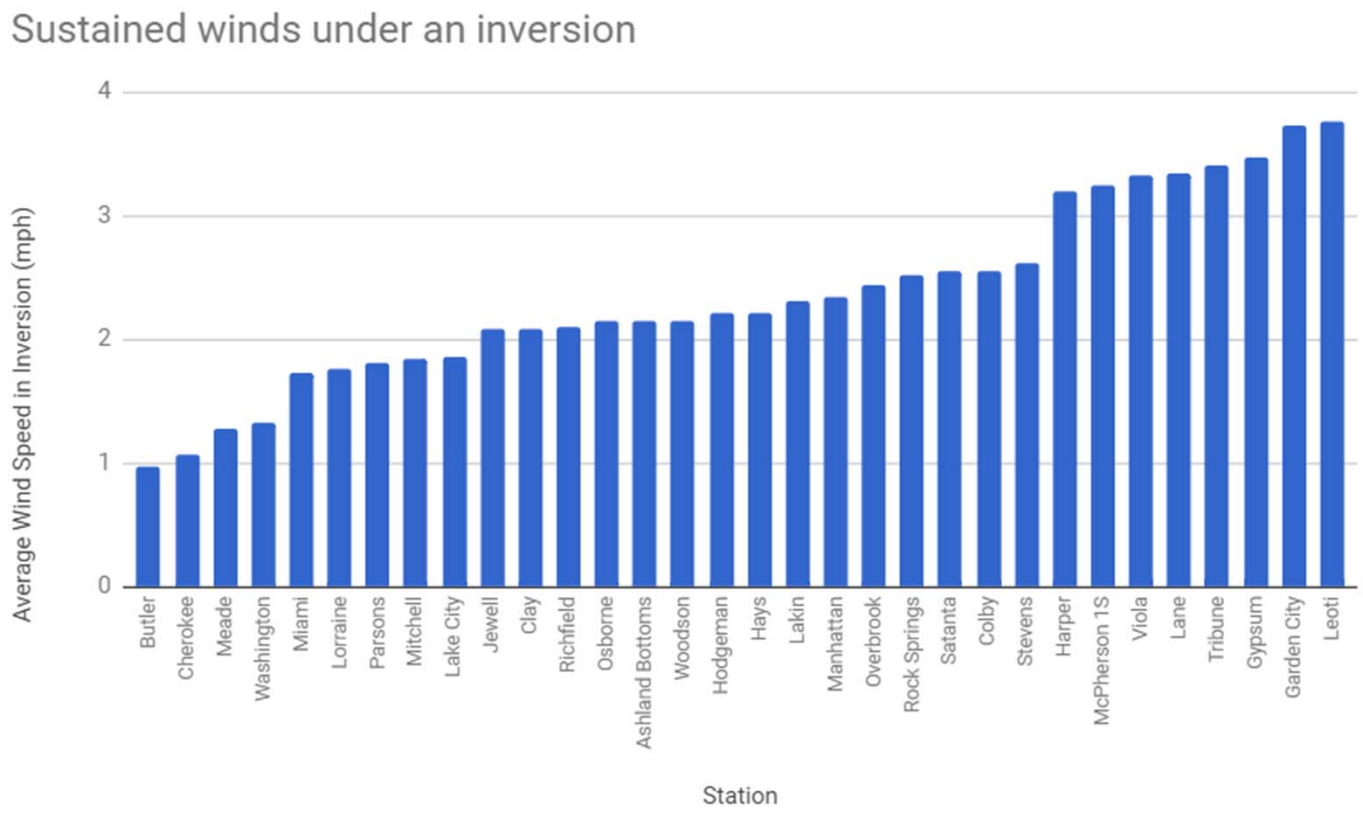

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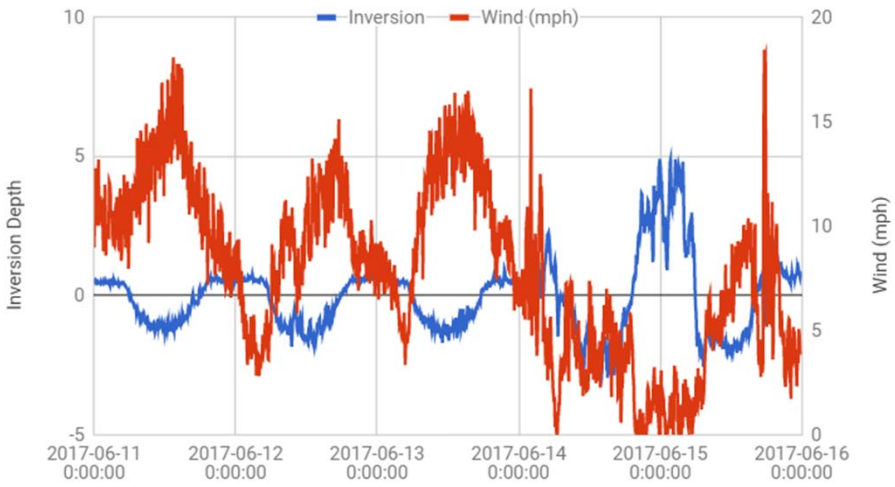
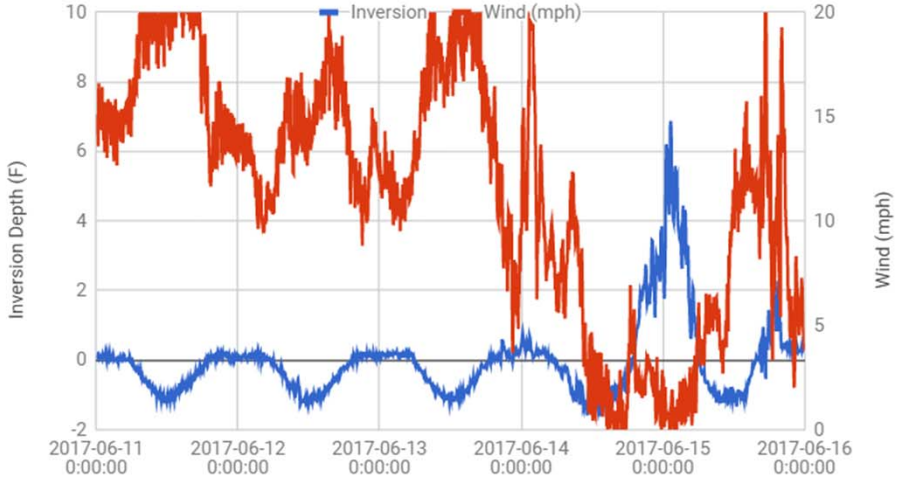
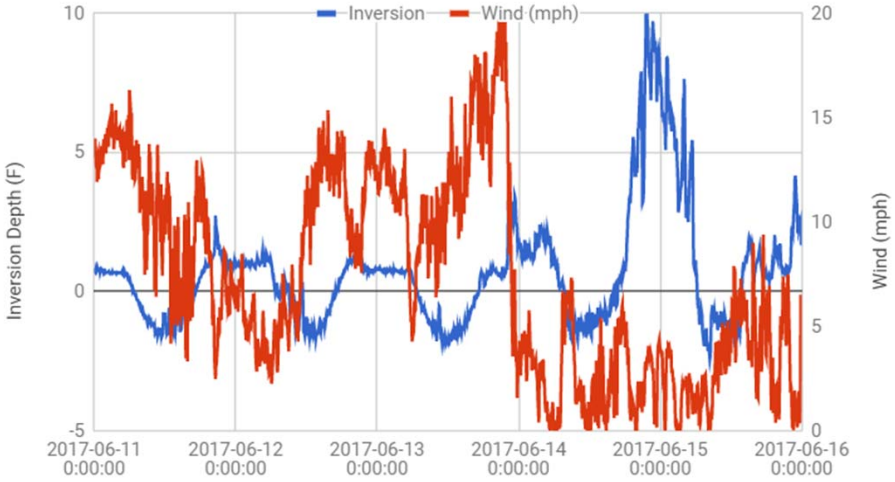
Manhattan, 6/13/17



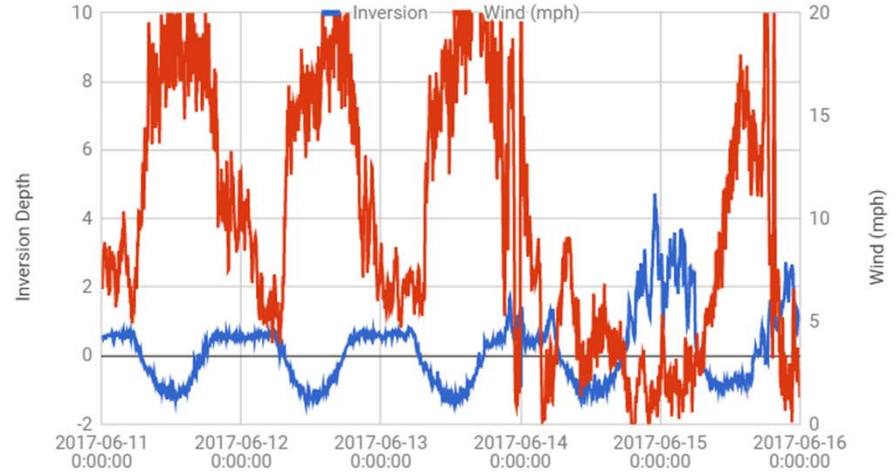
McPherson 1S, 6/13/17



Mitchell, 6/13/17



Lake City, 6/13/17



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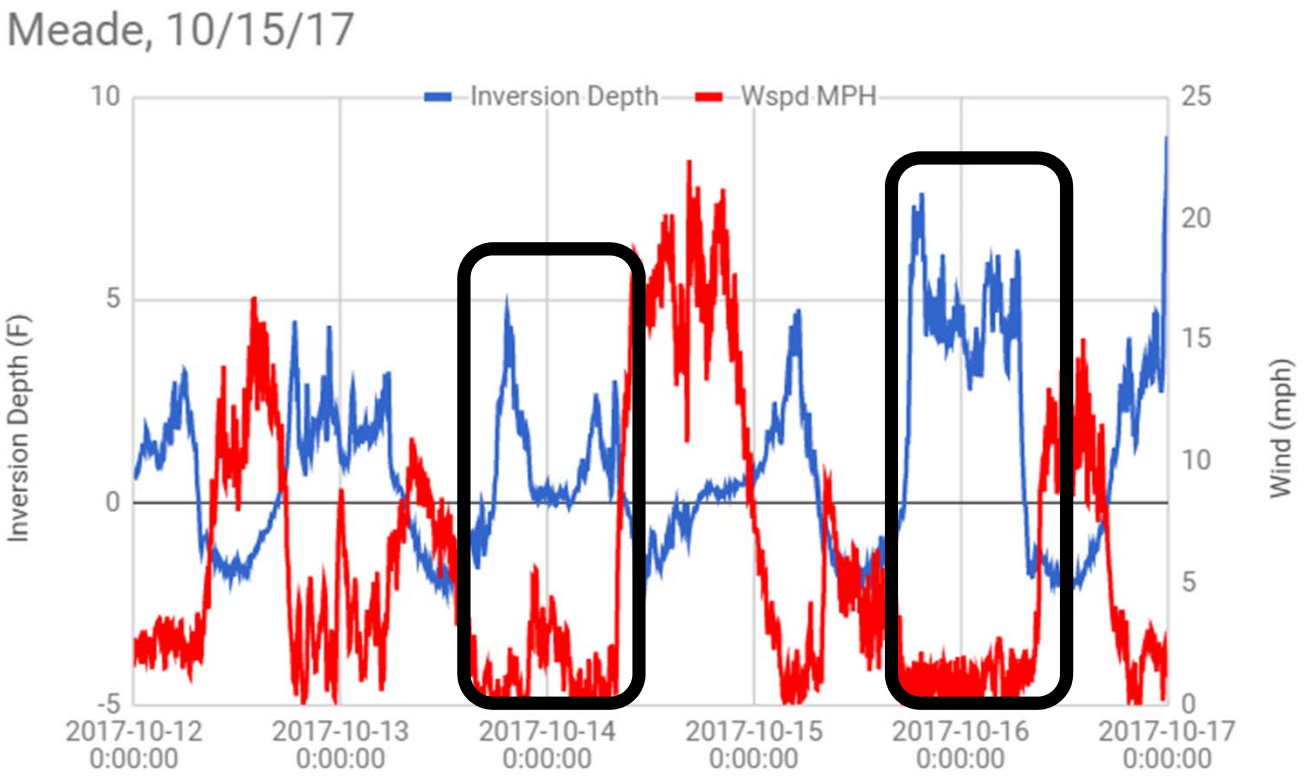

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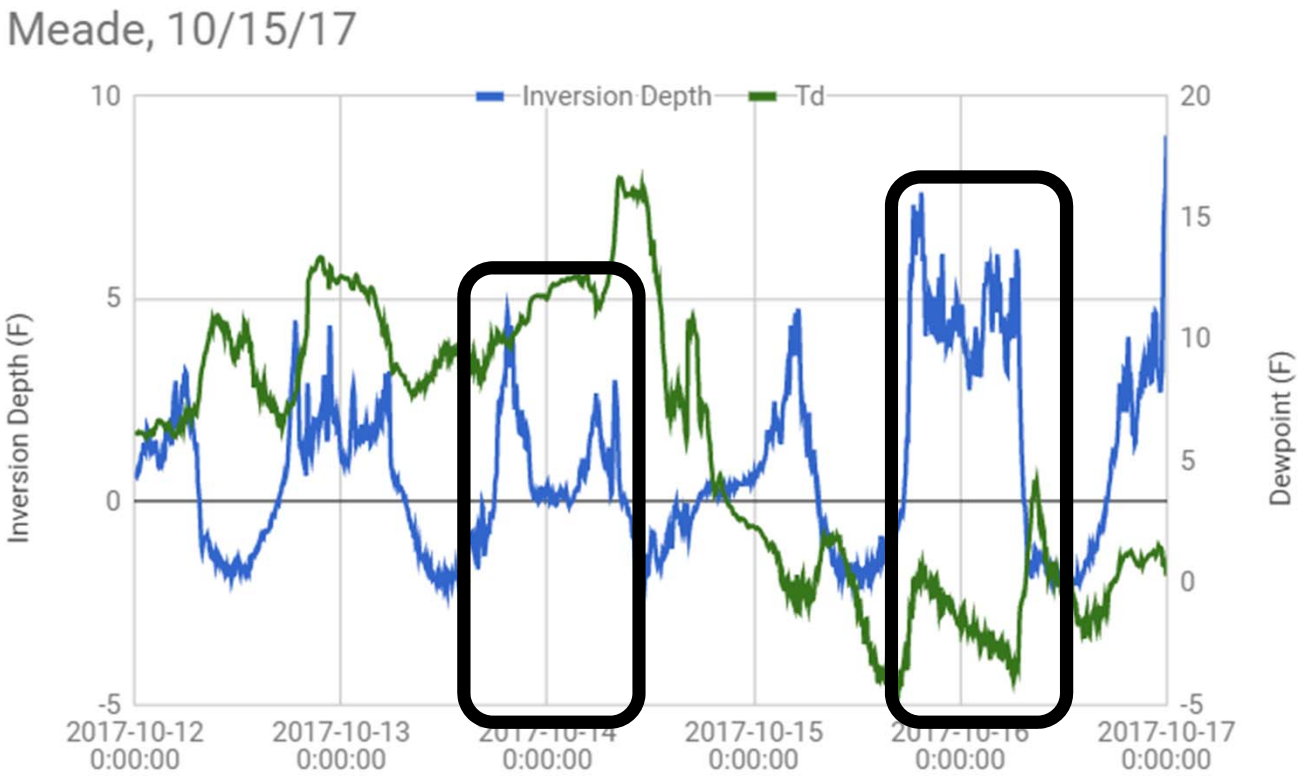

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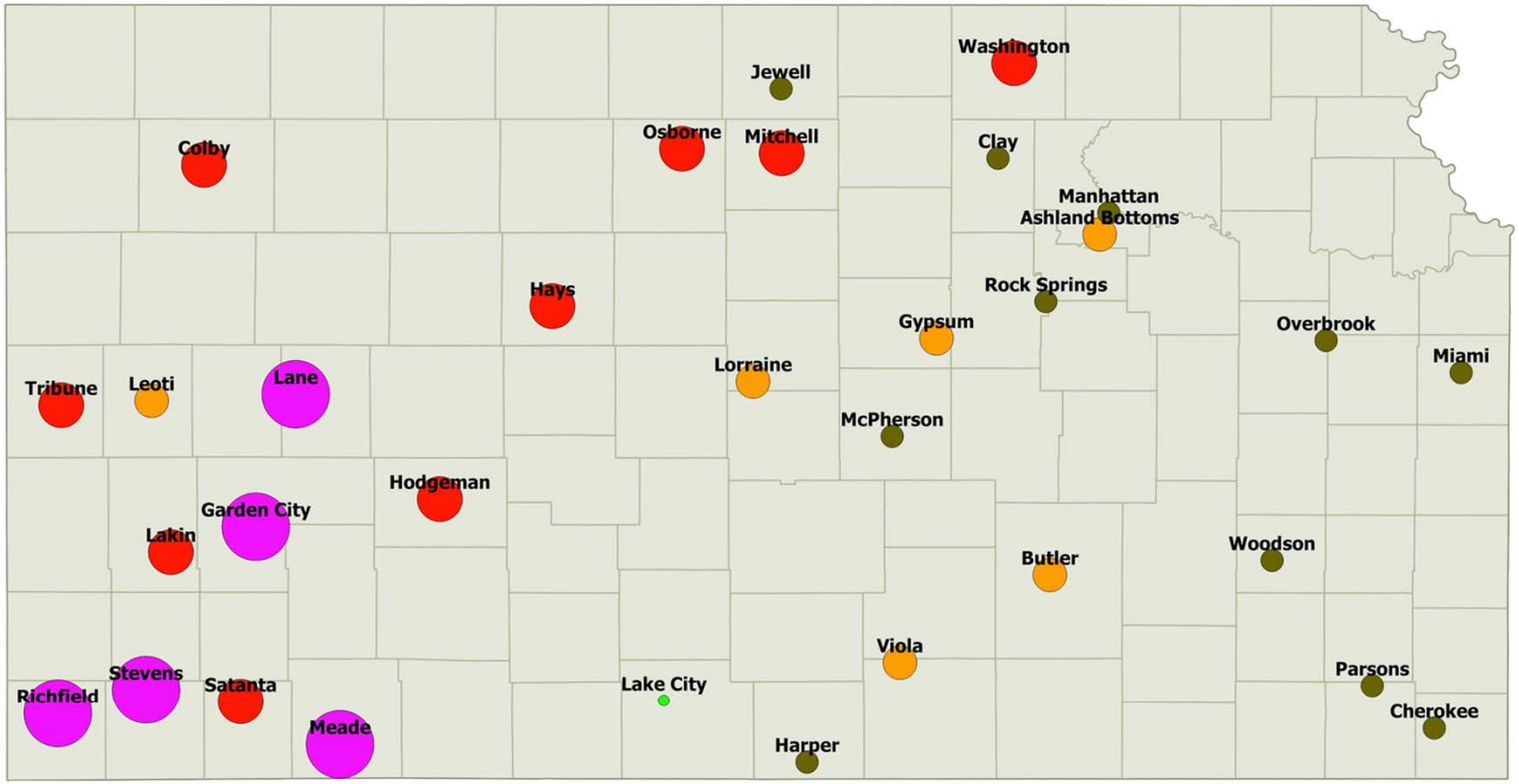
- Winds/clouds have significant impacts on inversions
- Daytime cloud cover can create weak inversions
- Windy conditions usually prevent inversion development at night
- Nearby locale has large influence on winds/temperatures
- Temperature/Dewpoint spread will often dictate inversion depth

Kansas Mesonet, Strongest Measured Inversion



Inversion Strength

- >= 12 F
- 10 - 11.9 F
- 8 - 9.9 F
- 6 - 7.9 F
- < 6 F

0 50 100 miles

North

Kansas State University, Kansas Mesonet
As of: 10/31/17
Created by: Christopher Redmond - Mesonet Manager
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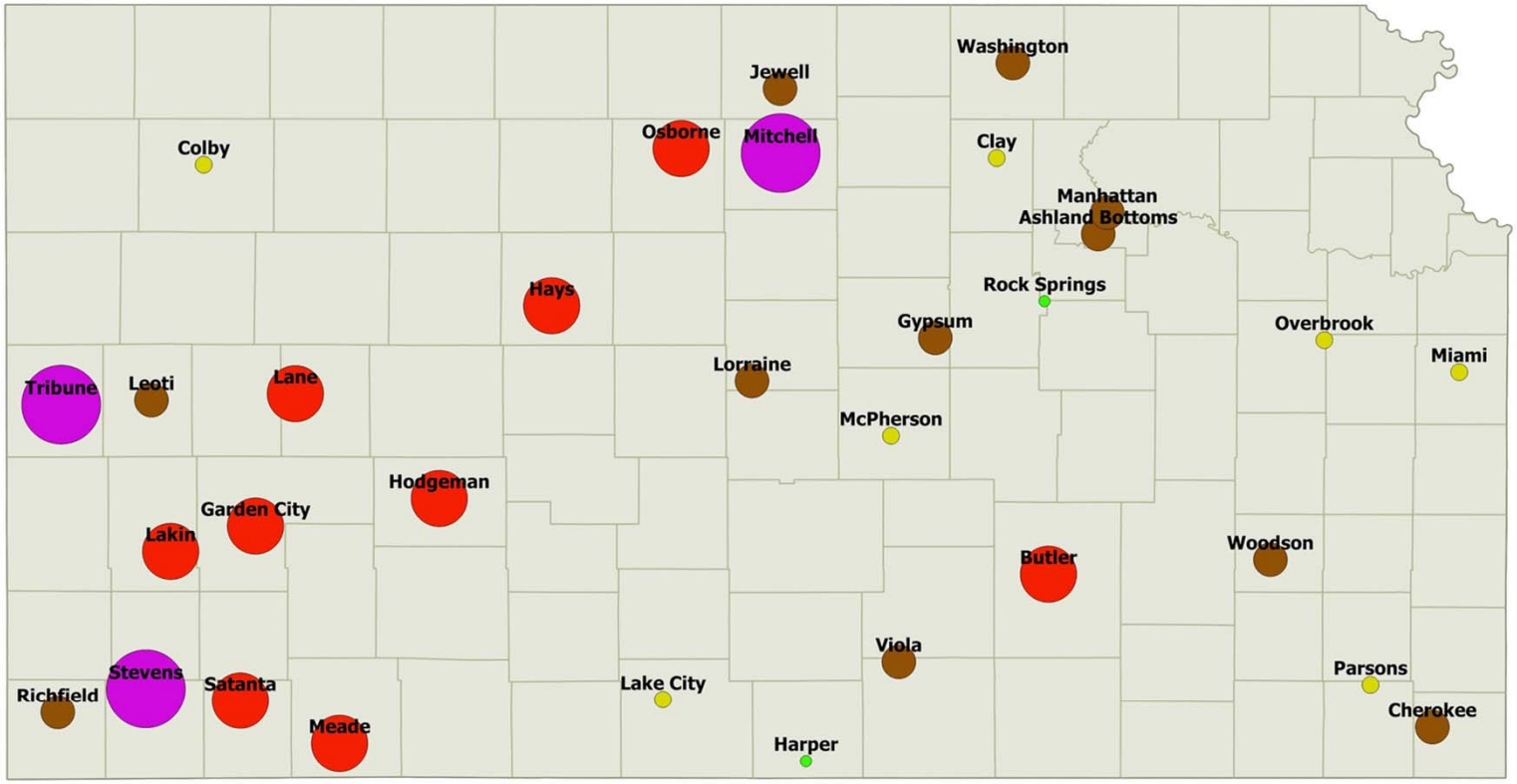
Kansas Mesonet, Average Inversion Maximum



Average Inversion Max (F)

- < 2.5 F
- 2.5 - 2.9 F
- 3 - 3.4 F
- 3.5 - 3.9 F
- >= 4 F

0 50 100 miles

North

Kansas State University, Kansas Mesonet
As of: 10/31/17
Created by: Christopher Redmond - Mesonet Manager
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mesonet.k-state.edu

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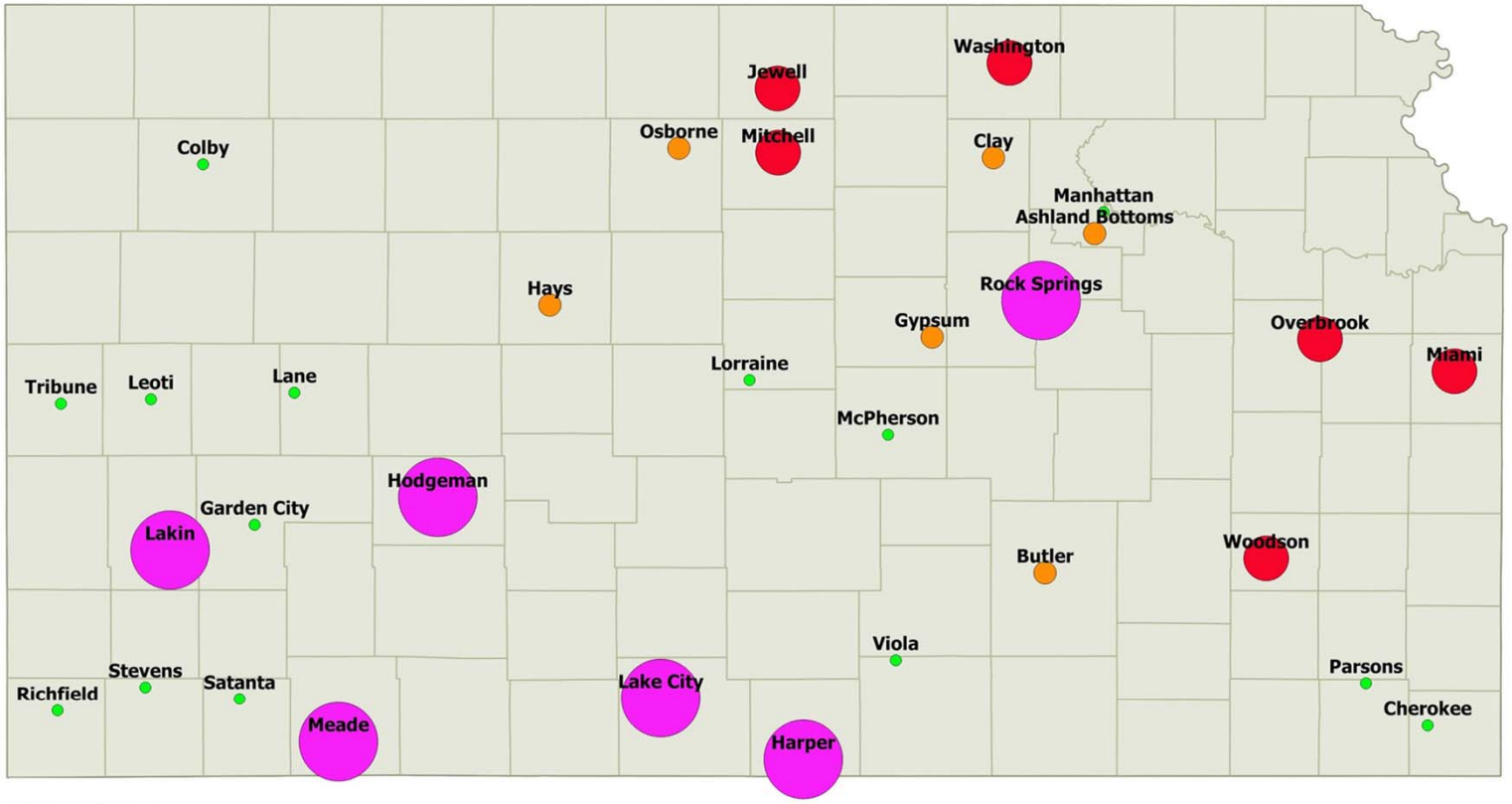
Kansas Mesonet, Change in Slope within 5 miles



Kansas State University, Kansas Mesonet
Slope data from NRCS Soil Survey
As of: 10/31/17
Created by: Christopher Redmond - Mesonet Manager
christopherredmond@k-state.edu
785-477-6204
mesonet.k-state.edu

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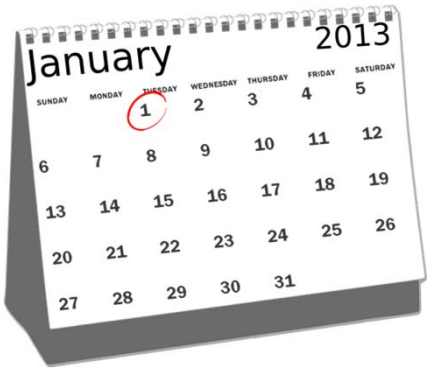
UNIVER

140 Days between June 1st - Oct 18

On average, 118 days had an inversion

Statewide, the mesonet averaged 22 days of 5F+

Each station averaged 2 days with 9F+ inversions



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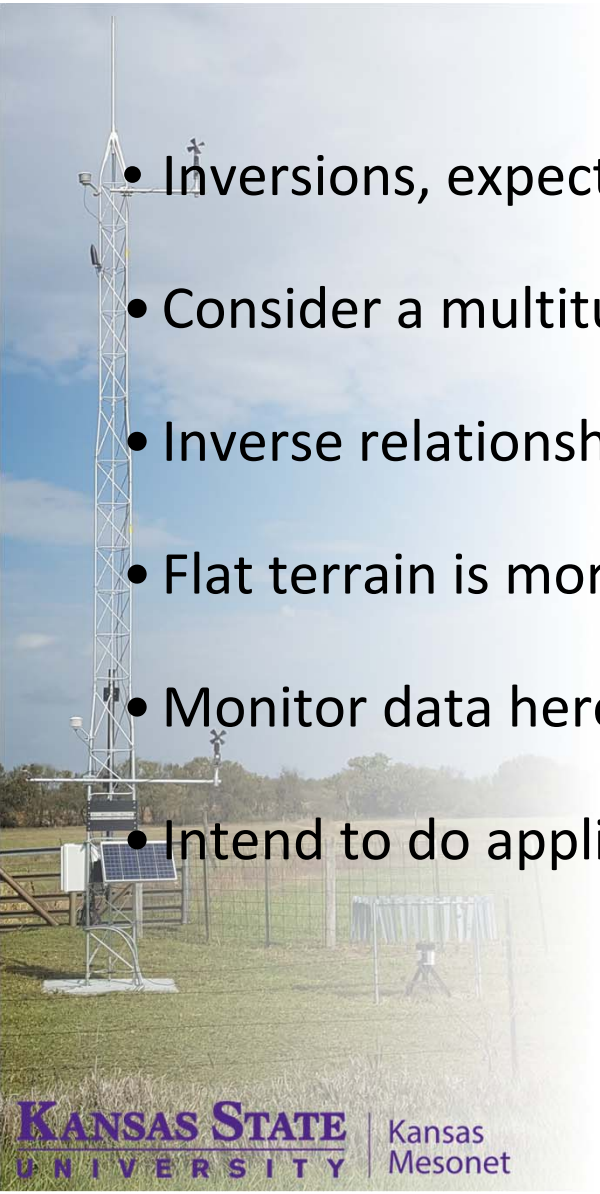
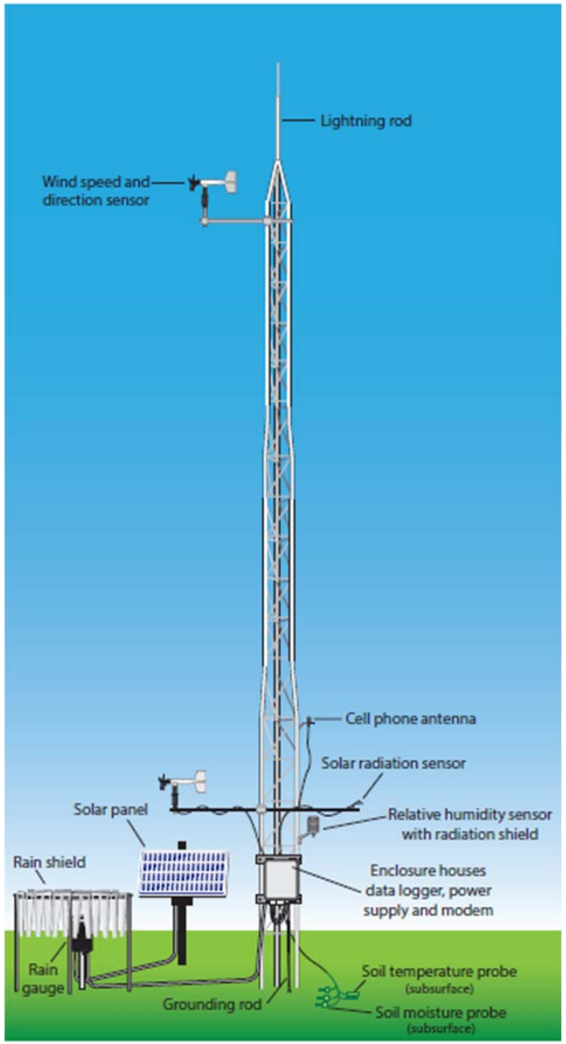


- Inversions, expect them at night
- Consider a multitude of micro-climate/synoptic influences
- Inverse relationship to wind
- Flat terrain is more vulnerable to deep inversions on the Mesonet
- Monitor data here: mesonet.ksu.edu/agriculture/inversion
- Intend to do application studies in the future

christopherredmond@ksu.edu

Twitter: @wx_chip



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Maintenance

- Twice yearly (fall/spring)
- Add'l visits as needed
- Real-time instrument comparison

Collaborate!

CHS

USDA NRCS
U.S. Department of Agriculture
Natural Resources Conservation Service

ESE Alcohol, Inc.
Bio-Refinery
Established1980

KANSAS EMERGENCY MANAGEMENT ASSOCIATION
KEMA

WSU
Wichita State University

KANSAS FOREST SERVICE
KANSAS STATE UNIVERSITY

KU

NATIONAL WEATHER SERVICE

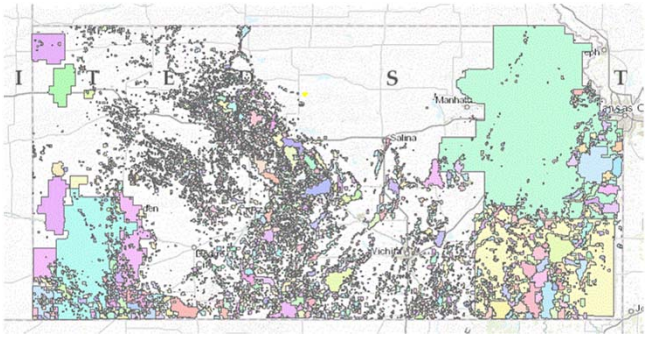
KANSAS WHEAT

Southwest GMD3

AD ASTRA PER ASPERA
Kansas
Water Office

KANSAS CORN

KANSAS LIVESTOCK ASSOCIATION



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Long term goals

- SUSTAINABILITY
- Greatly enhance QC
- Recognition within the state
- Strengthen usability for water sustainability in KS
- Expand network to all counties (105)
- Self-sustained budget

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