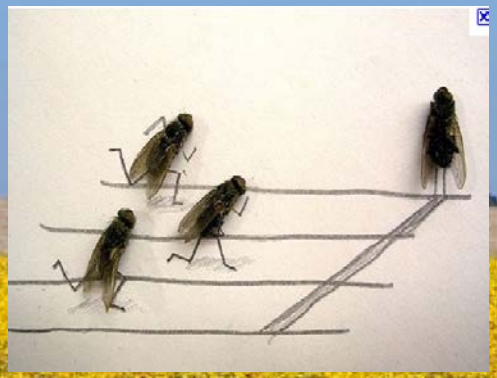
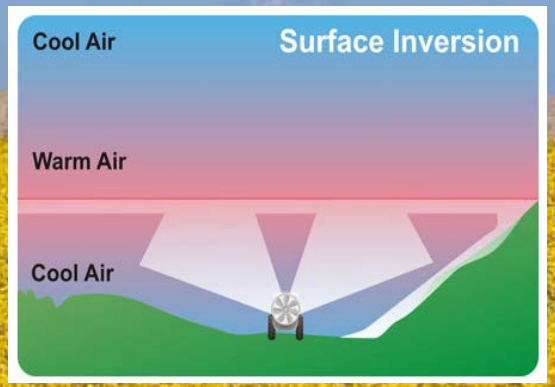
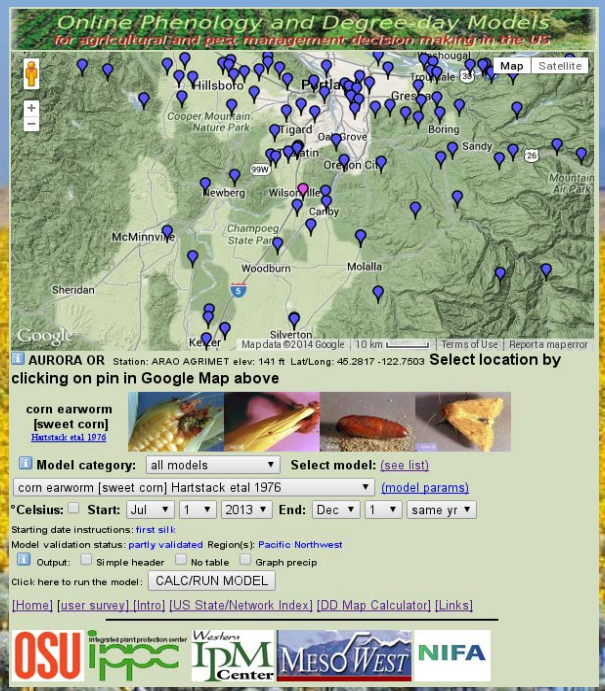
Weather models and Predictive Tools for IPM

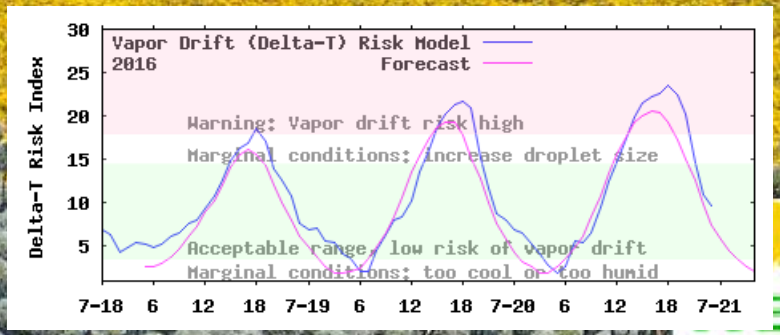
Len Coop, Oregon State University, Integrated Plant Protection Center

Nov. 30, 2017









ESTERN REGION
Pest Management Center

Ag Weather Net
Center for Precision Agricultural Systems

WASHINGTON STATE UNIVERSITY

UCDAVIS

UC IPM

NPDN
National Plant Diagnostic Network

CSREES
EDUCATION
RESEARCH
EXTENSION
USDA

USDA ARS

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

integrated plant protection center

OSU
Oregon State
UNIVERSITY

PRISM
GROUP

FOX WEATHER LLC

FieldWise

Topics for today's session:

- Phenology and degree-day concepts

- Some features of the IPPC "Online weather data and degree-days" website at uspest.org/wea

- Using the extended climate forecast with degree-day models

- A focus on thermal or vapor pesticide drift

- How to set up uspest.org/wea “MyPest Page” to forecast drift conditions

Typical IPM questions/tools:
(Leading up to the decision to treat)

- "Who?" and "What?"

Identification keys, diagnostic guides, management guides

- "When?"

Phenology/degree-day models (crops, insects, weeds), Risk models (plant diseases)

- "Wait: how many and If?"

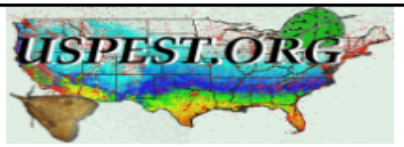
Sweep nets, pheromone traps, economic thresholds, sampling calculators.

- "Where?"

GIS, precision agriculture

http://uspest.org/wea

MyPest Page -
IPM Pest and Plant Disease Models and Forecasting



for Agricultural, Pest Management, and Plant Biosecurity Decision Support in the US

Introduction | Quick Start | Map Index | Shortcut Links | Degree-day Maps

Introduction:
This website brings together US weather data and plant pest and disease models to serve many decision support needs in agriculture. Currently this site provides over 73 degree-day and 18 hourly weather-driven models serving many IPM, regulatory, and plant biosecurity uses for the full USA, and specializes in IPM needs for the Pacific Northwest.

Weather data and forecasts are currently linked to the models for over 15,000+ US and nearby weather locations. Forecast sources include NWS Digital forecasts in all states, Fox Weather LLC forecasts in OR, WA, ID, W. MT, and CA, and NWS Zone forecasts for all US regions (max-min forecasts).

Funding has been provided by numerous USDA NIFA grants, USDA RMA ipmPIPE grants, NPDN grants, WR-IPM Center and Oregon Statewide IPM funds, and local and regional commodity grants.

Online Survey:
Please fill out our brief end-user survey! This site is free - please provide us feedback!

Additional Resources: Try this page if Tabs fail to work on your browser
- What's new
- Online tutorials
- Pacific NW interface to degree-day models and calculations
- Degree-day usage instructions
- Technical documents - how to customize settings for: webpage bookmarks and pest model charts and tables for mashups - NEW 4/22/2011
- Frequently asked questions
- Related web sites
- Full station list

Presentations:
- 09/06 Grower network support - slideshow
- 06/08 IPM Tools in Real Time

Zone forecast: NWS forecasts enter **Place, State** or **Zipcode**: GO

integrated plant protection center IPPC OSU | PRISM | Western IPM Center | ipmPIPE | NPDN National Plant Diagnostic Network | NIFA

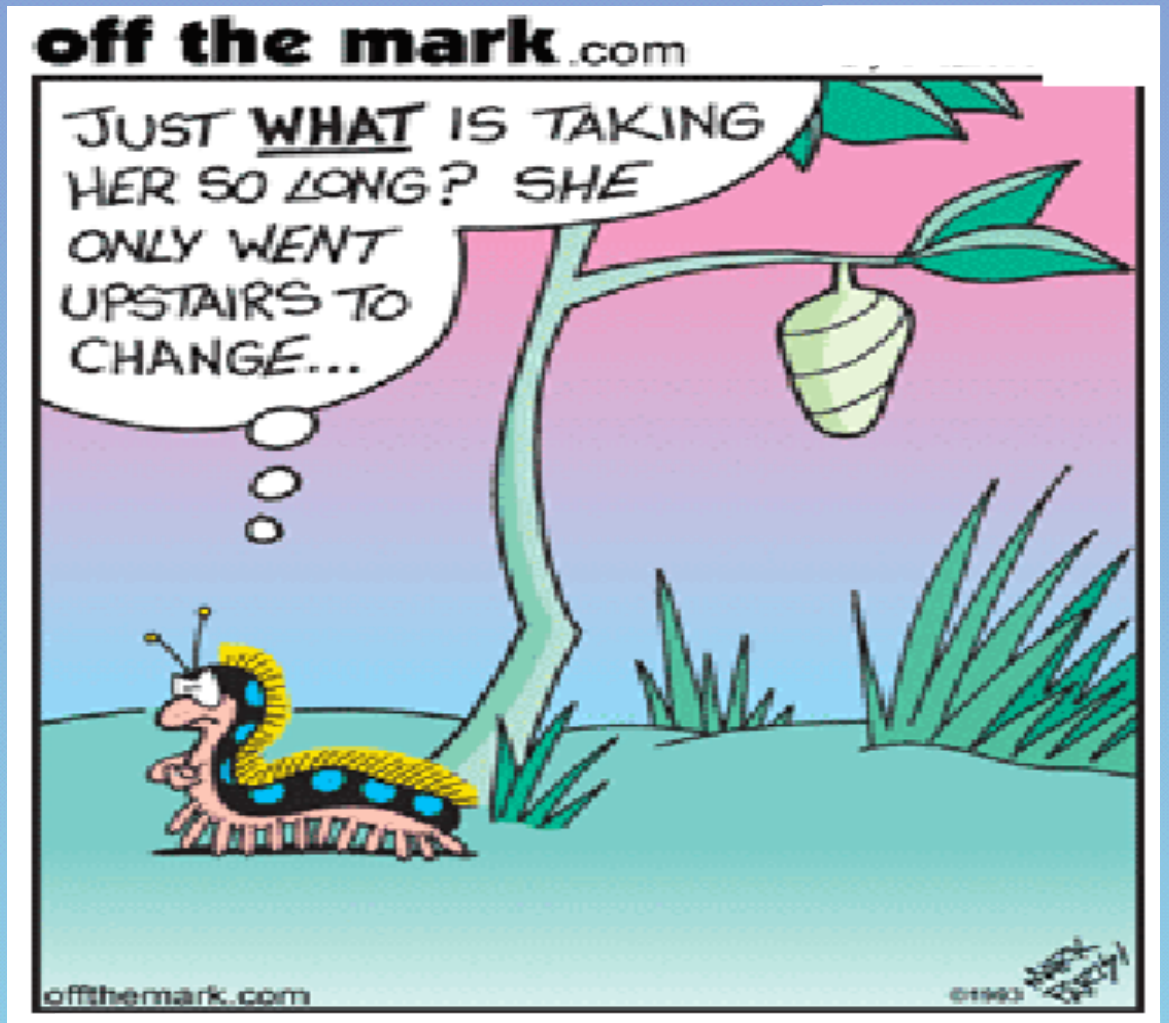
Phenology and degree-day concepts

- Phenology: the study of how organisms develop through stages over time.

- Degree-days: A simple heat unit method for recording physiological time used to represent development of many plants and animals that do not self regulate temperature

- Degree-day models are in common use for timing of sampling and management events in agriculture; a cornerstone of IPM

What to know about degree-days: Insects have complex life cycles

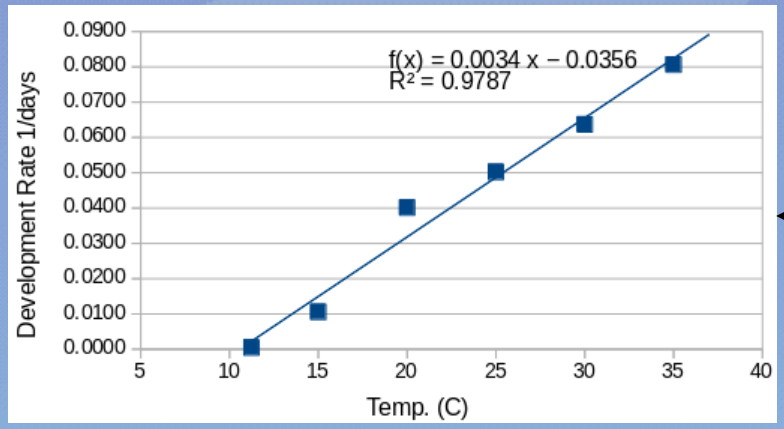


Eggs
Larvae
Pupae (most)
Adults

-Timing of all stages ***is often*** predictable using degree-days, which are a two dimensional “Heat Unit“ of development for cold blooded organisms

Degree-day Concepts

Lower and upper developmental thresholds



Typical Temperature – Development Rate response curve used to build degree-day models

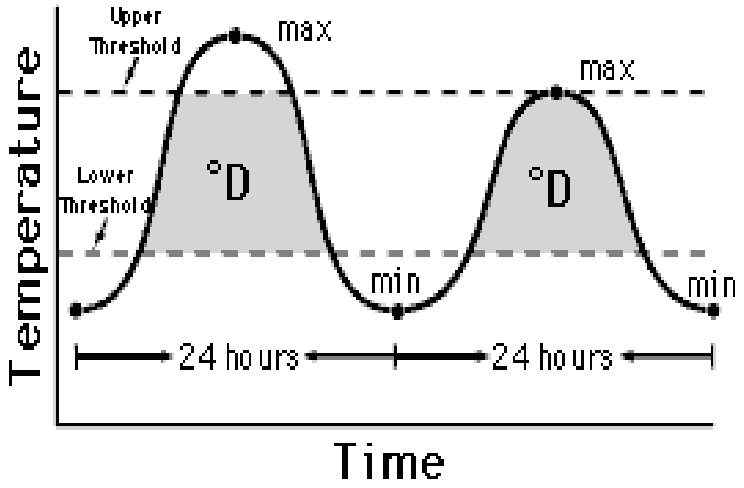
- Lower threshold: the temperature below which development stops
- Upper threshold: the temperature above which development is reduced according to the cutoff method
  - Horizontal cutoff method: assumes development does not stop but does not continue to accelerate with even higher temperatures
  - Vertical cutoff method: assumes development stops altogether above this temperature

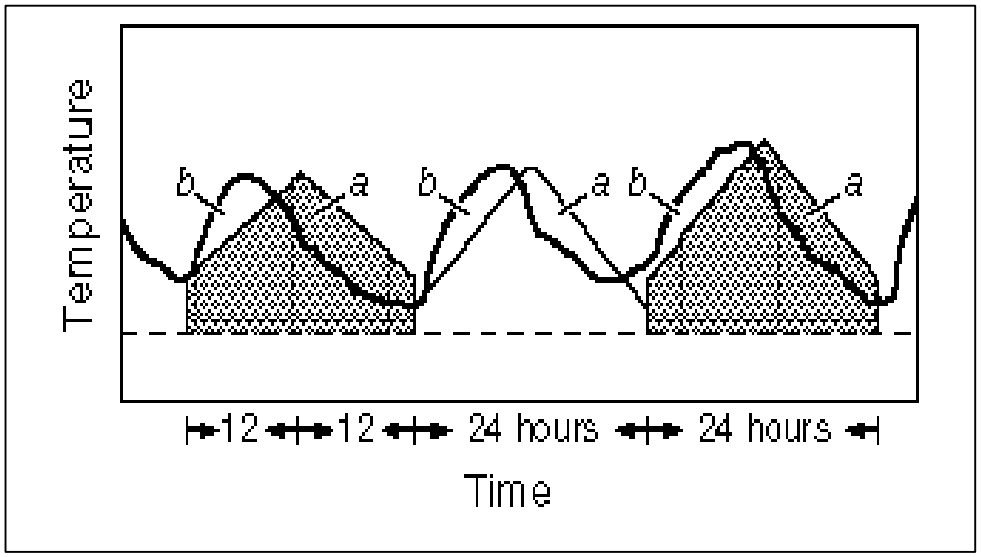
Types of degree-days

Used for insects, plants, plant diseases, other uses

- Simple average/growing degree-days for most except corn:
= daily (Tmax+Tmin)/2 - lower threshold
(use a more complex equation if there is an upper threshold)
- Single and double triangle: simple geometric equation (the latter uses tonights min for second half of today)
- Single and double sine curve: more complex use trig functions
- Growing degree-days for corn: use simple average but substitute the lower threshold in place of daily Tmin (if Tmin is lower), substitute the upper threshold in place of daily Tmax (if Tmax is higher)
- Heating and Cooling degree-days: used by the power industry

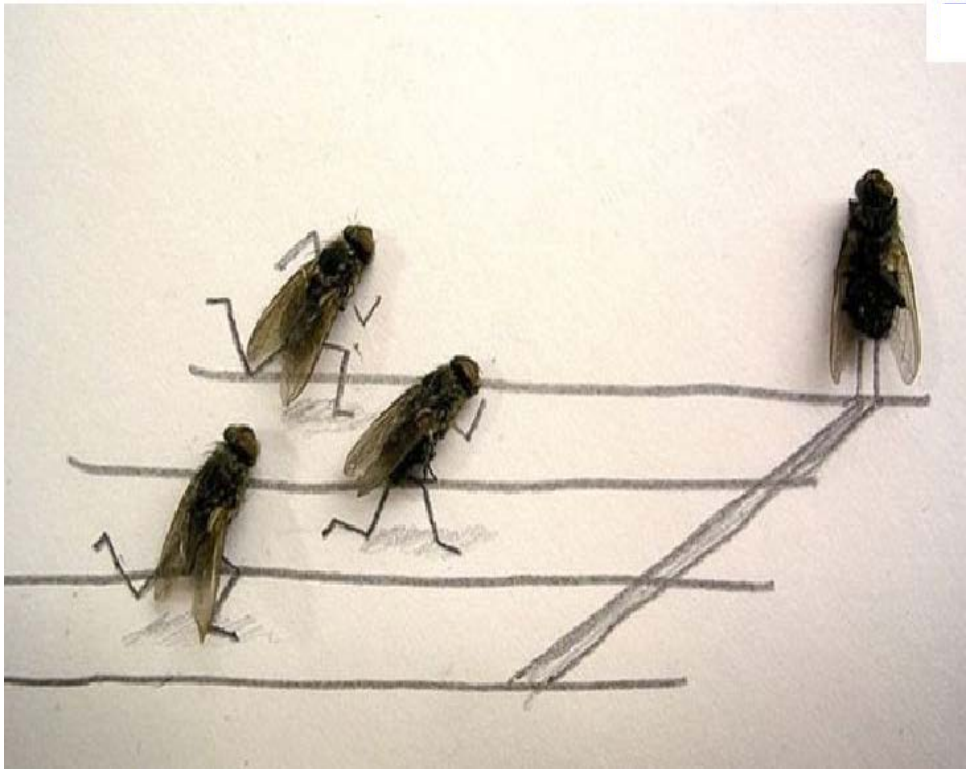
Degree-day calculations – all attempt to Integrate temperature over time





Single triangle compared with typical daily fluctuation

Look at that first one fly!



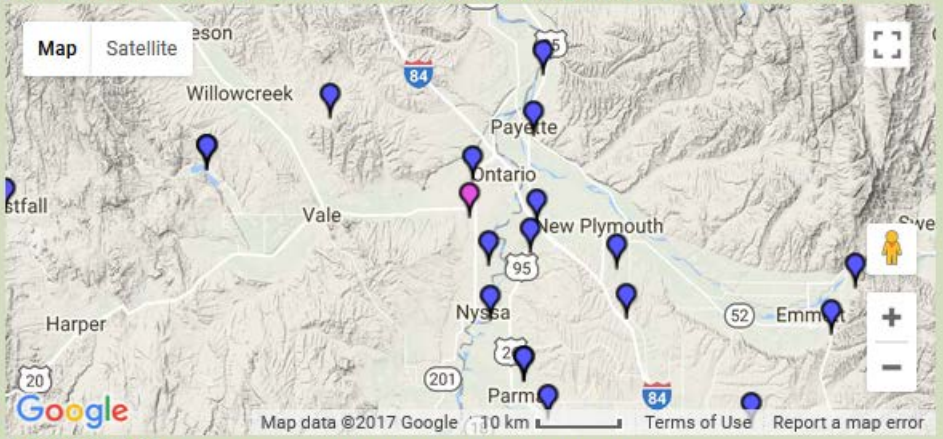
Comparison of Degree-Day Calculation Methods

e. g. codling moth (Tlow=50, Tupper=88, method=s. sine, biofix to egg hatch=250 DDs)

Online Phenology and Degree-day Models

for agricultural and pest management decision making in the US

Weather station map: pan, zoom and click on pin (red pin shows current location):



ONTARIO OR station: ONTO AGRIMET elev: 2260 ft lat/long: 43.9778 -117.0153

codling moth [apple & pear]

Brunner and Hoyt (1987)

Model category: apple and pear

Model: codling moth [apple & pear] params

Start: (starting date based on: first consistent capture of moths in pheromone traps)

Apr | 20 | 2017 **End:** May | 31 | same year

Forecast type: after 7day use NMME extended seasonal forecast

Output: Condensed: yes **Show Daylength:** yes **Critical Daylength:** 12.0

Click here to see full model output

Output preview: show 4 **future events:**

Weather station **QA score 0.99; 0 days missing**

Date	Days from today	DDs	Event
Sep 2	89 days ago	2620	3RD GENERATION, 50% EGG HATCH

Comparison of Degree-Day Calculation Methods

e. g. codling moth (Tlow=50, Tupper=88, method=s. sine, biofix to egg hatch=250 DDs)

Method	Degree-Days 4/20/17 to 5/26/17
Single Sine (codling moth default)	253
Double Sine	248
Single Triangle	237
Double Triangle	232
Simple Average (GDD)	201
Corn GDD	299

Degree-day Modeling Concepts

- Work best in temperate regions for populations that have relatively few, non-overlapping generations

- Degree-day models: accumulate a daily "index of development" (DD total) until some event is expected (e.g. egg hatch)

- DD models often require a "biofix" - biological monitoring event used to initialize the model

Weather and Degree-day Concepts

1) Degree-day models: accumulate a daily "heat unit index" (DD total) until some event is expected (e. g. egg hatch)

Eggs start developing: 0 DDs

cumulative: 20 38 70 84 106 126 152

daily: 20 18 32 14 22 20 26

$70^{o(avg)} - 50^{o(threshold)} = 20^{DD}$

Eggs hatch: 152 cumulative DDs

MyPest Page - IPM Pest and Plant Disease Models and Forecasting

for Agricultural, Pest Management, and Plant Biosecurity Decision Support in the US

uspest.org/wea

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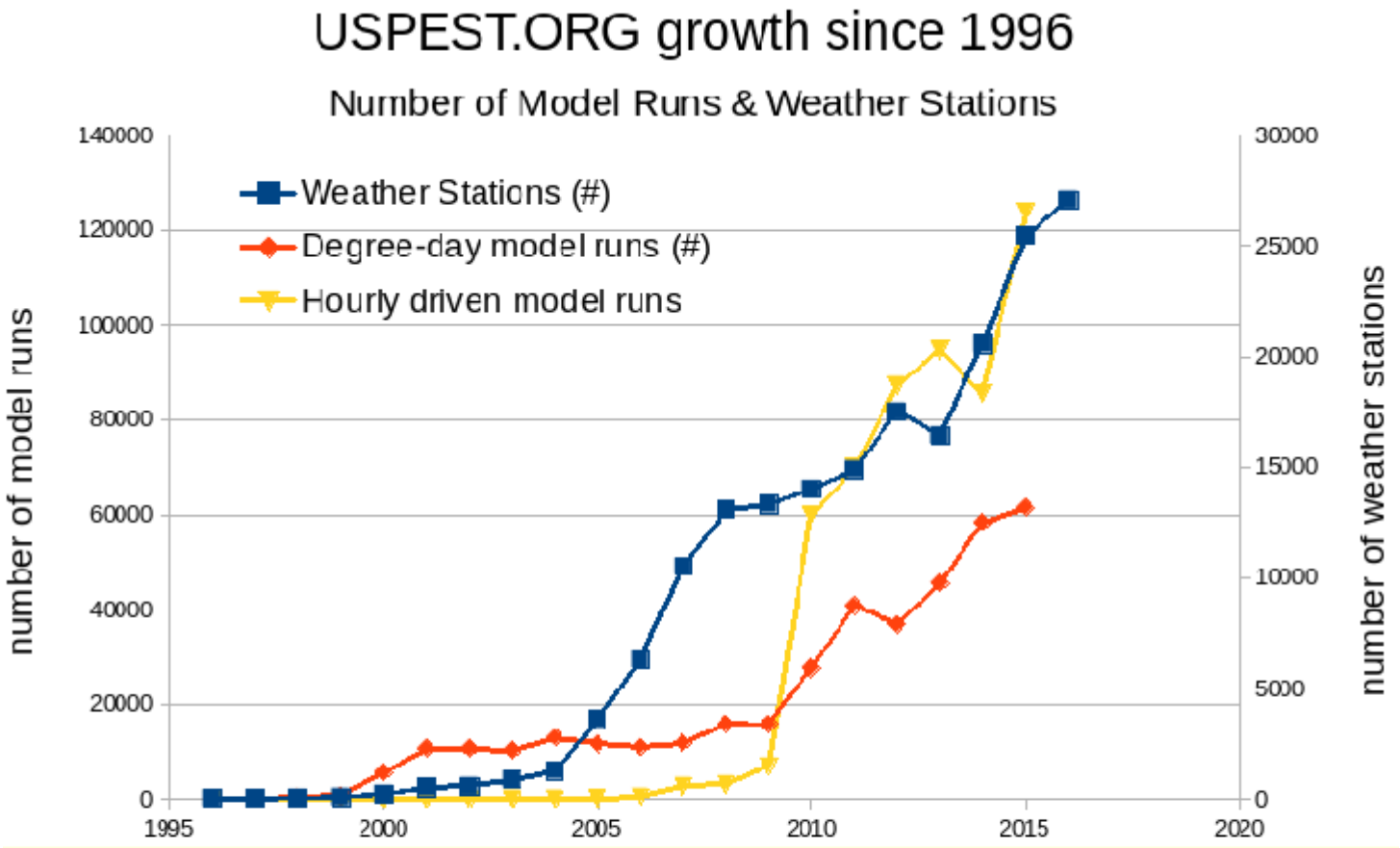
4. Systems modeling of crop and insect development for agricultural decision support OSU Horticulture Seminar, Corvallis, OR Nov. 2017 (60 min. video)

Partners and Support:

We are actively collaborating and partnering with Fox Weather, LLC and the National Weather Service for forecasts, with the OSU PRISM Climate group for climate data, with the W. Region IPM Center as a Signature Program, and with numerous state and private IPM decision support programs and entities. Funding has been provided by numerous USDA NIFA grants, USDA PPQ, RMA and ipmPIPE grants, NPDN grants, WR-IPM Center and Oregon Statewide IPM funds, and local and regional commodity grants.

integrated plant protection center IPPC OSU | PRISM GROUP | Western IPM Center | ipmPIPE | NPDN National Plant Diagnostic Network | NIFA

Increases in online access to Degree-Day models



USPEST.ORG has had steady increases in number of models, weather stations, and networks over the past 20 years, while the number of phenology (DD) and disease risk model runs has increased significantly especially over the past 8 years with full US coverage (27,000+ weather stations).

Online Phenology and Degree-day Models
for agricultural and pest management decision making in the US

Weather station map: pan, zoom and click on pin (red pin shows current location):

Rutherfordton Rutherfo NC station: KFQD METAR elev: 1079 ft lat/long: 35.4281 -81.9350

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Forecast type: after 7day use NMME extended seasonal forecast

Output: **Condensed:** no **Show Daylength:** yes **Critical Daylength:** 12.0

Click here to see full model output

Output preview: show 4 **future events:**

Weather station QA score 1.00; 0 days missing

Date	Days from today	DDs	Event
Jan 1	20 days ago	0	Model Start
Apr 4	73 days away	250	1ST GENERATION, 3% EGG HATCH
Apr 16	85 days away	360	1ST GENERATION, 20% EGG HATCH
Apr 28	97 days away	484	1ST GENERATION, 50% EGG HATCH
May 7	106 days away	610	1ST GENERATION, 75% EGG HATCH

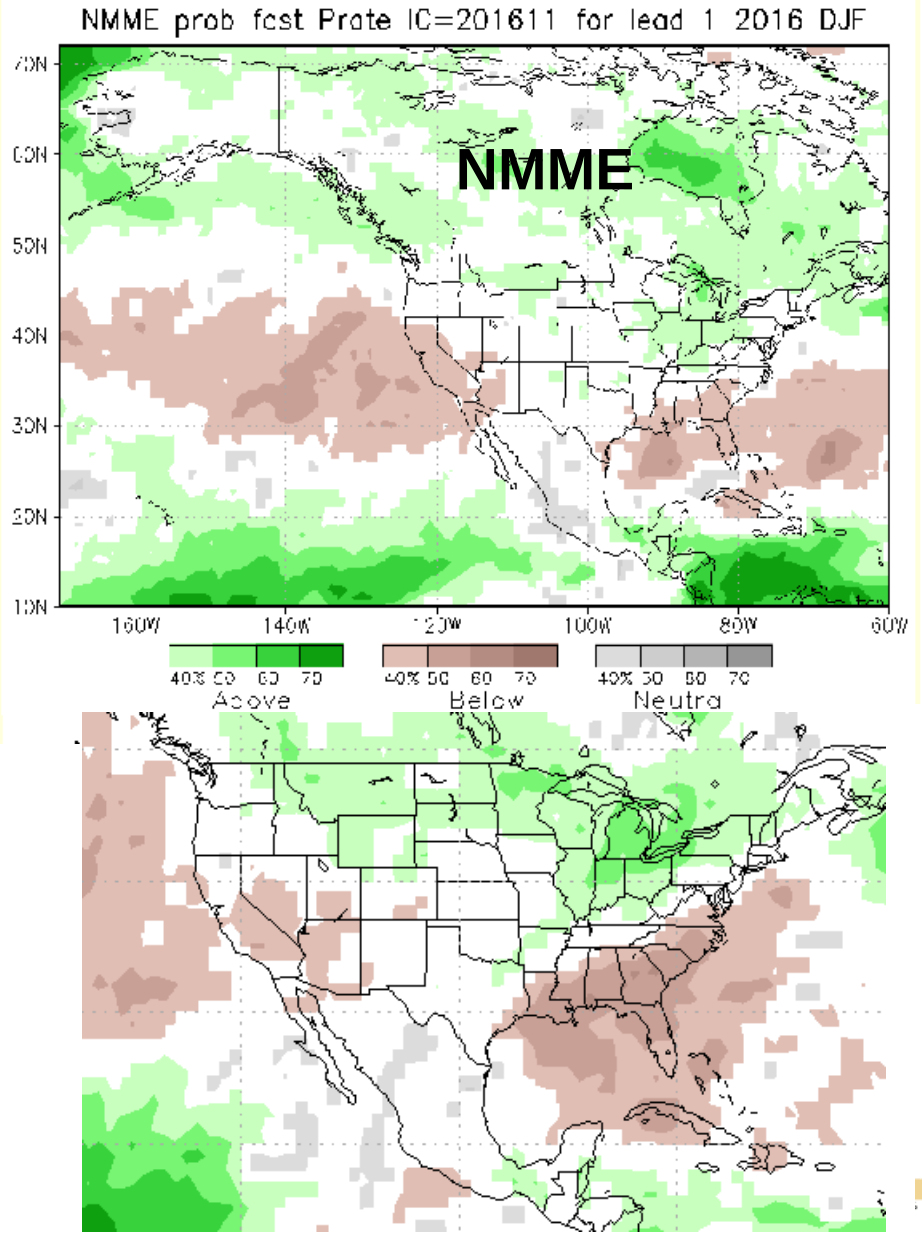
Degree-day Models – New Features w/ uspest.org/dd/model

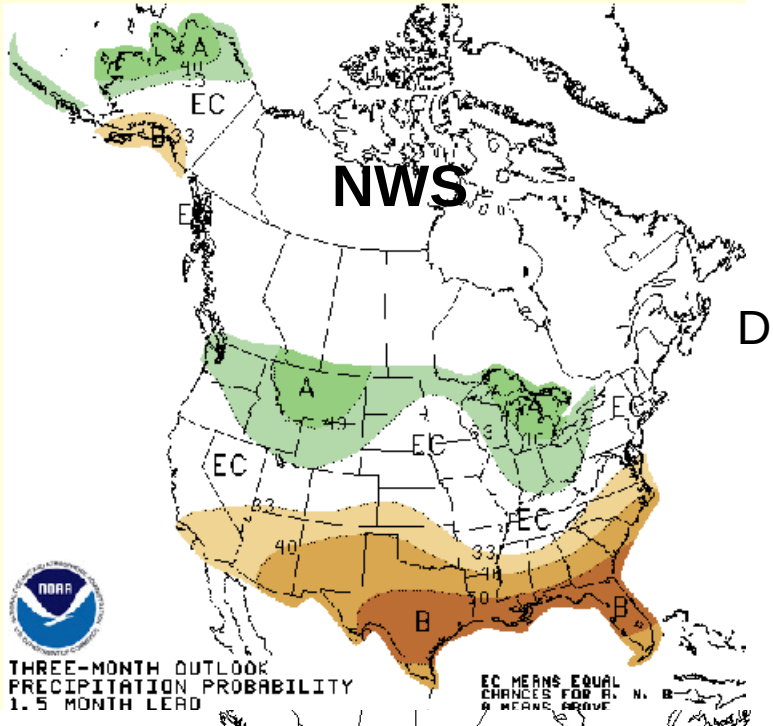
Degree-day Models – New Features w/ uspest.org/dd/model:

New Extended Seasonal forecasts - Thanks to NMME

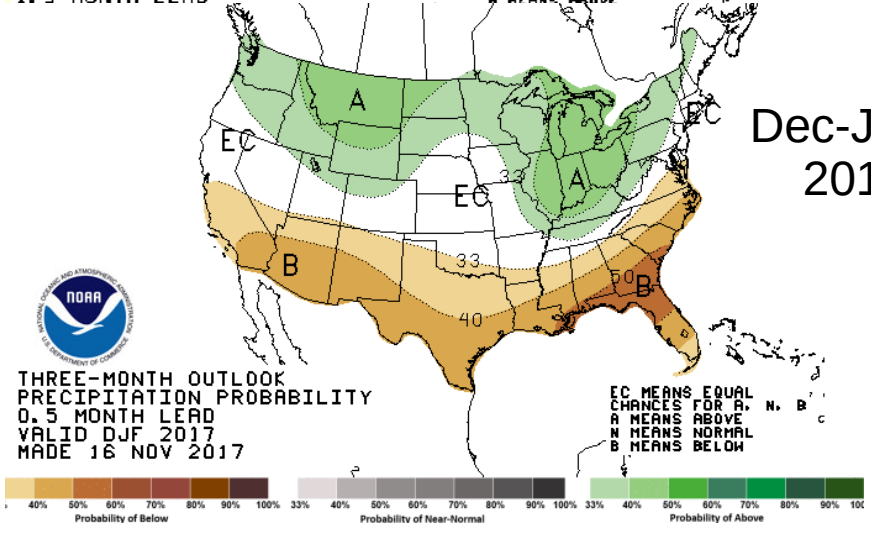
What is NMME anyway?

NMME: North American Multi-Model Ensemble – is an ensemble of 7 leading US and Canadian seasonal climate models from climate science centers such as NCEP, NCAR, NASA, CMC, and GFDL. NMME is the only system with a strict protocol that openly provides real-time climate forecasts and hindcasts for research and applications. OSU IPPC found a good similarity of predictions made by NMME and the official NWS extended outlook products. Examples for Dec-Jan-Feb:





Dec-Jan-Feb
2016-17



Dec-Jan-Feb
2017-18

Climate Prediction Center

Home | Site Map | News

HOME > Expert Assessments > ENSO Diagnostic Discussion

EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION

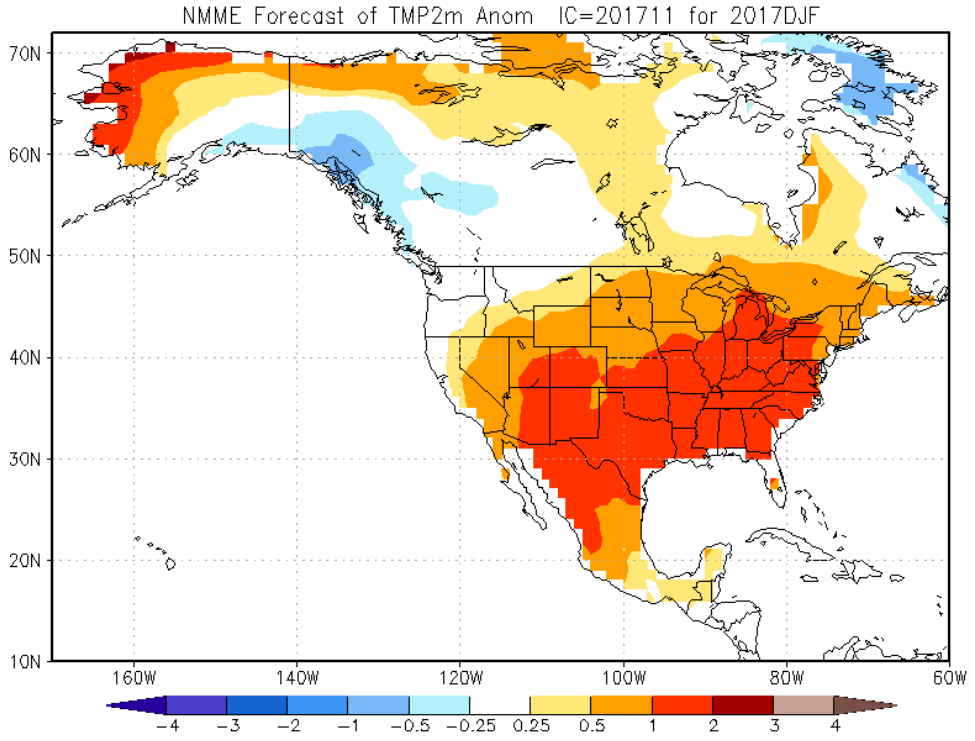
issued by
CLIMATE PREDICTION CENTER/NCEP/NWS
and the International Research Institute for Climate and Society
09 November 2017

ENSO Alert System Status: La Niña Advisory

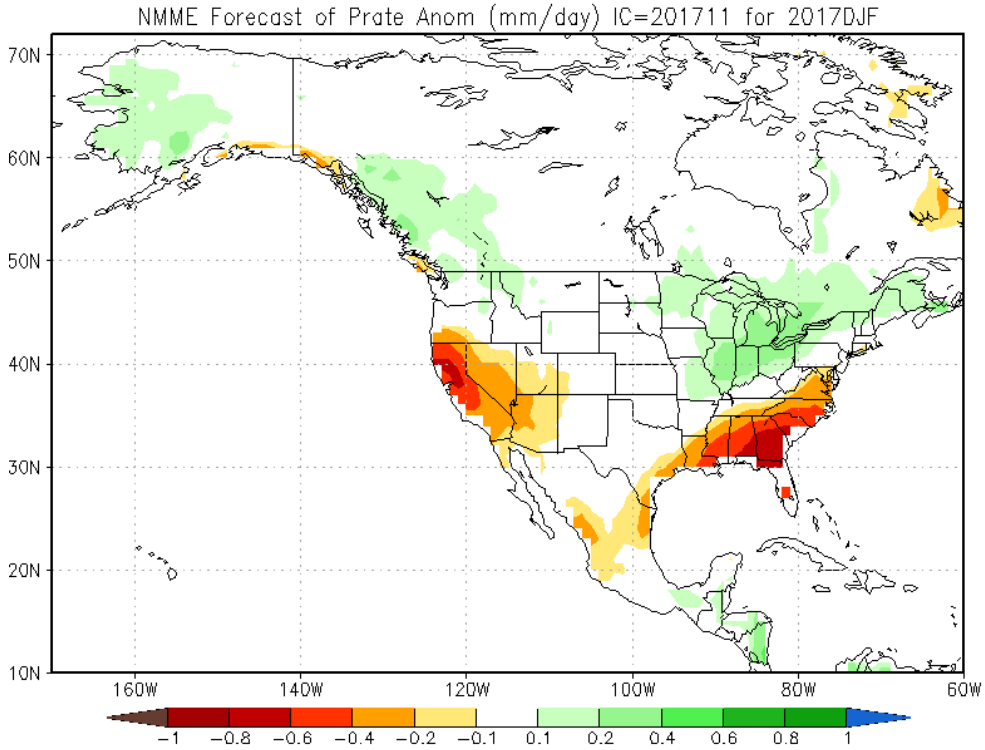
Synopsis: **La Niña conditions are predicted to continue (~65-75% chance) at least through the Northern Hemisphere winter 2017-18.**

La Nina Again!

Temperature anomalies Dec-Jan-Feb 2017



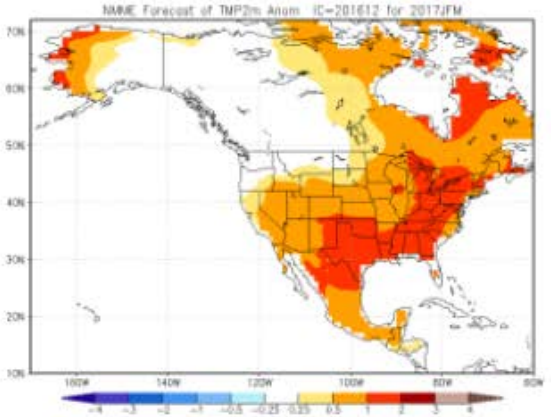
Precipitation anomalies Dec-Jan-Feb 2017



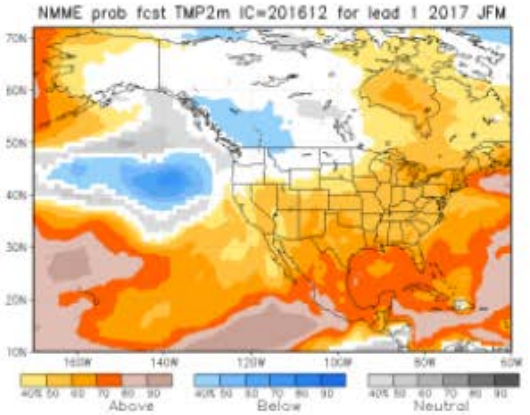
NMME Forecast Verifications Available: Example for Jan-Feb-Mar 2017 Temperatures

Season 1 tmp2m forecast

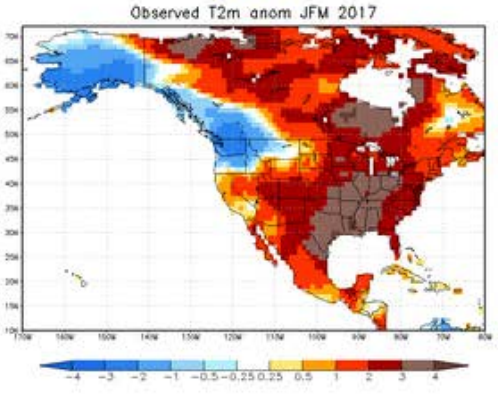
NMME



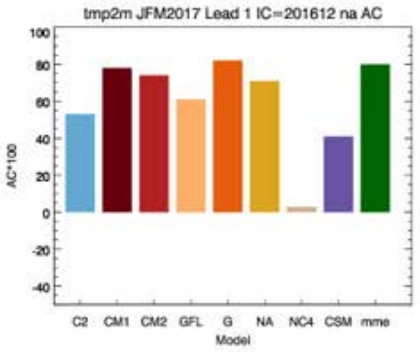
Prob fcst



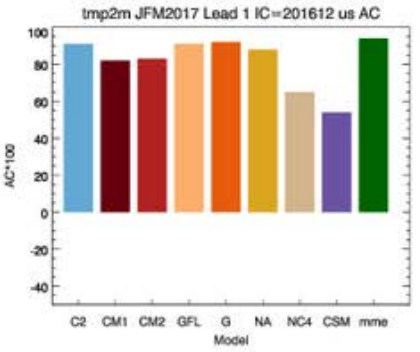
OBS



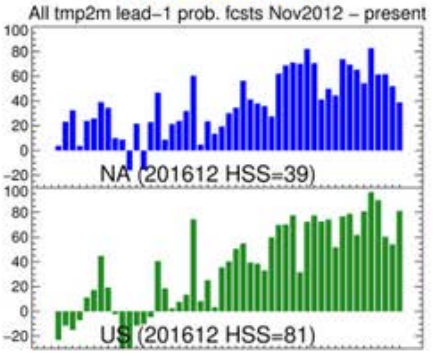
North Amer. AC



CONUS AC



Heidke SS



brown marmorated stink bug [multiple] invasive insect model of Nielsen etal 08

Output (condensed) from uspest.org/wea insect degree-day/phenology model program:
Heat Units and predictions of key events from daily weather data

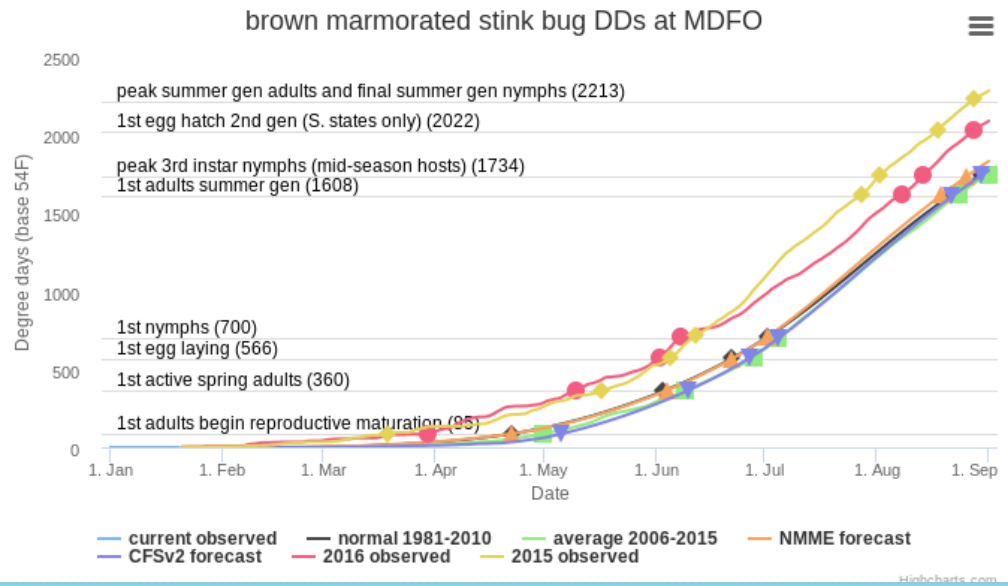
MODEL INPUTS

Model species/general links	brown marmorated stink bug [multiple]
Type	invasive insect
Model source/other links	Nielsen etal 08
Calculation method	single sine curve
Lower threshold	54 degrees Fahrenheit
Upper threshold	92 degrees Fahrenheit
Directions for starting/BIOFIX	calendar date
Starting date(s)	1-1 2017
Ending date	9-1
Model validation status	under development - new invasive species
Region of known use	data collected in PA
Extended forecast type	After 7 days, use 7-month NMME based seasonal climate forecast
Short day critical day length (hr)	12.0
Day length < critical value indicator:	**

MODEL OUTPUT

Weather station: 2017 MDFO Agrimet MEDFORD OR Lat:42.3308 Long:-122.9378 Elev:1339 QA score: 1.00

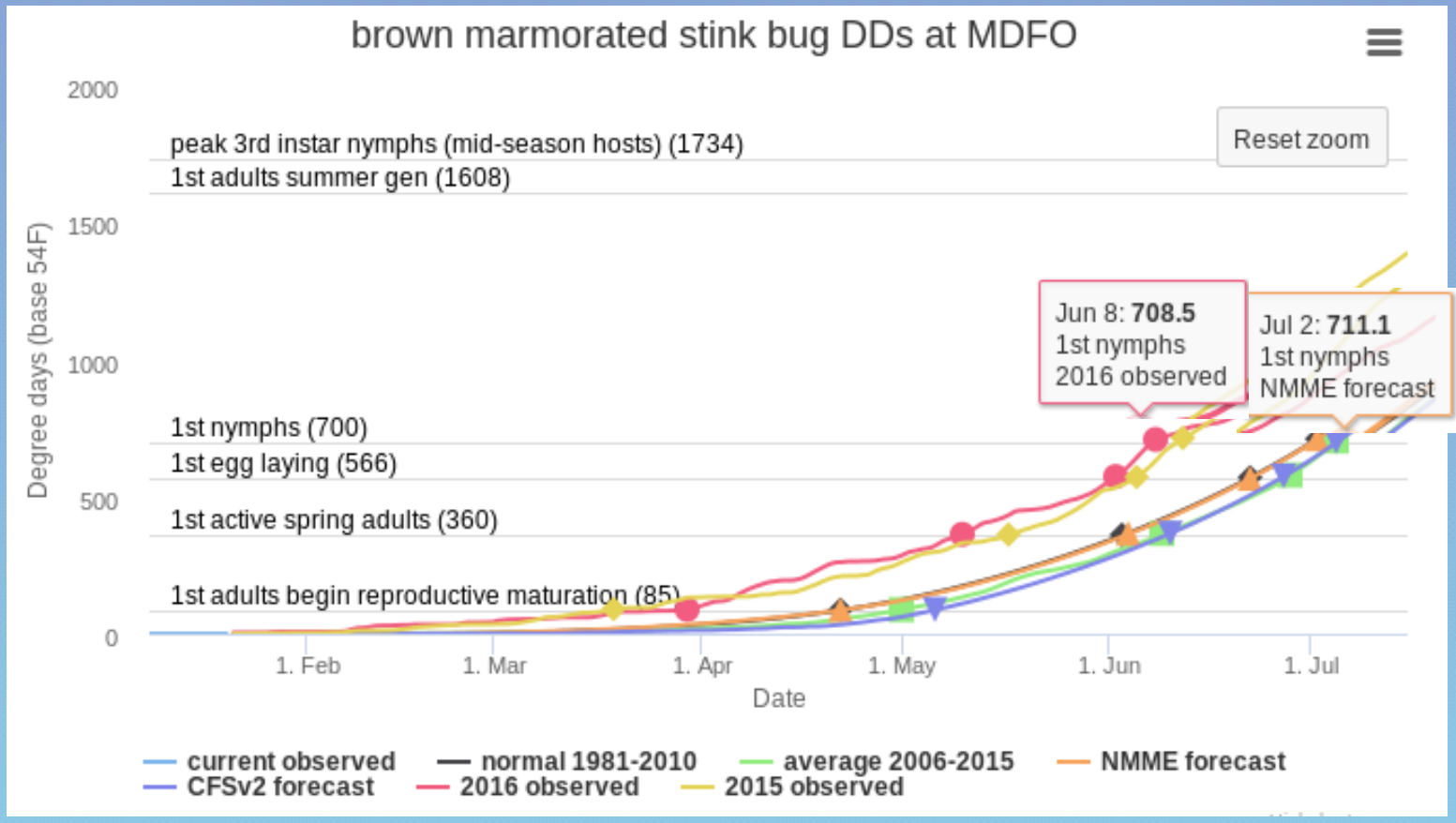
Month	Day	Max	Min	Precip	DDs Today	Day length (hr)	QA + Notes	Starting 1-1	
								Cumu. DDs	Model Events
1	1	35.8	25.4	0.09	0.0	9.5		0	* START *
4	22	65.1	39.9	0.036	3.3	13.9	NMME	87	1st adults begin reproductive maturation
6	4	76.7	47.9	0.026	9.5	15.5	NMME	366	1st active spring adults
6	22	81.9	51.2	0.012	12.9	15.7	NMME	567	1st egg laying
7	2	86.4	53.9	0.008	16.1	15.6	NMME	711	1st nymphs
8	19	89.6	53.9	0.01	17.8	14.1	NMME	1616	1st adults summer gen
8	26	88.4	52.7	0.011	16.7	13.8	NMME	1736	peak 3rd instar nymphs (mid-season hosts)



uspest.org/dd/model condensed output w/new multiple forecast output

Degree-day Models - Using graphs

New interactive graphs – multiple forecasts
Example compare date of 1st nymphs 2016 data vs 7-month extended forecast:



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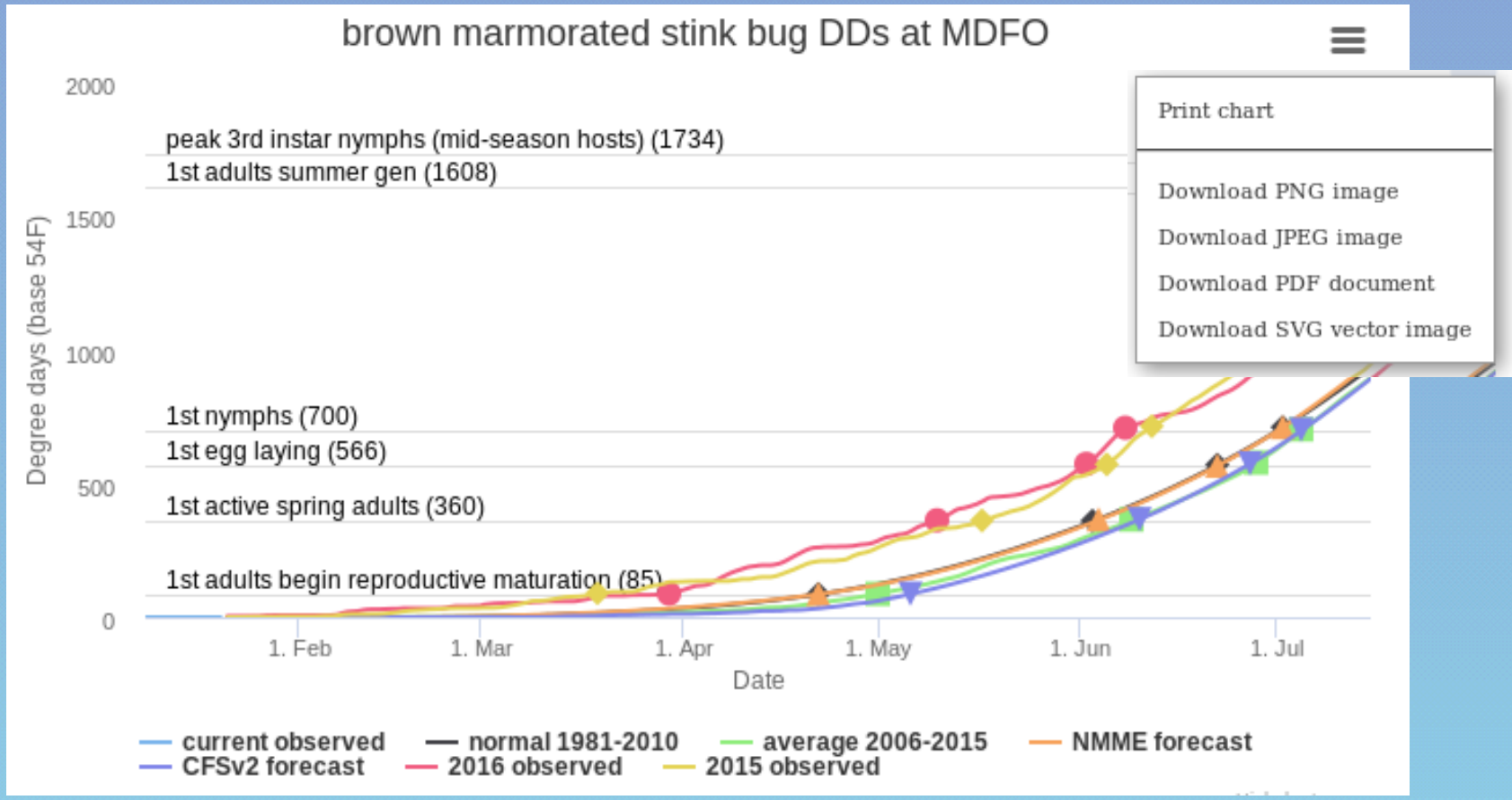
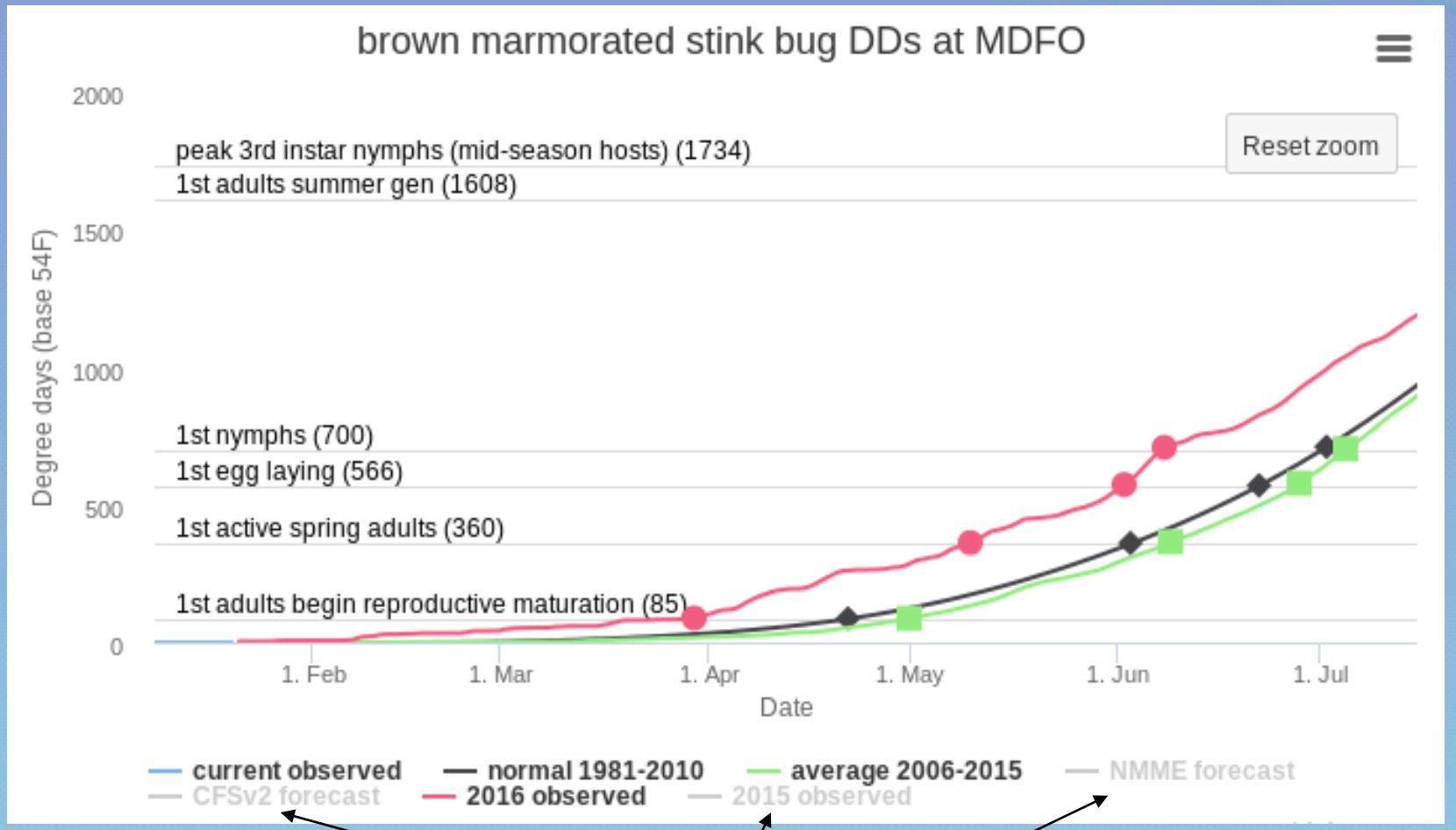


Degree-day Models - Using graphs

Feature: turn off/on data by clicking on legend entry:



Off: CFSv2, 2015 observed, NMME forecasts

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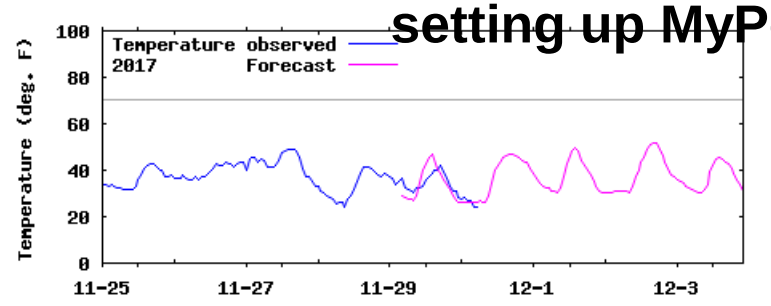
4. Systems modeling of crop and insect development for agricultural decision support OSU Horticulture Seminar, Corvallis, OR Nov. 2017 (60 min. video)

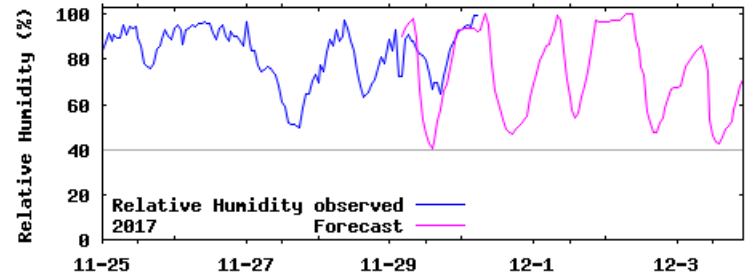
Partners and Support:

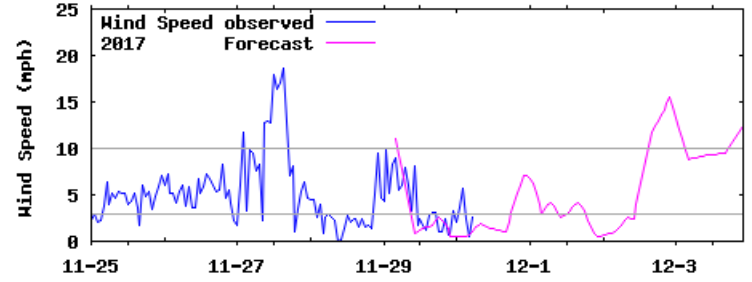
We are actively collaborating and partnering with Fox Weather, LLC and the National Weather Service for forecasts, with the OSU PRISM Climate group for climate data, with the W. Region IPM Center as a Signature Program, and with numerous state and private IPM decision support programs and entities. Funding has been provided by numerous USDA NIFA grants, USDA PPQ, RMA and ipmPIPE grants, NPDN grants, WR-IPM Center and Oregon Statewide IPM funds, and local and regional commodity grants.

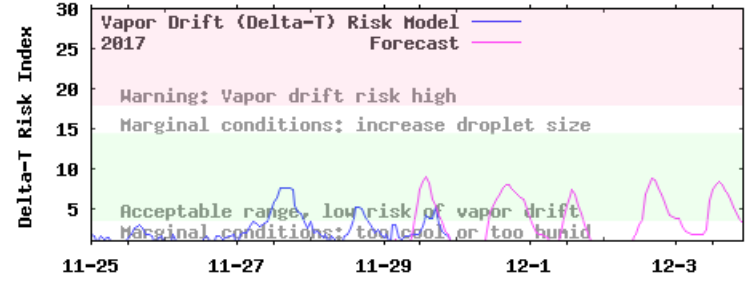
integrated plant protection center IPPC OSU | PRISM GROUP | Western IPM Center | ipmPIPE | NPDN National Plant Diagnostic Network | NIFA

Weather Data for Pest and Drift Management – setting up MyPest Page for Drift Forecast Conditions

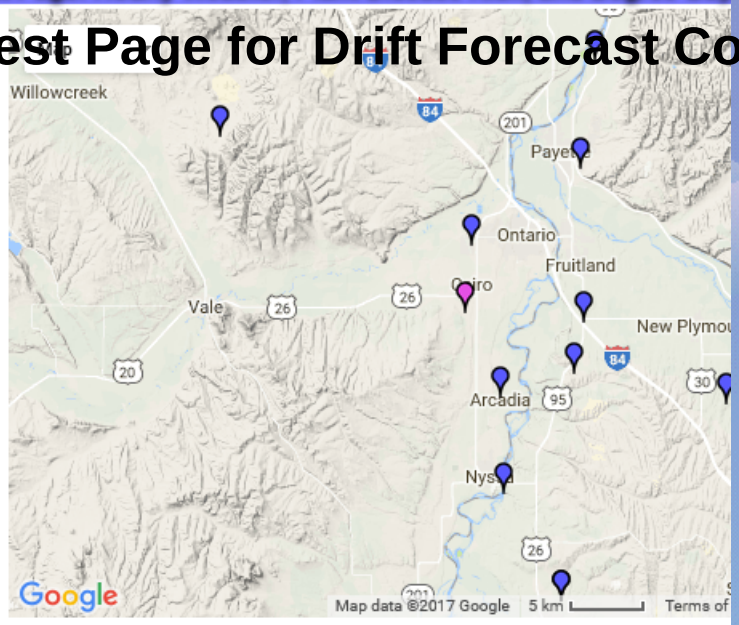








Forecast Engine Info:
Fox Weather, LLC
Versions used for '20171129' forecast
mtn1hrinterp Mon Jan 28 11:14:27 2013
input: fsfPN.txt



lat=

ONTO AGRIMET 43.9778 -117.0153
2017 ONTARIO OR elevation: 2260'

Refresh - click to reset display

- Display Dates
- Weather Parameters
- Plant Disease/Other Hourly Driven Models
  - Vapor Drift (Delta-T) Spray Drift Risk
- Degree-day/Phenology Models
- Display Settings
  - [ ] Disable Forecast Data Display
  - [x] Use NWS Digital Forecast
  - [ ] Leaf Wetness if Relative Humidity (%) above
  - [ ] Ignore Leaf Wetness Sensor Data (if available)
  - [ ] Ignore Sensor Data & Precip in Leaf Wetness Calculation
  - [ ] Plot QA for Temperature and Dew Point
  - Replace with virtual data:
  - Custom Threshold Lines for Weather Graphs

Temperature Threshold(s):	70
Relative Humidity Threshold(s):	40
Windspeed Threshold(s):	3,10

Set thresholds for Temp (70F), RH (40%), and Wind speed (3 and 10 mph)

NWS NDFD Forecast – updated constantly (uspest.org only once a day)

National Weather Service Forecast Office

Medford, OR

Home | News | Organization | Search for: | NWS

Point Forecast: 3 Miles WSW Roseburg OR
43.2N 123.4W (Elev. 574 ft)

Last Update: 3:32 am PST

Hourly Weather Forecast Graph

[dashes/dots] | [b/w] | [hide menu]

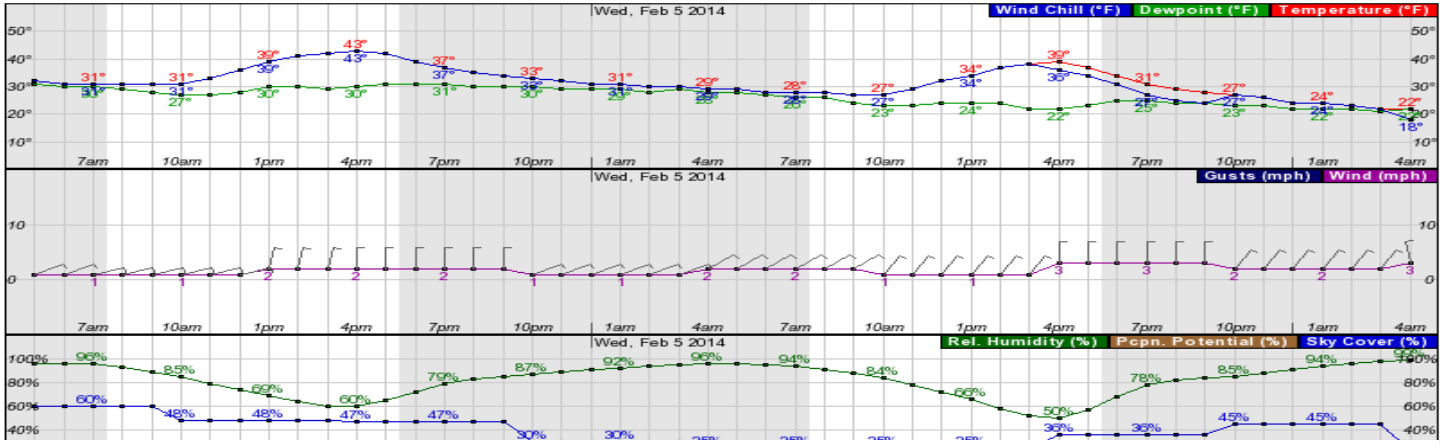
Weather Elements

- Temperature (°F)
- Dewpoint (°F)
- Wind Chill (°F)
- Surface Wind mph
- Sky Coverage
- Precipitation Potential
- Relative Humidity

Weather/Precipitation

- Thunder
- Rain
- Snow
- Freezing Rain
- Sleet

48-Hour Period Starting: 5am Tue, Feb 4 2014 | Submit | Back 2 Days | Forward 2 Days

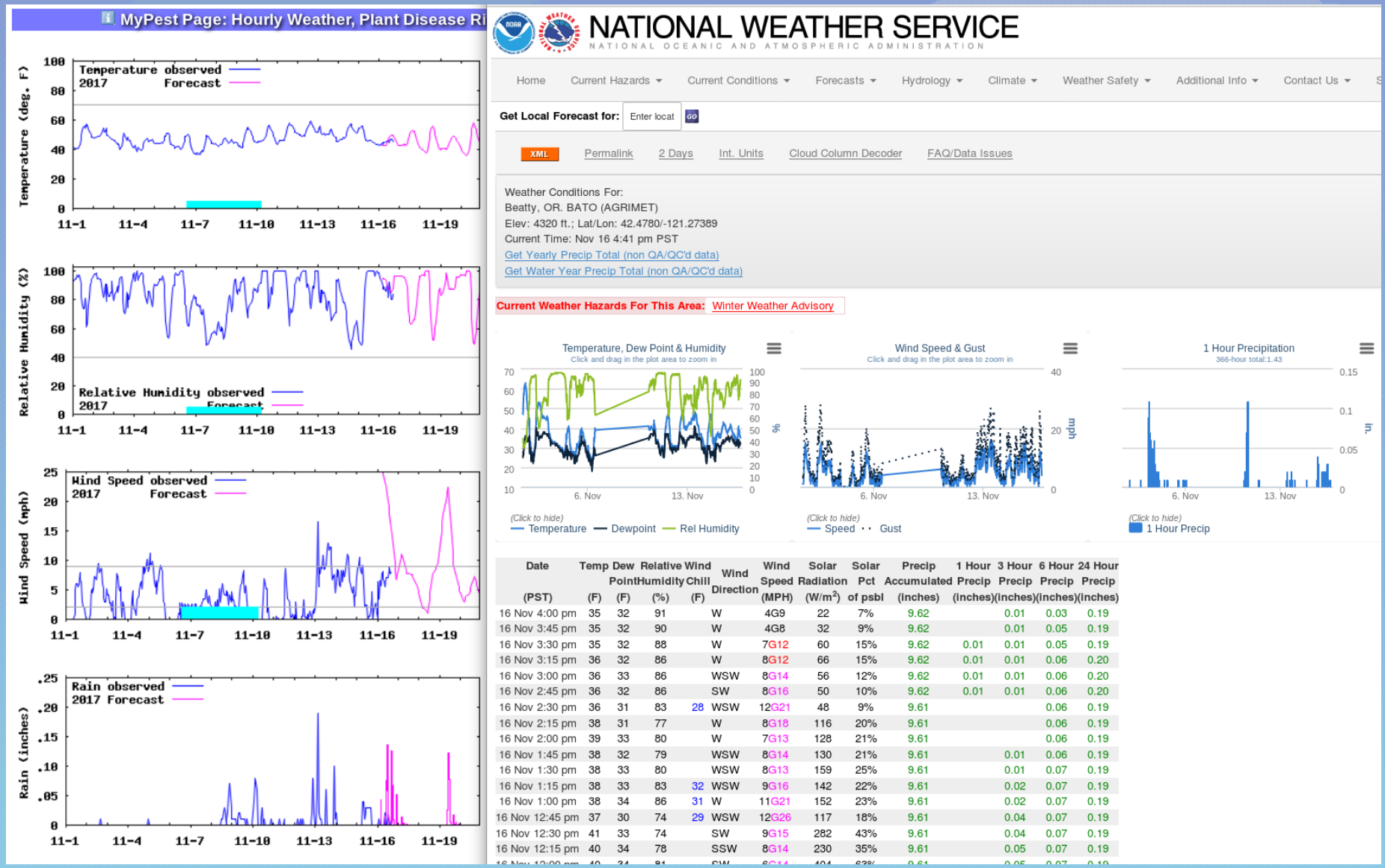


Additional Forecasts & Information

International System of Units	Forecast Discussion
7-Day Forecast	Tabular Forecast
Quick Forecast	
User Defined Area	

Date	02/04																			02/05				
Hour (PST)	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04
Temperature (°F)	32	31	31	31	31	31	33	36	39	41	42	43	42	39	37	35	34	33	32	31	31	30	30	29
Dewpoint (°F)	31	30	30	29	28	27	27	28	30	30	29	30	31	31	31	30	30	30	29	29	29	28	29	28
Wind Chill (°F)	32	31	31	31	31	31	33	36	39	41	42	43	42	39	37	35	34	33	32	31	31	30	30	29
Wind (kt)	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	2
Wind Dir	ENE	ENE	ENE	ENE	ENE	ENE	ENE	ENE	N	N	N	N	N	N	N	N	N	ENE	ENE	ENE	ENE	ENE	ENE	NE
Gust																								
Sky Cover (%)	60	60	60	60	60	48	48	48	48	48	48	47	47	47	47	47	47	30	30	30	30	30	30	25
Pcpn. Potential (%)	0	0	0	0	0	9	9	9	9	9	9	5	5	5	5	5	5	4	4	4	4	4	4	5
Rel. Humidity (%)	96	96	96	93	89	85	79	74	69	64	60	60	65	72	79	83	85	87	89	91	92	94	95	96

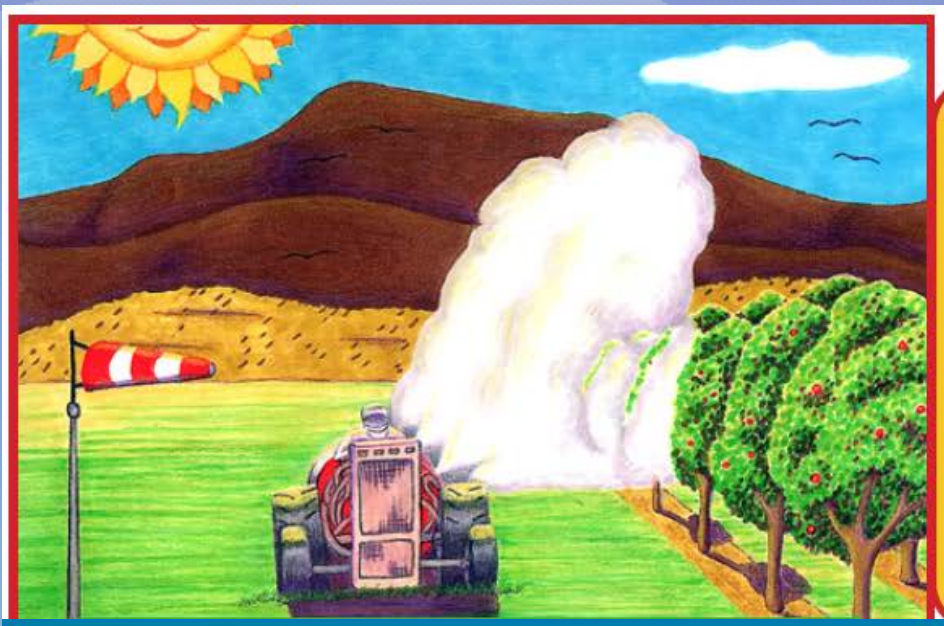
USPEST.ORG fills in missing data with “virtual” estimated data from nearby stations



Date (PST)	Temp (F)	Dew Point (F)	Relative Humidity (%)	Wind Chill (F)	Wind Direction	Wind Speed (MPH)	Solar Radiation (W/m²)	Solar Pct of psbl	Precip Accumulated (inches)	1 Hour Precip (inches)	3 Hour Precip (inches)	6 Hour Precip (inches)	24 Hour Precip (inches)
16 Nov 4:00 pm	35	32	91		W	4G9	22	7%	9.62		0.01	0.03	0.19
16 Nov 3:45 pm	35	32	90		W	4G8	32	9%	9.62		0.01	0.05	0.19
16 Nov 3:30 pm	35	32	88		W	7G12	60	15%	9.62	0.01	0.01	0.05	0.19
16 Nov 3:15 pm	36	32	86		W	8G12	66	15%	9.62	0.01	0.01	0.06	0.20
16 Nov 3:00 pm	36	33	86		WSW	8G14	56	12%	9.62	0.01	0.01	0.06	0.20
16 Nov 2:45 pm	36	32	86		SW	8G16	50	10%	9.62	0.01	0.01	0.06	0.20
16 Nov 2:30 pm	36	31	83	28	WSW	12G21	48	9%	9.61			0.06	0.19
16 Nov 2:15 pm	38	31	77		W	8G18	116	20%	9.61			0.06	0.19
16 Nov 2:00 pm	39	33	80		W	7G13	128	21%	9.61			0.06	0.19
16 Nov 1:45 pm	38	32	79		WSW	8G14	130	21%	9.61		0.01	0.06	0.19
16 Nov 1:30 pm	38	33	80		WSW	8G13	159	25%	9.61		0.01	0.07	0.19
16 Nov 1:15 pm	38	33	83	32	WSW	9G16	142	22%	9.61		0.02	0.07	0.19
16 Nov 1:00 pm	38	34	86	31	W	11G21	152	23%	9.61		0.02	0.07	0.19
16 Nov 12:45 pm	37	30	74	29	WSW	12G26	117	18%	9.61		0.04	0.07	0.19
16 Nov 12:30 pm	41	33	74		SW	9G15	282	43%	9.61		0.04	0.07	0.19
16 Nov 12:15 pm	40	34	78		SSW	8G14	230	35%	9.61		0.05	0.07	0.19

Weather Data for Drift Prediction

OSU IPPC Guidelines – thermal drift conditions



Thermal Drift

Thermal Drift

Do not spray in hot, dry conditions

- Spray drops evaporate rapidly, particularly above 70°F and when humidity is less than 40 percent.
- Drops become so small they fail to land on the crop and drift away.

Spray before heat builds and humidity falls

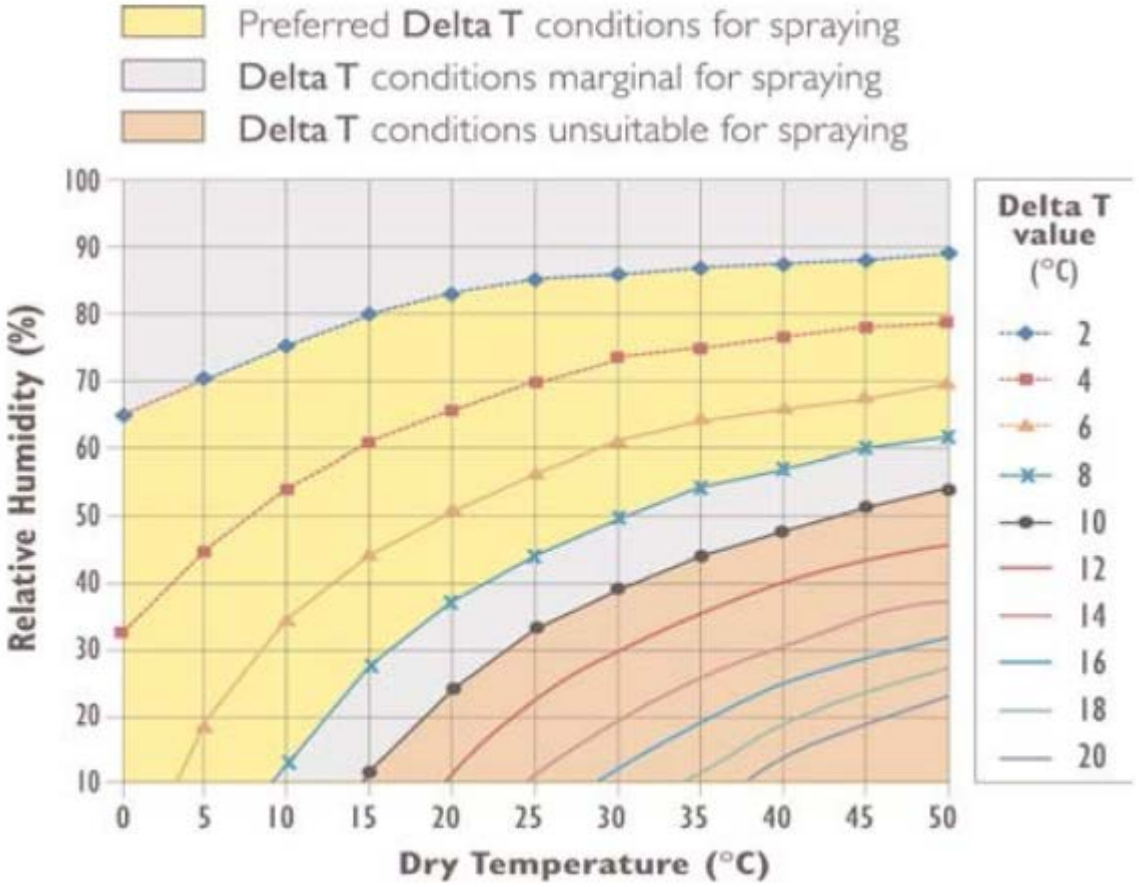
- Use weather forecasts and spray in cooler conditions.
- With air-blast sprayers:
  - Adjust nozzles to target the tree.
  - Turn off sprayer at row ends when turning.
  - Spray inwards in outer rows.
  - Moderate ground speed, nozzle flow rates, and air speeds.
- Use unsprayed offsets and buffers to protect sensitive downwind sites.

A New Tool for Predicting Thermal Drift

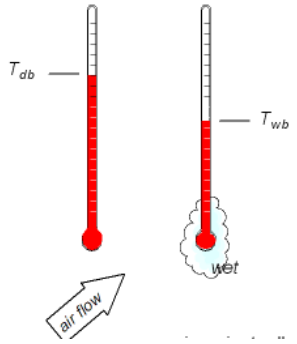
(Australian Gov. Bur. Meteorology)

DELTA T

Delta T is becoming one of the standard indicators for acceptable spray conditions. It is indicative of evaporation rate and droplet lifetime. Delta T is calculated by subtracting the wet bulb temperature from the dry bulb temperature. The diagram below relates air temperature and relative humidity to values of Delta T. When applying pesticides, Delta T should ideally be between 2 and 8,



The **Dry Bulb**, **Wet Bulb** and **Dew Point** temperatures are important to determine the state of humid air. The knowledge of only two of these values is enough to determine the state of the moist air - including the content of water vapor and the sensible and latent energy (enthalpy) in the air.



3.1 million acres of soybeans damaged
By dicamba in 2017 – Univ. Missouri IPM

Dicamba, Monsanto, and the Dangers of Pesticide Drift: A Modern Farmer Explainer

By Brian Barth on August 9, 2016

Soy beans plants that have been negatively affected by dicamba.

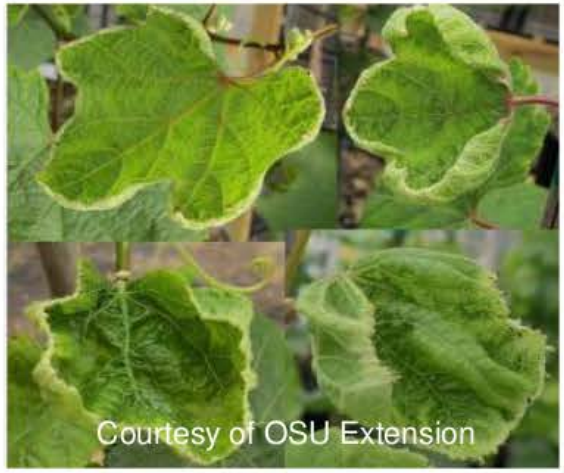
Bob Scott, University of Arkansas

Environmental conditions play a large role in how much dicamba will move off the target site in the days following application. Greater problems can be expected when high temperatures and low relative humidities occur following application. - Iowa State Extension Agronomy (2001)

Dicamba Symptomology

Other crops

Cucumbers



Grapes

Oak trees

Tomatoes

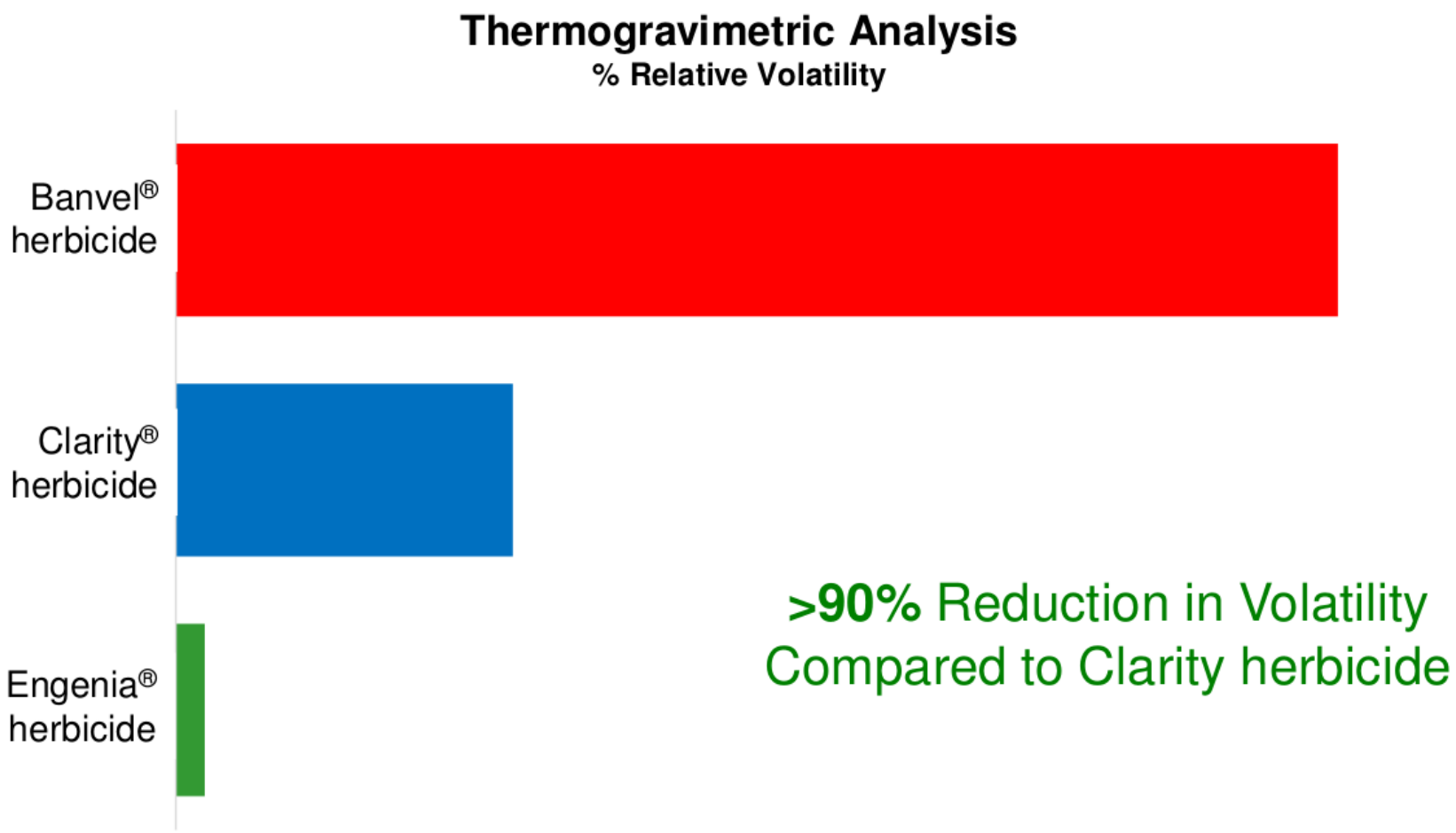
Sweet Potatoes

Dry Beans

Exercise extreme care with dicamba applications with nearby broadleaf crops

These slides were prepared by BASF to satisfy US EPA requirements. Please check with your state pesticide regulatory authority as additional requirements may be imposed by state regulatory authorities. DATE 11/17.

Mechanisms of Off-target Movement



Test conditions: Temp = 100° C/212° F, Time = 20 hours, Air flow = 60 mL/min, RH = 0%

Volatility has been addressed with new low volatility formulations and restrictions on tank mixtures and adjuvants

Always read and follow label directions. Engenia is a US EPA Restricted Use Pesticide.

These slides were prepared by BASF to satisfy US EPA requirements. Please check with your state pesticide regulatory authority as additional requirements may be imposed by state regulatory authorities. DATE 11/17.

Definitions and Semantics

(Particle) **Drift** and **Volatility** (Thermal or vapor drift) – both cause failure to reach the target, are causes of off-site movement.

Drift: physical (particle) movement by wind caused by unfavorable weather.
Most often combination of inappropriate application methods during windy conditions. Drift Rate is highly depedent upon **particle size in microns**

a typical particle drift threshold: < 200 microns spray droplets

Volatility: the pesticide changes from a liquid to a gaseous form (even after deposition on the intended target). The gaseous form then moves off-site with wind currents.

- The tendency for an organic substance to volatilize is expressed by its **vapor pressure**; The higher the vapor pressure value, the more likely to volatilize.

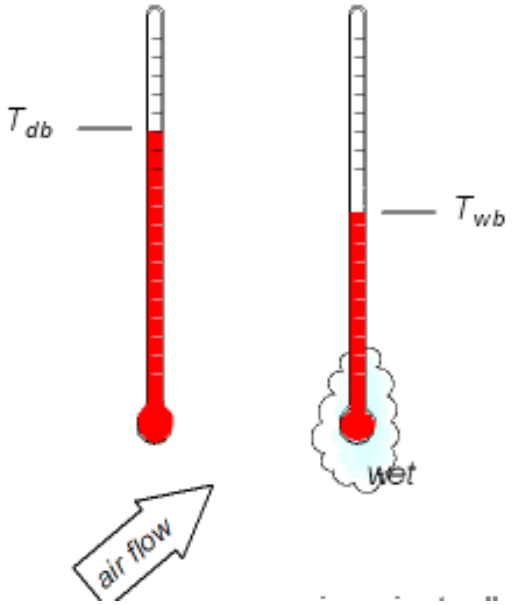
Dicamba vapor pressure: 4.5 mPa at 25C; is a “moderately volatile compound”

Glyphosate vapor pressure: 0.01 mPa at 25C; considered negligible

Water vapor pressure: 3.17 kPa (=3,170,000 mPa) at 25C; water is volatilizing anytime the Temperature is higher than the dew point!

Delta – T: wet bulb temp subtracted from dry bulb temp.

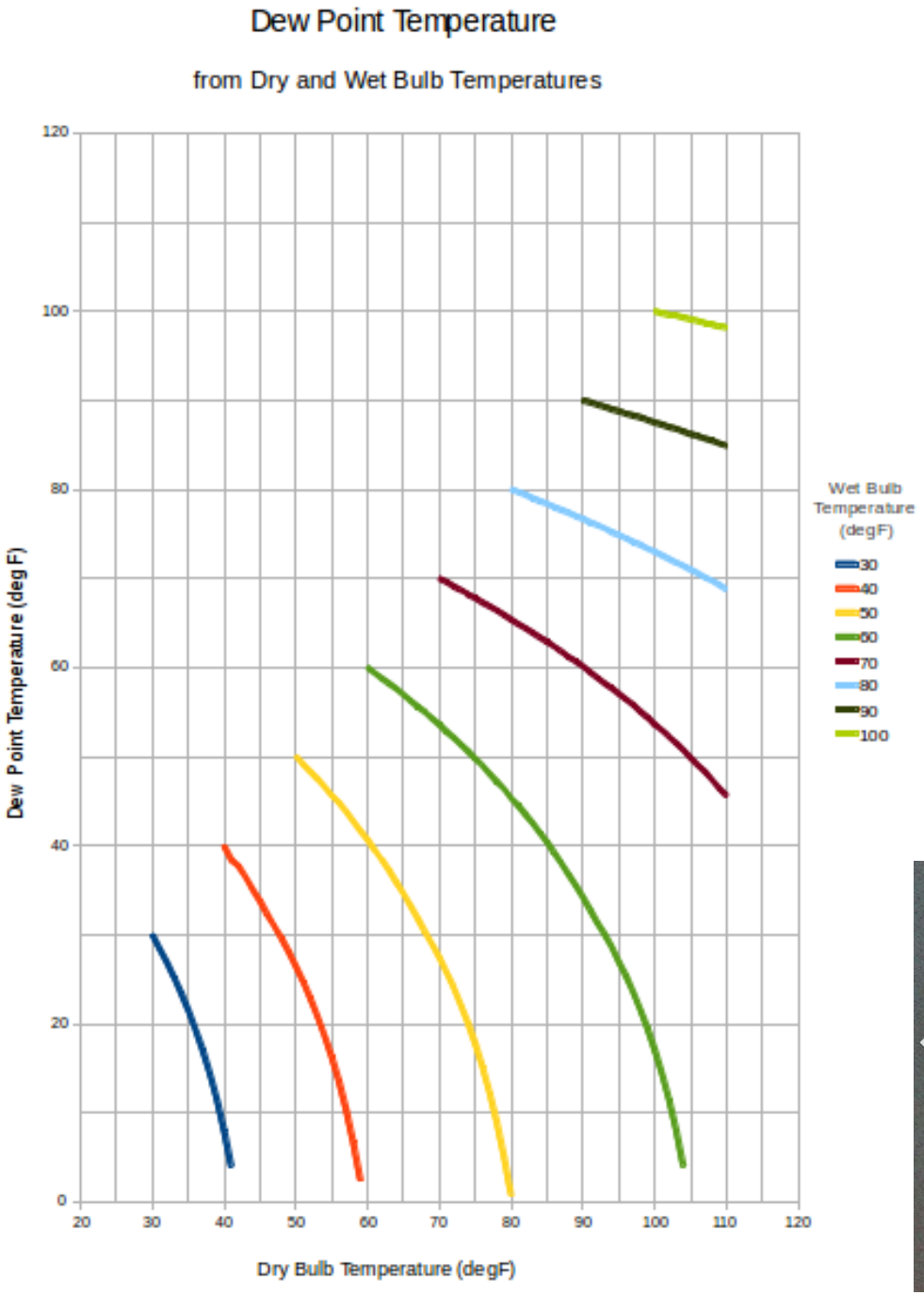
The **Dry Bulb**, **Wet Bulb** and **Dew Point** temperatures are important to determine the state of humid air. The knowledge of only two of these values is enough to determine the state of the moist air - including the content of water vapor and the sensible and latent energy (enthalpy) in the air.



Frey Scientific Sling Psychrometer

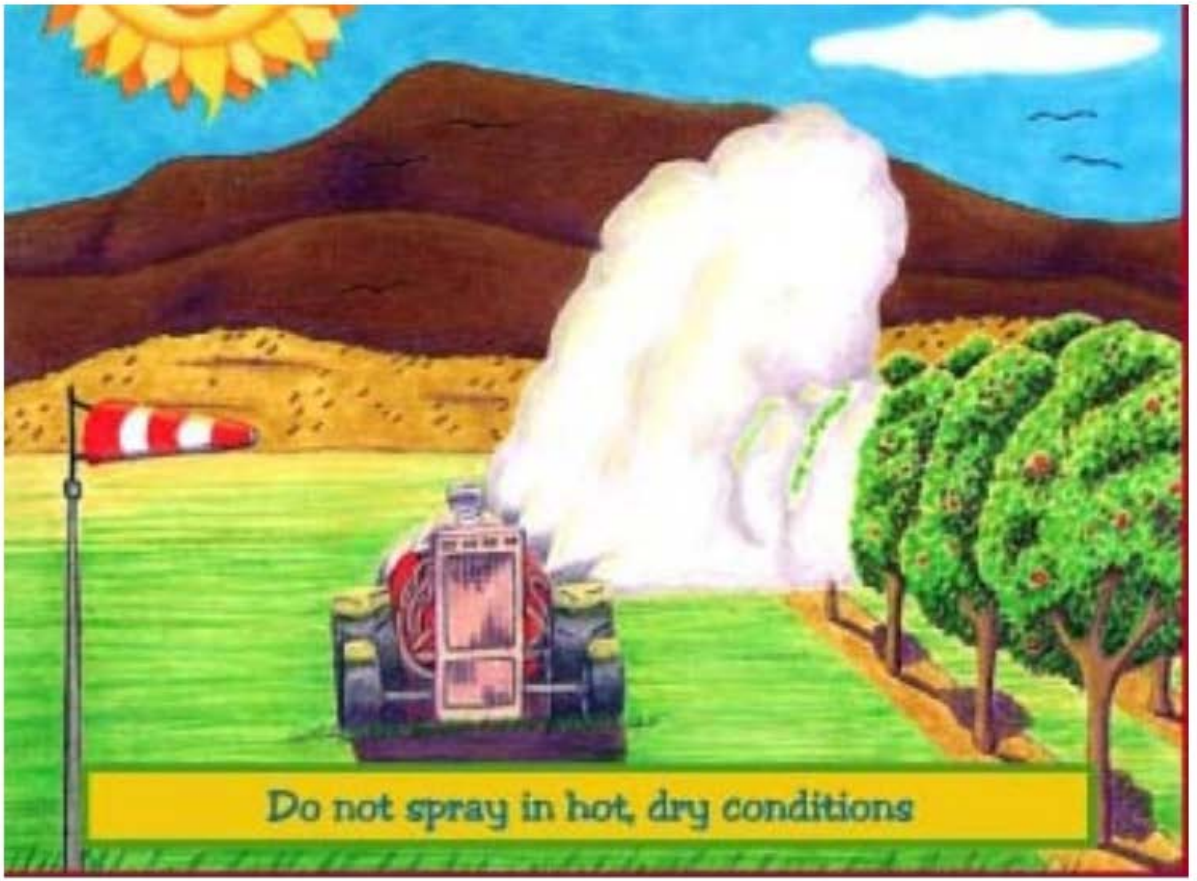
Catalog Price

$10.99



Determination of Dew Point from wet and dry bulb temperatures

(Delta-T is the simple difference)

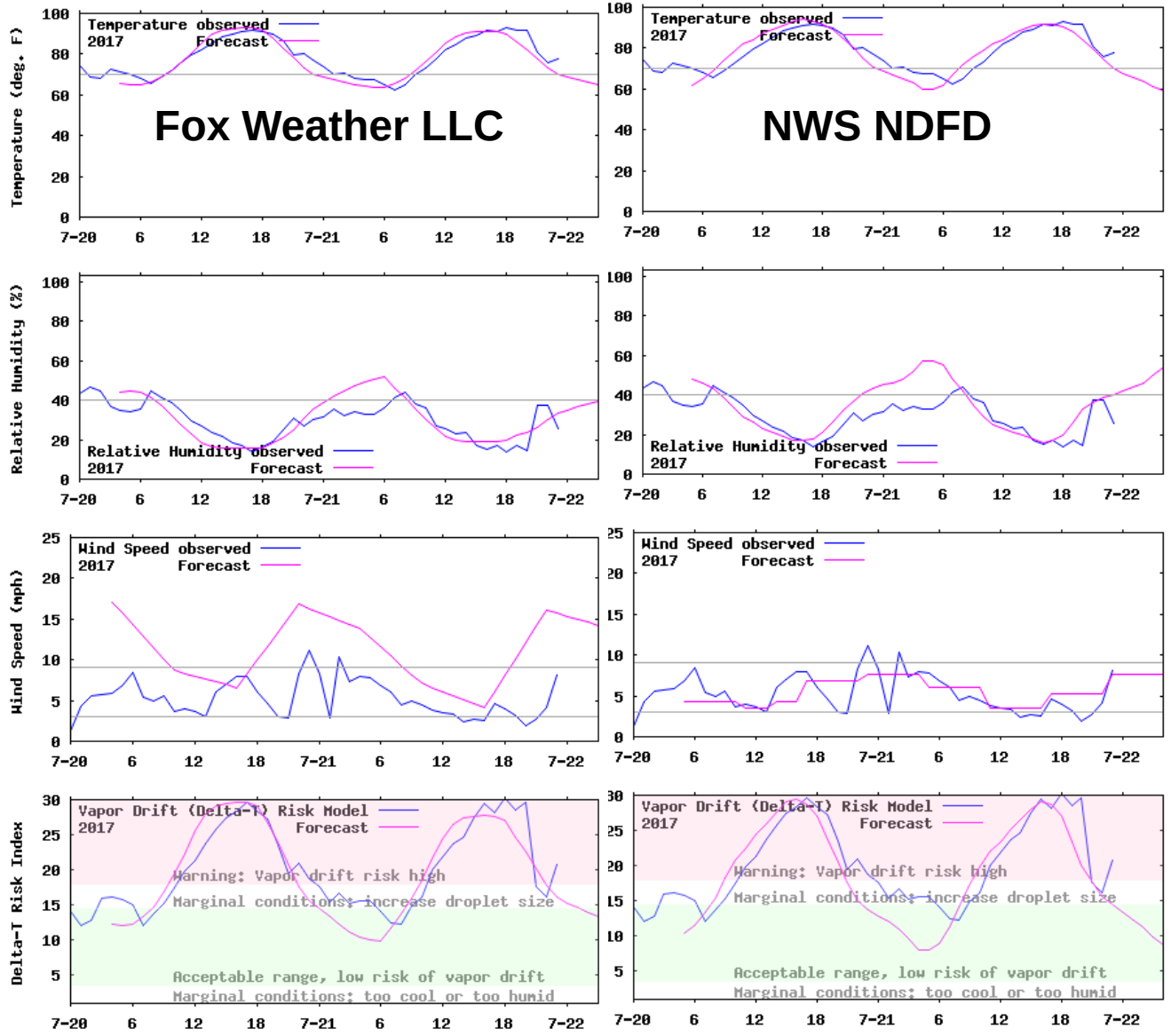


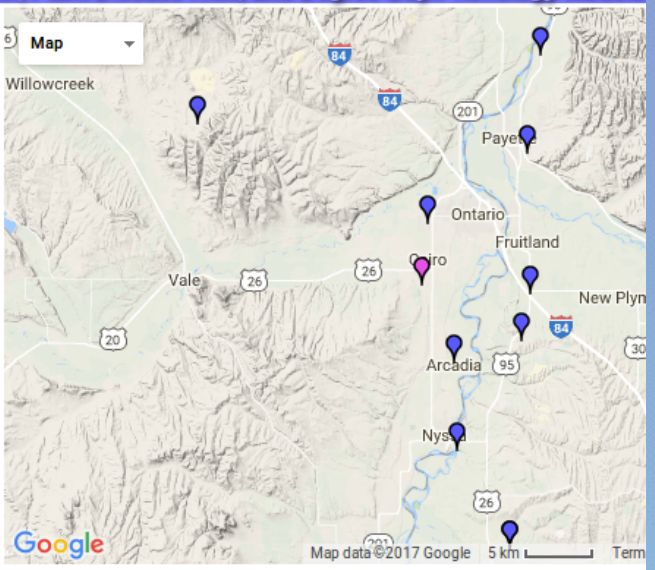
- **There is a high risk of thermal drift when temperatures exceed 70 degrees F and humidity falls below 40%.**

Degree-day Models – New Delta-T graphs
Choice of forecasts

MyPest Page: Hourly Wea

MyPest Page: Hourly Weather, Plant Disease Risk, and Degree-Day/Phenology Models



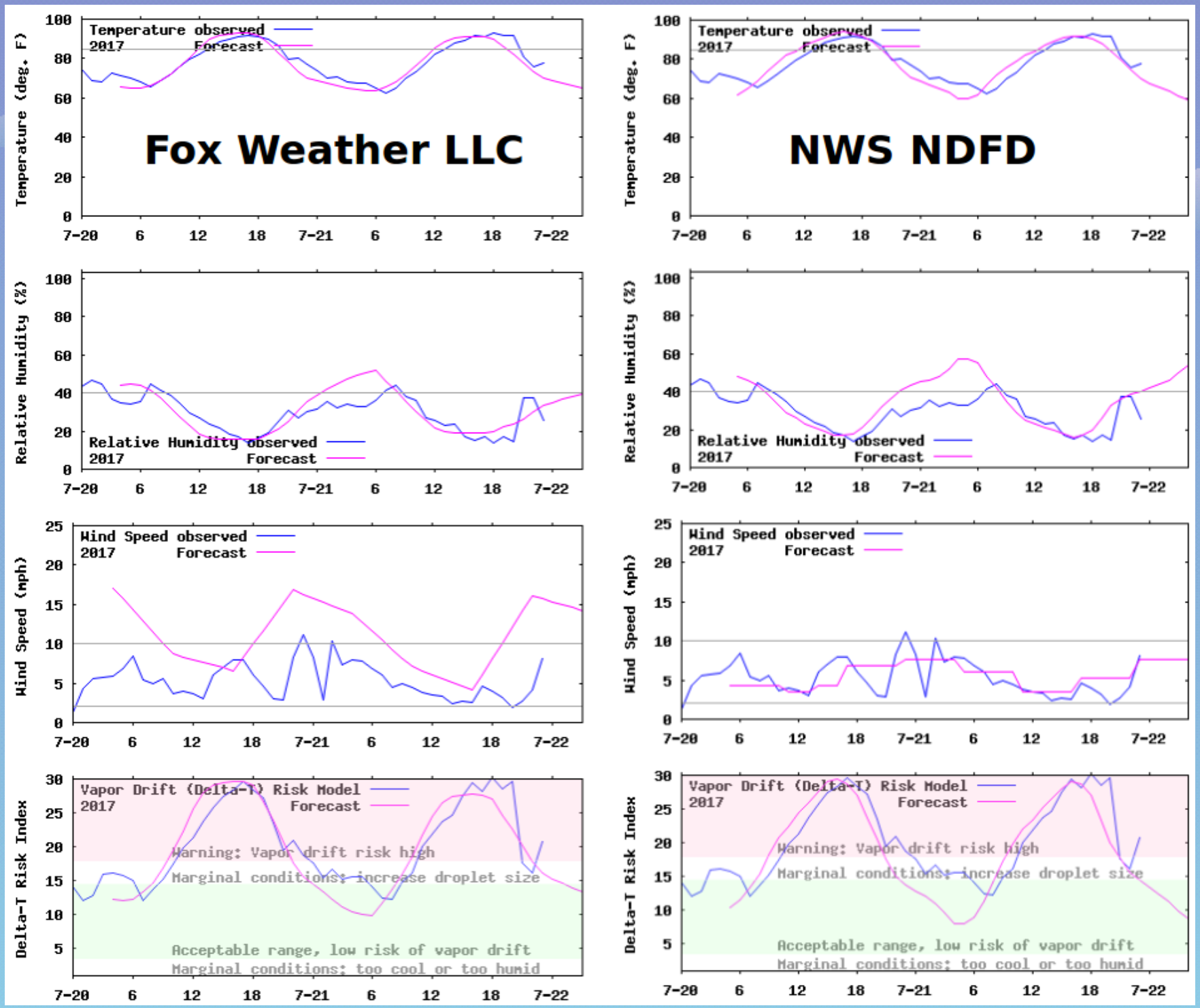


lat=

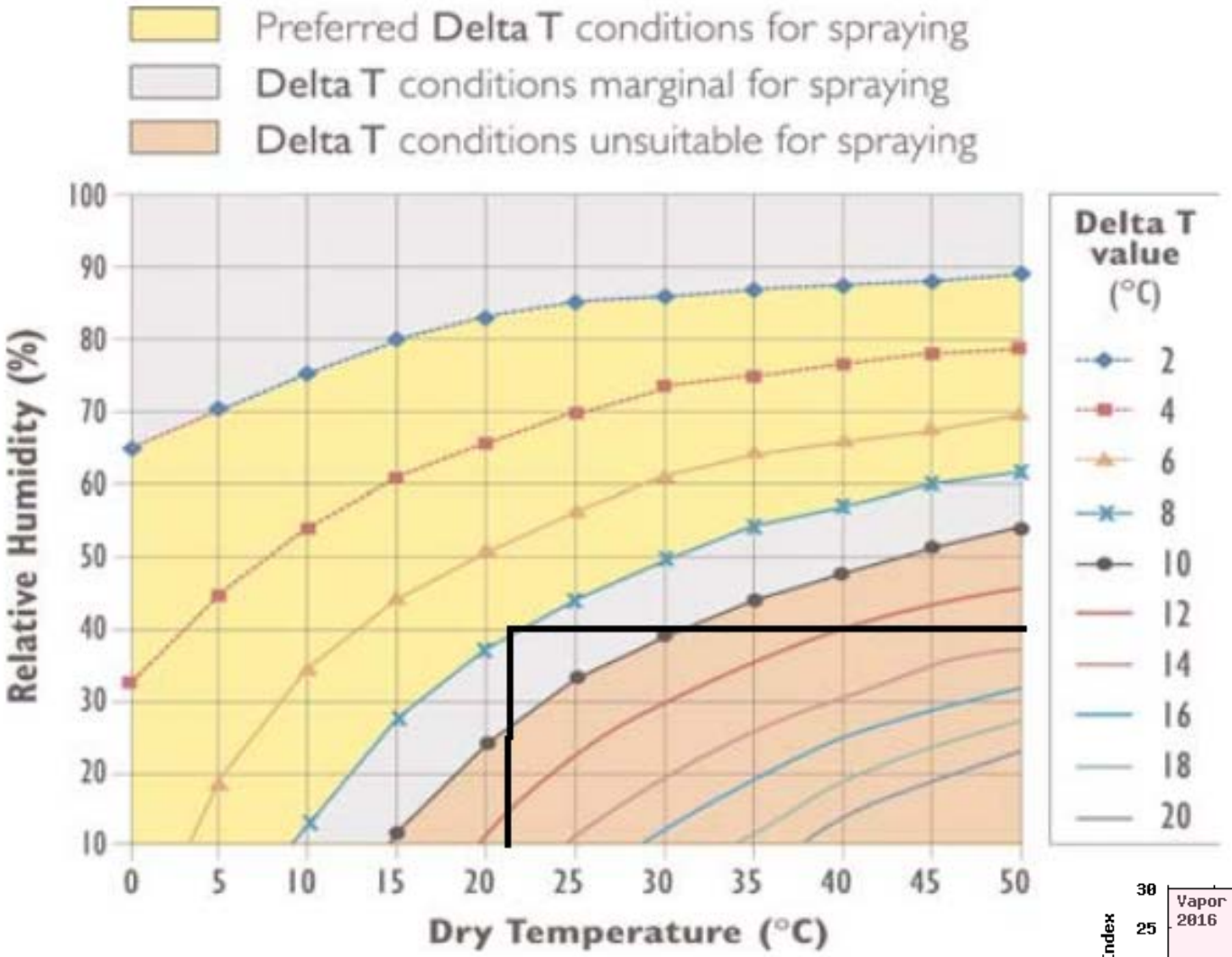
ONTO AGRIMET 43.9778 -117.0153
2017 ONTARIO OR elevation: 2260'

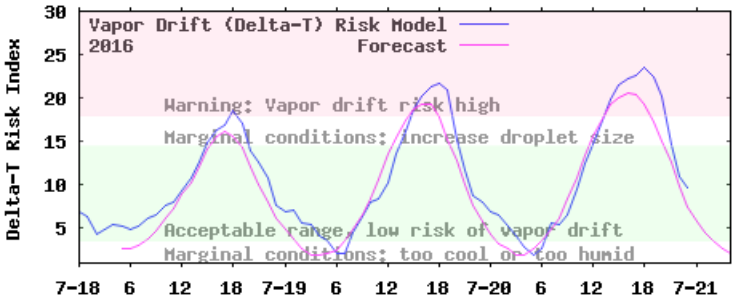
Refresh - click to reset display

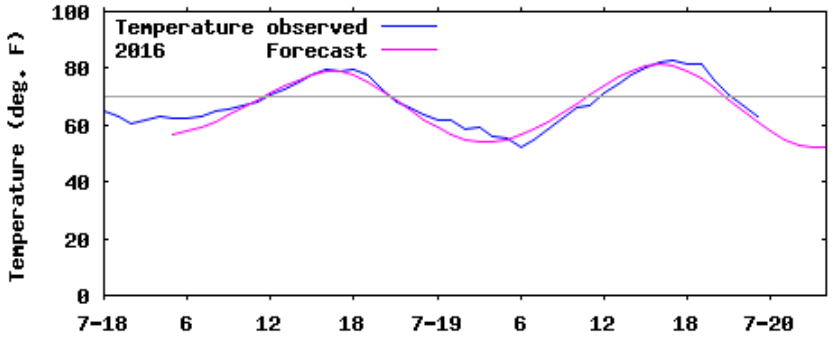
- **Display Dates**
- **Weather Parameters**
- **Plant Disease/Other Hourly Driven Models**
  Vapor Drift (Delta-T) Spray Drift Risk
- **Degree-day/Phenology Models**
- **Display Settings**
  - ☐ Disable Forecast Data Display
  - ☒ Use NWS Digital Forecast
  - ☐ Leaf Wetness if Relative Humidity (%) above
  - ☐ Ignore Leaf Wetness Sensor Data (if available)
  - ☐ Ignore Sensor Data & Precip in Leaf Wetness C
  - ☐ Plot QA for Temperature and Dew Point

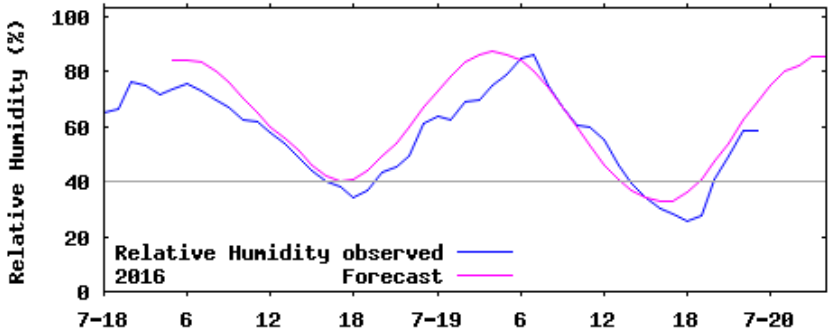

Temperature observed
2017
Forecast
Temperature (deg. F)
Fox Weather LLC
NWS NDFD
Relative Humidity (%)
Relative Humidity observed
Wind Speed (mph)
Wind Speed observed
Vapor Drift (Delta-T) Risk Model
Delta-T Risk Index
Warning: Vapor drift risk high
Marginal conditions: increase droplet size
Acceptable range, low risk of vapor drift
Marginal conditions: too cool or too humid
7-20
6
12
18
7-21
7-22

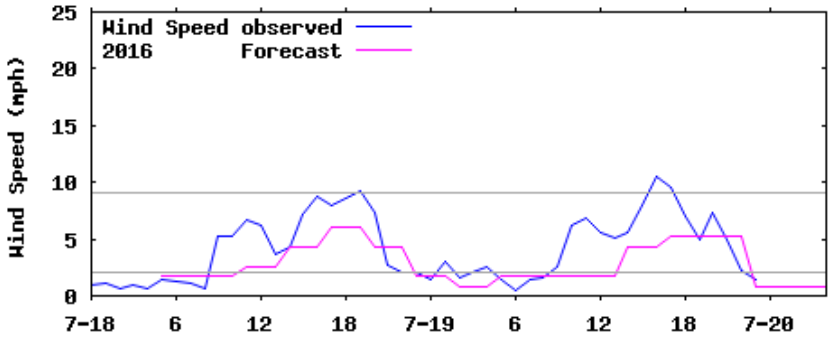
How does Delta-T compare to the 70F/40% RH Rule for Thermal Drift?

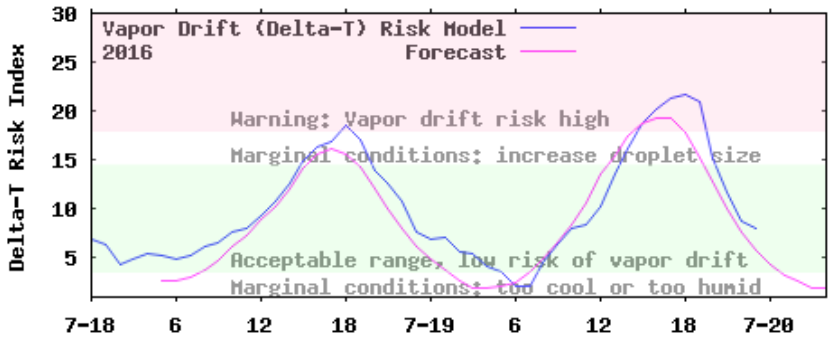








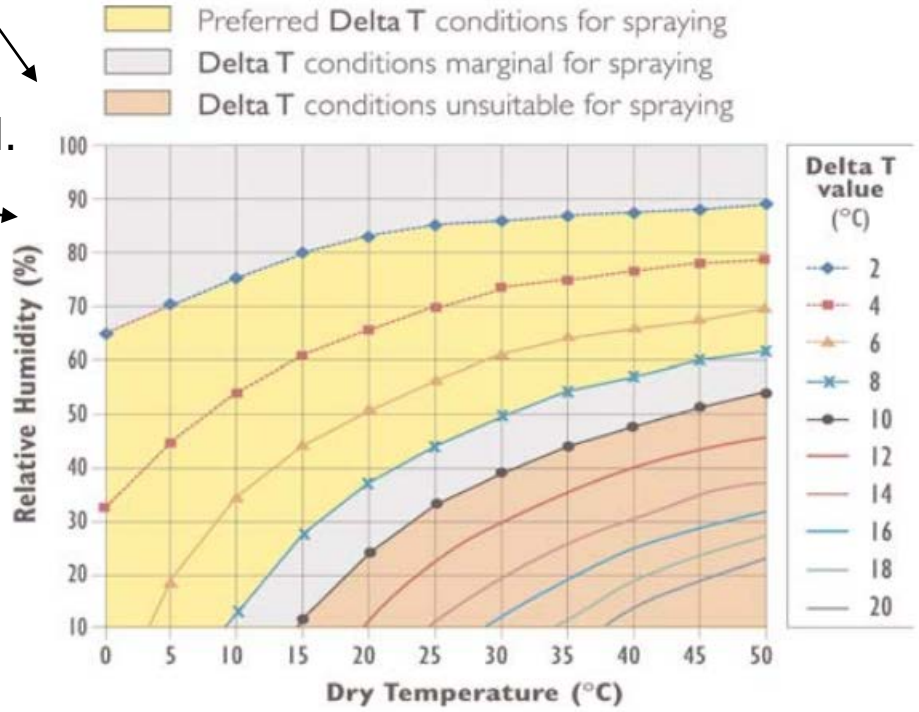




USPEST.ORG implementation of Delta-T

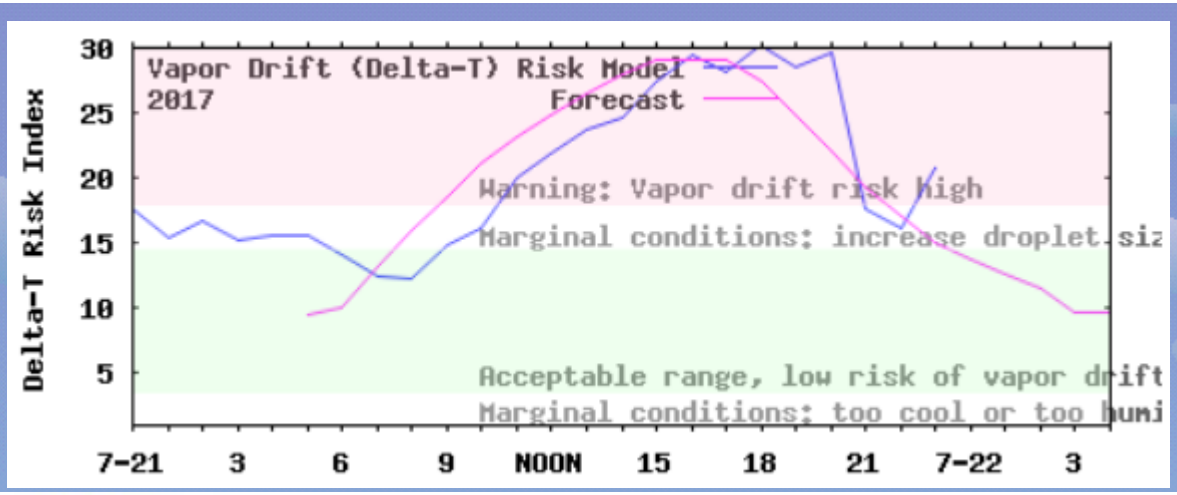
Temp.

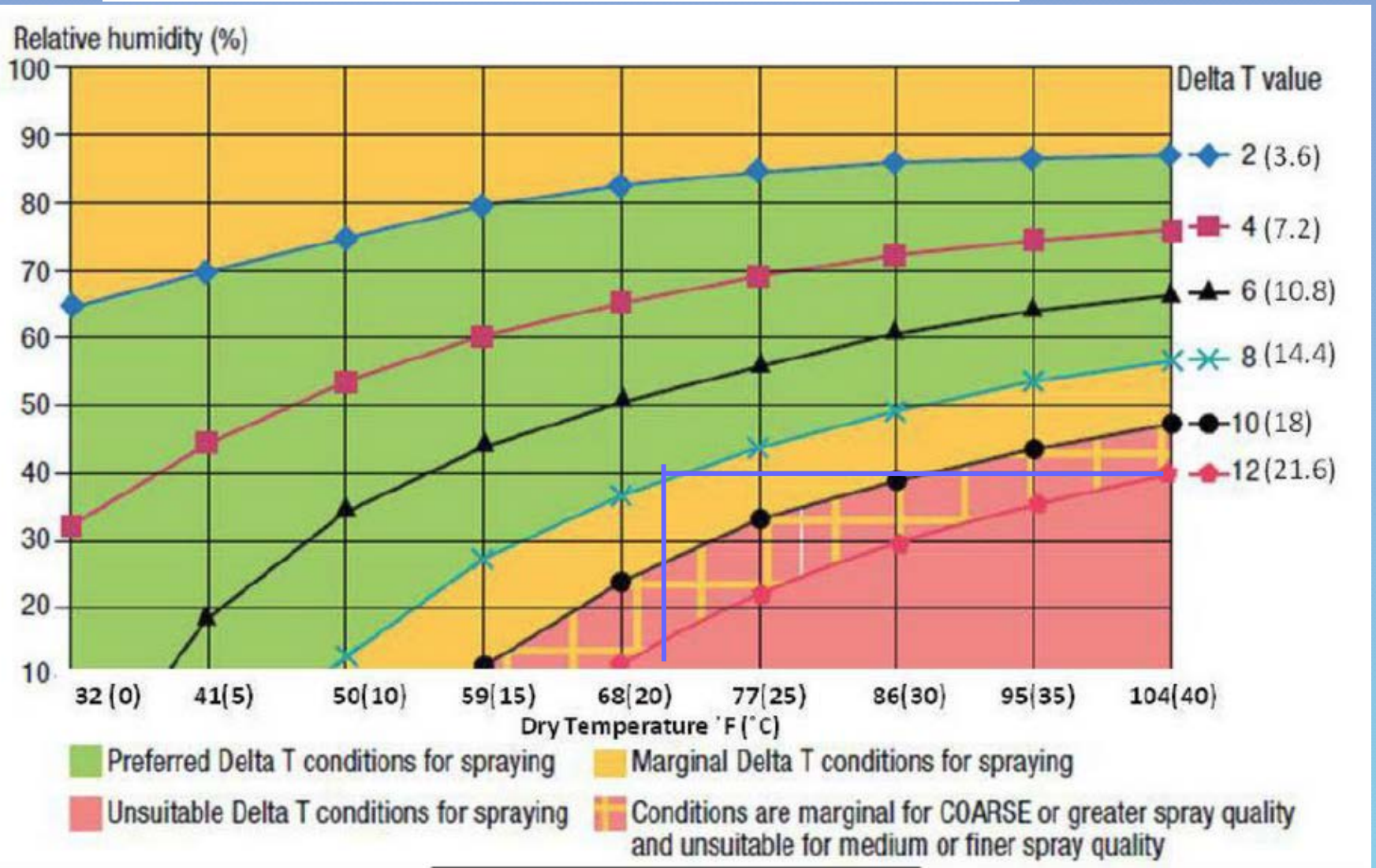
R.H.



Perform Lookup

Plot the
Delta-T
with default recommended zones
(High Risk, Marginal Conditions,
Acceptable Range, and too cool/humid)


Vapor Drift (Delta-T) Risk Model
2017
Forecast
Warning: Vapor drift risk high
Marginal conditions: increase droplet siz
Acceptable range, low risk of vapor drift
Marginal conditions: too cool or too humi
Delta-T Risk Index
30
25
20
15
10
5
7-21
3
6
9
NOON
15
18
21
7-22
3


Relative humidity (%)
100
90
80
70
60
50
40
30
20
10
Delta T value
2 (3.6)
4 (7.2)
6 (10.8)
8 (14.4)
10 (18)
12 (21.6)
32 (0)
41(5)
50(10)
59(15)
68(20)
77(25)
86(30)
95(35)
104(40)
Dry Temperature °F (°C)
Preferred Delta T conditions for spraying
Marginal Delta T conditions for spraying
Unsuitable Delta T conditions for spraying
Conditions are marginal for COARSE or greater spray quality and unsuitable for medium or finer spray quality

Weather Data for Drift Prediction

Be wary of pesticides that are sensitive to vaporization

But then vaporizes or gasses off during or after application

Summary Points:

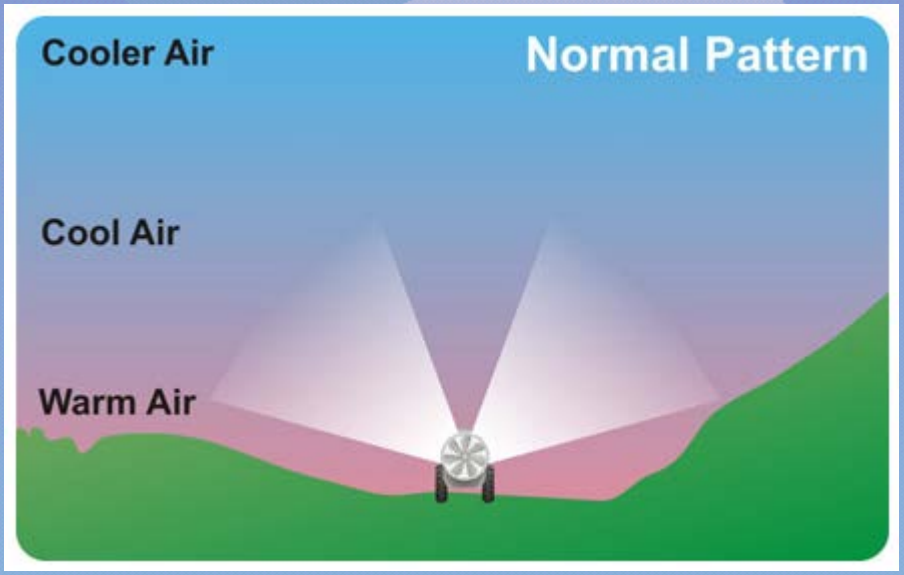
- Phenology/degree-day models are important tools in pest management
- We have new NMME climate prediction tools
- Use DD models with other IPM tactics: 1) Pest sampling 2) Action thresholds 3) Least-toxic chemicals 4) Drift avoidance/mitigation
- Delta-T: new tool for avoiding thermal drift; we are working on how we can add vapor pressure of the compound into a revised/more fine-tuned tool
- IPPC website uspest.org/wea has evolved as a hybrid for support of State, Regional, and National IPM needs.

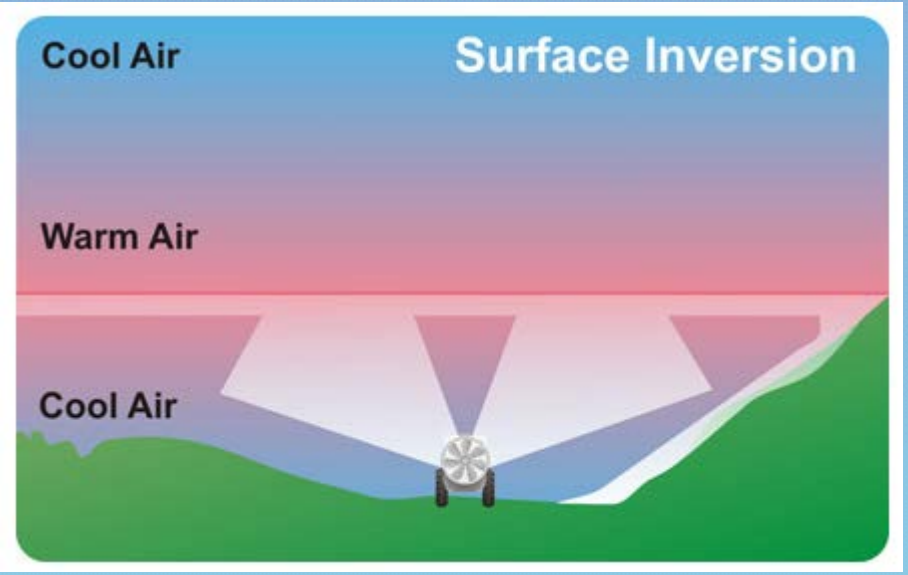
Weather Data Pest and Drift Management

– Questions?

"Hold it right there, young lady! Before you go out, you take off some of that makeup and wash off that gallon of pheromones!"

Weather Data for Drift Avoidance – Inversion Drift





Conditions indicating possible surface inversion:

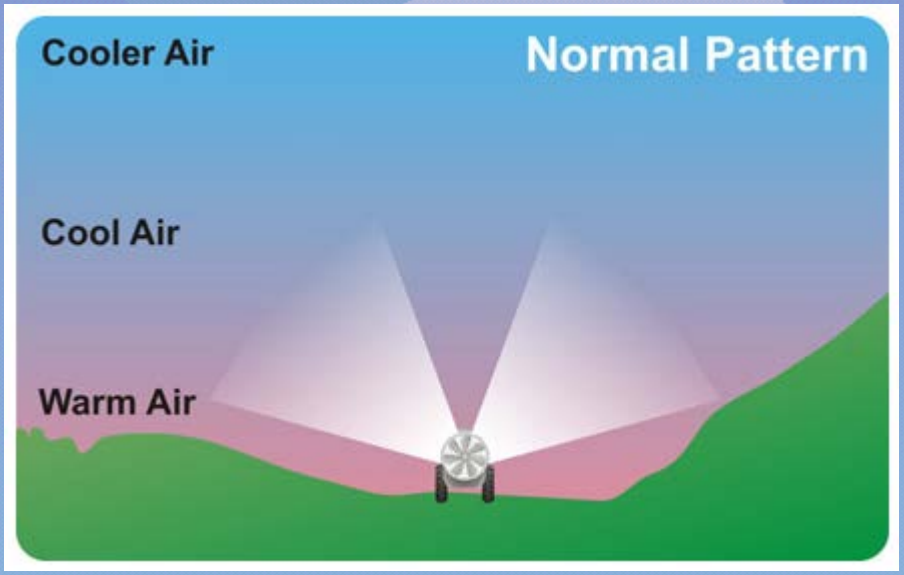
1) High pressure system, clear skies

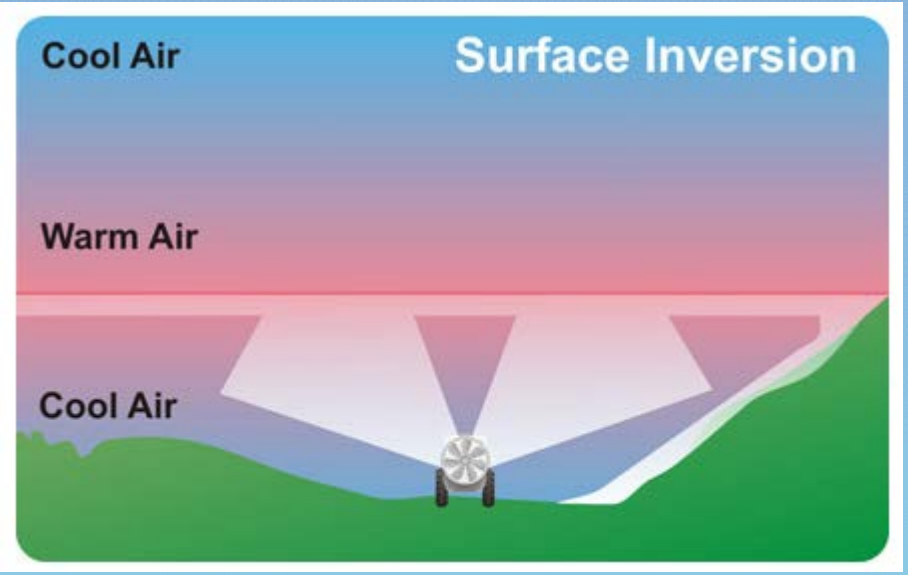
2) Temps increase with height; Suggestion: have a weather station with temp sensors at 6”, 5ft, and 30ft

3) Winds light w/minimal mixing

4) Fog, mist, and frost often occur

Weather Data for Drift Avoidance – Inversion Drift





Conditions indicating possible surface inversion:

5) Big difference day and night temps

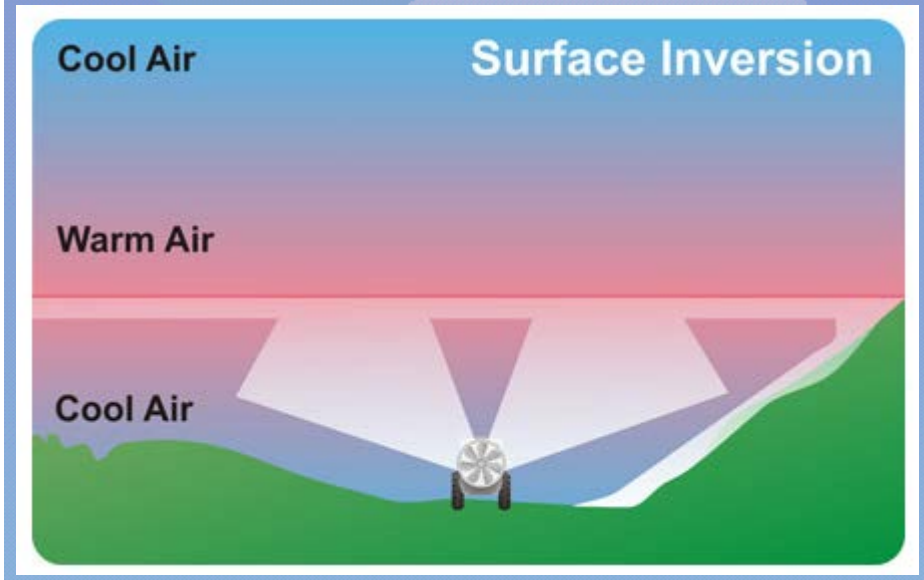
6) Evening/nt wind speeds much less than during day

7) Sounds seem to carry further

8) Odors seem more intense

9) Smoke/dust tend to hang in the air or move laterally

Weather Data for Weed Management – Sunset Radiation Inversions



Every day around sunset, the ground cools rapidly by radiating heat upwards. The air cools by conduction, making lower layers of air cooler than higher layers.

Problems include:

- Pesticide spray may stay concentrated for long periods above (not on) the target

- Move with the cool air for long distances

- Drain down slopes and concentrate in low-lying regions

For these reasons, there are daily cut-off times for spraying certain pesticides.

Weather Data for Drift Avoidance
Inversions – additional considerations

- frost prevention measure tend to work better during inversions

- heaters in particular work well during strong inversions – warm air rising from the heaters mixes with the air, which pushes the air back down towards the ground, helping to prevent frost