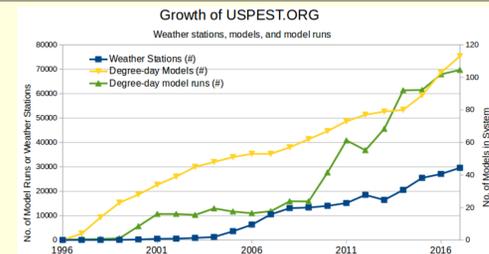


Weather and Climate Driven Models for IPM and Invasive Species Management



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USPEST.ORG has had steady increases in number of models, weather stations, and model runs over the past 21 years. In 2017 there were over 29,000 weather stations, 113 DD models (plus 24 hourly-driven models), and over 69,000 DD model runs serving agricultural decision support in the US.

ABSTRACT Predicting the timing of pest management activities is a crucial component of IPM and invasive species management. We provide an overview of the many uses of the online decision support tools at USPEST.ORG. There are numerous models for insect, weed, and crop phenology (105 total), and an additional 25 that are used for forecasting plant disease risk. Weather, climate, and forecast data are available for over 26,000 weather station locations and for gridded modeling and mapping needs. The models incorporate Fox Weather, LLC 7-day and 90 day forecasts, and NOAA/NWS 7-day and 7-month forecasts. We highlight new IPM models for this 20-years-existing website including the potato/tomato psyllid [*Bactericera cockerelli* (Sulc)], the threecornered alfalfa hopper [*Spissistilus festinus* (Say)], three new weed species, and a new model for pesticide vapor or thermal drift. New models that are classified as invasive species include the Asian longhorned beetle [*Anoplophora glabripennis* Motschulsky], the common cutworm [*Spodoptera litura* F.], and the Japanese flower thrips [*Thrips setosus* Moulton]. We also demonstrate new features at the website including interactive Highcharts and a new infrastructure for online creation of custom degree-day maps. Model uptake and usage has been steadily increasing; degree-day models alone exceeded 60,000 runs during each of the past four years.

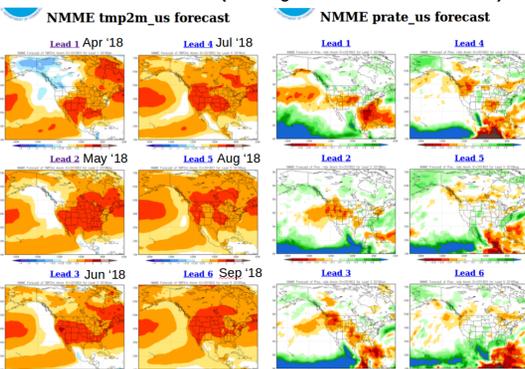
CREDITS IPPC works closely with and gives thanks and appreciation to: funding agencies USDA NIFA CPPM ARDP (Applied Research and Development Program), W. IPM Center, APHIS PPQ CPHST & CAPS, DoD SERDP, NOAA NWS, MESOWEST UTAH, USDA APHIS PPQ, the Western Weather Systems Workgroup, The OSU PRISM Group. And numerous sources of weather data including WSU AgWeatherNet, AGRIMET, ADCON, CIMIS, and numerous other public and agricultural networks. The system was built using open source software tools such as GNU/LINUX, GRASS GIS, and the Perl and R programming languages.

MyPest Page: IPM, Crop, Drift, Invasive Management Models in one Interface

What is NMME 7-month Forecast 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.

Forecasts Issued Mar. 2018 (showing 6 of the 7 months available)



NMME is updated monthly at: www.cpc.ncep.noaa.gov/products/NMME/ Monthly surface temperature and daily precipitation anomalies are available at 4KM resolution globally and for N. America. Recent forecast images shown above for 6 of 7 months (beginning with Apr. 2018) for temperature (tmp2m) and precipitation (prate). Much of US 7-month outlook is for much warmer and somewhat dryer than normal weather.

Introducing a New Interface for Running DD Models

Keeping standard Interface with numerous minor enhancements and better responsiveness including on mobile devices. Enter weather station code, output preview, intelligent page reload. Output: Date comparison, condensed output, Highcharts interactive graphs with up to 6 forecast options (selected above: NMME, 2016 and 2017 data, last 10-year average data).

Custom Degree-Day Maps including Pest Event Makers

Pre-parameterized and custom Degree-Day maps available from several interfaces. This tool (DDRP) developed for invasive species mapping of pest events such as adult flight (to aid PPQ CAPS trapping programs) and climate suitability mapping, showing regions where climate is suitable; ability to use long-term climate data including NMME and climate change prediction data. The next version of this tool will have new features developed to aid decision making for weed biocontrol (w/DoD SERDP support), including substage development and diapause effects triggered by photoperiod.

Beneficials - 7

Model/links to general info	Image	Model Documentation if avail.	Region of Known Usage	Validation Status	Lower Threshold °F
Spiders blue (Kinnodes)		OSU IPPC model analysis	W. Oregon	new - use with caution	41
Isomate-c+		Pacific Biocontrol Corporation	Pacific Northwest	experimental	32
Metasphaera occidentalis		Tanoshishi et al 1975	Pacific Northwest	not fully tested	52
Nesostichus fallacis		Dover et al 1979	Pacific Northwest	not fully tested	54
Rhodaba carmatis		OSU IPPC model analysis	Dev. for W. USA	under development	52
Galerucella californiensis [weevil biocontrol]		OSU IPPC model analysis	VA,OR,WA	under development	50
Ischnura leucosticta		OSU IPPC model analysis	US	under development	43

Plant Diseases - 6 (also 22 hourly weather-driven)

apple scab [apple]		Rodriguez et al 1995	Pacific Northwest	not fully tested	32
pear scab [apple]		MCAREC/Spotts	Pacific Northwest	in use in W. Oregon	32
early blight (potato)		Gen Schwanitz MSU Potato Lab	for use in most US states	newly added-undergoing evaluation	44.6
late blight (potato)		Smith WSU	Pacific Northwest	Validated & In Use - Contact Kim Johnson at science.osregonstate.edu	50
hop downy mildew [potato]		Gen et al 2010	Pacific Northwest	supported in Oregon	42.8
mummy berry [raspberry]		Pichardt 2014	W. Oregon	experimental	32

Weeds - 5

downy brome		Dan Ball et al 2004	W. Oregon	validated - see publication	32
barly nightshade		CRORMIE weed model	W. OR	research model - not yet validated	40
lambquarter		CRORMIE weed model	W. OR	research model - not yet validated	42
redroot pigweed		CRORMIE weed model	W. OR	research model - not yet validated	46
small brassica (red clover)		Cokerboom see Weed Handbook and model summary (pub in press)	Western Oregon	newly validated	32

Database of Degree-Day Models at <http://USPEST.ORG/WEA>: Currently 113 total

Insect/IPM Pests - 43 plus user-input parameter generic model

Model/links to general info	Image	Model Documentation if avail.	Region of Known Usage	Validation Status	Lower Threshold °F
Degree Day Calculator		calculator	USA	in regular use	41
apple maggot [cherry, apple]		Jones et al 89	Utah	testing	44
cherry [cherry, apple]		Jones et al 89	UT and OR	testing	44
alfalfa weevil [alfalfa]		UWY from Harcourt 1981	Canada Northern States (ND, WY)		48
black cutworm [vegetables]		Ballay 1976	Pacific Northwest	not fully tested	45
black cutworm [Michigan State Univ.]		Luckmann et al 1976	Pacific Northwest	partly validated	50
broccoli [vegetables]		Toba et al 1973	Pacific Northwest	not fully tested	50
corn earworm [sweet corn]		Hartstack et al 1976	Pacific Northwest	partly validated	55
w. cherry fruit fly [cherry]		Jones et al 21, Spong et al 2004	in general use, revised June 2011		41
w. cherry fruit fly [Cherry W. of Cascades]		AlNasser 1979	Pacific Northwest of W. of Cascades	fully validated	41
cooling moth [apple & pear]		Knight 2006	used in WA	actively undergoing evaluation	50
cooling moth [apple & pear]		Jones et al 2008	support for use in WA only	actively undergoing evaluation	50
cutworm [potato, tomato]		Fulmer et al 1979	OSU IPPC model analysis	requires local validation	48
cooling moth [apple & pear]		Rodriguez and Hoyt 1987	Pacific Northwest	Fully tested and in use	50
cooling moth [apple & pear]		U.C. Paterson OSU IPM Lab	Pacific Northwest	partly validated	39.7
douglas fir [Douglas fir]		OSU IPPC model analysis	W. Oregon	under development - unvalidated	39
European spruce sawfly [spruce]		Regan et al 1999	Pacific Northwest	partly validated	28
hibernian [barberry]		Almazzee 1983	Pacific Northwest	partly validated	50

Crops - 32

strawberry [strawberry]		Cackis 1982	Pacific Northwest	partly validated	48
sunflower [sunflower]		Merrill et al 2010	W. Great Plains	partly validated	41
variegated cutworm [pepper]		Coop & Berry 1987	Pacific Northwest	partly validated	41
western bean cutworm [corn & soybean]		Neh, IPM	developed in Neb.	unknown	50
western flower thrips [strawberry]		OSU IPPC model analysis	data from numerous sources	under development	45
walrus hawk [walrus]		Kanana & AlNasser 1997	Northwest Cascades	developed but not calibrated or validated	41
pea [pea]		OSU IPPC model analysis	developed for use in NW USA	new model would benefit from local validation	36
orange tortrix [small winter]		Knights 1988	Pacific Northwest	partly validated	41
pink bollworm [cotton]		U.C. Davis Cotton IPM 1976, model #3 UC IPM	CA AZ NM	used in CA	55
peanut root-knot [peanut]		Jackson and Harris 1983	in current use in NM and TX, OK use with caution; requires local validation		38
potato tuber moth [potato]		Brunner 1991	Pacific Northwest	partly validated	41
cutworm [potato, tomato]		OSU IPPC model analysis	collected in use in development for PNW OR, ID, WA, region - pest of potato TX, NZ, AZ		40
cutworm [potato, tomato]		2007 USU Ext. WSU IPM model	used in NW USA	requires local validation	50
cutworm [potato, tomato]		Rice et al 1982	Pacific Northwest	partly validated	51
cutworm [potato, tomato]		Bochinski et al 1990	Pacific Northwest	partly validated	47.5
canary		Miller MSU misc. rds	Montana	partly validated	32

Insect/Invasive Pests - 18

Japanese pine sawyer beetle [Japanese pine sawyer beetle]		OSU IPPC model analysis	Florida	under development	52
Asian longhorned beetle [Asian longhorned beetle]		OSU IPPC model analysis	Developed from multiple studies including South Korea	Could benefit from data from additional years and regions	50
brown marmorated stink bug [multiple]		Nelson et al 08	PA	under development - new invasive species	54
emerald ash borer [ash]		Daane 2012	2011-2012 data in Great Lakes region US	Could benefit from data from additional years and regions	50
European spruce sawfly [spruce]		U.C. Coop Ext 2010-11	Calibrated for CA Bay Area	experimental, undergoing validation work	50
cutworm [potato, tomato]		Russo et al 1993	East Coast US	partly validated	37.4
cutworm [potato, tomato]		Garner et al 1992	East Coast US	partly validated	45.8
cutworm [potato, tomato]		OSU IPPC model analysis	Midwest & PNW US	experimental	42
Japanese flower thrips [strawberry]		OSU IPPC model analysis	Montana	under development	52
Japanese beetle [multiple crops]		APHIS data	potential for use in US	incomplete based on trapping data	50
European spruce sawyer beetle [pine trees]		OSU IPPC model Dev for use in US	US	incomplete based on several studies mainly from Japan and Korea	54
light brown apple moth [monoculture]		OSU IPPC model analysis	W. USA	new - use with caution	45
Oak Ambrosia beetle [oak trees]		OSU IPPC model Dev for use in US	US	presumptive model based on several studies mainly from Japan	52
pine shoot borer [pine trees]		OSU IPPC model new testing for US	US	under development - unvalidated	54
pine tree shoot borer [pine trees]		OSU IPPC model Dev for use in US	US	Dev for use draft model based on several studies mainly from Europe	45
spotted wing thrips [strawberry]		OSU IPPC model analysis	US	first version, more spring flight data needed	51
spotted wing thrips [strawberry]		OSU IPPC model analysis	US	partly validated-has been compared to 2 years of field data in 50 PNW	50
spotted wing thrips [strawberry]		OSU IPPC model analysis	US	potential for use in US	53

