Next Generation Plant Disease Forecast Models

Roger Magarey
Center for IPM

NC STATE UNIVERSITY

Generation 1 ~ 1930s onwards

Hours of Wetting for Primary Apple Scab Infection

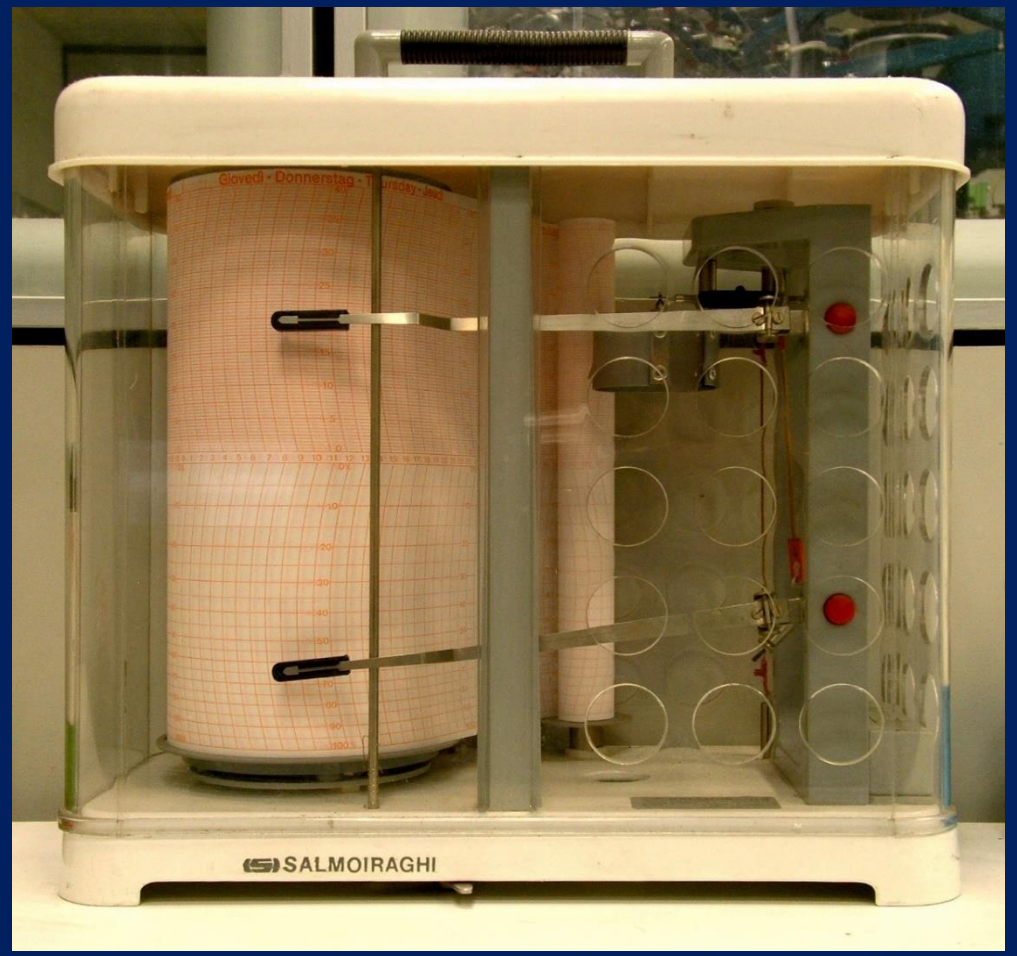
Number of hours at different air temperatures are approximate.

Avg. Temp. (°F/°C)	Hours of wetting required for infection from primary inoculum		
	Light Infection	*Mod. Infection*	*Heavy Infection*
78°/25.5°	13	17	26
77°/25°	11	14	21
76°/24.5°	9.5	12	19
63–75°/ 17–24°	9	12	18
62°/17°	9	12	19
61°/16°	9	13	20
60°/15.5°	9.5	13	20
59°/15°	10	13	21
58°/14.5°	10	14	21
57°/14°	10	14	22
56°/13.5°	11	15	22
55°/13°	11	16	24
54°/12°	11.5	16	24
53°/11.5°	11.5	17	25
52°/11°	12	18	26
51°/10.5°	13	18	27
50°/10°	14	19	29
49°/9.5°	14.5	20	30

Avg. Temp. (°F/°C)	Hours of wetting required for infection from primary inoculum		
	Light Infection	*Mod. Infection*	*Heavy Infection*
48°/9°	15	20	30
47°/8.5°	15	23	35
46°/8°	16	24	37
45°/7°	17	26	40
44°/6.5°	19	28	43
43°/6°	21	30	47
42°/5.5°	23	33	50
41°/5°	26	37	53
40°/4.5°	29	41	56
39°/4°	33	45	60
38°/3.5°	37	50	64
37°/3°	41	55	68
33–36°/ 0.5–2°	48	72	96

Adapted from North Carolina State University and Michigan State University fruit publications and based on the original "Mills" chart developed by W. O. Mills of Cornell University and modified by A. L. Jones. The infection period starts with the beginning of rain.

S. G. Aćimović
https://blogs.cornell.edu/acimoviclab/2018/03/28/2018-spray-recommendations-from-silvergreen-tip-onward/



https://en.wikipedia.org/wiki/Thermo-hygrograph

Generation 2 ~ 1980s onwards

Campbell Scientific CR-21 Datalogger 1979 onwards

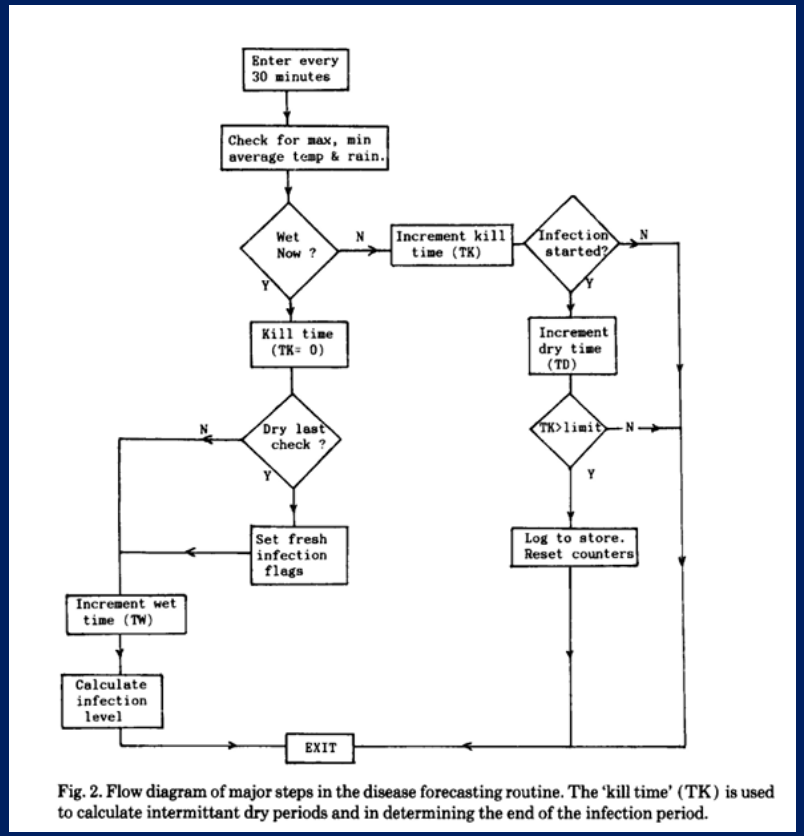
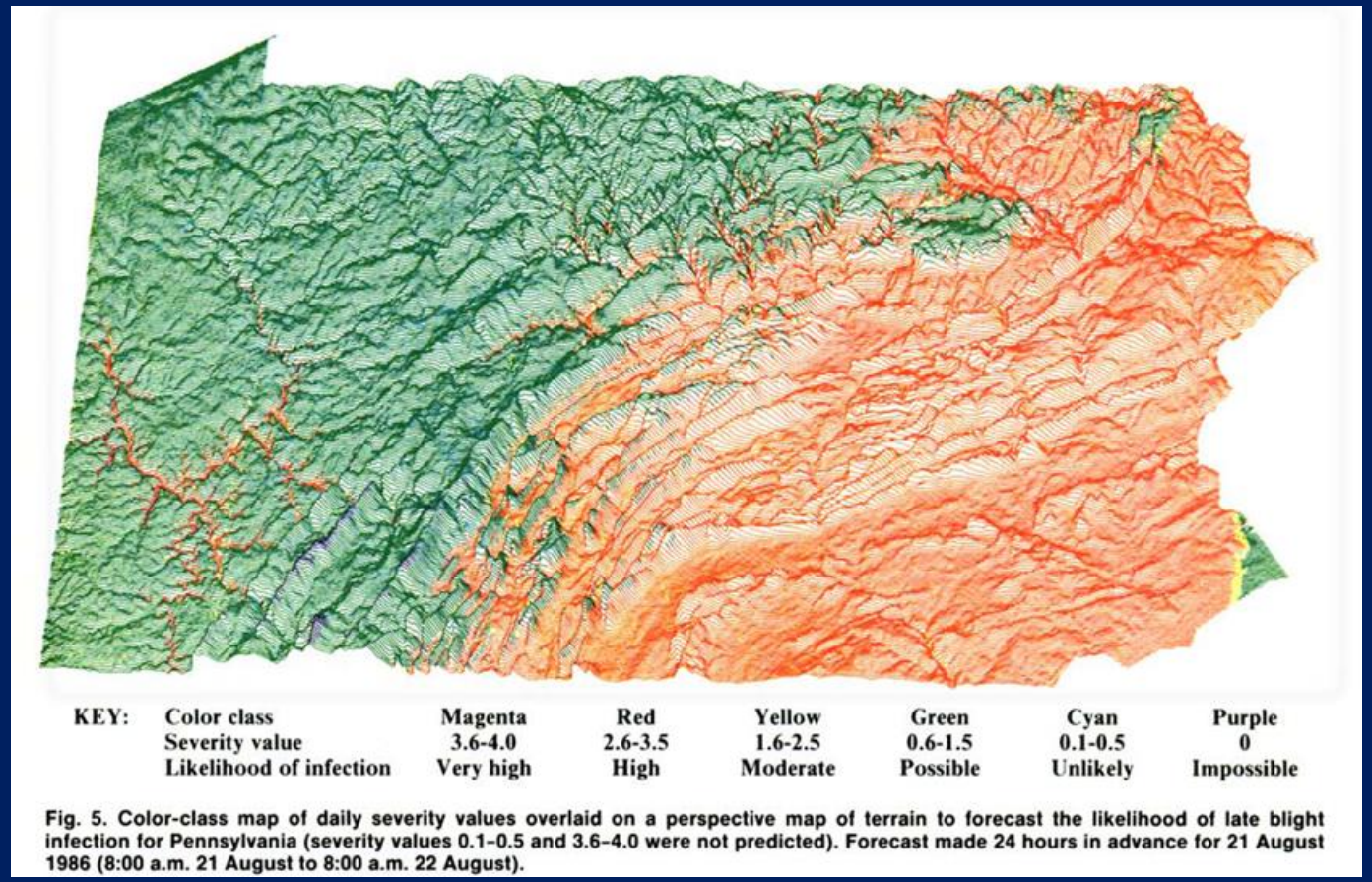


Fig. 2. Flow diagram of major steps in the disease forecasting routine. The 'kill time' (TK) is used to calculate intermittant dry periods and in determining the end of the infection period.

Peak *et al.* (1986). *Computers and electronics in agriculture, 1*(3), 251-262.

Generation 3 ~ 1990s onwards



KEY:	Color class	Magenta	Red	Yellow	Green	Cyan	Purple
	Severity value	3.6-4.0	2.6-3.5	1.6-2.5	0.6-1.5	0.1-0.5	0
	Likelihood of infection	Very high	High	Moderate	Possible	Unlikely	Impossible

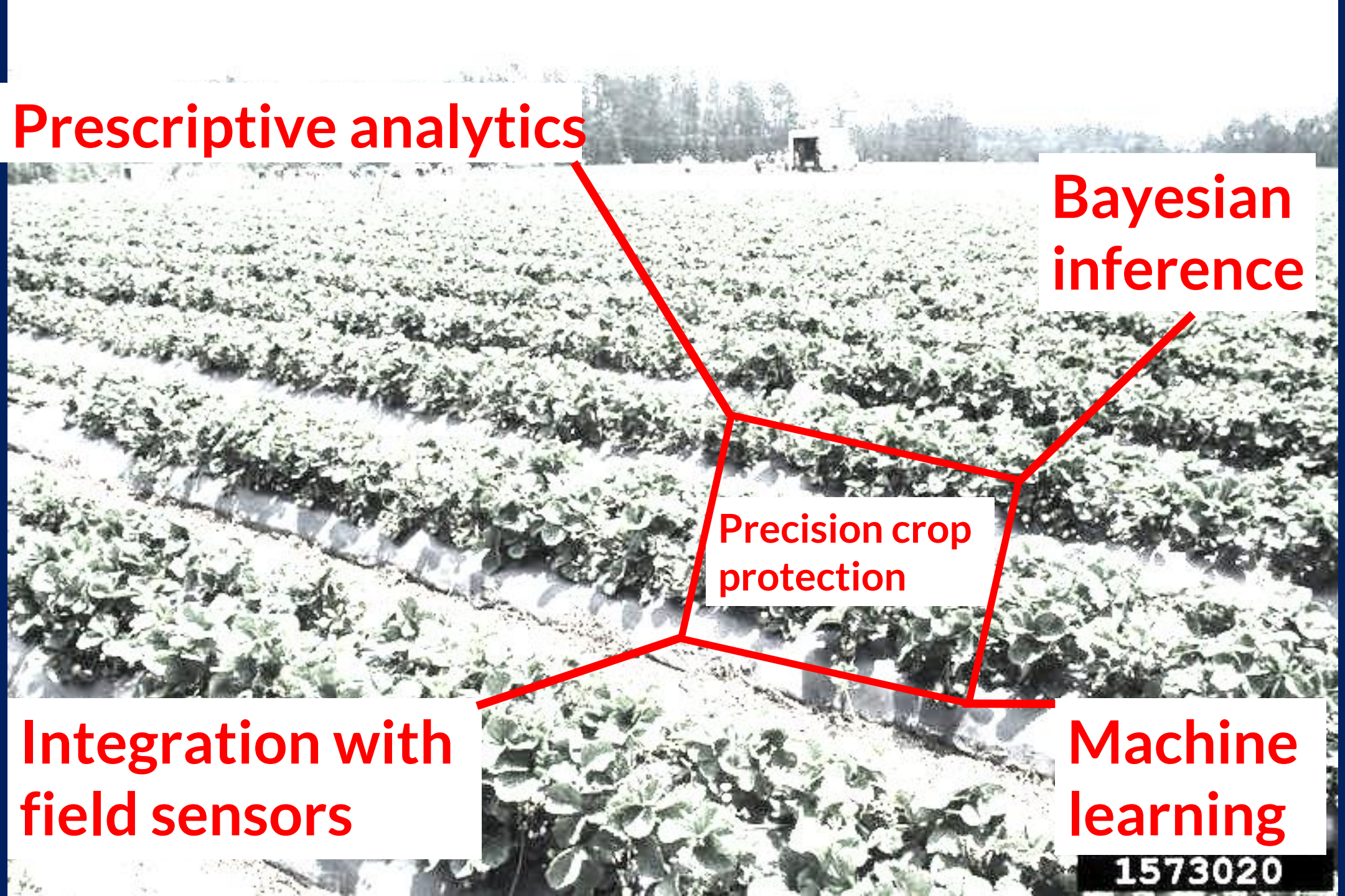
Fig. 5. Color-class map of daily severity values overlaid on a perspective map of terrain to forecast the likelihood of late blight infection for Pennsylvania (severity values 0.1–0.5 and 3.6–4.0 were not predicted). Forecast made 24 hours in advance for 21 August 1986 (8:00 a.m. 21 August to 8:00 a.m. 22 August).

Royer, M. H., Russo, J. M., & Kelley, J. G. W. Plant Disease Prediction Using High Resolution Forecasting Technique. *Plant Disease*, *73*(8).

Generation 4 ~ 2020s onwards?

Photo Gerald Holmes
Bugwood

Generation 4 ~ 2020s onwards?


Prescriptive analytics
Bayesian inference
Precision crop protection
Integration with field sensors
Machine learning
1573020

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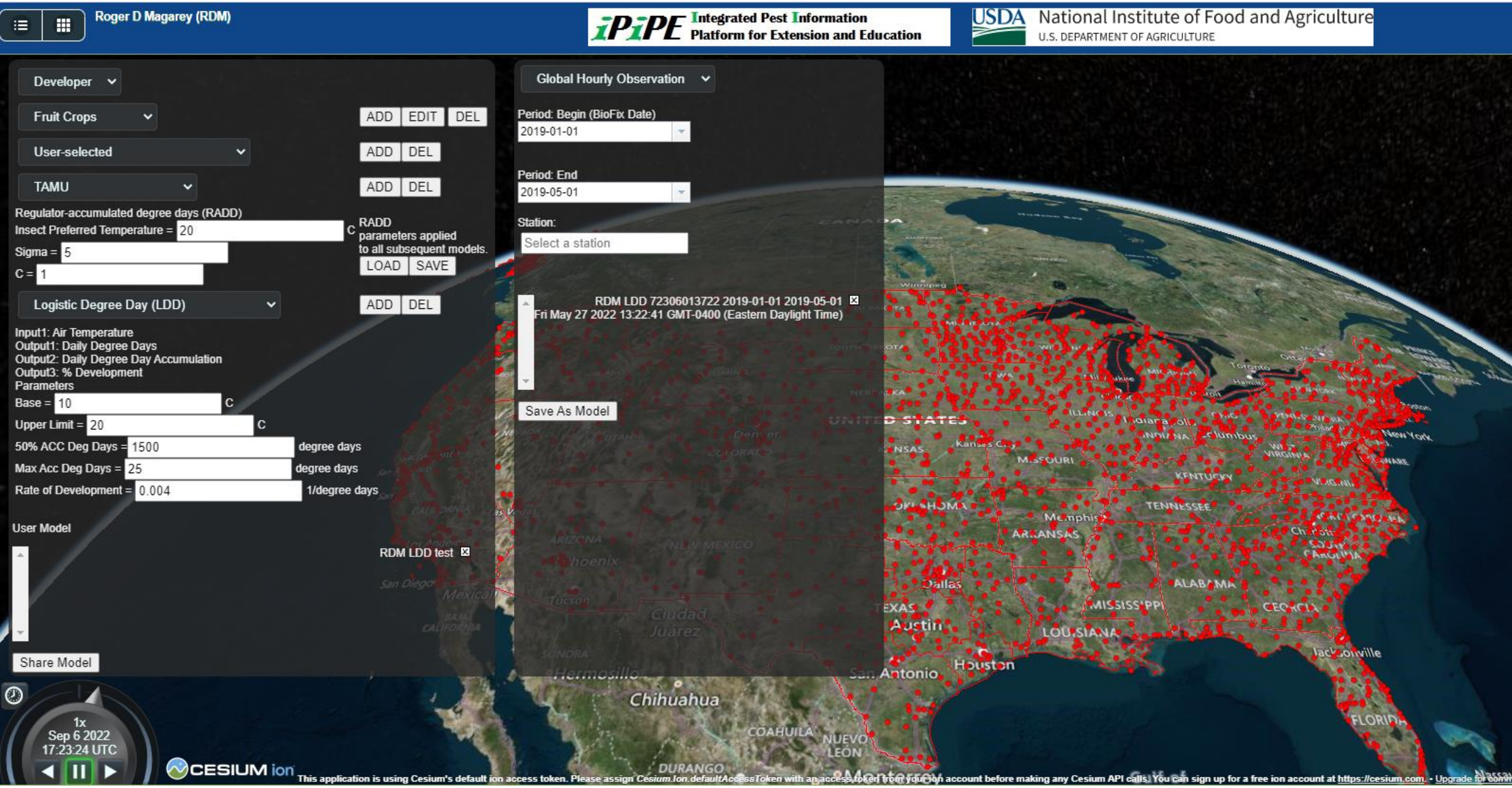
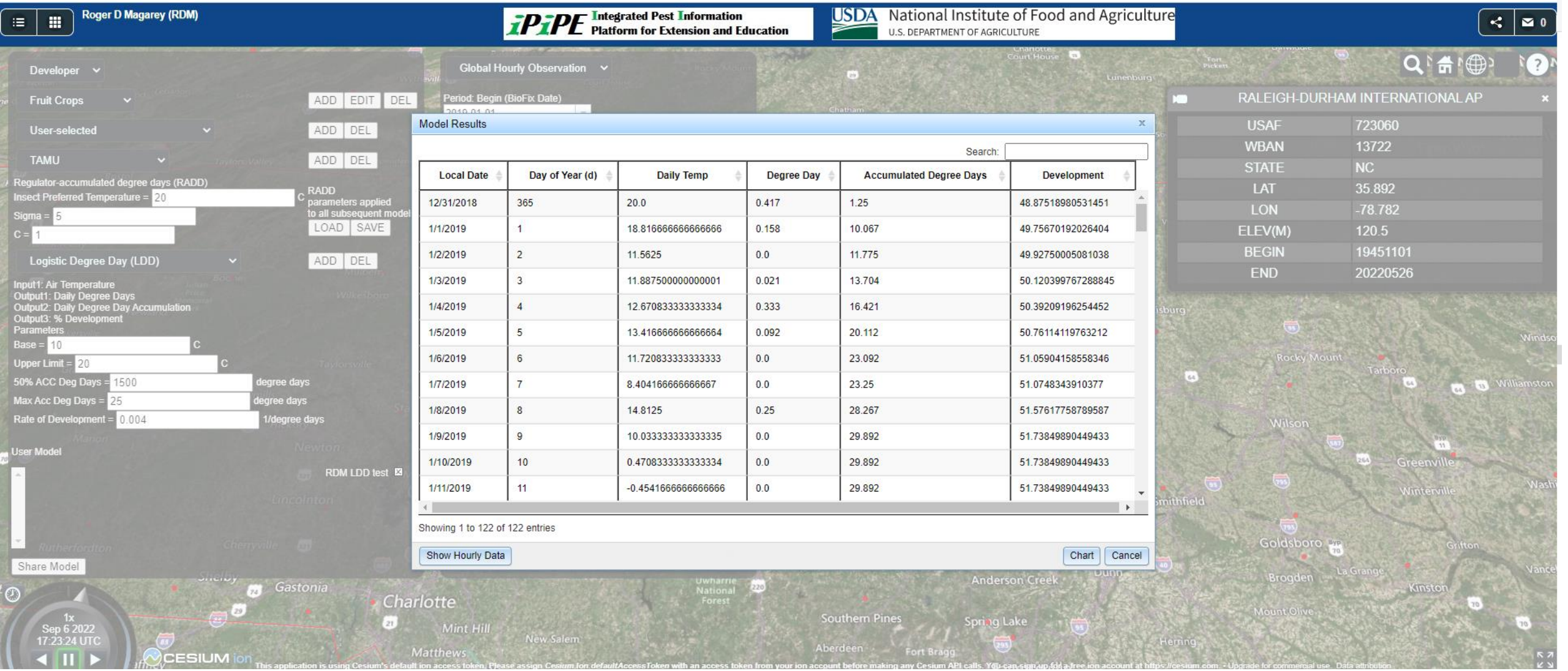

Roger D Magarey (RDM)
iPiPE Integrated Pest Information Platform for Extension and Education
USDA National Institute of Food and Agriculture
U.S. DEPARTMENT OF AGRICULTURE
Developer
Fruit Crops
ADD EDIT DEL
User-selected
ADD DEL
TAMU
ADD DEL
Regulator-accumulated degree days (RADD)
Insect Preferred Temperature = 20 C
Sigma = 5
C = 1
RADD parameters applied to all subsequent models.
LOAD SAVE
Logistic Degree Day (LDD)
ADD DEL
Input1: Air Temperature
Output1: Daily Degree Days
Output2: Daily Degree Day Accumulation
Output3: % Development
Parameters
Base = 10 C
Upper Limit = 20 C
50% ACC Deg Days = 1500 degree days
Max Acc Deg Days = 25 degree days
Rate of Development = 0.004 1/degree days
User Model
RDM LDD test
Share Model
Global Hourly Observation
Period: Begin (BioFix Date)
2019-01-01
Period: End
2019-05-01
Station:
Select a station
RDM LDD 72306013722 2019-01-01 2019-05-01
Fri May 27 2022 13:22:41 GMT-0400 (Eastern Daylight Time)
Save As Model
1x
Sep 6 2022
17:23:24 UTC
CESIUM ion
This application is using Cesium's default ion access token. Please assign Cesium.Ion.defaultAccessToken with an access token from your ion account before making any Cesium API calls. You can sign up for a free ion account at https://cesium.com. - Upgrade for comm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Regulator-accumulated degree days (RADD)
Insect Preferred Temperature = 20 C
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LOAD SAVE
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User Model
RDM LDD test
Share Model
Global Hourly Observation
Period: Begin (BioFix Date)
Model Results
Search:
Local Date
Day of Year (d)
Daily Temp
Degree Day
Accumulated Degree Days
Development
12/31/2018 365 20.0 0.417 1.25 48.87518980531451
1/1/2019 1 18.816666666666666 0.158 10.067 49.75670192026404
1/2/2019 2 11.5625 0.0 11.775 49.92750005081038
1/3/2019 3 11.887500000000001 0.021 13.704 50.120399767288845
1/4/2019 4 12.670833333333334 0.333 16.421 50.39209196254452
1/5/2019 5 13.416666666666664 0.092 20.112 50.76114119763212
1/6/2019 6 11.720833333333333 0.0 23.092 51.05904158558346
1/7/2019 7 8.404166666666667 0.0 23.25 51.0748343910377
1/8/2019 8 14.8125 0.25 28.267 51.57617758789587
1/9/2019 9 10.033333333333335 0.0 29.892 51.73849890449433
1/10/2019 10 0.4708333333333334 0.0 29.892 51.73849890449433
1/11/2019 11 -0.4541666666666666 0.0 29.892 51.73849890449433
Showing 1 to 122 of 122 entries
Show Hourly Data
Chart
Cancel
RALEIGH-DURHAM INTERNATIONAL AP
USAF 723060
WBAN 13722
STATE NC
LAT 35.892
LON -78.782
ELEV(M) 120.5
BEGIN 19451101
END 20220526
Rocky Mount
Tarboro
Williamston
Wilson
Greenville
Winterville
Goldsboro
Grifton
Brogden
La Grange
Kinston
Mount Olive
Smithfield
Anderson Creek
Southern Pines
Spring Lake
Aberdeen
Fort Bragg
Herring
Charlotte
Gastonia
Mint Hill
Matthews
New Salem
1x
Sep 6 2022
17:23:24 UTC
CESIUM ion
This application is using Cesium's default ion access token. Please assign Cesium.Ion.defaultAccessToken with an access token from your ion account before making any Cesium API calls. You can sign up for a free ion account at https://cesium.com - Upgrade for commercial use - Data attribution

Potential Areas of Collaboration

- Improved modeling infrastructure
- Student training on pest modeling
- Development of a pest modeling community including standards and shared data sets