Online IPM Weather Data and Degree-Days 2006 Update

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Abstract

Online decision support tools have been expanded at the website http://pnwpest.org/wea as supported by USDA grants, W. Region Pest Management Center, and the National Plant Diagnostic Network (NPDN). Near real time data from over 6,300 weather stations are coupled to degree-day (DD) calculators and models, DD mapping tools, and plant disease models. DD models have been featured at this website since 1996, and expanded to a national extent since 2005. DD mapping tools were first developed in 1998 and have been continuously improved and expanded to cover the 48-state US since then. New "date of phenological event prediction" (DPEP) maps allows dates of selected degree-day events to be mapped, which we expect to help end-user utility and acceptance. A new prototype 48-state disease risk modeling tool is demonstrated that will be available for a variety of existing and introduced plant diseases such as powdery mildew, apple scab, and potentially, invasives such as soybean rust. Other new and expanded features of the system include automated estimation of missing weather data, national and regional daily degree-day maps, a new server array for custom DD mapmaking by 5+ simultaneous users, a DD models database with 49 species linked to the degree-day modeling tool, a custom grass seed stem rust simulation model, and 7 to 10 day temperature forecasts integrated with DD models. Website usage has increased continuously, for example DD model/calculator usage has grown from 6,000 in 2000 to 15,000 in 2005.

Objectives

1. Develop automated phenological and disease risk modeling for US agricultural and biosecurity needs
2. Extend (interpolate) these model estimates geographically
3. Extend model estimates temporally using new weather forecast techniques
3. Deliver phenological and disease risk maps via the world-wide-web

Technologies Used

- Open source web application server - Linux/Apache/CGI/Perl
- Open source GIS: GRASS 5.4, GRASSLinks 3.4
- Oregon Climate Service PRISM climate maps (monthly temperature max and mins)
- Resolution: 2 KM, downscaled to 360 meters using custom geographically weighted regression written in GRASS r.mapcalc
- Data management programs: Perl, UNIX shell
- Weather data database: free format text files for individual stations and years, flat-file attributes database
- SQL database of phenological models (23 fields, web-interface for distributed database management)

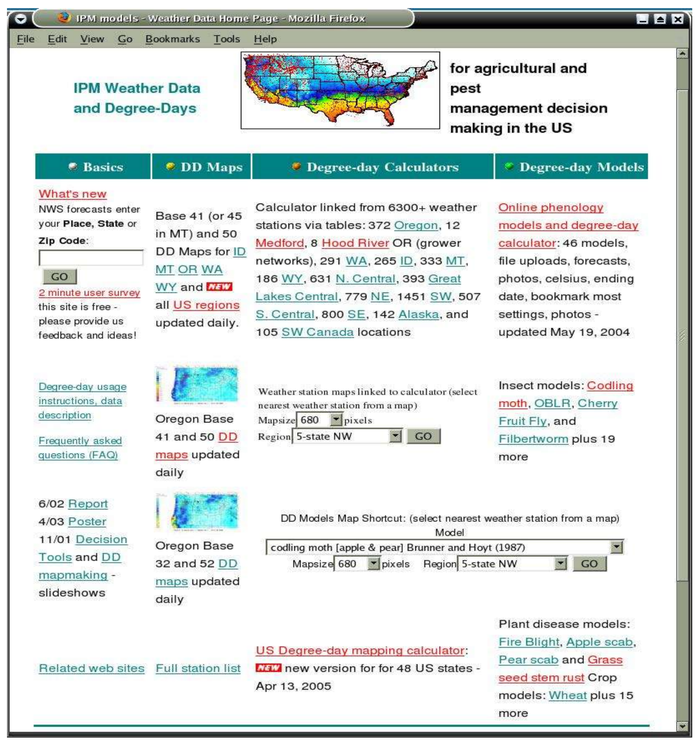

Fig 1. Homepage at http://pnwpest.org/wea The specific products described here are the daily DD maps and the NW DD mapping calculator

Database Description

- Weather database currently includes a total of 6300+ stations (data for each station and year in two text files (daily and hourly data), station attributes stored in a flat file database)
- All GIS datalayers (PRISM monthly temperature maps, elevation, roads, county lines, etc) stored within GRASS database
- Single-site phenology modeling program linked to database of 49 models (27 insect, 3 disease, 16 crop, 2 weed, 1 mating disruption dispenser)
- Mapping phenology program includes 4 types of degree-days (simple average, single and double triangle, growing degree-days)

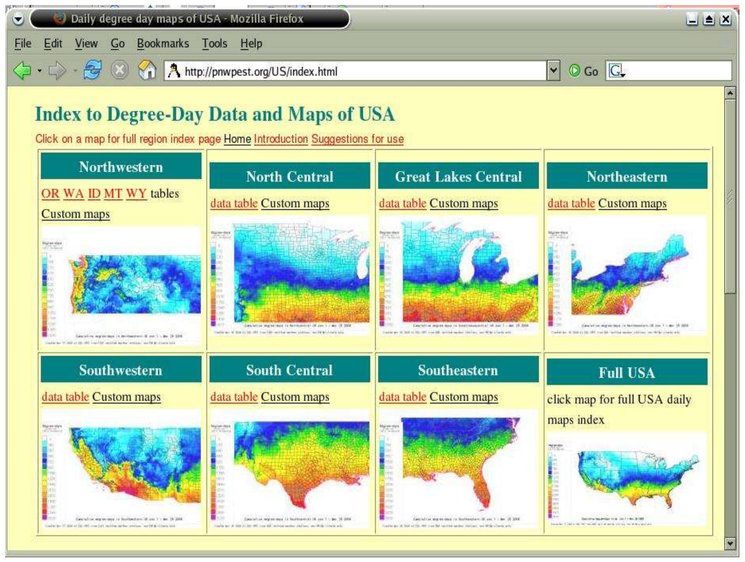

Fig 2. Base 32, 41, and 50 daily degree-day maps are available for each of 7 US regions, all 48 coterminous states, and with GRASSLinks interactive user interface

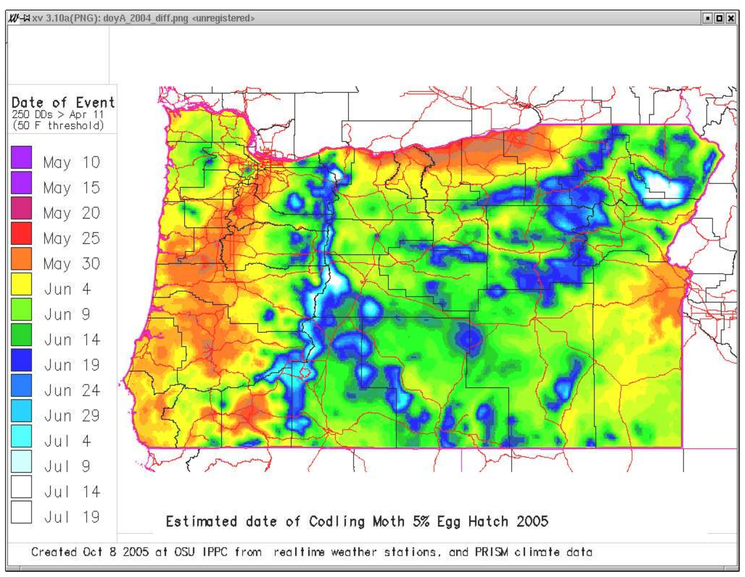

Fig 3. Prototype "Date of Phenological Event Prediction" (DPEP) map – this new form of IPM decision support aid converts degree-days to predicted dates for a given phenological event, such as codling moth 5% egg hatch. While more computing-intensive, we expect that such "DPEP" maps will be more intuitive and easier to use than "DD" maps.

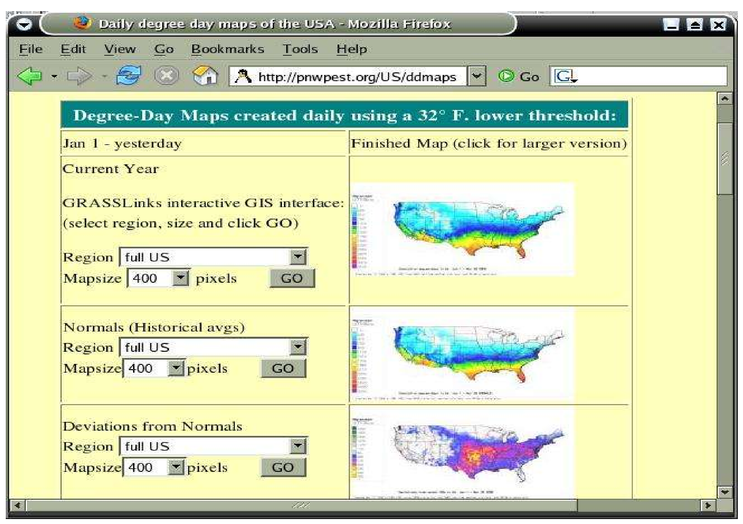

Fig 4. Example of a daily series (US) displaying at a glance, for Jan 1 - March 28, 2006, the current (top), historical average (middle), and deviations from normal (bottom) degree-days. Thus far in 2006, most of central and eastern US exhibit warmer than normal weather. In addition, user may click on maps for full size versions, and (on left), forms for entry into the GIS interactive interface allowing for more advanced zooming, queries, etc. (see Fig. 5)

Project Participants and Acknowledgements

- WR IPM Centers supported "Western Weather Systems Workgroup", including OSU IPPC, USDA Corvallis, OSU Climate Center, UC Davis, WSU, Fox Weather LLC
- USDA Areawide and WR IPM competitive grants (1995-2005)
- USDA NPDN grants (2005-present)
- USDA NRI biosecurity grant (2006-2009)
- Oregon Statewide IPM program funds (IPPC)
- Several Northwest grower networks for weather data
- Many public weather networks (e.g. NWS, Agrimet, RAWS, APRSWXNET)

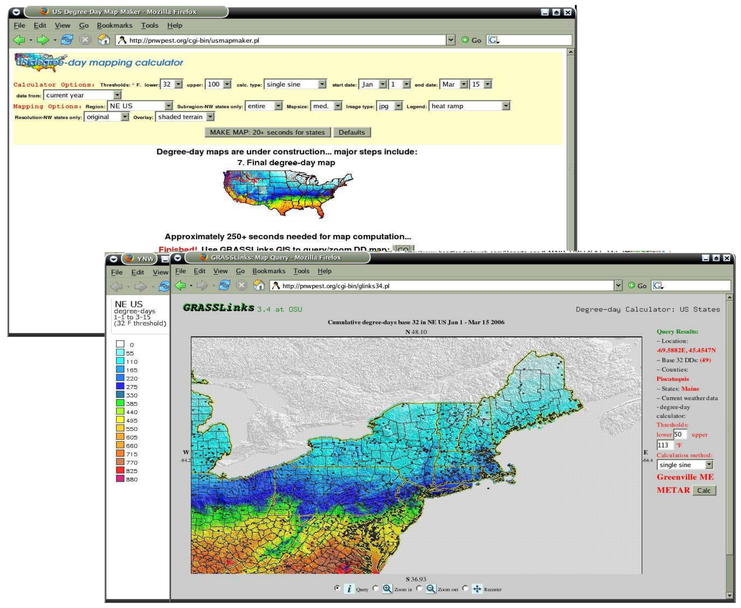

Fig 5. Custom interactive web-based degree-day map example. The online user has created, via a web-browser form (shown behind main image), a custom phenology map, for the settings shown, and clicked "GO" to use the GRASSLinks web GIS interface. The user then queried site-specific degree-days near the Greenville ME weather station. At the selected location, 49 DDs have accumulated (verifiable using the site DD calculator).

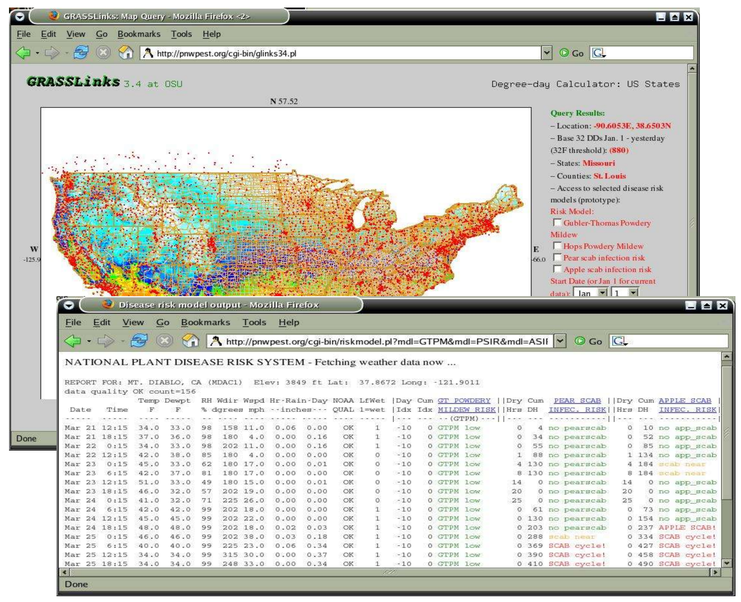

Fig 6. Prototype generic plant disease risk modeling system. Online user selects site from 5000+ available stations, selects models of interest (4 currently available, others in preparation), output duration, dates, and clicks "Calc" to run models and see text display of weather data and model results. This system is under development currently to support NPDN operations.

Degree-Day Mapmaking Strategy and Procedures

- Local weather parameter variation is largely a function of elevation and other terrain characteristics. The PRISM (Parameter-elevation Regressions on Independent Slopes Model) expert system, at Oregon State University's Oregon Climate Service, http://ocs.orst.edu, has resulted in a series of digital and paper climate maps for all of the USA, W. Canada, and China. This system produces high quality average precipitation, temperature, and other climate parameter maps using locally derived parameter vs. elevation regression analyses, with weighting adjusted for other climatic factors such as coastal effects and two-layer atmospheric (inversion) effects. Current spatial resolution is ca. 2 KM per cell border. Every available high quality historical dataset is used for PRISM analysis. Current PRISM maps are produced from 30-year 1971-2000 data
- Online weather station networks (currently up to 6300+ stations) are used as inputs to computing actual site DDs
- Custom degree-day (DD) maps are calculated from PRISM monthly max and min temperature GIS data layers for daily (Figs. 2 & 4) and user-selected thresholds, dates, and calculation method (via a regular web browser; Fig. 5) using the GIS GRASS 5.4
- For all sites, the difference between actual and PRISM-based DDs are computed
- These site differences are then interpolated to make a correction maplayer (inverse-distance^2 interpolation, using nearest 6 points) in the GIS
- This correction maplayer is then added to the PRISM-based DD map, effectively correcting historical average DDs to actual DDs
- This new corrected maplayer now has estimated DDs for the entire map surface - all values at weather station sites are accurate
- This same general procedure has been used for estimation of missing daily max and min temperatures for all weather station data since 2003

Ongoing and Future Developments

- Improve disease forecast and risk mapping capabilities, initially focusing on validations in WR tree fruit, small fruit, grass seed, and hop diseases and several existing generic disease models
- Expand forecast and risk maps for multi-region pest monitoring networks, and for local pest scouting and trapping networks
- More effectively estimate leaf wetness for disease models using temperature, dewpoint, windspeed, and other standard weather station parameters
- Develop improved downscaling algorithms that can also use slope, aspect, and proximity to water as required for sub-50 meter estimates
- Continue to serve and expand IPM and plant biosecurity products (models and weather data/forecasts) without cost to end users
- Continued automation of all activities to minimize maintenance and support costs