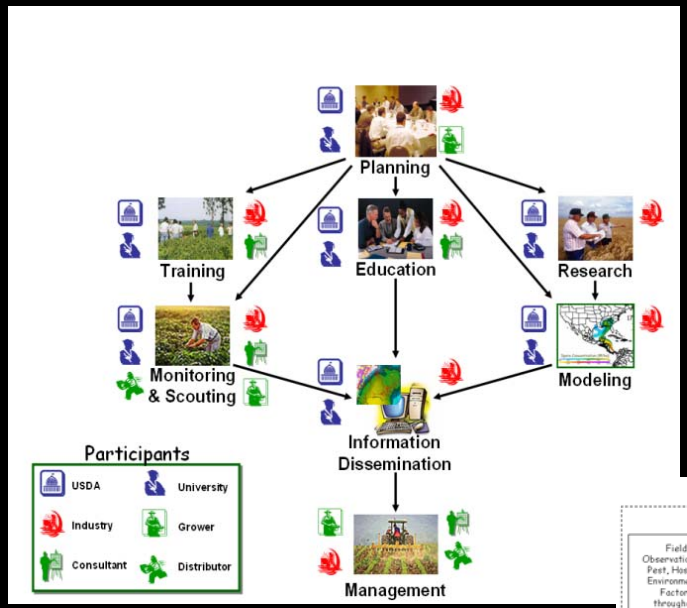
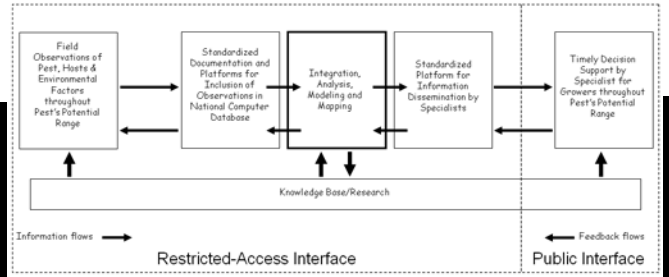
Early Warning Systems for Rust Diseases

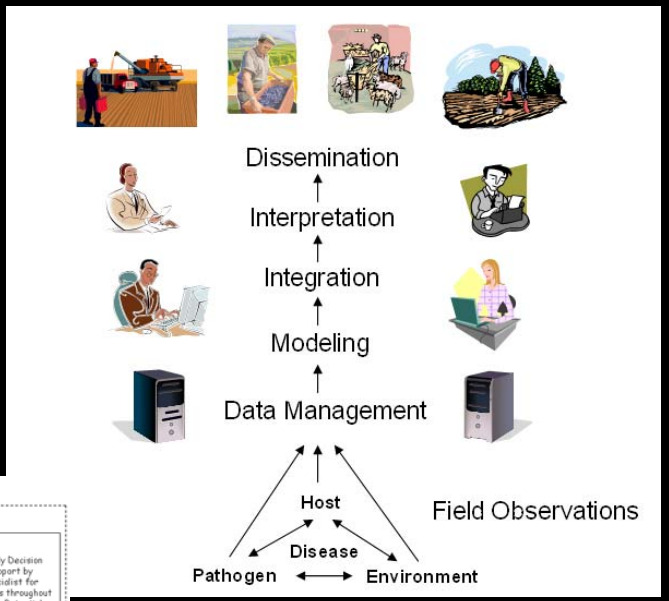
Scott A. Isard
Professor of Aerobiology
Departments of Plant Pathology
& Meteorology
Penn State University



Components & Participants

IT Platform





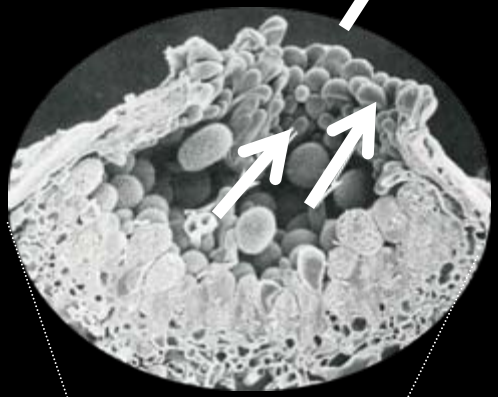
Tasks

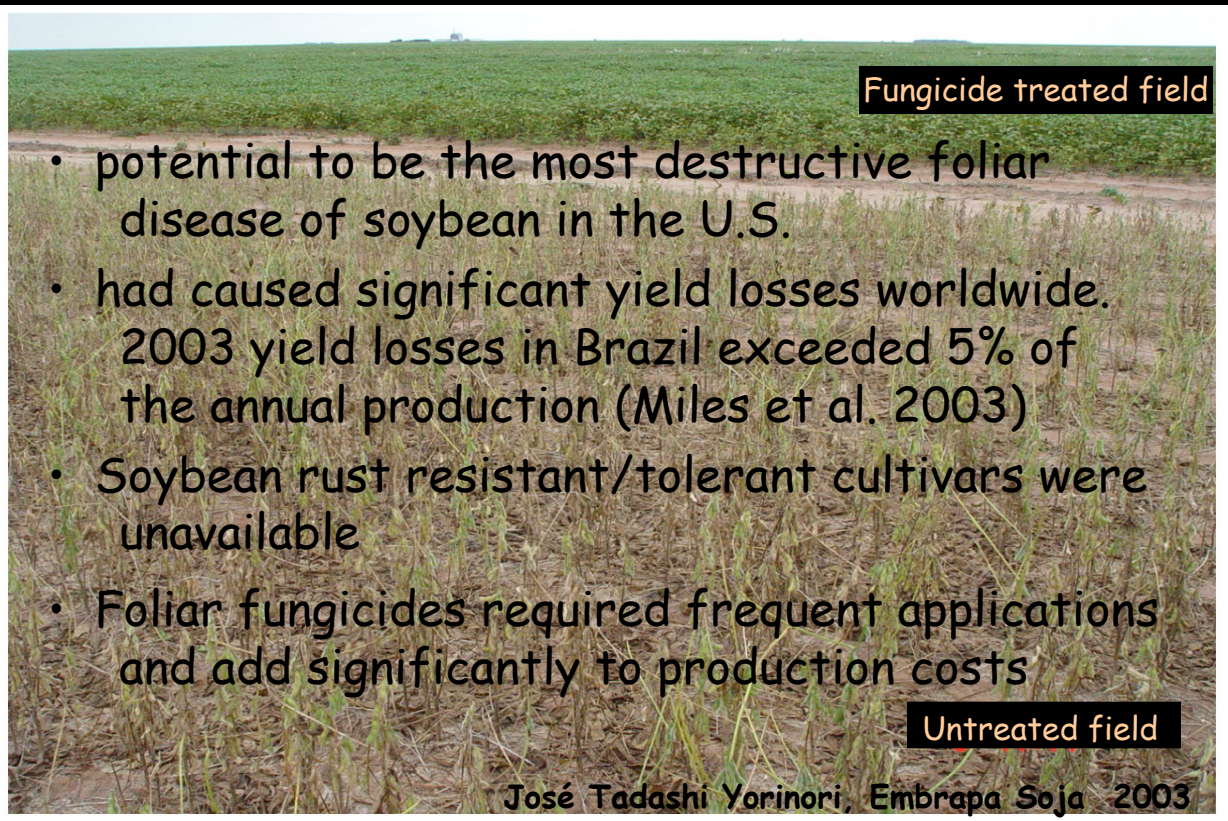
Early Warning Systems for Rust Diseases

Lessons learned from the Soybean Rust experience

Preparing for "in-season" management of new wheat stem rust races

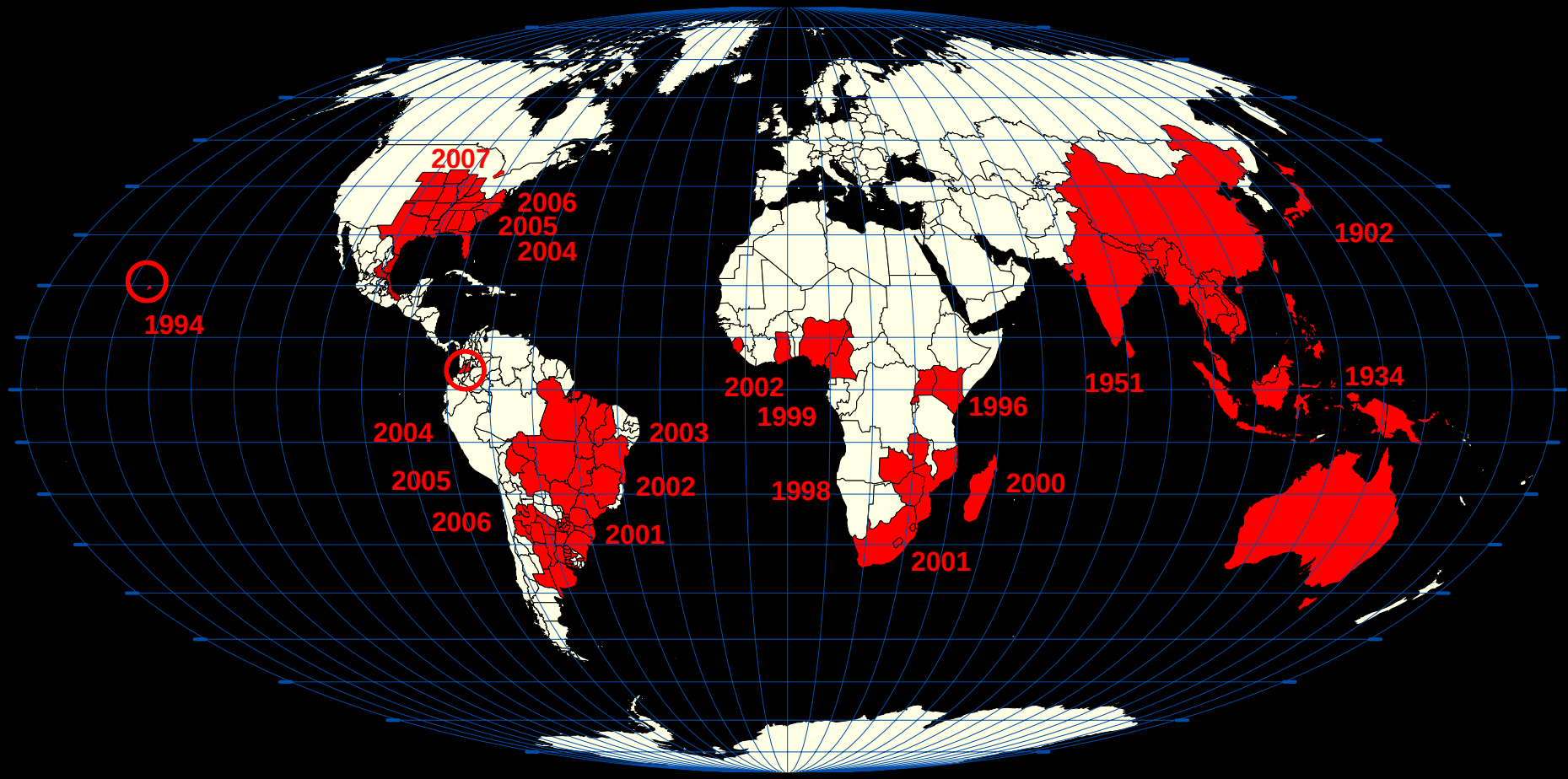
Situation regarding SBR in 2004 prior to entry into US

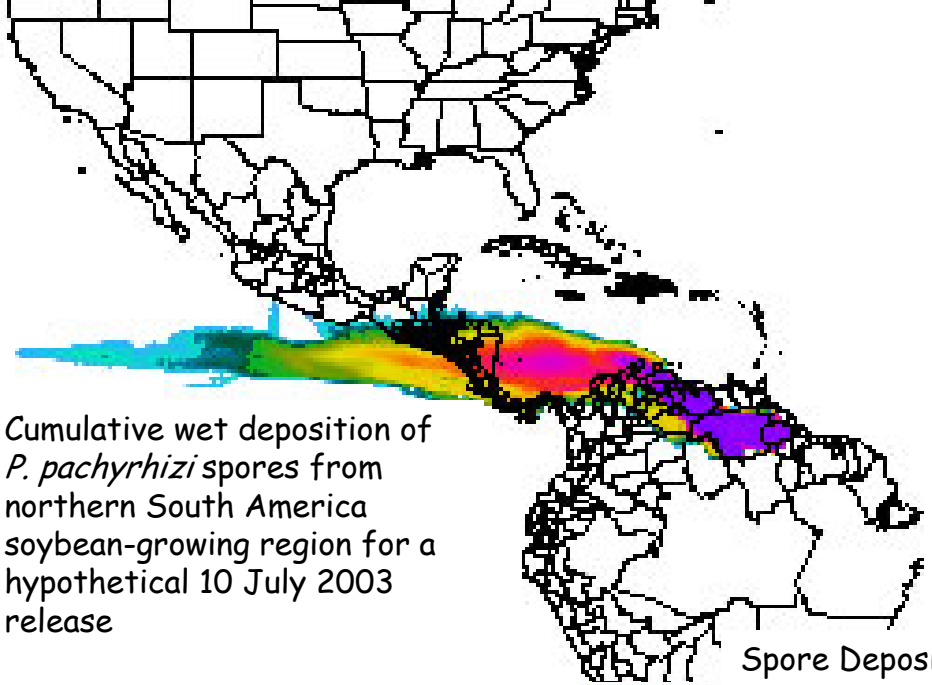




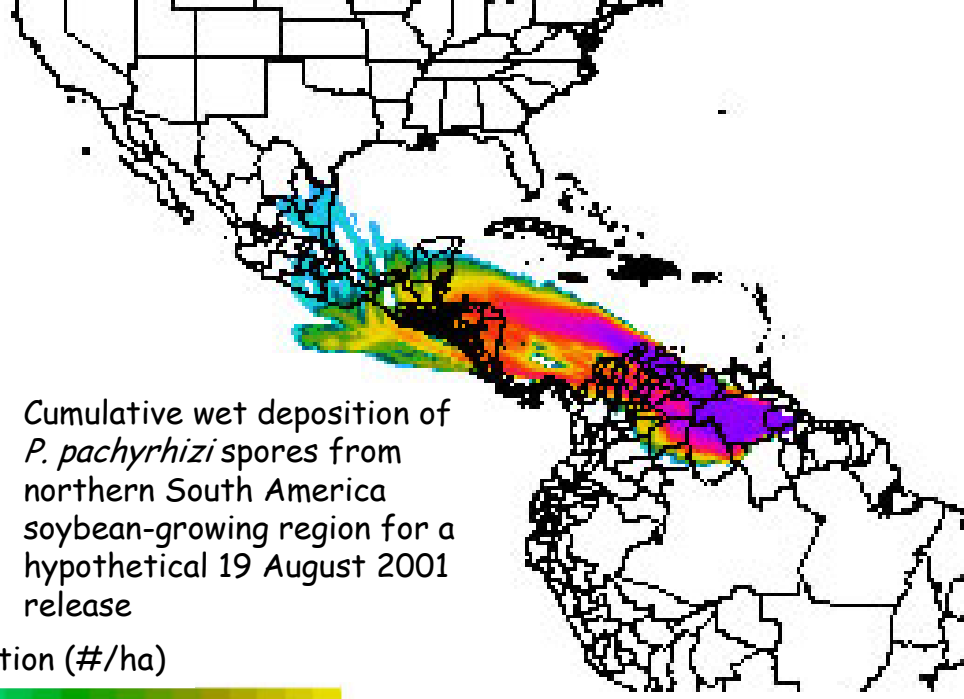
- potential to be the most destructive foliar disease of soybean in the U.S.
- had caused significant yield losses worldwide. 2003 yield losses in Brazil exceeded 5% of the annual production (Miles et al. 2003)
- Soybean rust resistant/tolerant cultivars were unavailable
- Foliar fungicides required frequent applications and add significantly to production costs

Soybean Rust Spread





Cumulative wet deposition of *P. pachyrhizi* spores from northern South America soybean-growing region for a hypothetical 10 July 2003 release

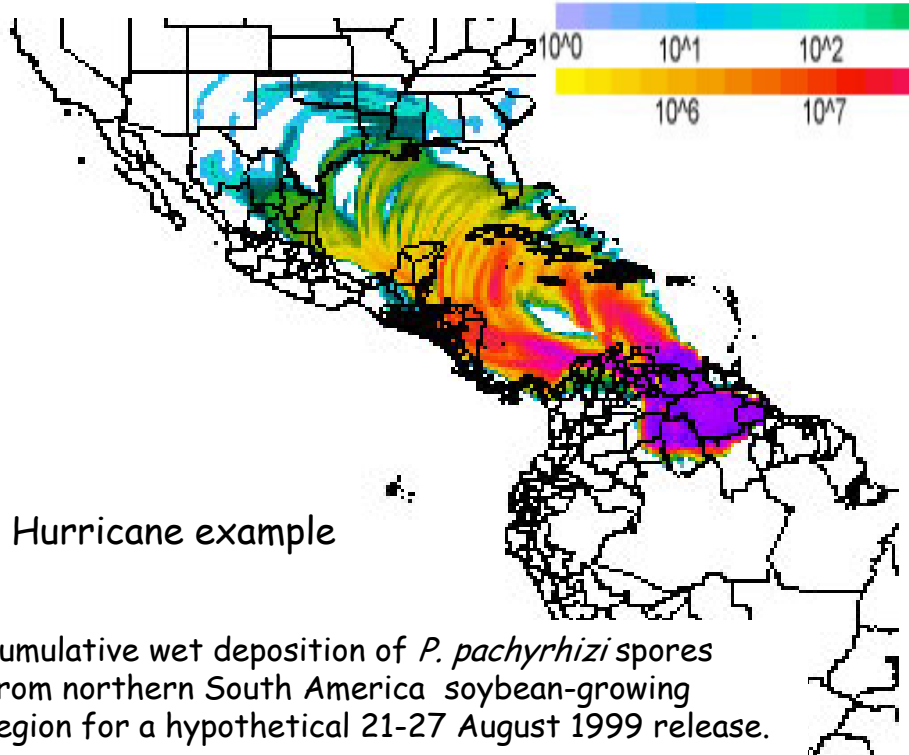


Cumulative wet deposition of *P. pachyrhizi* spores from northern South America soybean-growing region for a hypothetical 19 August 2001 release

Spore Deposition (#/ha)

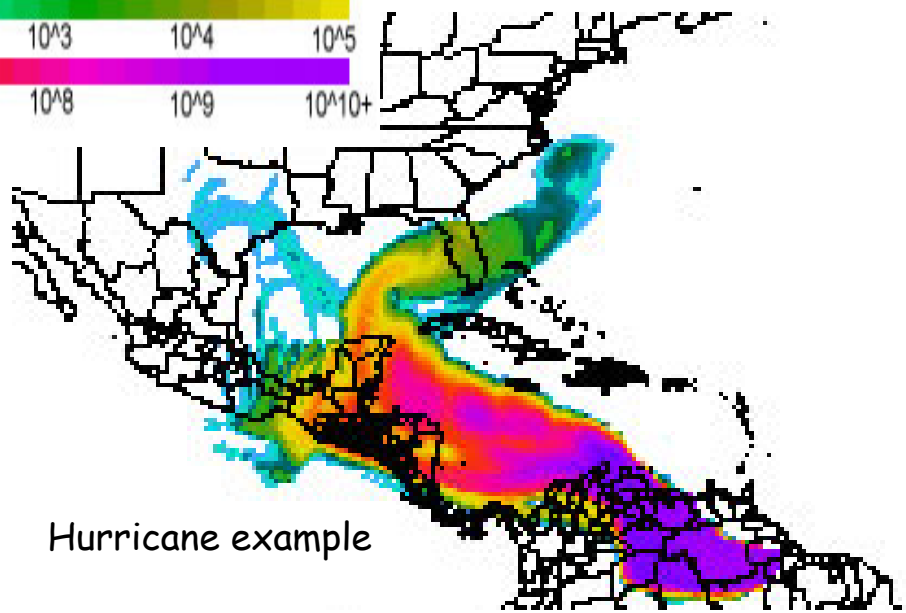
10^0 10^1 10^2 10^3 10^4 10^5

10^6 10^7 10^8 10^9 10^10+



Hurricane example

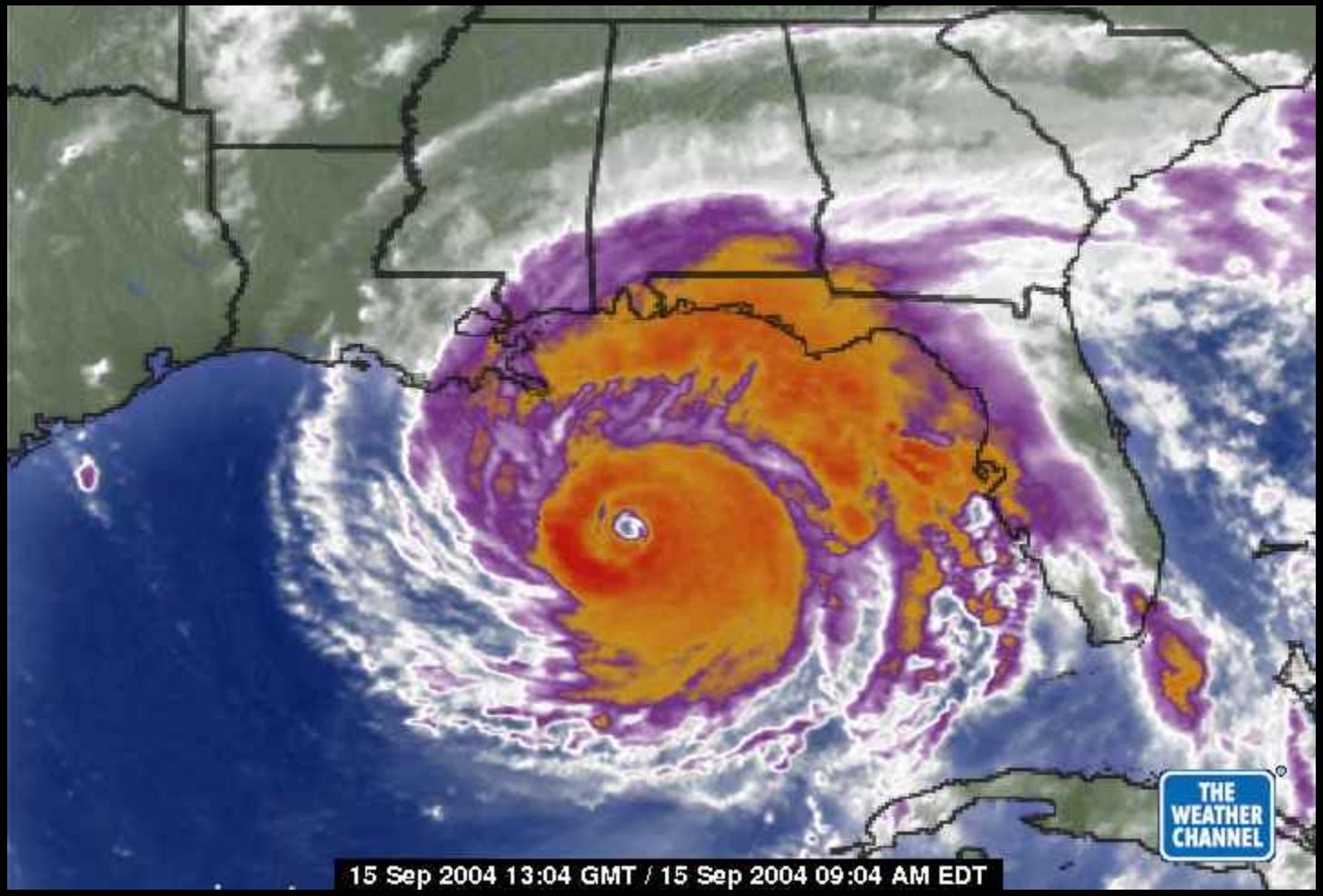
Cumulative wet deposition of *P. pachyrhizi* spores from northern South America soybean-growing region for a hypothetical 21-27 August 1999 release.



Hurricane example

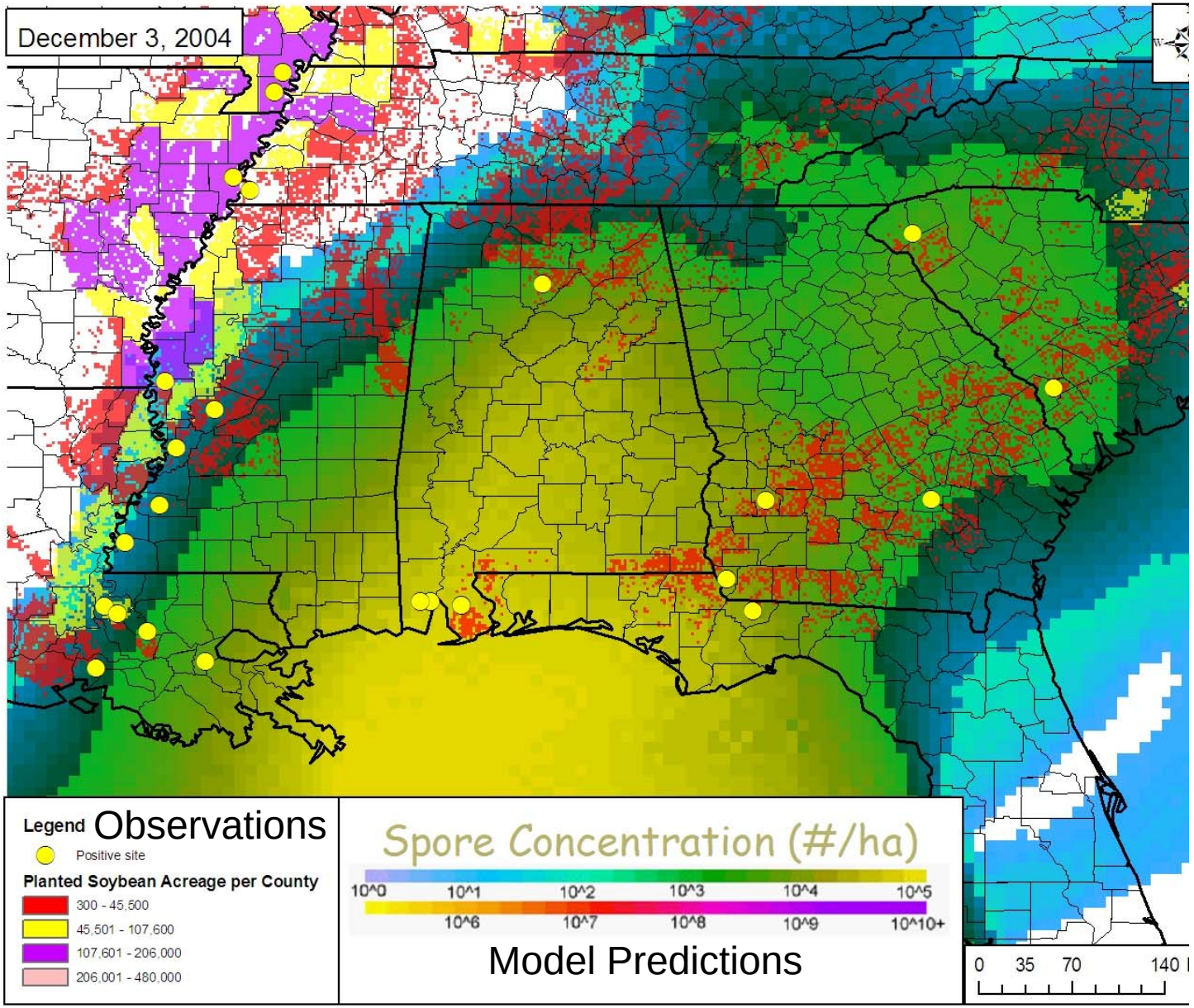
Cumulative wet deposition of *P. pachyrhizi* spores from northern South America soybean-growing region for a hypothetical 22-29 August 2003 release.

Hurricane Ivan 2004



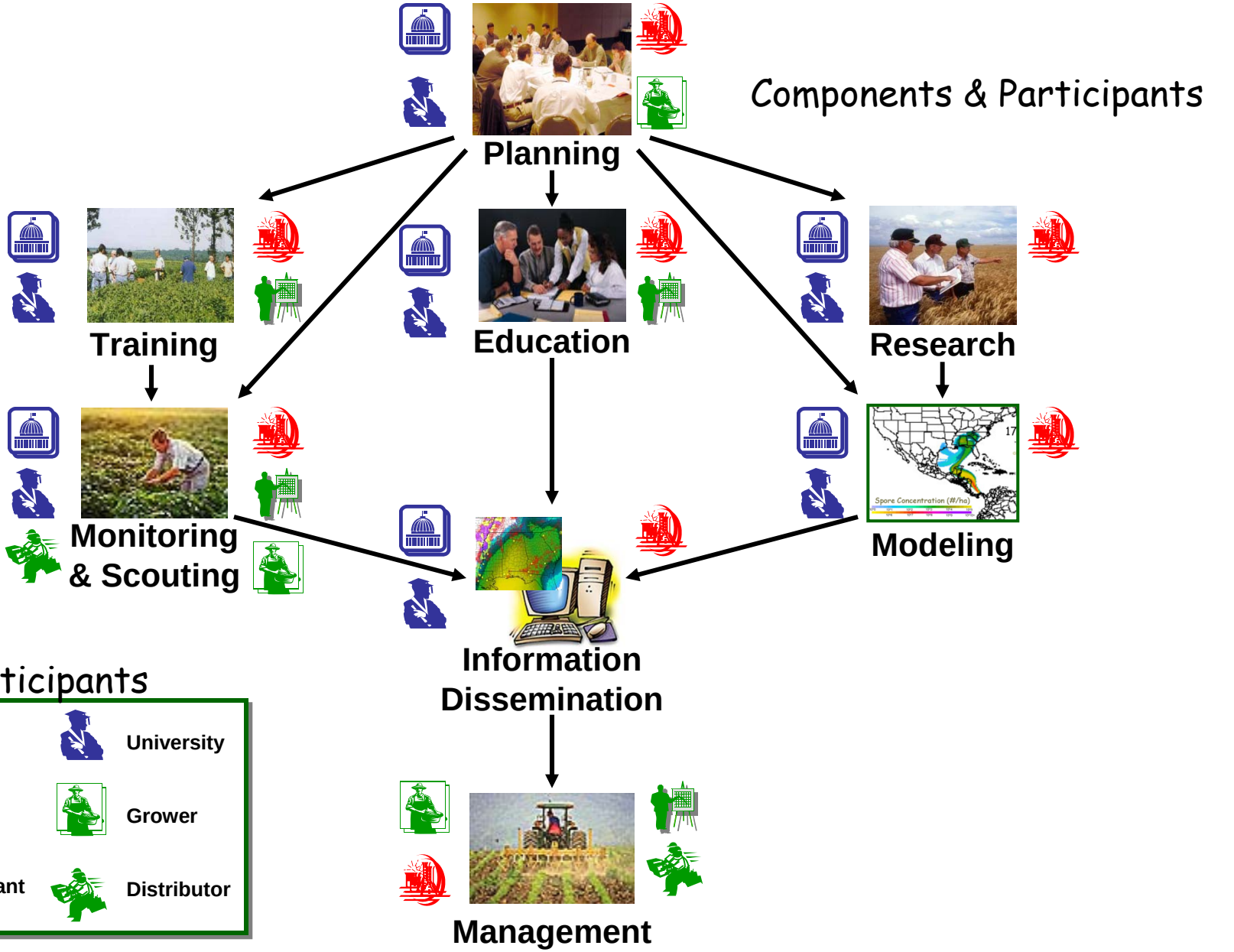
September 15, 2004

2004 Soybean Rust Incursion into Southeastern U.S.

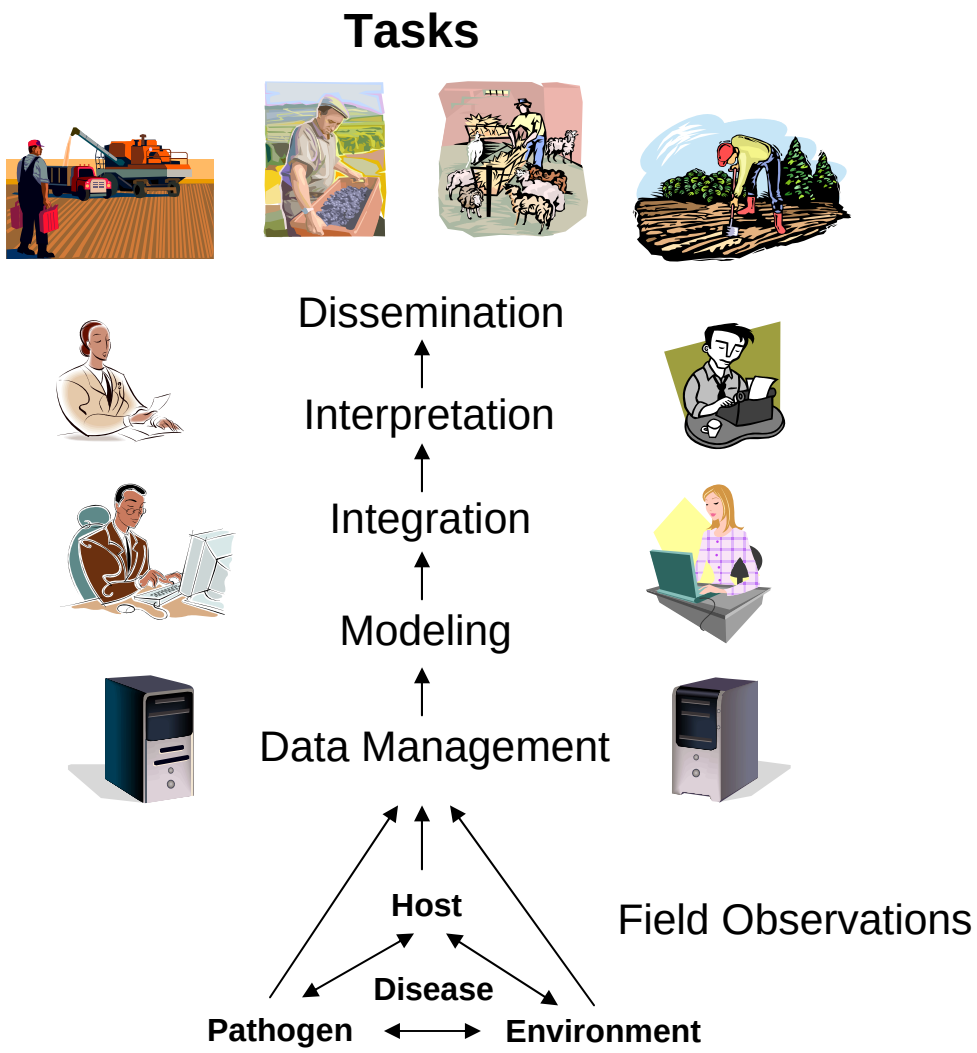


USDA Soybean Rust Coordinated Framework

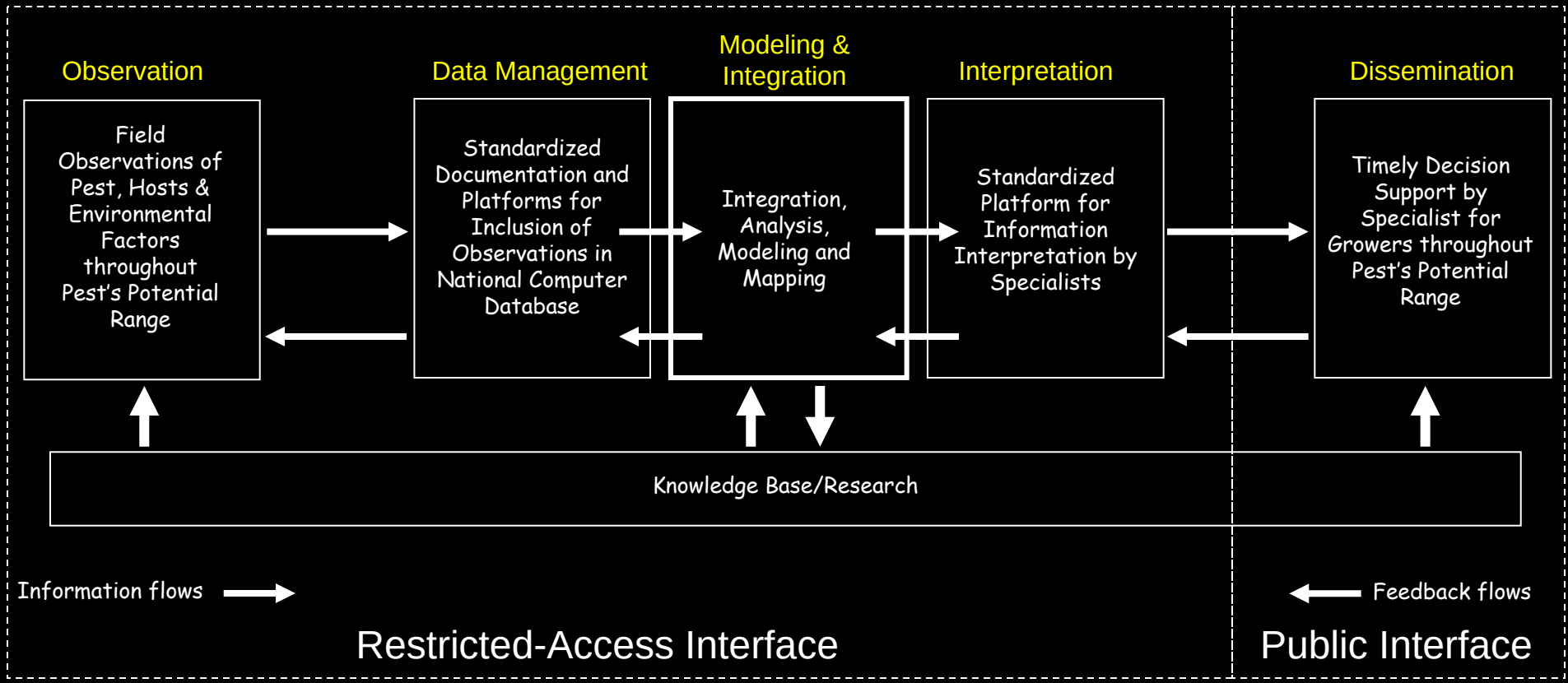
From planning to management in 2004/2005



Combining Information Technology and IPM Paradigms



Pest Information Platform for Extension & Education (PIPE)



People and computers linked by "state-of-the-art" Information Technology

Plot Setup Form

Observer Scott Isard

Obs Date 2005 Sep 29

Country USA

State --

County --

Location Type --

Location Name - Select one or enter below -

Longitude (DD)

Latitude (DD)

e Usage

Save Obs

Down

Observation Forms Help

- Location Type -

- Location Name - Setup

Online Entry | Download Excel | Upload Excel

PDA Edit

Lab ID

Obs Date

Country

State

County

Location Type

Location Name

Longitude (DD)

Latitude (DD)

Field Sample ID

Diagnostic Laboratory Form

Obs Date 2005 Sep 29

Country USA

State --

County --

Location Type --

Location Name - Select one or enter below -

Longitude (DD)

Latitude (DD)

Plot 1

Plot ID

Host --

Cultivar

Plant Date 2005 Sep 29

Height --

Veg Stage --

Rep Stage --

Canopy Closure --

Continue

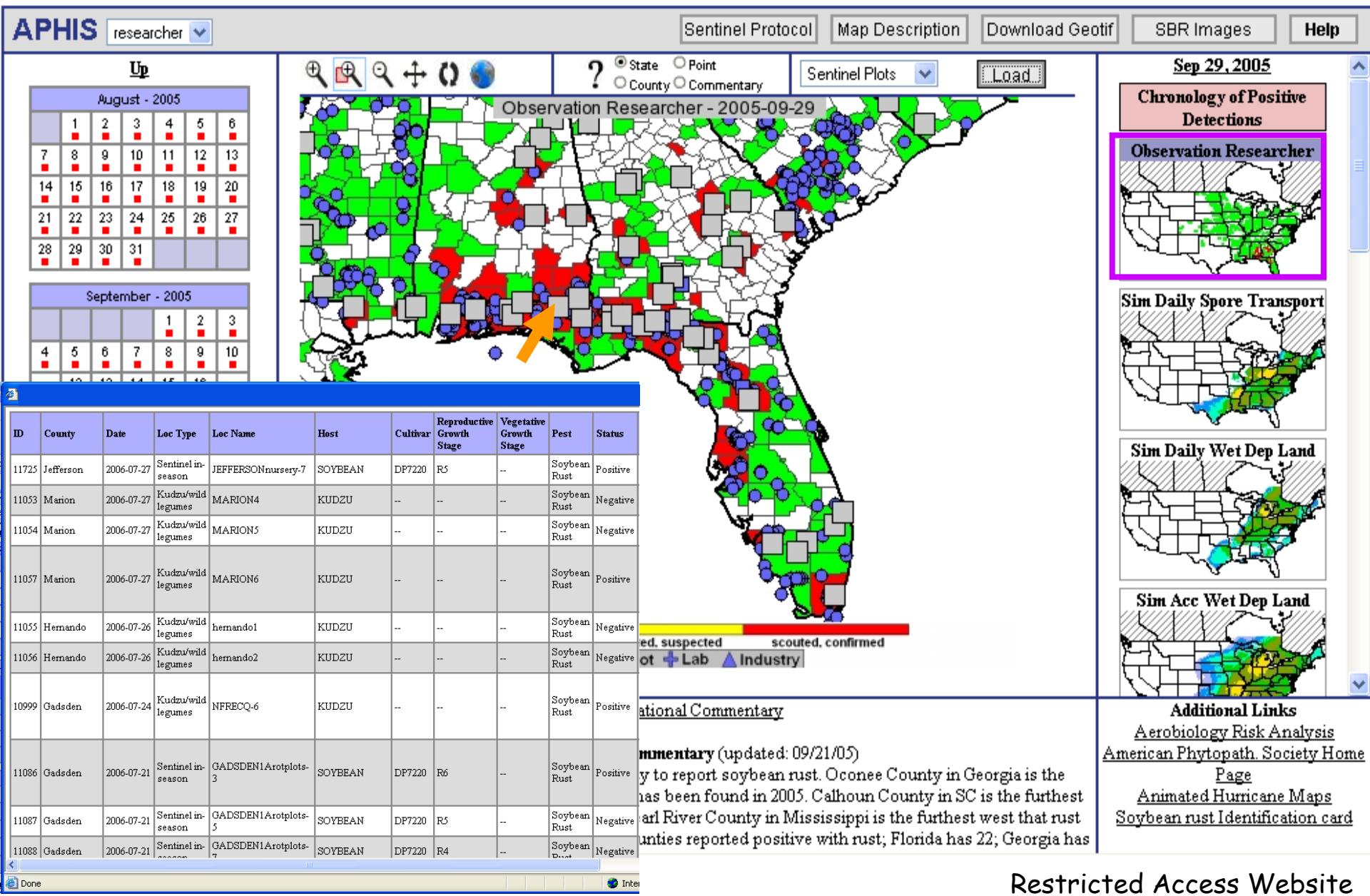
Save Obs

Data Entry Form

Data Management

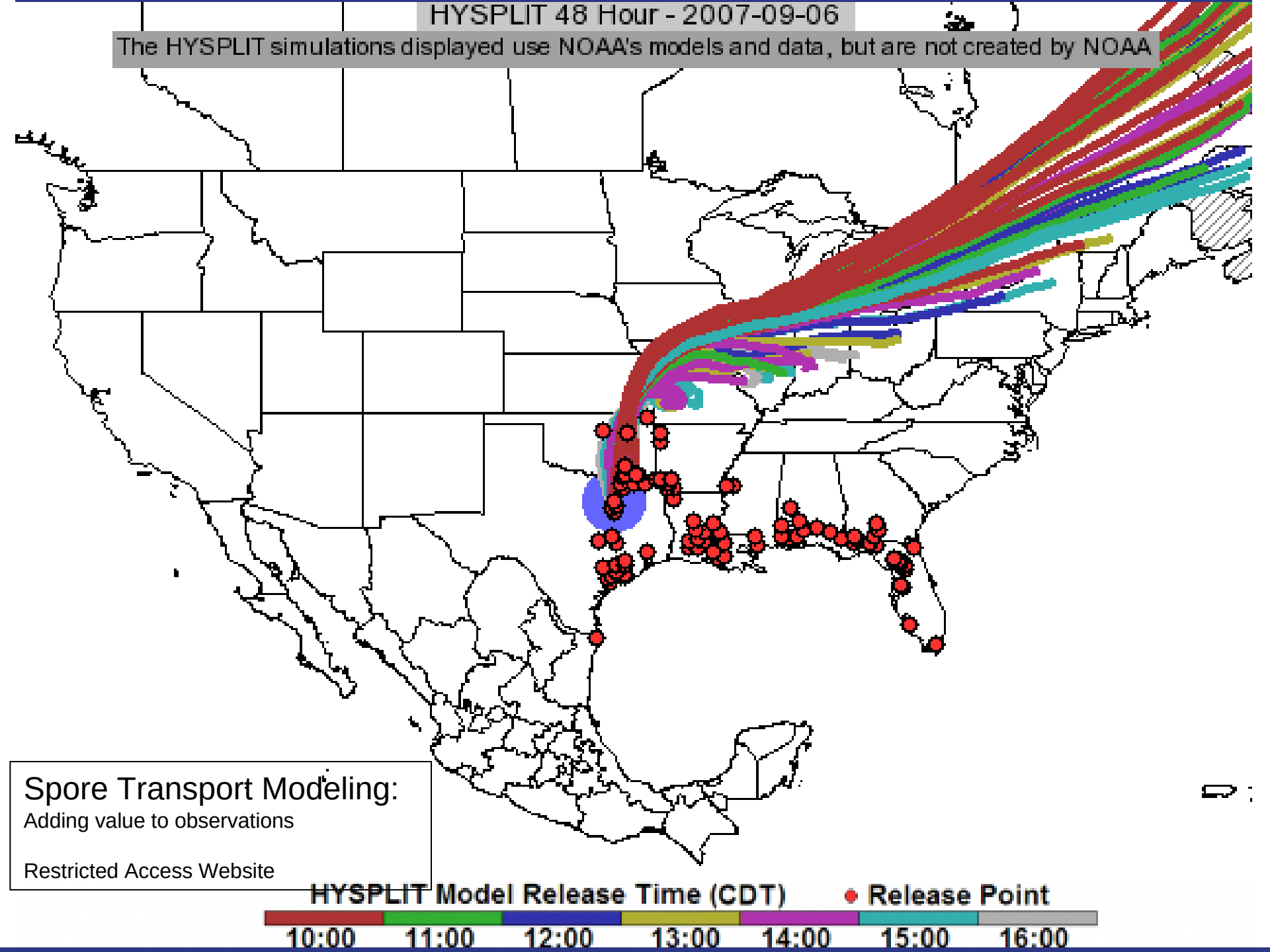
Restricted Access Website

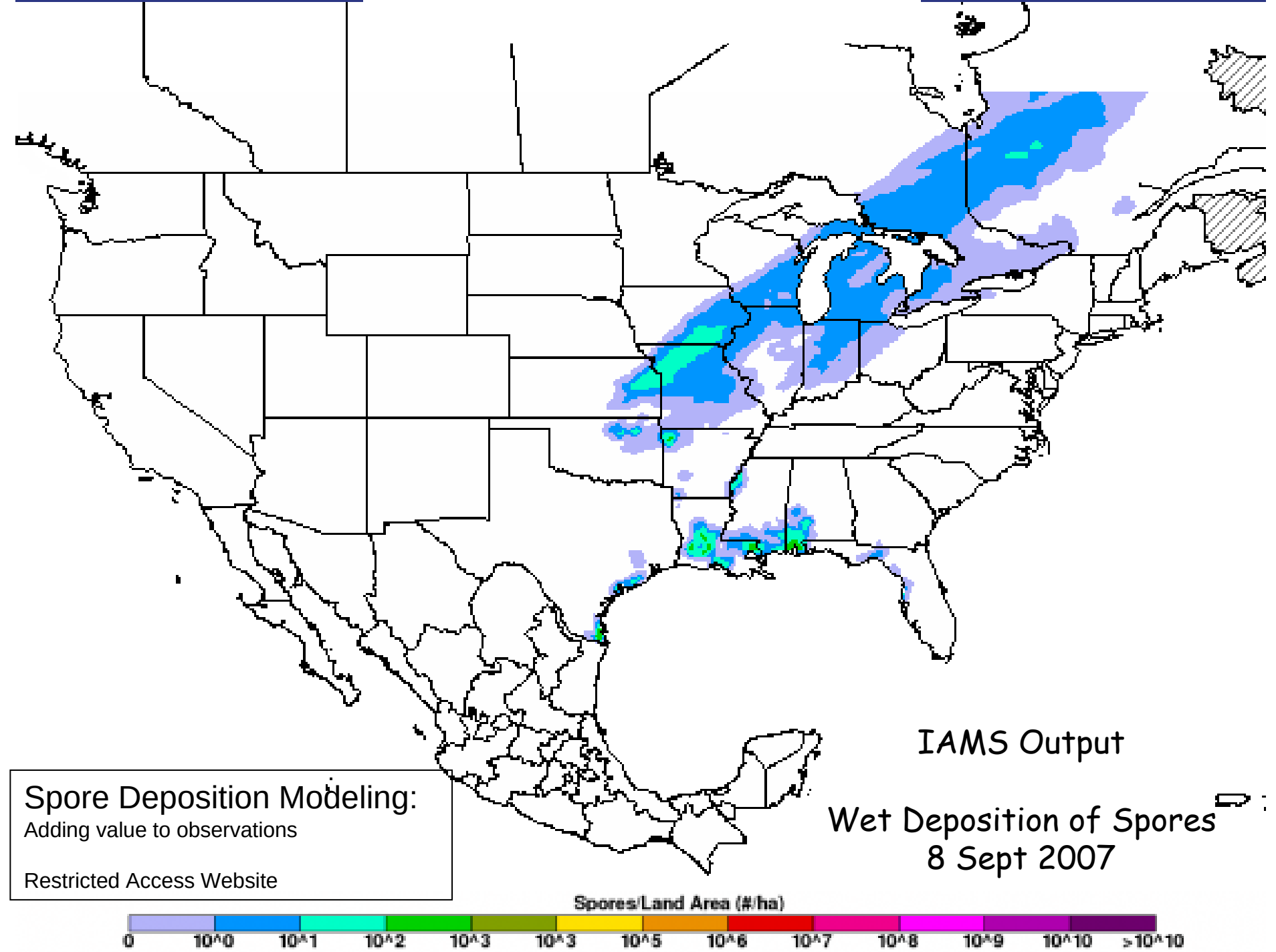
Data Management and Integration



ID	County	Date	Loc Type	Loc Name	Host	Cultivar	Reproductive Growth Stage	Vegetative Growth Stage	Pest	Status
11725	Jefferson	2006-07-27	Sentinel in-season	JEFFERSONnursery-7	SOYBEAN	DP7220	R5	--	Soybean Rust	Positive
11053	Marion	2006-07-27	Kudzu/wild legumes	MARION4	KUDZU	--	--	--	Soybean Rust	Negative
11054	Marion	2006-07-27	Kudzu/wild legumes	MARION5	KUDZU	--	--	--	Soybean Rust	Negative
11057	Marion	2006-07-27	Kudzu/wild legumes	MARION6	KUDZU	--	--	--	Soybean Rust	Positive
11055	Hernando	2006-07-26	Kudzu/wild legumes	hernando1	KUDZU	--	--	--	Soybean Rust	Negative
11056	Hernando	2006-07-26	Kudzu/wild legumes	hernando2	KUDZU	--	--	--	Soybean Rust	Negative
10999	Gadsden	2006-07-24	Kudzu/wild legumes	NFRECQ-6	KUDZU	--	--	--	Soybean Rust	Positive
11086	Gadsden	2006-07-21	Sentinel in-season	GADSDEN1Arotplots-3	SOYBEAN	DP7220	R6	--	Soybean Rust	Positive
11087	Gadsden	2006-07-21	Sentinel in-season	GADSDEN1Arotplots-5	SOYBEAN	DP7220	R5	--	Soybean Rust	Negative
11088	Gadsden	2006-07-21	Sentinel in-season	GADSDEN1Arotplots-7	SOYBEAN	DP7220	R4	--	Soybean Rust	Negative

Restricted Access Website


HYSPLIT 48 Hour - 2007-09-06
The HYSPLIT simulations displayed use NOAA's models and data, but are not created by NOAA
Spore Transport Modeling:
Adding value to observations
Restricted Access Website
HYSPLIT Model Release Time (CDT)
Release Point
10:00
11:00
12:00
13:00
14:00
15:00
16:00



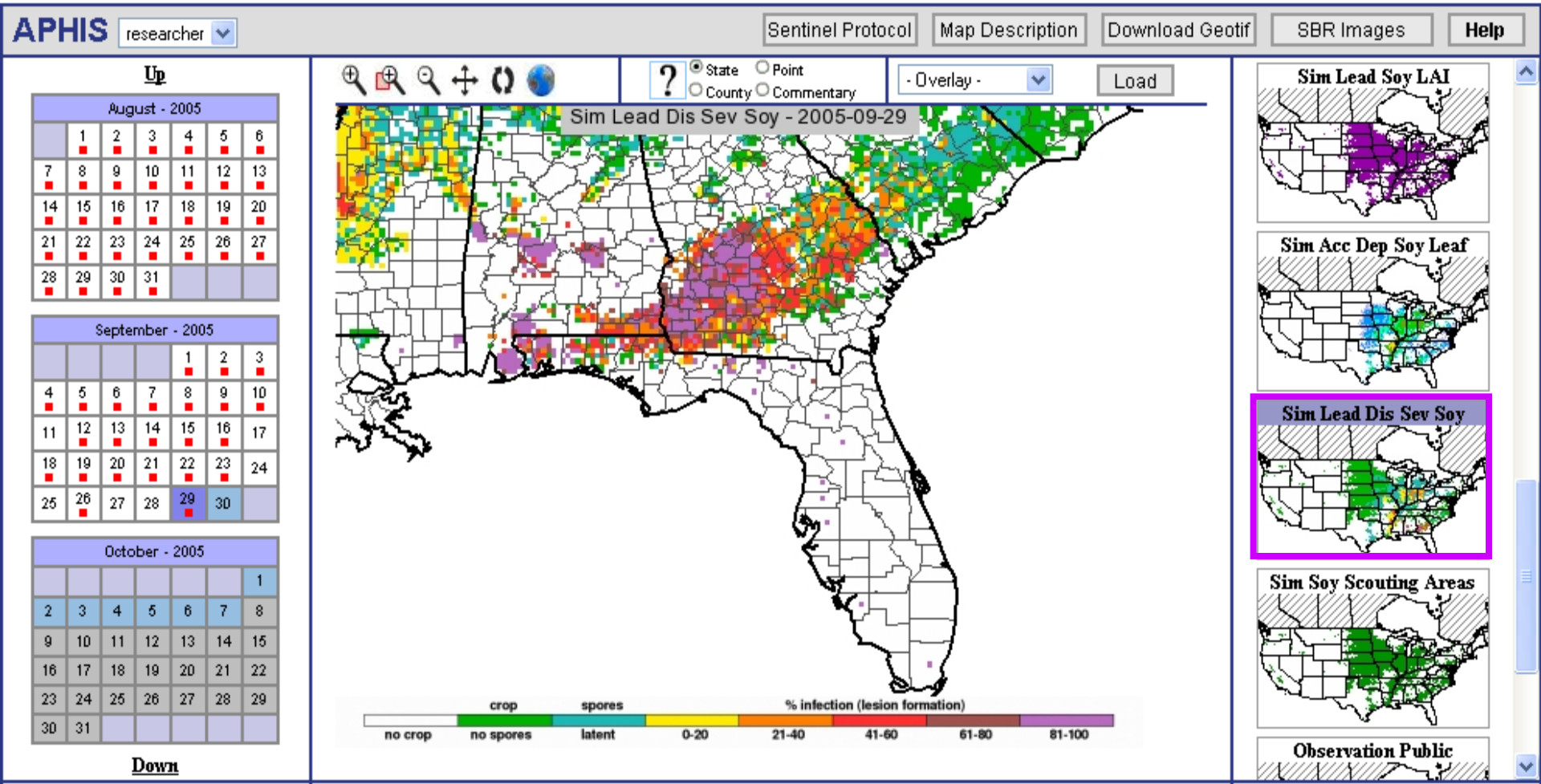
Spore Deposition Modeling:

Adding value to observations

Restricted Access Website

Disease Severity Modeling

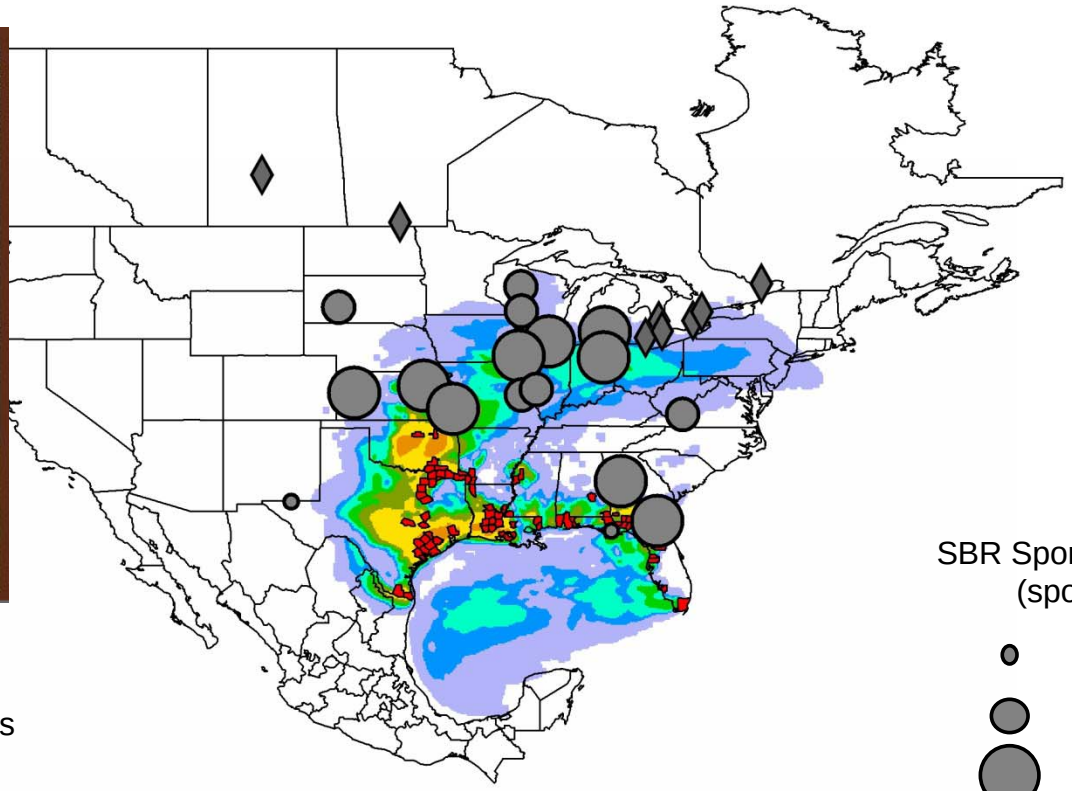
Adding value to observations



Restricted Access Website

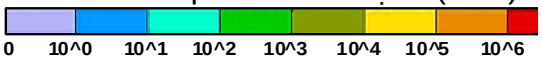
Comparison of IAMS Spore Deposition Predictions and SBR Spore Collections (16-22 August 2007)

NADP Rainwater Collector



County with SBR infected sites
(21 August 2007)

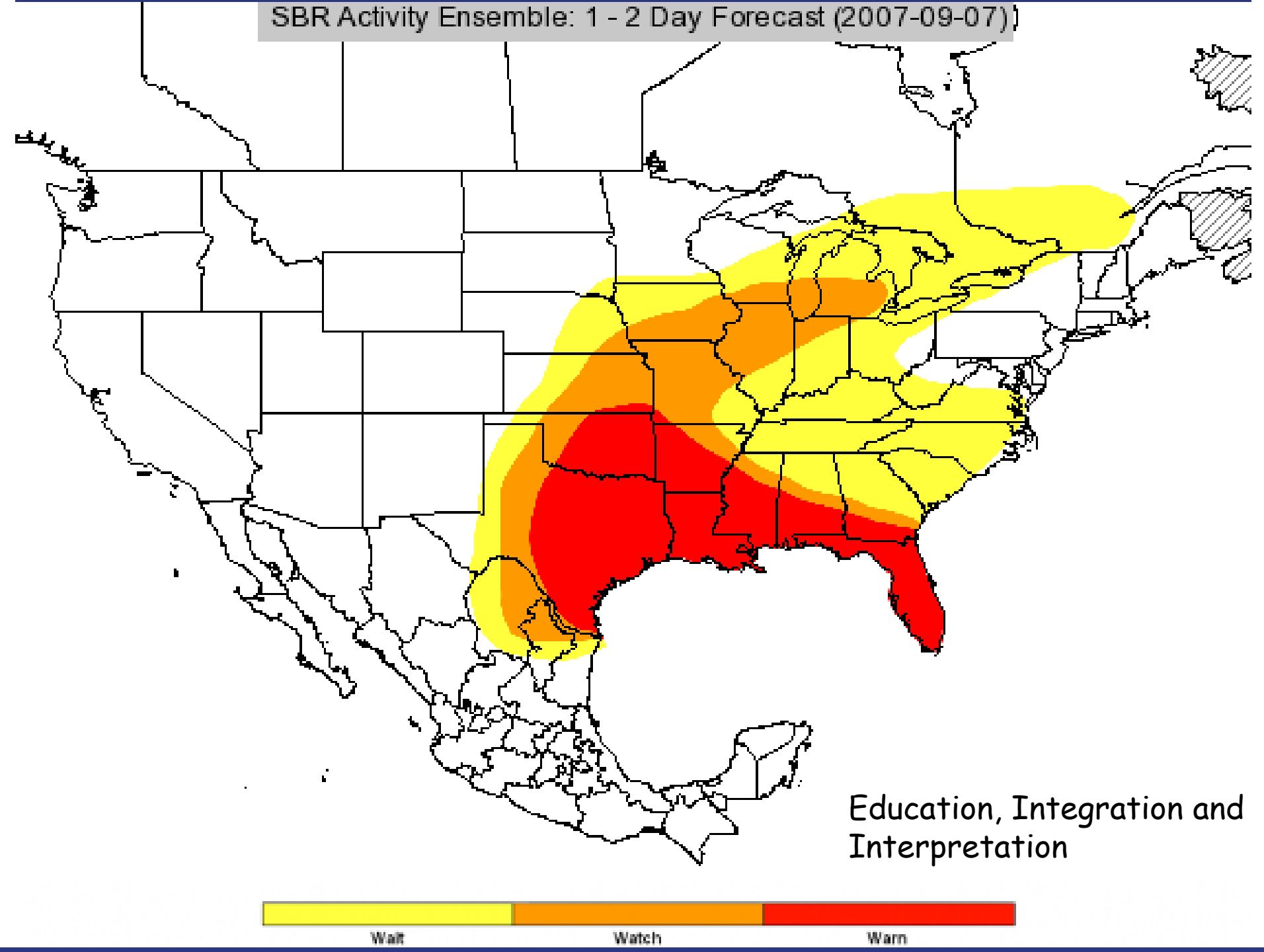
IAMS Wet Deposition Output
Viable SBR Spores/Land Area (#/ha)



SBR Spore Collections
(spores/m^2)

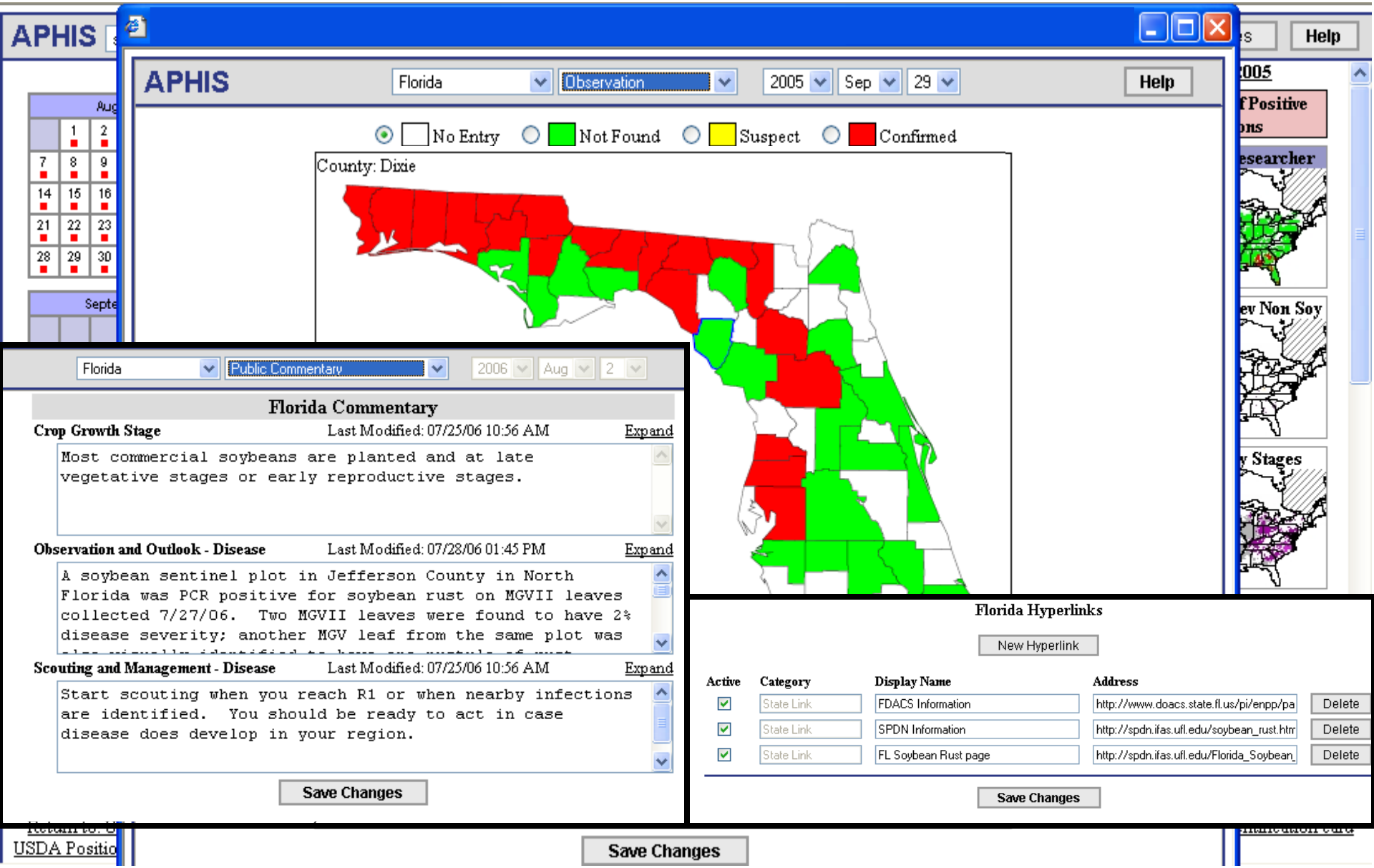
- 0 - 20
- 21 – 80
- 81 – 320
- >321
- Positive, # of spores unknown

Research: Integration and Model Validation


SBR Activity Ensemble: 1 - 2 Day Forecast (2007-09-07)
Education, Integration and Interpretation
Watch
Warn

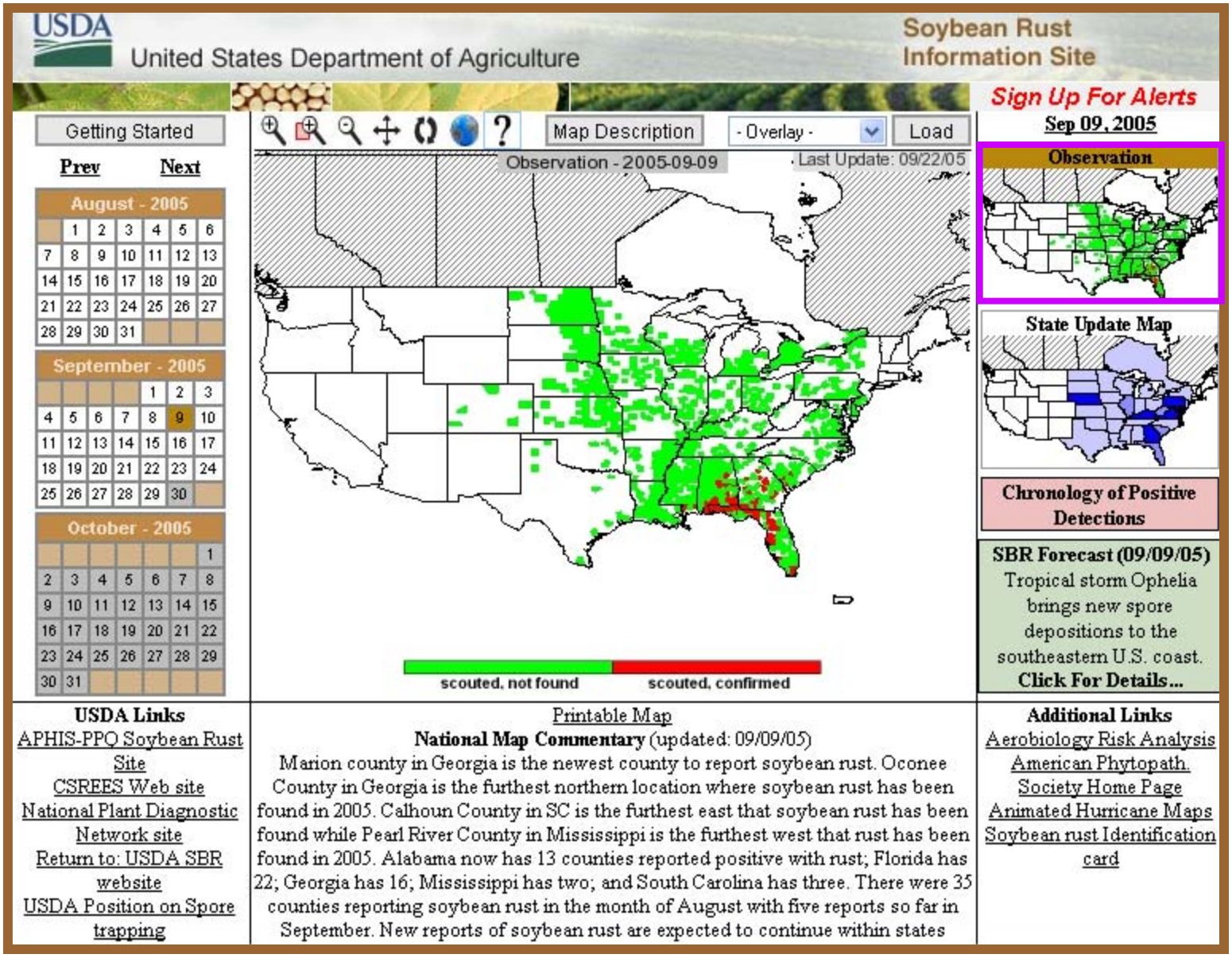
Interpretation & Communication by Specialists

(maps, textboxes, uploads)



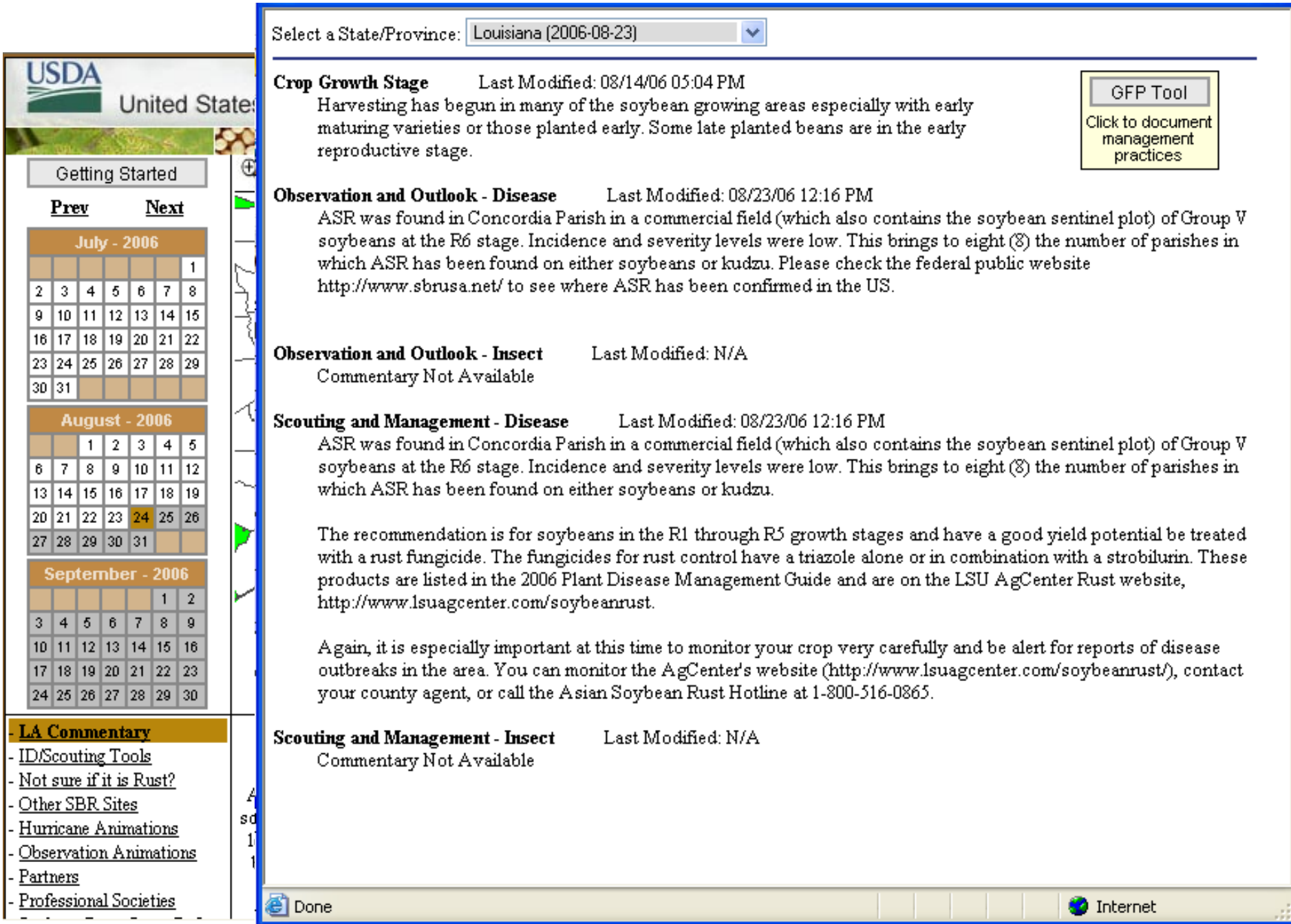
Restricted Access Website

Public Website: Observation Map

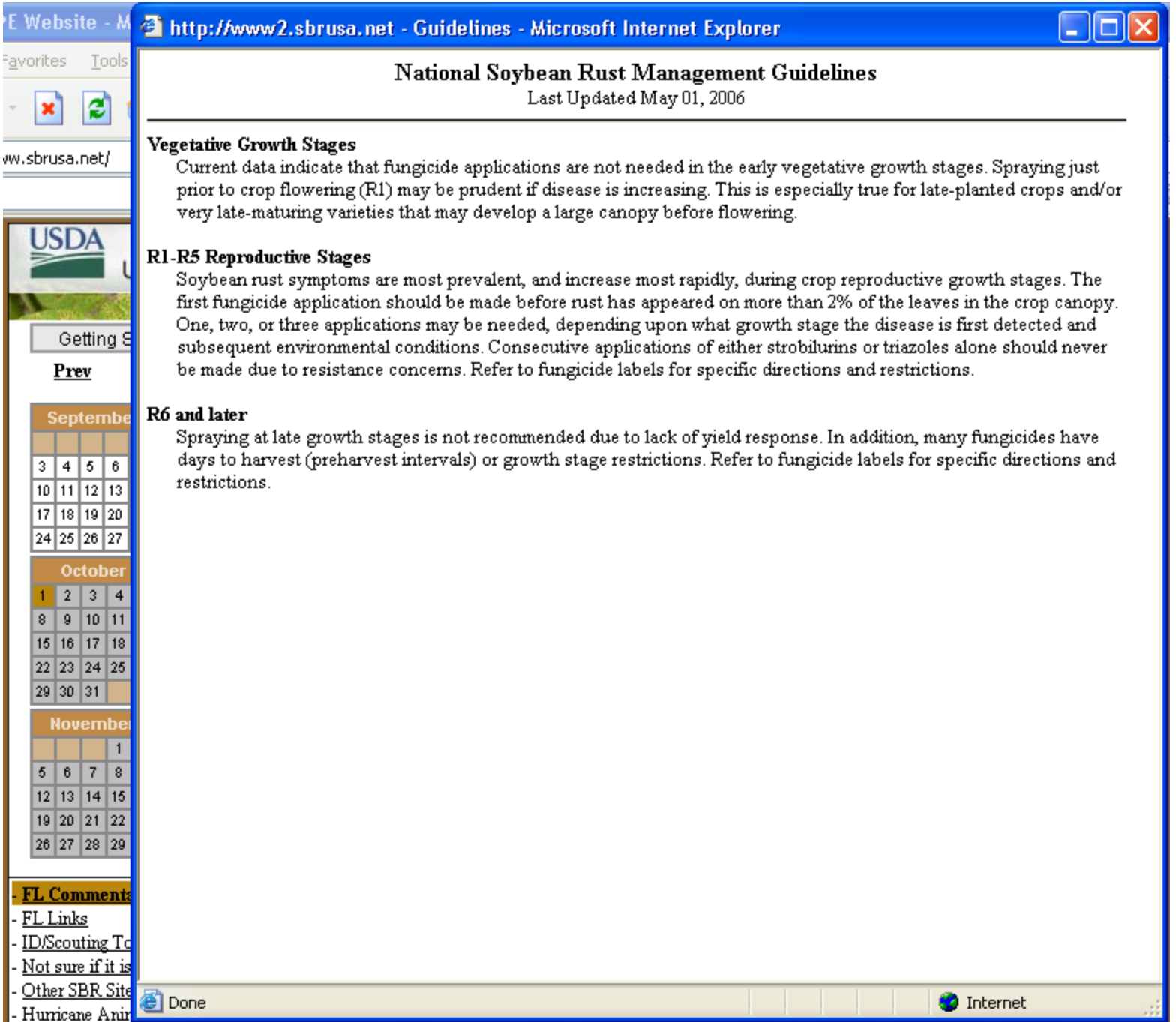


Public Access Website

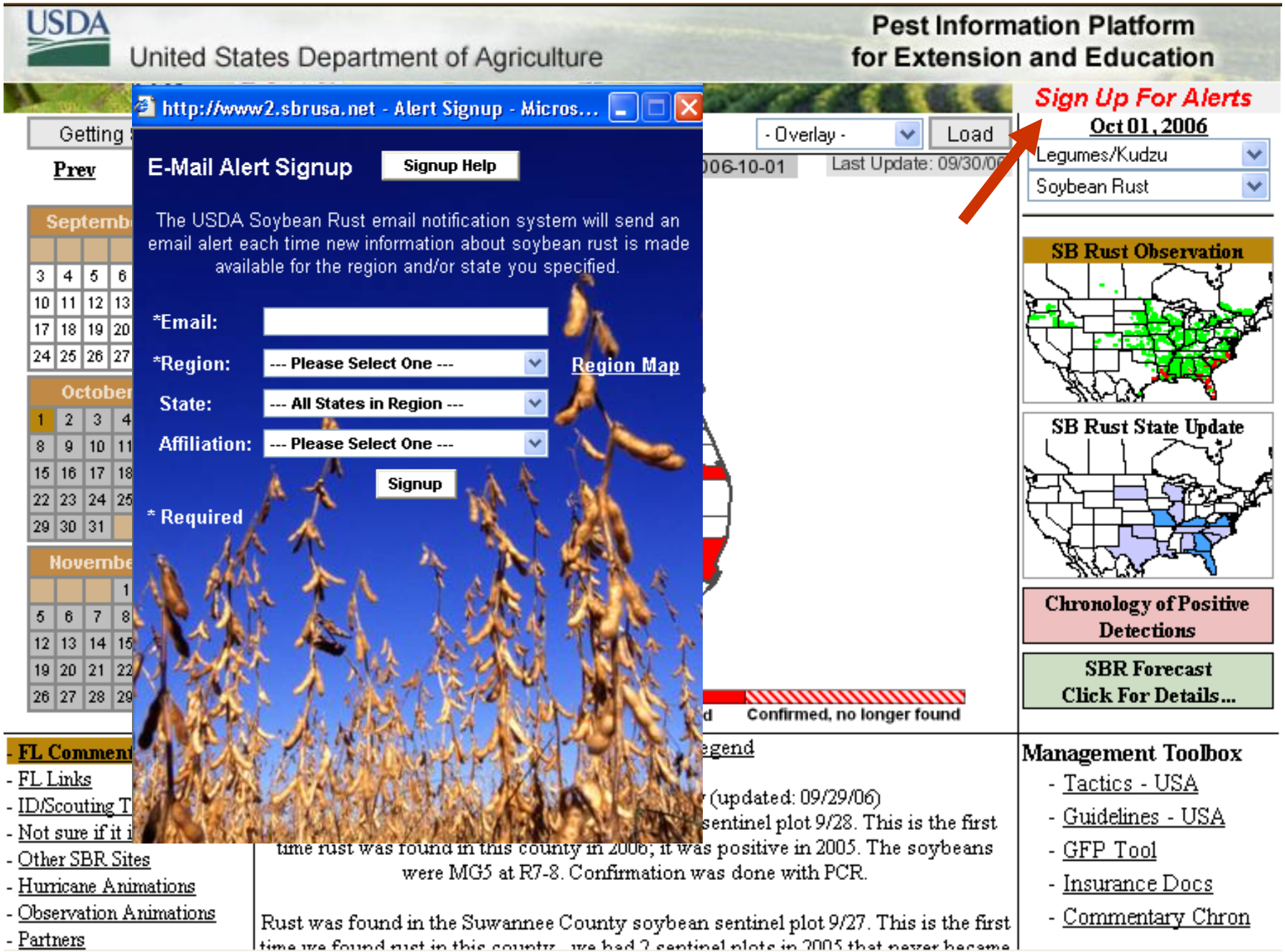
Public Website: Specialist Commentary



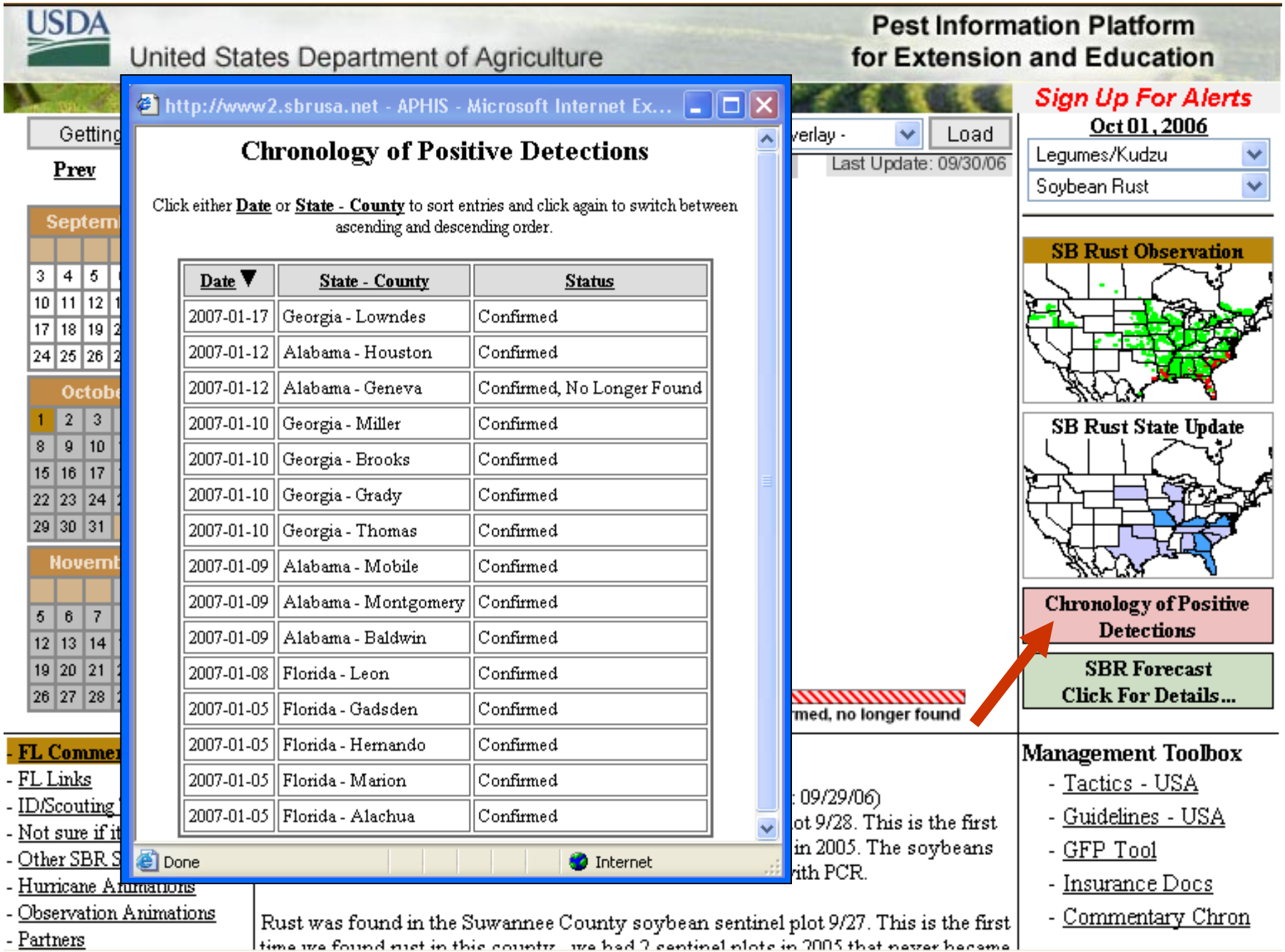
Management Guidelines for Growers



Automatic Notification Functions



Detection Chronology



Chronology of Positive Detections

Click either **Date** or **State - County** to sort entries and click again to switch between ascending and descending order.

Date ▼	State - County	Status
2007-01-17	Georgia - Lowndes	Confirmed
2007-01-12	Alabama - Houston	Confirmed
2007-01-12	Alabama - Geneva	Confirmed, No Longer Found
2007-01-10	Georgia - Miller	Confirmed
2007-01-10	Georgia - Brooks	Confirmed
2007-01-10	Georgia - Grady	Confirmed
2007-01-10	Georgia - Thomas	Confirmed
2007-01-09	Alabama - Mobile	Confirmed
2007-01-09	Alabama - Montgomery	Confirmed
2007-01-09	Alabama - Baldwin	Confirmed
2007-01-08	Florida - Leon	Confirmed
2007-01-05	Florida - Gadsden	Confirmed
2007-01-05	Florida - Hernando	Confirmed
2007-01-05	Florida - Marion	Confirmed
2007-01-05	Florida - Alachua	Confirmed

Good Farming Practice Documentation Tool for Growers

USDA United State

Getting Started

Prev Next

July - 2006

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

August - 2006

		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

September - 2006

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

- National Commentary
- ID/Scouting Tools
- Not sure if it is Rust?
- Other SBR Sites
- Hurricane Animations
- Observation Animations

Good Farming Practices Documentation Tool | Instructions | **Report Date: August 02, 2006**

Disclaimer: Use of this documentation tool is strictly voluntary. Information entered by you is not retained on this system and may only be printed or saved on your system in a PDF format. RMA does not control or guarantee the accuracy, relevance, timeliness, or completeness of this information. Neither RMA nor any of its employees makes any warranty, express or implied, including the warranties of fitness for a particular purpose, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of this tool.

First time users are strongly encouraged to read the instructions prior to using this documentation tool.

Preparer Name

Grower Name

State * Mississippi

County * --

Farm Description

Field ID(s)

Crop * Soybeans

Crop Stage * -- Crop Stage Images

* = Required

Mississippi Scouting and Management Commentary

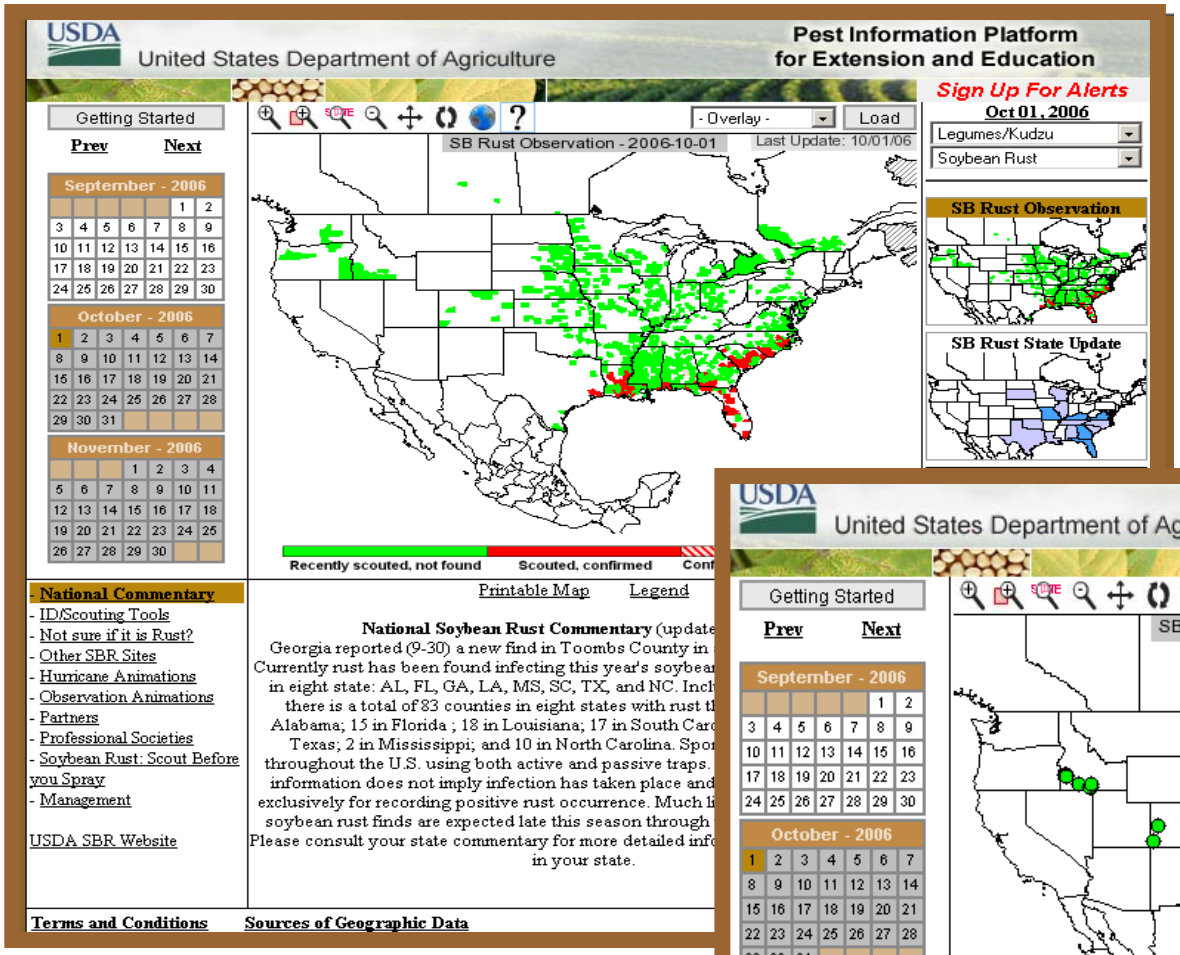
Soybean Rust

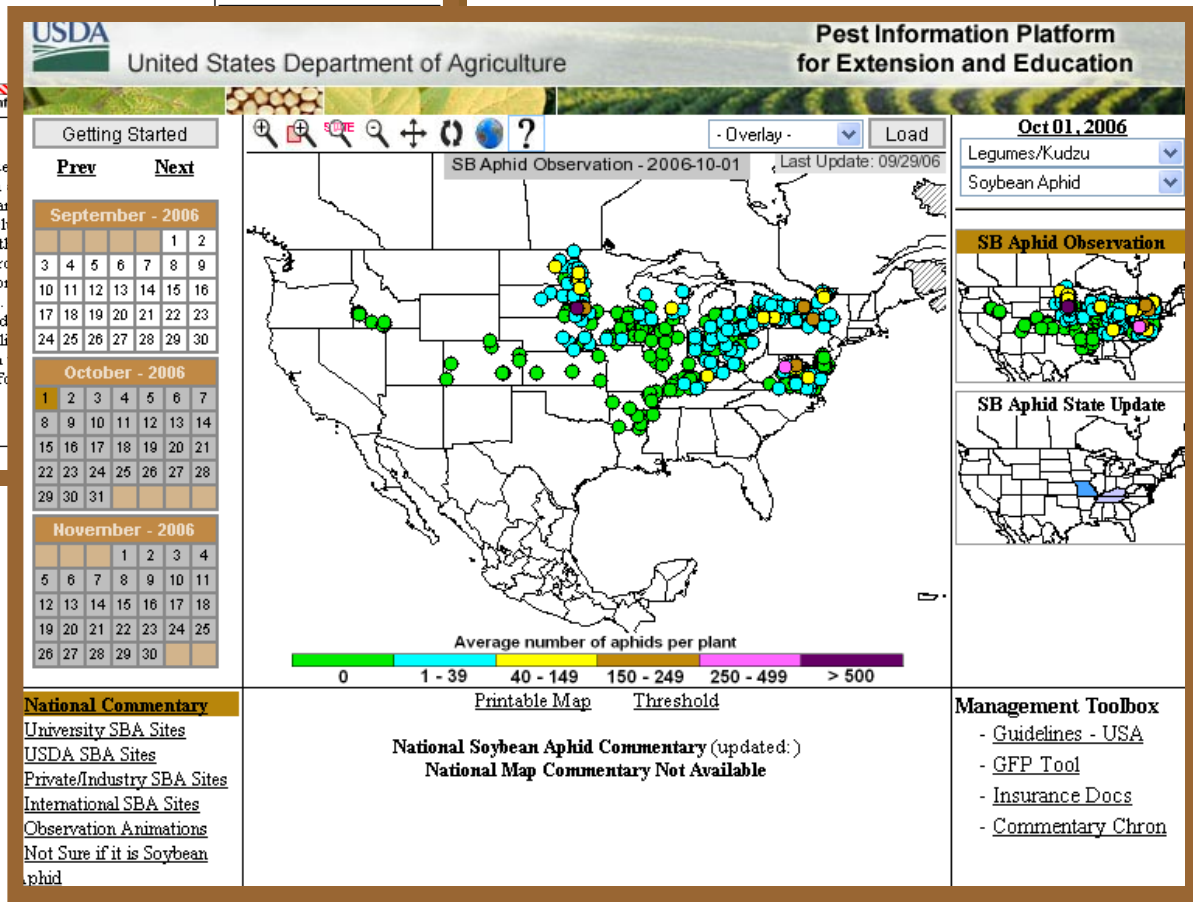
- August 02, 2006: Producers in the SW portion of that state that have soybeans that are in reproductive growth stage R5.5 or a younger reproductive stage, need to consider application of a fungicide, particularly a triazole or a mix. Soybean growers in our major growing areas in North Mississippi and the Delta have nothing to be concerned about at this time. It's been hot and extremely dry in those areas, unfavorable for rust development. Scouting will continue, and these management suggestions will be modified based on the scouting results and weather conditions. Concentrate scouting efforts along areas of the field that can have longer dew periods and cooler conditions. Focus the scouting more intensely during the reproductive stage.
- August 01, 2006: Producers in the SW portion of that state that have soybeans that are in reproductive growth stage R5.5 or a younger reproductive stage, need to consider application of a fungicide, particular a triazole or a

Done Internet

Soybean rust has been found in two sites in Jefferson County, SW Mississippi. Rust was confirmed on both kudzu and soybeans in that county. This is the first report of rust from Mississippi in 2006. Please consult the appropriate state commentary for

- GFP Tool
- Insurance Docs





2006-2007

IPM PIPE

What Made the Soybean Rust Information System/*ipm*PIPE So Attractive

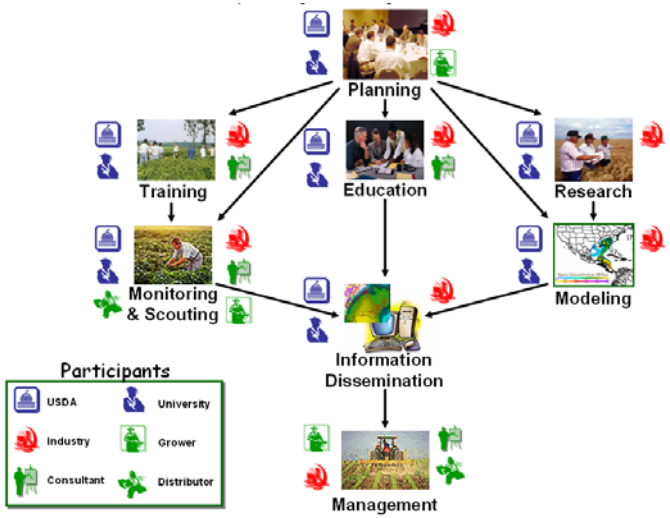
Simple design - flexible and expandable

Empowers the State Extension Specialists (protocols & dissemination)

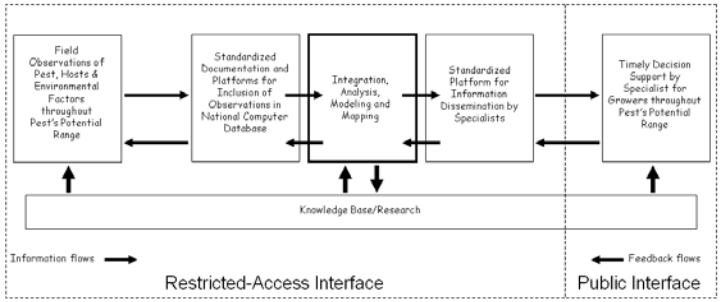
Enhances communications among stakeholders

Provides “one-stop” rapid access to information in easy-to-use formats

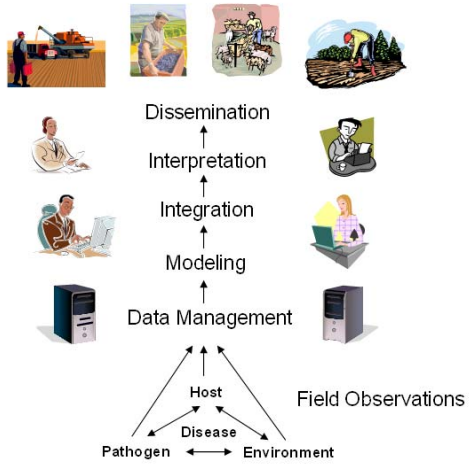
Coordinated Framework



State-of-the-Art IT Platform



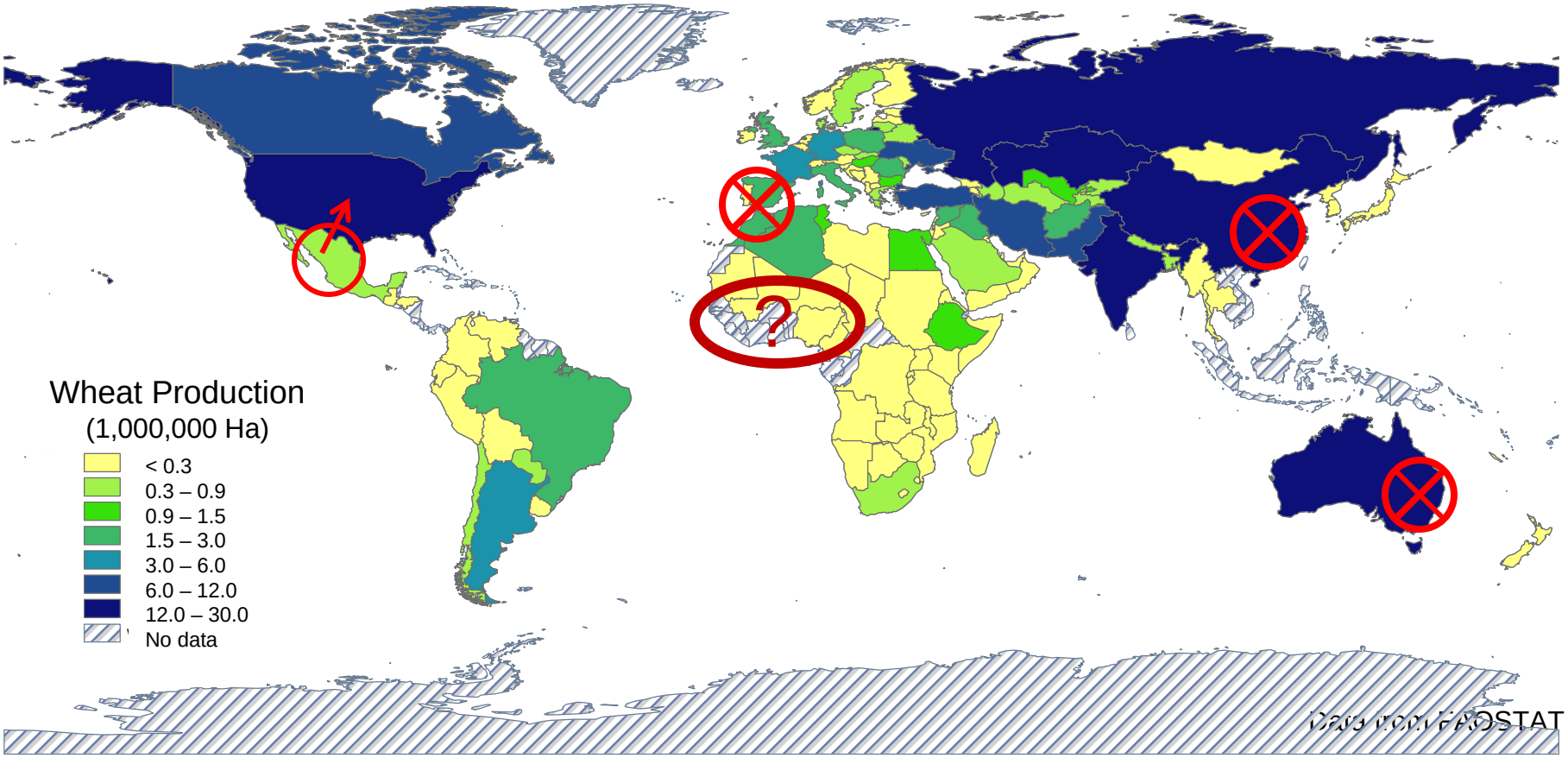
Integration of Tasks



Challenges associated with providing "state-of-the-art" IT for effective "in-season" management of wheat rusts

Challenges Associated with Providing an Effective Early Warning System for New Races of Stem Rust

New races of WSR are not known to be present in Western Hemisphere and IAMS model simulations suggest that they will not likely survive aerial transport across the Atlantic or Pacific Oceans.



Tropical western Africa is the most likely source area for aerobiota that are blown to the Western Hemisphere. However as far as we know, wheat/barley production is very low in this region. IAMS simulations suggest that it is likely that spores from heavily infected Mexican wheat production regions would be blown to U.S. wheat fields on a seasonal basis.

Challenges Associated with Providing an Effective Early Warning System for New Races of Stem Rust

Regardless of how new races are transported to the North America, they are likely to cause a sudden and dramatic alarm

How to expand existing surveillance programs? Effective "inseason" management of new virulent wheat stem rust races would require a high resolution (spatial and temporal) monitoring network of either 1) disease severity in potential inoculum source regions, 2) spore deposition throughout the region potentially impacted by the pathogen, or better yet, 3) both.

Overall, 17,797 observations of the presence and severity of soybean rust were submitted to the national soybean rust database in 2006 from over 2000 different geographic locations throughout the U.S., southern Canada, and Mexico. More than 15,000 observations were submitted to the system in both 2007 & 2008.

disease incidence and/or severity observations from:
- sentinel plots
- commercial fields
- mobile scouts
- industry plots
- diagnostic labs

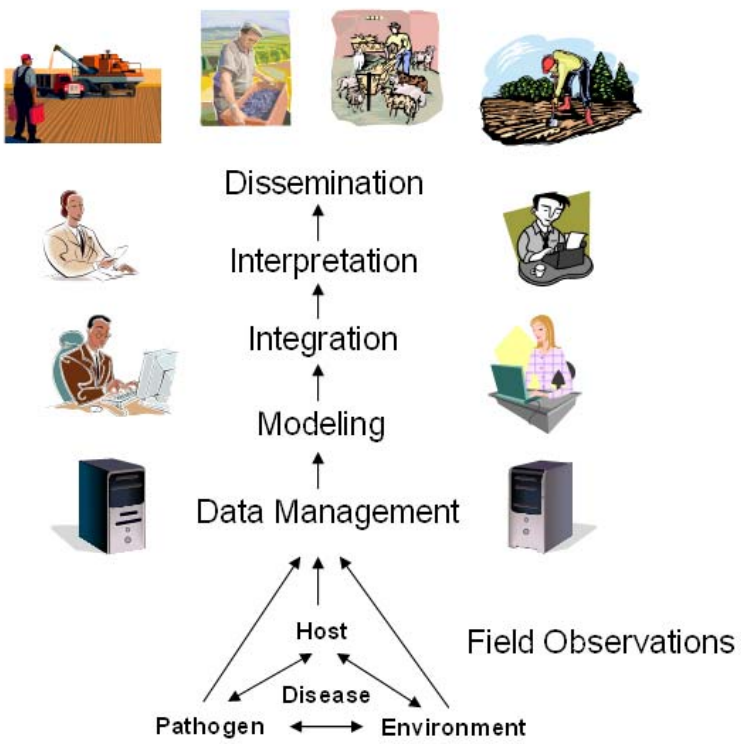
spore collections from:
- Industry passive vane trap network
- NADP rainwater trap network

Challenges Associated with Providing an Effective Early Warning System for New Races of Stem Rust

The IT functionality to manage, interpret, and communicate a large volume of wheat rust observations from diverse sources is not currently needed.

How do we prepare an IT system to anticipate a potential "overnight" onslaught of observations and demands for information.

Tasks



Potential Bottlenecks

Agreement among stakeholders regarding who will take responsibility for each of the 6 tasks.

Agreement among stakeholders regarding information dissemination (public vs restricted-access)

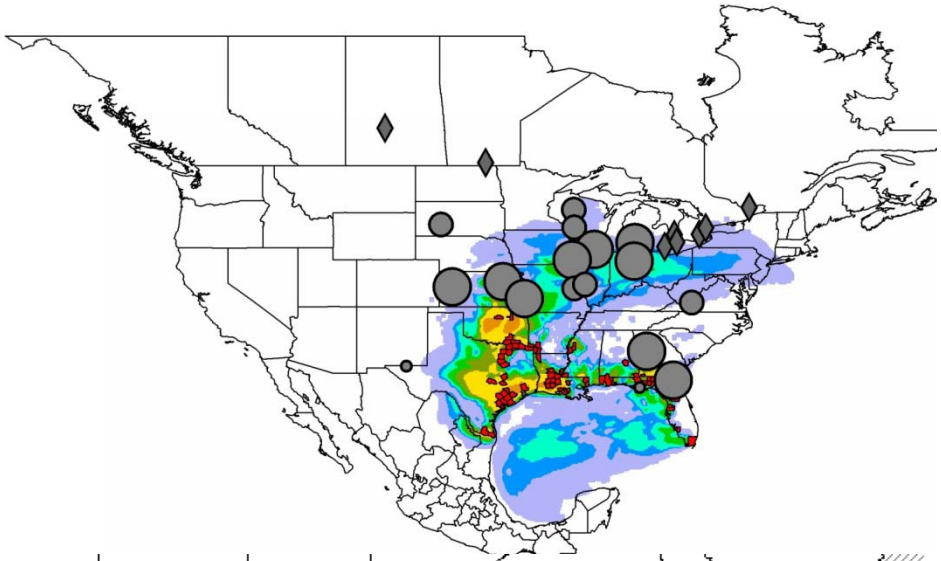
Development and deployment of rapid diagnostic tools

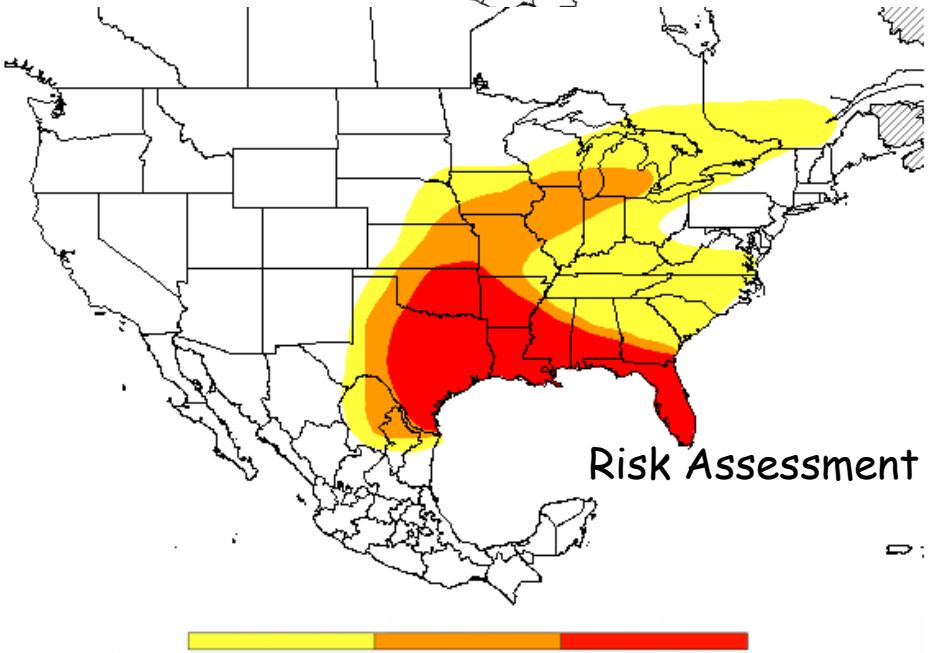
Agreement on field scouting and information dissemination protocols

Answers to anticipated stakeholder questions
- What are the variety reactions?
- What is my potential for yield loss?
- What can I spray?
- Is my current technology going to be effective?

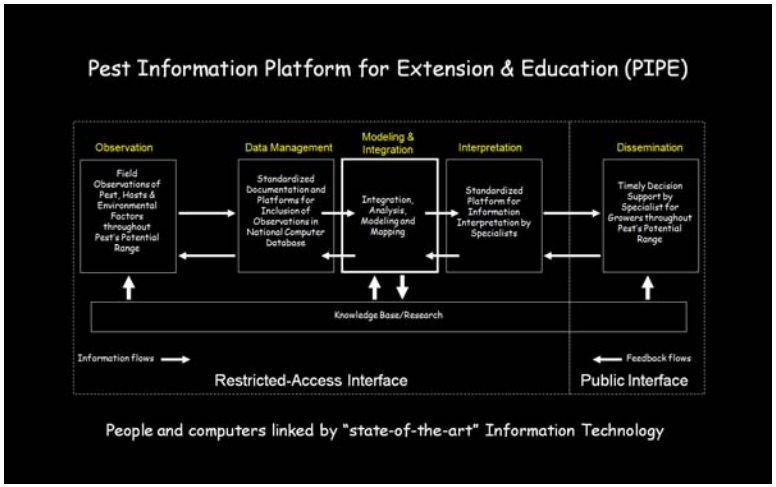
Early Warning Systems for Rust Diseases

Integration of Observations and Model Output





State-of-the-art IT Platform



One Stop Information Shop for Stakeholders