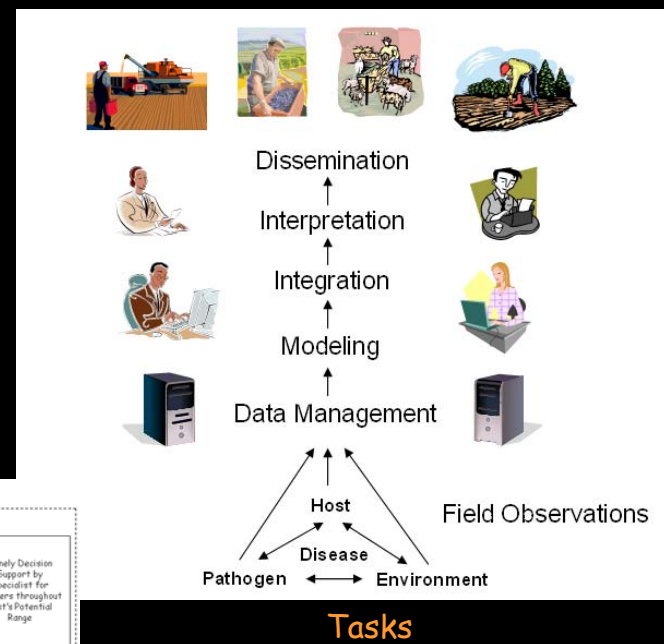
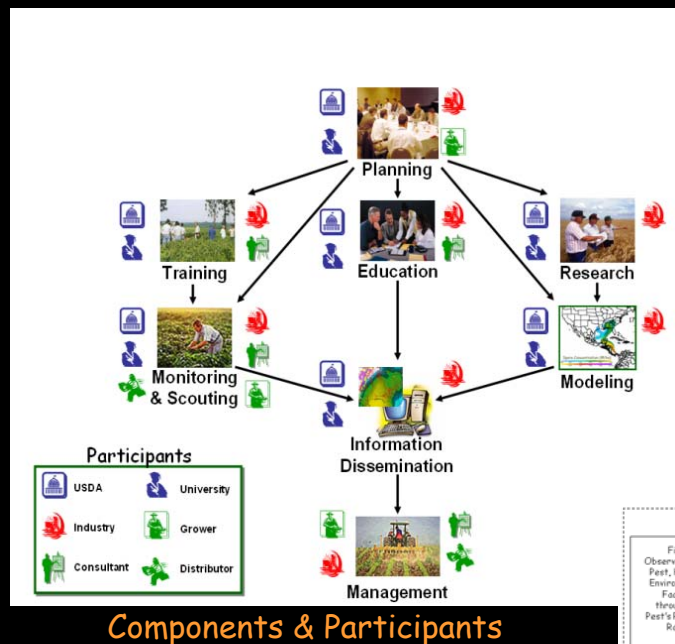


Early Warning Systems for Rust Diseases

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



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

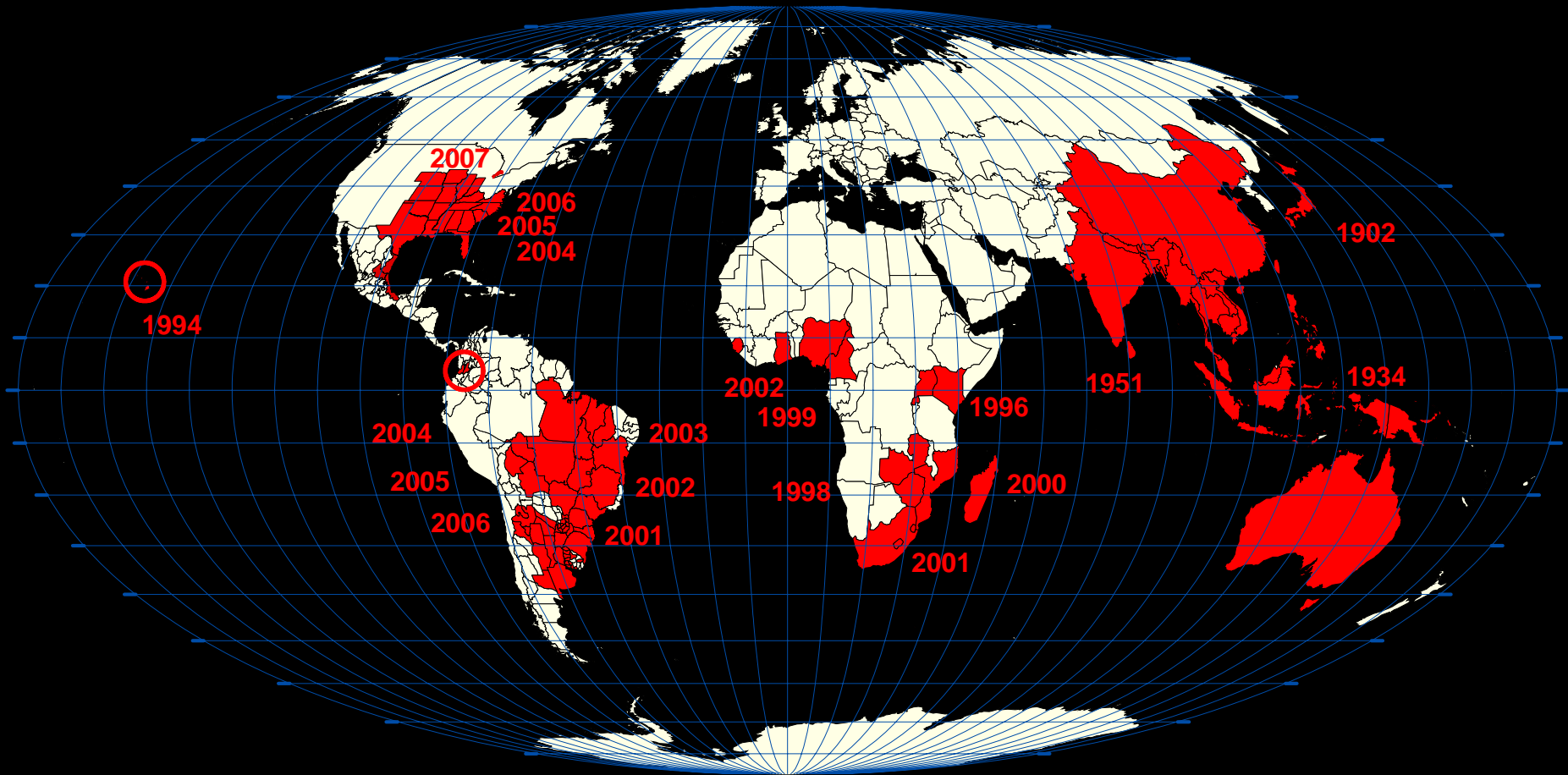


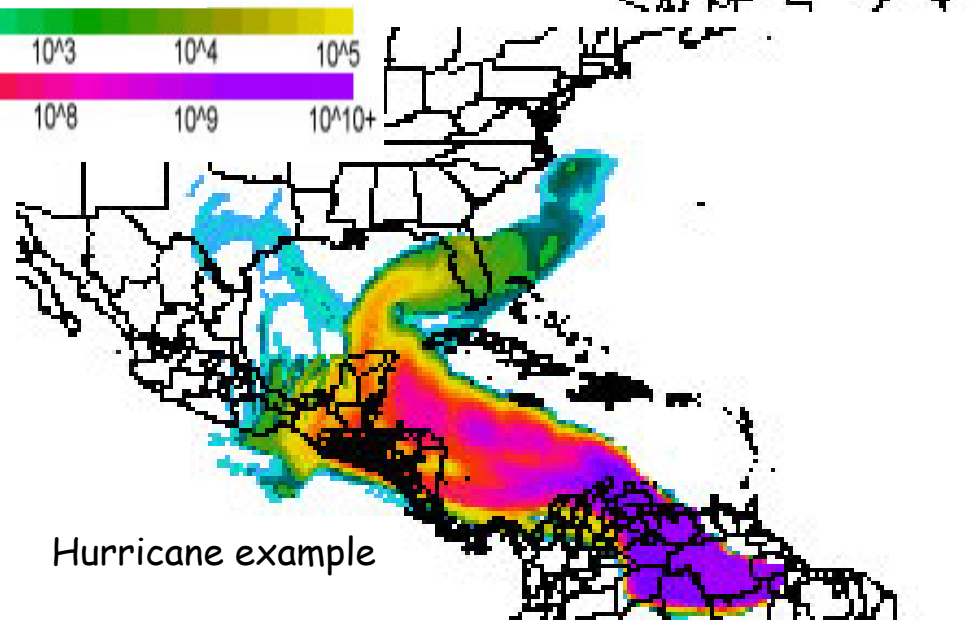
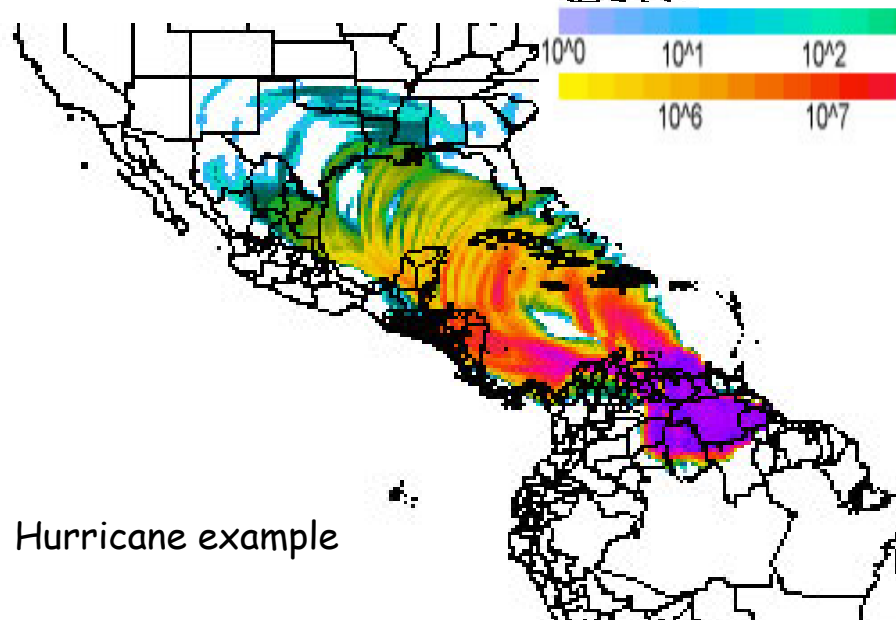
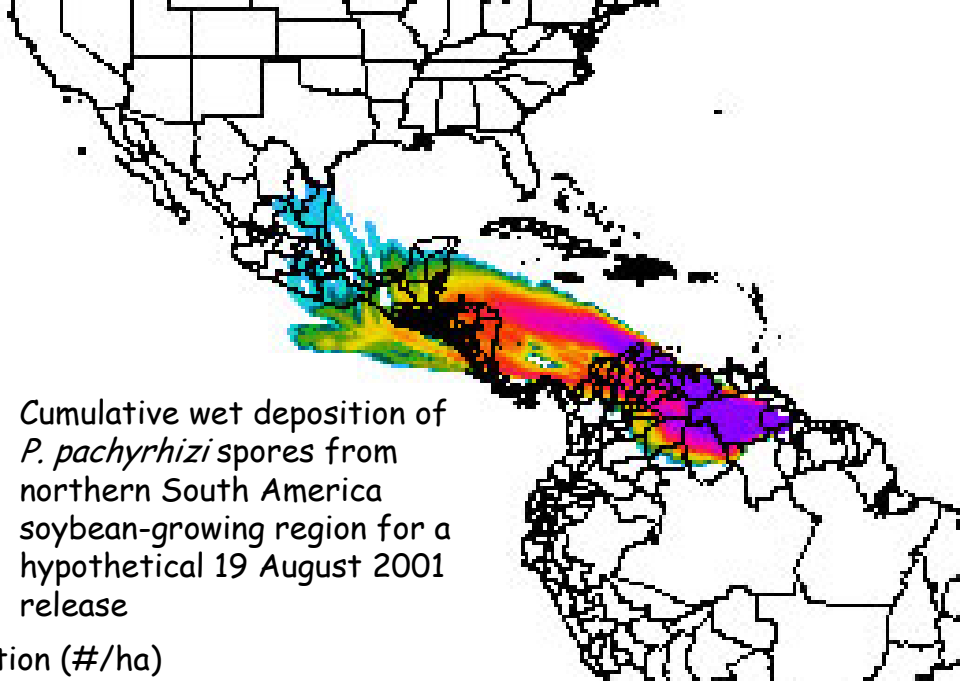
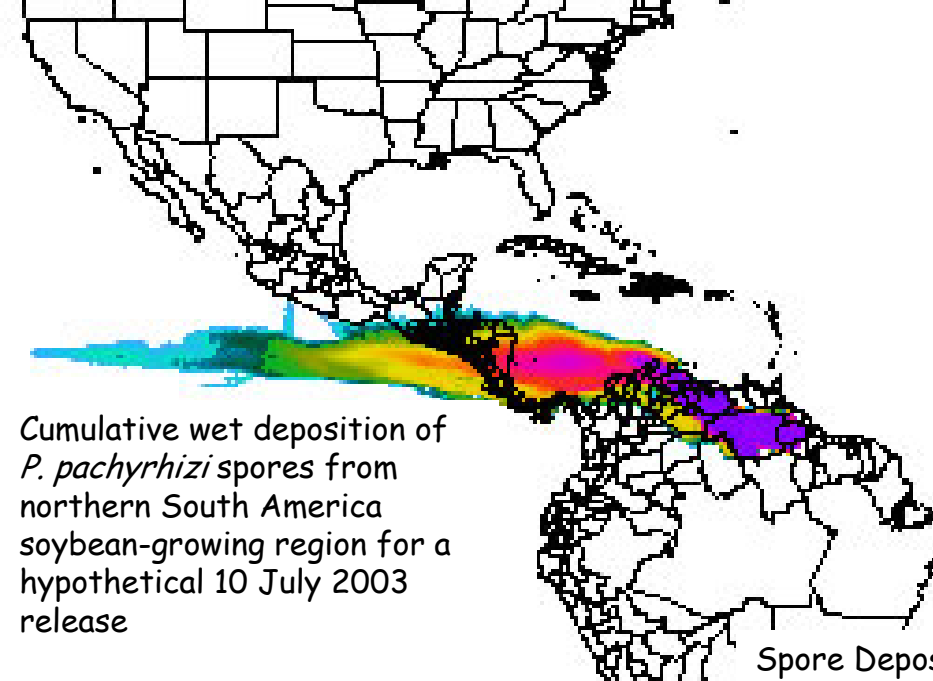
Fungicide treated field

- 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

Untreated field

Soybean Rust Spread

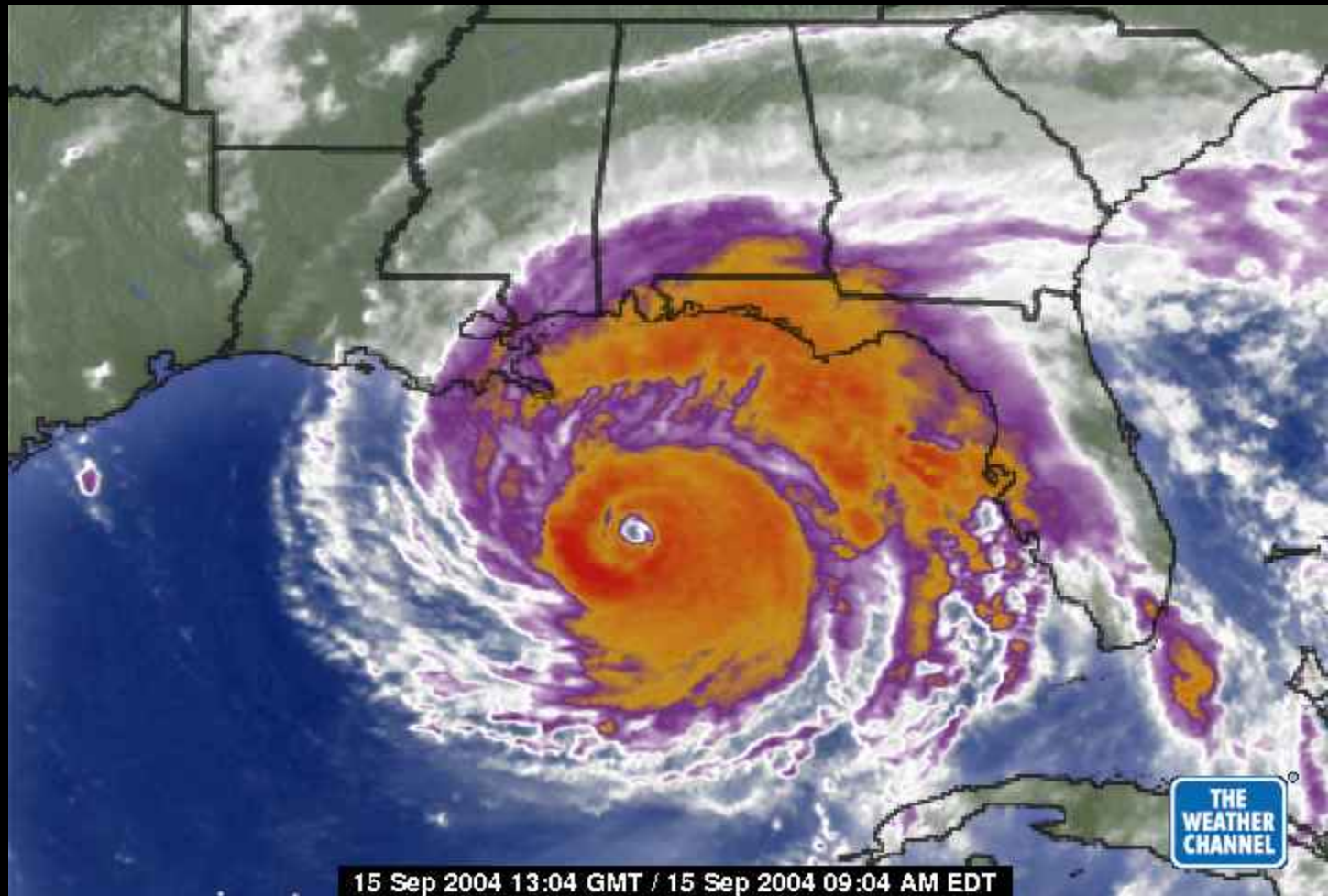




Cumulative wet deposition of *P. pachyrhizi* spores from northern South America soybean-growing region for a hypothetical 21-27 August 1999 release.

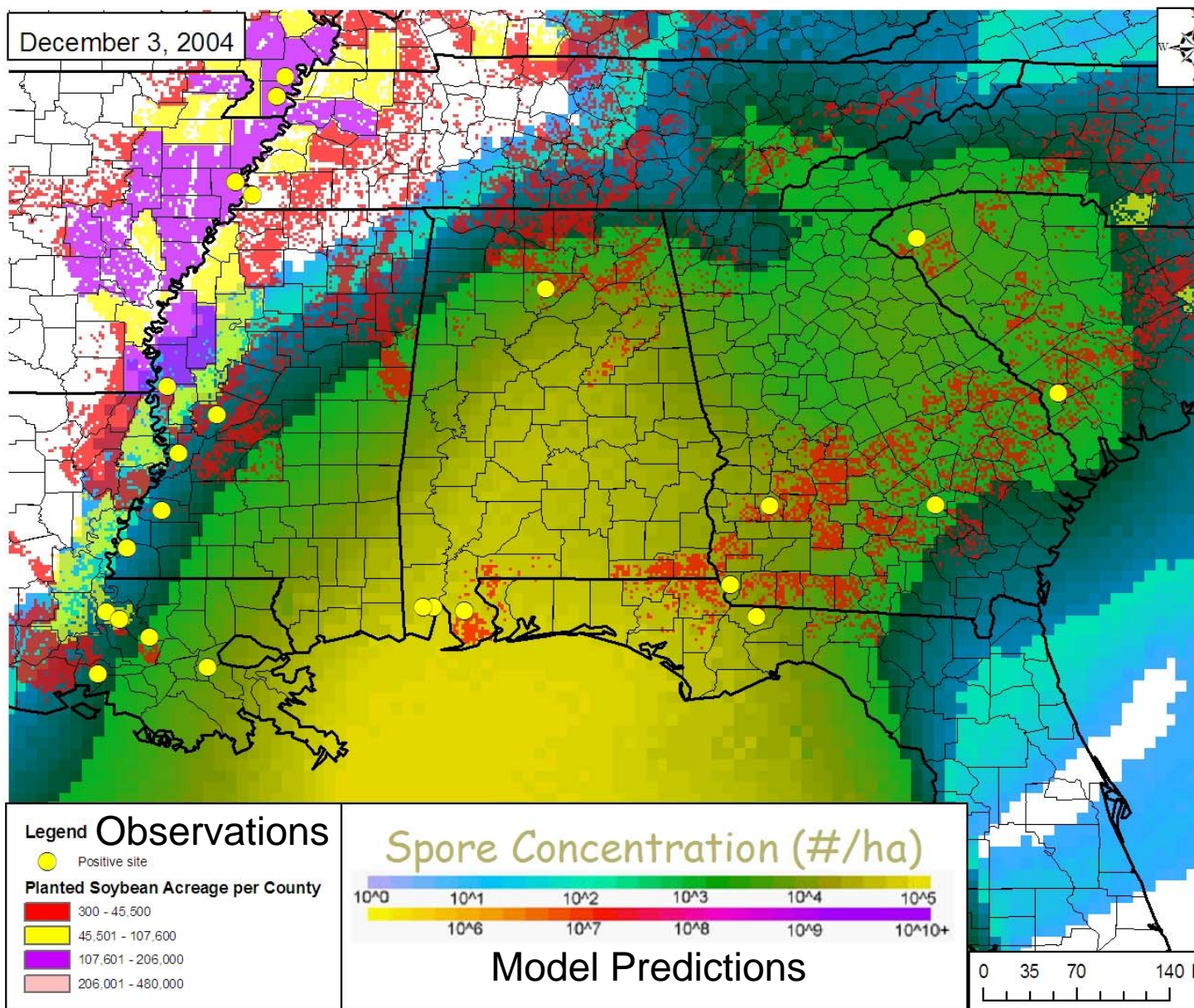
Cumulative wet deposition of *P. pachyrhizi* spores from northern South America soybean-growing region for a hypothetical 22-29 August 2003 release.

Hurricane Ivan 2004



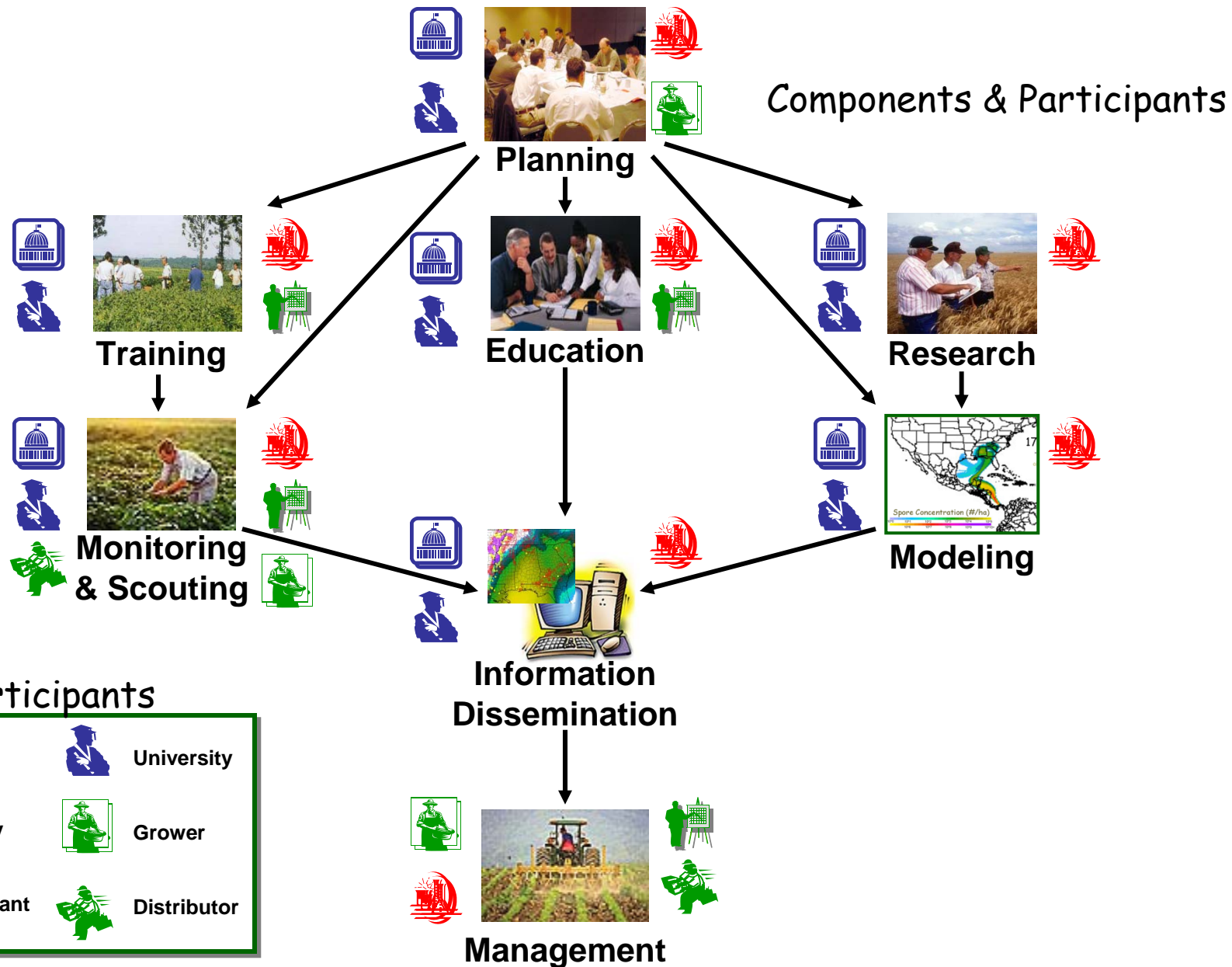
September 15, 2004

2004 Soybean Rust Incursion into Southeastern U.S.

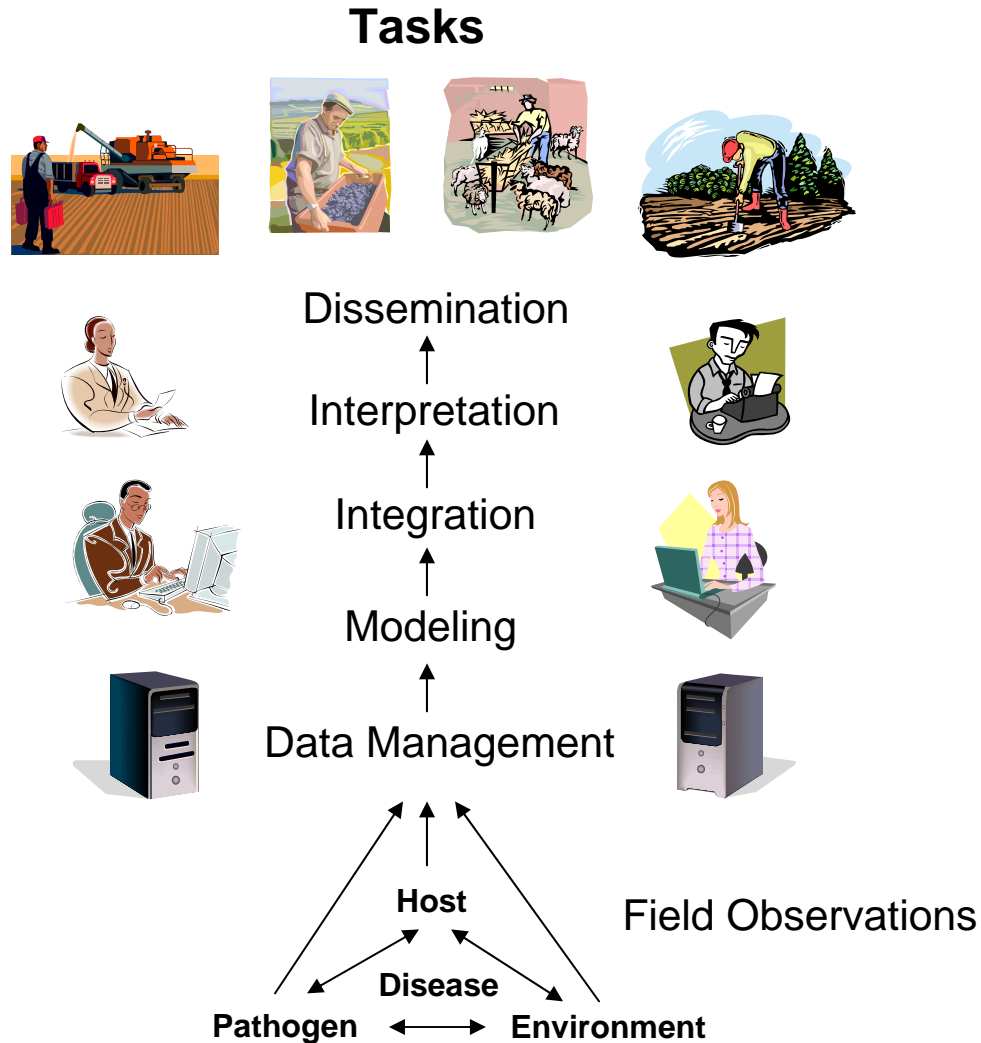


USDA Soybean Rust Coordinated Framework

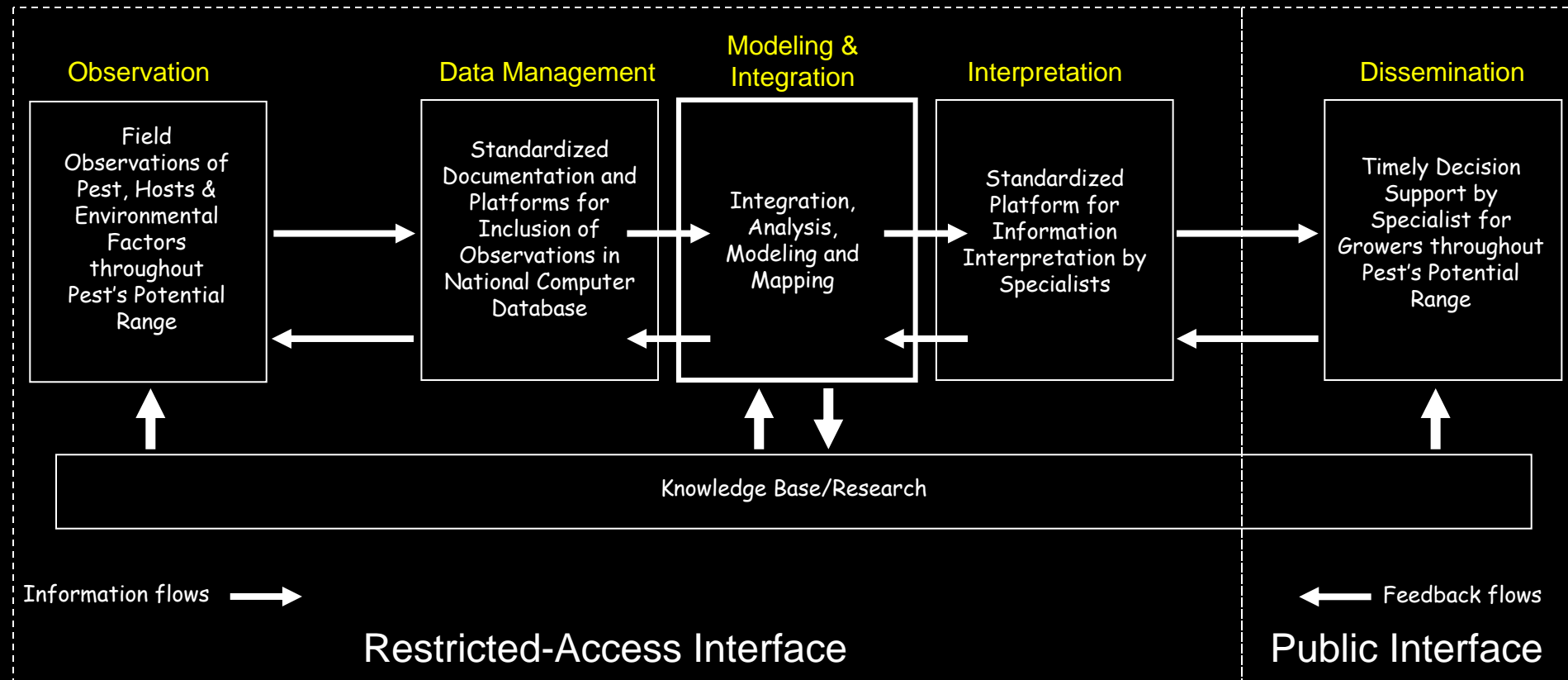
From planning to management in 2004/2005



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: --

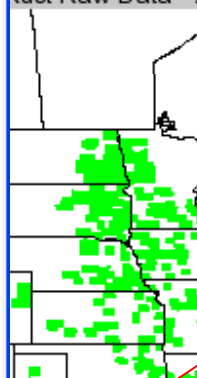
Location Name: - Select one or enter below -

Longitude (DD):

Latitude (DD):

? State Point
County Comm

Rust Raw Data - 2



Lab ID:

Obs Date:

Country:

State:

County:

Location Type:

Location Name:

Longitude (DD):

Latitude (DD):

Field Sample ID:

Diagnostic Laboratory Form



e Usage

Save Obs

Down

Observation Forms Help

- Location Type -

- Location Name - Setup

Online Download Upload

Entry Excel Excel

PDA Edit

Soybean n
kudzu and
appropriate
eight differ
28 counti
Louisiana
active and
plant sam
prevailed

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

Data Entry Form

Save Obs

Data Management
Restricted Access Website

Data Management and Integration

APHIS researcher

Sentinel Protocol Map Description Download Geotiff SBR Images Help

Up

August - 2005

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September - 2005

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22	23	24	25	26	27
28	29	30	31		

Observation Researcher - 2005-09-29

Legend:
■ scouted, confirmed
■ not + Lab
● Industry

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	NFRECO-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

Additional Commentary

mentary (updated: 09/21/05)

to report soybean rust. Oconee County in Georgia is the has been found in 2005. Calhoun County in SC is the furthest Earl River County in Mississippi is the furthest west that rust unties reported positive with rust; Florida has 22; Georgia has

Sep 29, 2005

Chronology of Positive Detections

Observation Researcher

Sim Daily Spore Transport

Sim Daily Wet Dep Land

Sim Acc Wet Dep Land

Additional Links

[Aerobiology Risk Analysis](#)

[American Phytopath. Society Home Page](#)

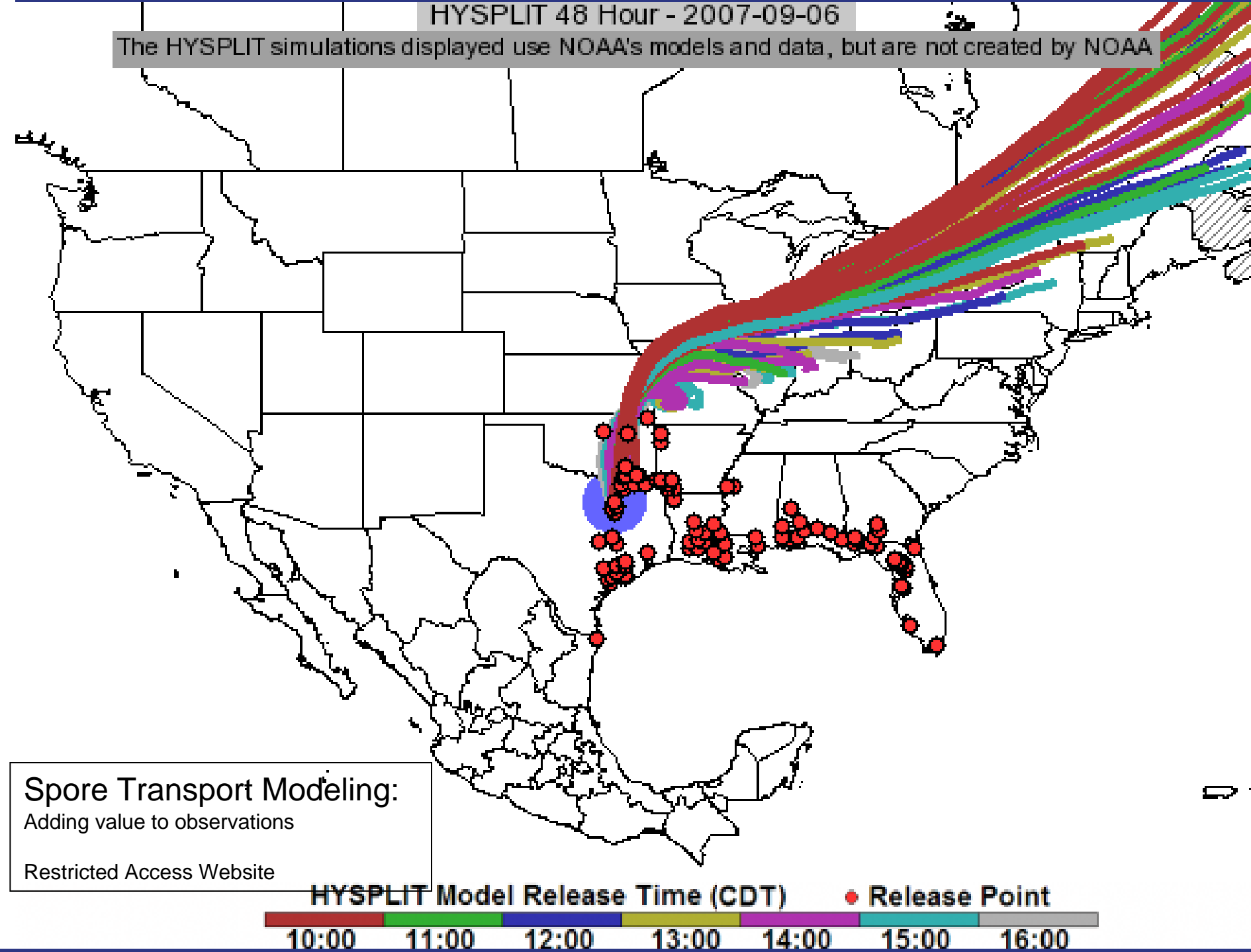
[Animated Hurricane Maps](#)

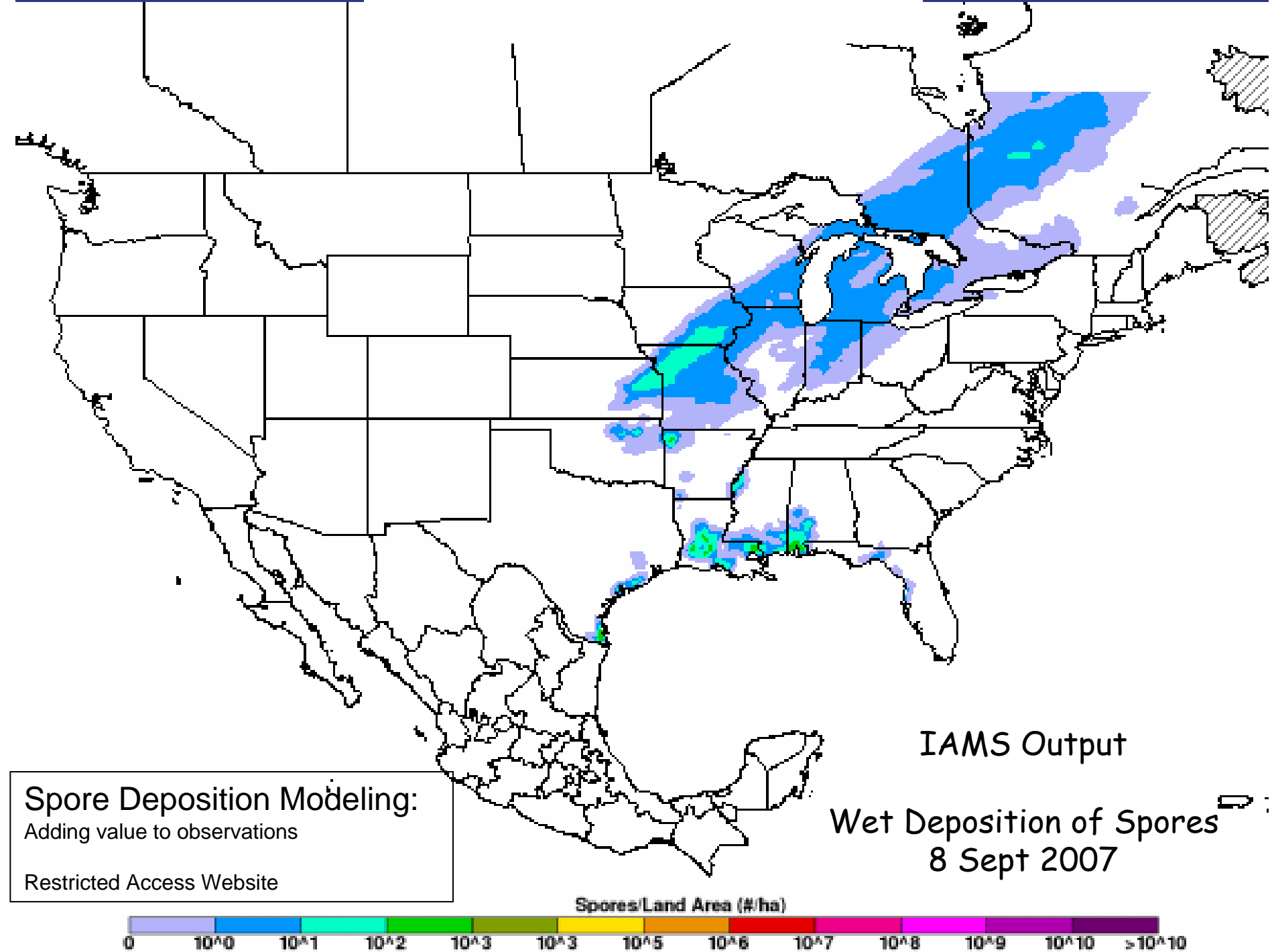
[Soybean rust Identification card](#)

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





Disease Severity Modeling

Adding value to observations

APHIS
researcher

Sentinel Protocol
Map Description
Download Geotiff
SBR Images
Help

Up

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September - 2005

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October - 2005

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23	24	25	26	27	28	29
30	31					

Down

USDA Links
[APHIS-PPO Soybean Rust Site](#)
[CSREES Web site](#)
[National Plant Diagnostic Network site](#)
[Return to: USDA SBR website](#)
[USDA Position on Spore trapping](#)

?
State
Point
County
Commentary
- Overlay -
Load

Sim Lead Dis Sev Soy - 2005-09-29

crop
spores
% infection (lesion formation)

no crop
no spores
latent
0-20
21-40
41-60
61-80
81-100

Sim Lead Soy LAI

Sim Acc Dep Soy Leaf

Sim Lead Dis Sev Soy

Sim Soy Scouting Areas

Observation Public

Additional Links
[Aerobiology Risk Analysis](#)
[American Phytopath. Society Home Page](#)
[Animated Hurricane Maps](#)
[Soybean rust Identification card](#)

Edit National Commentary

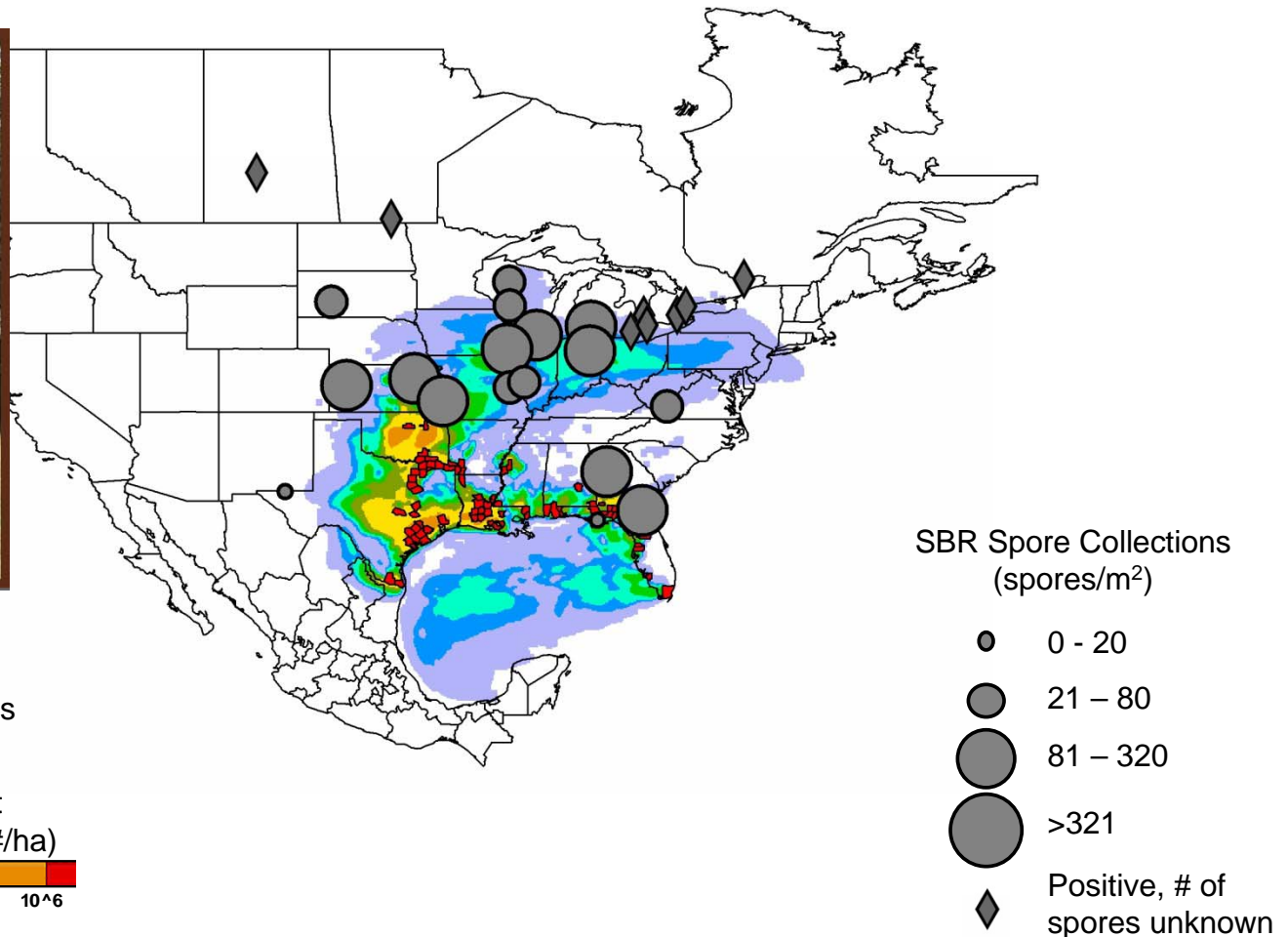
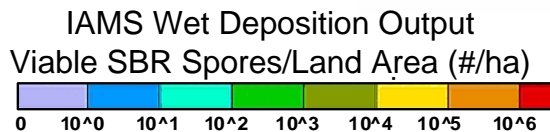
National Map Commentary (updated: 08/16/05)
By August 24th, rust is expected to be light to moderate to heavy in Georgia, part of Alabama and Florida. New light infestation is expected in Louisiana. All other states are expected to have either latent or no infection.

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

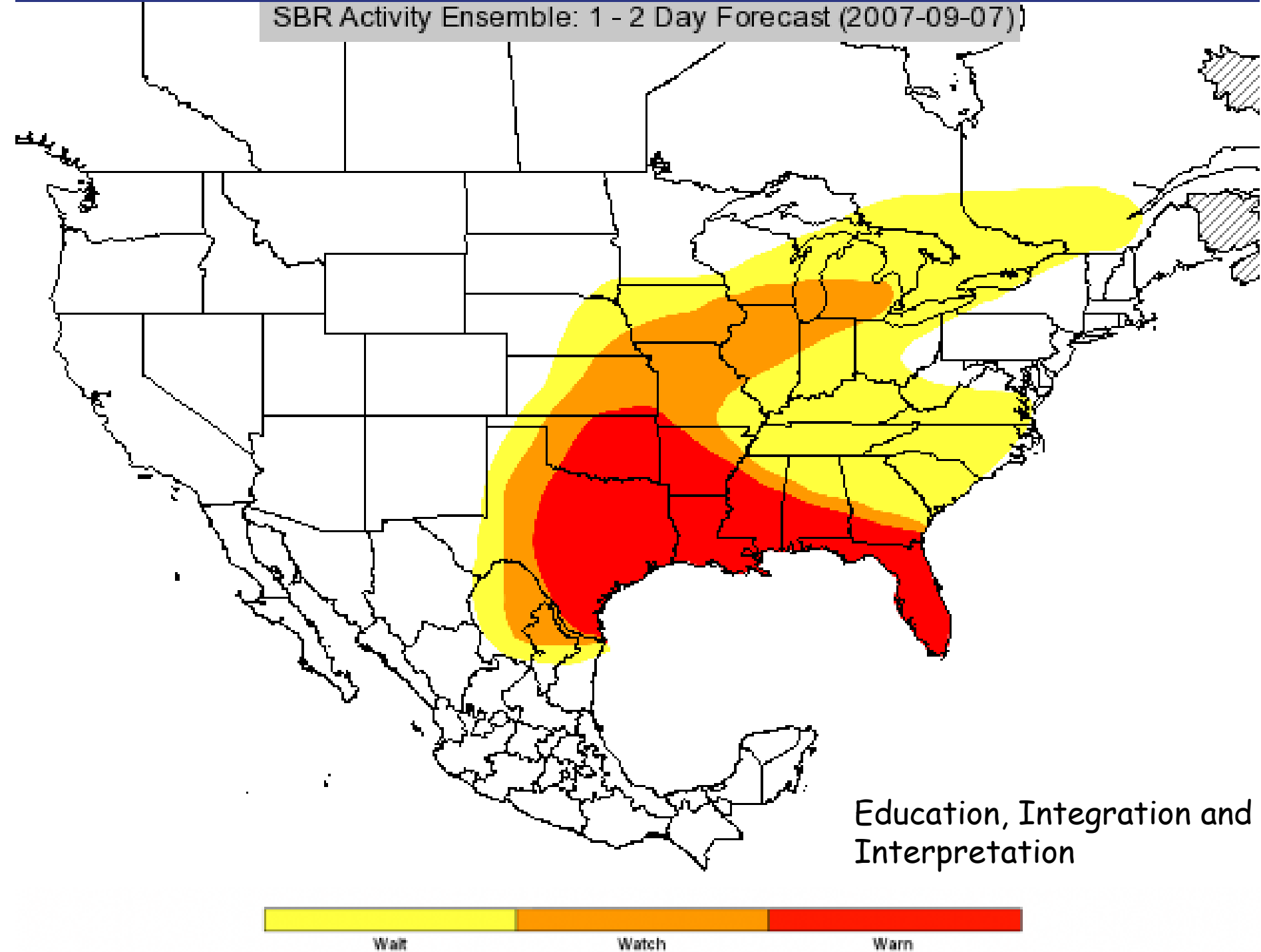
NADP Rainwater Collector



County with SBR infected sites
(21 August 2007)

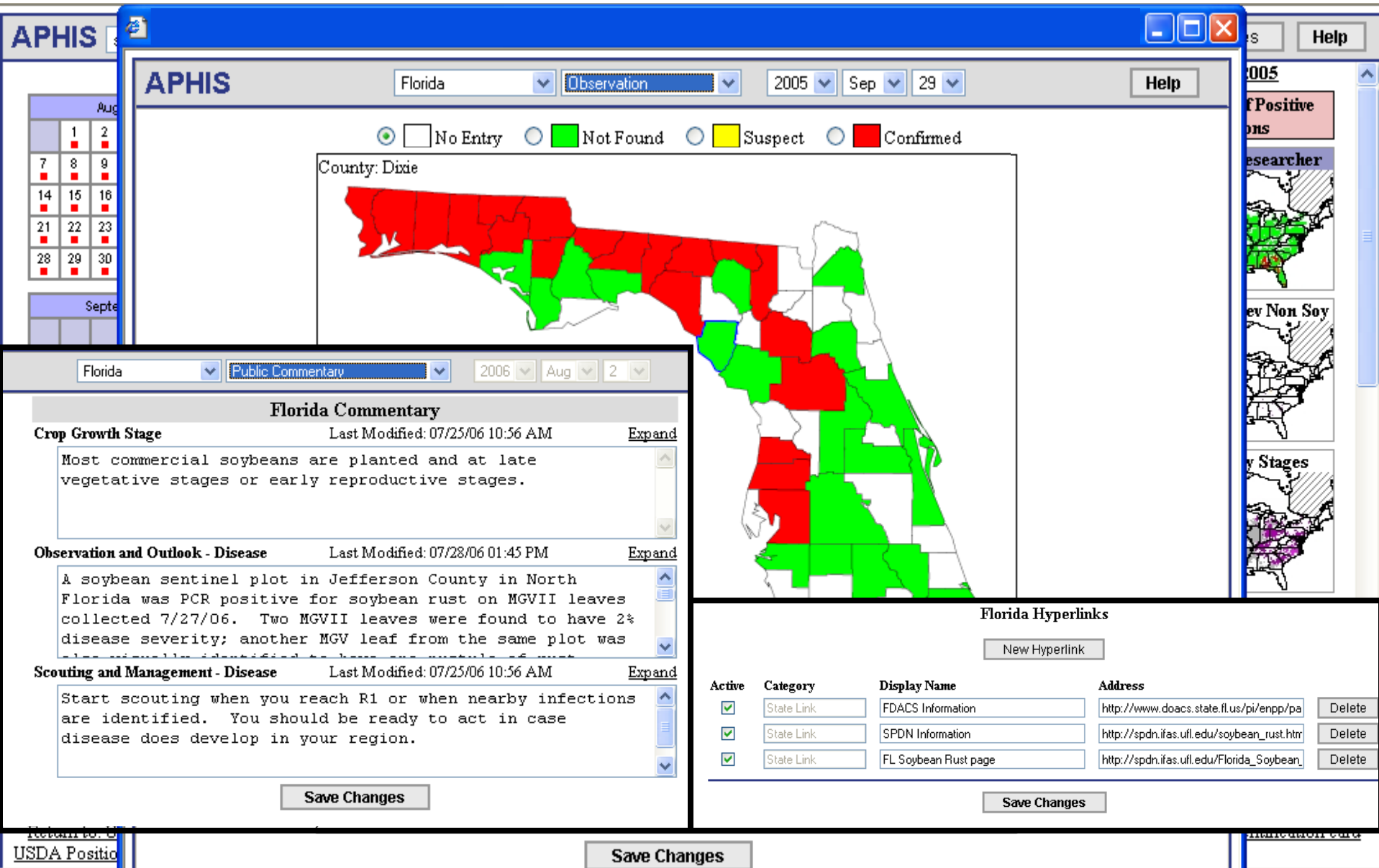


Research: Integration and Model Validation

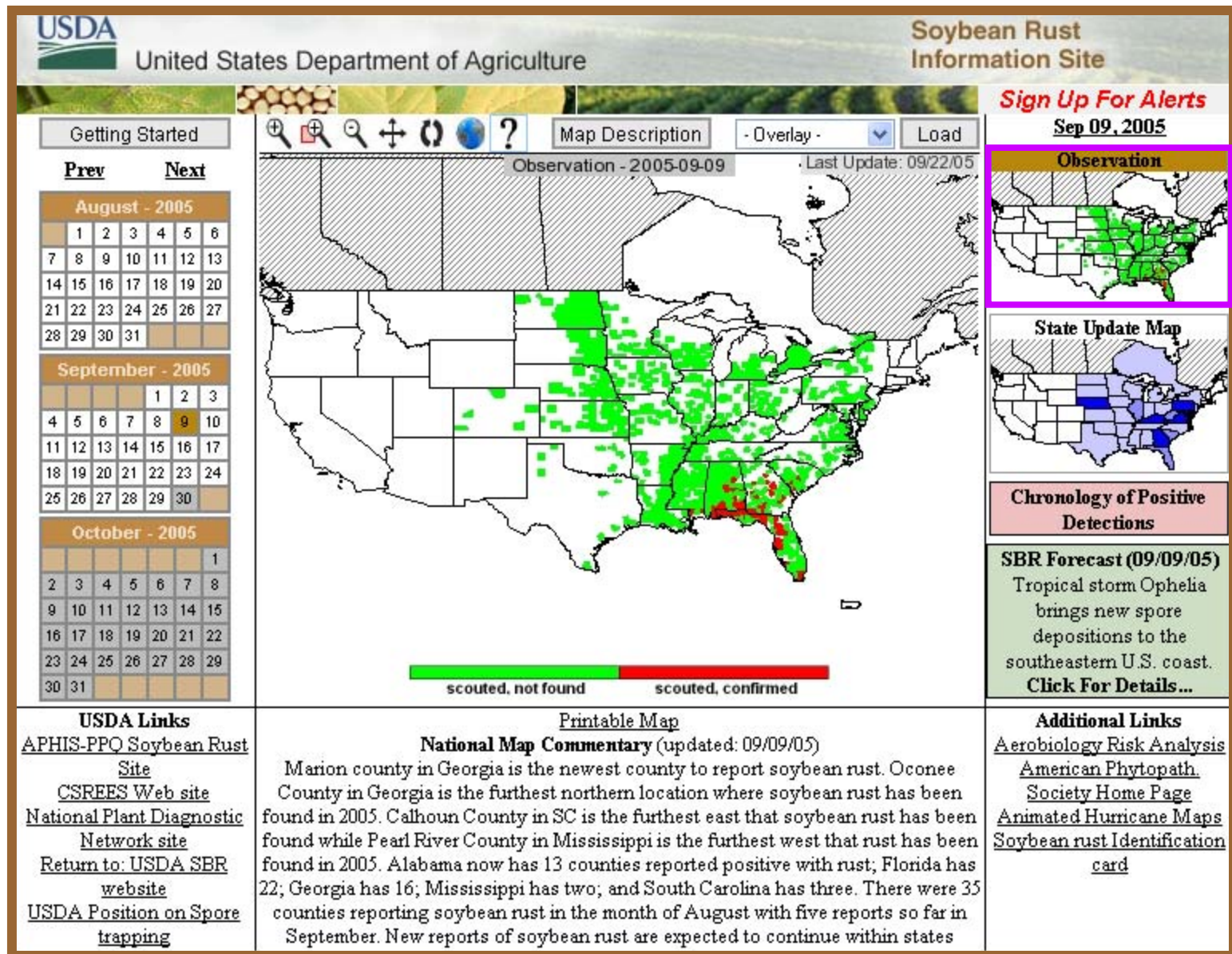


Interpretation & Communication by Specialists


(maps, textboxes, uploads)



Public Website: Observation Map



Public Website: Specialist Commentary



United States

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August - 2006

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September - 2006

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LA Commentary

- [ID/Scouting Tools](#)
- [Not sure if it is Rust?](#)
- [Other SBR Sites](#)
- [Hurricane Animations](#)
- [Observation Animations](#)
- [Partners](#)
- [Professional Societies](#)

Select a State/Province: Louisiana (2006-08-23)

Crop Growth Stage

Last Modified: 08/14/06 05:04 PM

Harvesting has begun in many of the soybean growing areas especially with early maturing varieties or those planted early. Some late planted beans are in the early reproductive stage.

GFP Tool

Click to document management practices

Observation and Outlook - Disease

Last Modified: 08/23/06 12:16 PM

ASR was found in Concordia Parish in a commercial field (which also contains the soybean sentinel plot) of Group V soybeans at the R6 stage. Incidence and severity levels were low. This brings to eight (8) the number of parishes in which ASR has been found on either soybeans or kudzu. Please check the federal public website <http://www.sbrusa.net/> to see where ASR has been confirmed in the US.

Observation and Outlook - Insect

Last Modified: N/A

Commentary Not Available

Scouting and Management - Disease

Last Modified: 08/23/06 12:16 PM

ASR was found in Concordia Parish in a commercial field (which also contains the soybean sentinel plot) of Group V soybeans at the R6 stage. Incidence and severity levels were low. This brings to eight (8) the number of parishes in which ASR has been found on either soybeans or kudzu.

The recommendation is for soybeans in the R1 through R5 growth stages and have a good yield potential be treated with a rust fungicide. The fungicides for rust control have a triazole alone or in combination with a strobilurin. These products are listed in the 2006 Plant Disease Management Guide and are on the LSU AgCenter Rust website, <http://www.lsuagcenter.com/soybeanrust>.

Again, it is especially important at this time to monitor your crop very carefully and be alert for reports of disease outbreaks in the area. You can monitor the AgCenter's website (<http://www.lsuagcenter.com/soybeanrust/>), contact your county agent, or call the Asian Soybean Rust Hotline at 1-800-516-0865.

Scouting and Management - Insect

Last Modified: N/A

Commentary Not Available

Management Guidelines for Growers


Website - M

http://www2.sbrusa.net - Guidelines - Microsoft Internet Explorer

Favorites

Tools

www.sbrusa.net/



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November

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19	20	21	22
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FL Comments

- FL Links

- ID/Scouting To

- Not sure if it is

- Other SBR Site

- Hurricane Anir

National Soybean Rust Management Guidelines

Last Updated May 01, 2006

Vegetative Growth Stages

Current data indicate that fungicide applications are not needed in the early vegetative growth stages. Spraying just prior to crop flowering (R1) may be prudent if disease is increasing. This is especially true for late-planted crops and/or very late-maturing varieties that may develop a large canopy before flowering.

R1-R5 Reproductive Stages

Soybean rust symptoms are most prevalent, and increase most rapidly, during crop reproductive growth stages. The first fungicide application should be made before rust has appeared on more than 2% of the leaves in the crop canopy. One, two, or three applications may be needed, depending upon what growth stage the disease is first detected and subsequent environmental conditions. Consecutive applications of either strobilurins or triazoles alone should never be made due to resistance concerns. Refer to fungicide labels for specific directions and restrictions.


R6 and later

Spraying at late growth stages is not recommended due to lack of yield response. In addition, many fungicides have days to harvest (preharvest intervals) or growth stage restrictions. Refer to fungicide labels for specific directions and restrictions.

Done

Internet

Automatic Notification Functions



United States Department of Agriculture

Pest Information Platform for Extension and Education

http://www2.sbrusa.net - Alert Signup - Micros...

E-Mail Alert Signup

[Signup Help](#)

The USDA Soybean Rust email notification system will send an email alert each time new information about soybean rust is made available for the region and/or state you specified.

*Email:

*Region: [Region Map](#)

State:

Affiliation:

* Required

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November

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19	20	21	22
26	27	28	29

- [FL Comment](#)

- [FL Links](#)

- [ID/Scouting T](#)

- [Not sure if it i](#)

- [Other SBR Sites](#)

- [Hurricane Animations](#)

- [Observation Animations](#)

- [Partners](#)

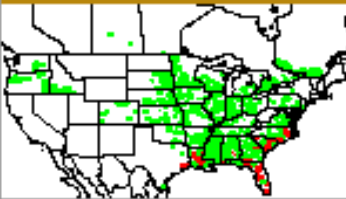
006-10-01 Last Update: 09/30/06

[Sign Up For Alerts](#)
Oct 01, 2006

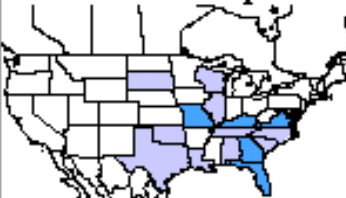
Legumes/Kudzu

Soybean Rust

SB Rust Observation



SB Rust State Update



Chronology of Positive Detections

SBR Forecast

[Click For Details...](#)

Management Toolbox

- [Tactics - USA](#)
- [Guidelines - USA](#)
- [GFP Tool](#)
- [Insurance Docs](#)
- [Commentary Chron](#)

Confirmed, no longer found

Legend

(updated: 09/29/06)

sentinel plot 9/28. This is the first time rust was found in this county in 2006; it was positive in 2005. The soybeans were MG5 at R7-8. Confirmation was done with PCR.

Rust was found in the Suwannee County soybean sentinel plot 9/27. This is the first time we found rust in this county. we had 2 sentinel plots in 2005 that never became

Detection Chronology



United States Department of Agriculture

Pest Information Platform
for Extension and Education

http://www2.sbrusa.net - APHIS - Microsoft Internet Ex...

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

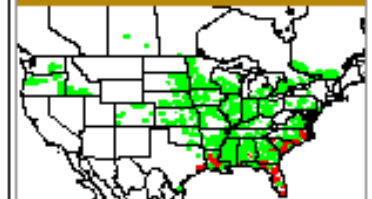
Sign Up For Alerts

Oct 01, 2006

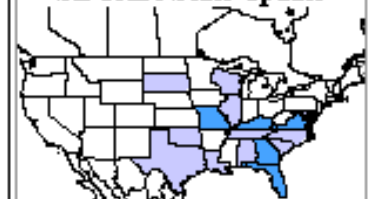
Legumes/Kudzu ▼

Soybean Rust ▼

SB Rust Observation



SB Rust State Update



Chronology of Positive Detections

SBR Forecast
Click For Details...

Management Toolbox

- [Tactics - USA](#)
- [Guidelines - USA](#)
- [GFP Tool](#)
- [Insurance Docs](#)
- [Commentary Chron](#)

... (09/29/06)
... not 9/28. This is the first
... in 2005. The soybeans
... with PCR.

Rust was found in the Suwannee County soybean sentinel plot 9/27. This is the first time we found rust in this county. We had 2 sentinel plots in 2005 that never became

Good Farming Practice Documentation Tool for Growers



United States

Getting Started

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August - 2006

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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 *

County *

Farm Description

Field ID(s)

Crop *

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, particularly a triazole or a



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 more information. Currently rust has been found on this week's soybeans in eight

- [GFP Tool](#)
- [Insurance Docs](#)

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

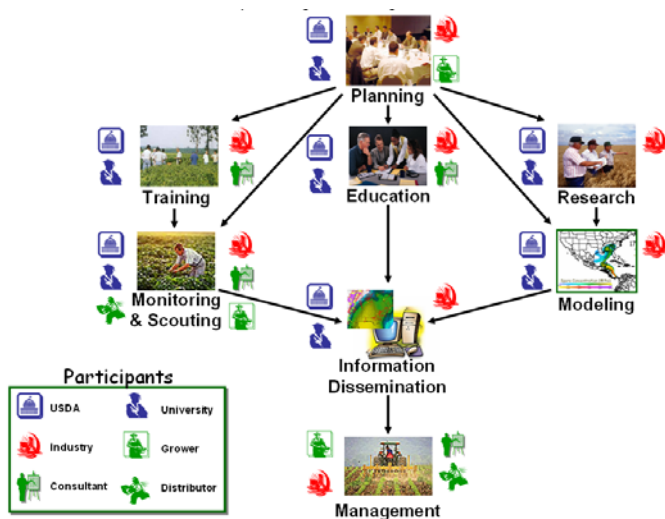
Simple design - flexible and expandable

Empowers the State Extension Specialists (protocols & dissemination)

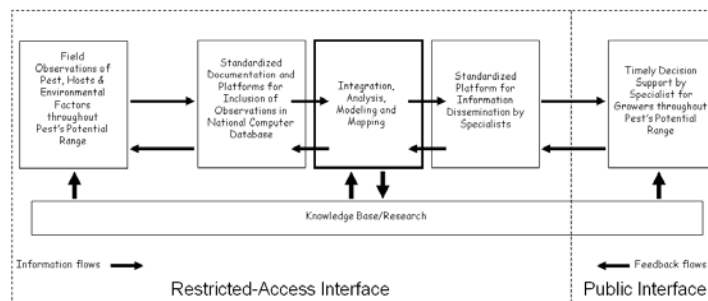
Enhances communications among stakeholders

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

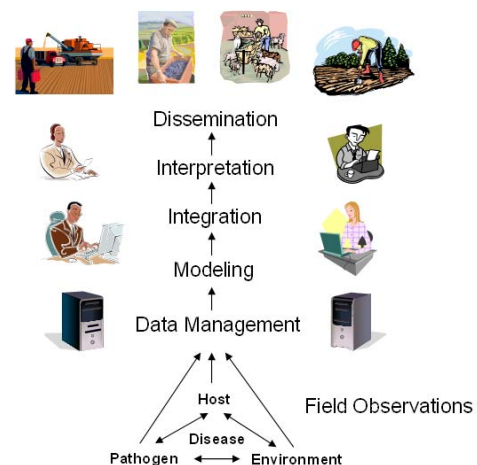
Coordinated Framework



State-of-the-Art IT Platform



Integration of Tasks



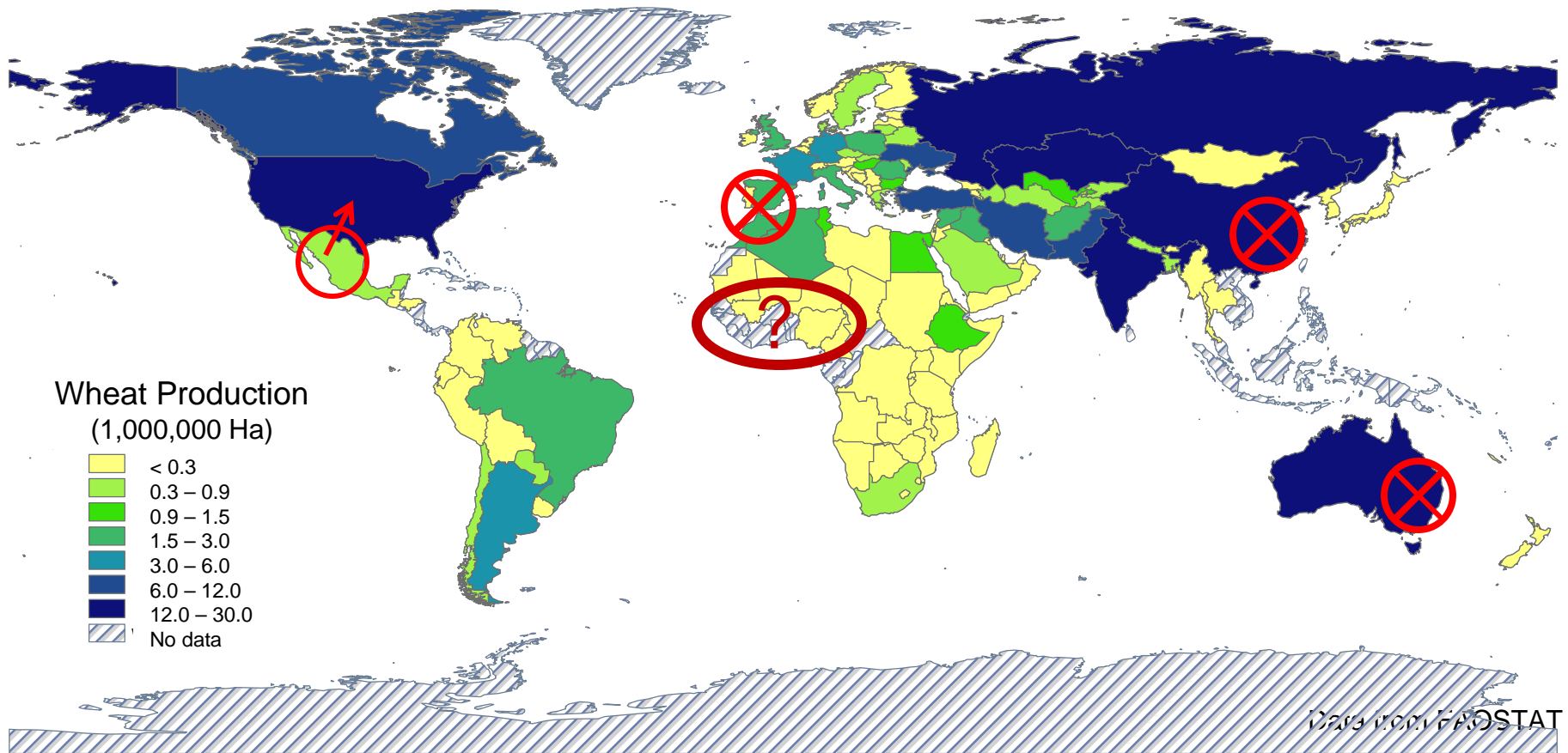


Challenges associated with providing
"state-of-the-art" IT for effective
"in-season" management of wheat
rusts



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

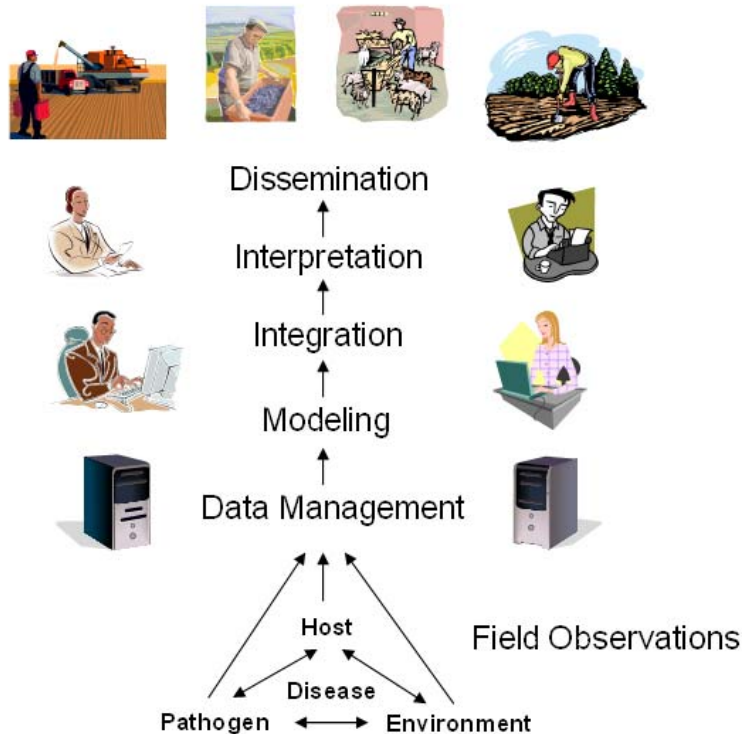
- NADP rainwater trap network

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?

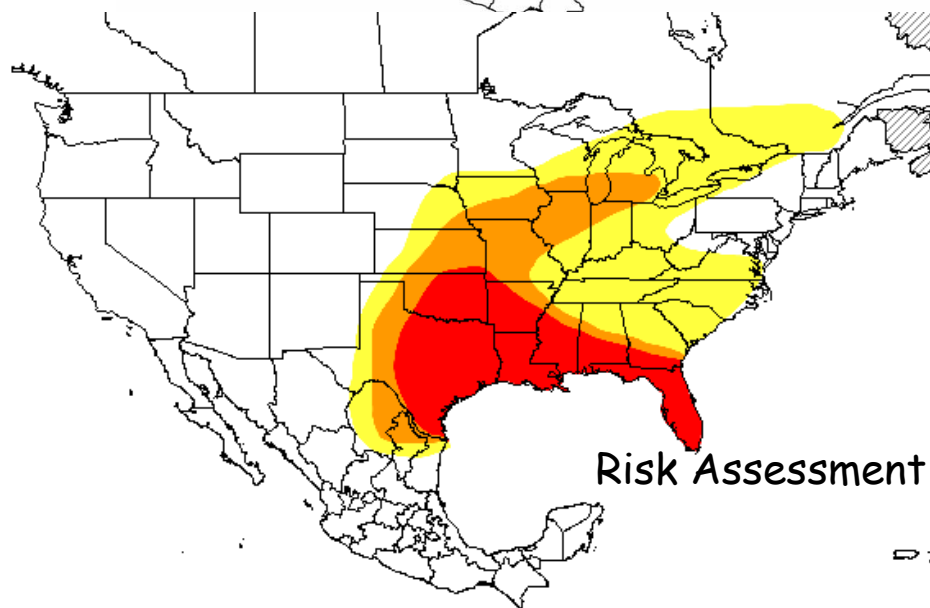
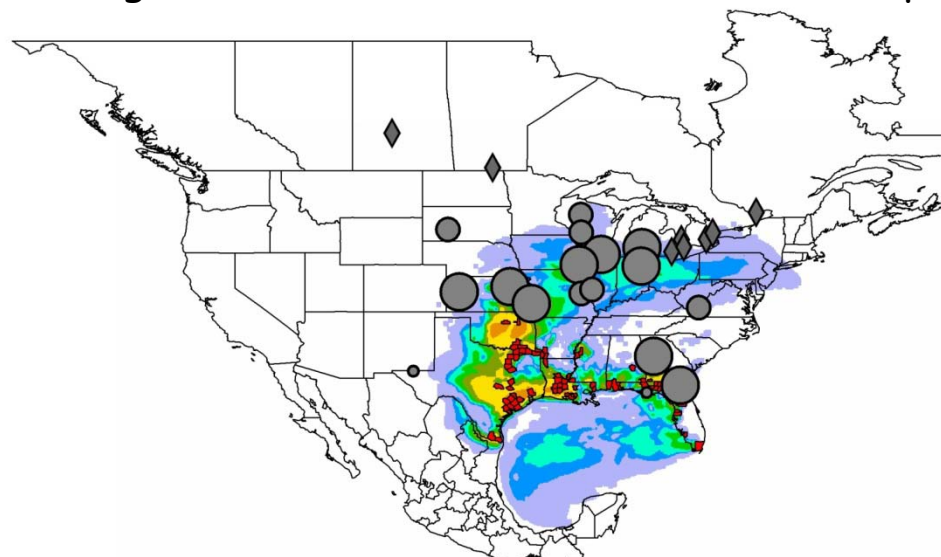
What is my potential for yield loss?

What can I spray?

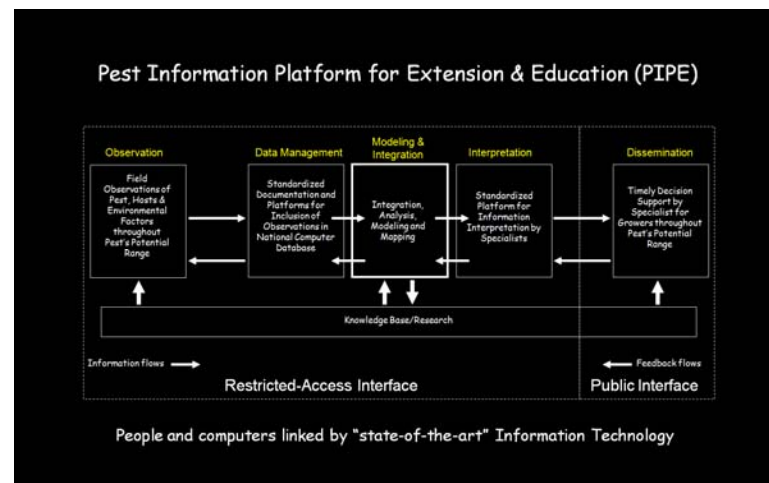
Is my current technology going to be effective?

Early Warning Systems for Rust Diseases

Integration of Observations and Model Output



State-of-the-art IT Platform



One Stop Information Shop for Stakeholders

