

Review of the Tropical Weather Systems in 2004 and their Potential Impact on the Transport of Soybean Rust Spores to the United States.

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Executive summary

NCSU staff used trajectory analysis to examine 10 tropical storms to determine the likelihood they may influence the transport of soybean rust from South America to the United States. Only three storms had a likely interaction with trajectories originating from potential source sites in South America. Of these trajectories showing interaction, those associated with Francis were unlikely to impact the United States. Trajectories interacting with Charley and Ivan may have impacted the United States. Those trajectories associated with Charley were highly unlikely to contain viable spores due to washout by precipitation. Trajectories associated with Ivan were also unlikely to contain viable spores but this possibility could not be eliminated using current analytical techniques. Further analysis is in progress. Deposition of viable spores is most likely in the Caribbean region. Soybean rust surveys on Jamaica and other islands in the south west Caribbean are recommended.

Introduction

The 2004 Atlantic Hurricane season has been quite active through early September. The question arises as to whether any of the tropical cyclones may have facilitated or enhanced the transport of soybean rust spores to the United States. This is dependent on many factors, including the system's size, strength, track, and timing. This report examines each tropical system and its interaction (if any) with air parcel trajectories originating in Cali, Columbia and far northern Brazil in the state of Roraima. The latest start date for the trajectories considered here is September 7. The trajectories represent the pathways taken by airborne SBR spores as they moved from the confirmed source in Columbia or the not-yet-confirmed potential source in Roraima.

The active 2004 hurricane season has experienced 10 tropical weather systems through early September. Each was examined to determine its potential impact on the transport of soybean rust spores from South America to the United States. 6 of the 10 had no impact. Two others (Bonnie and Frances) were highly unlikely to have had an impact. Hurricanes Charley and Ivan both demonstrated interaction with transport events from South America. These storms were explored in more detail.

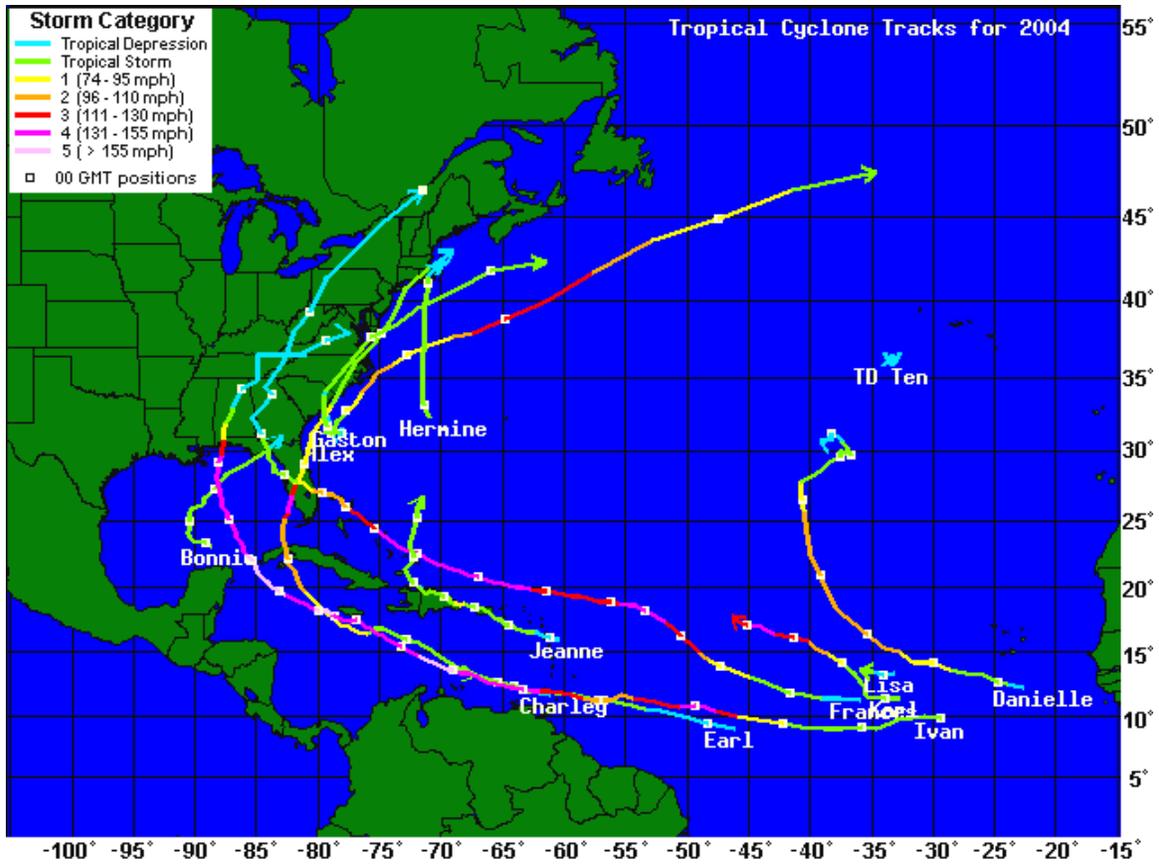


Figure 1: Tropical weather systems (Depressions, Storms, and Hurricanes) through 19 September 2004. Ongoing systems include Tropical Storm Jeanne (now nearly stationary northeast of the Bahamas; impact appears unlikely at this time), Hurricane Karl (forecast to turn north; probable No Impact), and Tropical Storm Lisa (future impact unknown).

Table 1: 2004 Tropical weather systems and their potential impact on atmospheric transport of soybean rust spores from South America to the continental United States

2004 Tropical Weather Systems	Interaction with trajectories	Likelihood of spore transport reaching United States
Hurricane Alex	None	None
Tropical Storm Bonnie	Highly Unlikely	Highly unlikely
Hurricane Charley	Highly Likely	Highly unlikely
Hurricane Danielle	None	None
Tropical Storm Earl	None	None
Hurricane Frances	Highly likely	None
Tropical Storm Gaston	None	None
Tropical Storm Hermine	None	None
Tropical Depression 10	None	None
Ivan (through September 7)	Highly Likely	Unlikely

Notes on Individual Storms

Alex: This system formed along the southeast U.S. coast, far away from known or suspected source regions, then moved away. No trajectories approached the storm's vicinity during its time near the U.S.

Bonnie: Bonnie was a small storm that moved north and northeast through the central and northern Gulf of Mexico. The only possible involvement with Bonnie was from the 500m August 3 trajectory from Roraima, Brazil. This trajectory ended near southwest Florida August 12. However, Bonnie was several days ahead in time and far off to the north and northwest of the trajectory. Interaction was quite unlikely.

Charley: There were indications that trajectories from Roraima on August 7, 8, and 9 interacted with Charley as he moved through the Caribbean Sea. The interactions all occurred on August 11 and 12. The 100m and 200m trajectories out of Roraima on August 7 are shown in Figure 2 below. Comparison of the position and timing of the trajectories to the position and timing of Charley's passage supports the behavior of the trajectories. Dispersion simulations (air concentrations and ground deposition) confirmed heavy air parcel interaction with Charley, with the result being the washout of any airborne particles (e.g., SBR spores). Charley's impact was thus more of a hindrance to airborne SBR transport to the U. S. than an aid.

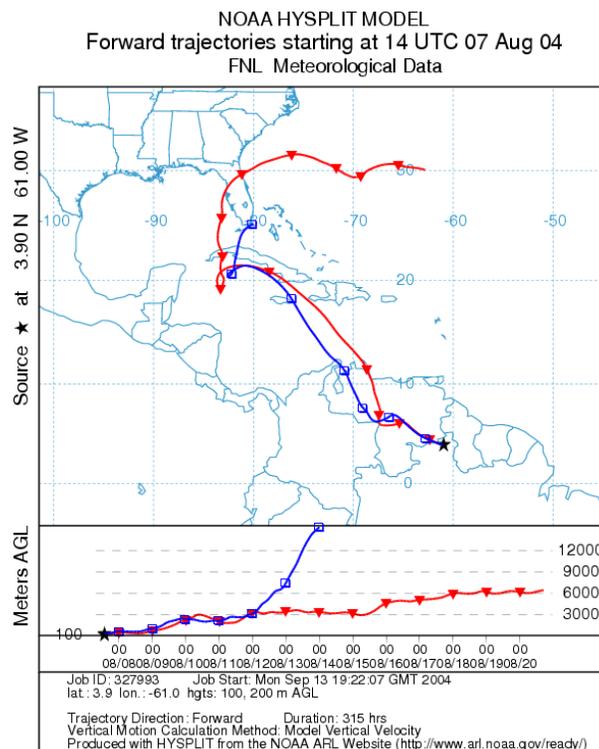


Figure 2: The 100m (red triangles) and 200m (blue squares) air parcel trajectories from Roraima, Brazil beginning August 7, 2004. There is one day of travel between each timepost. The period between the 00Z 11 August timeposts (closed triangle and open square at the South American coast) and the 00Z 13 August timeposts (same symbols located south of western Cuba) represents the major time of interaction with Hurricane Charley. Note the increase in speed of the trajectories as they left the coast, indicating the influence of Charley's wind field. The rapid rise of the 200m trajectory as it crossed Jamaica indicates capture of the air parcel by the inner portions of the hurricane, and thus certain washout.

Danielle: Located far out in the eastern Atlantic. No impact.

Earl: Weak, short-lived storm that died off the northern South American coast. No trajectories approached it.

Frances: Frances' track remained north of the Greater and Lesser Antilles through its lifetime. A trajectory from Roraima on 19 August showed interaction with Frances during 29 – 31 August. During that time Frances was a powerful hurricane moving westward near the U.S. Virgin Islands and Puerto Rico. This event occurred while Frances was still 4 days away from its eventual landfall in Florida. No other trajectories from Roraima or Cali interacted with Frances.

Gaston: Similar situation to Alex. The storm was too far north of the South American source sites at its inception off the Southeast coast. No trajectories neared the region during the storms lifetime.

Hermine: Similar to Alex and Gaston, and even farther out to sea.

T.D. Ten: Eastern Atlantic, extremely short-lived system. No impact.

Ivan: At least 2 transport episodes from Cali, Columbia were influenced by powerful Hurricane Ivan as he moved through the central and northwestern Caribbean, the Straits of Yucatan, and the Gulf of Mexico.

On September 4, 100m and 500m trajectories from Cali were drawn into Ivan on September 10 southeast of Jamaica. Behavior of the trajectories indicated entrainment of the air parcels into the inner regions of the hurricane and thus complete washout of any airborne spores.

The September 7 transport event from Cali was more troubling (see Figure 3). The trajectory that began at 100m moved north and NNW, crossing over southern Florida on the sixth day of travel. Examination of the track and speed of Ivan and the September 7 trajectory showed interaction of the air parcels with the eastern edges of Ivan's large wind field. Ivan's influence was also evidenced by the sharp increase in trajectory speed over the Caribbean Sea and beyond. Analysis of air concentrations and ground deposition indicated washout of airborne biota throughout the transport event, making it unlikely that air borne spores would reach Florida. However, this possibility could not be eliminated using current analytical techniques. Transport events similar to the one described for September 7 may have also occurred on September 8 and September 10. At this time the relevant data are incomplete. Deposition of viable spores is most likely in the Caribbean region. Soybean rust surveys on Jamaica and other islands in the south west Caribbean are recommended. Analyses for these potential events will be performed when possible and will be available in a future update. Complete analysis of these events will most likely require the use of the Integrated Atmospheric Modeling System (IAMS) (Isard et al. 2004).

NOAA HYSPLIT MODEL
 Forward trajectories starting at 14 UTC 07 Sep 04
 FNL Meteorological Data

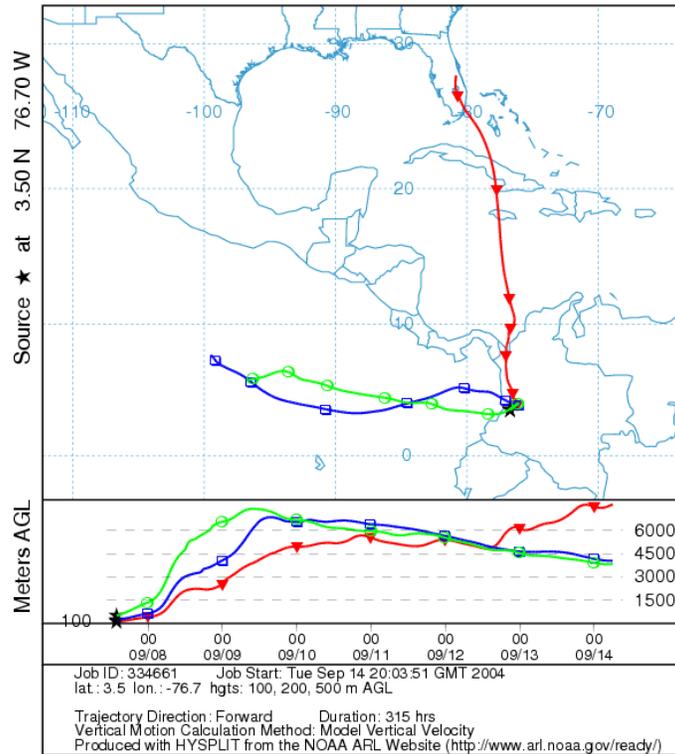


Figure 3: The 100m (red triangles), 200m (blue squares), and 500m (green circles) air parcel trajectories from Cali, Columbia beginning September 7, 2004. There is one day of travel between each timepost. The 100m trajectory was influenced by Hurricane Ivan as it moved northward through the Caribbean Sea and onward to southern Florida. Note the increase in speed as the transport event neared the stronger winds near the hurricane. There was potential transport to Florida although the extent is unknown.

Acknowledgment: We thank Dr Scott Isard of the Pennsylvania State University for reviewing this document. This is a preliminary report of soybean rust trajectories from two locations using the HYSPLIT model (Draxler and Rolph 2003; Rolph 2003). The methodology for this analysis is explained in detail in Isard et al. (2004).

Literature Cited

Draxler, R.R. and Rolph, G.D., 2003. HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) Model access via NOAA ARL READY Website (<http://www.arl.noaa.gov/ready/hysplit4.html>). NOAA Air Resources Laboratory, Silver Spring, MD.

Isard et al. 2004. Weather-Based Assessment of Soybean Rust Threat to North America Final Report to APHIS. http://www.aphis.usda.gov/ppq/ep/soybean_rust/sbrfinal15july.pdf.

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