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OBSERVATION:

The National Aeronautics and Space Administration (NASA) and the Japan Aerospace Exploration Agency (JAXA) will decommission the Tropical Rainfall Measuring Mission (TRMM) at the end of 2004. TRMM's capabilities provided an extremely valuable tool for forecasting hurricanes storm tracks and intensities worldwide. The 2004 Atlantic Hurricane Season is an ominous watershed--it marks the last time TRMM may be used while a dangerous weather pattern resumes in the Atlantic.

Evidence suggests that there will be a higher margin of forecasting error without TRMM. This logically suggests an impact on hurricane early warning, preparedness, and mitigation efforts--likely translating into increased fatalities until a replacement becomes operational between 2008 and 2010.

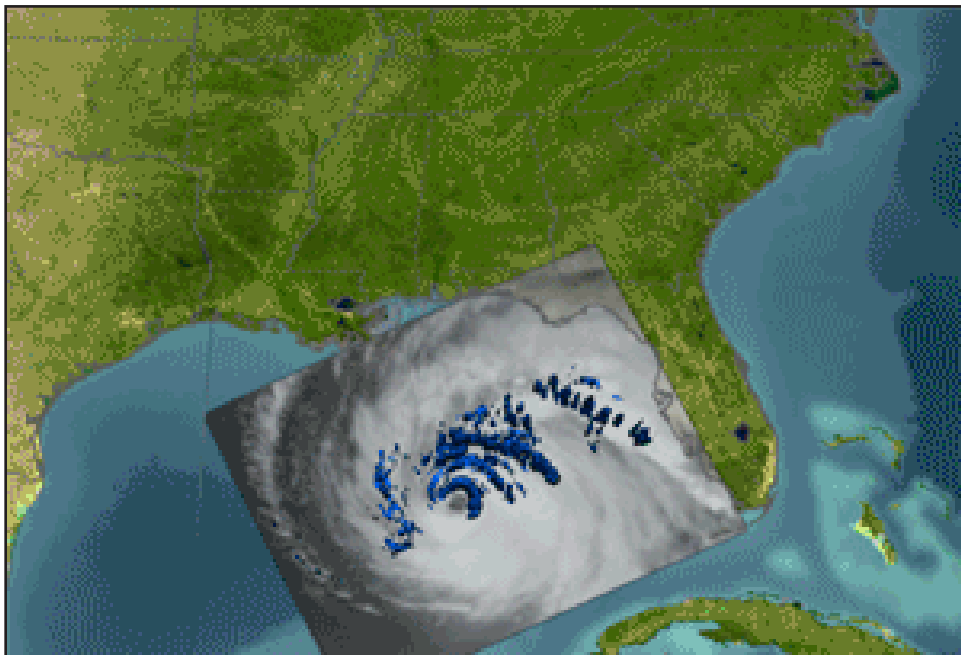
DISCUSSION:

On June 28-30, 2004 Typhoon Mindulle passed adjacent to the northern Philippine island of Luzon. Hammering Luzon with 75 mile per hour winds and triggering flash flooding, Mindulle left 16 dead and 17 missing in its wake before making landfall on Taiwan to the north. In terms of devastation, Mindulle paled in comparison to Typhoon Imbudo, which made a direct impact on Luzon in 2003, killing 21 and displacing more than 11,000 residents.

However, Mindulle was nearly a symbol of lives lost in a different sense--it was supposed to be one of the last typhoons to be monitored by NASA's Tropical Rain Fall Measuring Mission satellite. From its formation as a tropical storm less than 100 miles west of the Commonwealth of the Northern Marianas Islands, through its northeastern track past the Philippines and into Taiwan, TRMM data were able to provide weather analysts at the Joint Typhoon Warning Center with detailed observations about the formation and dissipation of the eyewall as well as bands of heavy rains that both provided key indicators about storm intensity.¹



The Tropical Rainfall Measuring Mission satellite. (Source: NASA.)



An image supported by TRMM data shows a representation of rainfall from Hurricane Ivan prior to its impact on the United States. The data helped to provide additional clues on Ivan's strengthening. (Source: NASA.)

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TRMM snapped the final image of a weakening Mindulle off the coast of Taiwan on July 1, and eight days later NASA and the Japan Aerospace Exploration Agency announced that the joint U.S.-Japan mission would be terminated, with observations ending in July and the satellite placed to rest through a controlled reentry into the ocean less than a year later.²

A flurry of controversy raised by the announcement to decommission a tool that had been of vital importance to weather forecasting caused NASA and the Japanese space agency to extend TRMM's mission until the end of 2004. This decision proved to be fortuitous as hurricanes Charlie, Frances, Ivan, and Jeanne wrecked havoc on the Southeastern coast of the United States between August 10 and September 27--collectively killing nearly 110 and causing USD \$52 billion in damage in the United States, and causing widespread destruction in Cuba, the Bahamas, Haiti and Grenada.

During this historic Atlantic Hurricane Season, TRMM provided detailed data on the storms, including a three-dimensional "CAT scan" of Hurricane Ivan that provided indicators about its intensity prior to impacting the United States.³

Until a replacement is launched, the termination of TRMM comes at a time when there is increasing consensus that the 2004 Atlantic Hurricane Season is a harbinger of a more dangerous weather pattern. Atlantic Hurricane Seasons exhibit prolonged periods lasting decades of generally above-normal or below-normal activity, referred to as the "Multi-Decadal Atlantic Oscillation." Since 1995, there is evidence that a more active pattern has resumed, similar to that of the 1960's. In the wake of the 2004, weather analysts are further concluding that this is the case.

Background

Launched in 1997, TRMM was lauded as a great success by NASA and by weather analysts alike. TRMM uses microwave imagery to monitor global rainfall data and hydrological processes, with diverse applications ranging from helping to monitor Global Climate Change and El Nino, to assisting with hazard mitigation through early warning for flash flooding, tropical cyclones, and even droughts. Among the success stories cited by NASA included TRMM's discovery that the African monsoon season is actually divided into two seasons, that warm rains in the tropics are more likely as tropical oceans heat, and that heating from coastal cities causes increased downwind rainfall.⁴

The debate over the decision to terminate TRMM's mission has been intense. While speculation on why the mission was terminated centers on funding compared to other NASA priorities (costs are estimated at \$3-4 million per year to maintain TRMM), another primary reason cited by NASA is safety. If the satellite “naturally” lives out a lifespan of an estimated two years before an uncontrolled descent to earth, NASA had predicted a 1:5000 chance that the satellite would injure a human being upon impact. Safely jettisoning the satellite in the ocean by the end of 2004 would eliminate this risk. But as pointed out in an internal memorandum from 2002 obtained by Space News from NASA's associate administrator for public safety:

[T]hese risks appear to be reasonable when subjectively weighed against the potential public safety benefits of improved storm analysis and forecasting abilities that appear to be realized by extending the TRMM mission.⁵

The exact magnitude of such “weighing” is difficult to determine. However, using figures estimated in 2001 by Dr. Robert Adler, NASA TRMM Project scientist, based on an assumed 15,000 annual deaths from tropical cyclones annually, “If you assume a very conservative 1 percent improvement in 24-48 hour track forecasts solely to TRMM, then approximately **240 lives/year may be saved because of the operational implementation of TRMM data.**”⁶ (Emphasis added). Given that a replacement for TRMM's capability might not be launched and functional until 2008 or 2010,⁷ projecting this figure translates into nearly 1000 fatalities over four years, and in excess of 1400 fatalities over seven years.

A Tool Removed from the Arsenal

NASA has described TRMM data as being an important “tool” in a weather forecaster's “arsenal.”⁸ The implications for the removal of such a tool are substantial, especially in terms of providing early warning of tropical storms.

From a theoretical perspective, the case for TRMM data contributing to effective mitigation and preparedness for tropical cyclone hazards is clear. As asserted by Robert Atlas et. al. in an article about the importance of monitoring missions like TRMM, “A timely and accurate warning can lead

In terms of human costs, TRMM's support of early warning for hurricanes translates to an estimated 240 lives saved per year. This projects to nearly 1,000 lives in total should a replacement become operational by 2008. (Image on right: damage in Niue from tropical cyclone Heta in January 2004. (Source: South Pacific Applied Geosciences Commission.)



to proper evacuation and damage control strategies and can produce immense benefits. However, overwarning can lead to unnecessary costs and a loss of confidence in warnings.”⁹ Atlas et. al. state that in experiments, improved analysis about rainfall from microwave data was a significant contributor to improving five-day storm track and precipitation forecasts.¹⁰

In addition, a scientific study published by researchers at Florida State University in 2000 indicated that weather forecasters had higher skill levels with TRMM data than without.¹¹ Applications of such techniques were applied during the 1999 hurricane season, and contributed to correct forecast tracking of hurricanes Dennis and Floyd.¹²

What would have happened if forecasters did not have the benefit of TRMM data in 2004?

Anecdotal evidence further supports the premise that TRMM data supported weather forecasters when making “judgment calls” about storm tracks and intensity:

- In 1998, TRMM captured an image of a 59,000-foot chimney cloud in Hurricane Bonnie, a rare feature in Atlantic hurricanes that indicated storm intensification 24-48 hours before it actually occurred.¹³

- In 2001, while other data incorrectly indicated that Hurricane Daniel was weakening in the Pacific, TRMM correctly predicted that the storm was in fact intensifying as it was nearing Hawaii.¹⁴

- Also in 2001, after Tropical Storm Cimaron, which developed in the Eastern North Pacific in 2001, Joint Typhoon Warning Center staff sergeant Ralph Parker reported "The system was very disorganized and hard to find in an infrared image...microwave imagery from the TRMM satellite was able to see through the obscuring cirrus, allowing me to see the low level cloud lines and

identify the center of circulation." Cimaron passed between the Philippines and Taiwan, and directly made landfall on Okinawa, Japan.¹⁵

- In 2004, TRMM monitored the active Atlantic Hurricane Season including Charlie, Frances, Ivan and Jeanne, and was directly used to monitor fluctuations in intensity prior to impact.

From this evidence, one can ask several “what if” questions that pertain to early warning without the benefit of TRMM: What if there was no indication that Bonnie was intensifying in 1998? What if Daniel had been a stronger storm on track to impact Hawaii in 2001, or Cimaron had tracked differently? And perhaps most importantly, what would have happened if forecasters did not have the benefit of TRMM data in 2004?

CONCLUSION

The decommissioning of TRMM is a clear downgrade to the weather analyst’s toolkit for accurately predicting the track and intensity of tropical cyclones. While NASA’s 2001 estimates of 240 lives per year saved by TRMM is difficult to quantify, anecdotal evidence firmly suggests that without TRMM, there will be a higher margin of forecasting error than in years past. This logically impacts early warning, preparedness, and mitigation efforts--thereby translating into increased fatalities. Had July’s Typhoon Mindulle been one of the last hurricanes in which weather forecasters would have benefited from TRMM's assistance, it is unclear what the detrimental effects would have been in terms of providing early warning for the 2004 Atlantic Hurricane Season. This is particularly important, given the speculation that a new Multidecadal Oscillation pattern is likely to produce more frequent and intense hurricanes in the Atlantic in the coming years.

SOURCES

1. Typhoon Mindule Brushes Past the Philippines. NASA. www.trmm.gsfc.nasa.gov/publications_dir/mindulle_june04.html.
2. Termination of Operation of Tropical Rainfall measuring Mission (TRMM). JAXA. July 9, 2004. www.jaxa.jp/press/2004/07/20040709_trmm_e.html.
3. Hurricane Ivan's 'CAT' Scan. National Aeronautics and Space Administration. September 20, 2004. www.nasa.gov/vision/earth/lookingatearth/IVAN_TRMM_9.15.html.
4. Joe Bauman. U. Scientist Fears Demise Of Earth-Imaging Satellite. Deseret Morning News, July 12, 2004. www.desertnews.com
5. Brian Berger. NASA Plan to Kill TRMM Mission Spurs Backlash, Debate. Space News. June 28, 2004. www.space.com/spacenews/businessmonday_040704.html.
6. NASA TRMM Satellite Critical to Real-Time Hurricane Monitoring. NASA. April 5, 2001. earthobservatory.nasa.gov/Newsroom/Nasanews/2001/200104054630
7. Brian Berger. NASA Plan to Kill TRMM Mission Spurs Backlash, Debate. Space News. June 28, 2004. www.space.com/spacenews/businessmonday_040704.html.
8. NASA TRMM Satellite Critical to Real-Time Hurricane Monitoring. NASA. April 5, 2001. earthobservatory.nasa.gov/Newsroom/Nasanews/2001/200104054630
9. Robert Atlas, Arthur Hou, and Oresete Reale. Hurricane & Flood Prediction Community Disaster Preparedness. Earth Observation Magazine. August 2002. www.eonline.com/Common/currentissues/Aug02/atlas.htm.
10. Robert Atlas, Arthur Hou, and Oresete Reale. Hurricane & Flood Prediction Community Disaster Preparedness. Earth Observation Magazine. August 2002. www.eonline.com/Common/currentissues/Aug02/atlas.htm.
11. Zhong Liu, L. Chiu, et. al. Examples of Climate Applications of TRMM Data. American Meteorological Society Meeting Papers. ams.confex.com/ams/pdfpapers/70685.pdf
12. NASA Satellite Greatly Improves Accuracy of Tropical Rainfall Forecasting. NASA. January 12, 2000. <http://www.spaceref.com/news/viewpr.html?pid=493>
13. Scientists Observe Tall Chimney Cloud in Hurricane Bonnie. NASA. September 1, 1998. www.xs4all.nl/~carlkop/camex.html.
14. NASA TRMM Satellite Critical to Real-Time Hurricane Monitoring. NASA. April 5, 2001. earthobservatory.nasa.gov/Newsroom/Nasanews/2001/200104054630
15. Capt. Chris Cantrell. Typhoons Beware-the Joint Typhoon Warning Center is Watching You. July-August 2001. <http://afweather.afwa.af.mil/observer>.