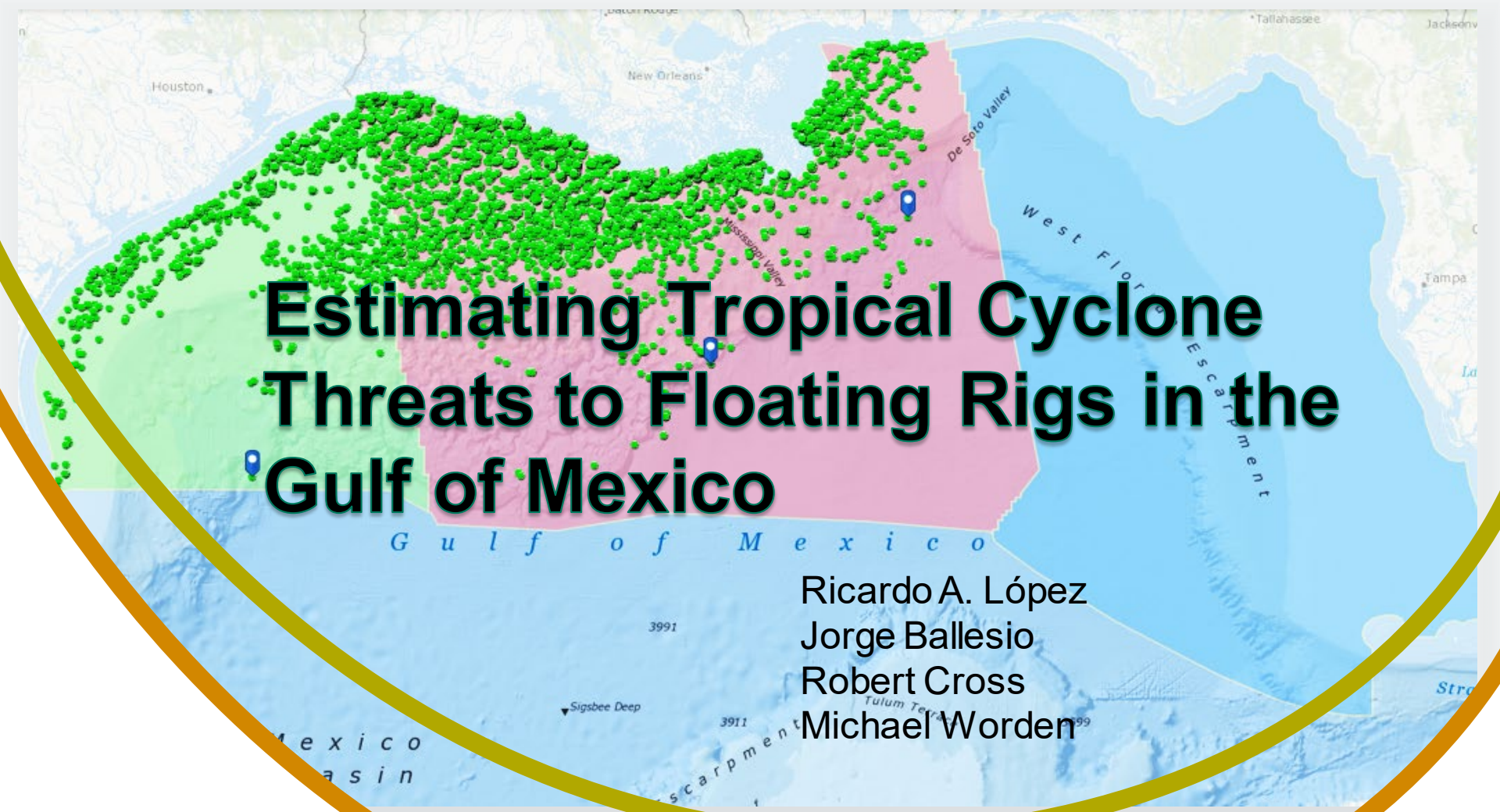

Estimating Tropical Cyclone Threats to Floating Rigs in the Gulf of Mexico

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Agenda

- Introduction
- Objective
- Weather Threats & T-Time
- Tropical Cyclone Data
- Forecasted Track Cone and Storm Size
- Automation Tool (MS Excel)
- Results and Conclusions

Introduction

- Interagency Agreement between the Bureau of Safety and Environmental Enforcement (BSEE) and the National Aeronautics and Space Administration (NASA) for risk assessment support
- Developed probabilistic risk assessment models of blow out preventer and related systems to control oil wells during drilling and completion
- Identified potential high risk of certain design arrangements when faced with upcoming tropical storms

Objective

- **Develop a better understanding of tropical cyclones' threat to offshore activities in the Gulf of Mexico**
  - Estimate the potential threat of upcoming cyclones at selected locations in the Gulf of Mexico
  - Evaluate the historical frequency of cyclones passing within 150 nautical miles from any location in the Gulf of Mexico
  - Estimate the threat of incoming cyclones that do not give enough advance notice to secure the well and evacuate/move at any location in the Gulf of Mexico

Weather Threats & T-Time

- **T-Time: time required to shutdown, secure the well, and evacuate/move to a safe location before a tropical cyclone is expected**
  - Can vary based on vessel type, well operation being performed, well/water depth
  - For example, T-times can be as long as nine days during some well activities.

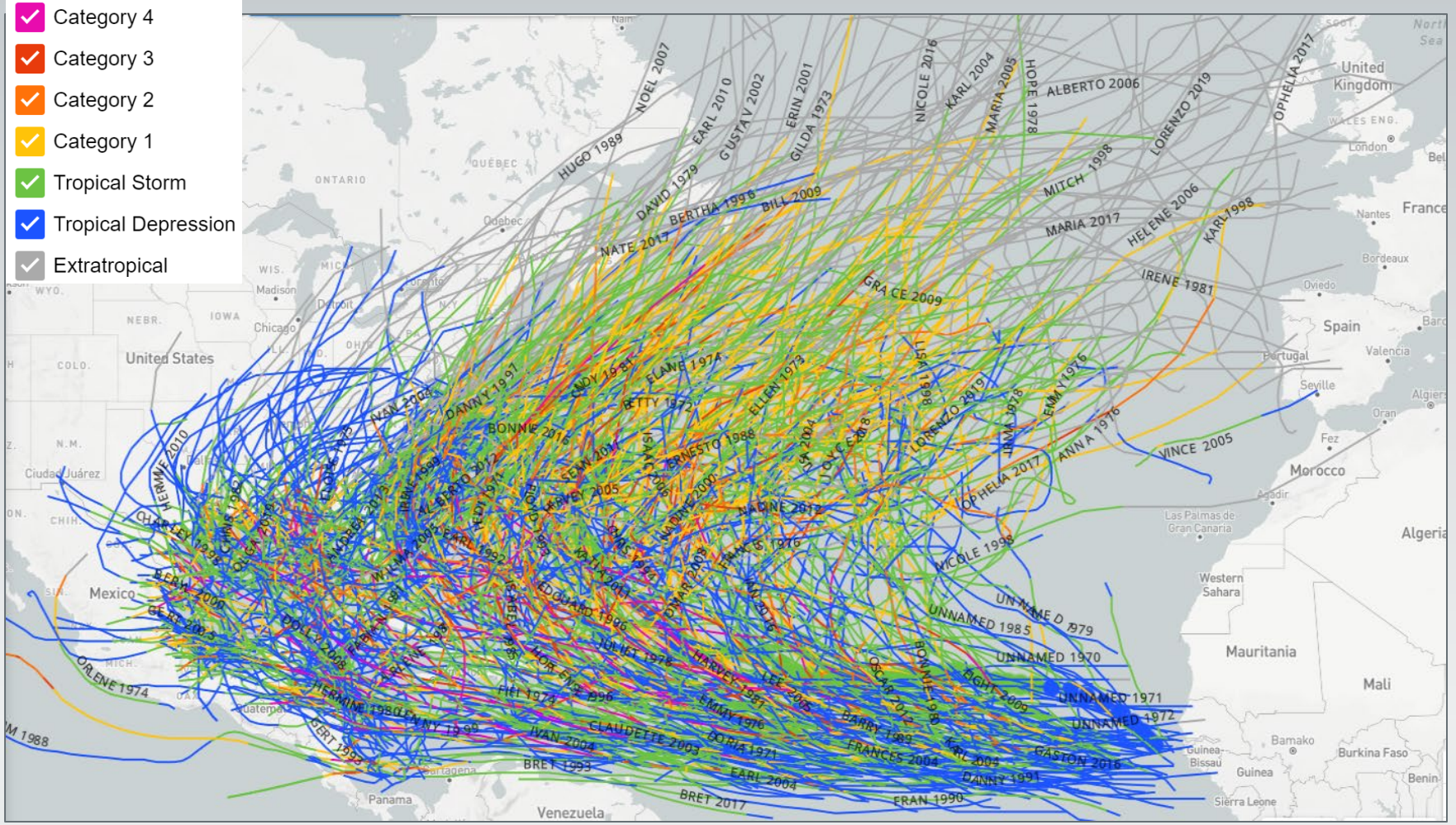
Tropical Cyclone Data

- **Data Needed for Analysis (time progression)**
  - Tropical cyclone history including:
    - Storm maximum wind speeds
    - Storm path
    - Storm size (wind speeds at different distances from the eye)
- **International Best Track Archive for Climate Stewardship IBTrACS (from National Oceanic and Atmospheric Administration) provided the required data**
  - Data selected from 1970-2019 (819 cyclones)
  - Deemed to reflect more accurate data after satellite tracking was started
  - IBTrACS provides longitude/latitude data every 3 or 6 hours generally

Cyclone Tracks (1970-2019)

Storm Categories *

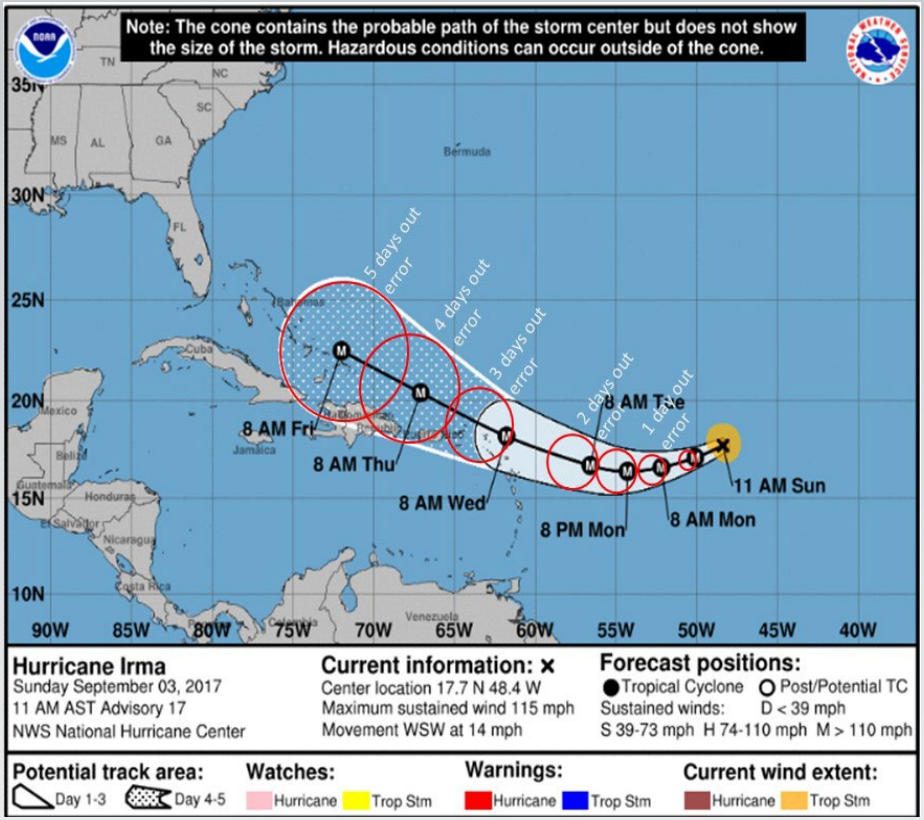
- Category 5
- Category 4
- Category 3
- Category 2
- Category 1
- Tropical Storm
- Tropical Depression
- Extratropical



* Categories shown are based on the Saffir-Simpson Hurricane Wind Scale

Forecasted Track Cone & Storm Size

- Uncertainty track cone per the National Hurricane Center (2/3 storms stay in cone)
- Storm size for tropical storm winds: assumed to be 150 nautical miles from the center (based on R34 values in IBTrACS)
- Threat area is evaluated adding storm size to the uncertainty cone



Automation Tool (MS Excel)

- **Inputs**
  - Location, longitude/latitude
  - Activity start date
  - Activity duration
  - T-Time

- **Outputs**
  - Cyclones occurring within the activity period
  - Cyclones occurring within the activity period passing within 150 miles of location
  - Cyclones occurring within the activity period passing within 150 miles of location with less than T-time of advance notice

Automation Tool (MS Excel)

TROPICAL CYCLONE COUNT ESTIMATOR				
Activity Start Date:	**1/1/2023**		**Lat: 27.195**	**Lon: -90.027**
Activity Duration (days, ≤ 365):	**365**	**Storm Count**	Percentages relative to cyclones that passed within 150nm	Percentages relative to all North Atlantic cyclones
Average cyclone count (TD-H5) anywhere in North Atlantic	**TD-H5 anywhere**	16.38		**100%**
Average cyclone count (TD-H5) within 150 nm from location	**TD-H5 within 150nm**	1.60		9.77%
Average cyclone count (TS-H5) anywhere in North Atlantic	**TS-H5 anywhere in NA**	12.14		**100%**
Average cyclone count (TS-H5) within 150 nm from location	**TS-H5 within 150nm of location**	1.14	**100%**	9.39%
Average cyclone count (TS-H5) within 150 nm from location generated less than 5 days out	5	0.78	68.42%	6.43%
Average hurricane count (H1-H5) (anywhere in North Atlantic)	**H1-H5 anywhere**	6.32		**100%**
Average hurricane count (H1-H5) within 150 nm from location	**H1-H5 within 150nm**	0.54	**100%**	8.54%
Average hurricane count (H1-H5) within 150 nm from location generated less than 5 days out	5	0.26	48.15%	4.11%

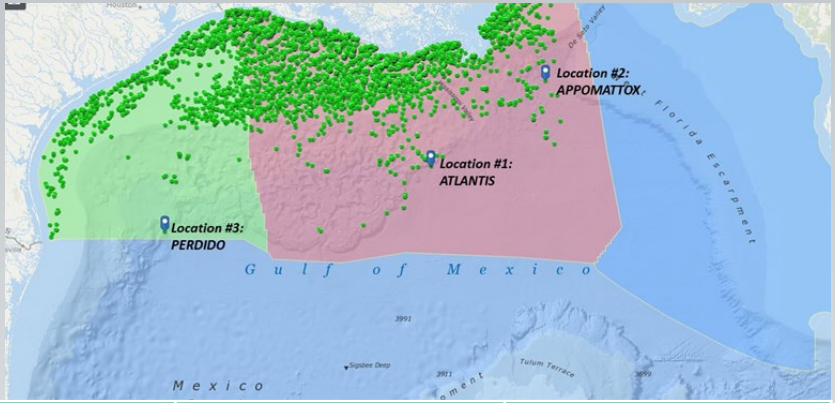
Results & Conclusions

Three locations assessed

- Atlantis, Perdido and Appomattox

T-Times (N days out)

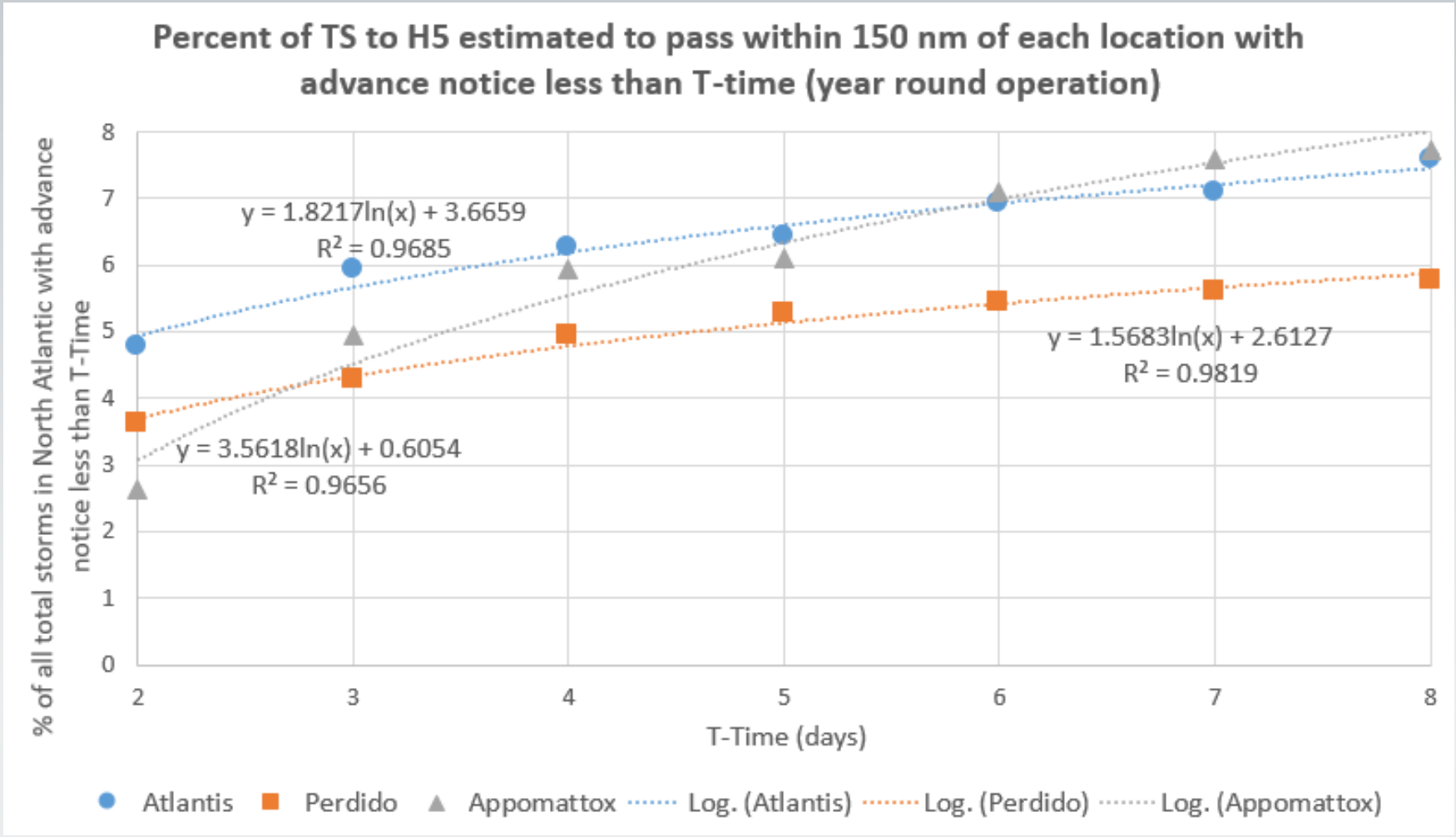
- 3 and 6 days



N days out or T-time [days]	Location	Total cyclones N days out from location (threat and non-threat)	Total cyclones N days out from location where forecast cone + storm size affects location (threat)	Average cyclones per year N days out from location where forecast cone + storm size affects location (threat)	Percentage of threat cyclones N days out from location relative to all (threat and non-threat) N days out
6	ATLANTIS	178	29	0.58	16.3%
3	ATLANTIS	365	42	0.84	11.5%
6	PERDIDO	187	27	0.54	14.4%
3	PERDIDO	379	32	0.64	8.4%
6	APPOMATTOX	184	33	0.66	17.9%
3	APPOMATTOX	374	51	1.02	13.6%

Results & Conclusions

- **The results were fitted to curves to provide an easy way to compare risk for different T times at a location**



Results & Conclusions

- This study highlights the importance of understanding the ‘advance notice’ that approaching tropical cyclones provide before they reach a location
- Tropical cyclones originating in the Atlantic generally provide enough time to secure the well and move people and assets to safety. Cyclones originating within the Gulf of Mexico can be more of a challenge
- The tool provides BSEE an informed way to discuss threats and emergency procedures with operators during the well permit process

Questions?

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