





intensification period from 22 Oct to 23 Oct that is the focus of this research.



Figure 2. Operational model forecasts of Hurricane Patricia (2015) compared against the best track data (black) compiled after the storm. NHC forecast data was available through 0000 UTC 24 October, while other storm data is shown from 0000 UTC 22 October until 1200 UTC 24 October. At most, operational models predicted a Category 3, rather than Category 5, hurricane.



Figure 3. Model simulated wind speed of Patricia. The outer domain has 9 km resolution. The moving nests (see inner boxes) have 3 and 1 km resolution, respectively.

1. Patricia Highlights

- ✤ Highest wind speed: 185 kt; Lowest pressure: 872 hPa (estimated at 1200 UTC 23 October 2015)
- ✤ Fastest 24-hr intensification on record
- Operational weather prediction models failed to forecast intensification

2. Research Questions:

- Why was Patricia so intense?
- How was intensification so rapid?
- How predictable was the intensification of Patricia?

3. High-Resolution Numerical Model Simulations

- ✤ WRF model with nested grids
- ✤ Vortex relocation replaced coarse GFS vortex
- ✤ 5-member ensemble: stochastic initial condition perturbations
- ✤ 60 hour forecasts predicted intensity (Figure 4), albeit 12 hours late



Figure 4. Same as Figure 1, but overlaid with the WRF control simulation, stochastic ensemble members, WRF coupled with a 1-d ocean model, and WRF including dissipative heating. The runs were all initialized with GFS at 0000 UTC October 2015. The GFS vortex was replaced using a vortex relocation method in order to allow WRF to initialize the with a more realistic vortex.

Behind the Rapid Intensification of Hurricane Patricia, the Strongest Recorded Hurricane in History K. Ryder Fox^{1,2} and Falko Judt³

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✤ Hurricane Hunter Aircraft collected data at 0600 UTC and 1800 UTC October, 2015 (right, Figure 5)

- The model generally reproduced the observed wind speed (top, left) and pressure (bottom, left) distributions
- ✤ The simulated hurricane vortex is smoother, has a wider eye and features less extreme gradients

Rapid Intensification:

- ✤ 24-hr increase in wind speed of \geq 35 kt.
- ✤ Patricia's 24-hr increase was 105 kt

4. Model – Aircraft Comparison



5. Environmental Conditions

- Environmental conditions were extremely favorable for intensification:
- 1. Sea surface temperature (SST) > 30° C (Figure 6, top left)
- 2. Vertical wind shear (SHR) < 5 m/s (Figure 6, top right)
- 3. Relative humidity at different levels: RHLO (850-700 hPa), RHMD (700-500 hPa) > 80% (Figure 6, bottom)



Figure 6. Control Simulation; Top Left: SST, Top Right: SHR, Bottom Left: RHLO, Bottom Right: RHMD



- percentiles (Figure 7)



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6. Comparison with Climatology

* Ranked the simulated environment of Patricia with respect to a 30+ year climatology (1982-2015) of all Eastern Pacific cyclones (climatological data: SHIPS, Kaplan et al., 2010) ✤ Variables examined: SST, SHR, RHLO, and RHMD

Against more than 13200 tropical cyclones, Hurricane Patricia's environment mainly ranked in the 98th and 99th

7. Conclusions

Patricia's intensity was accurately predicted with an ensemble of high resolution forecasts.

Intrinsic predictability appears to be high.

Achieving accurate intensity forecasts necessitates a realistic vortex initialization technique.

Patricia's explosive intensification was supported by an extremely favorable environment.

Most environmental variables analyzed ranked within the 98th or 99th percentile.

Acknowledgements

References

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