Investigating a Concentrated Tornado Outbreak in Southeastern Florida Preceding Hurricane Ian's Direct Impact

Mia Aurora Dorval

Faculty Advisor(s): Dr. Milla Costa, Melissa Zavaleta (T.A.), Dept. of Ocean Engineering and Marine Sciences, Florida Institute of Technology

Abstract: *Before Category 4 Hurricane Ian landed in Florida in 2022, a tornado outbreak produced South FL's average annual amount of tornadoes in less than 24 hours. This study investigated characteristics of the event to identify what contributed to this phenomenon. Previous research indicated tropical cyclones taking a northeastern track place South Florida in a favorable sector for tornadic events (Hagemeyer, n.d., pp. 1-2). Additional research suggested diurnal implications between sea-land surface temperatures on the timing of tropical cyclone tornado outbreaks (Hagemeyer, 1997, p.405). Consequently, the variables evaluated established the origin of such events.*

Introduction

Between Sept. 27th and 28th, a total of 14 tornadoes were confirmed by the NHC in FL. The intensity of these events ranged from multiple EF-0s to an EF-2 tornado (~125 mph). Two injuries occurred along with the relocation of 30 individuals and $2 million in property damage. The outbreak lasted from about 7 pm to 10 am (EDT) or 00 to 1500 UTC.

Data and Methodology

- Correlation: Reanalysis (ECMWF ERA5) vs ASOS (near KMIA; "average monthly precipitation" in 2022).
- Analyzed variables: surface latent heat flux, divergence, sea surface temperature, and u/v wind components.
  - Area studied: 90°W to 75°W and 20°N to 35°N.
- Source of energy for supercell production: Reanalysis variables, Skew-T's and Mesoscale Discussions (from SPC).

Results and Discussion

- R^2 value: 0.873; CORREL function: 0.934
- **SPC Skew-T at 00 UTC/7 pm EDT (Fig. 3 - 4):**
  - Rising air from about 1-15 km; SFC Temp: 81.0°F
  - Warm air advection: 0.2°C/km to 4.3°C/km
  - CAPE: 3285 J/kg; DCAPE: 624 J/kg; CINH: -6 J/kg
  - SARS-Sounding Analogs: 60% TOR; LowRH: 87%
- **SPC MCD Report (Fig. 5):** bulk shear, 35-50 kt
- **Surface latent heat flux (Fig. 6):** - 2e06 to -2.6e06 J/kg
- **Streamlines (Fig. 7):** CC circulation, 0 to 24 kt
- **Sea-surface temperatures (Fig. 7):** 304 K, nearly 88°F
- **Divergence (Fig. 8):** 0.0001 s^{-1} to 0.00025 s^{-1}

Conclusions

Energy from significant negative SLHF and high SST **(Fig. 6-7),** forced by strong circulation, enriched the atmosphere with necessary elements for tornadic events. Findings demonstrated atmospheric instability **(Fig. 3 - 4)** and enhanced rising air over the east coast **(Fig. 8),** coinciding with the region of the outbreak. Further, patterns suggested in prior research regarding diurnal influences and storm tracks were confirmed. Intended future analysis includes storm-relative helicity, additional convective parameters, and hodographs.

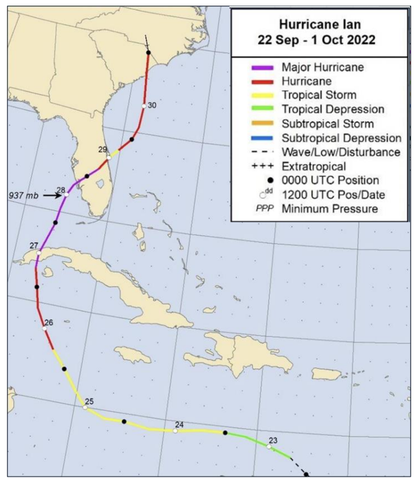

Fig. 1: *[Adapted] Hurricane Ian's track (NHC)*

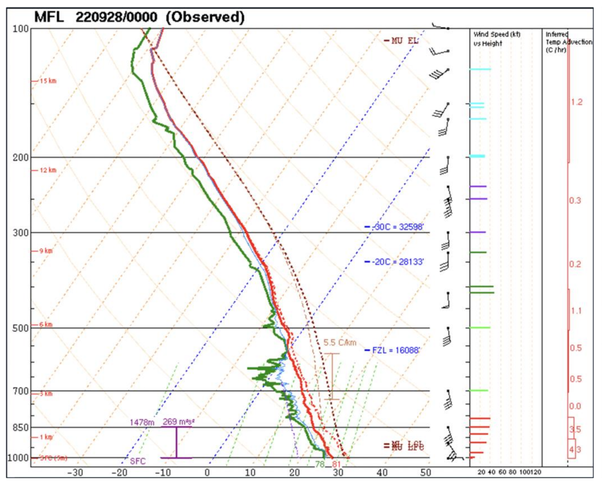

Fig. 3: *[Adapted] Skew-T (SPC)*

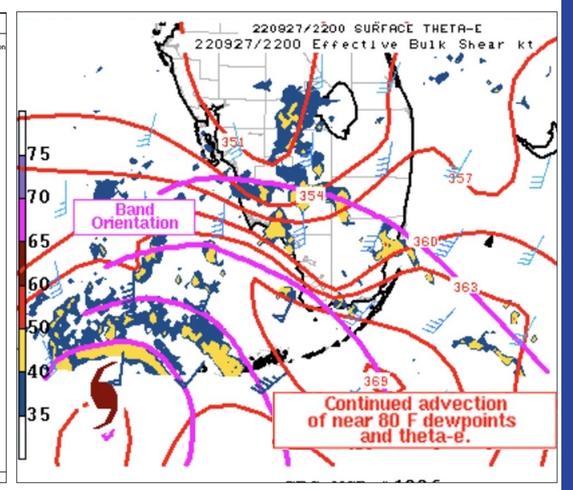

Fig. 5: *[Adapted] Mesoscale Discussion (SPC, #1836 at 2237 EDT)*

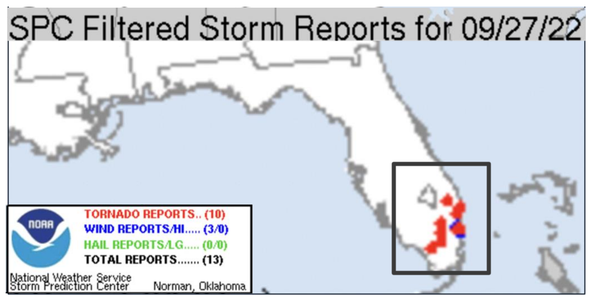

Fig. 2: *[Adapted] Preliminary storm reports (SPC)*

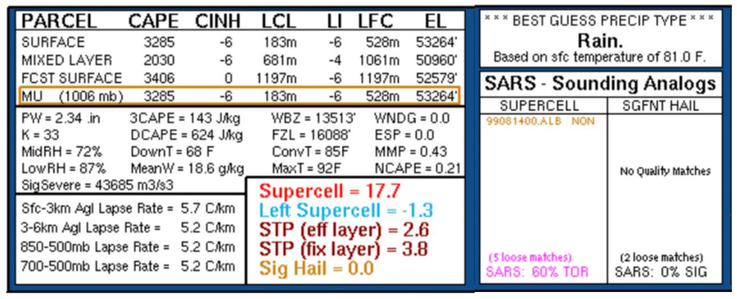

Fig. 4: *[Adapted] Calculations from SPC's Skew-T (Fig. 3)*

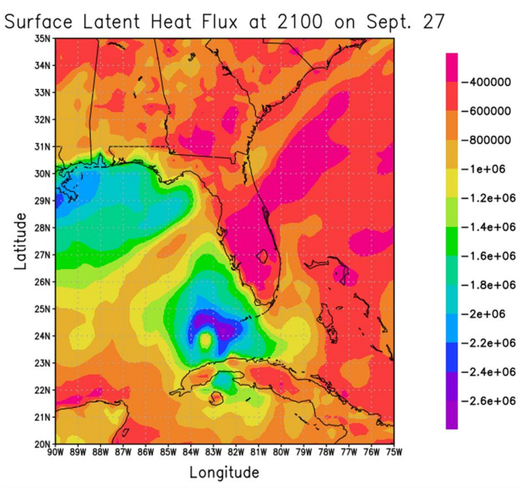

Fig. 6: *SLHF (J/kg) at 2100 EDT*

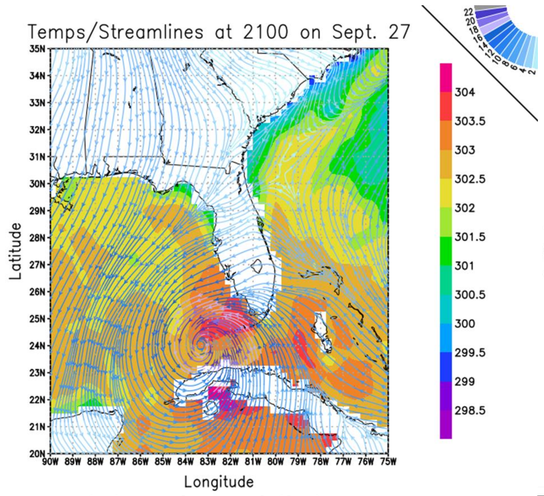

Fig. 7: *SST (K) and wind (kt) at 2100 EDT*

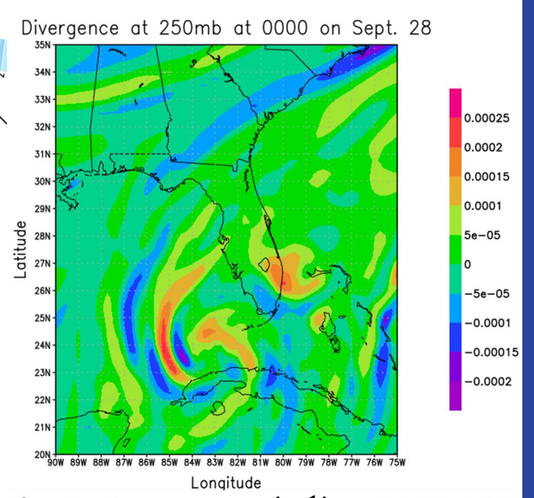

Fig. 8: *Divergence (s^{-1}) at 0000 EDT*

References and Acknowledgments

Special thanks to Dr. Milla Costa and Melissa Zavaleta for assistance with OpenGrADS and data acquisition.