Microburst Day Potential Index: Improving Launch and Public Safety

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1. Introduction / Background

Microbursts

- A common convective wind event
- Capable of causing damage from wind exceeding 30kts (NWS)
- Cape Canaveral is a prime microburst environment
- Can affect launch ops and daily activities by exceeding safety standards

2. Data

- Convective wind event dataset provided by 45th WS (31 convective events, 14 confirmed microbursts)
- XMR (Cape Canaveral) atmospheric soundings obtained from the University of Wyoming
- Soundings provide vertical profiles of pressure, temperature and dewpoint from the surface to the tropopause

3. Methods

- Soundings undergo QC to remove missing or unrealistic values
- Atmospheric profiles were interpolated to a 5hPa grid to ensure consistent layer sampling across cases
- Mixing ratio, equivalent potential temperature (θ_e) and virtual temperature were computed at each level
- θ_e deficit (max-min θ_e), DCAPE (downdraft potential), CAPE (instability) and 850-700 hPa lapse rate were derived
- MDPI, MDPIx and WINDEX were calculated
- Each sounding was classified as an event or non-event based on threshold values
- Model performance was evaluated using contingency tables (POD, FAR, HSS, ETS) and ROC-AUC analysis
- All calculations were performed using a reproducible Python physics engine

4. Results

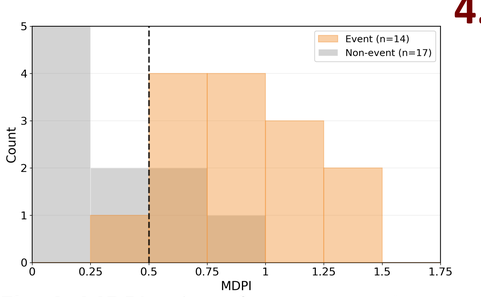

Fig. 1: MDPI values for event and non-event days and operational threshold (vertical line).

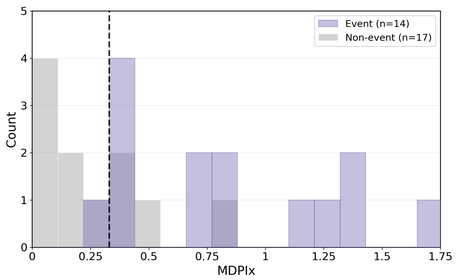

Fig. 2: MDPIx values for event and non-event days and operational threshold (vertical line).

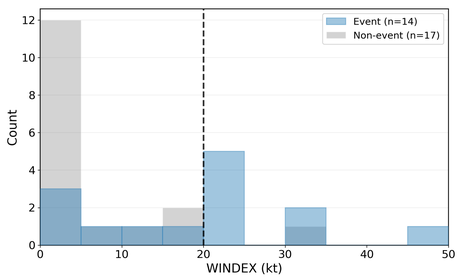

Fig. 3: Windex values for event and non-event days and operational threshold (vertical line).

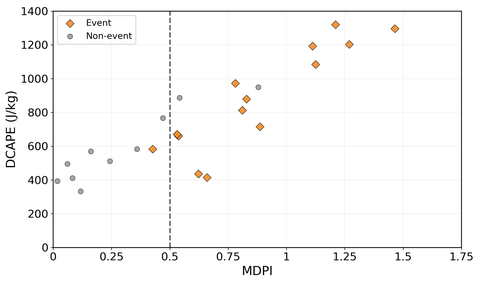

Fig. 4: MDPI vs DCAPE correlation with operational threshold and event classification.

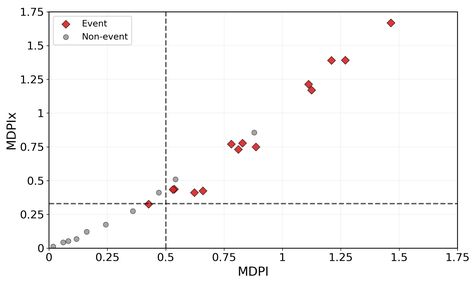

Fig. 5: MDPI vs MDPIx correlation with operational threshold & event classification.

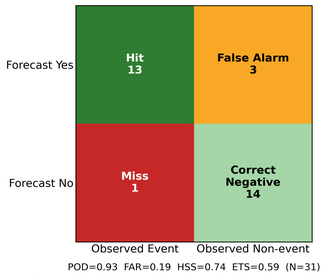

Fig. 1b: MDPI confusion matrix with values of POD, FAR, HSS & ETS.

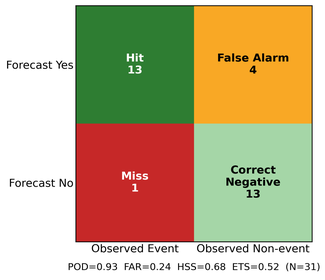

Fig. 2b: MDPIx confusion matrix with values of POD, FAR, HSS and ETS.

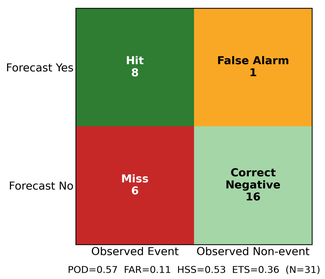

Fig. 3b: Windex confusion matrix with values of POD, FAR, HSS & ETS.

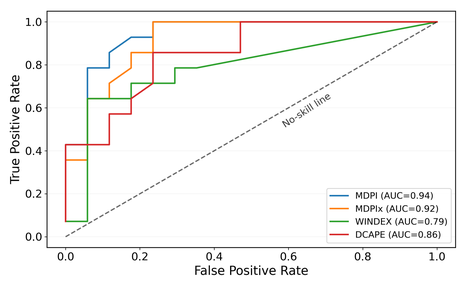

Fig. 6: ROC-AUC curves for MDPI, MDPIx, WINDEX and DCAPE (dashed line indicates no skill).

Metric	Event Median [IQR]	Non-event Median [IQR]	MW p-value
MDPI	0.82 [0.63–1.12]	0.08 [-0.12–0.36]	3.07E-05
MDPIx	0.76 [0.44–1.20]	0.05 [-0.05–0.27]	8.49E-05
WINDEX (kt)	20.86 [8.27–23.76]	0.00 [0.00–9.55]	4.62E-03

Table 1: Mann-Whitney distributions for WINDEX, MDPIx and MDPI with p-values.

5. Discussion

- Days with microbursts show much higher MDPI values (Figs. 1, 2)
- Small overlap between convective & nonconvective days (Figs. 1, 2 & 3)
- High positive correlation between MDPI & DCAPE (Fig. 4)
- MDPI & MDPIx also show positive correlation, MDPIx acts as a scaled MDPI (Fig. 5)
- Extremely low Fisher & Mann-Whitney values support proper environmental discrimination (yes/no) (Table 1)
- Confusion (contingency) matrices show a high percentage of correct forecast decisions (Figs. 1b, 2b & 3b)
- All ROC-AUC curves have values significantly higher than 0.5, denoting high skill in environmental classification (Fig. 6)

6. Conclusion and Future Work

- This project markedly improves microburst detection based on current results
- Multiple indices must be used for effective forecasting
- Correct discrimination of favorable convective wind environments is extremely important
- Machine learning on larger datasets is ongoing to further improve forecast accuracy

7. Acknowledgements

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8. References