

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

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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.

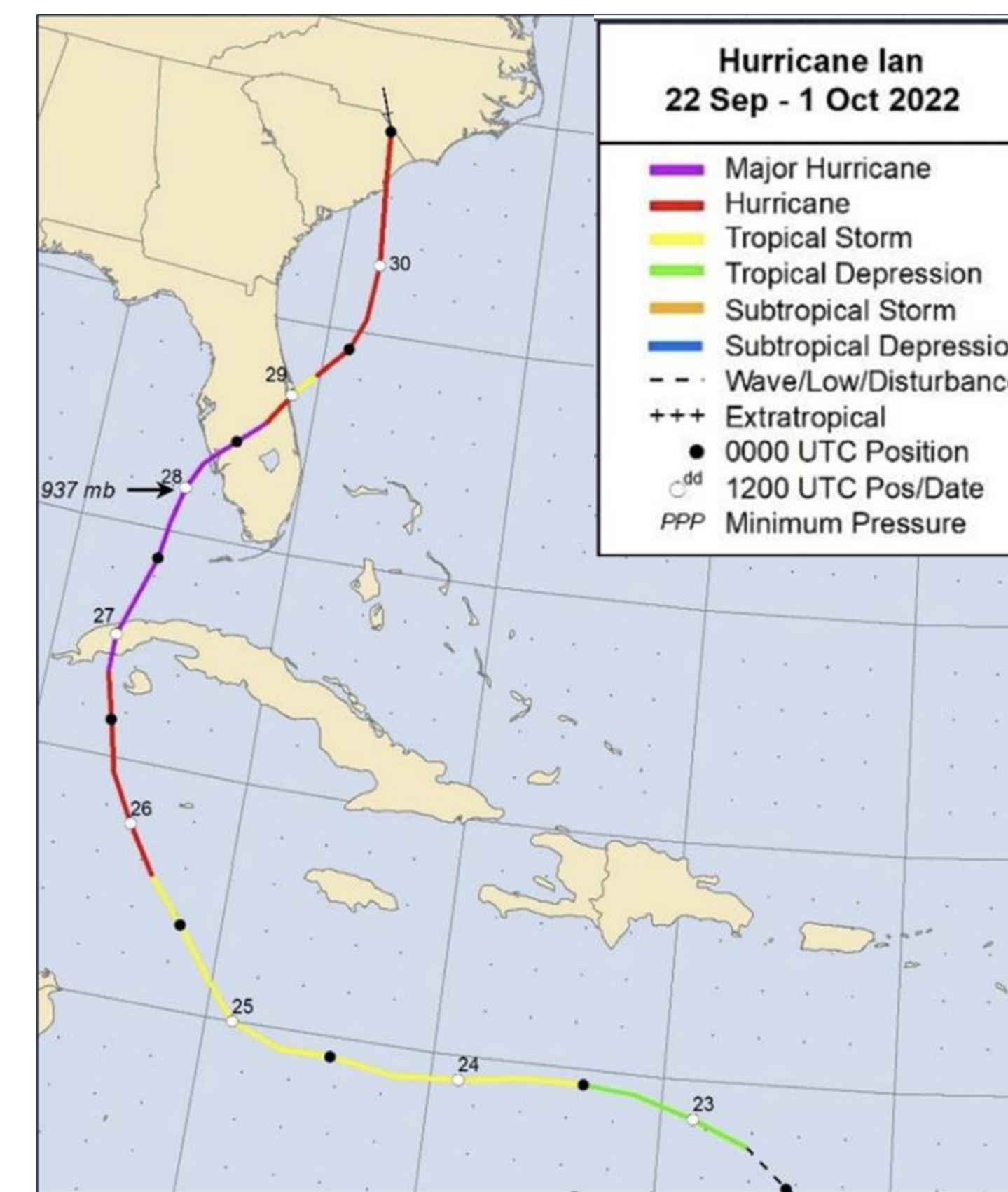


Fig. 1: [Adapted] Hurricane Ian's track (NHC)

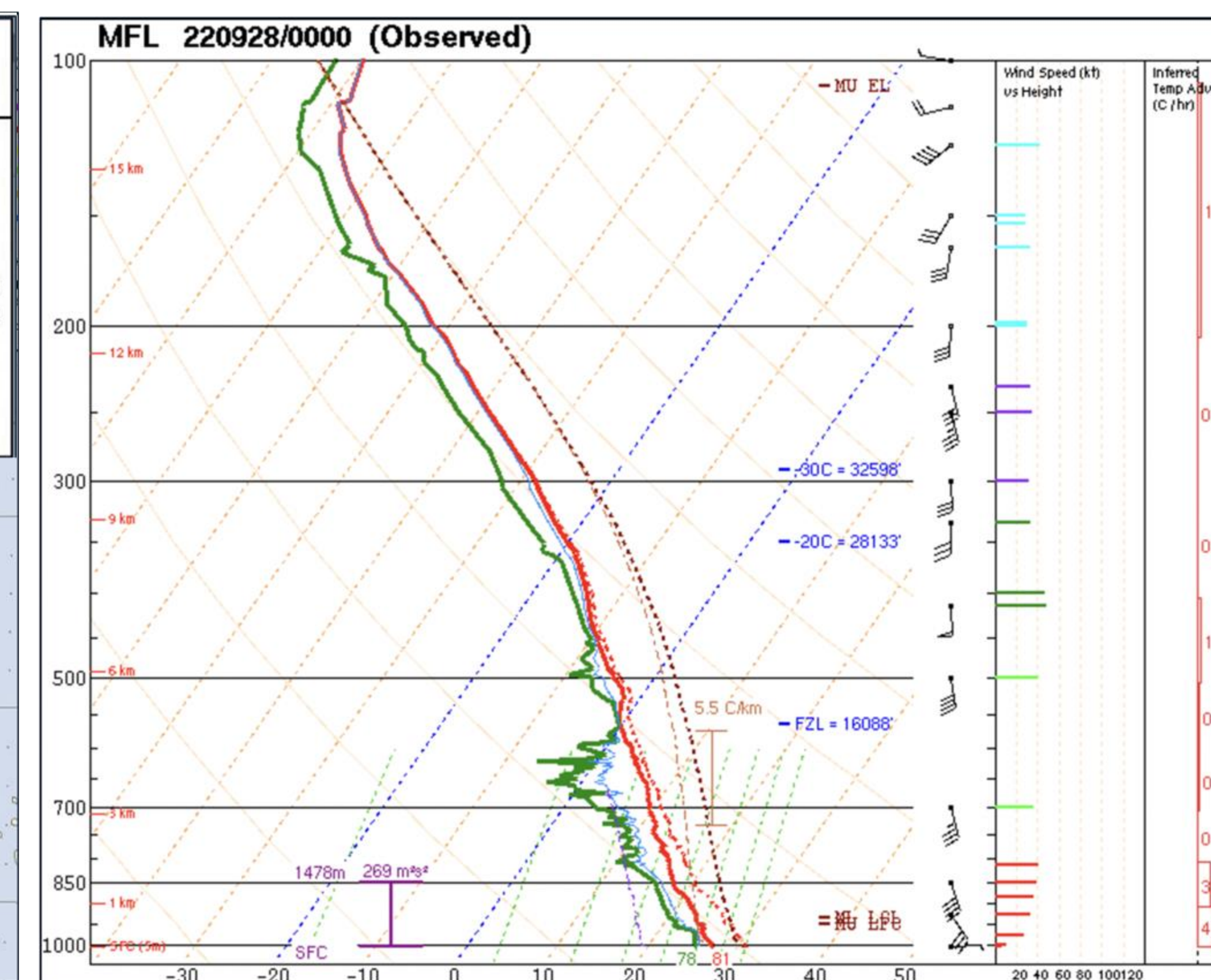


Fig. 3: [Adapted] Skew-T (SPC)

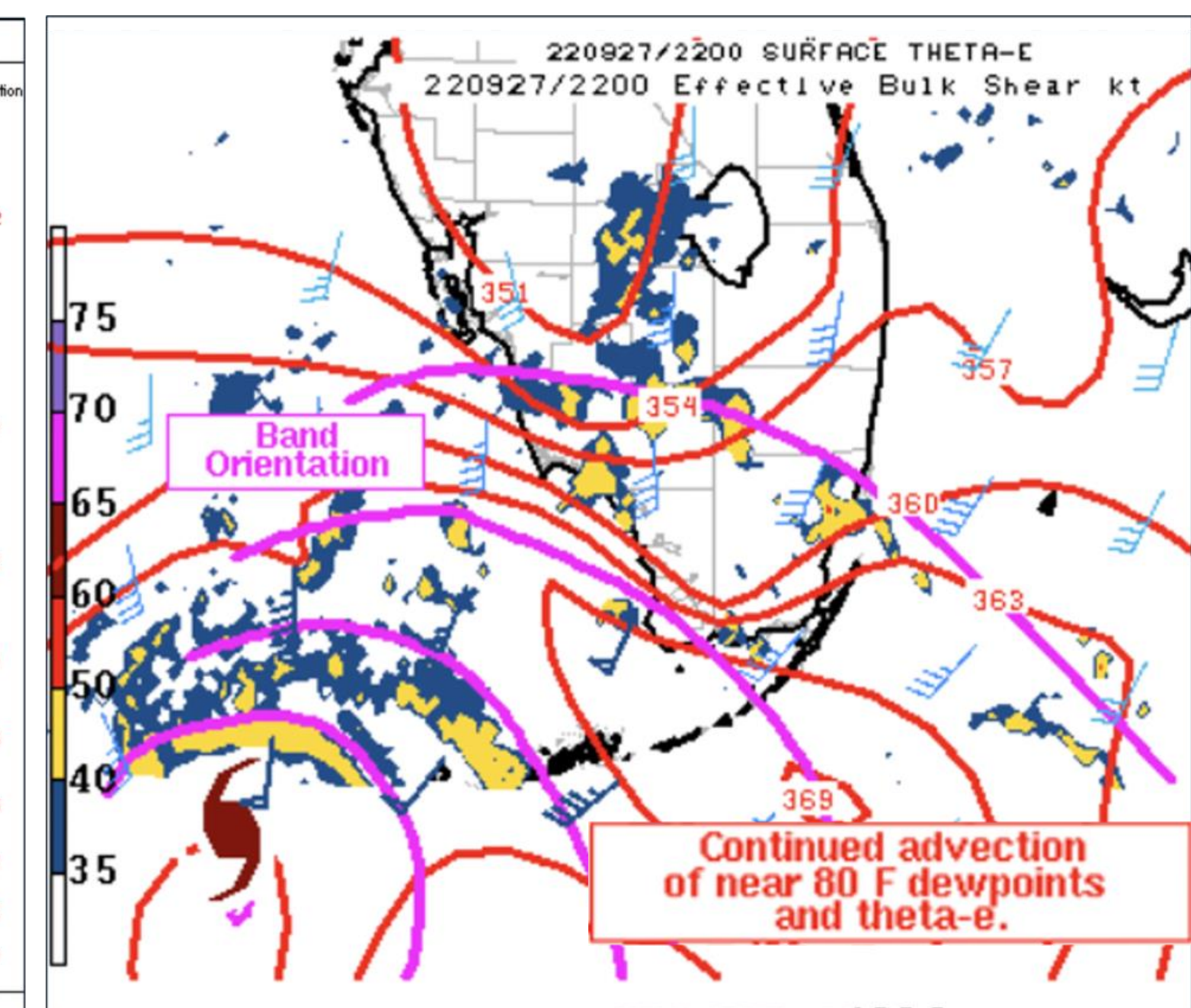


Fig. 5: [Adapted] Mesoscale Discussion
(SPC, #1836 at 2237 EDT)

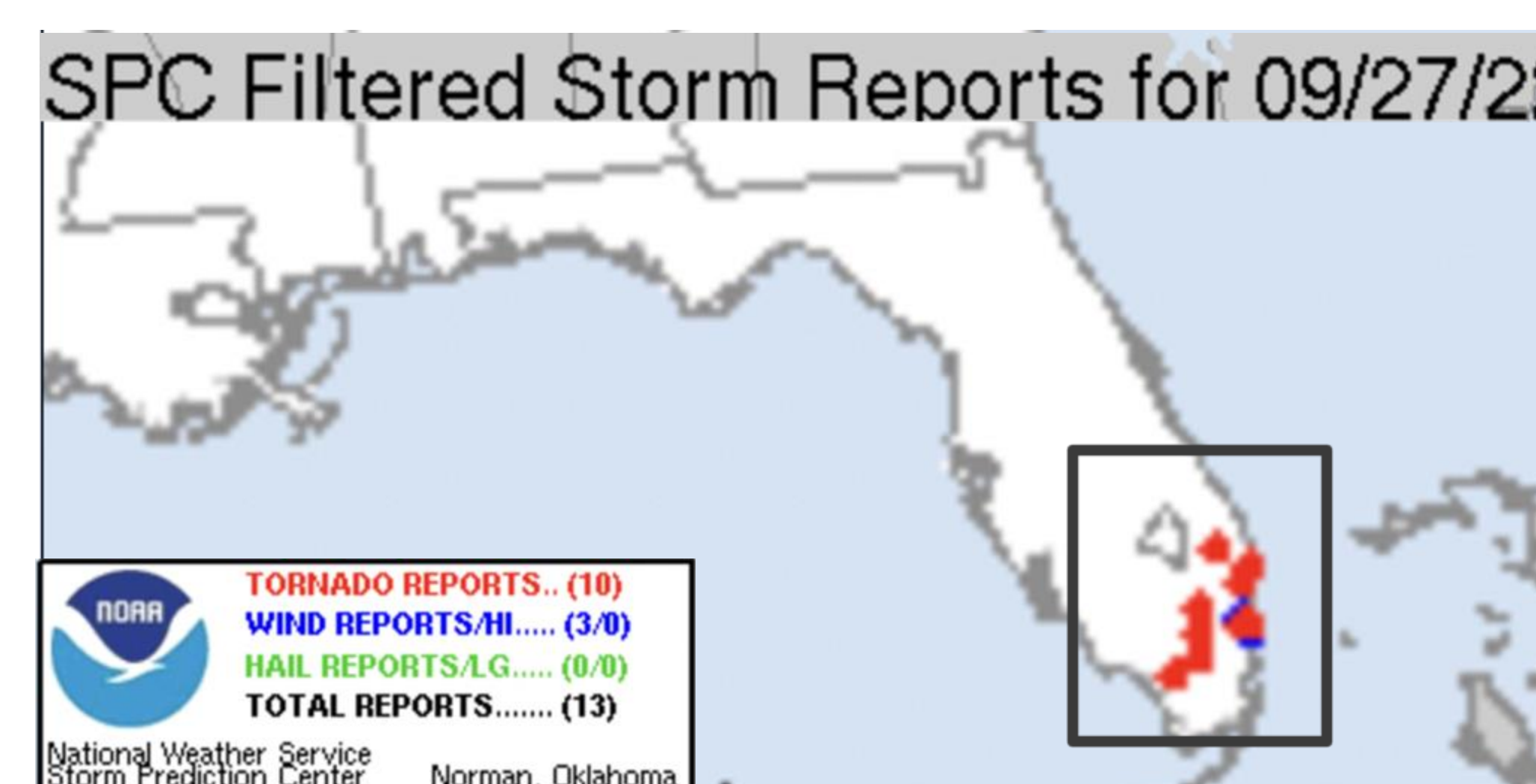


Fig. 2: [Adapted] Preliminary storm reports (SPC)

PARCEL	CAPE	CINH	LCL	LI	LFC	EL	*** BEST GUESS PRECIP TYPE ***	
SURFACE	3285	-6	183m	-6	528m	53264'	Rain.	
MIXED LAYER	2030	-6	681m	-4	1061m	50960'	Based on sfc temperature of 81.0 F.	
FCST SURFACE	3406	0	1197m	-6	1197m	52579'	SARS - Sounding Analogs	
MU (1006 mb)	3285	-6	183m	-6	528m	53264'	SUPERCCELL	SGFNT HAIL
PW = 2.34 in	3CAPE = 143 J/kg		WB2 = 13513'		WVNDG = 0.0		99081400.ALB	NON
K = 3.3	2CAPE = 624 J/kg		FZL = 16088'		ESP = 0.0			
MidRH = 72%	DownT = 68 F		ConvT = 85F		MMP = 0.43			
LowRH = 87%	MeanW = 18.6 g/kg		MaxT = 92F		NCAPE = 0.21			No Quality Matches
SigSevere = 43685 m/s3			Supercell = 17.7					
Sfc-3km Agl Lapse Rate = 5.7 C/km			Left Supercell = -1.3					
3-6km Agl Lapse Rate = 5.2 C/km			STP (eff layer) = 2.6					
850-500mb Lapse Rate = 5.2 C/km			STP (fry layer) = 3.8					
700-500mb Lapse Rate = 5.2 C/km			Sig Hail = 0.0				(5 loose matches) SARS: 60% TOR	(2 loose matches) SARS: 0% SIG

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

Surface Latent Heat Flux at 2100 on Sept. 27

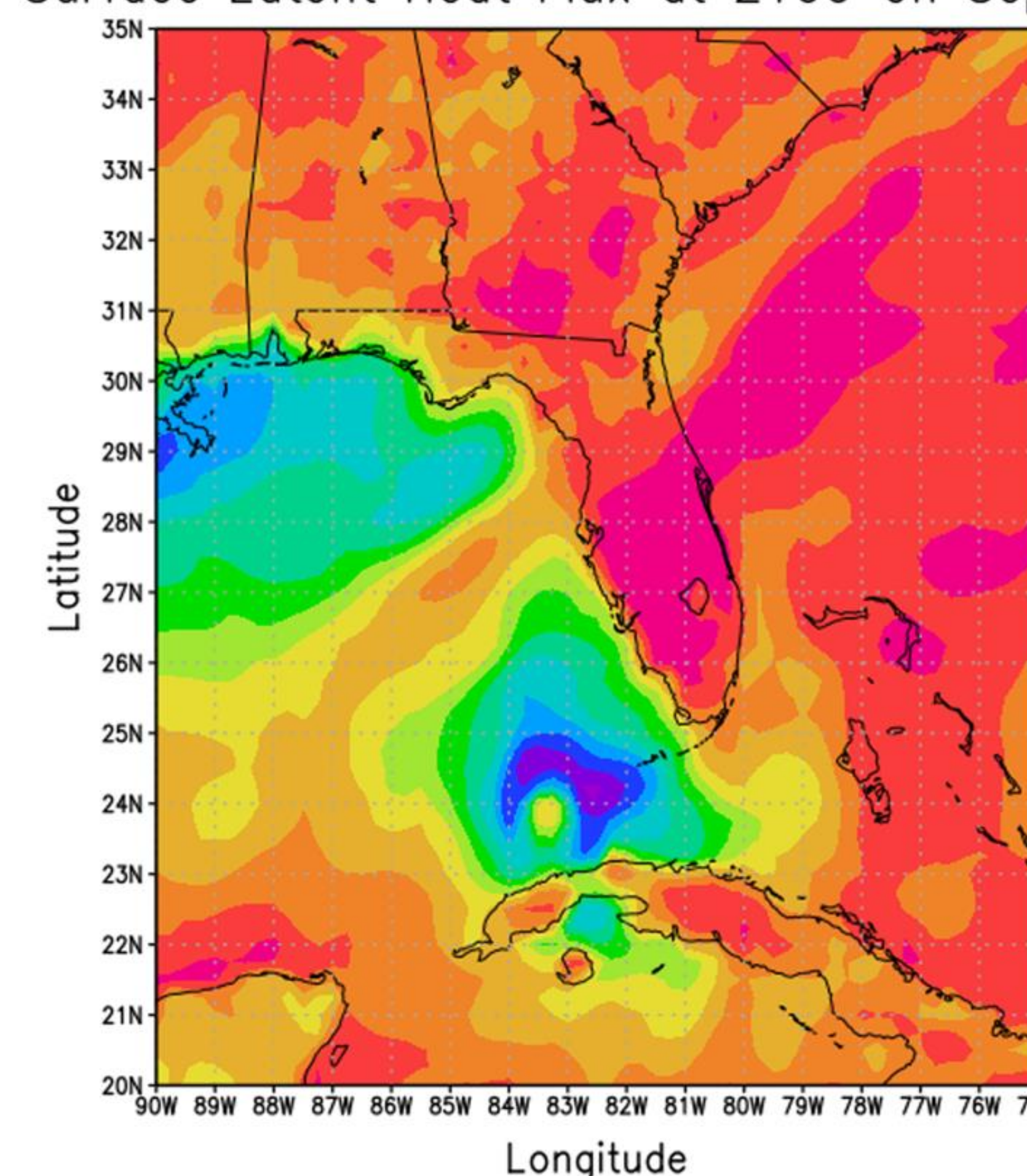


Fig. 6: SLHF (J/kg) at 2100 EDT

Temps/Streamlines at 2100 on Sept. 27

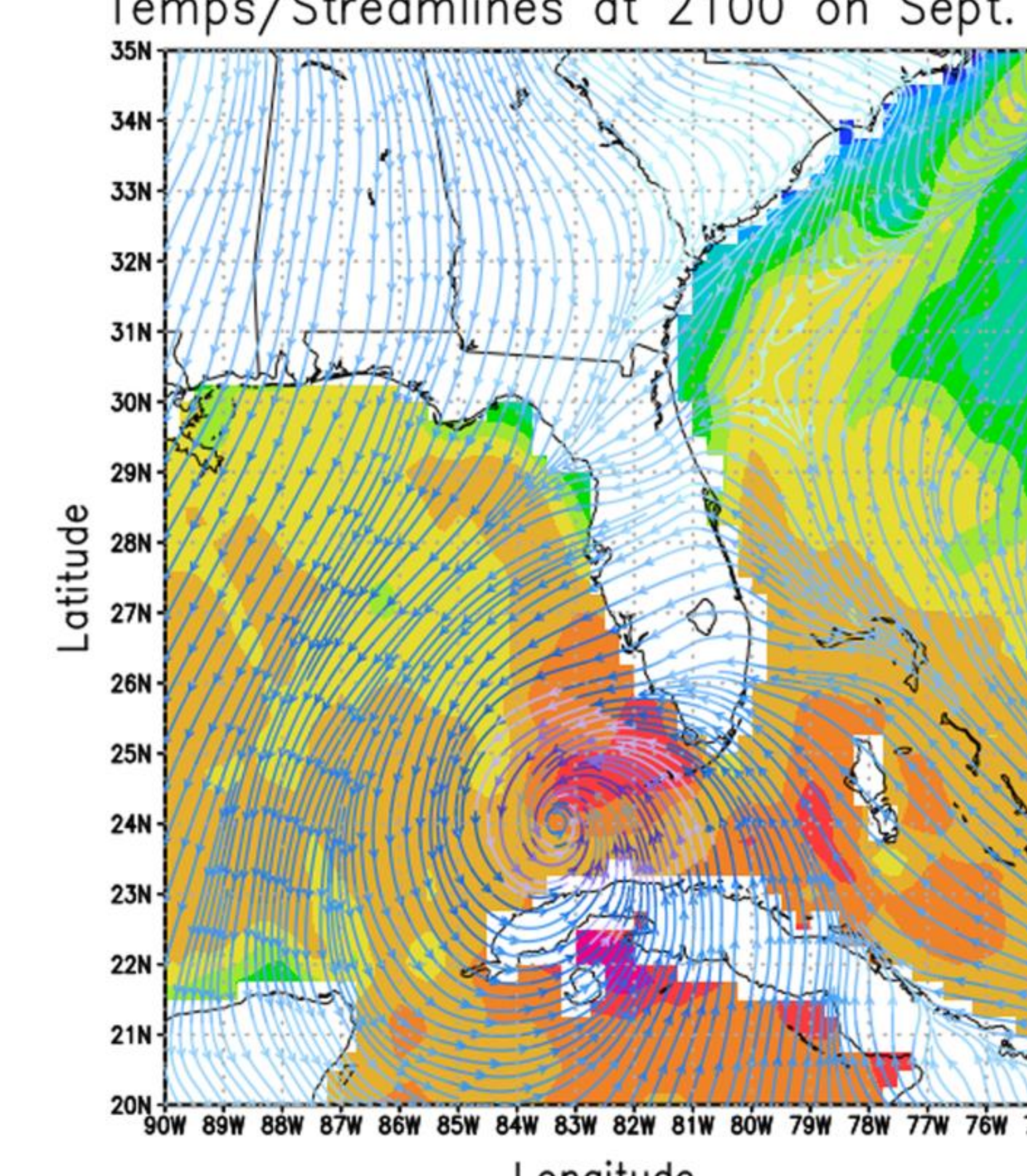


Fig. 7: SST (K) and wind (kt) at 2100 EDT

Divergence at 250mb at 0000 on Sept. 28

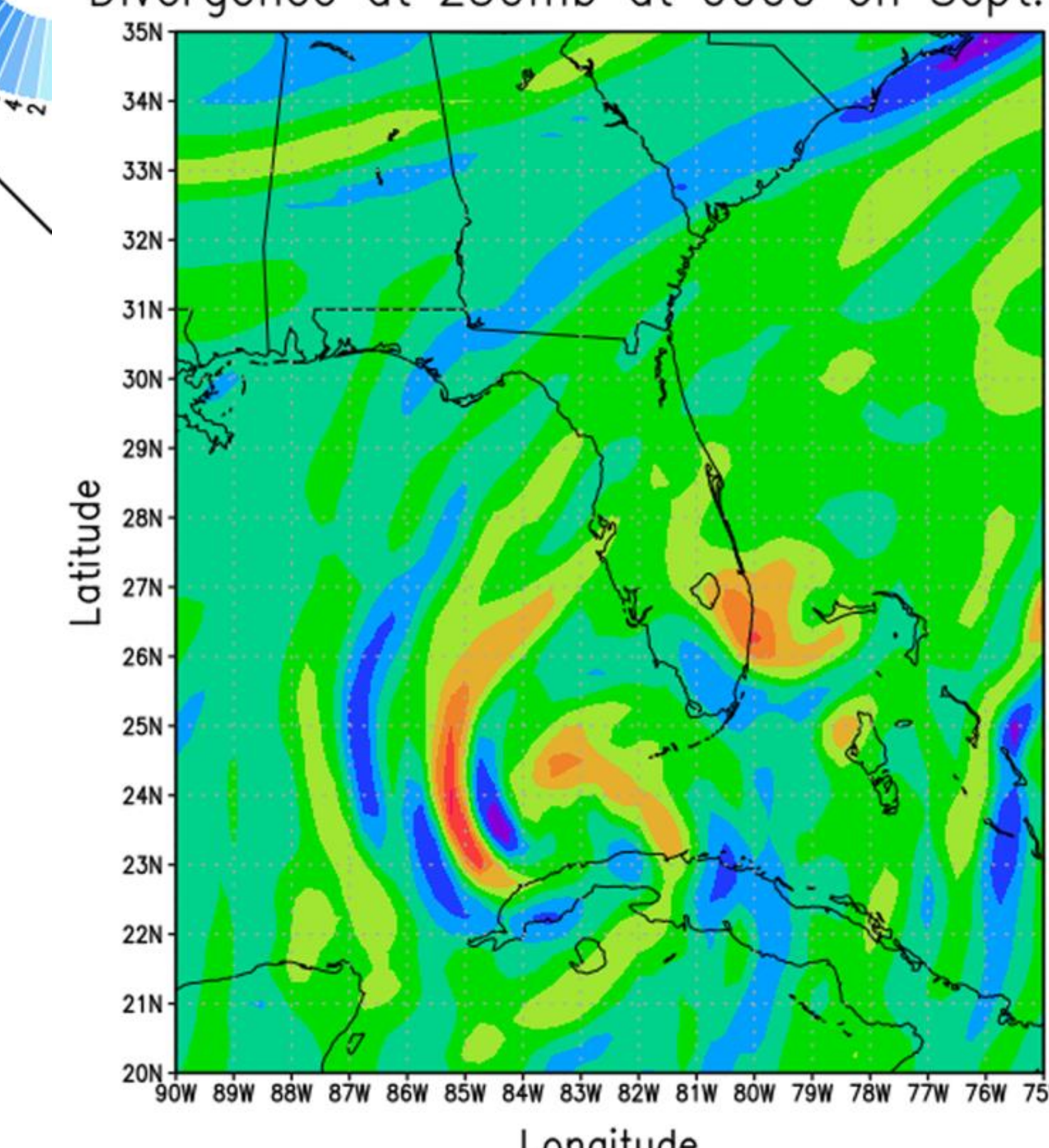


Fig. 8: Divergence (s^{-1}) at 0000 EDT

References and Acknowledgments

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