Does Cooler Air Near the Top of the Saharan Air Layer (SAL) Play a Role in Hurricane **Intensity Change during Hurricane-SAL** Interactions?







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The SAL and TCs

Hypothesized negative influences of the SAL (Dunion and Velden 2004)

- 1) Warm air increases stability
- Dry air contributes to downdrafts and storm ventilation
- Increase in vertical wind shear

Other influences:

 Dust impacts through both radiation and microphysics



0.2 0.3 0.4 0.5 0.6 0.7 Aerosol Optical Depth

Dust AOD and clouds during Hurricane Nadine (2012)

NASA Unified WRF Ensemble Simulations With Aerosols



WRF Simulations

- 30 ensemble members
- Dust, organic carbon, salt, sulfate aerosols initialized with GOCART model fields
- Radiative coupling (both long- and shortwave)
- Microphysics coupling as CCN and IN
- 5-day simulations starting at 00 UTC 10
 September



Analysis Approach



- All fields from Domain 2 (9 km grid spacing) smoothed using IDL's Gaussian smoother
- All fields shifted into a storm-centric reference frame
- Correlate final intensity with parameters at each grid point

 $\begin{bmatrix} INT_1 \\ INT_2 \\ \vdots \\ INT_{30} \end{bmatrix} \begin{bmatrix} U_1 \\ U_2 \\ \vdots \\ U_{30} \end{bmatrix}$



U(m/s)

Correlation Analysis Approach



- Uses approach of Sippel and Zhang (2010) and Sippel et al. (2011) to compute partial correlations between final storm intensity and various meteorological parameters
 - Allows removal of influence of other factors
- Final intensity taken as the area-average of –GHT at low-levels over last 24 hours of 5-day simulation
- Remove the effects of current intensity (–GHT) and storm latitude

SAL Temperature Correlated With Storm Intensity on 14-15 September

Shading: Ensemble mean 900-700 hPa Temperature

Thin solid contours: Ensemble mean SLP

Thick contours: Correlation coefficient ±0.3, 0.5, 0.7

Red contour: Dust boundary (AOD >0.1)





Motivation For Presentation Title



Moderate positive correlation associated with tongue of cold air at the top of SAL.

The colder the air, the weaker the storms.

Implies cold air may be a source of downdrafts.

Vertical Cross Sections—12 UTC 12 SEPT



Vertical Cross Sections—00 UTC 13 SEPT



Vertical Cross Sections—12 UTC 13 SEPT



Evolution of Low-Level Cooling



700-900 hPa

Vertical Cross Sections—12 UTC 13 SEPT







Original Science Question

Does Cooler Air Near the Top of the Saharan Air Layer (SAL) Play a Role in Hurricane Intensity Change during Hurricane-SAL Interactions?

Conclusions

- Moderate positive correlation is associated with cold air at the top of the SAL, but also ahead of the SAL
- Evaporative cooling on downshear side of storm is contributing to downdrafts.
- At later times, SAL air encroaches on downshear side of Nadine and enhances evaporative cooling and downdrafts.

Description of Ensembles

- WRF-VAR background error used to create large-scale, random perturbations to wind, temperature, pressure, and moisture. See Sippel and Zhang 2008 (JAS), Sippel et al. 2011 (JAS)
- Perturbations added to NCEP GFS analysis/forecast to create initial/boundary conditions for 30member ensemble
- Initial condition spread commensurate with analysis error.
- 30 ensembles members without dust, 17 so far with dust



