# Importance of Dust Radiative Feedback on the Trans-Atlantic Evolution of the Saharan Air Layer.

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## Intro

**The Saharan Air Layer (SAL)** is a hot, dry, and dusty air mass that forms over North Africa and moves westward over the Atlantic Ocean (Prospero and Carlson 1972).

Models estimate that approximately **170 Tg yr$^{-1}$** of Saharan dust are transported across and deposited over the Atlantic basin (Prospero et al 1996) .

Mineral dust is known to produce a wide range of impacts, including **physiological effects** on human health (Plumlee et al 2006) and **suppression of rainfall** by modifying cloud microphysics (Rosenfeld et al 2001).

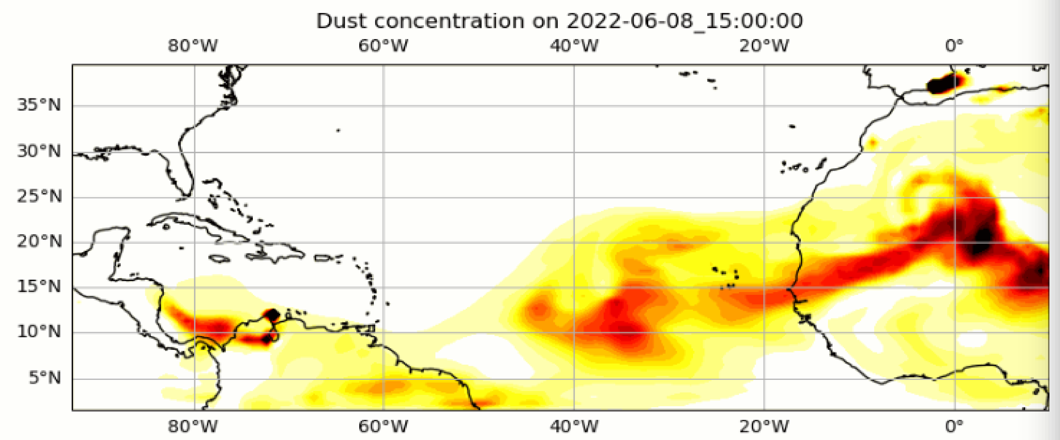


Fig 1: Long-range transport of Saharan dust across the tropical Atlantic.

## Research question

What is the impact of Saharan dust radiative feedback on the trajectories of the Saharan Air Layer?

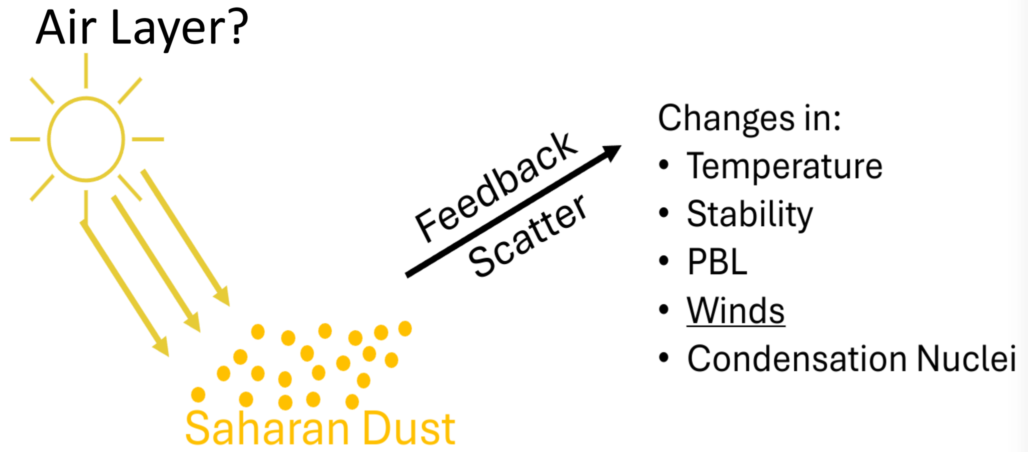


Fig 2: Diagram of radiation, Saharan Dust and feedback effects

## Methods

Based on MERRA-2 and Dolce and Miller (2025), 25 dust events were selected and simulated with WRF to evaluate SAL trajectories with and without radiative feedback.

| Star simulation | Start event | End event | End simulation | DUCMASS (g/m²) |
|---|---|---|---|---|
| 1984-07-06 | 1984-07-16 | — | 1984-07-18 | 0.71 |
| 2000-05-20 | 2000-05-30 | 2000-05-31 | 2000-06-02 | 0.92 |
| 2001-06-10 | 2001-06-20 | 2001-06-21 | 2001-06-23 | 0.63 |
| 2002-06-20 | 2002-06-30 | — | 2002-07-02 | 0.64 |
| 2003-06-15 | 2003-06-25 | — | 2003-06-27 | 0.75 |

Table 1: Example of 25 the selected dates

HYSPLIT was used to analyze Saharan Air Layer (SAL) particle trajectories.

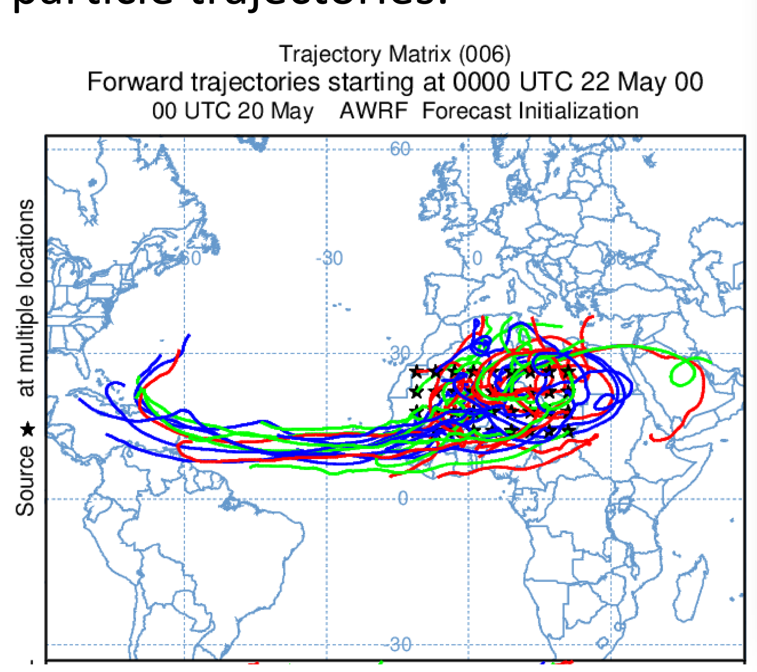


Fig 3: Example of simulations with Hysplit

**Radiative interactions** between **sunlight** and **dust** enhance particle motion, promoting **faster** and **more direct** transport across the **Atlantic.**

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## Results

There is no statistical difference in between values of wind speed, distance and curvature.

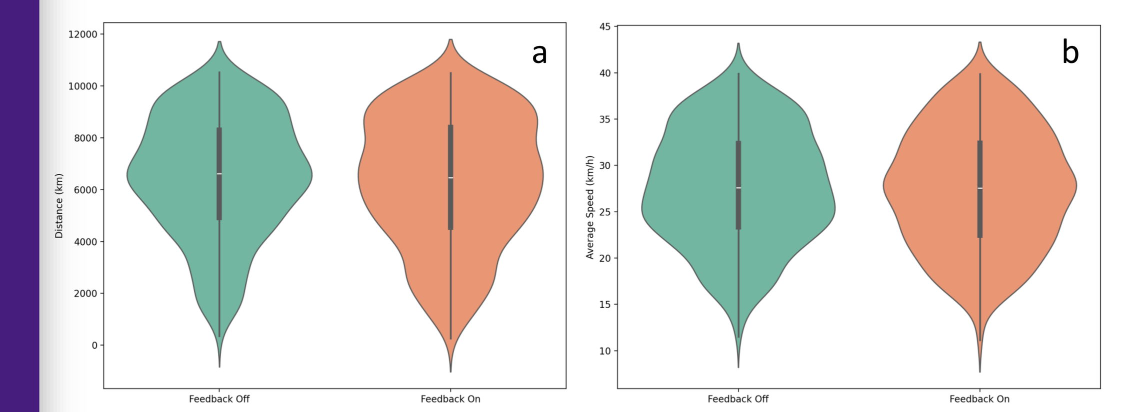


Fig. 4: Violin plots comparing feedback OFF and feedback ON simulations for (a) distance traveled by particles and (b) average particle speed.

The frequency of the top 10% highest values of distance, average speed, and curvature was evaluated. Differences in frequency were found for wind speed and curvature.

| | Top Fb-On | Top Fb-Off | Rest Fb-On | Rest Fb-On | Chi-square |
|---|---|---|---|---|---|
| Distance | 86 | 105 | 886 | 831 | 0.09 |
| Wind speed | 83 | 108 | 889 | 828 | 0.03** |
| Curvature | 112 | 79 | 860 | 857 | 0.03** |

Table 2. Frequency table for Chi-square analysis of distance, wind speed, and curvature. Top 10% (Top) and remaining values (Rest) are shown for Feedback On (FB-On) and Feedback Off (FB-Off). ** indicates statistical significance ($p < 0.05$).

## Discussion and Conclusions

Previous studies report mixed responses of Saharan dust radiative feedback on atmospheric circulation, with some indicating a weakening of transport (Jury et al 2010), while others suggest a strengthening of the flow (Bercos-Hickey et al 2017). In this study, simulations with radiative feedback enabled (Feedback On) produce noticeable changes in Saharan Air Layer (SAL) trajectories, leading dust particles to travel faster and follow paths with reduced curvature.

These results indicate that when dust radiative feedback is active, particle trajectories become more direct, characterized by higher transport speeds and less curved pathways across the Atlantic.

**Acknowledgment:**

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