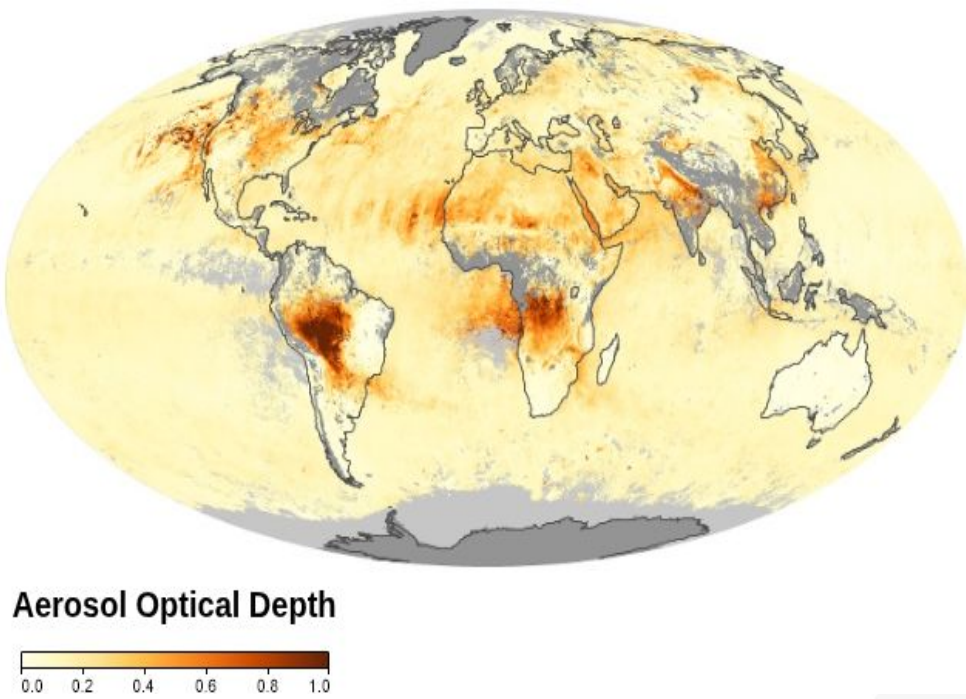
Aerosols and Radiative Heating in Hypersonic Flight

- **Marwa Majdi**, Assistant Research Professor, Atmospheric Sciences
- **Experience with hypersonics**
  - Atmospheric modeling for flight tests
  - Aerosol modeling & radiative properties → impacts on heating, sensing, and performance of the hypersonic vehicles
- **Research background and interests**
  - Atmospheric Aerosols: size, composition, optics
  - Cloud Microphysics
  - Aerosol Modeling: WRF/ WRF-Chem
  - Physics-informed ML
  - Data Fusion: Radar/GOES/WRF → operational products



NASA MODIS Aerosol Optical Depth on September 2020. Darker = more aerosols. Higher AOD → more absorption/scattering → potential extra radiative heat at the nose."

Research Highlights — Aerosol Radiative Heating

- **What happens:** Absorbing aerosols (soot/dust) add **extra radiative heat** (strongest near the **stagnation point)**.
- **Why it matters:** Small **extra radiative heat** can tighten **Thermal Protection System margins** and push designs toward limits.
- **What we can model:** Aerosol concentrations, size, composition, and optical properties along the flight corridor.
- **How we compute it:** Estimate and add a radiative heat term (Δq_rad) to the surface heat balance and couple it to Thermal Protection System analysis to set the right margin and help operations pick safer windows.