Surface fluxes, boundary layer heights, and mixing strength in Galveston Bay and the Gulf of Mexico

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HRDL operators and data processors
RHB sonde launchers
and many others
Surface fluxes over water

Surface fluxes (especially heat flux) drive the marine boundary layer.

Few previous measurements.

Findings

- Water temperature warms during the day and cools at night in the Gulf and Bay, in phase with the air temperature.
- Heat flux is almost always positive, day and night.
- A (well?)-mixed layer of reasonable depth is almost always present.
Heat flux in the Gulf
Heat flux in the Gulf
Heat flux in Galveston Bay
Different instruments measure different physical quantities and are interpreted to produce various types of heights.

“BL height” is general but ambiguous – sometimes all definitions agree!

“Mixing height” = the height to which some surface-emitted constituent is mixed on a time scale of ~1 hour.

“Aerosol layer height” = the height of a (surface-based) layer of different aerosol content.
What BL height measurements do we have?

- Land-based wind profilers
- Ship-based lidar
- Ship-launched radiosondes
- Lidar aircraft
- In-situ aircraft soundings
- Land-based sondes
- Others....
BL heights from ship-based lidar (HRDL)
BL heights from ship-based lidar (HRDL)

- Aerosol tops out ~2500 m
- Aerosol and mixing increase and rise after 1500 UTC as ship moves north
- Lowest layer becomes cleaner and mixing weakens as ship moves south
BL heights from ship-launched radiosondes

- 1 September 18Z at Barbour’s Cut, near time and place of peak ozone observed at the ship for the entire campaign (>170 ppb)
- Note multiple layers with “tops” at 200, 1200, 1800 m
Mixing heights over the Bay and Gulf

- Average mixing heights from a combination of lidar techniques
- Some diurnal cycle in Bay averages (including some land influence)
- BC and HSC are strongly influenced by surrounding land

TexAQS 2006 - HRDL RV Brown: Mixed layer heights 08/01 to 09/11

![Graph showing mixed layer heights over time with varying averages and influences from land.](image)
BL height distributions at midday from Moody and LaPorte profilers

- Lower heights, broader distribution, and lower confidence at LaPorte
Are mixing heights lower over Galveston Bay?

- Yes, generally lower than over nearby land at midday
- Mixing height often not well defined due to “soft” top
- Difficult to perfectly remove land influence, especially when ozone is high
- For example, Sept. 1
  - ozone peak is on the edge of a reduction in mixing height – is this water or land?
  - LaPorte profiler BL height ~1.5 km
- Generally BL heights over Bay are 500-600 m at midday
- LaPorte profiler BL heights 500-1800 m at midday
Are BL structure anomalies associated with ozone and/or aerosol events?

- 29 August ozone and aerosol offshore
- Unusually low heat flux and turbulence in plume (blob) from Houston
- Aerosol layer is deep (~1.5 km)
- LaPorte BL height max 1.3 km
- Sounding is near-neutral up to ~500 m and only slightly stable above that – difficult to define BL height
Summary

- BL over water is almost always weakly mixed, with positive heat flux and 500-600 m depth
- Mixing heights are generally lower over Galveston Bay than over nearby land at midday
- Boundary layer behavior is complex
- Good news:
  - We have lots of measurement resources
  - Surface measurements are representative of a deeper layer than in New England
  - We’re available to consult and collaborate