# Marine boundary Layer dynamics and heights during TexAQS 2006: HRDL measurements from the RV Brown

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**Acknowledgements**: Ann Weickmann, Daniel Law, Christoph Senff, Janet Machol, Richard Marchbanks, Brandi McCarty, Joanne George, Wayne Angevine, Bob Banta, Lisa Darby

NOAA

CIRES

# High Resolution Doppler Lidar (HRDL)

| | |
|---|---|
| Wavelength | 2.02 micron |
| Pulse Energy | 2-3 mJ |
| PRF | 200 Hz |
| Max Range | 3-8 km |
| Range Res. | 30 m |
| Beam rate | 2 Hz |
| Precision | <10 cm/s |
| Scanning | Full Hemispheric |

Poster
Ship-Based LIDAR Estimates of Marine Mixed Layer Heights during TexAQS 2006

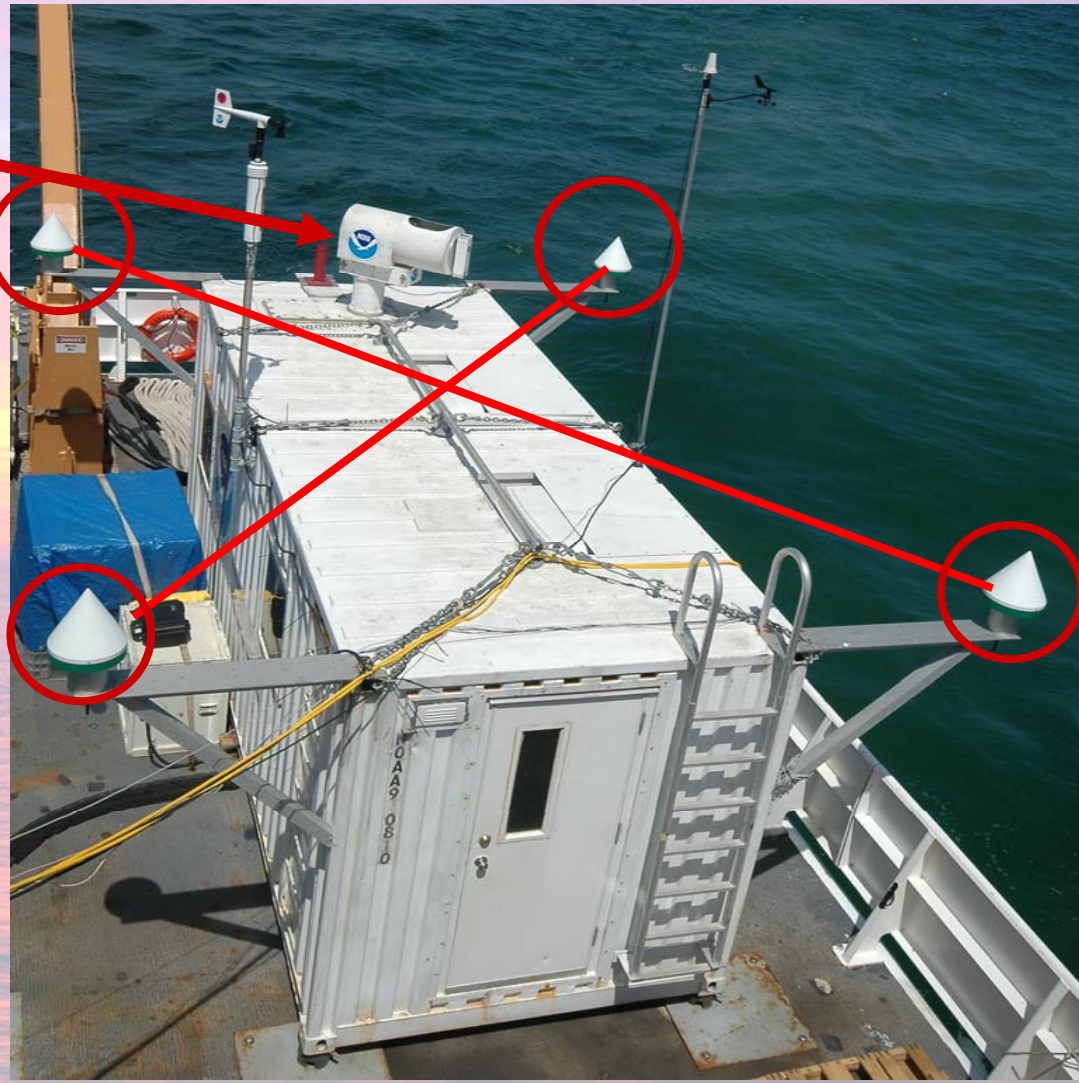
# Motion compensation

**Hemispheric beam scanner**

- Motion compensation calculations enable the scanner to perform “world frame” scans.
- Tilt axis enables us to do Zenith stares.
- New algorithms allow zenith stare as part of scan pattern.

**GPS based inertial navigation**

- Estimates orientation, angular rates, position, velocity, and acceleration at 20 Hz.
- Static precision 0.15°
- Dynamic precision < 0.5°



# HRDL wind and aerosol products for understanding Marine Boundary Layers

**Composite products**

- Horizontal mean wind profiles
- Profiles of relative aerosol strength and aerosol layering
- Vertical winds and vertical mixing/turbulence statistics
- Horizontal (near surface) mixing/turbulence statistics
- Aerosol and mixed layer (i.e. Boundary layer) heights
- Wind speed and directional shear profiles

**Individual Scan Products**

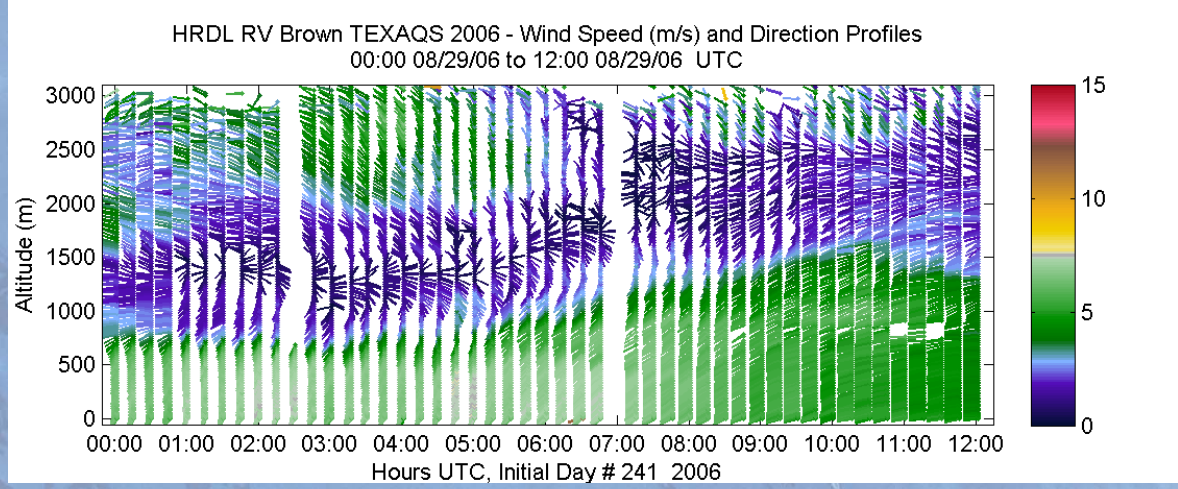
- Boundary layer dynamic features: rolls, surface streaks, thunderstorm outflows, etc
- Ship/oil-platform plume detection

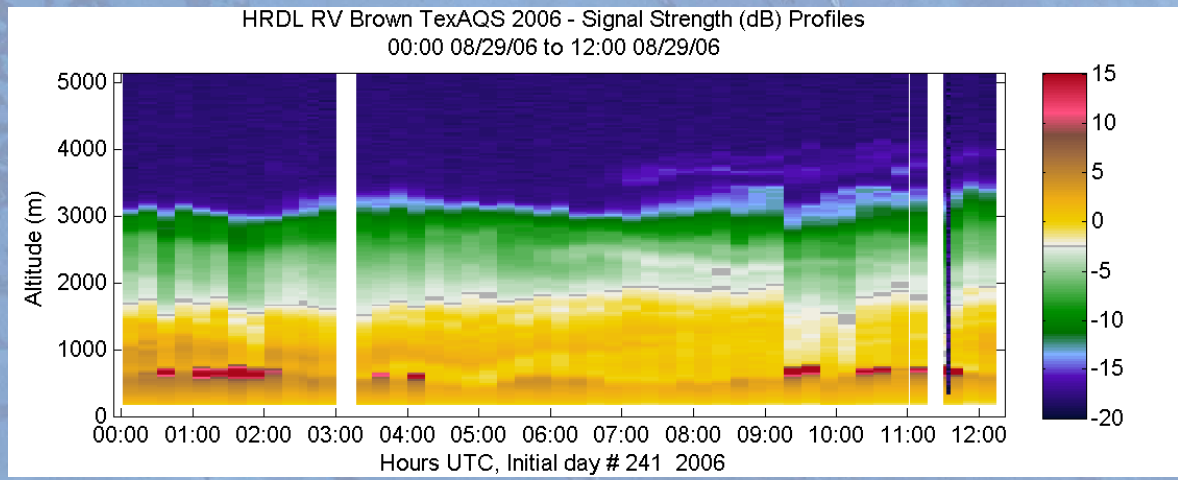
# Basic TexAQS 2006 HRDL Data Products

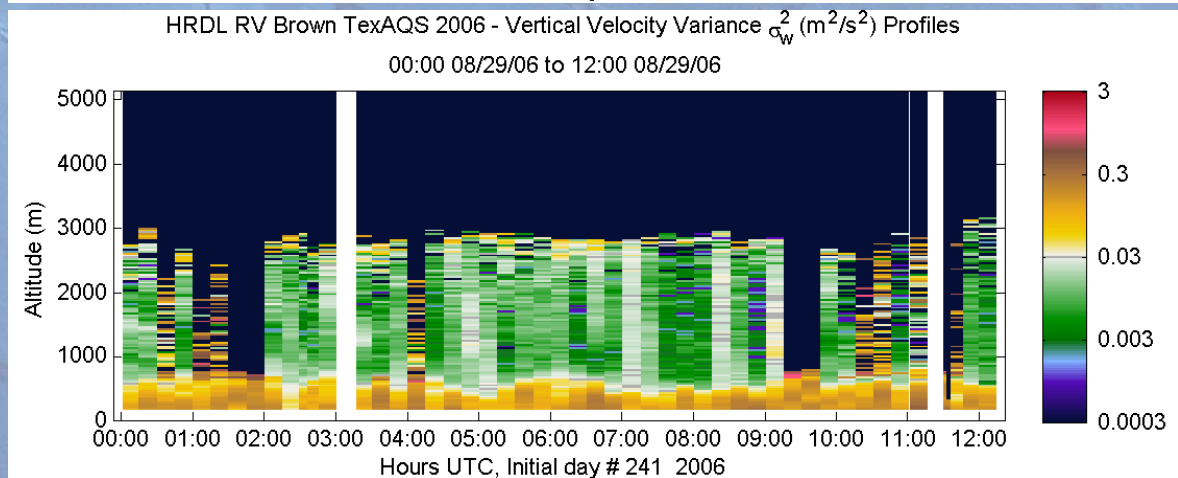
available at http://esrl.noaa.gov/csd/ors/data_pages/TexAQS06/hrdl/

Profiles of:

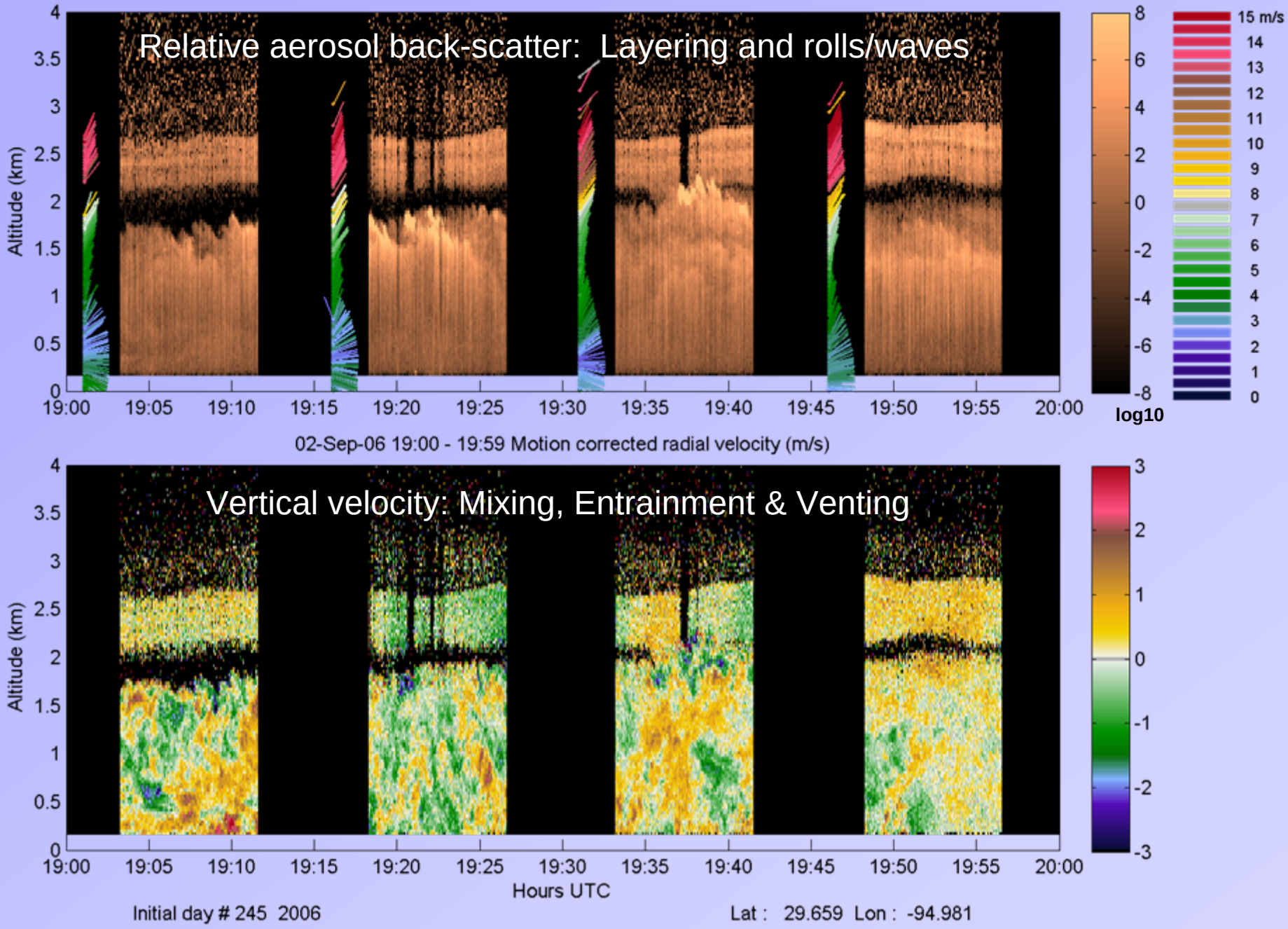
- Mean wind speed and direction
- Average return signal strength
- Small scale vertical mixing strength

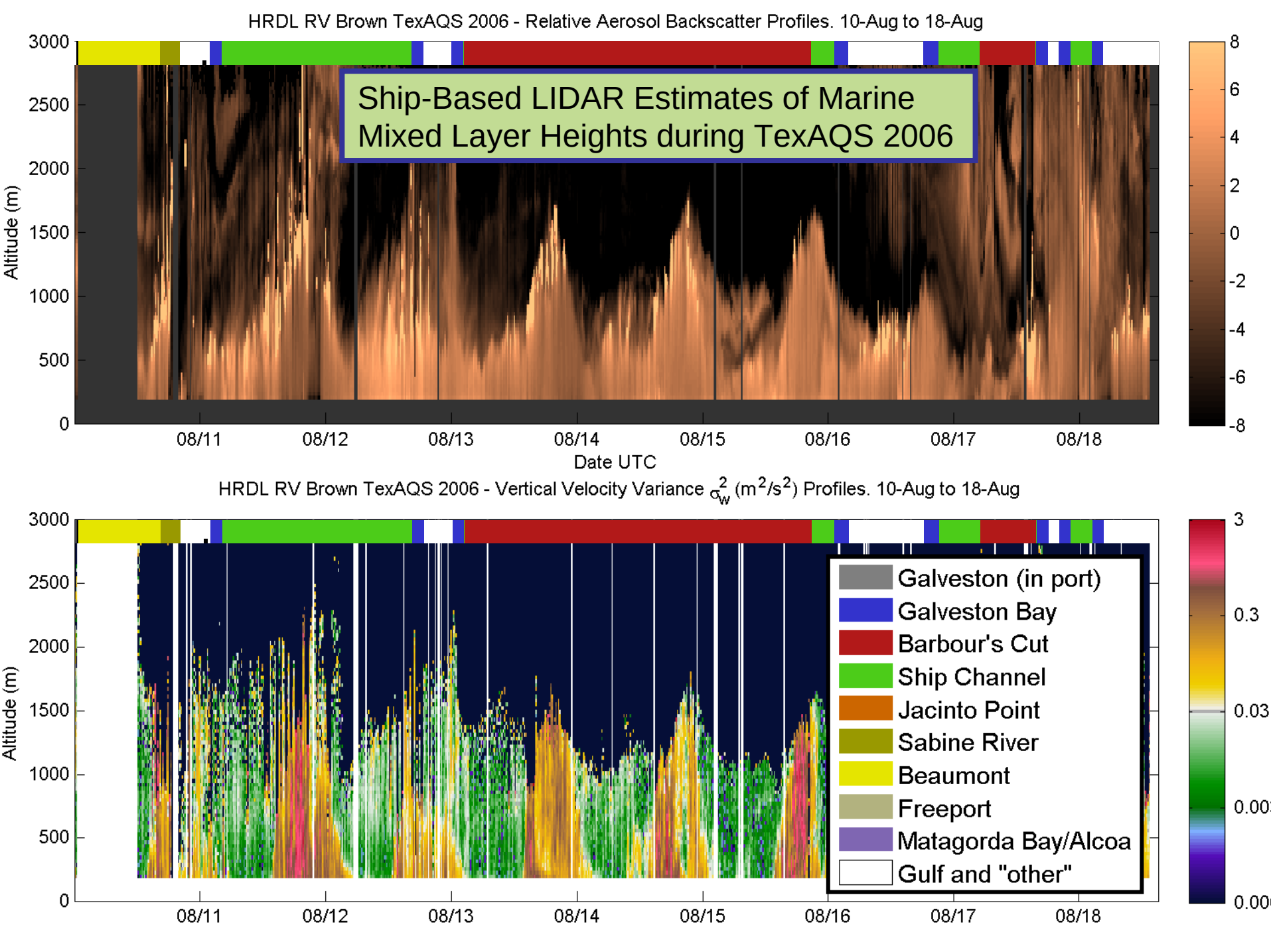


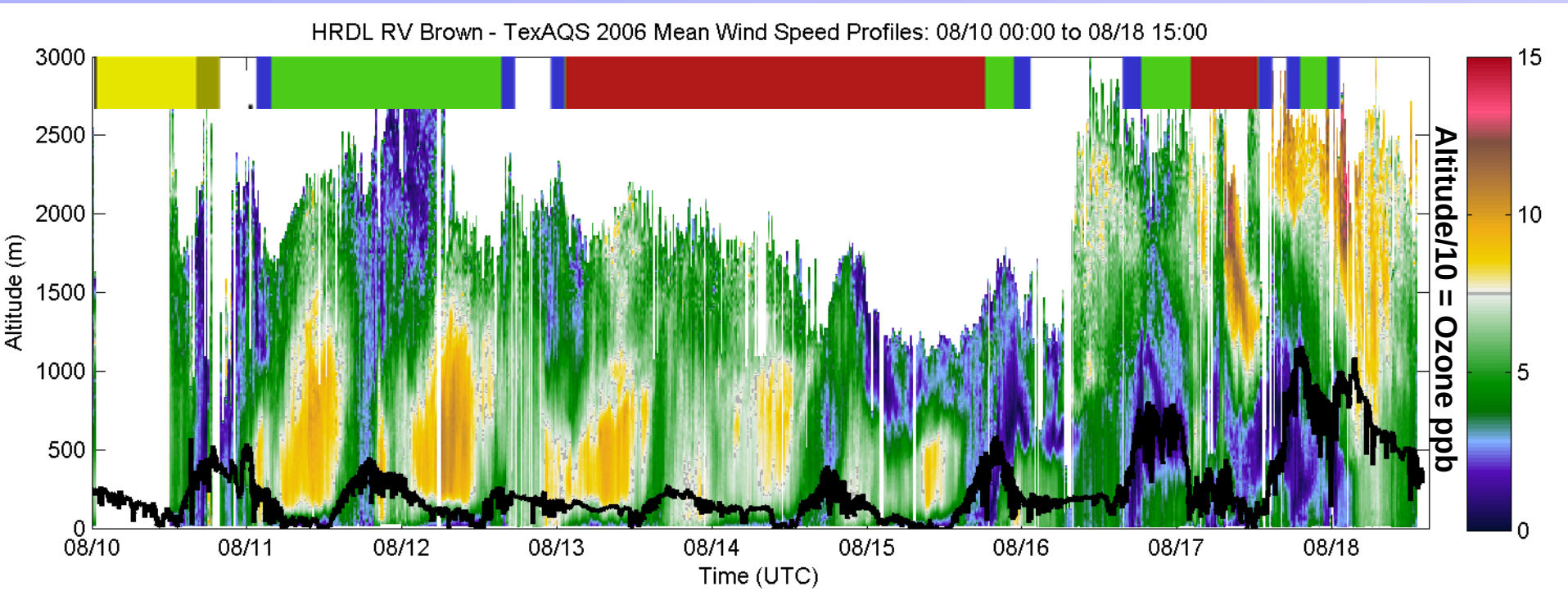
# Individual Scans: Zenith/Vertical stare data: Barbour's Cut and Galveston Bay



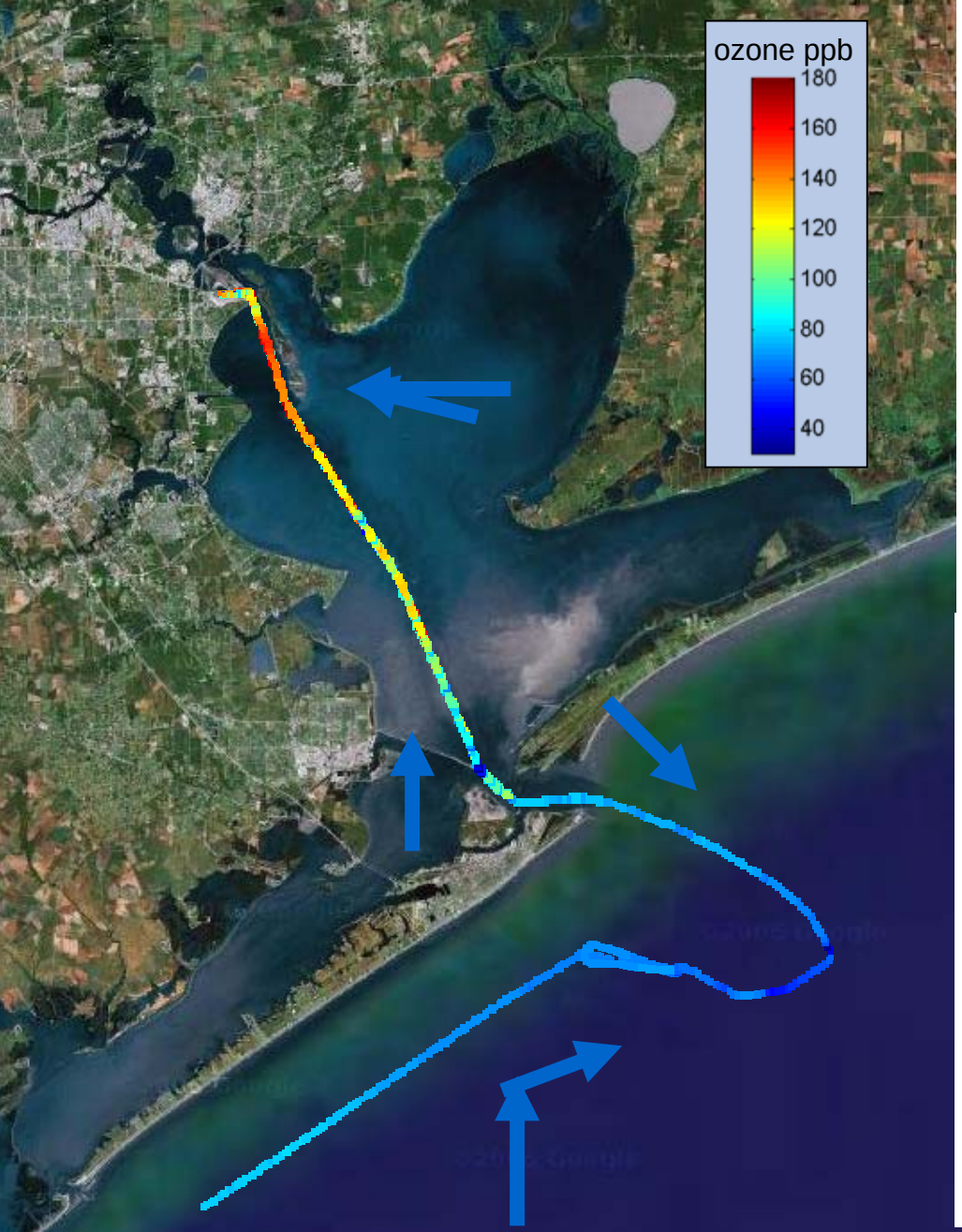

HRDL RV Brown TexAQS 2006 - Relative Aerosol Backscatter Profiles. 10-Aug to 18-Aug
Ship-Based LIDAR Estimates of Marine Mixed Layer Heights during TexAQS 2006
Altitude (m)
3000
2500
2000
1500
1000
500
0
08/11
08/12
08/13
08/14
08/15
08/16
08/17
08/18
Date UTC
8
6
4
2
0
-2
-4
-6
-8
HRDL RV Brown TexAQS 2006 - Vertical Velocity Variance $\sigma_w^2$ ($m^2/s^2$) Profiles. 10-Aug to 18-Aug
Galveston (in port)
Galveston Bay
Barbour's Cut
Ship Channel
Jacinto Point
Sabine River
Beaumont
Freeport
Matagorda Bay/Alcoa
Gulf and "other"
3
0.3
0.03
0.00

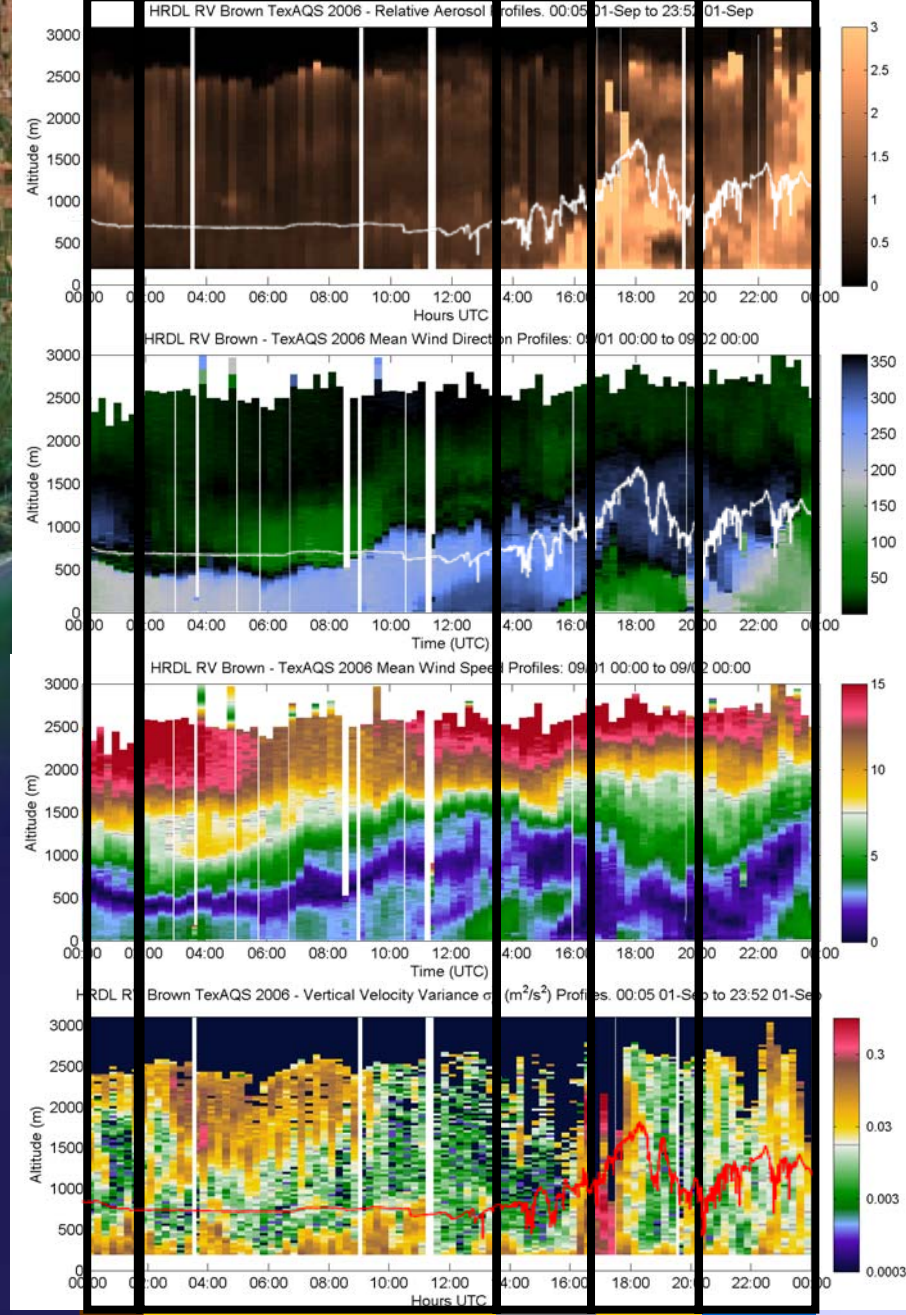
# Mean wind speeds and ozone as measured on the ship

- Diurnal cycle in wind speed observed when the ship is near land
- Nocturnal low-level jets correlate with ozone depletion.




**Ongoing Study**: What is the relationship between wind speed and ozone min/max values?




Making sense of a single day.

See Machol et. al. poster for more information on TEXAQS

1 Sept 2006 TEXAQS

# Additional TexAQS 2006 Observations with HRDL

- NOAA's High Resolution Doppler Lidar data provide contextual information about local transport and mixing conditions from the surface to the top of the aerosol layer.
- Within the HRDL dataset, nocturnal low-level jets correlate with low ship-measured ozone days.
- HRDL observed strongly capped (at ~500 m) nighttime boundary layers prior to high ozone days – despite ship position.
- Dust events typically correspond to higher aerosol layer heights

# Ongoing and Future studies

- Mixed Layer and Boundary Layer Heights
  - Comparison to other lidars
    - OPAL on the RV Brown
    - TOPAZ on the Twin Otter
    - HSRL on the King Air
  - Study of BL heights over the water prior to high ozone days
  - Study of BL heights during nocturnal LLJ – and effects on local chemistry
- MBL dynamics: shear, streaks, rolls – integration into large eddy simulation (LES) models.
- Comparison:  2-micron aerosol backscatter profiles and in-situ measurements
- Satellite comparisons of backscatter
- Dust trajectory studies
- Large (1.5-micron+) aerosol/dust flux estimates

Thank you.