Deployment of Ronald H. Brown during TexAQS II and GoMACCS 2006

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NOAA/ESRL/CSD
NOAA R/V Brown (RHB)

Length: ~300 ft
Draft: ~20 ft
Speed: ~12-14 kts
People: 22 officers/crew; 31 scientists

Consider RHB as a movable ground site in Houston Ship Channel (HSC):
1) 24-hour on station then move a few km & another 24-hour on station can give different perspectives on emissions, dynamics, chemistry
2) can get close to emission sources on the water (e.g., barge loading)
3) not just HSC (e.g., Beaumont/Port Arthur; Freeport; Port Lavaca)

Restrictions:
1) locations to park (ship ops in HSC: coordinate w/Houston Pilots)
2) potable water supply (~3 days)
3) charted AND uncharted obstructions (since Katrina/Rita)

Communication:
1) Radio
2) Phone: cell and INMARSAT
3) Internet/email
Summary of Measurements on R/V Brown

**2006 TexAQs GoMACCS**

**Central decks:**
- **PMEL VAN3** - Aerosol composition:
  - Organic speciation (PTR-MS)
  - NR composition (WTOF-AMS)
  - Radiometers

- **PMEL VAN2** - Aerosol parameters:
  - Number and size distribution
  - Light scattering (Neph)
  - Scattering f(RH) (Neph)
  - Light absorption (PSAP)
  - Light extinction (CaRDS)
  - Extinction f(RH) (CaRDS)
  - Light absorption (PAS)
  - Composition (impactors)
  - Functional groups (FTIR)
  - Radon

- **PMEL VAN1** - Aerosol composition:
  - Ions (PILS-IC)
  - Water sol. organics (PILS-TOC)
  - Organic speciation (PILS-LCMS)
  - NR speciation (AMS)
  - OC/EC
  - CCN
  - SO2, O3

**创新能力一：**
- **ESRL VAN3** - VOCs: GC-MS; PTR-MS; CH2O; Alkyl N; NO3; N2O5; H2O/RO2
- **ESRL VAN2** - VOCs: GC-MS; PTR-MS; CH2O; Alkyl N; NO3; N2O5; H2O/RO2
- **ESRL VAN1** - NO; NO2; NOy; PANs; HNO3; O3; CO; CO2; SO2; jNO2; jO3; jNO3; met; GPS/AIS

**Gas-phase inlets and radiometers tower**

**Fantail:** OPAL (O3/aerosol lidar), HRDL (Doppler lidar)

**Bow:** Turbulent Fluxes - heat; water; momentum: O3

**Lab:** seawater DMS, pCO2

**03 deck:** AOD, Wind profiler, Sondes, Ceilometer, Mini-sodar, C-Band radar
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>19 July</td>
<td>Begin loading in Charleston</td>
</tr>
<tr>
<td>27 July</td>
<td>Depart Charleston (Leg 1)</td>
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<tr>
<td>1 Aug</td>
<td>Arrive in Houston area</td>
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<tr>
<td>18 Aug</td>
<td>Port stop Galveston</td>
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<td></td>
<td>(try to dock next to the cruise ships)</td>
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<tr>
<td>21 Aug</td>
<td>Depart Galveston “Media Day” (Leg 2)</td>
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<tr>
<td>12 Sept</td>
<td>Port stop Galveston</td>
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<tr>
<td>14 Sept</td>
<td>Depart for Charleston (Transit)</td>
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<tr>
<td>19 Sept</td>
<td>Arrive Charleston</td>
</tr>
<tr>
<td>20 Sept</td>
<td>Unload in Charleston</td>
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Corpus Christi
Port Lavaca
Freeport
Houston
Port Arthur

Charleston

Working Area
TexAQS II and GoMACCS: NOAA’s Air Quality and Climate Plans
Based on results and experience from TexAQS 2000 and NEAQS 2004 studies

Emissions Verification: How well do current inventories represent actual emissions for: Cities, Power Plants, Industry, Ships, and Vegetation, (Forest Fires)?

Transport and Mixing: What are the roles of local, regional, and long-range transport processes in the accumulation and spatial distribution of pollution in the boundary layer over Eastern Texas, and in the export to the free troposphere?

Chemical Transformation: How do gaseous and aerosol emissions evolve chemically and physically as they are transported away from the source regions?

Aerosol Properties and Radiative Effects: What are the chemical, physical, and optical properties of the regional aerosol and how do these properties affect regional haze and aerosol direct and indirect radiative forcing of climate?

Models: What is the current skill of air quality forecast models and chemical transport/climate models on local and regional scales? What improvements can be made to enhance the accuracy of these models and to extend the periods of the forecasts?

But must consider ship capabilities and safe operation!
Primary region for characterizing urban/industrial emissions and near-source aerosol and gas-phase chemistry (day and night)

Possible regions to characterize sea-breeze development and return flow

Possible locations to characterize high O3 episodes and nighttime chemistry

Houston Ship Channel (dredged ~40' x ~500')

Primary region for characterizing marine vessel emissions
Emissions Verification and Assessment

1. What is the regional distribution of anthropogenic and biogenic emissions in Texas?
   - Ports other than Houston: Port Arthur; Corpus Christi; Freeport
   - Biogenics: along-shore cruise FL/AL/MS; Neches/Sabine Rivers (Port Arthur area)

2. What are the relative contributions from urban area sources, power plants, and industrial emissions within the Houston metropolitan air shed? How did the change in emissions from 2000 to 2006 affect the gas-phase and aerosol concentrations?
   - Mobile sources (AM from Port of Houston - west end of HSC)
   - VOC and NOx sources in HSC: only IF we can distinguish sources

3. Do ambient measurements of pollutant mixing ratios (e.g., CO/NOx, VOC/NOx, CO/CO2, LAC/CO, NH3/CO) reflect the temporal variation of urban emission ratios through diurnal cycles and weekday/weekend contrasts?
   - Industrial emissions survey in HSC
   - Marine vessel emissions in HSC; GoM (Instrument Comparison)
   - Small craft emissions in HSC and in Gulf of Mexico: weekday/weekend; Labor Day
   - Hg sources in study region: survey; chlor-alkali plant in Matagorda Bay

4. What are the Volatile Organic Compound emission rates from petrochemical industries?
   - Survey and target: stacks; filling operations, barges, pipelines
   - Offshore oil platforms

5. Can the direct emission of aerosols including black carbon be characterized by measurement of their ratio to major urban pollutants such as CO.
   - Can probably do with ship plumes
Example Holding Areas for Emissions Measurements

On-road emissions: AM rush hour;
(Port of Houston turning basin;
upwind of most industrial sources)

Point source emissions: co-gen plants;
(but near docks - may have to move)
Transport and Mixing

1. How do the heating and cooling cycle at the earth’s surface and the resulting changes in ABL vertical structure affect horizontal transport from the major sources? What is the horizontal variability of the BL depth and what effects does this have on transport and mixing?
   Variation of BL from Gulf of Mexico to Port of Houston
   Surface flux of energy/momentum

2. How do day-to-day variations in sea-breeze development (timing, intensity, etc.) affect peak local pollutant concentrations? What is the extent of inland transport by the sea breeze and what other factors control this transport?
   Transects from Gulf of Mexico to Port of Houston
   On station at select locations in HSC; Galv. Bay; GoM

3. Under what conditions does local urban pollution have a significant impact on other areas in the region? How effective are nocturnal transport and subsequent daytime vertical mixing in dispersing pollution from the major sources into the surrounding region?
   Transport of pollution from Houston to Gulf of Mexico

4. What conditions exist when elevated background concentrations imported from distant source regions outside of Texas impact air quality or climate in the state?
   Transport of pollution from Gulf of Mexico to Houston
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Primary region for characterizing marine vessel emissions
Chemical Transformations

1. What primary processes characterize the chemical evolution of ozone, aerosols and their precursors as they are transported from the source regions? What are the rates and efficiencies of processes that control ozone and secondary aerosol formation during the daytime downwind of urban areas, power plants, and industrial sources?
   - Photochemistry at different points in HSC and Galveston Bay
   - Chemistry in GoM: polluted outflow vs clean marine; Instrument comparison

2. Are the measurements of the products of VOC oxidation consistent with the current understanding of hydrocarbon chemistry?
   - Photochemistry at different locations in HSC and Galveston Bay
   - Transects from Port of Houston to Gulf of Mexico

3. What is the contribution of nighttime chemistry to the oxidation of NOx and what are the consequences for the formation and removal of ozone and aerosols?
   - On station at different points from Port of Houston to Gulf of Mexico
   - Biogenic VOC loss: Neches River/Sabine River
   - Offshore oil platforms: track plume at different ages

4. What sources and processes affect the levels and composition of organic aerosols?
   - Source regions: HSC - contrast high S/low S locations
   - Chemistry: isolated source plumes (oil platforms) with/without S
   - Biogenic sources: Neches River/Sabine River
Holding Areas for Emissions/Chemistry Measurements

Emission sources: Power plant and chemical plants

Chemical transformations: High O3 (stagnant) and nighttime
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What is the clear-sky radiative impact of aerosols over the ocean?

A-Train, Terra

AOD, aerosol vertical structure, solar flux, radiative efficiency, FMF

Up and downwelling radiative fluxes and AOD

Up and downwelling radiative fluxes and AOD

Extinction profiles

In-situ measurements of aerosol chemical, physical, optical, f(RH) properties

Ronald H. Brown
Green Lines – Terra track, overpass ~ noon local time

Swath of MISR local mode coverage

Terra Path 26
13Aug 29Aug

Terra Path 25
06Aug 22Aug 07Sept

Terra Path 24
15Aug 31Aug

Terra Path 23
08Aug 24Aug 09Sept
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**TO BE ADDRESSED AT THE AFTERNOON SESSIONS**
Coordinated activity with P3 and Twin Otter

P3: at least 2 possible overpasses on flight days; includes day into night and night into day - good overlap (if possible at night)
TO: at least 2 possible overpasses on flight days; guidance for Brown; ~3-D context for data; ground-truth

**Combined benefit:** get good diurnal coverage with RHB; connected to TO and P3 at discrete time points (day/night)

Reasons for coincident sampling:
A. Instrument comparison
B. Obtain snapshot of chemical/thermodynamic spatial profile
   where RHB provides surface layer data and time series info and TO and P3 "see" horizontal/vertical variability (the big picture)
C. Combined data: broader coverage in space/time; models benefit