Peak Ozone Concentrations on High and Low Wind Days Within and Outside of the Surface Measurement Network

Purpose

- Highest O$_3$ days associated with low wind speeds (< ~3 m s$^{-1}$), windshifts due to sea breeze
- Determine effects of wind speed on O$_3$ concentrations produced by Houston / Ship Channel area –
  - can still get high O$_3$ with stronger winds (> 4 m s$^{-1}$)
- Effectiveness of surface network, esp. on higher wind days (pollution blown out of network ?)
Procedure

- Peak $O_3$ for a given day
  - [P-3: A. Neuman, M. Trainer]

- Houston “add-on” – subtract background
  - Must determine background $O_3$ levels first – what is background?

- Datasets
  - TOPAZ airborne $O_3$ lidar (sample 14 days, 3 Aug – 7 Sept)
  - P-3 in situ $O_3$ sensors – (sample 10 days, 13 Sept – 6 Oct)
  - Surface measurement sites (daily 1-hr max; background low daily max’s)
Analysis technique

Stronger-wind case: 14 Aug

- Southwesterly flow
- Peak $O_3 \sim 90$ ppb
- Background $\sim 25$ ppb
- Traj. displacement – orange arrow
Analysis technique

Sea-breeze / weak-wind case: 15 Aug

- Early westerly flow carries plume to east
- Sea breeze undercuts plume with clean air
- Peak O₃ ~ 160 ppb
- Background ~ 30 ppb
**Peak O$_3$ vs. wind speed**

- **Peak total O$_3$ vs. 'wind speed' - TOPAZ days**
  
  \[ y = -1.0252x + 252.91 \]
  \[ R^2 = 0.9256 \]

- **Peak total O$_3$ vs. 'wind speed' - P-3 days**

- **Ozone add on vs. 'wind speed' - TOPAZ days**
  
  \[ y = -0.7603x + 179.92 \]
  \[ R^2 = 0.7532 \]

- **Ozone add on vs. 'wind speed' - P-3 days**
O_3 vs. ‘wind speed’

- O_3 add on
- Peak total O_3 vs. 'wind speed'

Airborne-TOPAZ + P3
Sfc meas

9/26
O$_3$ vs. 1 / ‘wind speed’

Next step: include mixing hgt
Summary (1 of 2)

- Confirms strong dependence of \([O_3]\) on wind speed
  - Many light-wind, high-\(O_3\) days – ‘a class by themselves’
    - most = wind shift (onshore)
  - ‘Tight’ (linear) relationship between daily peak \([O_3]\) and \(U\) for earlier “TOPAZ-days” sample (not \(1/U\) as expected)
  - Airborne lidar sampling method – good chance to get daily peak value, reasonable estimate of background

- 1 \(U\) dependence of \([O_3]\) consistent with data – in agreement with B. Lambeth forecast model
Summary, additional work

- Current surface sampling network, with 1-hr ave sampling
  - Underestimated highest a/b values on low-wind days
  - Apparent better agreement with stronger winds than previously reported, *but* still not sampling plume

- Additional work
  - Add 2000 and mixing height data, calculate ‘source strengths’ from $O_3$ – $1/U$ slope, intercept? Compare ’00 and ’06
  - Investigate 26 September ’06 behavior
  - High ozone with stronger winds assoc w/ high background
Peak ozone add-on vs. 10-h traj distance (~ mean speed)

- Surface-network-based: O$_3$ blown out of network
- Airborne-ozone-based: Houston still makes a lot of O$_3$ !
  
  (many of the high airborne values underestimated)
26 Sept 10-hr forward trajectories

- Why is 26 Sept special? – not answered here
- Wind speed increases significantly through mixed layer
- ~ 3°C cooler than previous days
- P-3 notes: “lots of clouds”
- Estimate of ‘background’?
‘Tight’ relationship between $[O_3]$ and $U$ for earlier “TOPAZ days” – *ascending branch of hyperbola*

- Many light-wind, high-$O_3$ days
  - most = wind shift (onshore)
- Sampling method – good chance to get daily peak value, reasonable estimate of background

- High ozone with stronger winds assoc w/ high background
- Current surface sampling network seems pretty good, *BUT…*
  - underestimates highest $a/b$ values on low-wind days
- More scatter for later “P-3 days”
- Investigate 26 September ’06 anomaly
- Add 2000 data, calculate ‘source strengths’ from $O_3$ – $1/U$ slope?