

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

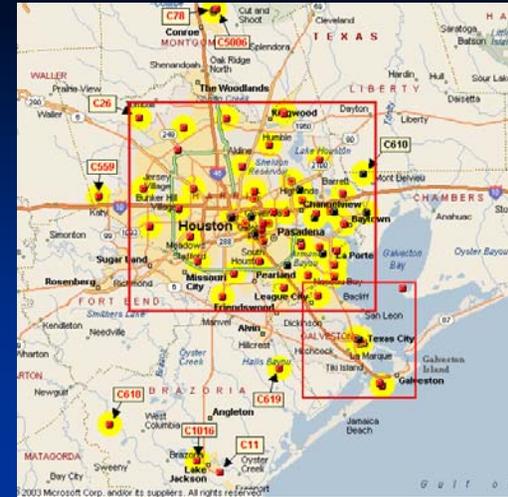
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Sandberg, T.B. Ryerson, D.D. Parrish, et al.

Purpose

- Highest O₃ days associated with low wind speeds ($< \sim 3 \text{ m s}^{-1}$), windshifts due to sea breeze
- Determine effects of wind speed on O₃ concentrations produced by Houston / Ship Channel area –
 - can still get high O₃ with stronger winds ($> 4 \text{ m s}^{-1}$)
- Effectiveness of surface network, esp. on higher wind days (pollution blown out of network ?)

Procedure

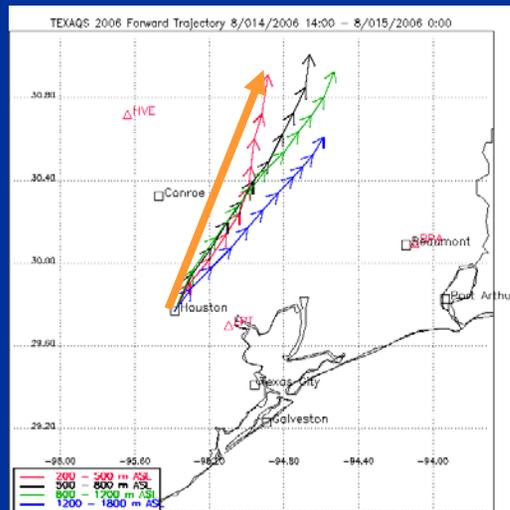
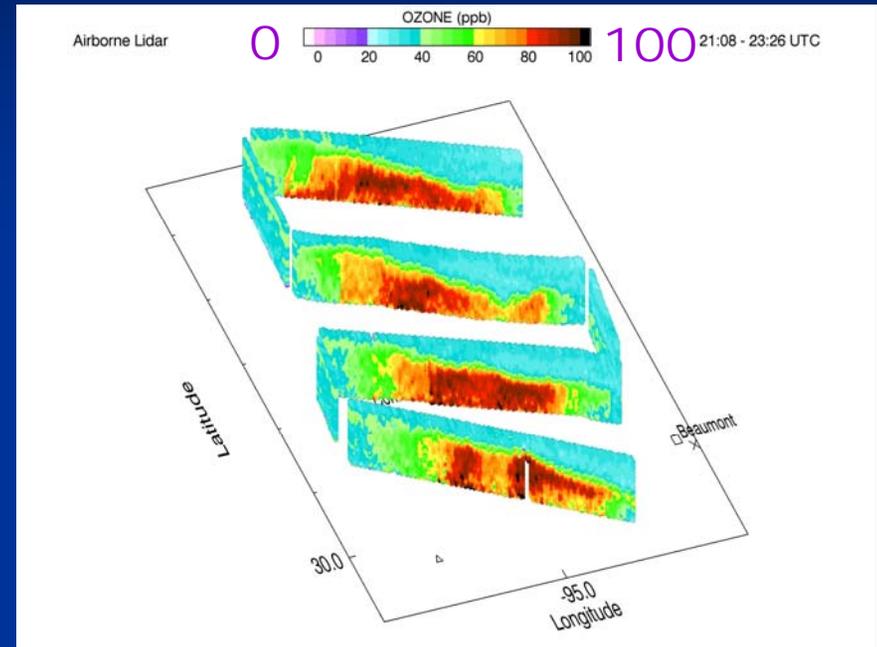
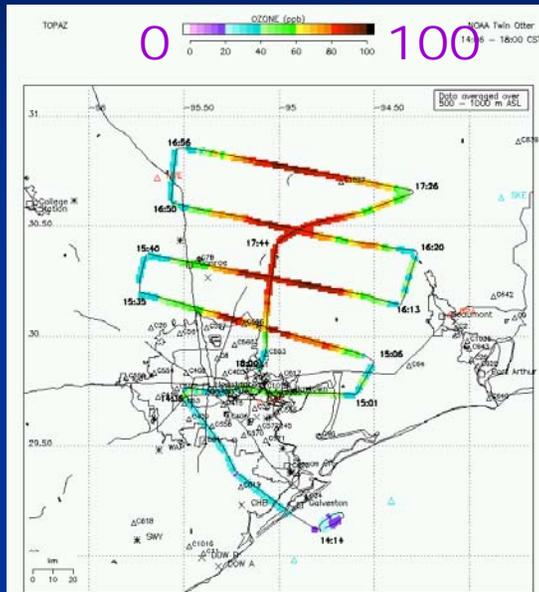
- Peak O₃ for a given day
 - *[P-3: A. Neuman, M. Trainer]*



- Houston “add-on” – subtract background
 - Must determine background O₃ levels first – what is background?
- Datasets
 - TOPAZ airborne O₃ lidar (sample 14 days, 3 Aug – 7 Sept)
 - P-3 in situ O₃ sensors – (sample 10 days, 13 Sept – 6 Oct)
 - Surface measurement sites (daily 1-hr max; background low daily max’s)

Analysis technique

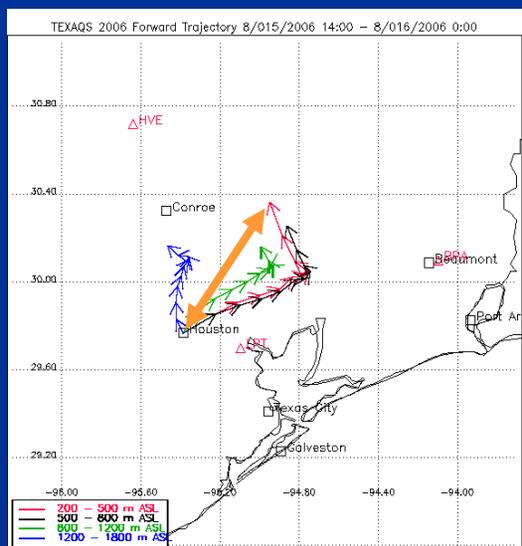
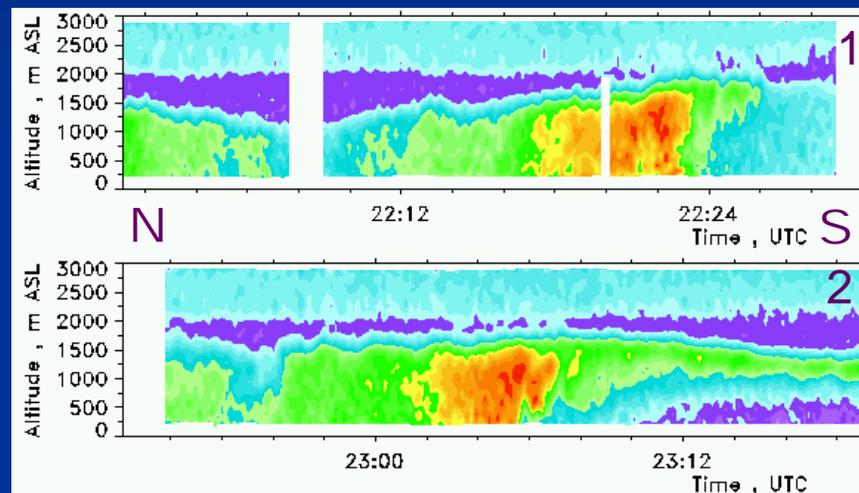
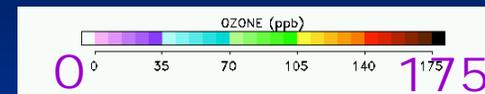
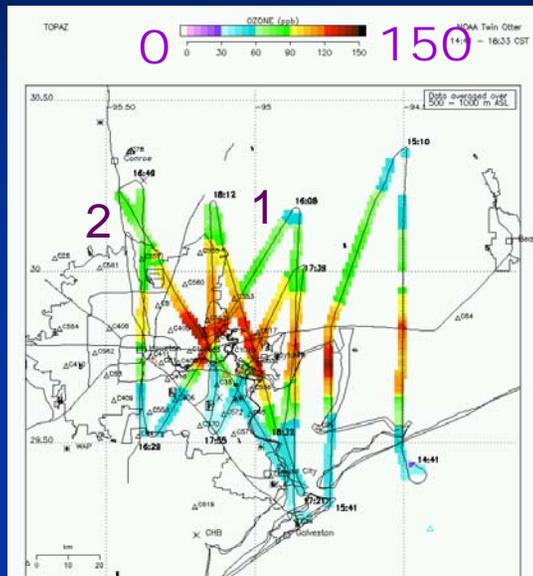
Stronger-wind case: 14 Aug



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

Analysis technique

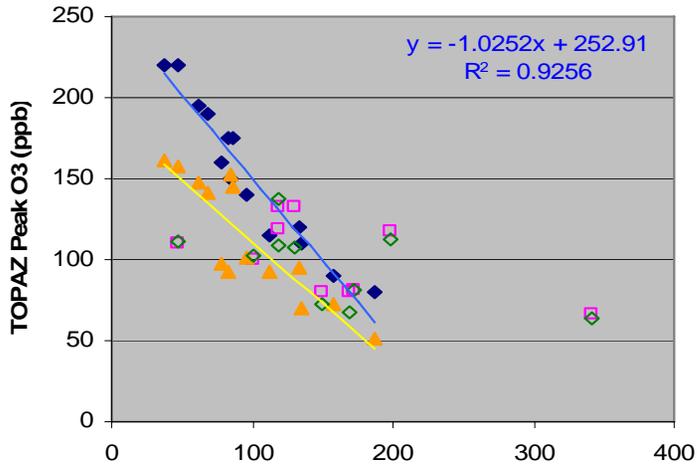
Sea-breeze / weak-wind case: 15 Aug



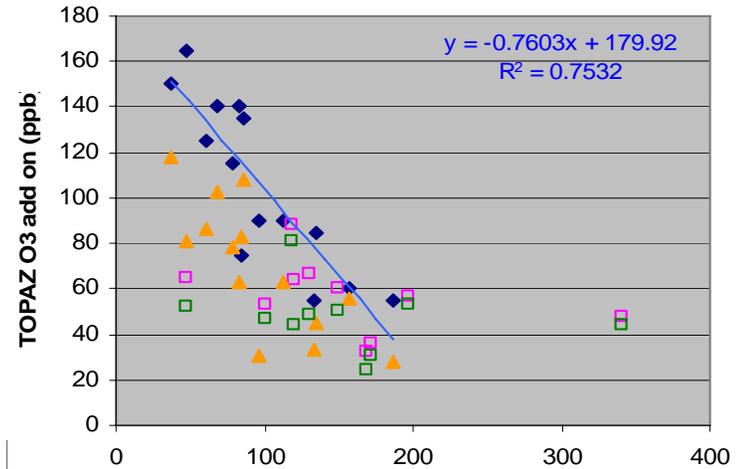
- Early westerly flow carries plume to east
- Sea breeze undercuts plume with clean air
- Peak $O_3 \sim 160$ ppb
- Background ~ 30 ppb

Peak O₃ vs. wind speed

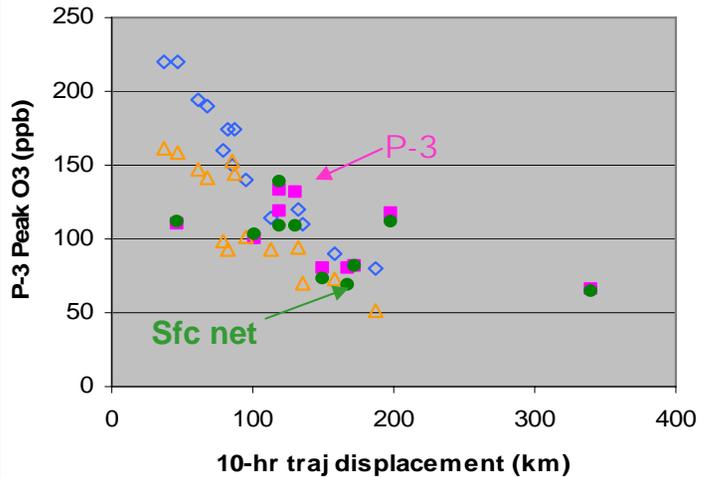
Peak total O₃ vs. 'wind speed' - TOPAZ days



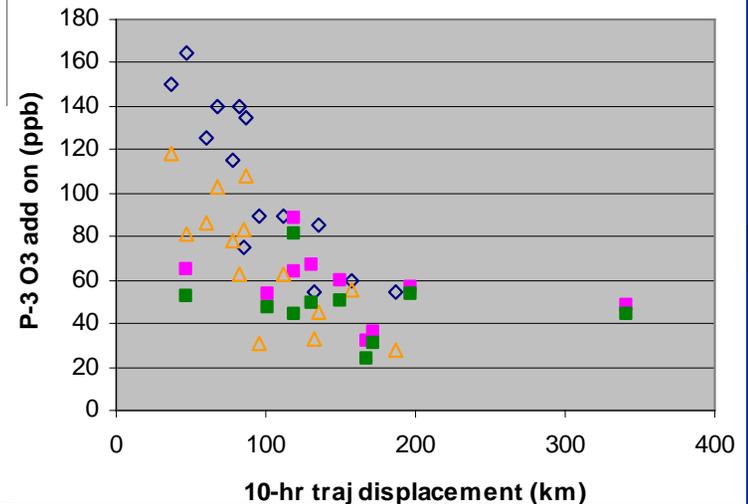
Ozone add on vs. 'wind speed' - TOPAZ days



Peak total O₃ vs. 'wind speed' - P-3 days

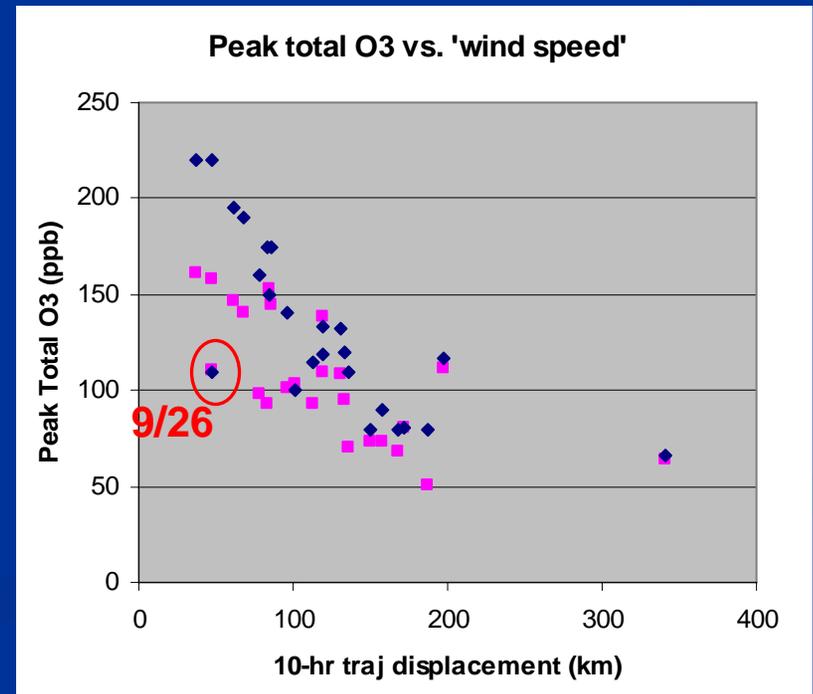
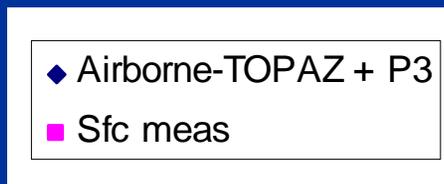
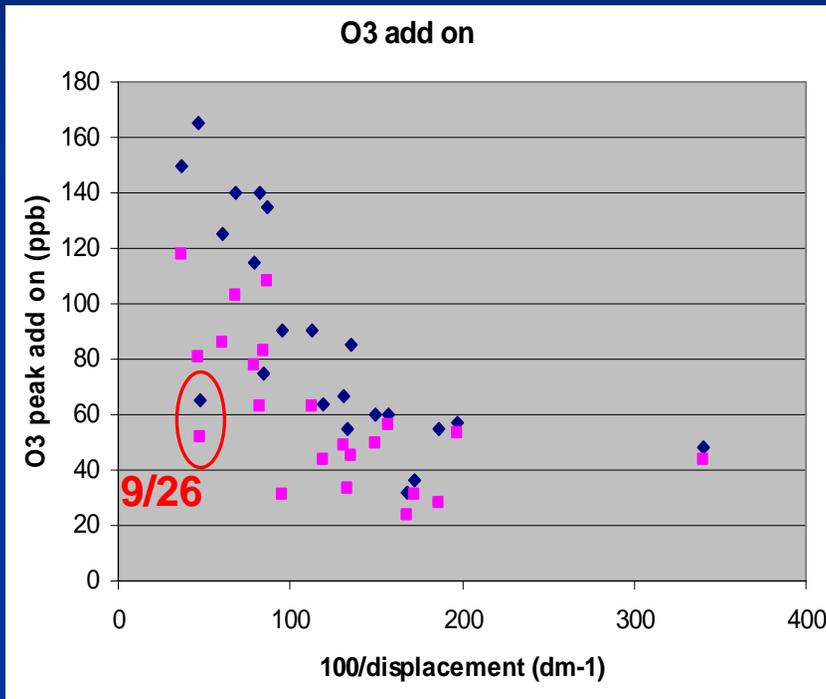


Ozone add on vs. 'wind speed' - P-3 days

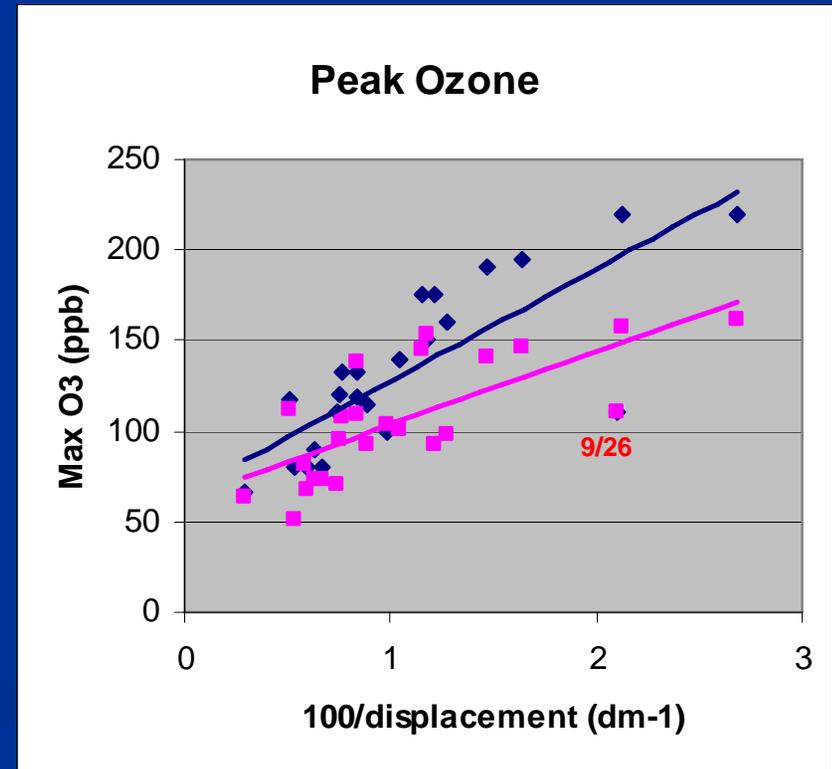
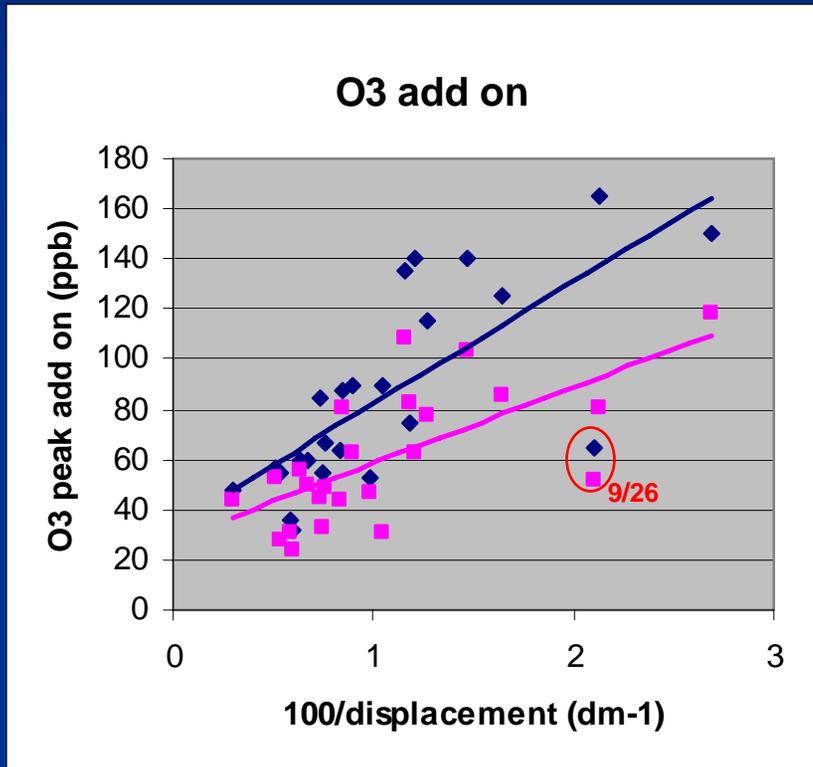
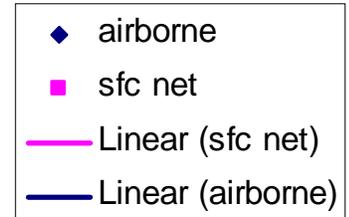


- Peak Total O₃ - P-3 days
- ▲ Peak sfc O₃ - TOPAZ days
- ◆ Peak total O₃ - TOPAZ days
- Peak sfc O₃ - P-3 days

O₃ vs. 'wind speed'



O₃ vs. 1 / 'wind speed'



Next step: include mixing hgt

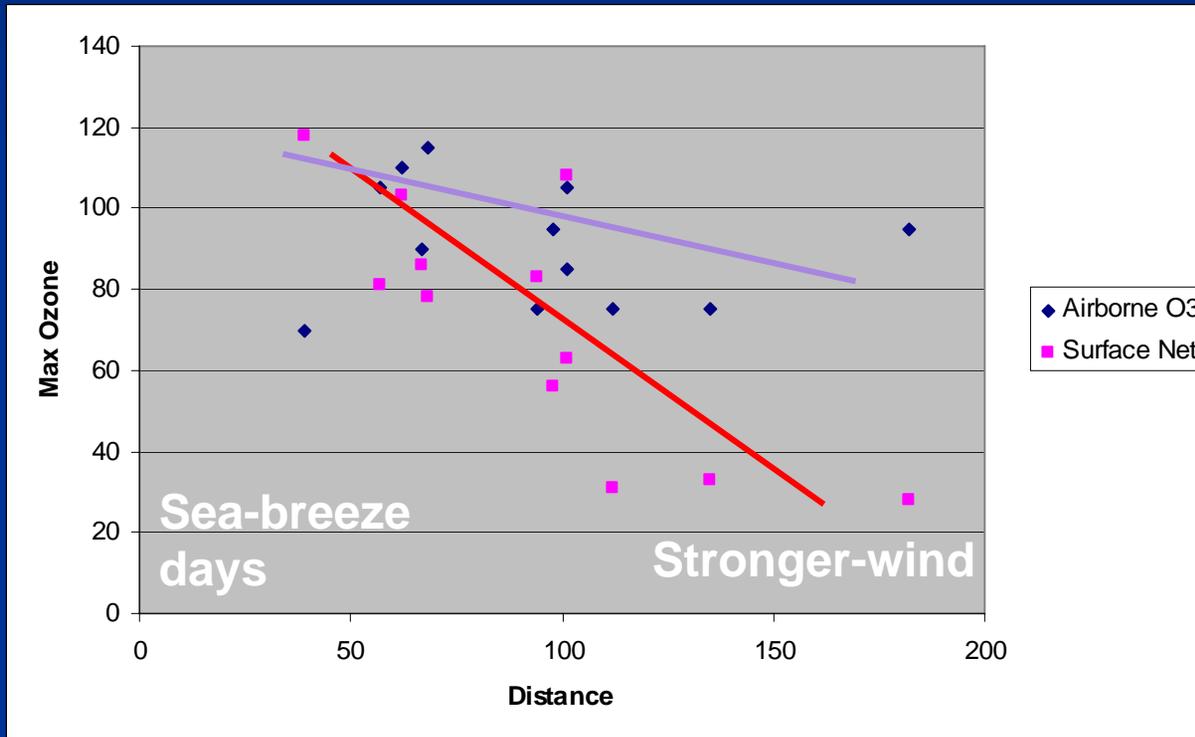
Summary (1 of 2)

- 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

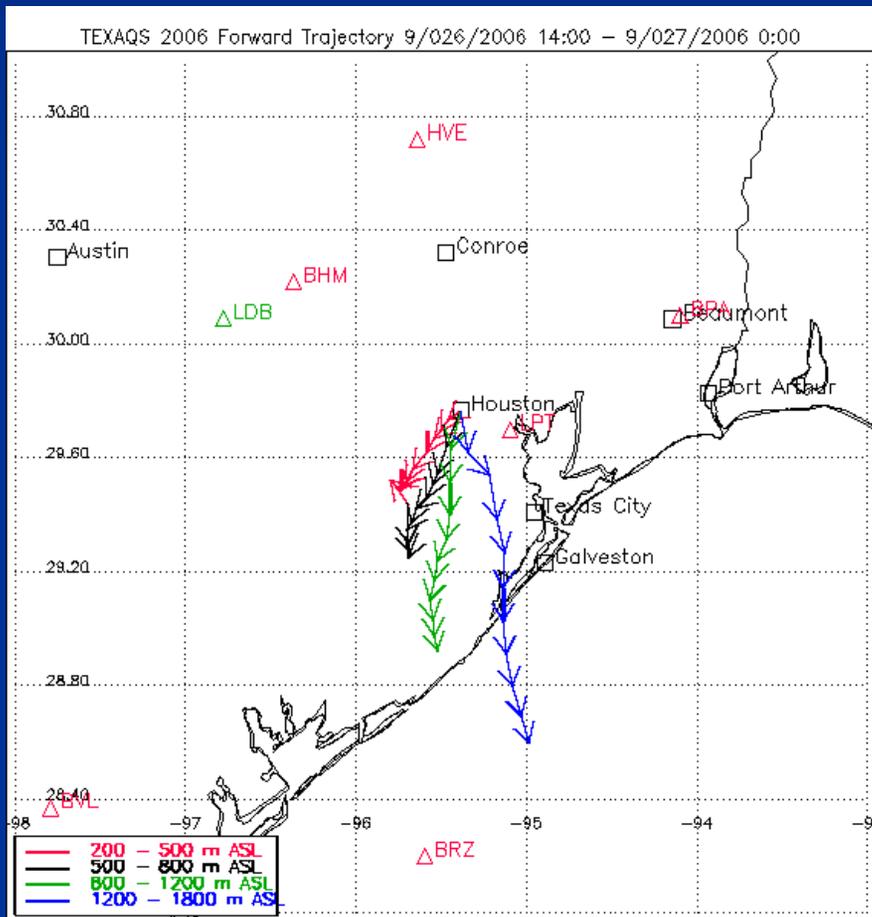
- Current surface sampling network, with 1-hr ave sampling
 - Underestimated highest a/b values on low-wind days
 - Apparent better agreement with stronger winds than previously reported, *but* still not sampling plume
- Additional work
 - Add 2000 and mixing height data, calculate 'source strengths' 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: O₃ blown out of network
- Airborne-ozone-based: Houston still makes a lot of O₃ !
(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’ ?

Summary, additional work

- ‘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?