Why Emission Factors Don't Work at Refineries and What to do About It

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Emissions Inventories – Meeting the Challenges Posed by Emerging Global, National, Regional and Local Air Quality Issues

Environmental Protection Agency's 20th Annual Emissions Inventory Conference

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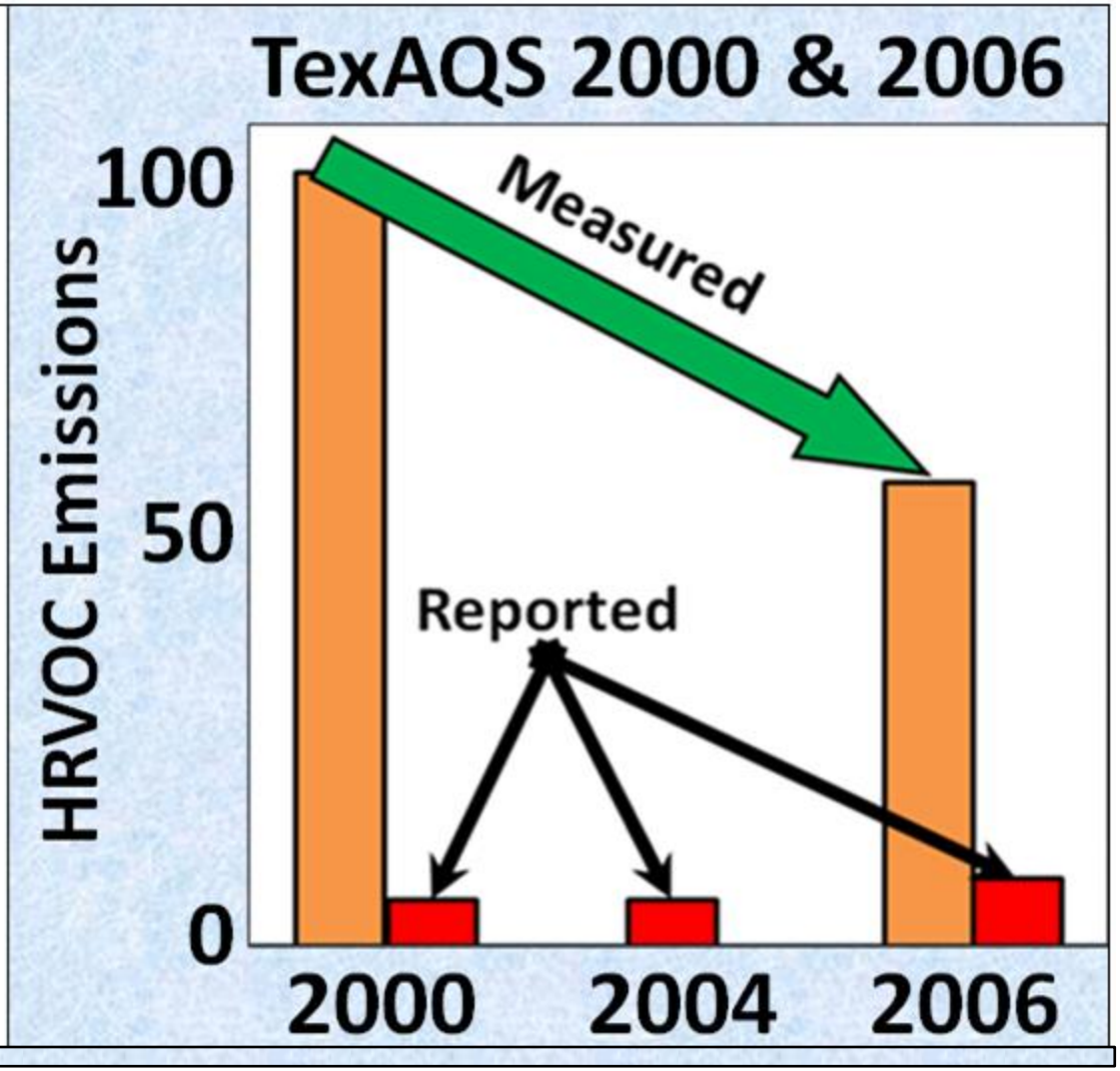
Air Quality Studies - Houston

Indications of problems with refinery emission inventories.

1. In 2000, measured HRVOCs were 3-15X (UT) or 10-100X (NOAA) reported.

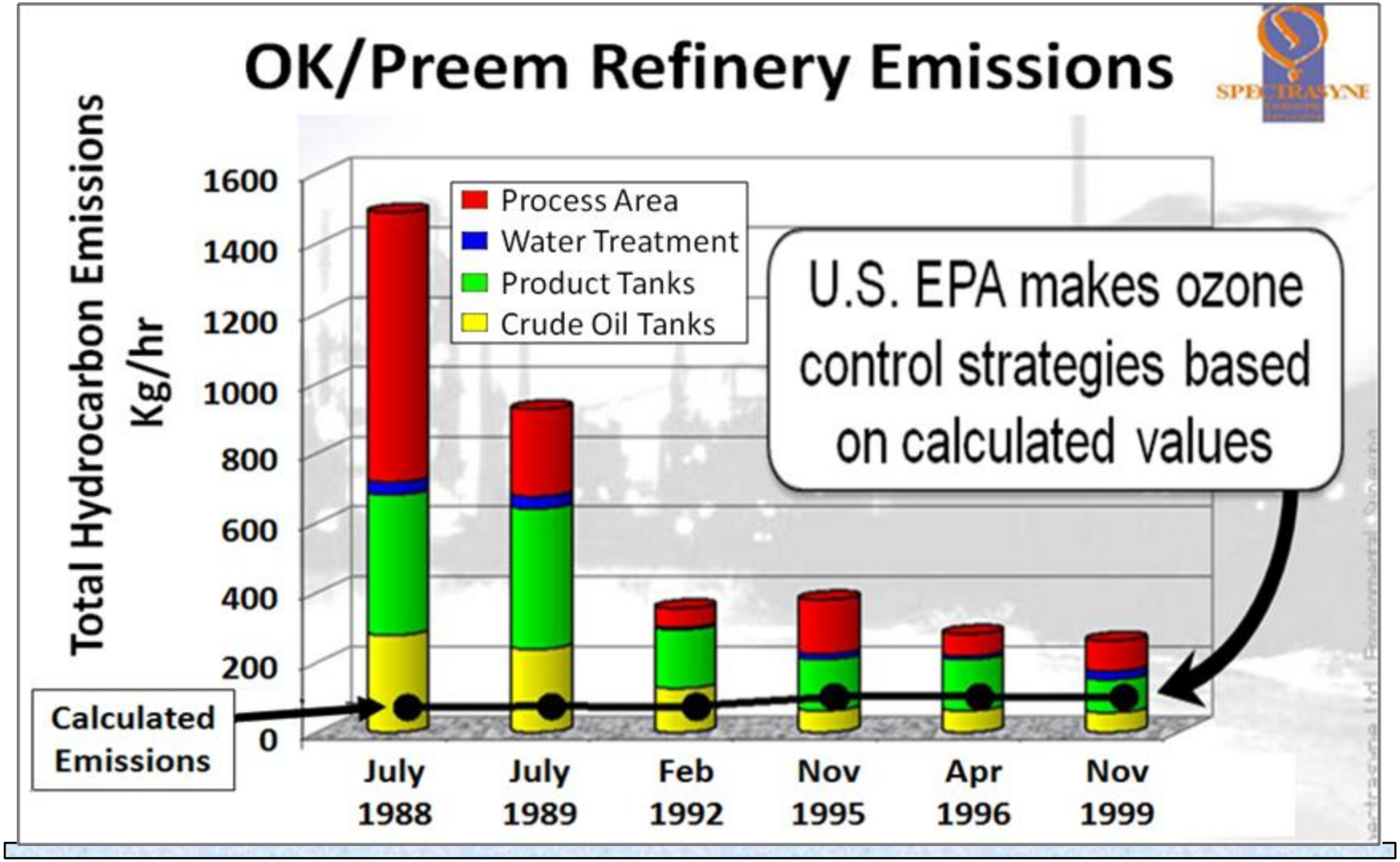
2. HRVOC (ethene) emissions dropped 40% between 2000 and 2006.

3. In 2006 HRVOCs were still roughly an order of magnitude higher than the 2006 inventory.

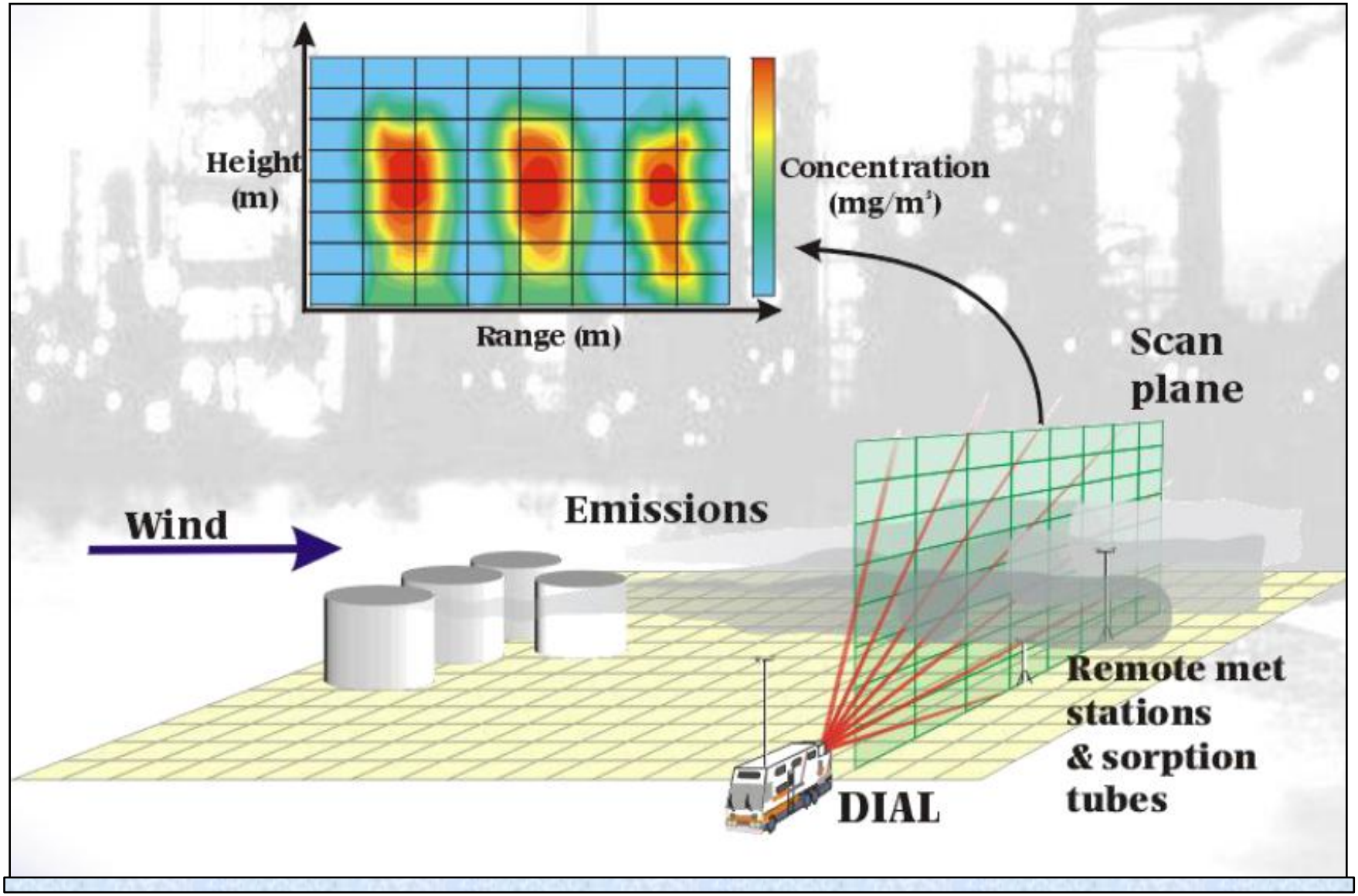


Air Quality Studies – Swedish Refinery

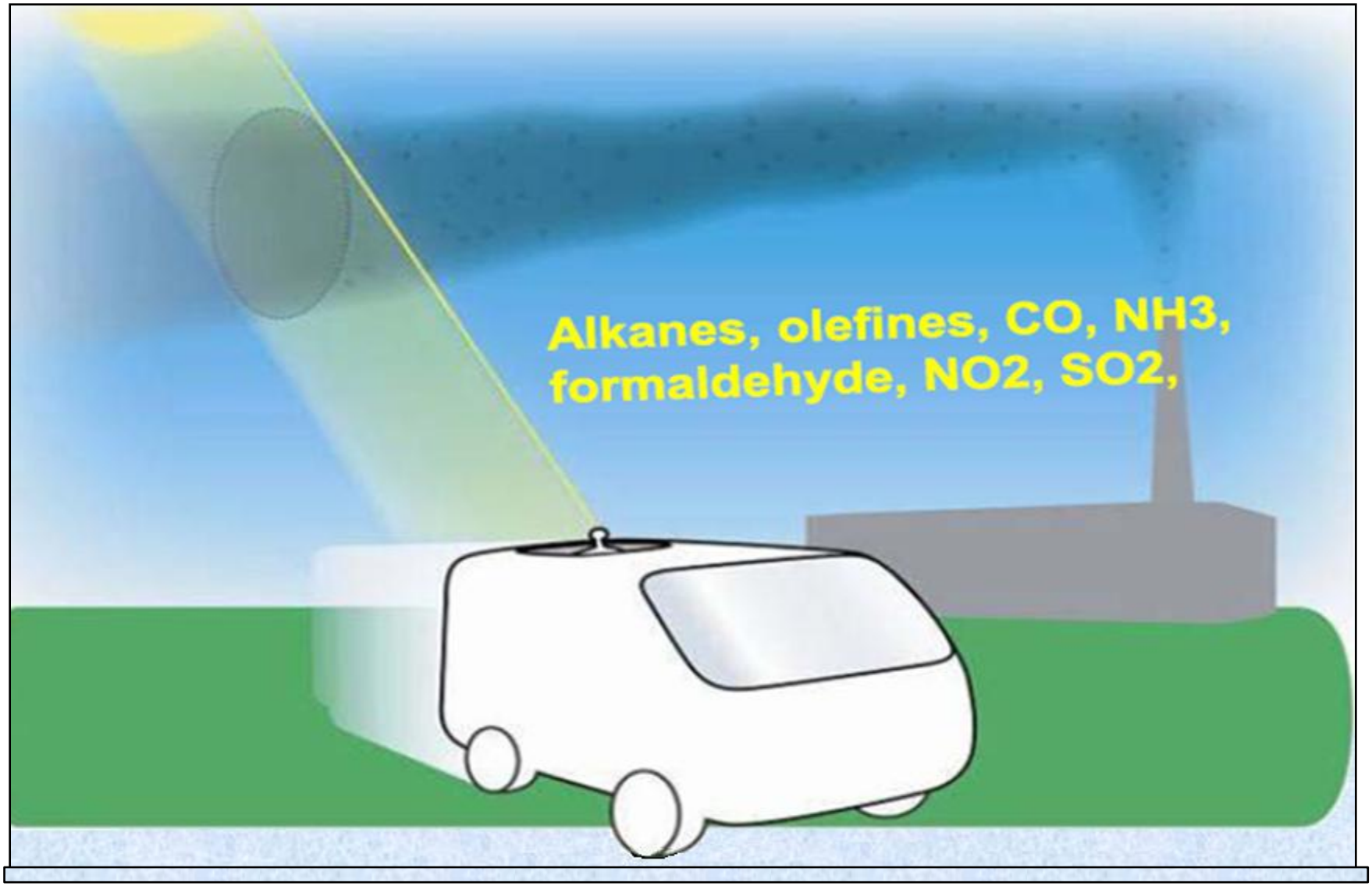
Indications of problems with refinery emission inventories.



Differential Absorption LIDAR (DIAL)



Solar Occultation Flux (SOF)



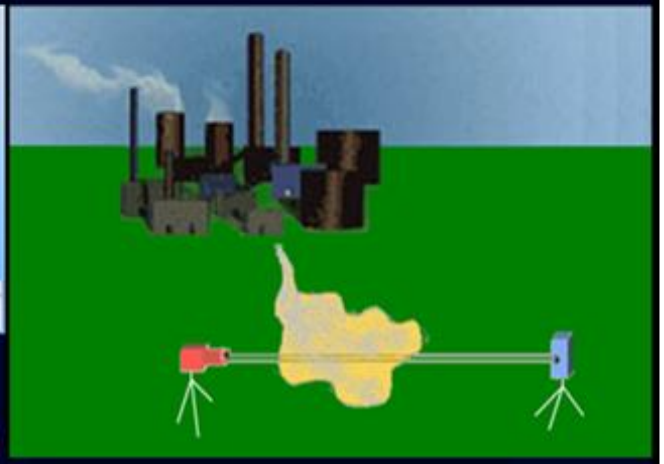
Standard Monitoring Methods

Every method has value, but each has major limitations in their ability to estimate emissions.

Total Vapor Analyzers

IR Camera

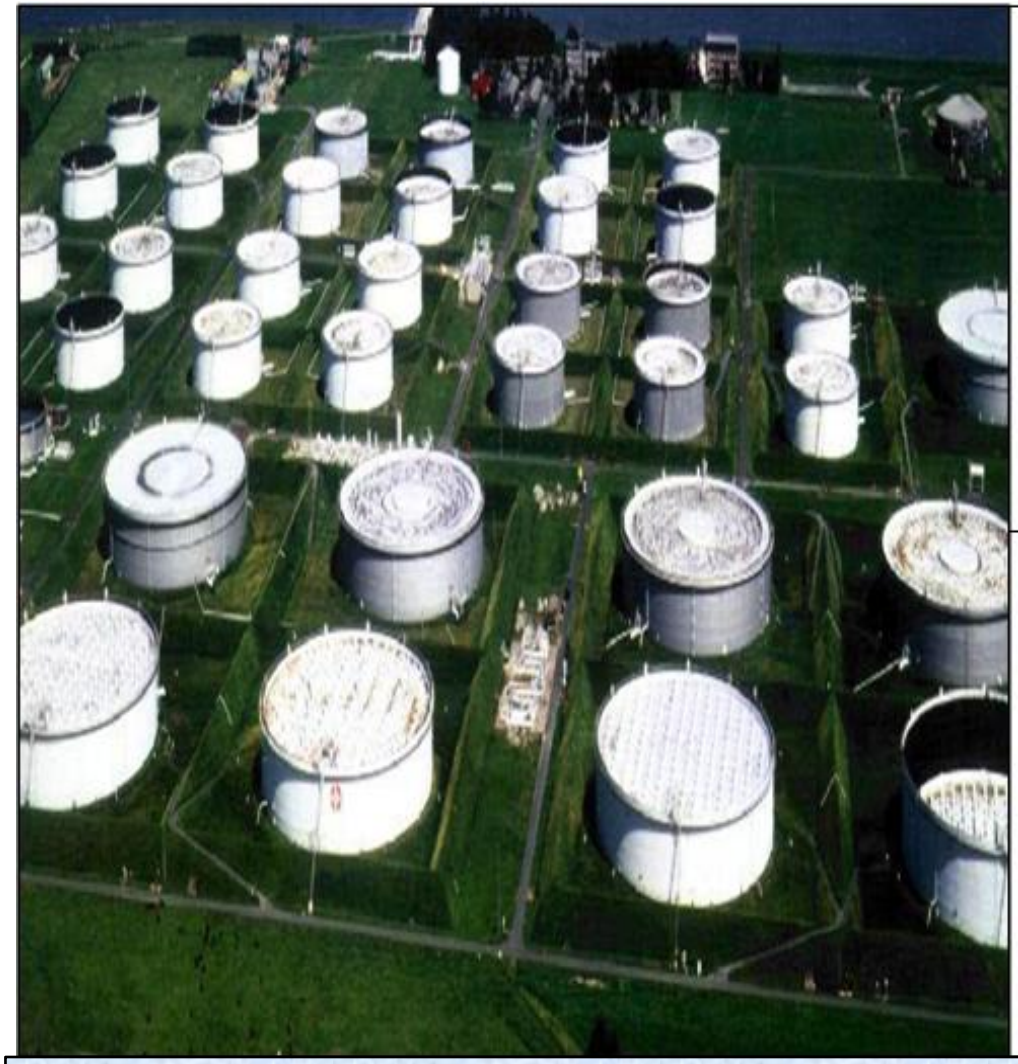
Auto-GC



Open Path FTIR or DOAS

Storage Tanks

How would you calculate emissions here?

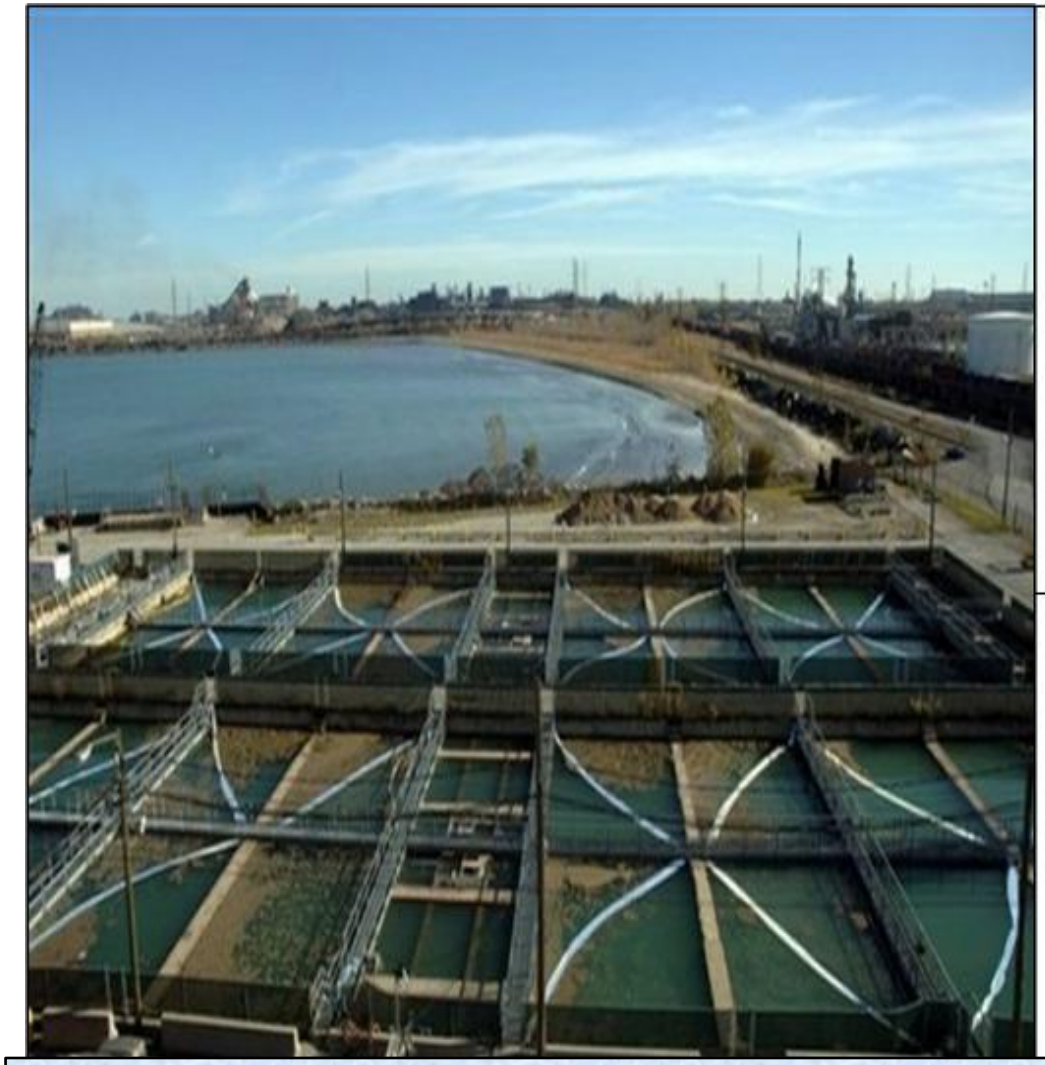


DIAL and SOF surveys indicate that storage tanks contribute >50% of the VOC emissions in a refinery.

A crude oil tank can be 400 ft in diameter and up to 40 ft high. Tanks can cover 75% of the refinery's area.

Wastewater Treatment

How would you calculate emissions here?



Refinery wastewater treatment facilities often have higher than reported values of VOCs.

But how can you quantify the air emissions from a pond?

Delayed Coker Emissions

How would you calculate emissions here?

DIAL surveys indicate that delayed cokers can contribute substantial VOC emissions in a refinery.

How do you measure VOCs when the 100 ft coke drums are emptied into the coke pit?

Flares

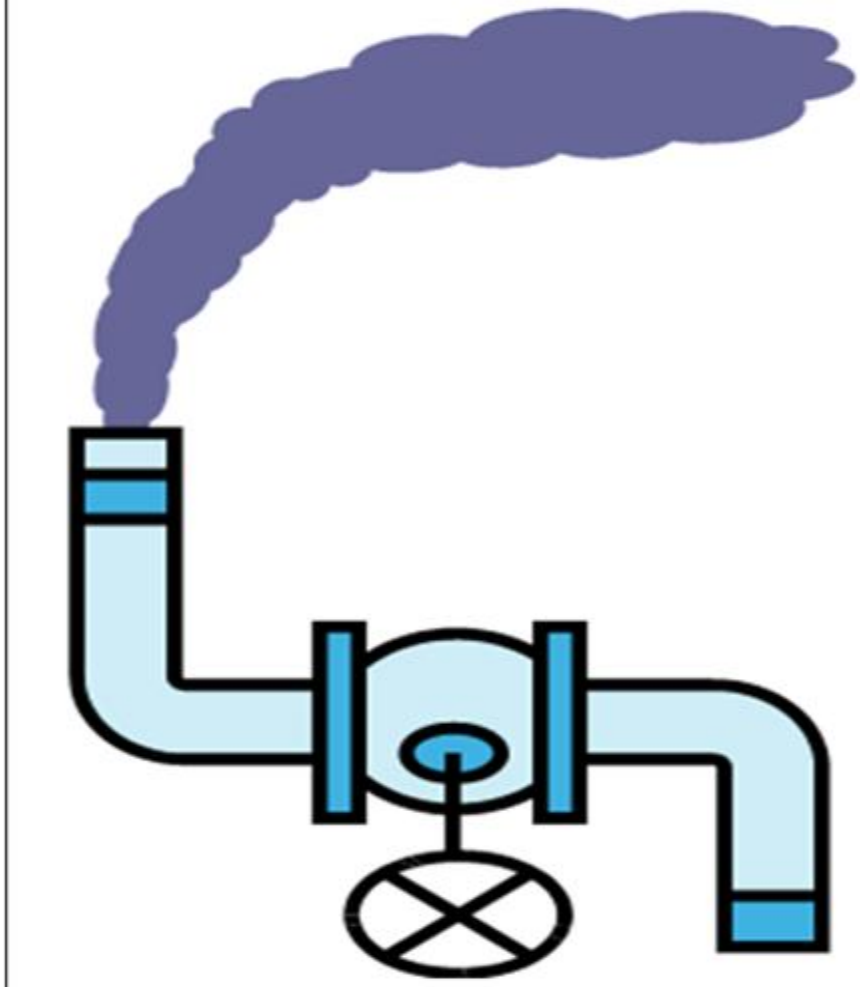
How would you calculate emissions here?

Many studies indicate that flares are less efficient than advertised, and as a result emit many unburned VOCs.

Sampling flare emissions is difficult without a crane - or using either DIAL or SOF.

Valve Left Open

How would you calculate emissions here?



This is easy if you know the flow rate and the composition.

But what if an operator accidentally left a valve opened and no one knew about the emissions?

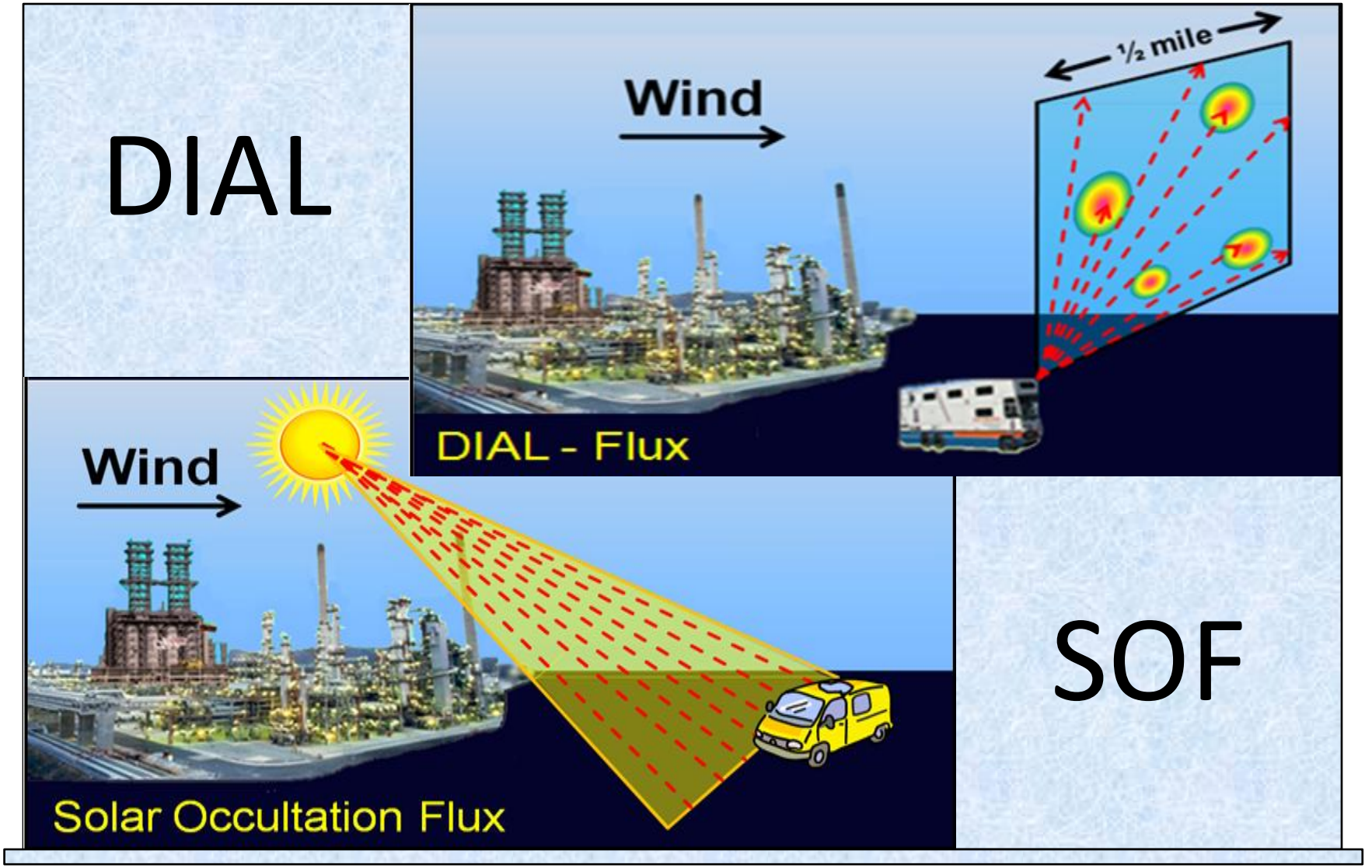
Process Units

How would you calculate emissions here?

Distillation, Cat. Reforming, Hydrotreating, Alkylation, Cat. Crackers, etc.

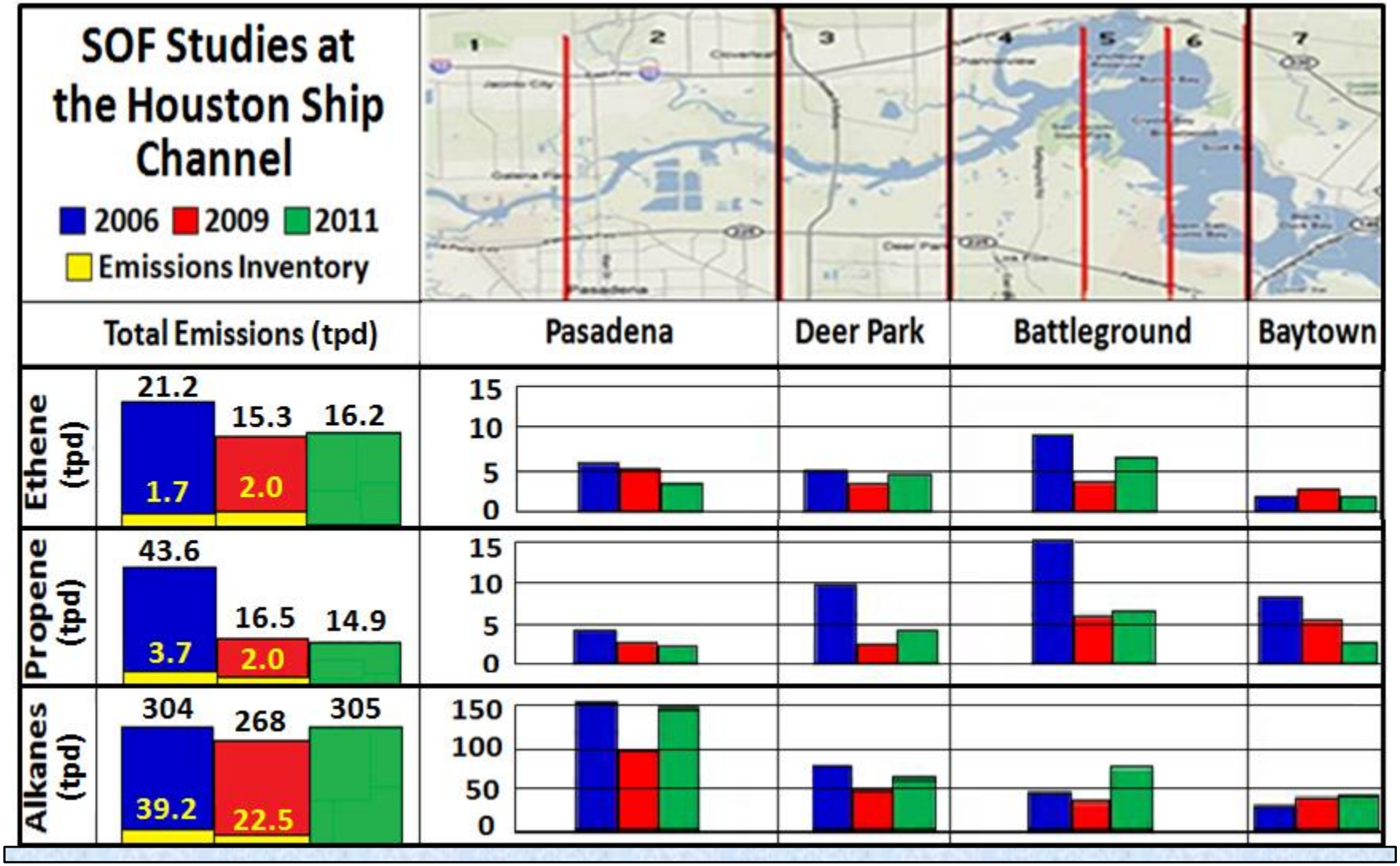
TVA's help a lot, but they also miss some things…

Compare With Flux Measurement Methods



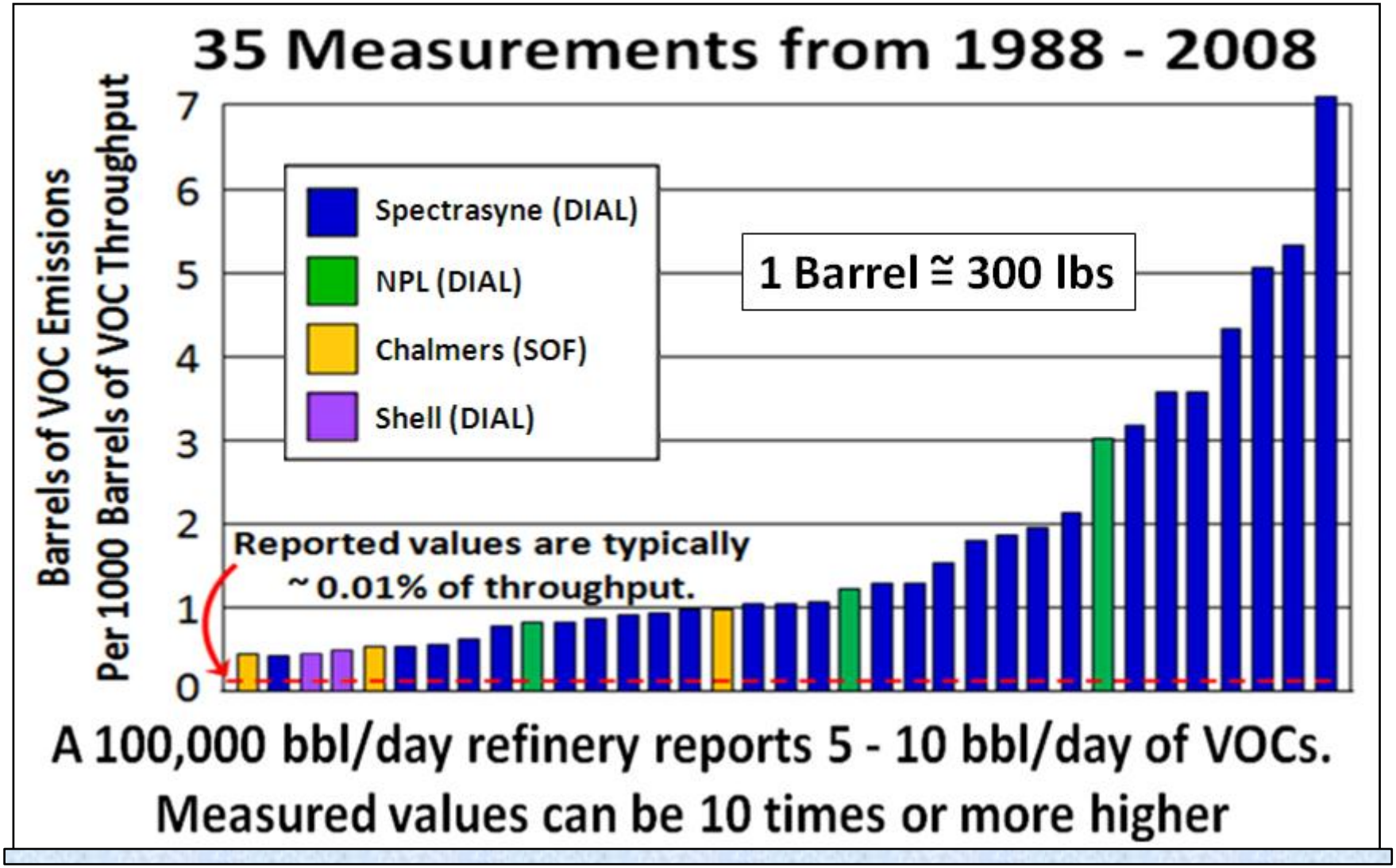
Air Quality Studies - Houston

Indications of problems with refinery emission inventories.



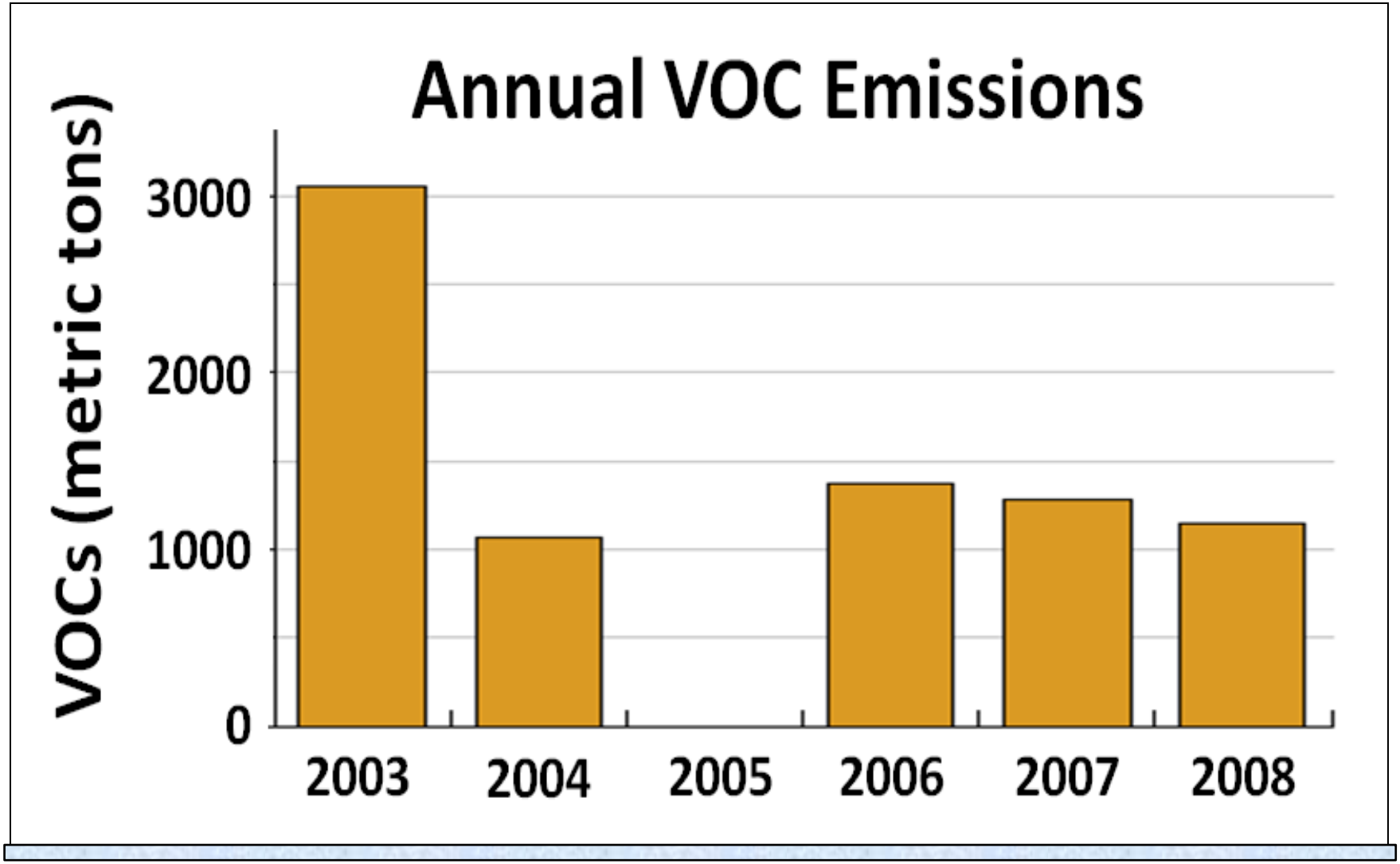
Air Quality Studies – Europe/Canada

Indications of problems with refinery emission inventories.



Shell Refinery Emissions by SOF in Sweden

Reported Emissions are based on measurements, not AP-42

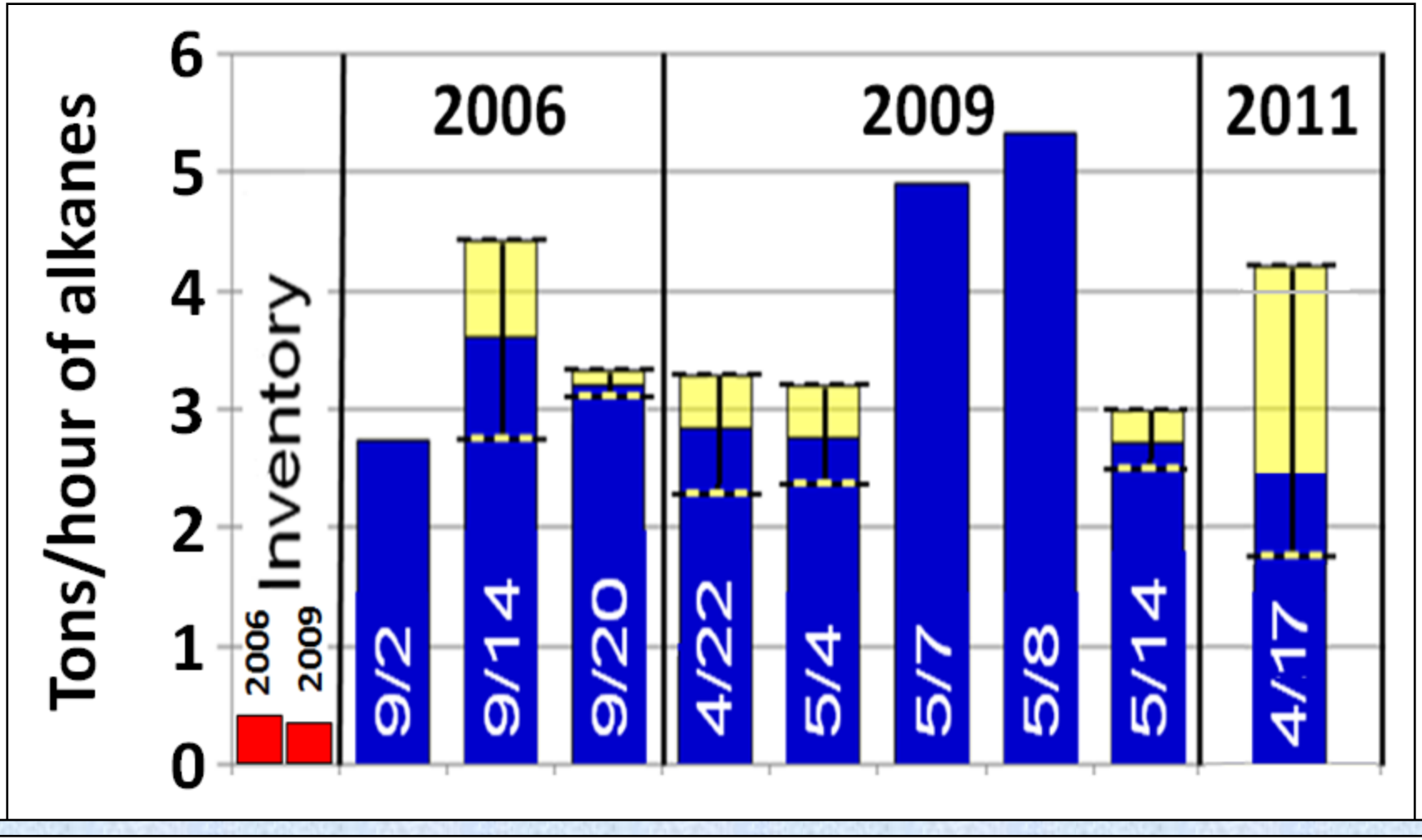


Texas City Industrial Complex

Texas City has wall-to-wall refineries, chemical plants and storage facilities.

Air Quality Studies – Texas City

Indications of problems with refinery emission inventories.
SOF measurements show little difference in alkane emissions.



Ozone Control Strategies

In 1999 Houston passed Los Angeles in high ozone days.

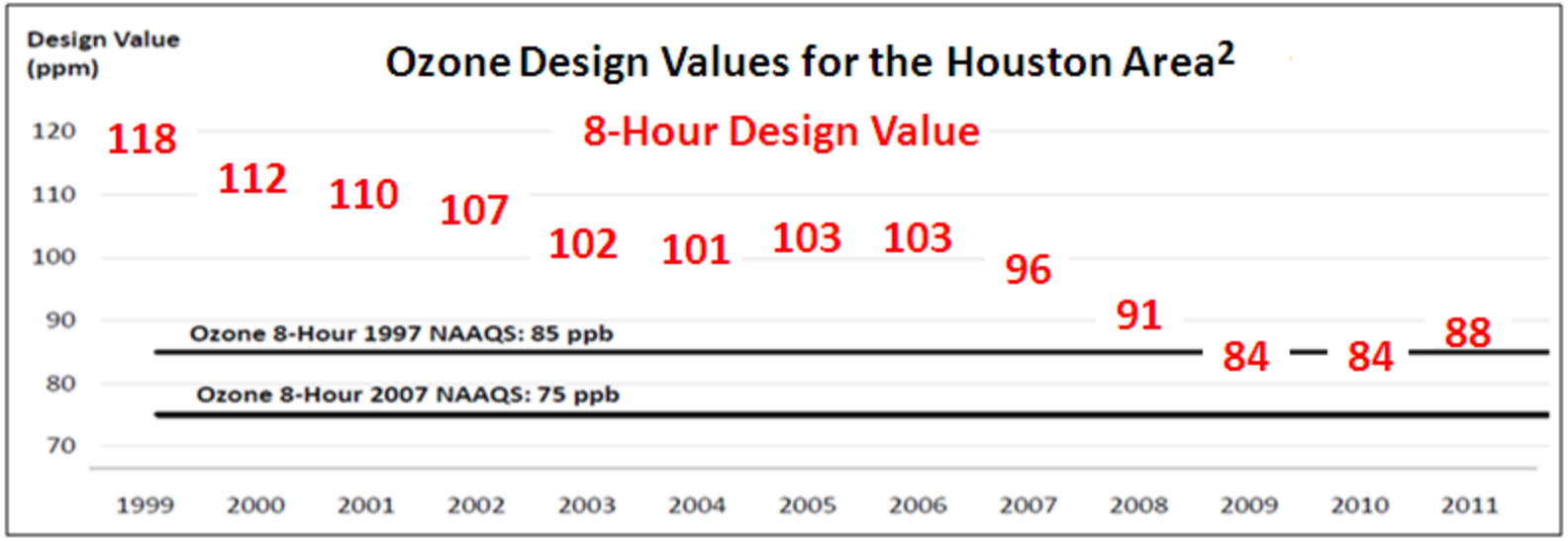
One proposal was to defer emissions by prohibiting anyone in 5 counties from mowing their lawns before noon.

After a comment period the lawn mowing ban was limited to commercial operations (anyone making > $400/year).

After reviewing the TexAQS 2000 data petrochems agreed to reduce HRVOCs and the mowing ban was repealed.[1]

[1] http://www.tceq.texas.gov/airquality/mobilesource/lg.html

Ozone Control Strategies



Ozone design values have been dropping...

Measured VOC emissions at petrochemical facilities are still higher than reported by several times.

How will the next control strategies be chosen?

[2]http://www.h-gac.com/taq/airquality/raqpc/documents/2011/July%2028%20Meeting/Ozone%20Slides.pdf - Data provided by TCEQ

Adapt the Swedish Approach in Texas?

One proposal goes like this...

Have a SOF company take measurements between Port Arthur and Corpus Christi. Generate quarterly report identifying "hot spots".

Companies located near the hot spots could hire the same SOF company to take measurements inside their facilities.

Conclusions

1. **EPA/AP-42 estimates compare poorly to measurements, sometimes off by a factor of 10 or more.**
2. **Underestimating emissions impairs EPA's ability to identify cost effective means to reduce ozone and air toxics.**
3. **Tweaking the calculations or emission factors improves estimates only for the equipment that is "well-maintained".**

Conclusions

4. **Without measuring with DIAL, SOF or similar you cannot know if equipment is maintained well, poor or not at all.**
5. **TVAs measure one point in space, but miss others.**
6. **IR Cameras help, but are 2-3 orders of magnitude less sensitive than DIAL or SOF, and respond very differently to different compounds.**

Conclusions

7. **Fixing VOC emission inventories should not wait for some newer technology. SOF and DIAL have a demonstrated a way to measure and reduce actual emissions.**
8. **Industry will always have concerns about a new monitoring technique because it might lead to regulations, maintenance, equipment redesign or lawsuits. These concerns need to be addressed in a thoughtful way.**

Conclusions

9. **Form a workgroup to identify benefits and disincentives for using DIAL and SOF for VOCs and GHGs. Consider impacts on permits, ozone reduction models, VOC taxes, the price of carbon, competitive disadvantages, etc.**

10. **Find ways to make refineries greener and more profitable. *If the greenest refineries go bankrupt, everyone loses.***

Questions?

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