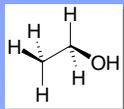


# Ethanol as a Fuel Component: Effect on Aerosol Composition

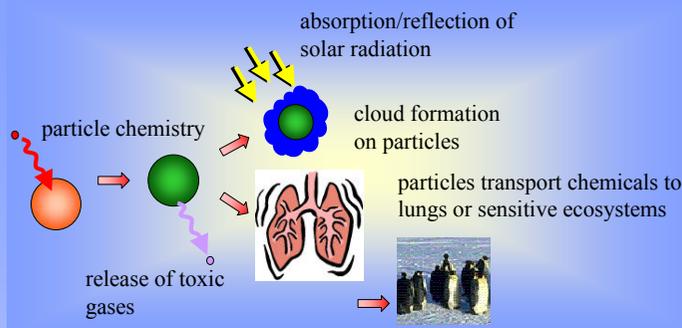
R. R. Michelsen, S. J. R. Staton, and L. T. Iraci NASA Ames Research Center–Earth Science Division

## Motivation & Focus



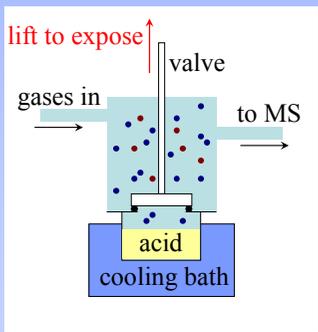
- Ethanol evaporates from fuels.
- Organic matter has been found in remote particles.

- How much ethanol is absorbed by particles?
- Will ethanol react in/on particles?
- What effects will it have on cloud formation and therefore climate?
- Are there health effects to consider?

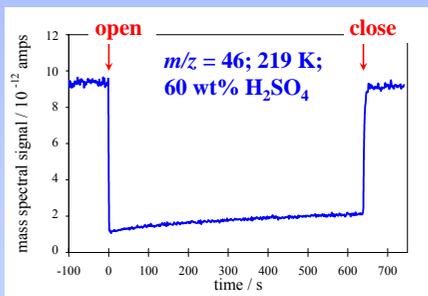


## Experimental Approach: Knudsen Cell Studies

- The gas-phase composition over a cold acid surface is monitored with mass spectrometry
- A drop in the gas-phase organic species is observed as it is taken up into the acid



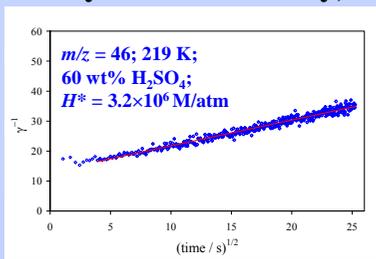
### Uptake of Ethanol Vapor by Aqueous H<sub>2</sub>SO<sub>4</sub>



- Raw data show significant loss of ethanol occurs during exposure to the acid/water surface
- Recovery is slow: lots of ethanol can be taken up before saturating the solution

### Determination of Henry's Law Solubility, H\*

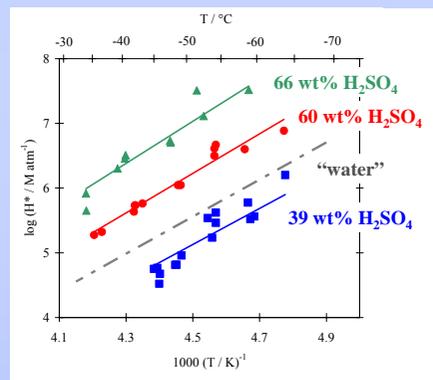
- From the raw data and experimental parameters the uptake coefficient,  $\gamma$ , is calculated



- When  $\gamma^{-1}$  versus  $\sqrt{t}$  is plotted, solubility is calculated from the slope of the line

### Summary of Ethanol Solubility

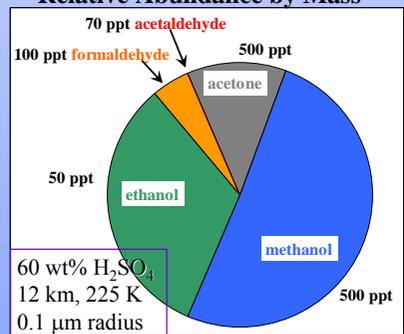
- Ethanol is extremely soluble under these conditions
- Solubility is enhanced at high acidities, in part by protonation



## Ethanol Accumulation in Particles

### Dissolution: Not Enough

#### Relative Abundance by Mass



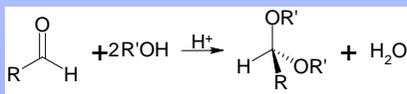
- A small gas-phase amount of ethanol is responsible for the second most abundant solute
- Does not account for organic content in the remote atmosphere: only 0.001 % carbon by mass

### Reaction: the Alternative

- esterification: too slow?

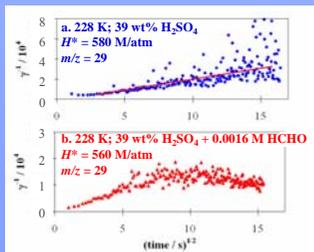
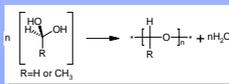


- acetal formation: untested



- gem-diol polymerization:

evidence for reaction between different organic compounds



- Uptake of acetaldehyde (a) is enhanced by formaldehyde in the acid (b). (Note plots are the inverse of uptake.)

## Conclusions

- Ethanol vapor is quite soluble in sulfate solutions
- Dissolution alone does not explain organic content of particles
- Reaction of ethanol with sulfuric acid is too slow to observe

## Future Work

- Investigate acetal formation from ethanol and aldehydes
- Investigate reaction of ethanol with sulfuric acid at warmer temperatures