Appendix P

BART Model Plant Criteria with PM

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August 29, 2006

Model Plant Criteria

- E < 500 tons & d > 50 km
- E < 1000 tons & d > 100 km
  - E = potential emissions of "SO2 or NOx or SO2 + NOx"
  - d is the distance to closest Class I area
- In the Southeastern U.S., SO2 (sulfate) typically has larger impact on light extinction than NOx (nitrate).
  - Conservative approach would be to assume 100% SO2 emissions
- **What about adding PM to the model plant criteria?**

Light Extinction

- *f(rh)* ranges from 2.3 - 4.7 with an average value of 3.2 in the VISTAS states
- Average contributions to b_{ext} (Mm^{-1})
  - Sulfate = 3**f(RH)**[SO_4] = 9.6*[SO_4]
    - [SO_4] assumed to be in form of $(NH_4)_2SO_4$
  - Nitrate = 3**f(RH)**[NO_3] = 9.6*[NO_3]
    - [NO_3] assumed to be in form of NH_4NO_3
  - Elemental Carbon = 10*[EC]
  - Organic Carbon = 4*[ORG]
  - Soils = 1*[Soils]
  - Coarse Mass = 0.6*[PMC]
- Conservative approach is to assume all PM is PM2.5
  - [PMC]=0

SO2 vs. PM Emissions

- SO2 does not impact light extinction
- Only a fraction of the SO2 becomes SO4 PM
- How much?
  - Function of SO2 to SO4 conversion rate
  - Function of distance downwind
  - Function of wind speed
- 100% of primary PM becomes PM
  - Speciation of PM will impact light extinction

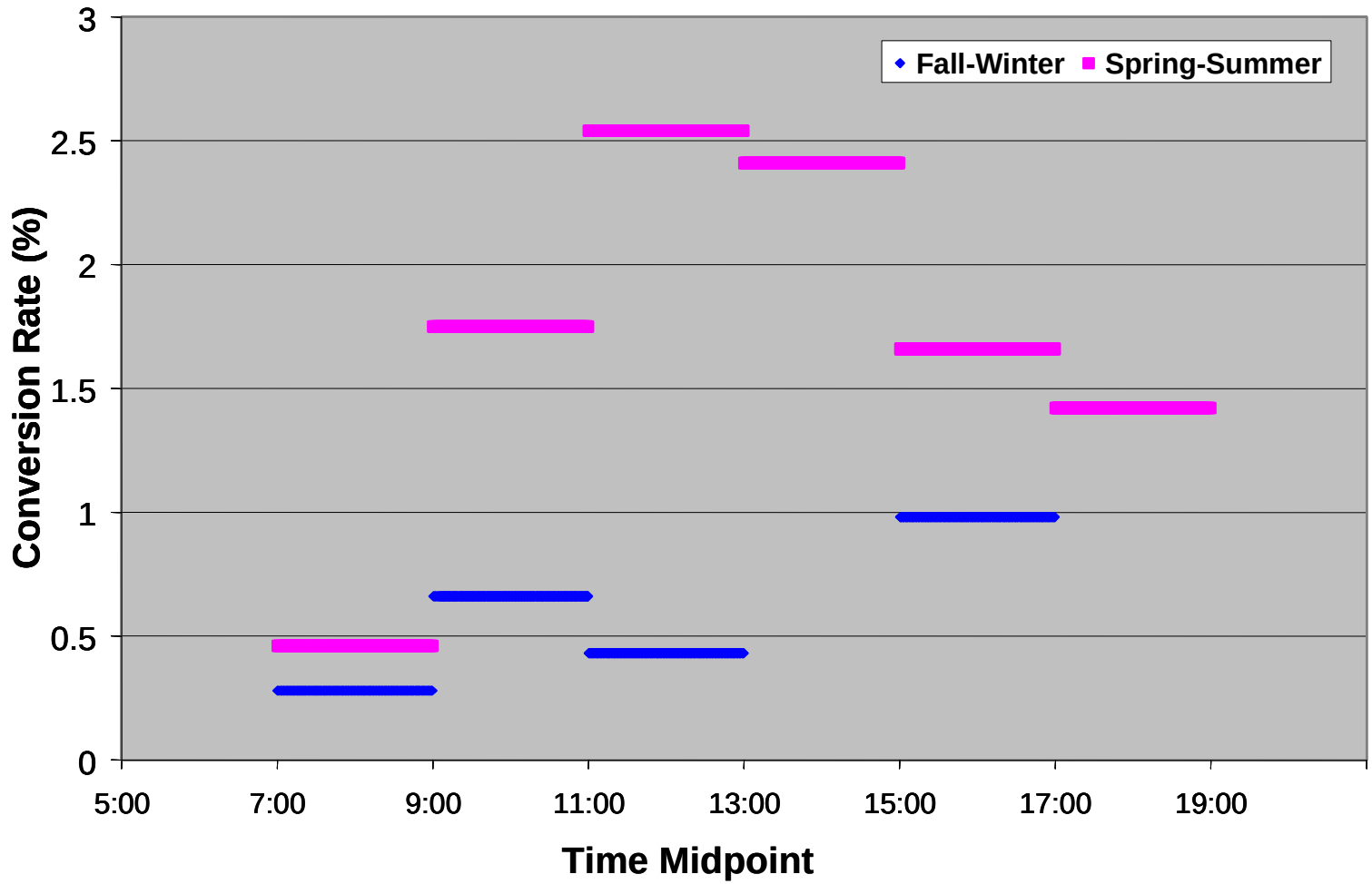
Conversion Factor

- Calculate a "PM factor" to relate primary PM to secondary sulfate PM from SO2
  - e.g., *E* = SO2+NOx+10*PM
- Lower SO2 to SO4 conversion results in higher PM factor
  - Higher PM factor is more conservative
- Conversion of 1 ton SO2 (MW=64) will produce 2.0625 tons $(NH_4)_2SO_4$ (MW=132)

Example

- Assume all primary PM is sulfate and ignore dry deposition
- 100 tons SO2 with 5% conversion rate
  - 100 tons SO2 * 5% conversion
    = 5 tons * 2.0625
    = 10.3125 tons SO4 PM produced
  - 100 tons PM = 100 tons PM
- *E* = SO2 + NOx + (100/10.3125)*PM
  = SO2 + NOx + 9.7*PM
  = SO2 + NOx + 10*PM

Mean SO_2 Conversion Rate in Power Plant Plume by Season and Time of Day



SEARCH

Assumptions

- Distance downwind = 50 km (31 miles)
  - Model plant criteria distance
- SO2 to SO4 conversion rate = 1.5% per hour
  - Max. sulfate production is during summer
  - Lower conversion rate produces higher PM Factor
- Wind speed = 5 m/s (11.2 mph)
  - Higher wind speeds produce higher PM Factor
  - Max. sulfate production occurs at lower WS
    - Likely < 5 m/s
  - t = 31 miles/11.2 mph = 2.77 hours

PM Factor

- SO2 conversion = 1.5% * 2.77 hours = 4.15%
  - 100 tons SO2 * 4.15% conversion
    = 4.15 tons * 2.0625
    = 8.56 tons SO4 PM produced
  - 100 tons PM = 100 tons PM
- E = SO2 + NOx + (100/8.56)*PM
  = SO2 + NOx + 11.7*PM
  = SO2 + NOx + 12*PM
  - Assumes all primary PM is sulfate

PM Speciation

- Not all primary PM will be sulfate
- Scale components of PM by ratio of species extinction coefficient to average sulfate extinction coefficient (9.6)
- E = SO2 + NOx + 12*PM*[(%SO4)*(9.6/9.6)+(%NO3)*(9.6/9.6)+(%EC)*(10/9.6)+(%OC)*(4/9.6)+(%Soils)*(1.0/9.6)]
- E = SO2 + NOx + 12*PM*[(%SO4)+(%NO3)+1.04*(%EC)+0.42*(%OC)+0.1*(%Soils)]

International Paper - Savannah

- SO2=0.0 tons, NOx=0.0 tons, PM=51.4 tons
- Distance to nearest Class I area = 83.6 km
  - Need *E* < 500 tons to be exempt
- Assume 100% primary PM is sulfate
  - *E* = 12 * 51.4 = 616.8 tons (> 500 ➔ not exempt)
- PM Speciation from SMOKE profile (AP-42)
  - SO4=20.40%, NO3=0.37%, EC=2.62%, OC=35.69%, Soils=40.91%
  - *E* = 12 * 51.4 * [(0.204) + (0.0037) + 1.04*(0.00262) + 0.42*(0.3569) + 0.1*(0.4091)]
  - *E* = 263.0 tons (< 500 ➔ EXEMPT!!)