Surface Layer (SL) aerodynamic resistance

quasi-laminar sublayer resistance

surface resistance
Consider a first order chemical reaction in which Chemical 1 is converted to Chemical 2

\[ C_1 \rightarrow C_2 \]

Rate = \( k C_1 \)

\[ \frac{dC_1}{dt} = -kC_1 \]

\[ C_1(t) = C_1(0)e^{-kt} \]

\[ C_2(t) = C_1(0) - C_1(t) \]

\[ C_2(t) = C_1(0) (1-e^{-kt}) \]

\[ M_2(t) = M_1(0) (1-e^{-kt}) \]

For values of chemical rxn time constant \( \beta = kt < 0.01, M_2 \approx M_1(0)kt \)

If the molecular weight (\( W_2 \)) of \( C_2 \) is different from the molecular weight (\( W_1 \)) of \( C_1 \), then the mass of \( C_2 \) is increased by the ratio of molecular weights, i.e.,

\[ M_2(t) = M_1(0) (1-e^{-kt}) \left( \frac{W_2}{W_1} \right) \]

For example: \( \text{SO}_2 \rightarrow \text{SO}_4^{2-} \)

Molecular weight of \( \text{SO}_2 = 64 \)
Molecular weight of \( \text{SO}_4^{2-} = 96 \)
Ratio = 1.5

For every amount of mass that \( \text{SO}_2 \) is depleted by the reaction, the mass of \( \text{SO}_4^{2-} \) increases by 1.5 x that amount of mass (the conversion adds two extra oxygen atoms to the molecule)
Not a very dramatic difference between gas-phase SO\textsubscript{2}, and 1 and 5 µm particles

If pollutant partitions to atmospheric particles, most would be associated with particles less than 5 µm

Bigger differences seen with 10 and 25 µm particles
Compare simulation with no deposition with simulation of SO2, PM01 and PM10 with default deposition parameters

For 5th percentile, where one might expect to see the consequences of deposition (e.g., when it is raining), little difference except for large distances with large particles (10 µm)
Compare simulation with no deposition with simulation of SO2, PM01 and PM10 with default deposition parameters

For median concentrations, little difference except for large particles (10 µm)
Compare simulation with no deposition with simulation of SO2, PM01 and PM10 with default deposition parameters

For maximum concentrations, little difference except for large particles (10 µm)
Example of overall impact of wet/dry deposition (for SO$_2$)

Statistical Distribution of Hourly Concentration Values

**local_grid_9.5_km**

- **Hourly average concentration** arising from 1 gr/hr emissions (pg/m$^3$)

![Box plot diagram showing statistical distribution of hourly concentration values for different conditions: without wet or dry deposition and with wet and dry deposition.](image)

- **Without wet or dry deposition**
- **With wet and dry deposition**

- Whiskers are the 5th and 95th percentiles
- Boxes show 25th, 50th (median), and 75th percentiles

**Example of overall impact of wet/dry deposition** (for SO$_2$)