**ATOC 3500/CHEM 3151 Spring 2018**

**Problem 20**

One of the challenging aspects of efforts to regulate emissions of various compounds to improve one environmental problem is that there can be negative impacts on other problems. One example is the reduction of NOx is urban air to limit ozone production. It may help with local air quality and visibility, but it could end up making global warming worse. Let’s take a look.

1. Methane oxidation in the atmosphere converts two molecules of NO into two molecules of NO2. Fill in the blanks below, and add up the individual reactions to show this is the case.

 CH4 + OH  CH3 + \_\_\_\_\_ (1)

 \_\_\_\_ + O2 + M  \_\_ + M (2)

 \_\_\_\_\_\_ + NO  \_\_\_\_\_ + NO2 (3)

 \_\_\_\_\_ + O2  \_\_\_\_\_ + CH2O (4)

 \_\_\_\_\_ + NO  \_\_\_\_\_ + NO2 (5)

 **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

 Net: CH4 + \_\_\_\_ + 2NO  \_\_\_\_ + 2NO2 + \_\_\_\_

1. Fill in the blanks below that show that NOx produces ozone in polluted urban areas.

 NO2 + h  \_\_\_\_ + \_\_\_

 \_\_\_ + \_\_\_+ M  O3 + M

1. Write an expression for the lifetime of CH4.
2. Write a steady state equation for [HO2] using reactions (4) and (5), and show that if [HO2] is constant, [OH] will decrease with decreasing [NO]
3. How will the lifetime of methane change if local municipalities are successful in limiting NOx emissions? How will this affect methane abundances in the atmosphere, and what impact will this have on global warming?