(HO) formed from the interaction of $O(^1D)$, the product of photolysis of ozone in the short end portion of the solar spectrum, with water.

$$O_3 + h\nu(\leq 310\ nm) \longrightarrow O(^1D) + O_2 \qquad (1)$$
$$O(^1D) + H_2O \longrightarrow 2HO \qquad (2)$$

The HO produced reacts with CH_4 and CO present in the clean troposhere, resulting in the generation of peroxyl radical species, HO_2, CH_3O_2.

$$HO + CH_4 \longrightarrow CH_3 + H_2O \qquad (3)$$
$$HO + CO \longrightarrow H + CO_2 \qquad (4)$$
$$CH_3 + O_2 + M \longrightarrow CH_3O_2 + M \qquad (5)$$
$$H + O_2 + M \longrightarrow HO_2 + M \qquad (6)$$

The peroxyl radicals, in turn, participate in a chain propagating sequence which converts nitric oxide (NO) to nitrogen dioxide (NO_2) and in the process produces additional hydroxyl and peroxyl radical species.

$$CH_3O_2 + NO \longrightarrow CH_3O + NO_2 \qquad (7)$$
$$HO_2 + NO \longrightarrow HO + NO_2 \qquad (8)$$
$$CH_3O + O_2 \longrightarrow HO_2 + H_2CO \qquad (9)$$
$$H_2CO + h\nu(\leq 370\ nm) \longrightarrow H + HCO \qquad (10)$$
$$HCO + O_2 \longrightarrow HO_2 + CO \qquad (11)$$

The major chain terminating steps include:

$$HO + NO_2 + M \longrightarrow HONO_2 + M, \qquad (12)$$
$$HO_2 + HO_2 \longrightarrow H_2O_2 + O_2. \qquad (13)$$

The reaction sequence for O_3 production involves converting NO to NO_2 at a rate sufficiently high to maintain a NO_2/NO ratio to sustain the observed background levels of O_3.

$$H_2O_2 + HO \longrightarrow H_2O + HO_2 \qquad (14)$$
$$HO_2 + NO \longrightarrow NO_2 + HO \qquad (8)$$
$$NO_2 + h\nu \longrightarrow NO + O \qquad (15)$$