

# HAMMONIA

- Hamburg Model of the Neutral and Ionized Atmosphere
- General Circulation and Chemistry Model
- vertical extension: from the surface up to the thermosphere (250km)

# HAMMONIA

## Ionization and reaction rates:

- Ionization rates provided by AIMOS

3-D

time dependent

(protons, electrons, alpha particles) here only protons

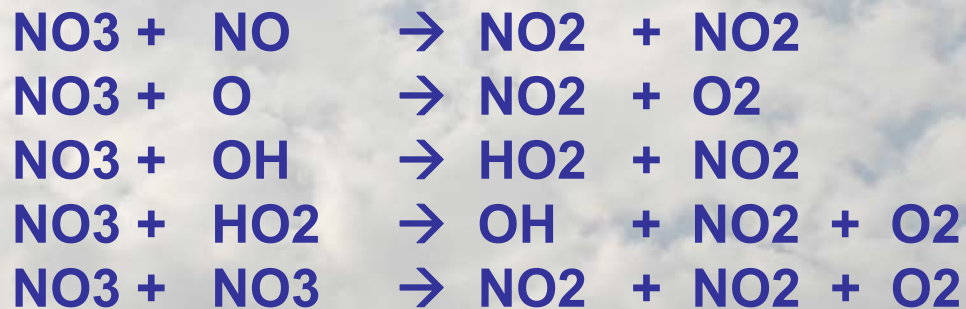
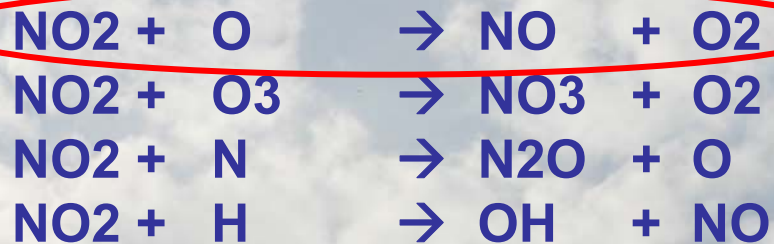
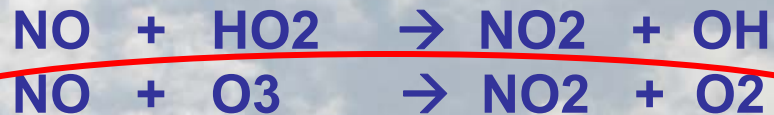
- above 0.001hPa: ionization rates are explicitly used for calculation of reaction rates of ionization, dissociation, and excitation of O, O<sub>2</sub>, N, N<sub>2</sub>
- below 0.001hPa: parametrizations from Porter et al., 1976 (J. Chem. Phys.) and Solomon et al., 1981 (Planet. Space Sci.) are used to produce:

0.7 N(<sup>2</sup>D), 0.55 N(<sup>4</sup>S) per ion pair  
OH, H (ca 2 HO<sub>x</sub> per ion pair)

- nudging from surface to tropopause

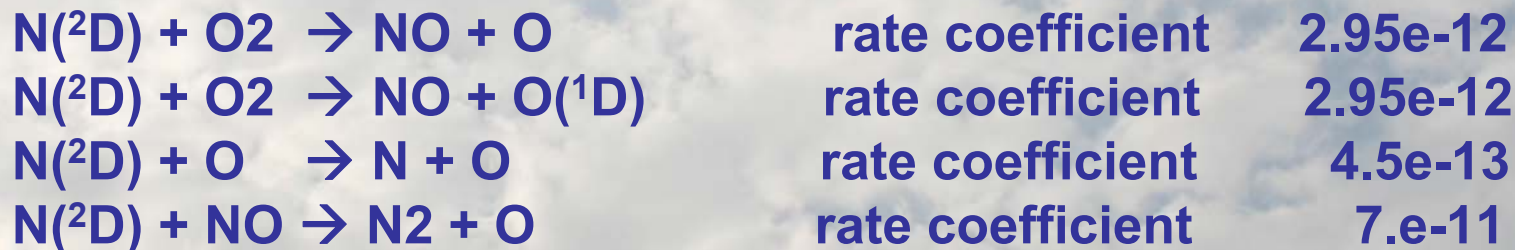
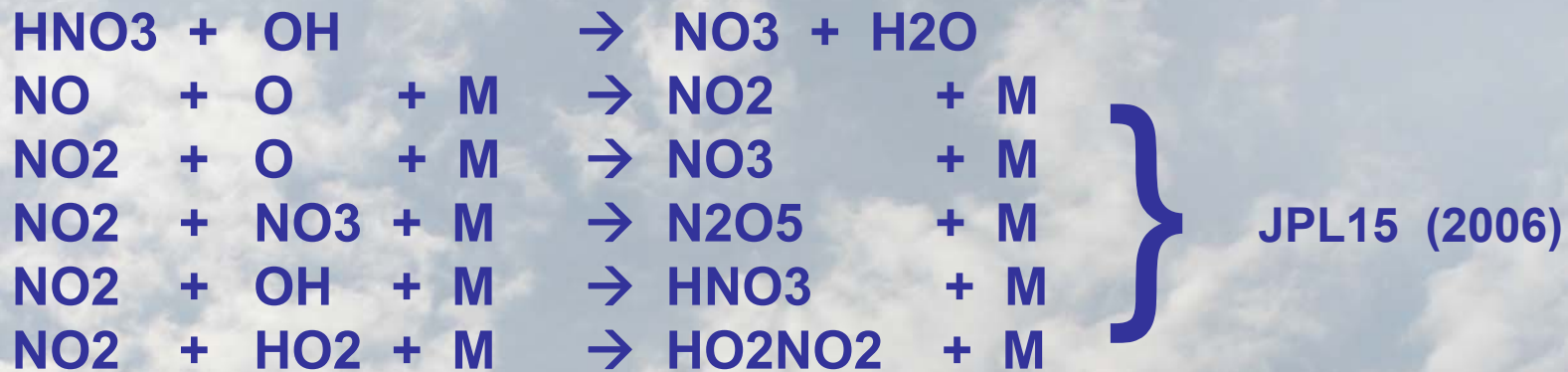
# HAMMONIA

Reaction rates (involving NO<sub>x</sub>): from JPL15 (2006)



# HAMMONIA

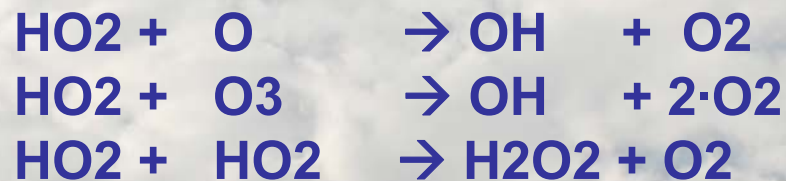
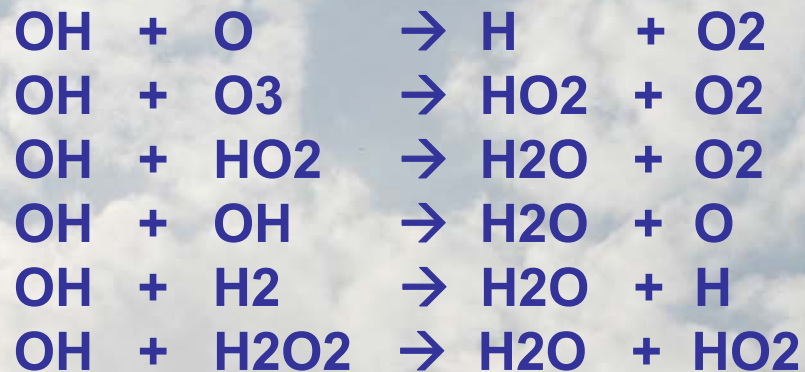
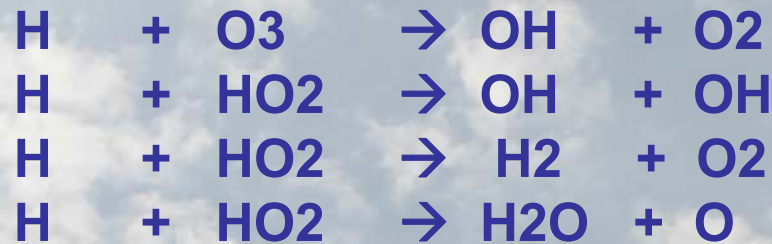
## Reaction rates (involving NO<sub>x</sub>):





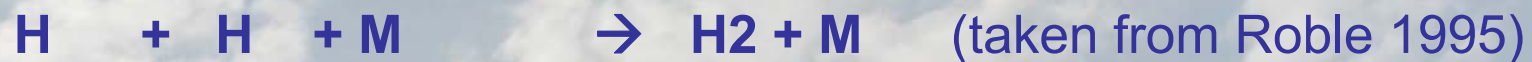
# HAMMONIA

Reaction rates (involving HOx): from JPL15 (2006)



# HAMMONIA

Reaction rates (involving HOx): from JPL15 (2006)



# HAMMONIA

- Hamburg Model of the Neutral and Ionized Atmosphere
- General Circulation and Chemistry Model
- vertical extension: from the surface up to the thermosphere (250km)

# HAMMONIA

## Ionization and reaction rates:

- Ionization rates provided by AIMOS

3-D

time dependent

protons, (electrons, alpha particles)

- above 0.001hPa: ionization rates are explicitly used for calculation of reaction rates of ionization, dissociation, and excitation of O, O<sub>2</sub>, N, N<sub>2</sub>
- below 0.001hPa: parametrizations from Porter et al., 1976 (J. Chem. Phys.) and Solomon et al., 1981 (Planet. Space Sci.) are used to produce:

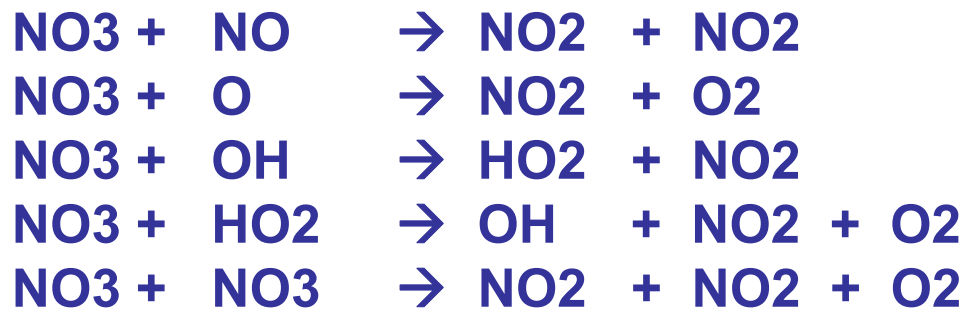
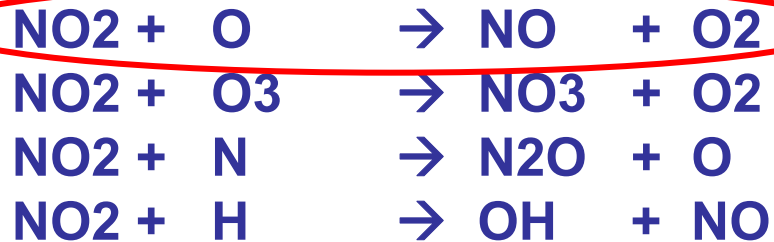
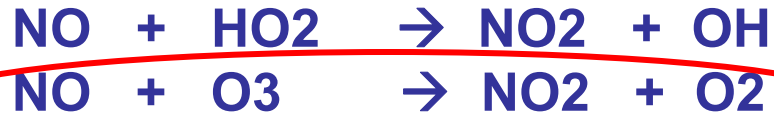
0.7 N(<sup>2</sup>D), 0.55 N(<sup>4</sup>S) per ion pair  
OH, H (ca 2 HO<sub>x</sub> per ion pair)

- nudging from surface to tropopause



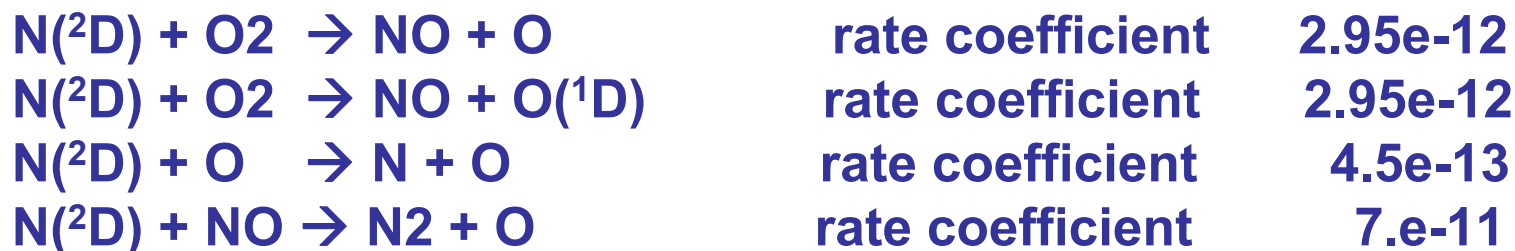
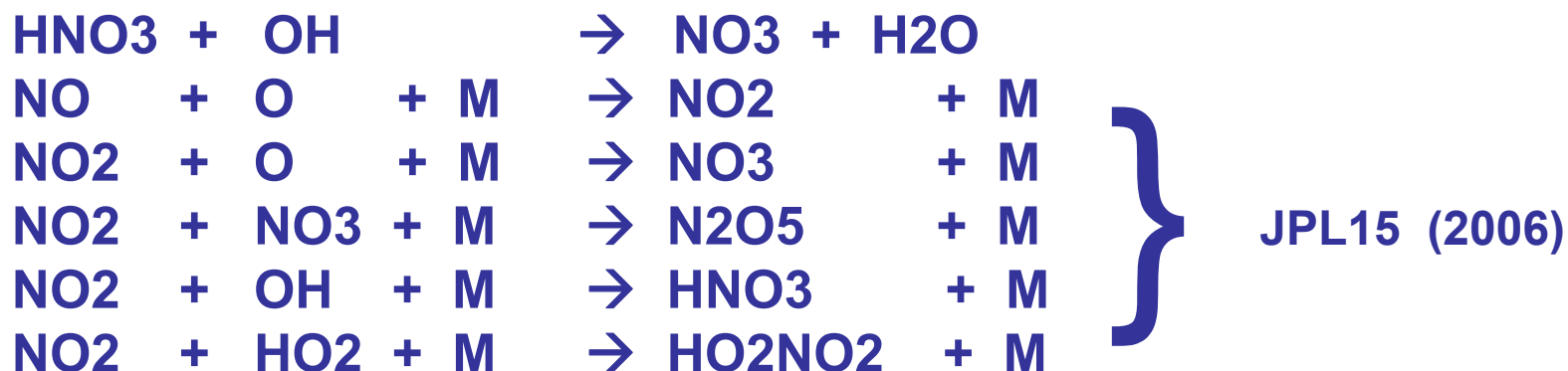
# HAMMONIA

Reaction rates (involving NO<sub>x</sub>): from JPL15 (2006)



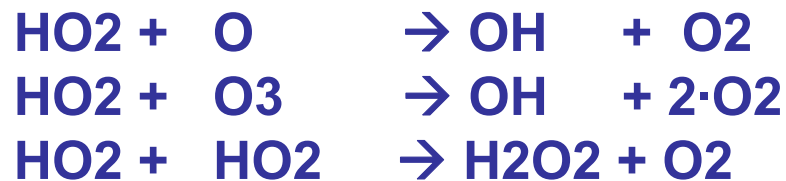
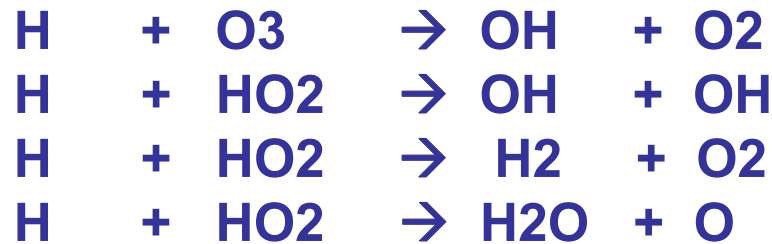
# HAMMONIA

## Reaction rates (involving NO<sub>x</sub>):



# HAMMONIA

Reaction rates (involving HOx): from JPL15 (2006)



# HAMMONIA

Reaction rates (involving HOx): from JPL15 (2006)

