Unit 17

Aerosols, removal and biochemical cycles

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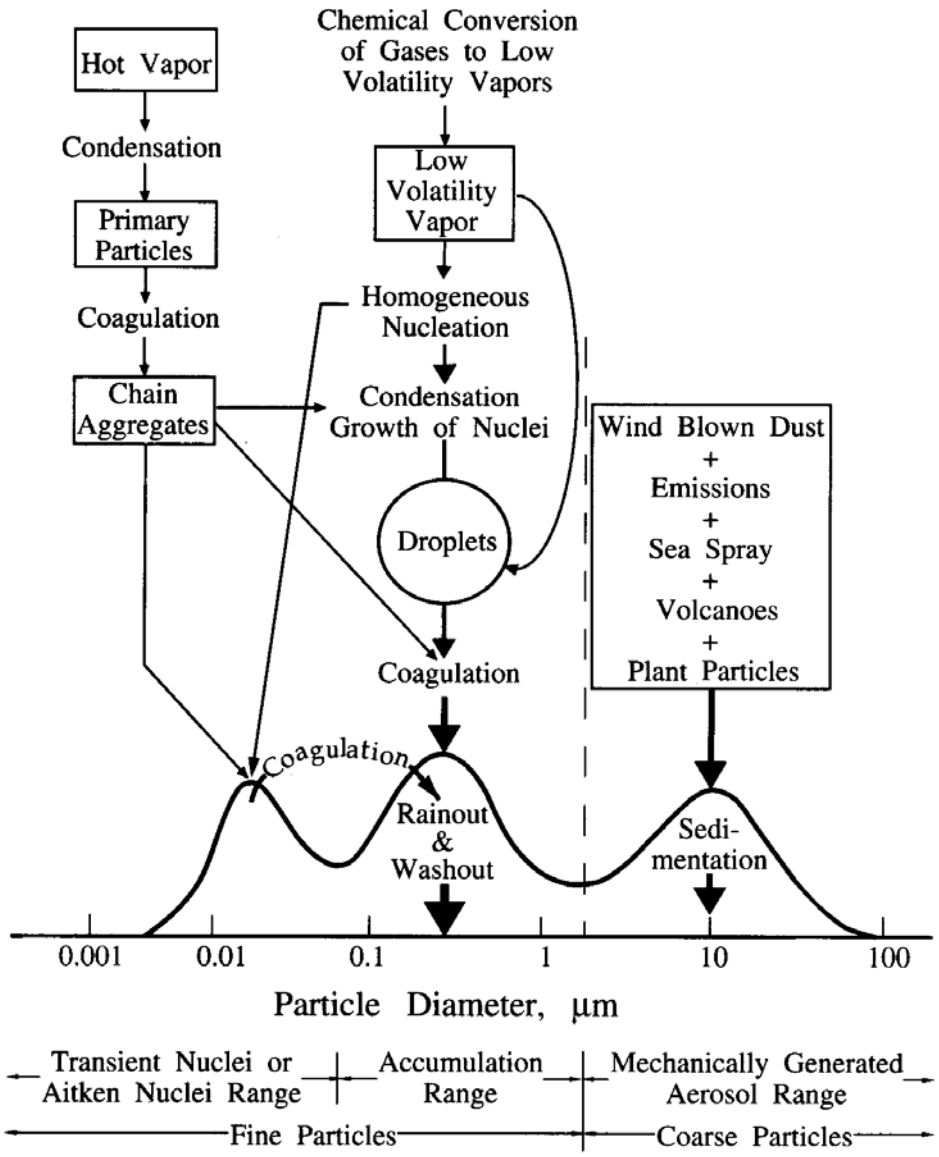
Particle formation and growth



From: Whitby and Cantrell, 1976

$$-\frac{dN}{dt} = \frac{4}{3}\frac{kT}{\mu}\left(1 + \frac{2AL}{D}\right)N^2$$

$$A \approx 1.257 + 0.4\exp\left(\frac{-0.55D}{L}\right)$$

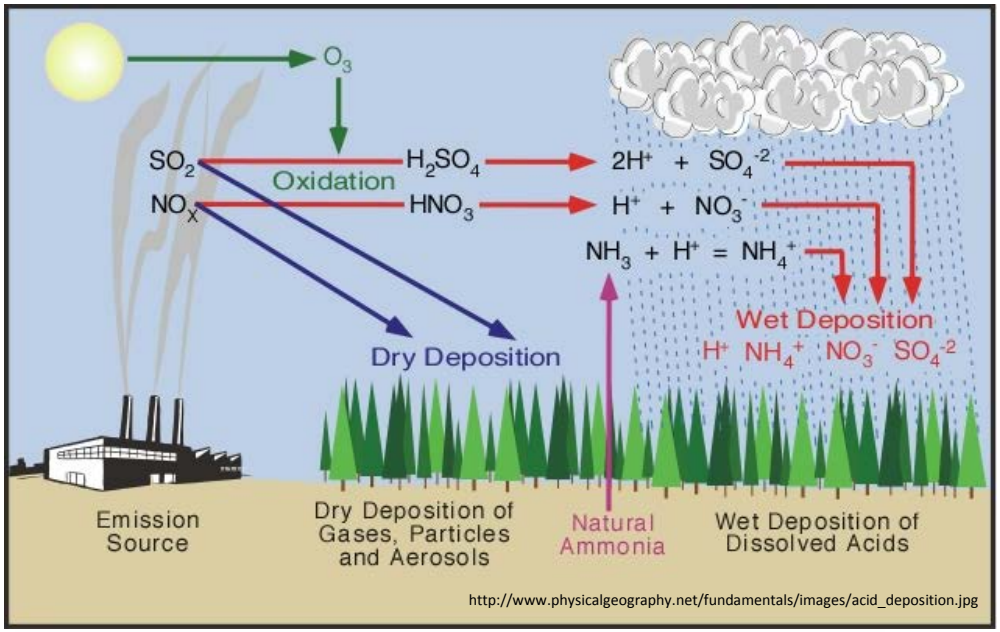
k Boltzmann constant, T temperature (K), μ dynamic viscosity of air, L mean free path of the gas molecules, D diameter, A Stokes-Cunningham correction factor

London type smog

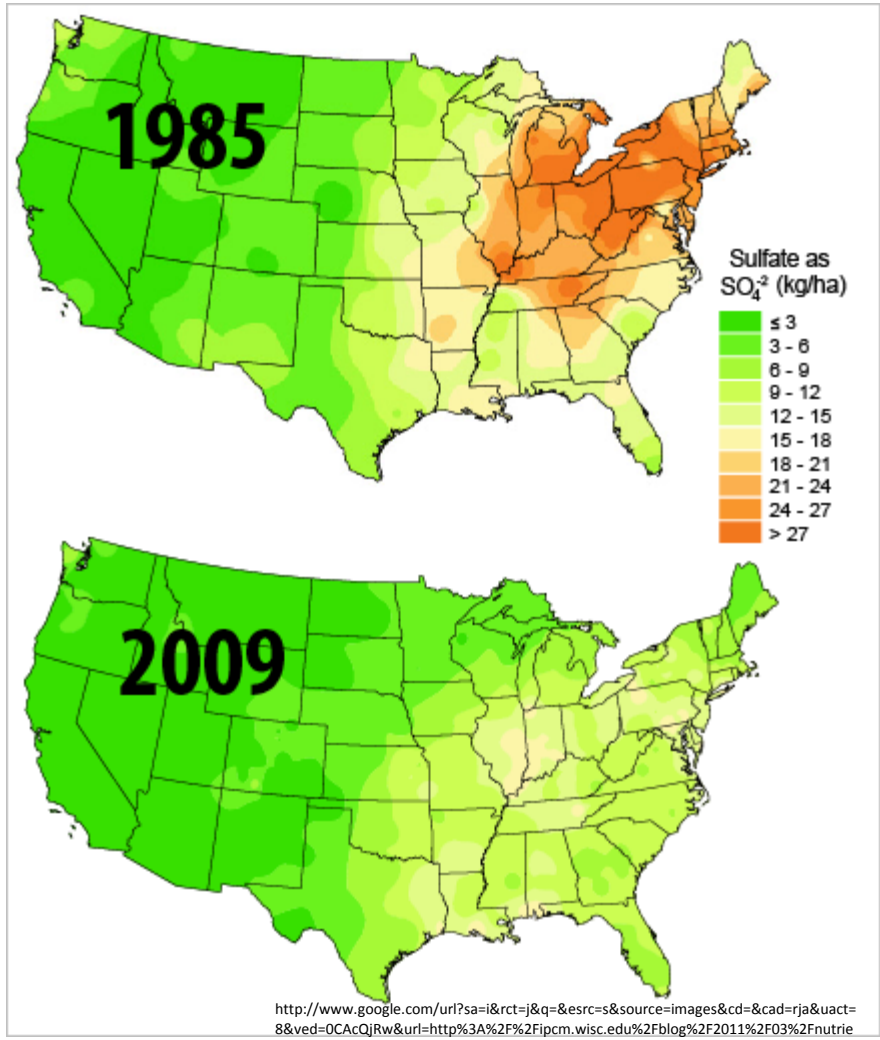
https://62e528761d0685343e1c-f3d1b99a743ffa4142d9d7f1978d9686.ssl.cf2.rackcdn.com/files/42943/width668/xvfv8r9f-1393828591.jpg

http://upload.wikimedia.org/wikipedia/commons/a/a4/Beijing_smog_comparison_August_2005.png

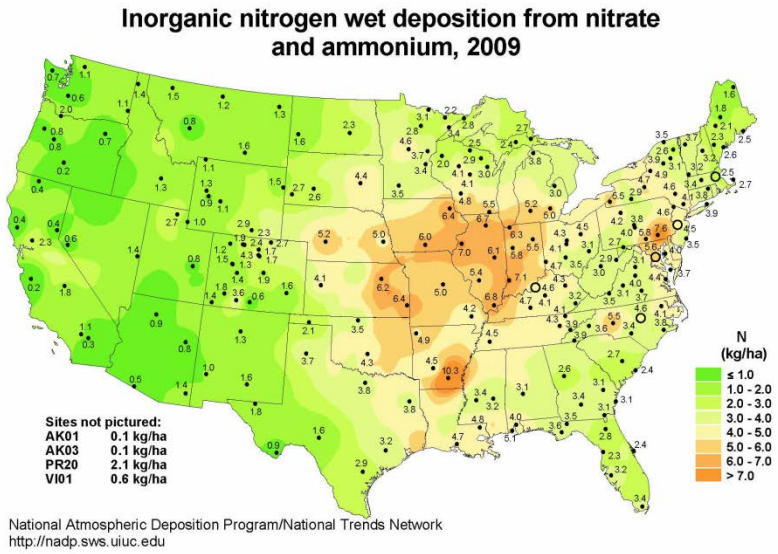
Atmospheric removal processes



http://www.physicalgeography.net/fundamentals/images/acid_deposition.jpg



http://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=0CAcQjRw&url=http%3A%2F%2Fipcm.wisc.edu%2Fblog%2F2011%2F03%2Fnutrients-to-watch-in-2011-sulfur-and-potassium%2F&ei=sAtIVL2BGuf1iQK31YGgBQ&bvm=bv.77880786,d.cGE&psig=AFQjCNHO1GiWQ7YNA-J7GqiQ7ZlSyuK8NQ&ust=1414094127663101



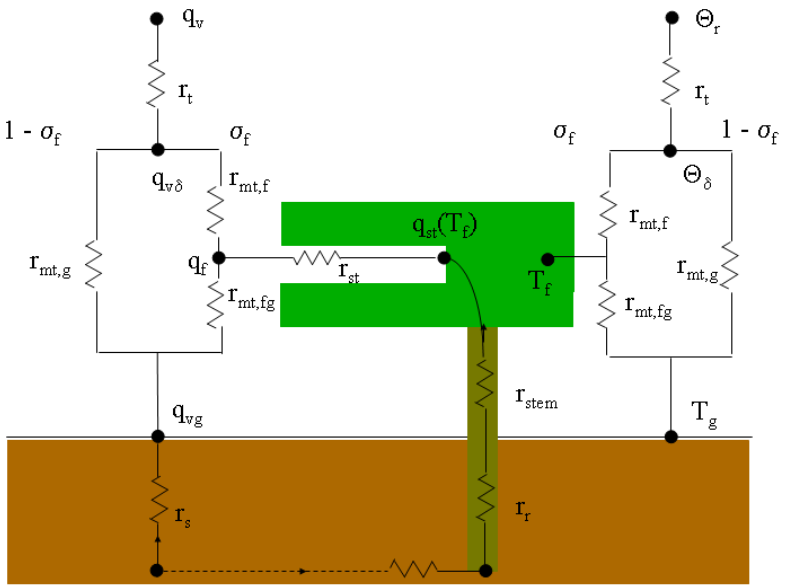
http://www.fws.gov/refuges/airquality/ARIS/WIMO/Images/Ndep%202009.jpg

Dry deposition

$$v_d = \frac{F}{C(x,y,z,t)}$$

$$v_d = \frac{1}{r_a + r_s + r_t}$$

μ < 1 => deposition
μ = 1 => compensation
μ > 1 => emission



Sedimentation of aerosols

$$v_d = \frac{1}{r_a + r_s + r_a r_s v_s} + v_s$$

$$v_s = \frac{D^2 g}{18\mu}(\rho_p - \rho)$$

$\rho_p >> \rho$ $\qquad$ $v_s \approx \frac{D^2 g \rho_p}{18\mu}$

Wet deposition

$$W_g = \int_0^\infty \Lambda(z,t) C(x,y,z,t) dz$$

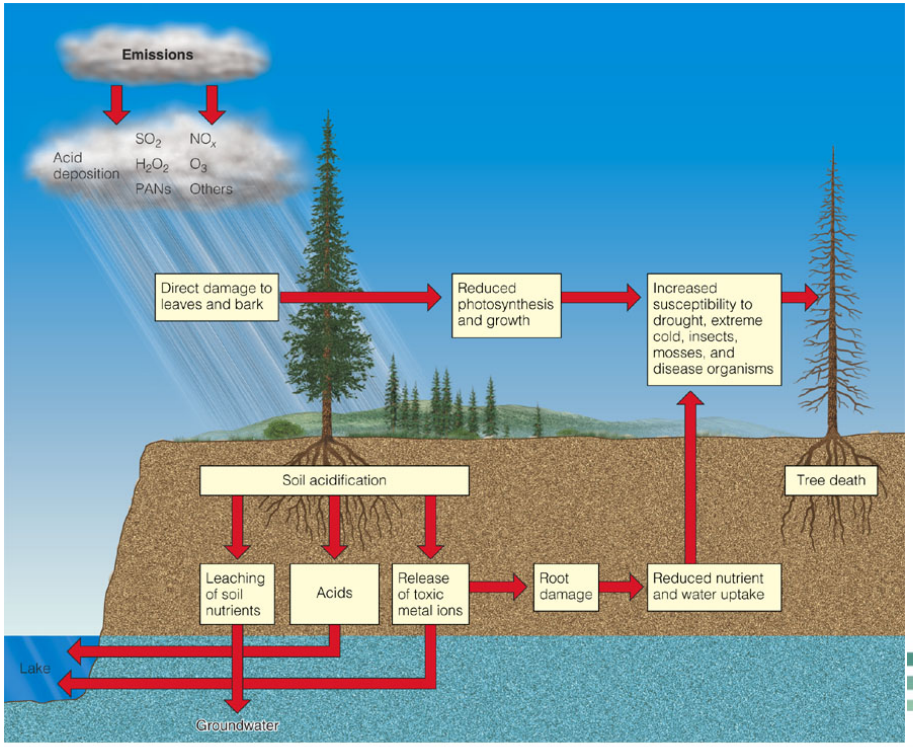
$$W_p = \int_0^\infty \Lambda(D,z,t) n(D,x,y,z,t) dz$$

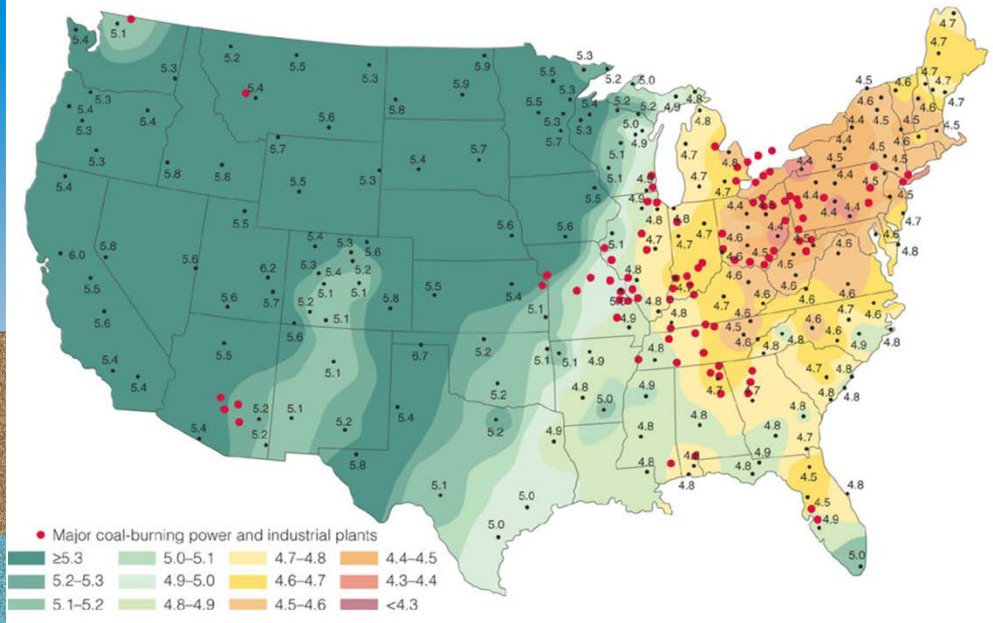
$$v_w = \frac{W_g}{C(x,y,z,t)}$$

$$v_w = \int_0^H \Lambda(z,t) dz = \overline{\Lambda} H \qquad v_w = \frac{W}{C(x,y,0,t)} = \frac{C(aq)P}{C(x,y,0,t)} = w_r P$$

$$w_r = \frac{C(aq)}{C(x,y,z,t)}$$

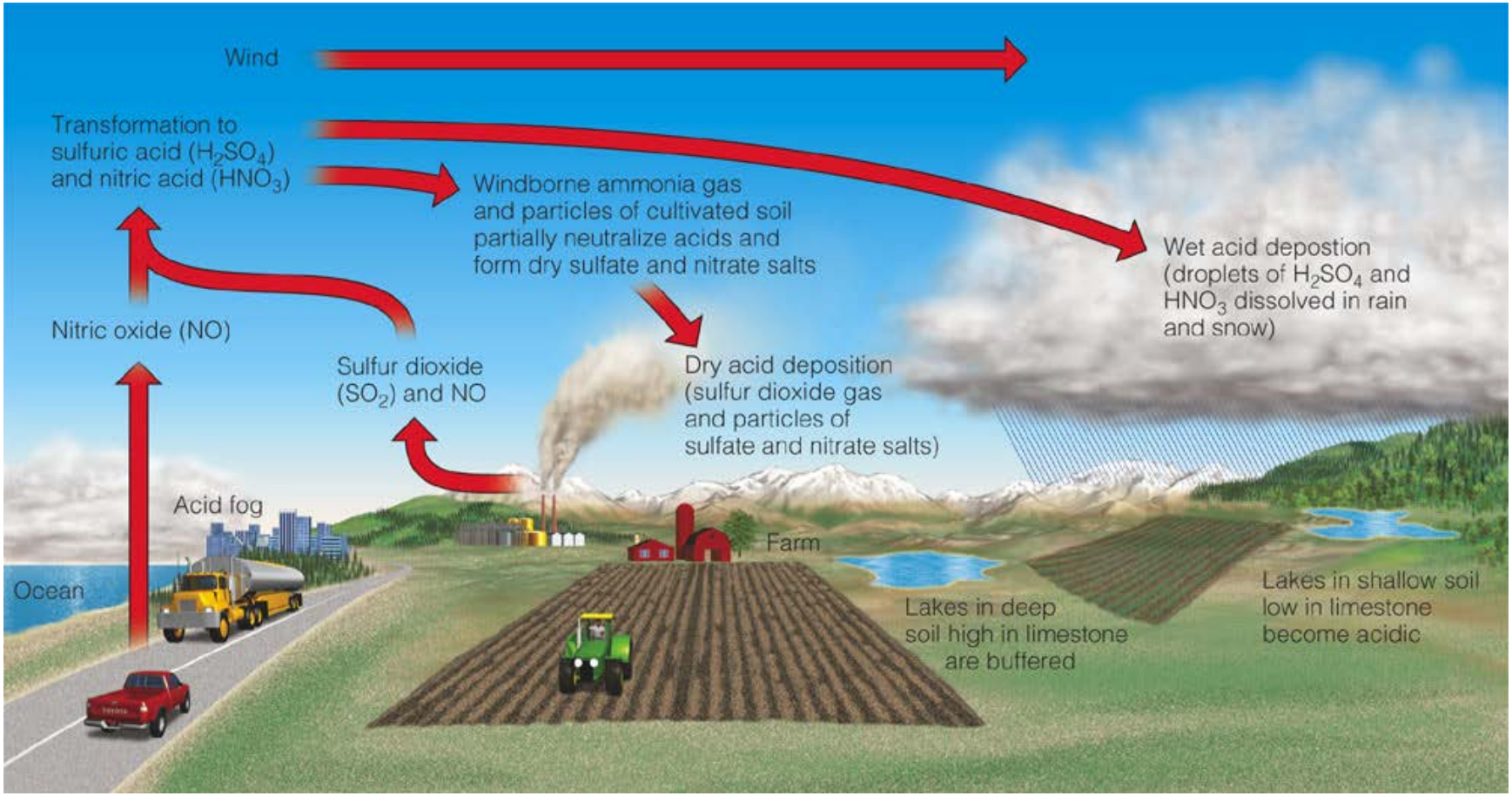
Acid deposition: a burden for ecosystems



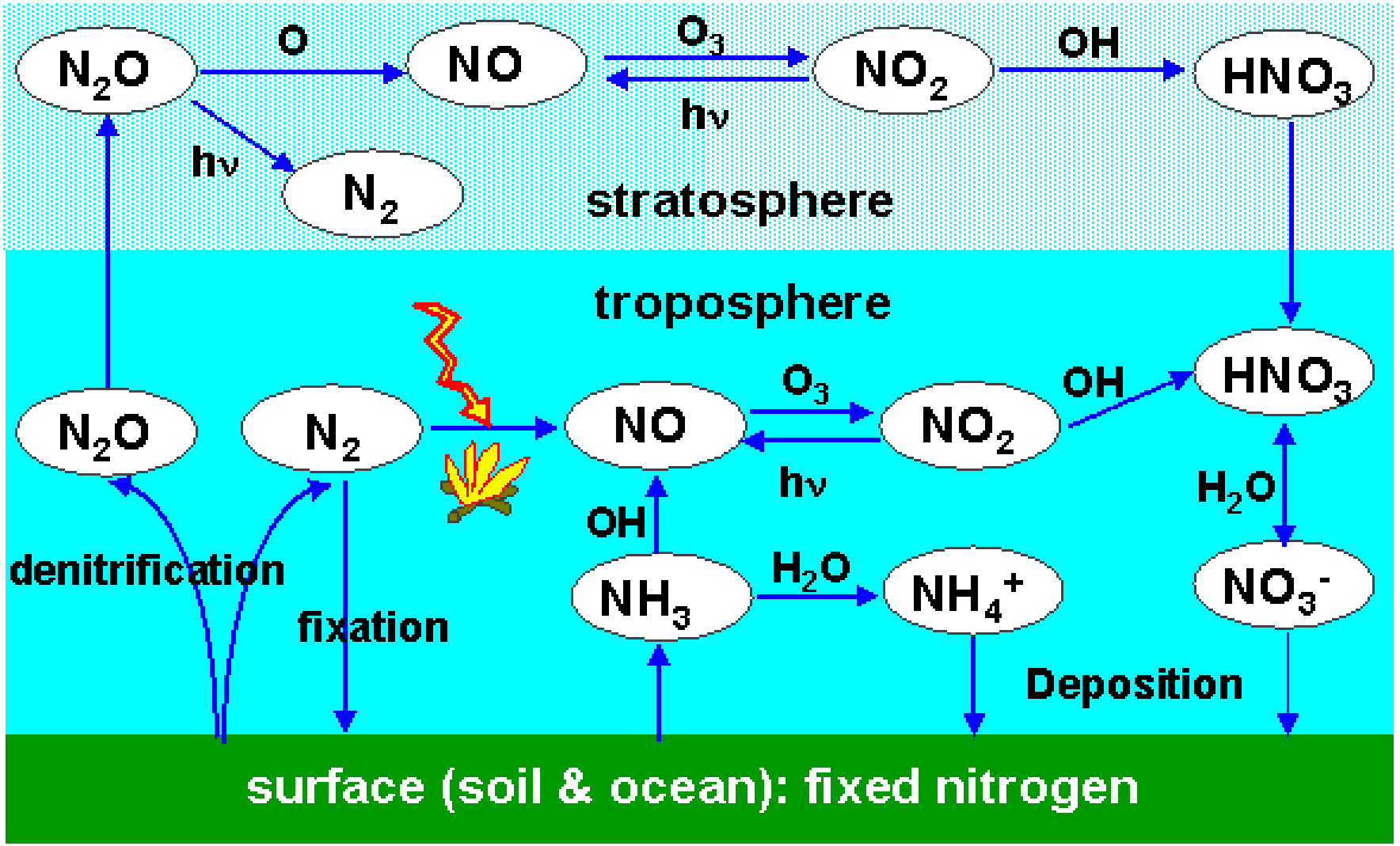


$$CO_2 + H_2O \rightarrow H_2CO_3(aq)$$
$$H_2CO_3(aq) \rightarrow H^+(aq) + HCO_3^-(aq)$$
$$HCO_3^-(aq) \rightarrow H^+(aq) + CO_3^-(aq)$$

Pollution from acid deposition

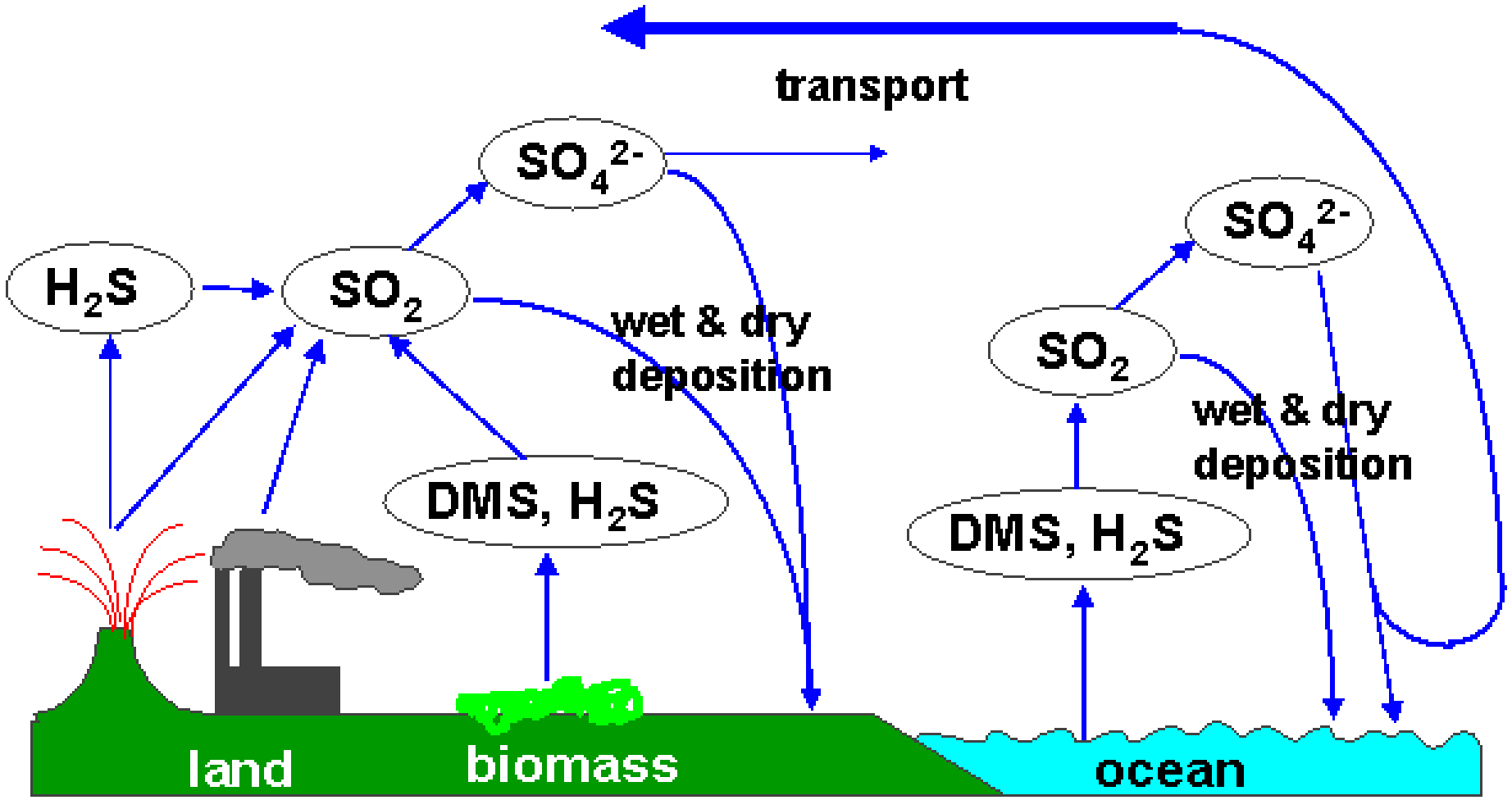


Nitrate cycle



Courtesy of Hugh Powell, Univ. of Durham, UK

Sulfur cycle



Courtesy of Hugh Powell, Univ. of Durham, UK

References

Material shown here partly stems from:

- *www.atmos.uiuc.edu/courses/atmos348.../Atmos348Lecture17.pdf*
- *www.ees.ufl.edu/homepp/cywu/.../Equilibrium%20&%20Kinetics.ppt*
- http://ua.acd.ucar.edu/Presentations/lecture2.pdf
- http://www.atmos.uiuc.edu/courses/atmos348-sp04/documents/Atmos348Lecture5.pdf
- *www.authorstream.com/.../aSGuest8996-131504-smog-chemistry-project-science-technology-ppt-powerpoint/*