The chemical composition of Earth's atmosphere IV: water vapor

Mole %	*Name*	*Chemical formula*	*Residence Time*
78.084	Nitrogen	N_2	10^6-10^7 years
20.948	Oxygen	O_2	3000-10,000 years
0.934	Argon	Ar	Forever
0.004 - 4	**Water vapor**	**H_2O**	**~10 days**
0.0385 (385 ppm)	Carbon dioxide	CO_2	2-10 years
0.001818 (18.18 ppm)	Neon	Ne	Forever
0.000524 (5.24 ppm)	Helium	He	~10^6 years
0.00017 (1.7 ppm)	Methane	CH_4	2-10 years
0.000114 (1.14 ppm)	Krypton	Kr	Forever
0.00005 - 0.0010	Stratospheric ozone	O_3	
0.000055 (0.55 ppm)	Hydrogen	H_2	4-8 years
0.000033 (0.33 ppm)	Nitrous oxide	N_2O	5-200 years
0.0000050 - 0.0000200	Carbon monoxide	CO	60-200 days
0.0000087 (87 ppb)	Xenon	Xe	Forever
0.0000010 - 0.0000500	Tropospheric ozone	O_3	
0.0000005 - 0.0000020	NMHC	C_xH_y	
0.0000000540 (540 ppt)	CFC12	CF_2Cl_2	>80 years
0.00000005 (500 ppt)	Carbonyl sulfide	OCS	~ 2 years
0.0000000265 (265 ppt)	CFC11	$CFCl_3$	~80 years
0.00000001 - 0.000001	Hydrogen peroxide	H_2O_2	1 day
0.00000001 - 0.0000001	Formaldehyde	CH_2O	5-10 days
0.0000000098 (98 ppt)	Carbon tetrachloride	CCl_4	≥ decades
0.0000000065 (65 ppt)	Methylchloroform	CH_3CCl_3	~7 years
0.000000001 - 0.0001	Nitrogen oxides	NO_x	A few days
0.000000001 - 0.0000001	Ammonia	NH_3	A few days
0.000000001 - 0.0000001	Sulfur dioxide	SO_2	hours to weeks
0.000000001 - 0.00000001	Dimethyl sulfide	CH_3SCH_3	<1 day
0.0000000001 - 0.00000003	Carbon disulfide	CS_2	~40 days
0.0000000005 - 0.00000005	Hydrogen sulfide	H_2S	<5 days
0.0000000002 (2 ppt)	Hydroperoxyl radical	HO_2	
0.000000000005 (0.05 ppt)	Hydroxyl radical	OH	≤ a few seconds

As we noted earlier, water vapor is commonly left out of lists like the one at left. It's also unusual among the things in this list, in several respects:

1) Its proportion among the gases is highly variable. A few components of the atmosphere vary in concentration by as much as an order of magnitude (e.g., carbon monoxide) or even two orders of magnitude (e.g., ammonia and SO_2), but the concentration of water vapor varies by three orders of magnitude.

2) Its residence time is an anomaly. In general, the abundant components (the ones high in the list) have residence times in years, and the scarce components have residence times in days. Water vapor, however, is commonly quite abundant but has a short residence time.

3) It's the only component that condenses out of the atmosphere, as fog, rain, sleet, or snow.

4) It's the only atmospheric gas that can exchange with liquid and solid components of the same chemical substance. That's to say that there are lakes, oceans, and glaciers of H_2O, but no lakes or glaciers, or even raindrops or snowflakes, of nitrogen, oxygen, and argon.

5) It's the one component that enters or leaves the atmosphere by making or breaking weak bonds - specifically, hydrogen bonds. All of the other components enter or leave the atmosphere via making or breaking of stronger chemical bonds, typically covalent bonds.

These five thoughts are of course related. Direct interchange with large non-gaseous reservoirs (Item 4) via changes in bonding that are readily effected (Item 5) means that water vapor comes and goes from the atmosphere readily (Item 3), resulting in variable concentration through space and time (Item 1) and comparatively rapid cycling in and out of the atmosphere (Item 2).

Sources: see Part I of this series.