Oxygen isotope anomalies in the atmosphere: From ozone in Heidelberg to tracers of climate change measured around the world

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Isotope effects can be used to study the origin and fate of atmospheric compounds. For oxygen, with three stable isotopes, ^{16}O, ^{17}O and ^{18}O, measurements show that the variations between these three isotopes in the atmosphere are anomalous, also called “non-mass-dependent”. The most important example for an anomalous isotope effect is the formation reaction of ozone. This reaction was studied in great detail in the group of K. Mauersberger at the MPI für Kernphysik. To date these are the most precise and insightful measurements, which still lack a fundamental explanation.

At the same time, non-mass dependent oxygen isotope compositions have been detected in many other atmospheric molecules. In fact, there is almost no atmospheric species for which an anomaly has not been detected, or at least postulated. This is because O_3 is at the center of atmospheric oxidation reactions. Via chemical reactions the oxygen isotope anomaly is transferred to other atmospheric compounds. Measuring the isotope anomaly therefore opens new opportunities to investigate chemical reaction mechanisms on the one hand, and mass fluxes between different species and reservoirs on the other hand. I will show that what started out as a peculiar isotope anomaly in Heidelberg many years ago has grown into a new research field that spans the full range from molecular physics studies to the reconstruction of climate parameters in the past.