Stable isotopes in the atmosphere

IMAU
Institute for Marine and Atmospheric research Utrecht

Universiteit Utrecht

Isotopes

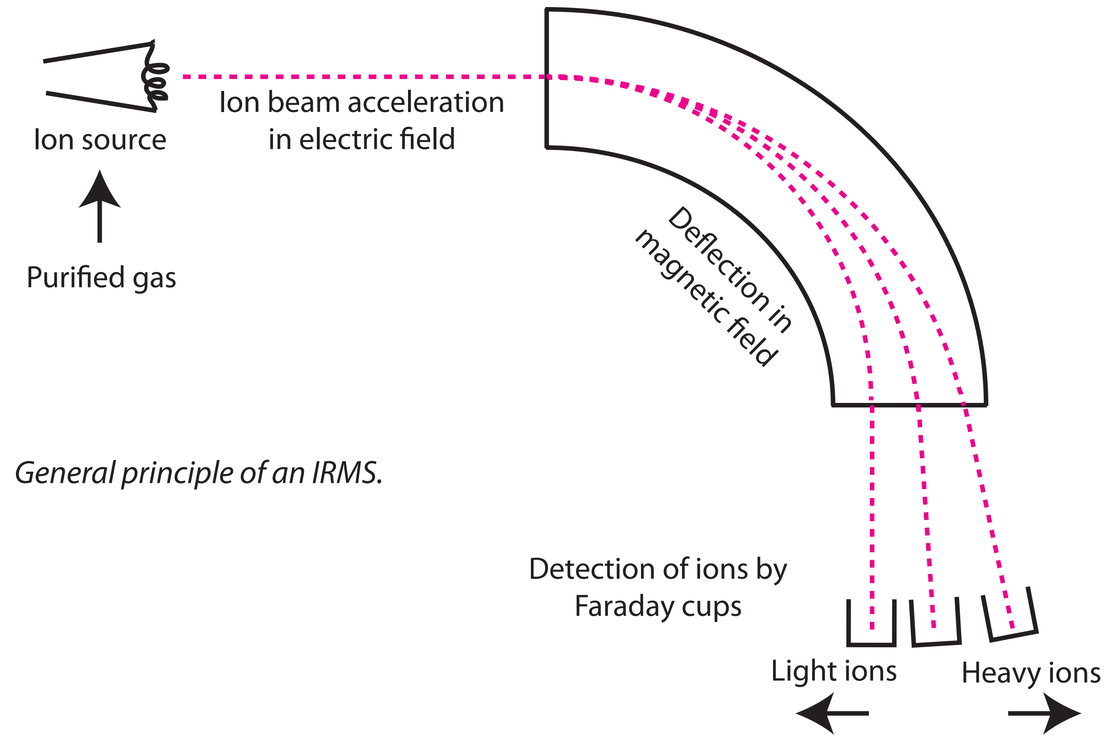
Isotopes are atoms with the same number of protons, but a different number of neutrons, and therefore a different mass. Some heavy isotopes, like ^{3}H and ^{14}C, are radioactive and decay over time. Others, like ^{2}H and ^{13}C, are stable and do not radiate. The IMAU focuses on stable isotopes.

Isotopes of the same element have the same chemical properties and form the same molecular species. However, the mass difference between them causes subtle differences in the isotopic composition of compounds that are produced by different processes; they have a different `isotopic fingerprint'.

The simplest example of isotopes are ^{1}H (`ordinary' hydrogen), with just a proton, and $^{2}H$ (`deuterium '), with a proton and a neutron.

Mass spectrometry

The amount of a stable isotope in a gas can be determined with an Isotope Ratio Mass Spectrometer (IRMS). Usually, compounds have to be purified before injection into the IRMS.

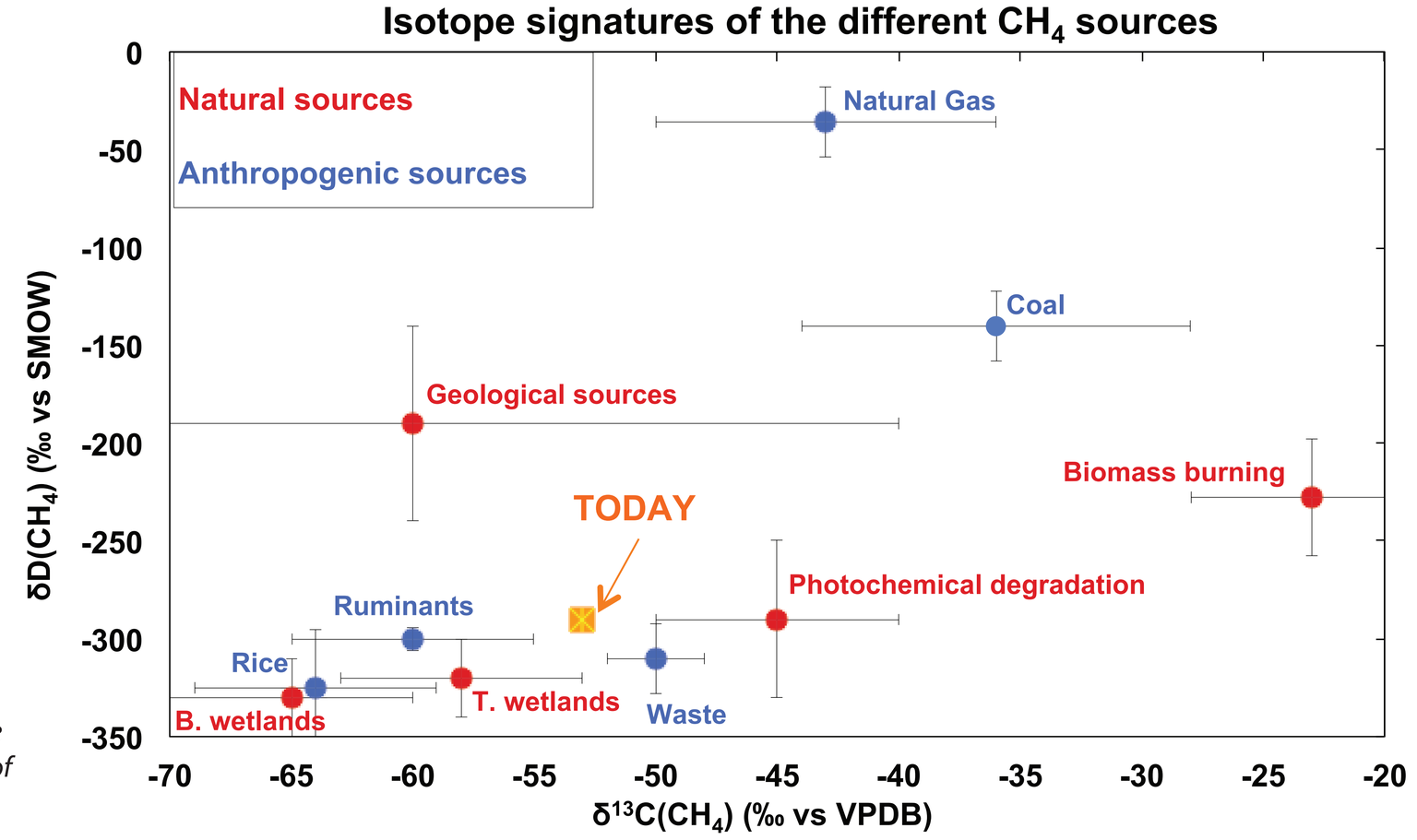


General principle of an IRMS.

Methane (CH_4)

- A potent greenhouse gas
- >150 % increase since preindustrial times
- Increase rate not constant
- Causes not well understood: future increase uncertain

The IMAU studies the processes that produce and destroy CH_4. As the different CH_4 sources produce methane with different `isotopic fingerprints', we can use measurements of ^{2}H and ^{13}C in CH_4 to learn more about these sources.

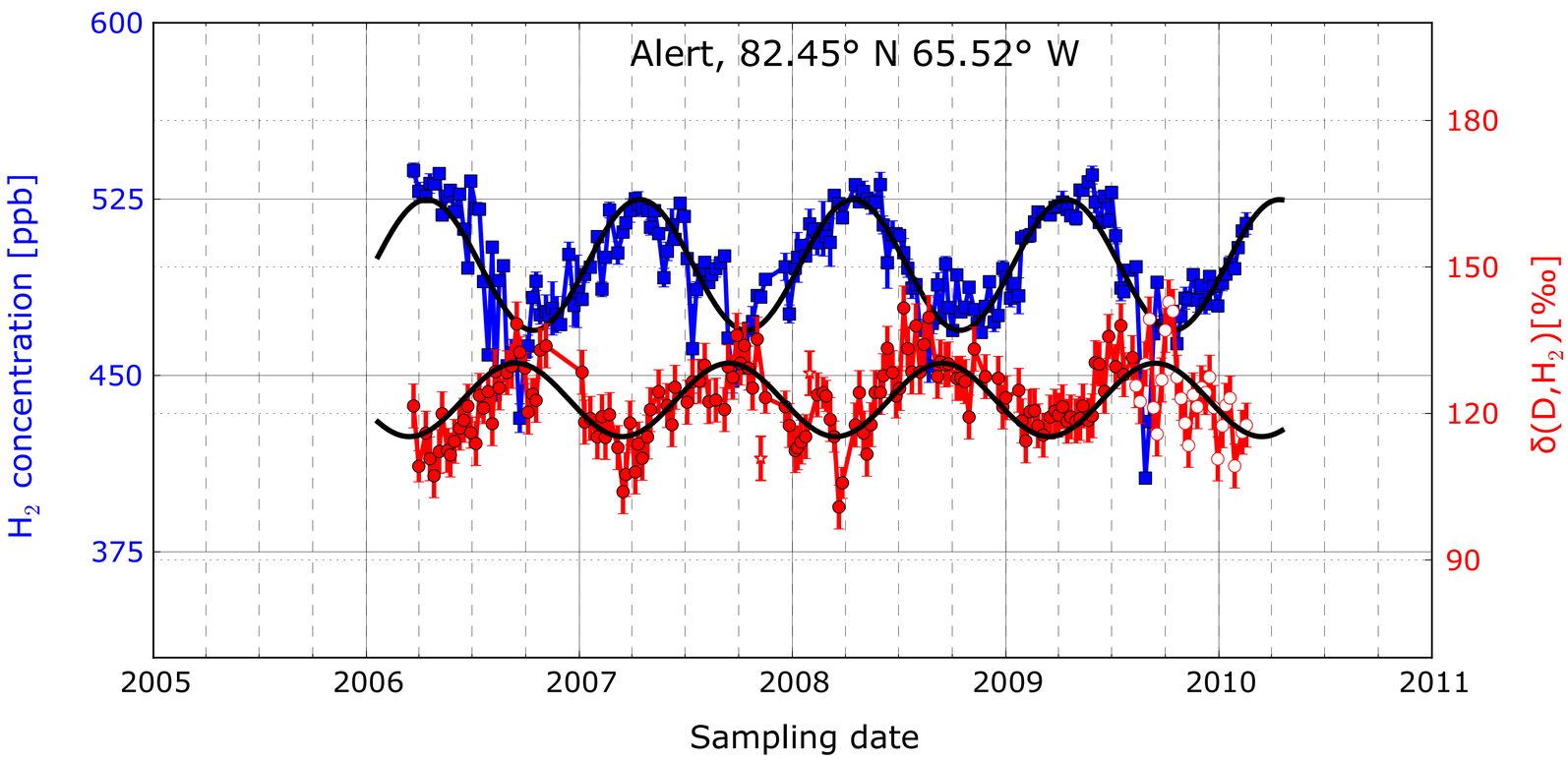


The relative amount of ^{2}H in the CH_4 ($\delta D(CH_4)$) plotted against the relative amount of ^{13}C in the CH_4 ($\delta^{13}C(CH_4)$) for different sources of atmospheric CH_4

Molecular hydrogen (H_2)

- Promising clean alternative to fossil fuels
- Risks of H_2 leakage for atmosphere uncertain.
- H_2 cycle not studied much before.

The IMAU analyzes samples from weather stations around the globe for H_2 concentration ($m(H_2)$) and ^{2}H content ($\delta(D,H_2)$).
These data give information about the seasonal cycle of H_2, its spatial distribution and the sources and sinks.



H_2 concentrations (blue) and relative ^{2}H content (red) plotted against sampling date of the analyzed samples from Alert, Arctic Canada. Here the seasonal cycles can be seen quite well.