Temporal and spatial variability in $\delta(D,H_2)$: measurement time series from six EUROHYDROS stations

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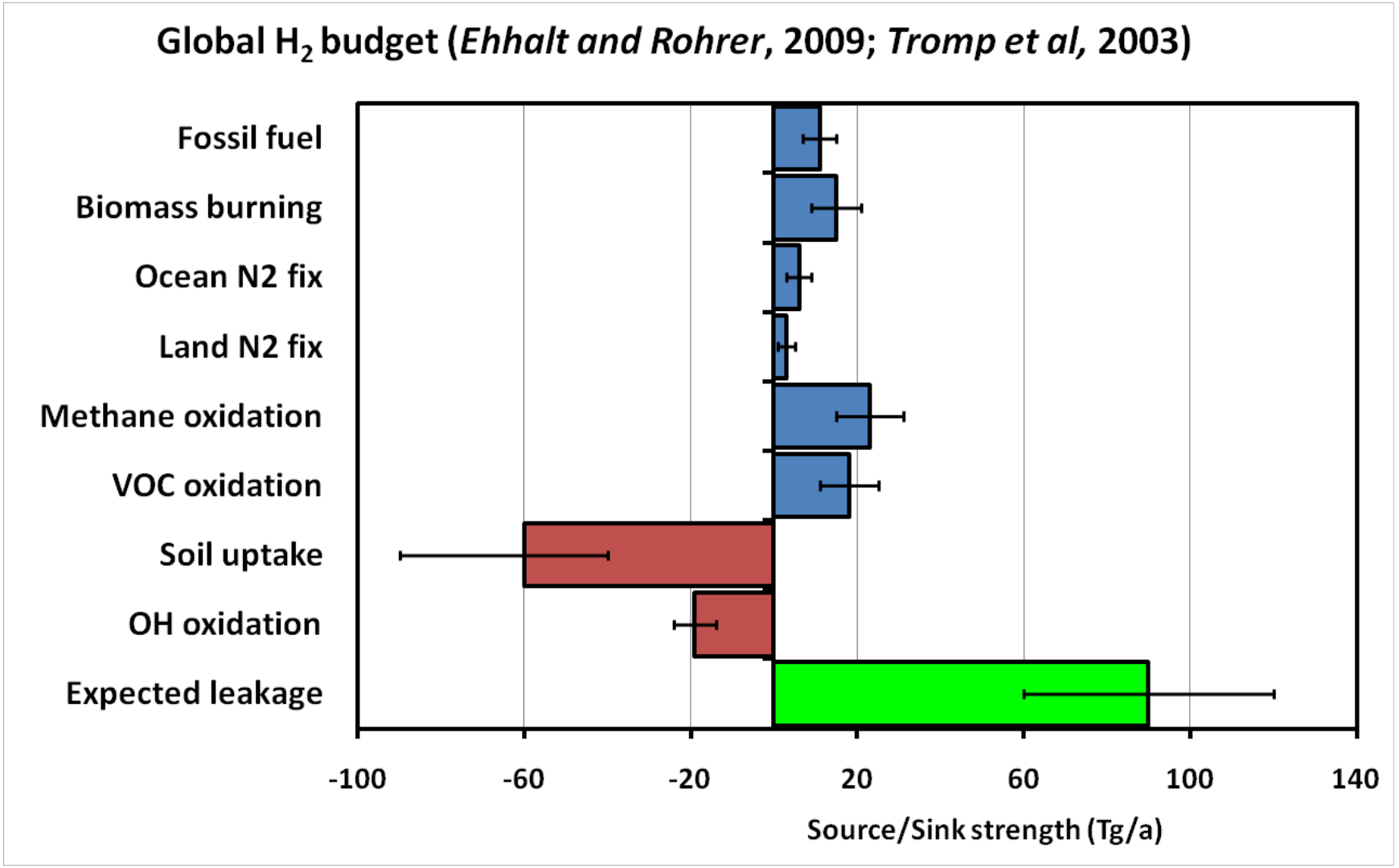
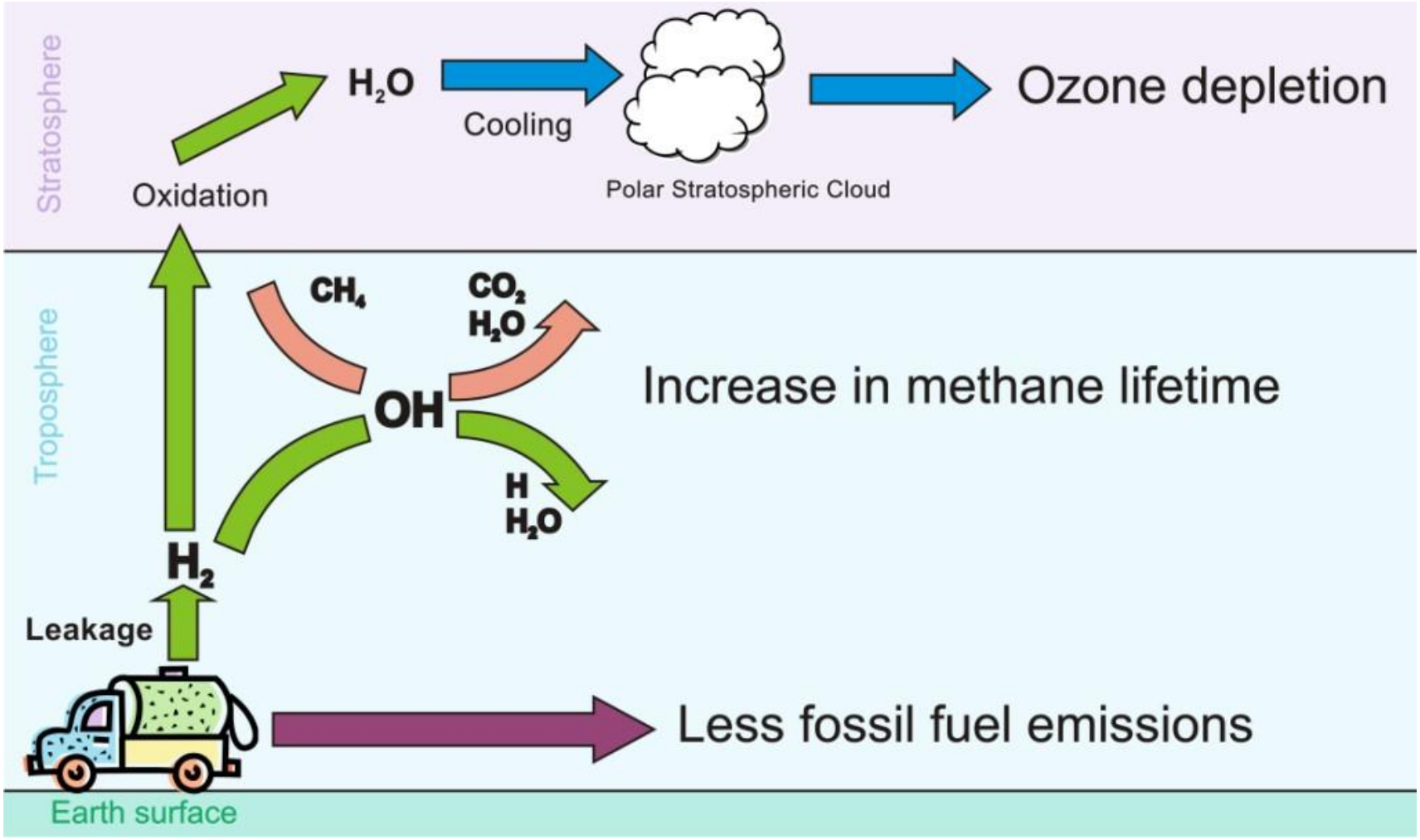
Presentation overview

- **Introduction**
  - * Hydrogen
  - * Hydrogen isotopes
  - * The EUROHYDOS network
- **Results & Discussion**
  - * Station time series and cycles
  - * Latitudinal gradient
  - * Uptake processes
- **Conclusions**

The atmospheric H_2 budget



Effects of a Hydrogen Economy

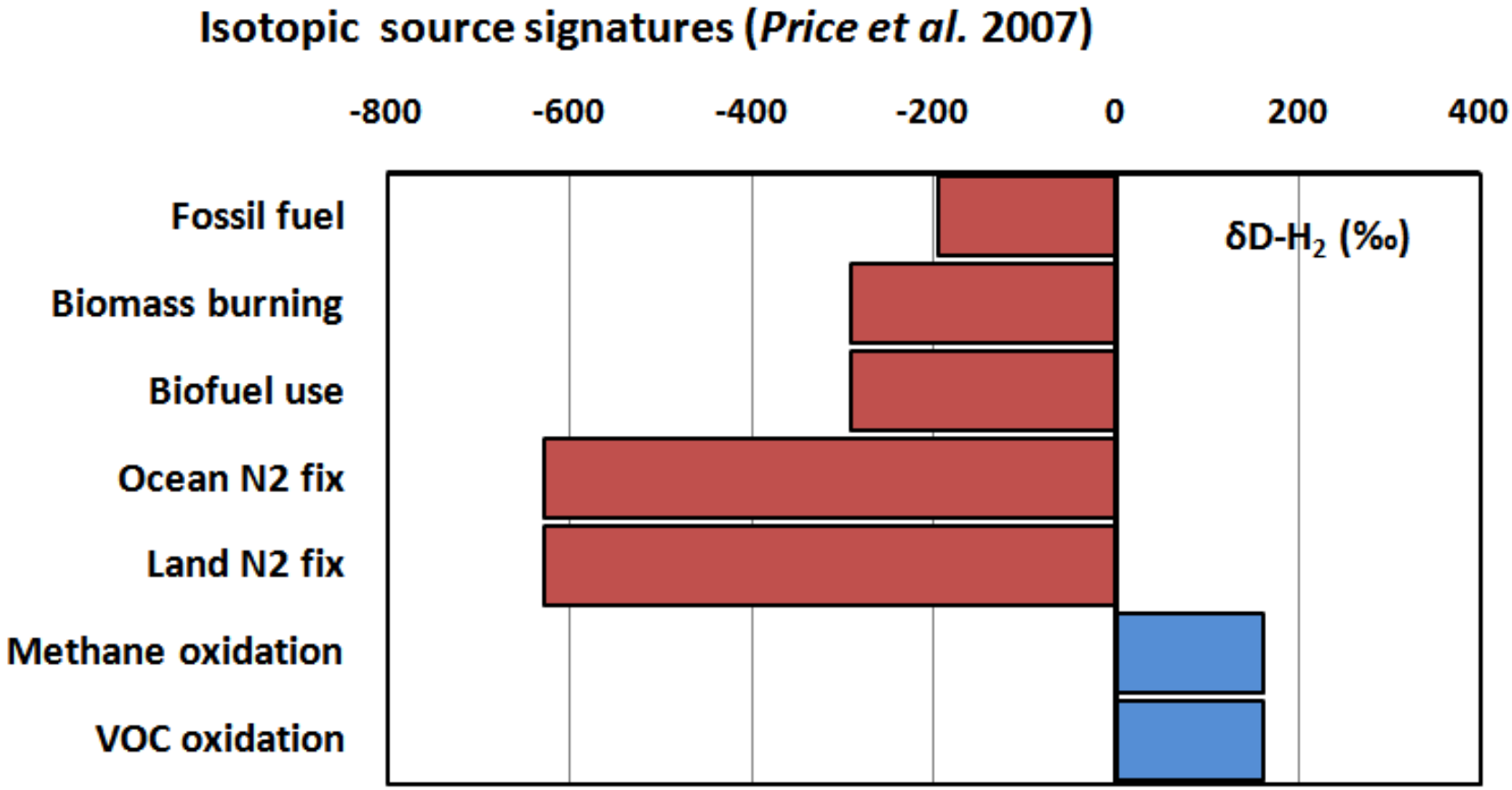


Isotope δ-notation

$$\delta(\mathrm{D},\mathrm{H}_2) = \left[\frac{\left(\frac{\mathrm{D}}{\mathrm{H}}\right)_{sample}}{\left(\frac{\mathrm{D}}{\mathrm{H}}\right)_{VSMOW}} - 1 \right] \cdot 1000‰$$

The $\delta(D,H_2)$ value represents the deuterium-to-hydrogen ratio in the H_2 relative to a standard (Vienna Standard Mean Ocean Water (VSMOW))

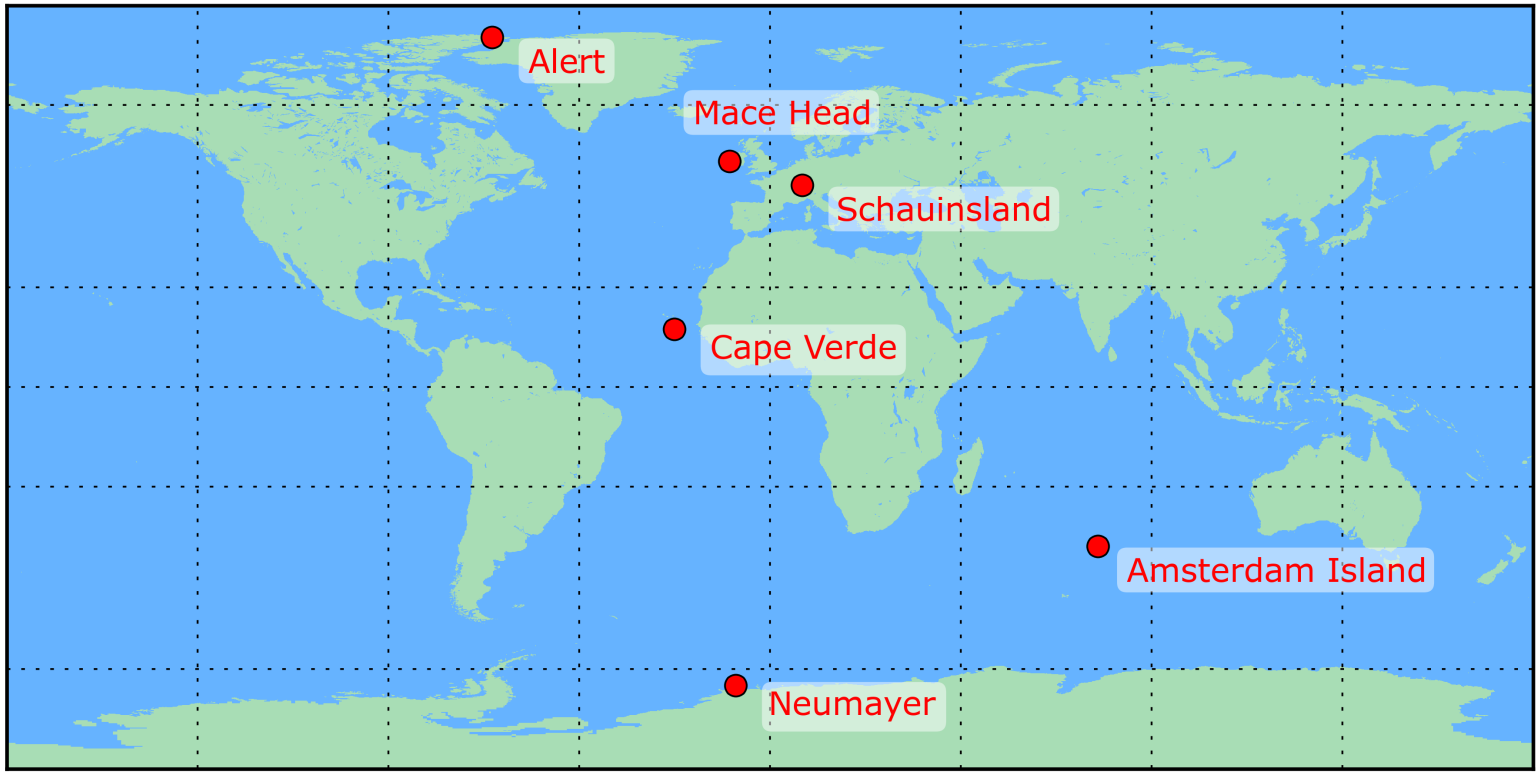
Isotopic source signatures



Isotopes can be used to gain information about different sources and sinks.

The EUROHYDROS network

EUROHYDROS $\delta D\text{-}H_2$ sampling stations



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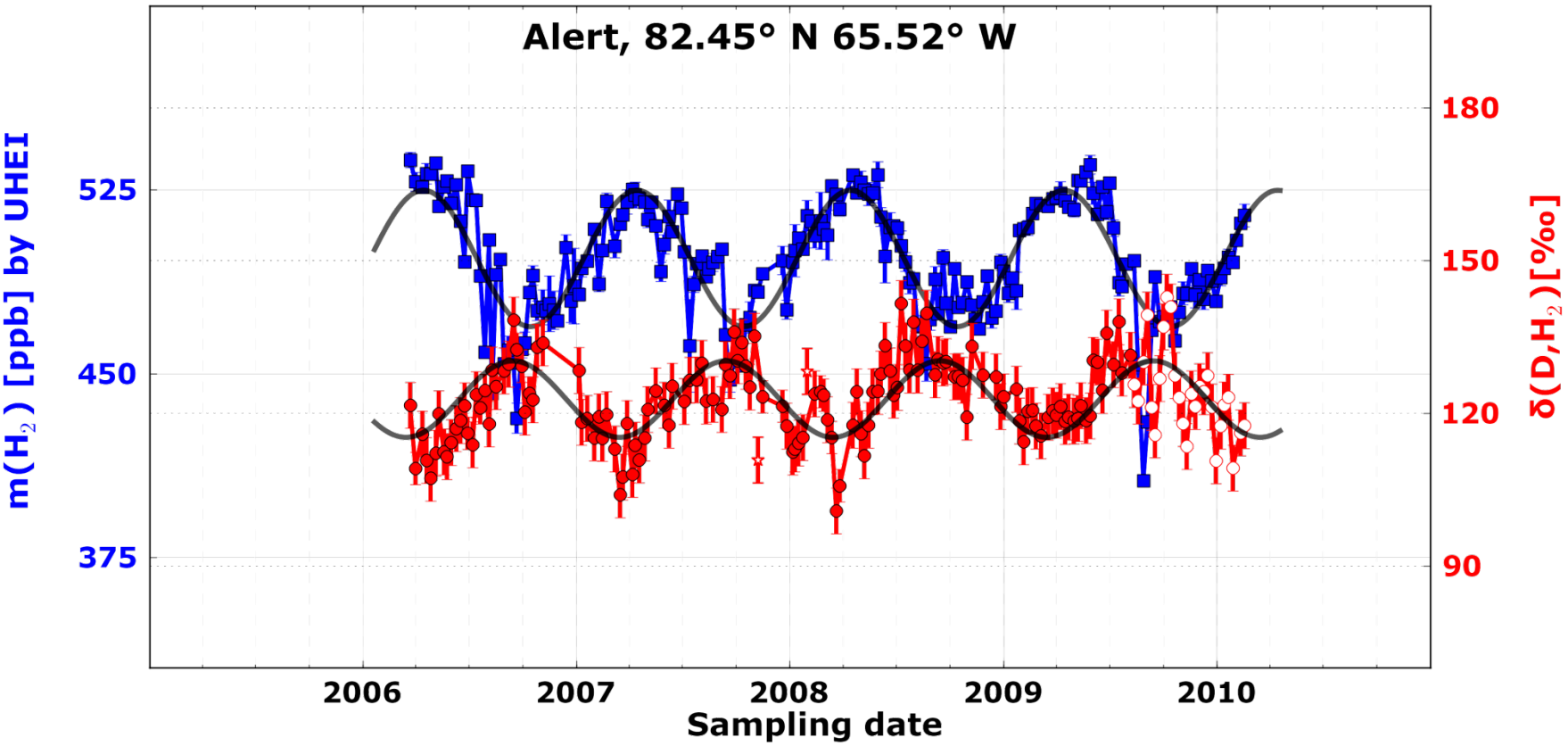
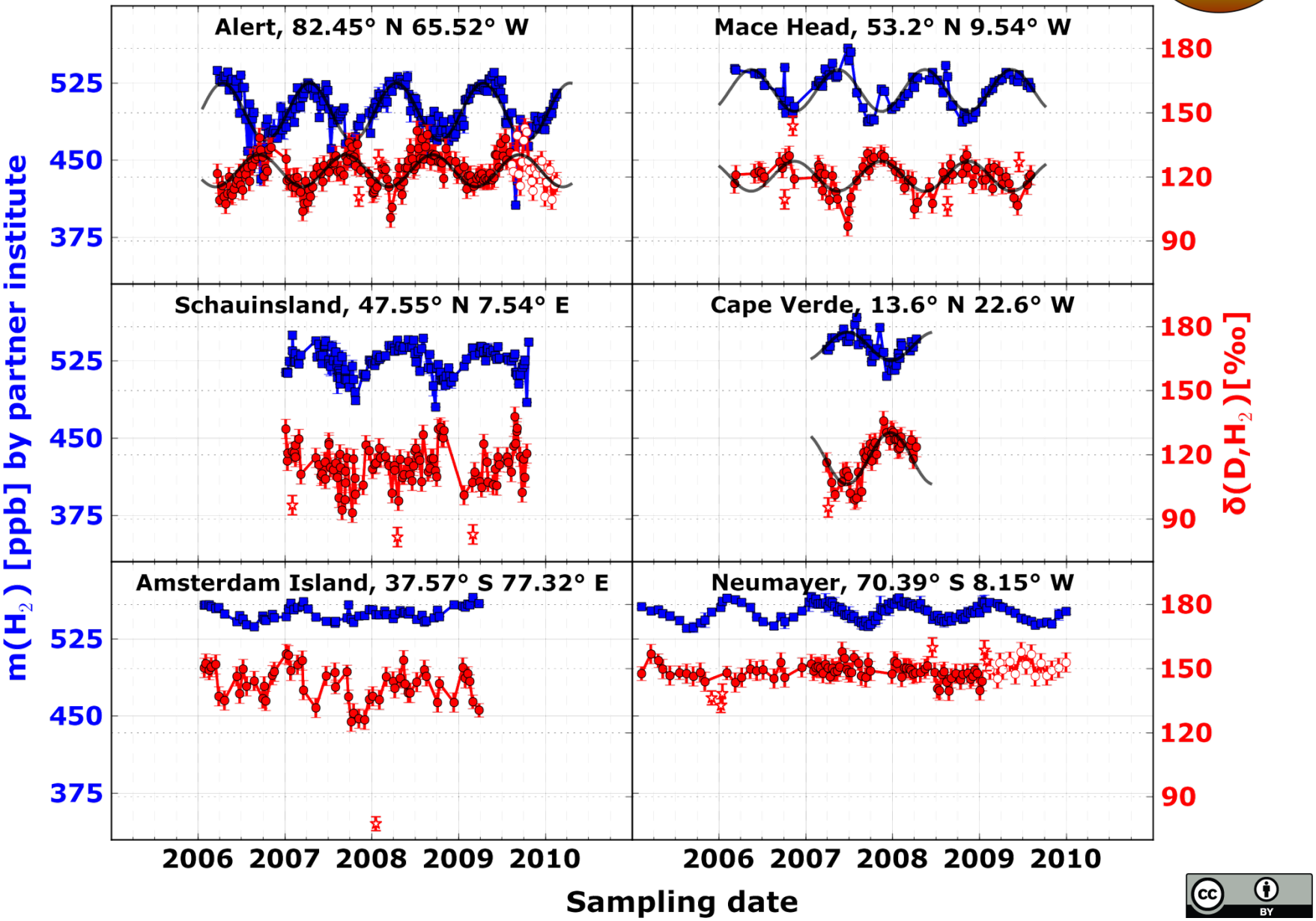
Alert



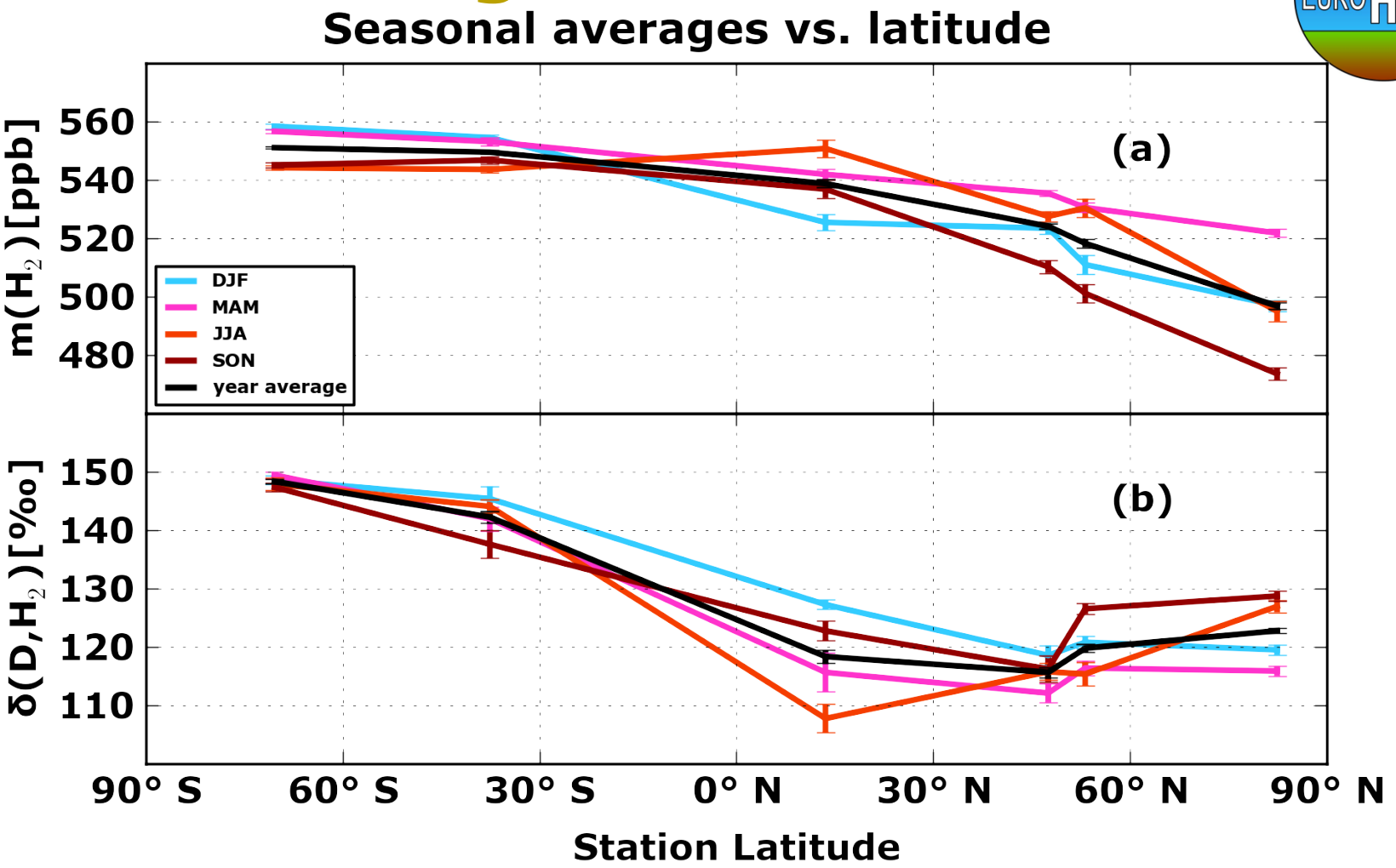
Out-of-phase seasonal cycles:

- D-depleted H_2 accumulates in Winter
- H_2 removal in Summer, preference for HH over HD
- Phase shift ≈ 5 months

Overview of the time series



Latitudinal gradient



- Larger mixing ratios and $\delta(D,H_2)$ on the SH
- Larger seasonal variability on the NH
- Minimum at NH midlatitudes >>> anthropogenic effect

Sink processes

Rayleigh fractionation formula:

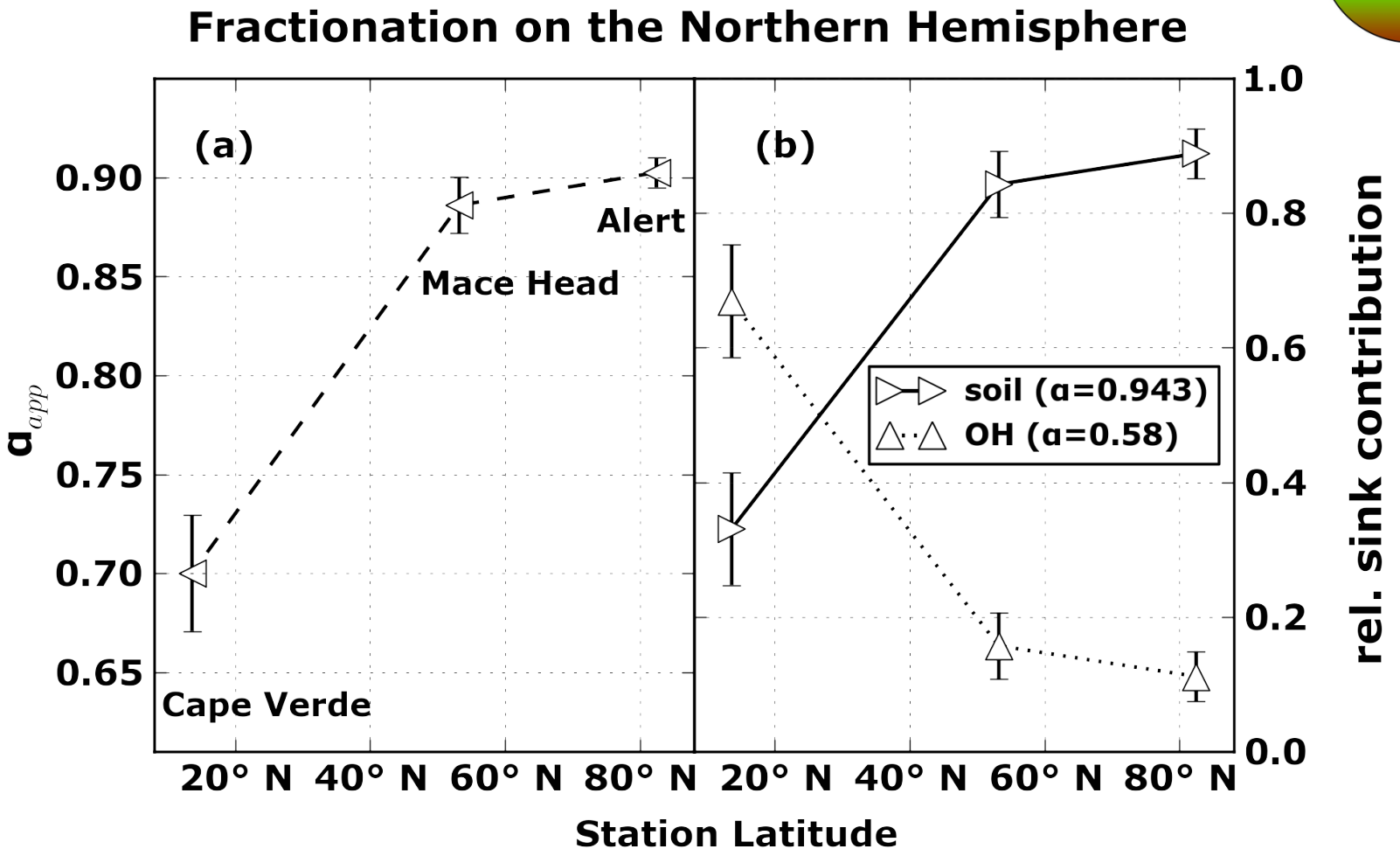
$$(\alpha - 1) ln \left[\frac{m(\mathrm{H_2})}{m(\mathrm{H_2}, max)} \right] = ln[\delta(\mathrm{D}, \mathrm{H_2}) + 1] + c$$

where $m(H_2,max)$ is the maximum mixing ratio, c a constant and α the fractionation factor:

$$\alpha = \frac{k_{\mathrm{HD}}}{k_{\mathrm{HH}}}$$

with k the removal rate of the species

NH sink processes: an estimate



- At the two northernmost stations, soil uptake is (by far) the largest H_2 sink
- In Cape Verde its relative size is much smaller

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Conclusions

Long records of $\delta(D,H_2)$ have been collected for six globally distributed stations. These provide information on:

- Seasonal cycles of $\delta(D,H_2)$
- The latitudinal distribution of $\delta(D,H_2)$
- The sources and sinks of H_2 that affect the stations

Questions?

More on these observations:

- A. M. Batenburg, S. Walter, G. Pieterse, I. Levin, M. Schmidt, A. Jordan, S. Hammer, C. Yver, and T. Röckmann, *Temporal and spatial variability of the stable isotopic composition of atmospheric molecular hydrogen: observations at six EUROHYDROS stations,* Atmos. Chem. Phys. Discuss., 11, 10087-10120, 2011, doi:10.5194/acpd-11-10087-2011

$\delta(D,H_2)$ around the tropopause:

- Poster XY146, **Today** (session 3.12)