HDO variability in the upper troposphere and lower stratosphere

J. Steinwagner\textsuperscript{1}, S. Füglistaler\textsuperscript{2}, G.P. Stiller\textsuperscript{3}, T. von Clarmann\textsuperscript{3} and T. Röckmann\textsuperscript{1}

(1) Universiteit Utrecht, Institute for Marine and Atmospheric Research Utrecht, The Netherlands
(2) University Cambridge, DAMTP, UK,
(3) Forschungszentrum Karlsruhe, Institut für Meteorologie und Klimaforschung, AME Group, Germany

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Motivation

• Stratospheric water plays an important role for ozone chemistry and radiative balance
• It is still not entirely clear how water enters the stratosphere
Method

• Isotopes as marker

• The amount of HDO and H₂O changes due to
  • Evaporation/Condensation
  • Transport
  • Chemistry

• A measure for the relative change in HDO and H₂O is the δD value
  • The more negative δD the less HDO is contained in a sample of probed air and vice versa
Dataset

- Measurements have been carried out using MIPAS onboard Envisat

- 1-4 measurement days per month
Processes

• Determination of relative magnitudes of different sources

• We interprete our remote sensing measurements on the proposal of three main processes
Observation

- While entering the stratosphere from the troposphere water faces a cold trap
  - Due to increasing T in the stratosphere this signature is conserved and transported upwards
  - Temperature minimum shows seasonal variation
  - Phenomenon is known as water “tape recorder”
- A Rayleigh process leads to a similar tape recorder like signature in HDO (δD)
Pathway B

- If Rayleigh was the only process a HDO:H2O correlation should follow a Rayleigh curve (red line)
- What is the reason for the differences?
  - Not supersaturation
Pathway C

• The slope of the stratospheric HDO:H2O correlation is more or less identical to that at the tropopause
  – contribution via pathway C is uniform on different altitudes
Pathway A

• Is there information about convection in delta D?
  • It should be possible to distinguish regions with high convective activity from such with low convective activity
  • Convective activity is on average stronger on the NH than on the SH

• Indeed, there is a significant difference between NH and SH (zonally averaged data)

Av. δD @ 18 km
Pathway A

- We observe no substantial moistening
  - Convection does not reach up to stratospheric levels
  - Detrainment moistens upper TTL
  - Stratospheric moisture level is still set by “last step dehydration”

Av. H$_2$O @18 km

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Conclusion

• Convection affects UT/LS δD values
  • Leaves a signal
  • No significant influence on stratospheric moisture
• dD values should not be generalized from “point measurements”

Open questions

• Seasonality in supersaturation?
• Appropriate treatment of cloudy measurement scenes
• Improve data quality
• More data
• Much more data!!
• A whole lot more data !!!