HIRDLS Status

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Overarching scientific themes for HIRDLS

• Stratospheric ozone
  ⇒ Monitoring ozone recovery

• Natural variability of the stratosphere, dynamical and chemical
  ⇒ Defining interannual variability on a wide range of scales in time and space

• Long term climate change, including global warming
  ⇒ Separating trends from natural variability

• Air quality
  ⇒ Gases and aerosols in the upper troposphere
Indicator of climate changes

The stratosphere can be a sensitive indicator of changes at lower levels:

1) Water vapour amounts are increasing at about 1% per year.
   - too much to be explained by increasing CH$_4$ in the troposphere.
   - does it indicate a change in the tropopause 'cold trap' temperature,
     meridional circulation,
     something else?

   How does it affect the chemistry and radiation?

2) The stratosphere is cooling
   - approx 0.5 C/decade in lower stratosphere (consistent with models)
   - approx 1.5 C/decade in upper stratosphere (larger than models)

   Can we verify these changes?

   What is happening in the mesosphere?
Stratospheric water vapour amounts are increasing at 1% per year. This more than is explained by CH$_4$ increase. HALOE satellite data give same result.

Trends in stratospheric water vapour observed above Colorado by balloon-borne frost-point hygrometers from 1981-1997. Blue area is 95% confidence limit in trend.

[Oltmans, Vömel, Hofmann, NOAA]
Can we see the underlying changes through the ‘noise’?

- Very big wintertime variations occur from year-to-year: by some measures this winter nearly 10 times colder than last winter for PSC formation.

- These changes are assumed to be dynamic in origin.

- Can we understand them?

- They introduce noise, so make it very difficult to detect underlying wintertime climatic changes unless they are very big or we wait many decades.

- Can we find ways to allow for them when measuring long term changes?
1999-2000 North Polar temperatures compared with daily means and extremes for 1979-2000

[From http://www.cpc.ncep.noaa.gov]
Accumulated ‘degree days’ below Type-1 PSC formation temperature (195 K) at 40 hPa (approx 20 km) at the North Pole 1992-2000 (from UK Met. Office).
Transport across and along the tropopause

• Our knowledge of transport of constituents, heat and momentum across the tropopause is relatively crudely known. This is a driver of stratospheric chemistry, dynamics and radiation and to a lesser extent of the troposphere.

• Can we make quantitative measurements of transports?

• Do we understand all of the processes?
Transport features observed by HIRDLS

[Figure from J.Holton/UGAMP]
Isentropic transport near the tropopause

Particles released on 400 K isentrope between 20° S and 20°N on 1/1/99

[From Bill Randel]
Stratosphere-troposphere exchange on small scales

Passive tracers on the 320 K isentrope. Coloured air is stratospheric, blank is tropospheric

[From Appenzeller et al. [1995]]