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)

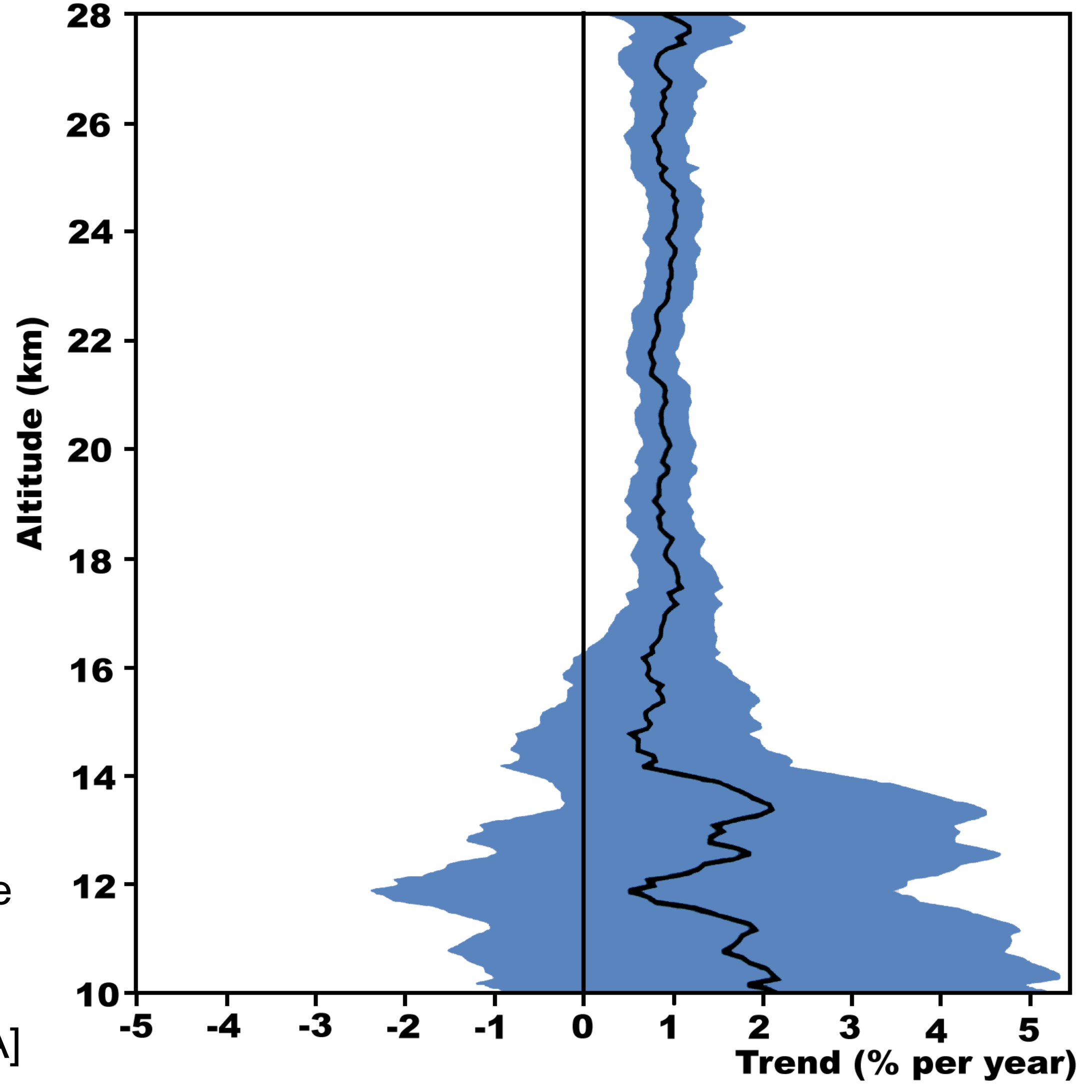
- approx 1.5 C/decade in upper stratosphere (larger than models)

Can we verify these changes?

What is happening in the mesosphere?

Upward trend of water vapour concentration

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.

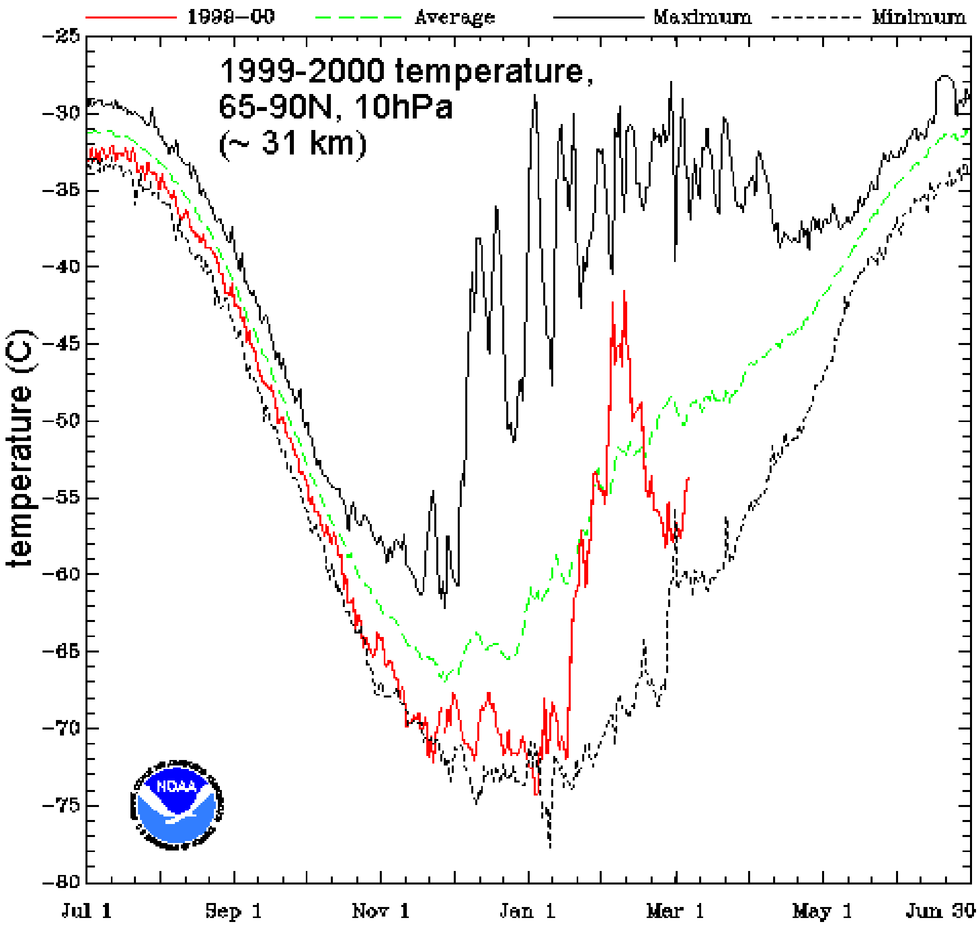


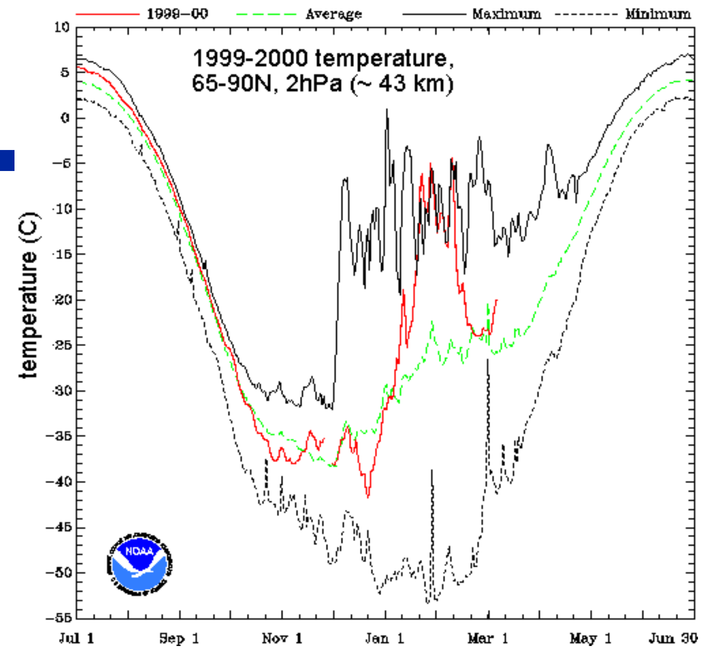
Trends in stratospheric water vapour observed above Colorado by balloon-borne frost-point hygrometers from 1981-1997. Blue area is 95% confidence limit in trend.
[Oltmans, Vömel, Hofmann, NOAA]

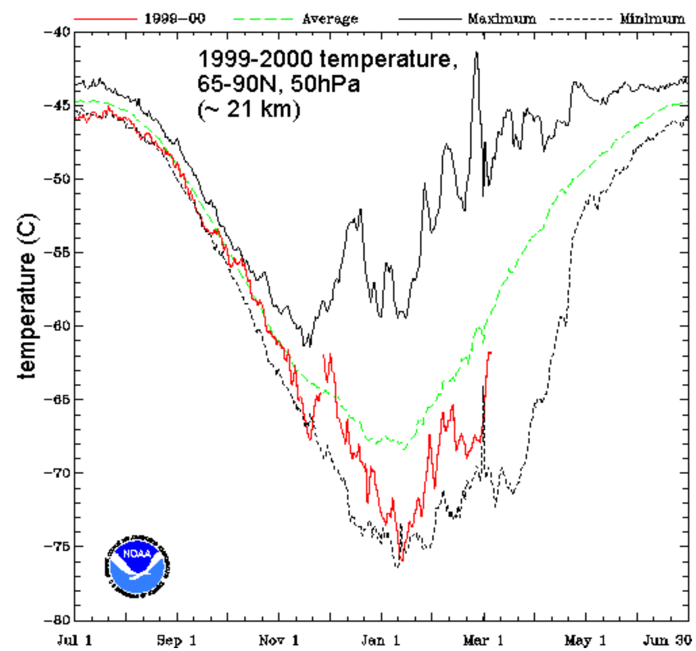
Can we see the underlying changes through the 'noise'?

- 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



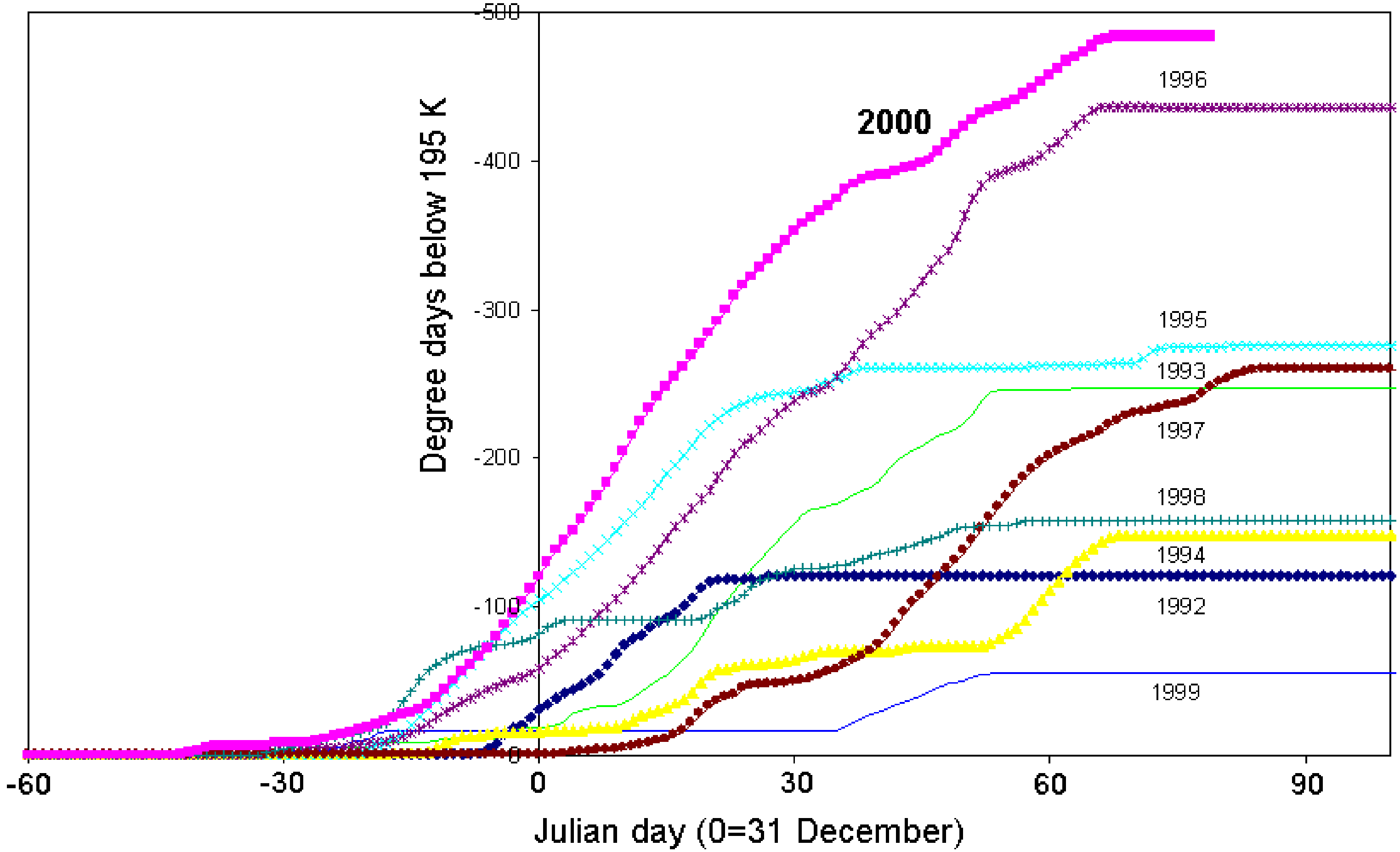




[From http://www.cpc.ncep.noaa.gov]

Conditions for PSC formation at North Pole

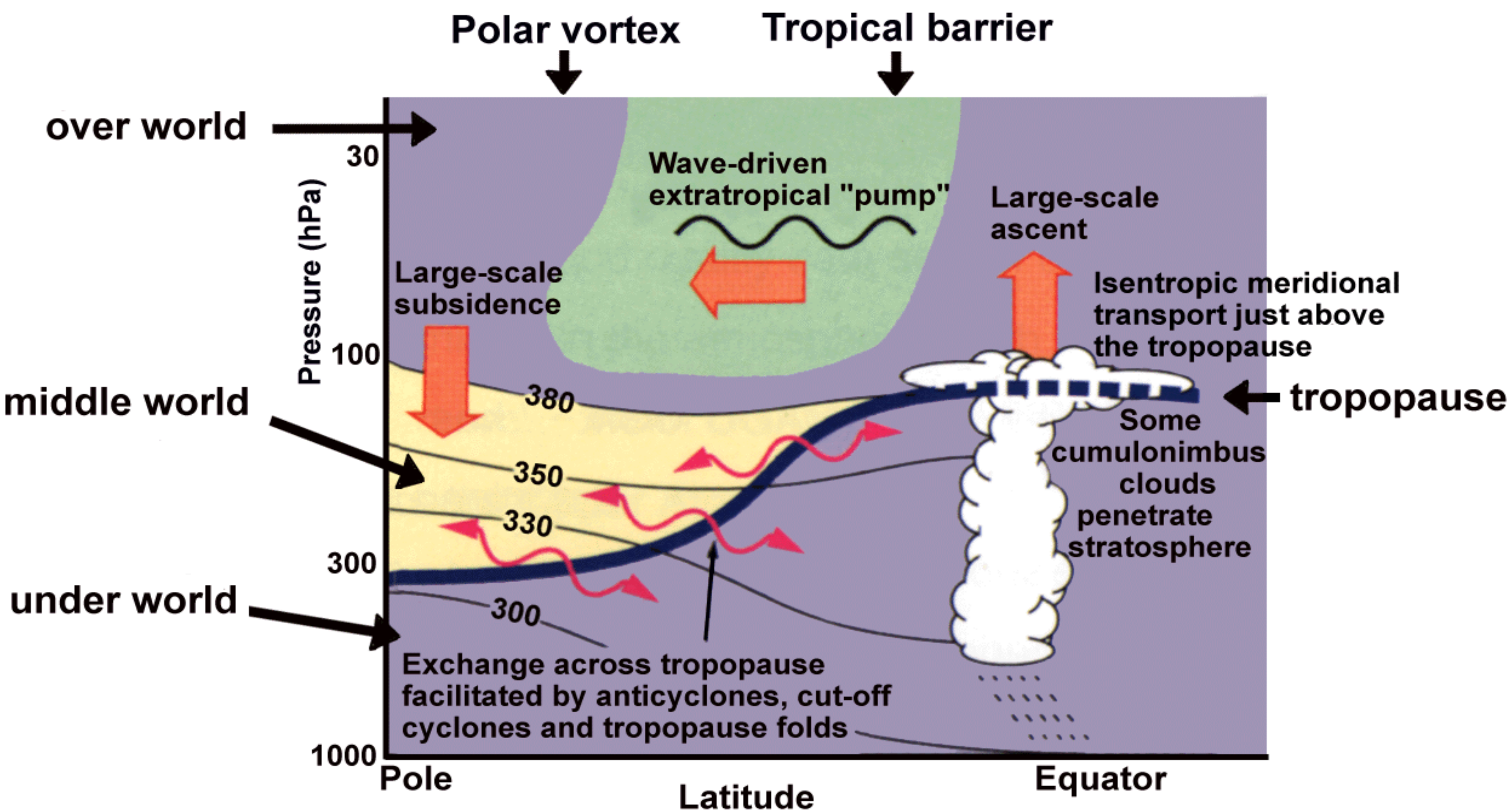
Accumulated 'degree days' below Type-1 PSC formation temperature (195 K) at 40 hPa (approx 20 km) at the North Pole 1992-2000 (from UK Met. Office).



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?

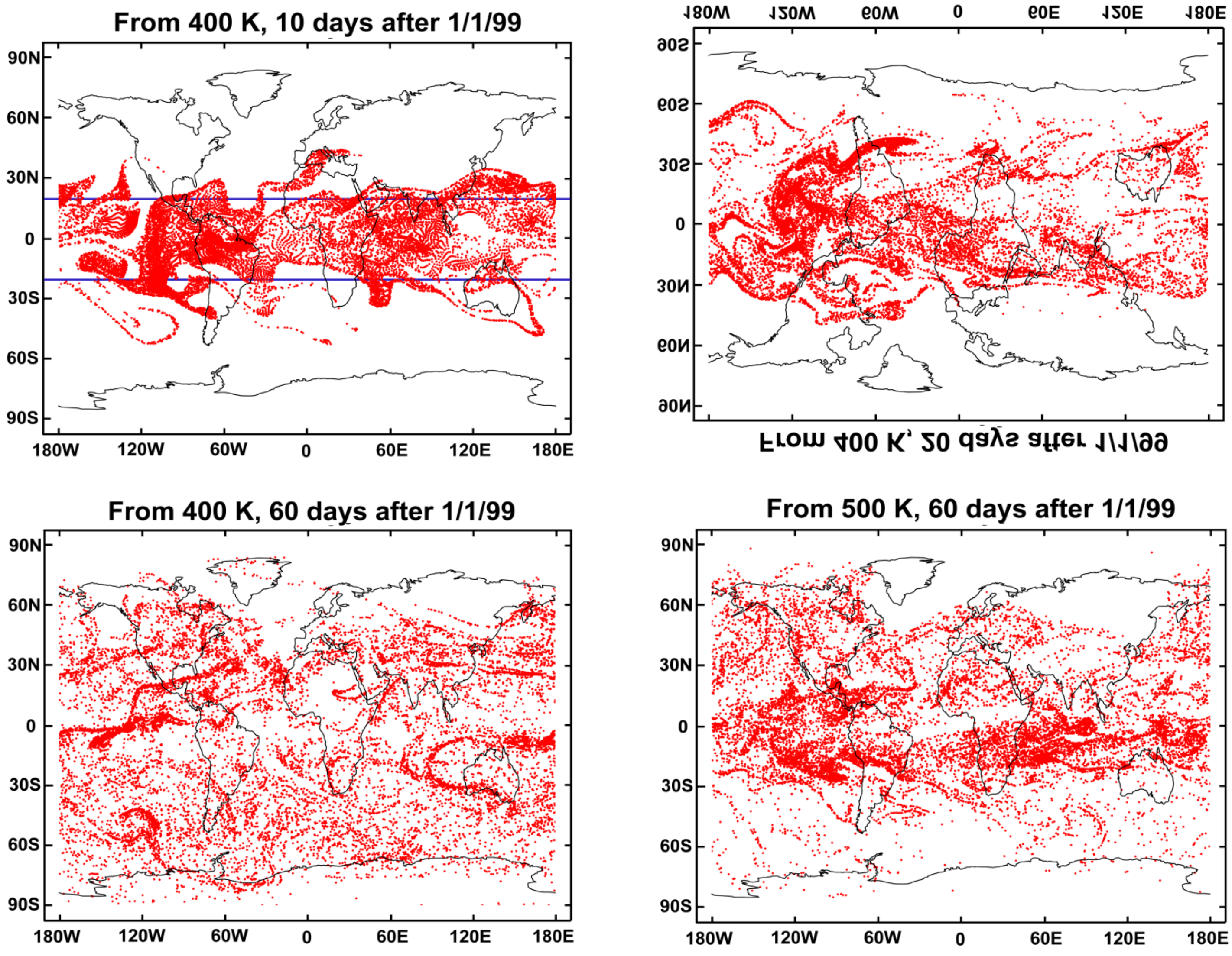
Transport features observed by HIRDLS



[Figure from J.Holton/UGAMP]

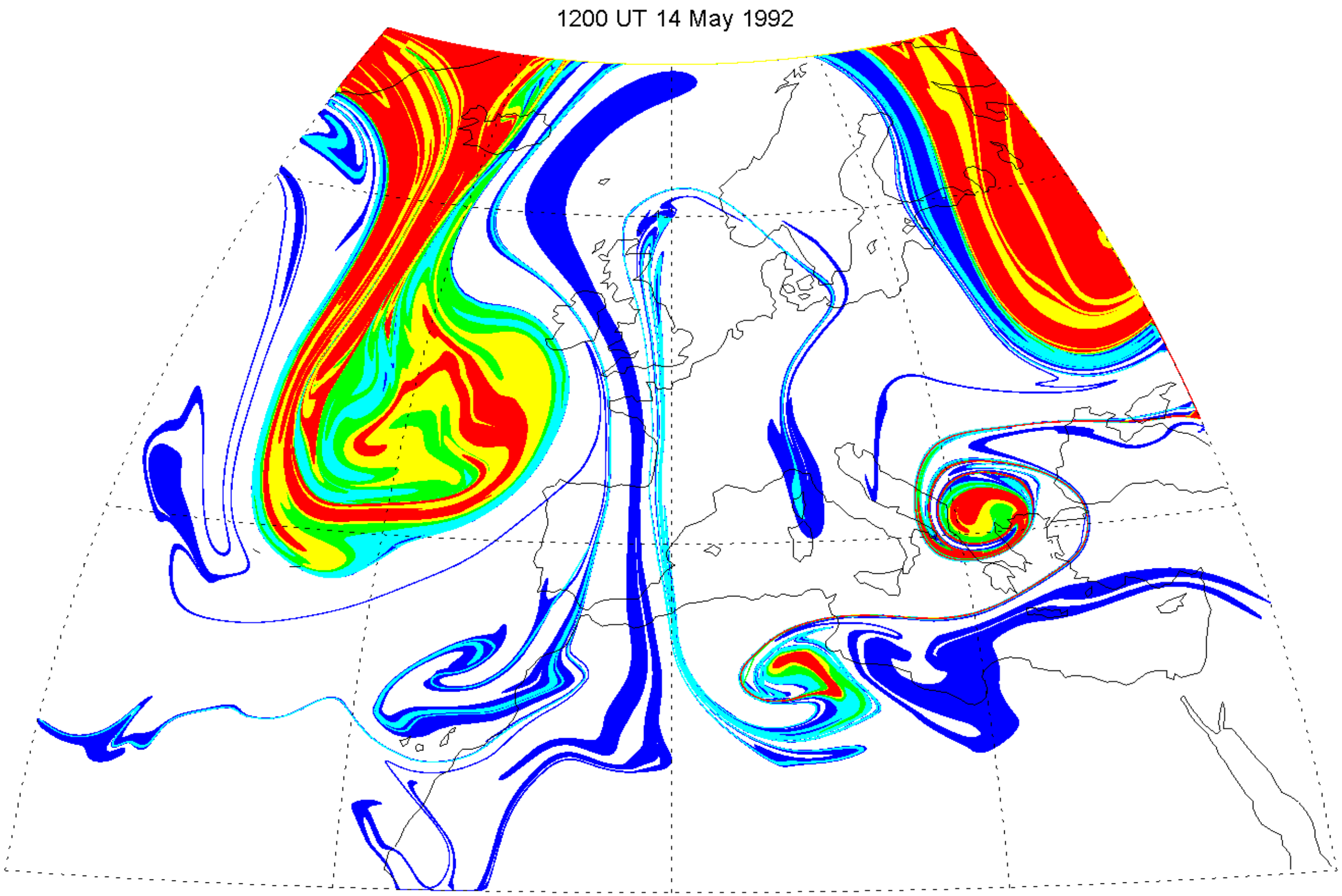
Isentropic transport near the tropopause

Particles released on 400 K isentrope between 20^{o} S and 20^{o}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]]