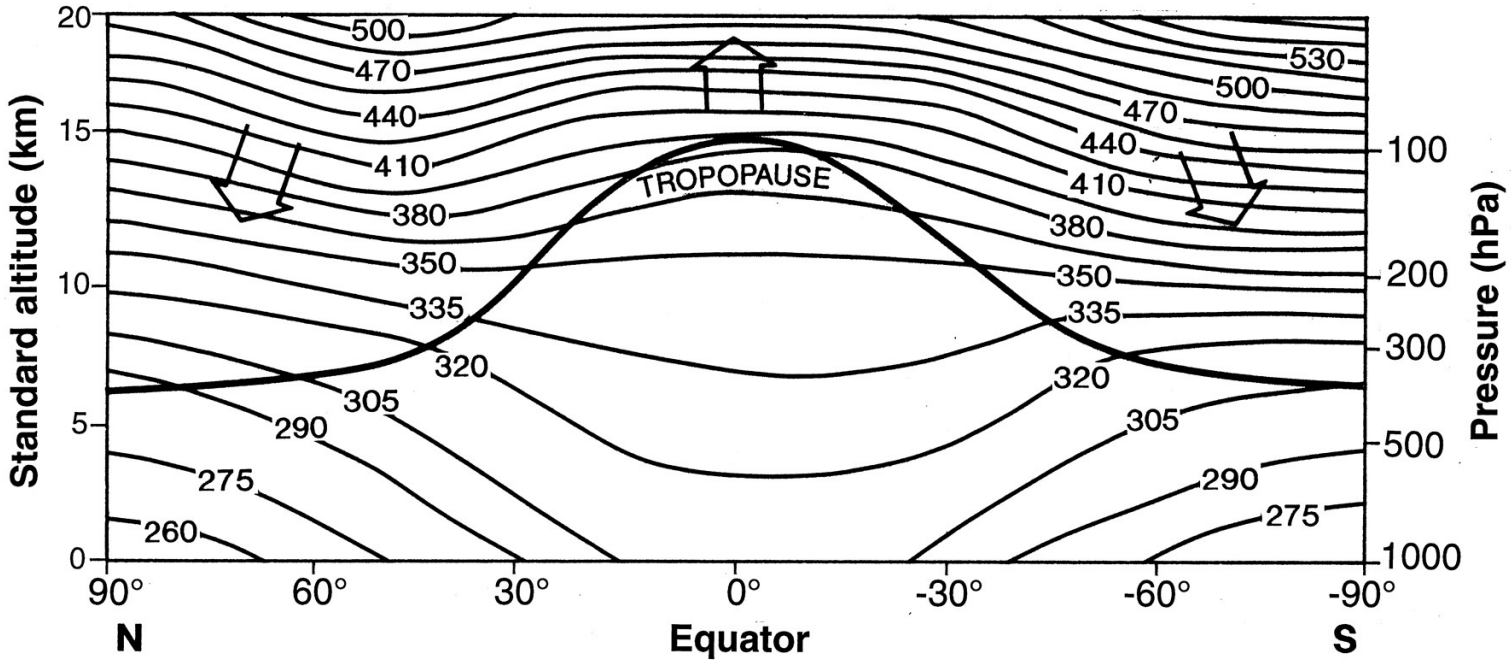
ENV 320 – Stratospheric Chemistry

Exercise session

01.05.2025

What is the approximate height of the tropopause ?



0 ×

5 km

0 ×

10 km

0 ×

20 km

0 ✓

It depends on the latitude and season.

What describes best the isentropic transport in the stratosphere ?

Isentropic transport happens **horizontally** (not vertically) along **surfaces of constant potential temperature**, **not pressure**.

0 ×

Transport that occurs only vertically along constant pressure surfaces.

Temperature varies with altitude and is **not conserved** during adiabatic processes.

0 ×

Transport along surfaces of constant temperature.

0 ✓

Transport along surfaces of constant potential temperature, often associated with large-scale horizontal movement.

Convection is **dominant in the troposphere**, not in the stratosphere.

0 ×

Transport caused solely by convection in the troposphere.

The tropopause is an impermeable barrier between the troposphere and the stratosphere.

0	0
True	False

What does 1 Dobson Unit (DU) represent ?

0 ×

The concentration of ozone at ground level in $\mu g/m^3$.

0 ×

A 1 mm thick layer of ozone at sea level pressure and temperature.

0 ✓

The amount of ozone that would form a 0.01 mm thick layer at STP.

0 ×

The number of ozone molecules in a cubic meter of air at 10 km altitude.

Which of the following is **not** considered part of the stratospheric ozone sink ?

0 ×

Catalytic cycles of O3 involving nitrogen oxides (NO, NO2).

0 ×

Catalytic cycles of O3 involving hydrogen oxides (OH, HO2).

0 ✓

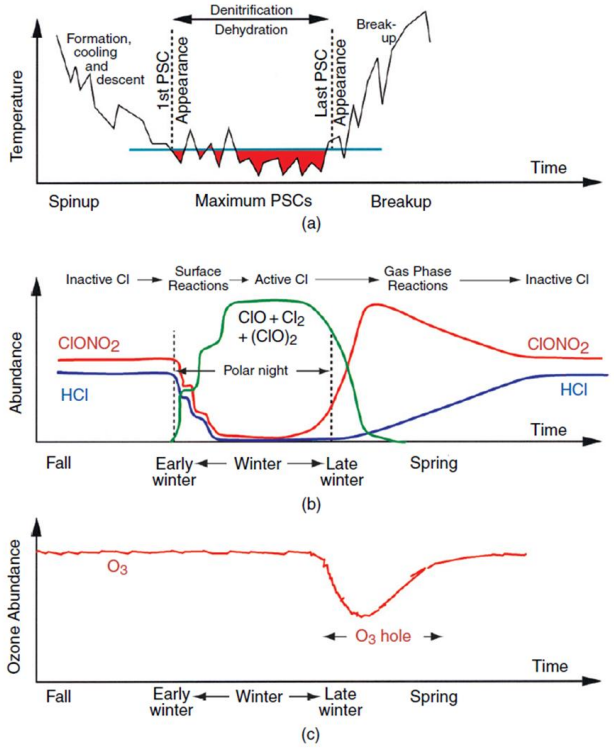
Catalytic cycles of O3 involving sulfur oxides (SO, SO2).

0 ×

Catalytic cycles of O3 involving halogens (Cl, Br).

Over Antarctica, ozone destruction is maximal in winter when there is no sunlight.

- Ozone destruction requires **sunlight**, which is absent during the Antarctic winter. Ozone destruction happens in **spring**, when sunlight returns.
- In **winter**, **PSCs** form and prepare reactive chlorine, but ozone destruction is minimal because sunlight is needed to activate the chlorine.



0 ×

True

0 ✓

False

Why are reservoir species important for stratospheric ozone depletion ? (multiple answers)

0 ✓

They temporarily store reactive radicals in inactive forms.

0 ×

They directly destroy ozone in catalytic cycles.

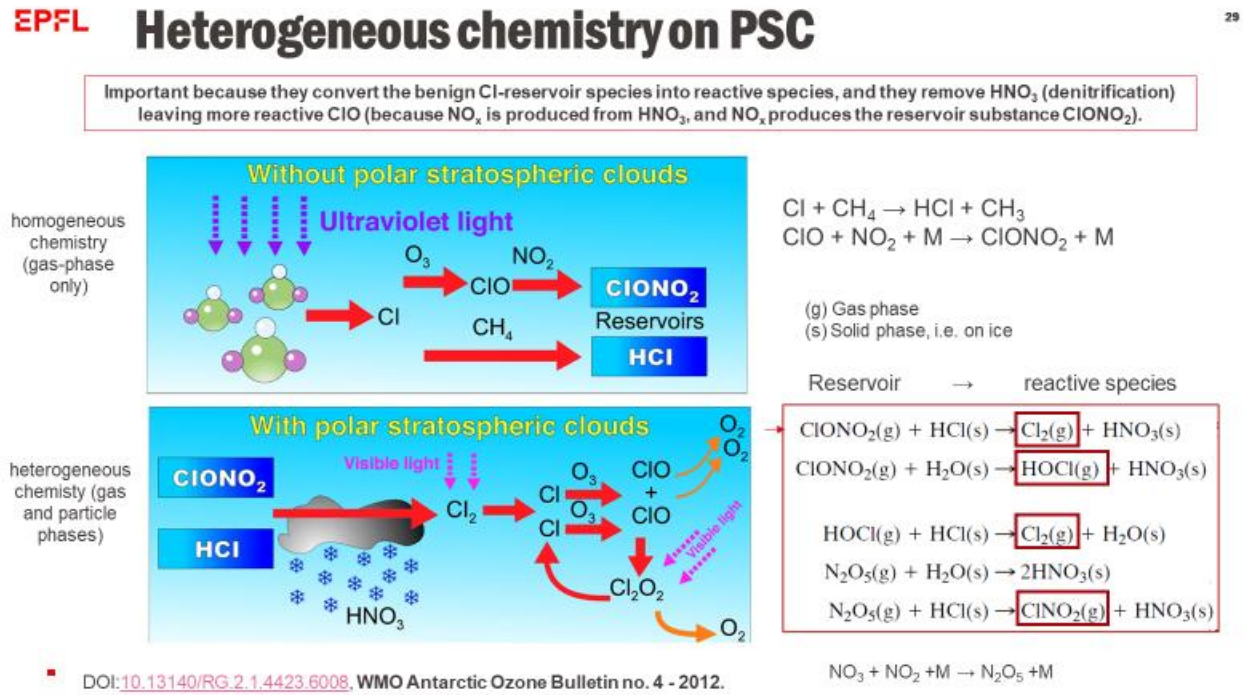
0 ✓

They can release reactive species (radicals or molecules) under certain conditions like PSC reactions or photolysis.

0 ×

They permanently remove radicals from the atmosphere.

How does denitrification contribute to ozone depletion via heterogeneous chemistry on polar stratospheric clouds (PSCs) ?



0 ×

It enhances the formation of ozone in the lower stratosphere.

0 ✓

It removes HNO_3 from the gas phase, reducing NO_x and shifting the equilibrium away from $ClONO_2$ formation, leaving more reactive chlorine.

0 ×

It increases the production of NO_2, which directly destroys ozone.

Processes leading to the Antarctic ozone hole also occur in the Arctic. Why is ozone depletion generally less pronounced in the Arctic?

0 ×

The Arctic has lower levels of chlorine and bromine compounds compared to Antarctica.

0 ×

The Arctic receives less sunlight in spring, reducing photochemical ozone destruction.

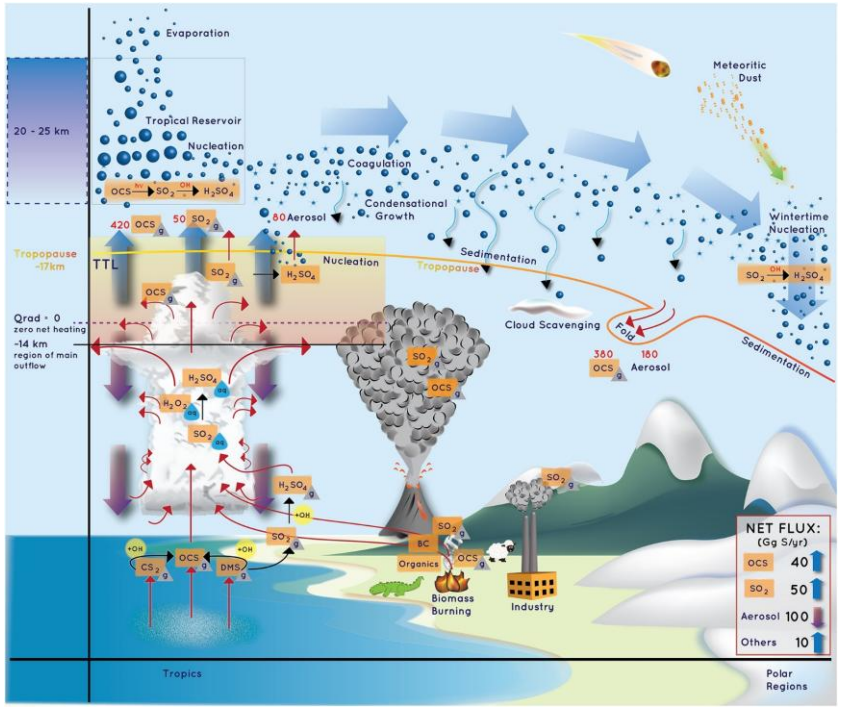
0 ×

It is dark year-round in the Arctic, so sunlight-driven ozone destruction cannot occur.

0 ✓

The Arctic stratosphere is generally warmer and less stable, leading to fewer and less persistent Polar Stratospheric Clouds (PSCs).

Which of the following are significant sources of aerosols in the stratosphere ? (multiple answers)



- Major volcanic eruptions can inject large amounts of SO_2 into the stratosphere, forming sulfate aerosols that influence both ozone chemistry and climate.
- Although most human emissions remain in the troposphere, some sulfur compounds can reach the lower stratosphere, contributing to aerosol formation.

Kremser et al., 2016, [10.1002/2015RG000511](https://doi.org/10.1002/2015RG000511)

0 ×

Sea salt spray from ocean waves.

0 ✓

Volcanic eruptions injecting sulfur gases into the stratosphere.

0 ✓

Anthropogenic emissions of sulfur compounds from aviation and industry.

0 ×

Pollen released from vegetation during spring.