Student question: why is the **ozone hole** partially ringed by an **ozone maximum**?

1) Why an Ozone HOLE? (This is covered in Sec 17.2.1, excluded from our curriculum)

NOT EXAMINABLE

Use of hydrofluorocarbons (CFCs) has resulted in chlorine being released into the atmosphere, albeit mostly in chemical forms that are stable under normal atmospheric conditions ("reservoir gases", e.g. HCl, $ClONO_2$). Residence times of these gases are of order 100 years (thus slow response of ozone hole to their prohibition under the 1987 Montreal Protocol).

During winter, polar stratospheric clouds (PSCs) form. Unusual chemical reactions take place on the surfaces of cloud particles (which may be water, ice, or nitric acid, depending on the temperature).The "reservoir" gases are converted into reactive forms; more specifically, nitric acid (HNO_3) reacts with the reservoir gases form molecular chlorine (Cl_2), which catalyzes the photochemical destruction of ozone. The consequent ozone destruction is greatest when the sunlight returns in spring.

Particularly in the S. hemisphere and particularly in winter, there is a strong wind current around the pole (the "stratospheric polar vortex", see following page). Major "eddies" in this current are infrequent (which is the same as to say that the polar vortex is predominantly a "zonal" current). Thus it can be said that latitudinal mixing by eddies – these being disturbances that cause meridional currents – is weak, effectively "isolating" the polar atmosphere. What is the implication? At least in a climatological sense, no strong southward eddy flux of ozone compensates for ozone destroyed over the S. polar region.

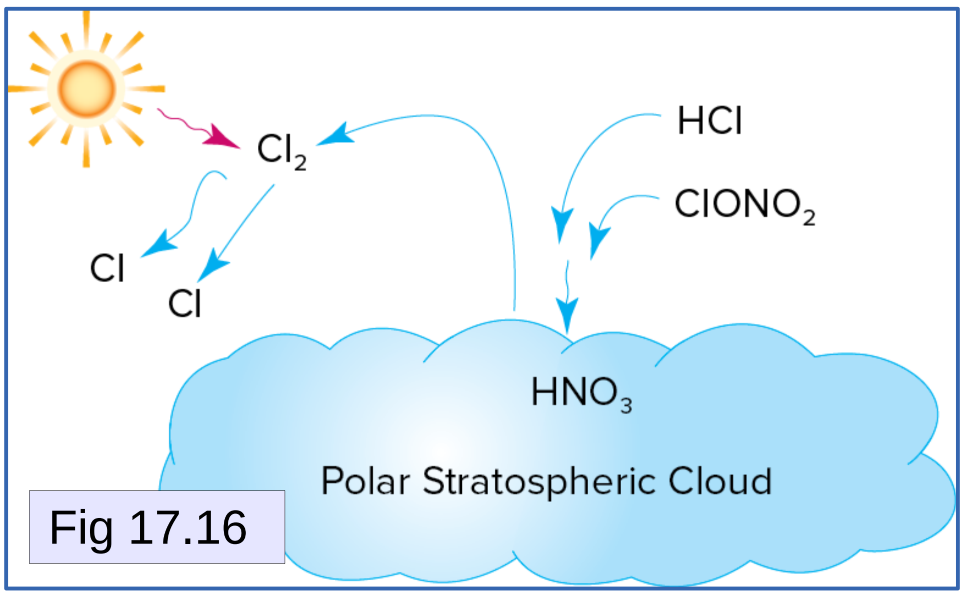
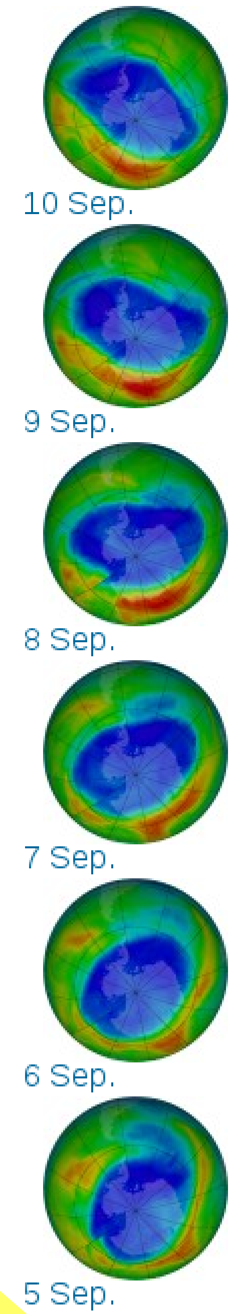


Fig 17.16



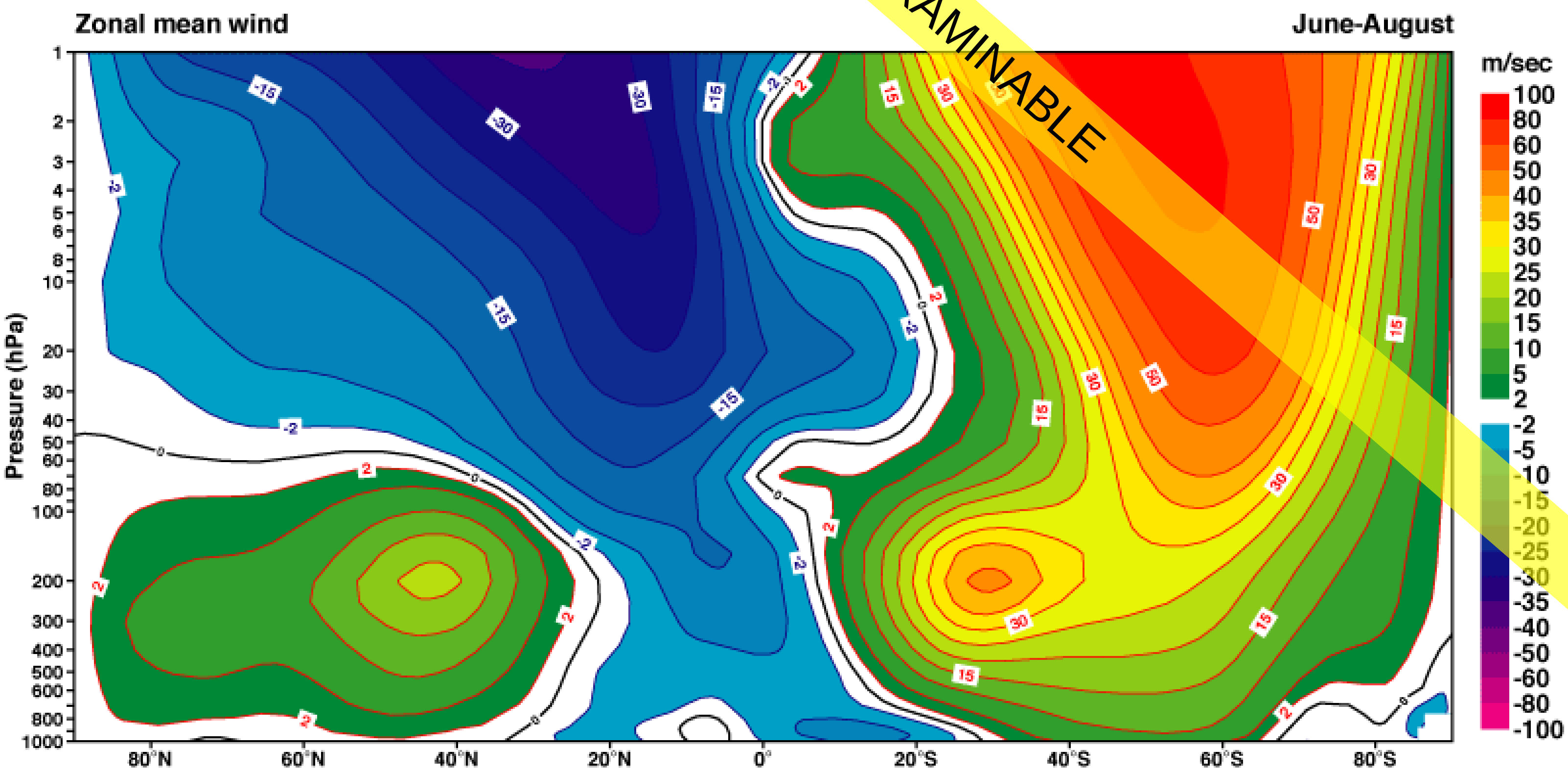
2) Why (on this occasion) is the hole partially ringed by an ozone maximum?

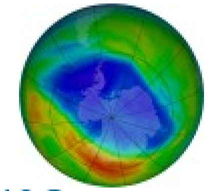
Firstly, the (fragmented) ring of enhanced concentration noted 10 Sept. 2016 is not a usual aspect of the ozone hole. More typically, plots like this show a steady increase in ozone concentration with distance away from the ozone minimum.

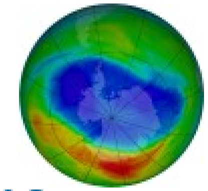
Secondly, we know that the instantaneous ozone concentration is sensitive to many factors, including the pattern of the winds (and degree of north-south transport of CFCs, i.e. latitudinal mixing), temperature, sunlight and (in fact) much more. Thus any explanation short of an explicit modelling study will be a hypothesis

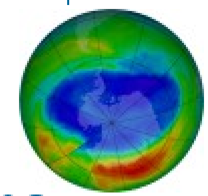
Thirdly, according to Ahrens, Jackson and Jackson ("Meteorology Today") the Antarctic stratosphere "normally has among the world's highest ozone concentrations." Therefore perhaps we can view the ozone "hole" as having been formed at the centre of a maximum in ozone concentration: this ***could*** explain the outer ring of enhanced concentration that is *sometimes* noticeable.

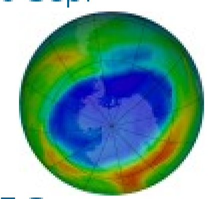
NOT EXAMINABLE

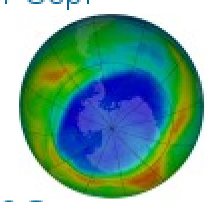


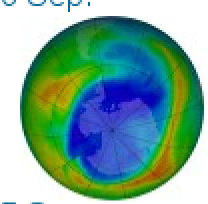

10 Sep.


9 Sep.


8 Sep.


7 Sep.


6 Sep.


5 Sep.