Subject: Scholes Cabin 5 (P): The ozone hole

02 December 2010 1829 UTM (near Atka Bukta - my GPS is switched off)

Dear Stirling

When we go outside here we are all bundled up against the cold, but we also have to remember to put on sunblock and sunglasses if we want to avoid sunburn and snow-blindness, which is a sort of sunburn of the eye. That is because although the sun is low in the sky here, it is fierce in ways that are not immediately obvious.

Most people have heard of the 'ozone hole', but they usually mix it up with global warming. There are some connections, but mostly they are separate things. Normally oxygen goes around in the atmosphere as a pair of atoms, O2. A tiny fraction is in the form of ozone, or O3. Ozone is formed as a byproduct of certain chemical reactions in the atmosphere, in the presence of sunlight. The oxygen triplet is unstable, and will react with just about anything. That includes the inside of our respiratory system, which makes ozone a dangerous gas if present in the part of the atmosphere that we breathe - the Troposphere- in concentration of more than a few parts per million.

But there is a good side to ozone too. Those O3 bonds are just right to absorb the energy of a part of the electromagnetic spectrum that is really bad for us: the ultra violet. (I am picking my words carefully here – some people call this 'Ultraviolet light', but strictly speaking, since humans can't see it with our unaided eyes, it is not light. It is the part of the spectrum where the wavelengths are just shorter than blue light. Some insects can see it.) UV also happens to have just the right energy to break up DNA, and that is not good for living things. So anything that absorbs UV in the atmosphere before it frazzles life on earth is a big benefit. That is where ozone, in a high part of the atmosphere called the Stratosphere, comes into the picture. The ozone concentration is much greater there, because of the bright sunlight above the clouds. Even so, if all the ozone in the Stratosphere were to be concentrated into one pure layer, it would be less than a metre thick. When we talk of an ozone 'hole', we don't actually mean a physical tear, but really a thinning in that layer, which isn't really a layer at all, just a way of thinking about it.

The polar regions are particularly important in this story. First, the magnetic poles, which are quite close to the pole of the Earth's rotation, set up a magnetic field which screens us from yet other forms of harmful radiation (and in the process, create lovely flickering lights in the night sky, called the aurora, which we can't see because the sun won't go down!). The rotation of the Earth causes a whirlpool in the atmosphere above the poles, called the Polar Vortex. It is particularly strong above Antarctica because there is hardly any land to slow down the air movement between 50 S and 66 S. This vortex draws in upper air, which descends over the poles, causing Antarctica to be a dry and windy

desert (though it doesn't look like one). In the process, human-caused pollutants are also sucked in. One of those is a group of gases called Chlorofluorocarbons, or CFCs. CFCs don't occur in nature, they are entirely human-made, and were only invented about seventy years ago.

The CFCs have wonderful properties. They are almost inert (in other words, unlike ozone, they do not pick fights with everything else). They make excellent gases for inside fridges and air-conditioners, fire extinguishers and aerosol cans. Incidentally, they are also very powerful 'greenhouse gases' - the connection to global warming- but their total concentration is small, so they are not a big contributor to that issue. The CFCs leaked into the atmosphere where they eventually wriggled and jiggled their way up to the Stratosphere, and were vacuumed down to the poles. There they found ideal conditions on the surface of ice crystals for chewing up ozone. The problem was that they were mostly not destroyed themselves in the process. The result was a big reduction in the Stratospheric ozone content, especially over the South Pole - what came to be known as the 'ozone hole'.

It was first discovered pretty much by accident, when some ground level UV measurements made in Antarctica in the 1960s did not agree with measurements made later. Then the size and shape of the depletion was revealed by satellites. The seriousness of the situation was clear, and there was not much doubt about what caused it. Fortunately, there was also another family of chemicals that could do more-or-less the same job as the CFCs, but were less destructive of ozone. The result was an international agreement to stop using CFCs. The ozone hole is still there, but is predicted to shrink gradually over the next few decades, as the last of the CFC finds its way through the atmosphere, down to the poles, and is used up.

That is the other connection with climate change. The experience of cooperating to fix the ozone hole lent hope that climate change could be tackled the same way. But it is proving a harder problem to solve.

The bay ice is breaking up, and it is no longer safe to unload at Atka Bukta. What is left is small loads, and it may be able to helicopter them off at Penguin Bukta. The weather a SANAE IV is forecast to improve soon, so there is hope to fly the takeover team and the summer workers there within a day or two. In the meantime it has turned snowy here.

Love,

Dad