August 7, 2016 @ Yaroslavl, Russia

Noctilucent Clouds

Noctilucent clouds are composed of tiny crystals of water ice up to 0.1 micron in diameter. They are the highest clouds in Earth's atmosphere, located in the mesosphere at altitudes of around 76 to 85 kilometres (47 to 53 mi).

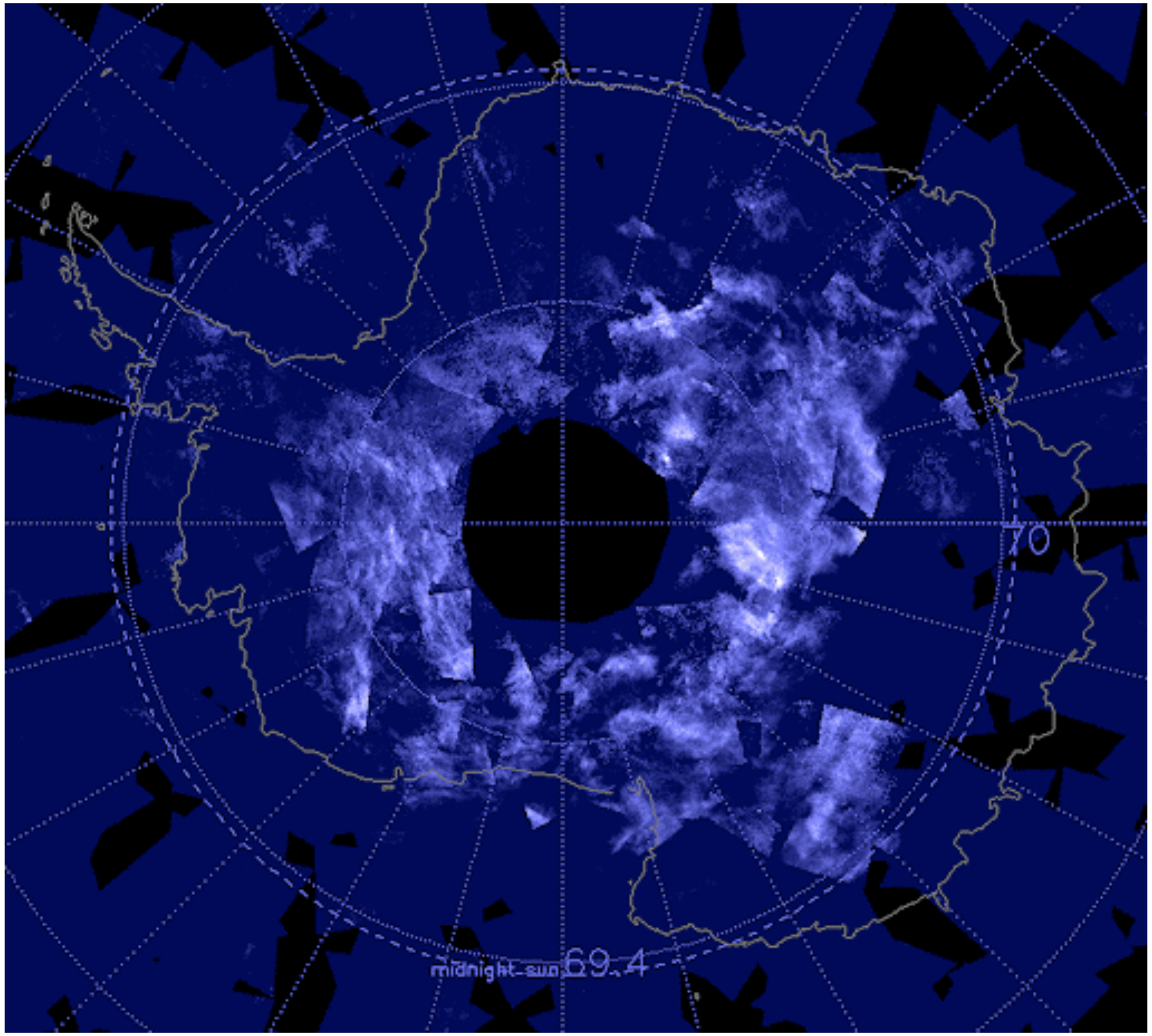
They are most commonly observed in the summer months at latitudes between 50° and 70° north and south of the equator. These clouds can be observed only when the Sun is below the horizon for the observer, but while the clouds are still in sunlight.

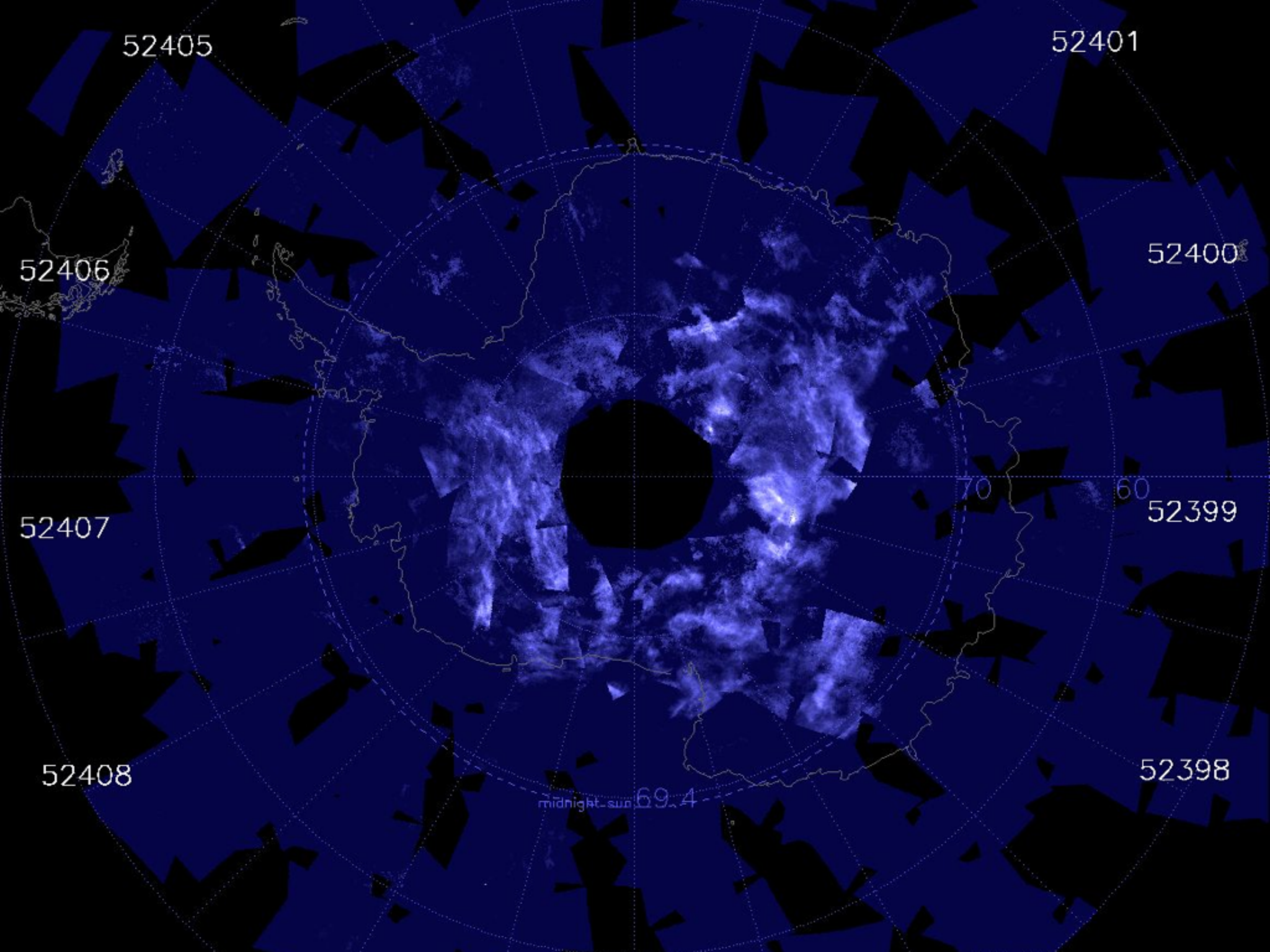
Noctilucent clouds require water vapour, dust, and very cold temperatures to form. The sources of both the dust and the water vapour in the upper atmosphere are not known with certainty.

The dust is believed to come from micrometeors, although particulates from volcanoes and dust from the troposphere are also possibilities.

The moisture could be lifted through gaps in the tropopause, as well as forming from the reaction of methane with hydroxyl radicals in the stratosphere.

NOCTILUCENT CLOUDS APPEAR OVER ANTARCTICA: This just in from NASA's AIM spacecraft: The sky above Antarctica is glowing electric blue. A ring of bright noctilucent clouds (NLCs) has formed around the South Pole, shown here in a Nov. 24, 2016, image taken by the spacecraft's Cloud Imaging and Particle Size (CIPS) Instrument:

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midnight sun 69.4

Southern Hemisphere Noctilucent Clouds

"This season started on Nov. 17th, and is tied with 2013 for the earliest southern hemisphere season in the CIPS data record," says Cora Randall, a member of the AIM science team at the University of Colorado.

NLCs are Earth's highest clouds. They form more than 80 km above Earth's surface. Indeed, they are a mixture of Earth and space: Wisps of summertime water vapor rising from the planet below wrap themselves around meteoroids, forming tiny crystals of ice. Emphasis on *summertime*; NLCs appear on the eve of summer in both hemispheres.

There is growing evidence that noctilucent clouds are boosted by climate change. In recent years they have been sighted at lower latitudes than ever before, and they often get started in earlier months as well.

"The early start of the 2016 season was not at all a surprise," says Randall. "The southern hemisphere polar stratospheric winds switched to their summer-like state quite early this year."

August 2, 2016 @ Milovaig, Isle of Skye, Scotland

The Aeronomy of Ice in the Mesosphere (AIM)

The Aeronomy of Ice in the Mesosphere (AIM) satellite mission is exploring Polar Mesospheric Clouds (PMCs), also called noctilucent clouds, to find out why they form and why they are changing.

The AIM mission was launched in 2007. The instruments monitor noctilucent clouds to better understand their variability and possible connection to climate change.

The primary goal of the AIM mission is to help scientists understand whether the clouds' ephemeral nature, and their variation over time, is related to Earth's changing climate - and to investigate why they form in the first place. By measuring the thermal, chemical and other properties of the environment in which the mysterious clouds form, the AIM mission will provide researchers with a foundation for the study of long-term variations in the mesosphere and its relationship to global climate change. In addition to measuring environmental conditions, the AIM mission will collect data on cloud abundance, how the clouds are distributed, and the size of particles within them.

July 20, 2016 @ Calgary, AB, Canada

The Aeronomy of Ice in the Mesosphere (AIM) Satellite is the first satellite with a primary mission dedicated to the study of polar mesospheric clouds.

It has aboard it three payloads:

1) the **Cloud Imaging and Particle Size (CIPS)** instrument, providing a 2-D panoramic look at polar mesospheric clouds by collecting 360 degrees of multiple images,

2) the **Solar Occultation for Ice Experiment (SOFIE)** payload, measuring the variability of cloud particles with respect to their altitude and their chemical composition, and

3) the **Cosmic Dust Explorer (CDE)**, recording the amount of space dust entering Earth's atmosphere in order to assess whether space dust provides the foundation for the cloud condensation nuclei in the formation of noctilucent clouds.

The AIM satellite typically makes fifteen overpasses each day. The image shows how each overpass can be superimposed during a period of one day.

Climate Change at the Edge of Space

http://news.spaceweather.com/climate-change-at-the-edge-of-space/

Noctilucent clouds are the highest clouds in the Earth's atmosphere, 83 km (50 miles) and are observed slightly below the mesopause in the polar summertime. These clouds are of special interest, as they are sensitive to both global climate change and to solar/terrestrial influences.

The first recorded sightings of noctilucent clouds were reported in 1885 and both satellite and ground-based observations over the past four decades have indicated that the presence of these clouds has been increasing in frequency, brightness, and extent.

Scientists now realize that these clouds are very sensitive indicators for what is going on in the atmosphere at higher altitudes as small changes in the atmospheric environment can lead to large changes in the properties of these clouds.

Further, since these clouds form on condensation nuclei through cold temperatures and the presence of water vapor – and these properties of the mesosphere are tied to carbon dioxide and methane, the anthropogenic causes of climatic change may be directly related to the presence of noctilucent clouds.

http://projectpossum.org/research/noctilucent-cloud/about-noctilucent-clouds/


July 28, 2016 @ Paisley Scotland

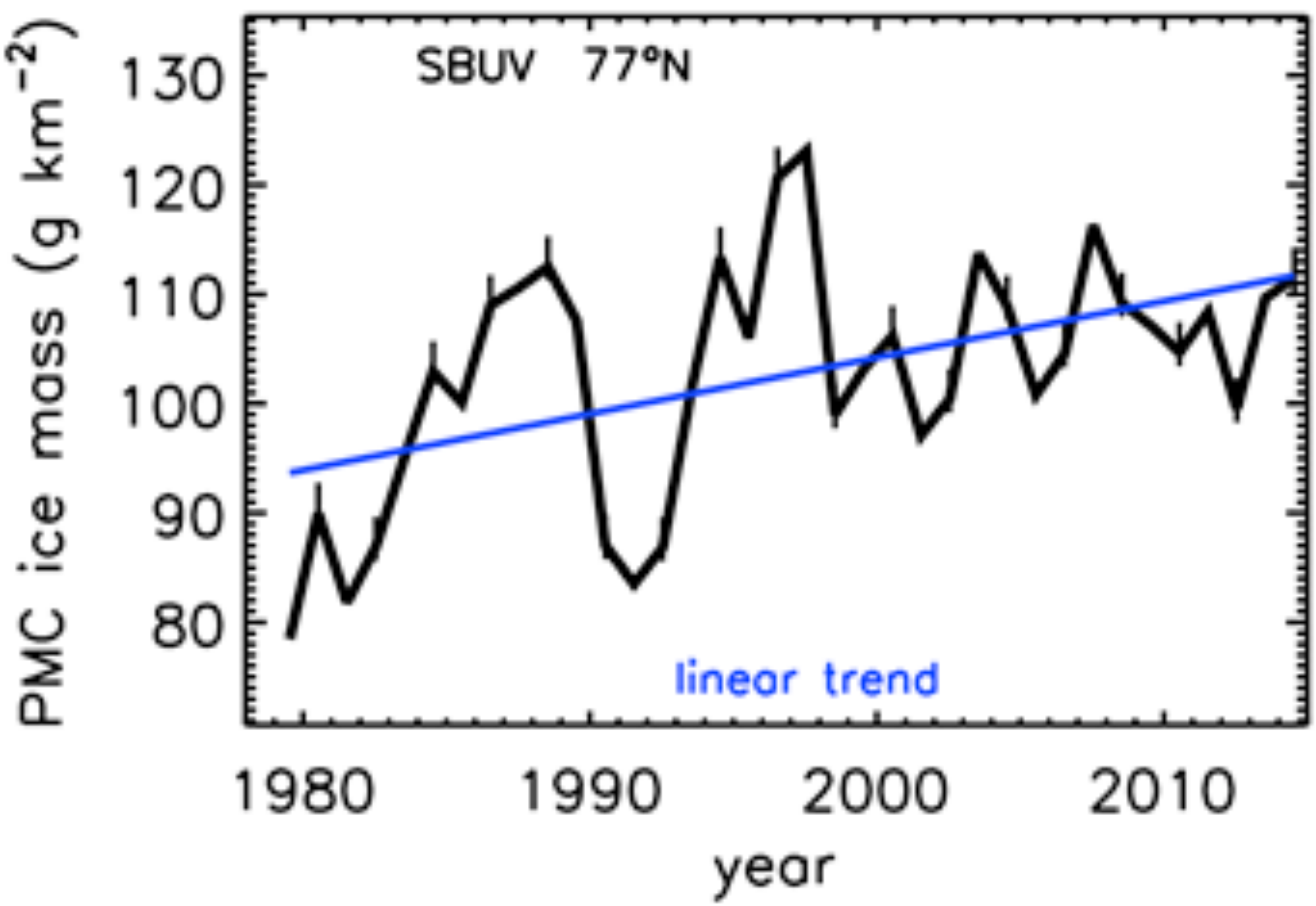
Noctilucent clouds (NLCs) appear with regularity in summer months, shining against the starry sky at the edge of twilight. They are normally too faint to be seen, and are visible only when illuminated by sunlight from below the horizon while the lower layers of the atmosphere are in the Earth's shadow. In the 19th century you had to go to high latitudes to see them. In recent years, however, they have been sighted from backyards as far south as Colorado and Kansas.

Noctilucent clouds are such a mystery that in 2007 NASA launched a spacecraft to study them. The Aeronomy of Ice in the Mesosphere satellite (AIM) is equipped with sensors specifically designed to study the swarms of ice crystals that make up NLCs. Researchers call these swarms “polar mesospheric clouds” (PMCs).

A study published in the *Journal of Geophysical Research* (doi: 10.1002/2015JD024439) confirms what some researchers have long suspected: PMCs in the northern hemisphere have become more frequent and brighter in recent decades—a development that may be related to climate change.

The story begins long before the launch of AIM.

According to data from the Solar Backscatter Ultraviolet (SBUV) instrument on NOAA weather satellites, the ice mass of PMCs has increased since 1980.



Why did the upper mesosphere (the atmospheric layer where PMCs form) become icier?

The ingredients for PMCs are simple enough. Ice requires water molecules + freezing temperatures. However, SBUV could not tell researchers if the mesosphere was getting wetter or colder–or both.

Fortunately, AIM has an instrument onboard named SOFIE that can unravel the water-temperature knot. Scientists recently interpreted the 36-year SBUV record using data from SOFIE, and this is what they found:

At altitudes where PMCs form, temperatures decreased by 0.5 ±0.2K per decade. At the same time, water vapor increased by 0.07±0.03 ppmv (~1%) per decade.

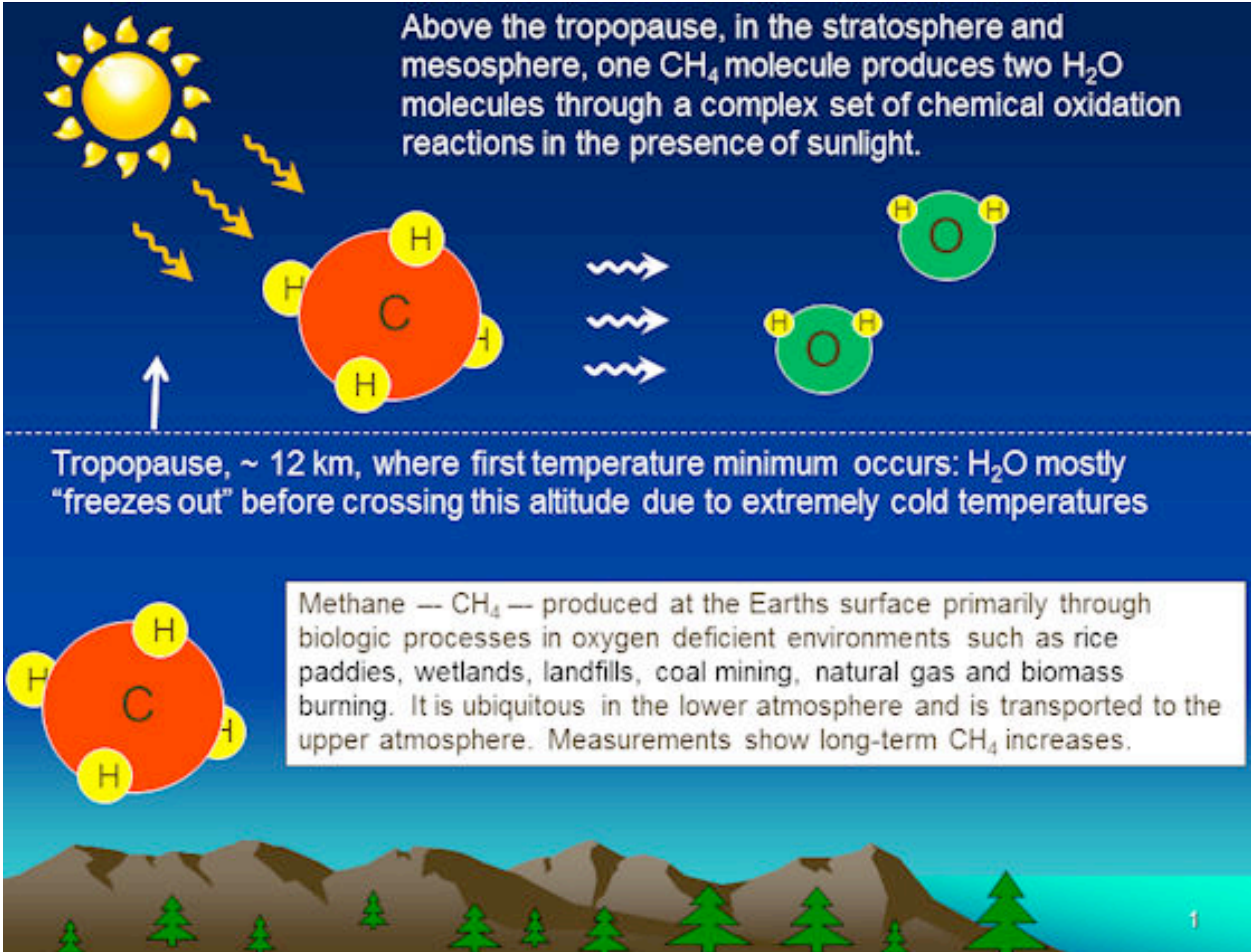
August 7, 2016 @ Kitee, Finland

A simple model links PMCs to greenhouse gases

These results are consistent with a simple model linking PMCs to two greenhouse gases.

First, carbon dioxide promotes PMCs by making the mesosphere colder. (While increasing carbon dioxide warms the surface of the Earth, those same molecules cool the upper atmosphere – a yin-yang relationship long known to climate scientists.)

Second, methane promotes PMCs by adding moisture to the mesosphere, because methane oxidizes into water (next slide).


Above the tropopause, in the stratosphere and mesosphere, one CH_4 molecule produces two H_2O molecules through a complex set of chemical oxidation reactions in the presence of sunlight.
H
H
C
H
H
H
O
H
H
O
H
Tropopause, ~ 12 km, where first temperature minimum occurs: H_2O mostly "freezes out" before crossing this altitude due to extremely cold temperatures
H
H
C
H
H
Methane — CH_4 — produced at the Earths surface primarily through biologic processes in oxygen deficient environments such as rice paddies, wetlands, landfills, coal mining, natural gas and biomass burning. It is ubiquitous in the lower atmosphere and is transported to the upper atmosphere. Measurements show long-term CH_4 increases.
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