Noctilucent Clouds and Climate Change

Professor James Russel / Hampton University

We are publishing a dialogue between students and Dr. Russell celebrated in the context of NASA Satellite Missions Study Climate Symposium, accompanied with Hampton University, Colorado State University, Fort Hays State University and NASA. This Symposium was celebrated in Tecnológico de Monterrey, Campus Guadalajara (Jalisco, México) on 26 January 2008.

This special event is designed for those students and professors who share an interest and experience in mathematics. The NASA Satellite Missions Study Climate symposium is focused on real life applications of mathematics to resolve worldly environmental issues such as Global Warming, Climate Change and Shift, and Noctilucent Clouds. The event consisted of live informative conferences and videoconferencing by expert scientists and researchers from recognized institutions in the United States, as well as workshops of advanced training taught by our knowledgeable staff.

Dr. Russell is an AIM Principal Investigator in Hampton University. His research has been focused on atmospheric science, remote sensing, and satellite data analysis to study properties and processes in Earth's atmosphere. He began his career in electrical engineering at the NASA Langley Research Center in Hampton, Virginia developing instrumentation and performing ground and rocket re-entry tests of heat shielded material used on the Gemini and Apollo capsules. He also worked on instrumentation for characterizing the Martian atmosphere during entry. His early research led naturally to a deep interest in atmospheric phenomena of all kinds. He has served as Co-PI on the Nimbus-7 LIMS experiment to study odd nitrogen effects on the ozone layer and PI for the HALOE experiment on the UARS satellite to study odd chlorine and odd nitrogen effects on ozone. He currently serves as PI for the SABER experiment on the TIMED satellite to study the chemistry, dynamics and energetics of the thermosphere and mesosphere and PI on the AIM mission to study noctilucent clouds.

Dr. Russell served as head of the Chemistry and Dynamics Branch and the Theoretical Studies Branch in the NASA Langley Atmospheric Sciences Division and currently is a Professor of Atmospheric and Planetary Sciences and Co-Director of the Center for Atmospheric Sciences at Hampton, University in Virginia.

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Prof. Russel: I am going to talk about what we call night shinning clouds, clouds that occur after the sun is going down, but they are still shinning. The word noctilucent in 'noctilucent cloud' means night shinning. I refer to NLC which means noctilucen clouds, or I may say, polar mesosphere clouds. Mesosphere is a region in atmosphere that starts at around 30 miles above the surface of the Earth and goes up to about 50 miles above the Earth surface, these clouds that we are talking about occur in the polar regions' mainland and in the upper part of the mesosphere, around 50 miles above the surface.

NLC are the highest clouds in our atmosphere. Most of the clouds that you see when you go outside are around 6 miles above the surface, but these clouds are 50 miles above the surface, around 83 km and they are almost at the edge of space where the atmosphere is also really changing significantly. The clouds usually occur at latitudes of colder high latitudes of 50 degrees and they occur at both atmospheres.

They form the coldest place on Earth which is a temperature of 130 Kelvin degrees or about minus 250 degrees Fahrenheit. And they usually occur at summer time. They are made up of water crystals, ice water ice crystals, which are very small particles. The radius of the particles is by 50 nanometers, that is 50 billions of a meter and if you look at the radius of the human hair 500 times larger than you see on small particle. The central particle is really small. In the sky you can see them very clearly.

NLC usually occur during a 12-week period, 2 weeks after the solstice. And of curse this solstice is on the entire atmosphere on June 21 for the summer and December 21 for the winter. They occur on the summer hemisphere always, and the natural time when you see them is about 20 days after the solstice.

The vertical axes go to 40 degrees latitude to 140 degrees latitude. So, does the latitude go to 140 degrees?

Student: It goes to 120.

Prof. Russel: Latitude goes to 90, that is a trick question and a trick figure, because this shows the kind of annuities, it goes from 40 up to 90 at the pole, and then if you go 10 degrees more then you are on the side of the Earth, you are back at 80 again and then your existing is 120 degrees. That is just for convenience.

That shows you that the clouds start at around 20 days before the solstice ant they peak around 20 days after, going away again around 60 days after the solstice. And I thought about that, about the horizontal axes. There are 20 days after this solstice whereas cero in June 21 in the northern hemisphere. And minus 20 is 20 days before, so that's June 1st, and 20 days after the solstice when they peak is around July 10.

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This is again a little tricky and a little tactical for you to know all about this. But the vertical axes show a frequency, it is like a probability. If you look at clouds of one day and you look at clouds of 100 days, how many days up to a hundred do you see the clouds? That is what the vertical axes are. 20 percent of the time, 40 percent of the time and so on… and again horizontal axes is day relative to solstice. Two curves, one is blue and one is red. The blue curve is for the northern hemisphere and red curve is for the southern hemisphere. This is done for latitudes of 7 degrees. What that shows you is that in the northern hemispheres, the clouds that you see are much more often, you see them 80 percent of the time and the northern hemisphere where you see them is a maximum in the southern hemisphere, the ride curve which occurs about 30 days after solstice. And this is about 50 percent of the time; you also see that the southern hemisphere clouds start appearing sooner. You see the red color rising sooner relative to solstice which in the southern hemisphere is December 21st. So you see them appearing sooner than the north, relative to the time period of solstice. Any questions so far?

Student: Hi doctor, I would like to know why can wee see the clouds more in the northern hemisphere than in the southern?

Prof. Russel: That is a very good questions and the answer is, we do not know. The reason we do not know is why this satellite mission is all about. We are trying to take the satellite data and answer questions like that. One thing we can say is that the northern hemisphere tends to be colder in the Polar Regions than it does in the southern hemisphere. And also we know that Earth motion dynamics tend to affect the formation of the clouds and there is more dynamics in the northern hemisphere than in the southern hemisphere. We do not know much more than that right now.

Any other questions?

Student: Even though there were lessen 10 in the southern pole they last longer, do you know why is this? Like, they start from minus 40 days instead of minus 20.

Prof. Russel: They start sooner in the southern hemisphere, like you say minus 40, we also say that they end sooner but maybe only 10 days sooner. And we do not know why that is. And again that is something that this mission will be able to tell you.

Any other questions? Please interrupt me if you have any questions.

We can see these clouds at night. These clouds are around six miles above the surface, the noctilucent cloud is about 50 miles above the surface. The reason why the person standing in the darkness can see clouds when there is dark is because the sun is reflecting off the clouds that are very high up.

Part of the reason we are interested in these clouds is that they are so beautiful to look at that they have so much information about the atmosphere bound up in them. And this is close about the waves in the air, much more like the waves in the ocean, the waves in the air make these clouds form and disappear.

About why the clouds are formed, we know for example that we need cold temperatures and because of the global circulation that is on the summer time in the Polar Regions… If you think about the tilt on the Earth, the Earth axes are tilted 23 degrees relative to the ecliptic plane, ecliptic plane that is a central plane of the central Milky Way galaxy. And in the summer time the tilt of the Earth is toward the sun, so you get the Polar Regions is floated with sunlight for most of the summer, they are part of the summer. This causes the Polar Regions to heat up. When it does, air in the Polar Regions rises and when the air rises, they expand because of the basic physics of the atmosphere, the air cools. And what it does when it gets to a point where the clouds form around 83 km or where the lowest temperature of the atmosphere occurs around 88 km. The temperature is always low, is 150 less than that a 130 degrees Kelvin or 123 degrees C minus 255 degrees F. In order to make ice crystals form at those altitudes, you need really extremely low temperatures. That is why we can see them only in the Polar Regions, because only in the summer time in the Polar Regions you get temperatures that are so cool. And because of that, we get the ice particles forming in that time of the year. The air pressure is only 100 000 times less than it is at the Earth's surface. The amount of water in the atmosphere is a 100000 or a million less than the Sahara dessert. Extremely dry, extremely low pressure, so you need very cool temperatures to make ice crystals form.

Student: During the summer time is it actually colder the temperature in the mesosphere?

Prof. Russel: Yes it is, it is like counter intuitive because it is normally what you would think because on summer they are getting warm. But it is true that the mesosphere and this high altitude, the atmosphere, is colder in the summer time than it is in winter time and the reason for that is the hot air rising and expanding and making air cool. But also wave activity can make the air cool as well. So it becomes the coldest spot in the atmosphere at that time of the year and those high altitudes on the summer time. That is a good question.

One of the ways we can measure the clouds is from rockets or balloons. We can mention it from rockets. You can see them going up. You can measure them by rockets or balloons but you do not know when they will occur from the ground. Rocket people that are trying to shut a rocket into a cloud have to wait for a long time. And that is not a very good way. You could measure them from balloon if you have an instrument that is looking up but balloons do not get high enough to look at them. Just by being emerged in, that is what in site means being emerged in the cloud itself. That is the only way that we measure them routinely from the ground.

Student: The noctilucent clouds are made of ice, what makes them to stay in the mesosphere, why don't they change of position in the mesosphere?

Prof. Russel: What makes them stay in the mesosphere is the cold temperature. If you change the temperature by one or two degrees, you can make the clouds appear or disappear. Only in the mesosphere the temperature gets cold enough for them to stay. Other questions?

Part of the reason we are interested in these clouds is that they are so beautiful to look at that they have so much information about the atmosphere bound up in them. And this is close about the waves in the air, much more like the waves in the ocean, the waves in the air make these clouds form and disappear

Student: Hi, excuse me, I was wondering… during winter does the crystal ice disappear completely and the noctilucent clouds could disappear during winter?

Prof. Russel: Yes they do, they disappear, around the time of the fourth equinox they are gone. In all the hemisphere for example, the last time that we saw a cloud was the 25 of August. We do not even make it for the fourth equinox. During the winter time they are gone because the temperature is just too warm to allow them to form.

Student: Where do they go after they disappear in winter?

Prof. Russel: Ice is made of water, and the water goes into the atmosphere because it is on vapor form, it not longer in crystal form, but in vapor form, so you can not see them.

Student: What makes possible that the water rises to the mesosphere passing through all the layers of the Earth?
Prof. Russel: The rising air in the Polar Regions when the sun heats the air in the summer time staring around May, the Polar Regions starts heating up at the ground. And starts heating the air and that rising air carries with it the water vapor, we can look at the water vapor from the satellite experiment we are talking about today and we can see that the water increases in a short time over a period of about a month from a low water to high water up in the mesosphere. And that is all because of the rising air in the Polar region as the sun heats the atmosphere. So you do not have a night and a day, you always have a day.
Student: That is why we can see the noctilucent clouds only in summer.
Student: What other forces might act on these noctilucent clouds. I mean, we know there is cold weather and they stay in the mesosphere, but is there magnetism or sun effect acting on them?

In order to make ice crystals form at those altitudes, you need really extremely low temperatures. That is why we can see them only in the Polar Regions, because only in the summer time in the Polar Regions you get temperatures that are so cool. And because of that, we get the ice particles forming in that time of the year

Prof. Russel: The main thing acting on them is air motions and temperature. Temperature changes can come and go, from one hour to the next and then they are gone, or if you go from one day to another day it might be a change. The short time changes are most lightly due to the temperature changes. They change from one day to the next or from one orbit to the next which is 96 or 90 minutes. Those are the main forces acting at the clouds.
Student: Have you been able to see the shape of these ice particles?
Prof. Russel: Yes, we can, we can tell from one of our instruments what the shape of the crystals are. They are like a squash sphere it is like you take the sphere and you push down it and squash it. That is what we see from the main Earth, but we can see some crystals that are not part of the main layer that you can see with your eye. Well, I will call them sub visual particles; they are more like flat plates instead of spheres. For a long time, there have been a lot of questions what the shape of the particles was and we were able to tell that from this mission.
Student: When the noctilucent clouds appear we can see a climatic change during this season, so there is a relationship between the noctulucent clouds and the green house effect or something?
Prof. Russel: That is the most reasonable theory of why the clouds are changing the way they are changing. We think because of climatic change at the Earth surface, where these clouds change 50 miles above the Earth surface. When the CO_2 builds up in the atmosphere near the Earth surface, it makes the atmosphere

warm. That is because it is like a thick blanket, when the air warms up, warms the Earth and starts eradiating its energy to space. CO_2 traps energy and eradiate it back to the Earth. And because the blanket is too thick it traps a lot of eradiation and the Earth is heating up. When you go up toward the clouds to 50 miles above where the clouds are, the blanket is very thin. When the eradiation is observed by the CO_2 at high it is lost back into space, you do not eradiate it back to space and so the atmosphere cools. And so the theory is that the CO_2 that builds up in the atmosphere is causing the atmosphere where the cloud is to cool down. Cooling down it makes the conditions more favorable for forming the clouds. We see more of them than we saw in the past. And the most new theory is caused by the build up in CO_2, but also methane in the atmosphere can create more water vapor, and you need water vapor to make the clouds form, that is two reasons. It has not been proven; we will address this question from the data from this mission. This is only a theory.

Student: Beside the satellite mission we can study the clouds with the naked eye to realize what the concentration of the particles or the elements that are in the clouds is.

Prof. Russel: It is very important that you know what the clouds are composed of to understand why they are formed and why they act the way they do. In fact, from this mission, we want people from the ground to tell us when they see them, so we can study them with the satellite in the same place and in the same time.

Student: Is there any relationship between the noctilucent clouds and the CO_2 and other greenhouse gases? Is it possible for the noctilucent clouds to be used to measure the rate of change of the green house emissions?

Prof. Russel: Yes it is. When we think that we can look at the rate of change of clouds and rate of CO_2. It is very reasonably to try to do that and we try to make that connection. Looking at the rate of change of the clods as you say, and the rate of build up of CO_2, there is a possible connection and we will be looking at that.

Student: Have you seen any changes in the mesosphere? Have you seen changes in the clouds more towards the Earth or more towards the space within the mesosphere?

Prof. Russel: We do not have that information, what you are asking is why the layer is getting thicker, we do not know the answer of that question.

Any more questions about CO2 and global warming?

Student: There is a theory that says that the concentration of CO_2 in the air are causing the increase of the noctilucent clouds, but the is there any possibility that the noctilucent clouds are causing the increase of green house gases CO_2 concentrations?

Prof. Russel: No, that is not possible. Because there is no source from above the CO_2 surface, it is all coming from the Earth's surface. Also the noctilucent clouds are so high up that they don't play an important role in what we call the eradiation budget of the planet. The ice layers are so thin they do not affect solar eradiation back to space. They do not affect the heating or cooling of the Earth's surface.

Student: Are the noctilucent clouds keeping solar energy or heat?

Prof. Russel: No, these particles' layers are so thin that this is not causing any heating at that region of the atmosphere at all. They tend to reflect solar energy, but it does not absorb at much.

Student: Do you know at what rate the temperature changes in the mesosphere?

Prof. Russel: There is no full answer, but of what we have is changing at a rate of 6 degrees on a decade. In the vertical direction the temperature changes 6 degrees per kilometer in altitude.

Student: Are the clouds growing at any constant rate, like exponentially or at any rate?

Prof. Russel: Yes they are. The clouds were first seen in 1885 and they have increased over the past 24 years.

Student: I have a question. Is it from the northern hemisphere, southern or both.

Prof. Russel: This rate is for the northern hemisphere.

Student: Is there any sort of cycle? Because it goes up and down that repeats any 5 or 20 years.

Prof. Russel: Yes, the rise and fall is tied to the solar cycle. Does anybody know what the solar cycle is, how long is the solar cycle?

Student: 365 days.

Prof. Russel: No, that is the rotation of the Earth. It actually takes 11 years to go through the full solar cycle. It takes 27 days to rotate at 260 degrees. The solar cycle takes 11 years, from the minimum output of energy to the maximum output of energy and back down to the minimum again. So, we are at a solar cycle number 24. The solar cycle is at minimum, is just beginning solar cycle 24. It takes 11 years to go from 1980 to 1991, from minimum to maximum, and then you see it go back again to the next solar cycle.

Student: Do the clouds get affected when the Earth is closest to the sun?

Prof. Russel: Remember that water vapor is very important for ice crystal Do you mean that the brightness of the clouds get affected when the Earth is closest to the sun or farthest to the sun. No it is not. There might be a small effect due to that, but it is not important. The main reason is that, remember I said that water vapor is very important for ice crystal. The sun puts out eradiation at a rate of 1240 nanometers, 1240 millions of meter of a wave length and we call this lambda Alfa region and it is just a name given to it. And that particular wave length breaks up the water molecule and at the solar maximum you have less water in that region of the atmosphere than the solar minimum because you have more radiation on this part. So, with less water at the solar maximum you are going to have less occurrence of noctilucent clouds. You need more (water) to make more. Do you follow that argument?

In the last 27 years we have seen a 50 percent increase in the brightness of the clouds. A reasonable theory is the build up of CO_2 and the build up methane in the atmosphere. There has been an increase of a rate 7 percent per decade, this frequency is also increasing around 7 percent per decade in frequency. 7 or 8 percent more of the time than years before.

Student: I have a question. It seems clear that the build up of gases and relation of growth of noctilucent clouds is related, but how can you know that is the reason of why they are getting bigger, because when you see that they are less contaminated, the clouds are smaller, and when it is more pollution they are bigger and brighter. So, how do you know that it is the main reason?

Prof. Russel: Ok, bright question. I talked about the eleven year solar cycle. In solar cycle you see a large build up a clouds, and what is causing that? The solar cycle is causing a lot of the variations you see due the break up of water molecules. You have to rebuild the solar cycle effects and look at what is left and compare it to the effect due to the build up of CO_2, temperature changes, build up methane which increases water vapor. In order to look at those this things, CO_2 build up you have to take out the solar cycle variations first and in order to do that, we need at least one solar cycle that is eleven years in order to fit it mathematically and look at what is left in the time series. And looking at what we call residual time series, that has the solar cycle, and see the CO_2 build up and the methane build up and see if they match up the changes that we have seen. Did you follow that?

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Student: Do you have any data without the solar cycle? Any data to compare without the solar cycle?

Prof. Russel: No, the provided data is good data, but it is not enough data. It is not the right data but we are collecting it. We are hoping that this study will ask the full solar cycle and if not, we will fit this data in very sophisticated models of the atmosphere, and test the models and verify the models to tell us the right thins and then we will be able to predict what the build up of CO_2 and methane are doing? I will answer the questions from the full solar cycle or using the models.

Student: Another question? The brightness is increasing in the noctilucent clouds, can wee see a variation of the size or density of the crystals in the clouds?

Prof. Russel: We do not have that kind of data. Variations and brightness agree with variations and density of the clouds. You can have a high density of particles which are very small, but they will not be very bright or you can have fewer particles that are very bright. We have not been able to answer that question yet.

Student: I have another question. The first time the noctilucent clouds were first seen was on 1885 in Berlin by Orogis. Which where the conditions that allow him to observe the noctilucent on Berlin?

Prof. Russel: The first reported observation was on 1885 from the ground with the naked eye. It was a British astronomer. They saw them over Great Britain. You needed to have latitude of about 50 degrees. Although in recent years you can see them at lower latitude, at 40 degrees latitude. So the conditions that you need are summer time at latitude of 50 degrees or higher.

Student: Why can we observe now latitudes of 40 degrees instead of 50? Is there a reason behind that phenomenon?

Prof. Russel: We do not know why. As the temperature is getting colder, that is going to spread further down from the polar regions to lower latitudes. And we do not why we are seeing them.

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Student: Does the noctilucent cloud exists below 40 degrees?

Prof. Russel: If the temperature gets colder enough they can exist. It depends in how cold the temperature is. They got to be near 250 degrees Fahrenheit to make the clouds form.

Student: Do you have any data on the thickness or density of the cloud mass?

Prof. Russel: Yes, we know that the cloud fitness where you can see them is what we call the visible cloud that you can see with your naked eye, and then there are some visible clouds. The parts of the clouds that you can see are about 2 miles thick; there are also parts of the clouds that are sub visible that you can not see are 3 miles. So, the thickness of the clouds comes between to 2 to 5 or 6 miles thick in the atmosphere.

Student: What could be the possible negative consequences of the noctilucent clouds in the world?

Prof. Russel: Why are you doing this? There are two reasons. The first reason is because I am a scientist and this is a very interesting scientific problem. The second reason is we are looking at this clouds to see if there is a connection with global change, if there is, if we conclude that clouds 50 miles above the surface in a very remote region of our atmosphere, very rarified region of our planet very cold very litter water vapor, if we are changing the clouds there, that means we are changing the while atmosphere from the ground all the way up to 50 miles altitude. And we need to understand the implications of this to life and Earth, this is what all this mission is all important.

Student: Clouds reflect the sunrays and the heat, so clouds cannot absorb heat, why does this happen if they are so cold, why don't they warm up?

Prof. Russel: Noctilucent clouds, because there is such a thin layer and the crystals are so small and it does trap a little bit, but it is not significant compare to clouds that are 6 miles above the surface. At six miles above the surface, they trap a lot of radiation that increases heating.

Student: So sunrays are reflected because of the chemical composition?

Prof. Russel: No, it is just because they are crystal and they reflect light like in the frosted refrigerator, like if you shot a flashlight into a frosted refrigerator light will just bounce around.

Why we have this mission, we see more of the clouds than even before and they are being absorbed closer to the equator and there are also difference in the properties of the clouds between the northern and southern hemispheres, this mission is trying to answer why these changes are occurring.

You need 3 things to make this clouds form: cold temperatures (-253), water vapor, and seed particles.

Student: The ice crystals, are they mixed with the methane and the CO_2 in the same crystal or are they pure?

Prof. Russel: You have to have what we call seeded particles, like when you have a mirror and you start getting water particles down the mirror, you have to have seed particles which is a very small particle and if the water sticks to the particle and the particle is cold enough it will freeze forming ice crystal. We do not know what these seed particles are, but we think it is cosmic dust, this is the main theory. The theory says that the small meteorites in the atmosphere heat the atmosphere and they burn up and they produce very small particles and we think this smog, cosmic smog, this smog particles are less than 1 nanometer, one million of a meter. This occur in the areas where the NLCs occur and this is at the exterior of the atmosphere and causes the crystals to form and this is the main theory and all this is just floating around. And during the summer time when the temperature gets cold, the water crystals stick and the temperature is getting colder and freeze.

Student: Does the seed particle have to do with the coloration of the noctulucent clouds? Does the shape and the seed particles need to do with the colors that the noctulucent clouds have? The coloration that de noctilucent clouds have is related with the shape of the crystals and the seed particles?

Prof. Russel: This has to be with the size. This is really from the Mie theory; he developed the theory from scattering light. We are looking at visible ice in this case, but the shape of the particles and the number of particles is giving the color.

Student: Are the clouds affected by any force like Earth gravity?

Prof. Russel: These clouds, the particles are suspended in the atom and the atom is held together to the earth by gravity. You see those waves in the sky like the ripple, like waves in the ocean. When you drop a rock in the lake and you see the ripples. When you drop a rock in the lake, gravity is going to try to make that lake to be smooth again. That is why we see the ripples. In the clouds we also see those ripples in the clouds affected by gravity that we call wave activity.

Student: In the noctilucent clouds we have a theory that global warming is causing the NCLs, is there any other theory beside this one?

Prof. Russel: There is another one that explains why they are changing while they are getting brighter and increasing. It is not a proven theory, but is the only one that makes sense.

Student: I have heard the karakatoa explosions and other kind of eruptions, I would like to know if there are viable theories?

Prof. Russel: The first seeing occurred just after the eruption of the karakatoa volcano in 1885 and the first thought was that the volcano had shot a lot of particles into the atmosphere and these particles formed clouds, but it has been showed that that is not the reason for forming clouds. You get volcanoes occurring in the high atmosphere in summer time, but they do not have occurred with enough frequency to explain the data that we are seeing.

Student: I would like to know if the presence of noctilucent clouds could affect the ozone layer.

Prof. Russel: No, but there is a theory that has been proposed, what we call teleconecction, where activity in the winter hemisphere can affect the summer hemisphere. It is possible that ozone variability in the winter atmosphere causes disruptions in the wind activity in the winter hemisphere and transmits it to the summer hemisphere and affect the noctilucent clouds. But we do not know how noctilucent clouds could affect the ozone layer itself.

Student: Do you think that it is important to disappear the NCL right now? It there a necessity to make the noctilucent clouds to go away?

Prof. Russel: No, they do not affect us in any way. They are what we call an early indicator of climate change. But they are not causing any problems.

Student: But do you think that in a few years we will have problems with the noctilucent clouds or are they going to be the same?

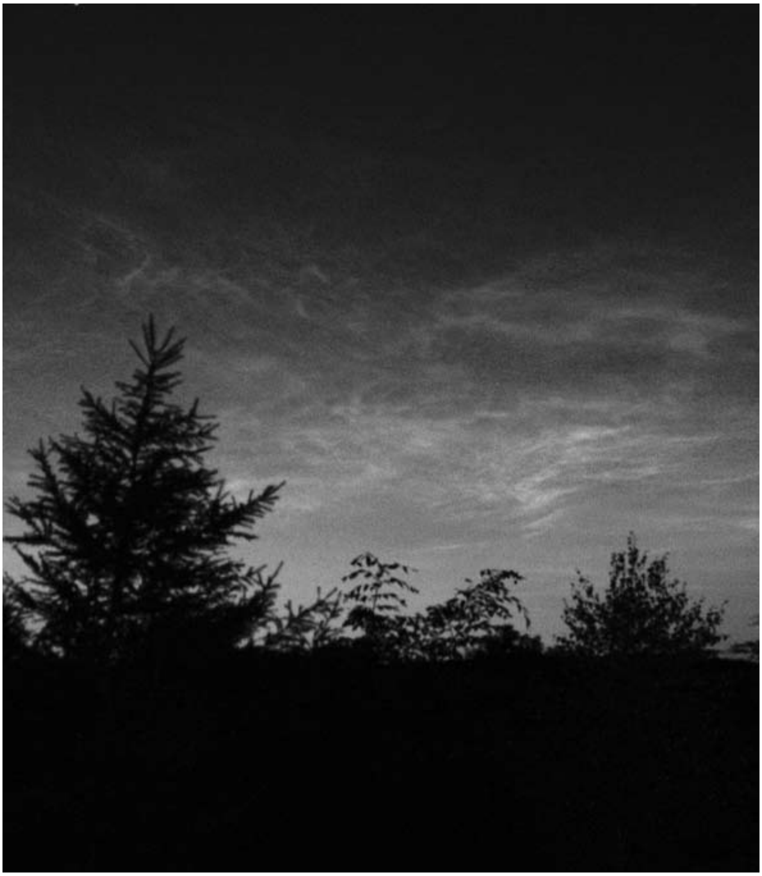
Prof. Russel: No, they are not increasing at any rate that will have any effect in eradiation in a very long time. They are mainly used to us as a nearly indicator of global change.

Student: Can the area where the noctulucent clouds are be calculated with the caliciuos claper equation of the graph?

Prof. Russel: Yes, that is the equation to calculate the frost point. At what temperature do you have to get the temperature to get the cloud form, and we use that equation in all our studies.

Student: This equation can tell us why the latitude of the noctilucent clouds comes near the equator?

Prof. Russel: Yes, you can. That will tell us that we should expect them.



Noctilucent clouds as photographed by Mark Bailey from Lisdoart on 14th July 2006 at 11.30 pm.

Las nubes noctilucentes y el cambio climático

Professor James Russel / Hampton University

Las nubes noctilucentes son un fenómeno que se registra en la parte más alta de la mesósfera de la Tierra. Estas nubes brillantes compuestas por micropartículas de hielo, son visibles en la oscuridad de las noches de verano en ambos hemisferios, dependiendo de elementos como la temperatura y la latitud. El Profesor James Rusell explica en esta entrevista las particularidades científicas de estas nubes, profundizando en su relación con la acumulación de dióxido de carbono en la atmósfera y el incremento que su visibilidad ha presentado en los últimos años. De acuerdo con Rusell, estas nubes han sido identificadas como un síntoma menor del cambio climático, por lo que merecen ser estudiadas.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