# Moving Forward with Atmospheric Conductivity Research While Adapting to COVID-19 Disruptions

Alexandra Ulinski[1], Rachel Nathan[1], Adrian Rangel[1], Elizabeth Hernandez[1], Andy Nguyencuu[1], and Dr. Edgar Bering[1]

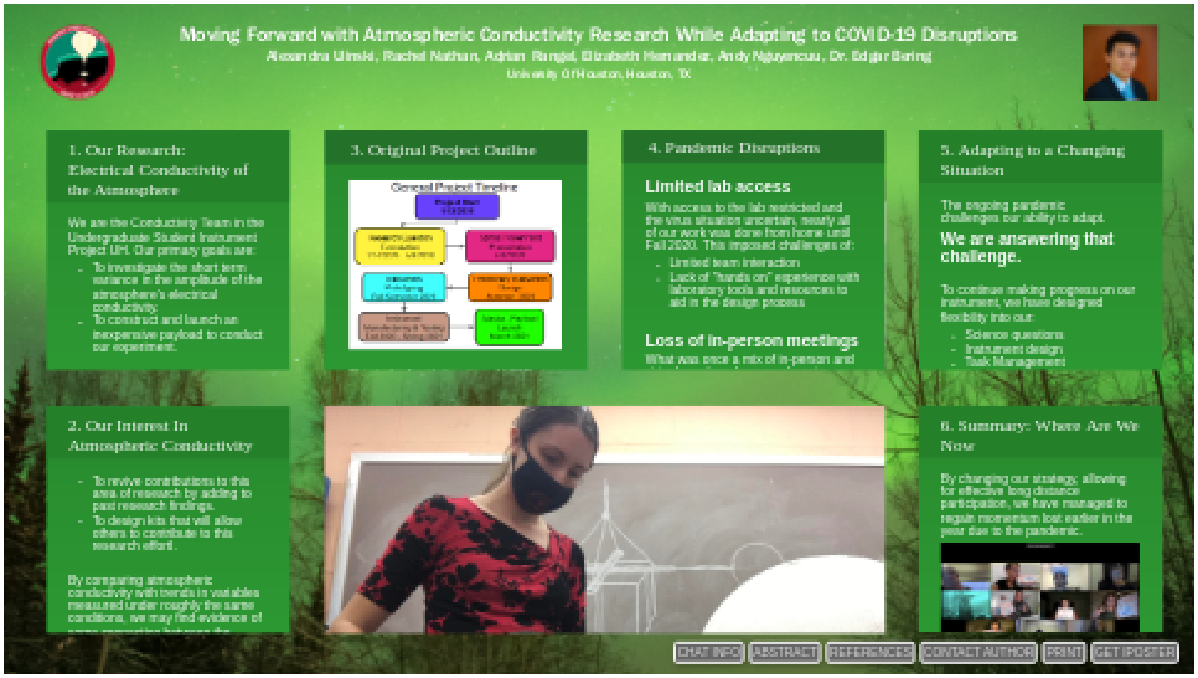
[1]University of Houston

November 21, 2022

**Abstract**

Previous study has shown that atmospheric conductivity variations are larger in amplitude than can be explained by current models. Several possible explanations for these variations have been proposed. However, recent conductivity research has been sparse, and no definitive explanations have been found. The latest iteration of the Undergraduate Student Instrument Project (USIP) at University of Houston seeks to add to previous work and explore possible contributing factors to these unexplained variations. To achieve this goal, the Conductivity team within USIP is designing and constructing an instrument that will be launched in Alaska. The data collected will be compared to measurements by other instruments launched during the same project. These include instruments studying microplastics, high energy particles, VLF waves, and gaseous compounds. In addition to contributing to the effort to understand the global electric circuit, the Conductivity team hopes to develop a low-cost kit that can be used by school groups to collect their own conductivity data. In the face of the COVID-19 pandemic, this student-led research project has overcome the challenges of distance, disrupted schedules, and uncertain funding by fostering a learning and working environment that can adapt to a variety of situations. In response to these challenges, USIP shifted towards the virtual resources that were already in use as a supplement to in-person work. The team uses Microsoft Teams and Zoom for virtual meetings, Slack for regular communication between members, and email to regularly coordinate with resources outside of the students in the research group. Diligent communication and adaptable budget, construction, and organization planning have been critical to maintaining the momentum of this project. Although the future remains uncertain, the Conductivity team continues to hope and prepare for the originally planned March 2021 launch.

# Moving Forward with Atmospheric Conductivity Research While Adapting to COVID-19 Disruptions

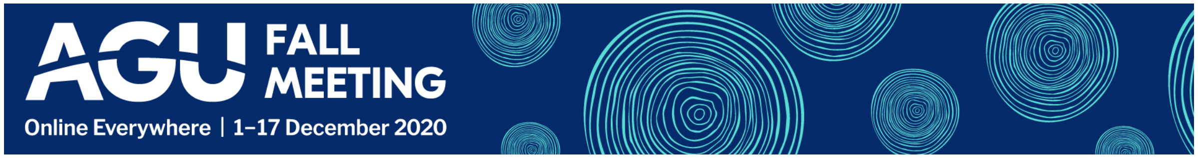



Alexandra Ulinski, Rachel Nathan, Adrian Rangel, Elizabeth Hernandez, Andy Nguyencuu, Dr. Edgar Bering

University Of Houston, Houston, TX




**PRESENTED AT:**



# 1. OUR RESEARCH:
# ELECTRICAL CONDUCTIVITY OF THE ATMOSPHERE

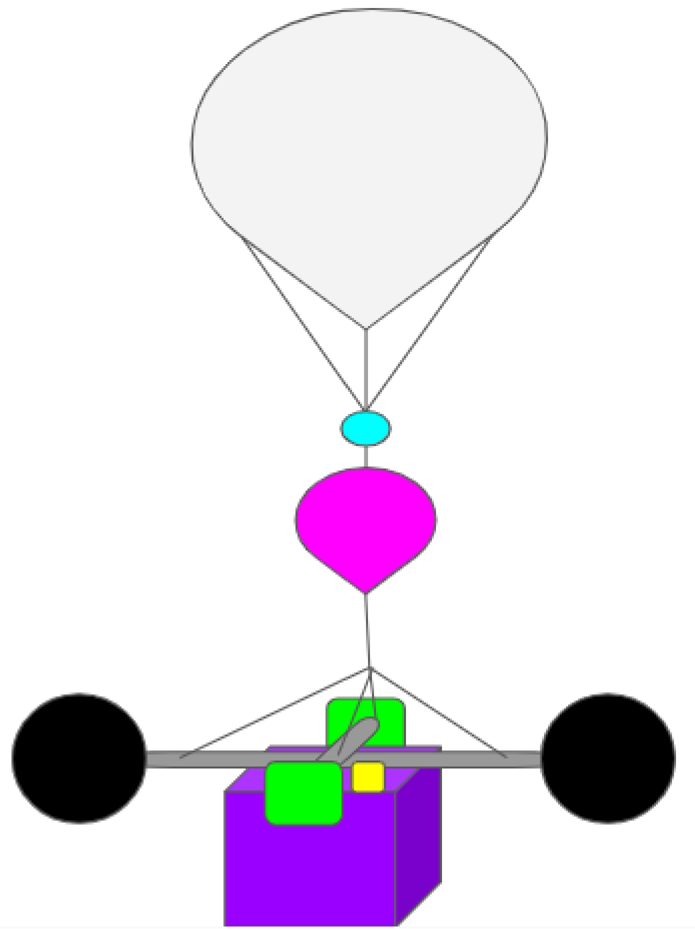
We are the Conductivity Team in the Undergraduate Student Instrument Project UH. Our primary goals are:

- To investigate the short term variance in the amplitude of the atmosphere's electrical conductivity.
- To construct and launch an inexpensive payload to conduct our experiment.

We plan to collaborate with other science sub-teams within USIP. This will allow us to look for possible correlations between the amplitude variance and:

- Humidity
- Airborne Microplastics
- Gaseous Compounds
- High Energy Particles
- VLF Waves
- The Aurora Borealis

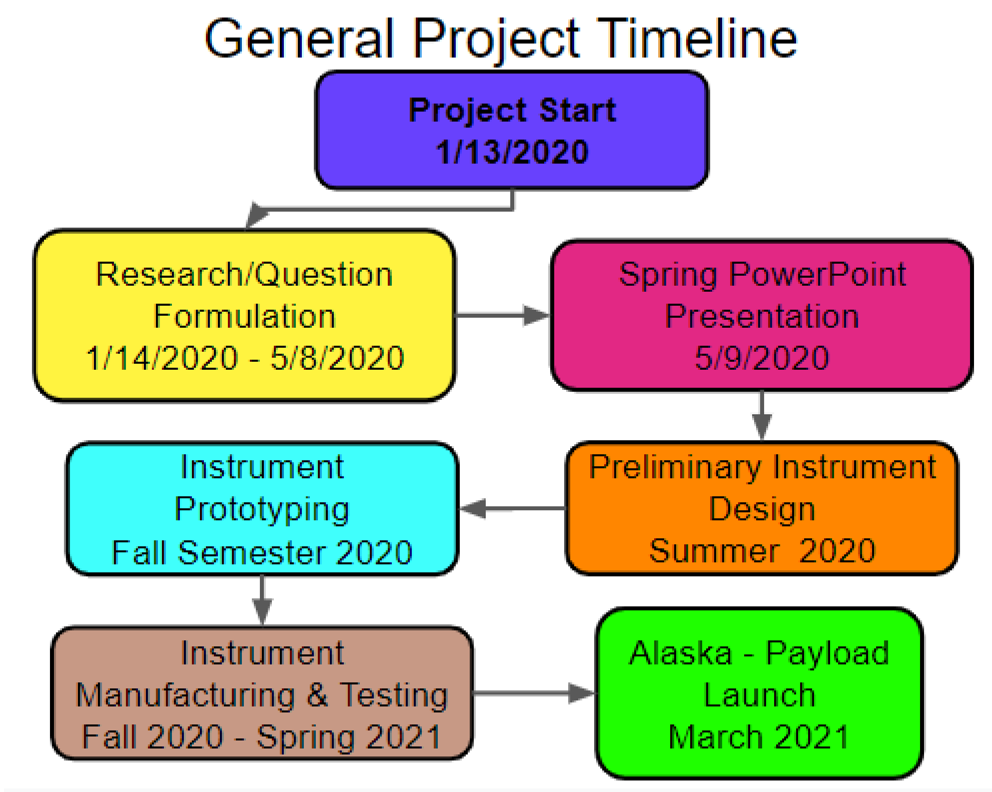
We'll use a latex weather balloon to transport our payload 30 km into the atmosphere.



## Time relaxation method:

The 2 probes of our payload will be charged to opposite potentials. By recording the time it takes for the potentials to return to zero, we can measure the atmosphere's electrical conductivity.

## 3. ORIGINAL PROJECT OUTLINE




This is the fourth iteration of USIP at University of Houston, originally planned as a 2 year project culminating in a scientific paper. This is student-led research where undergraduates gain practical experience designing, constructing, and deploying scientific instrumnets.

- Beginning in January 2020, students began developing science questions that could be answered by building a scientific instrument of our own.

- We broke into 5 new instrument teams all working on different science questions and building our own instruments to address them.
- The Conductivity team has 5 members.

- All USIP students are also on 2 systems or operations teams that work together to benefit the group as a whole. Each team speciallizes in an area such as telemetry, aviioncs, structures, flight operations, logistics, or data management.

The Conductivity team is designing and building an electrical conductivity measurement device that will include our own custom-built electronics.

# 4. PANDEMIC DISRUPTIONS

## Limited lab access

With access to the lab restricted and the virus situation uncertain, nearly all of our work was done from home until Fall 2020. This imposed challenges of:

- Limited team interaction
- Lack of "hands on" experience with laboratory tools and resources to aid in the design process

## Loss of in-person meetings

What was once a mix of in-person and virtual meetings became almost entirely virtual. Particularly damaging was the loss of in-person general meetings where entire the USIP group (including all other systems and science teams) would meet.

## Uncertainty in planning

Planning became significantly more challenging due to uncertainty in:

- When we would regain access to the lab
- When lockdowns would begin or end
- If funding for our project would still be available
- If we would be allowed to travel to Alaska for launch

## Difficulty Maintaining Engagement

Team member engagement suffered for several reasons:

- Increased stressors on personal life, including increased work hours, disrupted medical system, anxiety and isolation
- Changing academic format
- Lack of face-to-face interaction hindered team building

# 5. ADAPTING TO A CHANGING SITUATION

The ongoing pandemic challenges our ability to adapt.

## We are answering that challenge.

To continue making progress on our instrument, we have designed flexibility into our:

- Science questions
- Instrument design
- Task Management
- Timeline

**Science Questions**

Our science questions were intentionally developed so that our research can be productive even if we cannot launch in Alaska, or if there is no auroral activity during the flight.

While we cannot study the aurora in Texas, we can still look for the short-term variations in conductivity and compare to measurements of humidity, gaseous compounds, and microplastics from other teams.

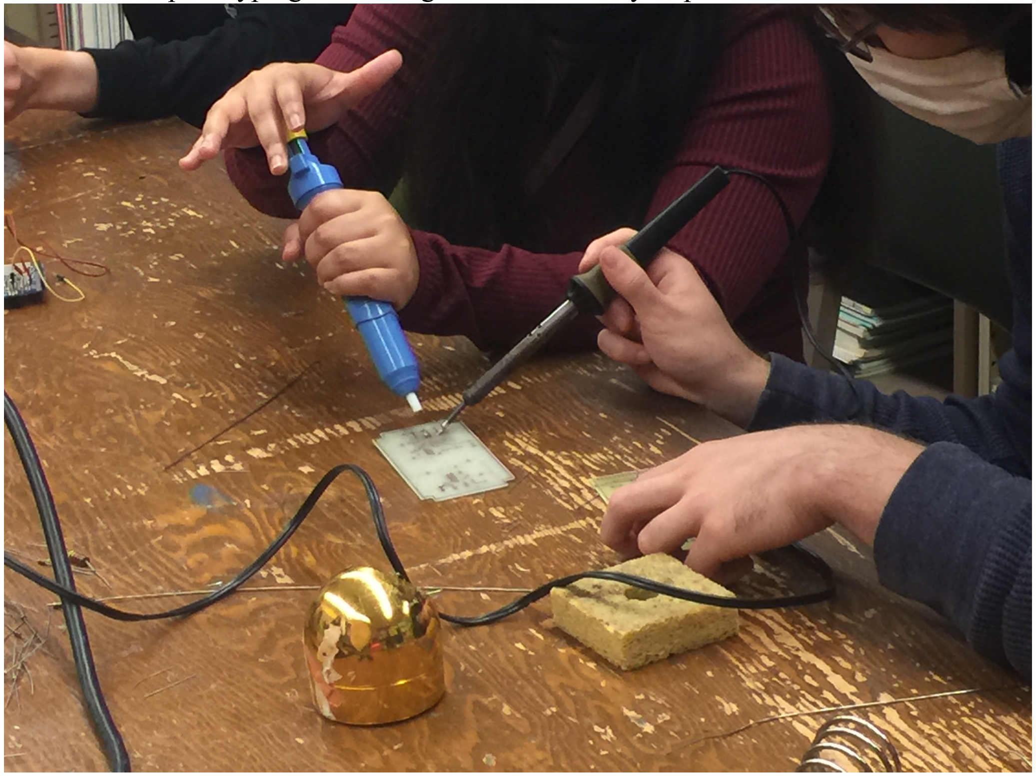
**Instrument Design**

It was originally hoped that we may be able to also measure the electric field with our instrument. However, due to setbacks from COVID-19, we were easily able to simplify the design, eliminating the motor required for the electric field measurements, so that we may still complete our instrument on time for a Spring 2021 deadline.

**Task Management**

Tasks have been separated by those which can be completed remotely and those that require presence in the lab.

- Tasks such as coding, part shopping, requirements research, and presentation design are assigned to our now-virtual team member.
- Tasks such as prototyping and testing are carried out by in-person team members.



**Timeline**

As the pandemic dragged on, it quickly became apparent that our original project schedule was not going to be realized. We have had to be flexible in these unprecedented circumstances as we continually try to rethink and reshape the way our project will be completed in order to be both understanding and realistic.

Although our preliminary and critical design review dates were pushed back by over a month, we are still hopeful that we can stay close enough to our general project outline to reach our goal of a March 2021 launch.

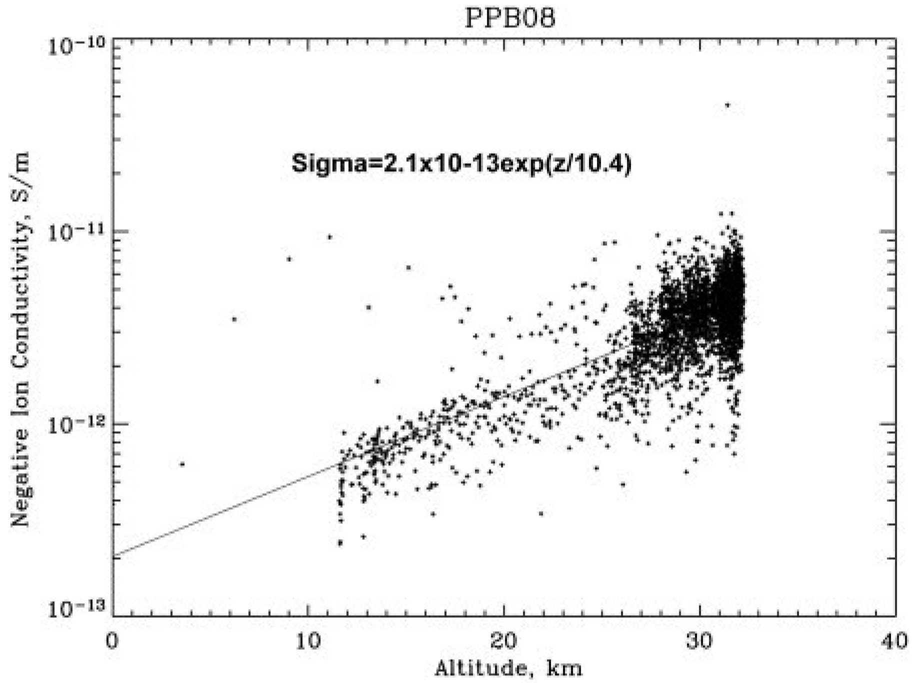
# 2. OUR INTEREST IN ATMOSPHERIC CONDUCTIVITY

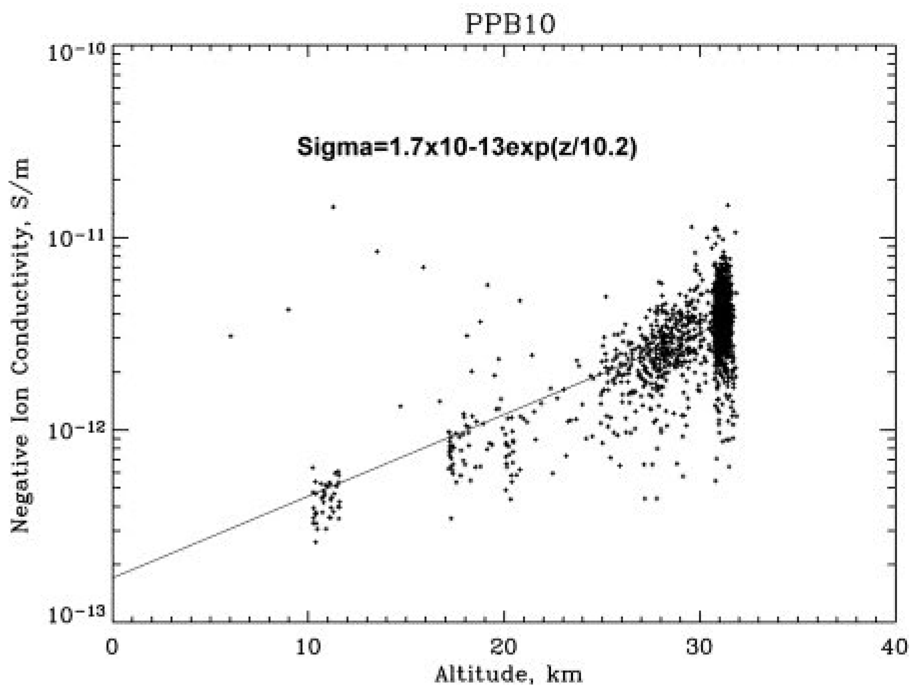
- To revive contributions to this area of research by adding to past research findings.
- To design kits that will allow others to contribute to this research effortl.

By comparing atmospheric conductivity with trends in variables measured under roughly the same conditions, we may find evidence of some connection between the variables to bring us closer to the answer to our question:

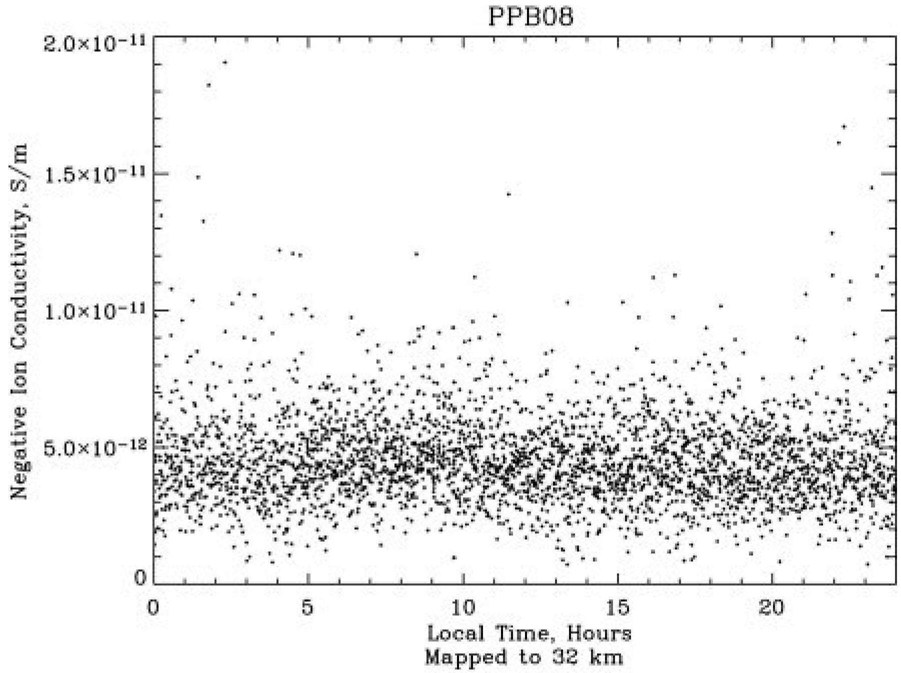
**What is causing the short-term (minutes to days) variations in atmospheric conductivity?**

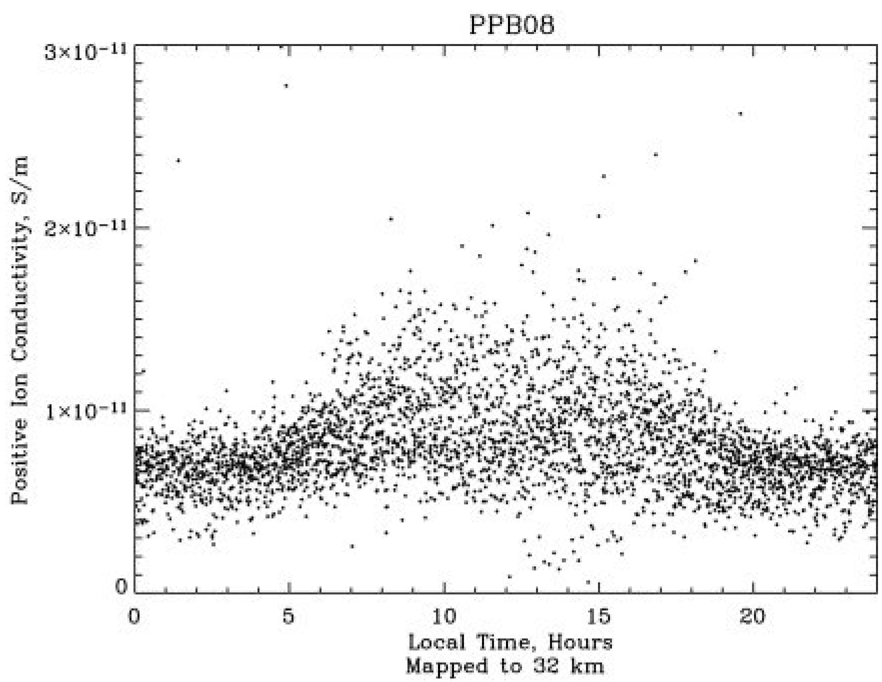
## Background


PPB08
Sigma=2.1x10-13exp(z/10.4)
Negative Ion Conductivity, S/m
Altitude, km
$10^{-10}$
$10^{-11}$
$10^{-12}$
$10^{-13}$
0
10
20
30
40


PPB10
Sigma=1.7x10-13exp(z/10.2)
Negative Ion Conductivity, S/m
Altitude, km
$10^{-10}$
$10^{-11}$
$10^{-12}$
$10^{-13}$
0
10
20
30
40

These graphs show the negative ion conductivity of the Southern polar region versus the altitude. PPB08 and PPB10 were two separate payloads launched along the same path by Bering et al. (2005).



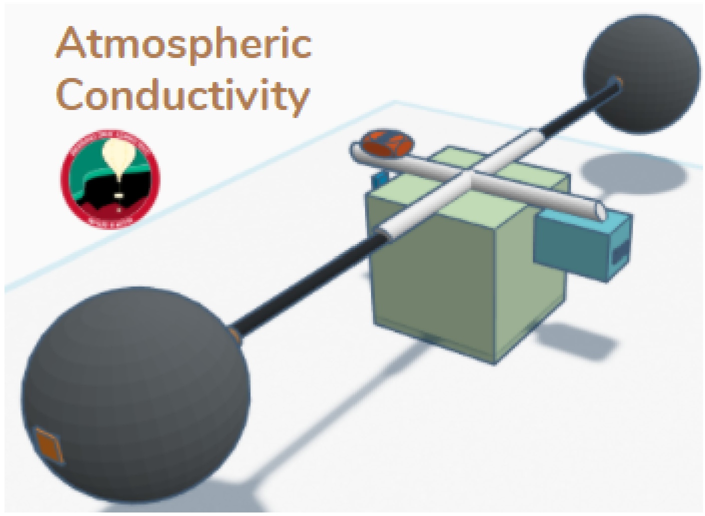



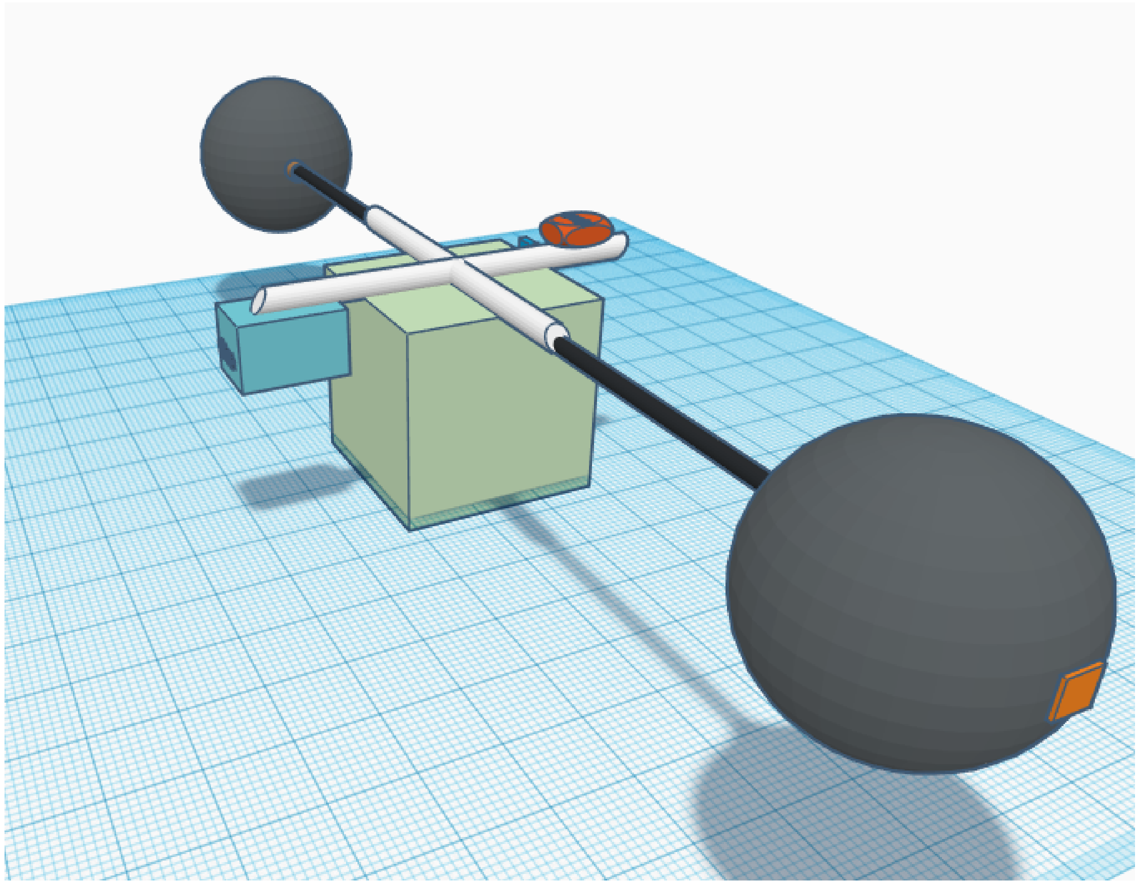

Top: Negative ion conductivity of Southern polar atmosphere versus local time (Bering et al., 2005).

Bottom: Positive ion conductivity of Southern polar atmosphere versus local time (Bering et al., 2005).

These graphs show the local time dependence of both the negative and positive atmospheric conductivity in Antarctica taken by the PPB8.

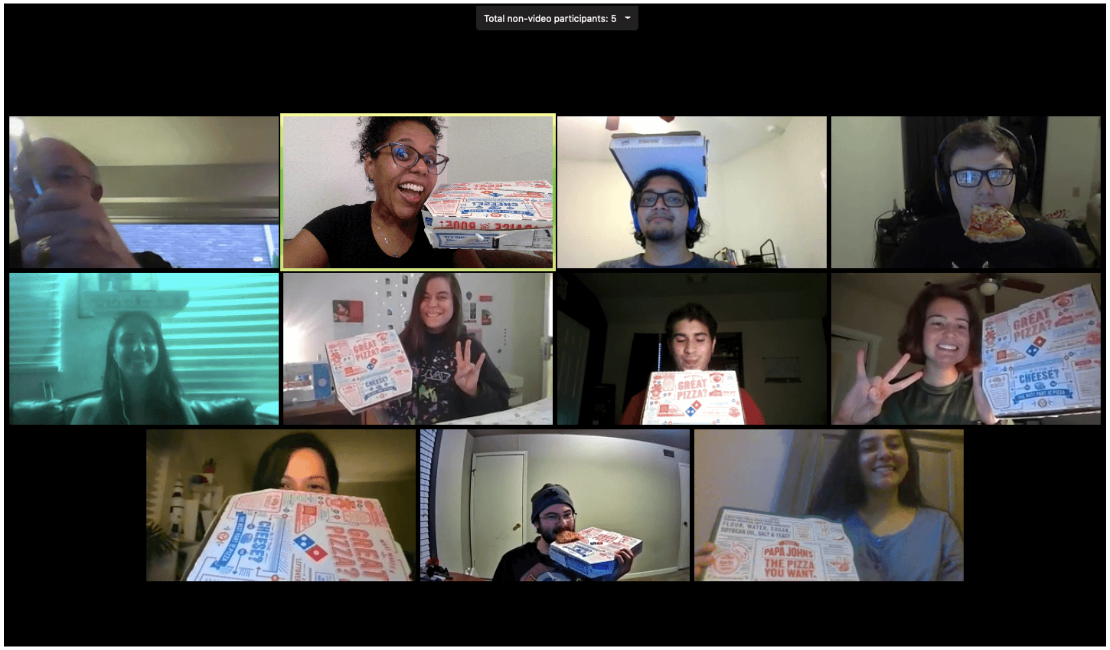
We expect to make similar findings during our launch in Alaska.





# 6. SUMMARY: WHERE ARE WE NOW

By changing our strategy, allowing for effective long distance participation, we have managed to regain momentum lost earlier in the year due to the pandemic.




We find creative solutions to enhance team bonding build enthusiasm and increase team engagement as we work together to make our goals a reality.

We have adjusted our schedule and we may not be able to follow our plan to launch in Alaska March 2021. However, we are not letting that dissuade us from our goals.

If we cannot launch in Alaska this Spring, we will delay the trip until Spring 2022 and we will launch our instrument in Texas instead.

This will give us a great opportunity to take more measurements in different locations, and we will be able to observe the lattitude gradient in conductivity.

## References

Bering, E.A., Holzworth, R.H.,Reddell, B.D., Kokorowski, M.F., Kadokura, A., Yamagishi, H., et al. (2005). Balloon observations of temporal and spatial fluctuations in stratospheric conductivity. Advances in Space Research, 35(8), 1434–1449. https://doi.org/10.1016/j.asr.2005.04.009.

Aurora photos taken by students in USIP II.

# ABSTRACT

Previous study has shown that atmospheric conductivity variations are larger in amplitude than can be explained by current models. Several possible explanations for these variations have been proposed. However, recent conductivity research has been sparse, and no definitive explanations have been found. The latest iteration of the Undergraduate Student Instrument Project (USIP) at University of Houston seeks to add to previous work and explore possible contributing factors to these unexplained variations. To achieve this goal, the Conductivity team within USIP is designing and constructing an instrument that will be launched in Alaska. The data collected will be compared to measurements by other instruments launched during the same project. These include instruments studying microplastics, high energy particles, VLF waves, and gaseous compounds. In addition to contributing to the effort to understand the global electric circuit, the Conductivity team hopes to develop a low-cost kit that can be used by school groups to collect their own conductivity data. In the face of the COVID-19 pandemic, this student-led research project has overcome the challenges of distance, disrupted schedules, and uncertain funding by fostering a learning and working environment that can adapt to a variety of situations. In response to these challenges, USIP shifted towards the virtual resources that were already in use as a supplement to in-person work. The team uses Microsoft Teams and Zoom for virtual meetings, Slack for regular communication between members, and email to regularly coordinate with resources outside of the students in the research group. Diligent communication and adaptable budget, construction, and organization planning have been critical to maintaining the momentum of this project. Although the future remains uncertain, the Conductivity team continues to hope and prepare for the originally planned March 2021 launch.

# REFERENCES

Bering, E.A., Holzworth, R.H.,Reddell, B.D., Kokorowski, M.F., Kadokura, A., Yamagishi, H., et al. (2005). Balloon observations of temporal and spatial fluctuations in stratospheric conductivity. Advances in Space Research, 35(8), 1434–1449. https://doi.org/10.1016/j.asr.2005.04.009.

Aurora photos taken by students in USIP II, mostly Bryan Gunawan and Megan Pina.