Summary of Activities of OSU's Ice Core Paleoclimate Research Group (2021-22)

Despite COVID, our ice core research team has remained fully functioning. In 2021 we produced 8 publications that appeared in a diverse selection of high quality journals: *Microbiome, Global and Planetary Change, Atmospheric Chemistry and Physics, Journal of Geophysical Research Atmospheres, Earth and Planetary Science Letters, PeerJ, and Journal of Climate (2 papers*). Since January 1, 2022, we published 2 more papers in *Journal of Geophysical Research-Atmospheres* and *Nature Reviews Earth & Environment.* We have additional papers in various stages of preparation and or under peer review. Moreover, our team has submitted 4 research proposals to the National Science Foundation. Two of these are in collaboration with our colleagues in the Microbiology Department at Ohio State and propose to develop the first microbial (bacteria and virus) history using our global collection of ice cores that are stored in the Byrd Center freezers.

We were very fortunate to have successfully recovered 4 ice cores (a total of 471 meters) in Peru during the summer of 2019. This abundance of ice allowed us to keep our laboratories fully functioning through the pandemic. We have completed the analyses of the water isotopes and the concentrations of mineral dust and major anions and cations on the two cores drilled to bedrock on the summit (22,205 ft) of the South Peak of Huascarán (Peru). These are the highest ice cores yet recovered in the Southern Hemisphere. We also drilled two cores to bedrock on the col of Huascarán (~20,000 ft) and have completed the analyses of one of them. The analysis of the second core is underway. These cores are providing remarkable records covering approximately 20,000 years in the tropical Andes of Peru right above the Amazon Basin. The interpretation of these records is now underway.

We are also in the process of developing tropical methane and $\delta^{18}O_{air}$ records from the Huascarán cores in collaboration with our colleagues at Oregon State University and SCRIPPS. Producing a methane record requires that the cores come from a very cold and low dust environment and that the cores have been kept very cold during the transit from the drill site to OSU. This was possible due to the use of a helicopter, provided by the President of Peru, to move the cores rapidly off the mountain. We have now completed the first set of methane measurements which are truly remarkable and have the promise to yield the very first atmospheric methane record from the tropics at a site just above Earth's largest natural methane source, the Amazon Basin. The methane community has been trying to infer changes in methane sources from the interhemispheric methane gradient and the isotopic composition of the methane from just two points on Earth: Antarctica and Greenland. Now the first methane results from these cores suggest that we will be able to add a third point - the tropical Andes of Peru. Both the methane and the $\delta^{18}O_{air}$ measurements will be used to constrain the timescales for the Huascarán cores.

In addition to our 3 current post docs, we have welcomed Austin Weber, an MS student, who is attempting to relate Huascarán ice core dust concentrations and ice accumulation to human

activity in the nearby Amazon Basin. Austin is also using historical records of deforestation, agriculture, and fires. If successful, he plans to expand his research to cover the last 20,000 years archived in the Huascarán ice cores for his PhD dissertation. Ms. Kara Lamantia, a new PhD student, is just starting to investigate 'elevation dependent warming' using the Huascarán ice cores. We are fortunate to have for the first time two sets of ice cores from two different elevations on Huascarán in the deep tropics, just 9° south of the equator. We recently interviewed a new M.S. student, Erica Scarpitti, who has just been awarded an OSU University Fellowship to undertake research investigating the recent methane records coming from the Huascarán ice cores.

We have continued to develop our Third Pole Environmental (TPE) Program, launched in 2010 in collaboration with our colleagues at the Institute of Tibetan Plateau Research (ITPR, NAS, Beijing). The program has continued to grow although two years ago the pandemic created difficulties with the travel required for our student exchange program. We had a visiting scholar from the ITPR in our TPE team, Dr. Meilin Zhu, who was with us for three years. When he joined our team in December of 2018 the plan was for him to work with us for one year and then move to another post-doctoral position in the UK. Unfortunately, due to the pandemic he had no opportunity to move to the UK nor return home to his family in China. Nevertheless, he had a very productive 3 years with us. He greatly improved his English skills and published 3 first-author papers in high quality journals. Meilin returned to China and his family at the end of December 2021 to take a faculty position at the University of Lanzhou in China. Negotiations are underway for PhD student, Ms. Dandan Yang, to join our team later this year to conduct research for her PhD program. One major objective of our TPE Program is to train the next generation of young scholars in order to foster the global collaborative efforts that will be needed to meet the challenges posed by global climate change. This challenge can only be met by working together internationally and through building bridges and understanding among nations.

In an attempt to preserve our global collection of ice cores for the next generation of young ice core researchers, we have continued our campaign to expand and renovate our freezers which are now over 30 years old. Recently, we had Ruscilli Engineering provide an updated quote for the required expansion and renovations. This yielded a minimum cost from $7,613,298 to a maximum of $15,596,529 which includes a system partially powered by alternative energy. Clearly construction costs have gone up since our last quote in 2016.

We have been quite busy working on public outreach to get the 'global climate change' message out to a larger fraction of the public, hopefully to millions of people. We are trying to do our part but we all know that we are running out of time to avoid serious consequences.

Lonnie gave a TEDx talk in March 2021 entitled: Icy Warning from the World's Highest Mountains which is available at this link: https://m.youtube.com/watch?v=vrmiygm3QfM
Ellen and Lonnie were interviewed for the PBS Newshour in October 2021. It is available here:.
https://www.pbs.org/newshour/show/glacier-ice-samples-act-as-records-of-climate-changes-impact-on-earth.
Ellen and Lonnie were honored to have the cover story, "Ice sages," in the winter 2021 Ohio *State Alumni Magazine.* We are just putting the final touches on a full-length documentary entitled "CANARY" that should be released in 2022. The film documents Lonnie's career from growing up in Gassaway West Virginia to conducting the ice core research with our team today. The film crew joined our field program on the Quelccaya ice cap (Peru), traveled to Beijing, China with Lonnie, filmed extensively in our labs here at the Byrd Polar and Climate Research Center, and even descended down a coal mine in Beckley, West Virginia. The film's goal is to tell the story of our 40+ years of ice core and climate change research while also inspiring the next generation of young scientists. Finally, we were both honored in October 2021 at Villanova University where each of us was awarded a Mendel Medal (the fiftieth and fifty-first). This was the first time the Mendel Medal Award was given to a couple since the first Mendel Medal was awarded in 1929. The link is here: https://www1.villanova.edu/villanova/president/university_events/mendelmedal/pastrecipients/thompsons.html and

In short 2021 has been a very productive year for our team! Given the events of the last few weeks in Ukraine is clear that we will all face major new challenges in 2022. However, these circumstances continue force each of us to consider our daily actions, to reflect on ways to innovate and adapt to what seems to be a new normal that will be with us for some time, and most importantly, to appreciate those who are most important in our lives. While 2022 has presented major challenges, both at home and internationally, it has also afforded us a few bright spots. One of these is being jointly awarded The BBVA Foundation Frontiers of Knowledge Award in climate science. In June we hope to attend the award ceremony in Bilbao, Spain.

We would be thrilled to share our latest research with you and have you meet our team members should you have the opportunity to visit the Byrd Polar and Climate Research Center.

Best regards,

Lonnie G. Thompson Ellen Mosley-Thompson

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