Griffith ABoVE Hyperwall AGU 2019

Explanatory text for each slide. Can be used as speaker notes or as text on the 10th screen when shown on a NASA Hyperwall.

**Slide 1**

10th screen: ABoVE Logo

**Slide 2**

10th Screen

ABoVE is a large-scale study of environmental change in the Arctic and boreal regions of western North America and the implications for ecological systems and society, with a strategy that spans spatial scales from leaf to orbit. During the course of this 10-year field campaign, we are making observations at plot, tower, airborne, and orbital scales and feeding this data into an integrated modeling framework. ABoVE’s Overarching Science Objective is to investigate the underlying processes and their interactions that control vulnerability and resilience in Arctic and Boreal ecosystems of western North America to environmental change, and to assess how people within and beyond this region may respond to changes in these processes and interactions.

**Slide 3**

10th Screen: The Arctic-Boreal Vulnerability Experiment (ABoVE) Airborne Campaign (April–October 2017) gathered remote sensing and in situ data over 4 million km2 of tundra and boreal forest across North America. Repeat flights with AVIRIS and L-band SAR were done in 2018 and 2019; and with LVIS in 2019. Airborne data are staged with critical ground calibration/validation measurements in the ABoVE Science Cloud, hosted on GSFC’s ADAPT high-performance computing environment. ADAPT provides the 400-member science team an unusual opportunity to analyze a petascale dataset acquired by 9 aircraft, 10 science payloads, and hundreds of sorties.

**Slide 4**

10th Screen: **Vegetation Greening Trend in Canada and Alaska: 1984-2012:** High-latitude regions have been warming rapidly since the last century, at a rate higher than the global average. At continental scales, satellite data since the 1980s have indicated increased vegetation productivity (greening) across northern high latitudes, and a productivity decline (browning) for certain areas of undisturbed boreal forest of Canada and Alaska. These remote sensing results have been corroborated by in-situ evidence.

White rectangles mark sites with repeat overflights of L-Band Synthetic Aperture Radar (SAR) during 2017, 2018, and 2019.

**Slides 5, 6**

10th Screen: ABoVE Logo

L-Band backscatter showing water (black), inundated vegetation (blue-green) and shrub-covered elevated areas.

**Slide 7**

Seasonal subsidence in burned and unburned areas near Great Slave Lake, NWT, Canada (Kevin Schaefer et. al). There is more seasonal subsidence by the end of the summer season in areas where intense fires burned away the insulating organic layer of soil during.

**Slides 8**

10th Screen: The NASA Gulfstream V and the LVIS team conducted science sorties (91 flight hours), including during the two transit legs, between 12 July and 7 August 2019 for the Arctic-Boreal Vulnerability Experiment. Targets requested by the Science Team included TomoSAR swaths at BERMS and Delta Junction for NISAR; underflights of IceSAT-2 Reference Ground Tracks; first-time observations and revisits of L-ban SAR swaths across the ABoVE domain for the Active Layer Working Group; opportunistic data acquisition of the Shovel Creek fire perimeter near Fairbanks, including reflights of an line flown in 2014 by G-LiHT; NGEE-Arctic sites in Barrow and the Seward Peninsula; and numerous burn scars around Yellowknife/Great Slave Lake for the Phase 2 Wildfire projects. Weather provided daily challenges to acquisition, but due to the excellent performance of the LVIS instruments and NASA5’s extended range and duration, in the end, the only targets not acquired were the Anaktuvuk Burn Scar on the North Slope of Alaska, and two SAR swaths on the Yukon-Kuskokwim Delta.

**Slide 9**

10th Screen: **A Comparison of L-band and S-band Interferometry and Tomography**

**of the BERMS Boreal Forest with UAVSAR and F-SAR Datasets**: The three dimensional structure of vegetation and its changes resulting from either natural or anthropogenic causes are key parameters in monitoring ecosystems. NASA and ESA conducted flight experiments with the NASA/JPL UAVSAR and DLR F-SAR systems respectively at the BERMS site near Saskatoon, Canada on August 19 and 23 of 2018 respectively. Tomographic data sets were collected at L-band by the NASA/JPL UAVSAR L-band radar and at L-band and S-band by the DLR F-SAR system. Ground truth data sets and lidar data from the NASA LVIS system were also acquired. We compare L-band and S-band tomography from the two systems to each other and

to the lidar data sets and use these data to estimate biomass and assess spatial gradients in the canopy vertical structure. (Hensley et al. EUSAR 2019)

**Slide 10**

Adrianna Foster’s model animation that used RCP 8.5.

10th Screen: **Warmer, Drier Climate Could Transform Alaskan Forests:** In a future with higher temperatures and other climate changes, Alaska’s boreal forests could look significantly different than they do now. According to a new study, the warmer, drier conditions of the future could lead to a net loss of plant life in some regions of Alaska, while also changing the ratio of species that grow in them. These vegetation changes caused by global climate change could, in turn, affect Arctic climate in complex ways. Boreal forests of high northern latitudes contain conifers, such as the black and white spruce that dominate Alaskan forests, and deciduous trees, like aspen and birch. In a warmer future, the ratio of conifers to deciduous trees is likely to change, with aspen and birch trees increasing compared to black and white spruce.

We initially see total biomass across all of interior Alaska. Dark greens represent high biomass, and yellows represent areas with low biomass. We then “zoom in” to a single site and show how the UVAFME model simulates individual tree growth, the response to wildfire, and re-establishment following fire. Severe fires combust the organic soil layer down to mineral soil, removing legacy carbon that may be hundreds of years old, thawing permafrost, and changing hydrology, in ways that favor recruitment of deciduous trees over conifers. This simulation occurred under climate change conditions, resulting in an aspen forest replacing the black spruce stand following fire.

*Importance of tree- and species-level interactions with wildfire, climate, and soils in interior Alaska: Implications for forest change under a warming climate* (2019) Ecological Modeling, Adrianna C. Foster, et al. doi.org/10.1016/j.ecolmodel.2019.108765

**Slide 11-12**

In ppt Abhishek’s flux methane and CO@ animation

10th Screen:

**Atmospheric Concentrations of CO2 and CH4**

Fluxes of CO2 and CH4 are controlled by a complex combination of temperature, soil water, geochemistry, and microbial processes – these vary both in space and time. We use general circulation models, or GCMs, where these fluxes are read in and then transported through the atmosphere, with a spatial resolution of 30km.

**First visualization**: shows atmospheric CO2 concentrations near the surface (ground to 100 meters) between May and June of 2017. We see strong pulsing of CO2 (drawdown by plants during the day when you see the cooler green-blue colors and build up during nighttime when the CO2 is trapped in the boundary layer (ground to 2,500 meters), i.e., when you see the hot red and magenta colors). Sources and sinks of CO2 include wildfire, fossil fuel extraction, and photosynthesis/respiration.

**Second visualization**: shows atmospheric CH4 concentrations near the surface, later in the Summer/early Fall of 2017. Methane sources are extremely heterogeneous. In this case, the largest source as we get to the end of Summer are wetlands, fires and emissions from oil and gas drilling. These pulses of CH4 show up as the hot red and magenta colors. In this case, the diurnal cycle is driven by the movement of the boundary layer, which traps methane in the night time.

These movies illustrate is that the dynamics of CO2, CH4 are quite complex and impacted by a variety of local sources and sinks, and atmospheric transport (you can see wafts of air flowing in from Russia or over the Beaufort Sea in both movies). ABoVE researchers will be collecting observations, conducting extensive modeling studies to better understand these carbon cycle dynamics, how these dynamics are responding to environmental change and understand the drivers behind those changes.

Credit: Adrianna Foster, Abhishek Chatterjee, Kristan Morgan, and the Goddard GMAO.

**Slide 13**

In ppt Natalie, Watts et al

10th Screen: **Large loss of CO2 in winter observed across the northern permafrost region:** Winter carbon emissions from Arctic regions appear to be adding more carbon to Earth’s atmosphere each year than is being taken up by Arctic plants and trees. It is a stark reversal for a region that has captured and stored carbon for tens of thousands of years.

This study estimated that 1.7 billion metric tons of carbon were lost from Arctic permafrost regions during each winter from 2003 to 2017. Over the same span, an average of 1 billion metric tons of carbon were taken up by vegetation during summer growing seasons. This changes the region from being a net “sink” of carbon dioxide into being a net source of carbon emissions.

S. Natali, J.D. Watts, B.M. Rogers, S.M. Ludwig, A.-K. Selbmann, P.F. Sullivan, et al. (Oct 2019). *Nature Climate Change,* 9:852-57 DOI: 10.1038/s41558-019-0592-8