



# Ocean subsurface study from ICESat-2 Mission

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## **Acknowledgments:**

- *supported by CALIPSO/CloudSat science team and Dr. David Considine of NASA HQ*
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Jan. 12, 2021, 1:55PM-2:00PM (EST)

# Outline

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## 1. Ocean research from ICESat-2 lidar

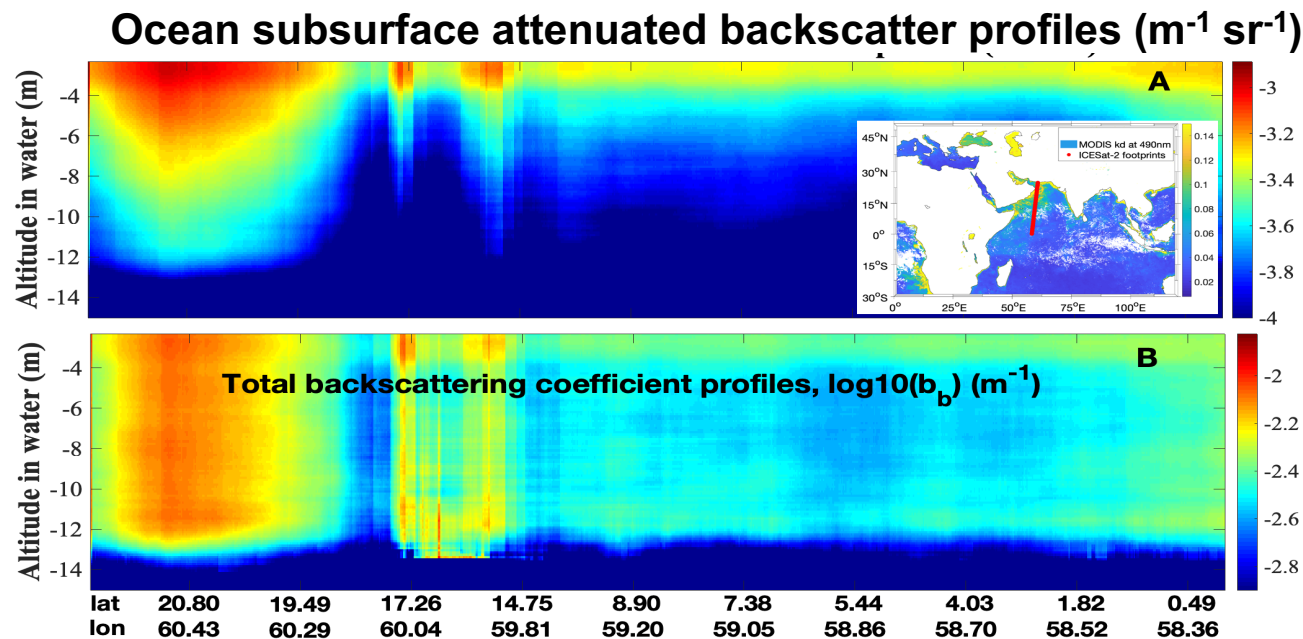
- Ocean subsurface Profiles at very high vertical resolution
- Antarctic spring ice-edge blooms
- Seasonal cycles of Antarctic ocean biology
- Ocean biology – atmosphere cloud interaction

## 2. Summary

# ICESat-2 Ocean subsurface vertical profiles



Depth-resolved structure **not previously available from passive sensor**



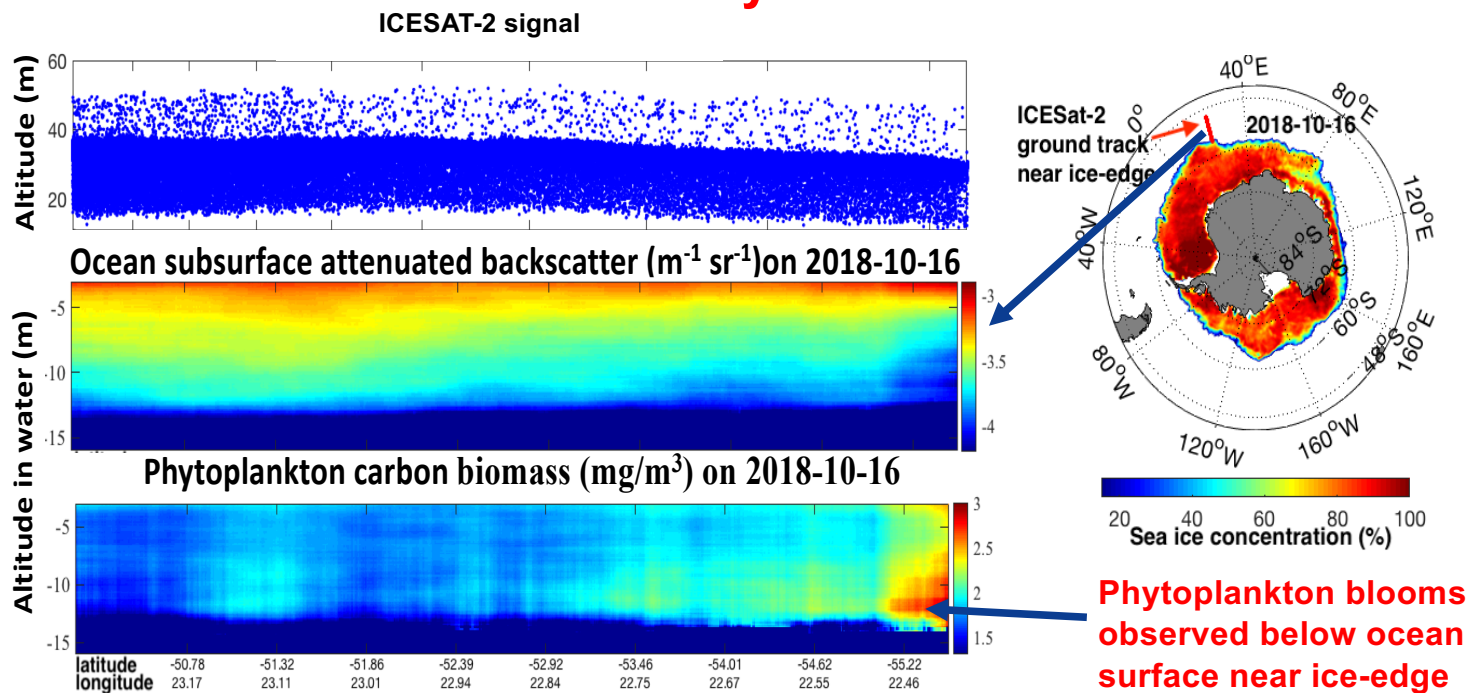
Lu, et al. (2019). Ocean Subsurface Study from ICESat-2 Mission. In *2019 Photonics & Electromagnetics Research Symposium - Fall (PIERS - Fall)* (pp. 910–918).  
<https://doi.org/10.1109/PIERS-Fall48861.2019.9021802>

Lu, et al., 2020, 'Antarctic spring ice-edge blooms observed from space by ICESat-2.' *Remote Sensing of Environment*, 194, p 248-263.  
<https://doi.org/10.1016/j.rse.2020.111827>

# Antarctic spring ice-edge blooms (X. Lu, Y. Hu, et al. 2020)



## First observations of depth-resolved structure of ice-edge blooms by ICESat-2



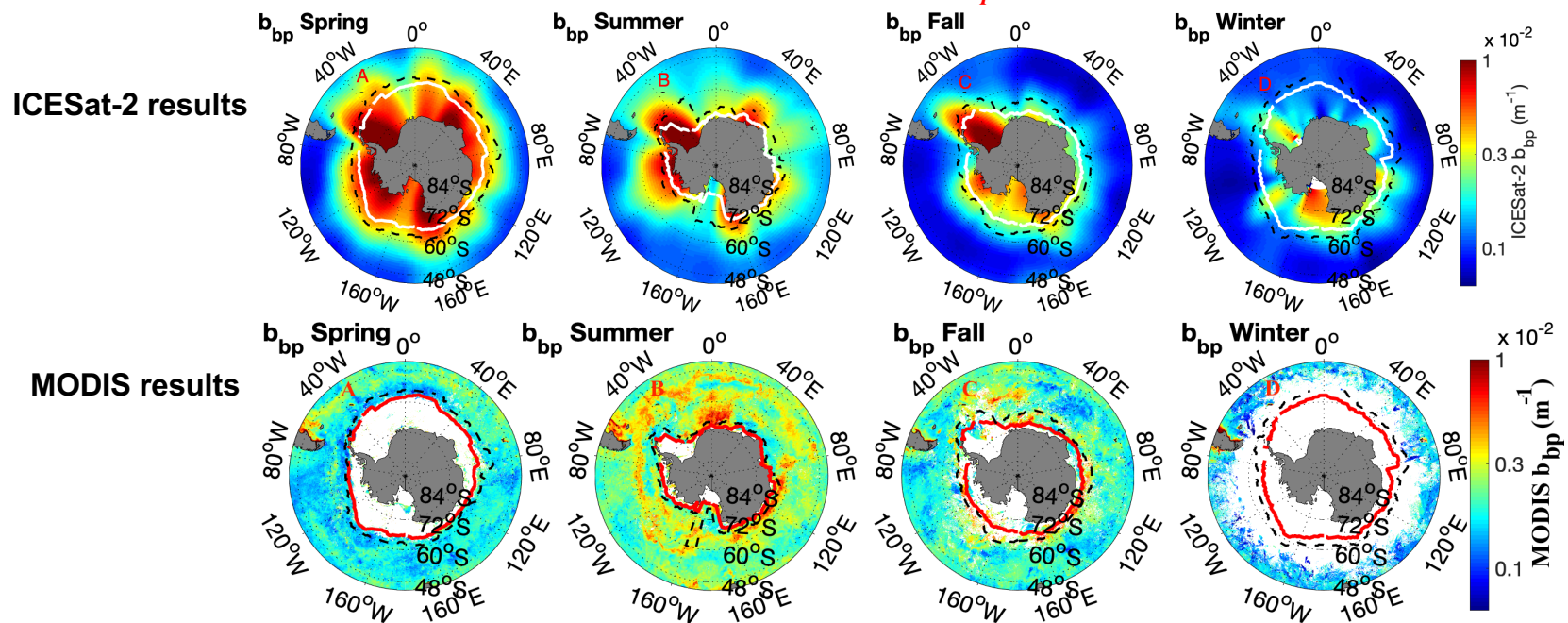
Lu, et al., 2020, 'Antarctic spring ice-edge blooms observed from space by ICESat-2.' Remote Sensing of Environment, 194, p 248-263.

# Seasonal cycles of Antarctic ocean biology



ICESat-2 provide ocean biology results throughout the year at high latitude where MODIS has limited observations.

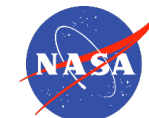
## *Seasonal pattern of oceanic $b_{bp}$ in polar regions*



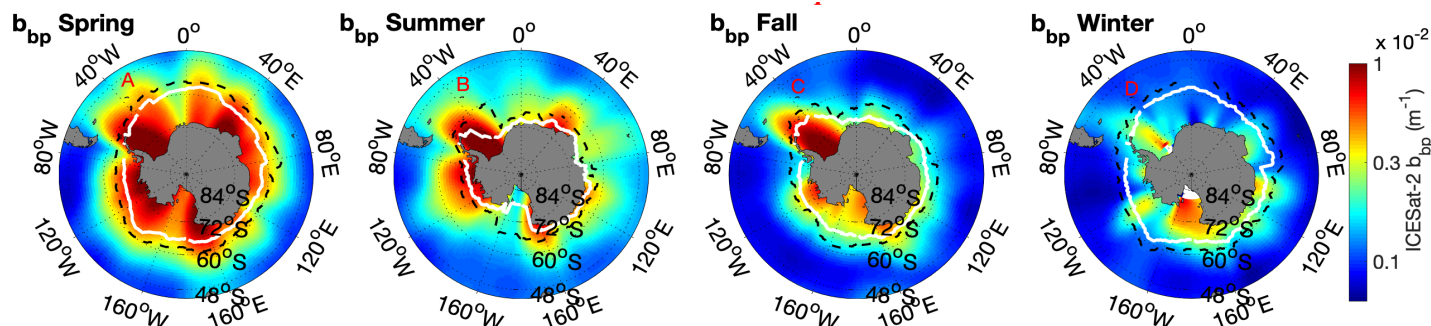
The space lidar fills observation gap of ocean biology when obscured by optically thin cloud and sea ice.

Lu, et al., 2020, 'Antarctic ocean biological activity response to sea ice changes and its impact on cloud microphysics.' in prepare, *PNAS*.

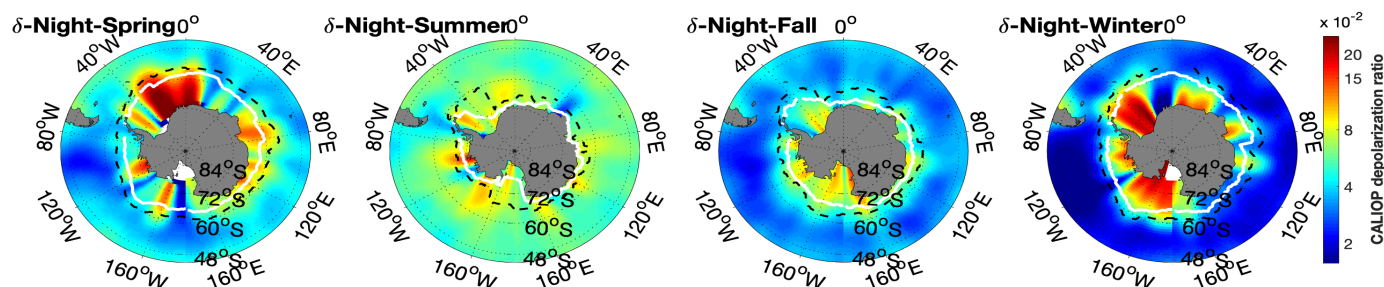
# ICESat-2 ocean biology vs. CALIOP subsurface depolarization



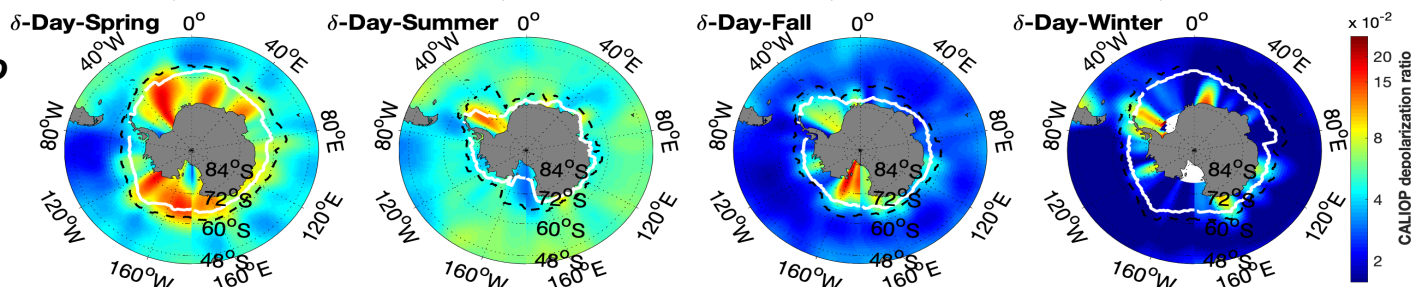
ICESat-2  $b_{bp}$   
Nighttime



CALIOP depo  
Nighttime



CALIOP depo  
Daytime



# Ocean biology – cloud interaction over Antarctic ocean

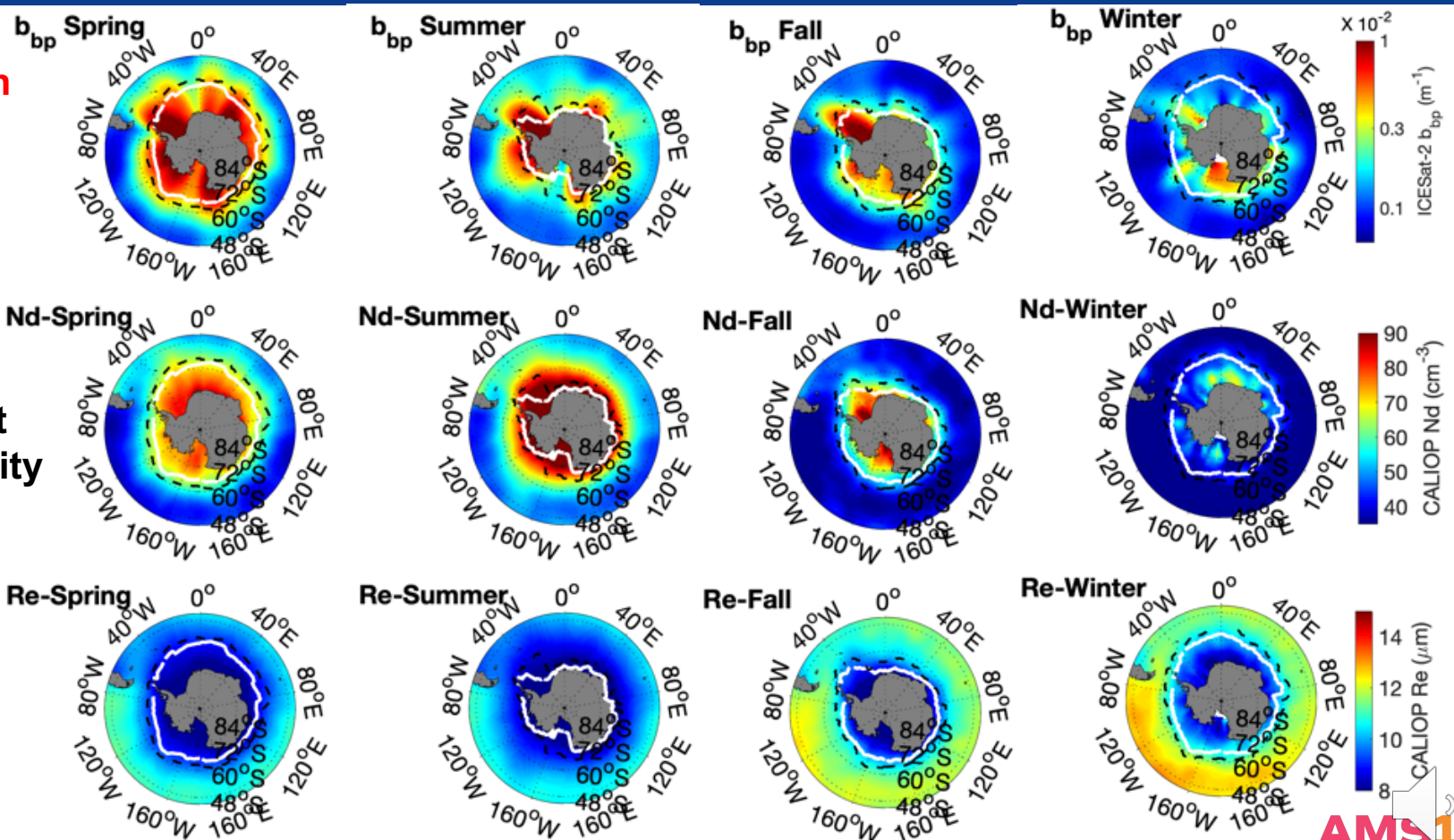


ICESat-2 ocean

CALIOP Cloud

Cloud droplet  
number density

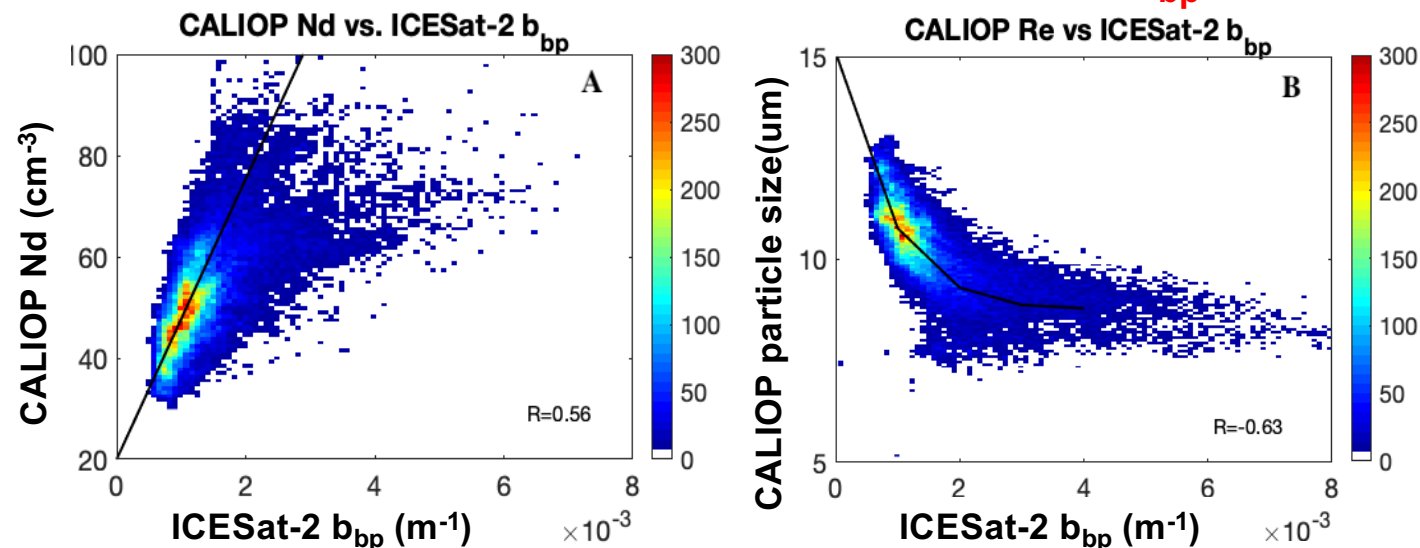
particle size



# Ocean biology – cloud interaction over Antarctic ocean



**Strong relation found between two independent Space-lidar measurements**  
**CALIOP cloud vs. ICESat-2 ocean  $b_{bp}$**



**Science investigations to improve our understanding of ocean-atmosphere interactions and their impact on the climate.**

Hu, et al., 2007, Global statistics of liquid water content and effective number concentration of water clouds over ocean derived from combined CALIPSO and MODIS measurements. *Atmos. Chem. Phys.* **7**, 3353–3359.

Lu, et al., 2020, 'Antarctic ocean biological activity response to sea ice changes and its impact on cloud microphysics.' in prepare, *PNAS*.

# Summary

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## **1. ICESat-2 ocean subsurface research at LaRC**

- augment existing ocean color records**
- provides both day and night ocean results at very high vertical resolutions**
- provide valuable ocean results over high latitude regions covered by sea ice.**
- ocean – aerosol – cloud interaction study.**

**Any questions?**

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