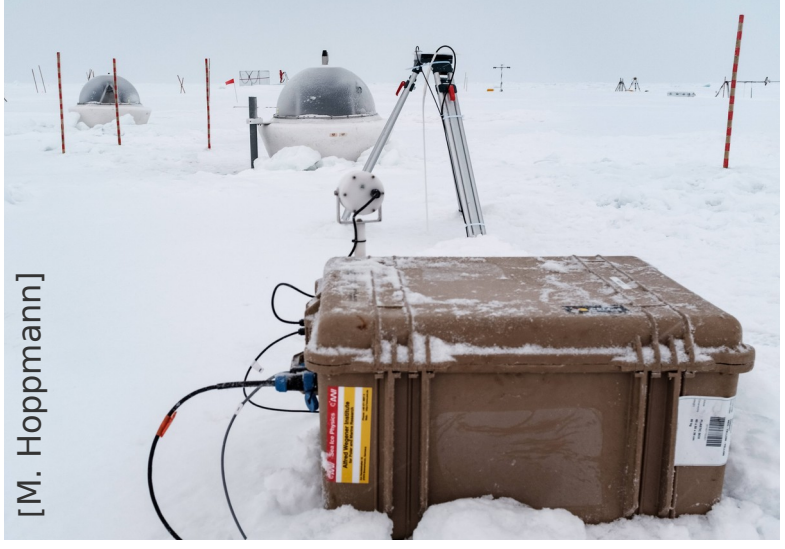
Autonomous measurements of physical and ecological key parameters in the Arctic Ocean

Giulia Castellani, H. Flores, L. Valcic, J. P. Wilkinson, M. Hoppmann, M. Karcher, J. Stroeve, G. Veyssiere, M. Nicolaus, J-H. Kim, E-J. Yang, F. Kauker, A. Crawford



[M. Hoppmann]

Acknowledgements
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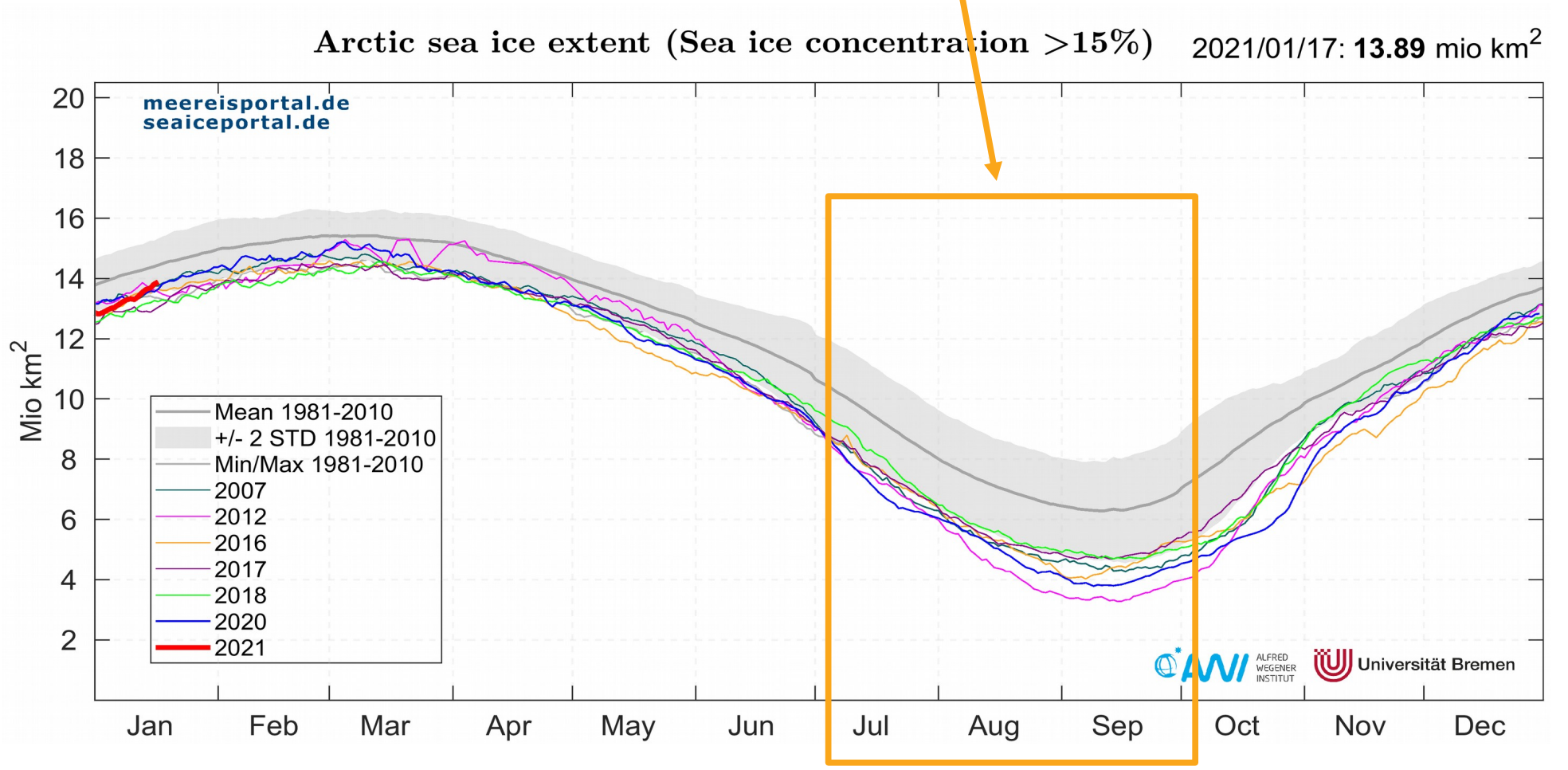
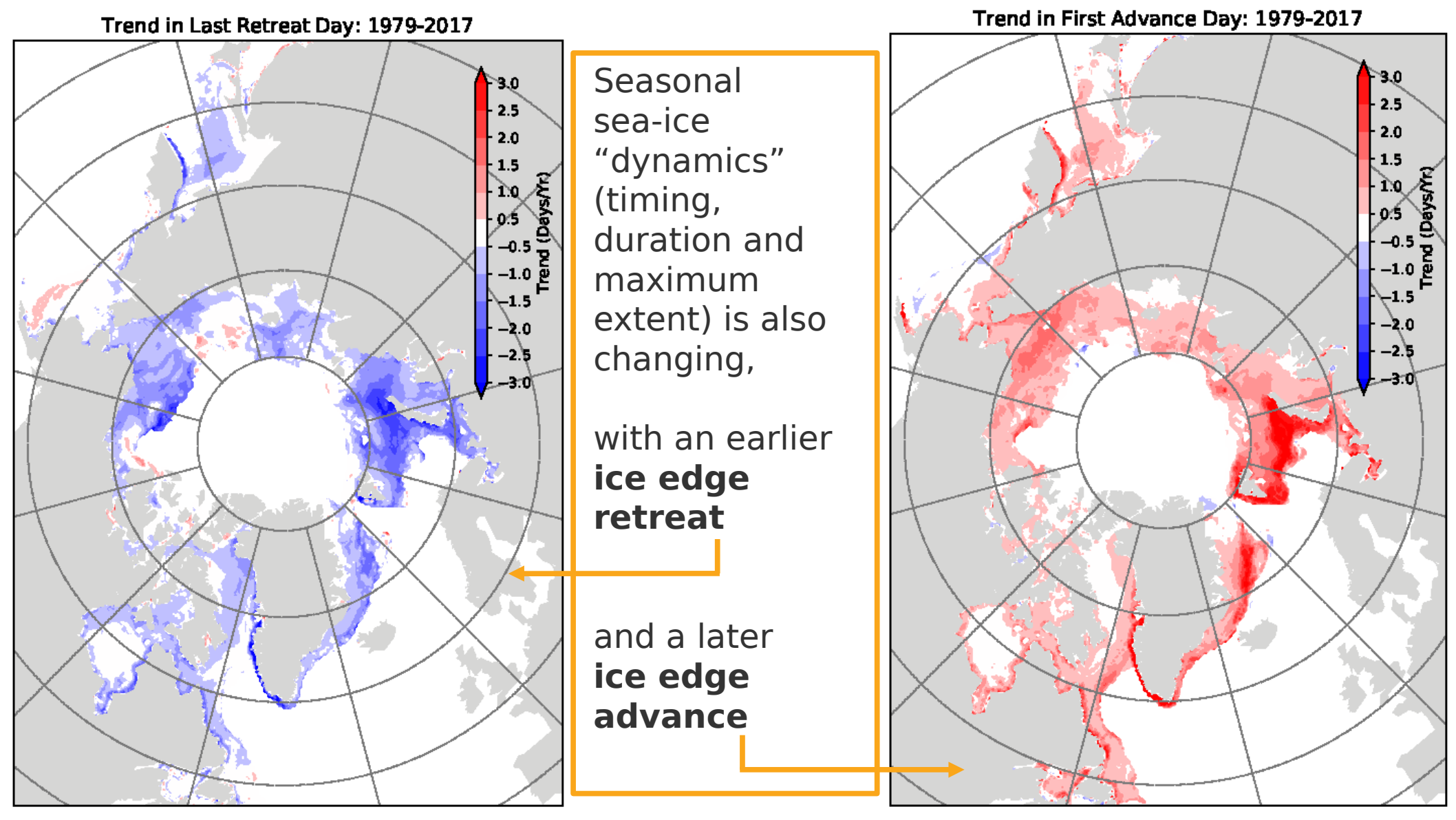
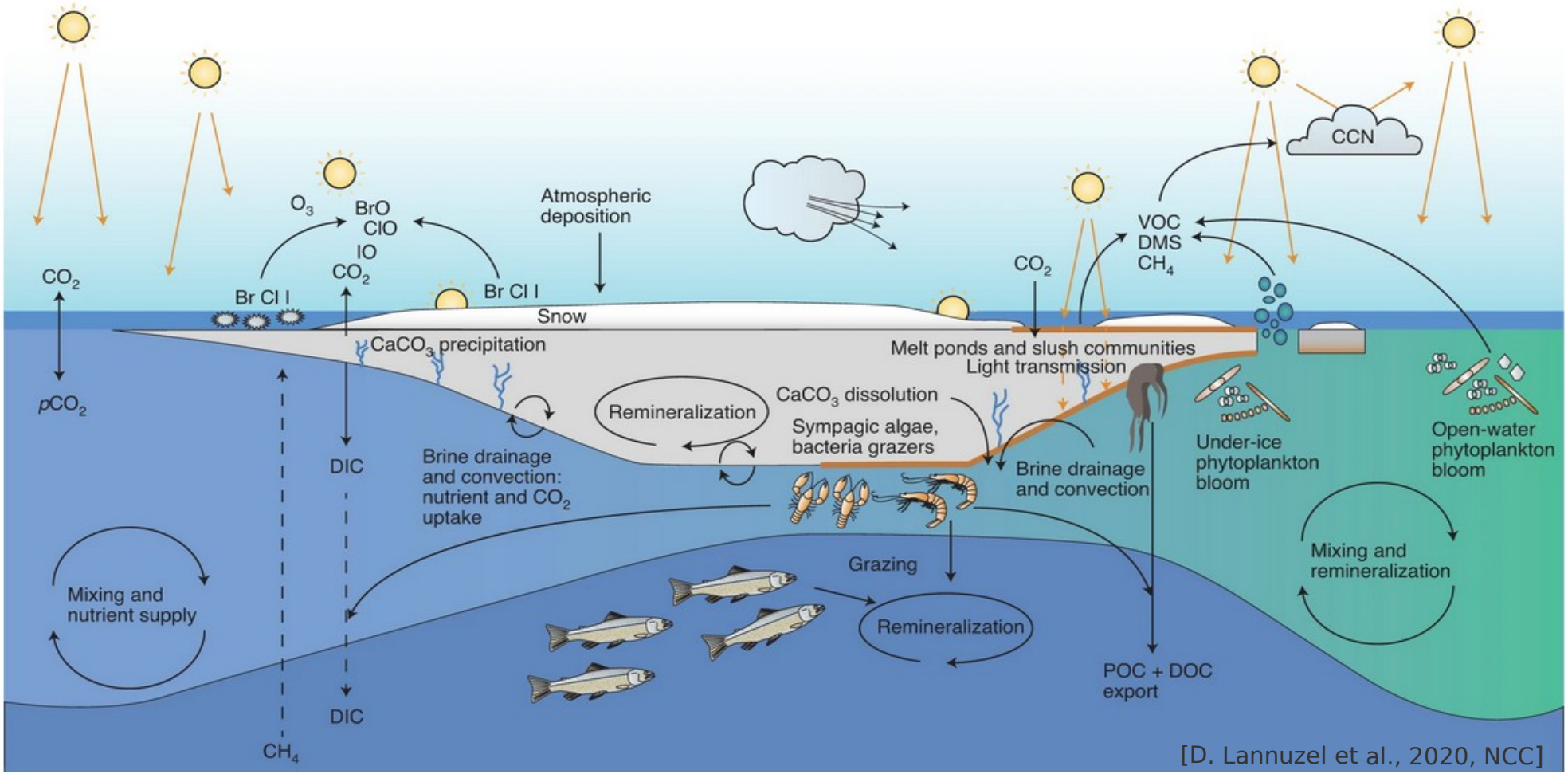
The current **drastic and rapid changes** in the Arctic are leading to a reduction in sea-ice extent and volume, especially in summer.




Trend in Last Retreat Day: 1979-2017
Trend in First Advance Day: 1979-2017
Trend (Days/Yr)
3.0
2.5
2.0
1.5
1.0
0.5
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
Seasonal sea-ice "dynamics" (timing, duration and maximum extent) is also changing,
with an earlier **ice edge retreat**
and a later **ice edge advance**

Changes in sea ice lead to **changes in habitat, food type and availability, and species distribution**, thus affecting ecosystem dynamics and biogeochemical cycling

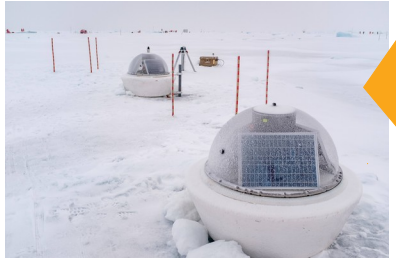


[D. Lannuzel et al., 2020, NCC]

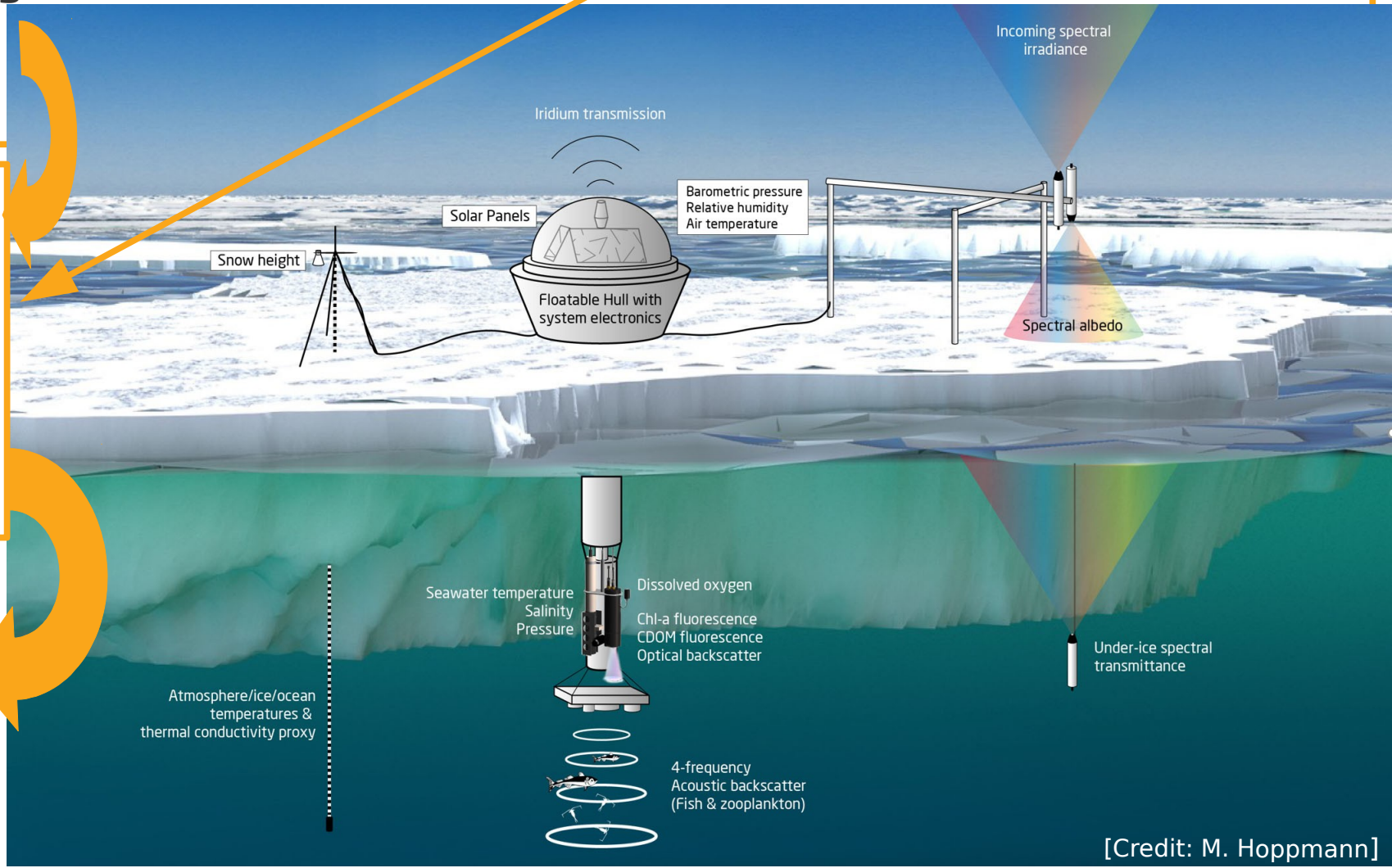
Future Arctic research needs a **holistic coupled physical-biological approach** and **continuous year-round observations**

Buoys cluster

- CTD
- Ice mass balance
- Snow
- **Zooplankton**
- **Radiation**



[M. Hoppmann]

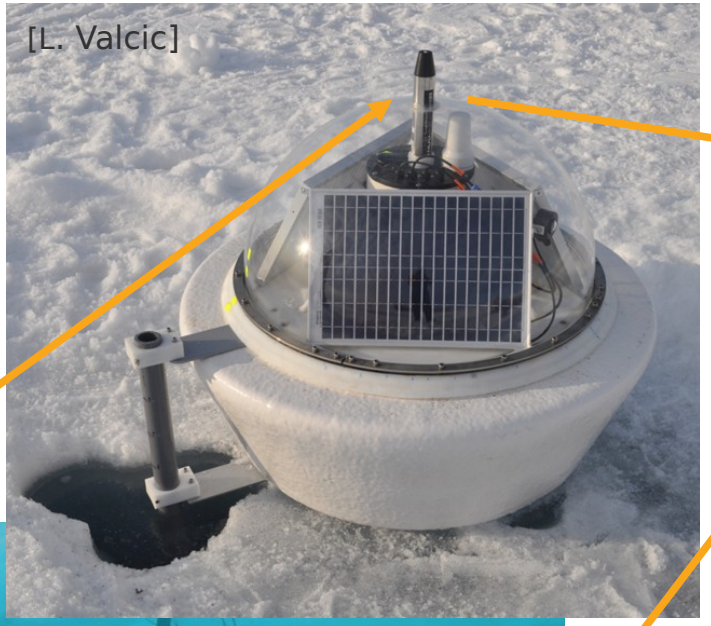


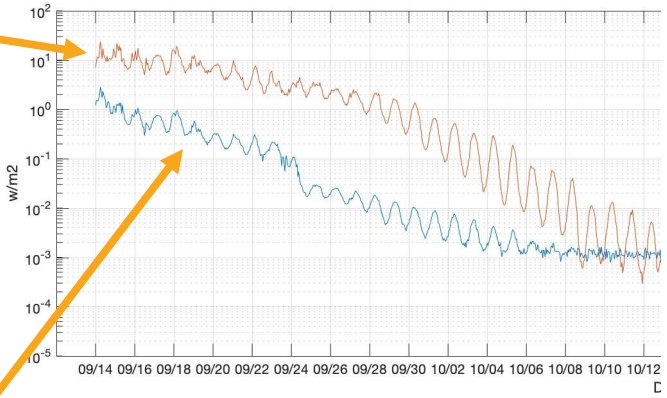
[Credit: M. Hoppmann]

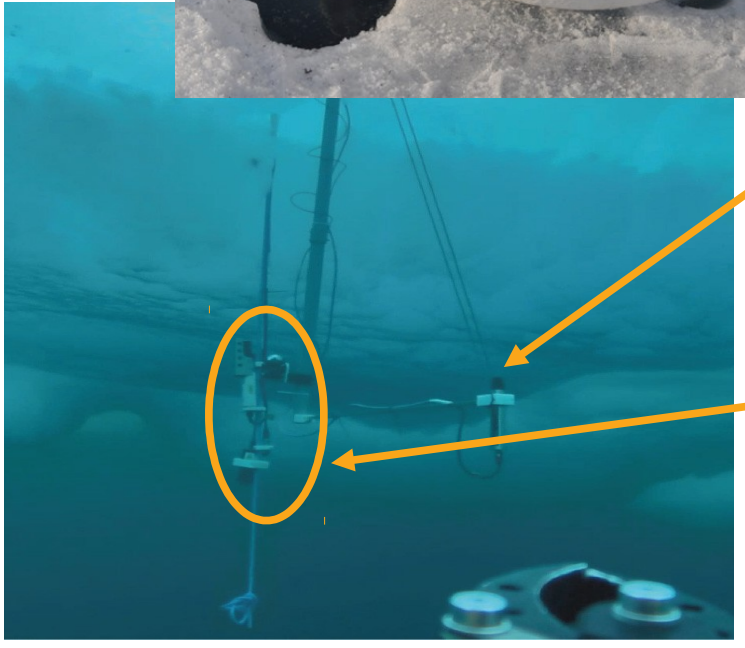
iBOB: Incoming and transmitted solar radiation

In AIR

- Incoming solar radiation
- Air pressure
- Internal tilt
- Internal temp.
- Camera


[L. Valcic]





In WATER

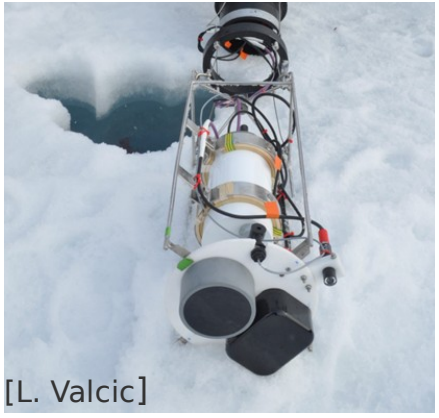
- Light transmitted through the sea ice
- Conductivity at 0.5m depth below sea-ice bottom
- Conductivity, Fluorometer, Oxygen Optode at 2.2m below sea-ice bottom
- Camera


[M. Hoppmann]

AZFP: Zooplankton distribution under the ice

In AIR

- Apogee shortwave incoming solar radiation
- Air pressure
- Internal temperature
- Internal tilt
- Camera



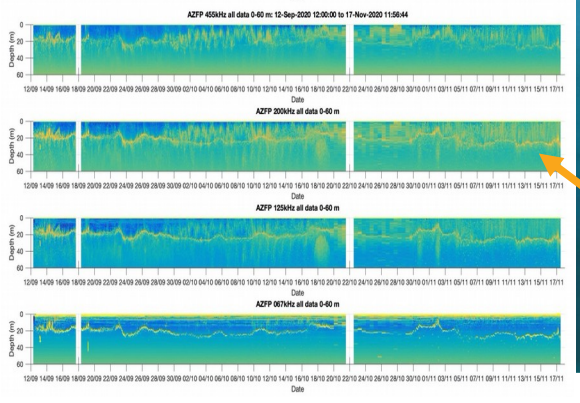
[kHz]

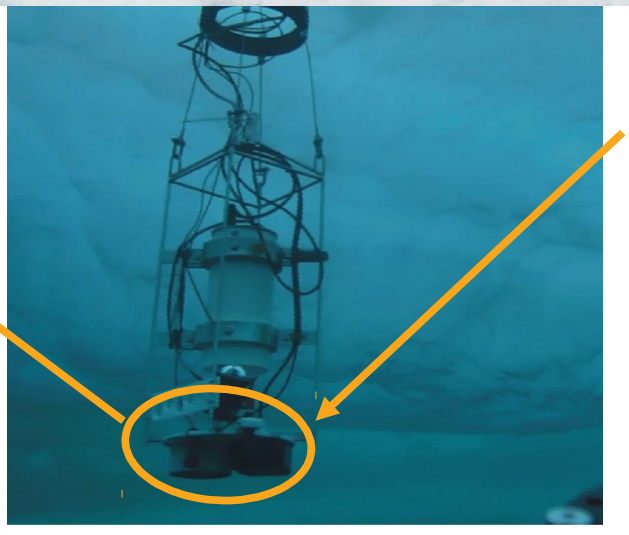
450

200

125

67

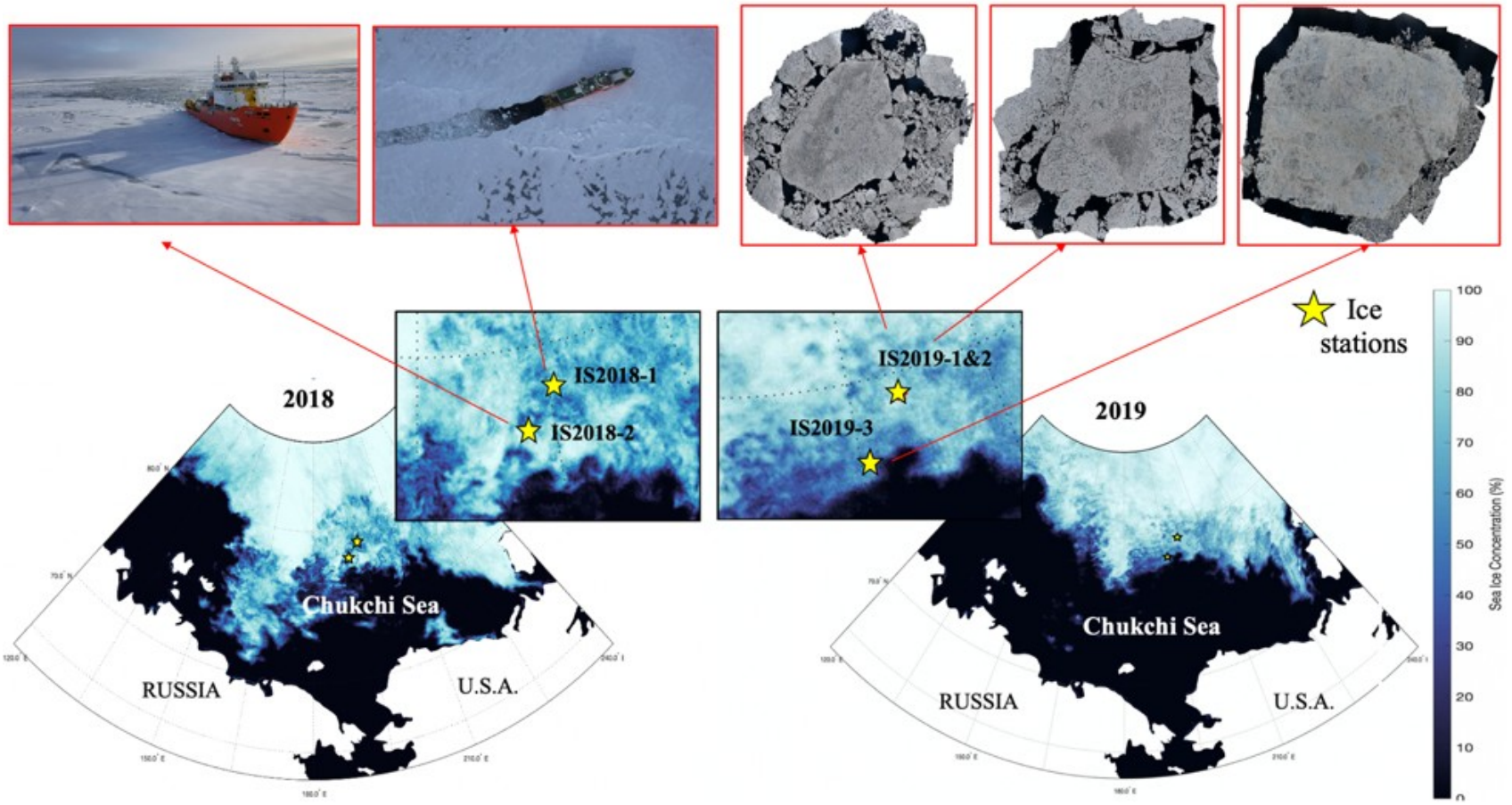




In WATER

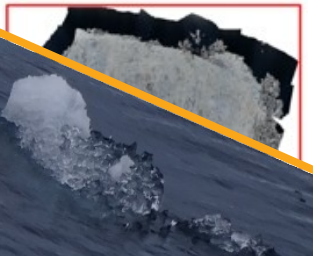
- ASL AZFP at 1.5m below sea-ice bottom
- TriLUX Flourometer at 1.5m below sea-ice bottom
- Conductivity at 1.5m below sea-ice bottom
- Camera

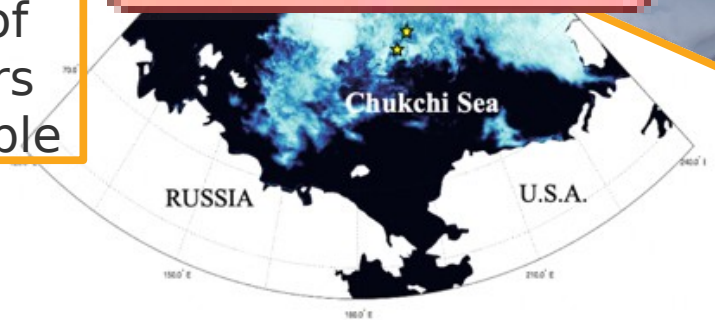
Deployments: Beaufort/Chukchi sea in August 2018 and August 2019 from the RV Araon (KOPRI)



[G. Veyssiere et al., *Under Rev.*, F. Mar. Sci.]

Deployments: Beafurt/Chukchi sea in 2018 and August 2019 from the RV Araon (KOPRI)

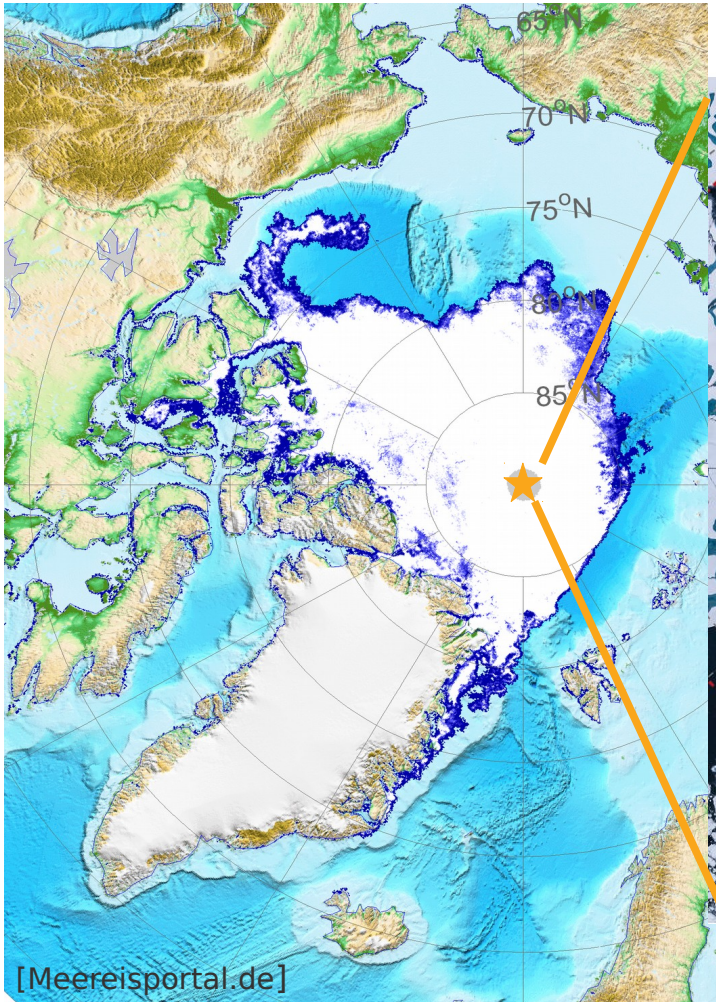


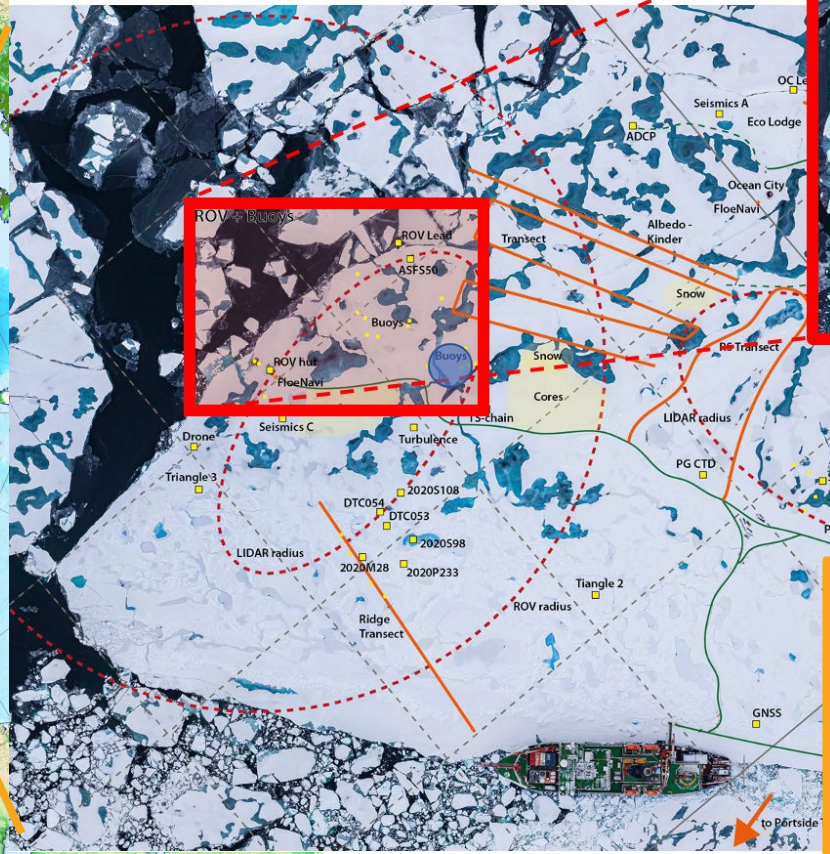


Both years a polar bear destroyed the buoys, in 2019 a full recovery of the sensors was possible

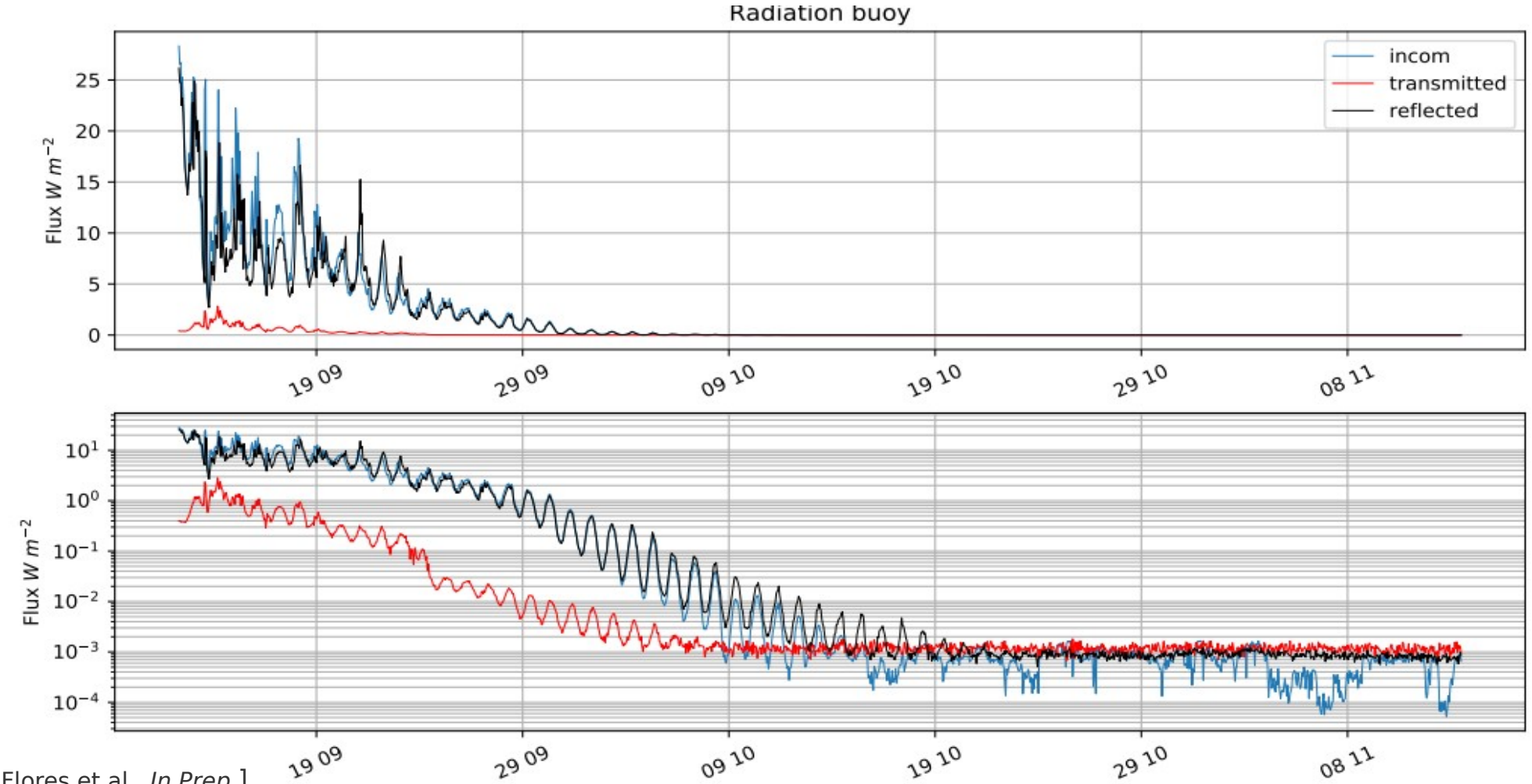
[G. Veyssiere et al., *Under Rev.*, F. Mar. Sci.]

Deployments: MOSAiC September 2020, 89.05°N 107.10°E



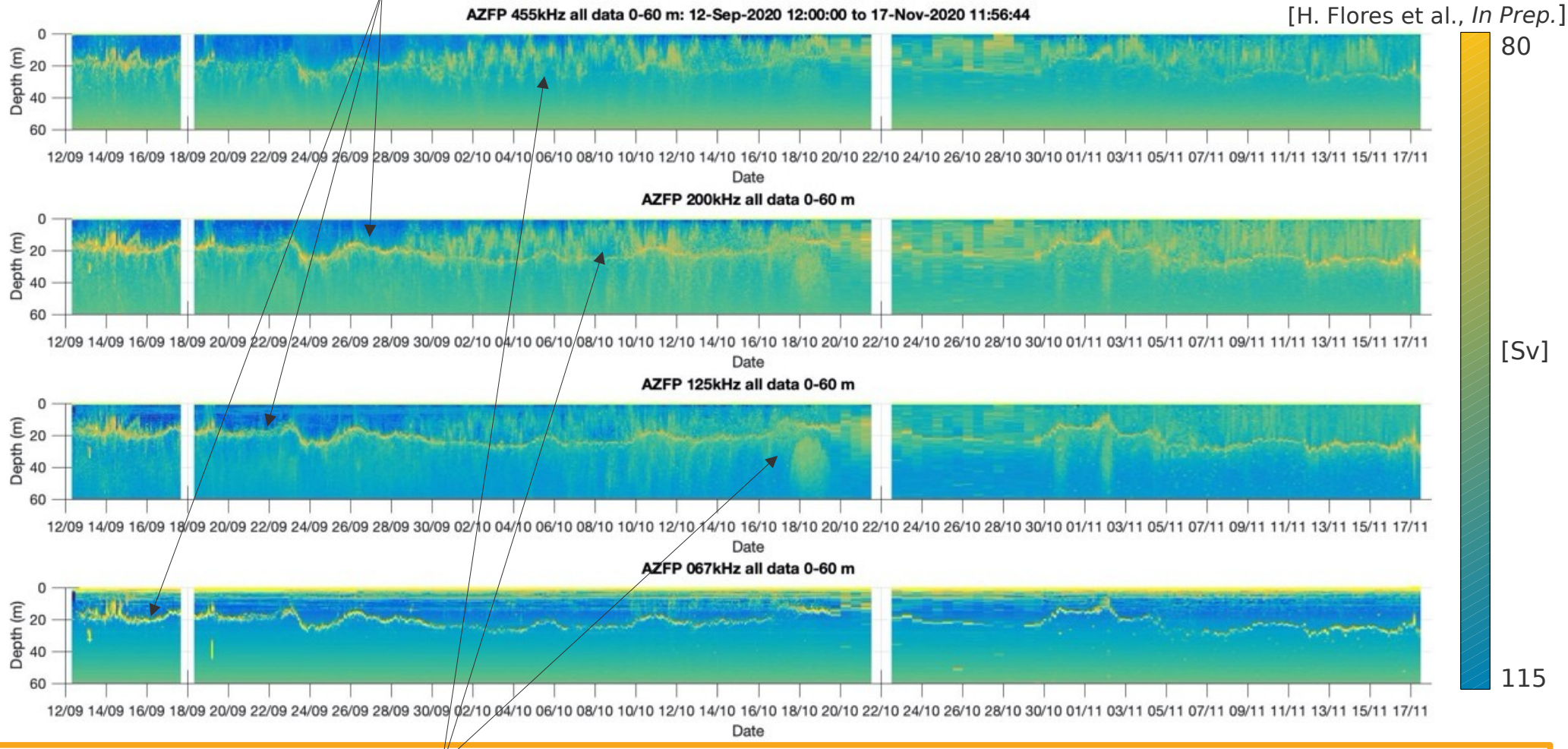


iBOB data show incoming, transmitted and reflected radiation



[H. Flores et al., *In Prep.*]

AZFP data show the **position of the pycnocline ...**

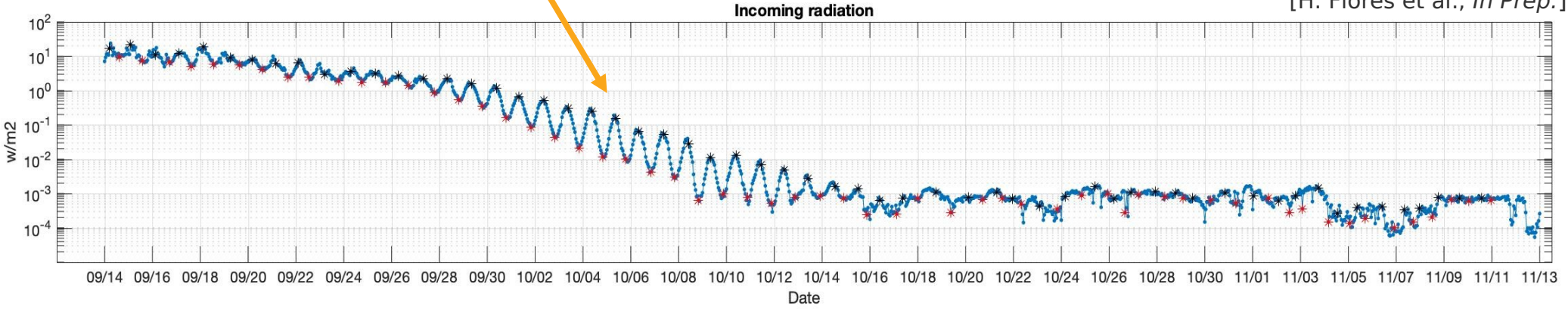


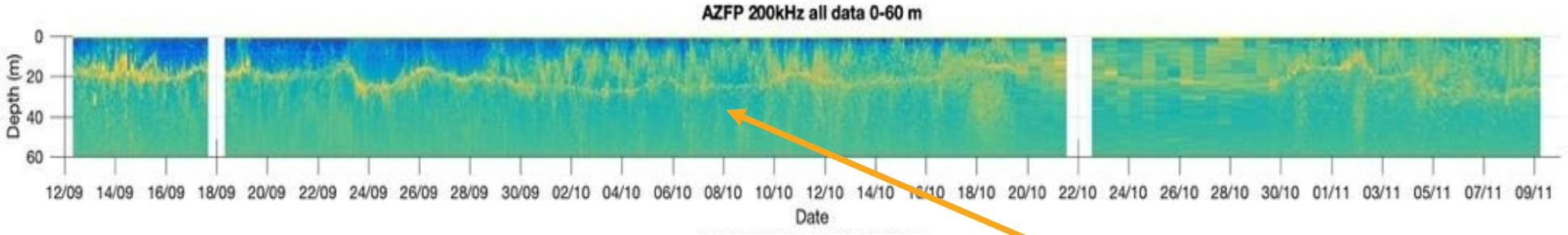
[H. Flores et al., *In Prep.*]

... and the **distribution of organisms** under the ice (high scattering)

Transition into polar night: at such high latitudes it is a matter of few days. **Incoming light decreases** from 10 W/m² to zero ...

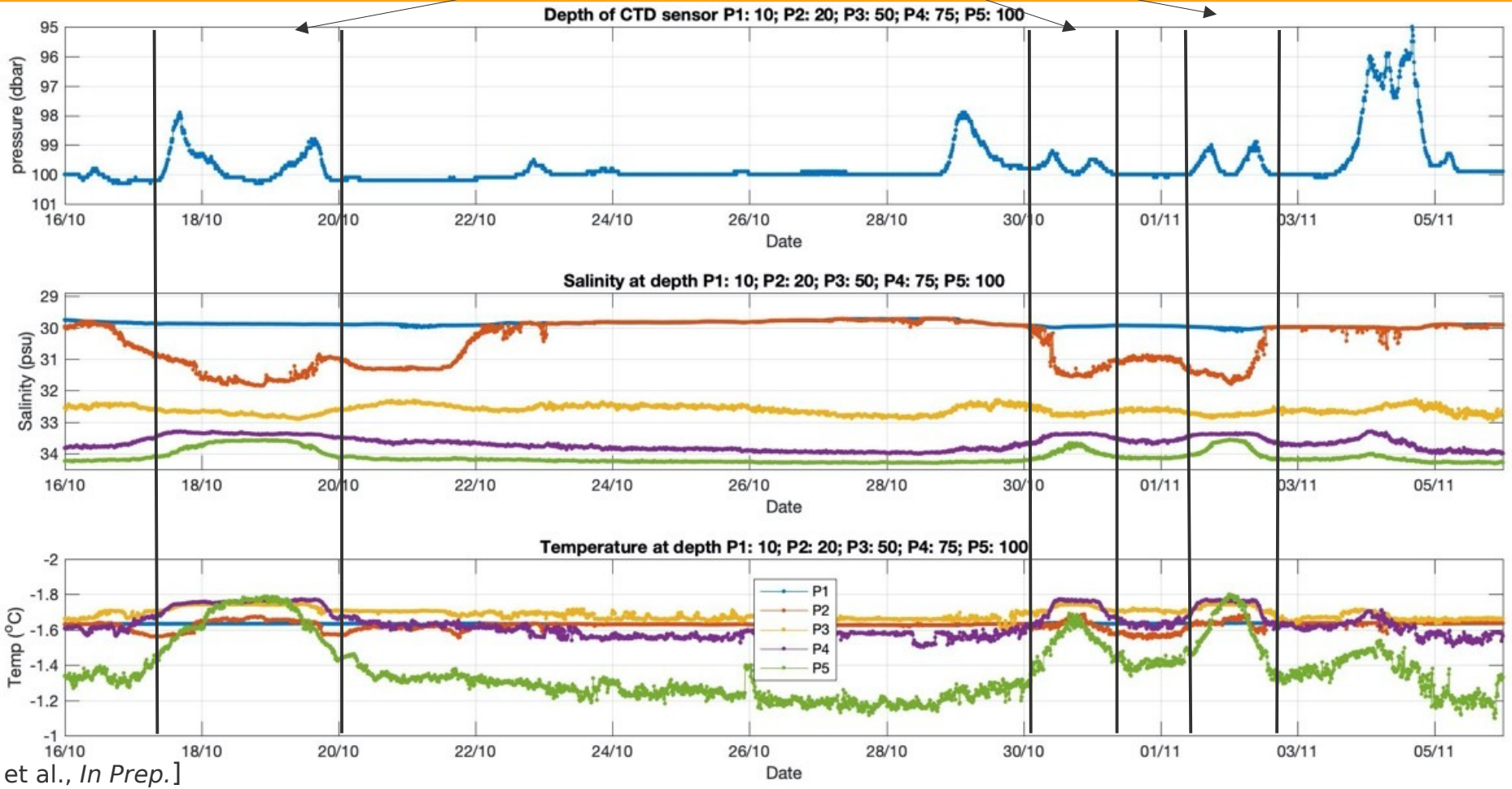
[H. Flores et al., *In Prep.*]





The zooplankton reacts to the changes in light and **moves upwards** in the top ~5m under the ice, above the pycnocline ...

Eddies: data from an oceanographic buoy deployed together with the iBOB and AZFP buoys allow the observation of **special features** and thus the investigation of how water properties and dynamics may affect zooplankton distribution



[H. Flores et al., *In Prep.*]

Main improvements

- Holistic observations of the coupled physical-biological system
- Capture transition phases when we are usually not there
- Observation of particular events (eddies)
- Possibility to transmit data at (almost) real time
- Remote monitoring of the battery level
- Possibility to remotely change the sampling settings in order to optimize battery consumption

Major challenges

- Polar bears love them!!
- Icing of sensors
- Ridging and rafting of ice
- Communication issues for data transmittance
- Internal software issues
- Sometimes we don’t know, we are not there!

Future improvements

- Everything must float!
- Wildlife resistant solutions
- Iridium Certus integration
- More powerful battery for winter sampling
- Deploy more clusters to capture spatial variability
- Towards the development of multidisciplinary buoys