FRAM

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

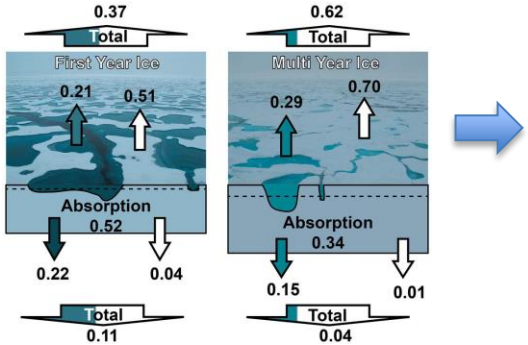
M. Nicolaus, **M. Hoppmann**, C. Katlein, B. Rabe, F. Wenzhöfer, M. Schiller, D. Scholz & many more

Recent developments in remotely operated and autonomous technology for interdisciplinary sea ice observations

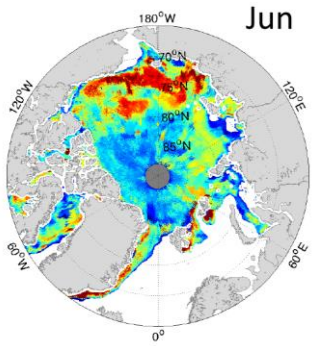
HELMHOLTZ ASSOCIATION

Challenge: The problem of scales

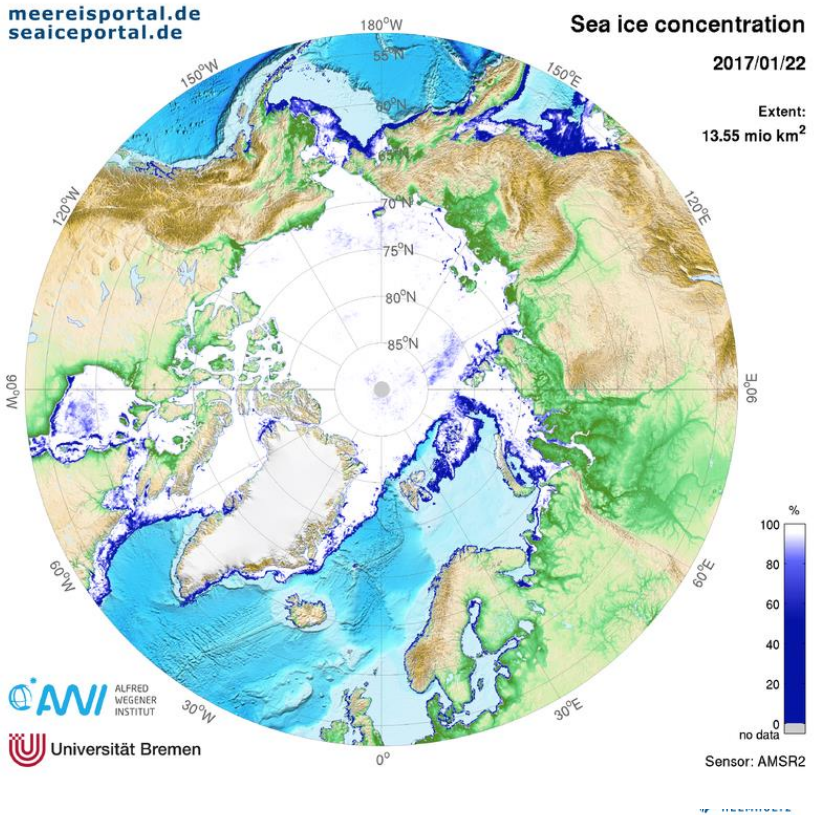
- High spatial variability on multiple scales
- Usual field observations: point measurements
- Sometimes: transects
- Upscaling: merge concepts with remote sensing and/or numerical models
- **Collect (much) more observations, across (much) larger areas!**



From Nicolaus et al. (2012, GRL)



From Arndt & Nicolaus (2014, Cryosphere)



Challenge: Seasonality

- Campaigns usually limited to summer
- Merging of campaigns in different seasons
- Again: connect field measurements to remote sensing and numerical models
- **Collect observations throughout all seasons!**
- (Manned observatories)

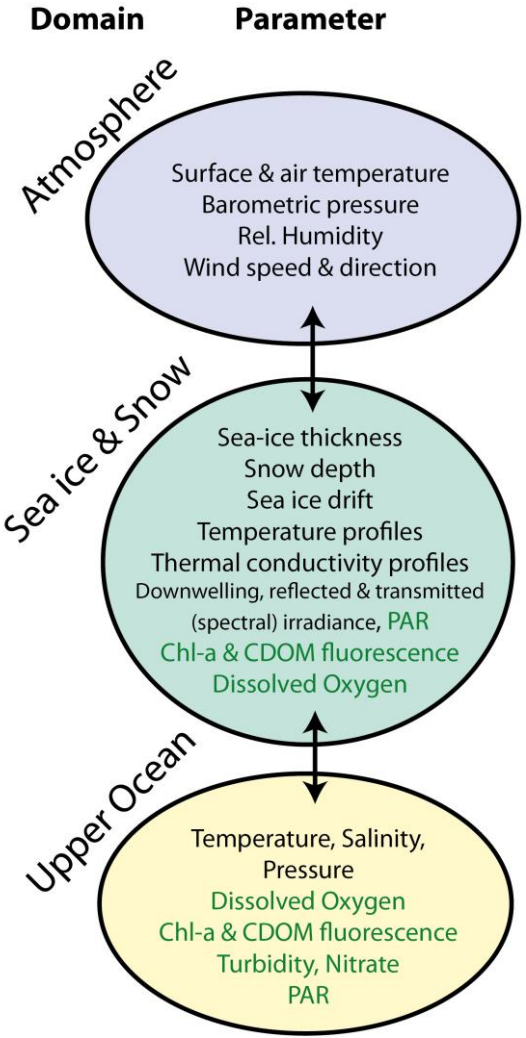
From Nicolaus et al. (2010, JGR)

Russian drift camp NP-38

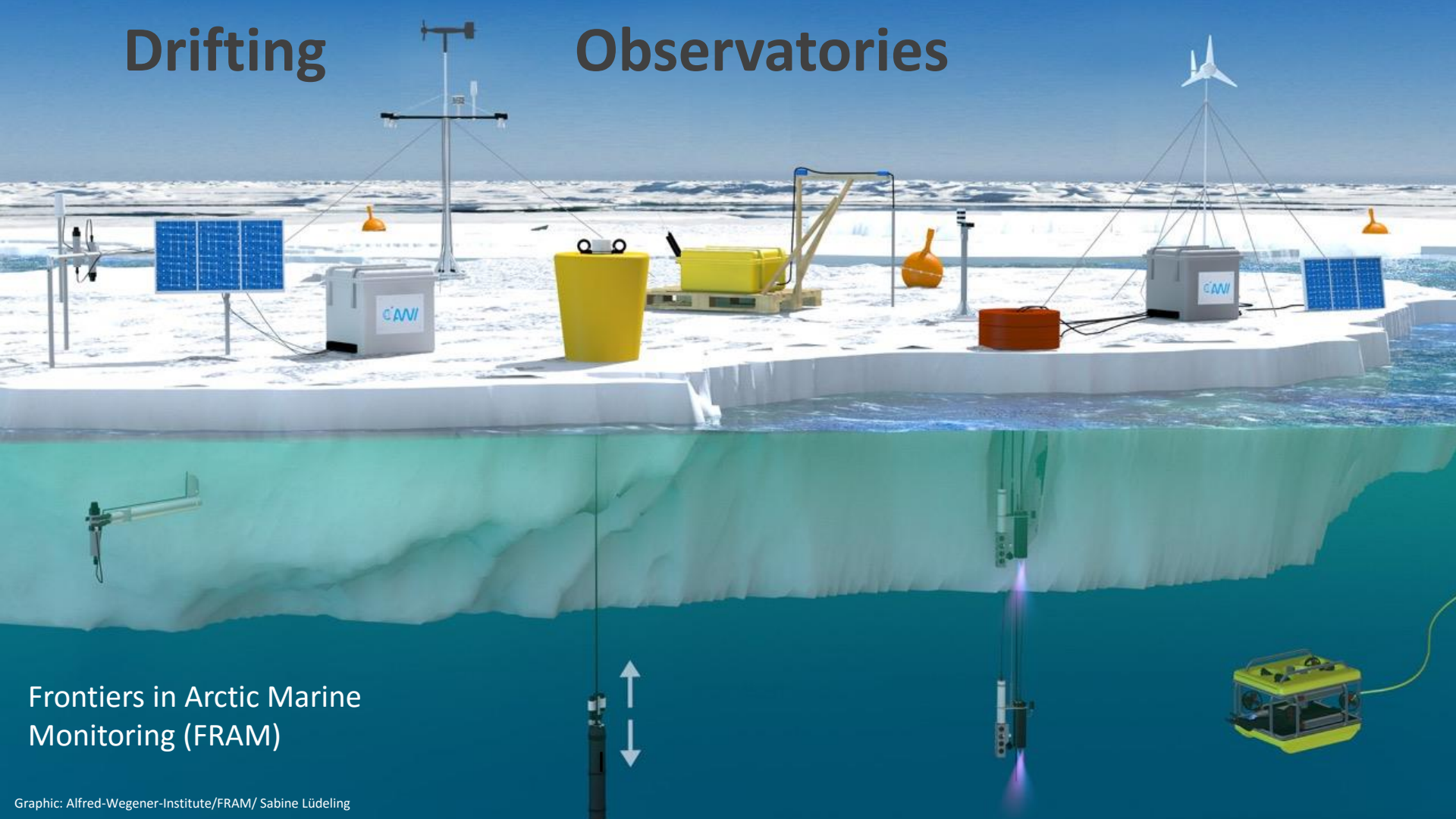
Challenge: Interdisciplinarity

- Interaction between atmosphere, sea ice, snow & ocean
- Linkages between physics, biological processes, biogeochemical cycles
- Link to surface properties to use remote sensing
- Coupling of models

- **Measure all key parameters simultaneously**
- Coordinated studies, e.g. N-ICE 2015



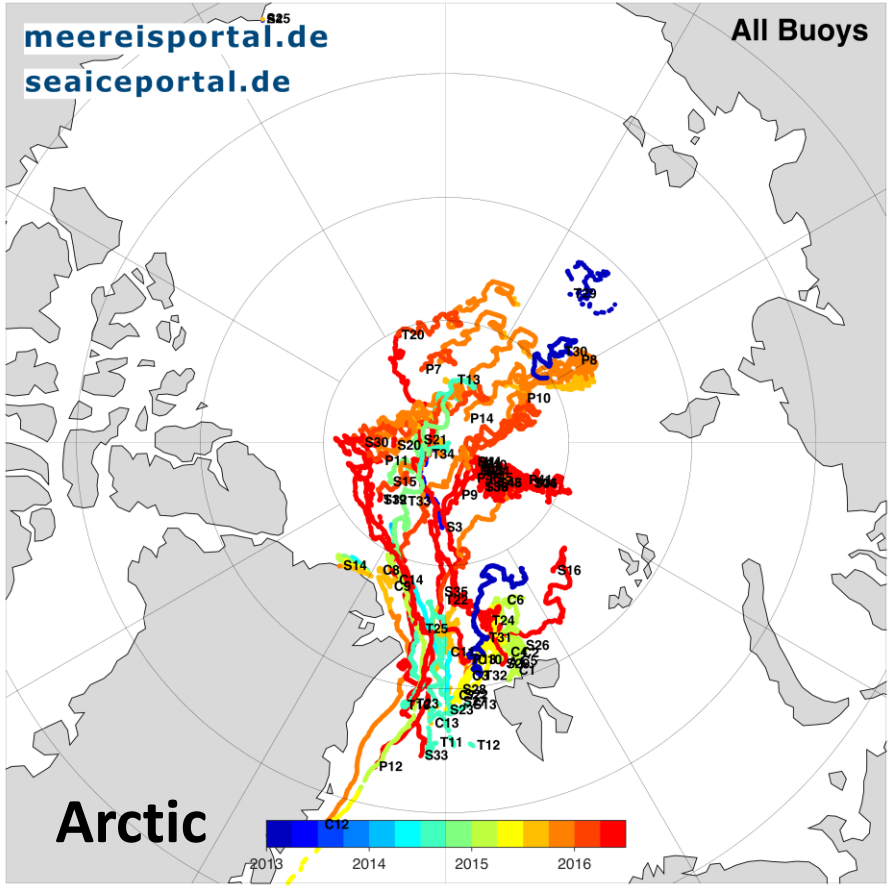
Drifting Observatories

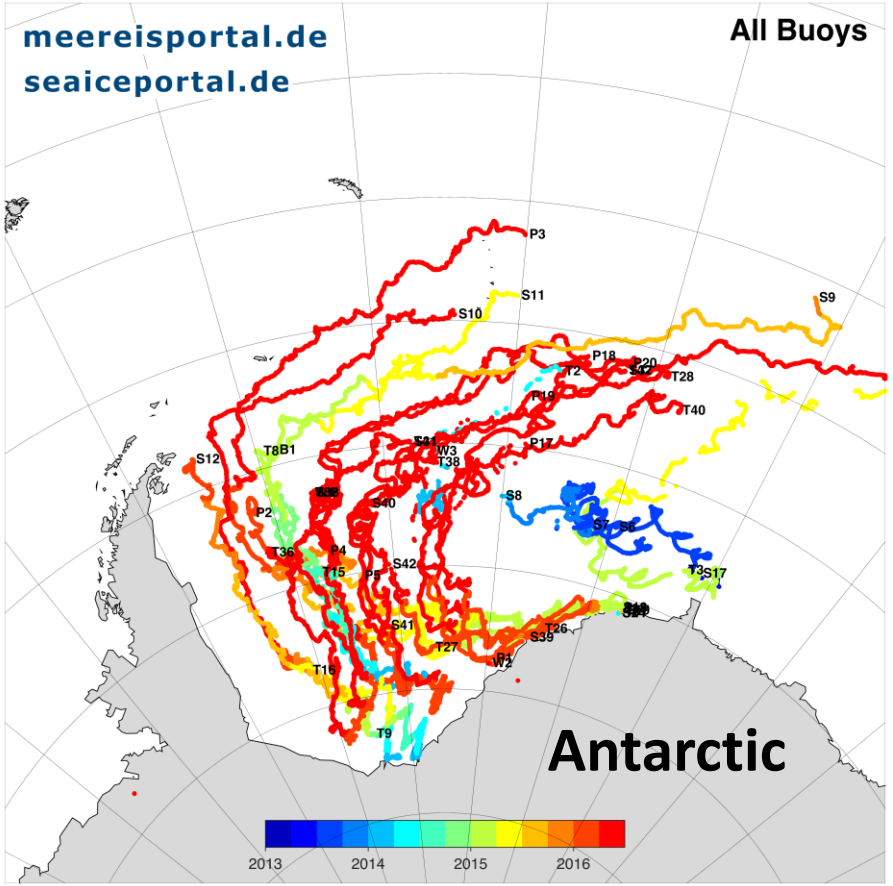


Frontiers in Arctic Marine Monitoring (FRAM)

Graphic: Alfred-Wegener-Institute/FRAM/ Sabine Lüdeling

Increased temporal & spatial coverage



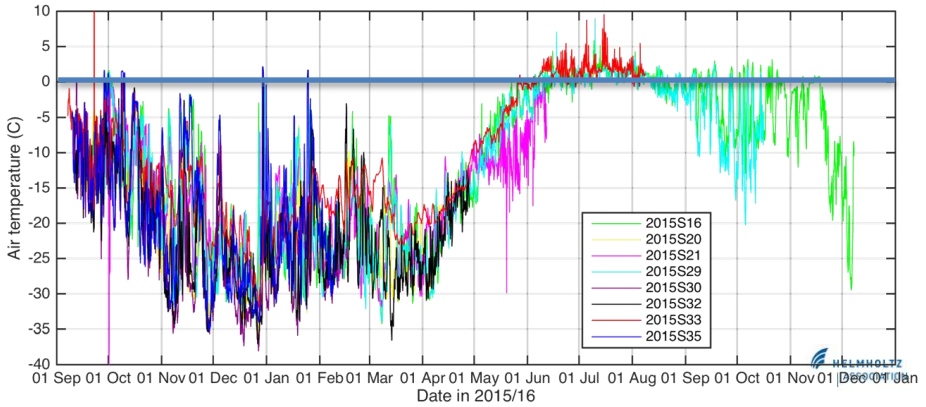


Snow Buoys

Snow is exceptionally important!

- Snow depth, air temperature, bar. pressure
- Variability on different scales
- Warm spells at the North Pole in winter
- Data into GTS => weather forecast
- Different behavior in Arctic vs. Antarctic
- Remote sensing ground truthing

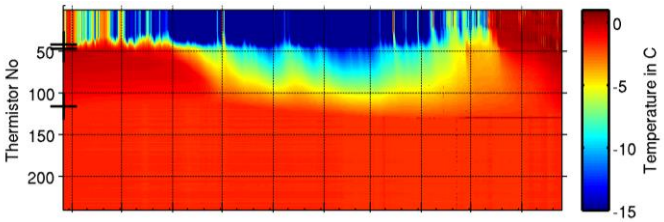
Open data portal:
data.meereisportal.de



Ice Mass Balance Buoys

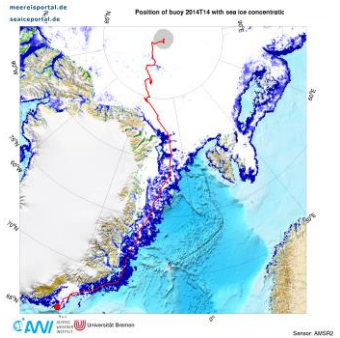
Key instrument in sea ice research

- Sea ice temperatures & thickness
- Sea ice mass & energy balance
- Air, snow, ocean temperatures, snow depth
- Thermal properties, internal melt, flooding, ponding, …
- Suited for process studies and large scale estimates



Current challenges

- Data processing & interpretation
- Synthesis analysis
- Link to other data types



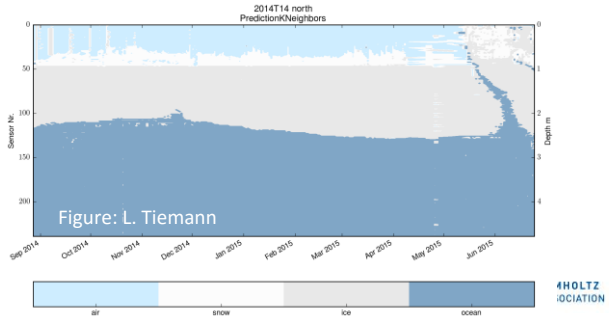
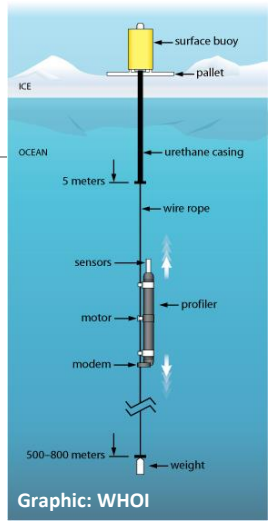


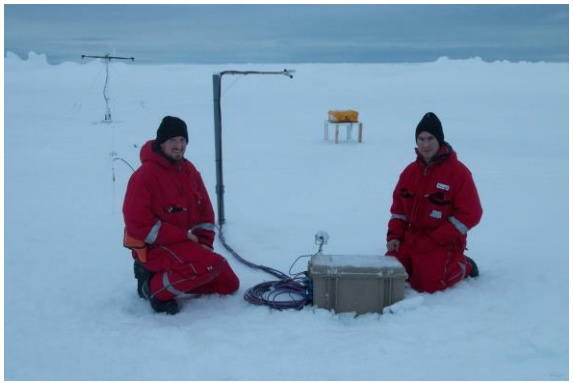
Figure: L. Tiemann

Bio-Optical Buoys / Bio-Profiler

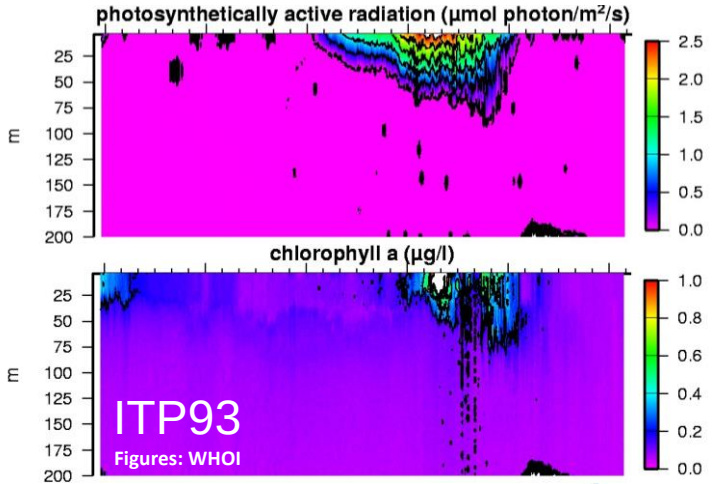
Advanced research platforms

- Profiling systems with physical, biological & biogeochemical sensors (5-800m), e.g. ITP (Woods Hole), IAOOS (LOCEAN)
- Ice-tethered bio-optical Buoys (in & just below sea ice)
- Temperature, Salinity, Oxygen, PAR, Chl-a, CDOM, Backscatter, Nitrate





Bio-Optical Buoy Prototype deployment in 2016



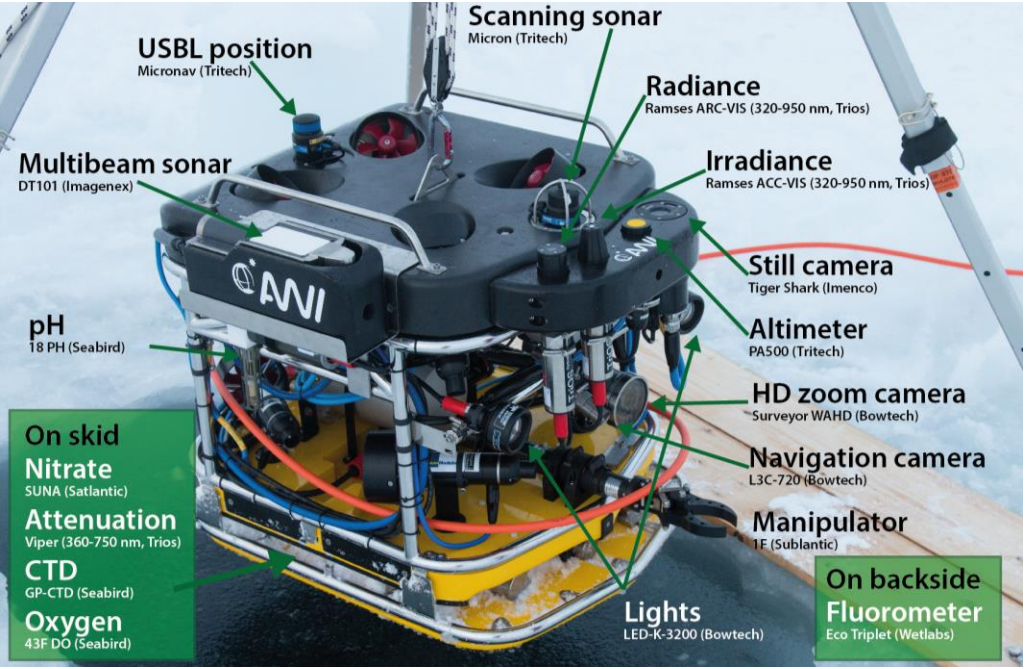
Sep 2015

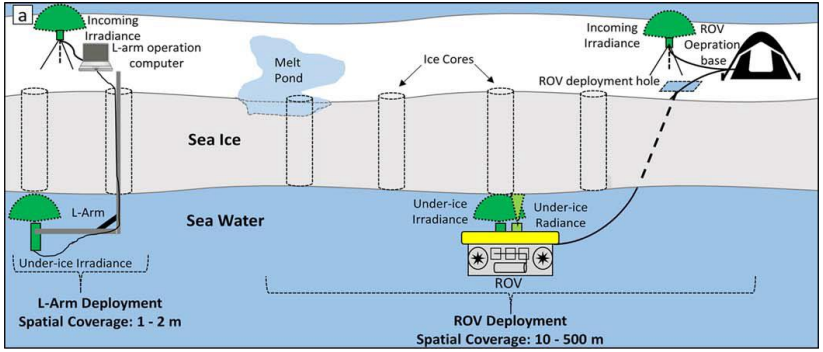
Jan 2017

A new under-ice robotic vehicle

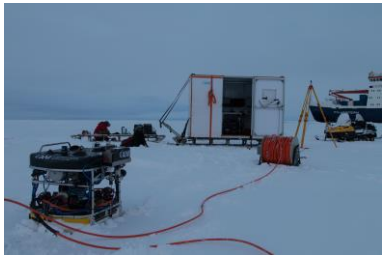
Ideal platform to bridge scales

(See Katlein et al. today @14:00)





From Lange et al. (2016, JGR)



- Operated from an ice floe
- Complex, interdisciplinary sensor suite
- Planned extensions (e.g. zooplankton)

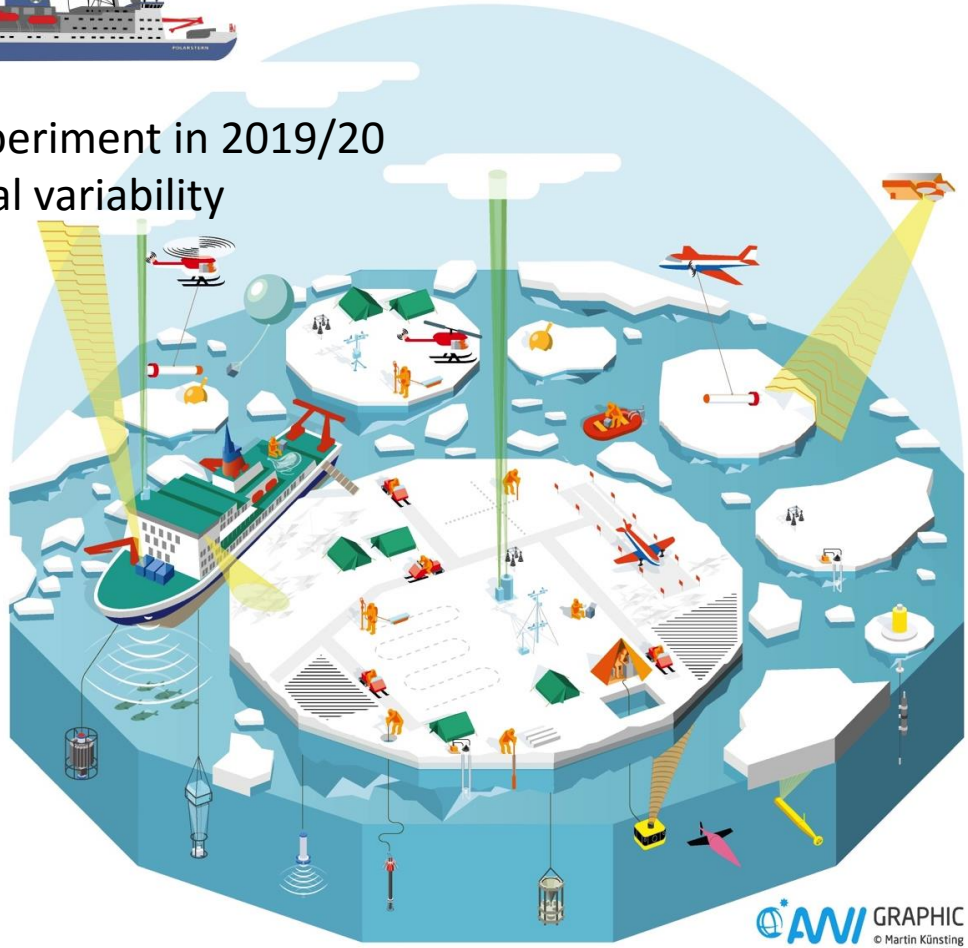
Road to MOSAiC

The International Arctic Drift Expedition

- Unique, year-long international drift experiment in 2019/20
- Focus: seasonal changes and their spatial variability

- Key processes as a function of seasonality and ice type
- Complete spectrum of parameters, processes, scales
- Effects of a changing ice pack

- **Drifting buoy observatories & ROV are key elements in this effort.**



Thank you!

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FRAM

HELMHOLTZ ASSOCIATION

REKLIM
Helmholtz-Verbund Regionale Klimaänderungen

OceanModules

MetOcean

WOODS HOLE OCEANOGRAPHIC INSTITUTION
1930

SCOTTISH ASSOCIATION for MARINE SCIENCE

LOCEAN

BRUNCIN