Biology break-out group notes:

Drivers of variability: (to be summarized in an opening statement)

Reduced pH (acidification) (incl. under different sea ice regimes)
Warming temperatures (air and water)
Snow cover and precipitation
Enhanced benthic predation from duraphagous predators
Invasive species changing community interactions
Salinity stress due to increase in sea ice and glacier meltwater input
Greater iceberg scouring from ice-shelf disintegration
Iceberg influences on pelagic ecosystems (nutrient enrichment…)
Increasing sedimentation and turbidity from glacial ablation and meltwater input
Increasing ocean stratification in some areas due to meltwater input
Deeper mixing in other areas due sea-ice loss and greater wind stress
Frequency and magnitude of storms
Extent, timing and quality of sea ice (ice as a habitat AND a cover)
Seasonality, interannual variability and long-term trends in temperature, sea ice, light quality/quantity, water column structure

Major themes:

1. Polar ecosystems and environmental variability
   - Ecosystem resilience, stability, and tipping points
   - How do polynya ecosystems vary in space and time? (summer vs. winter)
   - How is carbon cycled through polar ecosystems on annual time scales, and in particular under ice?
   - How vulnerable are polar ecosystems to key drivers : ocean acidification, temperature increase, sea ice change?
   - Vulnerability to changing seasonality? (timing and extent of sea ice retreat, and associated factors such as light quality, bloom development, vertical fluxes and benthic-pelagic coupling)

2. What is the role of polar ecosystems in biogeochemical cycles of carbon and greenhouse gases?
   - What is the role of sea ice dynamics on production and exchanges of globally relevant atmospheric gases, e.g., DMS, bromine?
   - Are polar oceans sources or sinks of greenhouse gases, and how is the role changing?

3. Physiology and adaptation to “extreme” environments in polar regions
   - Sea ice communities (microbes to megafauna)
   - Sea-ice dependent life cycles / life history strategies
   - Sub-ice shelf and deep sea communities (low-energy, chemosynthetic)
   - Over-wintering strategies

4. Biodiversity, evolution and biogeography in polar habitats
   - Species invasions and range shifts
   - Unexplored reservoir of genetic diversity and evolutionary novelty
   - Bioprospecting / pharmaceuticals
   - Are ecosystems under permanent sea ice and ice shelves ecologically analogous?

5. Exploration of remote/extreme/novel/under-studied habitats

- Currently inaccessible areas / time periods: East Antarctica, many places in winter
- Melt ponds: high light/low salinity communities

6. Ecosystem and climate models:
    - mechanistic understanding of biogeochemical and physical processes
    - validation / boundary conditions
    - ground-truth remote sensing measurements

7. Biological processes associated with ice-atmosphere-ocean interactions
    - How are plankton dynamics affected by surface ocean processes (mixing, stratification)?
    - Air-sea gas exchange (DMS)
    - Seeding/scavenging of sea ice communities during ice formation and melting?
    - Sea ice formation and melting effects on microbial communities and processes?
    - Communities associated with the underside of the ice ("inverted benthos")

8. Biological processes at land-ice-ocean boundaries
    - Influence of glacial meltwater, glacial till and riverine input in coastal ecosystems
    - How do cross-shelf and shelf-slope exchange influence ecosystem processes and structure on shelves and in basins?

9. Science-based resource management and conservation (fisheries, pollution—incl. noise, tourism)

Miscellaneous notes/comments –

Bigger ship needed to accommodate more interdisciplinary work.

What are the kinds of things that we will be looking at that we can't look at now. Biology impacted by the type (quality) as well as quantity of sea ice. Temperature-

Important though in getting the additional capability of getting in sea ice should not be traded off with open water handling.

Drivers in addition to sea ice – quantity, quality, timing

Communities under permanent sea ice vs seasonal ice

Seasonal/interannual variation of processes – capability to get there whenever vs. the snapshot approach

What is ecosystem response to changes? –

Light availability – both through changes in incident and transmission through ice/water column

Acidification – how does it vary with ice cover (links through ventilation).

Temperature interactions everything.

Invasive species – for example shell crushing predators that are currently barred from the Antarctic. Crab fishery moving north in Arctic. Fishery – will it open in the Antarctic. But how much would this PRV be involved in fisheries.

Understanding ecosystem sufficiently to know when they are near (past) "tipping points".

Most important factors – ice breaking and endurance, does science drive that much capability.

Future capability – present day working class ROVs will be replaced by AUVs in 20 y but ROVs will be used for other things.

They need to do sample the sea floor, bring up water from under the ice and the inverted sea ice. Understanding chemosynthetic and benthic ecosystems.

What is the role of polar ecosystems in carbon and other GHGs. Polynyas are an important part of the polar ecosystems
Discover presently unknown species and environments circumpolar, in particular East Antarctica.

Processes are important to define rates needed for biogeochemical models. A major gap is knowing what happens during the winter. Also, ground truthing remote sensing.

Ship of opportunity measurements during transits, adds to above also to the full year monitoring of polar ecosystems.

Climate change implications on a number of levels—

- ice quality and quantity, which in turn affects numerous other processes
- ocean acidification
- warming water temperatures
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Permanent vs. annual ice and differences in communities between these

Ecosystem resilience/"tipping points"

Fisheries
• large otter trawl capability compromises other ship applications and seems specific to fisheries implications—more of a NOAA concern?

Role of the polar ecosystems in global cycles of C and greenhouse gases, especially in ice-covered waters?

Polynya work? Roles in productivity and deep-water formation

Exploration: biodiversity, novel habitats

Needs for travel to East Antarctica? ice-covered areas at different latitudes

Underway sampling capabilities?

Sampling not the only need—focus on “processes”, live experiments also

Ground-truthing of models—winter processes are a particular black-box here, subsurface processes not observable by satellite or other remote sensing

How important is good dynamic positioning?

- for small-scale habitats, e.g. chemosynthetic systems, under ice, very important
- for any ROV/AUV ops, very important

Working-class ROV requires specific winch capabilities