Chl-a from sea ice cores

• Chl-a is a widely measured proxy for biomass

• Methods
  – Ice core extraction
  – Cutting core into sections
  – Melting in at < 5°C in the dark
  – Filtration
  – Fluorometric analysis
  – Get Data!
The ASPeCt-BIO dataset

39 campaigns (1983-2008) in pack ice

**Data origin**: publications, cruise reports, data repositories, private contributions

**Teams from**: Australia, Belgium, Germany, Russia, UK, USA

1300 integrated chlorophyll [mg/m²]

990 chlorophyll profiles with more than two sections [µg/l]

8245 chlorophyll samples [µg/l]

**Integrated chlorophyll**

\[ I_{chl} = \frac{\rho_i}{\rho_w} \int_0^{h_i} C_{chl}(z) \, dz \quad [\text{mg chla/m²}] \]
Chl-a from sea ice cores

30% of cores have less than 1mg chl-a/m²
1 Light

2 **Nutrient** supply mechanisms, e.g., brine dynamics, vary in time

3 Physical conditions (T and S) are not always optimal for ice algal growth

4 Snow

5 Water column
1 – Light

Incoming PAR computed as a function of latitude, day of year, cloud fraction, humidity [Shine, 1984; Vancoppenolle et al., 2011]

Averaged over the entire sea ice zone (using SSMI data)

Mean seasonal cycle of incoming PAR in the Southern Ocean sea ice zone

Incoming light takes off in September and shuts off in May

Small latitude variations
If unstable brine gradient in sea ice, nutrient fluxes are possible. Convection starts below -2.7°C
[Jardon et al., in revision]

If no unstable gradient in sea ice, no nutrient fluxes are possible, probable limitation by one of the nutrients
3 – Temperature and brine salinity

Photosynthetic efficiency decreases at low temperatures and high salinities.

Brine salinity increases fast with temperature and this effect outcompetes temperature.

At -5°C, growth is 10 x smaller than at -2°C.

Normalized ice algal growth in mesocosm experiments as a function of solution salinity (Arrigo and Sullivan, 1992)
Temperature constraints

Air temperature provides two constraints on algal growth:

Air temperature frequently drops below -3 °C from February to November

-> nutrient supply by brine convection possible

Air temperature does not go above -5° from April to October

-> brine salinity stress on ice algae
Summary

light and air temperature provide two key controls on ice algae

remaining questions:
why high chl-a in January?
snow?
water column?
forced convection due to ice motion?
u nut supply from storms?

why remaining chl-a in winter?
Normalized vertical chl-a profile

Profile-type classification

contribution to integrated chl-a
Dependence on ice thickness

P(chla>1.5*mean) vs core length (m)

Number of cores vs core length (m)

Limit of thermodynamic growth

RIDGING
Limitations

- Space and time coverage is uneven
- Chl-a in sea ice is patchy
- Humans who core avoid thick ice
- Material is lost during ice coring
- Varying chl-a/C ratios
Conclusions & Perspectives

• The ASPeCt-BIO data set has large-scale signals

• **Seasonal** peaks in spring and late summer
  – role of light, temp & nutrients
  – role of snow and water column?

• The **three community types** (surface, internal, bottom) equally contribute to biomass

• **Vertical profile** of chl-a changes with ice thickness

• **ROVs** to tackle patchiness issues and measure biomass at floe scales

• **Future changes** in winter ice thickness distribution will affect food availability for krill

• What about the **Arctic**?

• Modelling: **multi-layer** models have to be used

• **DATA AVAILABLE SOON VIA THE ASPECT PORTAL (Klaus)**