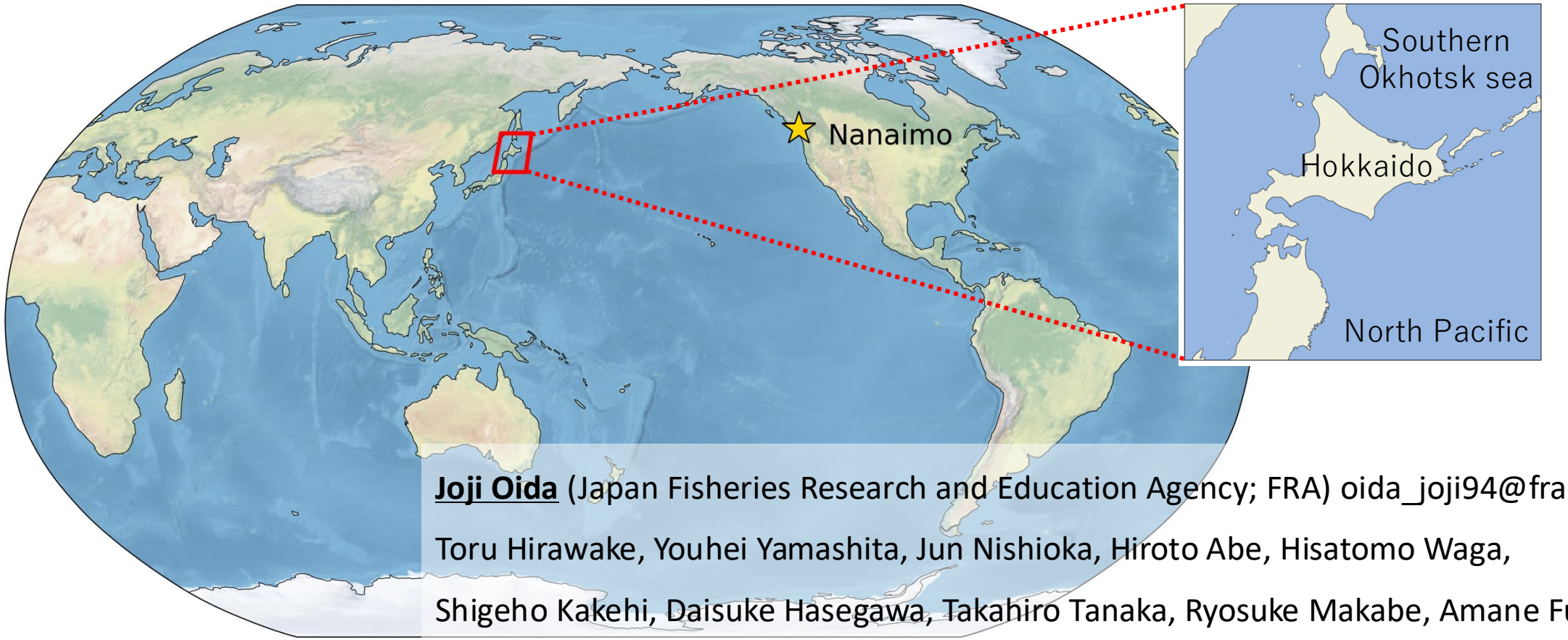
【機密性2情報】

2026/10/24-31
PICES-2026 Annual Meeting

マクロ沿岸海洋学
陸域から外洋におよぶ物質動態の統合的シミュレーション

Linkages between spring bloom seasonality off southeastern Hokkaido and environmental variability in the southern Okhotsk Sea



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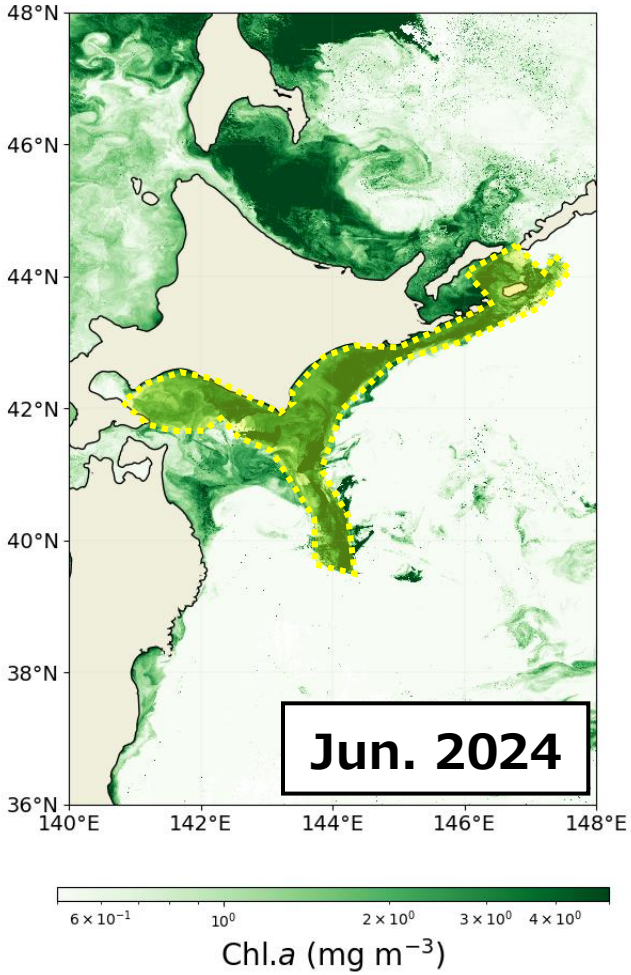
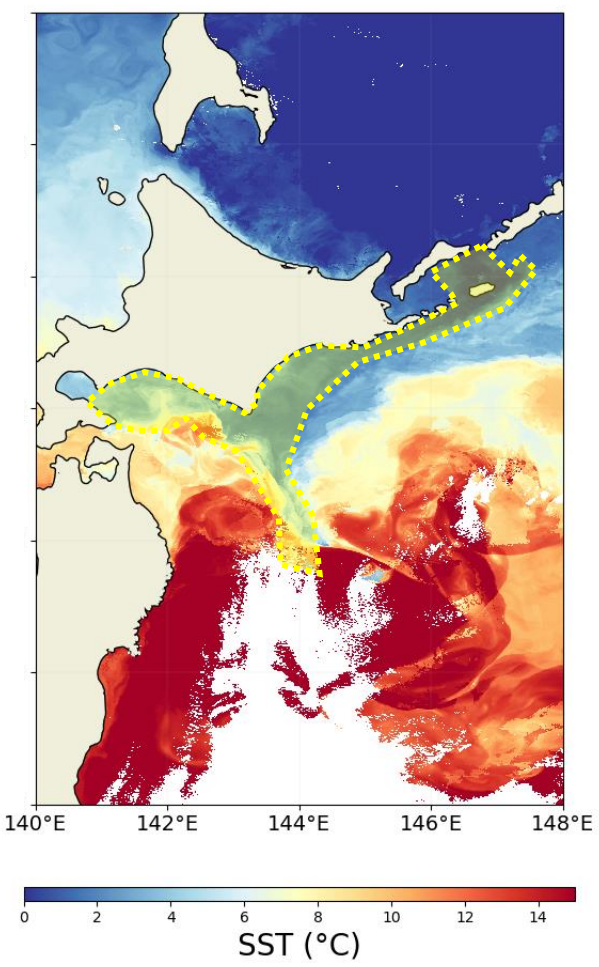
Introduction: Spring bloom off southeastern Hokkaido

Chlorophyll-*a* (chl.*a*)



Sea surface temperature (SST)

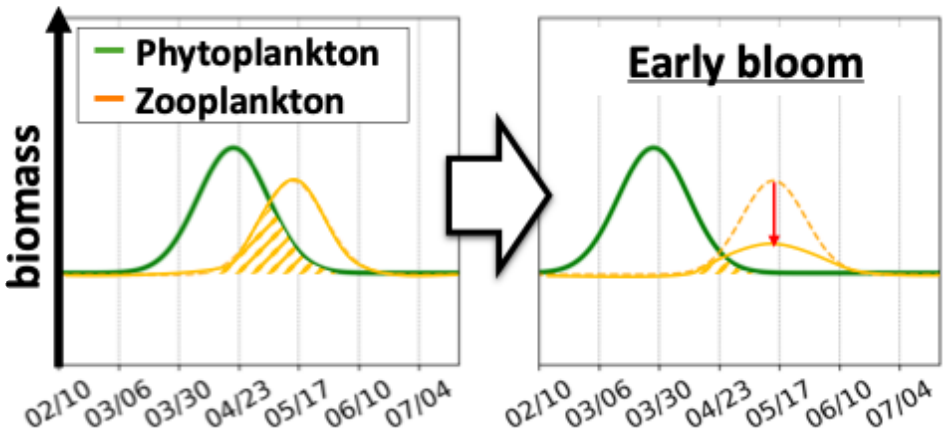


- Spring bloom

  → Marine ecosystems, Fishery resources

- Bloom magnitude and timing **(seasonality)** affect zooplankton and small fish survival

  (Ikeda et al., 2008; Sakurai, 2007)



- Bloom seasonality is affected by

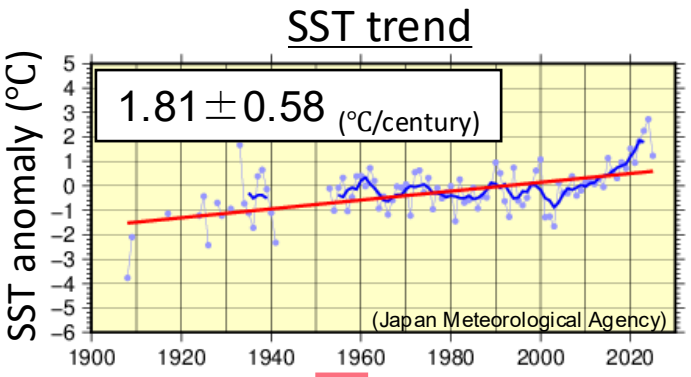
  - Sea Surface Temperature (SST) (Sverdrup, 1953)

  - Coastal Oyashio Water (COW)

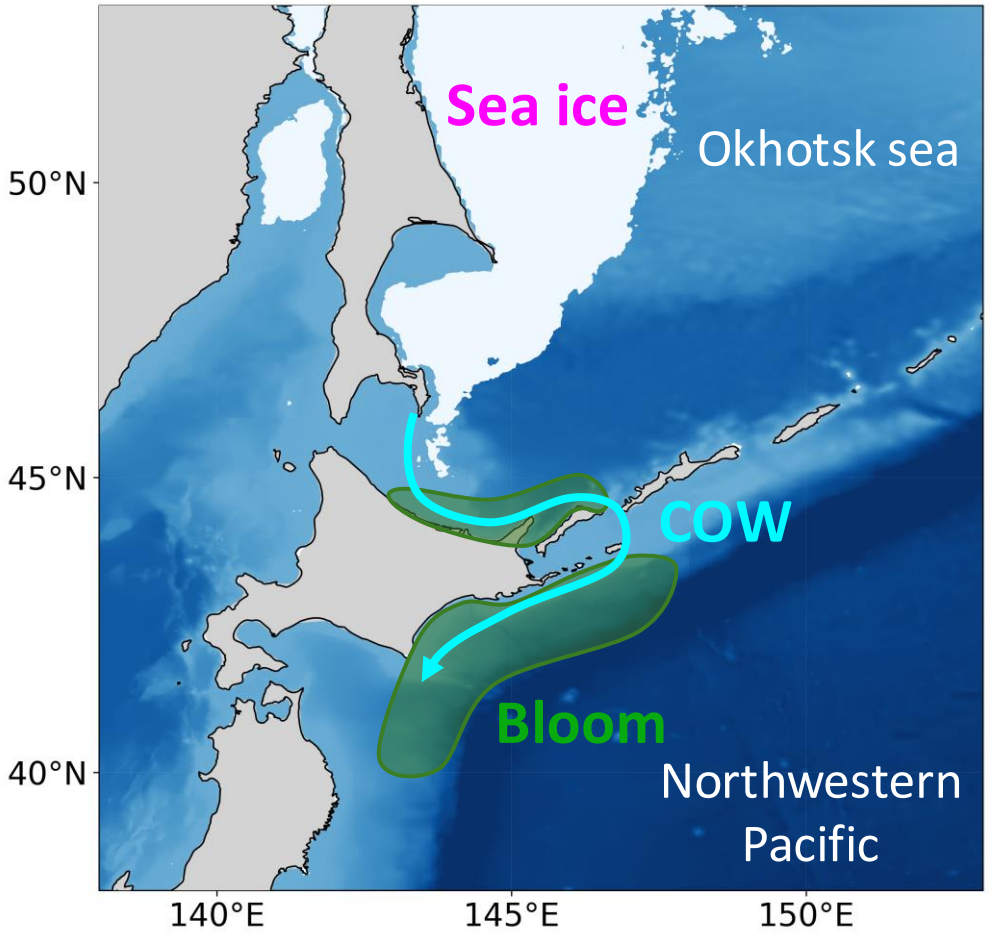
  (Kono and Sato, 2010; Isada et al., 2019)

Introduction: Environmental changes affecting spring bloom seasonality

SST



- Photosynthetic activity ↗
- Stratification ↗
  → Light condition ↗
- Nutrients from subsurface ↘



COW

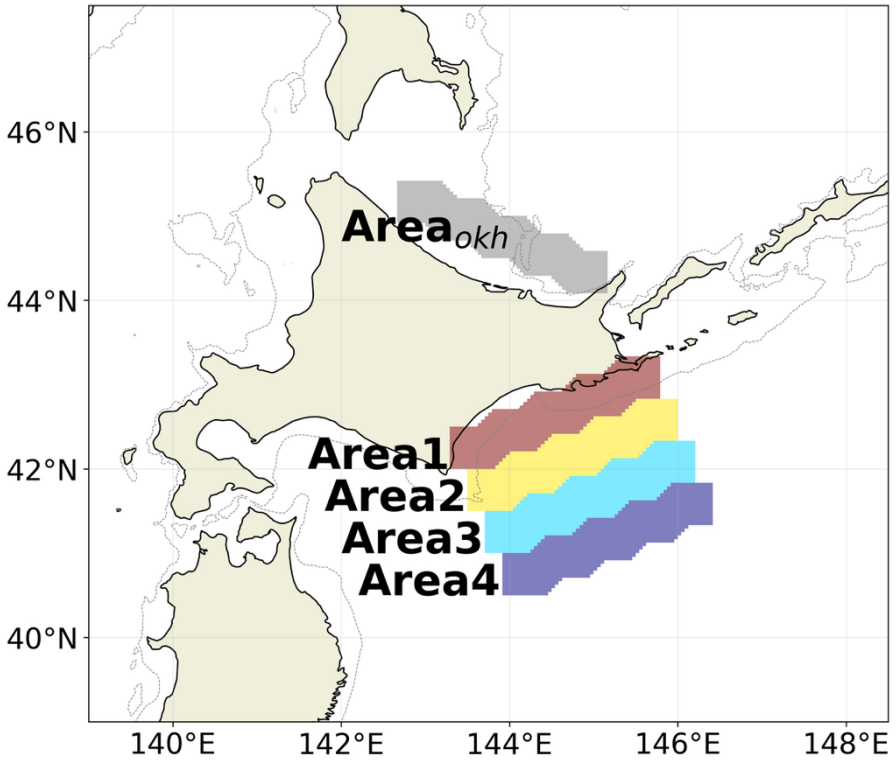
- Cold (Kusaka et al., 2013)
- Nutrient-rich (Nishioka et al., 2011)
- Okhotsk-origin (Isoda et al., 2003)
- Affects bloom seasonality

- Environmental changes
  →COW variability?

Question Objective

What controls the spring bloom seasonality off southeastern Hokkaido?

Materials & Methods: Estimation of COW distribution from satellite data



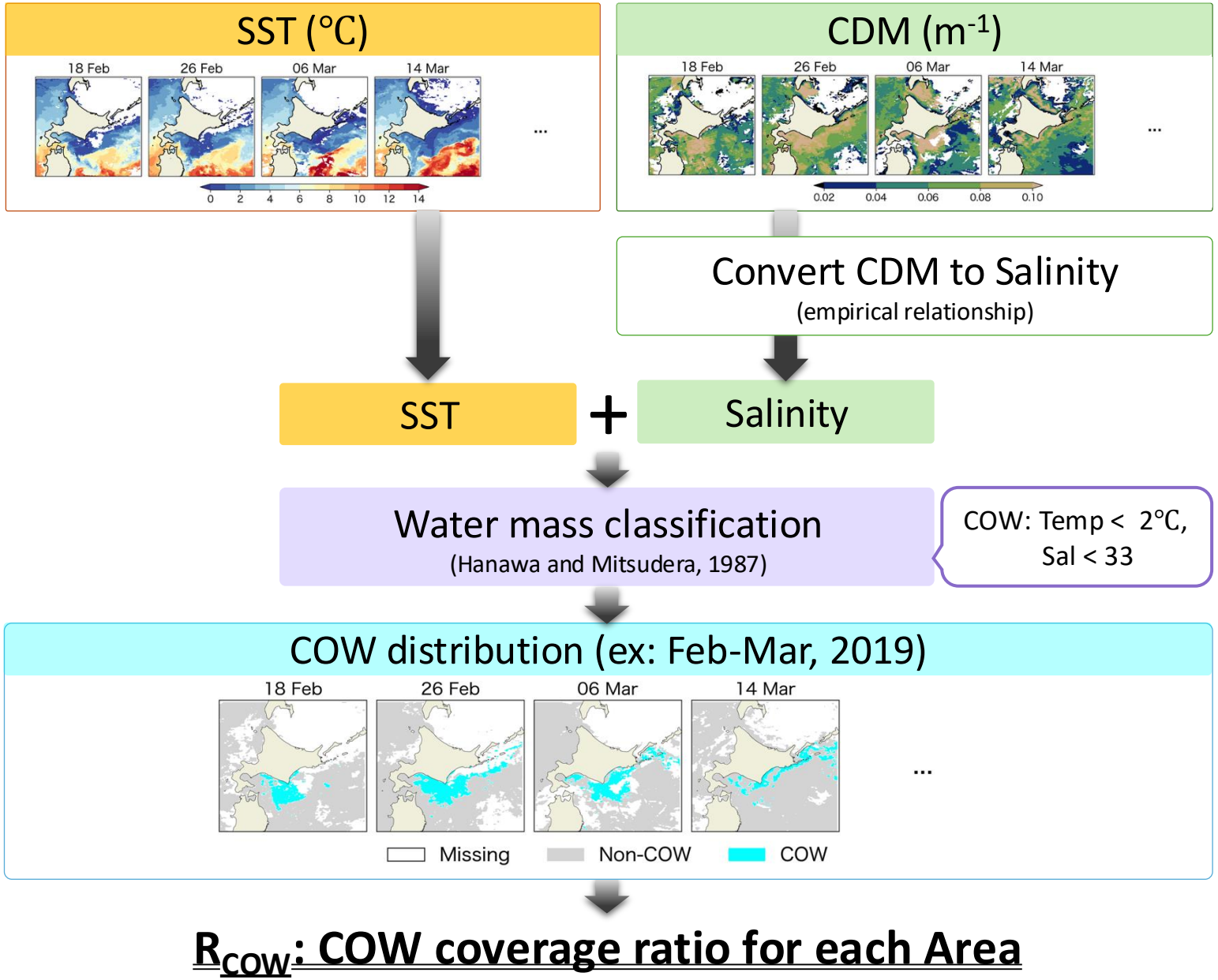
Resolution : 4 km, 8-day

Study period : Jan—Jul 2003—2023

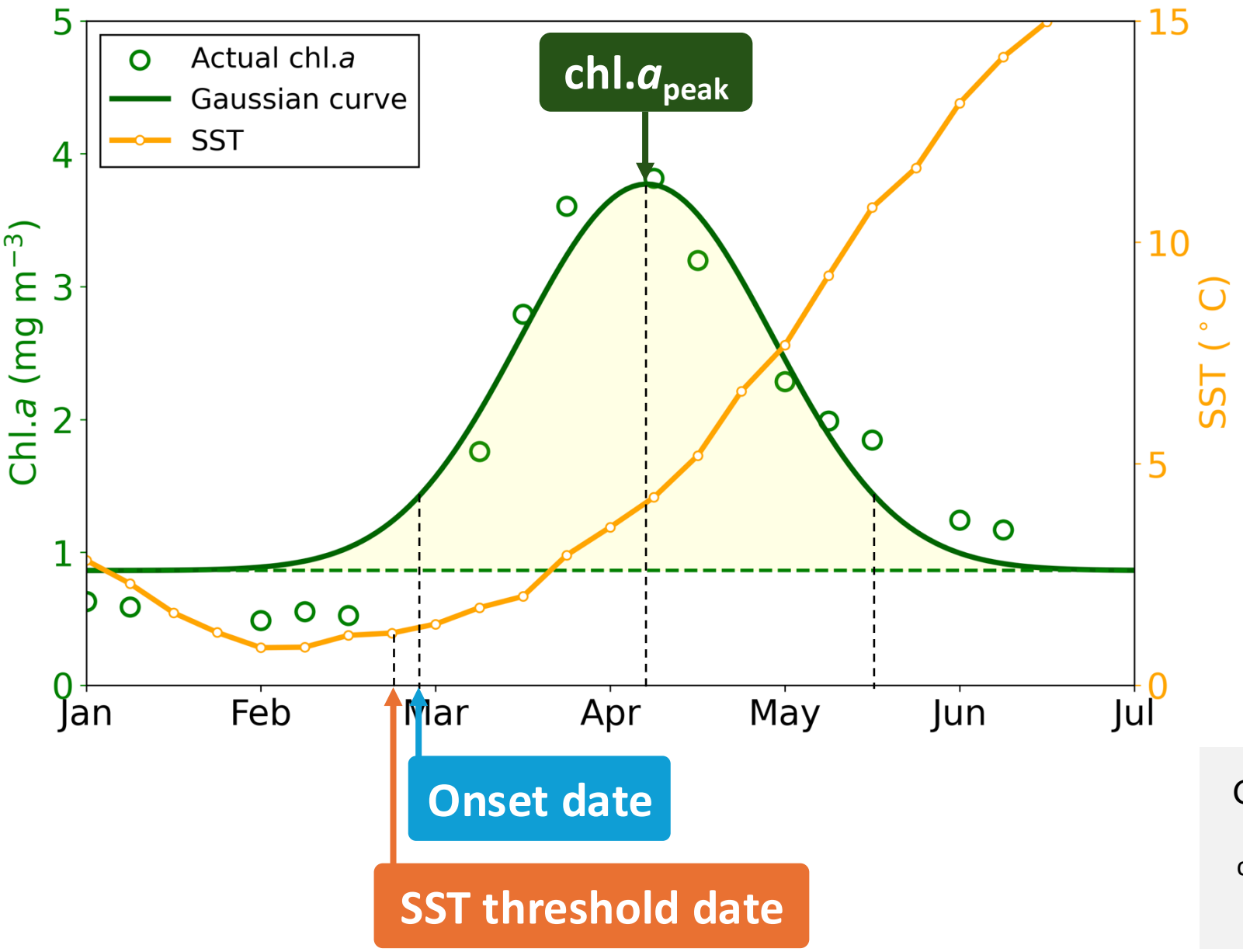
Study area : 39—47°N, 139—148°E

Parameter : chl.*a*, SST, CDM

(CDM: Coloured dissolved and detrital organic materials absorption coefficient)



Materials & Methods: Calculation of bloom seasonality parameters



Bloom seasonality parameters

chl.a_{peak}

Maximum chl.*a* during bloom

Onset date

Start date of bloom

SST threshold date

Date when SST reaches
the climatological SST at bloom onset

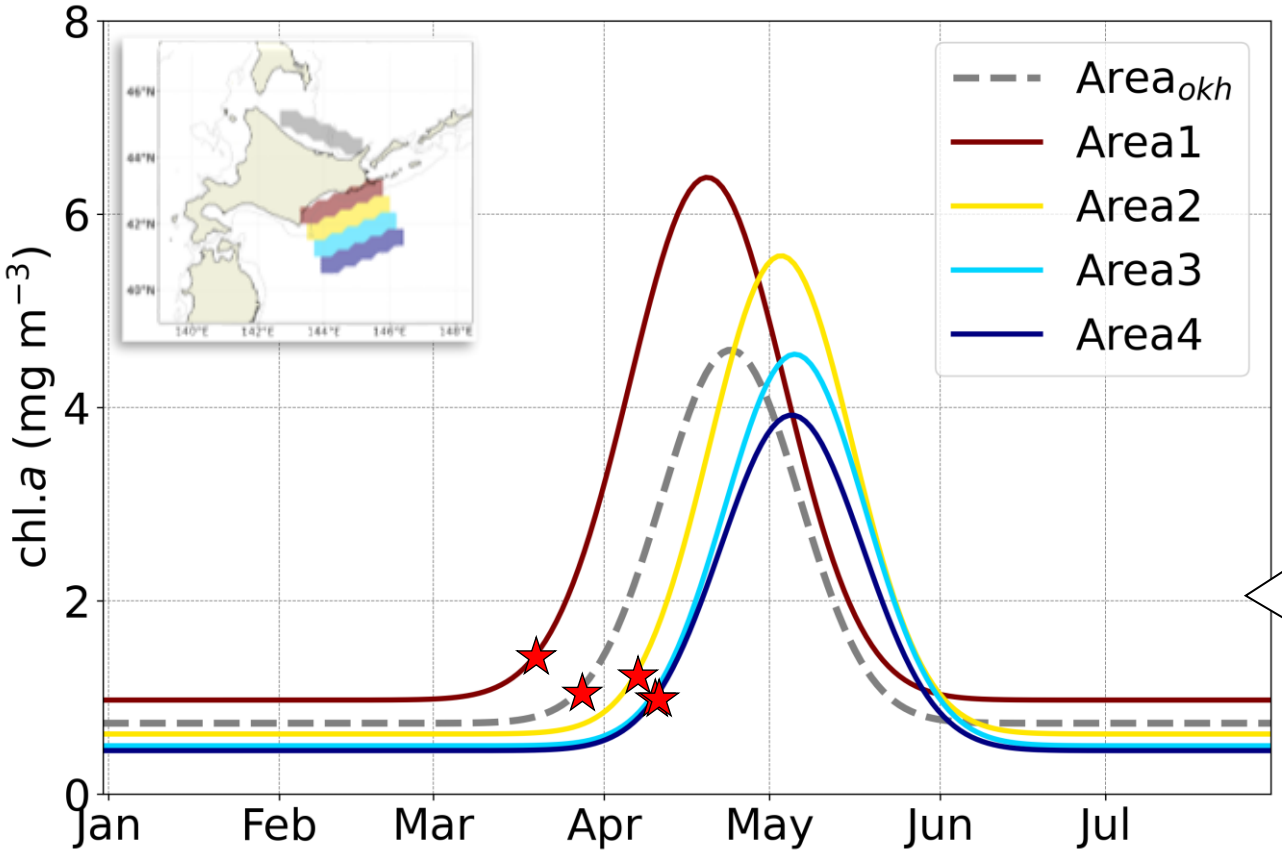
Gaussian fitting (Sasaoka et al., 2011)

$$\text{chl.}\,a(t) = \text{chl.}\,a_{baseline} + \left\{\text{chl.}\,a_{peak} \times \exp\left(-\frac{t - t_{peak}}{2\sigma^2}\right)\right\}$$

(t_{peak}: peak time, σ: standard deviation)

Results: Spatiotemporal variability of spring bloom seasonality

Climatological chl.*a* time-series among the Area

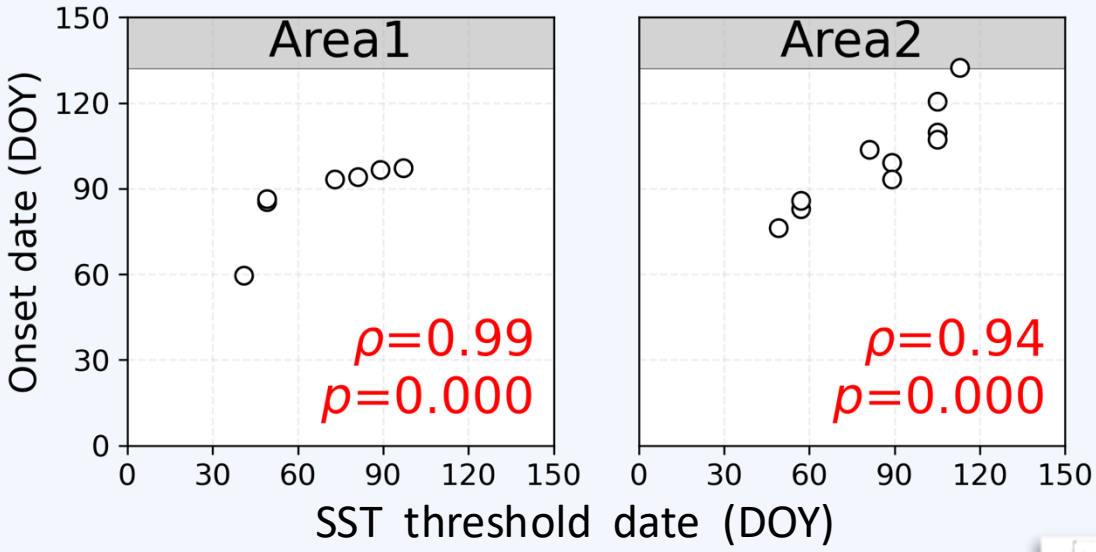


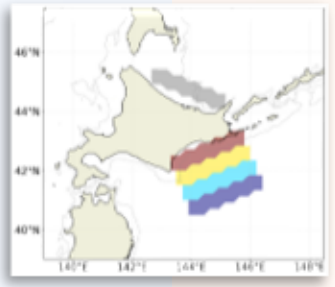
	chl.a_{peak} (mg m^{-3})	Onset date
Area1	6.38	22-Mar
Area2	5.57	7-Apr
Area3	4.55	10-Apr
Area4	3.92	9-Apr
Area$_{okh}$	4.59	30-Mar

- Coastal area : Earlier and Larger blooms
- Offshore area : Later and smaller blooms
- Okhotsk area : Earlier and smaller bloom

Results: SST controls onset, whereas SST and COW affect bloom magnitude

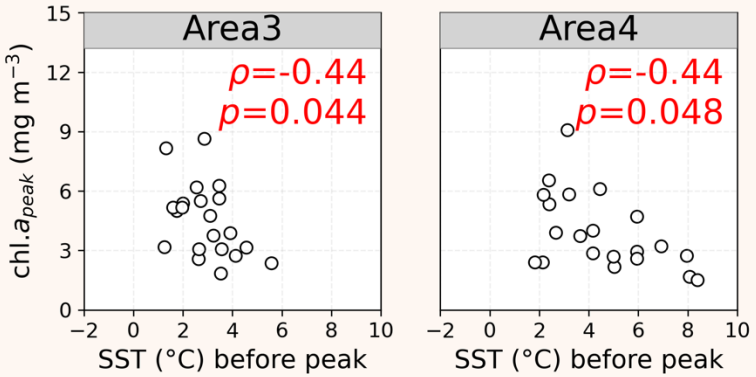
Bloom timing (onset date)



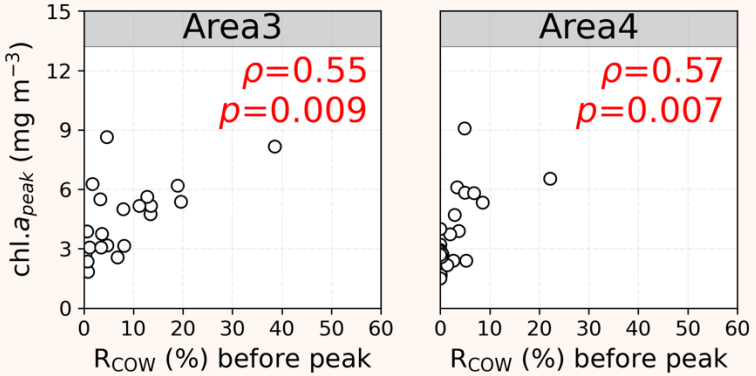


Bloom magnitude (chl.*a*_peak)

vs. SST



vs. R_{COW}



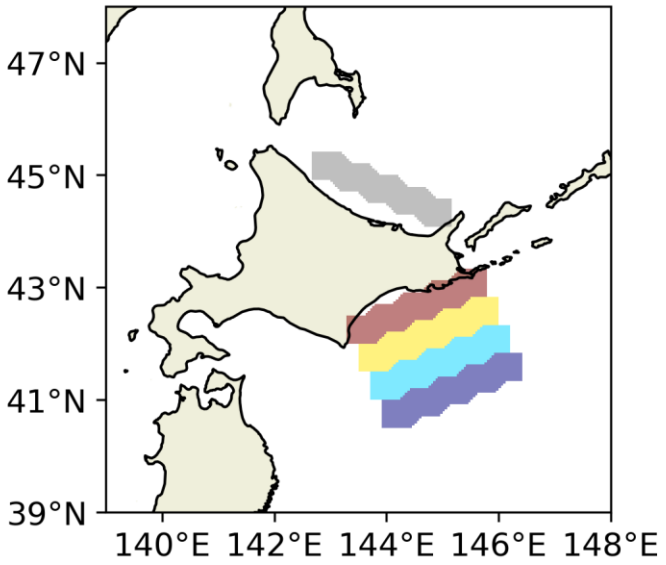
SST controls bloom onset (Area1 & 2)

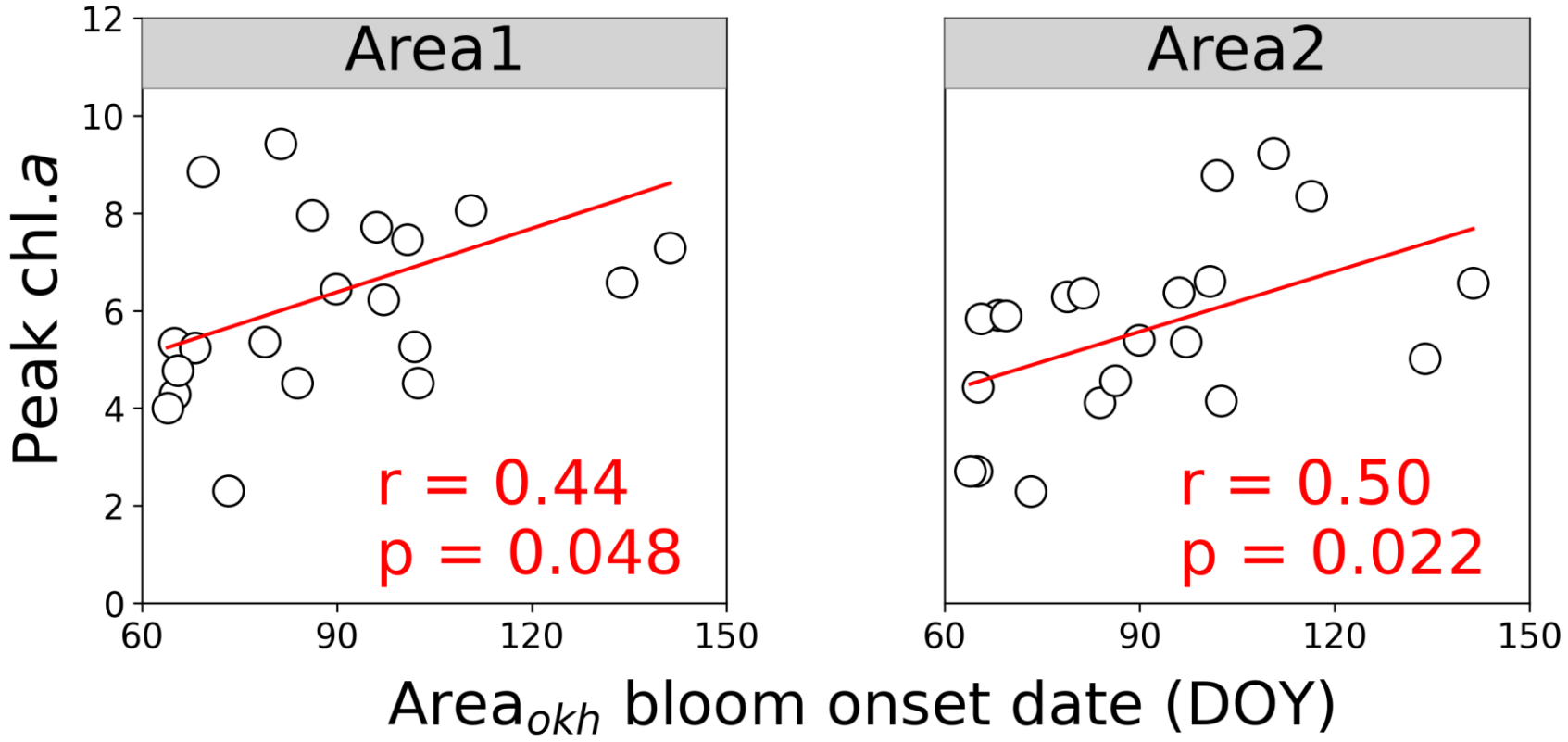
- Local SST conditions controls bloom timing
- No clear relationship with R_{COW}

SST/COW affect bloom magnitude (Area3 & 4)

- chl.a_{peak} is negatively correlated with SST
- chl.a_{peak} is positively correlated with R_{COW}

Results: Okhotsk bloom onset affects bloom magnitude off Hokkaido





- Positive relationship between bloom onset in Area$_{okh}$ and chl.a_{peak} in Area1-2
- Earlier blooms in the Okhotsk Sea → Smaller blooms in coastal Hokkaido

Discussion: Mechanism during warm years

Coastal (Area 1-2)

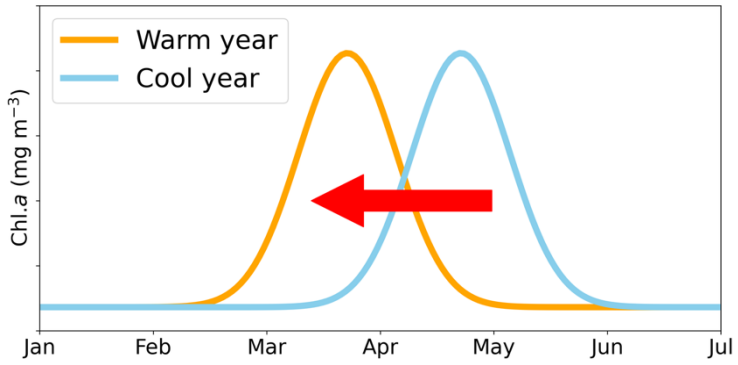
Warm-water intrusion

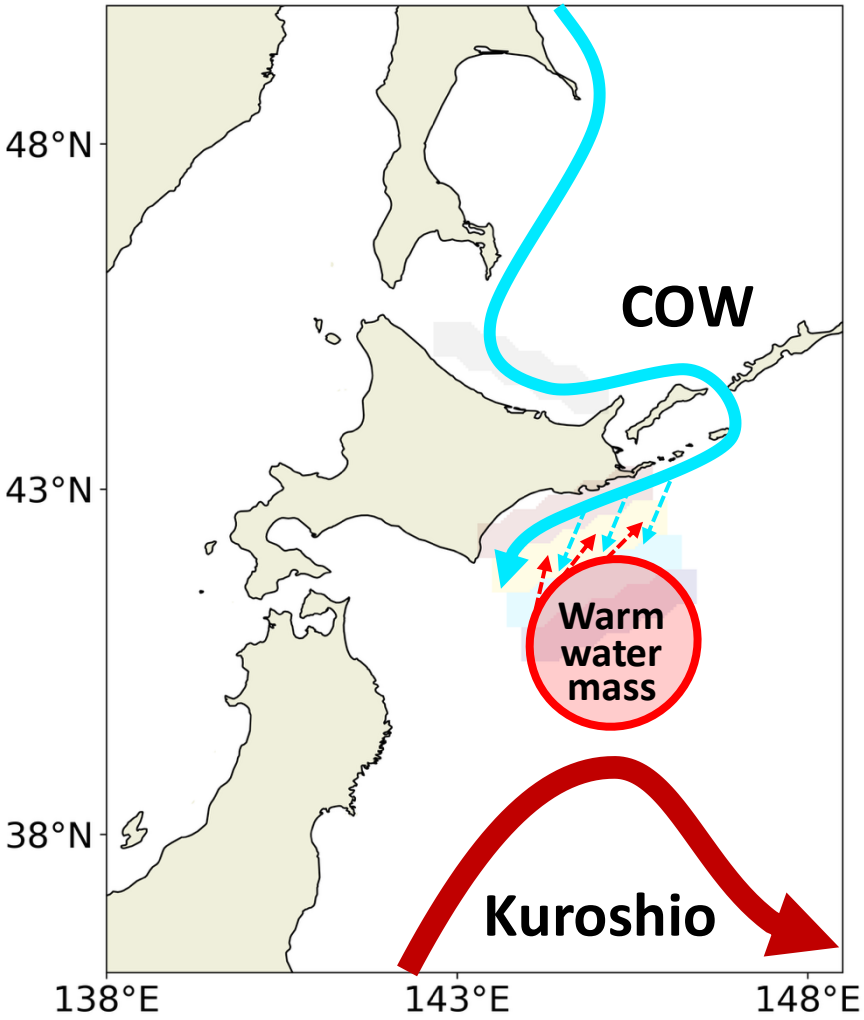
Favorable thermal condition

Earlier stratification

Earlier favorable growth conditions

Earlier bloom onset





Offshore (Area 3-4)

Warm-water intrusion

↓

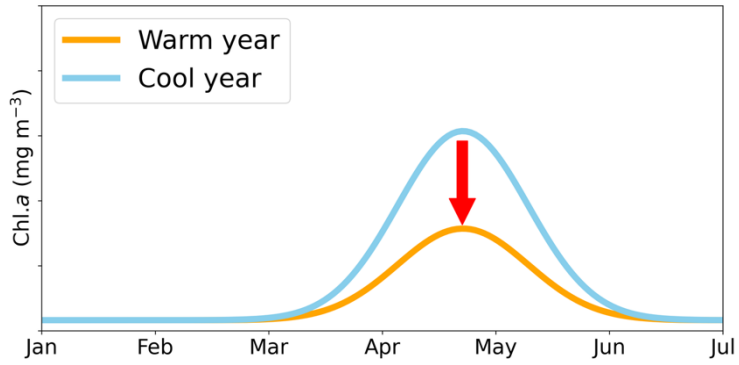
Suppressed COW expansion

↓

Reduced nutrients supply

↓

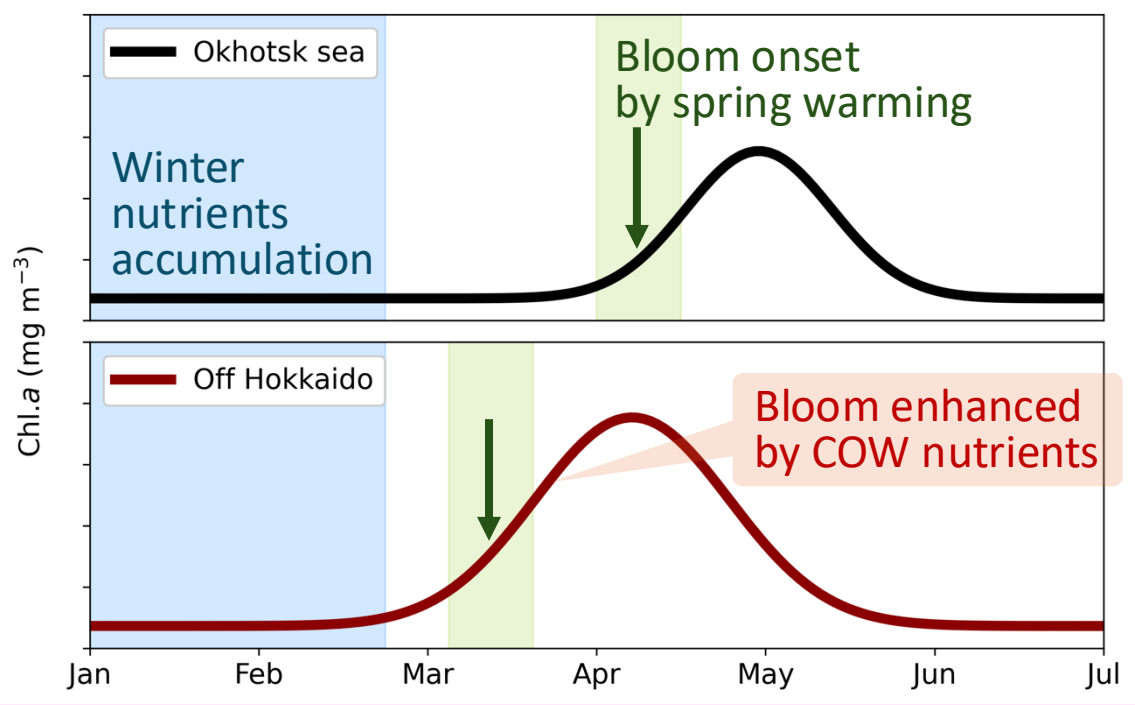
Smaller bloom magnitude



- Warm SST promotes earlier **coastal bloom onset** while reducing **offshore bloom magnitude** via reduced COW intrusion.

Discussion: Mechanism linking Okhotsk and Hokkaido blooms

Normal year

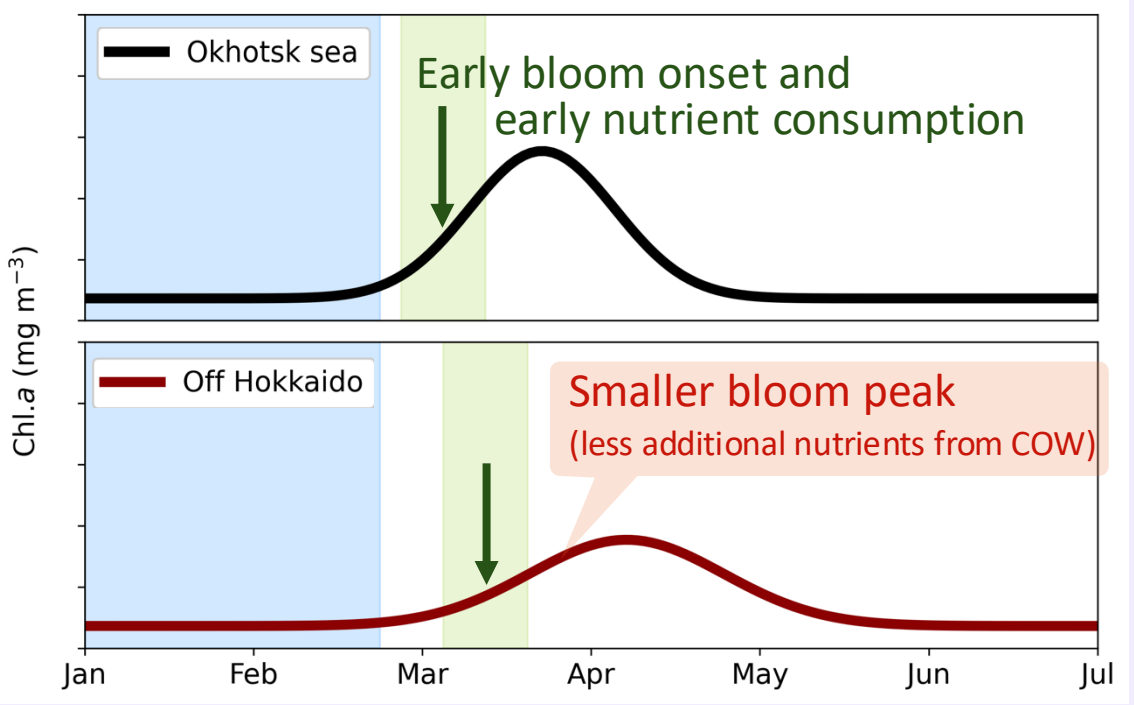


Later Okhotsk bloom

→ Nutrient-rich COW

→ Larger bloom peak off Hokkaido

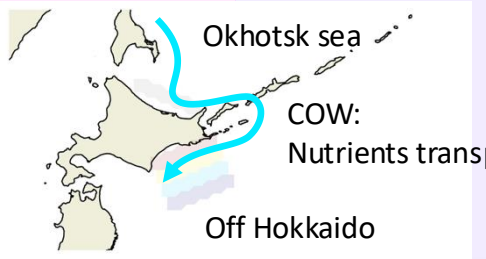
Early Okhotsk bloom year



Earlier Okhotsk bloom

→ Reduced nutrient export by COW

→ Smaller bloom peak



Proposed mechanism

Bloom timing in the southern Okhotsk sea controls the magnitude of the coastal bloom off southeastern Hokkaido

Conclusion and Future research

Main conclusion

1 Coastal bloom timing ↑ **SST**

2 Offshore bloom magnitude ↑ **Nutrient-rich COW**

3 Coastal bloom magnitude ↑ **Southern Okhotsk bloom timing**

Key findings

Spring bloom seasonality off southeastern Hokkaido is controlled by local warming, COW intrusion, and southern Okhotsk bloom timing

Future work

1. Validation of the proposed mechanism using in-situ data
2. Clarify the drivers of southern Okhotsk bloom timing