Winter sea ice variability in the Barents Sea

C. Herbaut, M.-N. Houssais et A.-C. Blaizot

LOCEAN, UPMC
Surface circulation
Motivation

January SAT - Sea ice concentration correlation map
1st SVD mode

Outten and Esau, 2011
Mechanisms of winter Barents Sea sea ice area variability

Atlantic Water transport
(Arthun et al. 2012, Schlichtholz, 2011)

Surface wind
(Pavlova and Pavlov, 2013).

Increased heat transport
→ decreased sea ice area (+ 2 years)

Southerly wind anomaly
→ Reduced sea ice extent
Winter Sea Ice Concentration (SSMR - SSM-I)

Two modes of interannual variability: Northern mode and Eastern mode

1979

Std (1979-2011)

2006

Sea ice area

R = 0.38

Northern Mode

Eastern Mode
Northern and Eastern SIC modes

Regression of SIC on Northern Mode Index

Regression of SIC on Eastern Mode Index

→ Two distinct spatial patterns
Impact of surface wind
ERA-Interim winter (JFM) 10-m wind (1979-2011)

Lag -1 year
Regression on the Northern Mode Index
Correlation with meridional wind

Lag 0

Min=-0.6
Min=-0.7

→ Northern SIC mode associated with northerly winds
Eastern SIC mode associated with easterly winds

Surface wind explains only 50% of the SIC variance: other forcings?
Ice-ocean interactions in an ice-ocean model

ORCA025 Arctic-Atlantic configuration, ERA-I forcing (1979-2011)

→ Same patterns of variability but weaker variance in the model
Winter (JFM) sea ice drift

Regression on the Northern Mode Index

Regression on the Eastern Mode Index

Eastern Mode: significant westward drift anomalies

Climatology 1979-2011
Winter (JFM) ice production

Regression on the Northern Mode Index

Regression on the Eastern Mode Index

Large ice melt anomalies (2 mm day$^{-1}$) at the ice edge:
• Eastern mode: response to the eastward expansion of the ice edge
• Two branches of Atlantic Water:
  • Northern branch: less intense
Heat transport through the western Barents Sea (BSO)

Correlation with Sea Ice Area modes

Northern mode:
- maximum correlation between BSO heat transport anomalies in fall and winter SIC anomalies in northern Barents Sea
- no significant correlation at earlier lags

Eastern mode:
- no correlation with the heat transport through BSO
Ocean current anomalies at 110 m

Regression on the Northern Mode Index (Seasonal lag)

Weakening of the northern branch of Atlantic Water in fall
→ Increased winter SIA in northern Barents Sea
Heat content in the western Barents Sea

Correlation with Sea Ice Area modes

Northern mode:
→ Maximum correlation at lag 0
→ Persistence gives significant lagged correlations when heat content leads by up to 1 year
Ocean temperature at 110 m

Regression on the Northern Mode Index

→ Northern mode associated with a contemporary large scale pattern of intermediate temperature anomalies
→ Part of the winter temperature anomalies originate in previous spring
  Wind-driven anomalies (explaining lagged correlation of Northern mode with wind stress ?)
Next

Origin of temperature anomalies

Link with the Atmospheric modes
Variability of the Atlantic Water in the Nordic Seas and the Arctic

Influence of mesoscale activity on the northward heat transport.

Circulation of the Atlantic Water in the Arctic:
- Variability of the Fram Strait Branch and Barents Sea Branch.

EKE 1/16° model (Agrif)  
Passive tracers

Fram Strait branch  
Barents Sea Branch
Regression of T 110 m on eastern SIA
Regression of velocity at 110 m on the eastern SIA

Weakening the circulation of AW in the eastern Barents Sea ➞ Increase northern SIA
Barents Sea

Sea ice extent

Surface circulation
Mechanisms of winter Barents Sea sea ice area variability

Atlantic Water transport
(Arthun et al. 2012, Schlichtholz, 2011)

Surface wind
(Pavlova and Pavlov, 2013).

Increased heat transport
⇒ decreased sea ice area (+ 2 years)

Southerly wind anomaly
⇒ Reduced sea ice extent