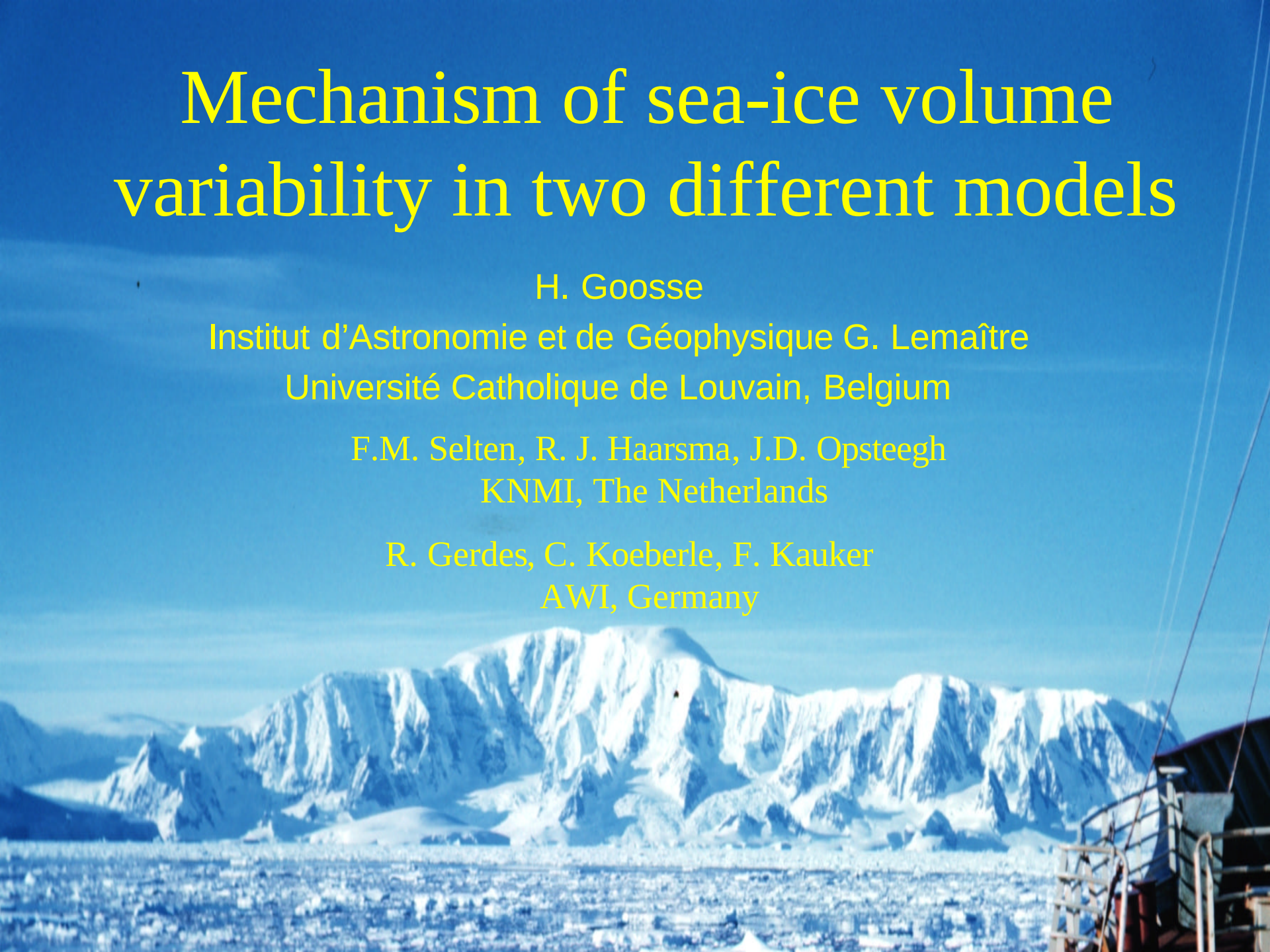
Mechanism of sea-ice volume variability in two different models

H. Goosse
Institut d'Astronomie et de Géophysique G. Lemaître
Université Catholique de Louvain, Belgium

F.M. Selten, R. J. Haarsma, J.D. Opsteegh
KNMI, The Netherlands

R. Gerdes, C. Koeberle, F. Kauker
AWI, Germany



Atmospheric input

NCEP/NCAR daily surface air temperatures and wind speeds + monthly climatological surface relative humidities, cloud fractions, precipitation rates and river runoffs

Bulk formulas

Surface fluxes of heat, freshwater and momentum

Relaxation towards observed annual mean SSSs

global domain: resolution 1.5° ´ 1.5°

Sea-ice model

Thermodynamics

- 3-layer snow–ice model
- Parameterisation of leads
- Scheme of snow-ice formation

Dynamics

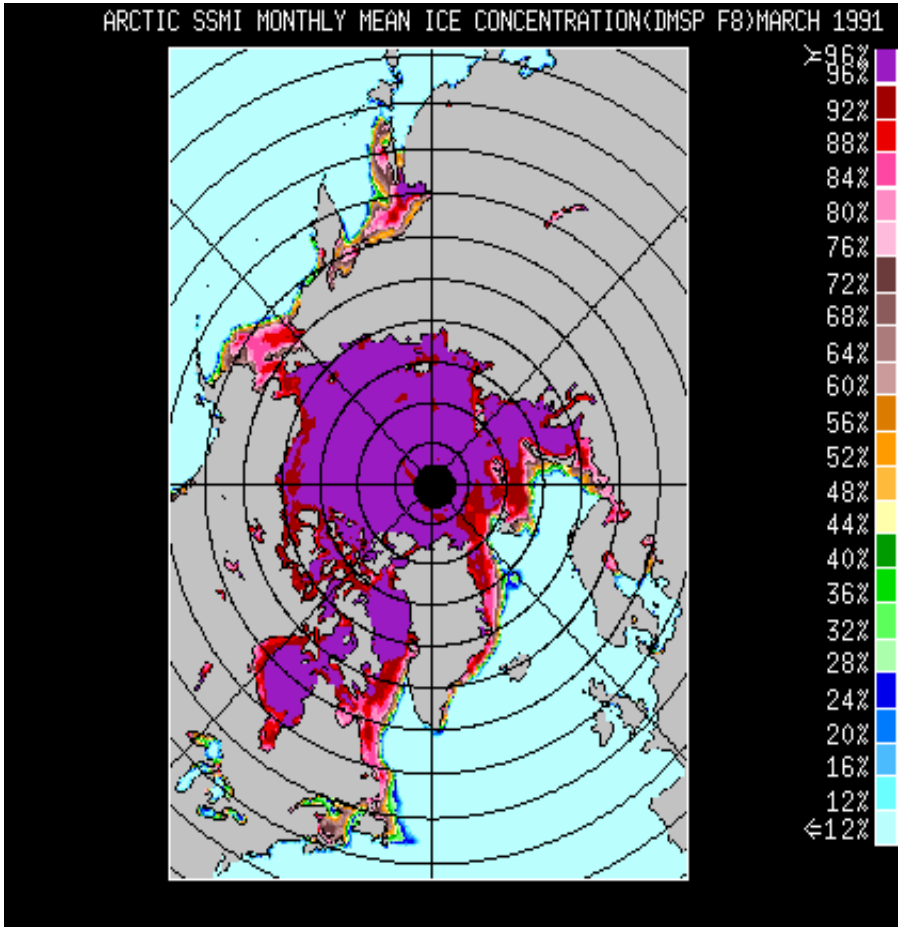
- Viscous-plastic rheology

OGCM :

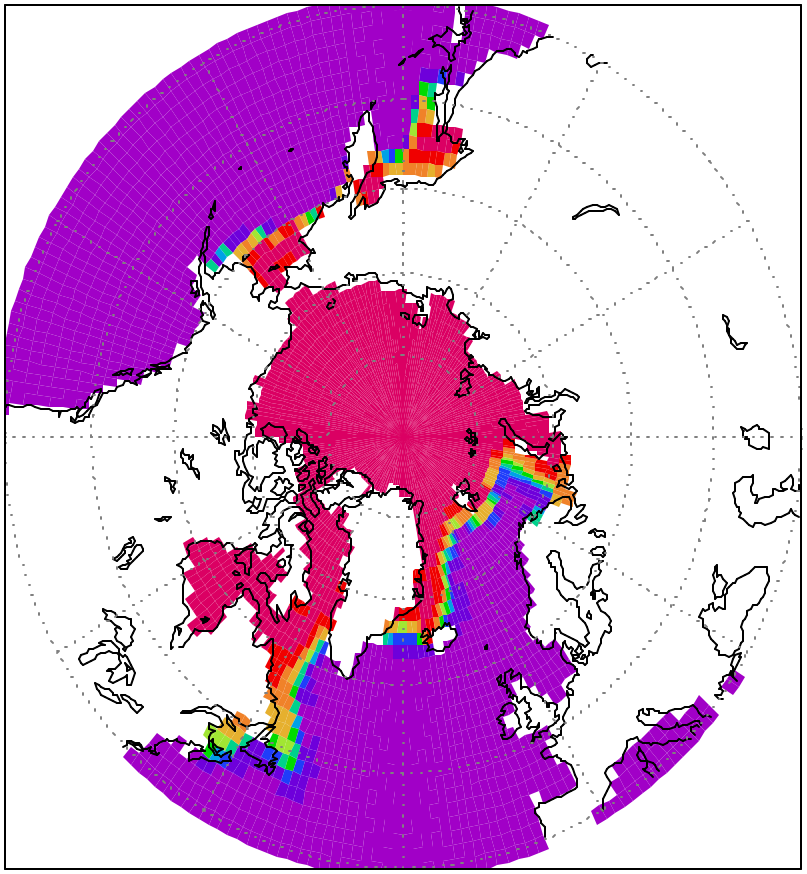
- Primitive equations, free surface
- Turbulence-closure scheme
- Parameterisations of the effect of meso-scale eddies on tracer distribution and of density-driven downslope flows
- 30 vertical levels

Ice concentration in March 1991

Observations



Simulation



ECBILT

- Quasi-geostrophic atmospheric model
- T21, 3 levels
- Simplified representations of the diabatic-heating processes
- Explicit hydrological cycle-soil-plus-snow model
- Prescribed cloudiness
- Various surface types (ocean, land, and sea ice) within each grid box

CLIO (3° ´ 3°)

Sea-ice model

Thermodynamics

- 3-layer snow–ice model
- Parameterisation of leads
- Scheme of snow-ice formation

Dynamics

- Viscous-plastic rheology

OGCM

- Primitive equations, free surface
- Level-2.5 turbulence-closure scheme
- Parameterisations of density-driven downslope flows
- 20 vertical levels

Climatology

- Reasonable simulation of the climate at high latitudes

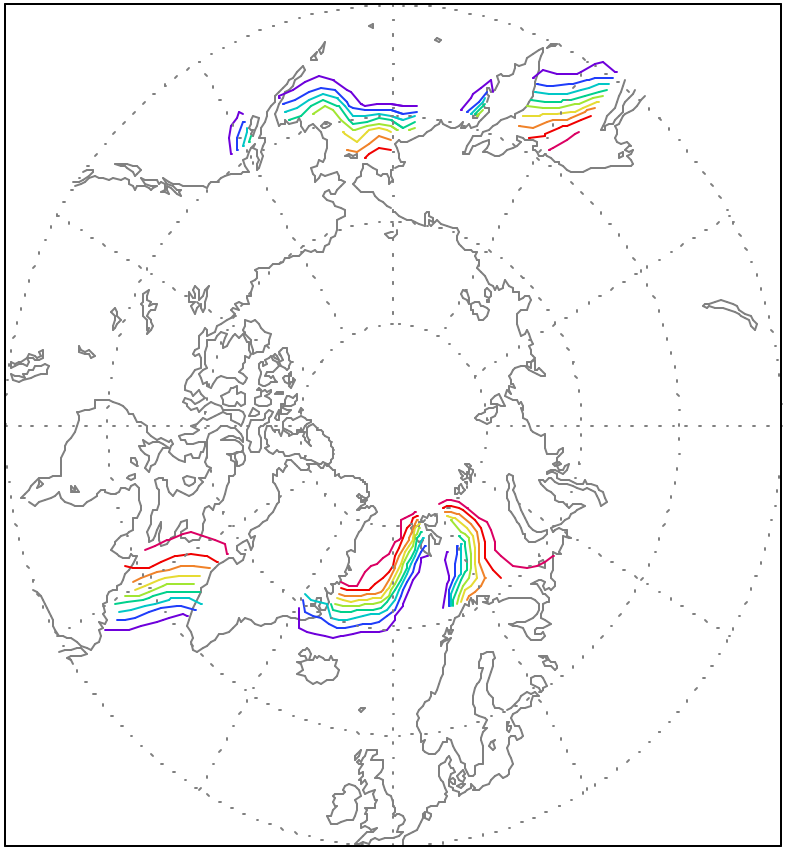
max. ice extent :13.7 x 10^6 km^2

Obs.:13.9 x 10^6 km^2

min. ice extent : 6.4 x 10^6 km^2

Obs.: 6.2 x 10^6 km^2

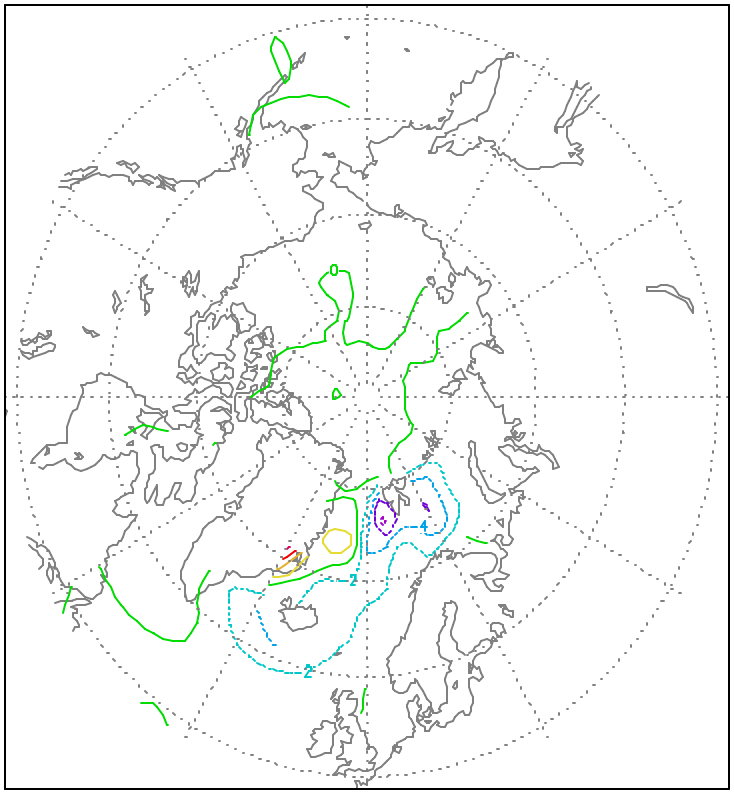
- Dominant mode of variability: Arctic Oscillation (AO)



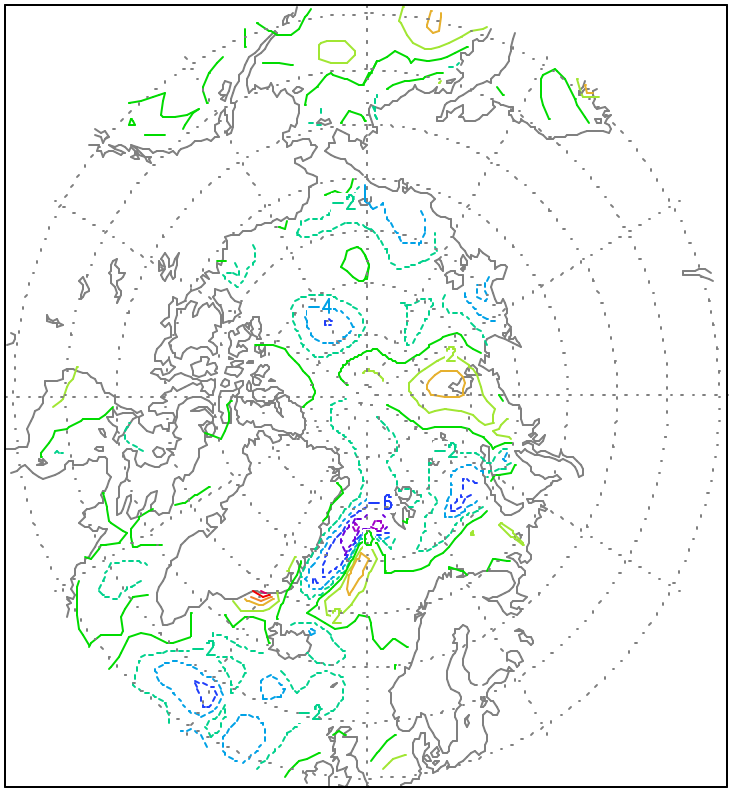
Ice concentration in March

Comparison of ECBILT-CLIO and CLIO : Oceanic forcing (I)

ECBILT-CLIO: Upward oceanic flux at lag -4 years (W m^{-2})

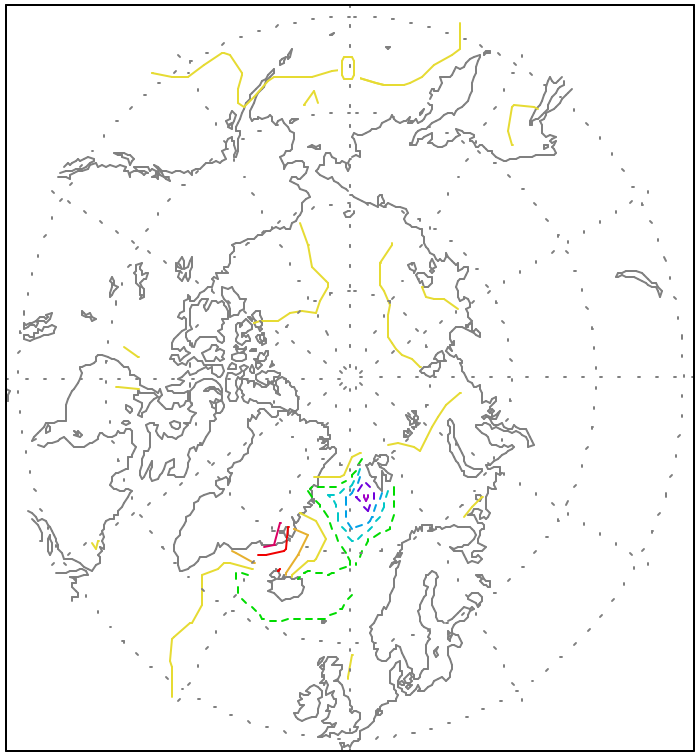


CLIO: Upward oceanic flux at lag -2 years (W m^{-2})



Comparison of ECBILT-CLIO and CLIO : Oceanic forcing (II)

ECBILT-CLIO: Depth reached by convection (lag -4 years) (m)



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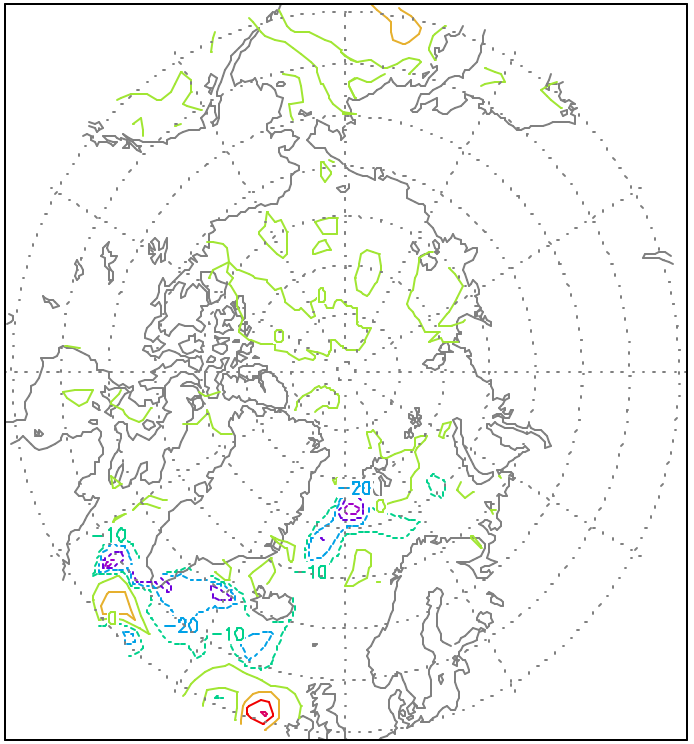
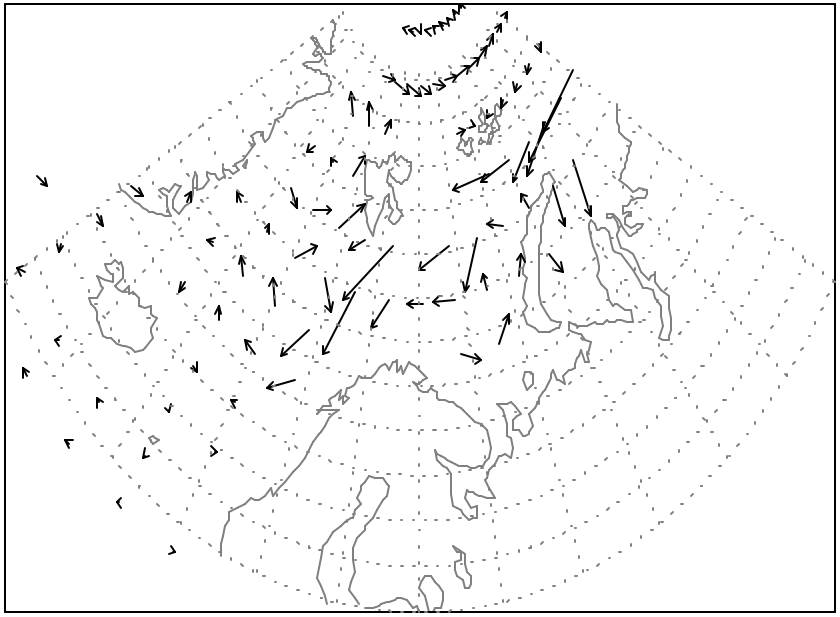


Comparison of ECBILT-CLIO and CLIO : Oceanic forcing (III)

ECBILT-CLIO: Oceanic currents (lag -2 years) (m/s)



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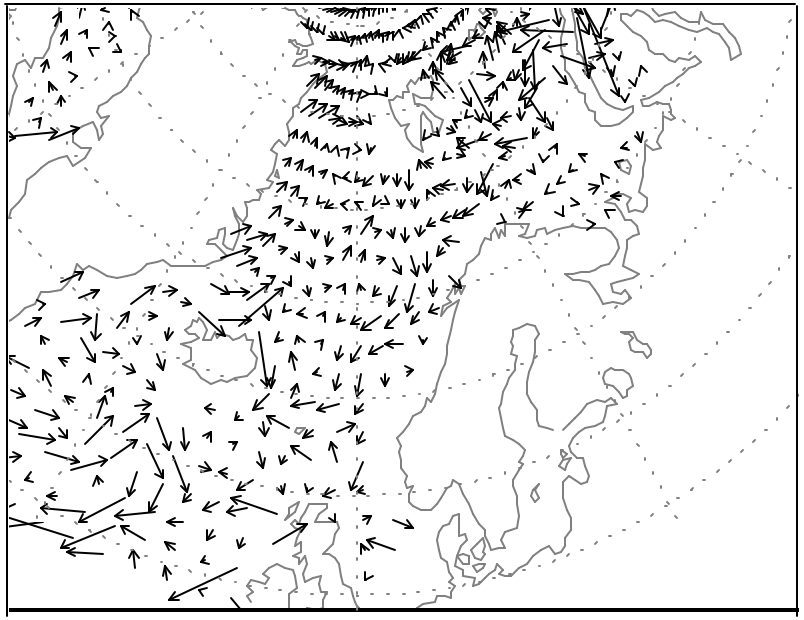
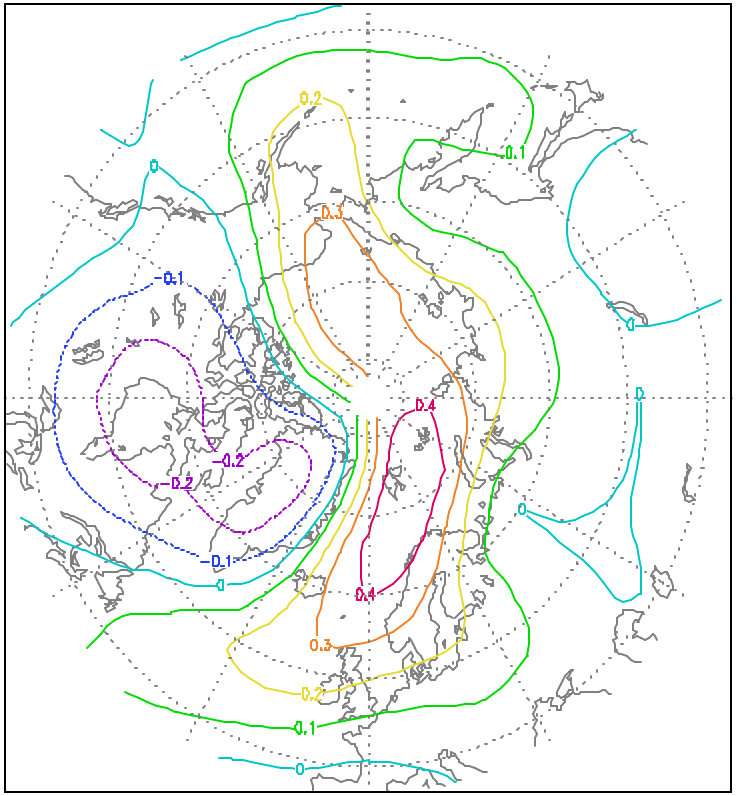
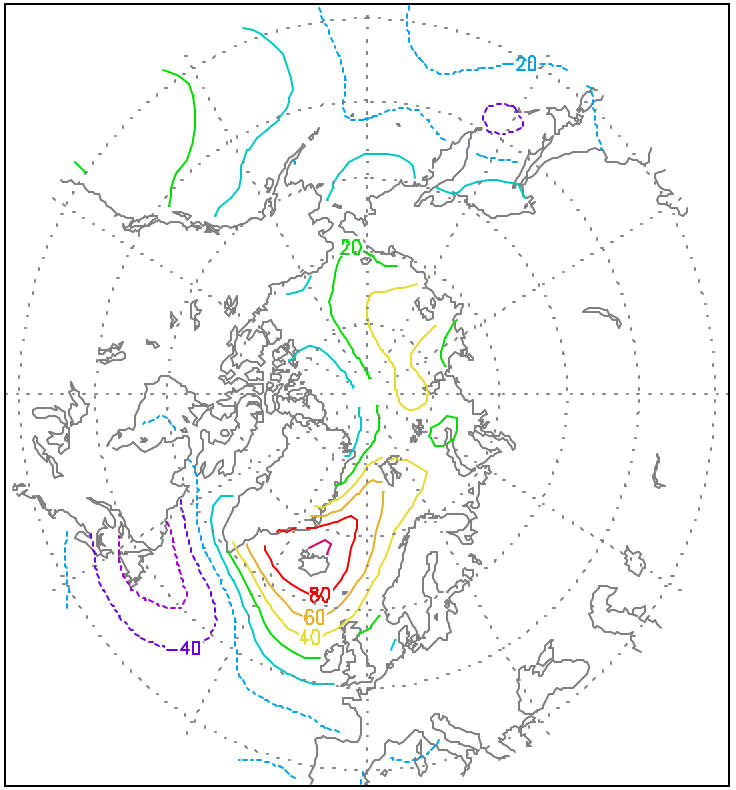


Comparison of ECBILT-CLIO and CLIO : Atmospheric forcing (I)

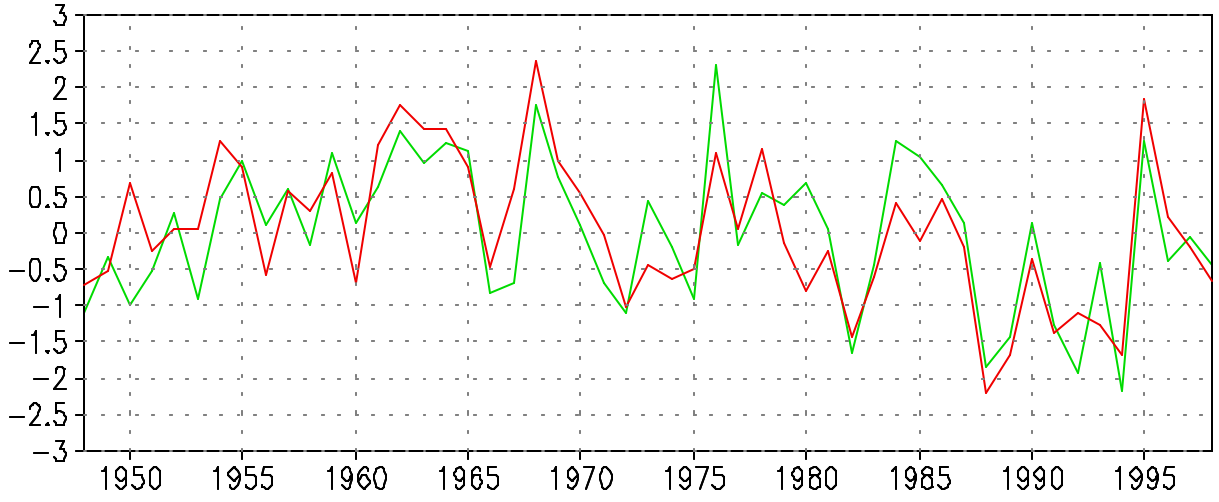
ECBILT-CLIO: Winter mean 800-hPa geopotential at lag -4 years (dam)



CLIO: Winter mean surface pressure at lag -2 years (p)



Links between the atmospheric pattern that drives ice volume changes and NAO in CLIO



Correlation : 0.7

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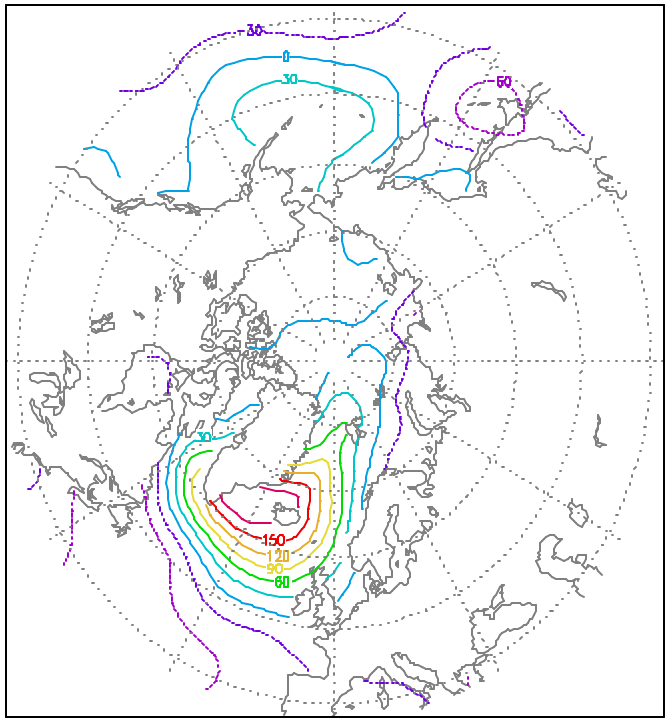
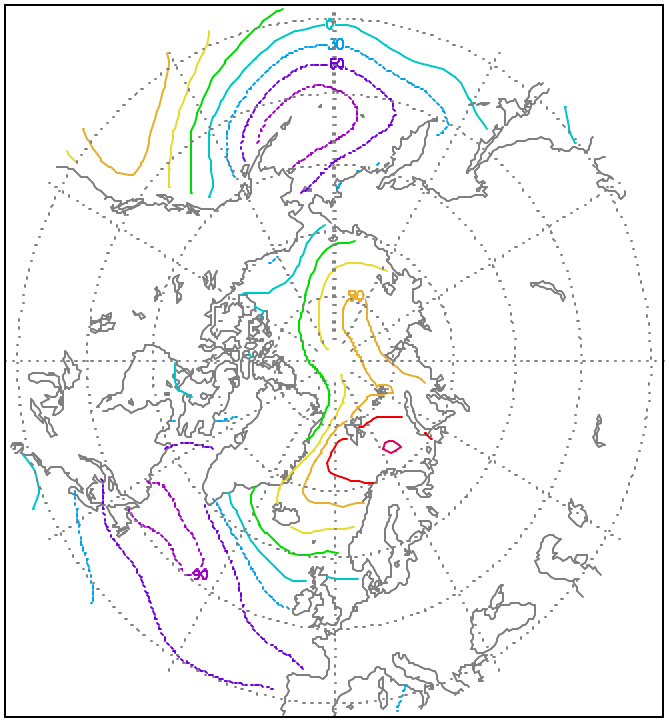
Winter mean surface pressure at lag -2 years (p)



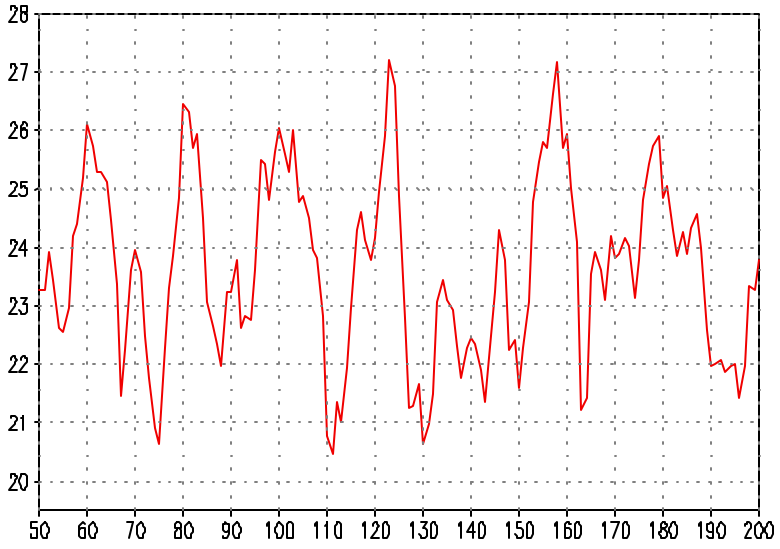
Years 1948-1973



Years 1974-1998

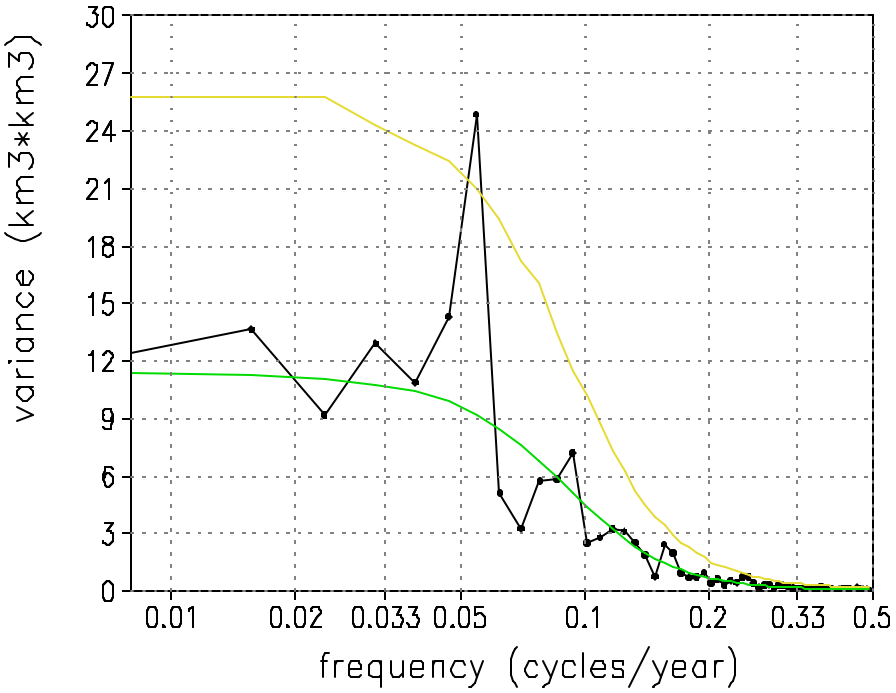
Decadal Variability of the sea-ice volume in ECBILT-CLIO

Time series (10^3 km^3)



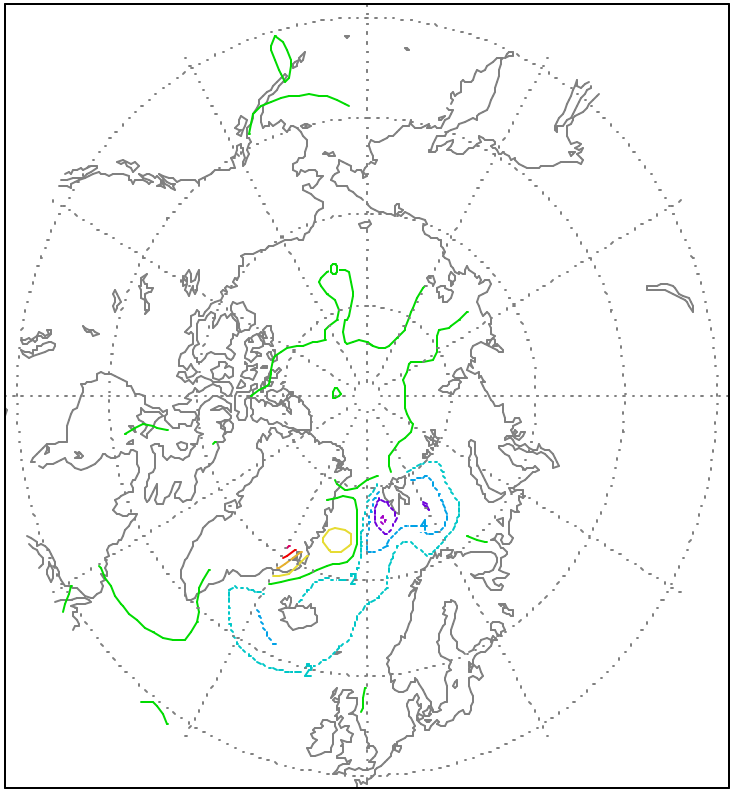
Time (years -2000)

Spectral analysis

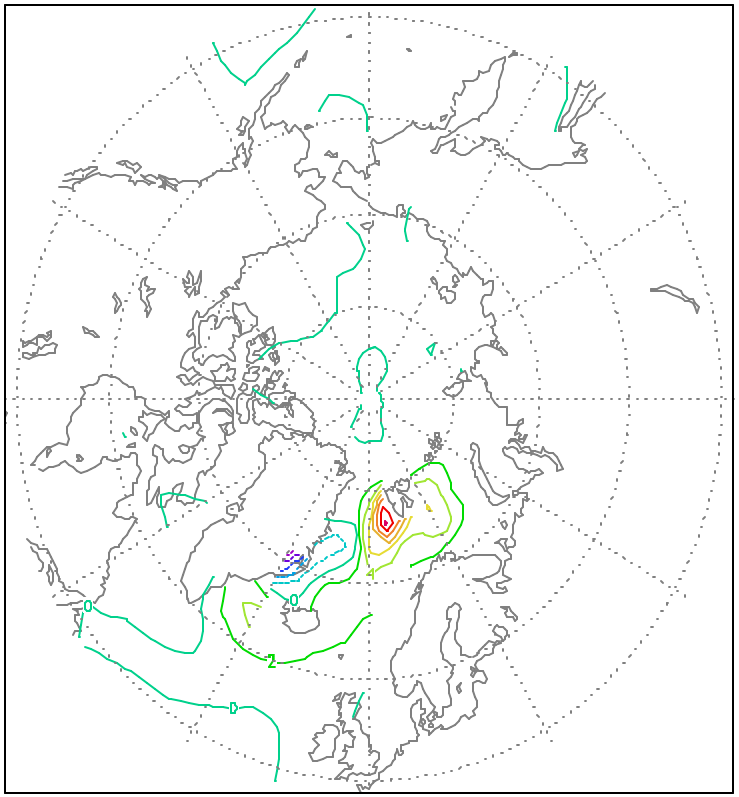


Oceanic causes of the ice volume increase

Upward oceanic flux at lag -4 years (W m^{-2})

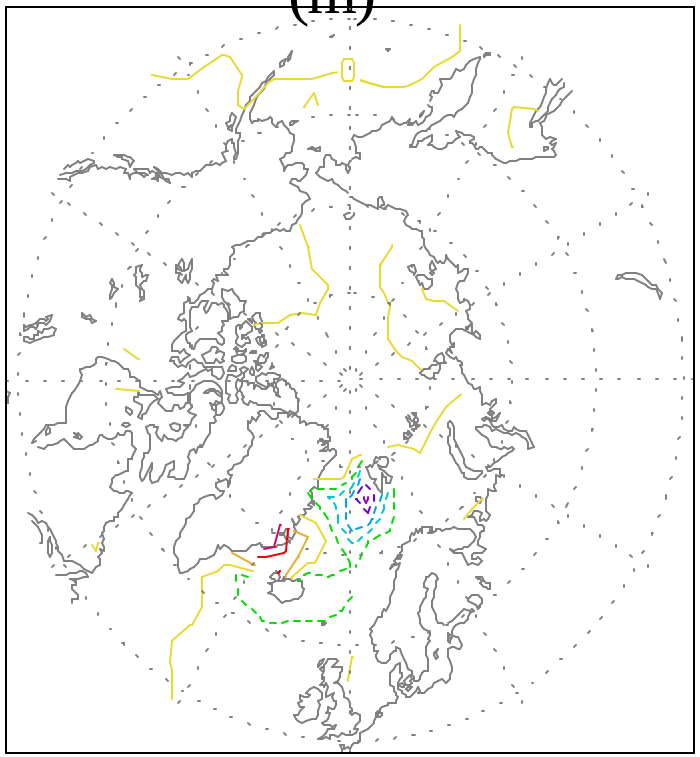


Upward oceanic flux associated with convection at lag 0 (W m^{-2})

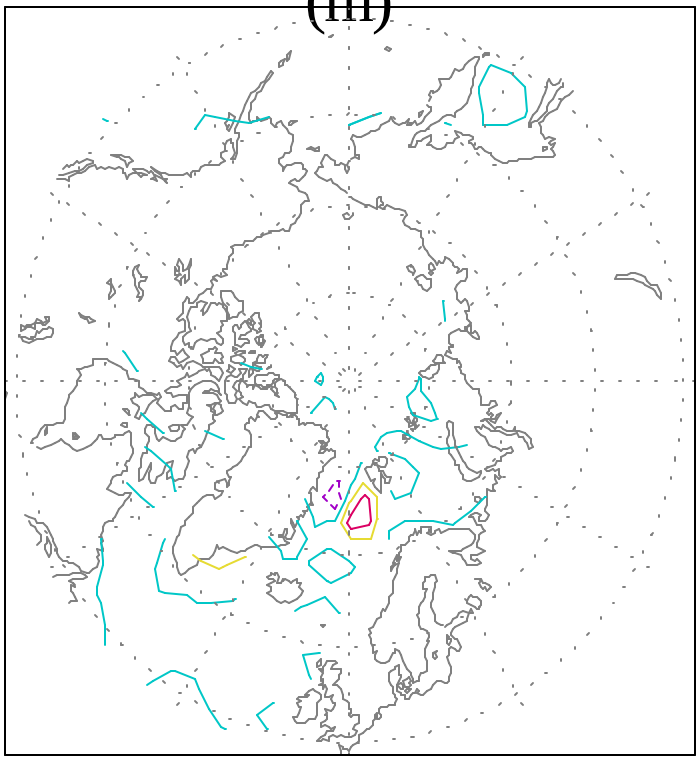


Links between sea ice volume and convection

Depth reached by convection (lag -4 years) (m)

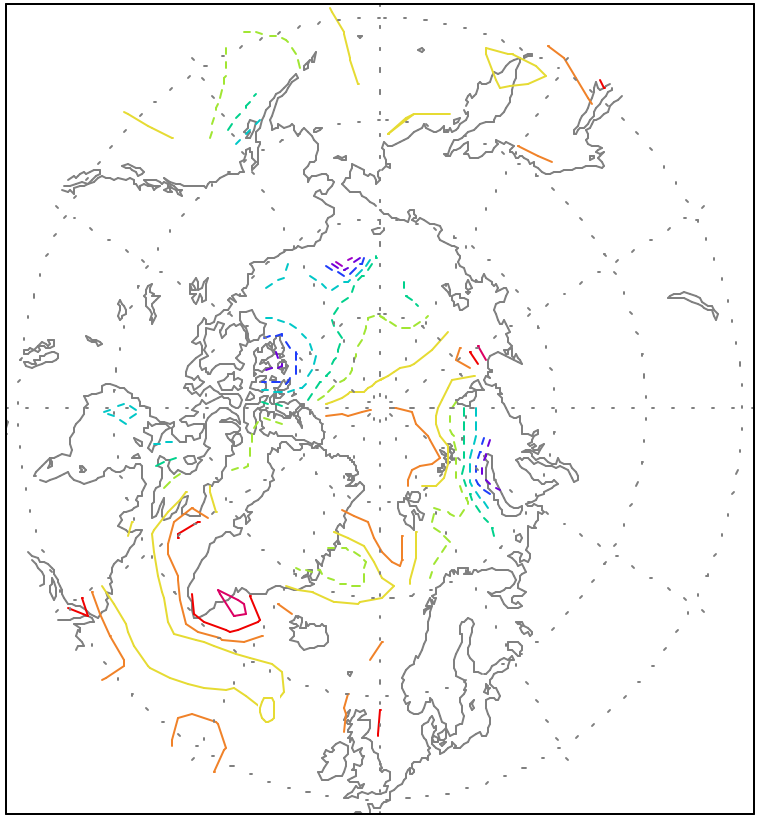


Depth reached by convection (lag +4 years) (m)



Role of salinity anomalies in the Arctic

Ocean salinity (top 500m) regressed upon the sea-ice volume (lag +4 years) (psu)



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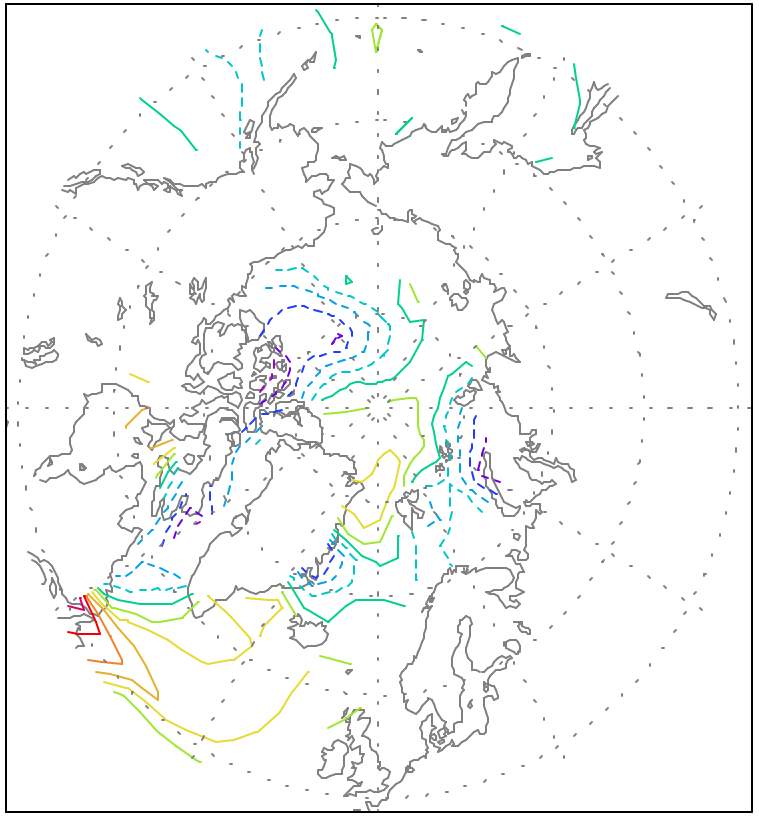
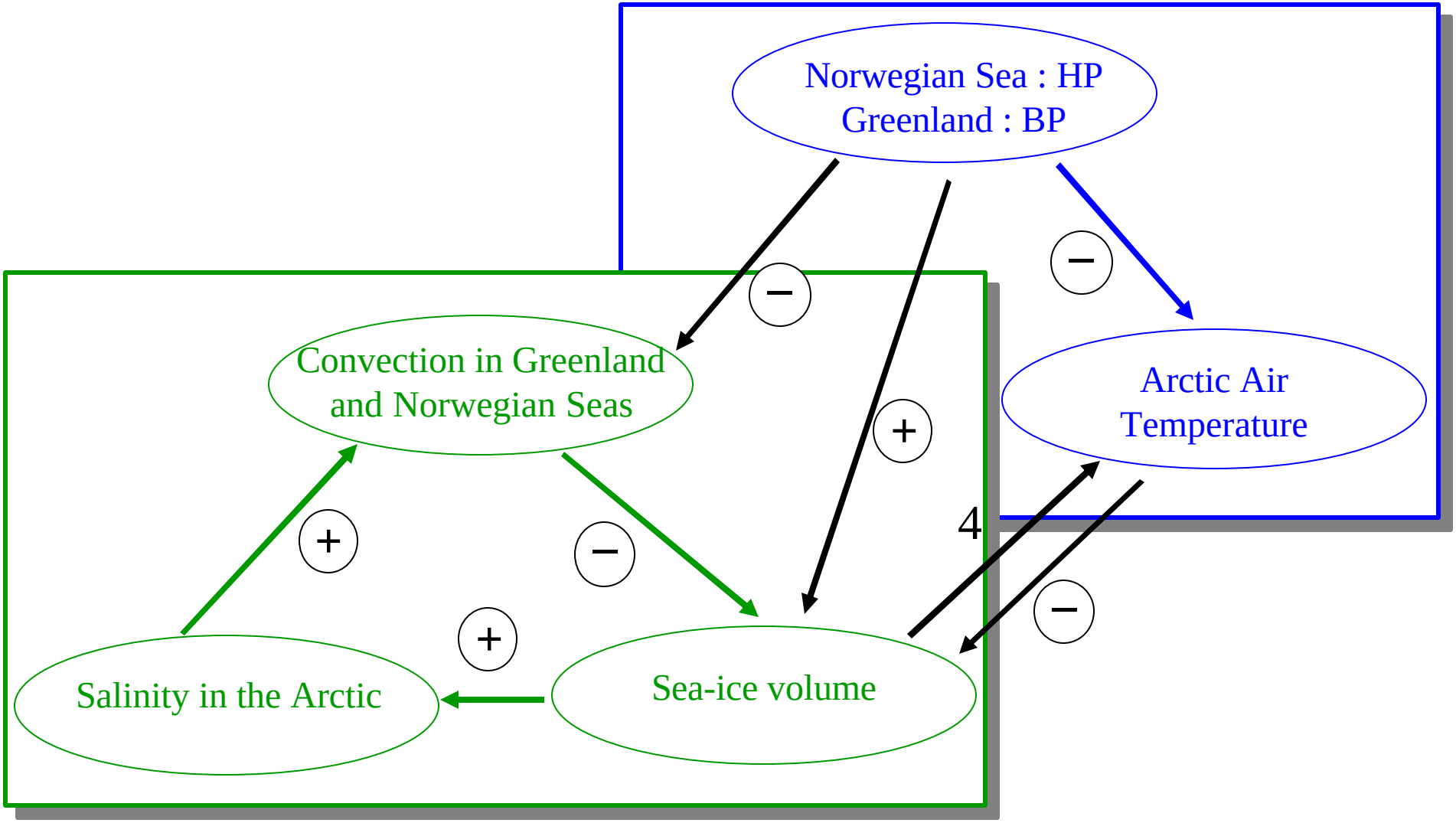


Sketch of the proposed mechanism



Conclusions

- Large decadal variability of the ice volume in the Northern Hemisphere.
- Both atmospheric and oceanic meridional exchanges in the Atlantic sector are important for the evolution of the ice volume in the Northern Hemisphere.
- Inflow and fate of Atlantic waters have a strong role.
- Links with NAO
- Different models provide complementary information:

Important to understand mechanisms