

# Arctic Climate Prediction: Progress and Impacts

François Counillon and Noel Keenlyside

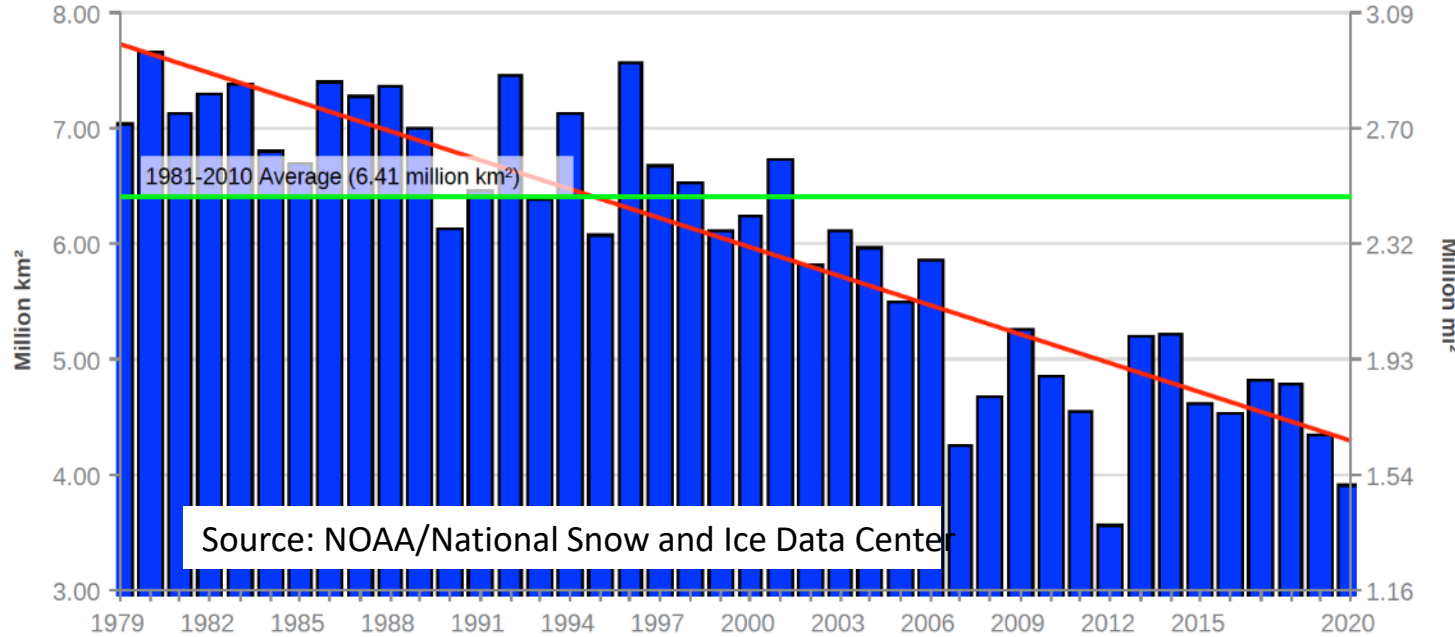
with contribution from Torben Koening (SMHI), Shuting Yang , Tian Tan (DMI) and many others



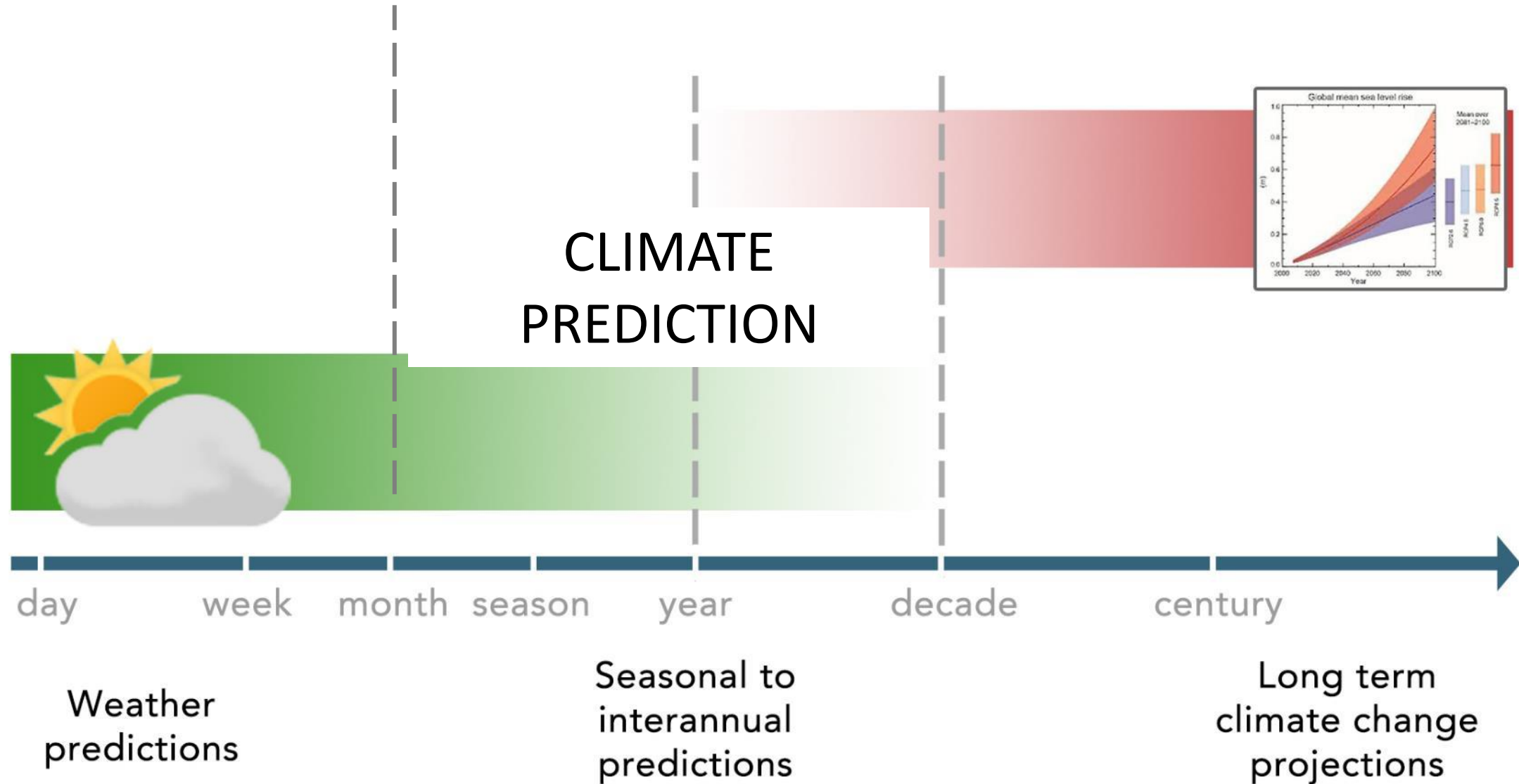
# Information needed on Arctic changes over the next few years

Northern Hemisphere Sea Ice  
September, 1979-2020

## Rapid warming and decline of sea ice



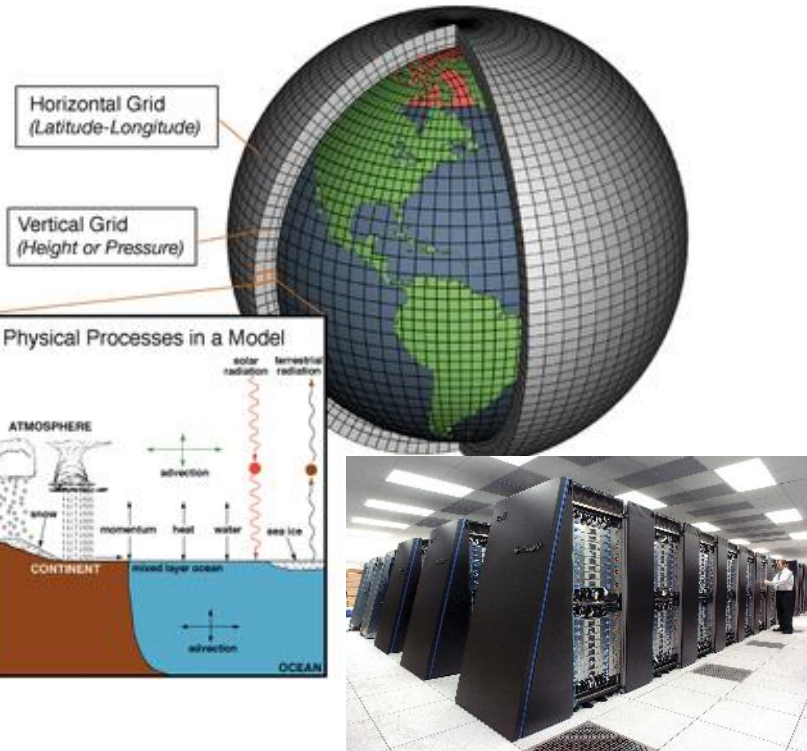
# Climate Prediction





# Dynamical predictions system

## Numerical Models



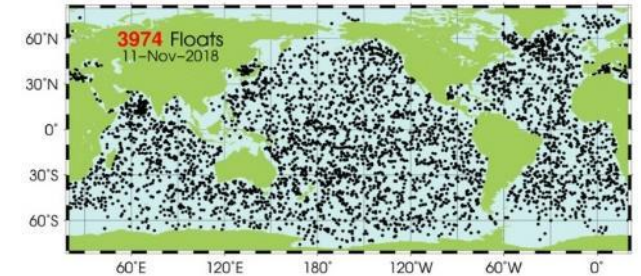
## Data assimilation



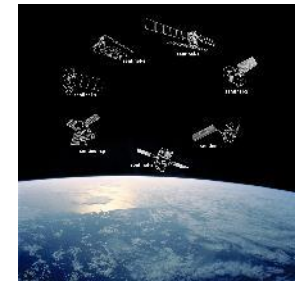
Statistical methods that bridge a model with observations

## Observations

From ships, float



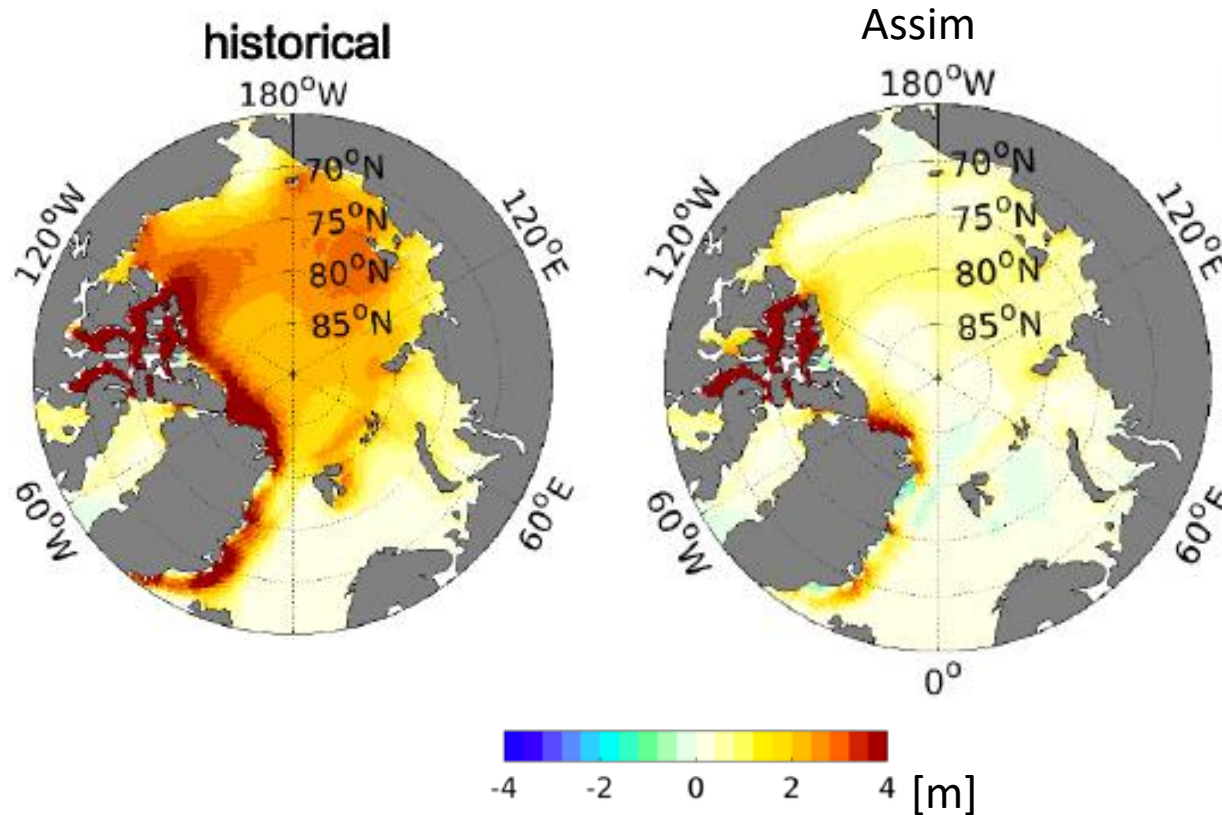
Satellites



*Enhanced predictions expected from improved models, observations and data assimilations methods*

# Improvement from data assimilations methods

*Can better use of sparse observations*



*Assimilation of ocean data can reduce error in sea ice thickness*

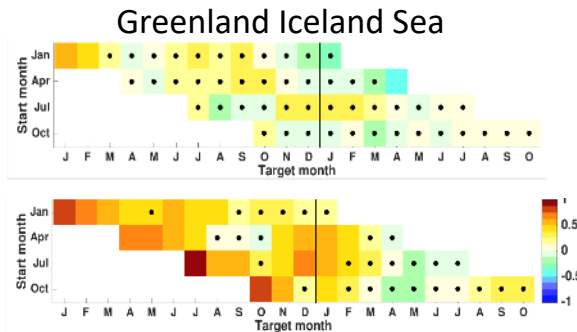
*[Bethke et al. 2021]*

# Enhancing seasonal prediction in the Arctic

*Detrended correlation skill of sea ice extent in real framework*

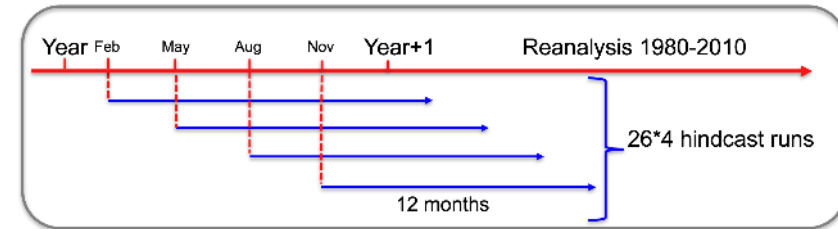
- means not significant  
1985:2010

ocean  
obs



ocean  
+sea ice

*Improved sea ice  
export*

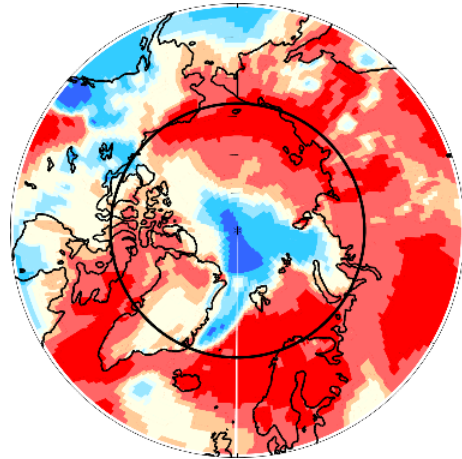


Complementing our system with sea ice concentration data greatly improved prediction skill of sea ice extent

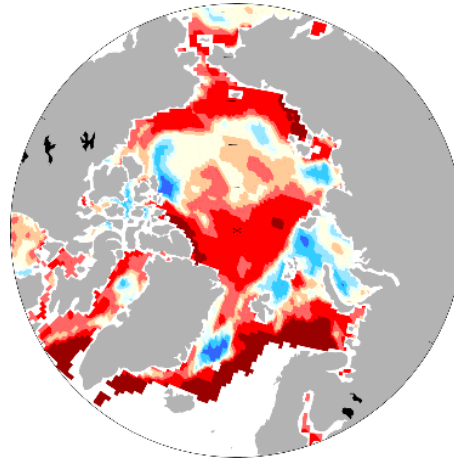
# Comparable developments with *EC-Earth3 Climate Prediction system*

predictions for lead-year 2-9

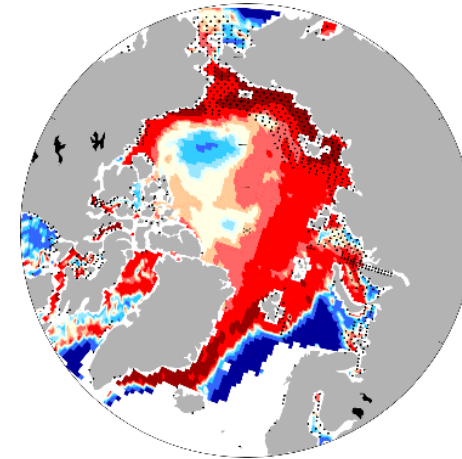
Surface air temperature



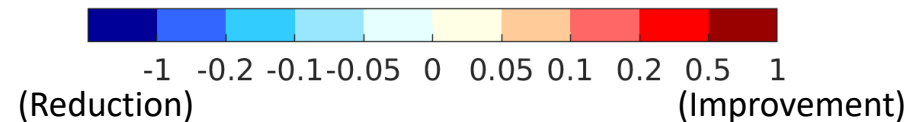
Sea Ice concentration



Sea Ice thickness

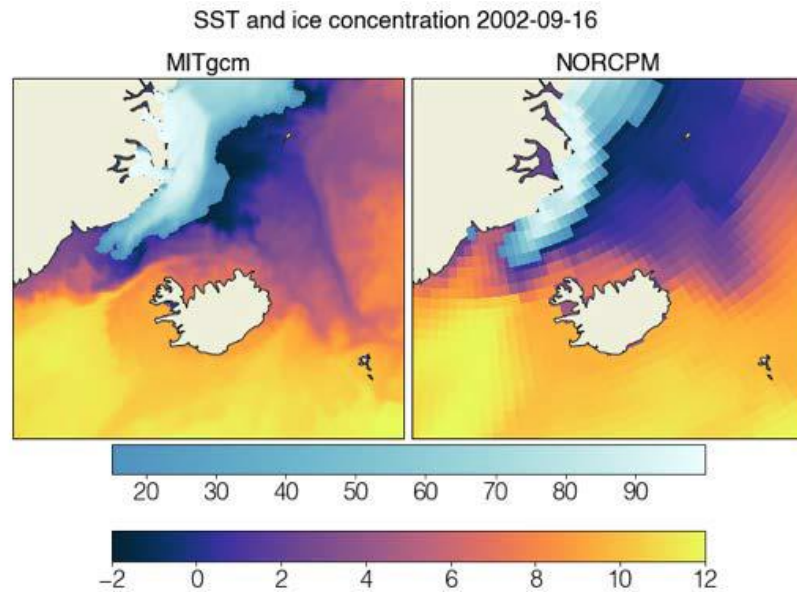


RMSE skill score



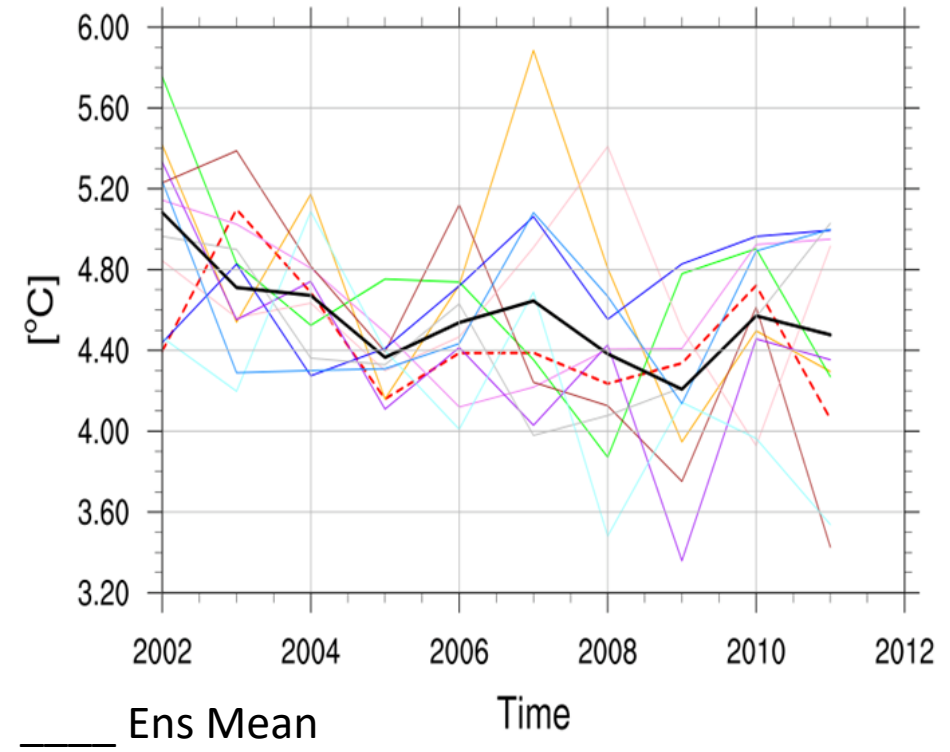
# Improving models can yields improvements

Regional downscaling (here with HCLIM) of global predictions can enhance the prediction locally



*Some improvement in coastal region not in the rest*

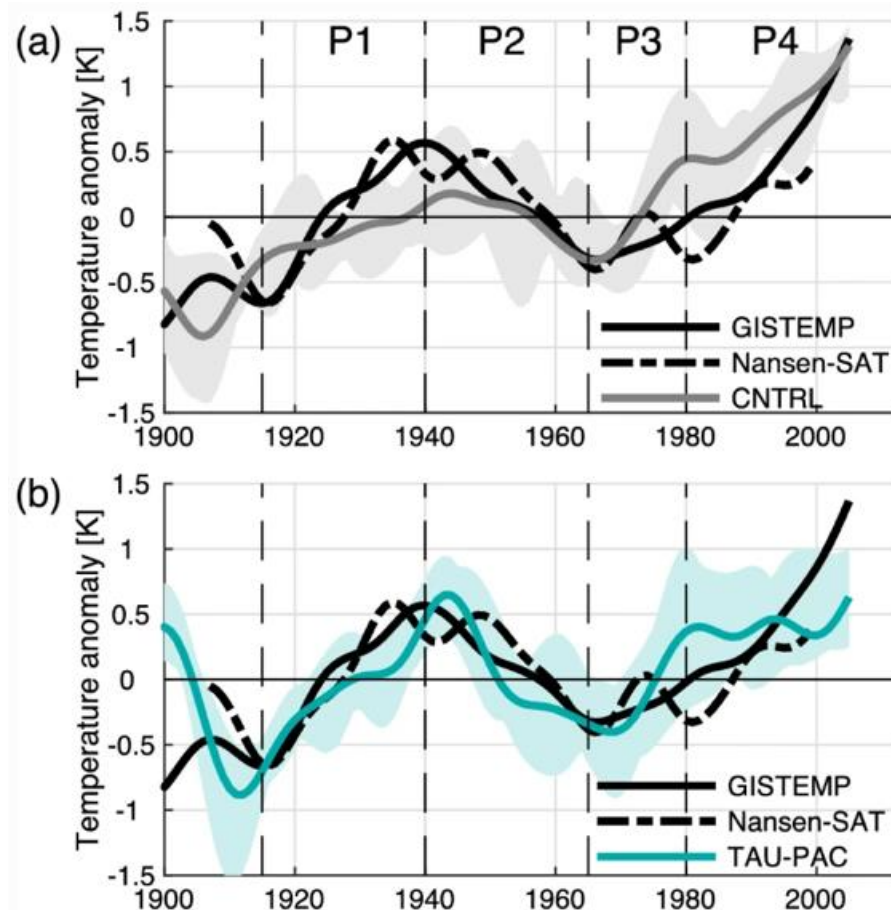
atmospheric temperature for Keflavik





# Identify the role of teleconnections between high and low latitudes

Use idealised model configuration can help to understand the between tropical region and the Arctic



Tropical and extratropical Pacific decadal variability can explain up to ~50% of the observed decadal surface temperature trends in the Arctic

# Conclusions

- Two prediction systems has been further developed within ARCPATH
- There are still large potential for improvement but they provide meaningful information of the climate from next month to a decade ahead
- Such tools will play a key role in development of climate services and building a resilient society