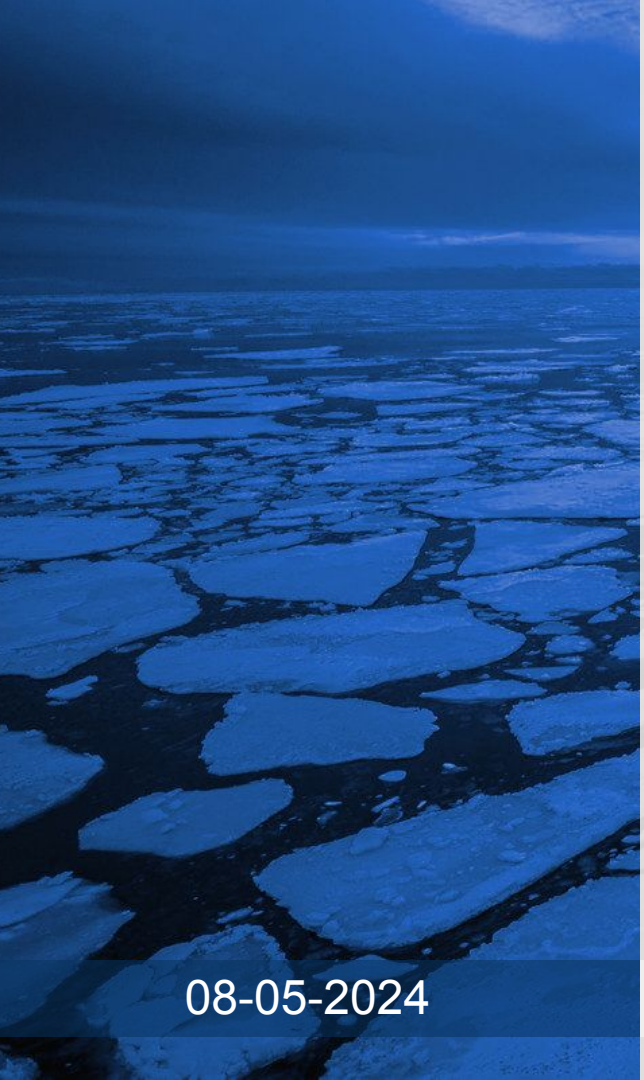

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Cooling Effect of Aerosols on Past Arctic Climate (1950-2014)

Alba Santos Espeso

Supervisors: María Gonçalves and Pablo Ortega

alba.santos@bsc.es

08-05-2024

Climate Modeling

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Simulating reality

Climate Modeling

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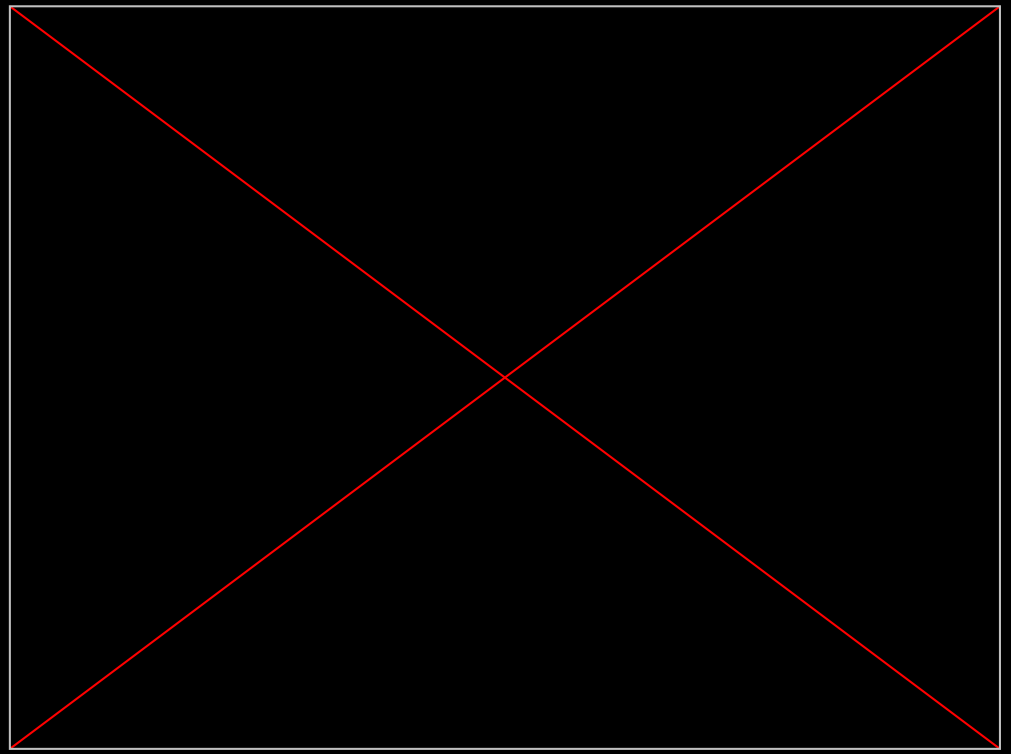
Simulating reality

Earth System Models



Credits: Oriol Tintó

Climate Modeling

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Simulating reality

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Climate Change

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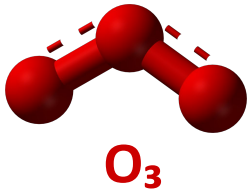
Human Emissions

Credits: EcoWatch, Michael Dantas, Paul Hanna

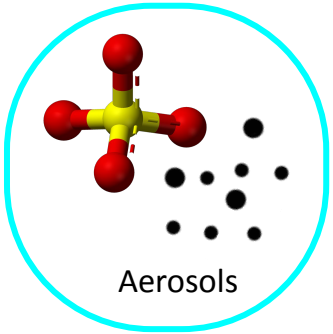
Near Term Climate Forcers

NTCFs are compounds with short atmospheric lifetimes (days or weeks)



O_3

Tropospheric Ozone



Aerosols

Sulphate aerosols reflect radiation and counteract greenhouse warming

Climate Change

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Human Emissions

Near Term Climate Forcers

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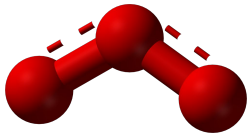
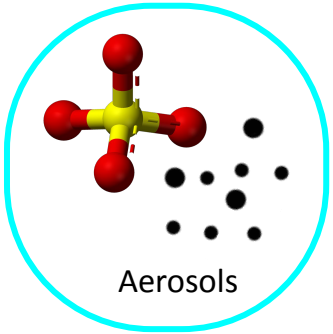


O_3

Tropospheric Ozone



Aerosols

Sulphate aerosols

DISCLAIMER

All anthropogenic emissions contribute to air pollution and constitute a major health emergency

Framework

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Aerosols Effects on Climate

- Interact with radiation

- Cloud Condensation Nuclei (CCN)

- Modification of heat transport

Framework

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Aerosols Effects on Climate

- Interact with radiation

- Cloud Condensation Nuclei (CCN)

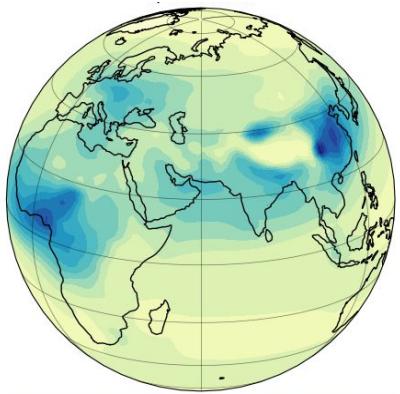
- Modification of heat transport

Experiments

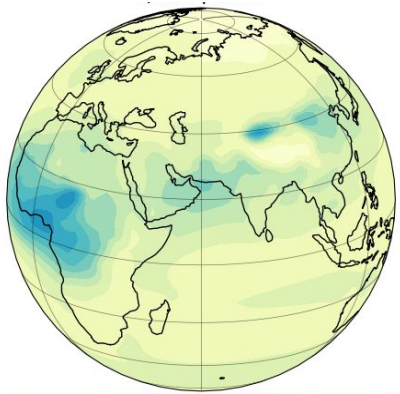
We will use model outputs from **two setups**

Period: 1950-2014

historical
historical emissions of NTCFs



hist-piNTCF
fixed 1850 emissions of NTCFs



Arctic Cooling

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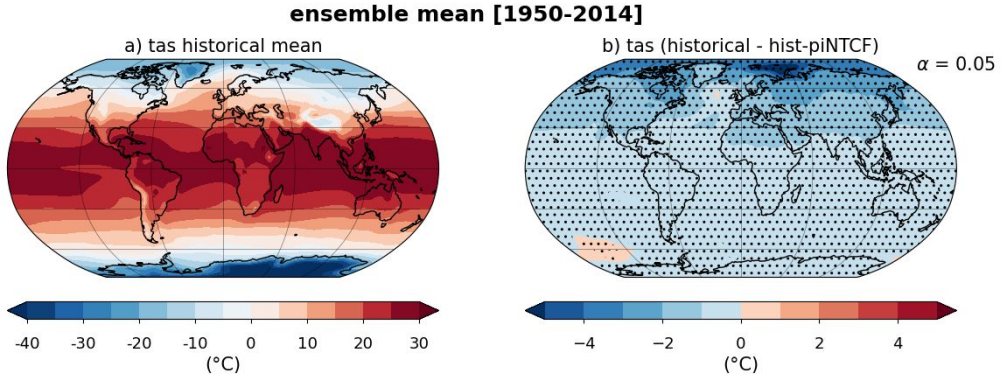
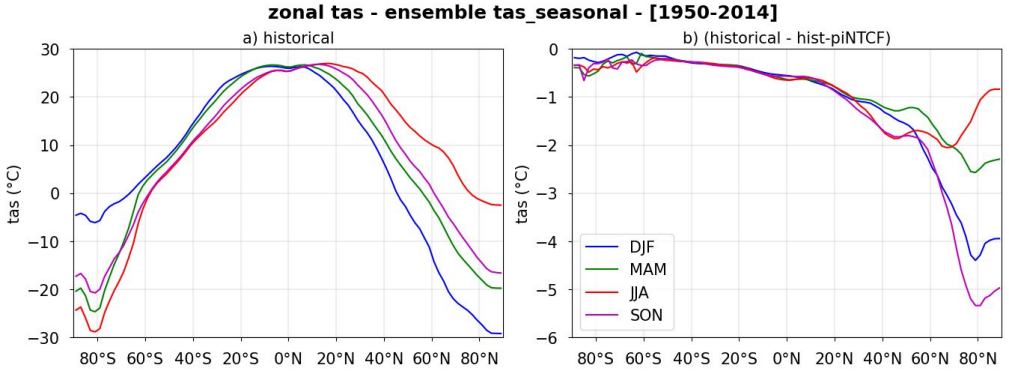
NTCFs Effects on Temperature

- NTCFs produce a worldwide cooling
- Most intense in the **Northern hemisphere** (where main aerosol sources are)



- Seasonal behaviour
- Most intense cooling in **autumn**
- Up to **-5°C in the Arctic**



Radiation

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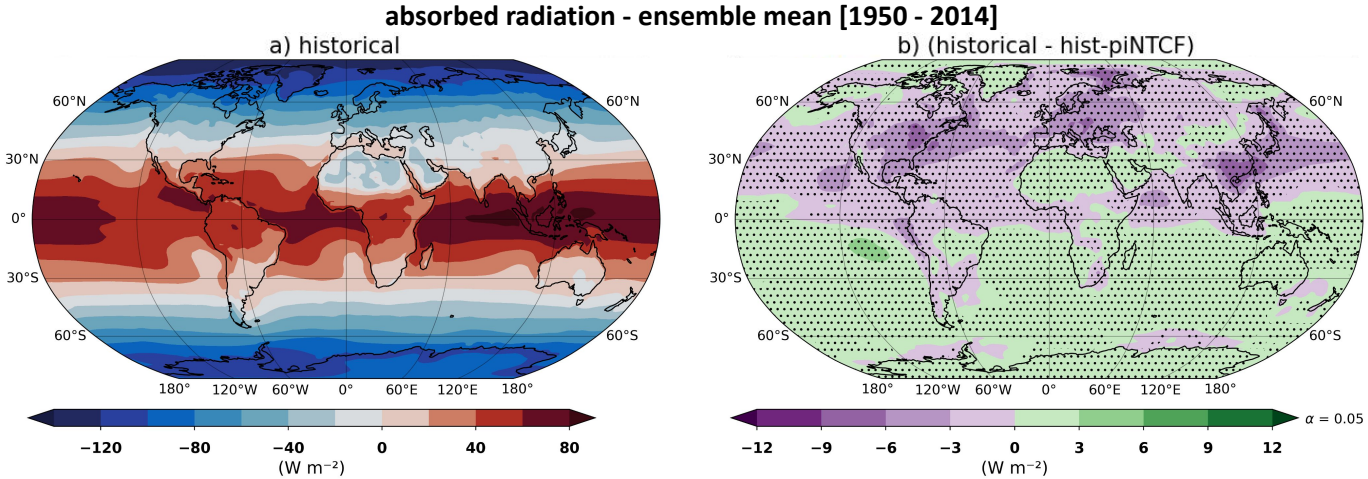
NTCFs Effects on Absorbed Radiation

- Local cooling in the main regions of emissions
- Unbalanced radiation between hemispheres
- Not a clear signal in the Arctic



Sea Ice Feedback

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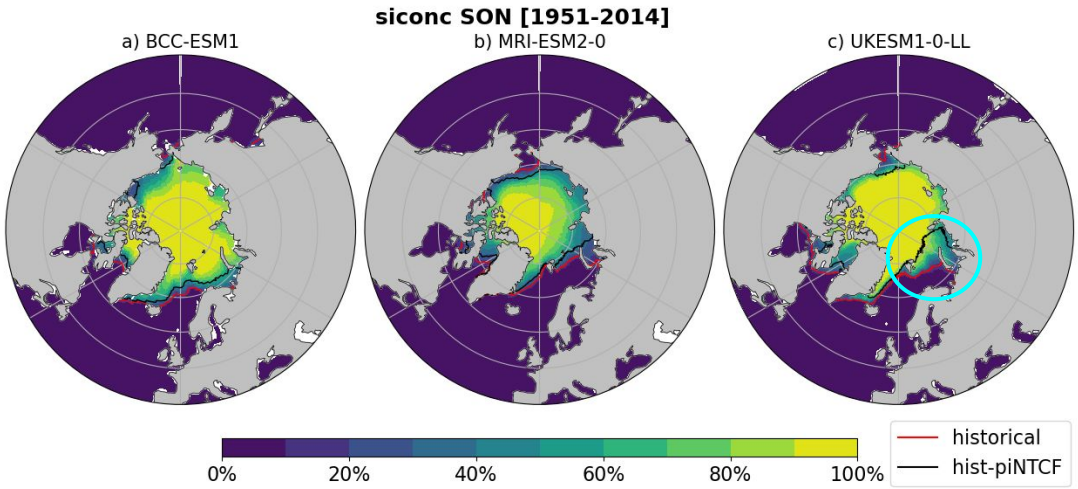
Autumn Sea Ice Concentration



Different models agree: there is **more sea ice with NTCFs**

Main change in the **Barents sea**

Sea Ice Feedback

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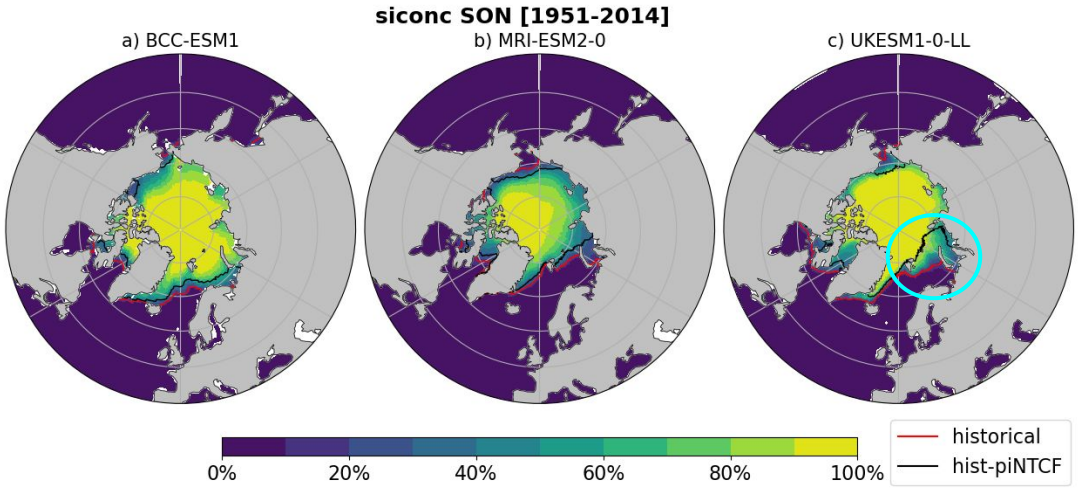
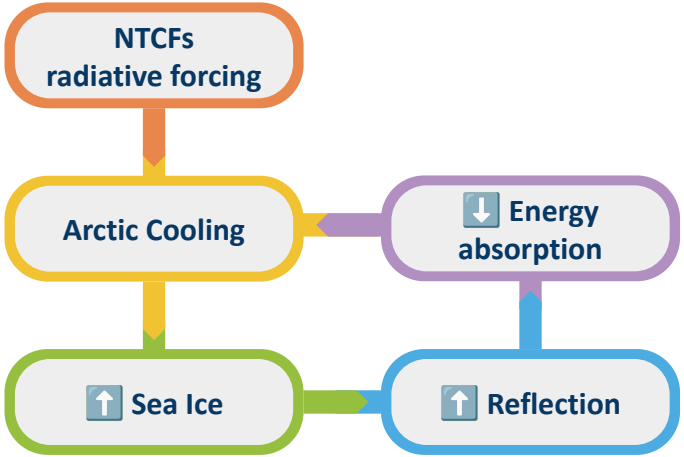
Autumn Sea Ice Concentration



Different models agree: there is **more sea ice with NTCFs**

Main change in the **Barents sea**

Mechanism



Amplification of the temperature change

Conclusions

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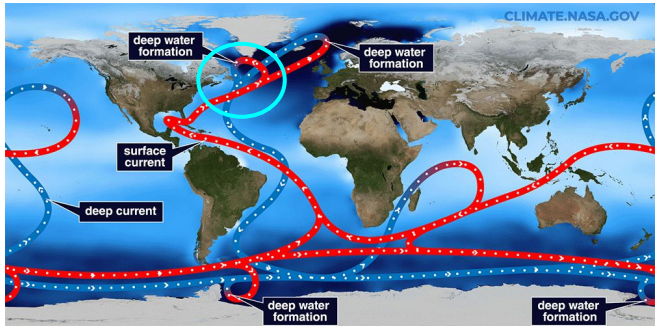
NTCFs Impacts on the Arctic

- Temperature decrease → Key for the implementation of **air quality policies**
- Sea Ice Feedback → **Fragile climatic system** with global consequences
- Not a clear mechanism → **NEXT PAPER**

NTCFs impact in the **Atlantic Meridional Overturning Circulation (AMOC)**



Credits: NASA

Thanks for your attention!

Clouds

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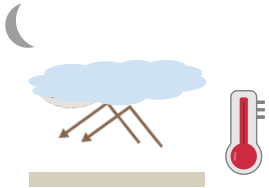
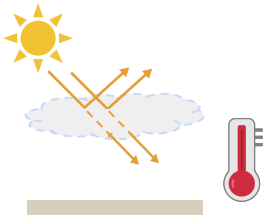
NTCFs effects on Cloud Cover

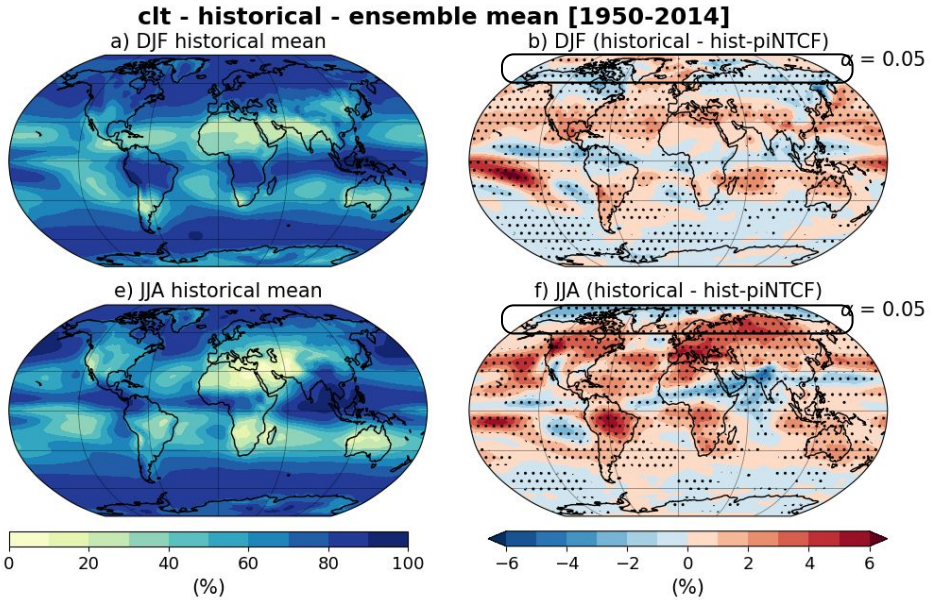
Seasonal signals in the Arctic:

- **Winter (DJF):** slightly more clouds



- **Summer (JJA):** less clouds





Heat Distribution

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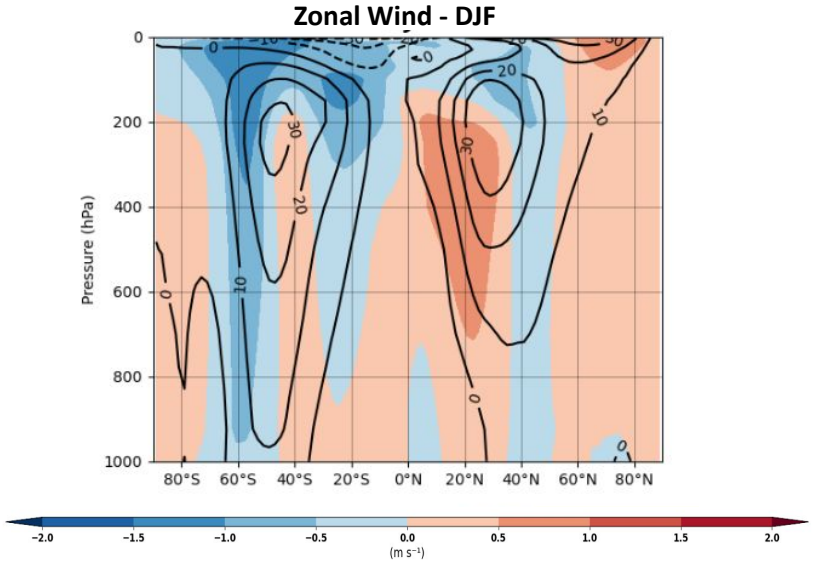
Atmospheric Transport

Atmospheric Circulation Cells

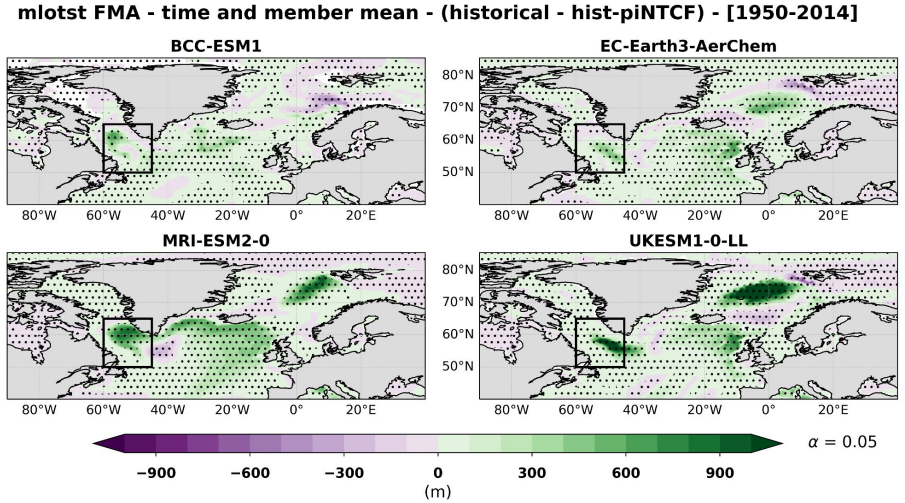
We detected an equatorward shift of the extratropical jet. (main circulation in the Northern Hemisphere)



Oceanic Transport

Meridional Overturning Circulation (MOC)

We detected increased circulation in the Labrador Sea Area (main circulation in the Atlantic Ocean)



Heat Distribution

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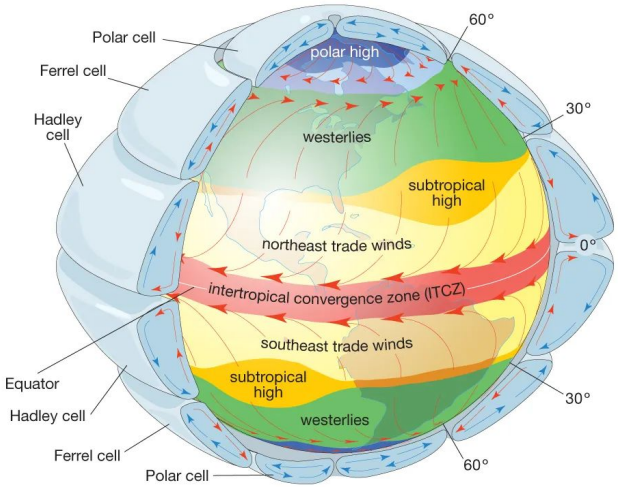
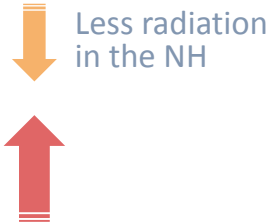
Atmospheric Transport

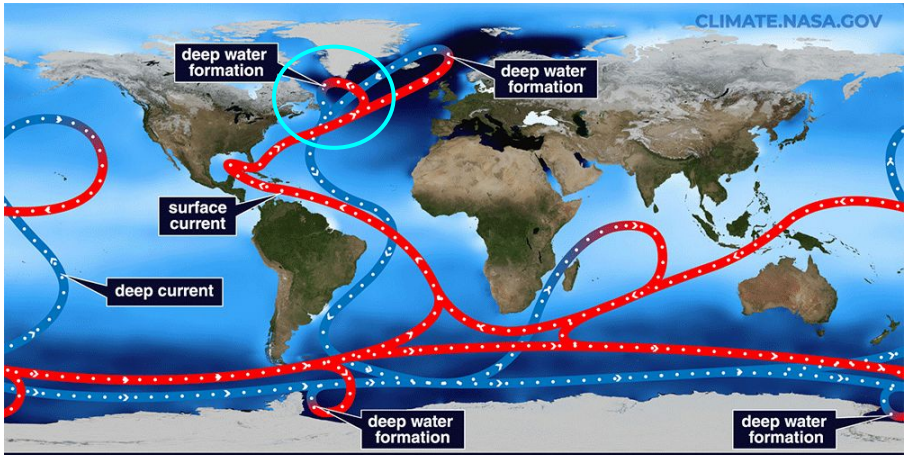
Atmospheric Circulation Cells
Unbalanced interhemispheric energy will cause an intensification of the northward atmospheric transport





Oceanic Transport

Meridional Overturning Circulation (MOC)
Changes in ocean surface heat fluxes can affect shallow and deep currents



Credits: Encyclopaedia Britannica

Credits: NASA