WP2
The added value of high-resolution in the atmosphere and ocean

(SMHI, BSC, UCL, CMCC, ECMWF, Met-Office, UREAD, KNMI, CNR, UOXF, MPG, CERFACS, NERC, AWI)

Main goals:

- Provide a systematic assessment of the benefits of increased atmospheric and oceanic resolution
- Evaluate the robustness of the response across the PRIMAVERA model ensembles

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Progress

Milestones

MS4: List of existing past-CMIP5 global model simulations and of the available high-resolution observational datasets for validation of the simulations (M2)

MS5: Exchange of model outputs from the past CMIP5 high resolution simulations already available at the start of the project and of observational datasets for validation (M4).

MS1: Observational/reanalysis/CMIP5 datasets required for metrics development and model assessment, available on JASMIN in appropriate format, with documentation (M6).

MS6: *Plan and tools for co-ordinated process-based analysis of the core-simulations (M12, WP1-WP2).*

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Available model simulations and observations

Pre-PRIMAVERA simulations

- High-resolution and standard resolution coupled, atmosphere-only, ocean-only
- pre-industrial, present-day and transient historical simulations
- 5 global coupled models, 3 atmosphere-only models, 1 ocean-only model

→ **/group_workspaces/jasmin2/primavera1/WP2**

Observations

- Data sets from 40 different observational-based sources

→ **/group_workspaces/jasmin2/primavera1/observations**

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WP2 - Progress
Deliverable D2.1

Assessment of the benefits of increased resolution on the North Atlantic ocean dynamics and processes and the Arctic sea ice conditions and their robustness across the pre-PRIMAVERA multi-model ensemble listed in milestone MS1 (M15).

→ Discussion of main research topics:

- AMOC/ AMO – causes (deep convection, surface heat fluxes, freshwater), consequences (heat transports to the north)
- Surface gradients, position of Gulf Stream, air-sea interactions
- Ocean heat content
- Linkages NA-Arctic (both directions, mass, freshwater, heat fluxes and impacts)
- Sea ice – variations, trends, ice exports, interactions with lower latitude
- Storm tracks, blocking
- Extremes
- Tropical cyclones and extra-topical transitions
- Biases and drifts (deep ocean)

→ Development of diagnostics and application on the pre-PRIMAVERA simulations

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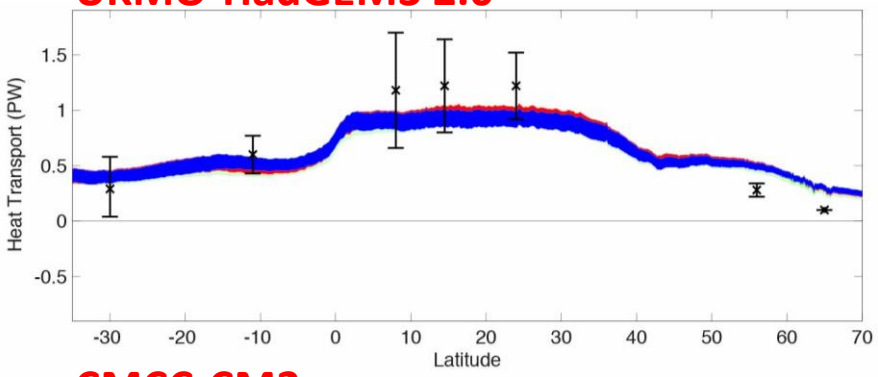
Resolution dependence of zonal Atlantic heat transport in pre-Primavera runs

No significant change with atmos resolution

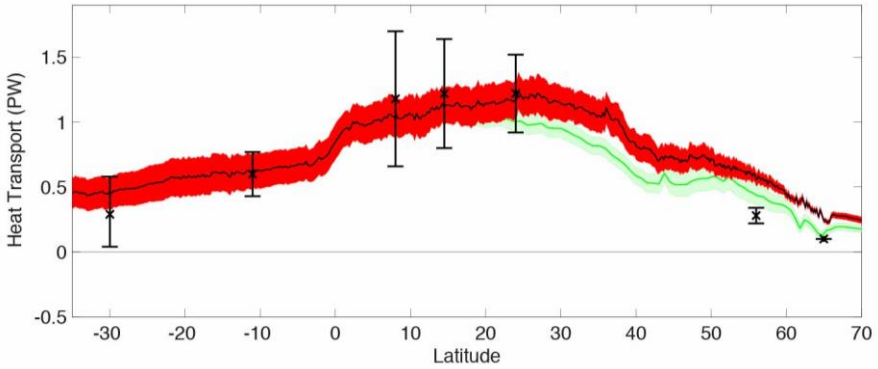
UKMO-HadGEM3 2.0



N96 ORCA025
N216 ORCA025
N512 ORCA025

Significant increase with ocean resolution

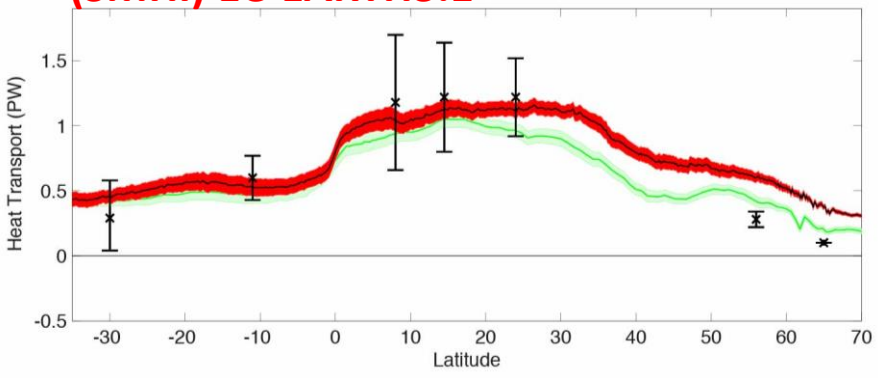
CMCC-CM2



192x288 ORCA1
192x288 ORCA025

Large increase when ocean & atmospheric resolution increase

(SMHI) EC-EARTH3.1

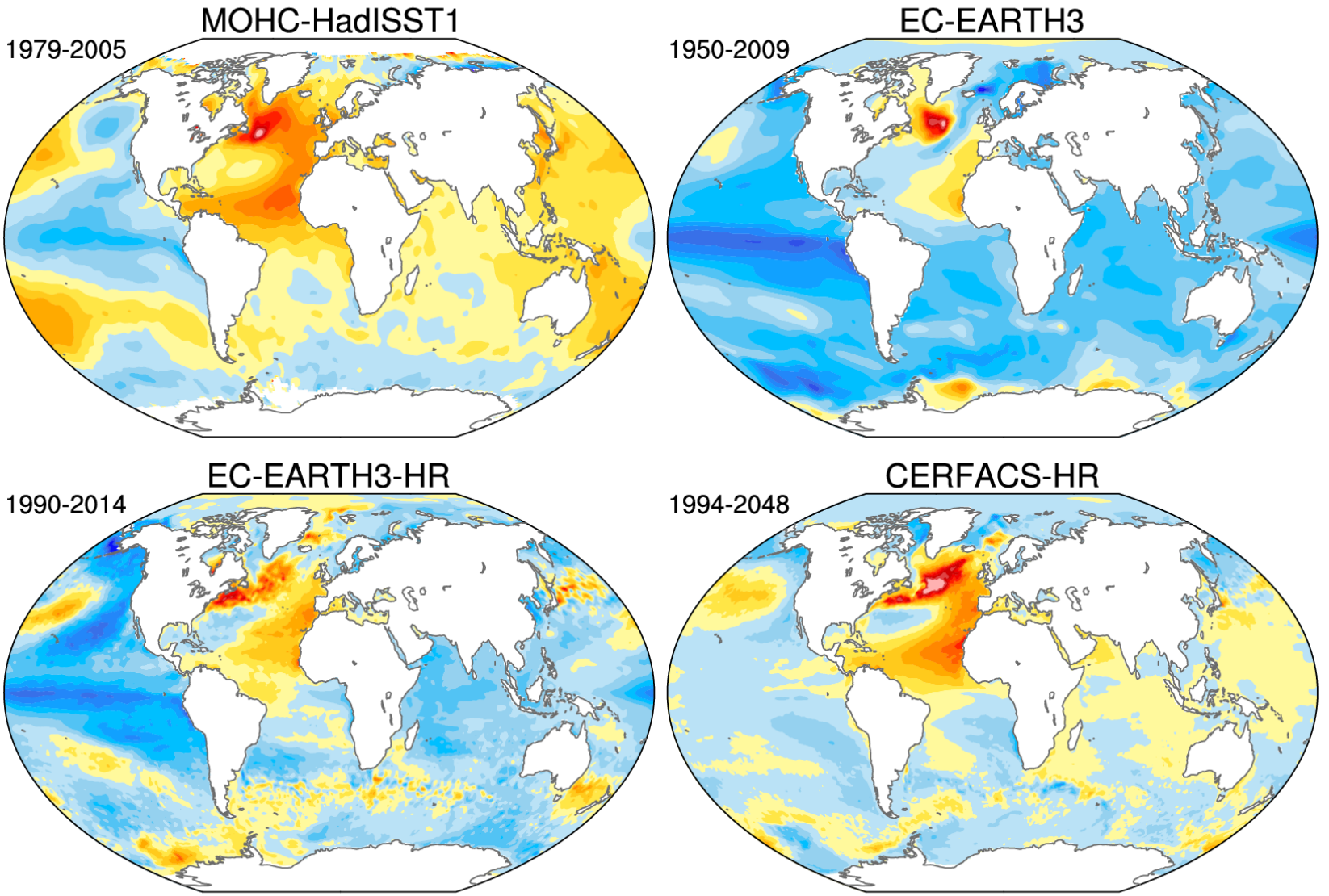


T255 ORCA1
T511 ORCA025

Error bars: observations

Grist et al. NOC

AMO (Monthly)



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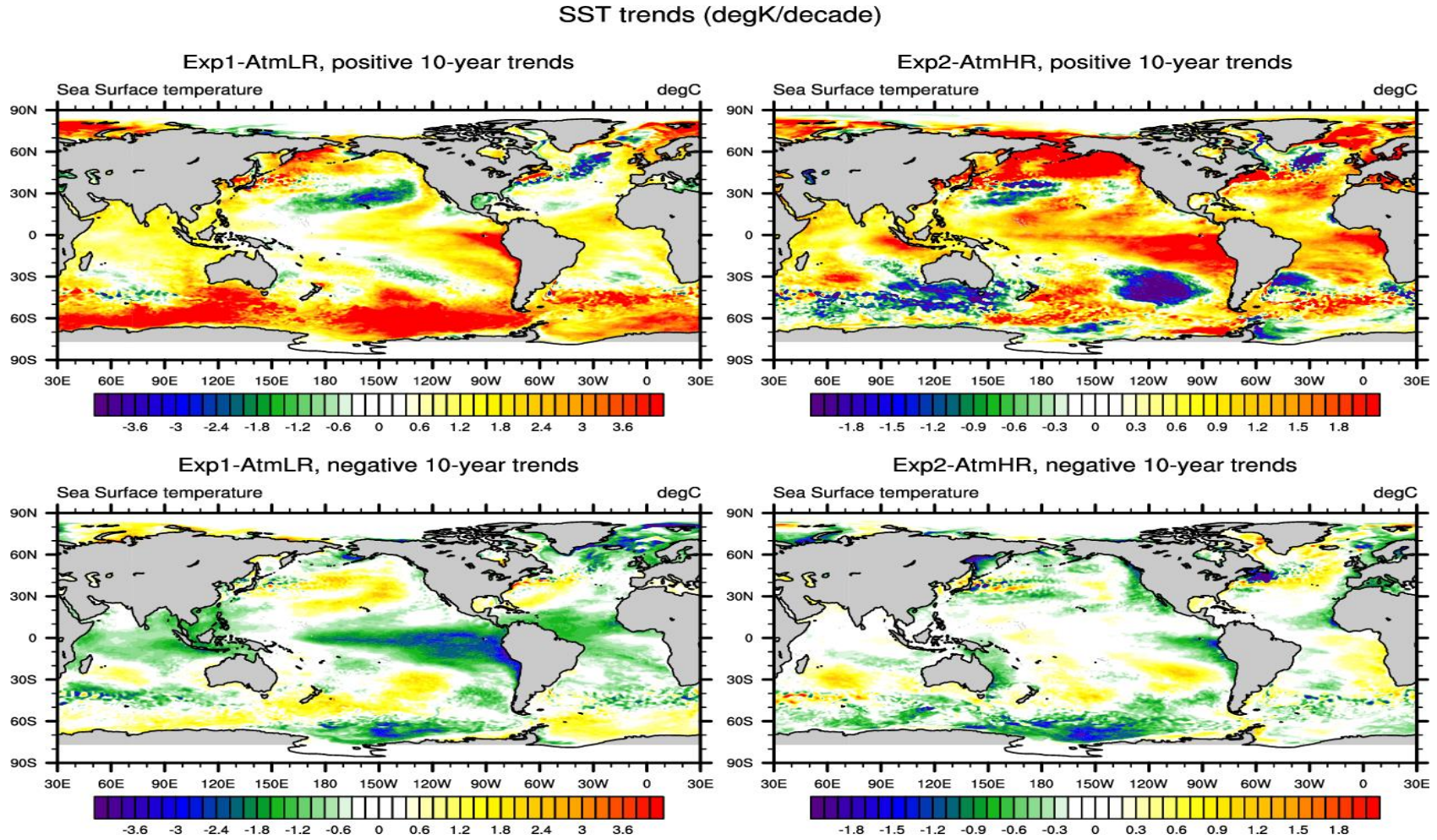
PRIMAVERA

What is the relationship between SST trends and ocean heat content at different depths? What is the impact of model resolution?



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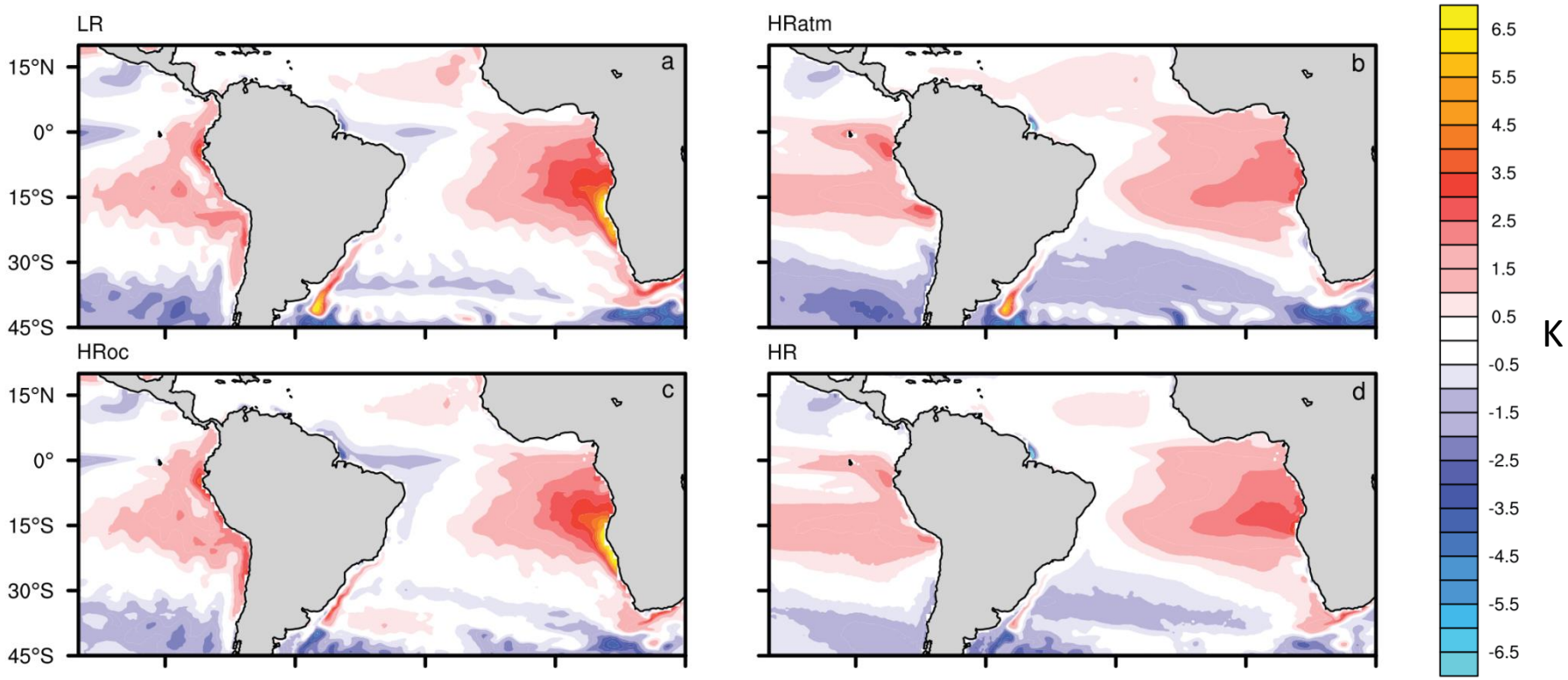
Tropical Atlantic SST bias in MPI-ESM



Milinski et al. (2016, GRL)

- **Panels show different combination of high and low resolution in atmosphere (1.8°, 0.5°) and ocean(0.4°, 0.1°)**
- **Coastal SST bias in southeastern tropical Atlantic reduced at high atmospheric resolution and independent of oceanic resolution**
- **Improvements due to better representation of low-level wind jet that affects upwelling in ocean. Half of improvements can be attributed to better resolved coastal orography that affects representation of wind jet.**

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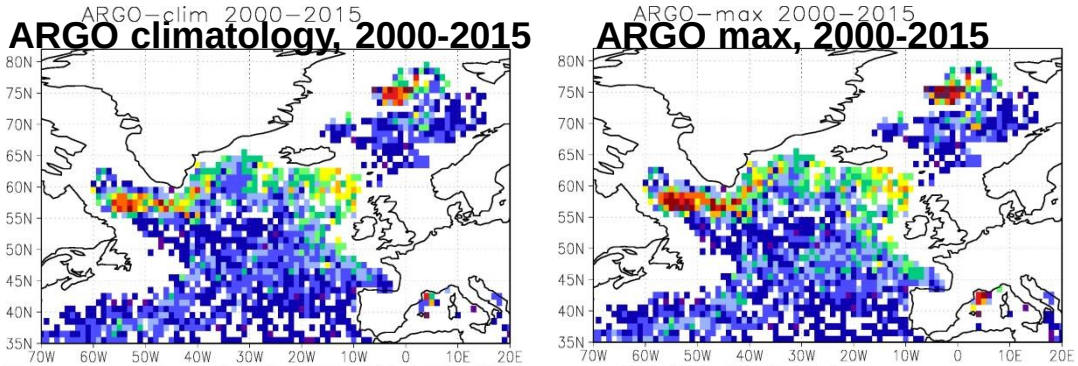
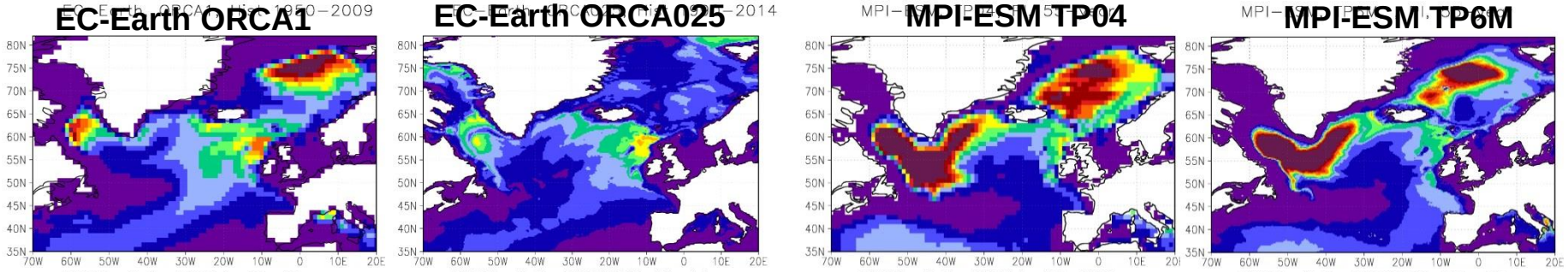
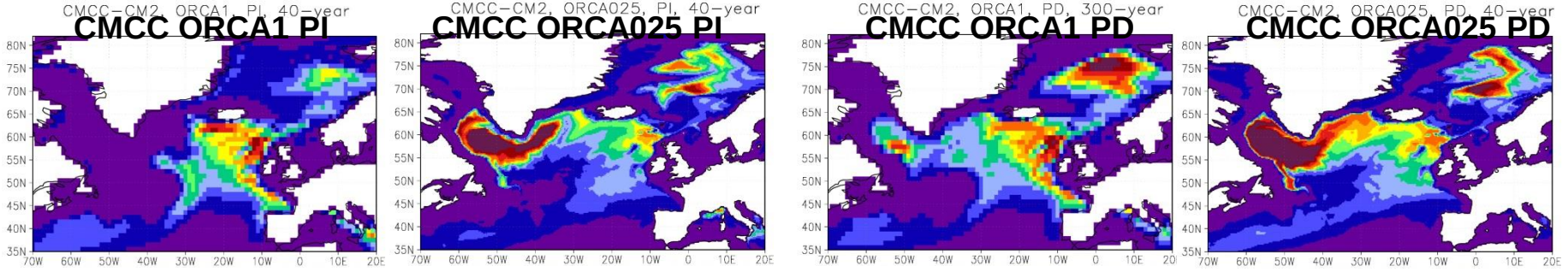
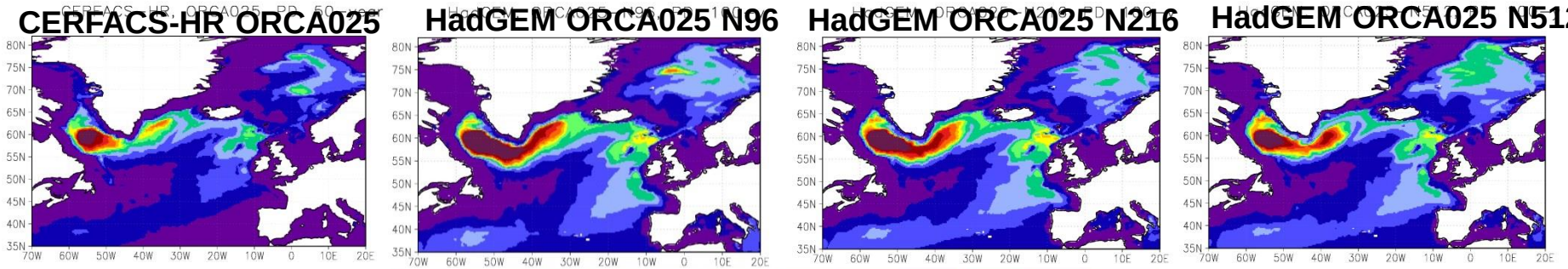
PRIMAVERA

Mixed layer depth March

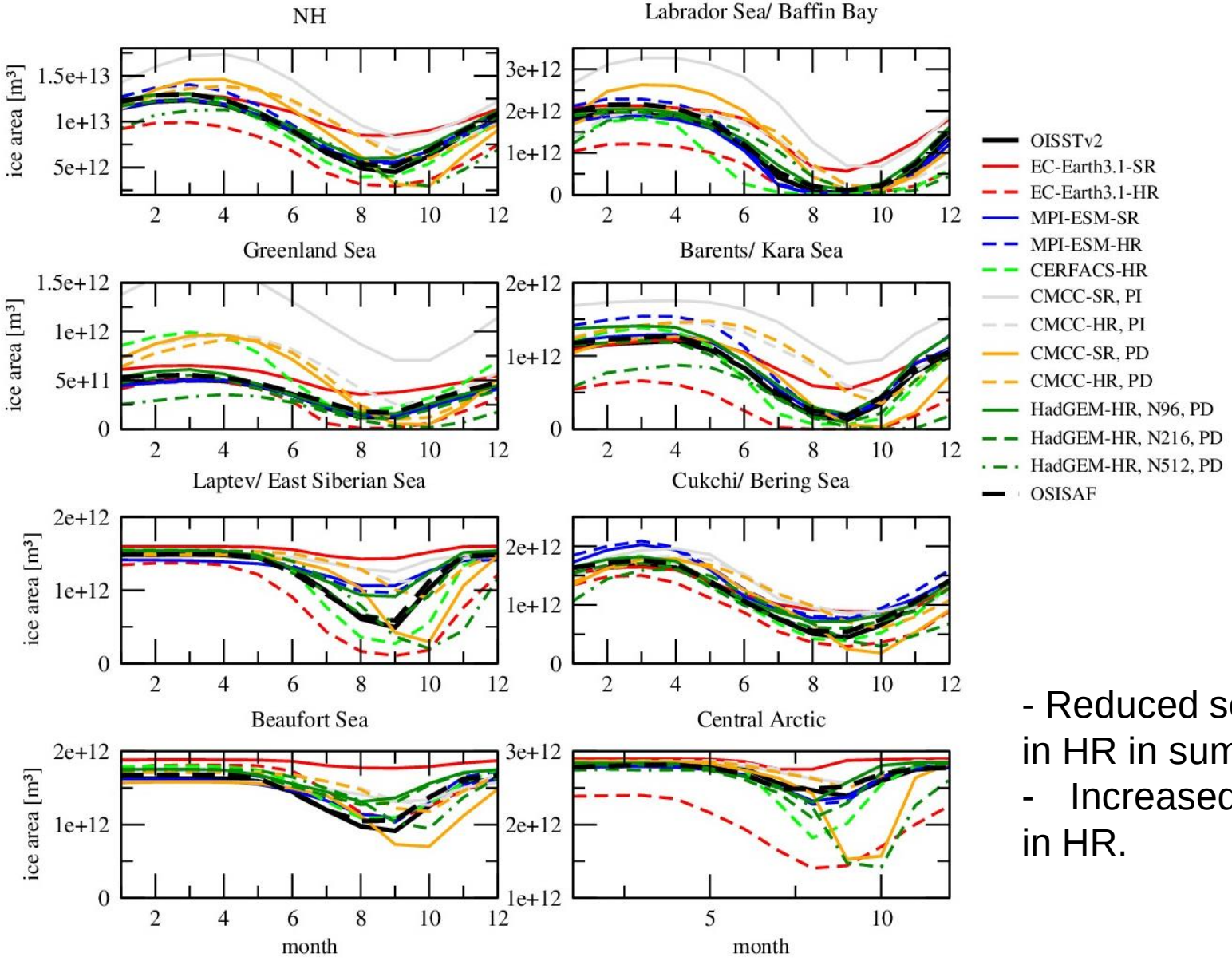








Sea ice area: Annual cylce



- Reduced sea ice area in HR in summer.
- Increased annual cycle in HR.

(SMHI)

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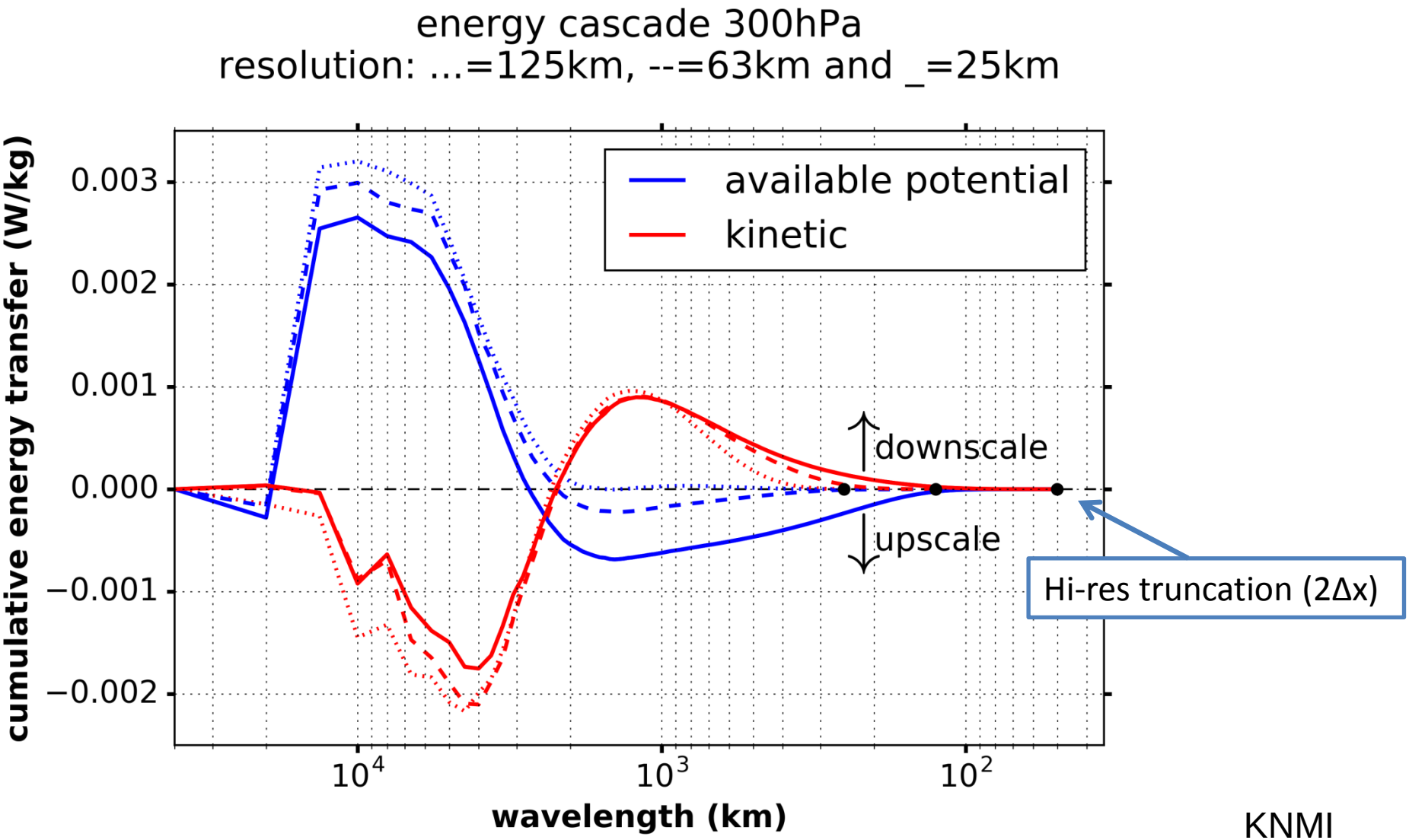
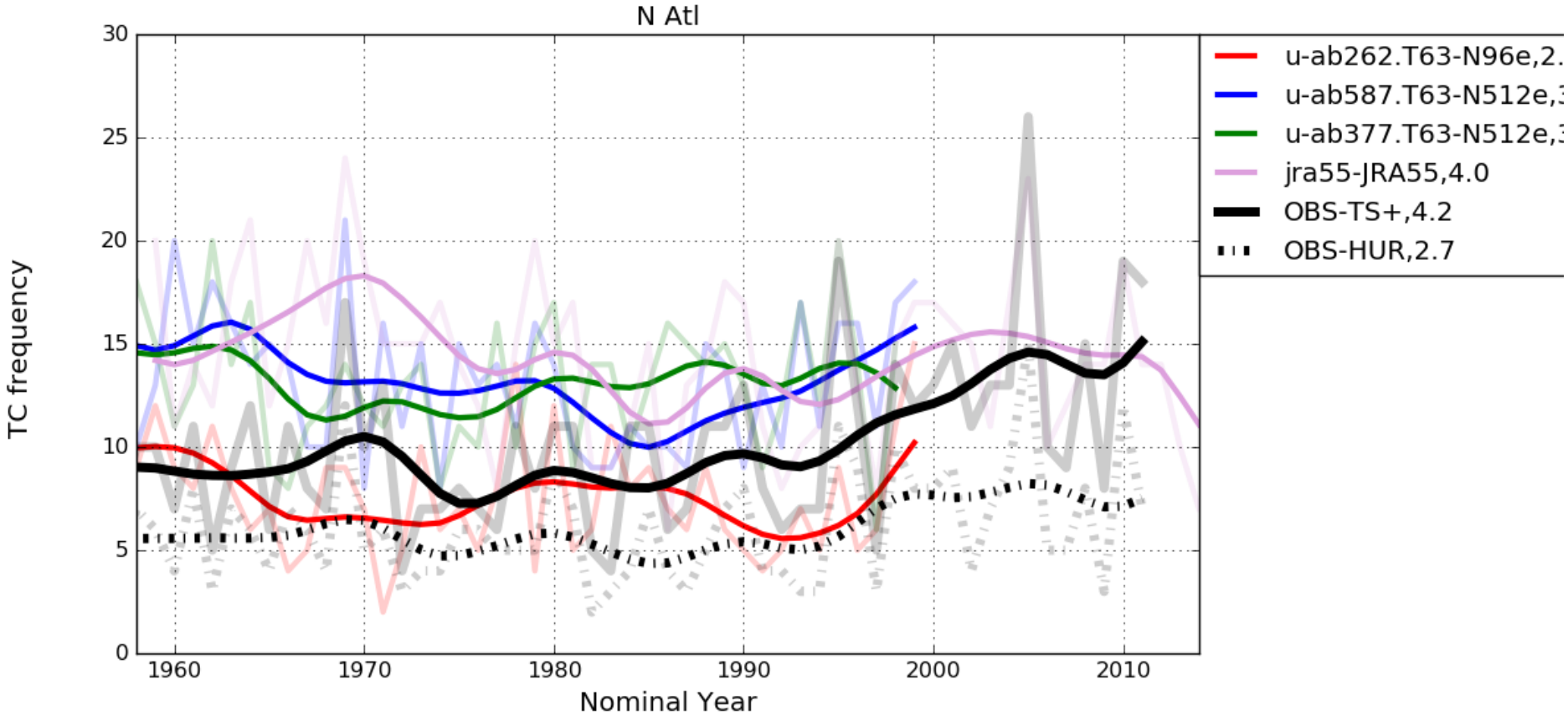
Stronger APE cascade with resolution in EC-Earth (pre primavera):

- **Upscale transfer from smallest scales**
- **Downscale transfer from large scales (from 4000 to 1400 km)**



KNMI

North Atlantic tropical cyclone variability from HadGEM3-GA7 forced atmosphere simulations (1958-2000 and eventually 2010) – N96 and N512



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PRIMAVERA

WP2 - 2017

D2.2: Quantification of the **benefits of increased resolution in the atmosphere only versus in the coupled system**, as well as their robustness across **WP6 Stream 1 simulations**, for processes which impact European weather and climate such as atmospheric blocking, ocean-sea ice-atmosphere interactions in the Arctic and for tropical cyclones and their extratropical transition (M24)

D2.3: Based on WP2 findings and initial sensitivity experiments in WP3, quantification of the **relative merits of increased resolution and model developments** on the North Atlantic, Arctic, Pacific and tropical climates and their robustness across the PRIMAVERA models to provide recommendations to WP6 for the Stream 2 design (M28)

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