

Influence of Atmospheric and Oceanic Model Resolution on Volume and Heat Transports through Arctic Gateways

The coupled climate model OASIS
AWI-CM = FESOM (ocean/sea-ice) ↔ ECHAM (atmosphere)

The experiment (Sein et al. 2018)

Six 150-year RCP 8.5 simulations:

- LR ocean (~25km*) + LR atmosphere (T63)
 - LR ocean (~25km*) + HR atmosphere (T127)
 - HR ocean (~10km*) + LR atmosphere (T63)
 - HR ocean (~10km*) + HR atmosphere (T127)
- + 2 control runs

* at the Arctic gateways/Nordic Sea

Unstructured ocean grids

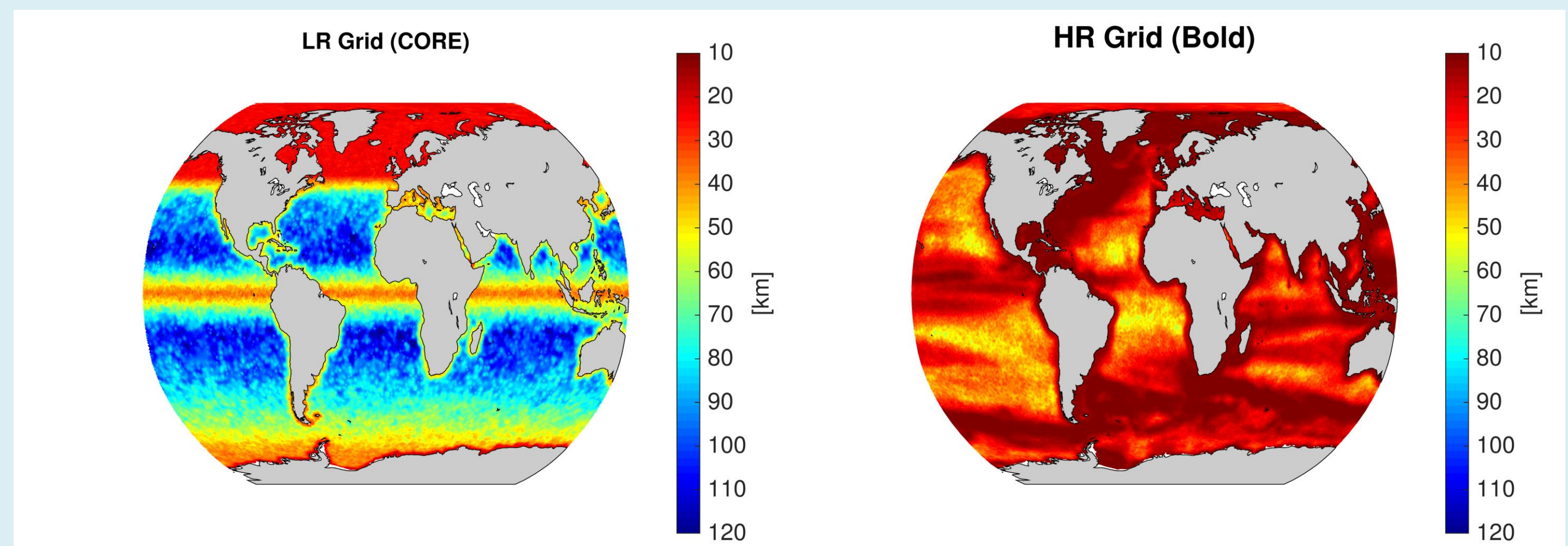


Fig 1: Global grid resolution [km]

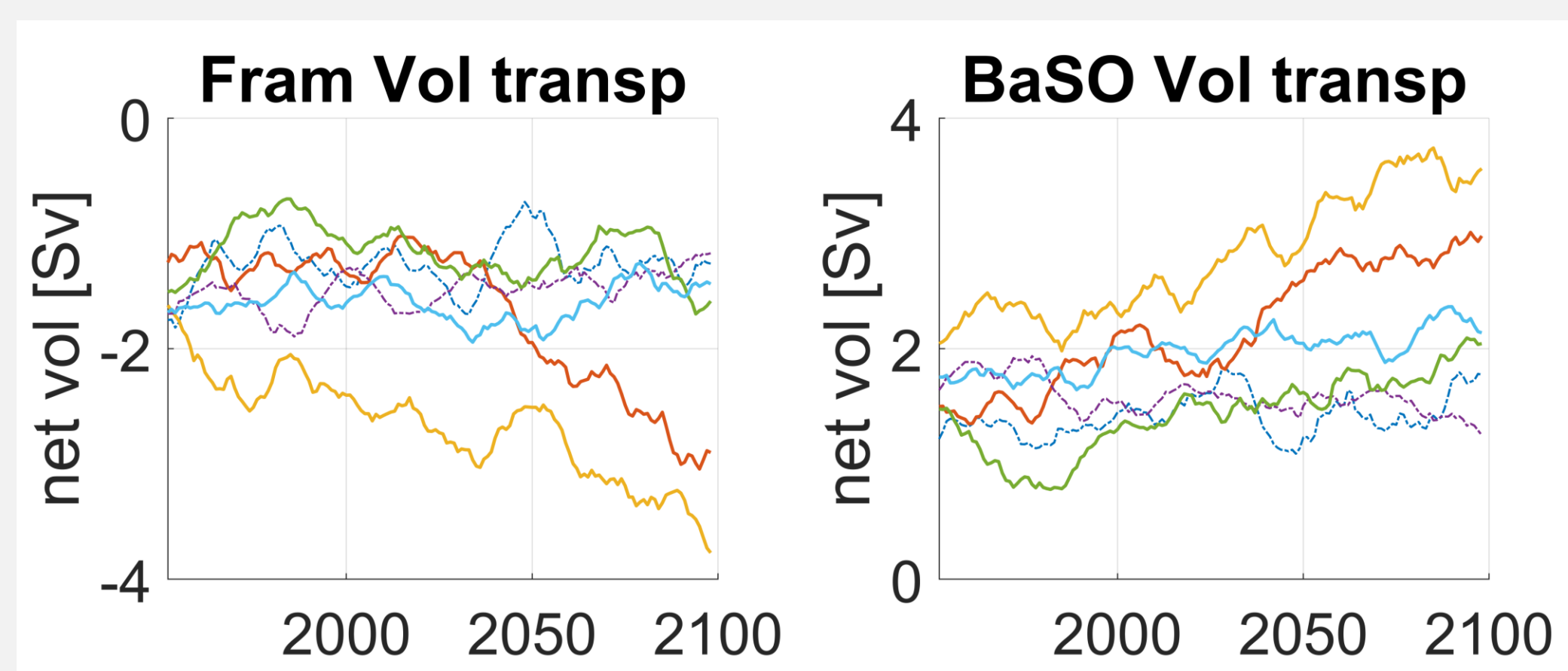


Fig 2: Net volume transport [Sv] through Atlantic gateways, 10-year moving mean

- LR T63 cntl
- LR T63 scen
- LR T127 scen
- HR T127 cntl
- HR T63 scen
- HR T127 scen

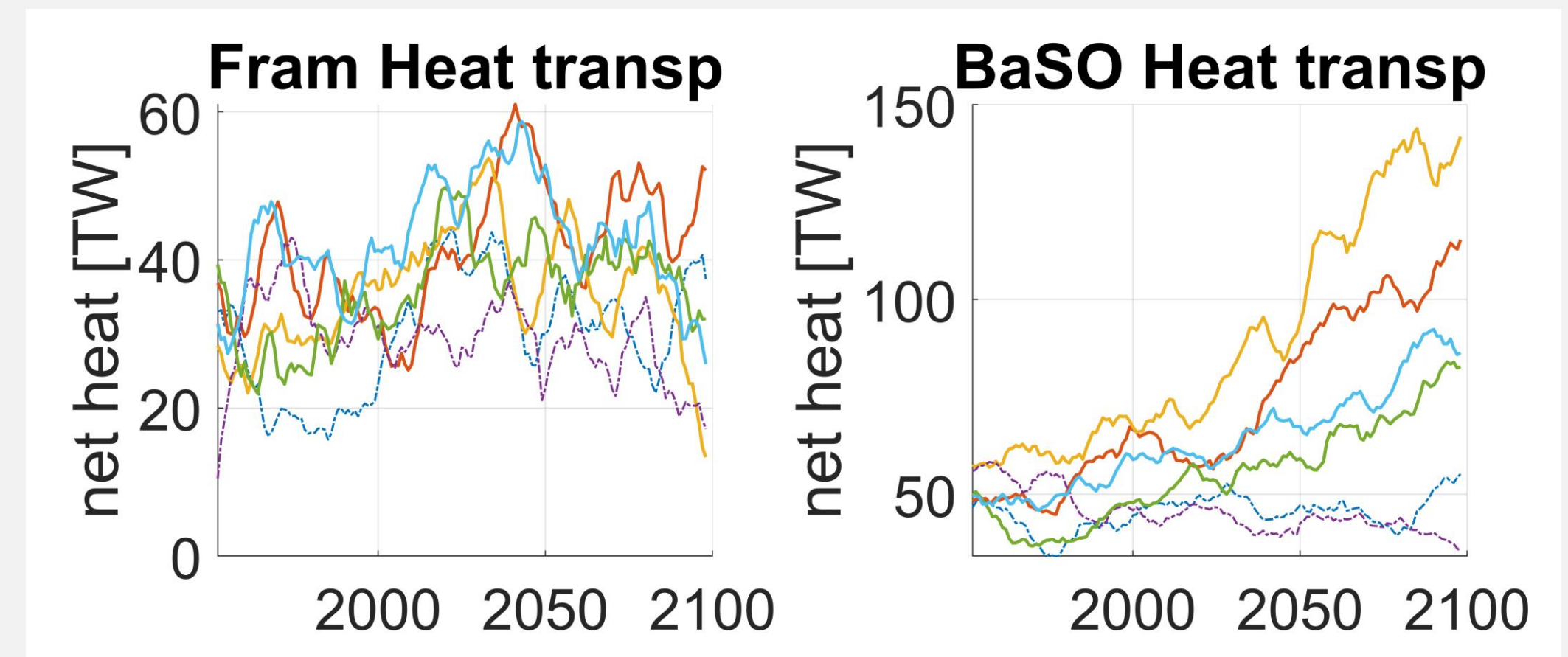


Fig 3: Net heat transport [TW] through Atlantic gateways, 10-year moving mean

Scenario	mean*		Volume transport in [Sv]	
	1990-2015	2070-2095	Obs***	6.6+/-0.4
Volume transport [Sv]			core_T063_scen	6.9
Obs**	-2.0+/-2.7		core_T127_scen	7.5
core_T063_scen	-1.2	-2.7	bold_T063_scen	6.9
core_T127_scen	-2.5	-3.3	bold_T127_scen	5.9
bold_T063_scen	-1.0	-1.2	Volume transport out [Sv]	
bold_T127_scen	-1.5	-1.4	core_T063_scen	-8.1
			core_T127_scen	-10.0
* positive into the Arctic Ocean			bold_T063_scen	-7.9
** Illicak et al. 2016			bold_T127_scen	-7.4
***Besczynska-Moeller et al. 2012				-8.0

Tab1: Fram Strait mean volume transports

- LR ocean greater future change in absolute net volume transports at both gateways
- At Fram Strait, in LR ocean, decrease in inflow (and outflow), HR ocean little change
- At BaSO, LR ocean greater change in inflow only (not shown)
- BaSO heat transport correlated to volume increase

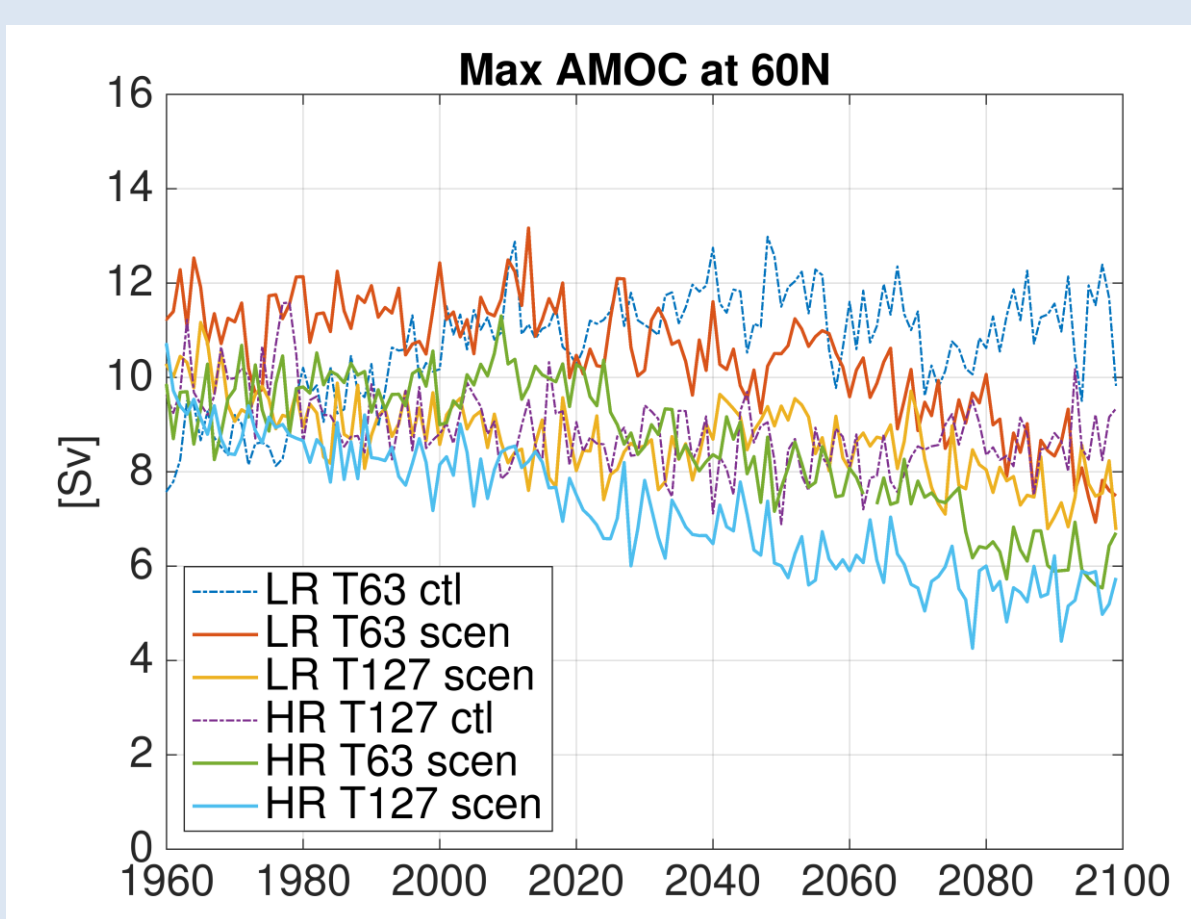


Fig4: AMOC at 60°N [Sv]

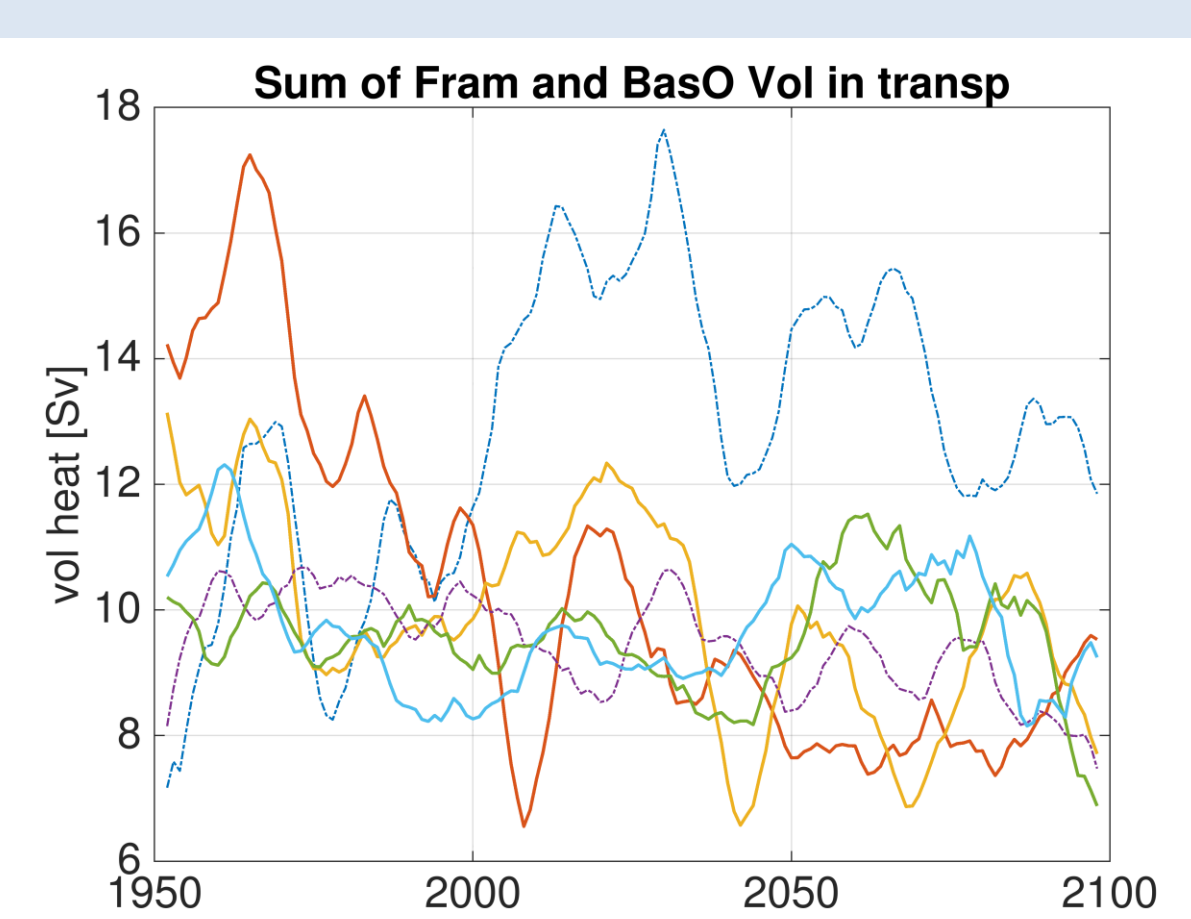


Fig5: Inward transport [Sv] at Fram+BaSO, 10y movmean

- Both ocean and atmosphere resolution contribute to AMOC representation in a complex way (see Sein et al. 2018)
- All scenarios show decrease of AMOC strength towards the end of 21st century
- HR ocean sees greater decrease of AMOC (here shown at 60°N)
- Fram+BaSO inward transport also downward trend, but correlation with AMOC 60N varies over time

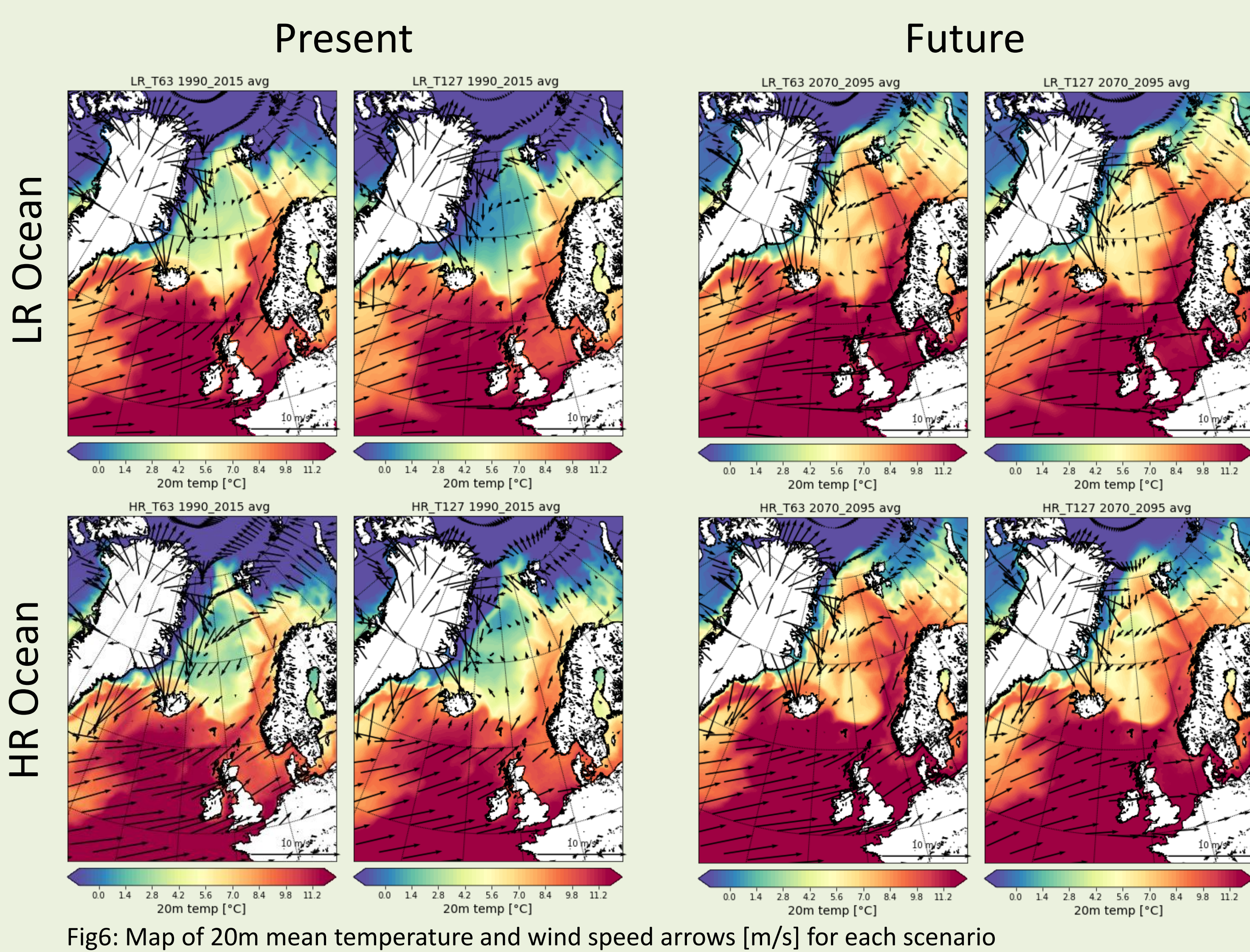


Fig6: Map of 20m mean temperature and wind speed arrows [m/s] for each scenario

- Besides the large scale NAO-pattern, local wind patterns are also important for transports into the Barents Sea and Fram Strait (see e.g. Chafik et al. 2015)
- E.g. HR ocean shows higher wind stress (curl) over the GIN Sea in present and future scenario and an along-shore wind pattern at the Norwegian coast

Conclusion

- When assessing the exchange between the Nordic Seas and the Arctic Ocean in future scenarios both ocean and atmospheric resolution play a role for volume and heat transport estimates
- Each resolution has complicated impacts on upstream (AMOC) and local (Nordic Seas and Arctic Ocean) conditions
- Not shown here are the SSH pattern for each scenario which are also important for Arctic inflow and outflow