Spread induced by initial perturbations in decadal forecasts: Where are the major sources of uncertainties?

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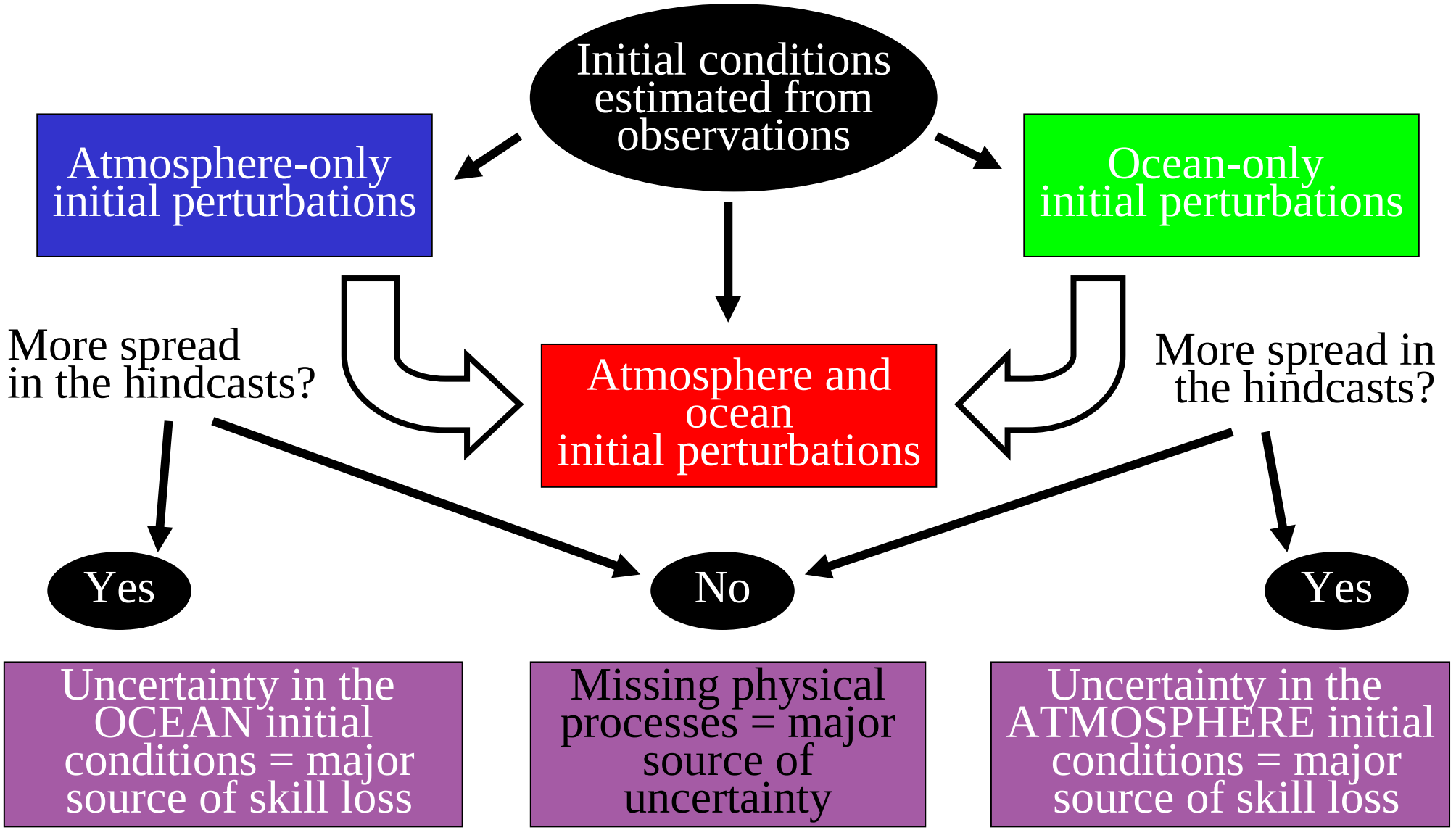
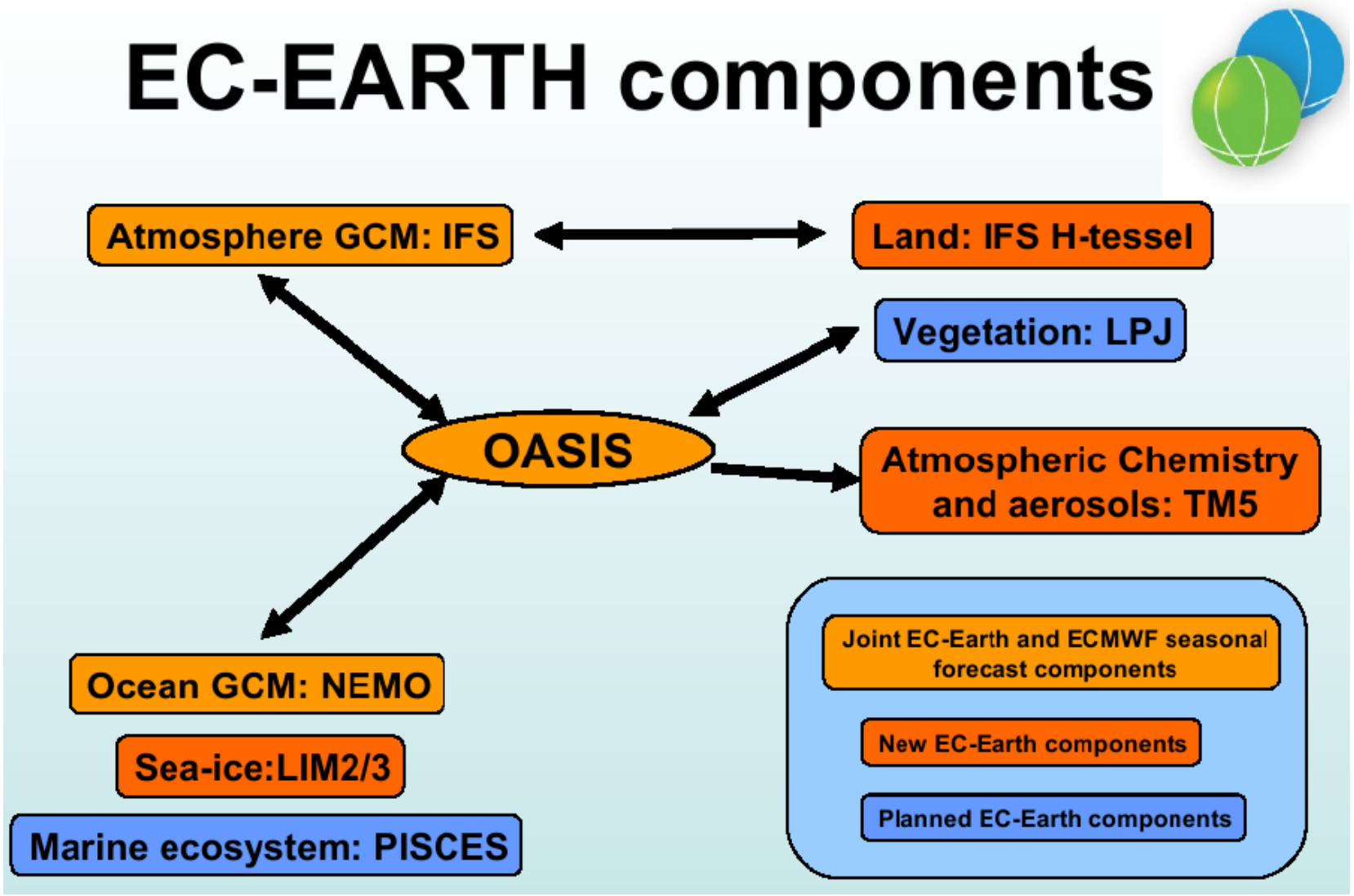
Introduction : the aim



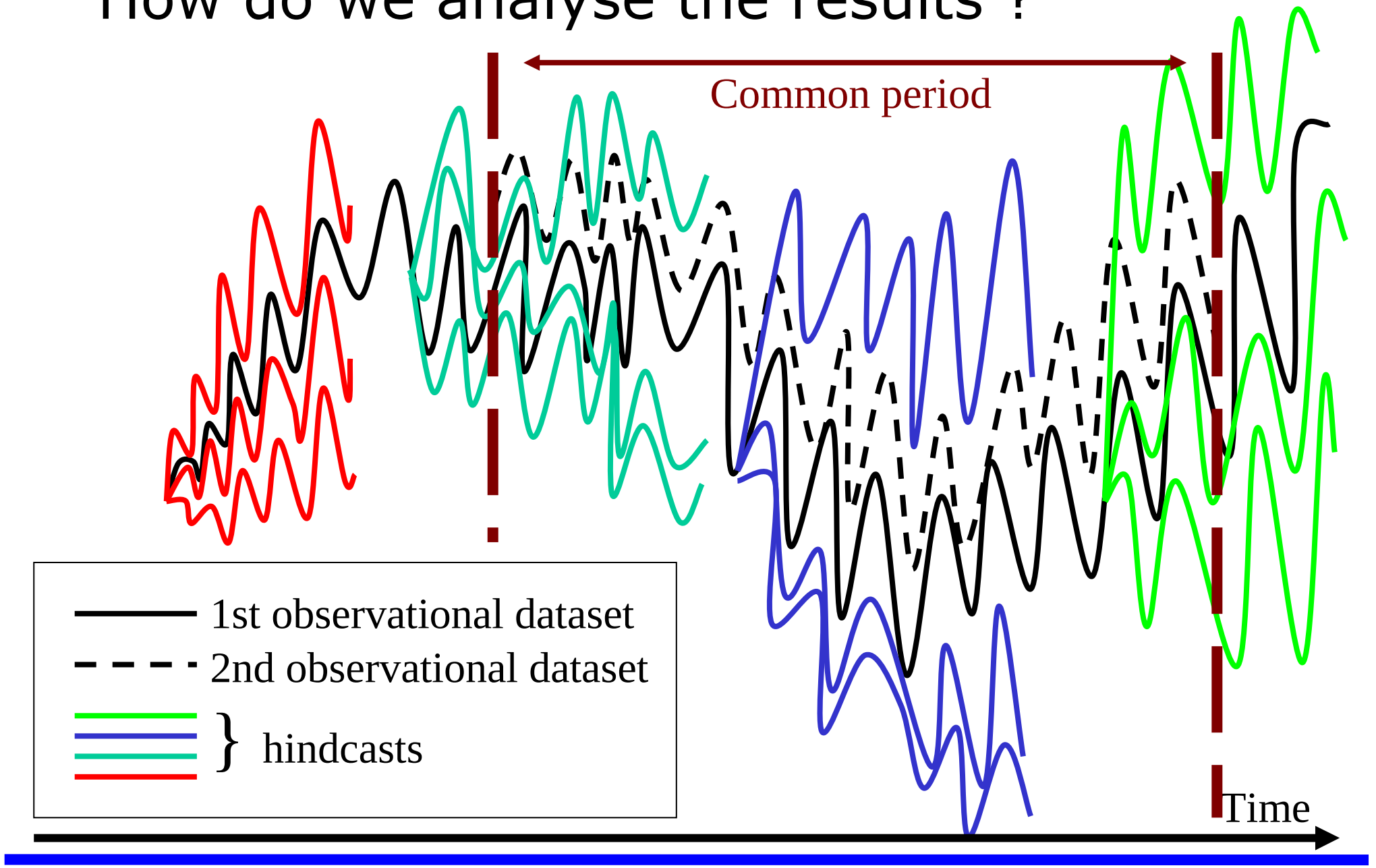
Which tool ? EC-Earth



Which experimental design ?

- Atmosphere and soil initial conditions: ERA40/ERAINT (five obtained with singular vectors, ECMWF)
- Ocean initial conditions: NEMOVAR (COMBINE, five members, ECMWF)
- Sea ice initial conditions: A single run of LIM2 forced with DFS4.3 (KNMI, SMHI)
- Three experiments :
  - Atmospheric perturbation only
  - Ocean perturbation only
  - Both Atmospheric and ocean perturbation
- 5-year long hindcasts starting November 1st, each 5 year, from 1960 to 2005

How do we analyse the results ?



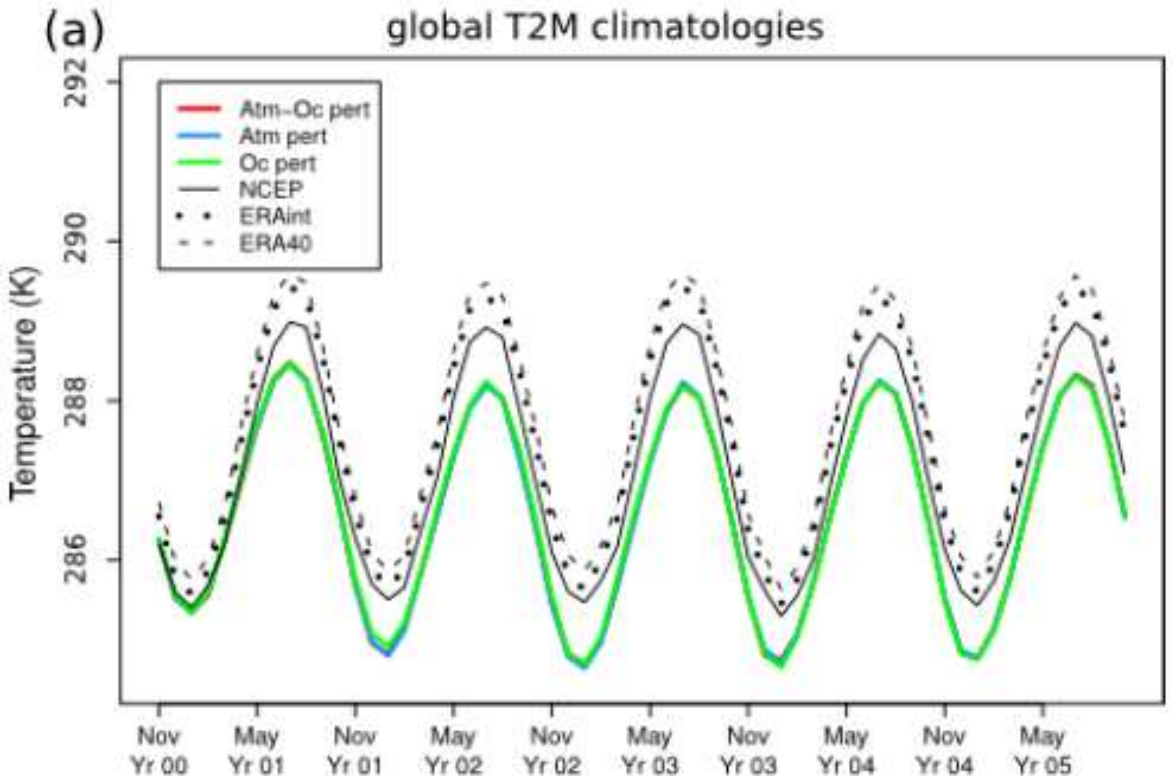
How do we analyse the results ?

Anomalies = Raw-data - Observations/reanalyses or hindcast climatologies over the whole period, not only the common one :

1) Two-meter temperature
2) Sea ice area (Arctic/Antarctic)
3) Global ocean heat content (0-315m, 373-657m, 800m-bottom)

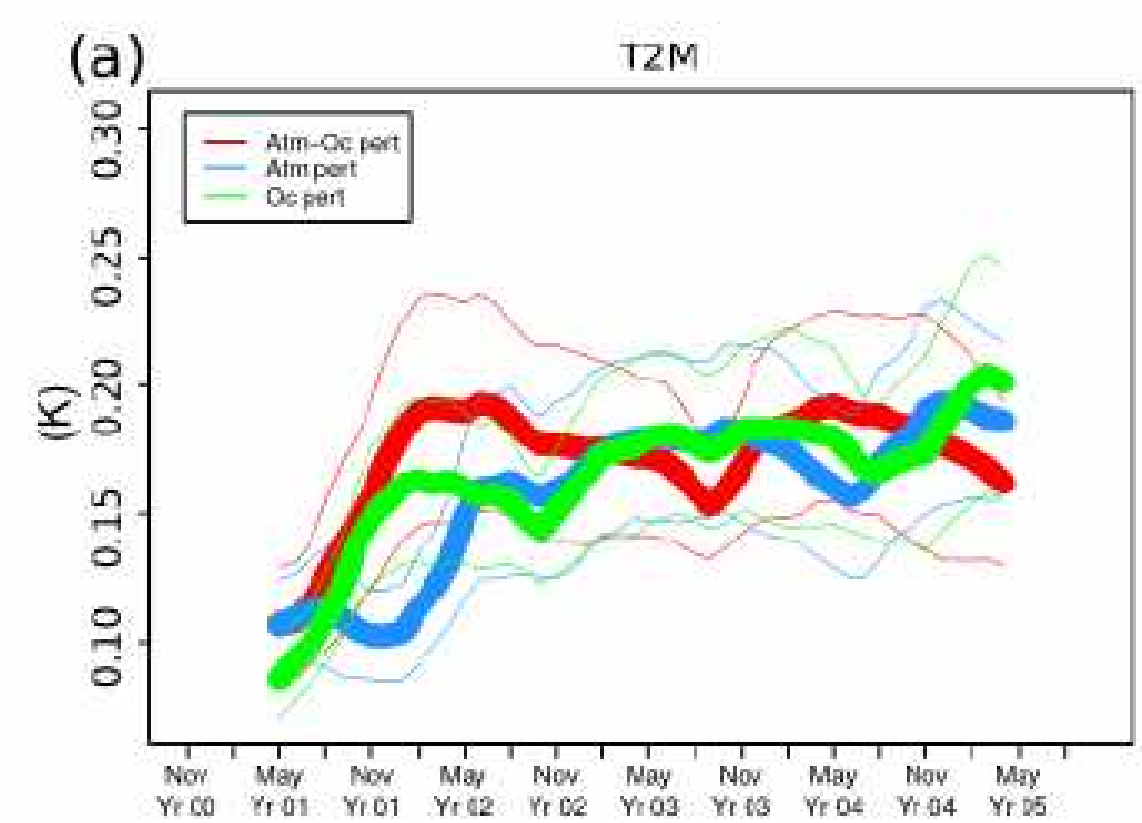
Two-metre air temperature

Global-mean temperature for EC-Earth v2.2 (pre-SO4 fix)



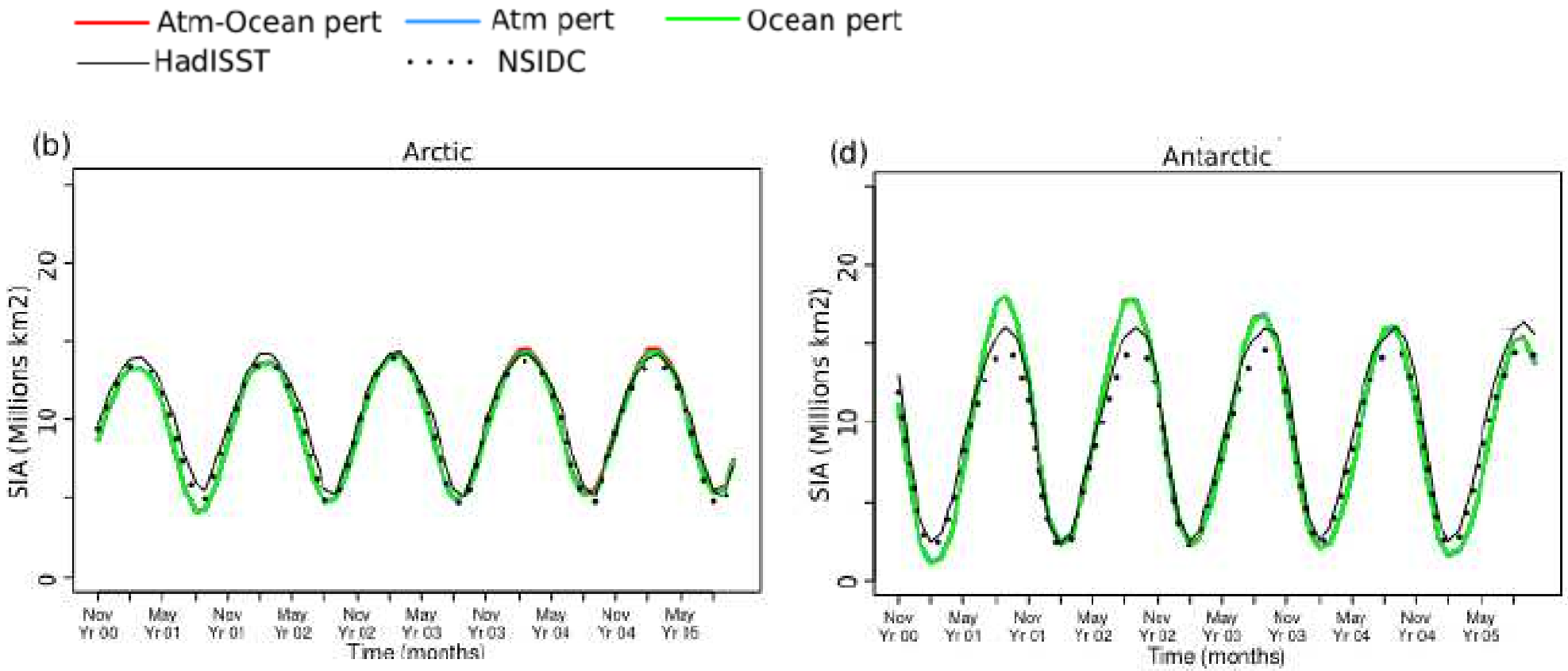
Two-metre air temperature

Average over the 10 starting dates of the maximum-minimum of smoothed anomalies



Arctic/Antarctic sea ice area

Sea ice area for EC-Earth v2.2 (pre-SO4 fix)



Arctic/Antarctic sea ice area

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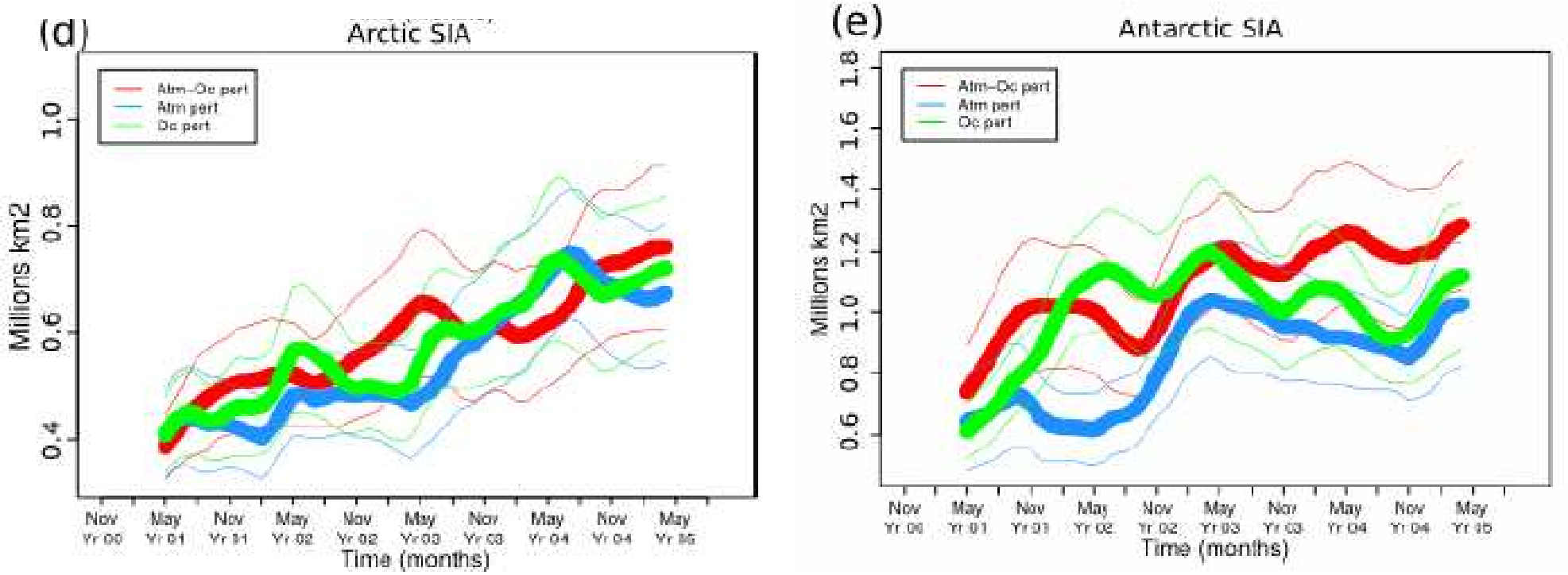
Average over the 10 starting dates of the maximum-minimum of smoothed anomalies

Atm-Ocean pert Atm pert Ocean pert



Global ocean heat content-OHC

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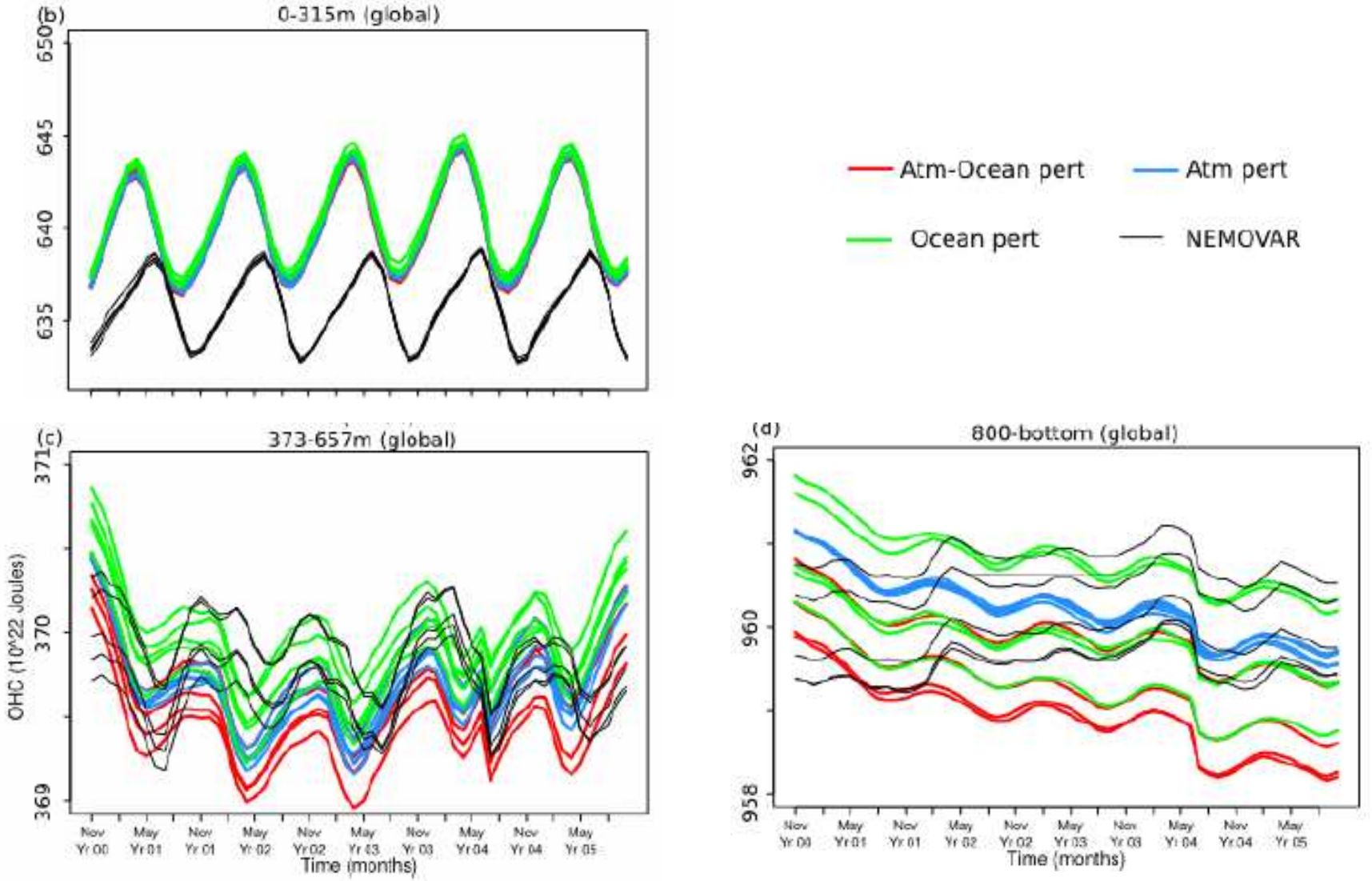
Global-mean OHC for EC-Earth v2.2 (pre-SO4 fix)



Global ocean heat content-OHC

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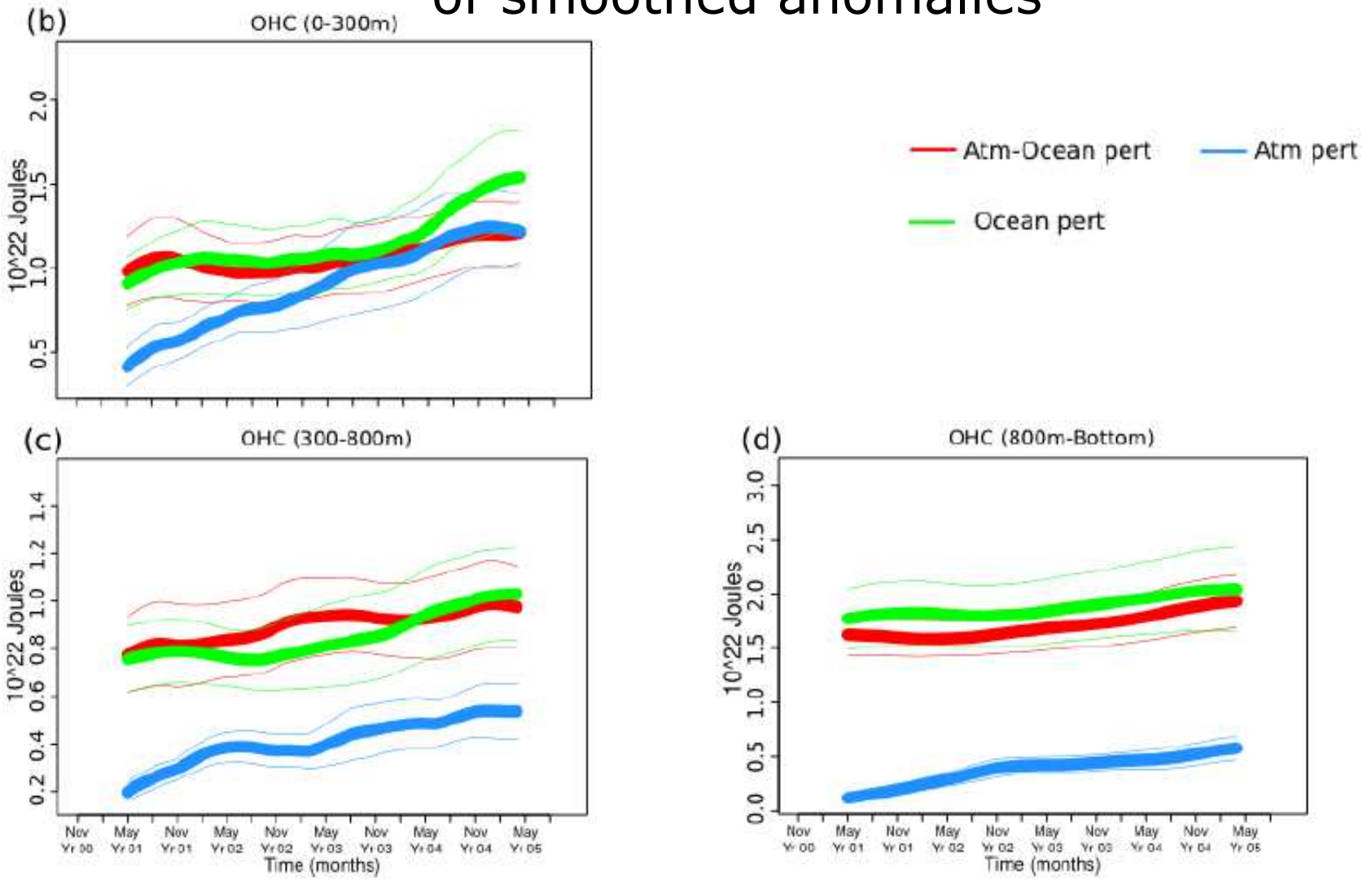
Average over the 10 starting dates of the maximum-minimum of smoothed anomalies



Conclusions

1) **Two-metre temperature (SST) :** ensemble dispersion can be generated with any perturbation method; more spread in year 1-3 (1-2) if oceanic perturbations

2) **Sea ice cover :** the spread increases substantially along the forecast time when oceanic perturbations are applied, especially in the Antarctic; the Artic is less sensitive to the way the initial conditions are perturbed

3) **Global ocean heat content :** warm bias in the upper layers and cold one in the deep ocean, continuous upward heat loss; oceanic perturbations are particularly important to produce enough spread for the OHC in the middle and deep ocean

Thank you for your attention !