Effects of Argo floats data in NWP and climate monitoring

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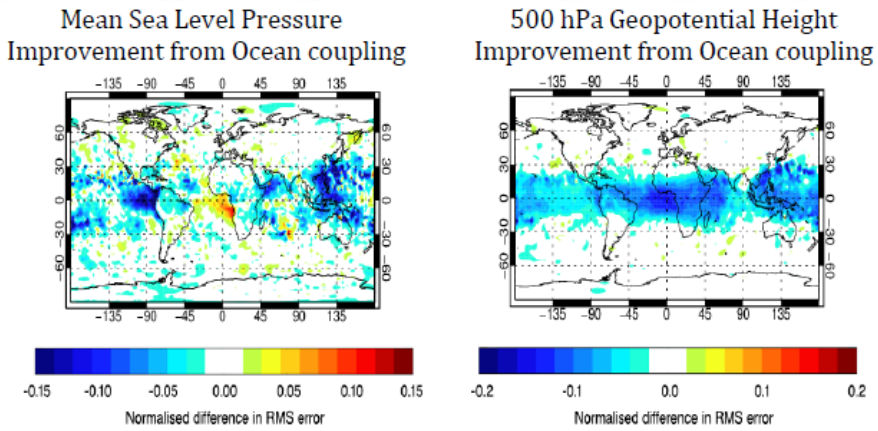
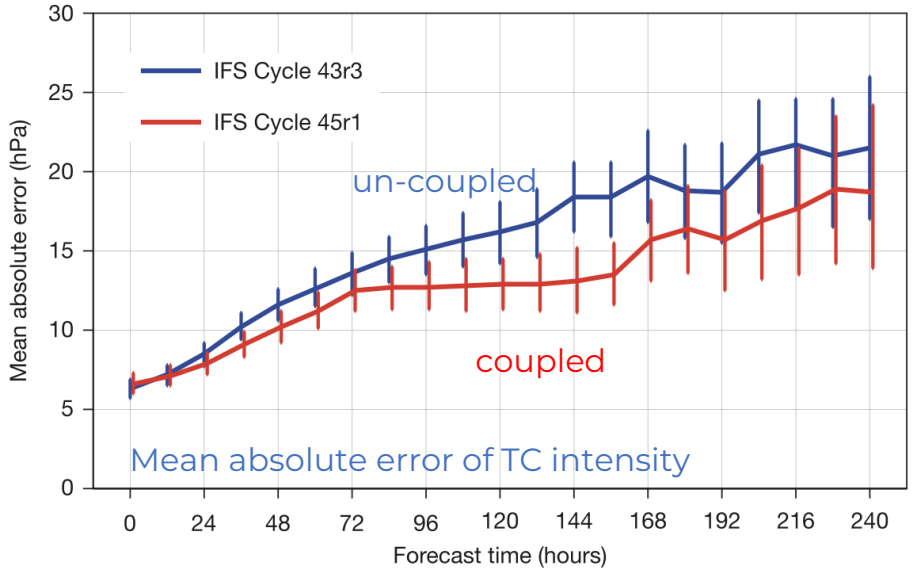
ECMWF

ECMWF coupled forecasting system



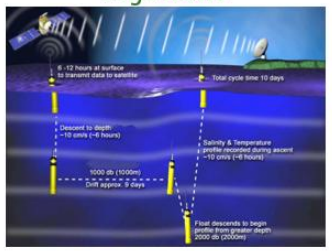
- ECMWF forecasts became coupled for all timescales since **2018** (CY45R1 HRES) - include dynamical ocean and sea-ice components (*Mogensen et al., 2018, Buizza et al., 2018*).
- Coupling with the ocean improves the weather forecast scores, with reduced RMSE (blue) in **day+5**.
- **Coupling with ocean reduces intensity error in HRES forecasts of tropical cyclone (TC).**



ECMWF Ocean DA system

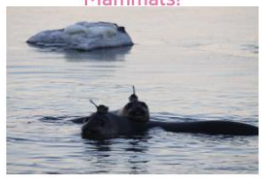
In-situ data

Argo floats



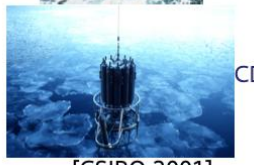
Argo operational cycle.
[Argo 2018]

Mammals!



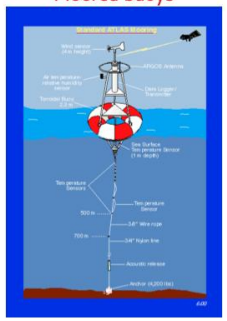
[MEOP et al. 2015]

Ship based observations



[CSIRO 2001]

Moored buoys



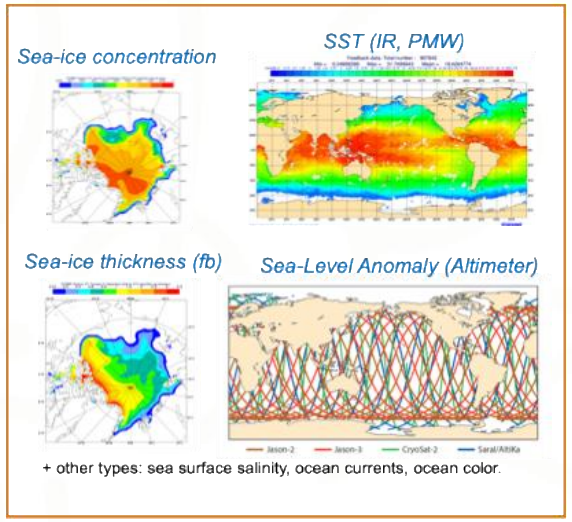
[PMEL 2018]

+ other platforms: ALAMO/AXBT, saildrone, ice-tethered profilers ...

Perturbed Observations

Observations:
- In-situ T/S prof.
- SIC
- SLA
- SST

Satellite data



ORAS6

Perturbed Forcings (hourly)

- Wind
- Net precipitation
- Solar radiation

Ensemble backgrounds

NEMOv4 + SI3

Innovations + updated $\boldsymbol{B}$

Ensemble 3D-Var

Ocean + sea-ice state variables

Increments IAU

Ensemble ocean and sea-ice analyses

Coupled Forecasts

- Ens/HRES
- SEAS6
- ERA6

Zuo et al., 2024, ECMWF NL 180

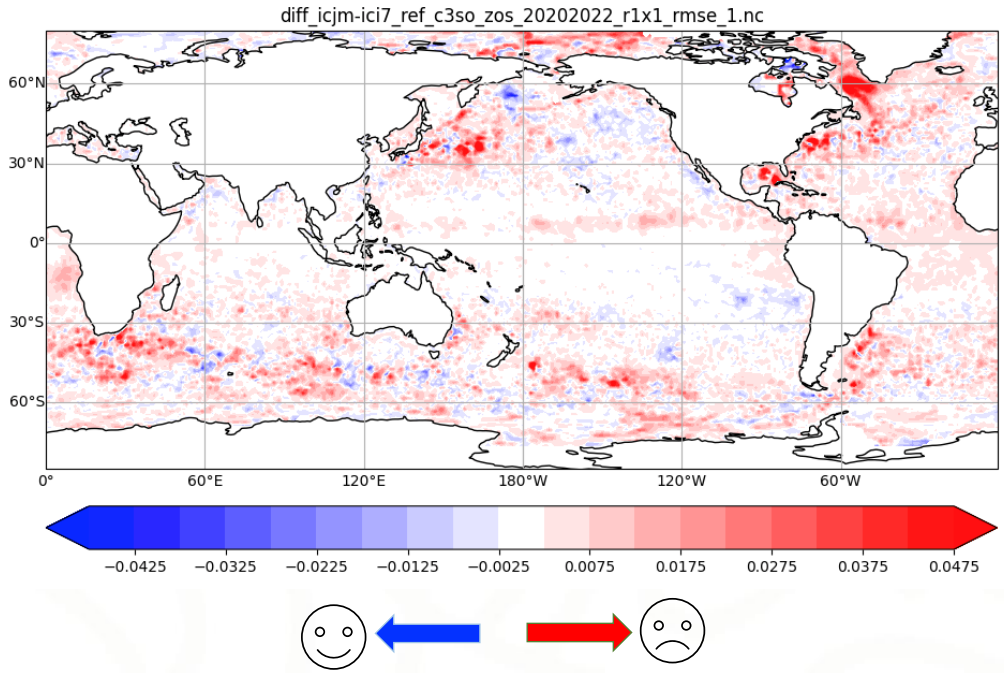
Effects of Argo data on ocean ReAnalysis

hindcasts and climate monitoring

The removal of Argo data leads to

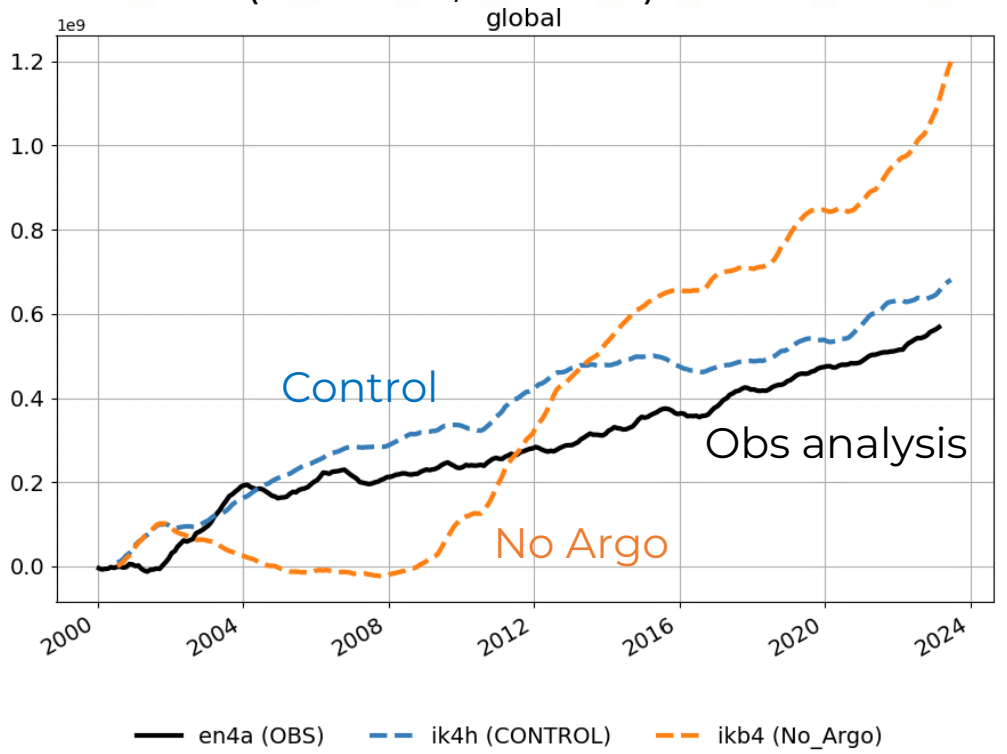
- increased errors in the sea surface states (SSH and SST)
- degraded performance in ocean heat content monitoring

SSH RMS err: Control – No Argo



Anomalies of global ocean heat content

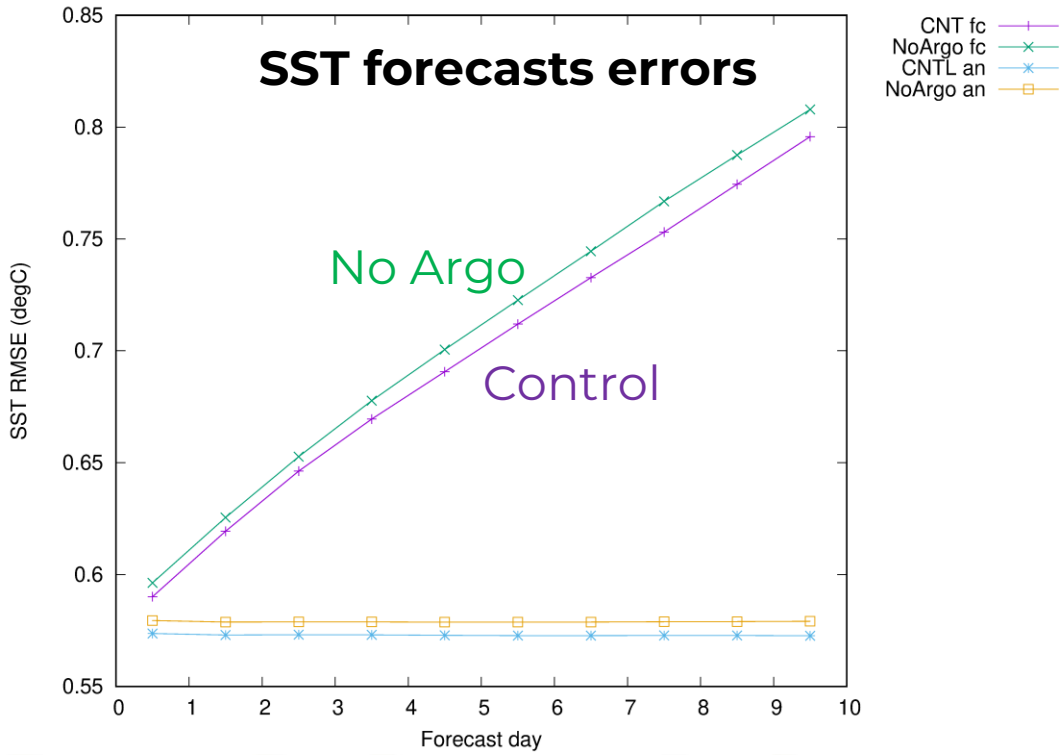
(0-700m, in J/m²)



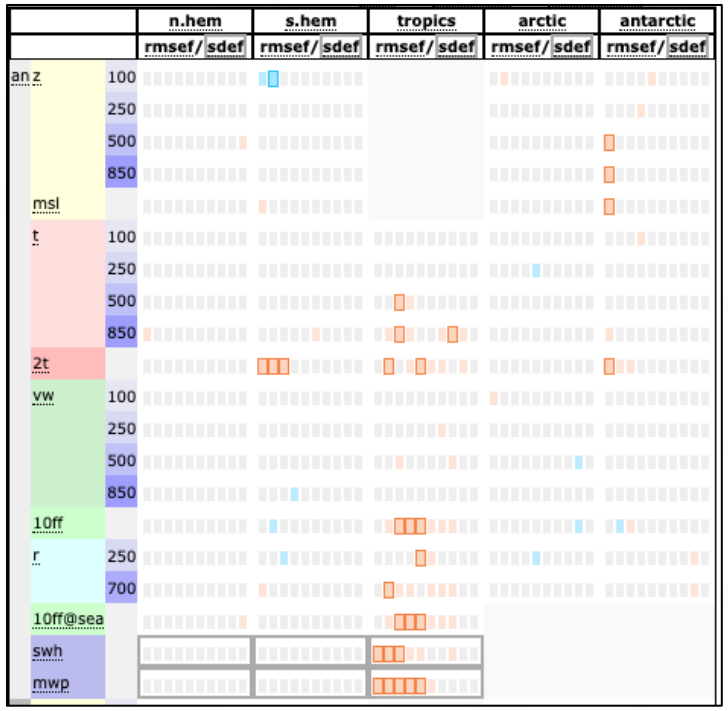
Effects of Argo data on coupled forecasts

medium-range forecasts

- The removal of ARGO data degrades the SST forecasts up to day 10.
- There are small but significant degradation of forecasted atmospheric fields. Impact of removing Argo data is **comparable to atmospheric model changes** in a typical ECMWF IFS Cycle upgrade.



Atmospheric forecasts errors: Control – No Argo



- *2m temperature (2t)*
- *mean sea level pressure (msl)*
- *temperature (t)*
- *geopotential height (z)*
- *significant wave height (swh)*
- *vector wind (vw)*
- *10m wind speed (10ff)*

Degradation

Improvement