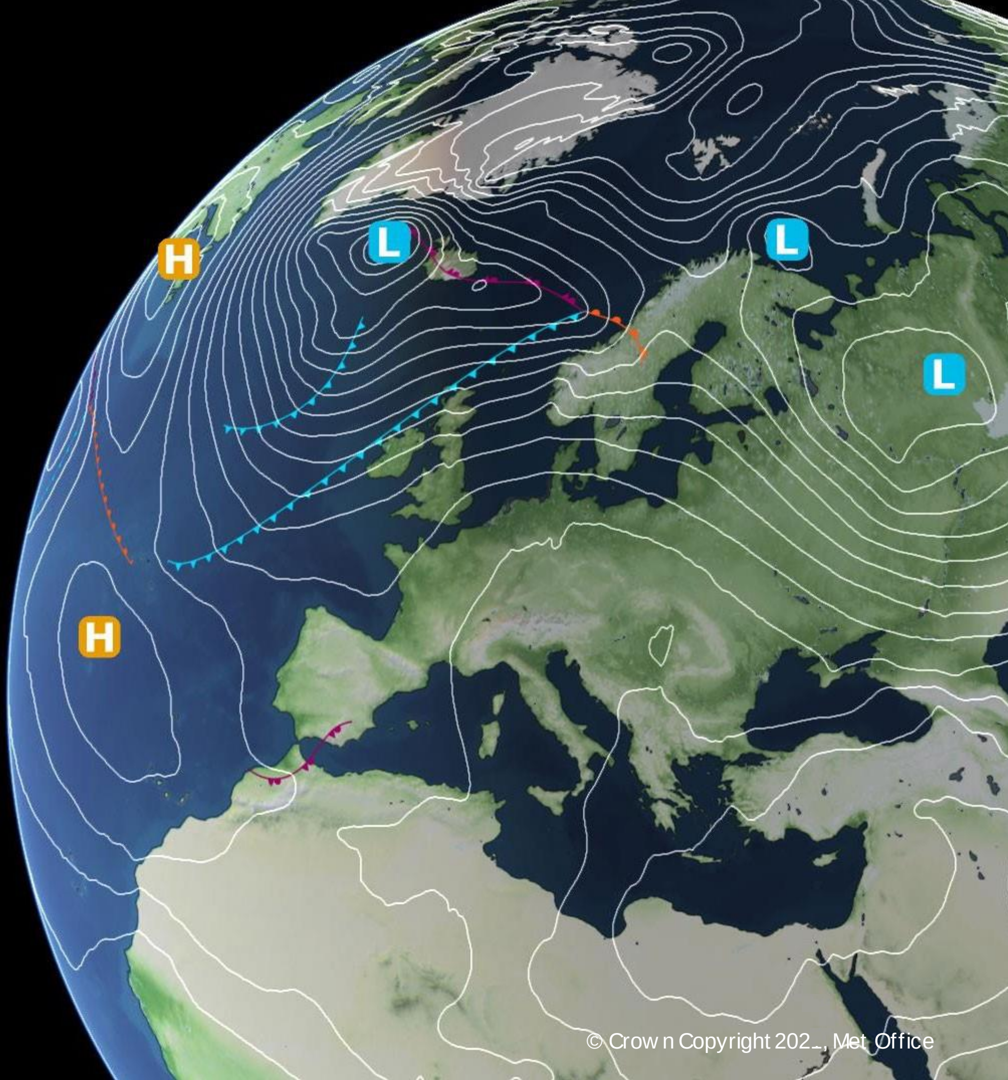
Met Office

New wind forcing option @ NEMO 4.2 Renault et al (2020)

Dave Storkey

OMG Meeting

23 June 2023



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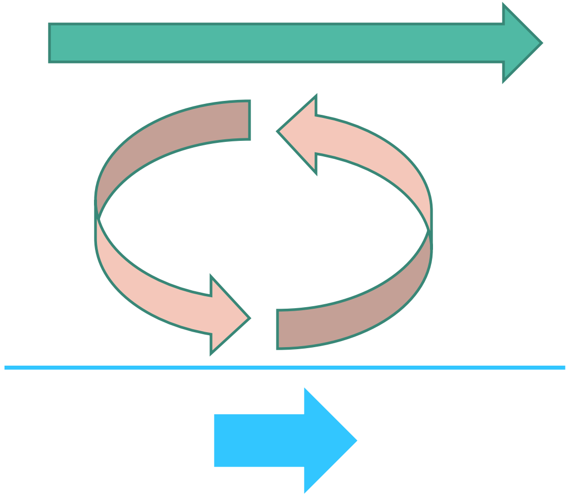
atmos-ocean stress:

$$\tau = \rho . C_{D.} (U_{10m} - \alpha U_{ocean}). |U_{10m} - \alpha U_{ocean}|$$



Current FeedBack (CFB)

relative wind forcing: $\alpha = 1$
absolute wind forcing: $\alpha = 0$
in between: $0 < \alpha < 1$

coupled: $\alpha = 1 \Rightarrow$ feedback loop
$\alpha = 0 \Rightarrow$ no feedback loop

forced: no feedback loop regardless of choice of α.

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RESEARCH ARTICLE
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Recipes for How to Force Oceanic Model Dynamics

Lionel Renault[1,2], S. Masson[3], T. Arsouze[4], Gurvan Madec[3], and James C. McWilliams[2]

Q: Can we mimic the effect of CFB on ocean currents in forced models?

Key Points:

- model
- A parameterization of the CFB based on a predicted coupling coefficient is the best parameterization
- Scatterometers are not suitable to correctly represent the CFB in a forced oceanic model (unless coherent surface currents are known)

Supporting Information:

- Supporting Information S1

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Abstract The current feedback to the atmosphere (CFB) contributes to the oceanic circulation by damping eddies. In an ocean-atmosphere coupled model, CFB can be correctly accounted for by using the wind relative to the oceanic current. However, its implementation in a forced oceanic model is less straightforward as CFB also enhances the 10-m wind. Wind products based on observations have seen real currents that will not necessarily correspond to model currents, whereas meteorological reanalyses often neglect surface currents or use surface currents that, again, will differ from the surface currents of the forced oceanic simulation. In this study, we use a set of quasi-global oceanic simulations, coupled or not with the atmosphere, to (i) quantify the error associated with the different existing strategies of forcing an oceanic model, (ii) test different parameterizations of the CFB, and (iii) propose the best strategy to account for CFB in forced oceanic simulation. We show that scatterometer wind or stress are not suitable to properly represent the CFB in forced oceanic simulation. We furthermore demonstrate that a parameterization of CFB based on a wind-predicted coupling coefficient between the surface current and the stress allows us to reproduce the main characteristics of a coupled simulation. Such a parameterization can be used with any forcing set, including future coupled reanalyses, assuming that the associated oceanic surface currents are known. A further assessment of the thermal feedback of the surface wind in response to oceanic surface temperature gradients shows a weak forcing effect on oceanic currents.

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Experiments

NEMO-ORCA12 and WRF atmosphere – 5 year integrations

1. Coupled: **CFB** : with current feedback (= “truth”)

   NOCFB : without current feedback

2. Forced: forced with coupled model winds and absolute wind calc

   forced with coupled model winds and relative wind calc

   forced with coupled model winds and parametrisations...

Proposed parametrisations

Wind correction approach (*Renault et al., 2016):*

$$U'_\alpha = s_w U_o$$

Stress correction approach (*Renault et al., 2017):*

$$\tau = \tau_0 + \tau'$$
$$= \tau_0 + s_\tau U_o$$

NB. absolute wind, not seeing ocean currents

where

$$s_\tau = \alpha|U_{10m}| + \beta$$

(and constant for low winds)

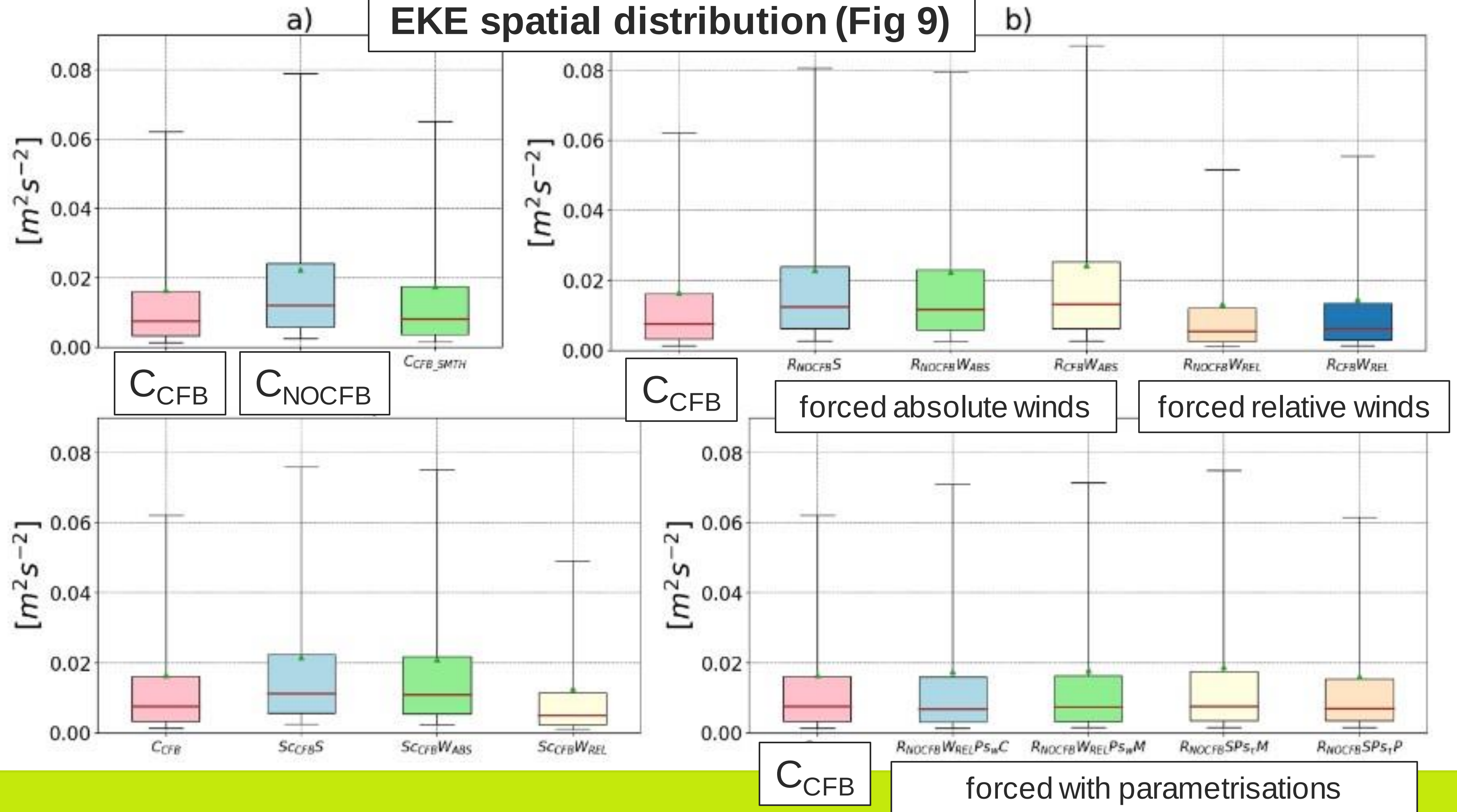
EKE

Use several metrics, including EKE:

$$EKE = \overline{{}^{1}/_{2}\sqrt{\overline{U_o'^2 + V_o'^2}}}$$

where U_o' is defined as the anomaly w.r.t. a spatially-filtered field instead of the more usual time average (ie. not Reynolds decomposition).

EKE spatial distribution (Fig 9)



Model dependence?

- Experiments done with ORCA12 with UBS momentum advection (which includes implicit biharmonic diffusion) and zero viscosity.
- Particular choice – will it affect results?

NEMO options (namsbc_blk)

pre NEMO 4.2: *rn_vfac = α = 0 for abs wind calc*

= 1 for rel wind calc

Stress correction approach implemented @4.2:

NEMO 4.2 + : *ln_crt_fbk = true to switch on stress correction param*

= false for absolute wind forcing

Currently using relative winds – would expect slight increase in EKE when we switch to parametrisation.

mesoscale diagnostics

- Currently don’t have any diagnostics of mesoscale as part of standard (global) diagnostics packages Marine Assess or Marine VAL. (Anything in COaST?)

- Opportunity to do something as part of testing new forcing option.

- One idea: mean + std dev EKE as Marine VAL metric. Could just use time averaging to define EKE for now.

- Good area to work on with forecasting groups: OFRD, BOM.

implementing new forcing data set: things to think about

- Appropriate choice of bulk formulae.

- Did the reanalysis winds “see” ocean currents? If so this effect should be subtracted before using stress correction parametrisation.

- ...

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