

OPTIMAL ADJUSTMENT OF ATMOSPHERIC PARAMETERS FOR SIMULATIONS OF GLOBAL OCEAN CIRCULATION

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2. Experimental context ●
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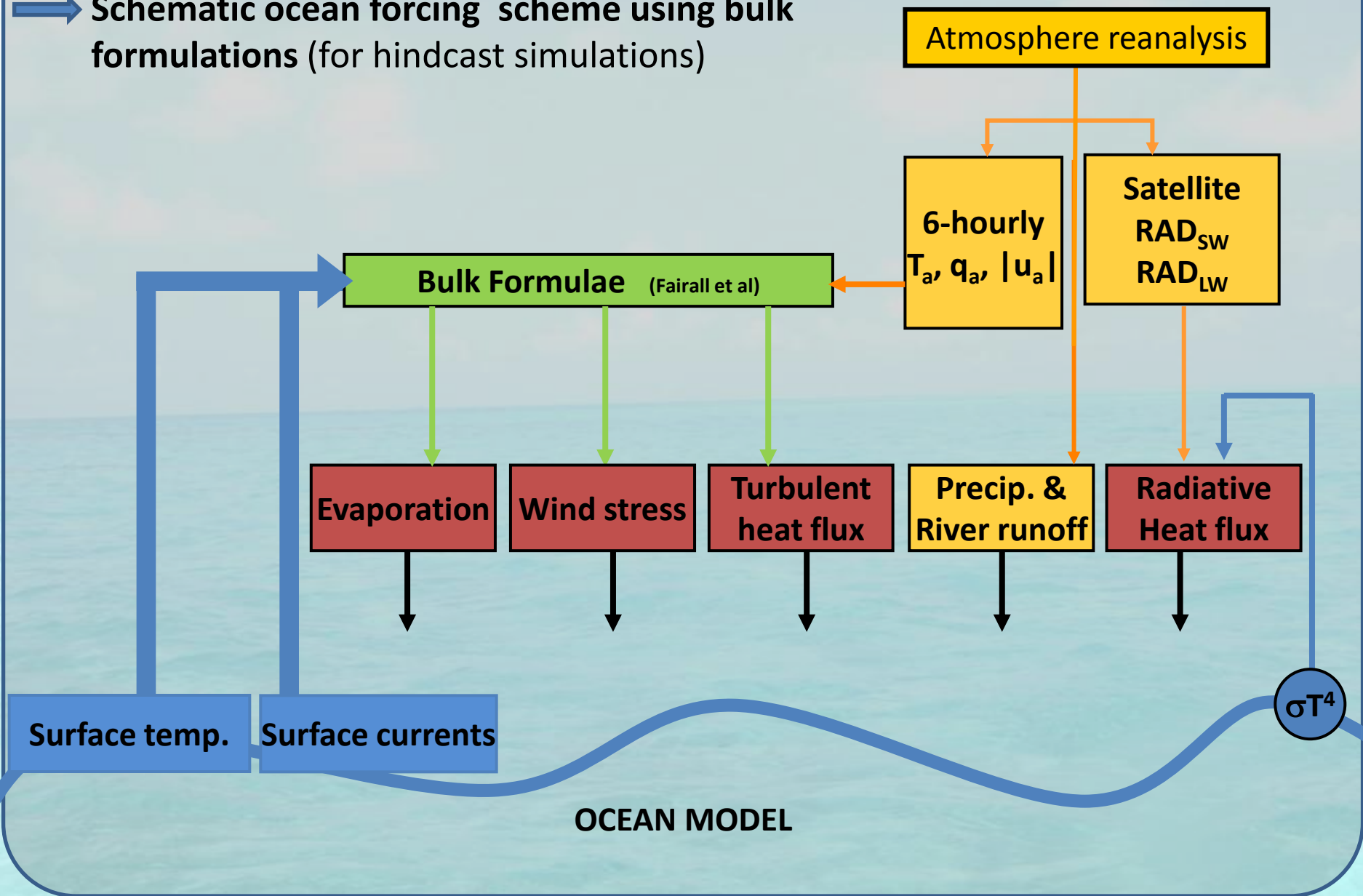
MultiscalE Ocean Modeling (MEOM) Group

LEGI/CNRS, Université de Grenoble, France

PROBLEM STATEMENT: OCEAN FORCING



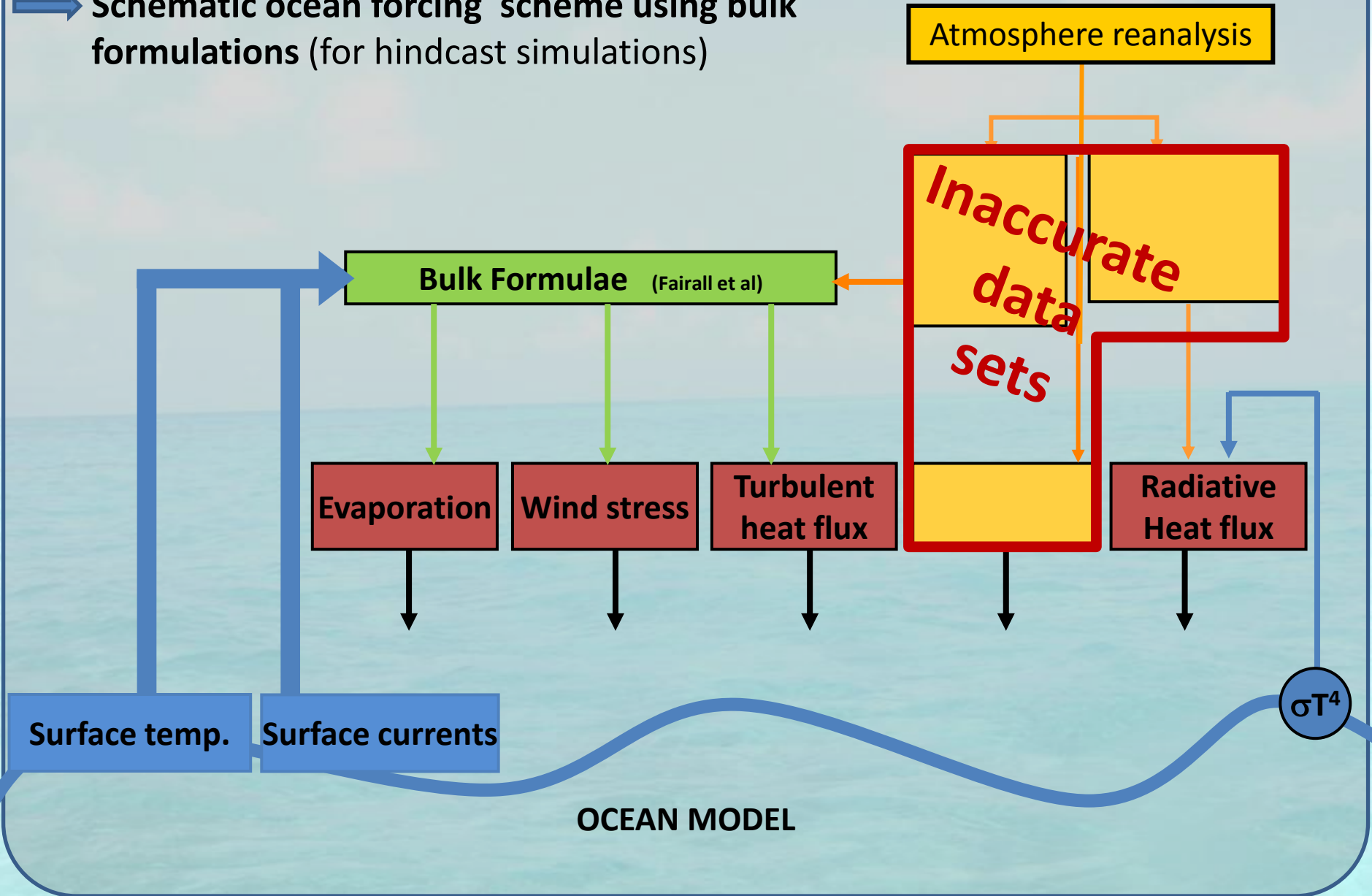
→ Schematic ocean forcing scheme using bulk formulations (for hindcast simulations)



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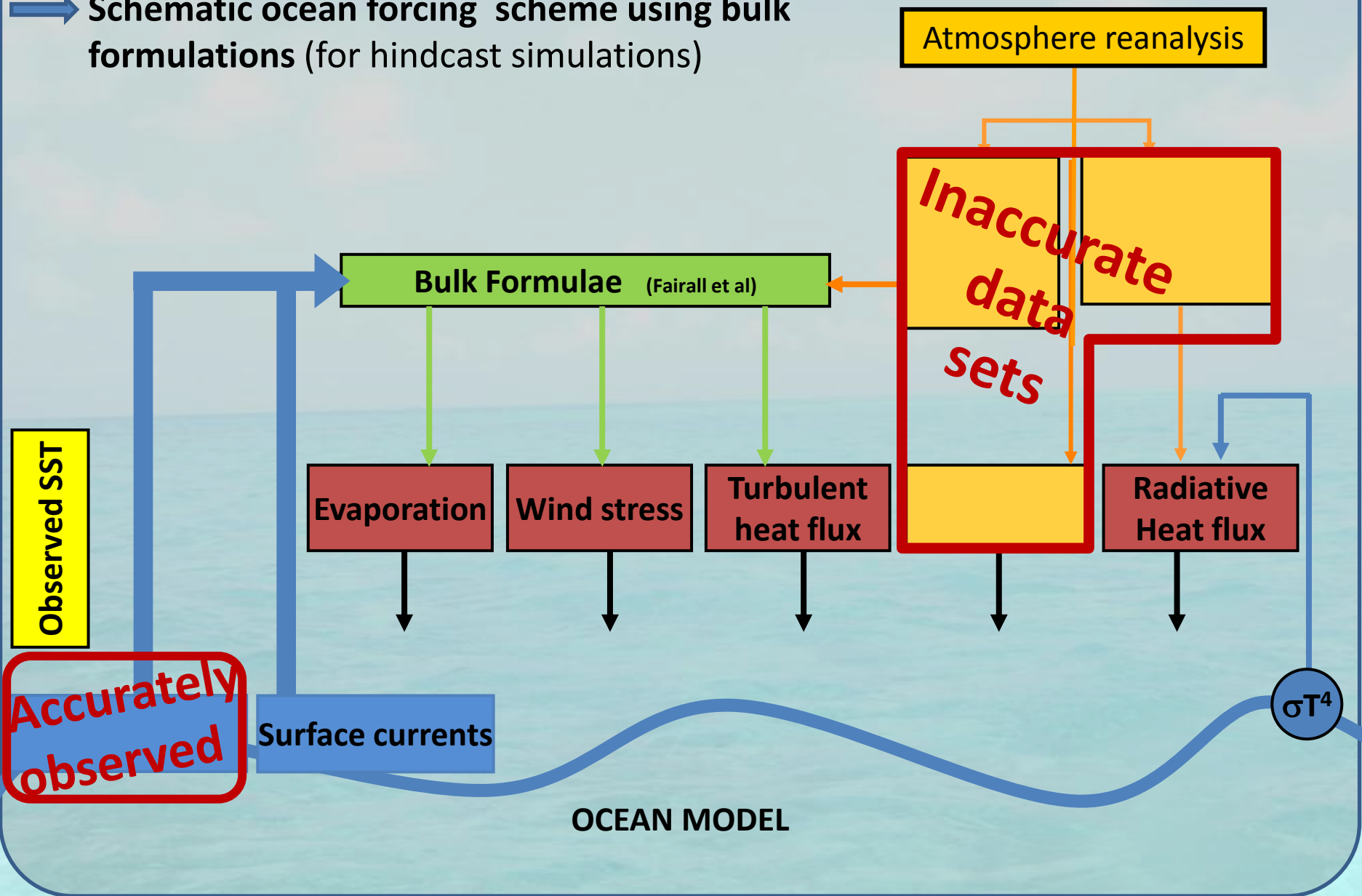
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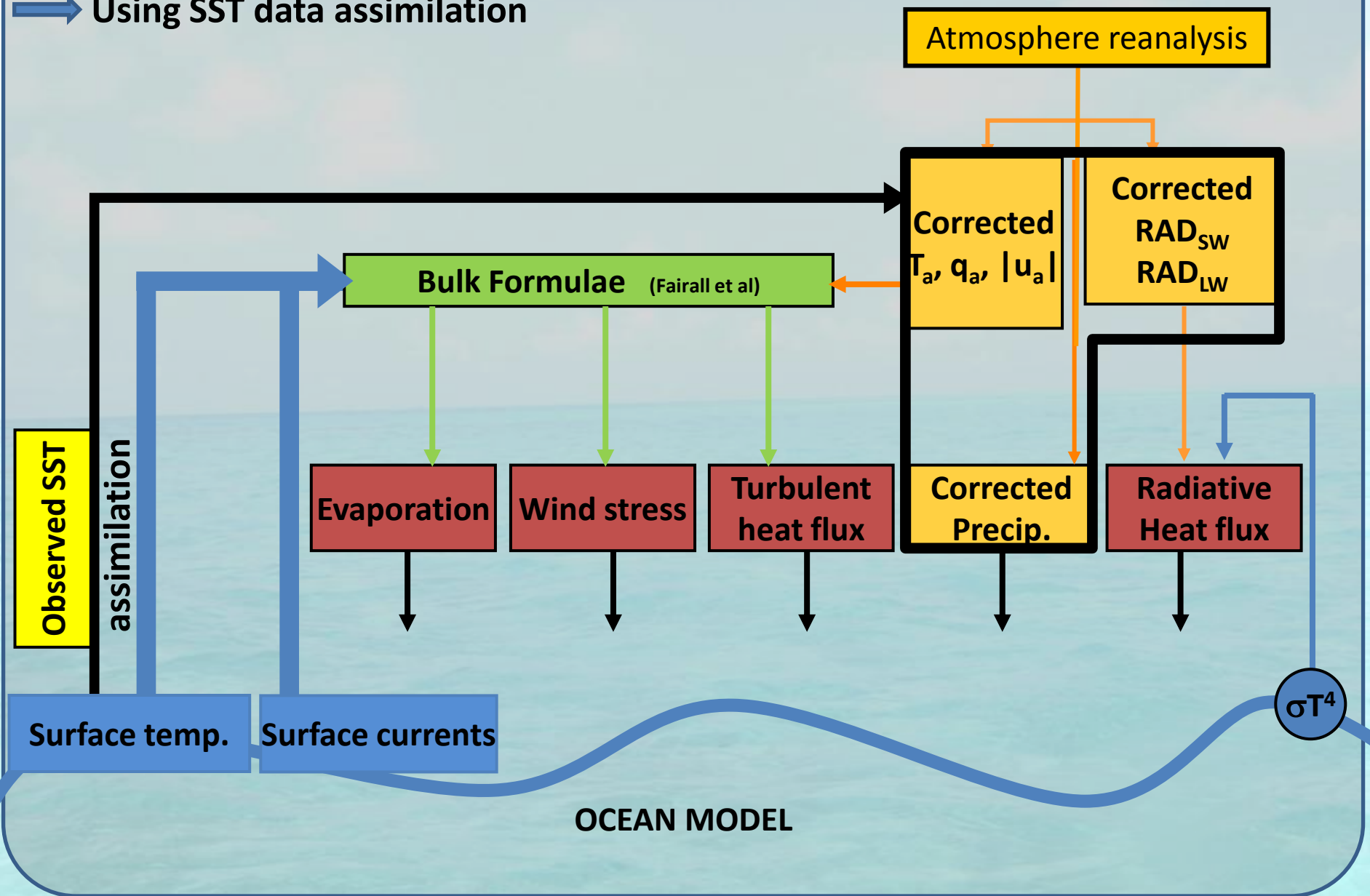
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PROBLEM STATEMENT: OPTIMAL CORRECTIONS



→ Using SST data assimilation



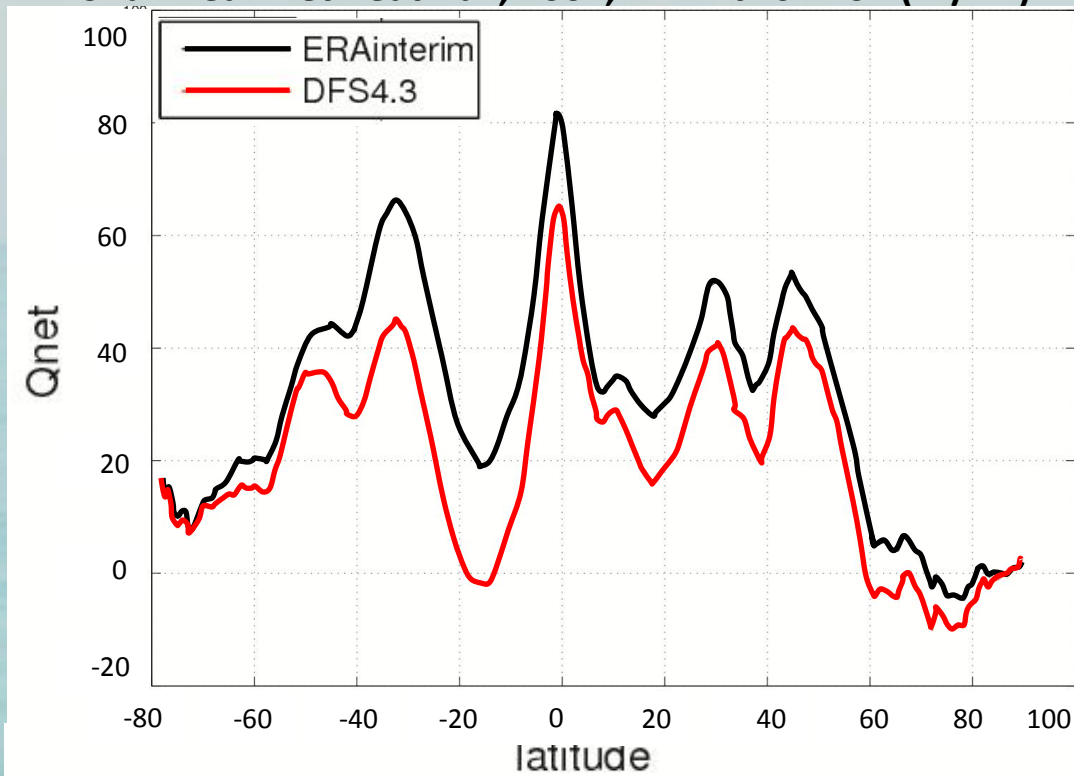
EXPERIMENTAL CONTEXT



- **Focus** : Heat content in long term simulations (20 years) → **Monthly time scale**
- **Forcing** : ERAinterim reanalysis (1989-2008)
- **Reference** : An ERA40 reanalysis based forcing set : DFS4 (Brodeau et al., 2010)

Net heat flux bigger than expected (vs Drakkar Forcing Set DFS4)

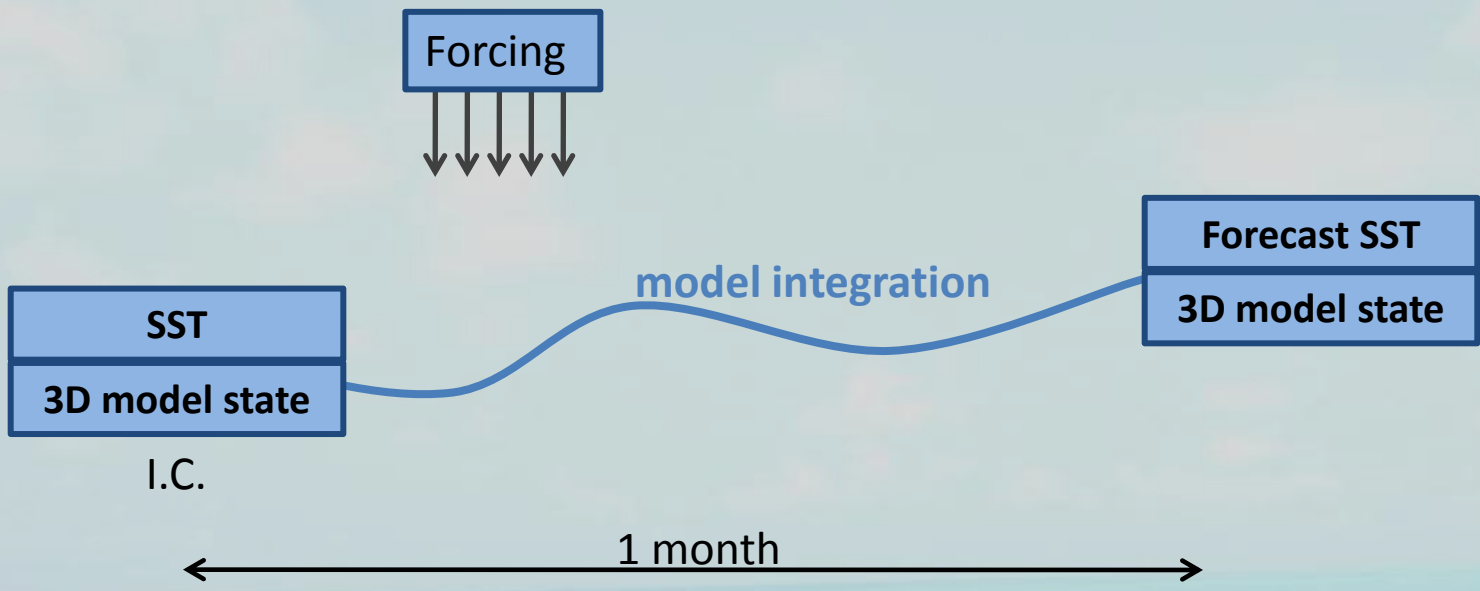
Zonal mean net heat flux, 2004, ERAint vs DFS4 (W/m²)



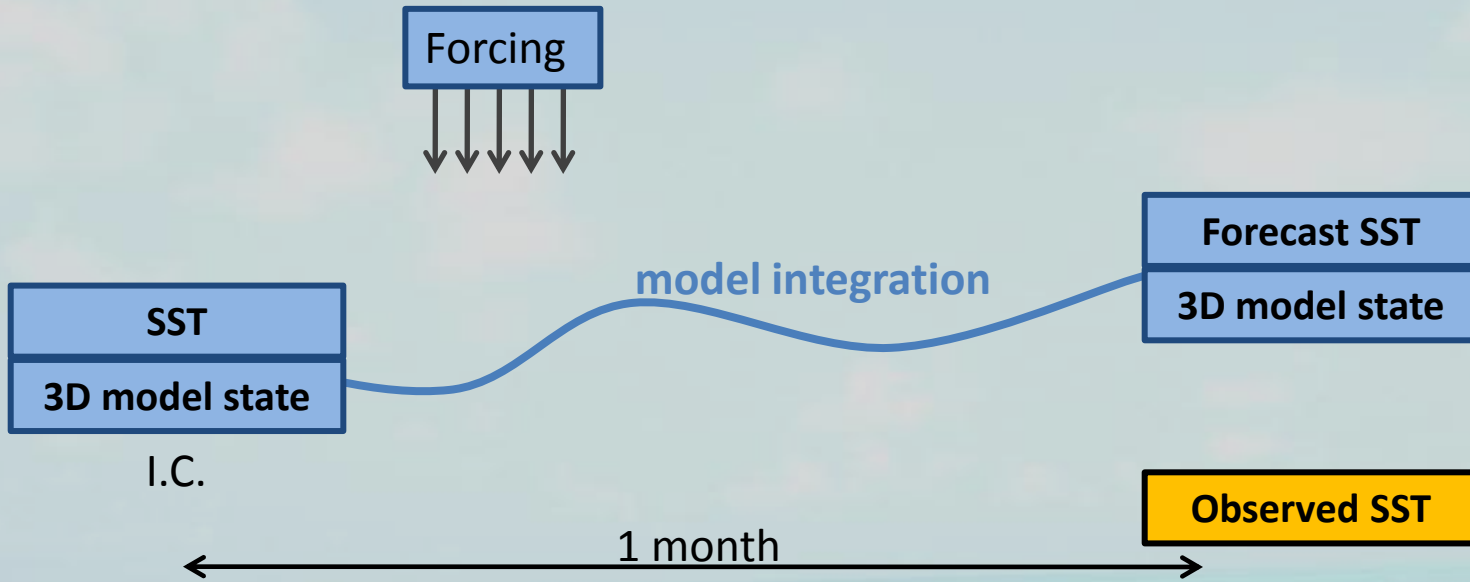
Estimated from monthly means of atmospheric variables .

- **Method** : Adaptation of recently developed SST assimilation schemes (Skachko et al., 2009 ; Skandrani et al., 2009)

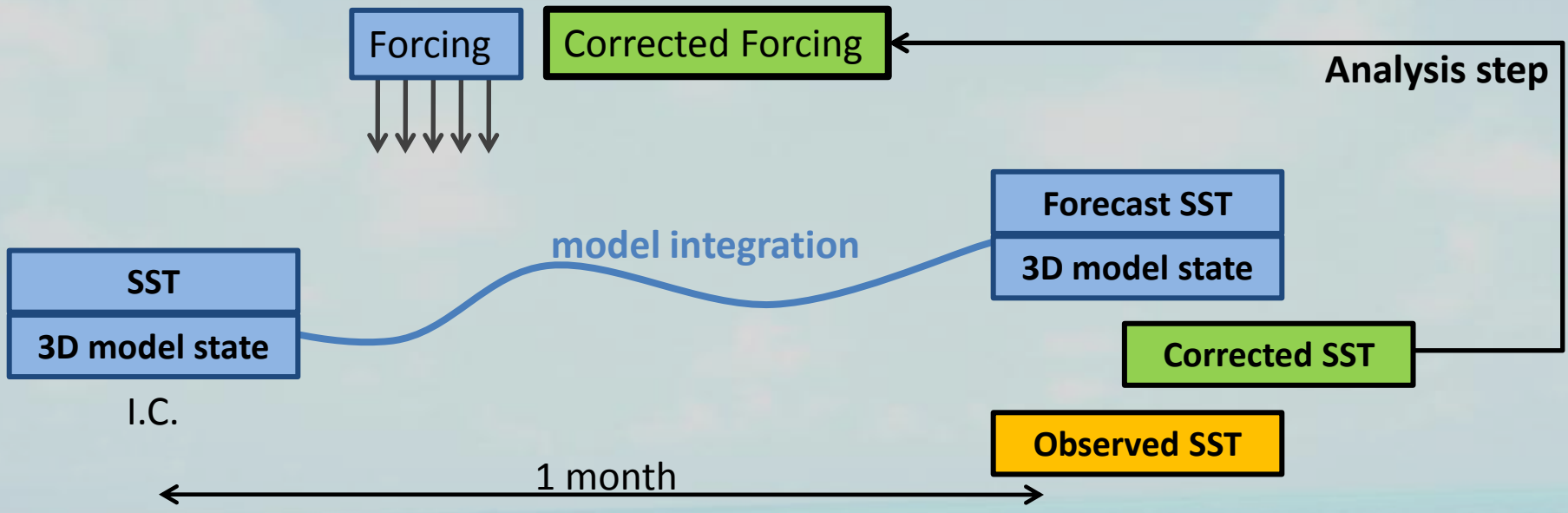
METHOD: PRINCIPLE



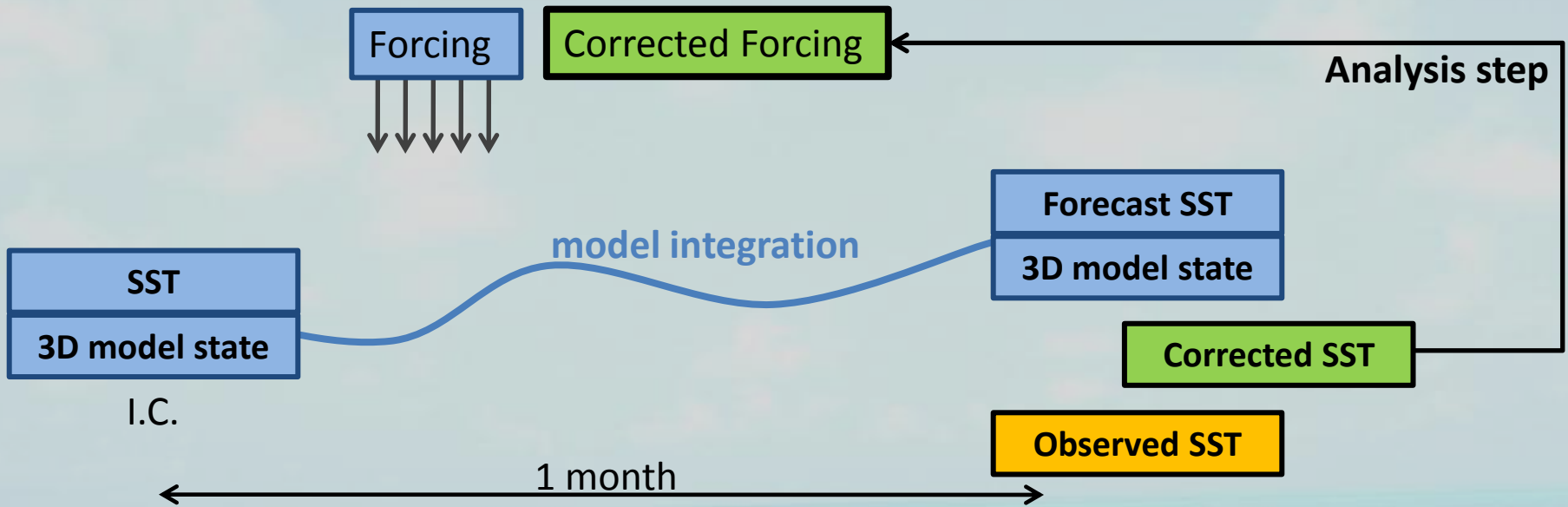
METHOD: PRINCIPLE



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$$\text{Analysis step : } X^a = X^b + K (Y - H X^b)$$

$$X^a = \begin{Bmatrix} \text{Forcing} \\ \text{SST} \end{Bmatrix} \quad X^b = \begin{Bmatrix} \text{Forcing} \\ \text{SST} \end{Bmatrix} \quad Y = \text{SST}$$

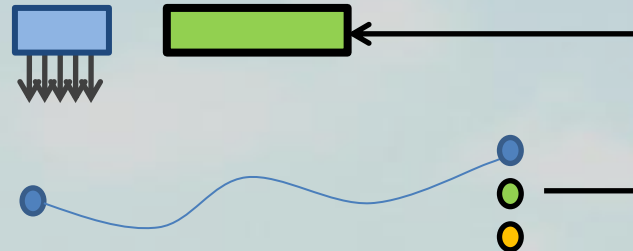
K ? \rightarrow Need to know the model uncertainty induced by forcing errors (P^f)

METHOD: PRINCIPLE



$$X^a = X^b + K (Y - HX^b)$$

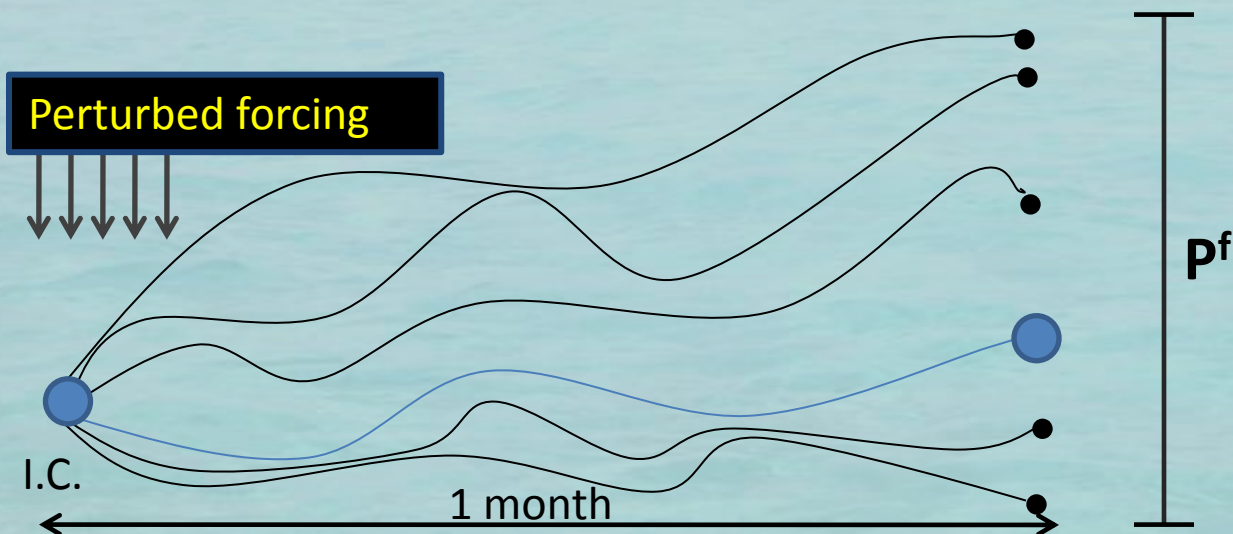
$$K = P^f H^T (H P^f H^T + R)^{-1}$$



depends on P^f

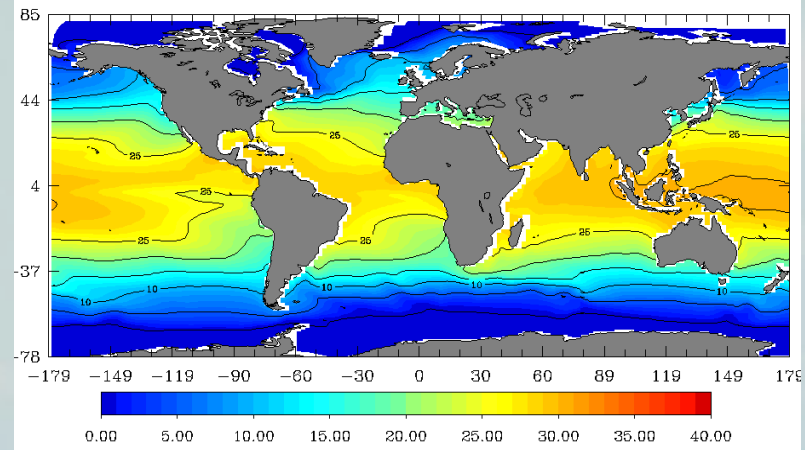
Forecast error covariance matrix P^f :

➔ Ensemble experiments



- **Model :**
NEMO, global configuration, 2° resolution
- **Monthly independent corrections :**
« Offline » assimilation month by month
- **Corrected atmospheric variables :**
Air temperature and humidity (at 2m), solar longwave and shortwave radiation, zonal and meridional 10m wind speed, precipitation
- **Assimilated data :**
Hurrel SST database (Hurrel et al., 2008)

ORCA2-ERAinterim, annual mean SST, 2004 (°C)



➔ **First results for one year : 2004**

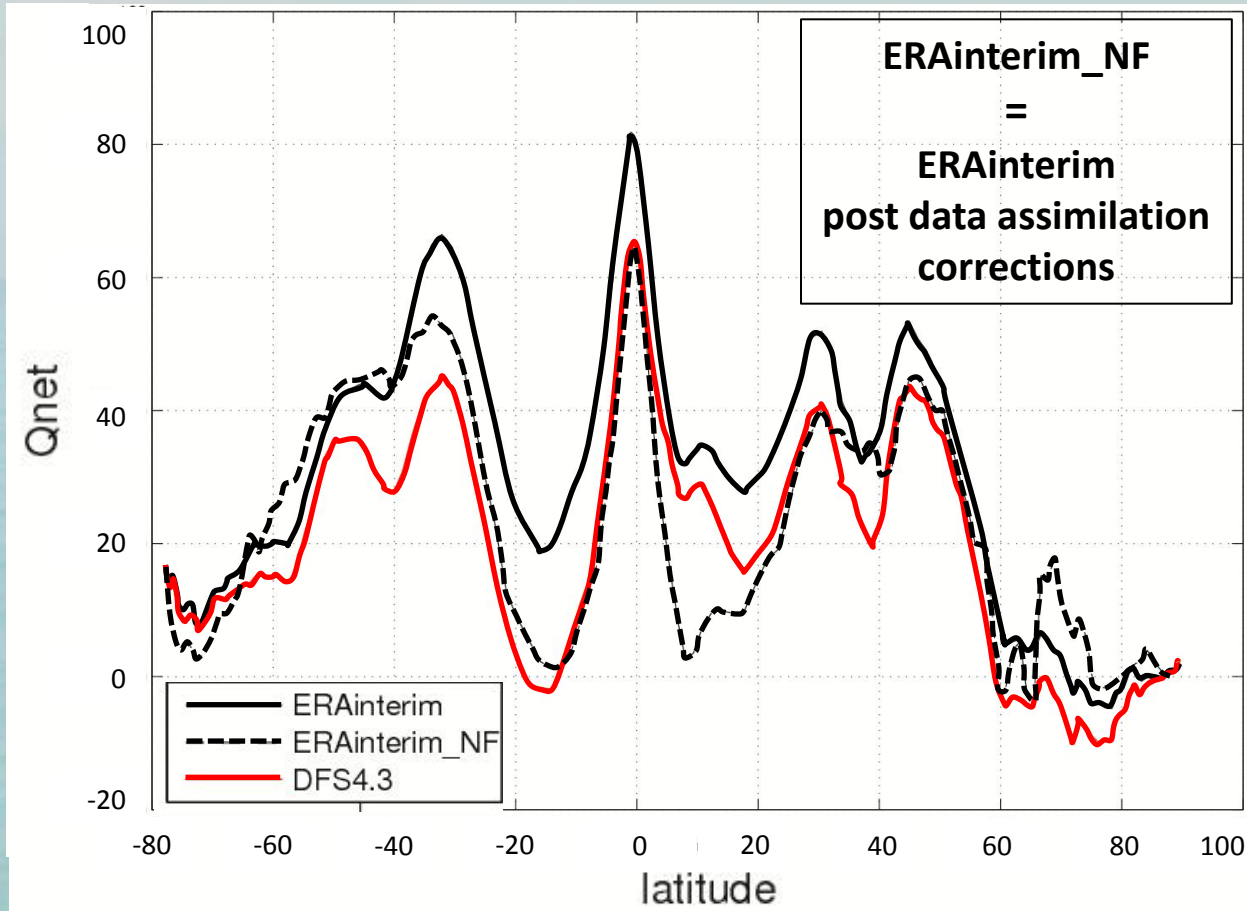
RESULTS: NET HEAT FLUX



- Corrections yield a reduction of the net heat flux :

➔ Results comparable to DFS4

Zonal mean net heat flux, 2004 (W/m^2)
ERAinterim vs DFS4 vs ERAinterim_NF



Estimated from monthly means of atmospheric variables .

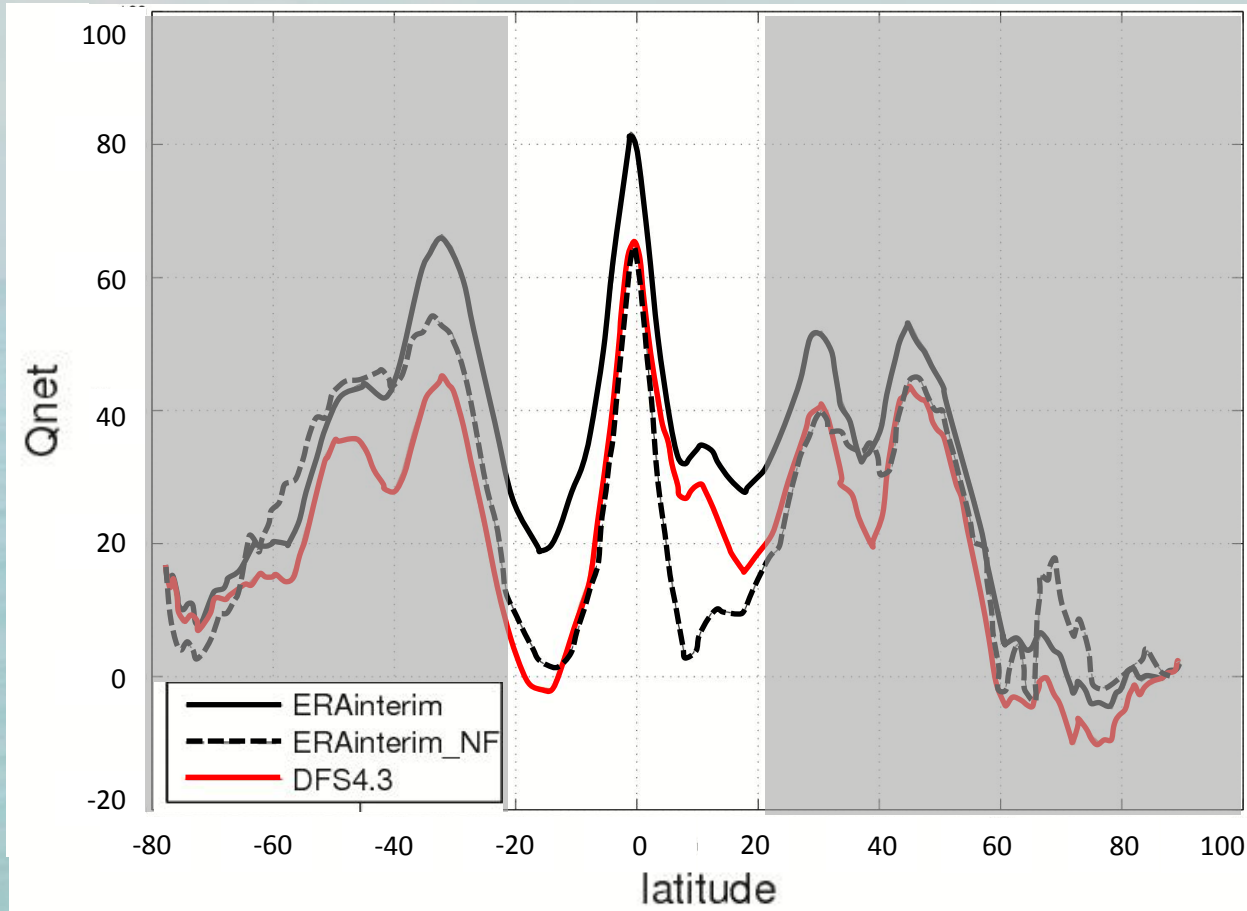
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In intertropical band :
-Impact of the forcing
on the warm bias



**Good agreement
between
reference (DFS4) and
ERAinterim_NF**

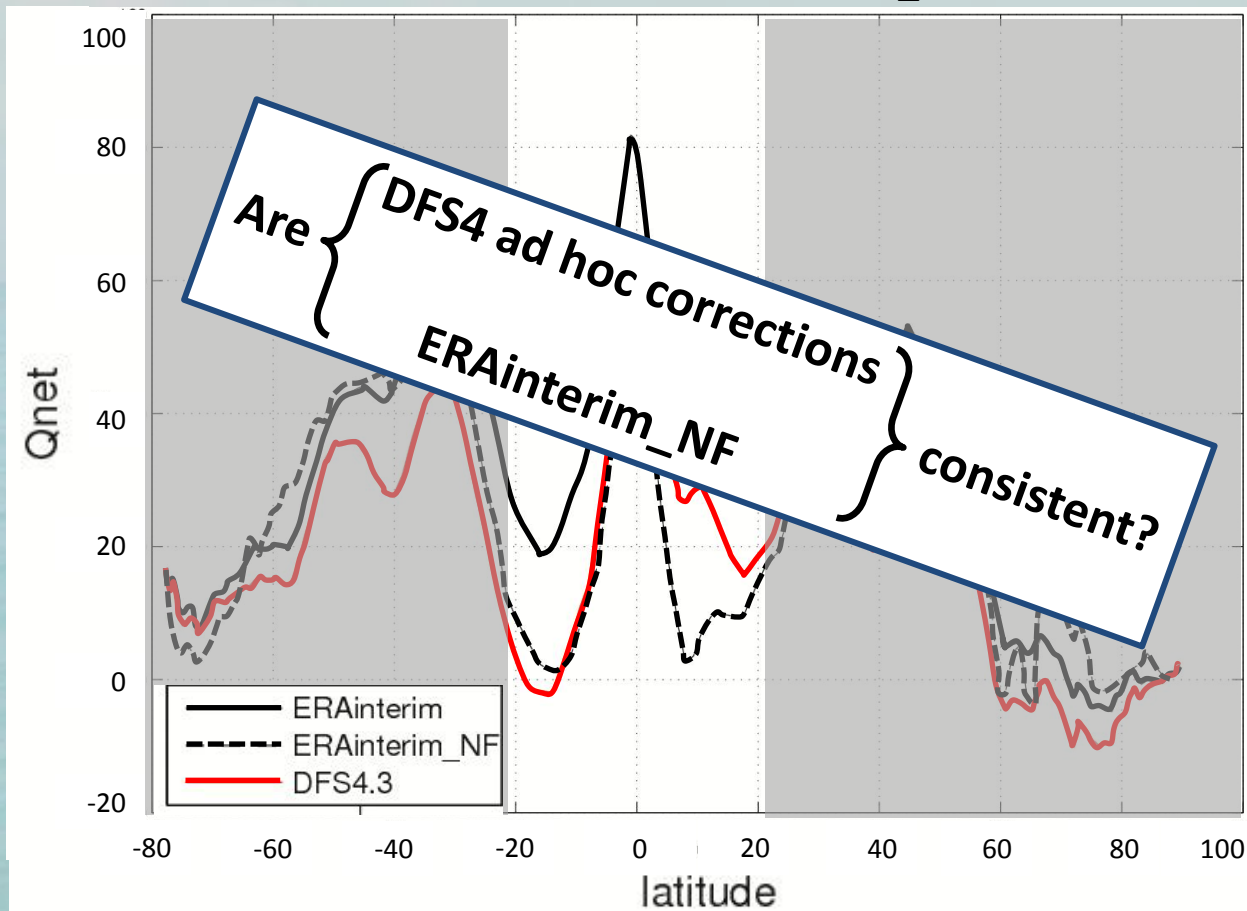
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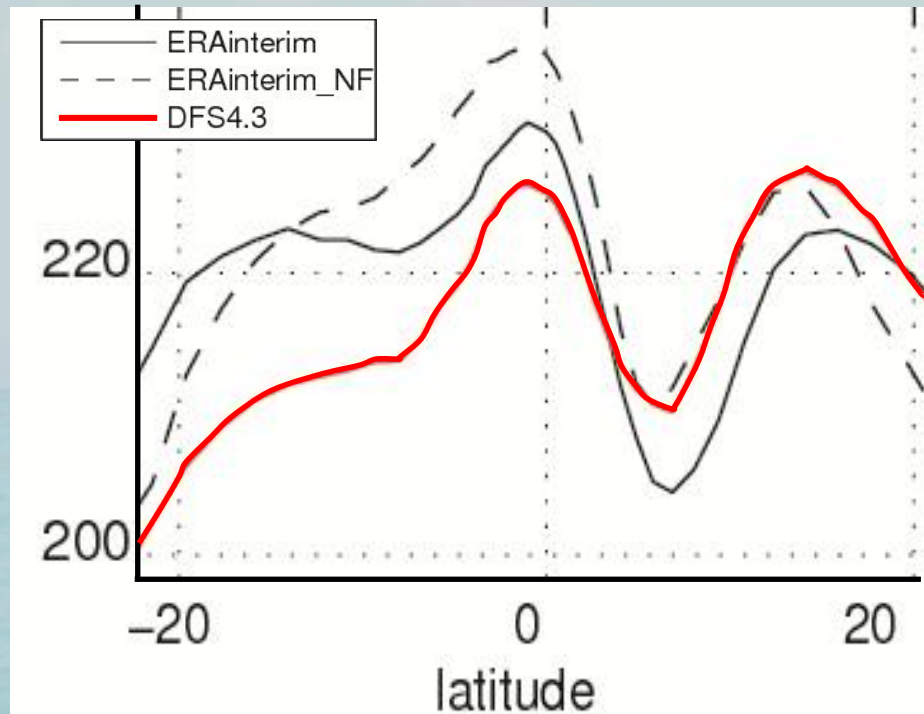
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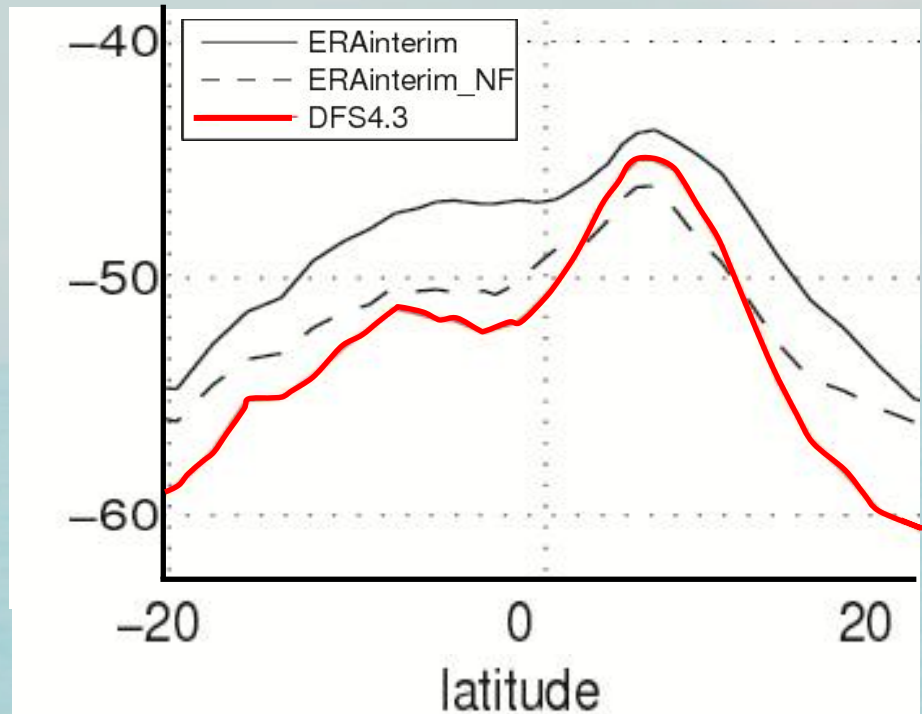
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- Shortwave and longwave radiations:

Zonal mean shortwave radiation flux (W/m^2), 2004



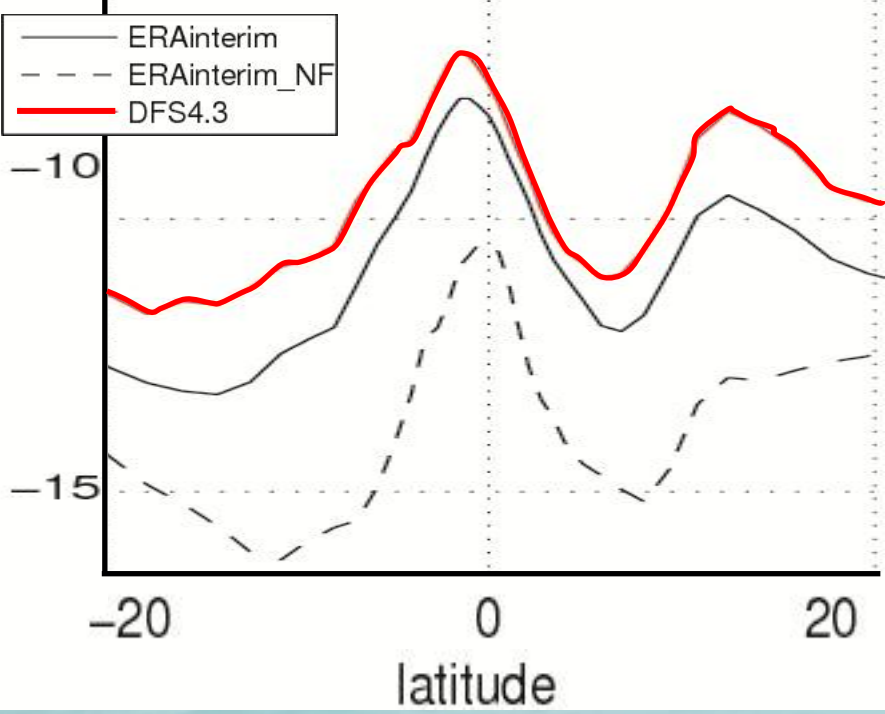
Zonal mean longwave radiation flux (W/m^2), 2004



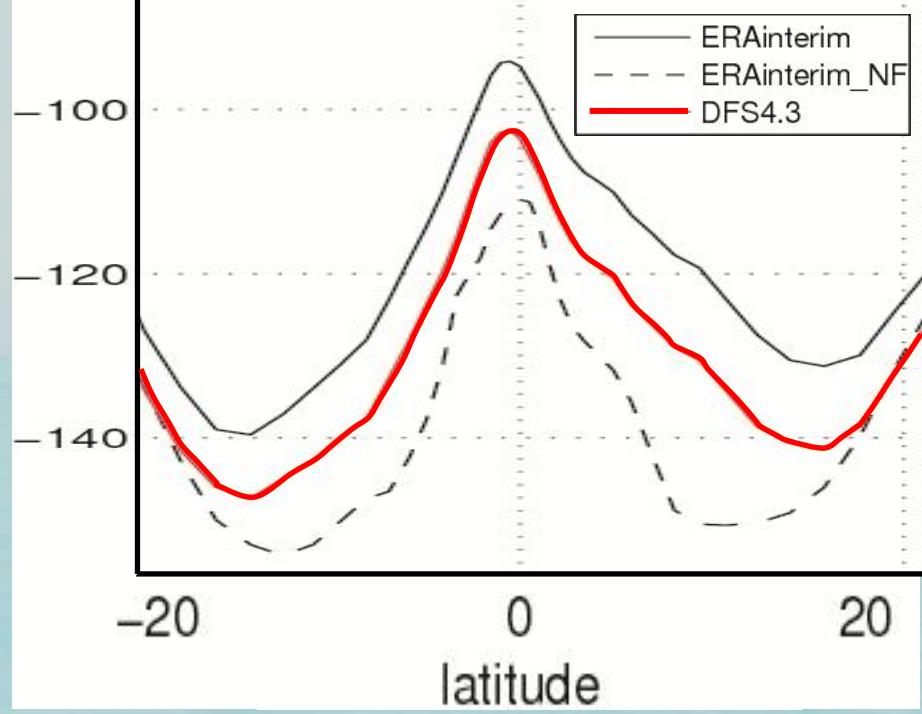
More solar radiation

- Sensible and latent heat:

Zonal mean sensible heat flux (W/m^2), 2004



Zonal mean latent heat flux (W/m^2), 2004

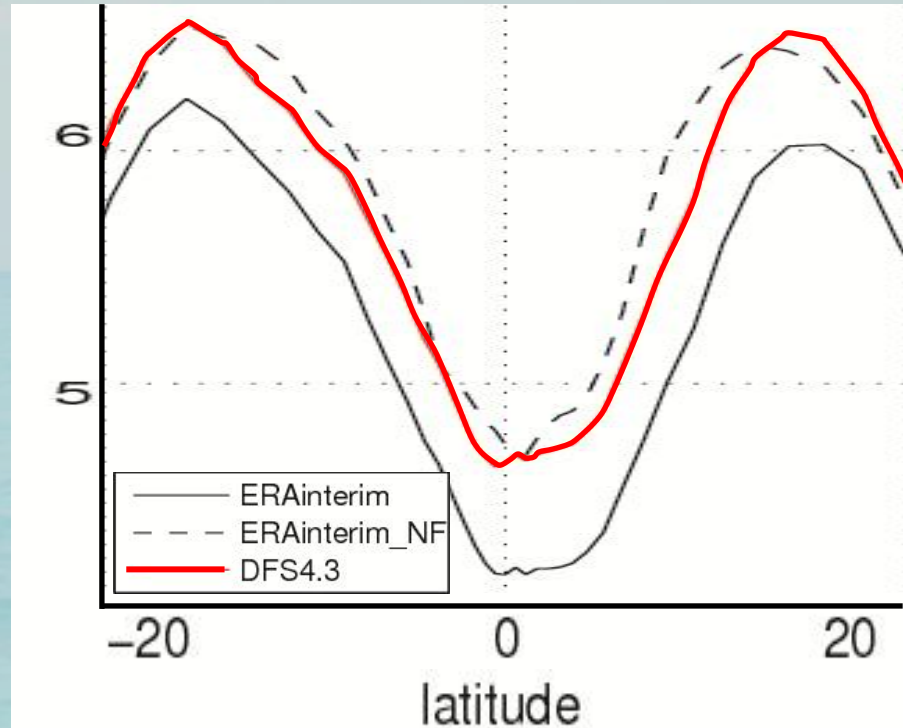


Stronger heat loss by sensible and latent heat flux

HYPOTHESIS : IS WIND RESPONSIBLE FOR THESE DIFFERENCES?

- Responsible for changes in evaporation and sensible heat fluxes
➡ To reduce the warm bias in the intertropical band

Zonal mean wind velocity (m/s), 2004

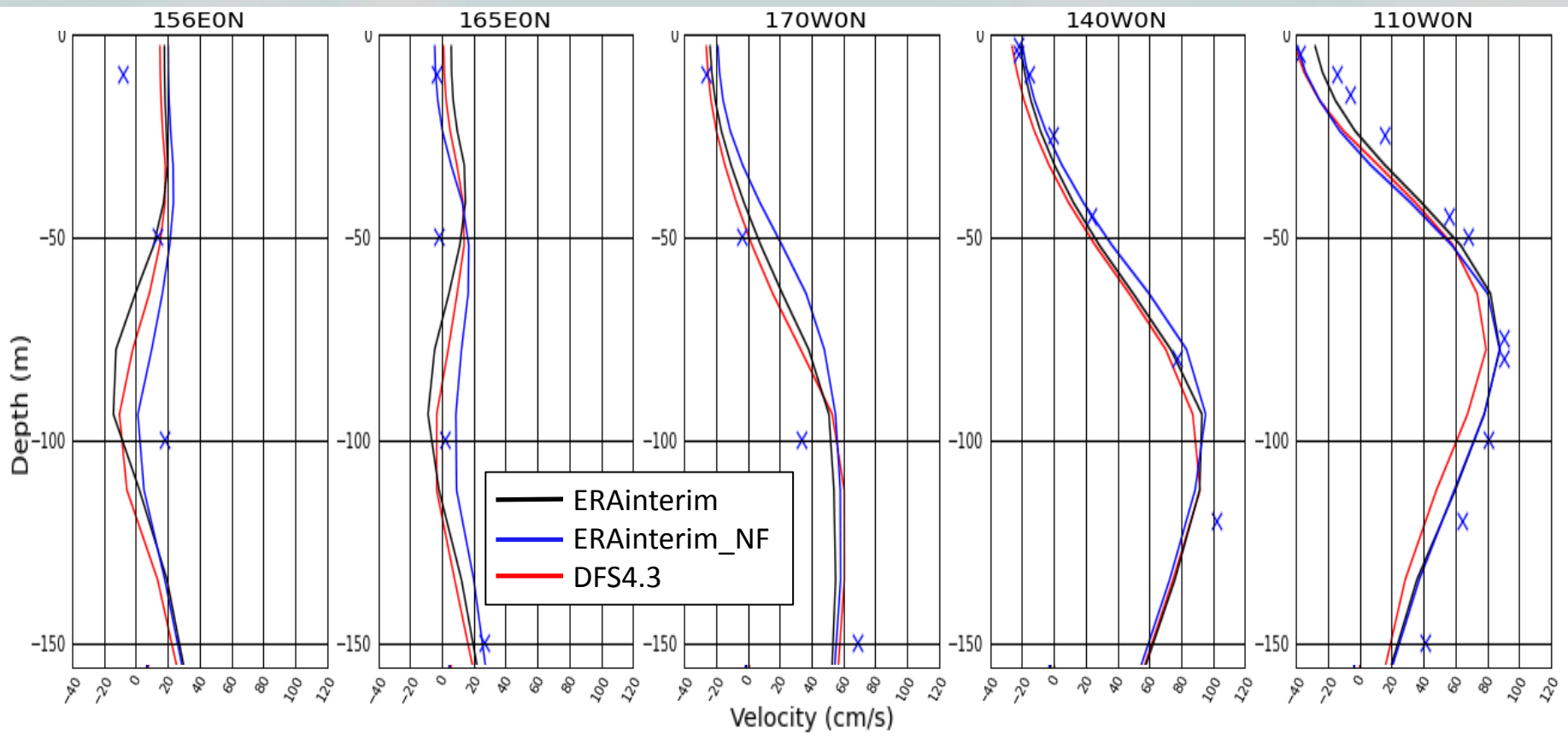


NB: DFS4 (red) calibrated with QUICKSCAT

➡ Stronger wind than both ERAinterim and DFS4 datasets

- Intensification of Equatorial Undercurrent (TAO, Pacific)

Mean profile of zonal current (cm/s), 2004



Model response consistent with stronger winds

CONCLUSIONS

DIAGNOSTICS OF THE FIRST RESULTS (year 2004):

- ➔ Validation of the methodology
- ➔ Corrections yield a net heat flux reduction in tropical regions
- ➔ Optimal partitioning of corrections between radiative and turbulent flux components

PERSPECTIVES:

In progress:

- ➔ Extension of the method to the whole ERAinterim period (1989-2008)

Long term:

- ➔ Evaluation of the relevance of the corrections with other air-sea fluxes datasets and observations
- ➔ Introduction of surface salinity observations in the assimilation method (SMOS, AQUARIUS)