OPTIMAL ADJUSTMENT OF ATMOSPHERIC PARAMETERS FOR SIMULATIONS OF GLOBAL OCEAN CIRCULATION

1. **Problem statement**
2. **Experimental context**
3. **Method**
4. **Results**

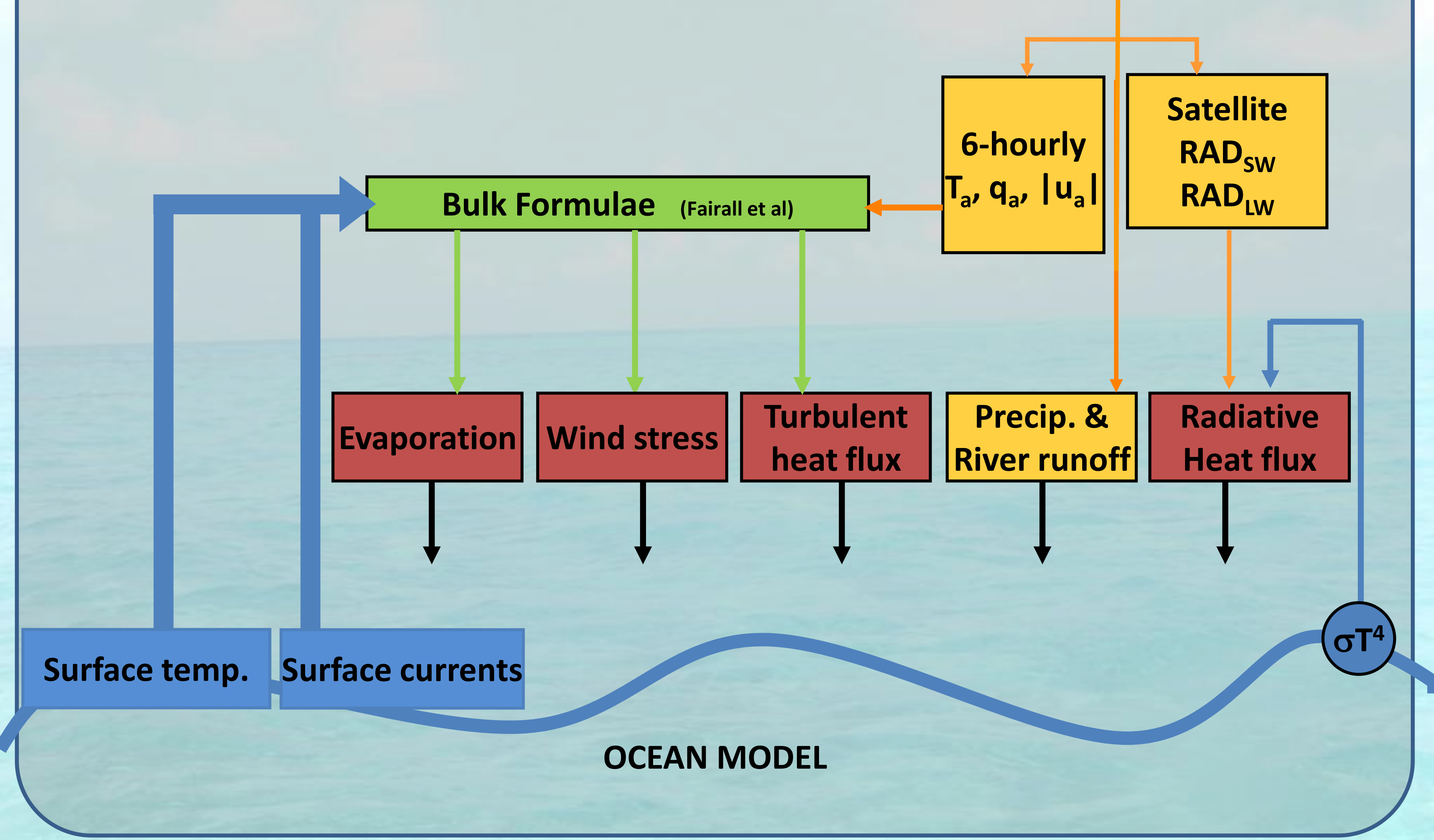
Marion Meinvielle, Pierre Brasseur, Jean-Michel Brankart, Bernard Barnier, Thierry Penduff, and Jean-Marc Molines

marion.meinvielle@legi.grenoble-inp.fr

Laboratoire des Ecoulements Géophysiques et Industriels
Multiscal**E** **O**cean **M**odeling (**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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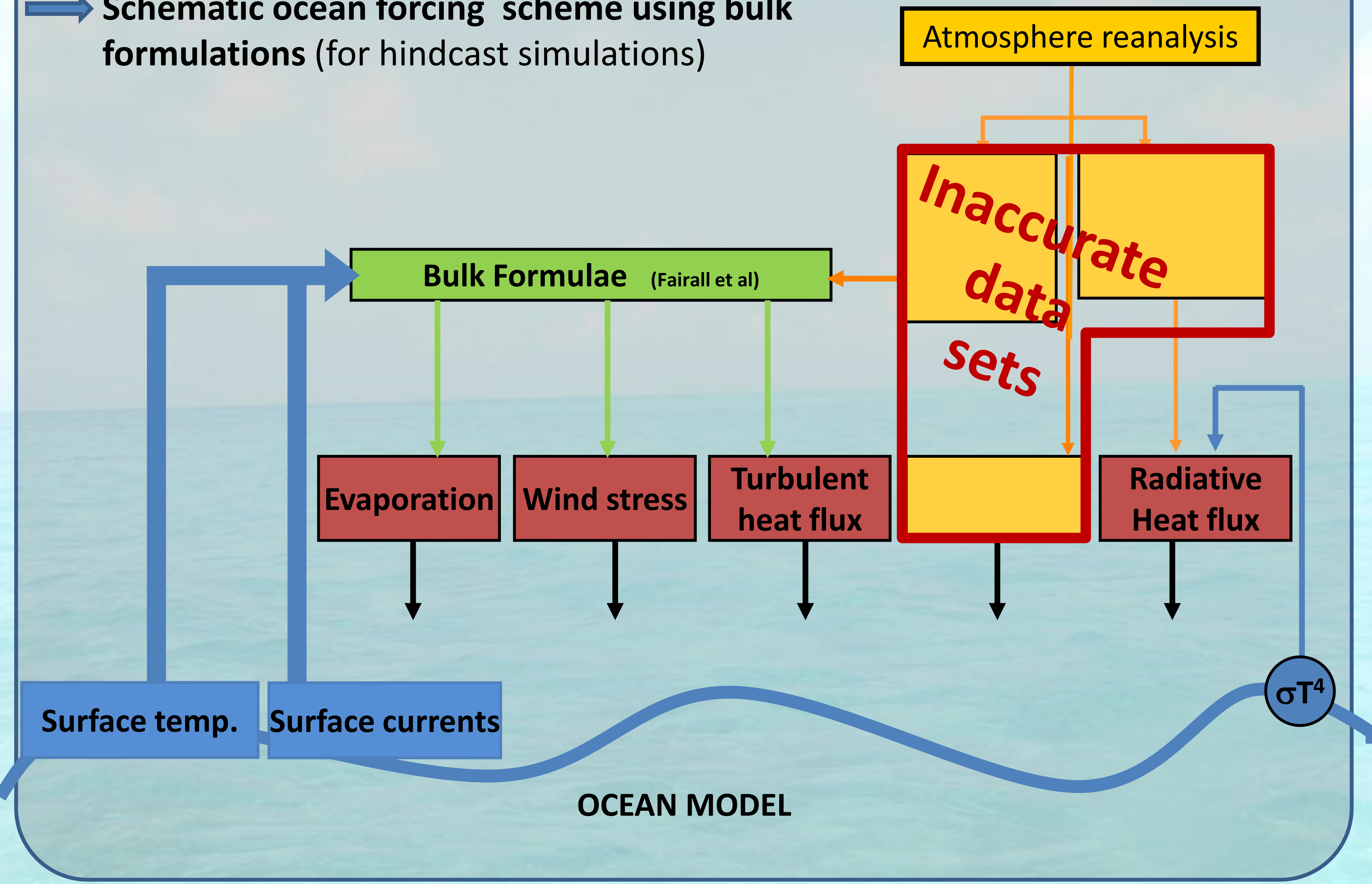

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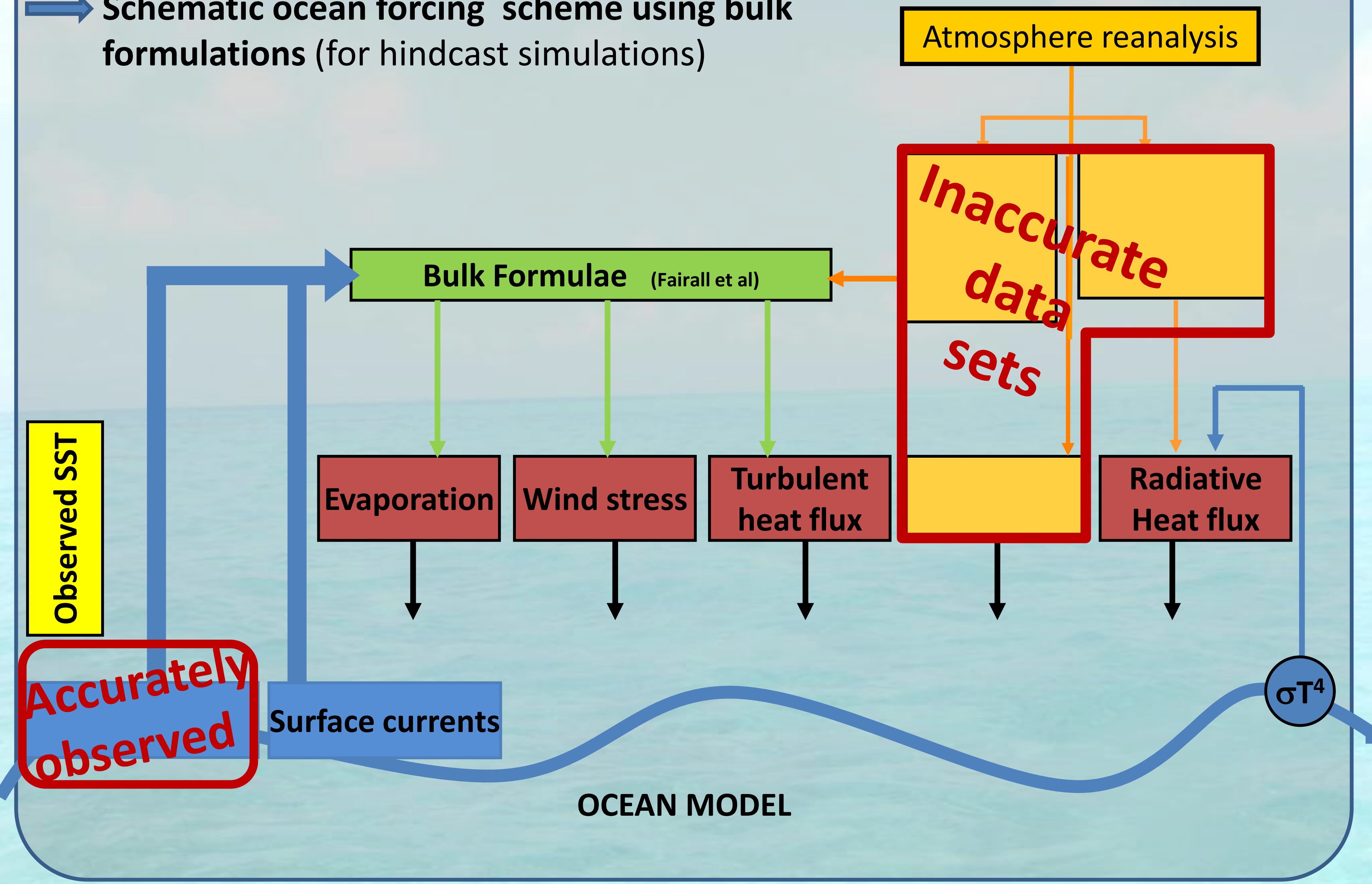
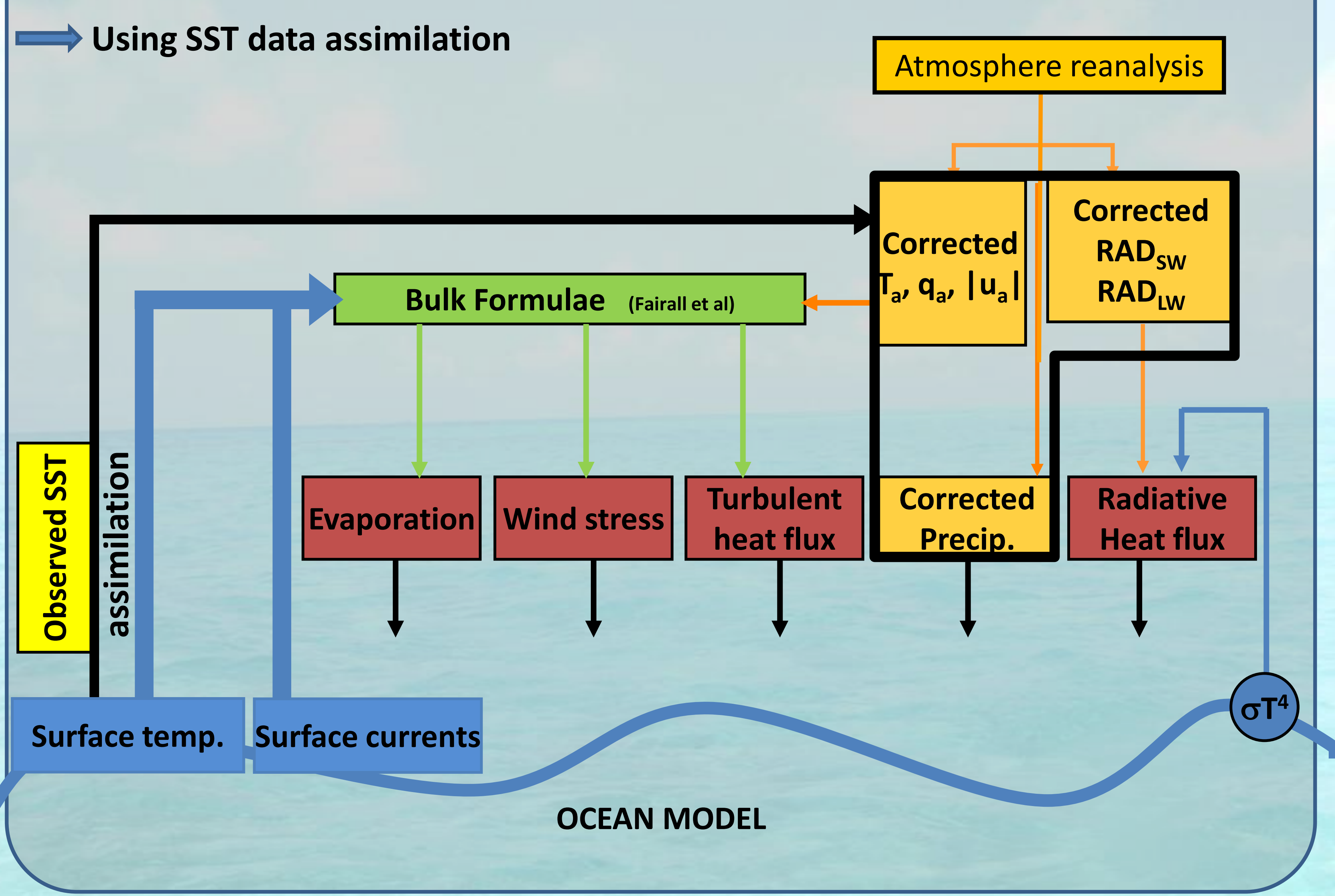


PROBLEM STATEMENT: OPTIMAL CORRECTIONS

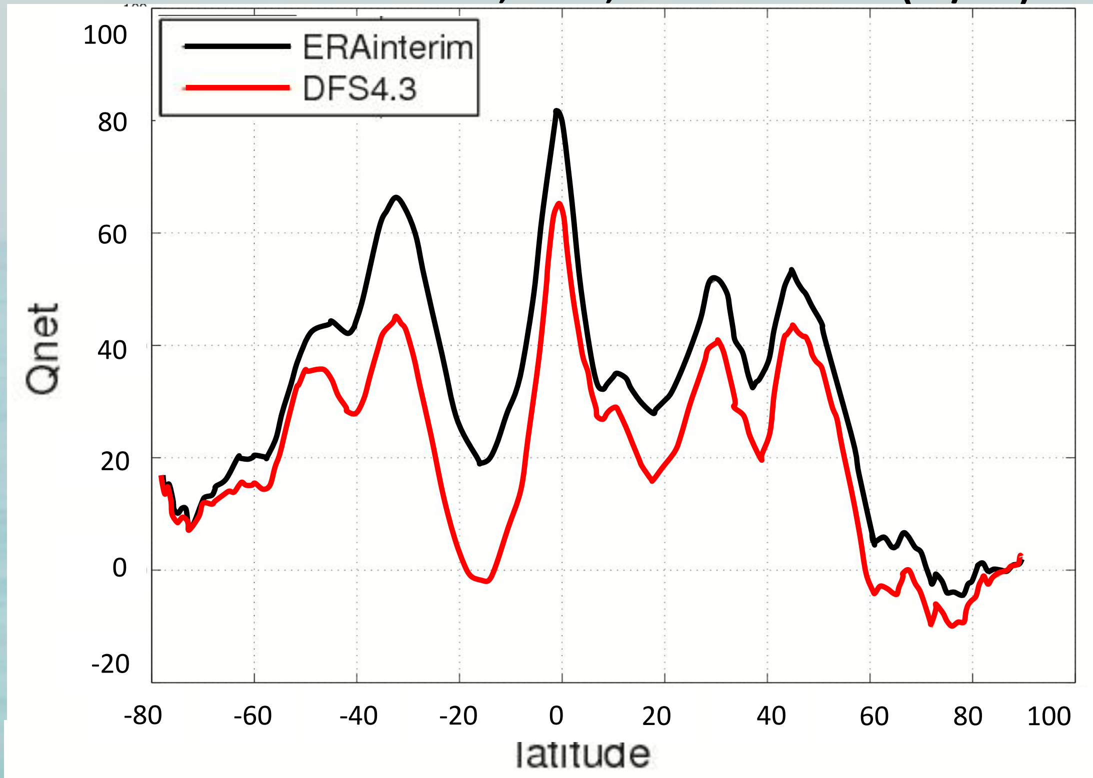


EXPERIMENTAL CONTEXT

- **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)

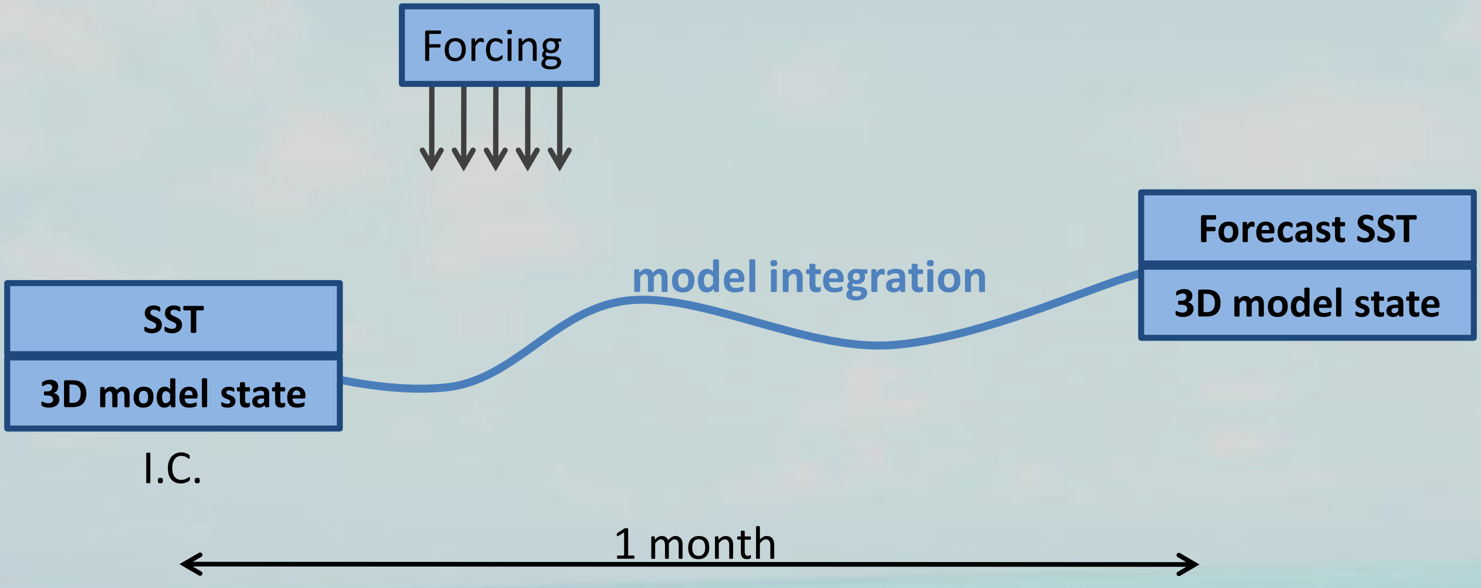
Zonal mean net heat flux, 2004, ERAint vs DFS4 (W/m²)



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



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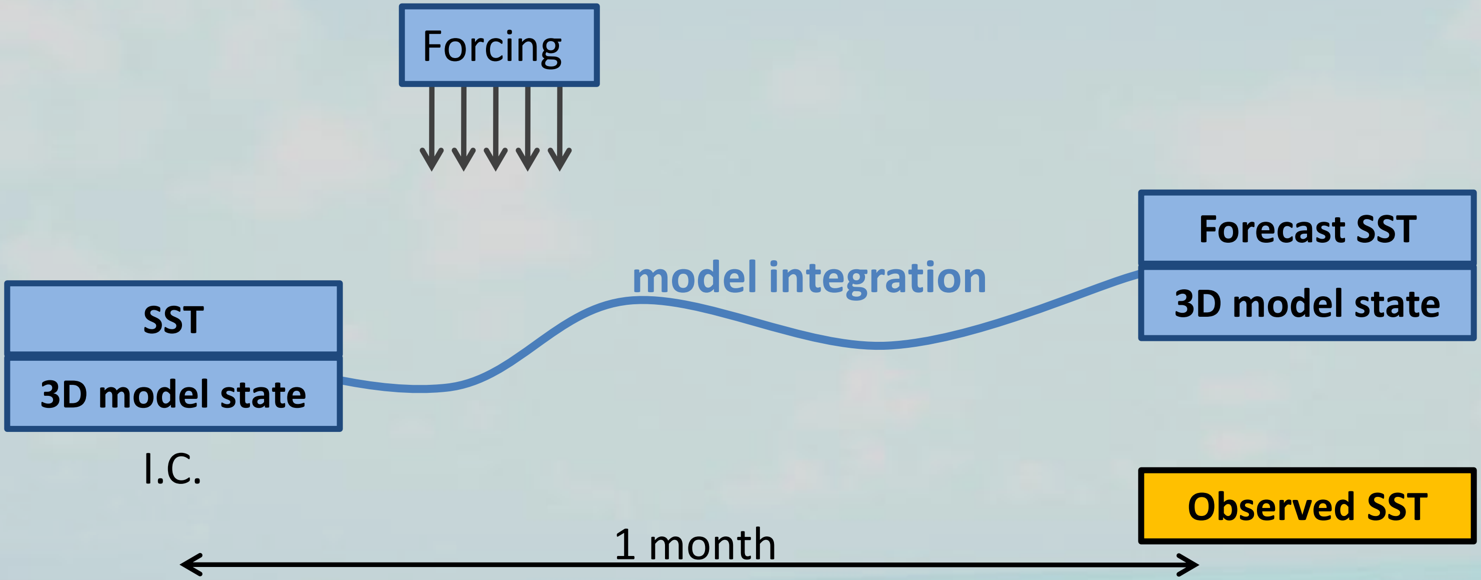

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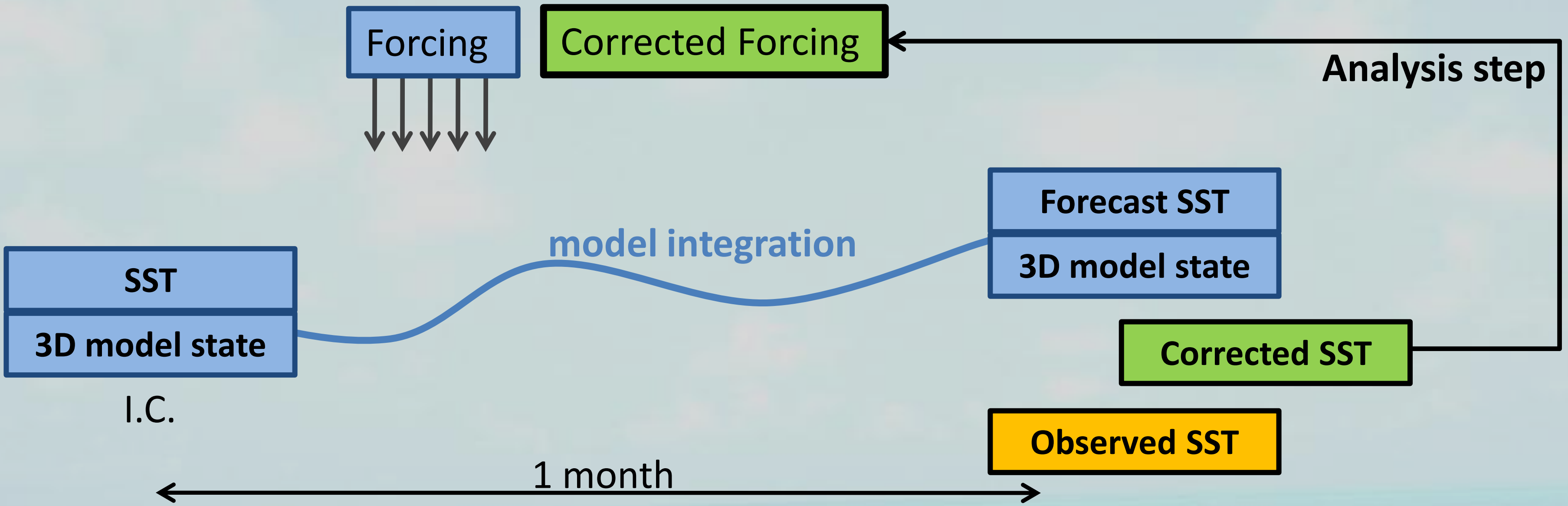

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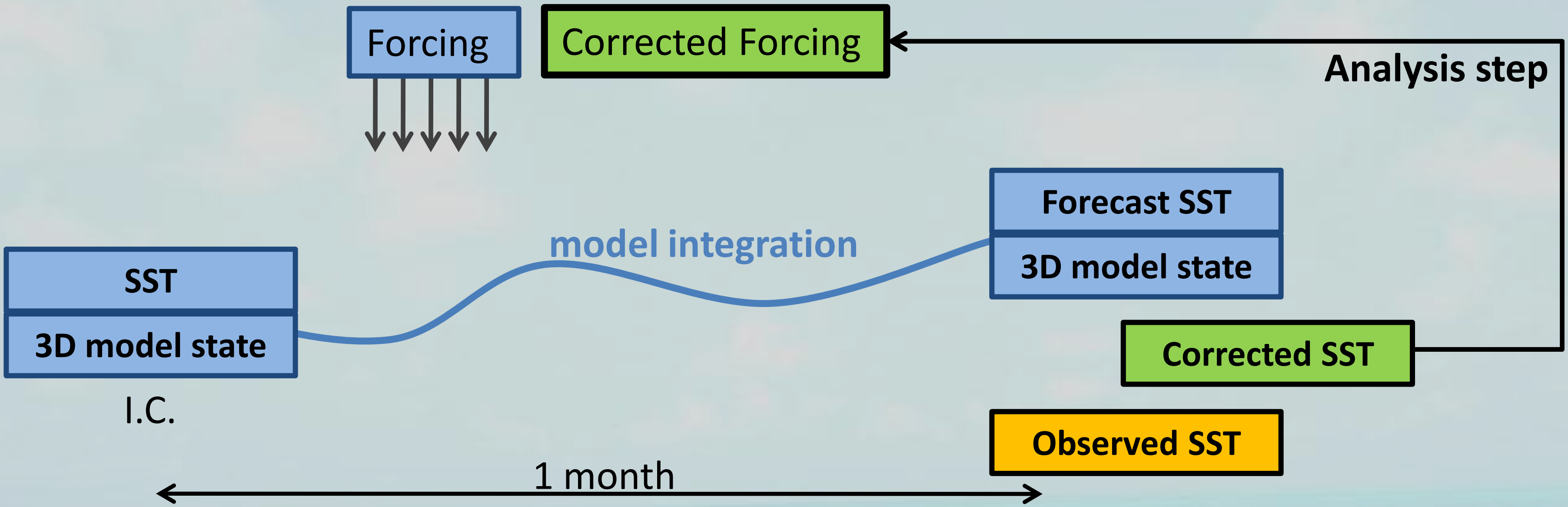


Analysis step : $X^a = X^b + K(Y - HX^b)$

X^a = { Forcing ; SST }

X^b = { Forcing ; SST }

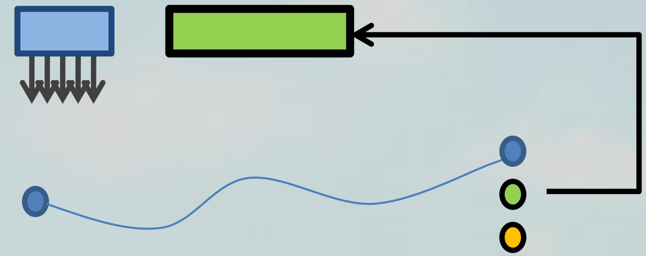
Y = SST

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

METHOD: PRINCIPLE

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

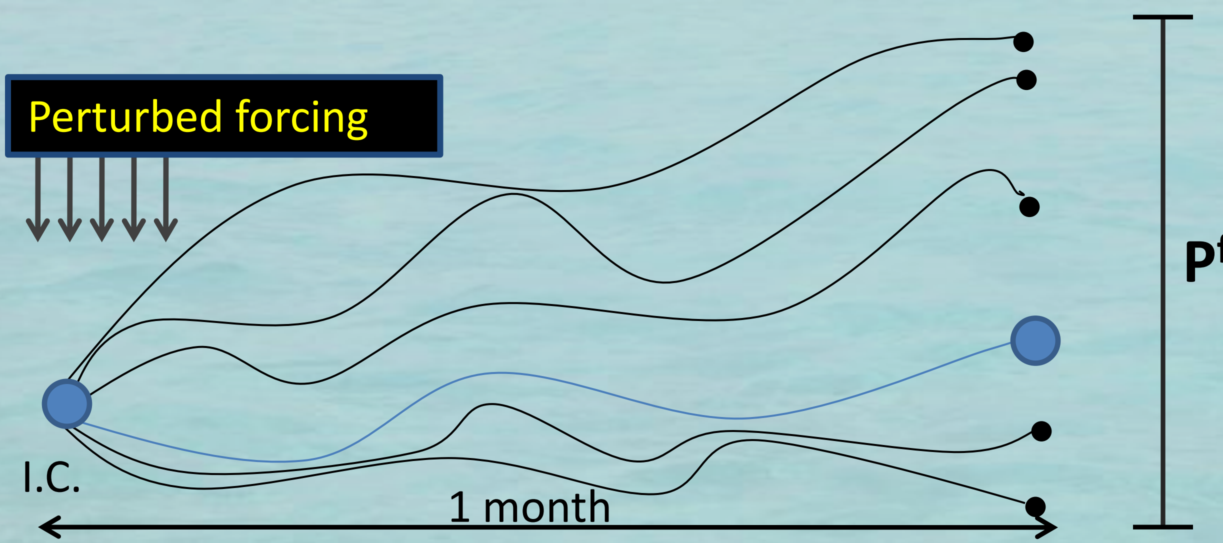
$$K = P^fH^T\,(HP^fH^T + R)$$



depends on P^f

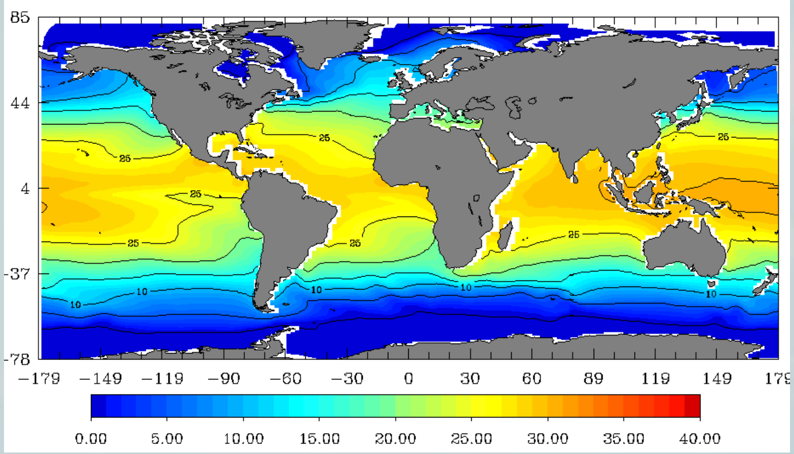
Forecast error covariance matrix $\mathbf{P^f}$:

→ **Ensemble experiments**



METHOD: IMPLEMENTATION

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



- **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)

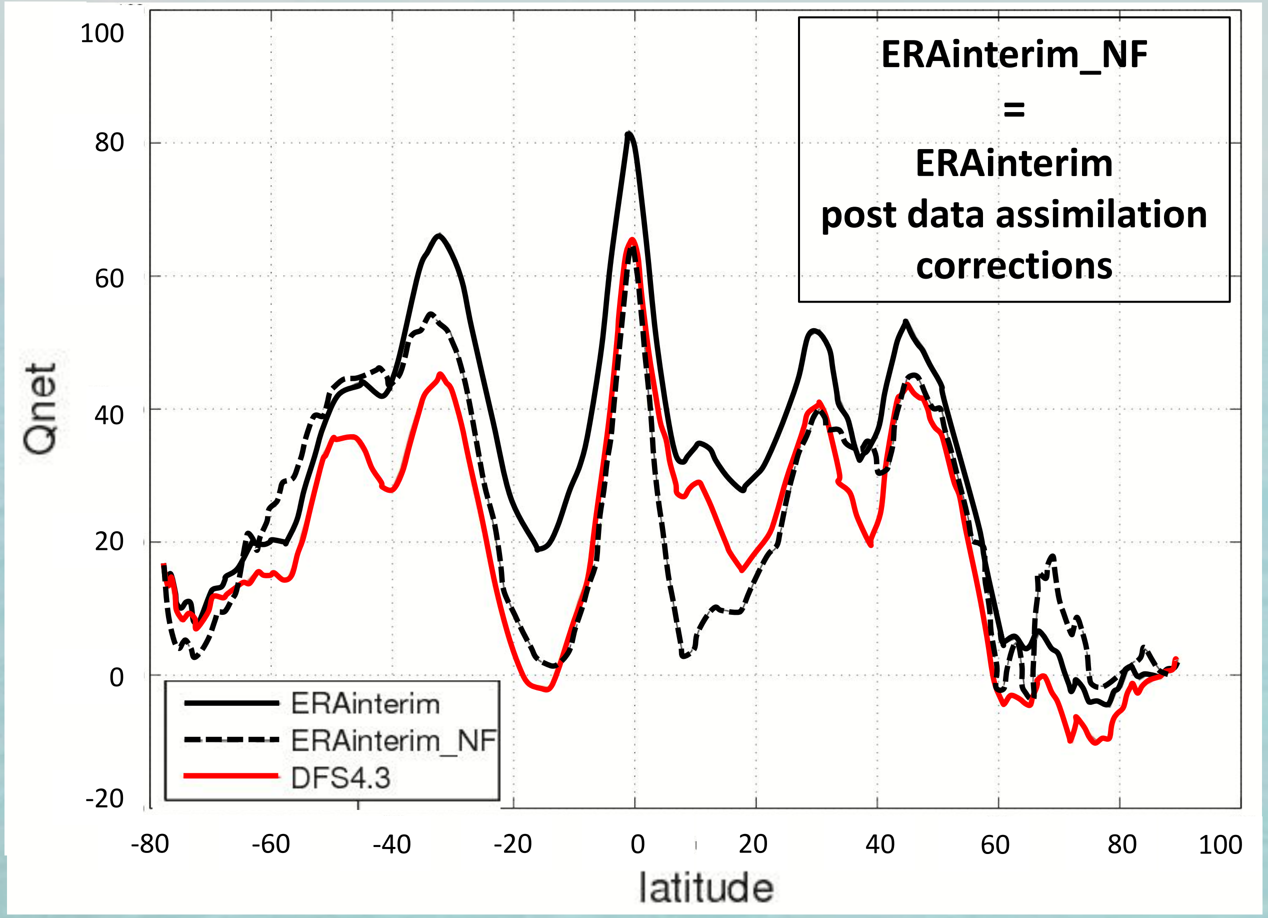
First results for one year : 2004

RESULTS: NET HEAT FLUX

- Corrections yield a reduction of the net heat flux :

→ Results comparable to DFS4

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



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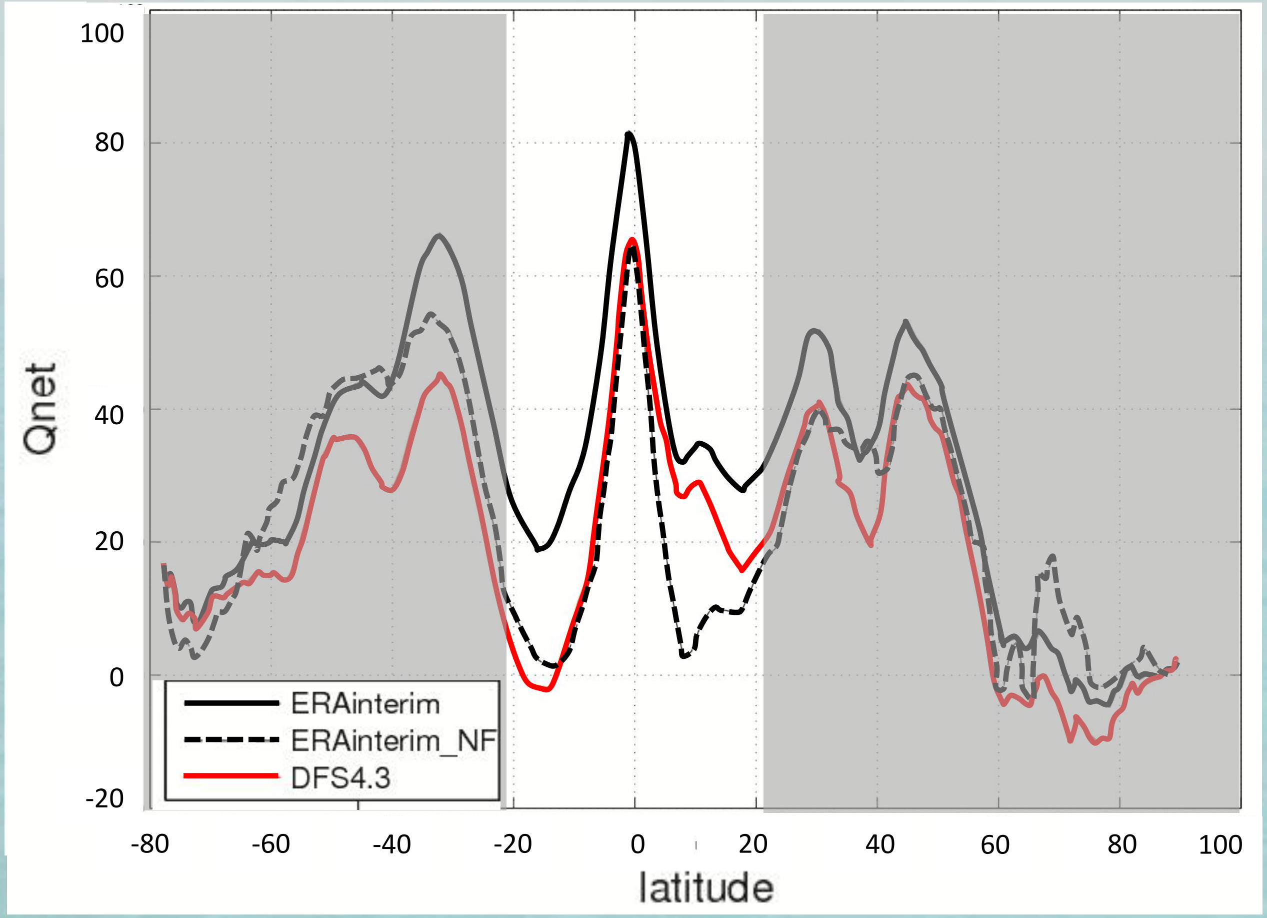

In intertropical band :
-Impact of the forcing on the warm bias

Good agreement between reference (DFS4) and ERAinterim_NF

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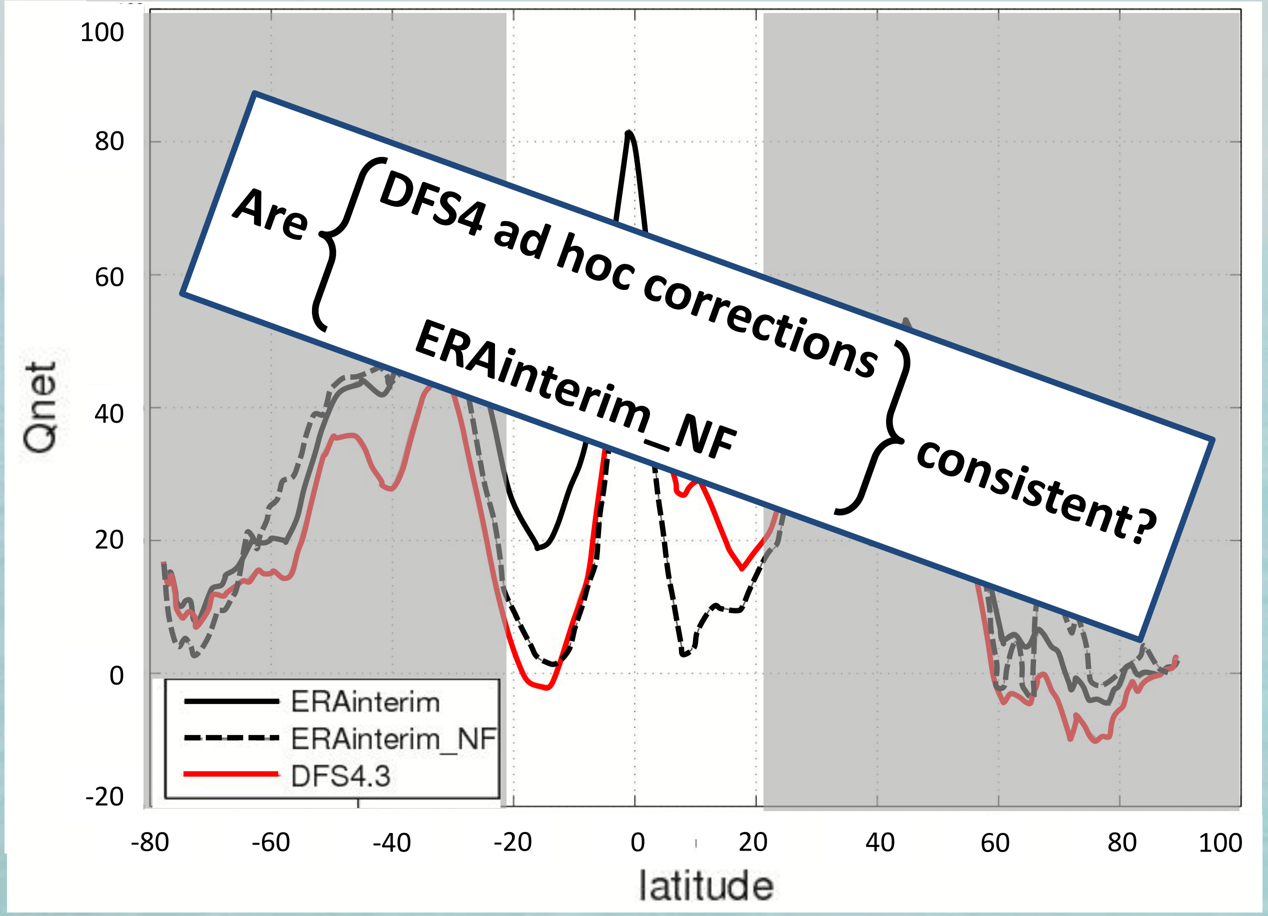

In intertropical band :
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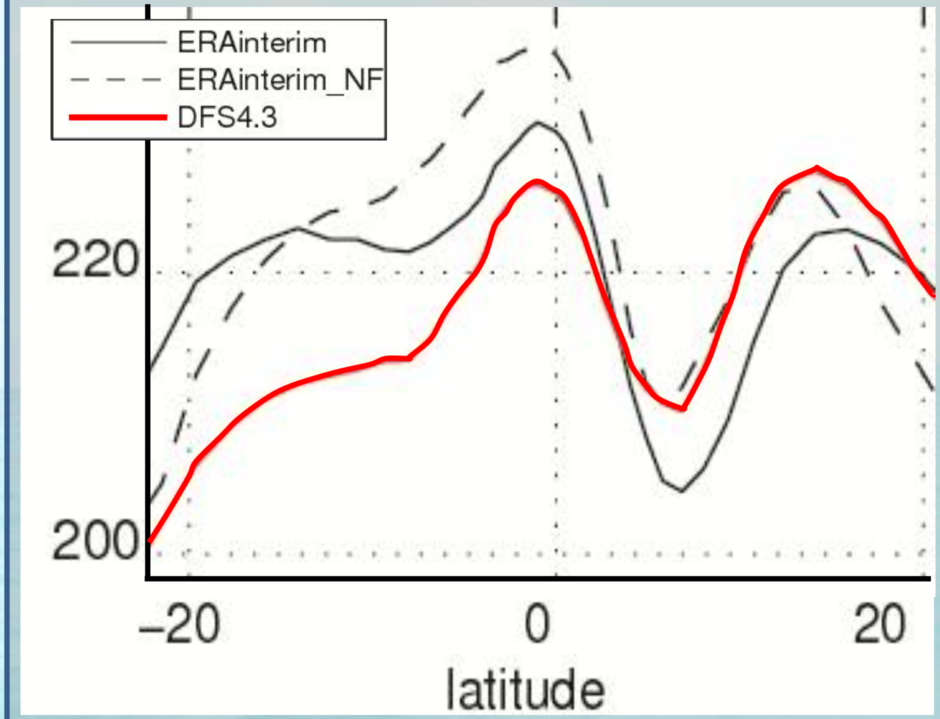
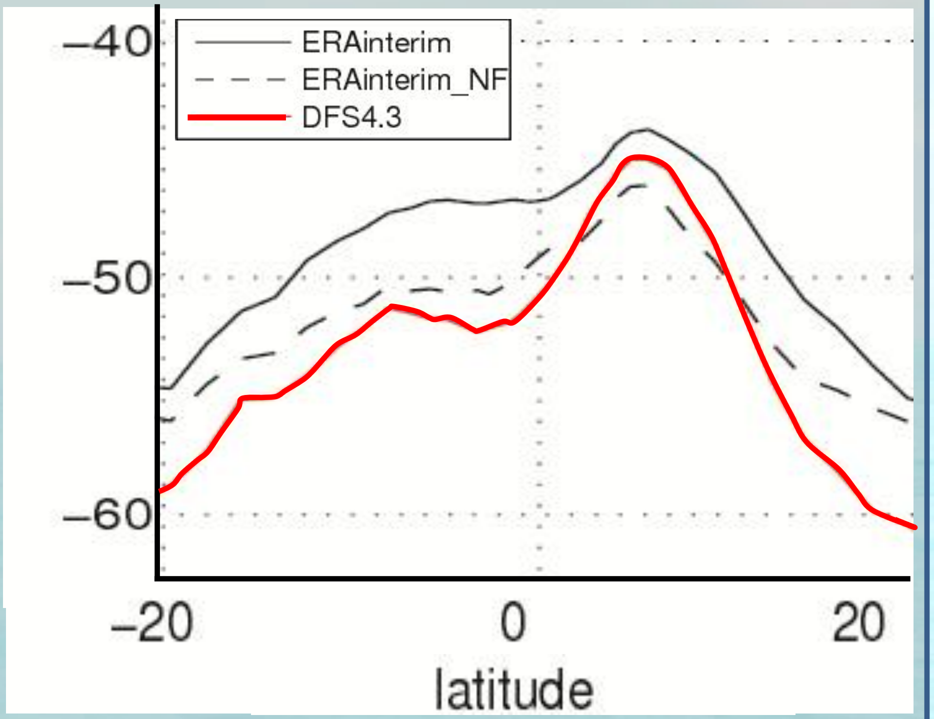
IMPACT OF ASSIMILATED SST ON RADIATIVE FLUXES

- Shortwave and longwave radiations:

Zonal mean shortwave radiation flux (W/m²), 2004



Zonal mean longwave radiation flux (W/m²), 2004

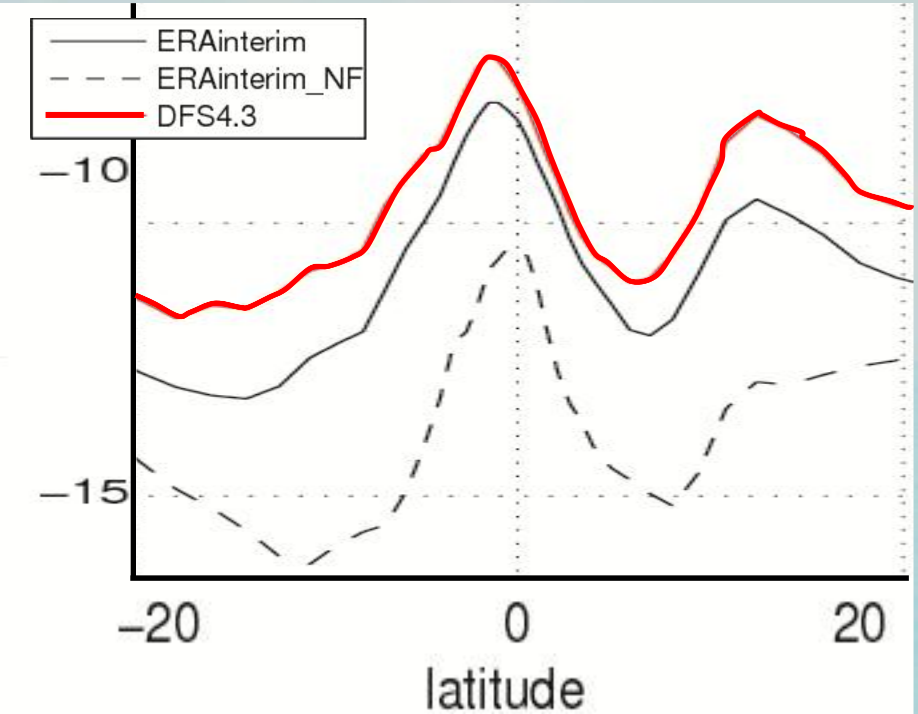


More solar radiation

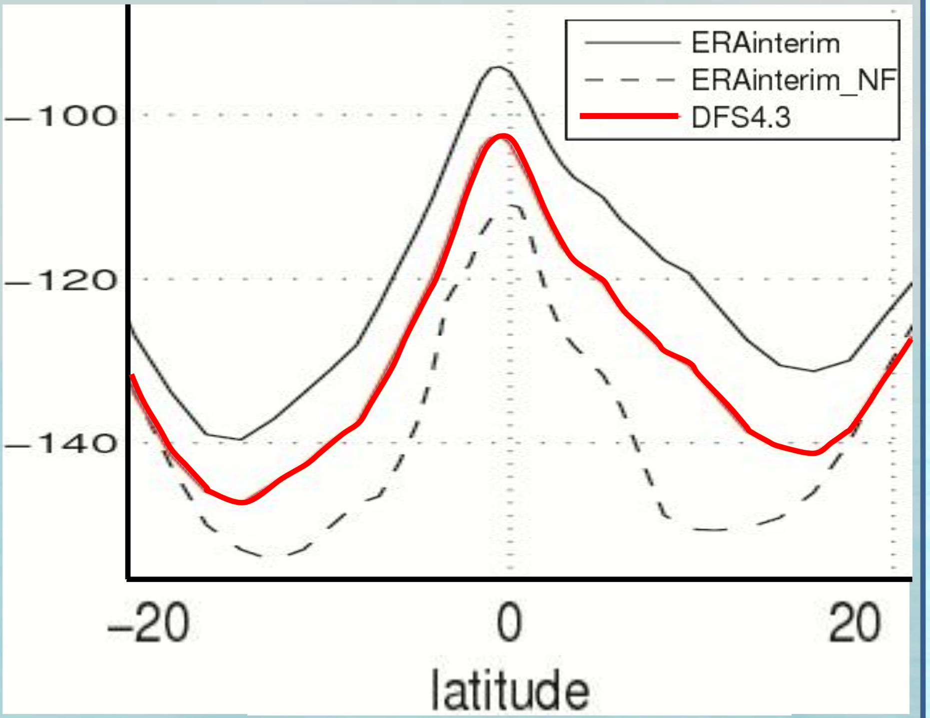
IMPACT OF ASSIMILATED SST ON TURBULENT HEAT FLUXES

• Sensible and latent heat:

Zonal mean sensible heat flux (W/m²), 2004



Zonal mean latent heat flux (W/m²), 2004



Stronger heat loss by sensible and latent heat flux

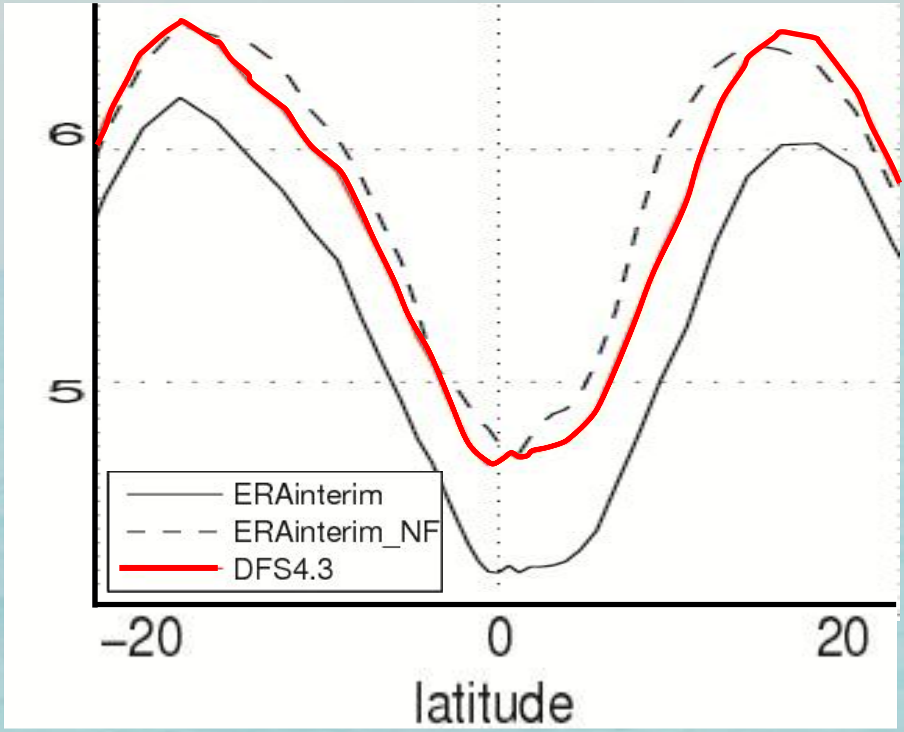
HYPOTHESIS : IS WIND RESPONSIBLE FOR THESE DIFFERENCES?

IMPACT OF ASSIMILATED SST ON WIND CORRECTIONS

- 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



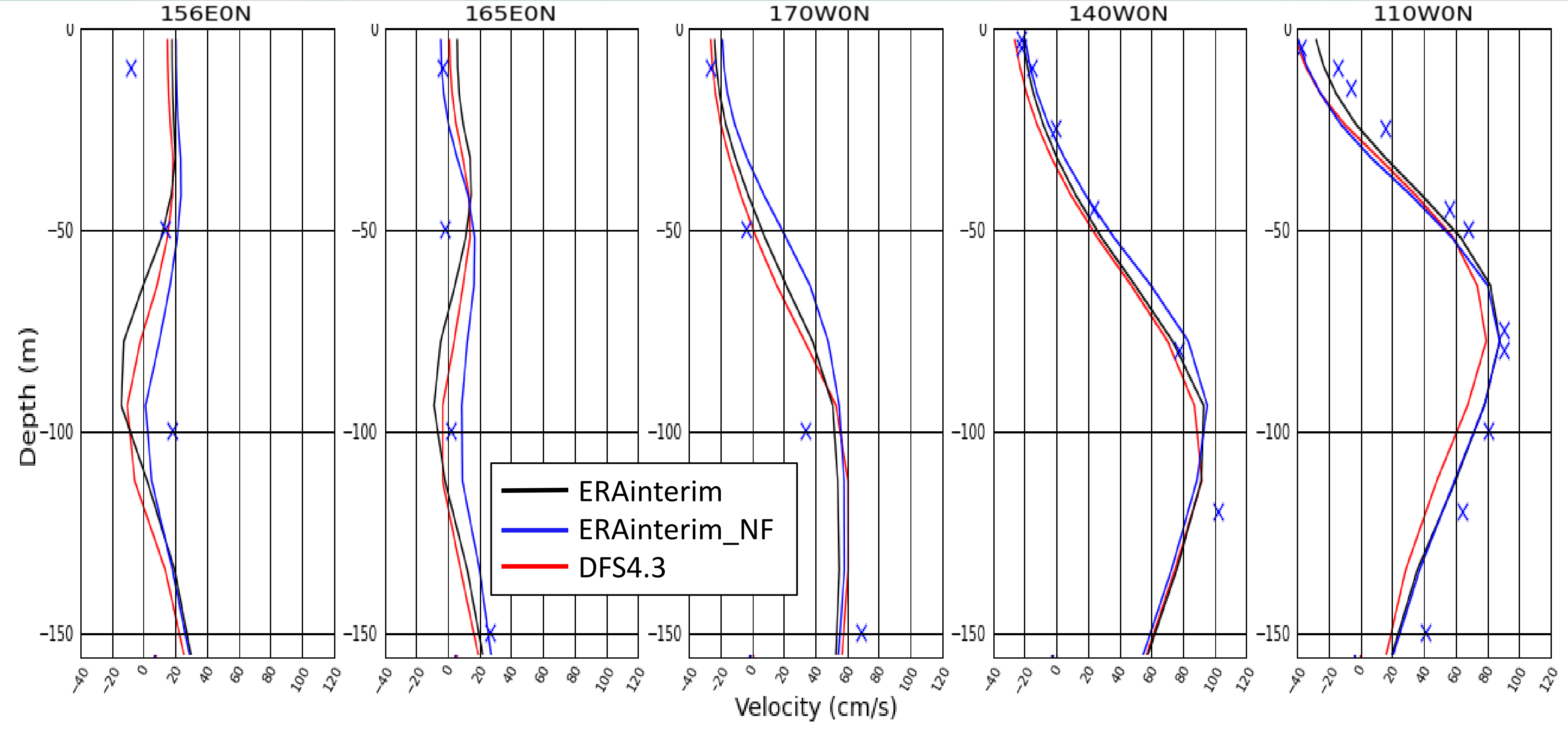
NB: DFS4 (red) calibrated with QUICKSCAT

➡ **Stronger wind than both ERAinterim and DFS4 datasets**

IMPACT OF ASSIMILATED SST ON WIND CORRECTIONS

• 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)