

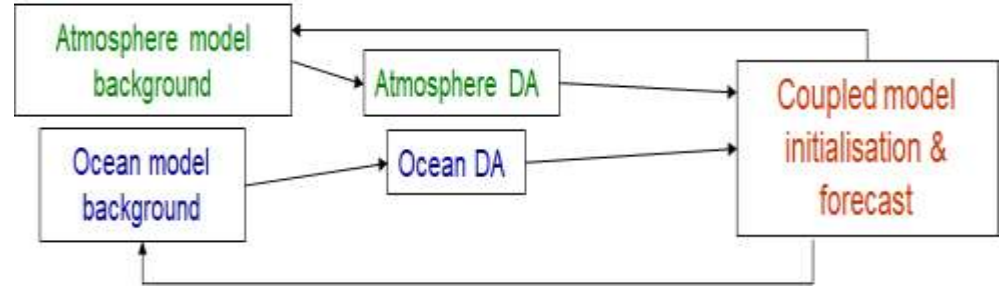
Coupled Initialisation

WGNE Ideas

Oscar Alves and Tim Graham

Background

- WGNE expanding to models of the earth system (previously focus on atmospheric modelling)
- Multiple modelling centers moving to coupled NWP (e.g. Canada, Met Office, ECMWF).
- Also coupled models widely used for subseasonal, seasonal and decadal forecasts.
- Currently using weakly coupled DA (i.e. use coupled model background but ocean & atmosphere DA are done separately).
- What is the path to strongly coupled DA?



WGNE 2020 DA Recommendations

- DAOS: Potential areas for collaboration:
 - a. Coupled initialization—Agreed would be a good joint project between WGNE, DAOS and OMDP. Next step is to set up a meeting between interested people from the three groups. Daryl recommended Andy Moore from DAOS, Baylor and others from OMDP (AI: Tim Graham as WGNE rep).
 - b. Use of DA for activities outside of creating initial conditions—Agreed next step is for WGNE to conduct a review of current activities in this area, to be presented at WGNE36 and a future activity with DAOS discussed there. (AI: Reynolds with DAOS)
 - c. Including evaluation, defining boundaries, of AI/ML methodology including TL/AD emulators. (R: Daryl to consider this for part of their DA workshop. Could be a topic for WGNE error workshop in 2022)

Related

- A survey of coupled model errors to be conducted (similar to that done for atmospheric model errors)
- WGNE Project on surface flux intercomparison from NWP models
- TC verification:
 - a. Review paper of TC initialization with DAOS involvement (AI: Masashi as contact point for WGNE).
 - b. Coordinate workshop to understand why all current initialisation methods result in TC's which are too weak despite models being capable of producing stronger TC's (AI: Masashi with DAOS, possibly part of review above)

Current WGNE Activities

- TC verification:
 - a. Review paper of TC initialization with DAOS involvement (AI:Masashias contact point for WGNE).
 - b. Coordinate workshop to understand why all current initialisation methods result in TC's which are too weak despite models being capable of producing stronger TC's (AI:Masashi with DAOS, possibly part of review above)

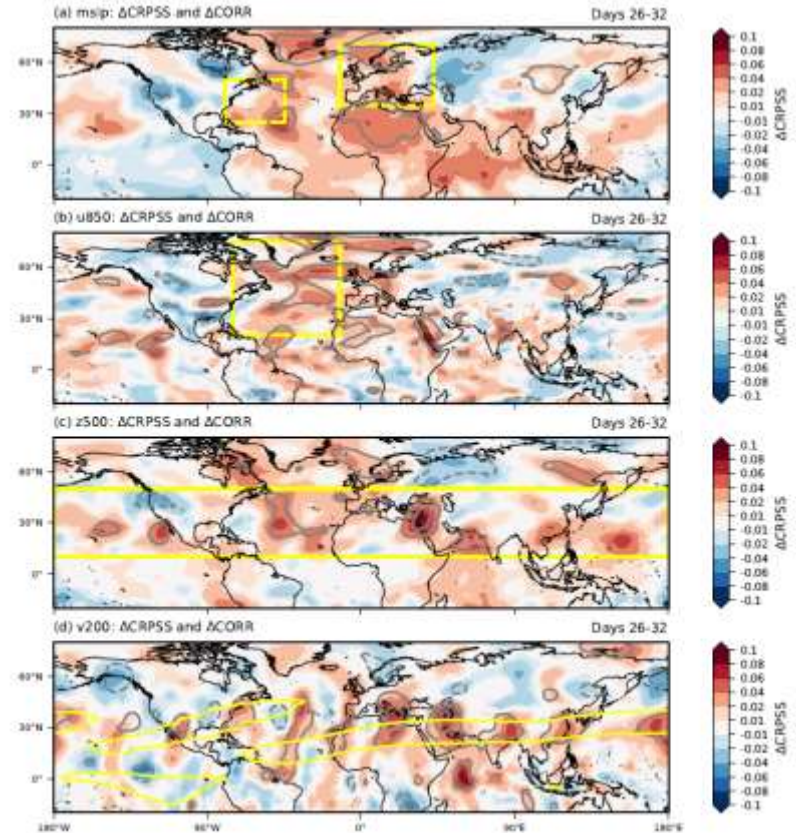
Using DA to Analyse/Understand Systematic Errors

- Improving models, particularly reducing systematic errors has been perhaps the main WGNE objective
- What can we gain from DA increments about systematic errors
- Can we use DA corrections to provide model bias correction
- Can we use machine learning to develop these bias corrections ?

- Idea: Forget about tuning coupled models - put the best physics together, run in DA mode and use machine learning to calculate \sim time step corrections. So DA and machine learning do the physics/bits the model cannot do - avoid tuning physics to compensate errors.

Understanding the impact of SST errors

For example, Roberts et al., 2021 showing the impact of SST errors on forecasts throughout the Northern Hemisphere



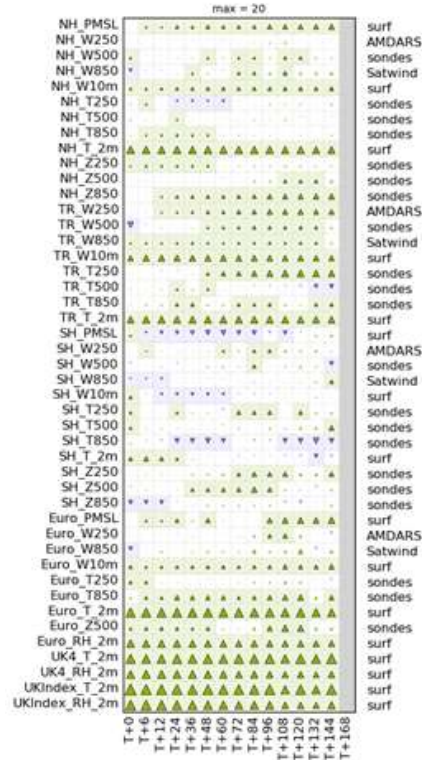
Strongly Coupled DA

- What are the best approaches for coupled DA
 - 4D - Var ?
 - EnKF
 - Hybrid
- How can we measure the benefits of cross covariances?
- Is it too early for WGNE to get involved ?

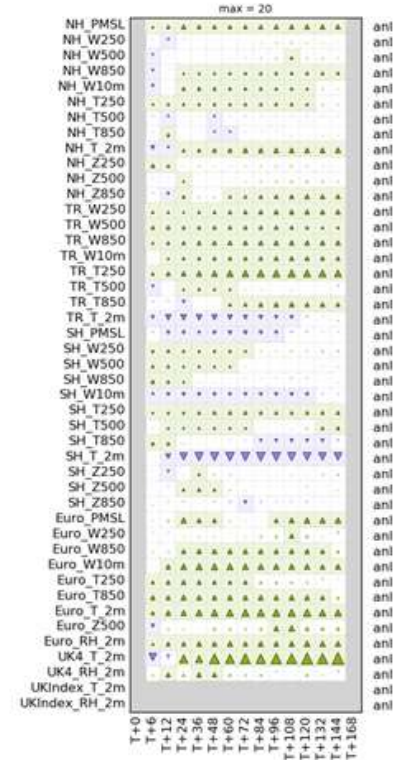
Coupled DA intercomparison

- Is there a common benefit of weakly coupled DA among centres?
- Can we design a set of experiments that isolate the impact of couplings vs other changes/differences?
- Is there evidence of biases in one component impacting other components ?

% Difference (N320 cpl :bp988 vs. P543 N320 uncpl std:u-bk932) - overall 1.49%
RMSE against observations for 20190615 to 20190903



% Difference (N320 cpl :bp988 vs. P543 N320 uncpl std:u-bk932) - overall 0.73%
RMSE against ownal for 20190615 to 20190903



Initialisation of Coupled Processes

- MJO
- Sea Breeze
- Tropical Cyclones
- Coastal Upwelling

Beyond Ocean/Atmosphere Coupled DA

- Land surface
 - Vegetation
 - Ocean Biogeochemistry
 - Atmospheric composition
 - Atmos/Ocean/Wave coupling
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- Use coupling observations - eg. surface fluxes, skin SST

Coupled Perturbations

- Developing Coupled Ensembles
- How do we ensure consistent perturbations across the different models?

Summary: Potential Areas for Collaboration

- Intercomparison of Coupled Re-analyses/real-time analyses
- Coupled DA and systematic errors
- Investigate use of new observations (particularly of coupled interface)