Exploring Joint Data Assimilation in a state space model of the atmosphere-ocean system

Harold Ritchie[1,2], Faez Bakalian[1], Keith Thompson[1] and William Merryfield[3]

[1] Dept. of Ocean., Dalhousie U., Halifax, NS, Canada , [2] Meteor. Res. Division, Environment Canada, Dartmouth, NS, Canada
[3] Canadian Centre for Climate Modeling and Analysis, Victoria, BC, Canada

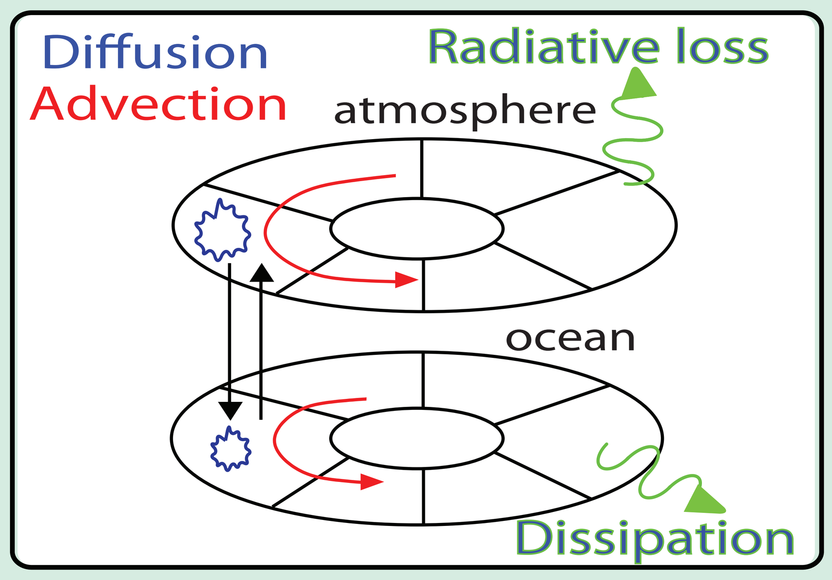
Introduction and background information

Exploratory studies were carried out for independent and joint data assimilation using a simplified state space model consisting of an annular atmosphere coupled to an annular ocean counterpart.

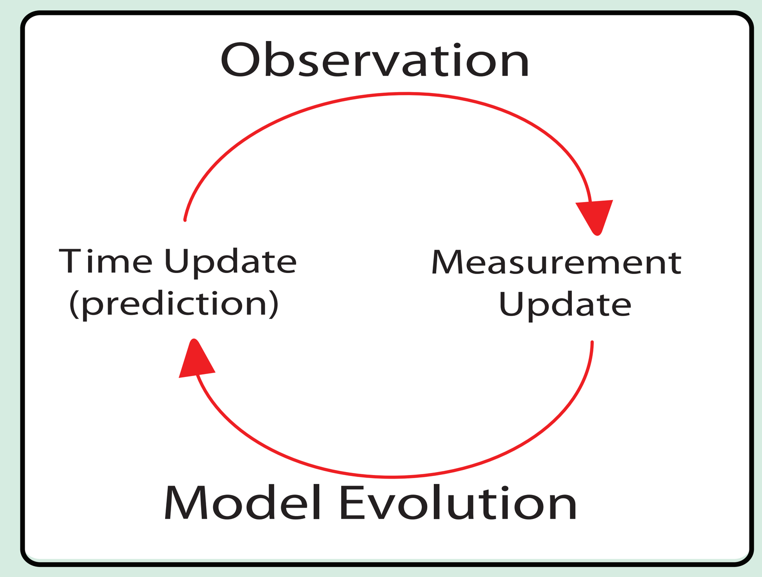
Advection and diffusion were assumed in both media, as well as radiative loss to space and dissipative processes.

Data was assimilated into the state space model using a linear Kalman filter.

State Space Model



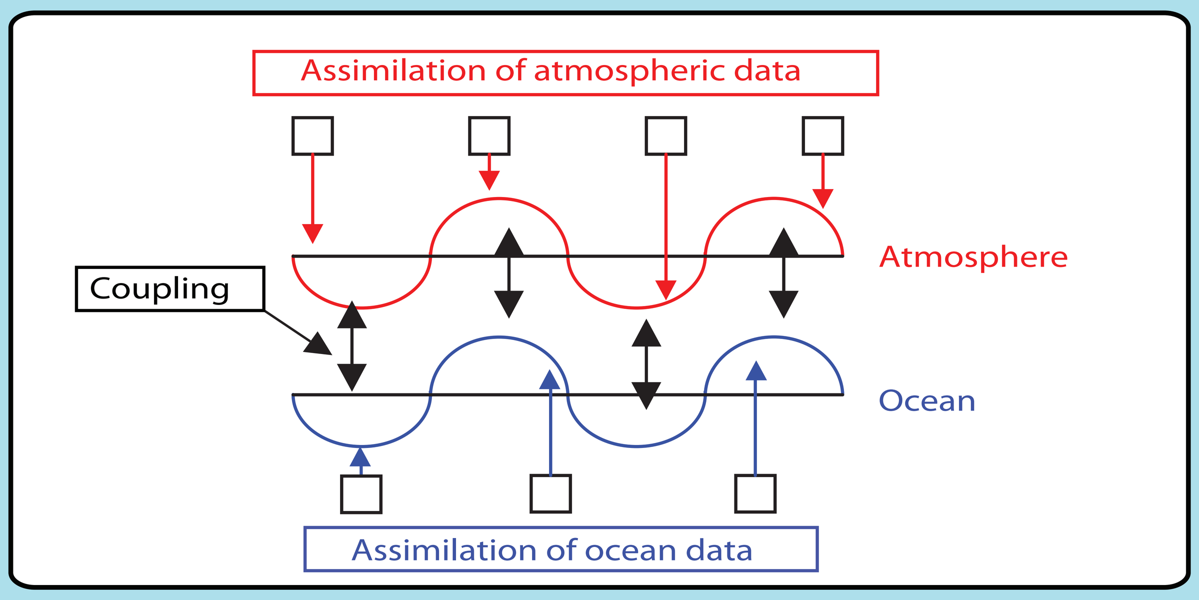
Kalman Filter



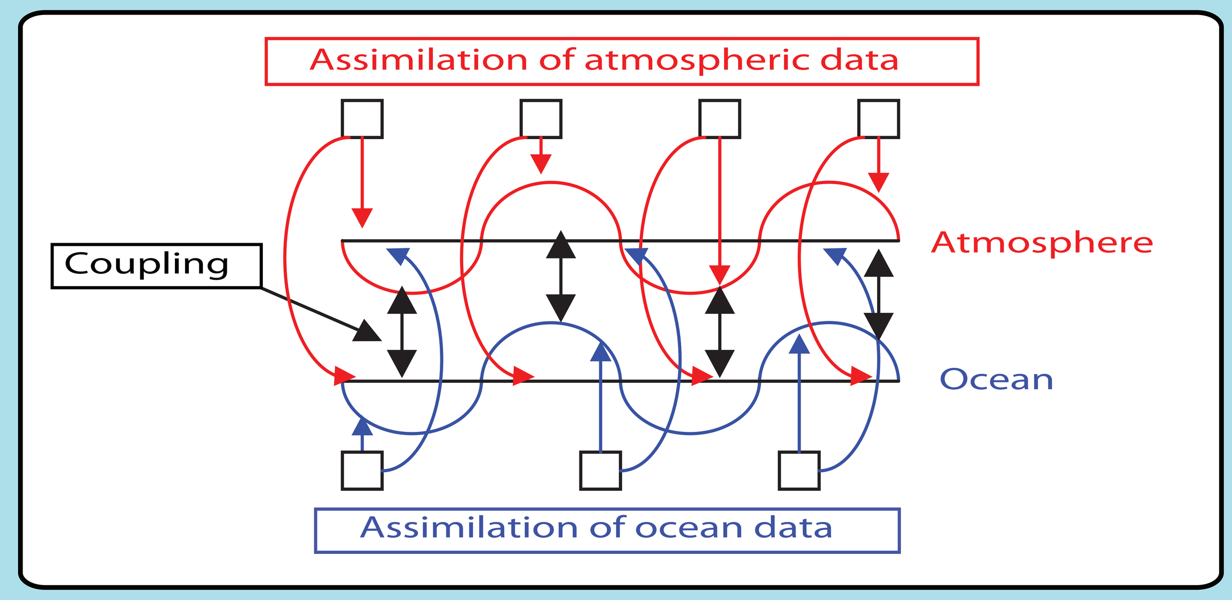
Methodology

In independent data assimilation, data from the ocean or atmosphere is used to update values in that medium only whereas in joint assimilation, data from one medium is used to update the values in both media.

Independent Assimilation



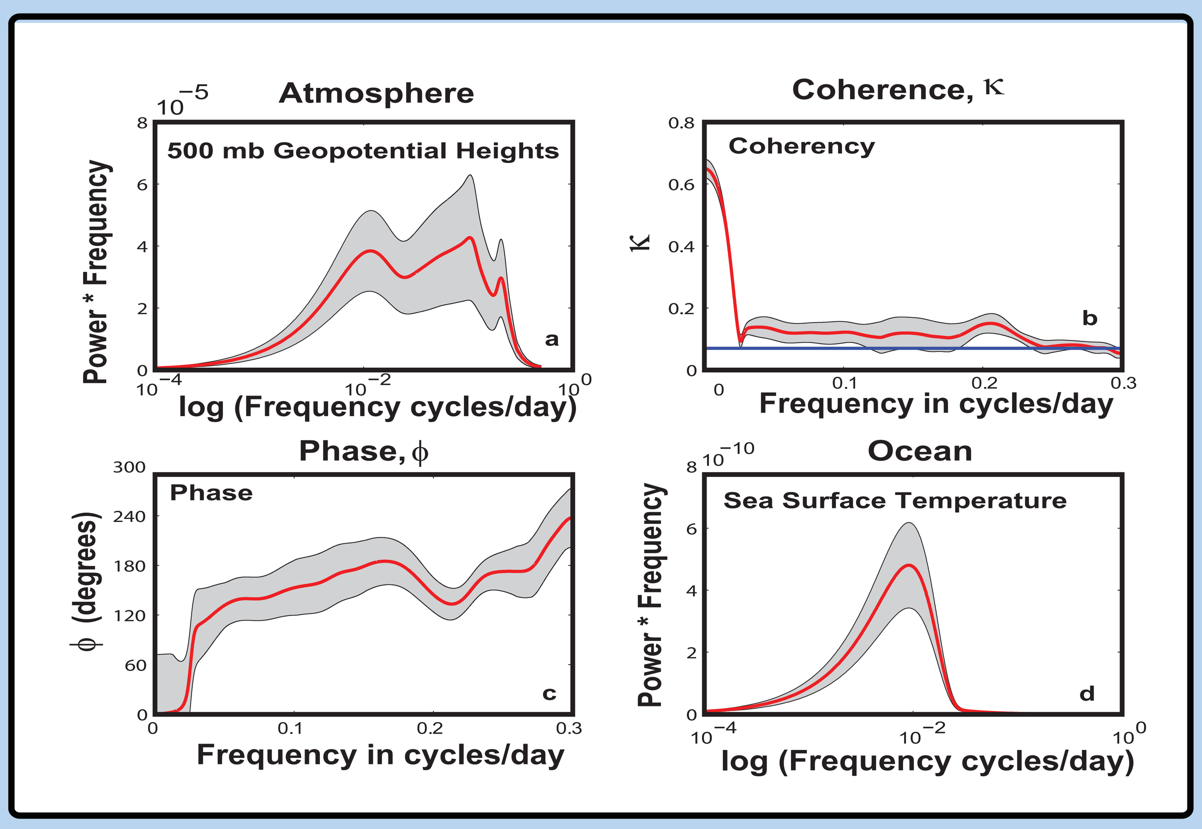
Joint Assimilation



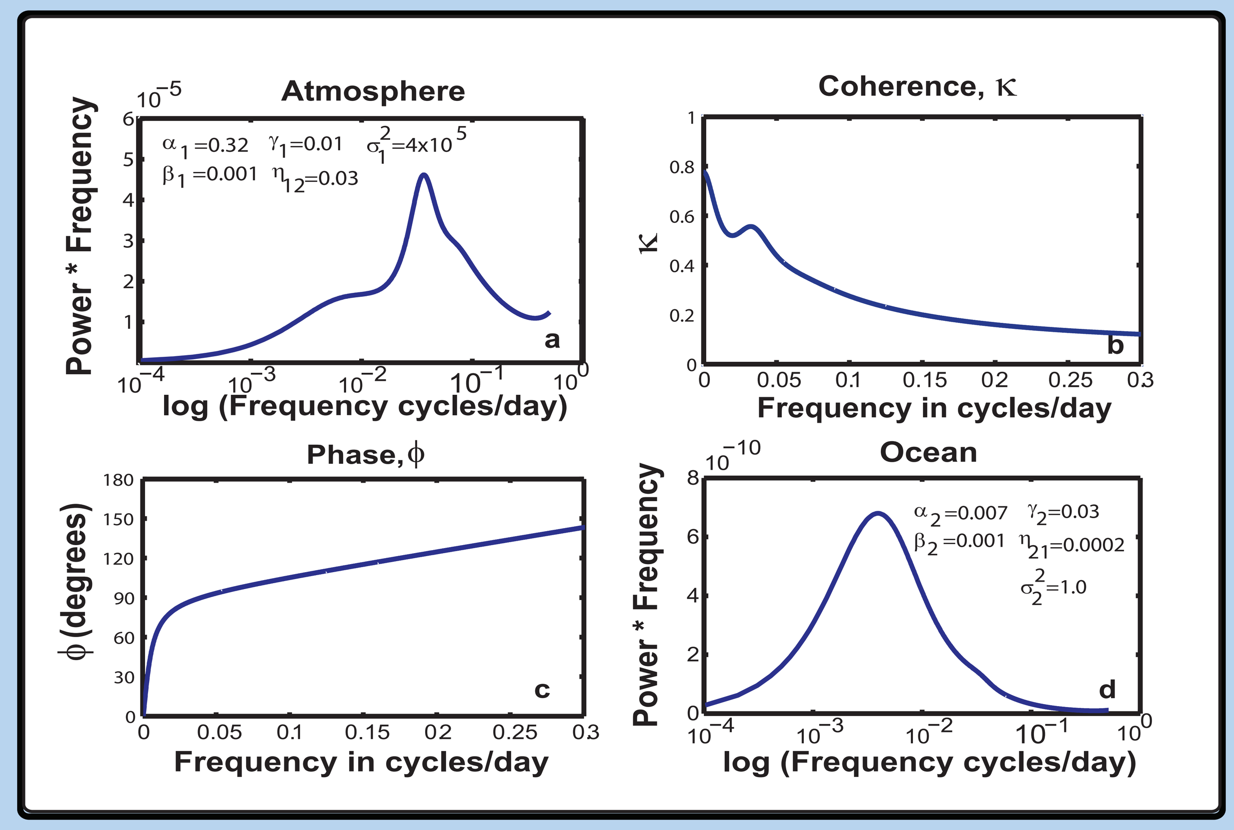
Model Constraints

Spectral analyses were carried out for SST and 500 Geopotential height from CCCma's CanESM2 Earth system model. The global data was subdivided into atmosphere/ocean sectors and spatially averaged over these sectors to compare with the state space model. Cross spectral analyses were used to constrain the state space model parameters.

CanESM2 Spectral Analysis



State Space Model Parameter Fit



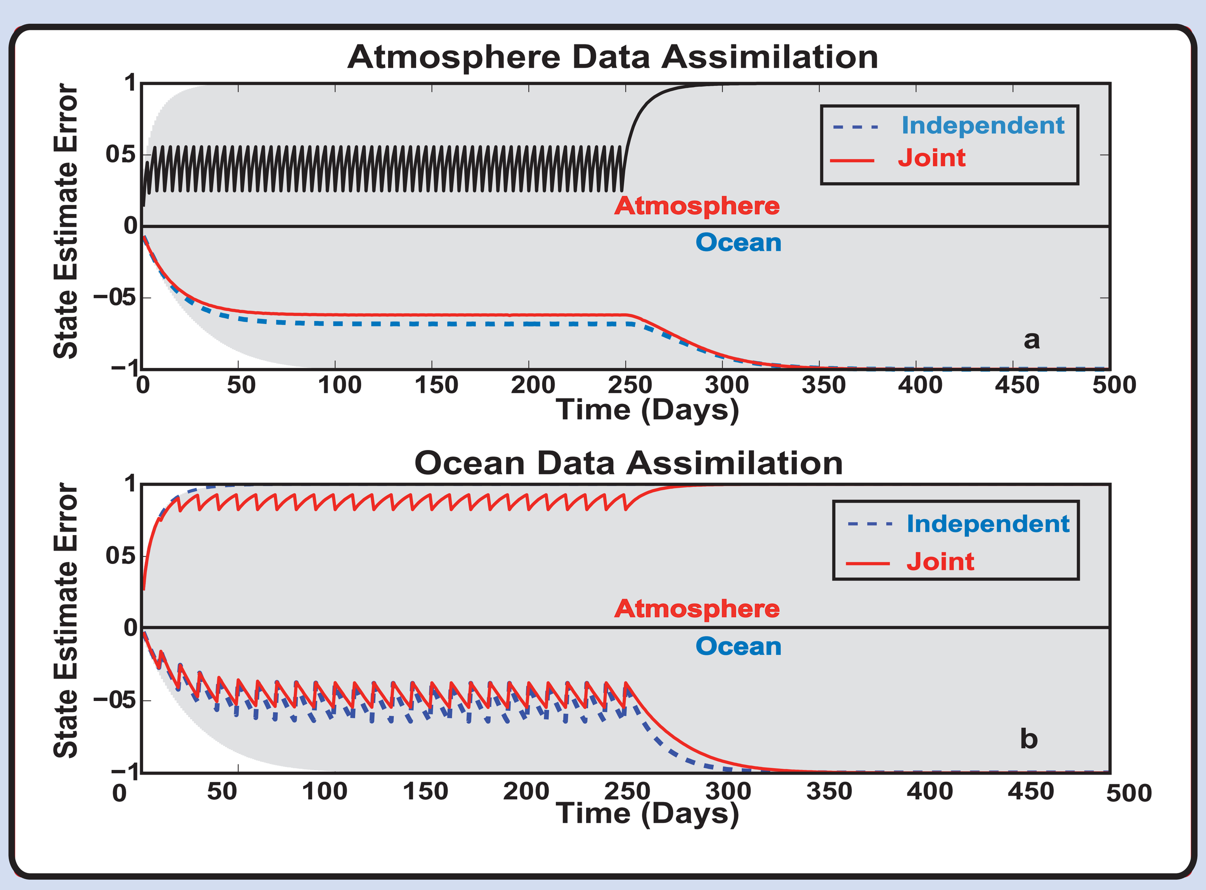
Results and Conclusions

Joint assimilation of ocean data is found to significantly reduce the errors in the atmosphere.

Little to no improvement, however, is observed during joint assimilation of atmosphere data for either the atmosphere or ocean.

The ocean state estimate errors are found to be sensitive to atmospheric forcing and the coupling dynamics.

Independent and Joint Assimilation Results (State Estimate Errors)



References

Arora, V.K., J.F. Scinocca, G.J. Boer, J.R. Christian, K.L. Denman, G.M. Flato, V.V. Kharin, W.G. Lee and W.J. Merryfield, Carbon emissions limits required to satisfy future representative concentration pathways of greenhouse gases, Geophys. Res. Lett., 38, L05805, 2011.

Bouttier, F., and P. Courtier, Data assimilation concepts and methods, Meteorological Training Course Lecture Series, 2001.

Thacker, W.C., Three lectures on fitting numerical models to observations, GKSS 87/E/65, 1988.

Welch, G., and G. Bishop, An introduction to the Kalman Filter, UNC-Chapel Hill, TR95-041, 2006.

This research was conducted through the Global Ocean-Atmosphere Prediction and Predictability (GOAPP) network funded by the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS).

GOAPP
Global Ocean-Atmosphere Prediction and Predictability

Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)
Foundation canadienne pour les sciences du climat et de l'atmosphère (FCSCA)