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Toward a coupled ocean-atmosphere data assimilation system: impact examination from the viewpoint of assimilated satellite radiances

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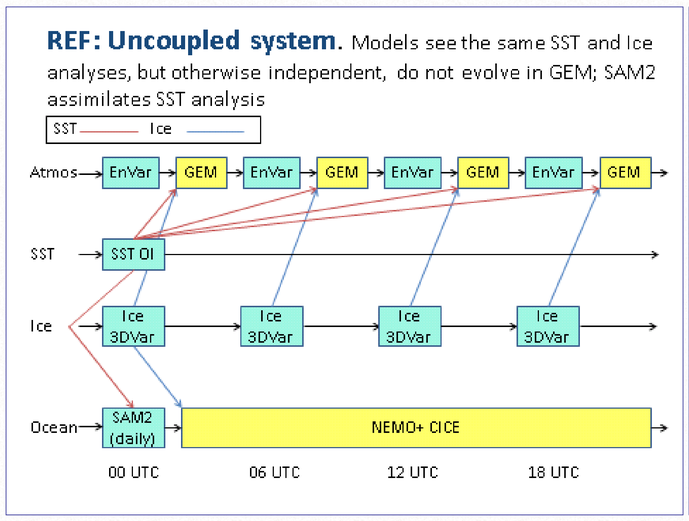
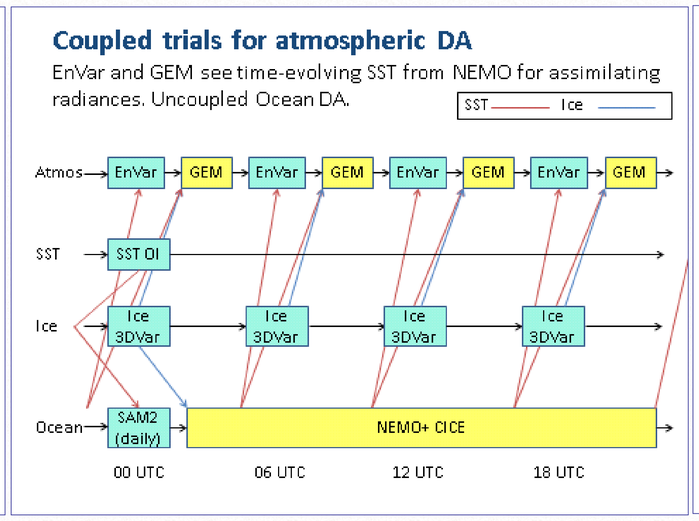
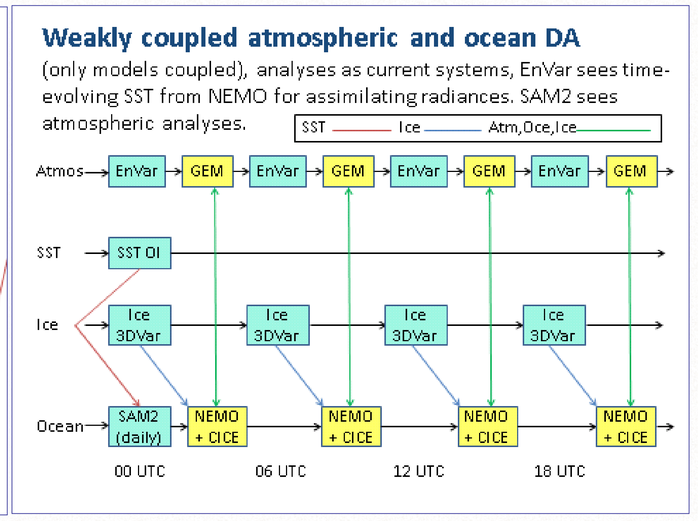
Introduction

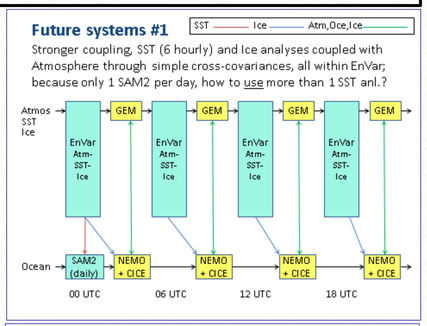
In this poster, we present preliminary results of coupled data assimilation experiments performed in the Environment and Climatic Change Canada. The positive impact of using a coupled atmosphere-ocean-sea-ice models was recently demonstrated. Here, we describe first coupled data assimilation experiments where 1) the atmospheric background was computed using coupled model with evolving sea surface temperature (SST) and sea ice and uncoupled ocean data assimilation system; 2) weakly coupled atmospheric and ocean-sea-ice data assimilation systems. We show the impact of evolving SST on the observation-minus-forecast (OmF) statistics of the assimilation of the sensible to the surface temperature instruments AIRS (channels 787, 950), IASI (channels 1090,1133), CrIS (channels 427, 534).

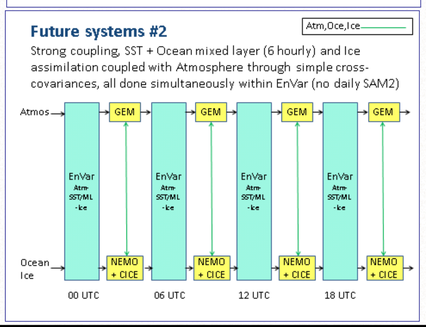
Description of the assimilation systems







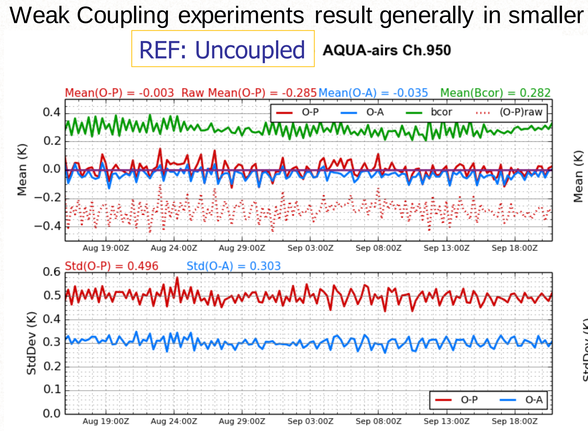


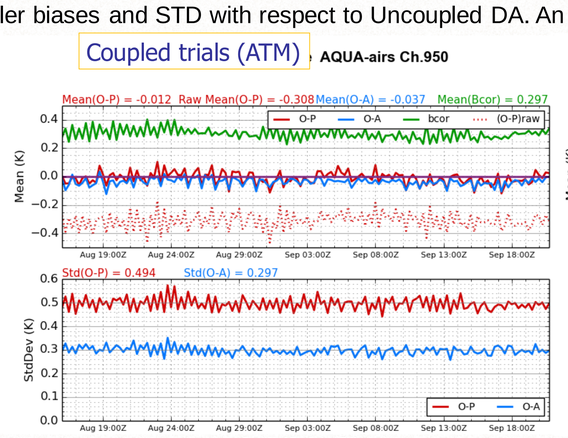


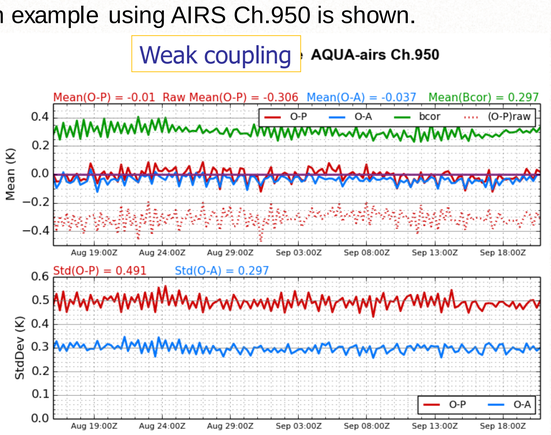
Current and future DA schemes (analyses only). EnVar: atmospheric hybrid data assimilation (50 km hor.resolution increments); GEM: global atmospheric model (25 km hor.resolution); SST OI: independent data assimilation based on Optimal Interpolation to compute daily mean SST analyses; SAM2: ocean data assimilation method is derived from the Kalman filter; NEMO-CICE: coupled global ocean-sea-ice model (1˚x1˚, 1/3˚ meridionally near the equator. 10-day forecast are computed within each system twice a day: at 00 and 12 UTC.

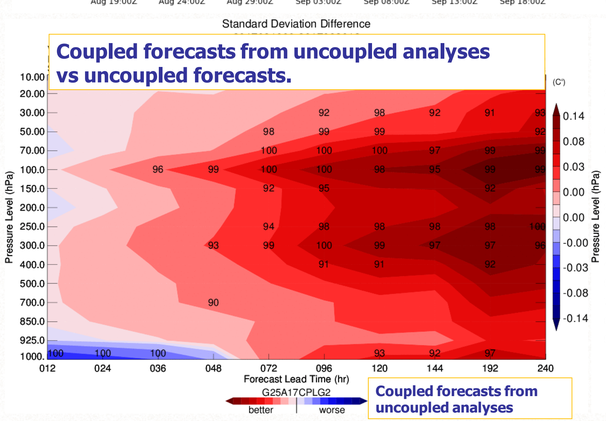
Assimilation experiments

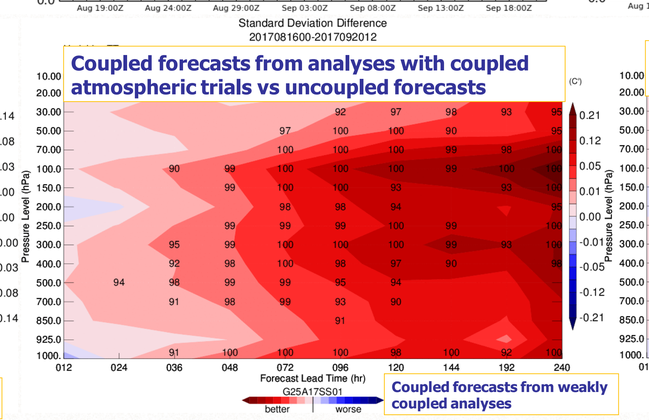
Data assimilation experiments are run from 2017-08-16 to 2017-09-21, the period of four hurricanes in the Atlantic: Harvey, Hose, Irma and Maria. All three experiments show similar global OmF/OmA statistics, though Coupled Trials and Weak Coupling experiments result generally in smaller biases and STD with respect to Uncoupled DA. An example using AIRS Ch.950 is shown.

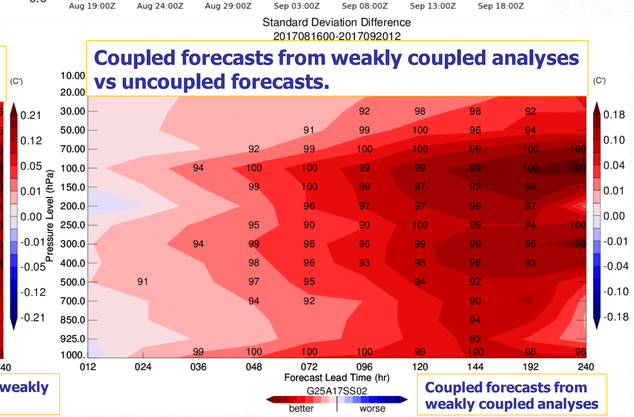


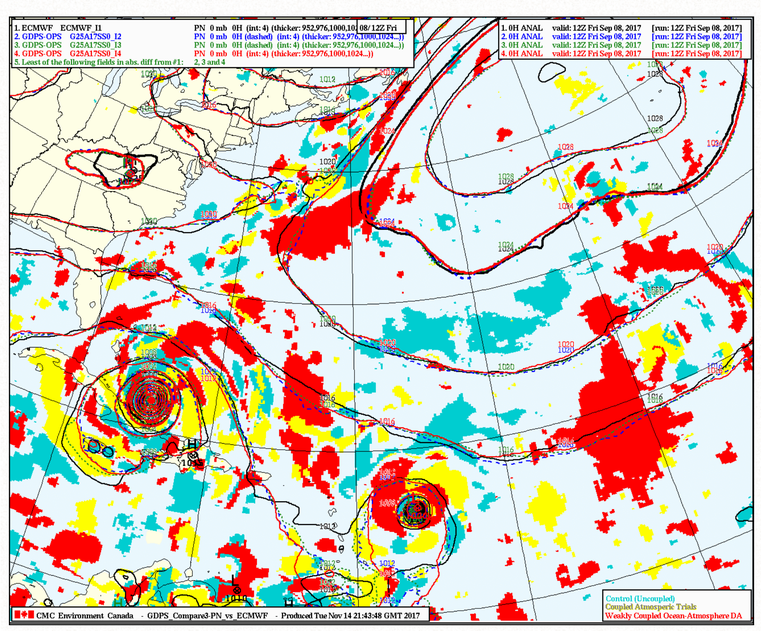












Hurricane positions (as seen by Sea Level Pressure) on 2017-09-08-12 for uncoupled (blue contours), coupled atmospheric trials (green) and weak coupling (red) compared to ECMWF analyses (black). Corresponding colored areas (legend) show which experiment results in the smallest absolute difference between our analyses and ECMWF analyses.

STD difference on temperature with respect to own analyses as a function of forecast lead time. The most significant improvement of the uncoupled forecast is demonstrated using coupled model forecasts. However, the coupled forecasts result in slightly worse temperature near the surface for the first 36h due to re-initialization from uncoupled oceanic analyses. This problem disappears when using coupled atmospheric trials and the weak coupling between ocean and atmosphere DA. These last two systems result in essentially similar forecast quality.

Conclusion and final remarks

A coupled ocean-atmosphere model is now run operationally at ECCC providing forecasts of significantly better quality than uncoupled forecasts. The use of coupled trials in the atmospheric DA further improves the analyses (smaller OmF STD and bias for instruments sensible to the surface). The weakly coupled ocean and atmosphere DA system show results similar to the system with coupled atmospheric DA only (and uncoupled ocean DA). The performance of both coupled DA system remains limited by using the daily SST analysis. This issue will be addressed using SST analyses computed with atmospheric EnVar data assimilation 4 times per day capturing the diurnal cycle. This will be the subject of further research and development toward stronger coupling.