Near-real-time satellite-based bias corrections for ocean model forecasts

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Background

Atmospheric heat fluxes at the ocean surface are used to force operational ocean models. The required heat fluxes include solar radiation, longwave radiation, sensible heat flux, and latent heat flux. These forcing fields come from atmospheric numerical weather prediction (NWP) models, which often have biases. Monthly or yearly bias correction can be identified and applied to these fields prior to starting the model forecast. However, when changes occur in the atmospheric model, i.e. model version updates, new bias corrections must be calculated which is often a time intensive process. The NWP model of interest in this study is the Navy Global Environmental Model (NAVGEM).

NFLUX

An alternative to NWP models is the Naval Research Laboratory (NRL) ocean surface flux system (NFLUX). NFLUX is a complete end-to-end data processing, automated quality control, and 2D assimilation system. This system provides near-real-time satellite-based 3-hourly gridded analysis fields over the global ocean for the following near-surface parameters:

- Specific humidity
- Air temperature
- 10-meter wind speed
- Solar radiation
- Longwave radiation

NFLUX and NAVGEM Performance

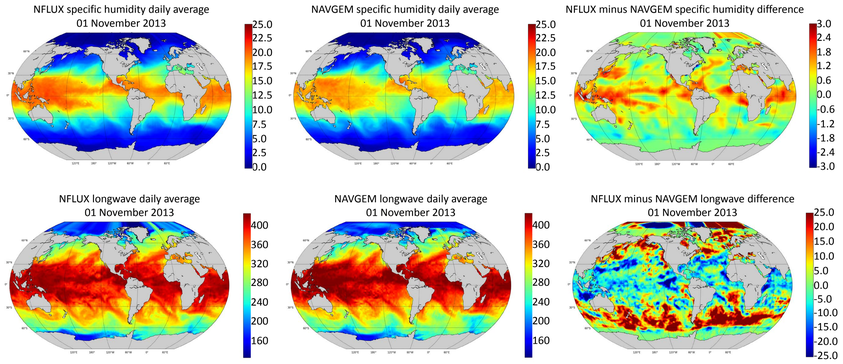
	N	Bias	RMSE	R^2
NFLUX specific humidity (g kg^{-1})	128,086	0.33	1.25	0.96
NAVGEM specific humidity (g kg^{-1})	128,086	-0.49	1.28	0.96
NFLUX air temperature (°C)	199,944	0.24	1.25	0.98
NAVGEM air temperature (°C)	199,944	-0.30	1.25	0.98
NFLUX 10m wind speed (m s^{-2})	194,649	0.21	2.07	0.64
NAVGEM 10m wind speed (m s^{-2})	194,649	-0.33	2.17	0.63
NFLUX solar radiation (W m^{-2})	34,495	12.56	140.80	0.89
NAVGEM solar radiation (W m^{-2})	34,495	2.66	160.59	0.85
NFLUX longwave radiation (W m^{-2})	42,130	-2.94	23.00	0.87
NAVGEM longwave radiation (W m^{-2})	42,130	-3.77	27.59	0.85

Method

NAVGEM provides the surface forcing fields to several operational ocean model systems, including the Global Ocean Forecast System (GOFS). The satellite-based NFLUX analysis fields are used to determine the NAVGEM bias corrections in near-real-time. NFLUX minus NAVGEM model differences provide bias corrections over the hindcast period. The recent history (days to weeks) of these differences are then used to determine long term and short term bias corrections, which are applied to the forcing over the forecast period.

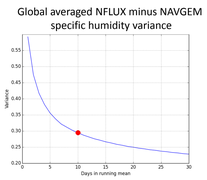
Forecast Bias Corrections

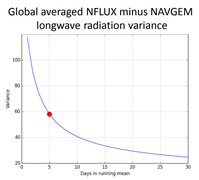
Long term (persistent) and a short term (weather-dependent) bias corrections are applied to the forecast period using unique averaging windows and decorrelation times for each parameter. These elements are determined from the recent history of NFLUX minus NAVGEM daily average difference fields.



Bias Averaging Windows

The averaging windows for the long term and short term bias corrections are determined from the NFLUX minus NAVGEM daily average time series for one year. For each ocean point, the variance of the n-day average difference time series is calculated, where n ranges from 1 to 30 days. The long term averaging window is identified when the calculated n-day variance becomes less than half of the original variance calculated from the 1-day average difference time series. All ocean points are averaged together to determine a single global long term bias correction averaging window for each parameter:





- 10 days – specific humidity
- 11 days – air temperature
- 5 days – wind speed, solar radiation, longwave radiation

The short term bias correction is determined by subtracting the long term bias from the NFLUX minus NAVGEM daily average time series.

Publications

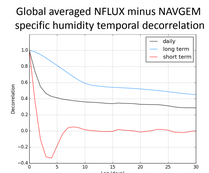
- May, J. C., C. Rowley, and N. Van de Voorde, 2016: The Naval Research Laboratory ocean surface flux (NFLUX) system: Satellite-based turbulent heat flux products. *J. Appl. Meteor. Climatol.*, **55**, 1221-1237, doi:10.1175/JAMC-D-15-0187.1.
- May, J. C., C. Rowley, and C. N. Barron, accepted: NFLUX satellite-based radiative heat fluxes Part I: Swath-level products. *J. Appl. Meteor. Climatol.*, accepted.
- May, J. C., C. Rowley, and C. N. Barron, accepted: NFLUX satellite-based radiative heat fluxes Part 2: Gridded products. *J. Appl. Meteor. Climatol.*, accepted.

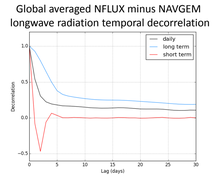
Acknowledgements

This work was funded of the Office of Naval Research under the Naval Research Laboratory project Calibration of Ocean Forcing with Satellite Flux Estimates.

Bias Decorrelation Time Scales

The decorrelation time scales for the long term and short term bias corrections are also determined from the NFLUX minus NAVGEM daily average time series for one year. For each ocean point in the time series, decorrelation times are calculated using the long term and short term biases from the previous 30 days. The decorrelation times are averaged together to produce a single globally averaged long term and short term temporal decorrelation for each parameter. The long term bias correction is applied throughout the entire forecast. The short term bias correction is applied with a decreasing weighting function from the analysis time out to:





- 2 days – specific humidity and air temperature
- 1 day – wind speed, solar radiation, longwave radiation

Long Term vs Short Term Biases