A Look at Short-Range Forecast Impacts of Drifting Buoy Observations in the NASA GEOS-5 Atmospheric Data Assimilation System

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NASA/GMAO GEOS-5 Observation Impact Monitoring

http://gmao.gsfc.nasa.gov/products/forecasts/systems/fp/obs_impact/

The following results are from the routine observation impact monitoring of NASA/GMAO's GEOS-5 atmospheric data assimilation system, focused here on the months of July 2011 and January 2012

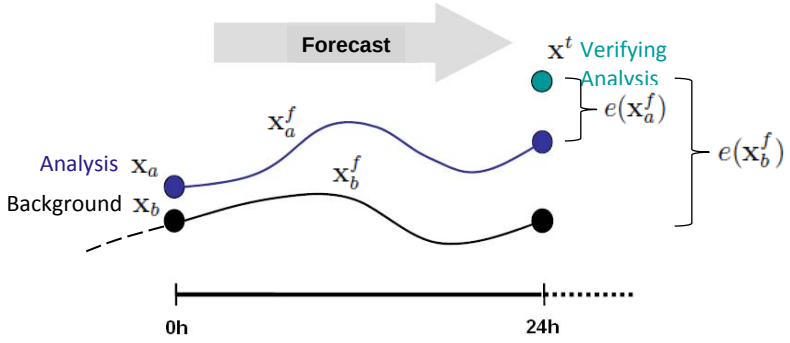
Observation impacts are computed daily using the adjoint of the GEOS-5 atmospheric data assimilation system, including the GEOS-5 global forecast model and Gridpoint Statistical Interpolation (GSI) analysis scheme

The metric is a 24-h global forecast error norm - dry total energy;

- Negative (positive) values indicate that assimilation of a given set of observation has improved (degraded) the 24hr forecast in terms of this metric

Definition of Observation Impact

following Langland and Baker (2004); extended for nonlinear analysis schemes by Trémolet (2008)

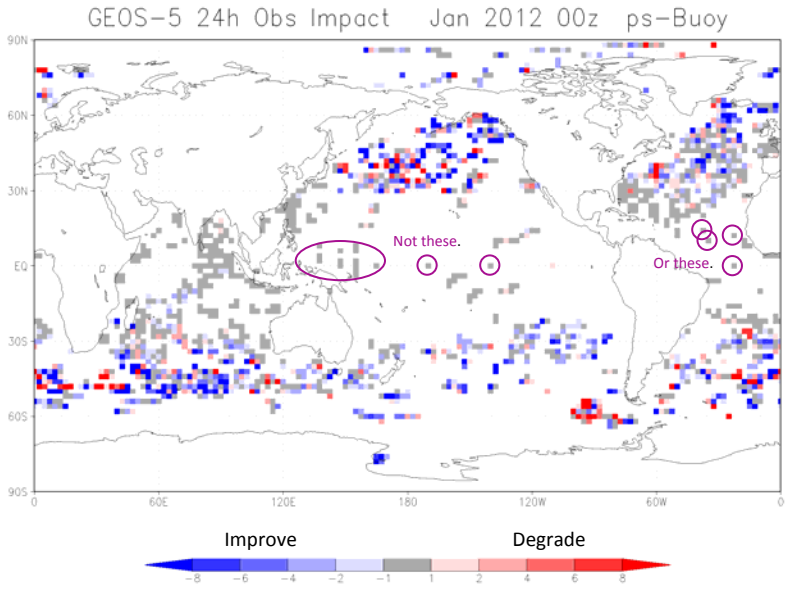


Observation Impact: $\delta e = e(\mathbf{x}_a^f) - e(\mathbf{x}_b^f)$

$\delta e < 0$ …the observation(s) improve the forecast

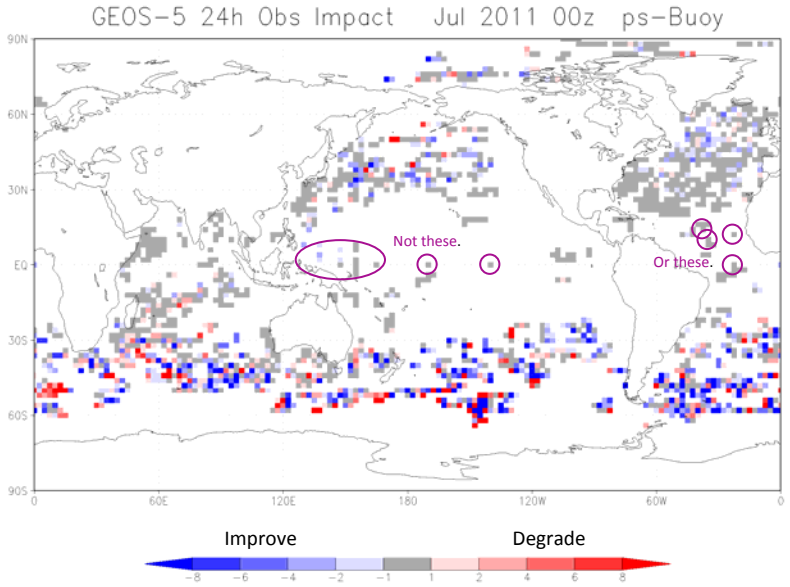
Identification of Drifting Buoy Observations

January 2012



Identification of Drifting Buoy Observations

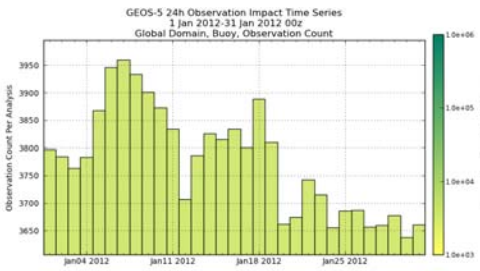
July 2011



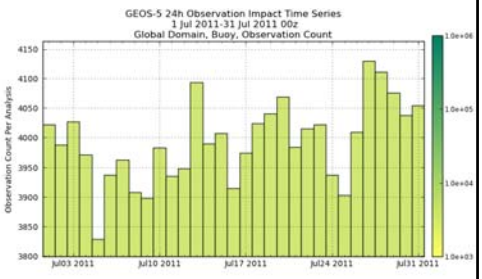
Time Series of Buoy Data Counts (Used)

Global Domain

January 2012



July 2011

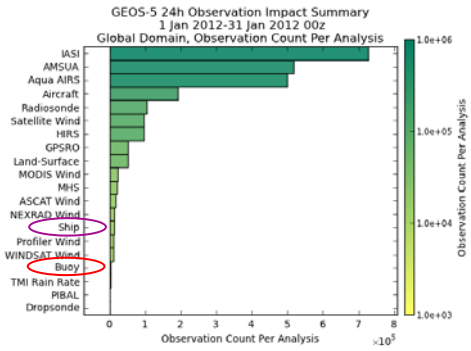


- 3,600 – 4,000 buoy observations assimilated per analysis (other marine surface observations ~14,000)
- Declining buoy count through January 2012 mostly in NH, presumably seasonal(?)

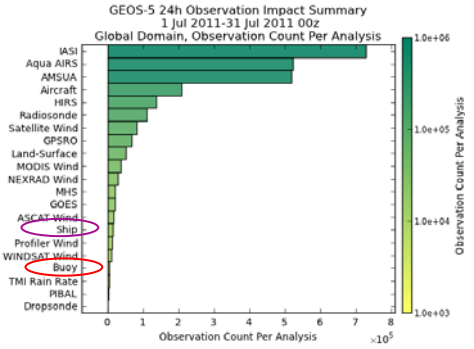
Summary of All Data Counts (Used)

Global Domain

January 2012



July 2011

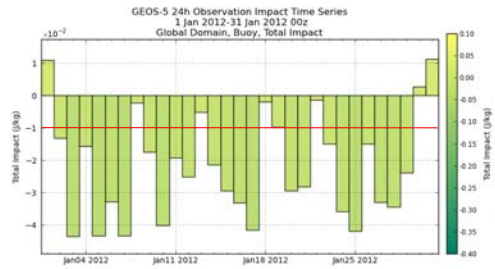


- Buoys are among the least numerous data types assimilated

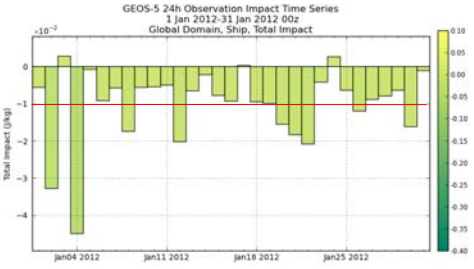
Time Series of Observation Total Impact

Global Domain, January 2012

Buoys



Ships, other marine sfc

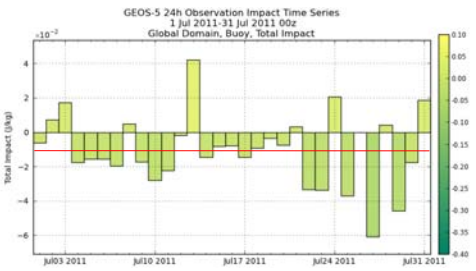


- Shading indicates magnitude of impact
- Buoys have comparable, perhaps slightly larger, total impact than ships plus other marine surface observations

Time Series of Observation Total Impact

Global Domain, July 2011

Buoys



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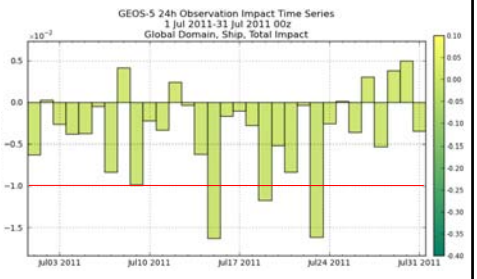

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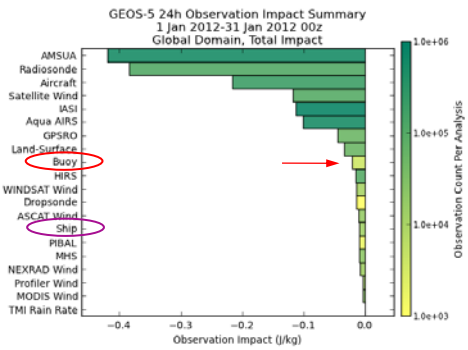
Summary of Observation Total Impact

Global Domain

January 2012



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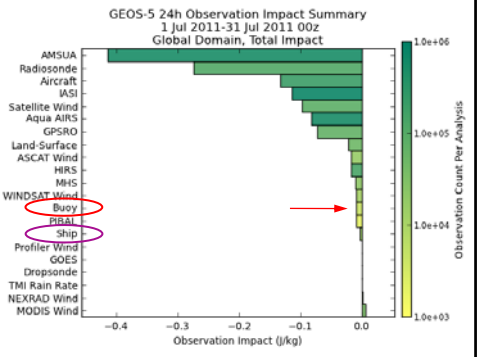
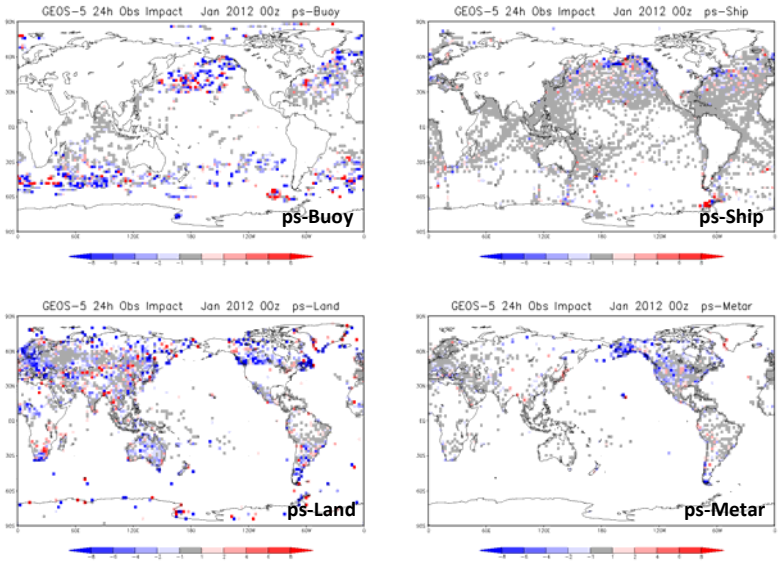


- Shading indicates observation count (buoys are among the least numerous data types assimilated)

Gridded Total Impact of Surface Pressure Observations

January 2012



Gridded Total Impact of Surface Pressure Observations

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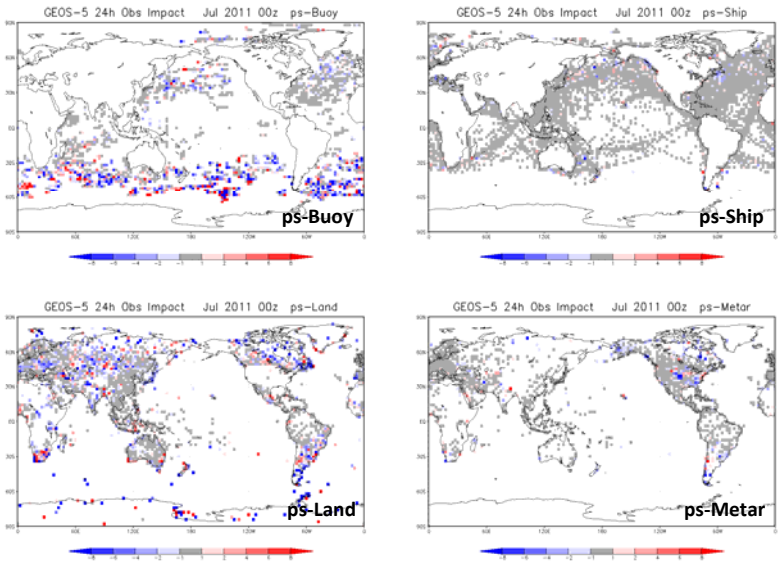
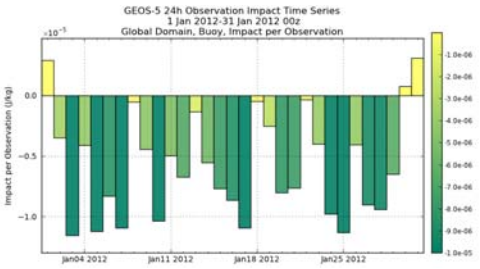


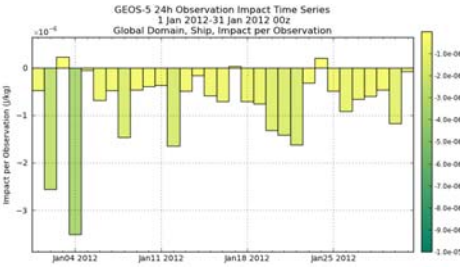
Time Series of Impact Per Observation

Global Domain, January 2012

Buoys



Ships, other marine sfc

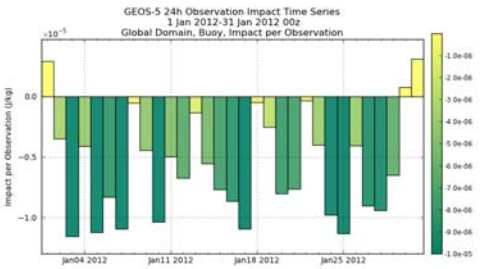


- Shading indicates magnitude of impact
- Buoys have much larger impact per-observation than all other marine surface observations

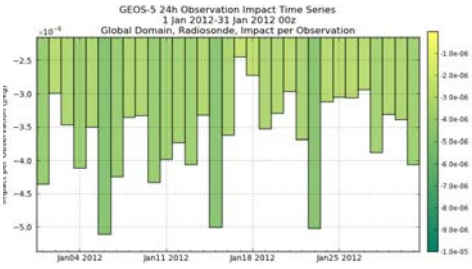
Time Series of Impact Per Observation

Global Domain, January 2012

Buoys



Radiosondes



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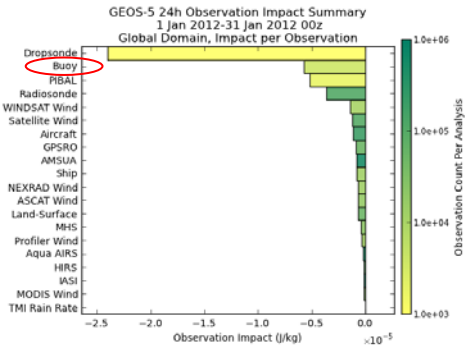
Summary of Impact Per Observation

Global Domain

January 2012



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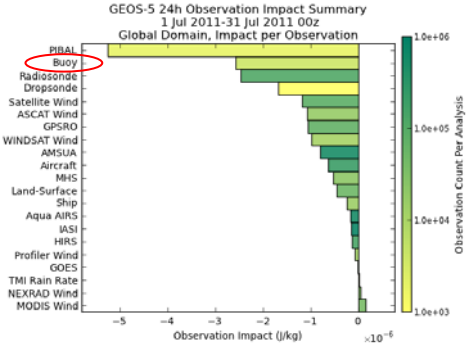
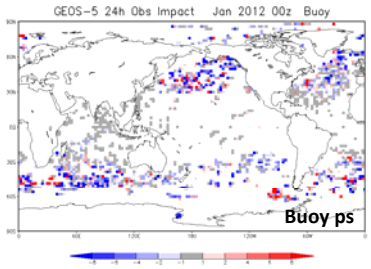
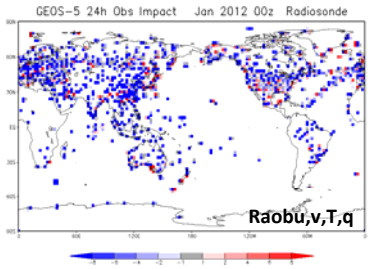


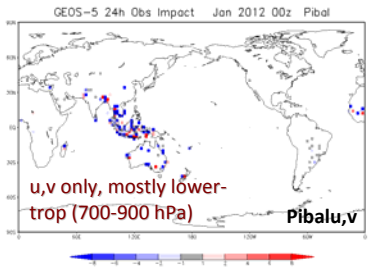
- On a per-ob basis, buoys have among the largest beneficial impacts of all observation types in terms of the 24h global error metric
- Only dropsondes in January and PIBALS in July have larger impact per ob

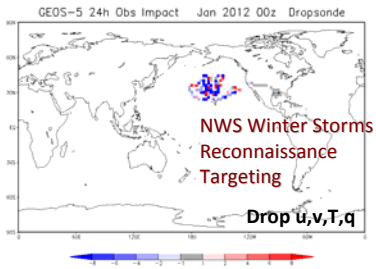
Gridded Observation Total Impact

January 2012









Gridded Observation Total Impact

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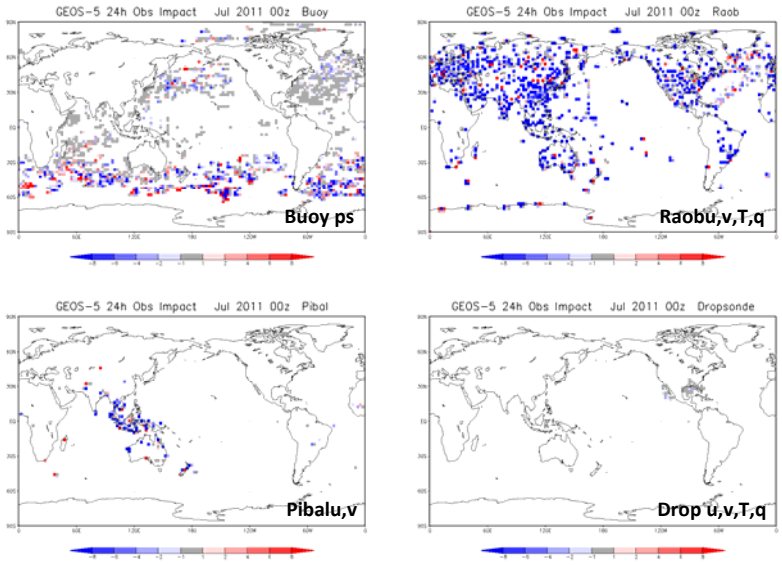
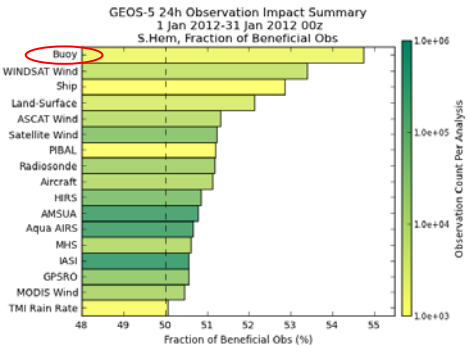


Fraction of Beneficial Observations

S. Hemisphere

January 2012



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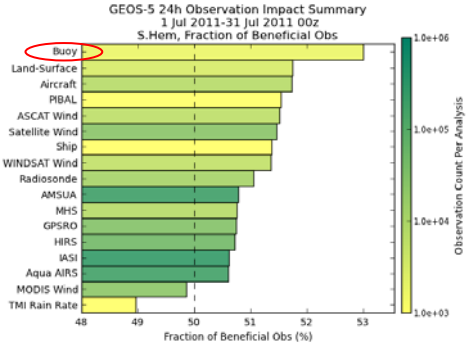

- Buoys have the largest or nearly largest fraction of beneficial observations in most locations (globe, NH, SH) in both seasons

Conclusion

- Though relatively few in number, surface pressure observations from drifting buoys provide measureable positive impact on short-range forecasts in a global sense.
- On a per-observation basis, buoys have among the largest beneficial impact (and fraction of beneficial observations) of all observation types in terms of the 24h global error metric.
- While not shown directly here, it would seem reasonable to assume that these data play an important role in anchoring the surface pressure field over oceanic regions, especially in the SH.