The impact of Argo on short-term coupled prediction

Robert King, Matt Martin, Isabelle Mirouze, Daniel Lea

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Outline

- Description of coupled system
- OSE analysis ocean impacts
- OSE analysis atmosphere impacts
- Forecast case study
- Summary

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Coupled data assimilation

- Eventual aim is to have a high resolution coupled system.
- Recently implemented a weakly-coupled DA system.
- On-going work to investigate impact of coupled DA on short-range prediction.
- This work aims to investigate the impact of Argo on coupled analyses and short-range forecasts.

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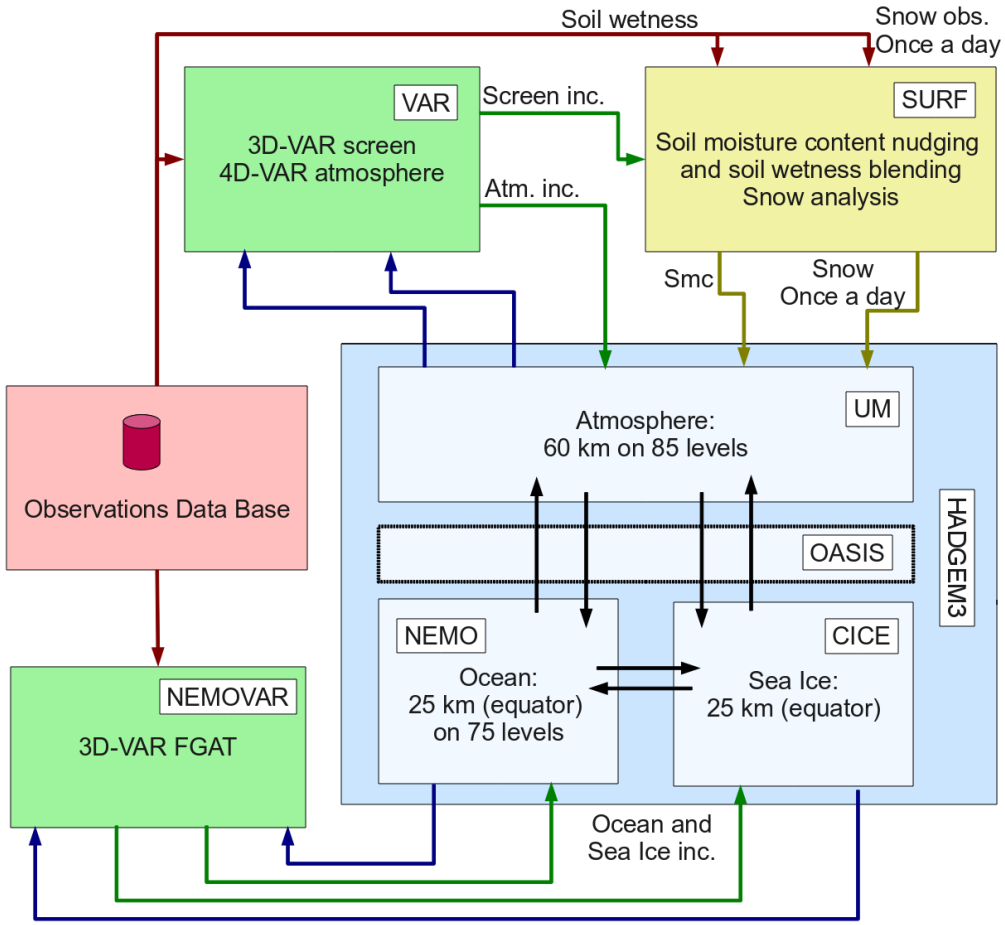
Coupled data assimilation system

- UM atmosphere N216 85L
- NEMO/CICE ocean ORCA025 75L
  - Hourly coupling
- Data assimilation
  - 4DVAR atmosphere plus land surface assimilation
  - 3DVAR ocean plus sea-ice concentration
  - 6-hour cycle
- Analysis runs
  - Dec 2011 – Dec 2012
- 2 case study forecast runs
  - 10-day forecast at 00Z and 12Z



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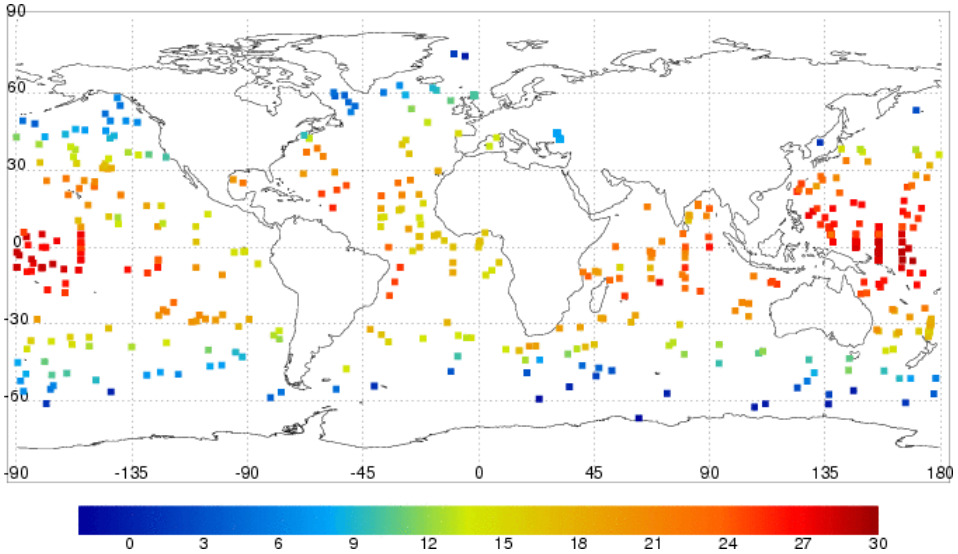
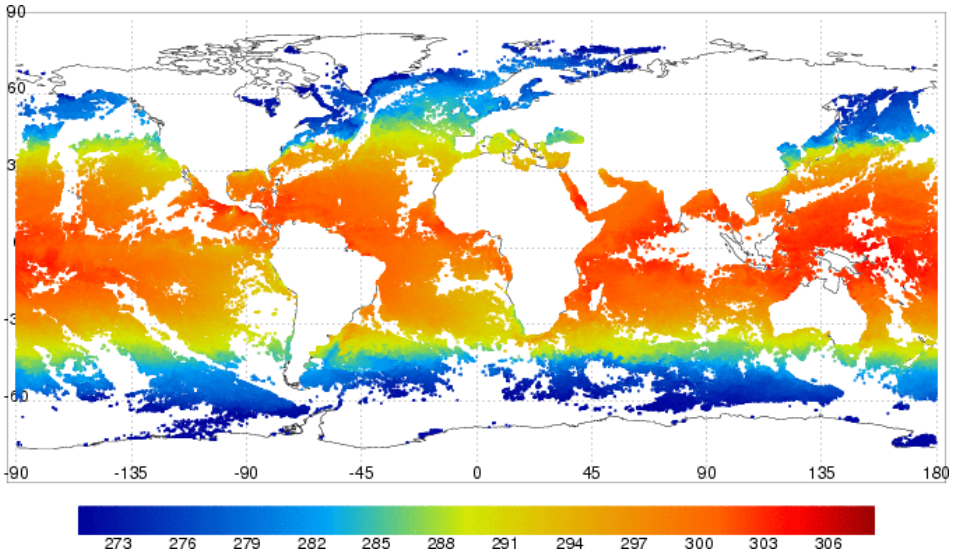
Observations assimilated

- Ocean
  - T/S profiles
  - SST
  - SLA
  - Sea-ice concentration



Temperature profiles at 100m depth for 1-day (Argo, moored buoys, XBTs, CTDs, marine mammals, gliders)



Satellite SST data for 1-day (NOAA/AVHRR, MetOp/AVHRR)

- Atmosphere
  - Temperature, wind, humidity and radiances from AIRS, IASI, ATOVS, GPSRO, SSMI, aircraft, radio-sondes, Surf-Scat
  - Already well-constrained

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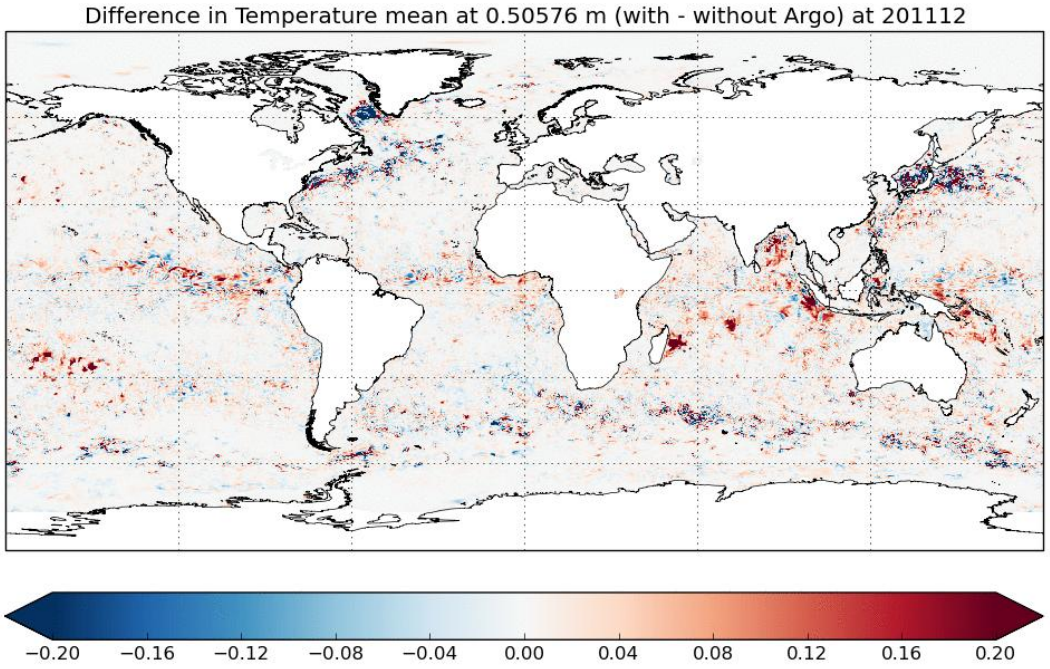
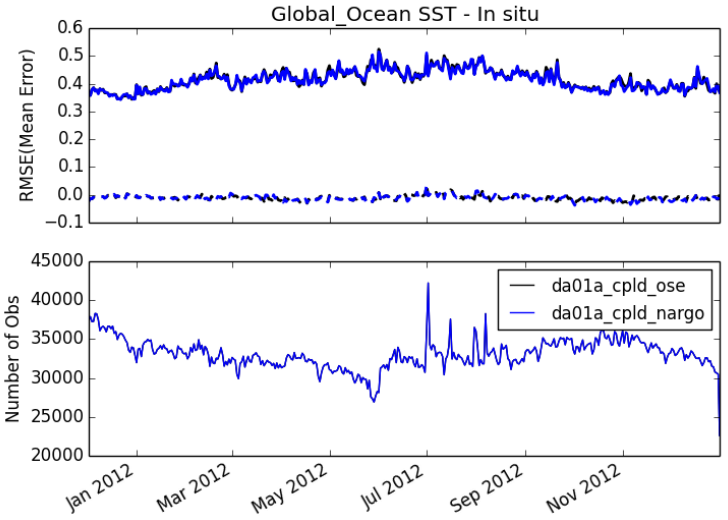
Coupled OSE – impact on SST

- SST assimilation in both the control and NoArgo run.
  - Effects mainly limited to equatorial regions and WBCs.



Monthly mean SST difference (K)



Time-series of global SST innovation mean error (dashed) and RMS error (solid) with and without Argo.

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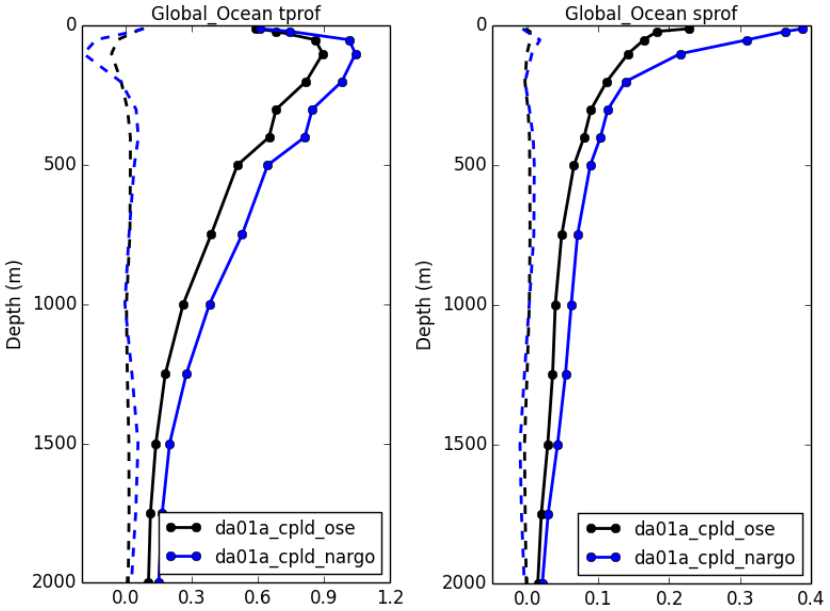
Sub-surface impact

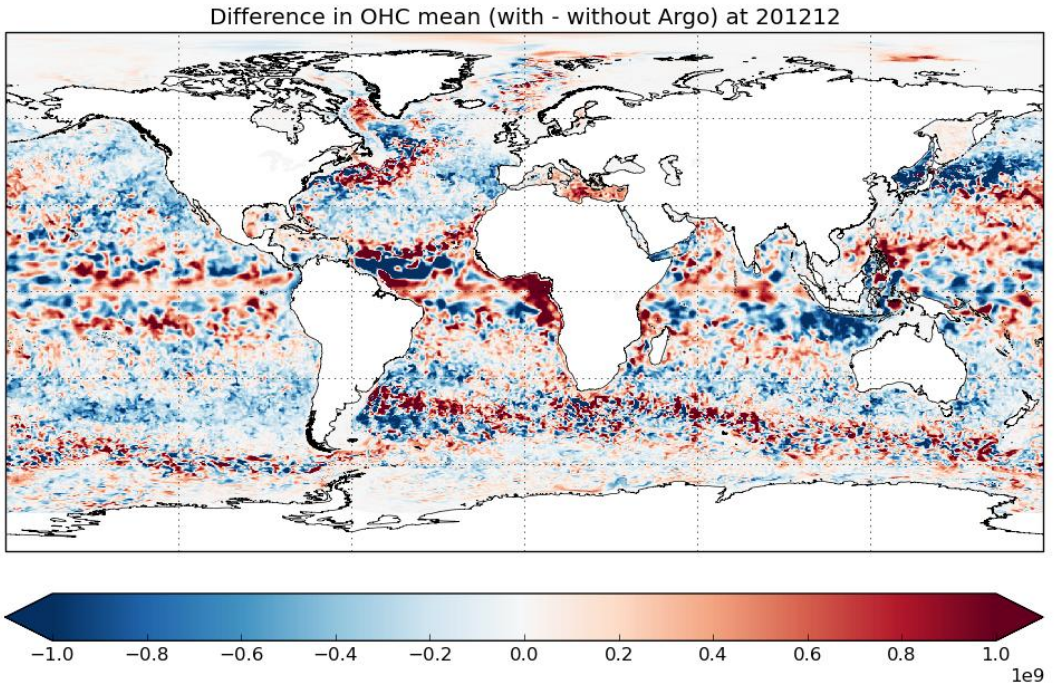
- Larger impact on sub-surface temperature

  Some equatorial differences stable over few months.

  Outside tropics and WBCs, general increase in upper-ocean heat content without Argo.



Global T/S innovation
mean error (dashed) and RMS error (solid)
over 13-month analysis
(with and without Argo).



Monthly mean ocean heat content difference (J)

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Sub-surface impact

- Larger impact on sub-surface temperature

  Some equatorial differences stable over few months.

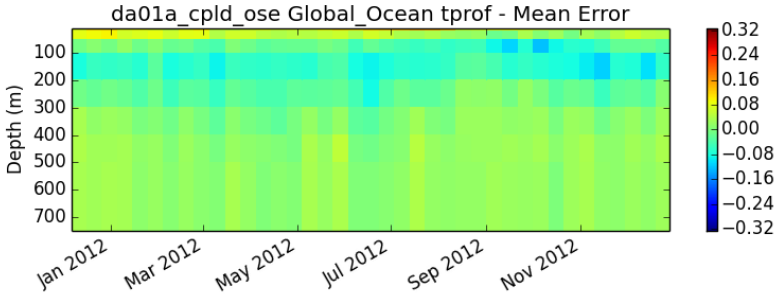
  Outside tropics and WBCs, general increase in upper-ocean heat content without Argo.

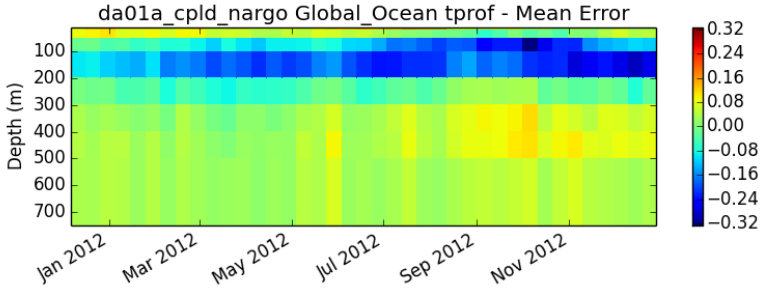
  Effects take several months to build – may not be complete by end of run.

CONTROL

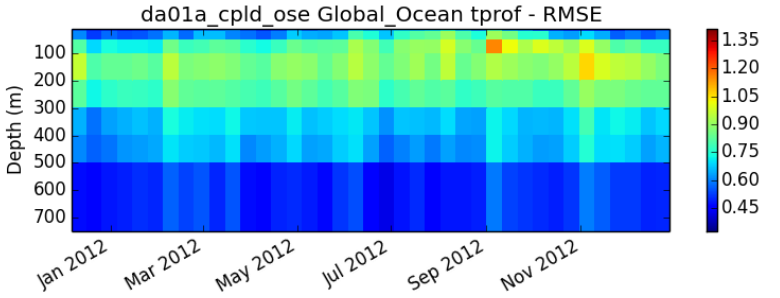
NO ARGO

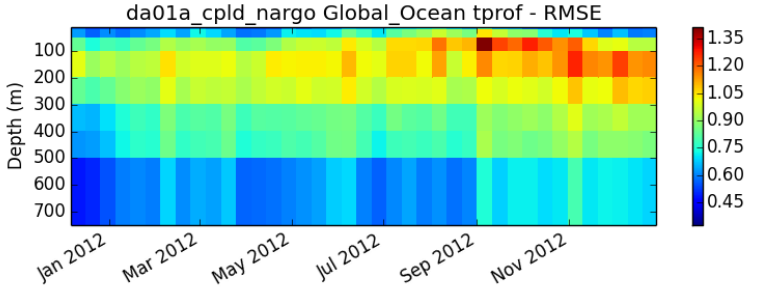
MEAN





RMS





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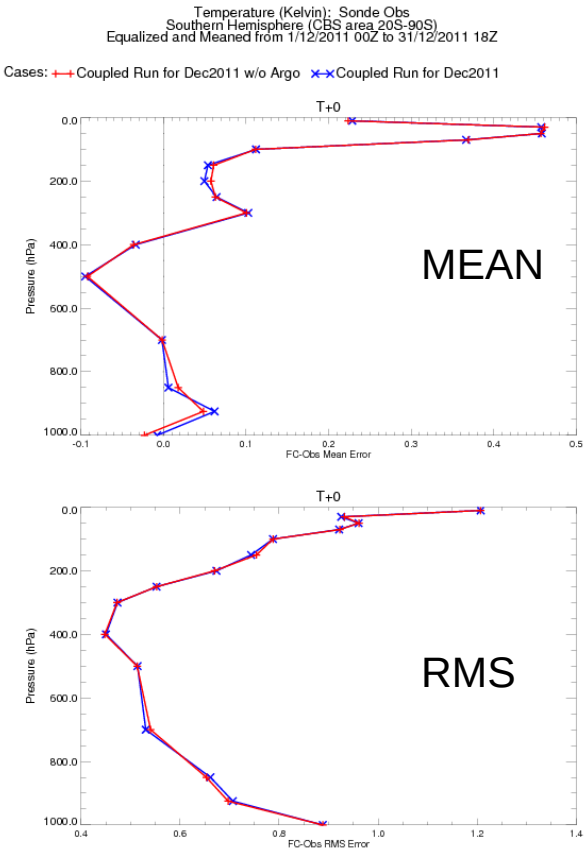
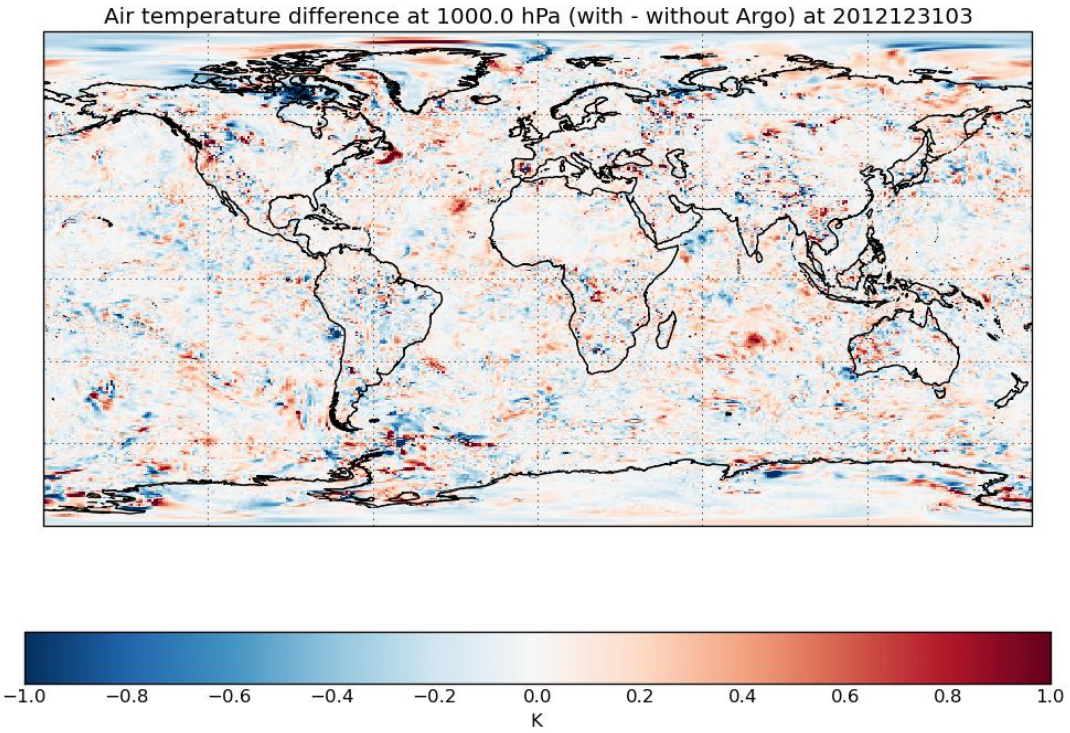
Atmosphere analysis impact

- Instantaneous field differences (with – without Argo) on last day of analysis run

  Observation-analysis statistics show little difference between control and no-Argo runs

  Both experiments assimilate all available atmosphere and SST observations.





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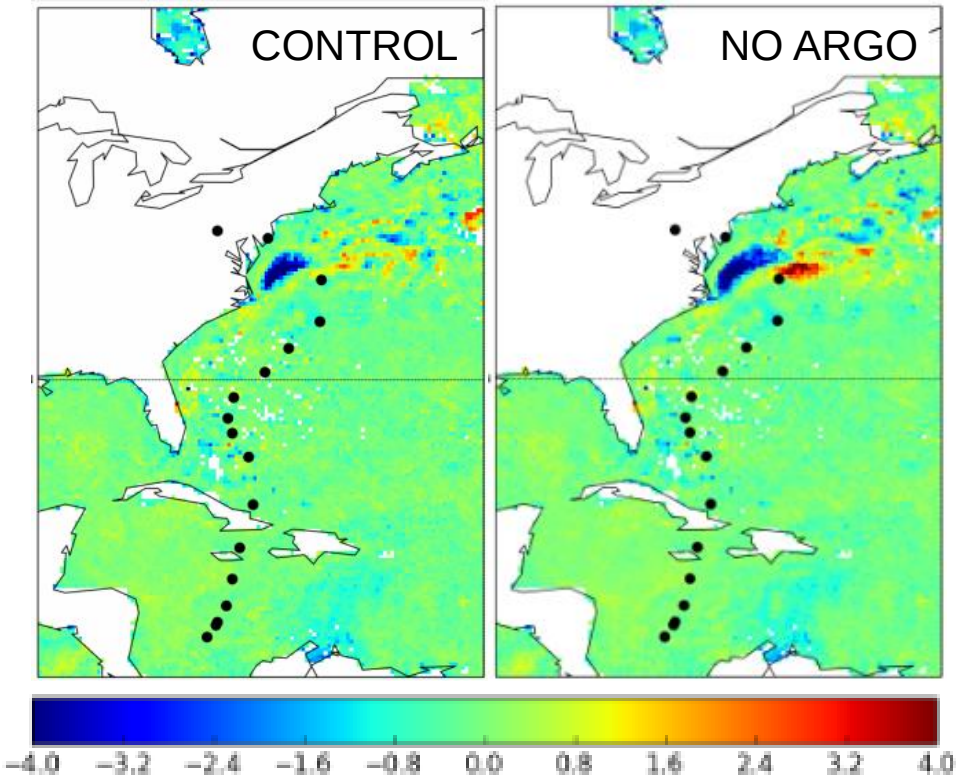
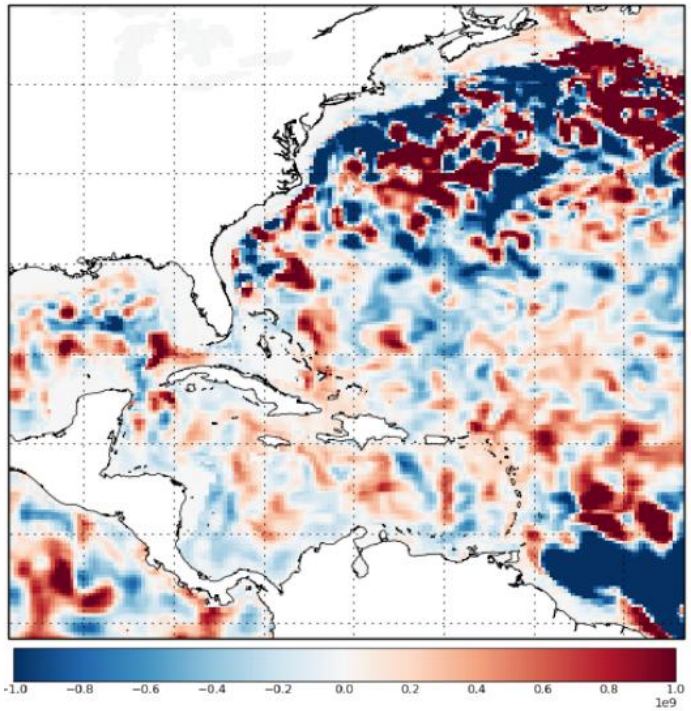
Hurricane Sandy

- 20-31 October – most destructive Atlantic storm of 2012 season.
- Obs-bkg shows better positioning of Gulf Stream with Argo.
- SST differences reflected in atmosphere analyses.





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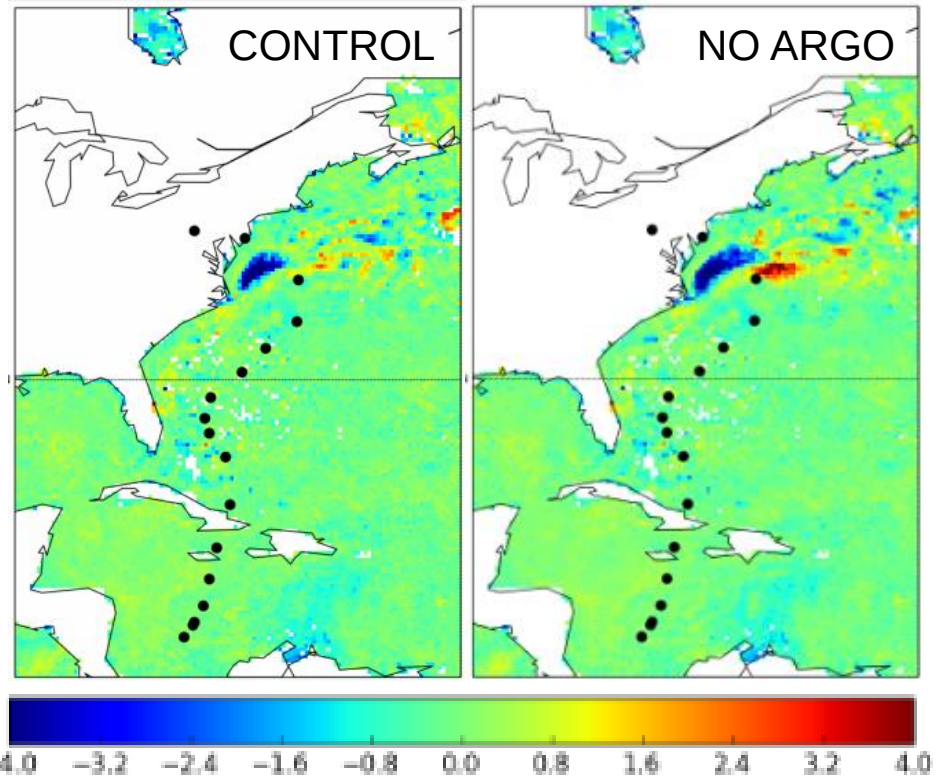

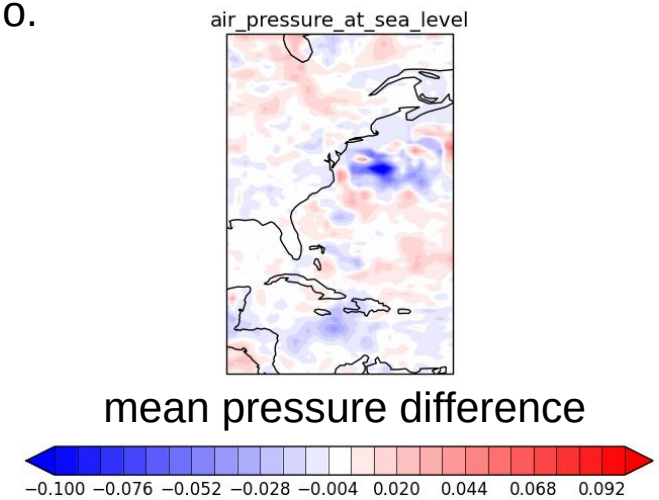

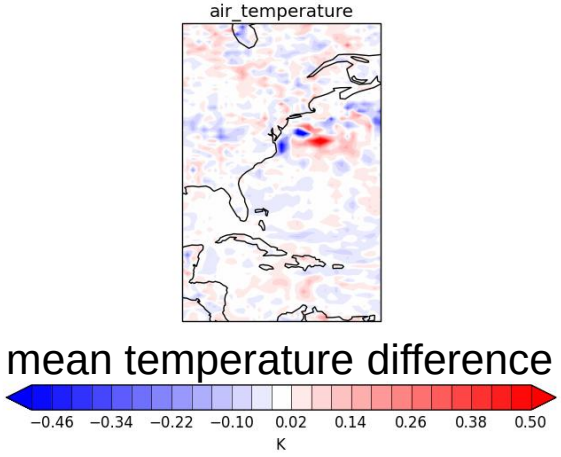

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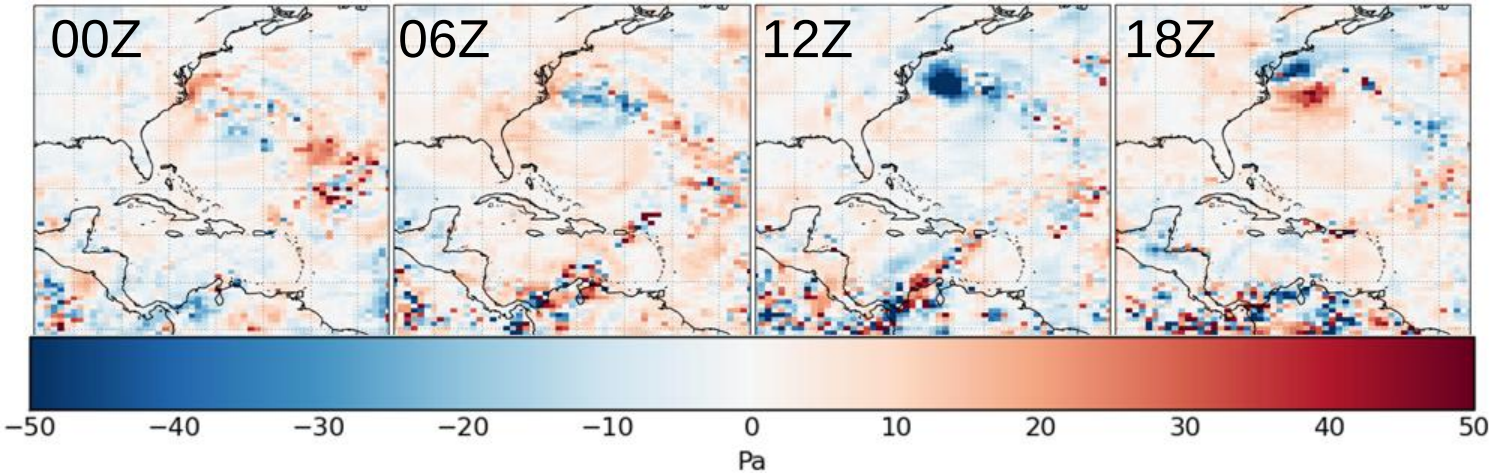
Hurricane Sandy

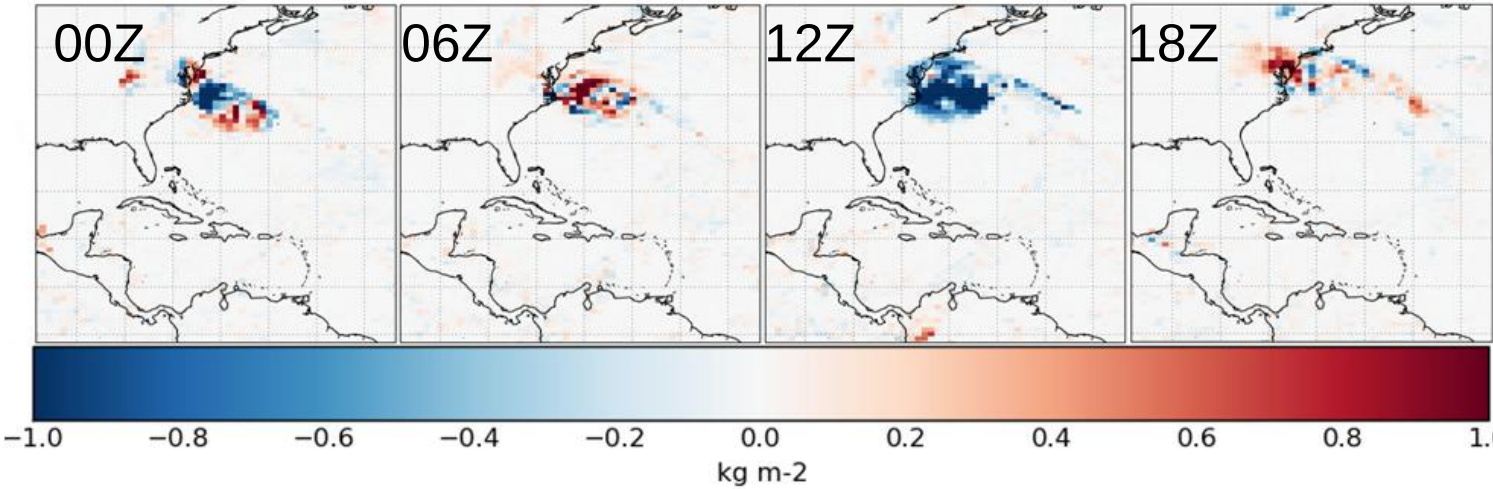
- Largest differences in atmosphere analyses appear over the Gulf Stream SST differences.

29-10-2012
Δsea level pressure



Control - NoArgo

29-10-2012
Δprecipitation



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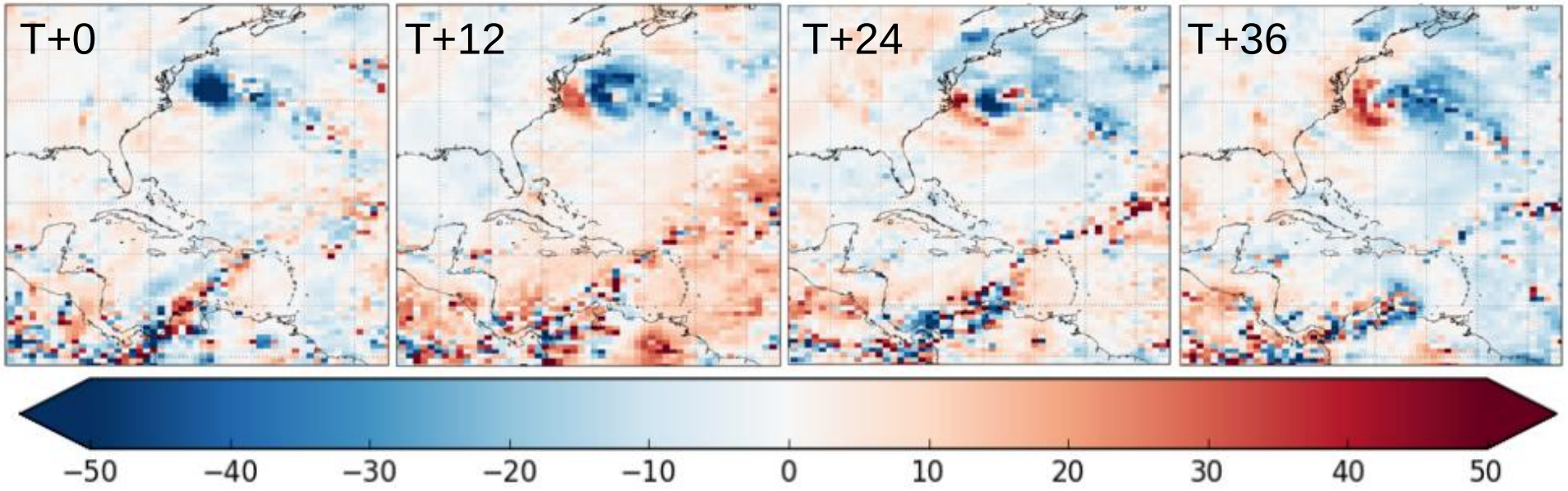
Hurricane Sandy

- Analysis and forecasts valid at 12Z 29-10-2012.
- Position well-constrained in analysis.
- Each forecast shows features similar to the SST differences



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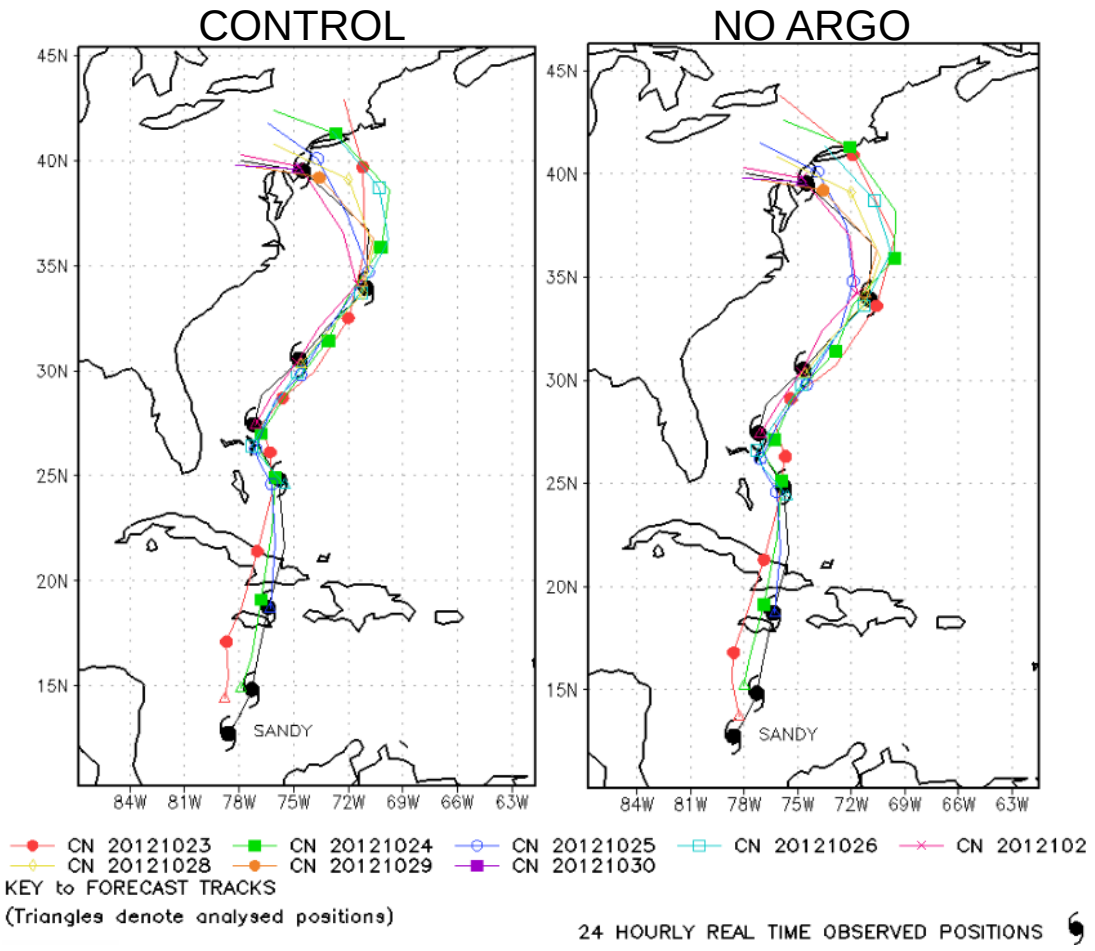
Hurricane Sandy

- Forecast tracks from 23-30 Oct.
- Later tracks better-predict landfall in both control and NoArgo
- No systematic improvement in position/intensity relative to observations
- Caveat: current coupled DA system uses low resolution atmosphere
- In future, could run ensemble of forecasts.



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Summary & Future Plans

- We have run a 13-month OSE with-holding Argo profiles.
- Some effect on SST analyses even with SST assimilation in ctrl/no-Argo.
- Significant sub-surface effect on temperature + salinity.
- Effect can take 1-year to peak

- Little effect seen in atmosphere analyses – not expected though.
- Differences in SST affect analyses for Hurricane Sandy.
- No clear systematic impact from sub-surface differences

- Impacts shown here apply only to our proto-type WCDA system.
  - Lots more we could look at (>300TB…)
- OSSEs looking at expanded Argo array
  - Highlight difficulty in using high density of profile observations
- Plan to run SST with-holding OSE as part of ERA-Clim2.

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Questions

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