The role of DYNAMO observations in improving GMAO reanalysis and CERES-like estimation of surface atmosphere radiation

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Motivation

- CERES EBAF-Surface (monthly) and SYN1deg_Lite (daily):
  - have been used to study observed phenomena (e.g. MJO)
  - are based on Fu-Liou radiative transfer calculations which use GMAO reanalysis as an input, their quality is thus subject to the GMAO reanalysis data used

- GMAO reanalysis can be improved by:
  - improving GEOS-5 AGCM, e.g. model moist physics in tropics
  - improving GEOS-5 data assimilation system (DAS)
  - assimilating observations that were previously unavailable, particularly in-situ obs over vast oceans
    - e.g., DYNAMO field observations over tropical Indian Ocean
A field campaign that took place in the Indian Ocean during October 2011 - March 2012 to collect in-situ observations, especially those for the MJO initiation processes.

Provides in-situ observations of T and Q, particularly their vertical profiles.

During convective events (e.g. MJOs): OLR↓; cloud amount↑; cloud top and bottom altitudes↑; ice dominant; τ↑
Objectives & Approaches

• Assess impact of DYNAMO observations on GMAO reanalysis
  – Produce Control reanalysis and DYNAMO reanalysis respectively assimilate global observations without and with DYNAMO observations
  – MERRA2 tag; 1 degree resolution

• ... and subsequent effect on CERES-like surface atmosphere radiation estimation (case study)
  – Fu-Liou calculations
  – Currently: 1Oct - 30Nov2011; daily mean
  – T & Q from GMAO reanalyses; rest from CERES SYN1deg_Lite Ed3A
  – Control T & DYNAMO Q
  – Control Q & DYNAMO T
Objectives & Approaches

• Assess impact of DYNAMO observations on GMAO reanalysis
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• ... and subsequent effect on CERES-like surface atmosphere radiation estimation
DYNAMO Obs Assimilated

- Spatially complete and quality controlled
  - L4 5mb Radiosonde at 33 sites (7 enhanced sites; 4 ships; 1 dropsonde; 21 PSS)
  - Pibal GTS Resolution Winds L4 Data at 27 sites (20 PSS + 7 NPSS)
  - NPSS GTS Resolution L4 Data at 16 NPSS (6 NPSS in GMAO blacklist)
  - PSS GTS Resolution L4 Data at 24 PSS (7 PSS in GMAO blacklist)
- Produced by Richard Johnson and Paul Ciesielski at CSU
Mean count of radiosonde specific humidity observations

Control Reanalysis

DYNAMO Obs

DYNAMO Reanalysis

Time series of DYNAMO radiosonde specific humidity data count

Data counts: Used (p) Passive Not used

Control vs. DYNAMO: Specific Humidity (Q)
0-10N Mean; Oct2011

Q tendency due to analysis

wet bias
dry bias
Control vs. DYNAMO: Air Temperature (T)  
0-10N; Oct 2011
Q: How do the changes in GMAO reanalysis T and Q from assimilating DYNAMO obs affect the estimation of CERES-like surface atmosphere radiative fluxes?
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- ... and subsequent effect on CERES-like surface atmosphere radiation estimation
  - Fu-Liou calculations (preliminary)
    - 1Oct-30Nov2011; daily mean
    - T & Q from GMAO reanalyses; rest from CERES SYN1deg_Lite Ed3A
      - Control T&Q
      - DYNAMO T&Q
      - Control T & DYNAMO Q
      - Control Q & DYNAMO T
OLR: Oct2011

FuLiou_DYNAMO vs. FuLiou_Control

Control

AllSky Diff

LWCRE Diff

ClrSky Diff

2.5Wm$^{-2}$
OLR: $\Delta T$ vs $\Delta Q$

$\Delta T$ & $\Delta Q$

$\Delta T$

$\Delta Q$

$\Delta Q$: dominant

Oct 1
2011

Nov 30
2011

MJO1

MJO2
Surface downward LW: Oct 2011

FuLiou_DYNAMO vs. FuLiou_Control

Control

AllSky Diff

LWCRE Diff

ClrSky Diff

5 Wm$^{-2}$
Surface downward LW
0-10N mean

Control

AllSky diff

ClrSky diff

LWCRE diff

MJO1

MJO2
Surface downward LW

$\Delta T$ vs $\Delta Q$

$\Delta T$: 2/3; $\Delta Q$: 1/3
Conclusions

• The assimilation of DYNAMO observations improves vertical profiles of T and Q in GMAO reanalysis over tropical Indian Ocean
  – partially compensating GEOS-5 AGCM moist physics deficiencies (dry/cold lower troposphere; wet/warm middle troposphere)

• The role of DYNAMO observations in affecting CERES-like surface atmosphere radiation over tropical Indian Ocean:
  – **Surface downward LW**: increases by 5Wm-2 regionally; primarily from ΔT, and secondarily from ΔQ
  – **OLR**: increases by 2-3Wm-2 regionally during dry periods; from change in ΔQ.
  – **Atmospheric LW**: cooling enhances