Description of the objective analysis of large scale forcing data at North Sounding Array during AMIE-Gan/DYNAMO field campaign

1. Overview

The constrained variational objective analysis approach described in Zhang and Lin [1997] and Zhang et al. [2001] was used to derive the large-scale single-column/cloud resolving model forcing and evaluation data set from the observational data collected during the Dynamics of the Madden-Julian Oscillation (DYNAMO) - ARM MJO Investigation Experiment (AMIE), which was conducted during October 2011 to March 2012 over Indian Ocean. The analysis data cover the period from **00Z October 1 - 21Z December 31 2011**. The forcing data represent an average over the analysis domain centered at (3 N, 76.5 E) with a diameter of 550 km as shown in Figure 1.

The forcing data was developed based on gridded sounding data from Paul *Ciesielski* at Colorado State University (http://johnson.atmos.colostate.edu/dynamo/), which were then constrained with observed surface rainfall from TRMM precipitation radar measurements through the constrained variational objective analysis. Other constraints used in the variational analysis are from the ECMWF forecast (Courtesy of Maike Ahlgrimm of ECMWF). Xie et al (2004) has shown that precipitation is the most critical constraint for the analyzed fields during precipitation periods.

The data here are in both ASCII and netCDF formats for the 550km domain.

Standard vertical resolution (25mb) data

There are two standard resolution (25mb) ASCII data files for layered variables and surface variables, respectively for each of the domain. They are:

> *dna180varanaecmwfanatrmmsurfaceC1.c1.20111001.000000.dat*
> *dna180varanaecmwfanatrmmlayerC1.c1.20111001.000000.dat*

These ASCII data files can be read using following FORTRAN files

> *read_layer.for*
> *read_surface.for*

The netCDF files that include all the variables contained in the two ASCII data files are also provided:

> *dna180varanaecmwfanatrmmC1.c1.20111001.000000.cdf*

To see the quick look plots of the data please go to:

http://portal.nersc.gov/project/capt/ARMForcingData/dynamo-north-array/

2. Some details of the analysis

The objective analysis domains used for analyzing the DYNAMO north sounding array data are shown in Figure 1. The analysis grid points overlap the sounding stations in the north sounding array that were available during DYNAMO. Sounding balloons were launched to measure the vertical profiles of temperature, relative humidity, and winds 8 times per day for certain interested stations and 4 times at others. For gridded sounding data details, please refer to Johnson's group at Colorado State University (http://johnson.atmos.colostate.edu/dynamo/). For details about the sounding data correction, please refer to Ciesielski et al, 2014. These measured upper-air data were first analyzed using the analysis scheme of *Cressman* [1957] with the background field from the ECMWF analysis data (Courtesy of Steve Williams of NCAR).

The domain-averaged surface and TOA radiative fluxes and surface heat fluxes constraints required by the variational analysis were obtained from ECMWF forecast data. TRMM precipitation data is based on 3B42 data.

3. References

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AMIE Homepage: http://campaign.arm.gov/amie/

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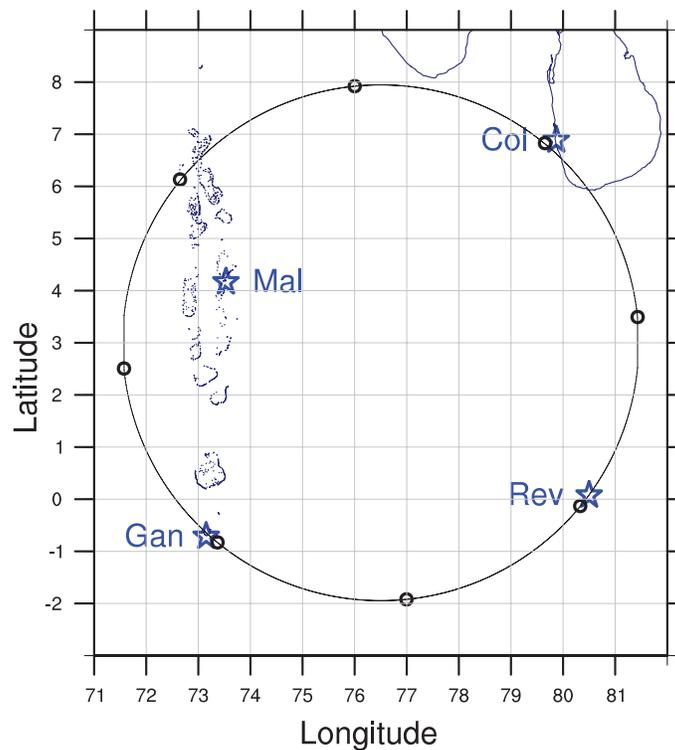
Figure 1: Analysis domain for north sounding array during DYNAMO, with a diameter of 550 km. The blue stars denote the sounding site locations and the small black circles are the analysis grid points on the circle of the domain.

Omega

vertical velocity   mb/hour

TRMM 3B42 Precipitation

Days in 2011

Figure 2: Surface precipitation measurements from TRMM 3B42 dataset and the corresponding vertical velocity based on variational analysis of sounding data.