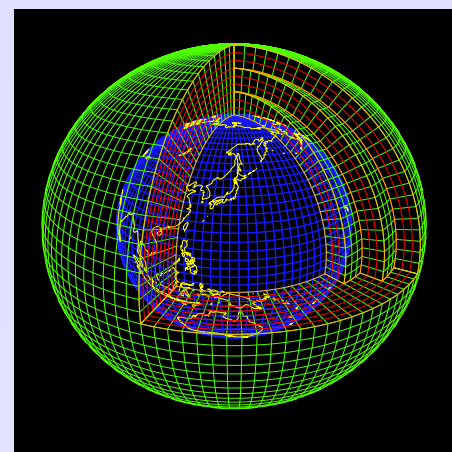


DPSIVS; an extensible and efficient verification system for Japan Meteorological Agency Global Spectral Model



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Introduction

- Forecast verification is an indispensable process in the development cycle of NWP system.
- A verification system needs to be computationally efficient to allow developers to promptly evaluate the impact of their work.
- It also needs to be easily extended to allow for its future evolution.
- Deterministic Prediction System Integrated Verification System (DPSIVS) is a **verification package “of the modelers, by the modelers, for the modelers”** designed to meet these desiderata.
- DPSIVS, by design, allows modelers a one-stop execution of various verifications, and this has facilitated them to share and discuss their results among other experts.
- This has been a key factor in understanding and reducing systematic errors, as systematic errors are caused from entangled components and are often compensated with each other in the state-of-the-art NWP system.

DPSIVS

- DPSIVS is a package of multiple independent verification tools (table 1).
- Users can easily select which tools to execute in one configuration script file (i.e. commenting out a line of unnecessary tool).
- Minimal required variables for execution are experimental numbers, abbreviations and periods (figure 1).
- DPSIVS includes various verifications to check model behavior and performance in detail, such as weather map (figure 2), time evolution of single point output (figure 3), initial tendencies (figure 4), planetary wave activities (figure 5), vertical profiles of statistics (figure 6) and so on.
- Lscore includes verification against analysis at radiosonde observation points to help interpretation of differences between against own analysis and against radiosonde observations (figure 6).

Table 1: List of verification tools in DPSIVS.

tool name	description
Quickscore	quick verification tool for selected elements
Lscore	statistical scores against analysis and radiosonde observations
TyVerif	typhoon verification against JMA best track
TyVerifG	global tropical cyclone verification against NOAA b-decks
AmedasRain_statist	verification of precipitation against AMeDAS* observations
Raverif	verification of precipitation against Radar-AMeDAS precipitation
Anlmap	comparison of mean analysis field between experiments and multiple centers
Errmap	forecast error maps against own and multiple centers' analyses
Jpemap	Japan region forecast error maps for quick look
Gmap	weather maps of forecasts, analyses, and forecast errors
Obstat	observation statistics (O-B and O-A)
Grainverif	global precipitation map of forecast and analysis (GPCP and CMORPH)
Phy2d	surface fluxes monitor against CERES, OAFLUX and RSS
CyVerif	cyclone verification
Synopv	verification against SYNOP observations
Sondev	verification against radiosonde observations
Ptdraw	monitor of single point output
Gnssro	O-B, O-A and forecast error statistics and maps against GNSS-RO bending angle and refractivity
AmedasRain_Station	verification of precipitation forecasts against AMeDAS observations at observation station point
AmedasRain_Grid	verification of precipitation forecasts against AMeDAS observations in verification grid
ITeM	initial tendency viewer

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# Minimal variables to run DPSIVS
EXP_NO=11000 ; EXP_SUBNO=2
ABBR_TEST="revised-GSM"

EXP_NO_CNTL=11237 ; EXP_SUBNO_CNTL=2
ABBR_CNTL="old-GSM"

# verification period (YYYYMMDD)
VERIF_SDATE=20160101
VERIF_EDATE=20160131
```

Figure 1: An example of minimal required variables for execution

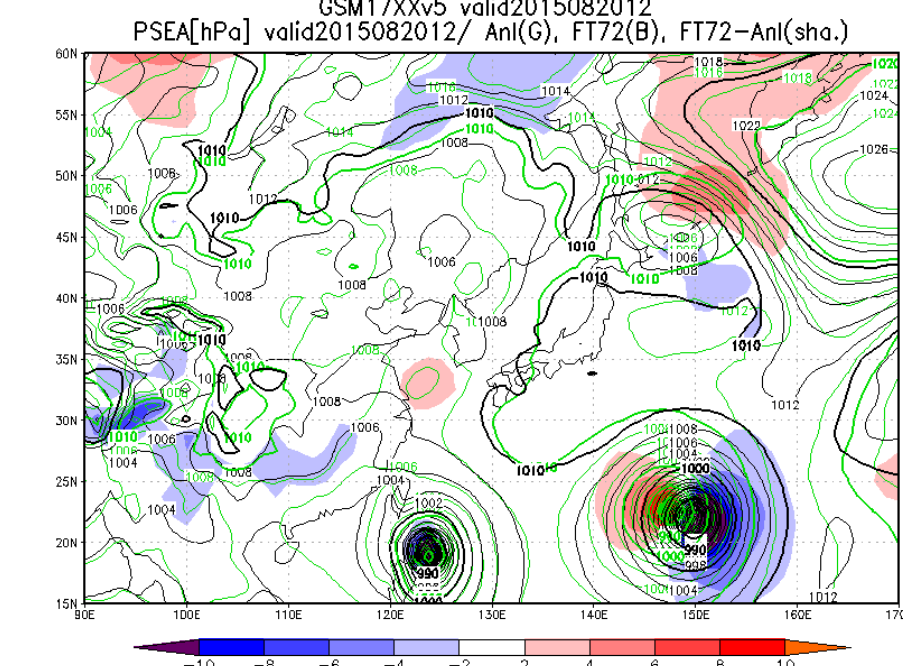


Figure 2: Sample figure of “Jpemap”. Weather map of a day (forecast, analysis and forecast error).

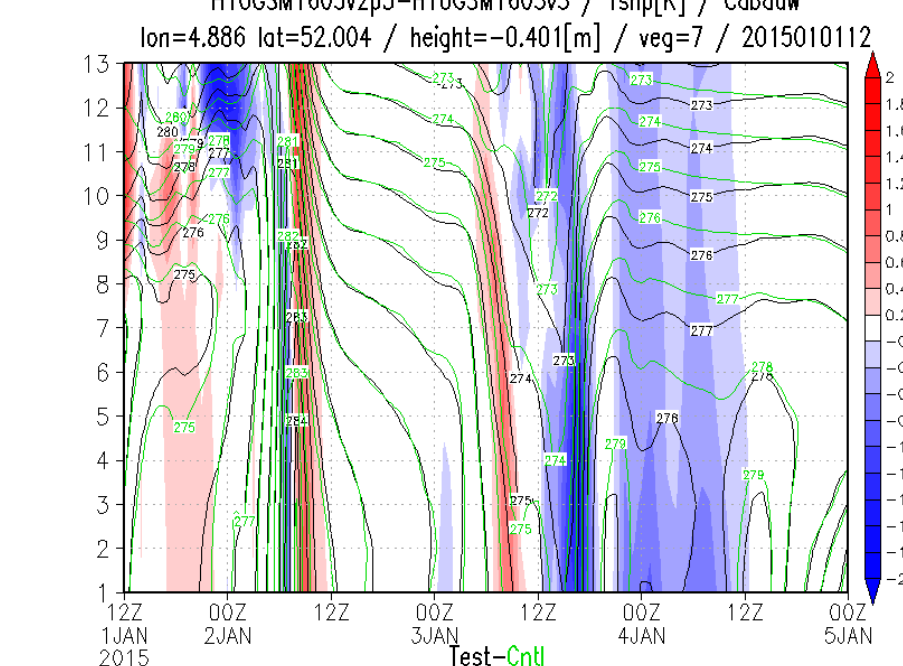


Figure 3: Sample figure of “Ptdraw”. Comparison of time evolution of T in model levels at single point in GSM from two experiments.

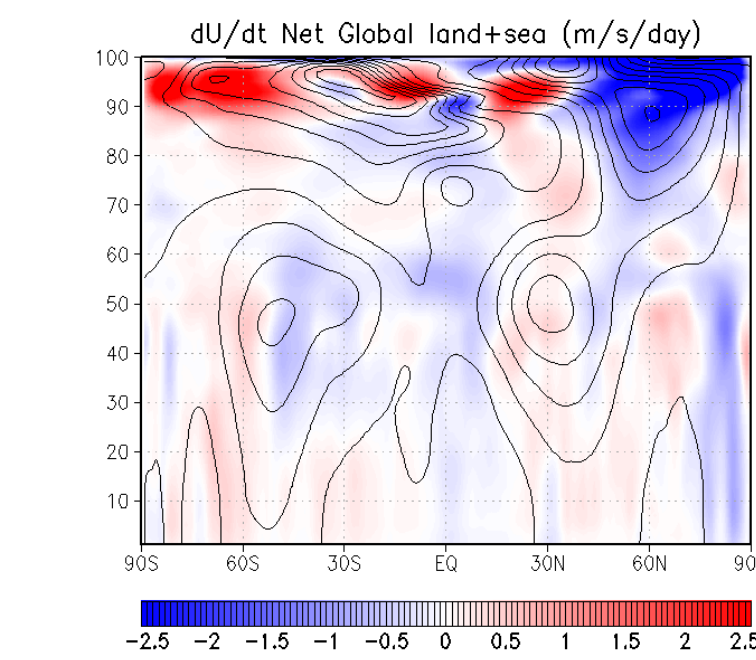


Figure 4: Sample figure of “ITeM”. Monthly mean zonal total wind tendency for Jan. 2016.

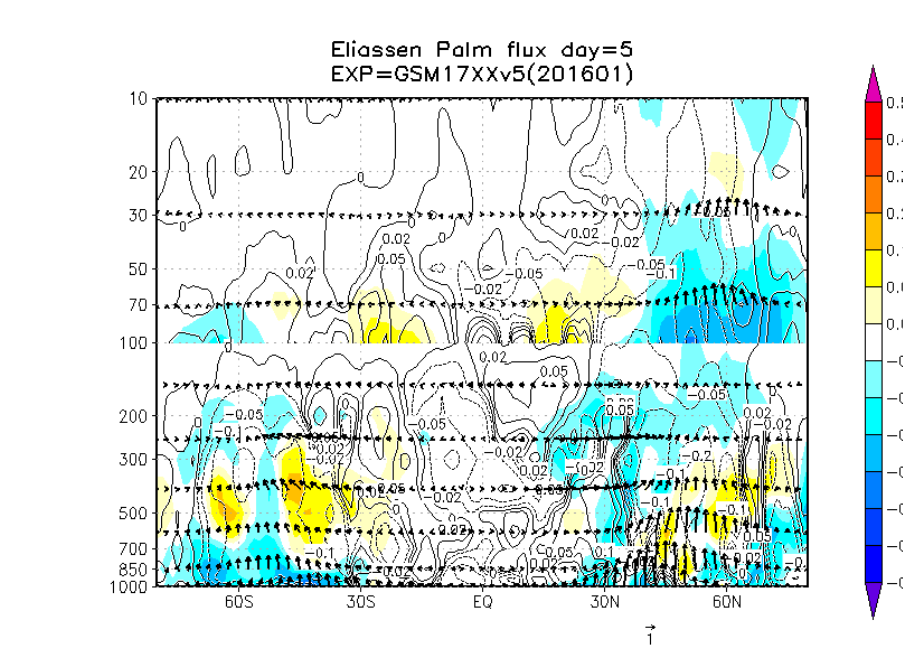


Figure 5: Sample figure of “Errmap”. EP-flux vectors and forecast errors of meridional and vertical components for Jan. 2016.

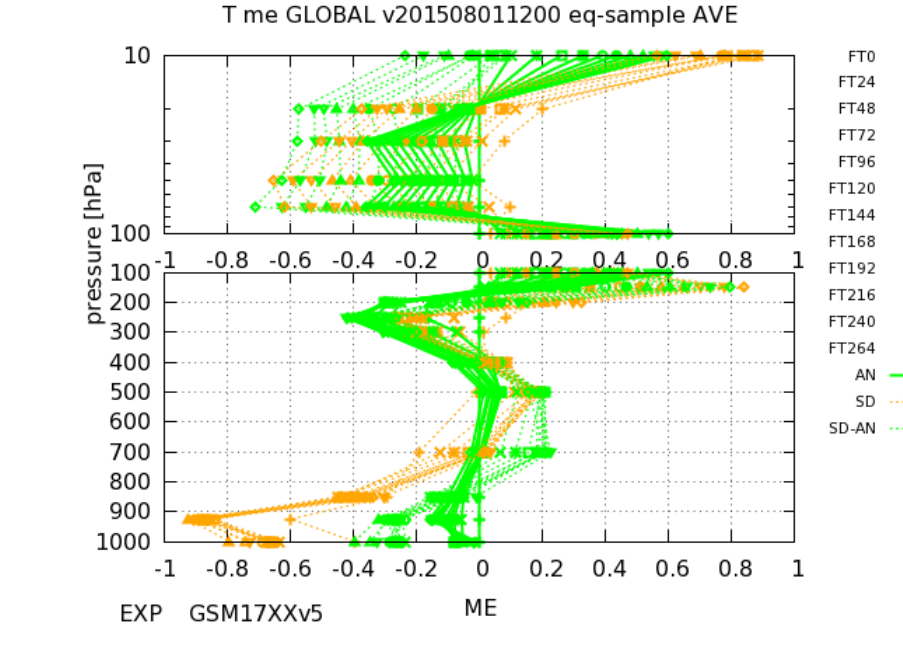


Figure 6: Sample figure of “Lscore”. Vertical plot of mean error against analysis, radiosonde and analysis at radiosonde station points.

* The Automated Meteorological Data Acquisition System (AMeDAS) is a collection of Automatic Weather Stations (AWSs) run by JMA for automatic observation of precipitation, wind direction/speed, temperature and sunshine duration

Acknowledgements

IVS families has been developed, tested and maintained by many of colleagues at JMA. The presenter is just lucky enough to have an opportunity to attend this WS and to introduce IVS families on behalf of developers in JMA.

Successful example of DPSIVS; new LSM case

- A new LSM is physically more sensible than the old LSM.
- Testing a new LSM had resulted in a cold bias, which had been hidden over ten years with old LSM by tuning to compensate shortage of downward LW radiative flux at ground.
- DPSIVS helped developers to analyze and discuss results of package test by providing visually common verification results with short turnaround time.
- Finally new LSM was put in operation with revised physics packages.

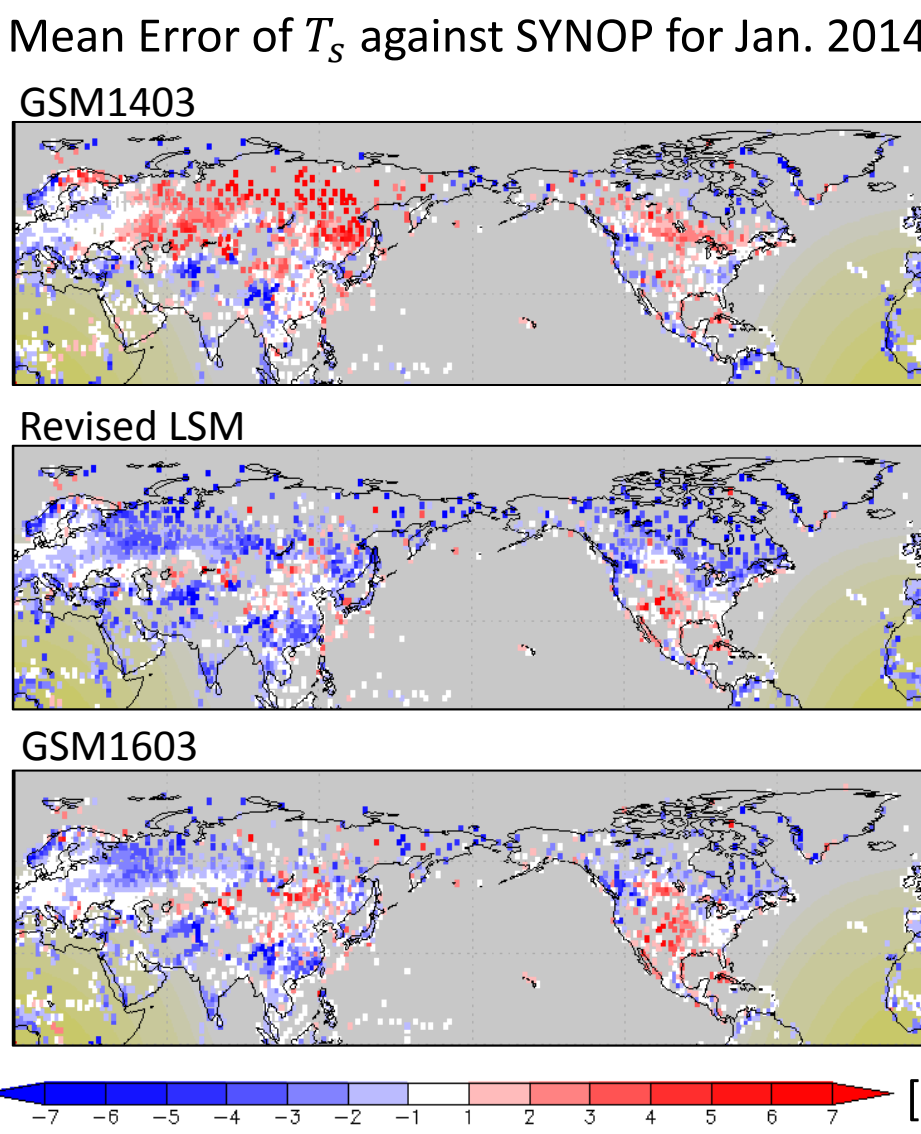


Figure 7: Mean Error of T_s against SYNOP obs. for Jan. 2014. (top) GSM1403, (middle) GSM1403 + new LSM and (bottom) GSM1603 (revised physics packages and new LSM). Figures are drawn by “Synov”.

An example of evolution; GNSS-RO verif. tool

- DPSIVS is designed to be easily extended.
- An example of extensions is an addition of a verification tool “Gnssro” after the start of assimilation of GNSS-RO bending angle.
- High accuracy of GNSS-RO bending angle observations and data availability up to 60 km enable verification of first guess and analysis fields in the stratosphere where model errors are considered to be large (figure 8).

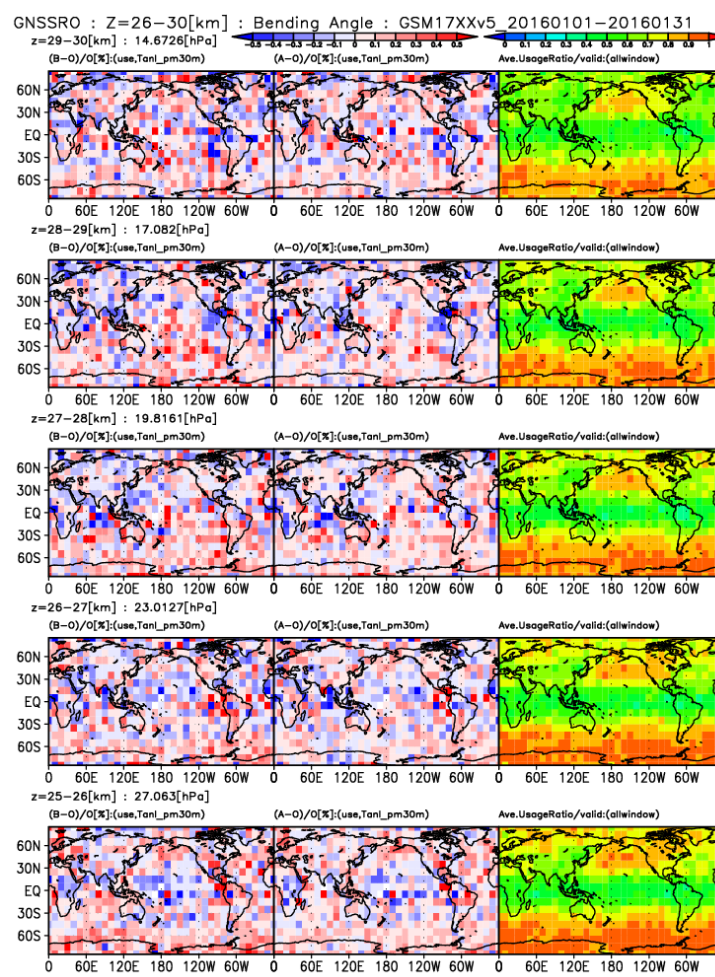


Figure 8: Example figure of “Gnssro”. Normalized O-B, O-A and data usage ratio for $z=25$ to 30 km for Jan. 2016.

IVS families for evaluation from weather and climate

- Following the success of DPSIVS approach for NWP system development, similar tools are utilized or under active development with same design philosophy for climate model experiments such as one-year run and AMIP run (table 2).
- The same approach is also applied to ensemble prediction system development.
- Hindcast type experiments are verified using other tool.

Table 2: IVS families

IVS	type of exp.	resolution	time required for exp.	time required for verif.
DPSIVS	data-assimilation and forecasts	TL959 (TL479)	one week for a month period	ten minutes to six hours
EPSIVS	ensemble forecast	TL479	four days for a month period	four hours
COOLIVS	4 or 12-member one-year run	TL159	half day (4) or one and half days (12)	one hour
AMIPIVS	AMIP run (30-year)	TL159	two to three days	one hour

Evaluation of basic GSM performance in climate scale

- COOL (Common evaluation tOOL) experiments, one-year run with four or 12 members in low-resolution (TL159), are utilized to evaluate basic model performance.
- COOLIVS enables quick evaluation of results of COOL experiment with minimal configuration as well as DPSIVS.
- Recent improvements in terms of radiation budget by continuous development of GSM are shown for OLR (figure 9) and RSDB (figure 10).
- Same evaluations are also available in AMIPIVS.

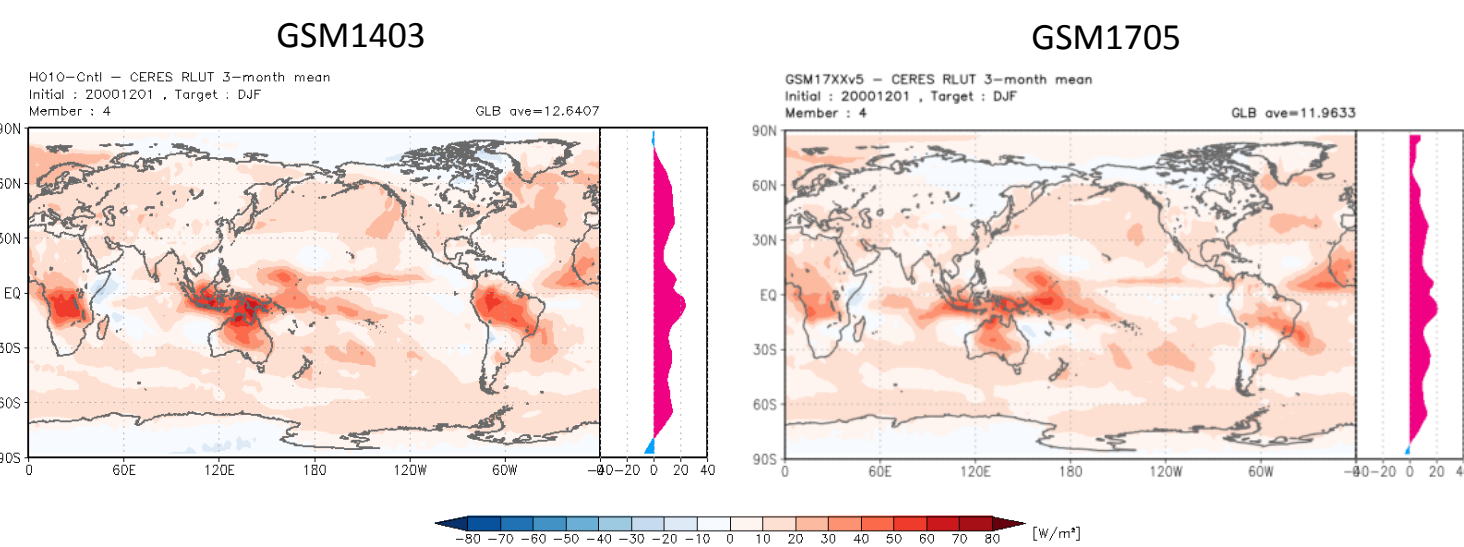


Figure 9: Mean error of outgoing long wave radiation flux (OLR) against CERES for DJF. (left) GSM1403 and (right) GSM1705.

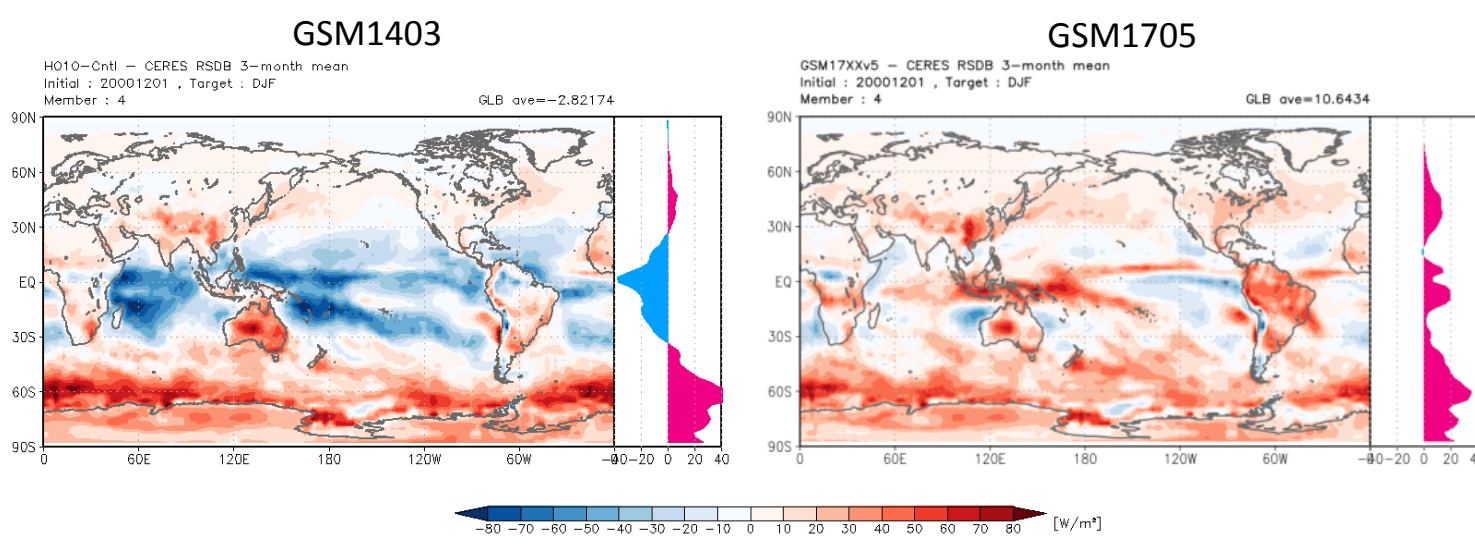


Figure 10: Same as figure 9, but for downward short wave radiation flux at ground surface (RSDB).

Future plan

- Addition of drawing tool for O-B and O-A maps to DPSIVS (figure 11).
- Verification of cloud and diurnal cycle.
- Addition of drawing tool for drag related elements (τ_{resol} , τ_{pbl} and τ_{sgo}).
- Collection of reference data set.
- Developing IVS families, especially AMIPIVS.

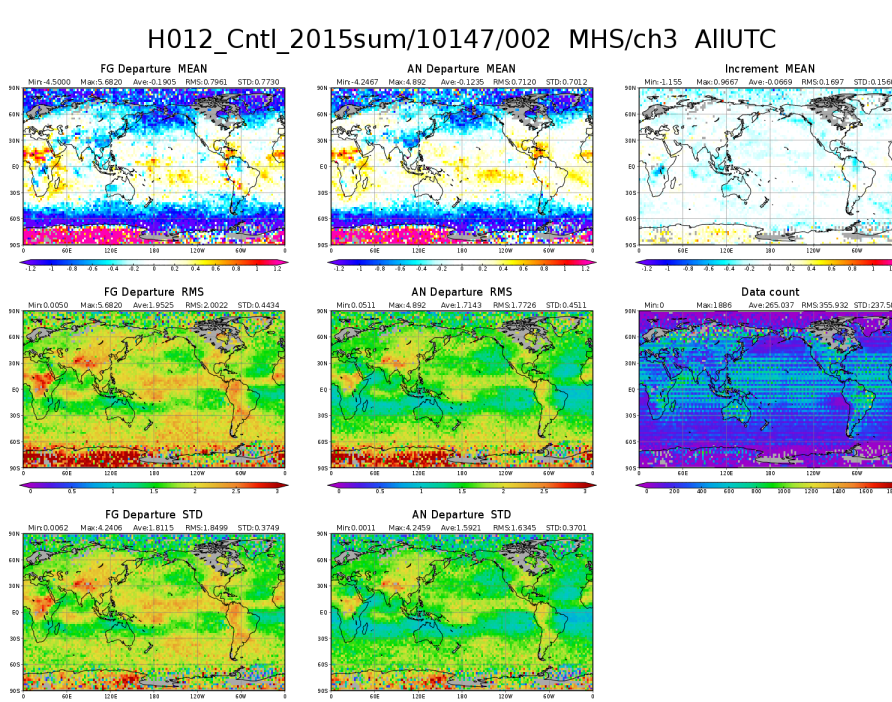


Figure 11: Sample figure of O-B and O-A maps. O-B, O-A, increments and data count for MHS/ch3.