

Recent Updates to the NASA/GEWEX SRB Longwave Flux Algorithm

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Introduction

The NASA/GEWEX (Global Energy and Water Exchanges project) Surface Radiation Budget (SRB) project produces longwave and shortwave radiative fluxes for the surface and top-of-atmosphere (TOA) (see, Stackhouse et al., 2011, GEWEX News). The primary inputs of cloud and meteorology data have been undergoing improvements in quality and spatial and temporal resolution. In anticipation of the release of these data, the SRB longwave flux algorithm has been updated both to accommodate these data and to improve the algorithm used in deriving radiative fluxes.

Changes in the inputs and algorithm are as follows:

- Synchronized algorithm with version used by NASA CERES (Rose et al. 2006).
- Atmospheric aerosols were added.
- Beta version of ISCCP H cloud properties used.
- Beta version of ISCCP nnHRS temperature and humidity used.
- Option of using a newly derived beta Princeton land surface temperature and diurnal Seaflux sea surface temperature as surface skin temperature added
- Updated ozone profile with GISS ozone and MeASURES GOZCARDS.
- Updated maps of surface topography, vegetation type, and snow/ice by ISCCP.

The beta GLW v4 IP has enhanced the output fluxes by adding pristine-sky (no clouds or aerosols) fluxes. The new version also computes fluxes at selected atmospheric levels (including the tropopause) rather than just at the surface and TOA.

The purpose of this study is to explore the effect of the above changes on the surface and top-of-atmosphere fluxes. These fluxes are compared to the previous version (release 3.1). We show preliminary results for the mid-seasonal months of 2007.

Data Sources

The nnHRS data are the HIRS temperature and water vapor retrievals (Shi et al., 2012) that are further processed by the ISCCP team to produce globally filled 3-hourly data products. The cloud properties are beta products from the next version of ISCCP data (called H Series) that makes use of higher resolution data. An additional cloud type of high water clouds has been added to the properties.

Aerosol climatology data and vertical structure comes from the Max-Planck-Institute Aerosol Climatology (MAC), courtesy of Stefan Kinne (Kinne et al., 2014 under review). The Princeton land surface temperature (PLST) data uses a process that adjusts output from the NCEP Climate Forecast System Reanalysis (CFSR) with satellite retrievals from HIRS analysis and then used to force the VIC macroscale model (Coccia et al, 2013). The Seaflux sea surface temperature is based on AVHRR data that has been adjusted with a daytime curve for diurnal variation (Clayson and Bogdanoff, 2012).

CERES SYN1deg computes fluxes with the Langley Fu-Liou radiative transfer model (used here for the Rel 4 longwave fluxes) and constrained by the observed CERES TOA fluxes (Doelling et al. 2013, Rose et al. 2013). CERES Energy Balanced and Filled (EBAF) data is based on the SYN1deg product (Loeb et al., 2009; Kato et al., 2012). It constrains the global net TOA fluxes to the ocean heat storage.

Fluxes from New Algorithm and Clouds Compared with Previous Release

The Rel. 4 shown in these set of maps use the GEOS-4 temperature and humidity fields and the new ISCCP HXS based cloud properties. Rel. 3.1 also used GEOS-4 but had ISCCP DX based cloud properties. Although both use the same basic meteorology, surface skin temperature is a blend of GEOS-4 and the ISCCP values. Therefore the difference in the upward surface flux is non-zero. Row A has the January 2007 outgoing longwave radiation (OLR) map of the absolute field from Rel. 4, the difference with Rel. 3.1 and the difference with Rel. 3.1 if aerosols are excluded from the Rel. 4 flux. Row B shows similar maps for the all-sky surface downward flux, while row C has the surface upward flux. Row D shows the differences in total cloud amount and surface skin temperature between the two versions.

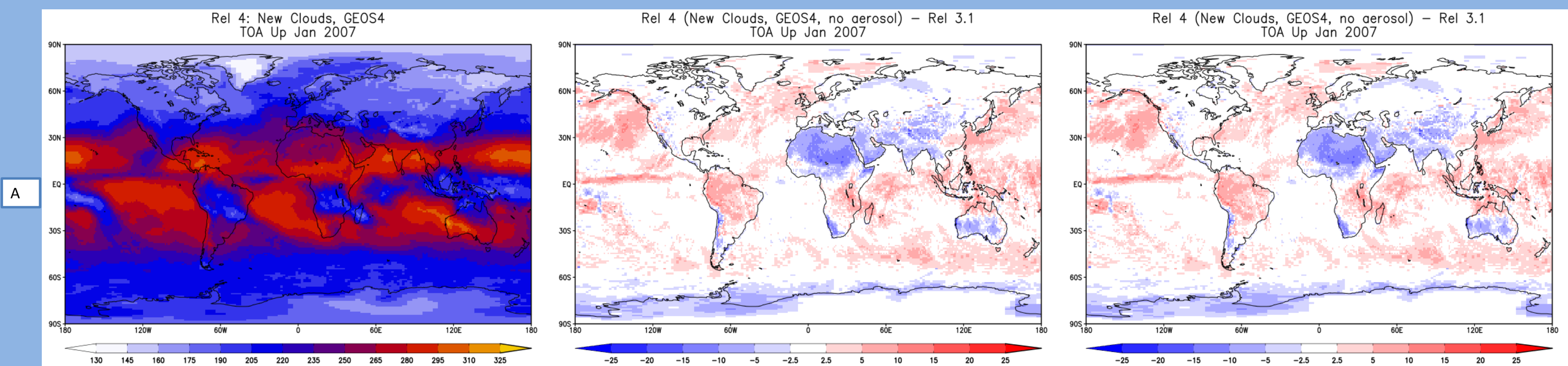


Table 1: Outgoing Longwave Radiation (OLR) global and 20°N-20°S areal averages of the mid-seasonal months of 2007.

OLR	Rel. 4-IP GEOS-4	Rel. 4-IP GEOS-4 No aerosols	Rel. 3.1 GEOS-4	CERES EBAF Ed. 2.7	CERES SYN 1-degree
Jan 2007	234.4 (255.6)	235.9 (257.1)	235.1 (255.5)	236.3 (250.9)	233.0 (246.1)
Apr 2007	235.2 (255.0)	237.7 (257.4)	237.1 (256.5)	238.4 (254.7)	236.0 (250.7)
July 2007	240.6 (256.1)	242.8 (258.3)	242.9 (258.3)	241.1 (247.3)	238.4 (243.4)
Oct 2007	236.9 (254.8)	238.6 (256.1)	239.0 (256.2)	239.1 (250.12)	236.7 (246.4)

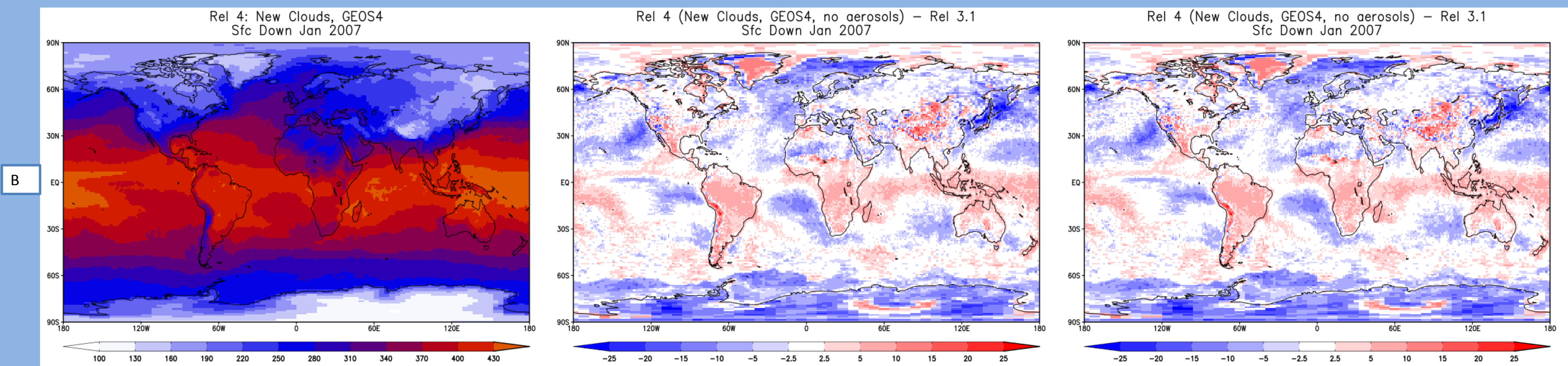


Table 2: As table 1, but for all-sky surface downward longwave flux

Sfc Down	Rel. 4-IP GEOS-4	Rel. 4-IP GEOS-4 No aerosols	Rel. 3.1 GEOS-4	CERES EBAF Ed. 2.7	CERES SYN 1-degree
Jan 2007	338.8 (405.8)	336.8 (403.8)	337.5 (402.6)	329.4 (401.0)	333.9 (399.1)
Apr 2007	346.4 (412.3)	343.4 (409.6)	344.8 (408.9)	343.0 (409.3)	342.0 (405.0)
July 2007	354.7 (404.1)	352.4 (402.1)	353.7 (402.7)	354.6 (404.6)	351.4 (400.0)
Oct 2007	345.1 (407.1)	343.1 (405.7)	344.3 (405.2)	341.4 (405.4)	342.7 (402.0)

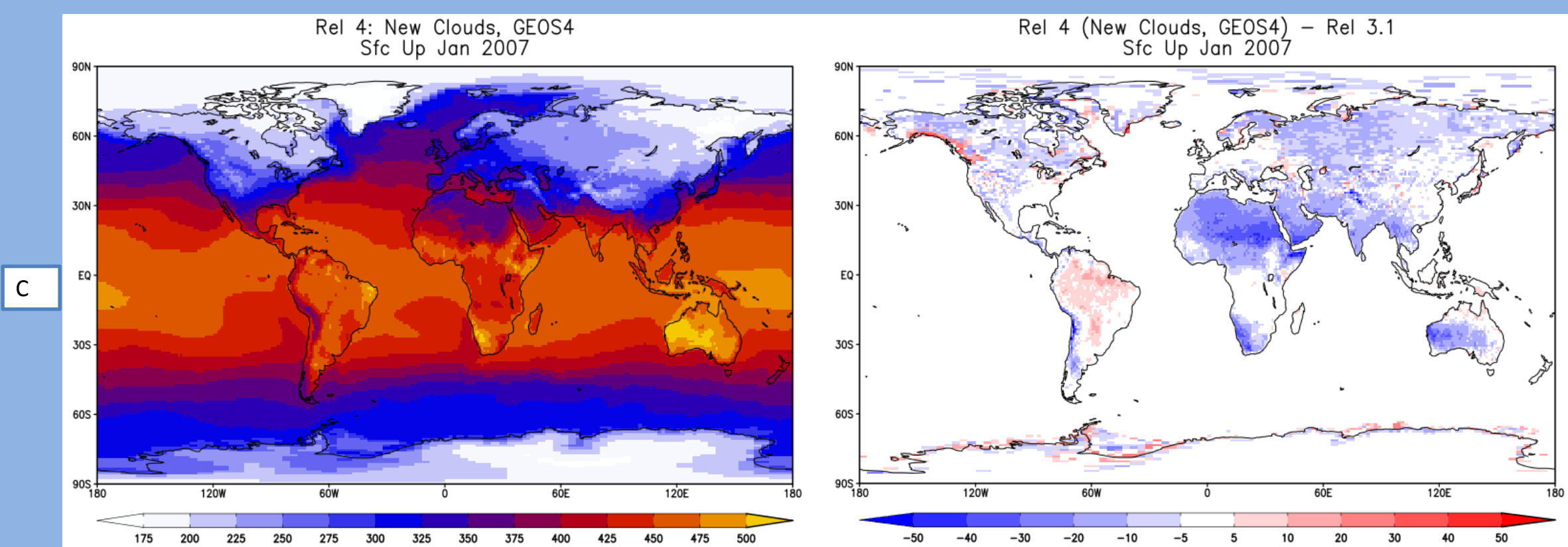
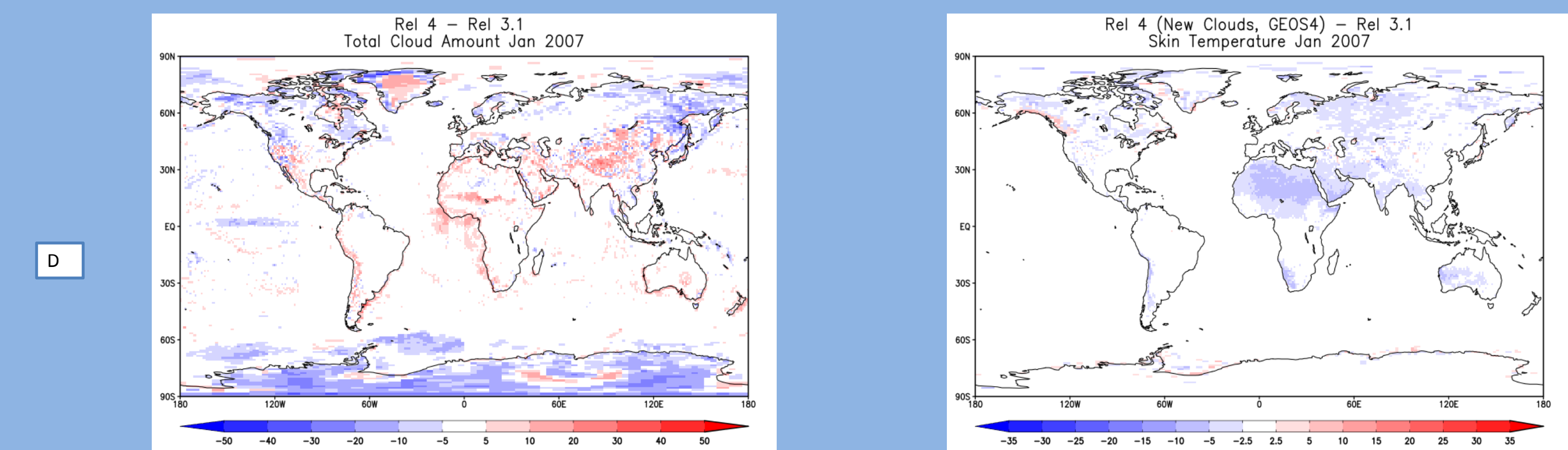


Table 3: As table 1, but for all-sky surface upward longwave flux

Sfc Up	Rel. 4-IP GEOS-4	Rel. 3.1 GEOS-4	CERES EBAF Ed. 2.7	CERES SYN 1-degree
Jan 2007	387.6 (457.2)	387.8 (456.3)	386.5 (459.5)	385.0 (458.4)
Apr 2007	398.8 (465.5)	399.1 (464.5)	401.1 (469.6)	400.6 (469.2)
July 2007	408.1 (457.0)	409.5 (457.2)	412.2 (460.8)	411.3 (460.2)
Oct 2007	397.1 (459.4)	398.4 (459.2)	399.3 (465.2)	398.6 (464.9)



Fluxes Comparisons as a Result of Differing Meteorological Conditions

These set of maps and tables in this section compare fluxes from using different meteorological conditions in the Rel. 4 algorithm with the same cloud property input. The basic algorithm version has nnHRS meteorology with ISCCP surface skin temperature. One version uses the nnHRS with the Princeton land surface temperature (PLST) and Seaflux sea surface temperature (SSST). Another uses the GEOS-4 meteorology, like that used in Rel. 3.1, while the last uses MERRA meteorology. These last three types are shown differenced from the basic version in the maps below for January 2007. As before, row A is OLR, row B is surface downward and row C is surface upward flux.

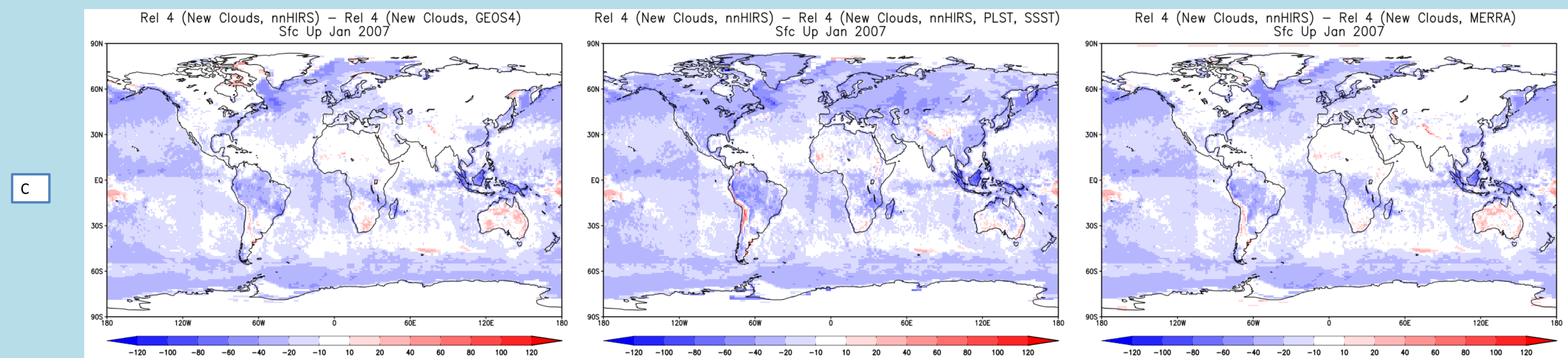
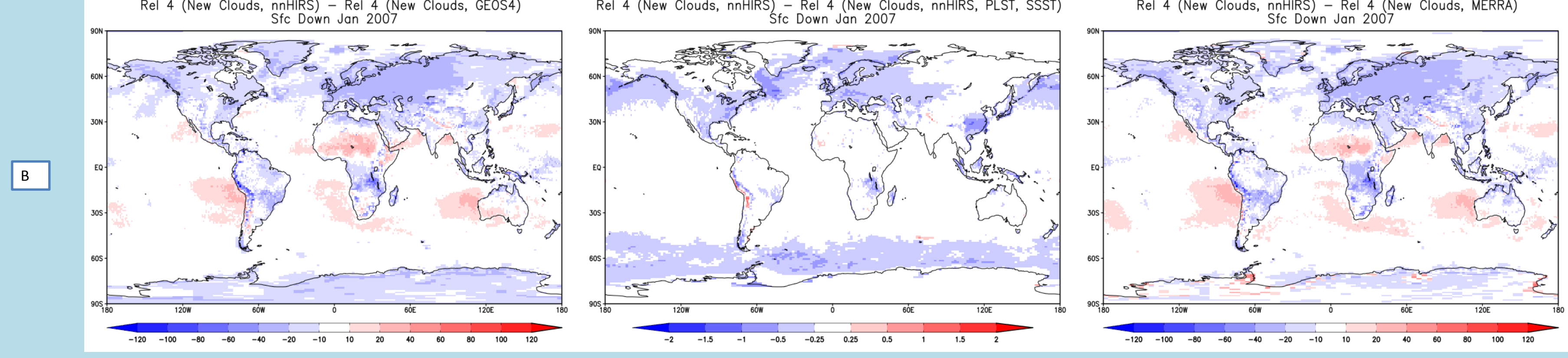
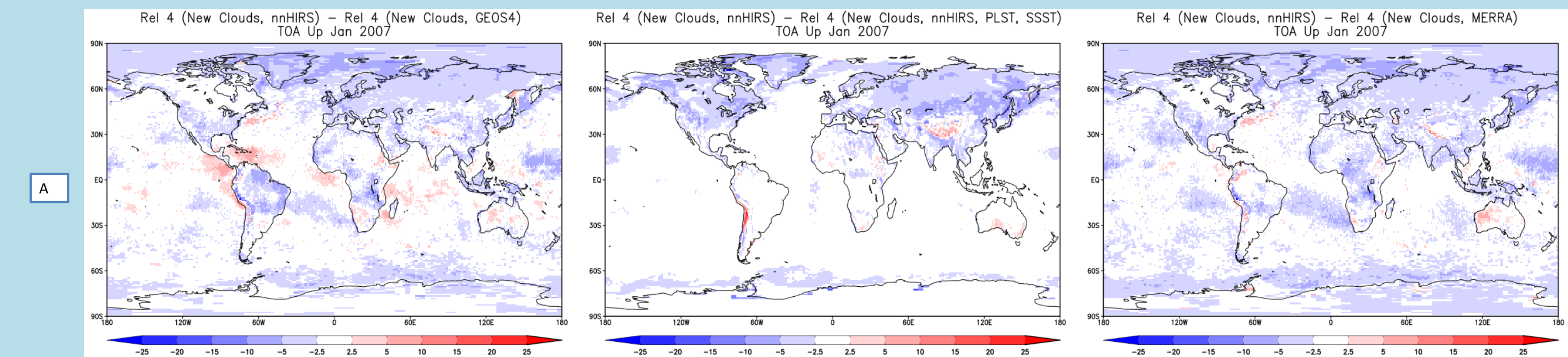


Table 4: Outgoing Longwave Radiation (OLR) global and 20°N-20°S areal averages of the mid-seasonal months of 2007.

OLR	Rel. 4-IP GEOS-4	Rel. 4-IP nnHRS	Rel. 4-IP nnHRS PLST/SSST	Rel. 4-IP MERRA	CERES EBAF Ed. 2.7	CERES SYN 1-degree
Jan 2007	234.4 (255.6)	233.1 (255.1)	234.5 (256.0)	235.0 (256.6)	236.3 (250.9)	233.0 (246.1)
Apr 2007	235.2 (255.0)	233.2 (253.3)	233.9 (253.4)	234.9 (254.9)	238.4 (254.7)	236.0 (250.7)
July 2007	240.6 (256.1)	239.2 (255.3)	239.9 (255.3)	240.7 (256.4)	241.1 (247.3)	238.4 (243.4)
Oct 2007	236.9 (254.8)	234.8 (252.9)	235.7 (253.4)	237.0 (254.9)	239.1 (250.12)	236.7 (246.4)

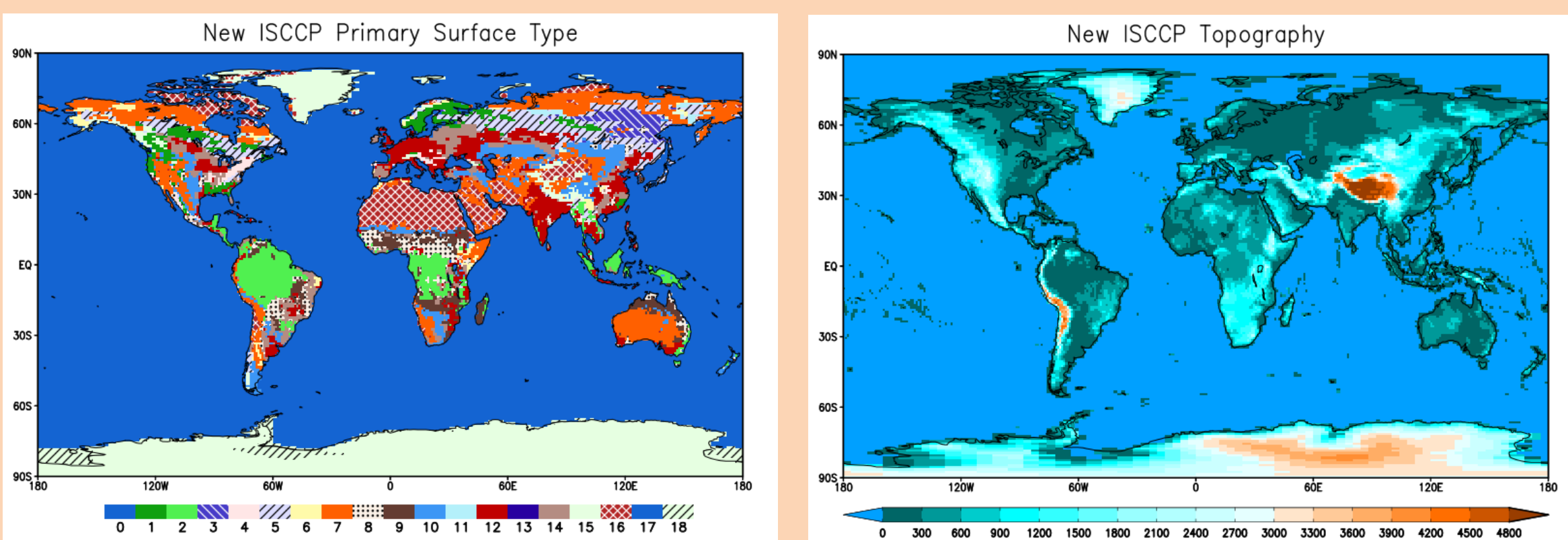
Table 5: As table 4, but for all-sky surface downward longwave flux

Sfc Down	Rel. 4-IP GEOS-4	Rel. 4-IP nnHRS	Rel. 4-IP nnHRS PLST/SSST	Rel. 4-IP MERRA	CERES EBAF Ed. 2.7	CERES SYN 1-degree
Jan 2007	338.8 (405.8)	335.3 (405.1)	335.5 (405.1)	338.7 (407.5)	329.4 (401.0)	333.9 (399.1)
Apr 2007	346.4 (412.3)	342.6 (411.2)	342.7 (411.3)	346.4 (413.2)	343.0 (409.3)	342.0 (405.0)
July 2007	354.7 (404.1)	351.4 (402.3)	351.5 (402.3)	355.2 (405.3)	354.6 (404.6)	351.4 (400.0)
Oct 2007	345.1 (407.1)	339.6 (402.9)	339.7 (403.0)	344.7 (407.1)	341.4 (405.4)	342.7 (402.0)

Table 6: As table 4, but for all-sky surface upward longwave flux

Sfc Up	Rel. 4-IP GEOS-4	Rel. 4-IP nnHRS	Rel. 4-IP nnHRS PLST/SSST	Rel. 4-IP MERRA	CERES EBAF Ed. 2.7	CERES SYN 1-degree
Jan 2007	387.6 (457.2)	374.8 (442.9)	391.5 (442.9)	387.5 (456.9)	386.5 (459.5)	385.0 (458.4)
Apr 2007	398.8 (465.5)	388.0 (458.3)	399.6 (458.2)	398.2 (465.2)	401.1 (469.6)	400.6 (469.2)
July 2007	408.1 (457.0)	398.1 (449.5)	408.5 (449.5)	407.5 (456.6)	412.2 (460.8)	411.3 (460.2)
Oct 2007	397.1 (459.4)	384.6 (449.0)	397.8 (459.6)	396.8 (458.5)	399.3 (465.2)	398.6 (464.9)

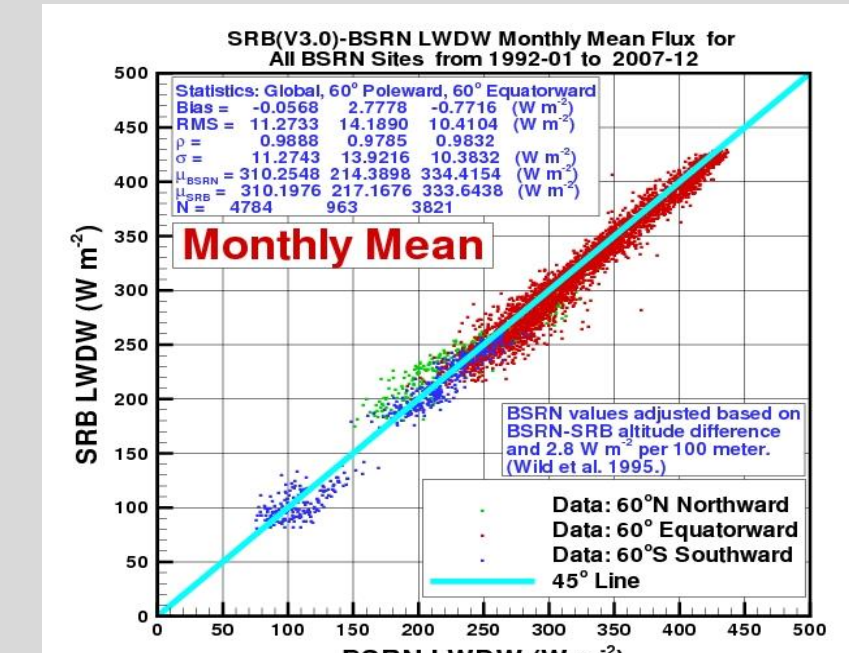
New Static Input Maps



- 0 & 17: water
1: evergreen needleleaf
2: evergreen broadleaf
3: deciduous needleleaf
4: deciduous broadleaf
5: mixed forest
6: closed shrubland
7: open shrubland
8: woody savanna
9: savanna
10: grassland
11: permanent wetland
12: cropland
13: urban
14: mosaic
15: snow/ice
16: bare soil
18: permanent ice shelf

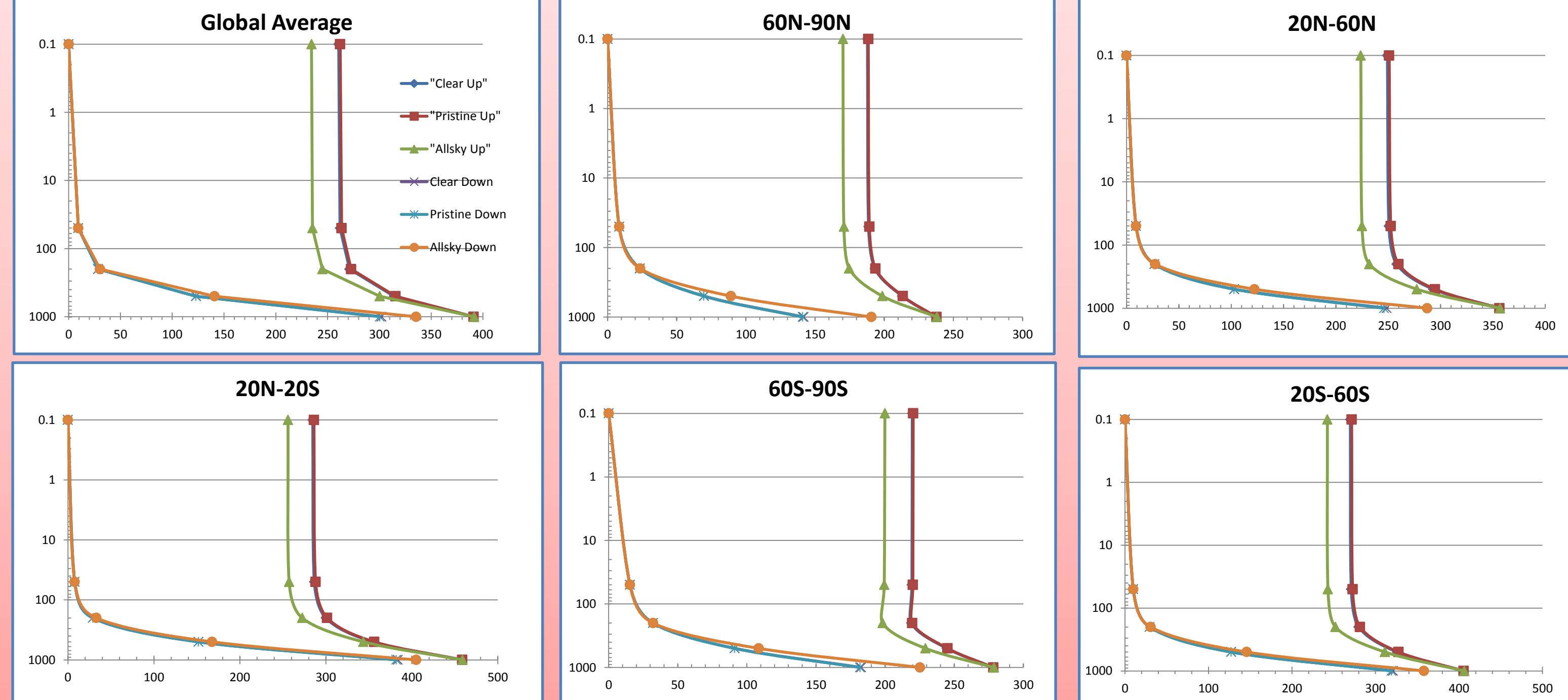
BSRN Validation

BSRN validation of surface downwelling longwave flux for release 4.0 for the monthly average timescales.



	All sites	60° Poleward	60° Equatorward
Monthly	Bias -0.57 RMS 11.27	Bias 2.78 RMS 14.19	Bias -0.77 RMS 10.41
3-hourly	0.69 13.37	2.84 15.45	-0.04 12.68
Daily	0.50 21.81	2.72 28.87	-0.11 19.42
3-hourly	0.75 30.11	2.76 35.72	0.22 28.42

New Output Condition and Levels



This section illustrates the added ability to output pristine-sky fluxes and levels other than surface and TOA. The pristine-sky is now available because of the inclusion of aerosols to the algorithm. These are comparable to Rel. 3.1 clear-sky fluxes.

Conclusions

This poster highlights the ongoing assessments made of the sensitivity of GEWEX/SRB longwave radiative transfer algorithm to changes in key inputs including upgraded new ISCCP clouds, new ISCCP HIRS analysis, global aerosol, ozone and surface inputs. In general the change to a slightly different version of the algorithm has little effect on the resultant fluxes. However, the inclusion of atmospheric aerosols results in significant changes in the aerosol heavy regions such as Western Africa.

The usage of the nnHRS meteorology along with the new ISCCP surface skin temperature retrievals produce significant changes with the largest being the surface skin temperature.

More assessment and intercomparisons are being performed in collaboration with the GEWEX partners: ISCCP, SeaFlux and Land Flux teams with the goal of a first version Integrated Production version in the fall 2014.

The GEWEX SRB website is <http://gewex-srb.larc.nasa.gov/>. A link to order Rel. 3.1 data is available through the website.

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