# Energy Intercomparison Update

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# Long Time Avg Tables for Global Bias Intercomparison

- NASA Energy and Water Cycle Studies Program (NEWS)
  - Closed water and energy budgets simultaneously with uncertainty estimates (generally focusing on NASA observations with MERRA helping to close gaps e.g. transport)
  - 2000-2010 and considering major basins and continents
- Rodell, M., and co-authors, 2015: The observed state of the water cycle in the early 21st century, J. Climate, 28 (21), 8289-8318, doi:10.1175/JCLI-D-14-00555.1.
- L'Ecuyer, T., and co-authors, 2015: The observed state of the energy budget in the early 21st century, J. Climate, 28 (21), 8319-8346, doi:10.1175/JCLI-D-14-00556.1.

# Global Budget

| Global (Jan 2000 - Dec 2010) | TOA Net Flux (W m-2) | Sfc Net Flux (W m-2) | Global Net Flux (W m-2) | Sfc Net Rad (W m-2) | OLR (W m-2) | TOA ASR (W m-2) | Sfc LW↓ (W m-2) | Sfc LW↑ (W m-2) | Sfc SW↓ (W m-2) | Sfc SW↑ (W m-2) | Sfc LE (W m-2) | Sfc Hs (W m-2) | Precipitation (mm day-1) | Evaporation (mm day-1) | P-E (mm day-1) | Total Column Water (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MERRA-2 | -4.0 | -4.5 | 1.4 | 101.0 | 238.4 | 234.4 | 332.1 | 393.9 | 186.0 | 23.2 | 86.2 | 19.3 | 3.02 | 3.02 | 0.00 | 25.0 |
| M2AMIP | -2.8 | -1.0 | -0.9 | 103.4 | 239.0 | 236.2 | 333.0 | 394.2 | 188.2 | 23.6 | 85.0 | 19.4 | 2.98 | 2.98 | 0.00 | 26.1 |
| MERRA | -0.7 | 11.4 | -7.4 | 105.4 | 242.5 | 241.8 | 330.6 | 394.3 | 192.7 | 23.6 | 75.9 | 18.0 | 2.80 | 2.67 | 0.13 | 24.8 |
| ERA-I | -1.5 | 6.1 | -7.6 | 107.7 | 245.7 | 244.2 | 341.7 | 398.2 | 188.0 | 23.9 | 84.1 | 17.5 | 2.88 | 2.90 | -0.03 | 24.4 |
| ERA20C | -1.0 | 1.6 | -2.6 | 103.6 | 240.9 | 239.9 | 337.6 | 396.3 | 187.8 | 25.4 | 82.9 | 19.1 | 2.85 | 2.86 | -0.01 | 23.6 |
| ERA20CM | -0.3 | 8.0 | -8.3 | 103.8 | 241.4 | 241.1 | 340.5 | 399.9 | 188.5 | 25.2 | 82.8 | 13.0 | 3.06 | 2.86 | 0.20 | 23.6 |
| CFSR | -0.6 | 11.0 | -11.5 | 110.1 | 243.8 | 243.3 | 342.8 | 398.6 | 191.8 | 25.9 | 82.8 | 16.3 | 3.22 | 2.92 | 0.30 | 24.9 |
| 20CR | 12.4 | 7.7 | 4.7 | 115.0 | 236.8 |  | 343.8 | 401.4 | 198.4 | 25.8 | 90.5 | 16.8 | 3.11 | 3.19 | -0.08 | 25.4 |
| JRA-55 | -10.1 | -11.2 | 1.1 | 102.3 | 251.4 | 241.3 | 338.1 | 399.6 | 189.4 | 25.6 | 93.2 | 20.3 | 3.30 | 3.21 | 0.09 | 24.0 |
| OBS | 0.8 |  |  | 110.4 | 240.2 | 241.0 | 345.1 | 398.5 | 187.1 | 23.3 |  |  | 2.70 |  |  |  |
| NEWS | 0.4 | 0.4 | -0.002 | 105.6 | 238.0 | 238.5 | 340.5 | 398.8 | 186.1 | 22.1 | 80.6 | 24.6 | 2.79 | 2.79 | 0.00 |  |
| NEWS Err |  |  |  |  | 2.1 |  | 5.2 | 4.3 | 5.4 | 1.8 | 4.2 | 4.3 | 0.15 | 0.15 |  |  |
| Reanalysis ENS | -0.9 | 3.2 | -3.5 | 105.8 | 242.2 | 240.3 | 337.8 | 397.4 | 190.1 | 24.7 | 84.8 | 17.7 | 3.0 | 3.0 | 0.07 | 24.6 |
| Reanaysis Var | 5.9 | 7.6 | 5.5 | 4.4 | 4.4 | 3.4 | 4.9 | 2.8 | 3.7 | 1.1 | 4.9 | 2.2 | 0.17 | 0.17 | 0.12 | 0.85 |


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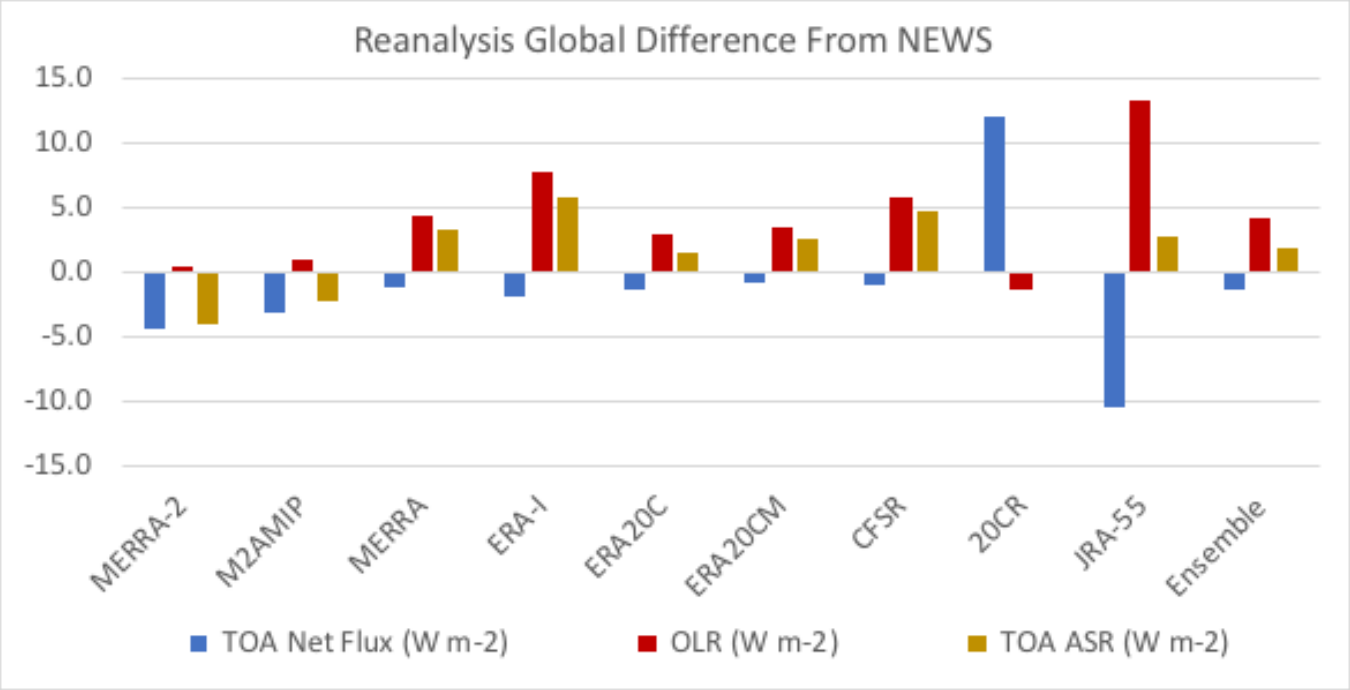
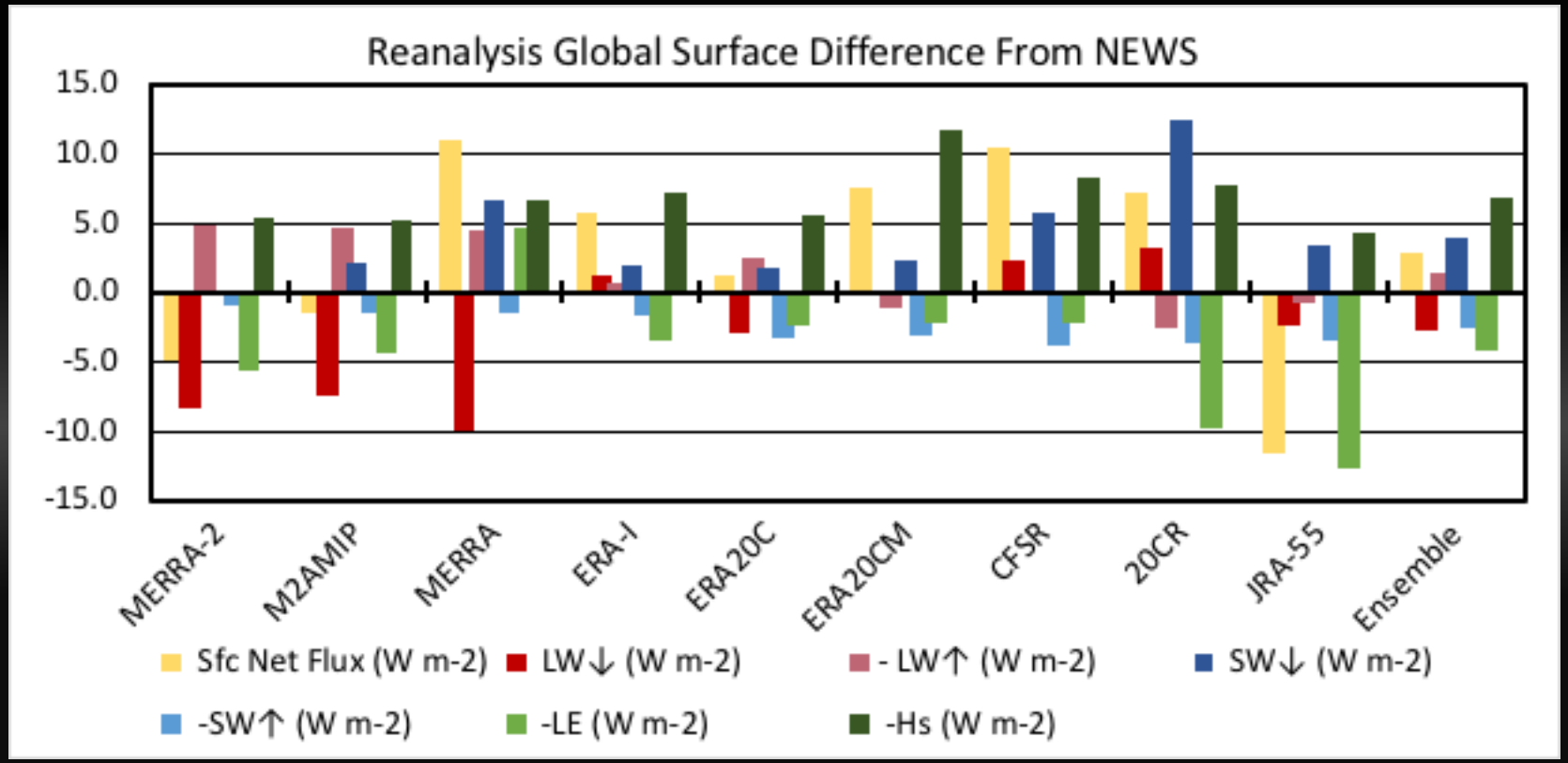
- L'Ecuyer, T., and co-authors, 2015: The observed state of the energy budget in the early 21st century, J. Clim., 28 (21), 8319-8346, doi:10.1175/JCLI-D-14-00556.1.

# Global TOA

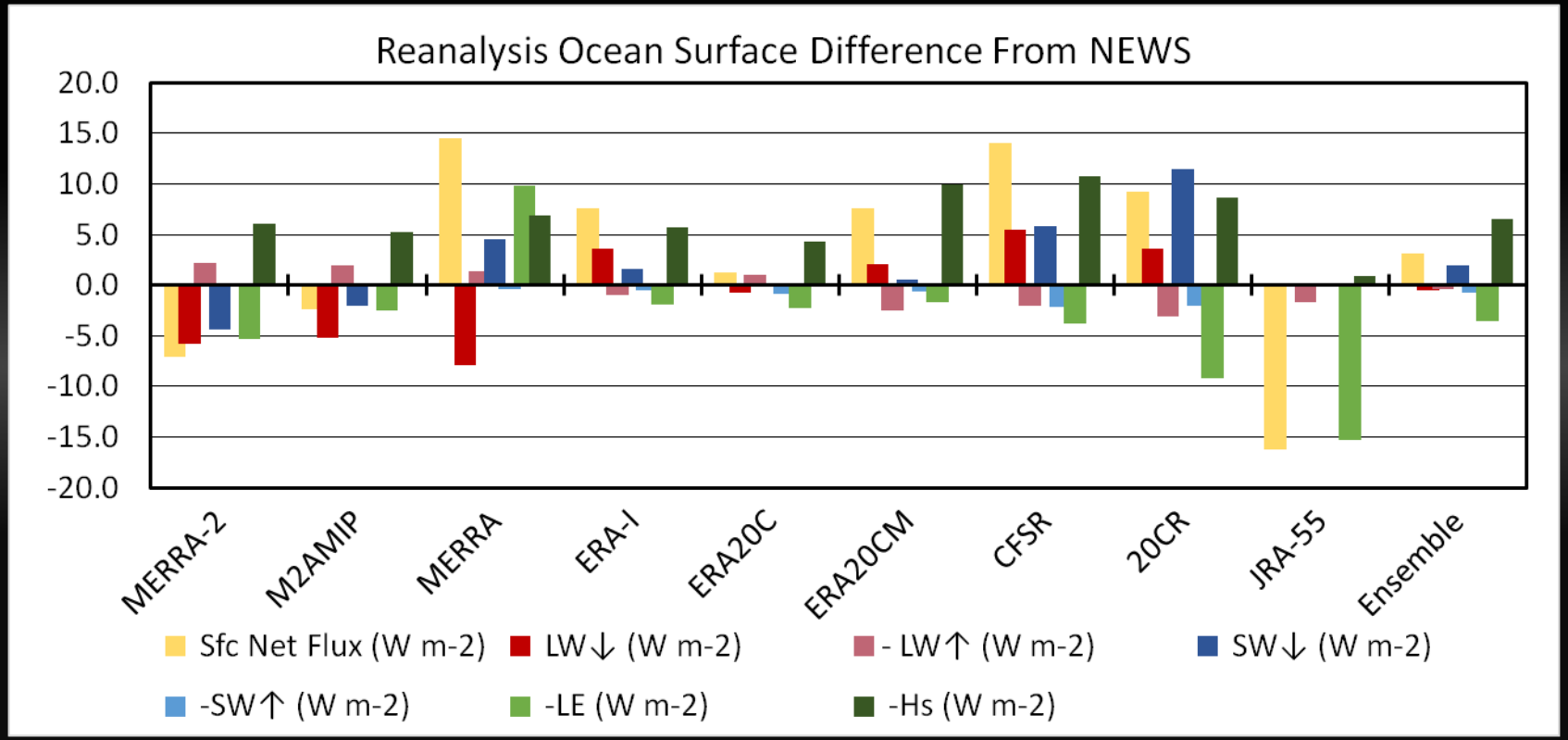

Reanalysis Global Difference From NEWS
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
MERRA-2
M2AMIP
MERRA
ERA-I
ERA20C
ERA20CM
CFSR
20CR
JRA-55
Ensemble
TOA Net Flux (W m-2)
OLR (W m-2)
TOA ASR (W m-2)

# Surface Differences From NEWS

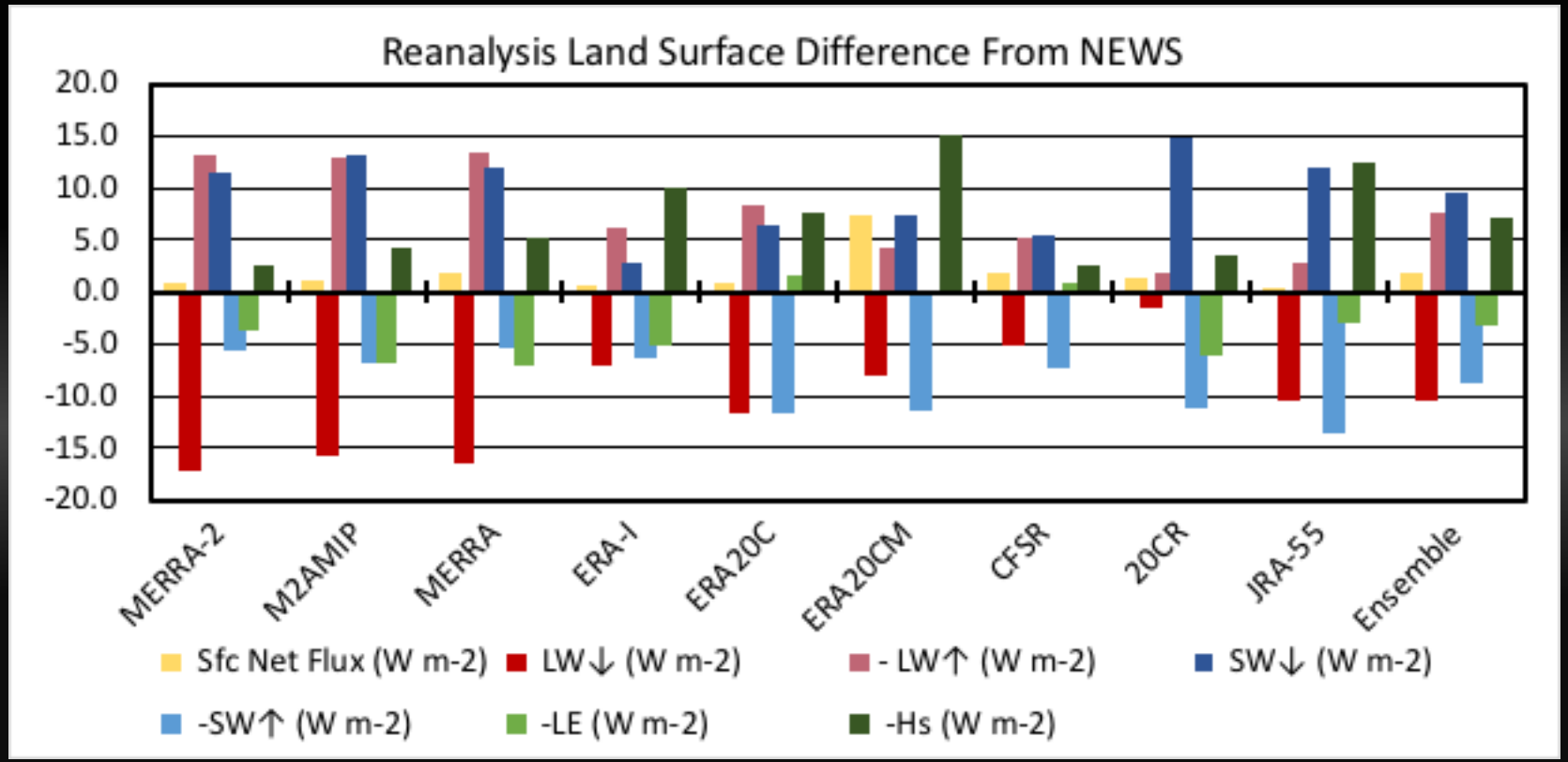



- Sign convention is positive down

# Ocean


Reanalysis Ocean Surface Difference From NEWS
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
MERRA-2
M2AMIP
MERRA
ERA-I
ERA20C
ERA20CM
CFSR
20CR
JRA-55
Ensemble
Sfc Net Flux (W m-2)
LW↓ (W m-2)
- LW↑ (W m-2)
SW↓ (W m-2)
-SW↑ (W m-2)
-LE (W m-2)
-Hs (W m-2)

# Land


Reanalysis Land Surface Difference From NEWS
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
MERRA-2
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-Hs (W m-2)

# Next Possibilities?

- What other observation data to add?
  - Independent surface flux data sets tend to be segregated into land/ocean (full global cover?)
- Compare to Reanalysis Ensemble?
- Precipitation comparisons? Remy Roca and Lisa Alexander observations, asking about reanalyses, need daily 1x1 grids
- What other analysis techniques?
  - Taylor Diagrams – require common grid data for spatial stats, time series could be done without this part, but would yield just one point for each system on the chart

# Taylor example from 2010