CERES-Like Global and Regional Top-of-Atmosphere Radiative Fluxes Using Machine Learning Techniques

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Introduction

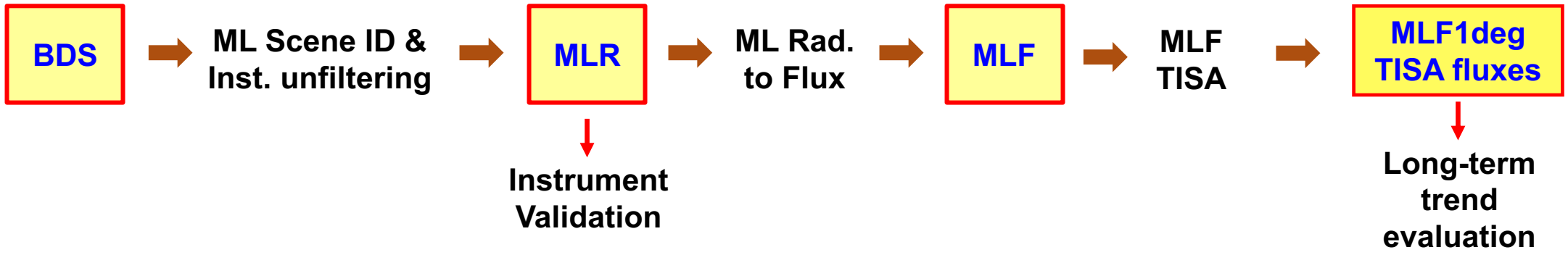
- **Current CERES products:** EBAF and SSF1deg fluxes rely on CERES radiances plus imager cloud properties, various ancillary data, and angular dependent models (ADMs), which may introduce ancillary-data impacts and data gaps.
- **Independent CERES-like fluxes:** Develop a flux product strictly from CERES footprint radiances independent of any other inputs to assess CERES calibration/performance.
- **Similar to ERBE-like:** Products can be quickly processed to provide long-term flux variability
- **Machine learning (ML) approach:** Use ML (ANN and Random Forests) and CERES climatology observations to establish ADMs, directional models, and scene identification, enabling fine-resolution CERES data processing and long-term data records.

CERES-like Data

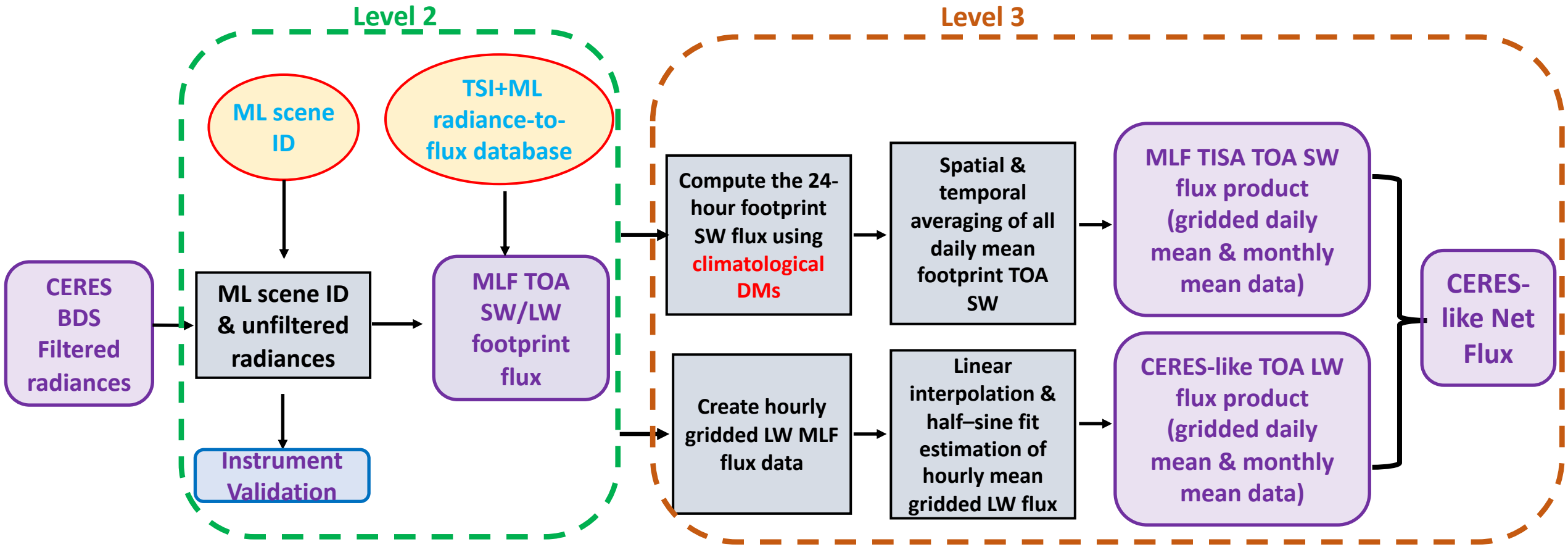
Legacy ERBE-like products



CERES-like MLR/MLF/MLF1deg products

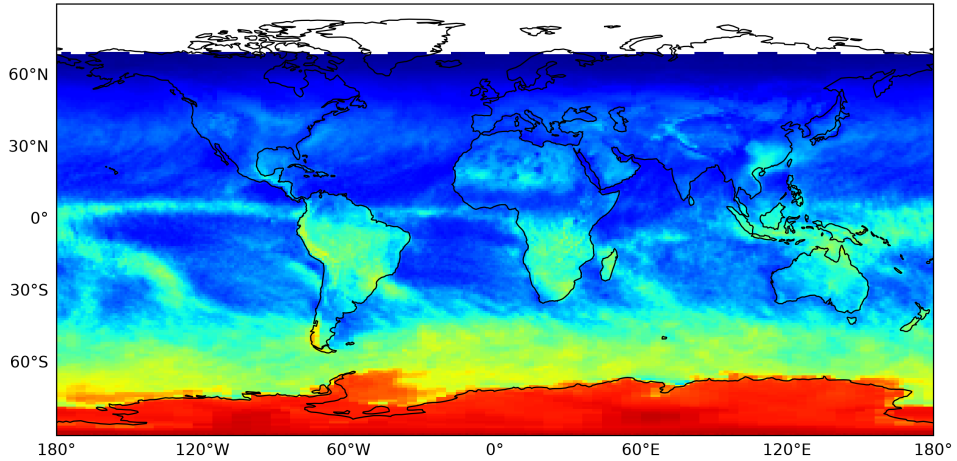


CERES-like Data Processing Flow Chart

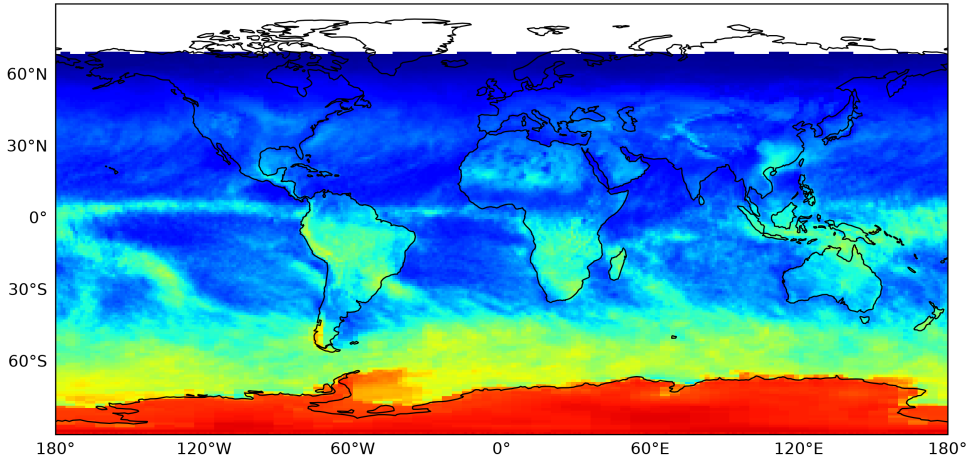


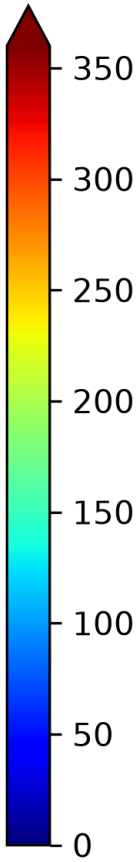
All-sky SW flux comparison: SSF1deg vs MLF1deg (January 2010)

Aqua SSF1deg

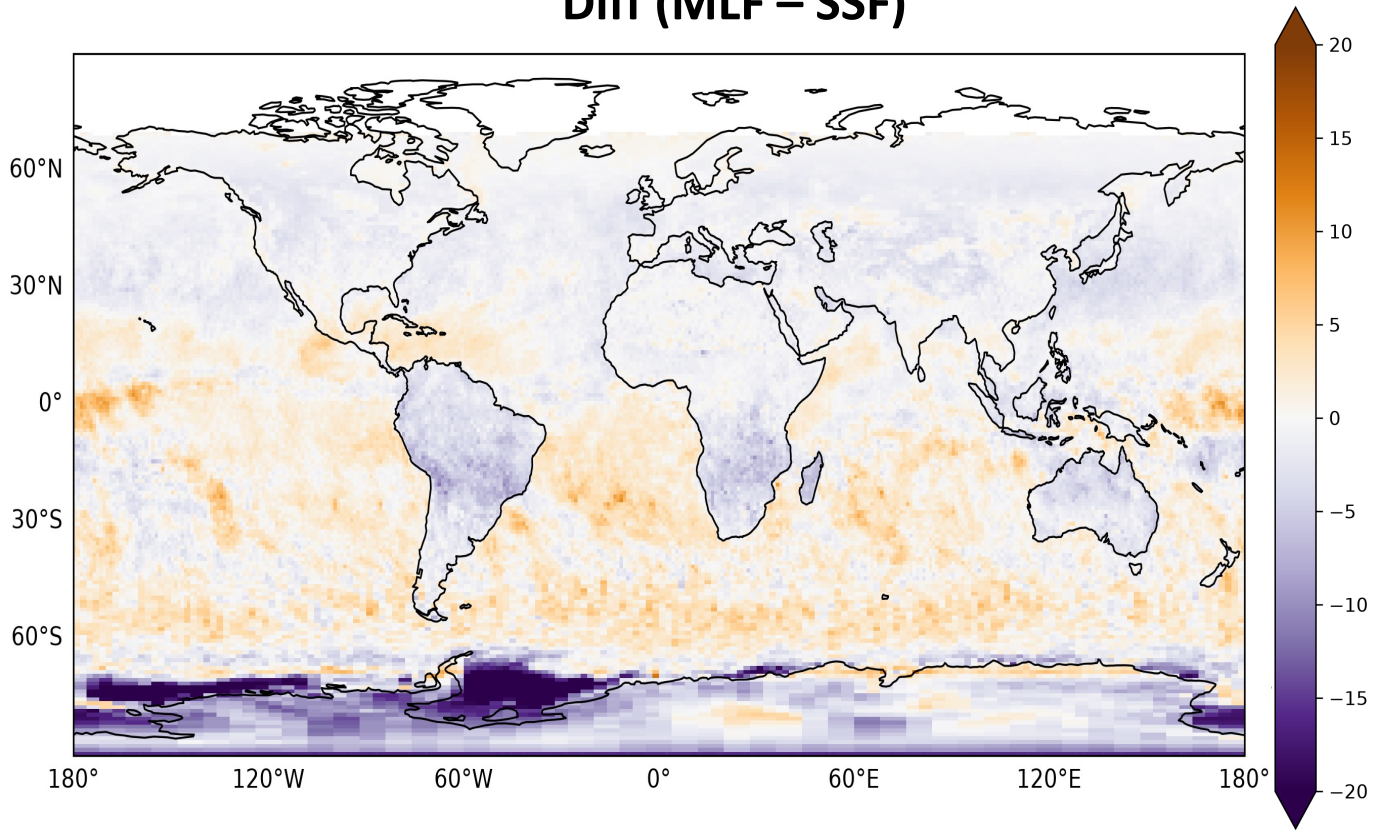


Aqua MLF1deg





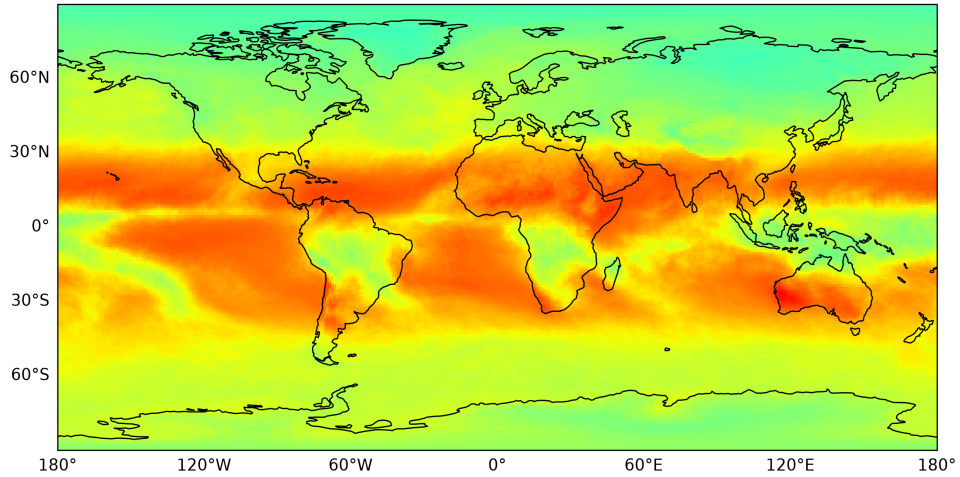
Diff (MLF – SSF)



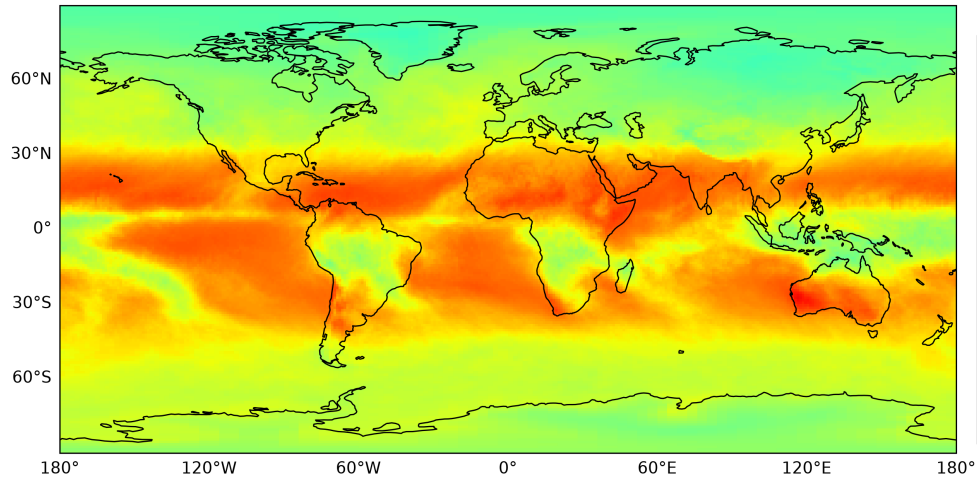
BIAS	STDEV.	RMSD
-0.21	4.37	4.37

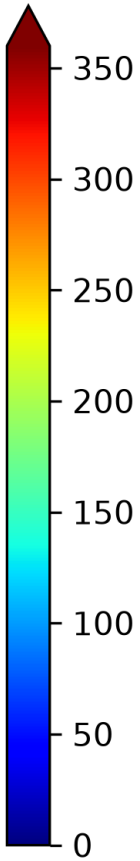
All-sky LW flux comparison: SSF1deg vs MLF1deg (January 2010)

Aqua SSF1deg

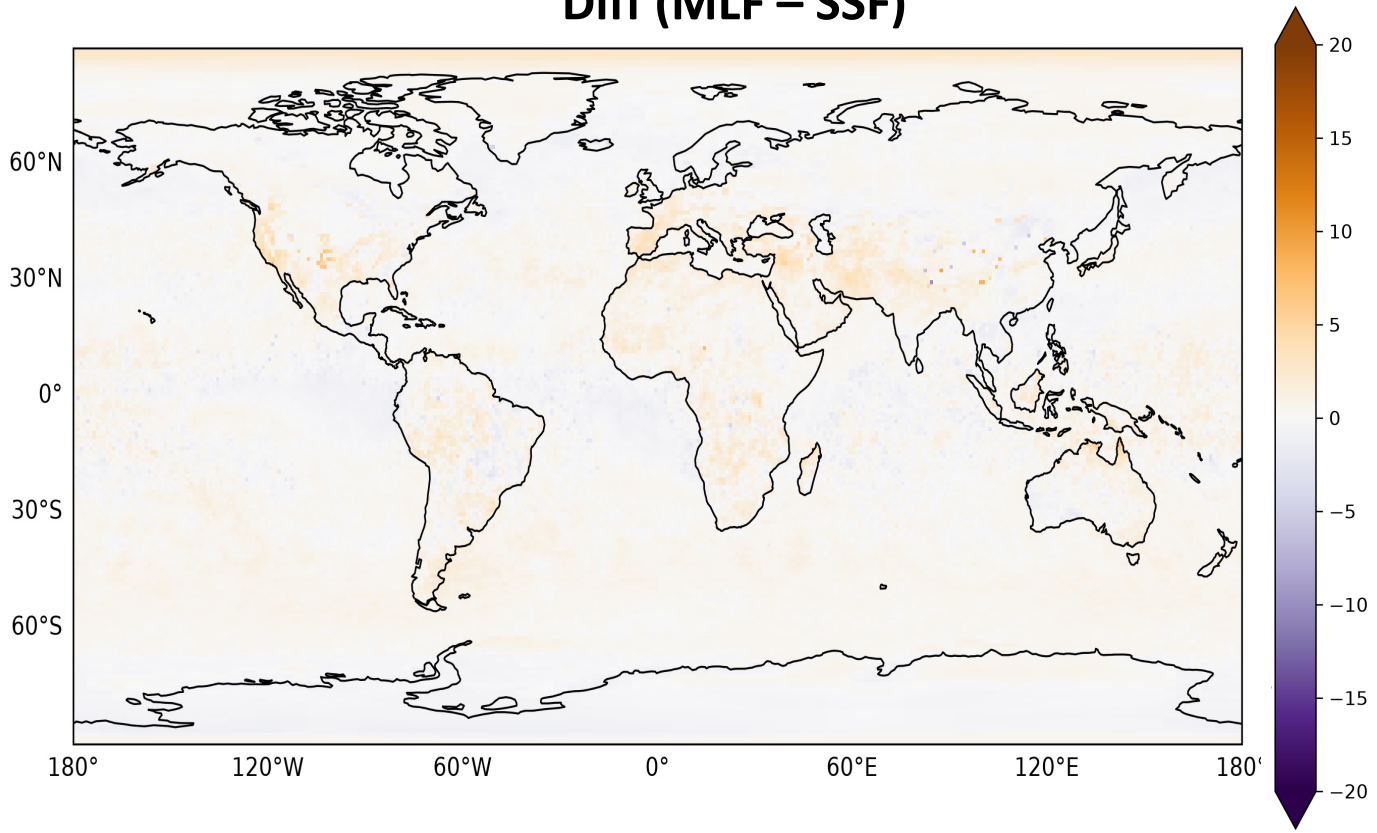


Aqua MLF1deg





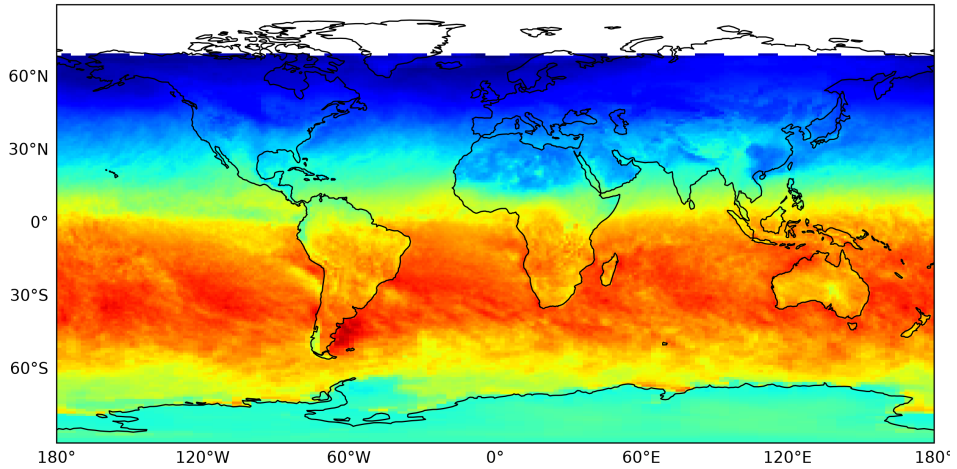
Diff (MLF – SSF)



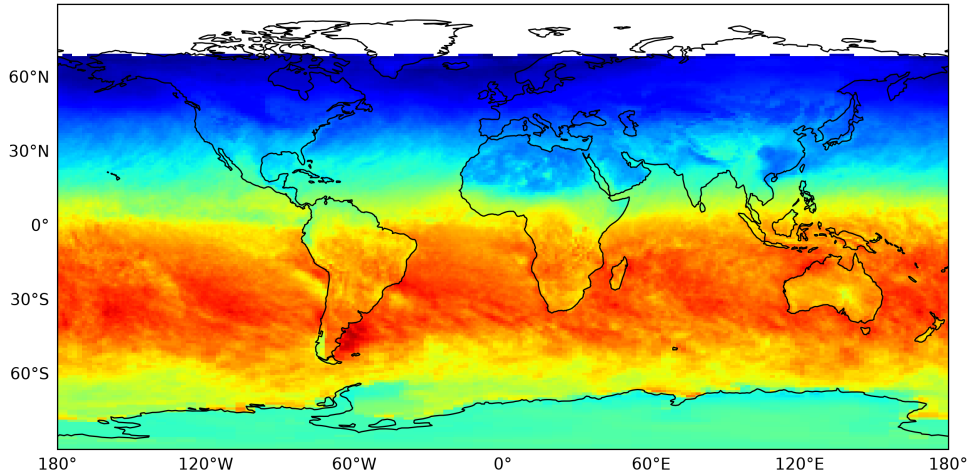
BIAS	STDEV.	RMSD
0.28	0.65	0.71

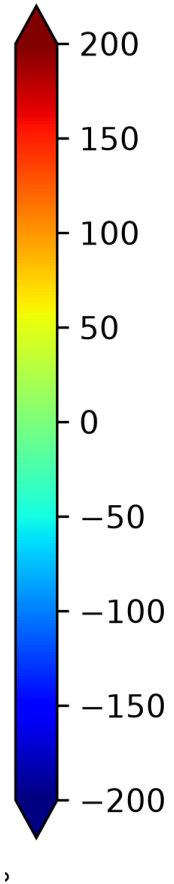
All-sky NET flux comparison: SSF1deg vs MLF1deg (January 2010)

Aqua SSF1deg

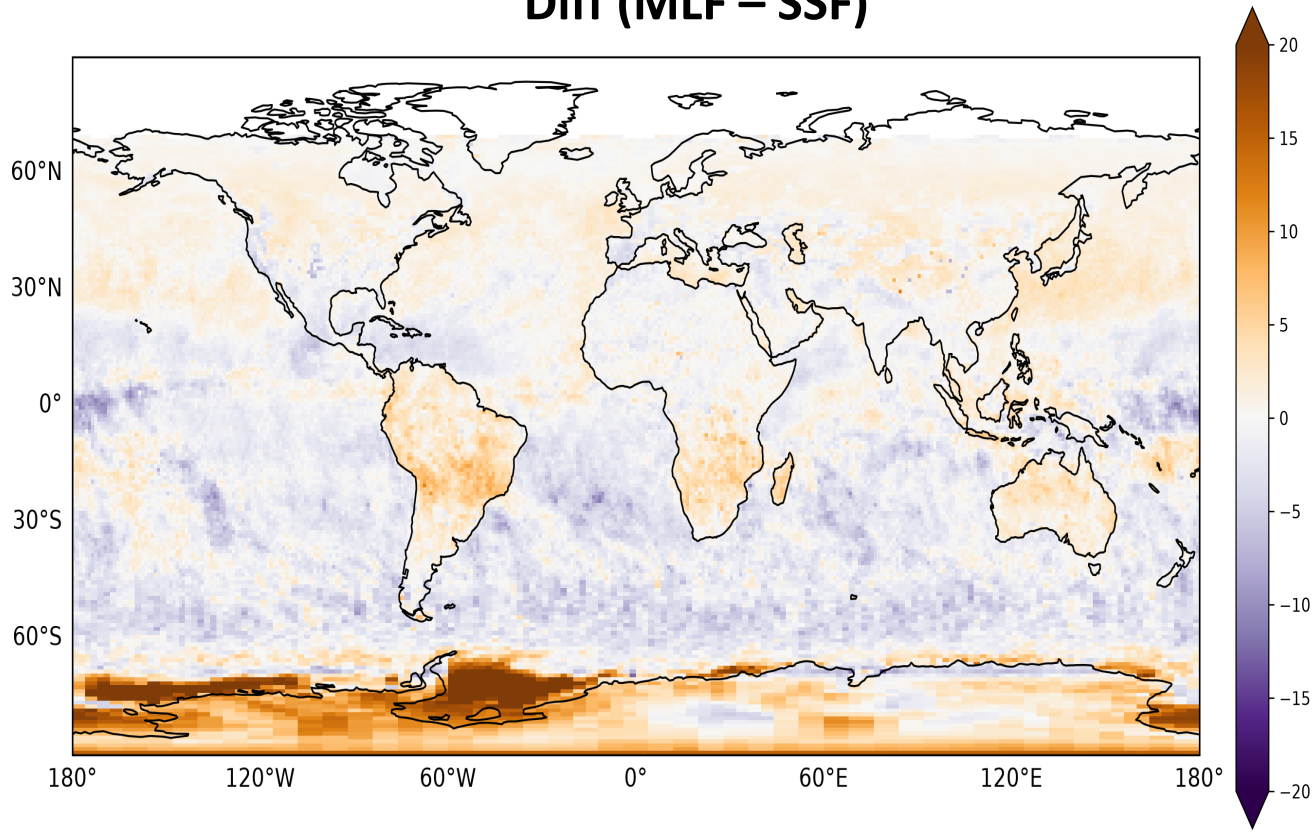


Aqua MLF1deg



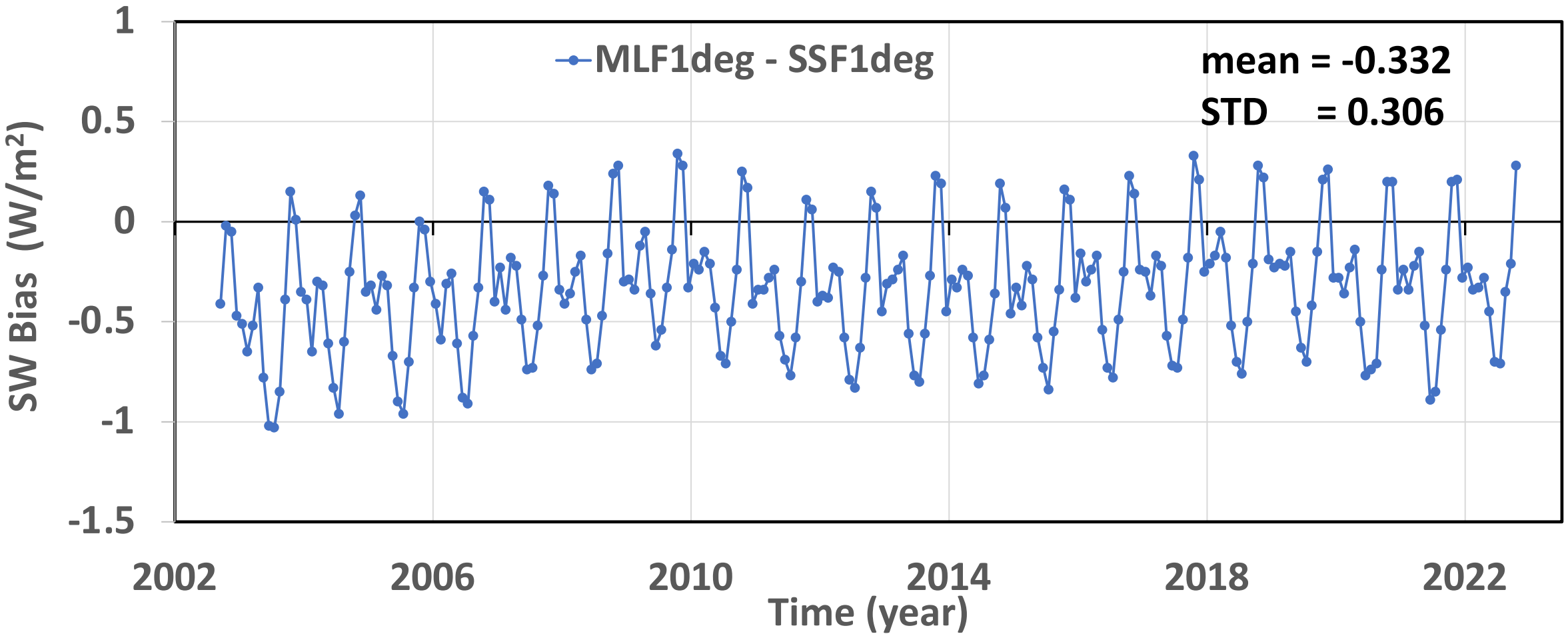


Diff (MLF – SSF)

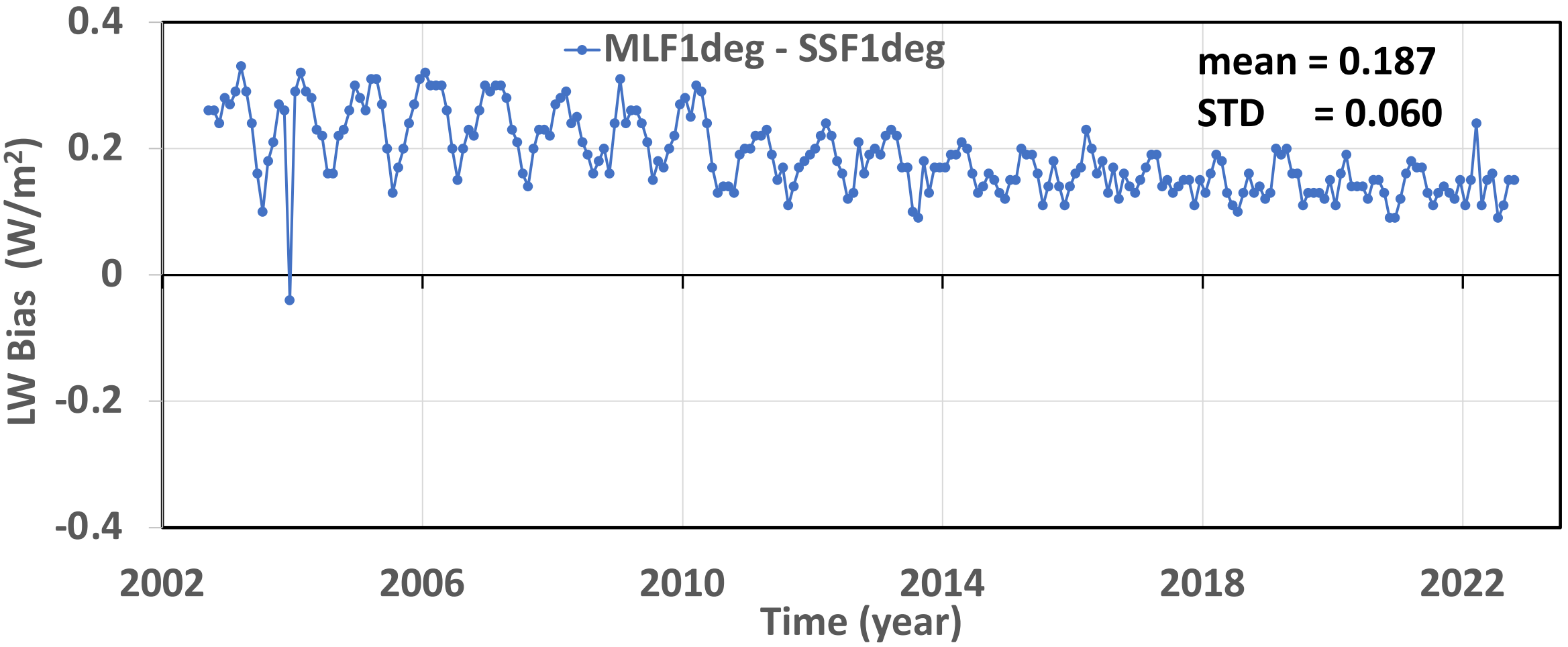


BIAS	STDEV.	RMSD
-0.06	4.47	4.47

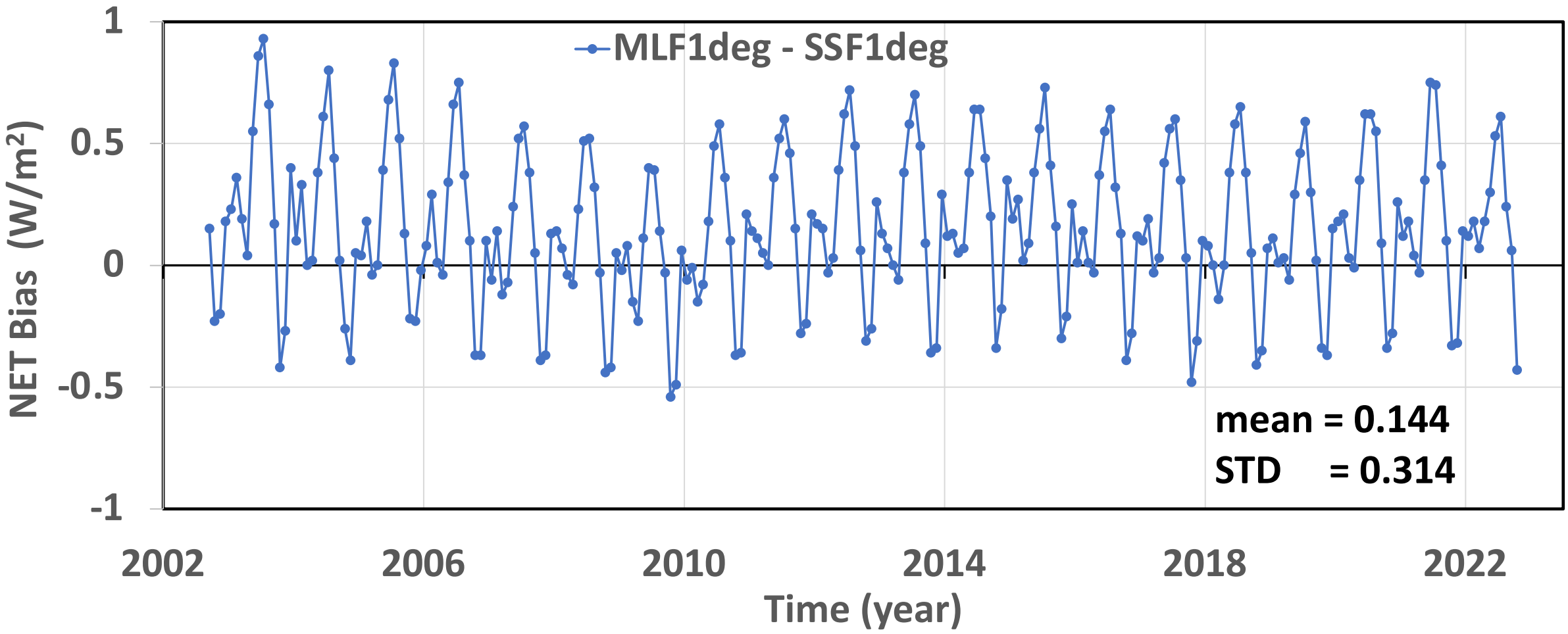
Global monthly mean AQUA SW flux difference



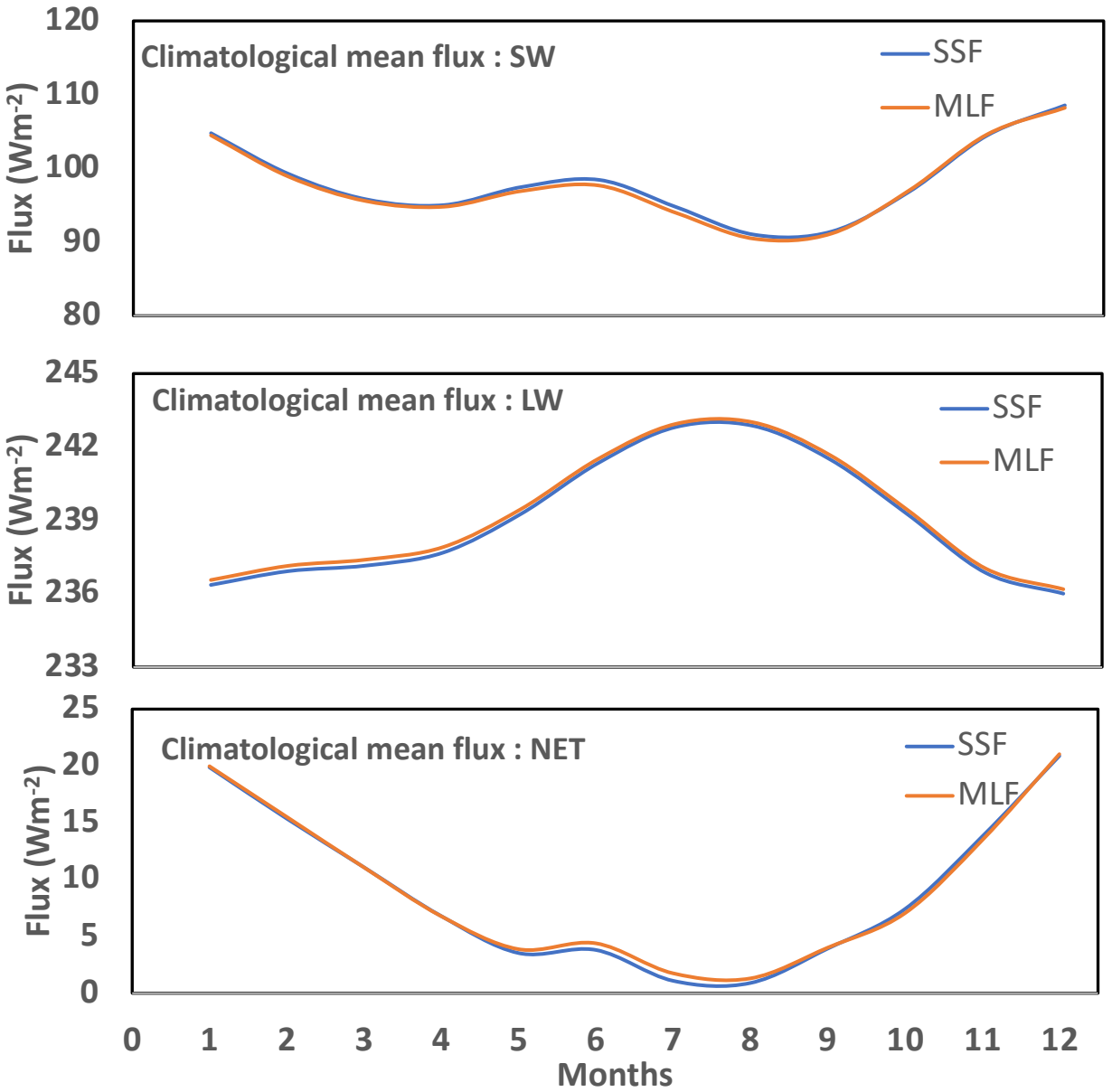
Global monthly mean AQUA LW flux difference

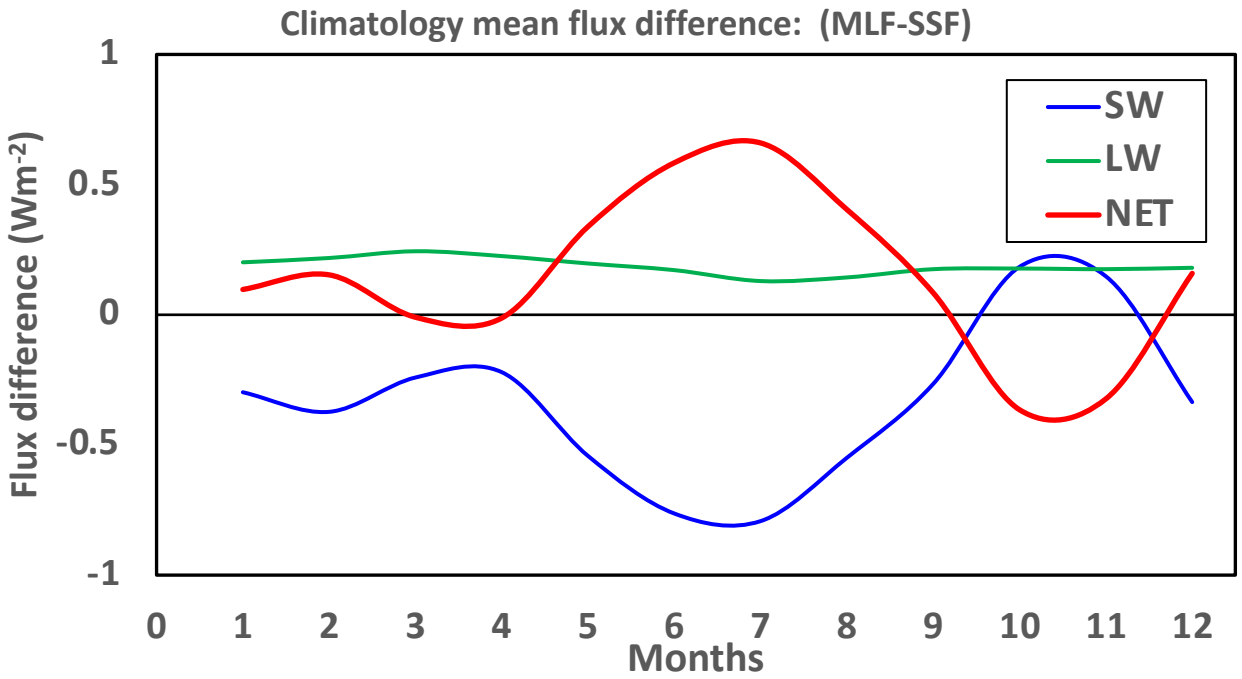


Global monthly mean AQUA NET flux difference



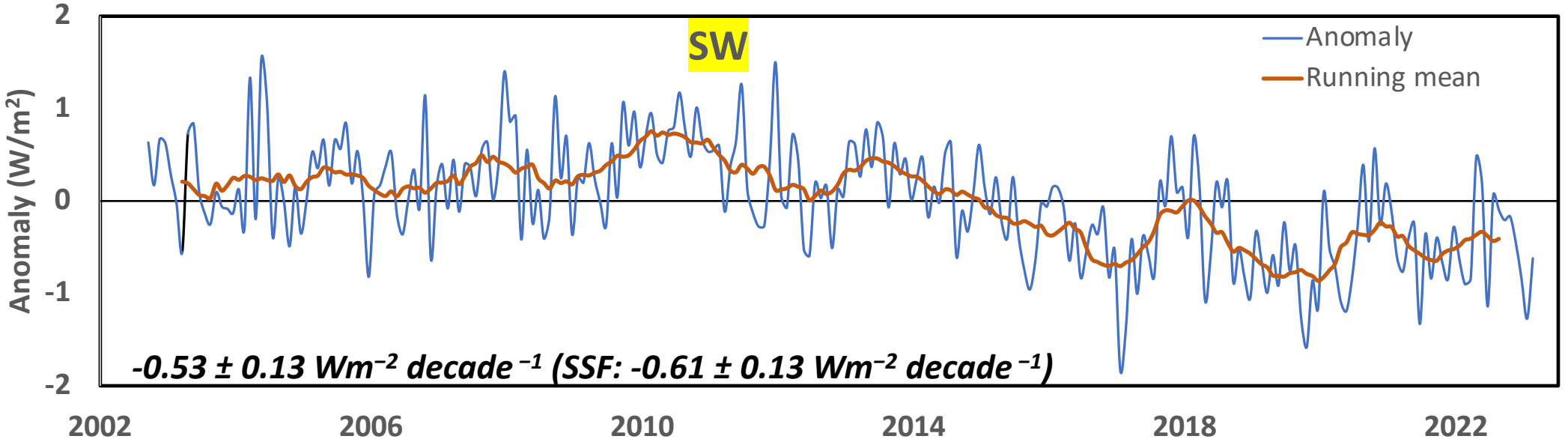
Monthly mean Flux Climatology: MLF1deg vs SSF1deg

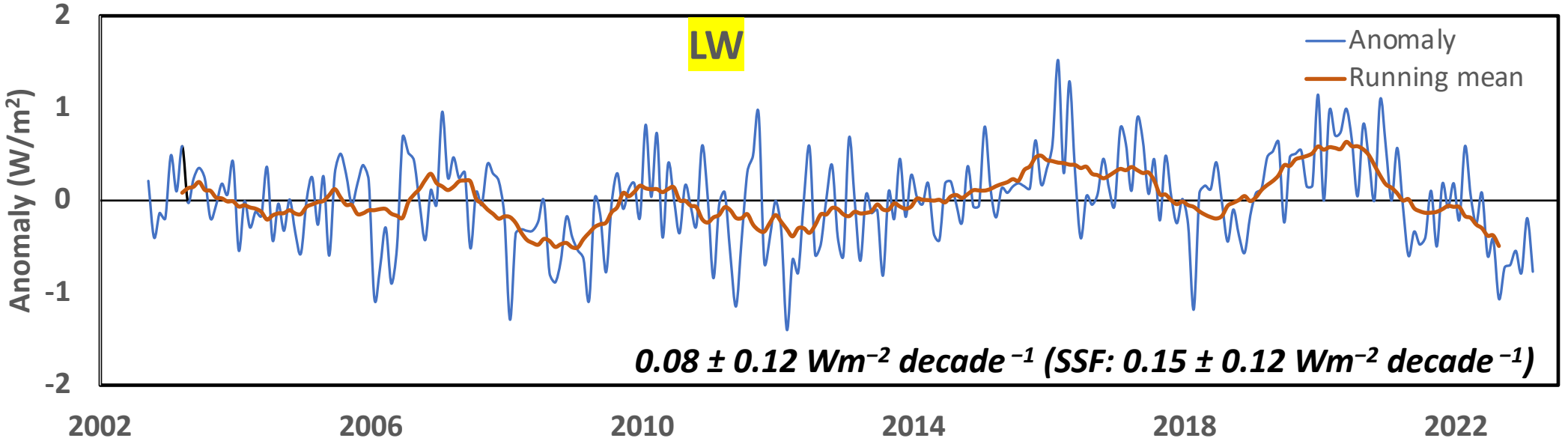




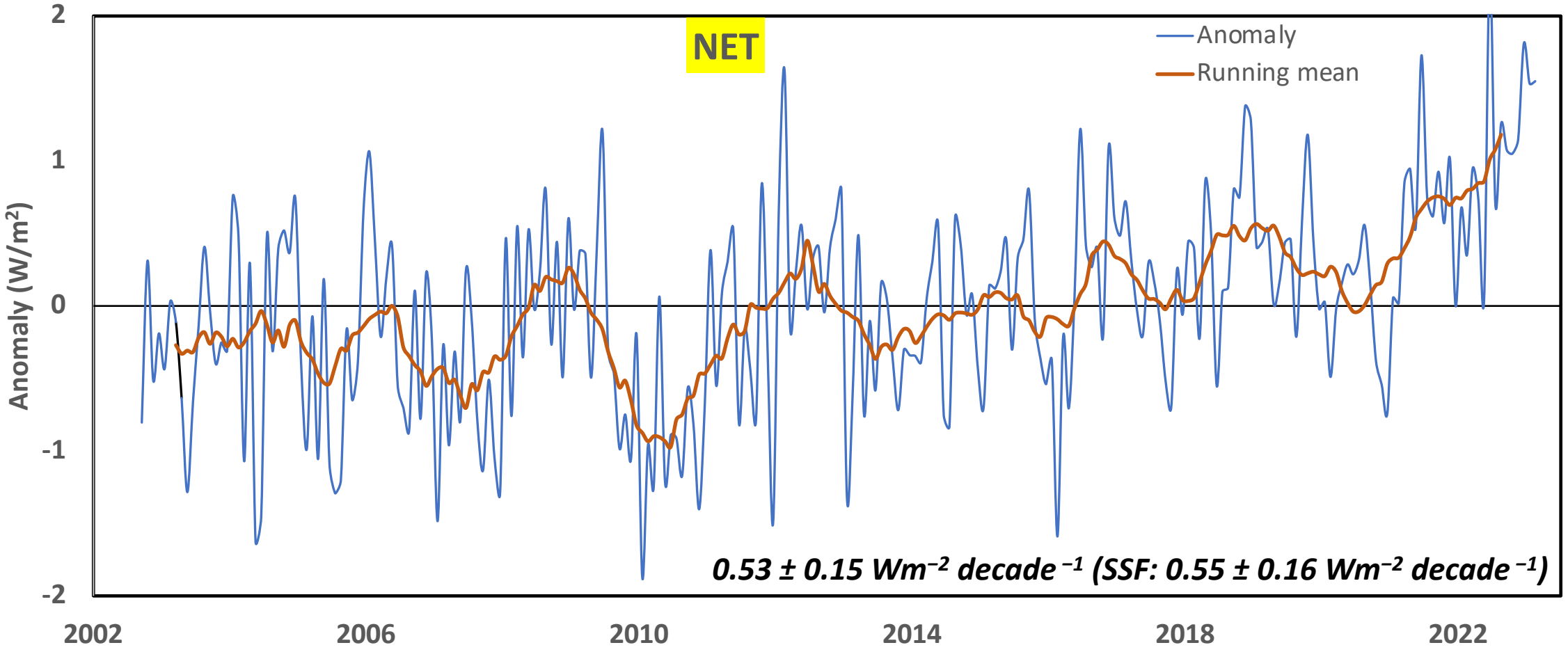
- Climatological mean flux use the SSF1deg and MLF1deg data for the period 09/2002 – 02/2023

Global mean MLF1deg TOA flux anomalies and trends





Global mean MLF1deg TOA flux anomalies and trends



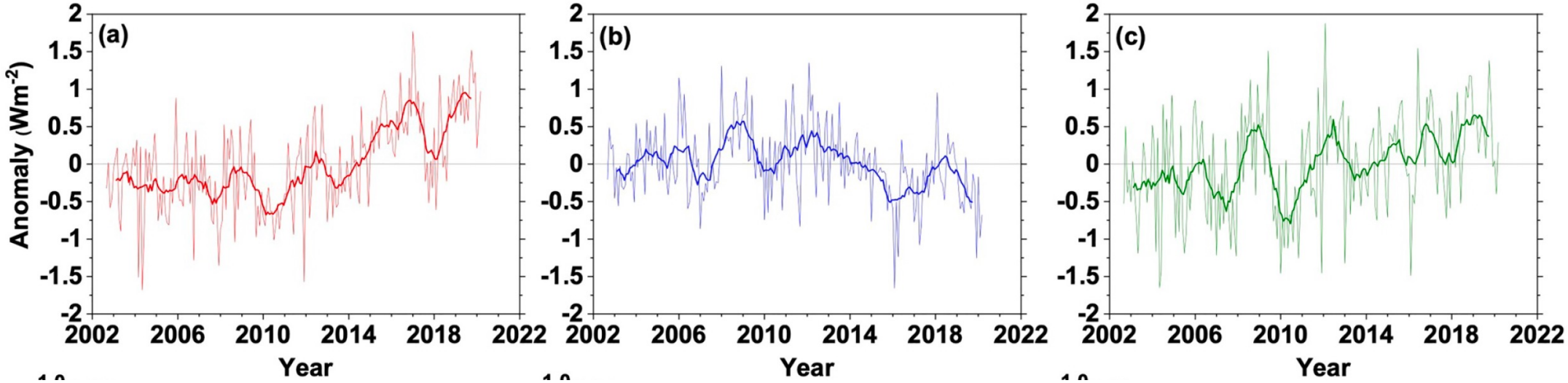
This compares well with results from Loeb et al., (2021) which show similar trend in absorbed solar radiation and downward radiation due to an increase in OLR and a net downward radiation trend of ***0.41±0.22 Wm⁻² decade⁻¹***

Summary

- The **MLR/MLF/MLF1deg** are new CERES products based on strictly CERES footprint observed radiances using a machine-learning methodology.
- Daily mean all-sky TISA fluxes derived from CERES instantaneous radiances show generally good agreement with SSF1deg, **despite differences in the underlying data-processing procedures.**
- For monthly mean all-sky fluxes, the mean differences between MLF1deg and SSF1deg are within ±0.5 W m^{-2}, while the standard differences are generally < 5 W m^{-2}.
- **Future work:**
  - Deliver the MLF TISA algorithm to CERES DMT for production.
  - Develop a 0.25 deg gridded CERES-like flux product suite.

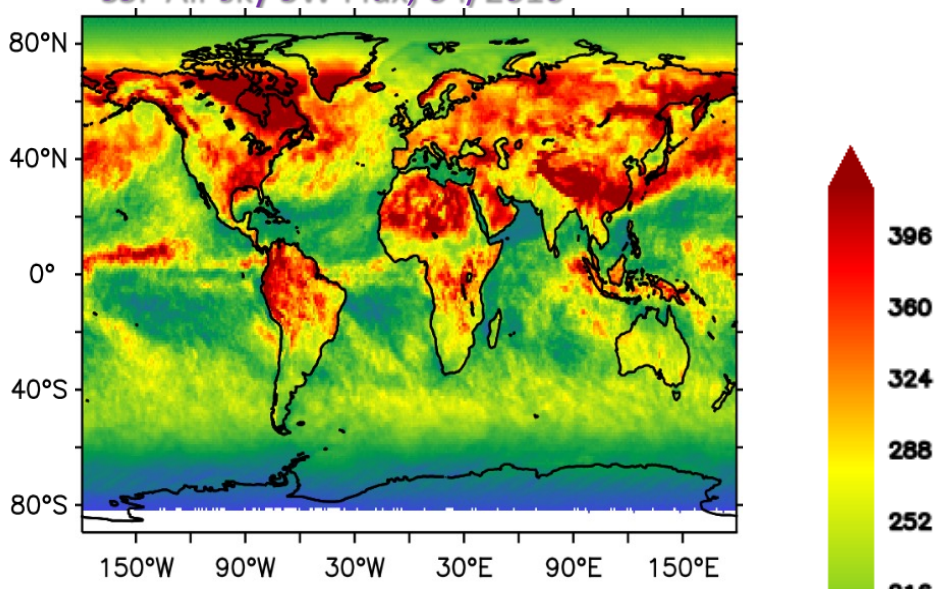
Thank you

SW/LW/NET anomalies and trends

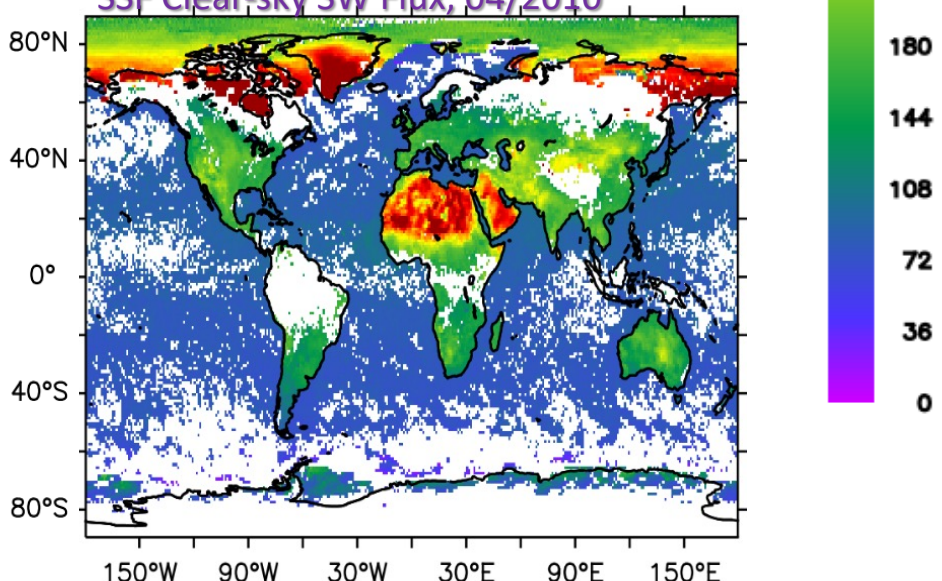


CERES-like instantaneous footprint ML SW flux (Wm^{-2}), April 2010

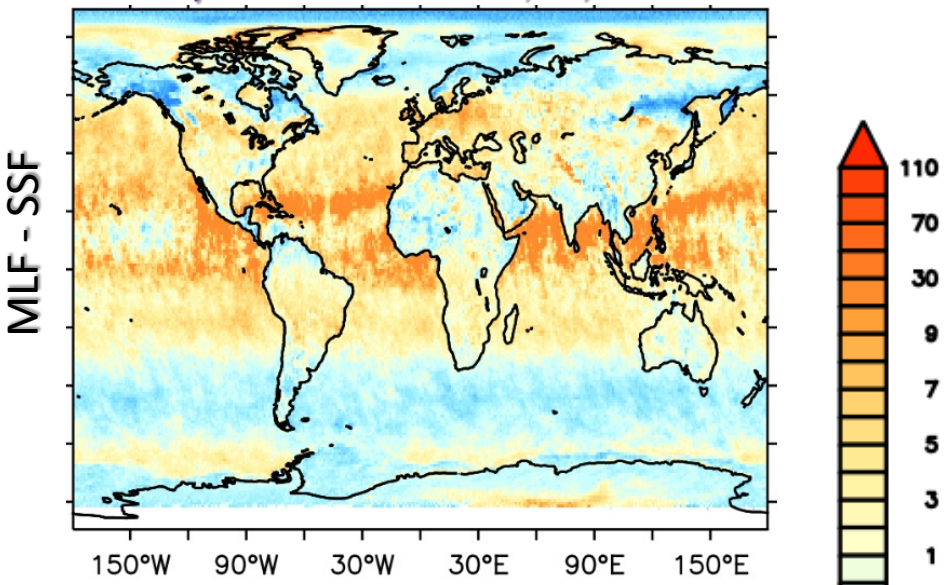
SSF All-sky SW Flux, 04/2010



SSF Clear-sky SW Flux, 04/2010

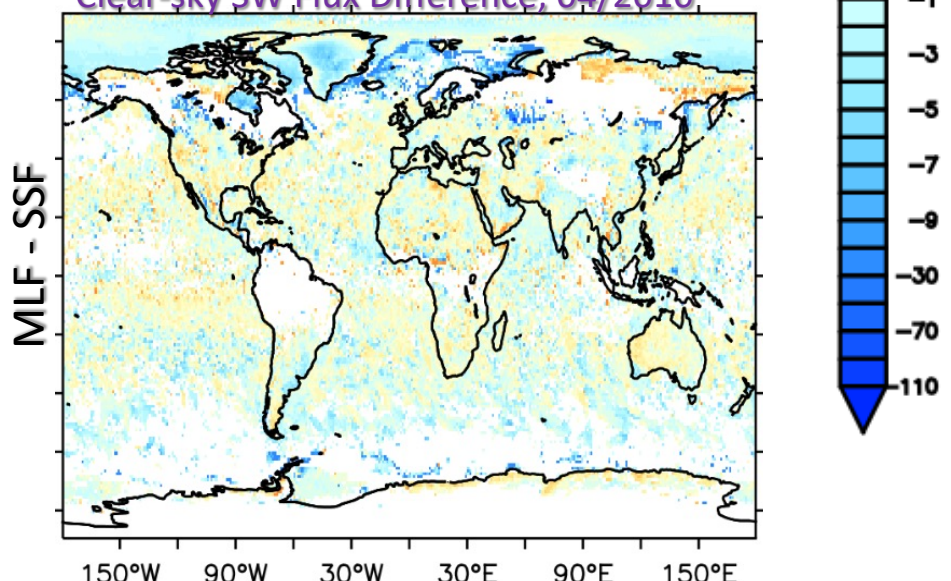


All-sky SW Flux Difference, 04/2010



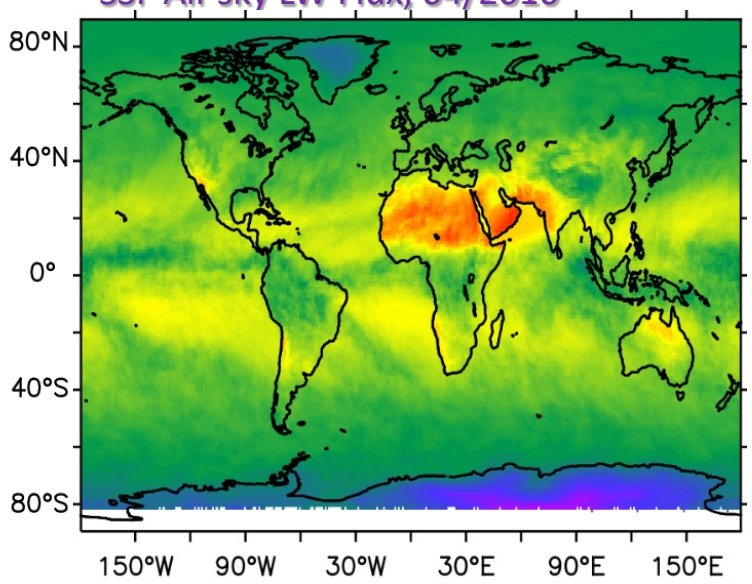


Clear-sky SW Flux Difference, 04/2010



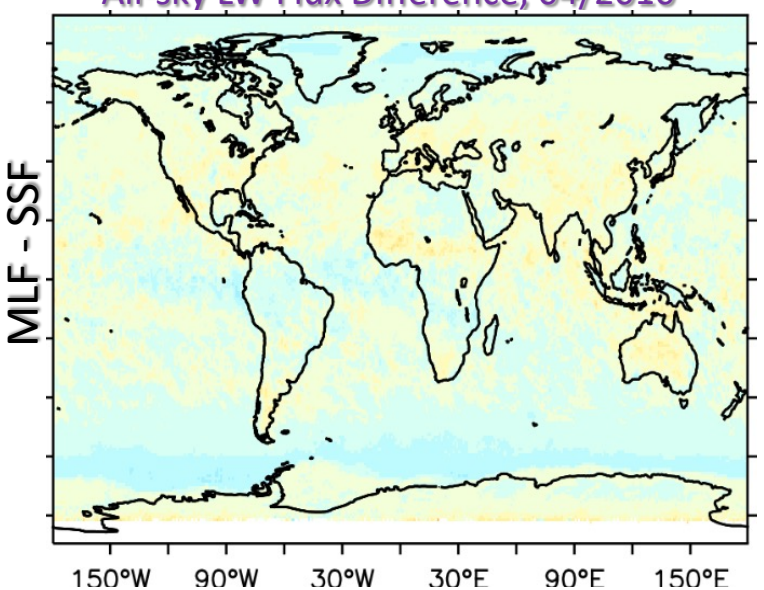
CERES-like instantaneous footprint ML LW flux (Wm^{-2}), April 2010

SSF All-sky LW Flux, 04/2010



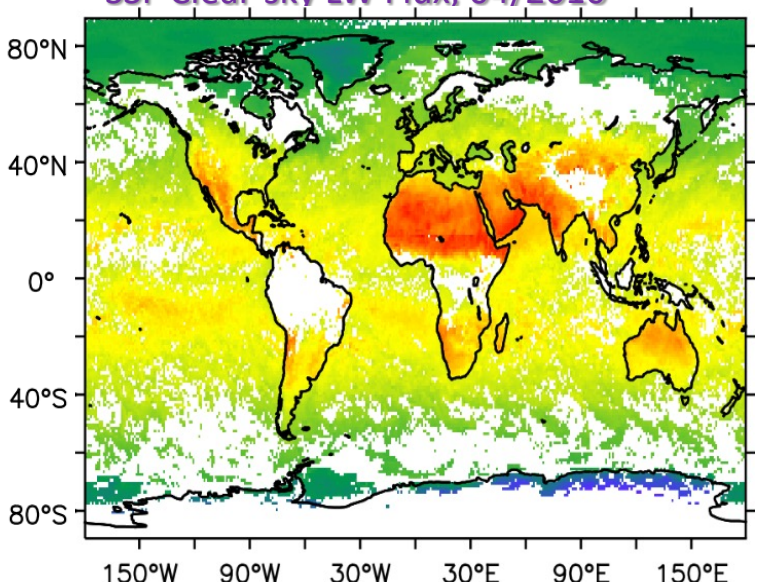


All-sky LW Flux Difference, 04/2010

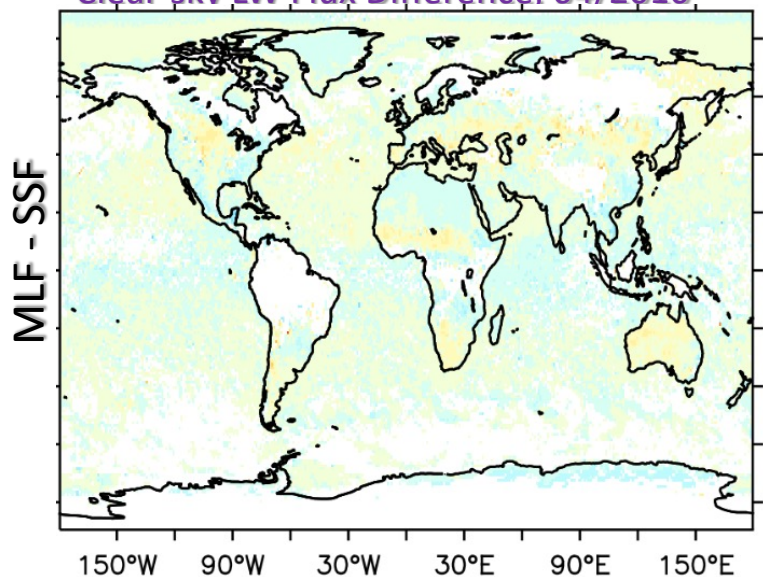




SSF Clear-sky LW Flux, 04/2010

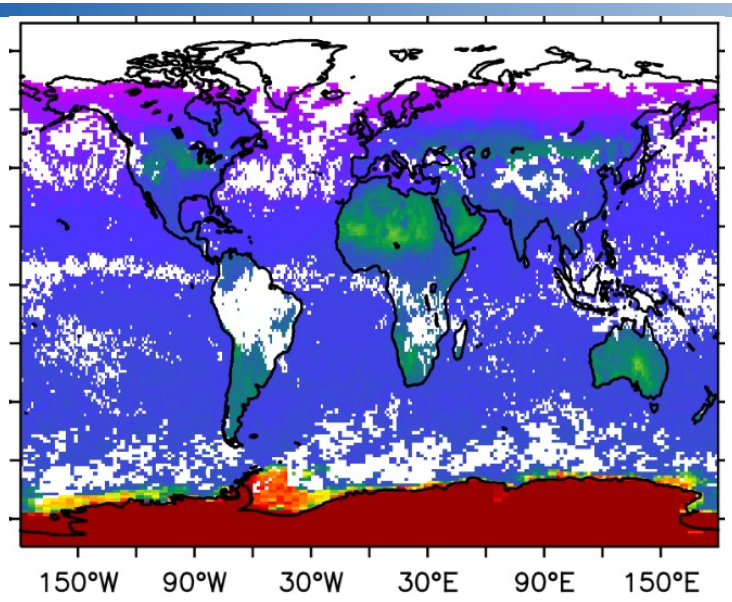


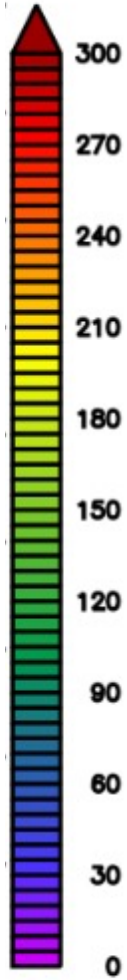
Clear-sky LW Flux Difference, 04/2010



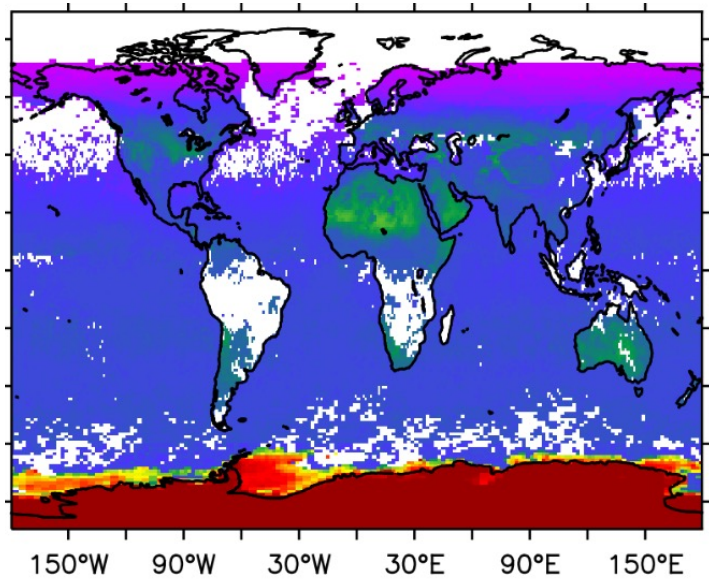
CERES-only TISA Clear-sky SW flux : SSF vs MLF (January 2010)

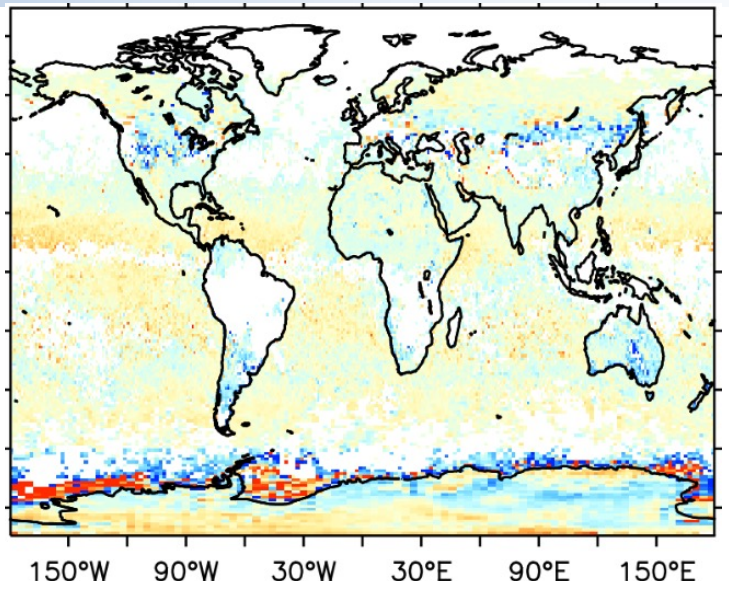
SSF 1deg



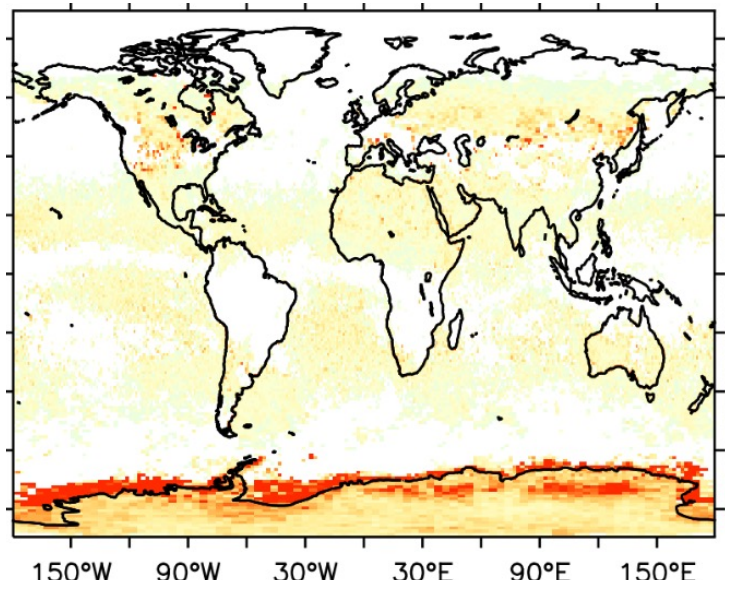


MLF 1deg

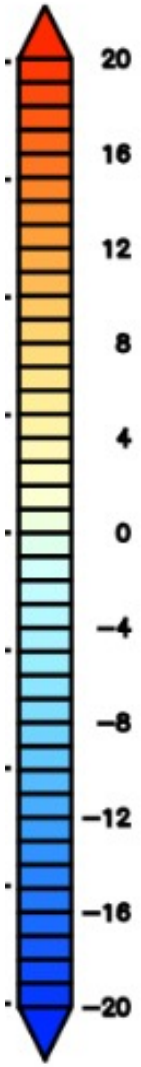




Bias
(MLF – SSF)

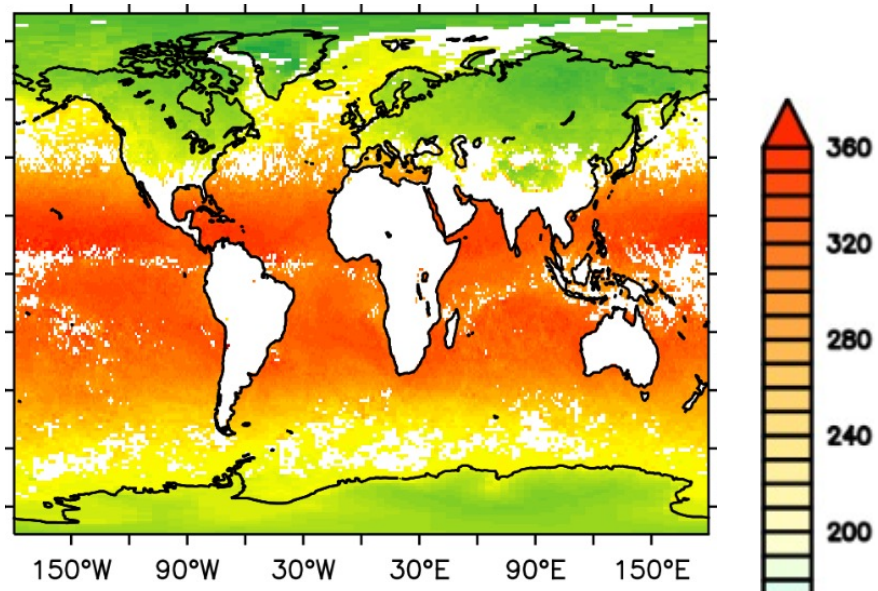


STD

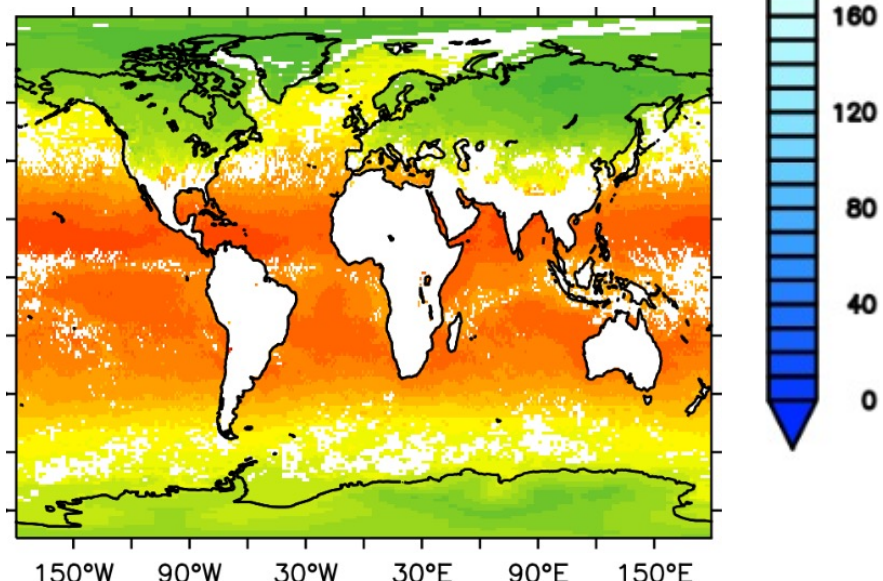


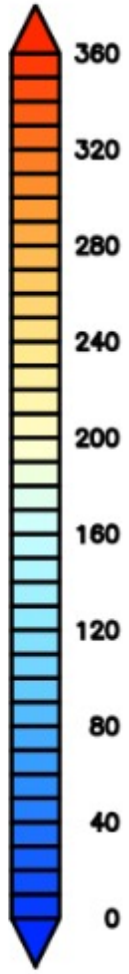
CERES-like TISA Clear-sky LW flux : SSF vs MLF (January 2010)

SSF 1deg

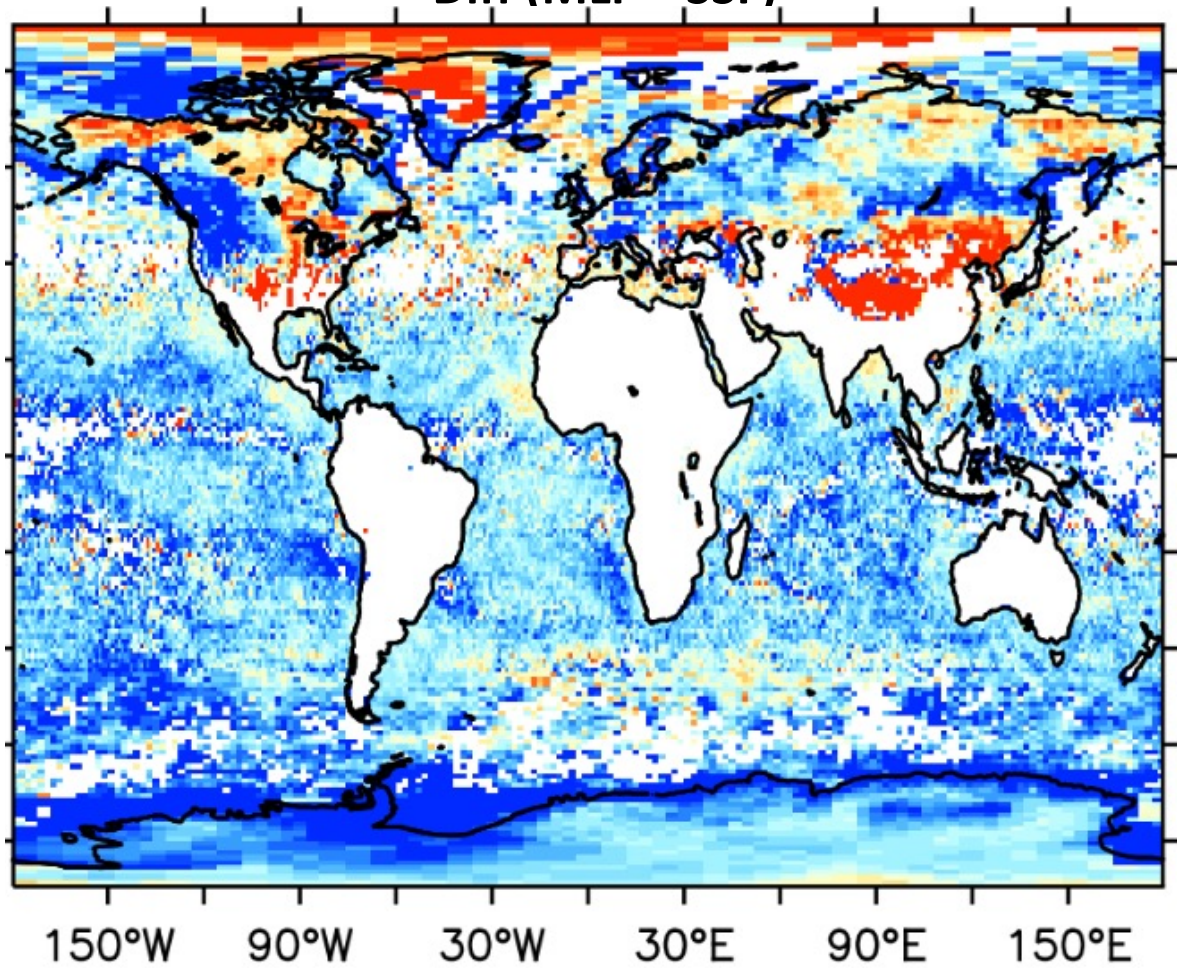


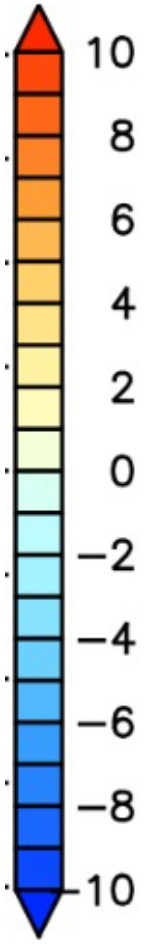
MLF 1deg





Diff (MLF – SSF)

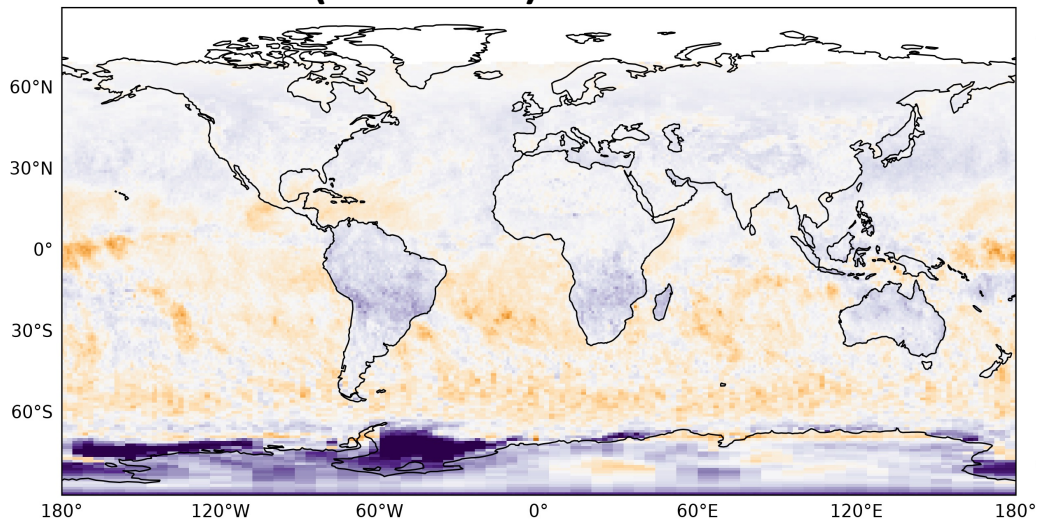




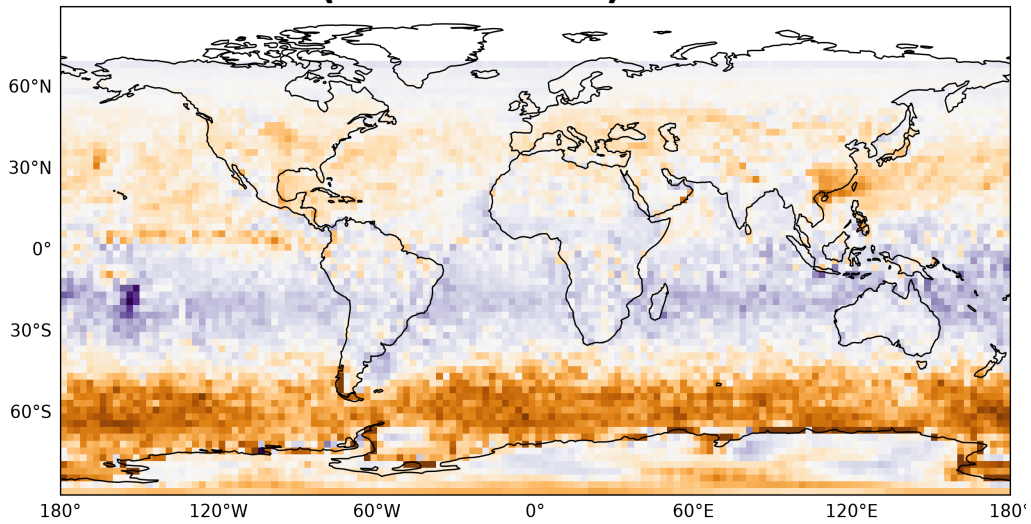
BIAS	STDEV.	RMSD
-3.84	10.54	11.22

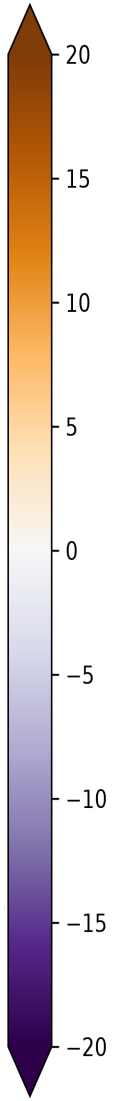
TISA All-sky flux difference: ERBElike vs MLF (JAN-2010)

SW Flux Diff (MLF – SSF)

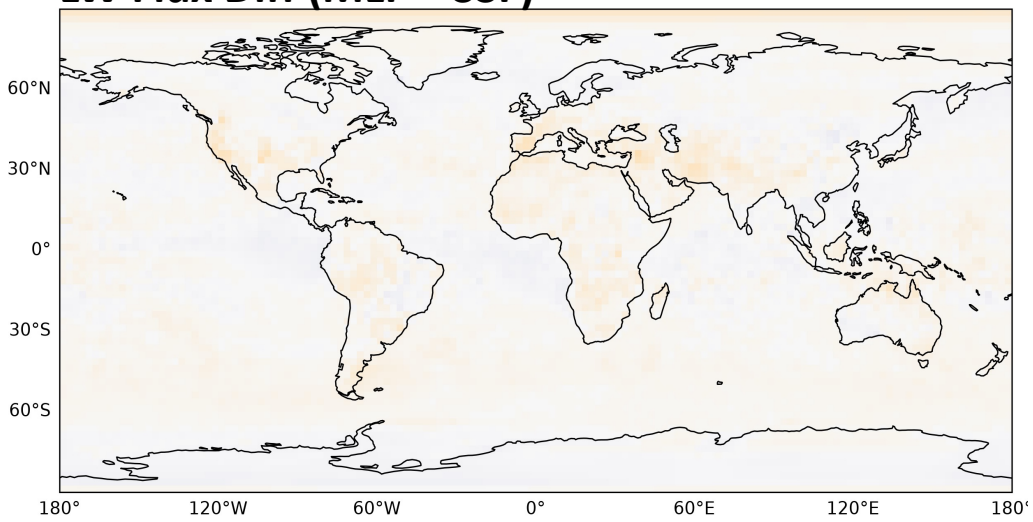


SW Flux Diff (ERBElike– SSF)





LW Flux Diff (MLF – SSF)



LW Flux Diff (ERBElike – SSF)

