National Aeronautics and Space Administration

Soil Moisture Active Passive Mission

SMAP

L4_C Version 5 Product Assessment

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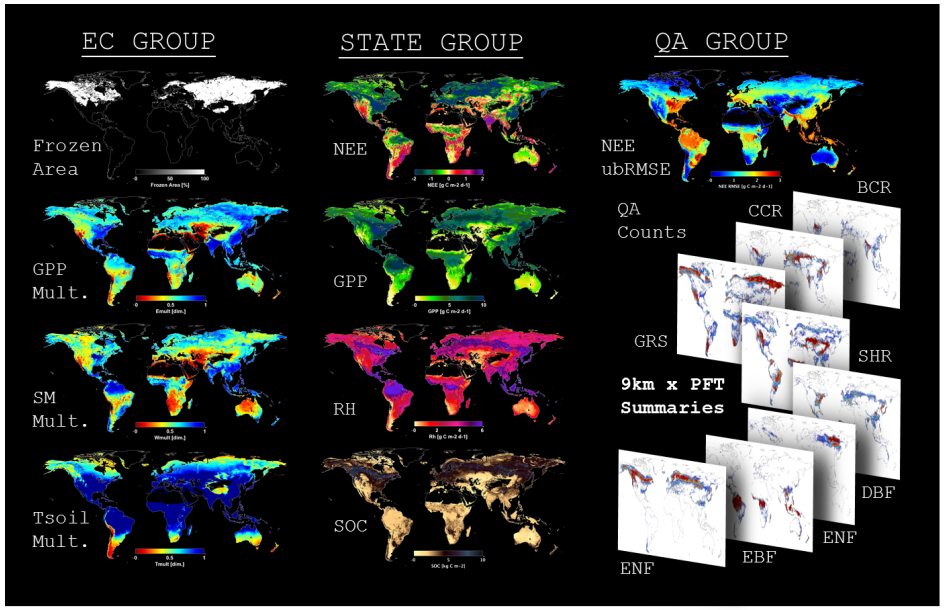
SMAP L4_C Product Summary

- Satellite data-driven C-flux model
  - Inputs: SMAP L4SM, MODIS (LC, FPAR) and GMAO FP daily meteorology (VPD, Tmn, PAR)
  - Daily product set Incl. C-fluxes (GPP, RH, NEE), SOC, EC and QA metrics.
- Model calibrated using global tower C-flux records (FLUXNET)
- 1-km processing and 9-km posting of model outputs
- Target accuracy: Mean NEE ubRMSE≤1.6 g C m^{-2} d^{-1}, emphasizing northern (≥45°N) ecosystems
- Product science objective: Link estimated C-fluxes with underlying environmental controls including SM related constraints to C-sink activity.
- Operational record: Mar 31, 2015 – present; available through NSIDC DAAC

L4_C daily product set



L4_C V5 updates from prior V4 product

- Uses SMAP L4_SM V5 inputs from the latest GEOS-5 assimilation system (NRv8.3);
- L4_C model BPLUT recalibration and SOC initialization using MODIS FPAR (c6), MERRA-2 daily meteorology & NRv8.3 L4_SM inputs
  - BPLUT recalibration using 329 tower site records covering all major global PFT classes (La Thuile + FLUXNET2015 synthesis)
  - Spatially weighted calibration emphasizing northern (≥45N) tower sites
  - Implemented more stringent PFT realistic range constraints for the BPLUT calibration
  - Other minor adjustments, incl. updates to product bitflag attribute descriptions & metadata, & HDF5 version compatibility (v.1.8 to v.1.10).
- All changes limited to model inputs, ancillary files & post-processing with no change to core algorithms.

L4_C Product Streams (Version 5)

L4_C Science Version IDs follow from L4_SM:
SVID(L4_C) ≈ SVID(L4_SM) + 10

Vv4030 → L4_C Vv4040

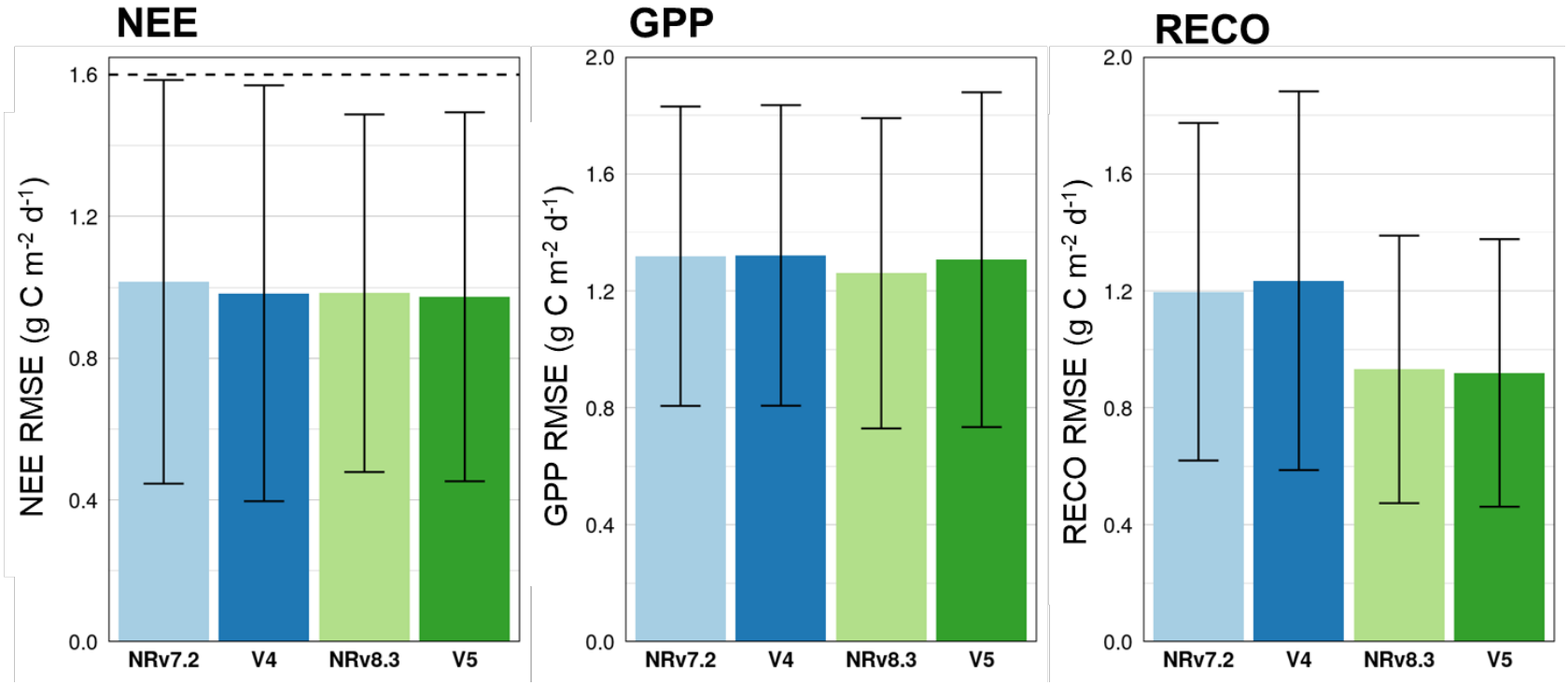
Vv5011 (L4_SM NRv8.1-based; sub-optimal scaling parameters) → L4_C Vv5021

Vv5012 (L4_SM NRv8.3-based; better scaling parameters) → L4_C Vv5022 **Vv5024**

Vv5030 (L4_SM NRv8.3-based; best scaling parameters; revised mwRTM calibration) → L4_C Vv5040

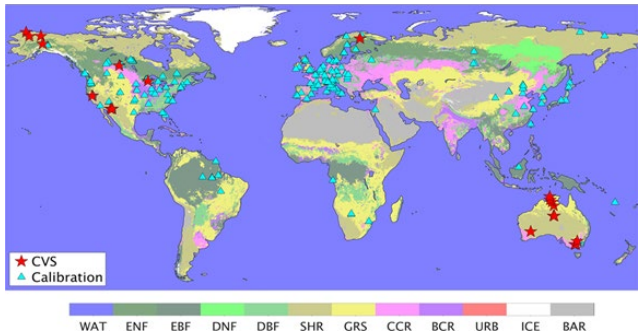
L4_C Stream	Data Period	Production Status (Wall Date)	Description
Vv**4040**	31 Mar 2015 – 27 Aug 2020	On-going	Version 4 ops (NRv7.2 based)
Vv**5**021 Vv**5**022	31 Mar 2015 – 27 Aug 2020	Stopped Currently processing	Version 5 test (NRv8.1 based) Version 5 ops (preliminary processing; NRv8.3 based)
Vv5024	27 Aug 2020 - …	Planned, starting Aug 31	Version 5 ops (initial stream using R17 ops inputs)
Vv**5**040	31 Mar 2015 – …	Planned, starting ~Sep 2020	Version 5 ops (“official” reprocessing stream; once caught up to present (~Nov 2020), Vv5040 replaces Vv5022 & Vv5024)

L4_C performance (26 CVS towers; 2015-2017)

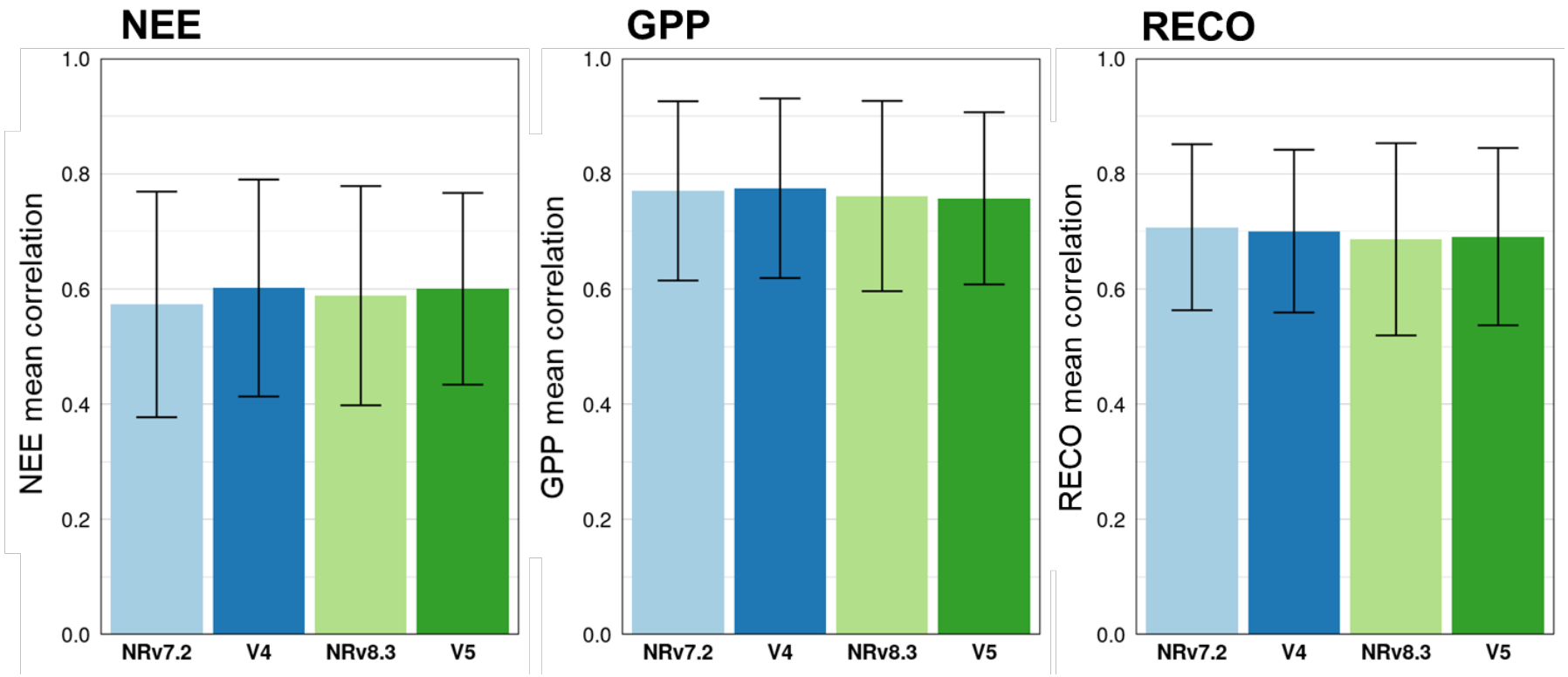


- Overall V5 (and NRv8.3) performance is similar to that of V4 (and NRv7.2);
- Small V5 performance gain for NEE; GPP similar; significant RECO improvement.
- V5 (NRv8.3) well within performance target (NEE mean RMSE≤1.6 g C m^{-2} d^{-1})

Tower Cal/Val Sites

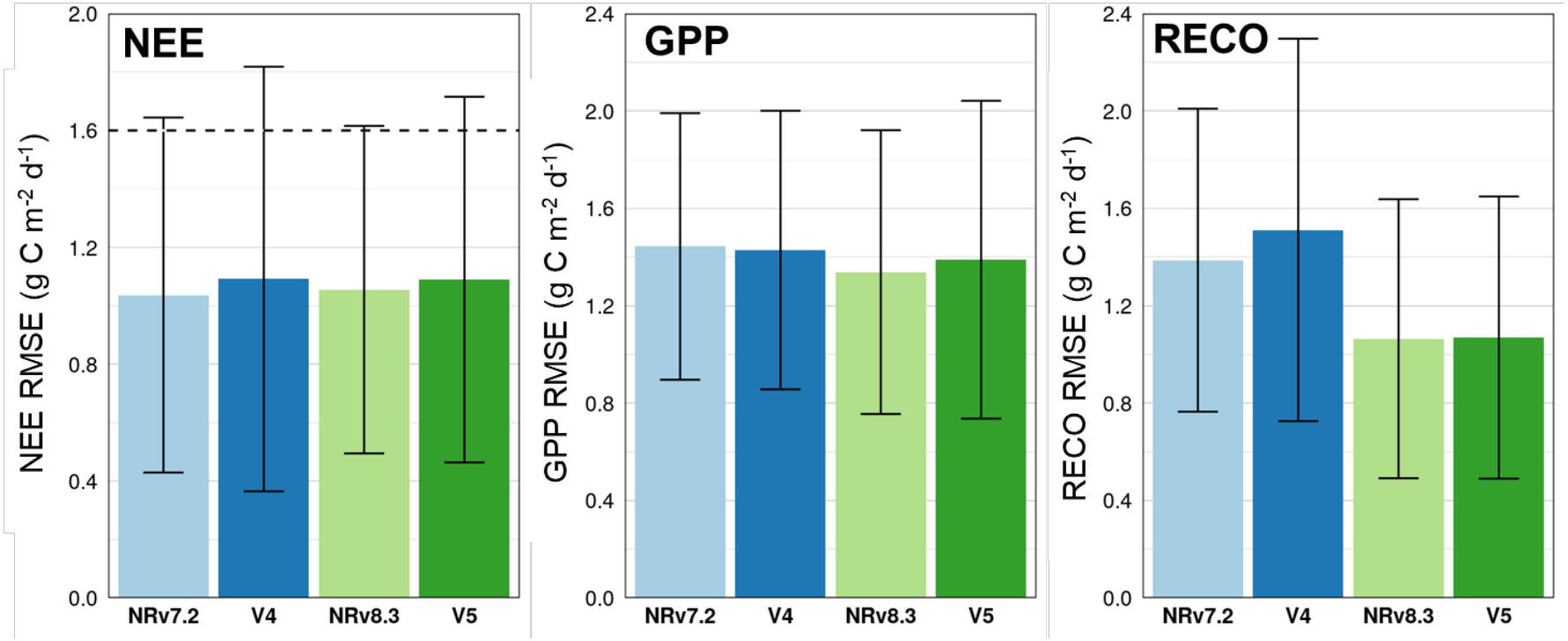


L4_C performance (26 CVS towers; 2015-2017)



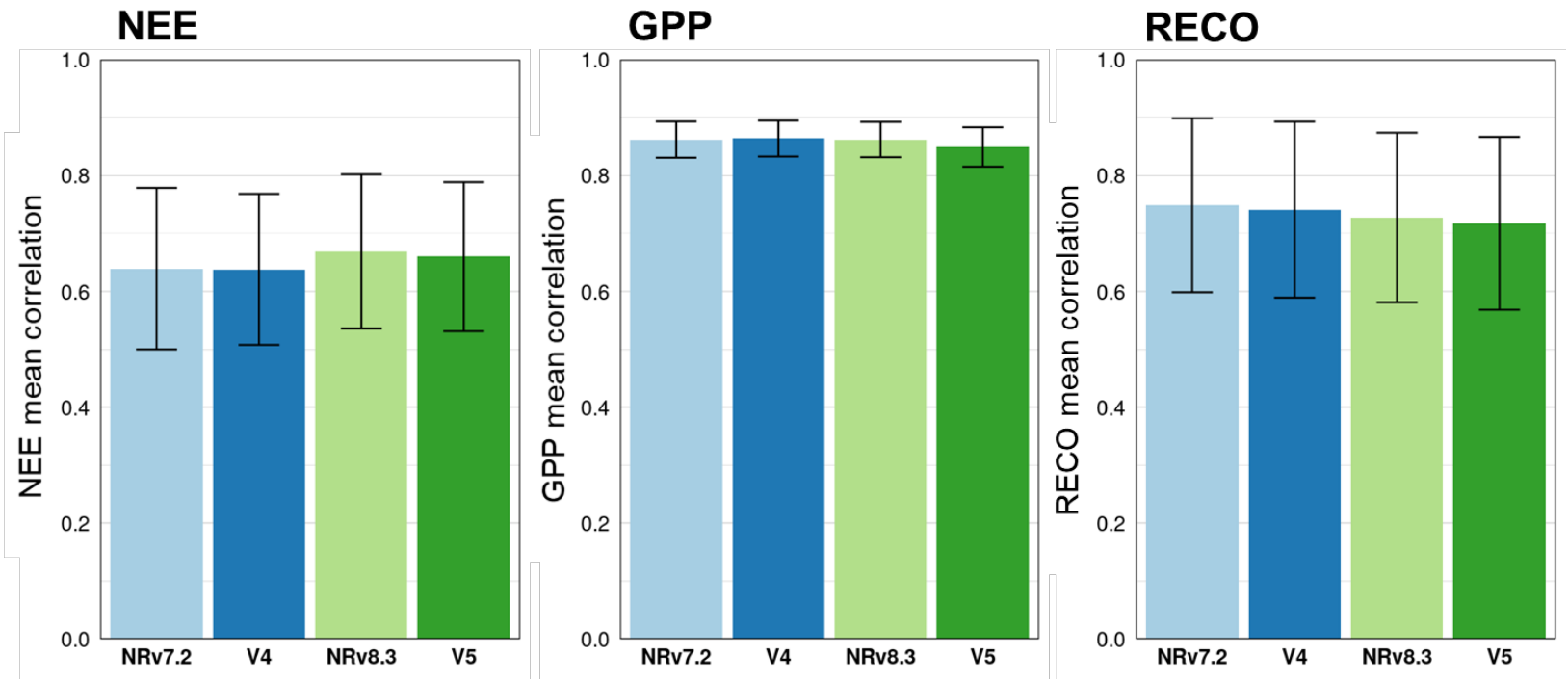
- NEE correlations with tower CVS observations similar between V4 and V5
- Slight V5 degredation in GPP and RECO correlations relative to V4

L4_C performance (11 CVS ≥ 45N; 2015-2017)



- V5 (and NRv8.3) gives higher calibration weight to northern tower PFT classes (≥45N).
- V5 GPP and RECO RMSE improved, but similar NEE performance from V4.

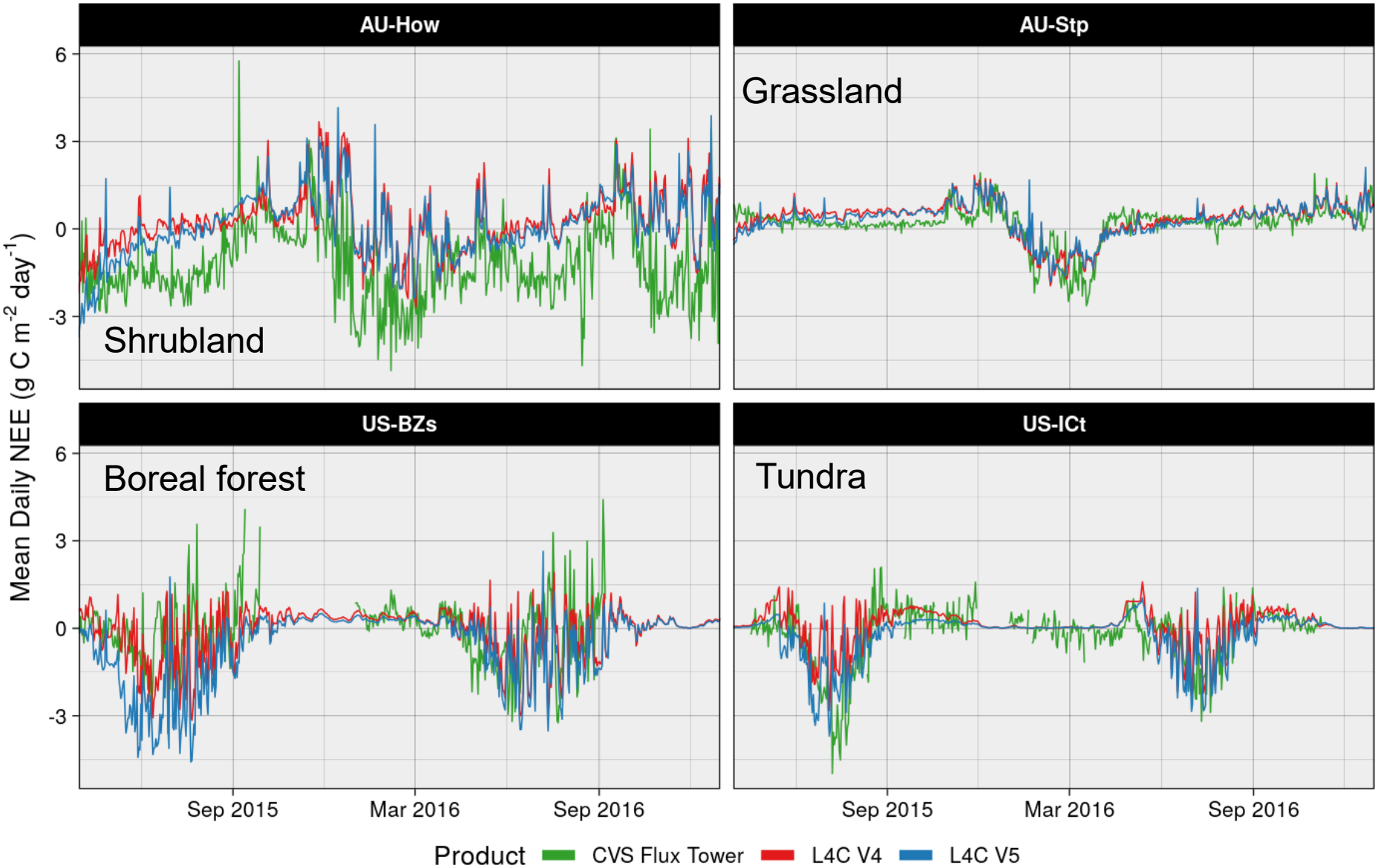
L4_C performance (11 CVS ≥ 45N; 2015-2017)



- V5 (and NRv8.3) gives higher calibration weight to northern tower PFT classes (≥45N).
- V5 NEE correlation improvement against northern CVS observations relative to V4; however, slight degradation in GPP and RECO correlations.

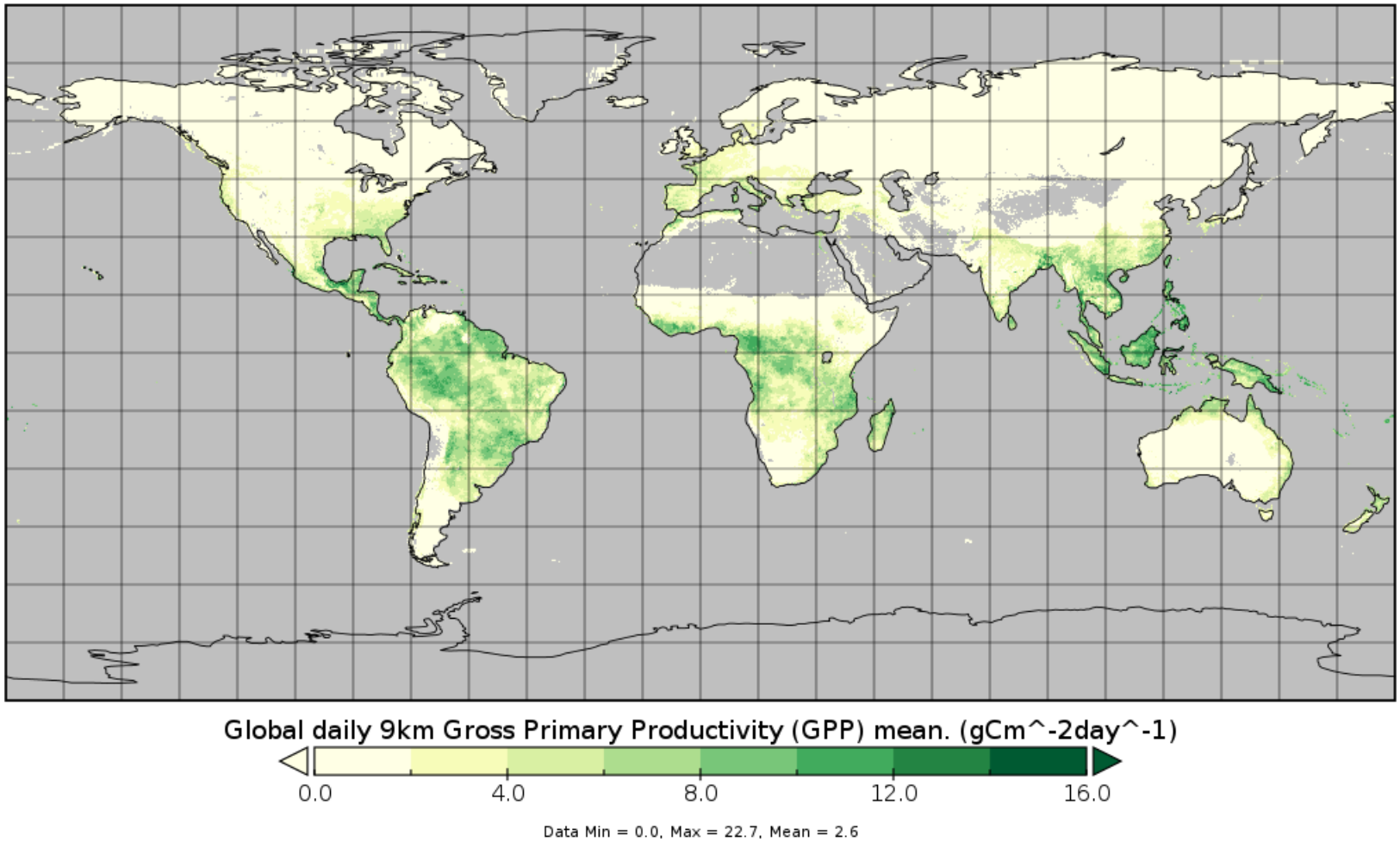
L4_C Daily NEE Time Series at Core Validation Sites

(V5 vs V4 and Tower NEE)



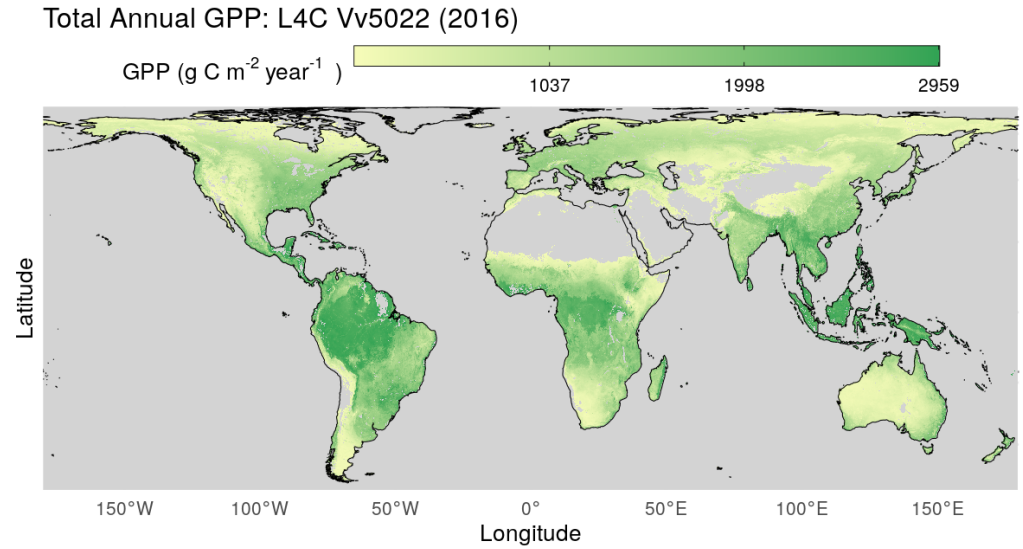
L4_C Vv5022 Mean Daily GPP (April 1, 2015)

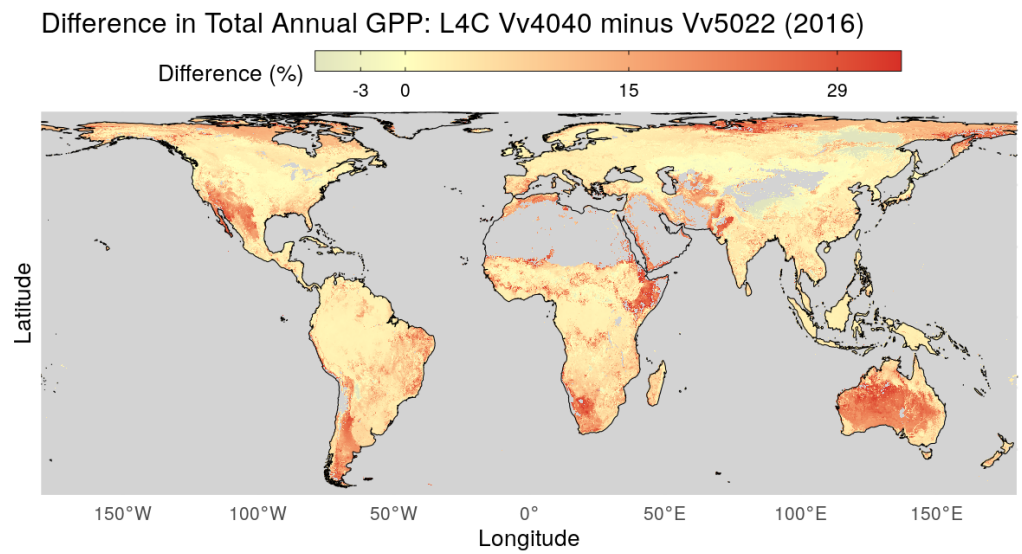
- V5 shows expected global seasonality with no artifacts detected
- No meaningful difference between V5 and V4



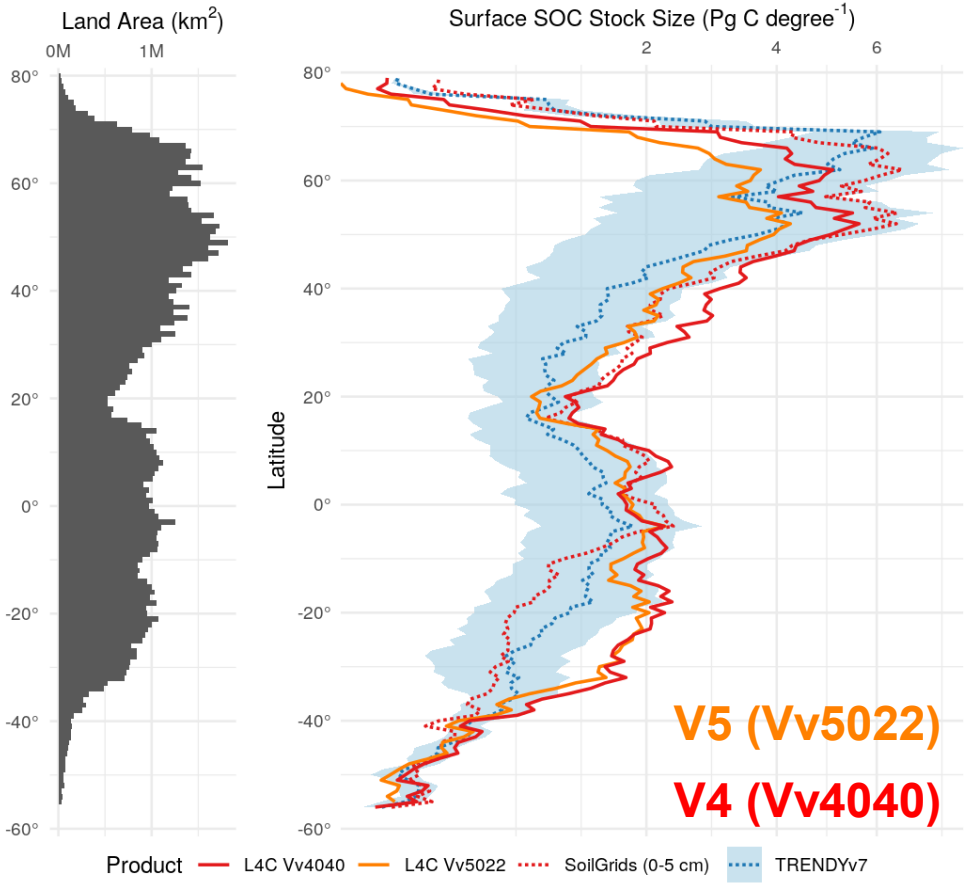
L4_C Vv5022 Annual GPP (2016)

- V5 shows expected global pattern & magnitudes with no artifacts detected
- V5 GPP slightly less productive than V4 overall; although larger relative differences (up to ~30%) in low productivity regions due to lower characteristic GPP magnitude in these areas.

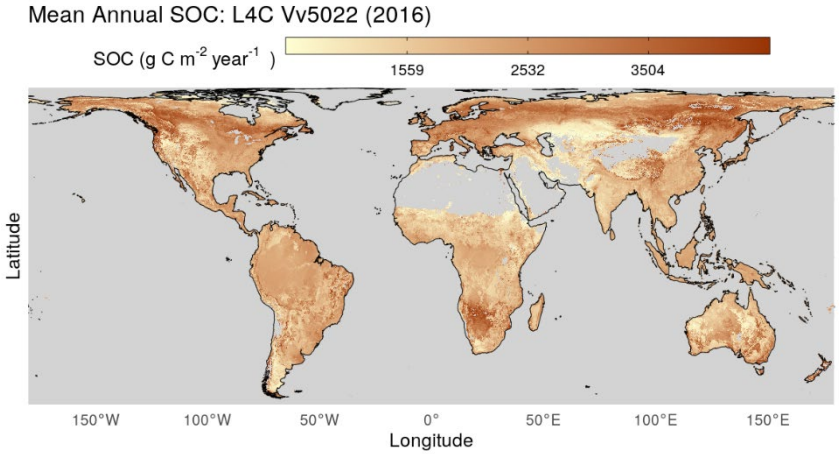




L4_C Surface Soil Organic Carbon



- V4 SOC distribution a good match to global inventory based records (SoilGrids), but relatively higher in the sub-tropics;
- In V5, lower surface SOC overall, but more consistent with SoilGrids & TRENDY DGVM estimates.



L4_C V5 Summary

- Latest L4_C V5 (and NRv8.3) product performance very similar to previous L4_C V4 (and NRv7.2) record based on global CVS tower site assessments over a 3-year product assessment period (2015-2017).
  - Small V5 RMSE global performance gains for NEE and RECO, but no meaningful change for GPP
  - Similar overall V5 correlation performance as V4
- Performance consistent with product design, with no apparent anomalies; reproduces characteristic global C-flux patterns and seasonality, and underlying controls.
  - Well within target accuracy threshold relative to tower CVS observations (mean NEE RMSE ≤ 1.6 g C m^{-2} d^{-1})
  - V5 incorporates latest L4 refinements for SMAP product consistency