Quantifying and reducing uncertainties

Work package 4

DWD, ECMWF , FFCUL, RIHMI,
UNIBE, UNIVIE, UVSQ

ERA-CLIM2 Review Meeting Jan 19, 2017

Main tasks

- 4.1 making optimal use of observations in reanalysis, and
- 4.2 providing end users with meaningful information about uncertainties in reanalysis products.
- involves a range of activities,
  - quality control and error estimation for input observations,
  - work on bias correction and homogenisation of data records,
  - comparisons with other reanalyses and high-level observational products.
  - diagnostic studies
  - Ensembles now available, do they describe true uncertainty?

Deliverables 19 Jan 2017

Deliverable number	Deliverable title	Delivery date
D4.1	RS bias adjustments (UNIVIE)	20
D4.2	Updated RS bias adjustments (UNIVIE)	48
D4.3	QC for observations from FFCUL (FFCUL)	48
D4.4	Visualization tool for QC (FFCUL)	12
D4.5	QC for upper-air, surface, and snow obs. (RIHMI)	36
D4.6	Methodology for quantifying obs error (UBERN)	36
D4.7	Verification of precipitation against GPCC (DWD)	48
D4.8	Global energy, water, carbon cycles (ECMWF,UNIVIE, UVSQ)	48
D4.9	Upper air data qc (UBERN, RIHMI)	24
D4.10	Comparison with other reanalyses (UNIVIE; ECMWF)	48
D4.11	Low frequency variability and trends (ALL)	48
D4.12	Uncertainty of input parameters for carbon budget (UVSQ)	20
D4.13	Confidence intervals on carbon fluxes (UVSQ)	48
D4.14	Comparison of CTESSEL, ORCHIDEE flux estimates (ECMWF, UVSQ, UNIVIE)	48

Status of Deliverables 13.12.

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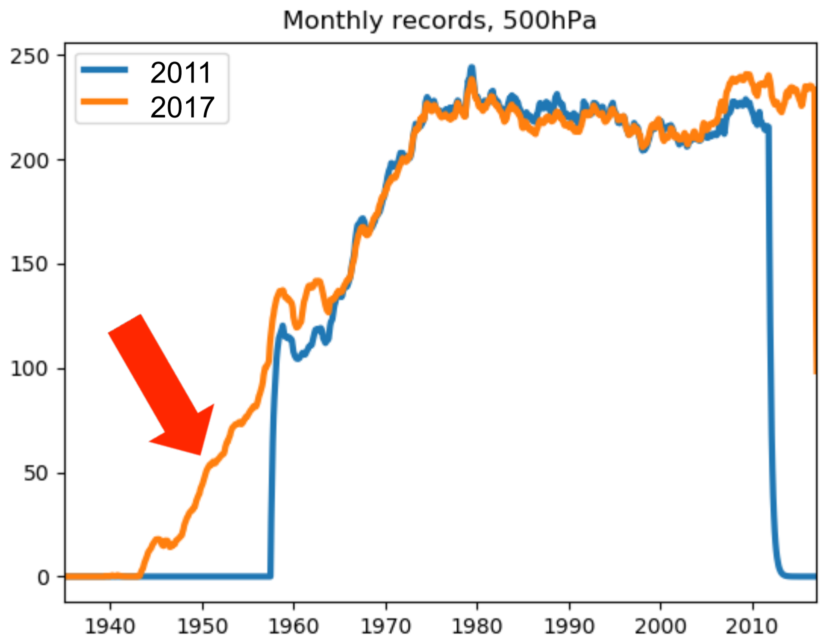
Upper air data base

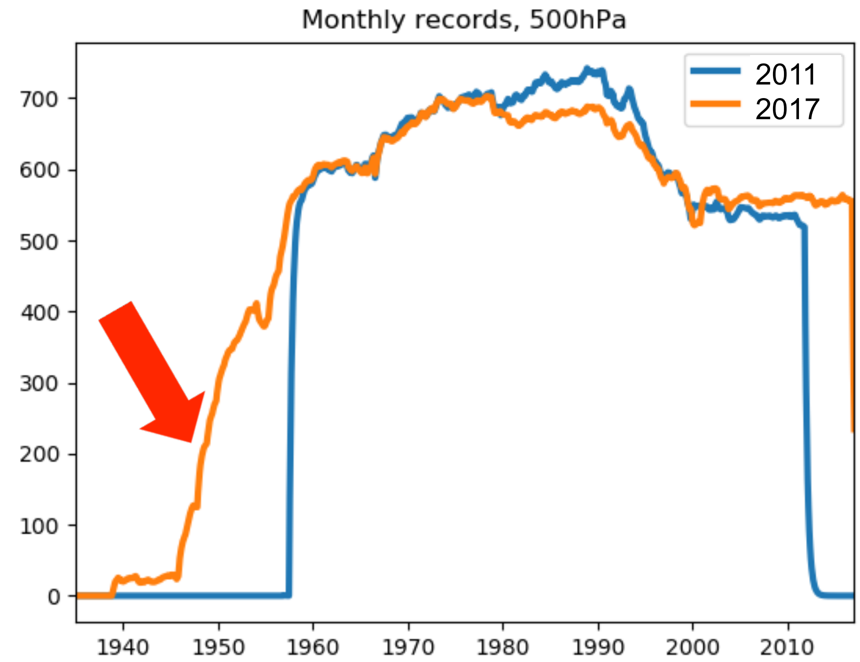
- ERA-preSAT was catalyst for progress in this respect
- CHUAN2.1 assembled in July 2017, including recent digitized data
- Data format (ODB2) fit for Copernicus Climate Data Store and for assimilation into reanalyses
- Prospect of ERA5 going back to 1950 is highly motivating
- More formal maintenance and documentation procedure should be implemented for Copernicus

Radiosonde temperature monthly records

South of 20N

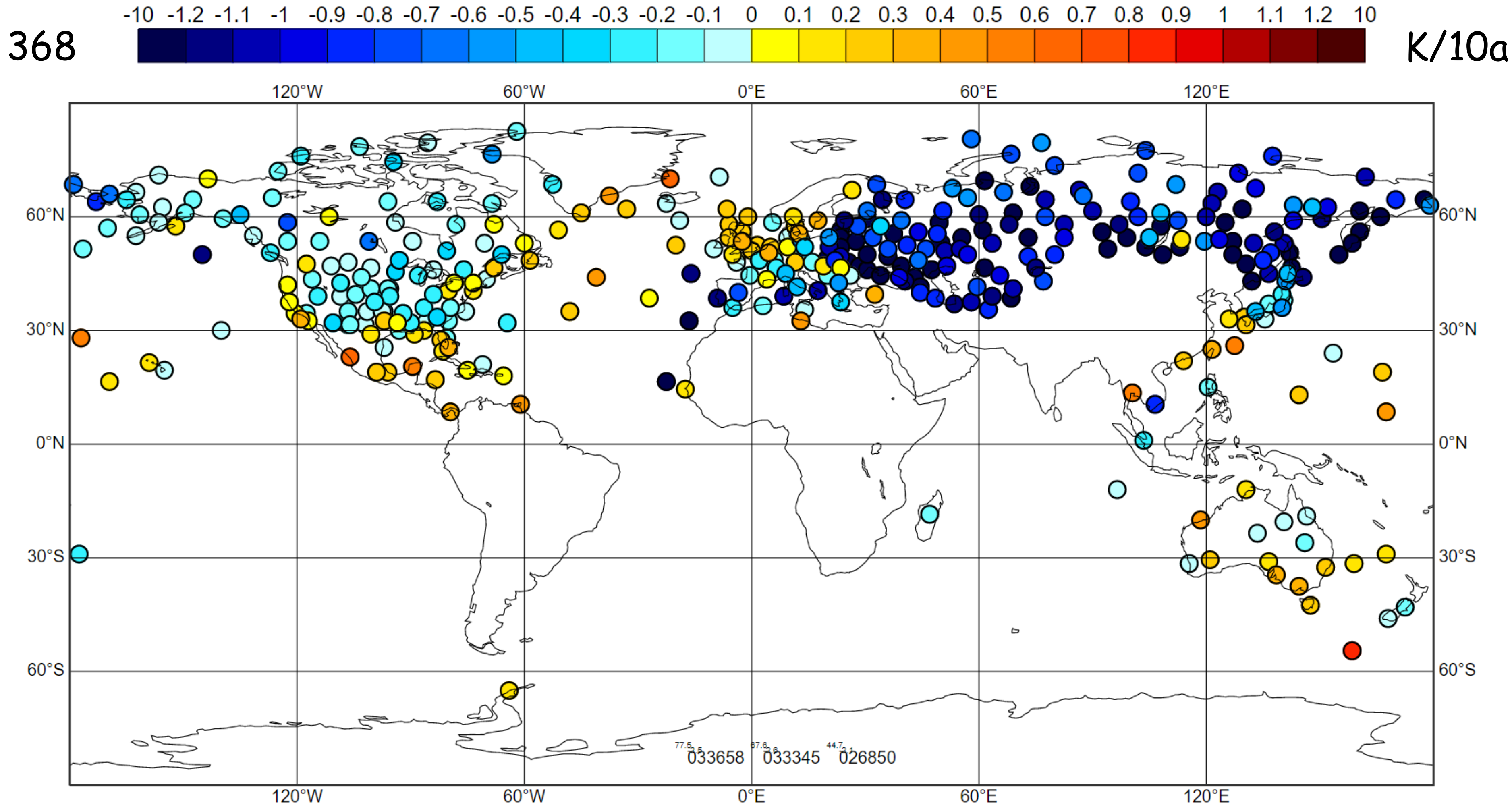


North of 20N



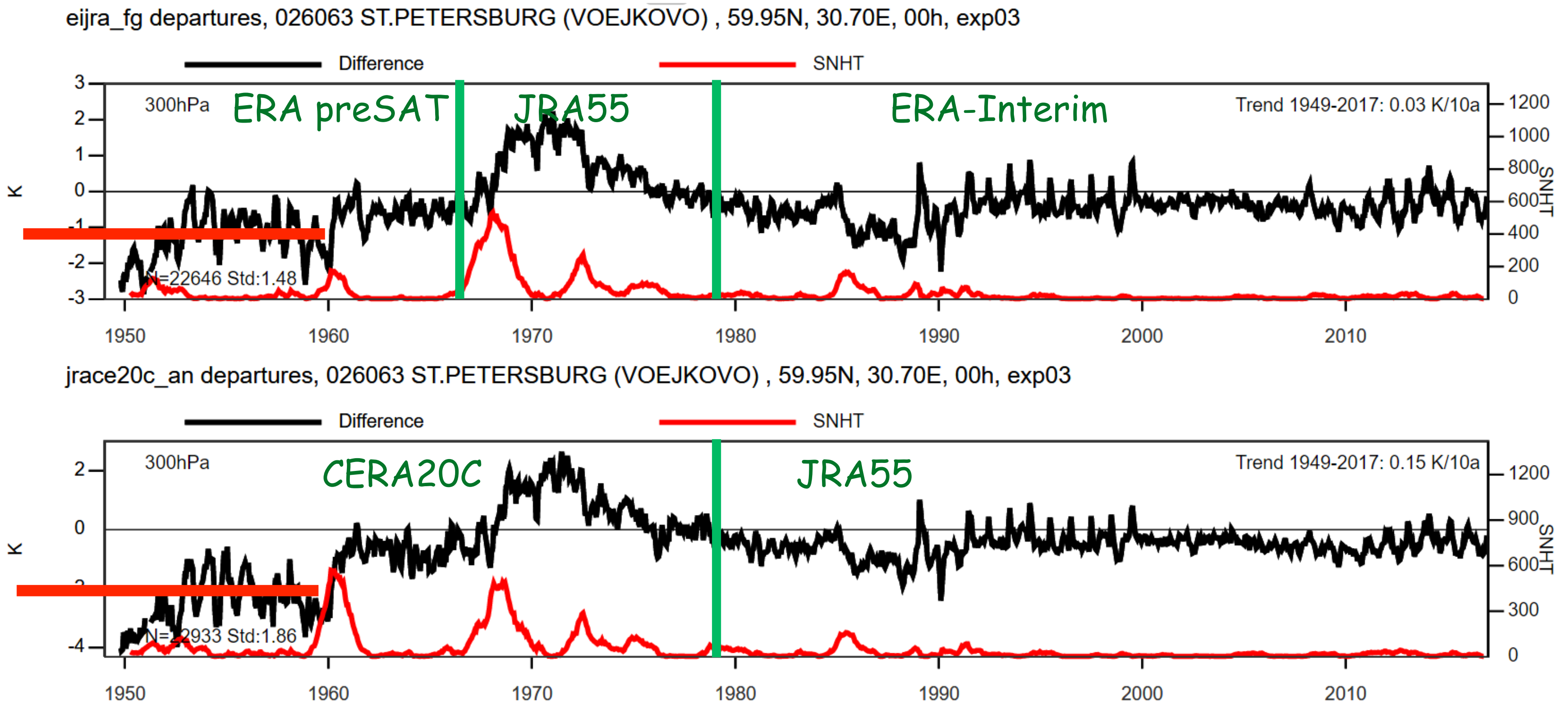
- Many of the pre-IGY data have been digitized only recently (ERA-CLIM(2))
- Are now in ODB format - ready for assimilation with Copernicus ERA5
- Homogeneity adjustments??

D4.2 Trends 1954-1974, 300 hPa

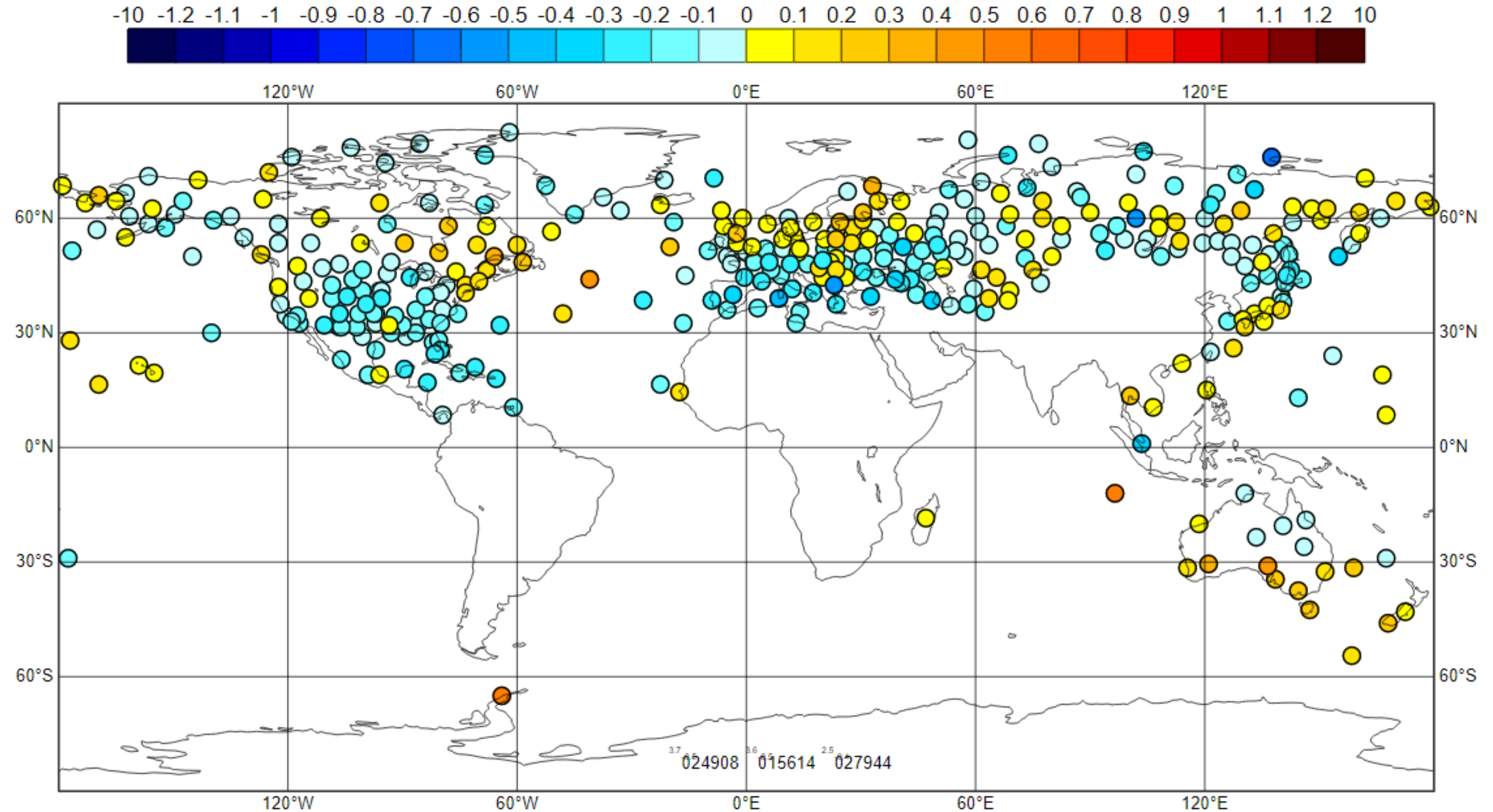


RAOBCORE/RICH

- Reference eijra: ERA-I+JRA55+preSAT
- Reference jrace20c: JRA55+CERA20C

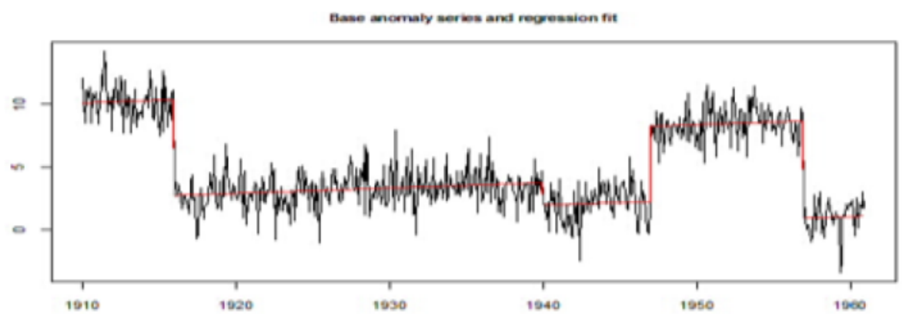


Adjusted trends 1954-1974



D4.3 QC for observations from FFCUL

- Long, recently digitized time series from Portugal, the Azores and former Portuguese dependencies have been homogenized
  - Surface pressure, Tmin, Tmax, relative humidity
- Put into ISPD for assimilation by reanalyses

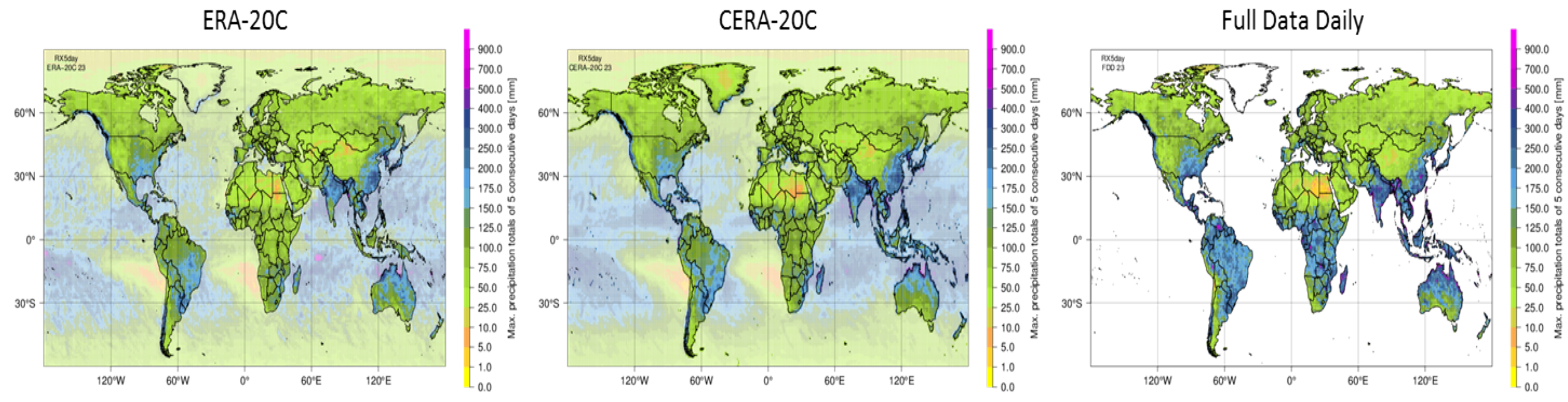


Mozambique – Maputo (1910-1960) RHTestsV4 absolute mode

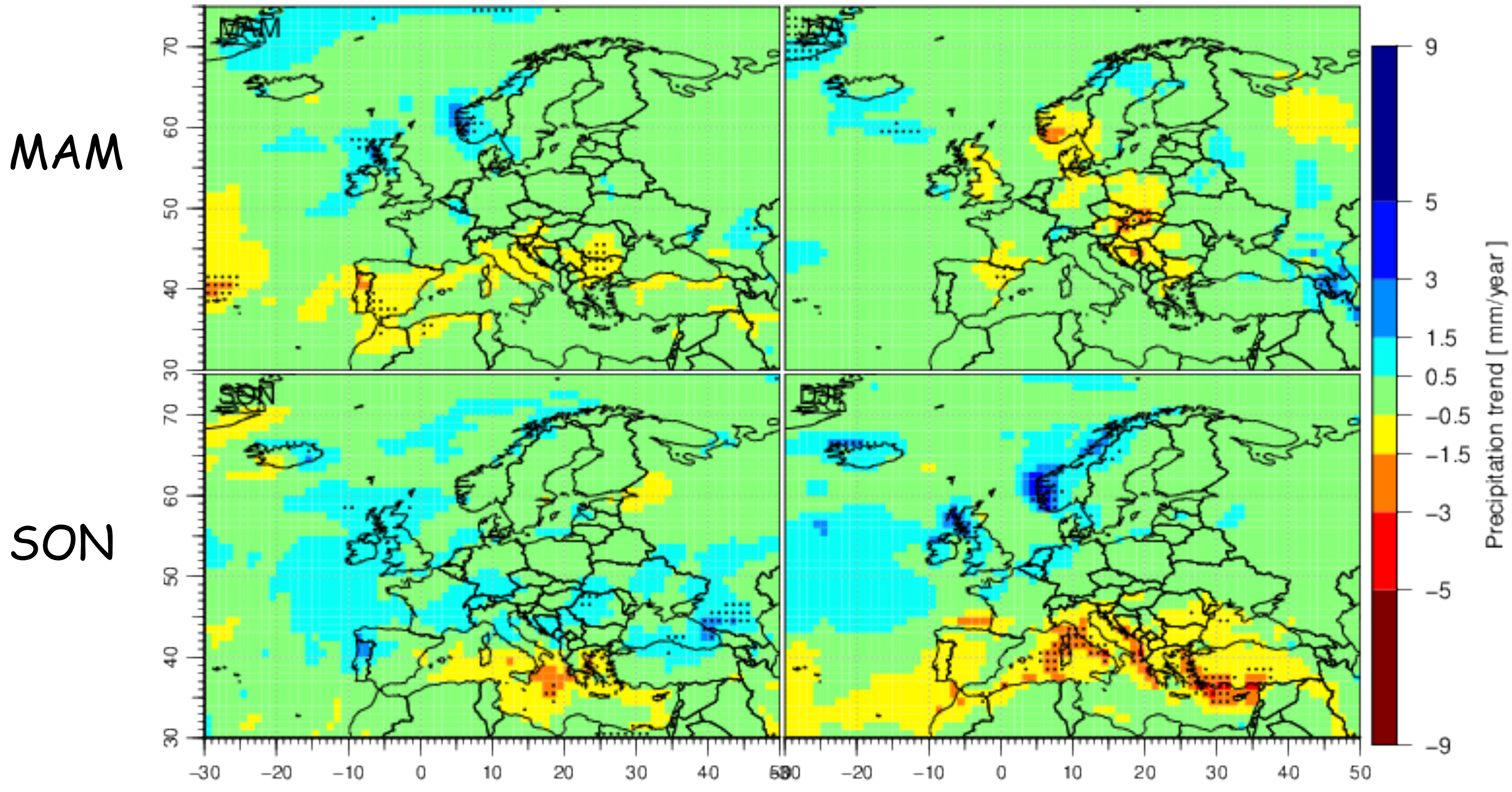
Fig. 9 – Base anomaly of Maputo's monthly surface pressure series as tested by RHTestsV4.

D4.7 Precipitation verification

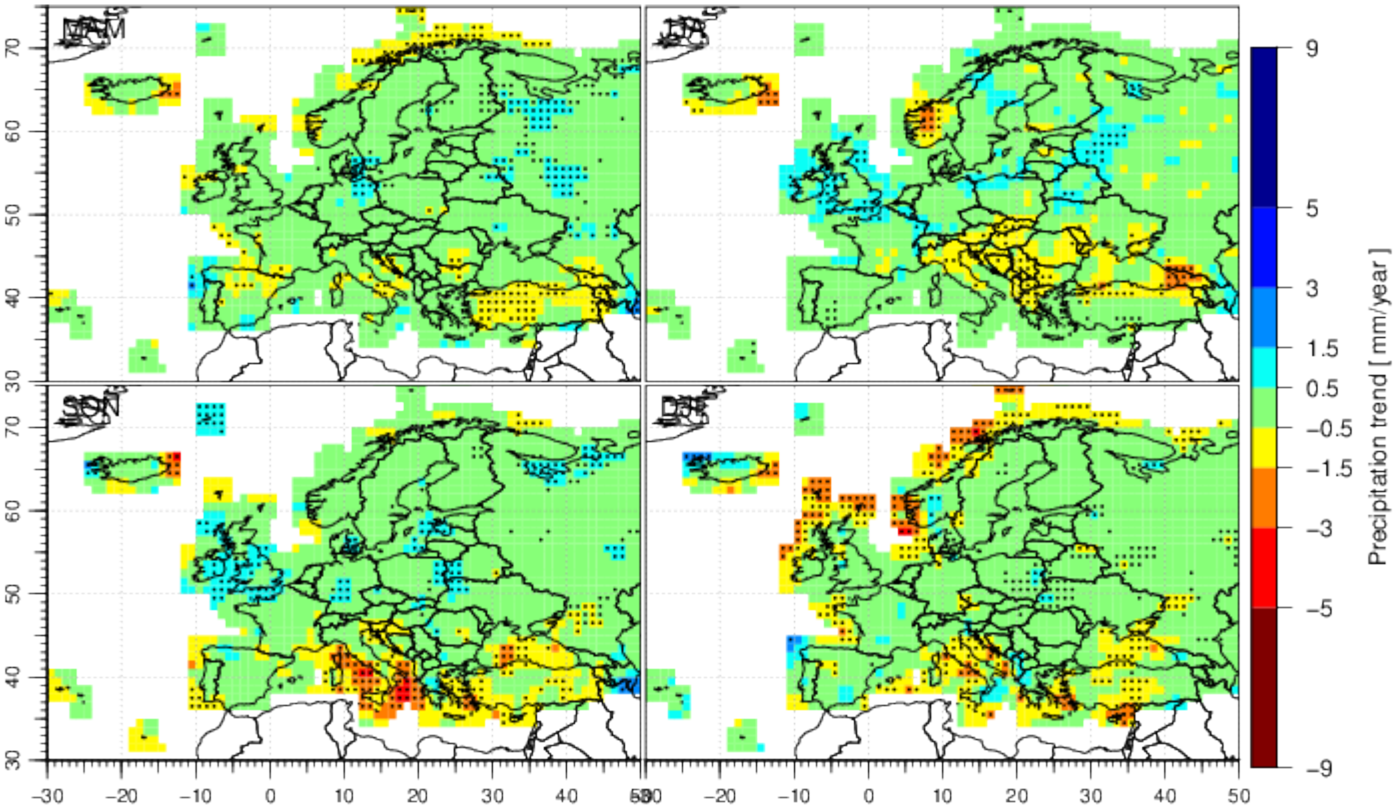
- Validation now also on daily precipitation
- Comparison against homogenized precipitation over Eorope



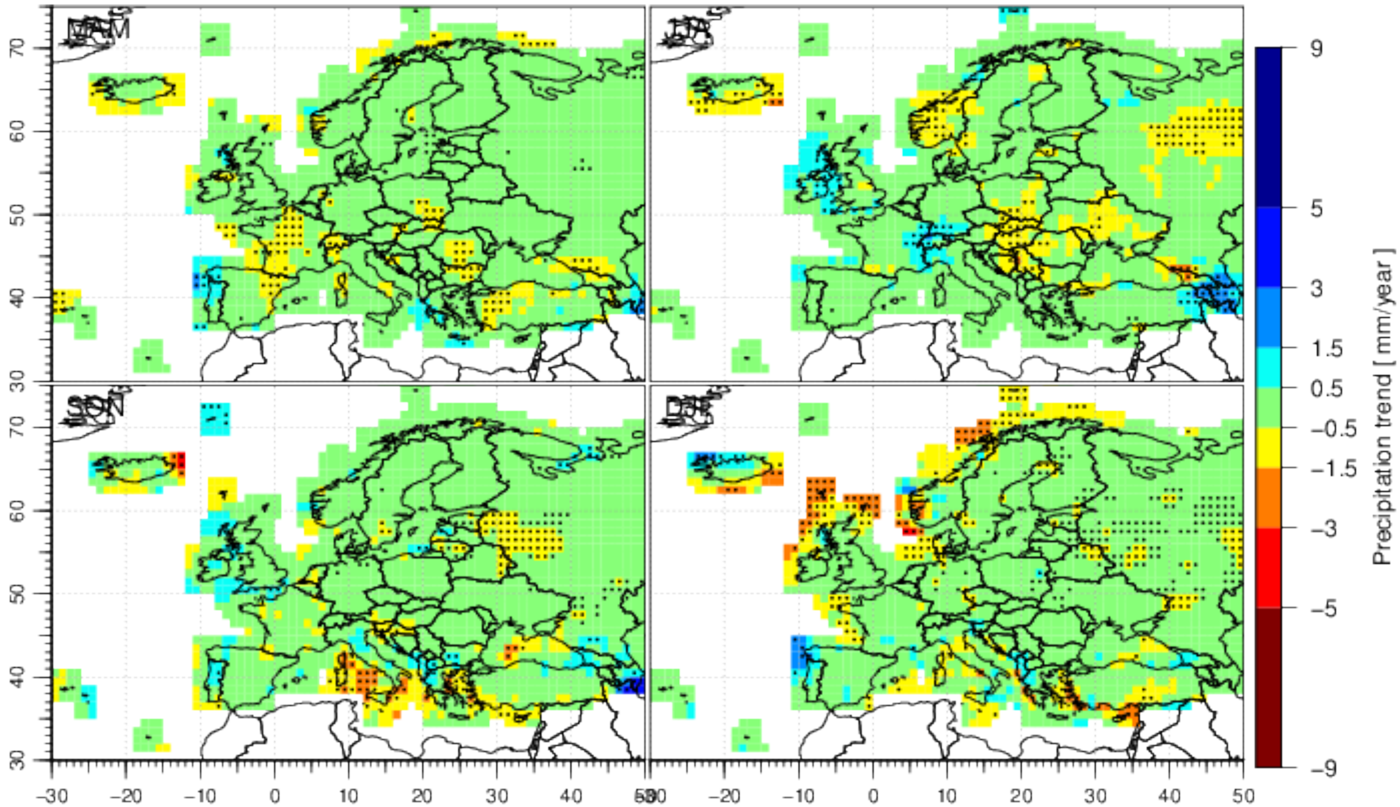
Seasonal precipitation trends 1951-2005 (CERA20C)



Difference ERA20C-homogenized daily precipitation HomPRA



Difference CERA20C-homogenized daily precipitation HomPRA



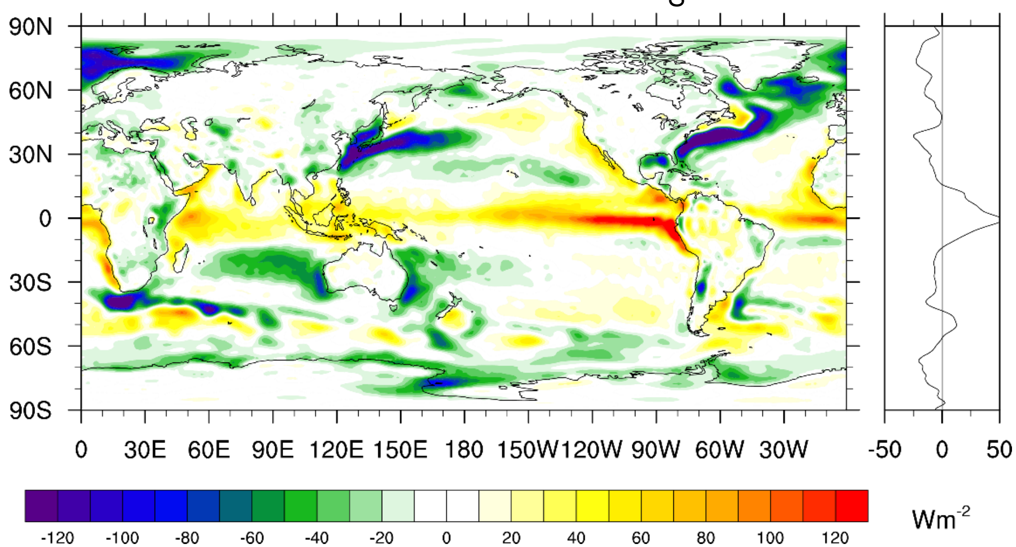
D4.8: Improved indirect estimation of net surface energy flux

- Vertically integrated atmospheric total energy budget equation can be used to infer net surface energy flux
- Divergence term requires mass-consistent winds

$$F_S = Rad_{TOA} - \nabla \cdot F_A$$

with $$F_S = LH + SH + Rad_S$$

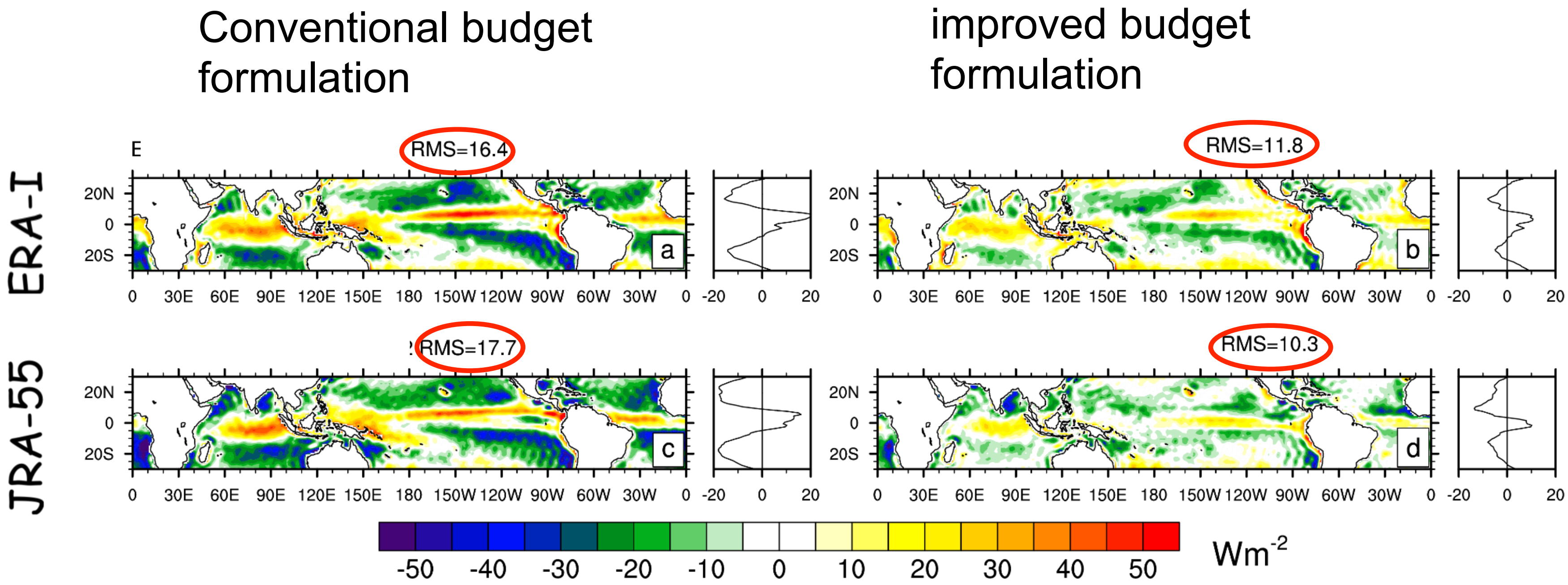
Inferred F_S



The patterns look nice and realistic, but there are substantial differences compared to independent F_S estimates

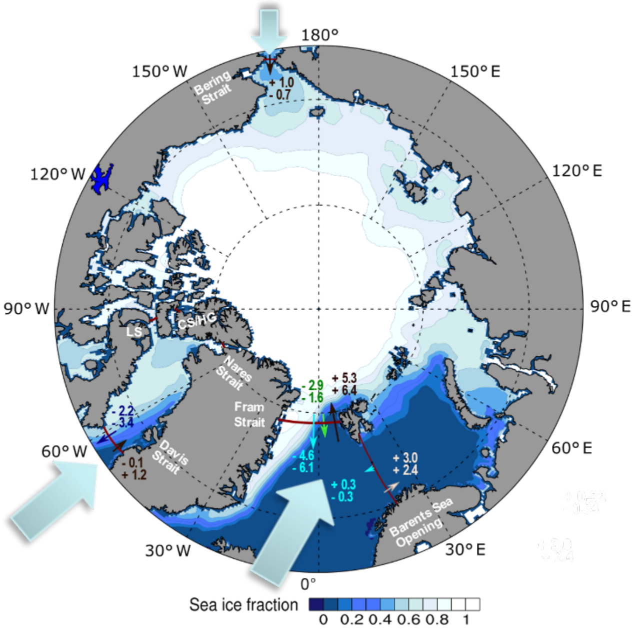
Improvement of results

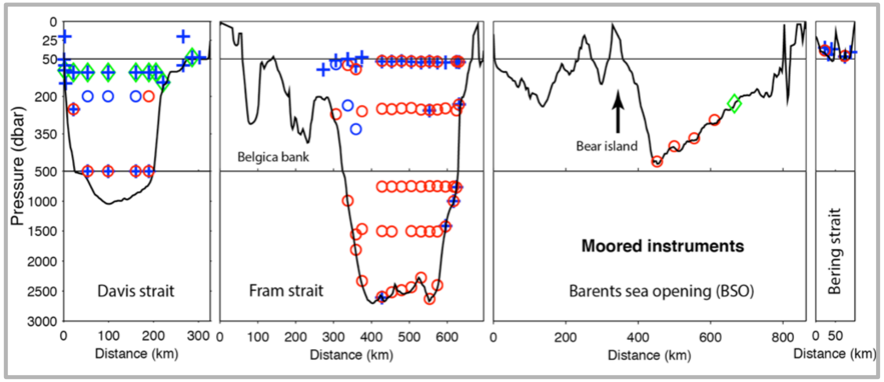
- More consistent budget formulation improves agreement between inferred flux and independent surface flux estimates (CERES, OAflux)
  → RMS difference drops by 30-40%
- Improvement seen also with several other flux products



Mayer et al. 2017

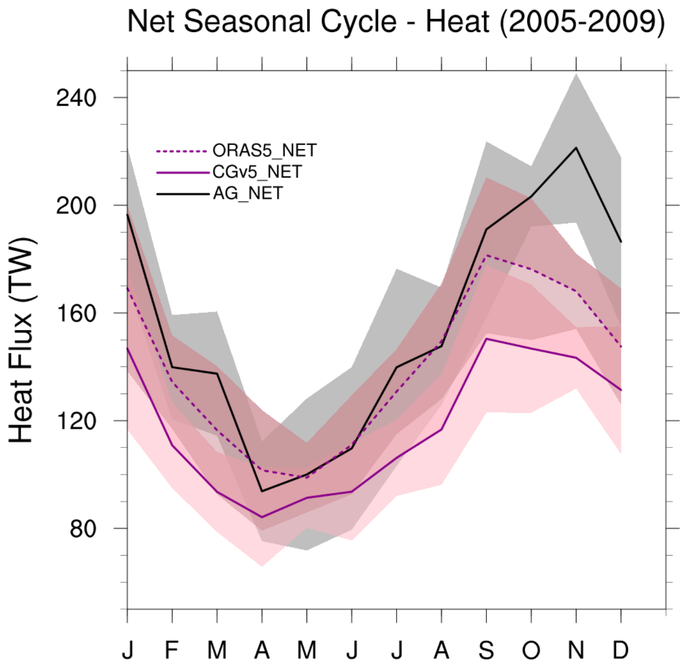
Energy and Freshwater fluxes through Arctic Gateways

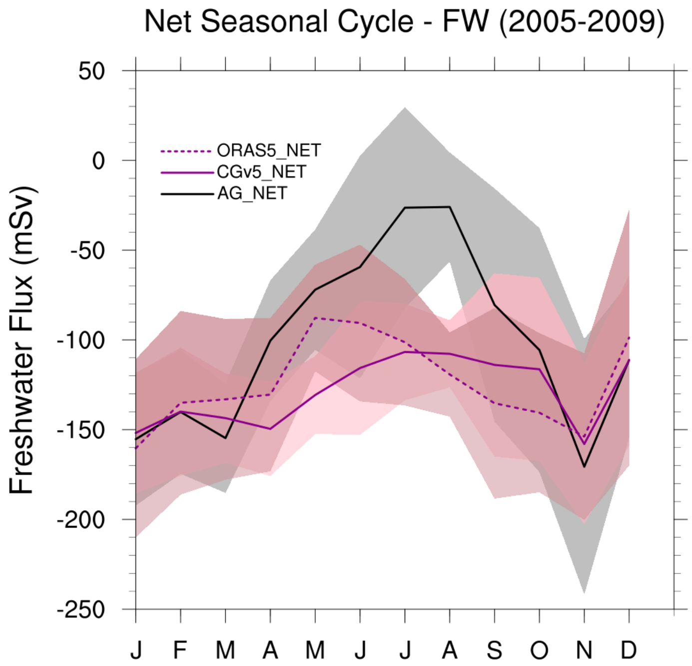




Location of 138 instruments at 41 mooring sites in the Arctic Gateways.
Source: Tsubouchi et al. 2017

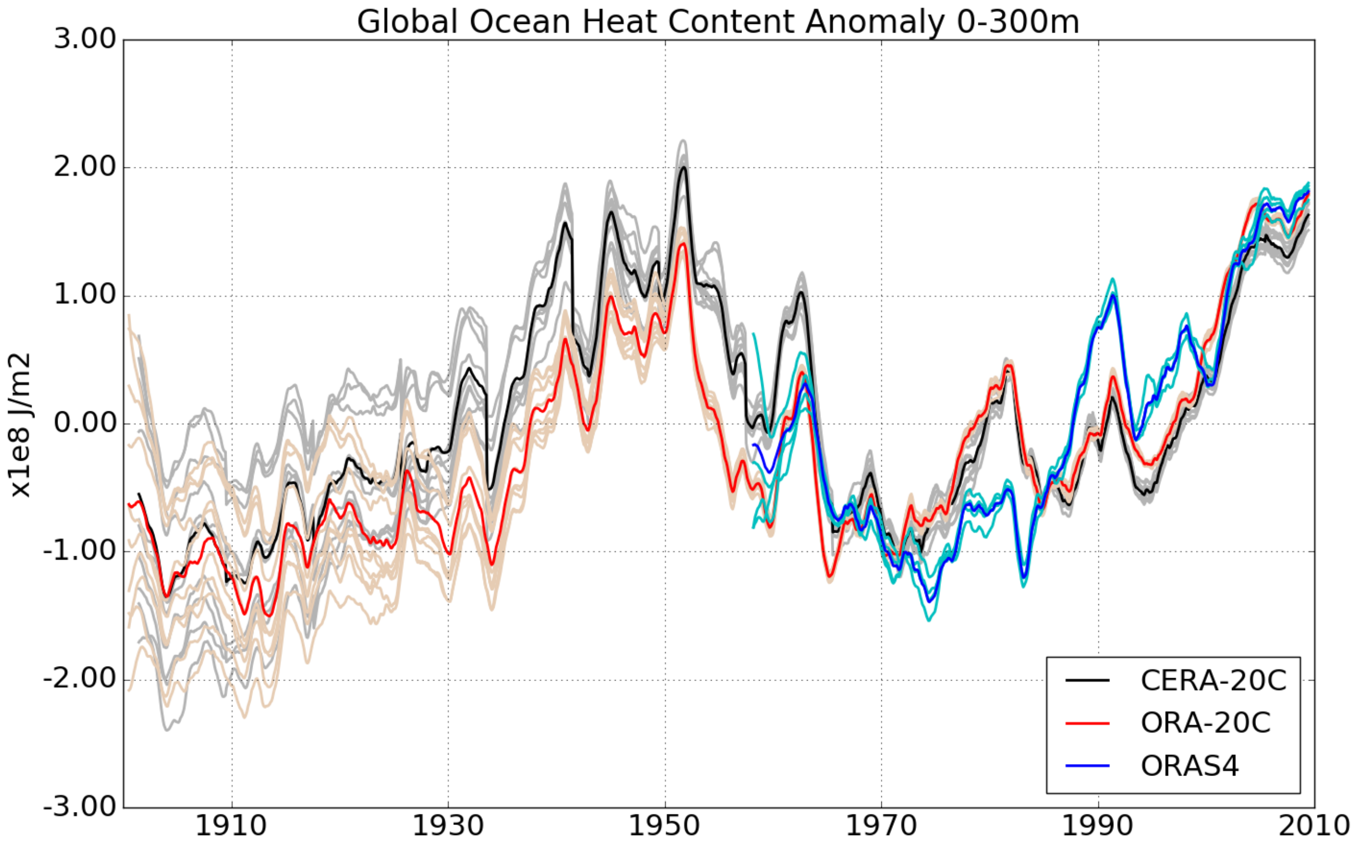
Net Heat and Freshwater Transport comparison





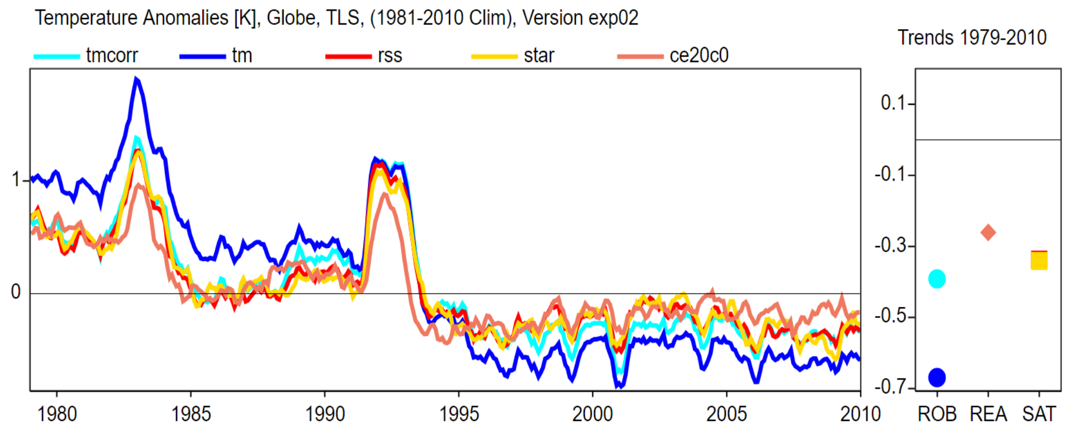
Pietschnig et al. 2017

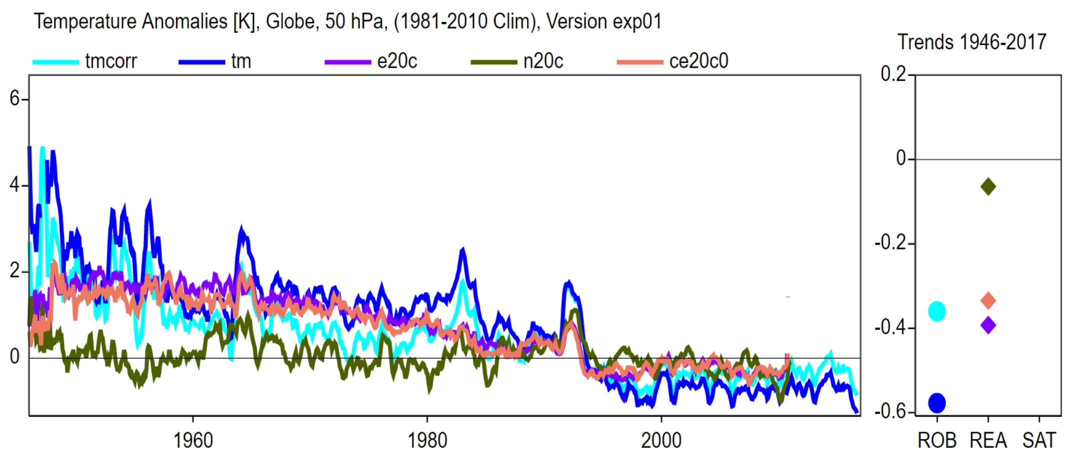
Oceanic heat content estimates



Few observations before 1950 – large ensemble spread

D4.10, D4.11 Lower Stratospheric Temperatures

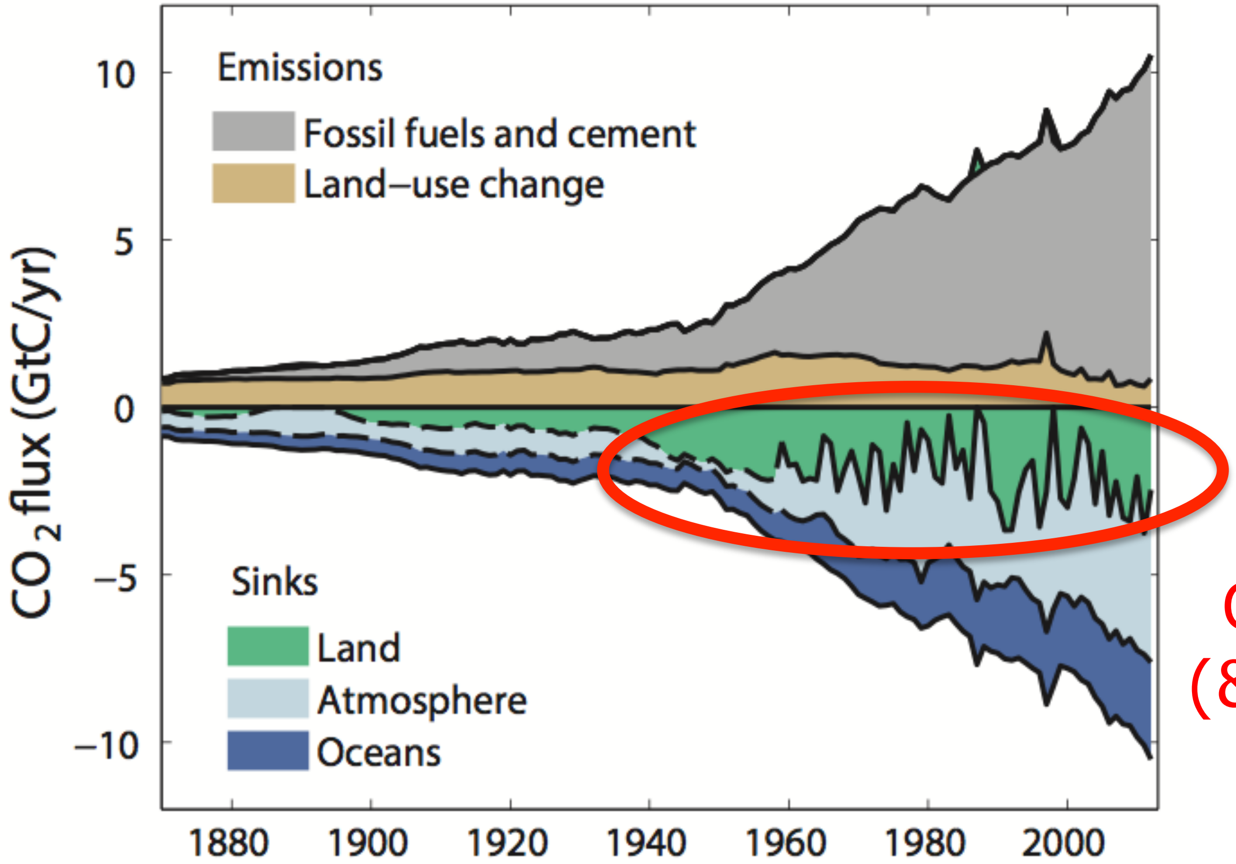




- Good agreement of CERA20C with MSU LS time series
- CERA20C shows slightly less cooling, has weaker response to Volcanic eruptions

- Back to 1948: Good agreement of ERA20C, CERA20C with adjusted radiosondes at 50hPa
- Weaker response to volcanic forcing than in Radiosondes. CMIP forcing to weak?
- NOAA-20CR shows no cooling of lower stratosphere

D4.13 Global Carbon Budget



LAND focus with ORCHIDEE (& CTESSEL)

Fossil fuel CO_2 emissions are ≈ 10 PgC yr-1 in 2015 (55% > 1990 level)

Over the past 50 years, 44 ± 6 % of emissions remains in the atmosphere

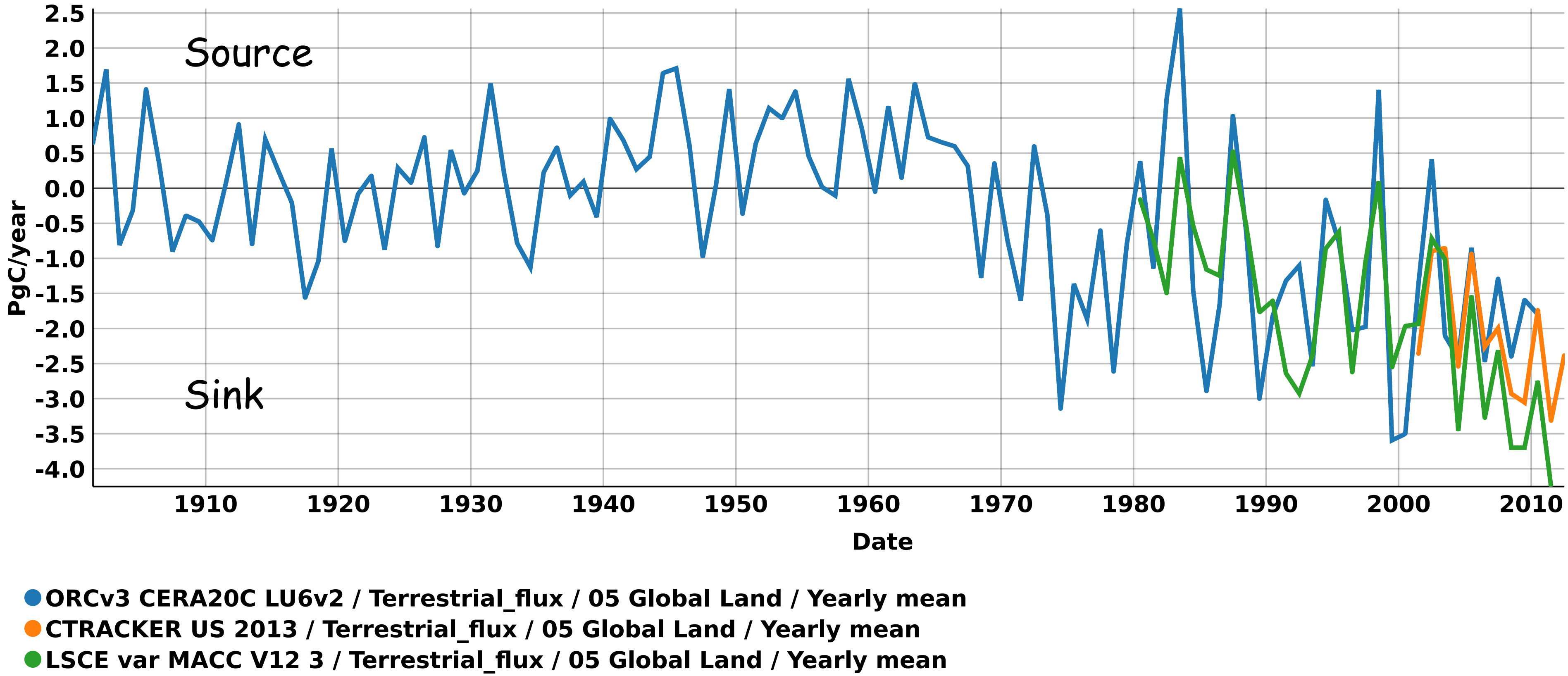
D4.13 Net Carbon fluxes evaluation

Global land flux (PgC/yr)

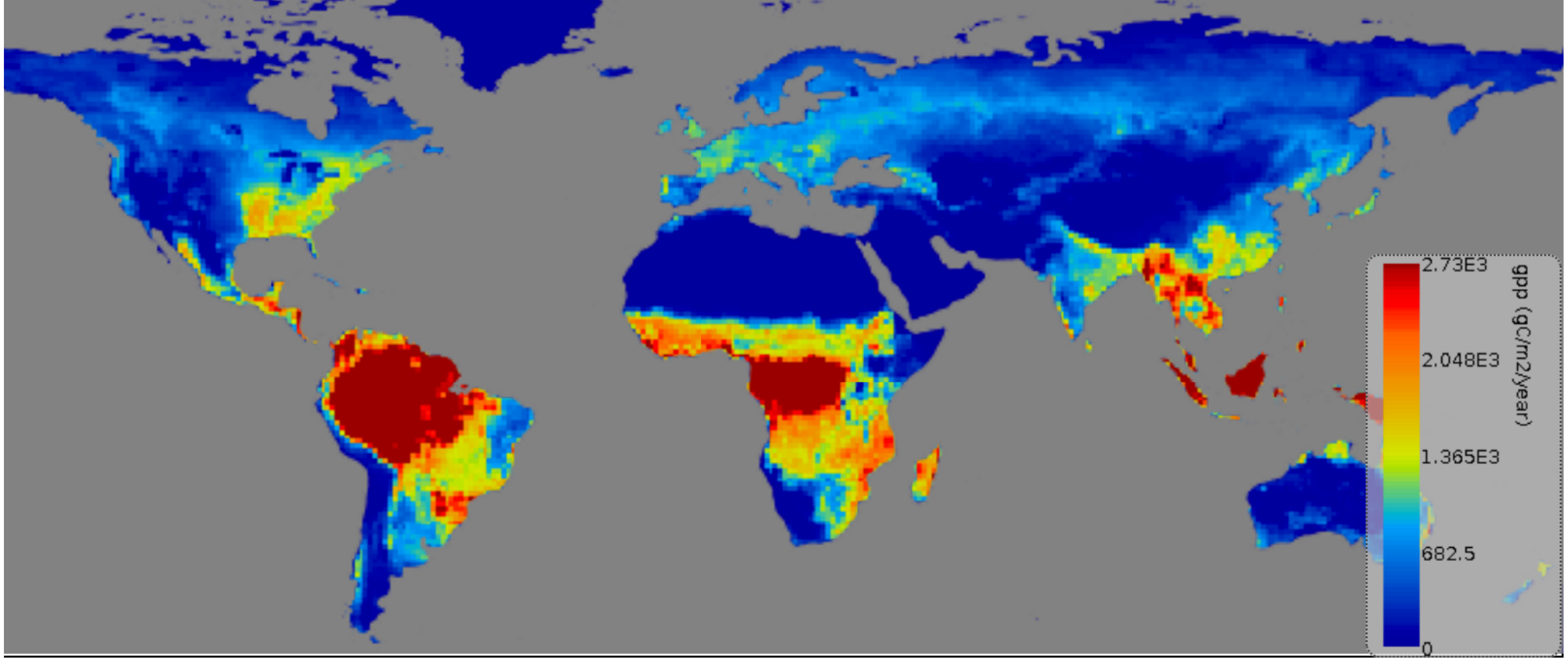
ORCHIDEE-CERA20C

MACC inversion

CTRACKER inversion

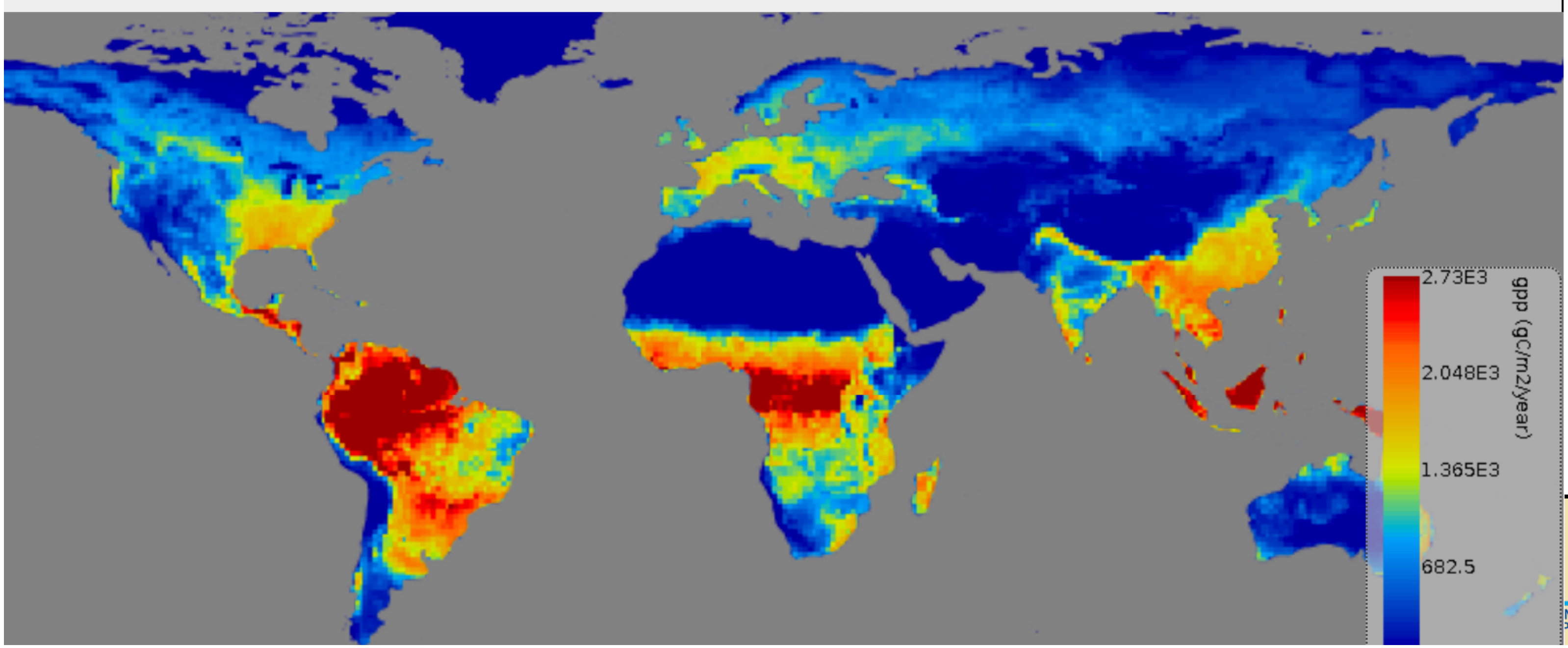


CTESSEL

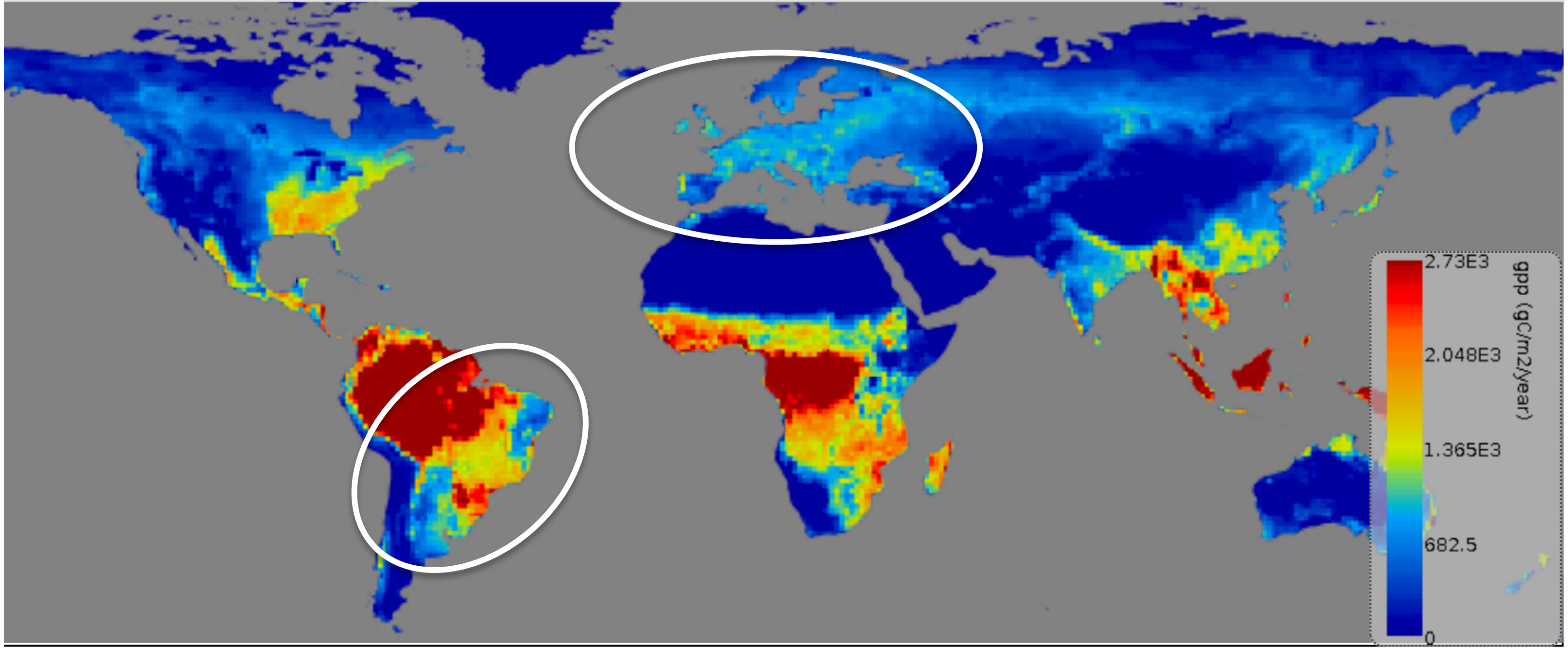


D4.14: Comparison with CTESSEL - GPP 2008

ORCHIDEE

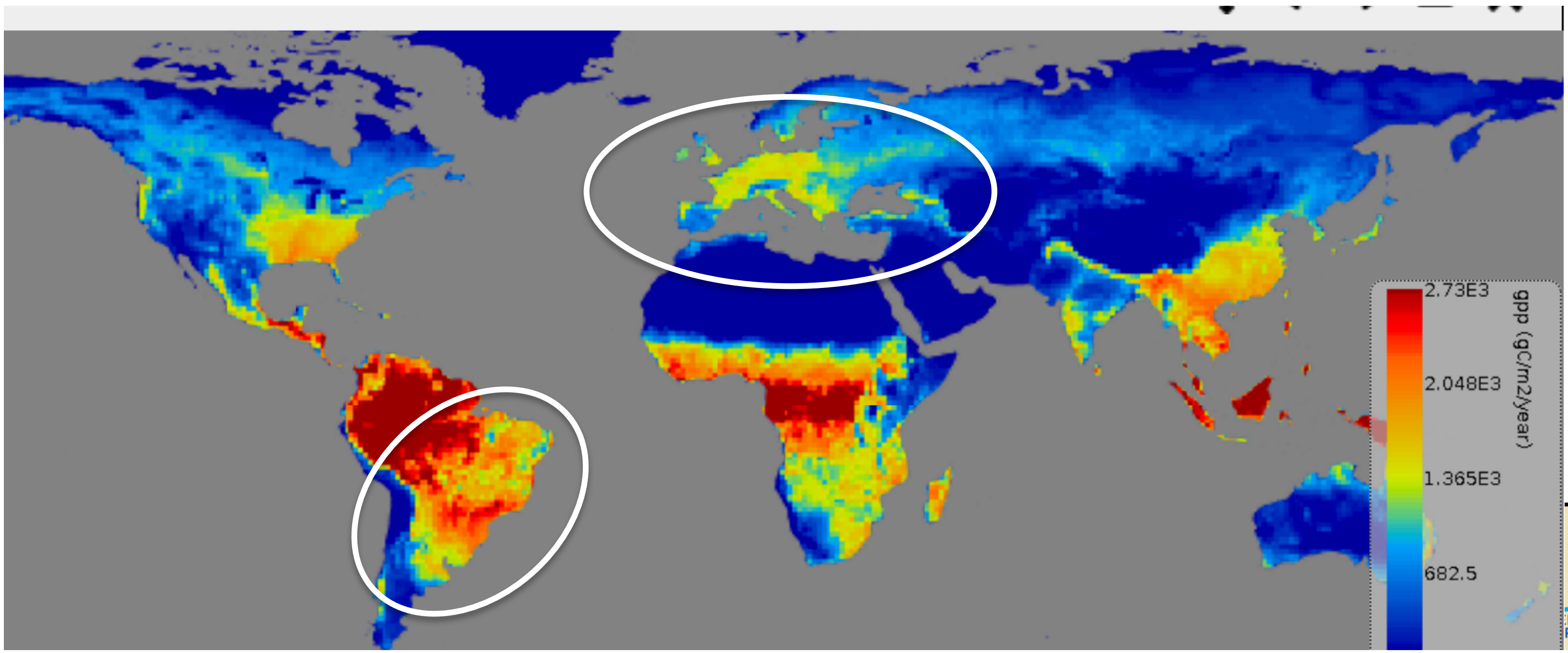


CTESSEL



D4.14: Comparison with CTESSEL - GPP 2009

ORCHIDEE



Data portals, visualization tools

- Continuous development until end of project

- http://www.ecmwf.int/en/research/climate-reanalysis
- http://transcom.globalcarbonatlas.org/
- http://srvx1.img.univie.ac.at/raobvis/
- http://eraclim-global-registry.fc.ul.pt/era/index.html

Conclusion

- CERA20C, CERA-SAT valuable assets
  - first coupled reanalyses
  - CERA20C highly competitive, CERA-SAT promising
  - Collaboration with „carbon community" established, good results with dynamic land biosphere models.
- Reanalysis back to 1950 within Copernicus
  - Upper air data ready for assimilation
  - Homogenization for T available, in dev for **v**,q
- Coupled Budgets -> GCOS, CMIP6
- Evaluation of PB-size data sets will take years
  - Will assist Copernicus

Upper air data base

- Ensure continuous updating, versioning
- Data format should be fit for Copernicus Climate Data Store and for assimilation into reanalyses
- Upper air data inventory at FFCUL, METEO-France

Rationale for EU follow on project

- Assimilation in presence of strong observation density gradients
- Coupled diagnostics, flux validation
- „Ultimate" solution for RS-T using GPS-RO as reference – GAIA-CLIM
- Evaluation of ensembles
  - apply EMOS, BMA to reanalysis ensembles, observation ensembles?
- Prove positive impact of rescued data

continued

- Update and include new ISPD version
- Continue data rescue (e.g. METEOSAT1 images, whaling log books) and feedback analysis
- Rescued data often not in shape to be assimilated or not CDR
- Carbon data assimilation? Feasible?
- Coupled long term SST assimilation

Achievements to be promoted into Copernicus

- Homogenized UA data consistent with GPS-RO – consistent anchor back to beyond 2001
- Energy budget diagnostics
- After further tests: RH and wind homogeneity adjustments.
- Feed QC flags into sources

- WP2-WP4 interaction
- Meteorological input for carbon models crucial
- CRUNCEP increases Primary production fluxes by 50% compared to CERA20C, net fluxes sometimes opposite
- Soil freezing important for co2 fluxes in extratropical boreal regions