SPECIAL PROJECT PROGRESS REPORT

Reporting year	2018
Project Title:	Coupled energy and freshwater budgets from and early upper air data enhancements for reanalysis
Computer Project Account:	spatlh00
Principal Investigator(s):	Leopold Haimberger
Affiliation:	University of Vienna
Name of ECMWF scientist(s) collaborating to the project (if applicable)	D. P. Dee, Hans Hersbach, M. Balmaseda, P. Berrisford, S. Tietsche
Start date of the project:	1.1.2018
Expected end date:	31.12.2020

Computer resources allocated/used for the current year and the previous one

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)			10000	0.6
Data storage capacity	(Gbytes)			2000	200

Summary of project objectives

The special project accompanies an Austrian Science Funds project devoted to evaluating the global energy budget, with emphasis on the Arctic. For this purpose access to experimental or not yet publicly available reanalysis data is needed. The second purpose of the project is to prepare early upper air data for assimilation into ERA5.

Summary of problems encountered (if any)

Summary of results of the current year (from July of previous year to June of current year)

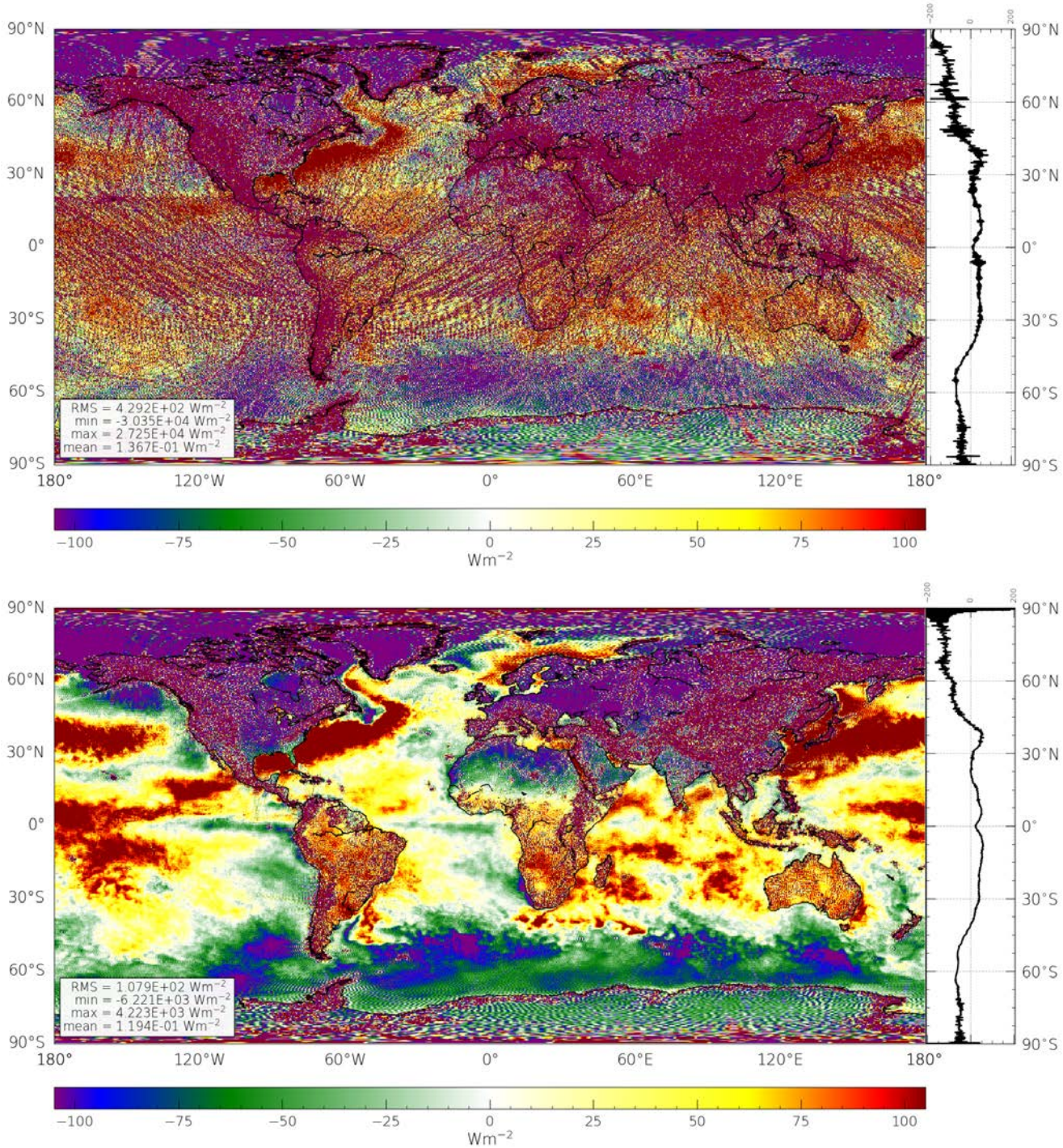

Fig. 1: Vertically integrated global total energy flux divergence from ERA5 averaged over January 2016. Upper panel: from MARS, without correction for vertically integrated mass flux divergence, Lower panel from current calculation method used at University of Vienna.

Since the project has just started, there are not so many results yet. We have downloaded one year of ERA5 hourly resolution model level data in order to evaluate the energy budgets diagnostically with unprecedentedly high spatial and temporal resolution. The challenge has been to reduce noise that occurs when calculating the budgets using a discretized Eulerian flux form over steep orography. This problem has been discussed also with ECMWF experts but has been so far not been satisfactorily solved. At least a clear positive impact of the high temporal resolution provided by ERA5 on the energy budget quality could be demonstrated. It could also be demonstrated that despite the noise problems we found that our calculation method using Simmons and Burridge vertical discretization and implementing a better correction for mass imbalances and a better diagnostic budget formulation

(Mayer et al. 2017) leads to better energy budget quality than is available from the total energy flux divergence fields in MARS (Fig. 1). However, as noticeable in panel b) there is some small scale noise near the poles in the new calculation method that does not appear in the MARS fields, so there is still room for improvement.
Before that we have evaluated ERA-Interim and ocean reanalyses to analyse differences between the 1997/1998 and 2015/2016 El Nino events (Mayer et al. 2018).
Regarding the preparation of homogeneity adjustments for ERA5 back to 1950, a new version of adjustments has been provided to the Copernicus group in early June. It is now available in MARS, ready to be used for assimilation with ERA5. A research paper documenting the properties of this data set is in preparation.

References:
Mayer, M., **L. Haimberger**, J. M. Edwards and P. Hyder, 2017: Toward Consistent Diagnostics of the Coupled Atmosphere and Ocean Energy Budgets. J. Climate 30.
Mayer, M., M. A. Balmaseda and **L. Haimberger**, 2018: Unprecedented 2015/16 Indo-Pacific heat transfer speeds up Tropical Pacific heat recharge. Geophys. Res. Lett. 45, in press

List of publications/reports from the project with complete references

Papers with results from this project have yet to be published.

Summary of plans for the continuation of the project

(10 lines max)

We will further analyse the noise problem in the budget calculations. Several ideas exist to reduce the noise, e.g. vertically variable distribution of the adjustments to the wind field needed for mass consistency or the removal of quasistationary noise signals at short wavelengths. We aim to publish global energy budgets from ERA5 at higher horizontal resolution than has been so far been possible with ERA-Interim data (typically T63 has been used). Ideally the vertically integrated budgets will not need smoothing or truncation of scales equivalent or larger than 1 degree horizontal resolution. This scale matches the resolution of CERES data at TOA or of some published global surface energy flux fields.
Regarding early upper air data, the PI has responded to a Copernicus ITT for preparing the upper air data base to be ready for the Copernicus data store as well as for assimilation purposes. The special project will help providing the necessary data access for this effort, if funded, as well.