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Conversion table for accumulated variables (total precipitation/fluxes)

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Introduction

Accumulated variables are those which are aggregated over a particular time periods.

The tables below show how accumulated variables from a number of C3S and ECMWF datasets should be processed to derive values for an hour, a day, a month and a year.

As these can be stored in different ways in different datasets, it is important that they are interpreted correctly.

For illustration, 'total precipitation' and 'solar radiation' are used, but the same processing should be applied to all precipitation and radiative flux variables.

Hydrological parameter table

Dataset	Variables	What it is	Grib units	Netcdf Units	To get the total precipitation for an hour (mm)	To get the total precipitation for a day (mm)	To get the total precipitation for a month (mm)	To get the total precipitation for a year (mm)
ERA5 reanalysis (hourly data)	Total precipitation	Accumulations are over the hour (the processing period) ending at the validity date/time	m (of water equivalent per hour)	m (of water equivalent per hour)	$\mathrm{tp}\,[\mathrm{mm}] = \mathrm{tp}\,[\mathrm{m}] \cdot 1000$ Total precipitation over the one hour ending at forecast step.	$\mathrm{tp}\,[\mathrm{mm}] = \left(\sum_{h=1}^{23} \mathrm{tp}_h\,[\mathrm{m}] + \mathrm{tp}_{d+1\,00\mathrm{UTC}}[\mathrm{m}]\right) \cdot 1000$ where h is the hour and d the day of interest (d+1 is the following day). The total precipitation over 24 hours is the sum of the individual total precipitation values for each hour.	$\mathrm{tp}\,[\mathrm{mm}] = \sum_{n=1}^{N}\left(\sum_{h=1}^{23} \mathrm{tp}_h\,[\mathrm{m}] + \mathrm{tp}_{d+1\,00\mathrm{UTC}}[\mathrm{m}]\right)_n \cdot 1000$ where *N* is the number of days in the month.	$\mathrm{tp}\,[\mathrm{mm}] = \sum_{n=1}^{N}\left(\sum_{h=1}^{23} \mathrm{tp}_h\,[\mathrm{m}] + \mathrm{tp}_{d+1\,00\mathrm{UTC}}[\mathrm{m}]\right)_n \cdot 1000$ where *N* is the number of days in the year.
ERA5 ensemble members (3 hourly data)	Total precipitation	Accumulations are over the **3 hours** (the processing period) ending at the validity date/time	m (of water equivalent per 3 hours)	m (of water equivalent per 3 hours)	$\mathrm{tp}\,[\mathrm{mm}] = \mathrm{tp}\,[\mathrm{m}] \cdot 1000$	$\mathrm{tp}\,[\mathrm{mm}] = \left(\sum_h \mathrm{tp}_h[\mathrm{m}]\right) \cdot 1000$ where h are the day timesteps available: 03 UTC, 06 UTC, 09 UTC, 12 UTC, 15 UTC, 18 UTC, 21 UTC and 00 UTC of the day after. The total precipitation over 24 hours is the sum of 8 **3-hour** total precipitation values.	$\mathrm{tp}\,[\mathrm{mm}] = \sum_{n=1}^{N}\left(\sum_h \mathrm{tp}_h[\mathrm{m}]\right)_n \cdot 1000$ where h are the day timesteps available: 03 UTC, 06 UTC, 09 UTC, 12 UTC, 15 UTC, 18 UTC, 21 UTC and 00 UTC of the day after and *N* is the number of days in the month.	$\mathrm{tp}\,[\mathrm{mm}] = \sum_{n=1}^{N}\left(\sum_h \mathrm{tp}_h[\mathrm{m}]\right)_n \cdot 1000$ where h are the day timesteps available: 03 UTC, 06 UTC, 09 UTC, 12 UTC, 15 UTC, 18 UTC, 21 UTC and 00 UTC of the day after, and *N* is the number of days in the year.
ERA5 monthly averaged reanalysis	Total precipitation	The accumulations in monthly means of daily means have been scaled to have units that include "per day"	m (of water equivalent per day)	m (of water equivalent per day)	N/A	N/A	$\mathrm{tp}\,[\mathrm{mm}] = \mathrm{tp}\,[\mathrm{m/day}] \cdot 1000 \cdot N$ where *N* is the number of days in the month.	$\mathrm{tp}\,[\mathrm{mm}] = \sum_{n=1}^{12}(\mathrm{tp}\,[\mathrm{m/day}] \cdot 1000 \cdot N)_\mathrm{n}$ where N is the number of days in the month and n is the number of the month.
ERA5 monthly averaged ensemble members	Total precipitation	The accumulations in monthly means of daily means have been scaled to have units that include "per day"	m (of water equivalent per day)	m (of water equivalent per day)	N/A	N/A	$\mathrm{tp}\,[\mathrm{mm}] = \mathrm{tp}\,[\mathrm{m/day}] \cdot 1000 \cdot N$ where *N* is the number of days in the month.	$\mathrm{tp}\,[\mathrm{mm}] = \sum_{n=1}^{12}(\mathrm{tp}\,[\mathrm{m/day}] \cdot 1000 \cdot N)_\mathrm{n}$ where *N* is the number of days in the month and n is the number of the month.
ERA5-Land hourly data	Total precipitation	Accumulations are from 00 UTC to the hour ending at the forecast step [1]	m (of water equivalent)	m (of water equivalent)	$\mathrm{tp}\,[\mathrm{mm}] = \begin{cases} \mathrm{tp}_h\,[\mathrm{m}] \cdot 1000 & h = 01\mathrm{UTC} \\ (\mathrm{tp}_h\,[\mathrm{m}] - \mathrm{tp}_{h-1}\,[\mathrm{m}]) \cdot 1000 & \text{otherwise} \end{cases}$	$\mathrm{tp}\,[\mathrm{mm}] = \mathrm{tp}_{d+1\,00\mathrm{UTC}}[\mathrm{m}] \cdot 1000$ where *d* is the day for which the average flux is being computed. The time step labelled *d*+1 00UTC should also be taken because it contains the accumulated flux over the previous 24 hours.	$\mathrm{tp}\,[\mathrm{mm}] = \left(\sum_{n=1}^{N} \mathrm{tp}_{d+1\,00\mathrm{UTC},n}[\mathrm{m}]\right) \cdot 1000$ where *d* is the day for which the total precipitation is being computed and *N* is the number of days in the month. The time step labelled *d*+1 00UTC should also be taken because it contains the accumulated total precipitation over the previous 24 hours. This implies that the sum goes from the 2nd of the month to the 1st of the next month (inclusive).	$\mathrm{tp}\,[\mathrm{mm}] = \left(\sum_{n=1}^{N} \mathrm{tp}_{d+1\,00\mathrm{UTC},n}[\mathrm{m}]\right) \cdot 1000$ where *d* is the day for which the total precipitation is being computed and *N* is the number of days in the year. The time step labelled *d*+1 00UTC because it contains the accumulated total precipitation over the previous 24 hours. This implies that the sum goes from 2nd January of the year to 1st January of the next year (inclusive).
ERA5-Land monthly averaged data	Total precipitation	The accumulations in monthly means of daily means have units that include "per day".	m (of water equivalent per day)	m (of water equivalent per day)	N/A	N/A	$\mathrm{tp}\,[\mathrm{mm}] = \mathrm{tp}\,[\mathrm{m/day}] \cdot 1000 \cdot N$ where *N* is the number of days in the month.	$\mathrm{tp}\,[\mathrm{mm}] = \sum_{n=1}^{12}(\mathrm{tp}\,[\mathrm{m/day}] \cdot 1000 \cdot N)_\mathrm{n}$ where *N* is the number of days in the month and n is the number of the month.
Seasonal daily data	Total precipitation	24 hour aggregation since the beginning of the forecast	m	m	$\mathrm{tp}\,[\mathrm{mm/hr}] = \frac{(\mathrm{tp}_{t2}\,[\mathrm{m}] - \mathrm{tp}_{t1}\,[\mathrm{m}]) \cdot 1000}{24}$ where t_2 is the day of interest, t_1 is the day before t2, tp_{t2} is the total precipitation at t2, and tp_{t1} is the total precipitation at t1.	$\mathrm{tp}\,[\mathrm{mm}] = (\mathrm{tp}_{t2}\,[\mathrm{m}] - \mathrm{tp}_{t1}\,[\mathrm{m}]) \cdot 1000$ where t_2 is the day of interest, t_1 is the day before t2, tp_{t2} is the total precipitation at t2, and tp_{t1} is the total precipitation at t1.	$\mathrm{tp}\,[\mathrm{mm}] = (\mathrm{tp}_{t2}\,[\mathrm{m}] - \mathrm{tp}_{t1}\,[\mathrm{m}]) \cdot 1000$ where t_2 is the 1st day of the month after the month of interest, t_1= is the 1st day of month before t2, tp_{t2}= is the total precipitation at t2, and tp_{t1} is the total precipitation at t1.	N/A For seasonal forecasts, as data only cover 7 months
Seasonal Monthly data	Total precipitation	The accumulations in monthly means have units that include "*per second*".	m/s	m/s	N/A	N/A	$\mathrm{tp}\,[\mathrm{mm}] = \mathrm{tp}_{t1}\,[\mathrm{m}] \cdot 1000$ where t_1 is the month of interest, N1 is the number of days in t_1, and tp_{t1} is the result of (total precipitation at t_1 * N1 * 24 * 60 * 60).	N/A For seasonal forecasts, as data only cover 7 months
Dataset	**Variables**	**What it is**	**Grib units**	**Netcdf Units**	**To get the total precipitation for an hour (mm)**	**To get the total precipitation for a day (mm)**	**To get the total precipitation for a month (mm)**	**To get the total precipitation for a year (mm)**
ERA-Interim sub-daily data	Total precipitation	Accumulations are from the beginning of the forecast	m (of water equivalent)	m (of water equivalent)	N/A NOT AVAILABLE HOURLY	$\mathrm{tp}\,[\mathrm{mm}] = (\mathrm{tp}_{12\,00\mathrm{UTC}} + \mathrm{tp}_{12\,12\mathrm{UTC}}[\mathrm{m}]) \cdot 1000$ where the time step labelled 12 has to be selected from time reference 00UTC plus the time step labelled *12* selected from time reference 12UTC because they contain the accumulated total precipitation over the 24 hours for each day.	$\mathrm{tp}\,[\mathrm{mm}] = \sum_{d=1}^{N}(\mathrm{tp}_{12\,00\mathrm{UTC}} + \mathrm{tp}_{12\,12\mathrm{UTC}}\,[\mathrm{m}])_d \cdot 1000$ where *d* is the day for which the total precipitation is being computed and *N* is the number of days in the month.	$\mathrm{tp}\,[\mathrm{mm}] = \sum_{d=1}^{N}(\mathrm{tp}_{12\,00\mathrm{UTC}} + \mathrm{tp}_{12\,12\mathrm{UTC}}\,[\mathrm{m}])_d \cdot 1000$ where *d* is the day for which the total precipitation is being computed and *N* is the number of days in the year.

Energy and momentum fluxes table

Dataset	Variables	What it is	Grib units	Netcdf Units	To get the average energy flux ($\mathrm{Wm^{-2}}$)	To get the average energy flux for a day ($\mathrm{Wm^{-2}}$)	To get the average energy flux for a month ($\mathrm{Wm^{-2}}$)	To get the average energy flux for a year ($\mathrm{Wm^{-2}}$)
ERA5 daily data	Surface Solar Radiation (SSR)	Accumulations are over the hour (the processing period) ending at the forecast step	$\mathrm{Jm^{-2}}$	$\mathrm{Jm^{-2}}$	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \mathrm{SSR}\,[\mathrm{Jm^{-2}}]\,/\,3600\,[\mathrm{s}]$ Average flux over the one hour ending at forecast step.	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \frac{\sum_{h=1}^{23}\mathrm{SSR}_h\,[\mathrm{Jm^{-2}}] + \mathrm{SSR}_{d+1\,00\mathrm{UTC}}[\mathrm{Jm^{-2}}]}{86400\,[\mathrm{s}]}$ The average flux over 24 hours is the sum of the individual fluxes for each hour divided by the number of seconds in a day.	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \frac{\sum_{n=1}^{N}\left(\sum_{h=1}^{23}\mathrm{SSR}_h\,[\mathrm{Jm^{-2}}] + \mathrm{SSR}_{d+1\,00\mathrm{UTC}}[\mathrm{Jm^{-2}}]\right)_n}{N \cdot 86400\,[\mathrm{s}]}$ where *N* is the number of days in the month. The average flux over a month is the sum of the individual fluxes for each day divided by the number of seconds in the month.	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \frac{\sum_{n=1}^{N}\left(\sum_{h=1}^{23}\mathrm{SSR}_h\,[\mathrm{Jm^{-2}}] + \mathrm{SSR}_{d+1\,00\mathrm{UTC}}[\mathrm{Jm^{-2}}]\right)_n}{N \cdot 86400\,[\mathrm{s}]}$ where *N* is the number of days in the year. The average flux over a year is the sum of the individual fluxes for each day divided by the number of seconds in the year.
ERA5 daily ensemble data	SSR	Accumulations are over the **3 hours** (the processing period) ending at the forecast step	$\mathrm{Jm^{-2}}$	$\mathrm{Jm^{-2}}$	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \mathrm{SSR}\,[\mathrm{Jm^{-2}}]\,/\,(3 \cdot 3600)\,[\mathrm{s}]$ Average flux over the three hours ending at forecast step.	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \left(\sum_h \mathrm{SSR}_h[\mathrm{Jm^{-2}}] + \mathrm{SSR}_{d+1\,00\mathrm{UTC}}[\mathrm{Jm^{-2}}]\right)/86400$ where h are the day timesteps available: 03 UTC, 06 UTC, 09 UTC, 12 UTC, 15 UTC, 18 UTC, 21 UTC and 00 UTC of the day after. The average flux over 24 hours is the sum of 8 **3-hour** fluxes divided by the number of seconds in a day.	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \sum_{n=1}^{N}\left(\sum_h \mathrm{SSR}_h[\mathrm{Jm^{-2}}] + \mathrm{SSR}_{d+1\,00\mathrm{UTC}}[\mathrm{Jm^{-2}}]\right)_n / N \cdot 86400$ where h are the day timesteps available: 03 UTC, 06 UTC, 09 UTC, 12 UTC, 15 UTC, 18 UTC, 21 UTC and 00 UTC of the day after and *n* is the number of days in the month. The average flux over a month is the sum of the individual fluxes for each day (computed as the sum of 8 **3-hour** fluxes) divided by the number of seconds in the month.	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \sum_{n=1}^{N}\left(\sum_h \mathrm{SSR}_h\right)_n / N \cdot 86400$ where h are the day timesteps available: 03 UTC, 06 UTC, 09 UTC, 12 UTC, 15 UTC, 18 UTC, 21 UTC and 00 UTC of the day after and *N* is the number of days in the year. The average flux over a year is the sum of the individual fluxes for each day (computed as the sum of 8 **3-hour** fluxes) divided by the number of seconds in the year.
ERA5 monthly averaged data	SSR	Monthly means of mean daily fluxes The accumulations in monthly means of daily means have been scaled to have units that include "per day"	$\mathrm{Jm^{-2}}$	$\mathrm{Jm^{-2}}$	N/A	N/A	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \mathrm{SSR}\,[\mathrm{Jm^{-2}}] \cdot \frac{N}{N \cdot 86400}\,[\mathrm{s}] = \frac{\mathrm{SSR}\,[\mathrm{Jm^{-2}}]}{86400\,[\mathrm{s}]}$ where *N* is the number of days in the month. 1. Multiply by N to obtain total monthly flux from mean daily flux 2. Divide by number of seconds in the month	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \frac{\sum_{m=1}^{12}\mathrm{SSR}_m\,[\mathrm{Jm^{-2}}] \cdot N_m}{D \cdot 86400\,[\mathrm{s}]}$ where N_m is the number of days in the month *m*, and *D* is the number of days in the year. 1. Multiply each value by the number of days in the month 2. Sum them together 3. Divide by number of seconds in the year
ERA5 monthly averaged ensemble data	SSR	Monthly means of mean daily fluxes The accumulations in monthly means of daily means have been scaled to have units that include "per day"	$\mathrm{Jm^{-2}}$	$\mathrm{Jm^{-2}}$	N/A	N/A	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \mathrm{SSR}\,[\mathrm{Jm^{-2}}] \cdot \frac{N}{N \cdot 86400}\,[\mathrm{s}] = \frac{\mathrm{SSR}\,[\mathrm{Jm^{-2}}]}{86400\,[\mathrm{s}]}$ where N is the number of days in the month. 1. Multiply by N to obtain total monthly flux from mean daily flux 2. Divide by number of seconds in the month	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \frac{\sum_{m=1}^{12}\mathrm{SSR}_m\,[\mathrm{Jm^{-2}}] \cdot N_m}{D \cdot 86400\,[\mathrm{s}]}$ where N_m is the number of days in the month *m*, and *D* is the number of days in the year. 1. Multiply each value by the number of days in the month 2. Sum them together 3. Divide by number of seconds in the year
ERA5-Land hourly data	SSR	Accumulations are from 00 UTC to the hour ending at the forecast step[1]	$\mathrm{Jm^{-2}}$	$\mathrm{Jm^{-2}}$	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \begin{cases} \frac{\mathrm{SSR}_h\,[\mathrm{Jm^{-2}}]}{3600\,[\mathrm{s}]} & h = 01\mathrm{UTC} \\ \frac{\mathrm{SSR}_h\,[\mathrm{Jm^{-2}}] - \mathrm{SSR}_{h-1}\,[\mathrm{Jm^{-2}}]}{3600\,[\mathrm{s}]} & \text{otherwise} \end{cases}$	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \frac{\mathrm{SSR}_{d+1\,00\mathrm{UTC}}[\mathrm{Jm^{-2}}]}{86400\,[\mathrm{s}]}$ where *d* is the day for which the average flux is being computed. The time step labelled *d*+1 00UTC is selected because it contains the accumulated flux over the previous 24 hours.	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \frac{\sum_{d=1}^{N}\mathrm{SSR}_{d+1\,00\mathrm{UTC}}[\mathrm{Jm^{-2}}]}{N \cdot 86400\,[\mathrm{s}]}$ where *d* is the day for which the average flux is being computed and *N* is the number of days in the month. The time step labelled *d*+1 00UTC because it contains the accumulated flux over the previous 24 hours. This implies that the sum goes from the 2nd of the month to the 1st of the next month, inclusive.	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \frac{\sum_{d=1}^{N}\mathrm{SSR}_{d+1\,00\mathrm{UTC}}[\mathrm{Jm^{-2}}]}{N \cdot 86400\,[\mathrm{s}]}$ where *d* is the day for which the average flux is being computed and *N* is the number of days in the year. The time step labelled *d*+1 00UTC because it contains the accumulated flux over the previous 24 hours. This implies that the sum goes from 2nd January of the year to 1st January of the next year, inclusive.
ERA5-Land monthly averaged data	SSR	Accumulations are created from data with a forecast period falling within the month. Monthly means of daily means for accumulations are created from the last forecast step (24) of the forecasts for each day of the month. The accumulations in monthly means of daily means have been scaled to have units that include "per day"	$\mathrm{Jm^{-2}}$	$\mathrm{Jm^{-2}}$	N/A	N/A	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \mathrm{SSR}\,[\mathrm{Jm^{-2}}] \cdot \frac{N}{N \cdot 86400}\,[\mathrm{s}] = \frac{\mathrm{SSR}\,[\mathrm{Jm^{-2}}]}{86400\,[\mathrm{s}]}$ where *N* is the number of days in the month. 1. Multiply by *N* to obtain total monthly flux from mean daily flux 2. Divide by number of seconds in the month	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \frac{\sum_{m=1}^{12}\mathrm{SSR}_m\,[\mathrm{Jm^{-2}}] \cdot N_m}{D \cdot 86400\,[\mathrm{s}]}$ where N_m is the number of days in the month *m*, and *D* is the number of days in the year. 1. Multiply each value by the number of days in the month 2. Sum them up 3. Divide by number of seconds in the year
Seasonal daily data	SSR	24 hour aggregation since the beginning of the forecast	$\mathrm{Jm^{-2}}$	$\mathrm{Jm^{-2}}$	N/A	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \frac{(\mathrm{SSR}_{t2}\,[\mathrm{Jm^{-2}}] - \mathrm{SSR}_{t1}\,[\mathrm{Jm^{-2}}])}{24*60*60}$ where t_2 is the day of interest, t_1 is the day before t2, SSR_{t2} is the SSR at t2, and SSR_{t1} is the SSR at t1	$\mathrm{SSR}\,[\mathrm{Wm^{-2}}] = \frac{(\mathrm{SSR}_{t2}\,[\mathrm{Jm^{-2}}] - \mathrm{SSR}_{t1}\,[\mathrm{Jm^{-2}}])}{N*24*60*60}$ where t_2 is the 1st day of month after the month of interest, t_1 is 1st day of month before t2, N is number of days in month of interest, SSR_{t2} is the SSR at t2, and SSR_{t1}= is the SSR at t1.	N/A For seasonal forecasts, as data only cover 7 months
Dataset	**Variables**	**What it is**	**Grib units**	**Netcdf Units**	**To get the average energy flux ($\mathrm{Wm^{-2}}$)**	**To get the average energy flux for a day ($\mathrm{Wm^{-2}}$)**	**To get the average energy flux for a month ($\mathrm{Wm^{-2}}$)**	**To get the average energy flux for a year ($\mathrm{Wm^{-2}}$)**
Seasonal	SSR				N/A		N/A	N/A For seasonal forecasts, as data only cover 7 months

data		in monthly means have units that include "*per second*".							

Notes

[1] Please, **note that the convention for accumulations used in ERA5-Land differs with that for ERA5**. The accumulations in the short forecasts of ERA5-Land (with hourly steps from 01 to 24) are treated the same as those in ERA-Interim or ERA-Interim/Land, i.e., they are accumulated from the beginning of the forecast to the end of the forecast step. For example, runoff at day=D, step=12 will provide runoff accumulated from day=D, time=0 to day=D, time=12. The maximum accumulation is over 24 hours, i.e., from day=D, time=0 to day=D+1,time=0 (step=24).

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Related articles

- What is ERA-40
- What is ERA-20C
- What is CERA-20C
- What data and maps are available through C3S (Copernicus Climate Change Service)?
- What are the changes from ERA-Interim to ERA5 and ERA5-Land?

c3s era5 era5-land seasonal-forecast

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