a brief history of eddy4R-Docker

[and how it might help with your growing pains, too]
the early beginnings

\[ F = \frac{w'}{c'} \]

Center of pressure
Center of gravity
expansion

Adam et al.: \( \text{NO}_x \), VOC over London

Torsten et al.: CH\(_4\) flux in Arctic

Stefan et al.: 47 towers @ NEON

Ankur et al.: tall tower
expansion
version control to the help

(6) integrate @ test branch
(1) official code @ NEON
(2) fork @ developer
(5) change control board @NEON
(4) pull request
(3) develop @ feature branch

✅ portable
✅ extensible
❌ reproducible: dependencies resolve differently across OSs
eddy4R-Docker: Development and Operations framework

- Docker shipping container system for code
- eddy4R-Docker: turn-key, reproducible, extensible and portable data processing + analysis environment
- DevOps community development framework
eddy4R-Docker: modular extensibility

- eddy4R family of R-packages (raw data → 30 min)
- NEON's eddy4R, nneo, metscanner + MPI's REddyProc R-packages: end-to-end, modularly adjustable and extensible workflows in single R-environment
eddy4R-Docker: documentation

composite Algorithm Theoretical Basis Document

- concise description of workflow and methods used
- links to interactive help files for detailed technical information (full transparency)

Help Pages

def agr.ecle dp01

def agr.vari.seSq

def base ec

def bin

def cent.pol

def coef.coef

def conv.poly

def dens.mass.h2o.press.h2o.temp

def dens.mole.air

def dens.mole.air.dry

def dens.pres.poi

def dens.temp.poi

def dens.temp.pres.poi

def dld.zip

def.env.glob

def.hdf5.crite

def.hdf5.dp01.pack

def.idx.agr

def.lag

def.mean.med.mode

def.med.mad

Definition function: aggregation of ecne dp01 outputs
Definition function: Determining mean, external, internal and total variance, and squared standard error
Definition function: Base state for eddy-covariance calculation
Definition function: Binning data
Definition function: Decomposing azimuth angles to cartesian vectors
Definition function: Coriolis coefficient
Definition function: Apply polynomial conversion
Definition function: Calculate absolute humidity from water vapor pressure and ambient temperature
Definition function: Calculation of the molar density of the mixture of dry air and water vapor
Definition function: Calculation of the molar density of the dry air alone
Definition function: Poisson’s equation (adiabatic change) - density as function of pressure change
Definition function: Poisson’s equation (adiabatic change) - density as function of temperature change
Definition function: Poisson’s equation (adiabatic change) - density as function of pressure and temperature change
Definition function: Download and extract .zip archives from a web address
Definition function: Global R-environment settings for use with the eddy4R family of R-packages
Definition function: Create the ECTE HDF5 file structure
Definition function: to package dp01 dp01 outputs to be written to HDF5 files
Definition function: indices for aggregation periods
Definition function: Lag two datasets, so as to maximise their cross-correlation
Definition function: Calculate descriptive statistics based on arithmetic mean, median and mode
Definition function: Median and median absolute deviation as robust measures of scale and dispersion
eddy4R-Docker: documentation

**def.dens.pres.pois (eddy4R.base)**

R Documentation

**Definition function: Poisson's equation (adiabatic change) - density as function of pressure change**

**Description**

Poisson's equation (adiabatic change) - density as function of pressure change.

**Usage**

```r
def.dens.pres.pois(dens01, pres01, pres02,
    Kppa = eddy4R.base::Int1Natu$KppaDry)
```

**Arguments**

- `dens01`: Measured density, Amount per volume [same unit as returned density, e.g. kg/m^3 or kmol/m^3].
- `pres01`: Measured air pressure [same unit as reference pressure].
- `pres02`: Reference pressure [same unit as measured air pressure].
- `Kppa`: Ratio of specific gas constant to specific heat at constant pressure. Default as KppaDry.

**Value**

Densities at reference pressure [same unit as measured density].

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**References**

License: GNU AFFERO GENERAL PUBLIC LICENSE Version 3, 19 November 2007

**See Also**

Currently none

**Examples**

```r
dens02 <- def.dens.pres.pois(dens01 = 1.056, pres01 = 845, pres02 = 1000, Kppa = eddy4R.base::Int1Natu$KppaDry)
```

```r
> eddy4R.base::def.dens.pres.pois
function (dens01, pres01, pres02, Kppa = eddy4R.base::Int1Natu$KppaDry)
dens02 = dens01 * (pres02/pres01)^((1 - Kppa)
```
eddy4R-Docker: traceability to community standards

eddy4R 0.2.0: a DevOps model for community-extensible processing and analysis of eddy-covariance data based on R, Git, Docker, and HDF5

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**eddy4R-Docker: operational data processing @ NEON**

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<td>3D Wind Speed, Direction and Sonic Temp</td>
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<td>NEON.DP4.00201</td>
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**pipeline capabilities**

- near-real-time (1 week → 1 month)
- extensible: e.g. operational data fusion
other, recent application examples

geologic CH₄ emissions from permafrost (Kohnert et al., 2017)

NOₓ emission over London (Vaughan et al., 2016)

CH₄ emission from dairy (Desjardins et al., 2017)
the leading edge of eddy4R: SAE in box

- translating transient EC observations into time-invariant fixed-frame

a) Tower turbulent and storage flux observations

b) Environmental response function virtual control volume approach (ERF-VCV)


the leading edge of eddy4R: ERF-VCV

volume-projected heat storage change (Xu et al., 2017)

2011-08-13 00:00 CST

grid-projected turbulent heat flux (Metzger, 2017)

2011-08-15 00:00 CST

\[
\rho C_p \frac{dT}{dt} \quad \text{[W / m}^3\text{]} 
\]
spatial flux from single tower (ERF-VCV validation ~ LES)

Xu et al. AGU talk today (B24D-07): How many flux towers are enough? How tall is a tower tall enough? How elaborate a scaling is scaling enough?