CDO's python bindings

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What to expect

Overview:

- General features
- Installation
- What it's *not*

Source Code Examples:

- Basics Usage
- Work with temporary files
- Parallelization with Python
- Integration with numpy/xarray/...

... and news on cdo-1.9.7

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  - netCDF4 or XDataset handles
  - strings for operators, which write to stdout
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    - strings for operators, which write to stdout
    - None on error (optional)
- access to all options
    - -f *file format*
    - -P *OpenMP-threads*
    - ...
- environment settings
- GPL-2 licensed like CDO itself

HOW ...

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- prebuild debian packages: python-cdo, python3-cdo
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- IO: optional use of existing files if present
- interactive help
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... on mistral

- `module load anaconda3/bleeding_edge`
- `module load anaconda2/bleeding_edge`

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WTH ... internals

cdo.{rb,py}

- is a *smart* caller of a CDO binary (with all the pros and cons)
- doesn't need to be re-installed for a new CDO version
- isn't a shared library, which keeps everything in memory
- doesn't allow write access to files via the numpy or masked arrays

See MPI-MET ort github page:

`https://code.zmaw.de/projects/cdo/wiki/Cdo{rbpy}`
`https://github.com/Try2Code/cdo-bindings`

Basic Python 2.7/3.x

```python
from cdo import Cdo
import glob

cdo = Cdo()

# use a special binary
cdo = Cdo(cdo='/sw/rhel6-x64/cdo/cdo-1.9.5-gcc64/bin/cdo') # or later in a script
cdo.setCdo('/sw/rhel6-x64/cdo/cdo-1.9.5-gcc64/bin/cdo')

# concatenate list of files into a temp file with relative time axis
ofile = cdo.cat(input = glob.glob('*.nc'), options = '-r')

# vertical interpolation
Temp3d = cdo.intlevel(100,200,500,1000, options = '-f grb',
                      input  = ofile,
                      output = 'TempOnTargetLevels.grb')

# perform zonal mean after interpolation in nc4 classic format with 8 OpenMP threads
zonmeanFile =  cdo.zonmean(input = "-remapbil,r1400x720 %s"%(Temp3d),
                           options = '-P 8 -f nc4c')
```

Parallelism with Python

```python
from cdo import Cdo
from multiprocessing import Pool

# define methods to use with the Pool
def cdozonmean(infile):
    ofile = cdo.zonmean(input=infile)

files = sorted([s for s in glob.glob(nicam_path+'*/sa_tppn.nc')])[0:20]

# create the Pool and a dict for collecting the results
pool, results    = Pool(4), dict()

# fill and run the Pool, keep the connection of input and output
for file in files:
    results[file] = pool.apply_async(cdozonmean,(file,))
pool.close()
pool.join()

# retrieve the _real_ results from the Pool (i.e. filenames)
for k,v in results.items():
    results[k] = v.get()

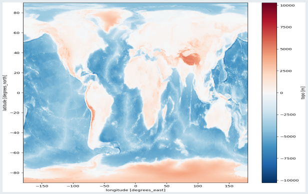
cdo.cat(input = [results[x] for x in files],output = wrk_dir+'test.nc')
```

XArray/Numpy interaction

XArray

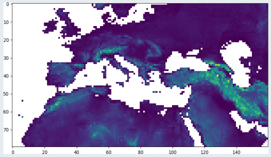
```
# plotting with XArray
cdo.topo(returnXArray='topo').plot()

# IO with XDataset
dataSet = xarray.open_dataset(cdo.topo('global_0.1',
                                        options = '-f nc'))
dataSet['topo'] = 1.0 + np.abs(dataSet['topo'])
cdo.fldmin(input=dataSet,returnArray='topo').min() == ?
```



numpy/matplotlib-based plotting

```
# or with masked arrays
from matplotlib import pylab
import numpy
oro = cdo.setrtomiss(-20000,0,
                     input='-sellonlatbox,-20,60,20,60  -topo',
                     returnMaArray='topo')
pylab.imshow(numpy.flipud(oro))
pylab.show()
```



Tempfiles - painless usage (mostly)

Using tempfiles can become a problem

Tempfiles are usually removed at the end of a script. But in long-lasting or SIGKILLed interactive session (ipython/jupyter notebooks) with possibly many users per node the system tempdir can get filled up sooner or later.
In other words: *How to avoid a reboot?*

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Solution

Manual clean-up for all files created by cdo.py belonging to the current user

```
cdo.cleanTempDir()
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Solution

Use other tempdir like `/dev/shm`

```
cdo = Cdo(tempdir='/dev/shm/{0}'.format(os.environ['USER']))
```

More Examples at github

Units test for all features available at Github

- numpy or masked arrays, XArray, XDataset, cdf handles ...

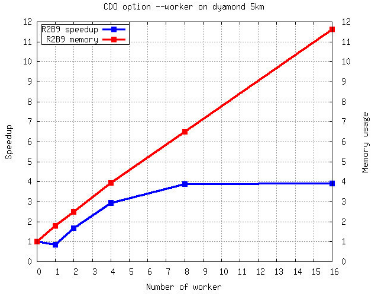
key	value	return type
returnArray	varname	numpy array
returnMaArray	varname	numpy masked array
returnXarray	varname	XArray
returnXDataset	Bool	XDataset handle
returnCdf	Bool	netCDF4 file handle

- conditional output
- return None on error
- exception handling
- output operators

News on CDO-1.9.7

Operators and options:

- Grib2 decodeing speedup: `--worker <N>`
  - set number for async decompression operations on a GRIB2 input file
  - best used on files with many records per timestep



- Grib-encoding: `--eccodes`
  choose between cgribex and eccodes to work with GRIB1
- Find timesteps with min/max: `timminidx`, `timemaxidx`, `yearminidx`, `yearmaxidx`

For more please check:Tutorial, FAQ and the Operator News

```
(10*rand).to_i.times {
  puts "thank you for your attention!"
}

audience.select {|human|
   human.has_questions?
}.each {|human| human.ask!(please: true) }
```

Appendix: Constructor

```python
def __init__(self,
             cdo               = 'cdo'                 # path to CDO binary
             returnCdf         = False,                # always return netCDF4 filehandle
             returnNoneOnError = False,                # don't raise exception, return No
             forceOutput       = True,                 # global switch for cond. output
             cdfMod            = CDF_MOD_NETCDF4,      # set the cdf module to by used
             env               = os.environ,           # environment for the object
             debug             = False,                # print commands, return codes, et
             tempdir           = tempfile.gettempdir(), # location for temporary files
             logging           = False,                # log commands internally
             logFile           = StringIO()):

    # read path to CDO from the environment if given
    if 'CDO' in os.environ:
      self.CDO = os.environ['CDO']
    else:
      self.CDO = cdo
```

Appendix: Pool.apply_async syntax explained

```python
from multiprocessing import Pool

def f(x, *args, **kwargs):
    print x, args, kwargs

args, kw = (1,2,3), {'cat': 'dog'}

print "# Normal call"
f(0, *args, **kw)

print "# Multicall"
P = Pool()
    sol = [P.apply_async(f, (x,) + args, kw) for x in range(2)]
P.close()
P.join()

for s in sol: s.get()
```

Appendix: Parallel with Ruby

```ruby
require 'parallel'
require 'cdo'

cdo = Cdo.new
files = Dir.glob("*nc")

ofiles = Parallel.map(files,:in_processes => nWorkers).each {|file|
    basename = file[0..-(File.extname(file).size+1)]
    ofile = cdo.remap(targetGridFile,targetGridweightsFile,
                      :input => file,
                      :output => "remapped_#{basename}.nc")
}

# Merge all the results together
cdo.merge(:input => ofiles.join(" "),:output => 'mergedResults.nc')
```