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# **MSS - Mission Support System Documentation**

*Release 1.5.0*

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## Mission Support System Usage Guidelines

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Welcome to the Mission Support System software for planning atmospheric research flights. This document is intended to point you into the right direction in order to get the software working on your computer.

Please read the reference documentation

Rautenhaus, M., Bauer, G., and Doernbrack, A.: A web service based tool to plan atmospheric research flights, *Geosci. Model Dev.*, 5, 55-71, doi:10.5194/gmd-5-55-2012, 2012.

and the paper's Supplement (which includes a tutorial) before using the application. The documents are available at:

<http://www.geosci-model-dev.net/5/55/2012/gmd-5-55-2012.pdf> <http://www.geosci-model-dev.net/5/55/2012/gmd-5-55-2012-supplement.pdf>

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## Mission Support Dependencies

### Mission Support System (MSS)

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Rautenhaus, M., Bauer, G., and Doernbrack, A.: A web service based tool to plan atmospheric research flights, *Geosci. Model Dev.*, 5, 55-71, doi:10.5194/gmd-5-55-2012, 2012.

Thank you.

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Below is a list of software packages that are used in the MSS or from which parts are used in the MSS (see the LICENSE file for the terms and conditions that apply to these components):

### OWSLib

Copyright (c) 2006, Ancient World Mapping Center

Package for working with OGC map, feature, and coverage services. Obtained from SVN (<http://svn.gispython.org/svn/gispy/OWSLib/trunk>), revision 1672, on 2010/08/11.

NOTE: The file “wms.py” has been modified for the MSS. Changes are marked with “(mss)”. We renamed it to “ogcwms.py” (2017-04-28)

We also did a PEP8 review of the ogcwms.py and adopted it to the recent 0.14 version <https://pypi.python.org/pypi/OWSLib/0.14.0>

### NETCDF4-PYTHON

Copyright: 2008 by Jeffrey Whitaker

`mllib/netCDF4tools.py` contains substantial parts taken from the `netcdf4-python` library – Python/numpy interface to netCDF

<https://code.google.com/p/netcdf4-python/>

## Installation

Current Releases of mss are based on *python 2*.

We are yet *not ready* for Python 3.

### Install distributed version by conda

**Anaconda** provides an enterprise-ready data analytics platform that empowers companies to adopt a modern open data science analytics architecture.

The Mission Support Web Map Service (mss) is available as anaconda package on a channel.

- `conda-forge`

The conda-forge packages are based on defaults and other conda-forge packages. This channel conda-forge has builds for `osx-64`, `linux-64`, `win-64`, `win-32`.

The conda-forge [github organization](#) uses various automated continuous integration build processes.

## conda-forge channel

Please add the channel conda-forge to your defaults:

```
$ conda config --add channels conda-forge
$ conda config --add channels defaults
```

The last channel added gets on top of the list. This gives the order: First search in default packages then in conda-forge. Then you could choose between as system wide installation or one in a preferred environment:

```
$ conda install mss
```

You also could install this project into an environment.

```
$ conda create -n mssenv python=2
$ source activate mssenv
$ conda install mss
```

For further details *Configuration of mss*

## Server based installation using miniconda

For a wms server setup you may want to have a dedicated user running mswms or the apache2 wsgi script. We suggest to create a mss user.

- create a mss user on your system
- login as mss user
- create a *src* directory in */home/mss*
- cd *src*
- get [miniconda](#) for Python 2
- set execute bit on install script
- execute script, enable environment in *.bashrc*
- login again or export `PATH="/home/mss/miniconda2/bin:$PATH"`
- `python --version` should tell Python 2.7.X
- `conda install -c conda-forge mss`

For a simple test you could start the builtin standalone server by *mswms*. It should tell:

```
serving on http://127.0.0.1:8081
```

Pointing a browser to <http://localhost:8081/?service=WMS&request=GetCapabilities&version=1.1.1> shows the generated XML data the mss app will use.

If you want to look on some data, we provide a demo data set by the program *demodata - simulated data*.

For further configuration see *Apache server setup* or *Standalone server setup*.

## mss - User Interface

The executable for the user interface application is “**mss**”. It does not provide any command line options. Warnings about CDAT features are due to the NAppy package and can be ignored. The program should open the main window of the user interface, from which you can open further windows, including top view, side view and so on.

Configuration for the user interface is located in “**mss\_settings.json**”. In this file, you can specify, for instance, the default WMS URLs for the WMS client, the size of the local image cache (the MSUI caches retrieved WMS images to accelerate repeated retrievals), or the predefined locations that the user can select in the table view.

A few options influencing the appearance of the displayed plots and flight tracks (colours etc.) can be set directly in the user interface (top view and side view).

## Configuration of mss

### Settings file

This file includes configuration settings central to the entire Mission Support User Interface (mss). Among others, define

- available map projections
- vertical section interpolation options
- the lists of predefined web service URLs
- predefined waypoints for the table view
- batch products for the loop view in this file.

If you don't have a **mss\_settings.json** then default configuration is in place.

Store this **mss\_settings.json** in a path, e.g. “**\$HOME/.config/mss**”

The file could be loaded by the File Load Configuration dialog or by the environment variable **MSS\_SETTINGS** pointing to your **mss\_settings.json**.

**/\$HOME/.config/mss/mss\_settings.json**

```
{
  "layout": {
    "topview": [963, 702],
    "sideview": [913, 557],
    "tableview": [1236, 424],
    "immutable": false
  },
  "locations": {
    "EDMO": [48.08, 11.28],
    "Hannover": [52.37, 9.74],
    "Hamburg": [53.55, 9.99],
    "Juelich": [50.92, 6.36],
    "Leipzig": [51.34, 12.37],
    "Muenchen": [48.14, 11.57],
    "Stuttgart": [48.78, 9.18],
    "Wien": [48.20833, 16.373064],
    "Zugspitze": [47.42, 10.98],
  }
}
```



```

    "Kiruna": [67.821, 20.336],
    "Ny-Alesund": [78.928, 11.986]
  },
  "predefined_map_sections": {
    "01 Europe (cyl)": {"CRS": "EPSG:4326",
      "map": {"llcrnrlon": -15.0, "llcrnrlat": 35.0,
        "urcrnrlon": 30.0, "urcrnrlat": 65.0}},
    "02 Germany (cyl)": {"CRS": "EPSG:4326",
      "map": {"llcrnrlon": 5.0, "llcrnrlat": 45.0,
        "urcrnrlon": 15.0, "urcrnrlat": 57.0}},
    "03 Global (cyl)": {"CRS": "EPSG:4326",
      "map": {"llcrnrlon": -180.0, "llcrnrlat": -90.0,
        "urcrnrlon": 180.0, "urcrnrlat": 90.0}},
    "04 Shannon (stereo)": {"CRS": "EPSG:77752350",
      "map": {"llcrnrlon": -45.0, "llcrnrlat": 22.0,
        "urcrnrlon": 45.0, "urcrnrlat": 63.0}},
    "05 Northern Hemisphere (stereo)": {"CRS": "EPSG:77790000",
      "map": {"llcrnrlon": -45.0, "llcrnrlat": 0.0,
        "urcrnrlon": 135.0, "urcrnrlat": 90.0}},
    "06 Southern Hemisphere (stereo)": {"CRS": "EPSG:77890000",
      "map": {"llcrnrlon": 45.0, "llcrnrlat": 0.0,
        "urcrnrlon": -135.0, "urcrnrlat": 90.0}}
  },
  "crs_to_mpl_basemap_table" : {
    "EPSG:4326": {"basemap": {"projection": "cyl"},
      "bbox": "latlon"},
    "EPSG:77790000": {"basemap": {"projection": "stere", "lat_0": 90.0, "lon_0": 0.0},
      "bbox": "latlon"}
  },
  "new_flighttrack_template": ["Kiruna", "Ny-Alesund"],
  "new_flighttrack_flightlevel": 250,
  "default_WMS": ["http://www.your-server.de/forecasts"],
  "default_VSEC_WMS": ["http://www.your-server.de/forecasts"],
  "WMS_login": {
    "http://www.your-server.de/forecasts" : ["youruser", "yourpassword"]
  },
  "num_interpolation_points": 201,
  "num_labels": 10,
  "wms_cache": "/tmp/.cache/.mss/msui/wms_cache",
  "wms_cache_max_size_bytes": 20971520,
  "wms_cache_max_age_seconds": 432000
}

```

### Flight track import/export

As the planned flight track has to be quickly communicated to different parties having different desired file formats, MSS supports a simple plugin system for exporting planned flights and importing changed files back in addition to the

main FTML format. These filters may be accessed from the File menu of the Main Window.

MSS currently offers several import/export filters in the `msslib.plugins.io` module, which may serve as an example for the definition of own plugins. The CSV plugin is enabled by default. Enabling the experimental FliteStar text import plugin would require those lines in the UI settings file:

```
"import_plugins": {
  "FliteStar": ["txt", "msslib.plugins.io.flitestar", "load_from_flitestar"]
},
```

The dictionary entry defines the name of the filter in the File menu. The list specifies in this order the extension, the python module implementing the function, and finally the function name. The module may be placed in any location of the PYTHONPATH or into the configuration directory path.

An exemplary test file format that can be ex- and imported may be activated by:

```
"import_plugins": {
  "Text": ["txt", "msslib.plugins.io.text", "load_from_txt"]
},
"export_plugins": {
  "Text": ["txt", "msslib.plugins.io.text", "save_to_txt"]
},
```

The given plugins demonstrate, how additional plugins may be implemented. Please be advised that several attributes of the waypoints are automatically computed by MSS (for example all time and performance data) and will be overwritten after reading back the file.

### Web Proxy

If you are in an area with a very low bandwidth you may consider to use a squid web proxy and add those lines in your `mss_settings` pointing to the proxy server.

```
"proxies": {
  "http": "http://yoursquidproxy:3128",
  "https": "http://yoursquidproxy:3128"
}
```

### Loop View

If you have an image server you can configure the loop view by

```
"loop_configuration": {
  "ECMWF forecasts": {
    "url": "http://www.your-server.de/forecasts",
    "init_timestep": 12,
    "products": {
      "Geopotential and Wind": {
        "abbrev": "geop",
        "regions": {"Europe": "eur", "Germany": "de"},
        "levels": [200, 250, 300, 500, 700, 850, 925],
        "forecast_steps": [0, 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36,
↪ 39, 42, 45, 48, 51, 54, 57, 60, 63, 66, 69, 72, 75, 78, 81, 84, 87, 90, 93, 96, 99,
↪ 102, 105, 108, 111, 114, 117, 120, 123, 126, 129, 132, 135, 138, 141, 144, 147,
↪ 150, 153, 156, 159, 162, 165, 168, 171, 174, 177, 180, 183, 186, 189, 192, 195, 198,
↪ 201, 204, 207, 210, 213, 216, 219, 222, 225, 228, 231, 234, 237, 240]
      }
    }
  }
}
```

```

    }
  }
}

```

## Trajectory Tool

For accessing trajectory data based on NASA AMES format you need the nappy python module installed and can configure this view by

```

"traj_nas_lon_identifier": ["GPS LON", "LONGITUDE"],
"traj_nas_lat_identifier": ["GPS LAT", "LATITUDE"],
"traj_nas_p_identifier": ["STATIC PRESSURE"]

```

## Docking Widgets Configurations

### Performance

MSS may also roughly estimate the fuel consumption and thus range of the aircraft neglecting weather conditions given a proper configuration file specifying the aircraft performance. Such a file may be loaded using the 'performance settings' button in Table View. The aircraft performance is specified using tables given in the JSON format. A basic configuration looks like the following file:

```

{
  "name": "DUMMY",
  "takeoff_weight": 91000,
  "fuel": 35000,
  "climb": [[0.00, 0.0, 0.0, 0.0, 0.0]],
  "descent": [[0.00, 0.0, 0.0, 0.0, 0.0]],
  "cruise": [[0.00, 0.00, 400, 2900.00]],
  "_comment1": "_comment fields are just for self-documentation!",
  "_comment2": "takeoff_weight: weight(lbs)",
  "_comment3": "fuel: weight(lbs)",
  "_comment4": "climb/descent: weight(lbs), altitude(m), duration(min),
↳ distance(nm), fuel(lbs)",
  "_comment5": "cruise: weight(lbs), altitude(m), total air speed(nm/h), fuel_
↳ flow(lbs/h)"
}

```

This example file assumes a constant speed of 400 nm/h and a constant fuel consumption of 2900 lbs/h irrespective of flight level changes. The aircraft weight and available fuel are also given, but these may also be adjusted in the GUI after loading.

The columns of the cruise table are aircraft weight (lbs), aircraft altitude (feet), speed (nm/h), and fuel consumption (lbs/h). MSS bilinearly interpolates in aircraft weight and altitude and extrapolates assuming a constant behaviour outside the given data. The climb table specifies the aircraft performance when climbing up from 0 feet altitude, while the descent table specifies the behaviour when descending down to 0 feet altitude. The column headers are aircraft weight (lbs), aircraft altitude (feet), time spent (minutes), distance required (nm), and fuel consumed (lbs). To compute the required data for a flight level change, a bilinear interpolation in the table for current aircraft weight and the two involved altitudes is performed and the difference of the resulting value is used in the calculation.

### Satellite Track Docking Widget

The TopView has a docking widget allowing the visualisation of satellite tracks. A [web site](#) to generate the data for such tracks is operated by NASA. The data can be downloaded as ASCII file that can be open by the docking widget. An example file is located at `docs/samples/satellite_tracks/satellite_predictor.txt`.

### KML Overlay Docking Widget

The TopView has a docking widget that allows the visualization of KML files on top of the map. This feature currently does not support all features of KML, for example, external resources such as images are not supported. Some example KML files are located at `docs/samples/kml/line.kml` and `docs/samples/kml/folder.kml`.

### Example WMS Server

Some public accessible WMS Servers

- <http://osmwms.itc-halle.de/maps/osmfree>
- <http://ows.terrestris.de/osm/service>
- <https://firms.modaps.eosdis.nasa.gov/wms>

## wms - Web Map Service

Once installation and configuration are complete, you can start the Web Map Service application (provided you have forecast data to visualise). The file “mswms” is an executable Python script starting up a Paste HTTP server with the WMS WSGI module. A short description of how to start the program is given by the `-help` option. The file “wms.wsgi” is intended to be used with an Apache web server installation.

We have methods to use data for ECMWF, CLaMS, GWFC, EMAC, METEOSAT implemented. The data have to use for their parameters the CF attribute `standard_name`.

Per configuration you could register horizontal (*register\_horizontal\_layers*) or vertical layers (*register\_vertical\_layers*), give a basemap table for EPSG mapping (*epsg\_to\_mpl\_basemap\_table*) and at all how to access the data (*nwpaccess*).

A few notes:

- If you run the Paste WMS on a remote machine (e.g. on your office computer which you access via ssh from a campaign site), consider the `ssh-tunnel` option. Create the ssh connection with the “-L” option and start the WMS with the `tunneled port` as option.
- The Paste WMS currently cannot run multithreaded (Apache does support multiple processes). This is due to that a single instance of the WSGI application handler class `MSS_WMSResponse` can create only one plot at a time (otherwise you get messed up plots when simultaneous requests occur). In the current implementation, only a single instance is passed to PASTE (to do all the initialisation work only once. To extend the software to handle simultaneous requests would probably involve creating a “factory” of `MSS_WMSResponse` instances.. If you want to do this, check if/how PASTE handles “worker” factories.
- Creating the capabilities document can take very long (> 1 min) if the forecast data files have to be read for the first time (the WMS program opens all files and tries to determine the available data and elevation ranges). Once the information used for the capabilities are in the cache, however, a `GetCapabilities` request should return a document within 1-2 seconds.

- A typical bottleneck for plot generation is when the forecast data files are located on a different computer than the WMS server. In this case, large amounts of data have to be transferred over the network. Hence, when possible, try to make sure the WMS runs on the same computer on which the input data files are hosted.

## Configuration file of the wms server

Configuration for the Mission Support System Web Map Service (wms).

In this module the data organisation structure of the available forecast data is described. The class `NWPDataAccess` is subclassed for each data type in the system and provides methods to determine which file needs to be accessed for a given variable and time. The classes also provide methods to query the available initialisation times for a given variable, and the available valid times for a variable and a given initialisation time. As the latter methods need to open the NetCDF data files to determine the contained time values, a caching system is used to avoid re-opening already searched files.

The configuration file have to become added to the `/home/mss/config` directory

`/home/mss/config/mss_wms_settings.py`

```
# -*- coding: utf-8 -*-
"""

mss_wms_settings
~~~~~

Configuration module for programs accessing data on the MSS server.

This file is part of mss.

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distributed under the License is distributed on an "AS IS" BASIS,
WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
See the License for the specific language governing permissions and
limitations under the License.
"""

import os
import sys

# Configuration of Python's code search path
# If you already have set up the PYTHONPATH environment variable for the
# stuff you see below, you don't need to do a1) and a2).

# a1) Path of the directory where the mss code package is located.
# sys.path.insert(0, '/home/mss/miniconda2/lib/python2.7/site-packages')

# a2) Path of the directory where mss_wms_settings.py is located
```

```

MSSCONFIGPATH = os.path.abspath(os.path.normpath(os.path.dirname(sys.
↳argv[0])))
sys.path.insert(0, MSSCONFIGPATH)
os.chdir(MSSCONFIGPATH)

import mslib.mswms.dataaccess
from mslib.mswms import mpl_hsec_styles
from mslib.mswms import mpl_vsec_styles
import mslib.mswms

#
# SETTINGS                                     ###
#
# Valid time cache settings:
# Path to the cache directory. Set to None to disable cache.
# valid_time_cache = "./vt_cache"
mslib.mswms.dataaccess.valid_time_cache = os.path.join(os.environ["HOME"], ".
↳mss", "mswms", "vt_cache")
if not os.path.exists(valid_time_cache):
    os.makedirs(valid_time_cache)
# Maximum size of the cache in bytes.
mslib.mswms.dataaccess.valid_time_cache_max_size_bytes = 10 * 1024 * 1024
# Maximum age of a cached file in seconds.
mslib.mswms.dataaccess.valid_time_cache_max_age_seconds = 10 * 86400

# Paths to data directories. Process callables (the functions that are
# executed by the dispatcher system) can access these paths, hence
# simply define the key/value pairs that are required.
datapath = {
    "ecmwf": "/path/to/data/mss/grid/ecmwf/netcdf",
    "emac": "/path/to/data/mss/grid/emac/netcdf",
    "meteosat": "/path/to/data/mss/grid/meteosat/netcdf",
    "camsglobal": "/path/to/data/mss/grid/camsglobal/netcdf",
}

# Objects that let the user query the filename in which a particular
# variable can be found. Objects are instances of subclasses of
↳NWPDataAccess,
↳NWPDataAccess,
# which provides the methods fc_filename() and full_fc_path().
nwpaccess = {
    "ecmwf_NH_LL05": mslib.mswms.dataaccess.ECMWFDataAccess(datapath["ecmwf
↳"], "NH_LL05")
    # "ecmwf_EUR_LL015": mslib.mswms.dataaccess.ECMWFDataAccess(datapath[
↳"ecmwf"], "EUR_LL015"),
    # "meteosat_EUR_LL05": mslib.mswms.dataaccess.
↳MeteosatDataAccess(datapath["meteosat"], "EUR_LL05"),
    # "emac_GLOBAL_LL1125": mslib.mswms.dataaccess.
↳EMACDataAccess(datapath["emac"])

    # The MSS-Chem project provides an easy way to download and
↳prepare
↳prepare
# forecasts from a range of different CTMs.
# The MSSChemDataAccess class is meant to provide access to
# the chemistry forecasts prepared by MSS-Chem. Therefore, it has

```

```

#         to be more general than the other DataAccess classes.
#         Its constructor takes four arguments:
#
#         1. The path to the data files. This directory has to contain
↳one
#         folder for each init_time, which is called "%Y-%m-%d_%H"
#         2. The model name, to be displayed in plot titles
#         3. The string with which the filenames start
#         4. The vertical layer type of the model; one of
#         - "pl" (pressure level)
#         - "ml" (model level)
#         - "tl" (potential temperature level)
#         - "al" (altitude level) -> CAUTION <- Only use if absolutely
↳necessary, for models without any pressure
#         information. For vertical sections, air_pressure will be
↳determined on-the-fly, from the layer
#         altitude alone, which is not very accurate
#         "CAMsglb": mslib.mswms.dataaccess.MSSChemDataAccess(datapath[
↳"camsglobal"], "CAMsglobal", "cams-global", "ml"),
}

nwpaccess[nwpaccess.keys()[0]].serviceCache()

#
# HTTP Authentication                                     ###
#
# If you require basic HTTP authentication, set the following variable
# to True. Add usernames in the list "allowed:users". Note that the
# passwords are not specified in plain text but by their md5 digest.
enable_basic_http_authentication = False

#
# Basemap cache                                           ###
#
# Plotting coastlines on horizontal cross-sections requires usually the
↳parsing
# of the corresponding databases for each plot.
# A simple caching feature allows to reuse this data from previous plots
↳using
# the same bounding box and projection parameters, dramatically speeding up
# the plotting. 'basemap_cache_size' determines hows many sets of coastlines
↳shall
# be stored in memory and 'basemap_request_size' determines the length of
↳history
# used to determine, which data shall be purged first if the cache exceeds
↳its
# maximum size.
basemap_use_cache = False
basemap_request_size = 200
basemap_cache_size = 20

#
# Registration of horizontal layers.                       ###
#

```

```

# The following list contains tuples of the format (instance of
# visualisation classes, data set). The visualisation classes are
# defined in mpl_hsec.py and mpl_hsec_styles.py. Add only instances of
# visualisation products for which data files are available. The data
# sets must be defined in mss_config.py. The WMS will only offer
# products registered here.

register_horizontal_layers = [
    # ECMWF standard surface level products.
    (mpl_hsec_styles.MPLBasemapHorizontalSectionStyle, ["ecmwf_NH_LL05"]),
    (mpl_hsec_styles.HS_CloudsStyle_01, ["ecmwf_EUR_LL015", "ecmwf_NH_LL05
↵"]),
    (mpl_hsec_styles.HS_MSLPStyle_01, ["ecmwf_EUR_LL015", "ecmwf_NH_LL05"]),
    (mpl_hsec_styles.HS_SEAStyle_01, ["ecmwf_NH_LL05"]),
    (mpl_hsec_styles.HS_SeaIceStyle_01, ["ecmwf_NH_LL05"]),
    (mpl_hsec_styles.HS_VIProbWCB_Style_01, ["ecmwf_EUR_LL015"]),

    # ECMWF standard pressure level products.
    (mpl_hsec_styles.HS_TemperatureStyle_PL_01, ["ecmwf_EUR_LL015"]),
    (mpl_hsec_styles.HS_GeopotentialWindStyle_PL, ["ecmwf_EUR_LL015"]),
    (mpl_hsec_styles.HS_RelativeHumidityStyle_PL_01, ["ecmwf_EUR_LL015"]),
    (mpl_hsec_styles.HS_EQPTStyle_PL_01, ["ecmwf_EUR_LL015"]),
    (mpl_hsec_styles.HS_WStyle_PL_01, ["ecmwf_EUR_LL015"]),
    (mpl_hsec_styles.HS_DivStyle_PL_01, ["ecmwf_EUR_LL015"]),

    # ECMWF standard model level products.
    (mpl_hsec_styles.HS_TemperatureStyle_ML_01, ["ecmwf_EUR_LL015"]),

    # ECMWF standard potential vorticity products.
    (mpl_hsec_styles.HS_PVTropoStyle_PV_01, ["ecmwf_EUR_LL015"]),

    # EMAC layers.
    # (mpl_hsec_styles.HS_EMAC_TracerStyle_ML_01, ["emac_GLOBAL_LL1125"]),
    # (mpl_hsec_styles.HS_EMAC_TracerStyle_SFC_01, ["emac_GLOBAL_LL1125"]),

    # Meteosat products.
    (mpl_hsec_styles.HS_Meteosat_BT108_01, ["meteosat_EUR_LL05"]),

    # MSS-Chem chemistry forecasts
    # (mpl_hsec_styles.HS_MSSChemStyle_ML_NO2_mfrac, ["CAMSGlb"]),
]

#
# Registration of vertical layers.          ###
#

# The same as above, but for vertical cross-sections.

register_vertical_layers = [
    # ECMWF standard vertical section styles.
    (mpl_vsec_styles.VS_CloudsStyle_01, ["ecmwf_EUR_LL015"]),
    (mpl_vsec_styles.VS_HorizontalVelocityStyle_01, ["ecmwf_EUR_LL015"]),
    (mpl_vsec_styles.VS_PotentialVorticityStyle_01, ["ecmwf_EUR_LL015"]),
    (mpl_vsec_styles.VS_ProbabilityOfWCBStyle_01, ["ecmwf_EUR_LL015"]),
    (mpl_vsec_styles.VS_VerticalVelocityStyle_01, ["ecmwf_EUR_LL015"]),
    (mpl_vsec_styles.VS_RelativeHumdidityStyle_01, ["ecmwf_EUR_LL015"]),
    (mpl_vsec_styles.VS_SpecificHumdidityStyle_01, ["ecmwf_EUR_LL015"]),

```



```

(mpl_vsec_styles.VS_TemperatureStyle_01, ["ecmwf_EUR_LL015"]),

# EMAC layers.
# (mpl_vsec_styles.VS_EMACEyja_Style_01, ["emac_GLOBAL_LL1125"]),

# MSS-Chem chemistry forecasts
# (mpl_vsec_styles.VS_MSSChemStyle_ML_NO2_mfrac, ["CAMSGlb"]),
]

#
# Server settings.                                     ###
#
# Here you can define to which IP addresses and ports the PASTE HTTP
# server should bind on different machines. The WSGI program obtains
# the hostname of the machine it is running on. For each hostname (key
# in the following dictionary) you can specify its IP-address, port,
# and alias. The alias will be used as the GetMap-URL in the
# capabilities document. Note that this alias setting will be
# overridden if the WMS is started with the "--ssh" option (see
# docstring of mss_wms_wsgi.py).
paste_ip_bind = {
    "server-name": {"host": "insert-ip-number", "port": "8081", "alias":
↳"mss.server.de"}
}

paste_use_threadpool = False

# xml_template directory is a sub directory of mswms

base_dir = os.path.abspath(os.path.dirname(mslib.mswms.__file__))
xml_template_location = os.path.join(base_dir, "xml_templates")

# get_capabilities.pt
service_name = "OGC:WMS"
service_title = "Mission Support System Web Map Service"
service_abstract = "Your Abstract"
service_contact_person = "Your Name"
service_contact_organisation = "Your Organization"
service_contact_position = "Your Position"
service_address_type = "postal"
service_address = "street"
service_city = "Your City"
service_state_or_province = ""
service_post_code = "12345"
service_country = "Germany"
service_email = "mail@example.com"
service_fees = "none"
service_access_constraints = "This service is intended for research purposes,
↳only."

#
# EPSG Code Definitions for Matplotlib basemap                                     ###
#
# In this section you can define how EPSG codes are interpreted in

```

```
# terms of Matplotlib basemap parameters. If you require a new EPSG
# code, define it here.

# Table to translate EPSG codes to Matplotlib basemap projection parameters.
# Extend this table to add further EPSG codes.
# Also see: http://external.opengeospatial.org/twiki\_public/bin/view/
#           MetOceanDWG/MetCoordinateReferenceSystemDefinition
epsg_to_mpl_basemap_table = {
    # EPSG:4326, the standard cylindrical lat/lon projection.
    4326: {"projection": "cyl"},

    # Non-standard EPSG codes, specifically defined for MSS purposes.
    # EPSG:77711LLL, north polar stereographic projections with lat_0=11 and
    # lon_0=LLL.
    77790000: {"projection": "stere", "lat_0": 90., "lon_0": 0.},
    77790010: {"projection": "stere", "lat_0": 90., "lon_0": 10.},
    77790015: {"projection": "stere", "lat_0": 90., "lon_0": 15.},
    77790340: {"projection": "stere", "lat_0": 90., "lon_0": -20.},
    77790105: {"projection": "stere", "lat_0": 90., "lon_0": -105.},

    77890000: {"projection": "spstere", "lat_0": 90., "lon_0": 0.},
    77890010: {"projection": "spstere", "lat_0": 90., "lon_0": 10.},
    77890015: {"projection": "spstere", "lat_0": 90., "lon_0": 15.},
    77890340: {"projection": "spstere", "lat_0": 90., "lon_0": -20.},
    77890105: {"projection": "spstere", "lat_0": 90., "lon_0": -105.},

    # Feel free to add other projections, e.g. a south polar projection
    # EPSG:77811LLL.
}
```

You have to adopt this file to your data.

## Standalone server setup

For the standalone server *msswms* you need the path of your *mss\_wms\_settings.py* added to the PYTHONPATH. E.g.:

```
export PYTHONPATH=/home/mss/config
```

## demodata - simulated data

We provide demodata by executing the demodata program. This creates in your home directory data files and also the needed server configuration file. The program creates 70MB of examples. This script does not overwrite an existing *mss\_wms\_settings.py*

```
mss
- mss_wms_auth.py
- mss_wms_settings.py
- testdata
  - 20121017_12_ecmwf_forecast.ALTITUDE_LEVELS.EUR_LL015.036.ml.nc
  - 20121017_12_ecmwf_forecast.CC.EUR_LL015.036.ml.nc
  - 20121017_12_ecmwf_forecast.CIWC.EUR_LL015.036.ml.nc
  - 20121017_12_ecmwf_forecast.CLWC.EUR_LL015.036.ml.nc
  - 20121017_12_ecmwf_forecast.EMAC.EUR_LL015.036.ml.nc
  - 20121017_12_ecmwf_forecast.P_derived.EUR_LL015.036.ml.nc
  - 20121017_12_ecmwf_forecast.PRESSURE_LEVELS.EUR_LL015.036.pl.nc
```

```

- 20121017_12_ecmwf_forecast.ProbWCB_LAGRANTO_derived.EUR_LL015.036.ml.nc
- 20121017_12_ecmwf_forecast.ProbWCB_LAGRANTO_derived.EUR_LL015.036.sfc.nc
- 20121017_12_ecmwf_forecast.PV_derived.EUR_LL015.036.ml.nc
- 20121017_12_ecmwf_forecast.PVU.EUR_LL015.036.pv.nc
- 20121017_12_ecmwf_forecast.Q.EUR_LL015.036.ml.nc
- 20121017_12_ecmwf_forecast.SEA.EUR_LL015.036.sfc.nc
- 20121017_12_ecmwf_forecast.SFC.EUR_LL015.036.sfc.nc
- 20121017_12_ecmwf_forecast.T.EUR_LL015.036.ml.nc
- 20121017_12_ecmwf_forecast.THETA_LEVELS.EUR_LL015.036.tl.nc
- 20121017_12_ecmwf_forecast.U.EUR_LL015.036.ml.nc
- 20121017_12_ecmwf_forecast.V.EUR_LL015.036.ml.nc
- 20121017_12_ecmwf_forecast.W.EUR_LL015.036.ml.nc

```

Before starting the standalone server you should add the path where the server config is to your python path. e.g.

```
$ export PYTHONPATH=~/.mss
```

Detailed server configuration `mss_wms_settings.py` for this demodata

```

# -*- coding: utf-8 -*-
"""

mss_wms_settings
~~~~~

Configuration module for programs accessing data on the MSS server.

This file is part of mss.

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distributed under the License is distributed on an "AS IS" BASIS,
WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
See the License for the specific language governing permissions and
limitations under the License.
"""

import os
import sys

# Configuration of Python's code search path
# If you already have set up the PYTHONPATH environment variable for the
# stuff you see below, you don't need to do a1) and a2).

# a1) Path of the directory where the mss code package is located.
# sys.path.insert(0, '/home/mss/miniconda2/lib/python2.7/site-packages')

```

```

# a2) Path of the directory where mss_wms_settings.py is located
#MSSCONFIGPATH = os.path.abspath(os.path.normpath(os.path.dirname(sys.
↳argv[0])))
#sys.path.insert(0, MSSCONFIGPATH)
#os.chdir(MSSCONFIGPATH)

import mslib.mswms.dataaccess
from mslib.mswms import mpl_hsec_styles
from mslib.mswms import mpl_vsec_styles
import mslib.mswms

# Configuration for mss_wms_settings accessing data on the MSS server.
# This is the data organisation structure of demodata.

#service_name = "OGC:WMS"
#service_title = "Mission Support System Web Map Service"
#service_abstract = "Your Abstract"
#service_contact_person = "Your Name"
#service_contact_organisation = "Your Organization"
#service_address_type = "postal"
#service_address = "street"
#service_city = "Your City"
#service_state_or_province = ""
#service_post_code = "12345"
#service_country = "Germany"
#service_fees = "none"
#service_access_constraints = "This service is intended for research_
↳purposes only."

#
# HTTP Authentication
#
# If you require basic HTTP authentication, set the following variable
# to True. Add usernames in the list "allowed:users". Note that the
# passwords are not specified in plain text but by their md5 digest.
#enable_basic_http_authentication = False

#xml_template directory is a sub directory of mswms
#base_dir = os.path.abspath(os.path.dirname(mslib.mswms.__file__))
#xml_template_location = os.path.join(base_dir, "xml_templates")

_vt_cache = r"/home/icg105/mss/vt_cache"
mslib.mswms.dataaccess.valid_time_cache = _vt_cache

_datapath = r"/home/icg105/mss/testdata"

nwpaccess = {
    "ecmwf_EUR_LL015": mslib.mswms.dataaccess.ECMWFDataAccess(_datapath,
↳"EUR_LL015"),
}

epsg_to_mpl_basemap_table = {
    # EPSG:4326, the standard cylindrical lat/lon projection.

```

```

    4326: {"projection": "cyl"}
}

basemap_use_cache = True

#
# Registration of horizontal layers.
#

# The following list contains tuples of the format (instance of
# visualisation classes, data set). The visualisation classes are
# defined in mpl_hsec.py and mpl_hsec_styles.py. Add only instances of
# visualisation products for which data files are available. The data
# sets must be defined in mss_config.py. The WMS will only offer
# products registered here.
register_horizontal_layers = None
if mpl_hsec_styles is not None:
    register_horizontal_layers = [
        # ECMWF standard pressure level products.
        (mpl_hsec_styles.HS_TemperatureStyle_PL_01, ["ecmwf_EUR_LL015"]),
        (mpl_hsec_styles.HS_GeopotentialWindStyle_PL, ["ecmwf_EUR_LL015"]),
        (mpl_hsec_styles.HS_RelativeHumidityStyle_PL_01, ["ecmwf_EUR_LL015
↪"]),
        (mpl_hsec_styles.HS_EQPTStyle_PL_01, ["ecmwf_EUR_LL015"]),
        (mpl_hsec_styles.HS_WStyle_PL_01, ["ecmwf_EUR_LL015"]),
        (mpl_hsec_styles.HS_DivStyle_PL_01, ["ecmwf_EUR_LL015"]),
    ]

#
# Registration of vertical layers.
#

# The same as above, but for vertical cross-sections.
register_vertical_layers = None
if mpl_vsec_styles is not None:
    register_vertical_layers = [
        # ECMWF standard vertical section styles.
        (mpl_vsec_styles.VS_CloudsStyle_01, ["ecmwf_EUR_LL015"]),
        (mpl_vsec_styles.VS_HorizontalVelocityStyle_01, ["ecmwf_EUR_LL015"]),
        (mpl_vsec_styles.VS_VerticalVelocityStyle_01, ["ecmwf_EUR_LL015"]),
        (mpl_vsec_styles.VS_RelativeHumidityStyle_01, ["ecmwf_EUR_LL015"]),
        (mpl_vsec_styles.VS_SpecificHumidityStyle_01, ["ecmwf_EUR_LL015"]),
        (mpl_vsec_styles.VS_TemperatureStyle_01, ["ecmwf_EUR_LL015"])
    ]

```

For setting authentication see `mss_wms_auth.py`

```

# -*- coding: utf-8 -*-
"""

mss_wms_auth
~~~~~

Configuration module for authentication to the MSS server.

This file is part of mss.

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```

```
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WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
See the License for the specific language governing permissions and
limitations under the License.
"""

#
# HTTP Authentication          ###
#
#
# Use the following code to create a new md5 digest of a password (e.g. in
# ipython):
#     import hashlib; hashlib.md5("my_new_password").hexdigest()
allowed_users = [("mswms", "add_md5_digest_of_PASSWORD_here"),
                 ("add_new_user_here", "add_md5_digest_of_PASSWORD_here")]
```

## Apache server setup

### One Instance

Our examples are based on the following directories located in the home directory of the mss user:

```
.
- config
|   - mss_wms_settings.py
|   - mss_wms_auth.py
- log
|   - mss_error.log
- miniconda2
|   - bin
|   - conda-bld
|   - conda-meta
|   - envs
|   - etc
|   - include
|   - lib
|   - LICENSE.txt
|   - pkgs
|   - share
|   - ssl
|   - var
- wsgi
  - auth.wsgi
  - wms.wsgi
```

Create that mss user first.

### Configuration of apache mod\_wsgi.conf

One possibility to setup the PYTHONPATH environment variable is by adding it to your mod\_wsgi.conf. Alternatively you could add it also to mss\_wms\_settings.py.

```
WSGIPythonPath /home/mss/config:/home/mss/miniconda2/lib/python2.7/site-packages
```

By this setting you override the PYTHONPATH environment variable. So you have also to add the site-packages directory of your miniconda or anaconda installation besides the config file path.

If your server hosts different instances by different users you want to setup this path in mss\_wms\_setting.py.

### Configuration of wsgi for wms

You can setup a vhost for this service.

**/home/mss/wsgi/wms.wsgi**

```
import logging
from mslib.mswms.wms import application
```

### Configuration of wsgi auth

As long as you have only one instance of the server running you can use this method to restrict access.

To restrict access to your data use this script.

**/home/mss/wsgi/auth.wsgi**

```
import sys
sys.path.extend(['/home/mss/config'])

import mss_wms_auth
import hashlib

def check_password(environ, username, password):
    for u, p in mss_wms_auth.allowed_users:
        if (u == username) and (p == hashlib.md5(password).hexdigest()):
            return True
    return False
```

This needs also a configuration **/home/mss/config/mss\_wms\_auth.py** script.

```
# -*- coding: utf-8 -*-
"""

    mss_wms_auth
    ~~~~~

    Configuration module for authentication to the MSS server.

    This file is part of mss.
```

```
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WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
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limitations under the License.
"""

#
# HTTP Authentication                               ###
#
#
# Use the following code to create a new md5 digest of a password (e.g. in
# ipython):
#     import hashlib; hashlib.md5("my_new_password").hexdigest()
allowed_users = [("mswms", "add_md5_digest_of_PASSWORD_here"),
                 ("add_new_user_here", "add_md5_digest_of_PASSWORD_here")]
```

At the moment you have many different instances with different users or different versions of mss you have to use basic auth of your webserver configuration.

### Configuration of your site as vhost

You have to setup a webserver server site configuration file

**/etc/apache2/sites-available/mss.yourserver.de.conf**

```
<VirtualHost *:80>
    ServerName mss.yourserver.de
    #ServerAlias localwms
    LogLevel debug
    ServerAdmin webmaster@yourserver.de
    ErrorLog /home/mss/log/mss_error.log
    TransferLog /var/log/apache2/mss_access.log
    CustomLog /var/log/apache2/mss_custom.log combined

    #all wsgi scripts are in /home/mss/wsgi
    <Directory /home/mss/wsgi>
        AuthType Basic
        AuthName "mss"
        AuthBasicProvider wsgi
        WSGIAuthUserScript /home/mss/wsgi/auth.wsgi
        AuthDigestDomain / http://mss.yourserver.de/
        Require valid-user
```



```

</Directory>

#alternative without authentication
#<Directory /home/mss/wsgi>
#   Require all granted
#</Directory>

WSGIScriptAlias / /home/mss/wsgi/wms.wsgi
WSGIDaemonProcess MSS python-home=/home/mss/miniconda2/bin user=mss_
↪group=mss home=/home/mss/config processes=2 threads=1 deadlock-timeout=25_
↪display-name=MSS
# WSGI Options
# python-home: path where your environment python bin is located
# home: where your config scripts are located
# Please see the documentation here : http://code.google.com/p/modwsgi/wiki/ConfigurationDirectives
↪wiki/ConfigurationDirectives
WSGIProcessGroup MSS

# Python Simplified GIL State API ( ISSUE )
# http://code.google.com/p/modwsgi/wiki/ApplicationIssues
WSGIApplicationGroup %{GLOBAL}

DocumentRoot /home/mss/htdocs

# don't loose time with IP address lookups
HostnameLookups Off

# needed for named virtual hosts
UseCanonicalName Off

# configures the footer on server-generated documents
ServerSignature On

</VirtualHost>

```

Enable it with a2ensite mss.yourserver.de.conf

## Many Instances

If you want to setup many instances we suggest to use a similiar proxy based configuration

```

<VirtualHost *:80>

ProxyRequests Off
ProxyPreserveHost On
RewriteEngine On
RequestHeader add X-SSL off
RewriteRule ^/demo/(.*) http://127.0.0.1/demo/$1 [P,L]

ServerName proxy_demo.yourserver.de
DocumentRoot /var/www/html
ProxyPreserveHost On
ProxyPass /demo http://127.0.0.1/demo

```

```
</VirtualHost>
```

and if you need authentication then use a Location based AuthType Basic

```
<VirtualHost 127.0.0.1:80>
  <Location /demo>
    AuthType Basic
    AuthName "mss"
    AuthDigestDomain /
    AuthUserFile /home/mss/DEMO/config/apache_users
    <Limit GET>
      Require valid-user
    </Limit>
  </Location>
  ServerName proxy_demo.yourserver.de
  RemoteIPHeader X-Forwarded-For
  RemoteIPInternalProxy 127.0.0.0/8
  LogLevel debug
  ServerAdmin admin@email

  # WSGI Options
  # home: Initial working directory of the script, make sure you change it.
  # python-path : Directories to search for Modules, make sure you change
↳ it as well.
  # Please see the documentation here : http://code.google.com/p/modwsgi/
↳ wiki/ConfigurationDirectives
  WSGIScriptAlias /demo /home/mss/DEMO/wsgi/wms.wsgi

  WSGIDaemonProcess MSS python-home="/home/mss/miniconda2/envs/demo/bin"
↳ home="/home/mss/DEMO/config" user=mss group=mss processes=2 threads=1
↳ deadlock-timeout=25 display-name=MSS

  WSGIProcessGroup MSS

  # Python Simplified GIL State API ( ISSUE )
  # http://code.google.com/p/modwsgi/wiki/ApplicationIssues
  WSGIApplicationGroup %{GLOBAL}

  # don't loose time with IP address lookups
  HostnameLookups Off

  # needed for named virtual hosts
  UseCanonicalName Off

  # configures the footer on server-generated documents
  ServerSignature On

</VirtualHost>
```

For further informations on apache2 server setup read <https://httpd.apache.org/docs/2.4/howto/>

## Development

This chapter will get you started with MSS development.

MSS is written in Python.

### Style guide

We generally follow pep8, with 120 columns instead of 79.

### Output and Logging

When writing logger calls, always use correct log level (debug only for debugging, info for informative messages, warning for warnings, error for errors, critical for critical errors/states).

### Building a development environment

If you want to contribute make a fork on bitbucket of [mss](#). For building you have to use the conda recipe locally and install in a new environment.

Some of used packages are in the conda-forge channel located, so we have to add this channel to the default:

```
$ conda config --add channels conda-forge
```

Or add the channel by an editor to the `.condarc` config file:

```
$ more ~/.condarc
channels:
- defaults
- conda-forge
```

On top level dir:

```
$ git clone https://bitbucket.org/yourfork/mss.git
$ cd mss
$ conda create -n mssdev python=2
$ source activate mssdev
$ conda build .
$ conda install --use-local mss
$ mkdir "$HOME/.config/mss"
$ # cp mss_settings.json.sample to "$HOME/.config/mss/mss_settings.json"
```

To install some additional packages needed for running the tests, activate your virtual env and run:

```
$ conda install --file requirements.d/development.txt
```

### Running tests

We have implemented demodata as data base for testing. On first call of `py.test` a set of demodata becomes stored in a `/tmp/mss*` folder. If you have installed `gitpython` a postfix of the revision head is added.

```
$ python -m pytest
```

Use the `-v` option to get a verbose result. By the `-k` option you could select one test to execute only.

A pep8 only test is done by `py.test --pep8 -m pep8`

Instead of running a library module as a script by the `-m` option you may also use the `py.test` command.

```
$ py.test --cov
```

This plugin produces a coverage report.

Profiling can be done by e.g.:

```
$ python -m cProfile -s time ./demodata.py > profile.txt
```

### Setup `mss_settings.json`

On default all tests use default configuration defined in `msslib.msui.MissionSupportSystemDefaultConfig`. If you want to overwrite this setup and try out a special configuration add an `mss_settings.json` file to the testings base dir in your `tmp` directory.

## Building the docs with Sphinx

The documentation (in reStructuredText format, `.rst`) is in `docs/`.

To build the html version of it, you need to have sphinx installed:

```
cd docs/  
make html
```

Then point a web browser at `docs/_build/html/index.html`.

## Merging stable into develop

Bug fixes we have done in stable we need to merge regularly into develop too:

```
git checkout stable  
git pull  
git checkout develop  
git pull  
git merge stable
```

## Creating a new release

- make sure all issues for this milestone are closed or moved to the next milestone
- update `CHANGES.rst`, based on `git log`
- check version number of upcoming release in `CHANGES.rst`
- verify that `version.py`, `meta.yaml`, `MANIFEST.in` and `setup.py` are complete
- merge from `develop` to `stable`

- tag the release:

```
git tag -s -m "tagged/signed release X.Y.Z" X.Y.Z
git push origin X.Y.Z
```

- create a release on anaconda conda-forge
- announce on:
- Mailing list
- Twitter (follow @ReimarBauer for these tweets)

## Contributors

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netcdf4-python (netCDF4tools.py in the mslib directory)  
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## CHAPTER 2

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### Indices and tables

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