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MSS - Software for planning research aircraft missions

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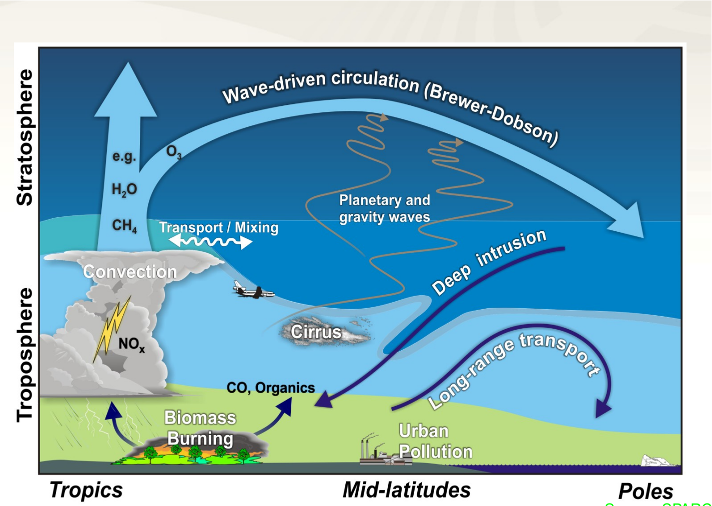
python powered

Atmospheric Research – WHAT?

Understand various individual processes and their interplay

Figure: NASA Earth Observatory

Sketch of Atmospheric Processes



Source: SPARC Report (check!)

Atmospheric Research – WHY?

Provide predictions for the atmosphere regarding

- Climate
- Global warming
- Ozone hole
- . . . and many more

Atmospheric Research – HOW?

- Measurements of chemical trace gas composition and other parameters of interest that characterize these processes
  - Laboratory
  - Balloons
  - Aircrafts
  - Satellites

- Simulations of the atmosphere (composition, particles) by a variety of models

Atmospheric Research – AIM

- Improved **understanding** of the individual processes
- **parametrize** these processes in atmospheric models, e.g. Chemistry climate models (CCMs) and Earth system models (ESMs)
- Quality improvement of models and **predictions** for ozone hole, climate,. . .

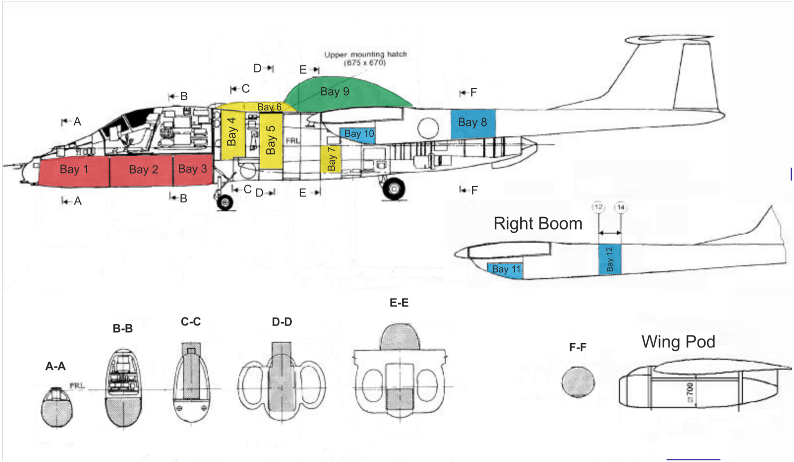
Atmospheric Research – Aircraft Measurements

- **Flexibility** to measure at locations of scientific interest
- **Cheap** compared to satellite measurements
- Research flight hours are **rare** and still very expensive
- **Collaboration** with various groups and institutions that are specialized for individual measurements

Example: The Geophysica Aircraft

Top altitude: 20 km, range: 3000 km

Example: The Geophysica Aircraft



Places for payload of scientific Instruments

Example: The Geophysica Aircraft

Instrument	Parameter	P.I.	Bay
FOZAN	O_3	Ulanovsky, CAO FabrizioRavegnani, CNR	Bay 5
FISH	H_2O (total)	MartinaKraemer, JUELICH	Bay 4
FLASH	H_2O (gas phase)	AlexeyLykov, CAO	Under Wing Pylon
SIOUX	NO NO_y Particle NO_y	HansSchlager, DLR	Under Wing Pod right
HALOX t.b.d.	ClO BrO	FredStroh, JUELICH	left Wing Pod
HAGAR	N_2O, CFC12 CFC11 CH_4, H_2 SF_6 Halon 1211 CO_2	MichaelVolk, BUW	Bay 8
WAS	Long lived trace gases and isotopo-logues	ThomasRoeckmann, UTRECHT	Fuselage Bay

Many more instruments for measurements of different parameters

Example: The HALO Aircraft

Top altitude: 15 km, range: 10000 km

HALO leaving the Arena Arctica. Picture by Peter Preuße, FZJ.

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Planning of Research Flights

- Typically, scientific campaigns with more flights from a base airport address one or more scientific questions
- Model simulations provide related parameters of interest for the near future using meteorological forecast data
- Optimization of the scientific outcome by finding the best flight path (in 4 dimensions time, latitude, longitude, altitude) in the "model world"
- Consideration of various aircraft constraints (range, flight altitude, overflight permits. . .)
- Discussion and iteration of the proposed flight plans with pilots and aircraft representatives

Mission Support System (MSS)

Software to aid scientific flight planning:
Marc Rautenhaus, formerly DLR, introduced MSS in 2012. It is since May 2016 a git FOSS project on bitbucket.

- Python 2.7.x and 3.6 Client / Server application
- OGC web map service based, version 1.1.1
- conda-forge - anaconda application Anaconda Cloud 1.5.1
- License: Apache 2.0
- Docs: mss.rtfd.io

Documented in GMT

Geosci. Model Dev., 5, 55–71, 2012
www.geosci-model-dev.net/5/55/2012/
doi:10.5194/gmd-5-55-2012

Geoscientific
Model Development

A web service based tool to plan atmospheric research flights

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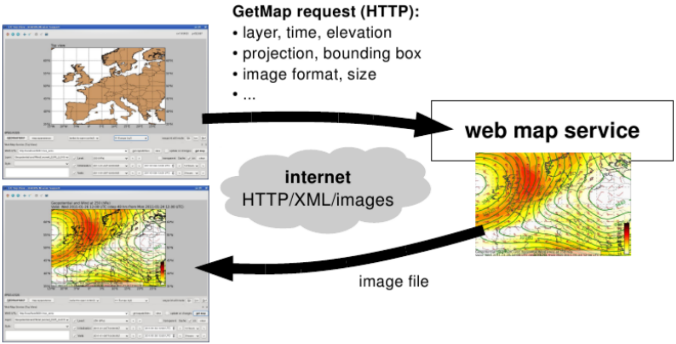
Correspondence to: M. Rautenhaus (marc.rautenhaus@dlr.de)

Received: 10 August 2011 – Published in Geosci. Model Dev. Discuss.: 1 September 2011
Revised: 13 January 2012 – Accepted: 13 January 2012 – Published: 17 January 2012

Abstract. We present a web service based tool for the planning of atmospheric research flights. The tool provides online access to horizontal maps and vertical cross-sections of numerical weather prediction data and in particular allows the interactive design of a flight route in direct relation to of atmospheric research flight planning is to explore large amounts of atmospheric prediction and observation data in order to extract specific regions of interest. Subsequently, a flight route is designed considering the scientific objectives of the campaign, the predicted atmospheric situation, and in-

Basic principle of the OGC Web Map Service standard



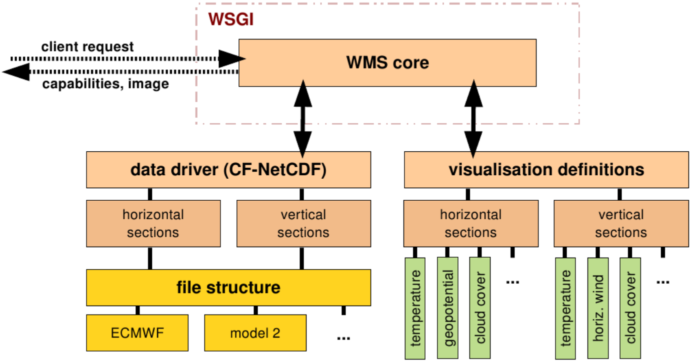
A client (left) sends a GetMap request, encoded as an HTTP URL to the server (right). The server creates an image file and sends it to the client.

Rautenhaus et al., GMD, 5, 55-71, 2012

Description MSS

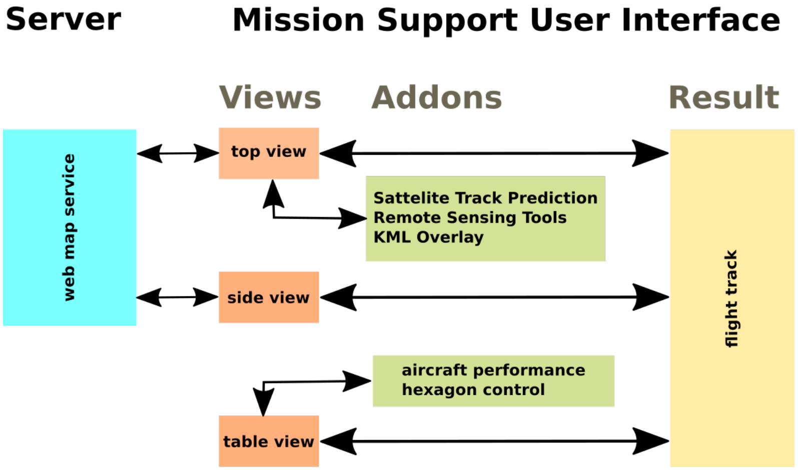
- A data center can install the MSS server component and configure it to provide data.
- Already implemented methods for ECMWF, CLaMS, GWFC, EMAC, METEOSAT data.
- The client is a QT 4/5 GUI application which can access many MSS Servers.
- The client accesses the server and requests vertical, horizontal views and receives generated images.
- Scientists interactively design a flight route in direct relation to atmospheric prediction data.
- Way points of a proposed flight route are overlayed on any view of requested data.
- All the information could be exchanged and manipulated by others.

Architecture of MSS WMS Server



Rautenhaus et al., GMD, 5, 55-71, 2012

Architecture of MSS GUI



Installing MSS and running Server and Client

$ conda config –add channels conda-forge

$ conda create -n mssenv python=2

$ source activate mssenv

$ conda install mss

$ #demodata and standalone server

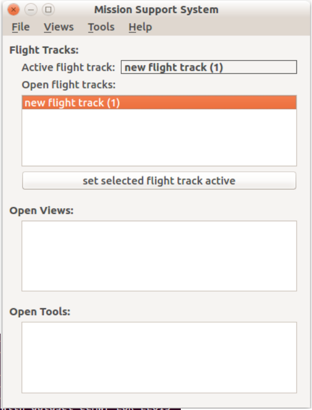
$ demodata

$ export PYTHONPATH=~/mss

$ mswms

$ #GUI

$ mss




```
2017-01-28 17:16:43 register_hsec_layer || registering horizontal section layer PLEQPT01
2017-01-28 17:16:43 register_hsec_layer || registering horizontal section layer PLW01 wi
2017-01-28 17:16:43 register_hsec_layer || registering horizontal section layer PLDiv01
2017-01-28 17:16:43 register_vsec_layer || registering vertical section layer VS_CC01 wi
2017-01-28 17:16:43 register_vsec_layer || registering vertical section layer VS_HV01 wi
2017-01-28 17:16:43 register_vsec_layer || registering vertical section layer VS_PV01 wi
2017-01-28 17:16:43 register_vsec_layer || registering vertical section layer VS_PWCB01
2017-01-28 17:16:43 register_vsec_layer || registering vertical section layer VS_W01 with dataset ecmwf_EUR_LL015
2017-01-28 17:16:43 register_vsec_layer || registering vertical section layer VS_RH01 with dataset ecmwf_EUR_LL015
2017-01-28 17:16:43 register_vsec_layer || registering vertical section layer VS_Q01 with dataset ecmwf_EUR_LL015
2017-01-28 17:16:43 register_vsec_layer || registering vertical section layer VS_T01 with dataset ecmwf_EUR_LL015
2017-01-28 17:16:43                main || Configuration File: /home/user/mss/mss_wms_settings.pyc
serving on http://127.0.0.1:8081
```

MSS User Configurations

All defaults can be changed by a json setting file.

- layout sizes of views, immutable sizes
- available map projections
- predefined waypoints
- import/export plugins
- lists of predefined web service URLs and login data
- optional proxy

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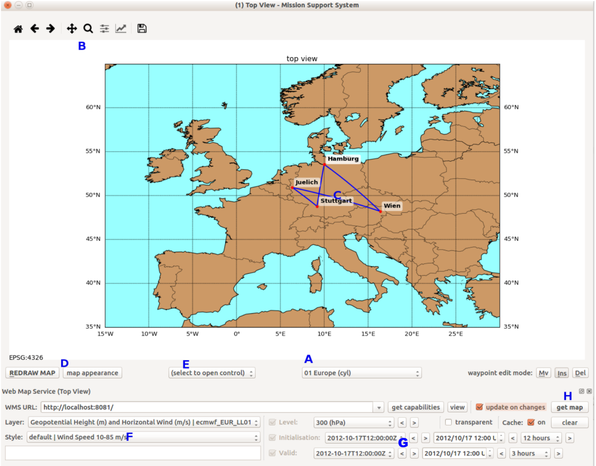
Top View



A) map projection

B) zoom/pan

C) way points

D) appearance

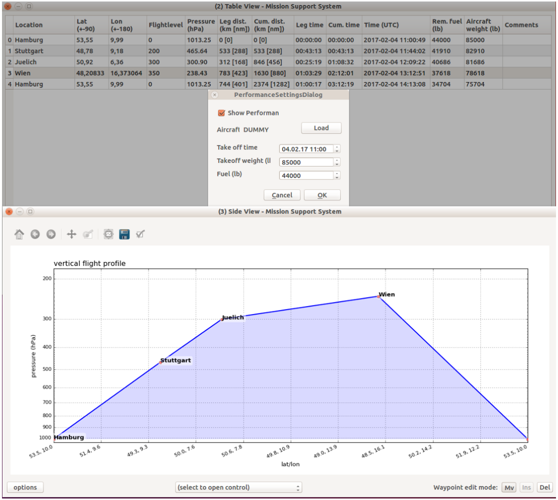
E) open controls

F) layer / styles

G) time setup

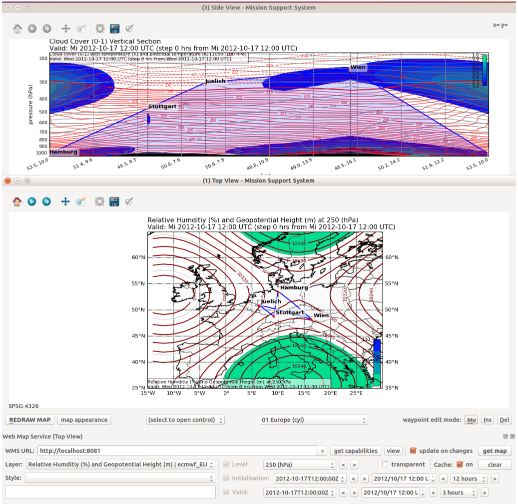
H) new request

Table View and Vertical Flight Profile


(2) Table View - Mission Support System

	Location	Lat (+-90)	Lon (+-180)	Flightlevel	Pressure (hPa)	Leg dist. (km [nm])	Cum. dist. (km [nm])	Leg time	Cum. time	Time (UTC)	Rem. fuel (lb)	Aircraft weight (lb)	Comments
0	Hamburg	53,55	9,99	0	1013.25	0 [0]	0 [0]	00:00:00	00:00:00	2017-02-04 11:00:49	44000	85000	
1	Stuttgart	48,78	9,18	200	465.64	533 [288]	533 [288]	00:43:13	00:43:13	2017-02-04 11:44:02	41910	82910	
2	Juelich	50,92	6,36	300	300.90	312 [168]	846 [456]	00:25:19	01:08:32	2017-02-04 12:09:22	40686	81686	
3	Wien	48,20833	16,373064	350	238.43	783 [423]	1630 [880]	01:03:29	02:12:01	2017-02-04 13:12:51	37618	78618	
4	Hamburg	53,55	9,99	0	1013.25	744 [401]	2374 [1282]	01:00:17	03:12:19	2017-02-04 14:13:08	34704	75704	

Reviewing Data



Features

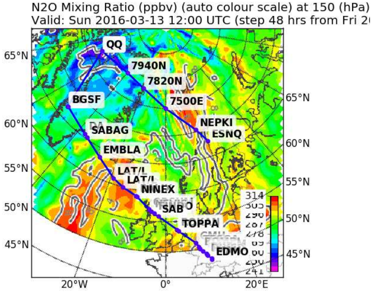
On Top View you could add different layers

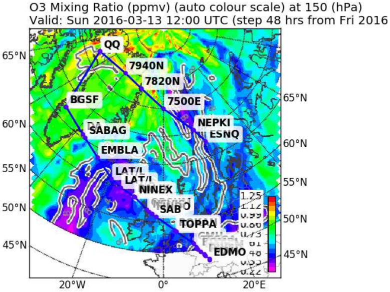
- Satellite Tracks
- Remote Sensing
- KML Overlay

On Table View we have the possibility to a add a hexagon flight pattern and to use aircraft performance data.

Example: HALO flight from Kiruna to Oberpfaffenhofen

Top view: Mixing ratios of N_2O and O_3:

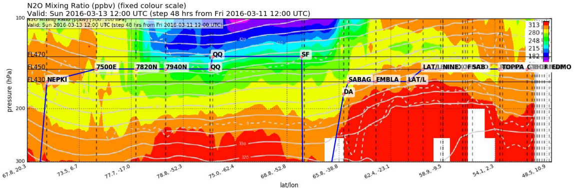


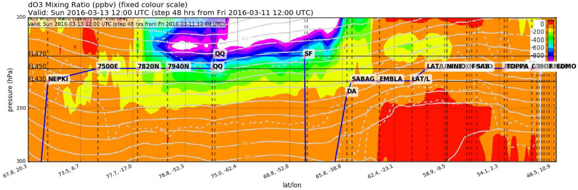


Source: POLSTRACC flight planning team

Example: HALO flight from Kiruna to Oberpfaffenhofen

Side view: Mixing ratios of N_2O and Ozone loss:





Source: POLSTRACC flight planning team

Examples of campaigns using MSS

ML-CIRRUS	2014	Oberpfaffenhofen http://www.pa.op.dlr.de/ML-CIRRUS/
POLSTRACC	2016	Kiruna https://www.polstracc.kit.edu/polstracc
STRATOCLIM	2016-17	Kalamata and Nepal http://www.stratoclim.org/
NAWDEX	2016	Iceland http://www.pa.op.dlr.de/nawdex/
EMeRGe	2017-18	EU and Asia http://www.halo.dlr.de/science/missions/emerge/
WISE	2017	Ireland https://www.blogs.uni-mainz.de/fb08-ipa/wise/

Documentation

- http://mss.rtfd.io
- https://bitbucket.org/wxmetvis/mss
- https://anaconda.org/conda-forge/mss
- 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

Ecosystem

- bitbucket, github

- pycharm
- quantified code
- py.test

- pypi, anaconda

- conda-forge community

- jenkins, travis, appveyor, circleci

- readthedocs

MSS - Mission Support System

Main Language: Python

Total Lines of Code: 19,580

Active Contributors: 8

Commit Activity

Updated Jun 28, 2017

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