An online service for analysing ozone trends within EOSC-synergy

Karlsruhe Institute of Technology IMK-ASF: **Tobias Kerzenmacher**, Peter Braesicke
SCC: Valentin Kozlov, Borja Esteban Sanchis, Ugur Cayoglu, Marcus Hardt

EOSC Synergy in a nutshell

Overview

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EOSC synergy expands the EOSC **capacity** and **capabilities** by leveraging **investments** and existing **know-how** & **resources** of national digital infrastructures.

It fosters EOSC services **integration** and promotes **quality.**

It exists of thematic services for scientific communities in **astrophysics**, **biomedicine**, **earth observation** and the **environment**

Spain, Portugal, UK, Czech Republic, Germany, Slovakia, Poland, Netherlands

The **expected impact** is a measurable **increase** in the number of **resources**, **services** and data **repositories** offered to **researchers** through EOSC.

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What is the ozone assessment?

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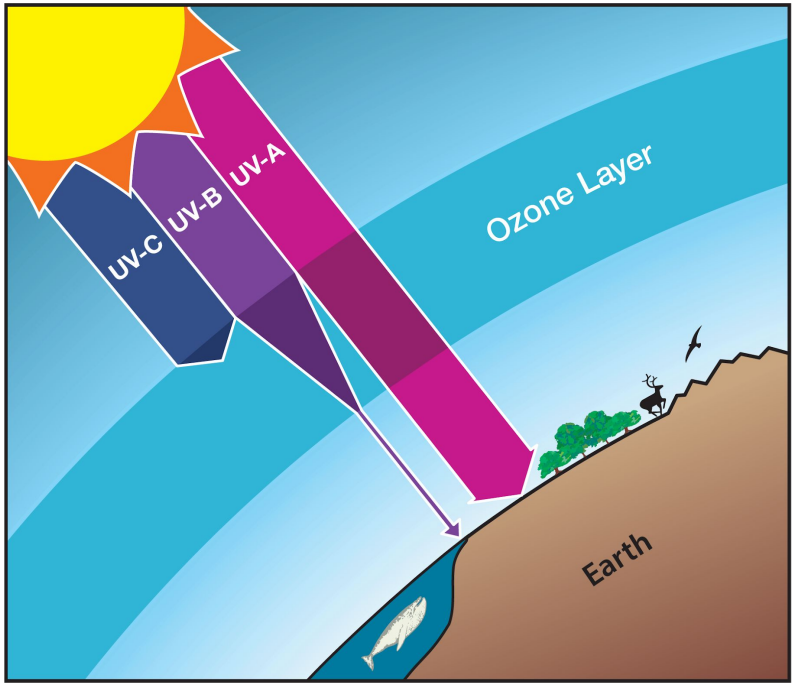
Assessment reports of ozone depletion since 1985

- Ozone assessment reports have been compiled since 1985
- The recent report from 2018 consists of 6 chapters and 5 appendices with about 25 people actively working on each chapter and a multitude working in support
- **Aim**: Provide a tool to extract ozone trends from big data and produce figures in publication quality interactively

Why ozone assessment?

UV Protection by the Stratospheric Ozone Layer

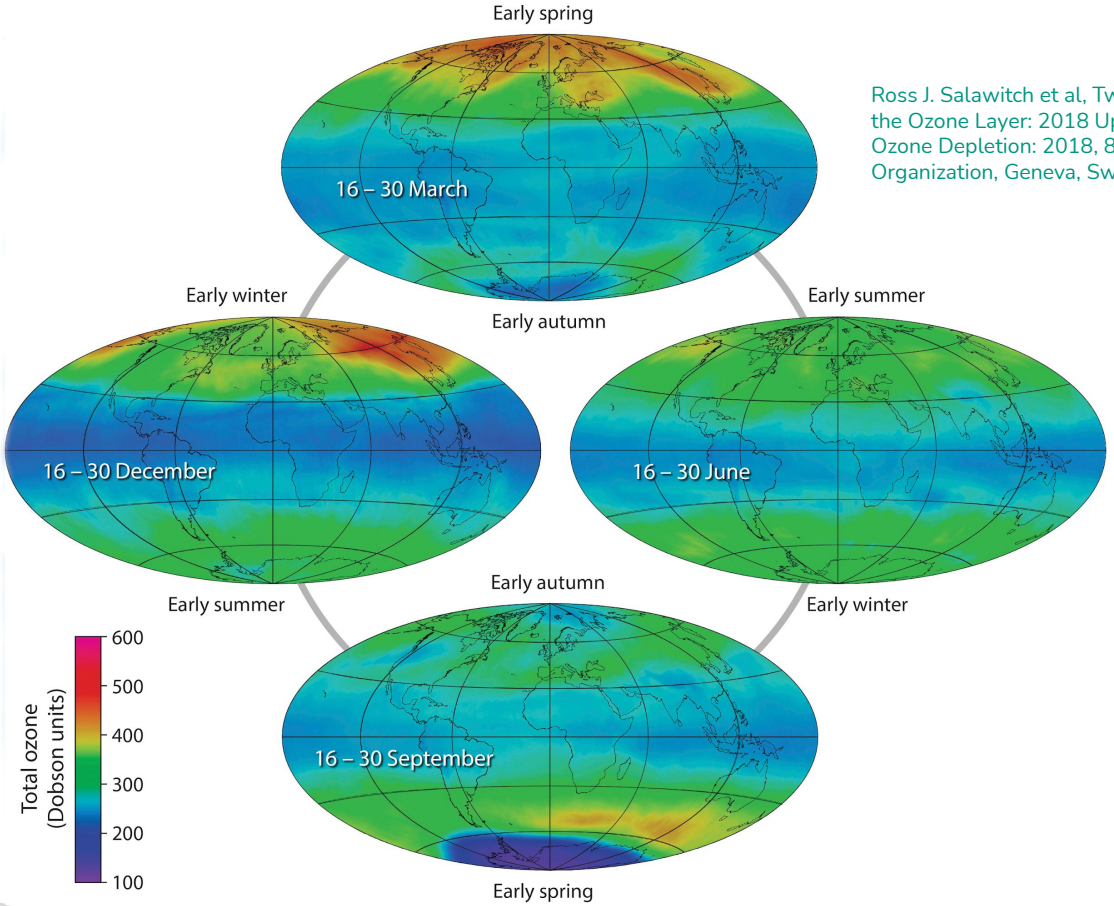


UV protection by the stratospheric ozone layer. Stratospheric ozone is concentrated in the ozone layer, a protecting layer around the entire Earth. Of the three ultraviolet (UV) radiations that the sun emits it absorbs all of the UV-C (100 to 280 nm), some of UV-B and only weakly UV-A or visible light.

Because of the depletion of the ozone layer more harmful radiation can reach the surface of the earth damaging all life forms, therefore the protection of the ozone layer i the principal objective of the ozone layer.

Ross J. Salawitch (Lead Author), David W. Fahey, Michaela I. Hegglin, Laura A. McBride, Walter R. Tribett, Sarah J. Doherty, Twenty Questions and Answers About the Ozone Layer: 2018 Update, Scientific Assessment of Ozone Depletion: 2018, 84 pp., World Meteorological Organization, Geneva, Switzerland, 2019.

Global Satellite Maps of Total Ozone in 2009



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Ross J. Salawitch et al, Twenty Questions and Answers About the Ozone Layer: 2018 Update, Scientific Assessment of Ozone Depletion: 2018, 84 pp., World Meteorological Organization, Geneva, Switzerland, 2019.

Total ozone is the the sum of all the molecules above a location on Earth. Total ozone varies by place and by time of year. On the figure you can see that there is a maximum of total ozone over the high latitudes in spring, also there is always low ozone in the tropical stratosphere. The high ozone that should appear in the low latitudes in autumn is destroyed and the ozone hole is visible. Summer and winter show a more equal distribution over the low and high latitudes. Shown are two-week averages of total ozone in 2009 as measured with a satellite instrument.

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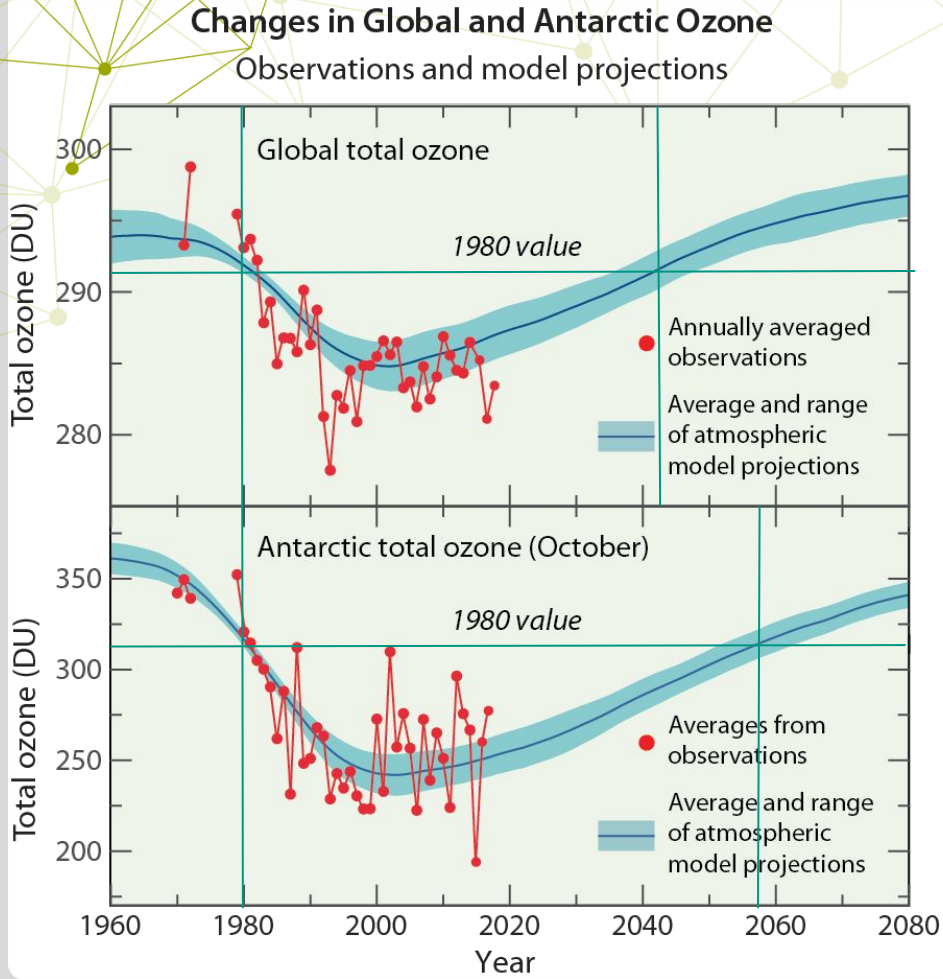
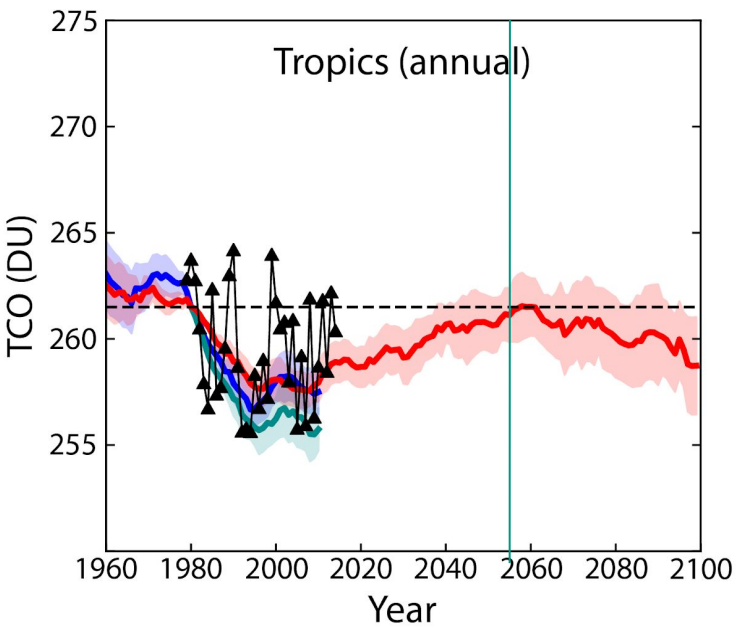
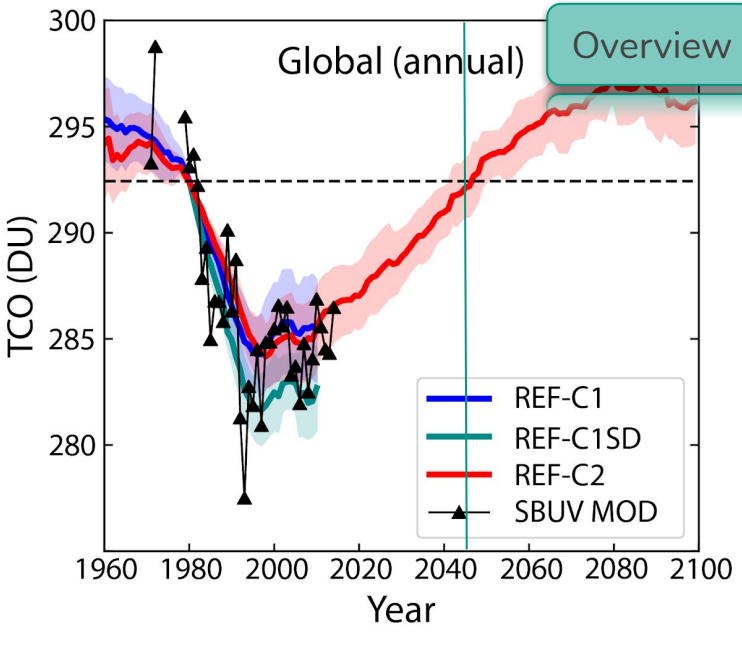


Simulations of ozone depletion. Chemistry-climate models that account for changes in ozone-depleting substances (ODSs) and greenhouse gases are widely used to assess past ozone changes. Shown are observations in red and the average and range of the atmospheric model projections. In the global total ozone you can see that the ozone that has been depleted reaches the 1980 value in about 2042 while the Antarctic total ozone October values need until about 2058 to get back to the level of 1980.

P. Braesicke, J. Neu, V. Fioletov, S. Godin-Beekmann, D. Hubert, I. Petropavlovskikh, M. Shiotani, B.-M. Sinnhuber, Update on Global Ozone: Past, Present, and Future, Chapter 3 in ***Scientific Assessment of Ozone Depletion: 2018***, Global Ozone Research and Monitoring Project — Report No. 58, World Meteorological Organization, Geneva, Switzerland, 2018.





Overview

Simulations of ozone depletion. The depletion has different ozone return rates, in the tropics you see a recovery close to the Antartic, but only momentarily. The global results are shown in more detail. Measurements are in black, the average of the projections is in read. Blue and green show model realisations based on measurements.

P. Braesicke, J. Neu, V. Fioletov, S. Godin-Beekmann, D. Hubert, I. Petropavlovskikh, M. Shiotani, B.-M. Sinnhuber, Update on Global Ozone: Past, Present, and Future, Chapter 3 in ***Scientific Assessment of Ozone Depletion: 2018***, Global Ozone Research and Monitoring Project — Report No. 58, World Meteorological Organization, Geneva, Switzerland, 2018.

Technical Description of the service

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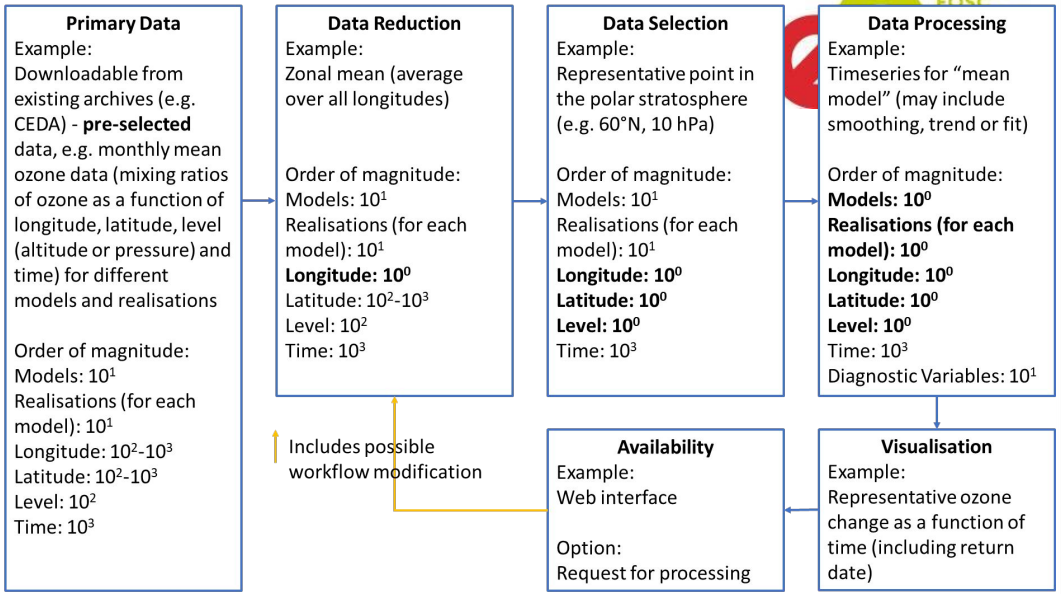
Resources

- Primary Data: Requires time to obtain (days to weeks), significant disk space (slow disk can be used), small compute res.
- Data Reduction: Requires time (hours to days), optional: from slow to fast (disk) storage, i/o driven, significant compute res.
- Data Selection: Relatively fast (on fast storage), small compute res.
- Data Processing: Relatively fast, from i/o driven to analysis driven performance timing

- Visualisation: In this example, only small resources required
- Availability: Trackable via web interface, future: new requests can be formulated

- Up-front data reduction: Smaller functionality, but generally faster turnaround



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Gaps and Bottlenecks

- Not all data has been downloaded (storage size, model data is continually updated)
- Need authentication to download data (ERA-5: www.ecmwf.int, CCMi: https://www.ceda.ac.uk), identify other sources (satellite data)
- Publications need to cite data providers
- I/O might be slow (thredds data server, mounted data e.g. sshfs, depending on hardware, e.g. optimised tiered storage would be best)

Technical Description

- BASH and python for data reduction and data analysis and graphic presentation of the data.
- Solution using docker, Jenkins, and Read the Docs under GPL.

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O3as: Ozone assessment for everyone

http://o3web.test.fedcloud.eu

(Almost all items are clickable to jump to the relevant description)

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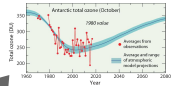
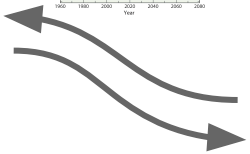
EOSC SYNERGY

Background

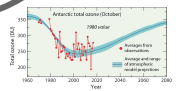
Anyone





EGI Checkin

Scientists



Datapoints, Interactive analysis

o3webapp

o3api
(REST API)

selected & processed

Ozone raw data

LSDF

reduced

raw

reduced

o3skim

HPC

Help!

O3as

- o3webapp
- o3api
- o3skim

: GPL + Jenkins CI/CD + docker + Read the Docs documentation

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o3skim

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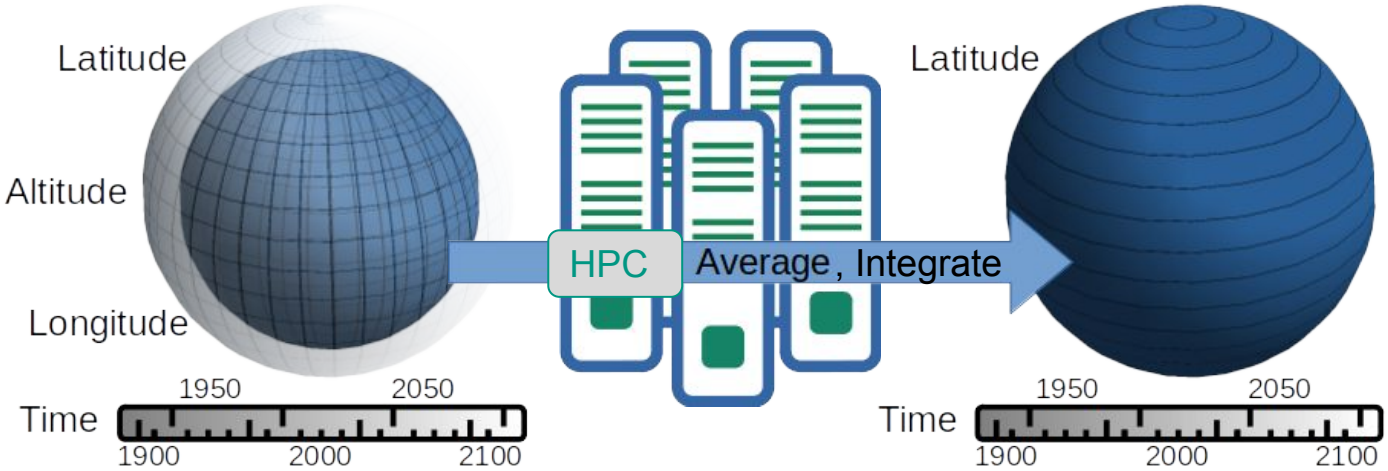
o3skim: Automatic reduction of raw data

4D problem → 2D (Latitude TCO + Time)
Reduction factor: TBytes → MBytes



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o3skim demo

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```
#
# Please, first pull the image and create container!
# udocker pull $DOCKER_IMAGE
# udocker create --name=$UCONTAINER $DOCKER_IMAGE
##########

# ----------------------
UDOCKER_DIR="$PROJECT/.udocker" # Location of udocker and containers
CONTAINER="o3skim_dev"
CONTAINER_STDOUT="o3skim.out"
CONTAINER_STDERR="o3skim.err"

# According to https://wiki.scc.kit.edu/hpc/index.php/ForHLR_-_Hardware_and_Architecture#LSDF_online_storage_2
# we can use $LSDF environment setting
LSDF_DIR="${LSDF}/kit/imk-asf/projects/O3as"

UDOCKER_OPTIONS="
--user=application \
--volume=${HOME}/sources.yaml:/app/sources.yaml \
--volume=${LSDF_DIR}:/app/data \
--volume=${LSDF_DIR}/Skimmed-tests:/app/output"

CONTAINER_OPTIONS="
--verbosity=DEBUG"

##### RUN THE JOB #####
echo "================================="
echo "=> udocker container: $CONTAINER"
echo "=> Running on: $HOSTNAME"
echo "================================="

#echo "Setting up F3 execmode"
#udocker setup --execmode=F3 $UCONTAINER  # Setup another execmode, if needed

echo "Running udocker container..."
udocker run ${UDOCKER_OPTIONS} ${CONTAINER} ${CONTAINER_OPTIONS} \
1>> ${CONTAINER_STDOUT} \
2>> ${CONTAINER_STDERR}
echo "Done with the script."
```

Overview

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o3api

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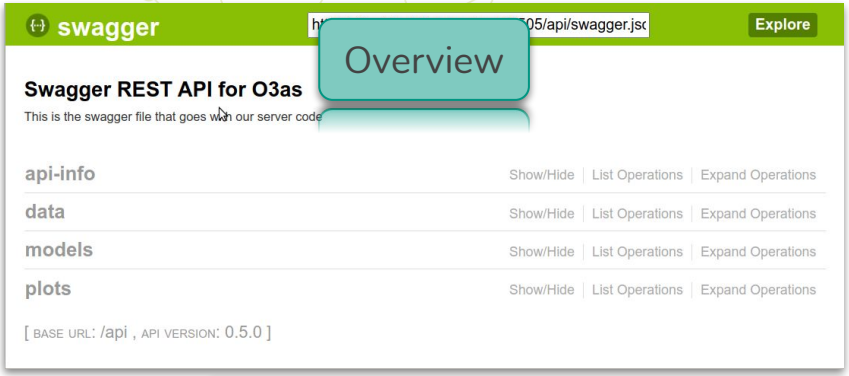
REST API: o3api

From data reduction to
data selection and plotting (pdf, json)

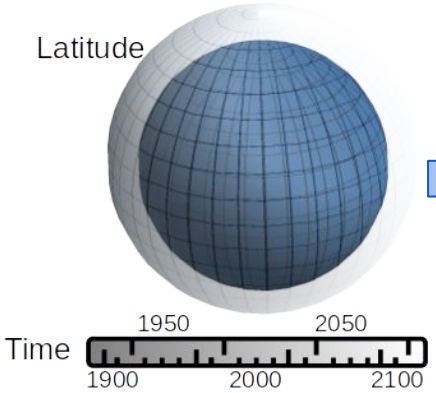


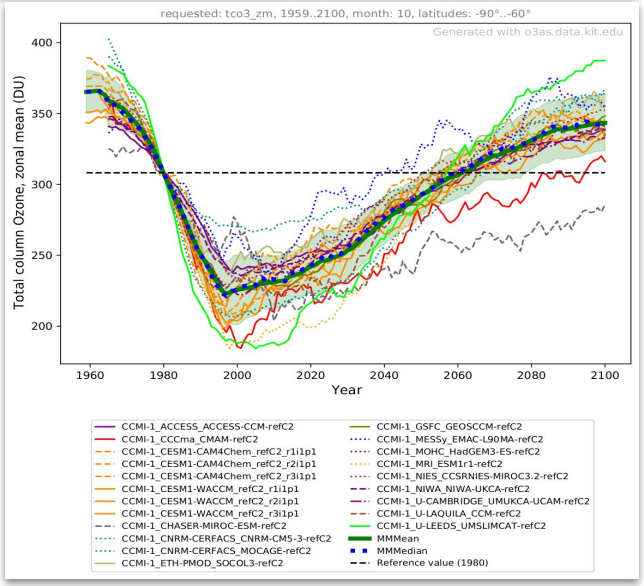
Based on:

- OpenAPI (swagger)
- Connexion
- Flask

E.g. zonal mean of total ozone input:

- Models to process
- Range of years
- Months to select
- Latitudes range





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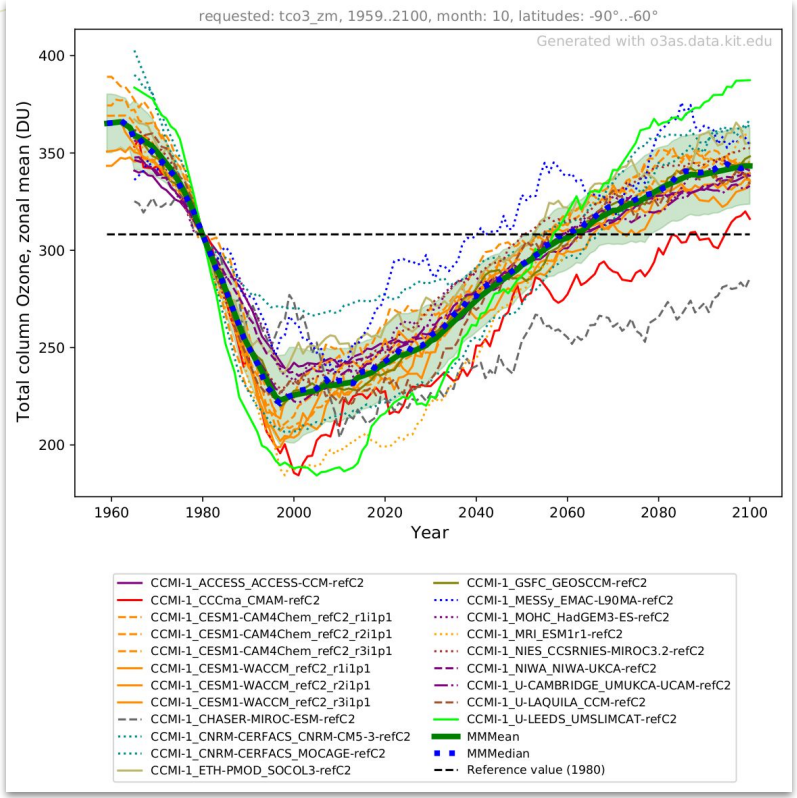
REST API: o3api, zonal mean of total ozone

Overview



In total **>100 models** to choose from

Fixed reference model:
SBUV_GSFC_merged-SAT-ozone

Fixed reference year: 1980

Multi-Model Mean (MMMean) &
Multi-Model Median (MMMedian):

calculated based on all models

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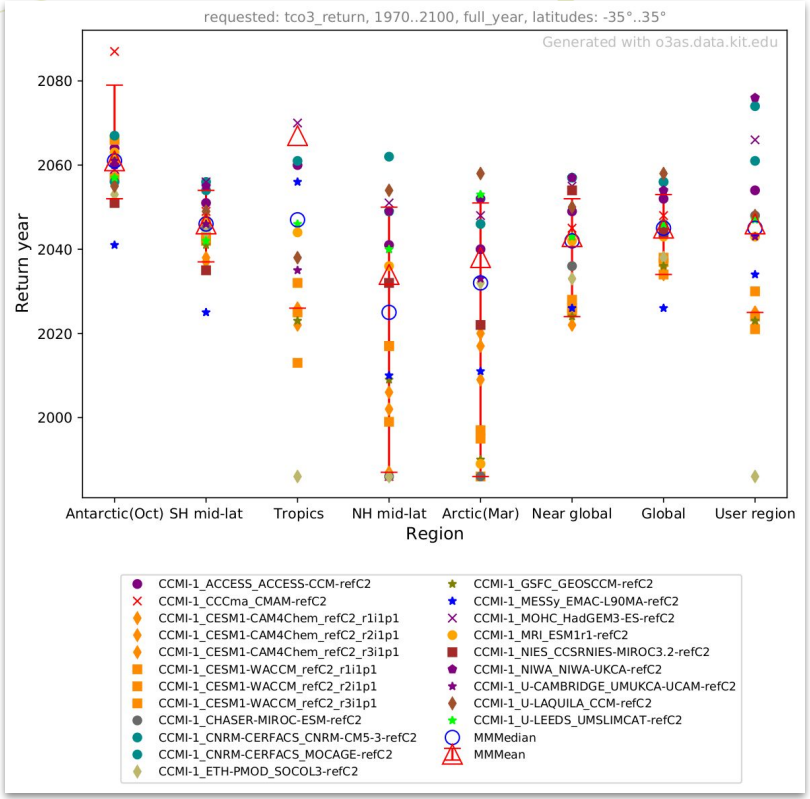

Reference model can be chosen
(this plot: SBUV_GSFC_merged-SAT-ozone)

Reference year can be chosen
(this plot: 1980)

7 pre-defined regions:
Antarctic(Oct), SH mid-lat, Tropics, NH mid-lat, Arctic(Mar), Near global, Global

User can define his own **region**

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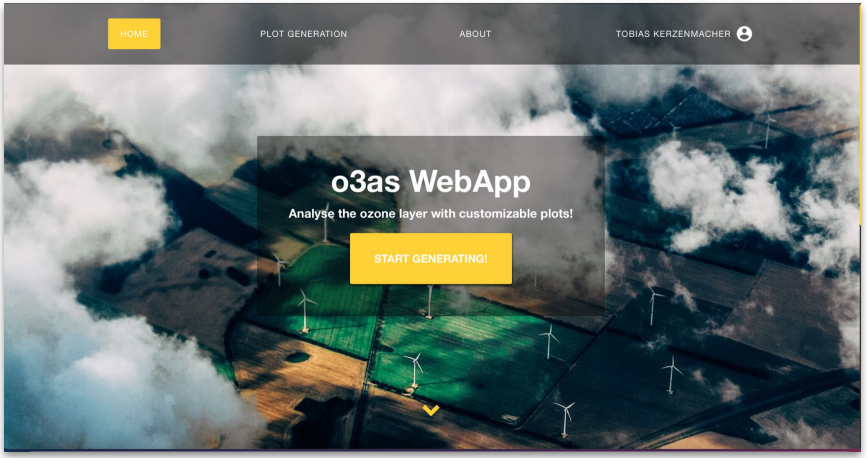
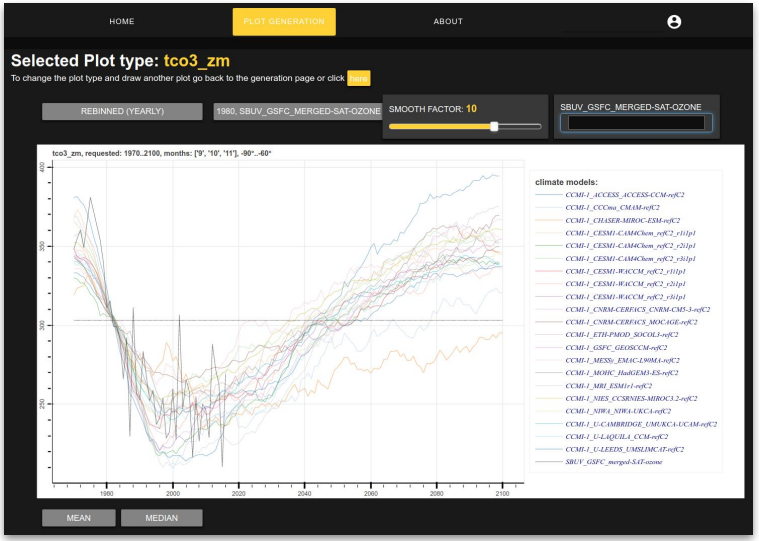
Webapp

Overview

- A **user-friendly** web **interface**
  - Easy plot customisation, more options
  - Online basic analysis
  - Additional features for authenticated users





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Summary on the O3as service

- **O3as** for **scientists**:
  Researches in an **easy way** retrieve ozone model **data**, perform basic **analysis**, create publication ready **plots**
- **O3as** is a service for **everyone**:
  e.g. teachers can use the service to illustrate ozone science
- **O3as** expands EOSC **capacity** and **capability**
- **O3as** will have more models added in the future (eg. ccmi2)
- **O3as** will also provide mixing ratio data to monitor the ozone projection at different altitudes in the future.

We need your help!

- Please consider trying out our webapi or/and webapp services.
- Report any issues or feature requests either via gitlab or via email.: o3as-support@lists.kit.edu

O3as public links:

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EOSC SYNERGY

Start here:	o3as.data.kit.edu
Detailed documentation:	o3as.readthedocs.io
Git organisation/repos:	git.scc.kit.edu/synergy.o3as
Docker Hub:	hub.docker.com/u/o3as
Webapp:	http://o3web.test.fedcloud.eu
Development endpoint:	o3api.test.fedcloud.eu:30505