NASA GIOVANNI Support for HTAP

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Introduction

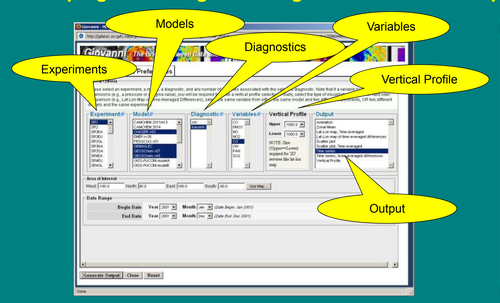
Air pollutants, such as aerosols and various trace gases, are transported on a hemispheric or global scale. The Task Force on Hemispheric Transport of Air Pollution (HTAP) is studying the intercontinental transport of air pollution in the Northern Hemisphere by conducting a series of multi-model evaluations and inter-comparison experiments to: produce estimates of intercontinental source-receptor relationships; improve the understanding of the variability and uncertainty in current model estimates; assess potential future changes in source receptor relationships; and guide future model developments to decrease uncertainties in source-receptor relationships.

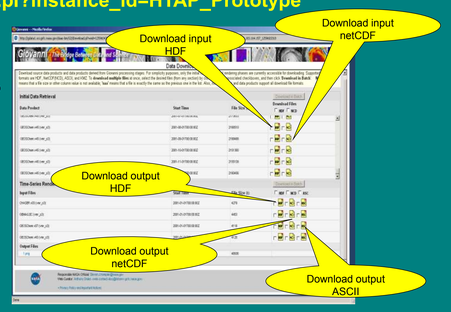
The Giovanni HTAP Prototype GUI provides the flexibility to display multiple experiments, models, diagnostics, and variables simultaneously on an array of visualizations. Image choices include: latitude-longitude maps (time-averaged), latitude-longitude maps of time-averaged differences, animations, vertical profiles, and time-series, scatter, and zonal mean plots. Users have the ability to choose the upper and lower limits of the vertical layer to display, along with the start and end time (for 2001 monthly data). The data is downloaded from the HTAP server, stored locally, and is then pre-processed to convert the different vertical levels for each model to uniform pressure levels. This tool is web-based, so all of the visualization, analysis, and data extraction can be done online using a regular web browser, without the need to remotely log on to HTAP servers or download data and software to a local machine.

Recently, Giovanni has implemented a demonstration site in which HTAP model data are received from the Juelich HTAP WCS server (i.e., not locally stored). Currently, the Giovanni HTAP WCS demo presents two models for viewing: CAMCHEM3311m13 (SR1 and SR2) and ECHAM5_HAMMOZ (SR1 and SR6EU). Ozone, sulfur dioxide, and nitrogen dioxide variables are available for these models and experiments. A large majority of HTAP data residing on the Juelich server are available on sigma levels. The data are not pre-processed to uniform pressure levels, making it difficult for model inter-comparison on specific vertical layers. Thus, multiple experiments may be compared for a single model, but the models themselves cannot be compared with one another.

GIOVANNI HTAP Prototype (data preprocessed at Goddard)

http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/iGui.pl?instance_id=HTAP_Prototype

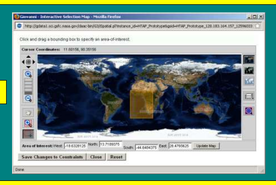




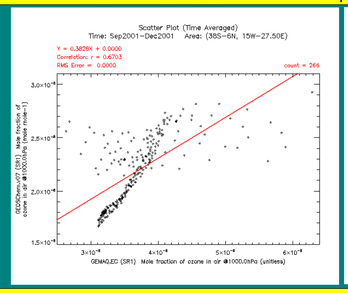
The user has the ability to edit plots in many ways.

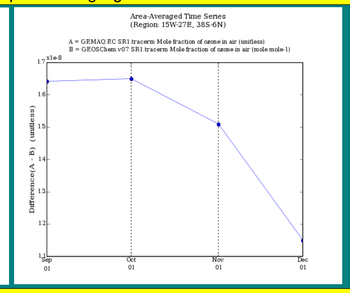
"**New Criteria**" creates a new pop-up window of the original GUI with a "clean slate" to start over.
"**Edit Criteria**" provides the flexibility to go back to the GUI with the user's selections and change them.
"**Edit Preferences**" allows the specification of image attributes, min and max, color bar mode, image height and width, map projection, choice of overlay, and the option for smoothing.
"**Download Data**" directs you to the download page.
"**View Lineage**" provides a description of image processing details.

Zoom into the area of interest.



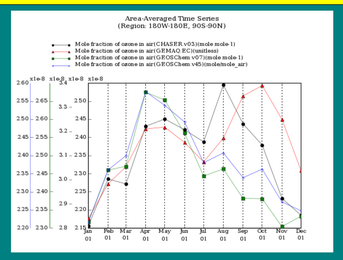
A scatter and time-series difference plot also highlight these differences.



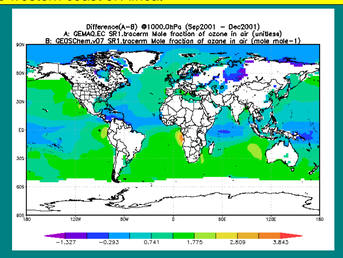


The GEOSChem.v07 model has a lower concentration of ozone near the surface than the GEMAQ.EC model. The vertical distribution of ozone for GEOSChem.v07 appears to be smoothed out vertically, whereas GEMAQ.EC has a more discrete structure. This may be due to the fact that the GEOSChem.v07 model does not include vertical wind (w) as in input variable, whereas the GEMAQ.EC model does (according to GEOSChem-v07.doc and GEMAQ-EC.doc available at http://htap.org).

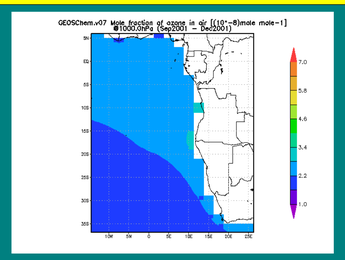
Four models for SR1 ozone are examined in a global time-series overlay for Jan-Dec 2001.

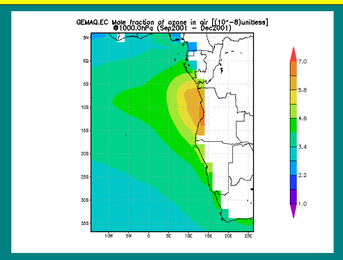


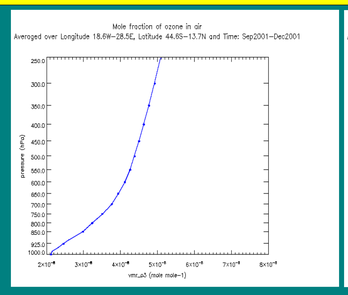
The 2 outliers (GEMAQ.EC and GEOSChem.v07) are examined from Sep-Dec 2001 via lat-lon difference map. There is a noticeable difference between the 2 models on the western coast of Africa.

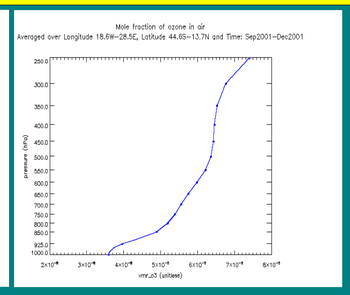


Side-by-side lat-lon maps, focused on the west coast of Africa, reveal how ozone is treated differently by the 2 models. The maximum value for GEOSChem.v07 is less than 3 mol/mol,while for GEMAQ.EC it is almost double that amount.



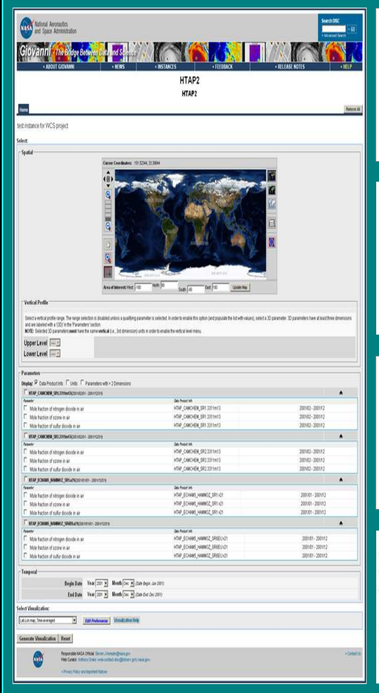


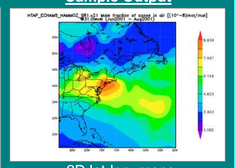




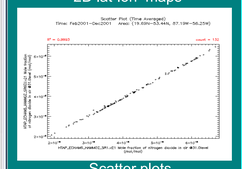
GIOVANNI HTAP (direct access to Juelich WCS archive)

Sample Output

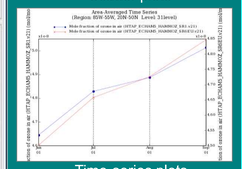




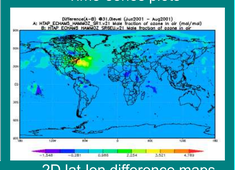
2D lat-lon maps



Scatter plots



Time-series plots



2D lat-lon difference maps

HTAP DATA DISCREPANCIES

- The available data via Juelich's WCS service are not pre-processed to uniform pressure levels making it difficult for model inter-comparison.
- Retrieval time for WCS data is on the order of 2 minutes (for a year request) as opposed to a few seconds, when stored locally.
- Models define time as "days since X", where X varies between models. Additionally, time is valid for day Y of the month, where Y also may vary by model.
- Quality control is needed for models which have fields that are populated with zeroes or that do not specify a missing value.

Time Discrepancies Between Models

Model	DescribeCoverage begin	DescribeCoverage end	value in NetCDF file for Jan01
CAMCHEM.3311m13	2001-02-01T00:00:00Z	2002-01-01T00:00:00Z	error "time empty after filtering"
CAMCHEM.3514	(product not available via WCS)	(product not available via WCS)	(product not available via WCS)
CHASER.v03	(product not available via WCS)	(product not available via WCS)	(product not available via WCS)
EMEP.rv26	2001-01-16T12:00:00Z	2001-12-16T12:00:00Z	15.5
FRSGCUCI.v01	2001-01-16T12:00:00Z	2001-12-16T12:00:00Z	15.5
GEMAQ.EC	2001-01-01T00:00:00Z	2001-11-27T00:00:00Z	15
GEOSChem.v07	2001-01-01T00:00:00Z	2001-12-01T00:00:00Z	0
GEOSChem.v45	2001-01-01T00:00:00Z	2001-12-01T00:00:00Z	0
GISS-PUCCINI.modelA	2001-01-16T12:00:00Z	2001-12-16T12:00:00Z	15.5
GISS-PUCCINI.modelE	2001-01-16T12:00:00Z	2001-12-16T12:00:00Z	15.5
GISS-PUCCINI.modelEaer	(product not available via WCS)	(product not available via WCS)	(product not available via WCS)
GMI.o3a	2001-01-16T12:00:00Z	2001-12-16T12:00:00Z	15.5
GMI.o3f	(product not available via WCS)	(product not available via WCS)	(product not available via WCS)
GOCART.l4p1	2001-01-16T12:00:00Z	2001-12-16T12:00:00Z	15.5
GOCART.l4p2	2001-01-16T12:00:00Z	2001-12-16T12:00:00Z	15.5
INCA.v2MS	(not working for WCS)	(not working for WCS)	(not working for WCS)
INCA.v5Sz	(not working for WCS)	(not working for WCS)	(not working for WCS)
MOZARTGFDL.v2	2001-01-16T12:00:00Z	2001-12-16T12:00:00Z	15.5
MOZECH.v16	2001-01-16T12:00:00Z	2001-12-16T12:00:00Z	14.5
MSCE-POP.v2p2	2001-01-01T00:00:00Z	2001-11-27T00:00:00Z	15
ULAQ.v02	2000-01-31T00:00:00Z	2000-12-26T00:00:00Z	360
GFDL.AM3	(product not available via WCS)	(product not available via WCS)	(product not available via WCS)
GLEMOS.rlp0	(product not available via WCS)	(product not available via WCS)	(product not available via WCS)
ECHAM5	2001-01-16T00:00:00Z	2001-12-16T00:00:00Z	15

January 2001 data were requested from Juelich's WCS server for the ECHAM5 model and the 23 models that had been pre-processed for the HTAP Prototype. The 1st and 2nd columns simply state the start and end values provided in DescribeCoverage. Some of the models have data available from the 1st of the month, while others begin in the middle or end of the month. These times do not appear to be consistent. (Note that January 2001 data are not available for the CAMCHEM3311 model.) The last column, "*value in netCDF file for Jan01*" shows the numerical time value provided in the netCDF file, which is valid for January. In most cases this value is near the middle of the month (~15th day), which is the mid-point of the interval for which the average may be computed. Yet, for the two GEOSChem models this value is zero and for the ULAQ model it is 360.

Model	time defined as days since...
CAMCHEM.3311m13	6/1/2000
CAMCHEM.3514	6/1/2000
CHASER.v03	1/1/2001
EMEP.rv26	1/1/2001
FRSGCUCI.v01	1/1/2001
GEMAQ.EC	1/1/2001
GEOSChem.v07	1/1/2001
GEOSChem.v45	1/1/2001
GISS-PUCCINI.modelA	1/1/2001
GISS-PUCCINI.modelE	1/1/2001
GISS-PUCCINI.modelEaer	1/1/2001
GMI.v02a	1/1/2001
GMI.v02f	1/1/2001
GOCART.v4p1	1/1/2001
GOCART.v4p2	1/1/2001
INCA.v2MS	1/1/2001
INCA.v5Sz	1/1/2001
MOZARTGFDL.v2	1/1/2001
MOZECH.v16	1/1/2001
MSCE-POP.v2p2	1/1/2001
ULAQ.v02	1/1/2000
GFDL.AM3	1/1/2001
GLEMOS.rlp0	1/1/2001
ECHAM5	1/1/2001

The time definitions given in the netCDF files are provided for the ECHAM5 model and the 23 models that had been pre-processed for the HTAP Prototype. Note that almost all times are defined as "days since X", where X is 01/01/01. The two CAMCHEM models, however, define time as "days since 06/01/2000" and the ULAQ model as "days since 1/1/2000".

Missing Data and Zero Field Discrepancies

Model Name	Missing Value
CAMCHEM.3311m13	N/A
CAMCHEM.3514	N/A
CHASER.v03	1 e+20f
ECHAM5-HAMMOZ-v21	N/A
ECHMERIT	N/A
ECHMERIT-V1	1 e+20f
EMEPGLOB	1 e+20f
EMEPGLOB-v3	1 e+20f
EMEP-v26	N/A
FRSGCUCI-v01	1 e+20f
GEMAQ-EC	1 e+20f
GEMAQ-v1p0	1 e+20f
GEMAQ-v1p0R1p5x1p5	1 e+20f
GEOSChem-v07	N/A
GEOSChem-v45	N/A
GFDL-AM3	1 e+20f
GISS-PUCCINI-modelA	1 e+20f
GISS-PUCCINI-modelE	1 e+20f
GISS-PUCCINI-modelEaer	1 e+20f
GLEMOS-v1.0	N/A
GMI-o2a	N/A
GMI-o2f	N/A
GOCART-l4p1	N/A
GOCART-l4p2	N/A
GRAHM-1.1	1 e+20f
HADGEM2-A-v01	14.5
IFS-CY32R3	N/A
INCA-v2MS	1 e+20f
INCA-v5Sz	1 e+20f
LLNL-IMPACT-T5a	N/A
MOZARTGFDL-v2	1 e+20f
MOZARTGFDL-v4	1 e+20f
MOZECH-v16	N/A
MOZECH-v16a	N/A
MSCE-HM-v4.5	1 e+20f
MSCE-POP-v2.2	1 e+20f
OsloCTM2	1 e+20f
SPRINTARS-v356	1 e+20f
STOC-HadAM3-v01	1 e+20f
STOC-HadAM3-v02	1 e+20f
STOCHEM-v02	1 e+20f
TM5-JRC-cy2-ipcc-v1	N/A
TM5-JRC-cy2-ipcc-v1-glb3x2	N/A
TM5-JRC-cy2-ipcc-v1-glb6x4	N/A
ULAQ-v02	N/A
UM-CAM-d1	1 e+20f

The missing value that is defined in the netCDFfile for each of the 46 HTAP models. If this value is not provided then the entry is marked as "N/A"(not available).

MODEL NAME	ZERO FIELDS
CAMCHEM.3311m13	aerosoload/od550_pm1 (Feb-Dec)
CAMCHEM.3514	aerosoload/od550_pm1 (Feb-Dec); depm/wet_du
CHASER.v03	metm/precip for SR1 Mar-Dec
EMEP.rv26	none
FRSGCUCI.v01	none
GEMAQ.EC	aerosoload/od550_pm1 (Feb-Dec)
GEOSChem.v07	none
GEOSChem.v45	sfc/vmr_o3_sumo6 for SR2 Dec
GISS-PUCCINI.modelA	none
GISS-PUCCINI.modelE	none
GISS-PUCCINI.modelEaer	aerosoload/od550_nh4 (Feb-Dec)
GMI.v02a	aerosoload/od550_nh4 (Feb-Dec); emim/emi_aso4
GMI.v02f	budgetm_prod_o3 for SR6 EU July and budgetm/loss_ch4 for SR6EU Aug-Dec
GOCART.v4p1	none
GOCART.v4p2	aerosoload/od550_nh4 (Feb-Dec)
INCA.v2MS	none
INCA.v5Sz	none
MOZARTGFDL.v2	none
MOZECH.v16	none
MSCE-HM-v4.5	none
MSCE-POP-v2.2	none
ULAQ.v02	aerosoload/od550_nh4 (Feb-Dec)
GFDL.AM3	none
GLEMOS.v1p0	none

There are several instances where the values for a given variable in a model's netCDF file are all equal to zero. No zero fields have been found for approximately half of the 23 models listed (these models had been pre-processed locally for the HTAP Prototype). However, for the other half, many of the aerosol aod diagnostic's od550_pm1 and od550_nh4 variables contain all zeroes. Several other zero fields exist and are noted.

Vertical Layer Discrepancies Between Models

Model Name	Vertical layer/levels	Reference Pressure (Pa)	Lev Formula	Lev_Bnds Formula
CAMCHEM-3311m13	pressure	100000	N/A	N/A
CAMCHEM-3514	pressure	100000	N/A	N/A
CHASER-v03	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
ECHAM5-HAMMOZ-v21	sigma	1	mlev=hyam+hybm*aps	N/A
ECHMERIT	sigma	N/A	mlev=hyam+hybm*aps	ilev=hyai+hybi*aps
ECHMERIT-V1	sigma	N/A	mlev=hyam+hybm*aps	ilev=hyai+hybi*aps
EMEPGLOB	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
EMEPGLOB-v3	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
EMEP-v26	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
FRSGCUCI-v01	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
GEMAQ-EC	sigma	80000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
GEMAQ-v1p0	sigma	80000	p(n,k,j,i)=ap(k)+b(k)*ps(n,j,i)	N/A
GEMAQ-v1p0R1p5x1p5	sigma	80000	p(n,k,j,i)=ap(k)+b(k)*ps(n,j,i)	N/A
GEOSChem-v07	N/A	N/A	N/A	N/A
GEOSChem-v45	sigma	N/A	p(n,k,j,i)=a(k)+b(k)*ps(n,j,i)	N/A
GFDL-AM3	sigma	101325	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
GISS-PUCCINI-modelA	sigma	98400	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
GISS-PUCCINI-modelE	sigma	98400	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
GISS-PUCCINI-modelEaer	sigma	98400	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
GLEMOS-v1.0	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
GMI-v02a	sigma	101325	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
GMI-v02f	sigma	101325	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
GOCART-v4p1	sigma	10132500	N/A	N/A
GOCART-v4p2	sigma	101325	N/A	N/A
GRAHM-1.1	sigma	1000	p(n,k,j,i)=ptop+lev(k)*(ps(n,j,i)-ptop)	p(n,k,j,i)=ptop+lev_bnds(k)*(ps(n,j,i)-ptop)
HADGEM2-A-v01	hybrid height	N/A	z(k,j,i)=az(k)+bz(k)*orog(j,i)	z(k,j,i)=az(k)+bz(k)*orog(j,i)
IFS-CY32R3	sigma	100000	N/A	N/A
INCA-v2MS	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
INCA-v5Sz	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
LLNL-IMPACT-T5a	sigma	1000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
MOZARTGFDL-v2	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
MOZARTGFDL-v4	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
MOZECH-v16	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
MOZECH-v16a	sigma	100000	N/A	N/A
MSCE-HM-v4.5	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
MSCE-POP-v2.2	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
OsloCTM2	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
SPRINTARS-v356	sigma	100000	N/A	N/A
STOC-HadAM3-v01	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
STOC-HadAM3-v02	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)
STOCHEM-v02	hybrid height	N/A	z(k,j,i)=a(k)+b(k)*orog(j,i)	z(k,j,i)=a(k)+b(k)*orog(j,i)
TM5-JRC-cy2-ipcc-v1	sigma	1	N/A	N/A
TM5-JRC-cy2-ipcc-v1-glb3x2	sigma	1	N/A	N/A
TM5-JRC-cy2-ipcc-v1-glb6x4	sigma	1	N/A	N/A
ULAQ-v02	sigma	100000	N/A	N/A
UM-CAM-v01	sigma	100000	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)	p(n,k,j,i)=a(k)*p0+b(k)*ps(n,j,i)

All 46 HTAP models and their assumed vertical levels are listed. If the netCDF files associated with that model contain the reference pressure then it is listed in the spreadsheet, otherwise it is denoted with "N/A" (not available). A majority of the reference pressure values are at or near 1,000 hPa, yet some models define reference pressure differently. Additionally, the level and level bands formulas for each model are included.

The spreadsheets highlight the data discrepancies that exist between the various models participating in the HTAP project. They have been shared with the modeling community on the ESIP wiki page (http://wiki.esipfed.org/index.php/WCS_Access_to_netCDF_Files). Resolving the differences between all models, in order to potentially create a uniform dataset both in vertical space and with time definition, is ideal for users. This would greatly enhance the capabilities of the Juelich HTAP WCS service. In conjunction with Giovanni, multiple-model and multiple-experiment data may then be visualized and compared almost instantaneously.

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