θ-S structure of the AMOC in high-resolution ocean simulations and in CMIP5 models

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NOAA
Model Diagnostics Task Force (MDTF)
Diagnostics Package

MDTF Variability Diagnostics3D Structures of AMOC

3D Structures of AMOC plots

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3D Structures of AMOC

One Latitude (26.5N)

	Transport Q(x,z)	Streamfunction $\Psi_z(z)$	Temperature θ(x,z)	θ(z)	Salinity S(x,z)	S(z)	Q(θ,S)	$\Psi_\sigma(\sigma)$	$\Psi_\theta(\theta)$	$\Psi_S(S)$
Observation or High-res Model		plot	plot	plot	plot	plot	plot	plot	plot	plot
GFDL-CM2p1	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot

Latitudinal Variation

	Layer Q(y)	Layer θ(y)	Layer S(y)	$\Psi_z(y,z)$	$\Psi_\sigma(y,\sigma)$	$\Psi_\theta(y,\theta)$	$\Psi_S(y,S)$	Heat Transport	Freshwater Tansport
High-res Model	plot	plot	plot	plot	plot	plot	plot	plot	plot
GFDL-CM2p1	plot	plot	plot	plot	plot	plot	plot	plot	plot

Directory and files configuration in brief

```
.
├── mdtf.py
├── README.pdf
├── CCSM4 CASENAME
│   ├── fx FIXDIR
│   │   ├── CCSM4.deptho.fx.nc      bathymetry
│   │   └── CCSM4.thkcello.fx.nc    layer thickness
│   └── mon MONDIR
│       ├── CCSM4.so.mon.nc    monthly ocean Temperature, Salinity,
│       └── CCSM4.vo.mon.nc    (volume/mass) transport/velocity
├── GFDL-CM2p1 CASENAME
│   ├── fx
│   │   └── GFDL-CM2p1.deptho.fx.nc
│   └── mon
│       ├── GFDL-CM2p1.so.mon.nc
│       ├── GFDL-CM2p1.vmo.mon.nc
│       ├── GFDL-CM2p1.vo.mon.nc
│       └── note
├── obs_data
│   └── transport_onto_TS REFDIR
│       ├── clim CLMREF
│       │   ├── HYCOM.AMOC_T2B.clim.nc    1/12 degree HYCOM simulation is used as reference
│       │   ├── RAPID.sf26.clim.nc
│       │   └── WOA13.so_viv.clim.nc
│       ├── fx  FIXREF
│       │   ├── HYCOM.sig2_on_TS.fx.nc
│       │   └── LICOM.BASIN.fx.nc
│       └── ref_AMOCz_yz_plot.png
├── var_code
│   ├── html HTMDIR
│   │   ├── mdtf1.html
│   │   ├── mdtf_diag_banner.png
│   │   └── template.html
│   ├── transport_onto_TS SRCDIR
│   │   ├── AMOC_T2B_from_climate.ncl    diagnose and plot scripts
│   │   └── AMOC_T2B_from_climate.py
│   └── util
│       ├── rgb RGBDIR
│       │   └── xbxu.rgb  Color tables
│       └── set_variables_CMIP.py  Set variables names in CMIP5
└── wkdir WKDIR
    ├── MDTF_CCSM4  CASDIR
    │   ├── index.html
    │   ├── mdtf_diag_banner.png
    │   └── transport_onto_TS QTSDIR
    │       ├── mdtf_diag_banner.png
    │       ├── model PNGDIR
    │       │   ├── AMOCz_yz_plot.png  Figures for html
    │       │   ├── netCDF OUTDIR
    │       │   │   ├── CCSM4.AMOC_T2B.clim.nc  results here for plot
    │       │   │   ├── mon_yr TMPDIR
    │       │   │   │   ├── CCSM4.AMOC_qts_2003-2003.yr.nc  temperatory files
    │       │   │   │   ├── CCSM4.AMOC_qts_2004-2004.yr.nc
```

Data is from https://esgf-node.llnl.gov/search/cmip5/, CMIP5 historical run.
User should cat monthly files into one, for example:
cdo cat so_Omon_CCSM4_historical_r1i1p1_??????-??????.nc CCSM4.so.mon.nc

Here results from CCSM4 and GFDL-CM2p1 are shown,
user might specify other CMIP5 models, providing corresponding netCDF files

```
54      │       │   │   │   ├── CCSM4.AMOC_qts_2005-2005.yr.nc
55      │       │   ├── PS FIGDIR
56      │       │   │   ├── AMOCz_yz_plot.pdf  temperatory figures
57      │       ├── obs PNGREF
58      │       │   ├── ref_AMOCz_yz_plot.png
59      │       │   ├── PS  FIGREF
60      │       └── transport_onto_TS.html
61      ├── MDTF_GFDL-CM2p1
62      │   ├── index.html
63      │   ├── mdtf_diag_banner.png
64      │   └── transport_onto_TS
65      │       ├── mdtf_diag_banner.png
66      │       ├── model
67      │       │   ├── AMOCz_yz_plot.png
68      │       │   ├── netCDF
69      │       │   │   ├── GFDL-CM2p1.AMOC_T2B.clim.nc
70      │       │   │   ├── mon_yr
71      │       │   │   │   ├── GFDL-CM2p1.AMOC_qts_2001-2001.yr.nc
72      │       │   │   │   ├── GFDL-CM2p1.AMOC_qts_2002-2002.yr.nc
73      │       │   │   │   ├── GFDL-CM2p1.AMOC_qts_2003-2003.yr.nc
74      │       │   │   │   ├── GFDL-CM2p1.AMOC_qts_2004-2004.yr.nc
75      │       │   │   │   ├── GFDL-CM2p1.AMOC_qts_2005-2005.yr.nc
76      │       │   ├── PS
77      │       │   │   ├── AMOCz_yz_plot.pdf
78      │       ├── obs
79      │       │   ├── ref_AMOCz_yz_plot.png
80      │       │   ├── PS
81      │       └── transport_onto_TS.html
82      ├── MDTF_GFDL-CM2p1.tar
```