YOPPsiteMIP – The YOPP site Model Inter-comparison Project

Gunilla Svensson[1], Barbara Casati[2], Jonny Day[3], Taneil Uttal[4] and Øystein Godøy[5], Leslie Hartten[6,4]

[1] Department of Meteorology, Stockholm University, Sweden. Contact: gunilla@misu.su.se
[2] Meteorological Research Division, Environment and Climate Change Canada, Canada.
[3] European Centre for Medium-Range Weather Forecasts, UK.
[4] NOAA Earth System Research Laboratory, Boulder, Colorado, USA.
[5] Norwegian Meteorological Institute, Norway.
[6]Cooperative Institute for Research in Environmental Science (CIRES), University of Colorado, Boulder, Colorado, USA.

Requested model output

In order to permit process-based evaluation and verification of numerical weather prediction (NWP) and climate models with observations from key locations in the Arctic, Antarctic and Third Pole, we are calling for modeling centers to participate in this project. Engagement can be through archiving and providing high frequency output from forecasts produced during the Year of Polar Prediction (YOPP: 1st May 2017-30th June 2019, possibly extended for the MOSAiC period, summer 2019 – summer 2020) and answering research questions by analyzing the data.

The proposed set of locations is comprised of IASOA supersites (https://www.esrl.noaa.gov/psd/iasoa), ECCC supersites (ecpass.ca), selected Antarctic stations, and key locations covering the so–called "third pole" (Tibetan plateau).
In order to facilitate the study of ocean-cryosphere-atmosphere coupling processes, we suggest that data also be extracted at the (changing) locations of the research icebreaker Oden (expedition during YOPP-Second Special Observing Period (SOP2), summer 2018), and the MOSAIC drifting observatory (http://www.mosaicobservatory.org/, 2019-2010)[1]. A few fixed locations over the Arctic Ocean (e.g. the approximate location of the Sheba drifting observatory 165°W, 76°N) are also desirable. Table 1 shows the locations of the suggested sites. If possible, we suggest that data be provided for all sites. However, reporting a comprehensive set of parameters for fewer sites, which is necessary for regional models, is more useful than reporting a more limited set for many sites, since the aim is to facilitate process studies.

Table 1 Locations for site-specific model output

Supersite ***Filename***	**Latitude Longitude**	**Elevation**
	Arctic	
Utqiaġvik[2] (Alaska) *barrow*	71.32°N, 156.62°W	8-20 m
Oliktok Point (Alaska)	70.50°N 149.89°W	2-6 m

[1] Locations can be found at http://www.polarprediction.net/yopp-activities/yopp-task-teams/verification/
[2] Formerly known as Barrow. Note that 'barrow' should be used in the file name, for consistency with earlier model data on the YOPP portal.

oliktok		
White Horse (Canada) *whitehorse*	60.71°N, 135.07°W	682 m
Eureka (Canada) *eureka*	80.08°N 86.42°W	0-610 m
Iqaluit (Canada) *iqaluit*	63.74°N, 68.51°W	5-11 m
Alert (Canada) *alert*	82.49°N, 62.51°W	8-210 m
Summit (Greenland) *summit*	72.58°N, 38.48°W	3210-3250 m
Ny-Ålesund (Svalbard) [Zeppelin station] *nyalesund*	78.92°N, 11.53°E [78.9°N, 11.88°E]	0-30 m [473 m]
Sodankylä (Finland) [Pallas] *sodankyla*	67.37°N, 26.63°E [67.97°N, 24.12°E]	198 m [305 m]
Tiksi (Russia) *tiksi*	71.60°N, 128.89°E	1-30 m
Cherskii (Russia) [Pleistocene Park] *cherskii*	68.73°N, 161.38°E [68.51°N, 161.53°E]	8 m [16 m]
Ice Base Cape Baranova (Russia) *baranova*	79.3°N, 101.7°E	24 m

Antarctic

Alexander Tall Tower *alexander*	79.01°S, 170.72°E	55 m
Casey *casey*	66.28°S, 110.53°E	30 m
Davis *davis*	68.58°S, 77.97°E	
Dome C *domec*	75.08°S, 123.34°E	3233 m
Dumont d'Urville *dumont*	66.66°S, 140.01°E	0-50 m
Halley IV *halley*	75.58°S, 26.66° W	130 m
King Sejong (King George Island) *kingsejong*	62.22°S, 58.79° W	10 m
Georg von Neumayer *neumayer*	70.65°S, 8.25°W	42 m

Mawson *mawson*	67.60°S, 62.87°E	15 m
Syowa (Showa) *syowa*	69.00°S, 39.59°E	18-29 m
Jang Bogo (Terra Nova Bay) *jangbogo*	74.62°S, 164.23°E	36 m
Amundsen-Scott South Pole *southpole*	90°S, 0°E	2835 m
Byrd *byrd*	80.01°S, 119.44°W	1539 m
Rothera *rothera*	67.57°S, 68.13° W	4 m
Vostok *vostok*	78.46°S, 106.84°E	3489 m
McMurdo [Scott base] *mcmurdo*	77.85°S, 166.67°E [77.85°S, 166.76°E]	10 m [10 m]
Troll *troll*	72.01°S, 2.54°E	1275 m

Third Pole

Mera (Nepal) *mera*	27.7°N, 86.9°E	4570-4520 m
Tanggula (China) *tanggula*	32.58°N, 91.86°E	5100 m
Xidatan (China) *xidatan*	35.72°N, 94.13°E	4940-6420 m
Laohugou (China) *laohugou*	39.5°N, 96.5°E	4180 m

Ocean sites

SHEBA location *sheba*	165°W, 76°N	Sea level
Arctic Ocean *ao1*	10°E, 85°N	Sea level
Arctic Ocean *ao2*	0°E, 90°N	Sea level
Arctic Ocean *ao3*	135°W, 81°N	Sea level

The motivation is to support detailed evaluation of the model representation of a range of physical processes, as described in the YOPP modelling plan (YOPP, 2017). The processes to be evaluated include the terms in the energy budget at the surface, momentum transfer, clouds and vertical profiles of a number of parameters, as well as other processes which are supported by the observations at the supersites or of interest to compare between models.

Some key issues:

- **Output levels.** In order to permit detailed process studies, model parameters should be on the native model vertical levels.
- **Output frequency**. High frequency output, preferably every model time step, is desirable to support process studies. At least every 5 or 15 minutes is required, in order to align with the Merged Observatory Data Files, which will include measurements at the highest reasonable frequency (usually 1 to 15 minutes). Since the output data is high frequency, averages and extremes during each output period are not required.
- **Output locations**. For coarser resolution models (10 km or coarser) we recommend archiving the four model grid-points nearest (surrounding) the supersite location. Ideally, model output should be provided for the set of model grid points within 20km of the observation site. Some of the supersite locations have two observational sites. Please provide data for the main location and make sure the other site is covered in the surrounding grid-points.

Output variables

Table 2 shows the site-specific output with variables in two tiers. Most variables in ***tier one*** are also included in the three-dimensional model output[3], however, no averaging is needed here and the output is on model levels.

Tier two model variables may not be as easy to compare with observations, but they allow for more process-based evaluation at some locations as well as for model inter-comparisons. Please use the variable names in Table 2; most are used in the CMIP experiments[4]. The ocean and sea-ice variables are also in this tier and variable names are updated to conform with SIMIP[5].

While the requested site-specific data primarily focus on atmospheric process studies at the observation supersites, additional sea ice and ocean output are also requested for some locations (Table 1). Please note that it is desirable to have the ocean and sea ice output on the atmospheric grid and the atmospheric model time-step frequency. In the presence of sea ice, the fluxes at surface should be partitioned over the sea ice and open ocean as done in the coupled model.

Please use the following convention for the naming of axes within the file. Please use 'lat', 'lon' (particularly if producing a cluster of points at each site) and 'time' as dimension names for each variable. If using a grid which is not regular in latitude and longitude, use a single index: 'station_id1' for all parameters including 'lat' and 'lon'. For variables with a vertical dimension, use 'level' as the axis name in the atmosphere (and 'half_level' if the model uses two vertical axes), 'olevel' for the ocean, 'snlevel' for snow and 'slevel' for soil (if snow or soil are multi-level). 'level' should contain integers with the highest number for the lowest model level (note that pressure and geopotential height should be provided as separate variables). 'olevel', 'slevel', and 'snlevel' should all be in meters.

If the land-surface model in your forecast system is split into categories, or tiles, use the parameter names in Table 2, but add the suffix "_cat" for categories. For example, surface temperature would have the variable name: "ts_cat". These variables would also need an additional index, "category", which is an integer referring to each surface type. Please also provide an attribute for the "category" index called "category_description", which explains what the surface type is. See the appendix for an example.

Please prepare a supporting text document providing information on model vertical grid, if half levels are used please provide information on which variables that are reported on which grid. Also, provide model documentation and basic information on how diagnostics, such as 2m temperature, visibility and boundary-layer height, are calculated. Explain if and how surrounding grid points are chosen as well as which sites that data are provided for. Information on static parameters used in the land model, such as vegetation type, soil type, etc. for the sites would be of great value. For ocean points, please provide information on if/how the coupling to sea ice and ocean is performed and how the model output should be

[3] http://www.polarprediction.net/fileadmin/user_upload/www.polarprediction.net/Home/Organization/Task_Teams/Modelling_Task_Team/YOPP_common_model_output_v13.pdf

[4] https://cmip.llnl.gov/cmip5/data_description.html

[5] Notz, D., Jahn, A., Holland, M., Hunke, E., Massonnet, F., Stroeve, J., Tremblay, B., and Vancoppenolle, M.: The CMIP6 Sea-Ice Model Intercomparison Project (SIMIP): understanding sea ice through climate-model simulations, Geosci. Model Dev., 9, 3427-3446, https://doi.org/10.5194/gmd-9-3427-2016, 2016.

interpreted. Include relevant model references and the person responsible for the data along with contact information in the document.

The model output should be netcdf format, with one file per forecast named with *model* name, *site* and startdate/time in hour UTC, combined as *site_model-institution_YYYYMMDDTT* (example sodankyla_ifs-ecmwf_2018020100). Include all model output variables using the *variable* names from Table 2. The heading of a sample netcdf file (a dump of the file heading) is provided for reference as Attachment. Note that the most important global attributes described in the CF and Attribute Convention for Dataset Discovery (ACDD) conventions are included at the end of this template file.

Transfer the files to Met Norway, where the supersite model output is hosted (contact Øystein Godøy, o.godoy@met.no). In order to initiate the upload process, please use the contact form at the YOPP data portal, https://yopp.met.no/contact. An issue tracker, to facilitate the upload process, will soon be available. Push or pull can be used for automated file submission. In the case of pull by the YOPP Data Portal, an end point offering SSH and scp or rsync is required. If push is preferred, the provider has to ask the YOPP Data Portal for the end point to use for scp. In order to allow push, the provider has to provide the YOPP Data Portal with the SSH key to use and the IP address(es) the upload process will be initiated from. Conformance checking prior to initiating a push is available at https://yopp.met.no/dataset_validation/form. Data will be served through OPeNDAP from the YOPP Data Portal. This allows aggregation of physical files into a dataset for each location. Data can be accessed directly from self-developed software, R, Python, Matlab etc.

Table 2 Model site-specific output. Tier 2 variables are shaded.

The table of requested diagnostics can be found here: https://www.polarprediction.net/fileadmin/user_upload/www.polarprediction.net/Home/Organization/Task_Teams/Atmospheric_Processes/Standalone_YOPPsiteMIP_Model_Variables_12-Jan-2020.pdf. Tier 2 parameters are shaded in grey.

APPENDIX

```
netcdf barrow_ifs-ecmwf_2018020100 {
dimensions:
        time = UNLIMITED ; // (576 currently)
        level = 137 ;
        half_level = 138 ;
        slevel = 4 ;
        category = 9 ;
        ncl5 = 1 ;
        ncl6 = 1 ;
variables:
        int level(level) ;
                level:positive = "down" ;
                level:standard_name = "model_level_number" ;
                level:units = "1" ;
        int half_level(half_level) ;
                half_level:units = "1" ;
                half_level:standard_name = "model_level_number" ;
                half_level:positive = "down" ;
        float time(time) ;
                time:standard_name = "time" ;
                time:long_name = "verification time" ;
                time:calendar = "standard" ;
                time:units = "hours since 2018-02-01 00:00:00" ;
        double slevel(slevel) ;
                slevel:positive = "down" ;
                slevel:long_name = "depth of middle of soil layer" ;
                slevel:units = "m" ;
        double category(category) ;
                category:category_description = "1: WATER, 2: ICE, 3: WET SKIN, 4: DRY
SNOW-FREE LOW-VEG, 5: SNOW ON LOW-VEG+BARE-SOIL, 6: DRY SNOW-FREE HIGH-VEG, 7:
SNOW UNDER HIGH-VEG, 8: BARE SOIL, 9: LAKE" ;
                category:long_name = "surface category number" ;
        double zg(time, level) ;
                zg:standard_name = "geopotential_height" ;
                zg:long_name = "Geopotential height" ;
                zg:units = "m" ;
                zg:_FillValue = 9.96920996838687e+36 ;
        double pfull(time, level) ;
                pfull:standard_name = "air_pressure" ;
                pfull:long_name = "Pressure on full levels" ;
                pfull:units = "Pa" ;
                pfull:_FillValue = 9.96920996838687e+36 ;
        double ta(time, level) ;
                ta:standard_name = "air_temperature" ;
                ta:long_name = "Temperature" ;
                ta:units = "K" ;
                ta:_FillValue = 9.96920996838687e+36 ;
        double ua(time, level) ;
                ua:standard_name = "eastward_wind" ;
                ua:long_name = "Eastward wind component" ;
```

```
                ua:units = "m/s" ;
                ua:_FillValue = 9.96920996838687e+36 ;
        double va(time, level) ;
                va:standard_name = "northward_wind" ;
                va:long_name = "Northward wind component" ;
                va:units = "m/s" ;
                va:_FillValue = 9.96920996838687e+36 ;
        double hus(time, level) ;
                hus:standard_name = "specific_humidity" ;
                hus:long_name = "Specific humidity" ;
                hus:units = "kg/kg" ;
                hus:_FillValue = 9.96920996838687e+36 ;
        double hur(time, level) ;
                hur:long_name = "relative_humidity" ;
                hur:units = "%" ;
                hur:_FillValue = 9.96920996838687e+36 ;
        double cl(time, level) ;
                cl:standard_name = "cloud_area_fraction_in_atmosphere_layer" ;
                cl:long_name = "Percentage cloud cover including both large-scale and
convective cloud" ;
                cl:units = "%" ;
                cl:_FillValue = 9.96920996838687e+36 ;
        double clw(time, level) ;
                clw:standard_name = "mass_fraction_of_cloud_liquid_water_in_air" ;
                clw:long_name = "Mass fraction of cloud liquid water" ;
                clw:units = "kg/kg" ;
                clw:_FillValue = 9.96920996838687e+36 ;
        double cli(time, level) ;
                cli:standard_name = "mass_fraction_of_cloud_ice_in_air" ;
                cli:long_name = "Mass fraction of cloud ice" ;
                cli:units = "kg/kg" ;
                cli:_FillValue = 9.96920996838687e+36 ;
        double wap(time, level) ;
                wap:standard_name = "lagrangian_tendency_of_air_pressure" ;
                wap:long_name = "Vertical large scale wind in pressure coordinates" ;
                wap:units = "Pa/s" ;
                wap:_FillValue = 9.96920996838687e+36 ;
        double tnt(time, level) ;
                tnt:standard_name = "tendency_of_air_temperature" ;
                tnt:long_name = "Tendency of air temperature" ;
                tnt:units = "K/s" ;
                tnt:_FillValue = 9.96920996838687e+36 ;
        double tnhus(time, level) ;
                tnhus:standard_name = "tendency_of_specific_humidity" ;
                tnhus:long_name = "Tendency of specific humidity" ;
                tnhus:units = "s-1" ;
                tnhus:_FillValue = 9.96920996838687e+36 ;
        double tnmmutot(time, level) ;
                tnmmutot:standard_name = "tendency_of_eastward_wind" ;
                tnmmutot:long_name = "Tendency of eastward wind" ;
                tnmmutot:units = "m/s2" ;
```

```
                tnmmutot:_FillValue = 9.96920996838687e+36 ;
        double tnmmvtot(time, level) ;
                tnmmvtot:standard_name = "tendency_of_northward_wind" ;
                tnmmvtot:long_name = "Tendency of northward wind" ;
                tnmmvtot:units = "m/s2" ;
                tnmmvtot:_FillValue = 9.96920996838687e+36 ;
        double phalf(time, half_level) ;
                phalf:standard_name = "air_pressure" ;
                phalf:long_name = "Pressure on half levels" ;
                phalf:units = "Pa" ;
                phalf:_FillValue = 9.96920996838687e+36 ;
        double zghalf(time, half_level) ;
                zghalf:standard_name = "geopotential_height" ;
                zghalf:long_name = "Geopotential height on half levels" ;
                zghalf:units = "m" ;
                zghalf:_FillValue = 9.96920996838687e+36 ;
        double uw(time, half_level) ;
                uw:standard_name = "downward_eastward_momentum_flux_in_air" ;
                uw:long_name = "Eastward turbulent momentum flux" ;
                uw:units = "kg m-1 s-2" ;
                uw:_FillValue = 9.96920996838687e+36 ;
        double vw(time, half_level) ;
                vw:long_name = "downward_northward_momentum_flux_in_air" ;
                vw:units = "kg m-1 s-2" ;
                vw:_FillValue = 9.96920996838687e+36 ;
        double tsl(time, slevel) ;
                tsl:standard_name = "soil_temperature" ;
                tsl:long_name = "Soil temperature profile" ;
                tsl:units = "K" ;
                tsl:_FillValue = 9.96920996838687e+36 ;
        double mrlsl(time, slevel) ;
                mrlsl:standard_name = "moisture_content_of_soil_layer" ;
                mrlsl:long_name = "Soil moisture profile" ;
                mrlsl:units = "kg m-2" ;
                mrlsl:_FillValue = 9.96920996838687e+36 ;
        double sftlf_cat(time, category) ;
                sftlf_cat:long_name = "Land area fraction over categories" ;
                sftlf_cat:units = "1" ;
                sftlf_cat:_FillValue = 9.96920996838687e+36 ;
        double ts_cat(time, category) ;
                ts_cat:long_name = "Skin temperature over categories" ;
                ts_cat:units = "K" ;
                ts_cat:_FillValue = 9.96920996838687e+36 ;
        double albs_cat(time, category) ;
                albs_cat:long_name = "Surface albedo over categories" ;
                albs_cat:units = "1" ;
                albs_cat:_FillValue = 9.96920996838687e+36 ;
        double rsus_cat(time, category) ;
                rsus_cat:long_name = "Upward surface short-wave radiation over
categories" ;
                rsus_cat:units = "W m-2" ;
```

```
                rsus_cat:_FillValue = 9.96920996838687e+36 ;
        double rsds_cat(time, category) ;
                rsds_cat:long_name = "Downward surface short-wave radiation over
categories" ;
                rsds_cat:units = "W m-2" ;
                rsds_cat:_FillValue = 9.96920996838687e+36 ;
        double rlus_cat(time, category) ;
                rlus_cat:long_name = "Upward surface long-wave radiation over categories"
;
                rlus_cat:units = "W m-2" ;
                rlus_cat:_FillValue = 9.96920996838687e+36 ;
        double rlds_cat(time, category) ;
                rlds_cat:long_name = "Downward surface long-wave radiation over
categories" ;
                rlds_cat:units = "W m-2" ;
                rlds_cat:_FillValue = 9.96920996838687e+36 ;
        double hfls_cat(time, category) ;
                hfls_cat:long_name = "Surface turbulence latent heat flux over categories" ;
                hfls_cat:units = "W m-2" ;
                hfls_cat:_FillValue = 9.96920996838687e+36 ;
        double hfss_cat(time, category) ;
                hfss_cat:long_name = "Surface turbulence sensible heat flux over
categories" ;
                hfss_cat:units = "W m-2" ;
                hfss_cat:_FillValue = 9.96920996838687e+36 ;
        double hfds_cat(time, category) ;
                hfds_cat:long_name = "Ground heat flux over categories" ;
                hfds_cat:units = "W m-2" ;
                hfds_cat:_FillValue = 9.96920996838687e+36 ;
        double rsds(time) ;
                rsds:standard_name = "surface_downwelling_shortwave_flux_in_air" ;
                rsds:long_name = "Downward surface short-wave radiation" ;
                rsds:units = "W m-2" ;
                rsds:_FillValue = 9.96920996838687e+36 ;
        double rlds(time) ;
                rlds:standard_name = "surface_downwelling_longwave_flux_in_air" ;
                rlds:long_name = "Downward surface long-wave radiation" ;
                rlds:units = "W m-2" ;
                rlds:_FillValue = 9.96920996838687e+36 ;
        double rsus(time) ;
                rsus:standard_name = "surface_upwelling_shortwave_flux_in_air" ;
                rsus:long_name = "Upward surface short-wave radiation" ;
                rsus:units = "W m-2" ;
                rsus:_FillValue = 9.96920996838687e+36 ;
        double rlus(time) ;
                rlus:standard_name = "surface_upwelling_longwave_flux_in_air" ;
                rlus:long_name = "Upward surface long-wave radiation" ;
                rlus:units = "W m-2" ;
                rlus:_FillValue = 9.96920996838687e+36 ;
        double hfls(time) ;
                hfls:standard_name = "surface_upward_latent_heat_flux" ;
```

```
        hfls:long_name = "Surface turbulence latent heat flux" ;
        hfls:units = "W m-2" ;
        hfls:_FillValue = 9.96920996838687e+36 ;
double hfss(time) ;
        hfss:standard_name = "surface_upward_sensible_heat_flux" ;
        hfss:long_name = "Surface turbulent sensible heat flux" ;
        hfss:units = "W m-2" ;
        hfss:_FillValue = 9.96920996838687e+36 ;
double rlut(time) ;
        rlut:standard_name = "toa_outgoing_longwave_flux" ;
        rlut:long_name = "Top of atmosphere outgoing long-wave radiation" ;
        rlut:units = "W m-2" ;
        rlut:_FillValue = 9.96920996838687e+36 ;
double rsdt(time) ;
        rsdt:standard_name = "toa_incoming_shortwave_flux" ;
        rsdt:long_name = "Top of atmosphere incoming short-wave radiation" ;
        rsdt:units = "W m-2" ;
        rsdt:_FillValue = 9.96920996838687e+36 ;
double rsut(time) ;
        rsut:standard_name = "toa_outgoing_shortwave_flux" ;
        rsut:long_name = "Top of atmosphere outgoing short-wave radiation" ;
        rsut:units = "W m-2" ;
        rsut:_FillValue = 9.96920996838687e+36 ;
double pr(time) ;
        pr:standard_name = "precipitation_flux" ;
        pr:long_name = "Total precipitation" ;
        pr:units = "kg m-2 s-1" ;
        pr:_FillValue = 9.96920996838687e+36 ;
double prsn(time) ;
        prsn:standard_name = "snowfall_flux" ;
        prsn:long_name = "Snowfall flux" ;
        prsn:units = "kg m-2 s-1" ;
        prsn:_FillValue = 9.96920996838687e+36 ;
double clt(time) ;
        clt:standard_name = "cloud_area_fraction" ;
        clt:long_name = "Total cloud Cover" ;
        clt:units = "%" ;
        clt:_FillValue = 9.96920996838687e+36 ;
double zmla(time) ;
        zmla:standard_name = "atmosphere_boundary_layer_thickness" ;
        zmla:long_name = "Height of boundary layer" ;
        zmla:units = "m" ;
        zmla:_FillValue = 9.96920996838687e+36 ;
double tas(time) ;
        tas:standard_name = "air_temperature" ;
        tas:long_name = "2m temperature" ;
        tas:units = "K" ;
        tas:_FillValue = 9.96920996838687e+36 ;
double ts(time) ;
        ts:standard_name = "surface_temperature" ;
        ts:long_name = "Skin temperature" ;
```

```
        ts:units = "K" ;
        ts:_FillValue = 9.96920996838687e+36 ;
double huss(time) ;
        huss:standard_name = "specific_humidity" ;
        huss:long_name = "2m specific humidity" ;
        huss:units = "kg kg-1" ;
        huss:_FillValue = 9.96920996838687e+36 ;
double uas(time) ;
        uas:standard_name = "eastward_wind" ;
        uas:long_name = "10m eastward wind" ;
        uas:units = "m s-1" ;
        uas:_FillValue = 9.96920996838687e+36 ;
double vas(time) ;
        vas:standard_name = "northward_wind" ;
        vas:long_name = "10m northward wind" ;
        vas:units = "m s-1" ;
        vas:_FillValue = 9.96920996838687e+36 ;
double tauu(time) ;
        tauu:long_name = "surface_downward_eastward_stress" ;
        tauu:units = "N m-1" ;
        tauu:_FillValue = 9.96920996838687e+36 ;
double tauv(time) ;
        tauv:long_name = "surface_downward_northward_stress" ;
        tauv:units = "N m-1" ;
        tauv:_FillValue = 9.96920996838687e+36 ;
double z0m(time) ;
        z0m:standard_name = "surface_roughness_length_for_momentum_in_air" ;
        z0m:long_name = "Surface roughness for momentum" ;
        z0m:units = "m" ;
double z0h(time) ;
        z0h:standard_name = "surface_roughness_length_for_heat_in_air" ;
        z0h:long_name = "Surface roughness for heat" ;
        z0h:units = "m" ;
double orog(time) ;
        orog:standard_name = "surface_altitude" ;
        orog:long_name = "Surface altitude" ;
        orog:units = "m" ;
        orog:_FillValue = 9.96920996838687e+36 ;
double ps(time) ;
        ps:standard_name = "surface_air_pressure" ;
        ps:long_name = "Surface Pressure" ;
        ps:units = "Pa" ;
        ps:_FillValue = 9.96920996838687e+36 ;
double tsn(time) ;
        tsn:standard_name = "temperature_in_surface_snow" ;
        tsn:long_name = "Snow temperature profile" ;
        tsn:units = "K" ;
        tsn:_FillValue = 9.96920996838687e+36 ;
double snd(time) ;
        snd:standard_name = "surface_snow_thickness" ;
        snd:long_name = "Surface snow thickness" ;
```

```
                snd:units = "m" ;
                snd:_FillValue = 9.96920996838687e+36 ;
        double rhos(time) ;
                rhos:standard_name = "snow_density" ;
                rhos:long_name = "Snow density" ;
                rhos:units = "kg m-3" ;
                rhos:_FillValue = 9.96920996838687e+36 ;
        double albsn(time) ;
                albsn:long_name = "Snow and ice albedo" ;
                albsn:units = "1" ;
                albsn:_FillValue = 9.96920996838687e+36 ;
        double snw(time) ;
                snw:standard_name = "surface_snow_amount" ;
                snw:long_name = "Snow water equivalent" ;
                snw:units = "kg m-2" ;
                snw:_FillValue = 9.96920996838687e+36 ;
        double hfdsnb(time) ;
                hfdsnb:standard_name = "downward_heat_flux_at_ground_level_in_snow"
;
                hfdsnb:long_name = "Downward heat flux at snow bottom" ;
                hfdsnb:units = "W m-2" ;
                hfdsnb:_FillValue = 9.96920996838687e+36 ;
        double snc(time) ;
                snc:standard_name = "surface_snow_area_fraction" ;
                snc:long_name = "Surface snow area fraction" ;
                snc:units = "%" ;
                snc:_FillValue = 9.96920996838687e+36 ;
        double lat(ncl5) ;
                lat:long_name = "latitude" ;
                lat:units = "degrees_north" ;
        double lon(ncl6) ;
                lon:long_name = "longitude" ;
                lon:units = "degrees_east" ;

// global attributes:
                :feature_type = "timeSeries" ;
                :time_coverage_end = "2018-02-04T0:00:00Z" ;
                :time_coverage_start = "2018-02-01T0:00:00Z" ;
                :geospatial_lon_max = "203.330002" ;
                :geospatial_lon_min = "203.330002" ;
                :geospatial_lat_max = "71.320000" ;
                :geospatial_lat_min = "71.320000" ;
                :project = "YOPPsiteMIP" ;
                :creator_email = "j.day@ecmwf.int" ;
                :creator_name = "Jonathan Day" ;
                :keywords = "YOPP, Polar, Supersite" ;
                :metadata_link =
"https://www.polarprediction.net/fileadmin/user_upload/www.polarprediction.net/Home/
Organization/Task_Teams/Modelling_Task_Team/YOPP_Supersite_common_model_output
_rev4.pdf" ;
                :summary = "3 day forcast for barrow" ;
```

:references = "https://www.ecmwf.int/en/forecasts/documentation-and-support/changes-ecmwf-model" ;
:history = "created from ECMWF DDH archive using script: convert_ddh_cmor_YOPP_tstep_final_ptloop_tiles.ncl" ;
:source = "ECMWF HIRES Operational forecast (Cy43r3)" ;
:institution = "European Centre for Medium-Range Weather Forecasts (ECMWF)" ;
:title = "barrow_ifs-ecmwf_2018020100.nc" ;
:date_created = "2019-03-04" ;
:Conventions = "CF-1.7, ACDD-1.3" ;
}

.