B. Site-Specific Output

In addition to the common set of output fields, modelling teams are requested to output additional data to permit process-based evaluation with observations from key locations. The proposed set of locations comprises IASOA super-sites (https://www.esrl.noaa.gov/psd/iasoa), ECCC super-sites (ecpass.ca) selected Antarctic stations, and at key locations covering the so–called "third pole" (Tibetan plateau). Table B1 shows the locations of the super-sites, including IASOA, ECCC and Antarctic sites.
In order to facilitate the study of ocean-cryosphere-atmosphere coupling processes, we invite data to also be extracted at the (changing) locations of the research icebreaker Oden (expedition during summer SOP 2018), and the MOSAIC drifting observatory (http://www.mosaicobservatory.org/). A few fixed locations over the Arctic Ocean (e.g. the Sheba location 165°W, 76°N) are also desirable.

Table B1: Locations for site-specific model output, corresponding to supersites

Supersite ***Filename***	**Latitude Longitude**	**Elevation**
	Arctic	
Barrow (Alaska) *barrow*	71.32°N, 156.62°W	8-20 m
Oliktok Point (Alaska) *oliktok*	70.50°N 149.89°W	2-6 m
White Horse (Canada) *white_horse*	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) *ny_alesund*	78.92°N, 11.53°E (78.9°N, 11.88°E)	0-30 m (473 m)
Sodankyla (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) *Cherskii*	68.73°N, 161.38°E (68.51°N, 161.53°E)	8 m (16 m)

Ice Base Cape Baranova (Russia) *cape_baranova*	79.3°N, 101.7°E	24m

Antarctic

Alexander Tall Tower *alexander*	79.01°S, 170.72°E	55m
Casey *casey*	66.28°S, 110.53°E	30m
Davis *davis*	68.58°S, 77.97°E	
Dome-C *dome_c*	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) *king_sejong*	62.22°S, 58.79° W	10m
Georg von Neumayer *neumayer*	70.65°S, 8.25°W	42 m
Mawson *mawson*	67.60°S, 62.87°E	15m
Syowa (Showa) *syowa*	69.00°S, 39.59°E	18-29 m
Jang Bogo (Terra Nova Bay) *jang_bogo*	74.62°S, 164.23°E	36m
Amundsen-Scott South Pole *south_pole*	90°S, 0°E	2835 m
Byrd *byrd*	80.01°S, 119.44°W	1538.582 m
Rothera *rothera*	67.57°S, 68.13° W	4m
Vostok *vostok*	78.46°S, 106.84°E	3,489 m
McMurdo (Scott base) *mcmurdo*	77.85°S, 166.67°E (77.85°S, 166.76°E)	10m (10m)
Troll *troll*	72.01°S, 2.54°E	1,275m

Third Pole

Mera (Nepal)	27.7°N, 86.9°E	4570-4520 m

mera		
Tanggula (China) *tanggula*	32.58°N, 91.86°E	5100 m
Xidatan (China) *xidatan*	35.72°N, 94.13°E	4940-6420 m
Iaohugou (China) *iouhugou*	37.5°N, 96.5°E	4180 m
Ocean sites		
SHEBA location *sheba*	165°W, 76°N	Sea level
Arctic Ocean *arctic_ocean_1*	10°E, 85°N	Sea level
Arctic Ocean *arctic_ocean_2*	0°E, 90°N	Sea level
Arctic Ocean *arctic_ocean_3*	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 includes 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 super-sites 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 IASOA Amalgamated Observatory Data Files, which will include measurements with a frequency of 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 lower) we recommend to archive the four model grid-points nearest (surrounding) the super-site location. Ideally, model output should be provided for the set of model grid points within 20km of the observation site. Some of the super-site 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 B2 shows the site-specific output with variables in two tiers. Most variables in ***tier one*** is also included in the three-dimensional model output (see Table A1) however, no averaging is needed here and the output is on model levels.

Tier two model output allows for more process-based evaluation and allow more comparison with super-site observations as well as model inter-comparisons. Please use the variable names listed in Table B2, most come from the CF naming convention and are used and explained in the CMIP experiment guides (SHOULD WE PROVIDE A WEBSITE HERE?).

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. 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 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 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 basic information on model documentation and how diagnostics, such as 2m temperature and boundary-layer height are calculated. Explain if and then how surrounding grid points are chosen as well as which of the sites that data are provided. Person responsible for the data along with contact information should also be provided.

The output format should be netcdf files, one file named with *model* and *site* name from Table B1, combined as *model_site* (example ifs_sodankyla) including all model output variables using the *variable* names from Table B2.

Table B2. Core atmospheric model site-specific output

Variable name as in CMIP	***Longer name***	***Unit***	***Notes***
Single Level fixed variables			
sftlf	Land area fraction	%	If applicable, provide information on tiles, and how they are populated for the main model output and the surrounding locations. For each tile provide information on what type of soil and vegetation
orog	Surface altitude	m	Provide information for the main grid output as well as for the surrounding locations
lat	Latitude	degrees East	
lon	Longitude	degrees North	
Atmospheric variables on model levels			
zg	Geopotential height	M	Provide for both full and half levels if applicable
pfull	Pressure on full levels	Pa	
phalf	Pressure on half levels	Pa	
ua	Eastward wind component	m s^{-1}	
va	Northward wind component	m s^{-1}	
wap	Vertical large-scale wind in pressure coordinates	Pa s^{-1}	Omega, positive downwards
ta	Temperature	K	
tdps	Dew-point temperature	K	
hus	Specific humidity	kg kg^{-1}	

tnt	Tendency of air temperature	K s^{-1}	
tnta	Tendency of air temperature due to advection	K s^{-1}	
tus	Tendency of specific humidity	s^{-1}	
tusa	Tendency of specific humidity due to advection	s^{-1}	
tua	Tendency of the wind U-velocity	m s^{-2}	
tuv	Tendency of the wind V-velocity	m s^{-2}	
rlu	Upward short-wave radiation	W m^{-2}	
rld	Downward short-wave radiation	W m^{-2}	
rsu	Upward long-wave radiation	W m^{-2}	
rsd	Downward long-wave radiation	W m^{-2}	
evu	Vertical eddy diffusivity coefficient for momentum due to parameterized turbulence	m^2 s^{-1}	
edt	Vertical eddy diffusion coefficient for temperature due to parameterized turbulence	m^2 s^{-1}	
wthv	Turbulent sensible heat flux based on virtual potential temperature	W m^{-2}	GCSS variable name
wqv	Turbulent moisture flux based on vapor content	W m^{-2}	GCSS variable name
uw	Eastward turbulent momentum flux	kg m^{-1} s^{-2}	GCSS variable name
vw	Northward turbulent momentum flux	kg m^{-1} s^{-2}	GCSS variable name
tke	Turbulent kinetic energy	m^2 s^{-2}	GCSS variable name
cl	Percentage cloud cover, including both large-scale and convective cloud	%	
clw	Mass fraction of cloud liquid water	kg kg^{-1}	
cli	Mass fraction of cloud ice	kg kg^{-1}	
Single Level atmospheric variables			

z0m	Surface roughness for momentum	m	No CMIP name
z0h	Surface roughness for heat	m	No CMIP name
psl	Mean sea level pressure	Pa	
ps	Surface pressure	Pa	
uas	10 m eastward wind	$m\ s^{-1}$	
vas	10 m northward wind	$m\ s^{-1}$	
zmla	Height of Boundary Layer	M	Provide description on how it is calculated
tas	2m temperature	K	
tdps	2m dew point temperature	K	
huss	2m specific humidity	$kg\ kg^{-1}$	
pr	Total precipitation	$kg\ m^{-2}\ s^{-1}$	At surface, both liquid and rain
prsn	Snowfall flux	$kg\ m^{-2}\ s^{-1}$	At surface, all precipitation in solid phase
clt	Total cloud cover	%	
cod	Cloud optical thickness		
prw	Total column water vapour	$kg\ m^{-2}$	
clwvi	Total column liquid water	$kg\ m^{-2}$	
clivi	Total column icewater	$kg\ m^{-2}$	
	Surface (2m) horizontal visibility	M	No CMIP variable
Surface and TOA variables			
snd	Surface snow thickness	M	
snc	Surface snow area fraction	%	
snw	Snow water equivalent	$kg\ m^{-2}$	
ts	Skin temperature	K	
tsns	Snow surface skin temperature	K	
tsnl	Snow temperature	K	Provide vertical grid if more than one layer
rhos	Snow density		No CMIP name. Provide vertical grid if more than one layer
cnc	canopy area fraction		
tgs	Surface ground skin temperature	K	
tsl	Soil temperature profile	K	Provide vertical grid if more than one layer

mrlsl	Soil moisture profile	kg m^{-2}	Provide vertical grid if more than one layer
rlut	Top-of-atmosphere outgoing long wave radiation	W m^{-2}	
rsdt	Top-of-atmosphere incoming short-wave radiation	W m^{-2}	
rsut	Top-of-atmosphere outgoing short-wave radiation	W m^{-2}	
rsus	Upward surface short-wave radiation	W m^{-2}	
rsds	Downward surface short-wave radiation	W m^{-2}	
rlus	Upward surface long-wave radiation	W m^{-2}	
rlds	Downward surface long-wave radiation	W m^{-2}	
hfls	Surface turbulence latent heat flux	W m^{-2}	
hfss	Surface turbulence sensible heat flux	Wm^{-2}	
hfds	Surface downward heat flux	Wm^{-2}	Ground heat flux
hfdsn	Surface downward heat flux in snow	Wm^{-2}	
hfdsnb	Downward heat flux at snow botton	Wm^{-2}	
albs	Surface albedo	0-1	
albsn	snow and ice albedo	0-1	Albedo over snowcovered portion of gridcell
tauv	Time-average northward turbulence surface stress	N m^{-2}	
tauu	Time-average eastward turbulence surface stress	N m^{-2}	
For ocean locations only, reported on atmospheric grid			
Fixed ocean variables			
thkcello	Ocean model cell thickness	M	
Ocean variables on model levels			
to	Ocean temperature	K	
so	Sea water salinity		The units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.

uo	Ocean u-velocity	m s^{-1}	
vo	Ocean v-velocity	m s^{-1}	
wo	Ocean w-velocity	m s^{-1}	
Ocean single level variables			
mlotst	Ocean mixed-layer depth	M	Defined by sigma T
hfsso	Atmosphere-ocean sensible heat flux	W m^{-2}	
hflso	Atmosphere-ocean latent heat flux	W m^{-2}	
rsntds	Net downward shortwave radiation at sea water surface	W m^{-2}	
rlntds	Net downward longwave radiation at sea water surface	W m^{-2}	
wfo	Fresh water flux into sea water	kg m^{-2} s^{-1}	
fsitherm	Water flux into sea water due to sea ice thermodynamic	kg m^{-2} s^{-1}	
tauuo	Ocean surface x-stress	N m^{-2}	Surface downward x Stress
tauvo	Ocean surface y-stress	N m^{-2}	Surface downward y Stress
	Significant wave height	m	
Sea ice variables, report on atmospheric grid Quantities refer to the ice-covered fraction portion of the grid-cell only			
siconc	Sea ice concentration (area fraction)	%	Only report variables if siconc > 0
siitdconc	Sea-ice concentration (area fraction) in categories		
sithick	Sea ice thickness	m	
siitdthick	Sea-ice thickness in thickness categories		
sisnthick	Snow thickness on sea-ice	m	
siage	Sea-ice age	s	
siu	Sea ice u-velocity	m s^{-1}	
siv	Sea ice v-velocity	m s^{-1}	
sisali	Sea ice salinity	g kg^{-1}	
sistressave	Sea ice normal stress (pressure)	Pa	
sicompstren	Compressive sea ice strength	Pa m	

sitemptop	Surface temperature (temperature at atmosphere-cryosphere interface)	K	
sitempsnic	Temperature at snow-ice interface	K	
sitempbot	Temperature at ice-ocean interface	K	
sialb	Sea-ice / snow albedo	%	
siflsensupbot	Ocean-ice net sensible heat flux	W m^{-2}	
siflsenstop	Net upward sensible heat flux over sea ice	W m^{-2}	
sifllatstop	Net upward latent heat flux over sea ice	W m^{-2}	
siflswdtop	Downwelling shortwave flux over sea ice	W m^{-2}	
siflswutop	Upwelling shortwave flux over sea ice	W m^{-2}	
sifllwdtop	Downwelling longwave flux over sea ice	W m^{-2}	
sifllwutop	Upwelling longwave flux over sea ice	W m^{-2}	
siflcondtop	Net conductive heat flux in ice at the surface	W m^{-2}	
sipr	Rainfall rate over sea ice	kg m^{-2} s^{-1}	
	Fast ice area fraction	%	
	Fast ice thickness	m	
	Ridged ice area fraction	%	
	Ridged ice thickness	m	

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