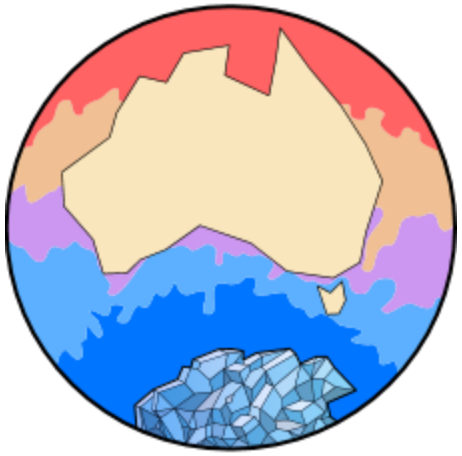

ACCESS-NRI Intake Catalog

Searching and accessing climate model datasets

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Australia's climate simulator

ACCESS National Research Infrastructure

Pre-work: Start ARE

Set-up like a normal session for COSIMA Recipes:

Projects:

gdata/xp65+gdata/hh5+gdata/ik11+gdata/cj50+gdata/$PROJECT
(+gdata/oi10+gdata/ol01+gdata/fs38+gdata/p73)

Module directories

`/g/data/hh5/public/modules`

Modules

`conda/analysis3`

Compute Size of `large` or greater.

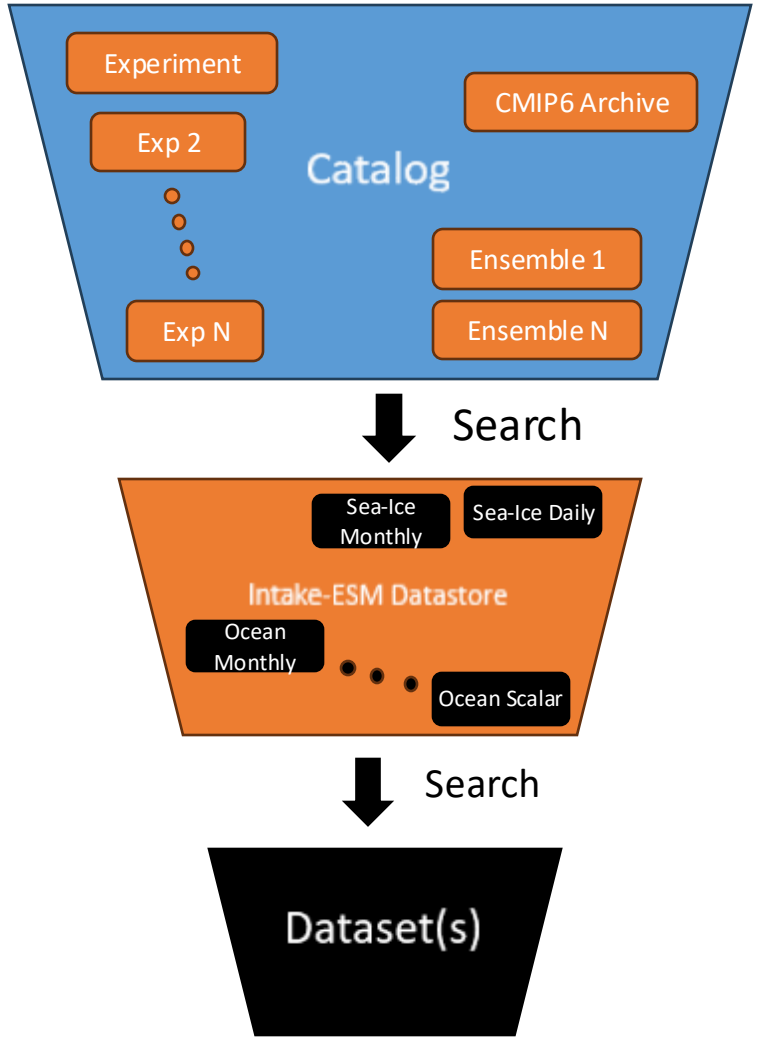
ACCESS-NRI Intake Catalog

A catalog provides functionality for searching, discovering and loading data.

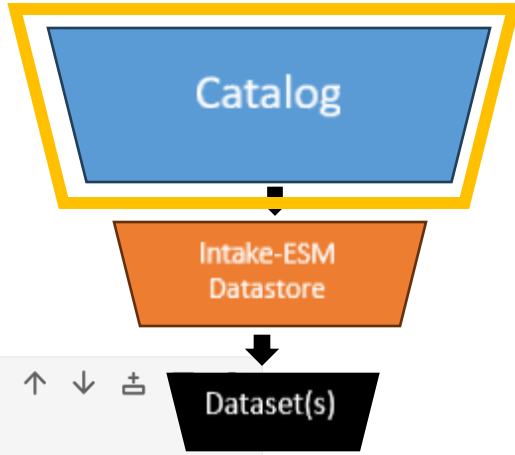
Data can be searched by many attributes, including:

- Experiment name
- Model
- Realm / Model Component
- Data Frequency
- Variable Name
- Variable Standard & Long Names

The ACCESS-NRI Intake Catalog is built upon Intake-ESM, and only shows data stored at the NCI.



ACCESS-NRI Intake Catalog



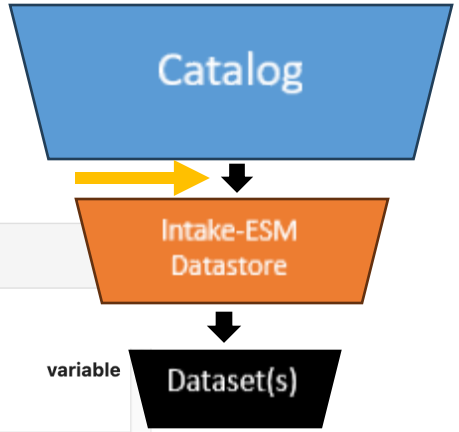
[1]:
```
import intake

catalog = intake.cat.access_nri
```

[2]:
```
catalog
```

access_nri catalog with 94 source(s) across 2268 rows:

name	model	description	realm	frequency	variab
01deg_jra55v13_ryf9091	{ACCESS-OM2}	{0.1 degree ACCESS-OM2 global model configuration with JRA55-do v1.3 RYF9091 repeat year forcing (May 1990 to Apr 1991)}	{ocean, sealce}	{3mon, 1mon, fx, 3hr, 1day}	{ANGLET, buoyfreq2_wt, dyu, fsalt_ai_m, tx_tran sss_m, frazil_r total_ocean_fprec, ke_tc total_ocean_lw_hea bih_fric_v, vocn_r frazil_3d_int_z, sig2_r tx_trans_rho, tau_ sfc_hflux_fr
01deg_jra55v140_iaf	{ACCESS-	{Cycle 1 of 0.1 degree ACCESS-OM2 global model	{ocean,	{1day,	{ANGLET, buoyfreq2_w bmf_u, u, dyu, fsalt_ai_r tx_trans, frazil_r total_ocean_fprec, ke_tc

Experiment filtering and data discovery



In [3]:
```
catalog_filtered_example = catalog.search(model="ACCESS-OM2")
catalog_filtered_example
```

Intake dataframe catalog with 76 source(s) across 334 rows:

name	model	description	realm	frequency	variable
01deg_jra55v13_ryf9091	{ACCESS-OM2}	{0.1 degree ACCESS-OM2 global model configuration with JRA55-do v1.3 RYF9091 repeat year forcing (May 1990 to Apr 1991)}	{ocean, sealce}	{3mon, 1mon, fx, 3hr, 1day}	{ANGLET, buoyfreq2_wt, u, dyu, fsalt_ai_m, tx_trans, sss_m, frazil_m, total_ocean_fprec, ke_tot, total_ocean_lw_heat, bih_fric_v, vocn_m, frazil_3d_int_z, sig2_m, tx_trans_rho, tau_y, sfc_hflux_fr...
01deg_jra55v140_iaf	{ACCESS-OM2}	{Cycle 1 of 0.1 degree ACCESS-OM2 global model configuration with JRA55-do v1.4.0 OMIP2 interannual forcing}	{ocean, sealce}	{1day, 1mon, fx}	{ANGLET, buoyfreq2_wt, bmf_u, u, dyu, fsalt_ai_m, tx_trans, frazil_m, total_ocean_fprec, ke_tot, sea_level_sq, total_ocean_lw_heat, bih_fric_v, bottom_temp, frazil_3d_int_z, daidtt_m, tau_y, temp_...
01deg_jra55v140_iaf_cycle2	{ACCESS-OM2}	{Cycle 2 of 0.1 degree ACCESS-OM2 global model configuration with JRA55-do v1.4.0 OMIP2 interannual forcing}	{ocean, sealce}	{1day, 1mon, fx}	{dvirdgdt_m, ANGLET, melts, buoyfreq2_wt, fresh_m, bmf_u, u, dyu, fsalt_ai_m, tx_trans, frazil_m, total_ocean_fprec, ke_tot, sea_level_sq, total_ocean_lw_heat, bih_fric_v, bottom_temp,

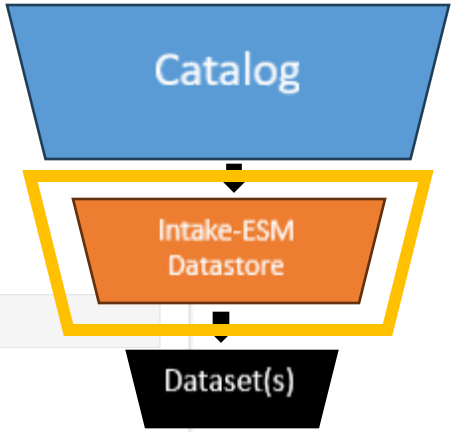
[ ]:
```
catalog.search(model="ACCESS-OM2", frequency="1day", variable="wdet100")
```

[ ]:
```
catalog.search(model="ACCESS-OM2", frequency="1day", variable="w.*")
```

[6]:
```
catalog.search(model="ACCESS-*").df.model.unique()
```

[6]:
```
array([('ACCESS1-0',), ('ACCESS1-3',), ('ACCESS-CM2',),
       ('ACCESS-ESM1-5',), ('ACCESS-OM2',), ('ACCESS-OM2-025',)],
      dtype=object)
```

Each experiment is an Intake-ESM Datastore




```
[12]: catalog['025deg_jra55_iaf_omip2_cycle6']
```

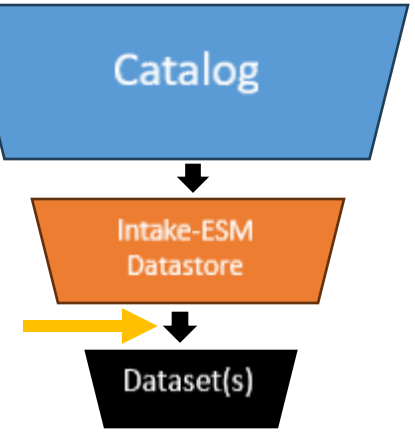
025deg_jra55_iaf_omip2_cycle6 catalog with 8 dataset(s) from 1830 asset(s):

	unique
path	1830
realm	2
variable	296
frequency	3
start_date	855
end_date	854
variable_long_name	271
variable_standard_name	57
variable_cell_methods	6
variable_units	63
filename	1470
file_id	8
derived_variable	0

```
[13]: catalog['025deg_jra55_iaf_omip2_cycle6'].keys()
```

```
[13]: ['iceh_XXXX_XX.1mon',
       'iceh_XXXX_XX_daily.1day',
       'ocean_budget.1mon',
       'ocean_daily.1day',
       'ocean_grid.fx',
       'ocean_month.1mon',
       'ocean_scalar.1mon',
       'ocean_scalar_snapshot.1day']
```

Refine to one dataset




```
[26]: ocn_1mon_search = catalog['025deg_jra55_iaf_omip2_cycle6'].search(frequency='1mon', realm='ocean')
      ocn_1mon_search
```

025deg_jra55_iaf_omip2_cycle6 catalog with 3 dataset(s) from 183 asset(s):

	unique
path	183
realm	1
variable	154
frequency	1
start_date	61
end_date	61
variable_long_name	144
variable_standard_name	56
variable_cell_methods	5
variable_units	45
filename	3
file_id	3
derived_variable	0

```
[27]: ocn_1mon_search.keys()
```

```
[27]: ['ocean_budget.1mon', 'ocean_month.1mon', 'ocean_scalar.1mon']
```

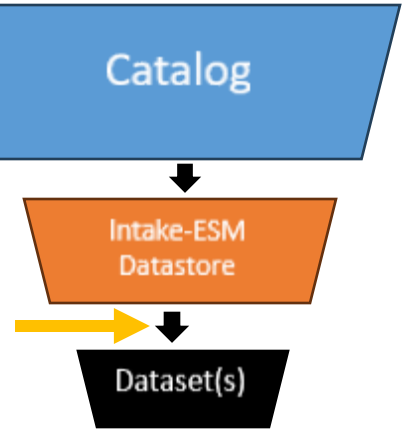
```
[28]: ocn_1mon_gridded_search = ocn_1mon_search.search(file_id='ocean_month')
```

Dataframe view helps with data discovery

```
[29]: ocn_1mon_gridded_search.df.variable[0]
```

```
[29]: ['pbot_t',
 'patm_t',
 'rho_dzt',
 'dht',
 'sea_level',
 'sea_level_sq',
 'pot_temp',
 'temp',
 'sst',
 'sst_sq',
 'bottom_temp',
 'salt',
 'sss',
 'sss_sq',
 'bottom_salt',
 'age_global',
 'mld',
 'mld_max',
 'mld_min',
 'mld_sq',
 'psiu',
 'psiv',
 'bv_freq',
 'buoyfreq2_wt',
 'hblt_max',
 'pot_rho_0',
 'pot_rho_2',
 'rho',
 'eta_t',
 'u',
 'v',
 'wt',
 'tx_trans',
```

Finding a Variable




```
[30]: sss_search = ocn_1mon_gridded_search.search(variable='sss')
```

```
[9]: sss_search
```

by647 catalog with 1 dataset(s) from 50 asset(s):

	unique
path	50
realm	1
variable	265
frequency	1
start_date	10
end_date	10
member	5
variable_long_name	260
variable_standard_name	51
variable_cell_methods	4
variable_units	50
filename	10
file_id	1
derived_variable	0

> ⓘ If we had a priori knowledge that the variable would or might be labelled *sss*, then we can skip straight to searching for it:

```
[7]: sss_search = catalog['by647'].search(frequency='1mon', variable='sss', file_id='ocean_month')
```

Exercise 1:

In a terminal, from ~ or your gdata folder:

```
$ git clone https://github.com/ACCESS-NRI/intake-training/
```

In ARE, open `cosima_exercises_202409.ipynb`

```
import intake
catalog = intake.cat.access_nri
```

View the catalog:

```
catalog
```

Search the catalog by the column in the catalog (e.g. model, experiment name, variable etc) and select an experiment

Find a datastore:

```
catalog.search()
datastore = catalog['experiment']
```

View the datastore:

```
datastore
datastore.df
```

Find a variable:

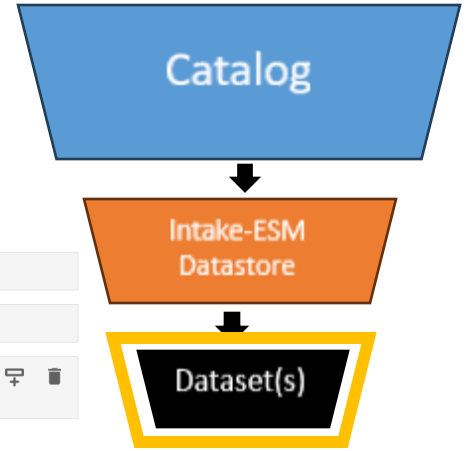
```
datastore.search()
```

Search the datastore by the column in the datastore (e.g. model, experiment name, variable etc) and select at experiment

Refine your search to reach 1 dataset.

Use `.keys()` to assist in refining

Opening one dataset




```
[34]: from dask.distributed import Client

[35]: client = Client(threads_per_worker=1)

[40]: search = catalog['01deg_jra55v140_iaf'].search(variable='temp_surface_ave')
      search.to_dask()
```

[40]: xarray.Dataset

▸ Dimensions: (**time**: 22280, **scalar_axis**: 1)

▾ Coordinates:

scalar_axis	(scalar_axis)	float64	0.0
time	(time)	datetime64[ns]	1958-01-02 ... 2019-01-01

▾ Data variables:

temp_surface_...	(time, scalar_axis)	float64	dask.array<chunksize=(1, 1), meta=np....

▸ Indexes: (2)

▾ Attributes:

title :	ACCESS-OM2-01
grid_type :	mosaic
grid_tile :	1
intake_esm_var...	['temp_surface_ave']
intake_esm_attr...	ocean
intake_esm_attr...	1day
intake_esm_attr...	ocean_scalar_1_daily_ym_XXXX_XX
intake_esm_attr...	netcdf
intake_esm_dat...	ocean_scalar_1_daily_ym_XXXX_XX.1day

Datasets can have more than one variable

```
[41]: search = catalog['01deg_jra55v140_iaf'].search(variable=['temp_surface_ave', 'salt_surface_ave'])
```

```
[42]: search
```

01deg_jra55v140_iaf catalog with 1 dataset(s) from 244 asset(s):

	unique
path	244
realm	1
variable	34
frequency	1
start_date	244
end_date	244
variable_long_name	34
variable_standard_name	3
variable_cell_methods	1
variable_units	11
filename	244
file_id	1
derived_variable	0

Collapse Output

```
[43]: search.to_dask()
```

```
[43]: xarray.Dataset
```

▸ Dimensions: (**time**: 22280, **scalar_axis**: 1)

▾ Coordinates:

scalar_axis	(scalar_axis)	float64	0.0
time	(time)	datetime64[ns]	1958-01-02 ... 2019-01-01

▾ Data variables:

salt_surface_ave	(time, scalar_axis)	float64	dask.array<chunksize=(1, 1), meta=np....
temp_surface_...	(time, scalar_axis)	float64	dask.array<chunksize=(1, 1), meta=np....

▸ Indexes: (2)

▸ Attributes: (9)

Related variables are often in different datasets

[52]:
```
search = catalog['01deg_jra55v140_iaf'].search(variable=['surface_salt', 'surface_temp'], frequency='1mon')
search
```

01deg_jra55v140_iaf catalog with 2 dataset(s) from 488 asset(s):

	unique
path	488
realm	1
variable	6
frequency	1
start_date	244
end_date	244
variable_long_name	6
variable_standard_name	3
variable_cell_methods	2
variable_units	4
filename	488
file_id	2
derived_variable	0

[53]:
```
search.keys()
```

[53]:
```
['ocean_2d_surface_salt_1_monthly_mean_ym_XXXX_XX.1mon',
 'ocean_2d_surface_temp_1_monthly_mean_ym_XXXX_XX.1mon']
```

Related variables on the same grid can be merged

[54]:
```
search = catalog['01deg_jra55v140_iaf'].search(variable=['surface_salt', 'surface_temp'], frequency='1mon')
```

[56]:
```
ds_dict = search.to_dataset_dict()
```

```
--> The keys in the returned dictionary of datasets are constructed as follows:
        'file_id.frequency'
```

100.00% [2/2 00:08<00:00]

[58]:
```
import xarray as xr
```

[61]:
```
xr.merge(
    ds_dict.values(),
)
```

[61]: xarray.Dataset

▸ Dimensions: (**time**: 732, **yt_ocean**: 2700, **xt_ocean**: 3600)

▾ Coordinates:

xt_ocean	(xt_ocean)	float64	-279.9 -279.8 ... 79.85 79.95
yt_ocean	(yt_ocean)	float64	-81.11 -81.07 ... 89.94 89.98
time	(time)	datetime64[ns]	1958-01-16T12:00:00 ... 2018...

▾ Data variables:

surface_salt	(time, yt_ocean, xt_ocean)	float32	dask.array<chunksize=(1, 540...
surface_temp	(time, yt_ocean, xt_ocean)	float32	dask.array<chunksize=(1, 540...

▸ Indexes: (3)

▸ Attributes: (14)

Experiment extensions can be combined

```
[16]: search = catalog.search(name='01deg_jra55v140_iaf_cycle4.*')
```

```
[17]: search
```

Intake dataframe catalog with 2 source(s) across 14 rows:

name	model	description	realm	frequency	variable
01deg_jra55v140_iaf_cycle4	{ACCESS-OM2}	{Cycle 4 of 0.1 degree ACCESS-OM2 global model configuration with JRA55-do v1.4.0 OMIP2 interannual forcing}	{sealce, ocean}	{3hr, 1mon, 6hr, 1day, fx}	{frazil_m, dyu, npp_int100, src07, dvidtd, radbio1, pprod_gross_intmld, melt, o2_xflux_adv, stf07, src01, fN_ai_m, det, dvirdgdt_m, total_net_sfc_heating, surface_pot_temp_min, frazil_3d_int_z, fs...
01deg_jra55v140_iaf_cycle4_jra55v150_extension	{ACCESS-OM2}	{Extensions of cycle 4 of 0.1 degree ACCESS-OM2 + WOMBAT BGC global model	{sealce,	{1day, 1mon,	{blkmask, albsni_m, v, frzmlt, dzt, ULON, area_t, src06, pprod_gross_int100, caco3, fresh_m, frzmlt_m, temp, frazil_m,

```
[18]: datastore_dict = search.to_source_dict()
```

```
[19]: dataset_dict = {
          name: datastore.search(variable="temp_surface_ave").to_dask()
          for name, datastore in datastore_dict.items()
      }

      ds = xr.merge(dataset_dict.values())
```

```
/g/data/hh5/public/apps/miniconda3/envs/analysis3-24.04/lib/python3.10/site-packages/distributed/client.py:3357: UserWarning:
Sending large graph of size 14.17 MiB.
This may cause some slowdown.
Consider scattering data ahead of time and using futures.
  warnings.warn(
```

```
[20]: ds
```

```
[20]: xarray.Dataset
```

▸ Dimensions: (**scalar_axis**: 1, **time**: 23984)

▾ Coordinates:

scalar_axis	(scalar_axis)	float64	0.0
time	(time)	datetime64[ns]	1958-01-02 ... 2023-09-01

▾ Data variables:

temp_surface_...	(time, scalar_axis)	float64	dask.array<chunksize=(1, 1), meta=np....

▸ Indexes: (2)

▸ Attributes: (14)

An aside about chunks

[19]:
```
dataset_dict = {
    name: datastore.search(variable="temp_surface_ave").to_dask()
    for name, datastore in datastore_dict.items()
}

ds = xr.merge(dataset_dict.values())
```

```
/g/data/hh5/public/apps/miniconda3/envs/analysis3-24.04/lib/python3.10/site-packages/distributed/client.py:3357: UserWarning:
Sending large graph of size 14.17 MiB.
This may cause some slowdown.
Consider scattering data ahead of time and using futures.
  warnings.warn(
```

[20]:
```
ds
```

[20]: xarray.Dataset

▸ Dimensions: (**scalar_axis**: 1, **time**: 23984)

▾ Coordinates:

scalar_axis	(scalar_axis)	float64	0.0
time	(time)	datetime64[ns]	1958-01-02 ... 2023-09-01

▾ Data variables:

temp_surface_...	(time, scalar_axis)	float64	dask.array<chunksize=(1, 1), meta=np....

	Array	Chunk
Bytes	187.38 kiB	13.32 kiB
Shape	(23984, 1)	(1705, 1)
Dask graph	22280 chunks in 1478 graph layers	
Data type	float64 numpy.ndarray	

▸ Indexes: (2)

▸ Attributes: (14)

Reducing the number of file operations

[22]:
```
datastore_dict['01deg_jra55v140_iaf_cycle4'].search(variable="temp_surface_ave")
```

01deg_jra55v140_iaf_cycle4 catalog with 1 dataset(s) from 732 asset(s):

	unique
path	732
realm	1
variable	31
frequency	1
start_date	732
end_date	732
variable_long_name	31
variable_standard_name	3
variable_cell_methods	1
variable_units	11
filename	732
file_id	1
derived_variable	0

[27]:
```
dataset_dict = {
    name: datastore.search(variable="temp_surface_ave").to_dask(
        xarray_open_kwargs={'chunks':{'time':-1}}
    )
    for name, datastore in datastore_dict.items()
}

ds = xr.merge(dataset_dict.values())
```

Reducing the number of file operations

[44]: ds

[44]: xarray.Dataset

▸ Dimensions: (**scalar_axis**: 1, **time**: 23984)

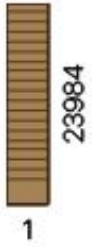
▾ Coordinates:

scalar_axis	(scalar_axis)	float64	0.0
time	(time)	datetime64[ns]	1958-01-02 ... 2023-09-01

▾ Data variables:

temp_surface_...	(time, scalar_axis)	float64	dask.array<chunksize=(31, 1), meta=n...

	Array	Chunk
Bytes	187.38 kiB	13.55 kiB
Shape	(23984, 1)	(1735, 1)
Dask graph	732 chunks in 1478 graph layers	
Data type	float64 numpy.ndarray	



▸ Indexes: (2)

▸ Attributes: (14)

[33]:
```
dataset_dict = {
    name: datastore.search(variable="temp_surface_ave").to_dask(
        xarray_open_kwargs={'chunks':{'time':-1}}
    ).load()
    for name, datastore in datastore_dict.items()
}

ds = xr.merge(dataset_dict.values())
```

A note about CICE output

[21]:
```
catalog['01deg_jra55v140_iaf'].search(variable='aice_m').to_dask(
    xarray_combine_by_coords_kwargs={
        'compat':"override", 'data_vars':"minimal", 'coords':"minimal"
    }
)
```

[21]: xarray.Dataset

▸ Dimensions: (**time**: 732, nj: 2700, ni: 3600)

▾ Coordinates:

time	(time)	datetime64[ns]	1958-02-01 ... 2019-01-01
TLON	(nj, ni)	float32	dask.array<chunksize=(675, 900), meta=np....
TLAT	(nj, ni)	float32	dask.array<chunksize=(675, 900), meta=np....
ULON	(nj, ni)	float32	dask.array<chunksize=(675, 900), meta=np....
ULAT	(nj, ni)	float32	dask.array<chunksize=(675, 900), meta=np....

▾ Data variables:

aice_m	(time, nj, ni)	float32	dask.array<chunksize=(1, 675, 900), meta=n...

▸ Indexes: (1)

▸ Attributes: (17)

Exercise 2:

Find 1 dataset:

```
search = datastore.search()
```

Start a dask cluster

Open the dataset:

```
search.to_dask()
```

Try another search which returns two variables.

```
search = datastore.search(variable=[…,…])
search.to_dataset_dict()
```

Try search with multiple experiments:

```
catalog.search(name='1deg_*')
```

And use `.to_source_dict()`

Try specifying in `.to_dask()`

```
xarray_open_kwargs={'chunks':{…}}
```

Ongoing Work

Marc is adding some datasets to the catalog.

- Panantarctic (GFDL-OM4) results need a new *builder*

Request additional datasets at

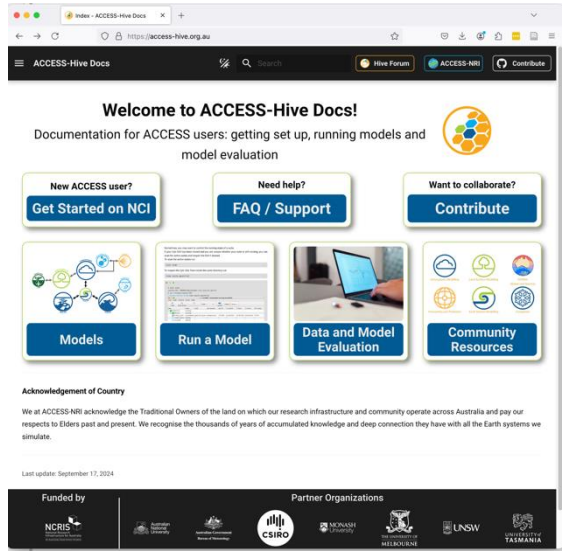
- https://github.com/ACCESS-NRI/access-nri-intake-catalog

List of cosima recipes converted to intake and open pull-requests:

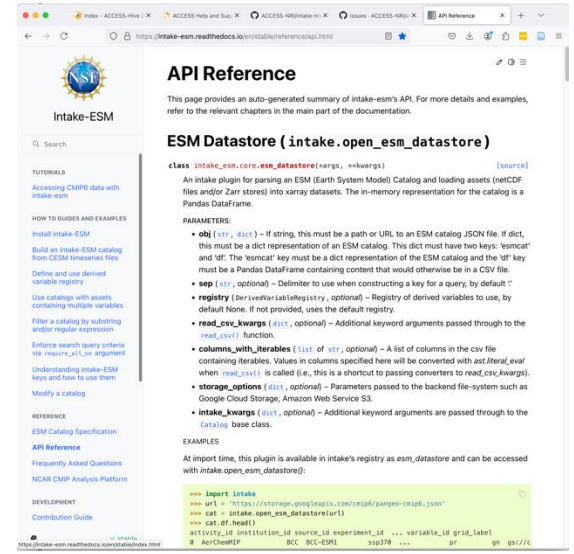
- https://github.com/COSIMA/cosima-recipes/issues/313

NCI also have and add intake catalogs (e.g. ERA5, BARRA/BARPA, CMIP6)

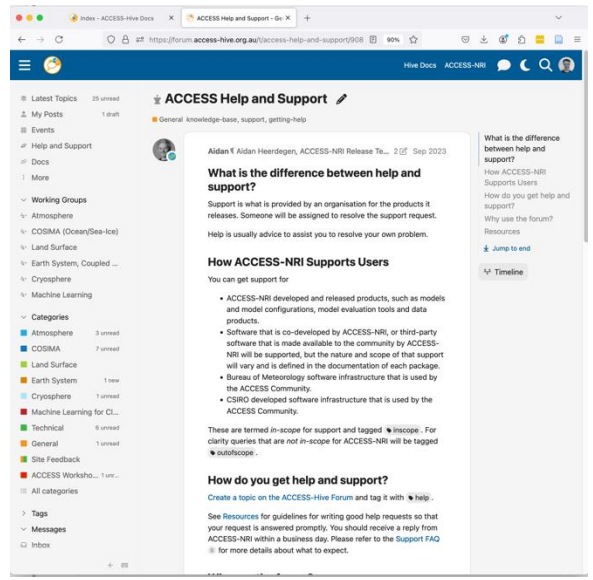
For ACCESS documentation – see ACCESS-HIVE



For intake documentation – see intake-esm website



For general support – use ACCESS-HIVE FORUM



For bugs–use access-nri-intake-catalog github