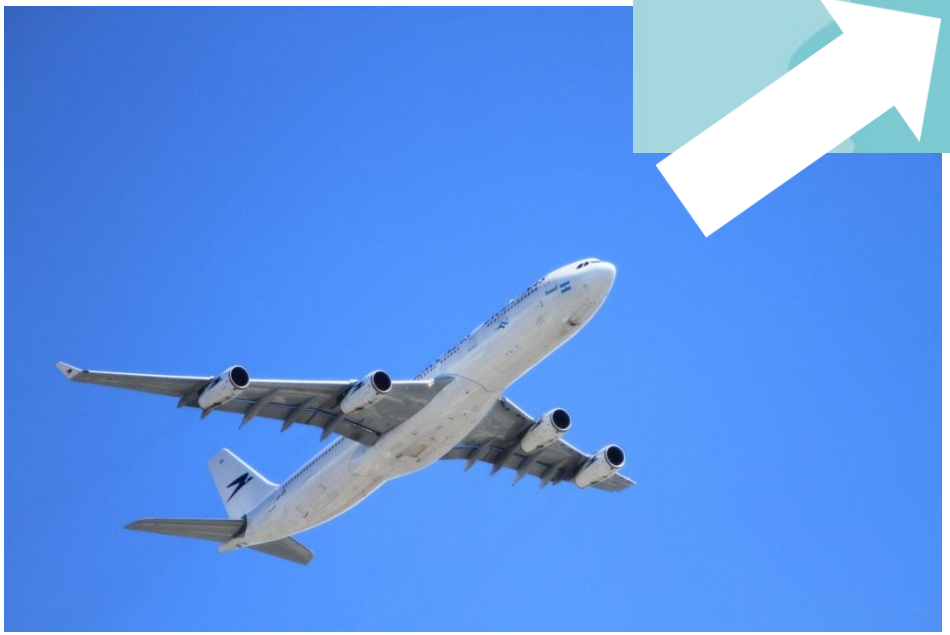
APCC
APEC CLIMATE CENTER

Subseasonal prediction and its application

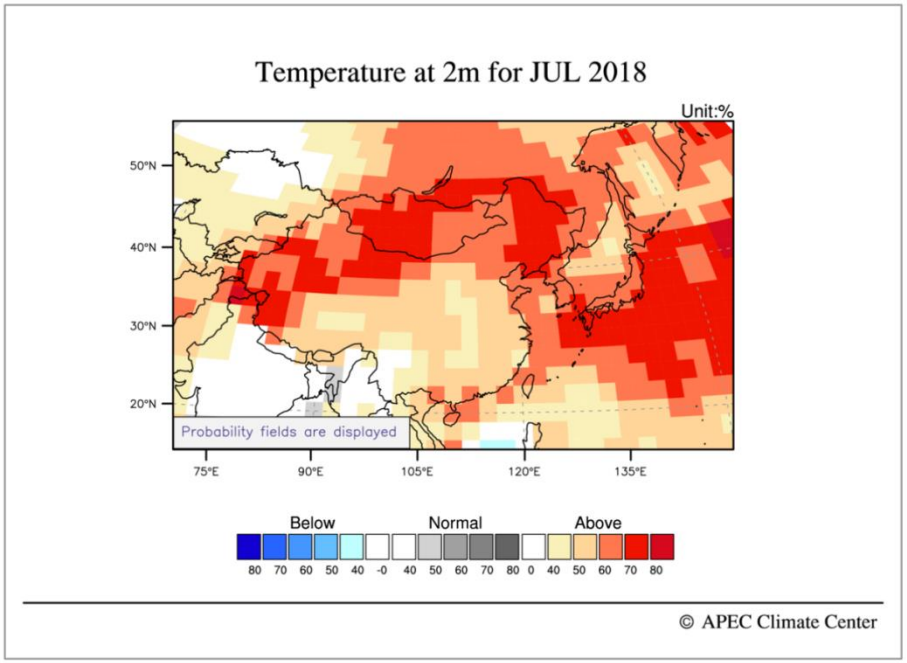
July 25, 2018
Ji-Hyun Oh
APEC Climate Center

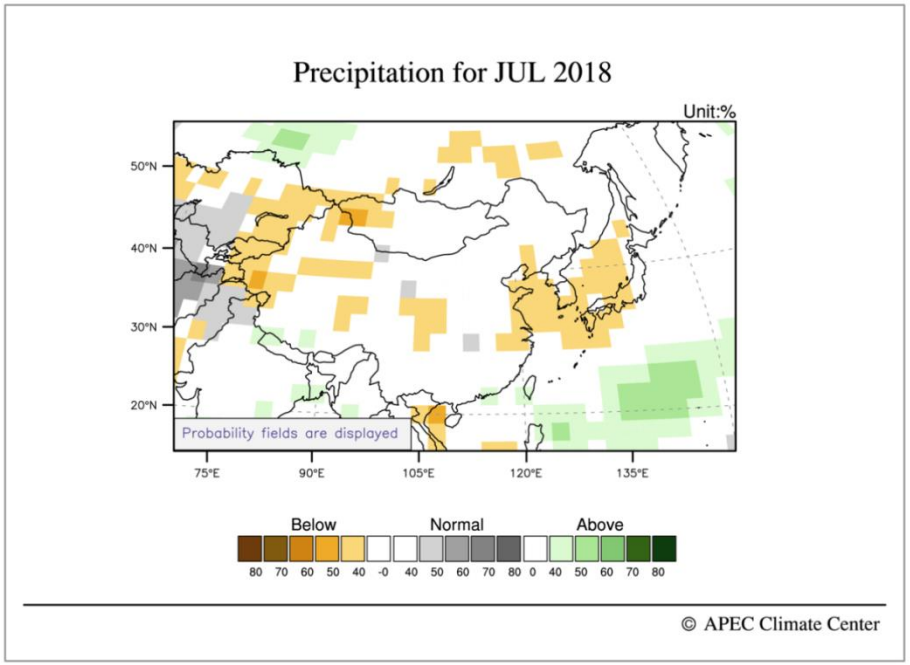
July 2018




China
North Korea
East Sea
Seoul
Ulleungdo
Dokdo
Yellow Sea
Republic of Korea
Busan
APCC
APEC CLIMATE CENTER
Pacific Ocean
Jejudo

Seasonal forecast

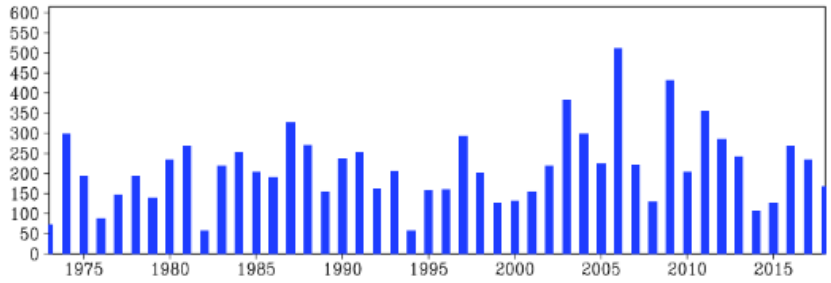




http://www.apcc21.org

Current status

Korea (45stn)
Precipitation
(01Jul2018 ~ 22Jul2018)

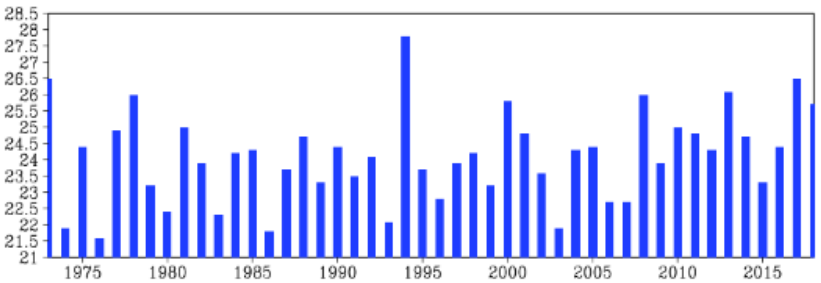


number of year: 46 (1973-2018)

year 2018: 168.3 (rank=30) median(81-10) : 213.2

rank(01)	2006	512.7	rank(24)	2010	203.9
rank(02)	2009	432.4	rank(25)	1985	203.8
rank(03)	2003	383.3	rank(26)	1998	202.4
rank(04)	2011	356.5	rank(27)	1975	194.2
rank(05)	1987	327.1	rank(28)	1978	193.8
rank(06)	2004	300.5	rank(29)	1986	191.9
rank(07)	1974	300.0	rank(30)	2018	168.3
rank(08)	1997	295.1	rank(31)	1992	164.6
rank(09)	2012	285.4	rank(32)	1996	160.2
rank(10)	1988	270.4	rank(33)	1995	157.9
rank(11)	2016	268.1	rank(34)	2001	156.6
rank(12)	1981	267.4	rank(35)	1989	155.1
rank(13)	1984	253.1	rank(36)	1977	147.9
rank(14)	1991	252.4	rank(37)	1979	139.5
rank(15)	2013	242.4	rank(38)	2000	132.7
rank(16)	1990	236.5	rank(39)	2008	130.5
rank(17)	1980	234.6	rank(40)	2015	127.7
rank(18)	2017	234.5	rank(41)	1999	126.8
rank(19)	2005	224.0	rank(42)	2014	108.0
rank(20)	2007	221.9	rank(43)	1976	88.0
rank(21)	1983	220.9	rank(44)	1973	74.6
rank(22)	2002	219.2	rank(45)	1994	57.2
rank(23)	1993	207.2	rank(46)	1982	57.1

Korea (45stn)
Mean Temperature
(01Jul2018 ~ 22Jul2018)

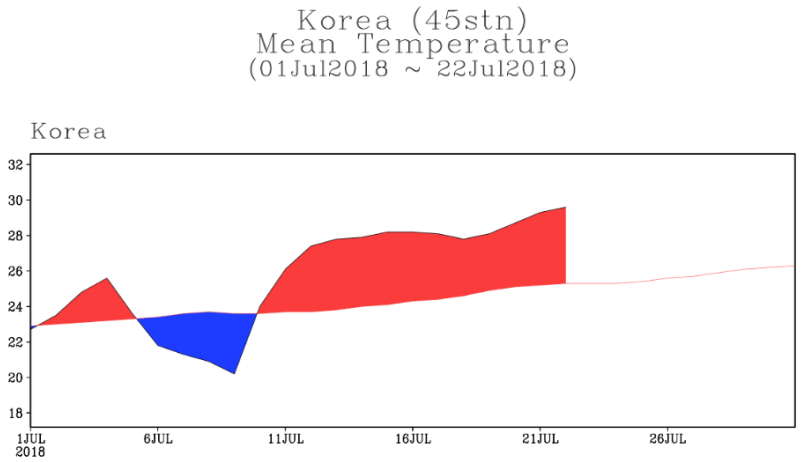


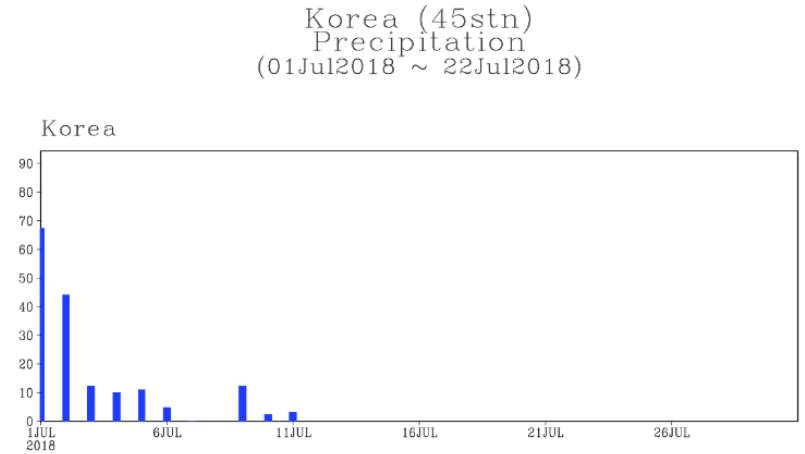
number of year: 46 (1973-2018)

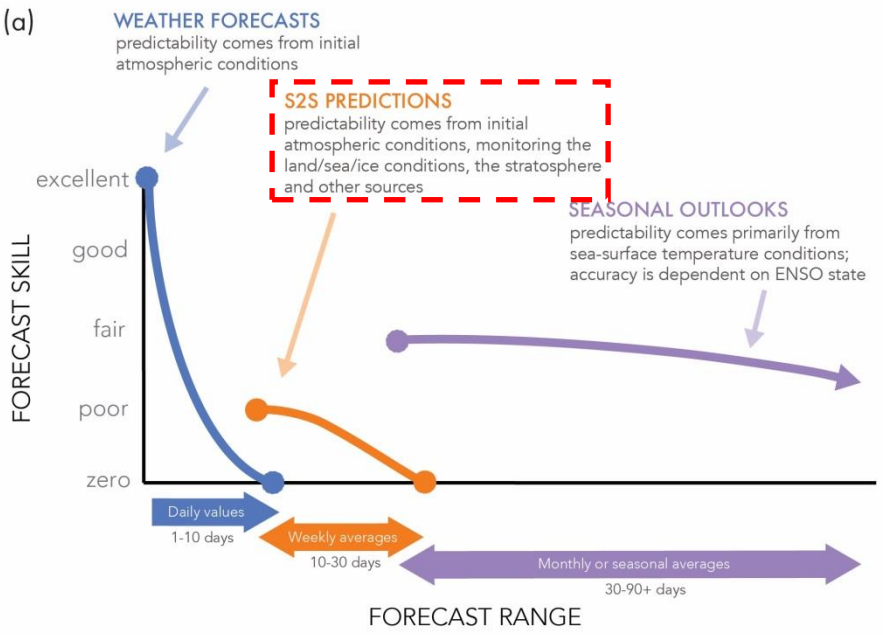
year 2018: 25.7 (rank=8) normal(81-10) : 23.9

rank(01)	1994	27.8	rank(24)	1984	24.2
rank(02)	2017	26.5	rank(25)	1992	24.1
rank(03)	1973	26.5	rank(26)	2009	23.9
rank(04)	2013	26.1	rank(27)	1997	23.9
rank(05)	2008	26.0	rank(28)	1982	23.9
rank(06)	1978	26.0	rank(29)	1995	23.7
rank(07)	2000	25.8	rank(30)	1987	23.7
rank(08)	2018	25.7	rank(31)	2002	23.6
rank(09)	2010	25.0	rank(32)	1991	23.5
rank(10)	1981	25.0	rank(33)	2015	23.3
rank(11)	1977	24.9	rank(34)	1989	23.3
rank(12)	2011	24.8	rank(35)	1999	23.2
rank(13)	2001	24.8	rank(36)	1979	23.2
rank(14)	2014	24.7	rank(37)	1996	22.8
rank(15)	1988	24.7	rank(38)	2007	22.7
rank(16)	2016	24.4	rank(39)	2006	22.7
rank(17)	2005	24.4	rank(40)	1980	22.4
rank(18)	1990	24.4	rank(41)	1983	22.3
rank(19)	1975	24.4	rank(42)	1993	22.1
rank(20)	2012	24.3	rank(43)	2003	21.9
rank(21)	2004	24.3	rank(44)	1974	21.9
rank(22)	1985	24.3	rank(45)	1986	21.8
rank(23)	1998	24.2	rank(46)	1976	21.6

Subseasonal forecast

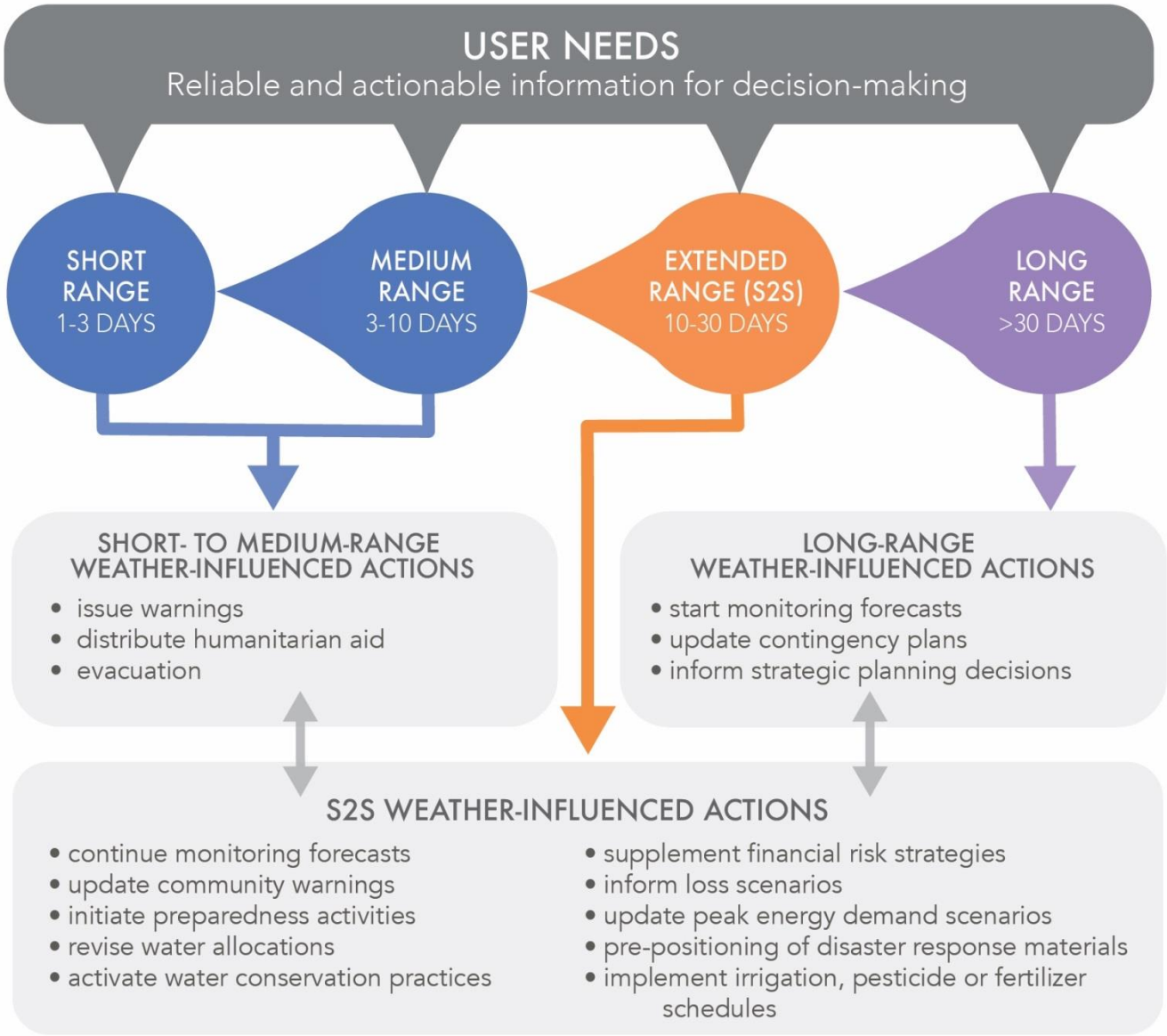






White et al.,(2017)

(b)



White et al.,(2017)

Goal

- Understand S2S prediction system provided by S2S project
- Download S2S forecast from data portal
- Apply data to your own research (advanced)

International project

- **WWRP/WCRP Sub-seasonal to Seasonal Prediction Project (S2S)**
- **North American Multi-Model Ensemble (NMME)**
- **Subseasonal Experiment (SubX)**

Research Priorities

1. Evaluate potential predictability of subseasonal events, including identifying windows of opportunity for increased forecast skill.
2. Understand systematic errors and biases in the subseasonal to seasonal forecast range
3. Compare, verify and test multi-model combinations from these forecasts and quantify their uncertainty.
4. Focus on some specific extreme event case studies.

Scientific issues

1. Identify sources of predictability at the sub-seasonal to seasonal time-range.
2. Prediction of the MJO and its impacts in numerical models
3. Teleconnections - forecasts of opportunity
4. Monsoon prediction.
5. Rainfall predictability and extreme events
6. Polar prediction and sea-ice
7. Stratospheric processes

Modelling issues

1. Role of resolution
2. Role of ocean-atmosphere coupling
3. Teleconnections - forecasts of opportunity
4. Systematic errors.
5. Initialisation strategies for subseasonal prediction
6. Ensemble generation
7. Spread/skill relationship
8. Verification

http://s2sprediction.net/

http://s2sprediction.net/

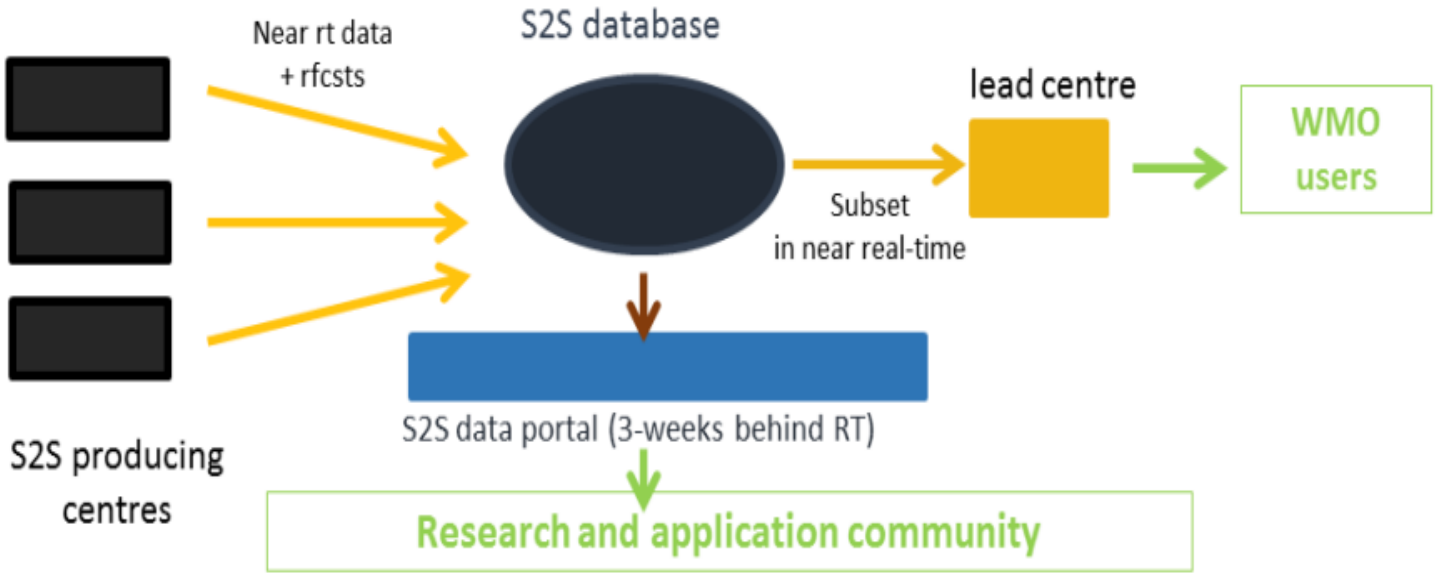
S2S project

- Launched in November 2013 and carried out for 5 years
- S2S phase II from November 2018 to December 2023

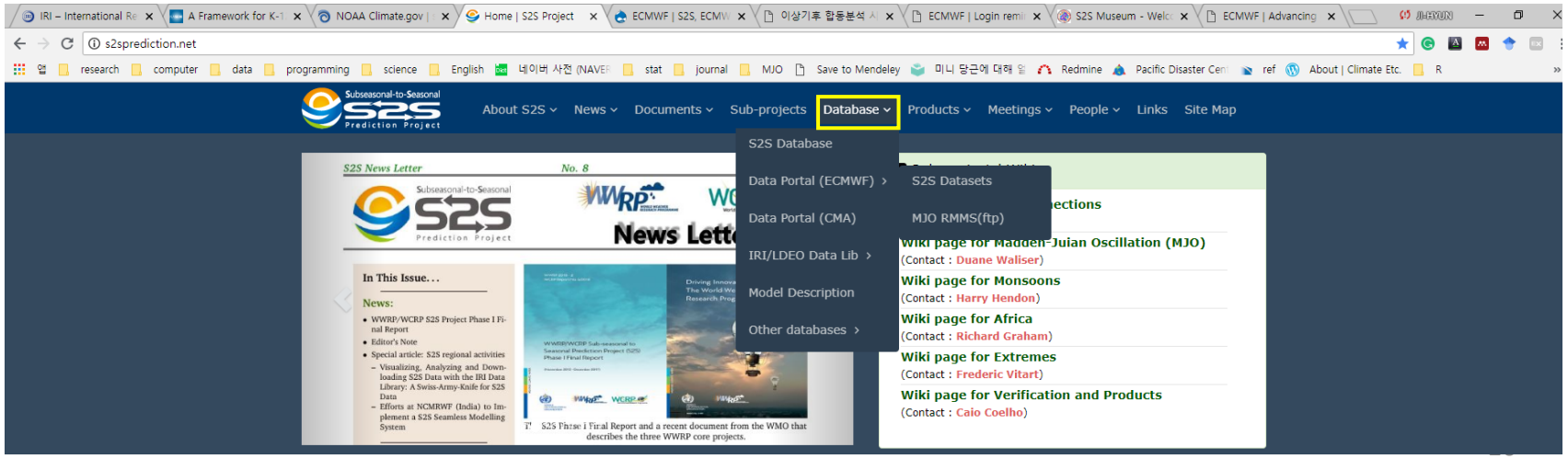
Status on 5th January 2018	Time range	Resolution	Ens. Size	Frequency	Re-forecasts	Rfc length	Rfc frequency	Rfc size
BoM (ammc)	d 0-62	T47L17	3*11	2/week	fix	1981-2013	6/month	3*11
CMA (babj)	d 0-60	T106L40	4	daily	fix	1994-2014	daily	4
CNR-ISAC (isac)	d 0-32	0.75x0.56 L54	41	weekly	fix	1981-2010	every 5 days	5
CNRM (lfpw)	d 0-32	T255L91	51	weekly	fix	1993-2014	2/month	15
ECCC (cwao)	d 0-32	0.45x0.45 L40	21	weekly	on the fly	1995-2014	weekly	4
ECMWF (ecmf)	d 0-46	Tco639/319 L91	51	2/week	on the fly	past 20 years	2/week	11
HMCR (rums)	d 0-61	1.1x1.4 L28	20	weekly	on the fly	1985-2010	weekly	10
JMA (rjtd)	d 0-33	TI479/TI319L100	50	weekly	fix	1981-2010	3/month	5
KMA (rksl)	d 0-60	N216L85	4	daily	on the fly	1991-2010	4/month	3
NCEP (kwbc)	d 0-44	T126L64	16	daily	fix	1999-2010	daily	4
UKMO (egrr)	d 0-60	N216L85	4	daily	on the fly	1993-2015	4/month	7

11 models

Links to operation and research



S2S project phase 1 final report



Research using S2S data

Rainy season onset prediction in Thailand

Climate of Thailand

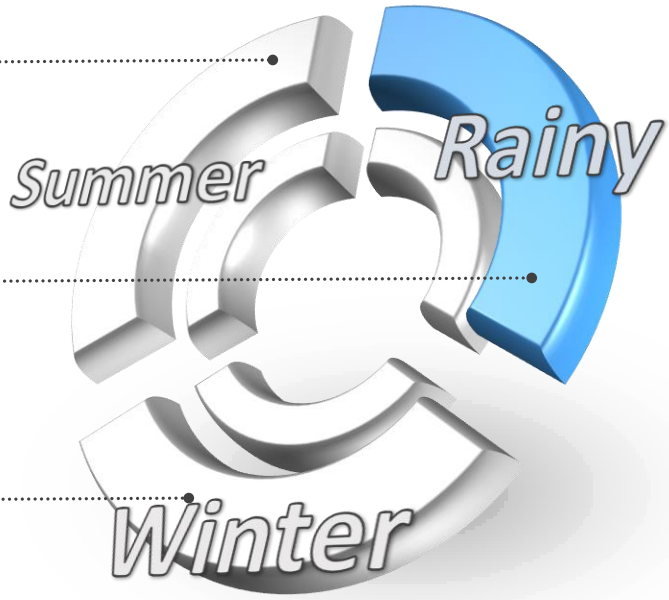
- Under the influence of monsoon winds of seasonal character
  - Southwest monsoon (mid-May~mid-Oct) & northeast monsoon (mid-Oct~mid-Feb)

- Season: divided into three seasons

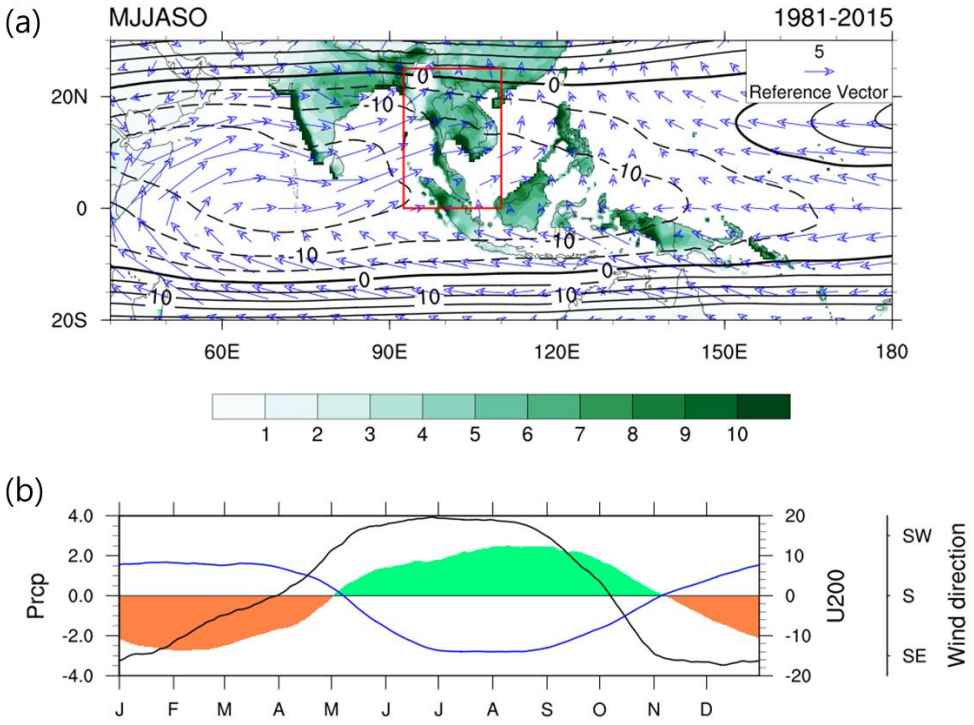
Pre-monsoon
Mid-Feb~Mid-May
Transition period
Warmer (hottest in April)

Southwest monsoon
Mid-May~Mid-Oct
Abundant rain
Wettest Aug & Sep

Northeast monsoon
Cold in Dec & Jan in upper Thailand
Excessive rain in Southern East coast during Oct to Nov

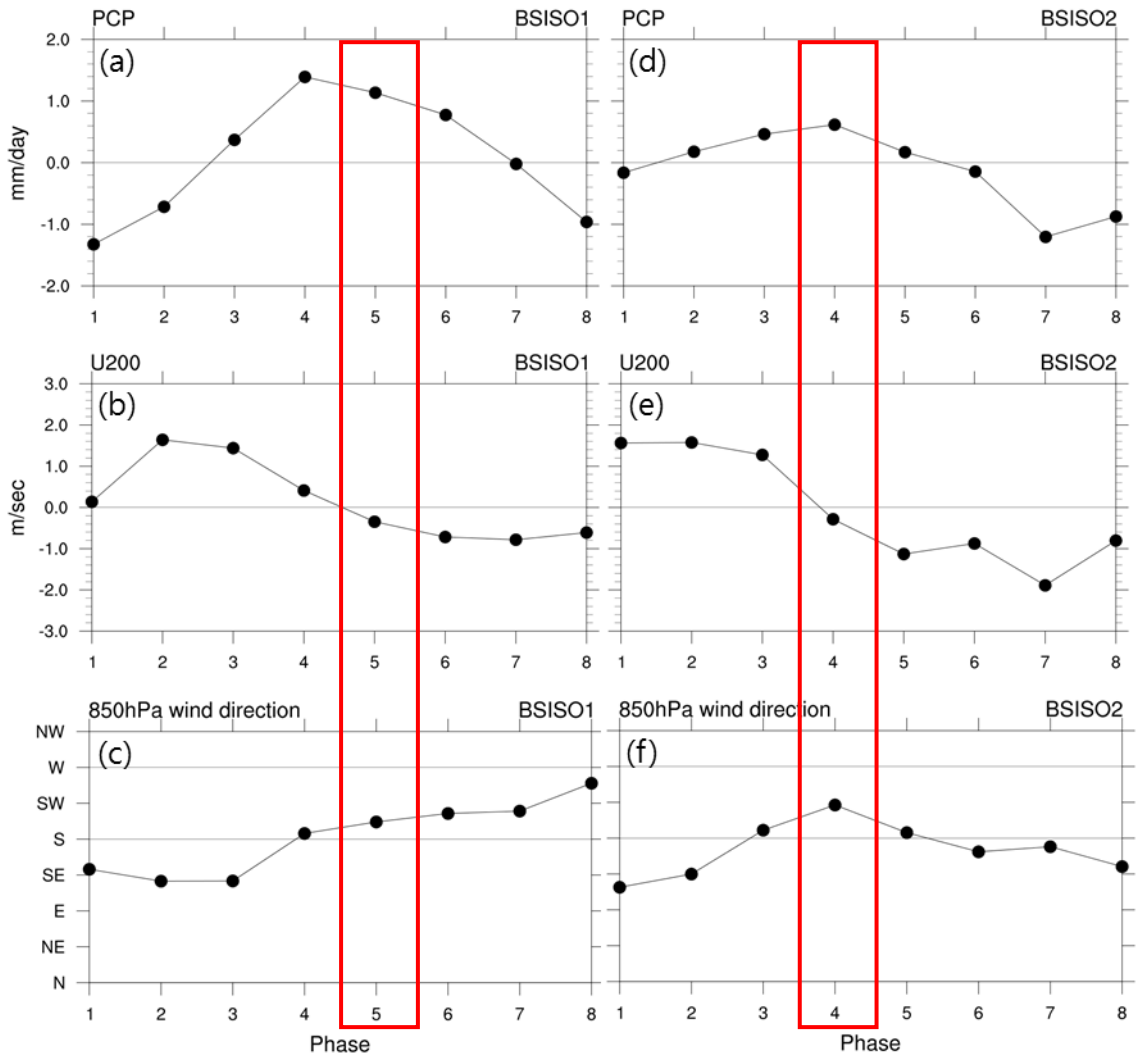


Research using S2S data



- The direction of wind at 850 hPa changes to southwest;
- The zonal wind at 200 hPa reverses from westerly to easterly;
- The daily precipitation anomalies obtained by subtracting climatological annual mean (30-year average from 1981 to 2010) from the total field reverse sign from negative to positive.

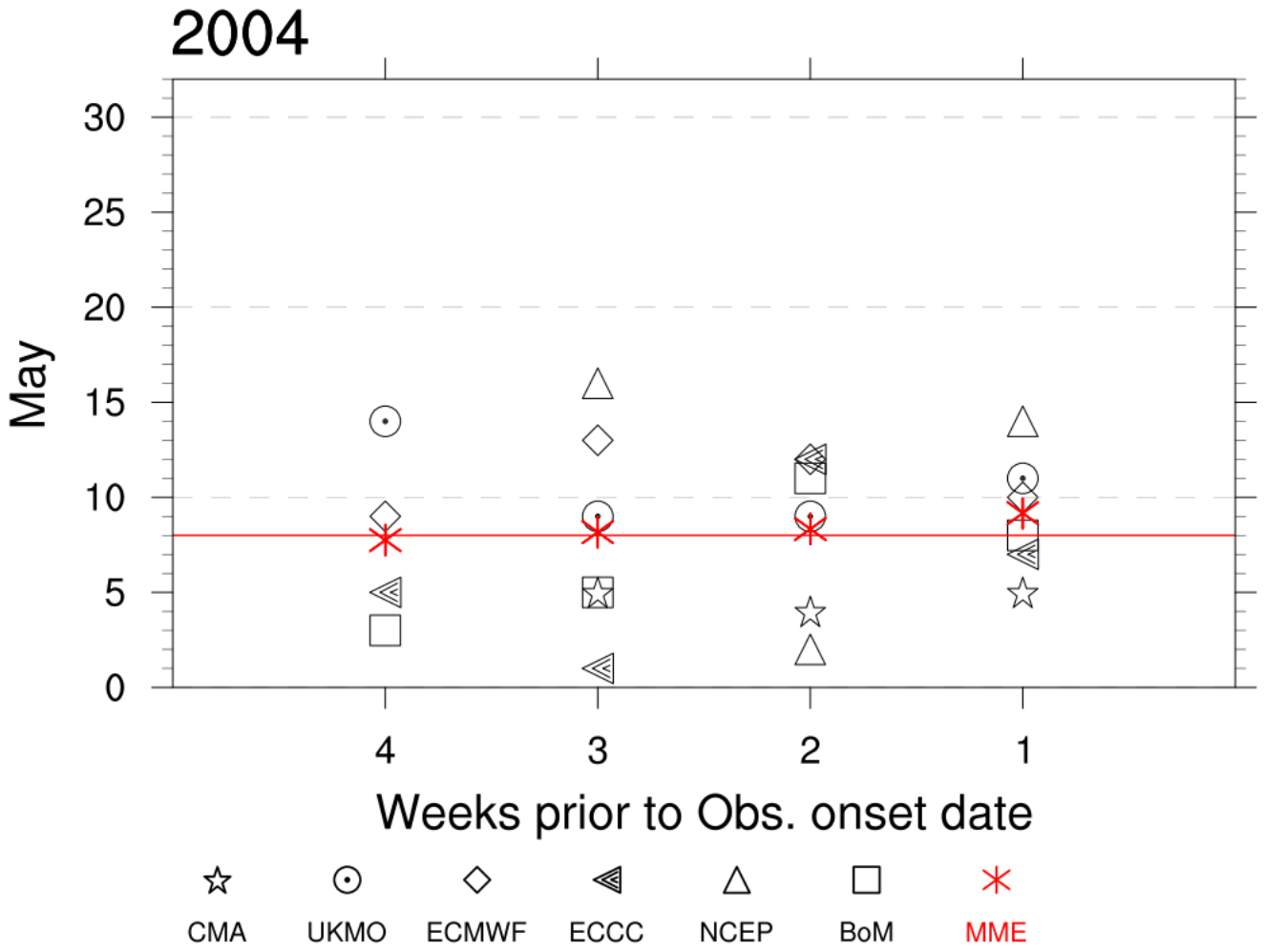
Rainy season onset prediction in Thailand



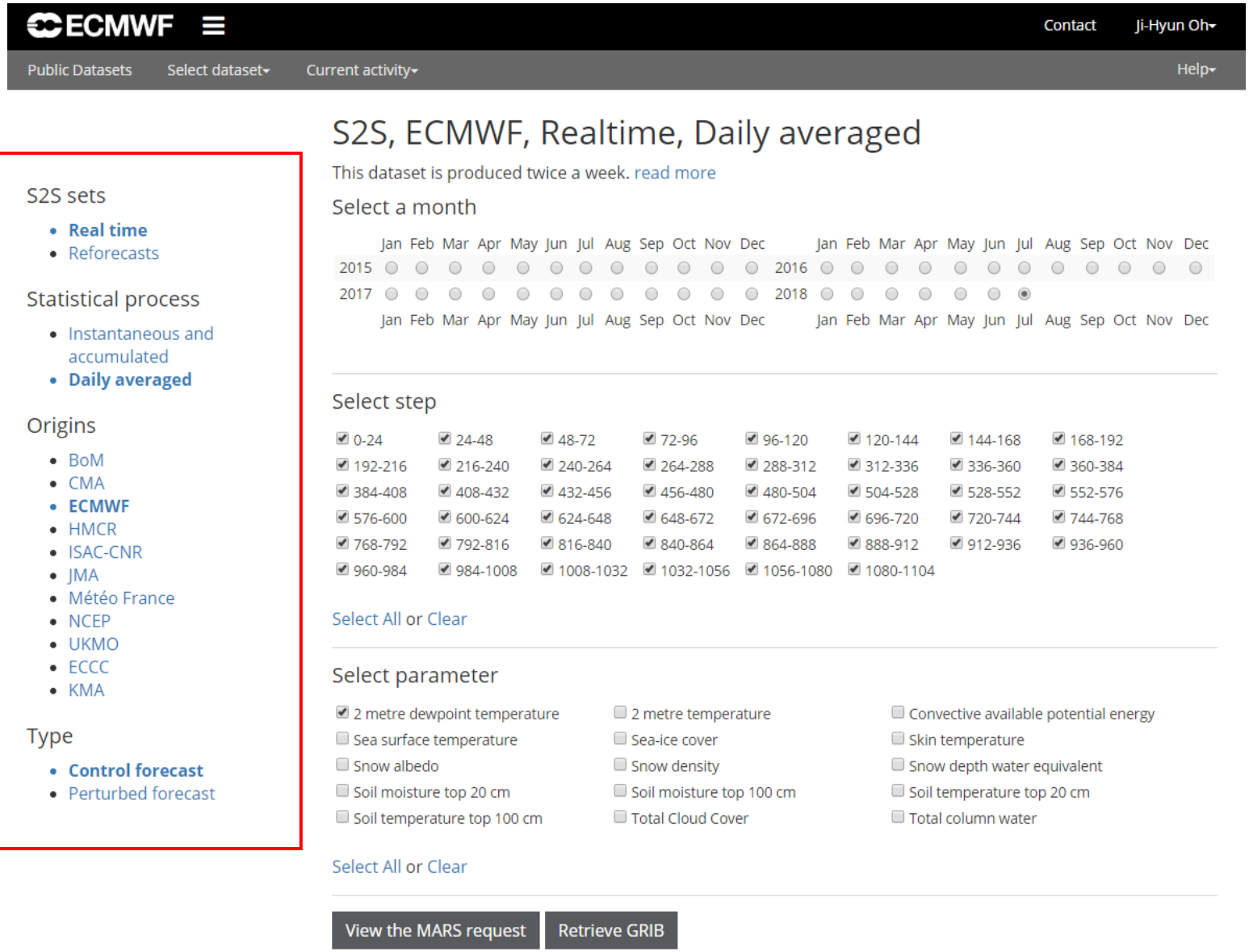
Either BSISO1 p5 or BSISO2 p4 meets three rainy season onset conditions at the same time

Rainy season onset prediction in Thailand

Either BSISO1 p5 or BSISO2 p4 with amplitude greater than 1.0



Download S2S data for your own application



Reforecast vs forecast

ECMWF

Public Datasets Select dataset

S2S sets

- **Real time**
- Reforecasts

Statistical process

- Instantaneous and accumulated
- **Daily averaged**

Origins

- BoM
- CMA
- **ECMWF**
- HMCR
- ISAC-CNR
- JMA
- Météo France
- NCEP
- UKMO
- ECCC
- KMA

Type

- **Control forecast**
- Perturbed forecast

Status on 5th January 2018	Time range	Resolution	Ens. Size	Frequency	Re-forecasts	Rfc length	Rfc frequency	Rfc size
BoM (ammc)	d 0-62	T47L17	3*11	2/week	fix	1981-2013	6/month	3*11
CMA (babj)	d 0-60	T106L40	4	daily	fix	1994-2014	daily	4
CNR-ISAC (isac)	d 0-32	0.75x0.56 L54	41	weekly	fix	1981-2010	every 5 days	5
CNRM (lfpw)	d 0-32	T255L91	51	weekly	fix	1993-2014	2/month	15
ECCC (cwao)	d 0-32	0.45x0.45 L40	21	weekly	on the fly	1995-2014	weekly	4
ECMWF (ecmf)	d 0-46	Tco639/319 L91	51	2/week	on the fly	past 20 years	2/week	11
HMCR (rums)	d 0-61	1.1x1.4 L28	20	weekly	on the fly	1985-2010	weekly	10
JMA (rjtd)	d 0-33	TI479/TI319L100	50	weekly	fix	1981-2010	3/month	5
KMA (rksl)	d 0-60	N216L85	4	daily	on the fly	1991-2010	4/month	3
NCEP (kwbc)	d 0-44	T126L64	16	daily	fix	1999-2010	daily	4
UKMO (egrr)	d 0-60	N216L85	4	daily	on the fly	1993-2015	4/month	7

What are reforecasts

- **Real-time ensemble forecasts** can be calibrated using historical sets of *reforecasts* (also known as *hindcasts)*
- **Reforecasts** are forecasts run using the **same *model version*** as the real-time forecast for a number of ***past dates***

Reforecast vs forecast

Status on 5th January 2018	Time range	Resolution	Ens. Size	Frequency	Re-forecasts	Rfc length	Rfc frequency	Rfc size
BoM (ammc)	d 0-62	T47L17	3*11	2/week	fix	1981-2013	6/month	3*11
CMA (babj)	d 0-60	T106L40	4	daily	fix	1994-2014	daily	4
CNR-ISAC (isac)	d 0-32	0.75x0.56 L54	41	weekly	fix	1981-2010	every 5 days	5
CNRM (lfpw)	d 0-32	T255L91	51	weekly	fix	1993-2014	2/month	15
ECCC (cwao)	d 0-32	0.45x0.45 L40	21	weekly	on the fly	1995-2014	weekly	4
ECMWF (ecmf)	d 0-46	Tco639/319 L91	51	2/week	on the fly	past 20 years	2/week	11
HMCR (rums)	d 0-61	1.1x1.4 L28	20	weekly	on the fly	1985-2010	weekly	10
JMA (rjtd)	d 0-33	TI479/TI319L100	50	weekly	fix	1981-2010	3/month	5
KMA (rksl)	d 0-60	N216L85	4	daily	on the fly	1991-2010	4/month	3
NCEP (kwbc)	d 0-44	T126L64	16	daily	fix	1999-2010	daily	4
UKMO (egrr)	d 0-60	N216L85	4	daily	on the fly	1993-2015	4/month	7

***fixed* configuration**:
In this case reforecasts for **all past dates** are produced **once** during the lifetime of a given **model version**. For every **new version** of the model, a **new set** of reforecasts is produced.

***on-the-fly* configuration**:
In this case reforecasts are produced at the **same time** as the real-time forecasts. **Each** reforecast refers to **a real-time** forecast.

Reforecast vs forecast

Status on 5th January 2018	Time range	Resolution	Ens. Size	Frequency	Re-forecasts	Rfc length	Rfc frequency	Rfc size
BoM (ammc)	d 0-62	T47L17	3*11	2/week	fix	1981-2013	6/month	3*11
CMA (babj)	d 0-60	T106L40	4	daily	fix	1994-2014	daily	4
CNR-ISAC (isac)	d 0-32	0.75x0.56 L54	41	weekly	fix	1981-2010	every 5 days	5
CNRM (lfpw)	d 0-32	T255L91	51	weekly	fix	1993-2014	2/month	15
ECCC (cwao)	d 0-32	0.45x0.45 L40	21	weekly	on the fly	1995-2014	weekly	4
ECMWF (ecmf)	d 0-46	Tco639/319 L91	51	2/week	on the fly	past 20 years	2/week	11
HMCR (rums)	d 0-61	1.1x1.4 L28	20	weekly	on the fly	1985-2010	weekly	10
JMA (rjtd)	d 0-33	TI479/TI319L100	50	weekly	fix	1981-2010	3/month	5
KMA (rksl)	d 0-60	N216L85	4	daily	on the fly	1991-2010	4/month	3
NCEP (kwbc)	d 0-44	T126L64	16	daily	fix	1999-2010	daily	4
UKMO (egrr)	d 0-60	N216L85	4	daily	on the fly	1993-2015	4/month	7

CMA reforecast (fixed): Jan 1st 1994- Dec 31 2014

ECMWF reforecast (on the fly):

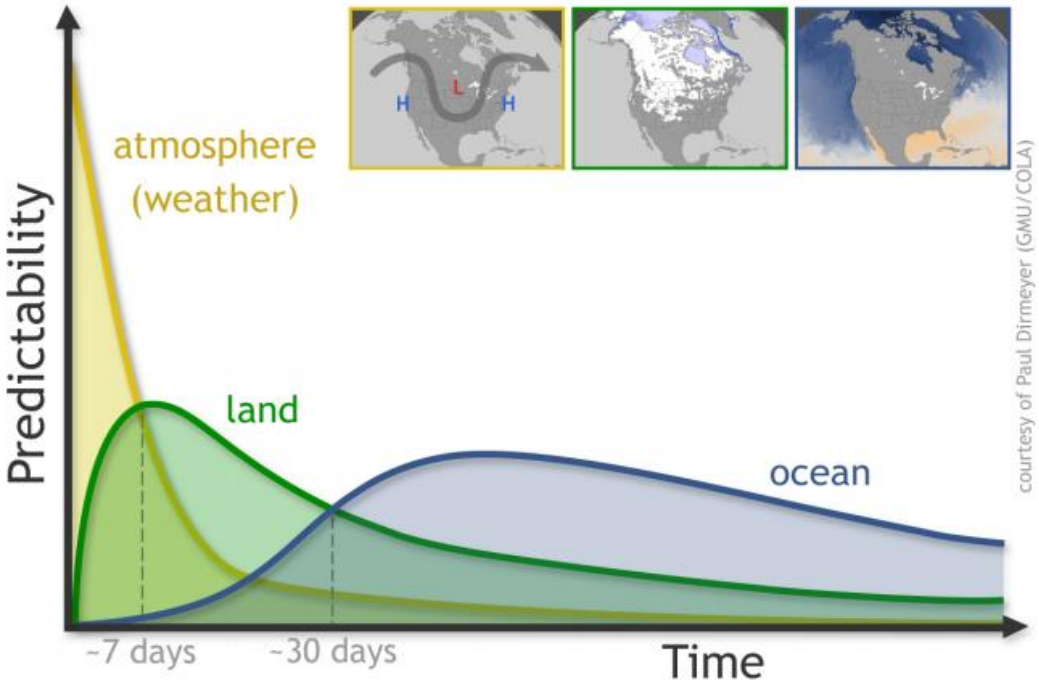
20150514

19950514	19960514	19970514	19980514	19990514	20000514	20010514	20020514	20030514	20040514	20050514	20060514	20070514	20080514	20090514	20100514	20110514	20120514	20130514	20140514

Ensemble

Status on 5th January 2018	Time range	Resolution	Ens. Size	Frequency	Re-forecasts	Rfc length	Rfc frequency	Rfc size
BoM (ammc)	d 0-62	T47L17	3*11	2/week	fix	1981-2013	6/month	3*11
CMA (babj)	d 0-60	T106L40	4	daily	fix	1994-2014	daily	4
CNR-ISAC (isac)	d 0-32	0.75x0.56 L54	41	weekly	fix	1981-2010	every 5 days	5
CNRM (lfpw)	d 0-32	T255L91	51	weekly	fix	1993-2014	2/month	15
ECCC (cwao)	d 0-32	0.45x0.45 L40	21	weekly	on the fly	1995-2014	weekly	4
ECMWF (ecmf)	d 0-46	Tco639/319 L91	51	2/week	on the fly	past 20 years	2/week	11
HMCR (rums)	d 0-61	1.1x1.4 L28	20	weekly	on the fly	1985-2010	weekly	10
JMA (rjtd)	d 0-33	TI479/TI319L100	50	weekly	fix	1981-2010	3/month	5
KMA (rksl)	d 0-60	N216L85	4	daily	on the fly	1991-2010	4/month	3
NCEP (kwbc)	d 0-44	T126L64	16	daily	fix	1999-2010	daily	4
UKMO (egrr)	d 0-60	N216L85	4	daily	on the fly	1993-2015	4/month	7

Ensemble

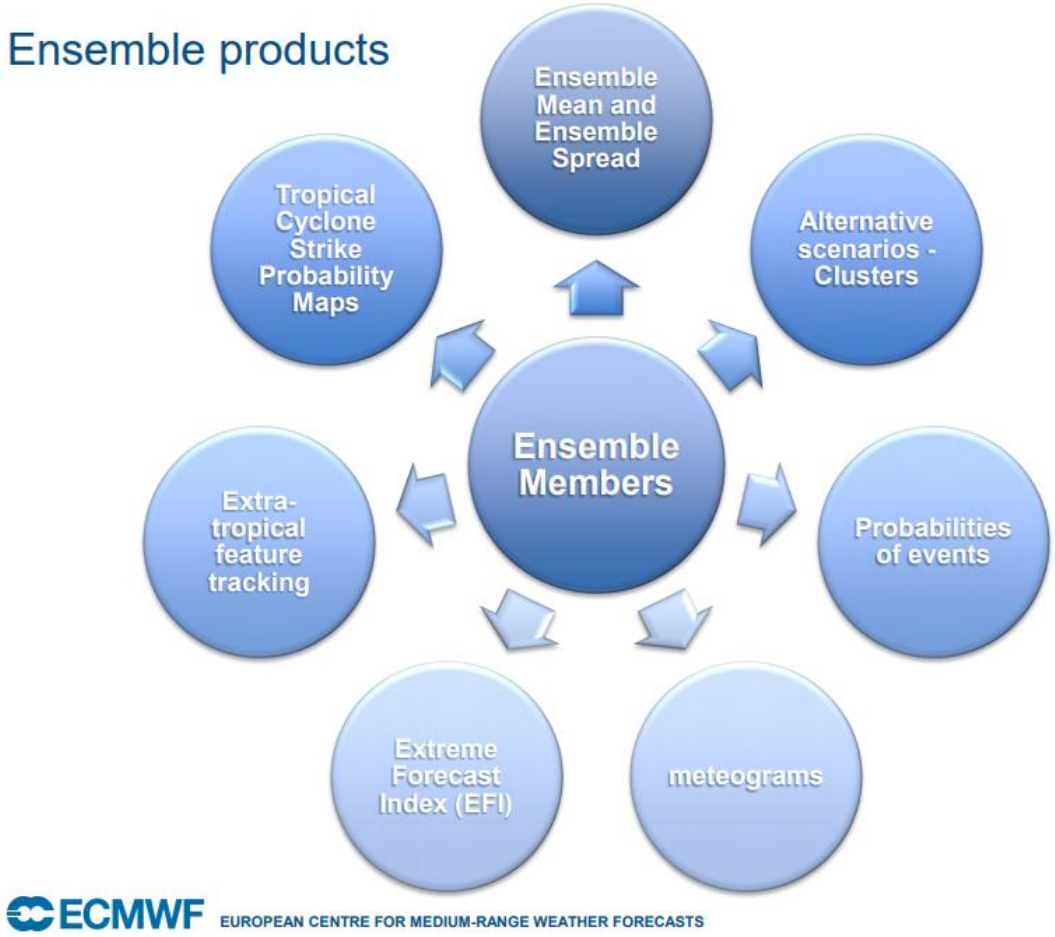


Weather is an initial value problem (depends on the state of the current atmosphere)
Cliamte is a boundary layer problem (slowly varying boundary conditions: ocean, sea ice)

Weather models forecast what is happening in a specific place at a specific time, while climate models forecast the state of the climate.

Ensemble

Ensemble forecasts: A set of forecasts run from slightly different initial conditions to account for initial uncertainties



http://www.wemcouncil.org/wp/wp-content/uploads/2015/07/1130_DavidRichardson.pdf

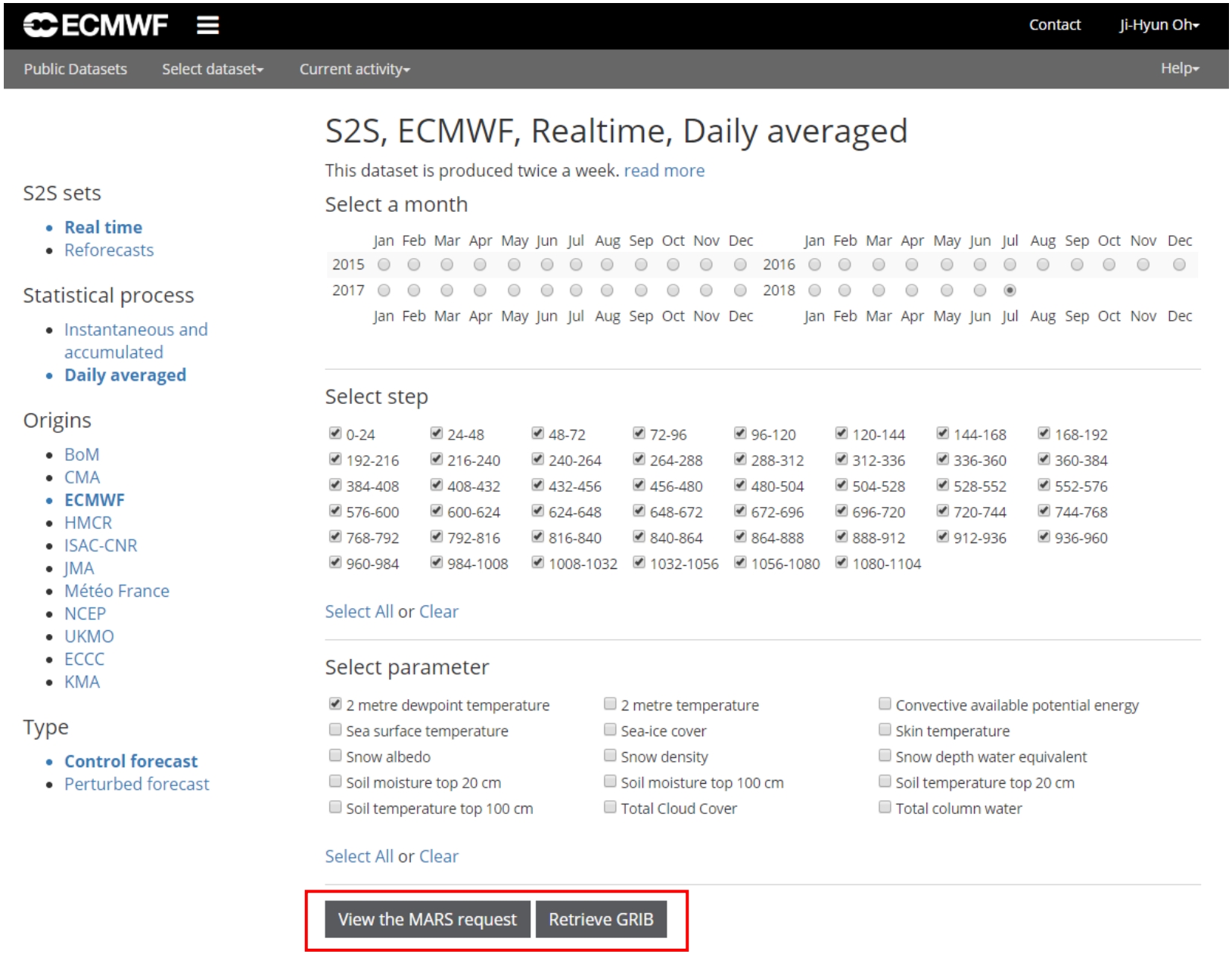
http://s2sprediction.net/

S2S project

Status on 5th January 2018	Time range	Resolution	Ens. Size	Frequency	Re-forecasts	Rfc length	Rfc frequency	Rfc size
BoM (ammc)	d 0-62	T47L17	3*11	2/week	fix	1981-2013	6/month	3*11
CMA (babj)	d 0-60	T106L40	4	daily	fix	1994-2014	daily	4
CNR-ISAC (isac)	d 0-32	0.75x0.56 L54	41	weekly	fix	1981-2010	every 5 days	5
CNRM (lfpw)	d 0-32	T255L91	51	weekly	fix	1993-2014	2/month	15
ECCC (cwao)	d 0-32	0.45x0.45 L40	21	weekly	on the fly	1995-2014	weekly	4
ECMWF (ecmf)	d 0-46	Tco639/319 L91	51	2/week	on the fly	past 20 years	2/week	11
HMCR (rums)	d 0-61	1.1x1.4 L28	20	weekly	on the fly	1985-2010	weekly	10
JMA (rjtd)	d 0-33	TI479/TI319L100	50	weekly	fix	1981-2010	3/month	5
KMA (rksl)	d 0-60	N216L85	4	daily	on the fly	1991-2010	4/month	3
NCEP (kwbc)	d 0-44	T126L64	16	daily	fix	1999-2010	daily	4
UKMO (egrr)	d 0-60	N216L85	4	daily	on the fly	1993-2015	4/month	7

“Nx” denotes a global latitude–longitude grid of 1.5x by 2x points (e.g.,N512 (=25km), N96(130km))
To convert the wave-number 'horizontal resolution' to an approximate grid-length, divide 360 by the wave-number, divide by 3 (it takes 3 grid-points to define a wave), then multiply by 111.1km (per deg. latitude)

Download S2S data for your own application



Download S2S data for your own application

ECMWF

Contact Ji-Hyun Oh

Public Datasets Select dataset Current activity Help

< Return to selection

request

Estimated number of fields: 46

Python script MARS request

For more information on how to retrieve data programmatically, in Python, please go to Access ECMWF Public Datasets.

```
#!/usr/bin/env python
from ecmwfapi import ECMWFDataServer
server = ECMWFDataServer()
server.retrieve({
    "class": "s2",
    "dataset": "s2s",
    "date": "2018-07-02",
    "expver": "prod",
    "levtype": "sfc",
    "model": "glob",
    "origin": "ecmf",
    "param": "168",
    "step": "0-24/24-48/48-72/72-96/96-120/120-144/144-168/168-192/192-216/216-240/240-264/264-288/288-312/312-336/336-360/360-384/384-408/408-432/432-456/456-480/480-504/504-528/528-552/552-576/576-600/600-624/624-648/648-672/672-696/696-720/720-744/744-768/768-792/792-816/816-840/840-864/864-888/888-912/912-936/936-960/960-984/984-1008/1008-1032/1032-1056/1056-1080/1080-1104",
    "stream": "enfo",
    "time": "00:00:00",
    "type": "cf",
    "target": "output",
})
```

Download S2S data for your own application

ECMWF ☰ Contact Ji-Hyun Oh

Public Datasets | Select dataset | Current activity | Help

< Return to selection

request

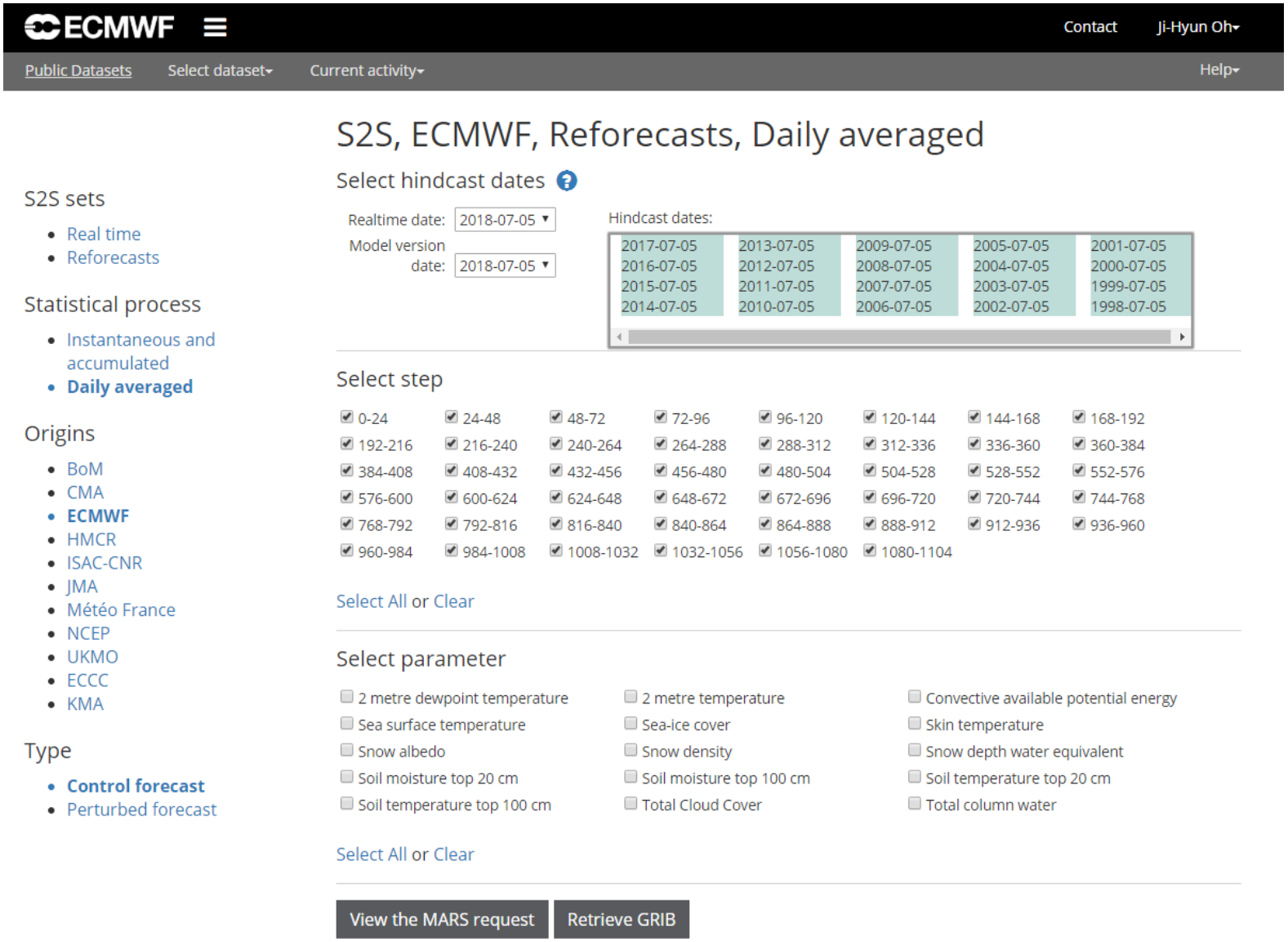
Estimated number of fields: 368

Python script | MARS request

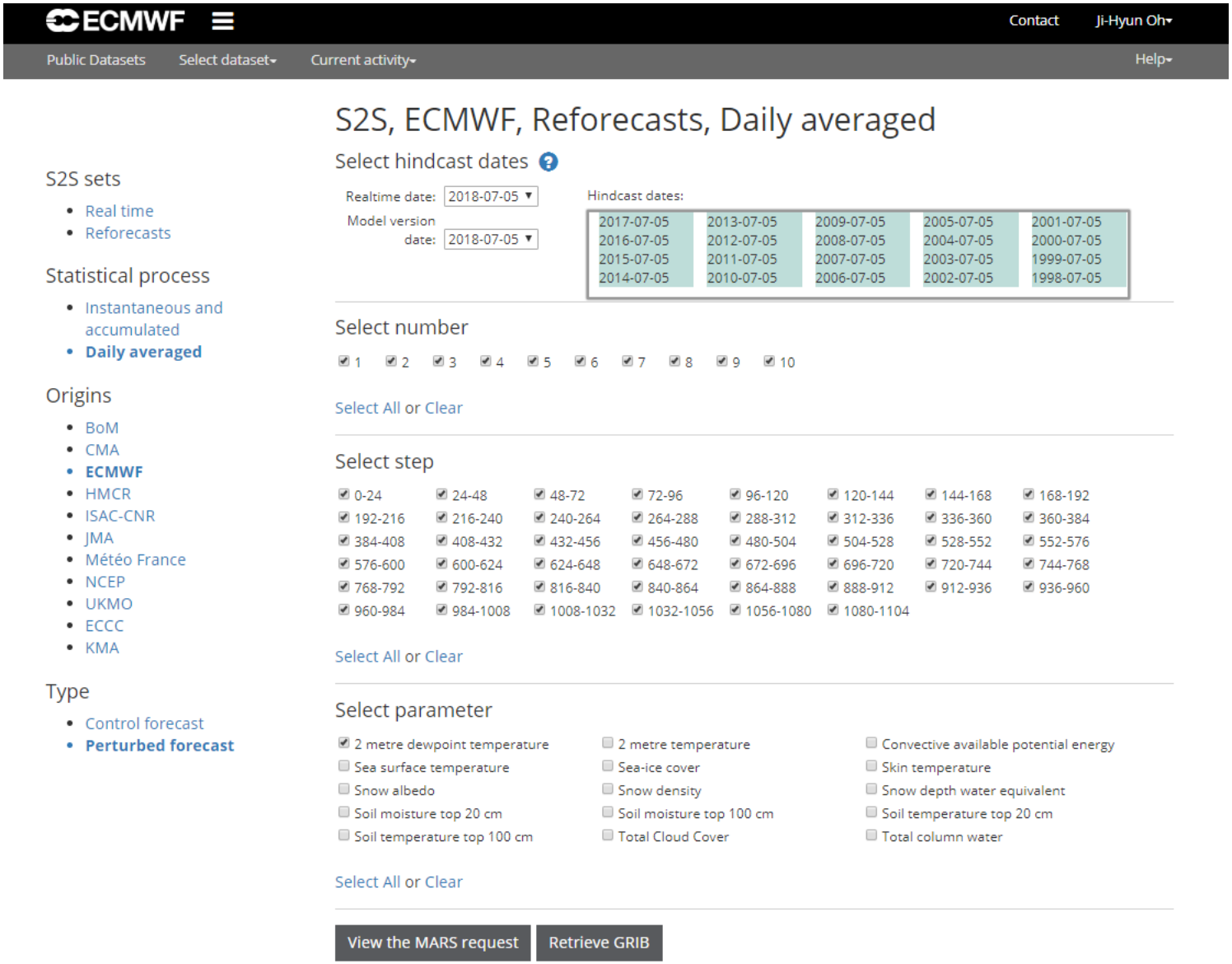
For more information on how to retrieve data programmatically, in Python, please go to Access ECMWF Public Datasets.

```
#!/usr/bin/env python
from ecmwfapi import ECMWFDataServer
server = ECMWFDataServer()
server.retrieve({
    "class": "s2",
    "dataset": "s2s",
    "date": "2018-06-04/2018-06-07/2018-06-11/2018-06-14/2018-06-18/2018-06-21/2018-06-25/2018-06-28",
    "expver": "prod",
    "levtype": "sfc",
    "model": "glob",
    "origin": "ecmf",
    "param": "168",
    "step": "0-24/24-48/48-72/72-96/96-120/120-144/144-168/168-192/192-216/216-240/240-264/264-288/288-312/312-336/336-360/360-384/384-408/408-432/432-456/456-480/480-504/504-528/528-552/552-576/576-600/600-624/624-648/648-672/672-696/696-720/720-744/744-768/768-792/792-816/816-840/840-864/864-888/888-912/912-936/936-960/960-984/984-1008/1008-1032/1032-1056/1056-1080/1080-1104",
    "stream": "enfo",
    "time": "00:00:00",
    "type": "cf",
    "target": "output",
})
```

Download S2S data for your own application



Download S2S data for your own application



Download S2S data for your own application

```
[jihyunoh@ecolog2 19970105]$ ncdump -h S2S_ECMWF_hind_19970105_pf_T2M.nc
netcdf S2S_ECMWF_hind_19970105_pf_T2M {
dimensions:
        longitude = 240 ;
        latitude = 121 ;
        number = 10 ;
        time = 46 ;
variables:
        float longitude(longitude) ;
                longitude:units = "degrees_east" ;
                longitude:long_name = "longitude" ;
        float latitude(latitude) ;
                latitude:units = "degrees_north" ;
                latitude:long_name = "latitude" ;
        int number(number) ;
                number:long_name = "ensemble_member" ;
        int time(time) ;
                time:units = "hours since 1900-01-01 00:00:0.0" ;
                time:long_name = "time" ;
                time:calendar = "gregorian" ;
        float t2m(time, number, latitude, longitude) ;
                t2m:_FillValue = 9.96921e+36f ;
                t2m:missing_value = 9.96921e+36f ;
                t2m:units = "K" ;
                t2m:long_name = "2 metre temperature" ;
                t2m:standard_name = "air_temperature" ;

// global attributes:
                :Conventions = "CF-1.6" ;
                :history = "2018-01-15 08:03:20 GMT by grib_to_netcdf-2.4.1: /ho
me/s2s/app/eccodes-2.4.1/bin/grib_to_netcdf -D NC_FLOAT /apccdb/APCC_S2S/RAW/HIN
DCAST/ECMWF/v2017/1997/19970105/S2S_ECMWF_hind_19970105_pf_T2M.grib2 -o /apccdb/
APCC_S2S/PRE/HINDCAST/ECMWF/v2017/1997/19970105/S2S_ECMWF_hind_19970105_pf_T2M.n
c" ;
}
```

Download S2S data for your own application


THANK YOU
APEC
Climate
Center