

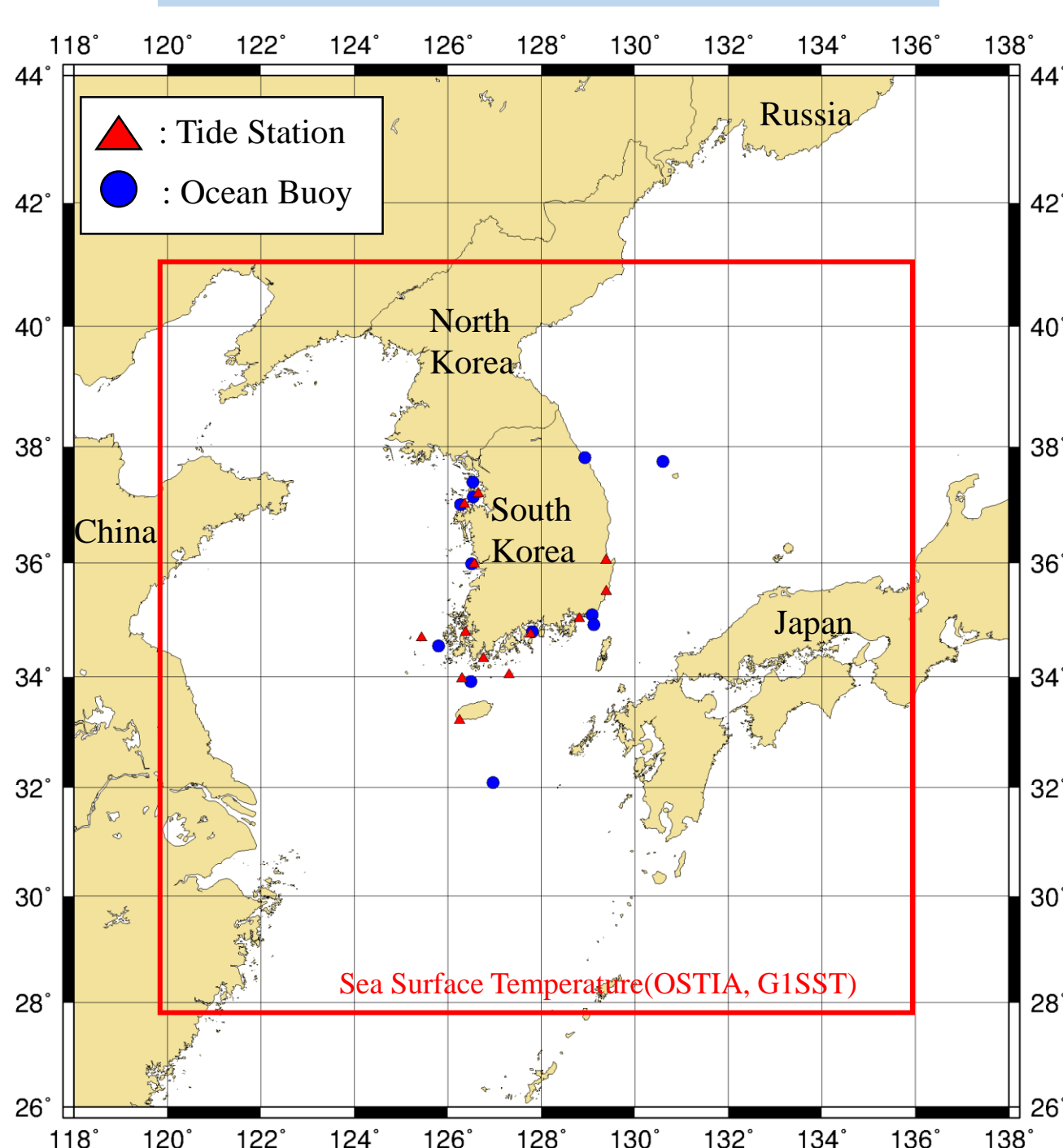
Abstract

- The purpose of the project is to provide information to users by predicting the SST around the Korean waters.
- KHOA(Korea Hydrographic and Oceanographic Agency) provides the observed and predicted SST information to ODGF(Ocean Data in Grid Framework service) on its homepage.
- KHOA obtains relevant SST data from G1SST, OSTIA, and KOOFS(Korea Ocean Observing and Forecast System) and uses the MOS(Model Output Statistics) and AR(AutoRegression) methods to predict SST.

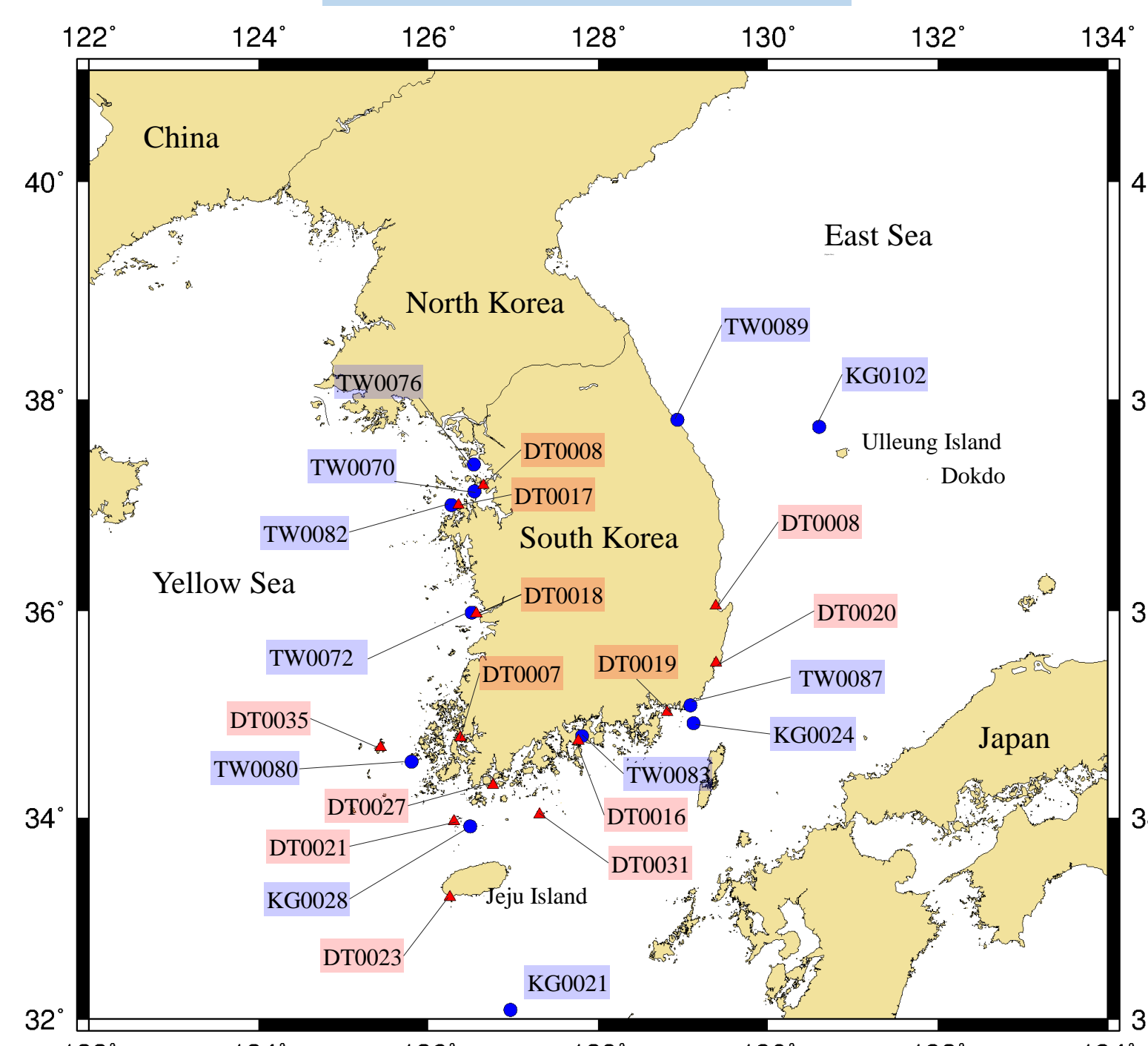
Study area & Data

- To apply MOS the method, observed satellite data(2014~2016) of G1SST and OSTIA were used.
- For AR method, observed sea temperature data(2014~2016) from 13 tide stations of Korea were used.
- Observed sea temperature data in 2017 from 13 tide stations and data of 12 ocean buoys were used to verify accuracy of predicted SST data.

Study area for MOS & AR



Stations of KOOFS



	Resolution	
	Spatial	Temporal
G1sst	1/20°	1day
OSTIA	1/20°	1day

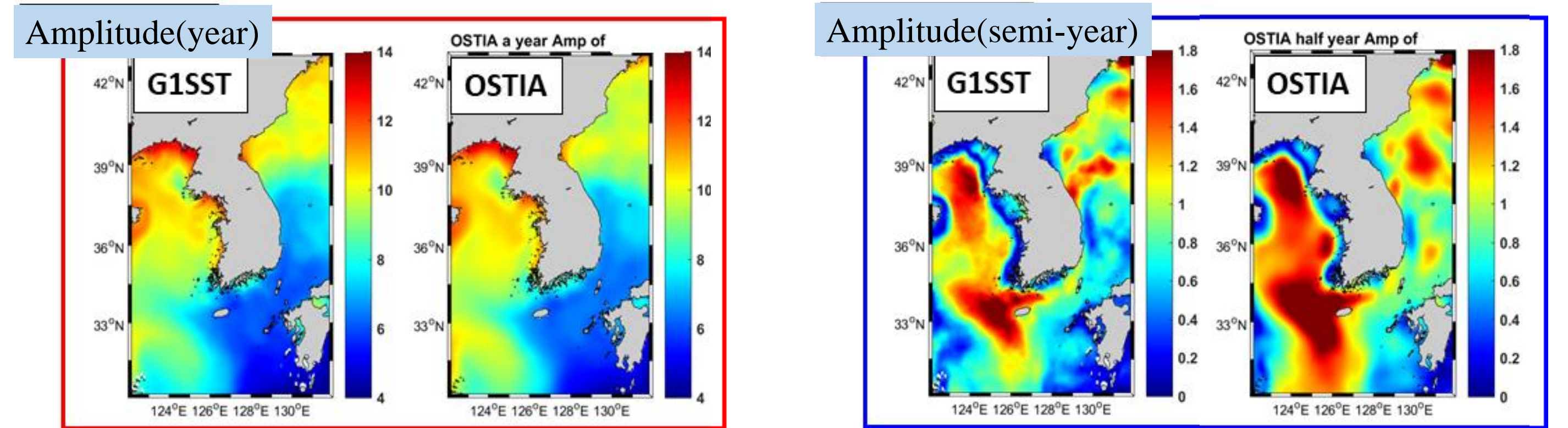
	Data Interval
	Tide Station
Ocean Buoy	5 ~ 10 m

MOS method for predicting SST

- Spatial & temporal weight analyze
- $$T_{sst}(t) = a_0 + a_1 \cos\left(\frac{2\pi t}{365.25} + b_1\right) + a_2 \cos\left(\frac{4\pi t}{365.25} + b_2\right)$$

T_{sst} : Predicted Temperature, 365.25 : Mean day(include leap year)
Harmonic constants
 a_0 : Mean Temperature, a_1 : Amplitude(year), a_2 : Amplitude(semi - year)
 b_1 : Phase(year), b_2 : Phase(semi - year)
- $$Res_{obs}(t) = T_{presst}(t) - T_{obsst}(t)$$

Res_{obs} : Reiduals of SST, T_{presst} : Predicted SST, T_{obsst} : Observed SST



AR method for predicting SST

- Disassemble SST to trend, Seasonal and irregular components

$$SST_t = T_t + S_t + I_t$$

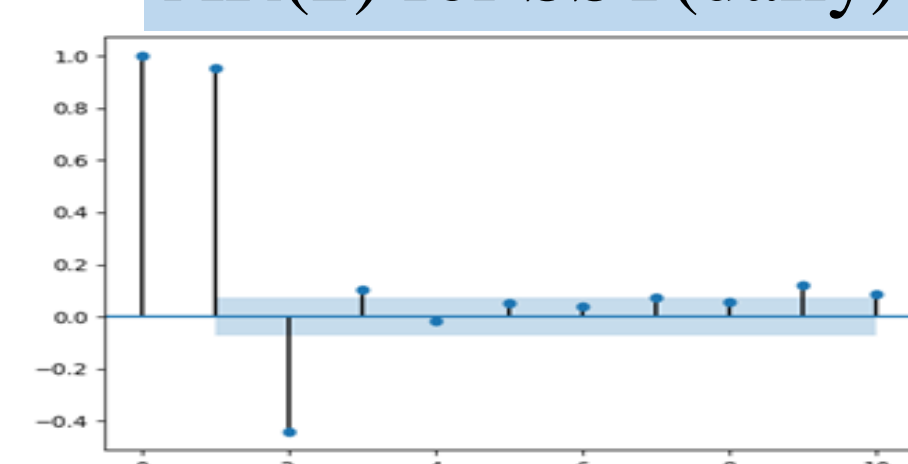
SST_t : SST(when t), T_t : Trend component, S_t : Seasonal component, I_t : Irregular component
- AR model for regular component

$$T_i + S_i = \beta_0 + \sum_{i \in \{1, j_1, j_2\}} \beta_{1,i} \sin\left(\frac{2\pi i t}{D_{year}}\right) + \beta_{2,i} \cos\left(\frac{2\pi i t}{D_{year}}\right)$$

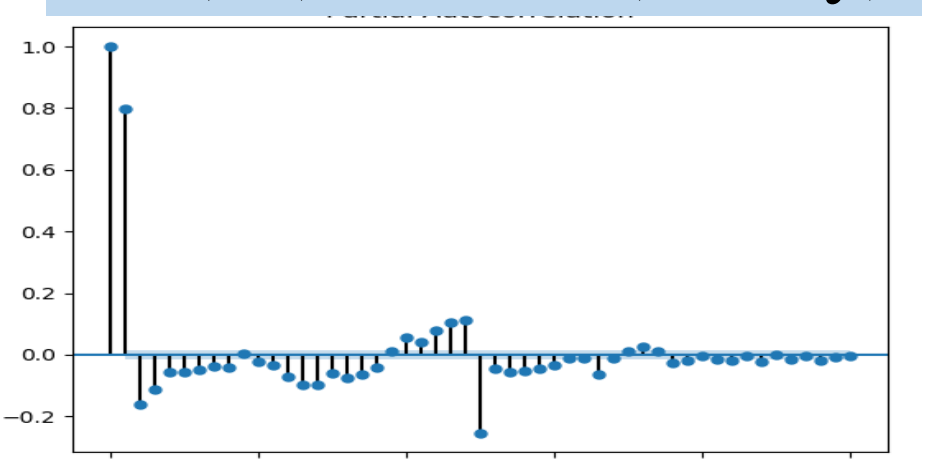
$i = 1$: Period of year, $i = 2$: Period of semi - year, D_{year} : 365 or 366,
 $\beta_0, \beta_{1,1}, \beta_{1,j_1}, \beta_{1,j_2}, \beta_{2,1}, \beta_{2,j_1}, \beta_{2,j_2}$: frequency

- AR model for irregular component

AR(2) for SST(daily)



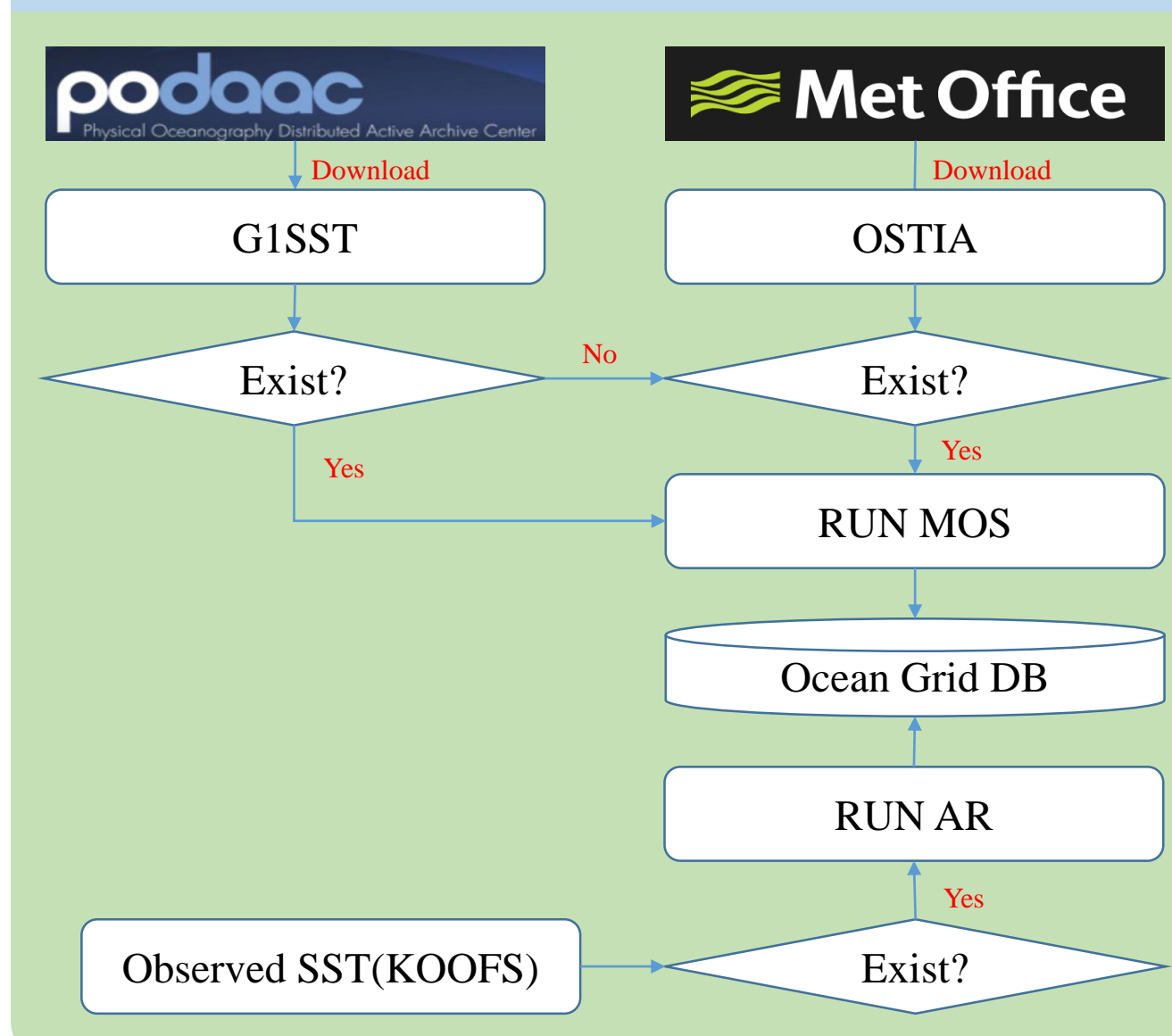
AR(30) for SST(hourly)



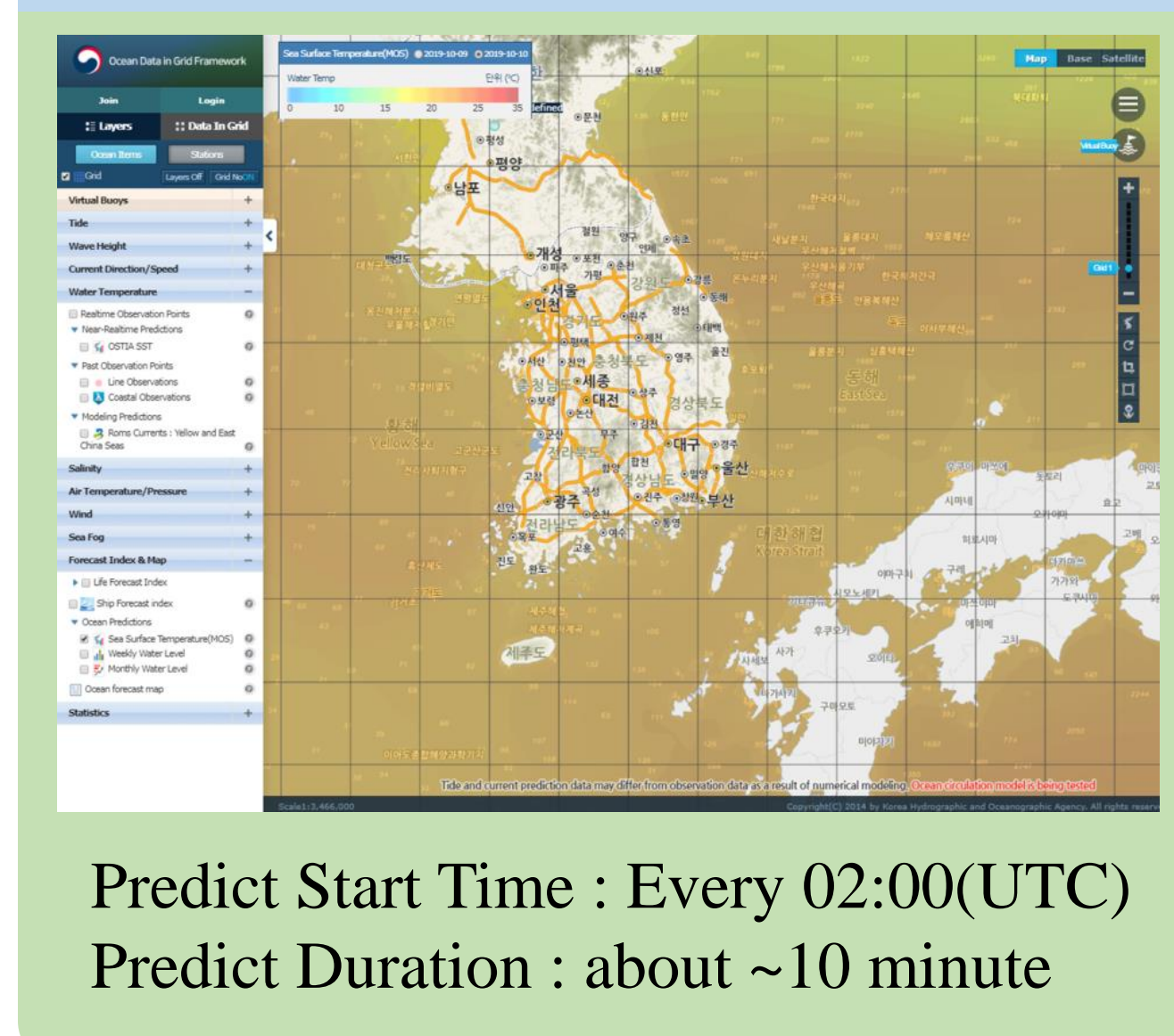
Results

- Automatic SST predict system in KHOA
- Download, check data, predict SST and present on ODGF.
- Water temperature forecasts are made for the two days(today and tomorrow).

Flowchart for Automatic Predict SST



Predict SST on ODGF



Methods	MOS(Model Output Statistics)	AR(Autocorrelation)
Data	OSTIA, G1SST	Observed Sea temperature
Predict duration	G1SST: 3 days(D-1, D 0, D+1) OSTIA: 3 days(D 0, D+1, D+2)	3 days(D 0, D+1, D+2) (Mean SST for daily and hourly)

- MAE SST between KOOFS on ocean buoys and MOS(G1SST & MOS) prediction (D +1 day)

MAE	Yellow Sea					South coastal of Korea					East Sea	
	TW0070	TW0072	TW0076	TW0080	TW0082	TW0083	TW0087	KG0021	KG0024	KG0028	TW0089	KG0102
G1SST	0.66	<u>0.89</u>	0.78	1.29	0.89	<u>0.59</u>	1.47	0.62	0.64	0.49	0.81	0.49
OSTIA	0.63	<u>1.12</u>	0.81	1.37	0.99	<u>0.81</u>	1.52	0.73	0.49	0.42	0.76	0.41

- MAE SST between KOOFS on tide Stations and AR prediction

MAE	Yellow Sea					South coastal of Korea					East Sea		
	DT0007	DT0008	DT0017	DT0018	DT0035	DT0016	DT0019	DT0021	DT0023	DT0027	DT0031	DT0009	DT0020
D+1	0.09	0.28	0.11	0.12	0.23	0.20	0.21	0.23	0.39	0.11	0.21	0.38	0.22
D+2	0.17	0.53	0.19	0.23	0.43	0.34	0.39	0.45	0.66	0.21	0.39	0.64	0.41
D+3	0.22	0.72	0.25	0.31	0.56	0.43	0.51	0.61	0.77	0.29	0.53	0.83	0.54

- Mean MAE SST between MOS and AR prediction

Method	AR-method			MOS-method			
	Date	D+1	D+2	D+3	D+1	D+2	D+3
MAE		0.27 ~ 0.54	0.35 ~ 0.69	0.41 ~ 0.77	0.30 ~ 0.59	0.35 ~ 0.72	0.39 ~ 0.82

Conclusions

- The predicted SST by the AR method is larger than that by the MOS method. And AR method can predict daily and hourly SST.
- Especially in coastal regions, accuracy of MOS method is lower than AR. However MOS method can predict spatial SST quickly.
- It is expected that better SST prediction can be made using assimilated SST data of AR and MOS methods.