# Development and validation of remote sensing algorithm for atmospheric aerosols by SGLI

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# Research History and this RA

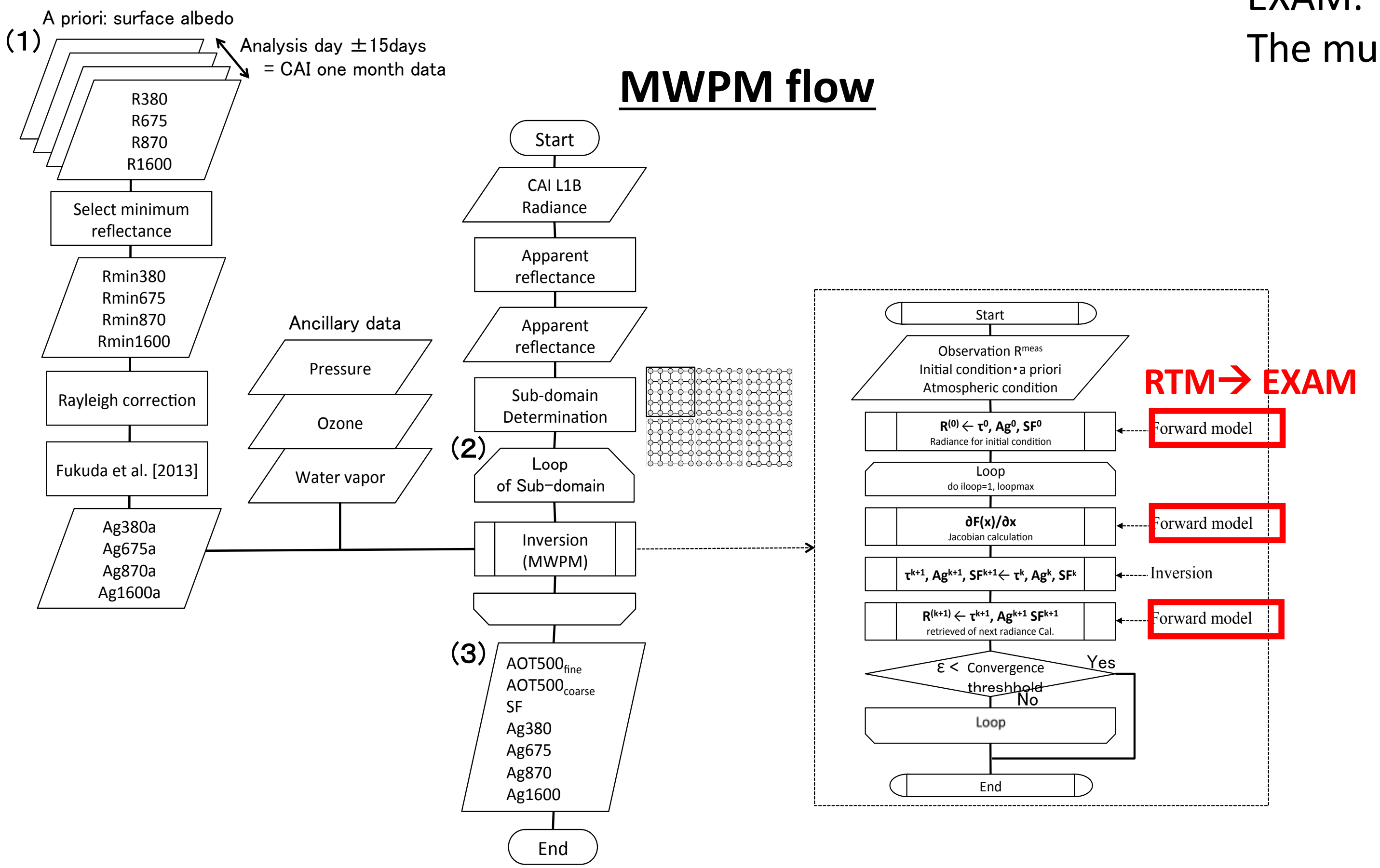
| | RA1-3 | RA4 | RA5 | RA6 | EORA2 |
|---|---|---|---|---|---|
| **Cloud shadow** | | | 100% | | |
| **2-channel ocean** | | | 100% | | |
| **Modified Kaufman land** | | | | | |
| **Kaufman land** | | | | | |
| **MWP method** (Multi-Wavelength and -Pixel method) | | | merged | Algorithm validation<br>Neural network | Simultaneous retrieval of AOT and OC |
| **SKYNET** | Improvement, comparison with AERONET | | | | |

MWP method can be applied to complex terrain such as urban area where it is difficult with standard algorithm.

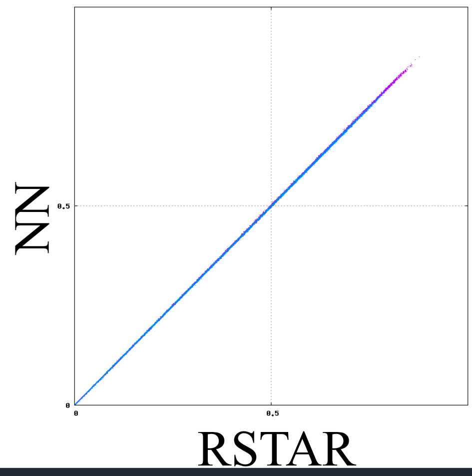
Objectives of this RA:

- Retrieved using MWP and Simultaneous method by SGLI and validated.
- Checked dependencies of bands, resolution of data.

# Neural Network solver : EXAM is updated




EXAM:
The multi-wavelength version
0.550 μm
0.339 μm
0.377 μm
0.441 μm
0.546 μm
0.672 μm
0.865 μm
1.630 μm
0.470 μm
0.510 μm
0.639 μm
0.856 μm
1.609 μm



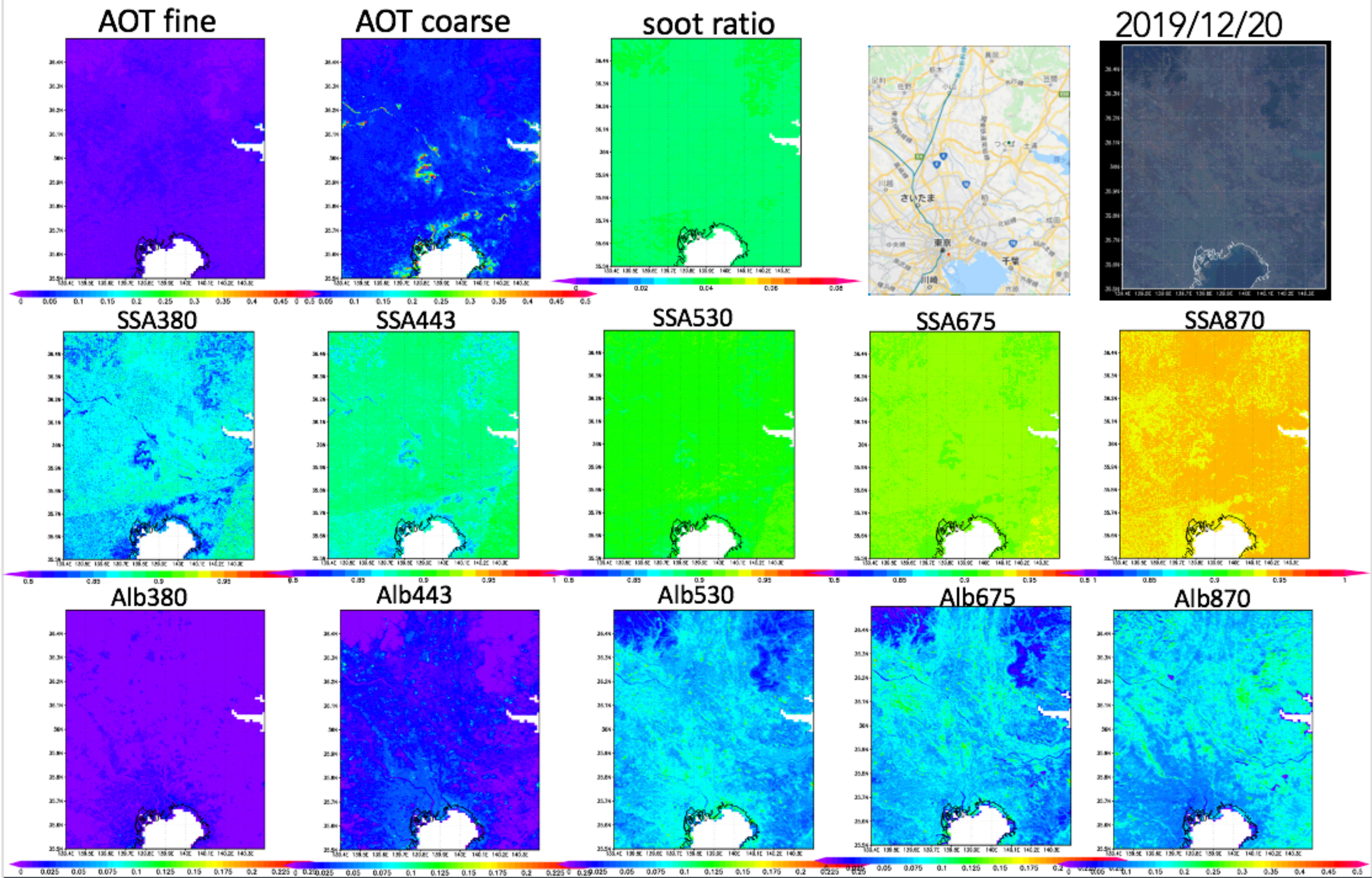

The method of Neural Network is updated.

- Speed :About 32000 times calculation /sec.
- Accuracy: Error < 5.0E-4 at TOA reflectance. (each ch.)

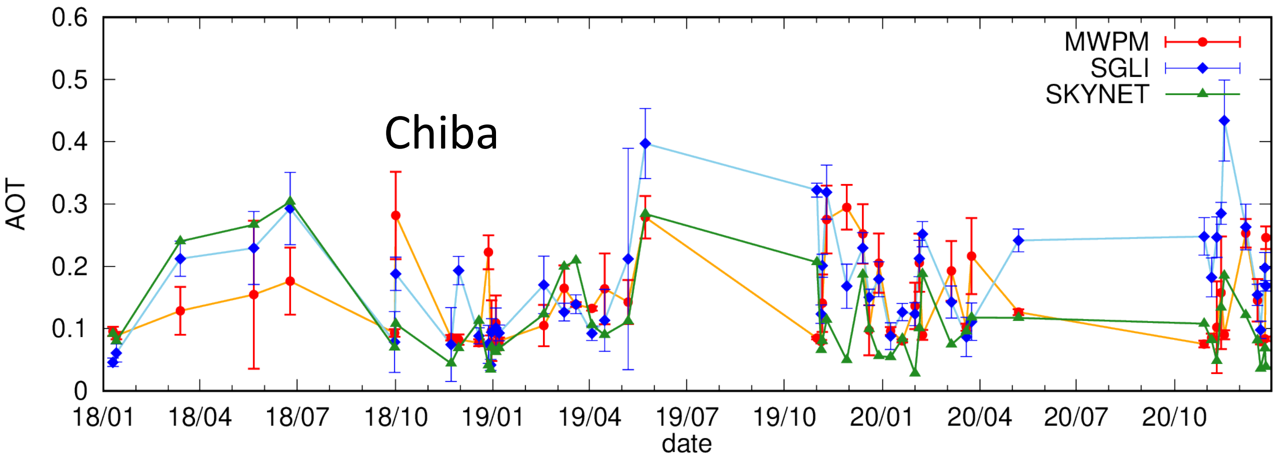
EXAM Multi-wavelength version released.

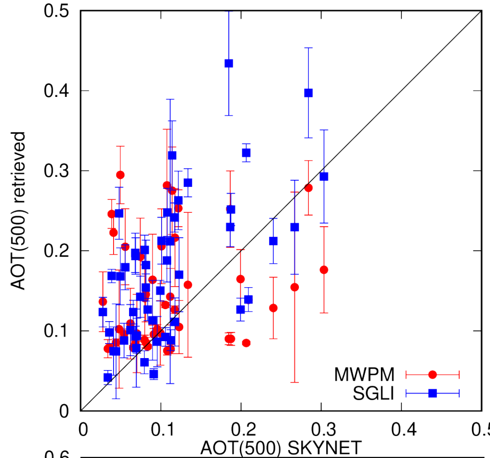
- 13 wavelengths can be calculated with NN.

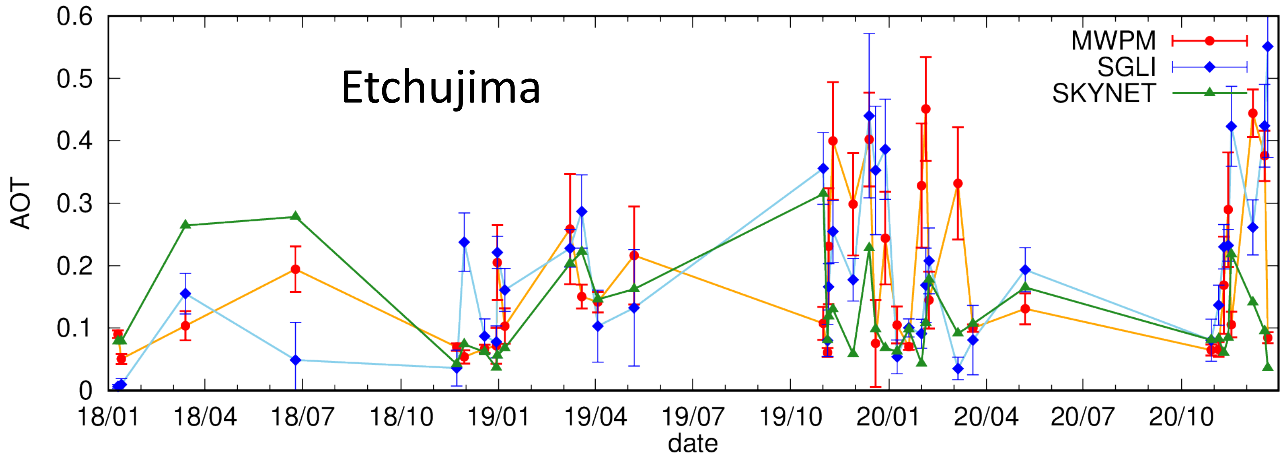
# Applying MWPM to SGLI aerosol analysis: Kanto Area

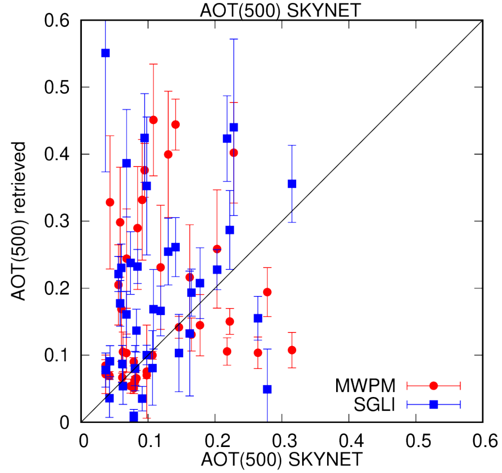


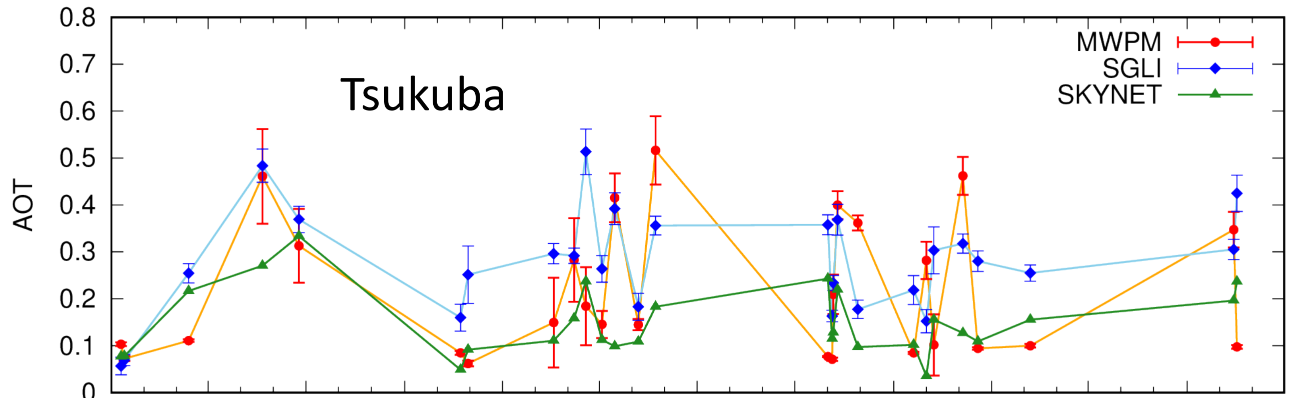
# Retrieved AOT Validation with SKYNET

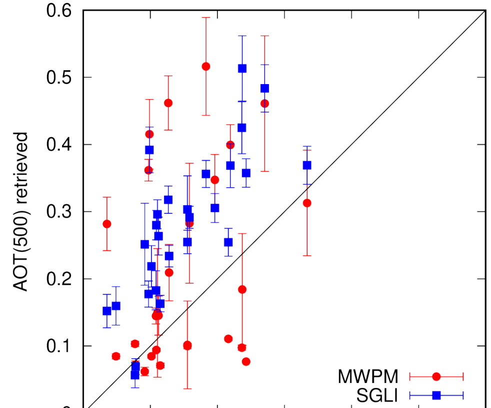


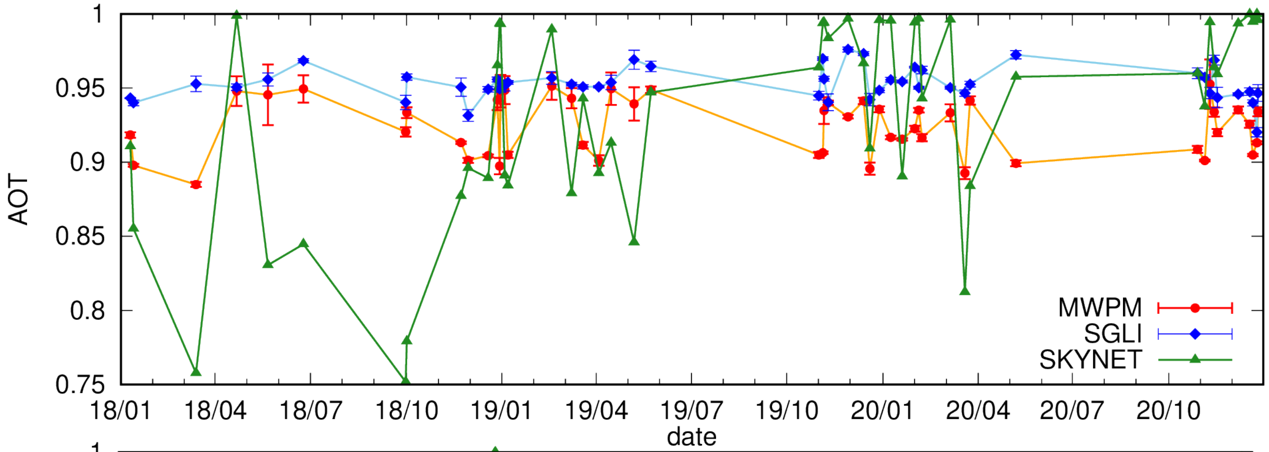



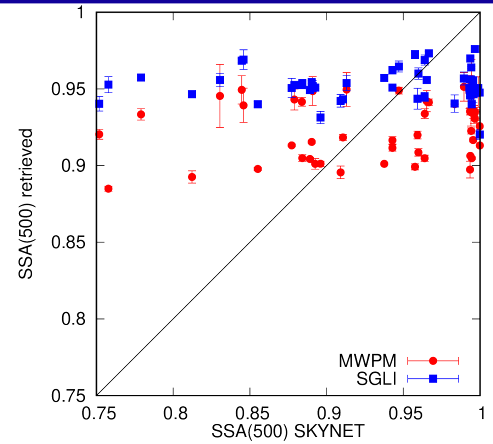



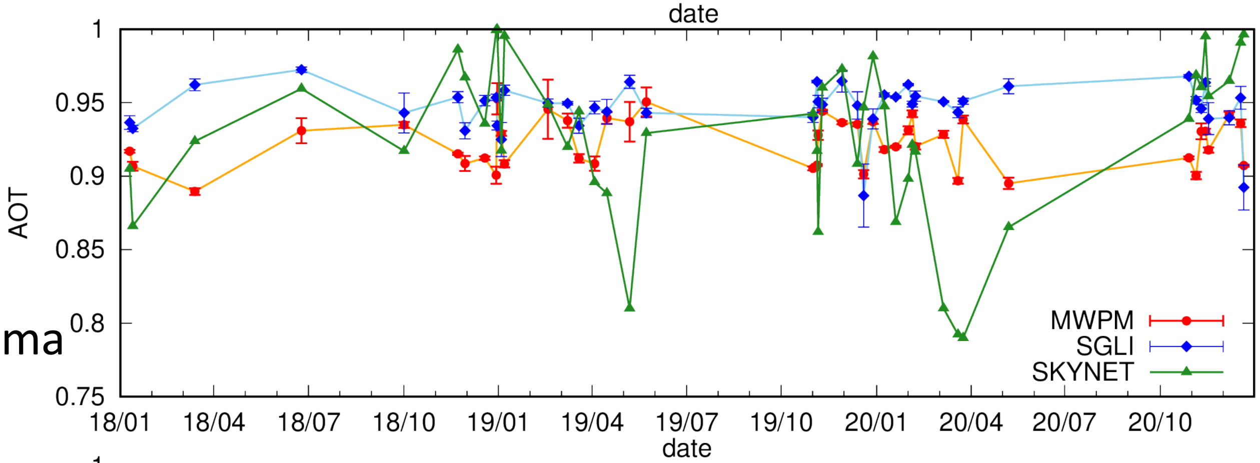
# Retrieved SSA Validation with SKYNET (Preliminary)

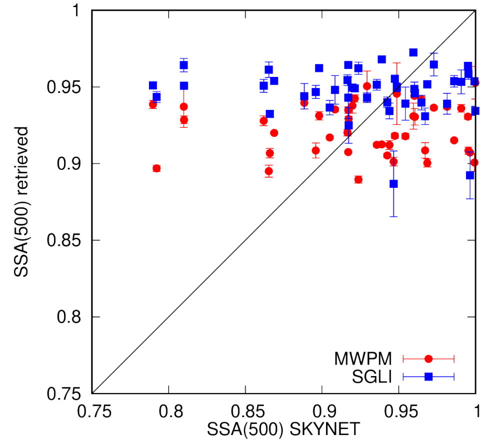
Chiba



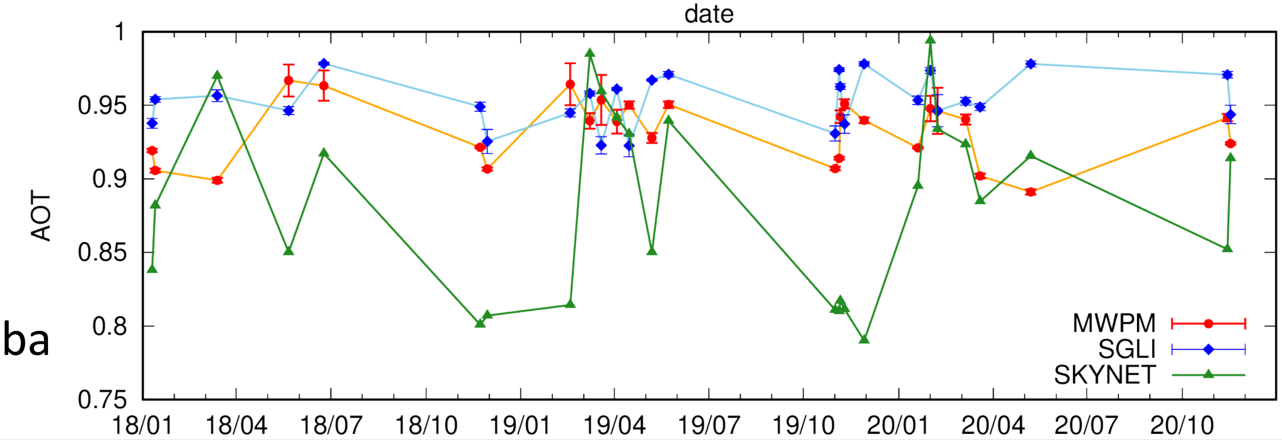



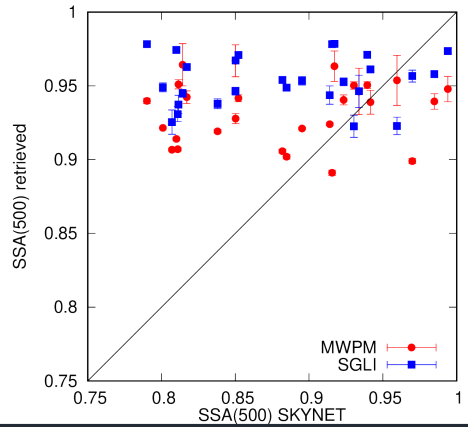

Etchujima



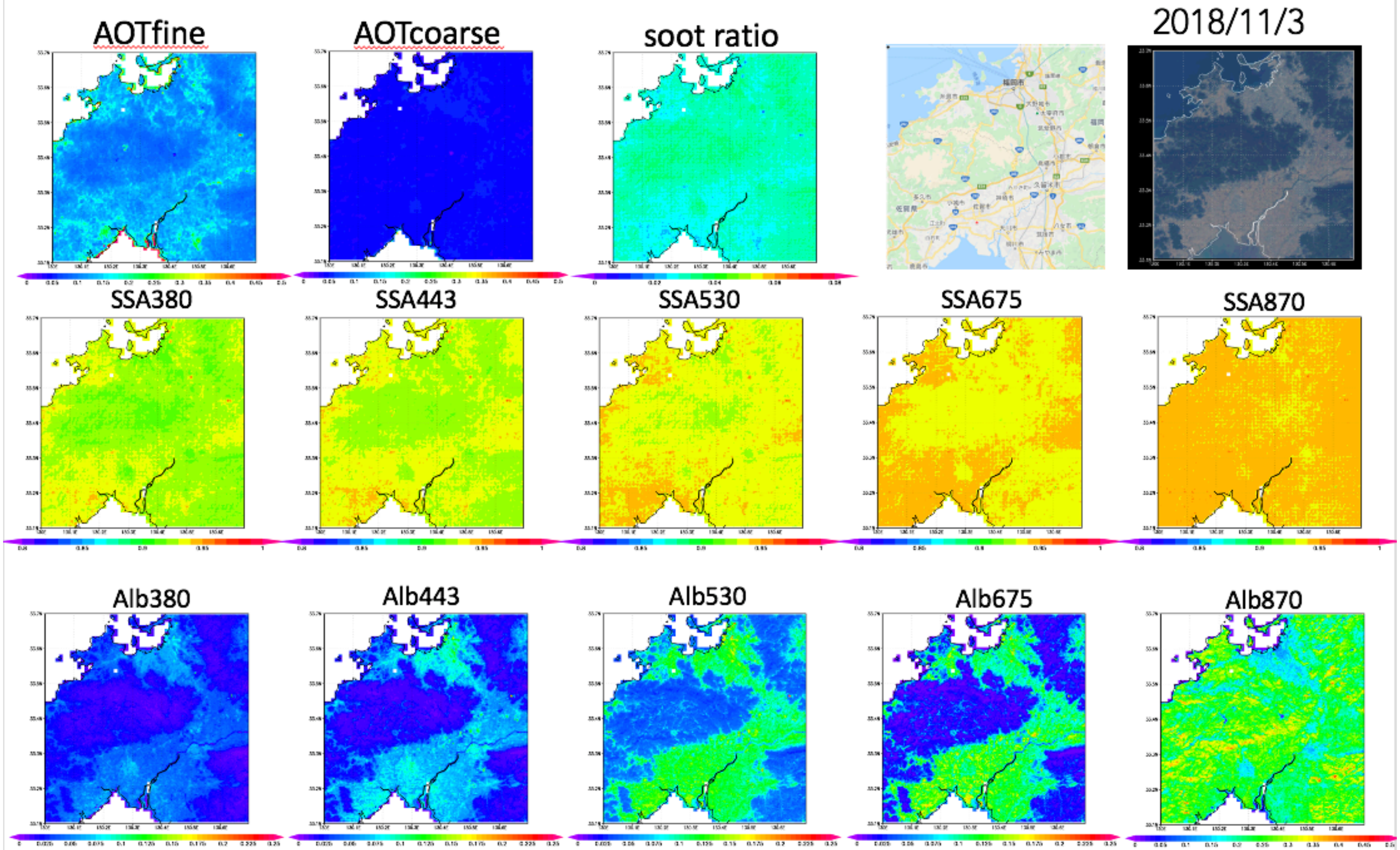




Tsukuba



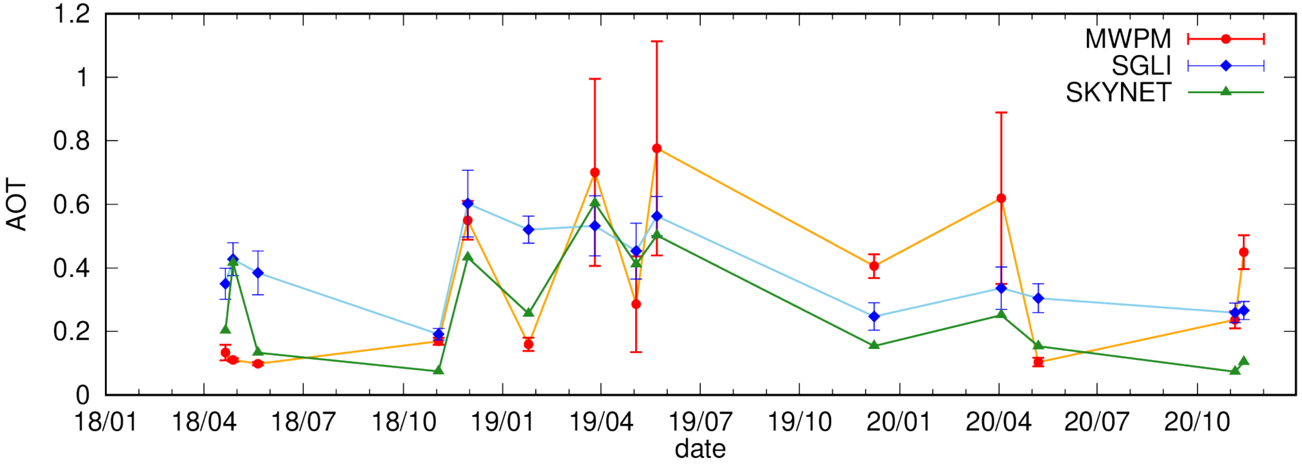



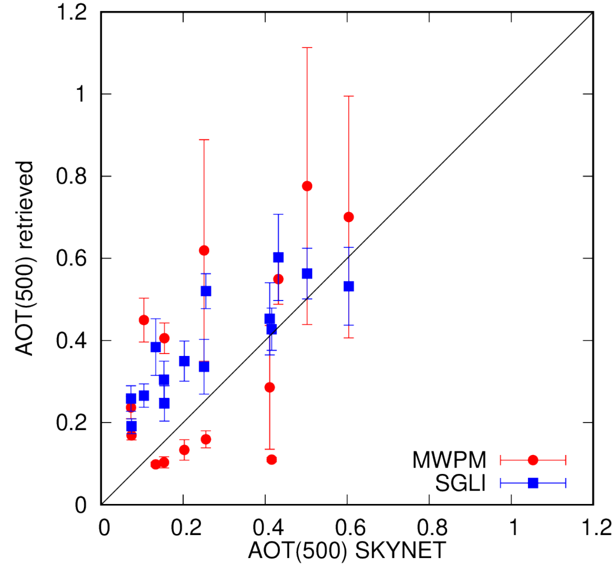
# Applying MWPM to SGLI aerosol analysis: Northern Kyushu



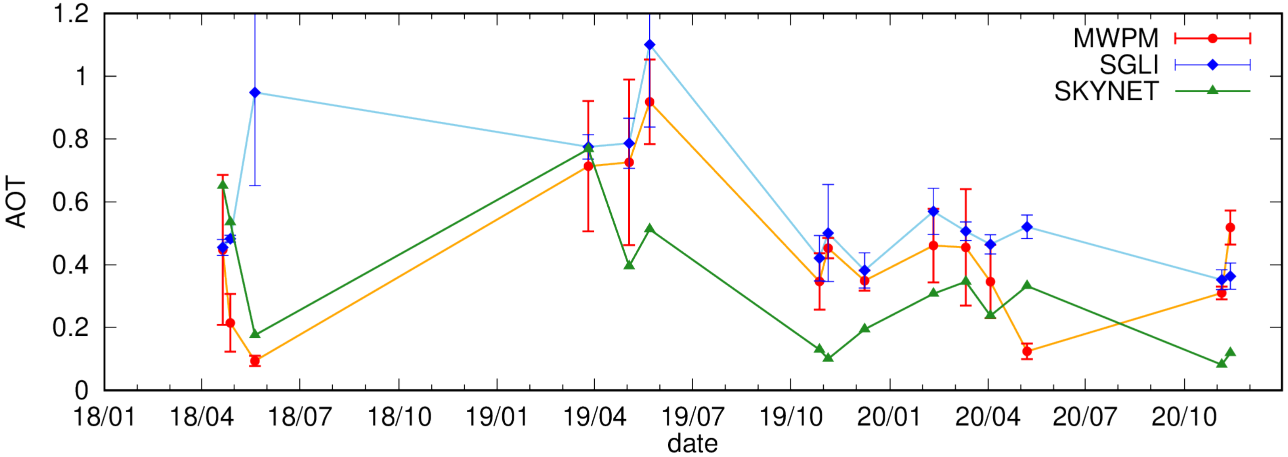
# Retrieved AOT Validation with SKYNET

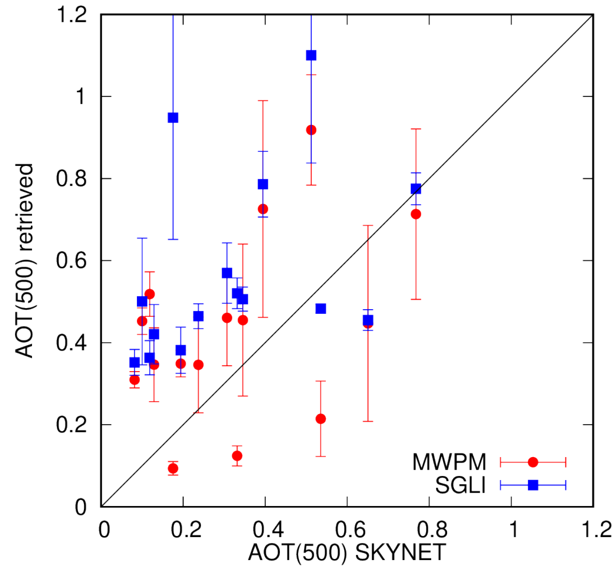
Kyushu-Univ.




Saga




Compared to SKYNET:
The retrieved AOT using this method are comparable, but there are sometimes large differences between them.

# MWPM : Wavelength dependency

- In this FY, we discussed the dependence of wavelength on the results of aerosol analysis.

  6 bands (circle): 380, 443, 530, 675, 870, 1630nm

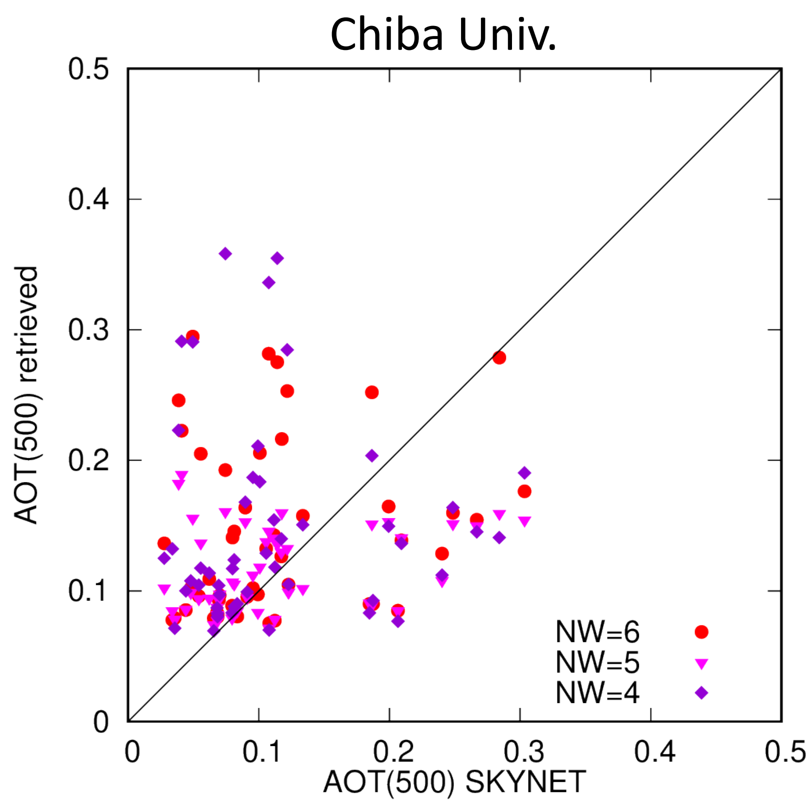
  5 bands (triangle): except for 1630 nm

  4 bands (square) : 380, 675, 870, 1630nm (same in last year)

In this case,

- The result of 6 bands looks better than that of 4 bands.
- The result of 5 bands looks better in clean air cases (e.g., AOT < 0.15).

Those features might be dependent to areas and conditions.

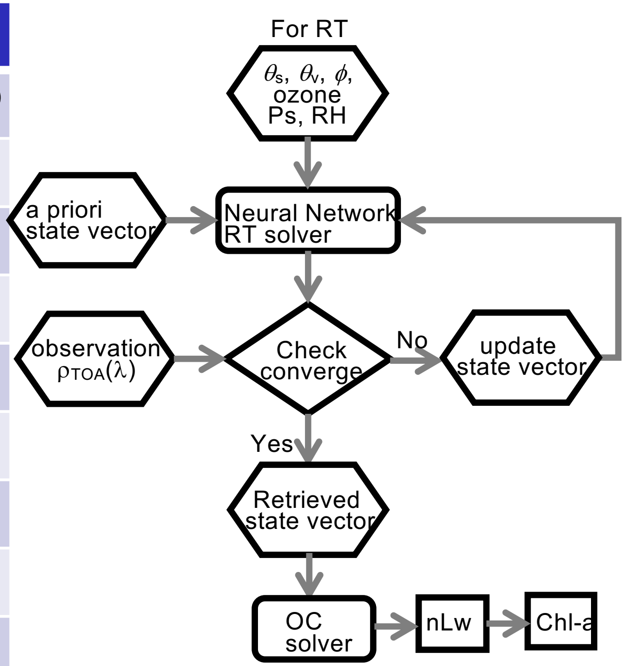


# SIRAW with MWP method

- ✧ SIRAW: Simultaneous Retrieval of Aerosol and Water-leaving radiance for ocean retrieval
- ✧ 8 parameters are retrieved simultaneously
- ✧ Correcting the surface transmission matrix to calculate the spectral water-leaving radiance
- ✧ Comprehensive Chlorophyll Inherent Optical Properties dataset
- ✧ Fine (water-soluble, dust-like and soot), Sea Spray, Dust particles are assumed

| Components | Parameters | Formulation |
|---|---|---|
| Sea Water | Absorption | $a_w(T,S,\lambda)=a_w(T_0,S_0,\lambda)+(T-T_0)\psi_T(\lambda)+(S-S_0)\psi_S(\lambda)$ |
| | Scattering | $b_w(T,S,\lambda)=\frac{8\pi}{3}\beta_w(90^\circ,T,S,\lambda)\frac{2+\delta_w}{1+\delta_w}$ |
| | Phase function | $\beta_w(\psi,T,S,\lambda)=\beta_w(90^\circ,T,S,\lambda)(1+\frac{1-\sigma}{1+\sigma}\cos^2\psi)$ |
| Chlorophyll | Absorption | $a_{ph}(\lambda)=A(\lambda)[Chl]^{1-B(\lambda)}$ |
| | Scattering | $b_{ph}(\lambda)=0.347[Chl]^{0.766}[\lambda/660]^{v([Chl])}$ |
| | Phase function | Fournier–Forland phase function |
| Sediment | Scattering | $b_{sed}(\lambda)=b_s(550)(\lambda/550)^{n_s}S$ |
| | Phase function | Fournier–Forland phase function |
| CDOM | Absorption | $a_y(\lambda,[Chl])=a_y(440,[Chl])\exp(-S(\lambda-440))$ |

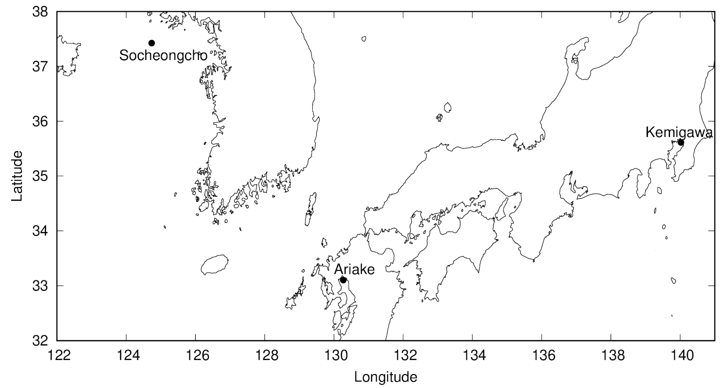
(colored dissolved organic matter)

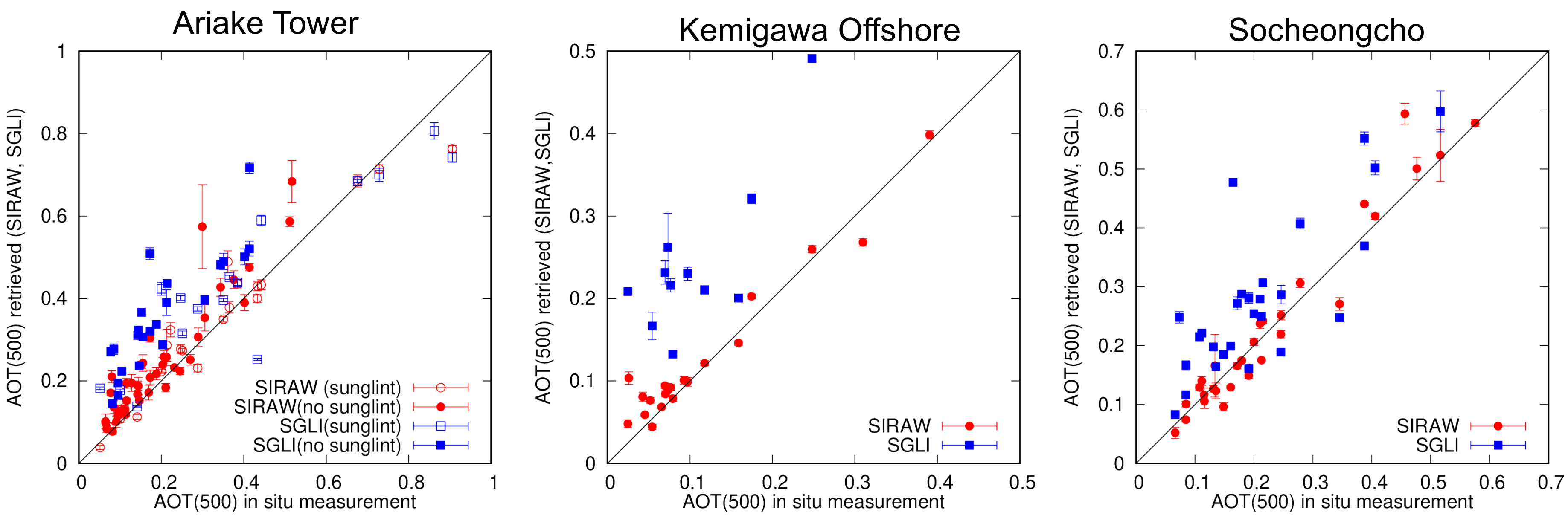



➢ Developing an improved neural network solver to replace the radiative transfer model, the relative difference between neural network and Pstar model in the simulated satellite reflectance is generally from 0.1 - 0.3% among 340nm - 1630nm.

# Comparisons of the retrieved AOT

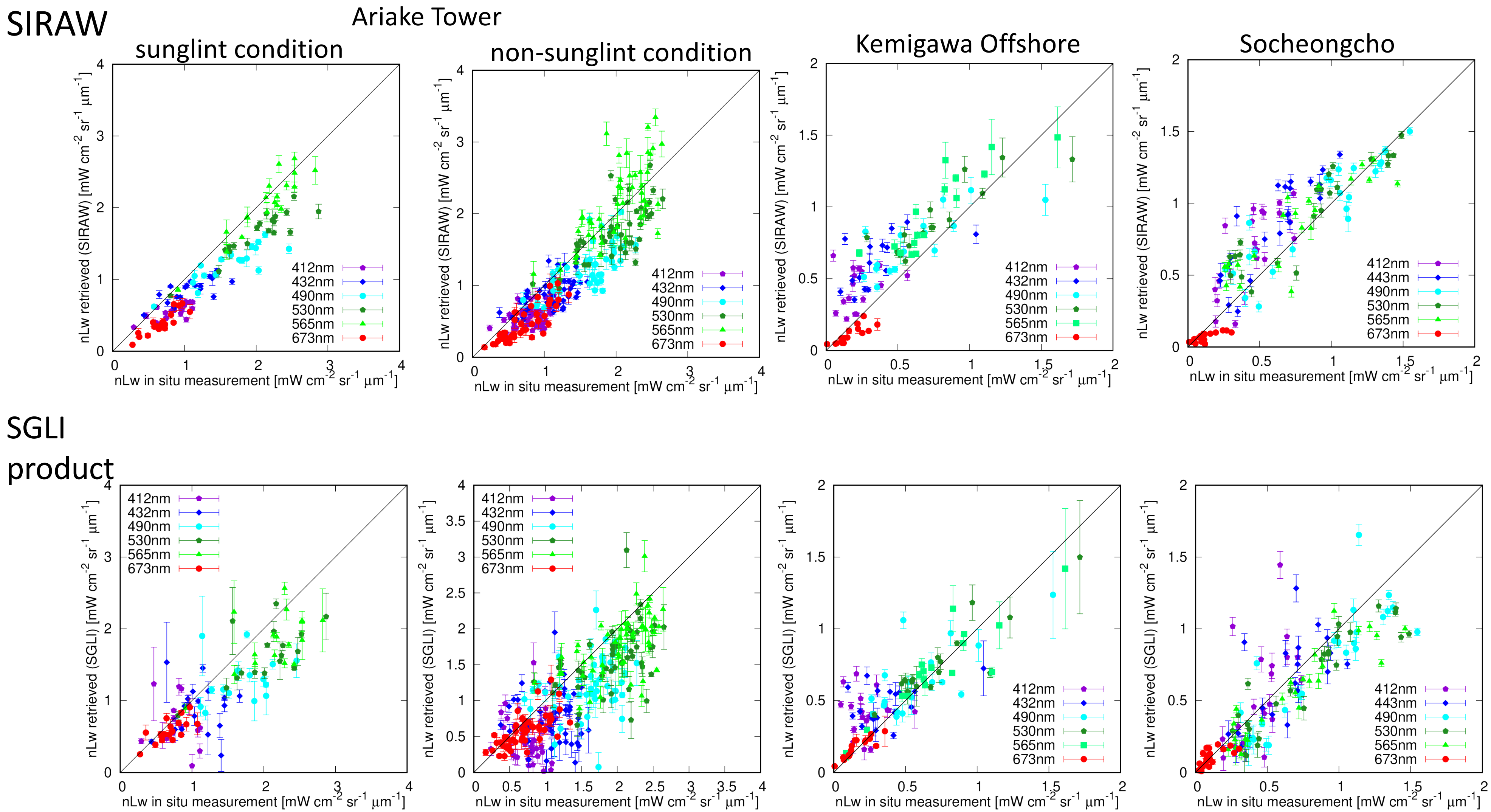
The retrieved SIRAW-AOT are more consistent with the observation values from AERONET-OC at these sites.



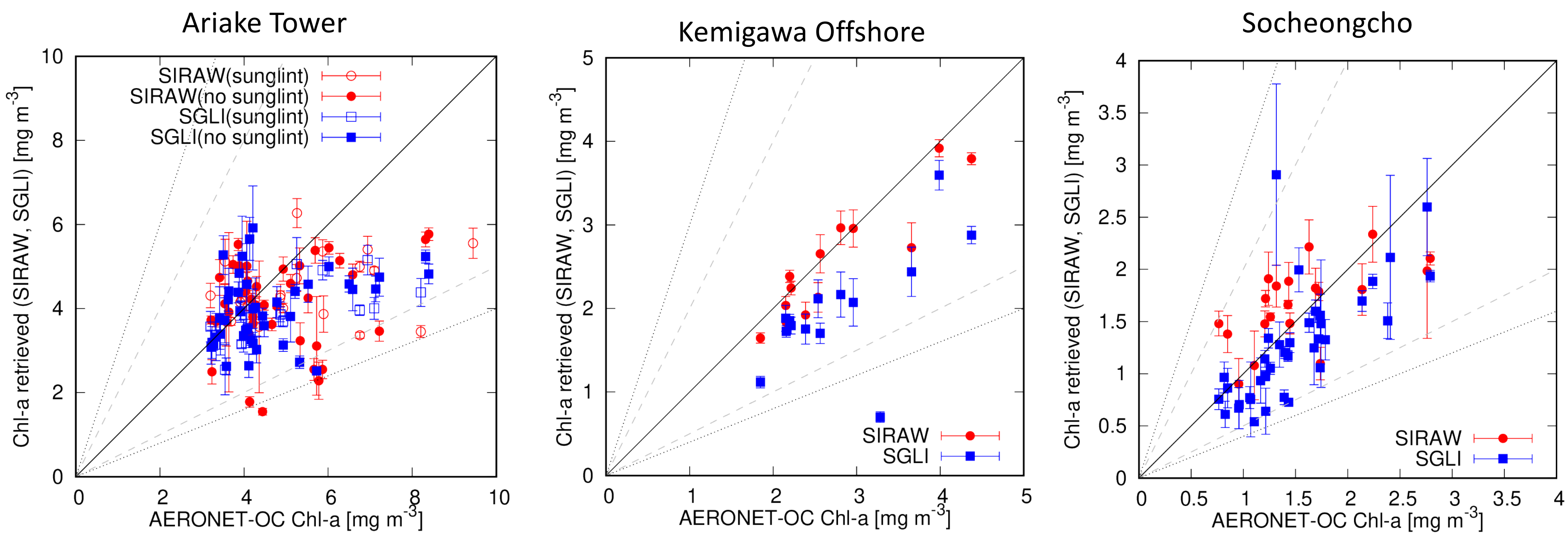

Comparisons of the retrieved AOT from SIRAW (red circles) and the SGLI aerosol product (blue squares) over ocean with AERONET-OC observations. The black solid line represents the 1:1 line.

# Comparisons of the retrieved nLw



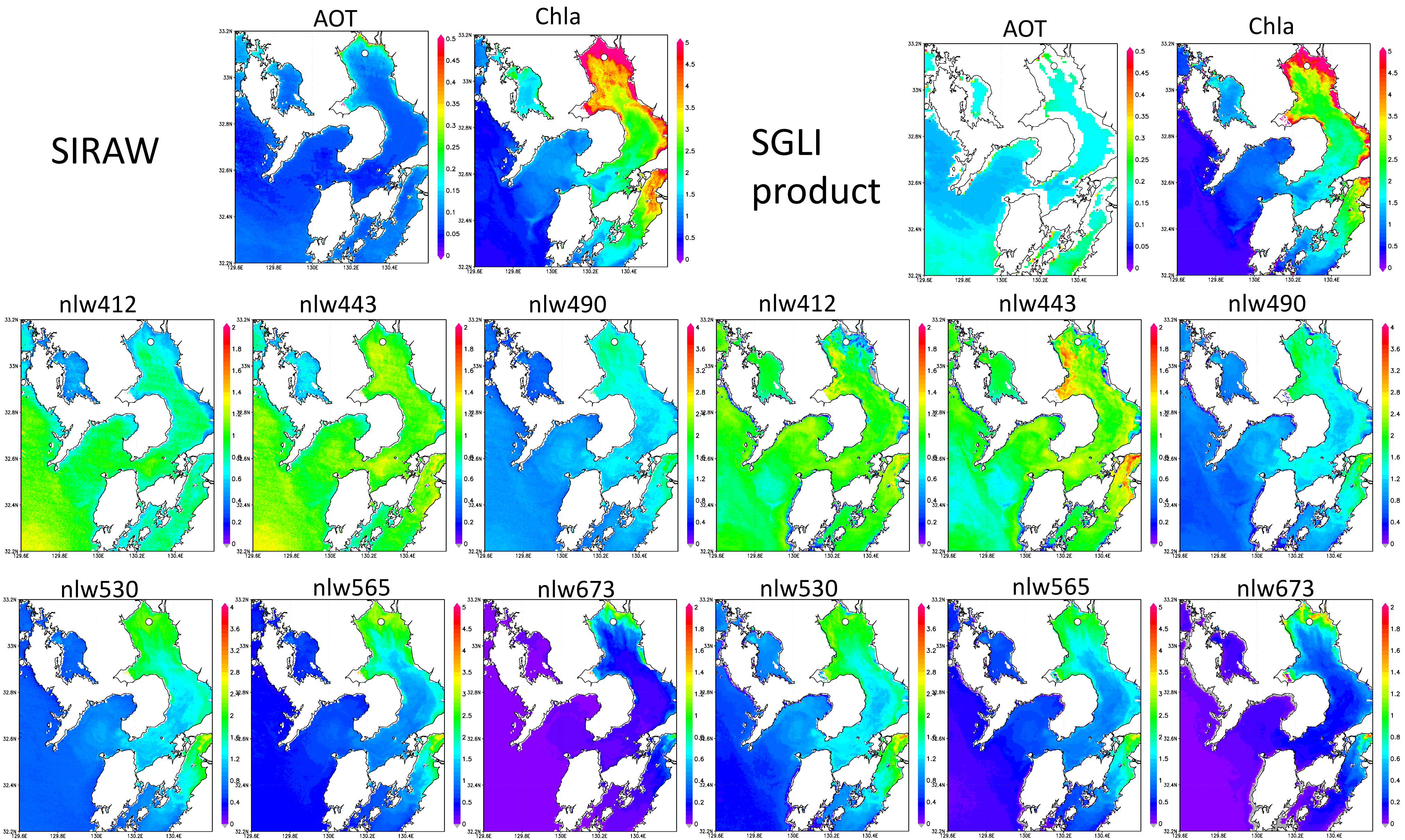
# Comparisons of the retrieved chl-*a* concentration

- At Kemigawa, the Chl-a retrieved using SIRAW is well-estimated and better than the SGLI Chl-a.
- At Ariake tower, the tendencies of SIRAW and SGLI product are roughly classified two types
    1. overestimate in moderate conditions
    2. underestimate the Chl-a in turbid conditions.




The dashed and dotted lines are indicated the range of the standard and goal accuracy of the SGLI Chl-a product.

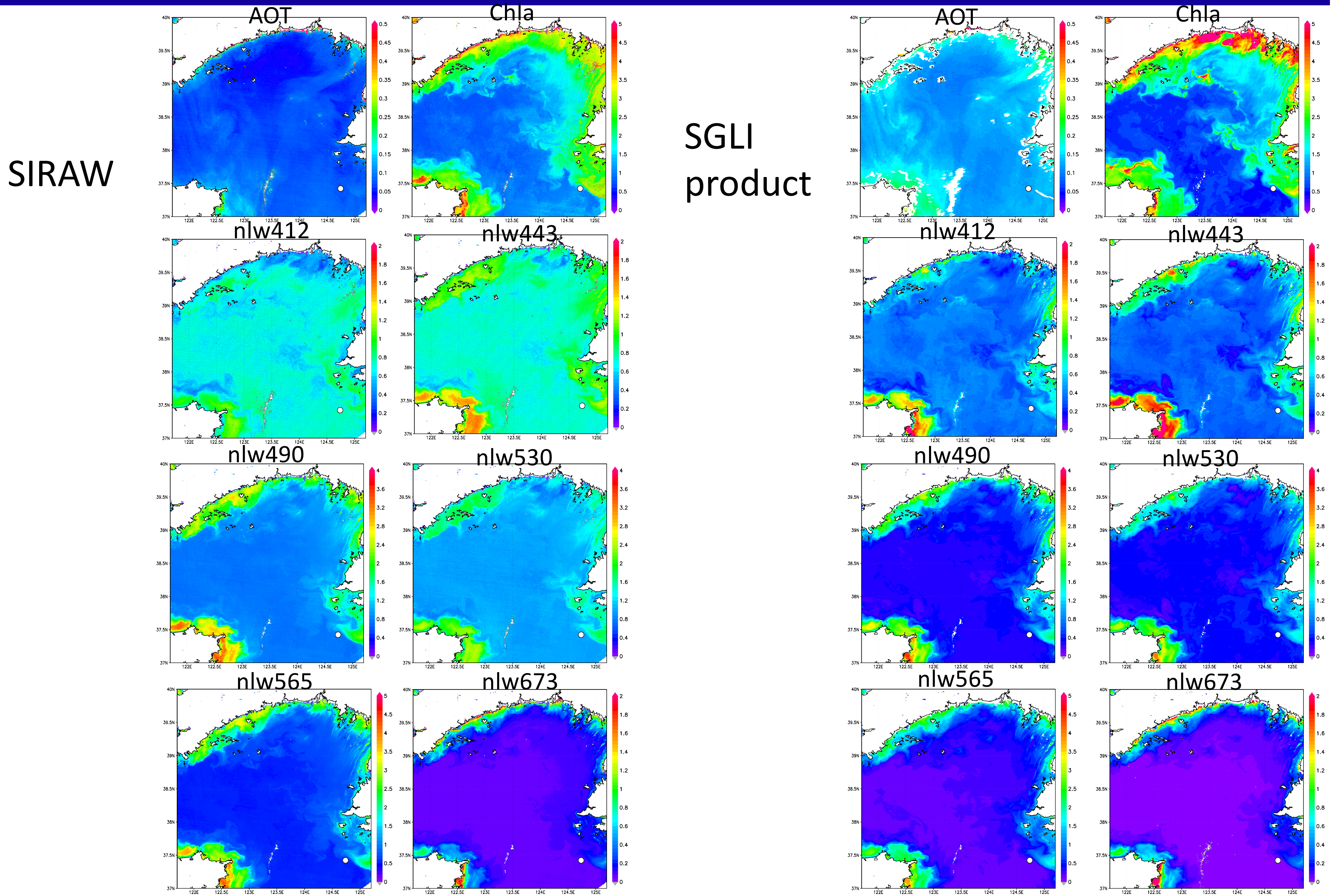
# The retrieved results around the Ariake Sea




The white dots at the right bottom of the panels indicate the location of the AERONET-OC site.

# The retrieved results around the Yellow Sea

on Sep. 23, 2019



# Conclusion

- **MWPM (land)**
  - **Overestimations of aerosol parameters have been improved with increasing bands and tuning parameters.**
  - **Sensitivity Test : SW03 band does not work well in clean air cases.**
- **SIRAW (ocean)**
  - **The retrieved SIRAW-AOT are more consistent with the observation values from AERONET-OC at these sites.**
  - **The retrieved SIRAW-Chla tend to be underestimated in large Chla cases.**
- **Future Work**
  - **Apply for more cases and validate.**
  - **Continue sensitivity tests for bands.**
  - **Consider PL bands to MWPM and SIRAW method.**

Thank you for your attention!