# DEPENDENCE OF SATELLITE OCEAN COLOR DATA PRODUCTS ON VIEWING ANGLES: A COMPARISON BETWEEN SEAWIFS, MODIS, AND VIIRS

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MODIS Aqua true color RGB 11 Oct 2014

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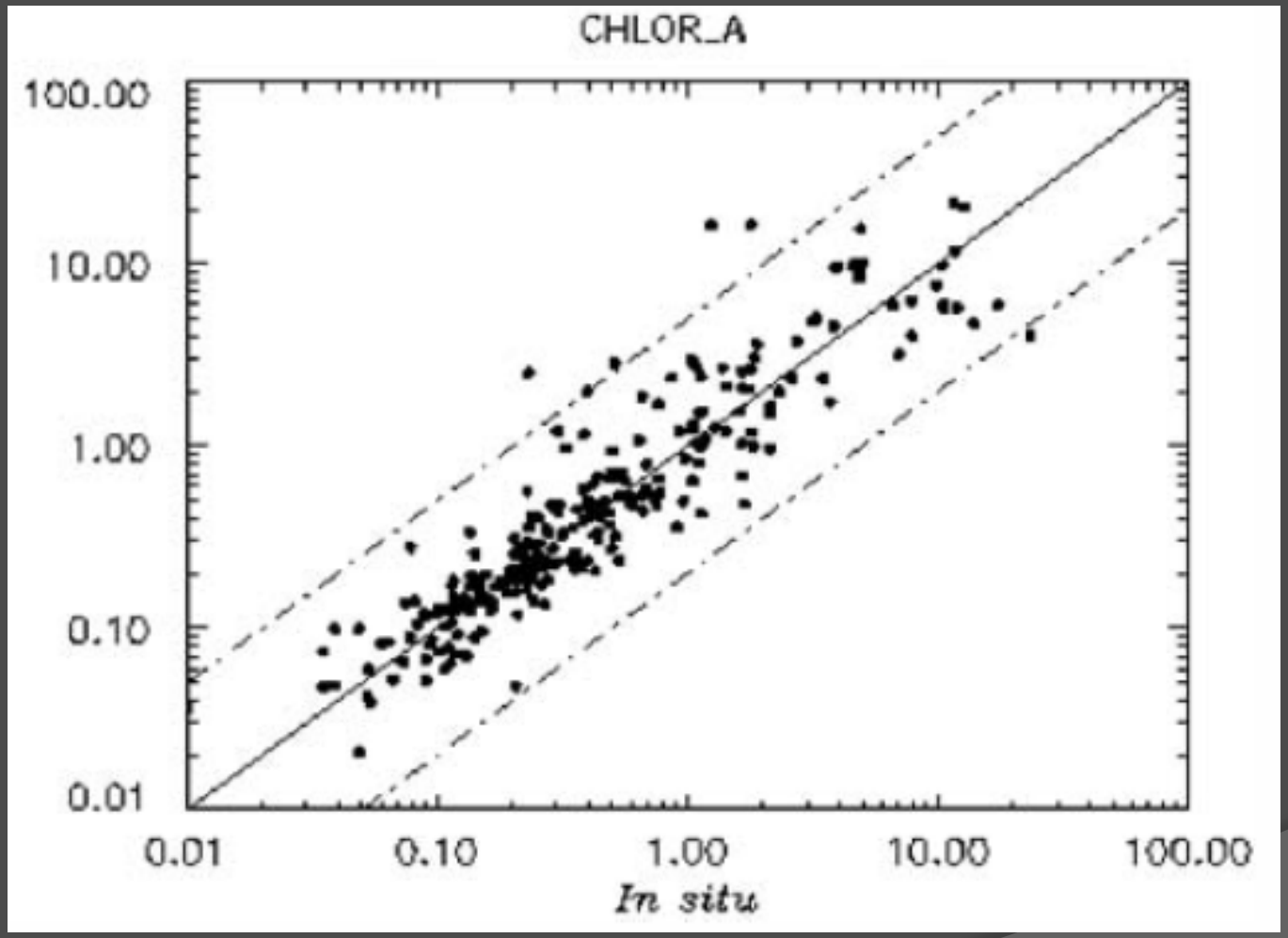
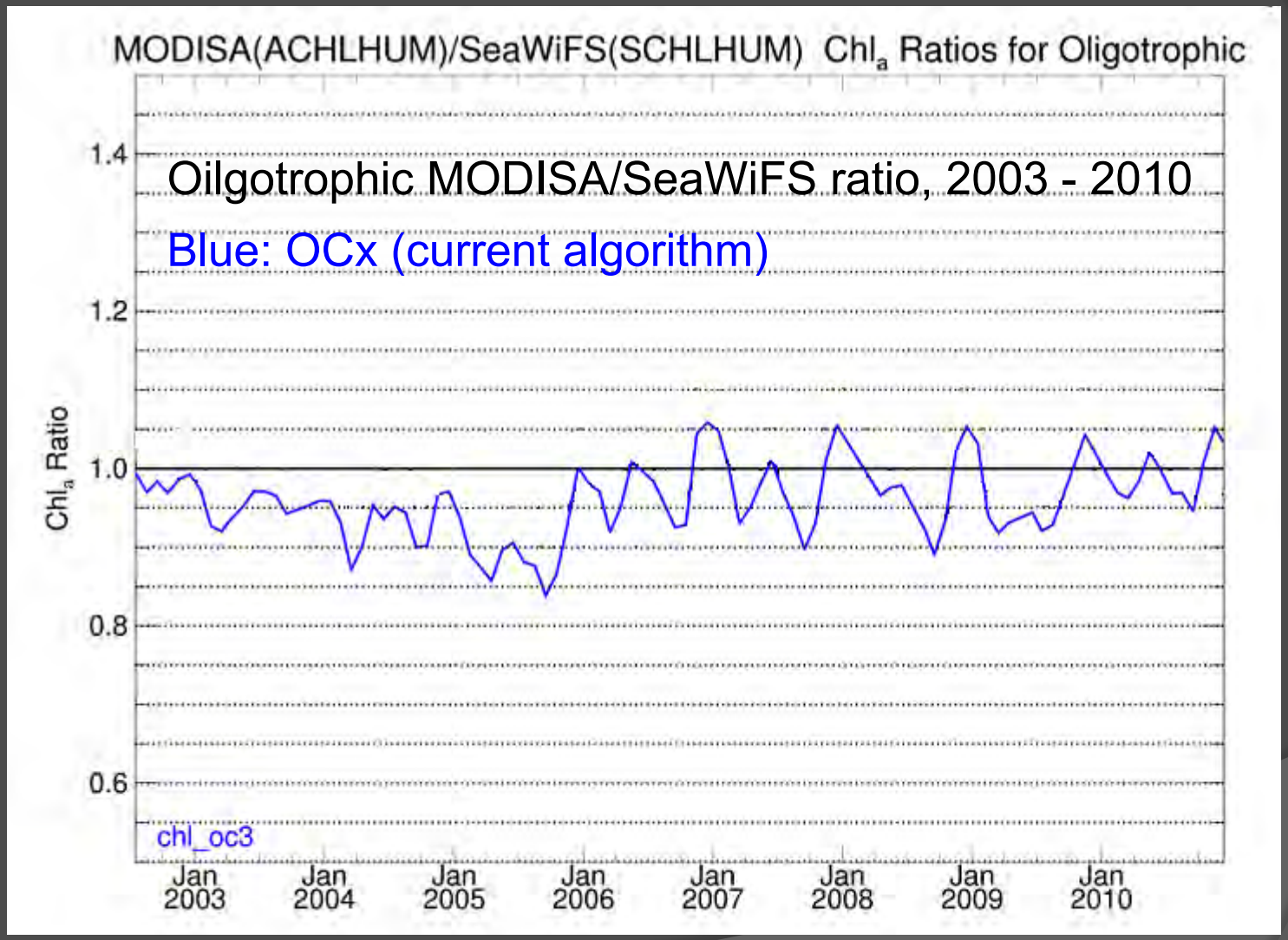
# Motivation: Understanding Uncertainties in Products

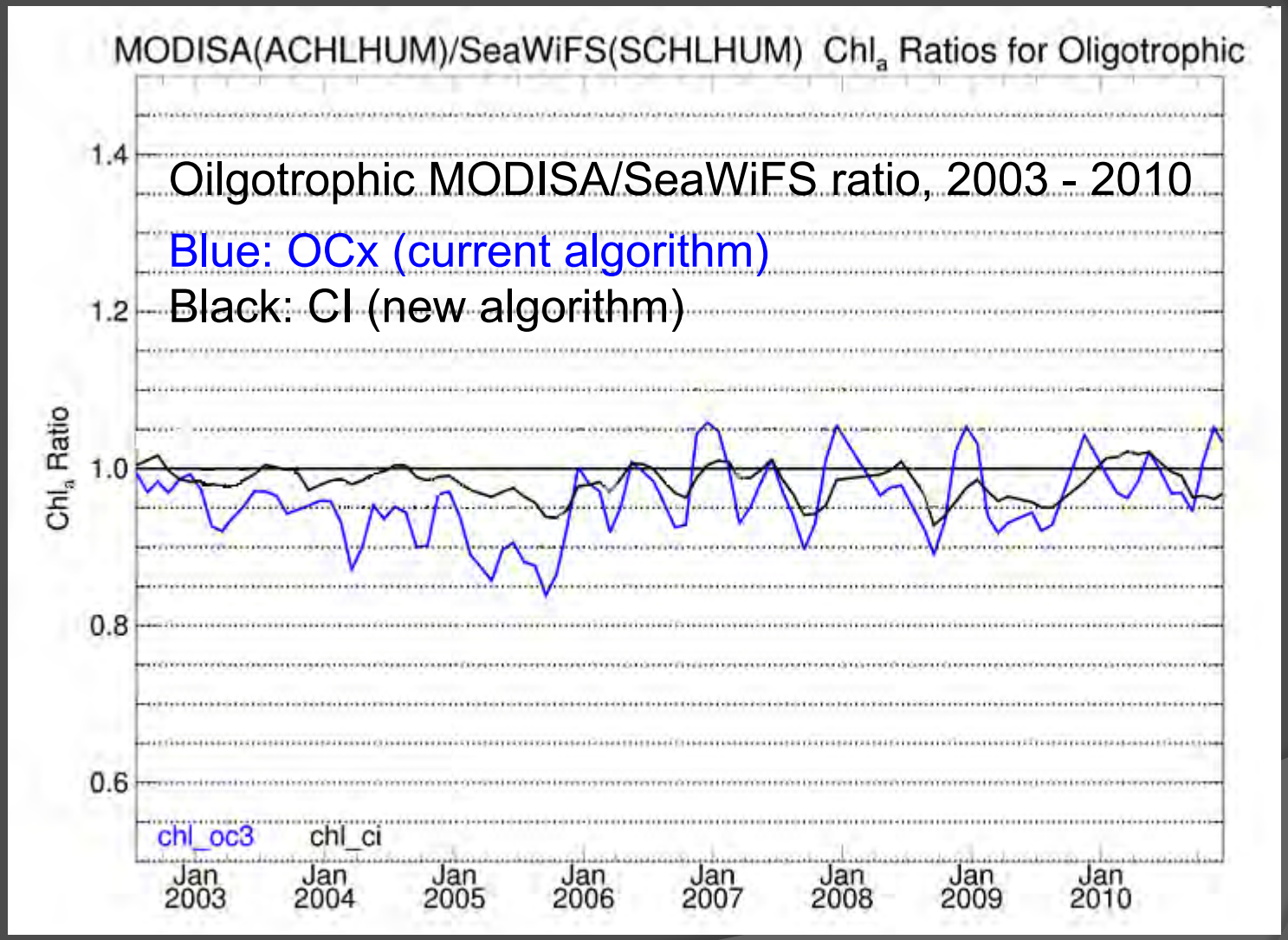



McClain et al. (2004, DSR-II), Gregg and Casey (2004, RSE)
Antoine et al. (2010, JGR), Moore et al. (2015, RSE)

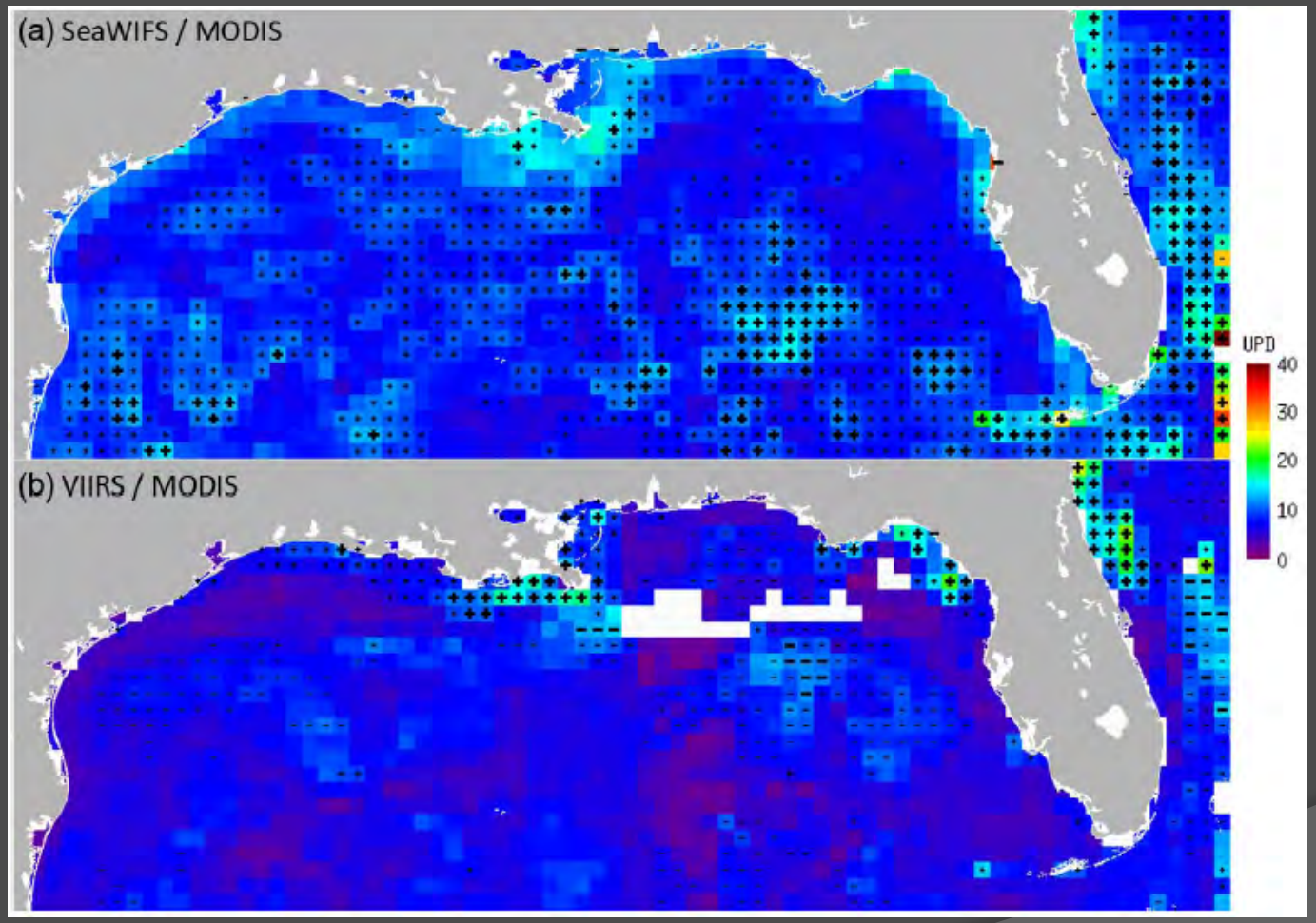
# Time series, global ocean



# Time series, global ocean

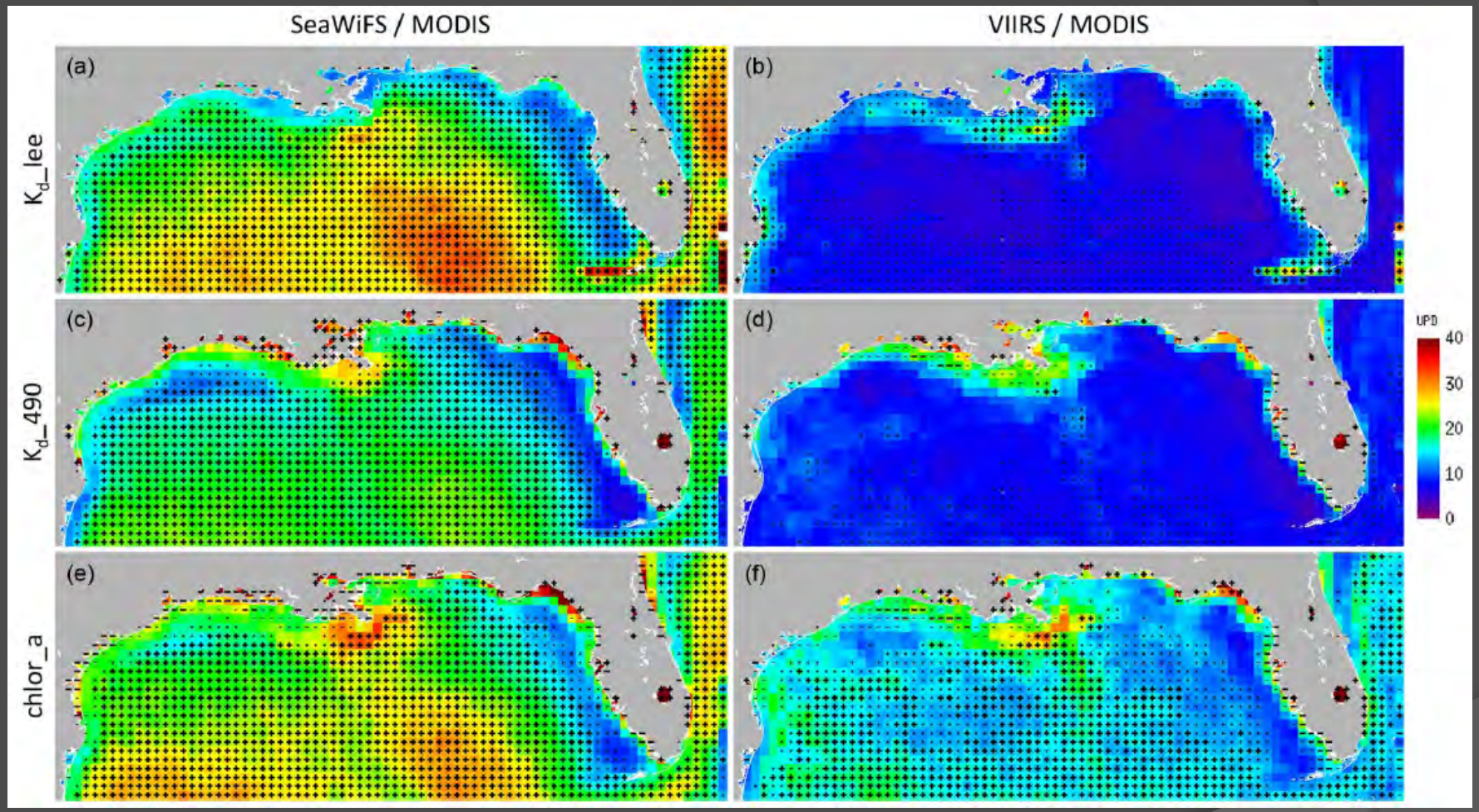


# Comparison of simultaneous (+- 5 minutes) measurements



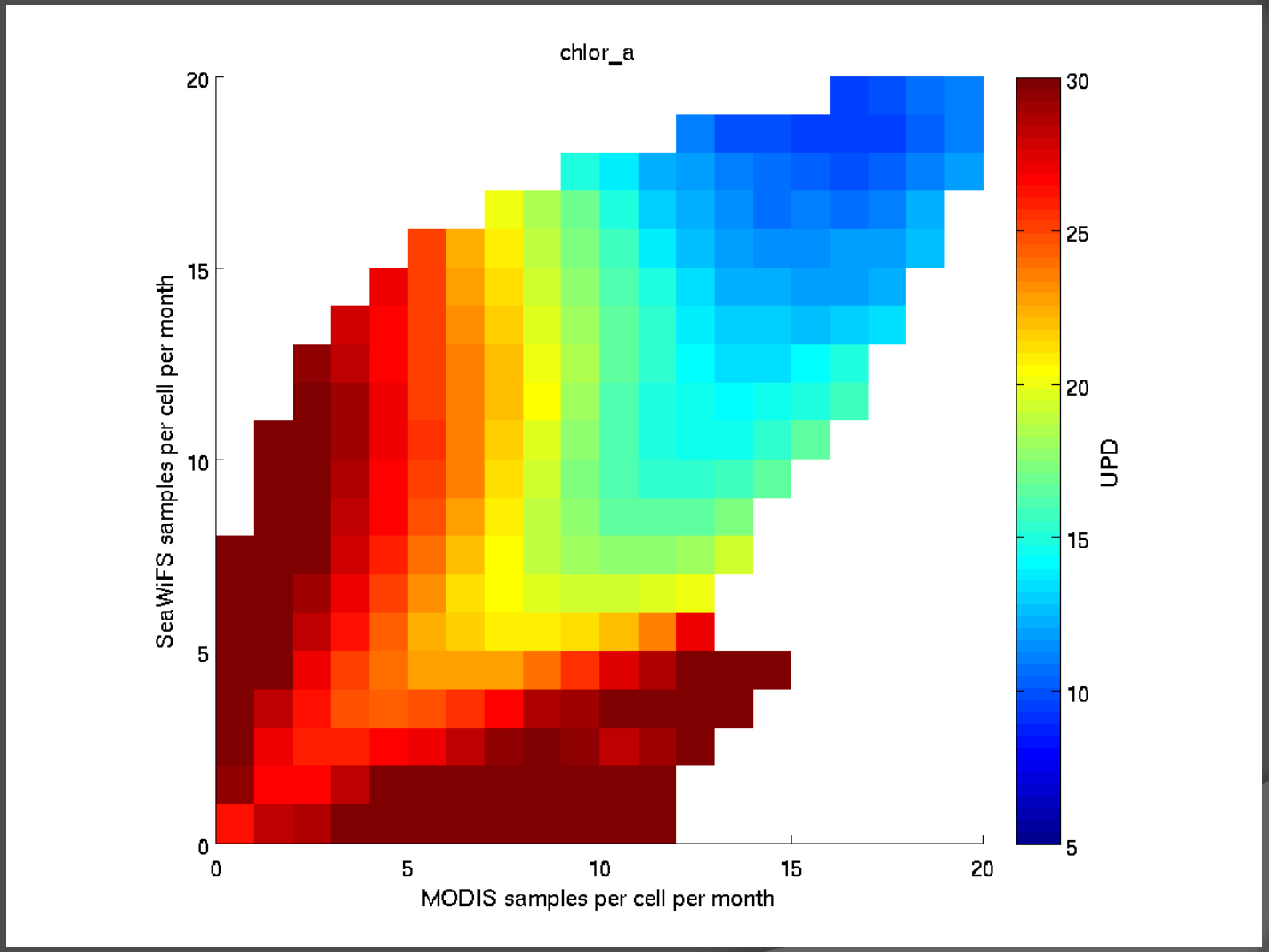

UPD for a) SeaWiFS / MODIS and b) VIIRS / MODIS simultaneous $K_d$_lee matchup at 0.25 degree resolution. Regions with positive or negative MRD greater than 5% are marked with '+' or '-', respectively. For MRD greater than 10%, symbols are bold.

# Comparison of monthly mean products



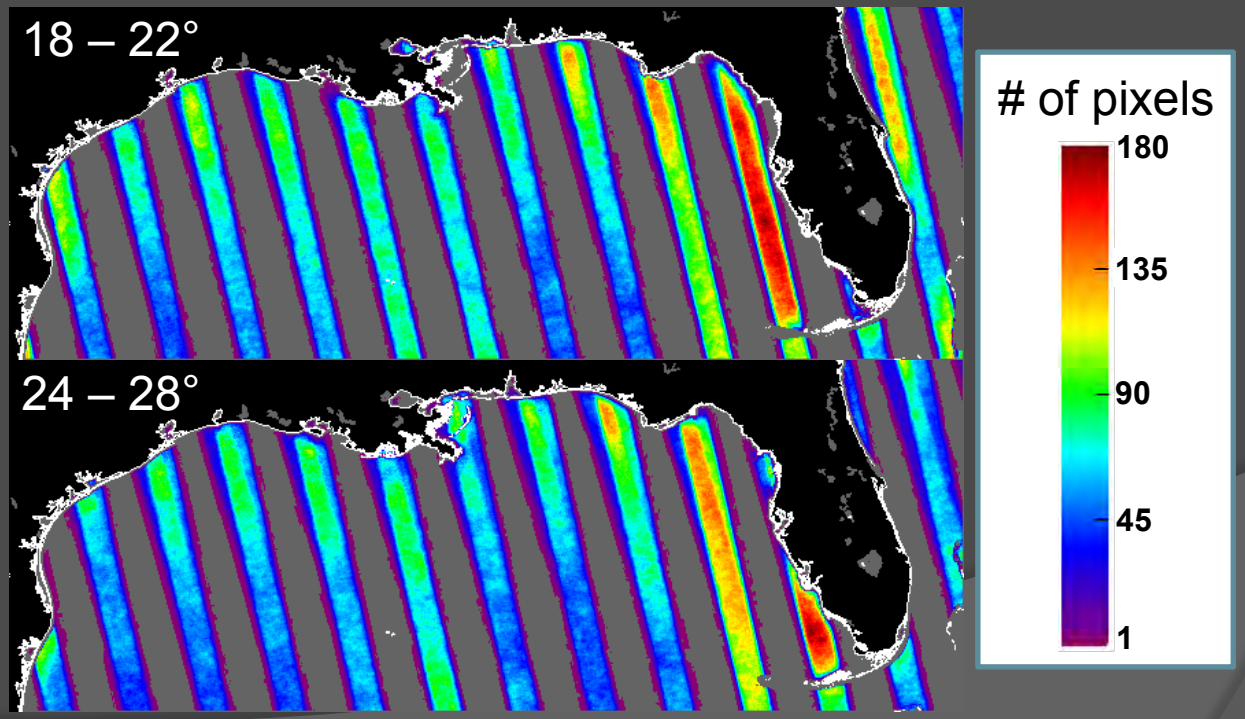

UPD for a) SeaWiFS / MODIS and b) VIIRS / MODIS monthly mean products

# Differences in monthly mean products for clear waters of the Gulf of Mexico



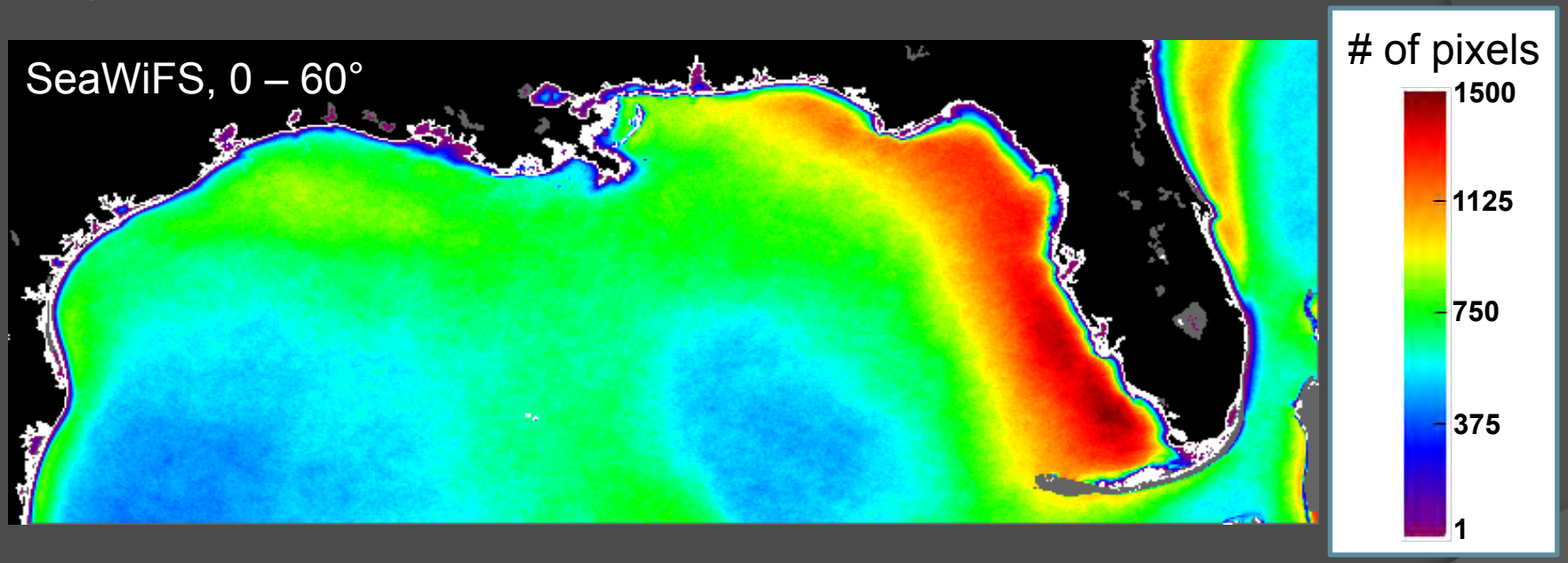
# Why does viewing angle matter?

- Satellite data may degrade at high SZA
- Geostationary sensor design
- Any (non polar) location is viewed from only ~6 SZAs for MODIS & VIIRS

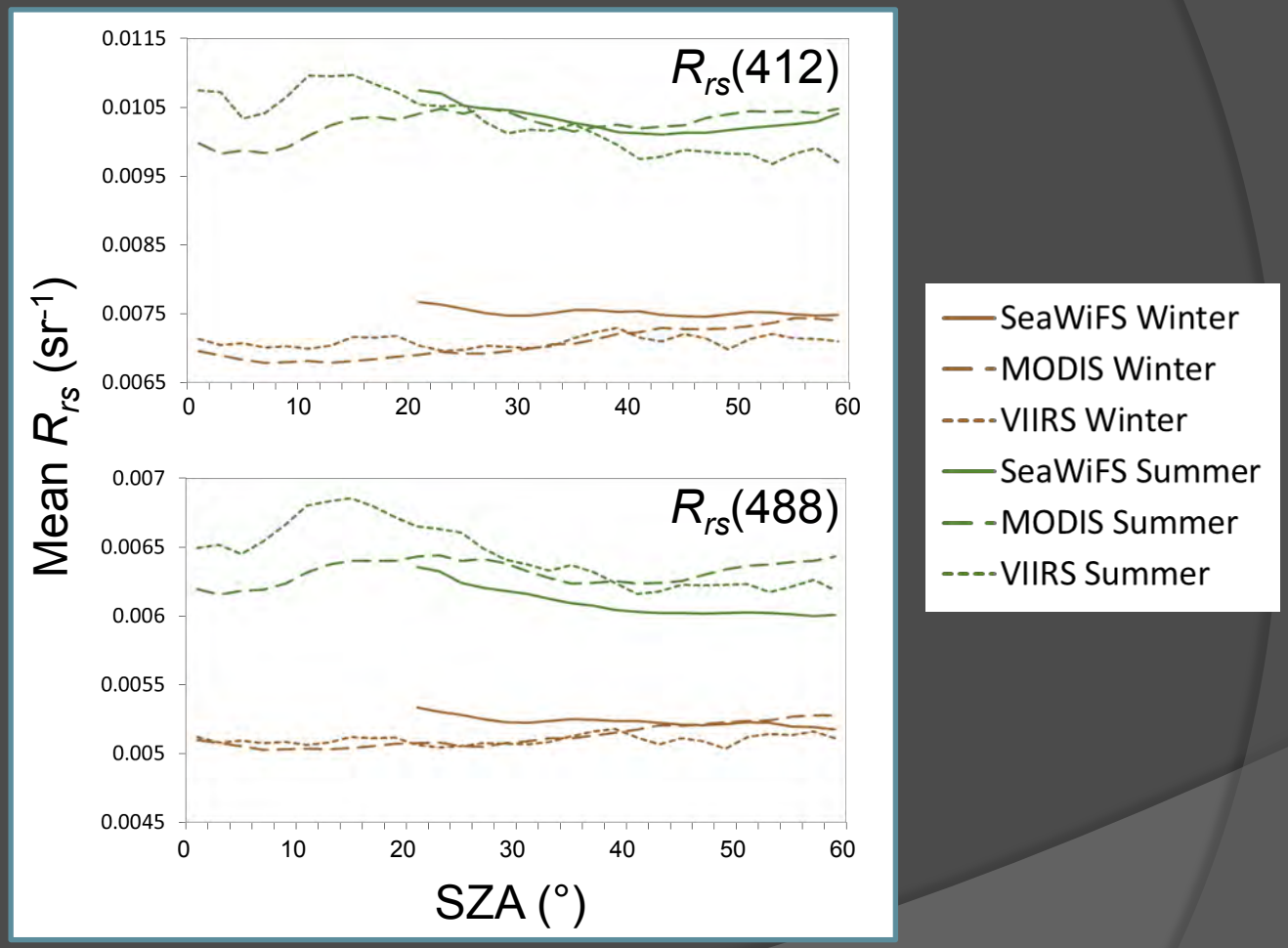


# Study area & data distribution

- SeaWiFS, MODIS, & VIIRS (1997 – 2014)
- 3 km resolution



# Single sensor SZA trends – $R_{rs}$




Offshore waters, $CHL_{OCI} \leq 0.25$ mg m$^{-3}$

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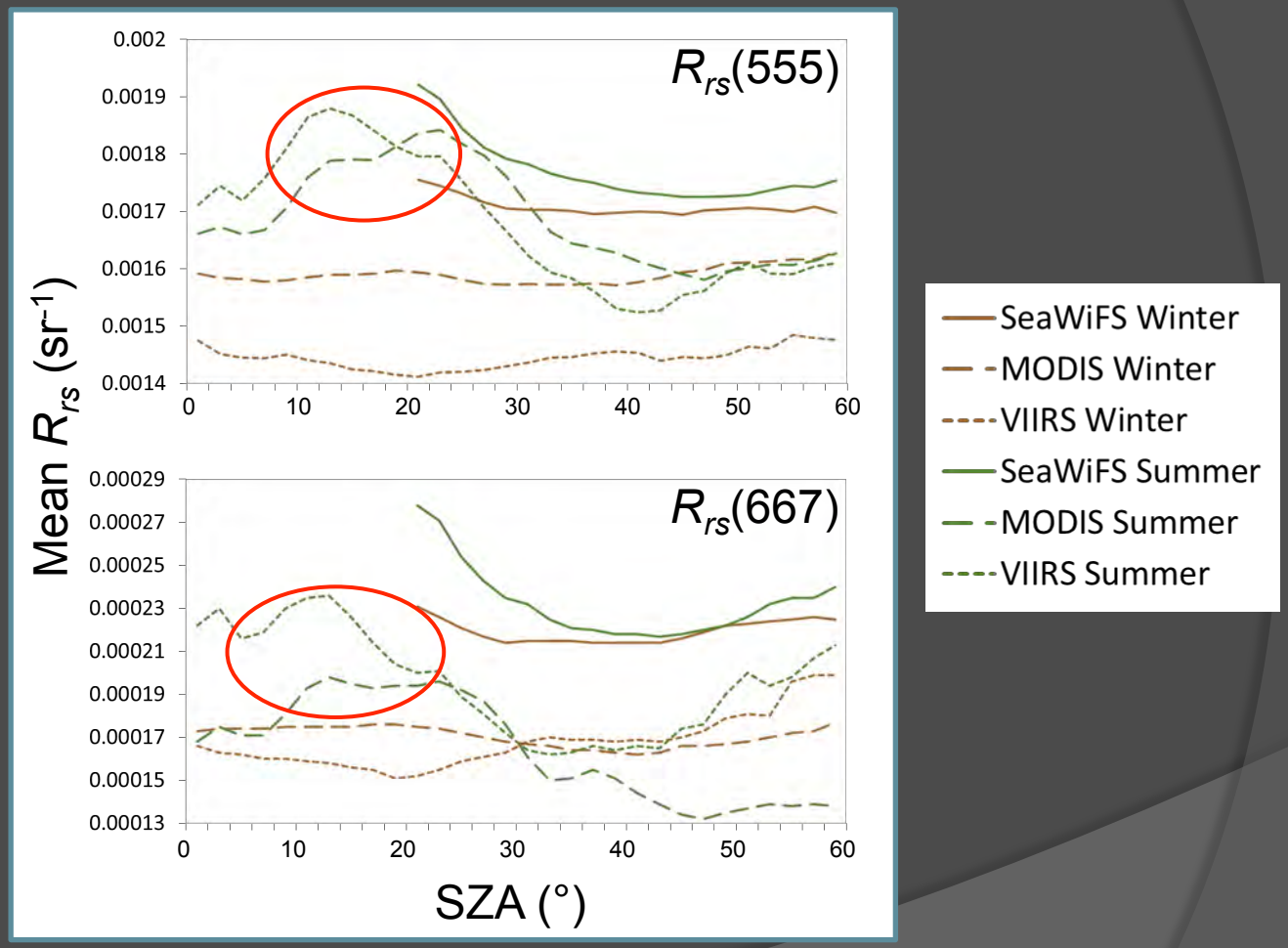


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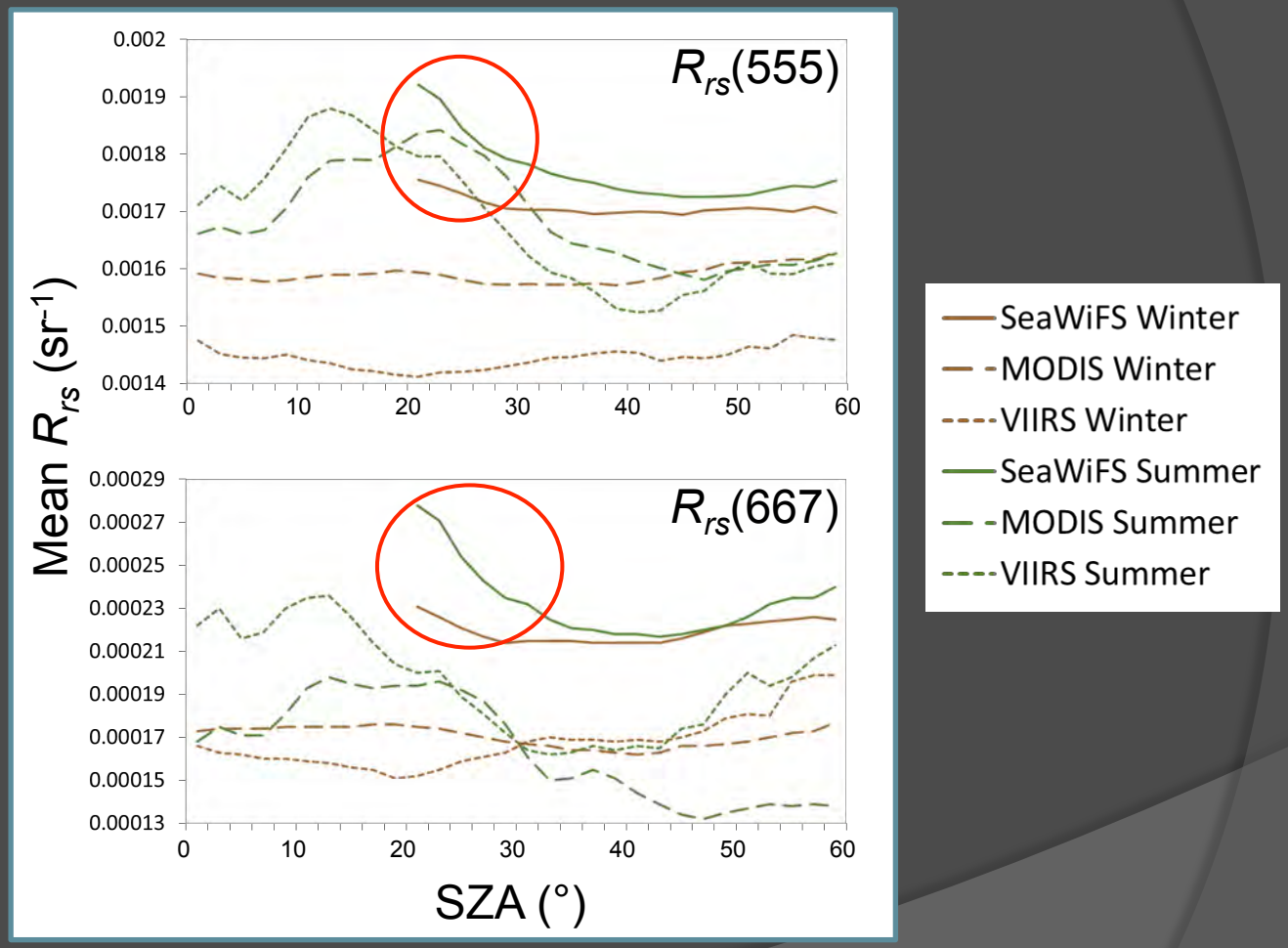
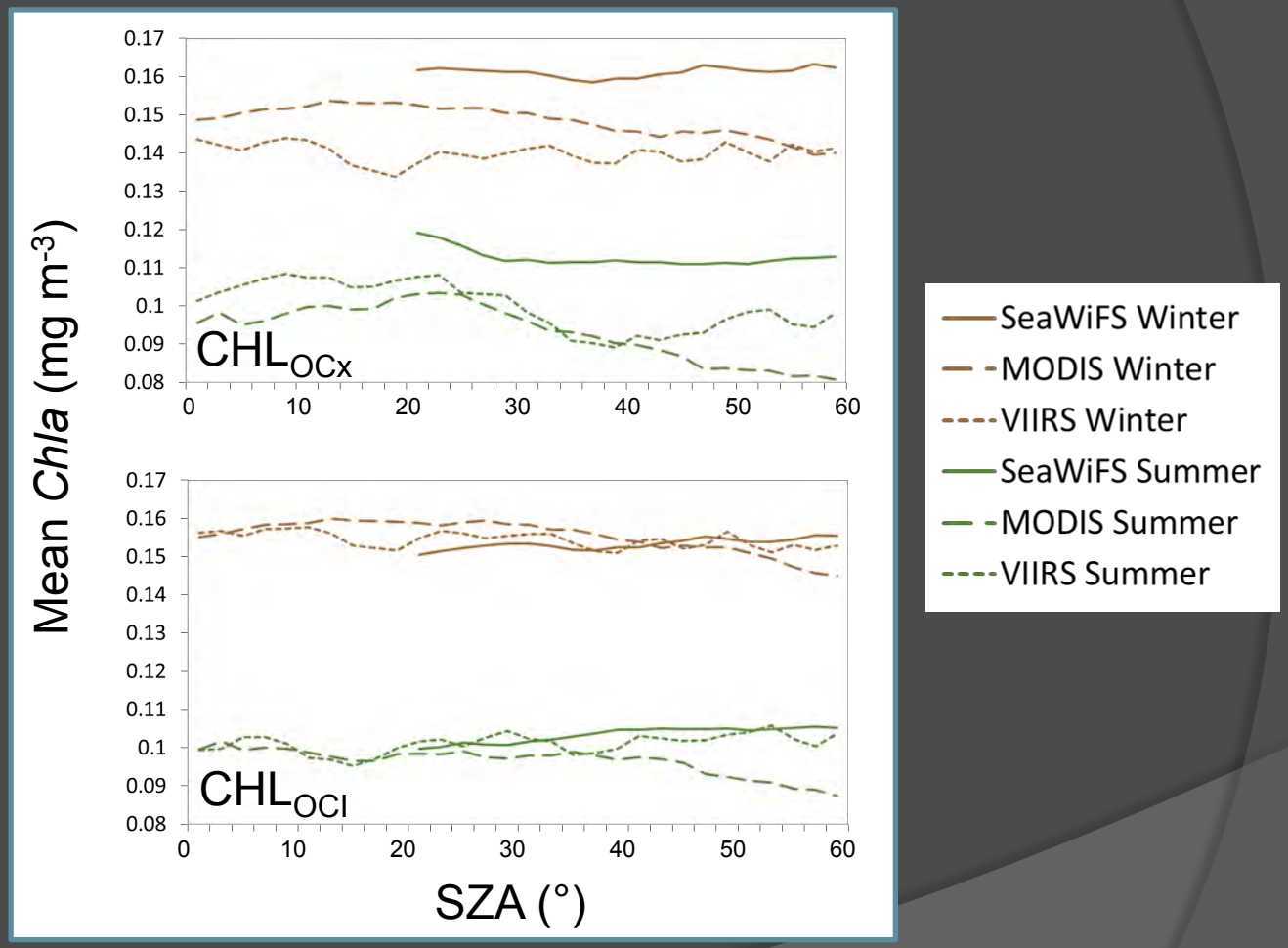


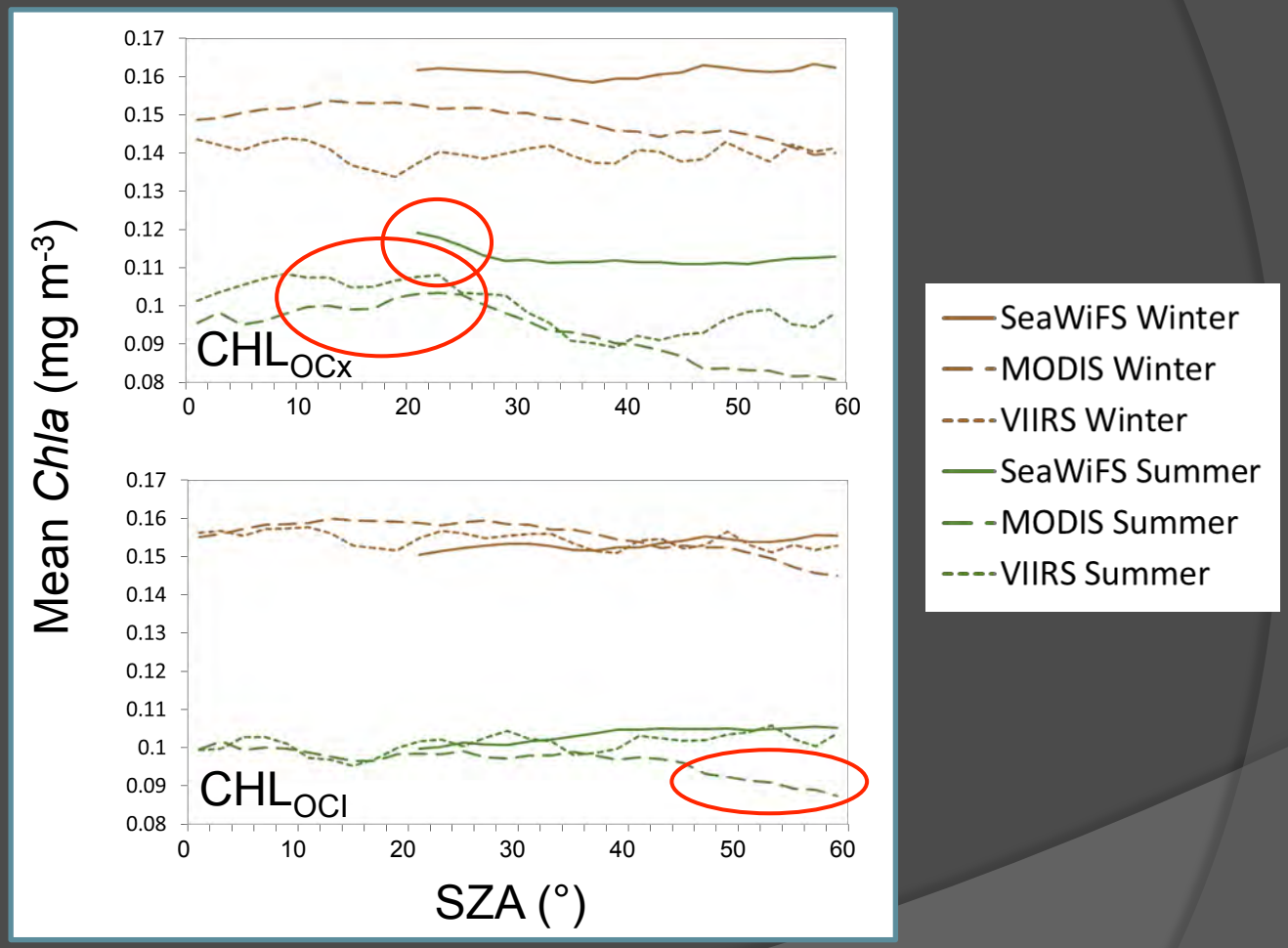

Offshore waters, $CHL_{OCI} \leq 0.25$ mg m$^{-3}$

# Single sensor SZA trends – *Chla*




Offshore waters, $CHL_{OCI} \leq 0.25$ mg m$^{-3}$

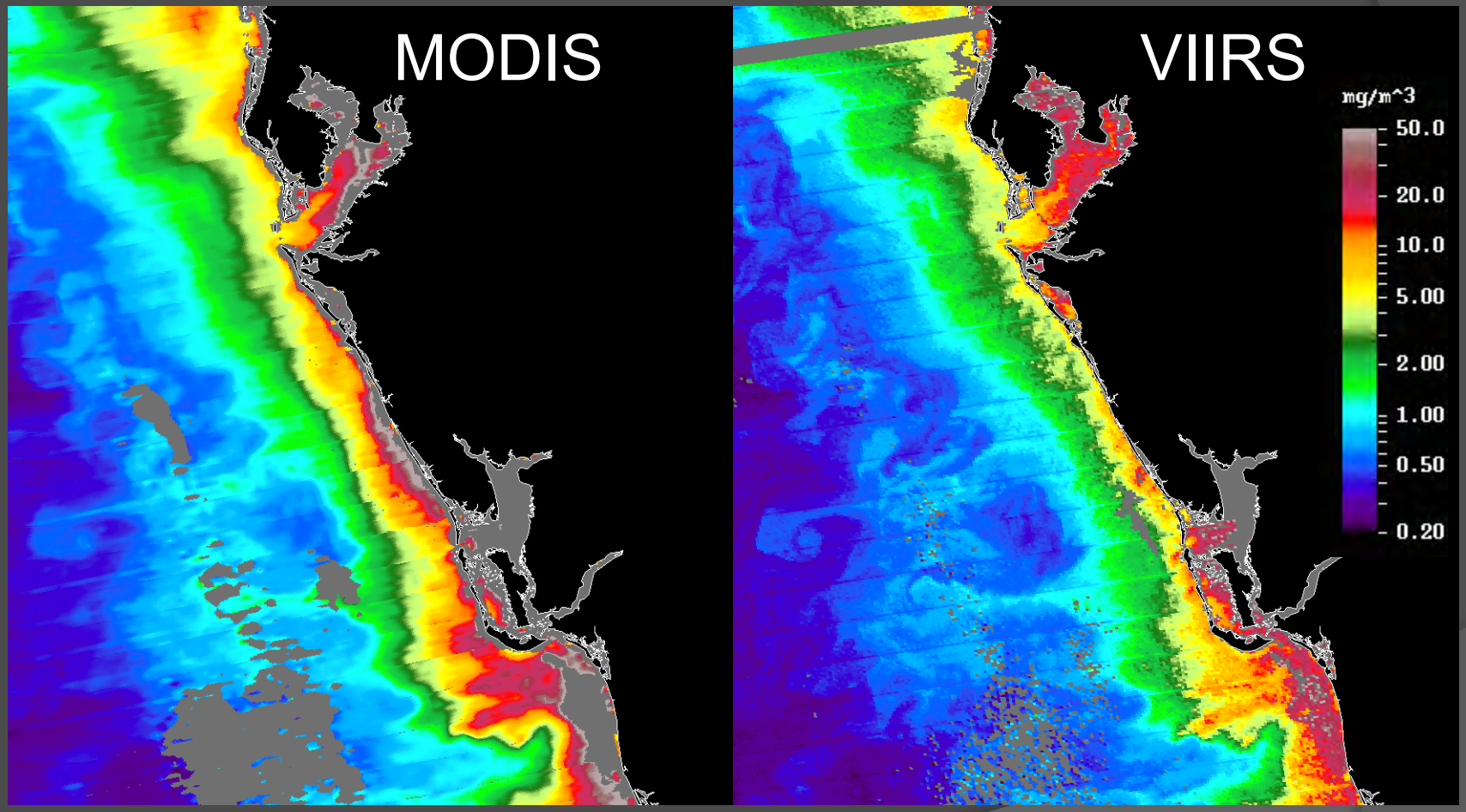
# Single sensor SZA trends – *Chla*




Offshore waters, $CHL_{OCI} \leq 0.25$ mg $m^{-3}$

# Cross-sensor SZA assessment

- Collocated, < 1 hour temporal overlap




MODIS Aqua and VIIRS NPP data from 11 November 2014

# Assessment terms

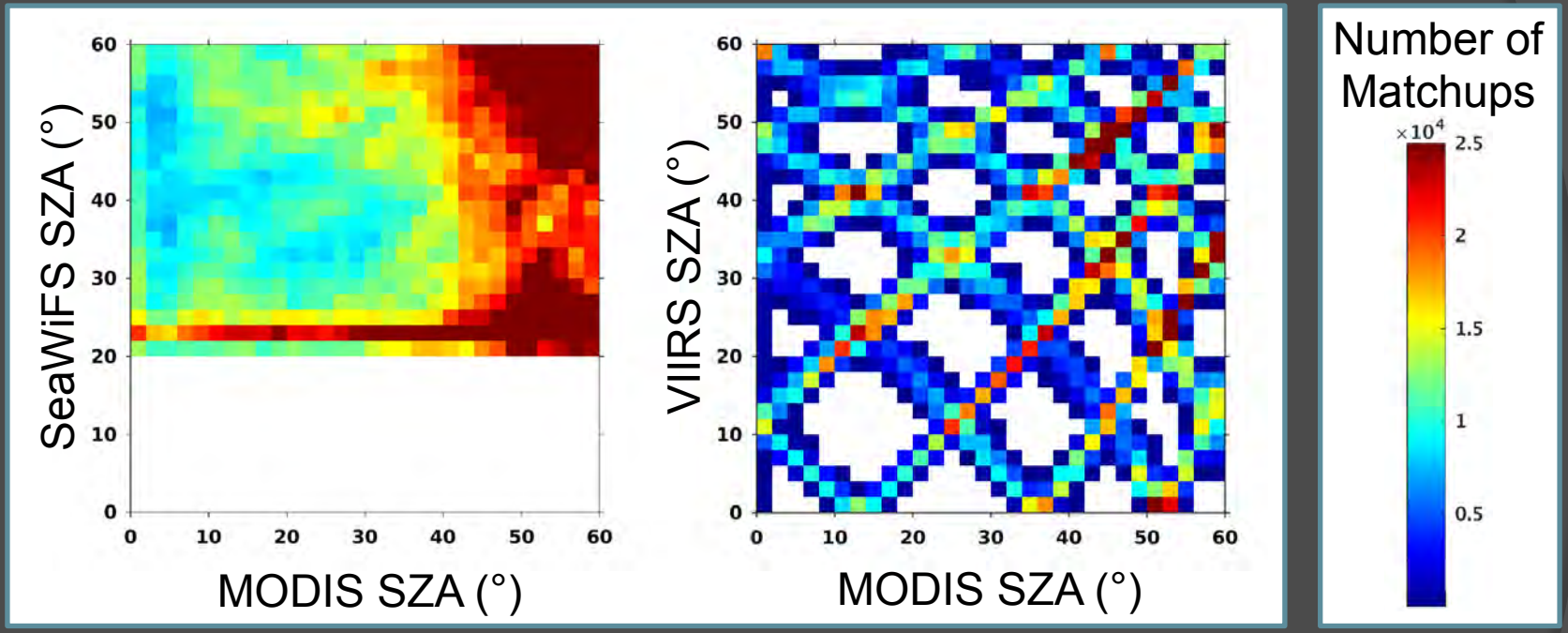
- UPD = Percent difference

$$1/N \sum 200 * {|(y_i - x_i)|}/{(y_i + x_i)}$$

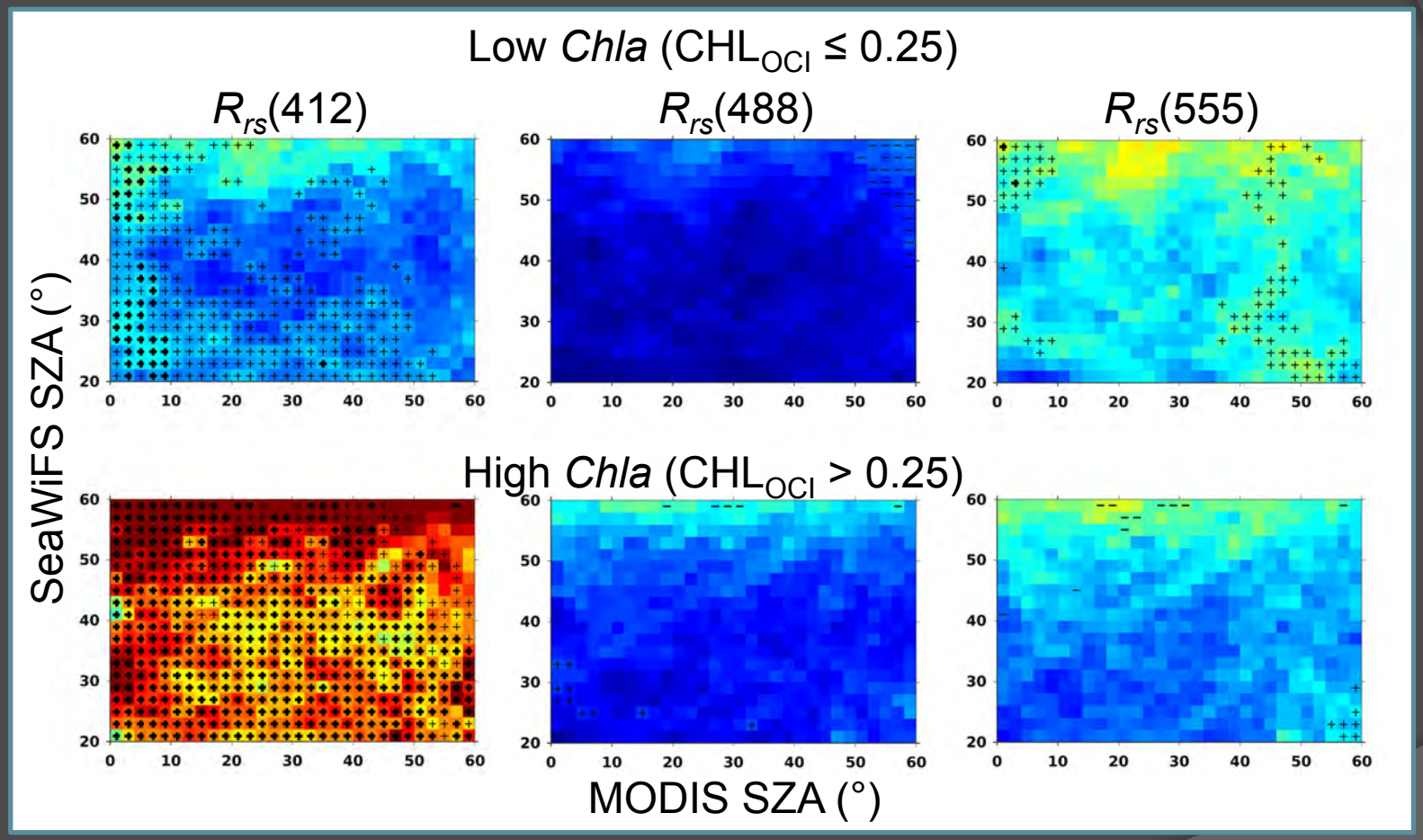
- MRD = Bias

$$1/N \sum 100 * {(y_i - x_i)}/{x_i}$$

# Data distribution by SZA



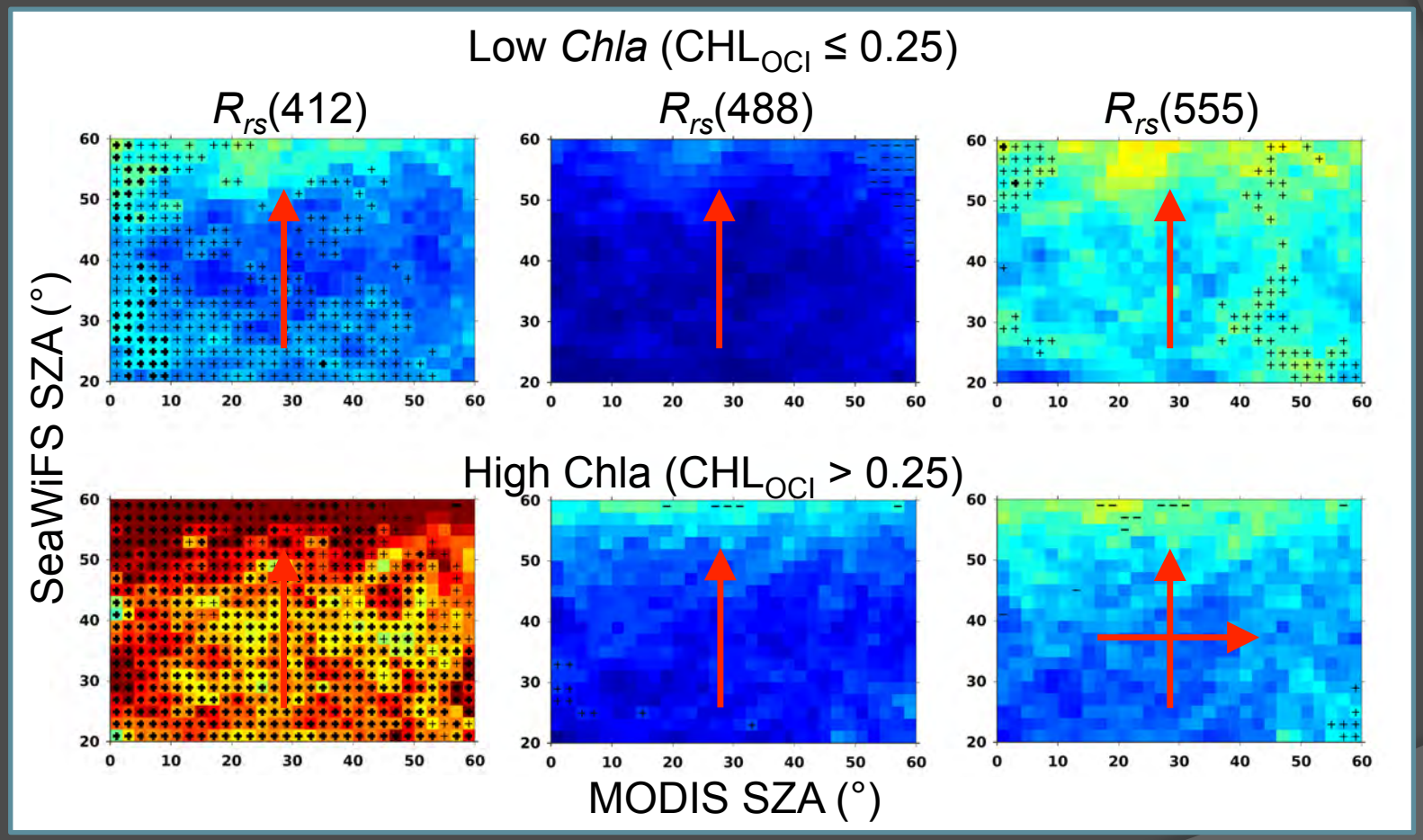
# SeaWiFS vs MODIS – $R_{rs}$




+ / - = MRD > 5%

**+** / **-** = MRD > 10%

# SeaWiFS vs MODIS – $R_{rs}$

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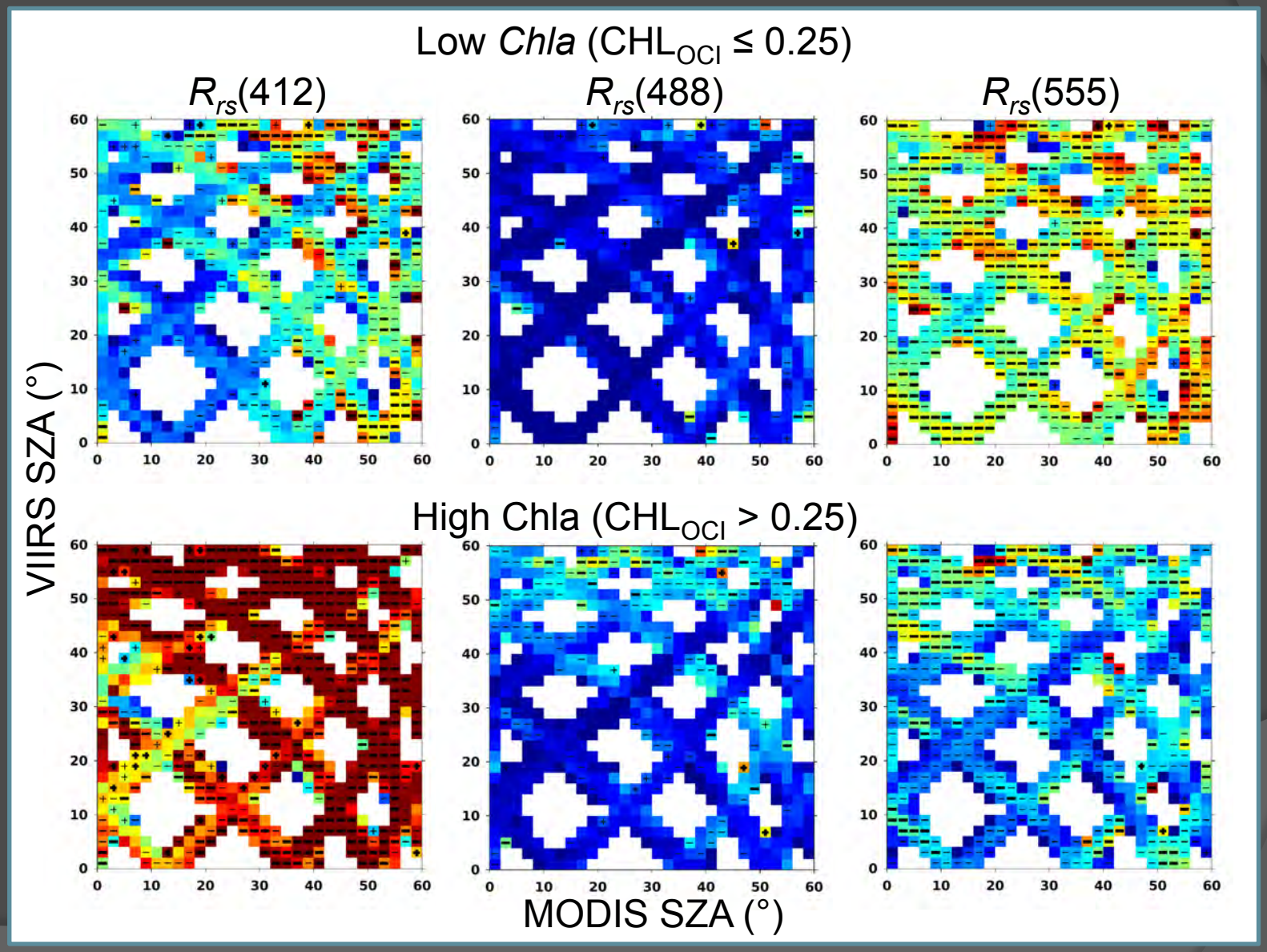
# VIIRS vs MODIS – $R_{rs}$



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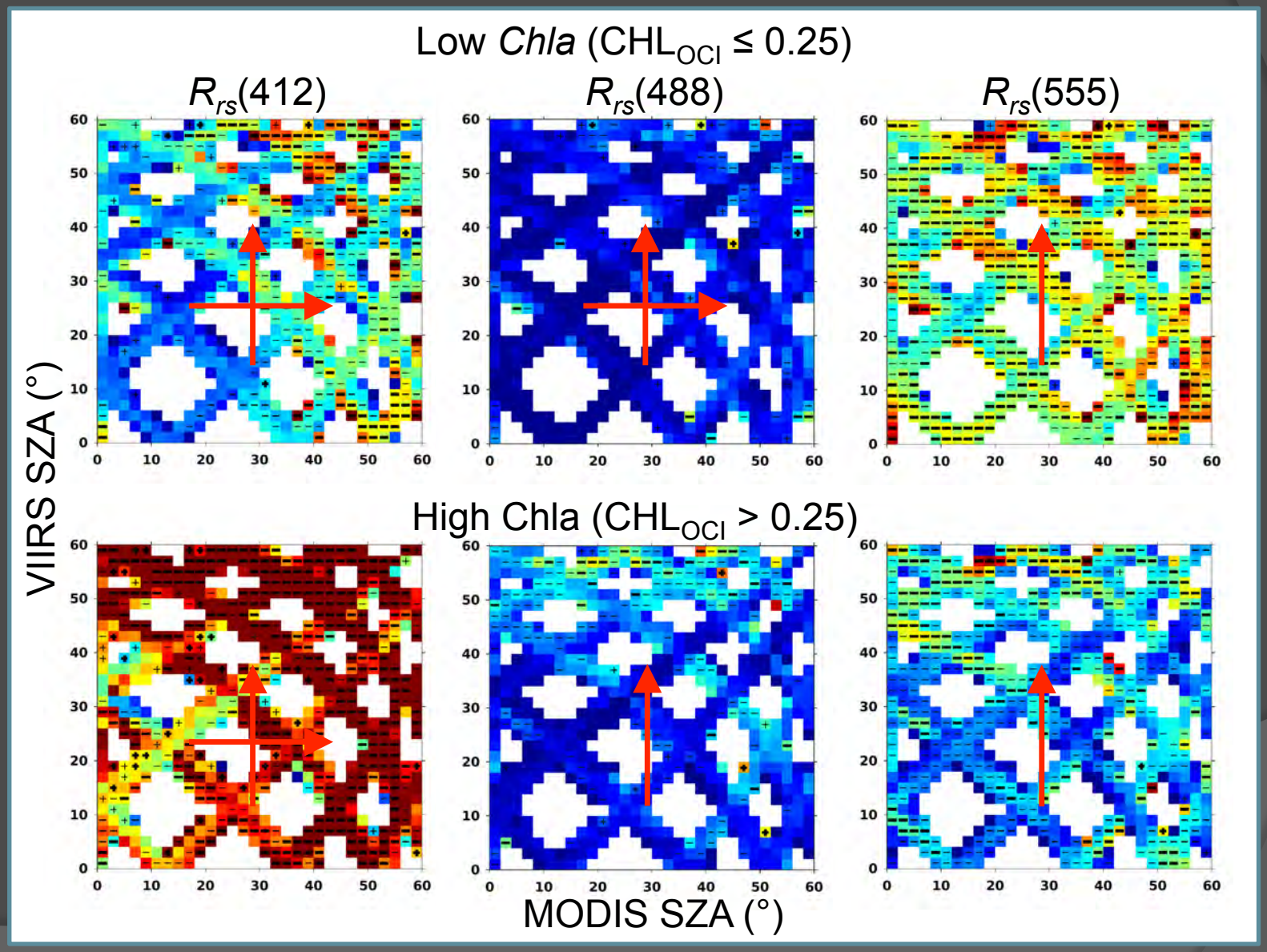
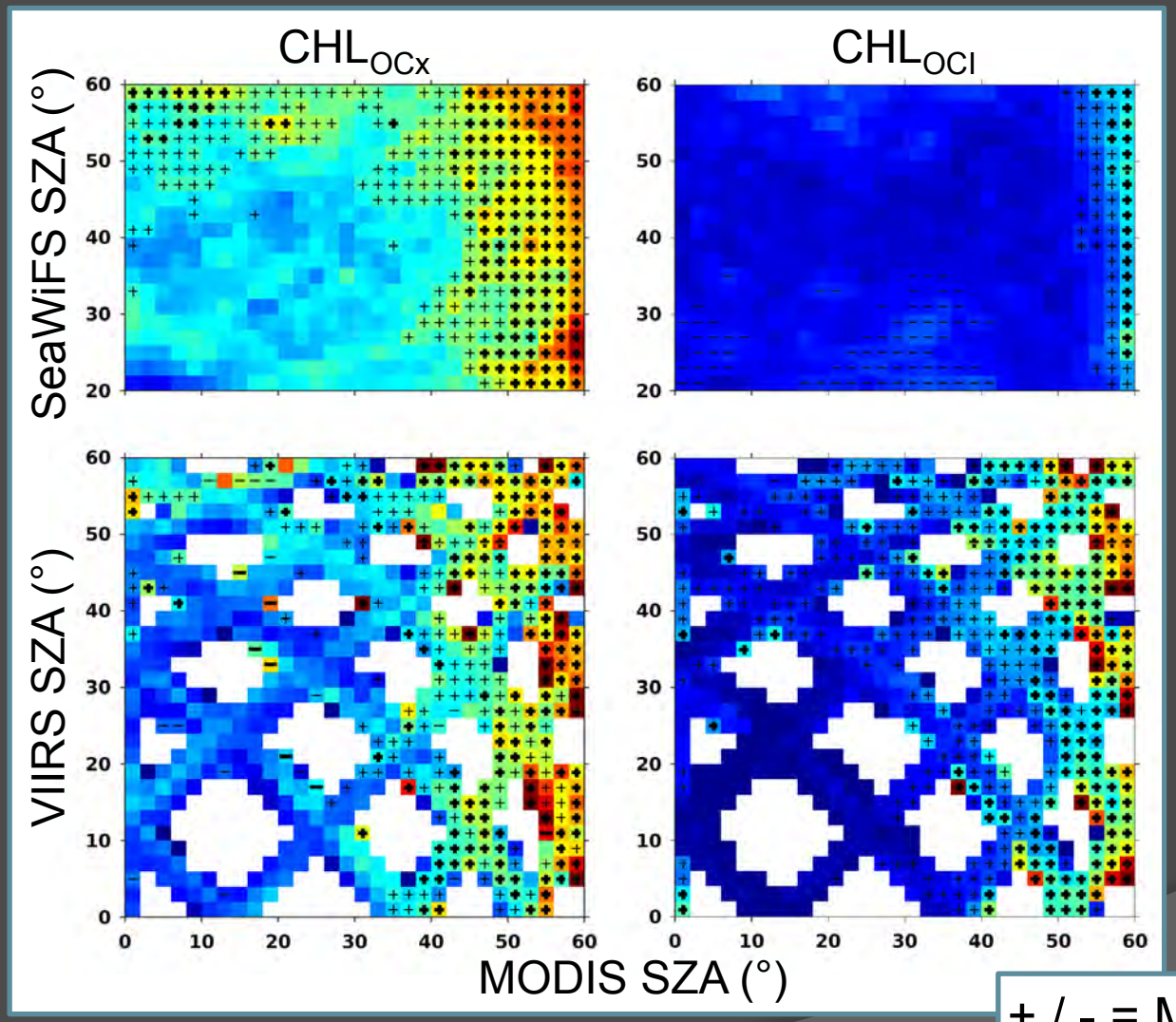
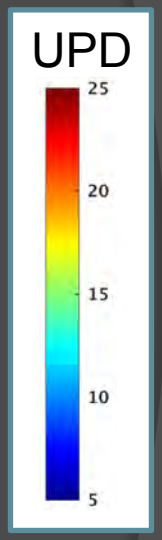


# Angular dependence in *Chla*

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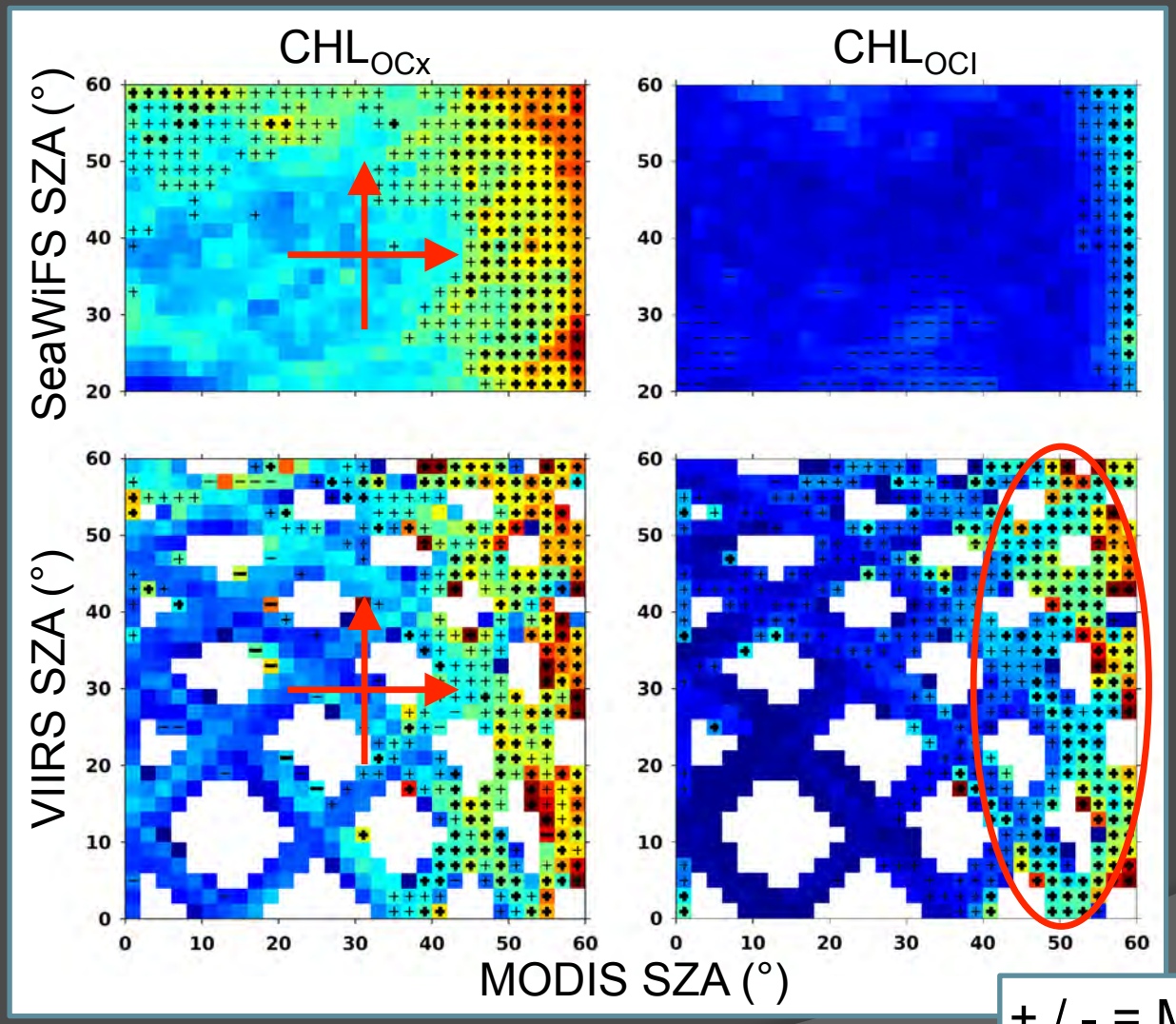
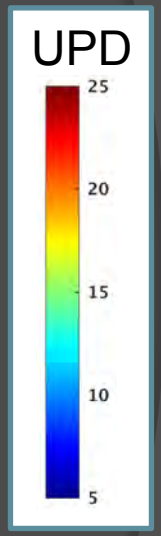
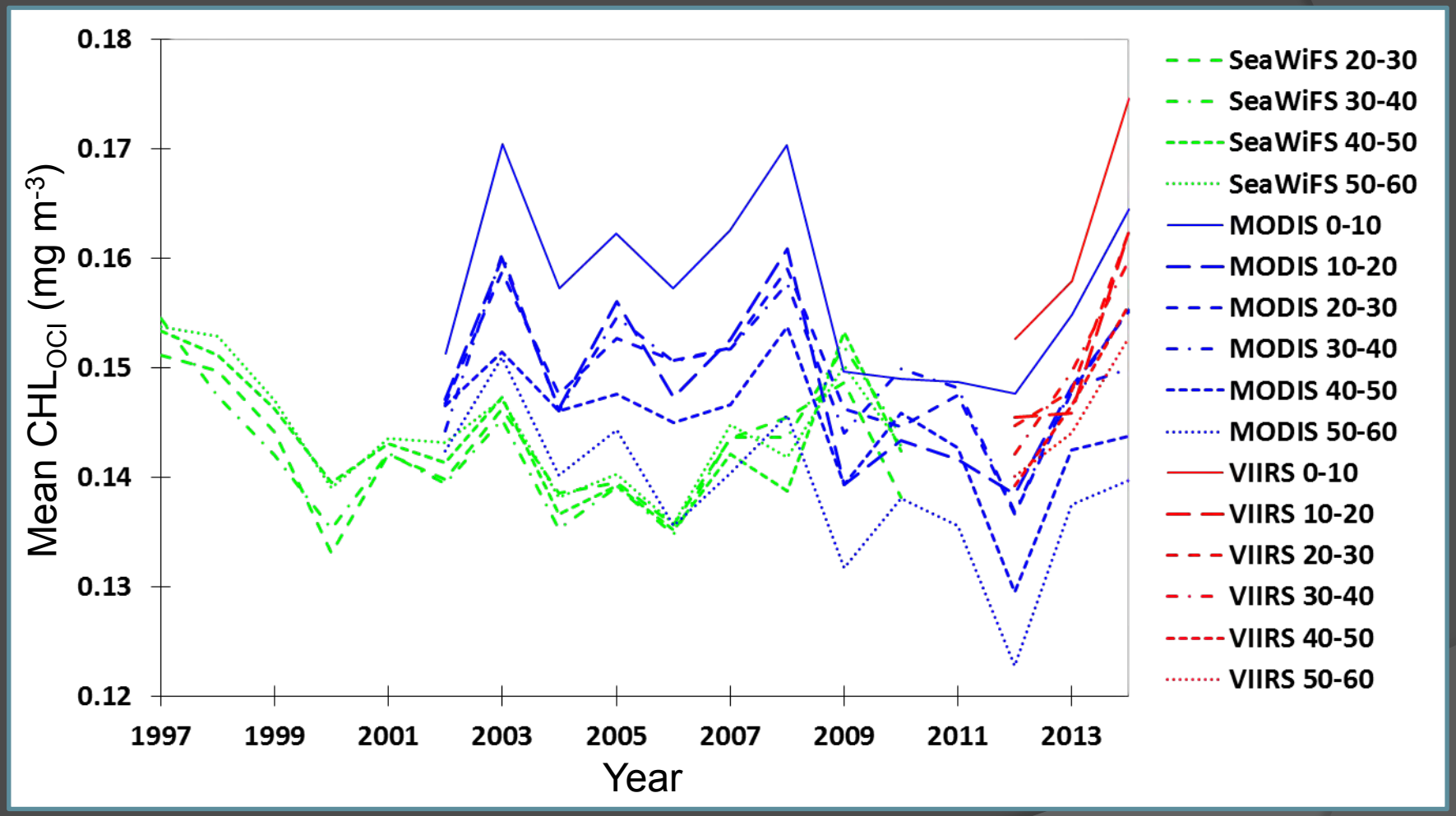



+ / - = MRD > 5%

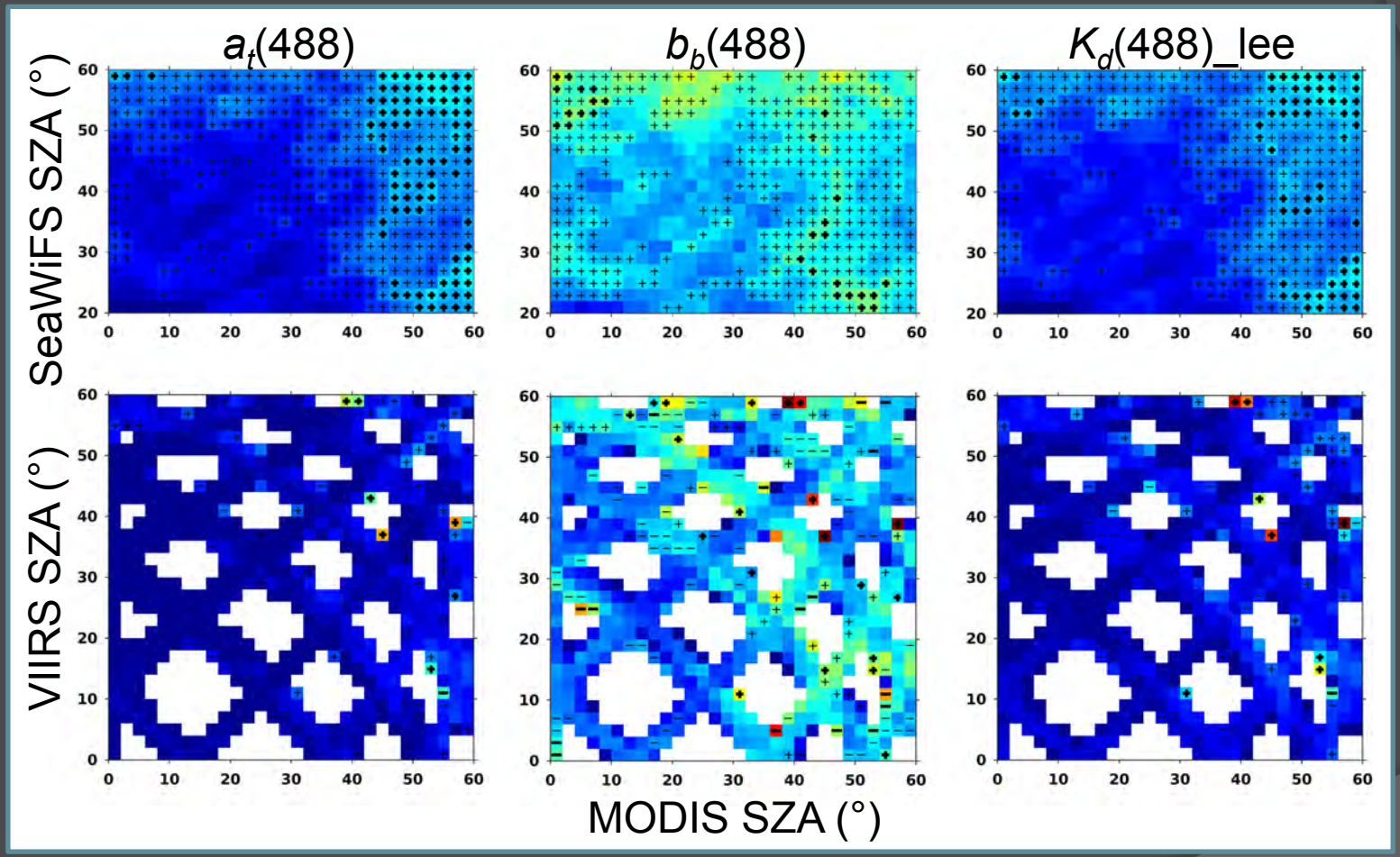
**+** / **-** = MRD > 10%

# SZA dependence - time series




All GoM, CHL$_{OCI}$ ≤ 0.25 mg m$^{-3}$

# Angular dependence in QAA




Low *Chla* ($CHL_{OCI} \leq 0.25$)

+ / - = MRD > 5%

**+** / **-** = MRD > 10%

# Conclusions

- Apparent SZA dependence for all instruments
  - Potential MODIS and VIIRS insufficient sun glint masking
  - Potential SeaWiFS BRDF correction uncertainties
- Impressive overall continuity for $R_{rs}$
  - Generally, UPD < 10%, except for red bands
  - MRD < 5%, but SeaWiFS > MODIS > VIIRS
  - Most angular dependence for SZA > 40°
- OCI much more resilient to angular dependence than OCx
- SZA dependence muted in QAA & $K_d$_lee products