NPL National Physical Laboratory | Centre for Carbon Measurement

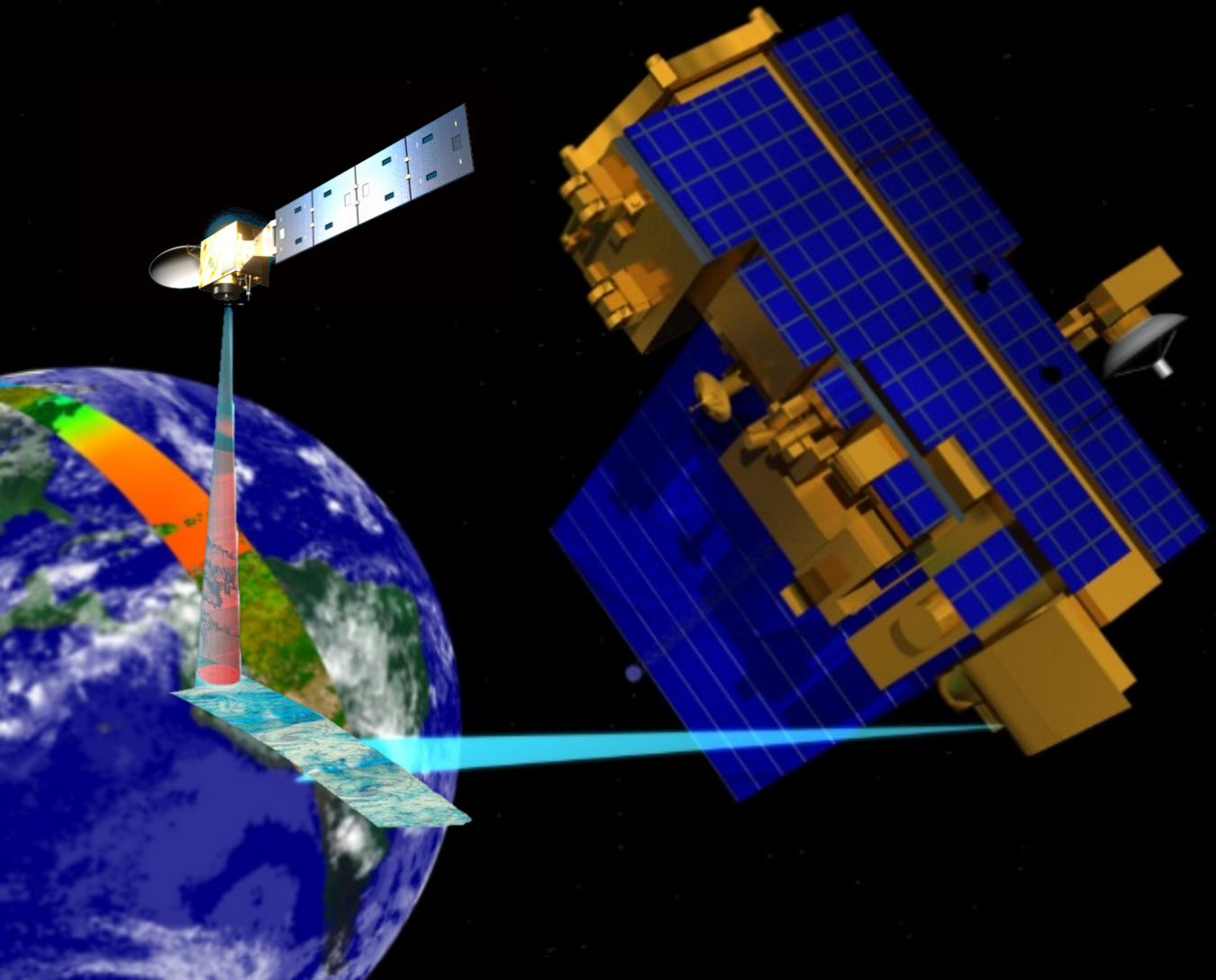
Establishing a CEOS-based harmonisation factor

Emma Woolliams

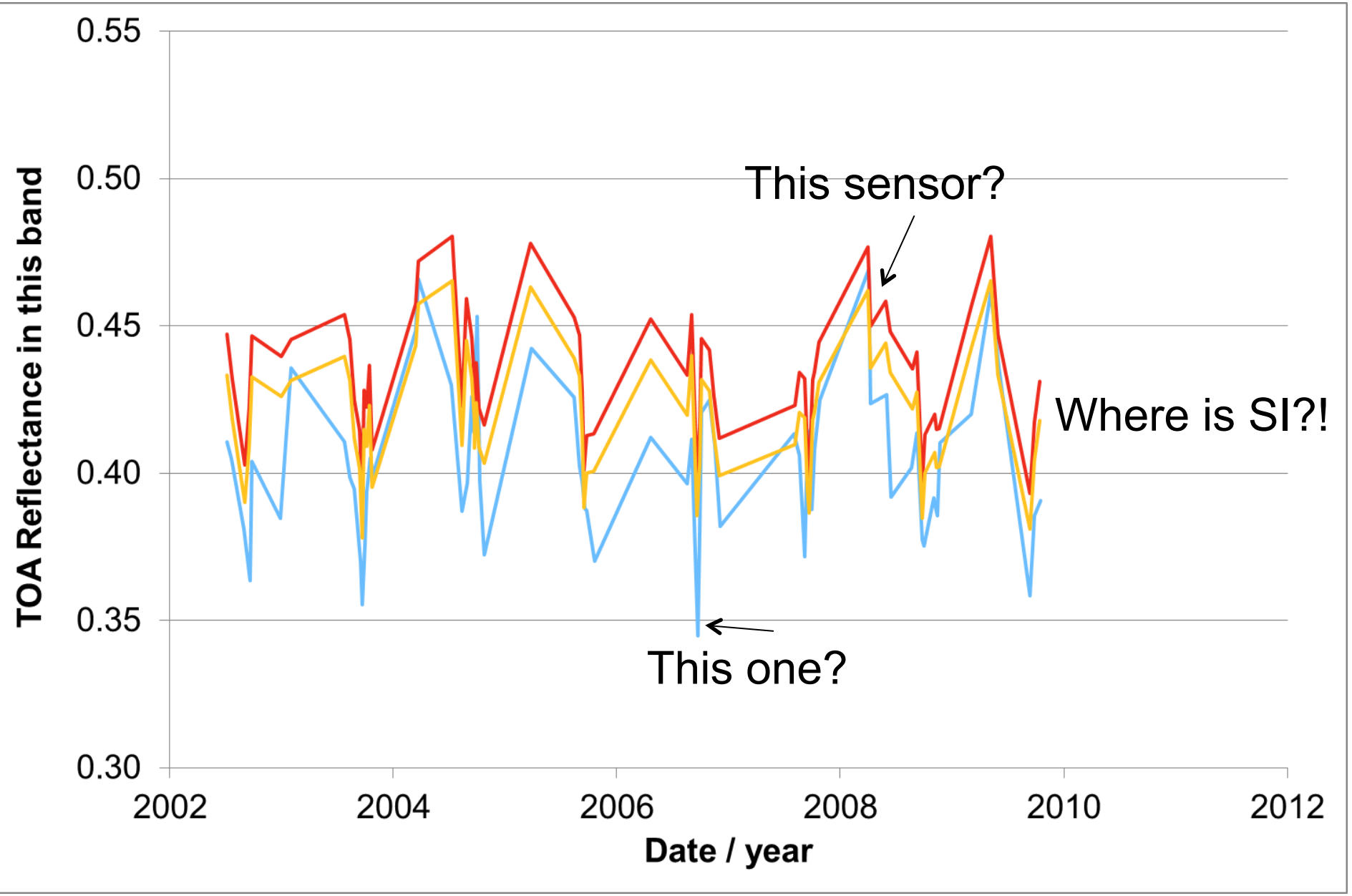
4th June 2014

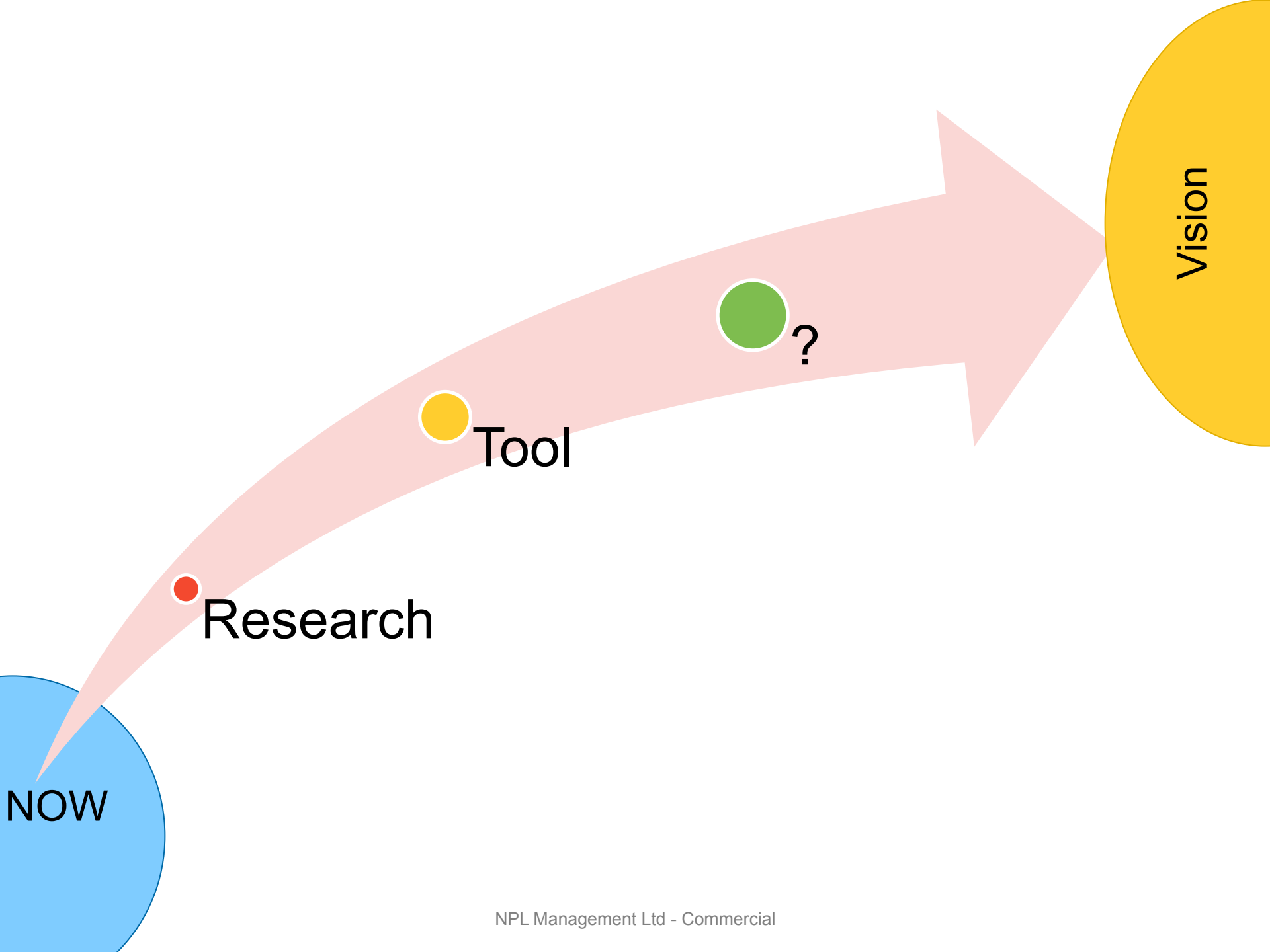
Can we harmonise the datasets?

And what do we define as ‘right’?



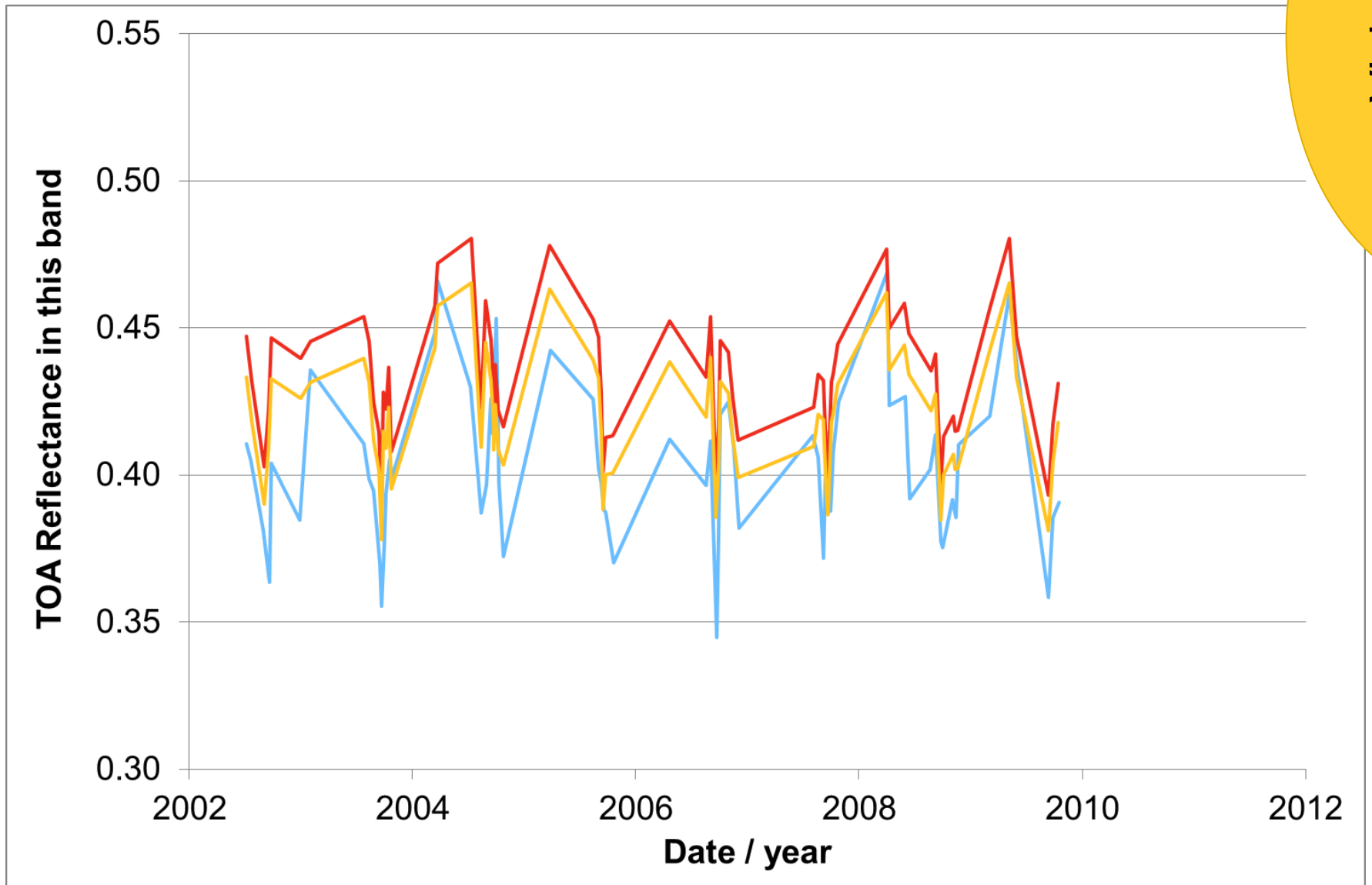
Reference?


0.55
0.50
0.45
0.40
0.35
0.30
TOA Reflectance in this band
2002
2004
2006
2008
2010
2012
Date / year
This sensor?
Where is SI?!
This one?

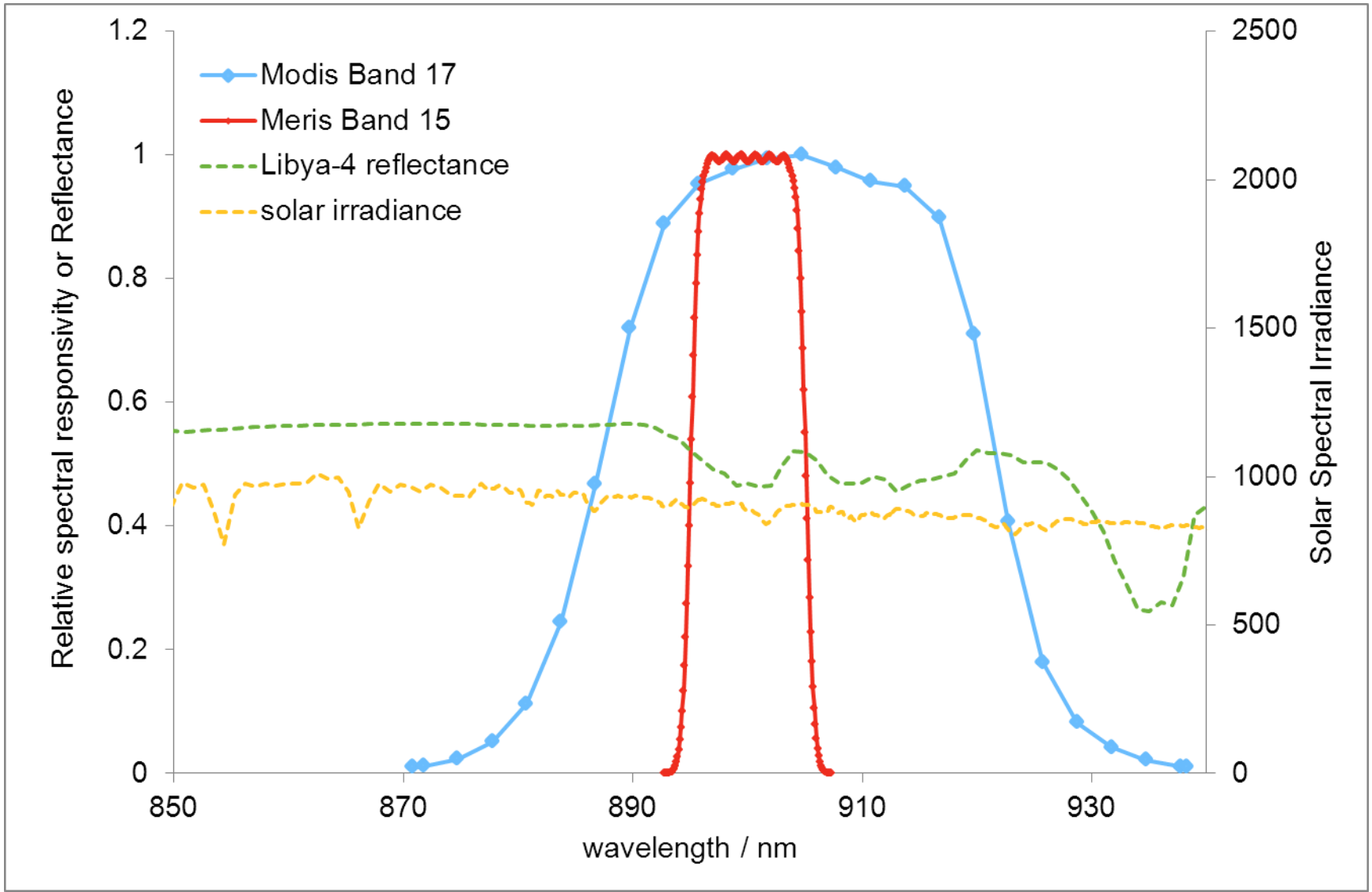

Vision
?
Tool
Research
NOW

The Virtual Reference
(eventually: SI)

Vision



The comparison quantity

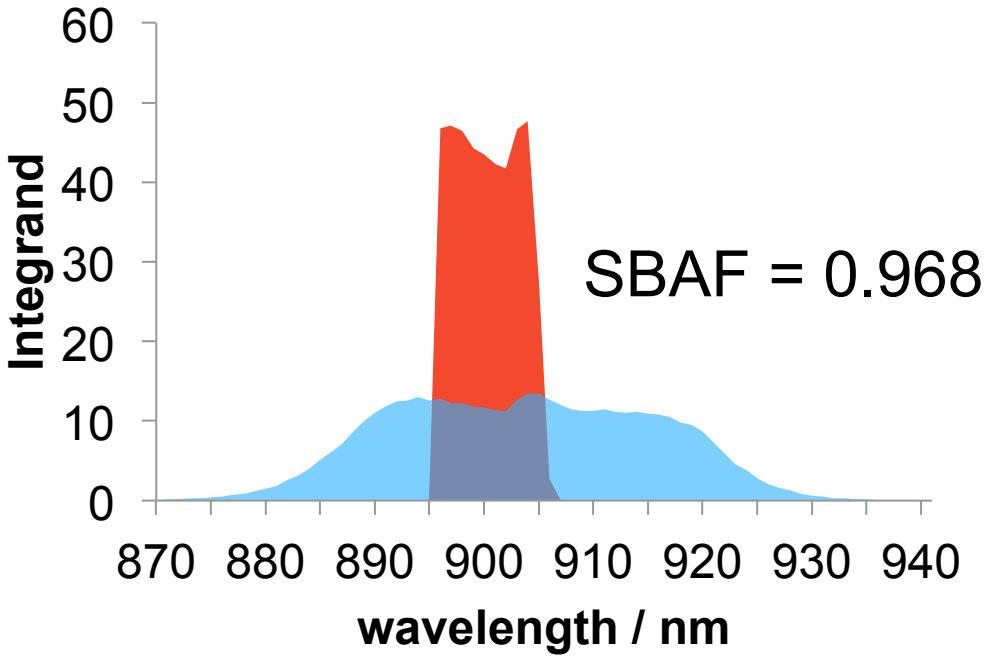


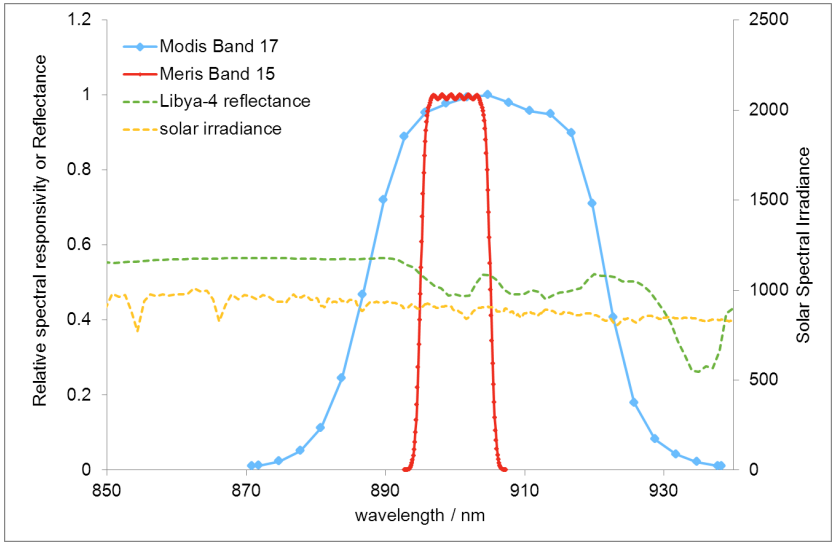
Spectral band adjustment factor

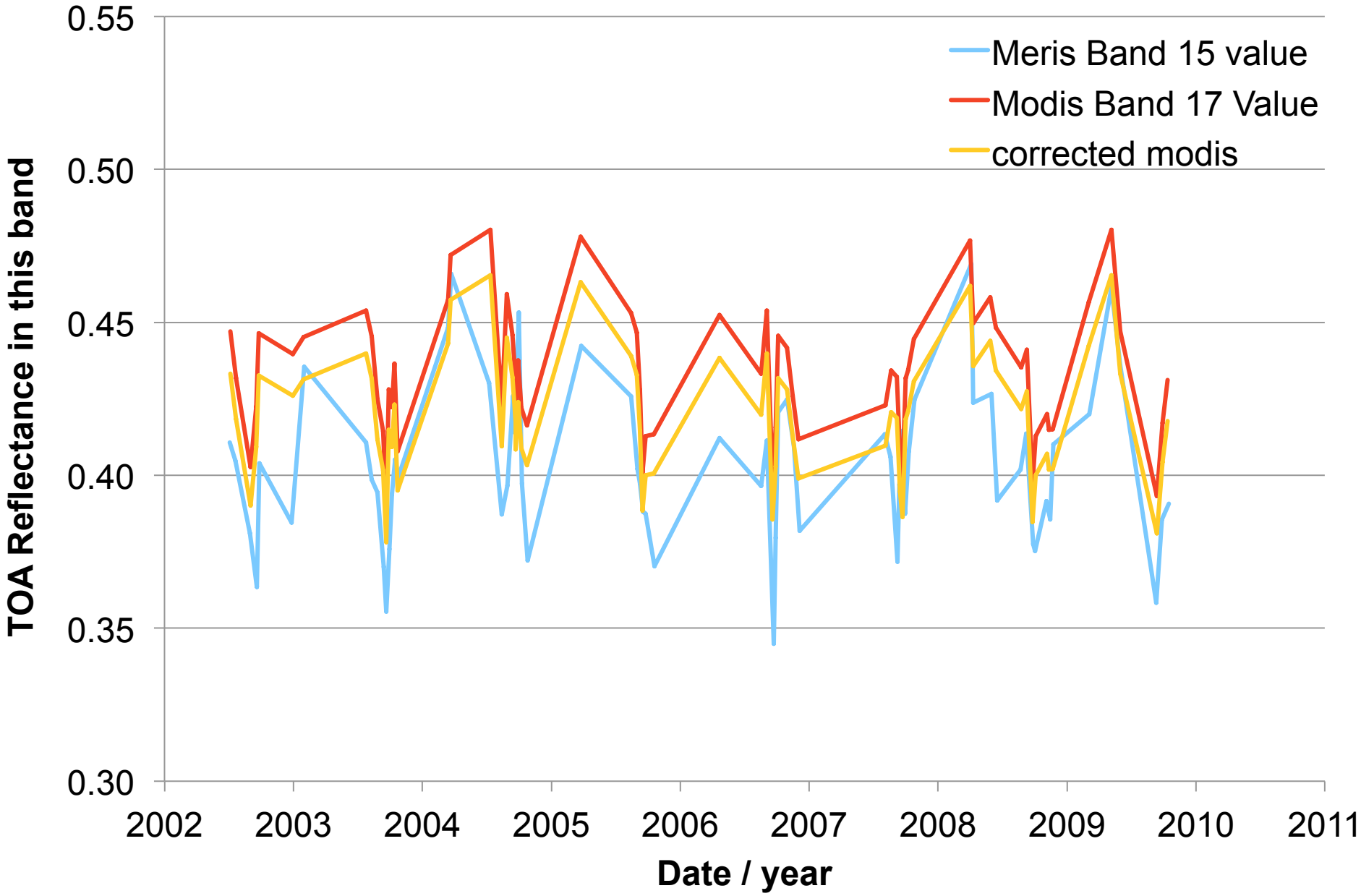
$$\hat{F}_{\mathrm{a2/b3},J} = \frac{\hat{I}_{\mathrm{SAG,b3},J}\,\hat{I}_{\mathrm{S,a2}}}{\hat{I}_{\mathrm{SAG,a2},J}\,\hat{I}_{\mathrm{S,b3}}}$$

$$\hat{I}_{\mathrm{S},i} = \int \hat{E}_{\mathrm{sun}}(\lambda)\,\hat{S}_i(\lambda)\,\mathrm{d}\lambda$$

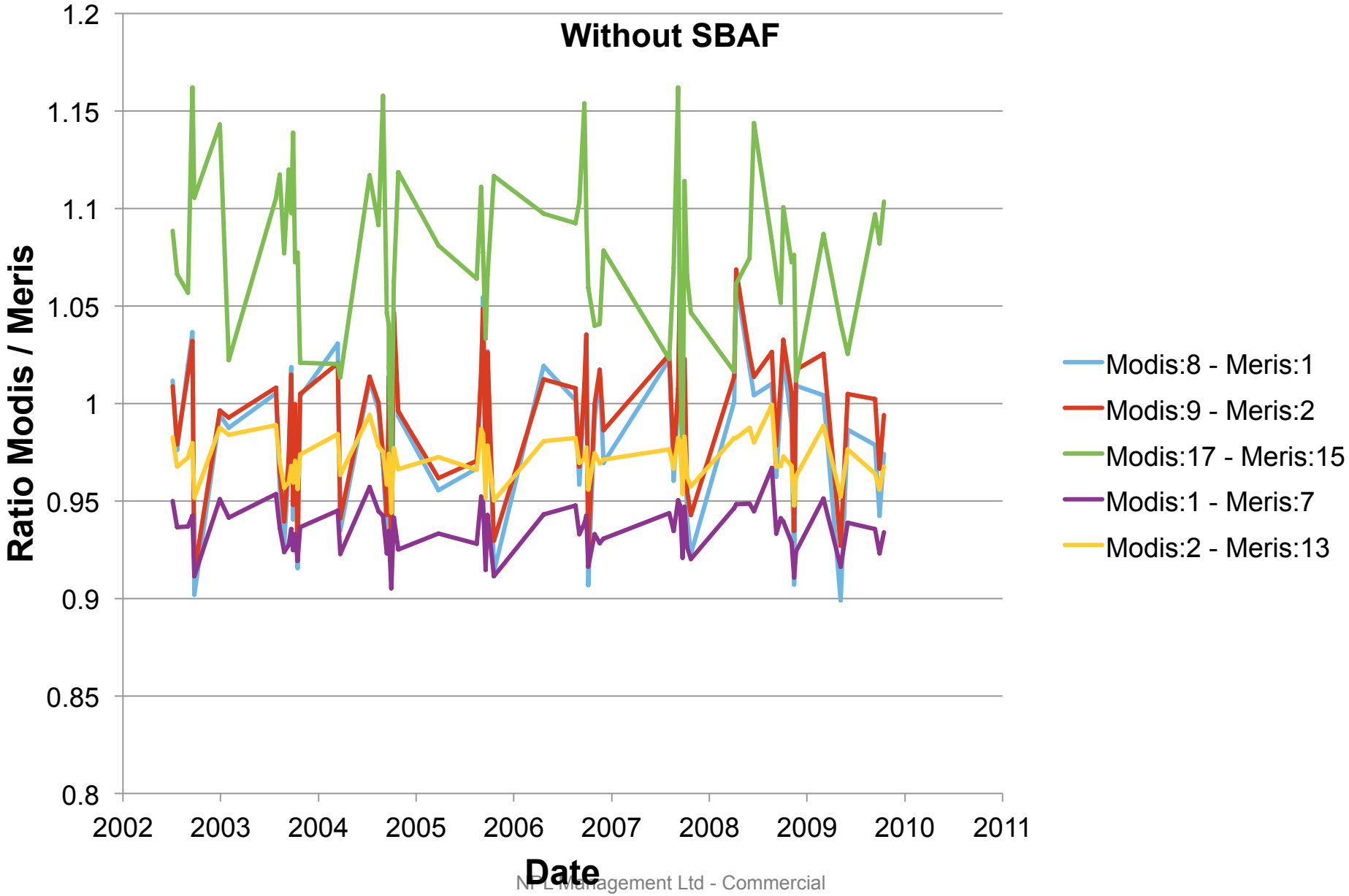
$$I_{\mathrm{SAG},i,J} = \int E_{\mathrm{sun}}(\lambda)\,\rho_{\mathrm{G}J}(\lambda)\,\tau_{\mathrm{atm},J}(\lambda)\,S_i(\lambda)\,\mathrm{d}\lambda$$



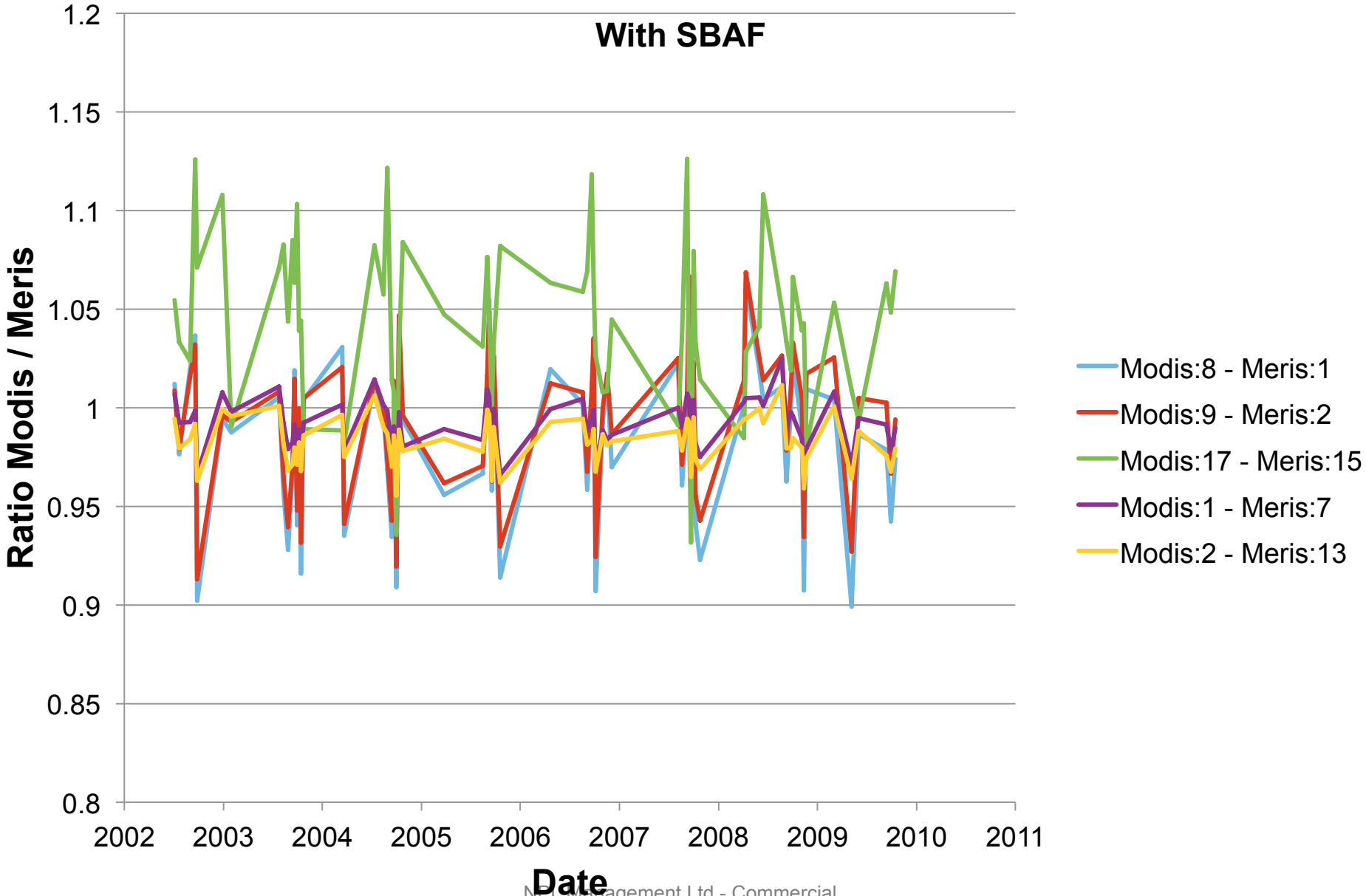




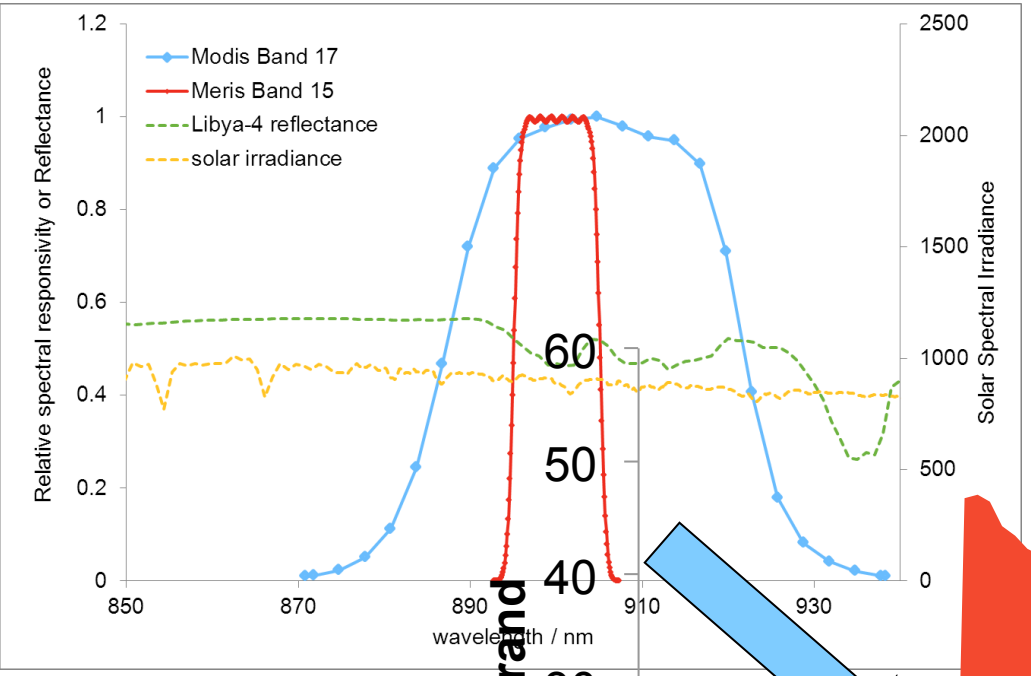
SBAF: Improvements

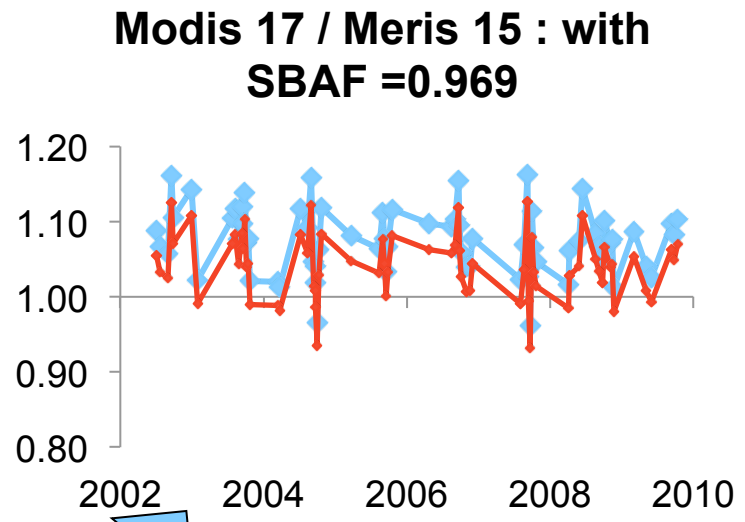


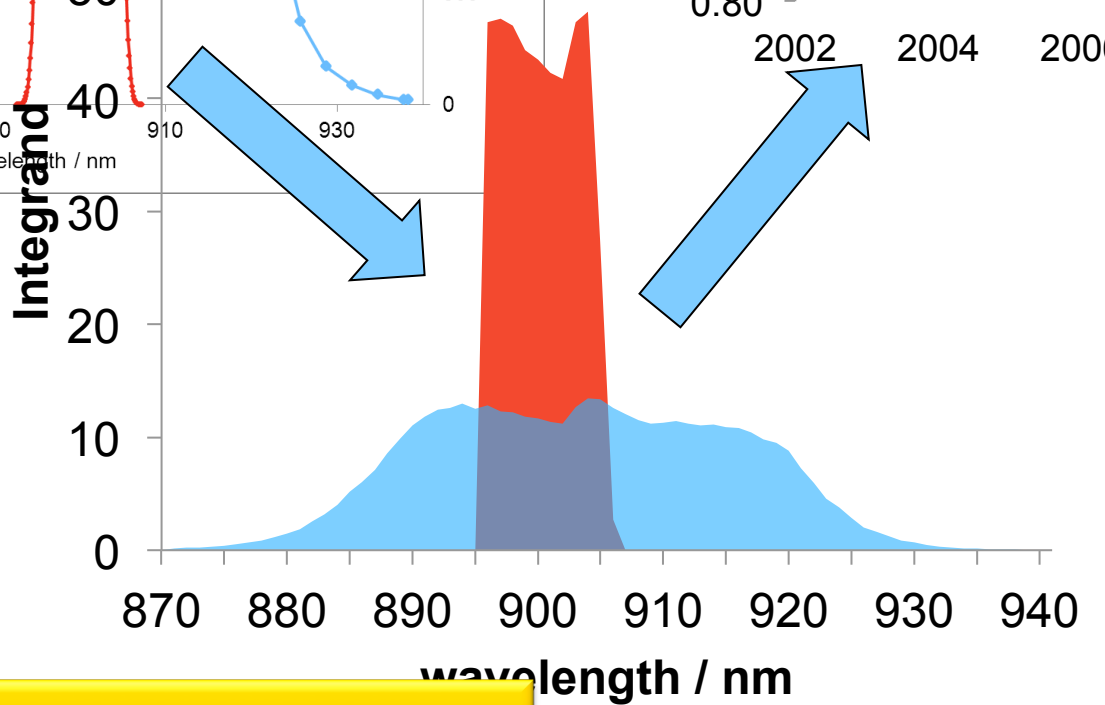
SBAF: Improvements



Single Sensor Reference?

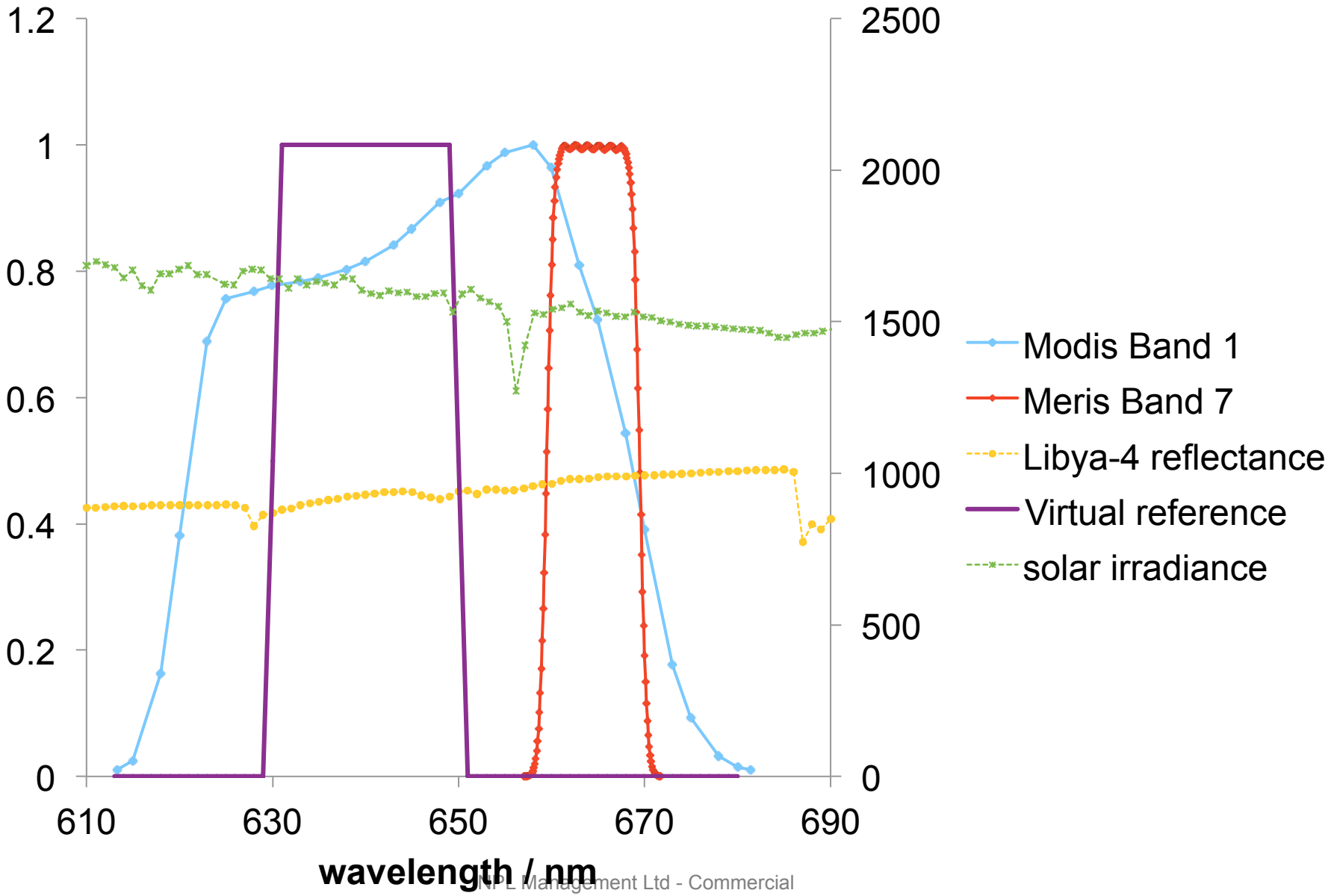




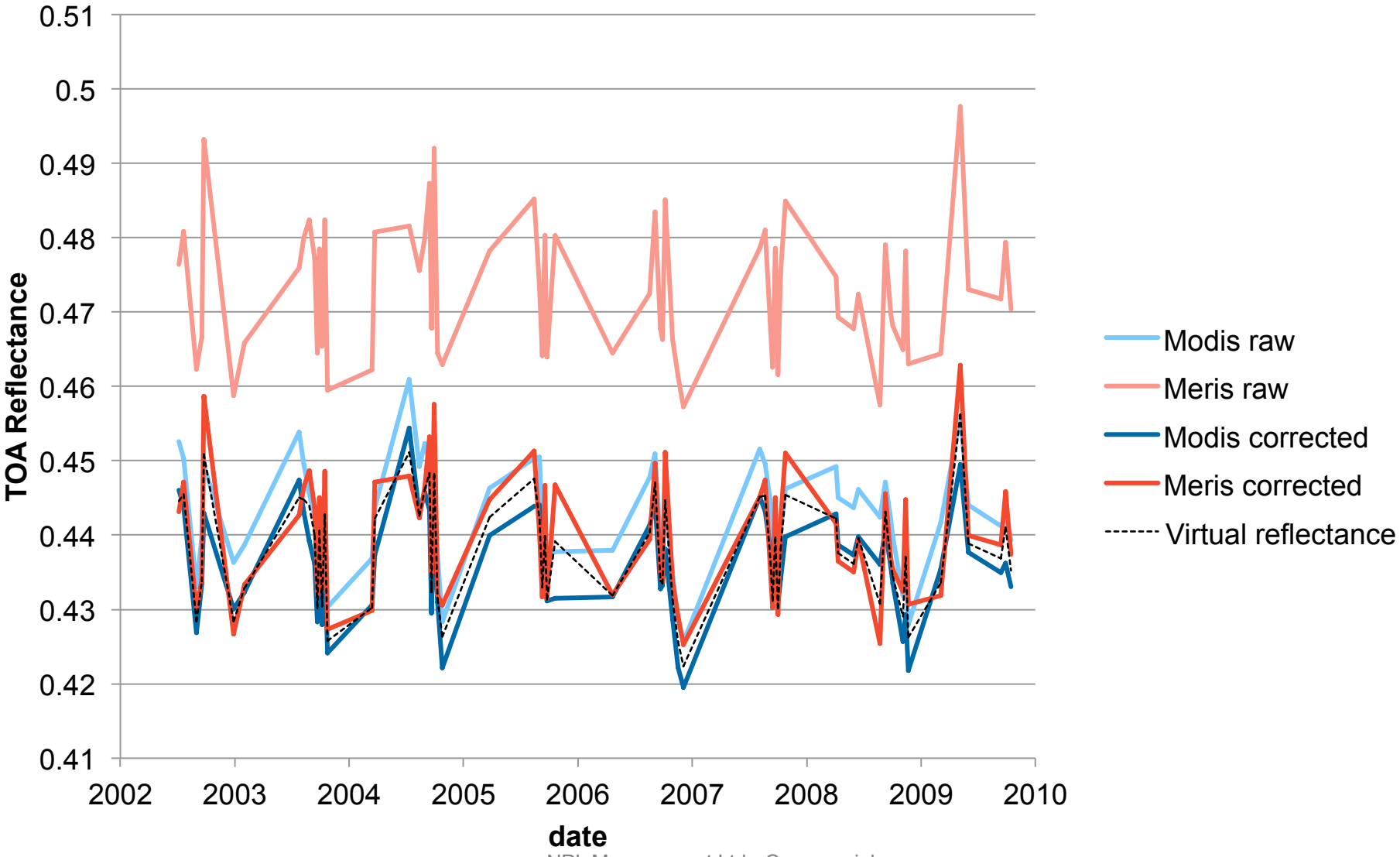


Meris is the reference at all steps

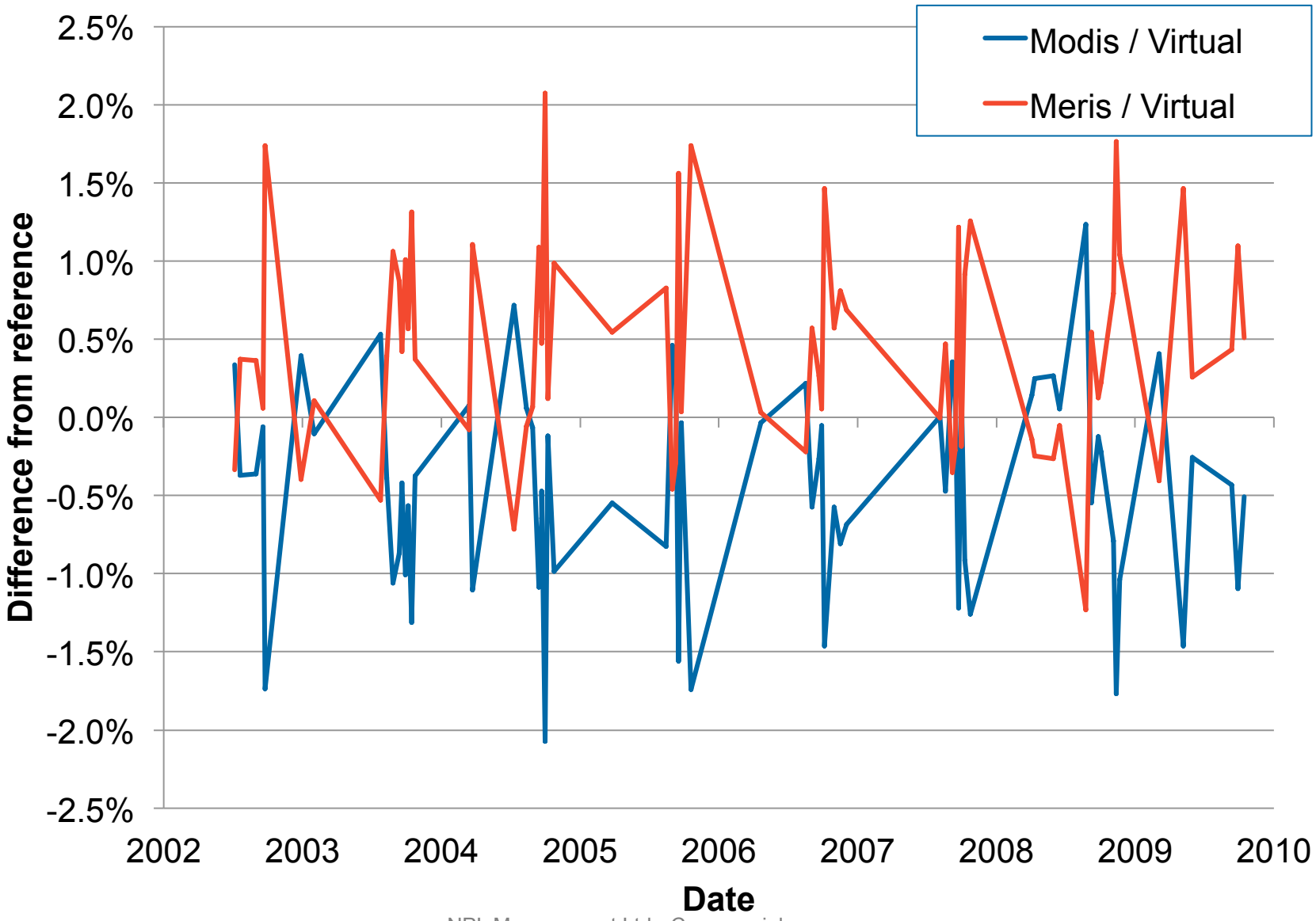
Virtual sensor reference



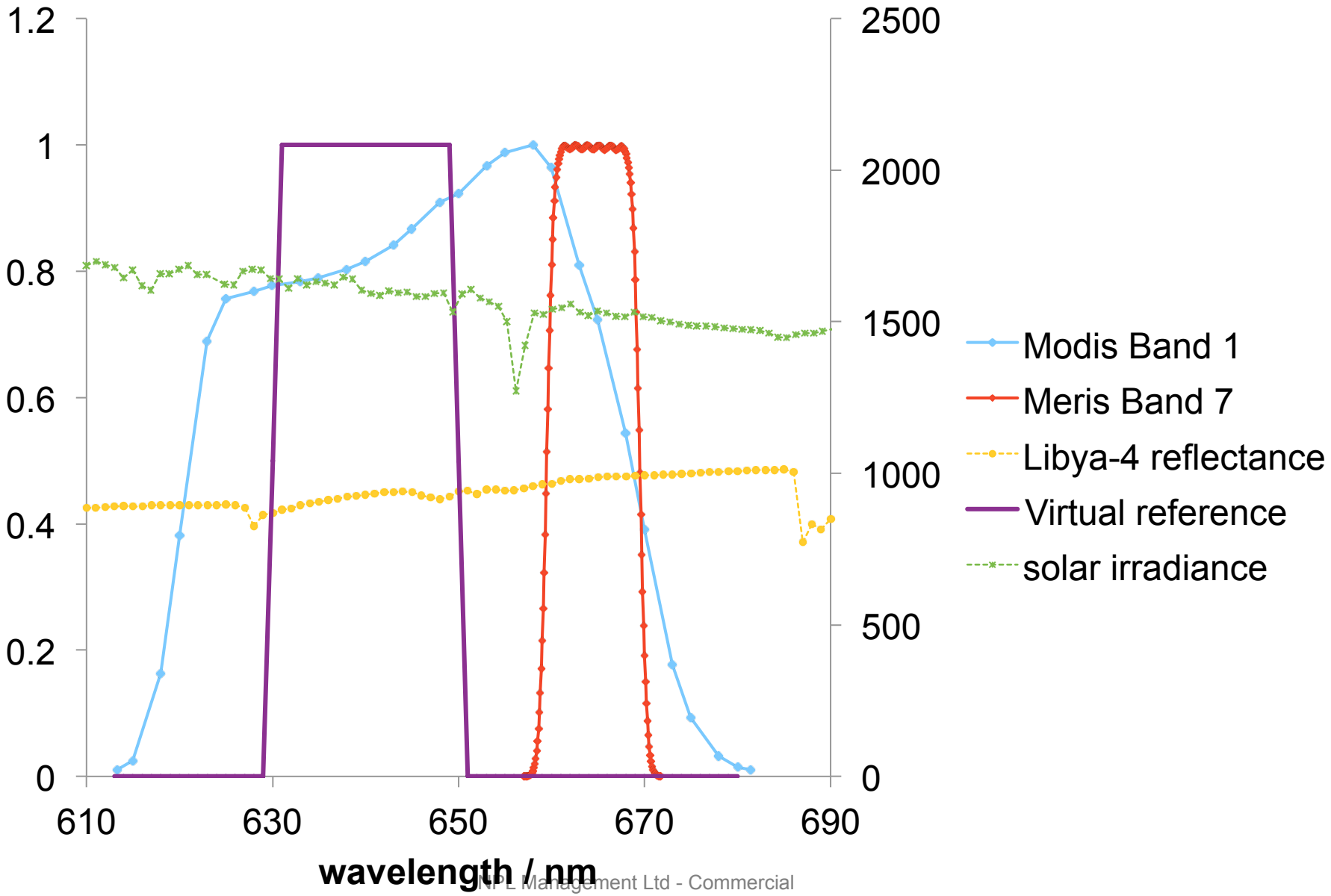
Virtual sensor reference



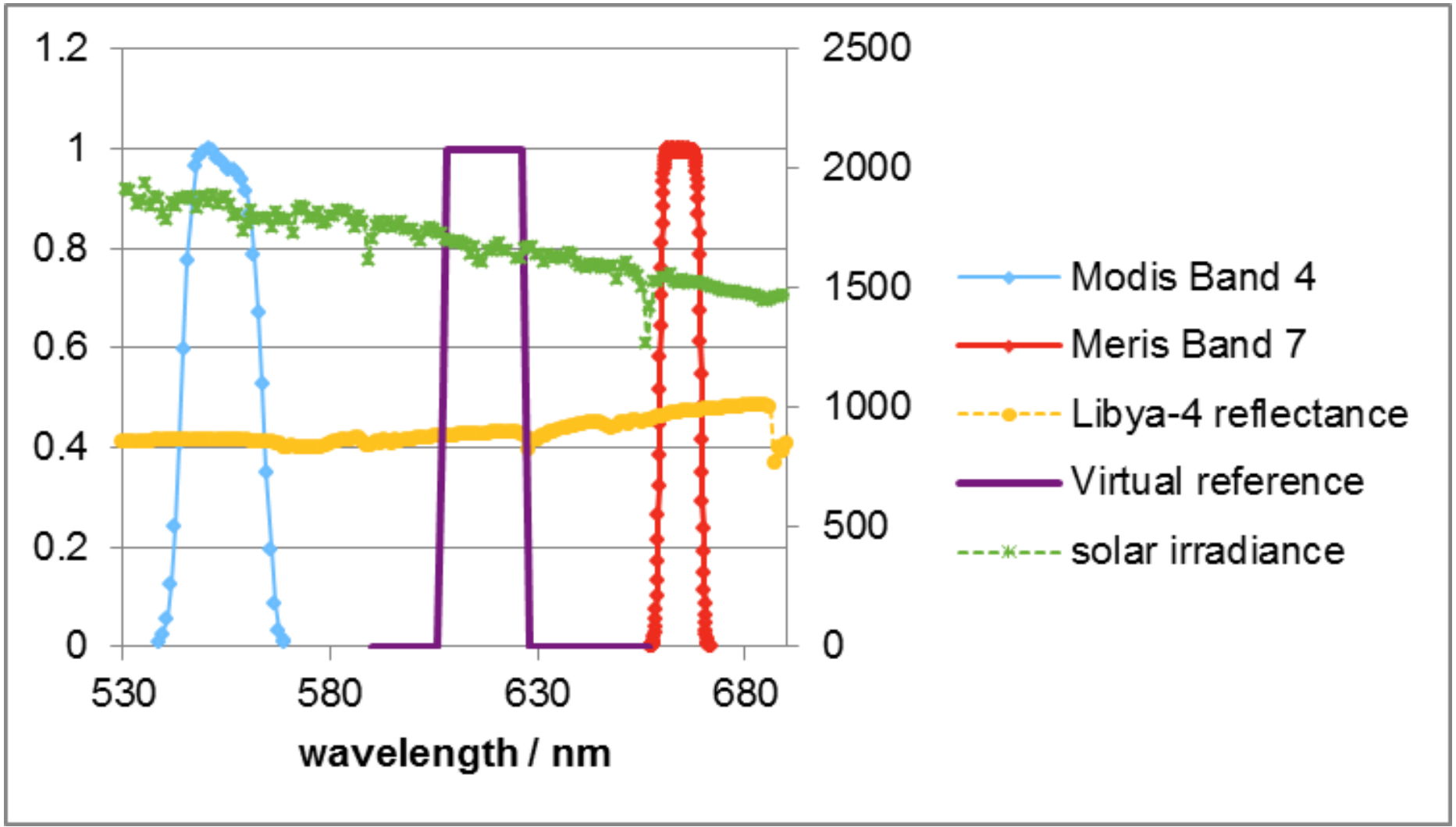
Virtual sensor reference



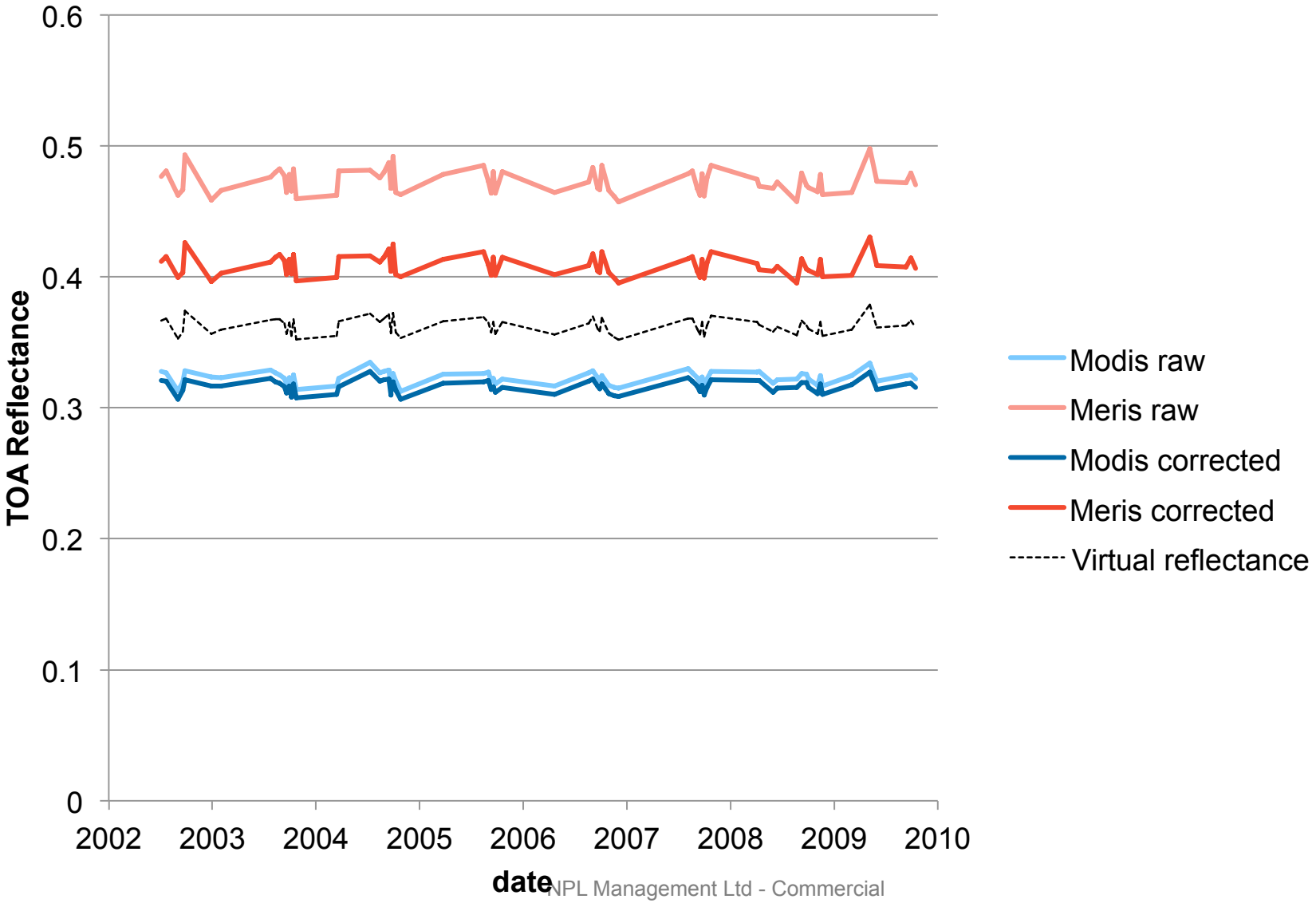
Virtual sensor reference



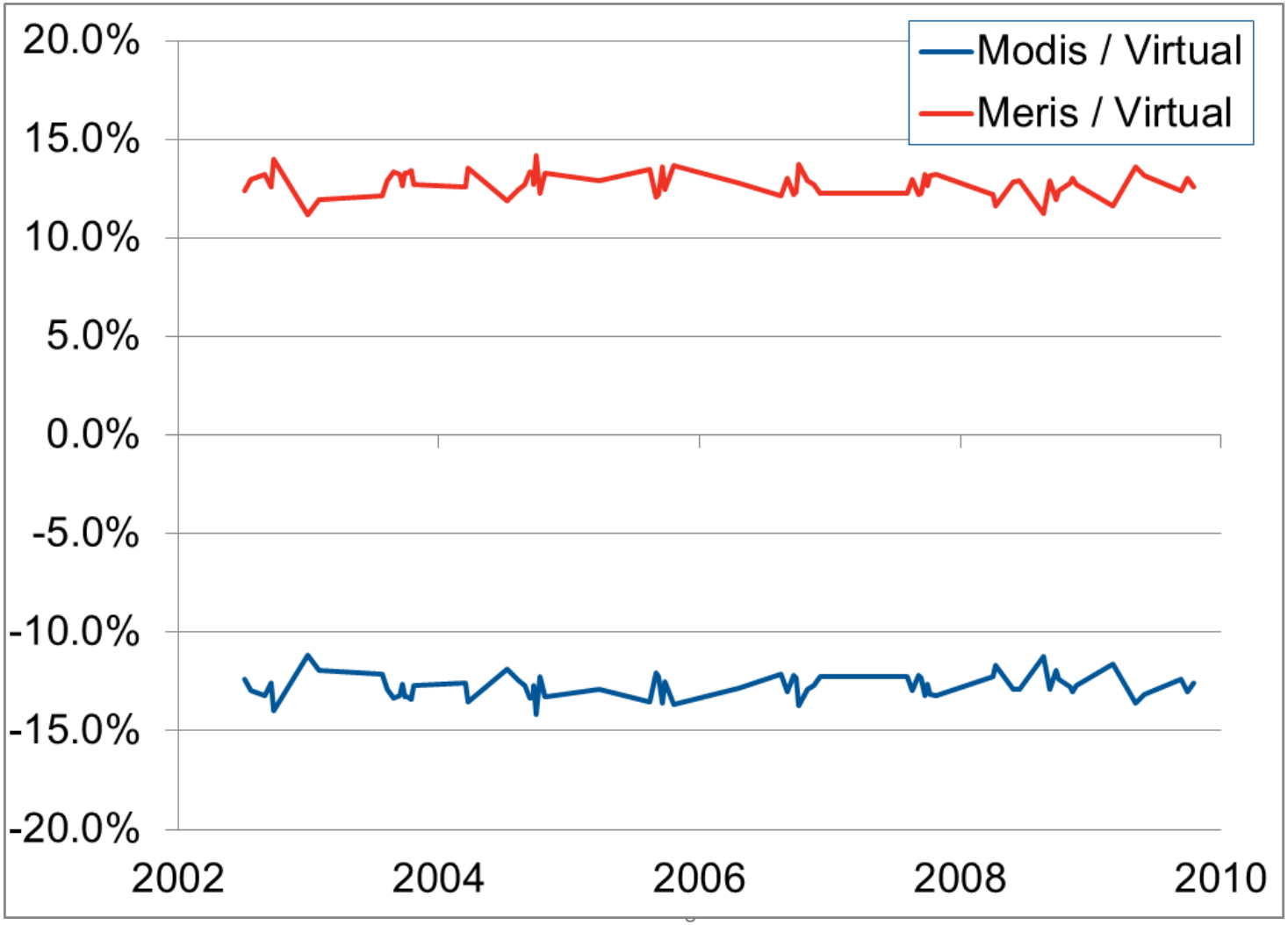
Do they have to overlap?



Comparisons without overlap



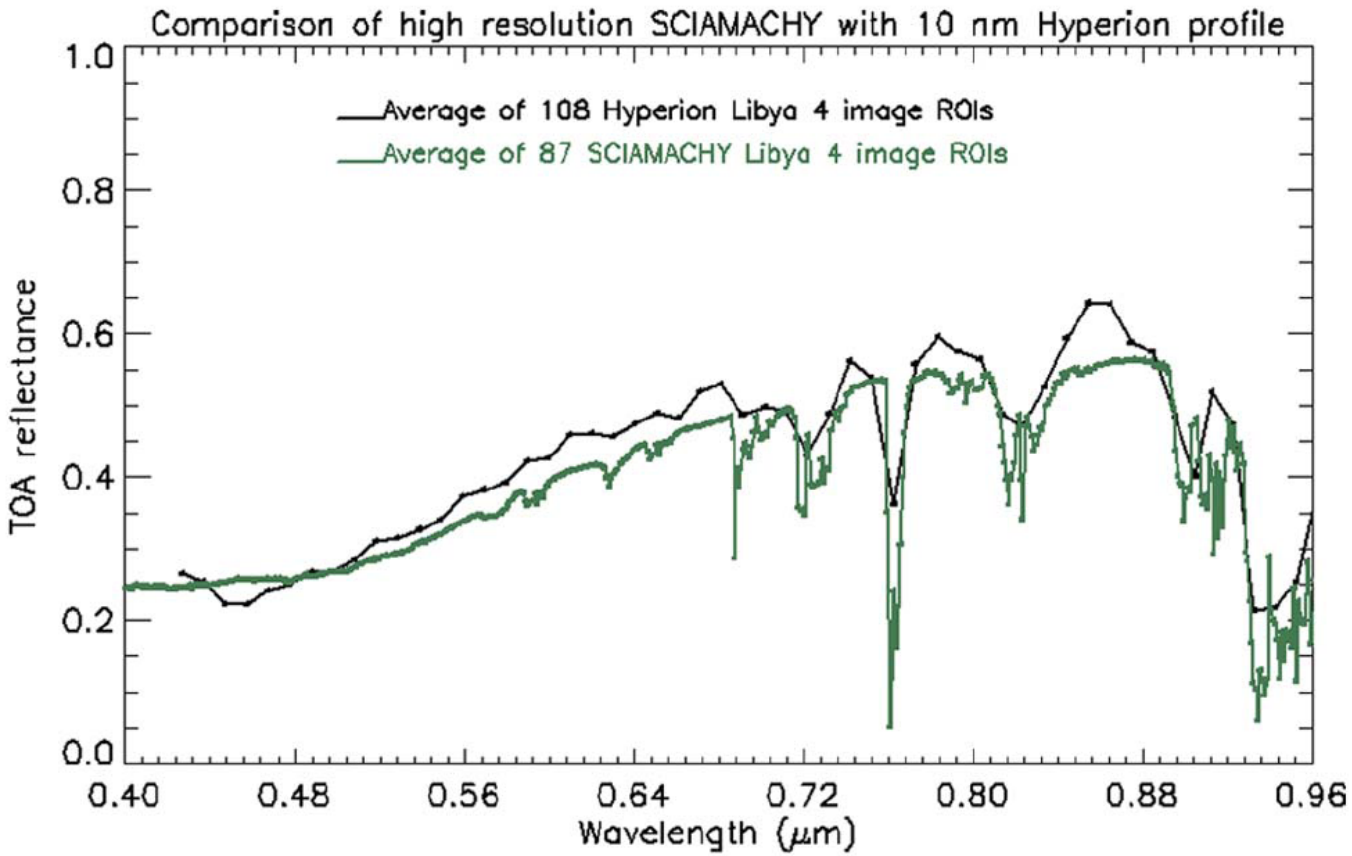
Where they don't overlap



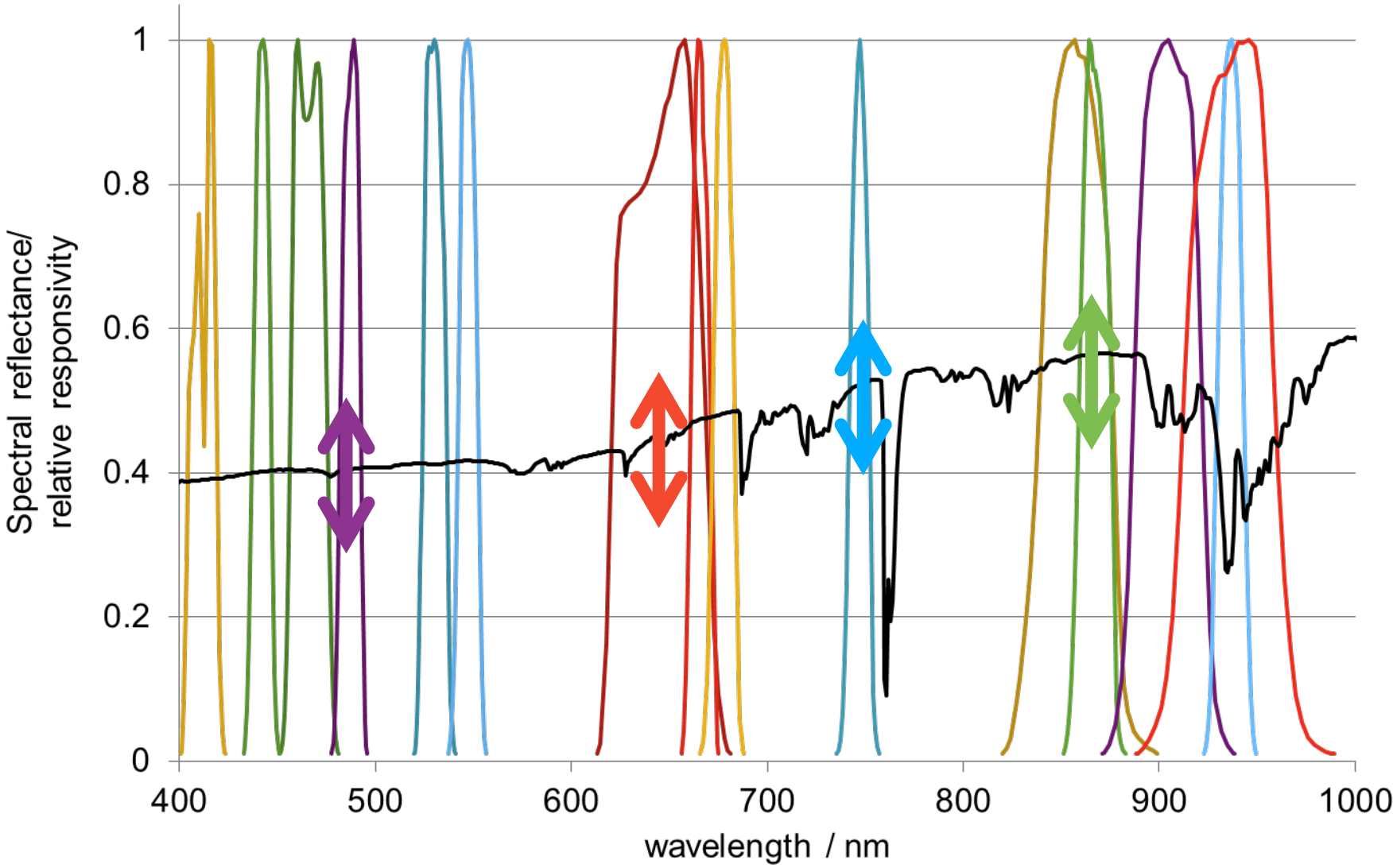
But …

Applications of Spectral Band Adjustment Factors (SBAF) for Cross-Calibration

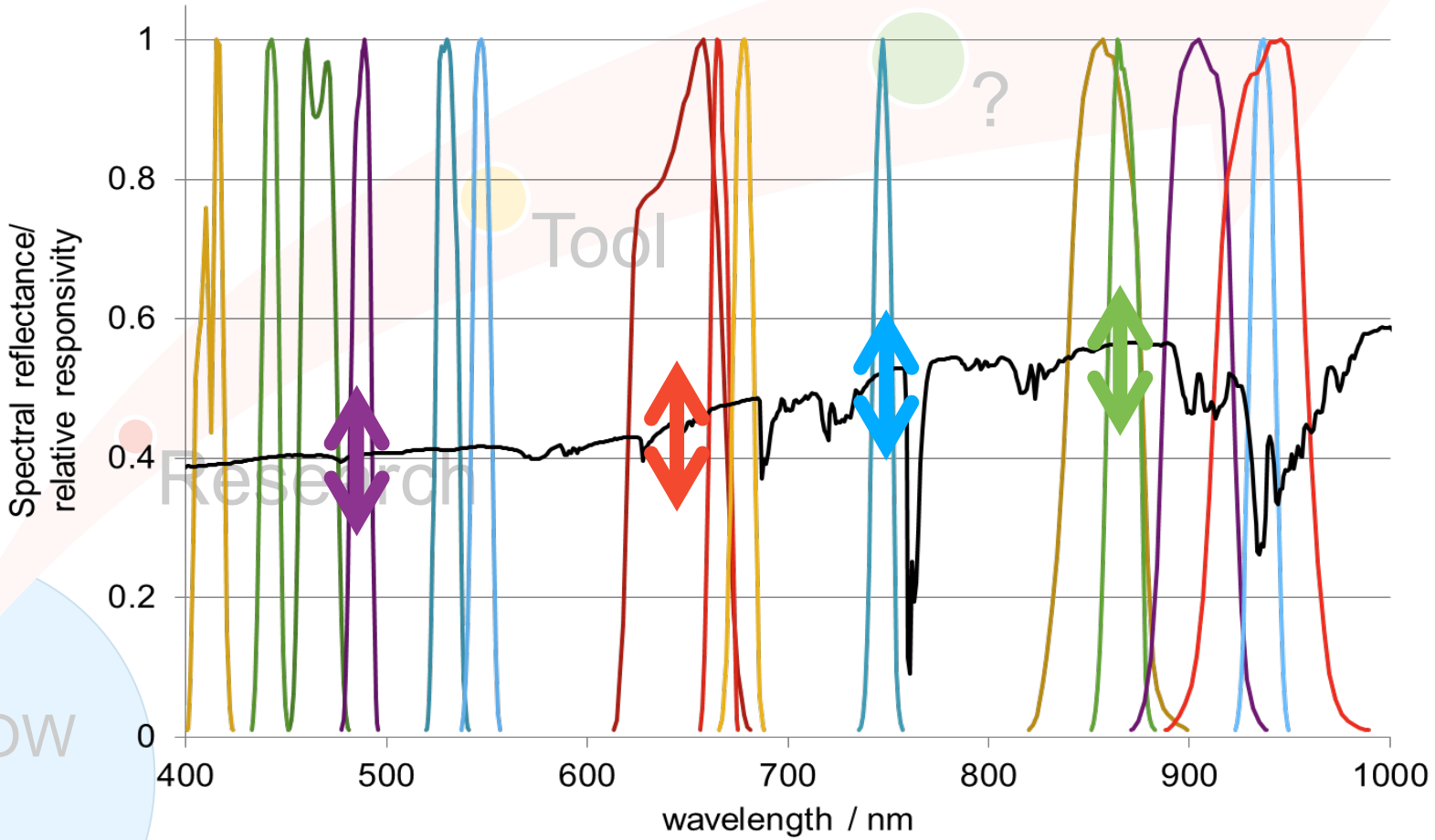
Gyanesh Chander, *Member, IEEE*, Nischal Mishra, Dennis L. Helder, *Senior Member, IEEE*, David B. Aaron, Amit Angal, Taeyoung Choi, Xiaoxiong Xiong, *Member, IEEE*, and David R. Doelling



Comparison reference curve



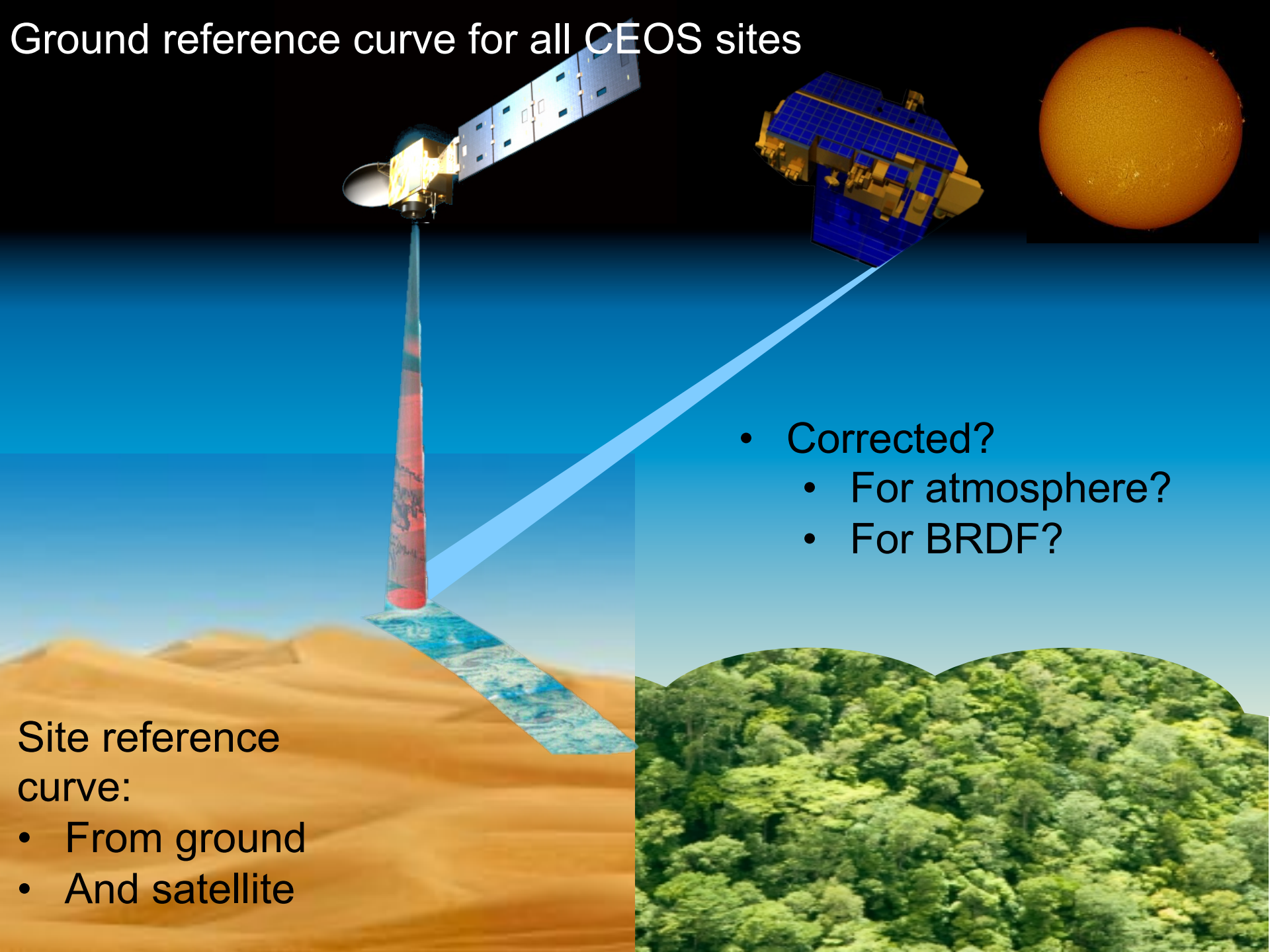
The Site Reference Curve



Vision

NOW

Ground reference curve for all CEOS sites

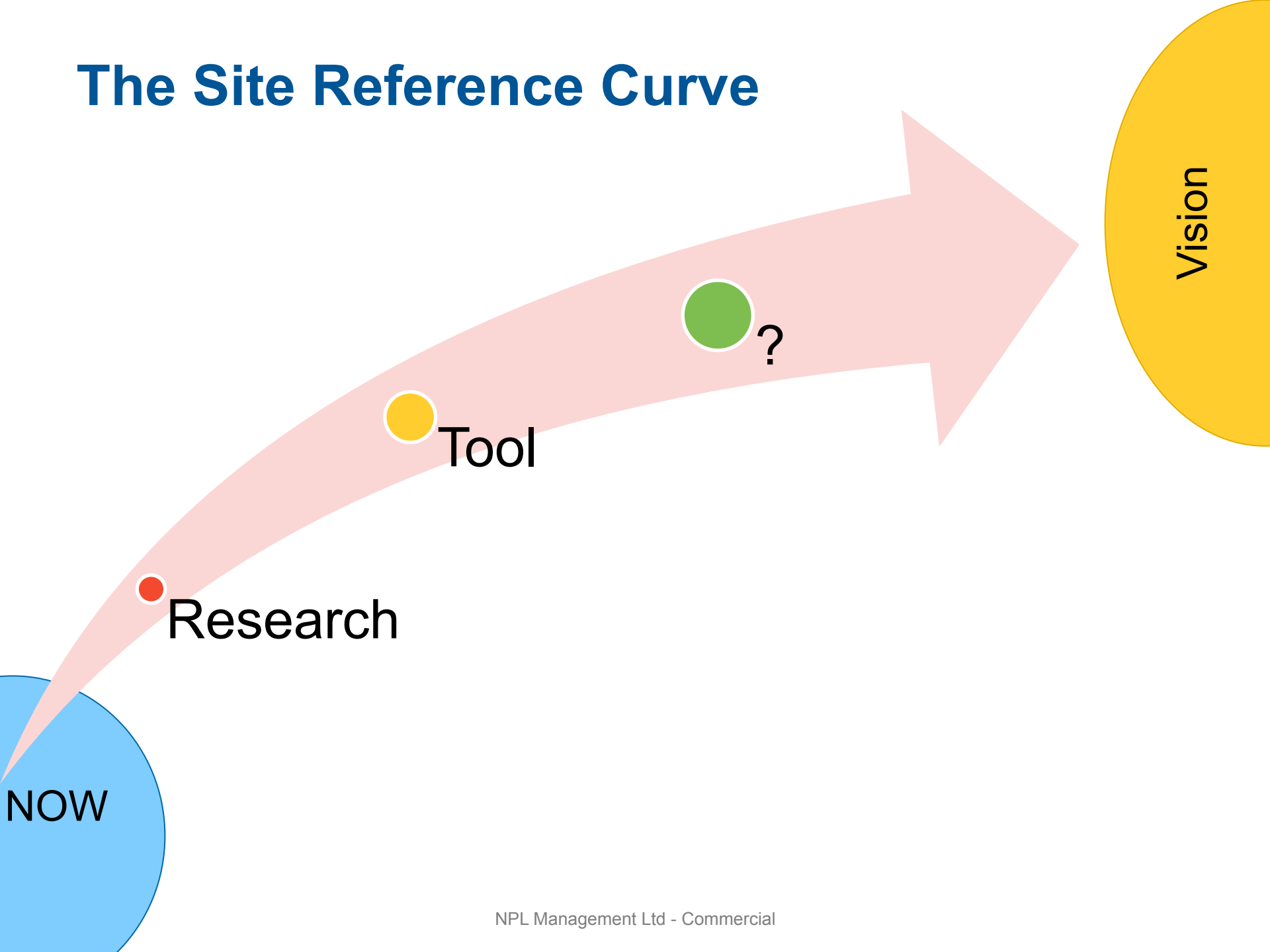


- Corrected?
  - For atmosphere?
  - For BRDF?

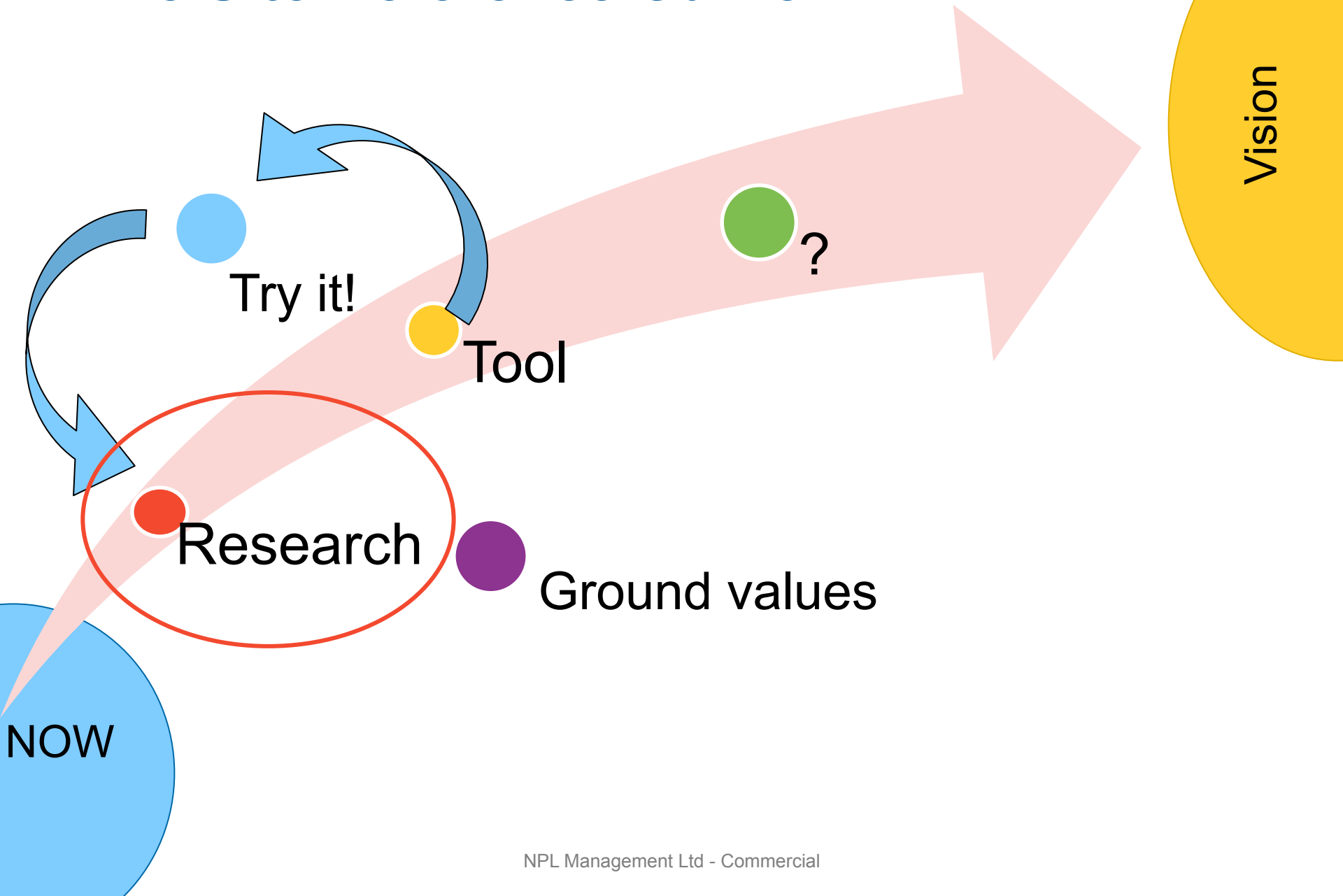
Site reference curve:

- From ground
- And satellite

The Site Reference Curve



The Site Reference Curve



Research Focus

- Sensor-to-sensor comparison
  - SBAF correction – how far can we push it?
  - BRDF corrections
  - Atmospheric corrections
- Other sites?
  - SBAF, BRDF, atmospheric with non-desert sites

Research Focus

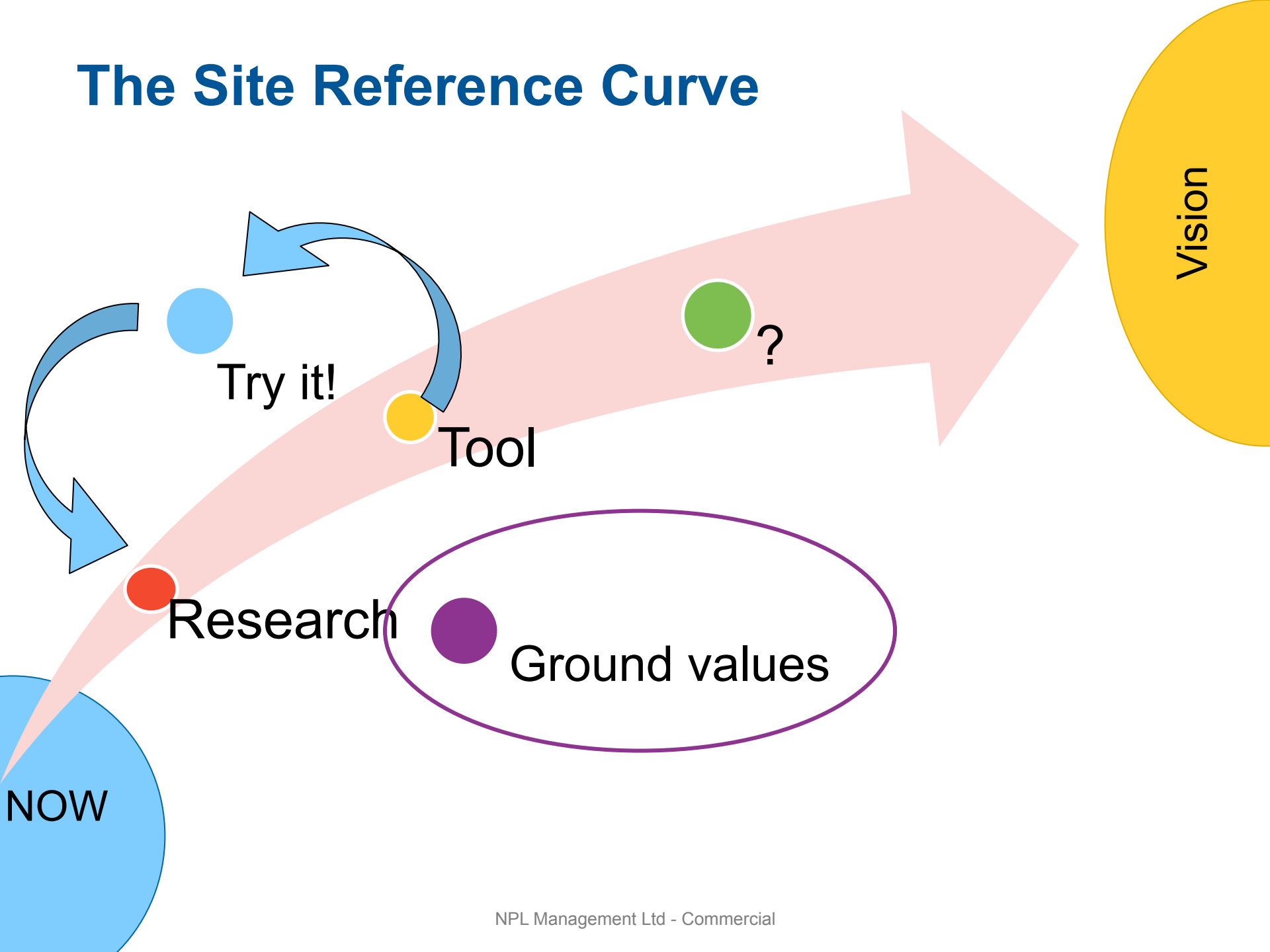
- Uncertainty analysis!

$$C^{\text{sp-corr}}_{\text{a2/b3},J} = \frac{B_{\text{a2}}}{B_{\text{b3}}} \frac{I_{\text{SAG,a2},J}}{\hat{I}_{\text{SAG,a2},J}} \frac{\hat{I}_{\text{SAG,b3},J}}{I_{\text{SAG,b3},J}}$$

$$I_{\text{SAG},i,J} = \int E_{\text{sun}}(\lambda)\rho_{\text{G}J}(\lambda)\tau_{\text{atm},J}(\lambda)S_i(\lambda)\mathrm{d}\lambda$$

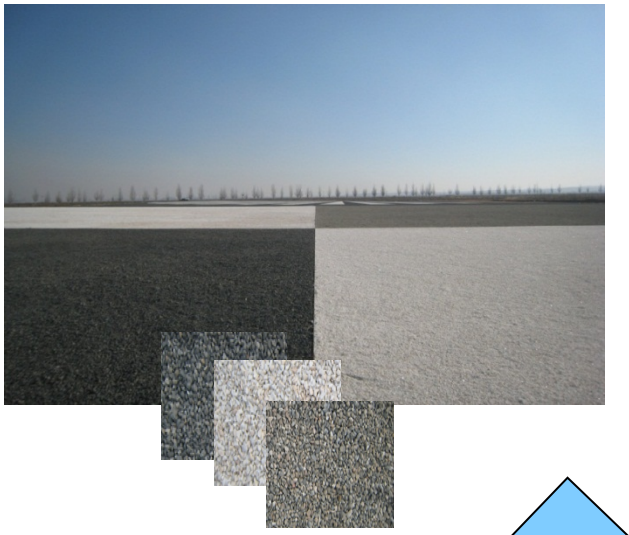
$$\hat{I}_{\text{SAG},i,J} = \int \hat{E}_{\text{sun}}(\lambda)\hat{\rho}_{\text{G}J}(\lambda)\hat{\tau}_{\text{atm},J}(\lambda)\hat{S}_i(\lambda)\mathrm{d}\lambda$$

The Site Reference Curve

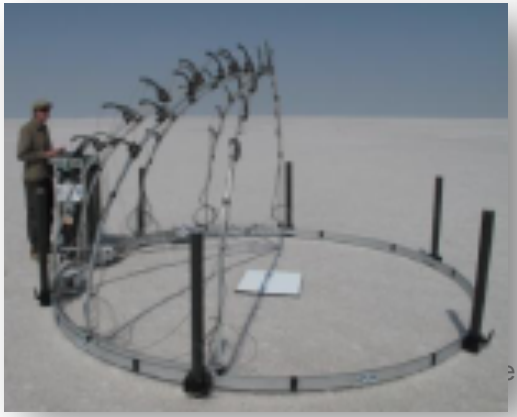


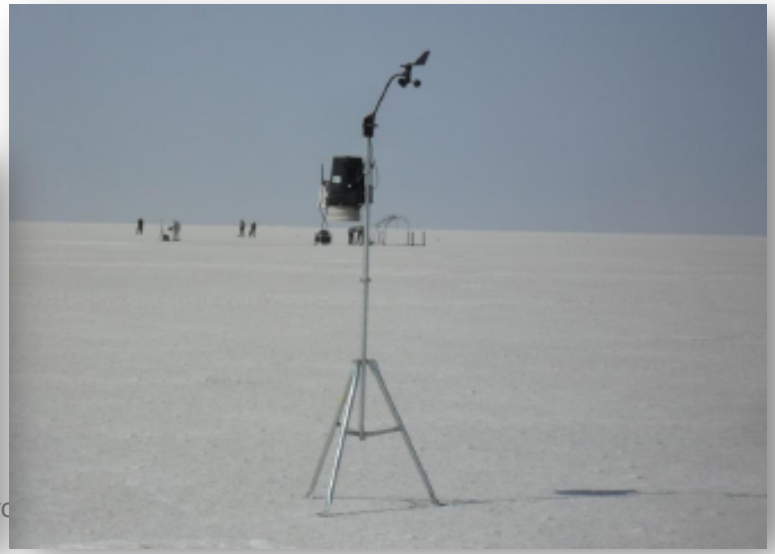
Ground reference values

RADCALNET

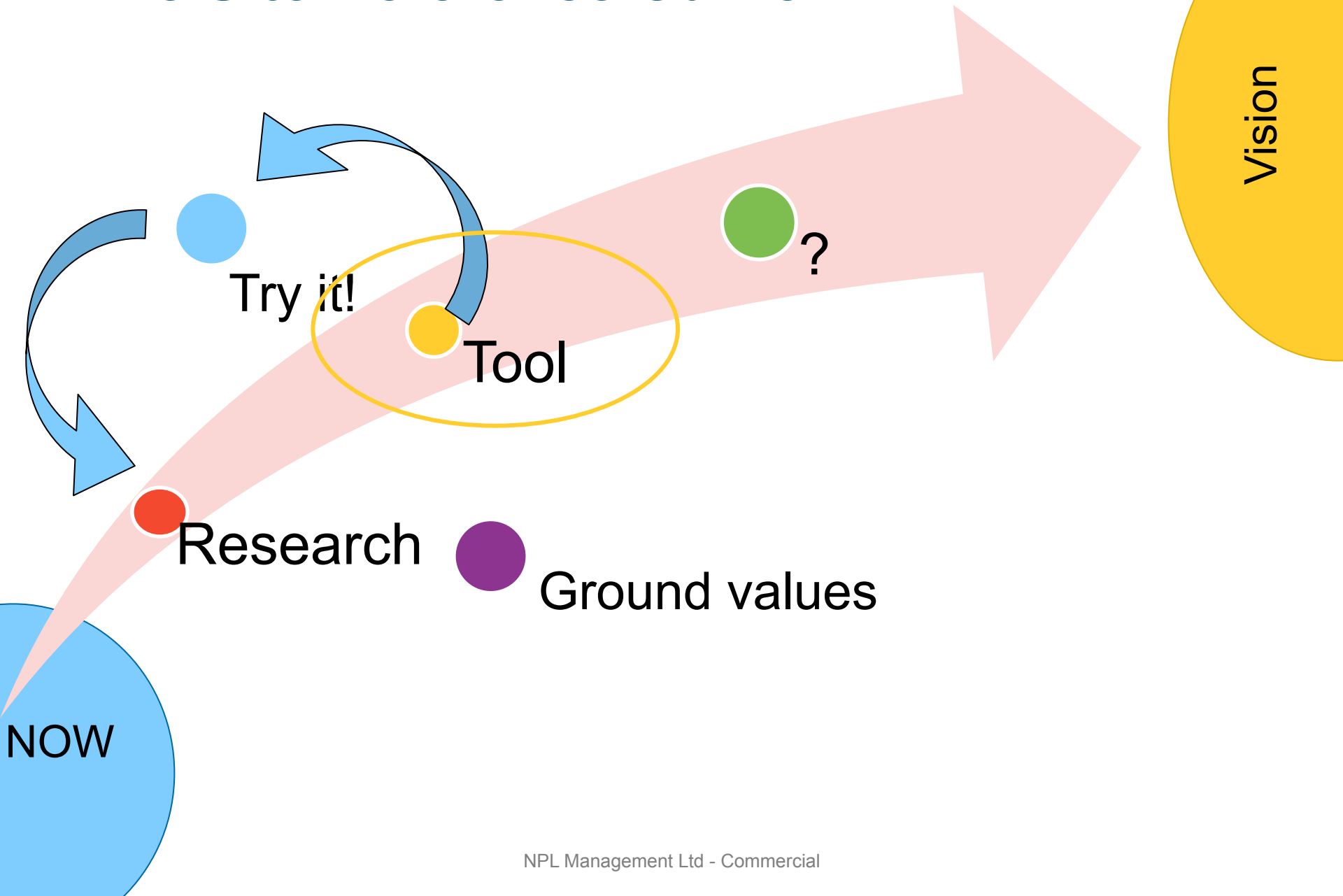


Link to SI





The Site Reference Curve



TruDat Web Portal

localhost:8080/octoolweb/

Optical Comparison

Parameter: TOA Reflectance ✓ Site: Libya-4, Libya ✓

Sensor Selection

Sensor | Virtual | Combined

Reference Sensor: MERIS ✓

Band: MERIS Band 15

Comparison Sensor

AATSR ✓ Add Clear

Sensors

MODIS(A) ✓

Start Date: 2006/01/01

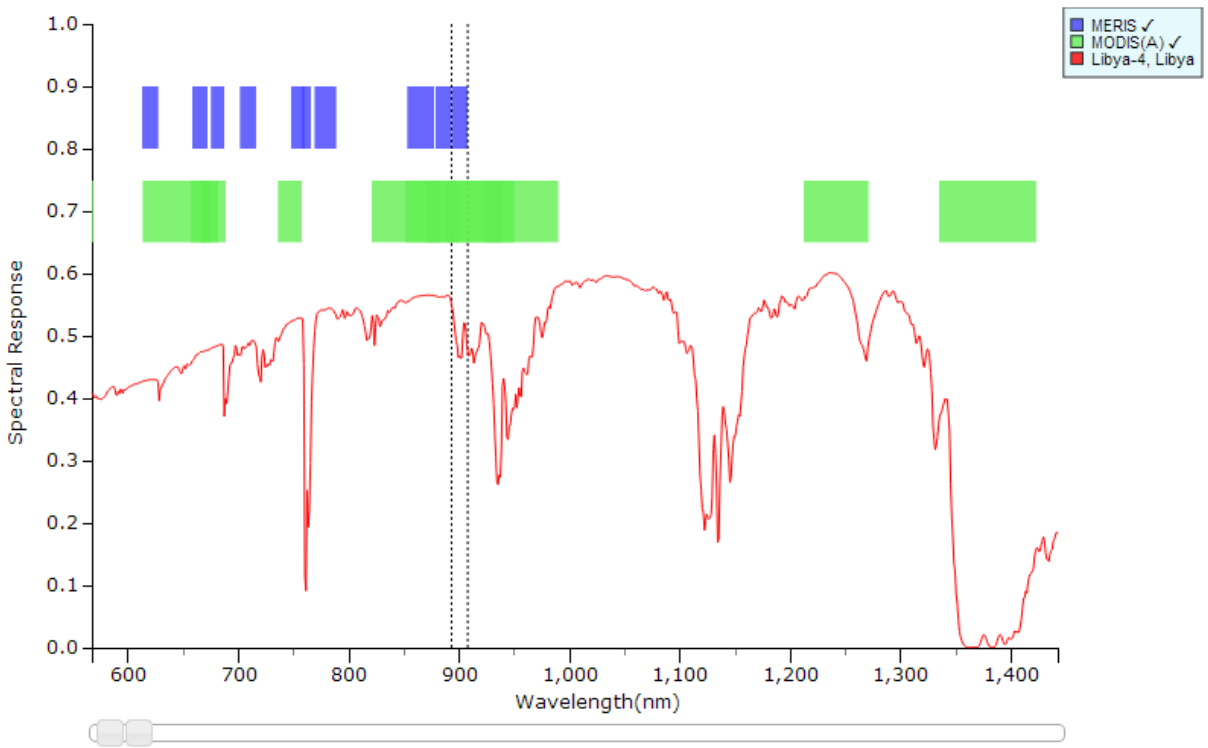
End Date: 2007/01/01

Search

Param: *TOA Reflectanc...*
Site: *Libya-4, Libya ✓*
Reference: *MERIS ✓*

Spectral Graph

Min Band Value 567 Max Band Value 1442 | Band View Spectral View



Computations

Ratio | SBAF | SBAF Ratio

TruDat Web Portal

localhost:8080/octoolweb/

CGI

Optical Comparison

NPL

Parameter: TOA Reflectance ✓ **Site:** Libya-4, Libya ✓

Sensor Selection

Sensor | Virtual | Combined

Reference Sensor: MERIS ✓

Band: MERIS Band 15

Comparison Sensor: AATSR ✓

Add | Clear

Sensors

MODIS(A) ✓

Start Date: 2006/01/01

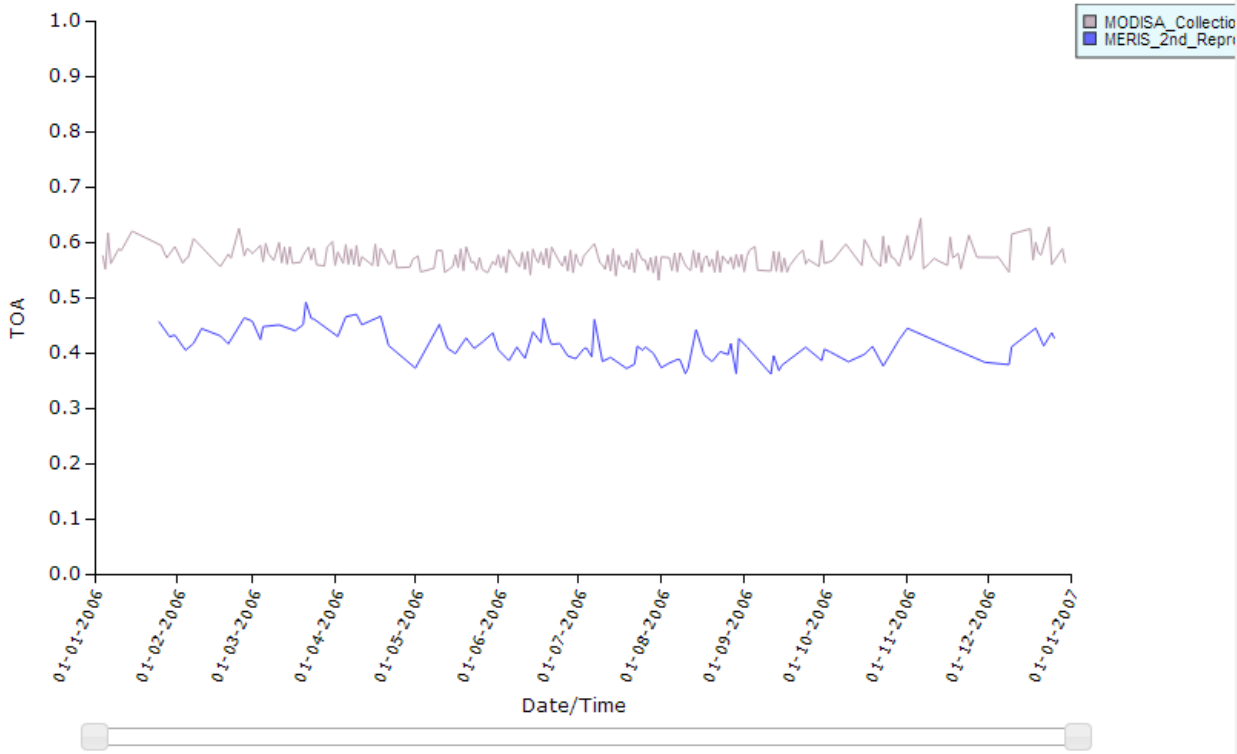
End Date: 2007/01/01

Search

Param: *TOA Reflectanc...*
Site: *Libya-4, Libya ✓*
Reference: *MERIS ✓*

Spectral Graph | TOA Plot 1

Min Date Value 2006/01/01 Max Date Value 2007/01/01



Computations

Ratio | SBAF | SBAF Ratio

TruDat Web Portal

localhost:8080/octoolweb/

Optical Comparison

Parameter: TOA Reflectance ✓ Site:

Libya-4, Libya ✓

Sensor Selection

Sensor | Virtual | Combined

Reference Sensor:

MERIS ✓

Band:

MERIS Band 15

Comparison Sensor

AATSR ✓

Add | Clear

Sensors

MODIS(A) ✓

Start Date: 2006/01/01

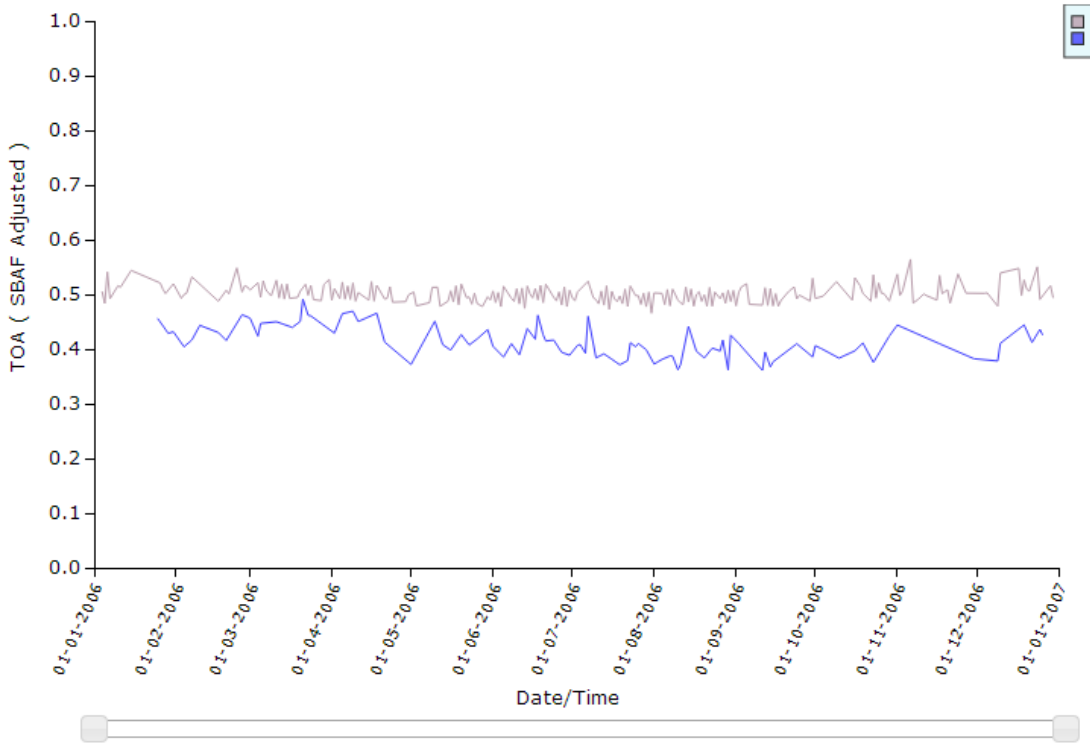
End Date: 2007/01/01

Search

Param: *TOA Reflectanc...*
Site: *Libya-4, Libya ✓*
Reference: *MERIS ✓*

Spectral Graph | TOA Plot 1 | SBAF Adj Plot 2

Min Date Value 2006/01/01 Max Date Value 2007/01/01



Computations

Ratio | SBAF | SBAF Ratio

TruDat Web Portal

localhost:8080/octoolweb/

CGI

Optical Comparison

NPL

Parameter: TOA Reflectance ✓ Site:

Libya-4, Libya ✓

Sensor Selection

Sensor | Virtual | Combined

Reference Sensor:

MERIS ✓

Band:

MERIS Band 15

Comparison Sensor

AATSR ✓

Add | Clear

Sensors

MODIS(A) ✓

Start Date: 2006/01/01

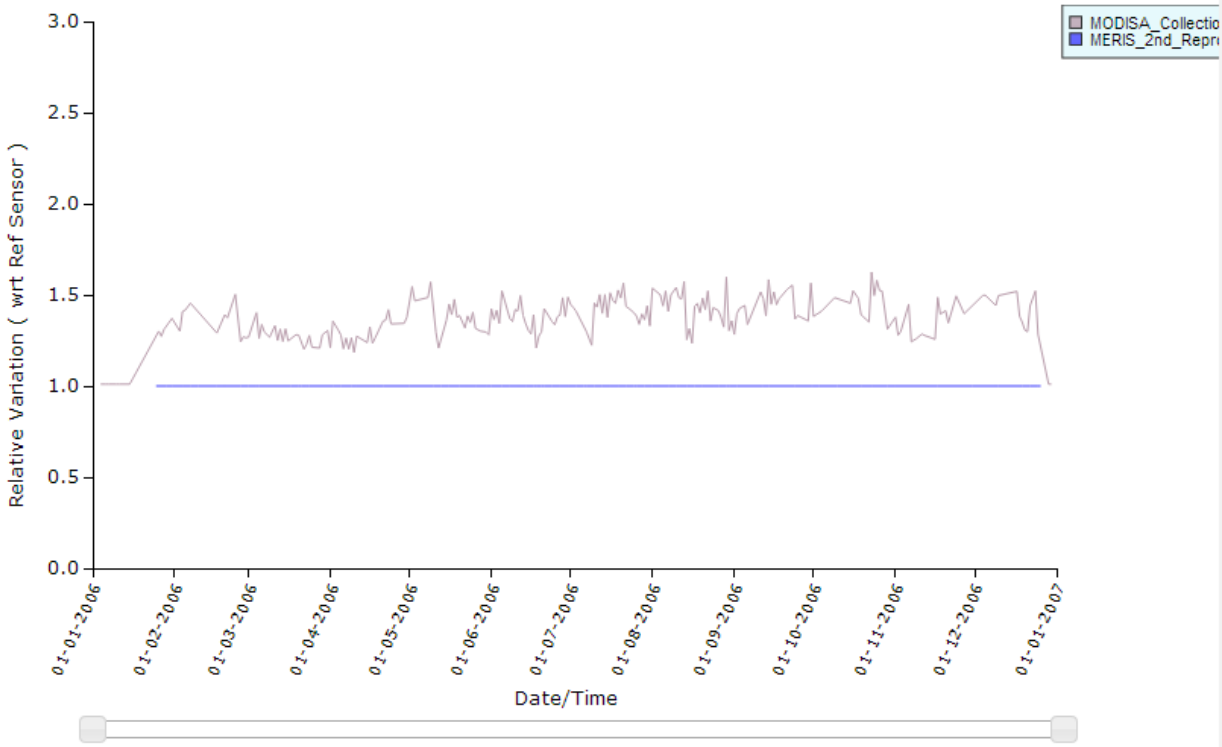
End Date: 2007/01/01

Search

Param: *TOA Reflectanc...*
Site: *Libya-4, Libya ✓*
Reference: *MERIS ✓*

Spectral Graph | TOA Plot 1 | SBAF Adj Plot 2 | Ratio Plot 3

Min Date Value 2006/01/01 Max Date Value 2007/01/01



Computations

Ratio | SBAF | SBAF Ratio

TruDat Web Portal

localhost:8080/octoolweb/

CGI

Optical Comparison

NPL

Parameter: TOA Reflectance ✓ Site:

Libya-4, Libya ✓

Sensor Selection

Sensor | Virtual | Combined

Reference Sensor:

MERIS ✓

Band:

MERIS Band 15

Comparison Sensor

AATSR ✓

Add | Clear

Sensors

MODIS(A) ✓

Start Date: 2006/01/01

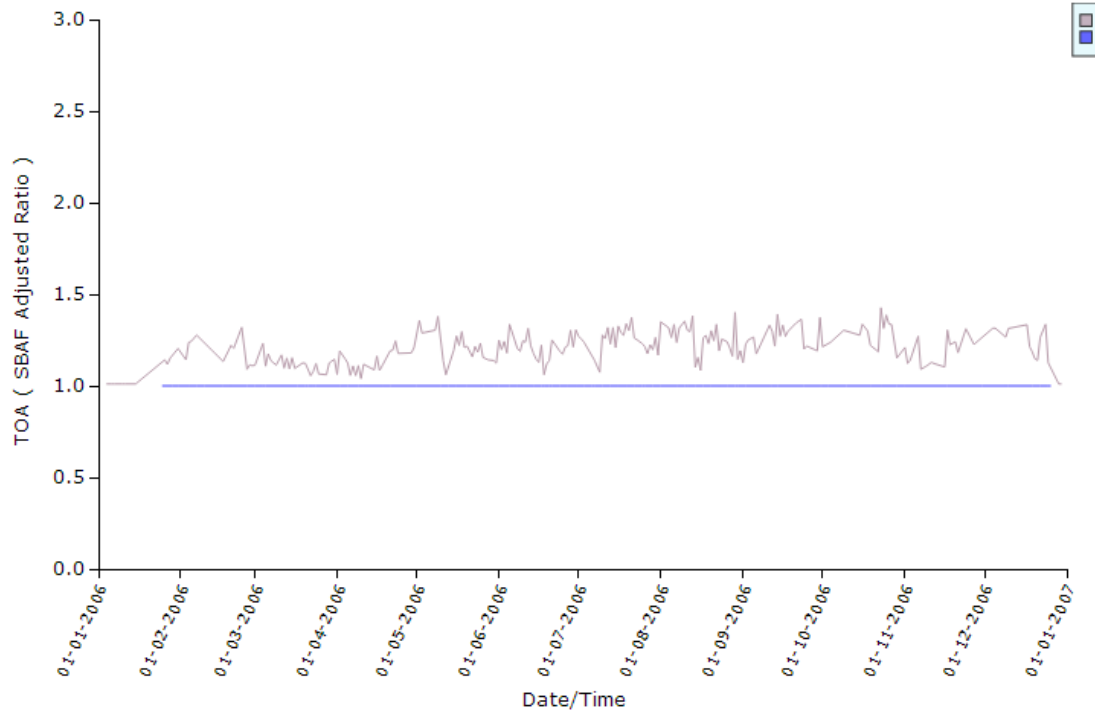
End Date: 2007/01/01

Search

Param: *TOA Reflectanc...*
Site: *Libya-4, Libya ✓*
Reference: *MERIS ✓*

Spectral Graph | TOA Plot 1 | SBAF Adj Plot 2 | Ratio Plot 3 | SBAF Plot 4

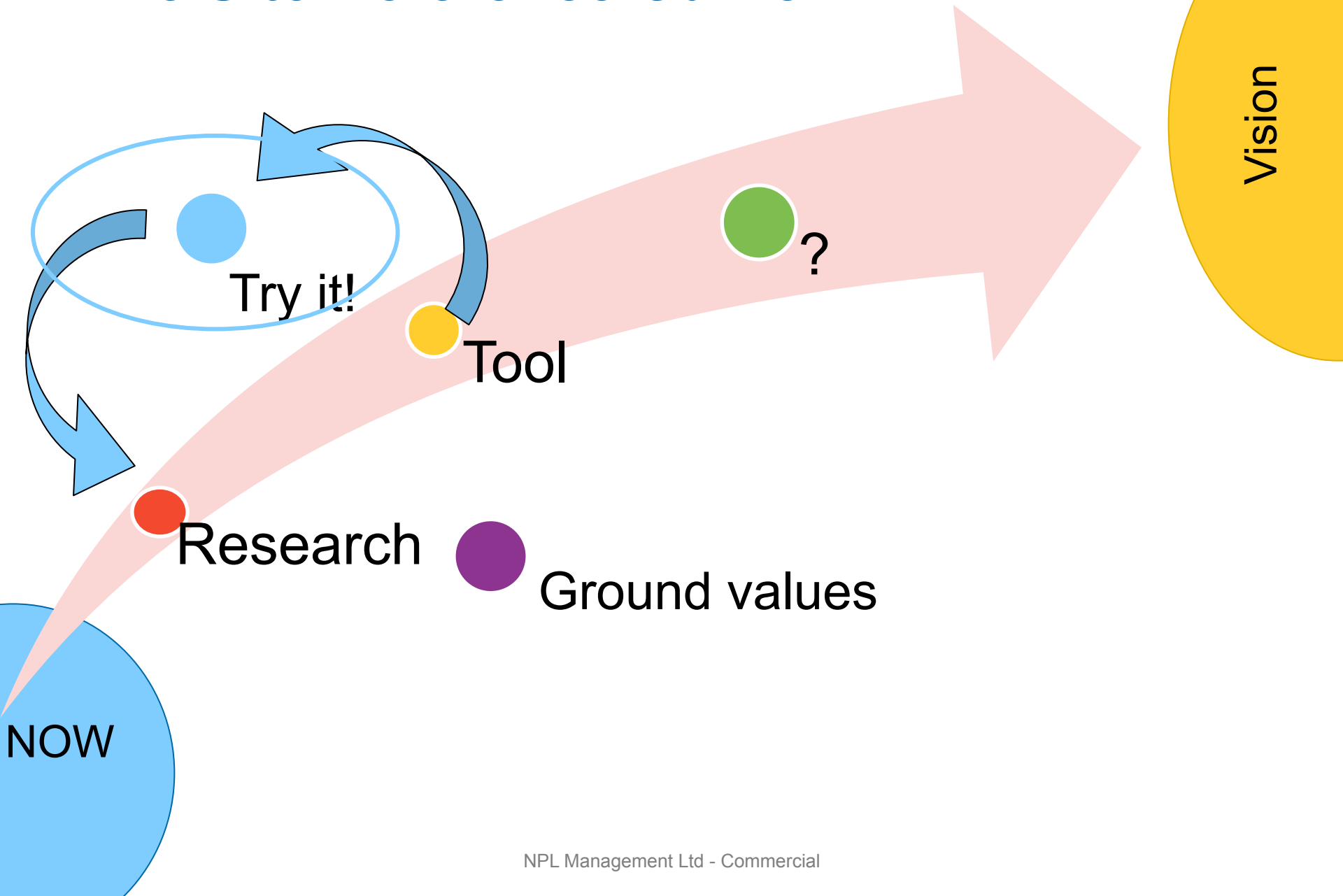
Min Date Value 2006/01/01 Max Date Value 2007/01/01



Computations

Ratio | SBAF | SBAF Ratio

The Site Reference Curve



Testing it

Collaborations?

Can we work together?

Can we learn from your work?

How is this compatible?

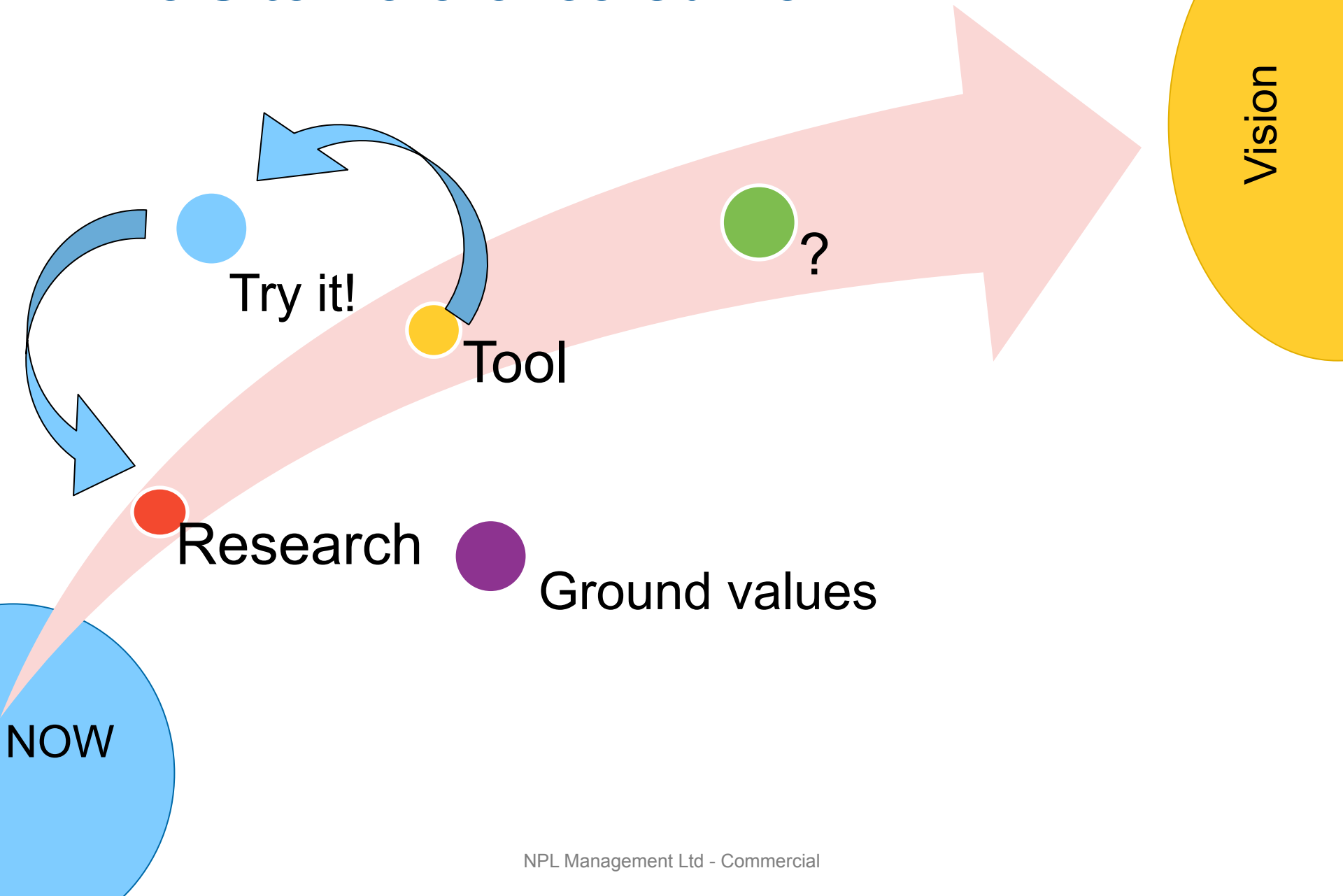
At NPL:

Growing team: (Agnieszka Bialek, Tracy Scanlon, Javier Gorrono, Emma Woolliams, more?)

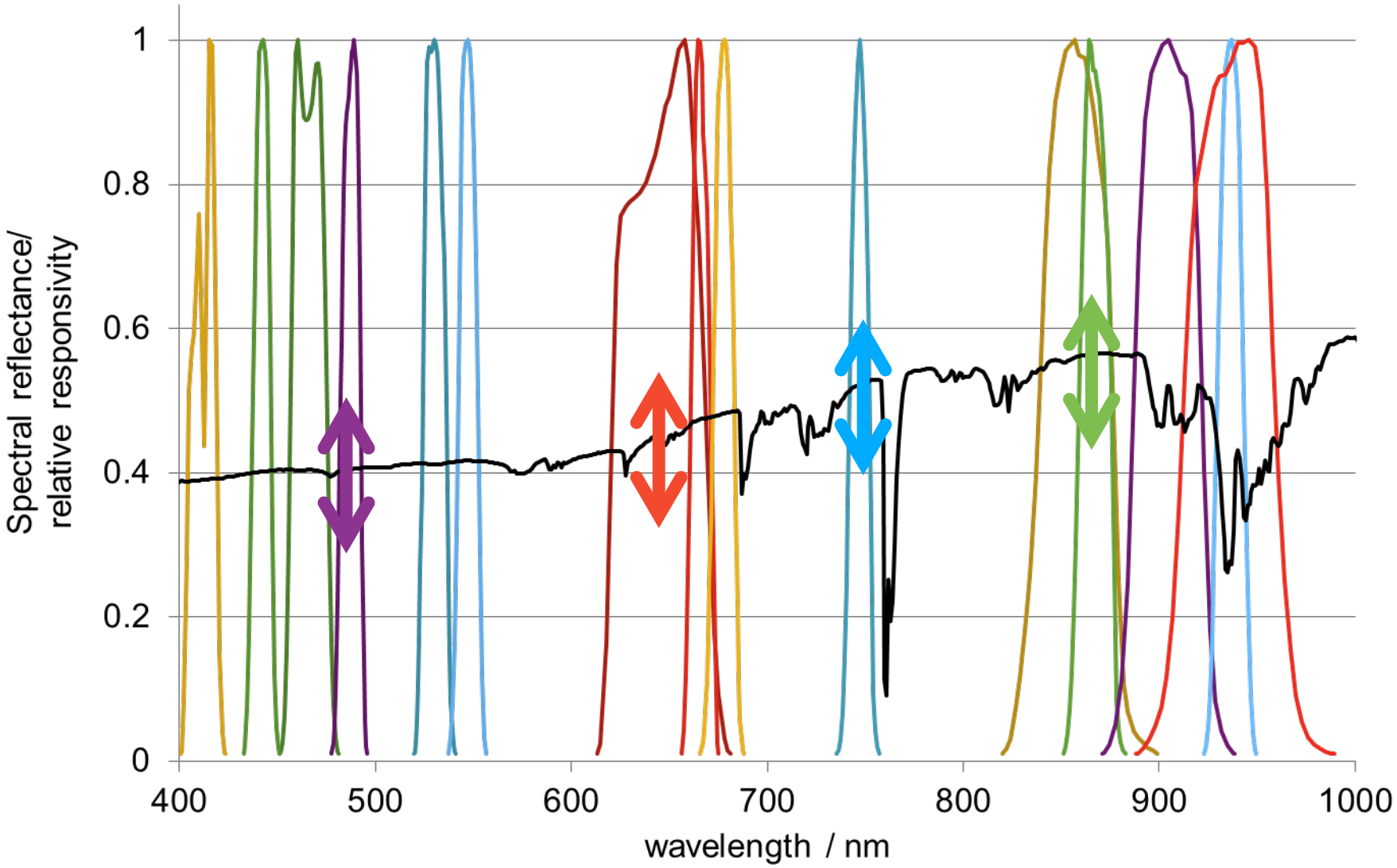
Relevant projects: ACTION, RadCalNet, MetEOC-2, …

Clearly builds on our NMI role

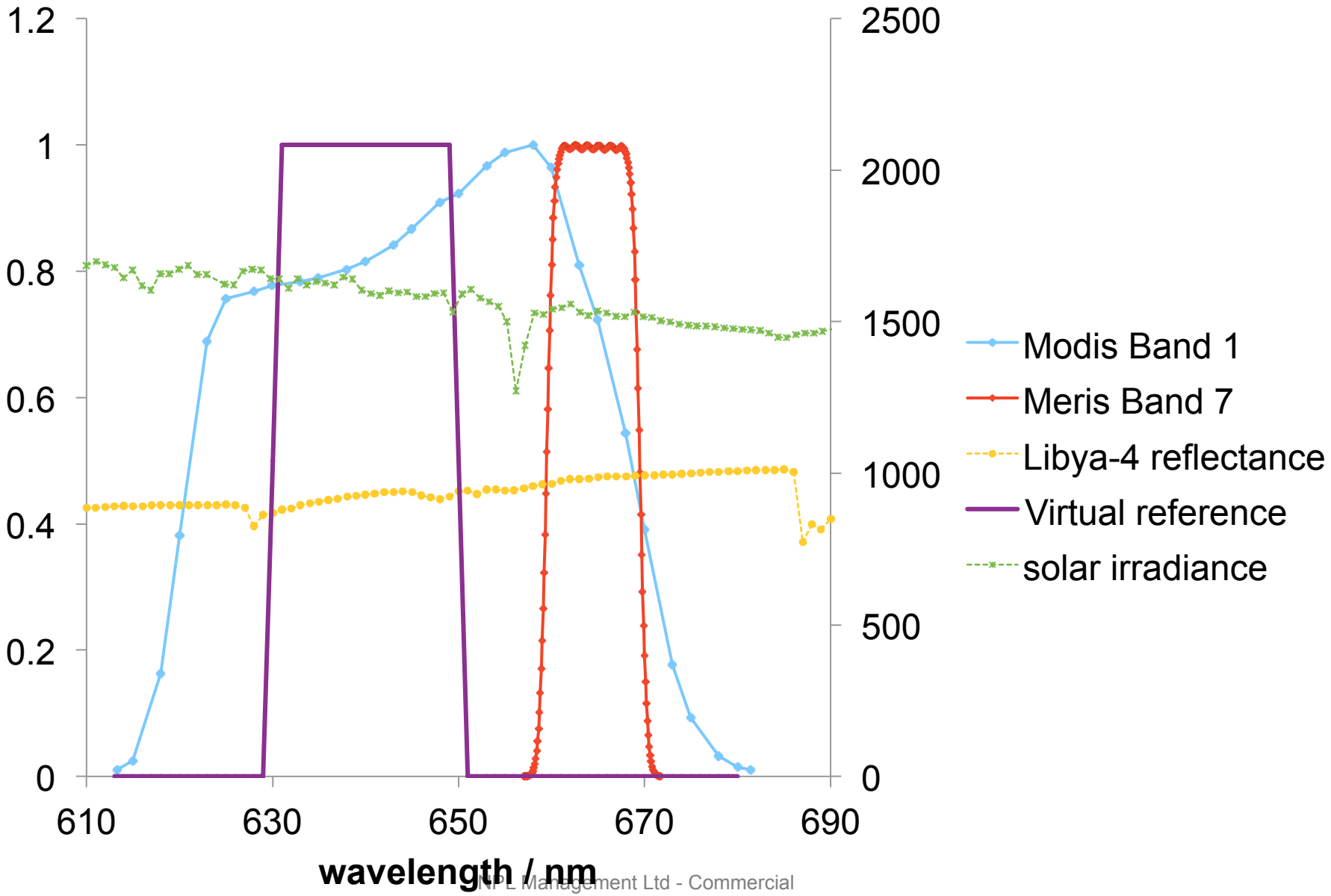
The Site Reference Curve



Comparison reference curve



Virtual sensor reference



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For more information:

Emma.Woolliams@npl.co.uk

Thank you!