PROBA-V Vicarious Calibration:
Investigation into the impact of in-orbit temperature variation
LIME (Lunar Irradiance Model ESA) model

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8 YEARS in orbit

Experimental phase

Platform commissioning
Instrument commissioning
User segment commissioning
CAL/VAL commissioning
Operational phase

Launch 6/05/2013
First Image 15/05/2013
Start Calibration campaigns 08/2013
1OCR 11/2013
Hand over to EOP EarthWatch

Proba-V - Predicted Evolution of LTDN

30 June 2020
Design complexity

➢ No on-board calibration devices
➢ Design complexity
  ➢ 3 Cameras
  ➢ 2 focal planes:
    ➢ VNIR with 3 bands
    ➢ SWIR with 1 band but staggered strips
Vicarious Radiometric Calibration Approach

\[ L_{TOA,i}^k = \frac{DN_{i,acquired}^k}{NL(DN_{i,acquired}^k)} - dc_{im}^k \]

\*Sterckx et al. RS, 2017, Sterckx et al. IJRS, 2014; Sterckx et al., TGARS, 2013; Govaerts et al., RSL, 2013

OSCAR* (Optical Sensor Calibration with simulated Radiances)

- Absolute REQ. 5%
- Interband REQ. 3%
- Temporal (REQ. 3%)
- DC Clouds
- Oceans
- Deserts

Inter-pixel
Long term trending VNIR
BLUE, RED, NIR
OSCAR Desert Approach

- 6SV simulations
- Surface RPV BRF
- ECMWF (P, O3, H2O)
- Desert aerosol
- AOT (month)

[Govaerts et al., RSL, 2013]
Instrument degradation

No absolute calibration (Ak) updates considered

Libya-4 VNIR

-0.26% /year

+ 0.12% /year

+ 0.30% /year

+ 0.08% /year

+ 0.50% /year
OSCAR Deep convective clouds calibration

- LibRadtran LUT
- Ice clouds optical properties (Baum et al. 2005)
- Fixed effective ice cloud radius
- Strict procedure to automatically select DCC
- Not for SWIR band
- INTER-BAND CAL. APPROACH

PROBA-V image 24/06

Sterckx et al. TGARS, 2013
Lunar Calibration

• Observation of the moon:
  • Twice a month at phase angle +/- 7°

• LIME (Lunar Irradiance Model ESA) model

• ONLY CENTER CAMERA
Long term trending
SWIR
**Instrument degradation**

No absolute calibration (Ak) updates considered

**Libya-4 SWIR**
Pre-flight Ak (absolute cal coef.)
-24°C
-10°C
+28°C

Radiometric model assumes Ak temperature independent

=> temperature increase that not considered in Ak results in L increase for NIR & RED bands (opposite for BLUE)
Pre-flight
Ak (absolute cal coef.)
-20°C
-7°C
+30°C
SWIR
Pre-flight Spectral Response curves
-20°C
-10°C
+20°C
(measured on the spare SI)
Conclusions

- PROBA-V instruments relatively stable over time
- Vicarious calibration results show impact of temperature change over the mission, but impact temperature CAMERA and BAND dependent
  - For VNIR:
    - Largest impact for NIR band:
      - Temperature increase correlates with observed increase in calibration results. Pre-flight calibration data “confirms” this behavior.
  - For SWIR: degrading trend counterbalanced by temperature increase
Conclusions

➢ Calibration updates PROBA-V Collection 2:

➢ 2nd degree polynomial model in function of date for each camera/band to correct for long term temperature change (but not abrupt temperature changes)