

Non-linearity and temperature dependence

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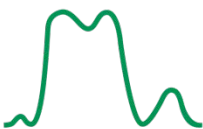
Department Biogeochemical Integration



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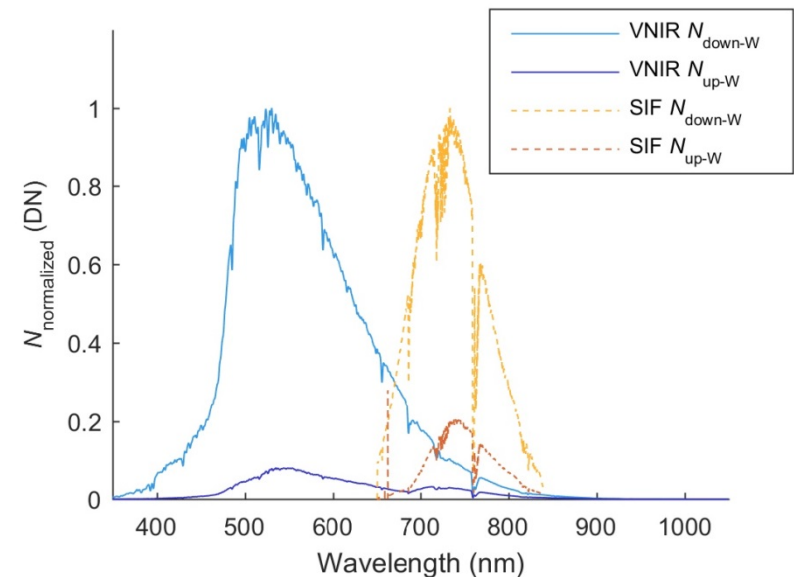
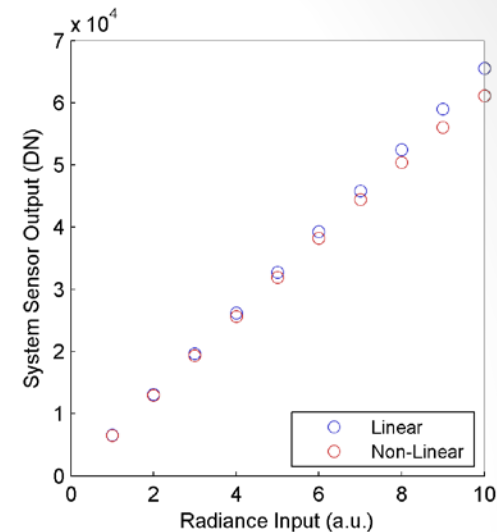


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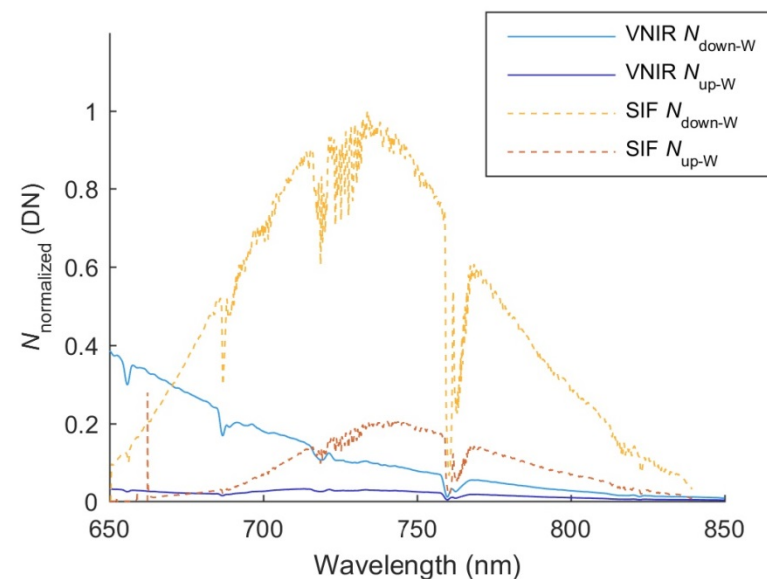
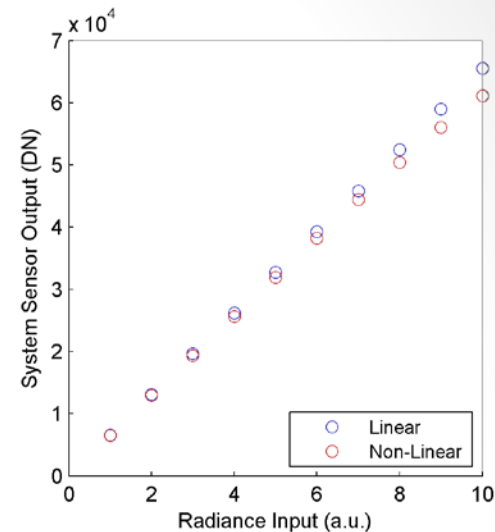
Non-linearity

- Non-linear $L - DN$ relationship
 - Most usually affects top of the dynamic range
 - Electronics and pixel saturation
 - Rule of thumb:
 - Stay away from very high DN values
 - Sensor model correction
- Relevance for SIF
 - Combination of very contrasting signals (in/out absorption bands)
 - Maximize signal inside vs. preventing saturation / NL outside
 - Spurious band depth reduction? – Sensor dependent
 - SIF and irradiance can be related



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Non-linearity

- Characterization

- $\mathcal{R}_{GL} = f(N) \rightarrow \Delta t_{\text{int}} \ \& \ \Delta \phi_e = 0$

- Easier

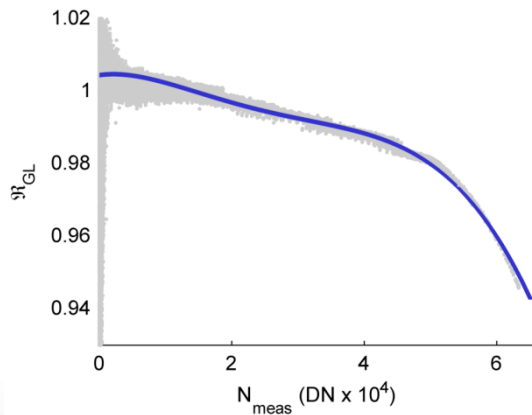
- $\mathcal{R}_{\phi_e} = f(\phi_e) \rightarrow \Delta \phi_e \ \& \ \Delta t_{\text{int}} = 0$

- Ocean Optics method

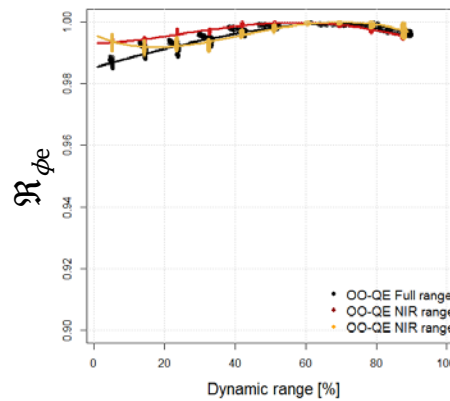
- Assumes no inter-pixel variability
 - Sensitive to low SNR

$$\mathcal{R}_{GL} = \frac{N_\lambda - N_{\lambda,0} / t_{\text{int}}}{\max(N_\lambda - N_{\lambda,0} / t_{\text{int}})}$$

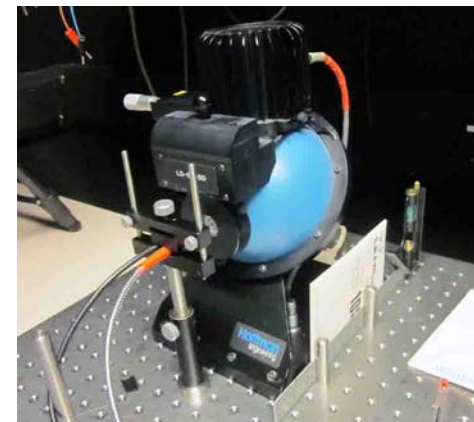
$$\mathcal{R}_{\phi_e} = \frac{N_\lambda - N_{\lambda,0} / \phi_e}{\max(N_\lambda - N_{\lambda,0} / \phi_e)}$$



Pacheco-Labrador et al, 2015



Julitta, T., 2015



NERC-FSF

Temperature dependence

- Band gap and temperature

- Varshni: $E_g(T) = E_g(0) - \frac{\alpha T^2}{T + \beta}$

- Photoresponse = $f(T)$

- NIR region (~1050) most sensitive since close to band edge of Si

- Other effects on electronics?

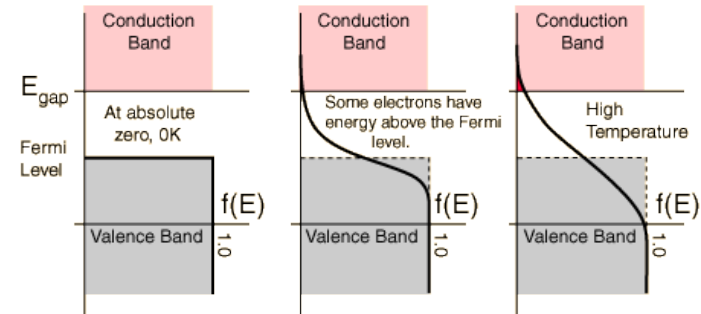
- Effects on spectral features

- SIF and Temperature

- Can be related (e.g. SCOPE)

- Most relevant

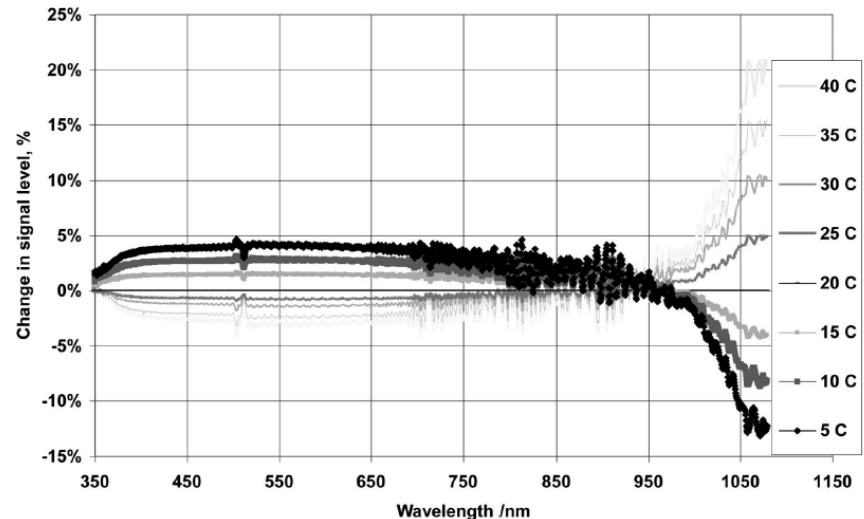
- Automated sensors
 - Drones
 - Seasonal campaigns



No electrons can be above the valence band at 0K, since none have energy above the Fermi level and there are no available energy states in the band gap.

At high temperatures, some electrons can reach the conduction band and contribute to electric current.

jntu-ece.blogspot.com

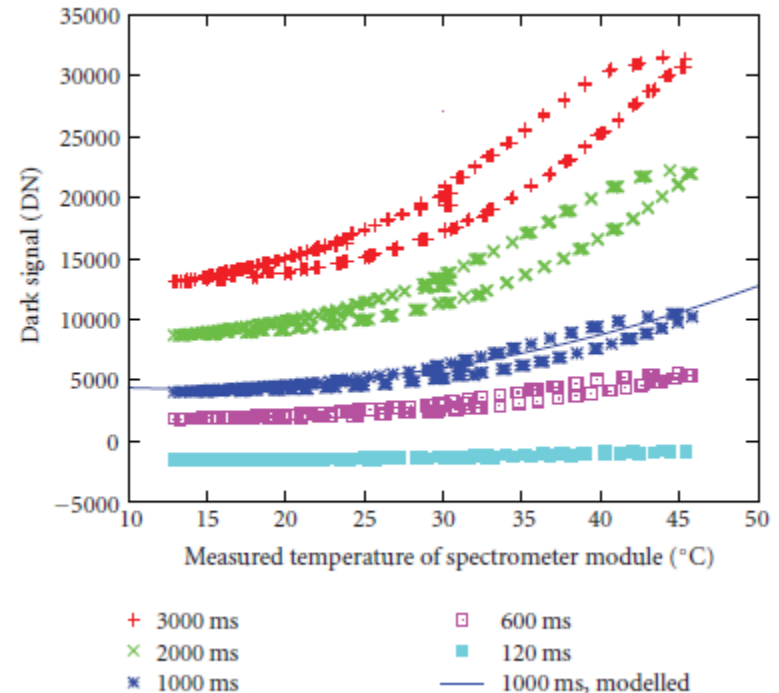


Saber et al, 2010

Temperature dependence

- Characterization

- $\mathcal{R}_T = f(T) \rightarrow \Delta T \ \& \ \Delta\phi_e = 0$
 - Temperature controlling system (oven, refrigerator...) + air mixer
 - Homogeneity maybe at lab but in field conditions might differ
 - Temperature sensors (if available) might not represent the temperature of the whole sensor array
 - Hysteresis



Kuusik, J., 2011

- Even if T can be controlled and stabilized in the field, was it the same than when:
 - Other sensor models were characterized
 - Radiometric / Spectral... calibration were carried out?