# PROBA-V REPROCESSING VALIDATION

E. SWINNEN, C. TOTE, ET AL.

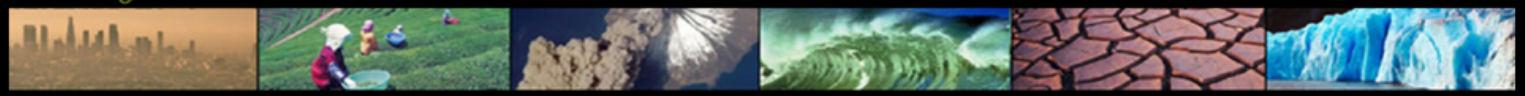
# RE-PROCESSING → COLLECTION 1 (C1)

*Implemented changes between C0 and C1*

- Improved cloud detection algorithm
- Updates on the radiometric ICP files
  - Inter-camera adjustments to the VNIR absolute calibration coefficients;
  - The application of a degradation model to the SWIR absolute calibration coefficients;
  - Improvement of the low frequency multi-angular coefficients (i.e. equalization) for the SWIR strips of the CENTER camera;
  - Changes to the dark current values;
  - Minor changes to the status of bad pixels;
  - Updates to the non-linearity values by OIP at the end of the commissioning, and small changes to the VNIR offset values (applied since 16/01/2014).
- Update product metadata for CF compliancy (implemented in C0 after 20160106)
- Bug fixes in the processing algorithm
  - Compression errors (implemented in C0 after 20160716)
  - Satellite attitude (implemented in C0 after 20160210)

# PLANNING

- Verification of implementation (June-July/2016)
  - Internal report
- Validation over 6 month period (September-October/2016)
  - Extended to 1 year period + prelim comparison with SPOT/VGT (November/2016)
  - Public report
- **Validation of entire archive (2017)**
  - **Report**
  - **Publication**



# CEOS Working Group on Calibration and Validation

# Land Product Validation Subgroup



**LPV Focus Areas**

- LAI
- Fapar
- Fire/Burn Area
- Phenology
- Vegetation Index
- Land Cover
- Snow Cover
- BRDF/Albedo
- Soil Moisture
- LST and Emissivity
- Biomass

## LPV Leadership and Focus Area Leads

### LPV Contacts

The LPV subgroup is led by a peer-nominated chair and vice-chair that serve 3-year terms. The current chair is Miguel Román and the vice-chair is Fernando Camacho. The subgroup consists of 9 Focus Areas, each led by internationally independent co-chairs who have been actively involved in validation activities and are respected community members (see table below).

Each participant in the LPV subgroup holds their position for a term of three years, after which nominations are requested.

| Group | First Name | Surname | Institution | Country | Email |
|---|---|---|---|---|---|
| Chair | Miguel | Román | NASA/GSFC | USA | miguel.o.roman[ at ]nasa.gov |
| Vice Chair | Fernando | Camacho | EOLab | Spain | fernando.camacho[ at ]eolab.es |
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| | Else | Swinnen | VITO | Belgium | e |
| | Oliver | Sonnentag | University of Montreal | Canada | Oliver.Sonnentag[at]umontreal.ca |
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| Surface Radiation Albedo | Zhuosen | Wang | UMD/NASA GSFC | USA | zhuosen.wang[ at ]nasa.gov |
| | Alessio | Lattanzio | EUMETSAT | Germany | alessio.lattanzio[ at ]eumetsat.int |
| Soil Moisture | Vacant | | | | |
| | Michael | Cosh | USDA BARC | USA | Michael.Cosh[ at ]ars.usda.gov |
| Land Surface Temperature & Emmisivity | Pierre | Guillevic | UMD/NASA GSFC | USA | pierre.c.guillevic[ at ]nasa.gov |
| | Frank | Goettsche | Karlsruhe Institute of Technology | Germany | Frank Goettsche[ at ]kit.edu |
| Phenology | Jadu | Dash | University of Southampton | UK | J.DASH[ at ]soton.ac.uk |
| | Matt | Jones | University of Montana | USA | matt.jones[ at ]ntsg.umt.edu.edu |
| Vegetation Indices | Tomoaki | Miura | University of Hawai'i | USA | tomoakim[ at ]hawaii.edu |
| | Else | Swinnen | VITO | Belgium | else.Swinnen[ at ]vito.be |

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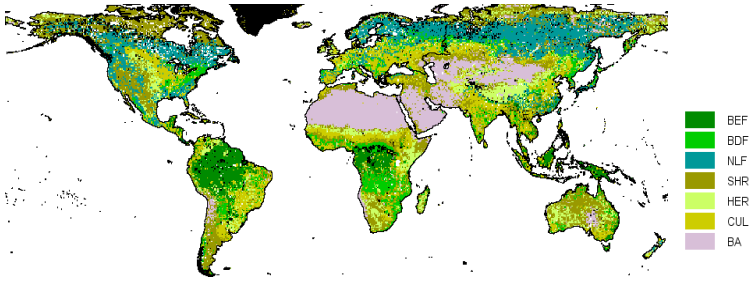
# Evaluation of reprocessing: Comparison C0 - C1

# EVALUATION APPROACH

*C1 compared to C0*
*Reflectances, NDVI*




- GLOBAL
  - Systematic sub-sample (21x21 pixel)
    - SM = clear
    - Same obsservation day
    - Same camera / all cameras
  - 11/2013 – 11/2016 (37 months)

As if comparing at segment level

- Three parts
  - C0 – C1
  - Comparison VGT2 C3 – PROBA-V C1
  - Comparison of VGT/PROBA-V data set with METOP-A/AVHRR and TERRA/MODIS



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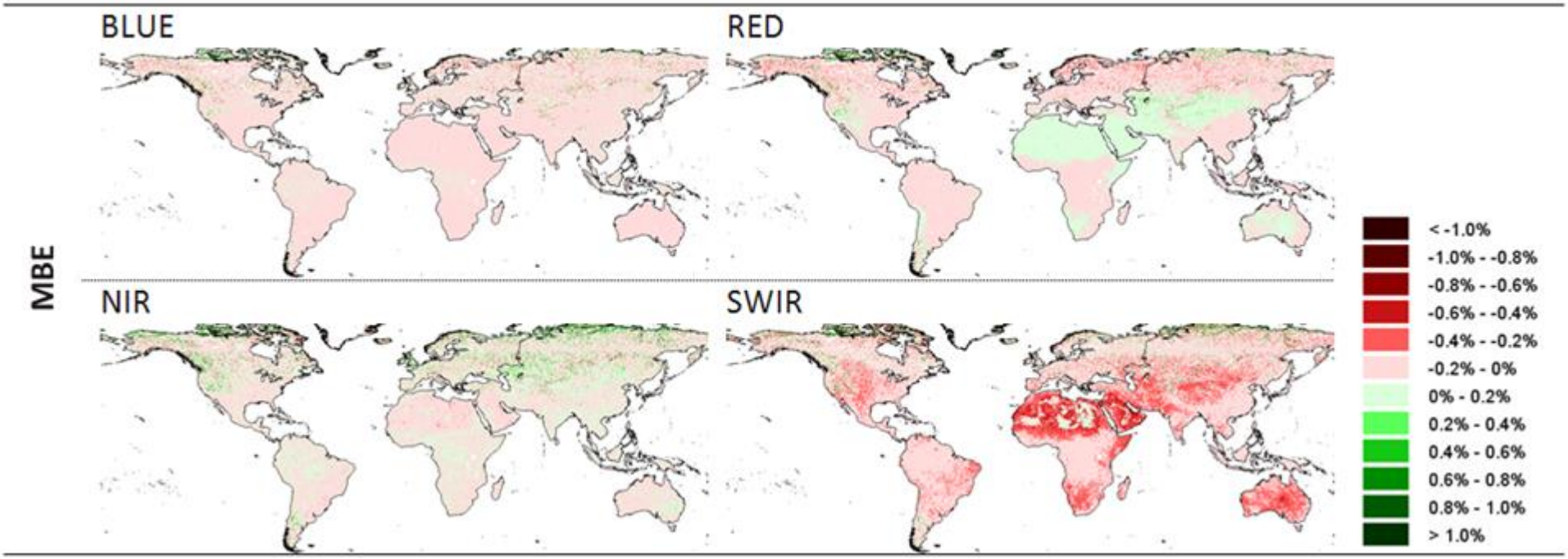
# SPATIAL PATTERN OF DIFFERENCES

*SM + OD*

*10/2013 - 11/2016*



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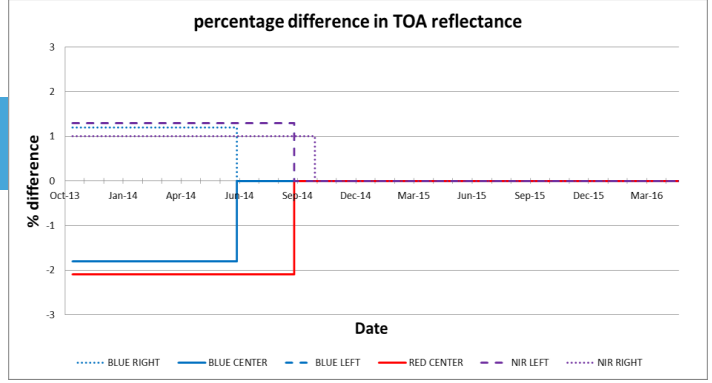
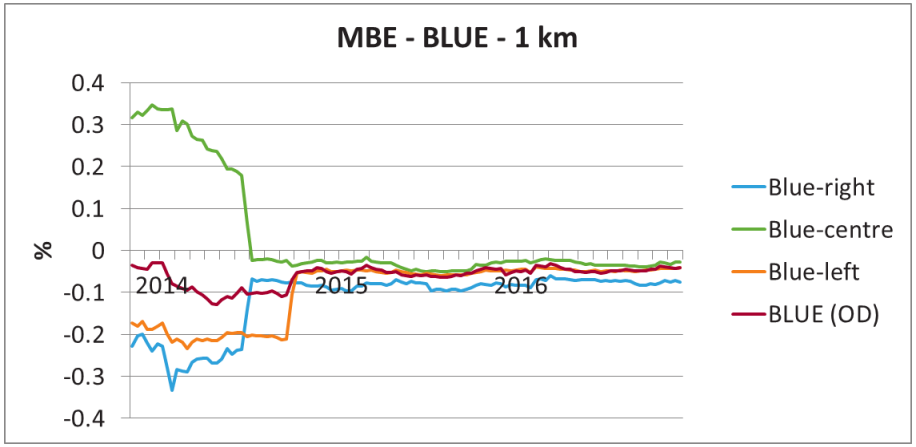
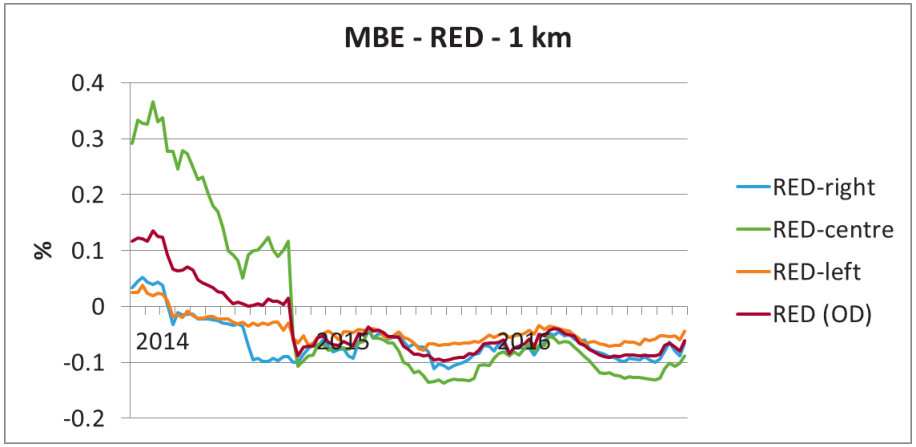
# C1 VS C0: TEMPORAL PATTERN OF DIFFERENCES

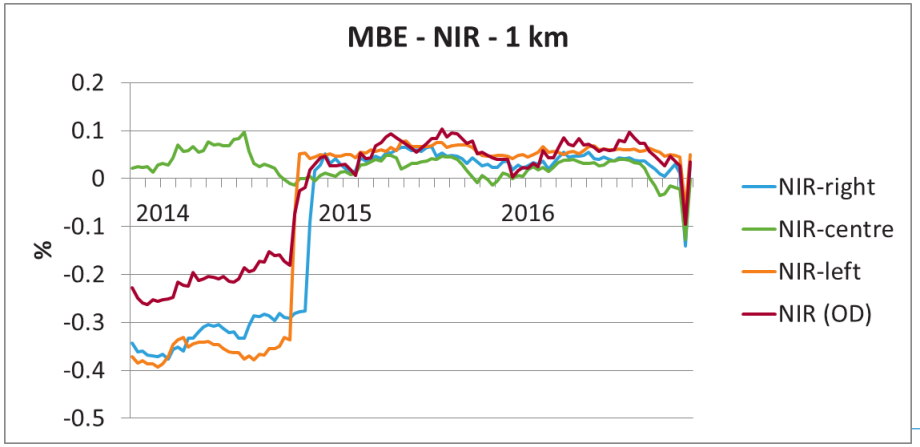
*MBE (C0-C1), [% reflectance]*

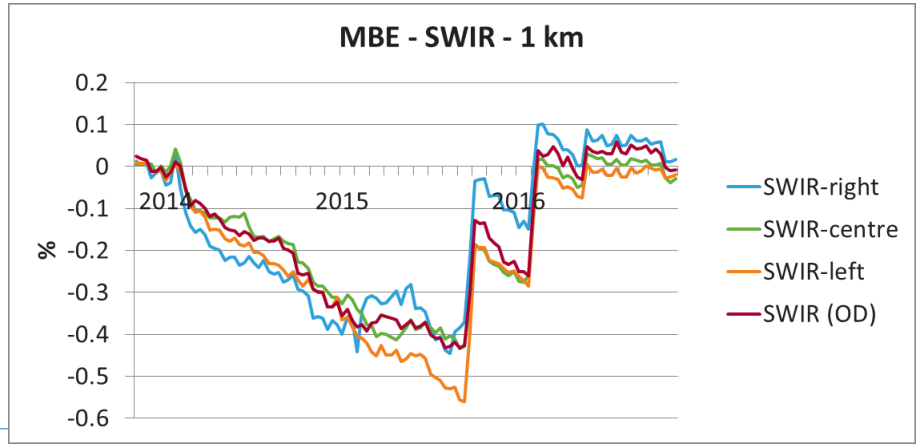
*Same camera + same day of observation*



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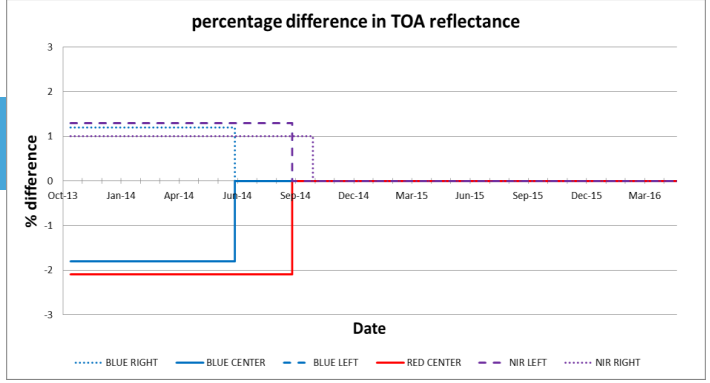
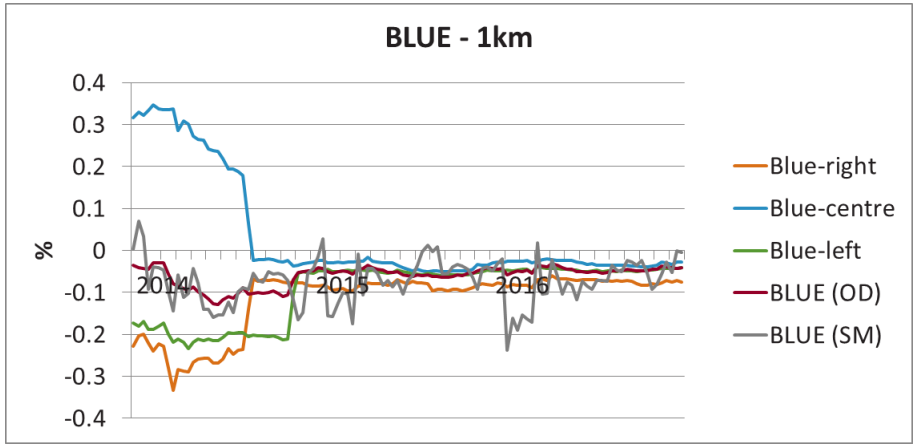
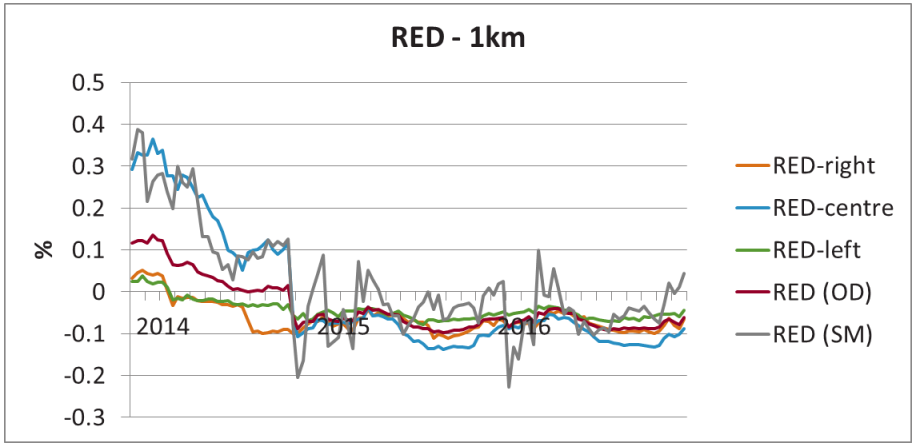
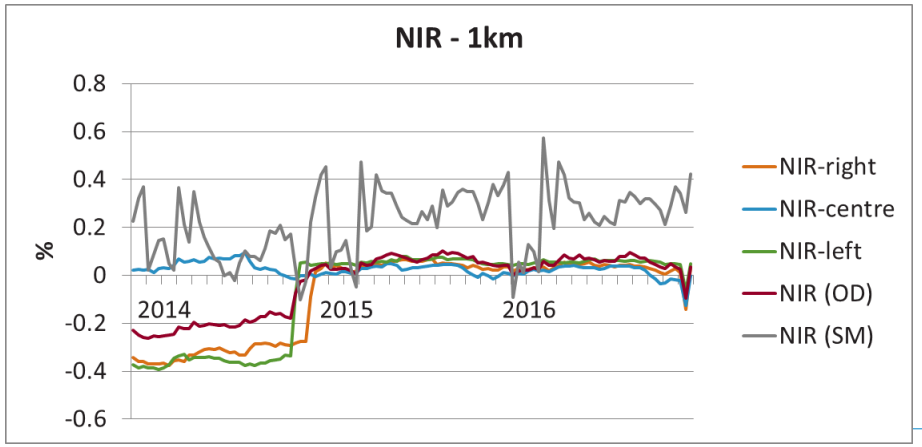
# TEMPORAL PATTERN OF DIFFERENCES

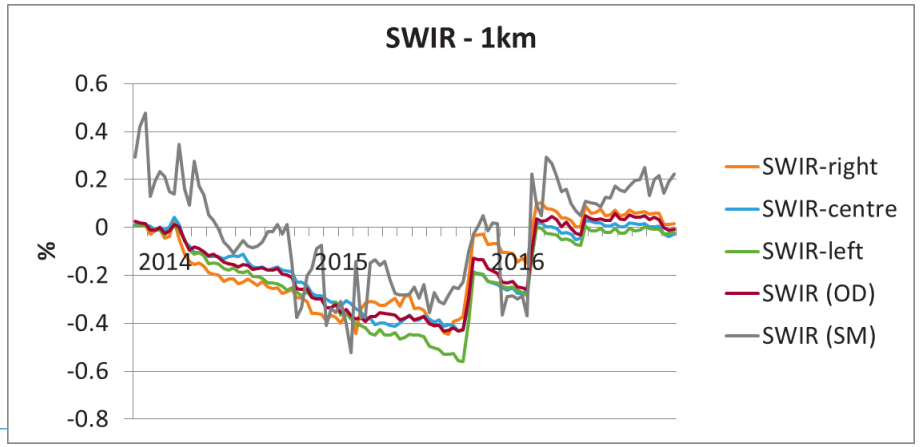
*MBE (C0-C1), [% reflectance]*



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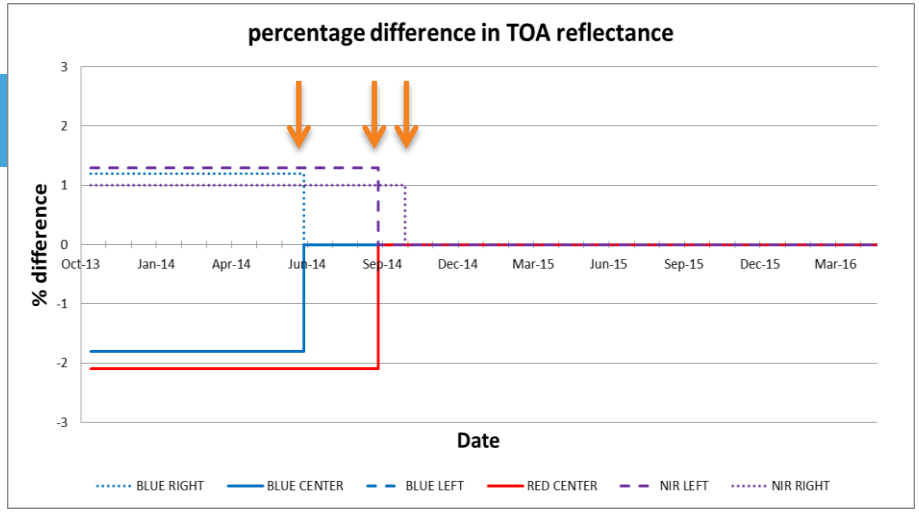
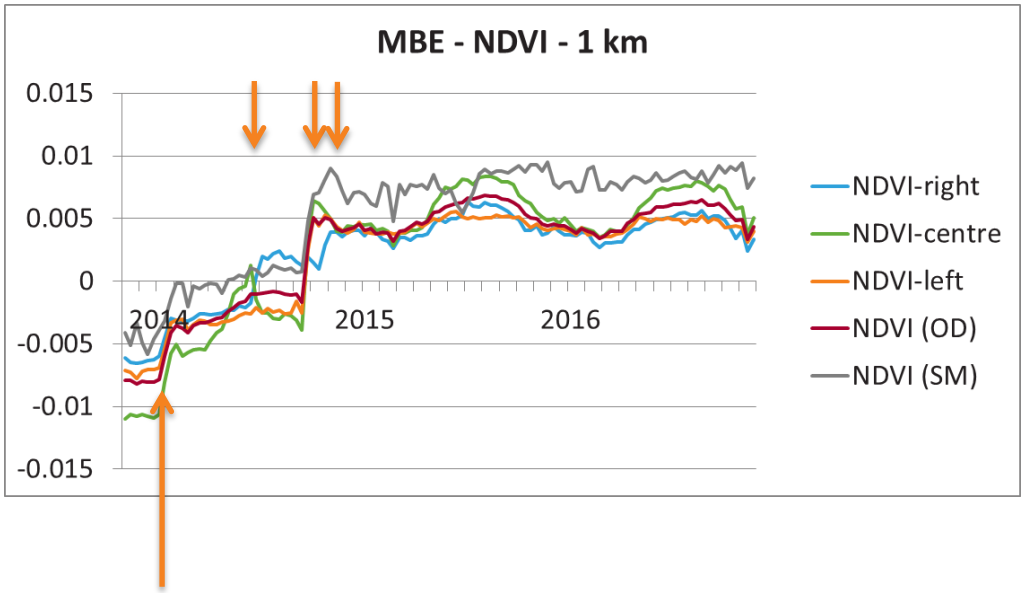
# TEMPORAL PATTERN OF DIFFERENCES

*MBE (C0-C1), [-]*




Non-linearity correction set to 0 and changes in offset



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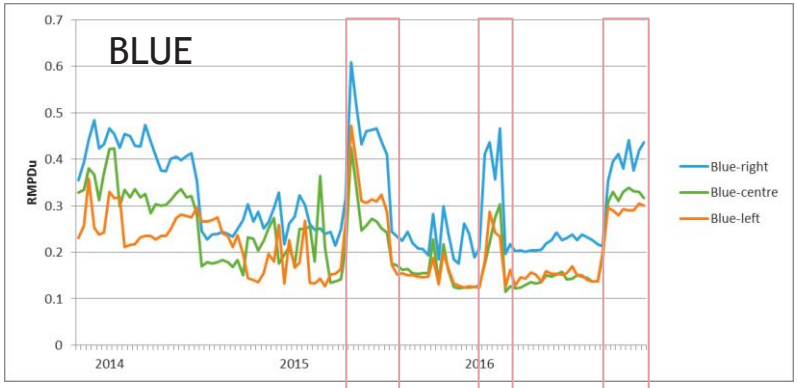
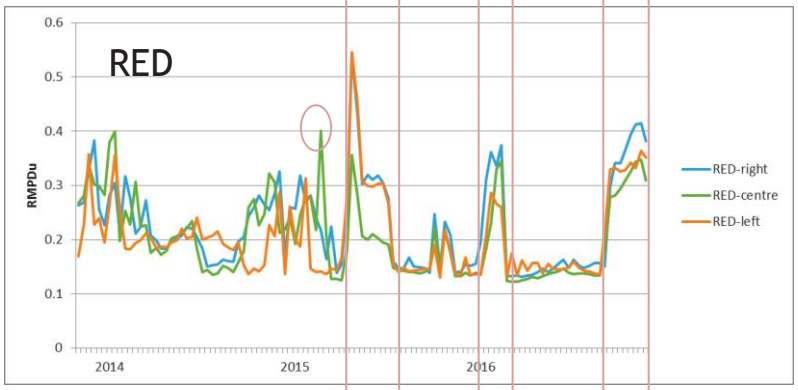
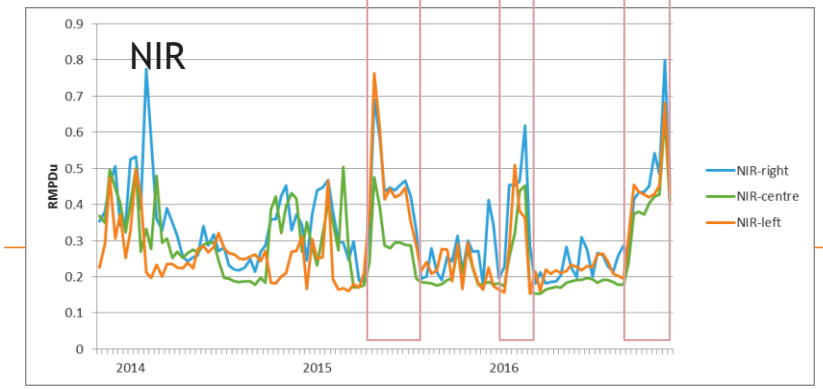
# TEMPORAL PATTERN OF **RANDOM** DIFFERENCES

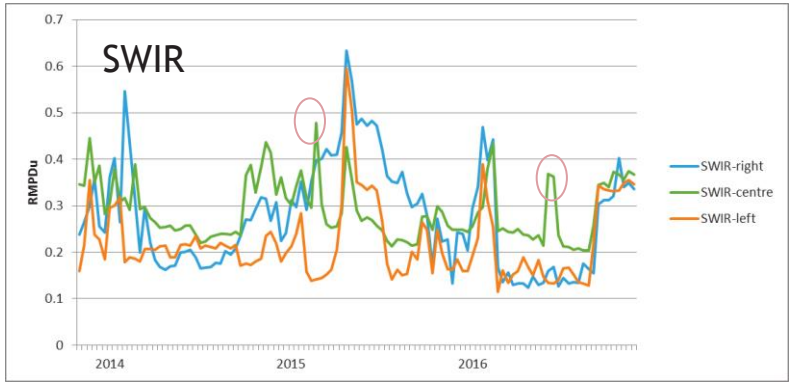
*Periods with slightly larger random difference between PV-C0 and PV-C1*

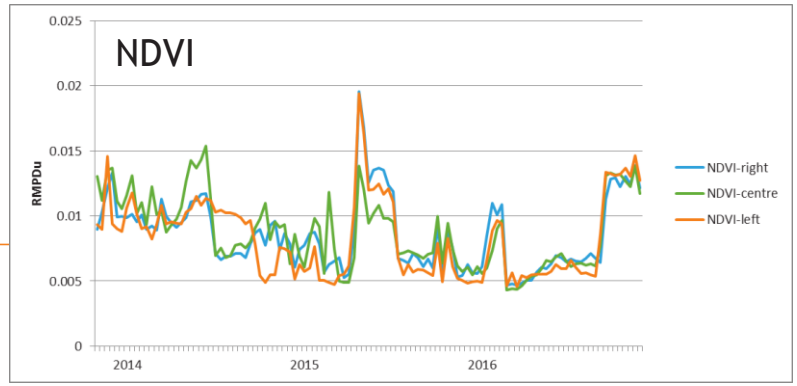



- Roughly:
  1. 20150421-20150701
  2. 20160111-20160211
  3. 20160911-end
- Not exactly the same period for each camera
- CENTER CAMERA peaks: 20150221 (all bands), 20160601-20160611 (SWIR)

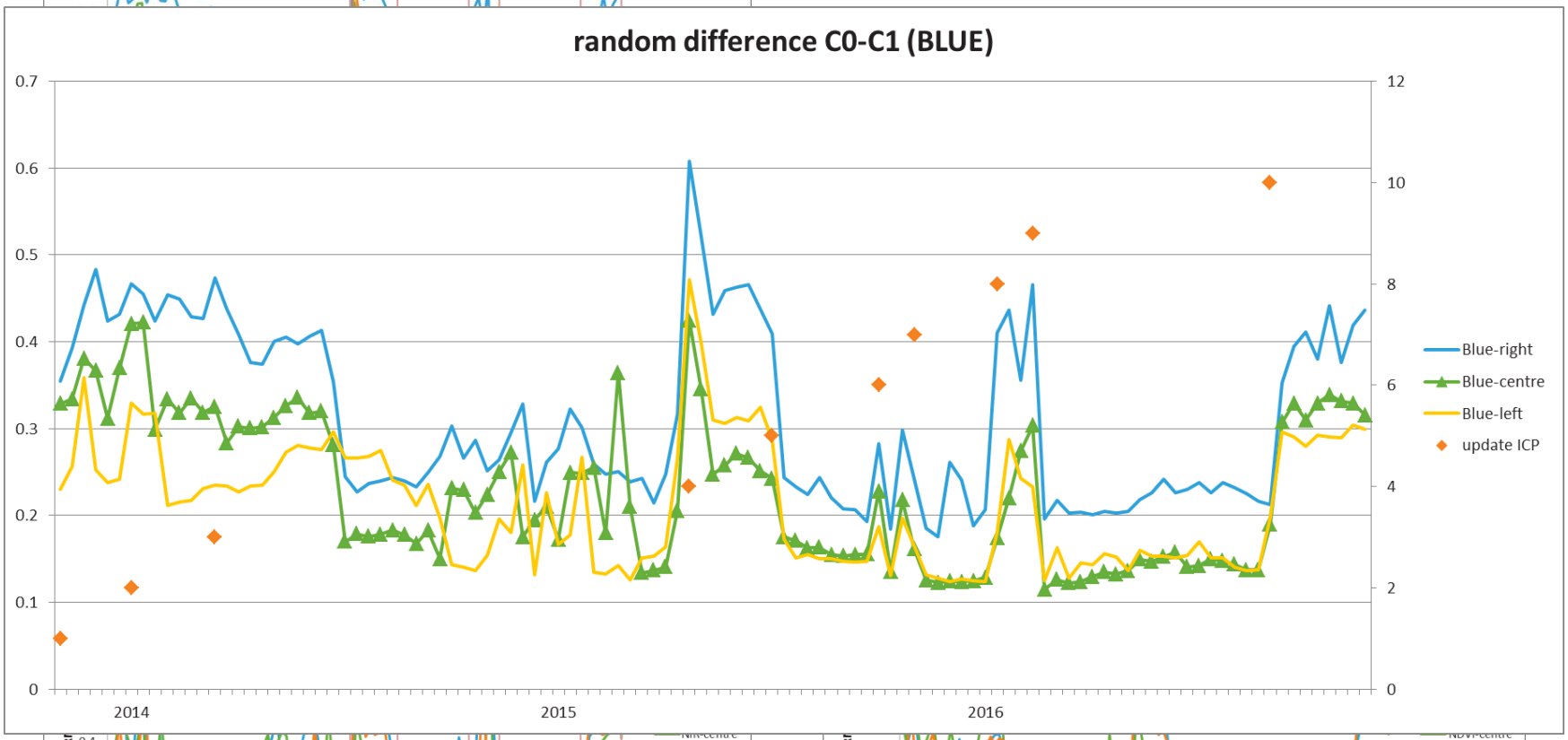


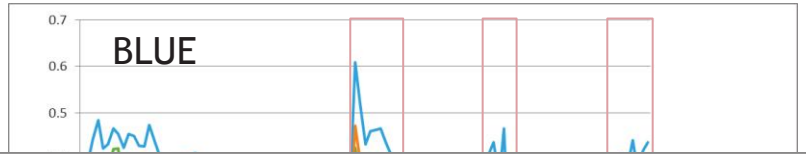



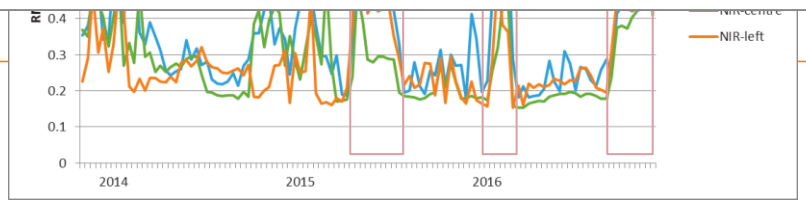
# TEMPORAL PATTERN OF DIFFERENCES: RANDOM

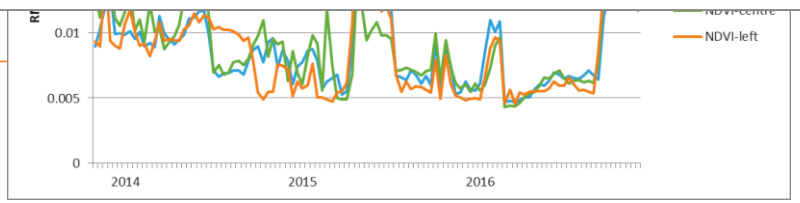
*Periods with slightly larger random difference between PV-C0 and PV-C1*

- Roughly:
  1. 20150421-20150701
  2. 20160111-20160211



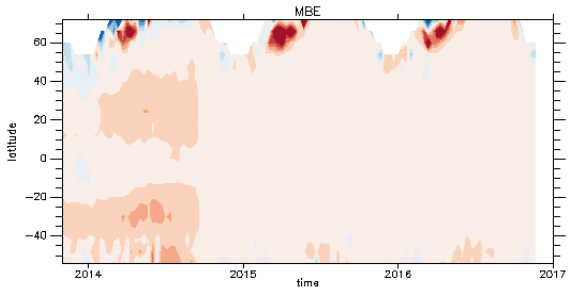
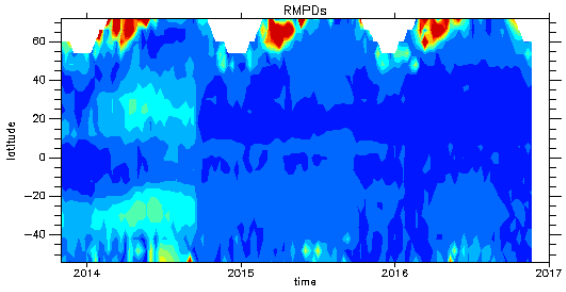
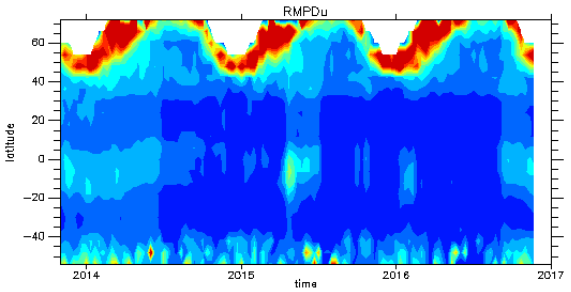
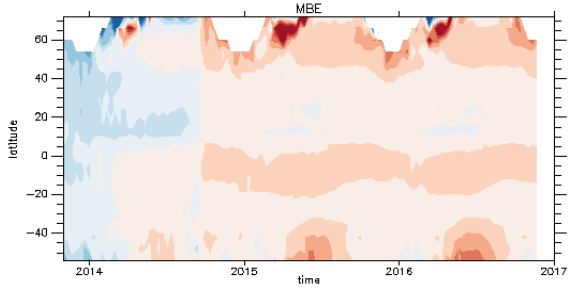
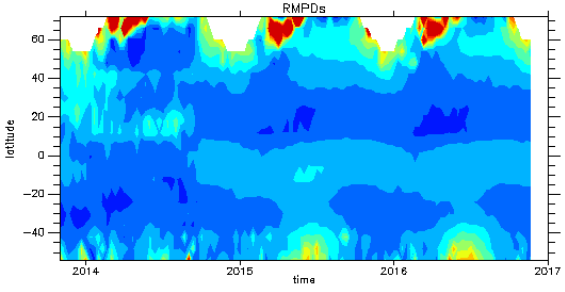
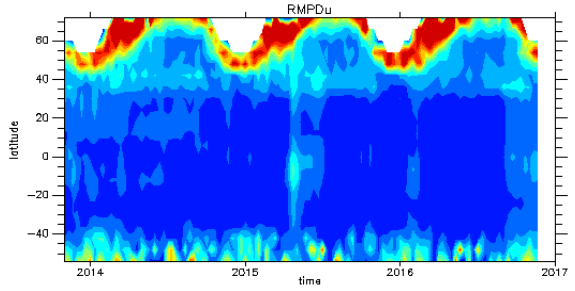
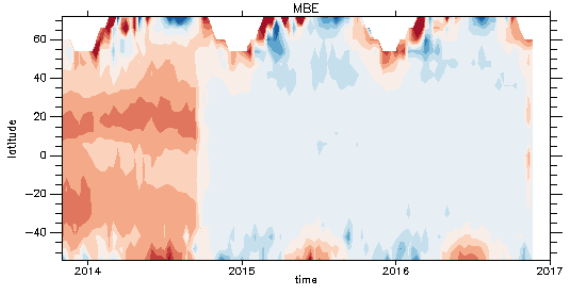
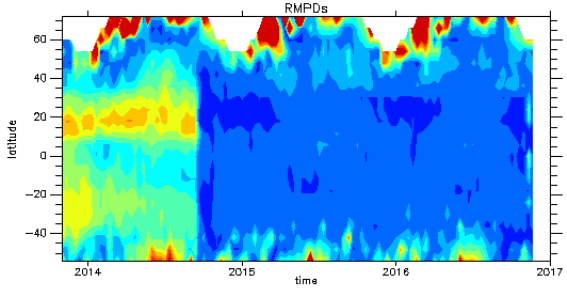
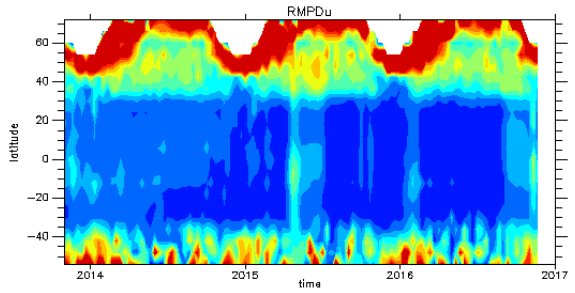
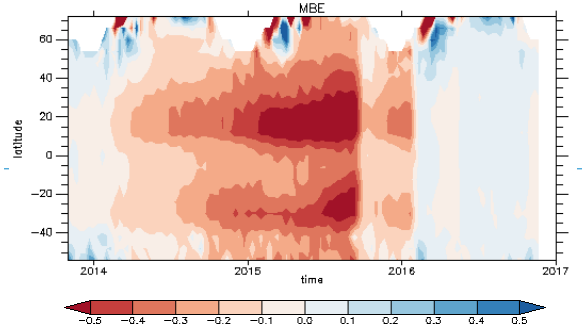
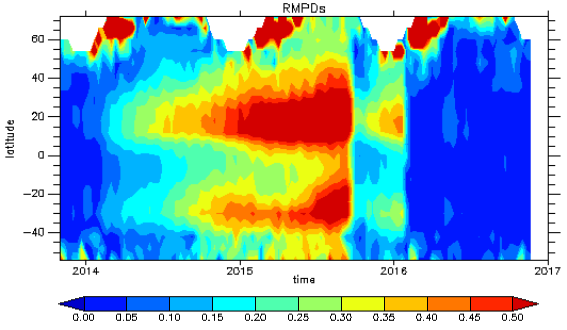
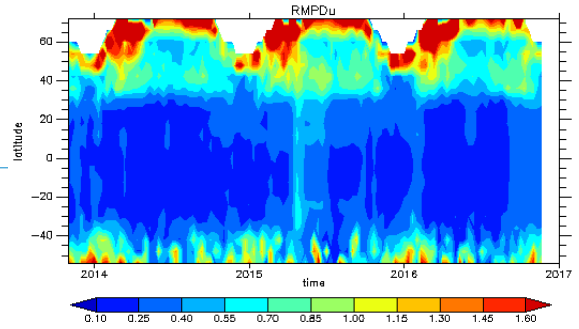



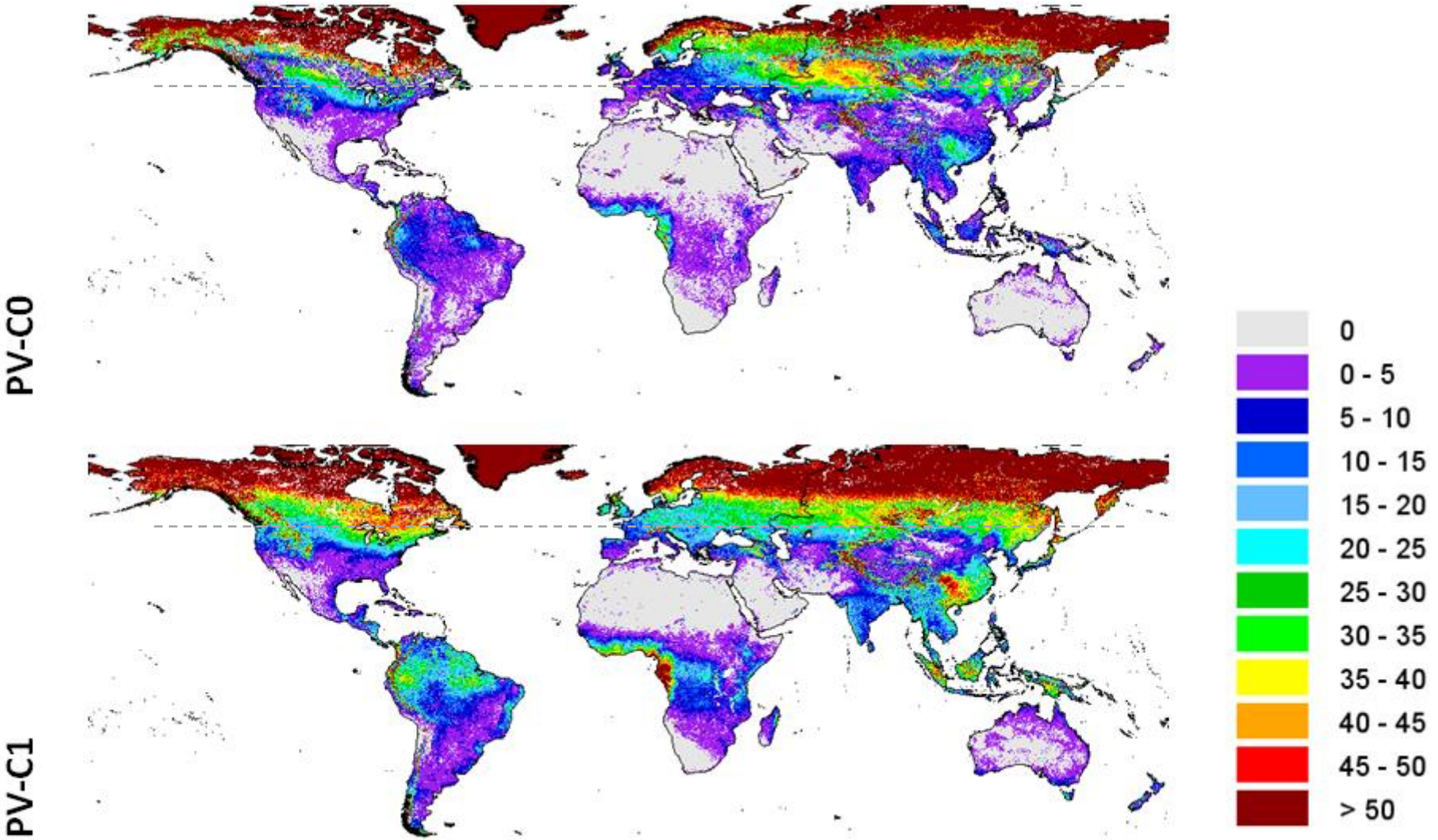



# HOVMÖLLER PLOTS (ALL CAMERAS)

SM + OD

| | MBE (C0-C1) [% reflectance] | RMPDs [% reflectance] | RMPDu [% reflectance] |
|---|---|---|---|
| BLUE |  |  |  |
| RED |  |  |  |
| NIR |  |  |  |
| SWIR |  |  |  |

# PERCENT MISSING OBSERVATIONS NDVI 20131101-20161121



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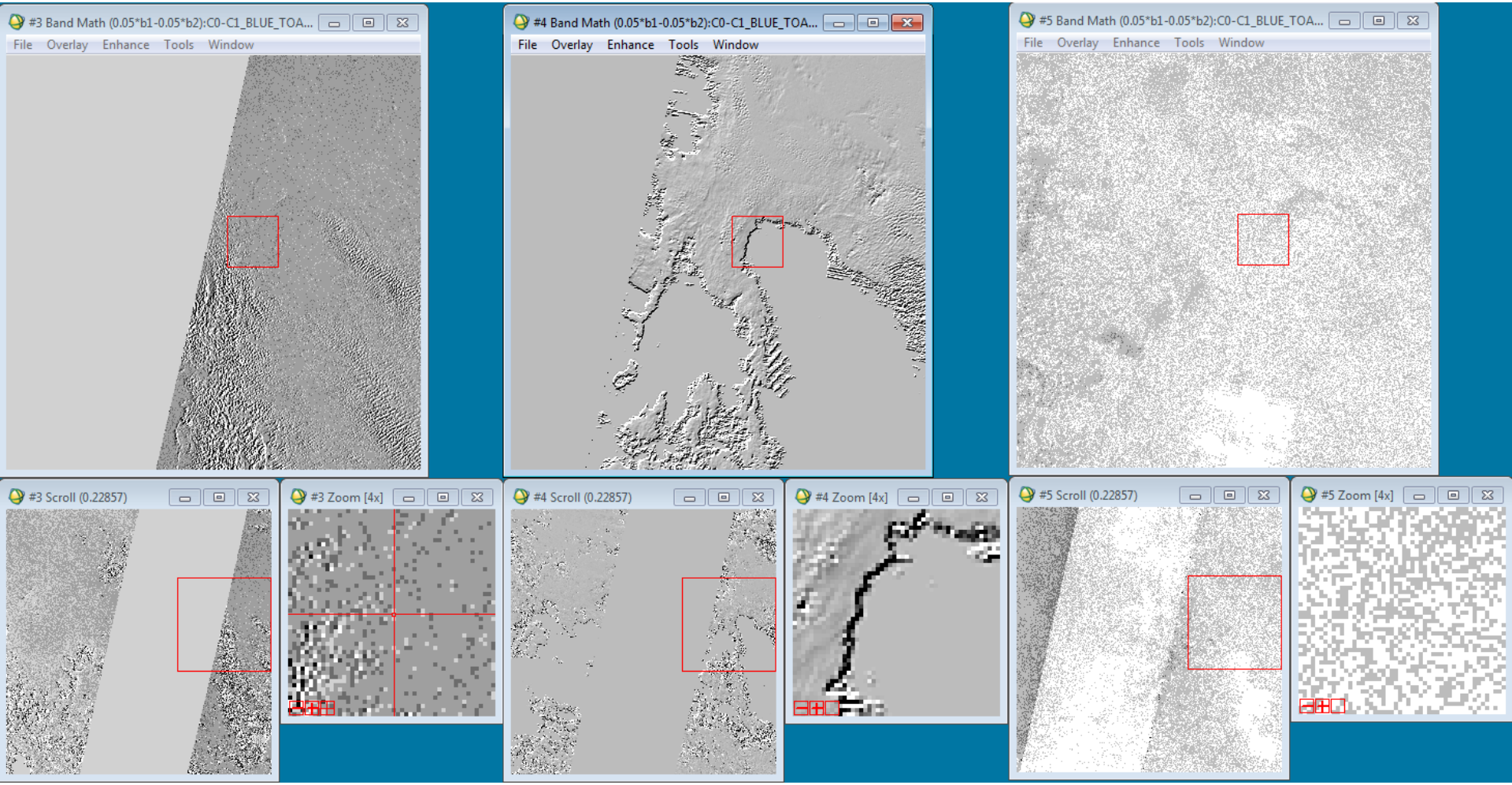
# DIFFERENCE C0-C1 S1-TOA

20160101
Same geometric ICP in C0 & C1

20160119
Different geometric ICP in C0 & C1

20160130
Same geometric ICP in C0 & C1

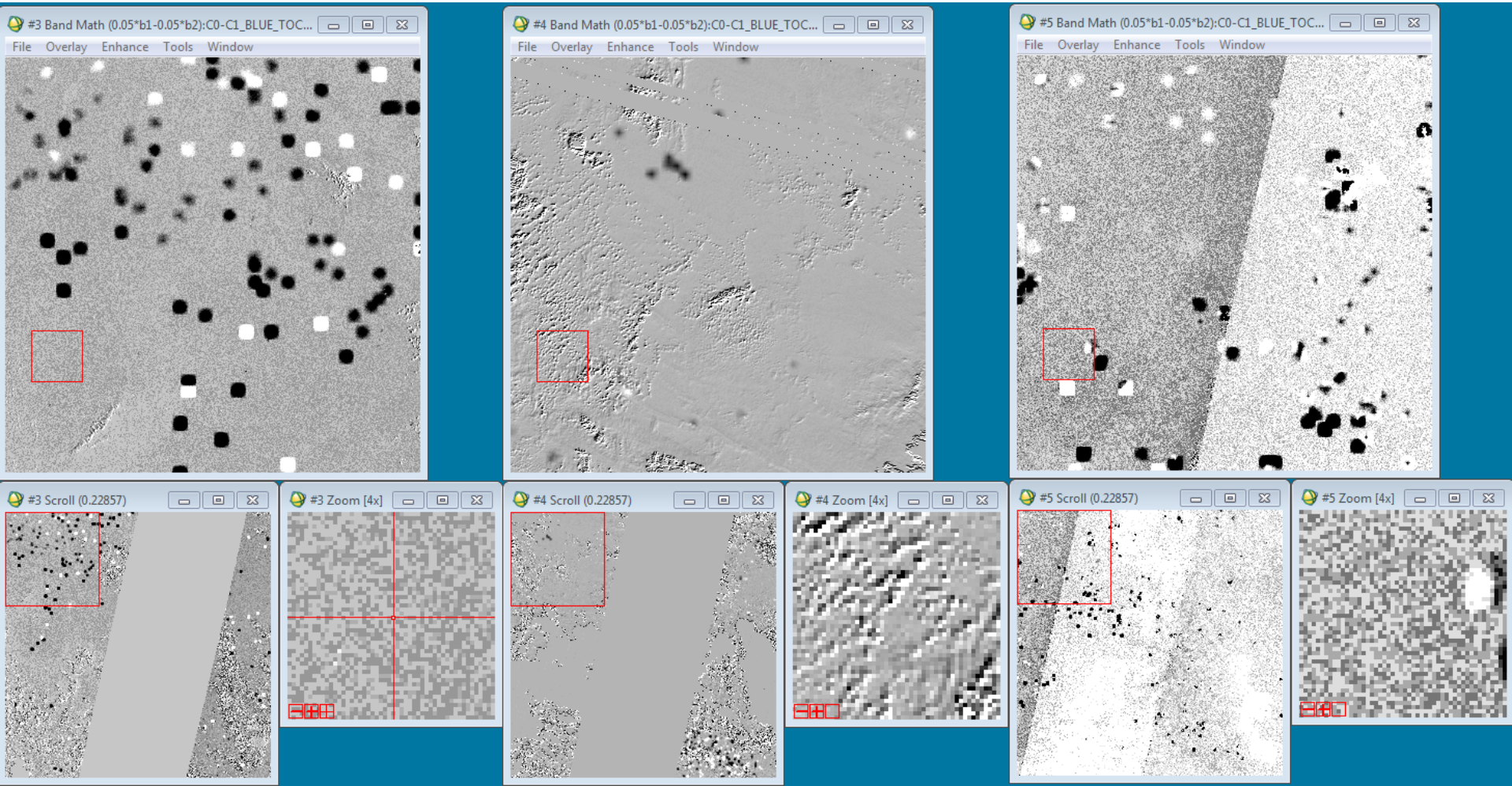


# DIFFERENCE C0-C1 S1-TOC

20160101
Same geometric ICP in C0 & C1

20160119
Different geometric ICP in C0 & C1

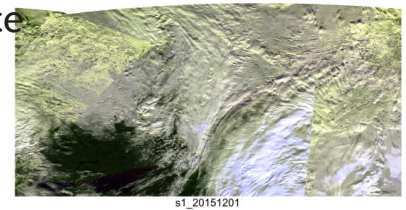
20160130
Same geometric ICP in C0 & C1

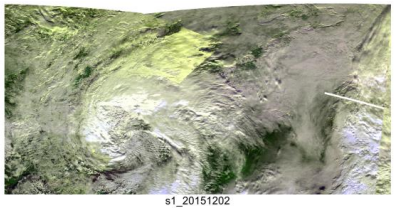


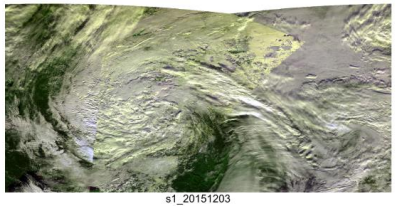
# CLOUD MASKING ERROR

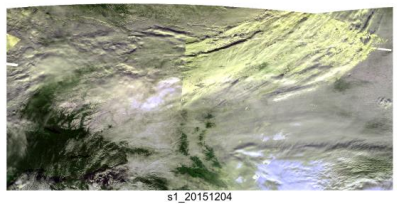
*Dec - Febr, every year*

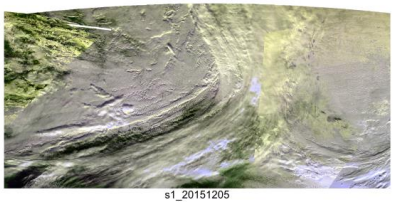
Red = cloud
Orange = undefined
Yellow = shadow
Cyan = snow/ice


s1_20151201


s1_20151202


s1_20151203


s1_20151204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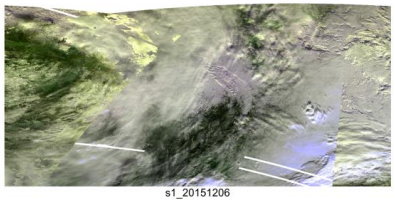
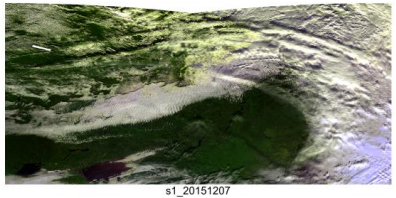
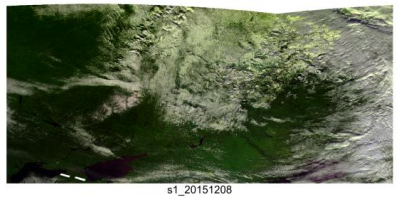
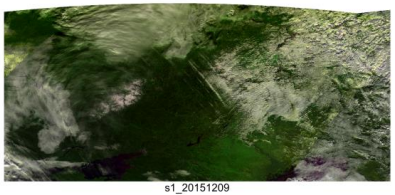

s1_20151206


s1_20151207


s1_20151208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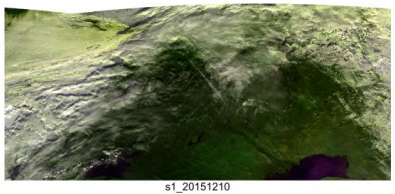
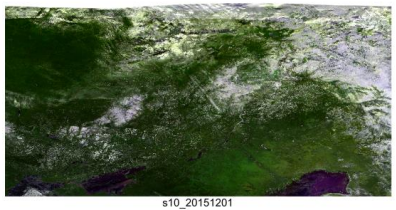
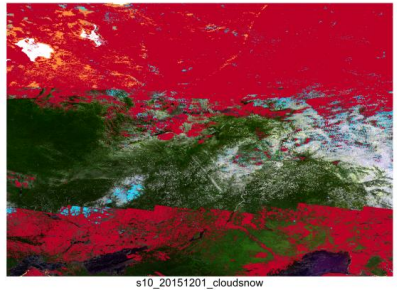

s1_20151210


s10_20151201


s10_20151201_cloudsnow



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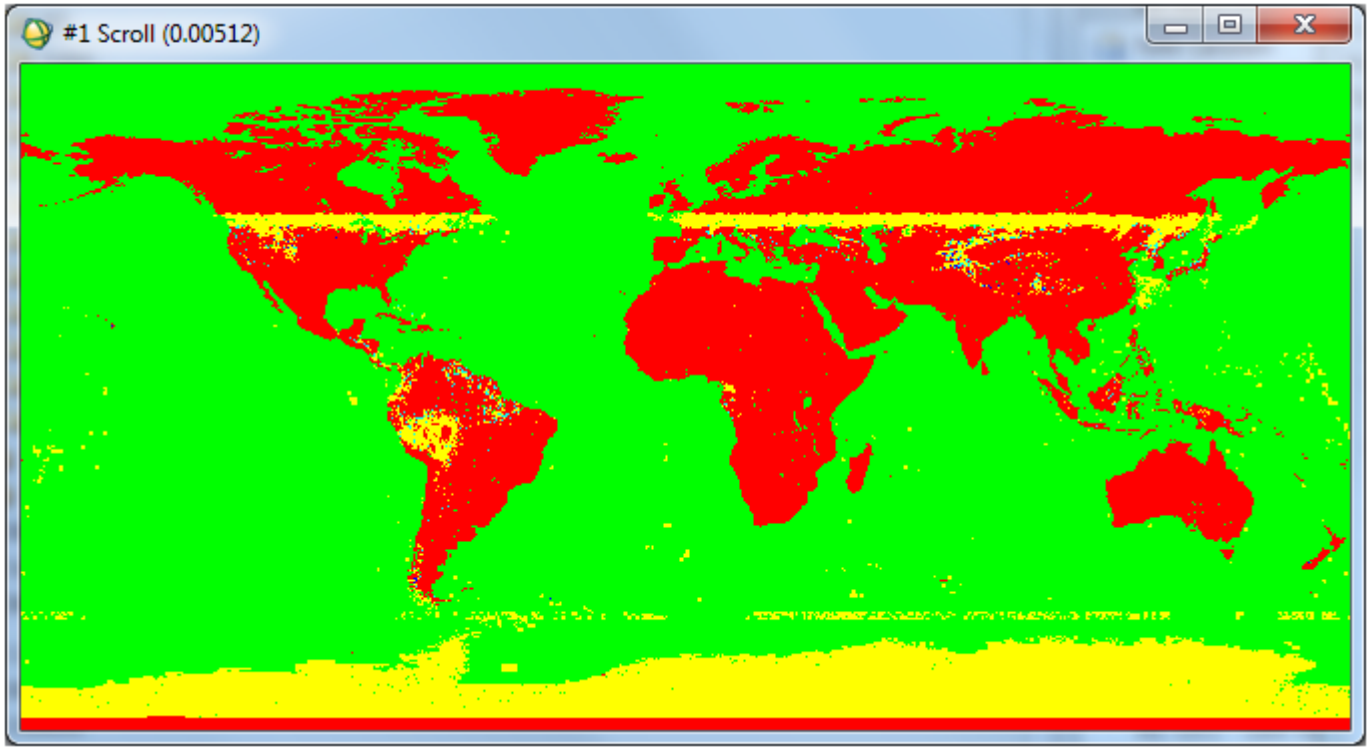
# CLOUD MASKING ERROR

*Classification file used in cloud detection for December*



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# Consistency with VGT2

# METHOD

*See also Technical note on Proba-V website (http://proba-v.vgt.vito.be/sites/proba-v.vgt.vito.be/files/comparison_between_spot-vgt_and_proba-v_v1.1_website.pdf )*

- Overlapping period
- 1 km  S10 TOC, systematically subsampled (21x21)
- Sampling
  - SM=clear
  - VZA < 30°
  - Same direction (both backscatter or both forward scatter)

- 2 sets of data are compared:
  - VGT C2 – PV C0 → old
  - VGT C3 – PV C1 → new

- Metrics
  - Geometric mean regression
  - $RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(X_i - Y_i)^2}$
  - $RD = median\left(\frac{X_i - Y_i}{Y_i}\right) \cdot 100\%$



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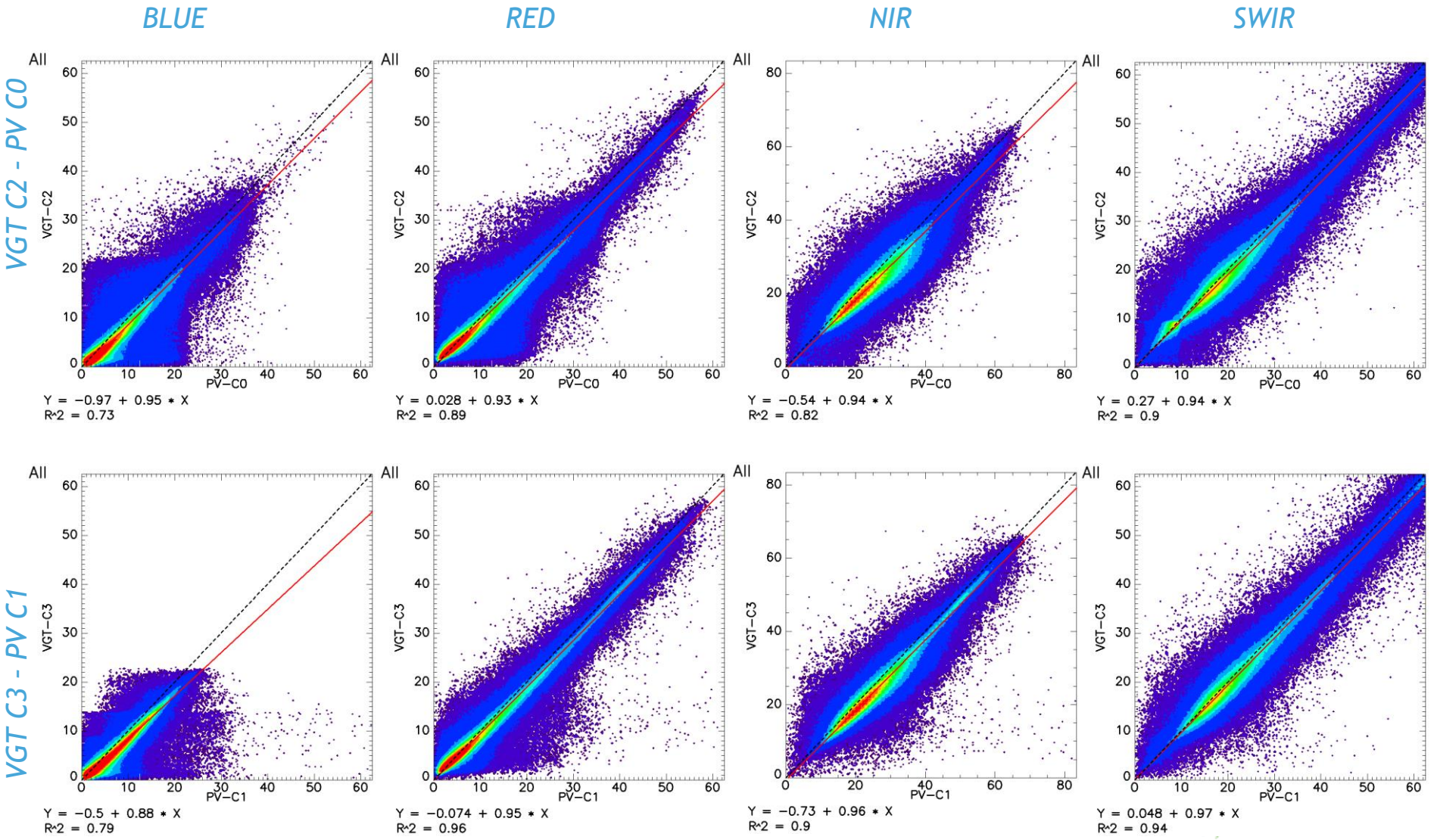
# RESULTS REFLECTANCES: SCATTERPLOTS & GM REGRESSION

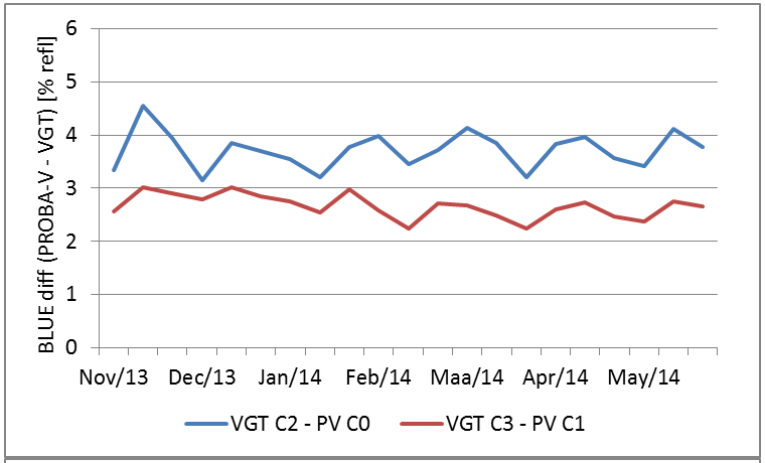


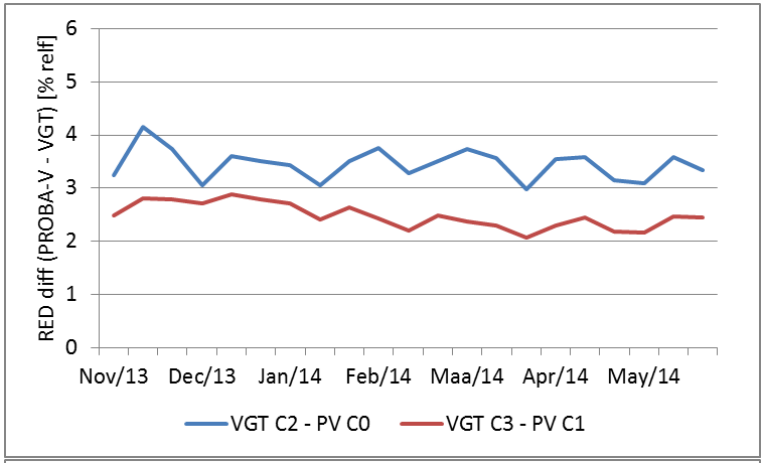
# RESULTS REFLECTANCES: TEMPORAL ANALYSIS

*BLUE*

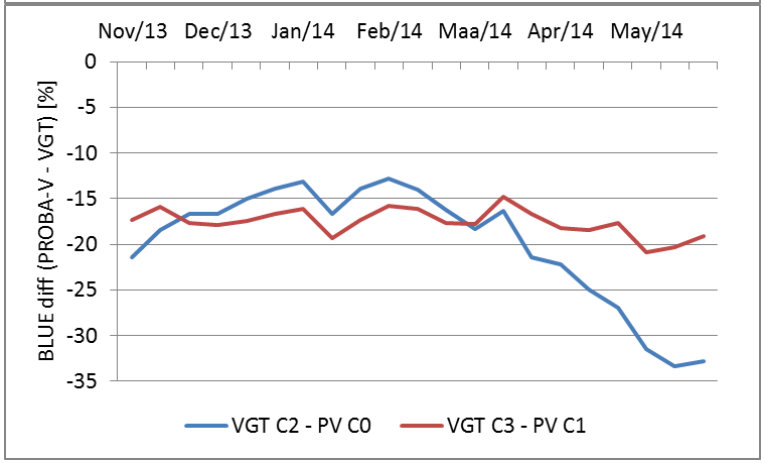
*RED*

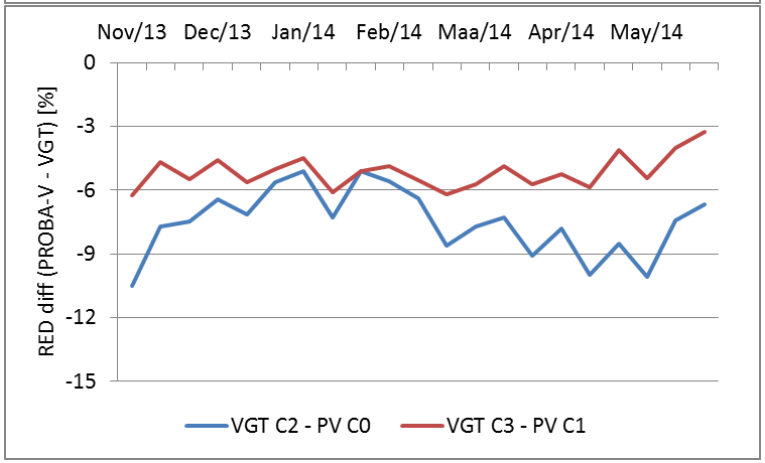
*RMSE*




*RD*



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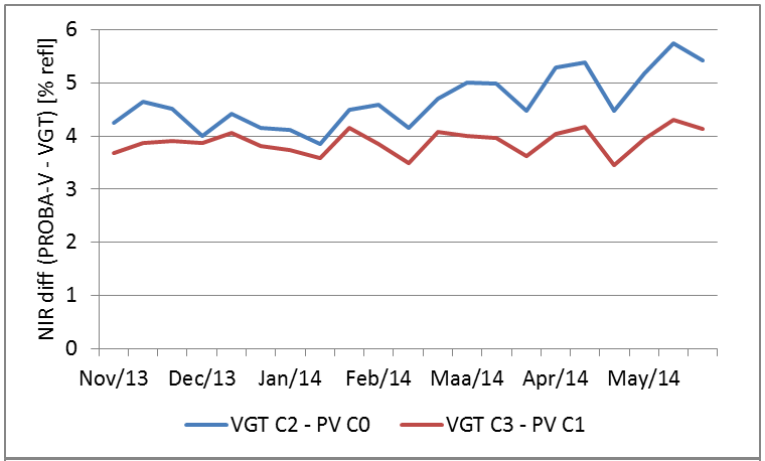
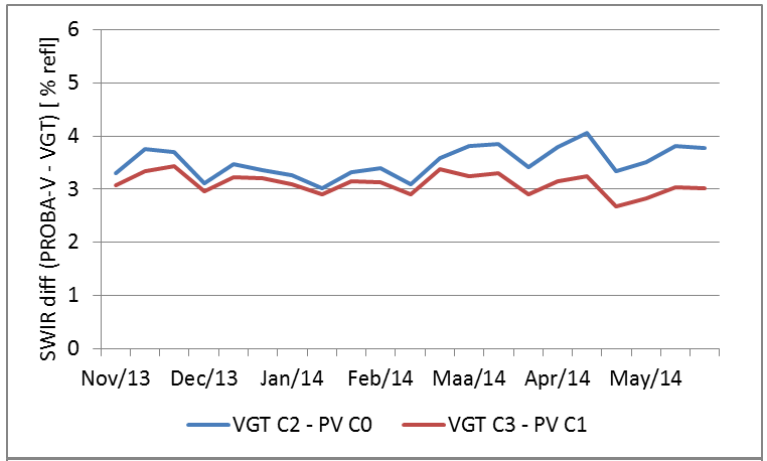
# RESULTS REFLECTANCES: TEMPORAL ANALYSIS

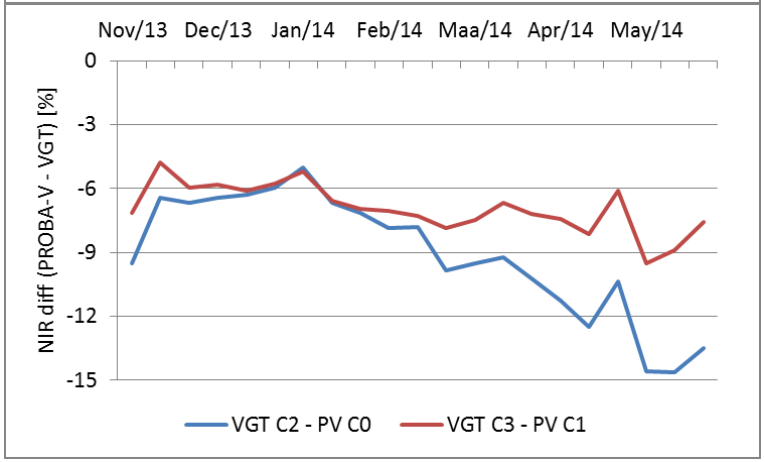
*NIR* *SWIR*

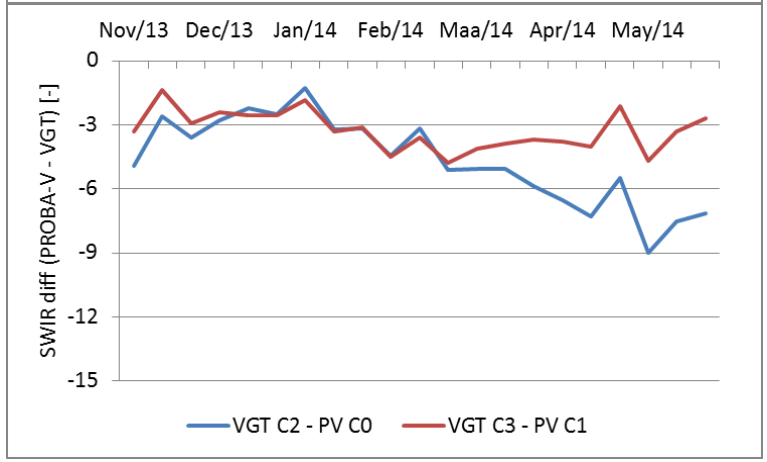
*RMSE*




*RD*



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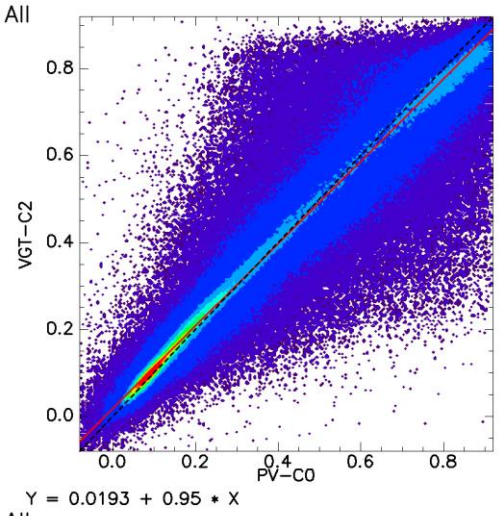
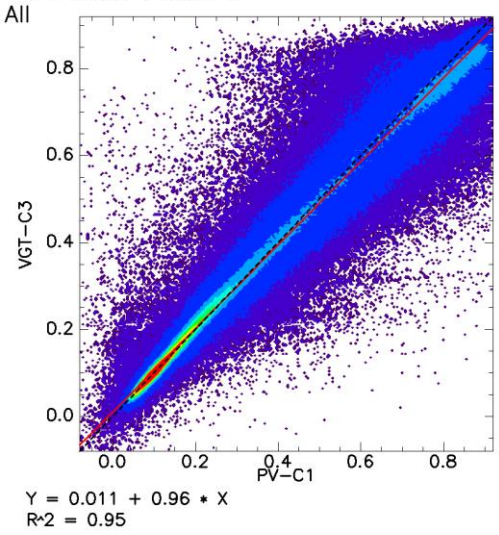
# RESULTS NDVI

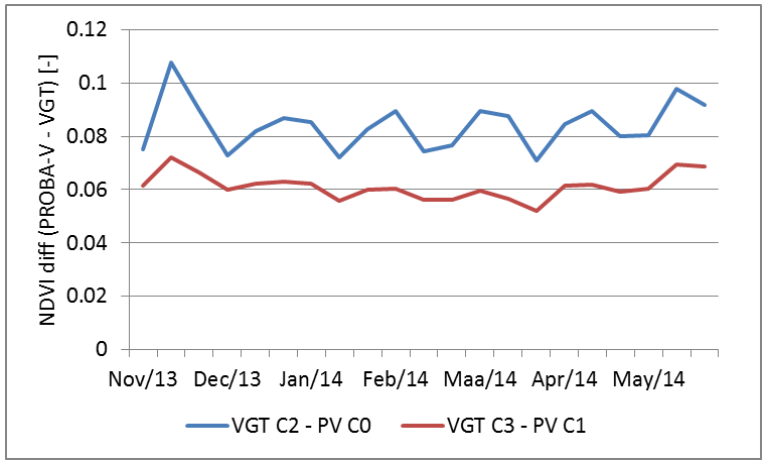
VGT C2 - PV C0



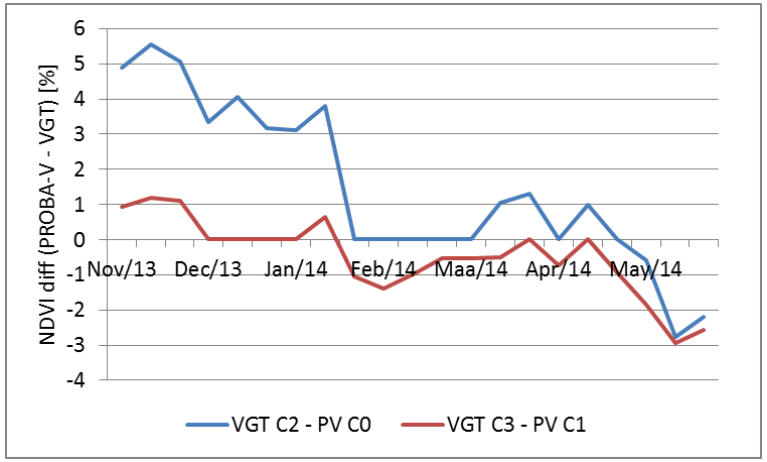

VGT C3 - PV C1




RMSE




RD



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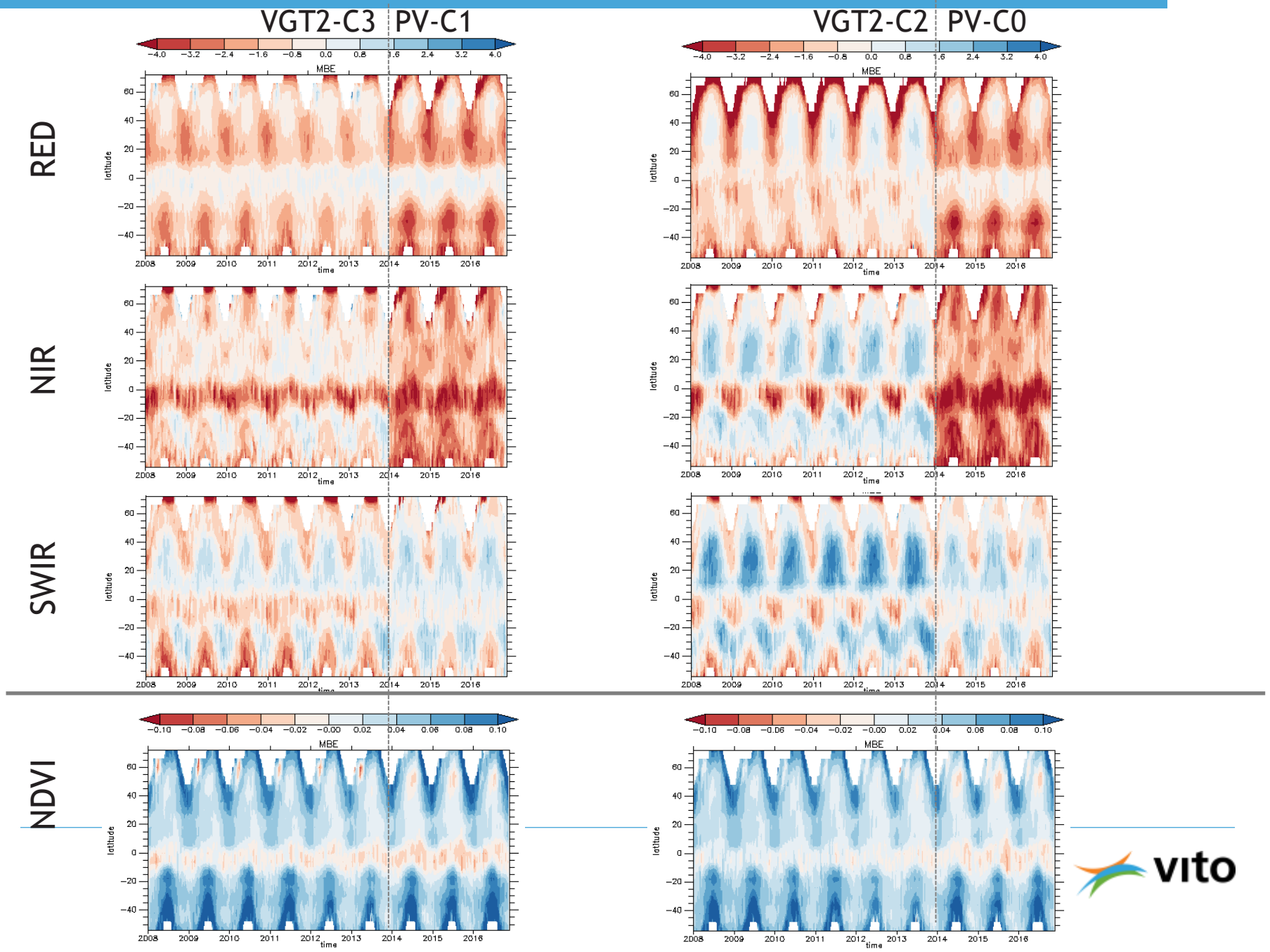
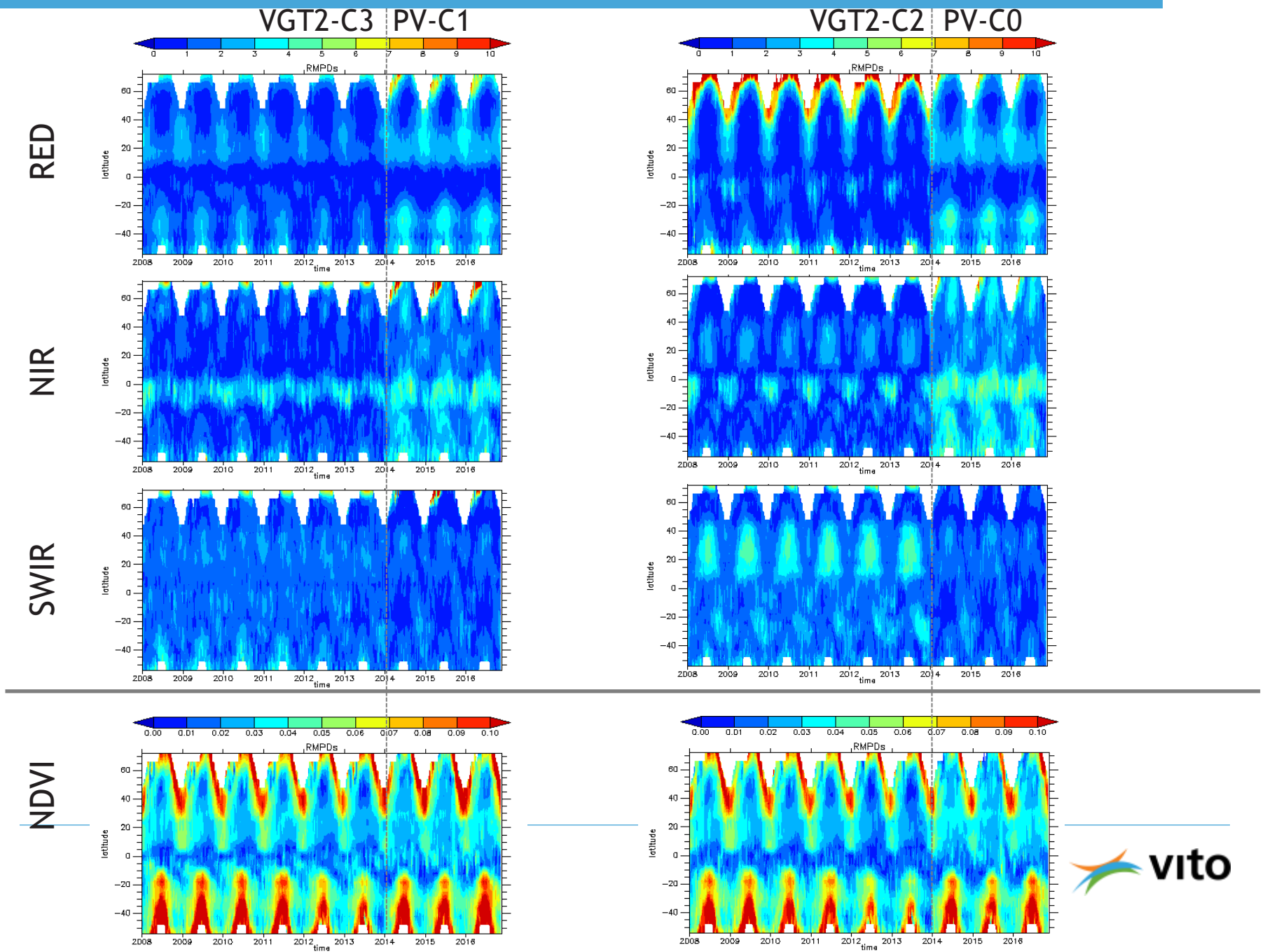
# Comparison with external data

# COMPARISON WITH METOP-A MBE



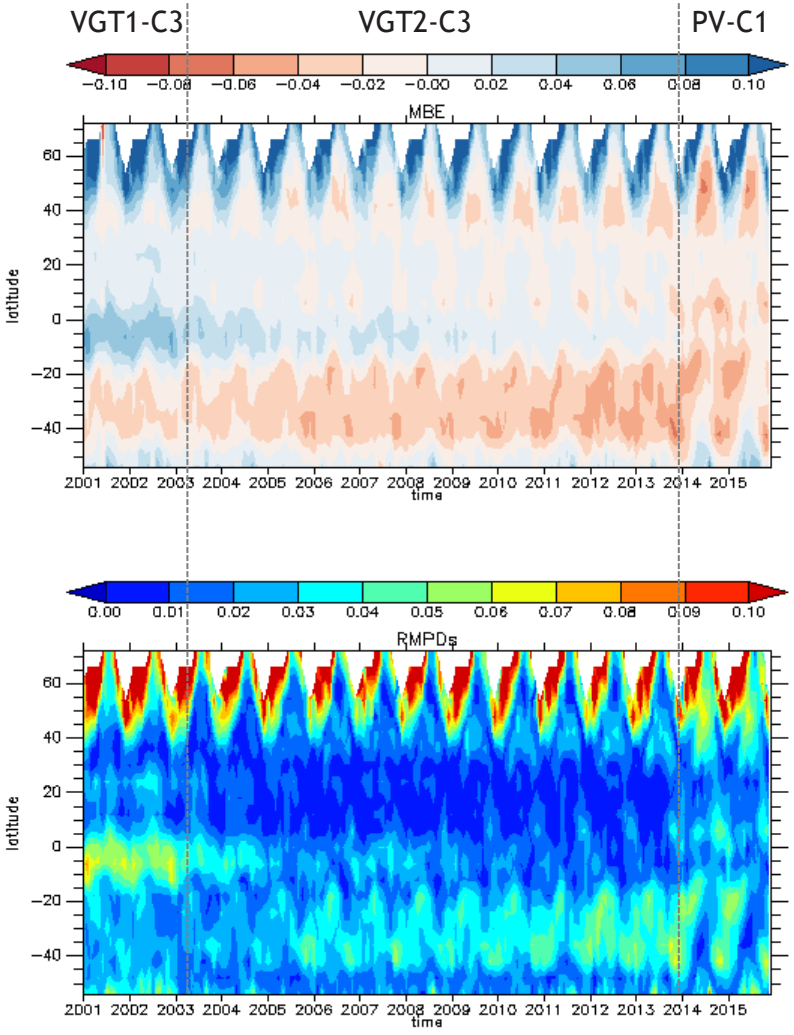
# COMPARISON WITH METOP-A RMPD$_S$

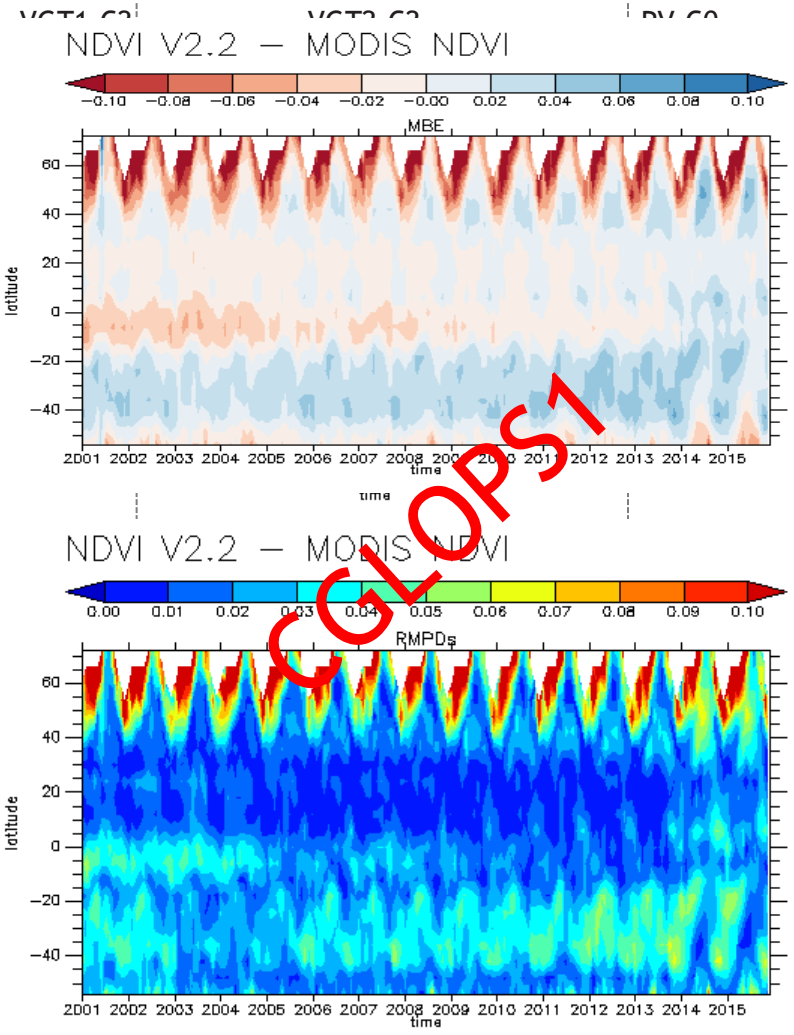


# COMPARISON WITH MODIS NDVI

MBE

RMPDs





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# Conclusions

# CONCLUSIONS

- Evaluation of PROBA-V C1
  - Changes in data set are as expected
  - Changes that have to be clarified further → << 1% random difference
  - Issue with cloud detection in Dec-Jan-Feb

- Re-processing of PROBA-V (and VGT) leads to better consistency between both data sets

- Remaining differences:
  - overpass time
  - inter-calibration