MODIS VI Product Suite Status

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Outline

- VIs

- C6 reprocessing

- PI SCF Work

  - Daily product Suite

  - MODIS VI APU : Accuracy-Precision-Uncertainty

  - Long term performance

  - MODIS to VIIRS Transition

- Outstanding issues

  - Atmosphere Correction, BRDF, and more

- Conclusions

Revisit VIs

- **Vegetation plays a key role and moderates the biosphere – atmosphere interaction (Water, CO_2, Albedo, etc...). How to measure this?**

- **Vegetation Indices**

  - Not physical parameters but a consistent and successful proxy for a long list of physical/ biophysical parameters (LAI, fPAR, GPP, LC, Biomass, Yield, etc...)

  - They enhance the vegetation signal with no assumptions (fully traceable)

  - They mitigate input data noise (Ratio-ing)

- **NDVI - Long record + historical value (AVHRR)**

- **EVI an improved/enhanced version with a better correlation with biomass/carbon, structure, less prone to below canopy variation**

  - EVI2 proposed as an alternative to EVI that addresses continuity - blue band dependency, snow/ice/ cloud and high aerosol related issues

- **Value of VIs and reasons they continue to be preferred over many other parameters are:**

  - They are quite simple and to a large degree sensor independent
    - From Red& NIR you get a VI (satellites, planes, handheld devices, digital cameras, etc...)

  - Delivers consistent and fairly accurate Phenology, vegetation cover change, climate impact, etc...

  - Challenge of generating other parameters accurately from RS data

- **Very large and diverse science community (from ranchers to modelers)**

  - VI = (N-R) / (N+R) – Everyone can be an expert

  - Vs. Parameter = Complex Look Up Table (f(long of list of Non RS input + Few RS pars.)+ Assumptions)

  - Because of this simplicity it gets scrutinized more than any other parameters

Current product suite (C5)

- **C5 and all previous versions adopted a strategy of incremental changes**
  - Improved QA driven Compositing
    - Eliminates poor quality data first since most methods are blind to poor data
  - Changes were consistent and aimed at converging towards a robust product suite, and learned many lessons
    - We learned that QA is key to compositing & using data
    - We also learned that the MODIS observations are stored in a special structure making them not fully representative of the grid pixel (% Cover that changes from orbit to orbit)
  - Introduced a simpler user friendly approach to QA via the "Pixel reliability", a simple measure of usefulness (no need for bit manipulation)

- **VIs Input related Global Error/Uncertainty of +/-5%**

Starting C6

- **MODAPS**
  - Algorithm(s) code maintenance at MODAPS
  - Implemented a new compositing method
  - No longer QA based compositing
  - Started using a pre-composited 8-day surface reflectance as input (2x 8-Day)
    - Based on minimum blue compositing (minimizes aerosol)
- **PI-SCF effort focused on**
  - Uncertainty/Error Analysis
  - Value added VI data records
  - Product performance, evaluation, and monitoring
  - Transition to VIIRS

C6 TEST EVALUATION

C6 Evaluation (Winter scene, 2003001)

- Results based on [C5-C6]
- Largest observed change (>+/-10%) over tropics and high latitude regions
- NDVI and EVI changed differently due to the lack of QA based compositing
  - Impact of snow/ice/clouds
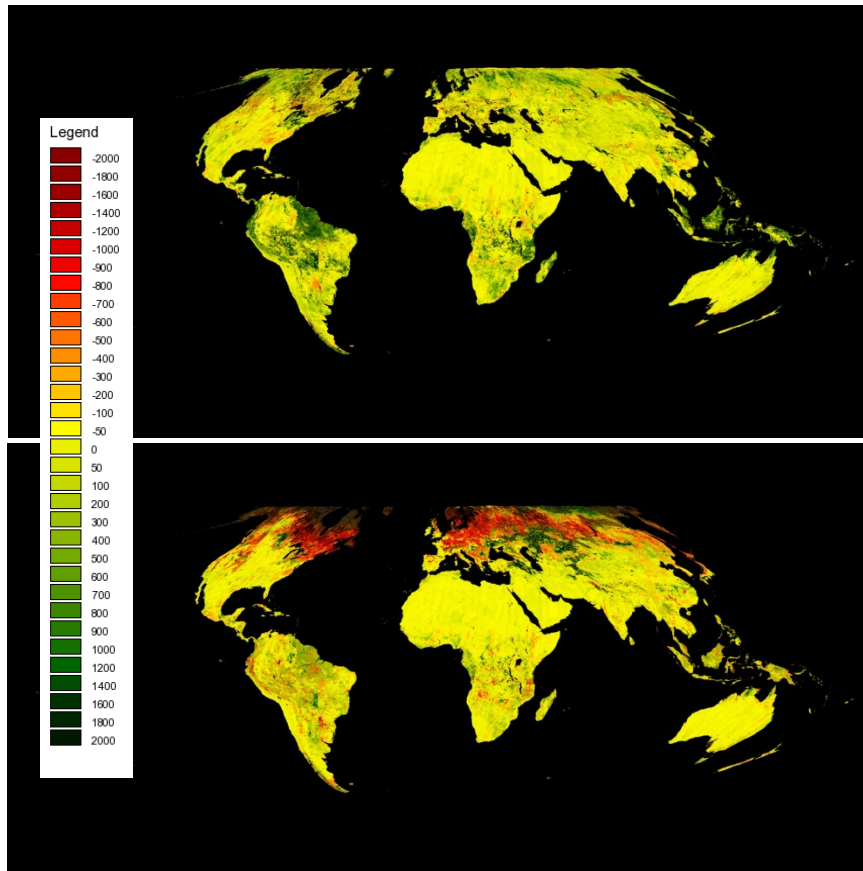
NDVI Diff
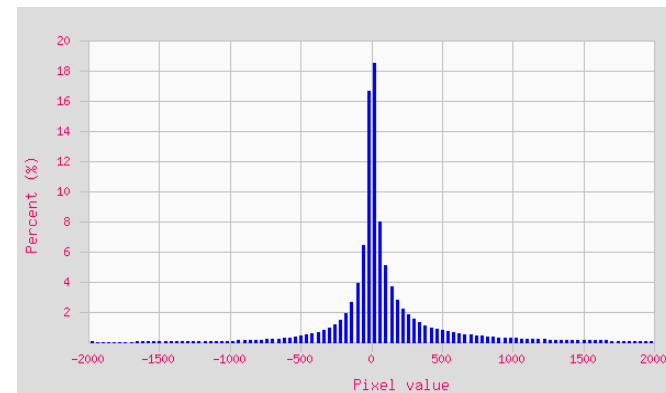
EVI Diff
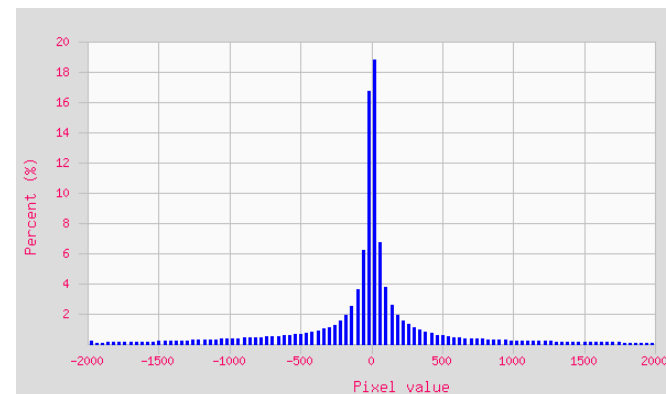
C6 Evaluation (Summer scene, 2003193)

- Largest change over tropics (points to clouds impact)
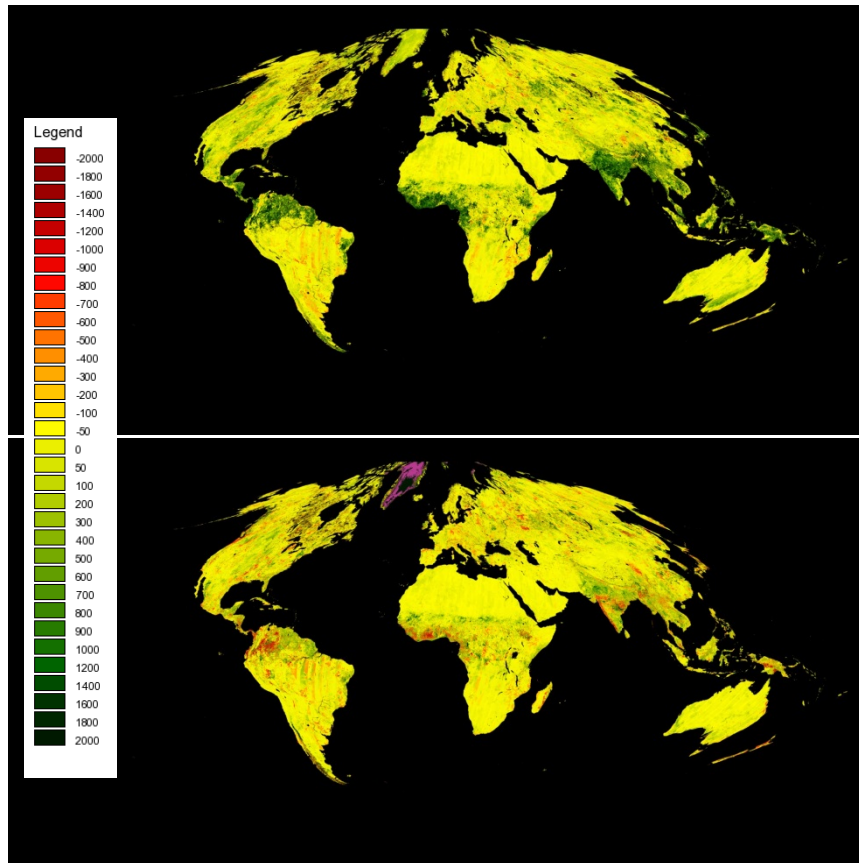
NDVI Diff

EVI Diff
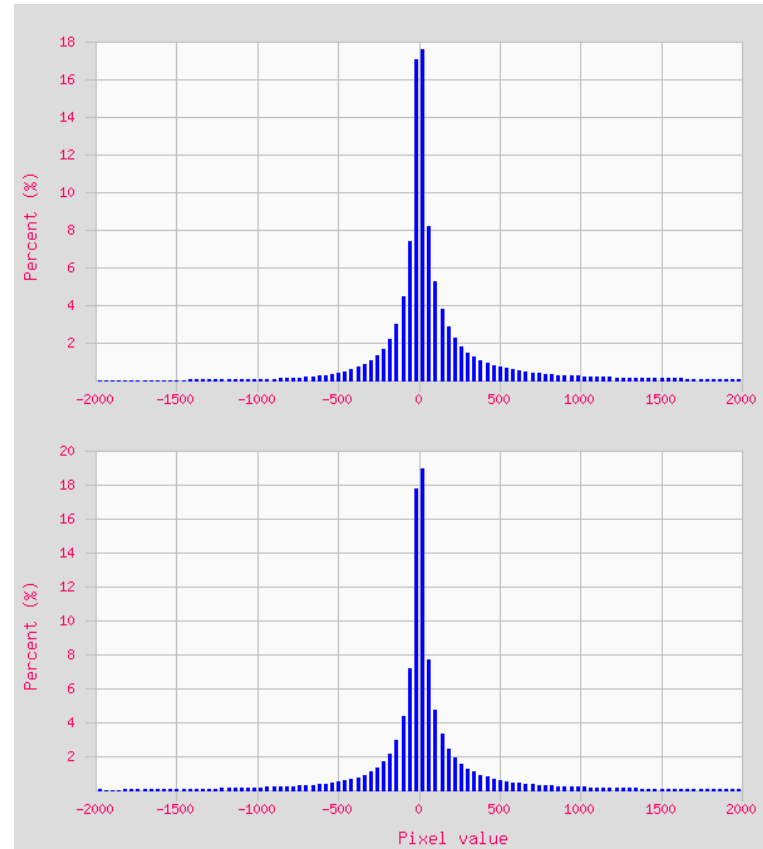
C6 LSR (Summer scene, 2003193)

- Small LSR increase around the tropics

Red   NIR   Blue
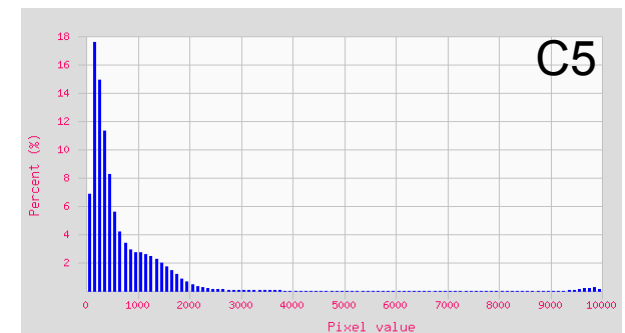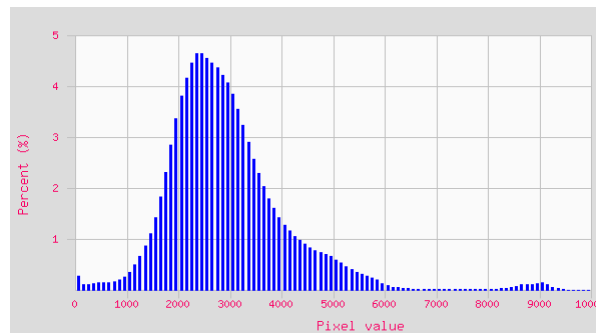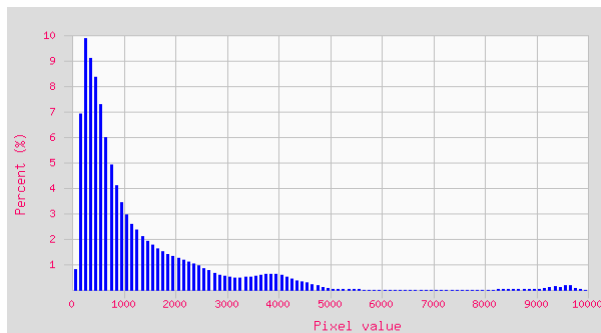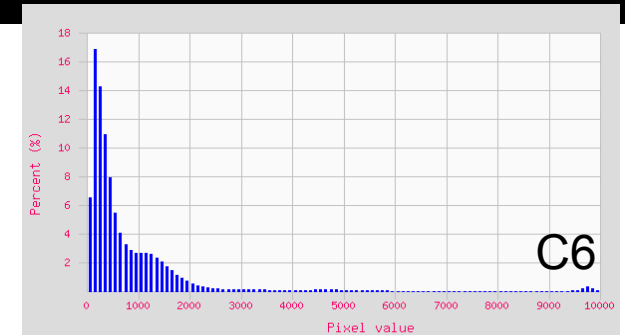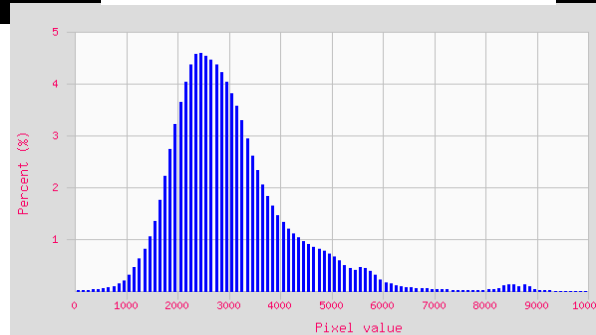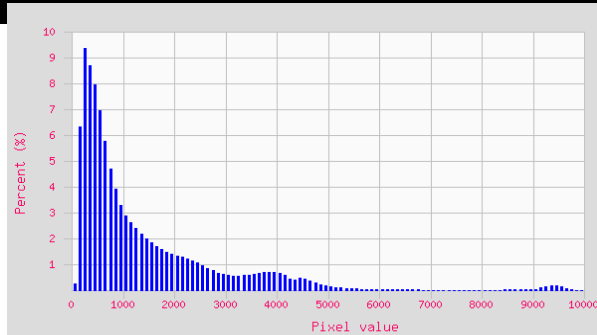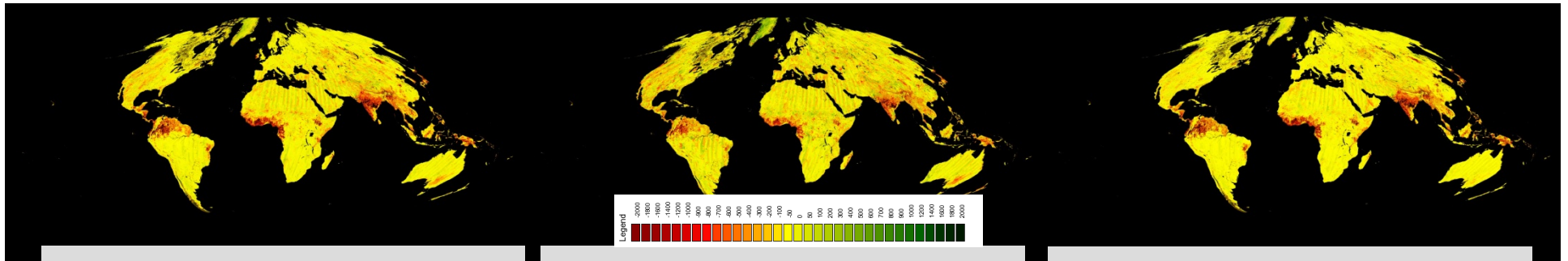
SCF Work focused on

- **High fidelity value added daily product suite**
    - **Aimed at change detection**
- **MODIS VI APU : Accuracy-Precision-Uncertainty**
- **Long term performance**
- **MODIS to VIIRS Transition**

Daily product suite

- **Phenology/Change detection and monitoring community**
- **CMG resolution for now and only high fidelity data retained + gap filling**
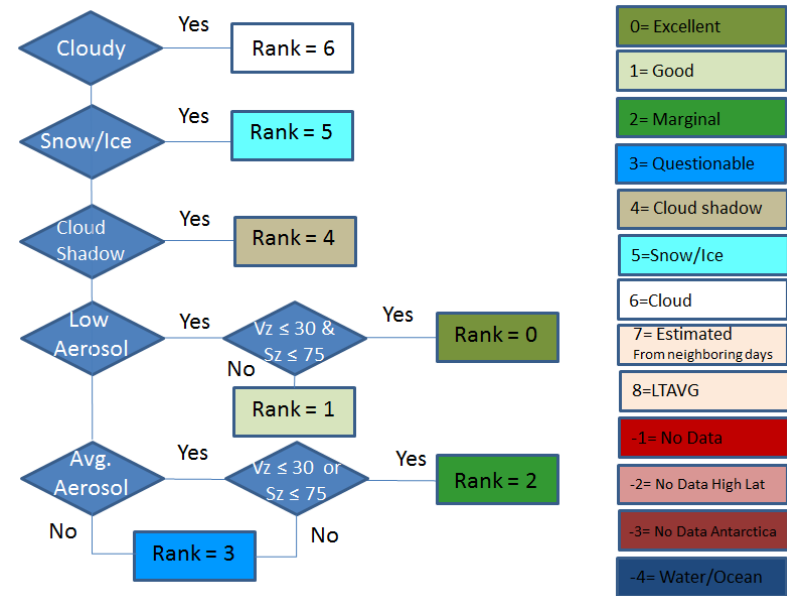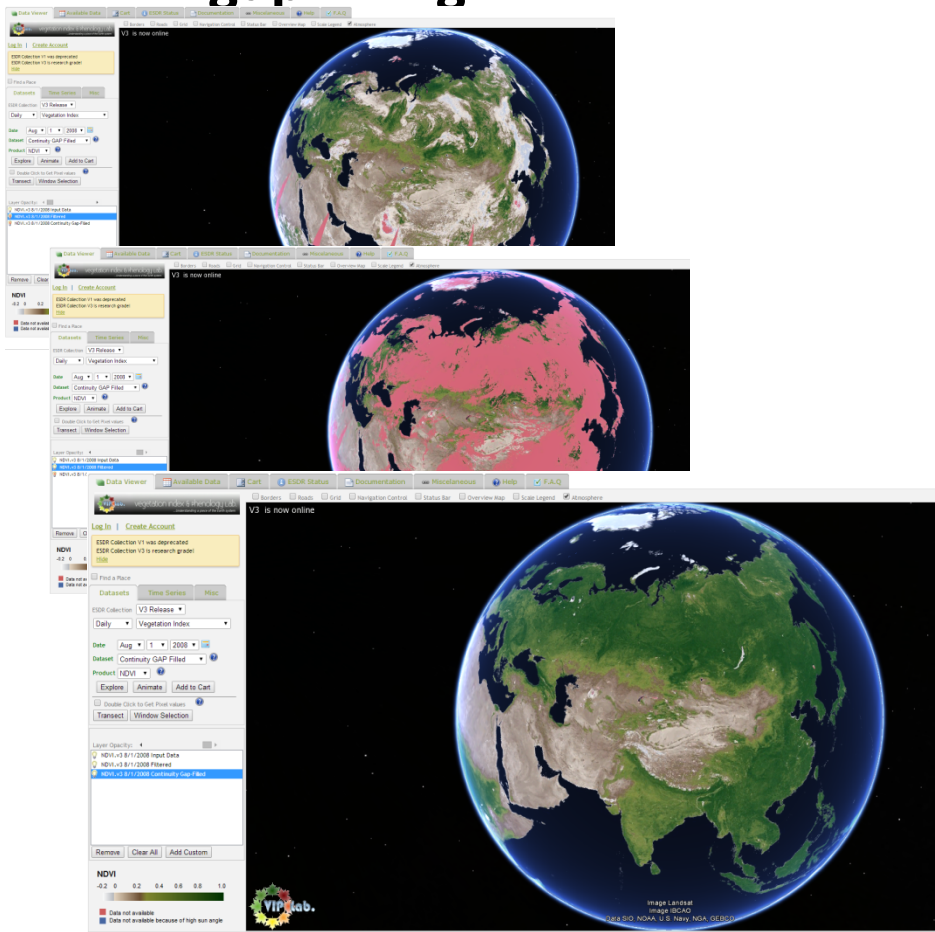
Data filtering scheme

Improved detection/monitoring during periods of fast change (start/end of growing season or disturbance)

Daily

Bi-weekly
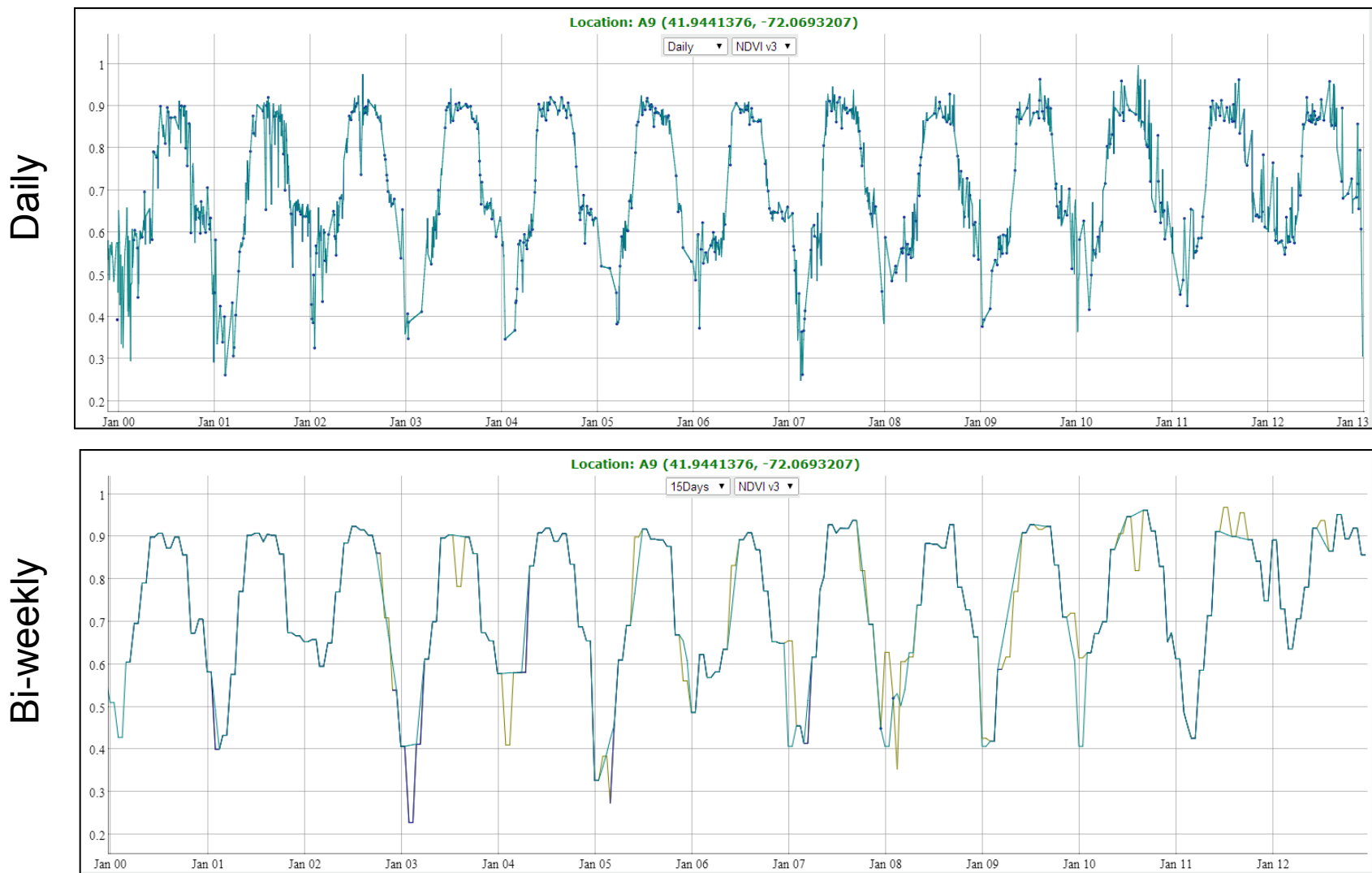
VI Record Accuracy, Precision, Uncertainty

- **Assess**:
  - Uncertainty : defines data envelope
  - Precision : data spread
  - Accuracy is how close to real value

- **Methods**:
  - Point based : Aeronet LSR then VI
    - Global VI Error around ±5%
  - Spatially explicit using transfer function
  - Statistical (per land cover)
    - Calculate Avg., STDEV
    - Uncertainty is a range between Avg. ± STDEV
    - Precision = (STDEV /Avg.)*100
    - Accuracy is the difference between the AVG and a 'true' measurement (ex: stable long term, other sources, validation)
    - Then apply LC-APU back to a global LC map
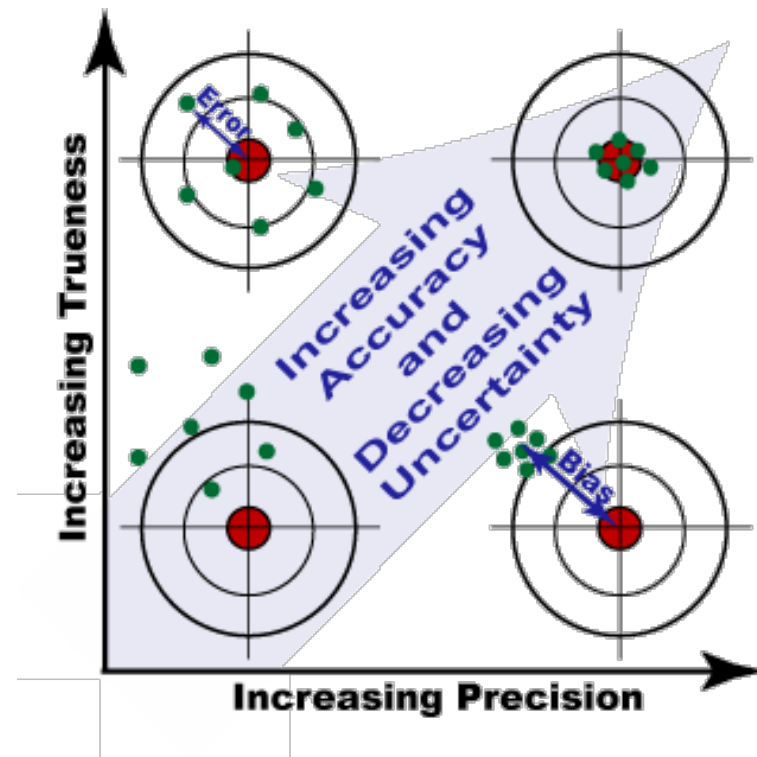
APU: NDVI
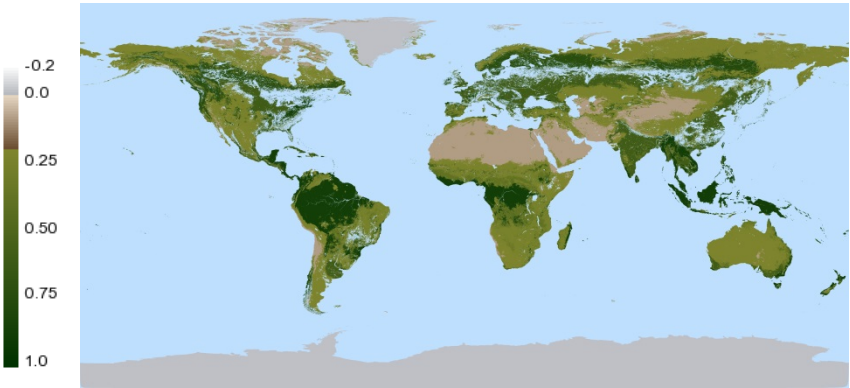
AVERAGE
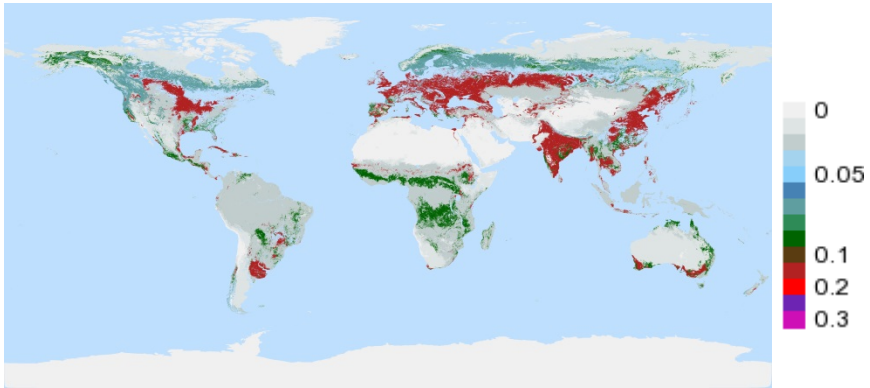
STDEV
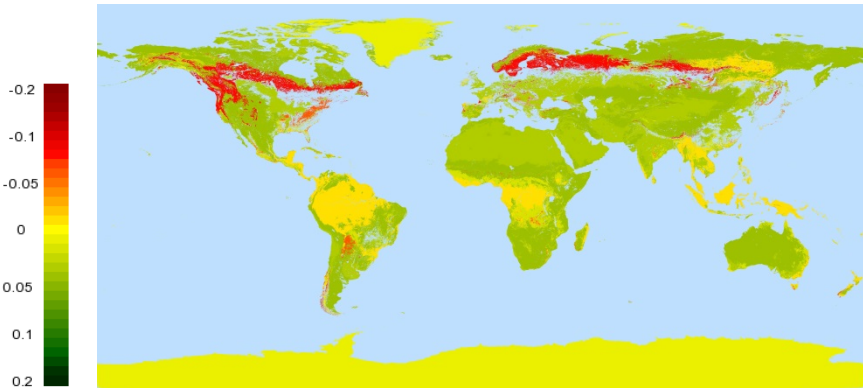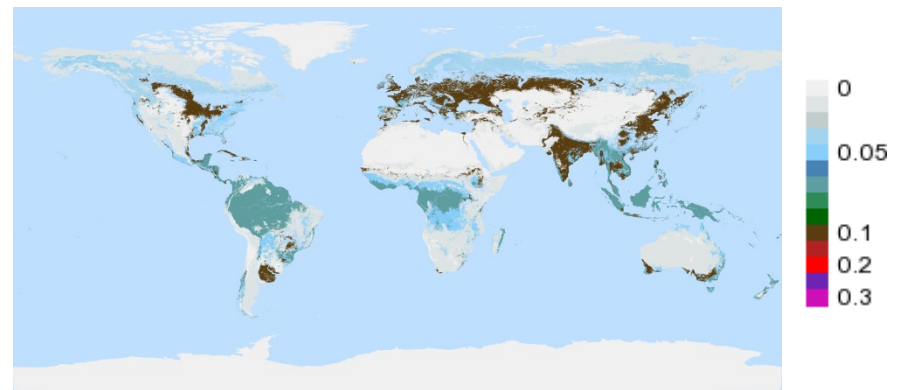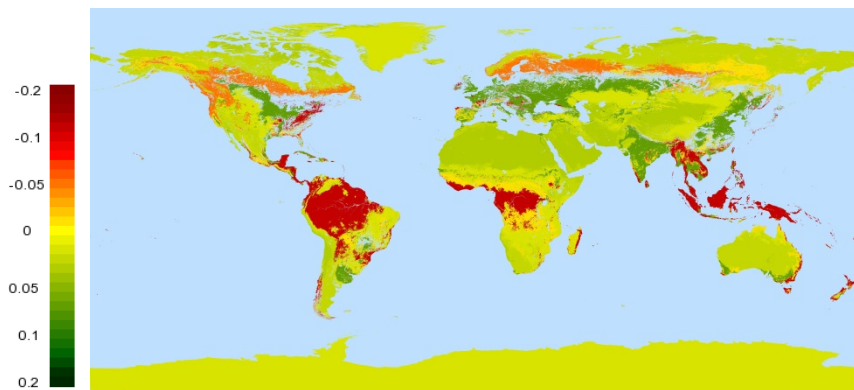
ACCURACY
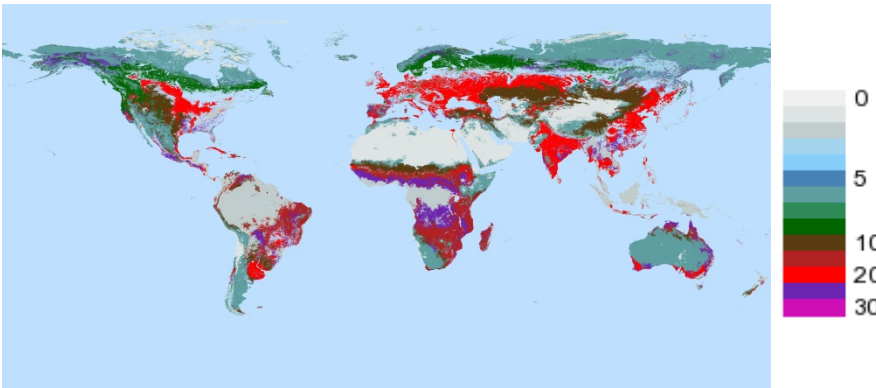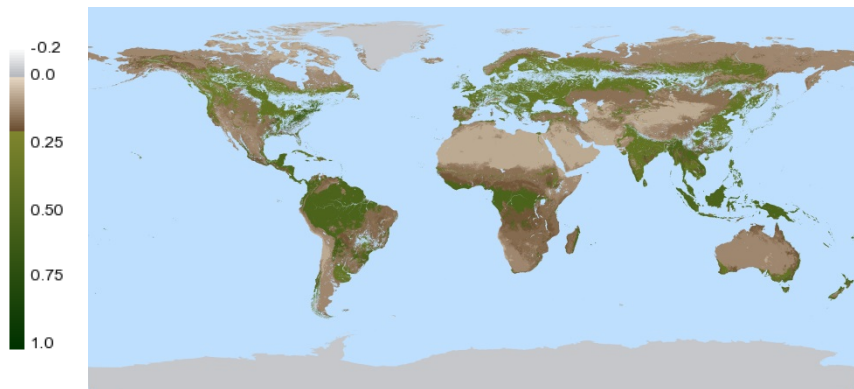
PRECISION

APU: EVI
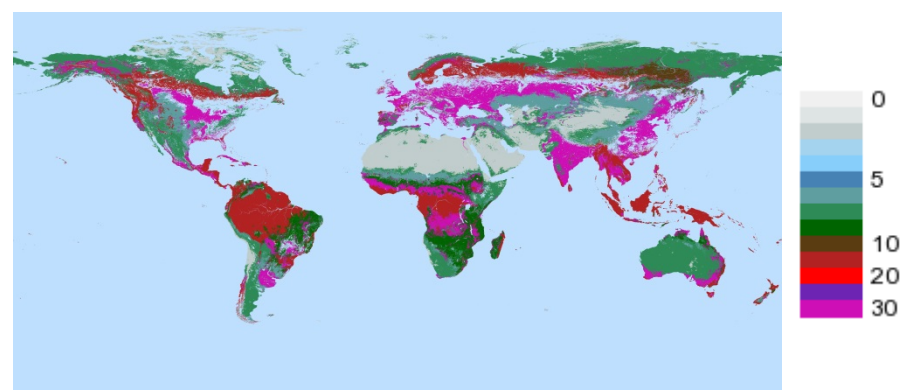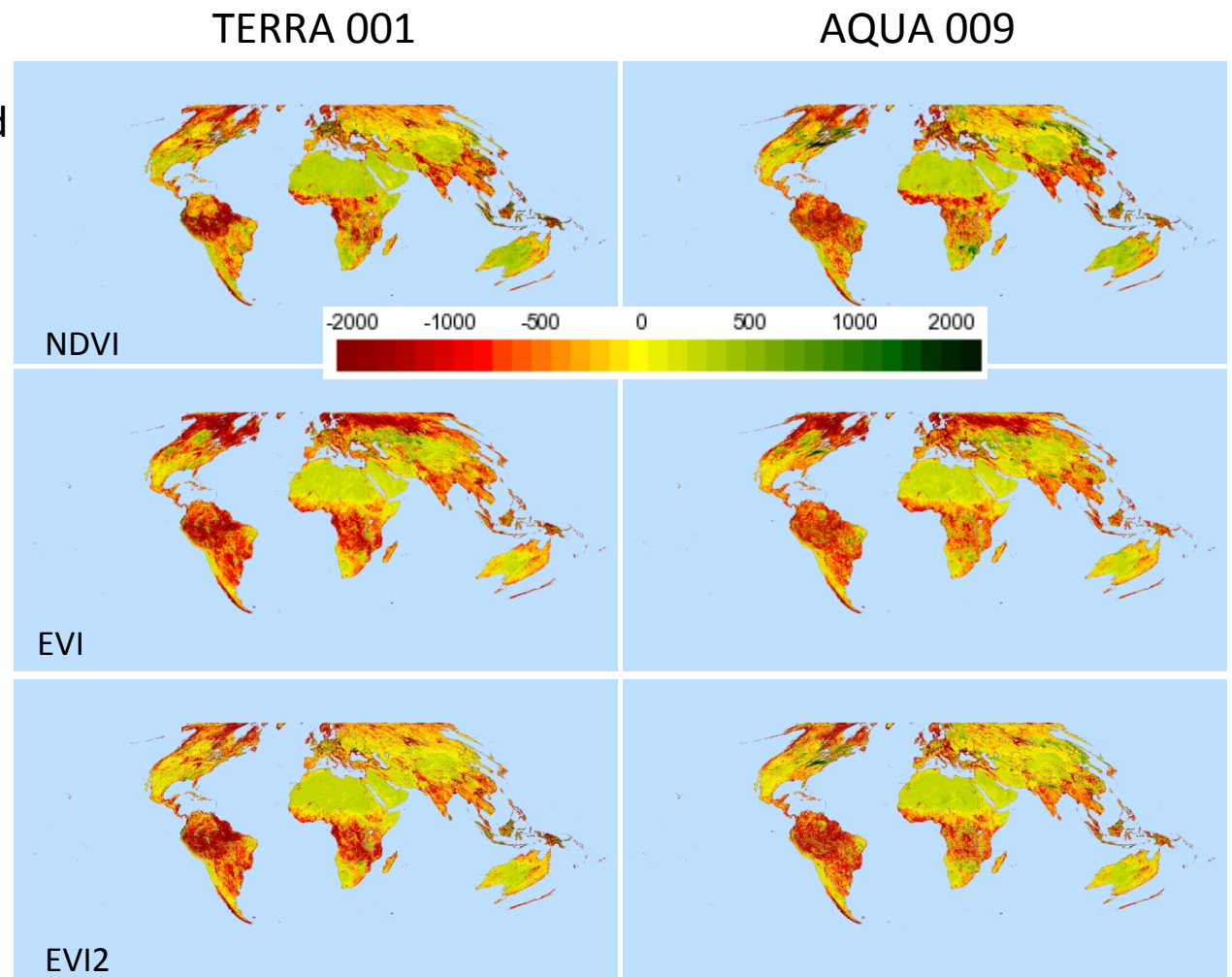

AVERAGE
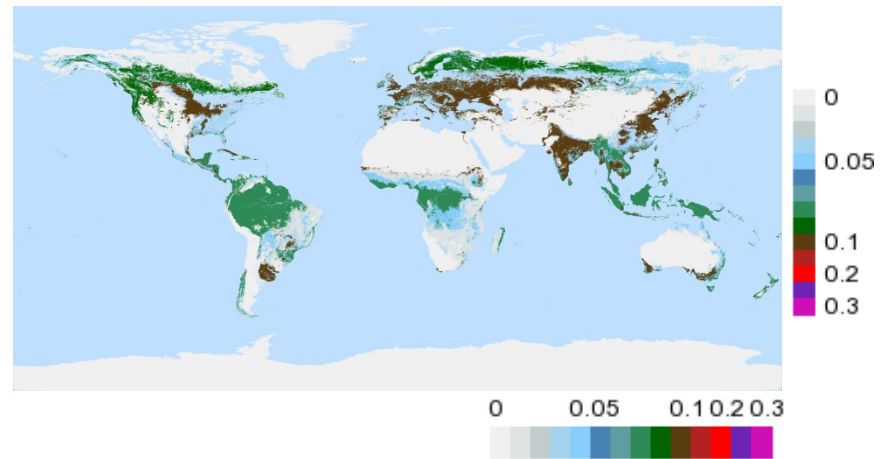
STDEV
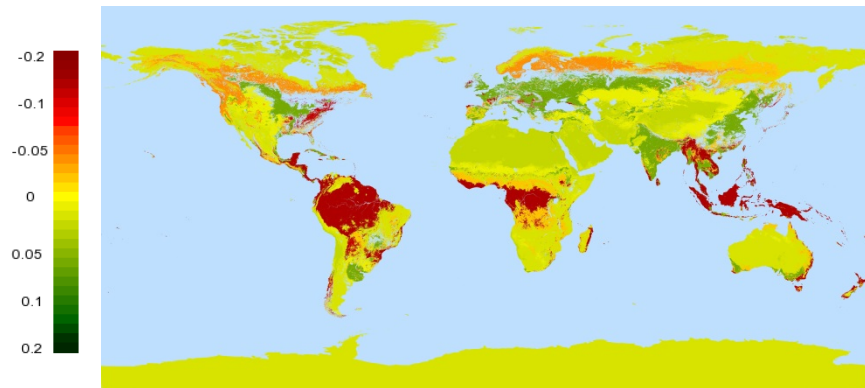
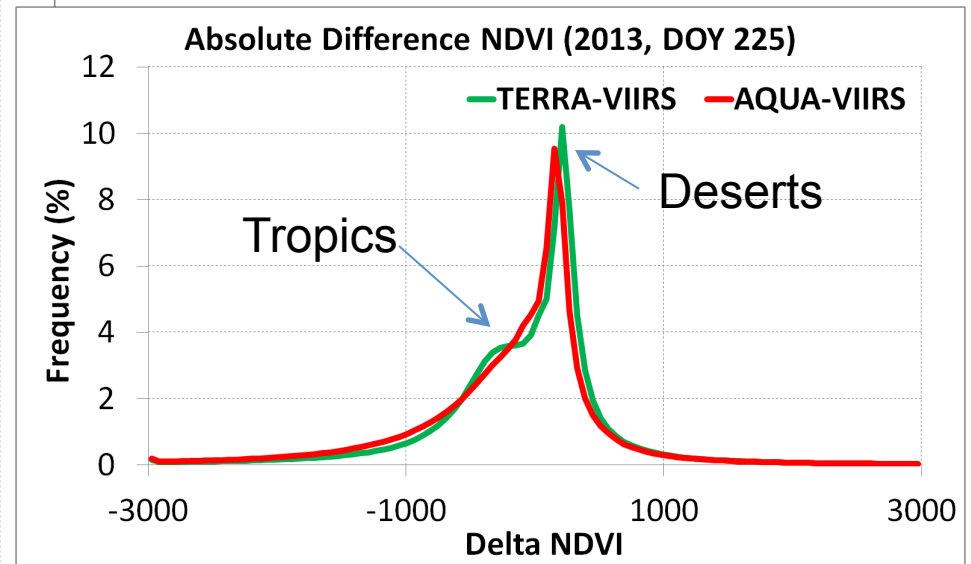ACCURACY
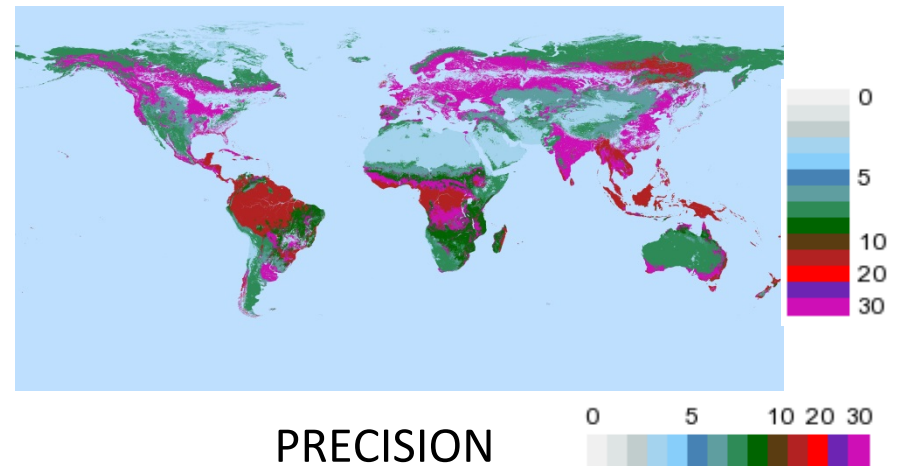
PRECISION

APU: EVI2
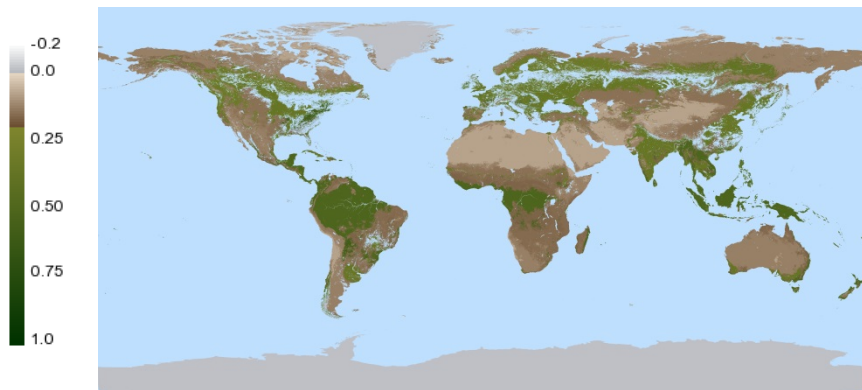
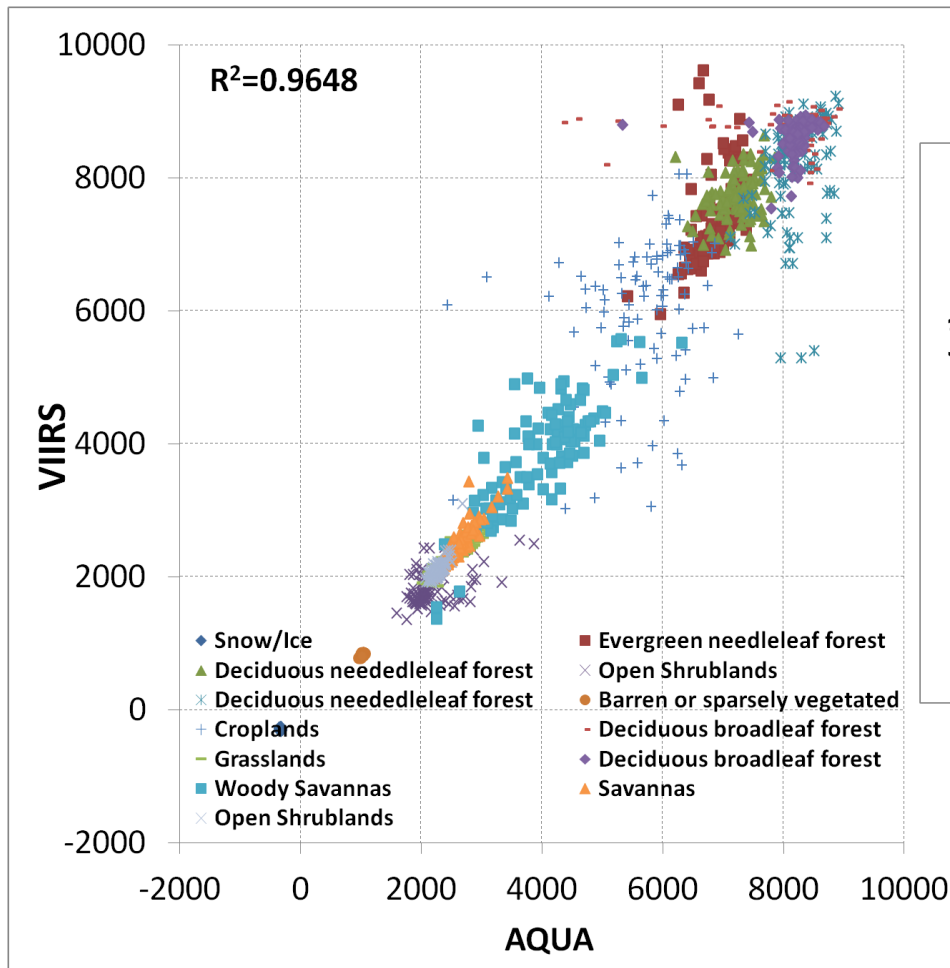AVERAGE

STDEV

ACCURACY

PRECISION (%)

Comparisons with VIIRS

- ## Assess data record continuity with VIIRS
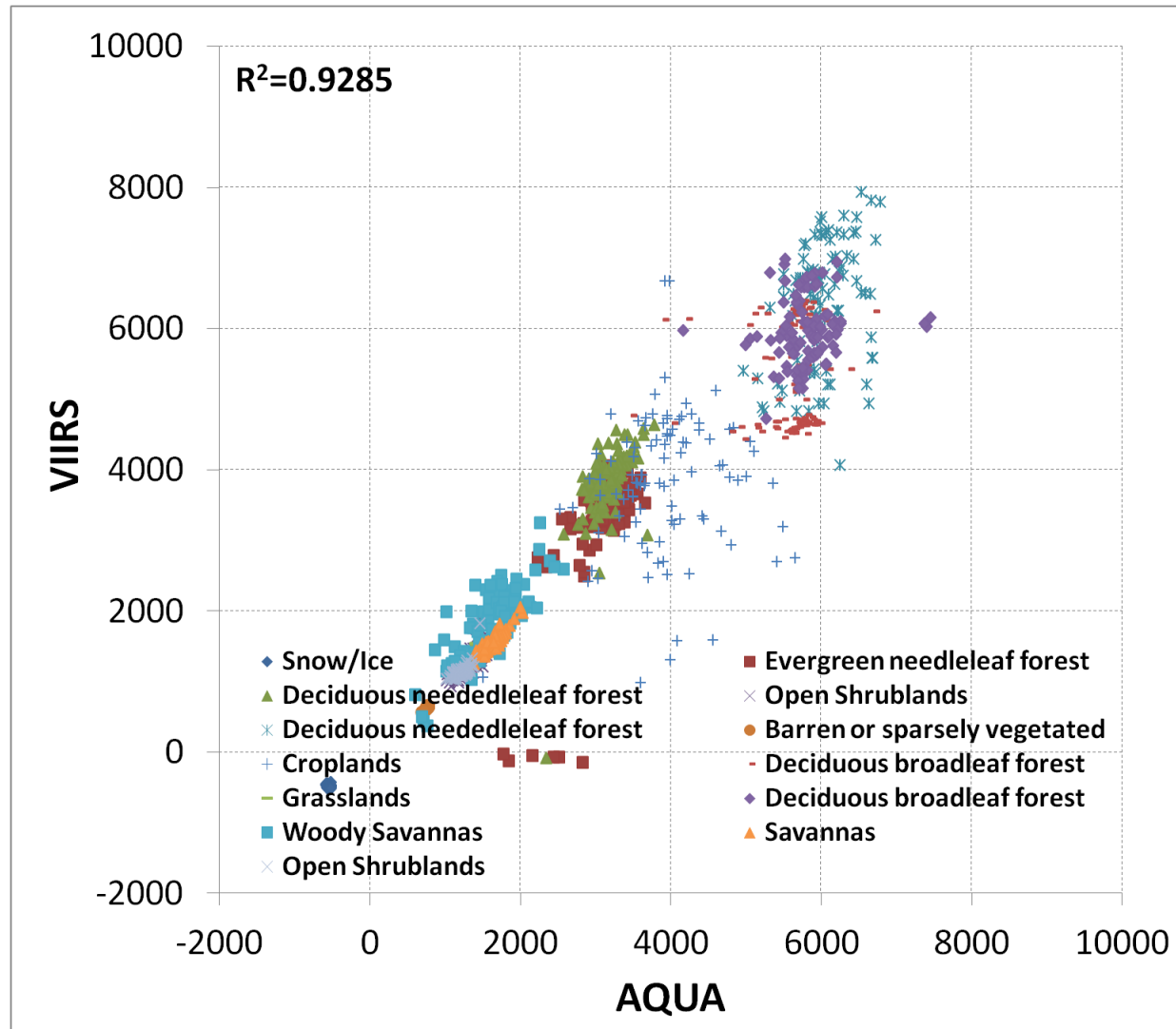
  – MODIS - VIIRS

  – Diff. as high as +/-10%

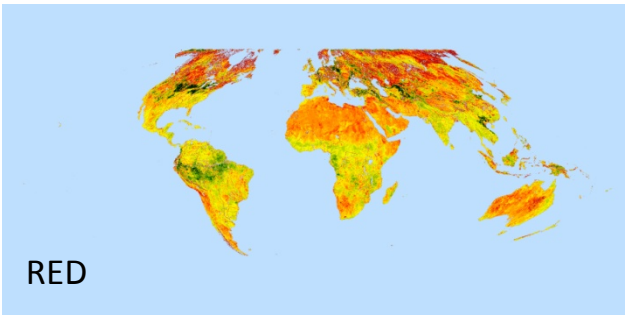 – Role of Snow/Ice/Cloud
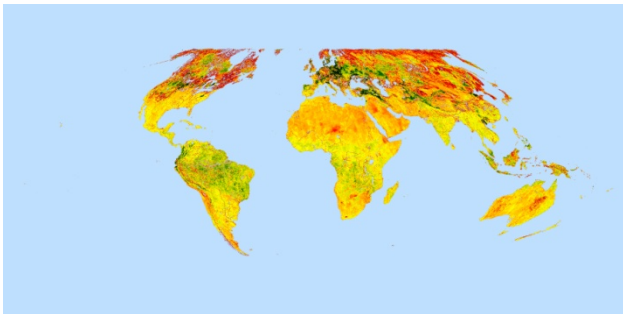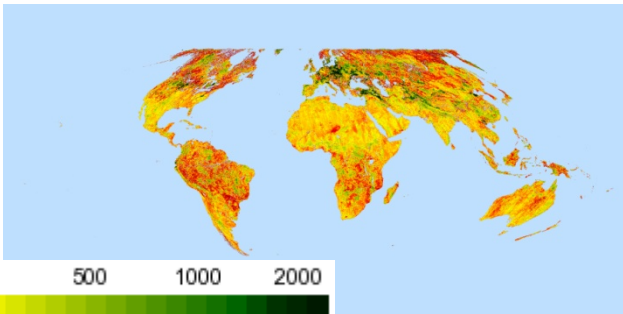
NDVI: AQUA vs VIIRS

EVI: AQUA vs VIIRS

MODIS Science Team Meeting - Columbia, MD. April 29-May 1, 2014

MODIS - VIIRS

VIIRS EVI2 vs VIIRS EVI

$R^2=0.9874$

Legend:
- Snow/Ice
- Evergreen needleleaf forest
- Deciduous neededleleaf forest
- Open Shrublands
- Deciduous neededleleaf forest
- Barren or sparsely vegetated
- Croplands
- Deciduous broadleaf forest
- Grasslands
- Deciduous broadleaf forest
- Woody Savannas
- Savannas
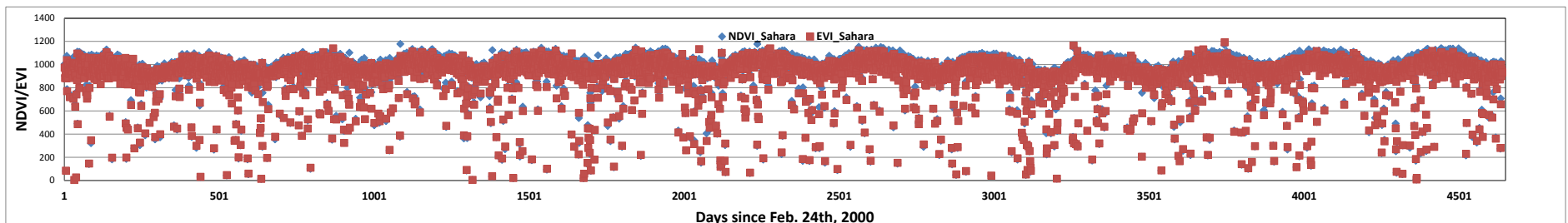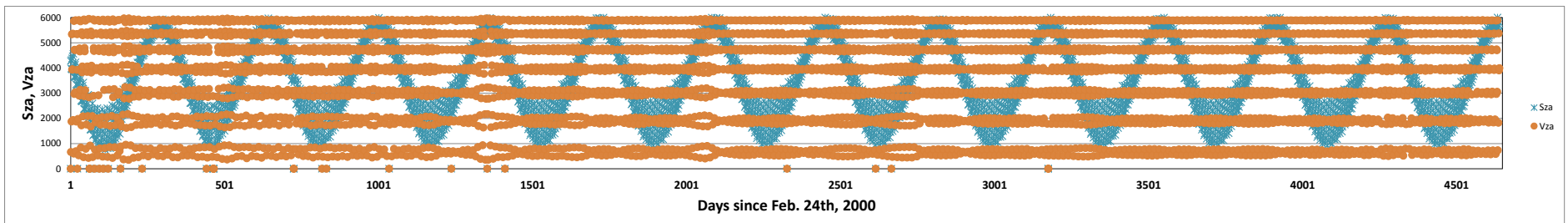- Open Shrublands

Axis labels: VIIRS EVI (y-axis), VIIRS EVI2 (x-axis)
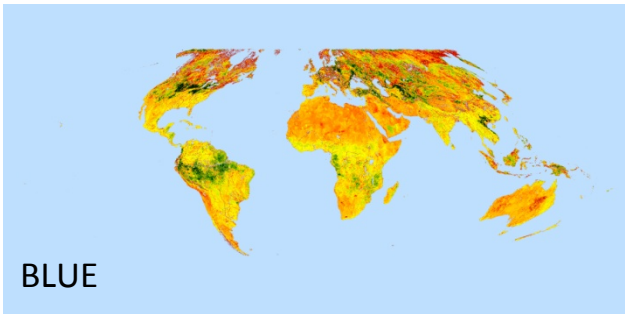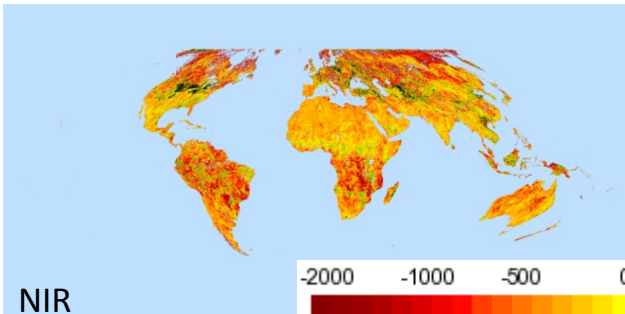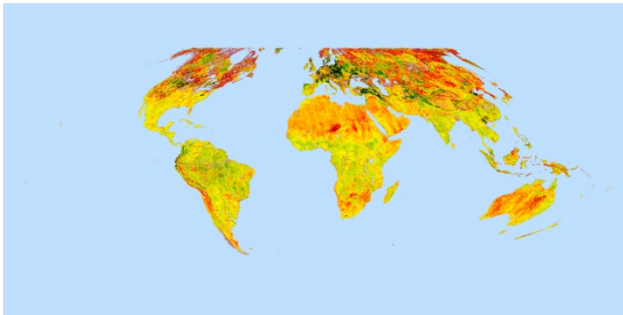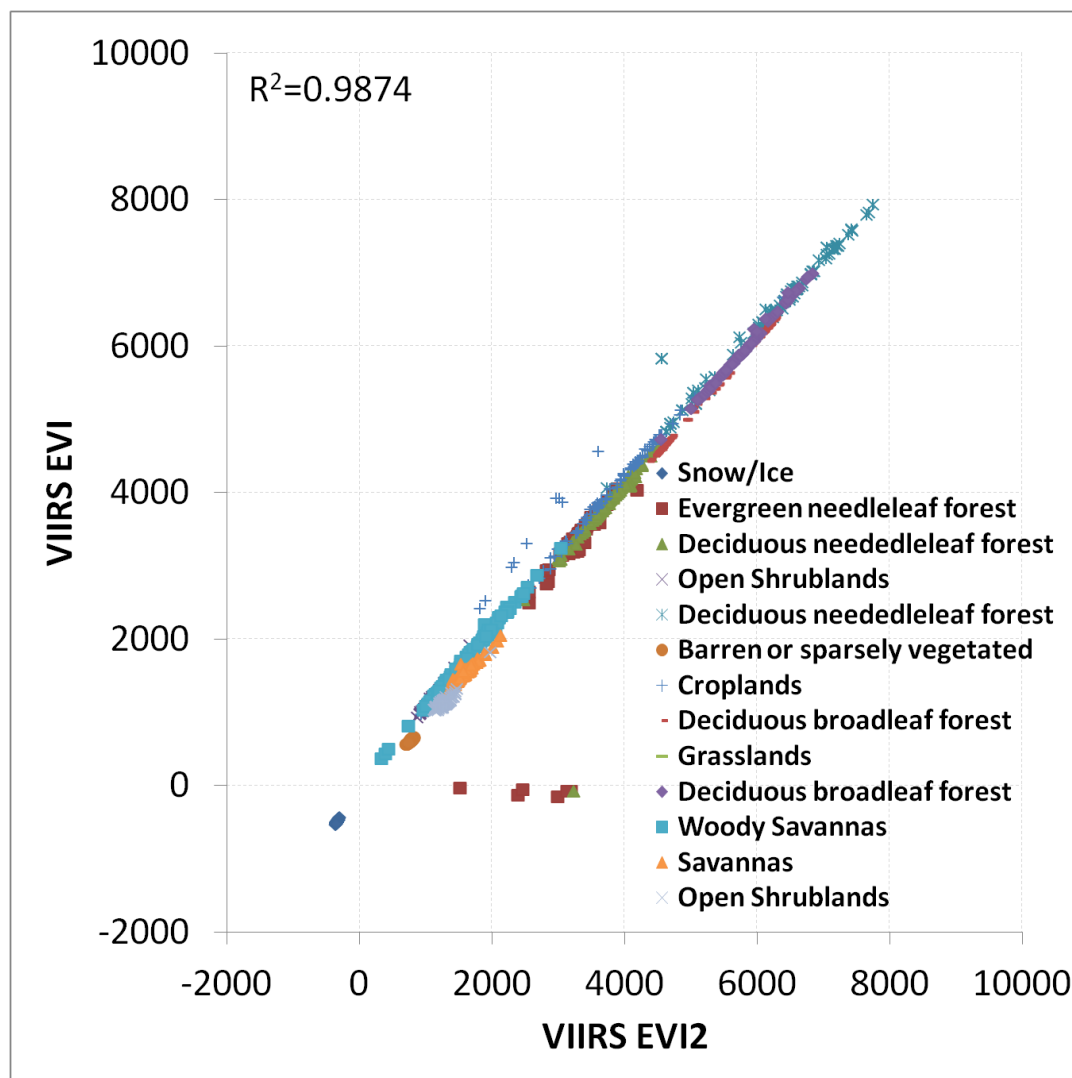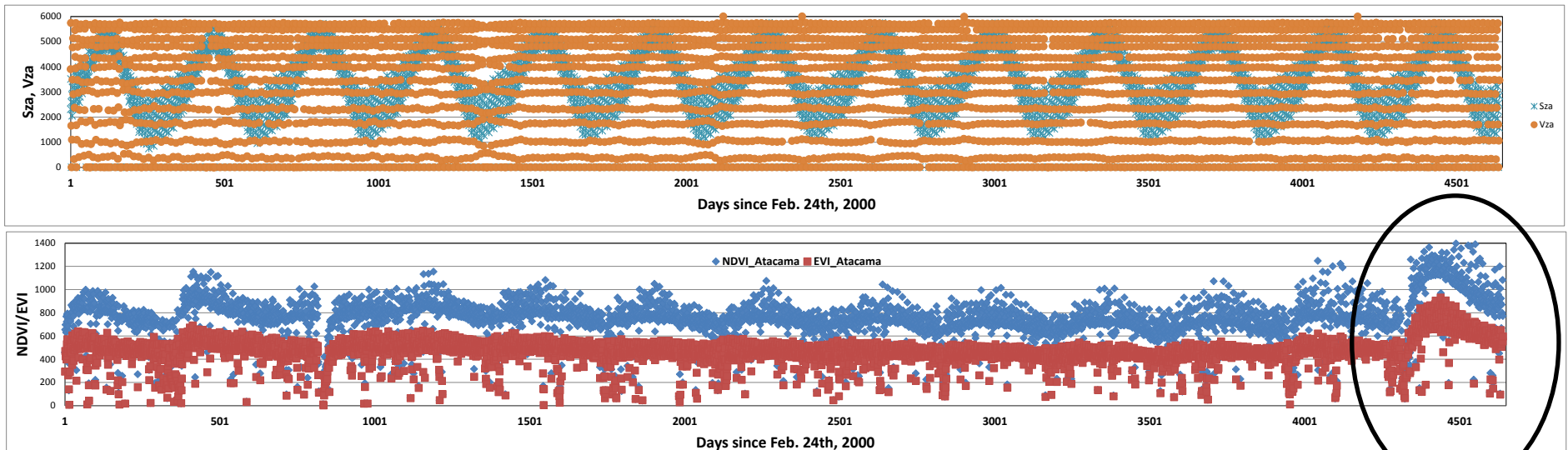
LONG TERM STABILITY MONITORING

Sahara desert Long term stability

- Measure of sensor stability/aging
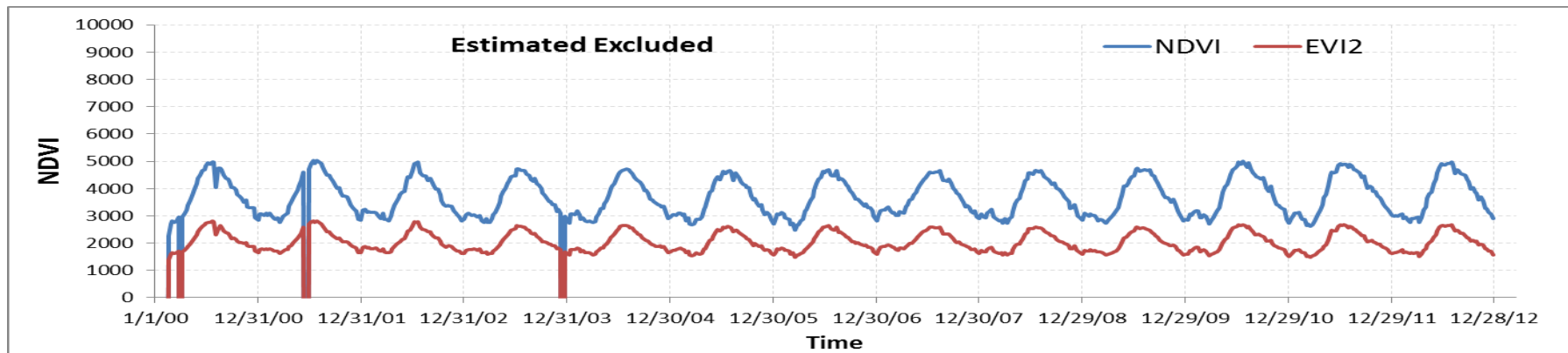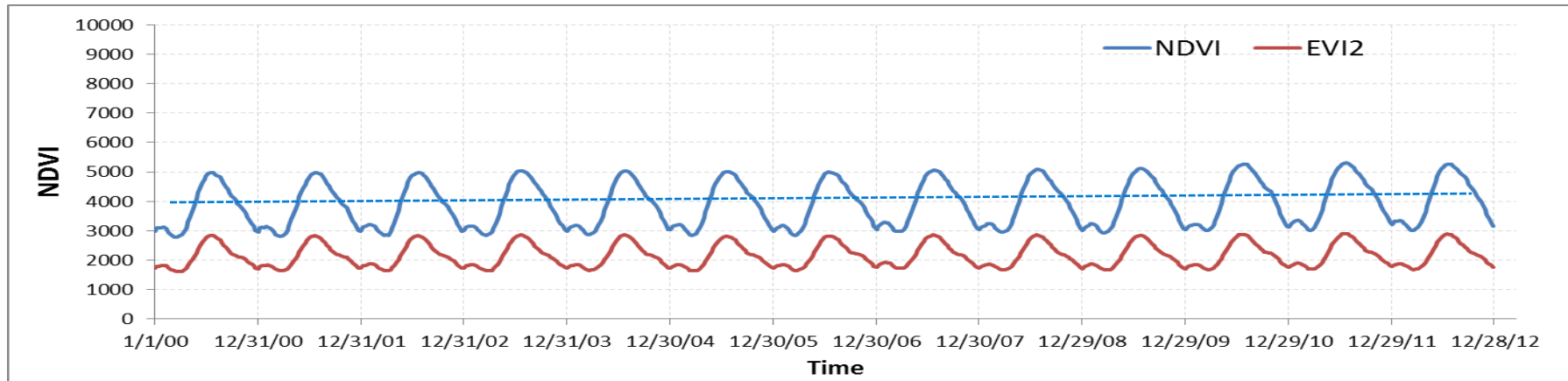 - Stable with a strong sun angle annual trend

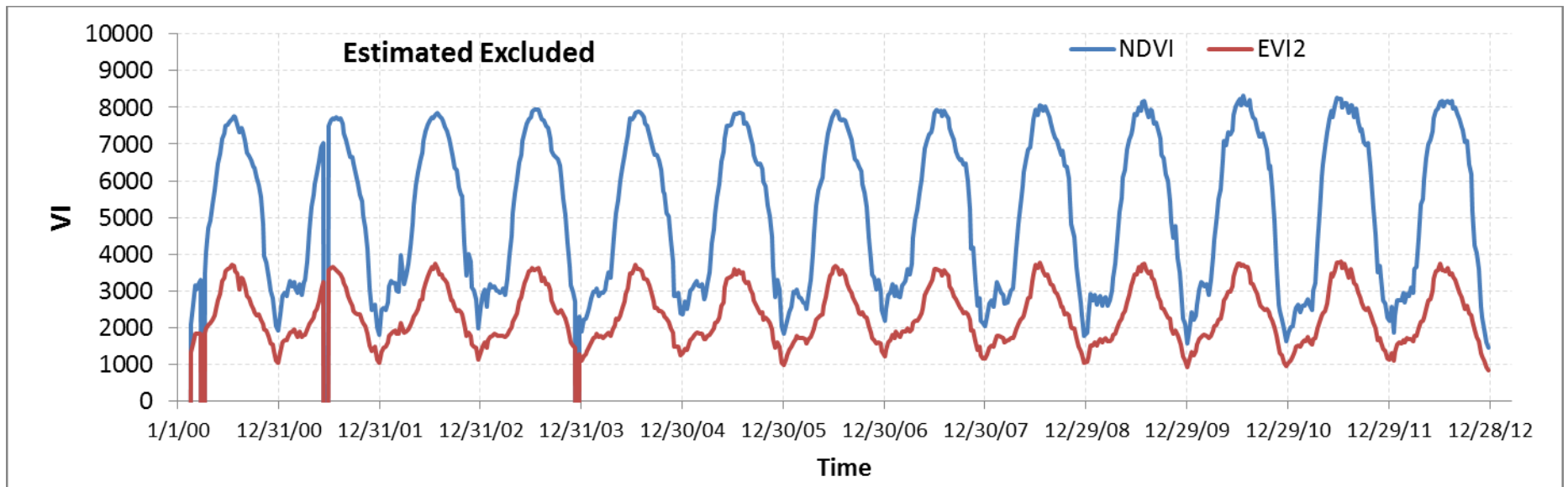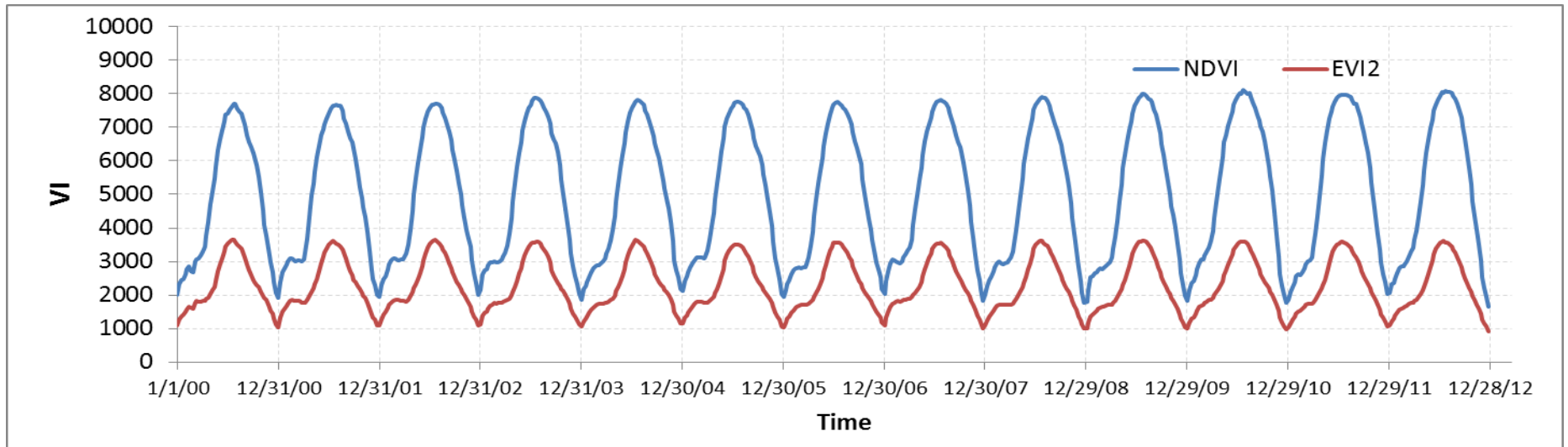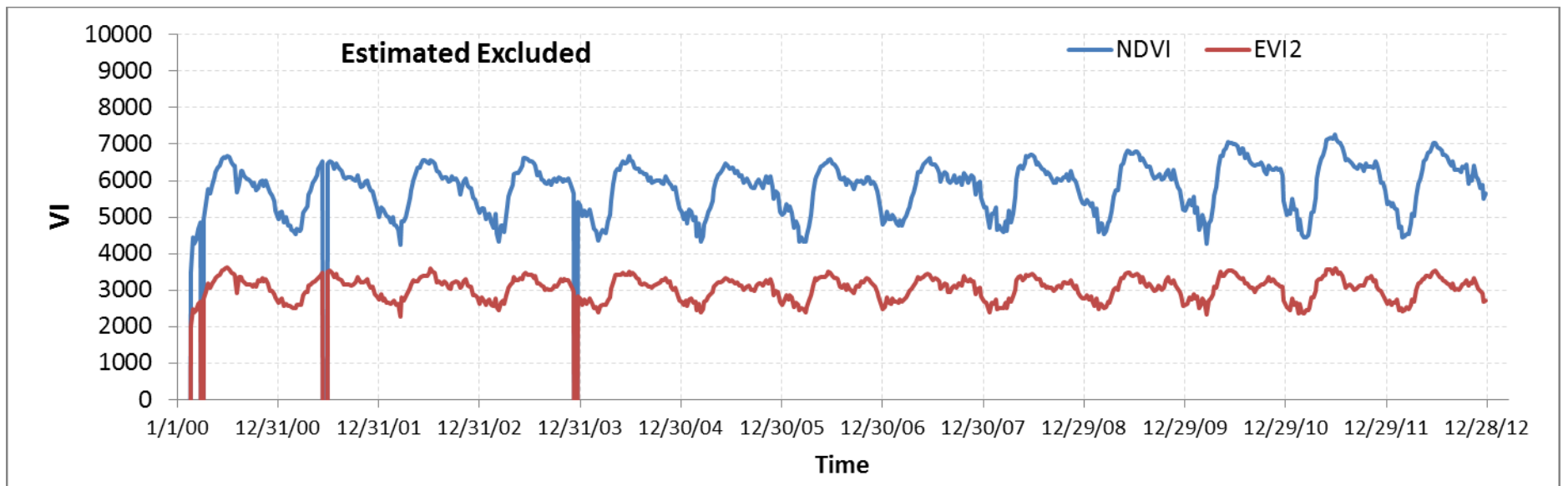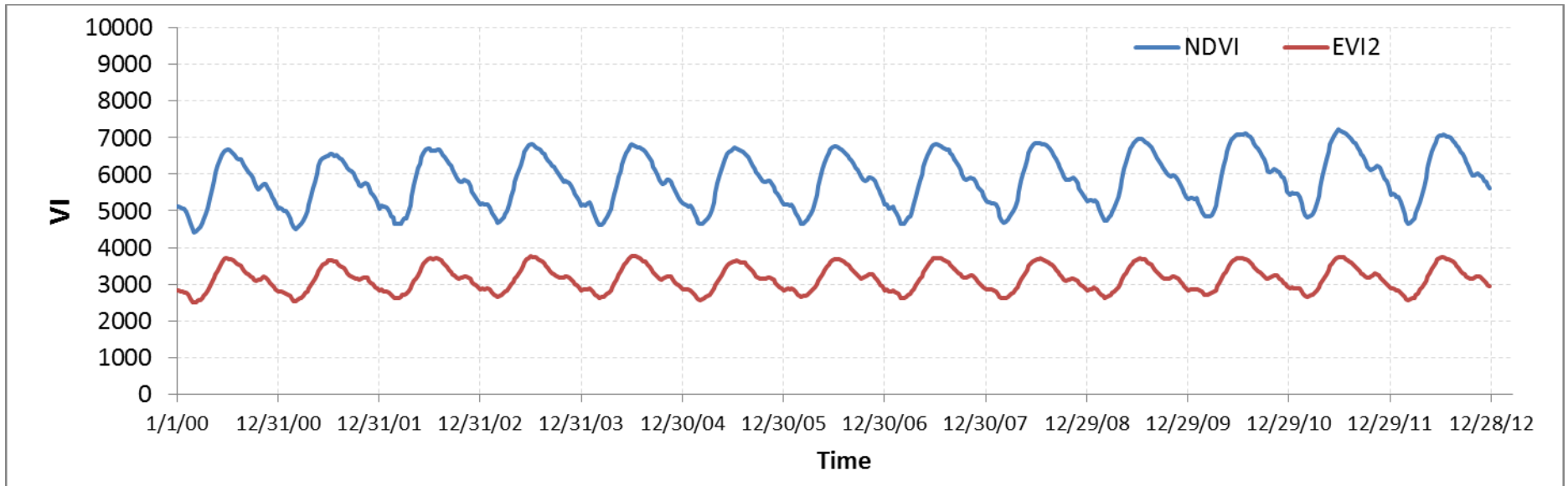# Atacama desert Long term stability

- 2012 increase?

Global Trends

Small increasing trend?

Evergreen needleleaf forest

Evergreen broadleaf forest
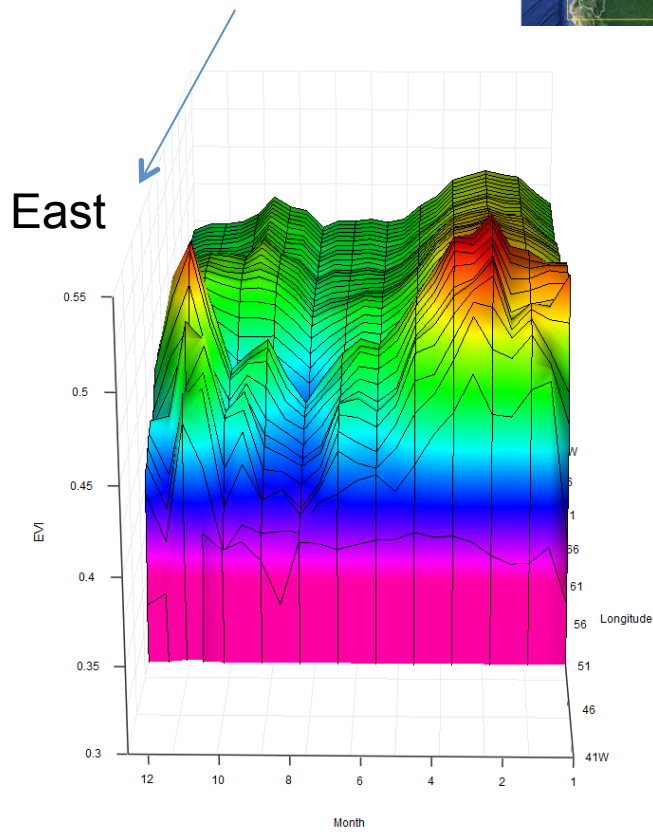
Recent issues

- **BRDF issues**
  - BRDF is a well known and understood issue
    - The problem is that there is no one way/model to address it properly
    - Sun angle is latitude dependent and cannot be globally standardized (nBAR)
  - BRDF has an impact but practically not as high as some suggest
  - We don't want to lose traceability

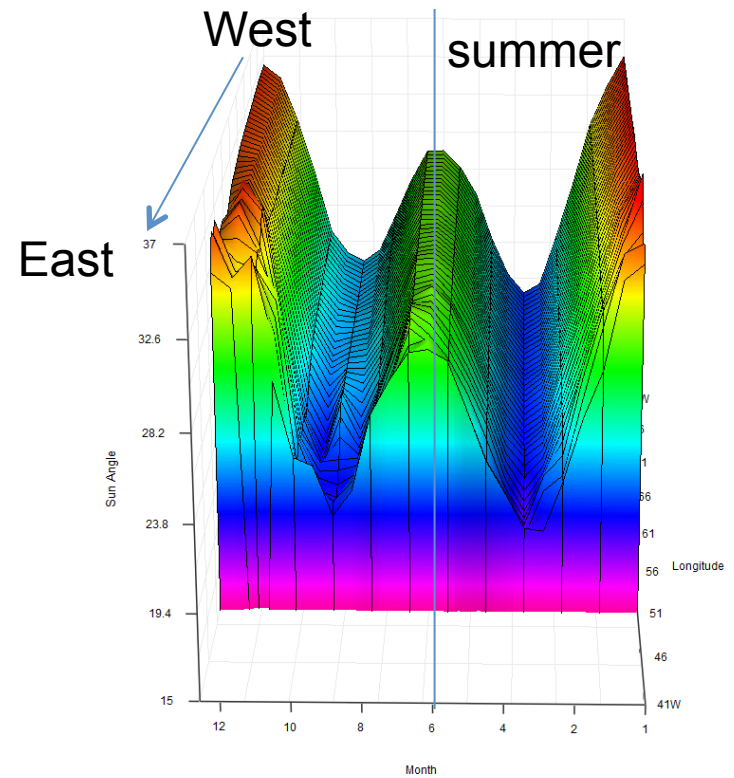- **Aging issue**

EVI vs. Sun Angle

West

East

West

summer

East

Annual EVI

Annual Sun angle

Conclusions

- **C6 will be different than all previous collections**
  - No clear convergence yet
  - Waiting on the full reprocessing

- **Error due to input is well constrained**
  - Max Error +/-5%
  - EVI with a slightly larger error

- **PI SCF**
  - Generating a high frequency (quasi-daily) data record
  - Monitor the product
  - Improve the product characterization
  - Comparisons with VIIRS (very similar – but systematic difference)
  - Readying the VI algorithm for VIIRS VI standard production

- **All is well with minor changes, issues, and anomalies**