Landsat 8 and Sentinel 2 higher order products: input to S2DUP

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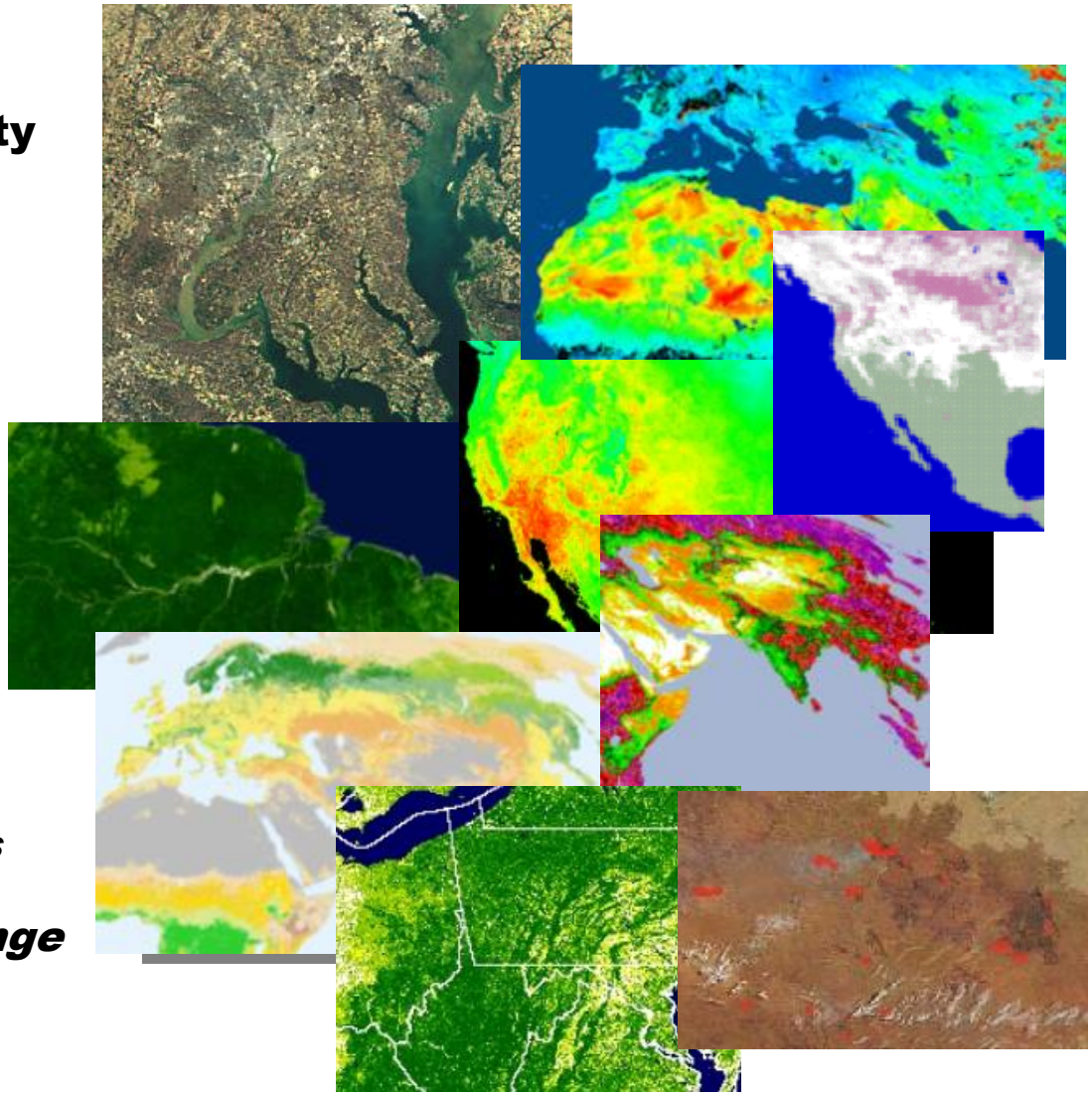
MODIS Land Products

- **Energy Balance Product Suite**
  - Surface Reflectance
  - Land Surface Temperature, Emissivity
  - BRDF/Albedo
  - Snow/Sea-ice Cover
- **Vegetation Parameters Suite**
  - Vegetation Indices
  - LAI/FPAR
  - PSN/NPP
- **Land Cover/Land Use Suite**
  - Land Cover
  - Vegetation Phenology
  - *Vegetation Continuous Fields*
  - *Vegetation Cover Change*
  - Fire
  - Burned Area



Higher Order Science Products from Landsat 7

- Never happened
  - Concerns about competing with the private sector (the value-added community)
  - Whatever concerns and interests concerning moderate resolution data have dissipated
- The concept of global Landsat data – is becoming a reality (increased acquisitions, investment in HPC processing e.g. WELD, NEX)
- As we move to higher spatial resolution optical systems to quantify and characterize land change – can we consider MODIS-like data products at 30m resolution (near daily)
  - Would need greater temporal frequency
  - “Truly exciting”

EU Copernicus (formerly GMES) Global Land Service (2012- present)

- Products
  - Global Component (Vito – Spot Vegn> Proba V)
    - Vegetation: LAI, Green Veg Fraction, Veg Condition, Burnt Area
    - Energy Budget: Albedo, LST, TOC Refl.
    - Water Cycle: Soil water index, Water bodies
  - Pan European Component (20m)
    - Artificial Services, Forest Areas, Ag Areas, Wetlands, Water bodies
  - Local Component
    - Environmental hot spots
  - Update CORINE Land Cover
- Date Access through ESA 'Sentinel on–line'
- Collaborative Ground Segments

International Terrestrial Essential Climate Variables (GCOS)

- River Discharge
- Water Use
- Groundwater
- Lakes
- Snowcover
- Glaciers and Icecaps
- Ice Sheets
- Permafrost
- Albedo
- **Land Cover (10-30m)**
- FAPAR
- LAI
- Above-Ground Biomass
- Soil Carbon
- Fire Disturbance
- Soil Moisture
- Land Surface Temperature

- **These products are still largely oriented to characterizing the Physical Climate System – IPCC Working Group 1.**
- **Some 'impacts' products - glaciers, ice sheets, permafrost**
- **Most/all products point to 250m - 1km products or coarser**
- **Emphasis on validation protocols**

USGS Landsat Science Products Under Development (2013 ST Presentation)

- Top of Atmosphere Reflectance
- ✓ Surface Reflectance
- Surface Temperature
- Burned Area – Provisional Q1 CY14
- Surface Water - Provisional Q1 CY14
- Fractional Snow Covered Area
- Global 30m Land Cover - Provisional Q1 CY14

Landsat Science Team participation in product evaluation will be solicited.

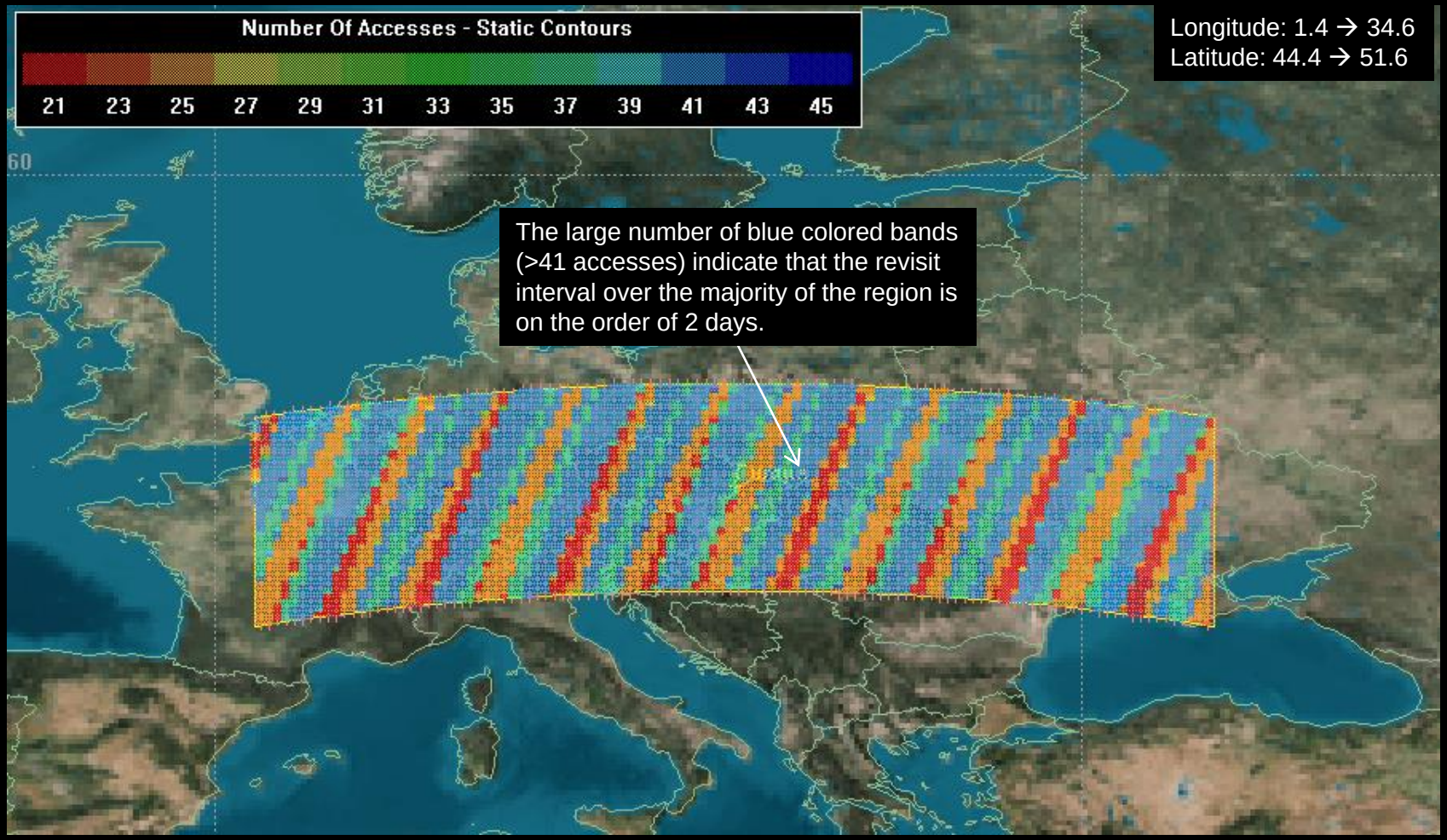
John Dwyer

Higher Temporal Frequency Moderate Resolution Imagery

- We have some experience
  - Landsat 5 and 7, Landsat 7 and 8 (8 day repeat BUT)
- Increased opportunity for cloud free observations
  - L7 SLC Off provided some constraints
- **Science Rationale for increased frequency of observations**
  - Rapidly changing surface phenomenon
- Upcoming Data Opportunities
  - L8 and S2a/b offers an opportunity for more frequent observations – increasing w. S2b
    - S2a June 12, 2015 Launch
  - L8 and other optical sensors w.data access issues e.g.
    - CBERS 4 (China / Brazil) - launched Dec 2014, 4 sensors.
    - Resourcesat 2, 2011(India) – AWIFS, LISS 3/4
  - Sentinel 1a (launched 3 April 2014, data available October 2014) - C Band SAR

NASA, CESBIO, ESA

Sentinel-2A and 2B - LDCM Europe



The picture shows the number of times LDCM and the Sentinel 2 satellites accessed areas on the ground over an 80 day period of time.

- 21 accesses indicates a maximum revisit interval of ~3 days 19 hours
- 46 accesses indicates a minimum revisit interval of ~1 day 18 hours

Masek, GSFC

Sentinel 2 Fully Integrated at IABG's Lab

24.02.15
ESA Photo Released

User requirements for multi-source merged products

- Free and open and EASY ACCESS to high-volume data
  - signs are good BUT the proof of the pudding is in the eating
- Calibrated data
- Ortho-rectified data
- Atmospheric Correction – Surface Reflectance
- NRT data for some time-sensitive science applications
- Validation for derived moderate resolution products
  - Validation of Moderate Resolution Products emerging – stage 2 validation using in-situ observations and high resn data
  - Validation of change products (challenging)
  - Will require fine resolution data (challenging) - GSFC TECLUB Decadal Survey whitepaper suggestion

Suggestions for Derived Multi-source Products for Land

- A generic, un-interpreted change product.
- Forest Cover Change products
- Vegetation Phenology
- LAI/FAPAR
- Fire Products
  - active fire (SWIR)
  - burned area product
- Agricultural Products
  - cropland extent,
  - crop type and area,
  - crop condition, crop rotation, crop yield,
  - field size,
  - irrigated extent and state product
- Flooding extent
- Urban characterization and built-area change.

What is needed to move forward?

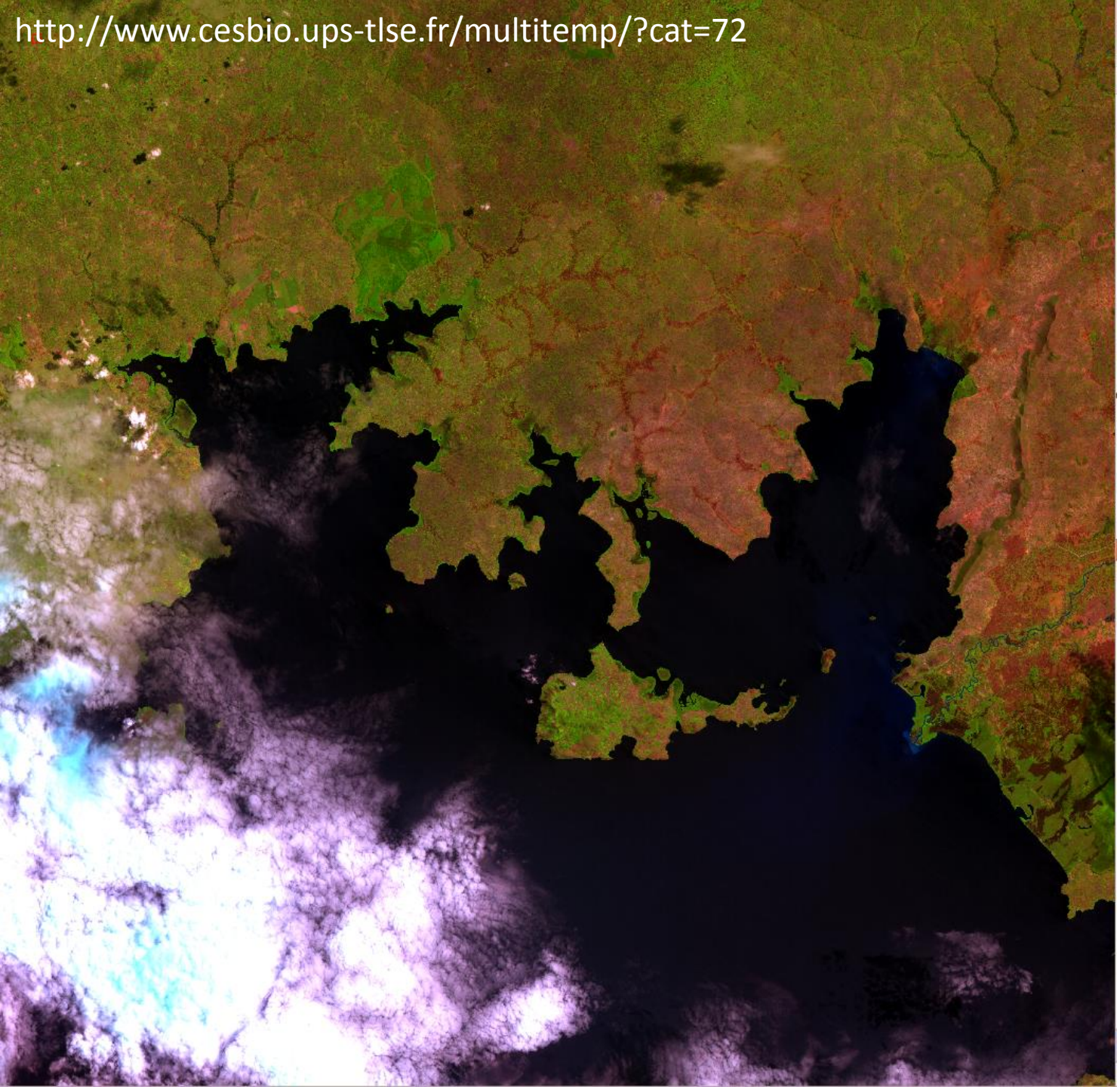
- Develop a merged data stream – common processing (moving towards standard processing ?)
- Initial Prototyping Activities
  - Surface Reflectance
  - Some preliminary derived products which demonstrate the science utility of more frequent observations and make the case for expanded investment (more proposals to be funded)
- Demonstrate feasibility and desirability

Differences to be aware of when merging data

- Not a lot of ‘best practices’ for data inter-use /merging / data fusion
- Differences in pixel size / locational accuracy
- Differences in swath-width (BRDF effects)
- Differences in local solar time (e.g. 10am/11am)
- Differences in spectral bands - center and width
- Cloud and shadow detection e.g. no Thermal Bands on S2

S2 Prototyping Activities

- **Spot 4 (Take 5) V2.0 (Olivier Hagolle et al.)**
  - 20m time-series
  - Lowering the Spot 4 Orbit by 3km to obtain 5 day repeat orbital cycle
  - Observation of Selected Study Sites
  - Improved ortho-rectification (Landsat 8 ortho)
  - Updated Radiometric calibration (MERIS/Envisat reference)
  - Level 2A reprocessed w. new aerosol model
  - Example french applications: estuarine turbidity, fodder yield estimation, alpine snowpack evolution, crop type mapping and irrigation requirements
    - http://www.cesbio.ups-tlse.fr/multitemp/?cat=6
- **VENµS**
  - 2 day repeat
  - 75 proposals received Feb 2015
- **Spot 5 Take 5** (First Image acquired 8th April 2015) – 2.5Km orbit lower
  - 149 Sites to be monitored with 5 day repeat
- **ESA Sentinel 2 Agri** (Defourny UCL, CESBIO, CS-SI Toulouse and Romania)
  - Initiated Jan 2014, 13 Sites Spot4 (Take 5) including JECAM Sites
  - Surface Reflectance L 3A, Crop Mask, Crop Type, Vegetation Indices
- **8th International Workshop on Multi-temporal Remote Sensing** (Multitemp 2015) – July 22-24 Annecy, France
  - Opportunity to see results



First Image
Spot 5 Take 5

8 April 2015

Ouganda,
E. Lake Victoria