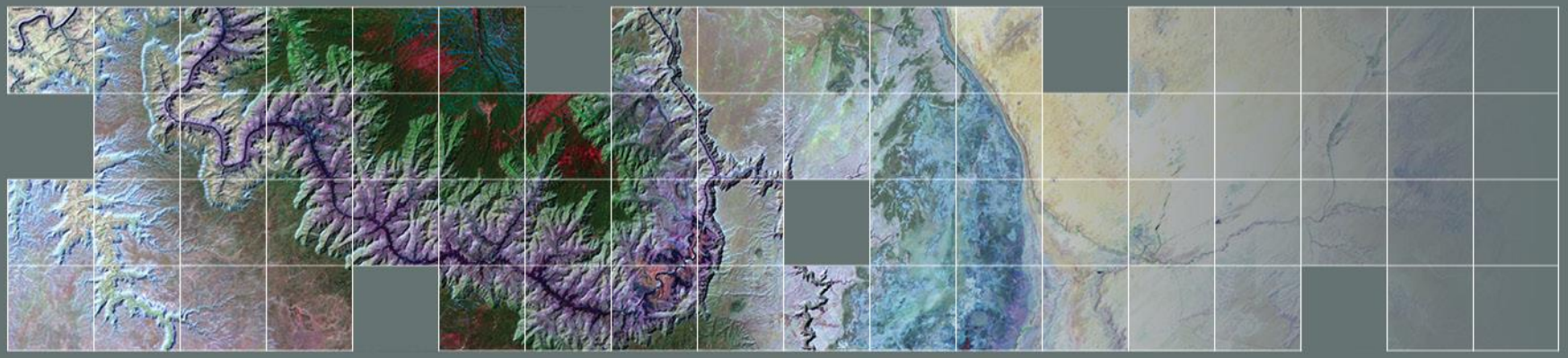
USGS
science for a changing world

Climate and Land Use Change
Earth Resources Observation and Science (EROS) Center

USGS Surface Reflectance Status



John Dwyer
January 12, 2016
Landsat Science Team

U.S. Department of the Interior
U.S. Geological Survey

Surface Reflectance Availability

- **Landsat TM and ETM+**
  - LEDAPS heritage
  - Released October 2012
- **Landsat OLI/TIRS**
  - New code (L8SR), based on MODIS/MISR/VIIRS and using MODIS aerosol & water vapor CMGs
  - Released December 2014
- **Accessible through EarthExplorer and EROS Science Processing Architecture (ESPA)**

USGS

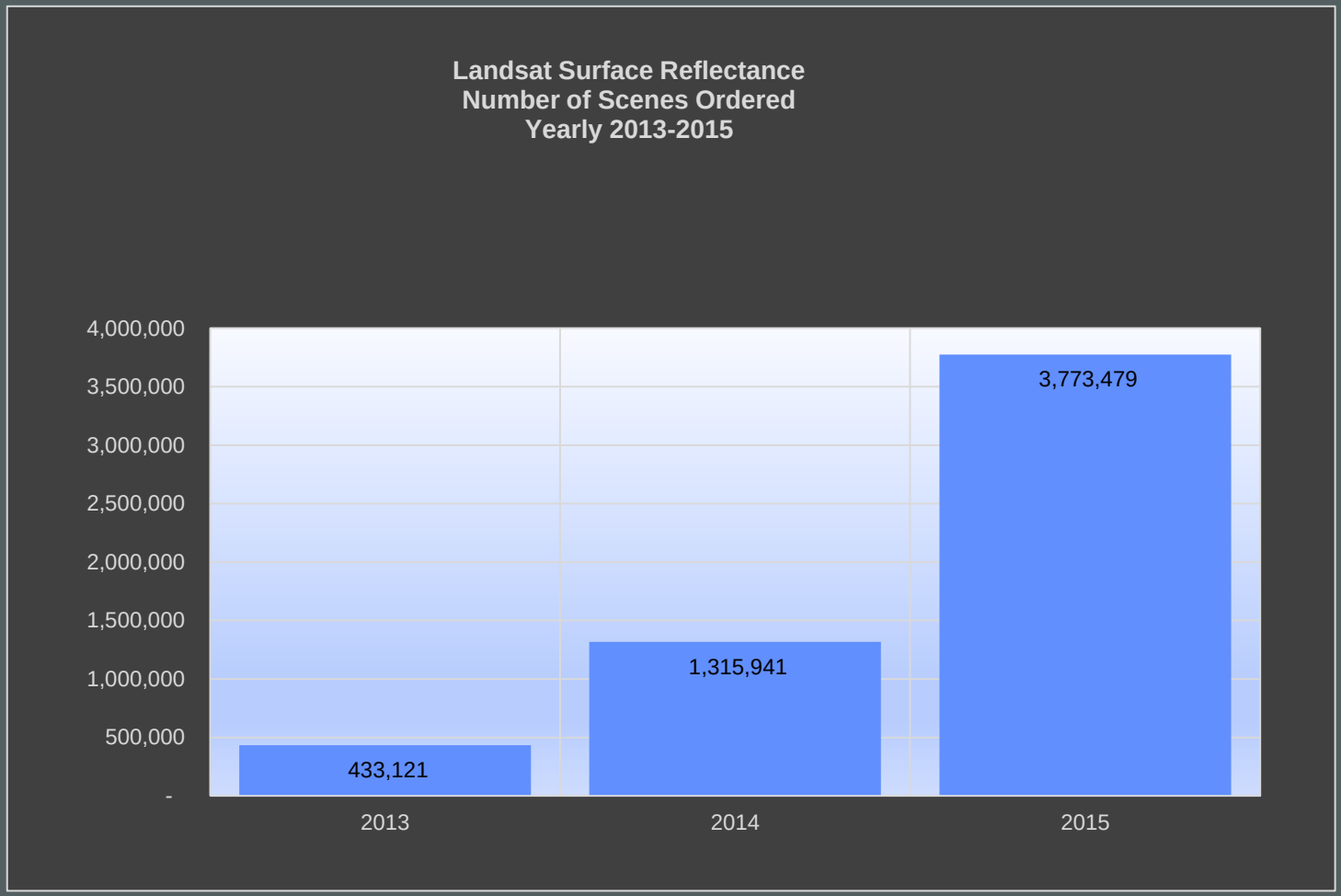
Differences between TM/ETM+ and OLI

Parameter	Landsat 4–5, 7 (LEDAPS)	Landsat 8 OLI (L8SR)
(Original) research grant	NASA GSFC, MEaSUREs (Masek)	NASA GSFC
Global coverage	Yes	Yes
TOA	Visible (1–5,7) + Brightness temp (6) bands	Visible (1–7, 9) +Thermal (10–11) bands
SR	Visible (1–5,7) bands	Visible (1–7) bands (OLI/TIRS only)
Radiative transfer model	6S	Internal algorithm
Thermal correction level	TOA only	TOA only
Thermal band units	Kelvin	Kelvin
Pressure	NCEP Grid	Surface pressure is calculated internally based on the elevation
Water vapor	NCEP Grid	MODIS CMA
Air temperature	NCEP Grid	MODIS CMA
DEM	Global Climate Model DEM	Global Climate Model DEM
Ozone	OMI/TOMS	MODIS CMG Coarse resolution ozone
AOT	Correlation between chlorophyll absorption and bound water absorption of scene	MODIS CMA
Sun angle	Scene center from input metadata	Scene center from input metadata
View zenith angle	From input metadata	Hard-coded to 0
Undesirable zenith angle correction	N/A	SR not processed when solar zenith angle > 76 degrees
Pan band processed?	No	No
XML metadata?	Yes	Yes
Brightness temperature calculated	Yes (Band 6 TM/ETM+)	Yes (Bands 10 & 11 TIRS)
Cloud mask	CFmask	CFmask
Data format	INT16	INT16
Fill values	-9999	-9999
QA bands	Cloud Adjacent cloud Cloud shadow DDV Fill Land water Snow Atmospheric opacity	Cloud Adjacent cloud Cloud shadow Aerosols Cirrus

http://landsat.usgs.gov/documents/provisional_l8sr_product_guide.pdf

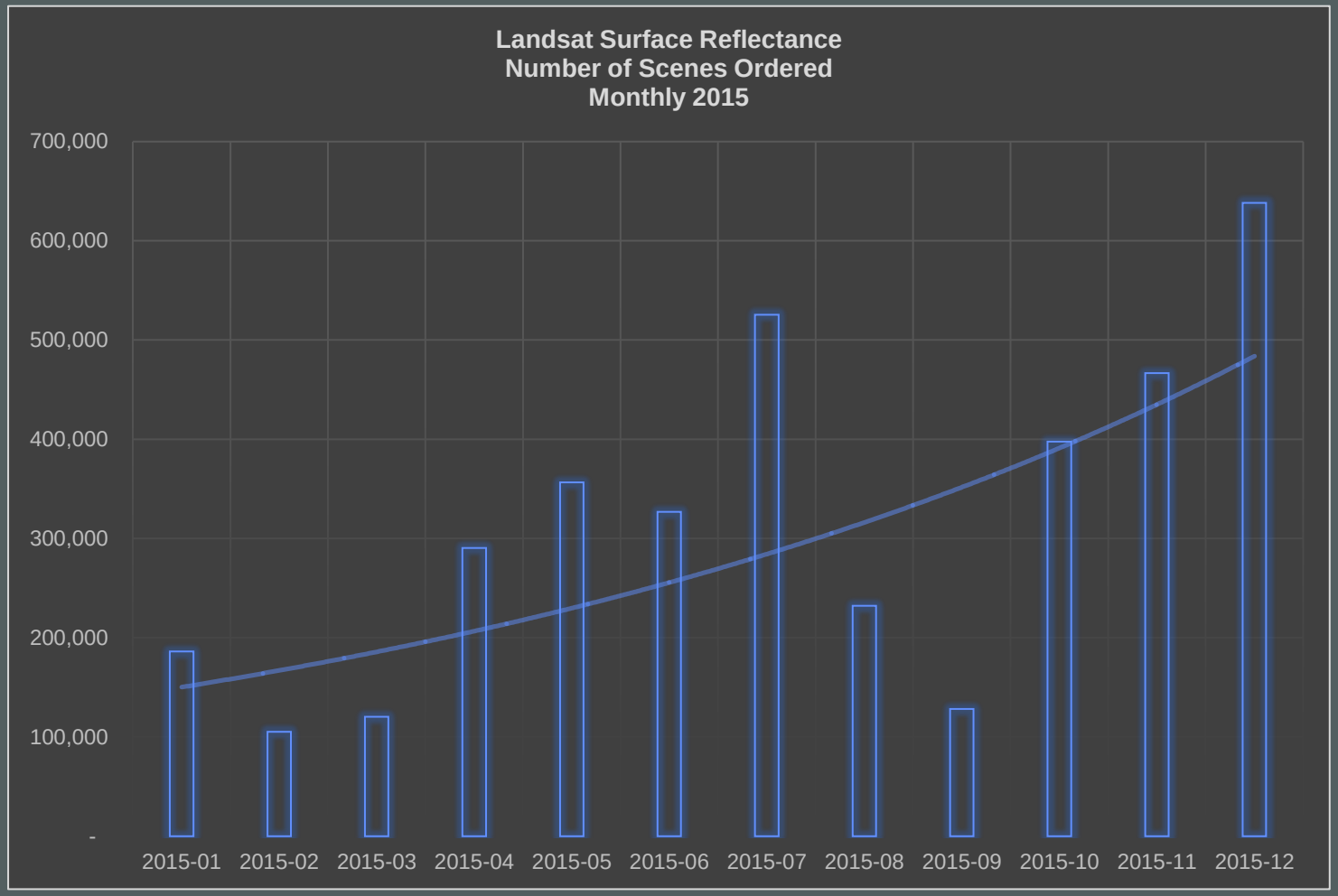
USGS

Annual Distribution Since Release



USGS

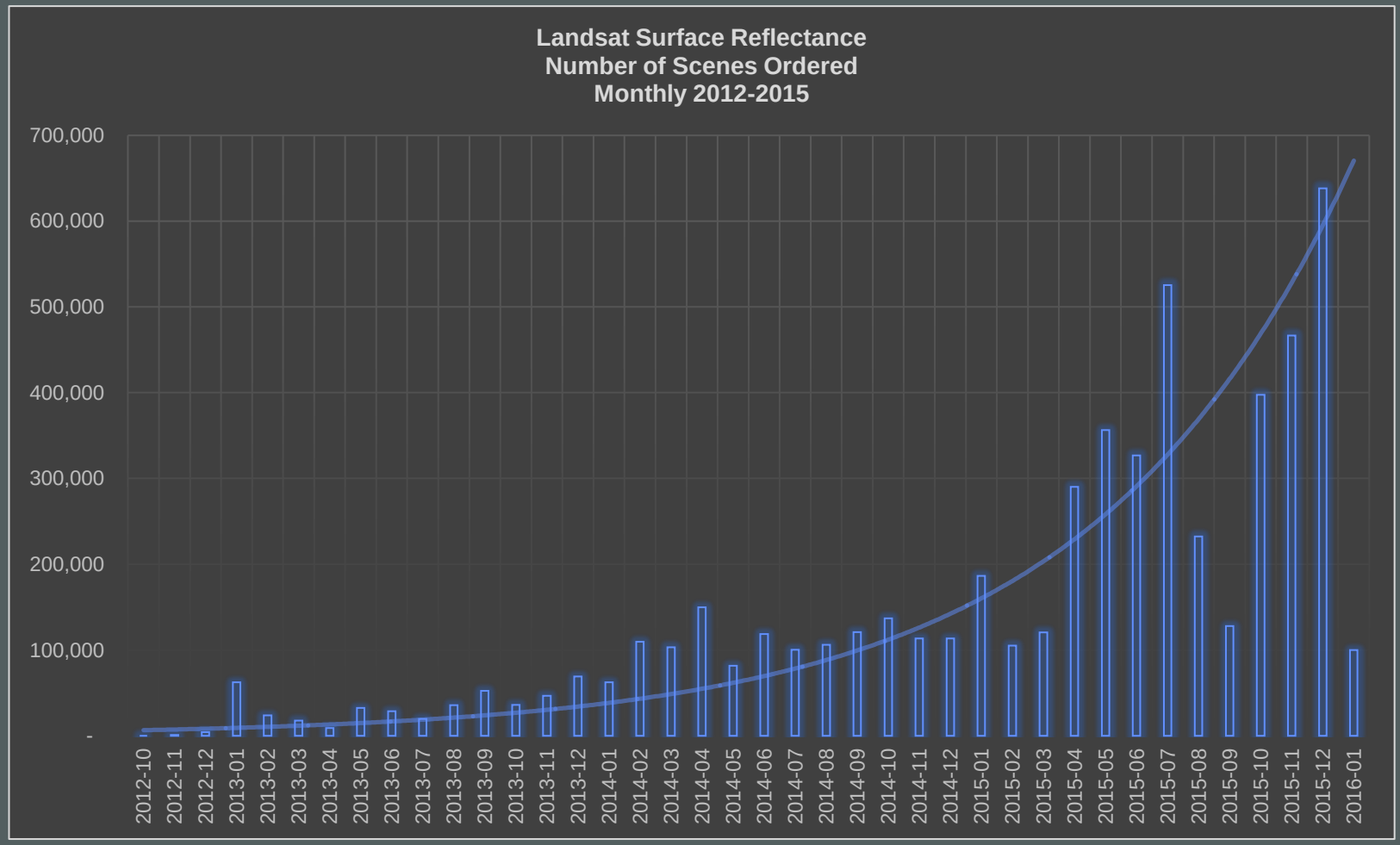
Monthly Distribution in 2015



The ESPA server was the largest single distribution server in the month of December (171 TB), and 2nd largest distribution by Project (LSGS = 275 TB).

USGS

Monthly Distribution Since Release



USGS

Discussion Topics

- The algorithm has not been published nor is there an algorithm theoretical basis document (ATBD) available, so it is difficult for us to trouble-shoot problems or know where in the code to make particular modifications.
- Need to fully characterize and communicate the differences between OLI and TM/ETM+ surface reflectance retrievals.
- We still see some visible “blockiness” in some areas of high relief and dense forest cover – not sure if this is related to the ETOPO-5 DEM or the MODIS aerosol and water vapor CMG data.
- We’d appreciate feedback evaluating the changes we made for per pixel solar illumination and sensor view angle implementation and coastal aerosol interpolation.
- Currently we are unable to generate OLI surface reflectance products without TIRS data because the algorithm uses TIRS for cloud detection – desirable to have option to use L1T cloud mask

USGS

USGS

Alternative Approaches

- From an operations and sustainment perspective it would be more desirable to strive towards a multi-path algorithm, but single code base, for surface reflectance retrievals across the Landsat instruments.
- Options for consideration
  - modify the LEDAPS code to accommodate OLI, although this is non-trivial;
  - implement the Geoscience Australia algorithm, assuming that their BRDF and terrain shadowing corrections are applicable on a broad scale basis;
  - consider the SDSU MODTRAN-based code, which employs single-value aerosol and water vapor coefficients per scene.
- The USGS EROS has a limited skill base with which to undertake this work without guidance and assistance from the Landsat Science Team.

USGS