ESD Budget/Program Overview

- The FY17-21 ESD program is executable and balanced, informed by and consistent with Decadal Survey and national Administration priorities:
  - advances Earth system science
  - delivers societal benefit through applications development and testing
  - provides essential global spaceborne measurements supporting science and operations
  - develops and demonstrates technologies for next-generation measurements, and
  - complements and is coordinated with activities of other agencies and international partners

- Funds operations and core data production for on-orbit missions in prime and extended phases, in keeping with 2015 Senior Review recommendations/decisions.

- Completes high priority missions: SAGE III/ISS, ICESat-2, CYGNSS, GRACE-FO, SWOT, TEMPO, RBI, OMPS-Limb, TIDS-1 and -2, CLARREO Pathfinder, Jason-CS/Sentinel-6A, Landsat 9, NISAR.

- Develops (for launch beyond budget window): PACE, Landsat 10, Jason-CS/Sentinel-6B.

- Continues all originally planned Venture Class solicitations/selections on schedule.

- Conducts limited Decadal mission studies, pending release of the 2nd ESAS Decadal Survey ~Jul 2017.

- Supports non-flight elements: Research, Applied Sciences, and Technology Development.

- Provides support to National Climate Assessment, USGCRP, international coordination activities (CCOS and GEO), USGEO, Carbon Monitoring System, data-related activities (CDI, BEDI, GCIS) in support of the Administration’s climate initiative, and GLOBE.

ESD Budget: FY17 Request/Appropriation

- ESD budget jumps significantly in FY17 – then becomes consistent with FY16 President’s Budget Request for the out-years.
**Elemental Summary: Flight**

- Continues development and launch of: SAGE-III/ISS, ECOSTRESS/ISS, GEDI/ISS, CYGNSS, TEMPO, RBl, OMPS- limb, TSIS-1/2, GRACE-FO, ICESat-2, SWOT, NISAR, PACE, CLARREO Pathfinder, ISS, Sentinel-6A and -6B

  - Sustainable Land Imaging Program (w/USGS; NASA funds flight hardware):
    - Full Class-B Landsat-9 to launch in FY2021
    - Focused technology development to inform designs of Landsat-10
    - Begins Landsat-10 late in budget window, for launch in 2027-2028

- Continues Venture Class: on schedule with full funding
- Completes OCO-3 delivered 3/2018, launched to ISS 6/2018
- Initiates Small Satellite Constellation effort (FY17 only! —ESSP-PO)

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**Earth Science Research**

**Focus Areas**

- Carbon cycle and Ecosystems
- Climate Variability and Change
- Atmospheric Composition
- Global Water and Energy Cycle
- Earth Surface and Interior
- Weather

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**Venture Class Selections/Solicitations**

<table>
<thead>
<tr>
<th>Mission</th>
<th>Mission Type</th>
<th>Selected Date</th>
<th>Inception Date</th>
<th>Major Missions</th>
</tr>
</thead>
<tbody>
<tr>
<td>EVI-1: CARVE, ATTREX, DISCOVER-AQ, AirMOSS, HS-3</td>
<td>EVM-1: CYGNSS (10/2016 LRD)</td>
<td>2016</td>
<td>2019</td>
<td>DA</td>
</tr>
<tr>
<td>EVI-2: AOrb, NAAMES, OMIC, ORACLES, ACT-America, CORAL</td>
<td>EVI-3: MAIA (2021; 2020 instrument delivery); TROPICS (12-sat cubesat constellation) selected</td>
<td>2019</td>
<td>2022</td>
<td>Venture Class: selected instrument</td>
</tr>
</tbody>
</table>

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**Earth Science**

- 2010 Climate Architecture Plan
- 2016 Climate Variability and Change
- 2017 Carbon Cycle and Ecosystems
- 2018 Atmospheric Composition
- 2019 Global Water and Energy Cycle
- 2020 Earth Surface and Interior
- 2021 Weather

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**DSCOVR – EPIC Camera: Lunar Transit from Earth-Sun L1**

**Stratospheric Ozone from LEO (OMPS) and L1 (EPIC)**
Beginning 2016, continuing FY16,17,18,19. Provide critical data and new models needed to analyze the status of missions in this period include:

- The Earth System Science Pathfinder (ESSP) increases funding for Applications Areas (via Hyderabad India B200, C). Starting spring 2016, multiple sailings Contracted GIV May, Oct/Nov Gabon Africa Korea DC.

Continues activities to develop techniques to imaging spectroscopy science and application investigation over Indian Spring 16 OCO (2017) and CATS (>2016) Various US and South America Summer 16, Spring 17, Fall 17, Re B200, C20A The Earth Systematic Missions (ESM) Dec America SMAP (>2021), DSCOVR (2019), S-GV (NSF) Feb Aug 16, Jan/Feb 17, Sep/Oct 17, Summer 16 FL, HI, Mariana Is., Palau, Australia 16 Mar 16

Validation Observation ABoVE SPURS II UAVSAR Operation IceBridge HyspIRI Airborne Southern Ocean O2/N2 Ratio and CO2 Experiment (ATom) OMG (NAAMES) Marine Ecosystems Study North Atlantic Aerosols and Transport Atmospheric Carbon and Korus AQ Mission - orbit dates correspond to end - Mission assumptions, consistent with 2015 Sr. Review - orbit technology validation and risk reduction for small instruments and instrument Instrument Incubator Program (IIP) 24 management of remotely sensed data and the efficient generation of data products innovative on new projects added in - total funding ~$21M - funded from SLI Improved estimates of future sea level rise. Greenland glacier melting. The study will help pave the way for NASA/ESA collaboration on algorithm development and future mission - led mission to - scale tropospheric distributions, gradients, and fluxes of O2 and CO2 over Southern Ocean. Investigate the large - of - - - 8 B, CLARREO Pathfinder - - 3 and Venture Technology selections (total funding ~$13M)

Earth Science Technology Office

Instrument Incubator Program (IIP) 2017 new instruments and measurement techniques 17 new projects added in FY14 (total funding ~$71M over 3 years)

Advanced Component Technologies (ACT) critical components and subsystems for instruments and platforms 17 new projects added in FY14 (total funding ~$13M over 3 years)

Sustainable Land Imaging Technology (SLIT); Managed by ESFO, funded from SLI new technologies and reduced costs for future land imaging (landbased) measurements - First solicitation released in FY15 (total funding ~$65M over 5 years from SLI budget – investigations managed by ESFO)

Advanced Information Systems Technology (AST) innovative on-orbit and ground capabilities for communication, processing, and management of remotely viewed data and the efficient generation of data products - 4 new projects added in FY15 (total funding ~$21M over 3 years)

In-Space Validation of Earth Sciences Technologies (INVEST) on-orbit technology validation and risk reduction for small instruments and instrument systems that could not otherwise be fully tested on the ground or airborne systems - 4 new projects added in FY15 (total funding ~$21M over 3 years)

ESM and ESSP Program Overviews

- The Earth Systematic Missions (ESM) development missions in this period include:
  - ICESat-2, SAGE III, GRACE-FO, SWOT, Landsat-9, RBl, TESIS-1 and -2, OMPS-Limb, NSAR, PACE, Jason CS/Sentinal 6A and -8, CLARREO Pathfinder
  - The Earth Systematic Missions (ESM) on-orbit* missions include:

- The Earth System Science Pathfinder (ESSP) development missions in this period include:
  - OCO-3, CYGNSS, TEMPO, GEDI, ECOSTRESS
  - EVI-2 and 3 and Venture Technology selections (GRAOW, Tempest), EVI-2 & 3, EVI-3, 4, 5, and 6
  - The Earth System Science Pathfinder (ESSP) on-orbit missions include:

*On-orbit dates correspond to end-of-mission assumptions, consistent with 2015 Sr. Review