

NASA Earth Observing Missions Applications Workshop  
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THE NATIONAL ACADEMIES  
*Advisers to the Nation on Science, Engineering, and Medicine*

Earth Science and Applications from Space:  
 National Imperatives for the Next Decade and Beyond (2007)

Decadal Survey Missions:

NEAR TERM	TIER I	TIER II
<b><u>NPP/NPOESS</u></b> (now JPSS)	CLARREO	ASCENDS
<b><u>GPM</u></b> (follow on to TRMM)	SMAP	HYSpiri
LDCM	DESDyni	SWOT
OCO (try again)	ICESAT-2	GEOCAPE
		<b><u>ACE</u></b>

## Weather and Aviation Applications

NEAR-TERM SATELLITES	RELEVANCE	APPLICATION
<b><u>NPP/NPOESS</u></b> ➡ JPSS	<b>HIGH</b>	VIIRS will provide MODIS-like observations of atmospheric, surface, cloud features and ash for nowcasting and for assimilation into forecast models -- <b>KEY MISSION</b>
<b><u>GPM</u></b>	<b>HIGH</b>	Near global measurements of precipitation with 3h frequency will provides useful information over oceans --- <b>KEY MISSION</b>
LDCM	LOW	Better characterization of surface parameters for forecast model initialization
OCO (2)	LOW	Limited application, availability of surface pressure over oceans could help forecasts
TIER I	RELEVANCE	APPLICATION
CLARREO	LOW	Use for calibration of imaging sensors but not critical for aviation weather applications
SMAP	LOW	Soil moisture estimates will improve initialization of weather forecast models used to diagnose hazard regions for aircraft
DESDynI	LOW	Possible surface winds in coastal regions an aid to weather forecasting
ICESAT2	LOW	Limited use unless it provides atmospheric profiles
TIER II	RELEVANCE	APPLICATION
<b><u>ACE</u></b>	<b>HIGH</b>	Aerosol and cloud profiles, and vertical motion in clouds likely quite useful for aviation weather applications --- <b>KEY MISSION</b>
<b><u>GeoCAPE</u></b>	<b>MODERATE</b>	Aerosol optical depth measurements useful for visibility and aircraft emissions assessments
ASCENDS	LOW	Limited unless atmospheric profiles are derived
HispIRI	LOW	Limited, possible volcanic ash detection
SWOT	LOW	Very limited

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# *Weather and Aviation Applications of Decadal Survey Satellites*

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## **Applications for both Research & Operational Satellites**

- Critical operational requirements for both GOES-R and JPSS

## **General Goals and Objectives**

- Observations to fill gaps in data sparse areas
- Enable early use of future operational satellite instrumentation
- Unique spectral, temporal, phenomenological, and spatial coverage
- High resolution research NASA satellite data can be used to independently develop, assess, and improve NWP, decision support systems, and future operational algorithms
- Synergy with other observations (Example: Convection - FAA CoSPA and Turbulence - GTG), satellite products do not stand alone

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## *Unique Requirements*

- High vertical resolution
- High spatial resolution
- High spectral resolution
- Broad area coverage
- Rapid temporal refresh rate

## *Data Distribution and Use (e.g. NextGen 4-D Data Cube)*

### Data policy issues

- Publicly and freely available, no obstacles to having access to data

### Archival, processing and distribution issue

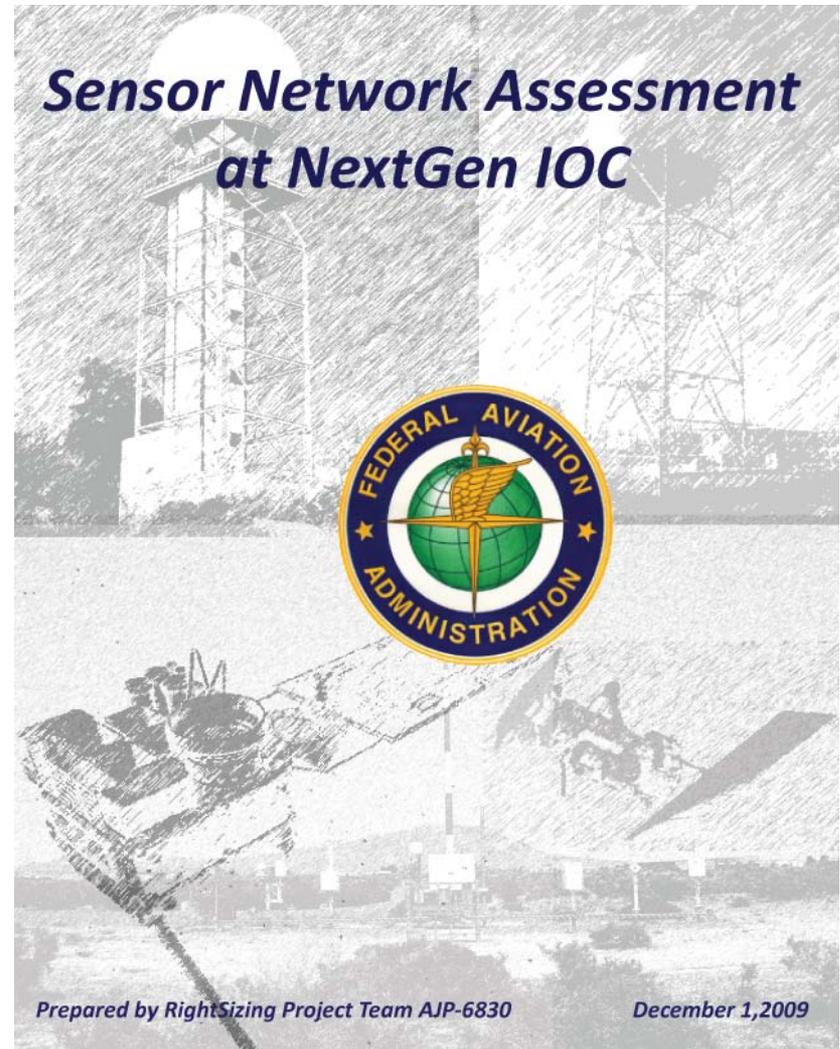
- High speed data collection and distribution systems serving both “internal” and “external” users, with data provided in **user appropriate formats**. Reprocessing (as required) and long term archival of all data.

### Timeliness of data products

- Direct broadcast/readout capability for time critical observations are needed for weather and aviation decision support systems

# FAA NextGen “Right Sizing”

- Evaluate the meteorological sensor network
- Ground-based, radar and lidar, airborne & satellite



**Table 4.3: Functional Gaps Associated with NAS Airborne/Spaceborne (AB) Sensors**

Gap #	Gap Description	Comments / Impacts	Term. Impact	En Route Impact	Global Impact
AB-1	<p>Access to non-US Satellite Data:                      Current and potential restrictions prevent or limit real-time access to satellite observations required to support US aircraft operating in data-sparse oceanic and remote regions not covered by US satellites.                      Status: Oceanic/remote data products are in development and can be supported only where US satellites provide coverage. Real-time access to Meteosat and MTSAT (The Multifunctional Transport Satellites) data is needed to support operational use in broader oceanic/remote domains.</p>	<p>NOAA has real-time access to Meteosat data, but there are significant restrictions on the use and distribution of these data. The Japanese MTSAT data is freely available, but may require special arrangements for reception and retransmission for FAA operational use.                      Unavailability of non-US satellite data yields a negative impact on global flight safety and traffic capacity.</p>	-	-	✓
AB-2	<p>GOES data refresh frequency: GOES data over the CONUS are routinely updated every 15 minutes, adjacent areas are generally observed every half hour, and full disk imagery is only obtained once every three hours. These update rates are inadequate for many aviation applications.                      Status: Refresh frequency will be significantly improved with the GOES-R series of satellites available by 2015 or later.</p>	<p>✓ <b>GOES-R</b>                      The temporal gaps within routine GOES data today yield a negative impact on global flight safety and traffic capacity.</p>	✓	✓	✓

AB-3	<p>Polar-orbiting satellite data latency: POESS, US DMSP and European Metop satellites provide coverage that is critical over polar regions and strongly complementary to geostationary observations at lower latitudes. Due to high latency, data from polar-orbiters are generally unavailable for real-time operational use. Real-time access to these observations will require the installation of a number of direct-transmission receiving stations in the observing domains of greatest interest.</p> <p>Status: No plans are in place to establish these additional receiving stations.</p>	<p style="text-align: center; color: red; font-size: 2em;">? JPSS</p> <p>High latency prevents real-time use of polar-orbiter data for aviation products.</p> <p>Negative impact on global flight safety and traffic capacity.</p>	✓	✓	✓
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<p>AB-4</p>	<p>Volcanic ash: Observe and track horizontal and vertical extent.                  Status: A variety of observational and numerical methods exist and achieve partial operational capability. Significant issues such as sensitivity of detection, obscuration by cloud, determination of plume height, and accuracy of trajectory modeling exist. Significant improvement using current approaches and new technologies is feasible.</p>	<p>Rapid response products to identify and track volcanic ash clouds are needed for aviation use and for other warning responsibilities carried by the international network of Volcanic Ash Advisory Centers (VAAC).                  Airborne FLIR devices can provide some capability. Under investigation by NASA.                  Negative impact on global, en route and terminal area flight safety and traffic capacity.</p>	<p>✓</p>	<p>✓</p>	<p>✓</p>
<p>AB-5</p>	<p>Volcanic ash: Characterize ash content and density.                  Status: Techniques for remote sensing of the characteristics of an ash cloud and estimation of its hazard to aircraft are extremely limited. Significant development is needed.</p>	<p>Beyond the problems of characterizing the properties of an ash cloud, there are significant unknowns in relating those observations to the severity of the hazard to aviation. Current practice is for aircraft to avoid any known ash clouds.                  Negative impact on global, en route and terminal area flight safety and traffic capacity.</p>	<p>✓</p>	<p>✓</p>	<p>✓</p>

AB-6	<p>Turbulence observations: Operational collection of EDR data for turbulence determination is in place, but many airborne platforms are not equipped with this capability, and new techniques (e.g., GPS occultation, airborne FLIR) need study to assess feasibility and utility.</p> <p>Status: EDR reporting from commercial aircraft is operational and in need of expansion, particularly over oceanic domains. EDR data should help the terminal area as well as enroute.</p>	<p>Negative impact on en route, and global flight safety and traffic capacity.</p>	✓	✓	✓
AB-7	<p>Cloud coverage and cloud type identification: Many operational products require satellite-based observations of cloud coverage and cloud type identification. While there are many different algorithms being used to classify clouds, there is no single, routinely available product for aviation use.</p> <p>Status: No approved products are available for operational use.</p>	<p style="text-align: center;"><b>OPPORTUNITY</b></p> <p>Negative impact on global, en route, and terminal flight safety and traffic capacity.</p>	✓	✓	✓

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<p>AB-8</p>	<p>Sea surface winds: Wind speed and direction observations over the ocean are essential for forecasting storm development and motion, particularly tropical storms. The polar-orbiting QuikSCAT scatterometer is well past its design lifetime and needs replacement. Status: A number of replacements have been proposed, but none are currently scheduled for launch.</p>	<p>Negative impact on global, en route, and terminal flight safety and traffic capacity.</p>	<p>-</p>	<p>-</p>	<p>✓</p>
<p>AB-9</p>	<p>Cloud top height: High resolution cloud top height information is critical to many aviation applications. Current techniques give useful information, but require improvement. Status: Current product capabilities have not undergone approval for operational use. No new products are in preparation.</p>	<p style="text-align: center;"><b>OPPORTUNITY</b></p> <p>Negative impact on global, en route, and terminal flight safety and traffic capacity.</p>	<p>✓</p>	<p>✓</p>	<p>✓</p>

AB-10	<p>Global situational awareness – flight deck products: Lack of approved products providing real-time situational awareness in the cockpit for operations in data-sparse regions outside the NAS.</p> <p>Status: Products are in development.</p>	<p><b>OPPORTUNITY</b></p> <p>Negative impact on global flight safety and traffic capacity.</p>	-	-	✓
AB-11	<p>Global situational awareness – communications: Limited operational communications bandwidth and systems required to uplink weather products to the cockpit of US aircraft operating in data-sparse oceanic regions outside the NAS.</p> <p>Status: Limited experimental uplink trials have been conducted.</p>	<p><b>OPPORTUNITY</b></p> <p>Negative impact on global flight safety and traffic capacity.</p>	-	-	✓
AB-12	<p>Satellite product research-to-operations: While there has been considerable development of experimental satellite-based products intended for aviation applications, there is uncertainty and limited support for transition of these products to operations.</p>	<p><b>CRITICAL NEED</b></p> <p>Negative impact on global, en route and terminal flight safety and traffic capacity.</p>	✓	✓	✓

# Decadal Survey Reverence Links

# Decadal Survey Missions-1

- **GPM**  
Global Precipitation Measurement Mission  
<http://gpm.gsfc.nasa.gov/>
- **LDCM**  
Landsat Data Continuity Mission  
<http://ldcm.nasa.gov/>
- **OCO-2**  
Orbiting Carbon Observatory  
<http://oco.jpl.nasa.gov/>
- **CLARREO**  
Climate Absolute Radiance and Refractivity Observatory  
<http://clarreo.larc.nasa.gov/>
- **SMAP**  
Soil Moisture Active & Passive  
<http://smap.jpl.nasa.gov/mission/>

# Decadal Survey Missions-2

- **DESDynI**  
Deformation, Ecosystem Structure and Dynamics of Ice  
<http://desdyni.jpl.nasa.gov/>
- **LDCM**  
Landsat Data Continuity Mission  
<http://ldcm.nasa.gov/>
- **ICESat-II**  
Ice, Cloud, and land Elevation Satellite  
<http://nasascience.nasa.gov/missions/icesat-ii>
- **ASCENDS**  
Active Sensing of CO2 Emissions over Nights, Days and Seasons  
[http://decadal.gsfc.nasa.gov/docjments/10\\_ASCENDS.pdf](http://decadal.gsfc.nasa.gov/docjments/10_ASCENDS.pdf)
- **HyspIRI**  
Hyperspectral IR Imager  
<http://hyspiri.jpl.nasa.gov/>

# Decadal Survey Missions-3

- **SWOT**  
Surface Water Ocean Topography  
<http://bprc.osu.edu/water/index.php>
- **GEO-CAPE**  
Geostationary Coastal and Air Pollution Events  
<http://geo-cape.larc.nasa.gov/mission.html>
- **ACE**  
Aerosol/Cloud/Ecosystems Mission  
<http://dsm.gsfc.nasa.gov/ace/index.html>

# Extra Slides

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