Overview of the NASA GEO-CAPE (GEOstationary Coastal ocean and Air Pollution Events) Mission

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MEST-NASA Technical Group on Atmospheric Composition Measurements From Geostationary Satellites
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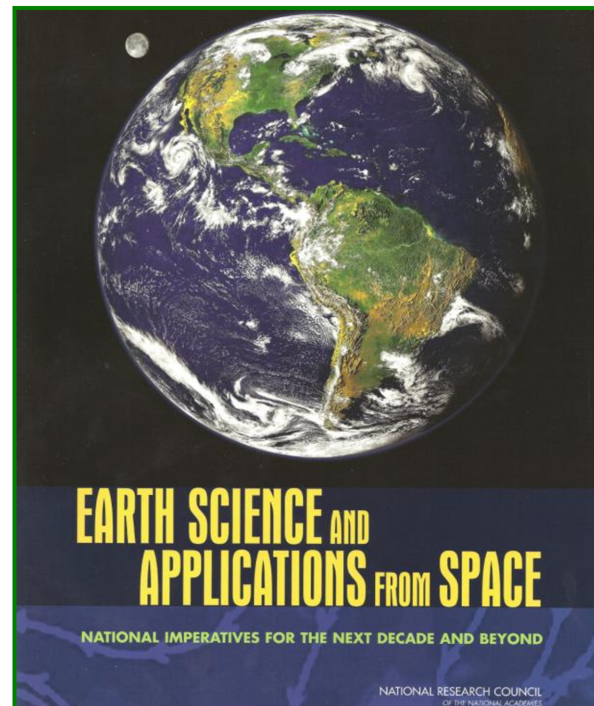
The US NRC Decadal Survey

- In 2004, NASA, NOAA and USGS requested the National Research Council (NRC) form a panel to identify and prioritize the next set of observational platforms that should be launched and operated over the next decade.
  - *Across all fields of Earth science*
- The Earth Science and Applications from Space Decadal Survey was released Feb 2007
  - *“Minimal but robust” Earth system science*
  - *Societal benefits should be a focus of all missions*
- NASA is implementing missions within 3 “Tiers” in accordance with the sequencing of the Decadal Survey.



NRC Recommended Missions - Early/Mid

Decadal Survey Mission	Mission Description	Orbit	Instruments	$ Estimate
Timeframe 2010 – 2013, Missions listed by cost				
CLARREO (NASA portion)	Solar and Earth radiation: spectrally resolved forcing and response of the climate system	LEO, Precessing	Absolute, spectrally-resolved interferometer	$200 M
SMAP	Soil moisture and freeze/thaw for weather and water cycle processes	LEO, SSO	L-band radar L-band radiometer	$300 M
ICESat-II	Ice sheet height changes for climate change diagnosis	LEO, Non-SSO	Laser altimeter	$300 M
DESDynI	Surface and ice sheet deformation for understanding natural hazards and climate; vegetation structure for ecosystem health	LEO, SSO	L-band InSAR Laser altimeter	$700 M
Timeframe: 2013 – 2016, Missions listed by cost				
HyspIRI	Land surface composition for agriculture and mineral characterization; vegetation types for ecosystem health	LEO, SSO	Hyperspectral spectrometer	$300 M
ASCENDS	Day/night, all-latitude, all-season CO_2 column integrals for climate emissions	LEO, SSO	Multifrequency laser	$400 M
SWOT	Ocean, lake, and river water levels for ocean and inland water dynamics	LEO, SSO	Ka-band wide swath radar C-band radar	$450 M
GEO-CAPE	Atmospheric gas columns for air quality forecasts; ocean color for coastal ecosystem health and climate emissions	GEO	High and low spatial resolution hyperspectral imagers	$550 M
ACE	Aerosol and cloud profiles for climate and water cycle; ocean color for open ocean biogeochemistry	LEO, SSO	Backscatter lidar Multiangle polarimeter Doppler radar	$800 M

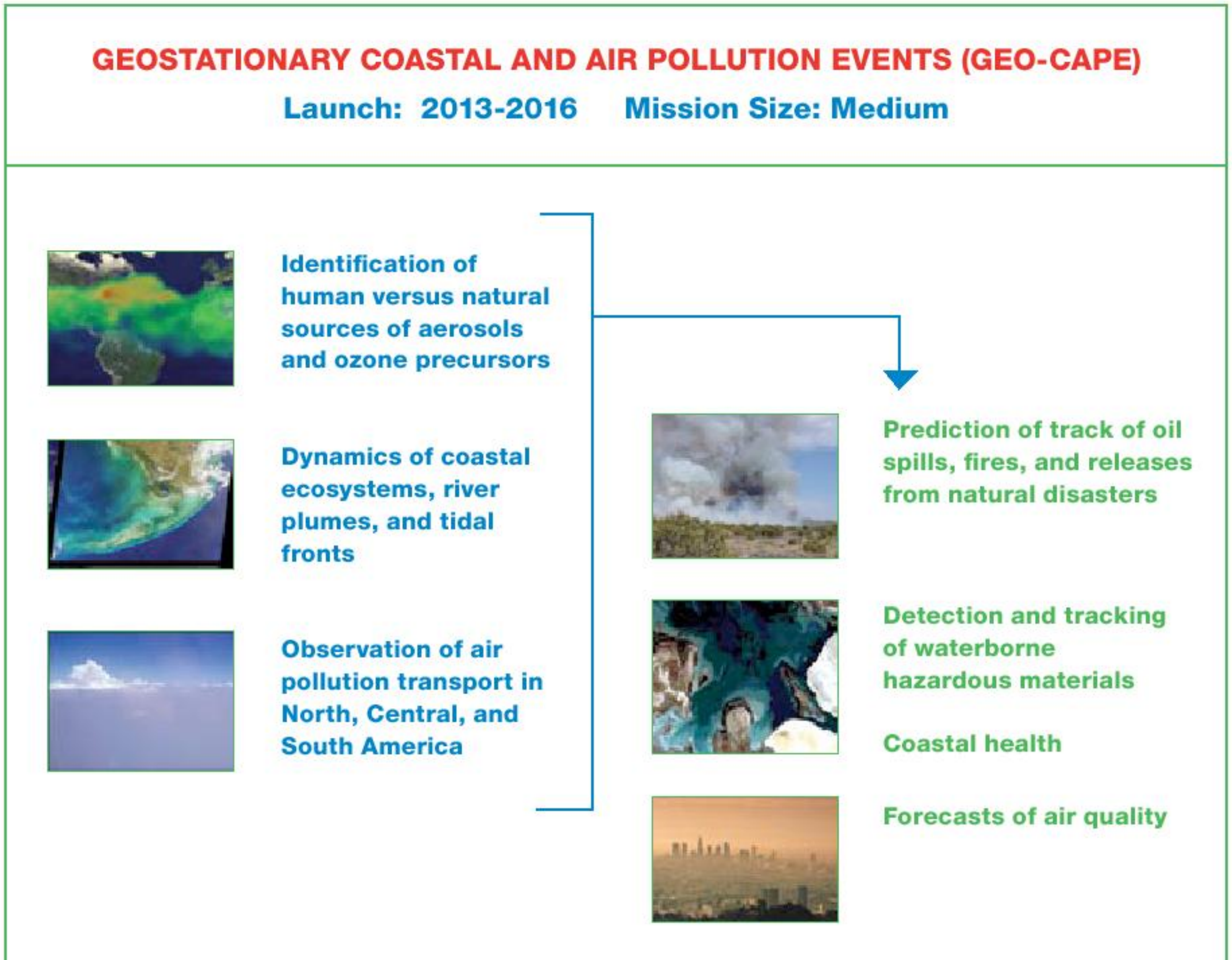
NRC Recommended Missions - Late

Timeframe: 2016 -2020, Missions listed by cost				
LIST	Land surface topography for landslide hazards and water runoff	LEO, SSO	Laser altimeter	$300 M
PATH	High frequency, all-weather temperature and humidity soundings for weather forecasting and SST*	GEO	MW array spectrometer	$450 M
GRACE-II	High temporal resolution gravity fields for tracking large-scale water movement	LEO, SSO	Microwave or laser ranging system	$450 M
SCLP	Snow accumulation for fresh water availability	LEO, SSO	Ku and X-band radars K and Ka-band radiometers	$500 M
GACM	Ozone and related gases for intercontinental air quality and stratospheric ozone layer prediction	LEO, SSO	UV spectrometer IR spectrometer Microwave limb sounder	$600 M
3D-Winds (Demo)	Tropospheric winds for weather forecasting and pollution transport	LEO, SSO	Doppler lidar	$650 M

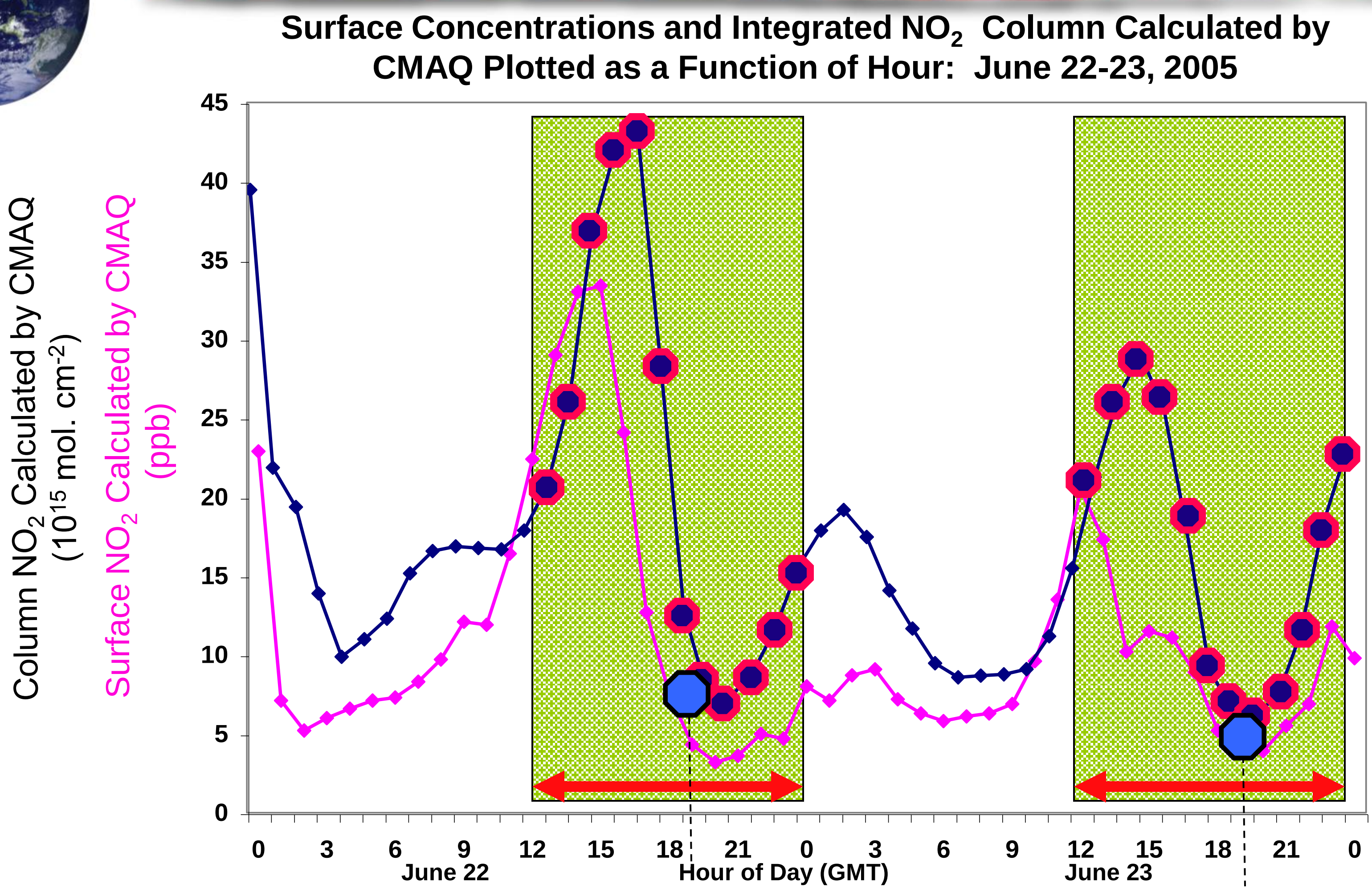
Overview of GEO-CAPE from the Decadal Survey

Geosynchronous orbit with notional payload of 3 instruments:

- UV-Vis-near IR wide area spectrometer, 45S to 50N, hourly (O_3, NO_2, CH_2O, SO_2, Aerosols)
- IR correlation radiometer for CO mapping
- High spatial resolution event-imaging spectrometer



Why GeoStationary? High Temporal Resolution



Measurements provided once per day from LEO (OMI,) provide relatively little information for examining AQ model performance

Hourly measurements possible from geostationary orbit capture daylight portion of diurnal cycle

Figure courtesy Jack Fishman, NASA

GEO-CAPE Status

- *All DS Tier-2 Missions, including GEO-CAPE, are in pre Phase-A*
- *Launch dates have slipped beyond DS recommendation*
  - Current expectation is launch no earlier than 2017
  - Launch dates recommended by the DS assumed increases to NASA budget, which have not yet happened in a sustained way
- *Current guidance is for all Tier-2 missions to continue pre Phase-A development (see next slide) and determine their readiness for potential transition to Phase A*
  - Science requirements and mission concepts
  - Advanced technology development and maturation

Key Pre-Phase A Questions

- What science MUST this mission achieve?
  - *What specific measurements?*
  - *To what accuracy?*
  - *What are the required data products?*

Should be resolved ~ 12 months prior to Phase A review

- What mission parameters can achieve the science?
  - *What orbit (inclination/altitude)?*
  - *Which instruments?*
  - *What is the baseline mission duration?*
- How can NASA achieve these measurements?
  - *Are there other missions required/desired to achieve the science?*
  - *Who can NASA partner with to achieve this mission?*

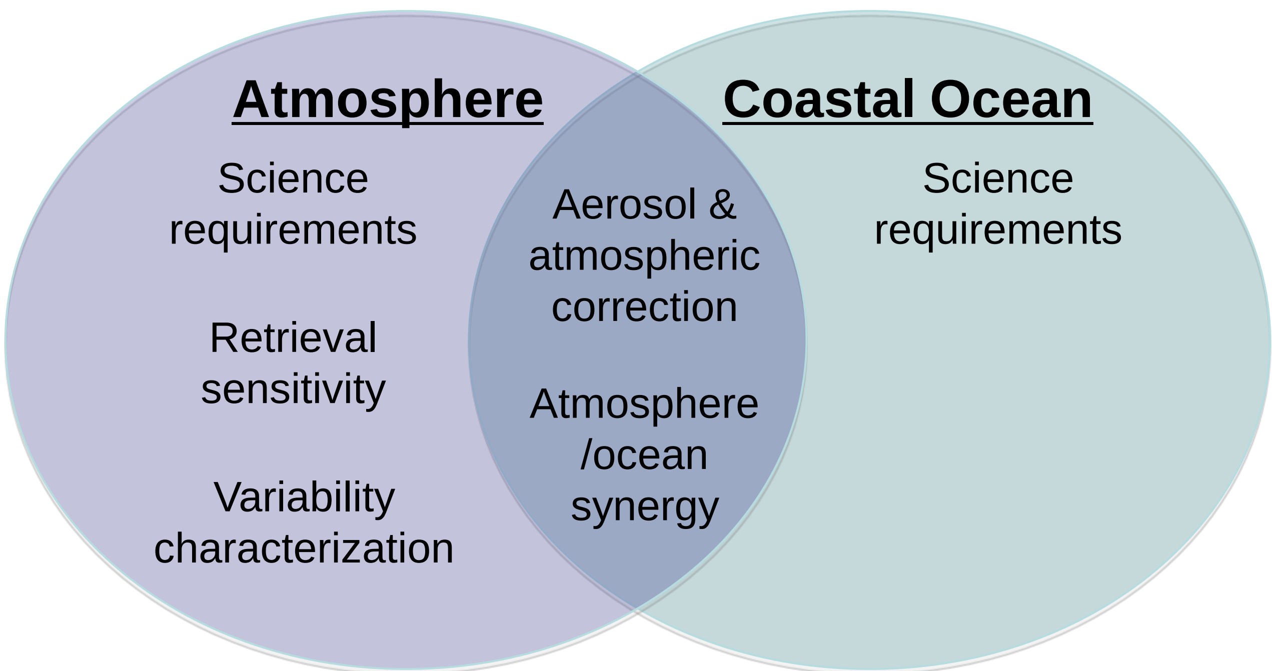
Should be resolved ~ 6 months prior to Phase A review

GEO-CAPE Mission Development

- *Technology Readiness*
  - Advanced instrumentation development through NASA Instrument Incubator and Advanced Component Technology programs, *http://esto.nasa.gov/solicitations.html*
- *Science requirements*
  - Nominal baseline requirements from the NRC Decadal Survey
  - 2008 Community Workshop Report (~150 participants from AQ and OC communities) available, *http://geo-cape.larc.nasa.gov/documents.html*
  - Science Working Groups are currently refining requirements, next workshop scheduled for September 22-24, 2009

GEO-CAPE Science Working Group

- *Atmosphere and Coastal Ocean subgroups working on near-term priority tasks as defined by the 2008 Workshop Report*
    - Broad and dynamic community involvement, currently includes NASA, University, NOAA, US EPA
- *Complete draft science and instrument requirements by end 2009*
- *Initiate focused OSSE and systems engineering design studies in 2010 to enable assessment of mission implementation alternatives and readiness to proceed to formulation*



GEO-CAPE SWG subgroup focus themes (9 June 2009)

GEO-CAPE Mission Study Issues

- Vertical resolution of air quality species within the troposphere
  - *Can multi-wavelength retrievals provide increased boundary layer sensitivity?*
  - *Is BL sensitivity a measurement science requirement?*
  - *Joint atmosphere/ocean retrievals*
- Observing strategy
  - *Combined atmosphere and ocean requirements for “fine” spatial / “frequent” temporal resolution with large area coverage present major technological challenges*
  - *Systematic vs episodic*
- Mission cost (including launch/orbit)
  - *Advanced instrumentation concepts may offer reduced mass and improved capability, but at higher mission risk or later launch date*
  - *Potential for “hosted payloads” on other geostationary platforms*
  - *Potential for common instrument development*

Assembling a Global View: International Cooperation

- Valuable synergies of international cooperation on geostationary systems
  - *Complementary coverage and data access*
    - Korean GOCI sensor (2009): ocean color observations from GEO
    - ESA Sentinel 4: GEO Satellite for atmospheric composition
    - JAXA GEO platform for atmospheric composition
    - Korean MP-GEO atmospheric composition/ocean mission
  - *Instrument development, calibration, validation and retrievals*
  - *Data applications for societal benefit: assimilation, inversion, decision support systems*

- Mutual participation on working groups and science teams

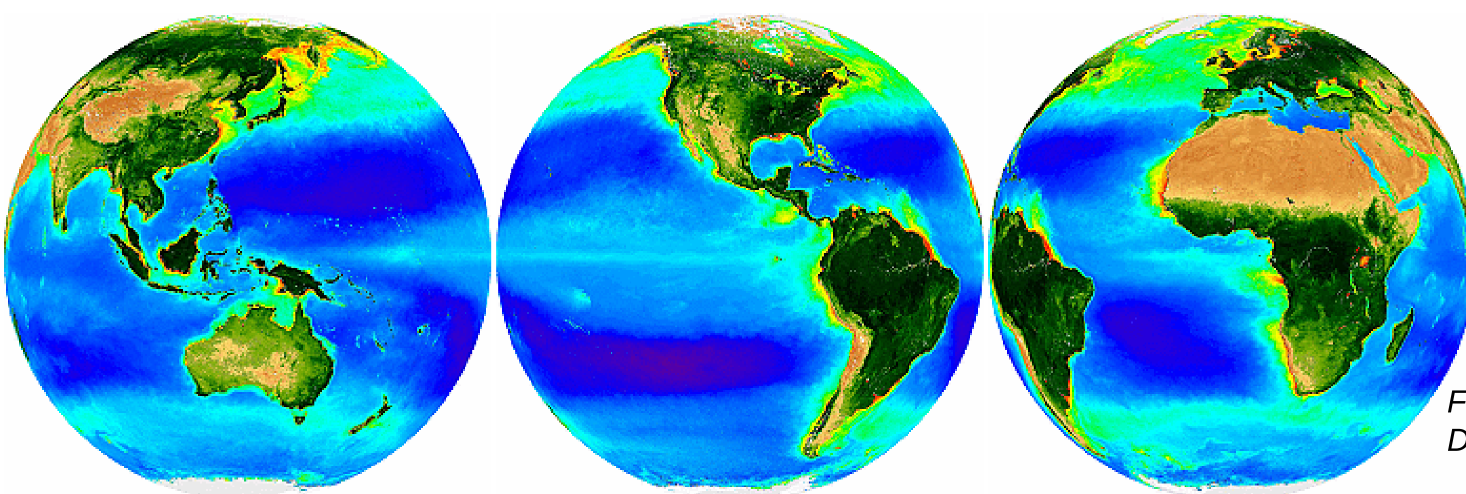


Figure courtesy Doreen Neil, NASA

Asia and Australia: JAXA, KARI

Americas: NASA

Europe and Africa: ESA

Backup slides

Instrument Incubator Program 2007 Awards vs. Decadal Survey Missions

2007 Instrument Incubator Awards versus Decadal Survey Missions	CLARREO	SMAP	ICESat-II	DESDynI	HyspIRI	ASCENDS	SWOT	GEO-CAPE	ACE	LIST	PATH	GRACE-II	SCLP	GACM	3D-Winds	CLARREO-NOAA	GPSRO	XOVWM
Abshire/GSFC - column CO_2, lidar						■												
Diner/JPL - aerosols and clouds, polarimetric imager									■									
Durden/JPL - clouds and precipitation, profiling radar									■									
Folkner/JPL - time-varying gravity, laser frequency stabilization												■						
Fu/JPL - surface water and ocean topography, interferometric SAR							■											
Grund/Ball - tropospheric winds, Doppler lidar															■			
Hackwell/Aerospace - mineral and gas, TIR spectrometer					■													
Heaps/GSFC - column CO_2, lidar						■												
Hook/JPL - mineral/water resources, hyperspectral TIR spectrometer					■													
Kavaya/LaRC - tropospheric winds, Doppler lidar															■			
Kopp/CU - radiation balance, UV-SWIR hyperspectral imager	■																	
Lambrigtsen/JPL - T, water vapor, precipitation; microwave sounder											■							
McClain/GSFC - ocean color, UV-SWIR radiometer									■									
Mlynczak/LaRC - radiation balance far-IR spectrometer	■																	
Neil/LaRC – CO from geostationary orbit, infrared correlation radiometer								■										
Papapolymerou/GT - snow-water equivalent, X-band phased array													■					
Revercomb/UWM - radiation balance, SI-traceable IR calibration	■																	
Sander/JPL - air pollution and coastal imaging, panchromatic FTS								■										
Stek/JPL - atmospheric composition, microwave limb sounder														■				
Weimer/Ball - vegetation canopy, steerable lidar				■														
Yu/GSFC - topography and vegetation structure, swath-mapping lidar										■								

■ IIP07 Awards

Advanced Component Technology Program
2008 Awards vs. Decadal Survey Missions

2008 Advanced Component Technology Awards versus Decadal Survey Mission	CLARREO	SMAP	ICESat-II	DESDynI	HyspIRI	ASCENDS	SWOT	GEO-CAPE	ACE	LIST	PATH	GRACE-II	SCLP	GACM	3D-WINDS	CLARREO-NOAA	GPSRO	XOVWM
Dobbs/ITT - corrugated mirror telescope array for lidar			X	X		X			X	X				X	X			
Fang/JPL - large deployable reflector for Ka- and W-band									X									
Hoffman/JPL - thermal packaging for RF hybrids, radar				X			X											
Illing/Ball - polarization scrambler, spectroscopy					X			X	X					X				
Janz/GSFC - visible NIR blind GaN focal plane array, hyperspectral								X										
Krainak/GSFC - NIR optical receiver, lidar			X	X		X			X	X					X			
Marx/GSFC - hybrid doppler wind lidar transceiver															X			
McGill/GSFC - detector technology for cloud aerosol lidar									X						X			
Meehan/JPL - RF ASIC for digital beamforming, GNSS															X		X	
Mlynczak/LaRC - FIR detectors for Earth radiation	X																	
Phillips/LockMart - CO2 laser absorption spectroscopy						X												
Reising/Colo. St. Univ.- radiometer for wet-tropospheric correction							X											
Rider/JPL - analog to digital converter from UV to mid-IR					X			X	X					X				
Siqueira/Univ. Mass. - low power, high BW receiver, Ka-band							X											
Taylor/Composite Tech. Dev. - large aperture, deployable reflector		X					X				X		X					X
Thomson/JPL - deployable Ka-band reflect array							X											

Tier 2 Mission Development Objectives

- Advance the science maturity and overall mission development
  - *Build on the results of the 2006-2007 mission studies*
  - *Define/refine scientific requirements*
  - *Develop mission/instrument requirements*
  - *Conceptualize mission/instruments*
  - *Mature mission-enabling technologies, assess, and downselect*
  - *Support cross and common mission activities*
  - *Develop partnering opportunities and conduct joint studies*

- Conduct the studies in an integrated fashion, led by the Program Scientist and Program Executive and coordinating across multiple levels within the Earth Science Community