

## NASA R&D on Future Space Vehicles Climbs

### AAAS R&D Funding Update on R&D in FY 2006 NASA Conference Appropriations

#### Highlights

- The National Aeronautics and Space Administration (NASA) continues to juggle its many missions within a flat budget of \$16.4 billion in FY 2006, 1.3 percent or \$215 million above last year. **In the final FY 2006 appropriation, NASA's R&D funding climbs 7.3 percent or \$776 million to \$11.5 billion** as an expected decline in Space Shuttle costs frees up money for NASA R&D programs, especially those related to NASA's vision for human space exploration (see Table).

- The large increase in NASA's R&D is partly due to mid-year cuts imposed on the 2005 budget. In May, NASA shifted \$284 million from R&D accounts to the Space Shuttle program to give it a record \$5 billion budget in preparation for a safe July 2005 return to flight. With the next shuttle launch delayed until May 2006 to address safety problems, the FY 2006 R&D budget could also be reduced in coming months to pay for new safety measures.

- While the agency receives additional resources for its ambitious plans to finish construction of the International Space Station, explore the solar system, and develop the technologies needed for future moon and Mars missions, there are steep cuts in other NASA missions. Even from a 2005 base reduced by mid-year cuts, **there are further cuts in NASA's aeronautics research portfolio (down 2.5 percent to \$938 million), the earth sciences portfolio (down 7.3 percent to \$2.1 billion), and especially biological and physical sciences research (down 13.6 percent to \$799 million).**

- **The largest increases go to applied research on human space flight technologies.** The Constellation Systems program to develop a new Crew Exploration Vehicle and Crew Launch Vehicle for human exploration sees its budget nearly triple to \$1.1 billion, while efforts to develop supporting technologies also receive large increases.

- The International Space Station receives \$1.8 billion, up 5.5 percent, in anticipation of the Space Shuttle returning to its role of transporting Station components into space.

#### NASA R&D in FY 2006 Conference Appropriations

On November 7, congressional appropriators released the conference report (final agreement) for the FY 2006 Science, State, Justice, and Commerce appropriations bill (HR 2862), setting the stage for final congressional approval and a presidential signature in the next week. But a later appropriations bill may impose across-the-board cuts of up to 2 percent on all programs, even after the bill is signed into law. **Congress gives NASA a total budget of \$16.4 billion in FY 2006, an increase of 1.3 percent or \$215 million (see Table) that falls slightly short of the request.** (For details of R&D in the FY 2006 request, please see Chapter 10 of *AAAS Report XXX: R&D FY 2006* or the March 9 AAAS R&D Funding Update.)

Because of an extensive reorganization of appropriations bill jurisdictions, in FY 2006 NASA and the National Science Foundation (NSF) are funded for the first time with the Departments of Commerce, Justice, and State. NSF and NASA were formerly funded in the now defunct VA-HUD appropriations bill alongside the Departments of Veterans Affairs and Housing/Urban Development. As a result, the former Commerce, Justice, and State appropriations bill now has "Science" in its name. The conference report contains an across-the-board cut of 0.28 percent to get the bill's totals under the congressional target, in

advance of a larger across-the-board cut for all domestic programs of up to 2 percent that is expected to be included in the last FY 2006 appropriations bill. (All figures in this analysis reflect the 0.28 percent cut.)

The National Aeronautics and Space Administration (NASA) may escape the tight funding squeeze facing other domestic programs in FY 2006, but the agency faces its own funding squeezing from trying to get the Space Shuttle back to safe flight, finish construction of the International Space Station, embark on an ambitious plan to return humans to the moon and send them onward to Mars, and also support R&D across a broad range of fields, all within an essentially flat budget. The FY 2006 \$16.4 billion NASA budget is a 1.3 percent increase, less than inflation, for a key year in which a dramatic ramp-up of R&D efforts on human space vehicles coincides with shuttle flights and resumed construction of the Space Station.

Because of mid-year reductions in the 2005 base along with an expected decline in non-R&D Shuttle funding, NASA's R&D funding increases dramatically in 2006 after a cut in 2005, but any increase in Shuttle costs in preparation for the next May 2006 launch, as well as an expected across-the-board cut, could eat away at the increase.

In order to keep up with changing shuttle launch schedules and shifting timelines for ending the Space Station and returning to the moon, NASA's budget has been in flux for the past few years with major changes happening even in mid-year. **NASA's R&D (two-thirds of the agency's budget) totals \$11.5 billion in the final FY 2006 appropriation, a 7.3 percent increase that is certain to be the largest percentage increase among the major R&D funding agencies (see Table and Figure 1).** R&D funding grows far faster than the total NASA budget because the agency anticipates a reduction in the non-R&D Space Shuttle program from a record \$5.0 billion funding level last year down to \$4.5 billion this year, and also because NASA made mid-year cuts in the 2005 R&D portfolio mid year (see Figure 1). But if safety upgrades in preparation for the May 2006 shuttle launch cost more than expected, money could be siphoned off from R&D programs to the shuttle midway through 2006, as was the case in preparation for the July 2005 return to flight.

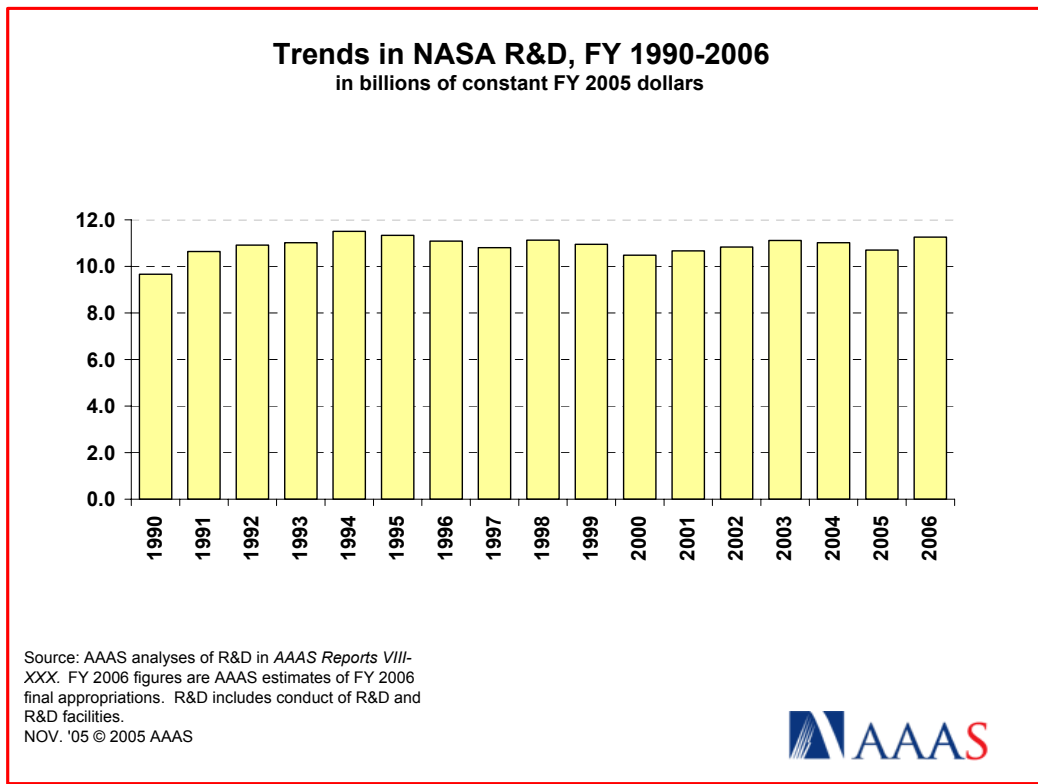


Figure 1. (click on image for PDF)

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For the moment, the latest FY 2006 budget plan agrees with NASA's plan to increase funding for the International Space Station. The Station is now essentially in maintenance mode until the Space Shuttle resumes its role of carrying Station components into orbit. After shrinking to \$1.4 billion in 2004, Space Station construction is scheduled to resume after the next shuttle launch with a \$1.8 billion budget, up \$93 million from 2005. The Space Station and the Space Shuttle make up the Exploration Capabilities (EC) account, which totals \$6.6 billion, a decline of 6.6 percent because of the expected fall-off in Shuttle costs (see Table). If the shuttle launch is delayed again, Space Station funding will be diverted to other projects.

With these two big-ticket current programs provided for in the EC account, **the Science, Aeronautics, and Exploration (SAE) account, which funds most of NASA's research, climbs \$684 million or 7.6 percent to reach \$9.7 billion. The entire increase and then some goes to the new Constellation Systems program** to develop replacements for the Space Shuttle which will eventually return humans to the moon and then onward to Mars. From \$422 million last year, funding nearly triples to \$1.1 billion in 2006 for applied research on the Crew Exploration Vehicle (CEV) and Crew Launch Vehicle (CLV) concepts. But NASA could wind up spending even more: Congress finalized its appropriation before an internal memo surfaced last week showing the agency's plan to devote \$1.6 billion to Constellation Systems to accelerate development of the CEV and CLV to have the vehicles ready by 2012 instead of the previously announced 2014.

**The large increase for the next space vehicles comes at the cost of sharply reduced funding for biological and physical sciences research, and new propulsion technologies.** Constellation Systems is part of a larger Exploration Systems account geared to next-generation human space flight technologies; the overall Exploration Systems account gets \$3.0 billion, a 26 percent boost over 2005, but the entire increase goes to the Constellation Systems effort. Congress thus winds up endorsing NASA's proposal to **dramatically restructure and downsize its biological and physical sciences research portfolio** into a Human Systems Research and Technology program more narrowly focused on research topics relevant to human space flight. Human Systems R&T within Exploration Systems receives \$799 million, down 13.6 percent from \$925 million last year. But NASA plans to reduce the portfolio even further in order to boost Constellation Systems; the latest NASA plan allocates just \$564 million, down 40 percent from 2004 funding levels. The Prometheus Nuclear Systems and Technology program to develop new power and propulsion technologies based on nuclear power for future NASA missions receives \$126 million, down from last year's \$270 million, since NASA now sees no need for these technologies until 2018 at the earliest. The other Exploration Systems account, the Exploration Systems Research and Technology (R&T) program on support technologies aligned with Constellation Systems needs, increases 22 percent to \$901 million, although NASA now plans to reduce funding down to \$745 million.

**NASA R&D programs in aeronautics and the earth sciences suffer cuts in the FY 2006 appropriation and could suffer further cuts as the year goes on.** Funding for the Earth-Sun System program, restructured from the former Earth Science program, declines 7.3 percent to \$2.1 billion. This NASA program is a key part of the interagency Climate Change Science Program and is responsible for space-based observations of the earth environment. NASA's support of aeronautics research falls less than requested, but at \$938 million is still 2.5 percent below last year's funding level. Language accompanying the NASA appropriation makes clear congressional support for sustaining NASA's investment in aeronautics research, especially at a time when other industrial nations are increasing their investments, but funding lags behind the language. The bill contains provisions first proposed by the House calling on the Bush Administration to develop a National Aeronautics Policy within the next year that sets out a clear policy direction for the federal role in the civil aviation industry, and calls on NASA to prepare a report on how the FY 2006 aeronautics investment would enhance U.S. competitiveness in aeronautics, lead to breakthrough technologies, and contribute to other NASA goals. That said, NASA's aeronautics support has been in steady decline over the last decade and FY 2006 appropriation leaves the portfolio at little more than half the size of a decade ago.

**Congress allocates \$271 million for the Hubble Space Telescope, to follow on \$291 million provided last year.** The allocation follows a recent decision by new NASA Administrator Michael Griffin to reassess the possibility of a servicing mission to the telescope. NASA attracted strong criticism a few years

ago for canceling a planned shuttle servicing mission to extend the life of the Hubble, instead focusing on robotic servicing. The FY 2006 budget proposal in February, prepared under the watch of the previous administrator, would have canceled any servicing mission, but the latest appropriation puts a servicing mission back on the agenda.

Congress deletes funding for the Centennial Challenges program to award competitive prizes for new technologies. The request of \$34 million would have funded NASA attempts to replicate the X-Prize program, but Congress has criticized NASA for requesting the funds but leaving the technology challenges, prize levels, and other milestones unidentified in a program that has yet to be authorized in law.

Funding for Mars Exploration remains at last year's level of \$680 million to fund extended operations of the Mars Exploration Rovers and other robotic Mars missions.

Despite tough budget times, one part of the NASA budget that continues to increase is congressional earmarks. **Congress allocates a record-breaking \$321 million for performer-specific projects in the FY 2006 NASA appropriation**, far above the \$217 million in similar earmarks in FY 2005. The earmarks are distributed throughout the SAE account, but many of them are in Education Programs, resulting in a dramatic boost of 53.8 percent in its budget to \$275 million. Although many of the earmarked projects fund R&D or R&D facilities related to NASA missions in earth, space, and physical sciences, the earmarks also fund science education programs, science museums, and high school science labs.

**Impacts and Next Steps**

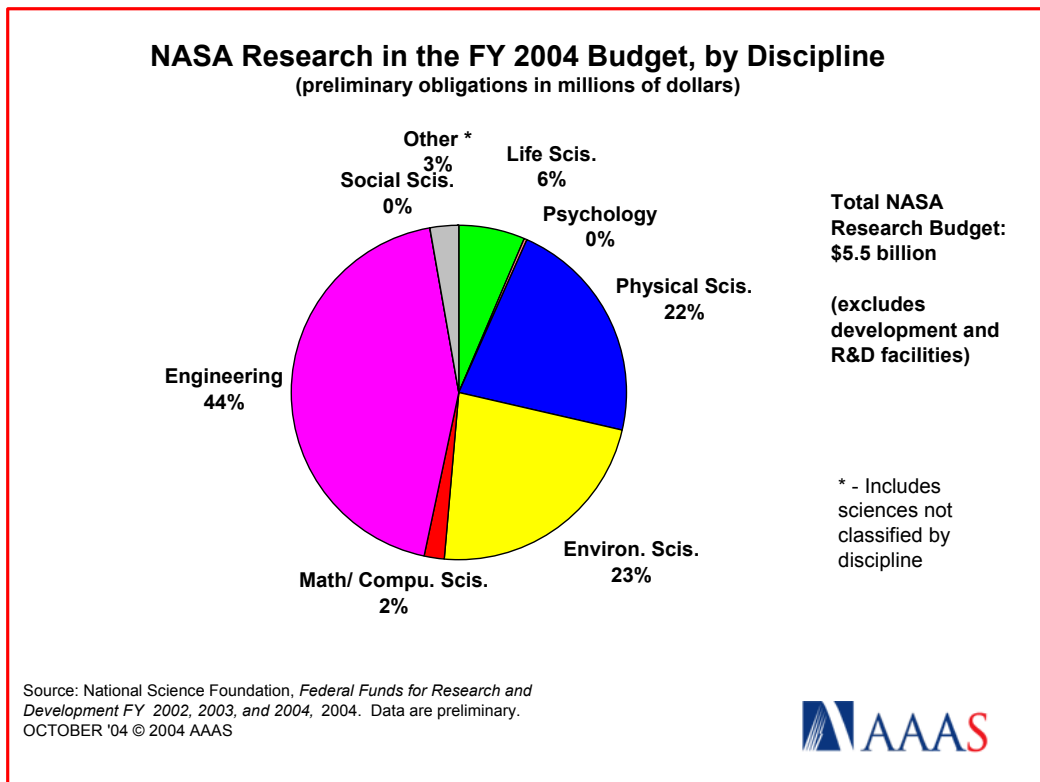


Figure 2. (click on image for PDF)

The large increase to NASA's R&D portfolio in FY 2006 continues a modest upward trend for the last few years, as shown in Figure 1, except for the drop in the 2005 budget. NASA's R&D funding has just kept pace with inflation going back to FY 1991, and recent increases have been just barely ahead of inflation. NASA has committed to carrying out its ambitious plans with a budget that would just keep pace with expected inflation over the next decade. Although inflationary increases are more than most R&D funding

agencies are likely to get in the next few years, NASA's big plans will still require NASA to reshuffle its resources and to meet ambitious targets for deployment, construction, and then phase-out of the Space Shuttle and Space Station programs to make room for moon and Mars programs.

Although much of NASA's R&D portfolio funds development and facilities projects such as the Space Station, **NASA is responsible for 10 percent of all federal support for basic and applied research with far larger roles in key fields.** Engineering research makes up the largest part of the NASA portfolio (see Figure 2). NASA funds more than a quarter of total federal support for engineering research. NASA supplies nearly all the federal support for some engineering sub-fields such as astronautical engineering and aeronautical engineering. NASA is the leading federal sponsor of the environmental sciences (oceanography, atmospheric sciences, geological sciences). The environmental sciences are a quarter of NASA's portfolio, but NASA accounts for a third of total federal support for environmental sciences research. NASA also invests heavily in the physical sciences (astronomy, chemistry, and physics). NASA is the second largest federal sponsor of physical sciences behind the Department of Energy, and is by far the leading sponsor of astronomy research with more than 70 percent of the federal total. NASA research increases dramatically in the FY 2006 budget, but the increases will overwhelmingly go to expand the engineering share of the portfolio because of the focus on next-generation space vehicles. There are likely to be cuts in NASA support for other disciplines.

**Industrial firms receive half the NASA R&D portfolio.** In FY 2004, industry received 50 percent of the NASA R&D budget. 20 percent of NASA R&D went to the agency's own federal laboratories, while another 14 percent went to the Jet Propulsion Laboratory in California, a privately-operated (by CalTech) NASA-owned laboratory. Universities and colleges received 10 percent of NASA's R&D.

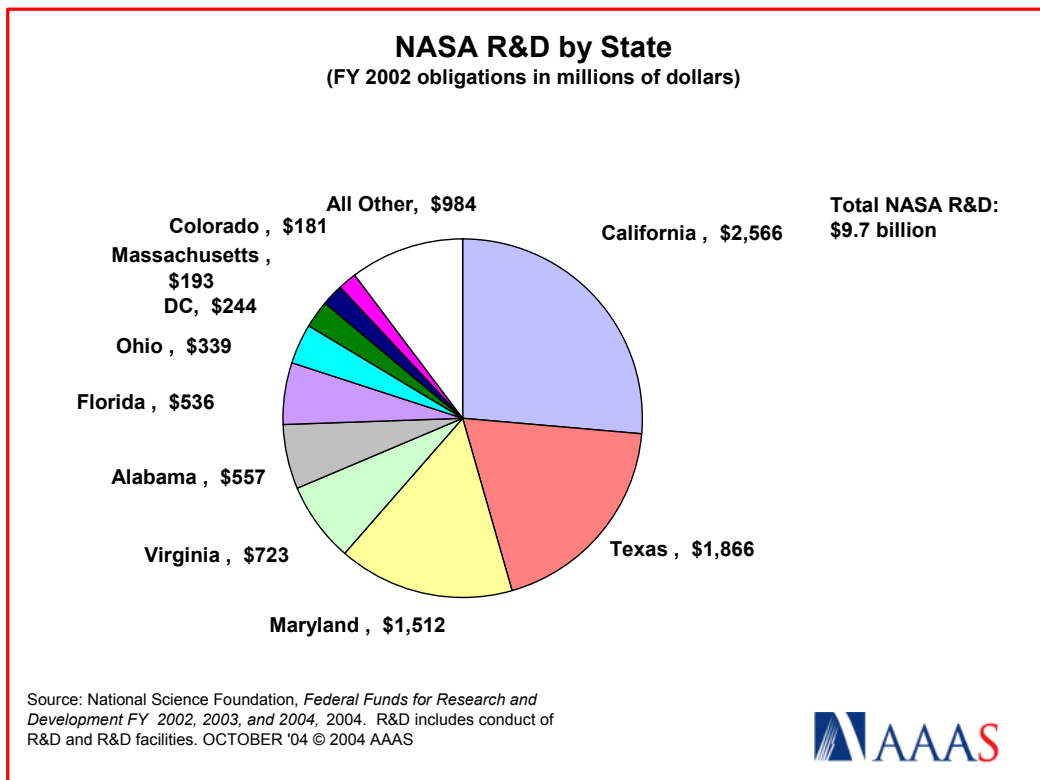


Figure 3. (click on image for PDF)

Because of NASA's reliance on large firms and large federal laboratories, NASA's R&D is heavily concentrated in just a few states. As shown in Figure 3, fully two-thirds of NASA's R&D is performed in just the four states of California, Texas, Maryland, and Virginia. California is home to three major NASA facilities: the Jet Propulsion Laboratory in Pasadena, the Ames Research Center in Moffett Field, and the

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Dryden Flight Research Center in Edwards, Texas is home to the Johnson Space Center in Houston; Maryland houses the Goddard Space Flight Center; and Virginia houses the Langley Research Center in Hampton. These states are also where many industrial contractors on projects such as the International Space Station are located.

The House and the Senate are expected to give final approval to the Science, State, Justice, and Commerce bill shortly, and President Bush is expected to sign the bill into law before the temporary FY 2006 funding bill expires on November 18. But this conference report may not be the final word; Congress is working on an across-the-board cut for all appropriations to add to the final FY 2006 appropriations bill. The cut is expected to reach back even to enacted appropriations bills and reduce funding for all programs by up to 2 percent.

(This analysis is one of a series of AAAS R&D Funding Updates on FY 2006 congressional appropriations. The complete series of AAAS R&D Funding Updates, including continually updated analyses of R&D in FY 2006 appropriations, is available on the AAAS R&D Web Site (<http://www.aaas.org/spp/rd>) in the "FY 2006 R&D" or the "What's New" sections.)

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Table. NASA R&amp;D in FY 2006 House-Senate Conference

**Table. National Aeronautics and Space Administration  
House-Senate Conference on R&D in the FY 2006 Budget  
(budget authority in millions of dollars)**

	FY 2005 Estimate	FY 2006 Request	House-Senate Conference				
			FY 2006 CONF.	Chg. from Request Amount	Chg. from Request Percent	Chg. from FY 2005 Amount	Chg. from FY 2005 Percent
Summary of R&D by Appropriation:							
<b>1. Exploration Capabilities (EC) *</b>							
International Space Station	1,676	1,857	<b>1,769</b>	-88	-4.7%	93	5.5%
Space Shuttle	4,964	4,531	<b>4,511</b>	-19	-0.4%	-453	-9.1%
Space and Flight Support	474	376	<b>364</b>	-12	-3.1%	-110	-23.2%
Total Exploration Capabilities	7,114	6,763	<b>6,644</b>	-119	-1.8%	-470	-6.6%
<b>2. Science, Aeronautics and Exploration (SAE) *</b>							
Solar System Exploration	1,787	1,901	<b>1,864</b>	-37	-1.9%	77	4.3%
The Universe	1,475	1,512	<b>1,562</b>	50	3.3%	87	5.9%
Earth-Sun System	2,291	2,064	<b>2,123</b>	59	2.9%	-168	-7.3%
Exploration Systems	2,356	3,165	<b>2,972</b>	-194	-6.1%	616	26.1%
- Constellation Systems	422	1,120	<b>1,146</b>	26	2.3%	724	171.6%
- Exploration Systems	739	919	<b>901</b>	-19	-2.0%	161	21.8%
- Prometheus	270	320	<b>126</b>	-194	-60.6%	-144	-53.4%
- Human Systems Res. & Tech.	925	807	<b>799</b>	-7	-0.9%	-125	-13.6%
Aeronautics Research	962	852	<b>938</b>	86	10.1%	-24	-2.5%
Education Programs	179	167	<b>275</b>	108	64.9%	96	53.8%
<b>Total ESA</b>	9,051	9,661	<b>9,734</b>	73	0.8%	684	7.6%
3. Inspector General	31	32	<b>32</b>	0	-0.3%	1	3.2%
<b>Total NASA Budget</b>	16,196	16,456	<b>16,411</b>	-46	-0.3%	215	1.3%
<i>minus non-R&amp;D Activities:</i>							
Space Shuttle	-4,964	-4,531	<b>-4,511</b>	19	-0.4%	453	-9.1%
Other non-R&D	-474	-376	<b>-364</b>	12	-3.1%	110	-23.2%
Inspector General	-31	-32	<b>-32</b>	0	-0.3%	-1	3.2%
Education and Training	-22	-21	<b>-22</b>	-1	4.3%	0	0.0%
Total NASA Non-R&D Activities	-5,491	-4,959	<b>-4,929</b>	30	-0.6%	562	-10.2%
<b>TOTAL NASA R&amp;D</b>	10,705	11,497	<b>11,481</b>	-16	-0.1%	776	7.3%

AAAS estimates based on FY 2006 appropriations bills. Includes conduct of R&D and R&D facilities.

FY 2005 and FY 2006 request figures based on OMB R&D data and supplemental agency budget data.

FY 2005 figures include emergency supplemental for hurricane damages.

FY 2006 Conference figures adjusted to reflect an across-the-board cut.

Figures are rounded to the nearest million. Changes calculated from unrounded figures.

**NASA proposes an extensive restructuring of its budget in FY 2006.**

**Figures for all years have been adjusted to reflect the proposed budget structure.**

\* NASA funds are not appropriated by program. The FY 2006 program-level figures are AAAS estimates based on report language in the FY 2006 Conference appropriations bill; NASA has broad flexibility to shift funds between programs.

\*\* FY 2005 figures have been adjusted to reflect the May and July 2005 FY 2005 Operating Plans.

These figures differ from those presented in AAAS Report XXX: R&D FY 2006.

November 8, 2005 - AAAS estimates of House-Senate conference report.

These figures may be reduced by later across-the-board reductions or rescissions.