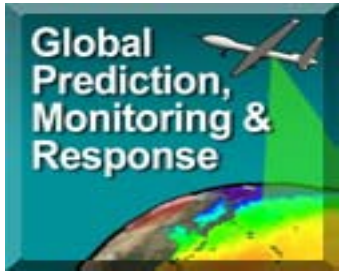
GREEN Forum

Hosted by NASA Glenn Research Center
May 11, 2009: 1:00 – 2:30 p.m.
Administration Building Auditorium

National Aeronautics and Space Administration

Greenspace

Leveraging NASA Capabilities for a Cleaner, Greener Earth



GREEN NASA AMES

Come join us as we continue to explore what could lie ahead for our country and our world in advanced renewable energy!

Ames Research Center
in Silicon Valley

Established in 1939
1800 Acres
Research & Technology Development
- Earth-Life-Space Sciences
- Computer systems
- Aeronautics

Astrobiology and Lunar Science Institutes
Science Missions
Exploration Systems
Small Satellites
Wind Tunnels
Thermal Protection Systems
Innovative Collaborations
2300 Employees
$600+ M Annual Budget

"We came all this way to explore the Moon, and the most important thing is that we discovered the Earth."

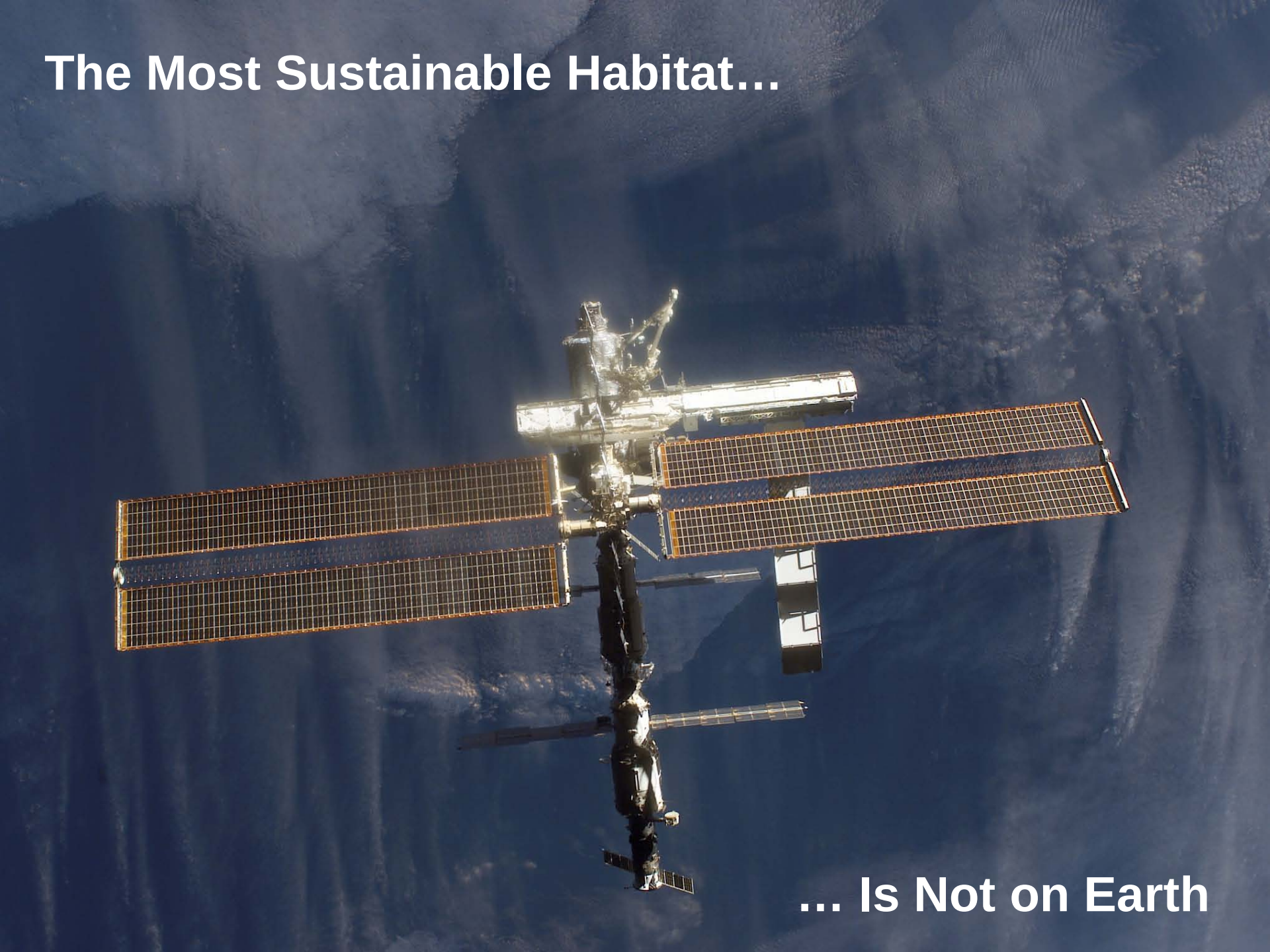
Bill Anders, Apollo 8 Astronaut

Climate Change Matters…

… Across the Solar System and Here on Earth

100 Watts is all that’s needed…
…Over five years and still roving on Mars

The Most Sustainable Habitat…



… Is Not on Earth

Our Crowded Airspace…

…Can improve efficiency and
reduce environmental impact

AMES FOCUS AREA:
GREEN/CLEAN TECHNOLOGY

At Ames, it is our goal to begin development of ARC/Moffett as a leader for Green/Clean technologies in Silicon Valley with focus on current issues of Global Change

The Ames Greenspace

Goal: The Greenspace initiative was established to align Ames' green activities with NASA Missions and green activities of other centers by providing strategy, integration and implementation support for the diverse portfolio of green projects and initiatives across the Center.

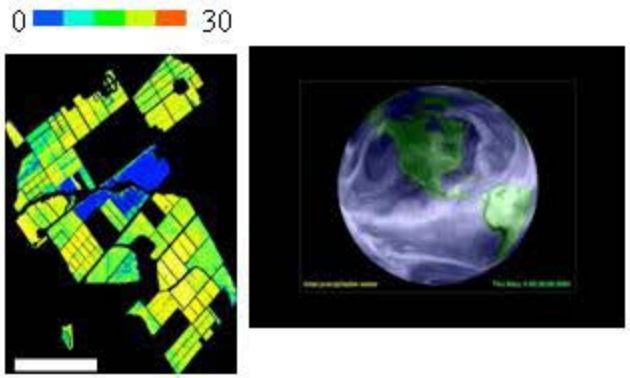
Focus Areas

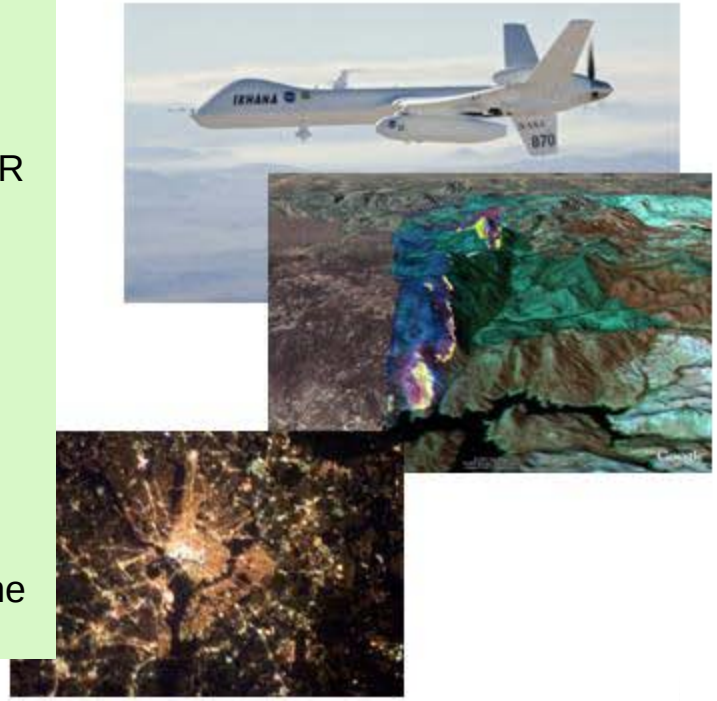
- **Global Prediction, Monitoring and Response**
  Sensors, airborne science, small spacecraft, computer climate modeling
- **Green Aviation**
  NextGen airspace, systems integration, new air transportation systems
- **Clean Energy**
  Biofuels, solar energy, partnerships, systems engineering
- **Sustainable Systems**
  Efficient use of resources for space and Earth, environmental stewardship, green buildings, facilities and land

Global Prediction, Monitoring and Response

Includes novel sensing technologies, airborne science capabilities, small space missions, and high-performance computer models for both global and regional climate impact analysis

- **Climate Impact Modeling**
  - TOPS, CQUEST, CCSM, NASA WorldWind
  - Major opportunities w/ CA DWR & CARB
- **Airborne observations**
  - Disaster response - (many calls to fly 2008 CA fires)
    - Partners - BP, PRCI, Cisco, Intel, USAF/Shuttle SAR
  - CARB supporting ARCTAS flights
  - Airborne platforms provide major opportunities for reimbursable work w/ state
  - Sierra, built on a shoestring, provides additional collaborative opportunities
- **Potential Venture Class missions**
  - NightSat - major link between geophysical & socio-economic issues
  - GeoView, CRESPO, LOCS, HS3 (Global Hawk hurricane mission)

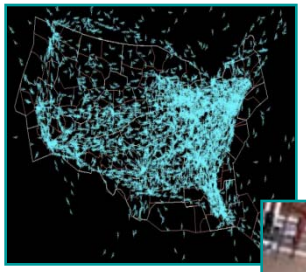




Green Aviation

Green Aviation R&D strengths at Ames includes activities to improve aircraft fuel efficiency, develop more efficient air traffic control, and pioneer new technologies to reach a carbon-neutral future of air transportation

- Development of the next generation of efficient air traffic control flight paths and procedures
- Development of new technologies and systems engineering processes to reach the future of carbon-neutral air transportation across the globe.
- Computational simulation and wind tunnel test capability to develop more efficient aircraft
- Systems engineering for overall improved aircraft and airspace system performance
- Innovative partnerships to bring future alternative energy aircraft, such as hydrogen-powered or electric, into the commercial airspace system



Air Traffic Management

Simulation and Testing

High-end Computing

Airfield

Systems Engineering

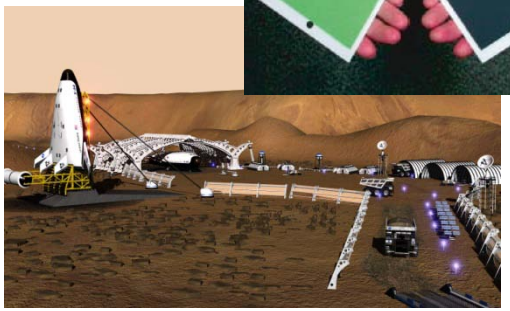
Fuels R&D

Relationships

Clean Energy

Research and partnerships to develop clean energy technologies that support our NASA missions; and, at the same time, help us here on Earth to transition away from greenhouse gas producers and become a more energy-independent nation

- **Algae Growth and Manipulation for Biofuels R&D**
  - Photobioreactor research and development
  - Microsatellites with algae in space
  - Characterization and Strain Selection to balance lipid content, growth rates, and other properties
- **Clean Energy Partnerships:**
  - Kleenspeed Inc: developer of advanced electric motors.
  - SolFocus, Inc.: advanced solar concentrator and solar thermal
  - Unimodal LLC.: advanced ground transportation technology
- **Systems Engineering**
  - Analysis of requirements for complex systems
  - Capability to technically facilitate and integrate the development of different algal processes into a single system
  - Ecosystem impacts; sustainability assessments



Sustainable Systems

Projects to maximize the efficient use of resources for future sustainable space systems; and projects to upgrade our NASA infrastructure to improve stewardship of environmental resources, reduce operating costs and diminish resource needs

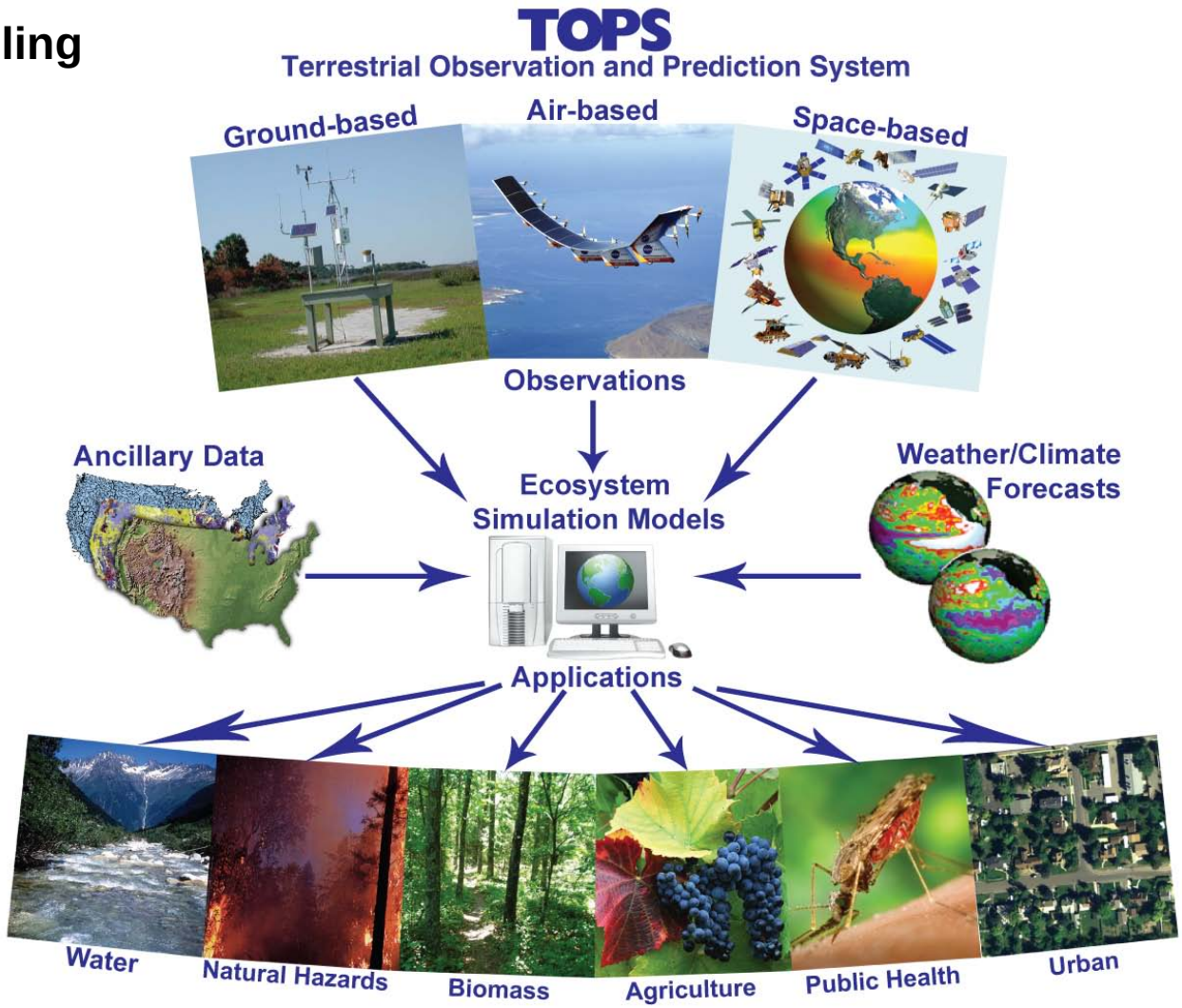
- **Exploration Life Support:** developing air water and waste recycling systems that minimize/eliminate waste and maximize self-sufficiency
- **High Performance Building:** designed for a sustainable future
  - LEEDS Platinum Plus
  - Create a highly flexible, collaborative and supportive work environment
  - Reduce energy demand
  - Reduce, reclaim and re-use water
  - Provide a sustainable landscape
- **Environmental Management:**
  - Use of reclaimed water for irrigation (100 M gal/yr)
  - Native plant species for reduction of water use
  - Bioremediation analysis

Highlights

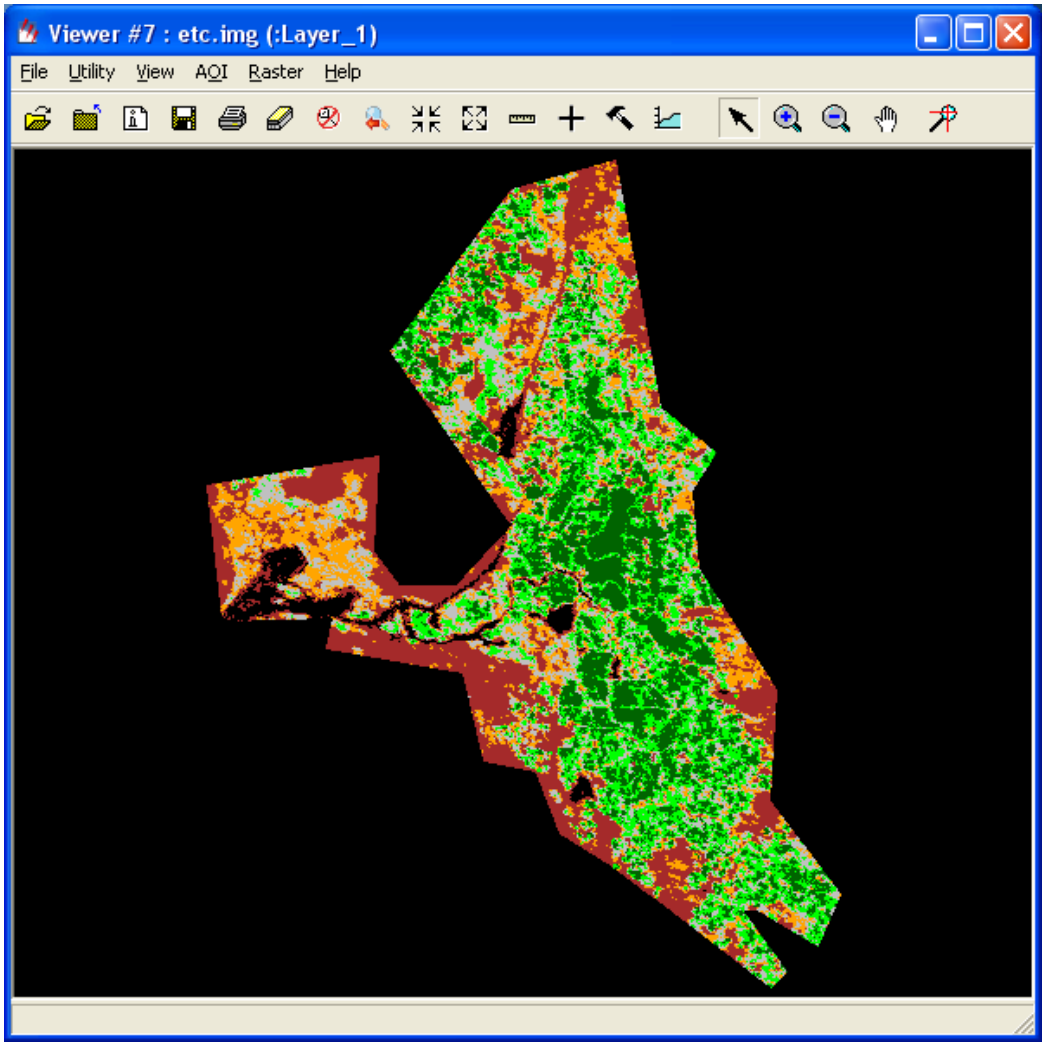
- Global Prediction, Monitoring and Response
- Green Aviation
- Clean Energy
- Sustainable Systems

Global Prediction, Monitoring and Response

- **Climate Impact Modeling**



TOPS-CIMIS Integration



By integrating spatially continuous satellite data with CIMIS data at various locations, we can provide farm-level irrigation requirements.

Daily ETc (mm)

<3
3-4
4-5
5-6
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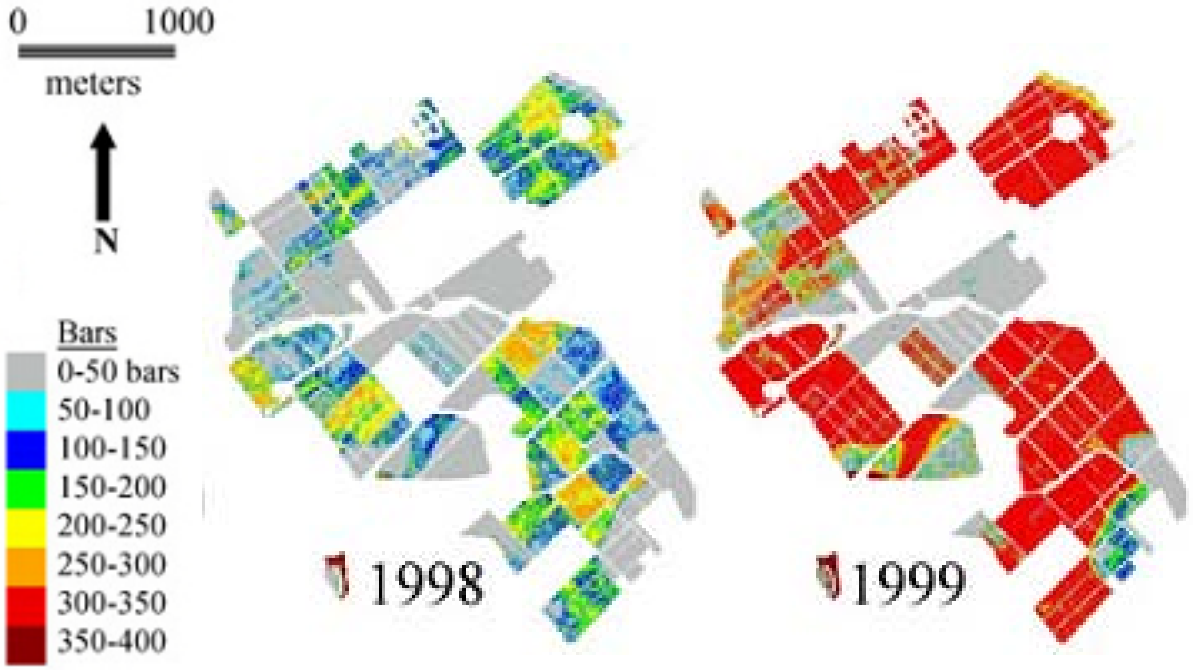
(California Irrigation Management Information System)

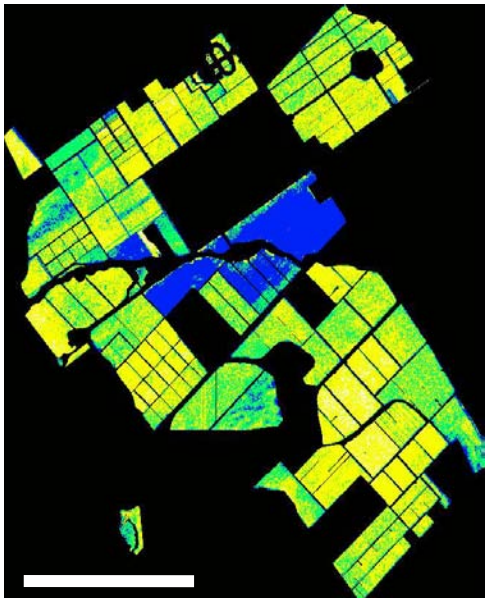
Helping NAPA Valley Vintners

manage impacts of seasonal weather and provide irrigation forecasts



CSUMB
UofMT
NASA-Ames
Vestra
R. Mondavi

1998 is warm and wet, 1999 cool, dry



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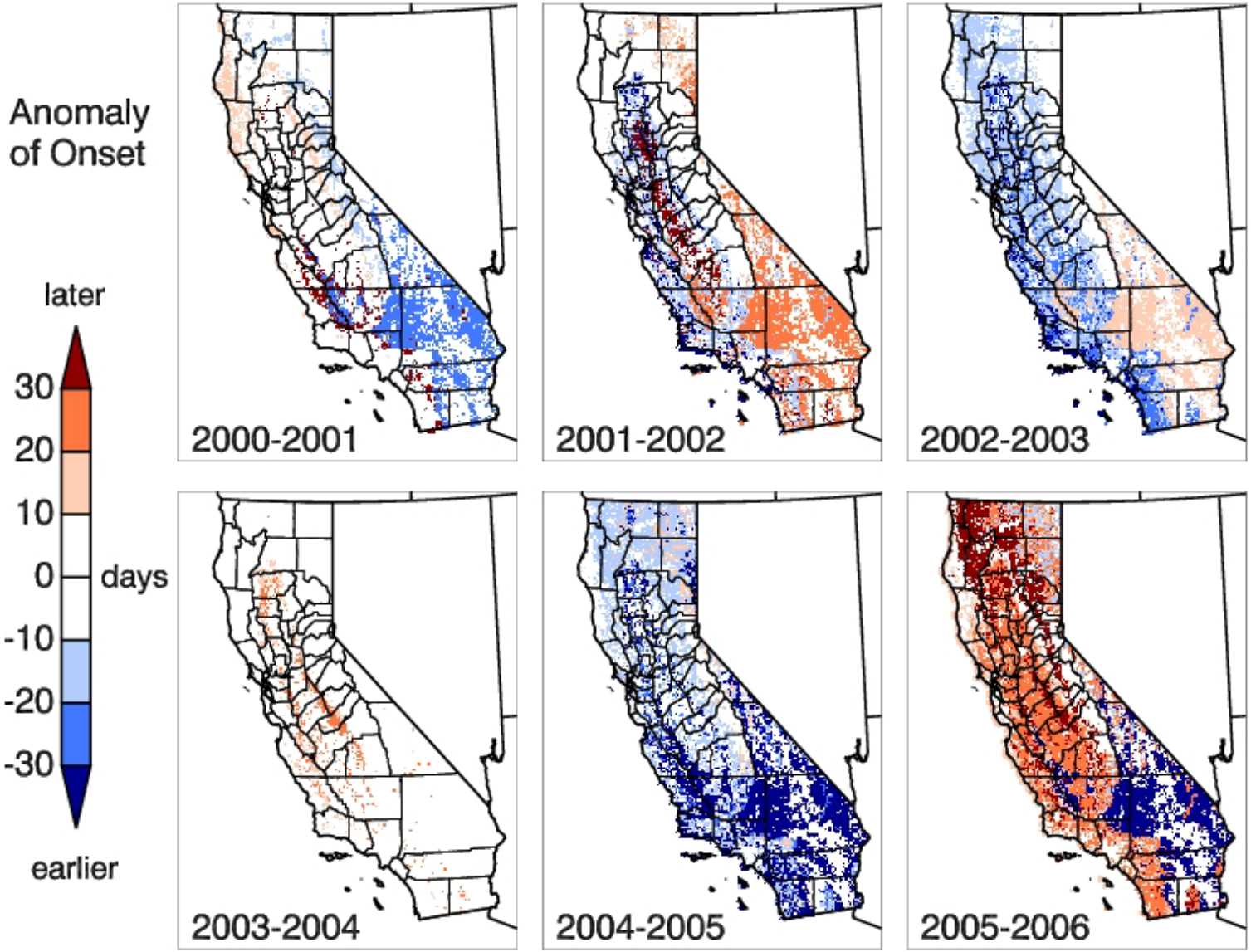
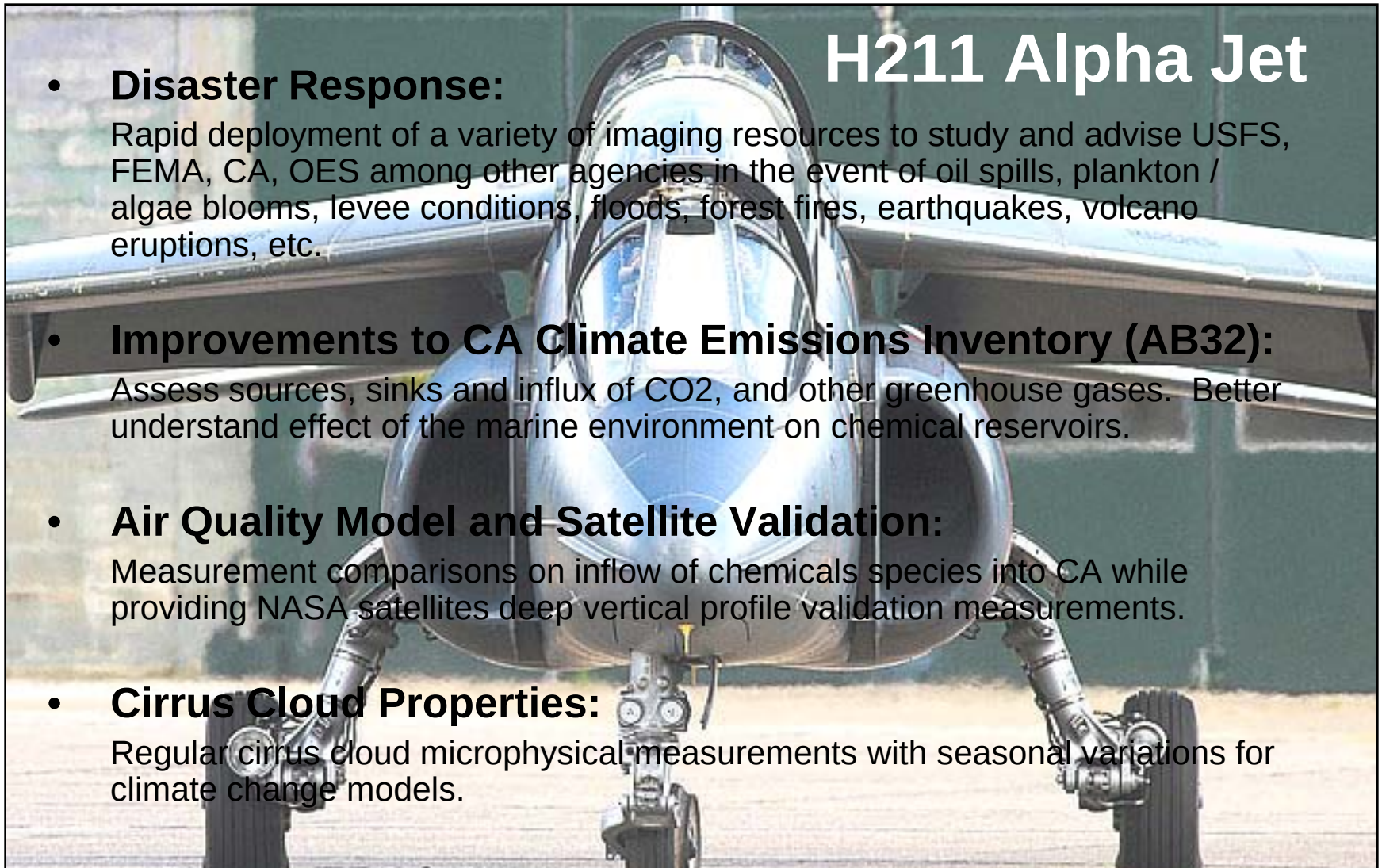
Forecast Irrigation (mm)
July 19-26, 2005

Predicting the Onset of Growing Season



Global Prediction, Monitoring and Response

- Airborne observations



- **Disaster Response:**
  Rapid deployment of a variety of imaging resources to study and advise USFS, FEMA, CA, OES among other agencies in the event of oil spills, plankton / algae blooms, levee conditions, floods, forest fires, earthquakes, volcano eruptions, etc.

- **Improvements to CA Climate Emissions Inventory (AB32):**
  Assess sources, sinks and influx of CO2, and other greenhouse gases. Better understand effect of the marine environment on chemical reservoirs.

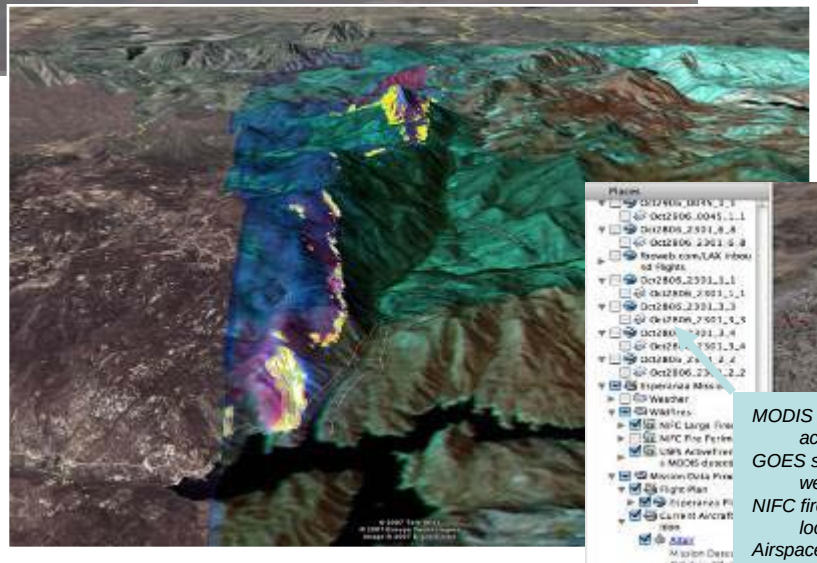
- **Air Quality Model and Satellite Validation:**
  Measurement comparisons on inflow of chemicals species into CA while providing NASA satellites deep vertical profile validation measurements.

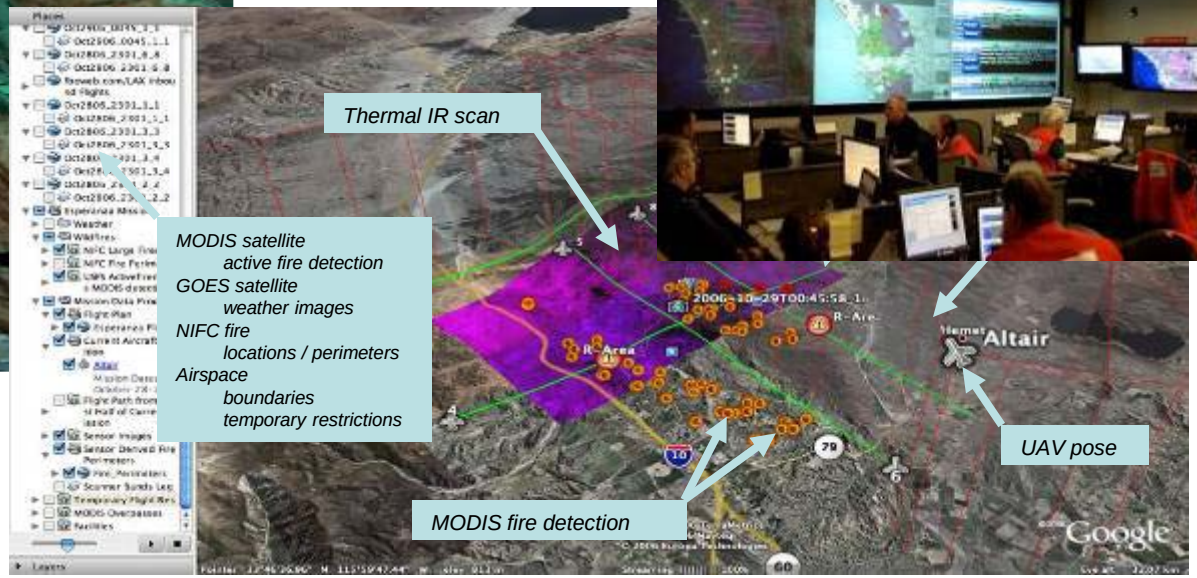
- **Cirrus Cloud Properties:**
  Regular cirrus cloud microphysical measurements with seasonal variations for climate change models.

Wildfire Monitoring

Real-time monitoring of Western States Wildfires

- Remote sensing with autonomous modular sensor
- Deployment of ground, aerial (UAV's), and orbital assets
- Integration of weather data (images and maps)
- Distributed data communication

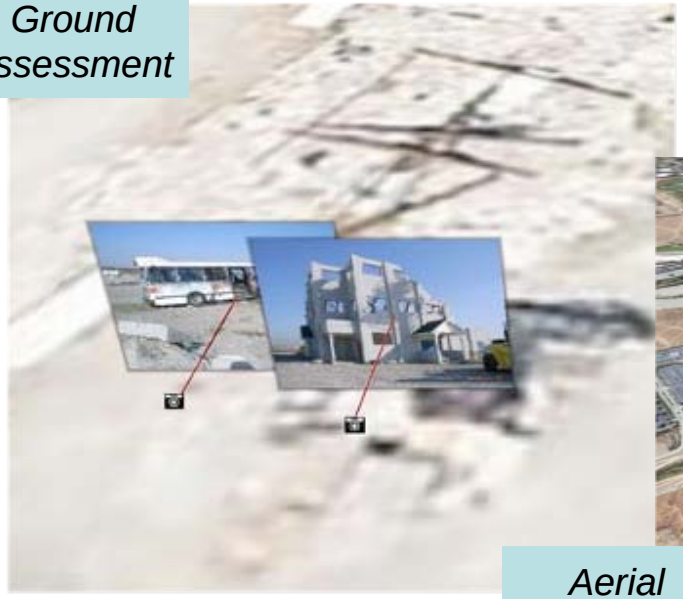




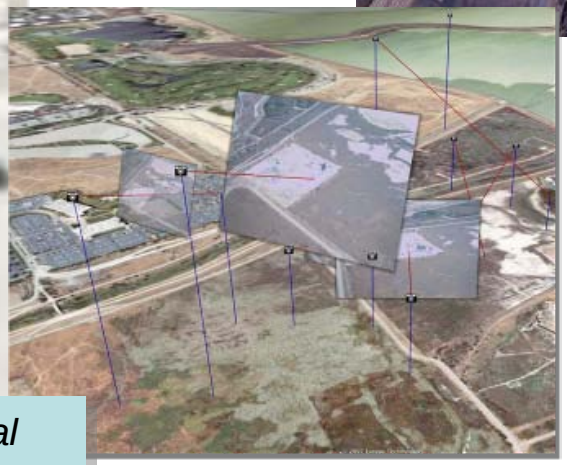
Disaster Imaging & Response

- **Improving Situational Awareness, Coordination and Speed of Response**

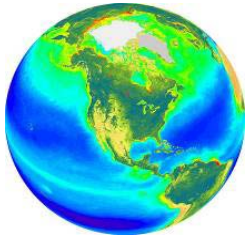
  –Rapid image processing/overlay of satellite imagery
  –Geo-positioning of aerial fly-over imagery
  –Integrated view of disaster zones



Ground assessment

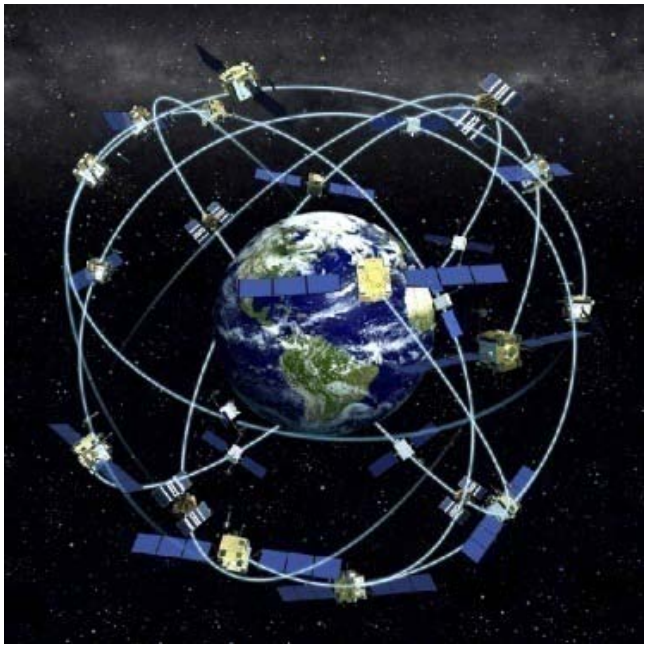


Aerial recon



"Planetary Skin"

capturing, collecting, analyzing and reporting data on environmental conditions around the world.

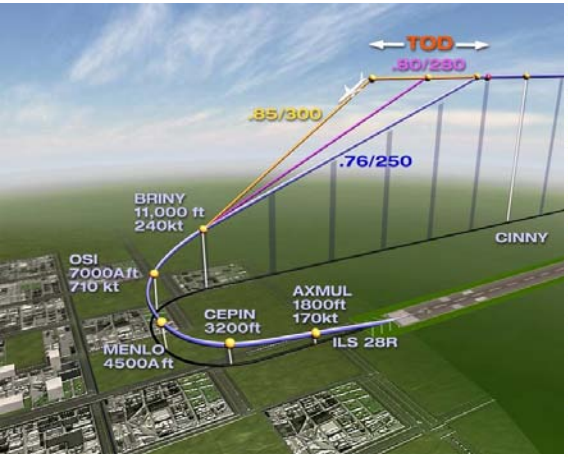


Highlights

- Global Prediction, Monitoring and Response
- Green Aviation
- Clean Energy
- Sustainable Systems

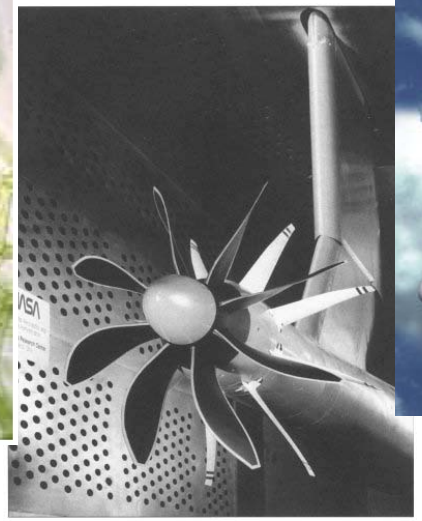
Green Aviation at NASA

Our First "A" is Getting Greener

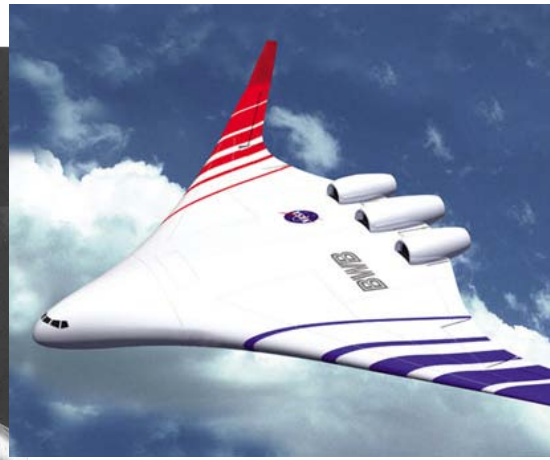


Air Traffic Management

Biofuels for Aviation



Propulsion



Structures and Airframes

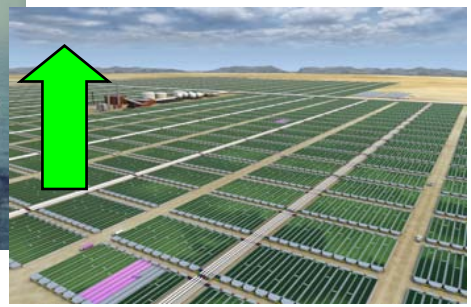
Both short-term and long-term strategies for Green and Environmentally Responsible Aviation will ultimately lead to field-ready products in several key technical disciplines

The Case for Greener Aviation

Reduce Environmental Impact

Freedom of Air Travel

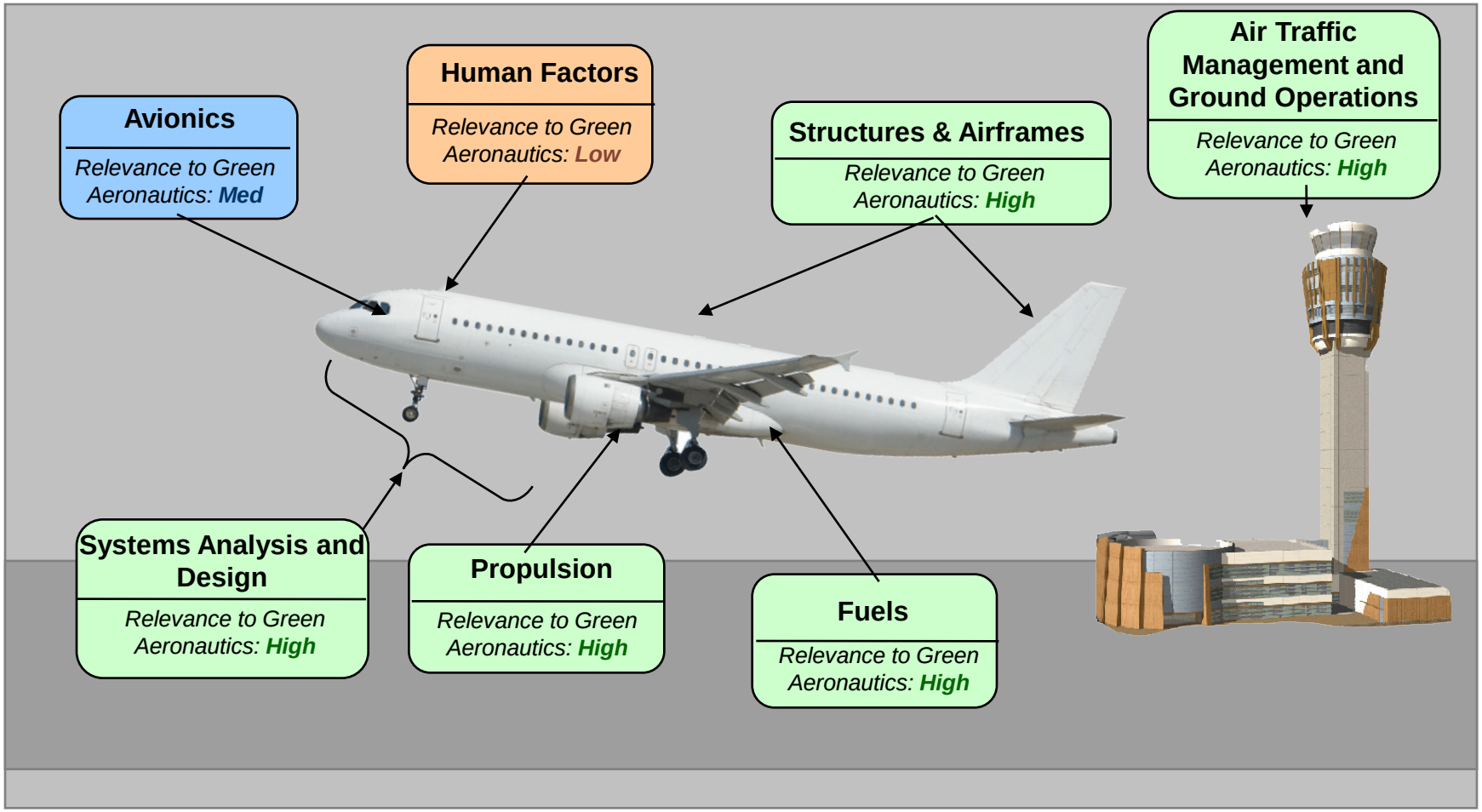
Energy Independence



National Security

Continued reliance on legacy aircraft and fuels makes America vulnerable
It also has a significant effect on the environment

Aeronautics Technology Areas



Five technology areas are of high relevance to green aeronautics and must be addressed to drive towards integrated solutions

Timeline: Potential Green Aviation Technical Areas and Contributions

	Near Term (3-7 years)	Medium Term (7-15 years)	Long Term (>15 years)
Air Traffic Management / Ground Systems	• Prove feasibility of continuous ascent/idle thrust descent • Evaluate turning ascent/descent • Fully develop ADS-B and begin fielding	• Trajectory optimization enabled by Intelligent Flight Control Systems • Implement continuous and turning ascent and descent • Standardize the use of ADS-B	• Satellite-enabled, automated control of aircraft through air traffic control (Next-Gen full use)
Fuels	• Evaluation of all biofuels for operational suitability to aviation • Synthetic land-based fuels field demos and limited production • Demonstration of algal biofuels	• Expanded production of biofuels • Limited production of algal biofuels	• Aid in development of biofuel industry for aviation; handoff responsibility to corporate partners • Feasibility of hydrogen fuels proven
Systems Analysis and Design	• Assessment of environmental impacts and benefits • Development and testing of control algorithms to reduce drag	• Modeling and simulation of advanced design concepts • Evaluation of innovative air systems (ESTOL, airships etc.) for viability and utility for green aero.	• Carbon footprint modeling/calculations for entire biofuels supply chain
Structures/ Airframes	• Next-gen concepts evaluation • Increasing use of composite airframes • Airships feasibility testing	• Selection of next-gen airframe geometry • Airframe fielding	• Funding and development of revolutionary airframe (*e.g.* joined wing) and structures (*e.g.* boron nanotubes) • UAV's for cargo
Propulsion	• Incremental gains in fuel efficiency, similar to those on the GEnx • Open rotor concept demos	• Thin film solar panels • Tech demos of other carbon-free concepts	• Carbon-free / electric aircraft • Hydrogen, hybrid or other power and propulsion systems for aircraft

Related Ames Capabilities

Systems Engineering

- Ames' competency in this area encompasses the entire life cycle of design, from concept development to implementation
- Computer aided design, simulation, and modeling will all be required to engineer the design
- Ames has significant expertise managing complex programs, with interagency and industrial participation

High-end Computing

- Ames' super-computing capability and its modeling expertise can deliver rapid, accurate results that are critical to aeronautics-related tests and evaluations
- NASA Ames' newest addition to their computing capability ranks 3rd in the top 500 fastest super-computers world wide

Relationships

- Ames has direct access to and experience with the technological innovation and entrepreneurial spirit resident in Silicon Valley
- A large number of these companies are highly specialized and skilled in green-related fields, including alternative fuel R&D

Fuels R&D

- NASA Ames is heavily involved in the early-stage research of growth, extraction, and use of alternative sources of fuel, including the feasibility testing of extracting lipids from algae to harness for aviation fuel
- A current push for offshore-membrane enclosures of algae promises results unmatched in open algae systems

Simulation and Testing

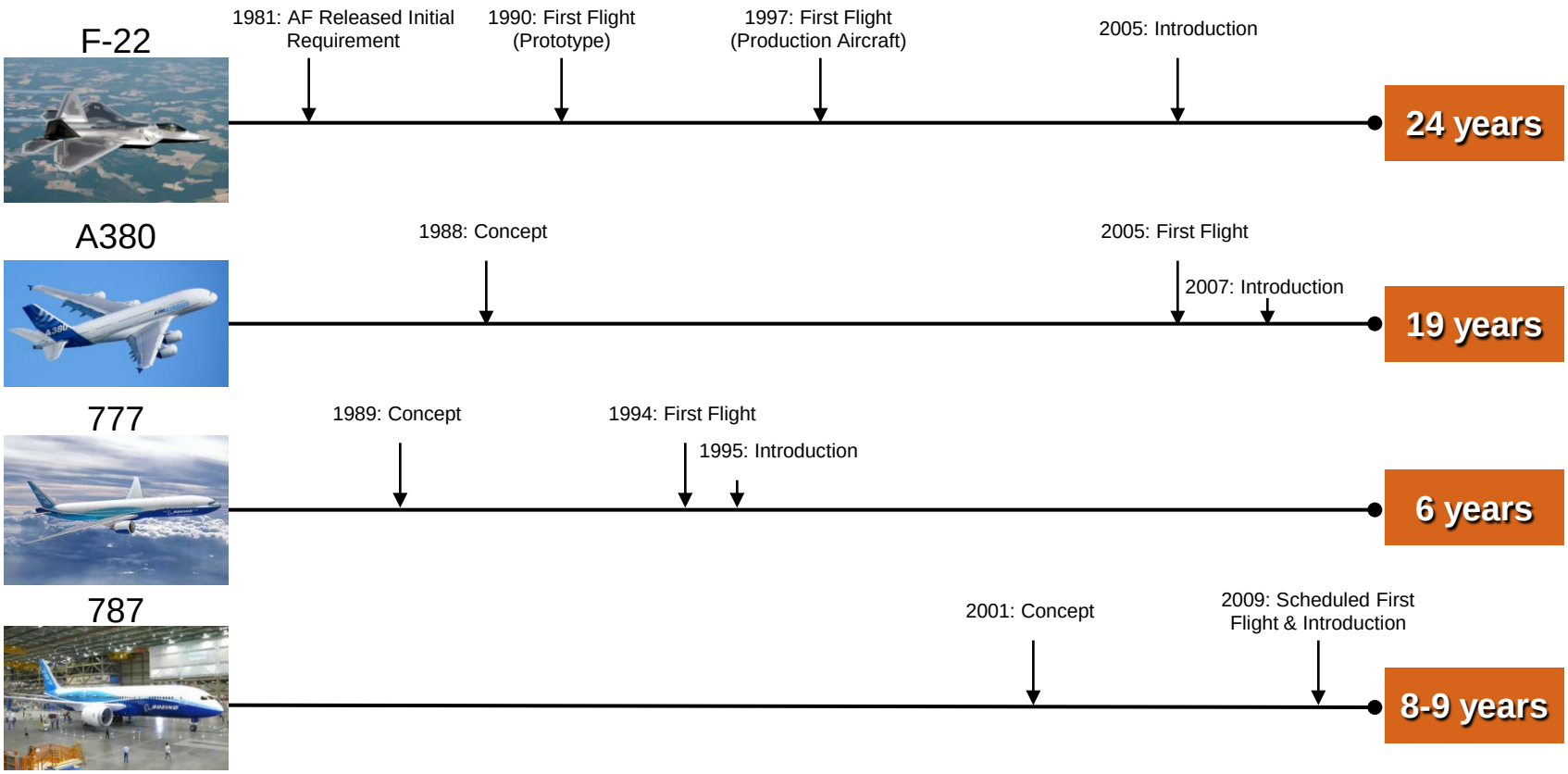
- Ames has the unique ability to perform computational fluid dynamics due to its IT capabilities and then test those calculations with in-house wind-tunnels
- Ames' Vertical Motion Simulator is the largest and highest fidelity six-degrees-of-freedom simulator in the world

Air Traffic Management

- The FAA has on numerous occasions partnered with NASA Ames on Air Traffic Management issues due to both its historical experience and present day expertise on the subject
- NASA Ames hosts a full-scale Air Traffic Management simulator which can be used to determine best practices for new approaches and solutions

NASA Ames retains a strong capability in several key technical areas related to green and environmentally responsible aviation

Timeline of Recent Evolutionary Aviation Developments



Today's evolutionary aircraft take many years ot develop. If green aircraft are to be developed in a timeline consistent with public demand, preliminary steps must be taken immediately

AVIATION FUEL: ENVIRONMENTAL & ENERGY SECURITY CONCERN

Environmental Concern:

- **Nearly 70% of aircraft emissions are CO_2 (FAA 2005)**
- **Nearly 30% of aircraft emissions are water vapor - a greenhouse effect (FAA 2005)**
- Global CO_2 emissions from Aviation > 1000 Mt CO_2/yr by 2025
  (IPCC 4th Assessment Report)
- US Aviation CO_2 emissions - 300 Mt CO_2/yr by 2025
  - **US General and Commercial Aviation - 350 million bl/yr**
    (Bureau of Transportation Statistics for 2006)
  - **US Military - 130 million bl/yr jet fuel**
    (Energy Bulletin, 2/26/06)

Energy Security Concern:

- **Aviation fuel is dependent on foreign oil from** hostile nations**.**
- Recent prices swings **from $147/bl to $37/bl have dramatic impacts on the nation's economic health**

FEDERAL AGENCIES WITH BIOFUELS INITIATIVES

Key Organizations	Relevant History/Capabilities
• Sandia, NREL • USDA	• DOE has the charter for developing biofuels technology • R&D activities include overall development of critical biofuels technology. **NASA Ames assisting DOE with algal biofuels technology roadmap.** • Teams with USDA on Energy Crop Initiatives. • **No R&D focus on aviation concerns.**
• AFRL • DARPA	• DARPA Issued a BAA for 3-year, biofuel-based jet fuel development • AFRL develops alternative fuels for military flight. A number of renewable fuel flight tests flown on B-1, B-52, & C-17
• Aviation Policy, Planning and Environment Office • Hughes Technical Center • Joint Planning and Development Office	• FAA holds the primary responsibility for aviation policy-making, • **Commercial Aviation Alternative Fuels Initiative (CAAFI). NASA is participating in this initiative (GRC)** • NASA Ames and the FAA have successfully partnered on air traffic management technology development and testing

Biofuels Development For The Unique Needs of General and Commercial Aviation Is Not Addressed

INTERNATIONAL BIOFUELS ACTIVITIES

EU Regulation of aircraft emissions through a cap-and-trade program have led to new biofuels activities abroad

- February, 2008 - Virgin Atlantic completed the first biofuels test flight of a commercial plane from London to Amsterdam. The flight used a 20% blend of coconut and babassu oil.
- May 2008 - Airbus, International Aero Engines, Jet Blue, and Honeywell-UOP have partnered to develop jet fuel from algal oils. KLM also announces a partnership to developed algal based jet fuel with AlgaeLink.
- January 2009 – Air New Zealand completes a biofuels flight over Auckland. The flight used a 50% blend of jatropha oil.
- Spring 2009 - European Clean Sky Joint Technology Initiative will launch a $1.6 billion public-private partnership research program aimed at reducing environmental impact from air transport, validating advanced technologies thru full-scale demonstrations.

US Technology Leadership and Demonstrations on Aviation Biofuels Absent Due to FAA Restrictions and No Coordinated Development Strategy. Much R&D Needed To Develop Sustainable Aviation Biofuels

THE BIOFUELS ROLE FOR NASA

ROLE: Biofuels for General and Commercial Aviation

NASA can address these R&D needs here.

WHY NASA?

- **Successful technology development for this sector under the AGATE program**
- **Unique R&D Biofuels Capabilities**

BENEFIT TO NASA:

- **With Biofuels, NASA contributes to a fully integrated Green Aeronautics Program**
- **Biofuels technology will be needed for life-support/fuel on long-term NASA missions**

Working With Industry And Other Federal Agencies, Sustainable Aviation Biofuels Can Be Developed Within A 10-Year Timeframe

ALGAL RESEARCH TODAY AT NASA AMES

Algae Growth:

- Photobioreactor research and development
- Algal biological contactor development
- Microsatellites with algae in space (Slime Sat)
- Extensive collection of algae from extreme environments

Long-Term Manipulative Studies:

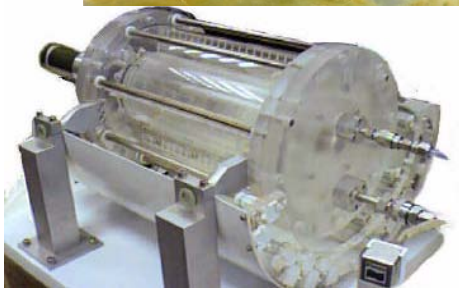
- Effects of algae communities on water composition, flow, irradiance

Biofuels:

- Lipid extraction and analyses

Environmental Control:

- Targeted carbon sequestration and nutrient removal (DOE collaboration)



ESA Photo: ecls.esa.int/ecls/?p=biorat

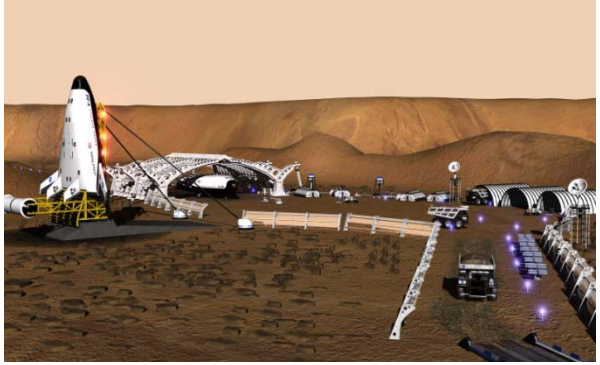
ALGAL BIOFUEL R&D CAPABILITIES AT AMES

Algae Growth:

- Characterization and Strain Selection:
  - Balancing lipid content, growth rates, and other properties
- Monitoring Algal Growth:
  - Algal ecosystems and growth needs
  - Monitoring capabilities for algal ecosystems
- Algae Manipulation

System Engineering:

- Understanding of system requirements for complex systems
- Capability to technically facilitate and integrate algal processes into a single biorefinery system
- Ecosystem impacts; sustainability assessments
- Novel scalable systems for off-shore growing

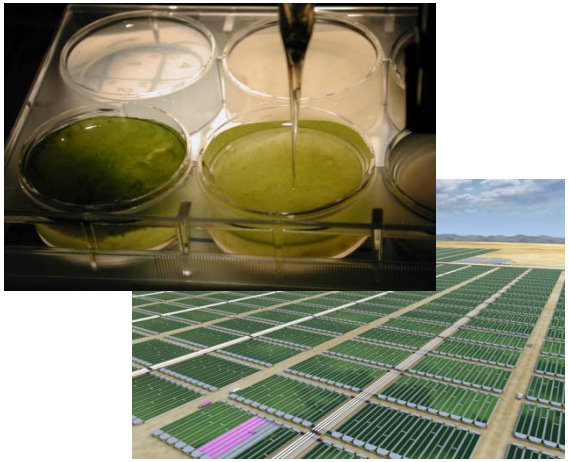


ALGAL BIOFUELS CONSORTIUM (ABC)

A National, Strategic Public/Private Partnership For The Development Of Algal Biofuels

ABC includes:

- National Labs, Universities, and Industry
- Technologies, Expertise, and Facilities across:
  - Algal strain selection/growth
  - Algae harvesting and extraction
  - Biofuel refining
  - Co-product applications
  - System engineering



ABC does not represent DOE

GOAL: To Leverage Partner Expertise To Help Define The Technology Roadmap And Provide Critical R&D To Commercialize Algal Biofuels

NASA AMES ALGAL BIOFUEL PARTNERSHIPS

Currently Partnered With Industry and DOE

- Development of algal growth technologies
- Research algal ecosystems and manipulation studies

Seeking Partners To Advance Algal R&D:

- The growth and manipulation of algal systems for aviation biofuels
- Develop algal growth technologies, including photobioreactors, ponds, and ocean-based systems
- Develop biorefinery systems leveraging NASA's algal and system engineering expertise

Highlights

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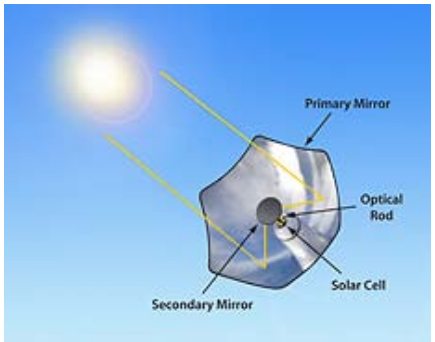
- Green Aviation
- Clean Energy
- Sustainable Systems

Clean Energy Partnerships at NASA Ames

SolFocus
Innovation Inspired by Nature



Solar Thermal Technology Prototype for Earth and Space Applications

Test and evaluate at NASA ARC a new, prototype, solar thermal technology. The prototype will consist of approximately ten solar collector modules plumbed together. This effort will support NASA ARC green energy objectives by adding new test capability to evaluate solar thermal systems for space applications (such as a future Lunar outpost).

+Home

NASA Advanced Supercomputing (NAS) Division

+ ORGANIZATION
+ PROJECTS
+ PARTNERS

The NASA Advanced Supercomputing (NAS) Division is enabling advances in some of the toughest science and engineering challenges facing NASA today.

ABOUT THE NASA ADVANCED SUPERCOMPUTING (NAS) DIVISION

For nearly 25 years, the name "NAS" has been associated with leadership and innovation throughout the high-end computing (HEC) community. We play a significant role in shaping HEC standards and paradigms, and have a leading part in the development of large-scale, single-system image computers.

As part of the Exploration Technology Directorate at Ames Research Center, our division supplies some of the world's most powerful supercomputing resources to NASA and U.S. scientists.

We provide an integrated high-end computing environment to accelerate NASA missions and make revolutionary advances in science. The 245-teraflop Pleiades supercomputer, will increase our computing capability 2.5 times over the current 14,336-processor Columbia system — one of the fastest operational supercomputers in the world.

In addition, our integrated environment includes smaller testbed and next-generation systems, high-fidelity modeling and simulation, high-bandwidth

NASA'S HEC PROGRAM

+ Get more information

NASA MISSIONS

+ Aeronautics Research
+ Exploration Systems
+ Science
+ Space Operations

LEGACY OF ACHEVEMENT

+ NAS Legacy of Achievement

Internet | Protected Mode

National Aeronautics and
Space Administration

NASA Research Park and Ames Research Center
Exploration and Sustainability Expo

The Technology Showcase is a great opportunity to network with Ames and Silicon Valley communities.
NASA and NRP partners will exhibit their technologies and discuss collaborations.

Tuesday, April 21, 2009
Building 943
9am to 4pm
Open to the public
FREE

Additional Info:
www.researchpark.arc.nasa.gov

Co-Sponsored by NASA Ames Innovative Partnerships Program

www.nasa.gov

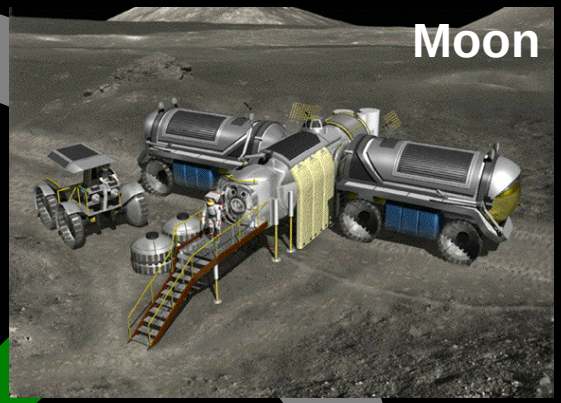
Highlights

- Global Prediction, Monitoring and Response
- Green Aviation
- Clean Energy
- Sustainable Systems

Sustainable Systems:

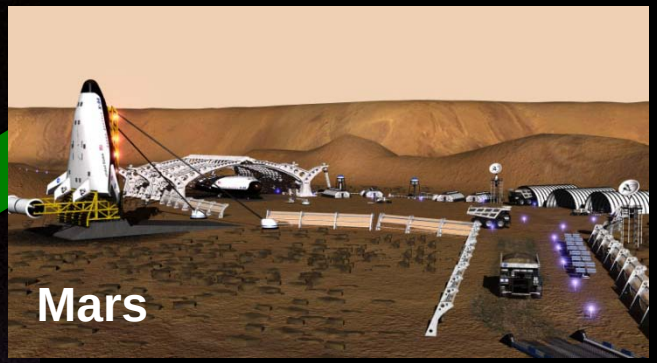
Human Spaceflight Pushes the Limits creating a technology cycle with benefits back on Earth

Technology Cycle



Spacewalk

Technology Recycle

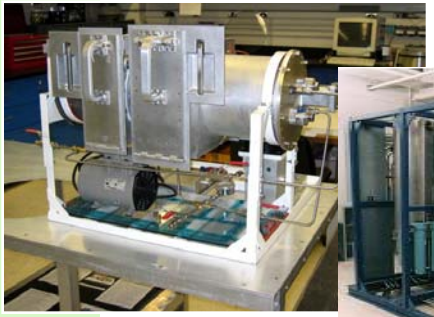


2004 - Water Treatment Systems
2004 - Home Heating/Cooling Efficiency
2005 - Hydrogen Sensors Boost Hybrids
2005 - Harnessing the Power of the Sun
2005 - Restoring Contaminated Grounds
2005 - Utilizing Waste Energy
2006 - Validating Remote Ocean Imaging
2006 - Plastic Film Creates Solar Energy
2006 - PRP: Cleaning Up Oil Spills
2007 - Map, Monitor, Manage Earth Resources
2007 - Sensor Network Provides Environmental Data

Sustainable Systems: Exploration Life Support

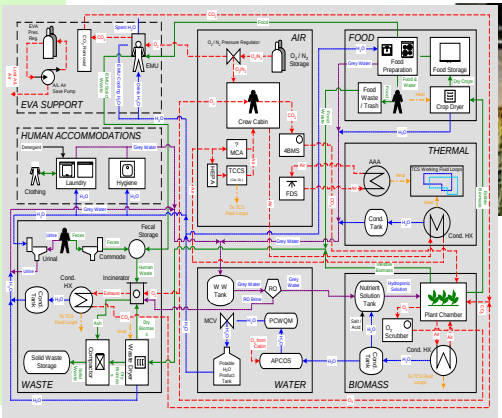
Developing systems that minimize/eliminate waste and maximize self-sufficiency

- **Air Revitalization**
  - Regenerable, low power CO_2 capture, separation, compression and storage systems
  - Air contaminant removal systems
- **Water Recovery**
  - Extremely low power, regenerative wastewater-to-potable water processing systems
  - Contingency water purification – portable, no power required
- **Waste Recovery**
  - Waste minimization and safening
  - Conversion to valuable products (e.g., H_2O, CO_2, H_2, fuels, nutrients/soil, building materials, activated charcoal)

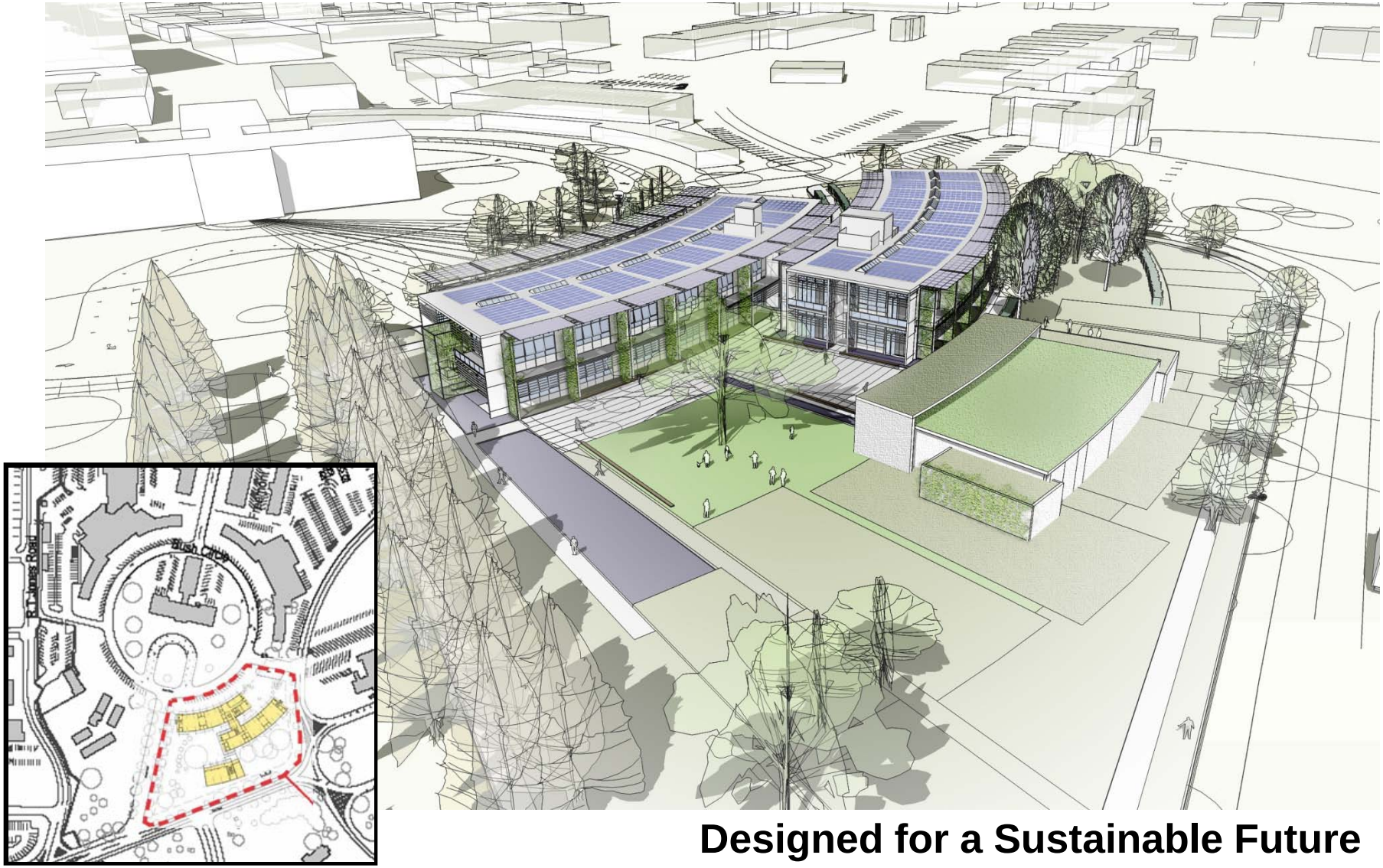


Sustainable Systems: Efficient Use of Resources

- **Systems Engineering for Sustainability**
  - **Systems Analyses/Trade Studies**
    - Management of complex, large-scale systems
  - **On-Line Project Information System (OPIS)**
    - Collects/disseminates critical project and technology data required for integration of complex systems
- **Future Environmental Life Support – Green Synergies**
  - CO_2 conversion/sequestration technologies
  - Advanced technologies for complete H_2O recycle
  - Closing materials/food production loops
  - Biofuels produced from algae and ligno-cellulose
  - Systems engineering for sustainable Earth systems



Ames High Performance Building



Designed for a Sustainable Future

LEEDS Platinum: with showcase of NASA sustainability technology inside

Create a highly flexible, collaborative and supportive work environment with community spaces, operational flexibility, daylight & views, fresh air, user control, healthy materials

Reduce energy demand through natural ventilation, daylighting in connection, intelligent control systems connected to the building monitoring system and use of renewable energy resources on-site and off-site

Reduce, reclaim and re-use water with high performance fixtures, gray water capture systems, rainwater capture systems, on-site black water treatment, connections to local non-potable sources and intelligent landscape design

Provide a sustainable landscape with native and drought tolerant plant palette, drip irrigation tied to building gray water and rainwater harvesting systems and include water cleansing zones designed as features in the landscape

Ames High Performance Building: Sustainability Goals

Environmental Management for Sustainability

- **Bioremediation analysis**: identification of the mix of microorganisms and substrates that will reduce the remaining levels of solvents and other chemicals for proactive risk mitigation consistent with NASA environmental policy (14CFR 1216.1).

- **Air Sparge Curtain** to mitigate ground water spread of trichloroethylene soil and groundwater contamination source. NASA Environmental Compliance and Restoration funding for the Air Sparge Curtain will help sustain and eventually improve groundwater quality.

- **Plant Conservation Alliance** to promote native plants and discourage invasive weed species. Meeting Executive Order 13423 goals to reduce pesticide, herbicide, fertilizer, water, fuel use, and employee exposure. Demonstration garden met USEPA National Performance Track 2006-2009 goal.

- **South Bay Salt Marsh Restoration Project**: negotiating for acquisition of the Northern Channel for Center storm water management, Compliments Corps of Engineers Shoreline Study and provides consideration of flood control to benefit Ames.

Water reclamation and Conservation

- Ames total potable water use 300 M gal/yr
- Irrigation use 100 M gal/yr
- Wastewater discharge 200 M gal/yr
- Project to use reclaimed water for landscape irrigation in Ames' northeast sector now saving 30-40M gal/yr (13% of total use)
- Wind Tunnel and Arcjet Cooling towers use ~ 5 M gal
- E.O. 13423 sets new baseline and goals for water conservation

Ames water treatment plant

◆Sustainable Transportation System

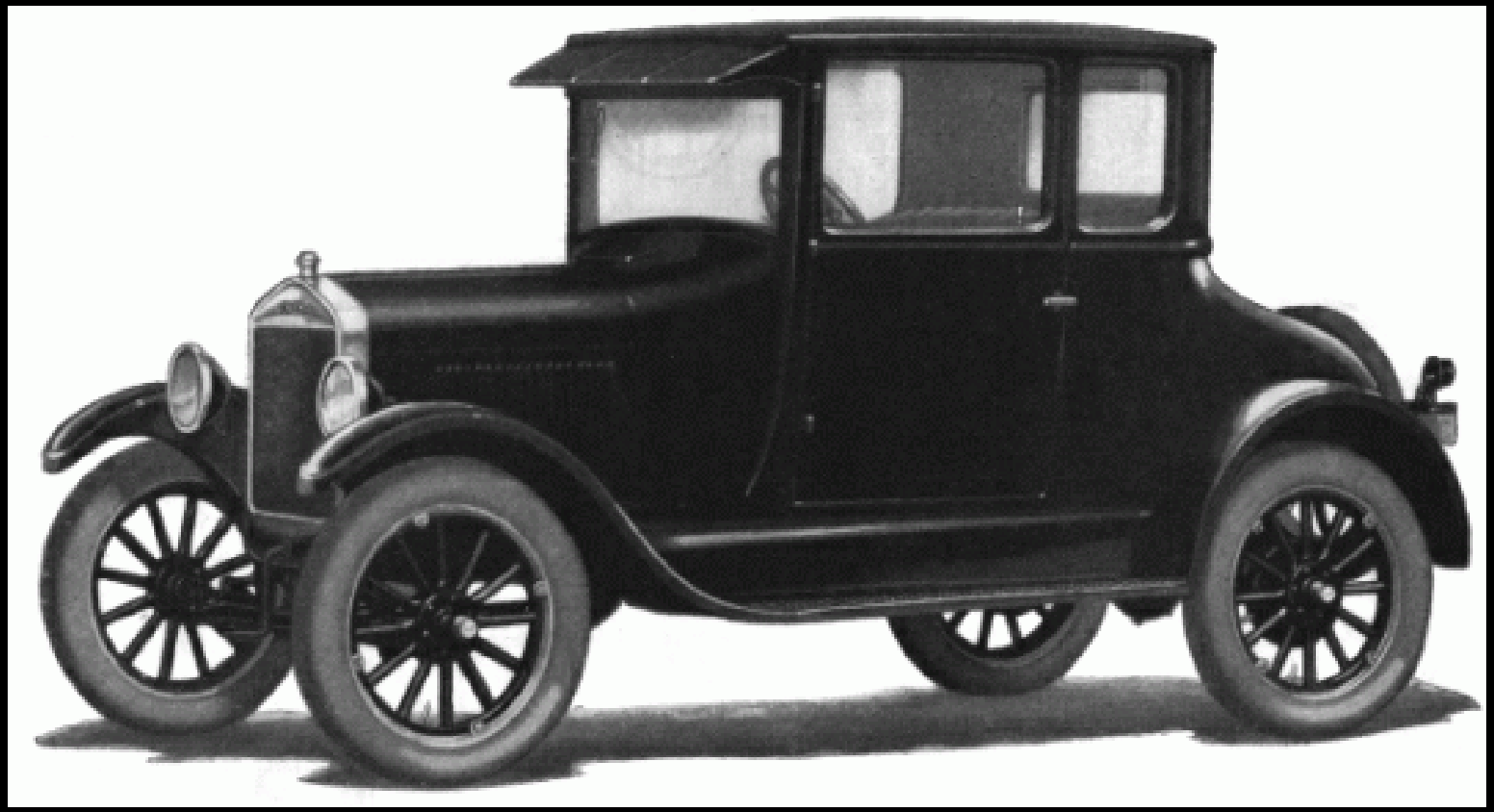
SkyTran

UniModal Systems

Congestion, GHG and Urban Planning Crisis of 1898

UniModal Systems LLC

The Liberator of 1908



Ford Introduces the Model T

UniModal Systems LLC

The Auto is Now the Occupier of 2008

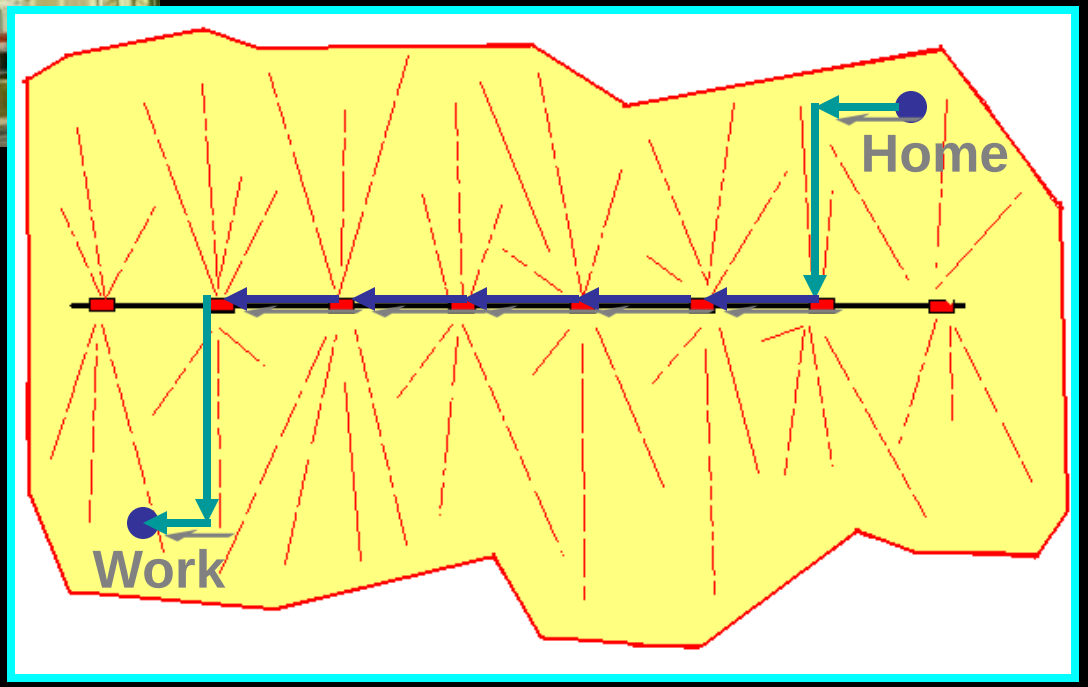
The Future is Not Sustainable

New Paradigm Required to Fix Congestion , GHG, Energy and Urban Planning Crisis

2% VMT Growth by 2020

Rail & Buses As A Solution?

Riders Have to Change Modes, Wait For Departures and Stop At EVERY Stop on the Route

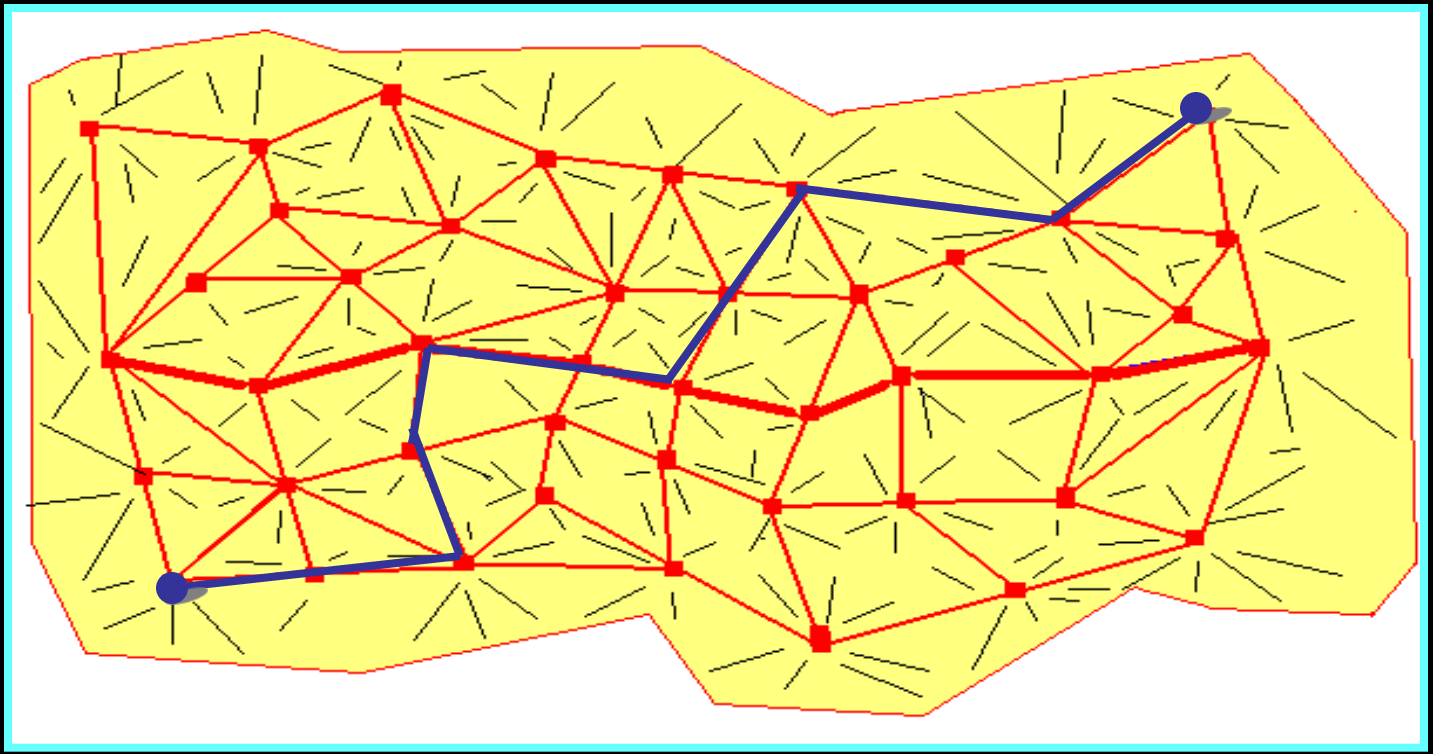


Only 2-3% of the public uses this "solution"

Personal Rapid Transit Architecture Solution

Like Interstate Highways you ride non-stop in a personal vehicle traveling on a guideway "lane"anywhere in the network.

Physical Internet for People

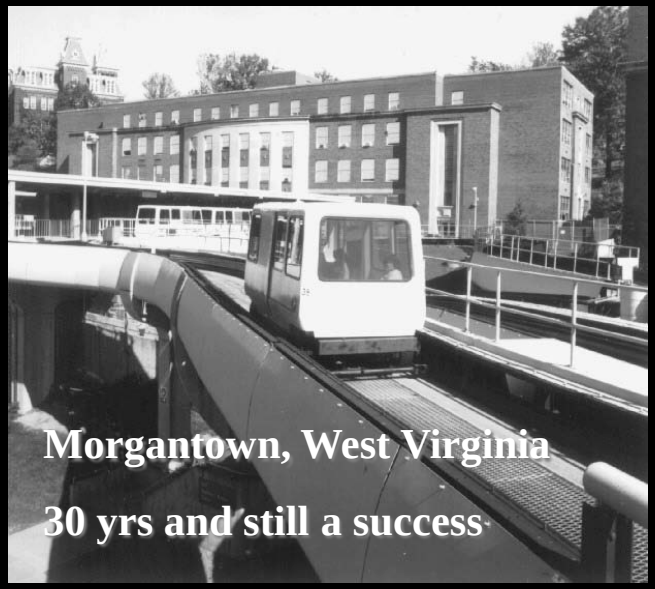


Average 5 minute walk to any urban portal.

UniModal Systems LLC

PRT Past and Present

UniModal Systems LLC



Present Generation

Low Speed
Up to 30 mph

Small Scale
Local Circulators Only

High Maintenance
Uses wheels

Over 1000 lbs.
Uses larger vehicles

Worldwide Personal Rapid Transit Development

Second Generation

ULTRA (United Kingdom)
Government funded demonstration system in development

POSCO (Korea)
Government funded demonstration system in development in Sweden

RUF (Denmark)
In development

MAIT (Germany)
In development

Coaster (Austria)
Demonstration in development

SkyWeb-Taxi2000 (Minnesota, USA)
In development

Next Generation PRT

SkyTran™

High Speed
Up to 150 mph

Scalable Networks
Local, Regional, National Service

Low Maintenance
Uses maglev instead of wheels

Under 1000 lbs.
Uses aerodynamic vehicles

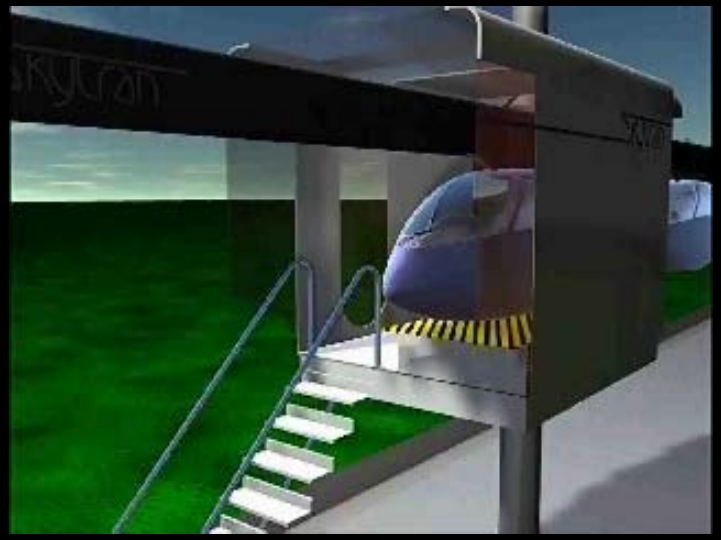
Energy Efficient
Up to 500 mpg

Zero Carbon
Solar Powered

SkyTran Off-Line Portal

UniModal Systems LLC

SkyTran™ Merges the Convenience of a Car With the Benefits of Public Transportation



On-Demand , Personal Vehicle

Non-Stop, Point-to-Point Travel

Light-weight, 2-4 Person Vehicles

Accessed from Elevated On & Off Ramps

Low Cost, Mass Produced, Easy to Install

Minimal Right-of-Way Required

Can Carry More PPH than 3-lane Freeway

Easy Access and Easy to Use

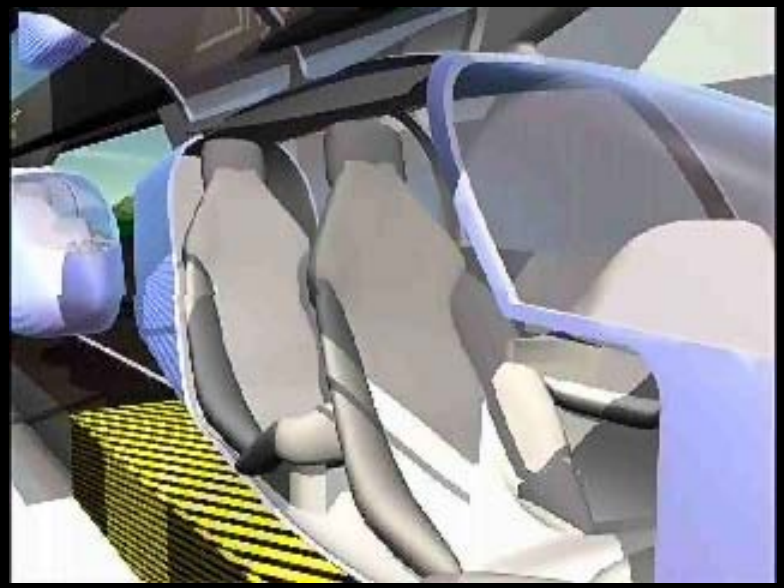
Order On-line or via Phone

Select destination via simple touch screen map

Confirm price

Insert Cash or Credit Card

Magstripe ticket issued



Swipe ticket in vehicle at Dashboard Destination Control

Follow audio & touch screen prompt to confirm destination

Why is NASA Interested in SkyTran?

#1

"The Congress declares that the general welfare of the United States requires that the unique competence in scientific and engineering systems of the **National Aeronautics and Space Administration also be directed toward ground propulsion systems** research and development. Such development shall be conducted so as to contribute to the objectives of **developing energy- and petroleum-conserving** ground propulsion **systems, and of minimizing the environmental degradation** caused by such systems."

National Aeronautics and Space Act
(Pub. L. No. 85-568, 72 Stat. 426, Section 102:e)

Why is NASA Interested in SkyTran?

#2

NASA Mission Relationships

- Control Systems (power control and traffic management)
- Human Factors Engineering
- System Prognostics and Diagnostics
- Systems Engineering and Analysis
- Aerodynamics

Summary of Ames' Greenspace Strengths

- **Environmentally committed** community, culture, history, workforce
- **Private Capital investments** over past year clean-tech deals were $1B in Silicon Valley. State investments in green technology were $1.8B
- **Strong Ames achievements in Green projects:**
  - Proven performance in earth sciences applications for public benefits
  - Proven performance in orbital missions, lead for airborne remote sensing and UAV applications, ground truth, and data-driven computational models for monitoring and prediction.
  - Spacecraft regenerative life support provides basis for sustainability and recycling applications.
  - 1800 acre Moffett Field site provides opportunities for new environmental management methods
- **Pipeline of innovative solutions:**
  - Ames workforce has the ideas and the motivation to promote Green solutions
  - Numerous design and innovation studies are in progress
- **Ames strengths in innovation via multidisciplinary and multi-organizational integration particularly relevant to 'green' solutions**

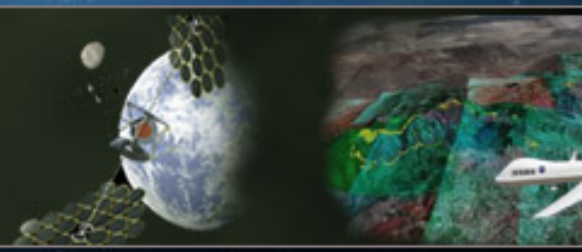
Greenspace Home

Green Aviation
Earth and Environment
Clean Energy
Sustainable Systems
Green NASA Ames

Ames Green Activities At-A-Glance
News and Events
Green Spinoffs From NASA
Partner With Us
NASA Research Park
Green Efforts at Other NASA Centers
Greenspace on Sharepoint (NASA Employees Only)
Links and Resources

Greenspace

Leveraging NASA for a Greener Earth



Ames Green Activities At-A-Glance

ARC Research and Capabilities

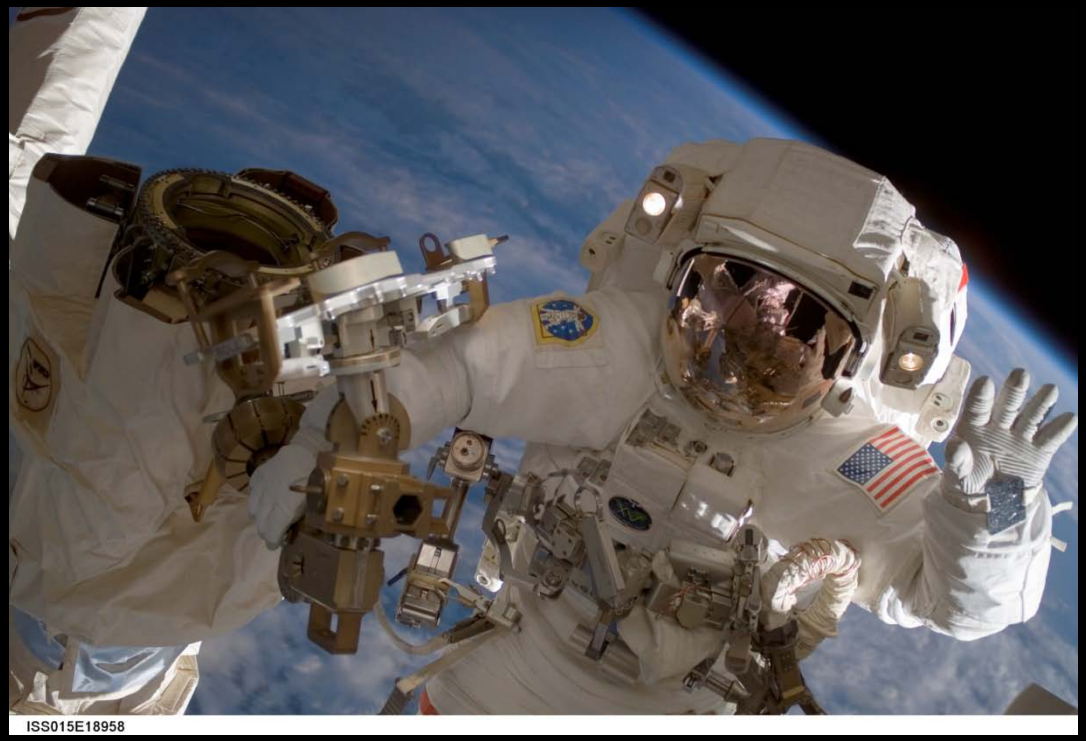
Capabilities/Tools

- Terrestrial Observation and Prediction System (TOPS)
- Carbon Query and Evaluation Support Tools (CQUEST) and NASA-CASA
- Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (
- Green Aviation
- Solar Energy
- Wind Energy
- Green Transportation including:

Visit Us at <http://green.arc.nasa.gov>

Thank You!

Larry Barrone
Debra Bazar
Lee Bebout
Bill Buchan
Ann Clarke
Steve Hipskind
Michael Marlaire
Chris Perkins
John Hogan
Jonathan Trent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