The Vision for Serving 21st Century Needs with Commercial Space Weather Products and Services

Space Weather Enterprise Forum

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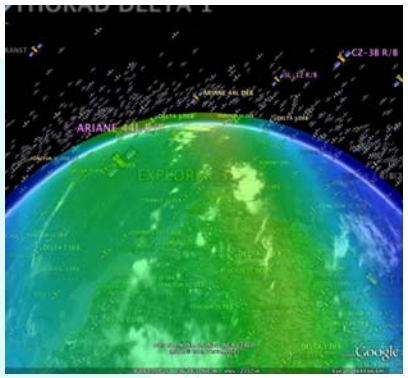
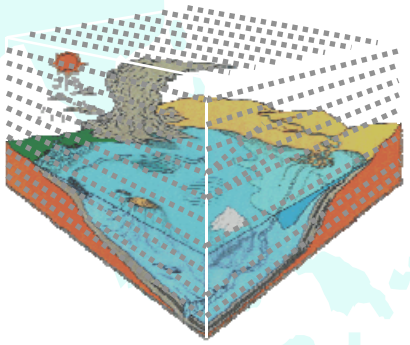
Emerging Technology Challenges

1. **Space:** automated management
   a) Low Earth Orbit debris mitigation
   b) Commercial space tourism
   c) Lunar exploration
   d) ISS resupply
2. **Transportation**: FAA's NextGen
   a) GPS reduced uncertainty
   b) Cross-polar HF and satcom link availability
   c) Radiation safety for air crews and passengers
3. **Energy**: Clean energy + power grid
   a) Reduction of global carbon footprint
   b) Development of alternative energy sources
   c) Upgrade of U.S. power grid
4. **Water**: water management
   a) Fresh water for arid Western U.S.
   b) Flood mitigation in Central U.S.
   c) Rising sea levels in all U.S. coastal areas





Space Weather Effects & Changing Climate

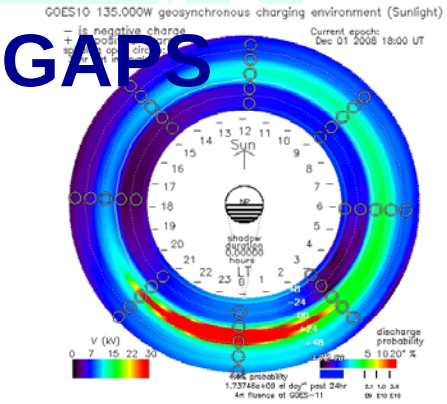
1. **Space**
   a) High solar fluxes & geomagnetic storms affect LEO debris
   b) Cosmic rays & solar energetic particles (SEP) affect space tourism
   c) Cosmic rays, SEPs, low energy electrons affect exploration
   d) High solar fluxes & geomagnetic storms affect ISS resupply
2. **Transportation**
   a) Ionospheric TEC and scintillation affect GPS positioning
   b) Ionospheric TEC and scintillation affect HF, satcom availability
   c) Cosmic rays & solar energetic particles affect air crew, passengers
3. **Energy**
   a) CO_2, CH_4 transport to upper atmosphere affect global heat budget
   b) Low energy electrons affect solar arrays for space solar power
   c) Geomagnetic storms' ground induced currents affect power grid
4. **Water**
   a) Coupled solar cycle/cosmic ray modulations affect global rainfall
   b) CO_2, CH_4 in lower atmosphere increases latent heat capacity
   c) Increased energy from released latent heat magnifies storms

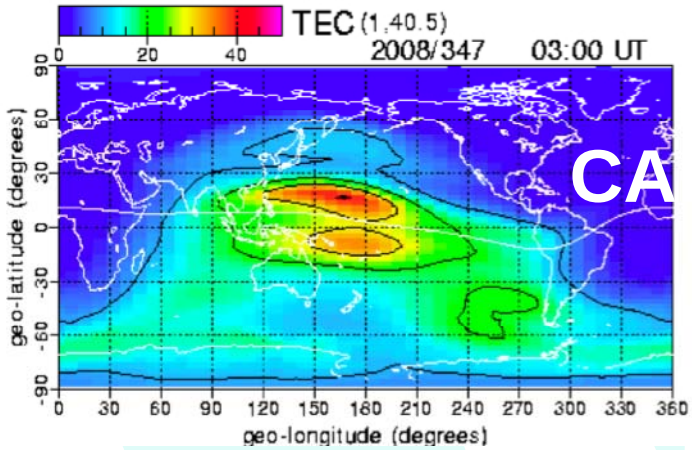
Existing Example Commercial Contributions

1. **Ionospheric TEC and scintillation**
   Space Environment Technologies (SET), Space Environment Corporation (SEC) CAPS and IPS MeteoStar (IPSM) LEADS: **http://sol.spacenvironment.net/~ionops/index.html**
   USTAR GAIM: **http://www.innovationutah.com/**
2. **Cosmic rays & solar energetic particles**
   Carmel Research Center (CRC) SEP: **crcspaceweather@yahoo.com**
3. **High solar fluxes &LEO atmosphere densities**
   SET JB2008: **http://sol.spacenvironment.net/~JB2008/**
4. **Geomagnetic storms**
   Carmel Research Center (CRC) HHMS: **crcspaceweather@yahoo.com**
   Exploration Physics International (EXPI) HAFv2: **http://www.expi.com**
5. **Low energy electrons' surface charging**
   SET GAPS: **http://terra1.spacenvironment.net/~gapops/index.html**
6. **Ground induced currents**
   Metatech Powercast: **http://www.metatechcorp.com/**

Space Weather Products and Services

GAPS

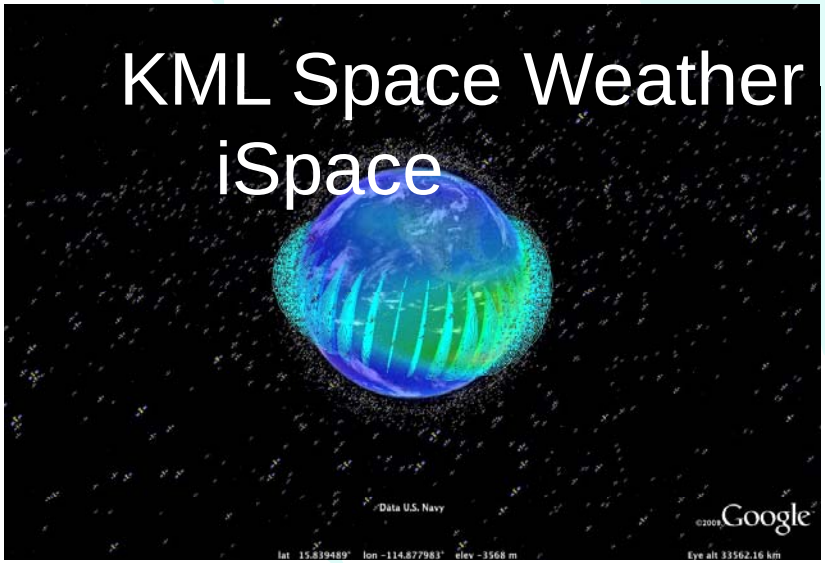




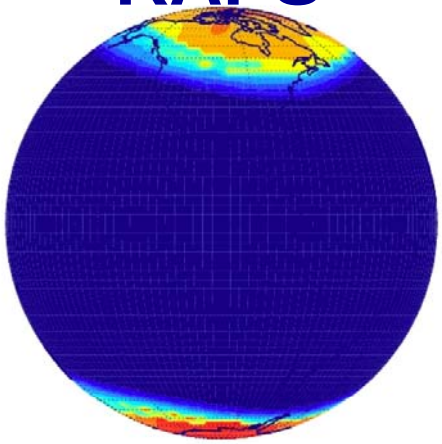
LEADS

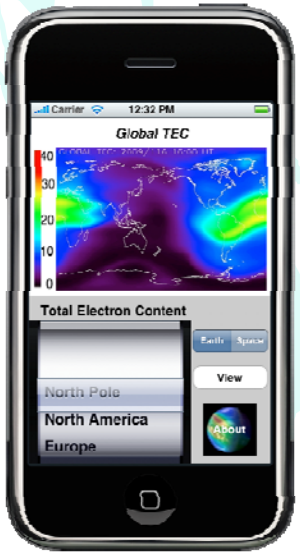
CAPS

KML Space Weather
iSpace



RAPS





The changing terrain from 2009 to 2019

1. 2011-2014 Solar Cycle 24 Maximum

- Possibility of either a high cycle or a low cycle; solar storms in either case
- Largest technological dependence on space assets ever in existence
- WE NEED AUTOMATED MANAGEMENT OF SPACE WEATHER

2. Major programs coming online

- NextGEN, lunar exploration, power grid upgrade, new energy sources
- WE NEED INTEGRATED SPACE WEATHER WITH THESE SYSTEMS

3. Water infrastructure management is critical

- Fresh water needed for growing demand in Western U.S.
- Flood control necessary for entire Mississippi basin
- WE NEED 21st CENTURY WATER MANAGEMENT SYSTEMS

4. Terrestrial problems require space assets

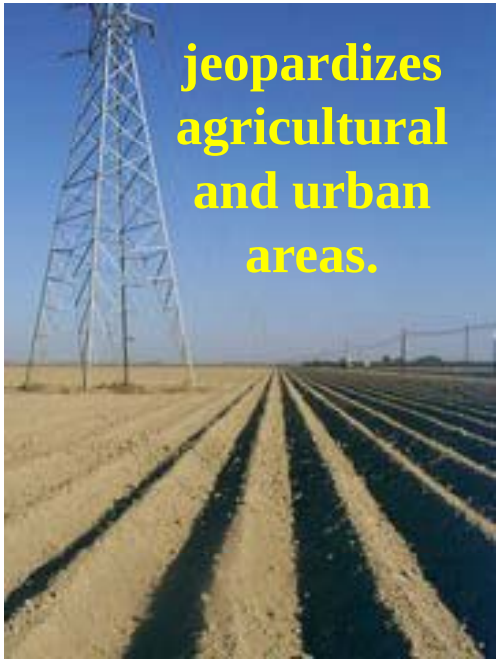
- Need continues for global observing systems to monitor climate change
- Comsat population will grow in a more crowded GEO environment
- Need for HF communications and UHF, L-band satcom links will increase
- Navigation & geolocation will require more GPS precision, accuracy
- Pressure to find major new sources of power -> space solar power (SSP)

Space Assets can Solve Terrestrial Problems

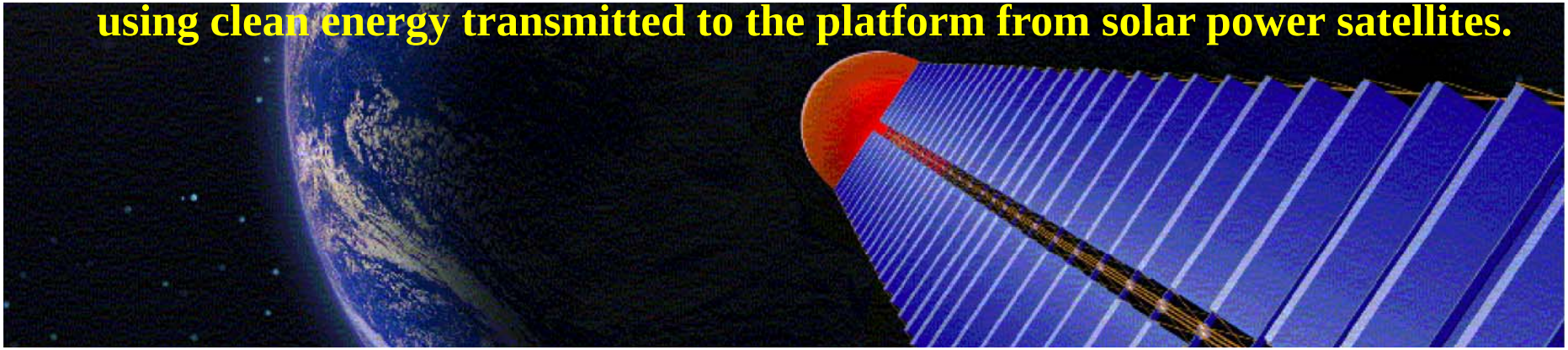
A New Architecture: Space Water – production of industrial quantities of fresh water on re-commissioned oil and gas platforms, using energy from solar power satellites, is *a breakthrough concept for addressing the 21st Century climate, water, and economic issues*

- **Escalating climate crisis** is resulting in severe shortages of fresh water world-wide
- **Western U.S. reduced water** and increasing demand provoke water resources competition
- **Coastal seawater desalination** is a proven source for urban and agricultural water supplies
- **Offshore oil & gas platforms** already use seawater desalination for personnel and equipment
- **California coastal platforms** can be re-commissioned at the end of their productive life
- **Large-scale fresh water production** facilities can be built on re-commissioned platforms
- **Solar panels on oil platforms** can provide partial power for daytime seawater desalination
- **Efficient fresh water production** requires 24/7 operations
- **Solar power transmitted from orbiting satellites** can augment power for night generation
- **1 satellite can power platform distillation** with clean energy to provide coastal fresh water

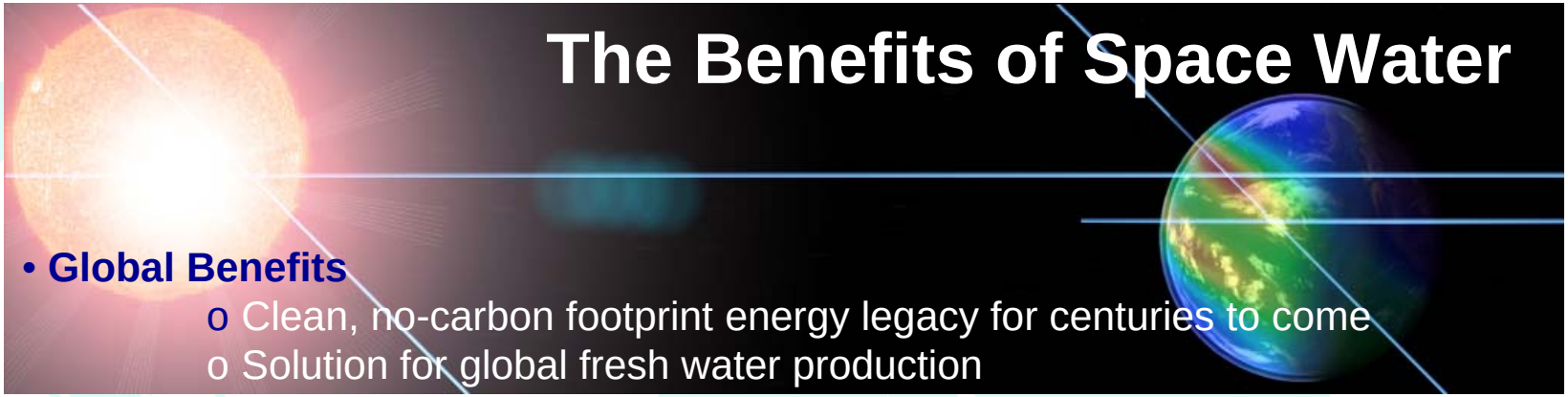
Elements of the Space Water Chain



using clean energy transmitted to the platform from solar power satellites.



The Benefits of Space Water



- **Global Benefits**
  - o Clean, no-carbon footprint energy legacy for centuries to come
  - o Solution for global fresh water production
  - o Economic growth from added energy and water resources
- **U.S. Benefits**
  - o Clean energy source for water production and electricity
  - o Military energy and water independence at forward bases
  - o Global leader for developing competitive 21st Century space assets
- **Regional California Benefits**
  - o Potentially unlimited fresh water source for Southern California
  - o Job creation in aerospace, energy, water, and agriculture industries
- **Industry Benefits**
  - o Water, power, and mineral industries – new source for natural resources
  - o Oil & gas platform owners – low-cost decommissioning, lease revenue
  - o Aerospace industry – leverages access to space with a major program
  - o Farming – water means jobs