**BioLaunch**

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(Quakefinder and Stanford)  
Lynn Rothschild  
(NASA ARC and Stanford)  
*Students: Matt Maniscalco, Andy Sadhwani, Matt Hammond*
Extremophile Sites

- Yellowstone
- Baja California
- Bolivian altiplano
- Hotsprings of New Zealand
- Australia
- Kenya
- Maine
- Lassen
- SF Bay
The Solar Spectrum

NASA Ames, 19 March 2007

Time matters!
2:13
2:41

Irradiance (µW/cm²/nm)

wavelength (nm)

γ-rays  x-rays  UV  infrared  microwaves  radio waves

wavelength (m)

<table>
<thead>
<tr>
<th>wavelength (m)</th>
<th>10^-12</th>
<th>10^-11</th>
<th>10^-10</th>
<th>10^-9</th>
<th>10^-8</th>
<th>10^-7</th>
<th>10^-6</th>
<th>10^-5</th>
<th>10^-4</th>
<th>10^-3</th>
<th>10^-2</th>
<th>10^-1</th>
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<tbody>
<tr>
<td>irradiance</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
</tbody>
</table>

DNADNA proteinprotein
Background to project

• In January, we initiated **BioLaunch**, a collaboration between AA 236--Spacecraft Design (a four quarter series) and HumBio 183--Astrobiology and Space Exploration

• AA 236 built and managed the balloon platform, and select students from HumBio 183 designed, built and managed the science payload.

• Payload exploited vertical profile through atmosphere, and was a natural outgrowth of Rothschild’s astrobiology studies at Ames.
  – **Solar profile from ground level to ~30 km**
  – **Effect of solar radiation on DNA**
  – **Student run test of solar radiation on pre-biotic chemical**
Solar spectra: ratio at different altitudes in Chile and Bolivia, Feb. 2007
BioLaunch:
SSDL/Astrobiology Initiative

High-Altitude Balloons and NanoSatellites
Low-Cost Technologies Bridging the Gap for Scientific Research
• Space Systems Development Laboratory (SSDL)
  - Established ~ 1994

• Missions
  - Sapphire, Opal, QuakeSat-1, Genest
  - MAST
  - PolarBot, Antarctic weather stations

• Student demographics:
  - ~400 students throughout the years
  - Before 2000, all Stanford students
  - Now a mixture of industry
Flight Hardware and Experiments: Spectrometer Flight Box

- Spectroradiometer
- Radiation Exposed Cuvettes
- AstroChemistry Experiment
- PC104 Computer
- Webcam
- GPS and Radio Beacons
View from Flight

Pete’s Golf Course
Santa Cruz
Flight Profile
Flight Profile

Burst - 82,274

Landing Site

NASA Ames

Lick Observatory - Launch Site

Stanford Ground Station

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Image © 2007 TerraMetrics
Results

Temperature
Spectrometer
DNA damage
Prebiotic chem exp.
Temperature profile (ambient)
• Flight spectra are not higher than ground controls and suggest swinging of basket.
Spectrometer Data During Flight

-5.00E+00  0.00E+00  5.00E+00  1.00E+1  1.50E+1  2.00E+1  2.50E+1

0 100 200 300 400 500 600 700 800 900 1000

Wavelength (nm)

Irradiance

2:00 PM  2:30 PM  3:00 PM  3:30 PM  4:00 PM

2.50E+01  2.00E+01  1.50E+01  1.00E+01  5.00E+00

Wavelength (nm)
DNA damage experiments

This includes two types of experiments.

1. **Base modification**, for example, the production of thymine dimers from adjacent thymines using a dosimeter made of herring sperm DNA.

2. **Nicking and breakage of the phosphate backbone** using supercoiled plasmid DNA.

<table>
<thead>
<tr>
<th>treatment</th>
<th>mean cpd/mb</th>
<th>st dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSDNA flight dark</td>
<td>1047</td>
<td>100</td>
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<tr>
<td>HSDNA flight light</td>
<td>3729</td>
<td>679</td>
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<td>HSDNA ground dark</td>
<td>1437</td>
<td>0</td>
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<td>HSDNA ground light</td>
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<td>225</td>
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<td>pUC flight light</td>
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<td>704</td>
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<td>pUC ground dark</td>
<td>986</td>
<td>0</td>
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<tr>
<td>pUC ground light</td>
<td>5308</td>
<td>682</td>
</tr>
</tbody>
</table>

666 A
659 T
675 C
686 G
total: 2686 bp
139 TT

so, total potential of 139 dimers in 2686 bp, or 51,749.8 dimers per megabase.
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2. Nicking and breakage of the phosphate backbone using supercoiled plasmid DNA.

Results from Kenya, Jan 2007
Kyle Rothschild-Mancinelli

<table>
<thead>
<tr>
<th>Open circle</th>
<th>Linear DNA</th>
<th>Supercoiled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight exposed</td>
<td>Flight dark control</td>
<td>Ground exposed</td>
</tr>
</tbody>
</table>
How to explain these results?

1. The samples weren’t exposed to direct sun, i.e., the payload was not pointing up. *(check solar readings)*
2. The payload was shaded by the balloon. *(check solar readings)*
3. The samples were frozen, and the freezing cuts down on damage. *(controls in lab)*
4. The samples cuvettes were frozen over thus the samples were shaded by ice. *(camera)*
Hypothesis: The samples were frozen, and the freezing cuts down on damage.

- pUC19 was exposed in cuvettes to UV radiation in a sterilizing hood at the SETI Institute for 0, 5, 10 and 15 minutes.
- Results show less damage when the sample was frozen, even with the addition of glycerol.
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What does this mean?
Future plans...

- Balloons
- Long duration balloons
- Small sats
- Other vehicles
Acknowledgements

– Hector D’Antoni, Dana Rogoff and Joe Minafra, NASA Ames
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– Ocean Optics and BigRedBee Companies