Group 4: Innovative Science Produced by Nano-Satellite Observation

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Objective

Recent subsequent success of micro-/nano-/pico-satellite launch and operation accelerates low-cost satellite scientific monitoring as well as satellite constellation, which contributes to detailed spatio-temporal measurement from the space to the Earth. Present science conducted by the measurements of ground-based network and single large satellite equipped with various instruments is expected to be improved by such a small satellite constellation monitoring. In particular, space-based scientific data using satellite constellation would drastically facilitate disaster mitigation science such as earthquake and global warming, which are still very serious for human being and are unsolved issue. In this group, the feasibility of various innovative science promoted by the micro-/nano-/pico-satellite constellation is discussed.
Mini satellites prove their scientific power (Jones, Nature, 2014)

CubeSats are swarming—and transforming space science (Hand, Science, 2015)
Nanosatellites by launch years

Note! At this time QB50 and SHERPA are still scheduled to launch in 2016 among many others.
The **highest** cost performance scientific microsatellite (< 50kg)

Microsatellite: DEMETER  
(130 kg, 2004-2010)

Publication (IF journals) (-2011)  
1) Thunderstorm activity: 19  
2) Ionosphere: 27  
3) Seismicity: 41  
4) Man-made activity and active experiments: 31  
5) Description of the experiments and first results: 13

Cubesat/Nano-satellite project will reach the similar performance.
Current status of scientific results (Cubesat and Nano-satellite)

• Nature and their journals
  Only 7 news, no paper.

• Science
  Only 8 news, no paper.

• American Geophysical Union (AGU) journal
  (Geophys. Res. Lett, J. Geophys. Res., etc..)
  27 papers!
  (Energetic particles, electromagnetic waves, radar, etc..)
## Cubesat instruments *(Nanosatellite database)*

<table>
<thead>
<tr>
<th>Technology</th>
<th>Selva* and Krejci, 2012</th>
<th>Freeman et al 2016</th>
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<tr>
<td>Atmospheric Chemistry Instruments</td>
<td>Problematic</td>
<td>Feasible</td>
<td>PICASSO, IR sounders</td>
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<tr>
<td>Atmos Temp and Humidity Sounders</td>
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<td>Feasible</td>
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<tr>
<td>Cloud Profile and rain radars</td>
<td>Infeasible</td>
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<td>Earth Radiation Budget radiometers</td>
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<td>Gravity Instruments</td>
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<td>Need a demo mission</td>
</tr>
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<tr>
<td>Imaging microwave radars</td>
<td>Infeasible</td>
<td>Problematic</td>
<td>Ka-Band 12U design</td>
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<td>Imaging multi-spectral radiometers (Vis/IR)</td>
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<tr>
<td>Imaging multi-spectral radiometers (μWave)</td>
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<td>TEMPEST,</td>
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<tr>
<td>Lidars</td>
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<td>DIAL laser occultation</td>
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<td>Lightning Imagers</td>
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<td>Magnetic Fields</td>
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<td>Feasible</td>
<td>InSPiRE</td>
</tr>
<tr>
<td>Multiple direction/polarization radiometers</td>
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<td>Ocean color instruments</td>
<td>Feasible</td>
<td>Feasible</td>
<td>SeaHawk</td>
</tr>
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</table>
Innovative idea: Sample
Tsunami observation

2011.3.11 Tohoku Earthquake

18 Million dollar
Ship equips with GPS
Expected Nankai earthquake – tsunami

1) Tsunami detection (Height measured by GPS) on the ship
2) AIS communication
3) Collection of tsunami height distribution
4) Arrival tsunami height estimation
Topics

• Earthquake observation
  Earthquake, tsunami, lightning etc.
• Ionosphere, magnetosphere, plasma sphere
• Planetary monitoring
• Astronomy