Group 4:
Innovative Science Produced by Nano-Satellite Observation

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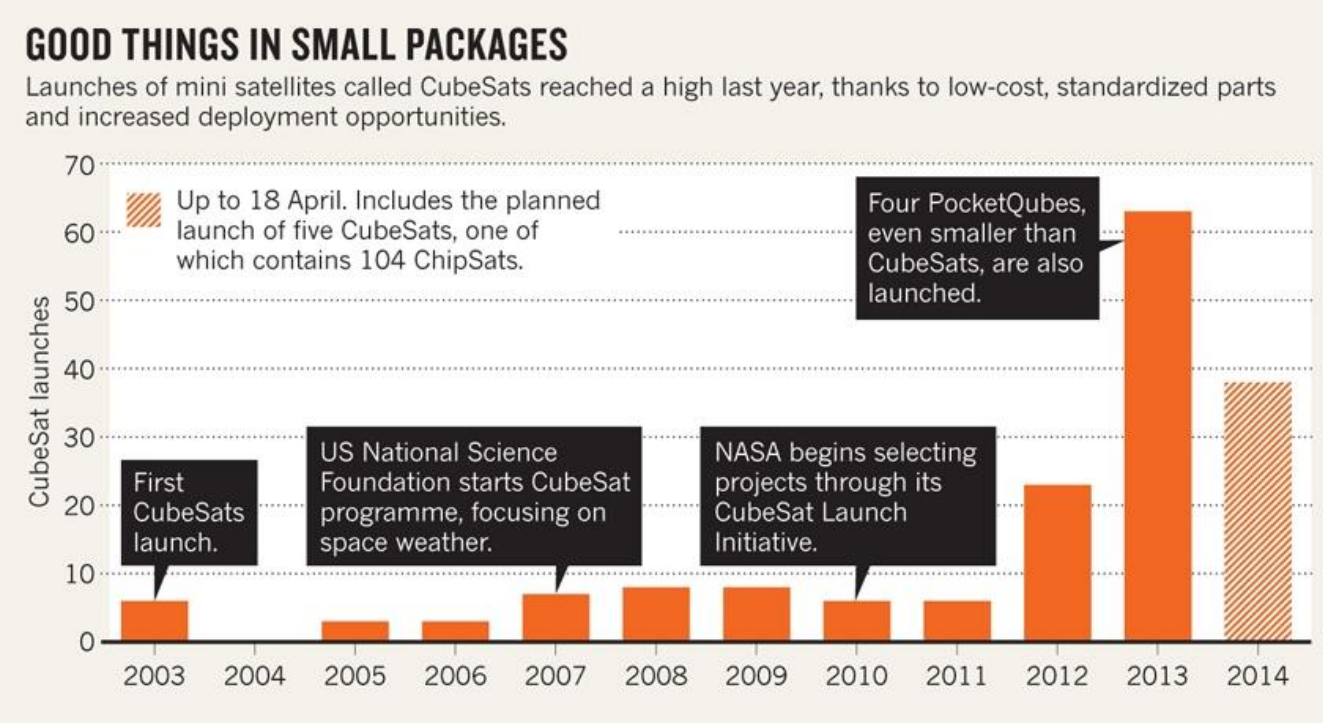
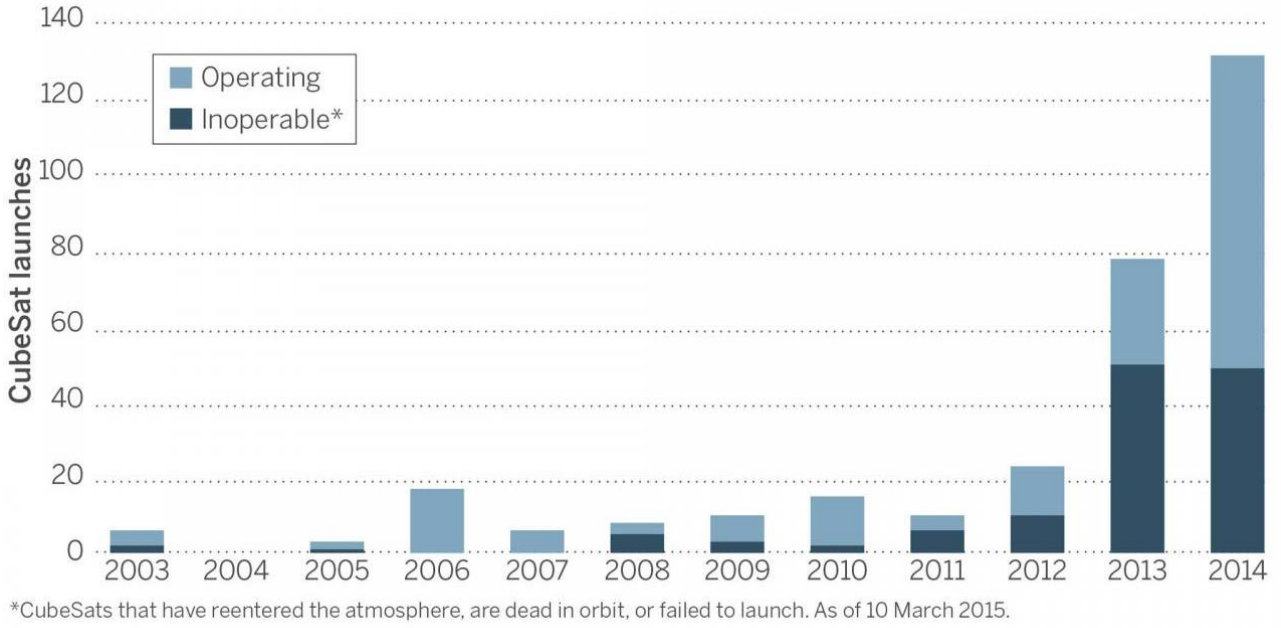
Objective

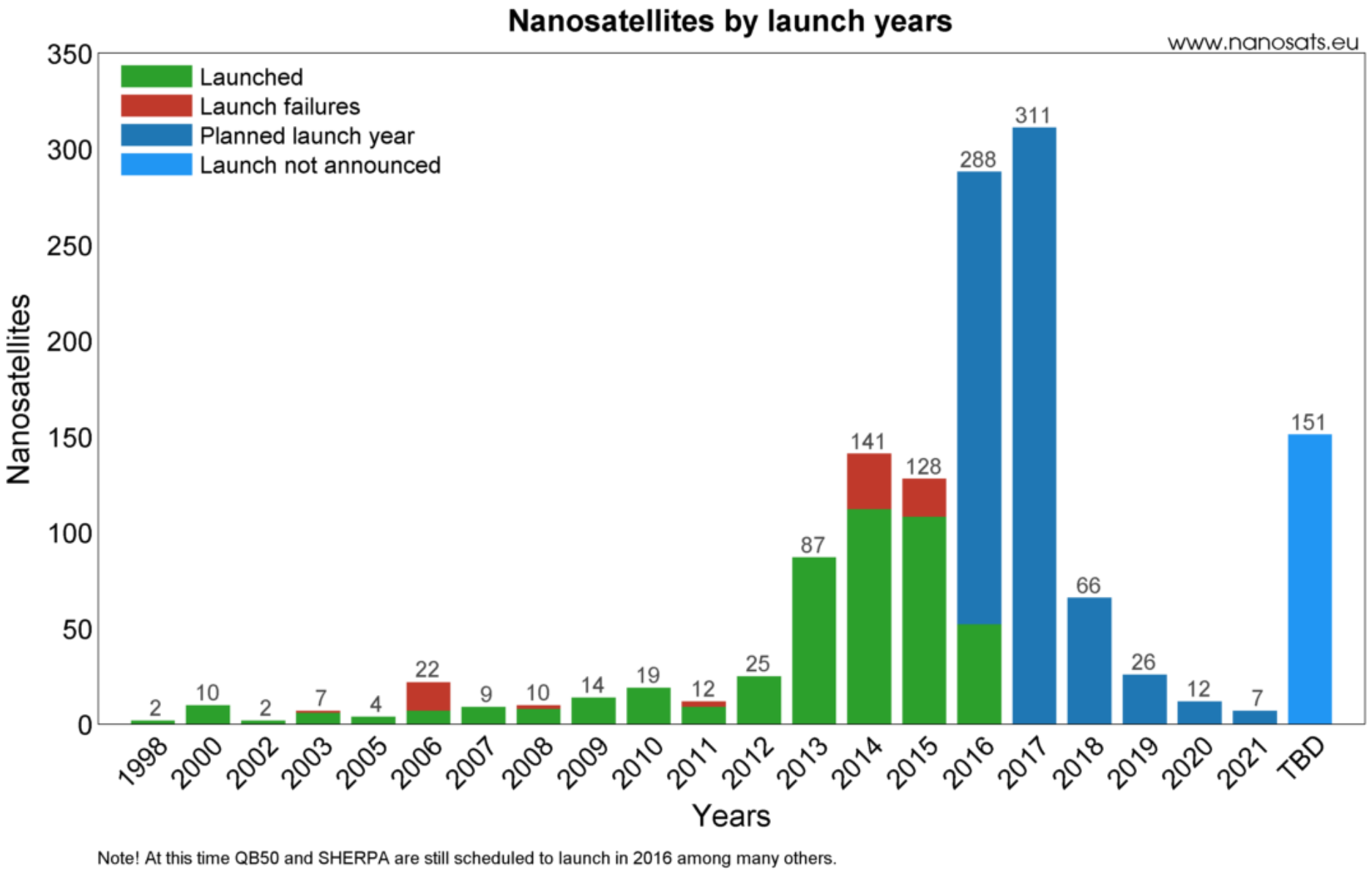
Recent subsequent success of micro-/nano-/pico-satellite launch and operation accelerates low-cost satellite scientific monitoring as well as satellite constellation, which contributes to detailed spatio-temporal measurement from the space to the Earth. Present science conducted by the measurements of 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)

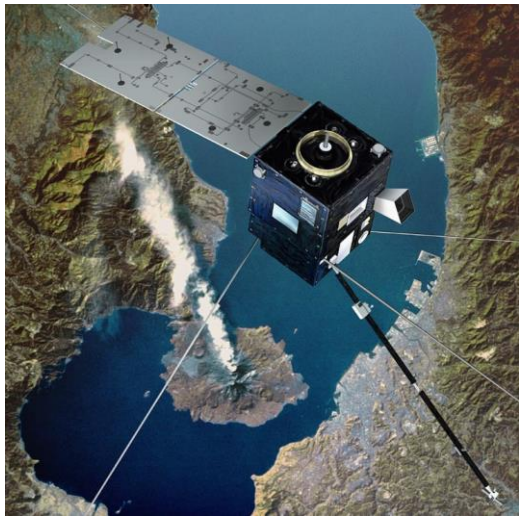




Note! At this time QB50 and SHERPA are still scheduled to launch in 2016 among many others.

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..)

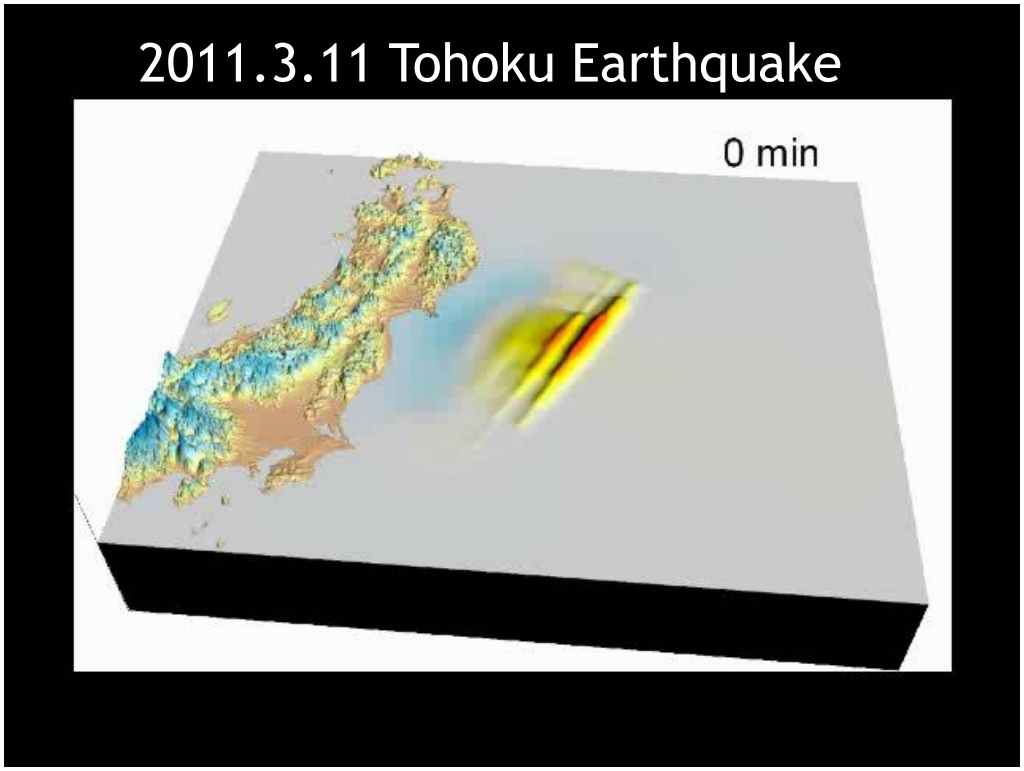
  27 papers!

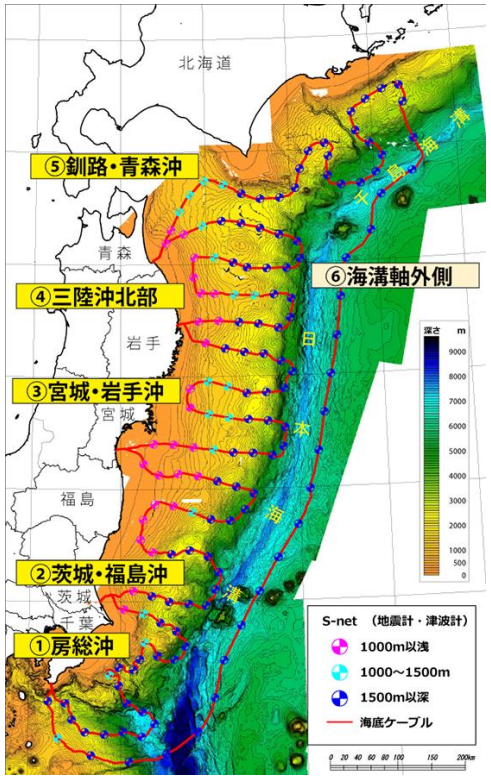
  (Energetic particles, electromagnetic waves, radar, etc..)

Cubesat instruments (Nanosatellite database)

Technology	Selva* and Krejci, 2012	Freeman et al 2016	Justification
Atmospheric Chemistry Instruments	Problematic	Feasible	PICASSO, IR sounders
Atmos Temp and Humidity Sounders	Feasible	Feasible	
Cloud Profile and rain radars	Infeasible	Feasible	JPL RainCube Demo
Earth Radiation Budget radiometers	Feasible	Feasible	SERB, RAVAN
Gravity Instruments	Feasible	Feasible	Need a demo mission
Hi-res Optical Imagers	Infeasible	Feasible	Planetlabs
Imaging microwave radars	Infeasible	Problematic	Ka-Band 12U design
Imaging multi-spectral radiometers (Vis/IR)	Problematic	Feasible	AstroDigital
Imaging multi-spectral radiometers (μWave)	Problematic	Feasible	TEMPEST,
Lidars	Infeasible	Problematic	DIAL laser occultation
Lightning Imagers	Feasible	Feasible	
Magnetic Fields	Feasible	Feasible	InSPIRE
Multiple direction/polarization radiometers	Problematic	Feasible	HARP Polarimeter
Ocean color instruments	Feasible	Feasible	SeaHawk

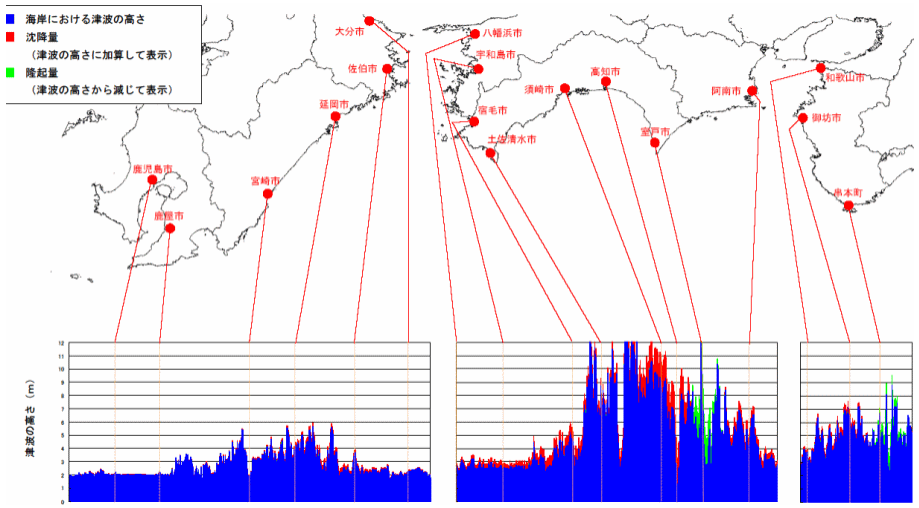
Innovative idea: Sample Tsunami observation

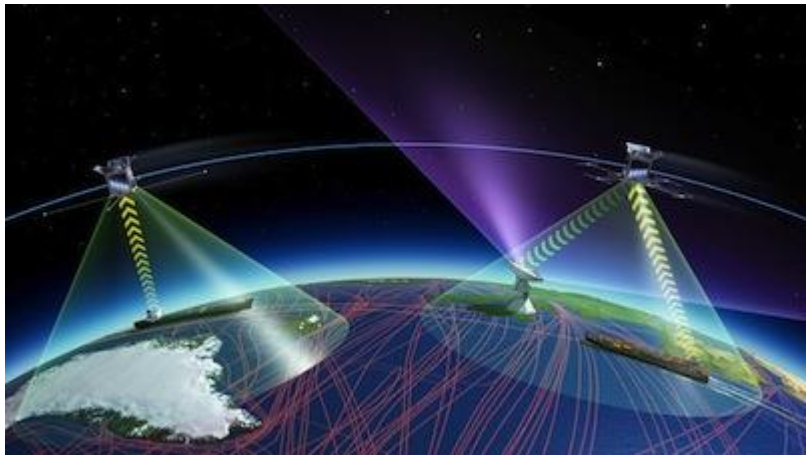


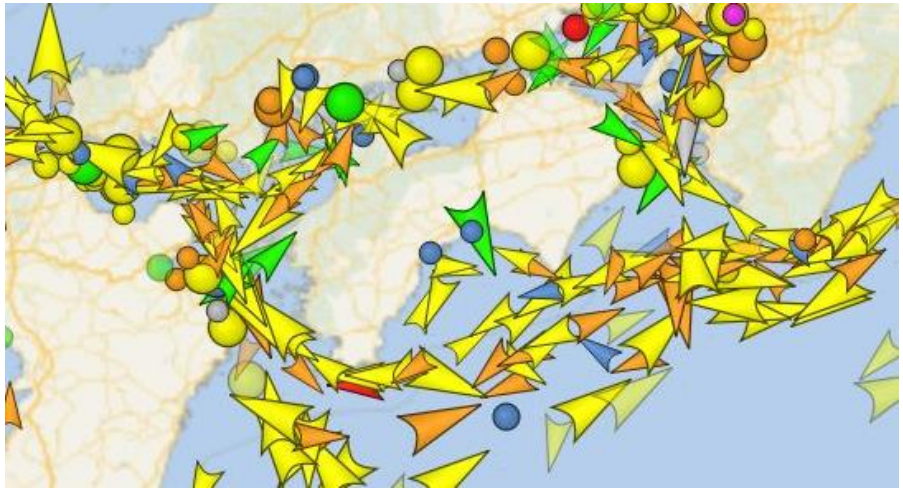


18 Million dollar

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