Electrical Engineering
FACULTY OF PHYSICS AND MATHEMATICAL SCIENCES
UNIVERSITY OF CHILE

SPEL
Space and Planetary Exploration Laboratory

Feasibility study of using a Small Satellite constellation to forecast, monitor and mitigate natural and man-made disasters in Chile and similar developing countries.

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Questions of this work

- Can CubeSats (pico- and nano- Sats) help in monitoring (perhaps predicting) disasters?
- Is it feasible for Chile?
- Do similar countries (even the whole world) might be benefited if coordination is added?

Outline

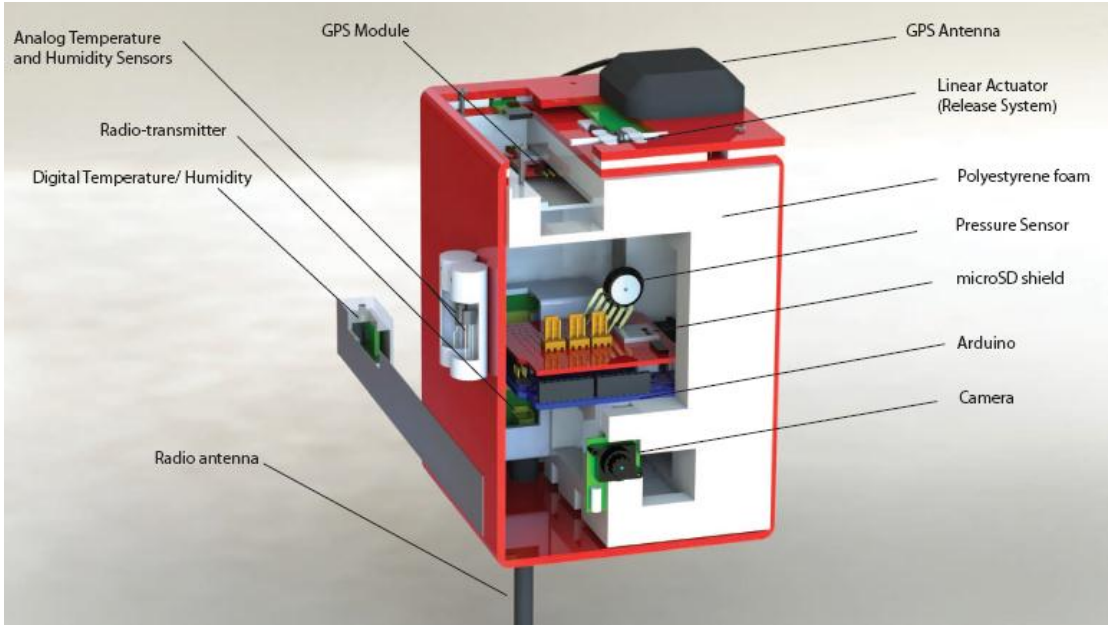
1. Where we are and what we dream
2. Disasters in Chile
3. State of the technology for Cubesats: What we could do with them?.
4. What we envision for Chile
5. What we could do with the international community

Where we are and what we dream

- **Chile: 3 micro satellites**
  - FAsat Alfa (1995-failed), Bravo (1998-2001. Success) and Charlie (2011. Success).
- **University of Chile (2 years of work)**
  - **3 Labs:** Smart Machine Synthesis Lab, Space and Planetary Exploration Lab and FabLab.
  - 4 Assistant Professors: Electrical Engineering, Mechanical Engineering, Geo-Physics and Physics.
  - 1 Post-doc, 3 Engineers, 2 Master students and over 30 undergraduate students.

Where we are and what we dream

SPEL web site: http://spel.ing.uchile.cl



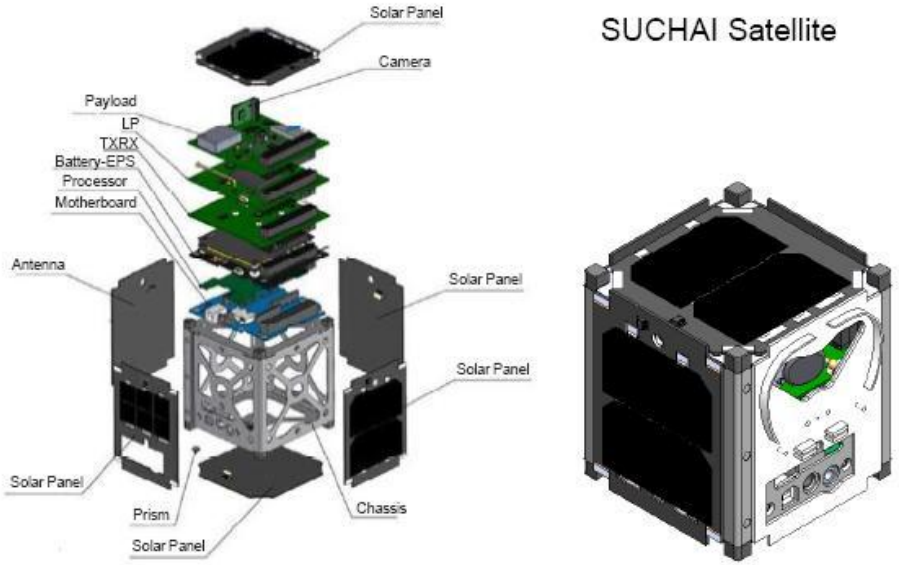
UAV for meteorology (T, P, H and GPS) and air pollution (CO2, CO, SO2, H2S and O3)

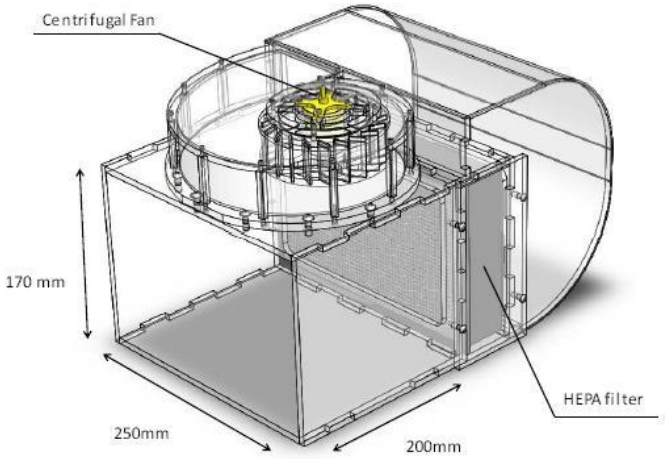
CKELINAR Project – Open hardware/firmware radiosonde.

The FCFM radiosonde. Published in BAMS.
http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-11-00163.1

Where we are and what we dream

SUCHAI project (Satellite of University of CHile for Aerospace Investigation)





Open digital prototyping concept. In the picture a desktop clean hood.

AMUNCHE Project - Rockets

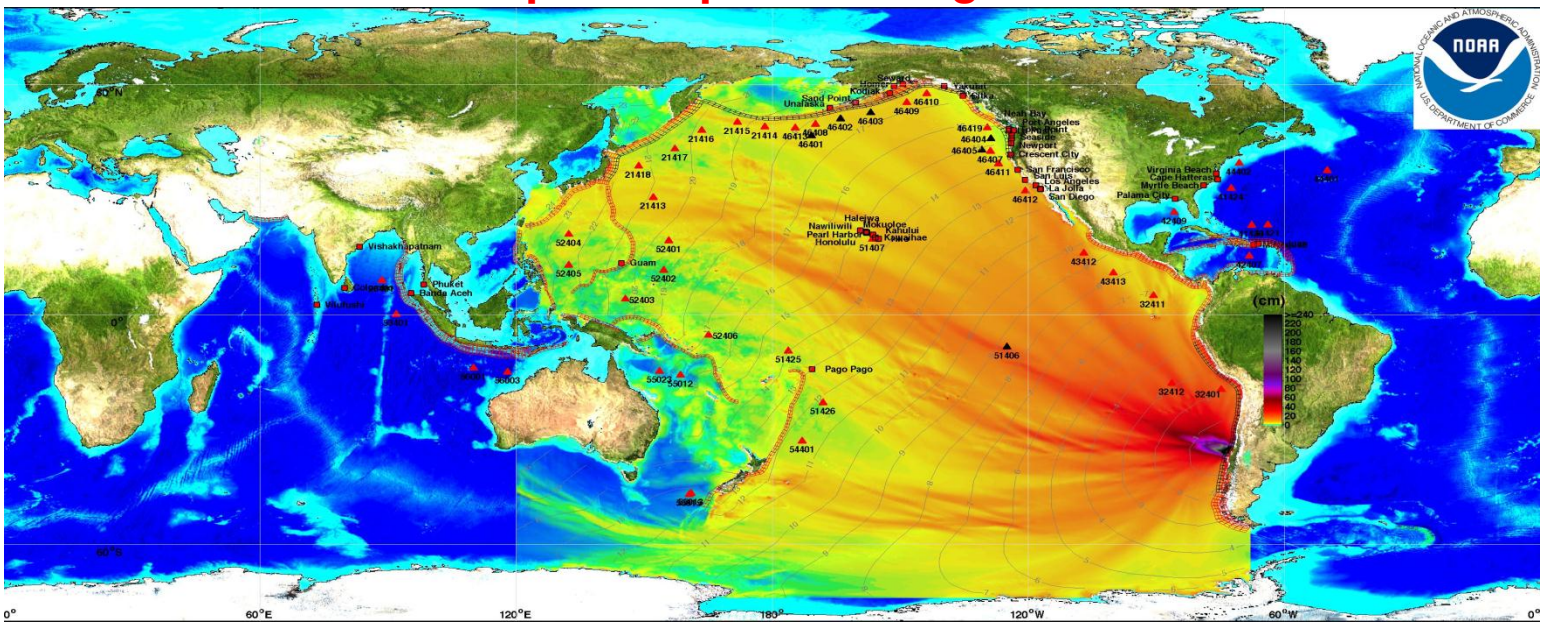
Where we are and **what we dream**

- A Space Program
  - Development of small sats
  - Development of Payloads
    - Astronomy
    - Geophysics and Geology
- Impact Chile
  - Lives
  - Technology
  - Economy

High damage natural and manmade disasters are common in Chile. Space Technology can have a huge impact on monitoring and predicting disasters.

Disasters in Chile

http://nctr.pmel.noaa.gov/



- **Earthquake and Seaquakes**: Long history of major events (e.g. 1922, 1960 and 2010). Las century 54,373 victims, over 20% of the GDP each major event.
- **Hydro-meteorological**: Frequent winter events. Geography of Chile difficult for ground radars.
- **Volcanic activities and Fires**: They have important economical impacts (Airport disruptions, Relocation of towns, etc.)

Disasters in Chile

- Possible Earthquake Precursors, anomalies of:
  - Total electron content
  - Magnetic field
  - Water Vapor and surface temperature.
- Seaquake early alerts
  - Ocean altimetry
- Communication Systems (text)

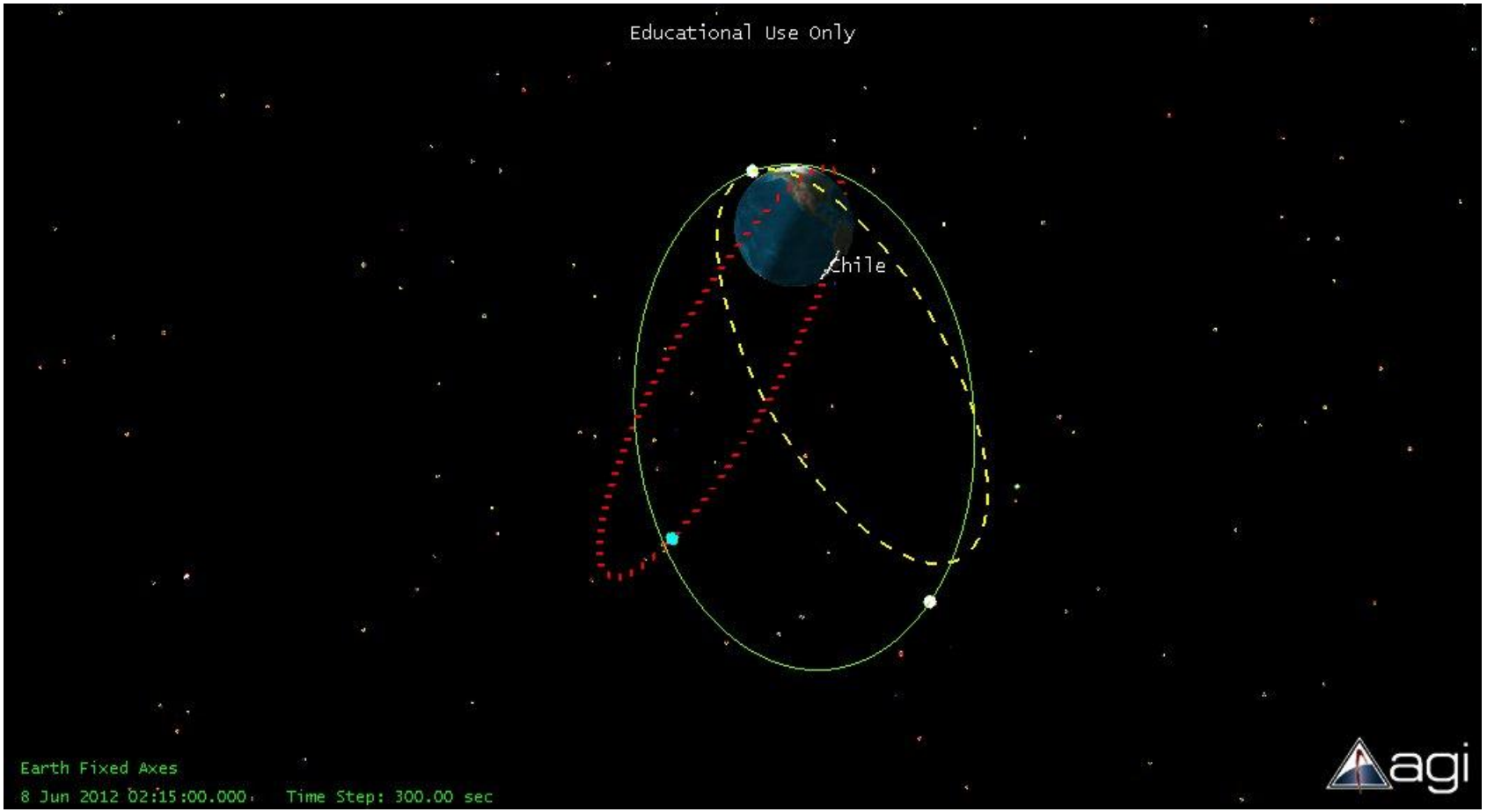
State of the technology for Cubesats

- Water Vapor and Surface Temperature
  - CanX2: 1.4 mm spectral line. 4 laser for on flight callibration.
  - Uncooled or thermoelectrically cooled microbolometers.
- TEC and Magnetic Field
  - Double channel GPS
  - Magnetometers
- Ocean Altimetry
  - GNSS Receiver
- Liquid water in clouds
  - GNSS Receiver

"A survey and assessment of the capabilities of CubeSats for Earth observation". Selva, D. and Krejci, D. Acta Astronautica, 2012.

What we envision for Chile

- Constellation: Molinya-type orbit. 3 Sats



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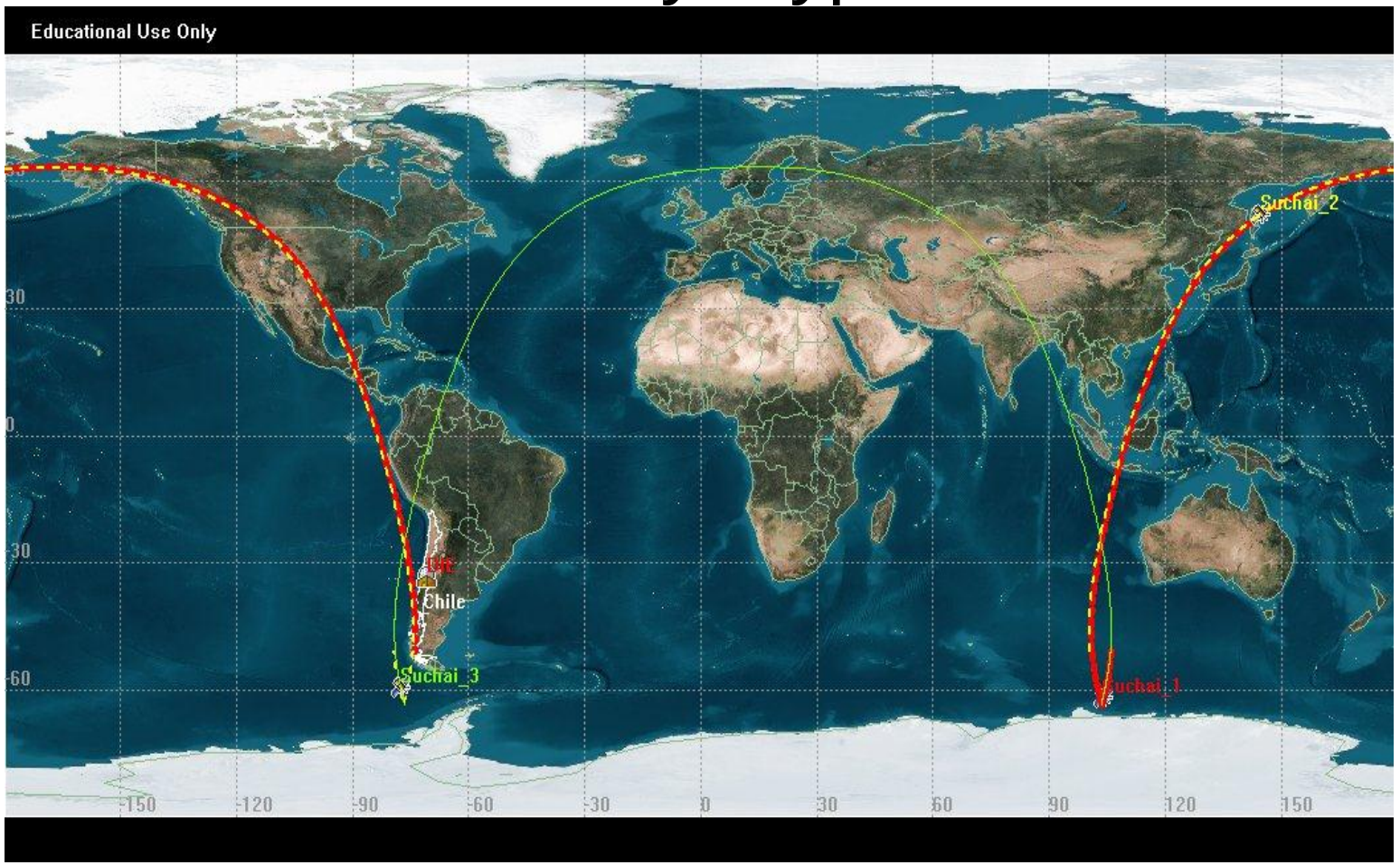

What we envision for Chile

- Femto Sats in LEO (Attitude control)
- Nano Sats for Molinya
- To verify if any of the geophysical variables is an earthquake precursor, we need more data!

Other Countries

- Coordinates Payloads
- Coordinates Ground Stations
- Coordinate orbits
- Coordinate operation of ad hoc constellations
- Communication standard (protocol for disasters)

Conclusion

- Geophysical research can be combined with impact for the population if disasters are the target of the research.
- Development of payloads for studding those phenomena might be done in Chile (Radio Astronomy and Geophysics/Geology technology)
- Analysis of constellations (Ad Hoc) at different orbits can facilitate monitoring and prediction of disasters.

Thank you. Questions? Suggestions?