Synergy between ballooning and satellite missions - validation and instrument development

Kaley Walker

Department of Physics, University of Toronto

CSA Suborbital Workshop - 14 - 16 April 2010

Outline

- Balloon measurements are a very valuable part of the development and operation of a satellite mission
  - Pre-launch testing of instruments / observation scenarios
  - Post-launch validation of results and cooperative studies

- How this can be incorporated in future missions…
  - APOCC: Atmospheric Processes of Climate and its Change
  - PHEMOS: Polar Highly Elliptical / Molniya Orbit Science on Polar Communication and Weather (PCW) Mission

Instrument Development and Testing

Ballooning provides access to space for testing of satellite instruments

- For all missions, need a well-tested engineering model
  - To understand instrument and its performance
- For new concepts, flying a proto-type on a balloon can be used to reduce risk
  - Increases technology readiness level - TRL
- Also, can fly new instrument with well-characterized instruments to better understand measurement performance
  - Comparing different techniques when measuring simultaneously

Validation of Satellite Measurements

Ballooning provides a complementary view of the atmosphere for validation measurements

- Provides atmospheric profiling capability at float altitude or during ascent
  - Higher vertical resolution than is possible from ground
- Regular flights with well-characterized set of instruments can be used to assess aging process of satellite instruments
- Flying complementary instruments to sample same air mass
  - Investigating differences between techniques

APOCC: Atmospheric Processes of Climate and its Change

Goal: Missions that will lead to new scientific understanding of atmospheric processes that regulate Earth's climate and thereby lead to reduced uncertainty in climate forecasts

- Six selected in mid-2008 for one-year concept studies
  - STEP - Stratosphere-Troposphere Exchange Processes
  - MCAP - Mission for Climate and Atmospheric Pollution
  - SOAR - Solar Occultation for Atmospheric Research
  - MEOS - Miniature Earth Observing Satellite
  - TICFIRE - Thin Ice Clouds in a Far IR Experiment
  - SnowSat - Clouds, snowfall and light precipitation (EC)

(four missions build from current satellite mission heritage)

APOCC Example: TICFIRE

Risk mitigation for new instrument - TICFIRE

- Nadir-viewing radiometer operating in FIR
- Focus on polar regions with global view
- Pointing to switch from measurement to calibration views of deep space / blackbody

- Balloon flight for testing proto-type
  - ~30 kg instrument; 25 km altitude
  - Launch locations: Arctic; mid-latitudes for initial testing?

Thanks to Jean-Pierre Blanchet

PHEMOS: Polar Highly Elliptical / Molniya Orbit Science Mission

PHEMOS on Polar Communication and Weather Mission

- Two satellites in one orbital plane to provide continuous GEO-like imagery 50-90 N

One of three types of instrument payloads for PHEMOS to be complementary to primary meteorological payload

- Atmospheric Remote Sensing instruments to observe chemistry, dynamics and other processes of neutral atmosphere

Proposals for Phase 0 studies (with possible continuation to Phase A) were submitted in February 2010

"Needs" for Satellite Instrument Development and Validation

- **Mass:** ~10 - 50 kg for single instrument; up to several hundred kg for multi-instrument (payload-level) testing
- **Altitude:** stratosphere ~25-35 km
- **Location:** mobile capability would be advantageous; Arctic capability required for PHEMOS and some APOCC
- **Duration of Flights:** on order of 24(?) hours
- **Schedule:** estimate over next 5 years for pre-launch activities but depends on mission selection timelines
- **Funding / International Collaborations:** To be developed
- **Student Involvement:** High potential in these projects to bring students into satellite mission with suitable timeline

** Caveat: Because these projects are in Phase 0, this list is based entirely on my projections of future needs