Toward a Global Planetary Boundary Layer Observing System: NASA PBL Incubation Study Team Report

João Teixeira

NASA PBL Incubation Study Team

The latest U.S. National Academies Earth Science and Applications from Space Decadal Survey was published in January 2018.

Planetary Boundary Layer Incubation

The Planetary Boundary Layer (PBL) is an Incubation Targeted Observable.

Planetary Boundary Layer

2017 NAS Earth Science Decadal Survey

The Decadal Survey recommended the Planetary Boundary Layer (PBL) as an Incubation Targeted Observable.

Planetary Boundary Layer

2017 NAS Earth Science Decadal Survey

The Decadal Survey recommended the Planetary Boundary Layer (PBL) as an Incubation Targeted Observable.

NASA PBL Study Team Charter

The summarized charter of the NASA PBL Study Team was to:

- Identify the most critical PBL science and applications questions in the context of Earth System science.
- Identify specific PBL needs from a data-assimilation, modeling and prediction (weather, climate, regional, LES) perspectives.
- Identify the geophysical observables and their associated spatial and temporal measurement requirements (resolution, sampling) as so as to address the key PBL questions and needs.
- Identify the observational gaps from the current program of record.

Summarized PBL SATM

- Identify practical yet effective emerging measurement approaches and technologies to address measurement goals from space.
- Develop a technology roadmap to enable a future orbital observing system (in combination with suborbital and ground-based observatories, models and data-assimilation systems).
- Identify simulator methodologies to explore optimal combinations of potential measurement approaches and technologies.
- Develop a strategy to field emerging airborne instruments in science campaigns.
- Synthesize these findings in a preliminary PBL Science and Applications Traceability Matrix (SATM).
- Produce the PBL Report

PBL Science and Technology Roadmap

Global Planetary Boundary Layer (PBL) Observing System

The Global Planetary Boundary Layer (PBL) Observing System includes:

- Essential components:
  - DIAL and DARM in LEO for high vertical resolution (200 m) water vapor
  - IR and MW sounders in horizontal revisit in LEO Cubesat constellations
  - Radio Occultation: larger constellations of GNSS-R receivers and/or novel orbital configurations
  - Geostationary hyperspectral IR sounders (EUMETSAT, NOAA)
  - PBL modeling and data assimilation

PBL Geophysical Variables and Requirements

The essential geophysical variables identified as uniquely required to address the four science goals are:

- PBL profiles of temperature.
- PBL height.
- The SATM leads to the following measurement requirements (that can only be satisfied with a combination of different technologies):
  - Vertical resolutions as fine as 100-200 m.
  - Horizontal resolutions as fine as 1 km.
  - Temporal sampling of at least 4 times per day.

A Global PBL Observing System

A global Planetary Boundary Layer (PBL) observing system is urgently needed to address fundamental PBL science questions and societal applications related to weather, climate, and air quality.

This PBL observing system should optimally:

- combine new space-based observations of the PBL thermodynamic structure
- with complementary surface-based and suborbital assets,
- while taking advantage of, and helping improve, modeling and data assimilation systems.

Copyright 2021 California Institute of Technology. Government Sponsorship Acknowledged.