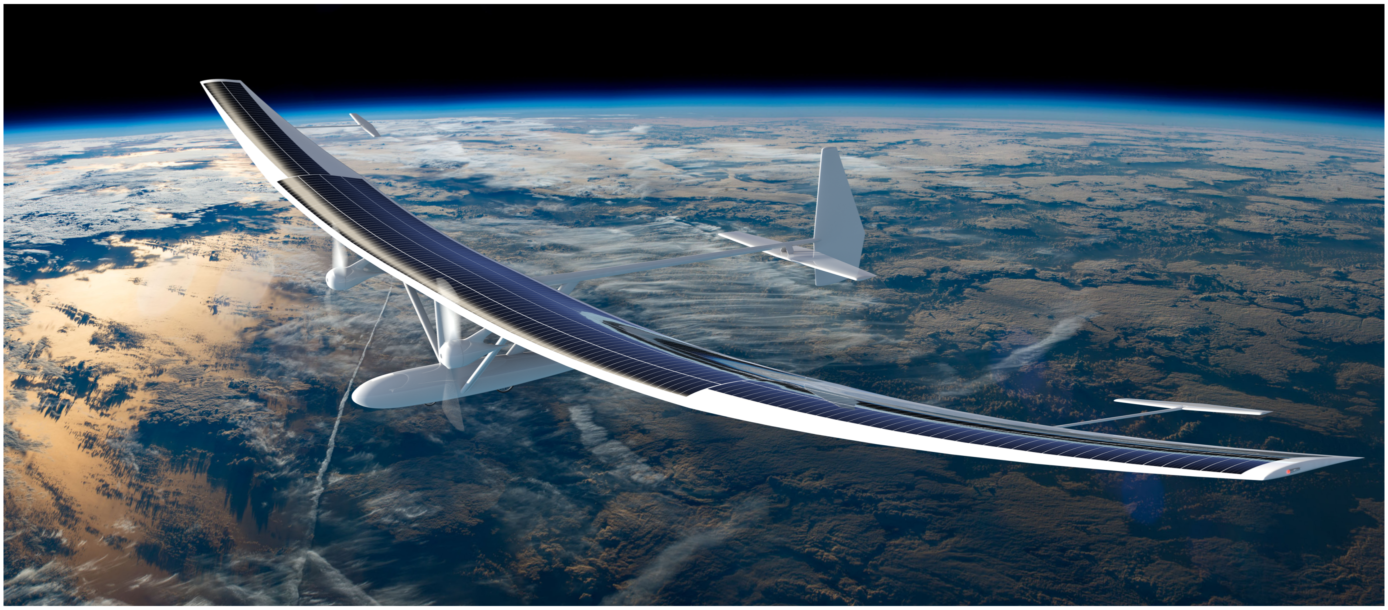

Stratospheric Airborne Climate Observatory System to Initiate a Climate Risk Forecasting Revolution

Problem: Need for Fundamental Advances in Climate Observations for Quantitative Risk Forecasting

Large uncertainties in climate forecasts create massive challenges to mitigation and adaptation efforts needed to allow society to prepare for and adjust to changes in the climate system, such as increased storm severity and frequency, more severe droughts, sea-level rise, and ozone depletion. As a result, we are unable to quantify and navigate the risks of rapid, irreversible changes to Earth's climate. These large uncertainties in climate forecasts arise in large part from the sparsity of observations of key climate variables.

There is a critical need for higher spatial and temporal resolution observations of various components of the climate system than are currently available through satellite, airborne, and in situ sensors. This gap in our observational capability drives gaps in our understanding of key mechanisms of the climate system, particularly those mechanisms that couple different climate components, including oceans and atmospheres, atmospheres and land, and ice sheets and oceans. By understanding these couplings and providing scientists with the means to test and develop climate models and continuously monitor and calibrate climate parameters, high spatial and temporal resolution observations can play a key role in accelerating climate science and dramatically improving the knowledge available to planners, policy makers, and the rest of society to prepare for the changes to come.

Solution Approach: Observatory System of Solar Aircraft Targeting Specific Climate Missions

We propose a **Stratospheric Airborne Climate Observatory System (SACOS),** an ensemble of unmanned solar powered aircraft operating for weeks or months in the stratosphere, each integrally designed with instrument systems focused on a suite of climate-observing missions. Together, these enable a combination of long duration solar powered observing systems, each targeted at the highest priority risk factors that threaten global societal stability. The resulting observations will, for the first time, provide the irrefutable evidence needed for quantitative forecasts of the dominant risk factors stemming from the global use of fossil fuels. In addition, marked advances in public policy that have historically resulted from a new generation of quantitative, irrefutable observations will constitute a central element in the strategy upon which this new research endeavor is founded.

SACOS MISSIONS

There is a broad range of critical observing missions for the SACOS observatory system and there is strong synergy with a number of Climate Grand Challenge (CGC) white paper efforts. Example missions are presented below. Detailed mission plans, impact strategies, instrumentation development, and sponsorship for operational vehicles and missions will be led by four mission definition teams which link to parallel CGC efforts:

1. High Latitude Ice Observations (led by **Brent Minchew**, Earth, Atmospheric, and Planetary Sciences)
   - Mission 1: Antarctic Ice Shelf Collapse Forecasting
   - Mission 2: Greenland Glacier Flow Prediction
2. Direct Stratospheric Sampling (led by **Jim Anderson**, Harvard and Bill Herzog, Lincoln)
   - Mission 4: Sampling of Stratospheric Aerosols
   - Mission 5: In-situ Measurement of Storm Driven Stratospheric Chemistry
3. Drought, Wildfire, and Flood Monitoring (led by **Dara Entekhabi**, Earth, Atmospheric, and Planetary Sciences)
   - Mission 3: Coastal Flooding Monitoring
   - Mission 6: Drought and Wildfire Prediction
4. Oceanic Surface and Cyclone Monitoring (led by **Kerry Emanuel**, Earth, Atmospheric, and Planetary Sciences)
   - Mission 7: Oceanic Surface and Cyclone Monitoring

VEHICLE DEVELOPMENT

The SACOS vehicle will address challenges to high altitude solar electric aircraft through an integrated design and operational strategy to minimize aero-structural and technical risk as well as taking advantages of advancements in solar cell and battery technology coupled with high performance, low mass payload instruments. By operating during summer months, when many key climate phenomena are active, the short night periods reduce the battery mass, vehicle size, and technical risks. Vehicle development will be led by **John Hansman** (Aeronautics and Astronautics) and **Mark Drela** (Aeronautics and Astronautics). Flight vehicle construction will be subcontracted to Electra.aero, led by MIT alumnus **John Langford**.