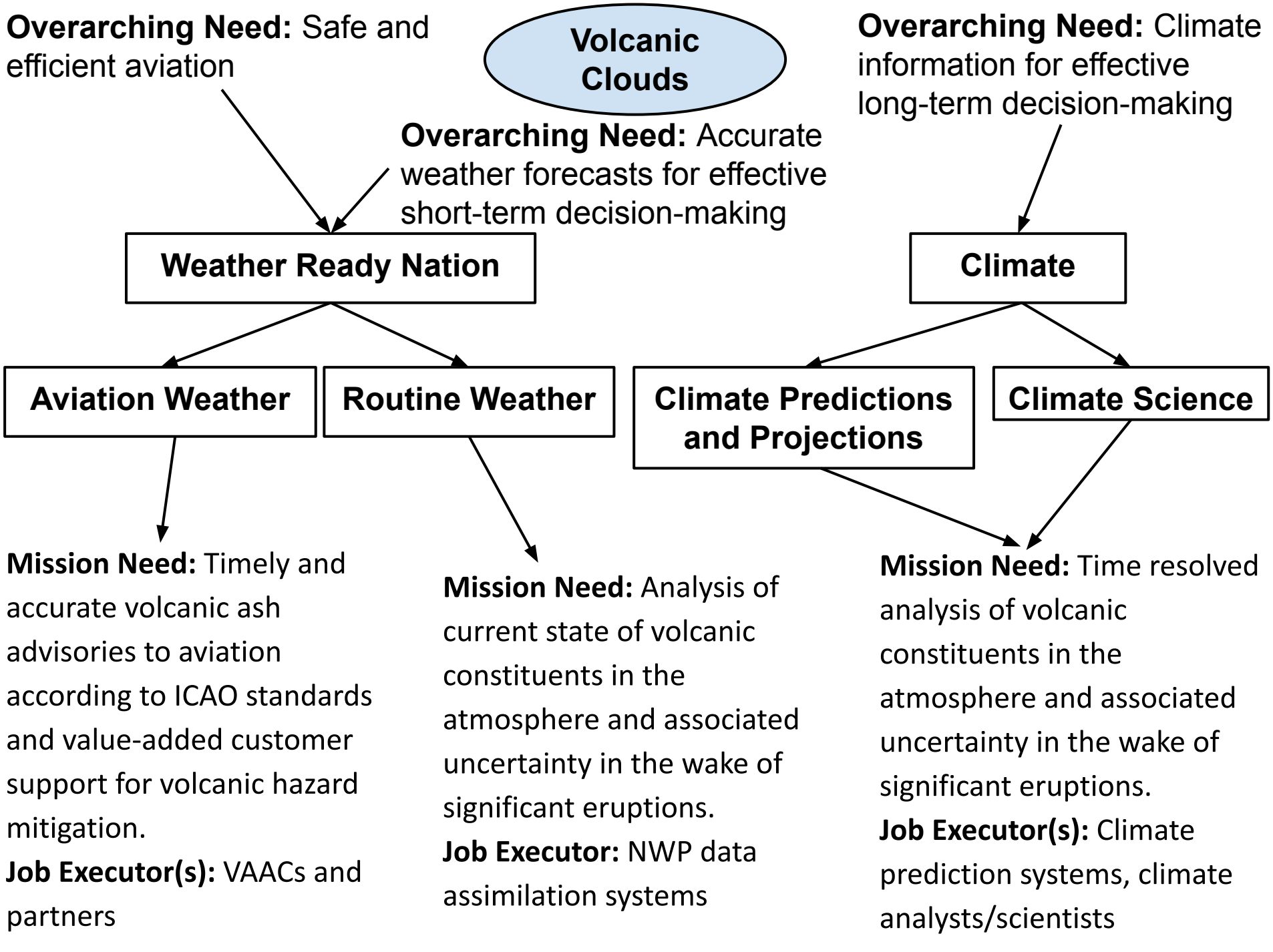
Overarching Need: Safe and efficient aviation
Volcanic Clouds
Overarching Need: Climate information for effective long-term decision-making
Overarching Need: Accurate weather forecasts for effective short-term decision-making
Weather Ready Nation
Climate
Aviation Weather
Routine Weather
Climate Predictions and Projections
Climate Science
Mission Need: Timely and accurate volcanic ash advisories to aviation according to ICAO standards and value-added customer support for volcanic hazard mitigation.
Job Executor(s): VAACs and partners
Mission Need: Analysis of current state of volcanic constituents in the atmosphere and associated uncertainty in the wake of significant eruptions.
Job Executor: NWP data assimilation systems
Mission Need: Time resolved analysis of volcanic constituents in the atmosphere and associated uncertainty in the wake of significant eruptions.
Job Executor(s): Climate prediction systems, climate analysts/scientists

Functional Scoping of VOLCAT - Aviation Weather

Timely detection of new volcanic events

Capability	Description	Environmental Observation Input
Automated eruption detection	*Practical Objective:* replicate human expert ability to identify new volcanic clouds in satellite imagery as required to address data overload challenge *Performance targets (relative to human expert analysis of satellite imagery):* Correct detection of at least 75% of cloud producing events with cloud lifetime > 60 minutes; at least 50% of alerts are issued based on auto detection within the satellite scan where the eruption is first unambiguously apparent in the corresponding satellite imagery; correct detection of at least 90% of statistically significant thermal anomaly jumps; daily correct detects > number of false alerts for multi-spectral features, on average; correct source volcano is identified in at least 80% of confirmed events; processing latency relative to image acquisition time should be less than the cadence of input GEO satellite imagery and no more than 15 minutes for LEO data	All earth scans from core GEO ring satellites, NOAA LEO, NASA LEO, and EUMETSAT/ESA LEO Ground-based lightning detection
Eruption alerting	*Practical Objective:* package results of automated eruption detection to minimize the latency of volcanic ash advisories and ensure that the 20 minute ICAO requirement is met *Specifications*: web-based alert subscription tool that allows users to filter alerts by geographic criteria such as VAAC region, volcanic arc, and Flight Information Region; email and SMS distribution options; web-based alert reports and associated searchable database; web-based, user configurable, volcanic event dashboard as a collection point for all alerts; alerts automatically link to underlying satellite imagery with volcanic feature overlay options; web-based volcano thermal output time series dashboard to capture short and long term trends	Results from automated eruption detection

Functional Scoping of VOLCAT - Aviation Weather

Current state of volcanic ash cloud and associated confidence relative to ICAO thresholds

Capability	Description	Environmental Observation Input
Automated ash cloud tracking	*Practical Objective:* automatically track volcanic ash features in the atmosphere in a manner that is consistent with human expert analysis of satellite imagery, including end-to-end labeling as a function of source emission, as needed to support downstream capabilities (ash property retrievals and forecasting) *Performance targets (relative to human expert analysis of satellite imagery):* Detection accuracy of 90% where loading >10 g/m^2, 80% where loading >1 g/m^2, and 70% where loading > 0.1 g/m^2; Correct feature labeling throughout lifecycle for at least 80% of tracked features with detectable lifespan exceeding 3 hours *Additional specifications:* automated region of interest generation for overlaying on satellite imagery, time series of cloud area for each feature, aggregation of lightning strikes within feature region, multi-satellite feature association	All earth scans from core GEO ring satellites, NOAA LEO, NASA LEO, and EUMETSAT/ESA LEO Results from automated eruption detection
Ash properties and uncertainty	*Practical Objective:* provide estimates of key ash properties, and associated uncertainty, as needed to directly inform volcanic ash advisories in accordance with ICAO standards and thresholds defined in ICAO Annex 3 - *Meteorological Service for International Air Navigation* *Specifications*: -Ash properties are only reported where ash is determined to be present by upstream eruption detection and ash cloud tracking -Minimum median accuracy of ash cloud top height of highest layer: 4 km (stratospheric clouds), 3 km (upper tropospheric clouds), and 2 km (low to mid tropospheric clouds) -Minimum median accuracy of ash mass loading for highest layer: factor of 5 -Uncertainty information expressed as probability of ICAO ash concentration threshold exceedance	All earth scans from core GEO ring satellites, NOAA LEO, NASA LEO, and EUMETSAT/ESA LEO Results from automated ash cloud tracking

Functional Scoping of VOLCAT - Aviation Weather

Future state of volcanic cloud and associated confidence relative to ICAO thresholds

Capability	Description	Environmental Observation Input
Eruption source parameters	*Practical Objective:* estimate variables that are critically important for parameterizing the source term used by forecast models *Specifications:* -Time resolved mass eruption rate for high level eruptions (factor of 100 median accuracy) -Time resolved maximum injection height (1 km median accuracy for tropospheric injections, 2 km median accuracy for stratospheric injections) -Source volcano (80% accurate) -Eruption start time (median accuracy of 15 minutes) -Eruption cessation (median accuracy of 15 minutes) -Fine ash fraction (median accuracy of 5%) -Time resolved total mass of ash per feature (median accuracy of ??) -Time resolved total mass of SO2 per feature (median accuracy of ??)	Results from automated eruption detection, tracking, and characterization Infrasound, seismic data, and radar data
Model tools	*Practical Objective:* provide volcanic cloud forecasts and associated uncertainty, as needed to directly inform volcanic ash advisories in accordance with ICAO standards and thresholds defined in ICAO Annex 3 -*Meteorological Service for International Air Navigation* *Required tools*: -Automated initialization of model eruption source parameters -Automated satellite property based inverse modeling for volcanic ash and SO2 -Automated satellite property based data insertion for volcanic ash and SO2 -Automated satellite property based model verification for volcanic ash and SO2	Results from automated eruption detection, tracking, and characterization Eruption source parameters