Terminal Weather System for Tactical Lightning Avoidance (Research project plan)

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Motivation

■ Lightning and aircraft

Lightning is one of the heaviest issues for civilian flights in Japan.

ref) Z. Kawasaki et al., 2002

■ Frequency

- ➢per 1,000 – 20,000 flight hours
  (Life of aircraft is 60,000 – 100,000 flight hours)
- ➢Hundreds of reports per year (Japan).

■ Impact to operation

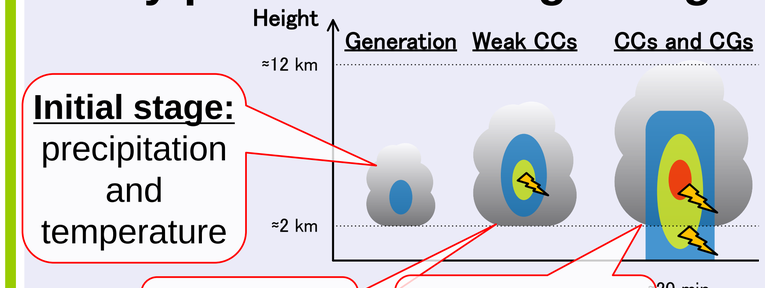
- ➢Flight cancel: tens per year
- ➢Delay: Hundreds per year
- ➢Repair cost: Millions of dollars per year by temporary repair (Japan)

■ Characteristics of Japan

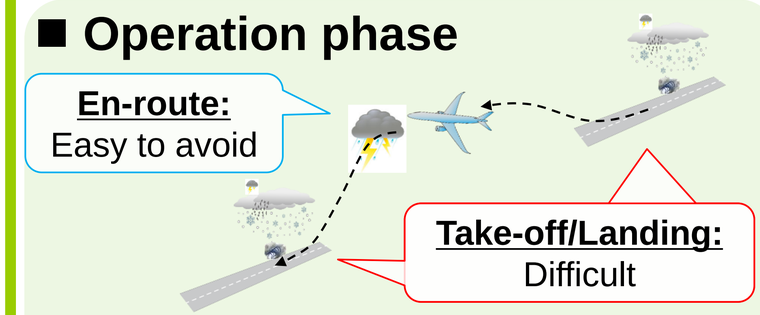
- ➢Frequent take-off and landing in the small country
  (most of lightning strikes occur in take-off or landing phase)
- ➢Winter lightning with high energy in the side of Japan sea

Approach

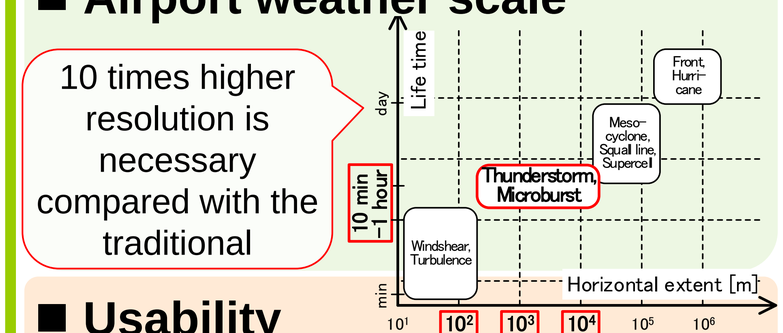
■ Key parameters of lightning



■ Operation phase



■ Airport weather scale



■ Usability

Only experts can interpret traditional indications of physical parameter. This kind of product is NOT usable.

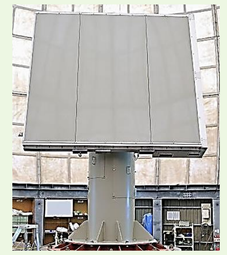
Proposed approach

■ Integrated observation

- ➢3-D precipitation by a radar
- ➢Lightning detection and location
- ➢Temperature by aircraft sounding

■ Tactical support

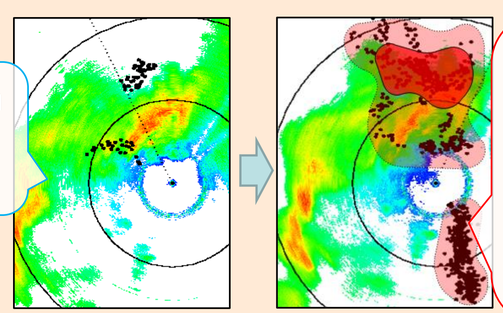
- ➢Airport-based observation with high resolution (or accuracy)
  - ✓**Phased array weather radar (PAWR)** with a high volume scan rate of 30 sec.
  - ✓Accurate lightning detection by **BOLT** (Broadband Observation network for Lightning and Thunderstorm)
  - ✓High-frequency temperature profile on aircraft paths; **SSR mode-S**



■ Lightning risk management

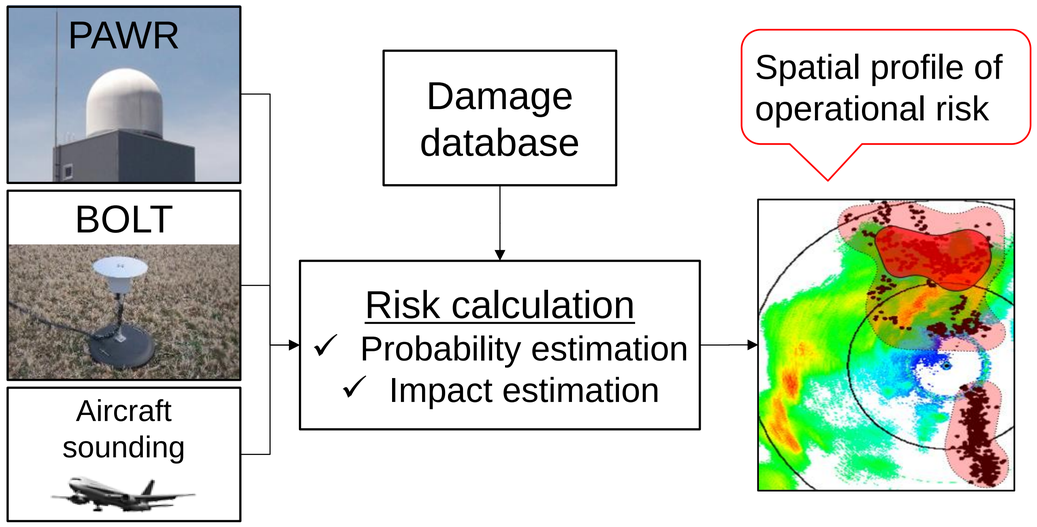
- ➢Operational risk caused by lightning is calculated for non-weather-experts.

× Indication of physical parameters



○ Operational risk is calculated from the physical parameters with the high resolution or accuracy.

System



■ Weather observation

- ➢PAWR
- ➢BOLT
- ➢Aircraft sounding via SSR mode-S
- ➢Other ground based devise

■ Risk calculation

- ➢Probability estimation; outputs a spatial profile of probability of lightning occurrence.
- ➢Impact estimation; outputs energy of discharge if a lightning occurs.
- ➢Risk is calculated by a combination of the probability and impact via the database.

■ Damage database

relates energy of discharge to damage of aircraft bofy or operational cost which is developed by operational data and artificial lightning experiments.

■ Nowcasting

- ➢Short-time (10, 20, or 30 min) prediction is valid to reduce workloads of pilots, controllers, or operators.

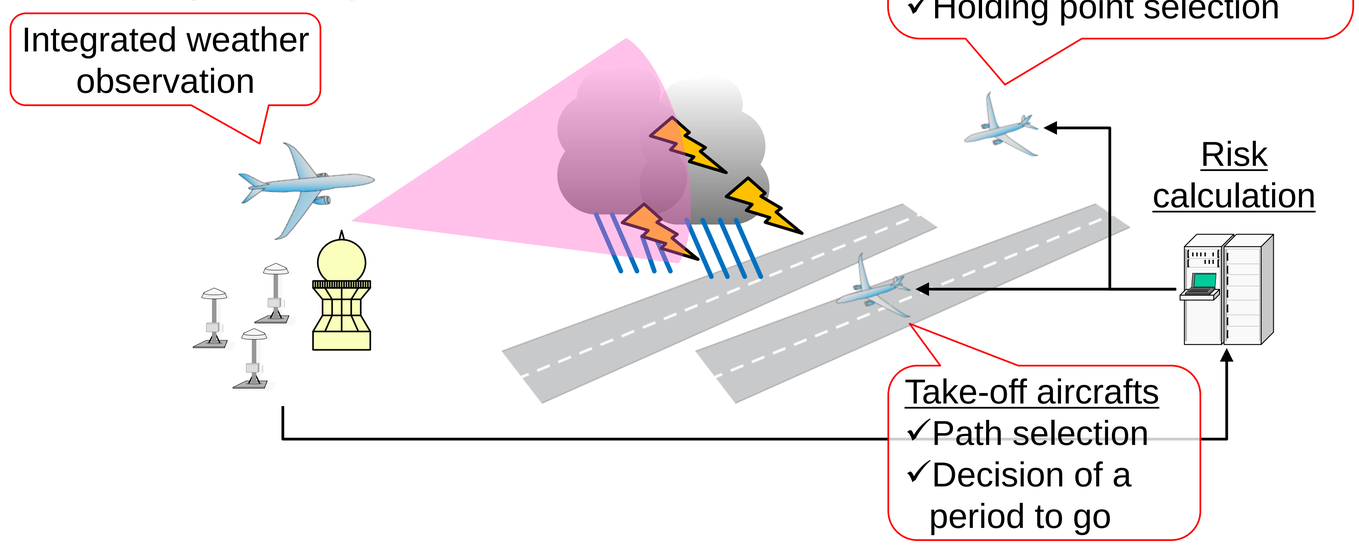
Operation image

■ Path decision support

- ➢Integrated weather observation (mainly, precipitation, lightning and temperature)
- ➢Risk calculation
- ➢Send a 3-D plot of operational risk to pilots, controllers, or operators.
- ➢Select a path with low operational risk

■ Go/NG decision support

- ➢Risk-nowcast calculation
- ➢Decide a proper period to Go
- ➢Or, keep holding in a low risk area



Research plan

■ Observation campaign

- ➢will start in this November in Shonai and Ibaraki area, which focus on summer and winter lightning, respectively.
- ➢Weather and flight data will be obtained.

■ Artificial lightning experiment

■ Algorithm development

- ➢A basic algorithm of the risk calculation will be developed and evaluated through the observation and experiment for its feasibility study until March 2018.