SP/04
(IP/03)

# Improvement of impact-based meteorological information to support ATM operation

## -adverse weather in airspace


Japan Meteorological Agency (JMA)

Japan Civil Aviation Bureau (JCAB)


ICAO APAC MET/ATM Seminar, 1 May 2023

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国土交通省
*Ministry of Land, Infrastructure, Transport and Tourism*

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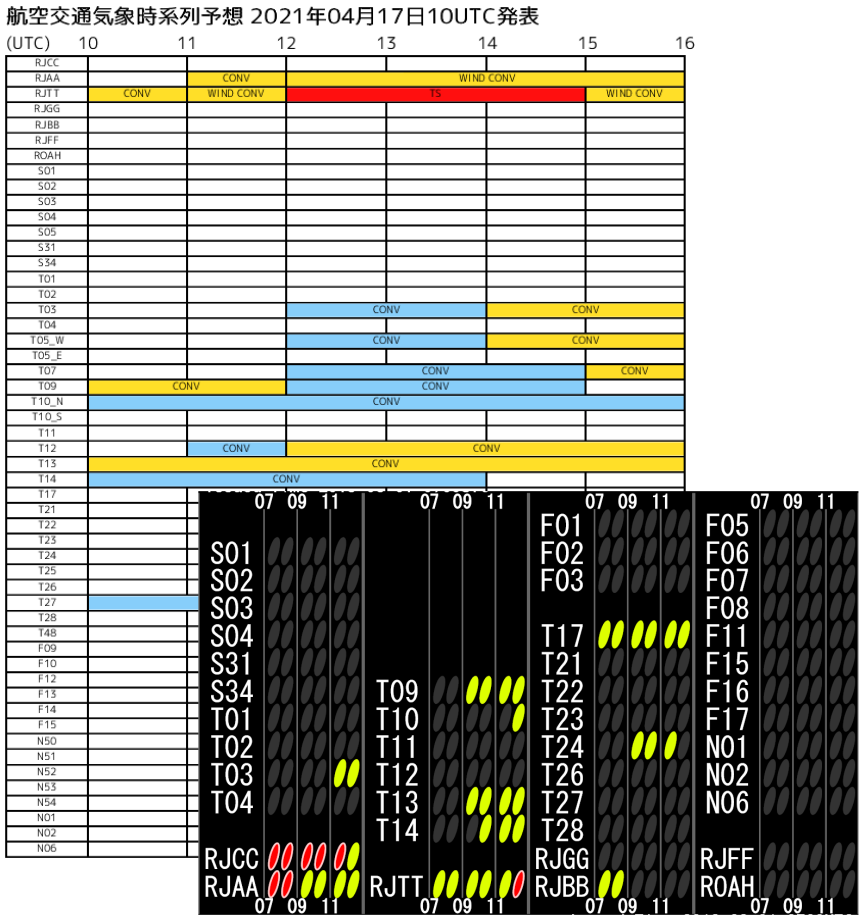
1. Introduction
   - Impact based MET information to support ATM in Japan
2. Criteria for color-code in airspace
3. Improvement of the product in coordination with JCAB
4. Challenges: evaluation/verification of the products
5. In future

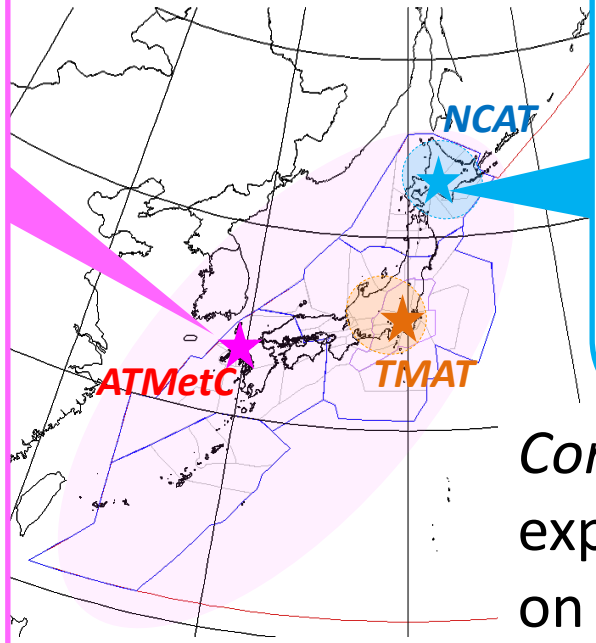
# *Impact-based category forecasts to support ATM*

- sequential category forecasts

## ATMet Category Forecast

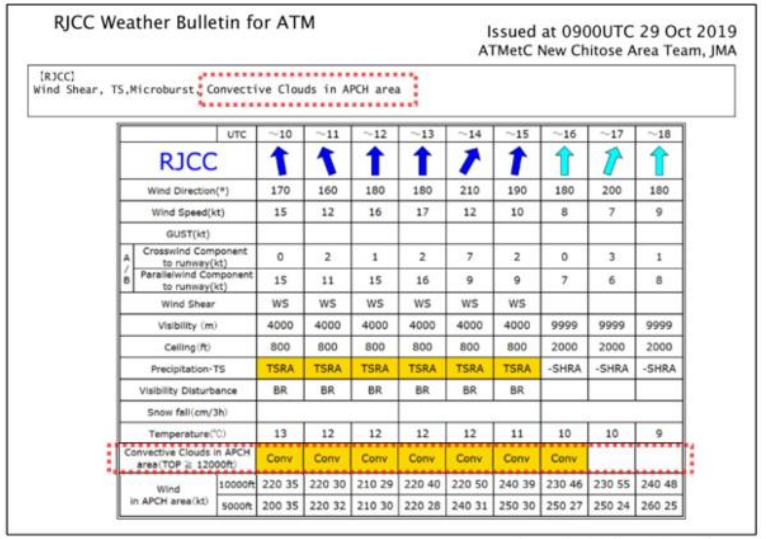
*Up to 6 hours, for all domestic airspace, major airports*




## WX Bulletin

*Up to 9 hours, for RJCC and Approach control area*




*Contents:*

expected impacts of weather conditions on air traffic flow

| High | Medium | Slight | None |
|---|---|---|---|

*Target phenomena:*

Airports: Thunderstorm, Visibility, Ceiling, Wind, etc.

Approach control area: CBs, Convective clouds and Wind

ATC sectors: CBs, Convective clouds



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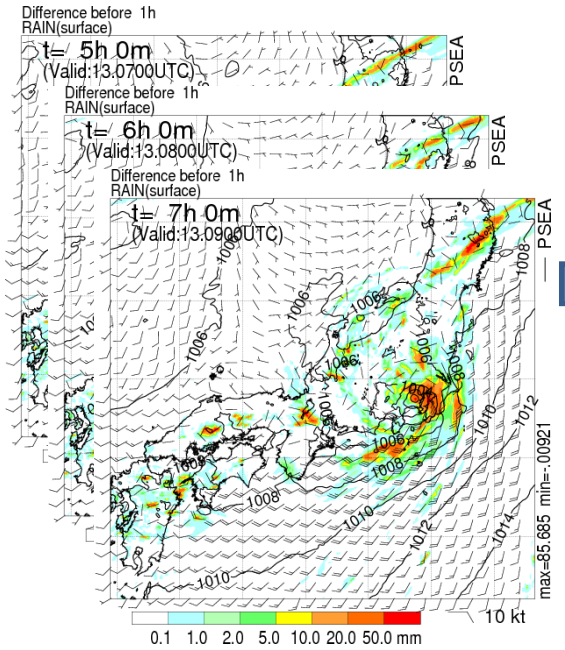
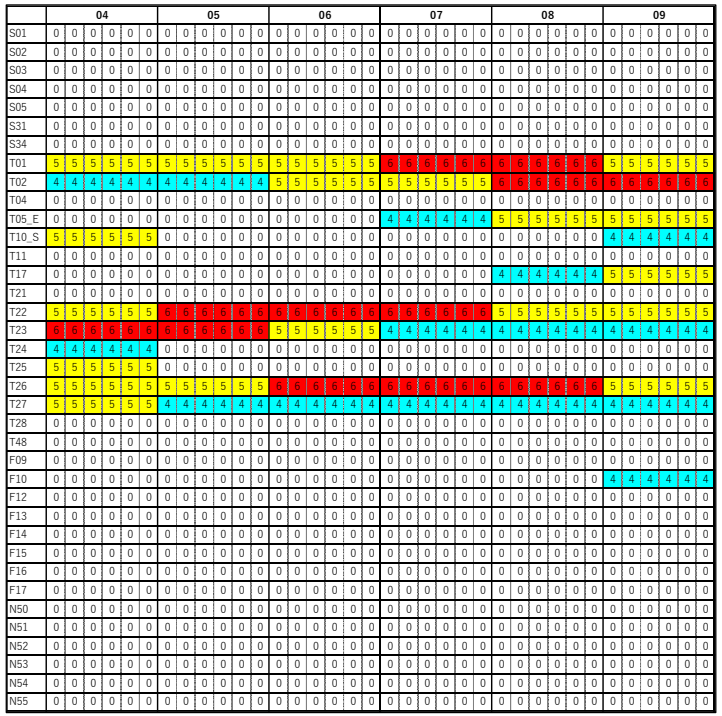
- Procedure of creating category forecast
  - Calculate ATM SIGWX index as **first guess data** derived from VSRF (very short range forecast) and high resolution NWP model (ref: MET/R WG/7 IP/05 )
  - **Manual modification** of the first guess in consideration of **actual meteorological condition**

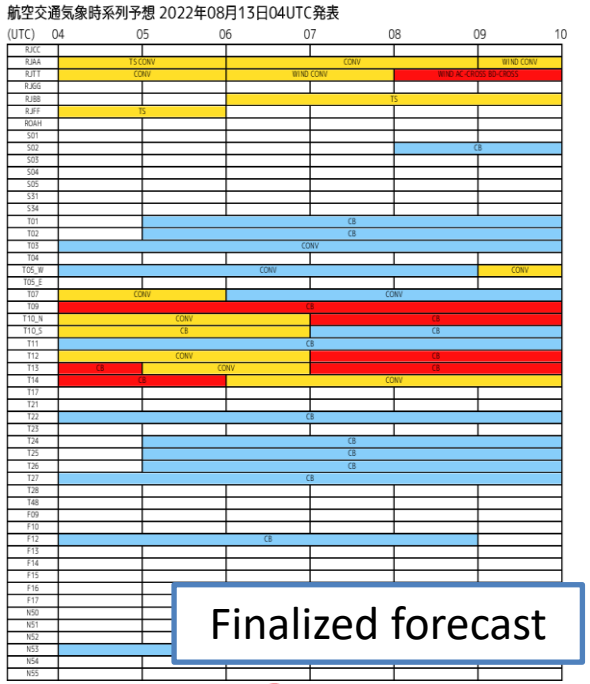



NWP, VSRF




ATM SIGWX index: **first guess**

Manual input




Finalized forecast



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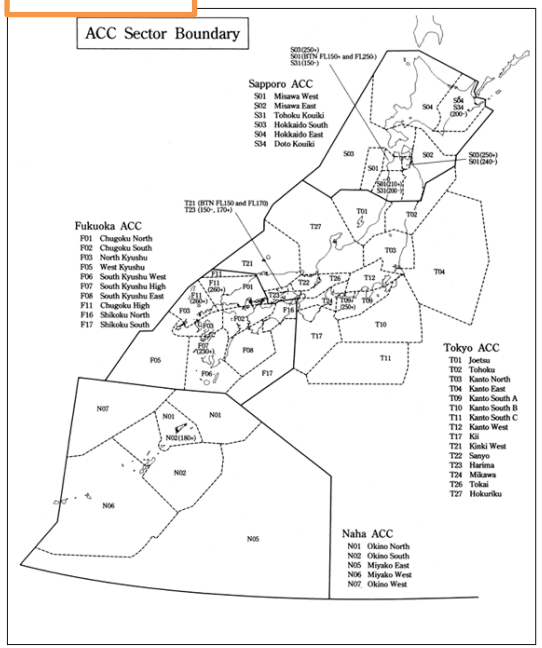
# Improvement history of CB detection for color-coding

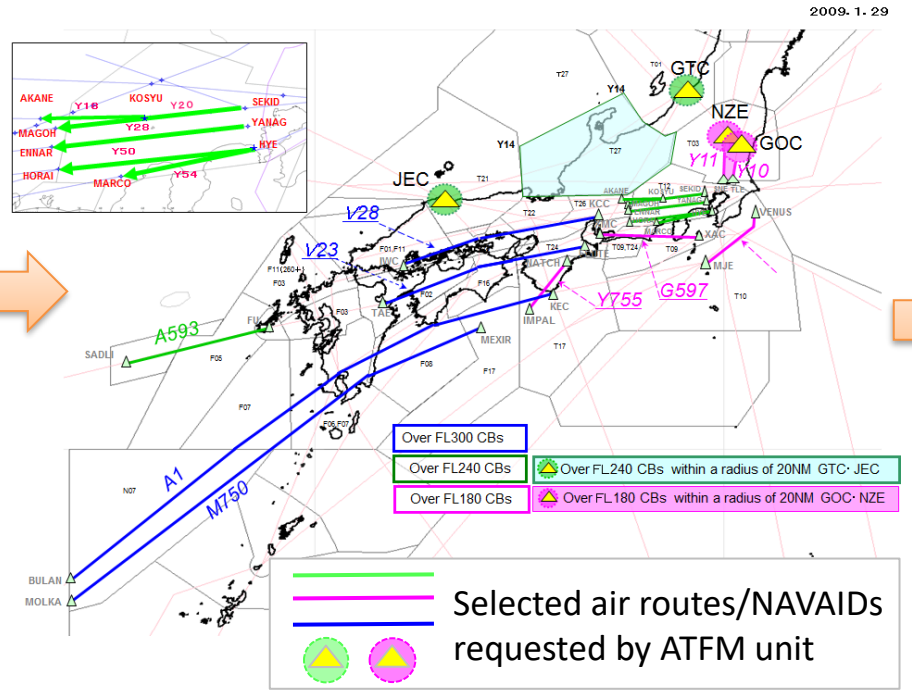
Investigation and trial with ATM officers (2018-2020)

- ☞ All domestic ATC sectors (2005 –)
- ☞ All domestic ATC sectors and selected air routes/navigation aids (2006 –)
- ☞ Set “CB detection area” including congested air routes was introduced (2020 –)
- ☞ “CB detection area” was applied to Sectors of Sapporo ACC (2023 Apr. –)

2005 –

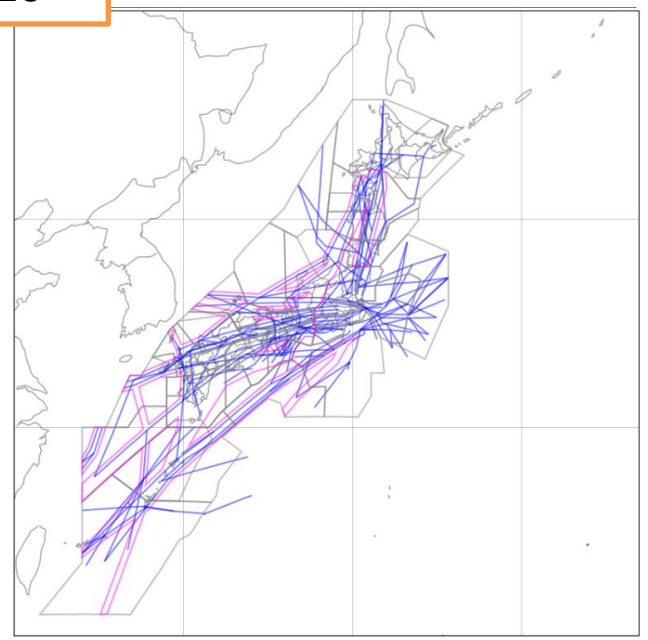



2006 –




2020 –

Step-wisely introduced



# Contents

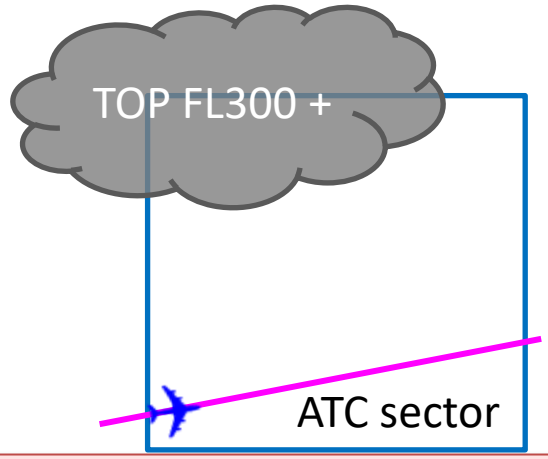
- Former criteria for Convective clouds in ATC sectors (2006 –)

**Coverage of CBs (top ≥ FL300*) in each sector**

*FL240 in some sectors depends on the altitude of most aircrafts

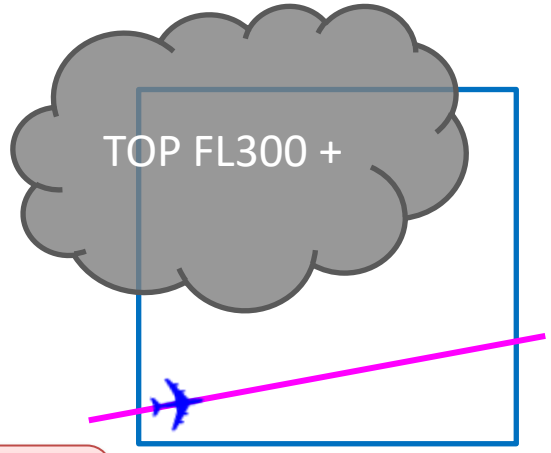
Expected impacts

**Slight**



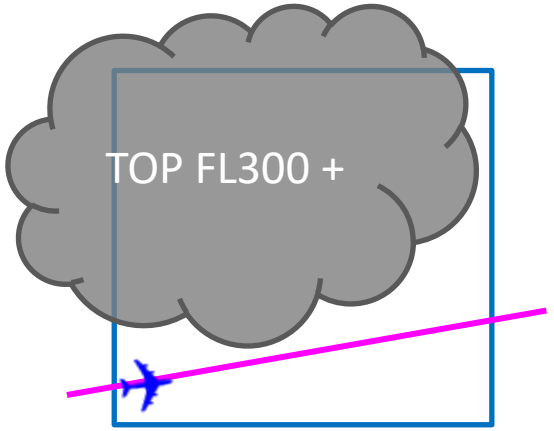

✓ not effectively converted to impacts on air traffic flow.

**Medium**




20 % or more

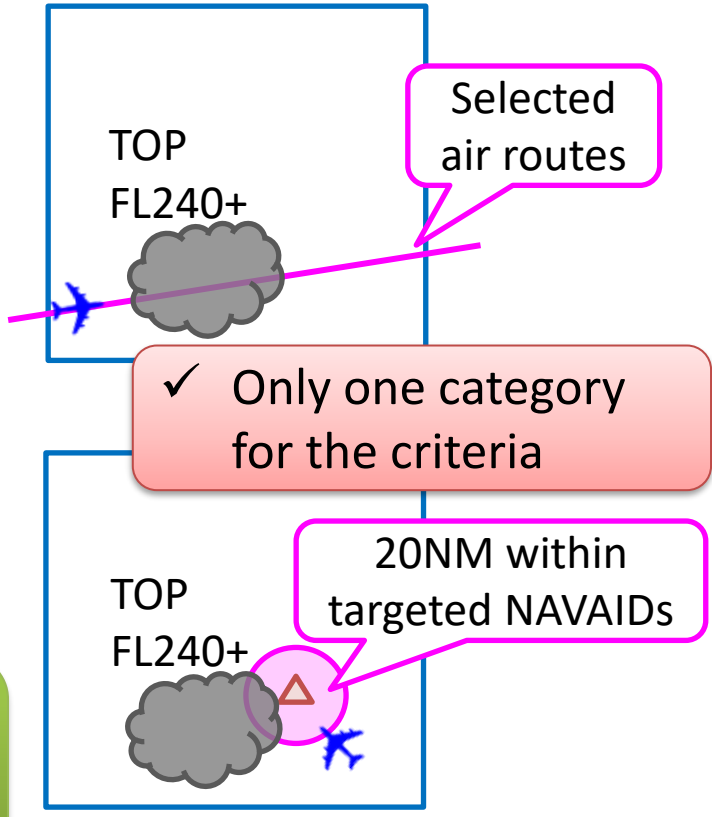
**High**




50 % or more

**Existence of CBs on the selected air routes/navigation aids**

**Medium**




✓ Only one category for the criteria

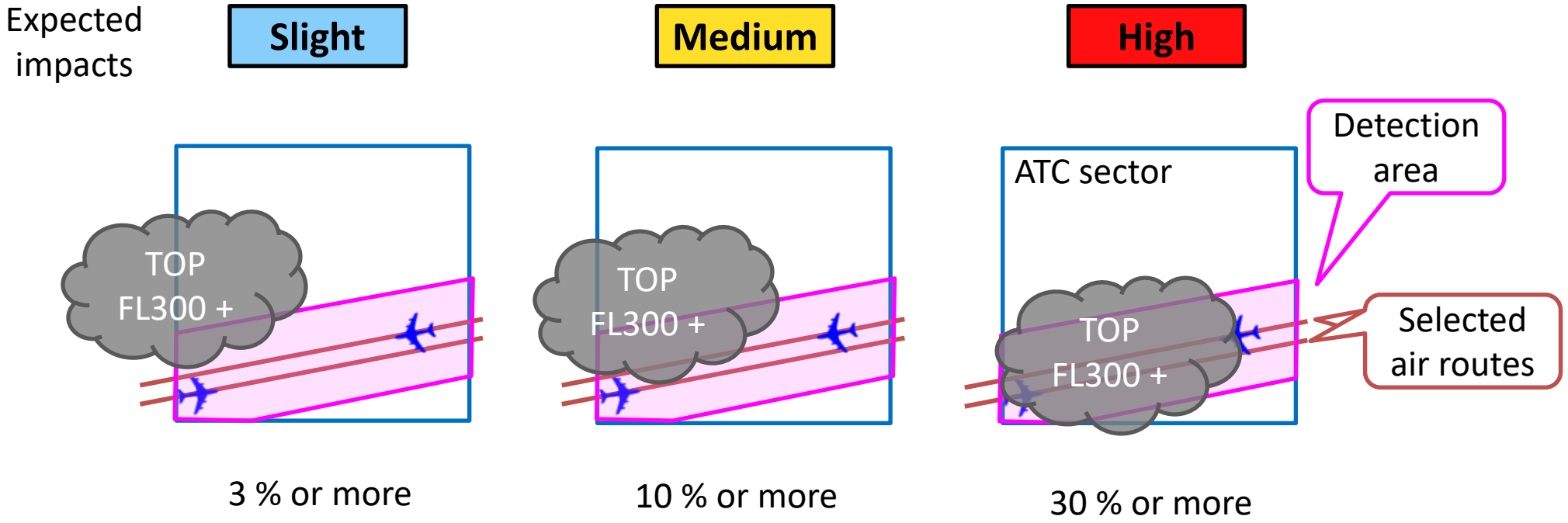
**Request from JCAB:**

- ✓ **More focus on high traffic volume area for appropriate estimation of impacts on ATFM**
- ✓ **Earlier notification of expected convective clouds' impact**

- Improved criteria for Convective clouds in ATC sectors (2020 –)

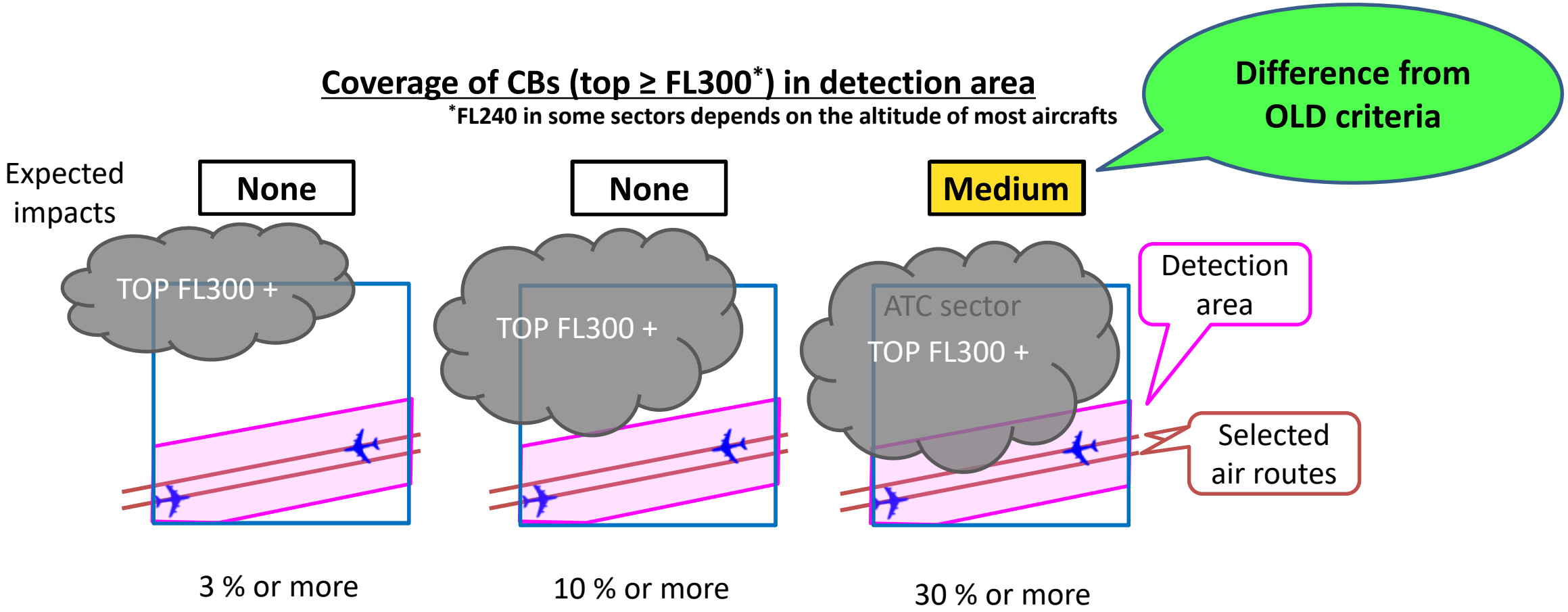
**Coverage of CBs (top ≥ FL300*) in detection area**

*FL240 in some sectors depends on the altitude of most aircrafts




✓ Areas for calculating ATM SIGWX index (i.e., the first guess data) was also updated to be same as the detection area

- Improved criteria for Convective clouds in ATC sectors (2020 –)



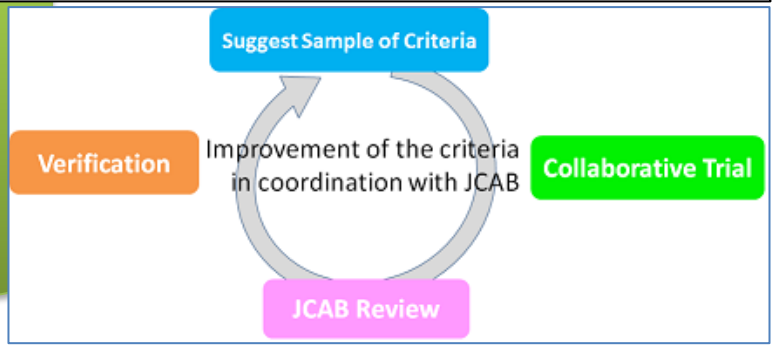

✓ Areas for calculating ATM SIGWX index (i.e., the first guess data) was also updated to be same as the detection area

# Contents

# 3. Improvement of the product in coordination with JCAB

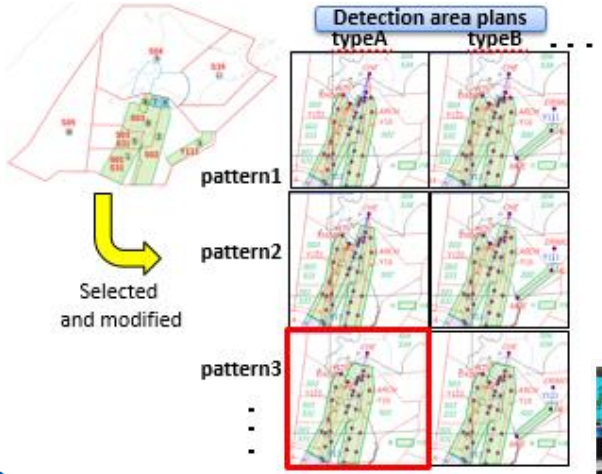
- **Request from JCAB:**
  - ✓ More focus on high traffic volume area for appropriate estimation of impacts on ATFM
  - ✓ Earlier notification of expected convective clouds' impact

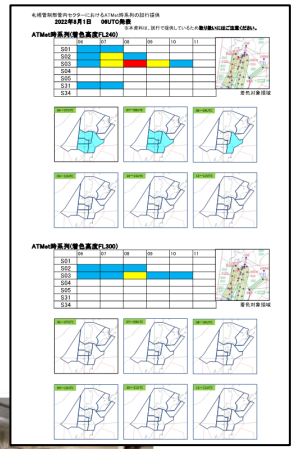
<<continuous improvement cycle>>

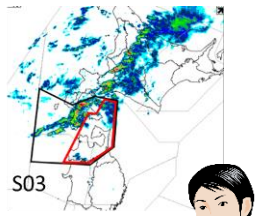


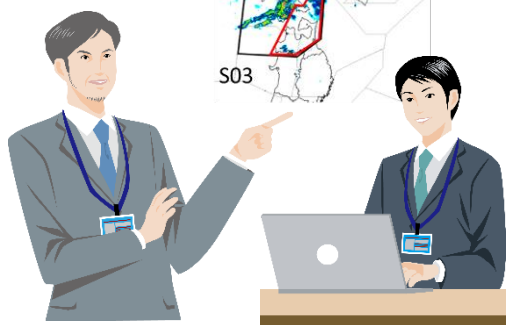

- Improvement of criteria in coordination with JCAB

**Create sample criteria** → **Provide trial product** → **Review by JCAB** → **Implementation**

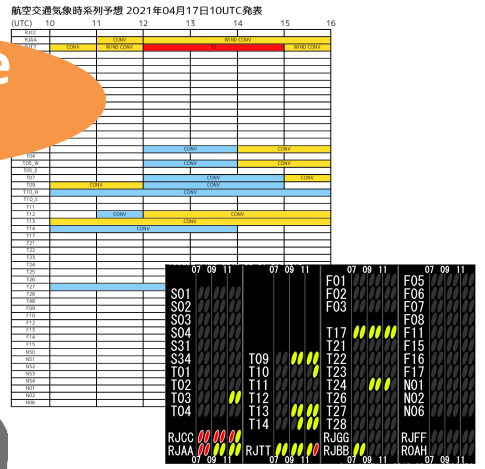


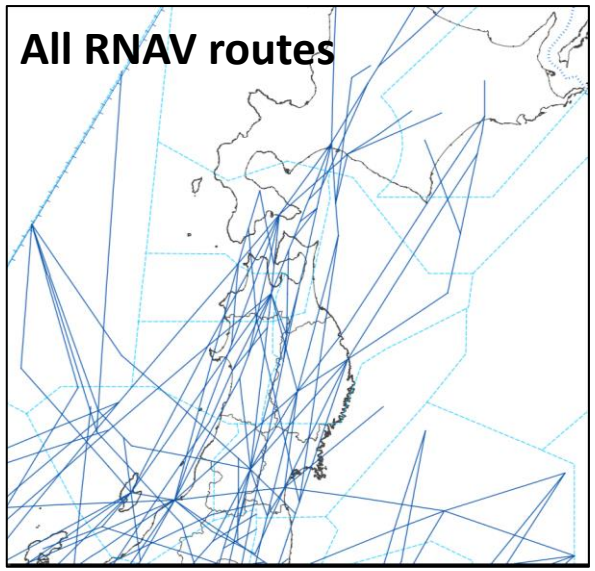
**Analyze the feedback**

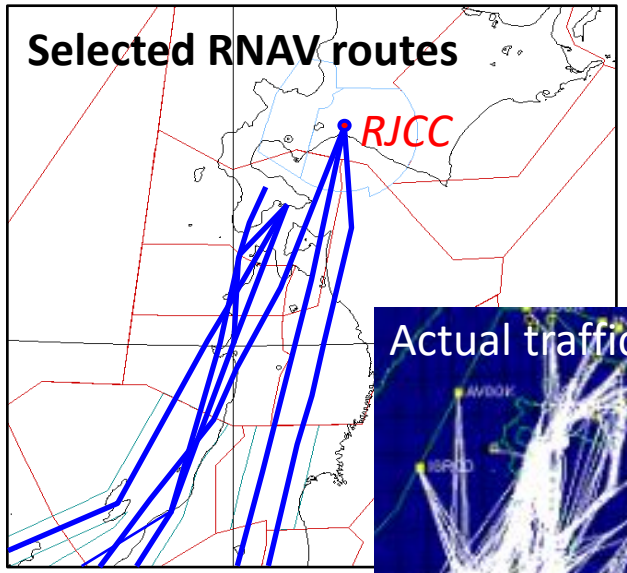


# 3. Improvement of the product in coordination with JCAB

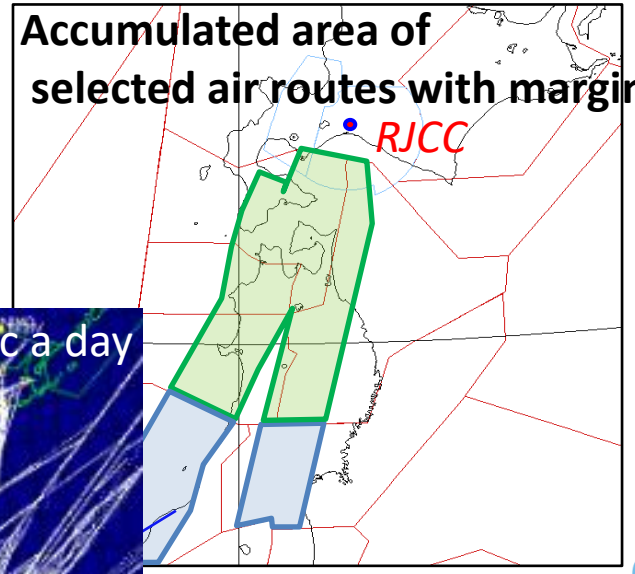
- Preparation of new criteria – MET/ATM collaborative investigation
  - ✓ **Set the small detection area for CBs**
    - **Identification of air routes with heavy air traffic**
    - **Accumulation of identified air routes with margins**
  - ✓ Set minimum cloud top height in each area considering flight altitude
  - ✓ Set criteria for level of impact to ATM using CB coverage and selected altitude
    - Based on the correlation of CB coverage and frequency of ATFM measures or deviation

Data in COVID-19 period was excluded








CARATS Open Data
Visualized by PlotTrack (ENRI)



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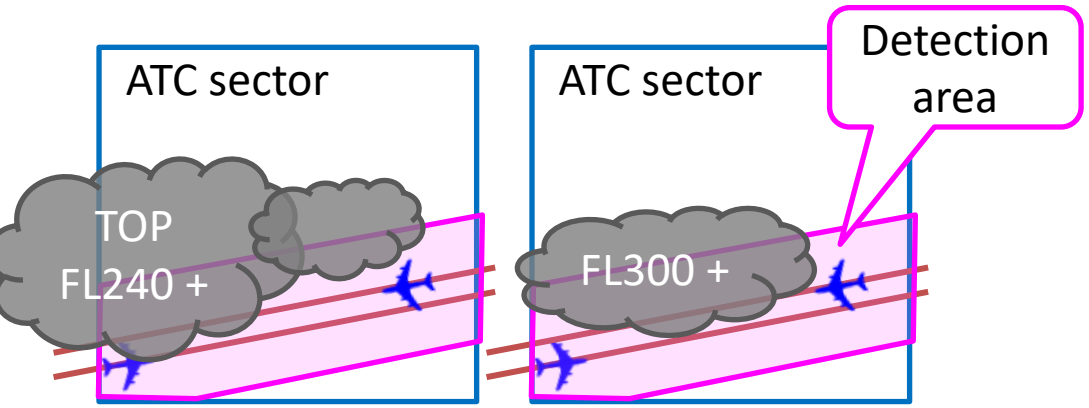


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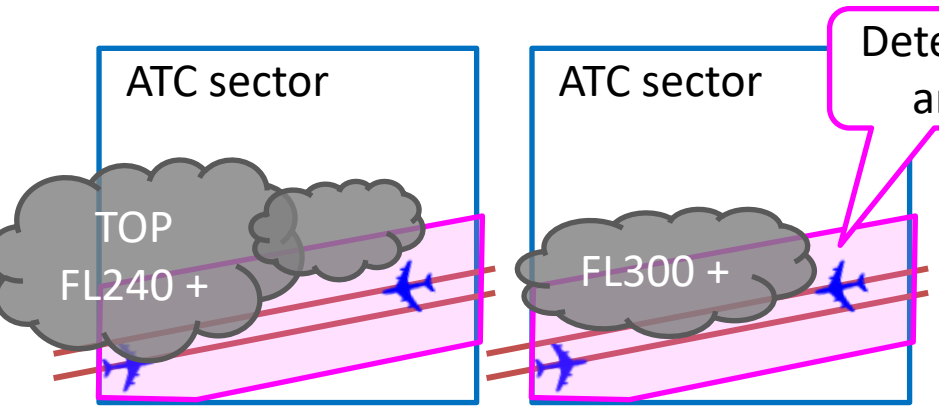


## Frequency of each impact category

**Current criteria**

| S01 / TOP FL300+ | | Frequency (%) |
|---|---|---|
| None | ～10% | 5569 (96.9%) |
| Slight | 10～20% | 102 ( 1.7%) |
| Medium | 20～50% | 68 ( 1.2%) |
| High | 50%～ | 14 ( 0.2%) |

**New criteria**

| S01 / TOP FL300+ | | Frequency (%) |
|---|---|---|
| None | ～ 3% | 5458 (93.3%) |
| Slight | 3～10% | 207 ( 3.5%) |
| Medium | 10～30% | 132 ( 2.3%) |
| High | 30%～ | 56 ( 1.0%) |

Pattern 1

Most appropriate

| S01 / TOP FL240+ | | Frequency (%) |
|---|---|---|
| None | ～ 3% | 4792 (81.9%) |
| Slight | 3～10% | 371 ( 6.3%) |
| Medium | 10～30% | 330 ( 5.6%) |
| High | 30%～ | 360 ( 6.2%) |

Pattern 2 ・・・

Compared with frequency of ATFM measures or deviation

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# 3. Improvement of the product in coordination with JCAB

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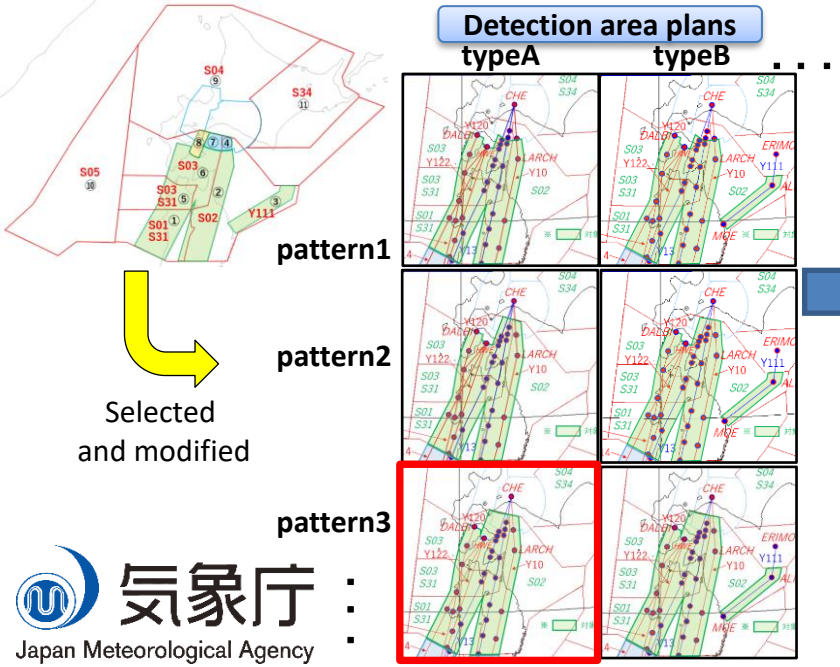
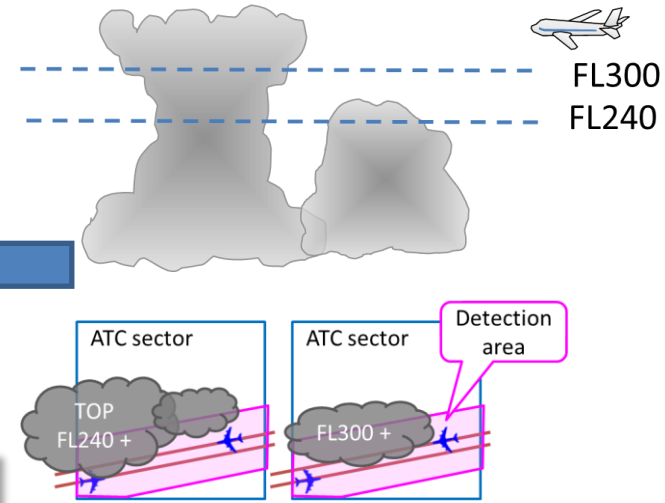



| Sector + pattern +altitude | Area | Slight | Medium | High |
|---|---|---|---|---|
| S01_FL240 | ① | FL240以上 3% | FL240以上 10% | FL240以上 30% |
| S01_FL300 | ① | FL300以上 3% | FL300以上 10% | FL300以上 30% |
| S02_pattern1_FL240 | ② | FL240以上 3% | FL240以上 10% | FL240以上 30% |
| S02_pattern2_FL240 | ② | FL240以上 3% | FL240以上 10% | FL240以上 30% |
| S02_pattern1+Y111_FL240 | ②+③ | FL240以上 3% | FL240以上 10% | FL240以上 30% |
| S02_pattern2+Y111_FL240 | ②+③+④ | FL240以上 3% | FL240以上 10% | FL240以上 30% |
| S02_pattern1_FL300 | ② | FL300以上 3% | FL300以上 10% | FL300以上 30% |
| S02_pattern2_FL300 | ② | FL300以上 3% | FL300以上 10% | FL300以上 30% |
| S02_pattern1+Y111_FL300 | ②+③ | FL300以上 3% | FL300以上 10% | FL300以上 30% |
| S02_pattern2+Y111_FL300 | ②+③+④ | FL300以上 3% | FL300以上 10% | FL300以上 30% |
| S03_pattern1_FL240 | ⑤+⑥ | FL240以上 3% | FL240以上 10% | FL240以上 30% |
| S03_pattern2_FL240 | ⑤+⑥+⑦ | FL240以上 3% | FL240以上 10% | FL240以上 30% |
| S03_pattern2+Y12_FL240 | | | | |
| S03_pattern1_FL300 | | | | |
| S03_pattern2_FL300 | | | | |
| S03_pattern2+Y12_FL300 | | | | |
| S04_FL240 | | | | |
| S04_FL300 | | | | |

**Several pattern of criteria were prepared.**



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# 3. Improvement of the product in coordination with JCAB


Level of impact

Slight　Medium　High

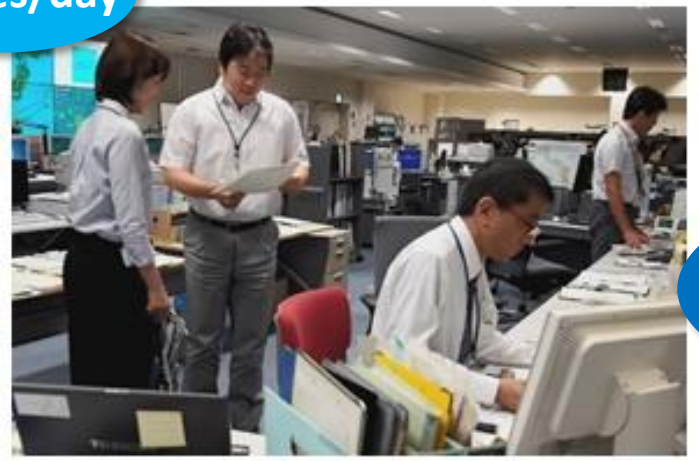
Trial of product based on new criteria

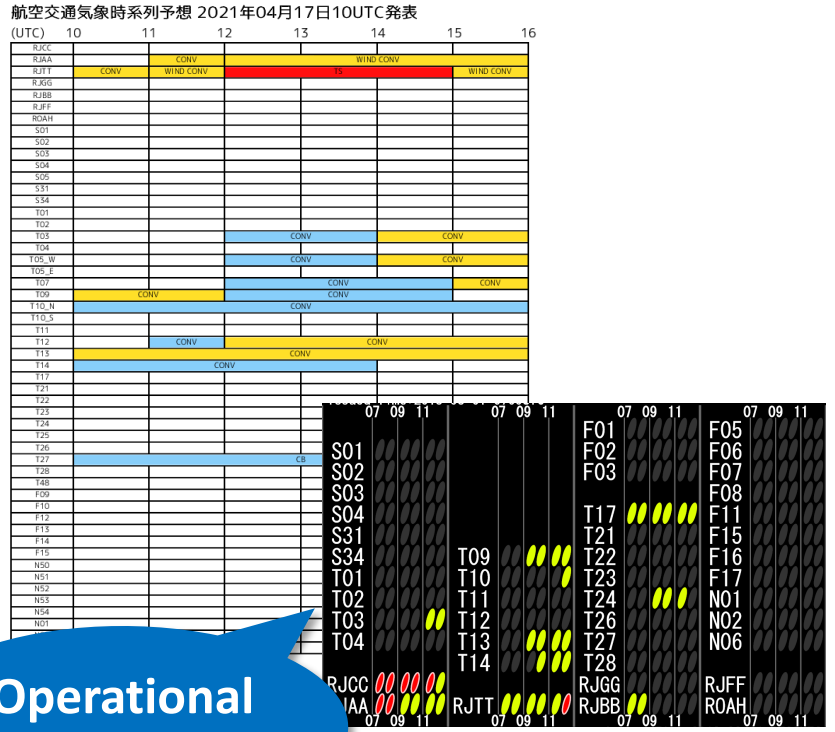
- northern Japan, in summer 2022

Trial category forecast was provided simultaneously with operational one.

Trial product with selected a few pattern criteria

2 times/day






Operational product

21 times/day



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# 3. Improvement of the product in coordination with JCAB

## Reviews provided by ATM officer

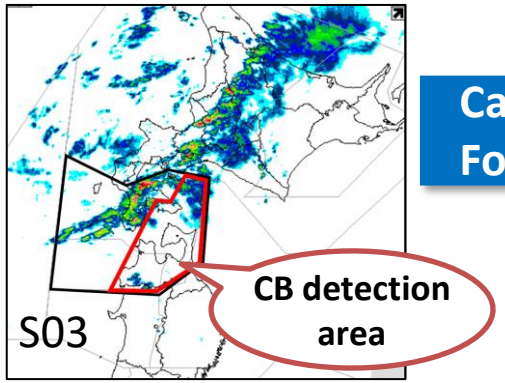
- Forecast based on new criteria showed “yellow (medium)” from 08UTC.
- 10 aircrafts in S03 sector on this day and all the aircrafts deviated.
- ACC Air traffic controllers had a heavy workload
  because of responding to radio communications between 08 and 10 UTC.
- “plan A” was preferable on this day.

Level of impact

**Slight？**

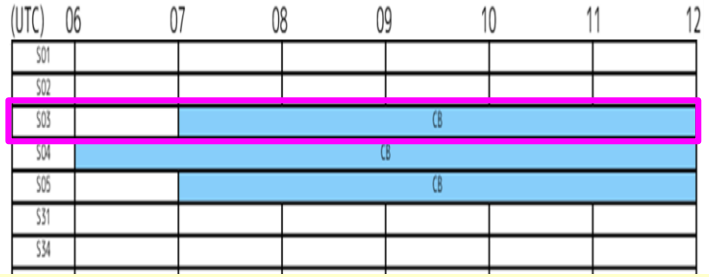
**Medium？**

**High？**




**Category Forecast**

**Current criteria**




**New criteria**

plan A

| | 06 | 07 | 08 | 09 | 10 | 11 |
|---|---|---|---|---|---|---|
| S01 | | | | | | |
| S02 | | | | | | |
| S03 | | | | | | |
| S04 | | | | | | |
| S05 | | | | | | |
| S31 | | | | | | |
| S34 | | | | | | |

plan B

| | 06 | 07 | 08 | 09 | 10 | 11 |
|---|---|---|---|---|---|---|
| S01 | | | | | | |
| S02 | | | | | | |
| S03 | | | | | | |
| S04 | | | | | | |
| S05 | | | | | | |
| S31 | | | | | | |
| S34 | | | | | | |

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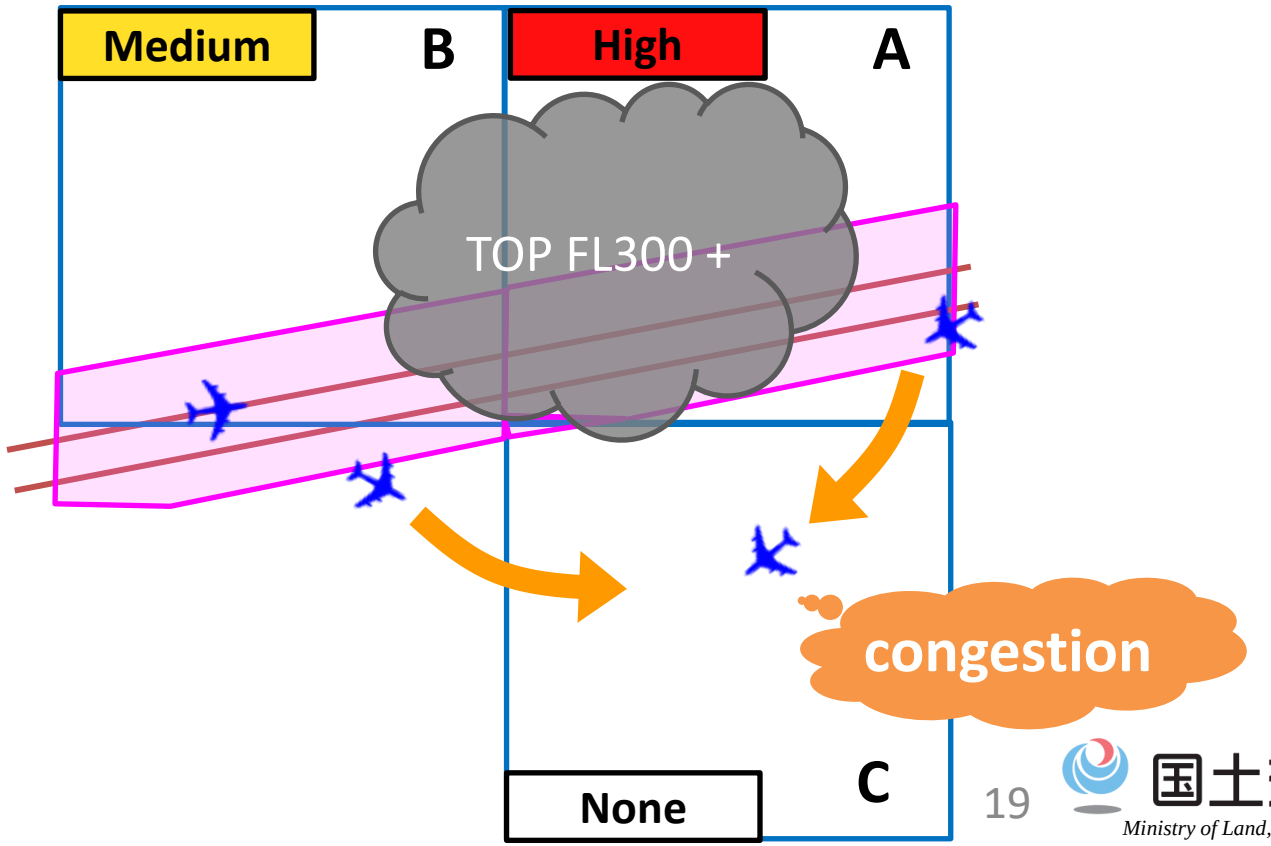
# Contents

# Challenges in assessing forecast of adverse weather impact on ATFM

- CB coverage does not necessarily correspond to ATC capacity
  - ATC capacity is not determined only by meteorological condition
  - Detour of CB area in other ATC sectors can cause reduction of airspace capacity.
- Assessment includes
  - Weather forecast accuracy
  - Evaluation of impact on ATM

**Require careful evaluation considering factors separate**



# 4. Challenges: evaluation/verification of the products

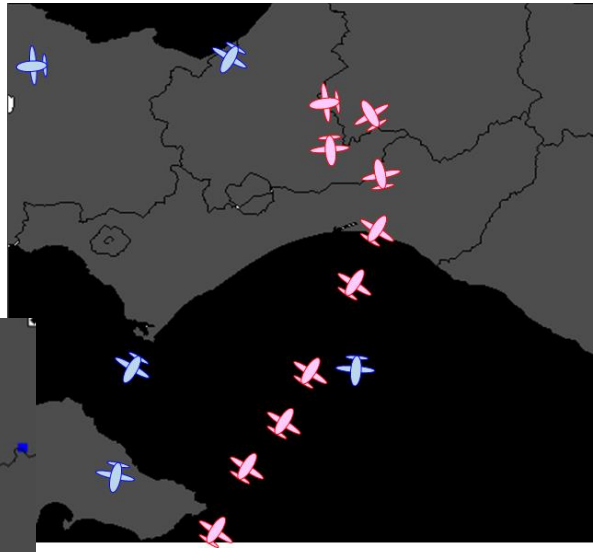
How could we measure the “impact of adverse weather” on air traffic flow?

- Current practices…
  - Correlation of color-codes versus airspace capacity
  - Correlation of color-codes versus coverage ratio of radar echo where echo top height exceeds target altitude
  - Case study, statistical research

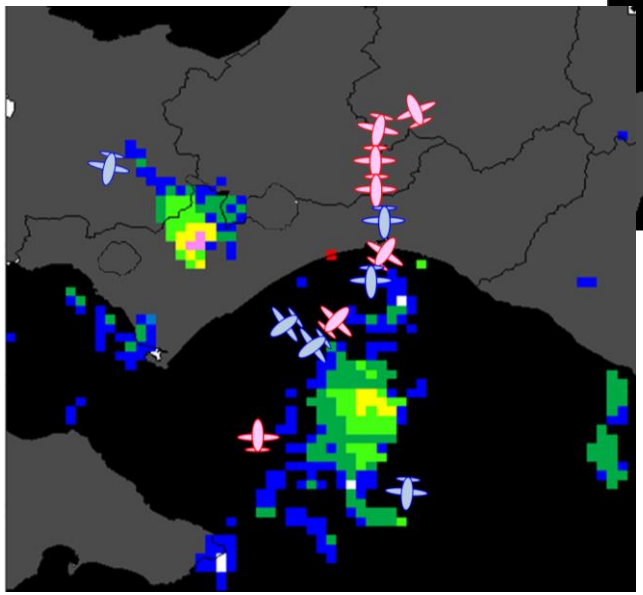
**NOT ENOUGH to measure the Impact!!!**

**Current Initiatives**

**Using trajectory data for evaluation**



<<No CB on en-route>>



<<CB on en-route>>



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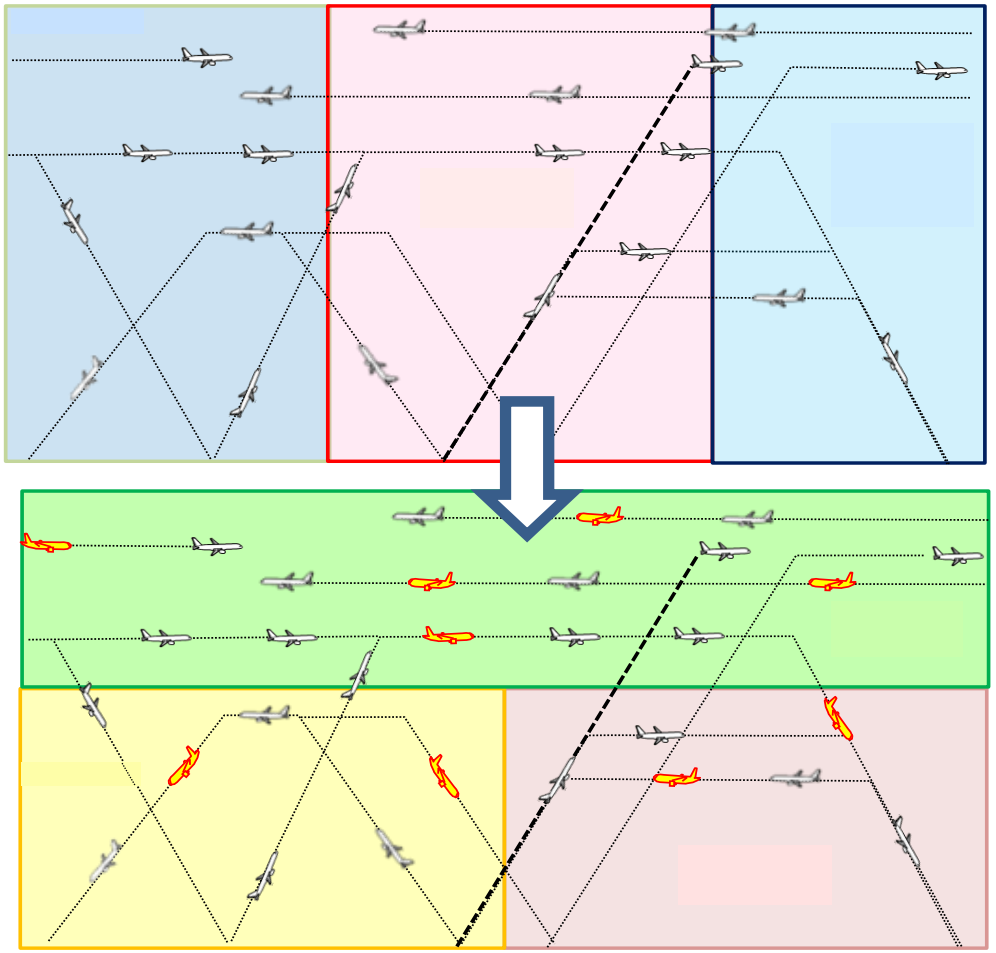
# Contents

# Restructure of domestic en-route airspace in Japan

- JCAB is going forward with the airspace restructure to divide the domestic en-route airspace by altitude of FL335.
- The main objective of the restructure is to expand the capacity of en-route airspace.
  - High altitude en-route airspace is designed for cruising traffics.
  - Low altitude en-route airspace is designed for departure, arrival and short distance traffics.

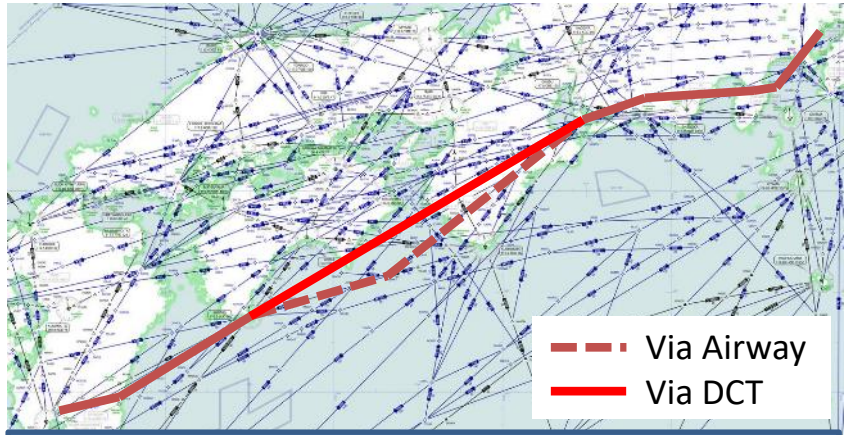


# Free routing Procedures in high altitude en-route airspace

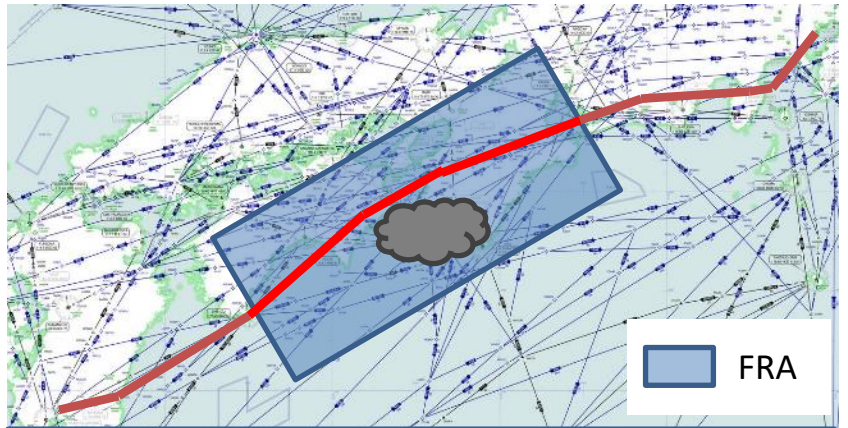
- The restructure also allow free routing in the high altitude en-route airspace.
- JCAB has a plan to realize free routing procedures in following 3 steps.

1. To replace the flight planed route to connect specific points from the existing airway (i.e. DCTs).
2. To realize user preferred routes (UPRs) within the defined free route airspace (FRA).
3. To implement airborne reroute procedures initiated by airline operator with latest weather information (i.e. DARPs).

Note.—UPRs and DARPs are already implemented in oceanic airspace within Fukuoka FIR.




Step 1. Direct routings (DCTs)




Step 2. User preferred routes (UPRs)

# To contribute to future advanced ATM operations

- **Evolve the current product to be suitable for the future operations.**
  - ✓ **Calculate degree of impacts of adverse weather**

    ***more dynamic, flexible and phenomenon based***
  - ✓ **Integration of adverse weather distributions and trajectories**

**JCAB/JMA continue our cooperation for effective ATM operations for safe and efficient air traffic flow.**



*Ha-re-run*

# THANK YOU!



*Kunimaru-kun*

**Mt.Fuji**