Study of relationship between spatial and temporal image resolutions for AMV Derivation of Next Generation Satellites

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Motivation of this study

1. JMA/MSC plans to produce AMV with high time and fine space resolution from the Japanese follow-on satellite Himawari-8.

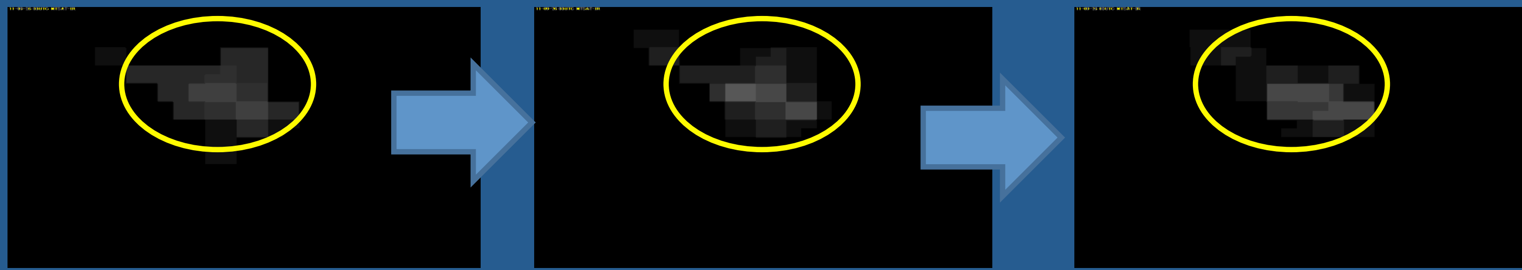
2. For generating high-resolution AMV from Himawari-8, relationship of target box size (corresponds to space scale of meteorological phenomena) and time intervals of imagery (corresponds to time scale of meteorological phenomena) should be studied

We consider only tracking procedure,
because it becomes hard to search where the problem comes from,
when we treat another procedure such as height assignment together

Difficulty of using small target box size

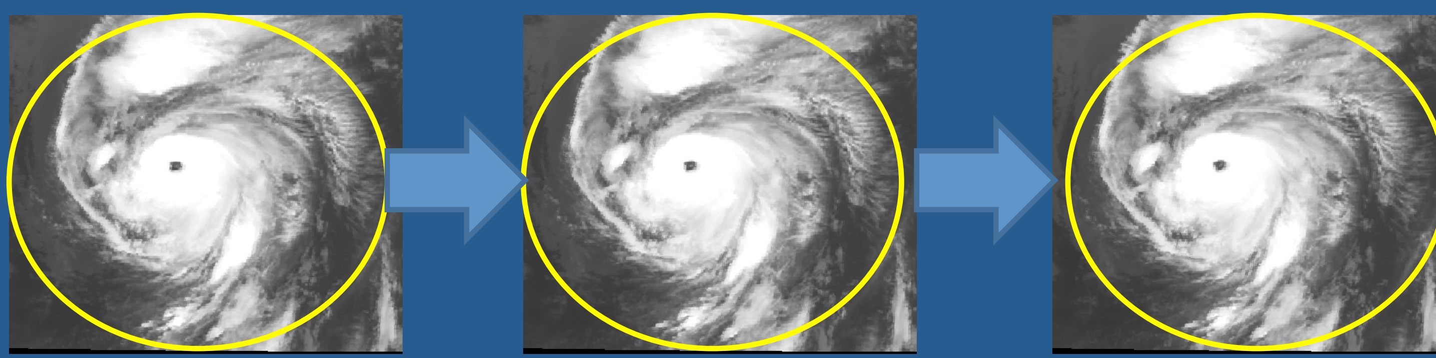
Feature of small scale phenomena vanishes in a short time

0min. 5min. 10min.



Feature of large scale phenomena is consistent for long period

0min. 5min. 10min.



lifetime of cloud feature is correlating with its size

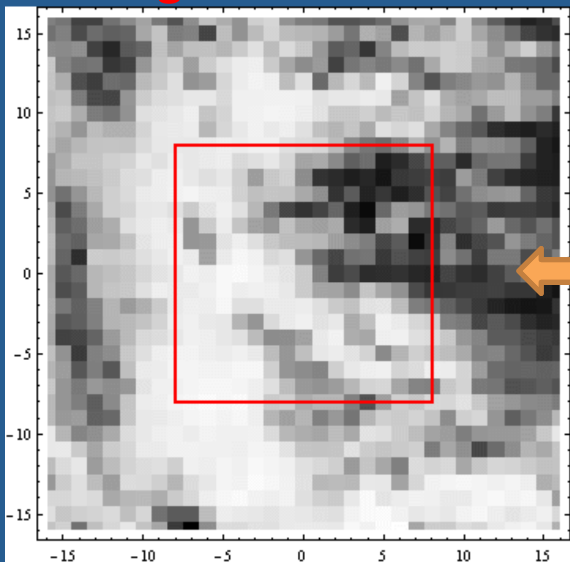
Difficulty of using small target box size

Cloud system deforms as time goes by

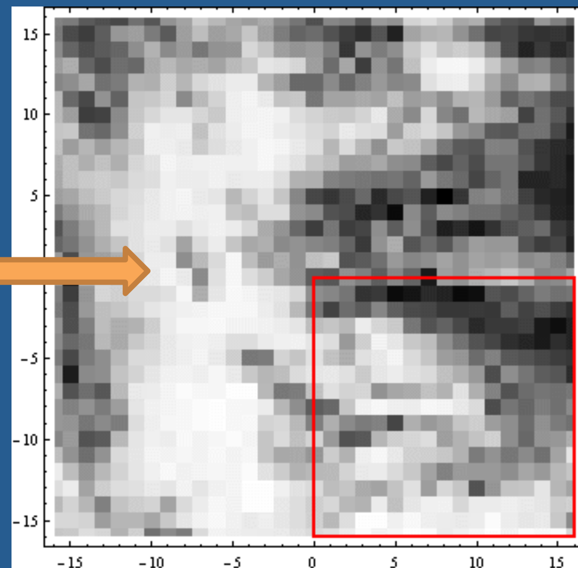
Appropriate “target size” determined if “observation intervals” determined, and vice-versa

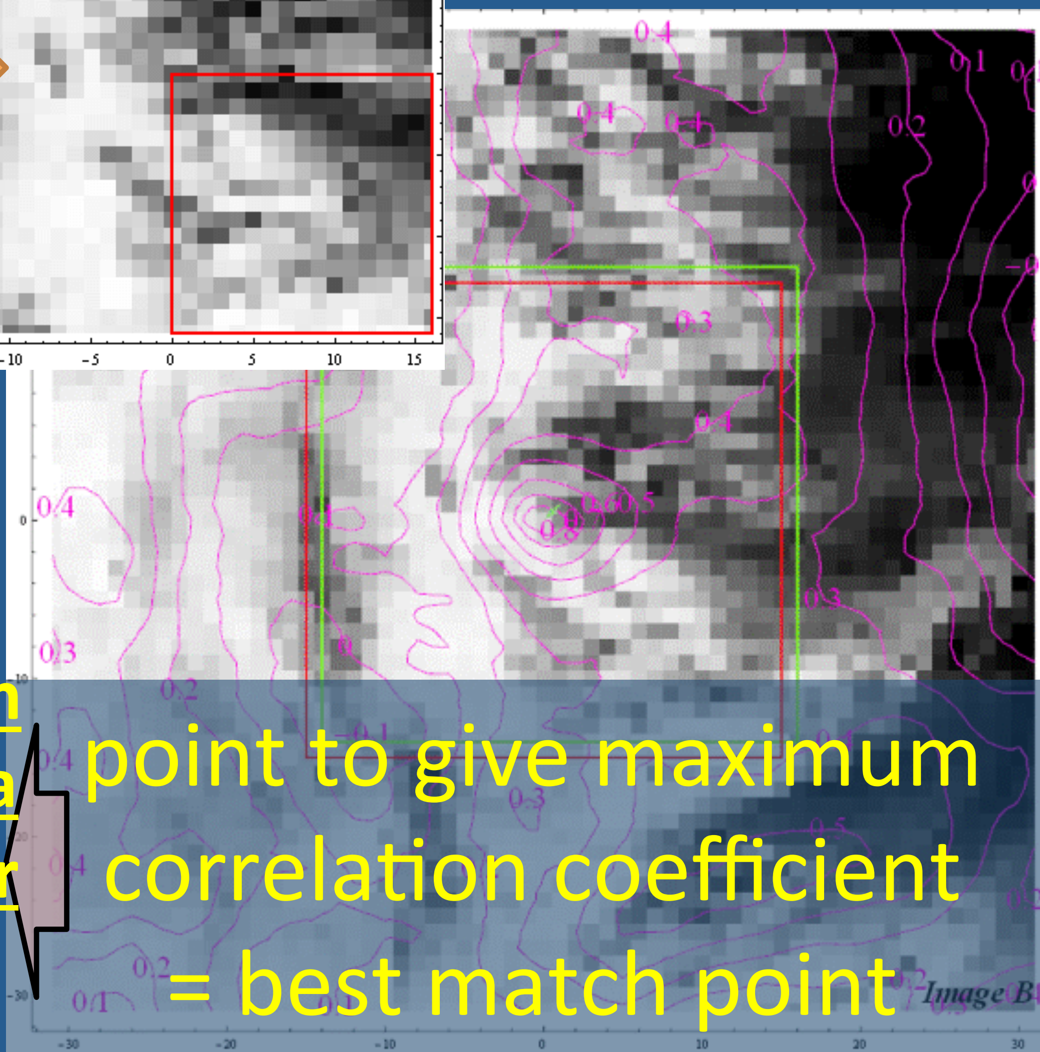
Tracking cloud by Pattern Matching

targeted feature



searching





Method to find the most similar pattern from follow-throw image

Maximum cross-correlation coefficient can be used as a similarity measure of a pair of "pattern"

point to give maximum correlation coefficient = best match point

Study of Relationship b/w Box Size and Time Interval

Method to evaluate the relationship:

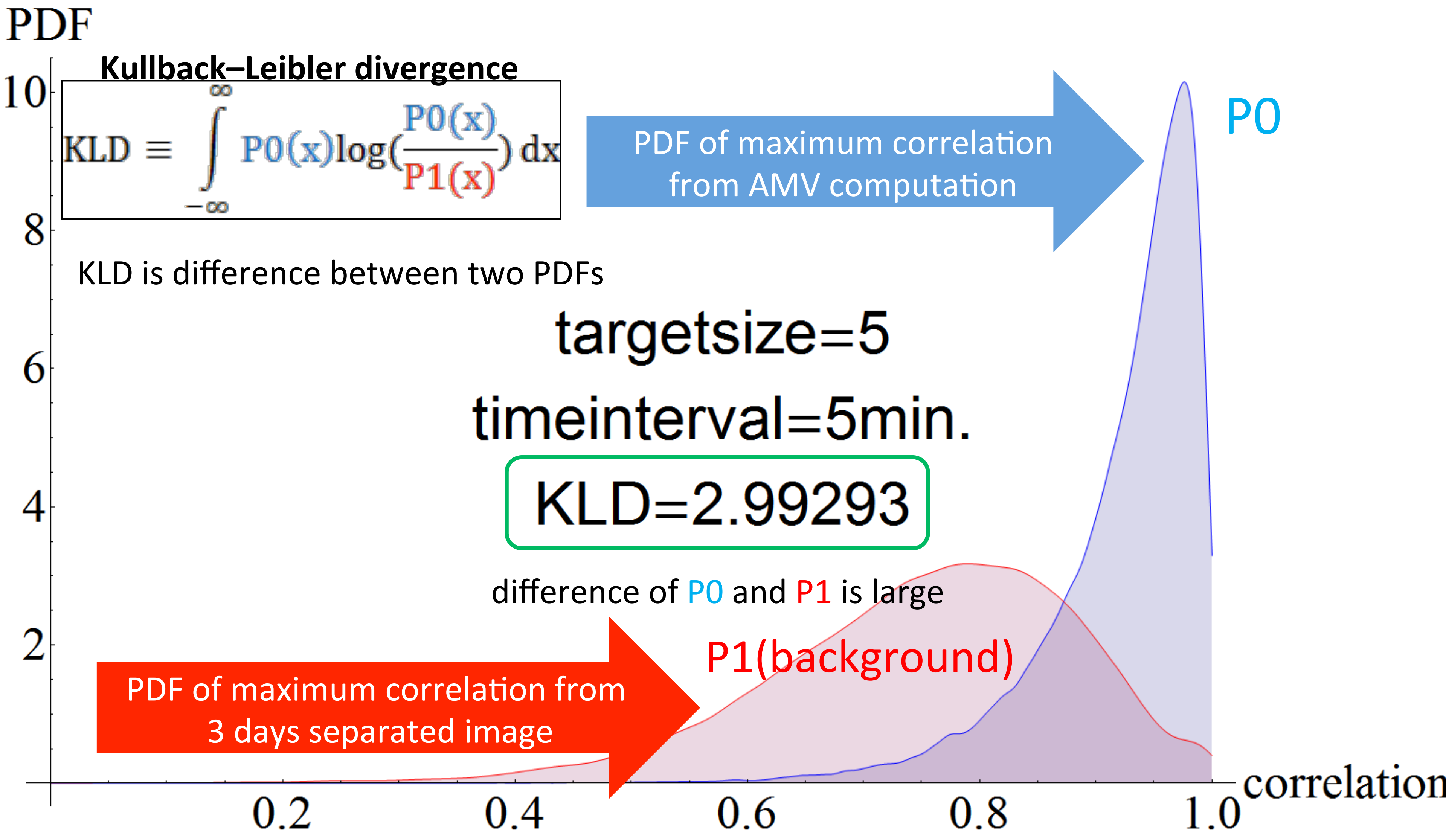
- **Two satellite images of different observation times prepared**
- **Tabularization of maximum correlation PDFs derived from many pairs of target box sizes and time intervals**
- **Corresponding background (noise) maximum correlation PDFs are also computed from 3 days separated imagery for considering effect of coincidental match**

Dataset

Rapid-scan MTSAT-1R image : September 2011 (daytime only)
Target box size: 5,7,9,11,13,15,17,19,21,23,25,27,29,31 and 33 pix
Time interval of imagery : 5,10,15,20,25 and 30 minutes

Case Analysis to Cross-correlation Coefficients in Case of Short Time Interval

cloud feature conserved, coincidental match suppressed



Case Analysis to Cross-correlation Coefficients in Case of Long Time Interval

cloud feature vanished, coincidental match gained ground

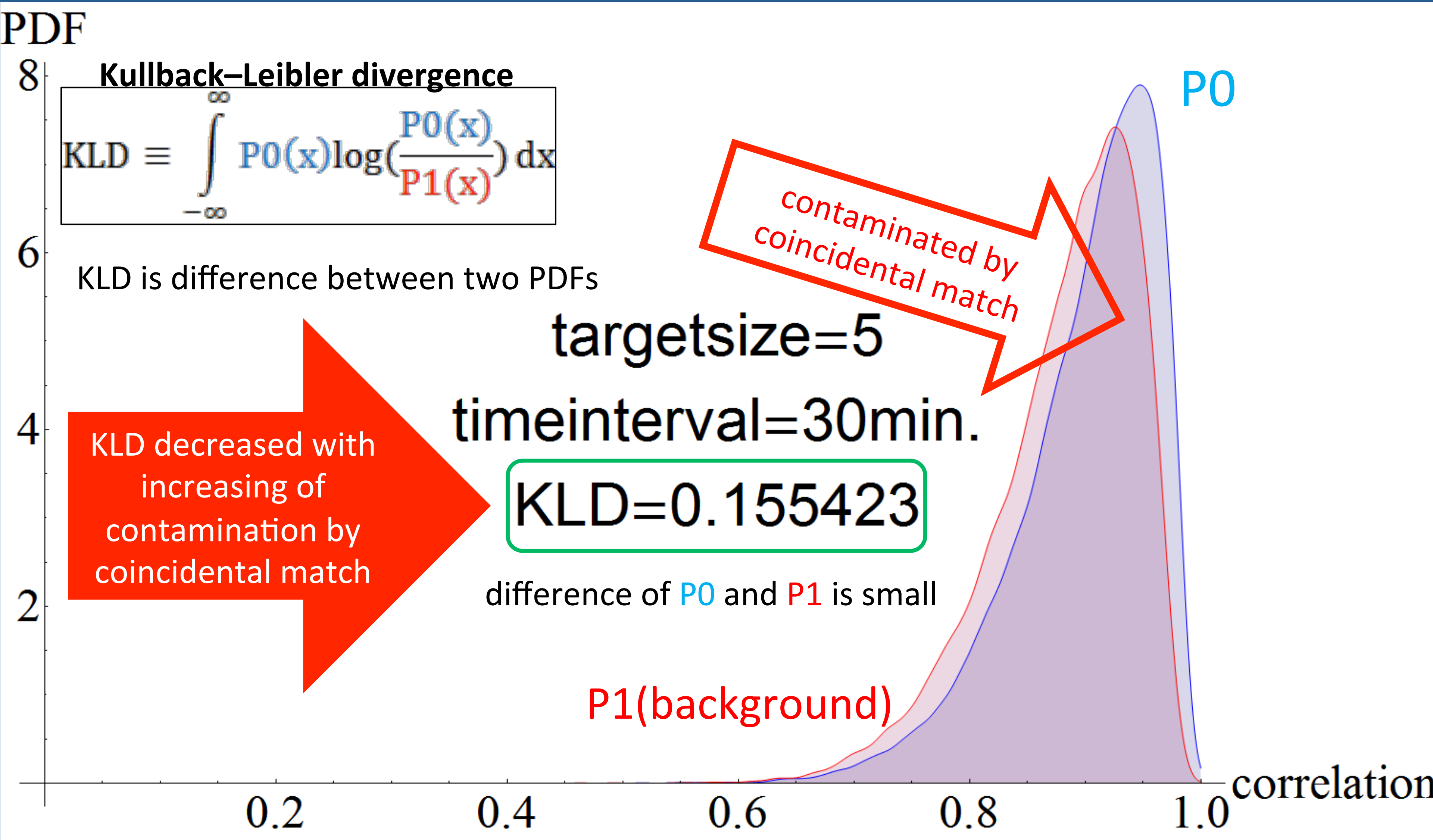


table of cross correlation PDF computed from many pairs of target Box sizes and time

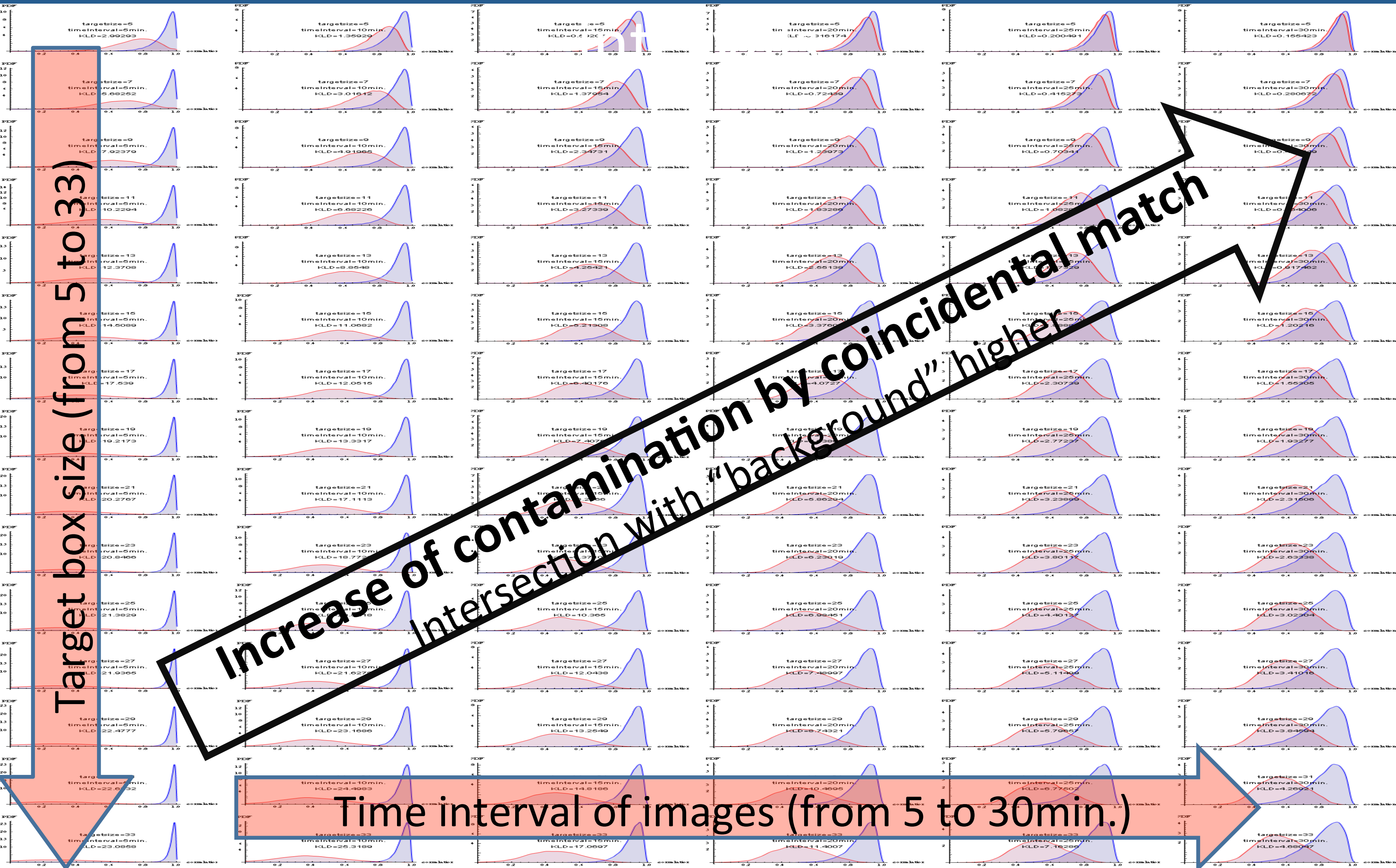


Table of KLDs computed from many pairs of target Box sizes and time intervals

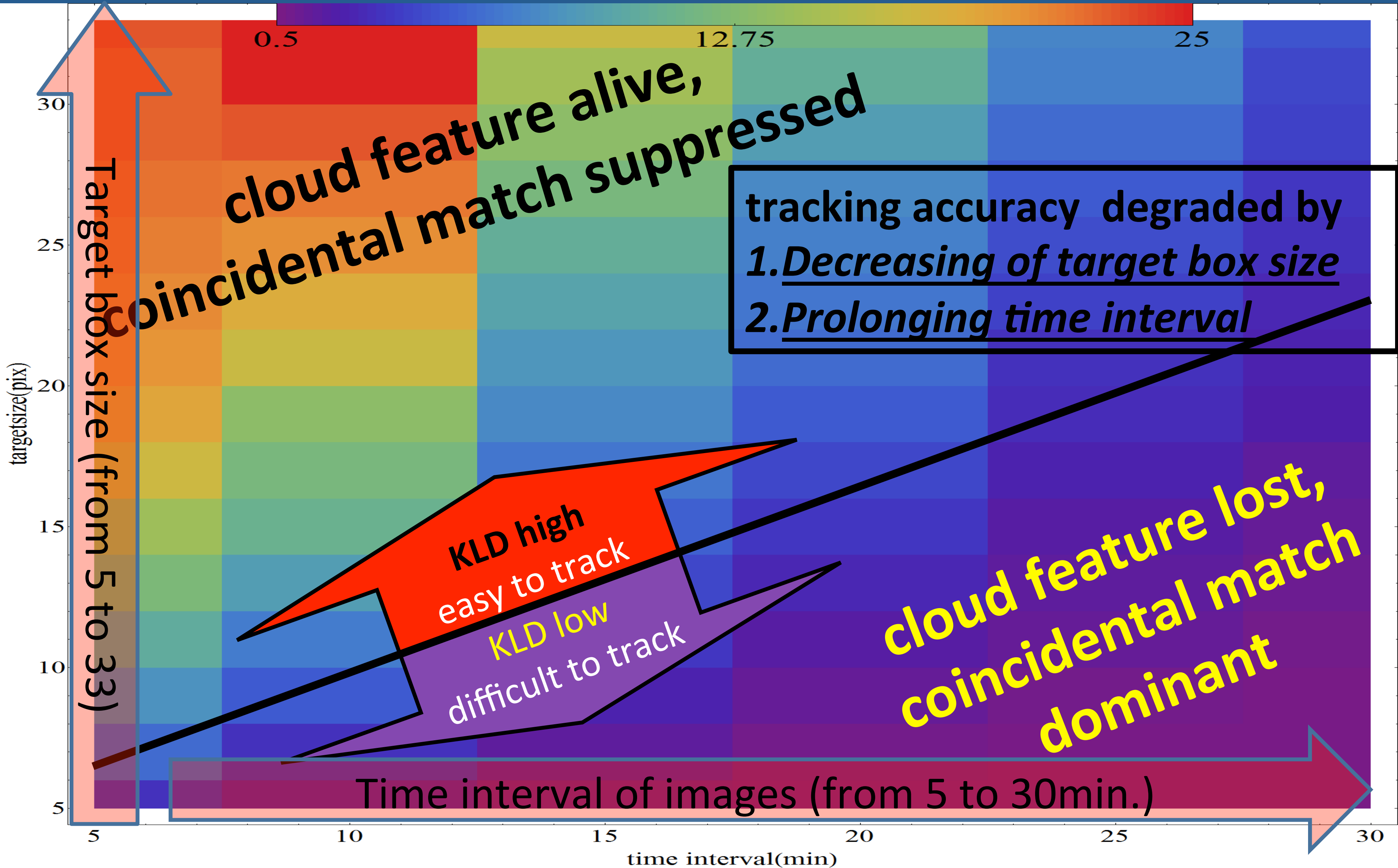
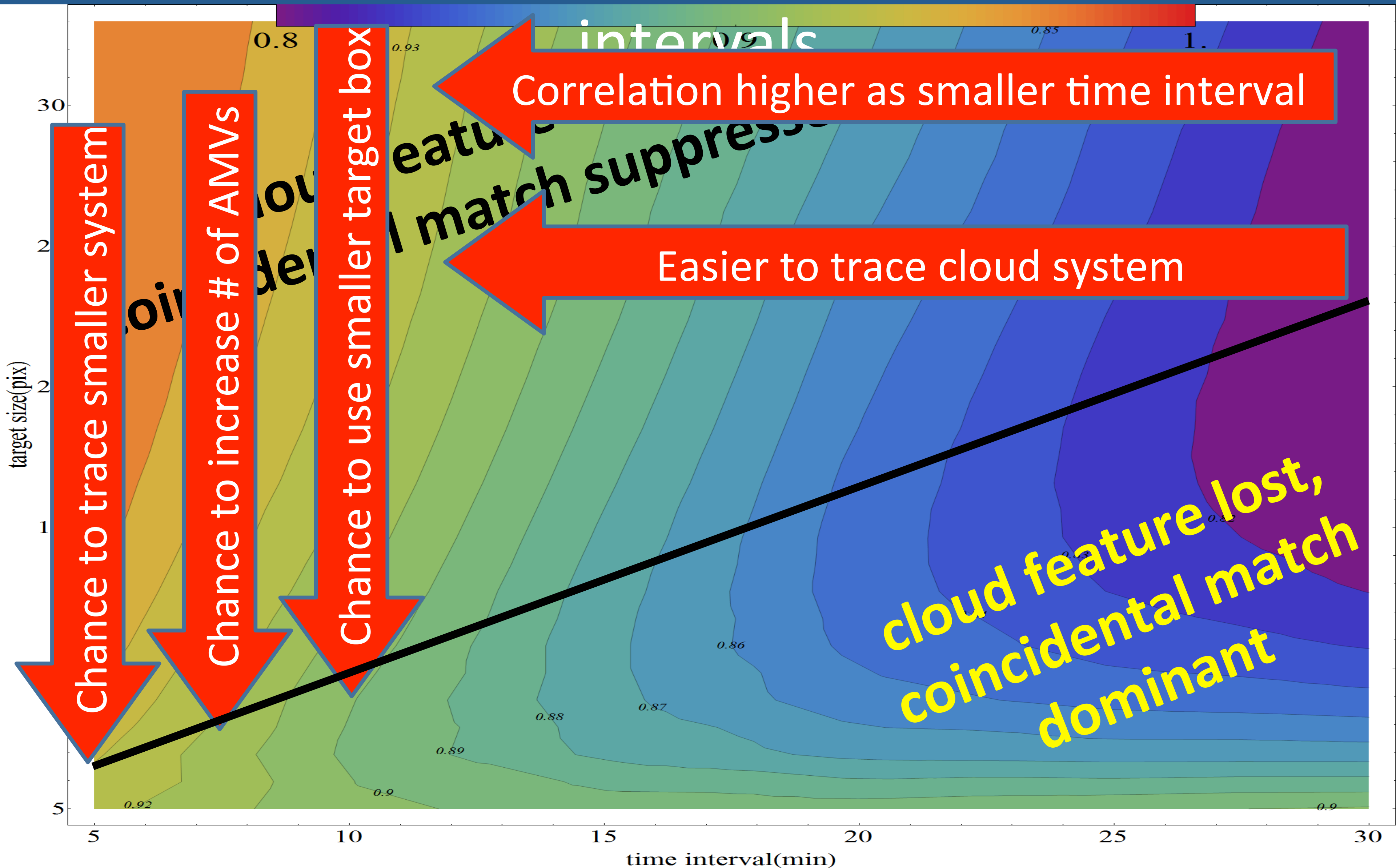
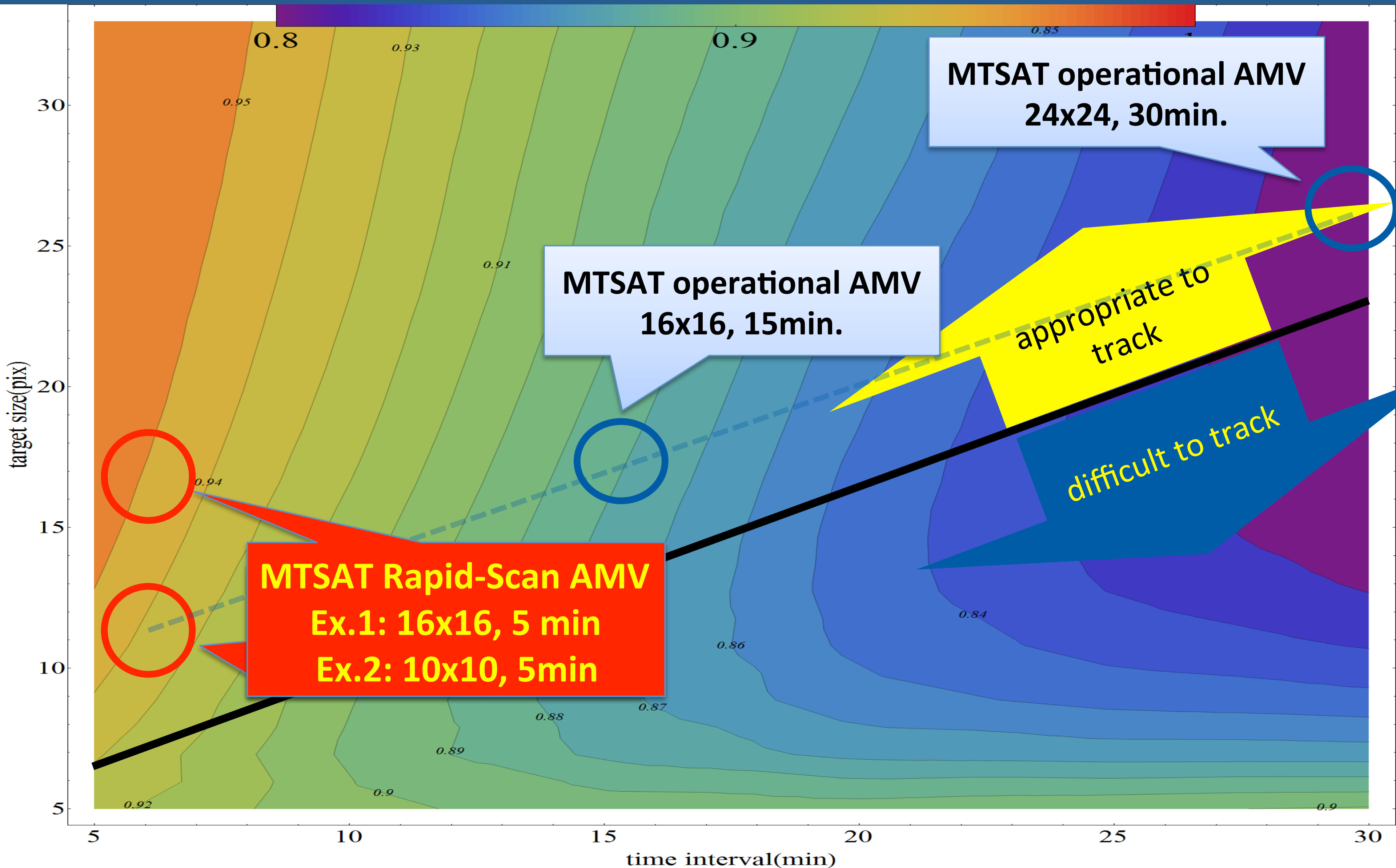
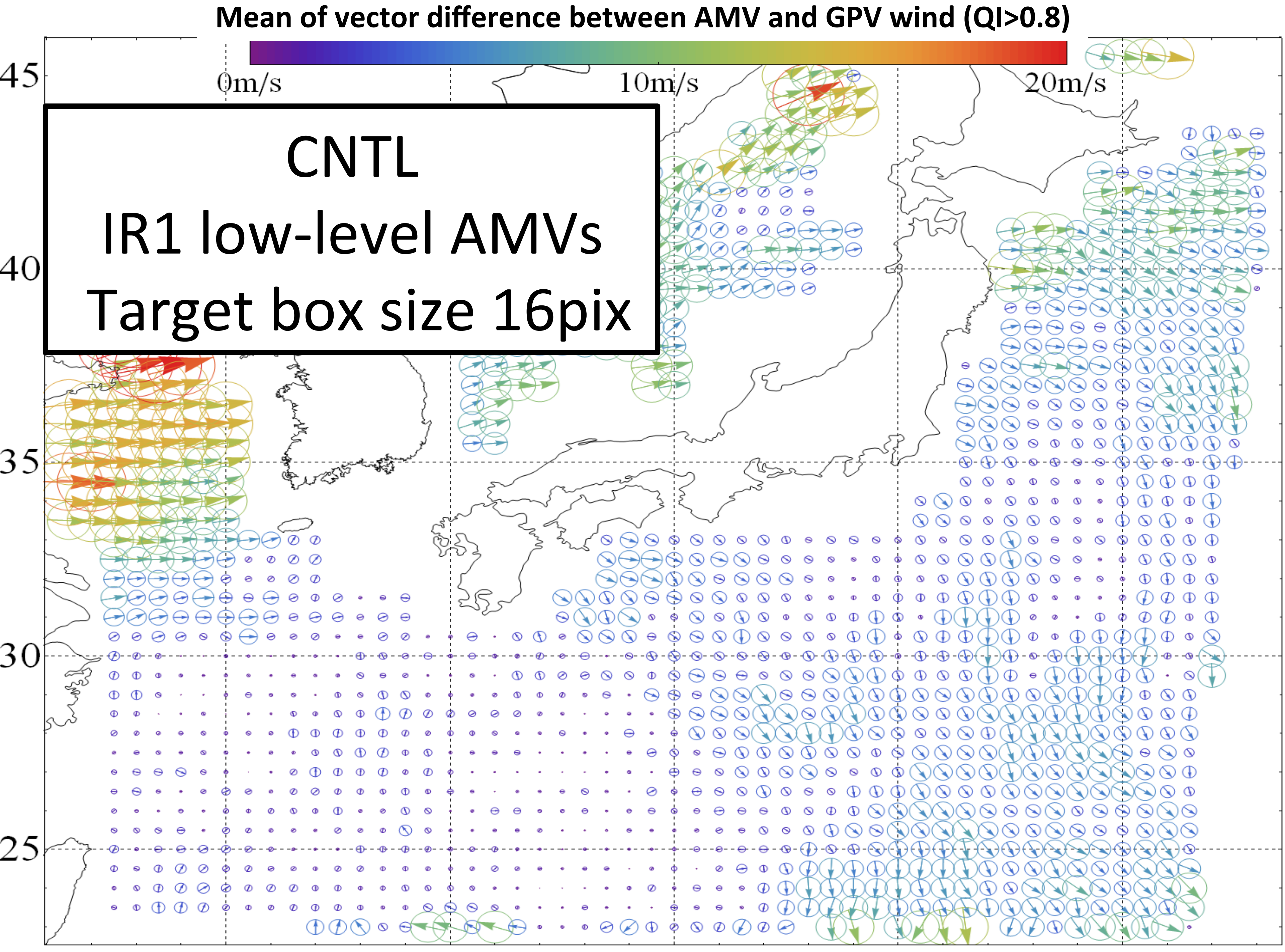


Table of maximum correlation computed from many pairs of target Box sizes and time intervals

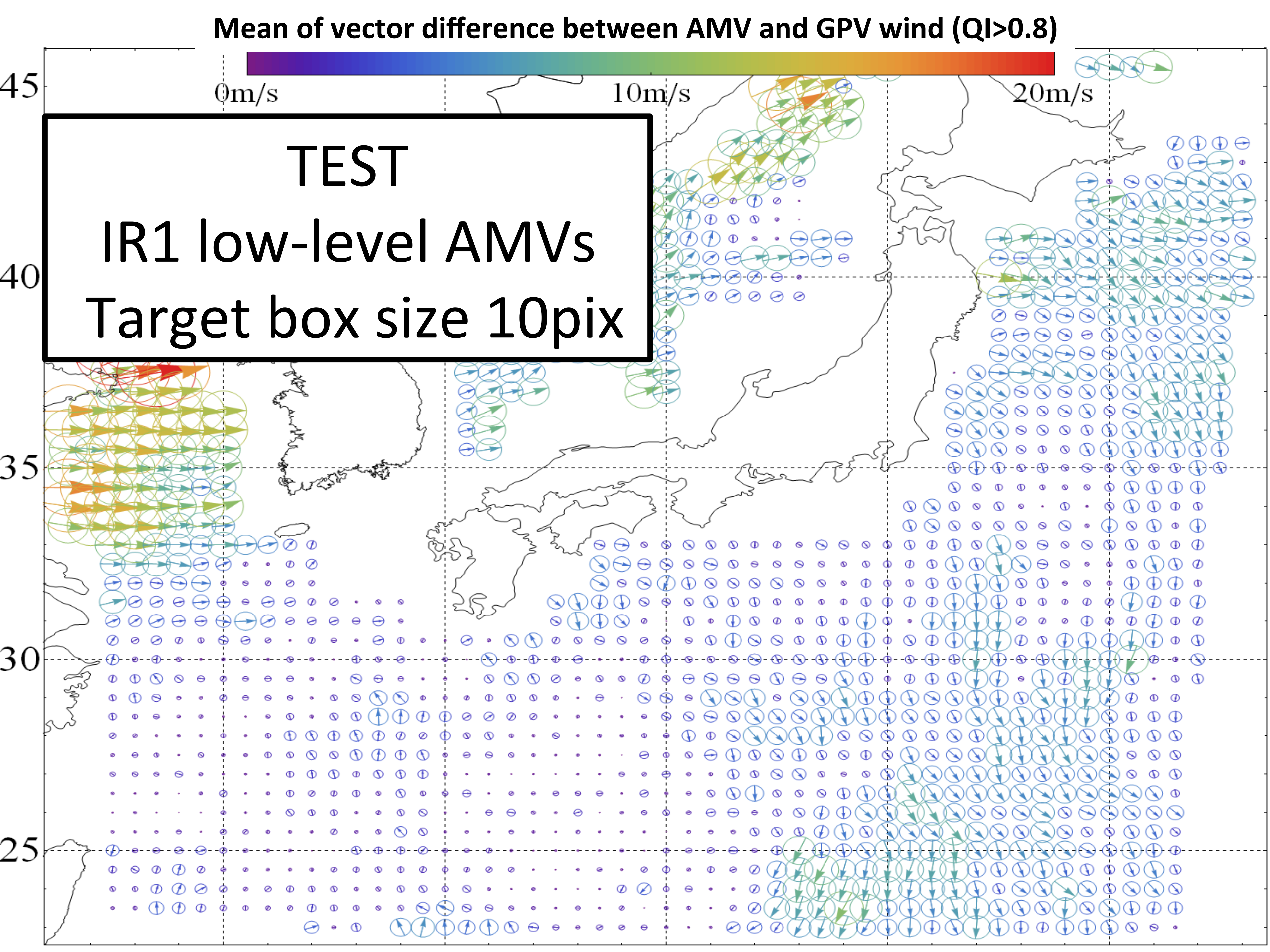


Experiment to resize target box size for MTSAT-1R rapid-scan AMV



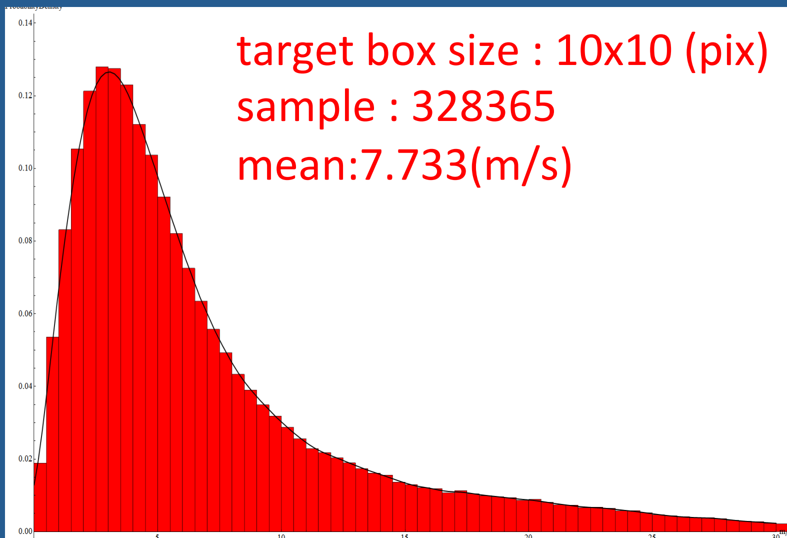


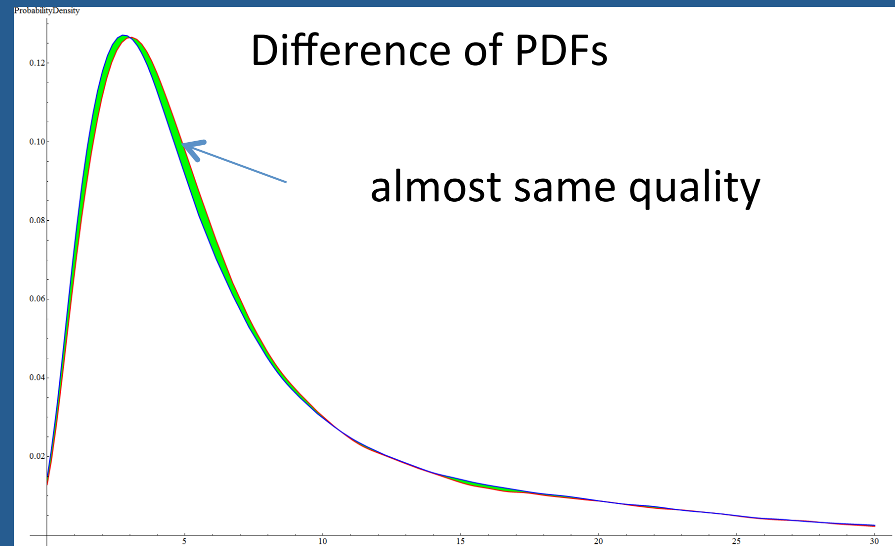
Mean of vector difference between AMV and GPV wind (QI>0.8)
0m/s
10m/s
20m/s
CNTL
IR1 low-level AMVs
Target box size 16pix
45
40
35
30
25

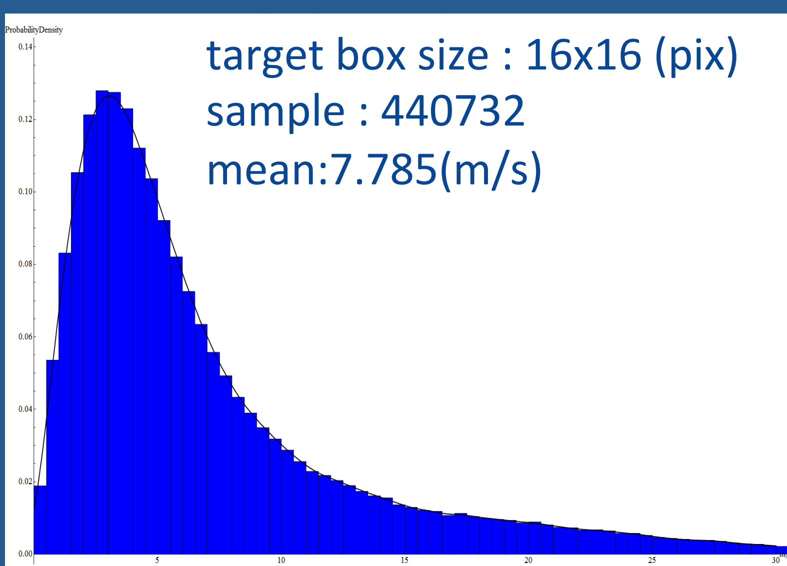

Mean of vector difference between AMV and GPV wind (QI>0.8)
0m/s
10m/s
20m/s
TEST
IR1 low-level AMVs
Target box size 10pix
45
40
35
30
25

Change of AMVs accuracy by resizing target box size

Probability Distribution Function
for norm of wind vector difference against First Guess wind







<u>effect of resizing target box size from 16 to 10</u>

- number of targets increase by a factor of 2.56 in case of using optimal target alignment
- AMV quality not changed significantly
- AMV number decreased to 75%
- Expected increase of number is a factor of 1.92(=0.75x2.56) after implementation of optimal target alignment (not implemented on current system)

Summary

1. JMA/MSC is developing rapid-scan high resolution AMV for Japanese follow-on satellite “Himawari-8”

2. Rapid-scan high-resolution AMV needs appropriate a pair of observation interval and target box size.

3. “cloud tracking limit” which corresponds to cloud life cycle achieved from relationships of “KDF” or “maximum correlation coefficient”, “time interval” and “target box size” by using 90 pairs of different sizes and different intervals using MTSAT-1R rapid-scan IR imagery.

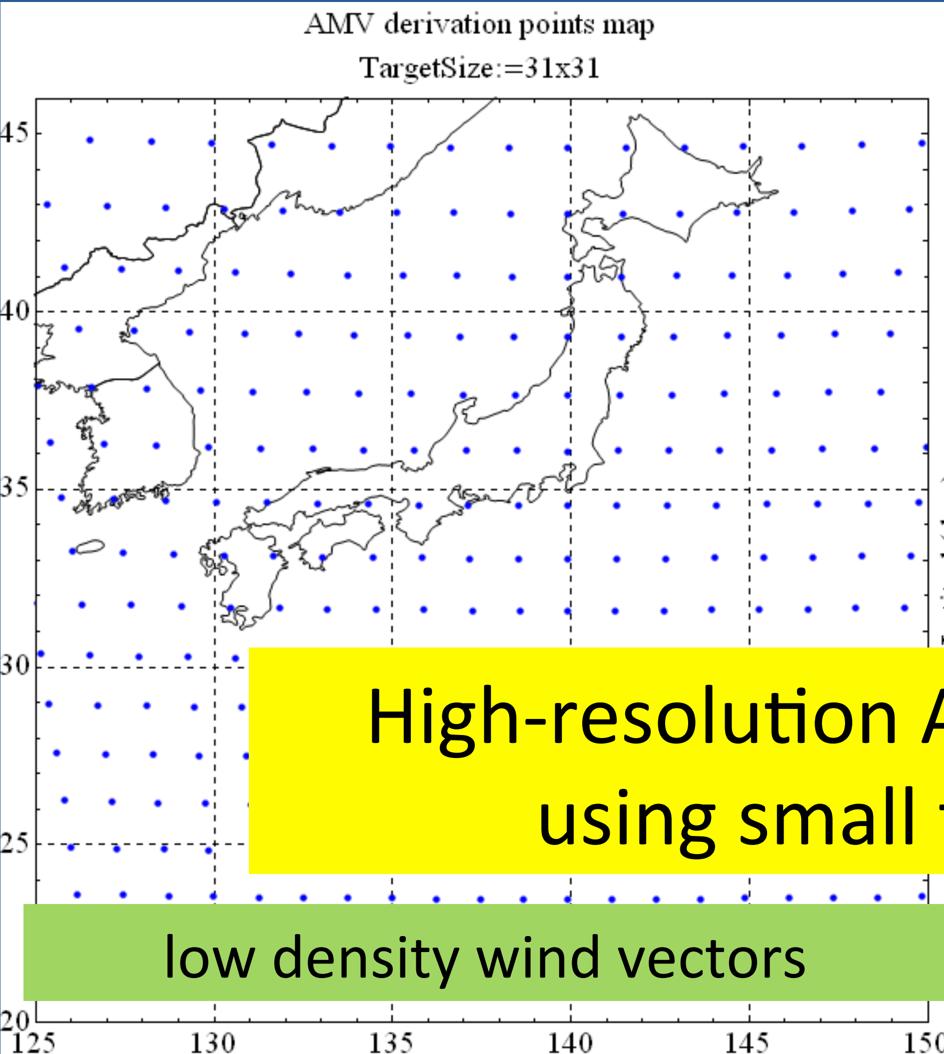
4. Comparison experiment using target box sizes 10x10 and 16x16 was examined for checking a part of cloud tracking limit”. As a result, AMVs from 10x10 target box size show comparable quality from 16x16. this result also suggests that resizing target box size from 16x16 to 10x10 can increase number of AMV without debasement of quality.

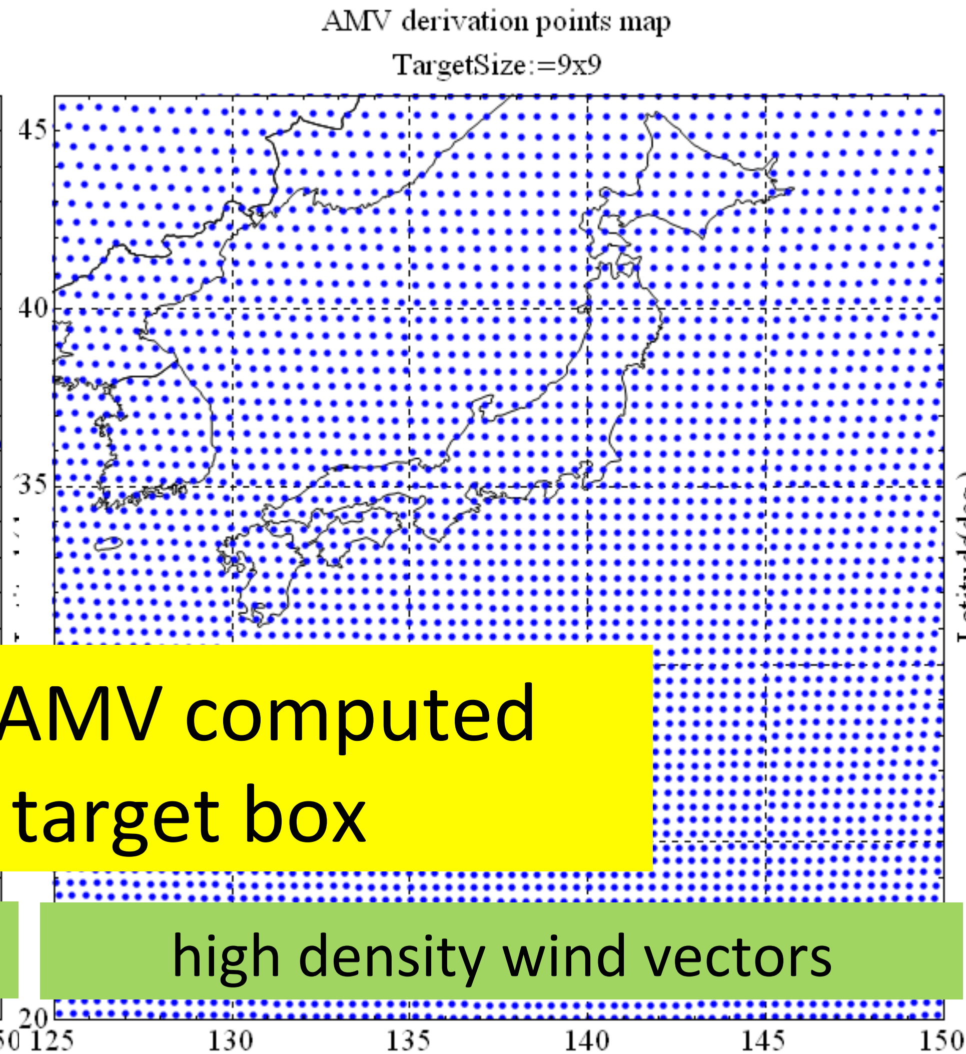
Thank you
for your attention!

Backup

Development to high-resolution AMV

Optimal distribution of AMV derivation points
without correlated error





High-resolution AMV computed
using small target box

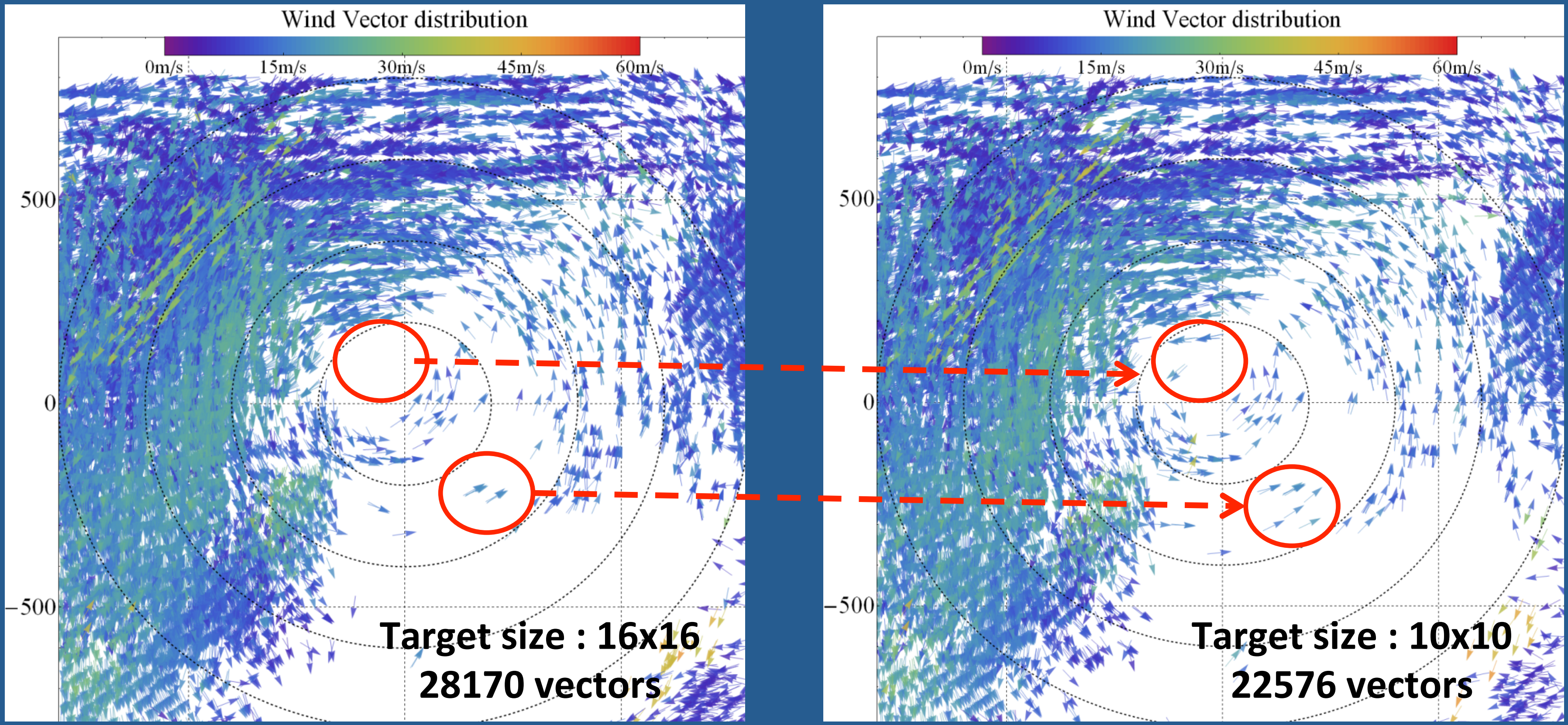
low density wind vectors

high density wind vectors

Rapid-Scan AMVs around Typhoon

Enlargement of data coverage near typhoon center
by using small target box size
even without optimal target alignment

Accumulated AMVs(Qi > 0.8) around center of typhoon “ROKE”
From 9 Sep 2011 to 24 Sep 2011



Summary of Motivation

JMA/MSC develops high-resolution AMV.

For high resolution AMV products…

1. Small target box should be used.
2. But feature of small target disappear immediately.
3. Therefore, next observation should be done **before target feature disappear.**

Relationship of lifetime and size of cloud feature should be investigated.

Study of Relationship b/w Box Size and Time Interval using MTSAT Rapid Scan Images

Method to evaluate the relationship:

- Two satellite images of different observation times prepared
- Cross-correlation between cloud features in boxes of the two images computed to evaluate the lifetime of cloud system

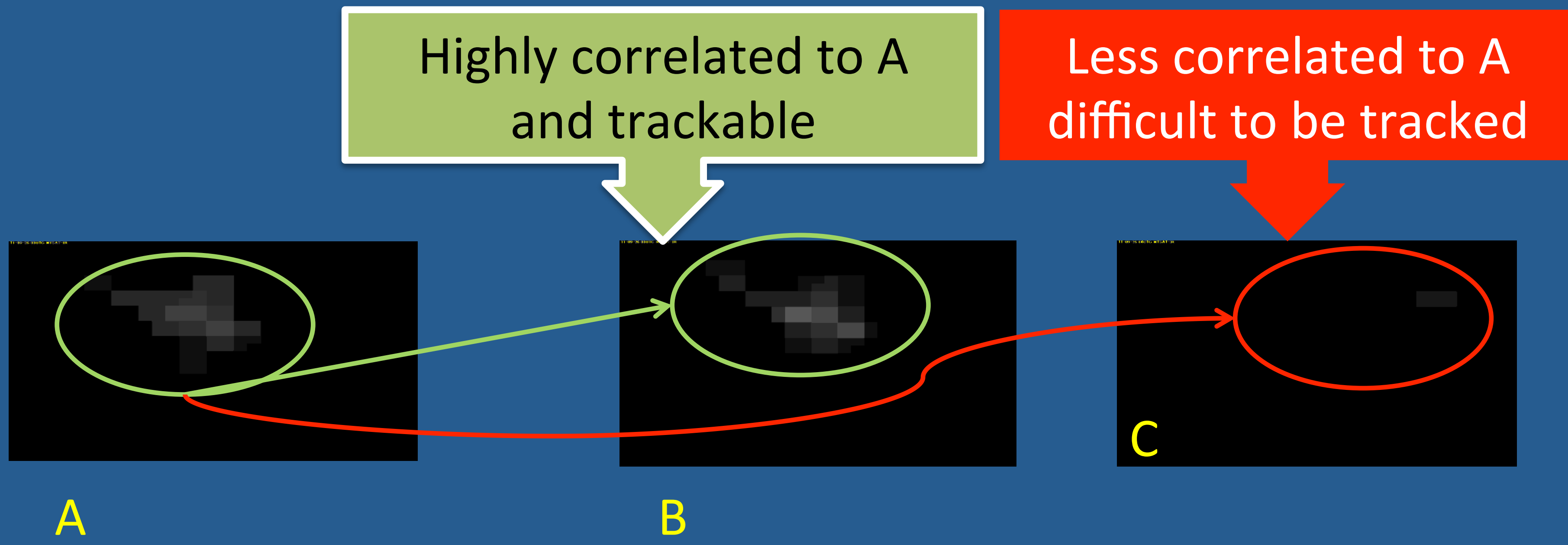
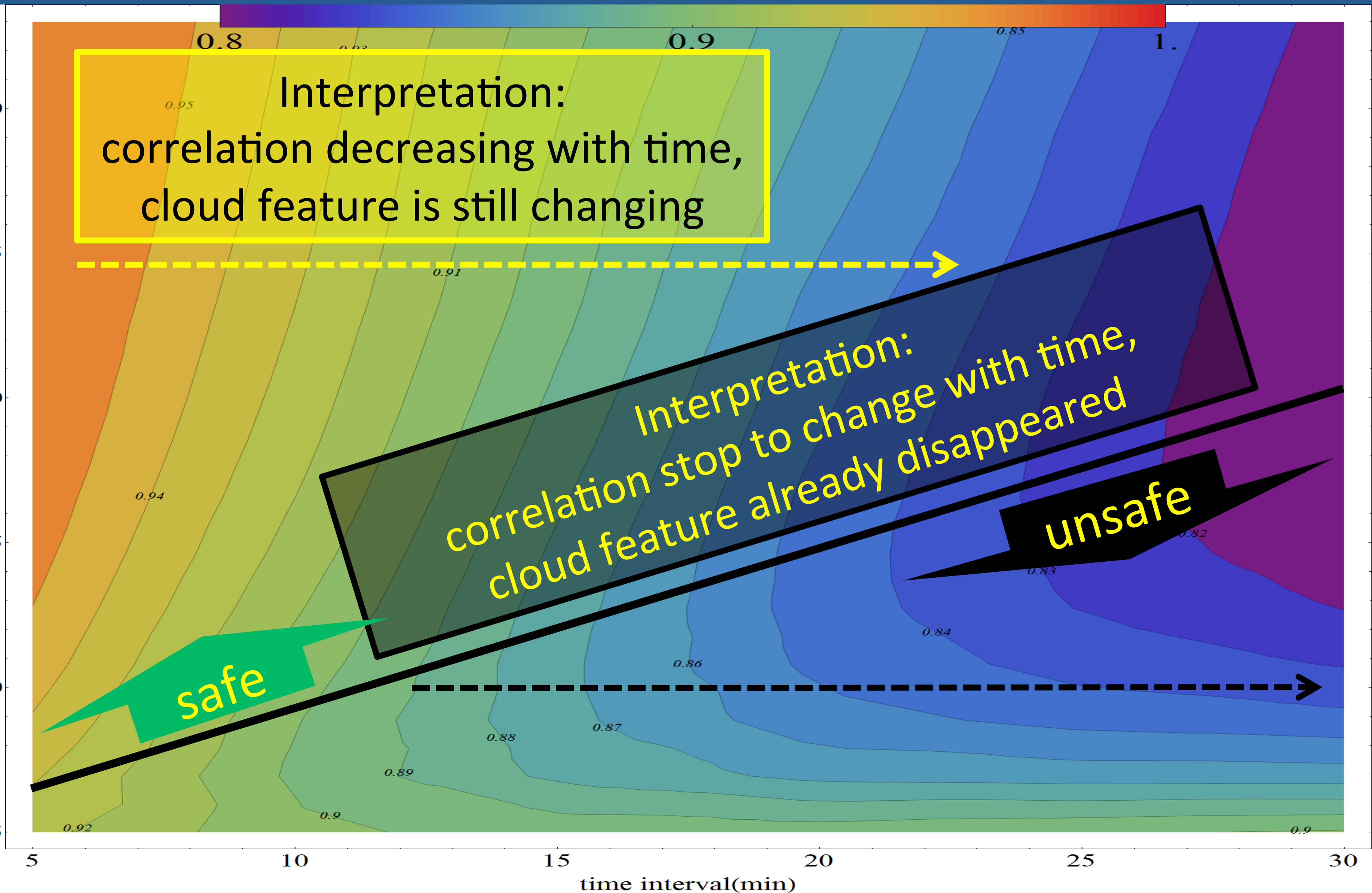
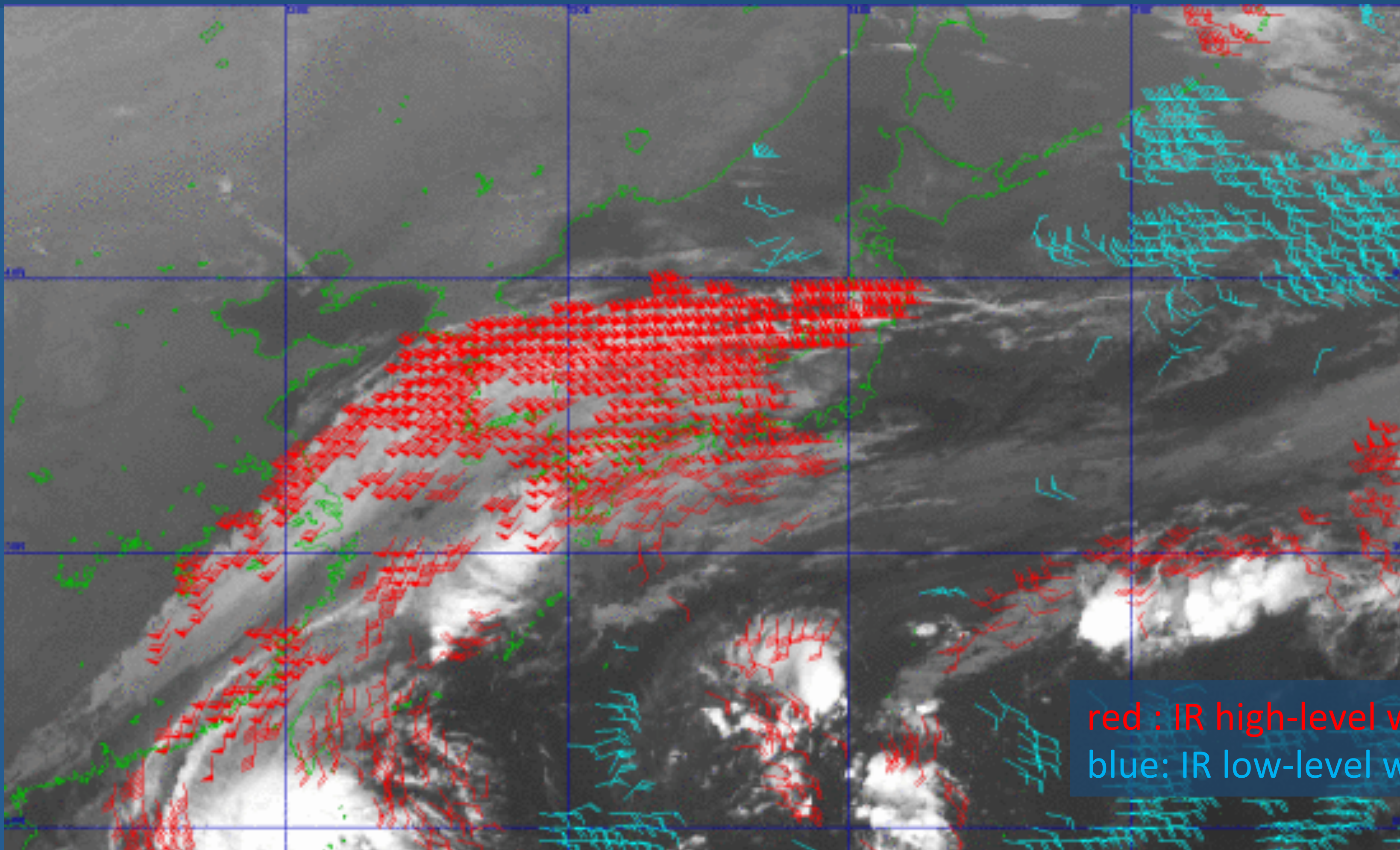


Table of mean of maximum correlation computed from many pairs of target Box sizes and time intervals



Introduction to Atmospheric Motion Vector



- ***Atmospheric Motion Vector products is derived from successive satellite imagery***
- ***Wind vectors are routinely utilized for NWP assimilation***

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