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Tropical meteorology and tropical cyclones
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Dropsonde Observations of Intense Typhoons in 2017 and 2018 in the T-PARCII

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T-PARCII

- Violent wind and heavy rainfall associated with a typhoon cause huge disaster in East Asia including Japan.
- For prevention/mitigation of typhoon disaster, accurate estimation and prediction of typhoon intensity are very important as well as track forecast.
- However, intensity data of the intense typhoon category such as supertyphoon have large error after the US aircraft reconnaissance was terminated in 1987.
- Intensity prediction of typhoon also has not been improved sufficiently for the last few decades.
- To improve these problems, in situ observations of typhoon using an aircraft are indispensable.
- The main objective of the **T-PARCII** (Tropical cyclone-Pacific Asian Research Campaign for Improvement of Intensity estimations/forecasts) project is improvements of typhoon intensity estimations and forecasts.

Violent wind and heavy rainfall associated with a typhoon cause huge disaster in East Asia including Japan.

Payment of insurance due to disasters in Japan

No.	Disaster	Region	Year/Month	10^8¥
1	**TY #19**	All Japan	Sept. 1991	5,680
2	**TY #18**	All Japan	Sept. 2004	3,874
3	snowstorm	Kanto	Feb. 2014	3,224
4	**TY #18**	Kyushu, W. J.	Sept. 1999	3,147
5	**TY #15**	All Japan	Aug. 2015	1,642
6	**TY #7**	Kinki	Sept. 1998	1,599
7	**TY #23**	Western Japan	Oct. 2004	1,380
8	**TY #13**	N. Kyushu	Sept. 2006	1,320
9	**TY #21 LAN**	All Japan	Oct. 2017	1,217
10	**TY #16**	All Japan	Aug. 2014	1,210

From The General Insurance Association of Japan
http://www.sonpo.or.jp/archive/statistics/disaster/

Typhoons are still the largest cause of natural disaster in Japan.

Flooding Kinu River on Sept. 20, 2015

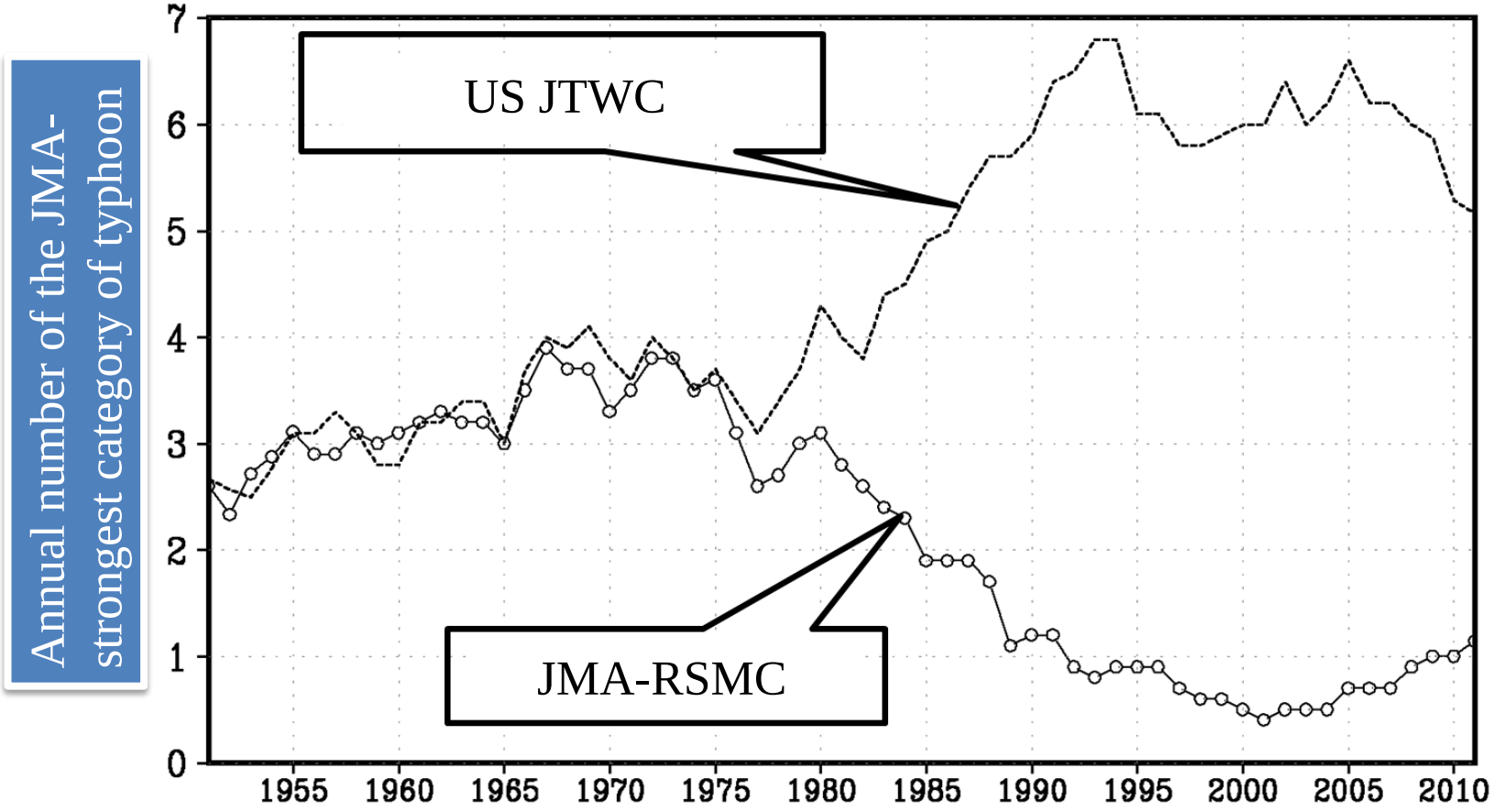
A disaster of Japan in the present climate

After supertyphoon Haiyan in Nov. 2013

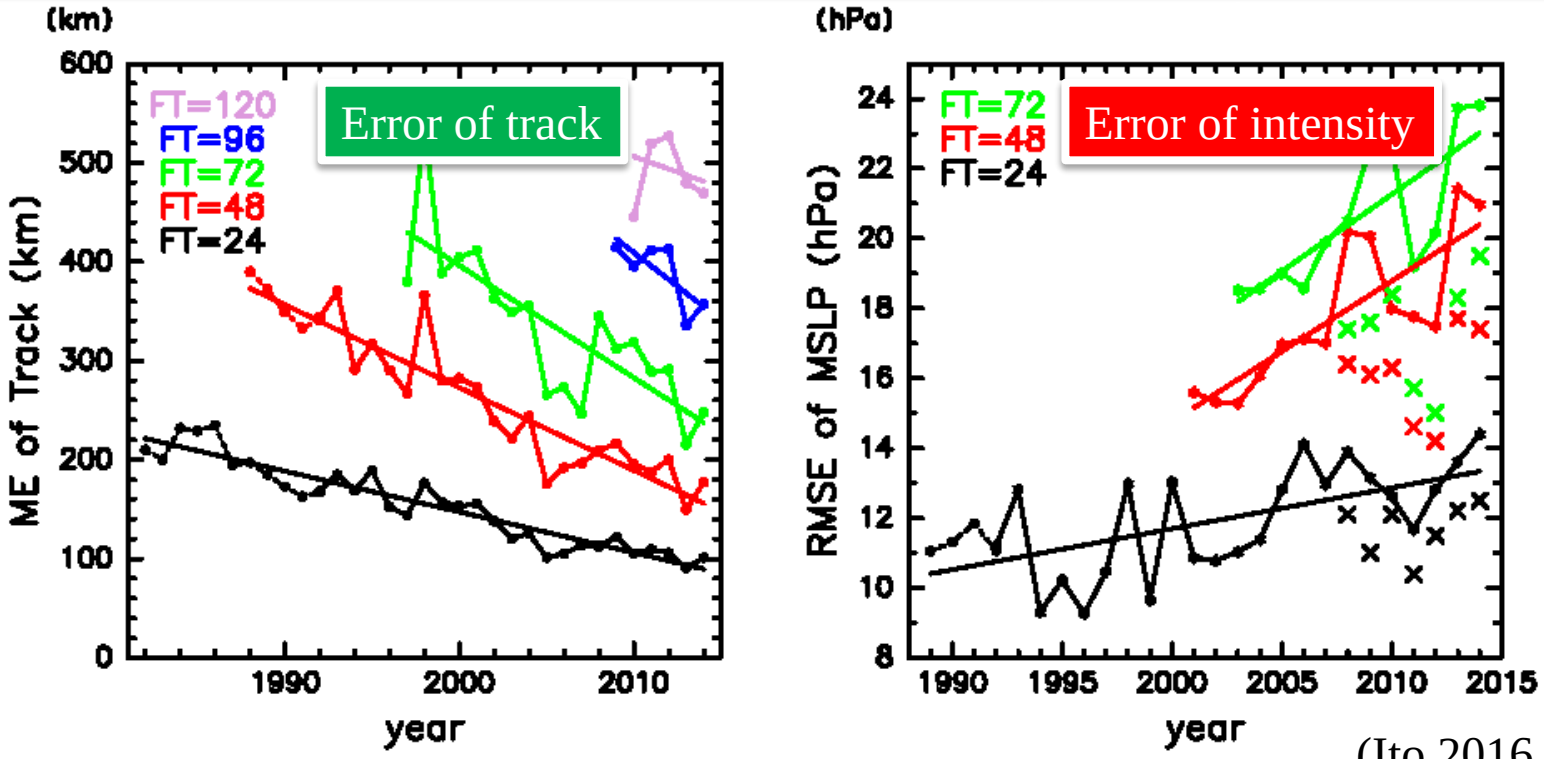
T-PARCII performed an aircraft observation of Typhoon LAN (2017) ranked as #9.

Problem in historical data of typhoon intensity

- The historical data of typhoon include large uncertainty.
- In particular, intensity of intense typhoons includes large error after the termination of the typhoon reconnaissance by the US aircraft in 1987.
- In fact, the annual number of the JMA-strongest category of typhoon (10 min. averaged sustained wind is 54 m/s or more) shows large difference between JMA and JTWC.



Problem in typhoon intensity prediction



(Ito 2016, *SOLA*)

In the last 25 years, track prediction has been improved while intensity not improved.

For accurate and quantitative prediction of typhoon intensity;

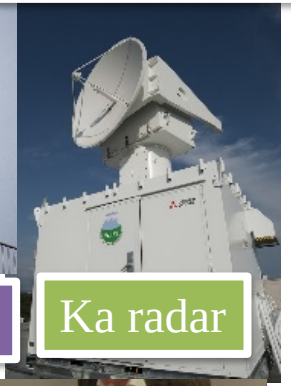
- **High resolution: 2km at least to resolve inner core process of tropical cyclones (e.g. Hill and Lackmann 2011).**
- **Non-hydrostatic, cloud-resolving model**
- **And in-situ observation data.**

T-PARCII (Tropical cyclone-Pacific Asian Research Campaign for Improvement of Intensity estimations/forecasts) is aiming to improve estimations and forecasts

dropsonde from the aircraft

Using dropsondes dropped from the aircraft, temperature, humidity, pressure, and wind are measured in the surrounding region of the typhoon eyewall.

X band radar



Ka radar

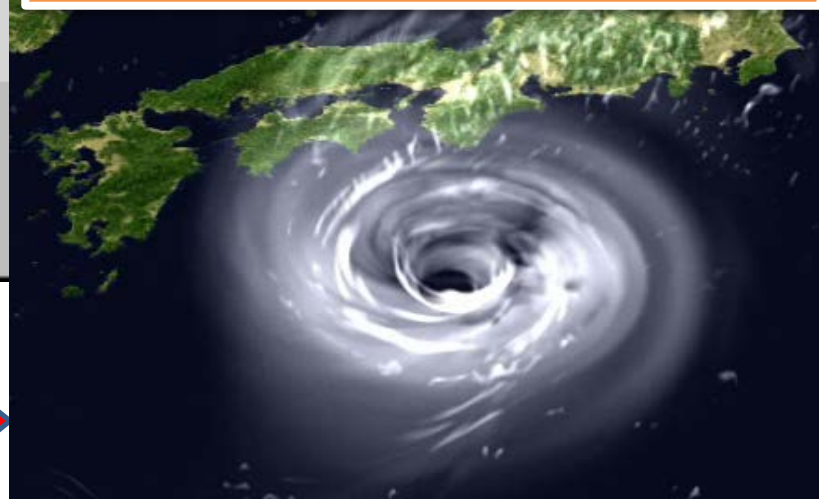
drone

COBRA

沖縄

The dropsonde data are assimilated to the numerical models

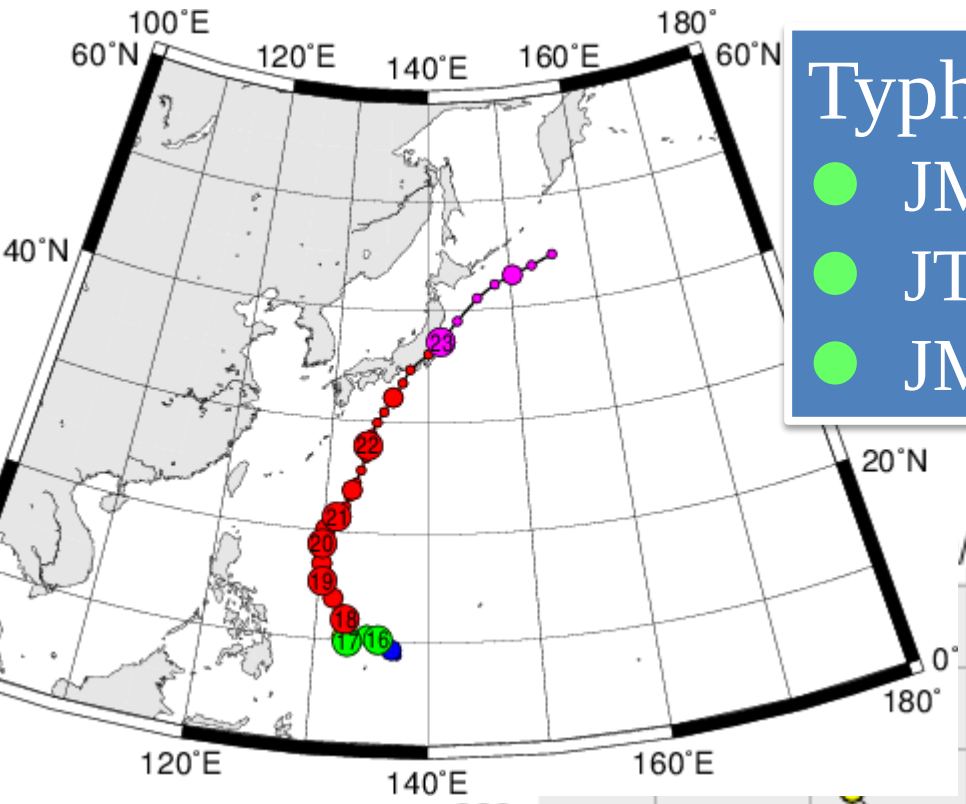
Typhoon prediction using numerical model

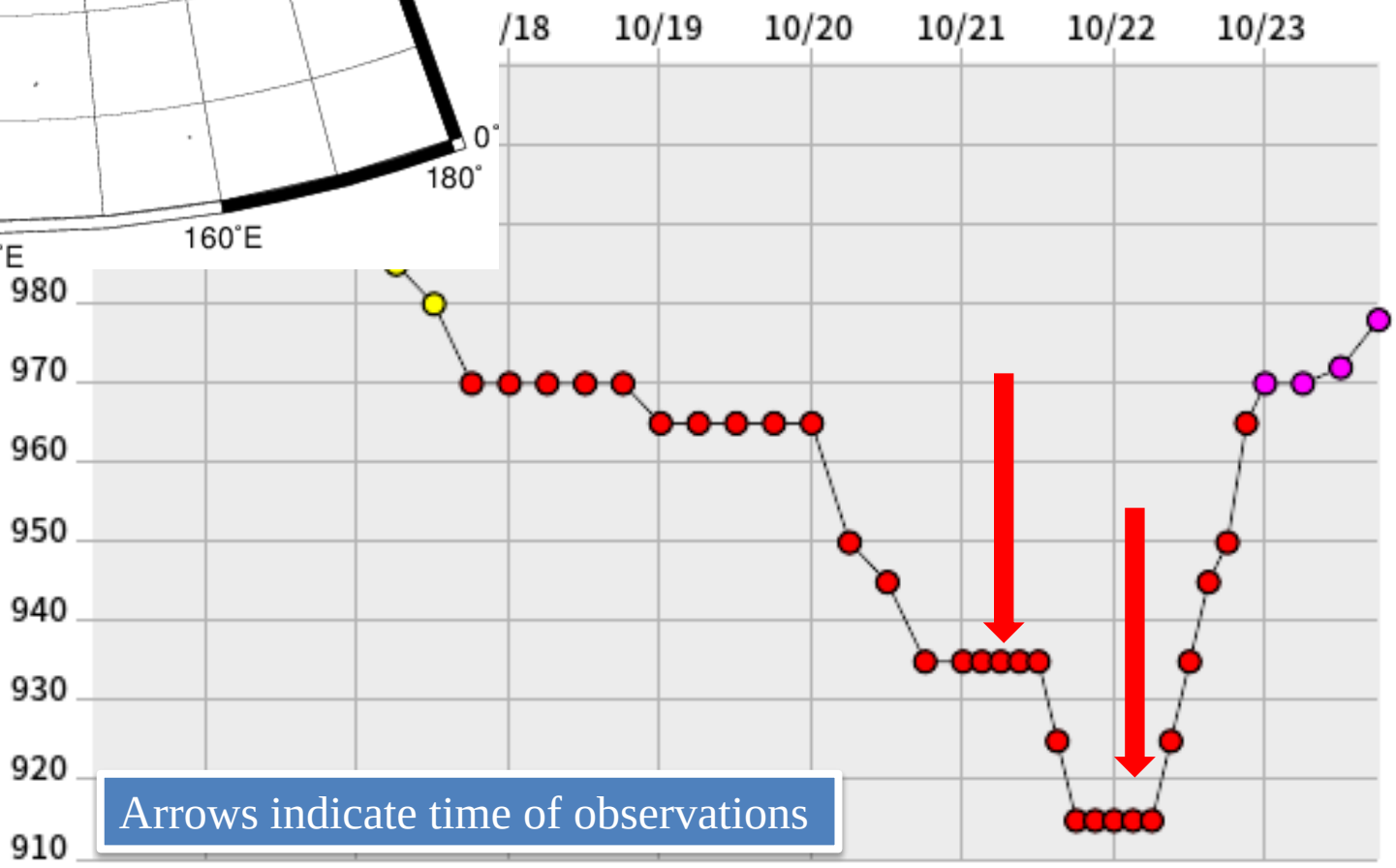


Newly developed dropsonde (Meisei electric Co and Nagoya University)

Typhoon LAN (2017)

- JMA: huge size, very intense
- JTWC: supertyphoon
- JMA max. wind :100 kt =51m/s



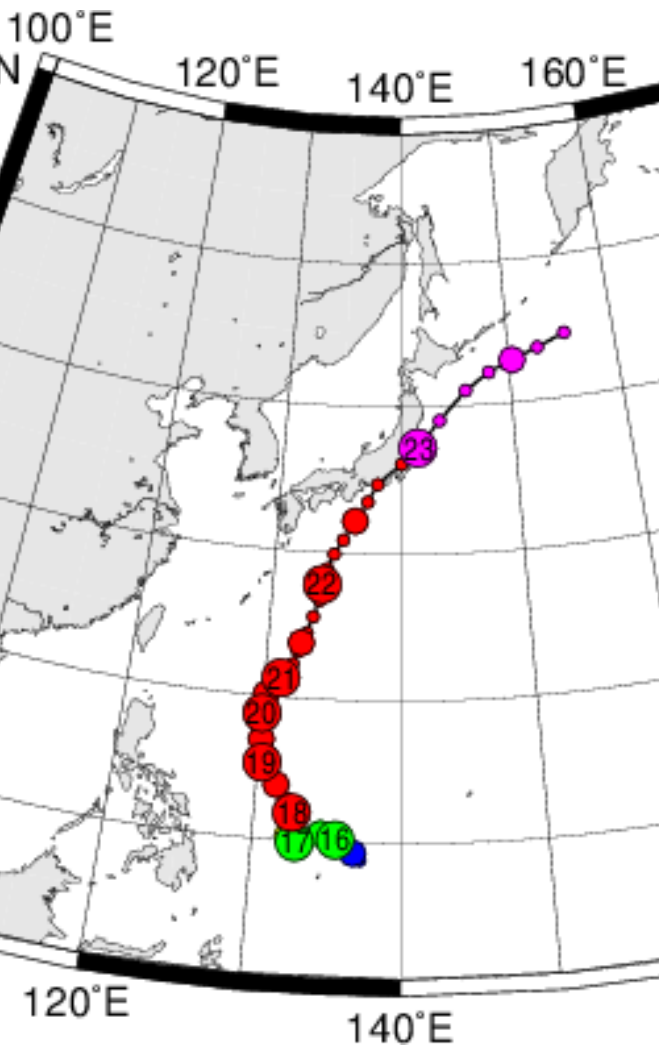


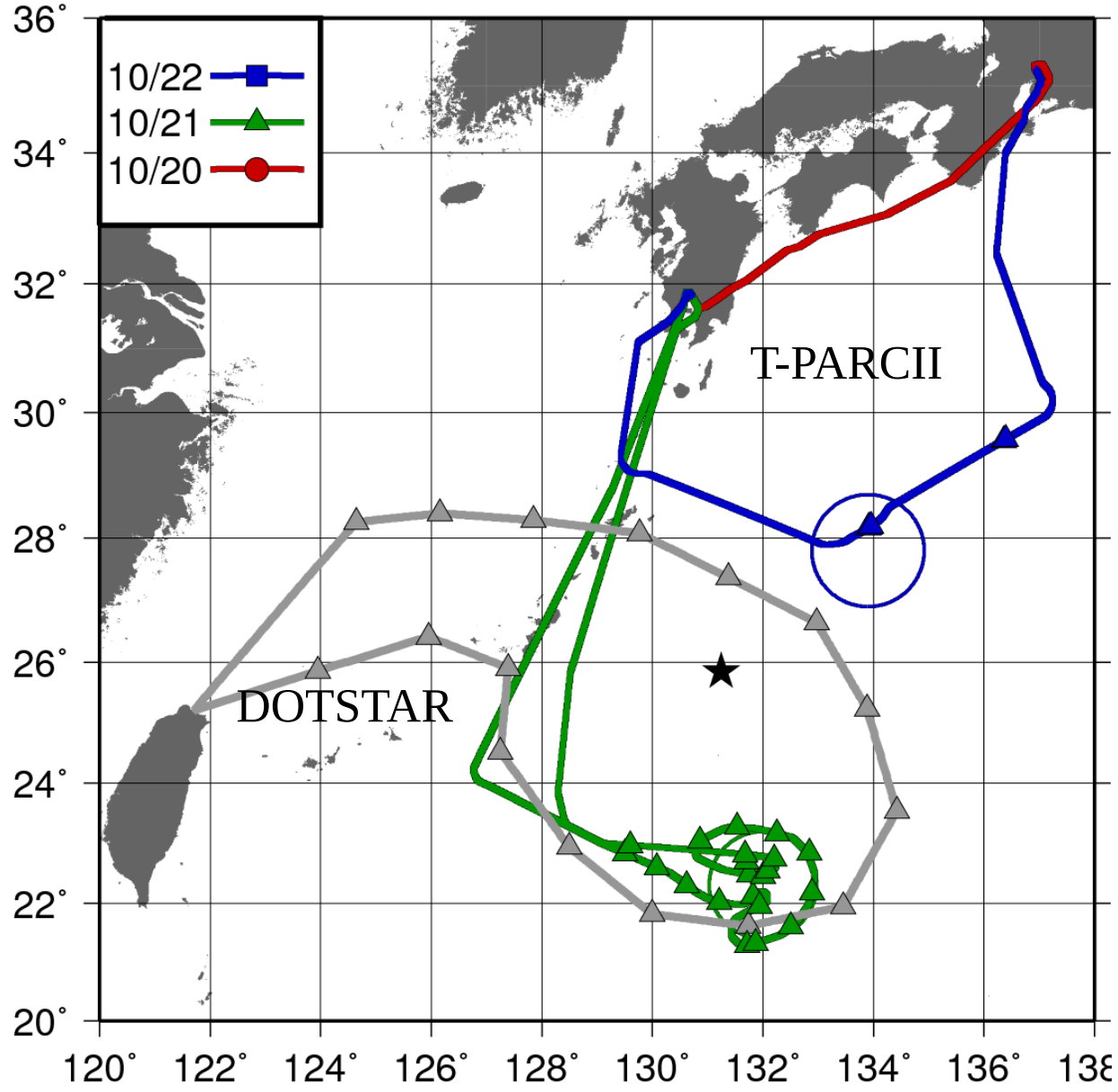
Arrows indicate time of observations

Flight passes of T-PARCII, SATREPS-ULAT and DOTSTAR missions

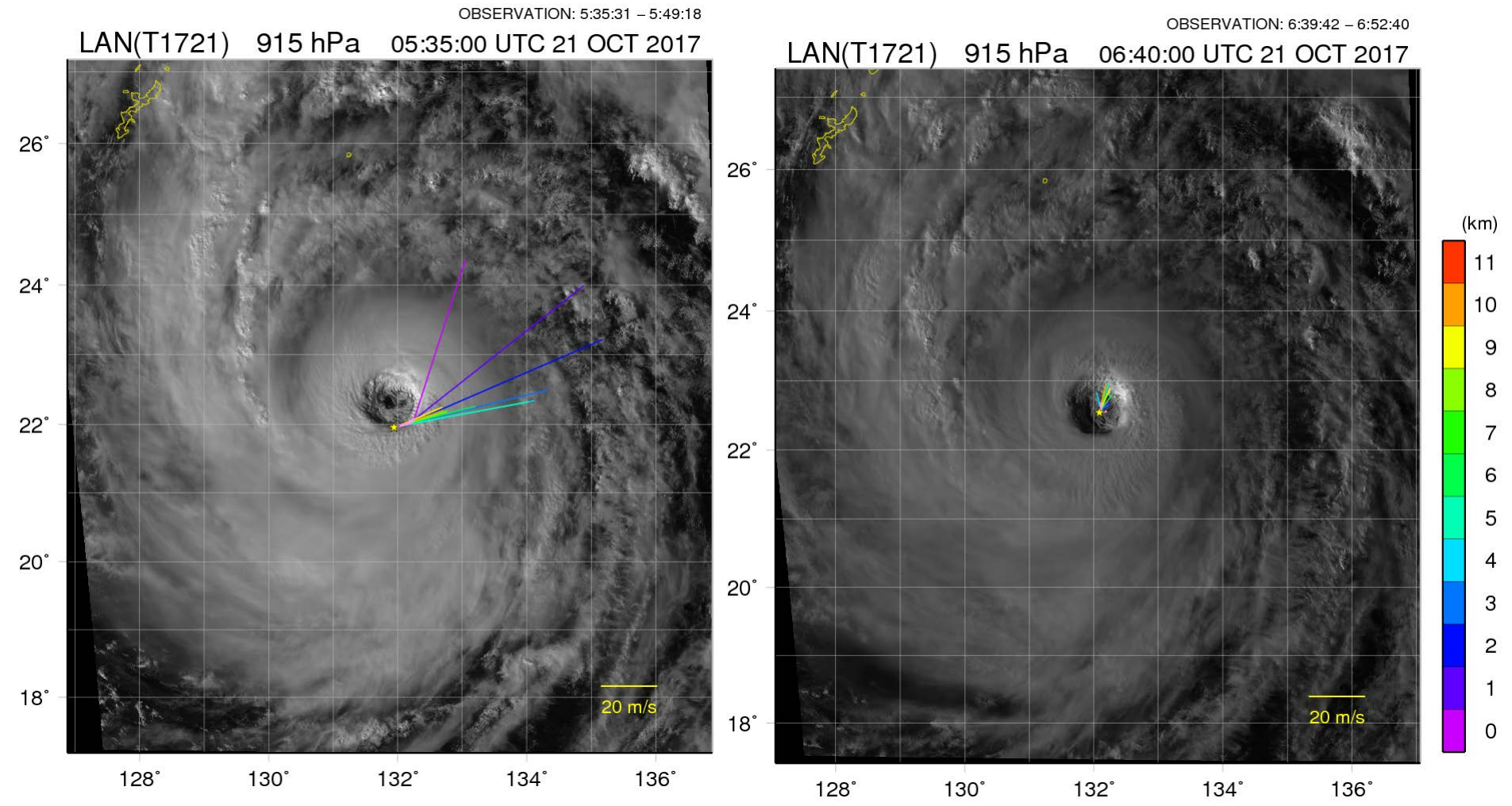
Typhoon Lan (2017)

October 2017





Dropsonde soundings from the aircraft in the surroundings of the eyewall



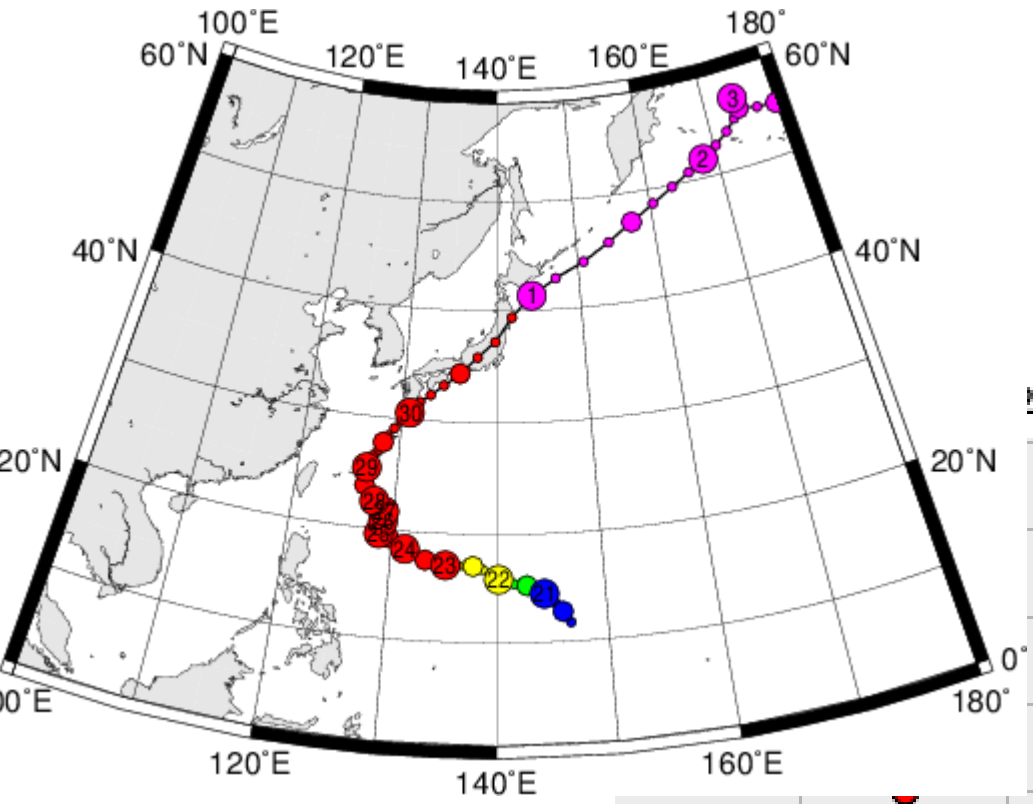
Sea level pressure observed in the eye of Typhoon Lan (2017)

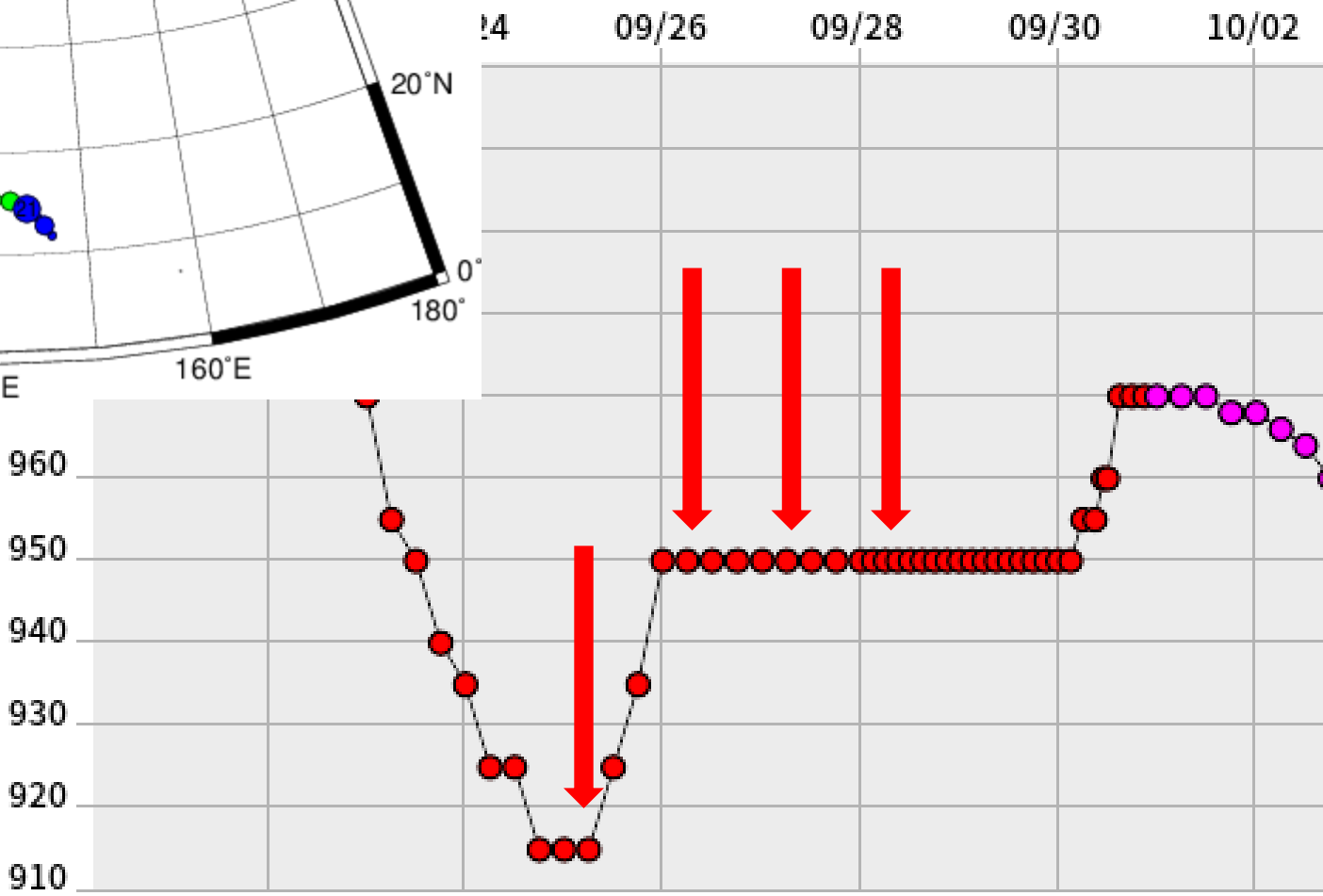
Date and time (UTC) in 2017	Dropsonde observations (hPa) (diff: sonde-JMA bst)	JMA best track (hPa)	JTWC best track (hPa)
10/21, 05:30	926.6＊(-8.4)	935	926
10/21, 06:27	928.2 (-6.8)	935	926
10/21, 06:39	925.7＊(-9.3)	935	926
10/22, 01:01	927.8＊(12.8)	915	931.8

＊ tentative value and will be improved.

- The dropsonde observations show that the central pressure slightly increases from 21 to 22 October.
- The JMA best track data indicate that the central pressure decreases from 935 hPa on October 21 to 915 hPa on October 22.
- The JTWC best track data show a good agreement with observation.

Typhoon Trami (2018)
JMA max wind: 105 kt





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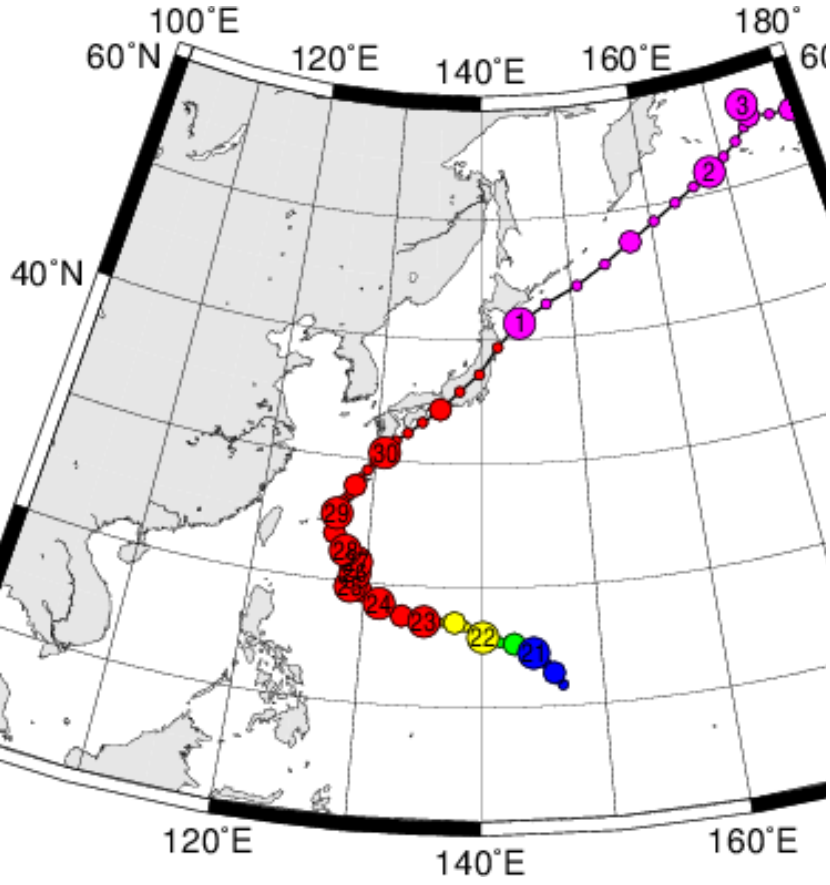
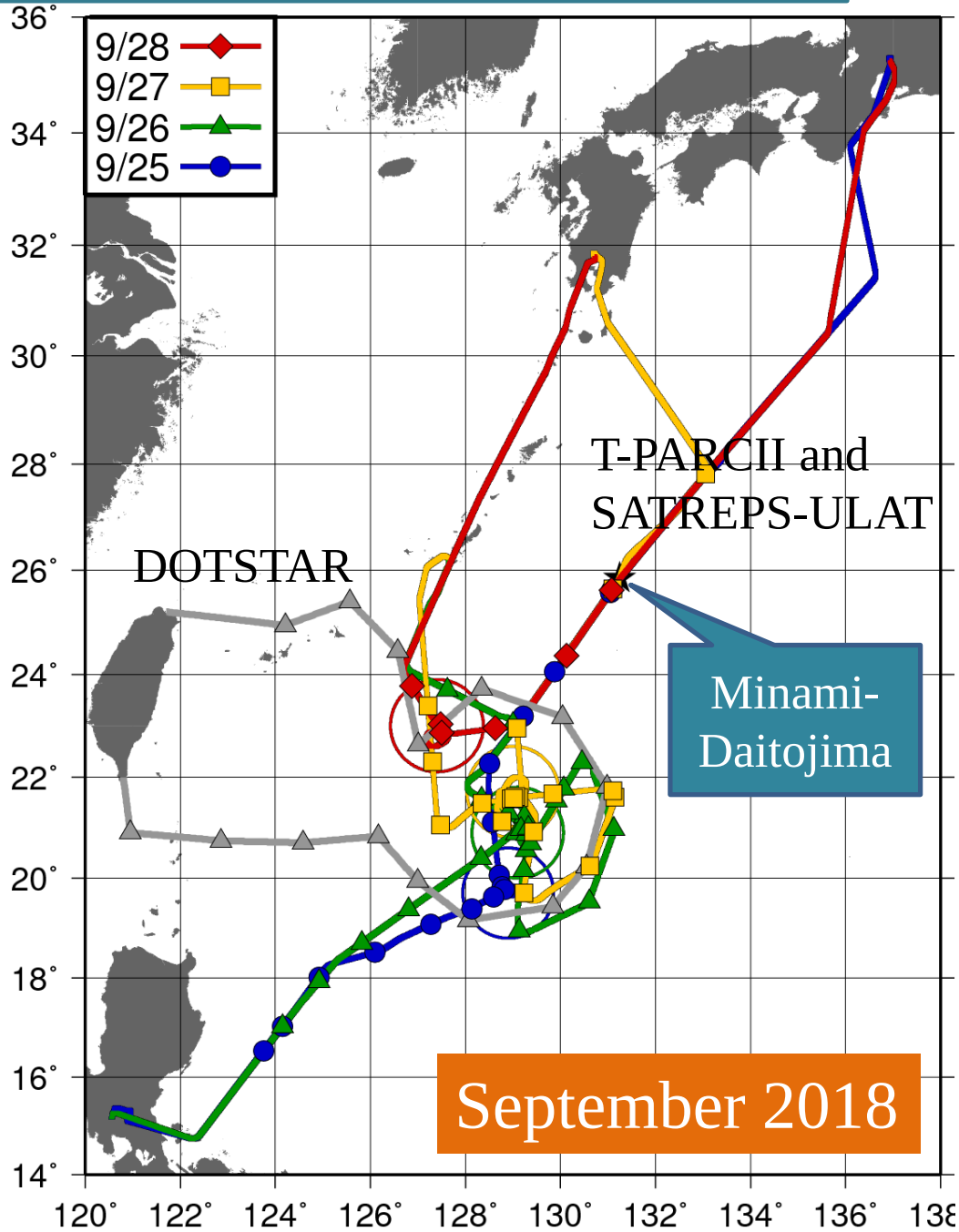
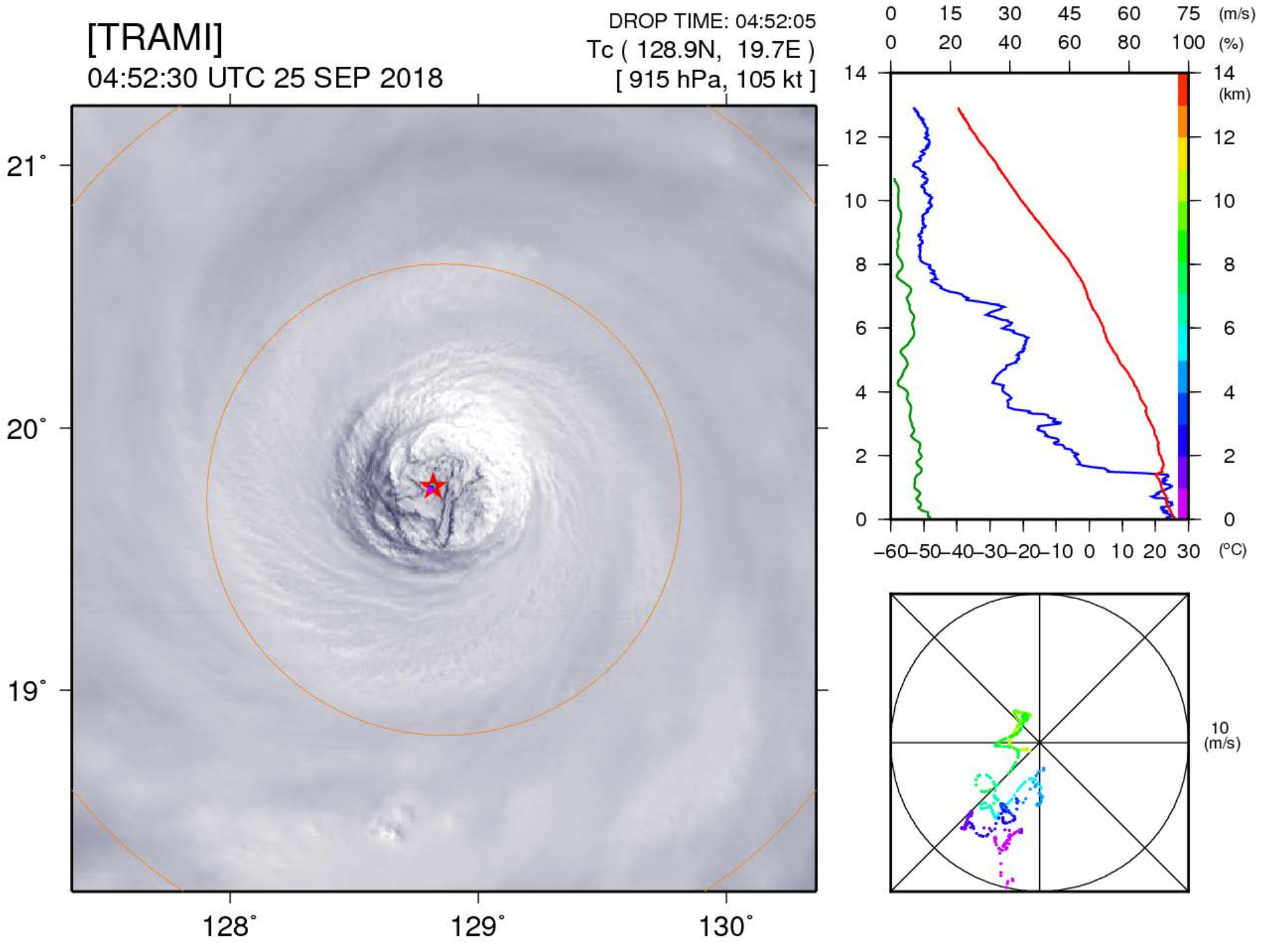
Flight passes of T-PARCII, SATREPS-ULAT and DOTSTAR missions

Typhoon Trami (2018)






[TRAMI]
04:52:30 UTC 25 SEP 2018
DROP TIME: 04:52:05
Tc (128.9N, 19.7E)
[915 hPa, 105 kt]
21˚
20˚
19˚
128˚
129˚
130˚
0 15 30 45 60 75 (m/s)
0 20 40 60 80 100 (%)
14 (km)
12
10
8
6
4
2
0
–60 –50 –40 –30 –20 –10 0 10 20 30 (°C)
10 (m/s)

Sea level pressure observed in the eye of Typhoon Trami (2018)

Data and time (UTC) in 2018	Dropsonde observations (hPa) (diff: sonde-JMA bst)	JMA best track (hPa)	JTWC best track (hPa)
9/25, 04:52	918.8 (3.8)	915	921
9/26, 06:04	945.8 (−4.2)	950	952
9/26, 07:19	951.4 (1.4)	950	952
9/27, 04:13	955.4 (5.4)	950	953
9/27, 05:31	955.4 (5.4)	950	952
9/28, 04:37	959.3 (9.3)	950	950

- The JMA and JTWC best track data indicate that the central pressure is almost constant for the period from 26 to 28 September.
- The dropsonde observation show that the central pressure steadily increases from 26 to 28 September.

- The T-PARCII is aiming to improve estimations and forecasts of tropical cyclone intensity as well as storm track forecasts.
- Nagoya University and the Meisei Electric Co., Ltd. developed a new dropsonde and four-channel receiver.
- Dropsonde observations were compared with upsonde observations from Minami-Daitojima and showed a good agreement.
- First observation was performed on October 21 and 22, 2017 to observe the very large and intense Typhoon LAN (2017) to the southeast of Okinawa with DOTSTAR.
- Second observation was made to observe Typhoon Trami (2018) from 25 to 28 September 2018 in collaboration with the SATREPS group and DOTSTAR.
- We made dropsonde observations in and around the eyewalls of LAN and Trami at a height of 43,000 ft.
- The central pressures of typhoons were derived from dropsonde observations. The data were transmitted to GTS in real time and used for operational prediction of typhoon.