Assimilation of Himawari-8 all-sky radia.ices e very 10 minutes: A case of the September 2015 Kanto-Tohoku rainfa ll

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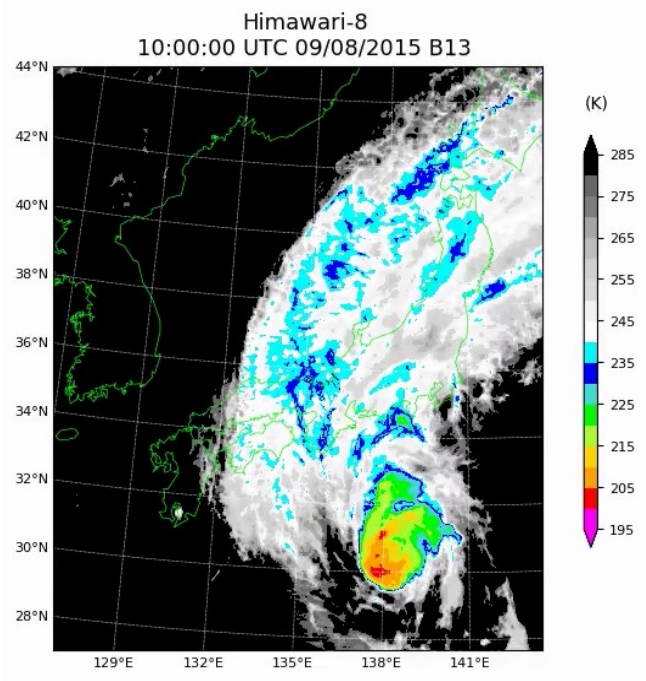
Himawari-8: A new geostationary satellite

2nd generation	2.5 generation	3rd generation
Himawari-6/7 (JMA) GOES-13/14/15 (NOAA) and many others Every 30 min	MSG/SEVIRI (EUMETSAT) (e.g., Himawari-7)	**Himawari-8/9 (JMA)** GOES-R(16) (NOAA) and many others

High spatiotemporal resolution
~ 2.5 min & 2 km
High spectral resolution
~3 VIS, 3 NIR, & 10 IR bands



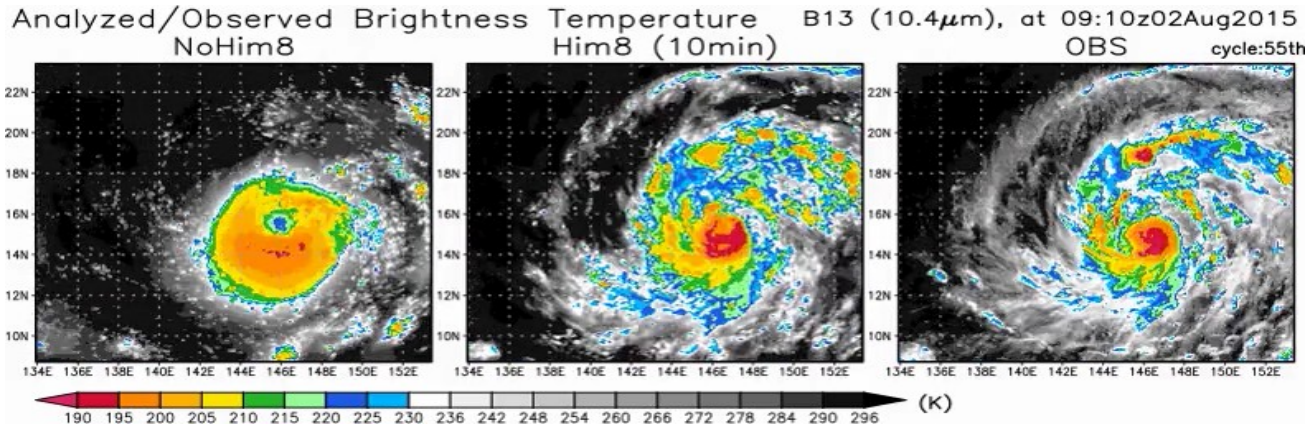
The 1st case study: Typhoon Soudelor (2015)

Every-10-minute Himawari-8 radiances improve the TC analyses and for ecasts.

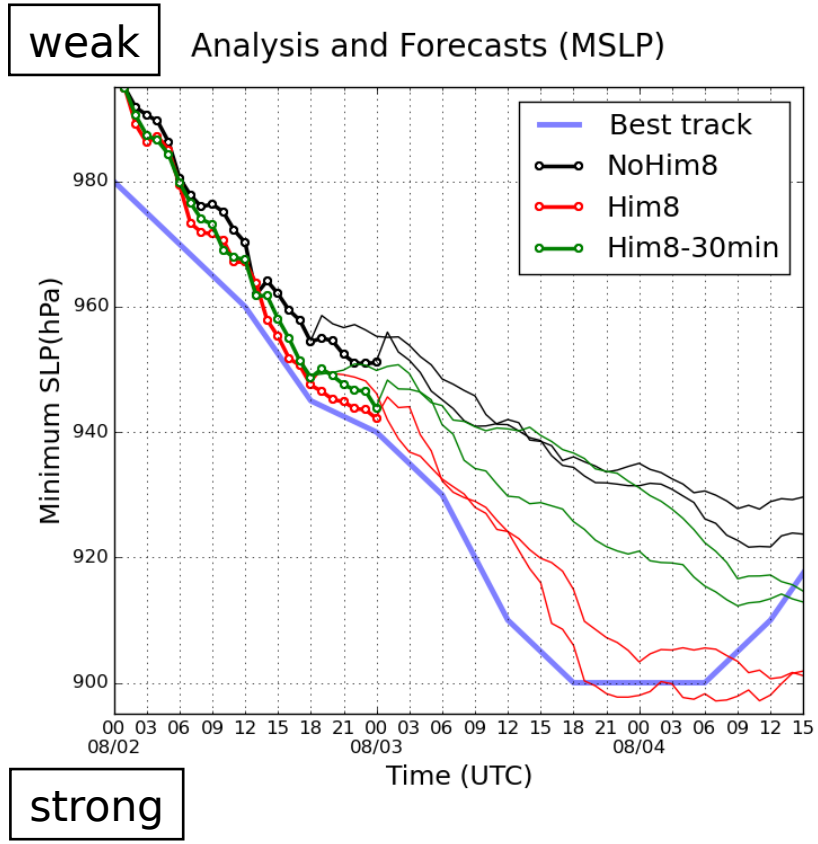
Honda et al. (2018a): Assimilating All-Sky Himawari-8 Satellite Infrared Radiances: A Case of Typhoon Soudelor (2015), *Mon. Wea. Rev.*

TC analyses

NoHim8 Him8 OBS

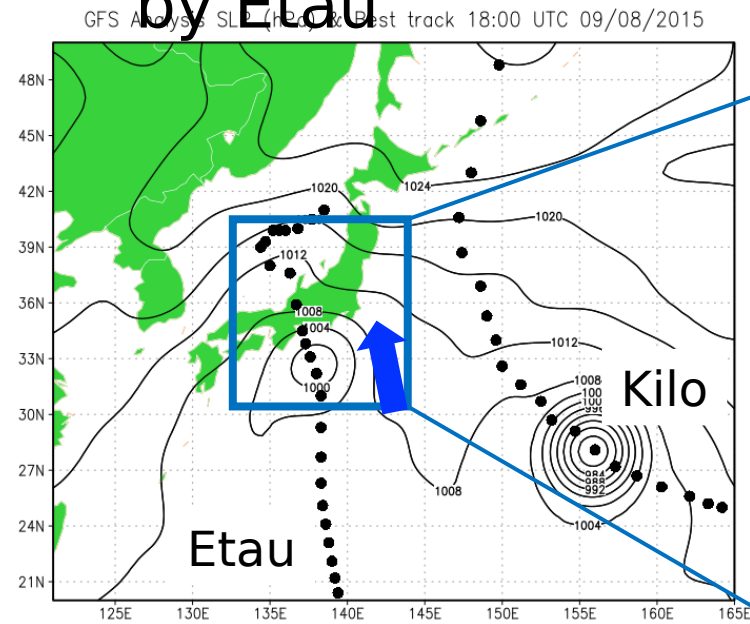


TC intensity

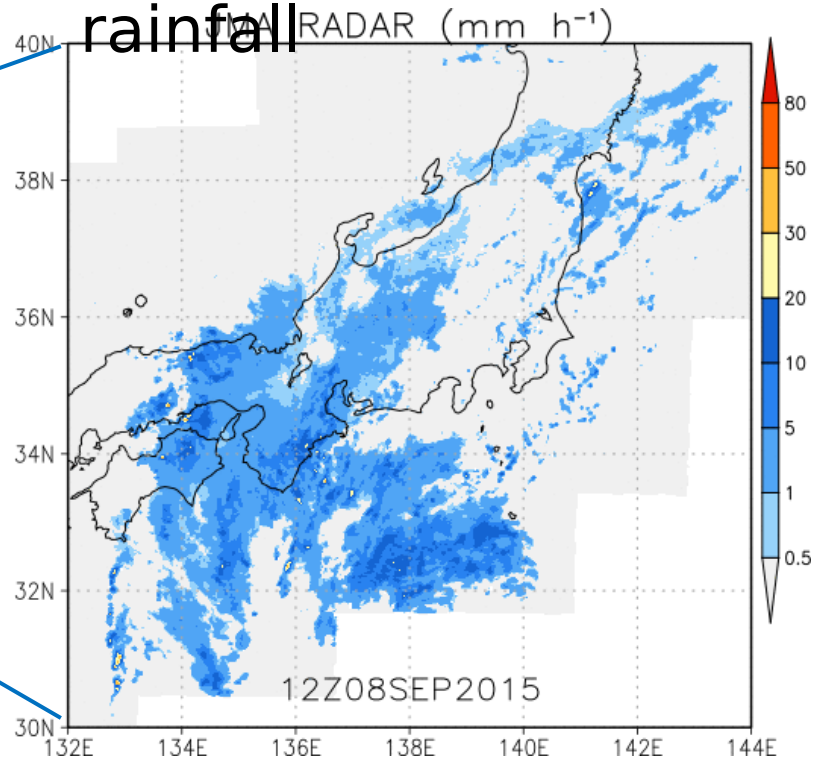


Kanto-Tohoku rainfall in 2015

Northward moisture transport by Etau



Record-breaking rainfall



Collapse of a levee

Kinu River flooding (*Asahi news*)

Key questions

- Can we improve forecasts of a major precipitation event by assimilating all-sky Himawari-8 radiances?

- If so, how does the every-10-minute Himawari-8 data assimilation (DA) contribute to capture the flood risk as early as possible?

Experimental design

SCALE-LETKF (Lien et al. 2017)

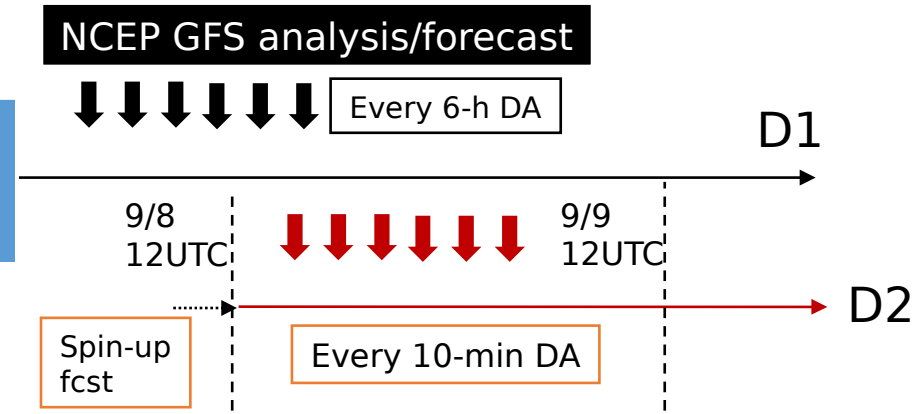
Atmos. model + **DA**

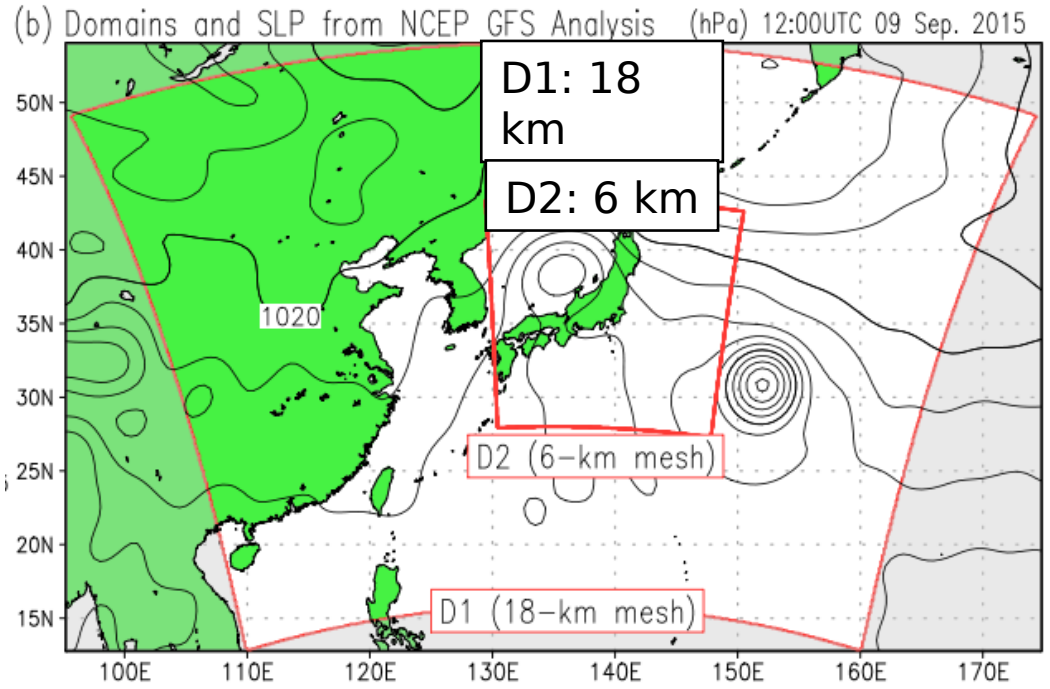
LETKF

(Nishizawa et al. 2015; Sato et al. 2015)

(Hunt et al. 2007; Miyoshi and Yamane 2007)

50-member ensemble from Lien et al. (2017)





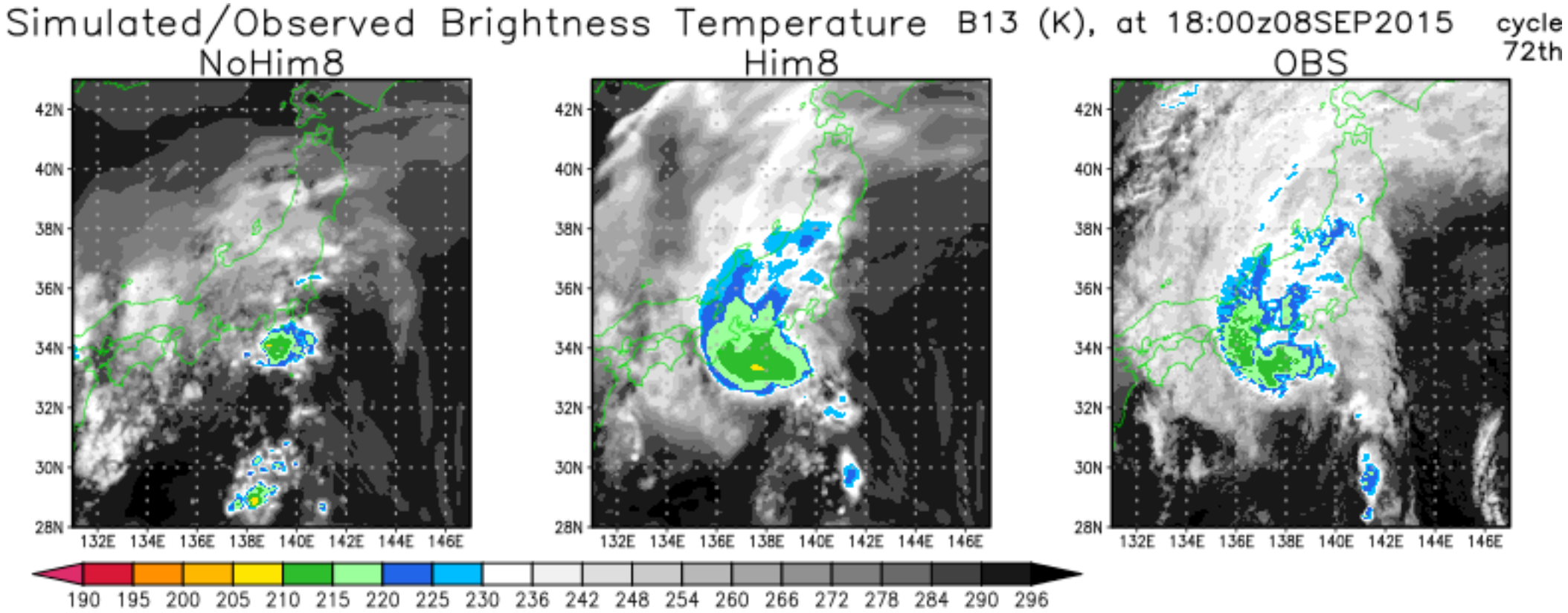
All-sky **band 9** (6.9 μm; **mid-level moisture**) is assimilated by using RTTOV11.2 (Saunders et al. 2013).

Analysis (Him8 radiance)

Himawari-8 radiances dramatically improve cloud patterns.

Not directly assimilated band (B13 , 10.4μm)

NoHim8 Him8 OBS

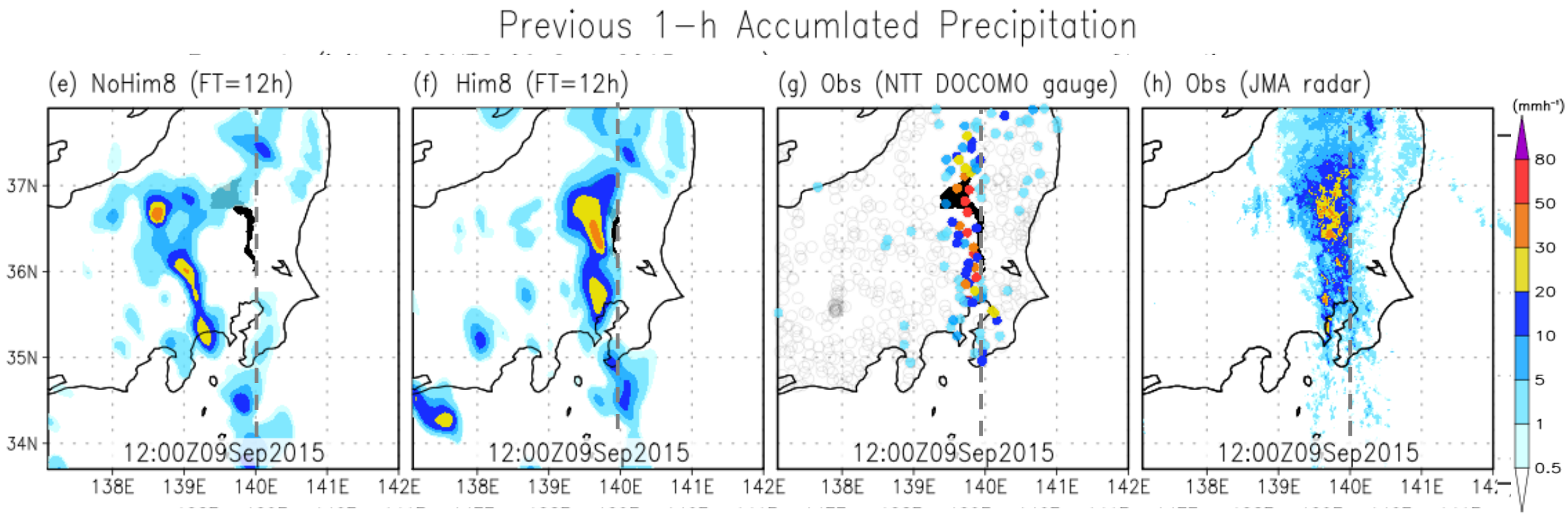


Precipitation forecast

Himawari-8 radiances modify the rainband location.

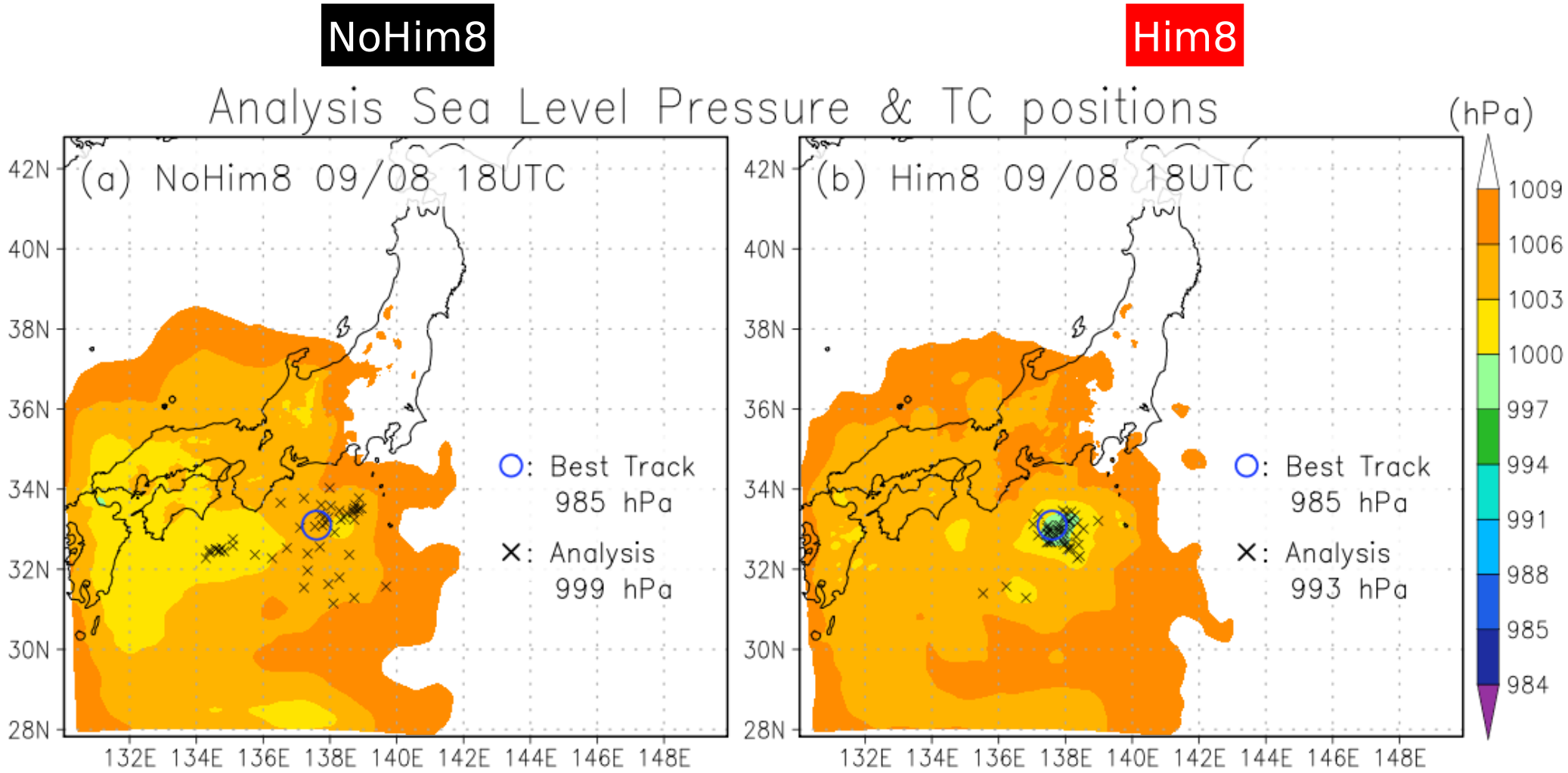
12-hour forecasts from the ensemble mean

NoHim8 | Him8 | OBS (gauge) | OBS (JMA)



Analysis (TC)

Uncertainty of Typhoon Etau (2015) is reduced by Himawari-8.

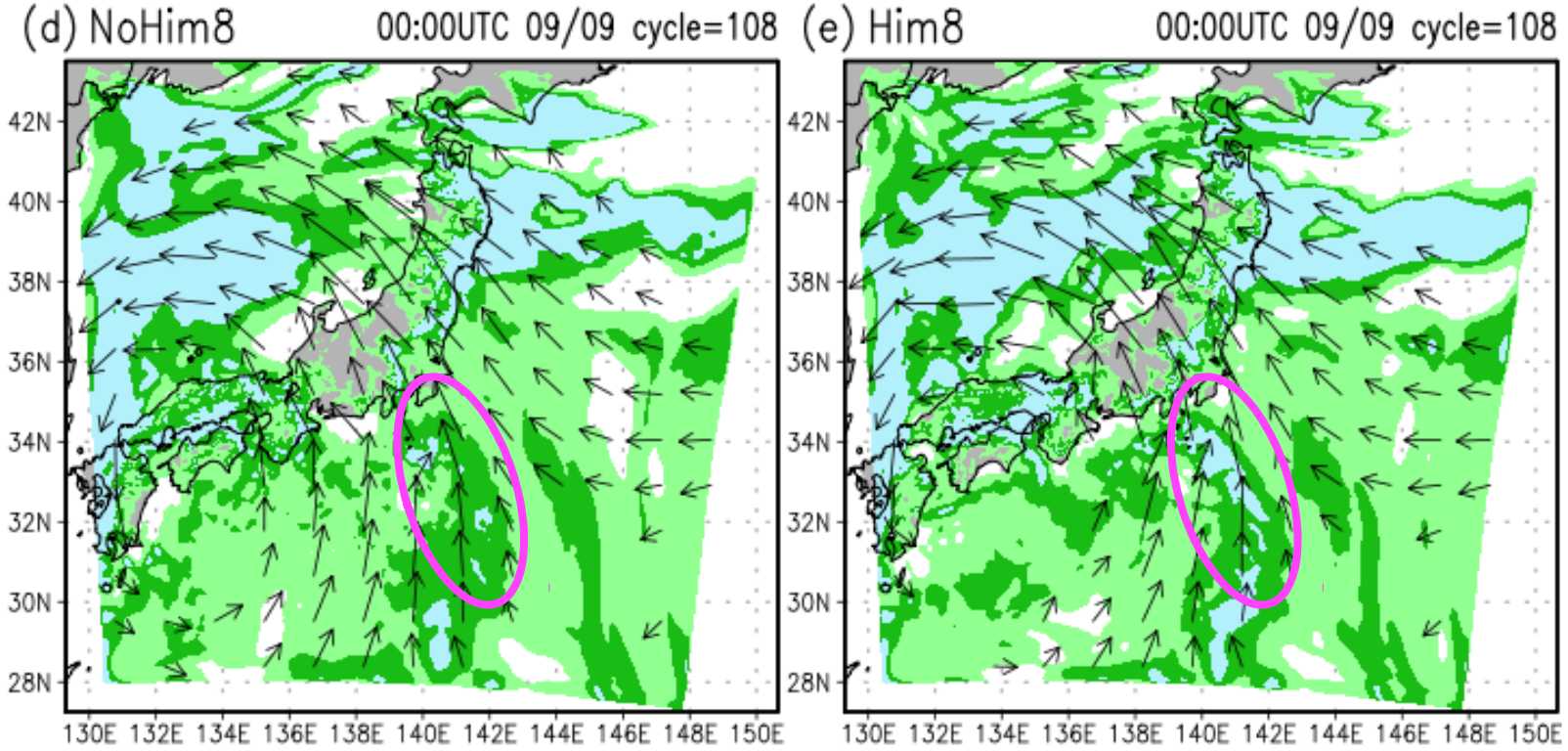


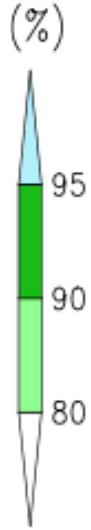
Analysis (RH950 & Moisture flux)

More humid air & northward moisture transport are analyzed in Him8.

NoHim8

Him8





Key questions

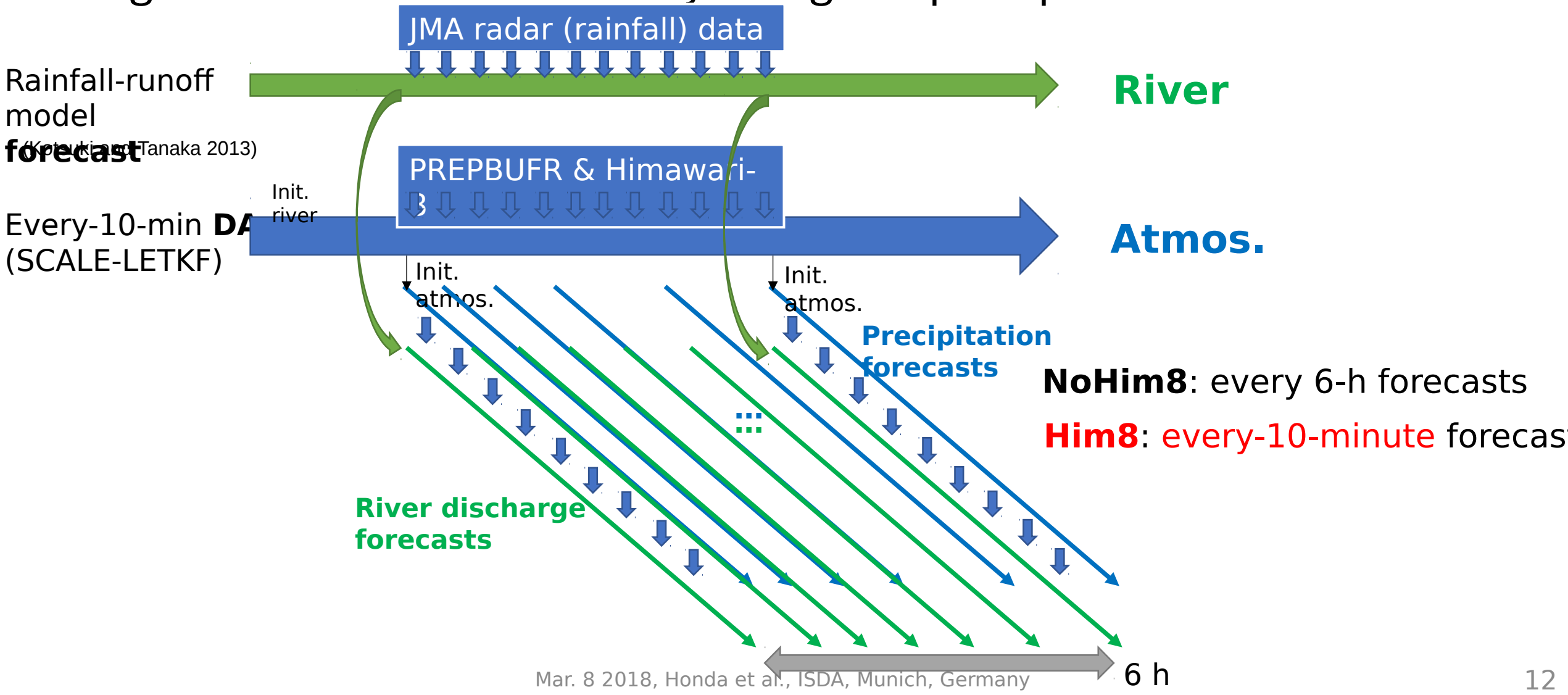
- Can we improve forecasts of a major precipitation event by assimilating all-sky Himawari-8 radiances?

Yes! Himawari-8 radiances dramatically improve the precipitation forecasts by modifying the TC position and moisture transport.

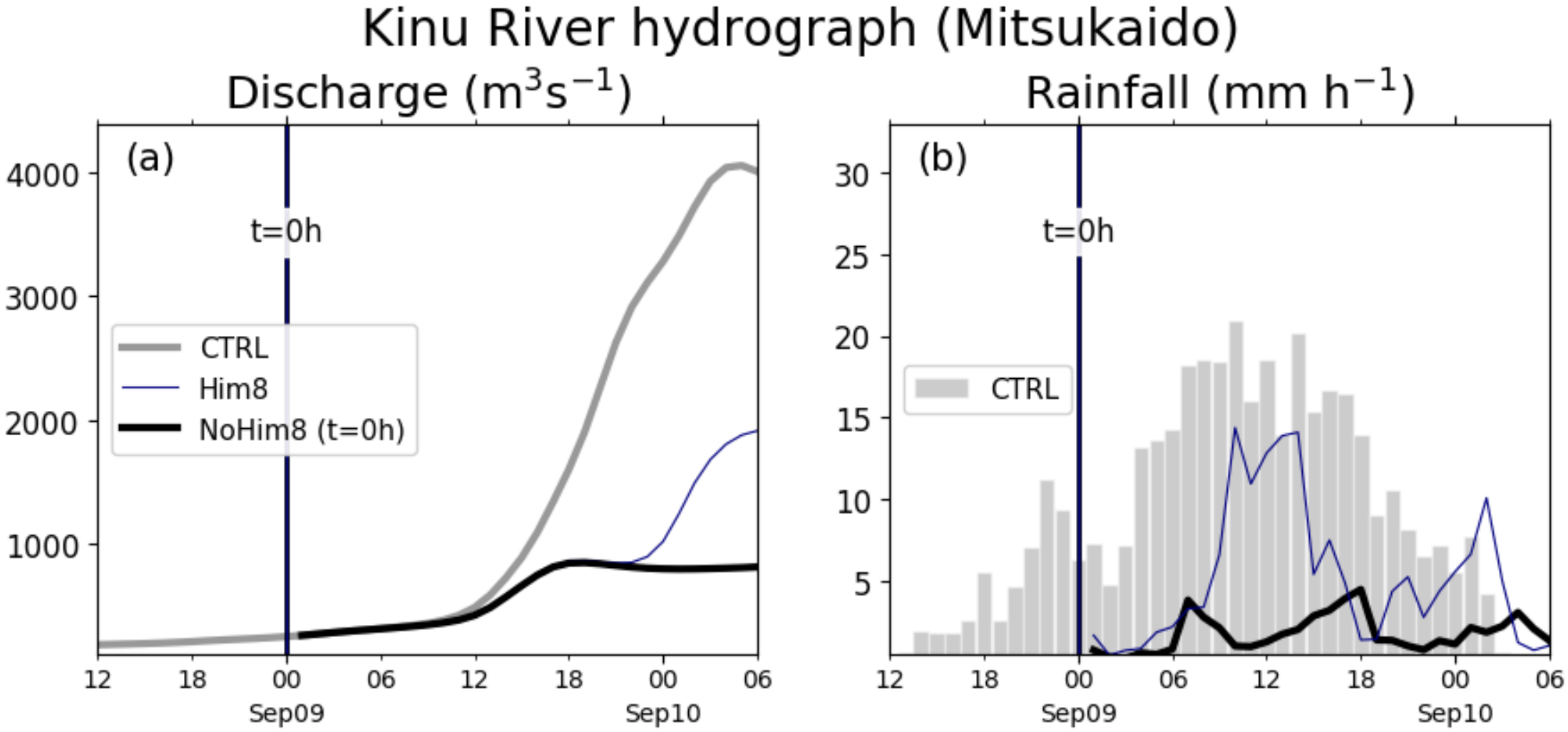
- **If so, how does the every-10-minute Himawari-8 data assimilation (DA) contribute to capture the flood risk as early as possible?**

Flood risk prediction

Driving a rainfall-runoff model by using the precipitation forecasts

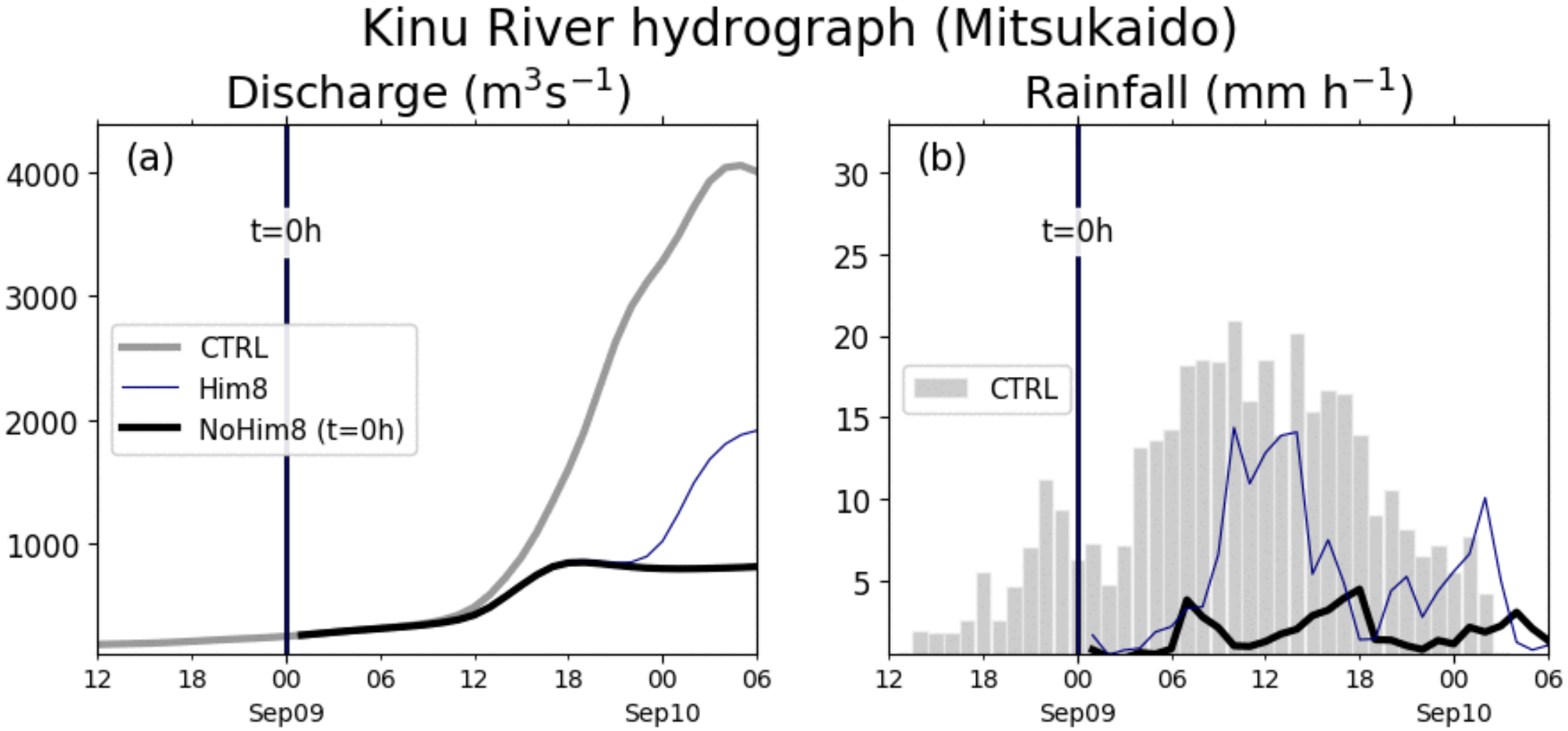


River discharge forecast



Black curves: **NoHim8,** **Colored** curves: **Him8**

River discharge forecast



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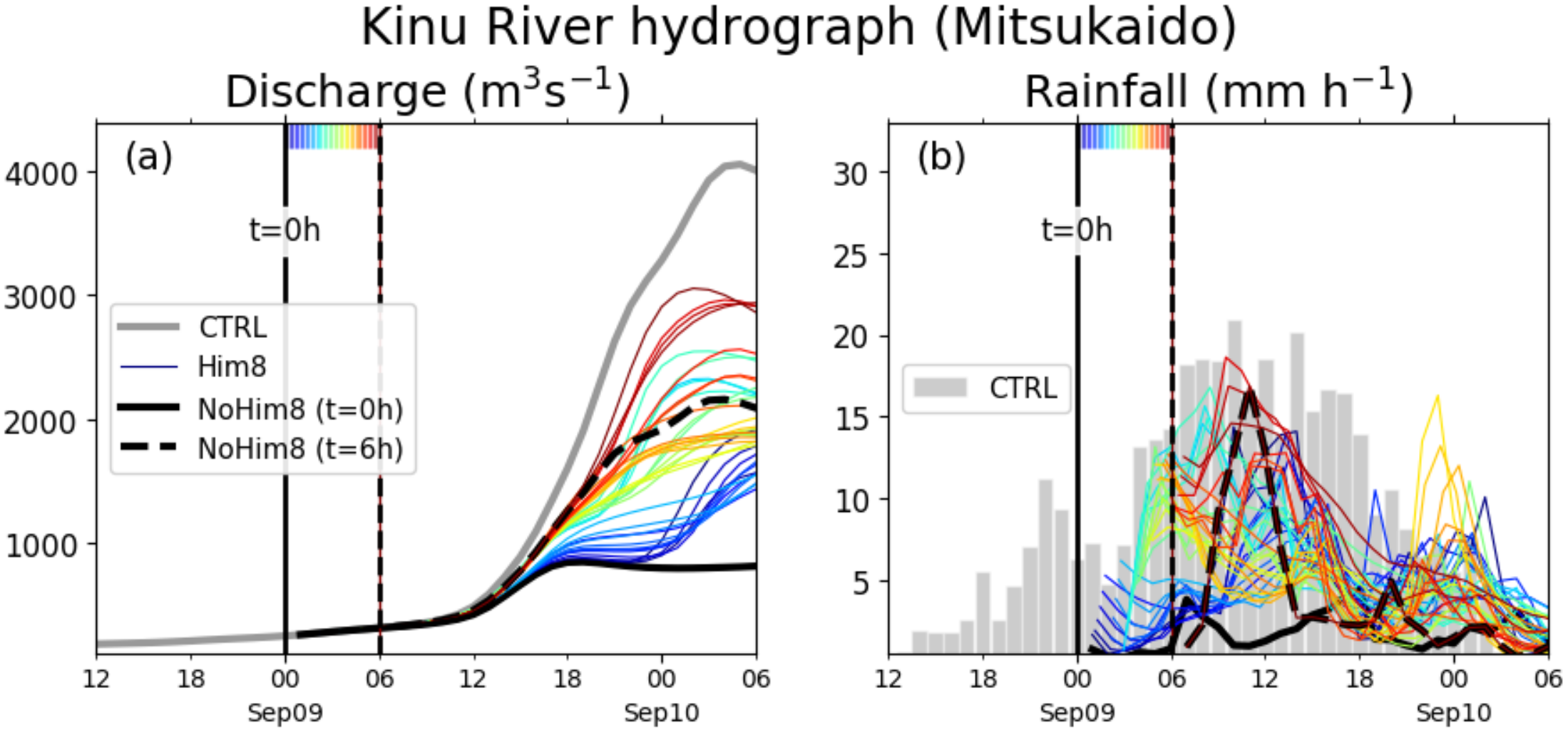
River discharge forecast



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Key questions & answers

- Can we improve forecasts of a major precipitation event by assimilating all-sky Himawari-8 radiances?

Yes! Himawari-8 radiances dramatically improve the precipitation forecasts by modifying the TC position and moisture transport.

- If so, how does the every-10-minute Himawari-8 data assimilation (DA) contribute to capture the flood risk as early as possible?

Himawari-8 radiances enable us to refresh the precipitation and river discharge predictions every 10 minutes, giving longer lead times.

Honda et al. (2018b): Assimilation of Himawari-8 All-Sky Radiances Every 10 Minutes: Impact on Precipitation and Flood Risk Prediction, *JGR-A*.

Thank you for your kind attention!
Questions?

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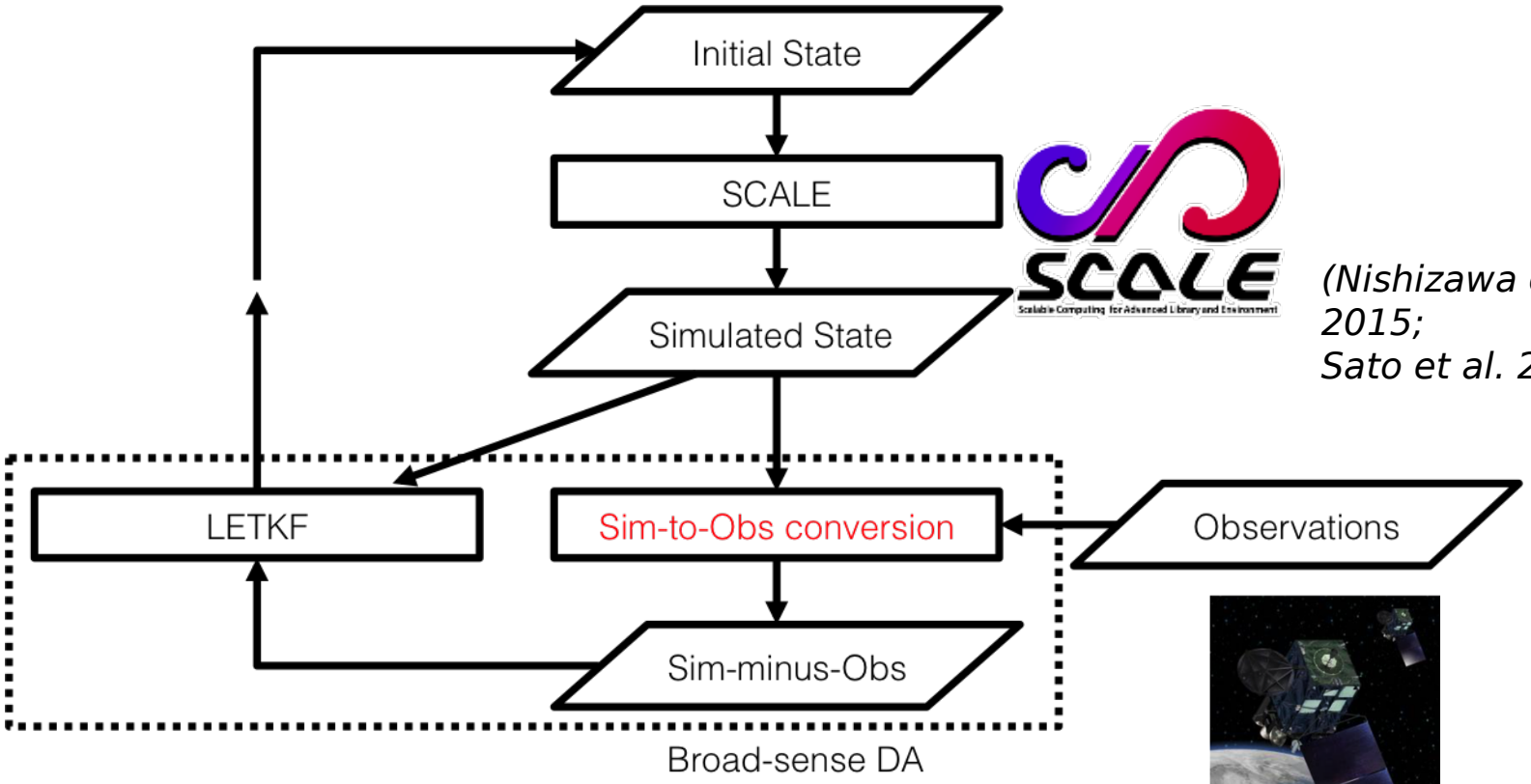
Honda et al. (2018a): Assimilating All-Sky Himawari-8 Satellite Infrared Radiances: A Case of Typhoon Soudelor (2015), *Mon. Wea. Rev*.

Honda et al. (2018b): Assimilation of Himawari-8 All-Sky Radiances Every 10 Minutes: Impact on Precipitation and Flood Risk Prediction, *JGR-A*.

The SCALE-LETKF system

Lien et al. (2017)



(Nishizawa et al. 2015; Sato et al. 2015)

Flowchart of SCALE-LETKF

Himawari-8
Bessho et al. (2016)

Observation operator

Model variables (t, q_v, q_c…)

↓

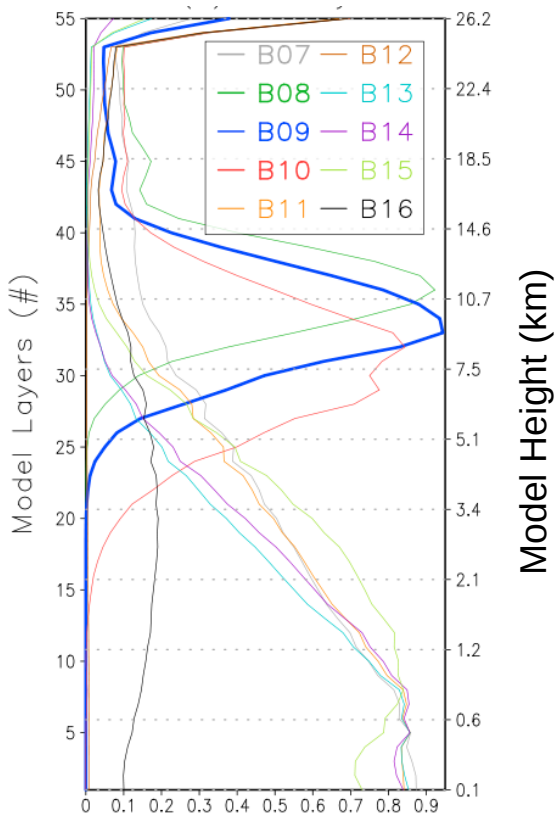
Forward RTM (RTTOV 11.2) → Brightness

Forward RTM (RTTOV 11.2) → Weighting Function

Band #	Wave length (μm)	Supposed Uses
7	3.9	moisture at lower levels
8	6.2	moisture at mid / upper levels
9	6.9	moisture at mid levels
10	7.3	moisture at mid levels
11	8.6	SO_2
12	9.6	O_3
13	10.4	cloud imagery / cloud top
14	11.2	cloud imagery / SST
15	12.4	cloud imagery / SST
16	13.3	cloud top

Assimilated

http://www.jma-net.go.jp/msc/ja/



Weighing function