How well do the Aeolus winds represent the Indian summer monsoon and North Indian Ocean cyclone features?

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Outline

- Impact of single component of Radiosonde winds in the NCMRWF assimilation and forecast system: A Prelude to the assimilation of Aeolus HLOS.

- Validation of Aeolus HLOS winds against independent observations and NWP equivalents

- Complementarities of Aeolus and Radiosonde wind profiles: Single profile assimilation experiment

- Indian monsoon circulation features in the Mie-cloudy and Rayleigh-clear HLOS winds

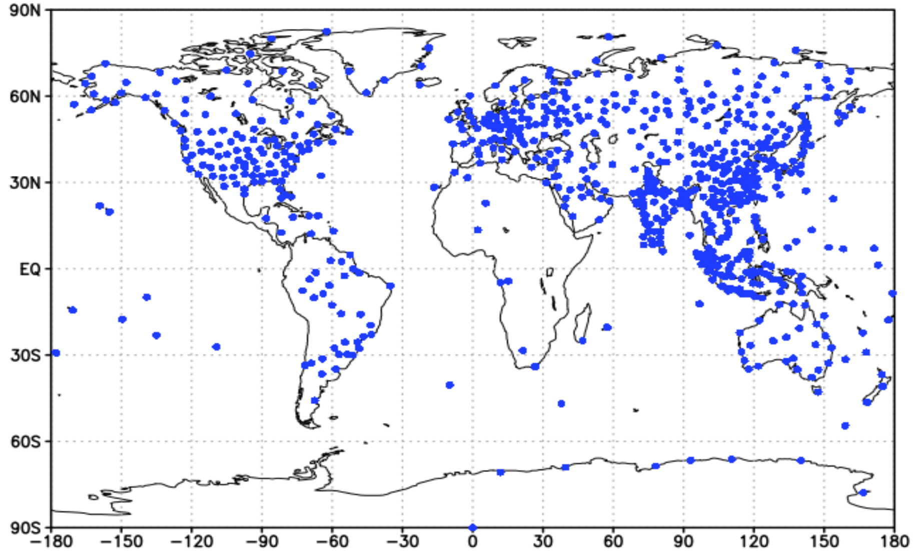
- Impact of Aeolus HLOS wind assimilation in the simulation of North Indian Ocean tropical cyclones

- Summary

1. Impact of single component of Radiosonde winds in the NCMRWF assimilation and forecast system: A Prelude to the assimilation of Aeolus HLOS winds.

Wind observations are very important for the better atmospheric analysis for NWP particularly over the Tropics.

Locations: Global Radiosonde and Pilot balloons

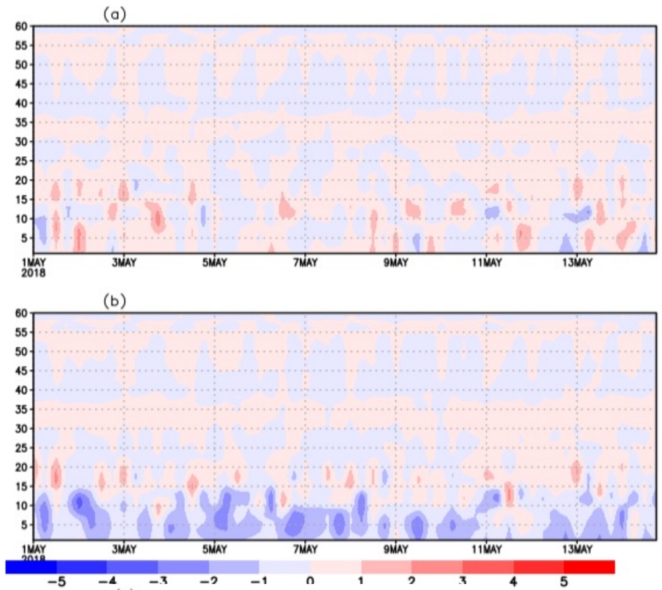


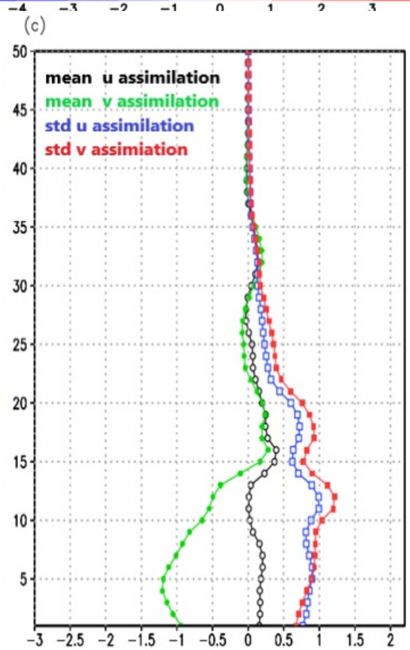
OSEs were conducted with assimilation of only the zonal component of radiosonde winds to assess the impact of single component of wind information in the NCMRWF assimilation-forecast system compared to the assimilation full wind vector.

Over the Tropics, zonal component of wind vector in the assimilation system plays major role in controlling the analysis increments of different meteorological variables

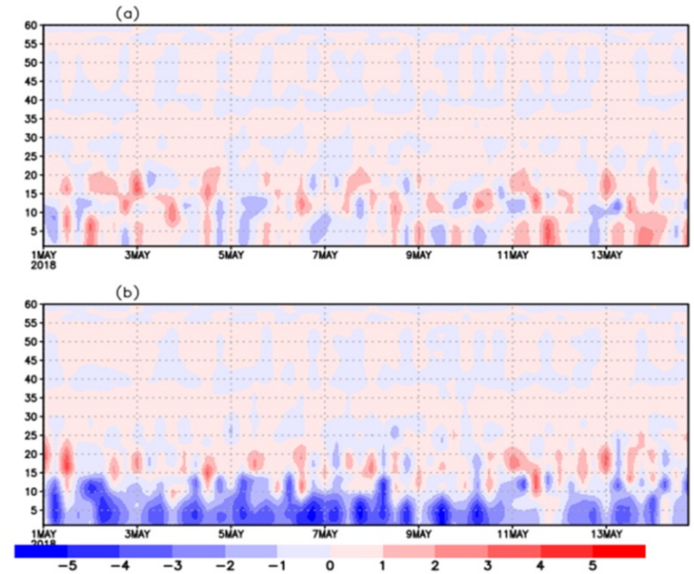
Differences in mean analysis increment of specific humidity (*10^5 kg/kg) between full vector and single component assimilation

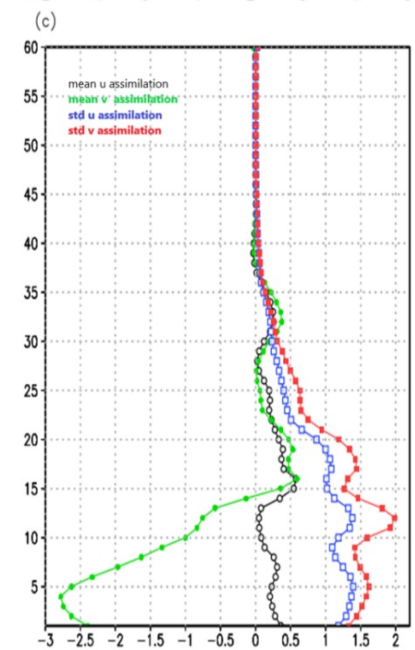
Global





Tropics





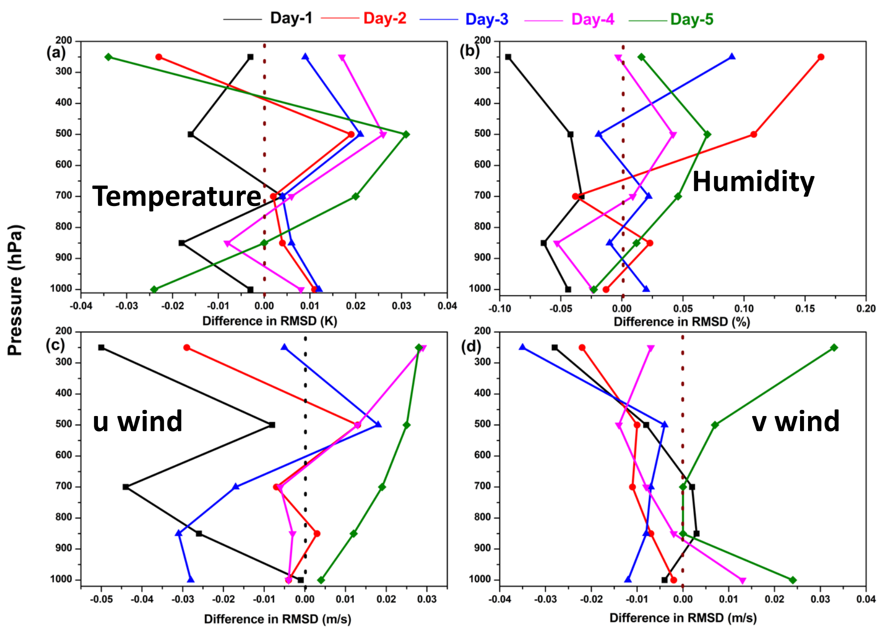
Only Zonal component assimilation

Only Meridional component assimilation

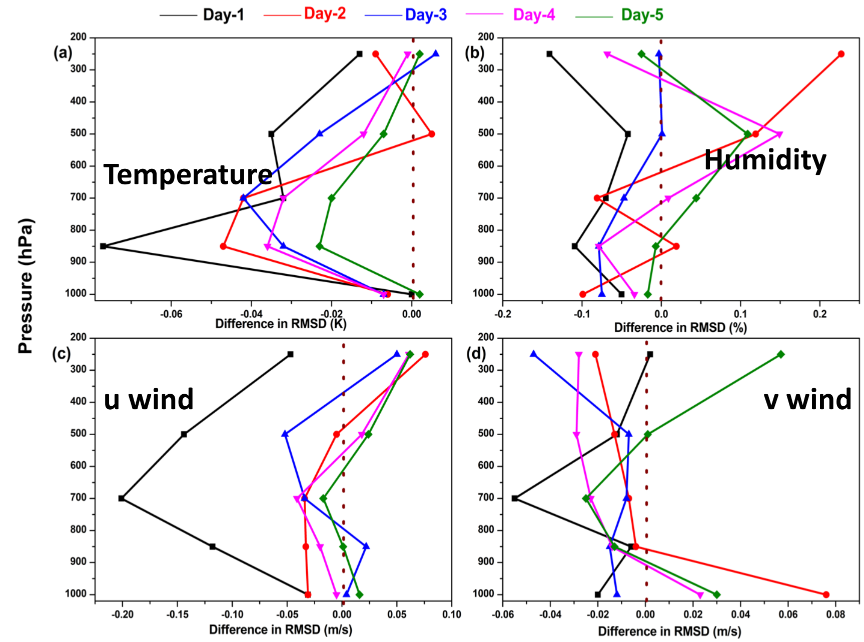
Mean difference profiles

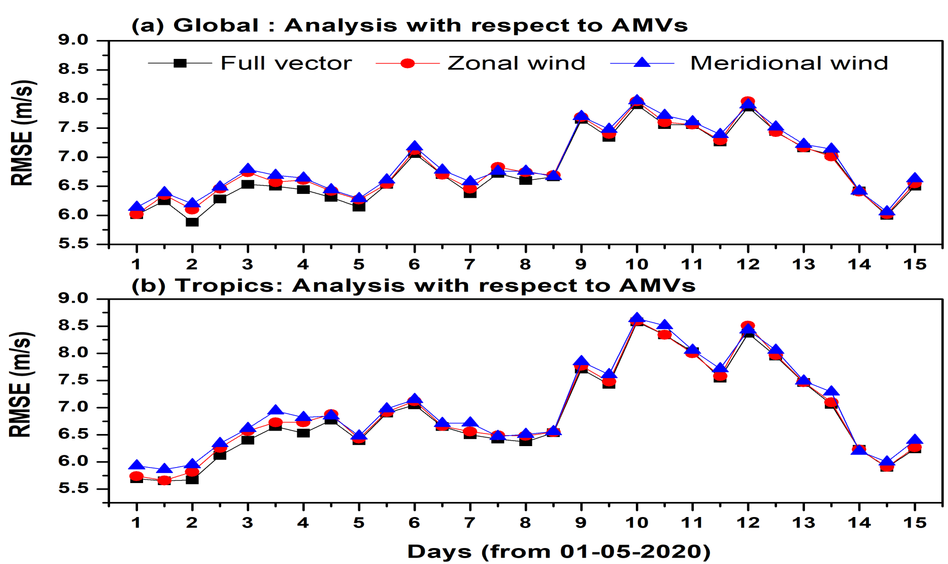
Mean vertical profiles of Root Mean Square Differences (RMSD) in forecast between zonal and meridional component assimilation experiments

Global

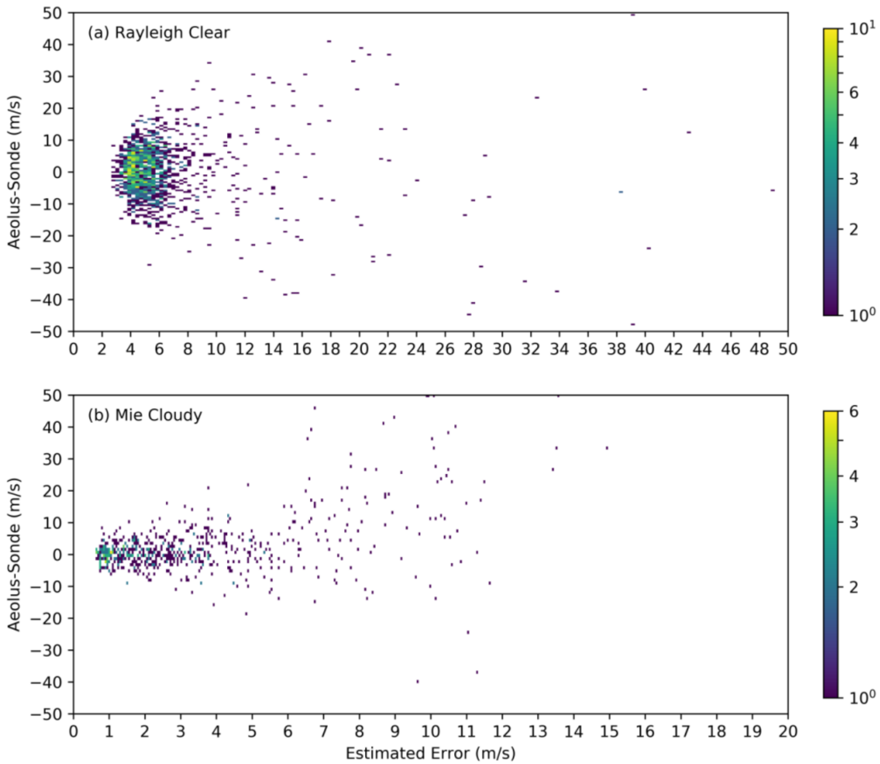


Tropics



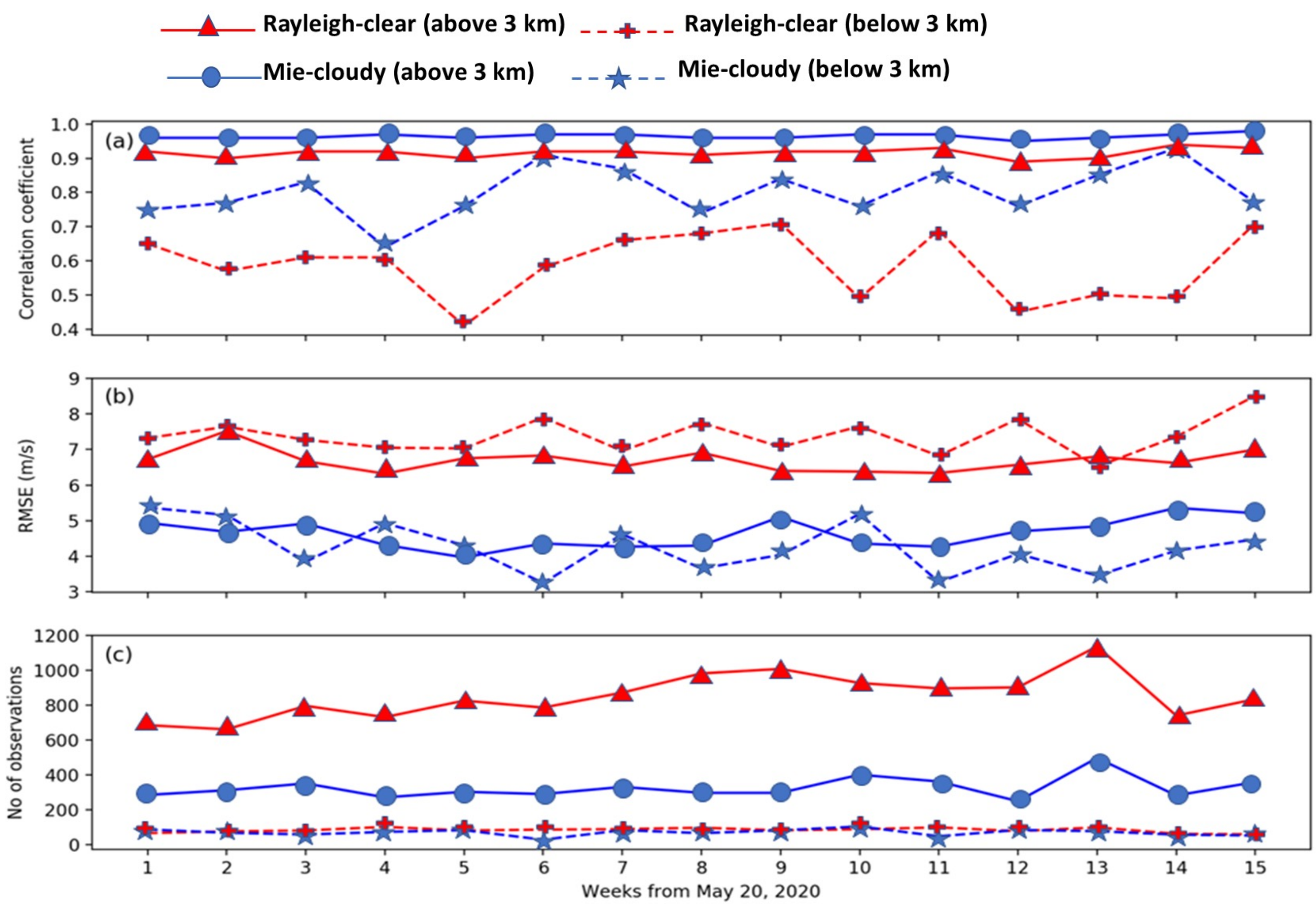


2. Validation of Aeolus HLOS winds against independent observations and NWP equivalents

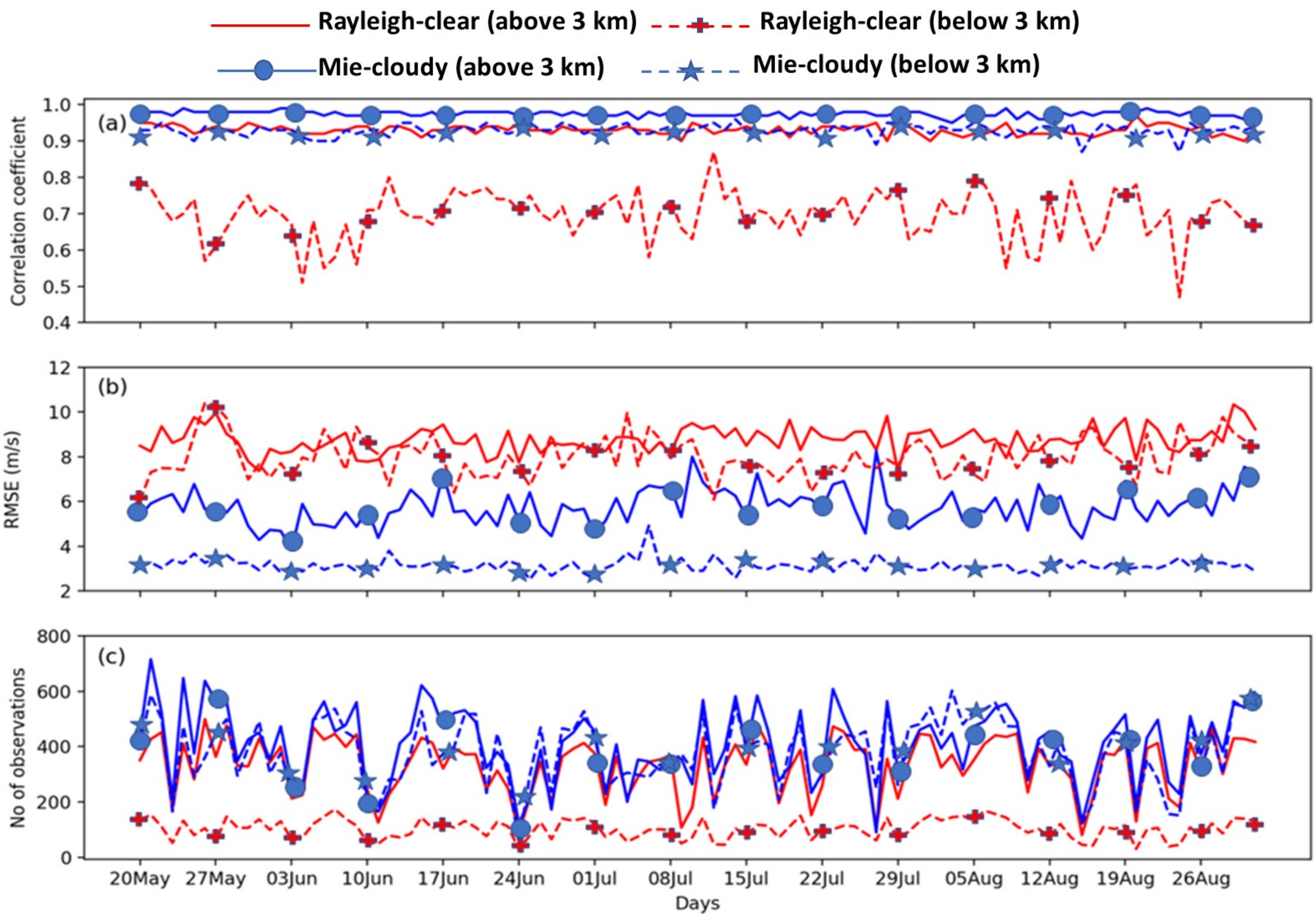


Aeolus winds estimated error vs. difference between the Aeolus HLOS wind and the sonde winds projected in the HLOS plane for (a) Rayleigh-clear and (b) Mie-cloudy for June - August 2020. The color bar indicates the number of collocations.

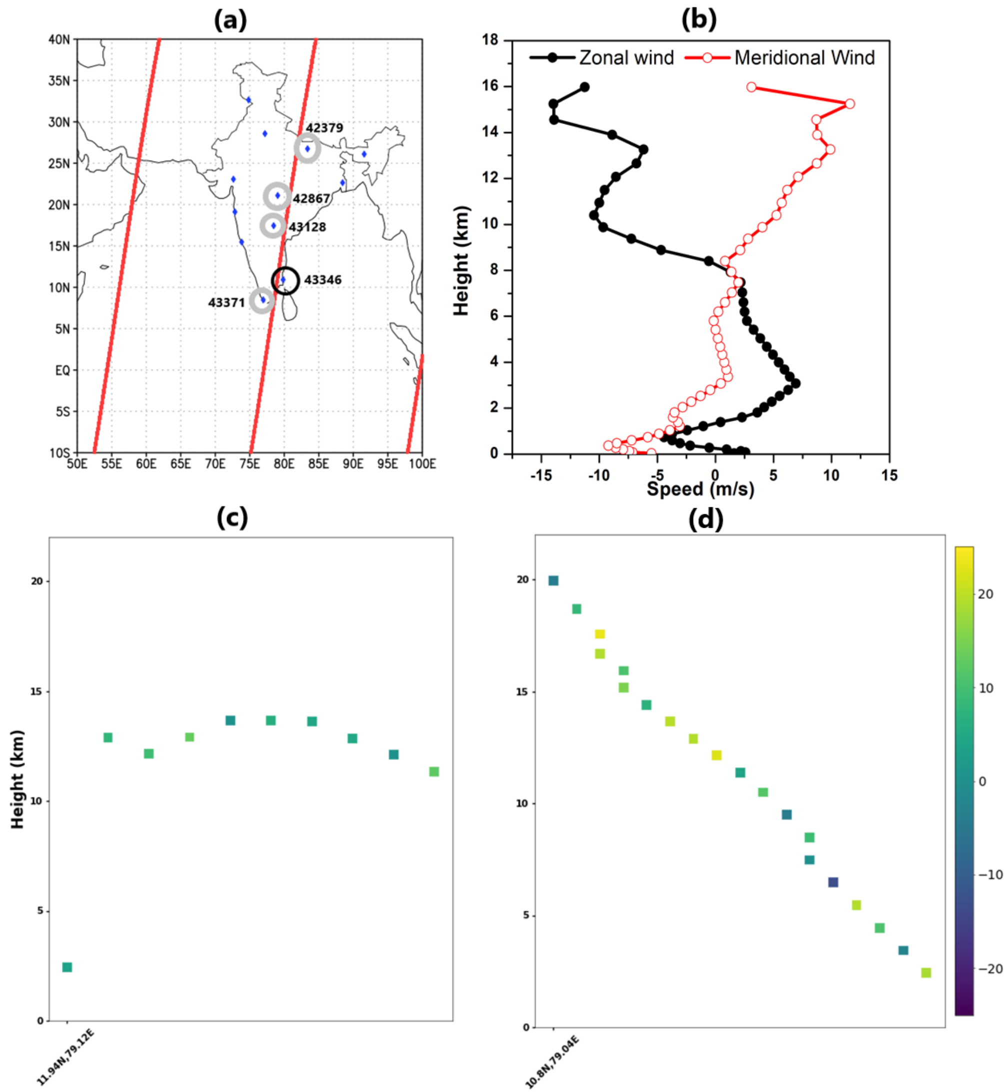
Time series of globally averaged statistical scores for Rayleigh-clear and Mie-cloudy HLOS winds validated against sonde and Aircraft winds



Time series of globally averaged statistical scores for Rayleigh-clear and Mie-cloudy HLOS winds validated against AMVs



3. Complementarities of Aeolus and Radiosonde wind profiles: Single profile assimilation experiment



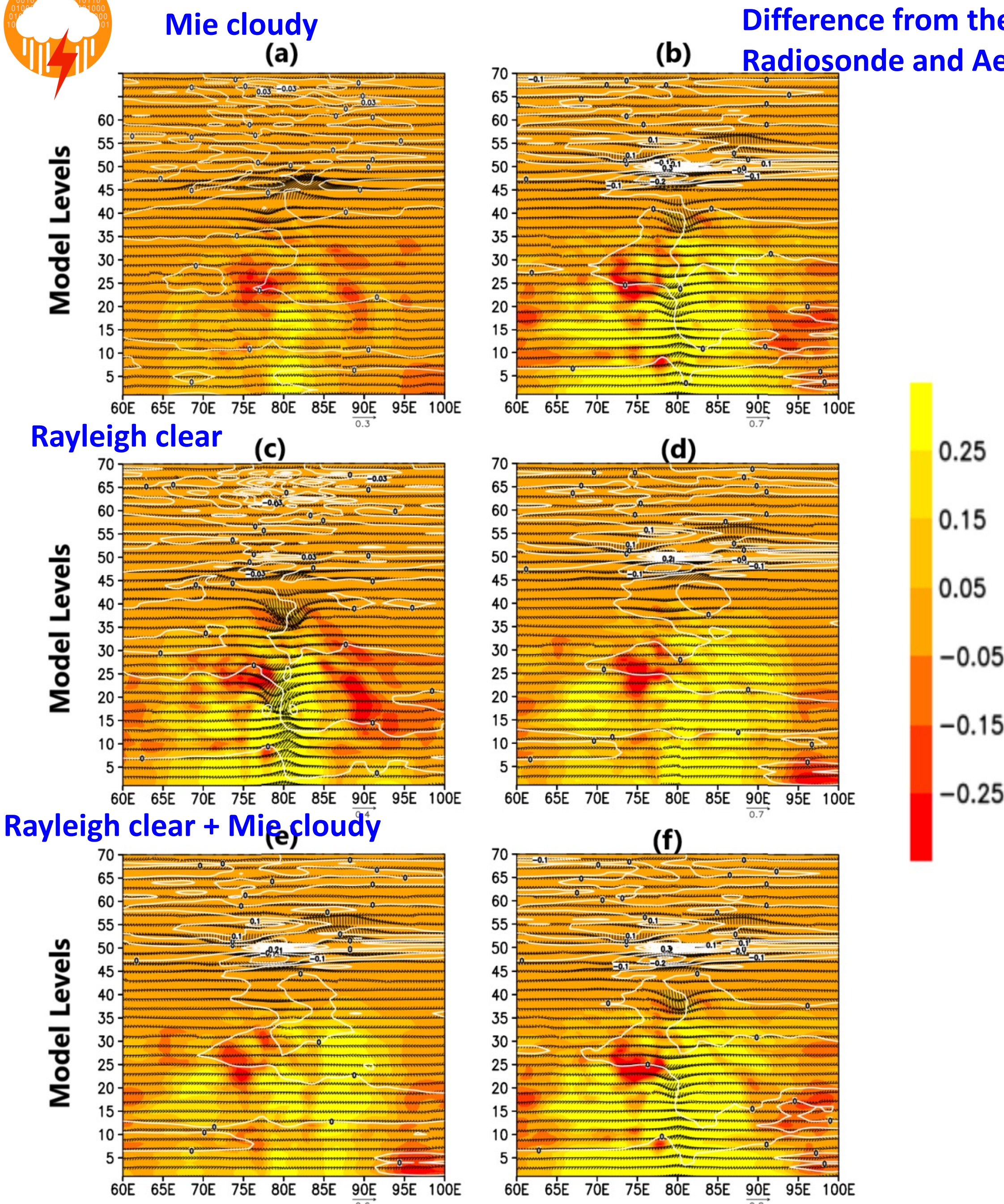
(a) Aeolus wind coverage and collocated radiosonde observations over India and surrounding regions received at NCMRWF during the 00UTC assimilation cycle of 30 October 2020.

The radiosonde locations close to the Aeolus pass are circled and labeled with the respective WMO identification number. Radiosonde wind profiles from the black circled location is selected for the single profile assimilation experiment.

(b) Profiles of radiosonde wind components

(c) Mie-cloudy winds assimilated

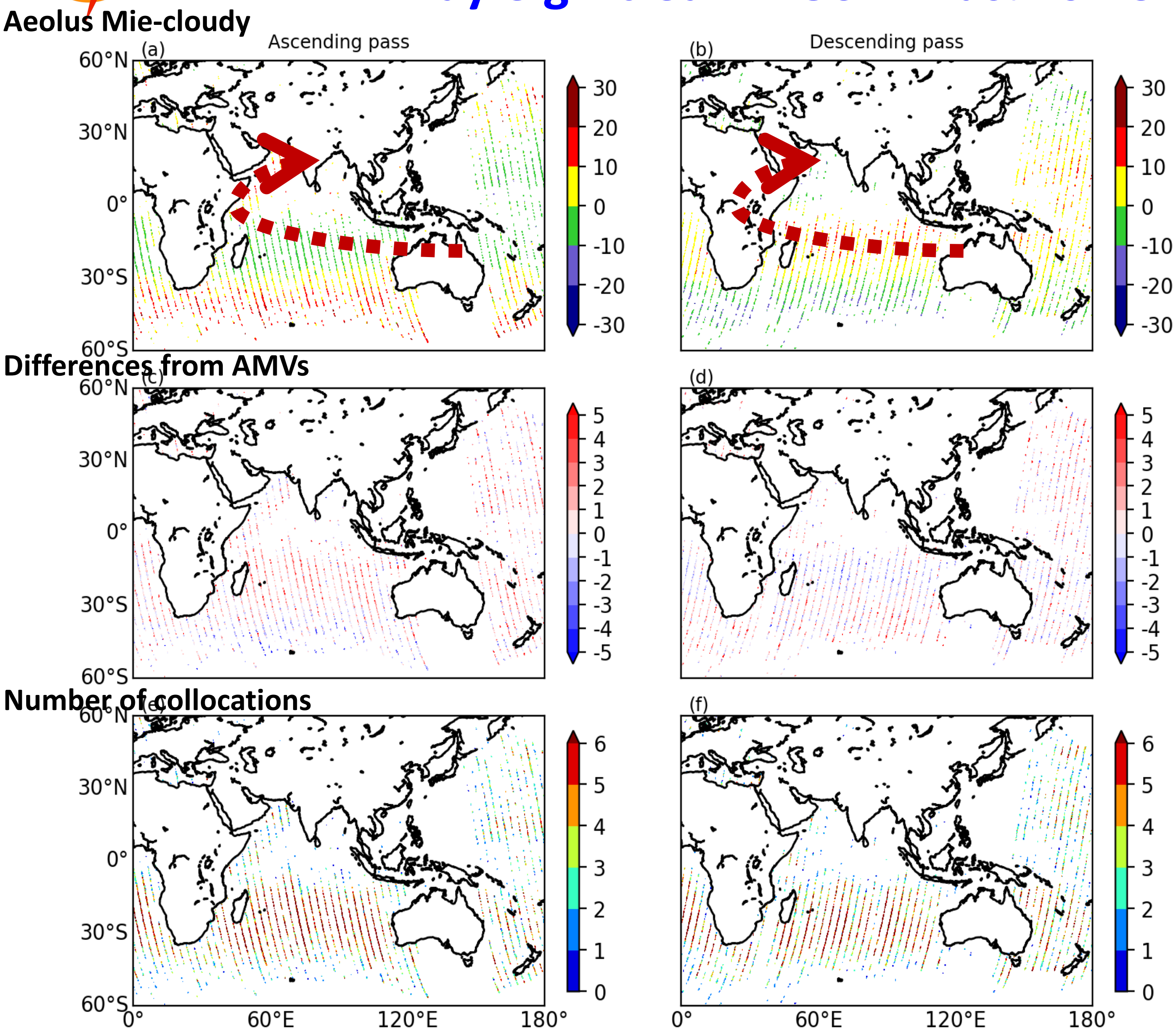
(d) Rayleigh-clear winds assimilated



Meridional mean vertical cross-section in model levels of the analysis increments in potential temperature (contours), specific humidity (shading), and wind fields (vectors) over the Indian longitudes (between 60°E – 100° E) from the single profile experiments averaged over 0-30°N for the assimilation of

(a) only Mie-cloudy profile,
(b) difference between Mie-cloudy profile and combined Mie and radiosonde profile,
(c) only Rayleigh-clear profile,
(d) difference between Rayleigh-clear profile and combined Rayleigh and radiosonde profile,
(e) both Mie-cloudy and Rayleigh-clear profiles, and
(f) difference between both HLOS profiles and combined HLOS and radiosonde profile.

4. Indian monsoon circulation features in the Mie-cloudy and Rayleigh-clear HLOS winds: Lower Level



Spatial plot of lower tropospheric (1.5 km) mean Mie-cloudy winds

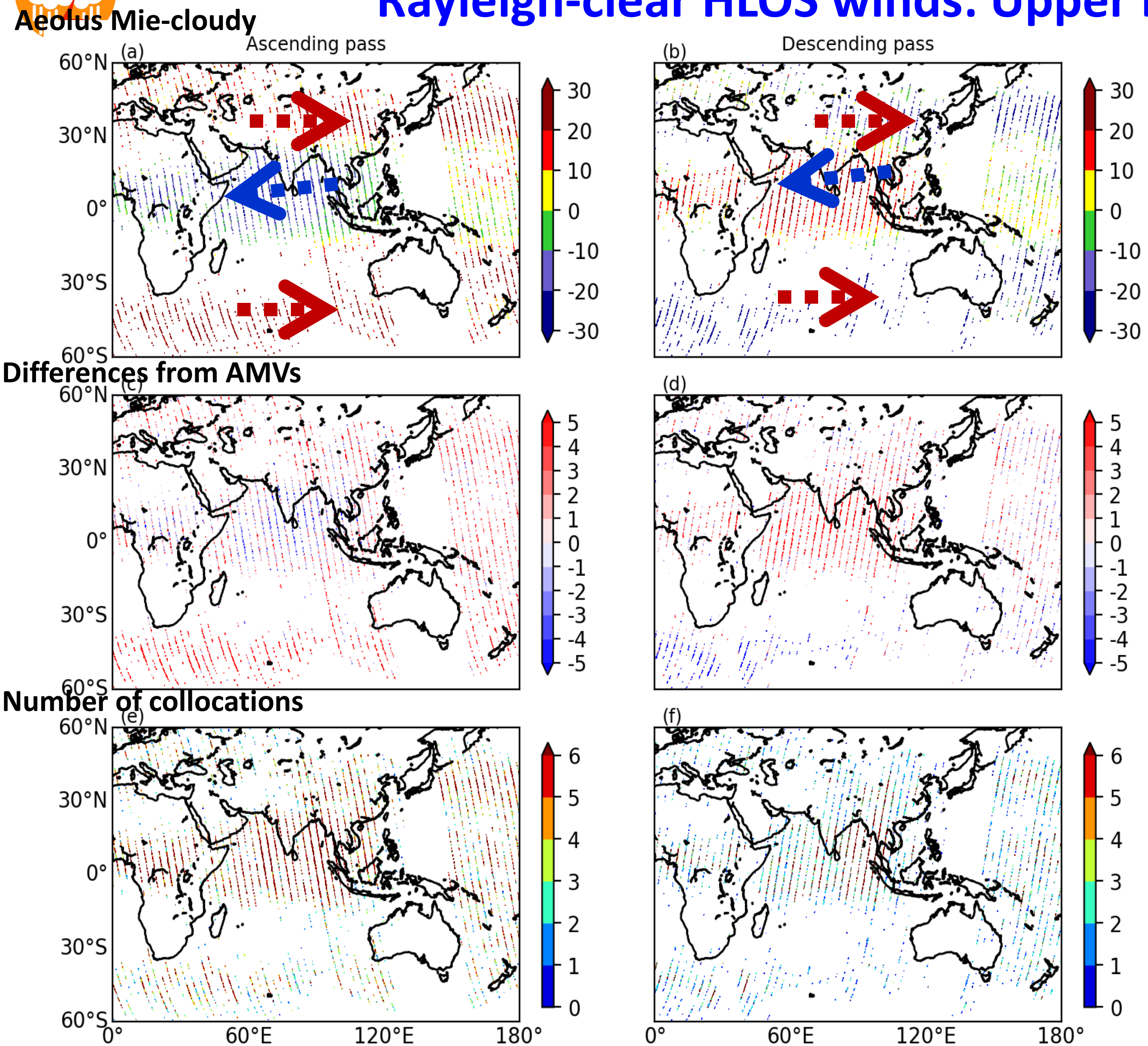
during (a) the ascending and (b) descending passes of the satellite,

the difference between the mean Mie-cloudy winds and AMVs for (c) ascending and (d) descending passes,

and the number of collocations during (e) ascending and (f) descending passes during the study period, June-August 2020, over the Indian summer monsoon region.

The dotted arrows in (a) and (b) represent the LLJ pattern and the associated cross-equatorial flow.

4. Indian monsoon circulation features in the Mie-cloudy and Rayleigh-clear HLOS winds: Upper Level



Spatial plot of upper tropospheric (8 km) mean Mie-cloudy winds

during (a) the ascending and (b) descending passes of the satellite,

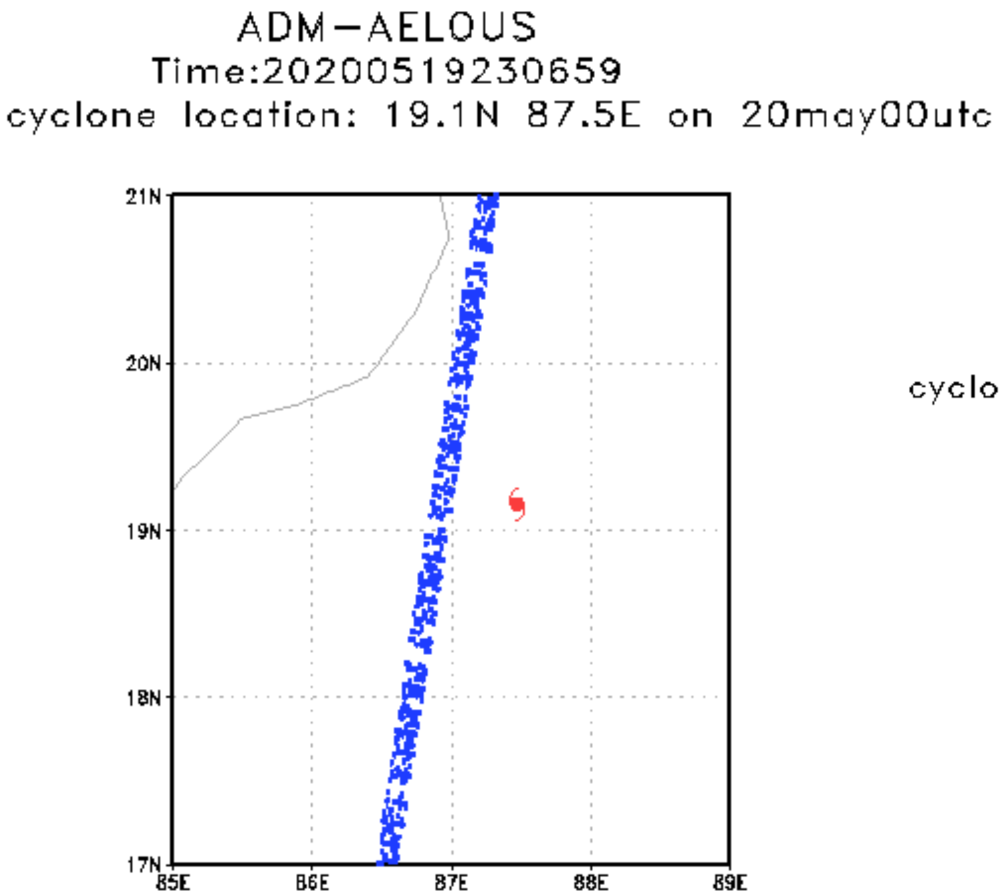
the difference between the mean Mie-cloudy winds and AMVs for (c) ascending and (d) descending passes,

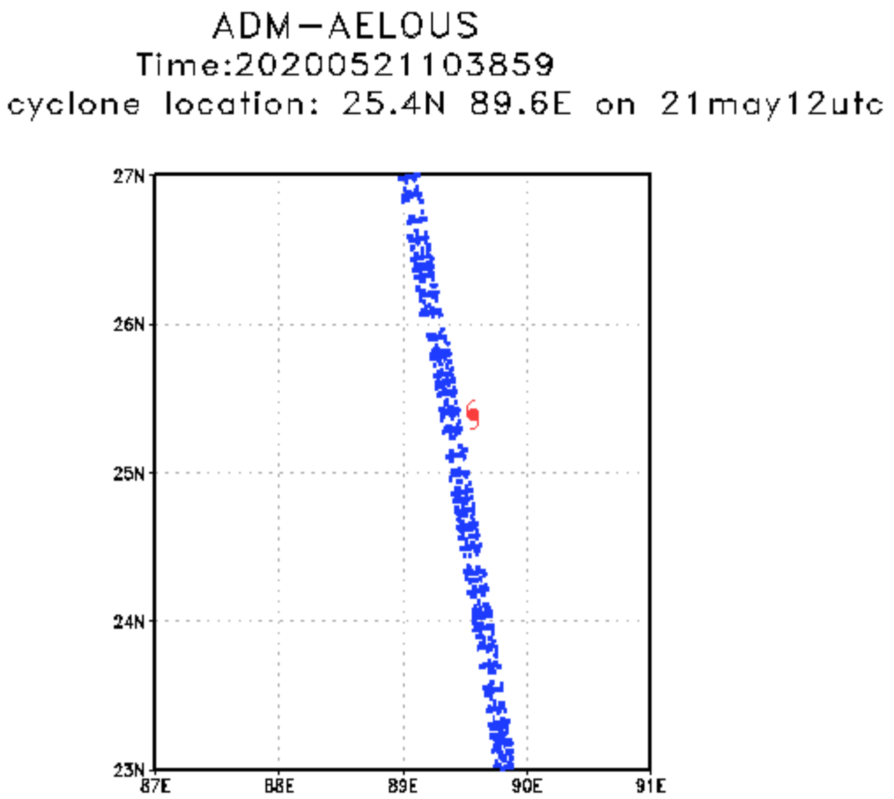
and the number of collocations during (e) ascending and (f) descending passes during the study period, June-August 2020, over the Indian summer monsoon region.

The dotted arrows in (a) and (b) represent the TEJ and subtropical jets.

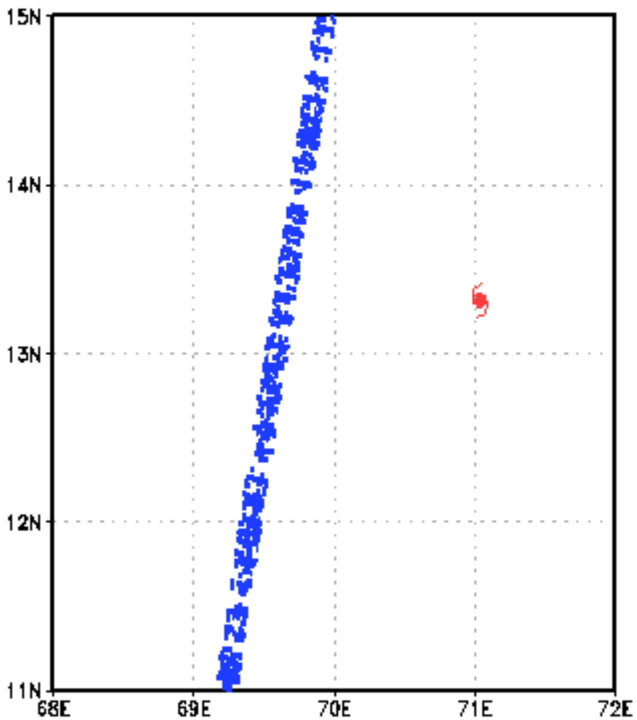
5. Impact of Aeolus HLOS wind assimilation in the simulation of North Indian Ocean tropical cyclones

During Amphan cyclone (16-21 May 2020) over the Bay of Bengal



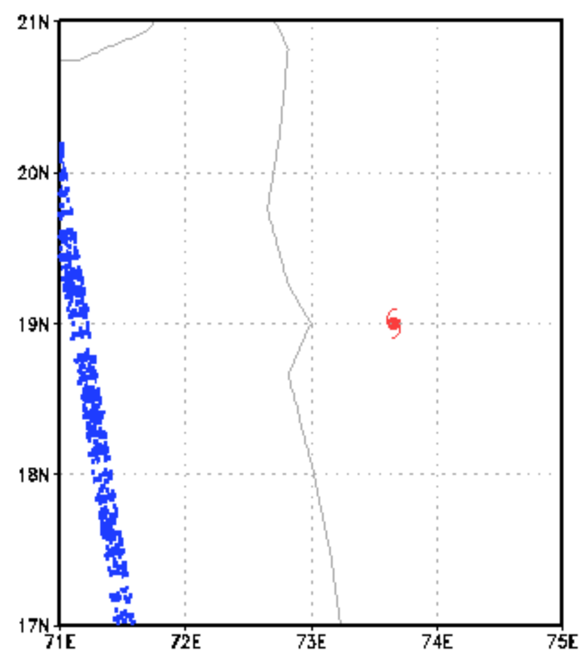


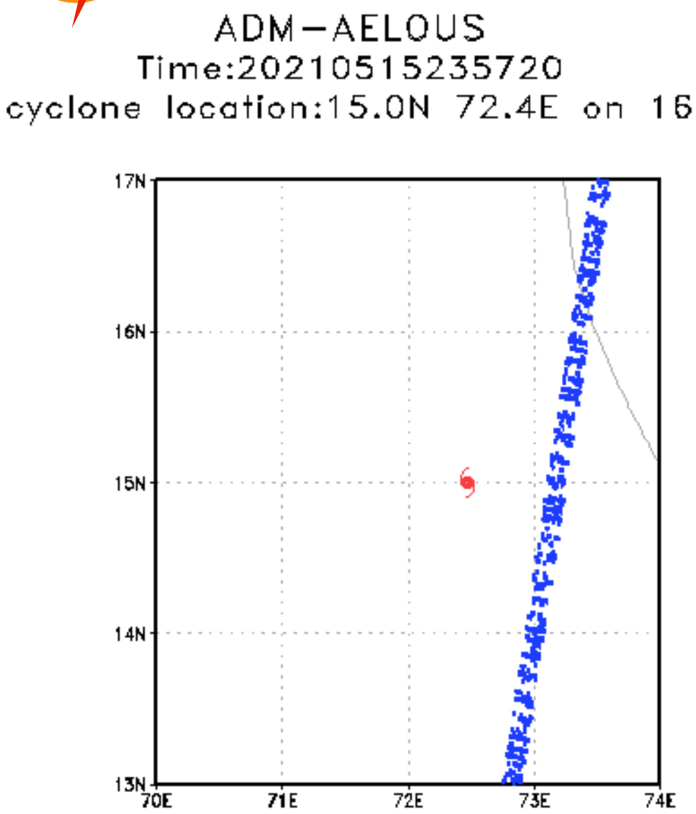
ADM-AELOUS
Time:20200601001123
cyclone location:13.0N 71.4E on 01June2020 00utc



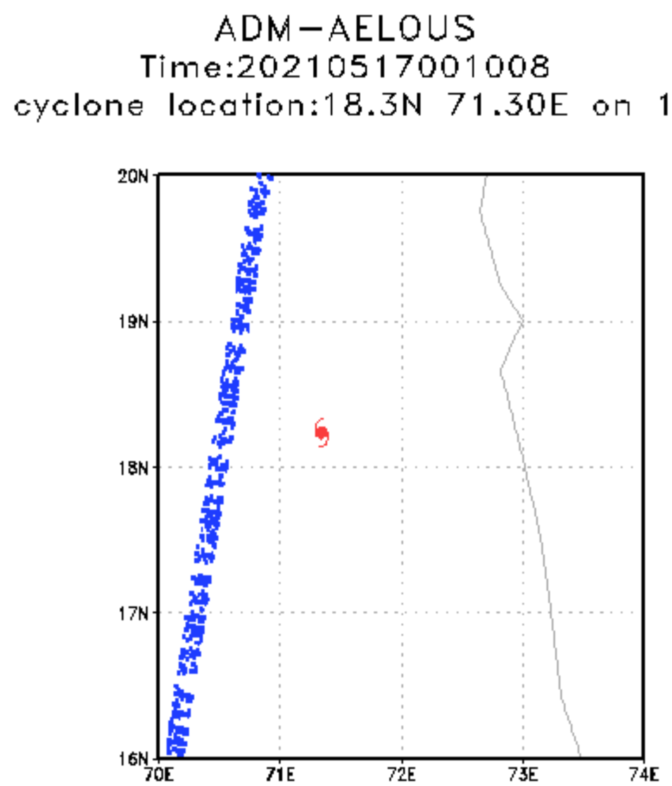
During Nisarga Cyclone (1-4 June 2020) over the Arabian Sea

ADM-AELOUS
Time:20200603115535
cyclone location:19.0N 73.7E on 03June2020 12utc

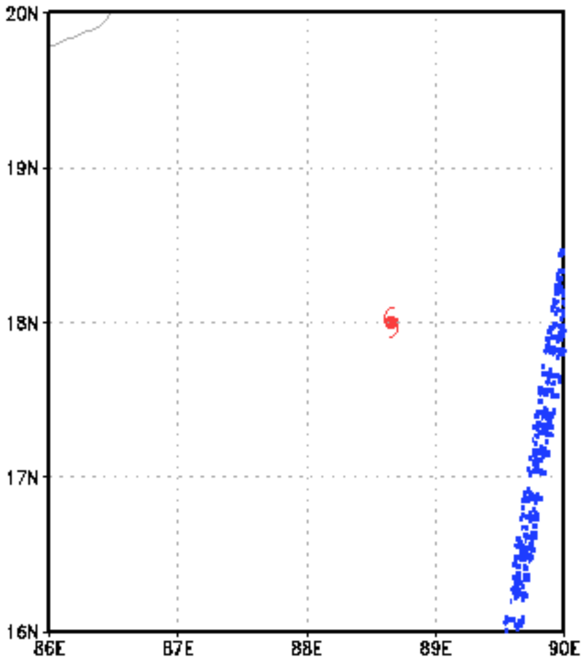




During Tautkae cyclone (14-19 May 2021) over the Arabian Sea

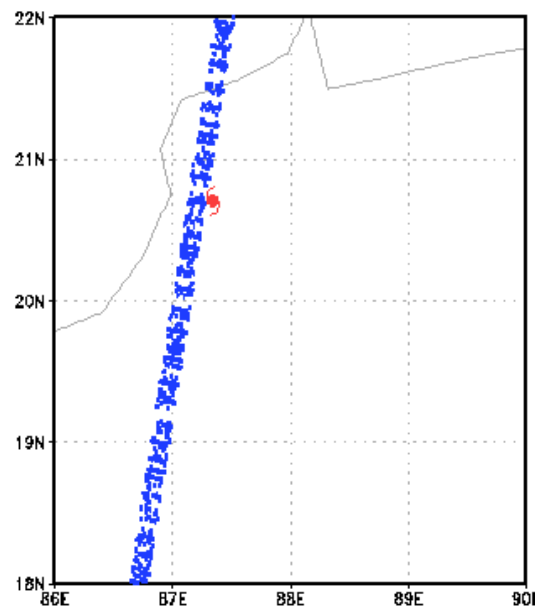


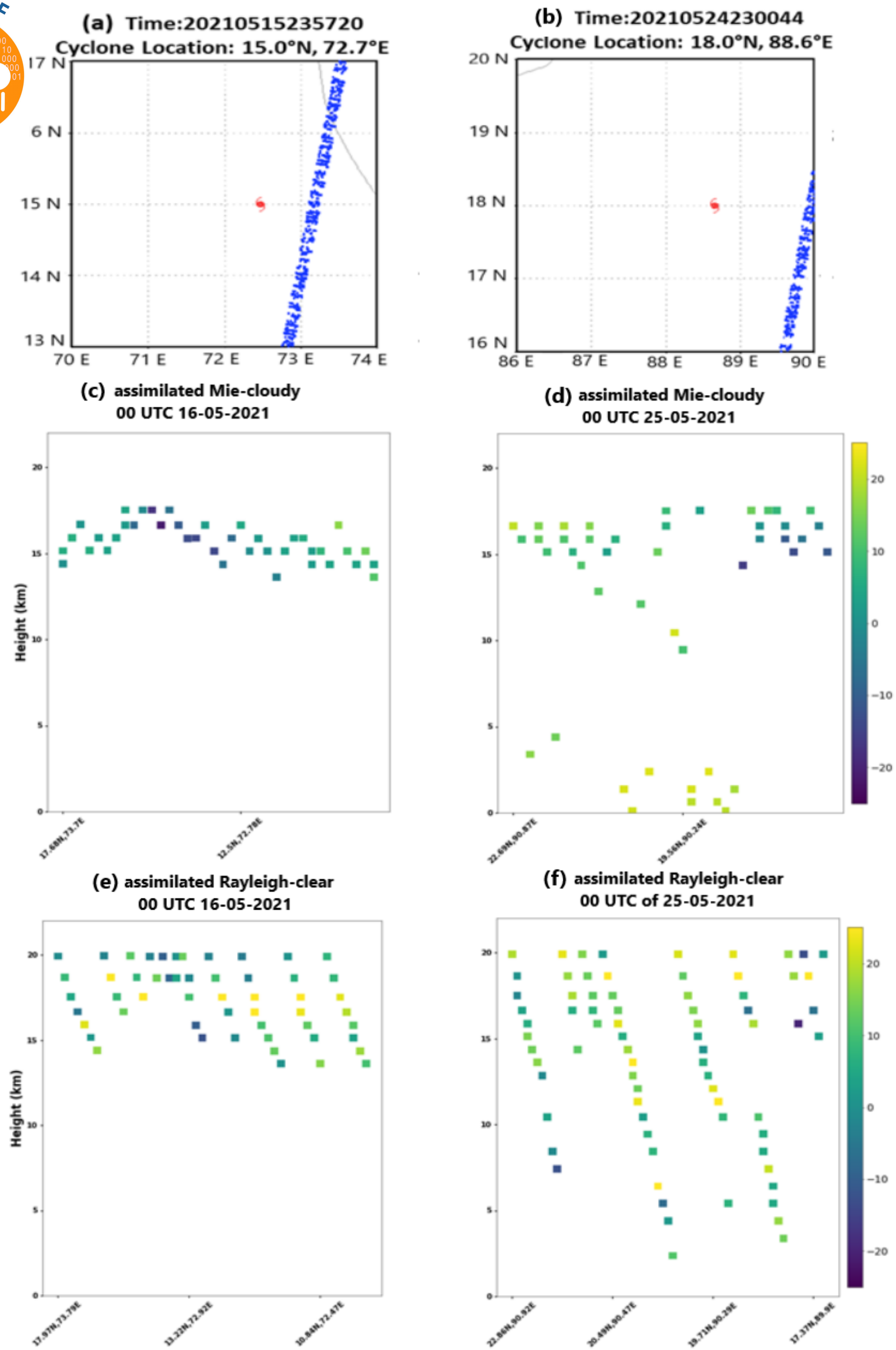
ADM-AELOUS
Time:20210524230044
cyclone location:18.0N 88.6.7E on 25 May2021



During YAAS cyclone (23-28 May 2021) over the Bay of Bengal

ADM-AELOUS
Time:20210525231344
cyclone location:20.8N 87.3.7E on 26 May2021 00UTC





Approximate time and coverage of Aeolus passes during the North Indian Ocean cyclones

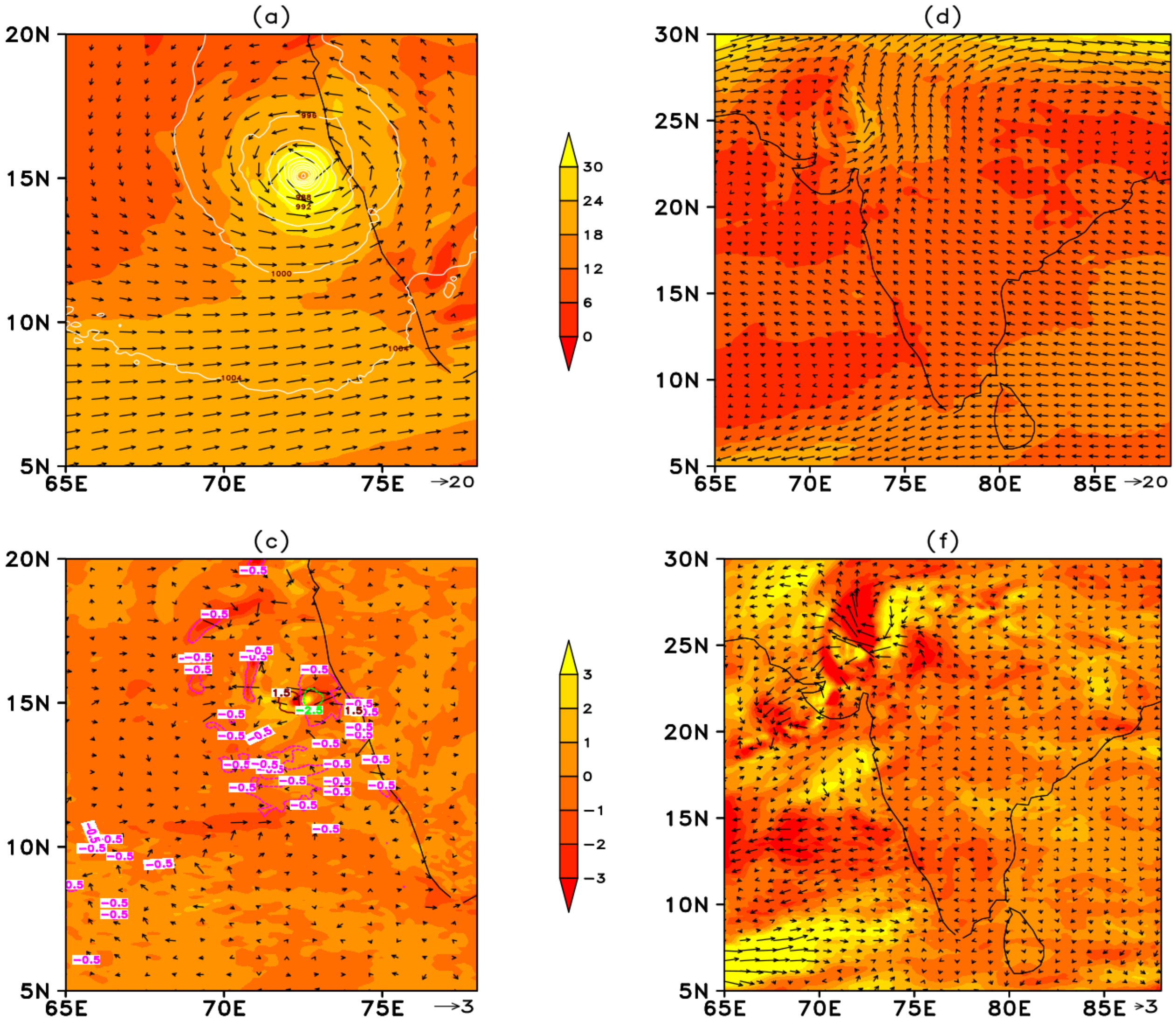
Tauktae at (a) 2357 UTC of 15 May 2021,

Yaas (b) 2300 UTC of 24 May 2021.

The assimilated Mie-cloudy winds (c) and (d),

and Rayleigh-clear winds (e) and (f) respectively during the 00 UTC of 16 and 25 May 2021.

Impact of the assimilation of Aeolus winds in the simulation of the cyclone Tauktae



EXP- with Aelous winds

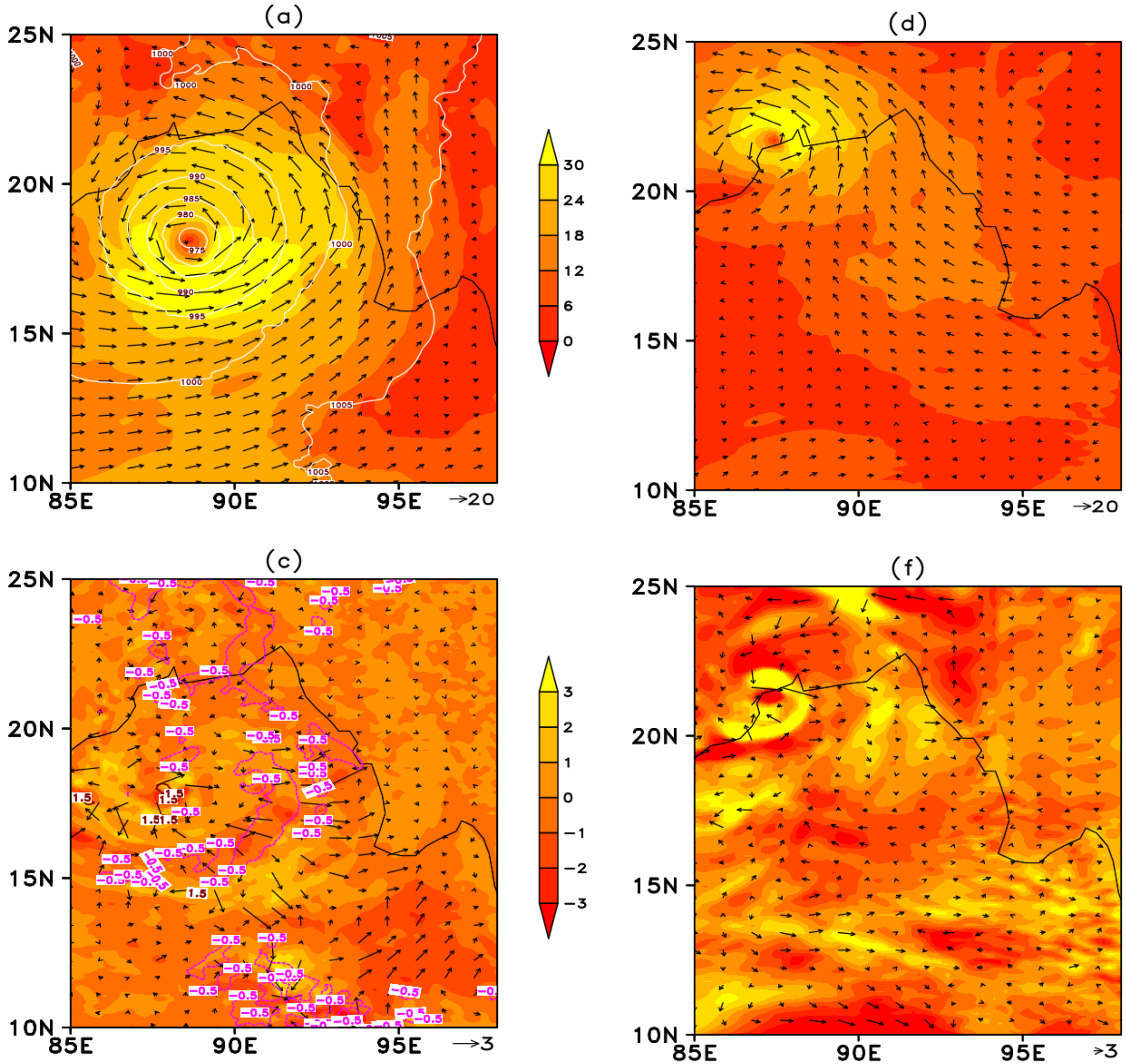
(a) Analysis field of MSLP (hPa) in contours and 850 hPa wind field (direction in vector and magnitude shaded) from EXP

(b) 250 hPa day-3 wind simulation,

(c) differences in the analysis field of MSLP and 850 hPa winds between EXP and CTL and

(d) differences in the day-3 250 hPa wind between EXP and CTL based on 16 May 00 UTC analysis

Impact of the assimilation of Aeolus winds in the simulation of the cyclone Yaas



(a) Analysis field of MSLP (hPa) in contours and 850 hPa wind field (direction in vector and magnitude shaded) from EXP

(b) 250 hPa day-1 wind simulation,

(c) differences in the analysis field of MSLP and 850 hPa winds between EXP and CTL and

(d) differences in the day-1 250 hPa wind between EXP and CTL based on 25 May 00 UTC analysis

Summary

1. NCMRWF assimilated single component of radiosonde winds as a prelude to the assimilation of Aeolus HLOS winds. Over the Tropics, zonal component of wind vector in the assimilation system plays major role in controlling the analysis increments of different meteorological variables
2. Validation of Aeolus HLOS winds against in-situ observations (sonde, aircraft), AMVs and NWP equivalents shows that the statistical scores are independent of the validation datasets.
3. Single profile assimilation experiment shows that Rayleigh-clear profiles have approximately the similar impact of radiosonde winds for the selected locations
4. Indian summer monsoon characteristics like Low Level Jet (LLJ) and Tropical Easterly Jet (TEJ) and the subtropical jets are well represented in the Aeolus HLOS winds.
5. Assimilation of Aeolus HLOS winds during the North Indian Ocean Tropical cyclone cases indicate that incorporation of Aeolus winds improves the intensity and track of the cyclone simulation.

Thank you