A Validation of the Internal Tides in 1/12° Global HYCOM

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Objective

- To compare the modeled internal tides to that seen by satellite altimetry
  - Globally
  - All eight tidal constituents in global HYCOM

- This work extends that of Arbic et al. (2010), which examined a region around Hawaii
  - M_2 only
  - 1 day of model output

Data Sets

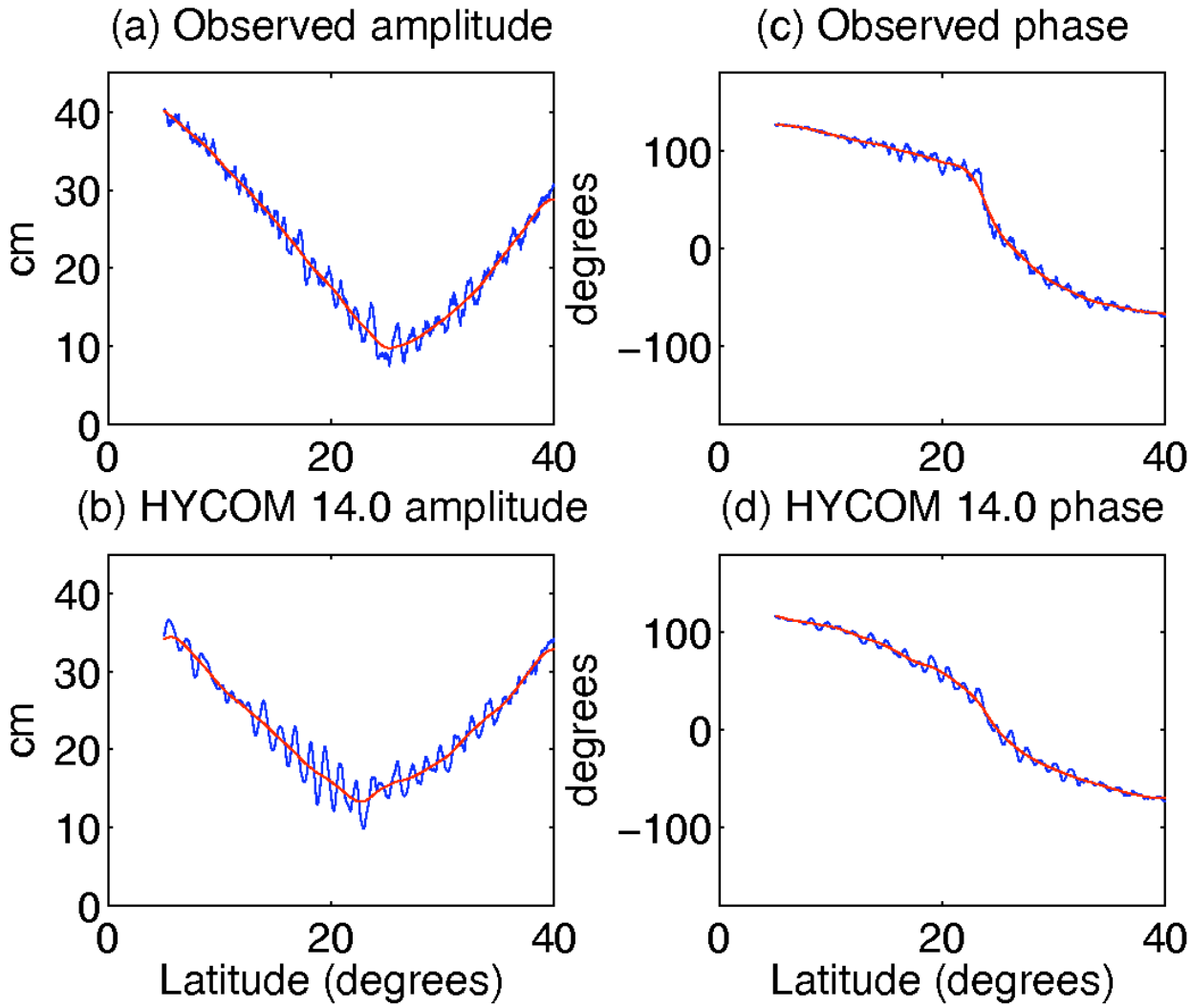
Altimetric-based tidal analysis

- Along-track tidal analysis provided by Richard Ray (NASA)
- Near-global, 63°N - 63°S

1/12° global HYCOM with tides

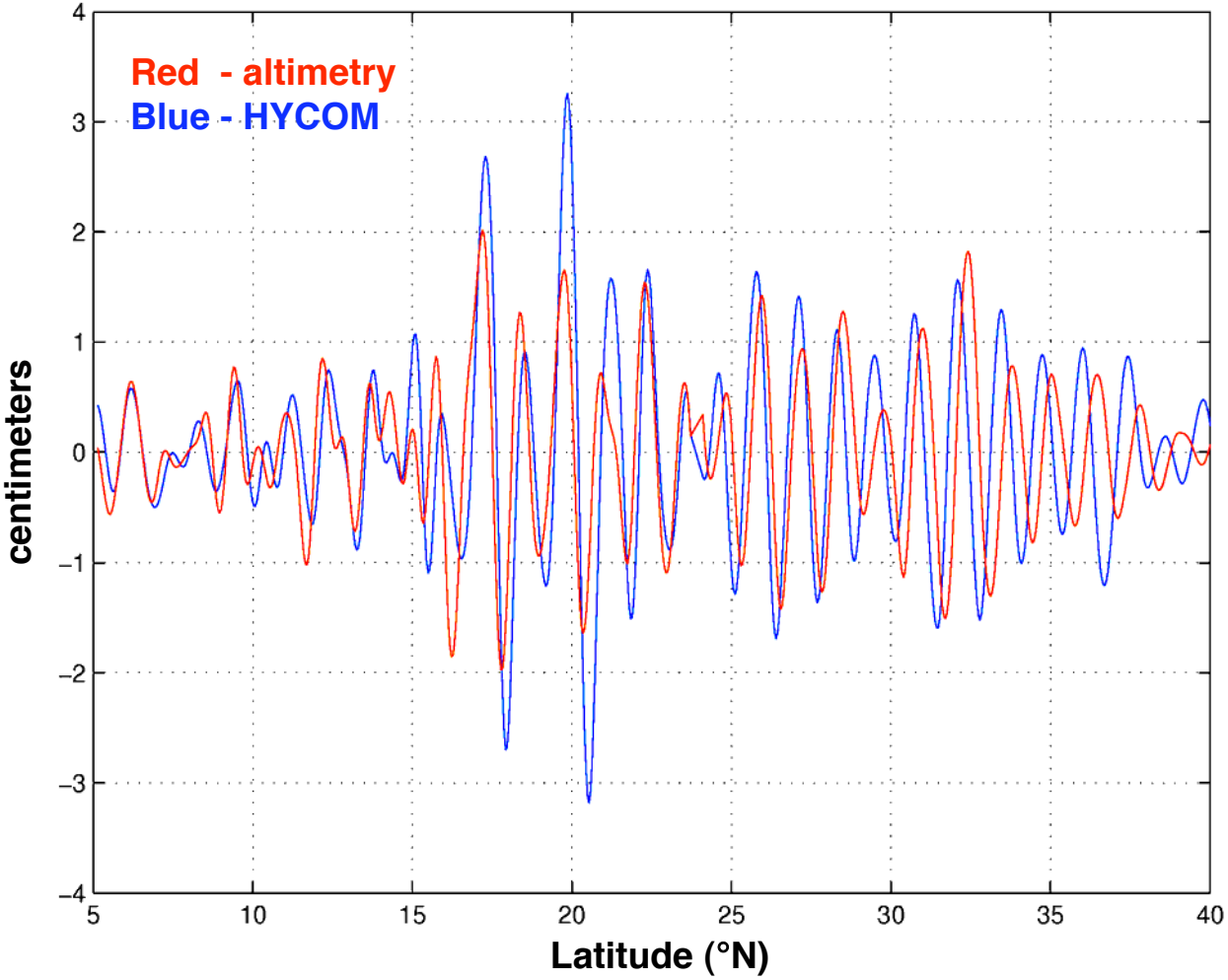
- Total SSH
- 1x/hour snapshot
- 2006
- No data assimilation

Filtering to obtain perturbations in amplitude and phase at the surface due to internal waves



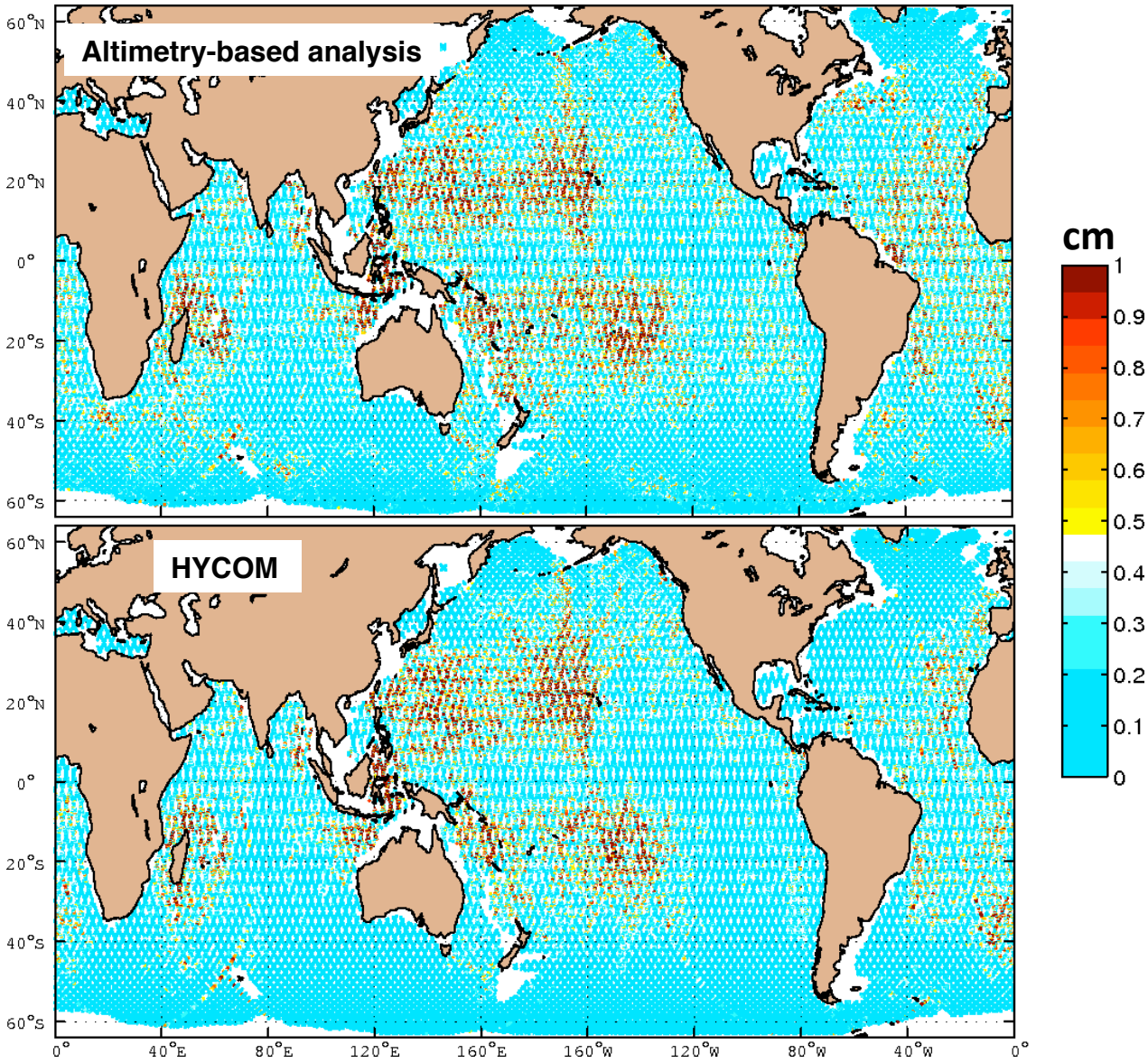
- Band pass filtered to remove barotropic and short wavelength contributions

M_2 internal tide amplitude: altimetry data vs 1/12° Global HYCOM



RMS amplitude Altimetry = .71 cm
HYCOM = .90 cm
Difference = .81 cm

M_2 internal tide amplitude: along-track altimetry data vs 1/12° Global HYCOM



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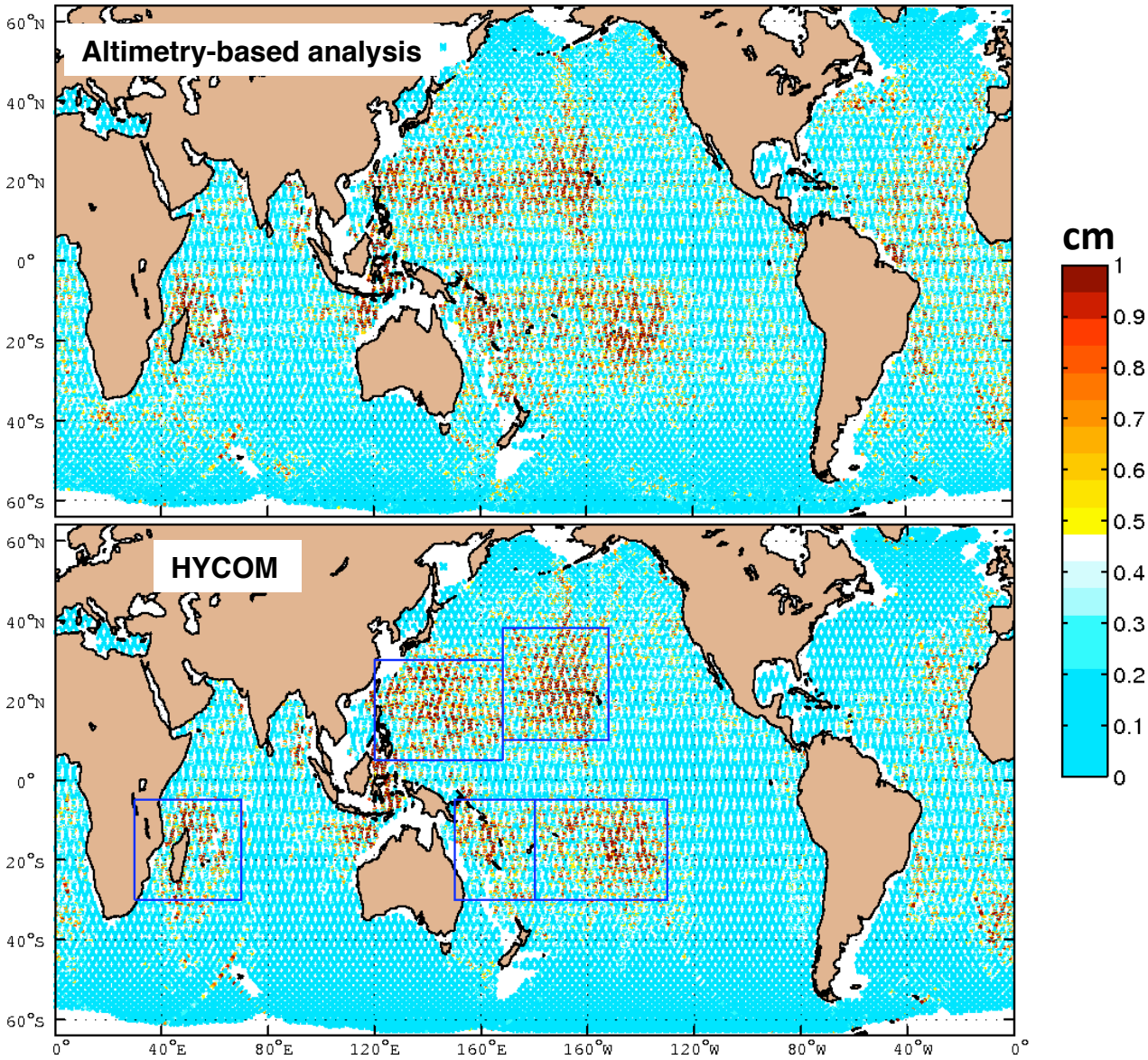

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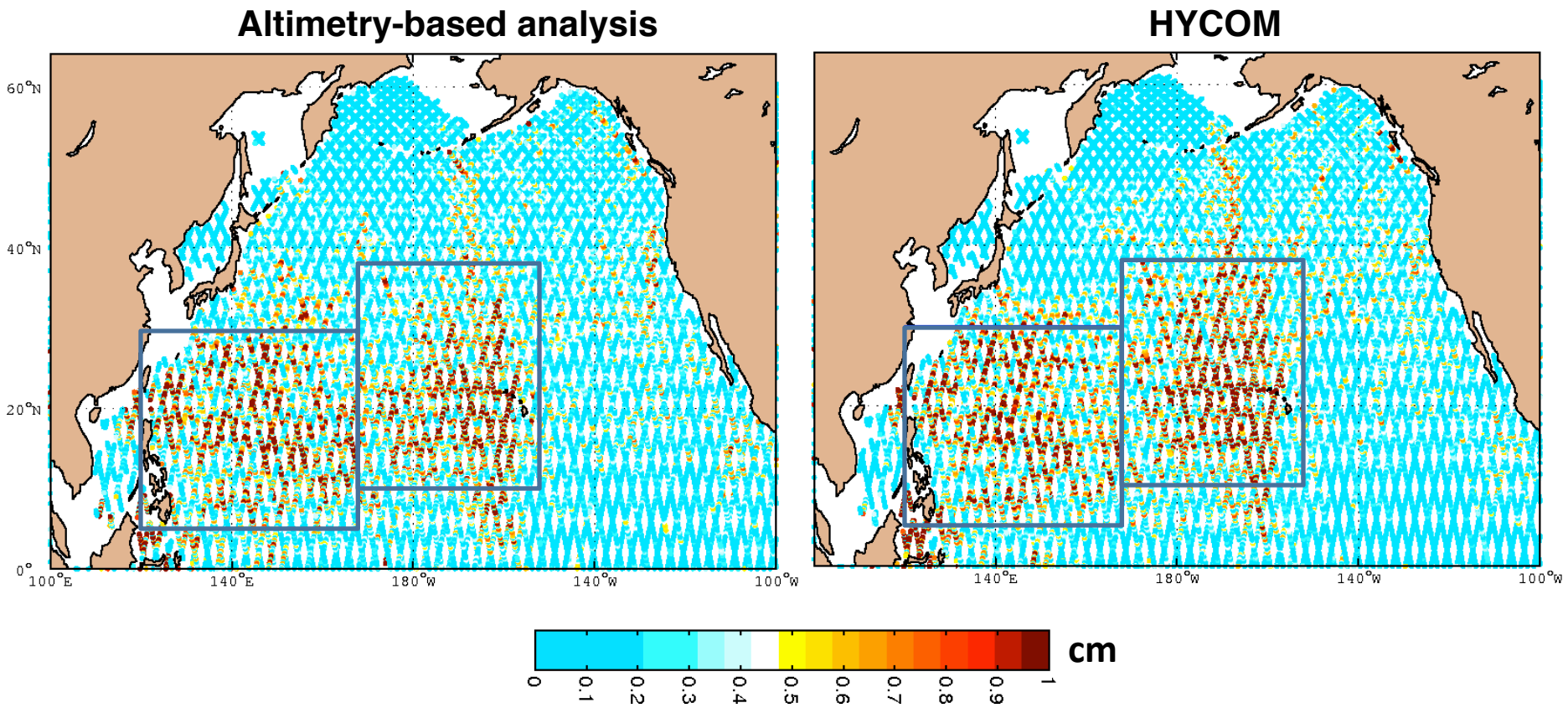
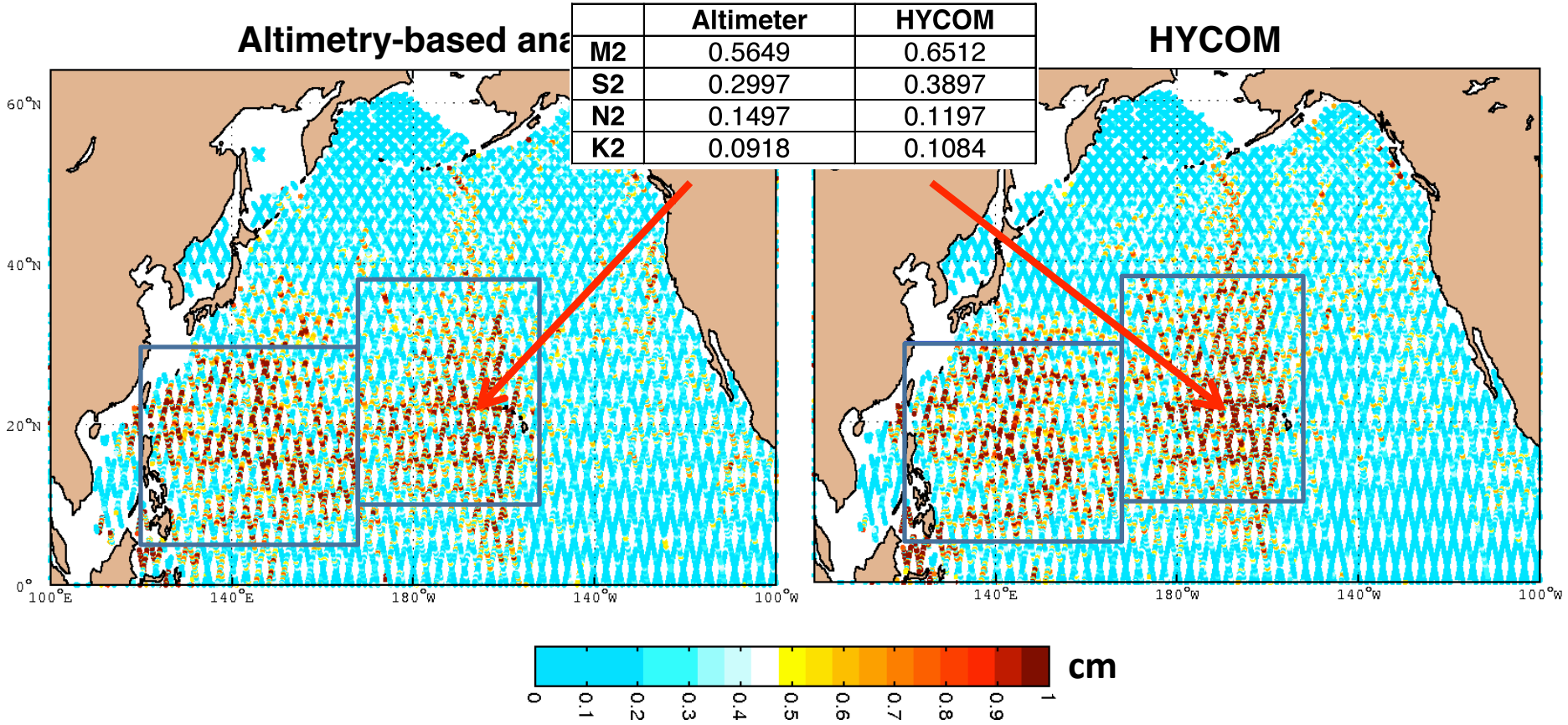


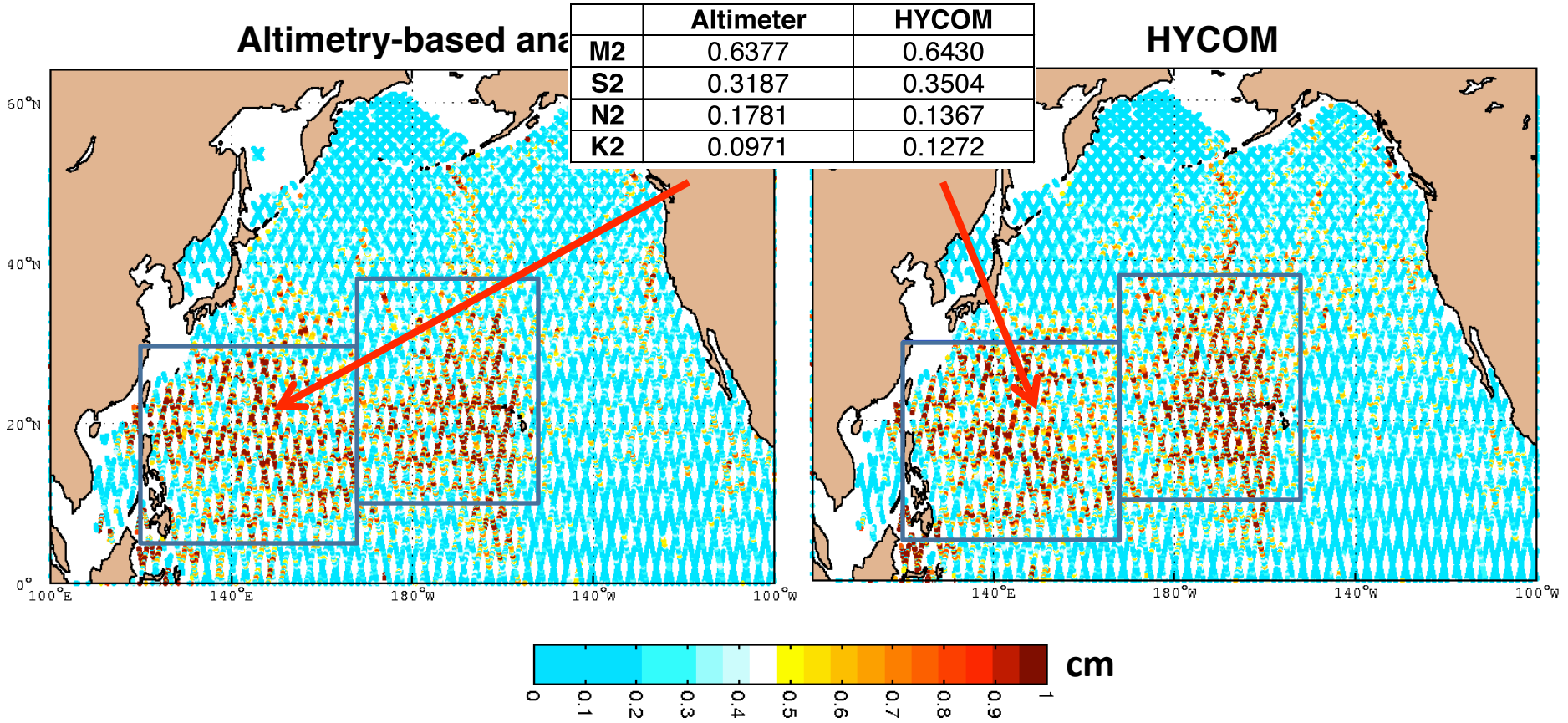
M_2 internal tide amplitude: along-track altimetry data vs 1/12° Global HYCOM

	Altimeter	HYCOM
M2	0.5649	0.6512
S2	0.2997	0.3897
N2	0.1497	0.1197
K2	0.0918	0.1084



M_2 internal tide amplitude: along-track altimetry data vs 1/12° Global HYCOM

	Altimeter	HYCOM
M2	0.6377	0.6430
S2	0.3187	0.3504
N2	0.1781	0.1367
K2	0.0971	0.1272



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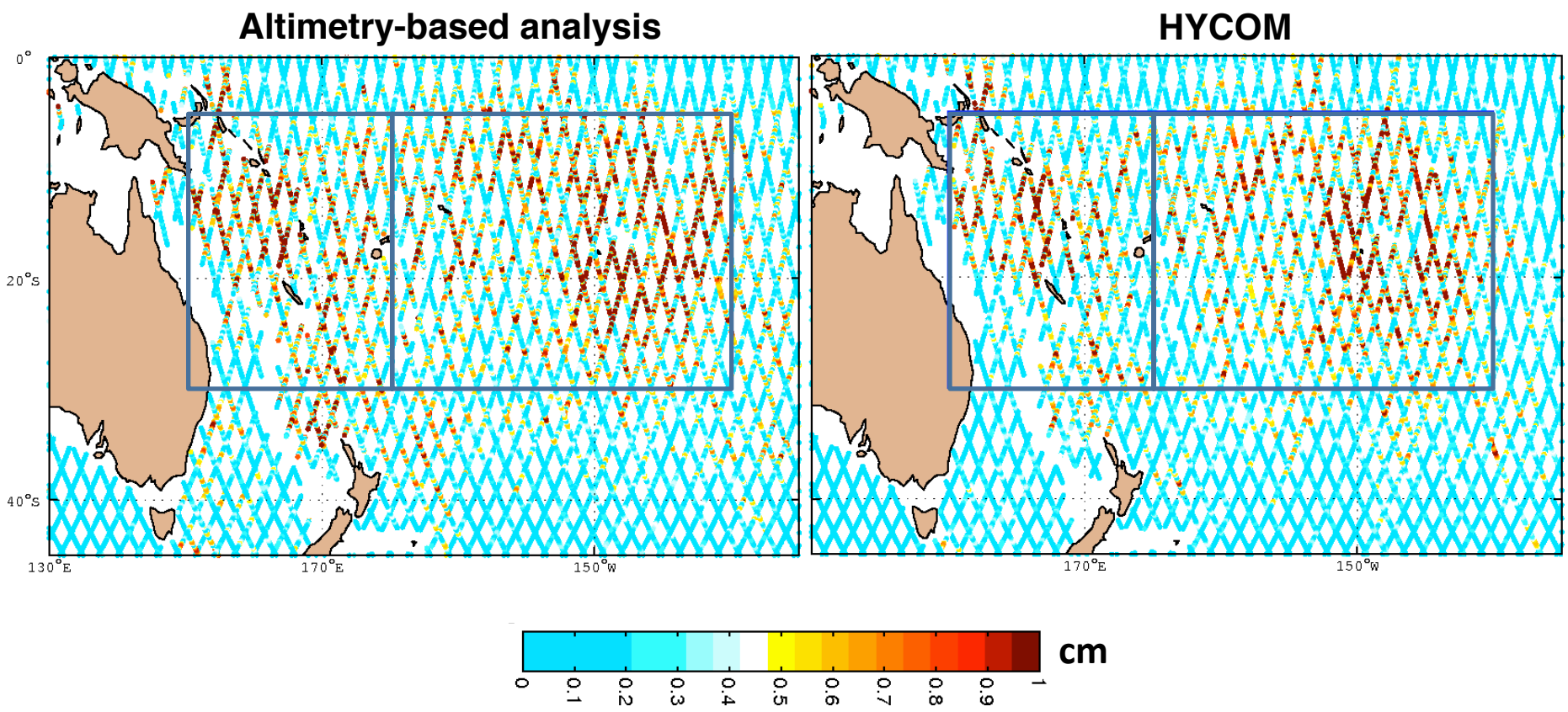
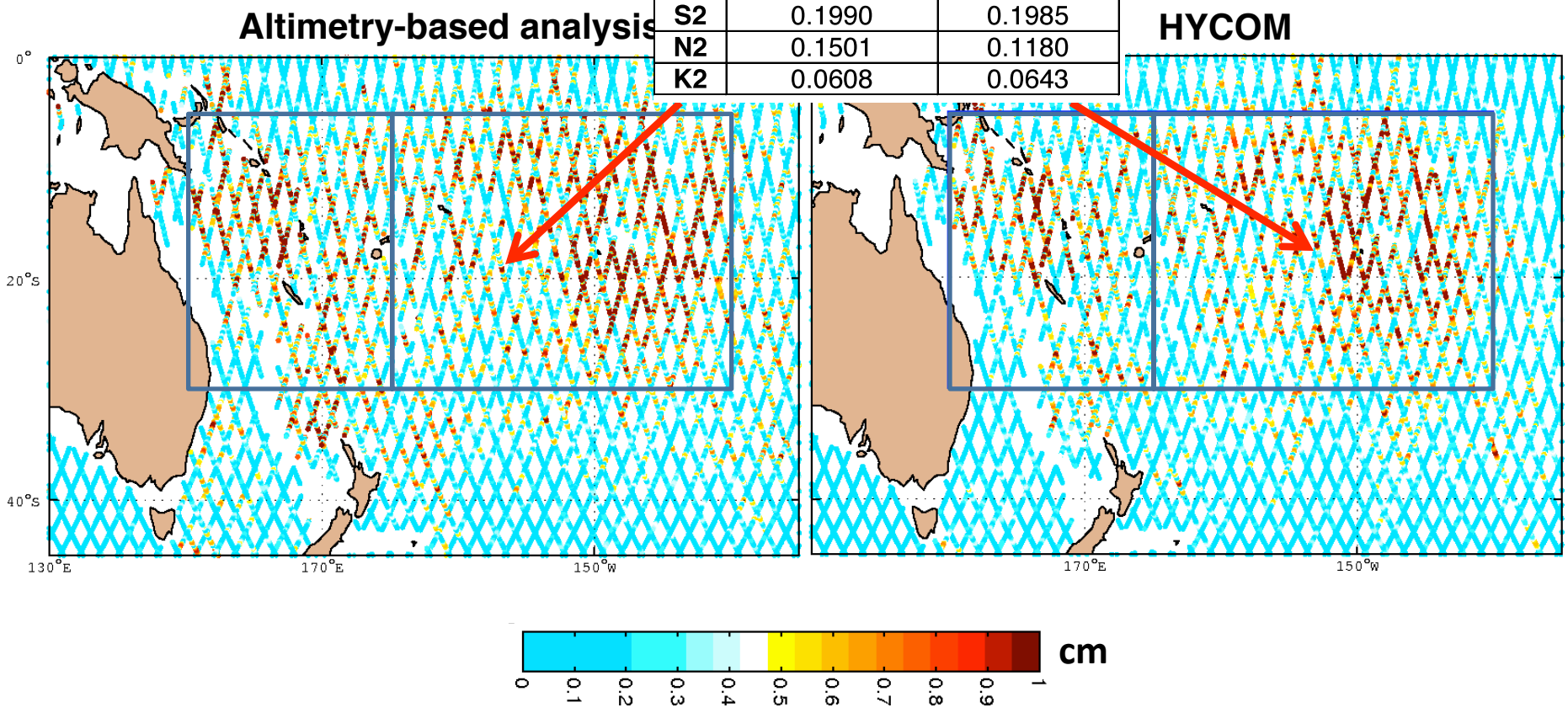


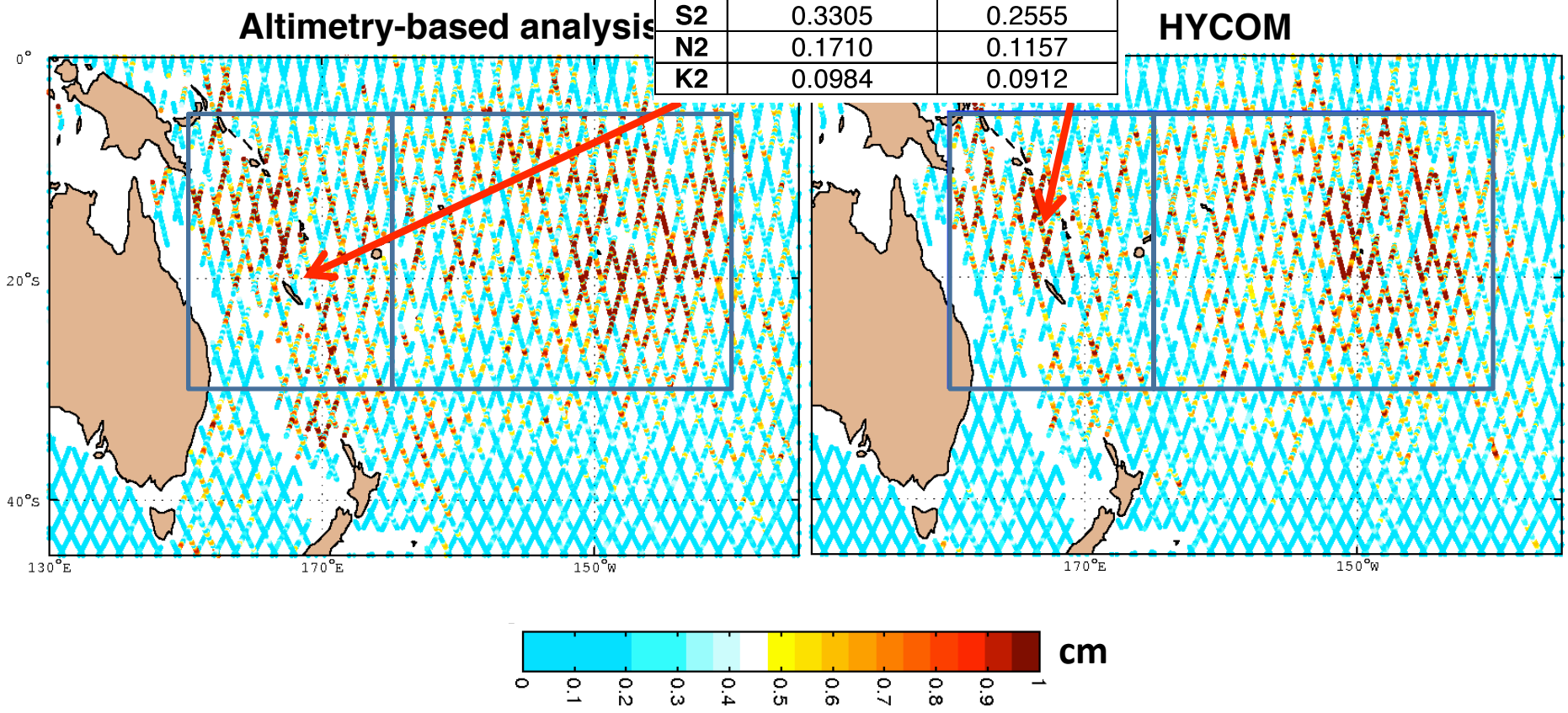
M_2 internal tide amplitude: along-track altimetry data vs 1/12° Global HYCOM

	Altimeter	HYCOM
M2	0.6177	0.5720
S2	0.1990	0.1985
N2	0.1501	0.1180
K2	0.0608	0.0643



M_2 internal tide amplitude: along-track altimetry data vs 1/12° Global HYCOM

	Altimeter	HYCOM
M2	0.6021	0.5026
S2	0.3305	0.2555
N2	0.1710	0.1157
K2	0.0984	0.0912



RMS average amplitude over selected subregions

	M2	S2	N2	K2
Hawaii	0.5649 0.6512	0.2997 0.3897	0.1497 0.1197	0.0918 0.1084
Western North Pacific	0.6377 0.6430	0.3187 0.3504	0.1781 0.1367	0.0971 0.1272
Central South Pacific	0.6177 0.5720	0.1990 0.1985	0.1501 0.1180	0.0608 0.0643
Western South Pacific	0.6021 0.5026	0.3305 0.2555	0.1710 0.1157	0.0984 0.0912
Madagascar	0.5848 0.5394	0.3298 0.2911	0.1602 0.1029	0.0988 0.0988
Rest of world ocean	0.0622 0.0094	0.0630 0.0084	0.0419 0.0016	0.0191 0.0068

Black – altimetry based analysis Red – HYCOM

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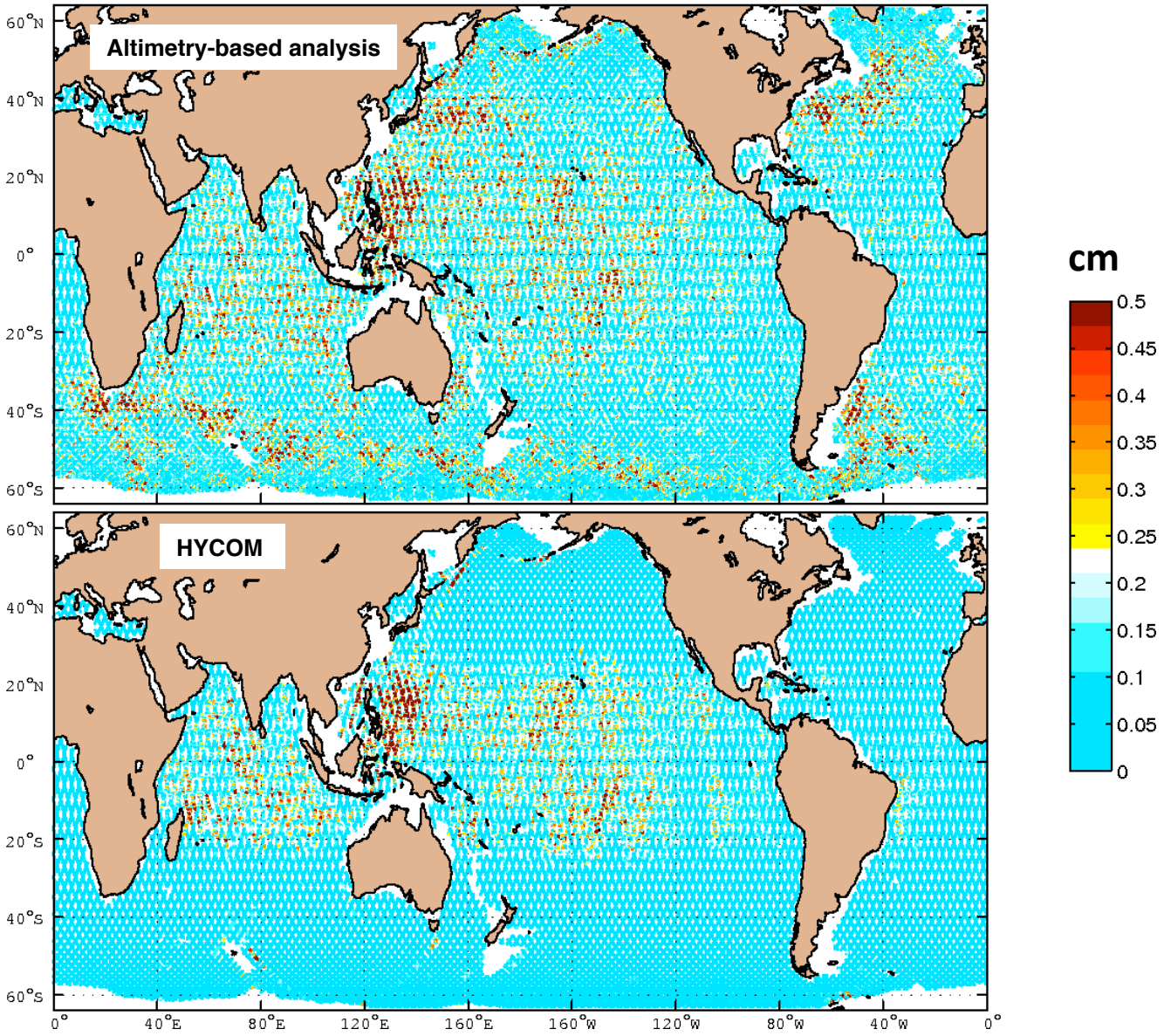
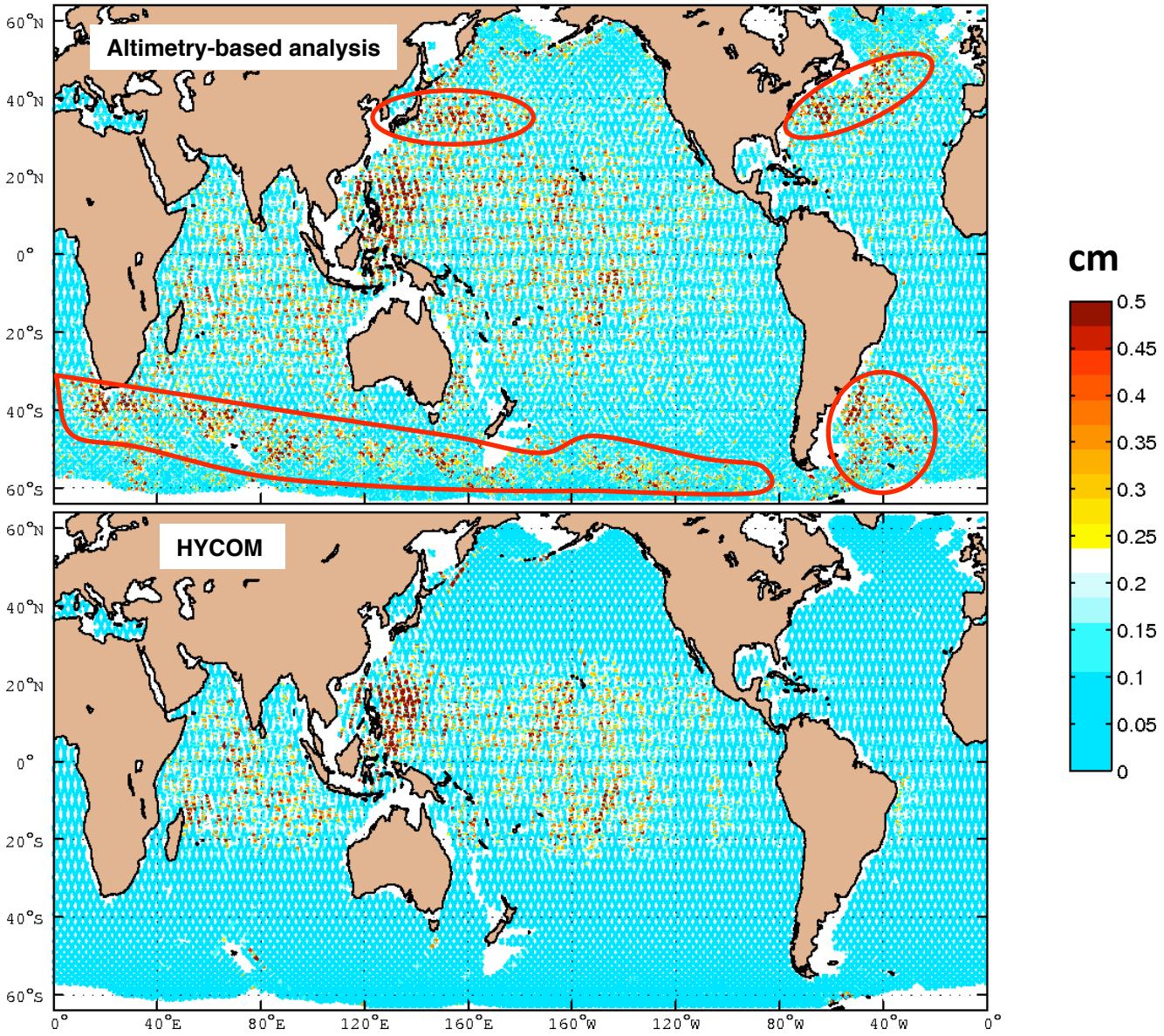
K_1 internal tide amplitude: areas of mesoscale leakage in altimetry-based tidal analysis



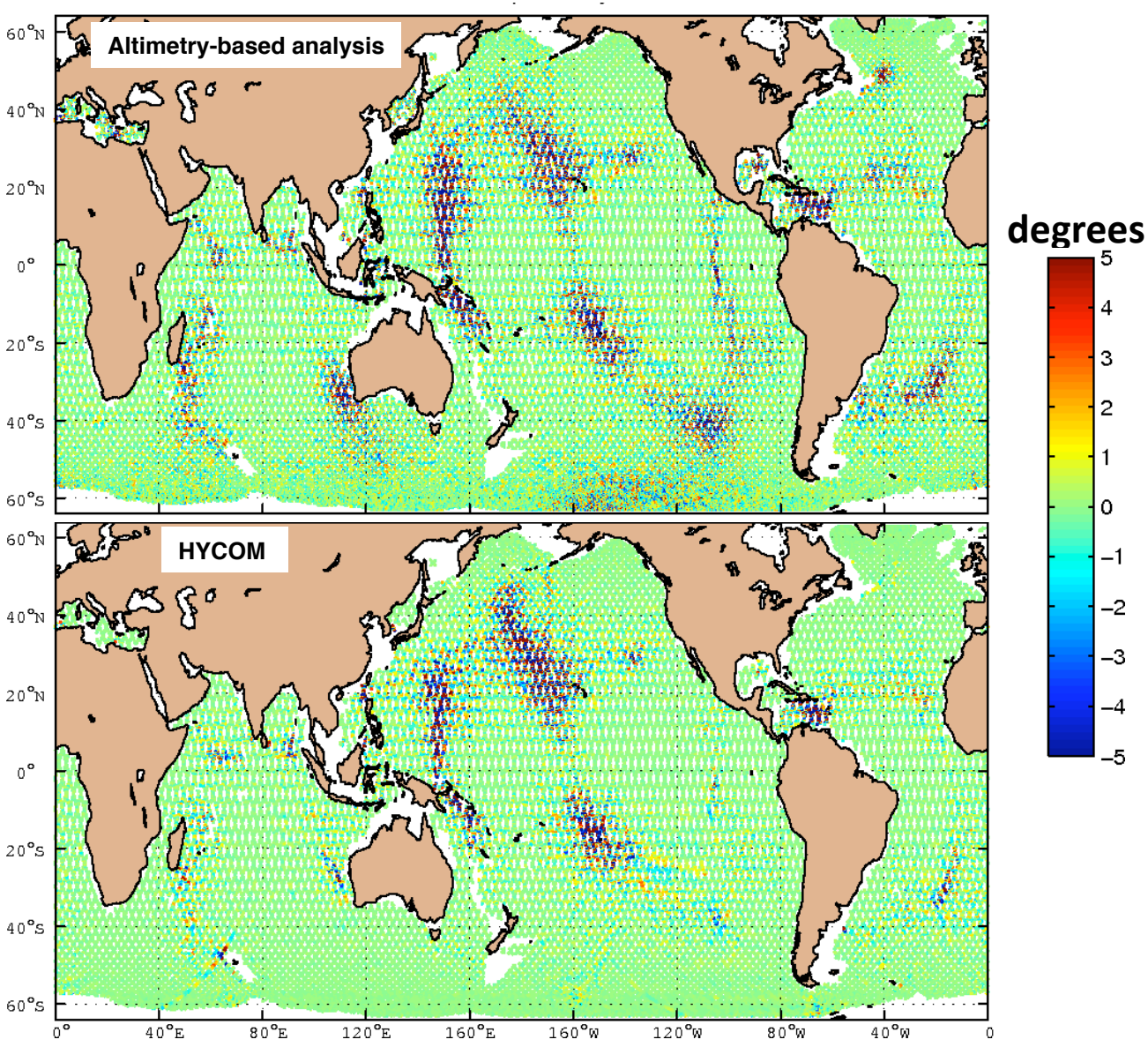
Diurnal internal waves are bound between +/- 30 by the dispersion relation (Gill, 1982)

K_1 internal tide amplitude: areas of mesoscale leakage in altimetry-based tidal analysis



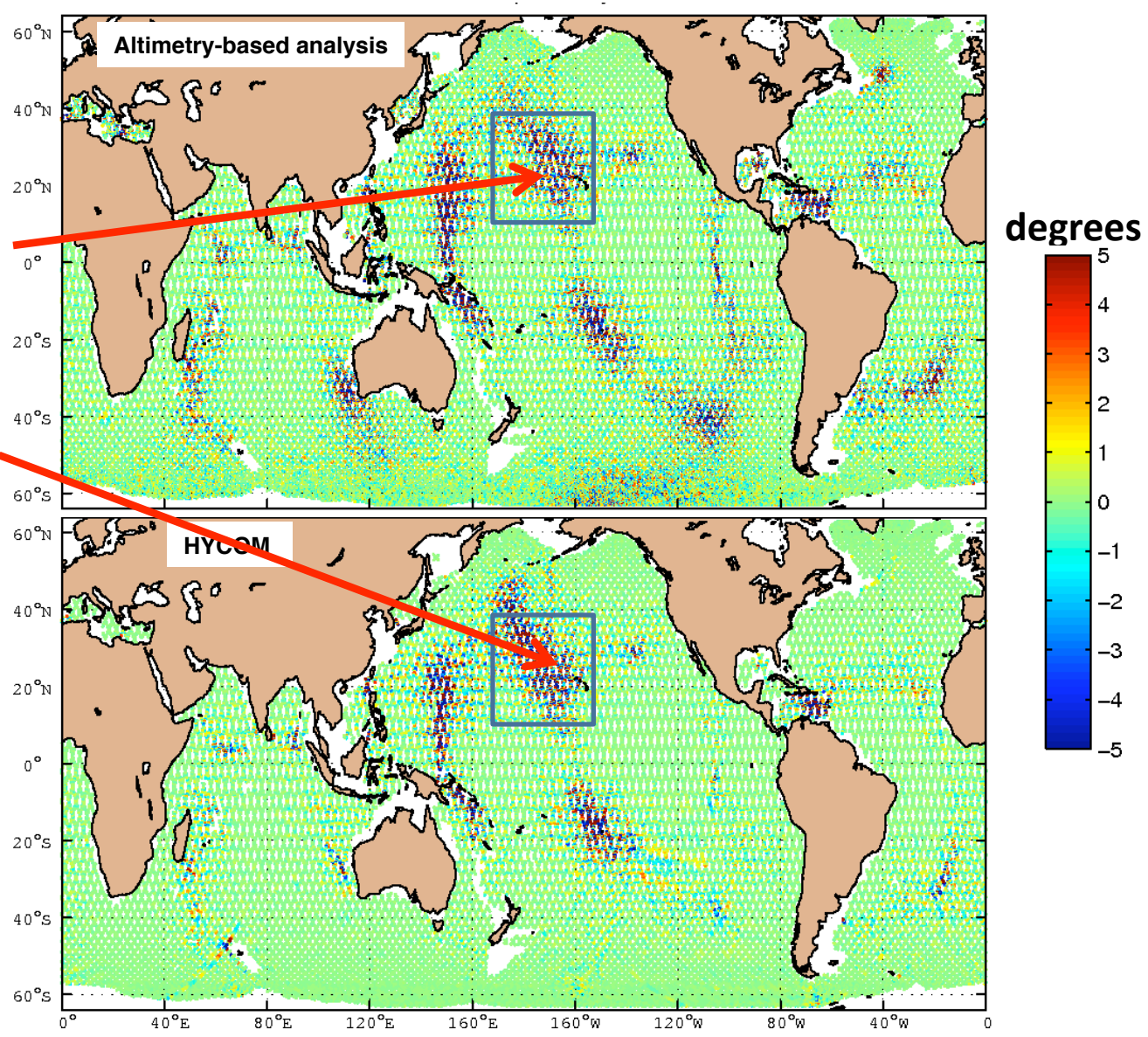
Diurnal internal waves are bound between +/- 30 by the dispersion relation (Gill, 1982)

M_2 internal tide phase: along-track altimetry data vs 1/12° Global HYCOM



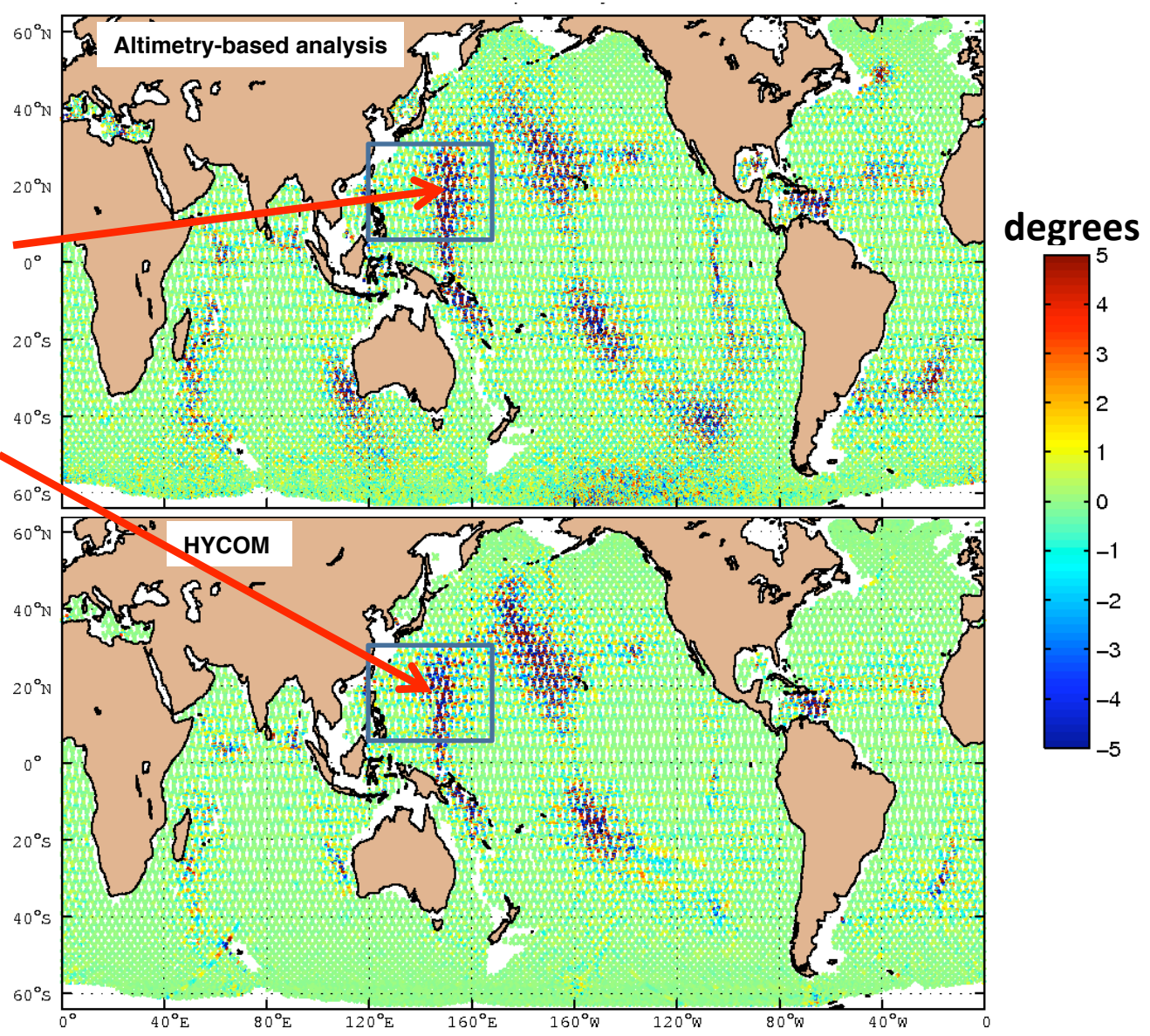
M_2 internal tide phase: along-track altimetry data vs 1/12° Global HYCOM

	Altimeter	HYCOM
M2	2.6328	3.9715
S2	7.8893	4.4727
N2	4.0833	3.1999
K2	8.4167	4.8336



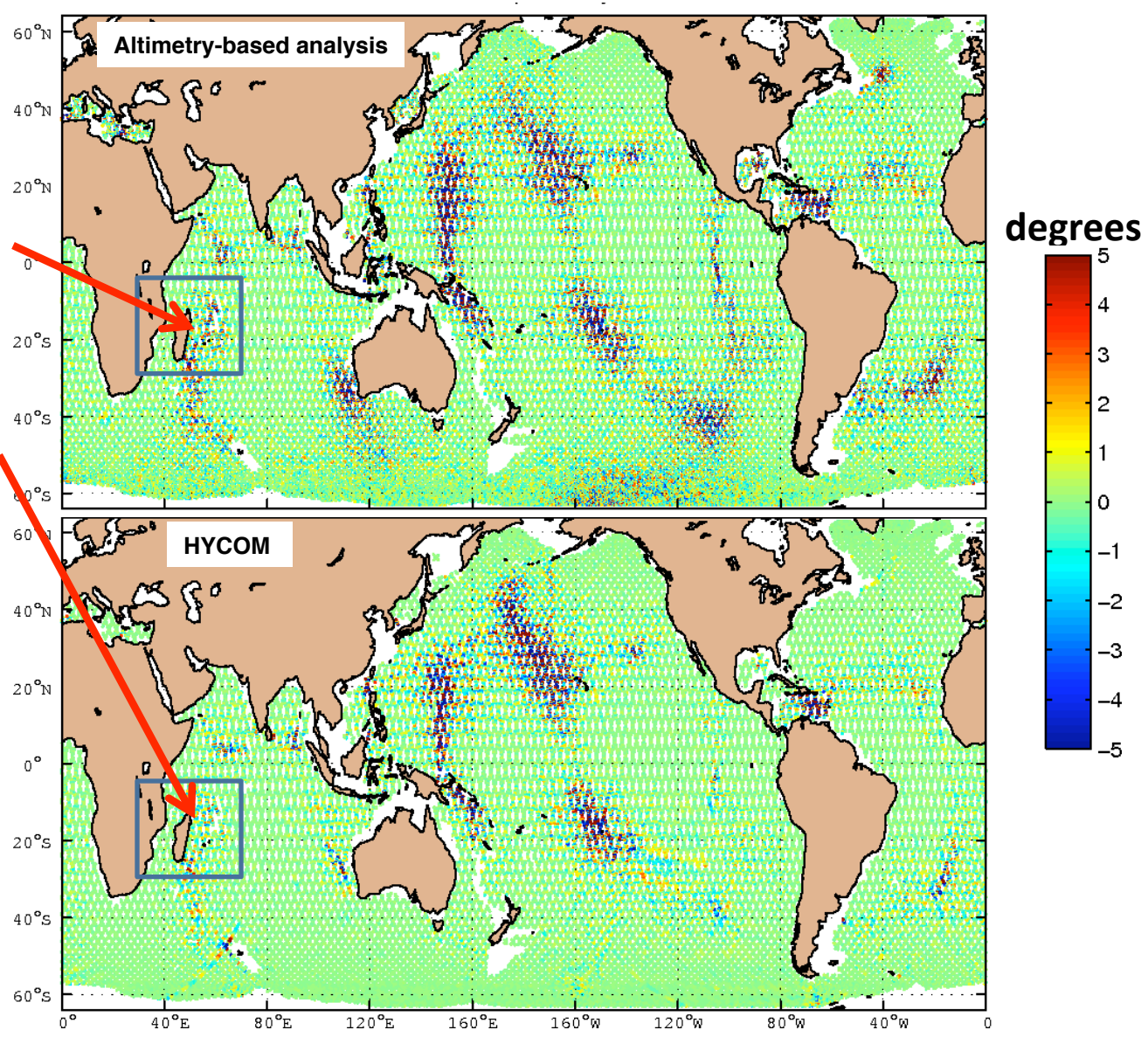
M_2 internal tide phase: along-track altimetry data vs 1/12° Global HYCOM

	Altimeter	HYCOM
M2	6.9211	5.1087
S2	6.0836	2.2124
N2	11.4512	4.8202
K2	6.3346	2.8267



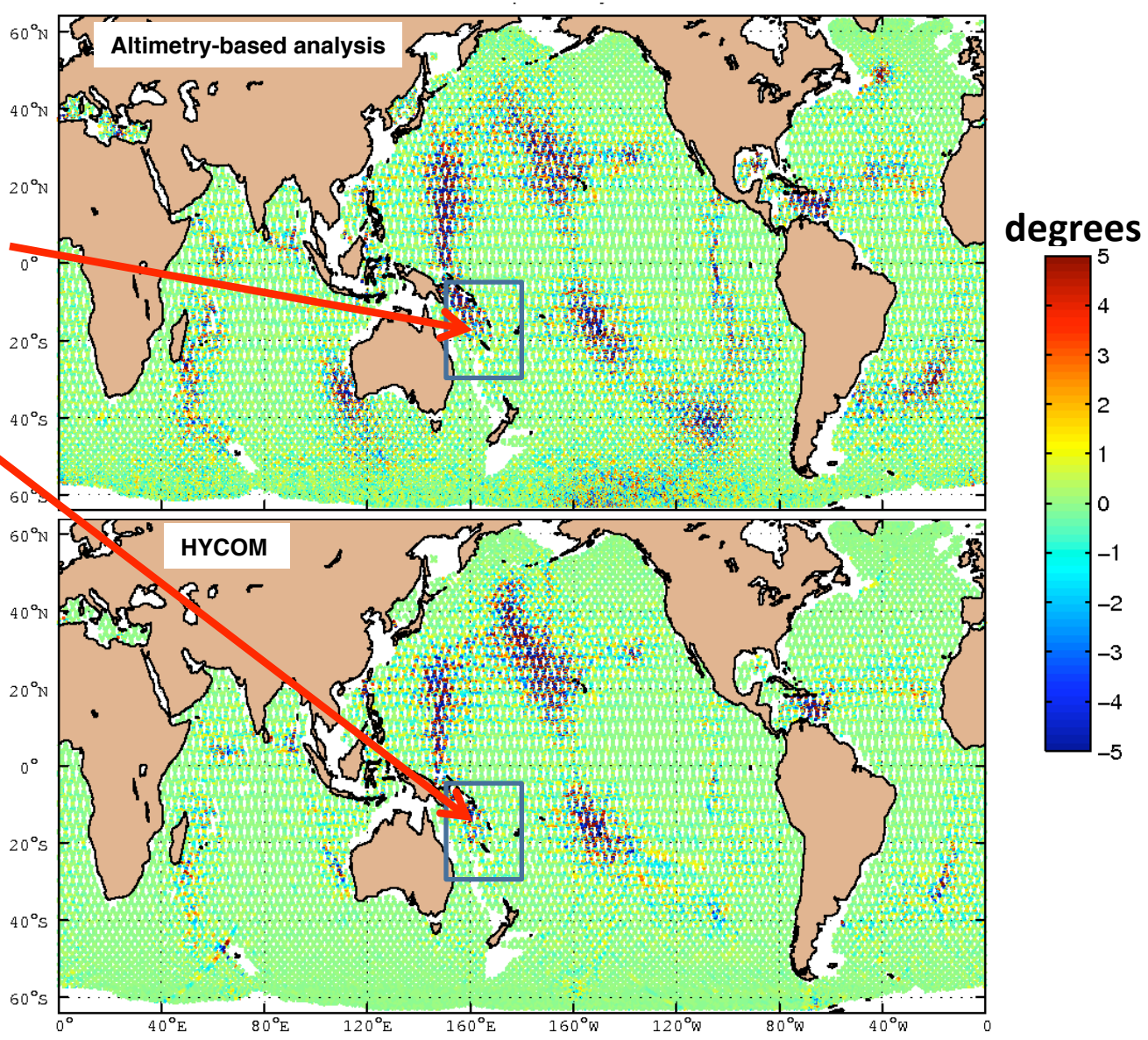
M_2 internal tide phase: along-track altimetry data vs 1/12° Global HYCOM

	Altimeter	HYCOM
M2	1.5030	0.9608
S2	1.6629	0.8220
N2	5.5343	1.1799
K2	1.7619	1.0466



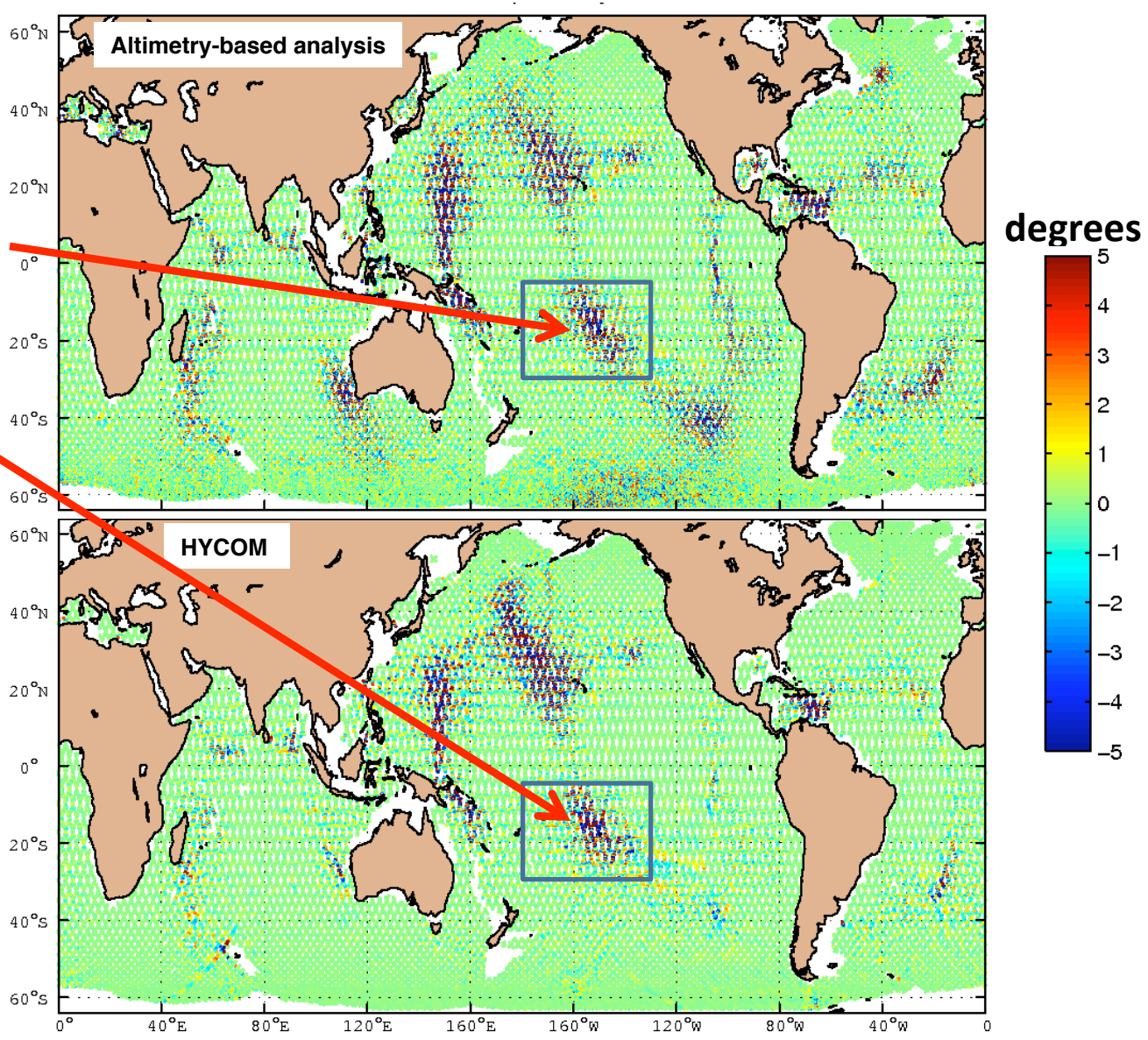
M_2 internal tide phase: along-track altimetry data vs 1/12° Global HYCOM

	Altimeter	HYCOM
M2	6.1587	4.4026
S2	1.9318	1.6119
N2	3.5064	1.7796
K2	2.2224	2.0374

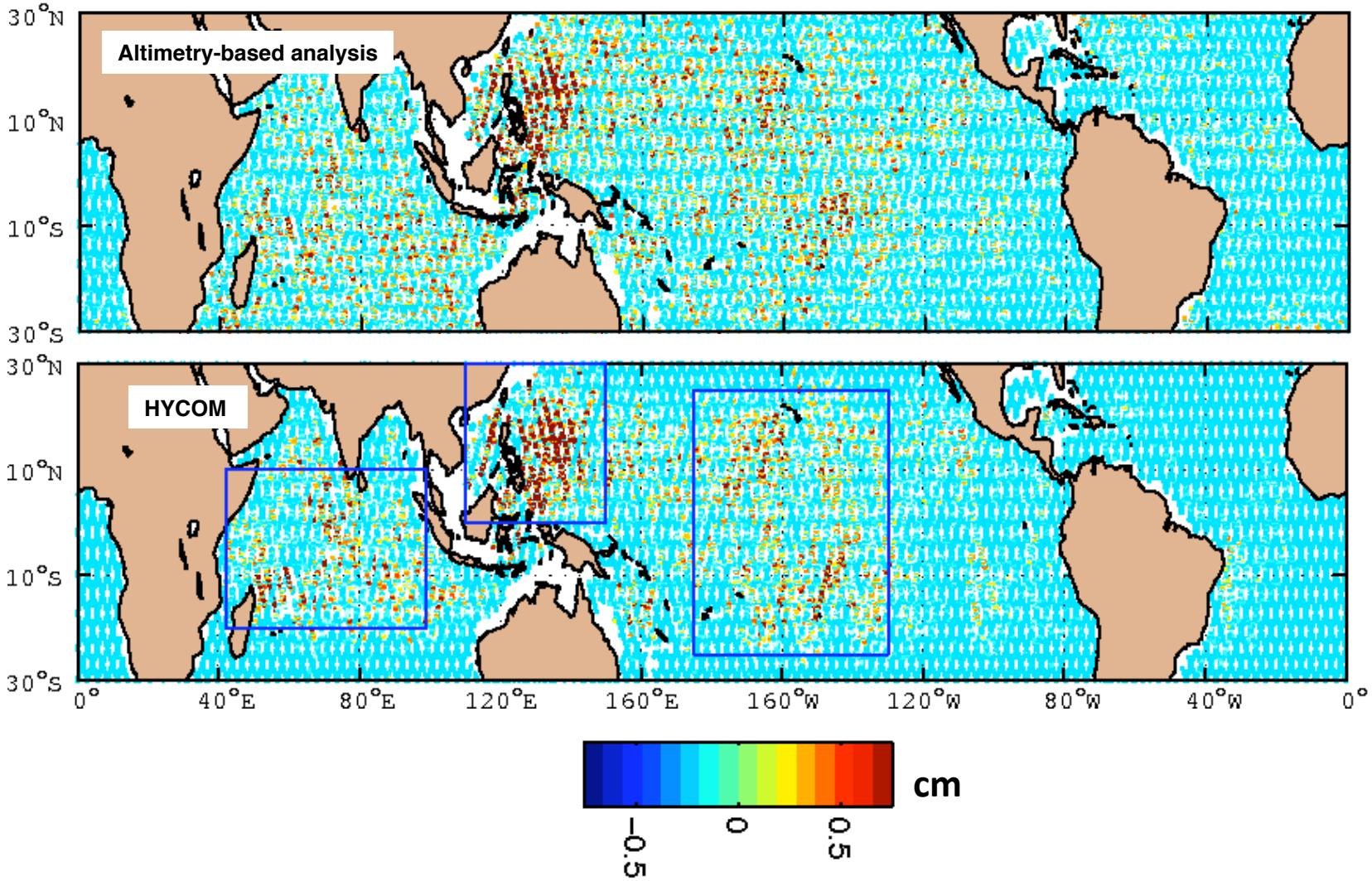


M_2 internal tide phase: along-track altimetry data vs 1/12° Global HYCOM

	Altimeter	HYCOM
M2	3.0591	3.5887
S2	3.1474	2.4079
N2	3.9573	2.9638
K2	6.1529	3.1994



K_1 internal tide amplitude: along-track altimetry data vs 1/12° Global HYCOM



RMS average amplitude over selected subregions

	Central Pacific	Philippines	Indian Ocean	Rest of world ocean
K1	.202/.190	.303/.365	.200/.205	.140/.100
O1	.137/.110	.293/.336	.140/.148	.112/.072
P1	.065/.071	.112/.147	.065/.092	.046/.044
Q1	.081/.028	.123/.080	.082/.035	.076/.022

Black – altimetry based analysis Red – HYCOM

RMS average phase over selected subregions

	Central Pacific	Philippines	Indian Ocean
K1	6.92/4.30	1.37/1.30	2.78/2.14
O1	8.06/3.97	1.65/1.65	4.42/1.38
P1	6.86/4.80	1.30/1.50	3.23/5.23
Q1	22.36/7.64	4.35/1.63	11.45/1.57

Black – altimetry based analysis Red – HYCOM

Summary and Conclusions

• Area averaged amplitude and phases compare well for 7 of the 8 constituents over hotspots

- The modeled perturbations have similar amplitude and horizontal length scale to those observed
- Problems matching the locations of the observed peaks and troughs, especially away from hot spots

• Away from hotspots altimetric data is contaminated by mesoscale leakage, making quantitative assessments difficult