Observing Propagating Ocean Features Using SMOS Surface Salinity data

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1. Background

A number of issues still affect the performance of SMOS in retrieving sea surface salinity (SSS) in particular related to the direction the satellite is travelling. Comparisons with SSS from ascending passes (SSS_A; SMOS moving south to north at ~6 am local time) and SSS from descending passes (SSS_D; SMOS moving southwards at ~6 pm) clearly show SMOS displays temporally varying biases. This study uses anomalies to significantly reduce these biases and to study oceanographic processes in the Indian Ocean.

2. Building climatologies

Source: Reprocessed SMOS ESA L2, Model 1, 2010–2013, SSS_A and SSS_D
Data Quality: Removed data using flags so no issues with convergence, geophysical or RFI
Processing: Each 1° cell is based on all data, from all four years, for that cell plus data from those cells within 2° and ± 4 days.
Daily Data Products: daily, 1° x 1° climatology based on median SSS - $CLIM_A$ and $CLIM_D$ (averaged values shown in Fig. 1).
Monthly Data Products: Monthly 1° climatological values (median) of each cell.
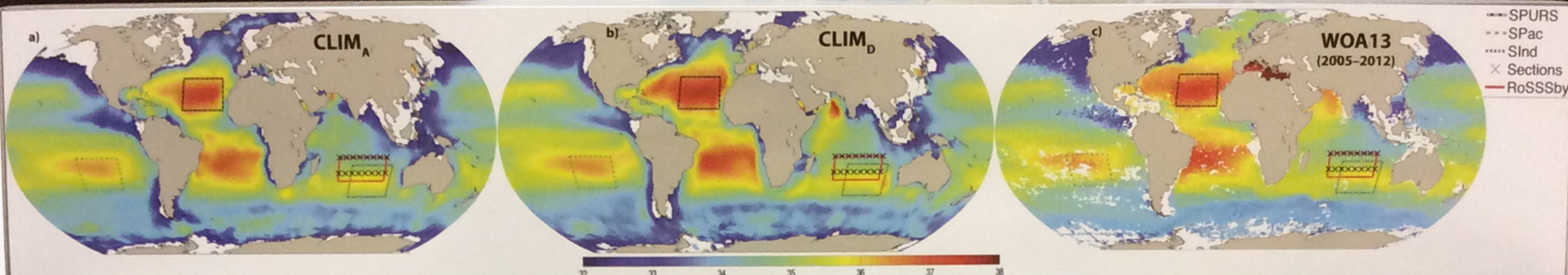

Fig. 1 Contour of annual averaged values of daily 1° with the study regions and locations of the sections used in Indian Ocean indicated (X) for: a) $CLIM_A$; b) $CLIM_D$; and c) for comparison WOA13 (Boyer et al., 2013)
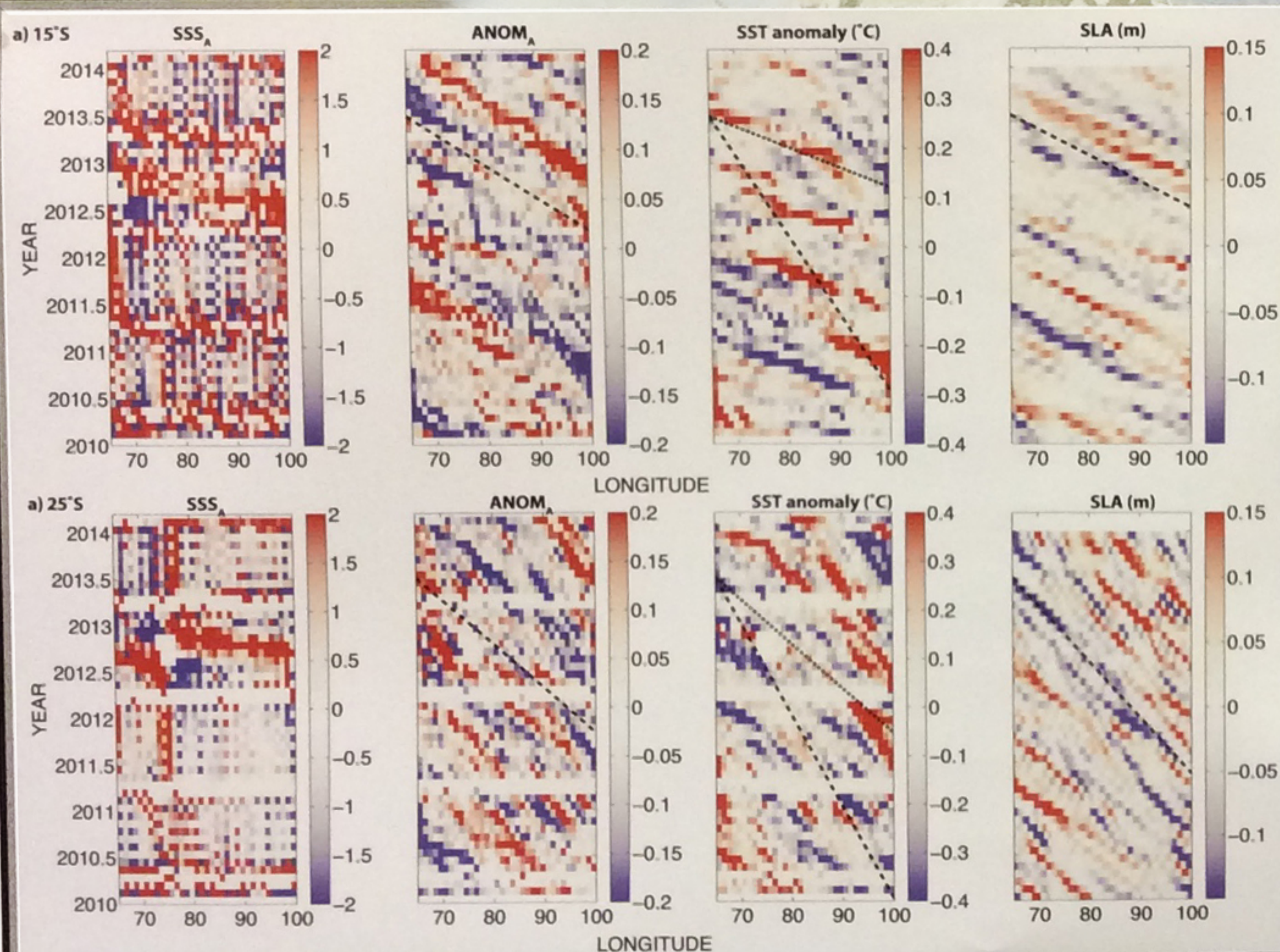

Fig. 2 Longitude-time plots of monthly anomalies for sections shown in Fig. 1 for (from left) SSS_A (pss), $ANOM_A$ (pss), SST anomaly from ascending passes (°C) and sea level anomaly (SLA, m) from ESA Climate Change Initiative (Ablain et al., 2015) during the period February 2010 - February 2014 between 65°–100°E at: a) 15°S and b) 25°S. The same processing of anomalies has been applied to all datasets (filtered using a westward-propagating filter similar to the one described in O'Brien et al. (2013) such that the filter rejects any signals stationary in time and/or space). Dashed black lines show feature propagation speed based on Radon Transform (first peak): dotted lines for SST anomaly are speeds from the second peak of the Radon transform.

3. Monthly anomalies

Each month (February 2010–February 2014) and each 1° cell, SSS_A and SSS_D were based on the median. Monthly anomalies ($ANOM_A$ and $ANOM_D$) were calculated by subtracting monthly $CLIM_A$/$CLIM_D$ for the RoSSSby region (Fig. 1). Fig. 2 shows westward- propagating features in longitude-time plots for the sections shown in Fig. 1.

4. Propagation speeds

Propagation speeds calculated with the Radon Transform (Cipollini et al., 2006) and removing the mean as suggested by de la Rosa et al. (2007). Theoretical speeds based on the extended theory of Killworth and Blundell (2003a, b) for baroclinic modes of planetary waves have been calculated using WOA13 (Boyer et al., 2013) and shown alongside speeds based on the observations in Fig. 3.

5. Summary

- ESA Level 2 SSS data contain biases between data from ascending passes and data from descending passes that vary both in space and time.
- These strong seasonally varying signals can be significantly reduced in magnitude through the use of SMOS climatology products to build SSS anomalies.
- Geophysical signals are clearly visible within the anomaly products for salinity, temperature and the independent sea surface height data.
- Propagation speeds of westward moving features consistent among datasets and previously published results on large-scale non-linear eddies/Rossby waves in South Indian Ocean.

Banks, C.J. et al. (In Press), "Reduced ascending/descending pass bias in SMOS salinity data demonstrated by observing westward-propagating features in the South Indian Ocean." Remote Sensing of Environment SMOS Special issue
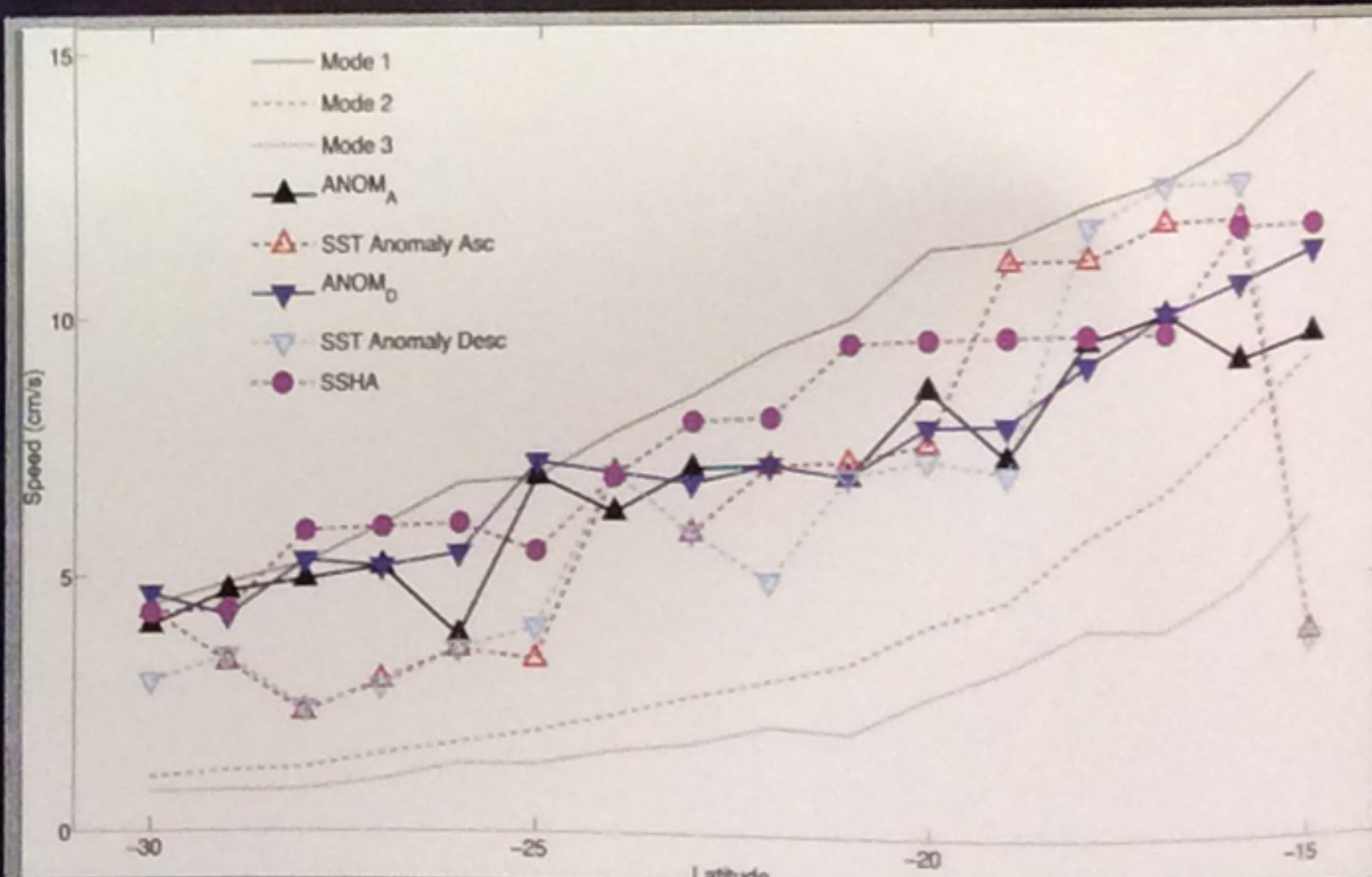

Fig. 3 Speed of westward propagating features from $ANOM_A$; $ANOM_D$; SST anomaly from ascending passes; SST anomaly from descending passes; SLA. The grey lines are the theoretical speeds for the 1st (solid), 2nd (dashed) and 3rd (dotted) baroclinic mode of planetary wave propagation based on Killworth and Blundell (2003a, b) recomputed using WOA13.

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