OSTM / Jason-2

Near Real-Time Data Annual Quality Report 2014-2015

July 2015

Prepared by:

U.S. Department of Commerce
National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite, Data, and Information Service (NESDIS)

Near Real-Time Data Annual Quality Report 2014-2015
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Preface

This document comprises the initial National Oceanic and Atmospheric Administration (NOAA) National Environmental Satellite, Data, and Information Service (NESDIS) baseline publication of the OSTM / Jason-2 *Near Real-Time Data Annual Quality Report 2014-2015* (July 9, 2015 issue).

The purpose of this document is to assess the overall quality of the Jason-2/OSTM near real-time products, Operational Geophysical Data Records (OGDRs), which are produced by NOAA and EUMETSAT. For each 10-day cycle, five primary parameters are displayed, divided into ascending and descending passes: sea surface height, significant wave height, ocean surface wind speed, altimeter-based ionosphere correction, and radiometer-based wet troposphere correction. All anomalies evident in these plots, such as orbital maneuvers or data gaps from calibration exercises, are described and documented based upon operational processing logs, etc. Statistics for data latency and data return are presented to demonstrate that high-level mission requirements have been met.

Future updates and revisions to this document will be produced and controlled by NOAA/NESDIS.

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Section 1.0 Introduction

The Jason-2/Ocean Surface Topography Mission is the successor to the Topex/Poseidon and Jason-1 radar altimetry missions. Jason-2 was launched from Vandenberg AFB on 20-Jun-2008, and the onboard instruments began producing data shortly thereafter, on 22-Jun-2008. Prior to achieving its final ~10-day exact repeat orbit, Jason-2 executed a series of maneuvers after injection into orbit. The exact repeat orbit was finally achieved on 04-Jul-2008. Since this resulted in a partial 10-day cycle, it was dubbed cycle-0. All subsequent cycles (beginning with cycle-1) are comprised of 254 half-revolution 'passes' with odd-numbered ascending passes extending from south to north, and even-numbered descending passes going north to south.

The primary instrument on-board Jason-2 is a dual-frequency radar altimeter (Ku-band & C-band) that provides measurements of sea surface height, significant wave height, and ocean surface wind speed. Three independent orbit determination systems are provided by the DORIS, GPSP, and passive laser retro-reflector instruments. Sea surface height is computed from the difference in orbital altitude from these systems and the fundamental range measurement (from round-trip travel time) made by the altimeter. Finally, a three-frequency passive microwave radiometer provides measurements of integrated total precipitable water, which is used to correct the sea surface height measurements for path delays due to atmospheric water vapor. Path delay corrections for the ionosphere are based on the dual-frequency altimeter measurements, and for the dry troposphere based on ECMWF model surface pressure fields. Finally, sea surface heights are corrected for signals not associated with large-scale ocean circulation (tides, inverse barometer, and sea state bias).

The Ocean Surface Topography Mission is a four-partner collaboration between NOAA, NASA, CNES and EUMETSAT. As partner operational agencies, NOAA and EUMETSAT share responsibility for production of near real-time data sets. These data, the Operational Geophysical Data Records (OGDRs) are the focus of this quality assessment report. OGDRs are typically produced 1-3 hours after the telemetry are received from the spacecraft, leading to nominal data latencies of 3-5 hours after accounting for two hours of data acquisition on board between data dumps to the ground. The data latency statistics over the seventh year of mission operations are discussed in the next section.

Section 2.0 Data Latency Statistics

The four project partners hold Operational Coordination Group (OCG) meetings weekly, and NOAA routinely reports statistics for near real-time product latency. The latency is computed for each OGDR, based on the time difference between the data itself (measurement time) and the time of availability of the product to end users. The calculation is performed for both the 3 hour / 75% requirement and 5 hour / 95% requirement. The overall latency of the OGDRs, produced by both NOAA and EUMETSAT, is accumulated over the previous week for reporting at the OCG meeting.

Figure 1 is a graphical representation of the weekly latency statistics over the seventh year of operations. At each weekly interval along the x-axis, the percentage of data available within 3 hours is shown by the height of the green area (on a y-axis scale of 60-100%). The percentage of data available within 5 hours is shown by the height of the combined green + yellow areas. Finally, the red areas show the percentage of data NOT available within 5 hours, as a difference between 100% and the yellow area. The target 75% and 95% requirements are shown as horizontal dashed lines.

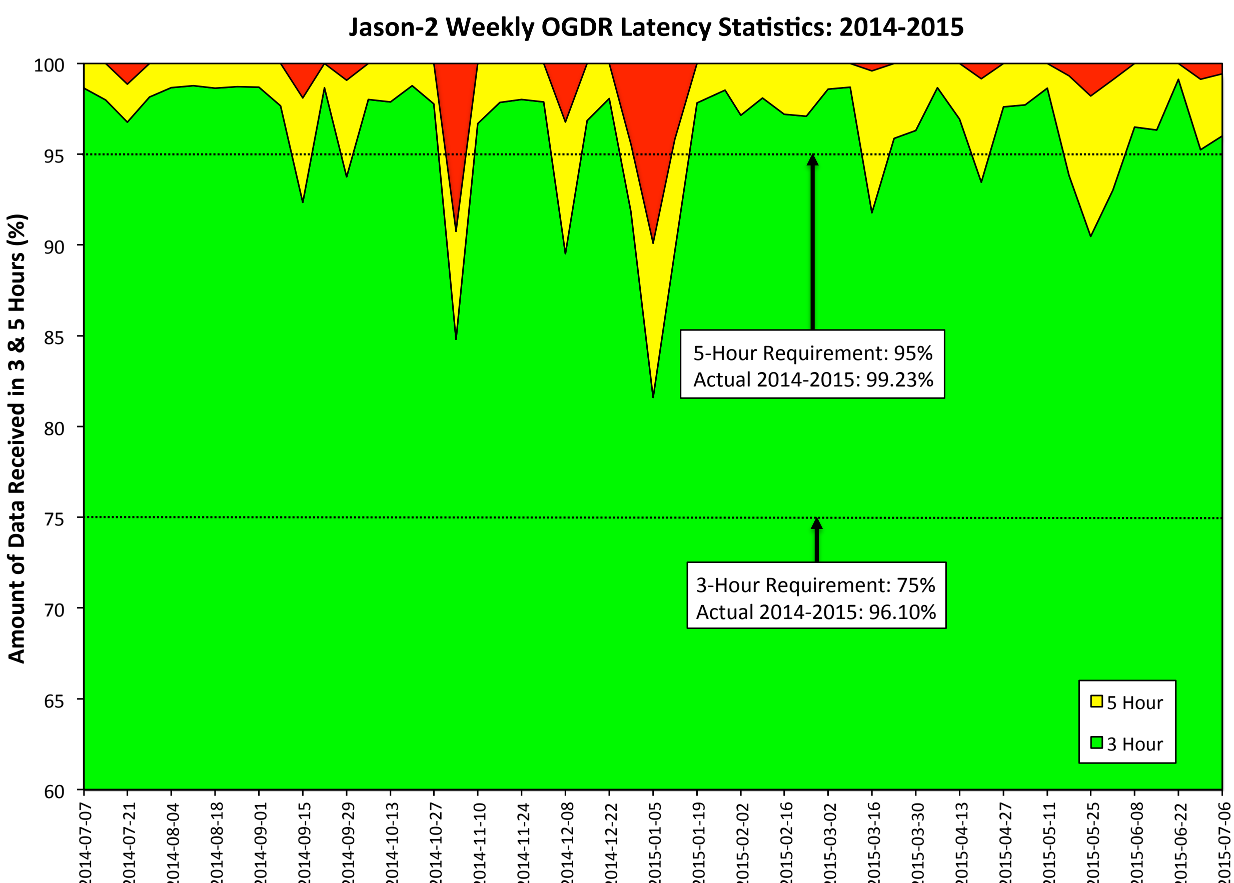


Figure 1 – Jason-2 OGDR Latency Statistics for July 2014 to July 2015

This figure demonstrates that the 3-hour / 75% requirement was satisfied for all weeks. The 5-hour / 95% requirement was not met during the two weeks of 2014-11-03 and 2015-01-05, due to ground segment issues at NOAA. The yearly averaged values (over the 53 weeks shown in Figure 1) are: 96.10% of all data were available within 3 hours, and 99.23% of all data were available within 5 hours.

Section 3.0 Data Quality Analysis Plots

In this section data from the seventh year of operations are analyzed, covering the time period from 2014-07-12 to 2015-07-04: cycles 222-257. We focus the analysis on five primary geophysical parameters measured by the on-board instruments: sea surface height anomaly (relative to a multi-year altimetric mean sea surface), significant wave height, ocean surface wind speed, wet tropospheric path delay from the radiometer, and ionospheric path delay based on dual-frequency altimeter measurements.

Each of the five geophysical parameters are analyzed on a per-cycle basis, with data from ascending and descending portions of the ground track plotted separately to prevent overlapping points. The start and end times of each cycle are based on an average cycle duration of 9d 21h 58m 31.612s (856711.612 seconds). The start and end times in the plot labels are rounded to the nearest second, and agree within a few seconds with the actual cycle boundaries. The individual 1-second data points, read from the NetCDF formatted OGDR files, are reported every 10-seconds along track. Each of these 10-second values is plotted as a filled circle, color coded by the vertical scale bar, which is based on a prescribed maximum-minimum range for that variable. Note that the scale for SSHA is centered on zero, after the removal of an ~18 cm bias in OGDR-D range compared to OGDR-C. For each ~10-day cycle, the five parameters are plotted on a single page as ten subplots (separate ascending/descending data) in Appendix-A. Each cyclic subplot represents a map view of a single variable, over the region 22°-382° longitude, ± 70° latitude. The longitude axis is offset by 22° to split the plots at Cape Agulhas, where there is minimal oceanic latitudinal extent between the Atlantic & Indian basins.

Plots for cycles 222-257 are contained in Appendix-A. These plots provide an excellent means of assessing the overall data coverage (or data gaps) as well as anomalies in the data values of the five analyzed parameters. If a parameter map has long stretches of data that are ‘off-scale’ in either the positive (red) or negative (blue) directions, there is a clear indication of degraded quality. These 36 plots form the basis of the quality assessment provided in the following sections.

Section 4.0 Anomalies Impacting Quality

Since the launch of Jason-2 a variety of anomalies have occurred which impact the quality of the data. These can be related to spacecraft maneuvers, instrumental problems, telemetry transmission difficulties, ground station anomalies, or data processing errors. The anomalies impacting data quality from July 2014 to July 2015 are presented in chronological order below, including the names of the impacted OGDR files. The detailed explanations are based on the cyclic GDR reports kindly provided by CNES, and the weekly OCG reports.

A general observation regarding the SSHA figures at the top of each page is that there are numerous data dropouts distributed randomly across the globe, which are not observed in the other four variables. The annual reports for 2008-2012 didn't exhibit this SSHA data loss while the 2013-2014 reports, based on OGDR-D, did. It is due to the fact that SSHA values are now defaulted whenever the rain flag is set. This is new in OGDR-D, since OGDR-C didn't have a usable rain flag. SSHA values were NOT defaulted when edit flags were set, prior to cycle-151. Flags are provided so end users can edit according to their needs; the SSHA data itself should not be set to a default value when flags are set.

This needs to be addressed immediately by the four-partner project teams!

Cycle-222

GYRO calibrations on pass 114 on 2014-07-16, between 20:05:19 and 20:10:34 and between 20:23:21 and 20:34:51. Data are missing for this period. Percentage of missing points (latitude < 50°, bathy < -1000m) on that cycle: 0.16%.

JA2_OPN_2PdS222_113_20140716_191912_20140716_213405.nc

Cycle-224

DIODE orbit error on descending pass #160 in Central Pacific and ascending pass #161 off Africa. An in-depth analysis by Christian Jayles @ CNES concluded that there were two back-to-back problems, with two DORIS beacon datasets, that led to the degraded onboard orbits. One station had issues from ionospheric noise (near the equatorial electrojet) which degraded the entire 'pass' of data. A second station had a radically bad first point that polluted the remainder of the 'pass'. Nominal orbits were obtained by eliminating the data from the first station and just the first bad point from the second station.

JA2_OPN_2PdS224_159_20140807_103316_20140807_122425.nc

Cycle-230

Problems with the ECMWF meteorological files for 2014-09-30 caused data processing to fail at EUMETSAT and NOAA. No products were generated at EUMETSAT for the period 07:44 - 11:36. For the period 11:37 - 15:19, OGDRs were produced, but the inverse barometer correction

(IB) values were defaulted and therefore all SSHA values were defaulted. A correction was put in place by NOAA to resume normal processing. Wind and wave content was not impacted.

JA2_OPN_2PdS230_020_20140930_113726_20140930_130854.nc
JA2_OPN_2PdS230_021_20140930_130853_20140930_152007.nc

Cycle-231

Maneuver Burn on 2014-10-16 from 19:00:21 to 19:00:24 (Pass 184; not visible).

JA2_OPN_2PdS231_173_20141016_093147_20141016_112628.nc

Cycle-236

CAL1 I&Q on 2014-12-07 at 02:42:25 & CAL CNG on 2014-12-07 at 09:13:54. Pass 235 is partially missing due to calibrations. Only 8.3% of missing measurements over ocean (most missing measurements over land).

JA2_OPN_2PdS236_228_20141207_022147_20141207_040030.nc
JA2_OPN_2PdS236_234_20141207_075233_20141207_111823.nc

Cycle-237

Maneuver Burn on 2014-12-10 from 05:01:10 to 05:01:13 (Pass 053; not visible).

JA2_OPN_2PdS237_052_20141210_033034_20141210_050848.nc

Cycle-238

No AMR data were available from 2014-12-18 19:18:48 to 2014-12-19 17:47:57 (impacting passes 020 to 043). Passes 21 to 42 are completely edited by radiometer wet troposphere. Passes 20 and 43 are partly edited with respectively 33.73%, and 20.28% of edited measurements due to radiometer wet troposphere correction at default values.

JA2_OPN_2PdS238_018_20141218_172901_20141218_192550.nc
JA2_OPN_2PdS238_020_20141218_192549_20141218_205735.nc
JA2_OPN_2PdS238_021_20141218_205734_20141218_230947.nc
JA2_OPN_2PdS238_024_20141218_230946_20141219_010501.nc
JA2_OPN_2PdS238_026_20141219_010501_20141219_024414.nc
JA2_OPN_2PdS238_027_20141219_024413_20141219_044027.nc
JA2_OPN_2PdS238_029_20141219_044033_20141219_063646.nc
JA2_OPN_2PdS238_032_20141219_063646_20141219_080730.nc
JA2_OPN_2PdS238_033_20141219_080729_20141219_100103.nc
JA2_OPN_2PdS238_035_20141219_100102_20141219_115951.nc
JA2_OPN_2PdS238_037_20141219_115949_20141219_135822.nc
JA2_OPN_2PdS238_039_20141219_135822_20141219_155542.nc
JA2_OPN_2PdS238_042_20141219_155541_20141219_175159.nc

Cycle-243

Wallops pass 31035 on 2015-02-07 at 11:31:40 contained anomalously large errors. CNES confirmed that the root cause of the event was TRIODE software implemented on the TM-NRTs resulting in bad management of the UT1R-UTC value when crossing from -0.499873 to -0.501113 (improper rounding in the code). This generated a large discontinuity and distortion in the triode orbit interpolation.

JA2_OPN_2PdS243_046_20150207_094153_20150207_111202.nc

Cycle-245

Maneuver Burn on 2015-03-05 from 11:12:34 to 11:12:36 (Pass 205; not visible).

JA2_OPN_2PdS245_204_20150305_094121_20150305_112106.nc

Cycle-247

Passes 227 and 228 are partly missing due to telemetry dropouts during the pass and a MMREAD ACK sent by mistake on the next pass. 13.91% of pass 228 is missing (over land only). 80.37% of pass 227 is missing (76.69% over sea).

JA2_OPN_2PdS247_226_20150326_020958_20150326_031245.nc
JA2_OPN_2PdS247_228_20150326_040517_20150326_060412.nc

Cycle-248

DIODE orbit error on descending pass #142 in Indian Ocean and ascending pass #143 off Mexico. Caused by the DIODE on-board processing of RF-disturbed measurements from the DORIS beacon of Male on the 400MHz channel.

JA2_OPN_2PdS248_141_20150401_171823_20150401_191543.nc

Cycle-253

Station keeping maneuver on 2015-05-19 at 21:21:28 (Passes 105 & 106; visible in N Pacific and SW of Africa).

JA2_OPN_2PdS253_105_20150519_213057_20150519_232620.nc

Section 5.0 Analysis of Data Gaps in the OGDRs

There is a high-level Jason-2 mission/system requirement that is relevant to the anomalies discussed in the previous section:

The GDR shall contain 95% of all possible over-ocean data (acquisition and archive) during any 12 month period, with no systematic gaps.

To assess our performance with regard to this requirement, based on the near real-time OGDRs, all of the data for cycles 222-257 were checked for data gaps between measurements (and between files) when either of the two measurements was over the ocean. Using a nominal inter-record spacing of $\Delta t = 1.02$ seconds, a gap is identified whenever two measurements are separated by more than $2*\Delta t$. Duplicate data, associated with re-dumping of data stored on-board Jason-2 (i.e. when two OGDRs have the same start time) were skipped during gap detection.

The cumulative result over the 4427 analyzed OGDRs is a total of 21,427,472 over-ocean records (out of a total 29,429,823 records) with data gaps totaling 39,113 records. This equates to 11h 4m 55s of missing data over the course of the year, and an over-ocean data return of 99.82%.

The following OGDRs had cumulative data gaps (both internally and relative to the previous file) in excess of 100 seconds. OGDRs are not reported in this list if the data were redumped on a subsequent pass, but they are included in the statistics reported above.

OGDR File Name	Gap
JA2_OPN_2PdS230_020_20140930_113726_20140930_130854.nc	13694
JA2_OPN_2PdS240_100_20150110_181716_20150110_201425.nc	7352
JA2_OPN_2PdS253_253_20150525_155450_20150525_175819.nc	5384
JA2_OPN_2PdS247_228_20150326_040517_20150326_060412.nc	3091
JA2_OPN_2PdS254_071_20150528_112409_20150528_144136.nc	2402
JA2_OPN_2PdS256_132_20150619_154839_20150619_172943.nc	1808
JA2_OPN_2PdS222_113_20140716_191912_20140716_213405.nc	1525
JA2_OPN_2PdS256_234_20150623_152304_20150623_162135.nc	735
JA2_OPN_2PdS235_198_20141126_001704_20141126_020517.nc	251
JA2_OPN_2PdS236_124_20141203_005158_20141203_024552.nc	225
JA2_OPN_2PdS249_009_20150406_112237_20150406_131926.nc	217
JA2_OPN_2PdS253_108_20150519_232619_20150520_005802.nc	129

Section 6.0 Summary

The overall quality of the Jason-2/OSTM near real-time OGDR data is extremely good. The amount of missing data, attributed to all of the anomalies discussed in sections 4 and 5 is about 11 hours 05 minutes. **This represents an over-ocean data return of 99.82%, over the time period of 357 days analyzed in this report.**

In addition to the high overall data return, the data availability in terms of latency is also well above the mission requirements: **96.10% of all data were available within 3 hours and 99.23% of all data were available within 5 hours**.

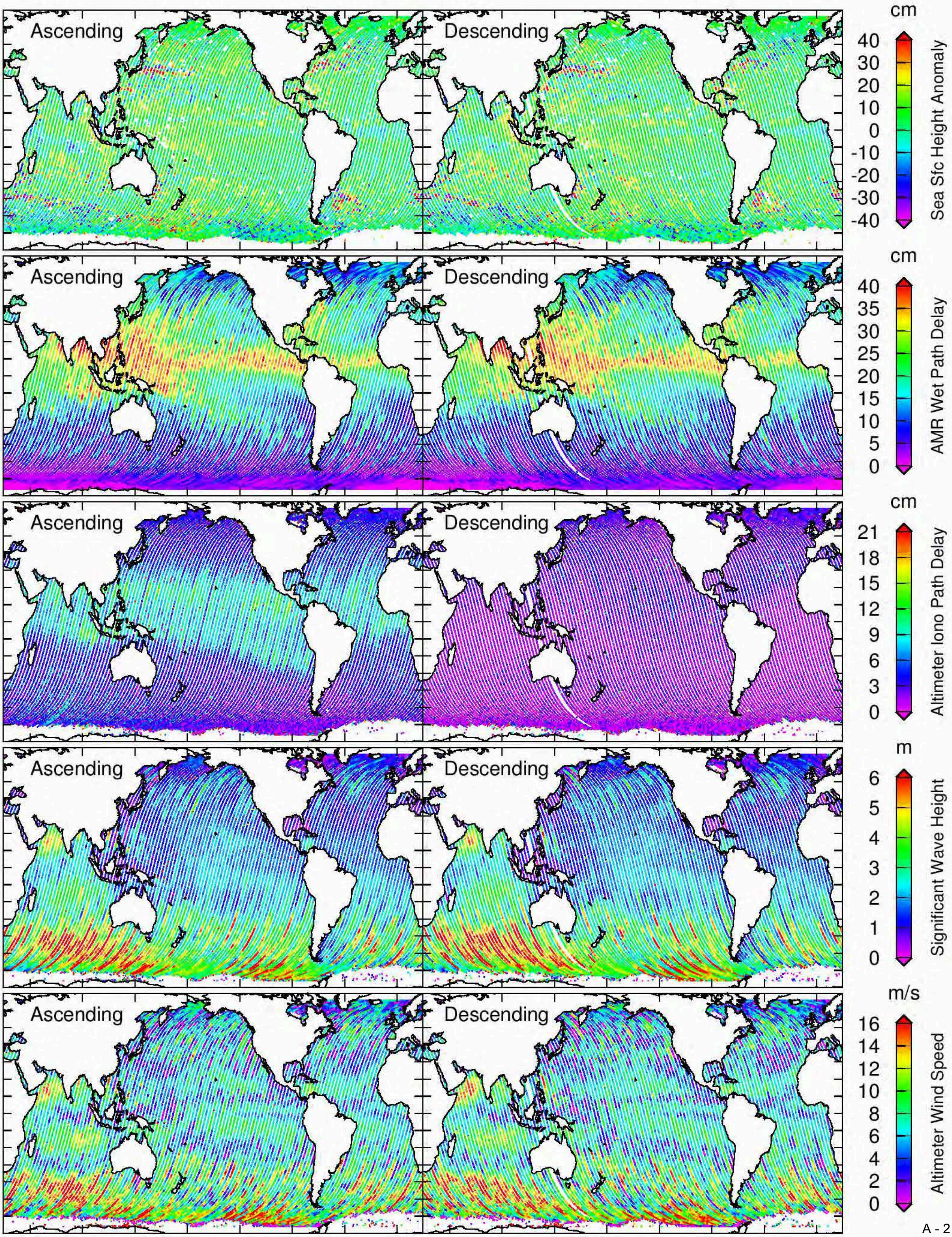
This third report based on OGDR-D data reiterates a concern which the project team needs to address:

SSHA values are being defaulted when the rain flag (and others) are set. The values should be provided, with the flags providing edit criteria guidance.

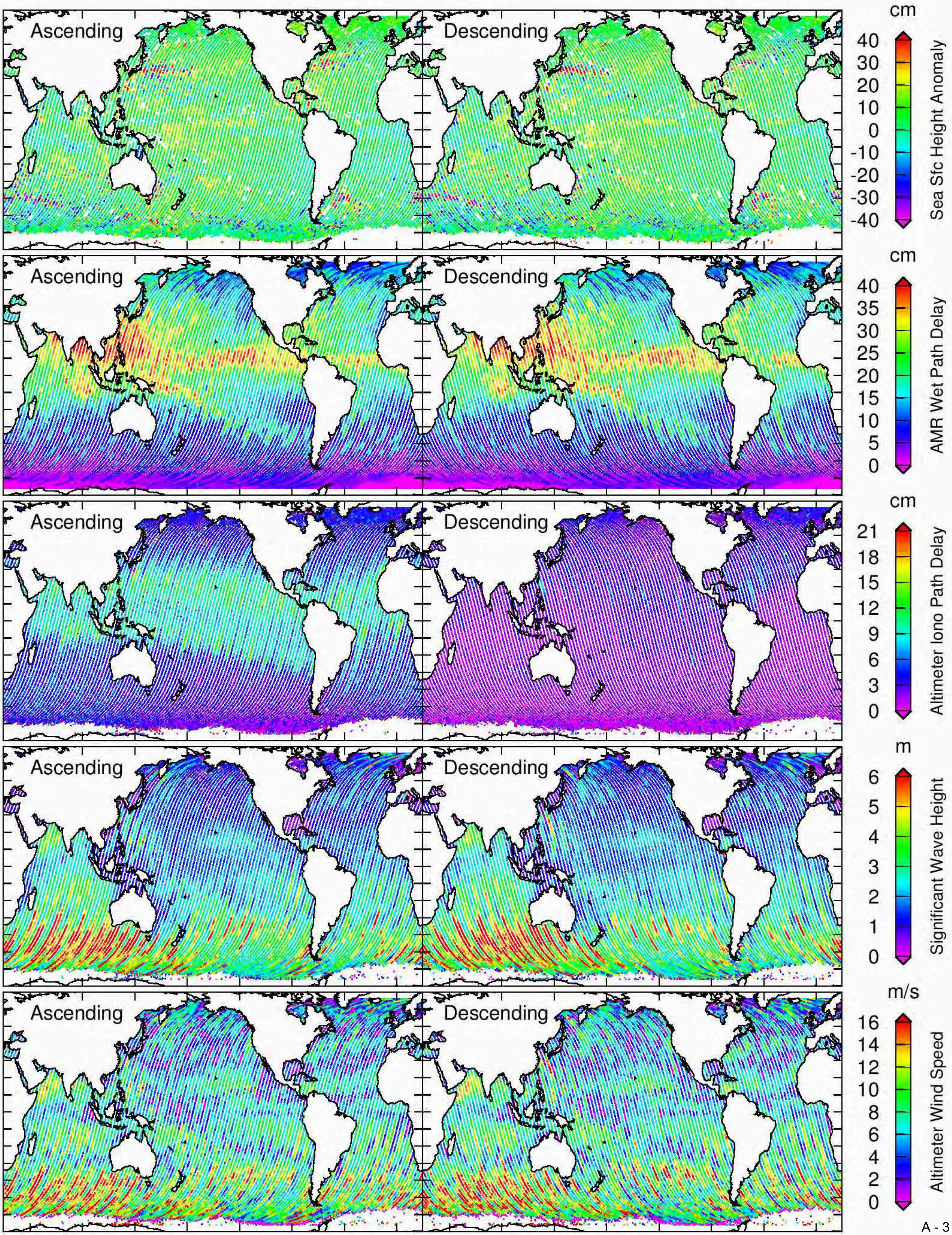
Appendix A. Cyclic Parameter Plots Cycle-222 to Cycle-257

See individual plots on the following 36 pages.

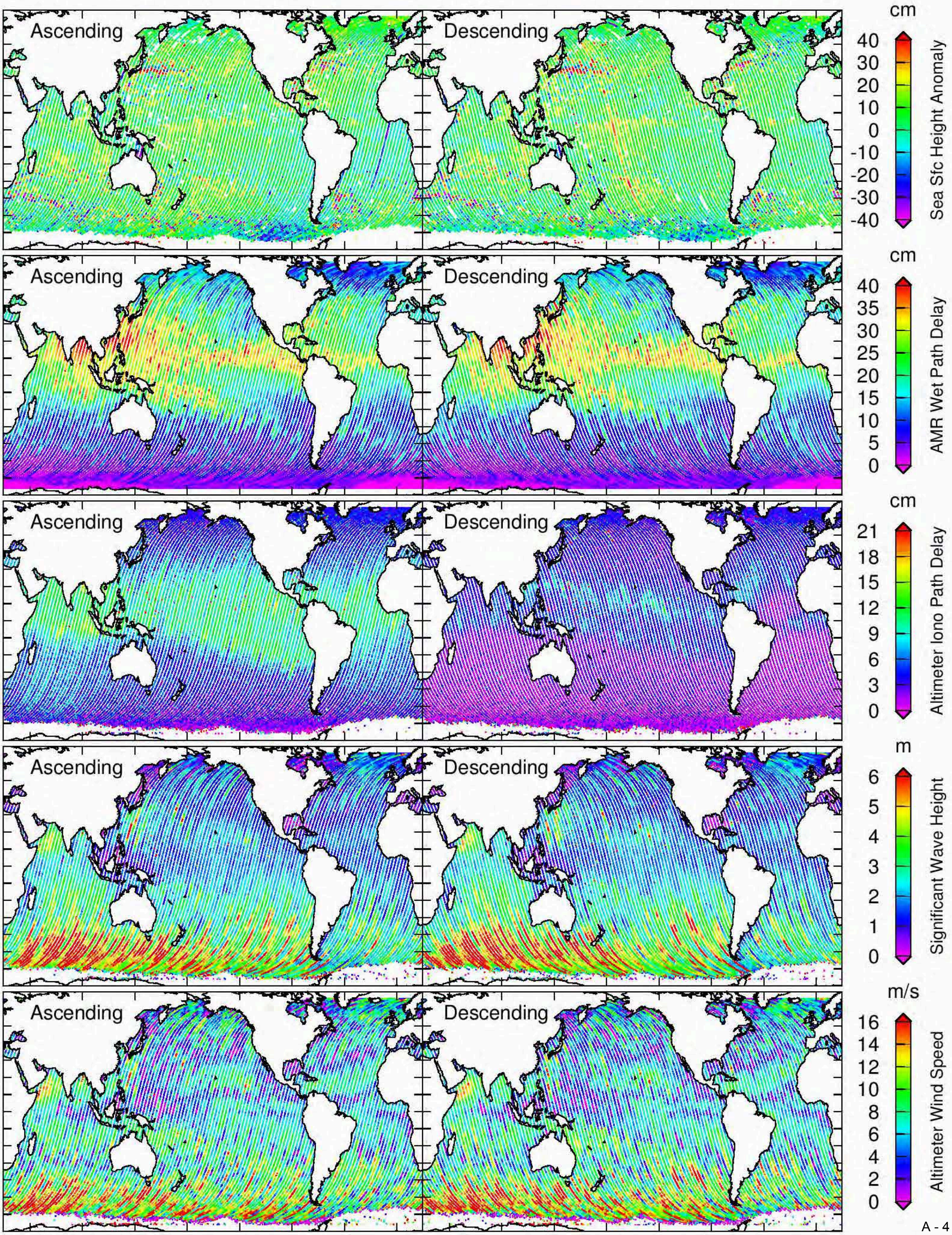
Jason-2 Cycle-222 2014-07-12 09:54:17 - 2014-07-22 07:52:50



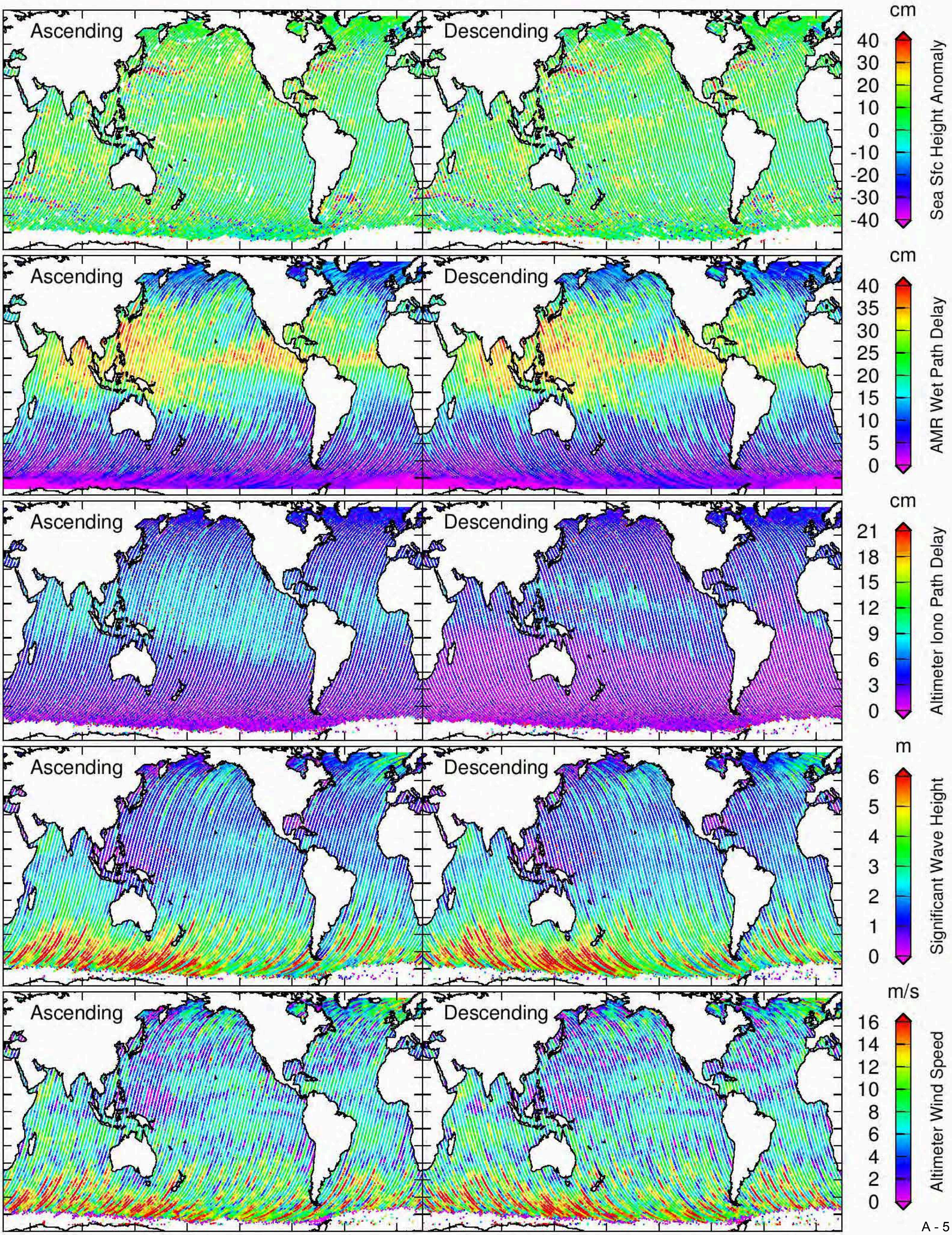
Jason-2 Cycle-223 2014-07-22 07:52:50 - 2014-08-01 05:51:21



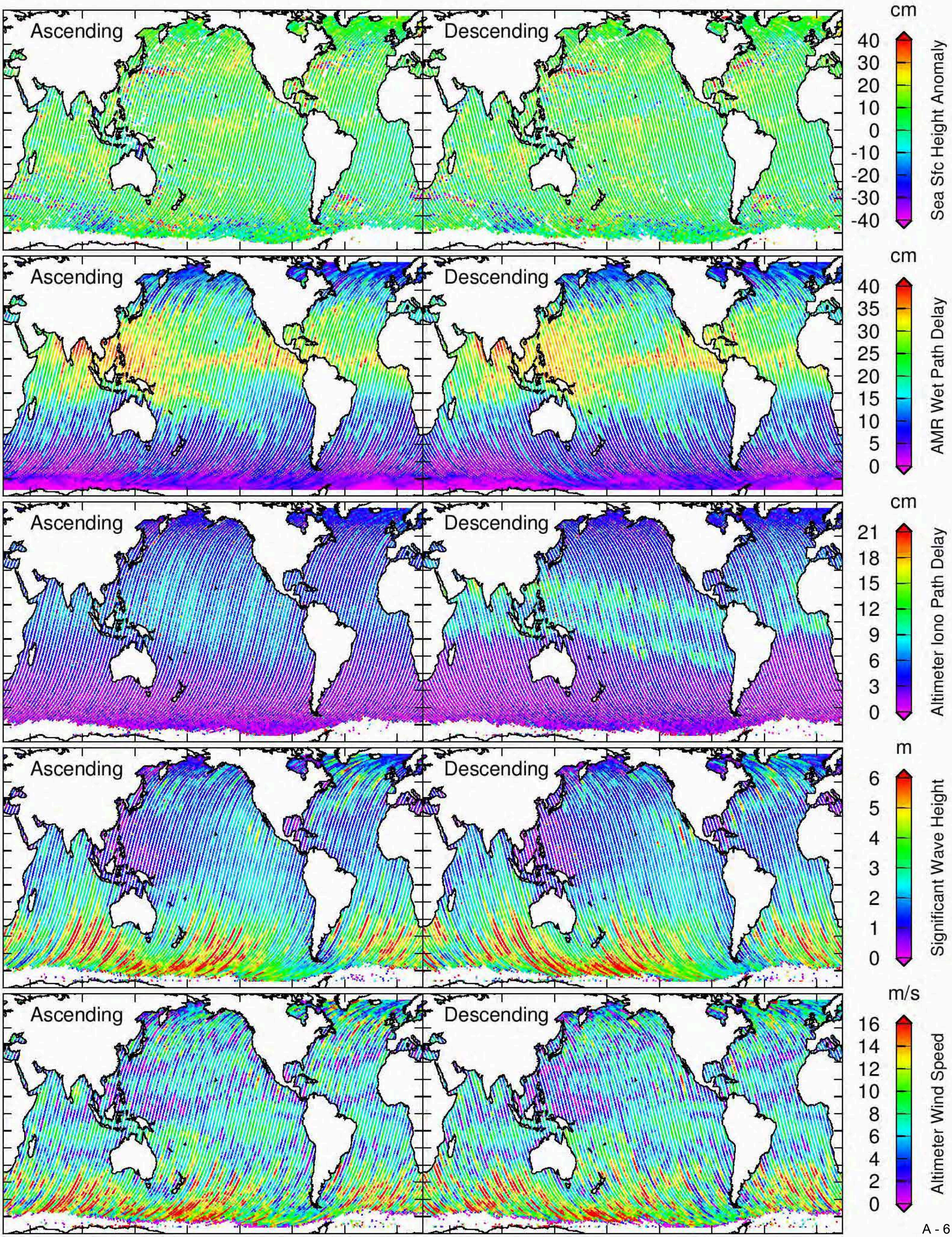
Jason-2 Cycle-224 2014-08-01 05:51:21 - 2014-08-11 03:49:53



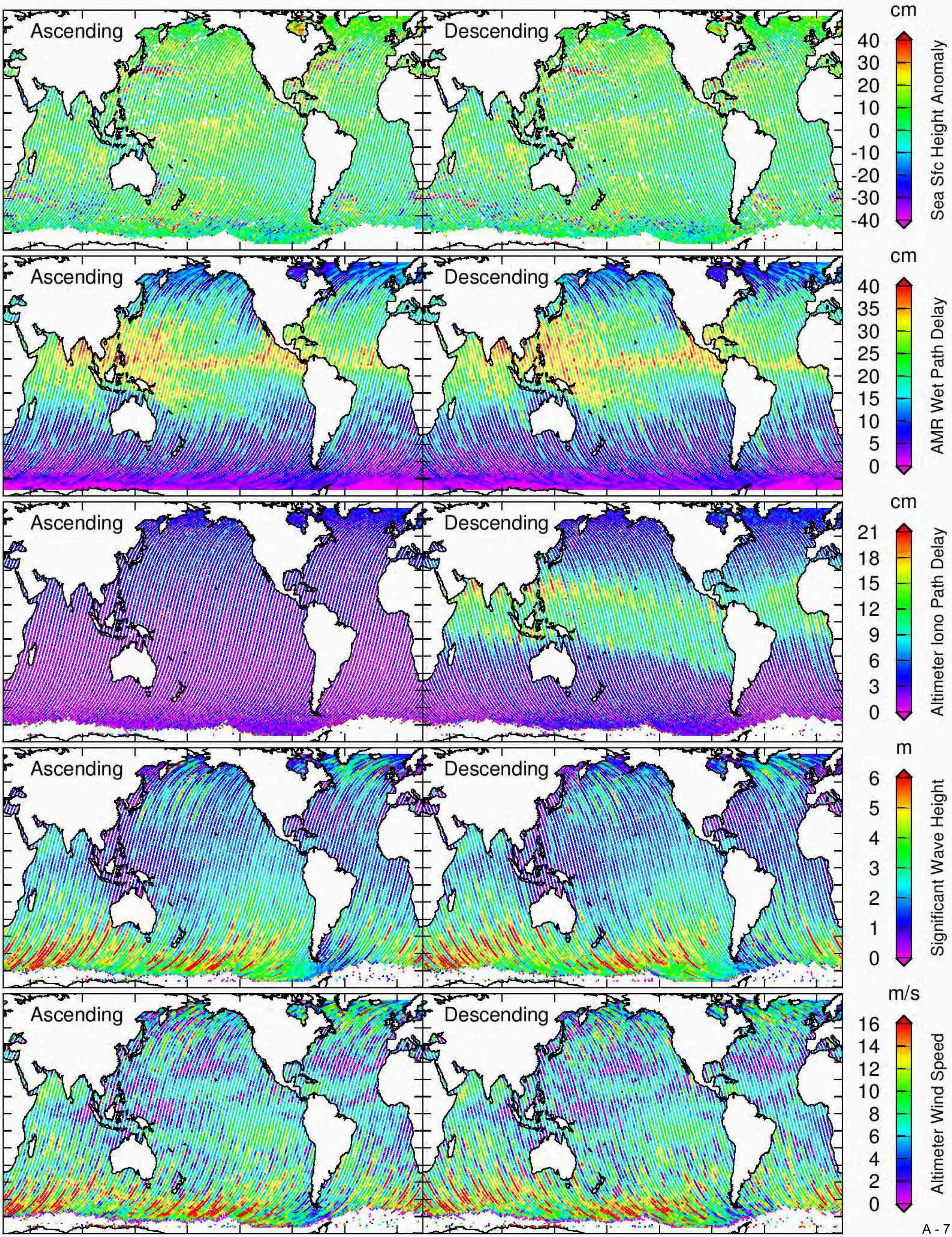
Jason-2 Cycle-225 2014-08-11 03:49:53 - 2014-08-21 01:48:24



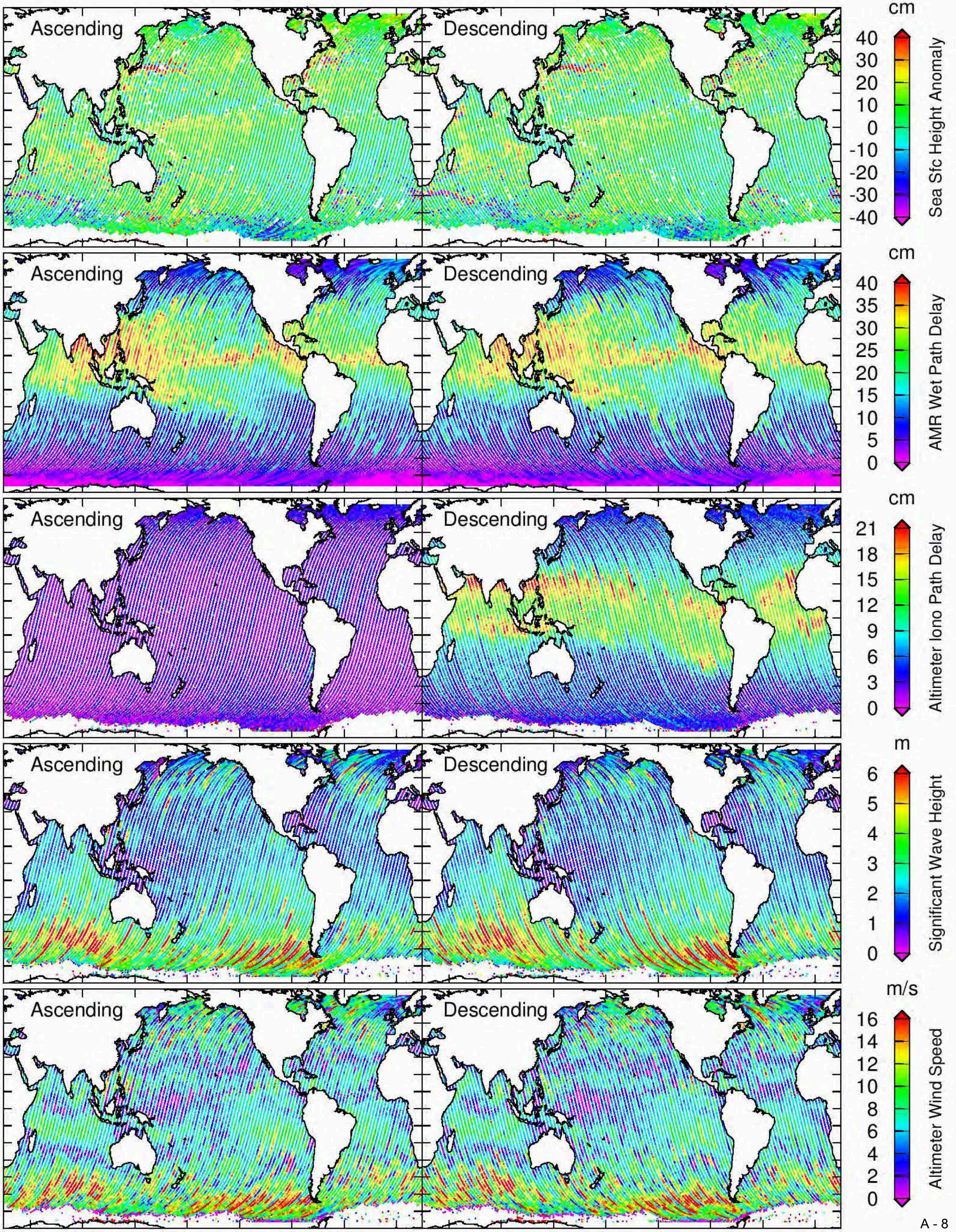
Jason-2 Cycle-226 2014-08-21 01:48:24 - 2014-08-30 23:46:56



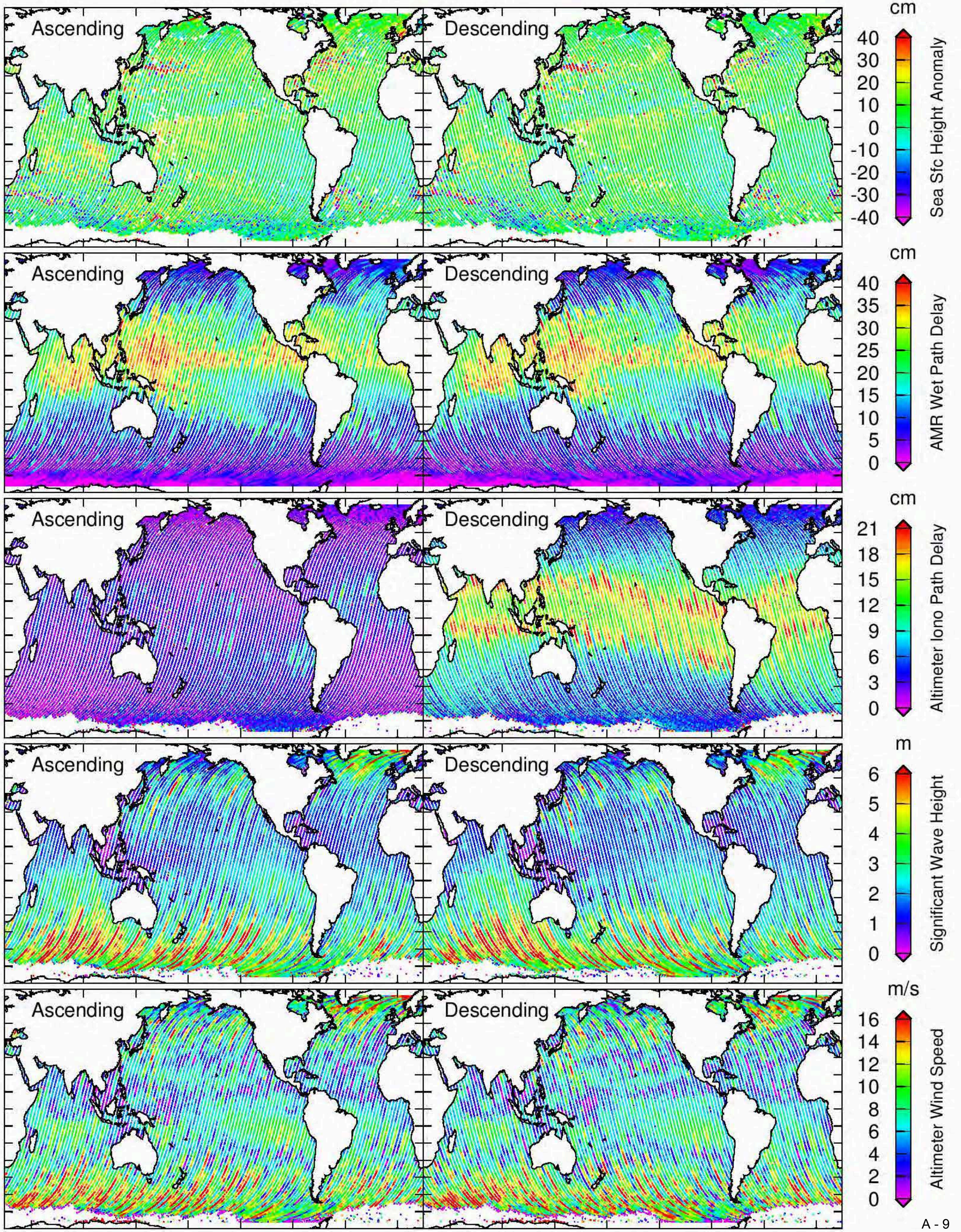
Jason-2 Cycle-227 2014-08-30 23:46:56 - 2014-09-09 21:45:28



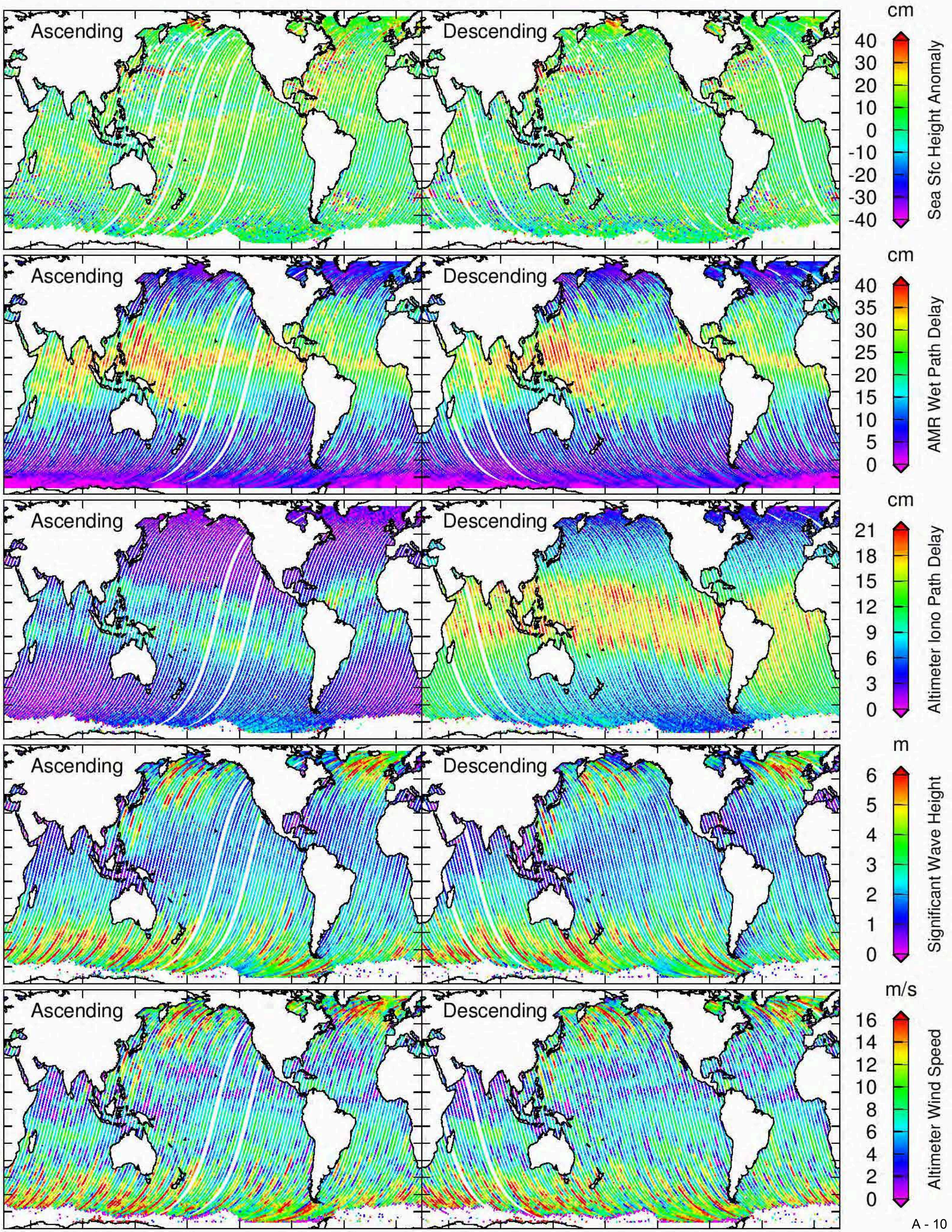
Jason-2 Cycle-228 2014-09-09 21:45:28 - 2014-09-19 19:43:59



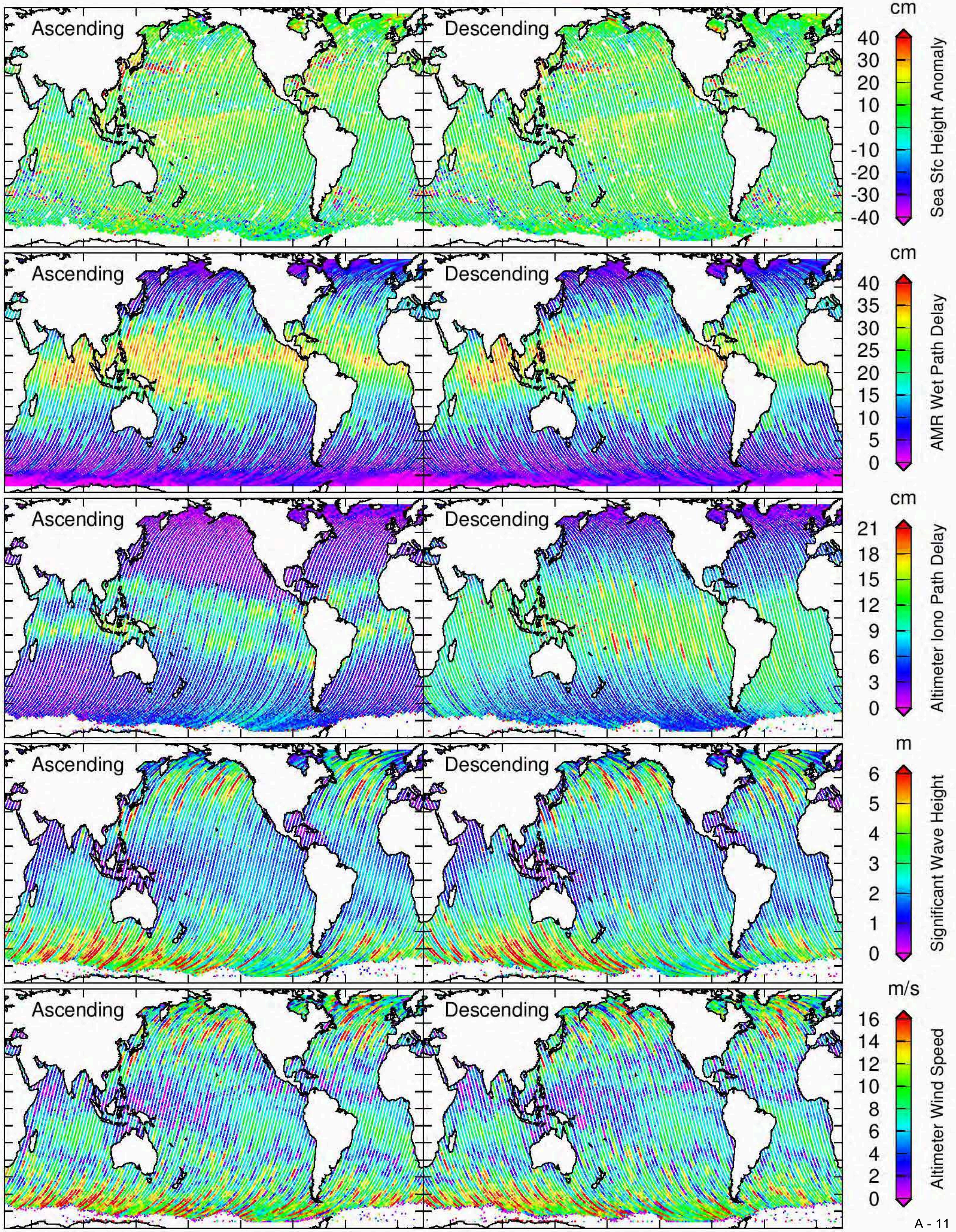
Jason-2 Cycle-229 2014-09-19 19:43:59 - 2014-09-29 17:42:31



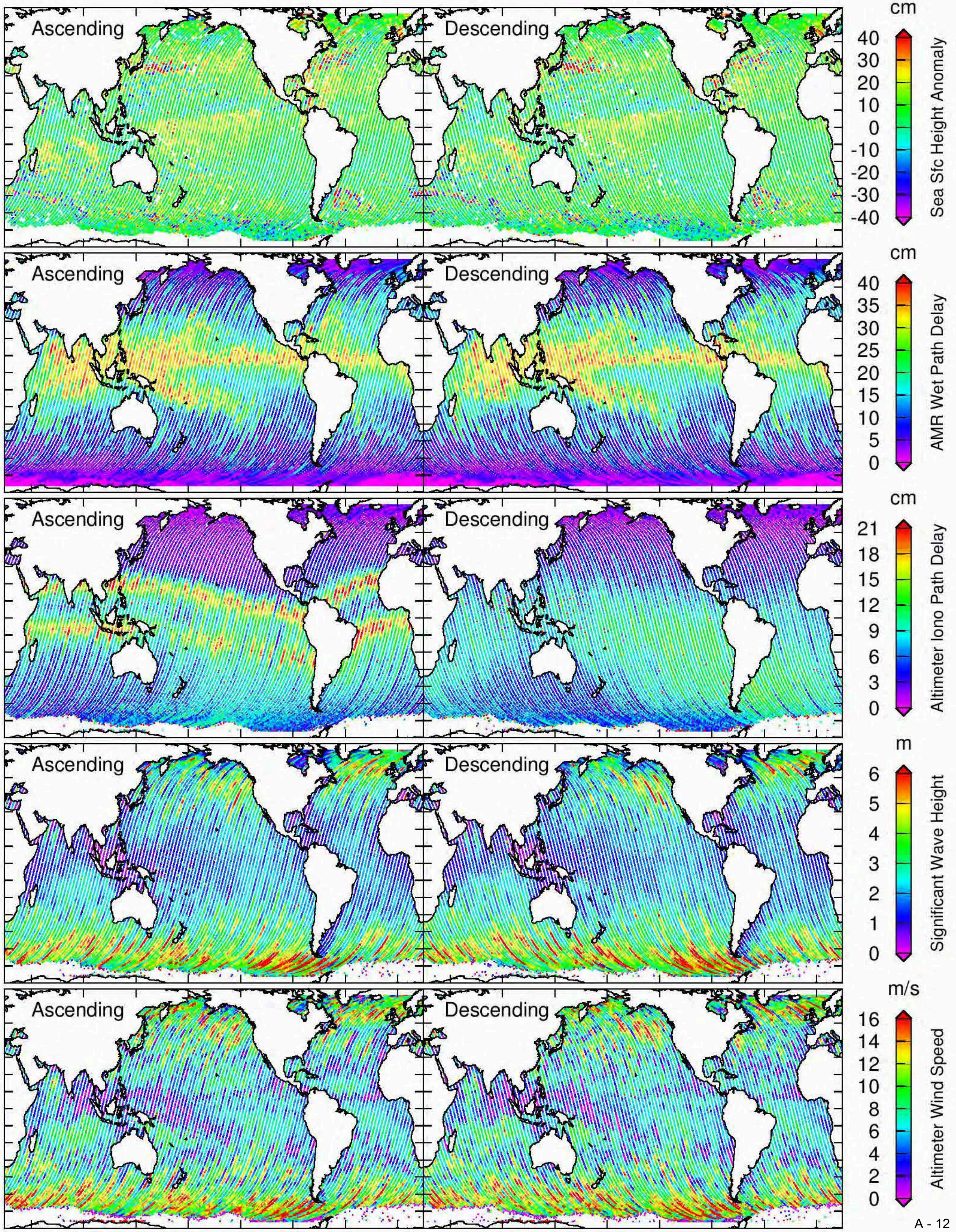
Jason-2 Cycle-230 2014-09-29 17:42:31 - 2014-10-09 15:41:03



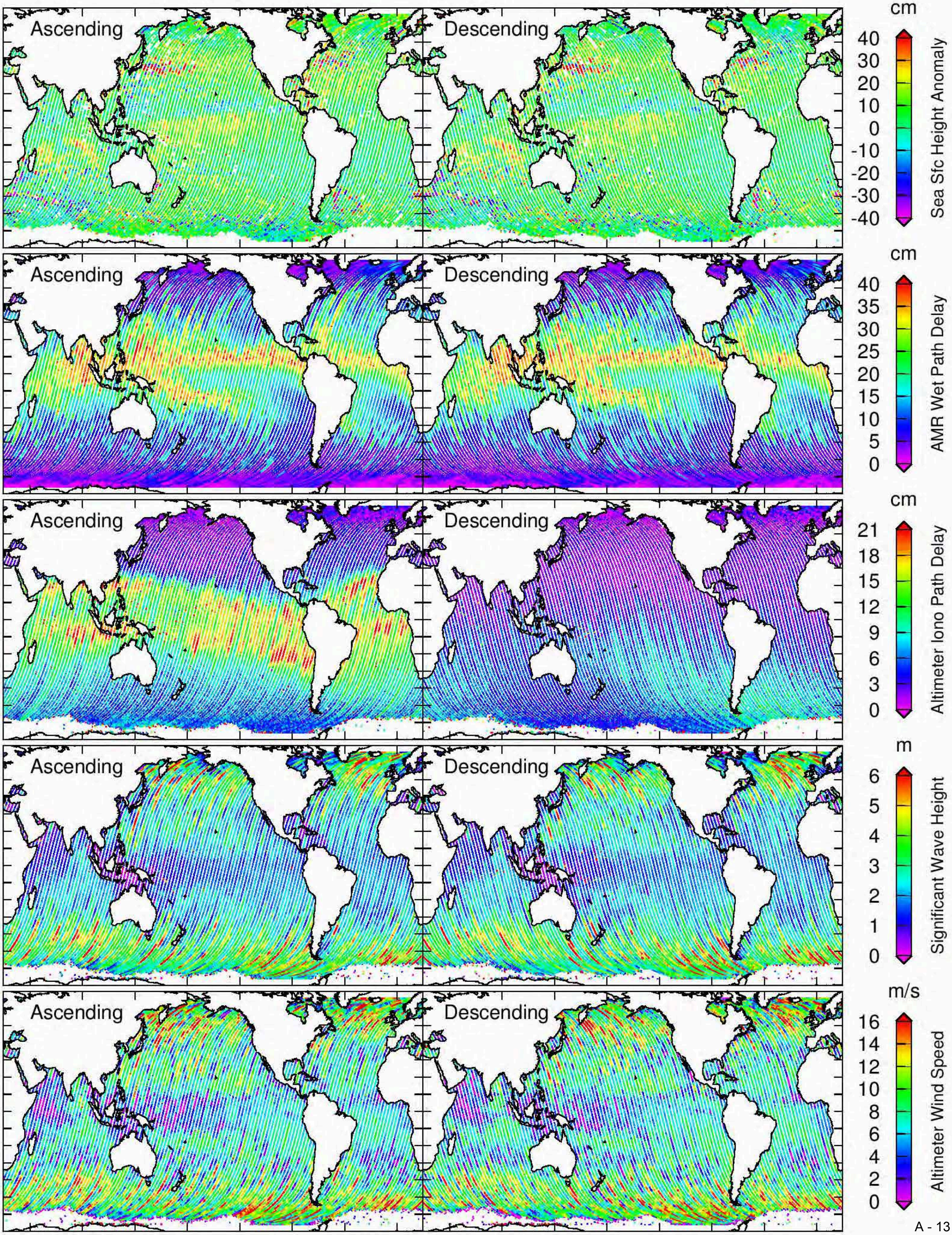
Jason-2 Cycle-231 2014-10-09 15:41:03 - 2014-10-19 13:39:34



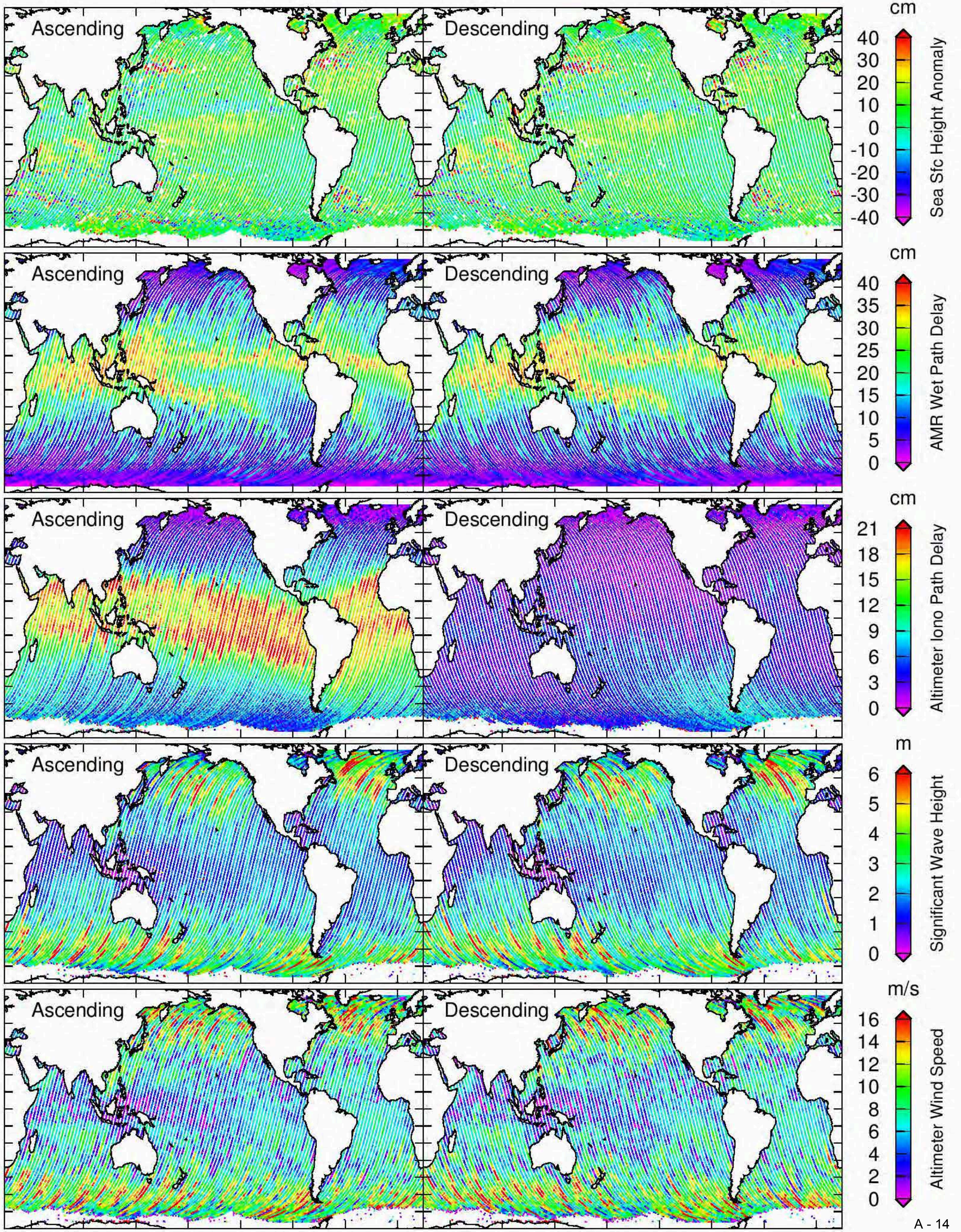
Jason-2 Cycle-232 2014-10-19 13:39:34 - 2014-10-29 11:38:06



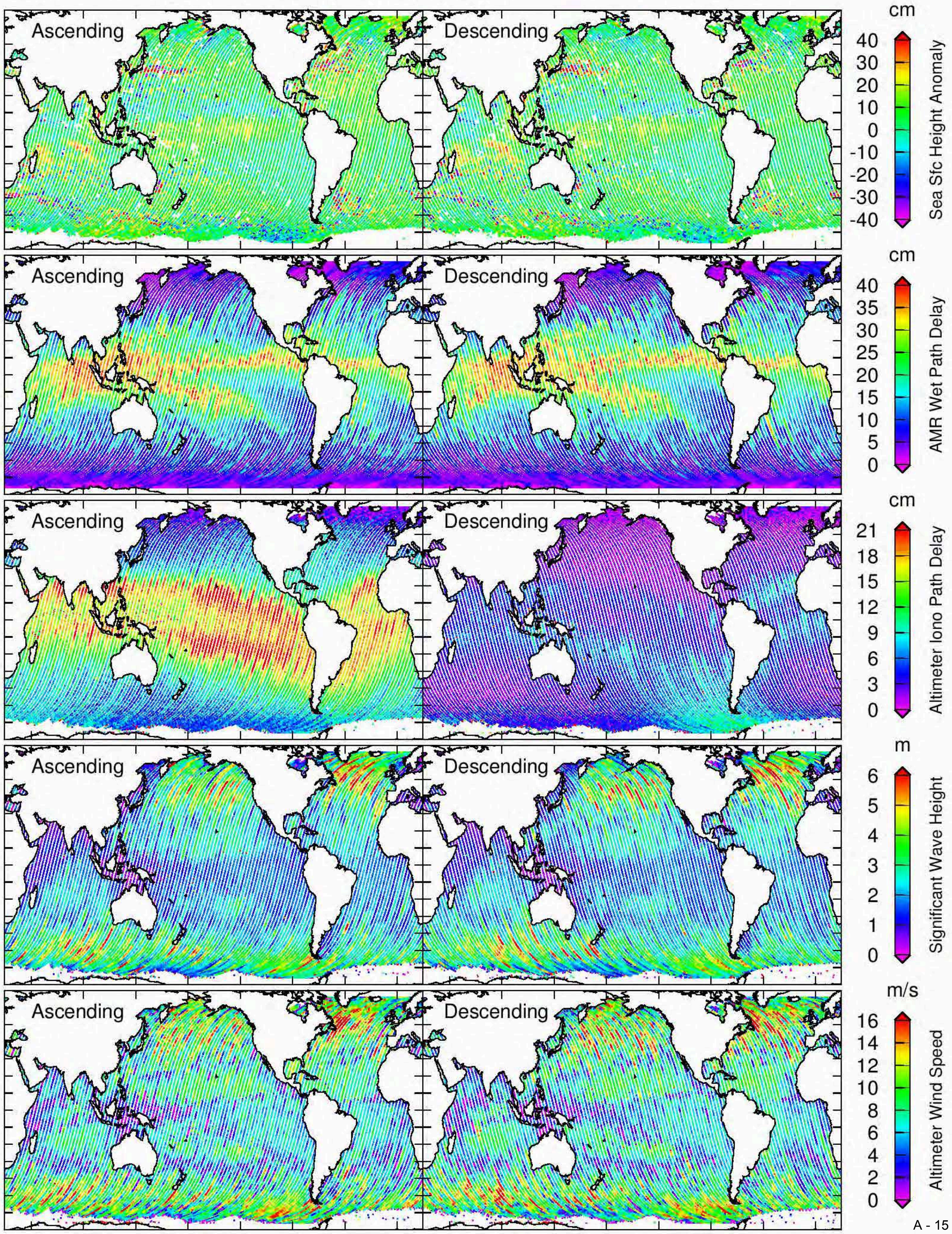
Jason-2 Cycle-233 2014-10-29 11:38:06 - 2014-11-08 09:36:37



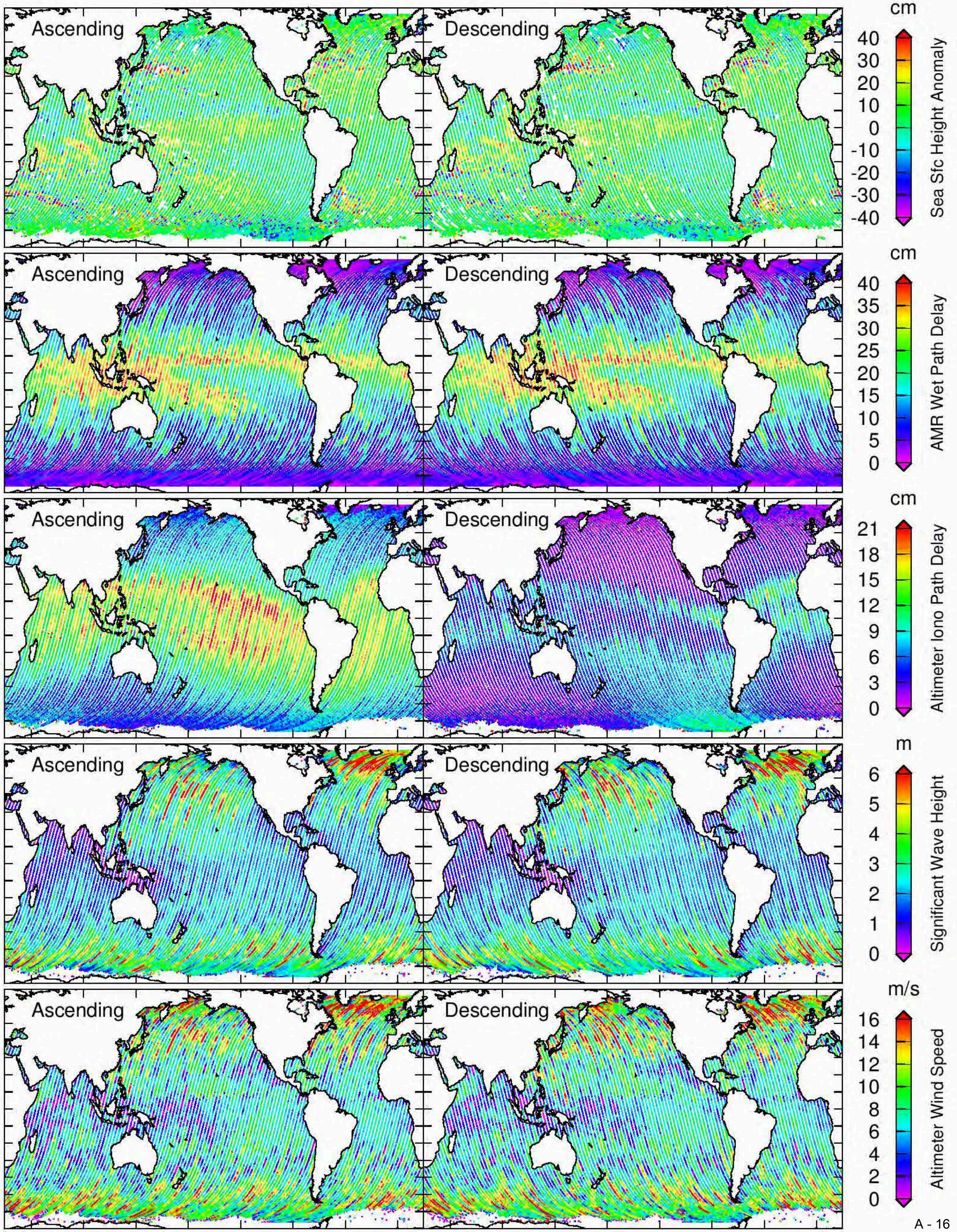
Jason-2 Cycle-234 2014-11-08 09:36:37 - 2014-11-18 07:35:09



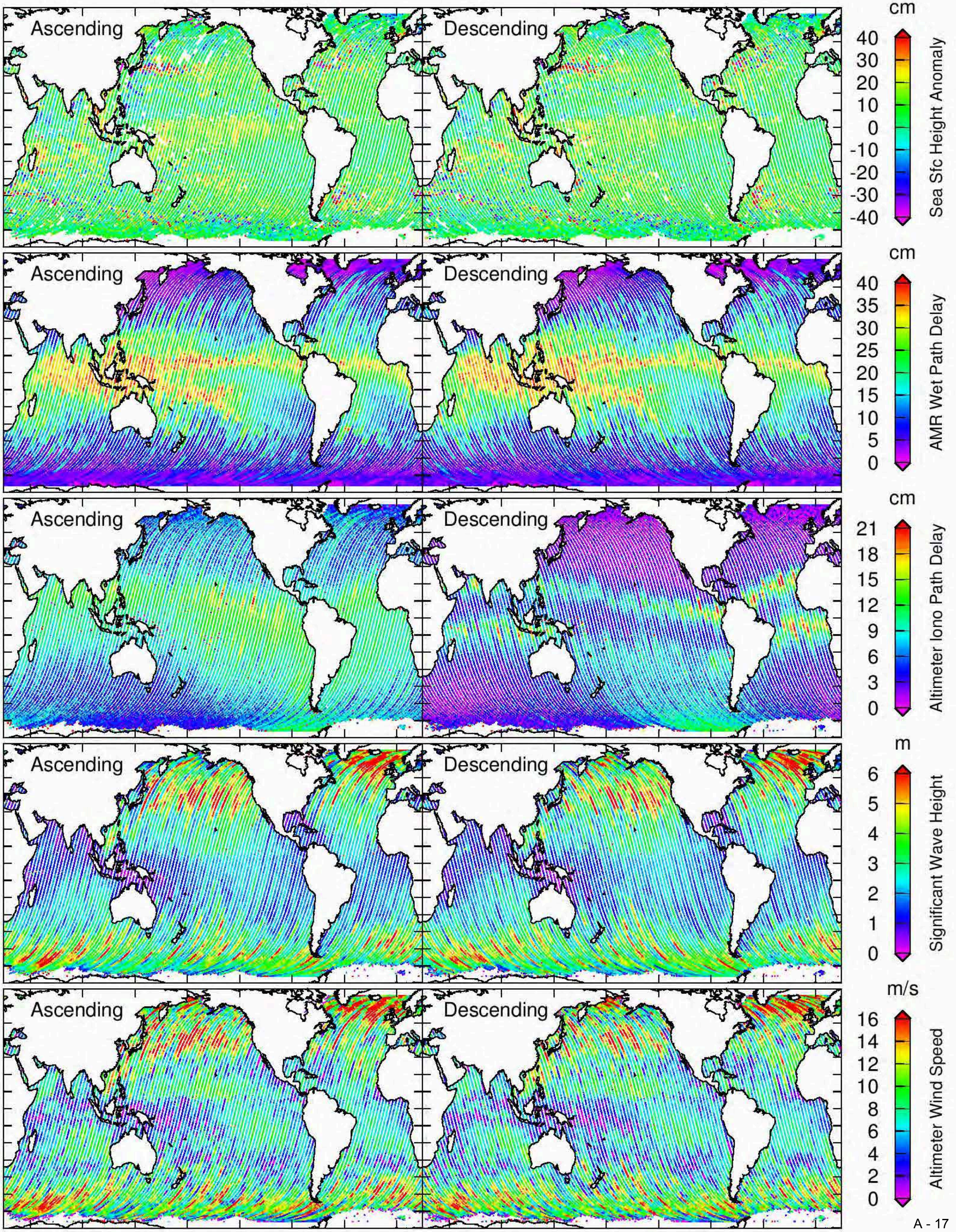
Jason-2 Cycle-235 2014-11-18 07:35:09 - 2014-11-28 05:33:41



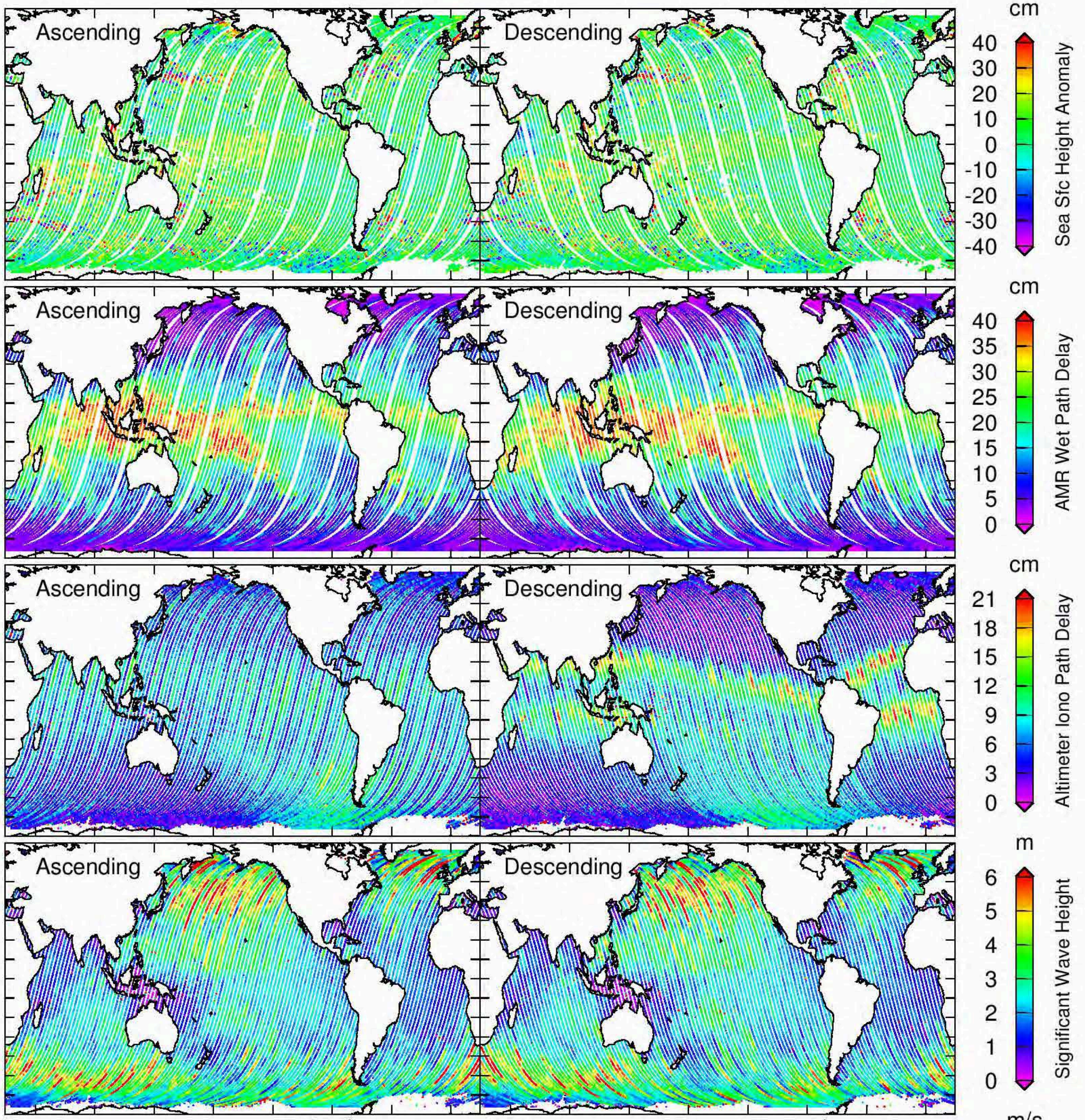
Jason-2 Cycle-236 2014-11-28 05:33:41 - 2014-12-08 03:32:12



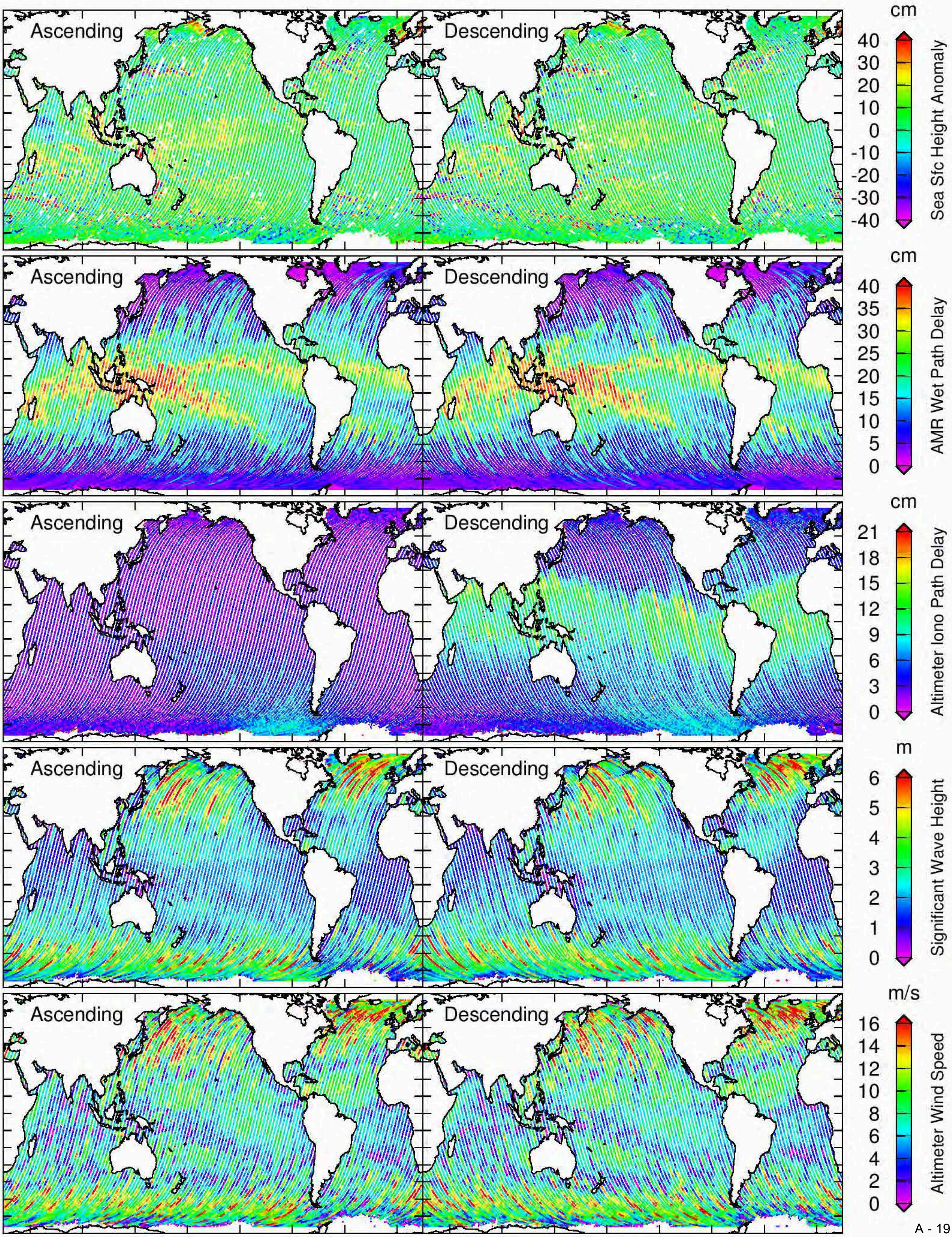
Jason-2 Cycle-237 2014-12-08 03:32:12 - 2014-12-18 01:30:44



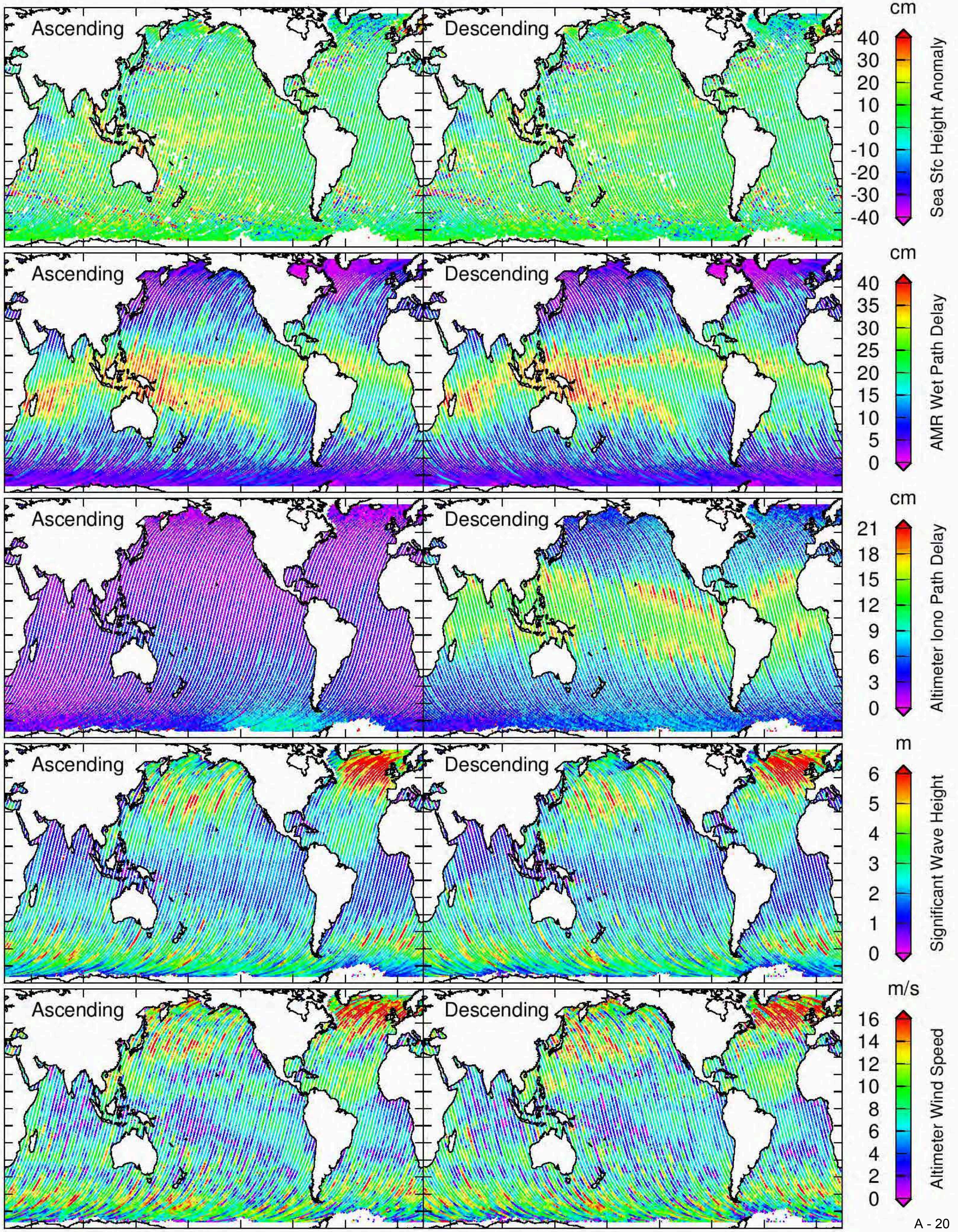
Jason-2 Cycle-238 2014-12-18 01:30:44 - 2014-12-27 23:29:15



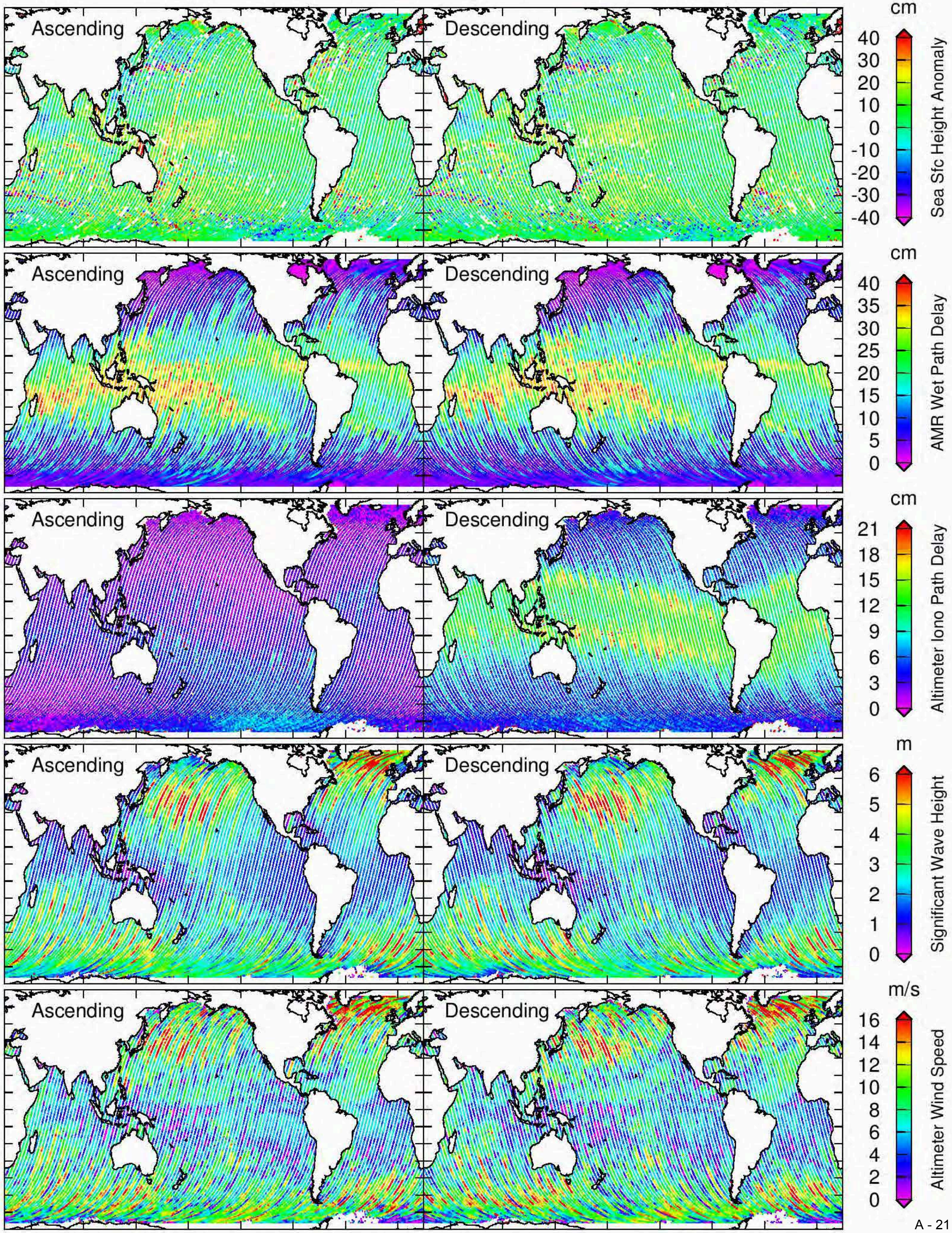
Jason-2 Cycle-239 2014-12-27 23:29:15 - 2015-01-06 21:27:47



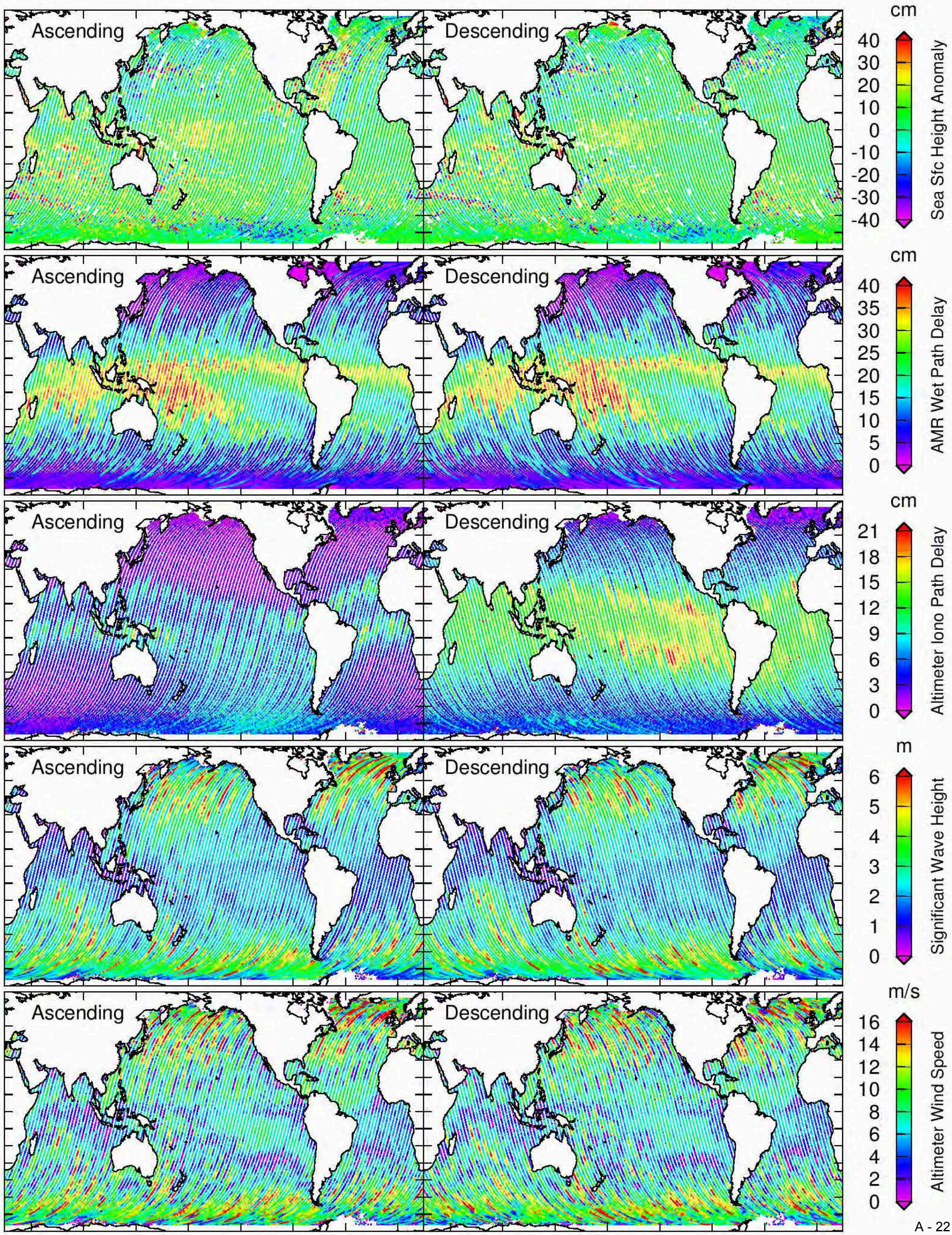
Jason-2 Cycle-240 2015-01-06 21:27:47 - 2015-01-16 19:26:19



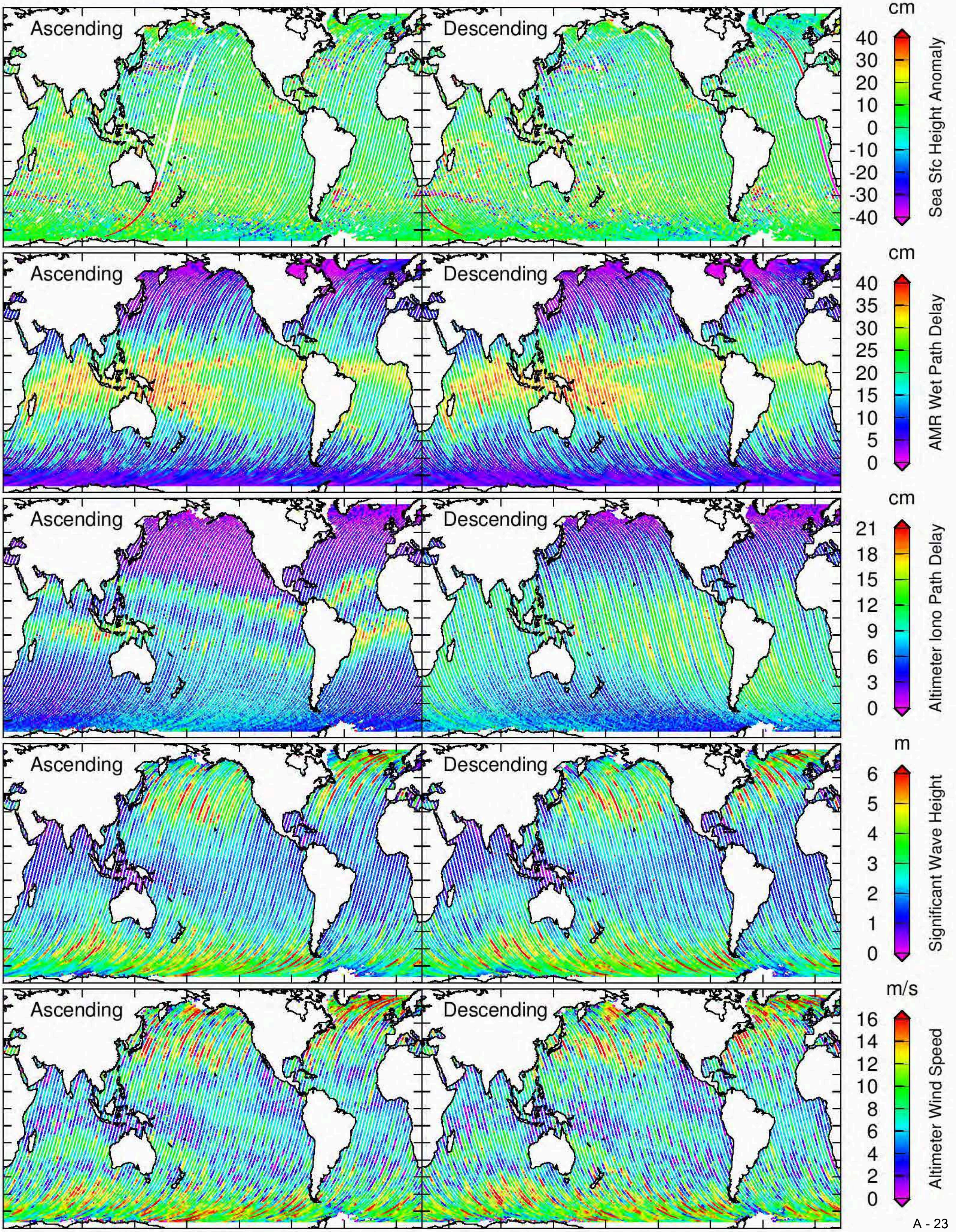
Jason-2 Cycle-241 2015-01-16 19:26:19 - 2015-01-26 17:24:50



Jason-2 Cycle-242 2015-01-26 17:24:50 - 2015-02-05 15:23:22



Jason-2 Cycle-243 2015-02-05 15:23:22 - 2015-02-15 13:21:53



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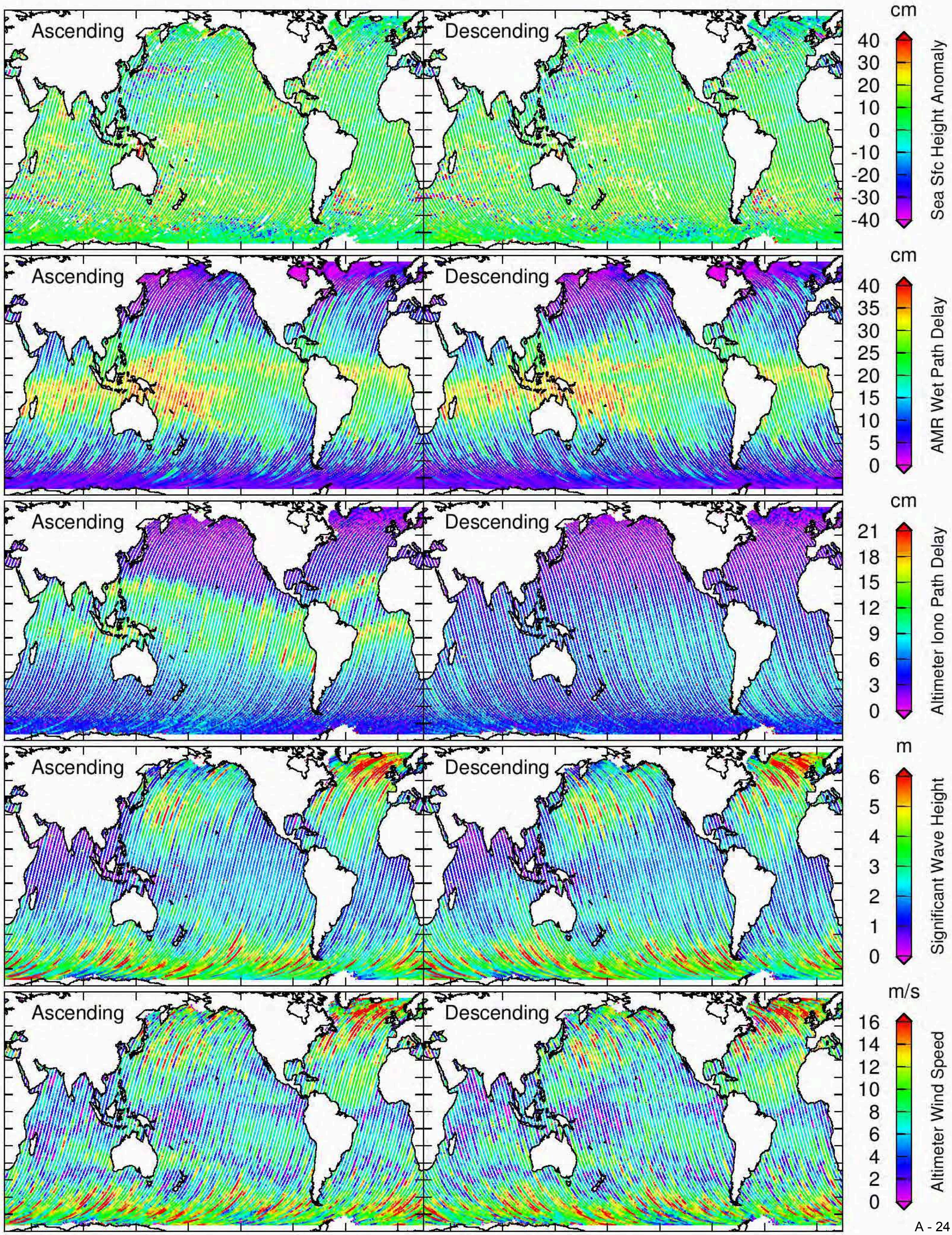

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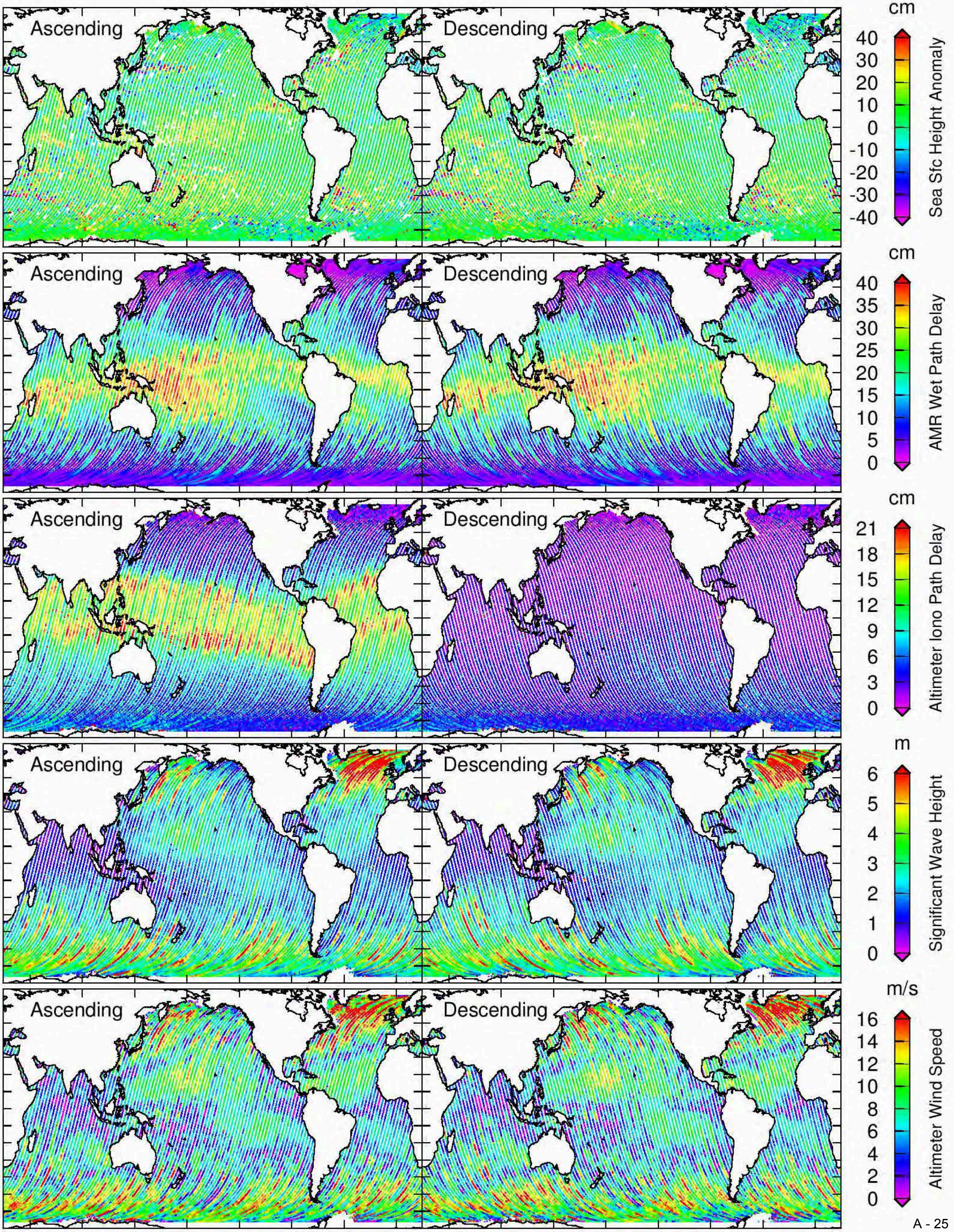
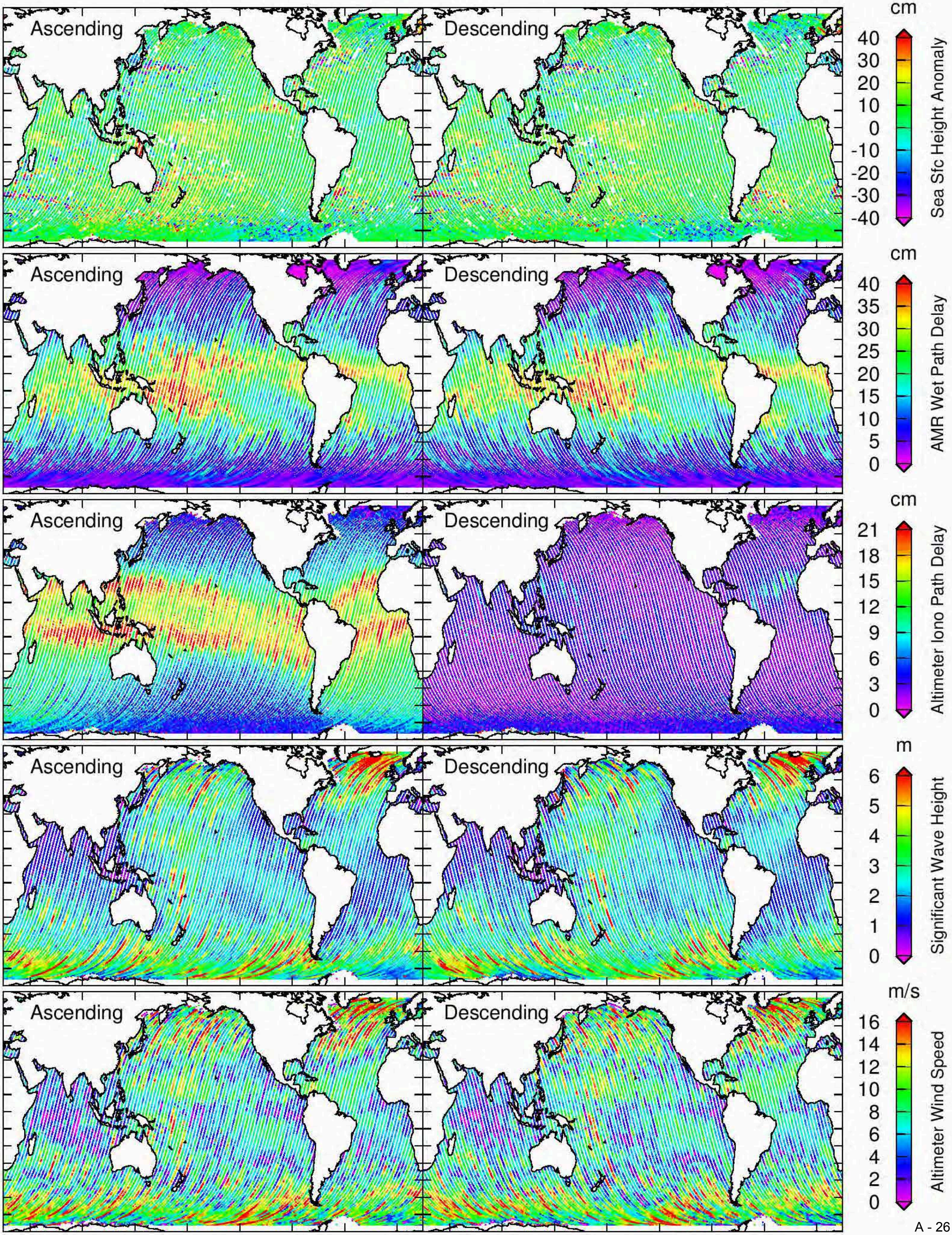
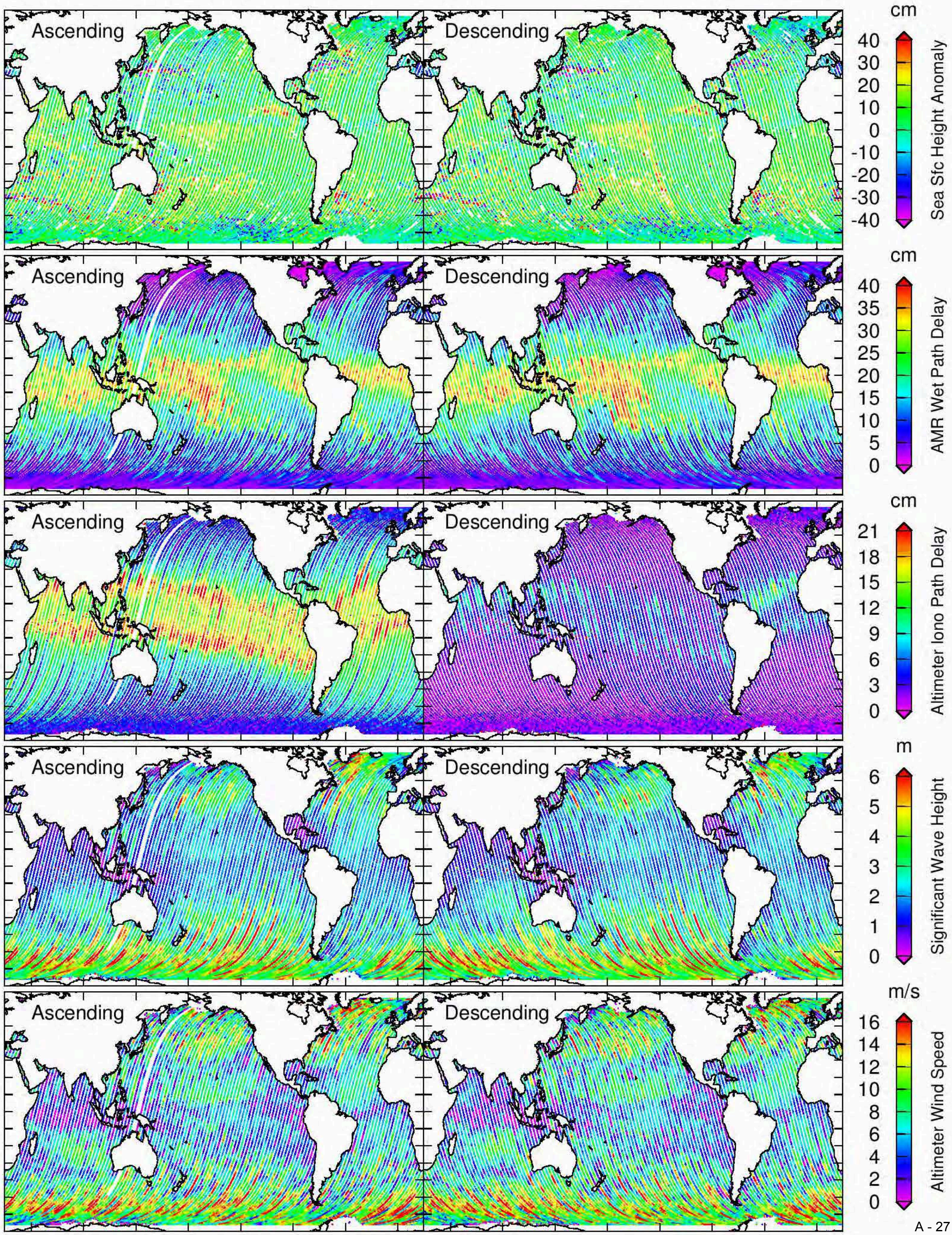


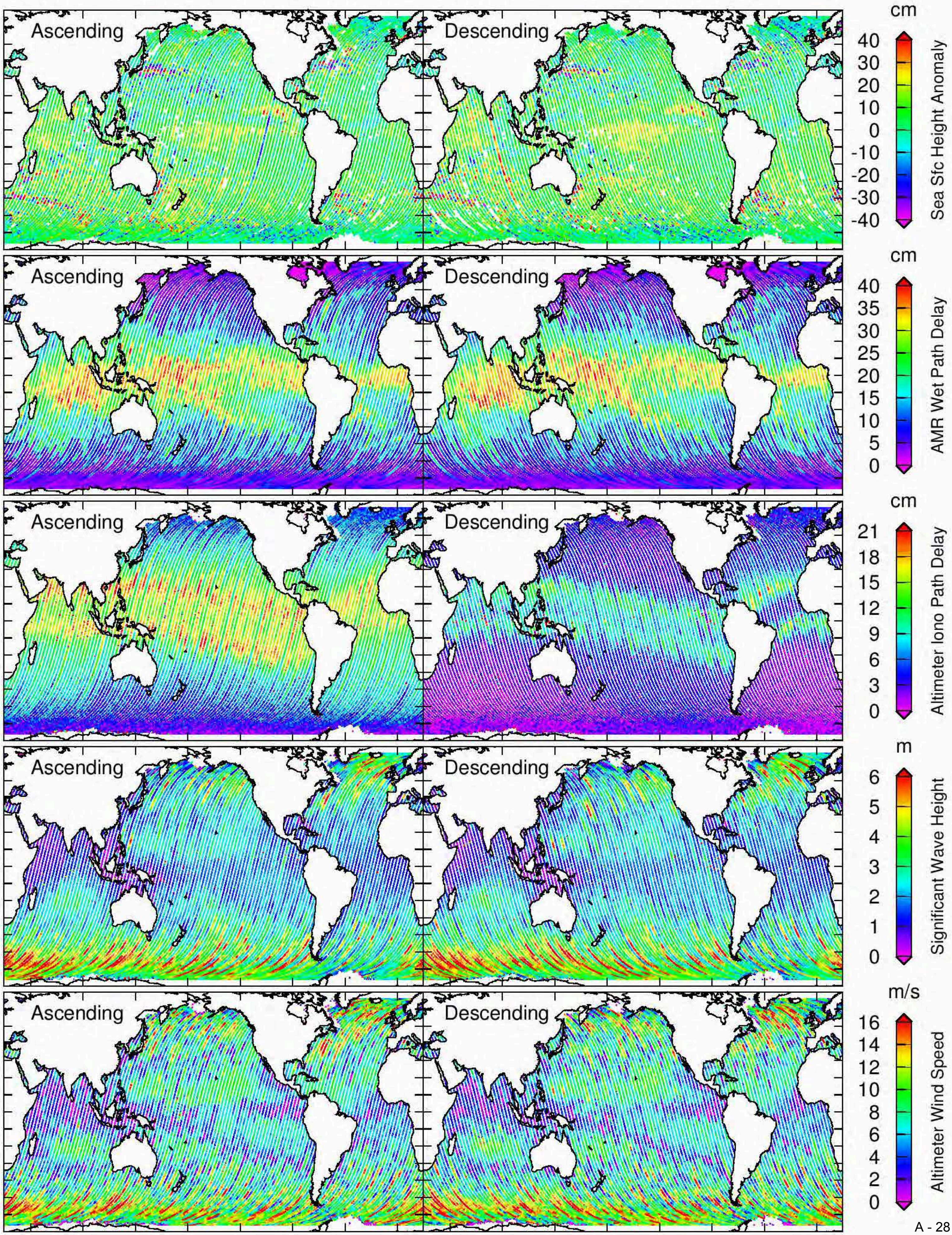
Jason-2 Cycle-246 2015-03-07 09:18:57 - 2015-03-17 07:17:28



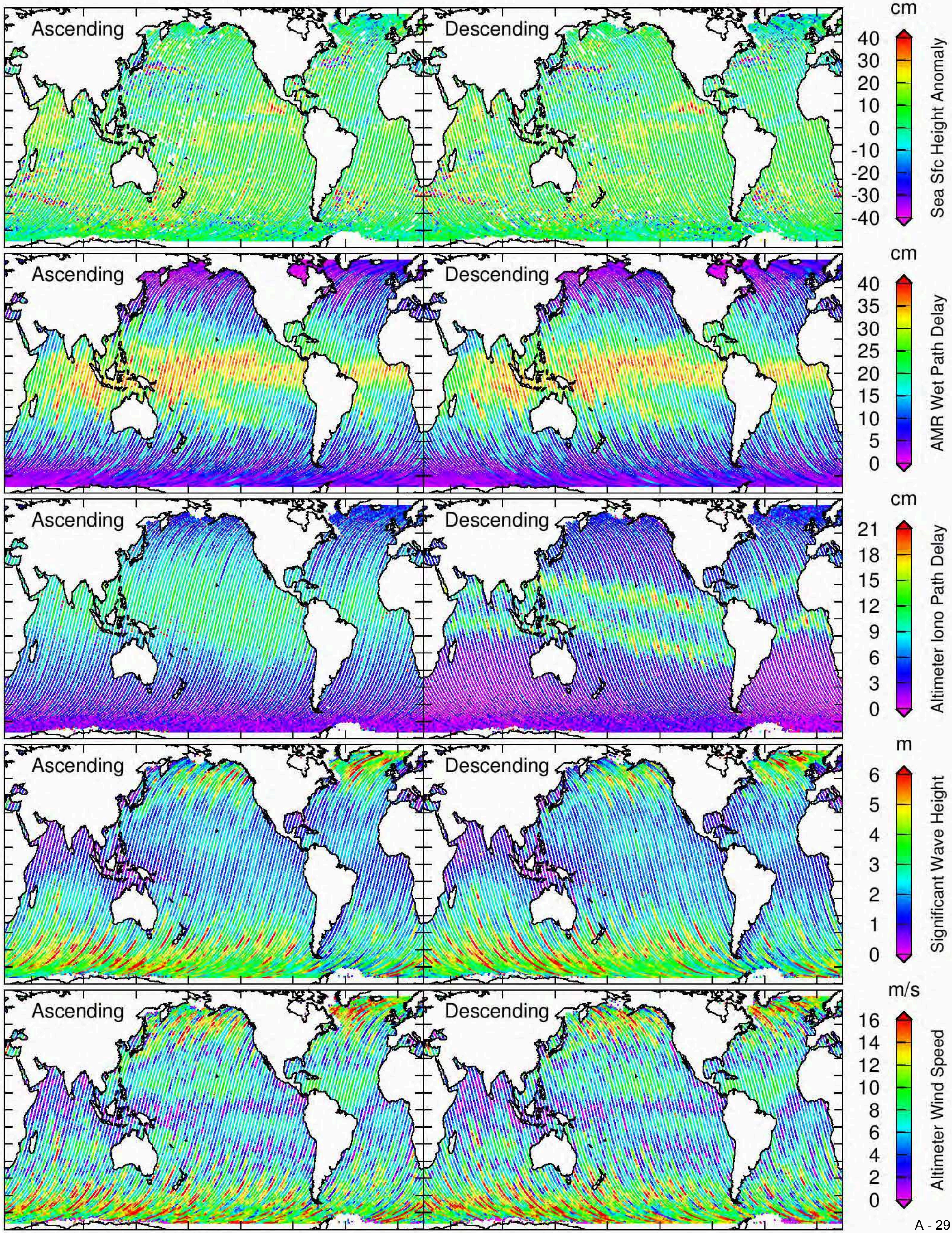
Jason-2 Cycle-247 2015-03-17 07:17:28 - 2015-03-27 05:16:00



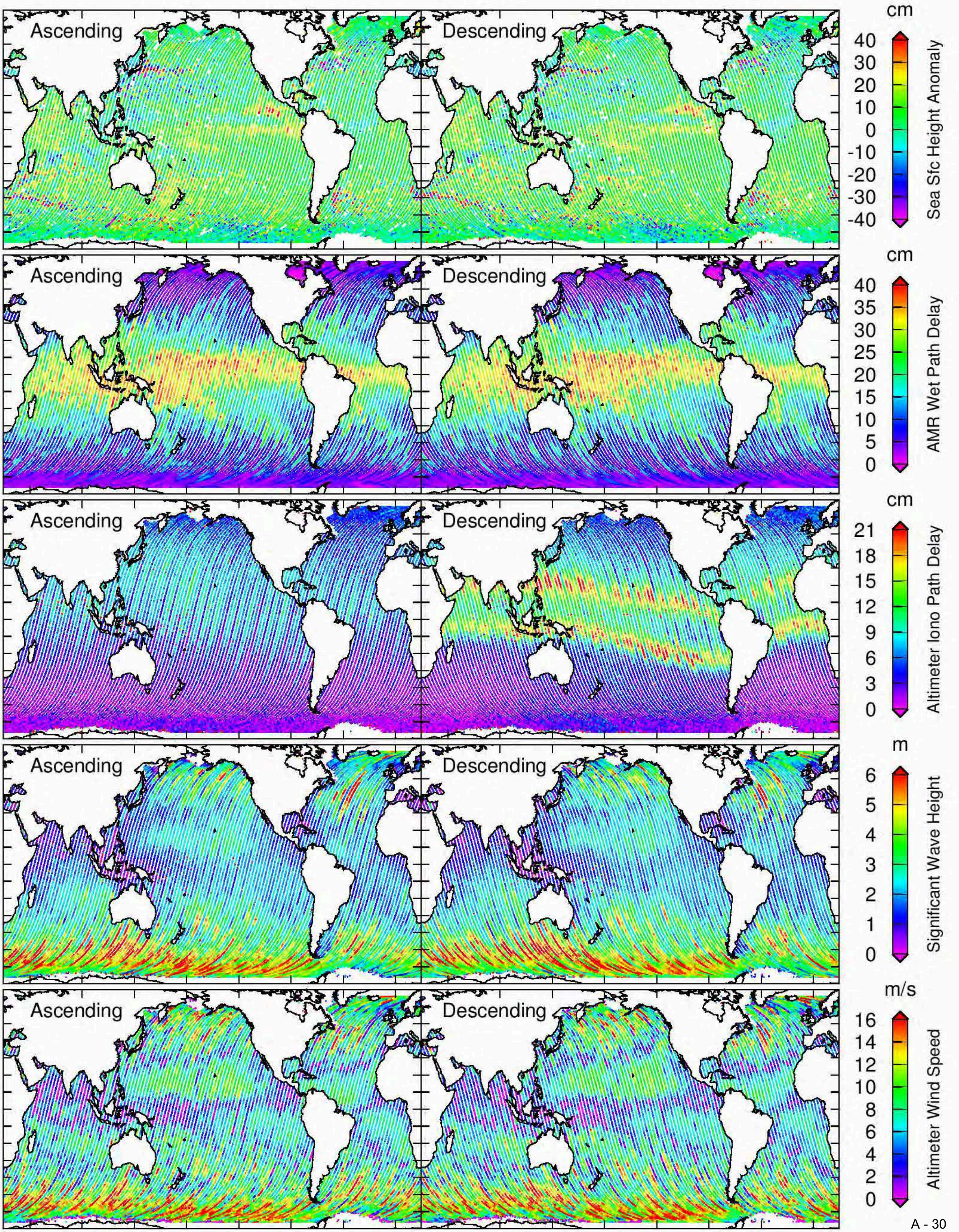
Jason-2 Cycle-248 2015-03-27 05:16:00 - 2015-04-06 03:14:32



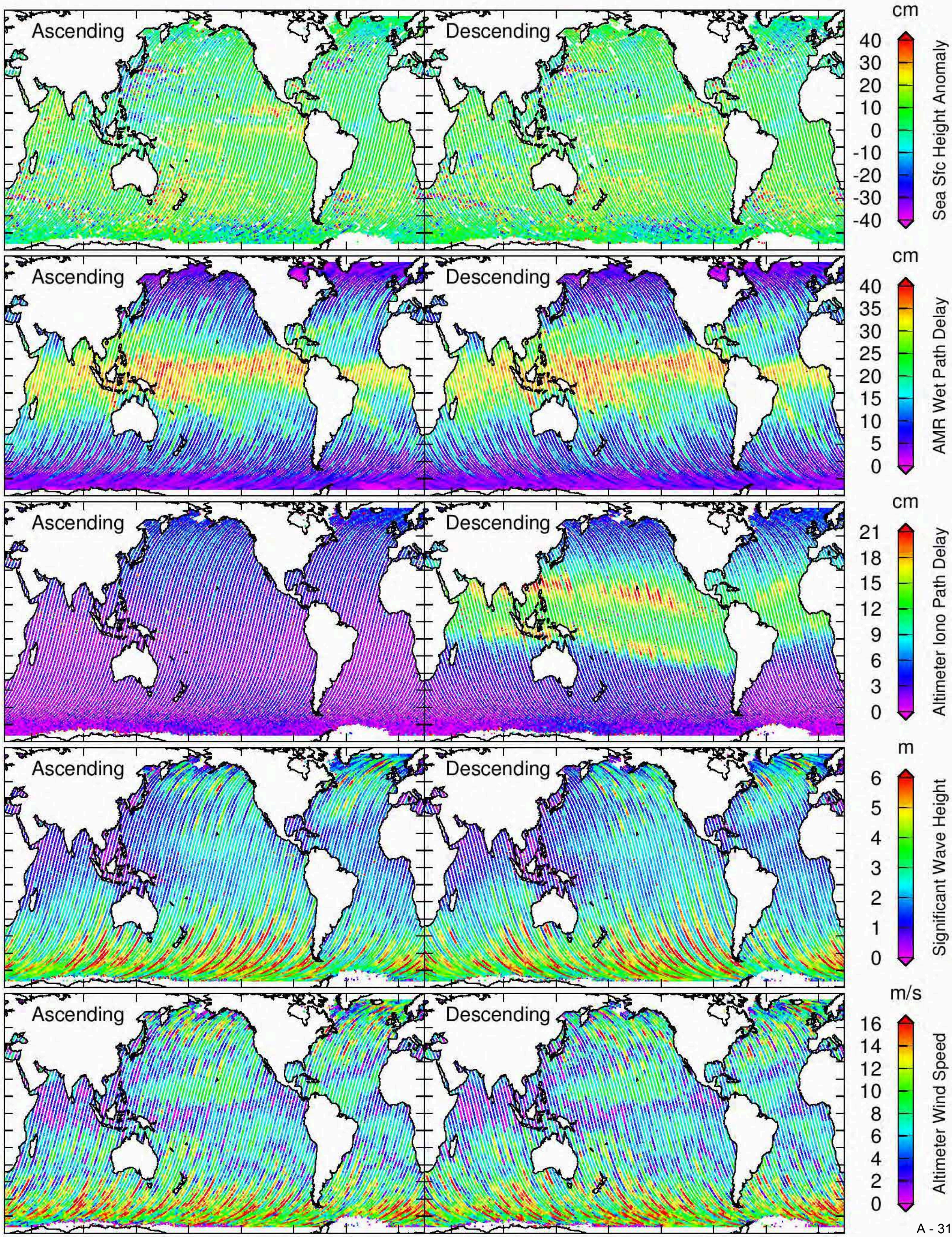
Jason-2 Cycle-249 2015-04-06 03:14:32 - 2015-04-16 01:13:03



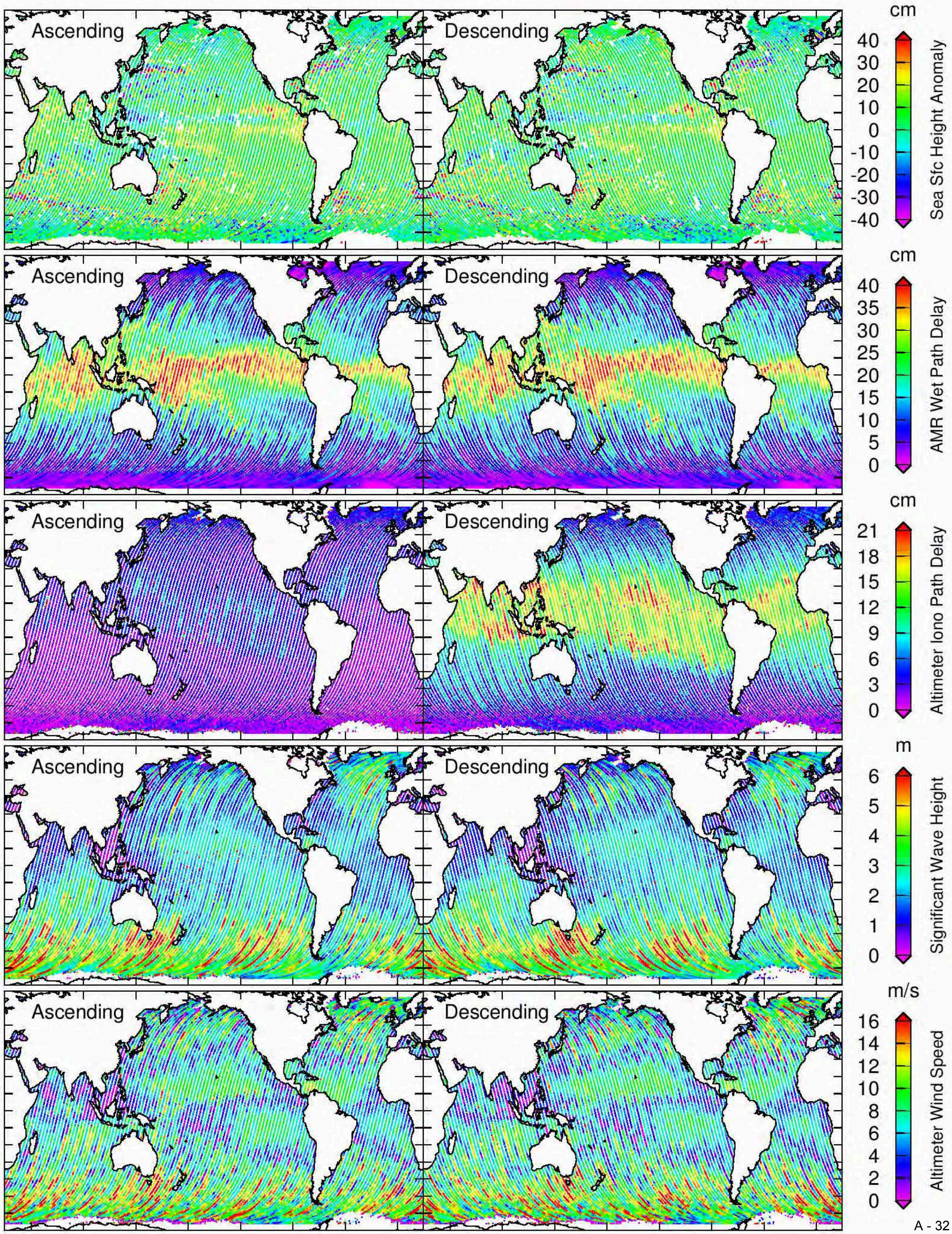
Jason-2 Cycle-250 2015-04-16 01:13:03 - 2015-04-25 23:11:35



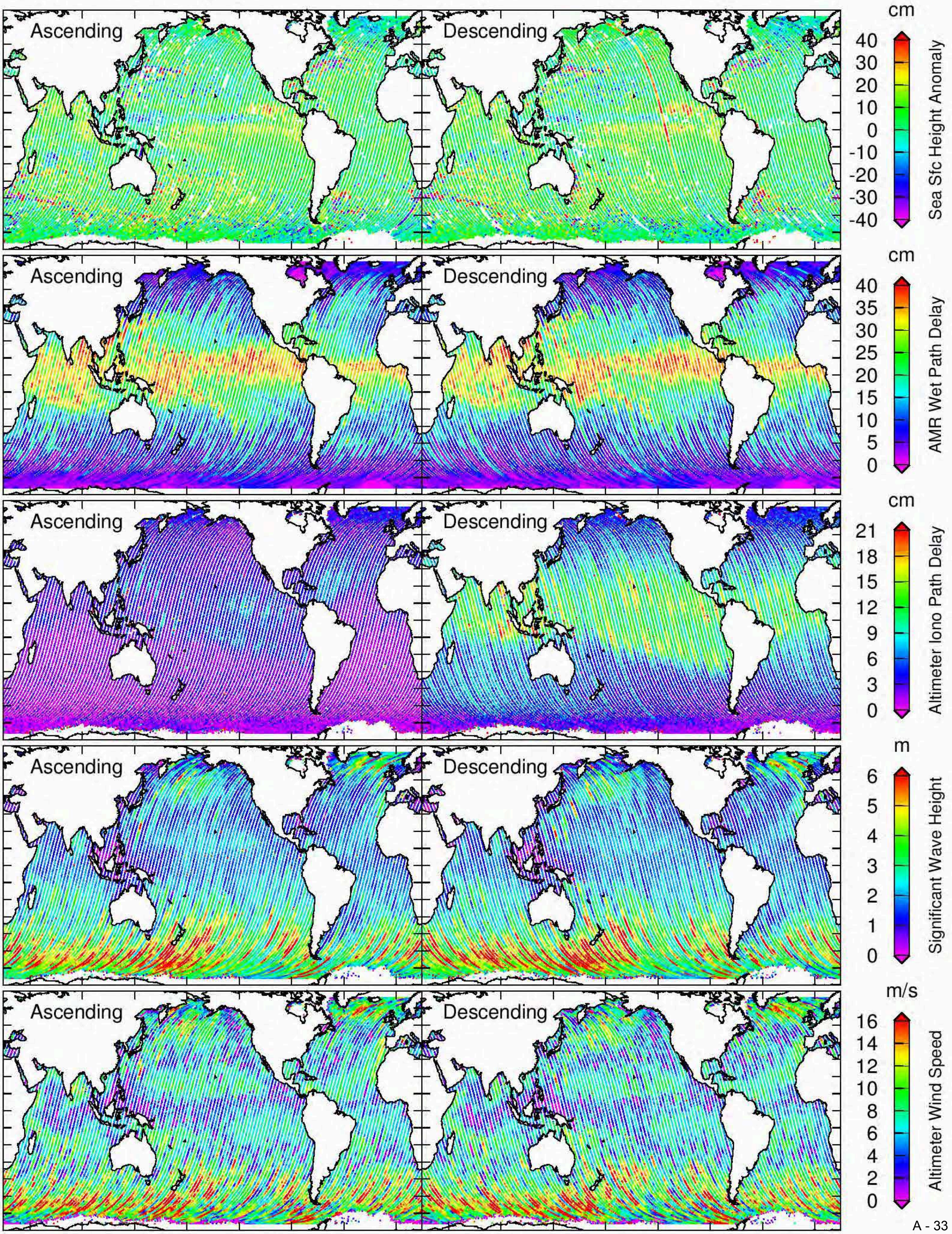
Jason-2 Cycle-251 2015-04-25 23:11:35 - 2015-05-05 21:10:06



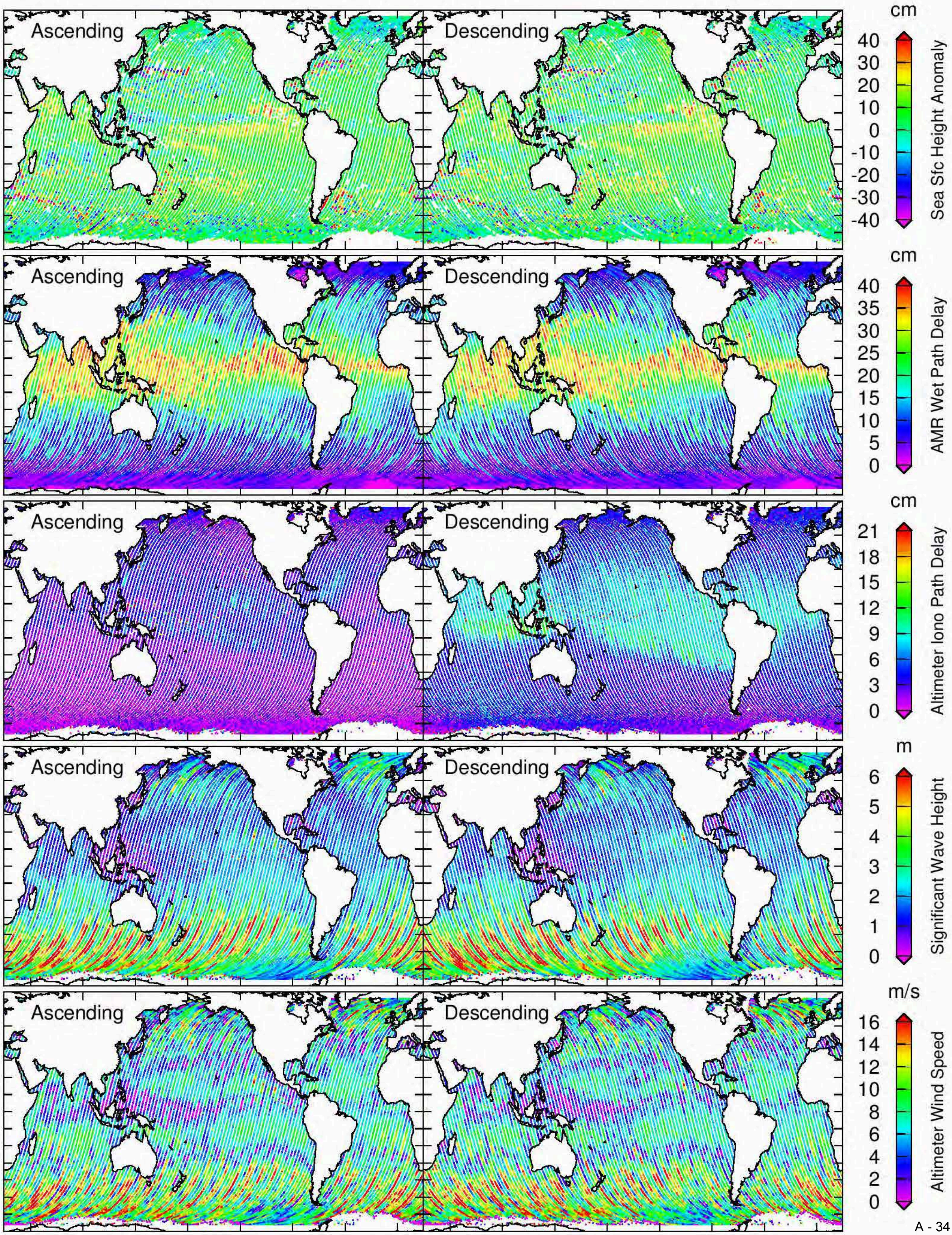
Jason-2 Cycle-252 2015-05-05 21:10:06 - 2015-05-15 19:08:38



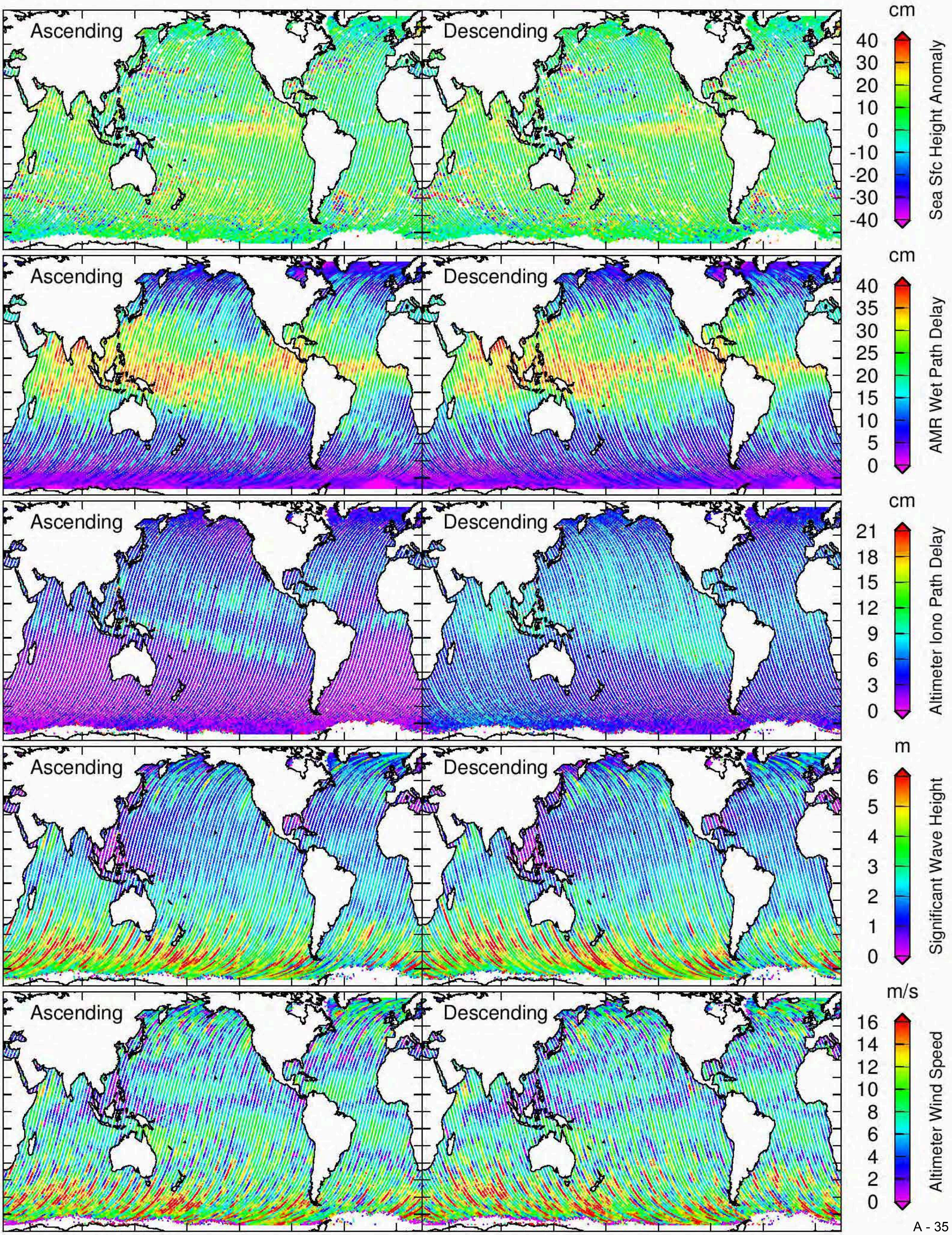
Jason-2 Cycle-253 2015-05-15 19:08:38 - 2015-05-25 17:07:10



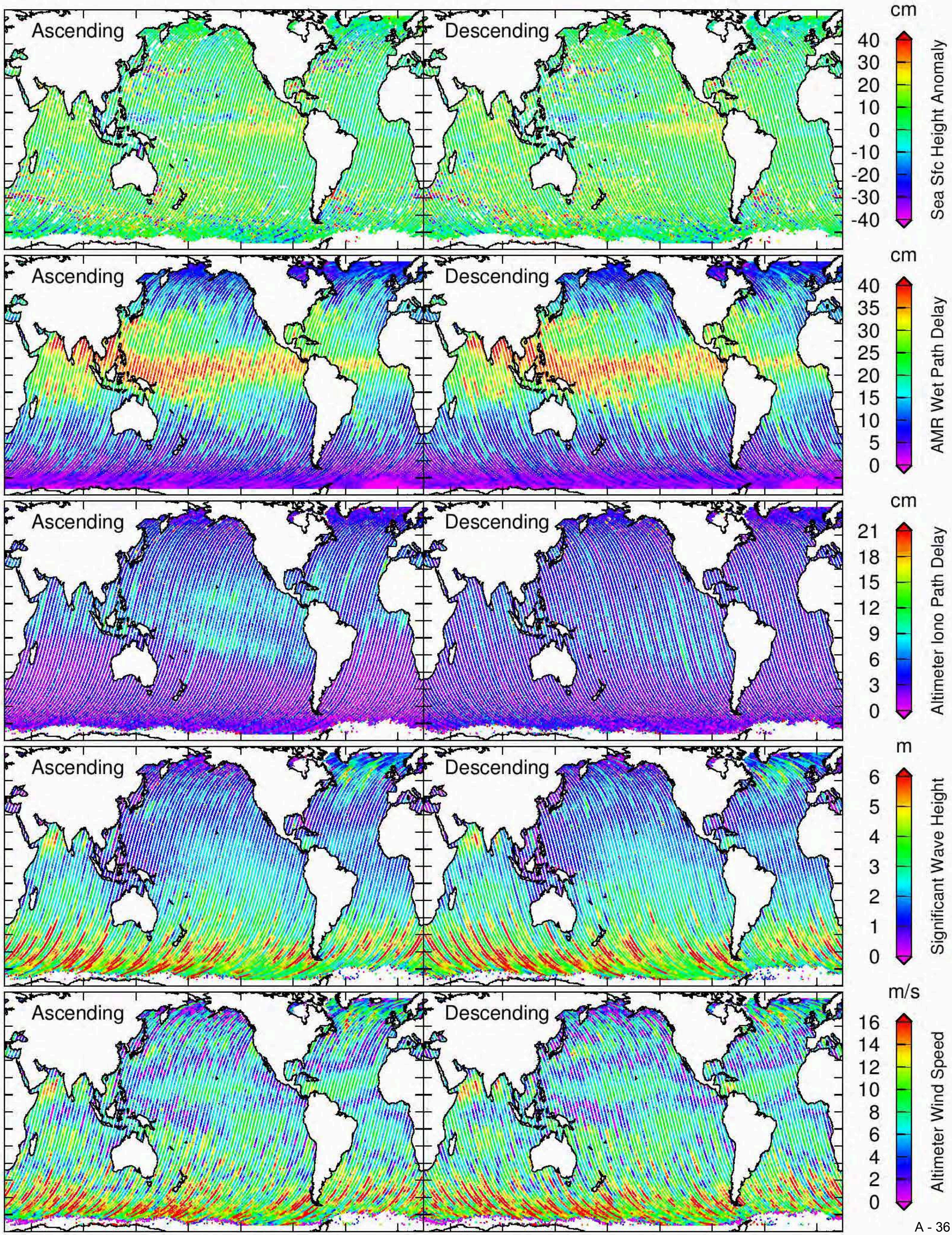
Jason-2 Cycle-254 2015-05-25 17:07:10 - 2015-06-04 15:05:41



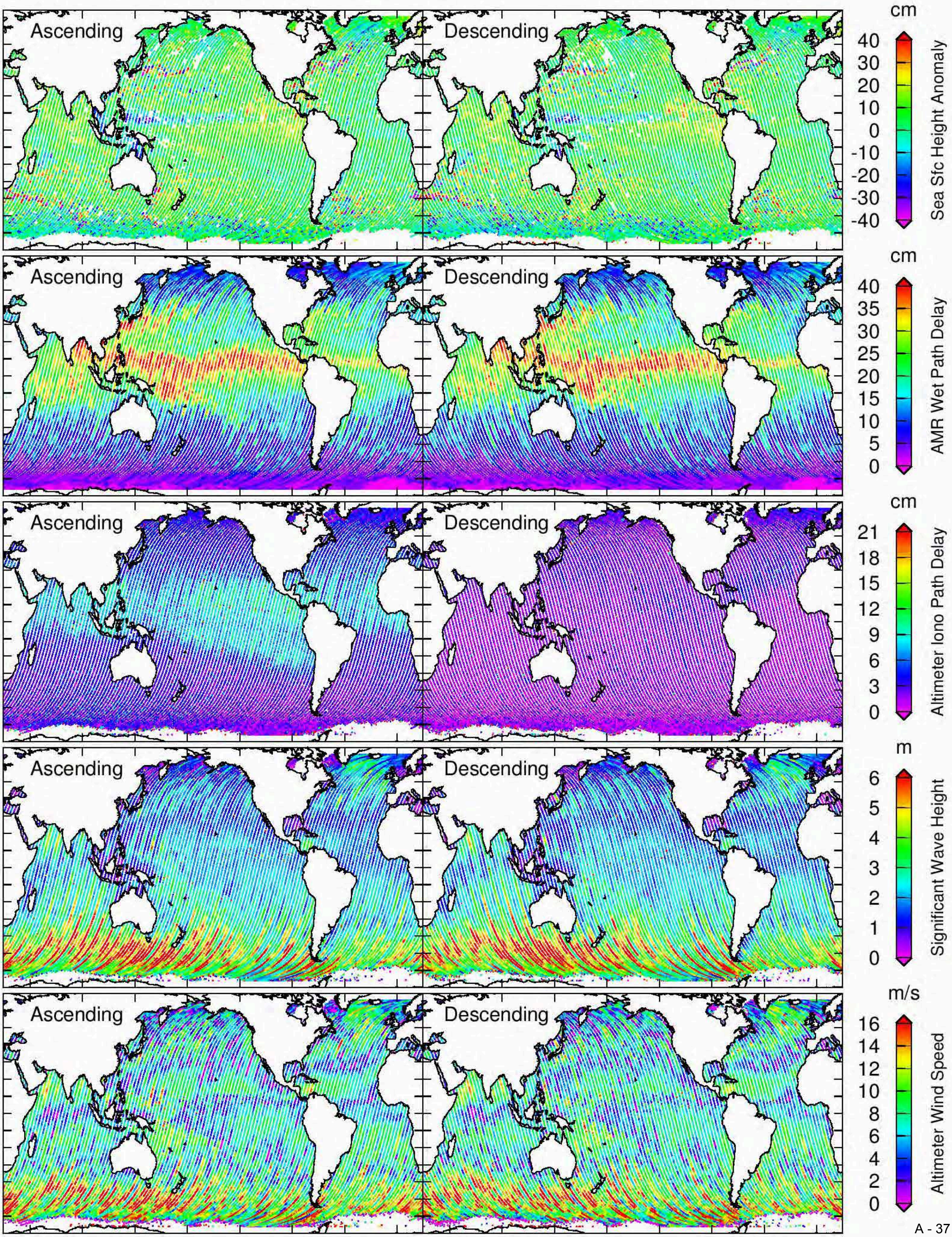
Jason-2 Cycle-255 2015-06-04 15:05:41 - 2015-06-14 13:04:13



Jason-2 Cycle-256 2015-06-14 13:04:13 - 2015-06-24 11:02:44



Jason-2 Cycle-257 2015-06-24 11:02:44 - 2015-07-04 09:01:16



Appendix B. Acronyms

Acronym	**Definition**
AMR	Advanced Microwave Radiometer
CLS	Collecte Localisation Satellites
CNES	Centre National d'Etudes Spatiales
CNG	Consigne Numerique de Gain (altimeter gain calibration)
DEM	Digital Elevation Model
DORIS	Doppler Orbitography and Radiopositioning Integrated by Satellite
ECMWF	European Centre for Medium-range Weather Forecasting
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
GPSP	Global Positioning System Payload
J2TCCS	Jason-2 Tele-Command and Control System
JPL	Jet Propulsion Laboratory
NASA	National Aeronautics and Space Administration
NESDIS	National Environmental Satellite Data and Information Service
NOAA	National Oceanic and Atmospheric Administration
NRTAVS	Near Real-Time Altimeter Validation System
OGDR	Operational Geophysical Data Records
OSTM	Ocean Surface Topography Mission
SOCC	Satellite Operations Control Center
SSH(A)	Sea Surface Height (Anomaly)
SWH	Significant Wave Height
TM-NRT	Telemetry analyzer Near Real-Time