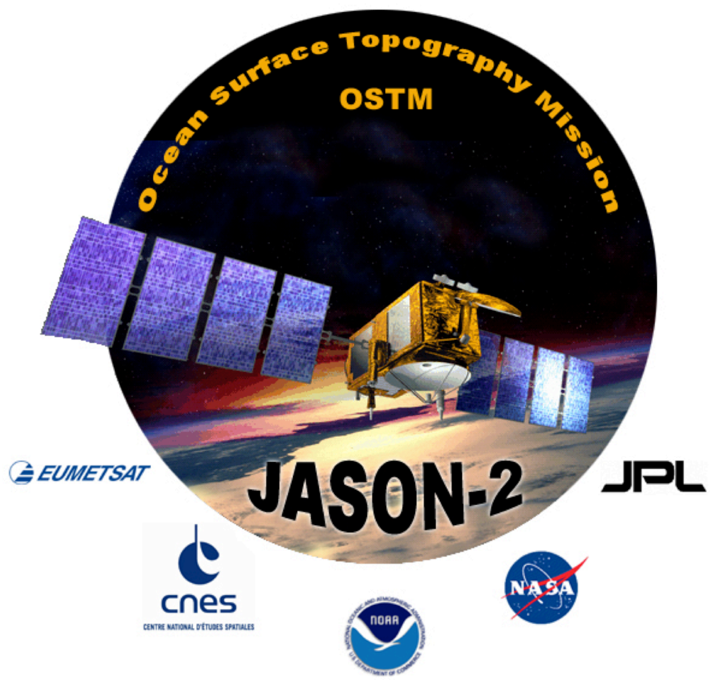
OSTM / Jason-2

Near Real-Time Data Annual Quality Report 2015-2016

July 2016



Prepared by:

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

OSTM / Jason-2

Near Real-Time Data Annual Quality Report 2015-2016

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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 2015-2016* (July 21, 2016 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 overall latency of the OGDRs, produced by both NOAA and EUMETSAT, is accumulated over the previous week for reporting at the OCG.

In this year's report we switch to a new methodology for reporting latency, based on the Jason-3 "PROPRO-005" algorithm[1]. Each OGDR is evaluated to determine if 75% of the 1-Hz data records inside the file have a latency of < 3 hours. If so, that OGDR is "good". If not (< 75% of data < 3 hours old) that OGDR is considered "bad". Each week the percentage of files that are good is reported, compared to the algorithm goal of 90%.

Figure 1 illustrates the weekly latency statistics during the eighth year of operations. At each weekly interval along the x-axis, the percentage of files meeting the 75% < 3 hours criteria is plotted. This year's statistics begin in October, when the algorithm was first deployed with the NOAA Jason Ground System (NJGS). In subsequent annual reports a full year's worth of statistics will be shown. We are clearly meeting the 90% goal, with only one instance (2016-04-18: 89.53%) falling below 90%. It is apparent that the percentage decreased after the launch of Jason-3 in early 2016, when ground operations were shared between the two missions, passing over the ground stations simultaneously.

The overall percentage of low-latency OGDRs from 2015-10-05 to 2016-07-11 was 96.71%.

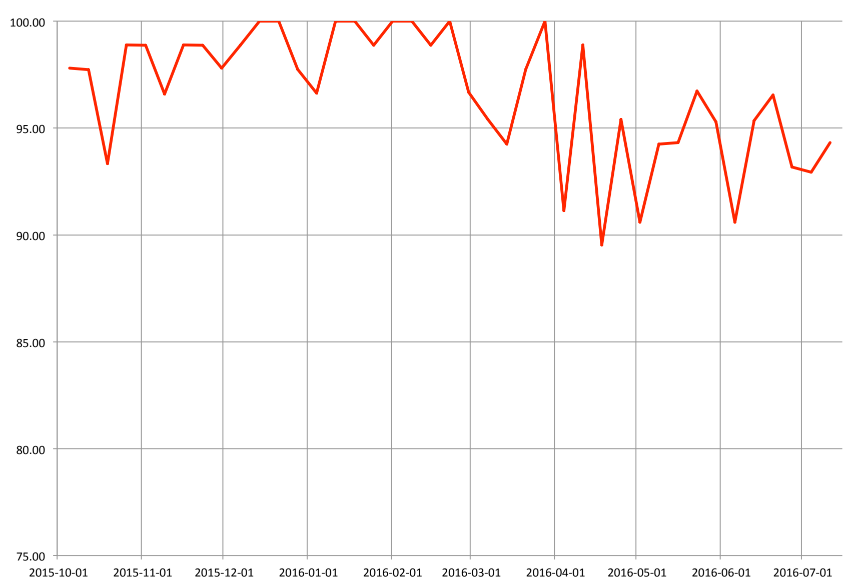


Figure 1 – Jason-2 OGDR Latency Statistics for October 2015 to July 2016

[1] Algorithms About Jason-3 Telemetry Data Availability And OGDR Data Latency: TP4-J0-NT-86-CNES, Christophe Jouan & John Lillibridge, 2011.

Section 3.0 Data Quality Analysis Plots

In this section data from the eighth year of operations are analyzed, covering the time period from 2015-07-04 to 2016-06-25: cycles 258-293. 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. 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 258-293 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 2015 to June 2016 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, as well as 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 2013-2015 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 began with 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 will be resolved when the OGDRs are compliant with GDR-E standards.

Cycle-269

AMR outage during passes 111-115 on 2015-10-25, between 18:18 and 22:25. SSHA & radiometer wet data are missing for this period

JA2_OPN_2PdS269_109_20151025_163421_20151025_182725.nc
JA2_OPN_2PdS269_111_20151025_182728_20151025_202518.nc
JA2_OPN_2PdS269_113_20151025_202517_20151025_222415.nc
JA2_OPN_2PdS269_115_20151025_222414_20151026_002206.nc

Cycle-271

Two collision avoidance maneuvers on 2015-11-18 21:49:09-27 & 2015-11-19 01:34:01-19. Passes 222 & 226 impacted, but only second maneuver visible in SSHA plot.

JA2_OPN_2PdS271_222_20151118_215002_20151118_233752.nc
JA2_OPN_2PdS271_225_20151119_012309_20151119_032916.nc

Cycle-277

AMR outage during passes 33-37 on 2016-01-10, between 01:00 and 05:00. SSHA & radiometer wet data are missing for this period.

JA2_OPN_2PdS277_032_20160109_233606_20160110_011059.nc
JA2_OPN_2PdS277_033_20160110_011058_20160110_030410.nc
JA2_OPN_2PdS277_035_20160110_030409_20160110_050203.nc

Cycle-278

Station-keeping maneuver on 2016-01-21 03:45:20-22. Pass 64 impacted. Gyro calibration on 2016-01-26 19:50:13-20:06:27 (mostly over land) caused the short data gap seen on the west coast of South Africa, pass 207.

JA2_OPN_2PdS278_063_20160121_032352_20160121_052249.nc
JA2_OPN_2PdS278_207_20160126_182513_20160126_200756.nc

Cycle-279

AMR outage during passes 17-20 on 2016-01-29, between 05:58 and 08:21. SSHA & radiometer wet data are missing for this period

JA2_OPN_2PdS279_015_20160129_043207_20160129_062855.nc
JA2_OPN_2PdS279_018_20160129_062854_20160129_082511.nc

Cycle-285

There was an AMR outage from 2016-03-31 09:30:51-11:39:11, impacting SSHA & radiometer wet corrections on passes 85-87:

JA2_OPN_2PdS285_083_20160331_074042_20160331_094155.nc
JA2_OPN_2PdS285_085_20160331_094154_20160331_113812.nc
JA2_OPN_2PdS285_087_20160331_113810_20160331_133707.nc

The onboard GPS (NOT GPSP) software was updated, resulting in a nearly 24-hour data gap between 2016-04-05 13:35:10 and 2016-04-06 12:02:39, passes 217-241:

JA2_OPN_2PdS285_217_20160405_133501_20160405_133510.nc
JA2_OPN_2PdS285_241_20160406_120239_20160406_135848.nc

Cycle-287

A data loss occurred due to a bad ground station contact at the Fairbanks CDA. The pass was accidentally acknowledged on the next contact, resulting in a data gap from 2016-04-17 20:15:20-20:39:41, pass 24. This appears to be the only instance of operator error this year that resulted in an actual loss of data.

JA2_OPN_2PdS287_024_20160417_195750_20160417_214312.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 258-293 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 Δt = 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 4518 analyzed OGDRs is a total of 21,386,193 over-ocean records (out of a total 29,418,739 records) with data gaps totaling 122,793 records. This equates to 34h 47m 28s of missing data over the course of the year, and an over-ocean data return of 99.426%. Nearly 24 hours of this data gap was associated with the onboard GPS software upload that affected cycle-285.

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.

```
JA2_OPN_2PdS285_241_20160406_120239_20160406_135848.nc 79265
JA2_OPN_2PdS273_176_20151206_224046_20151207_003829.nc  7569
JA2_OPN_2PdS271_176_20151117_024424_20151117_044044.nc  7370
JA2_OPN_2PdS270_076_20151103_070440_20151103_084503.nc  6677
JA2_OPN_2PdS290_152_20160522_134908_20160522_152729.nc  6676
JA2_OPN_2PdS282_109_20160302_135104_20160302_160832.nc  4193
JA2_OPN_2PdS273_172_20151206_185745_20151206_201617.nc  1718
JA2_OPN_2PdS287_024_20160417_195750_20160417_214312.nc  1405
JA2_OPN_2PdS267_070_20151004_073156_20151004_090515.nc  1347
JA2_OPN_2PdS284_172_20160324_204138_20160324_221500.nc   824
JA2_OPN_2PdS287_051_20160418_215859_20160418_235638.nc   600
JA2_OPN_2PdS268_146_20151017_044221_20151017_081607.nc   522
JA2_OPN_2PdS278_207_20160126_182513_20160126_200756.nc   413
JA2_OPN_2PdS272_071_20151122_225747_20151123_010716.nc   321
JA2_OPN_2PdS286_122_20160411_174953_20160411_192107.nc   204
JA2_OPN_2PdS290_228_20160525_134539_20160525_134553.nc   167
JA2_OPN_2PdS271_029_20151111_095143_20151111_114514.nc   156
JA2_OPN_2PdS265_081_20150914_224226_20150915_002002.nc   152
JA2_OPN_2PdS278_210_20160126_202437_20160126_215447.nc   143
JA2_OPN_2PdS282_198_20160306_010749_20160306_024436.nc   117
```

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 34 hours 47 minutes. **This represents an over-ocean data return of 99.43%, 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 meeting the weekly 90% goal, with an **overall percentage of low-latency OGDRs of 96.71%.**

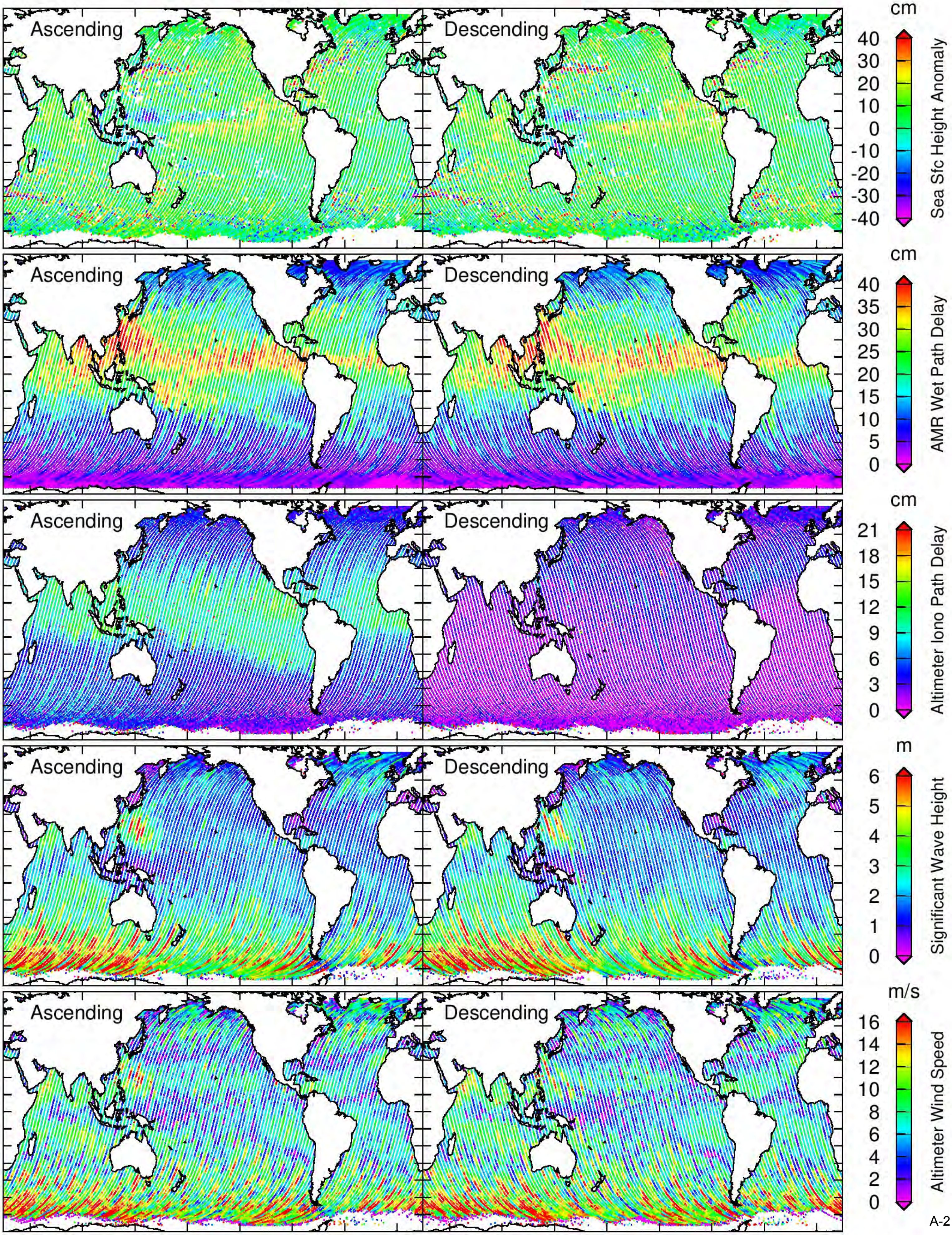
This fourth report based on OGDR-D data reiterates a long-standing concern that the project team is in the process of addressing:

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.

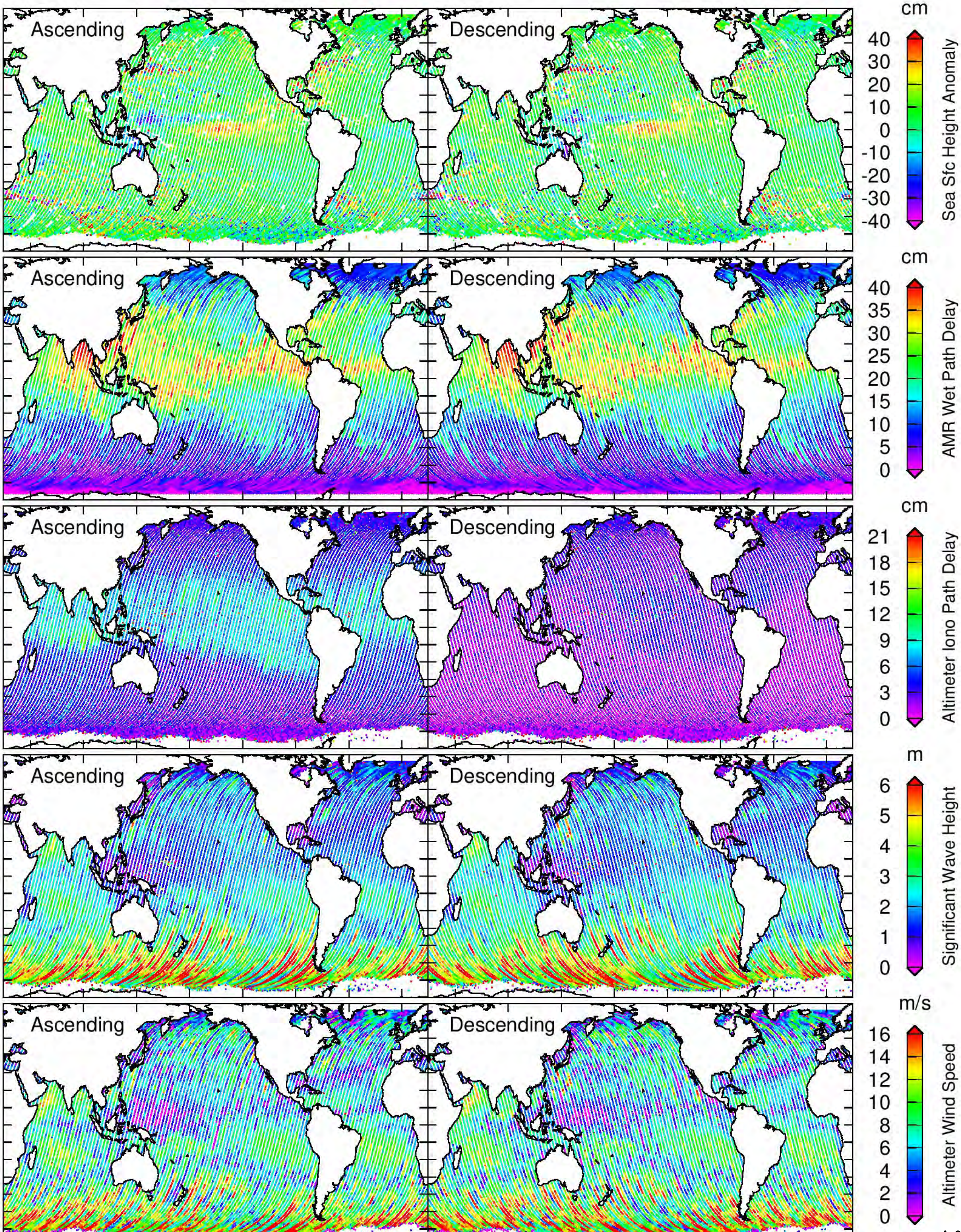
Appendix A. Cyclic Parameter Plots Cycle-258 to Cycle-293

See individual plots on the following 36 pages.

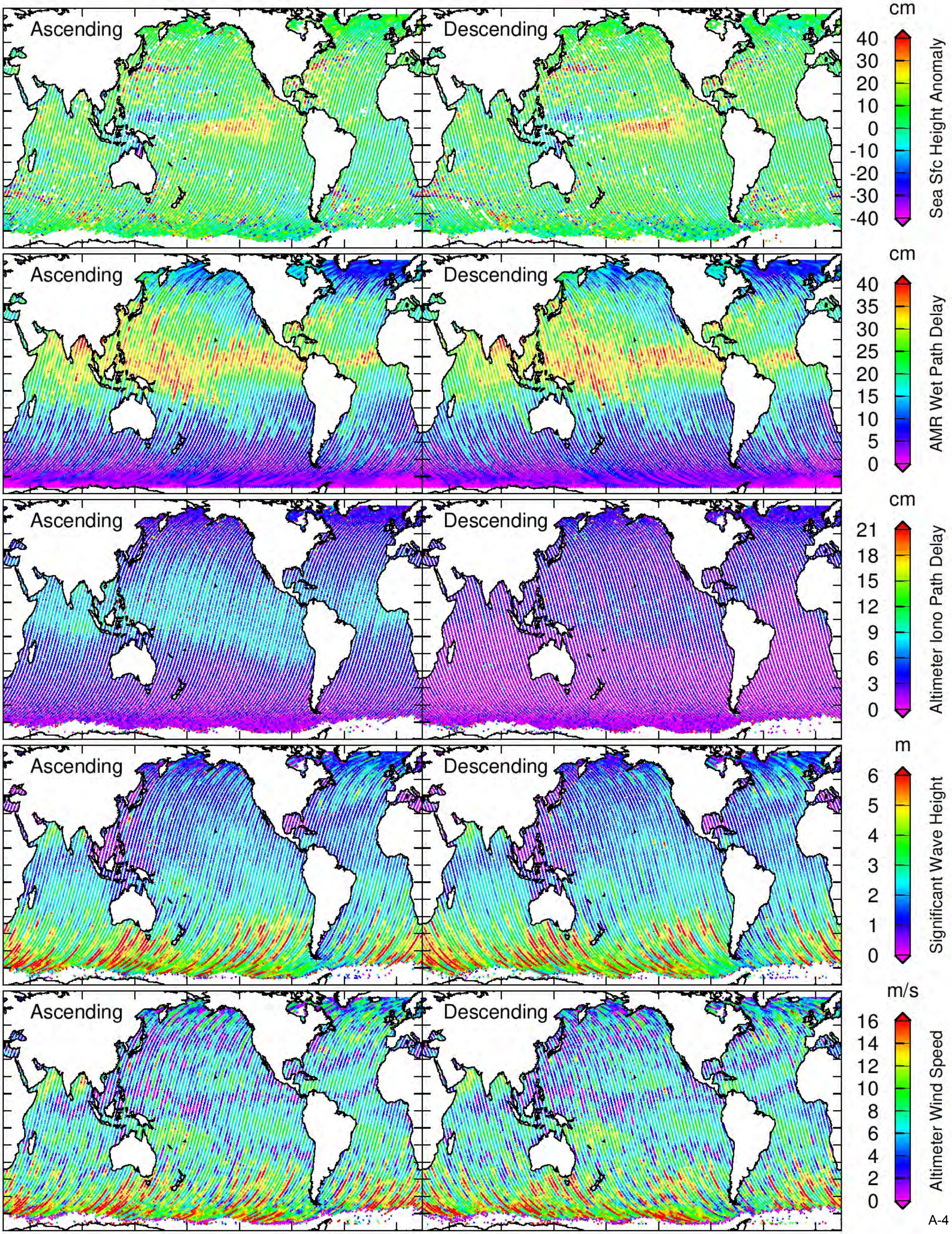
Jason-2 Cycle-258 2015-07-04 09:01:18 - 2015-07-14 06:59:49



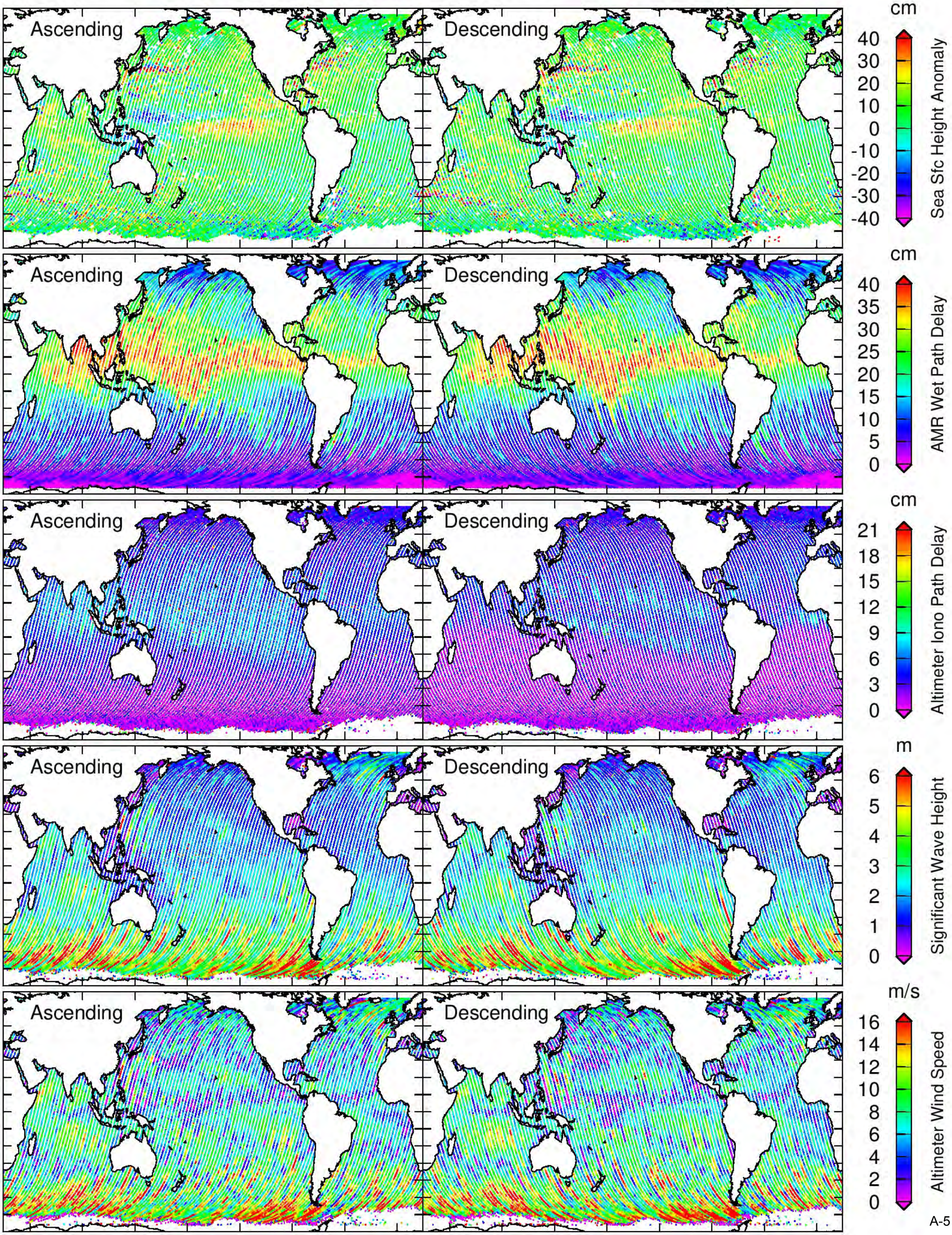
Jason-2 Cycle-259 2015-07-14 06:59:49 - 2015-07-24 04:58:21



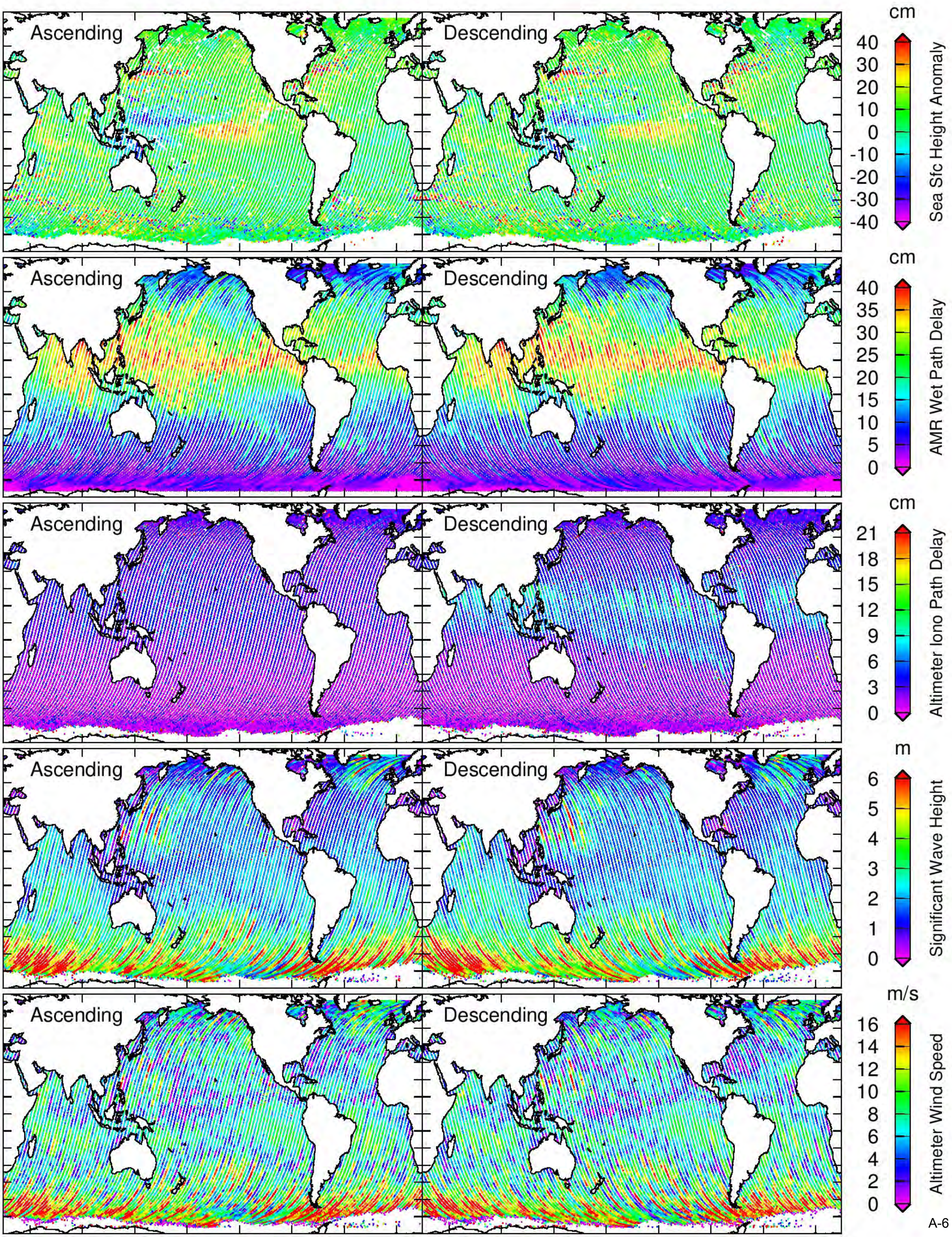
Jason-2 Cycle-260 2015-07-24 04:58:21 - 2015-08-03 02:56:53



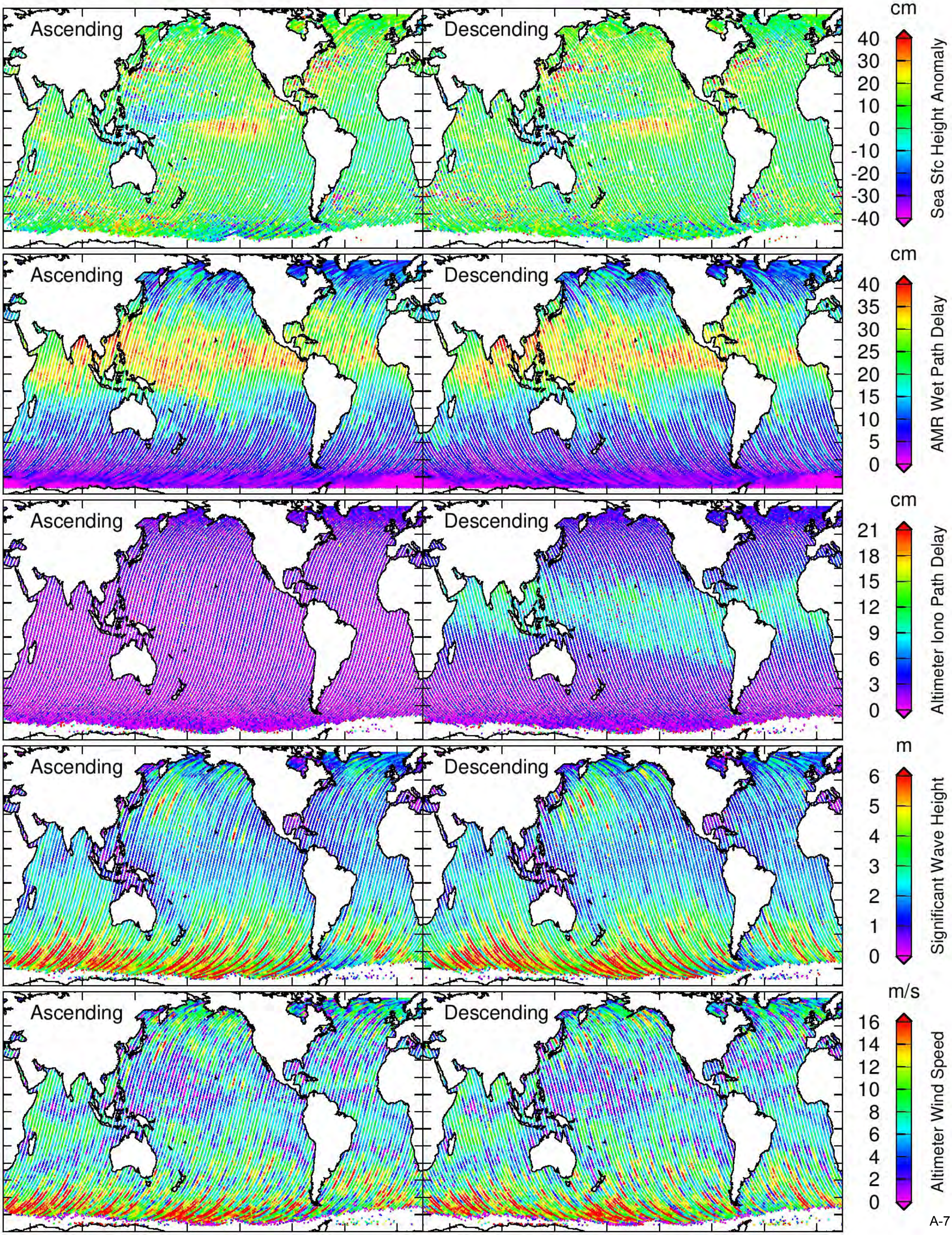
Jason-2 Cycle-261 2015-08-03 02:56:53 - 2015-08-13 00:55:24



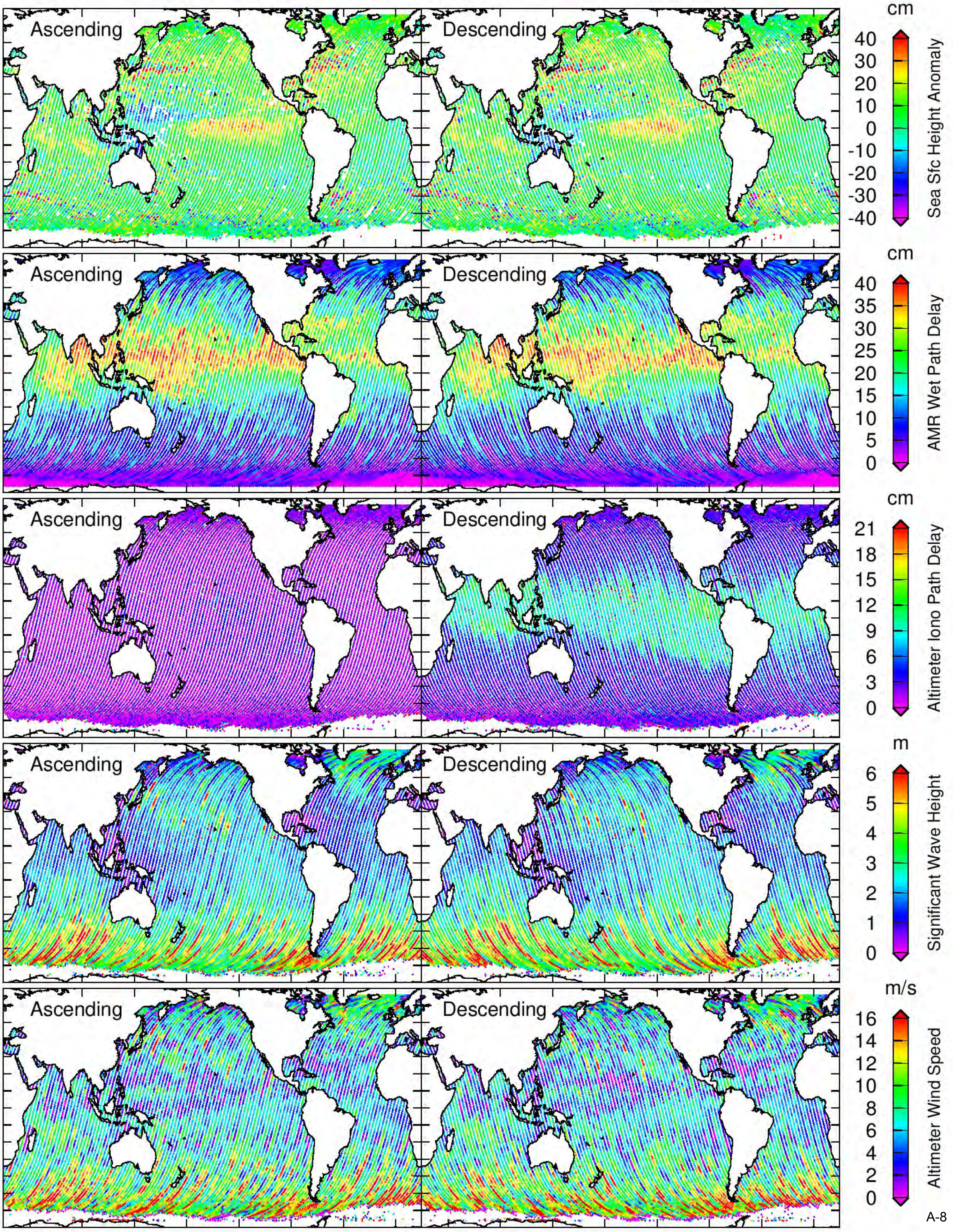
Jason-2 Cycle-262 2015-08-13 00:55:24 - 2015-08-22 22:53:56



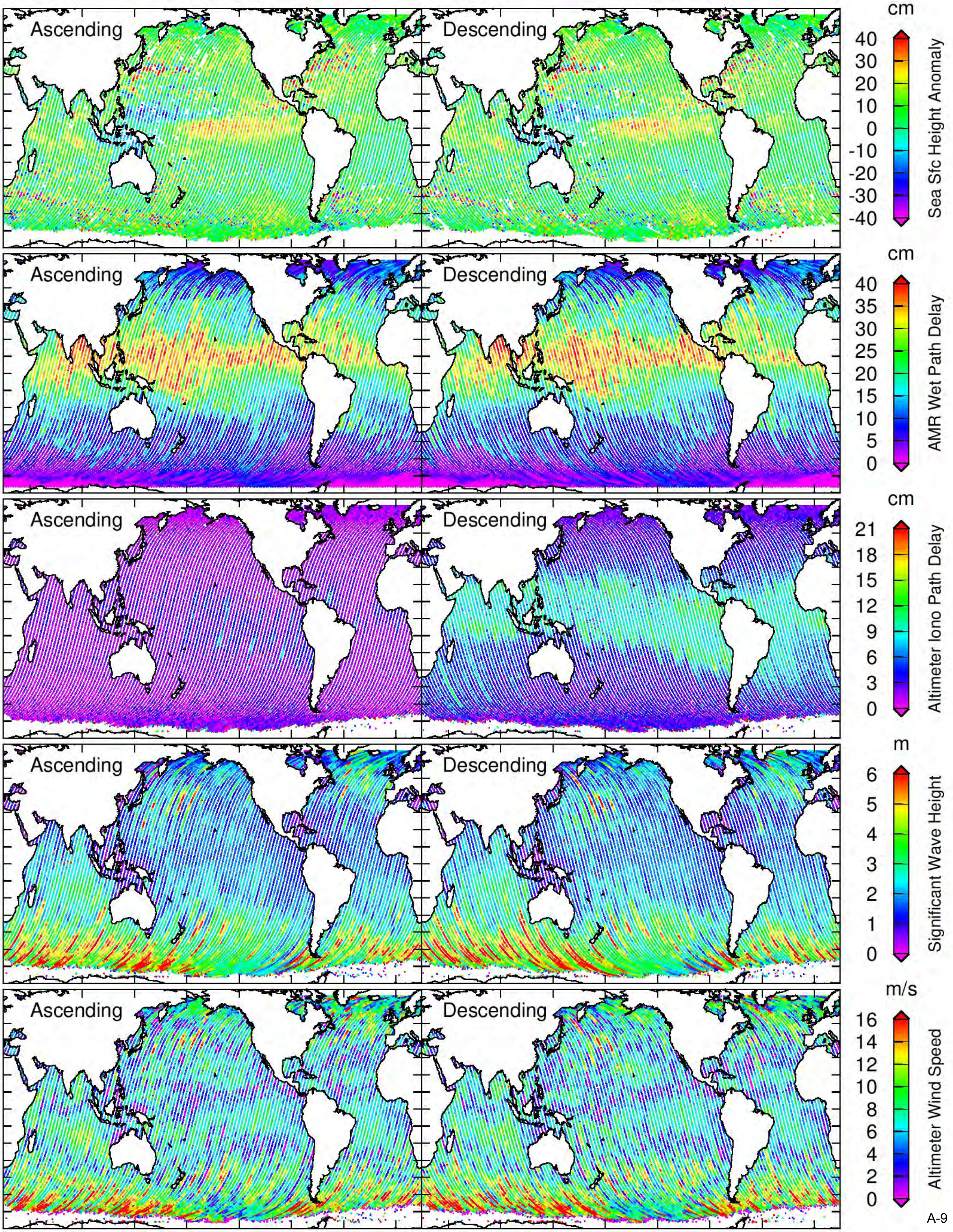
Jason-2 Cycle-263 2015-08-22 22:53:56 - 2015-09-01 20:52:27



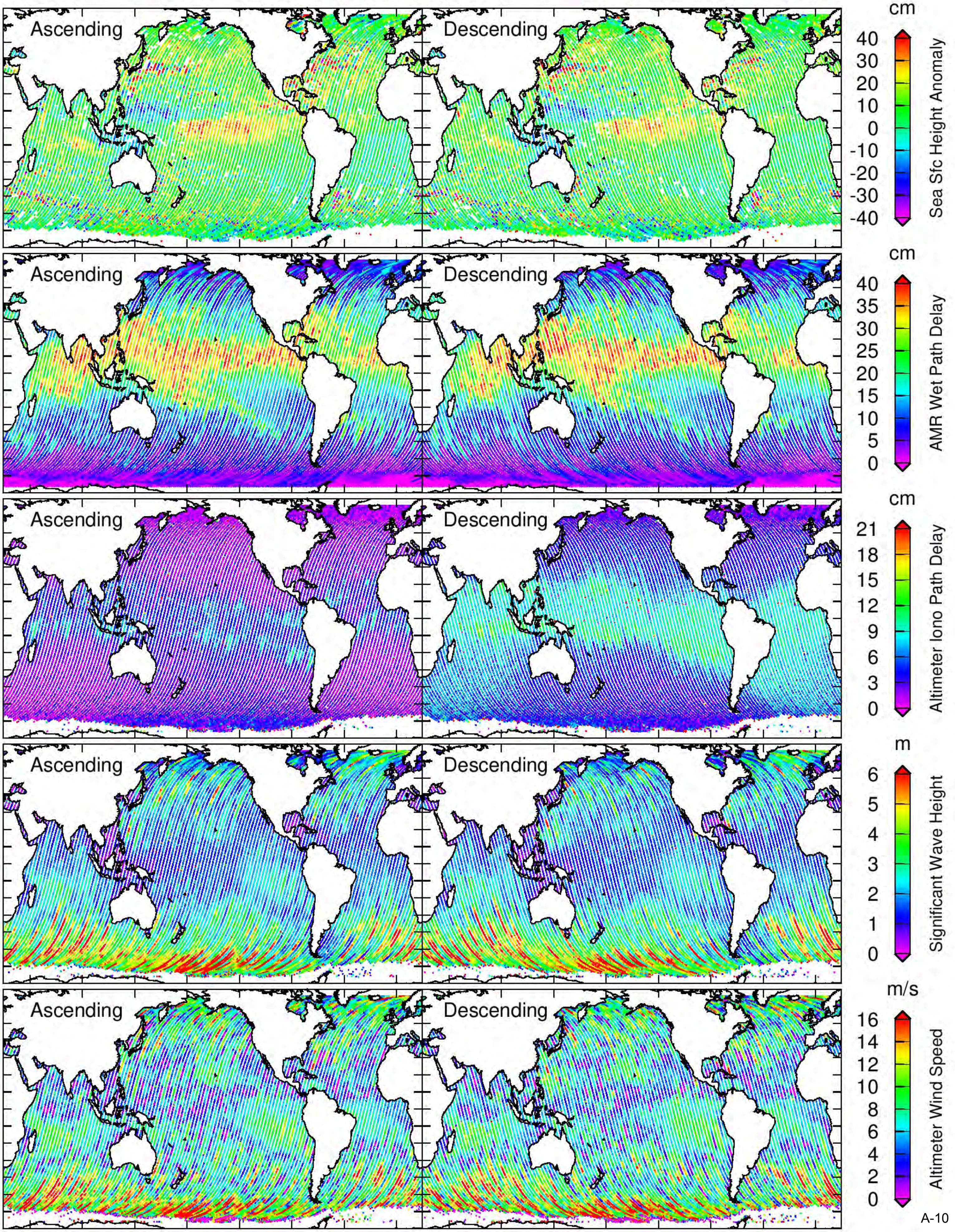
Jason-2 Cycle-264 2015-09-01 20:52:27 - 2015-09-11 18:50:59



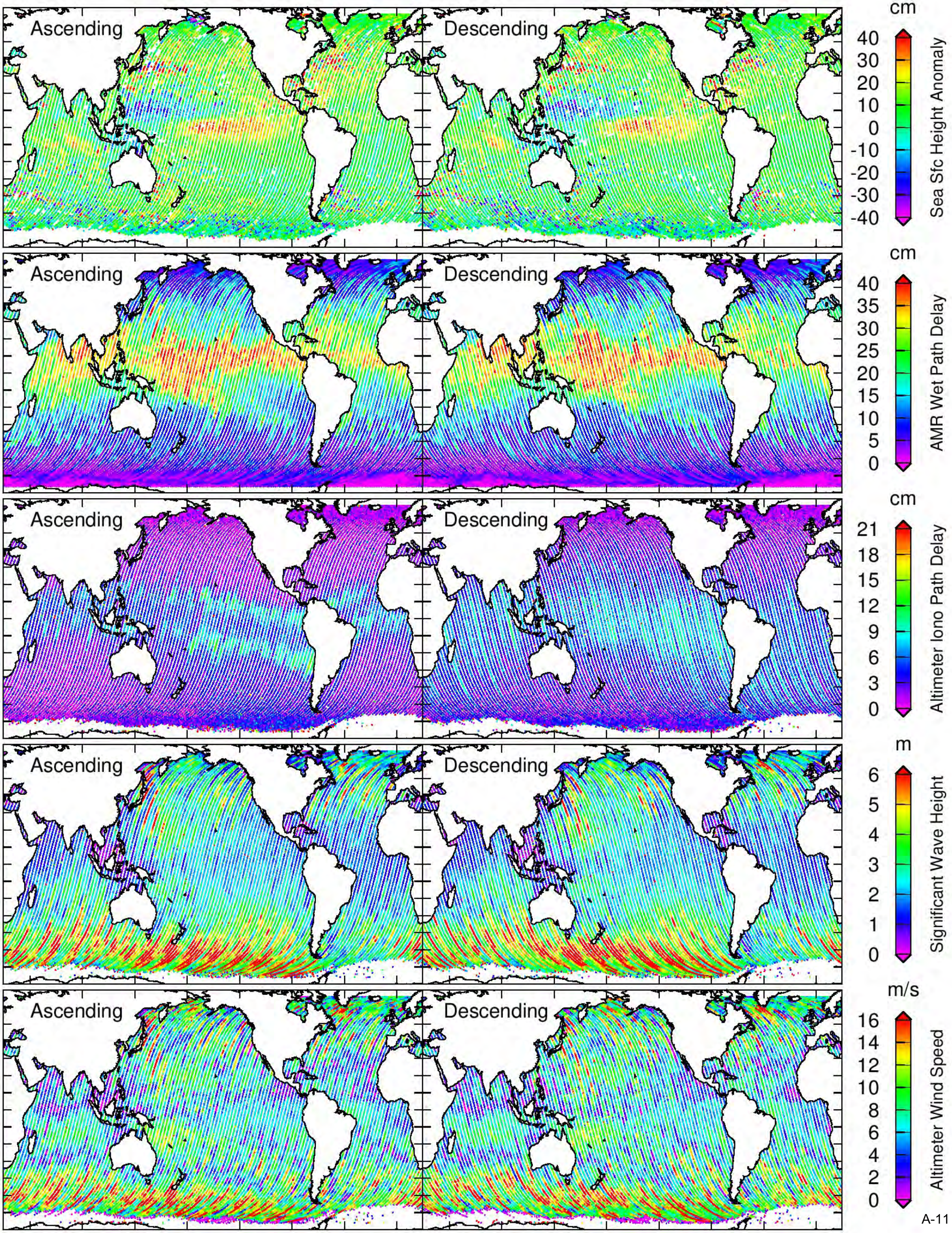
Jason-2 Cycle-265 2015-09-11 18:50:59 - 2015-09-21 16:49:31



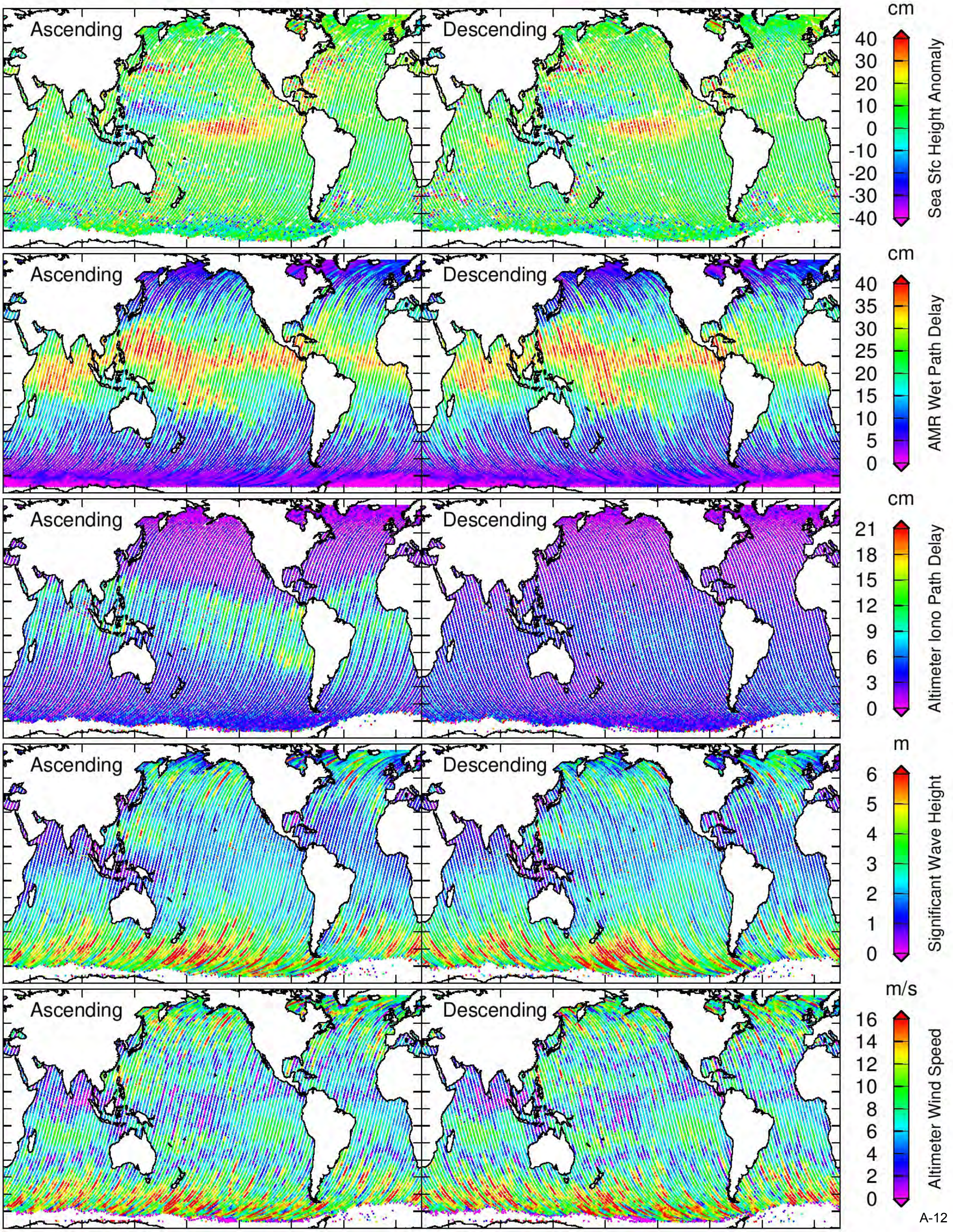
Jason-2 Cycle-266 2015-09-21 16:49:31 - 2015-10-01 14:48:02



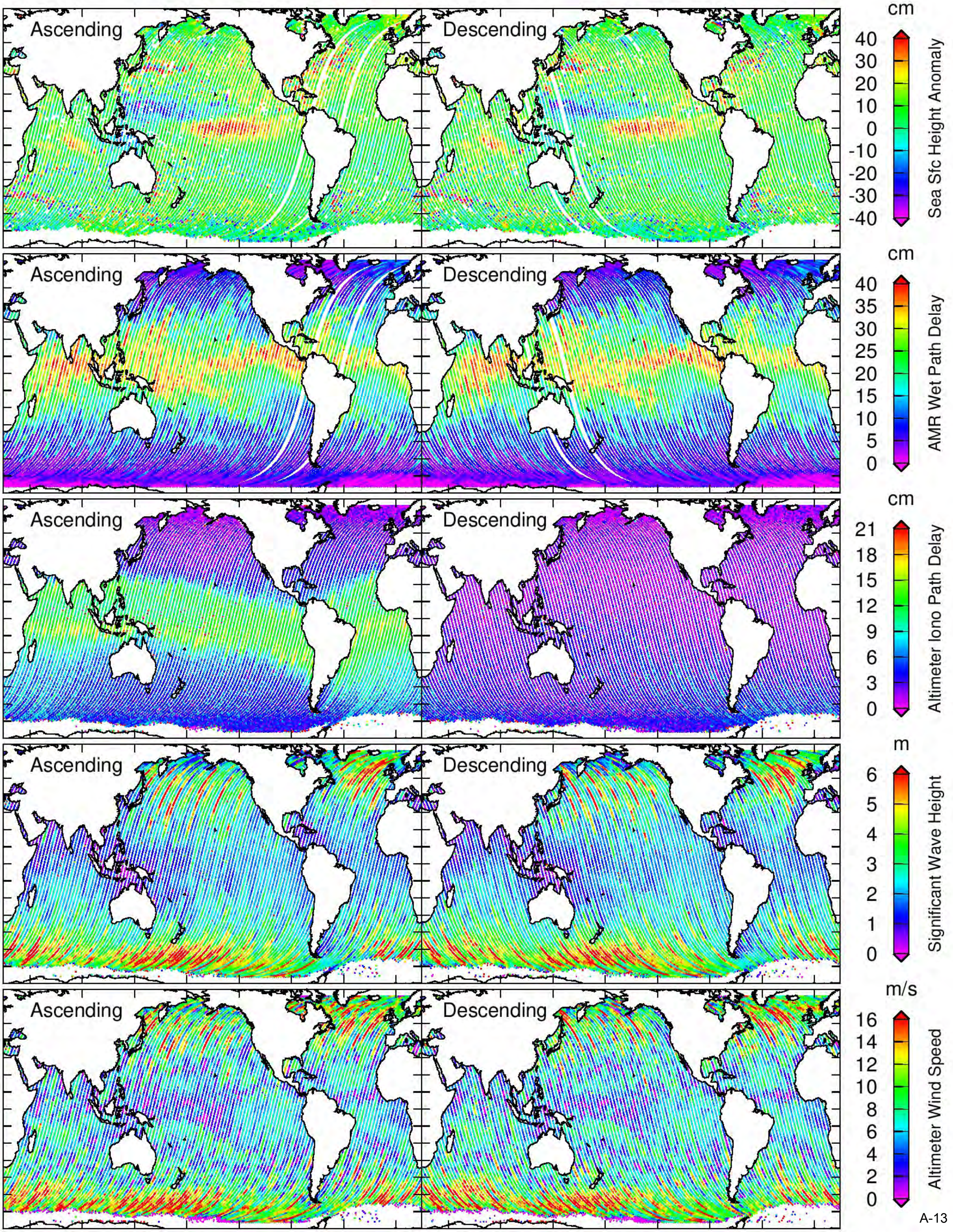
Jason-2 Cycle-267 2015-10-01 14:48:02 - 2015-10-11 12:46:34



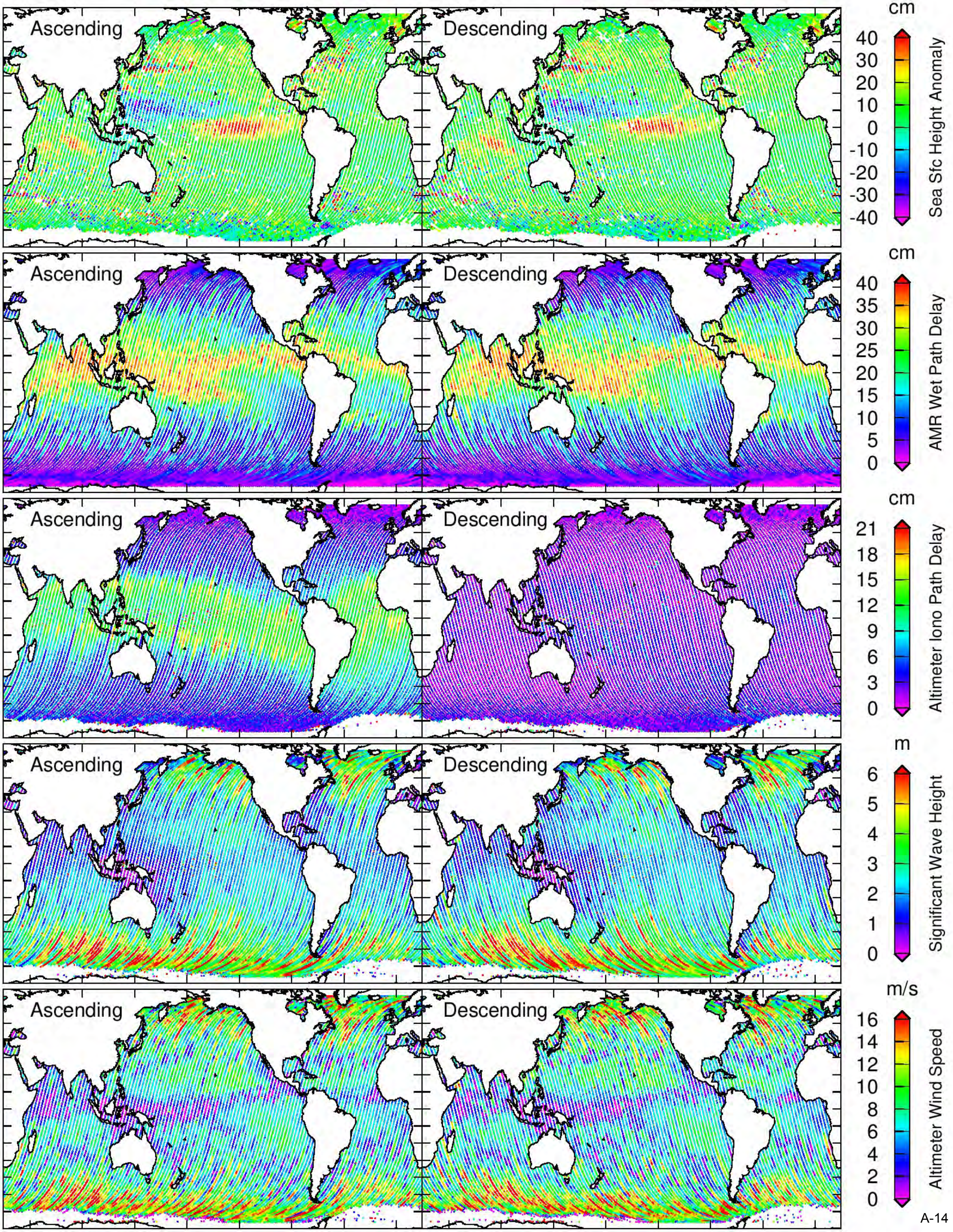
Jason-2 Cycle-268 2015-10-11 12:46:34 - 2015-10-21 10:45:05



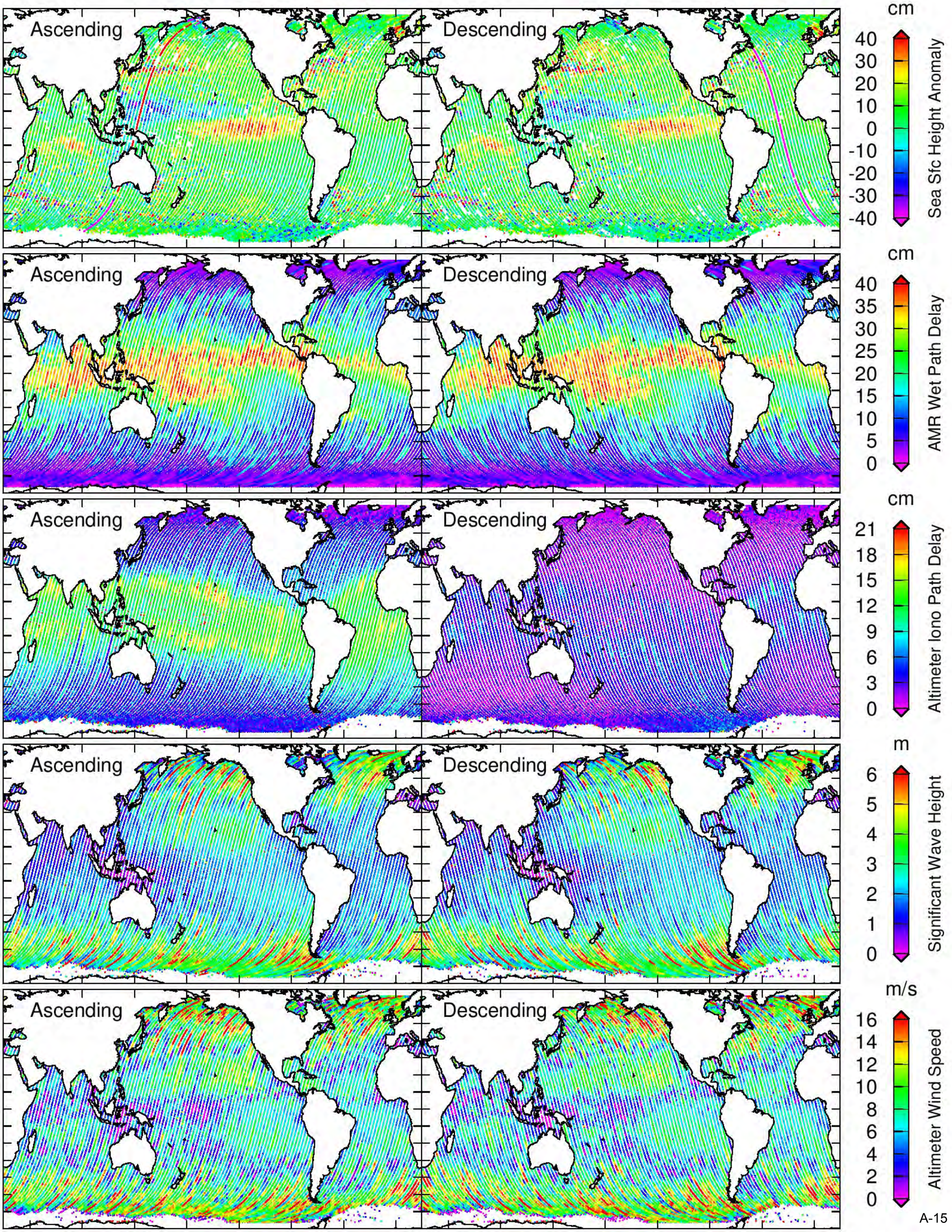
Jason-2 Cycle-269 2015-10-21 10:45:05 - 2015-10-31 08:43:37



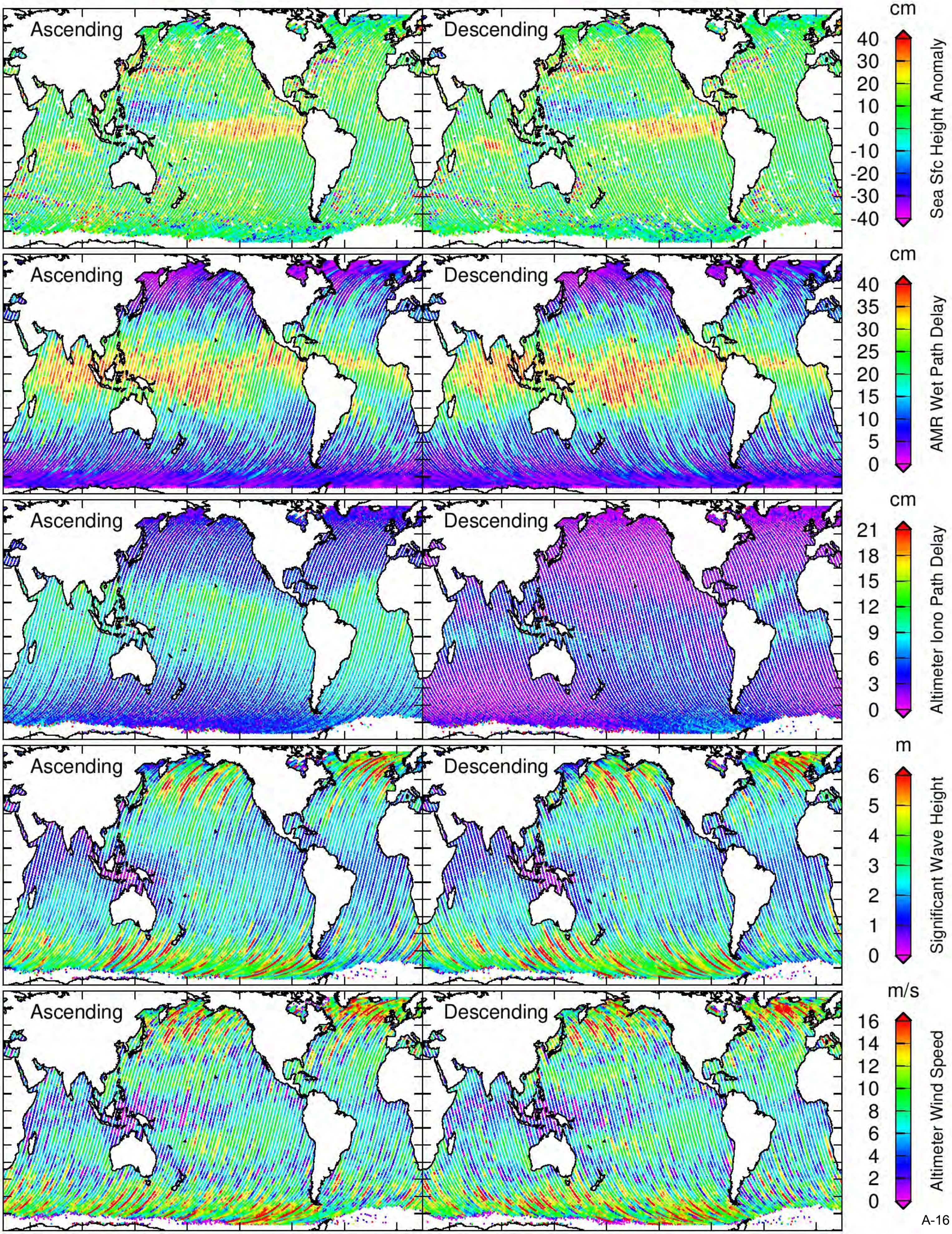
Jason-2 Cycle-270 2015-10-31 08:43:37 - 2015-11-10 06:42:09



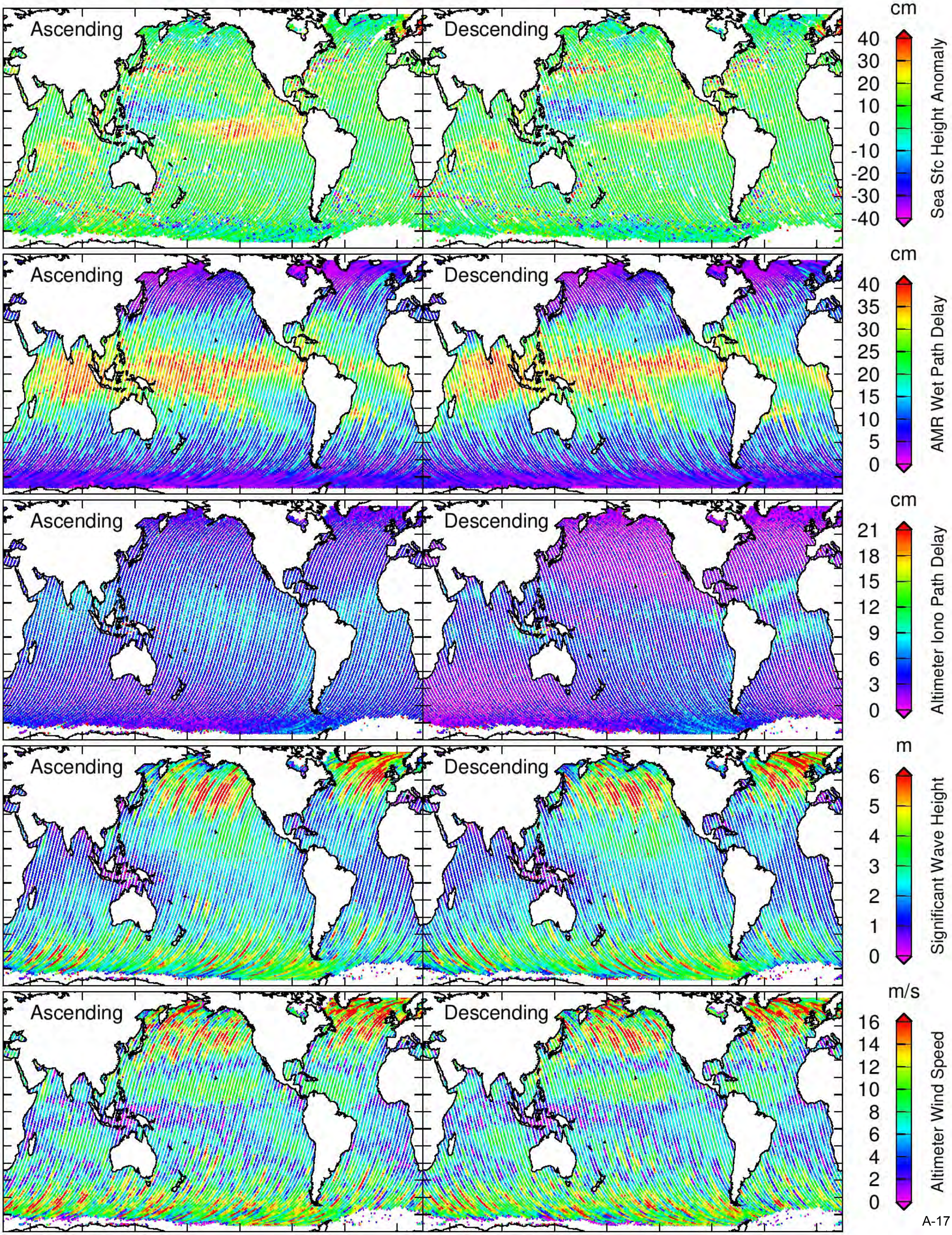
Jason-2 Cycle-271 2015-11-10 06:42:09 - 2015-11-20 04:40:40



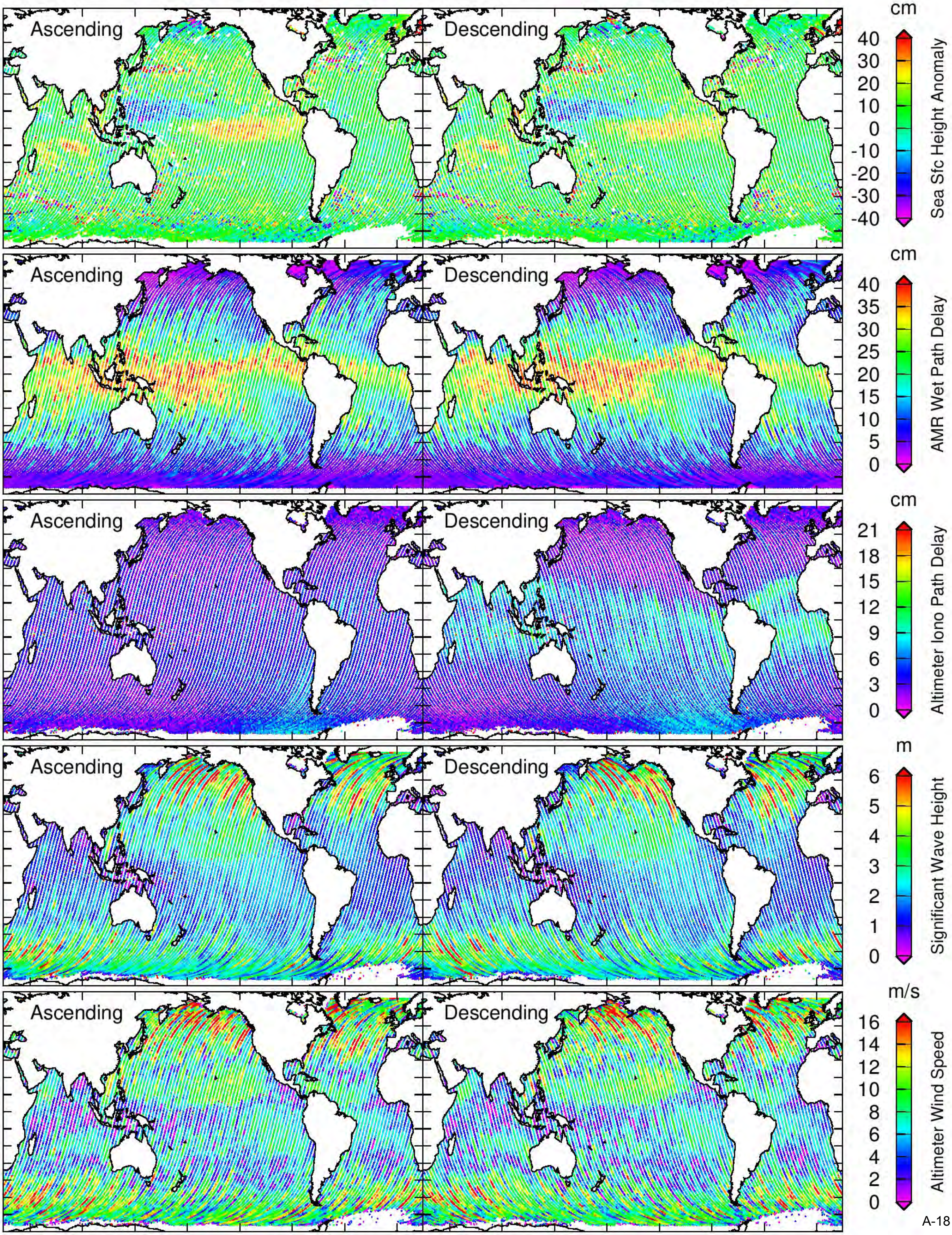
Jason-2 Cycle-272 2015-11-20 04:40:40 - 2015-11-30 02:39:12



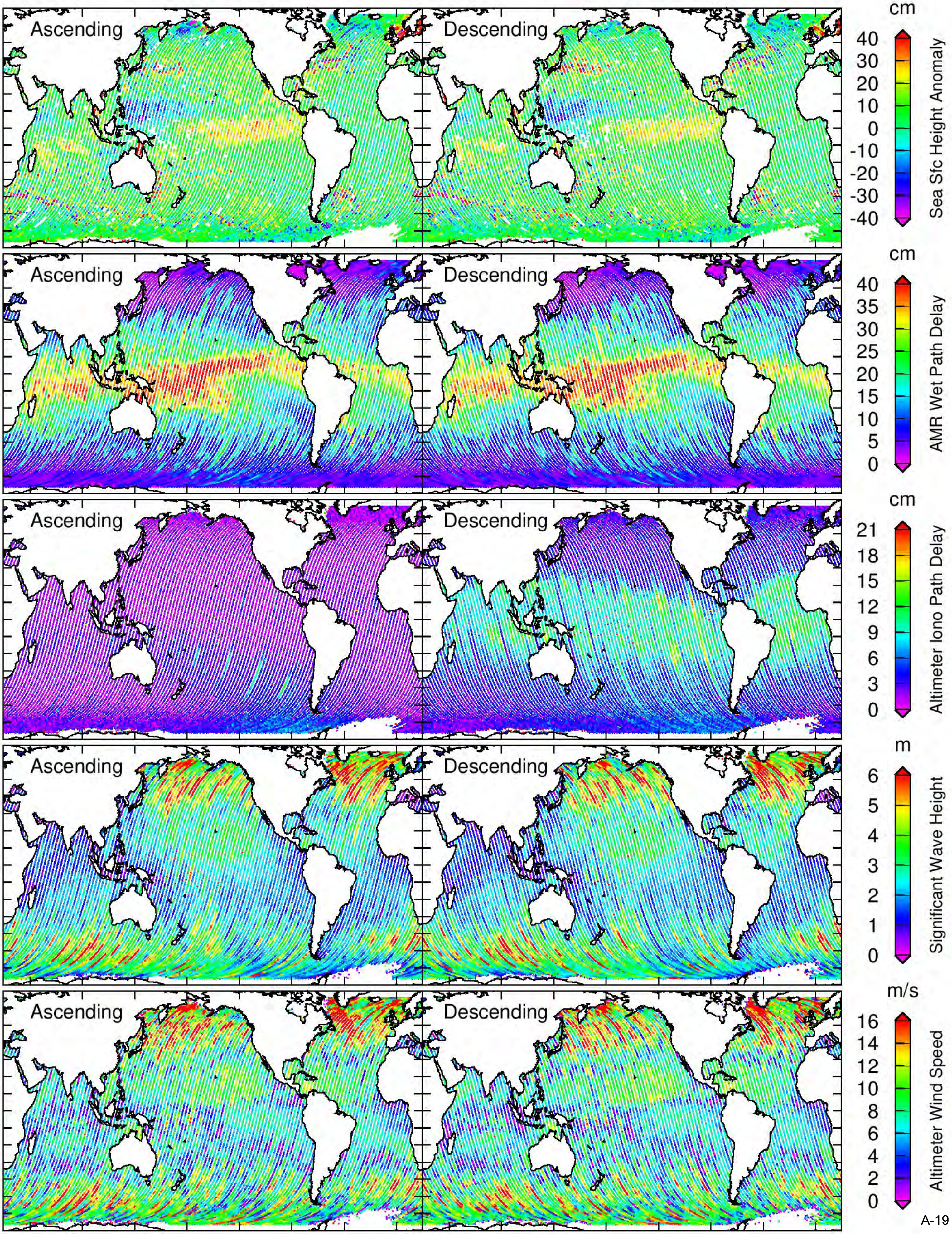
Jason-2 Cycle-273 2015-11-30 02:39:12 - 2015-12-10 00:37:43



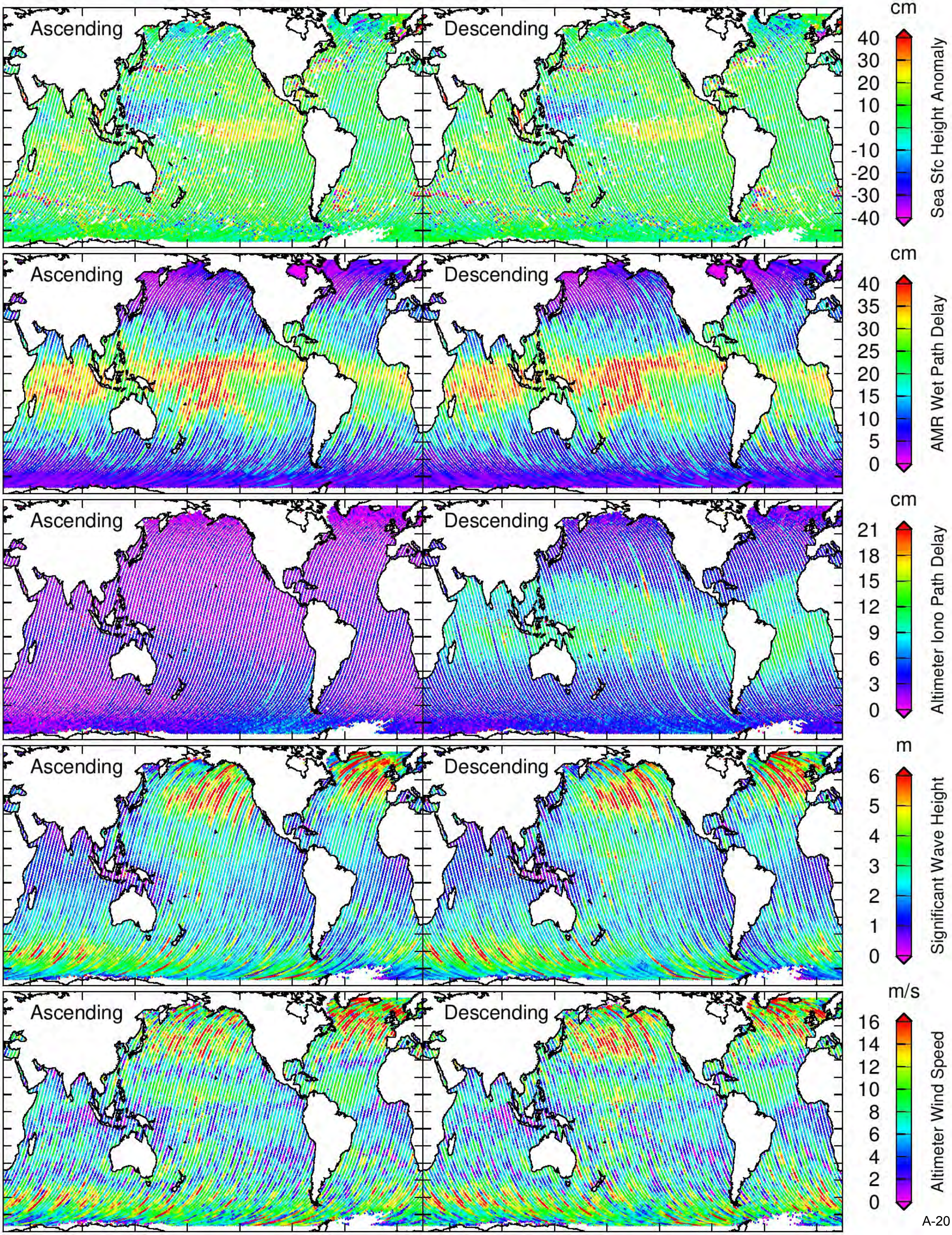
Jason-2 Cycle-274 2015-12-10 00:37:43 - 2015-12-19 22:36:15



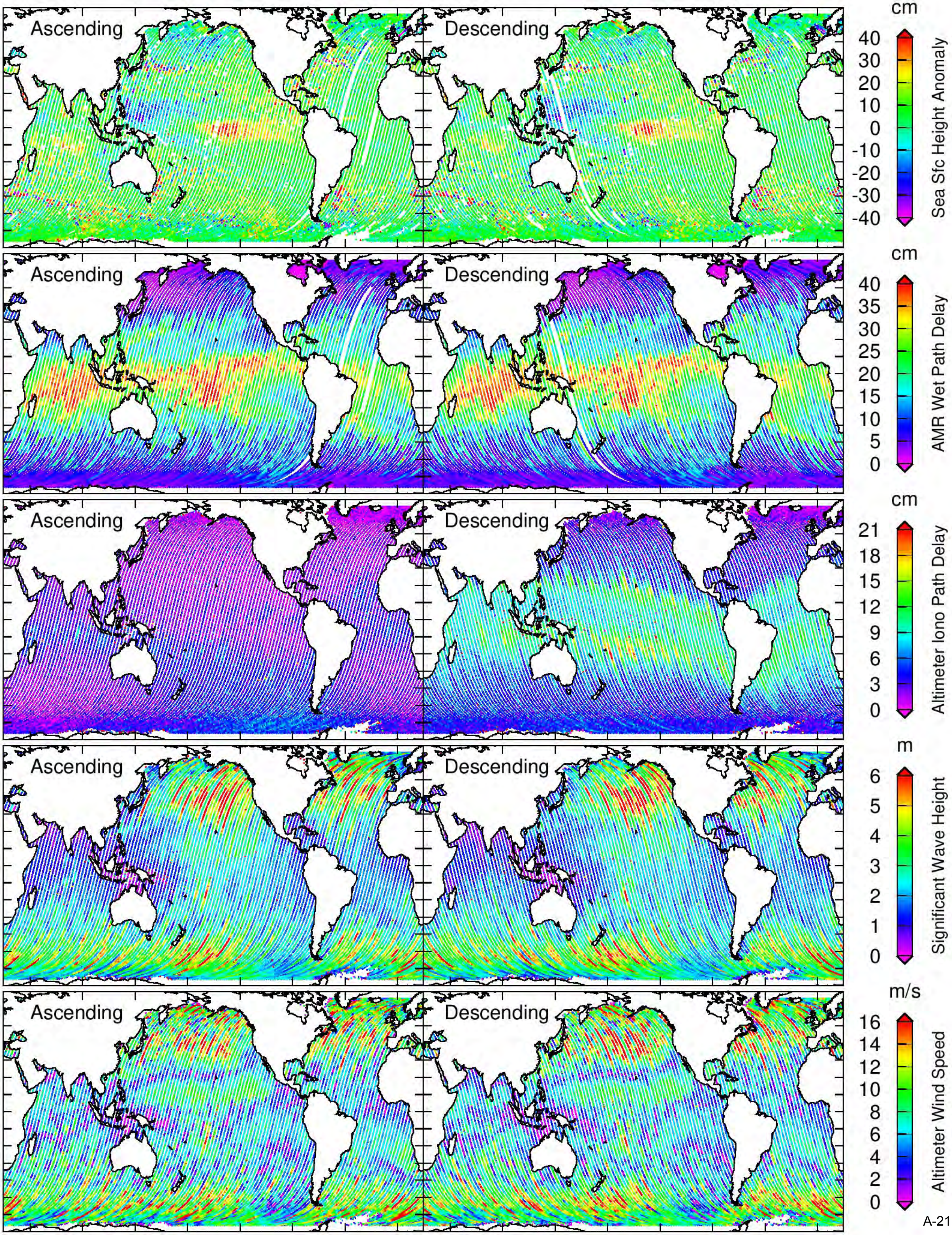
Jason-2 Cycle-275 2015-12-19 22:36:15 - 2015-12-29 20:34:47



Jason-2 Cycle-276 2015-12-29 20:34:47 - 2016-01-08 18:33:18



Jason-2 Cycle-277 2016-01-08 18:33:18 - 2016-01-18 16:31:50



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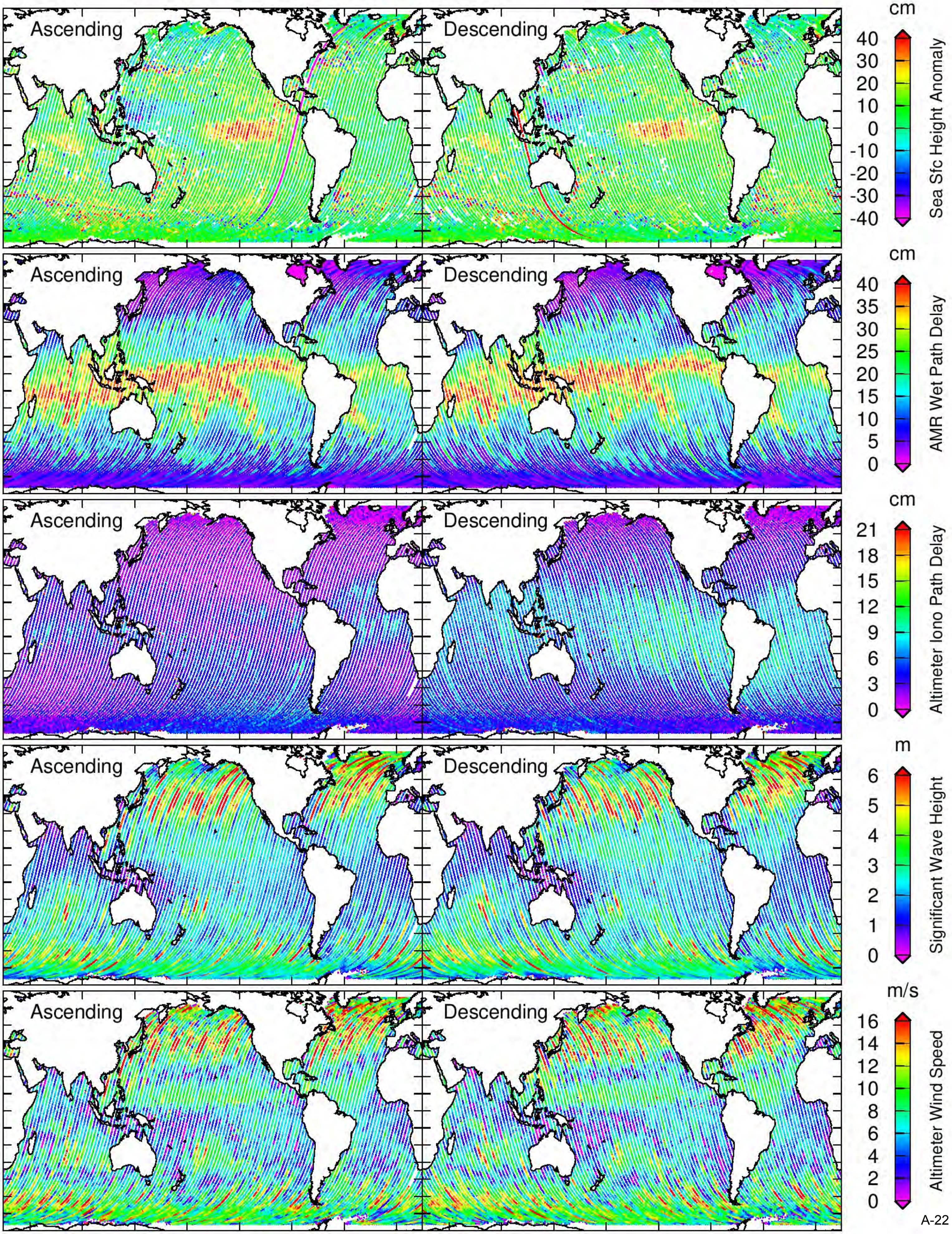

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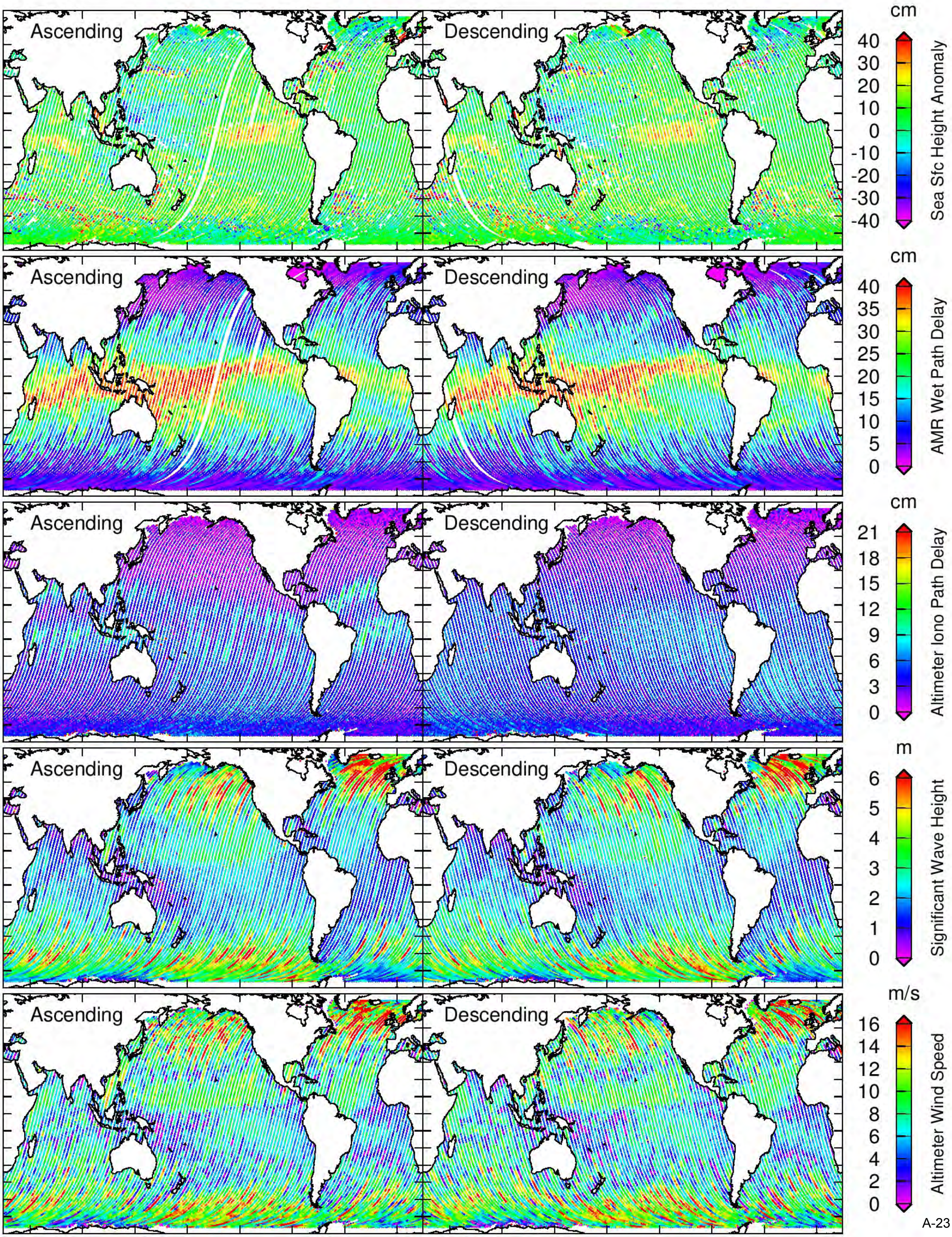

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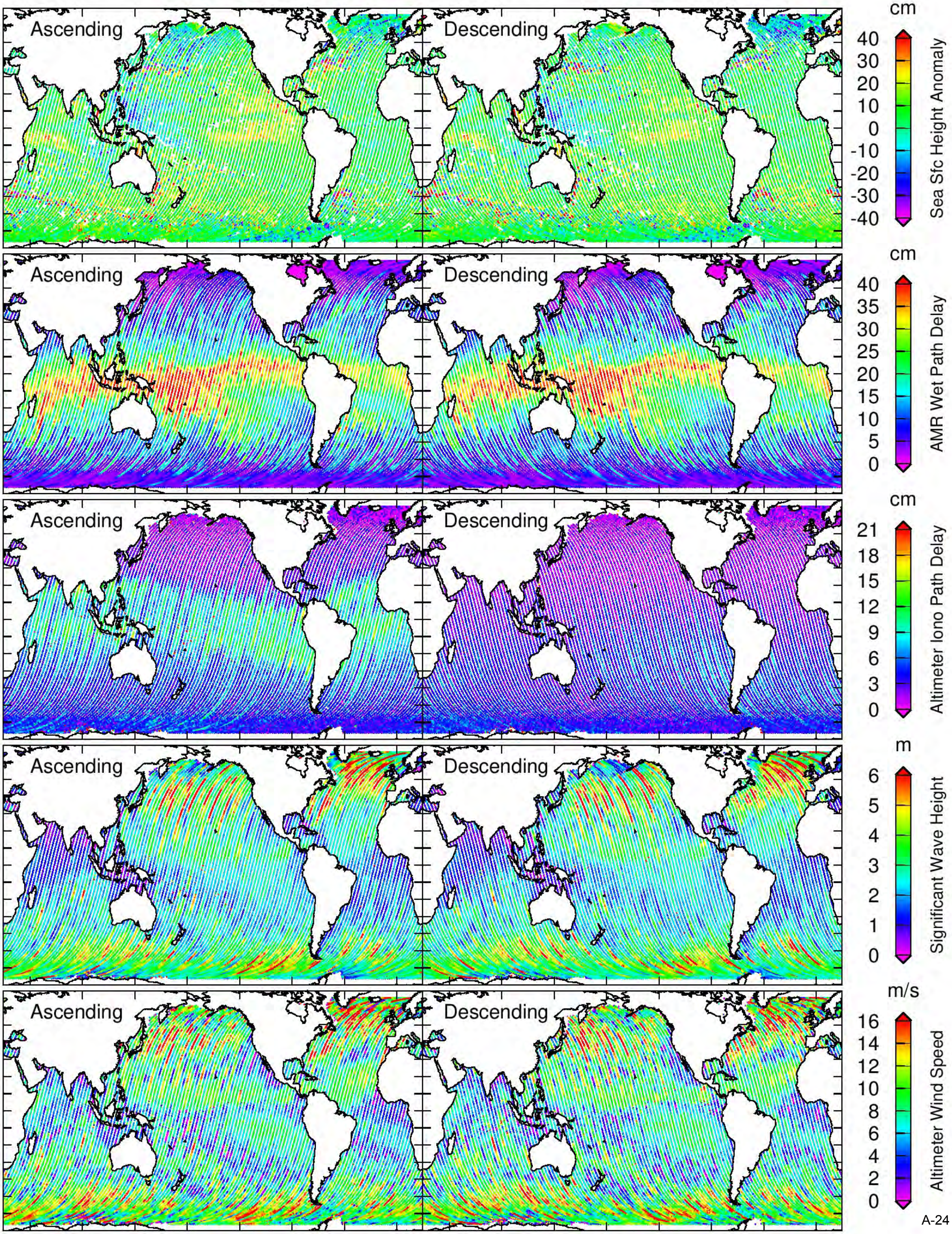

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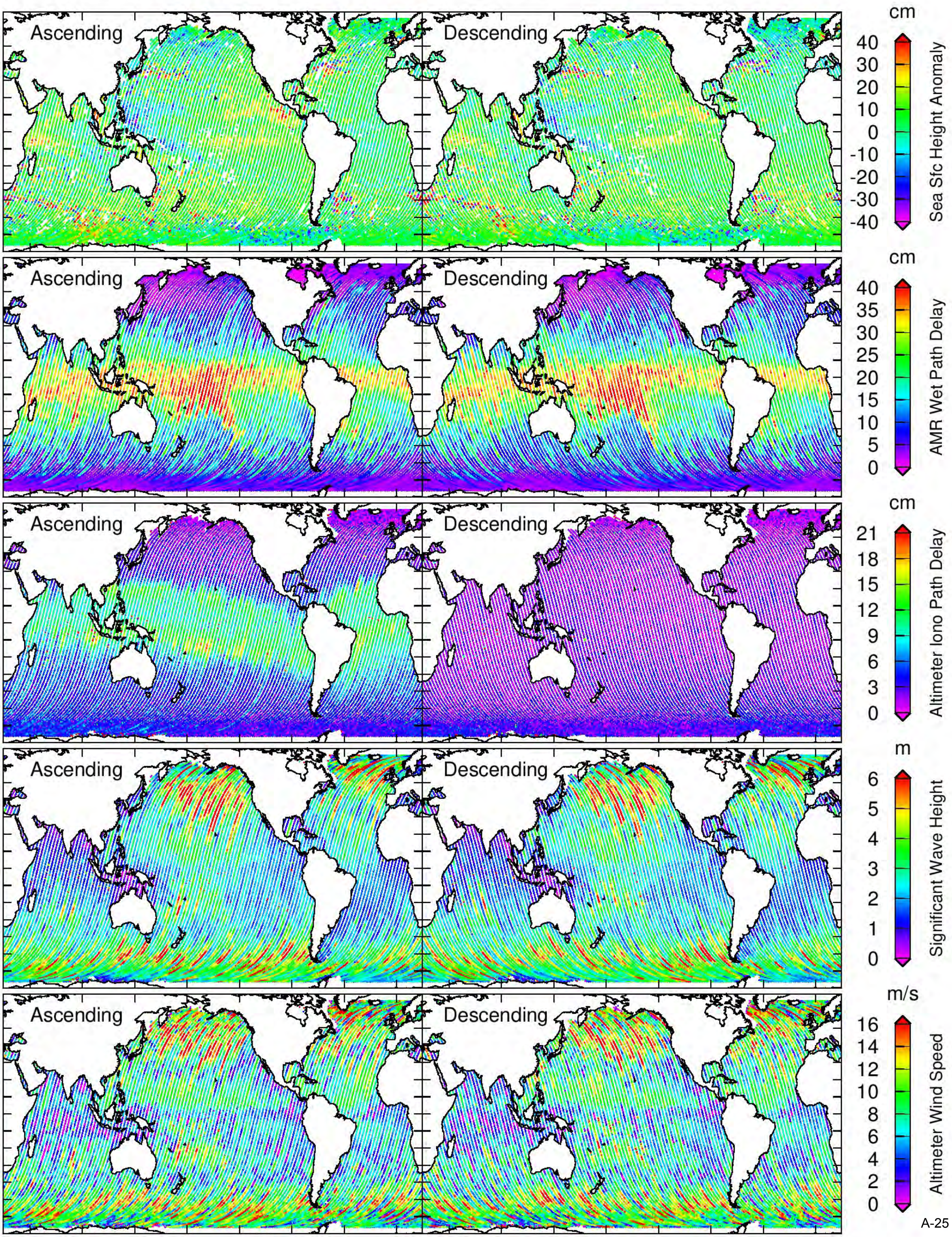
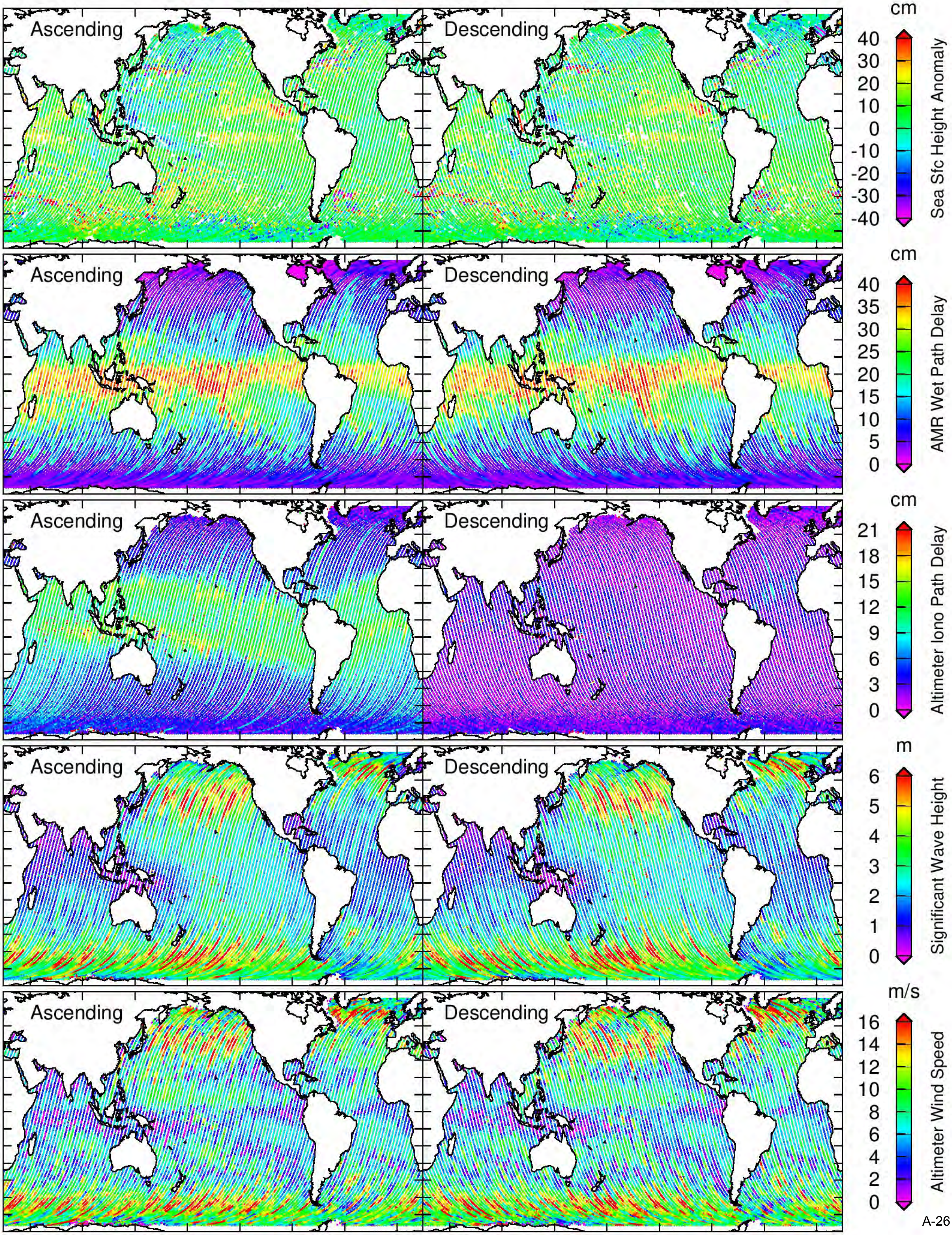
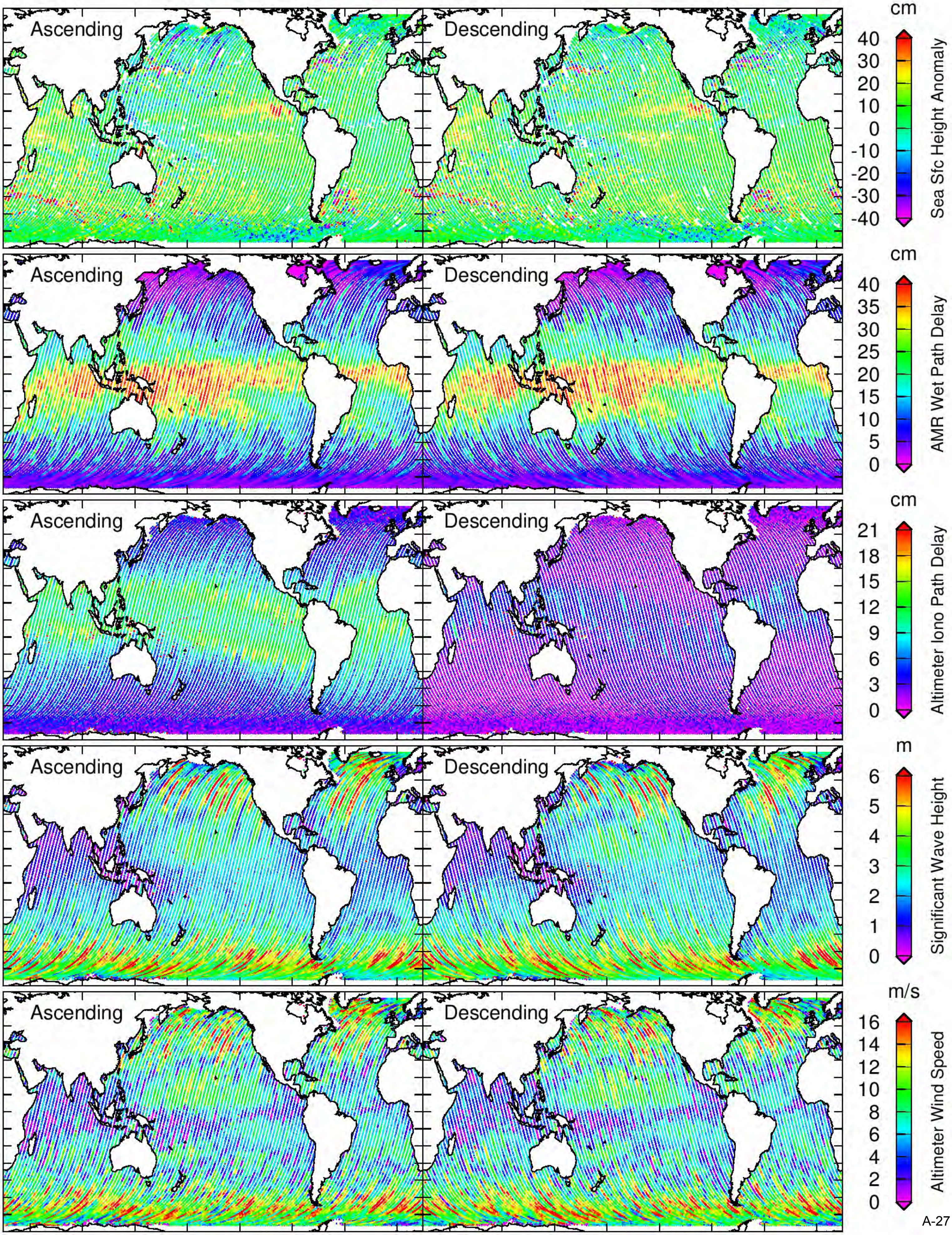


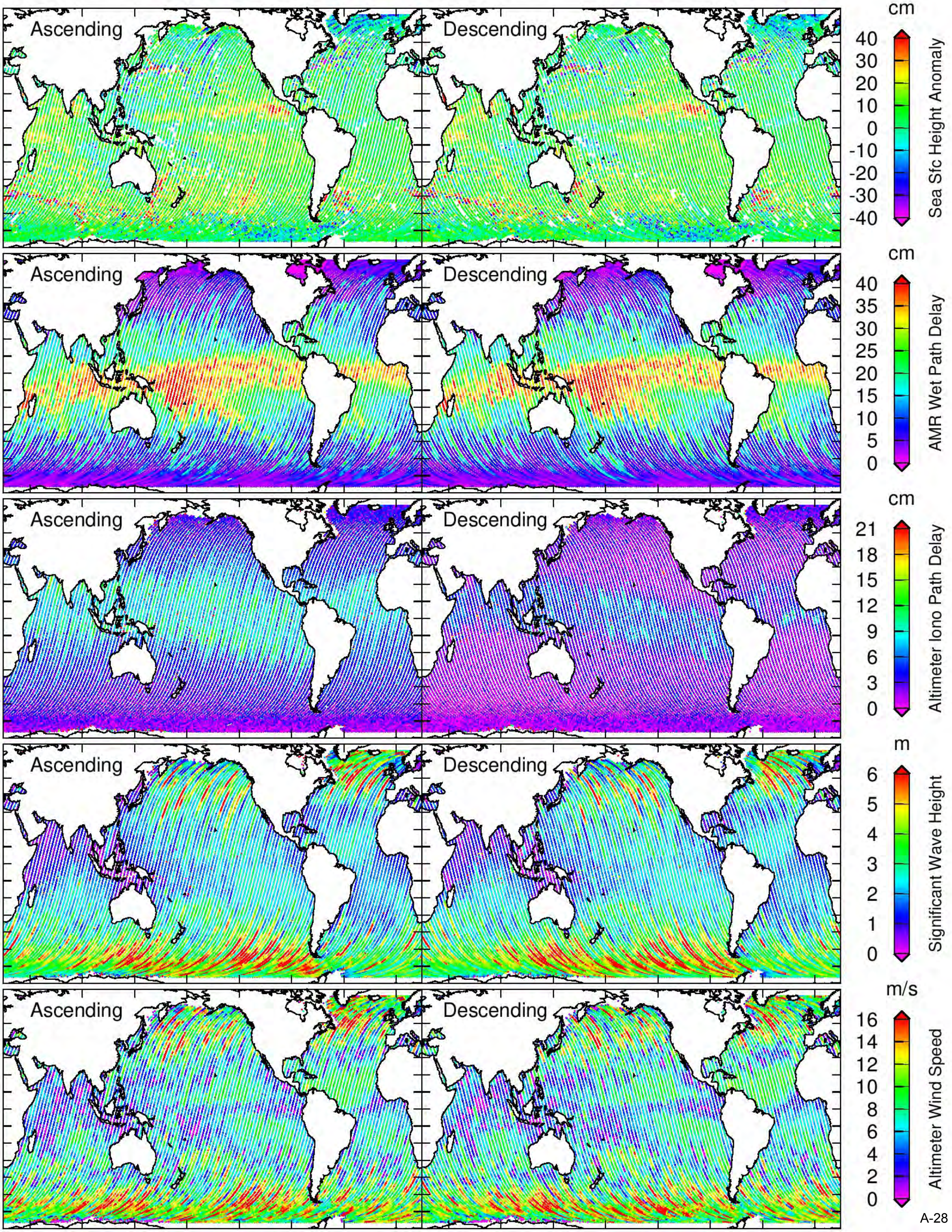
Jason-2 Cycle-282 2016-02-27 08:25:56 - 2016-03-08 06:24:28



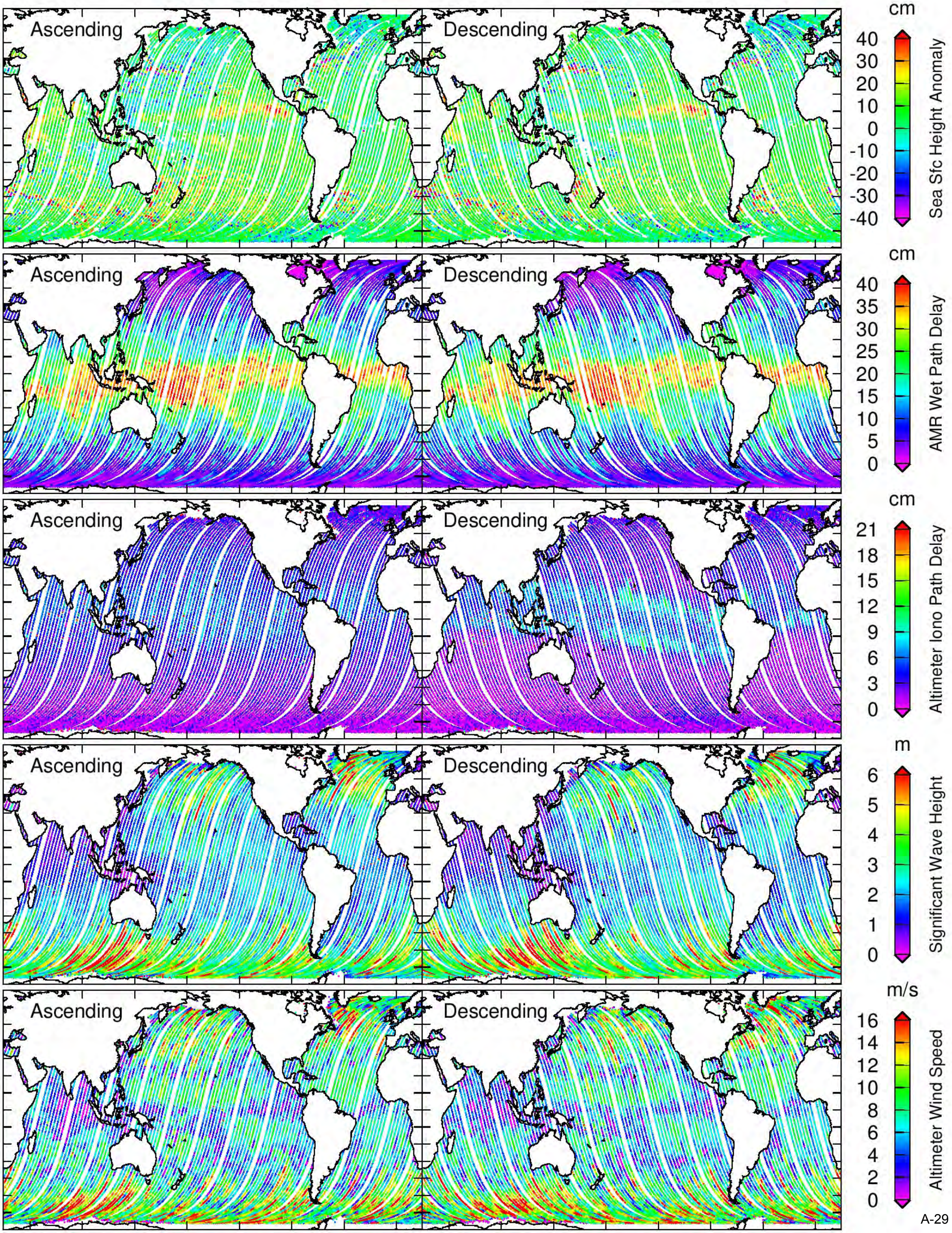
Jason-2 Cycle-283 2016-03-08 06:24:28 - 2016-03-18 04:23:00



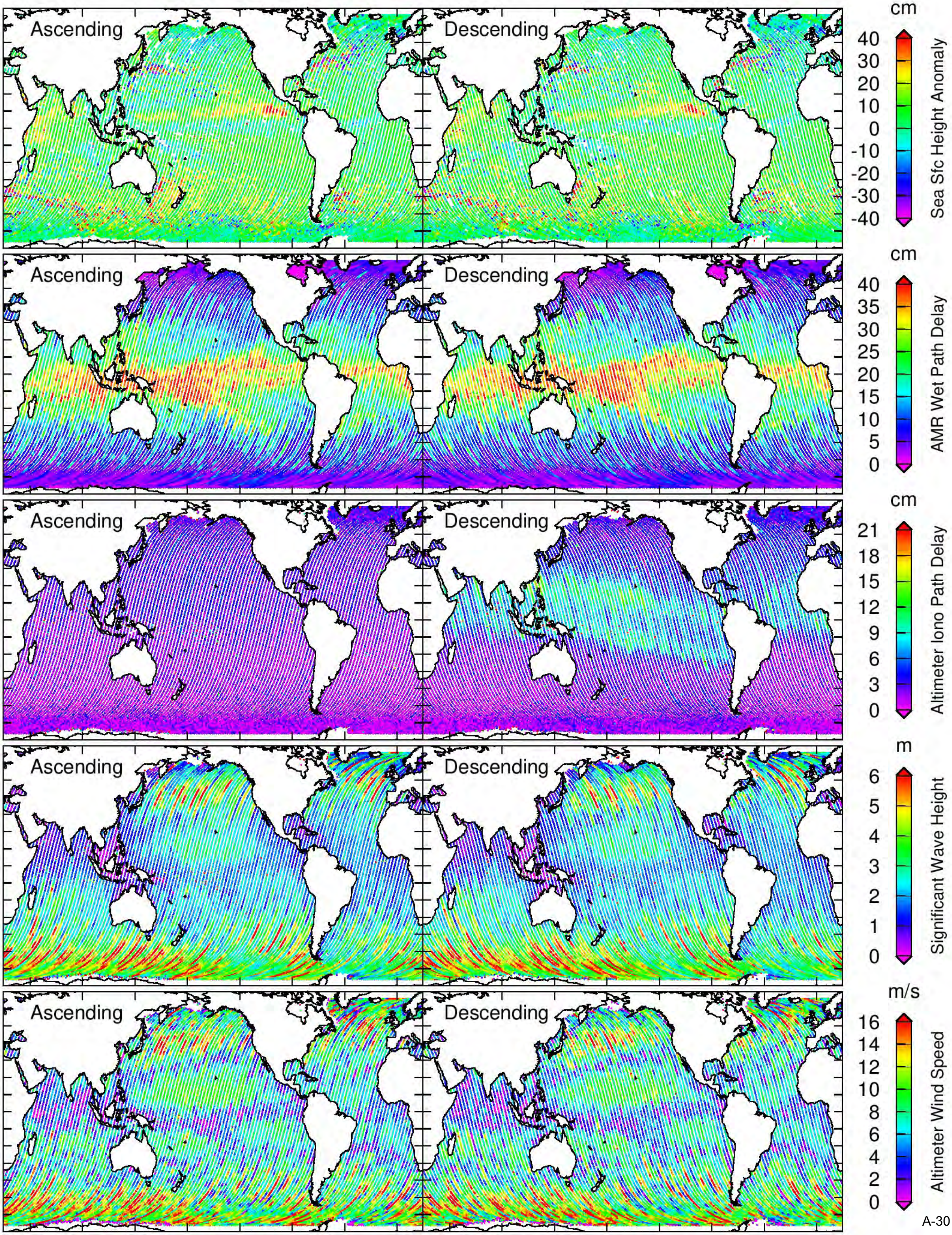
Jason-2 Cycle-284 2016-03-18 04:23:00 - 2016-03-28 02:21:31



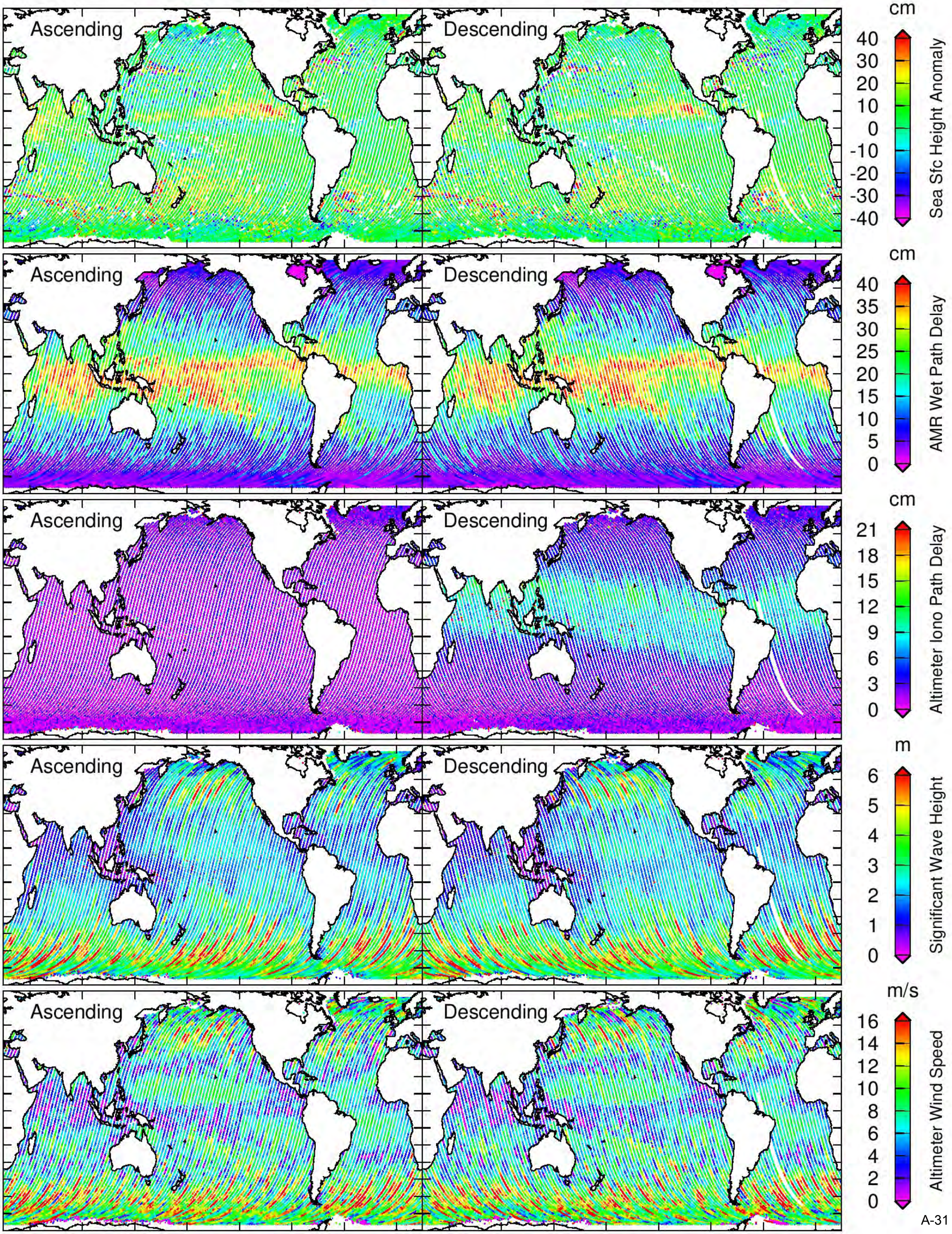
Jason-2 Cycle-285 2016-03-28 02:21:31 - 2016-04-07 00:20:03



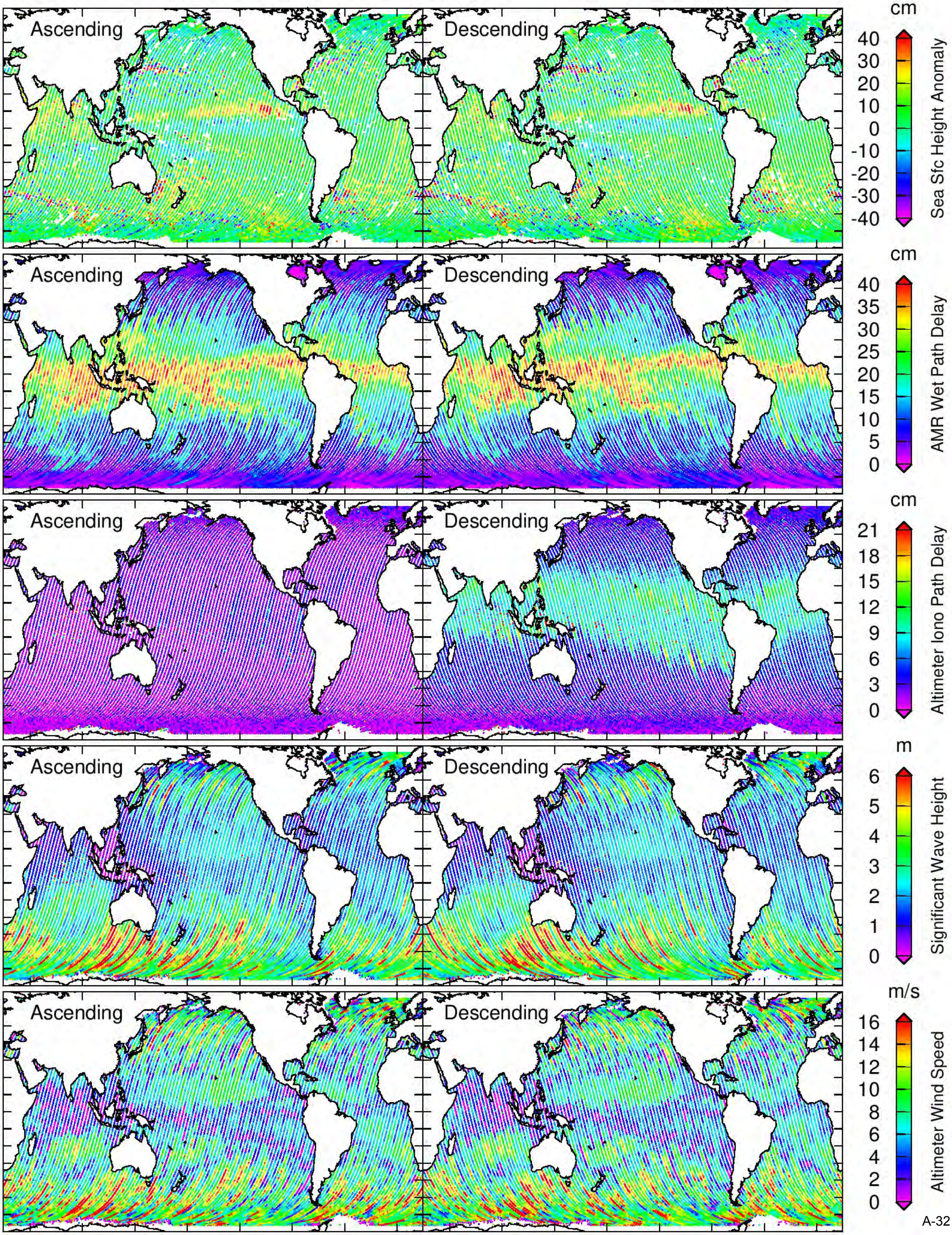
Jason-2 Cycle-286 2016-04-07 00:20:03 - 2016-04-16 22:18:34



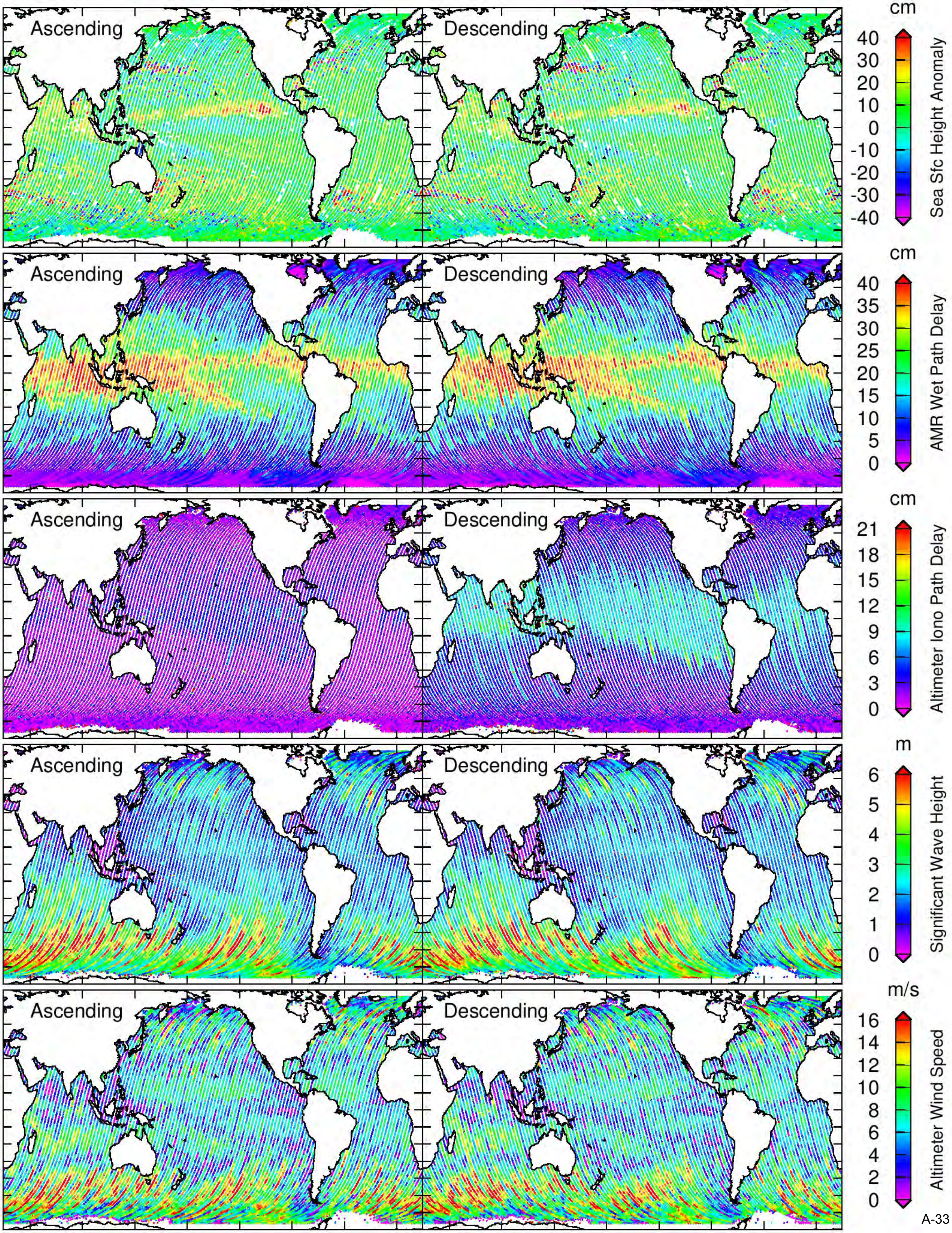
Jason-2 Cycle-287 2016-04-16 22:18:34 - 2016-04-26 20:17:06



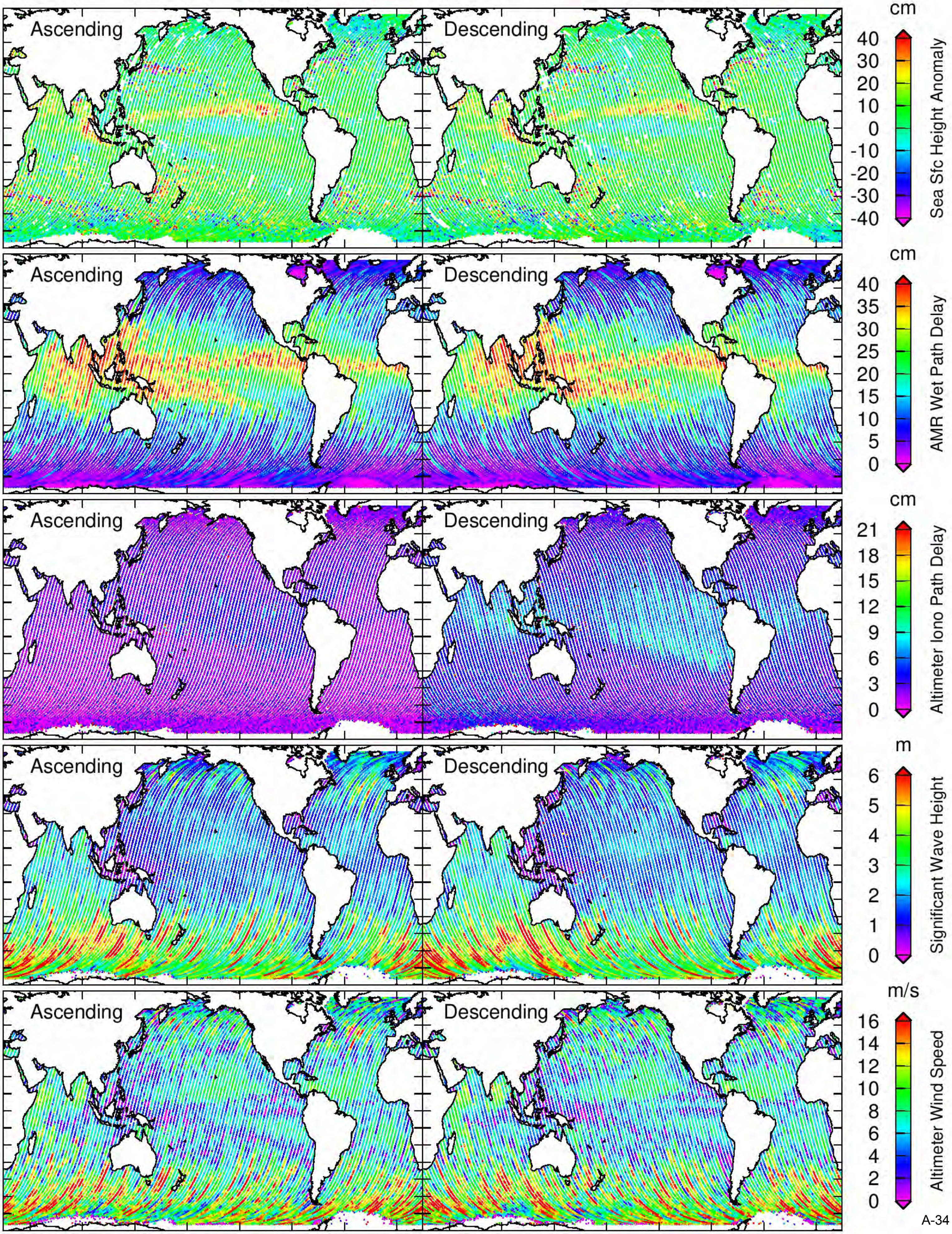
Jason-2 Cycle-288 2016-04-26 20:17:06 - 2016-05-06 18:15:38



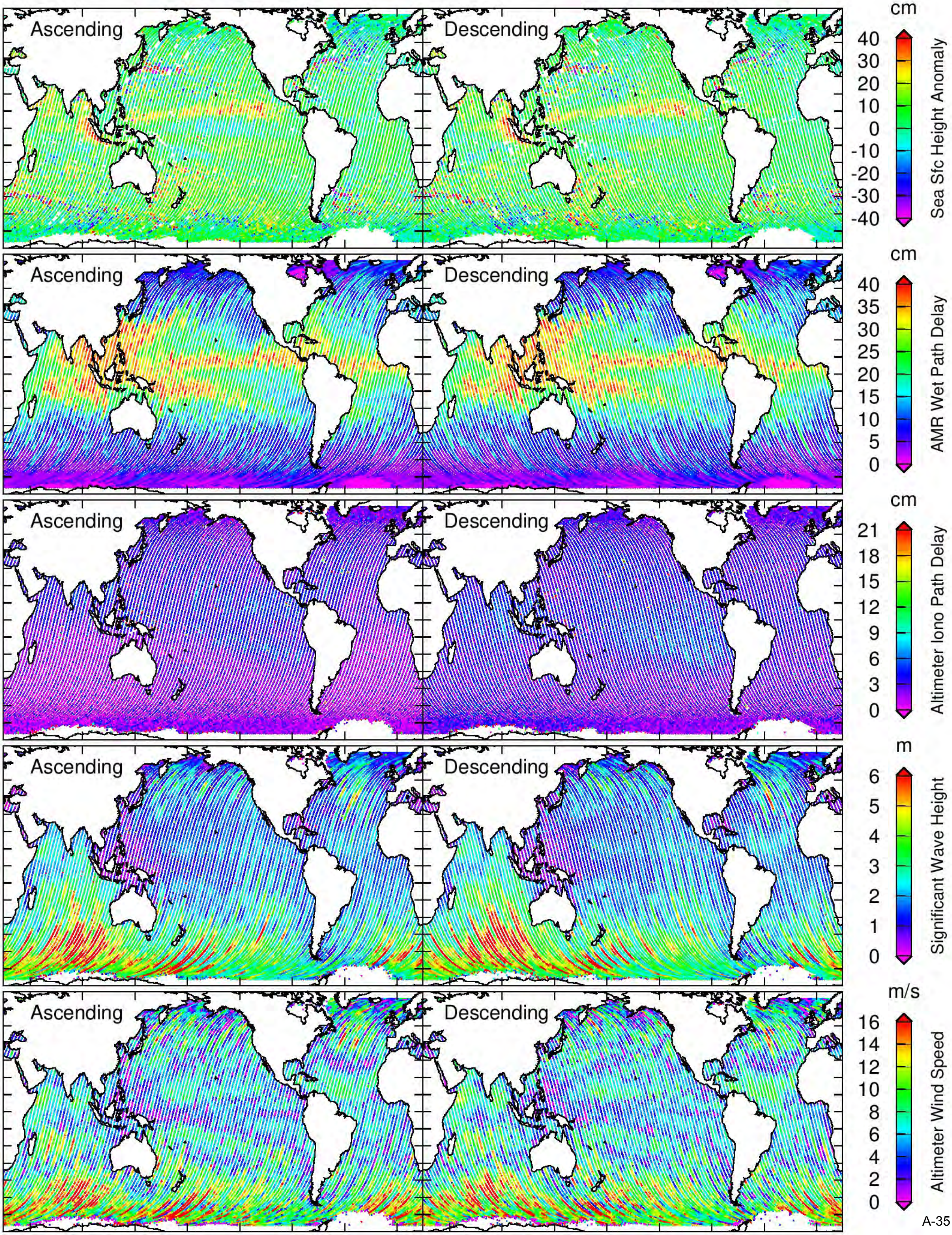
Jason-2 Cycle-289 2016-05-06 18:15:38 - 2016-05-16 16:14:09



Jason-2 Cycle-290 2016-05-16 16:14:09 - 2016-05-26 14:12:41



Jason-2 Cycle-291 2016-05-26 14:12:41 - 2016-06-05 12:11:12



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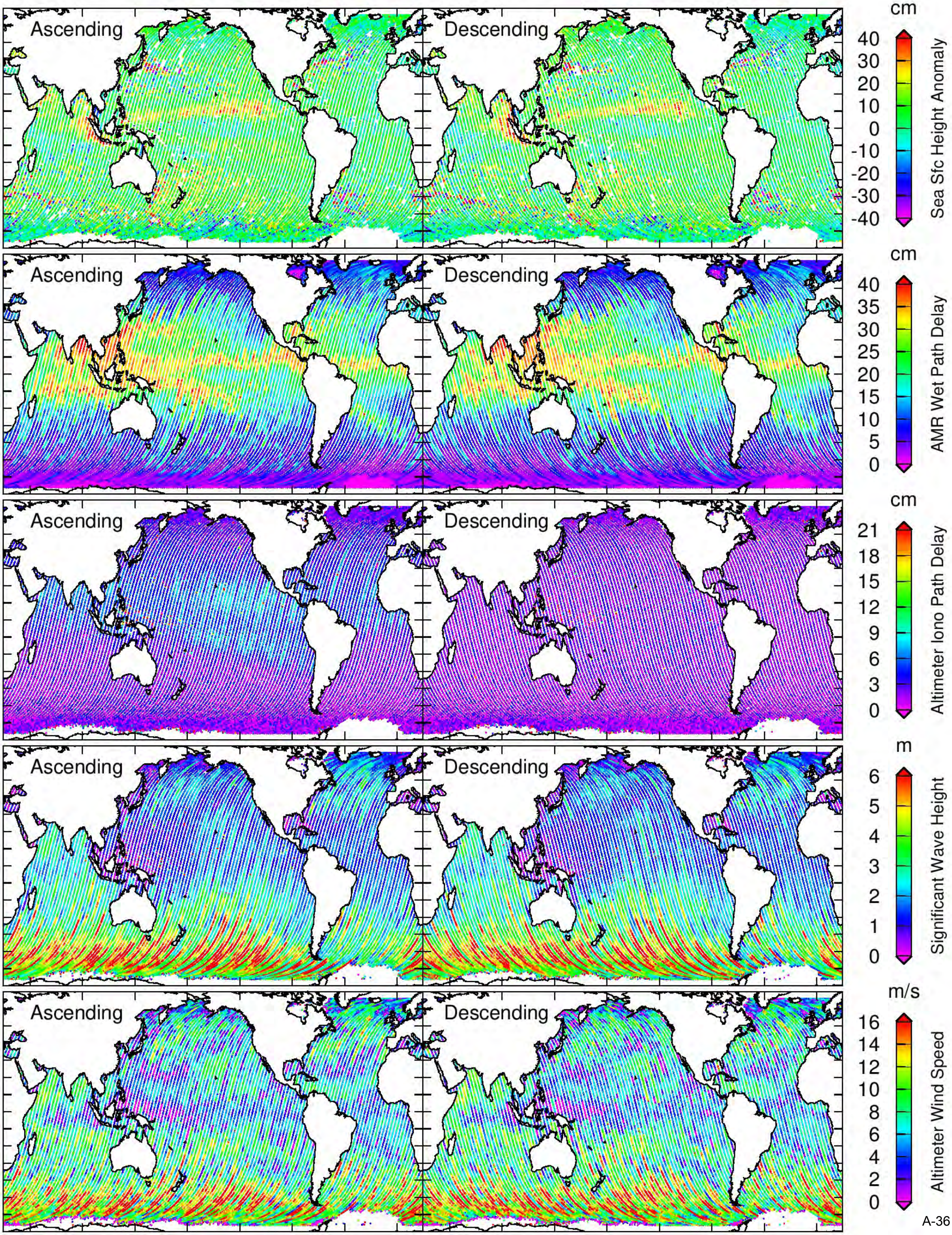
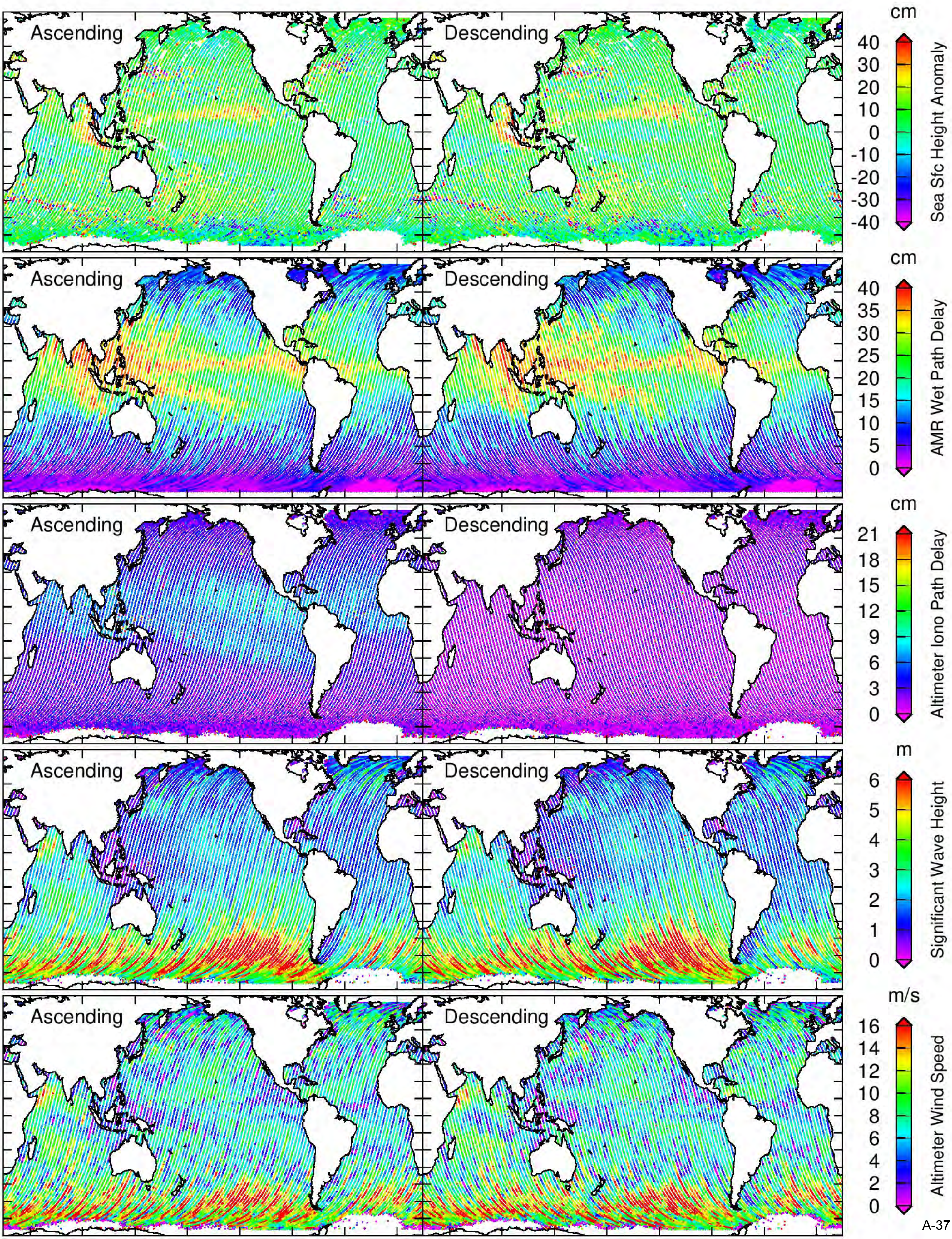


Jason-2 Cycle-293 2016-06-15 10:09:44 - 2016-06-25 08:08:16



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