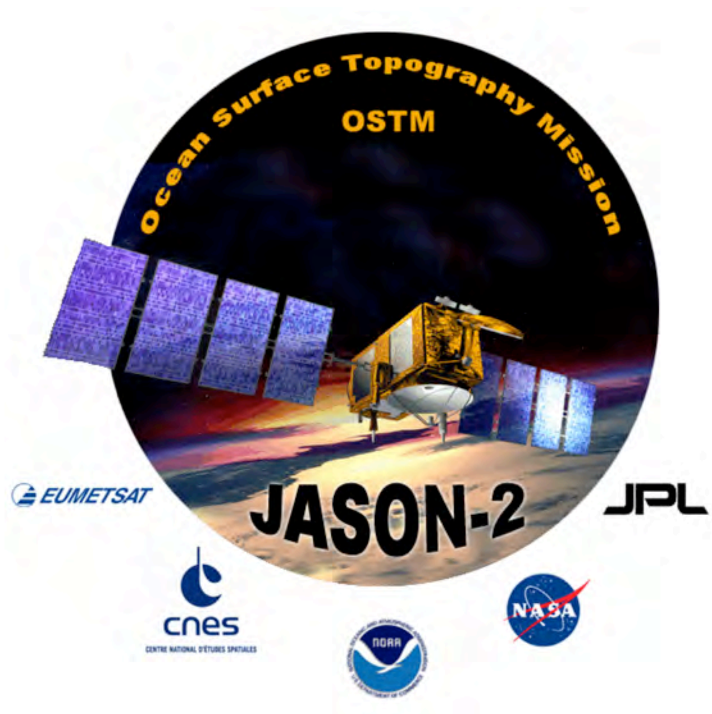
OSTM / Jason-2

Near Real-Time Data Annual Quality Report 2013-2014

August 2014



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 2013-2014

August 2014

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eApproval Page

Document Numbers:	
NOAA/NESDIS Polar Series/OSTM J447	Near Real-Time Data Annual Quality Report 2013-2014 NOAA-Jason2/OSD-2014-0001R0 August 1, 2014

Document Title Block:

OSTM / Jason-2

Near Real-Time Data Annual Quality Report 2013-2014

PROGRAM: OSTM / Jason-2	**DOCUMENT DATE**: August 1, 2014
APPROVALS	
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Version Description Record

DOCUMENT TITLE:
OSTM / Jason-2 Near Real-Time Data Annual Quality Report 2013-2014

DOCUMENT CHANGE HISTORY

Revision	Date	Description of Change
R0	August 1, 2014	Initial Release
-	August 1, 2014	Reformatted (no change to content)

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 2013-2014* (August 1, 2014 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 sixth year of mission operations are discussed in the next section.

This year Jason-2 experienced its third satellite safehold, resulting in an unusually low data return during cycles 190-191. Nonetheless, the 95% mission data return requirement was still met as in all previous years.

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 sixth 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.

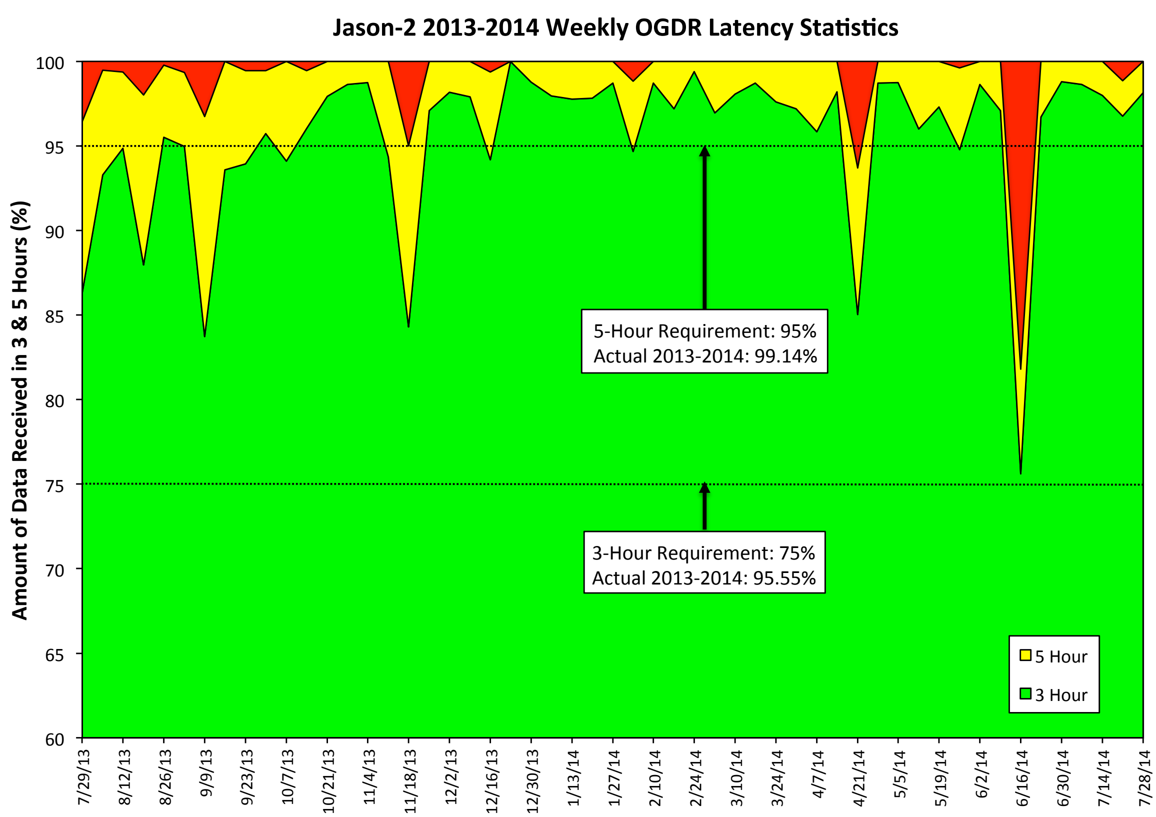


Figure 1 – Jason-2 OGDR Latency Statistics for July 2013 to July 2014

This figure demonstrates that the 3-hour / 75% requirement was satisfied for all weeks. The 5-hour / 95% requirement was not met the three weeks of 18-Nov-2013, 21-Apr-2014, and 16-Jun-2014. The exceptionally low value of 81.8% in June was the result of a fire alarm at SOCC, which resulted in a complete network outage. Several scheduled NOAA ground contacts went unsupported and the data accumulated onboard until routine Usingen contacts resumed. The yearly averaged values (over the 54 weeks shown in Figure 1) are: 95.55% of all data were available within 3 hours, and 99.14% of all data were available within 5 hours.

Section 3.0 Data Quality Analysis Plots

In this section data from the sixth year of operations are analyzed, covering the time period from 20-Jul-2013 to 12-Jul-2014: cycles 186-221. 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 186-221 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 2013 to July 2014 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.

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 last year's 2013 report, the first 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-188

Maneuver burn on 2013-08-11 from 17:57:51 to 17:57:53 (Pass 064).

JA2_OPN_2PdS188_063_20130811_173621_20130811_193445.nc

Cycle-190

The Jason-2 spacecraft entered safe hold mode on 2013-09-05 at 09:26. The last available science data is on 2013-09-05 at 07:44:17. Consequently, pass 185 has 10.2% of missing measurements over sea and passes 186 to 254 are entirely missing.

JA2_OPN_2PdS190_184_20130905_061128_20130905_074417.nc

Cycle-191

The Jason-2 spacecraft was in safe hold mode from 2013-09-05 at 09:26 through 2013-09-12. The first post-safehold measurement is on 2013-09-12 at 12:25:52. Due to this safe hold passes 1 to 115 are missing and passes 116-125 had no AMR data.

JA2_OPN_2PdS191_116_20130912_122550_20130912_142405.nc
JA2_OPN_2PdS191_118_20130912_142404_20130912_161424.nc
JA2_OPN_2PdS191_120_20130912_161424_20130912_181009.nc

JA2_OPN_2PdS191_122_20130912_181008_20130912_195754.nc
JA2_OPN_2PdS191_124_20130912_195753_20130912_215338.nc

Cycle-196

Maneuver burn on 2013-10-28 from 21:23:35 to 21:23:37 (Pass 033).

JA2_OPN_2PdS196_033_20131028_210858_20131028_230402.nc

Cycle-201

Maneuver burn on 2013-12-18 from 05:54:13 to 05:54:15 (Pass 053) [Not evident in Appendix-A SSHA plot].

JA2_OPN_2PdS201_051_20131218_040516_20131218_060254.nc

Cycle-207

677 second gap on 2014-02-20 between 14:15:16 and 14:26:33 over the Caribbean during initial preparation for Jason-2 DIODE MNT mode to be performed during cycle 209. Pass 178 had 24.6% of global missing data and 11.8% missing data over ocean due to DEM upload [barely visible in Appendix-A].

JA2_OPN_2PdS207_176_20140220_121801_20140220_141517.nc
JA2_OPN_2PdS207_178_20140220_142632_20140220_155400.nc

Cycle-208

Maneuver burn on 2014-02-27 from 16:27:44 to 16:27:46 (Pass 105).

JA2_OPN_2PdS208_104_20140227_153516_20140227_180950.nc

821 second gap on 2014-02-24 between 14:38:27 and 14:52:06 from the southern rollover below S. Africa into the Indian Ocean. There were recurring network problems between Fairbanks and SOCC. 37.5% of pass 27 is missing (40.7% over ocean) due to these network issues.

JA2_OPN_2PdS208_026_20140224_134911_20140224_143827.nc
JA2_OPN_2PdS208_027_20140224_145206_20140224_152825.nc

Cycle-212

Due to the antenna elevation being stuck at Usingen, telemetry data was lost on rev. 27197 and rev. 27198 was a failed support. The lost PLTM-1 data was not recovered, resulting in a product gap on 2014-04-13 from 18:17:04 to 19:26:24. The partially missing passes for O/IGDR (244 and 245) were redelivered and are totally available for GDR production.

JA2_OPN_2PdS212_243_20140413_174629_20140413_181706.nc
JA2_OPN_2PdS212_245_20140413_192620_20140413_194319.nc

Cycle-214

Maneuver burn on 2014-04-25 from 08:57:04 to 08:57:07 (Pass 033).

JA2_OPN_2PdS214_033_20140425_084342_20140425_103638.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 186-221 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 4379 analyzed OGDRs is a total of 21,005,699 over-ocean records (out of a total 29,099,731 records) with data gaps totaling 659,843 records. This equates to 7d 15h 17m 23s of missing data over the course of the year, and an over-ocean data return of 96.86%. The majority of this loss is due to the safehold in September, 2013 affecting cycles 190-191. If we ignore the safehold mode gap, the missing over-ocean data decreases to 50,333 records, for a data return of 99.76%.

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_2PdS191_116_20130912_122550_20130912_142405	609510
JA2_OPN_2PdS205_101_20140128_184755_20140128_204510	9569
JA2_OPN_2PdS203_152_20140110_215708_20140110_235513	6759
JA2_OPN_2PdS187_076_20130802_070343_20130802_090703	6460
JA2_OPN_2PdS215_151_20140509_212558_20140509_233806	5969
JA2_OPN_2PdS211_127_20140330_070245_20140330_085920	5730
JA2_OPN_2PdS212_245_20140413_192620_20140413_194319	4075
JA2_OPN_2PdS189_025_20130820_032730_20130820_055739	3877
JA2_OPN_2PdS192_129_20130922_232630_20130923_010308	1422
JA2_OPN_2PdS197_108_20131110_165006_20131110_181955	850
JA2_OPN_2PdS208_027_20140224_145206_20140224_152825	804
JA2_OPN_2PdS197_009_20131106_204428_20131106_223914	748
JA2_OPN_2PdS207_178_20140220_142632_20140220_155400	663
JA2_OPN_2PdS188_056_20130811_101738_20130811_134213	371
JA2_OPN_2PdS197_131_20131111_151513_20131111_184120	284
JA2_OPN_2PdS188_096_20130812_235136_20130813_013930	176
JA2_OPN_2PdS197_089_20131109_234714_20131110_014539	154
JA2_OPN_2PdS197_032_20131107_173706_20131107_190851	109
JA2_OPN_2PdS192_061_20130920_073224_20130920_093152	104

Section 6.0 Summary

The overall quality of the Jason-2/OSTM near real-time OGDR data is extremely good. Jason-2 suffered its third (lifetime) safehold in September, resulting in a loss of more than 7-1/2 days of data during cycles 190 and 191. The amount of missing data, attributed to all of the anomalies discussed in sections 4 and 5 (excluding safeholds) is about 13 hours 59 minutes. **This represents an over-ocean data return of 99.76%, excluding the safehold, 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: **95.55% of all data were available within 3 hours and 99.14% of all data were available within 5 hours**.

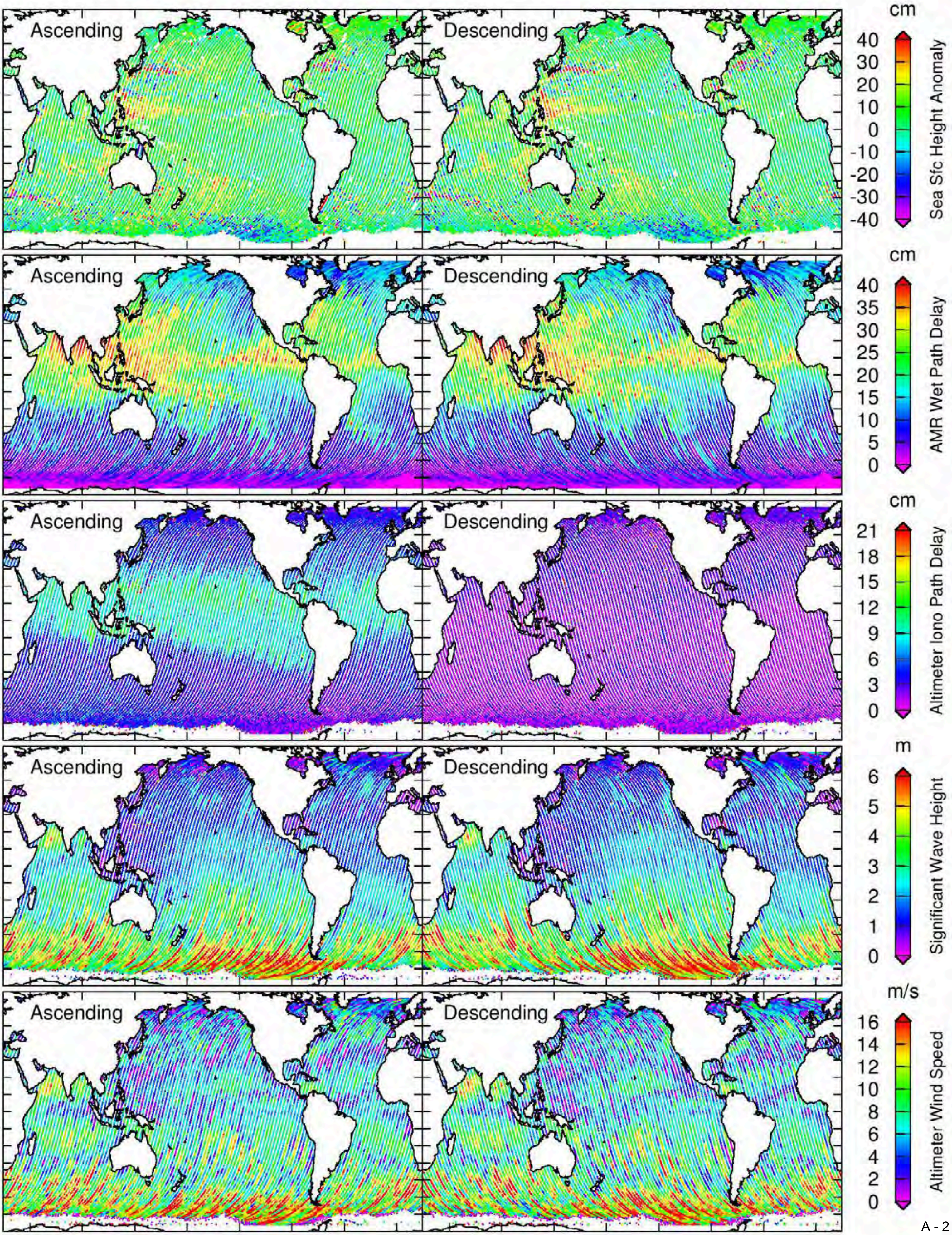
This second report based on OGDR-D data reiterates a concern which the project team needs to address:

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.

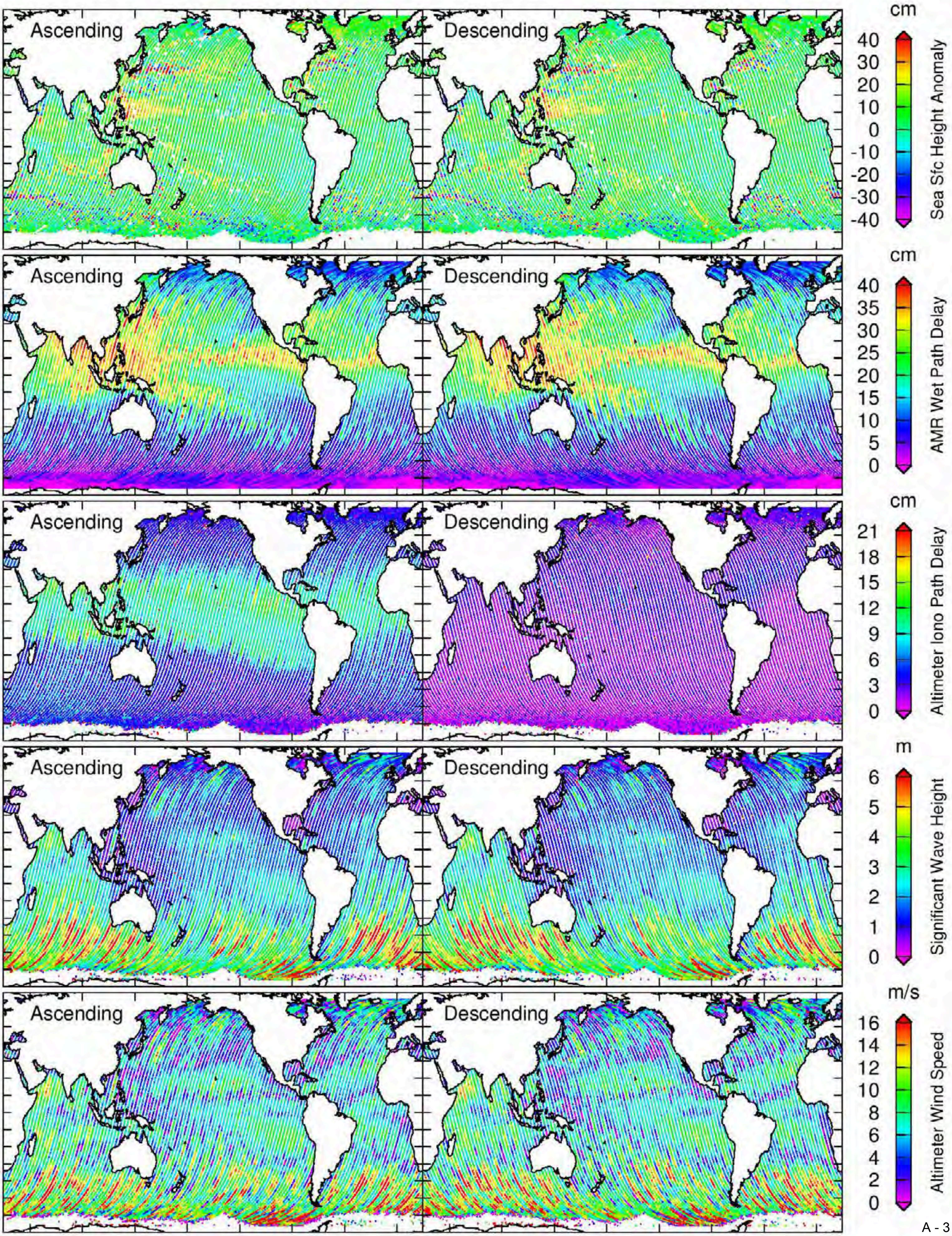
Appendix A. Cyclic Parameter Plots Cycle-186 to Cycle-221

See individual plots on the following 36 pages.

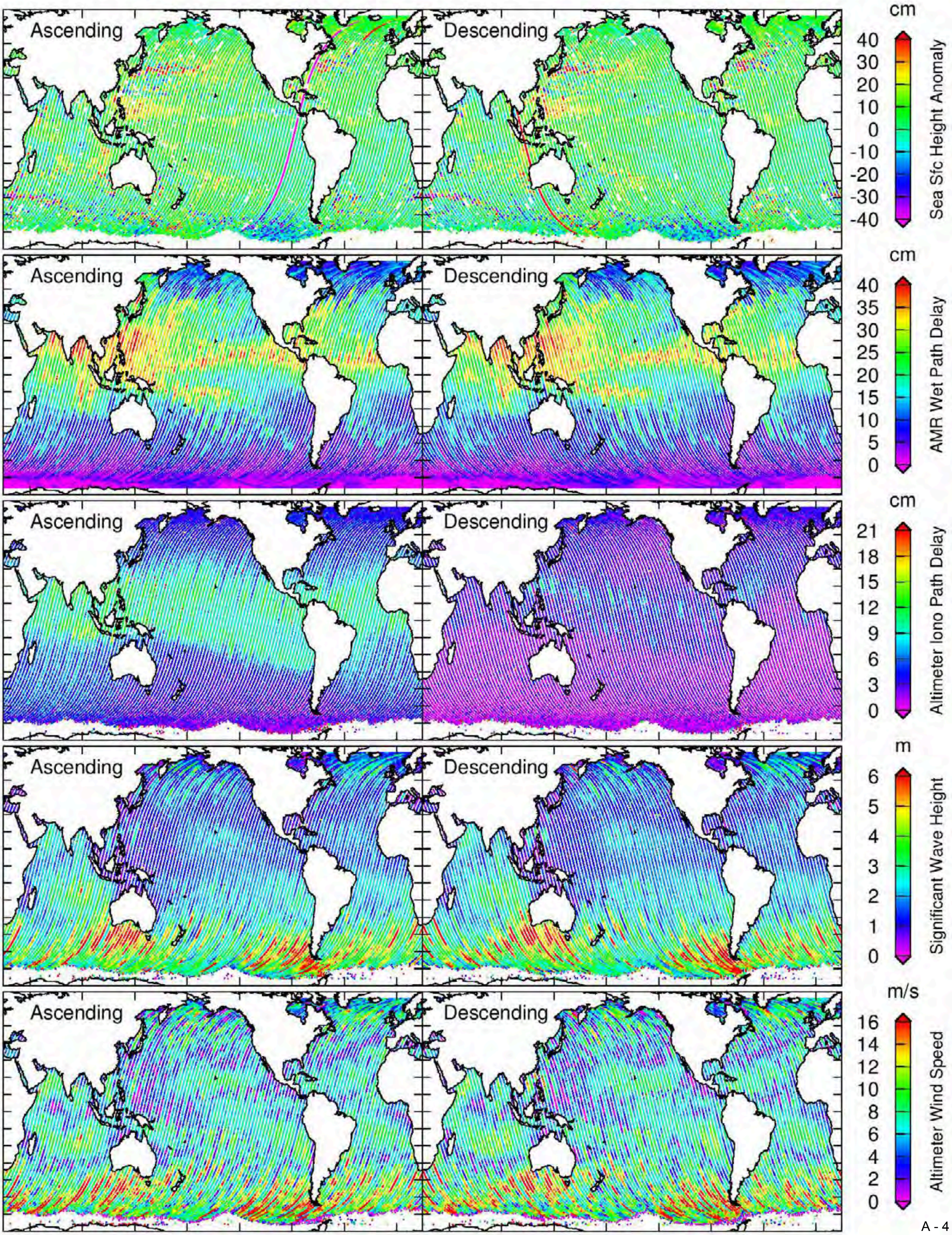
Jason-2 Cycle-186 2013-07-20 10:47:20 - 2013-07-30 08:45:51



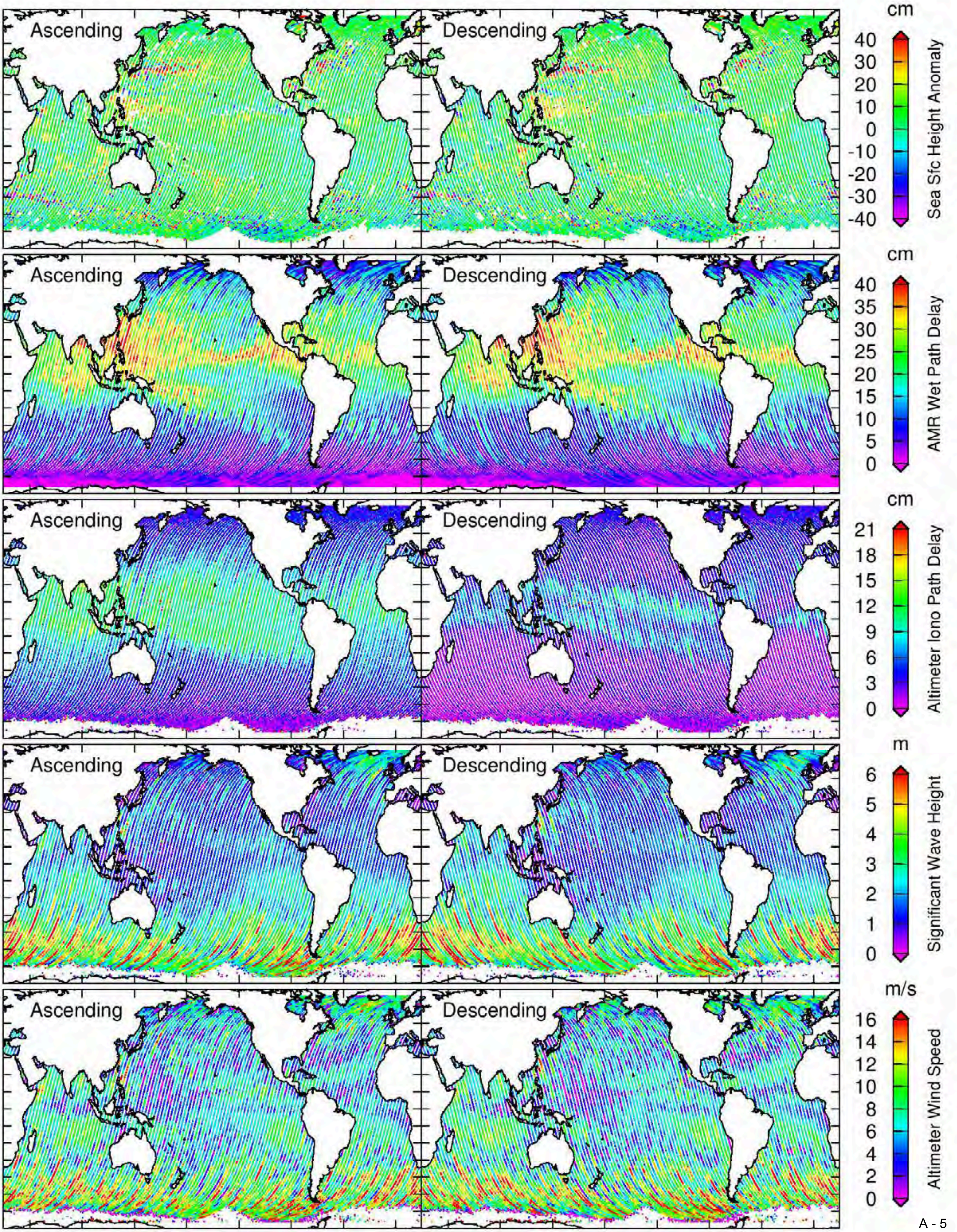
Jason-2 Cycle-187 2013-07-30 08:45:51 - 2013-08-09 06:44:22



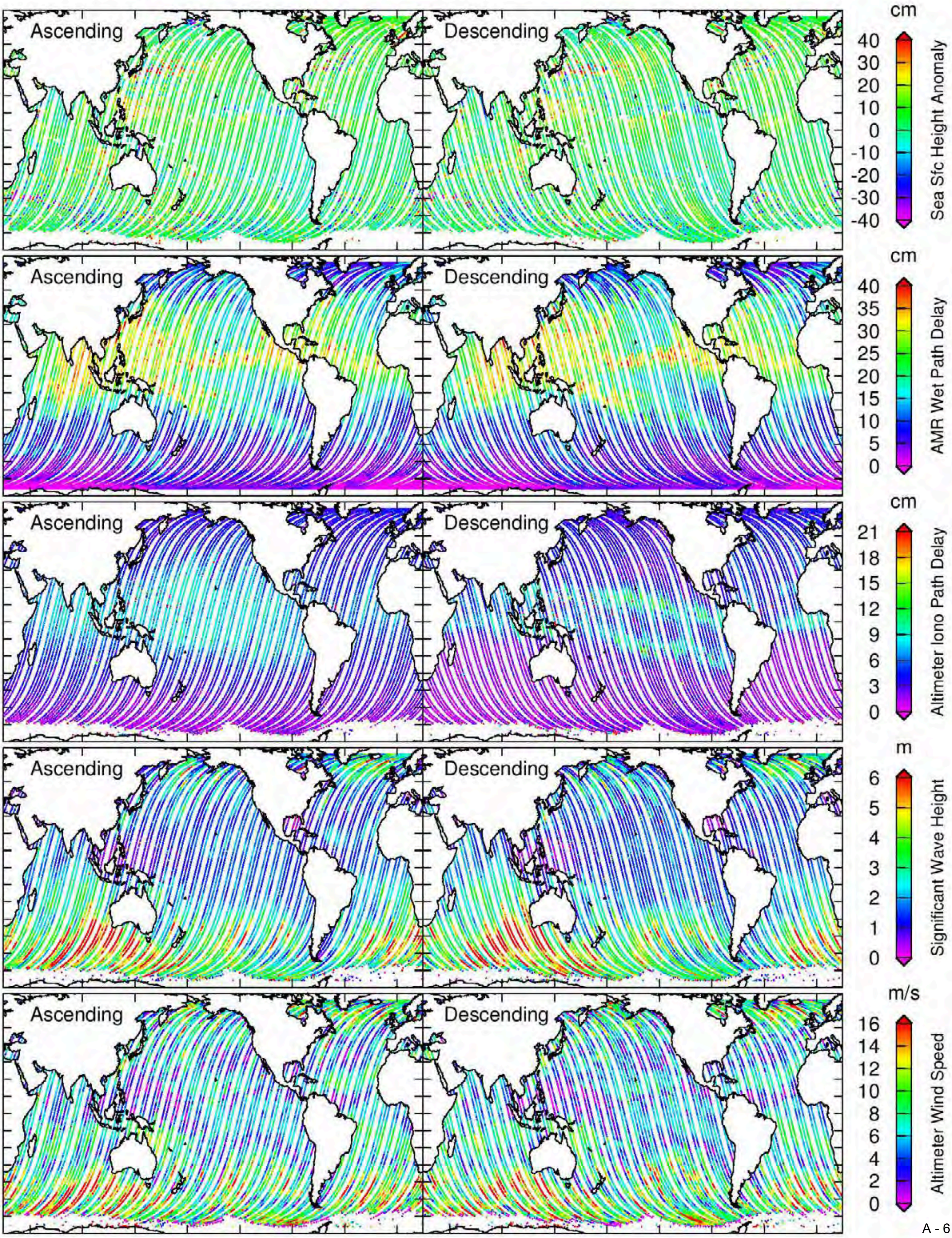
Jason-2 Cycle-188 2013-08-09 06:44:22 - 2013-08-19 04:42:54



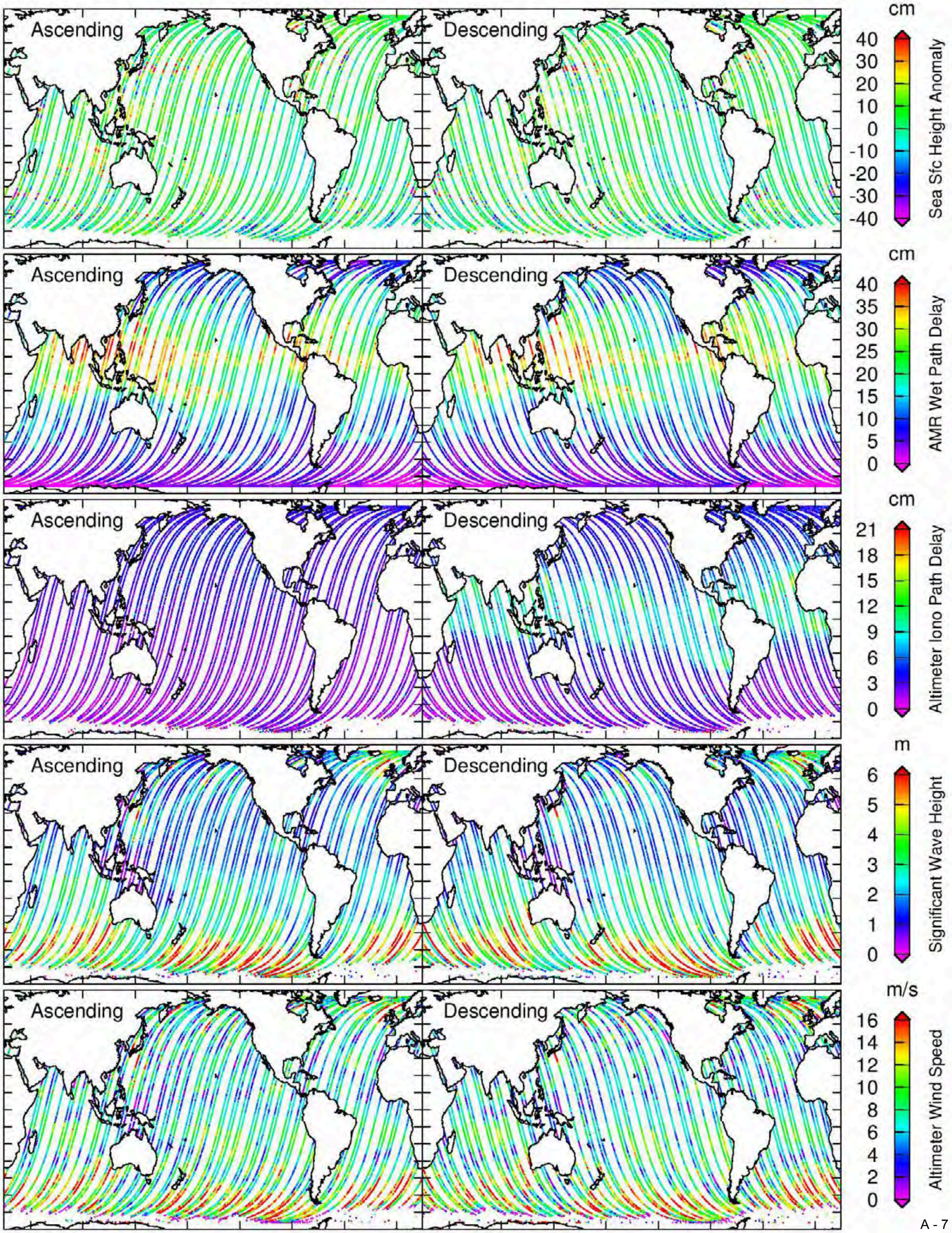
Jason-2 Cycle-189 2013-08-19 04:42:54 - 2013-08-29 02:41:25



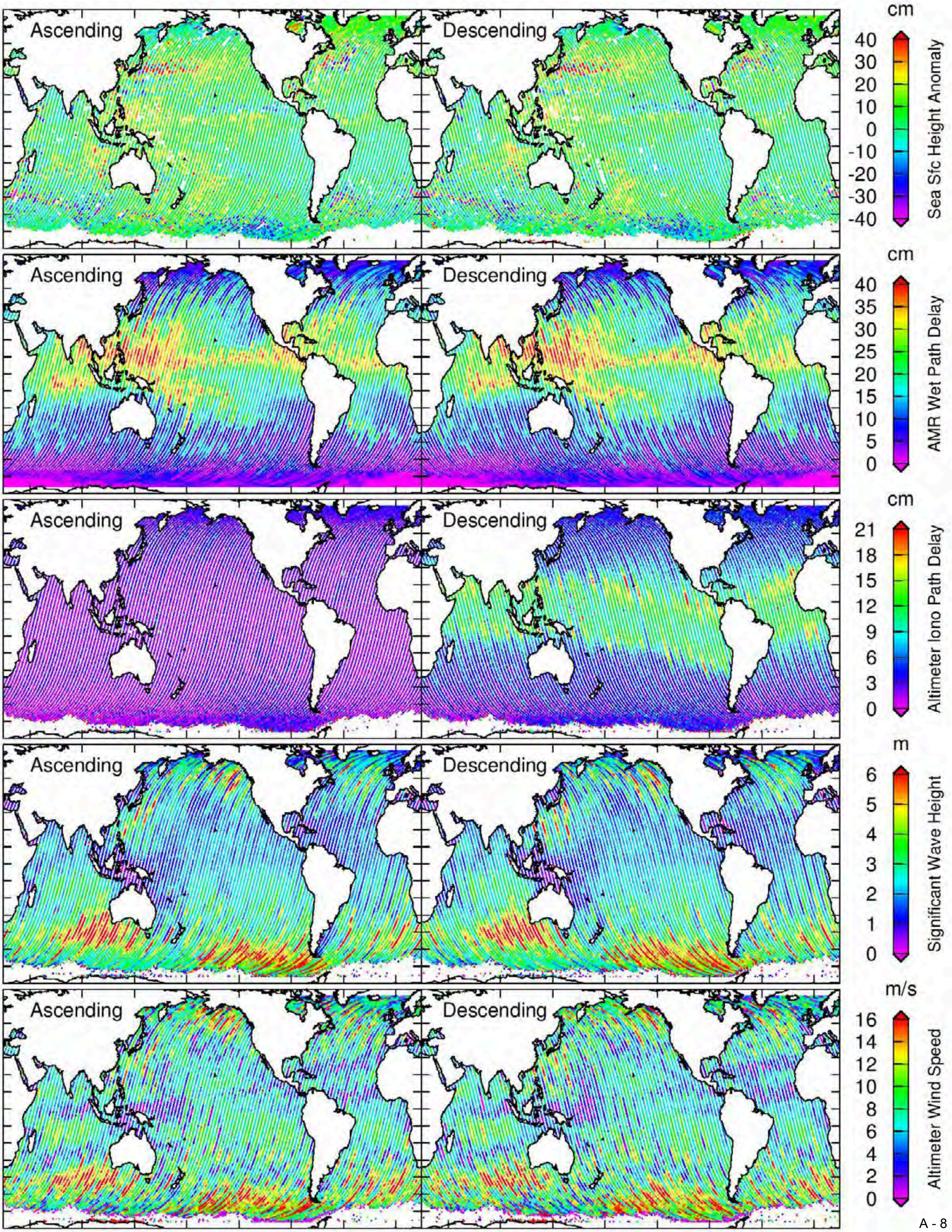
Jason-2 Cycle-190 2013-08-29 02:41:25 - 2013-09-08 00:39:57



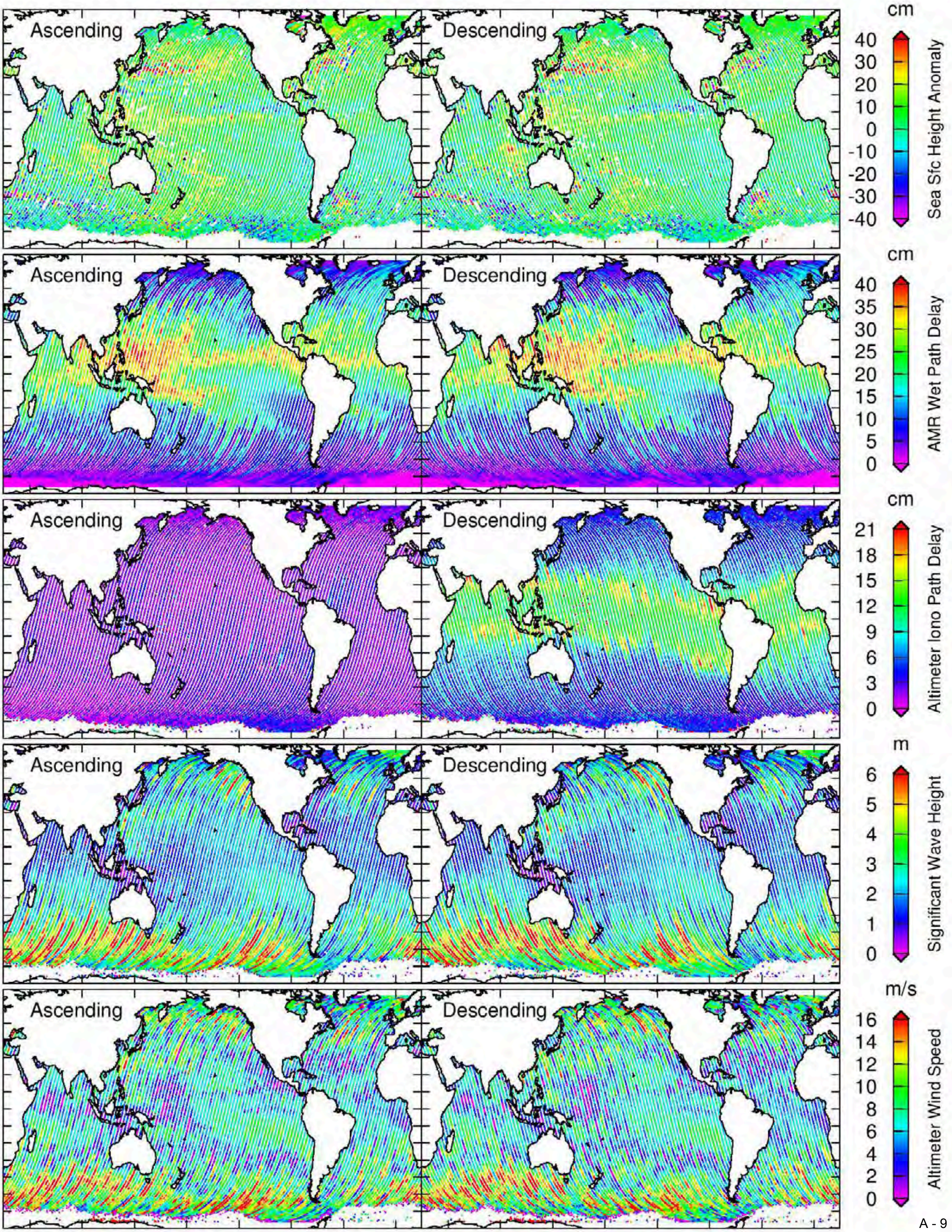
Jason-2 Cycle-191 2013-09-08 00:39:57 - 2013-09-17 22:38:29



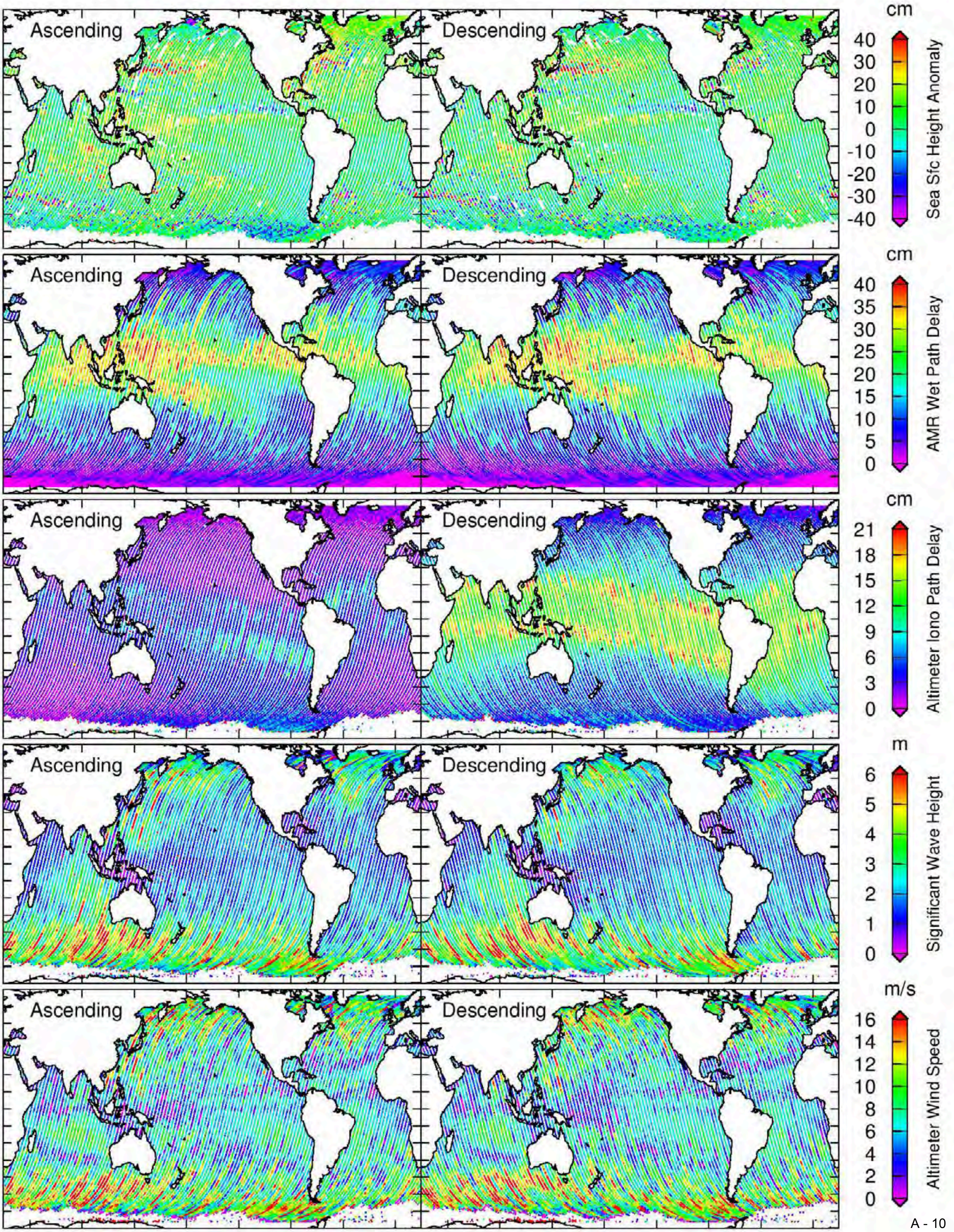
Jason-2 Cycle-192 2013-09-17 22:38:29 - 2013-09-27 20:37:00



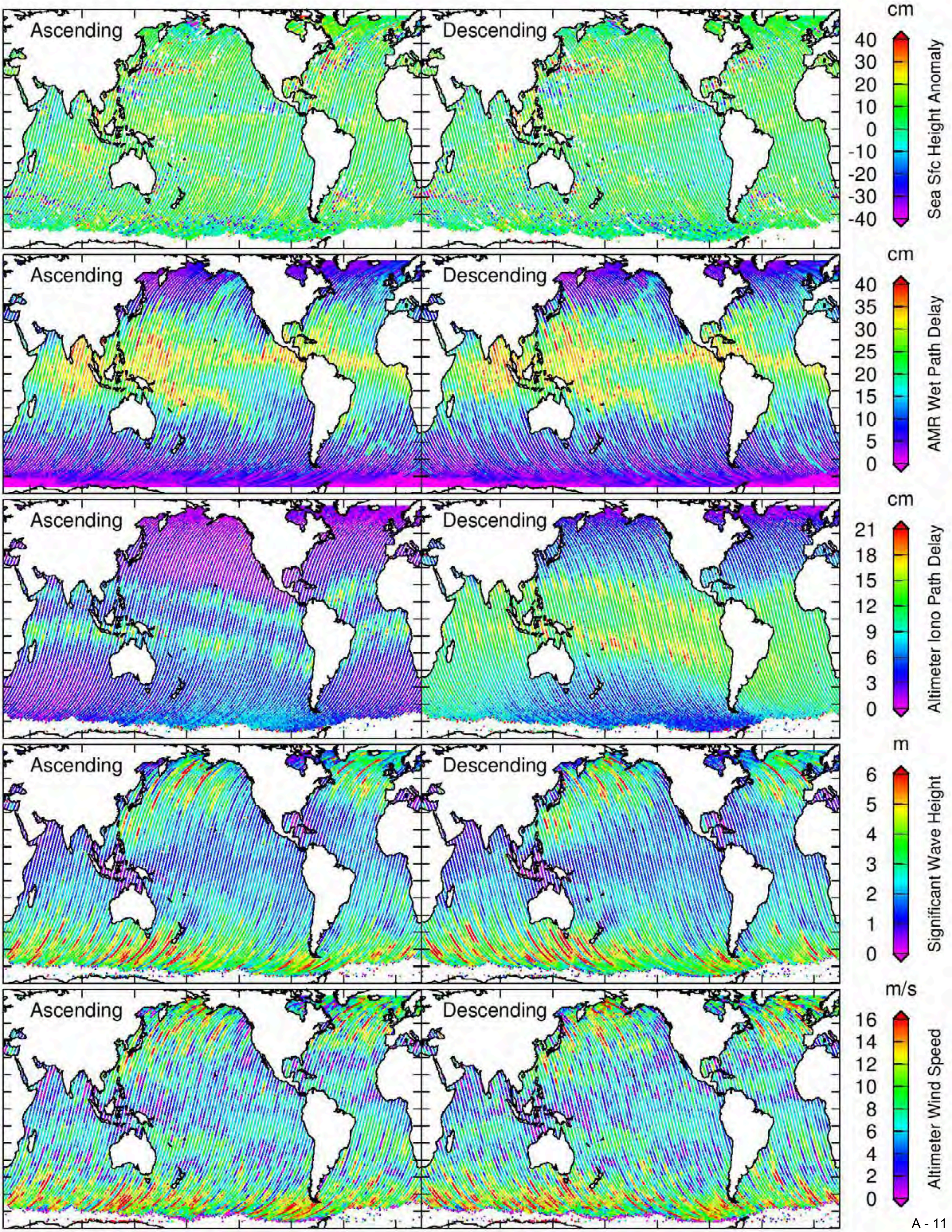
Jason-2 Cycle-193 2013-09-27 20:37:00 - 2013-10-07 18:35:32



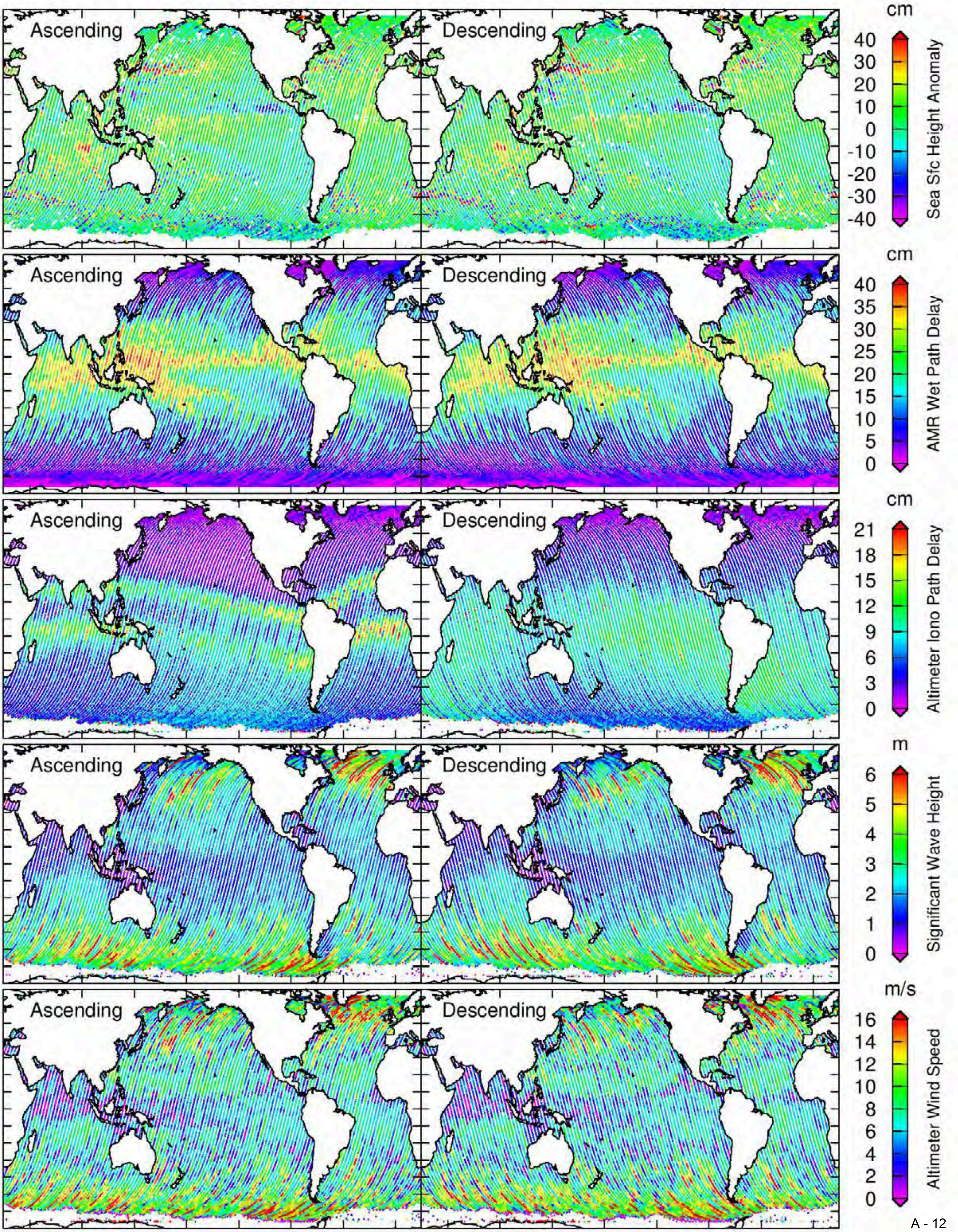
Jason-2 Cycle-194 2013-10-07 18:35:32 - 2013-10-17 16:34:04



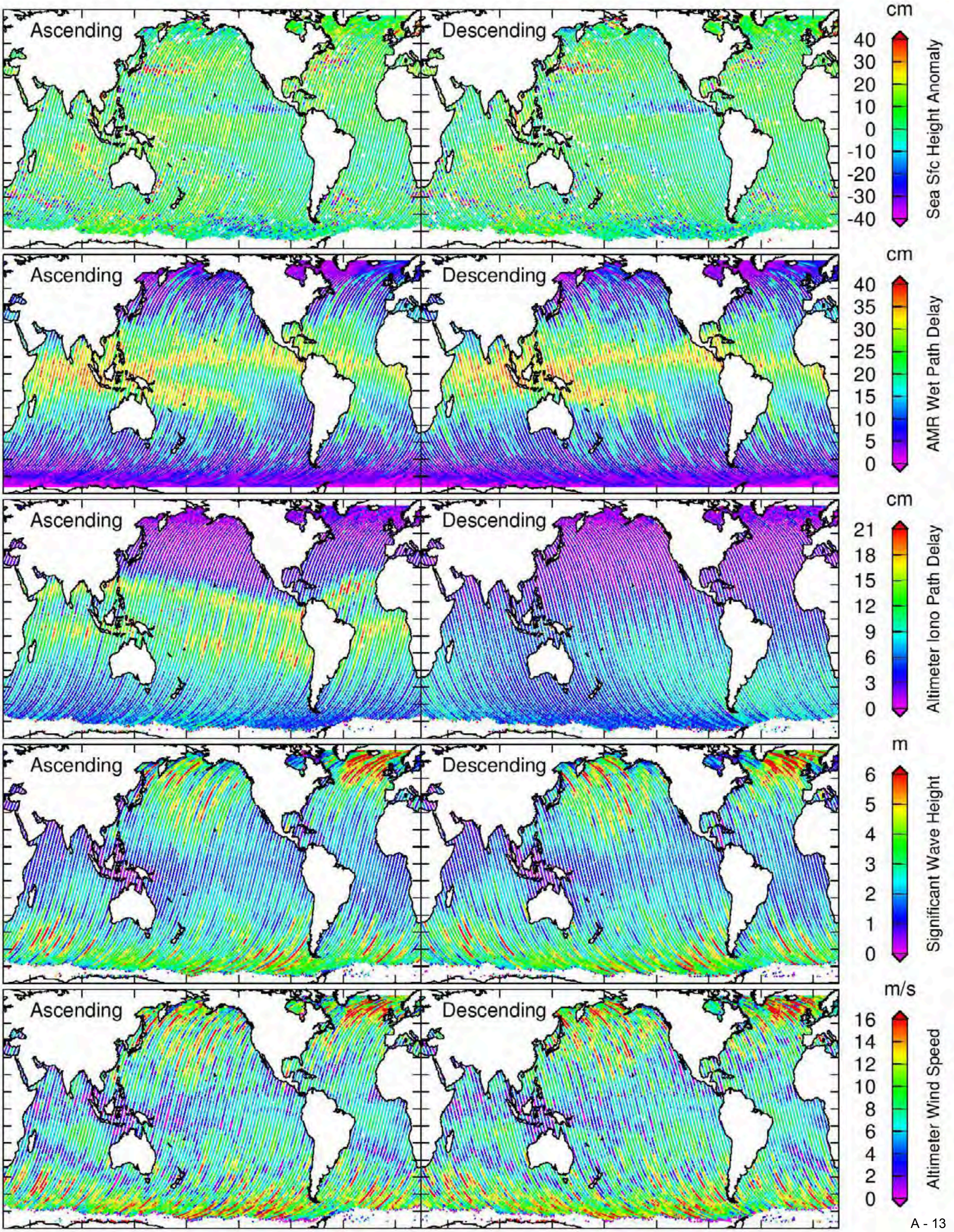
Jason-2 Cycle-195 2013-10-17 16:34:04 - 2013-10-27 14:32:35



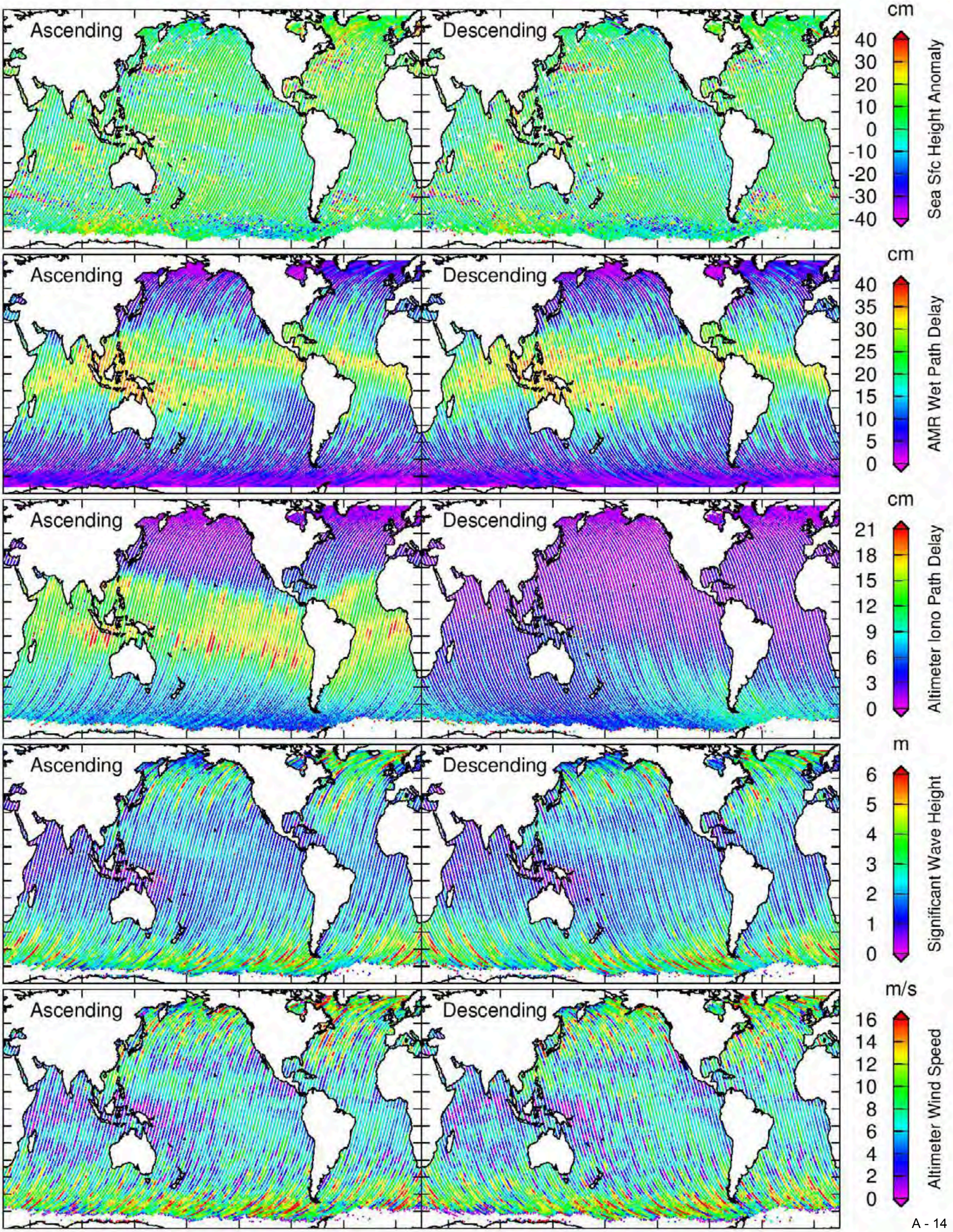
Jason-2 Cycle-196 2013-10-27 14:32:35 - 2013-11-06 12:31:07



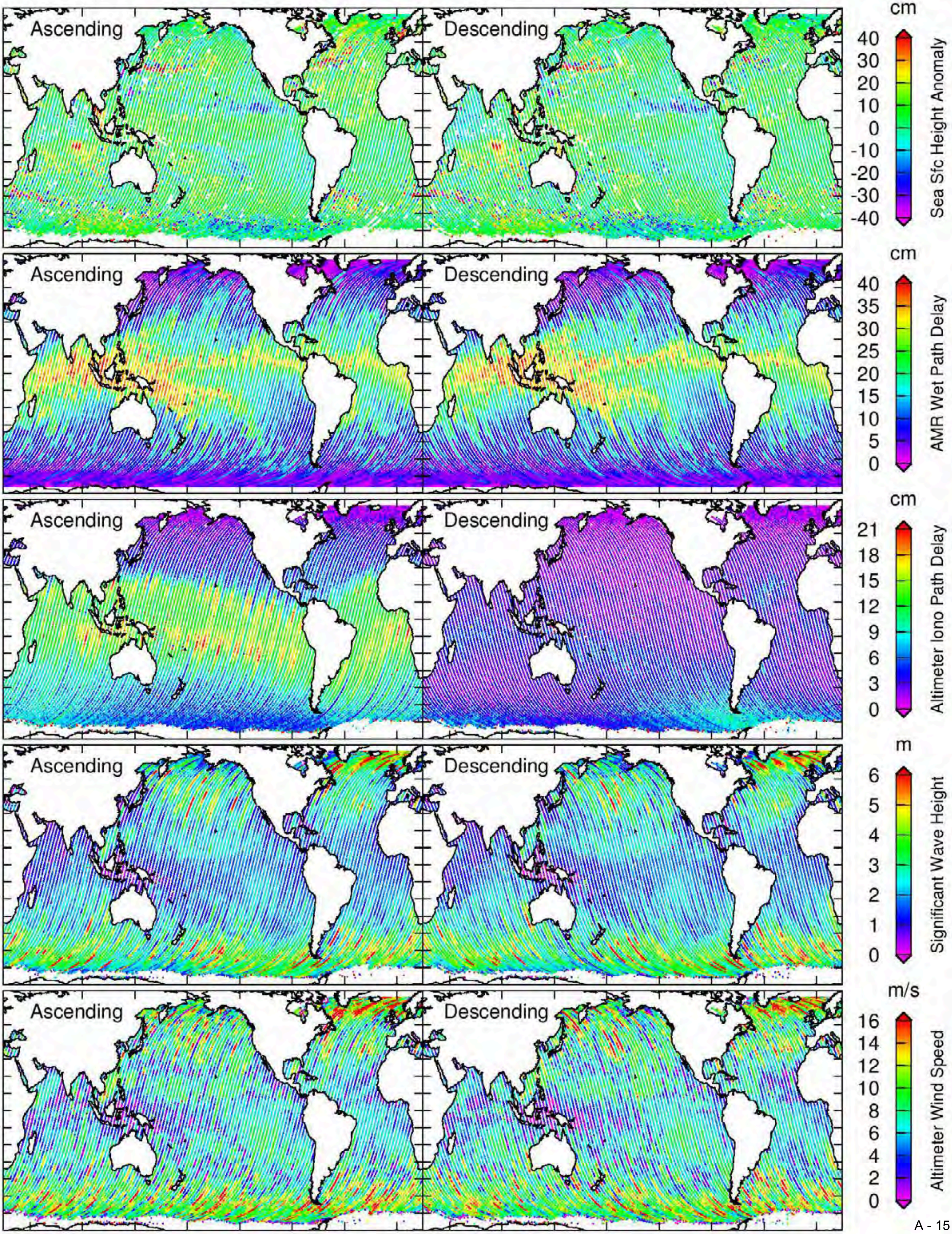
Jason-2 Cycle-197 2013-11-06 12:31:07 - 2013-11-16 10:29:38



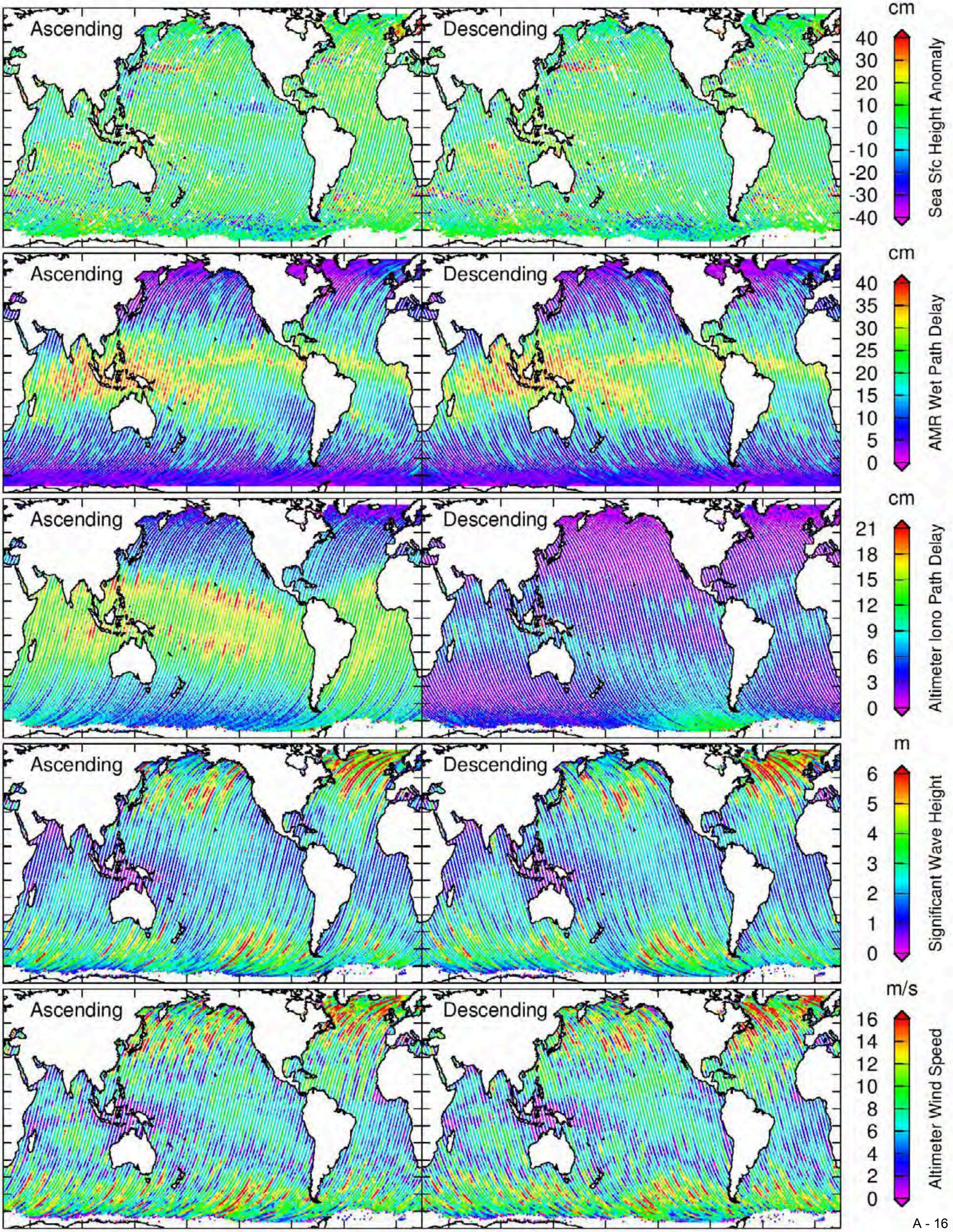
Jason-2 Cycle-198 2013-11-16 10:29:38 - 2013-11-26 08:28:10



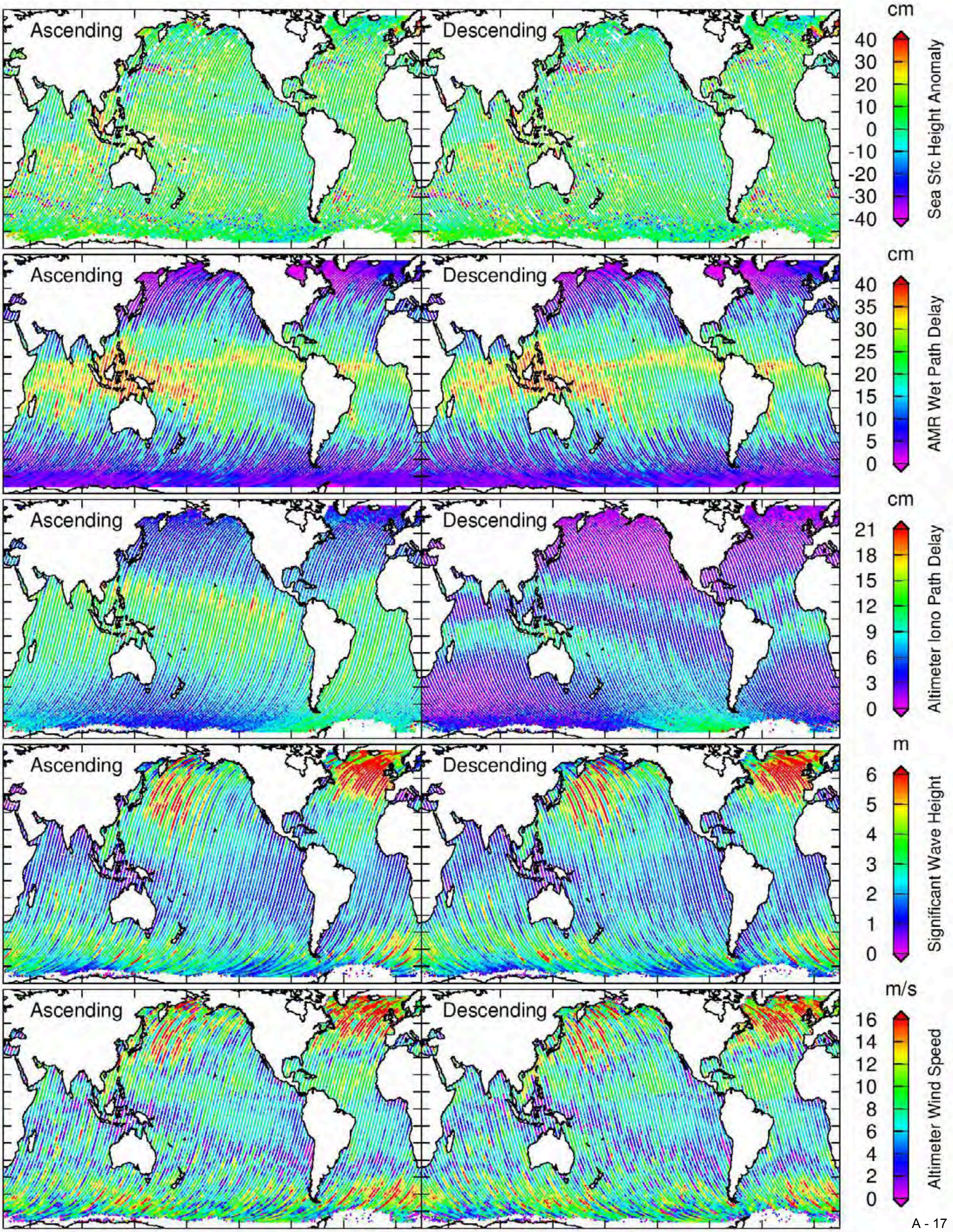
Jason-2 Cycle-199 2013-11-26 08:28:10 - 2013-12-06 06:26:42



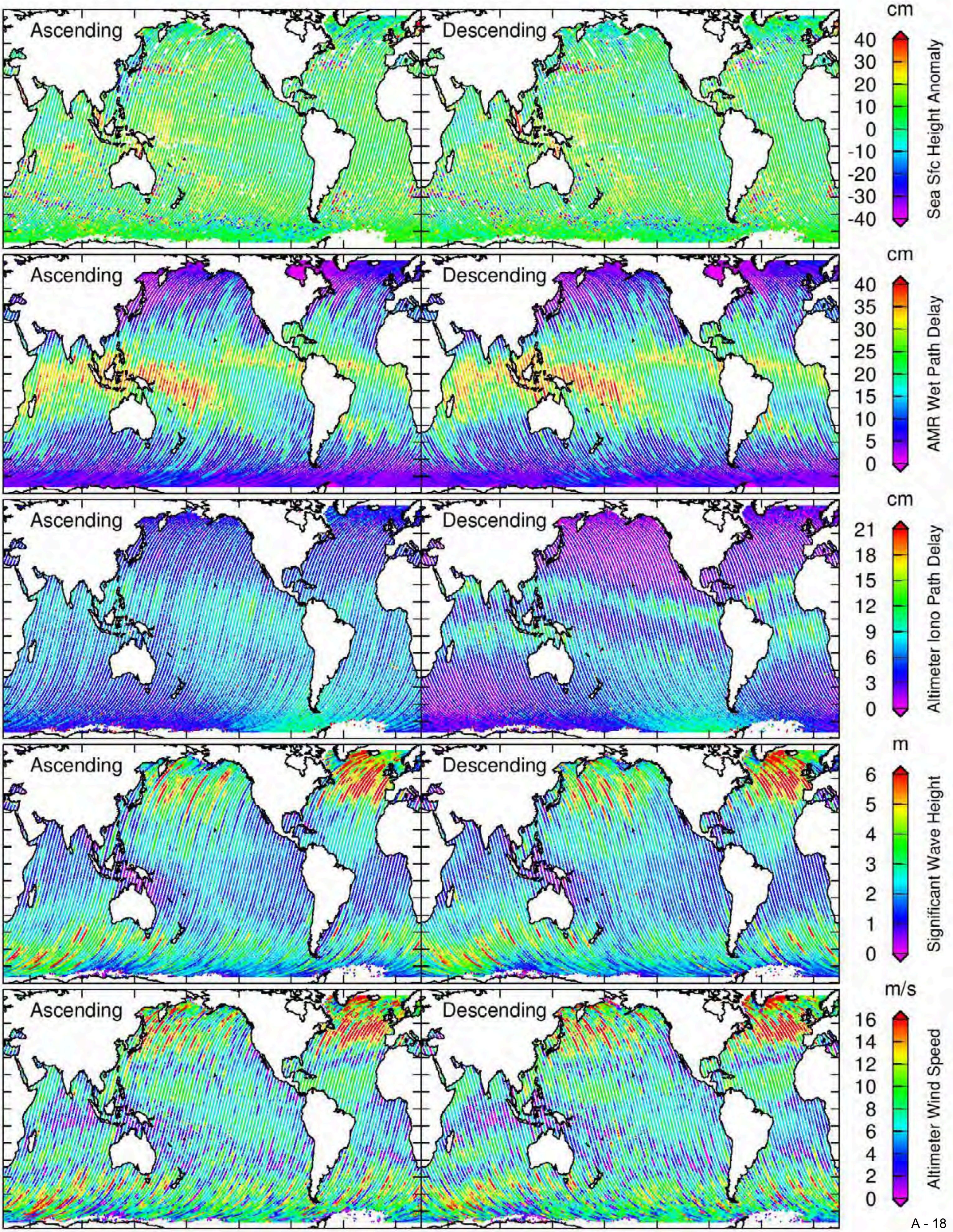
Jason-2 Cycle-200 2013-12-06 06:26:42 - 2013-12-16 04:25:13



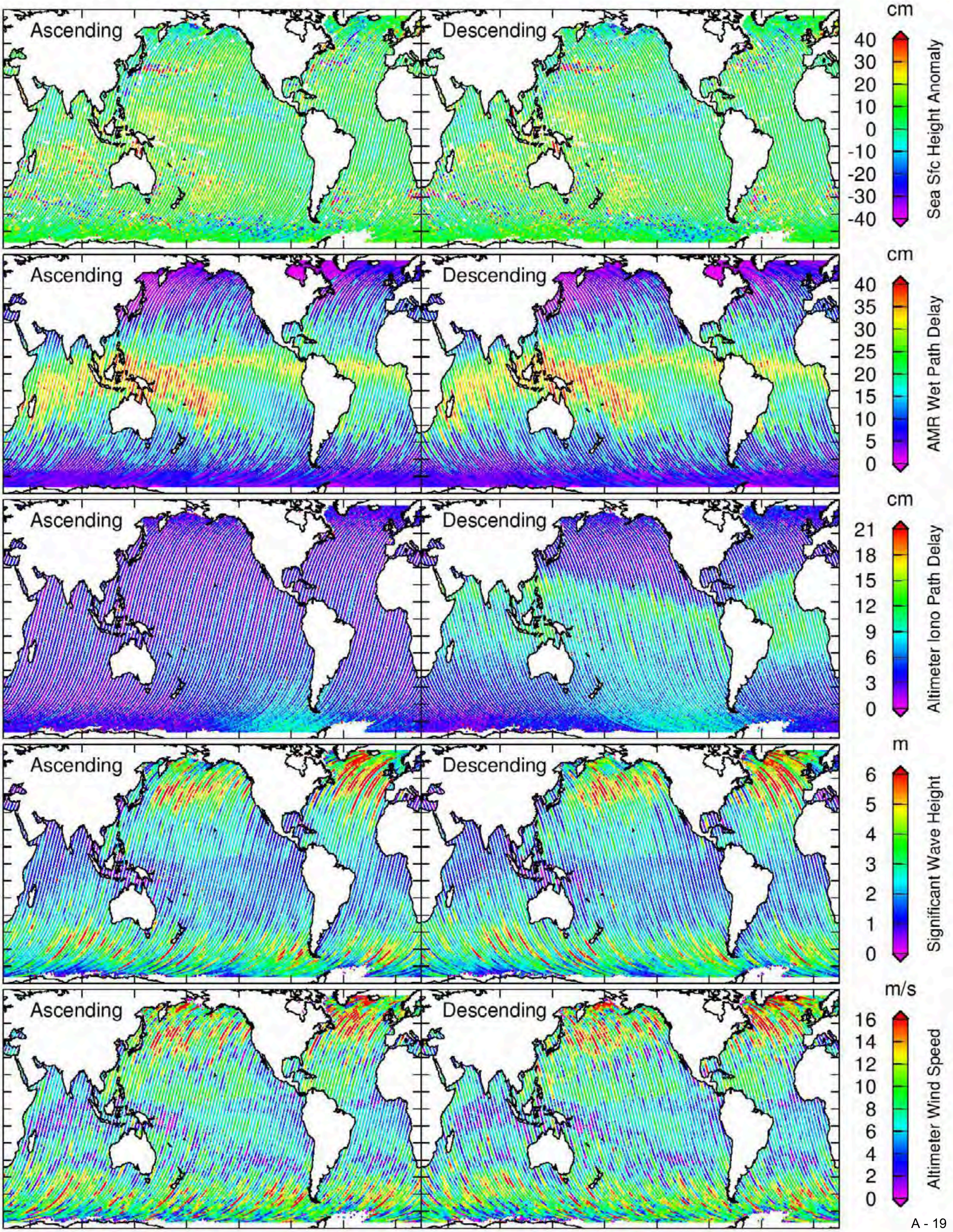
Jason-2 Cycle-201 2013-12-16 04:25:13 - 2013-12-26 02:23:45



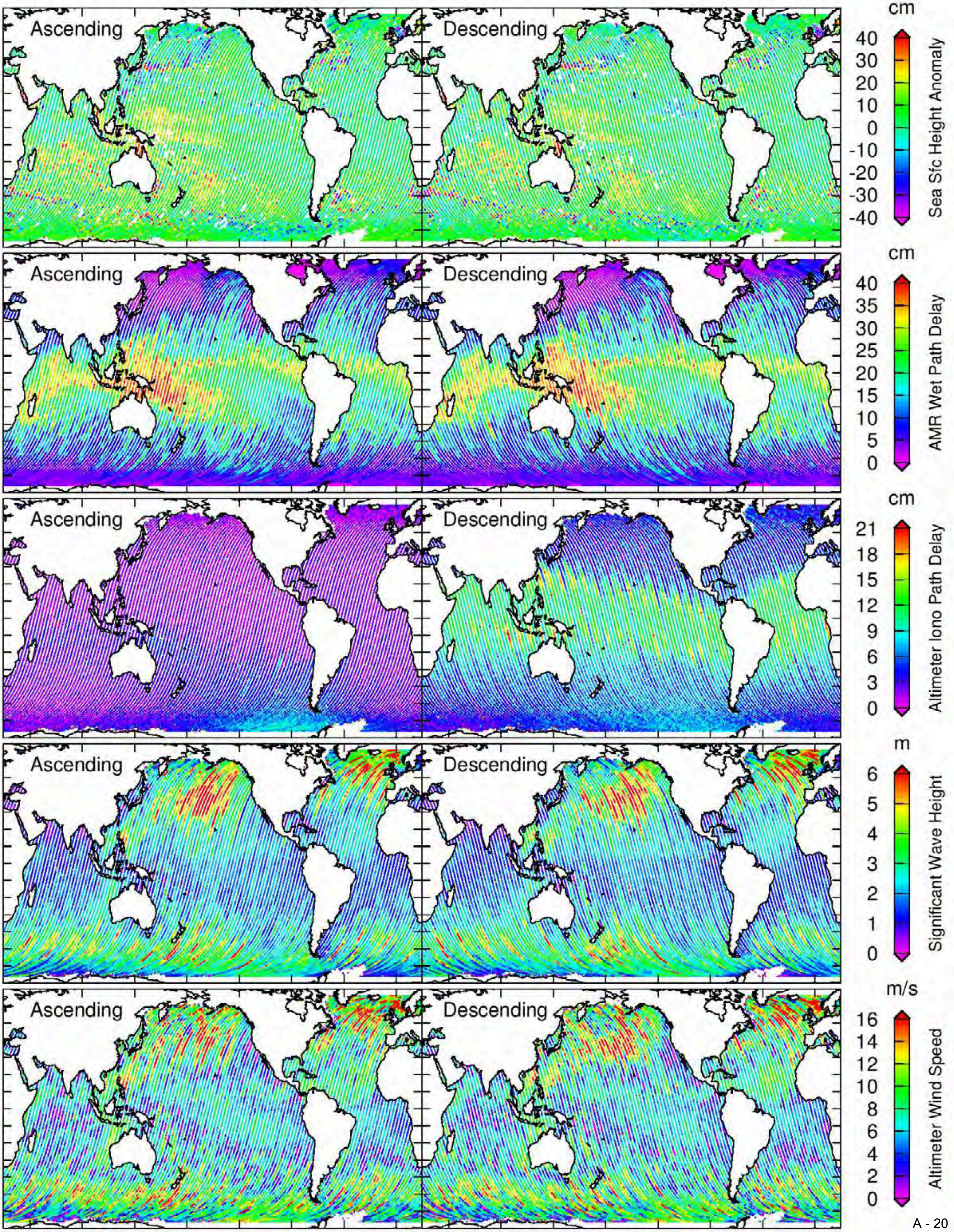
Jason-2 Cycle-202 2013-12-26 02:23:45 - 2014-01-05 00:22:16



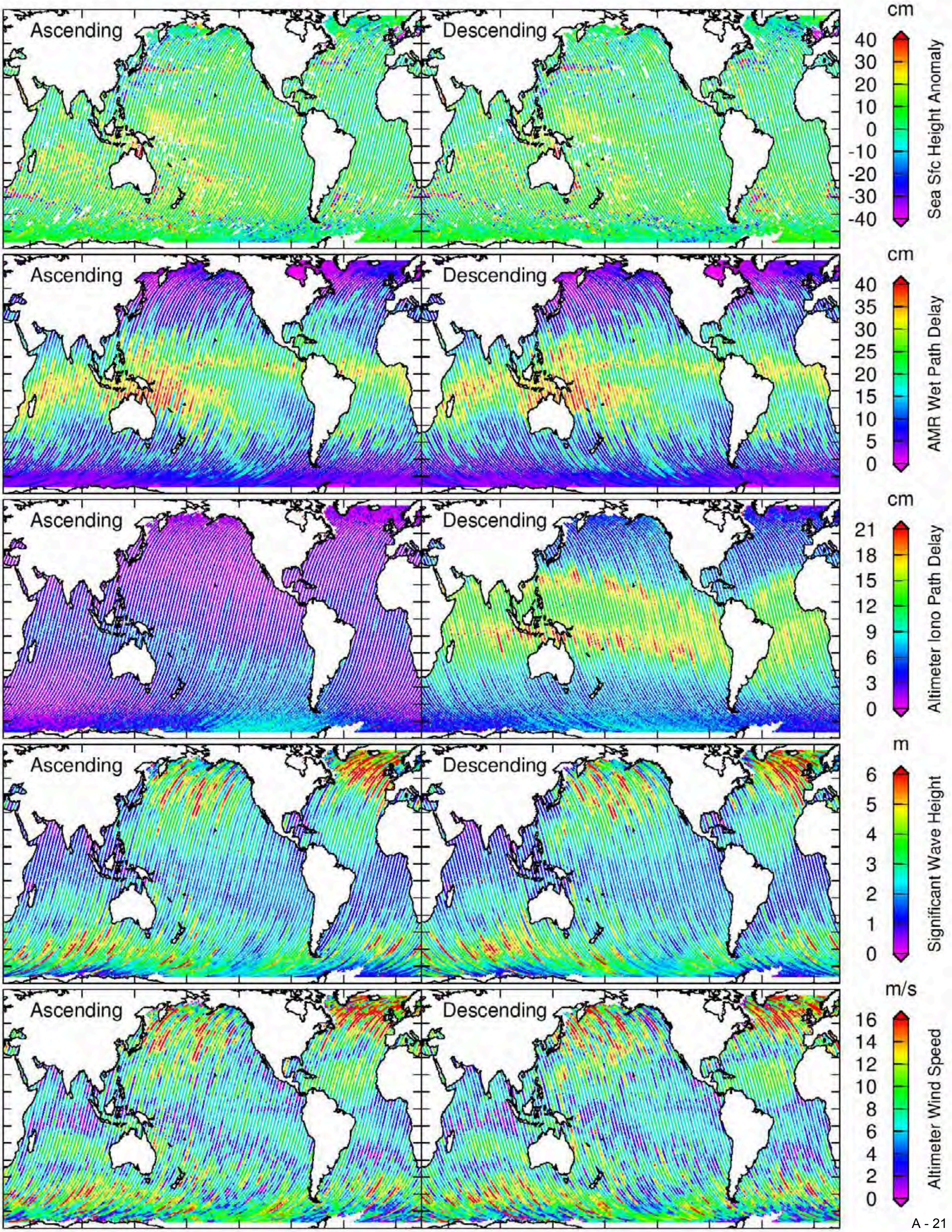
Jason-2 Cycle-203 2014-01-05 00:22:16 - 2014-01-14 22:20:48



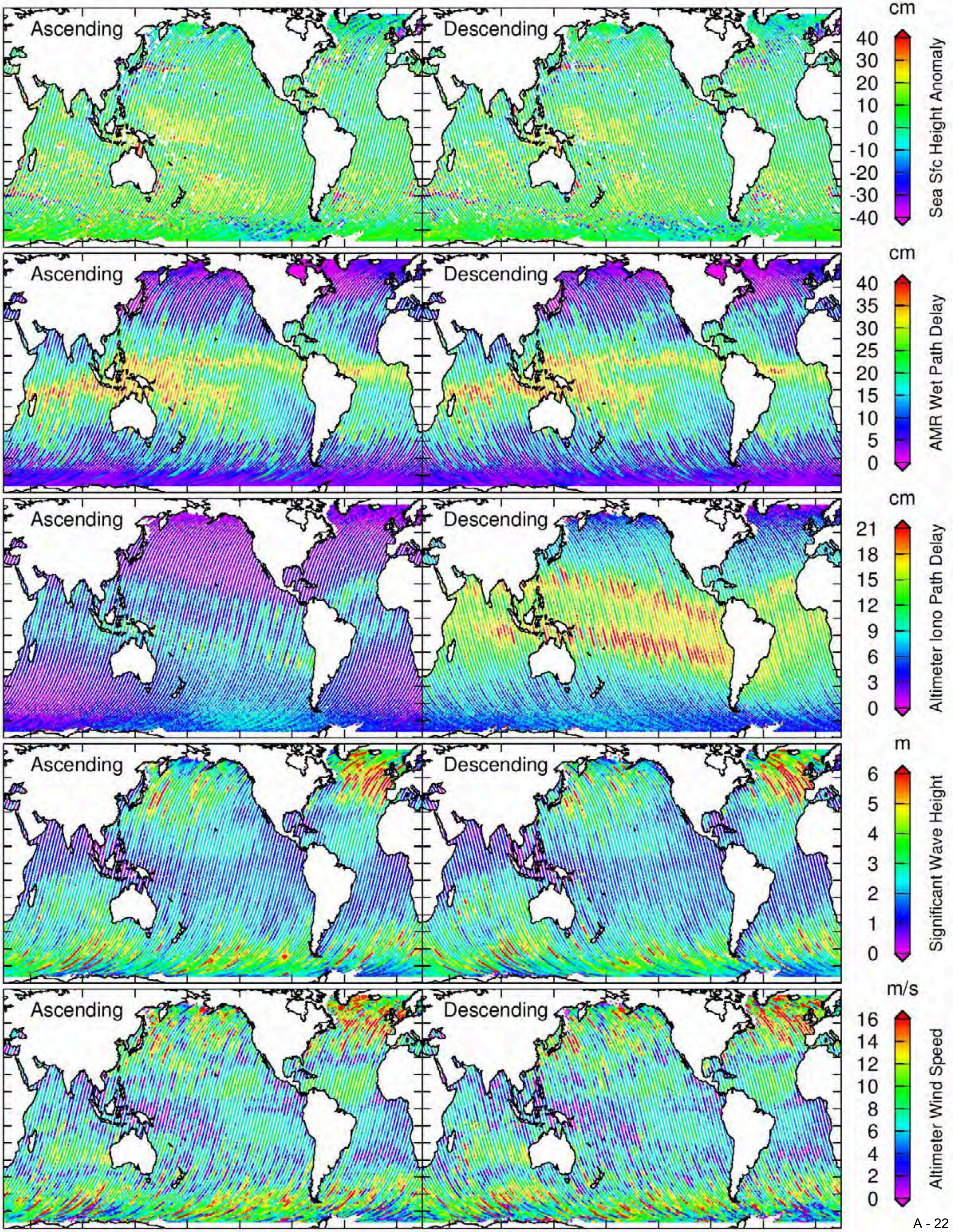
Jason-2 Cycle-204 2014-01-14 22:20:48 - 2014-01-24 20:19:20



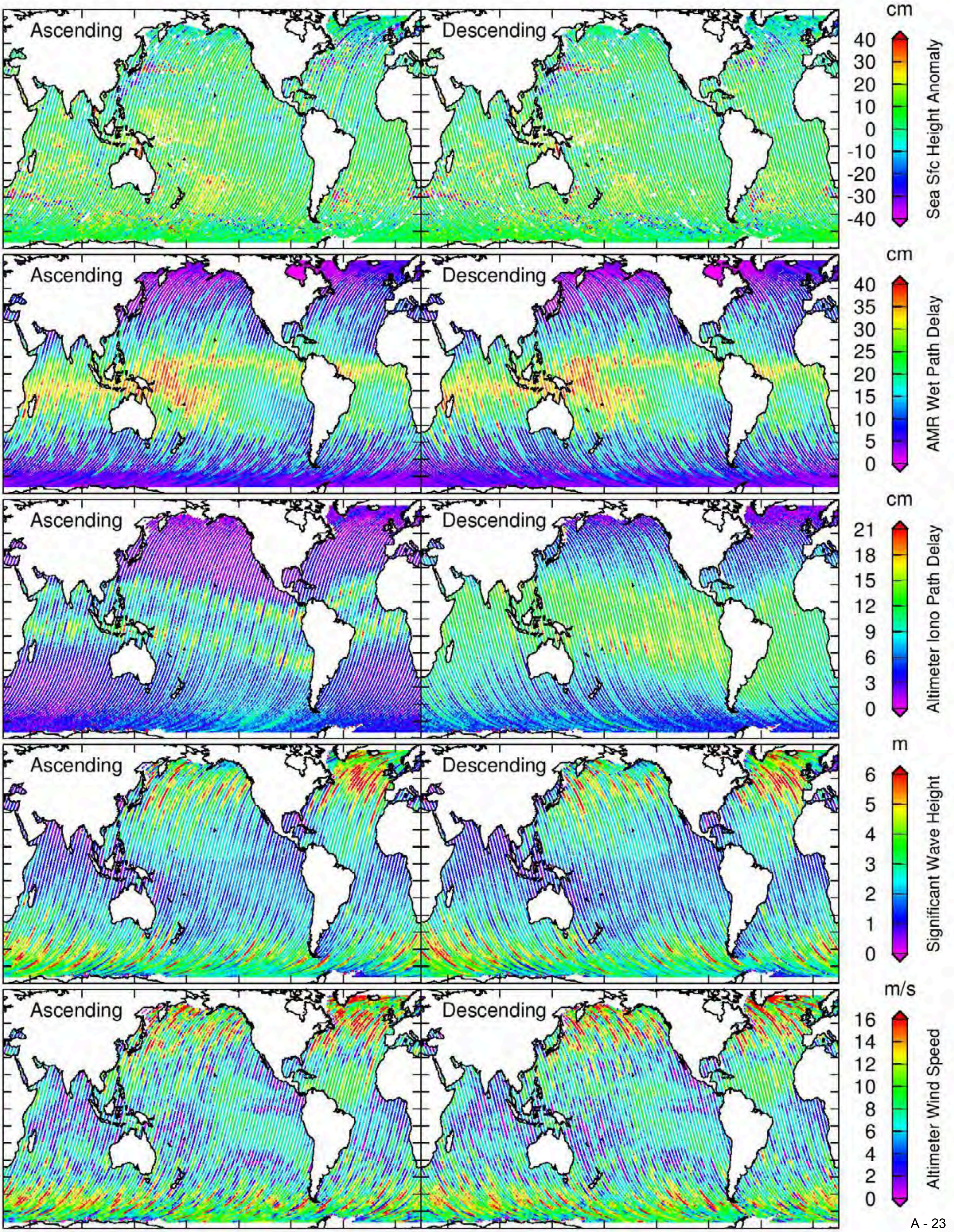
Jason-2 Cycle-205 2014-01-24 20:19:20 - 2014-02-03 18:17:51



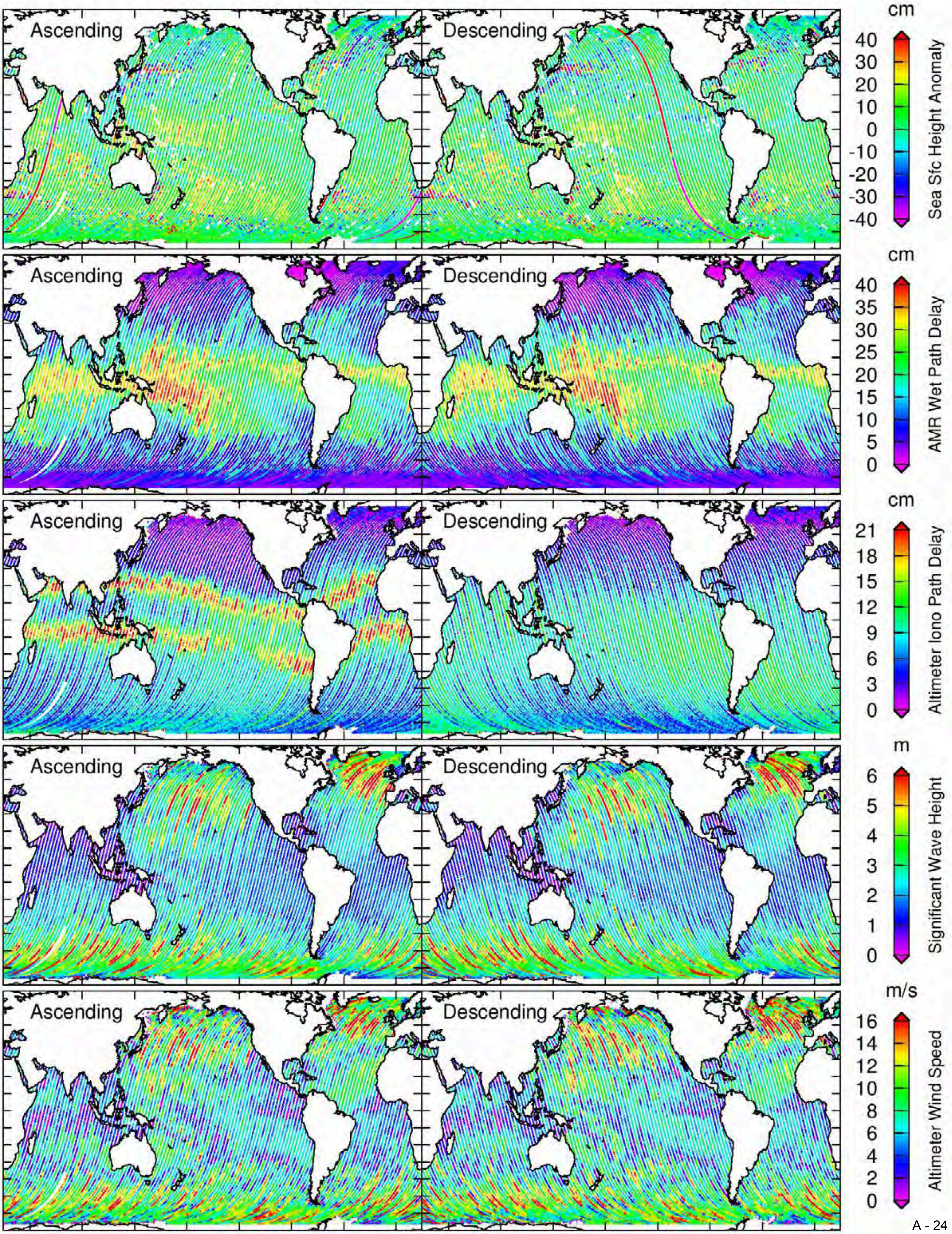
Jason-2 Cycle-206 2014-02-03 18:17:51 - 2014-02-13 16:16:23



Jason-2 Cycle-207 2014-02-13 16:16:23 - 2014-02-23 14:14:54



Jason-2 Cycle-208 2014-02-23 14:14:54 - 2014-03-05 12:13:26



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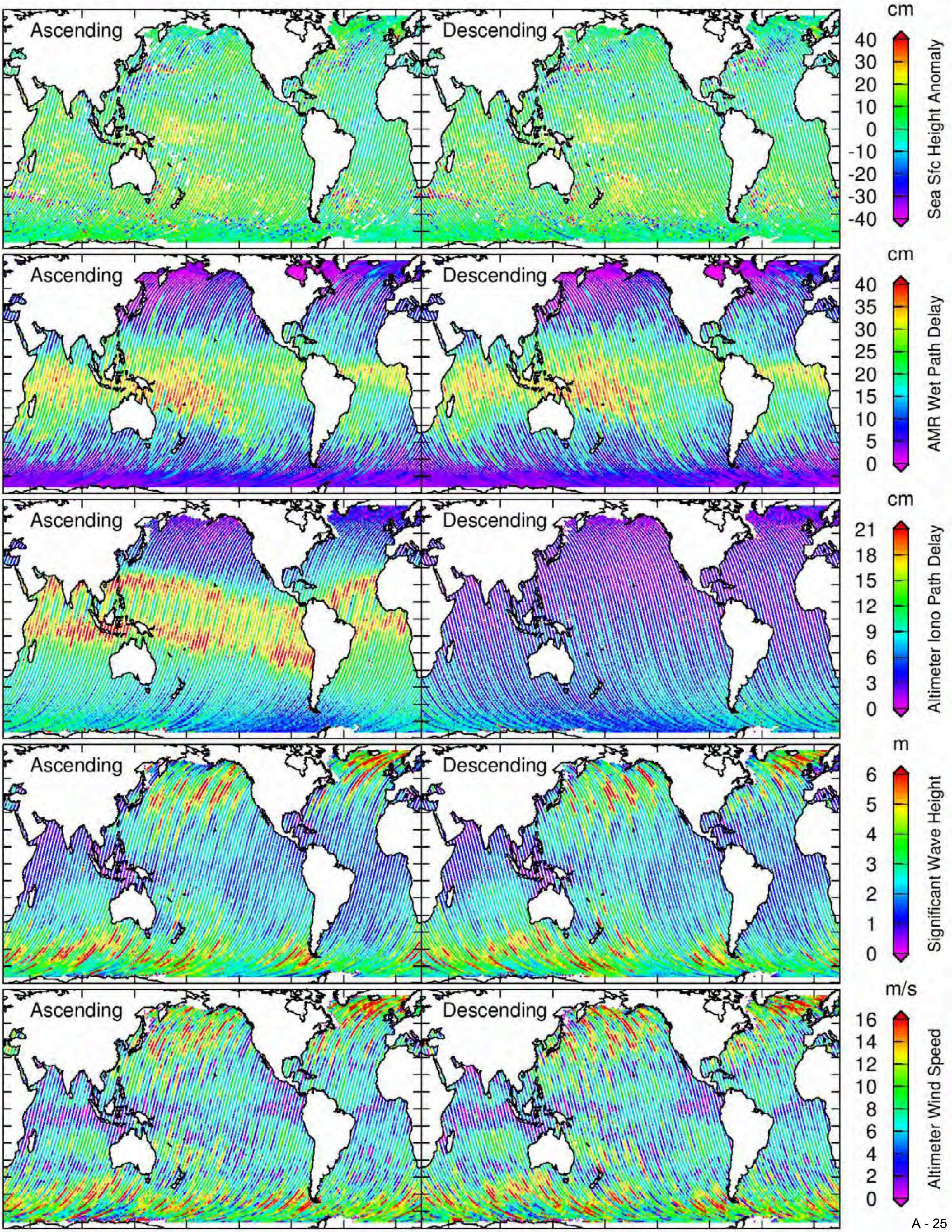

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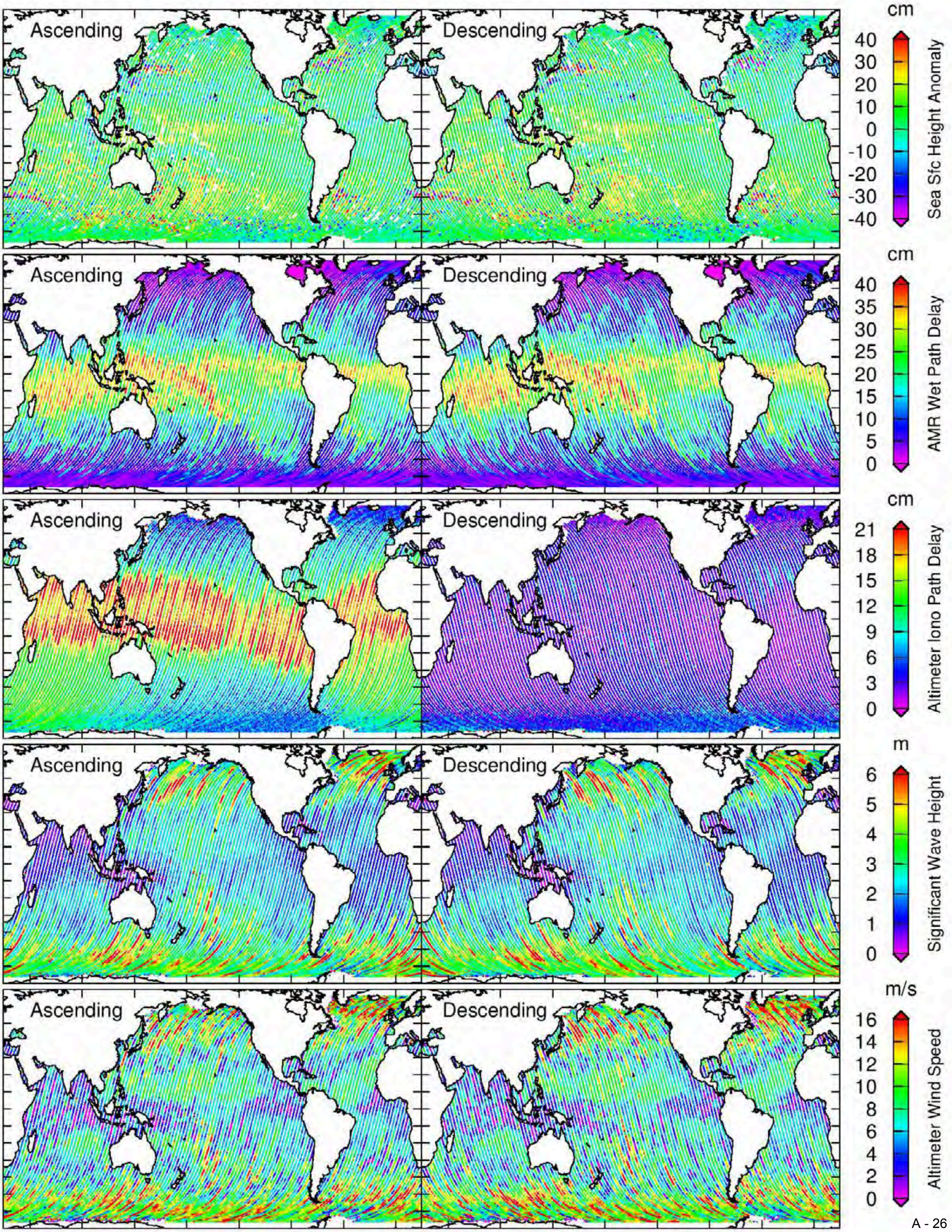
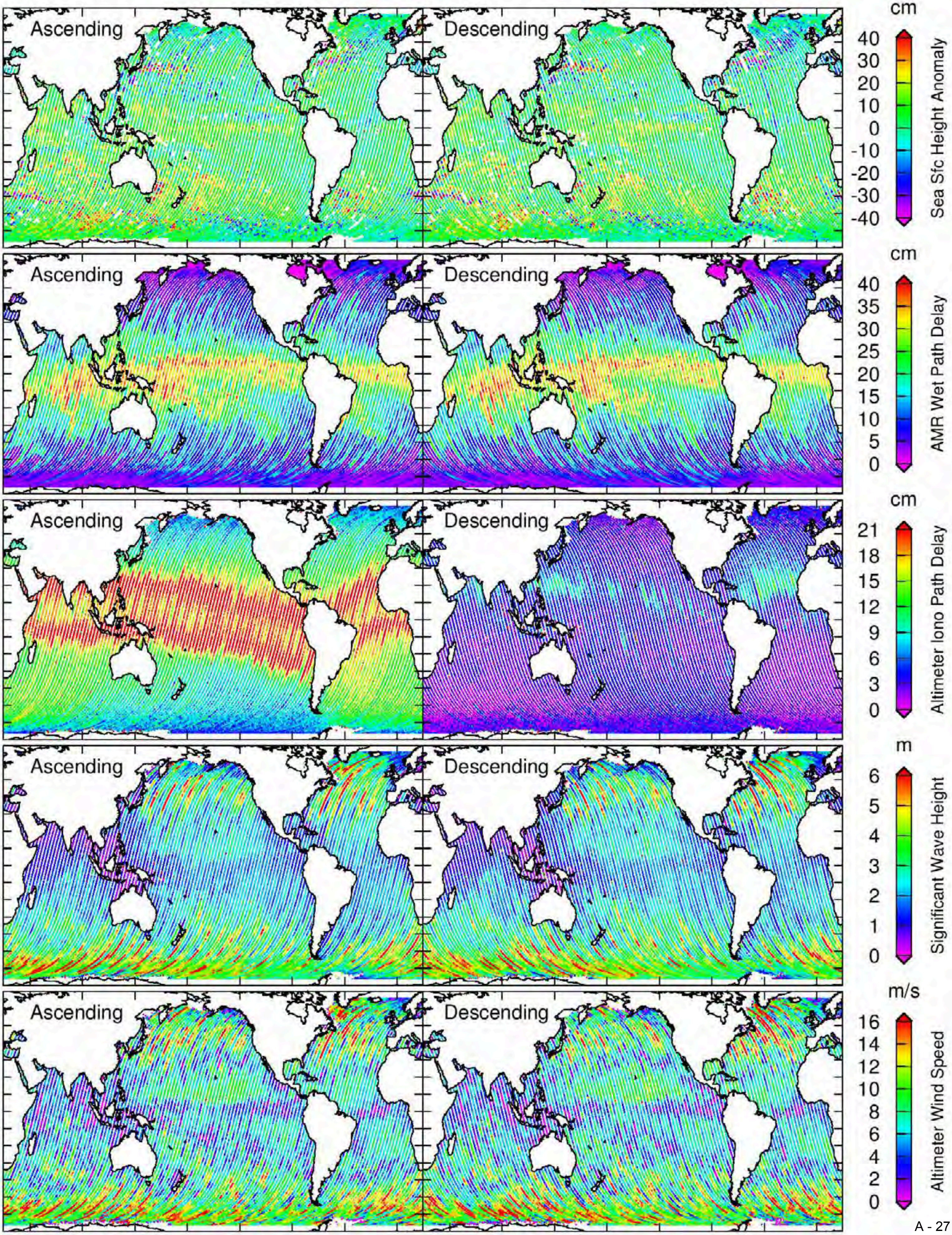
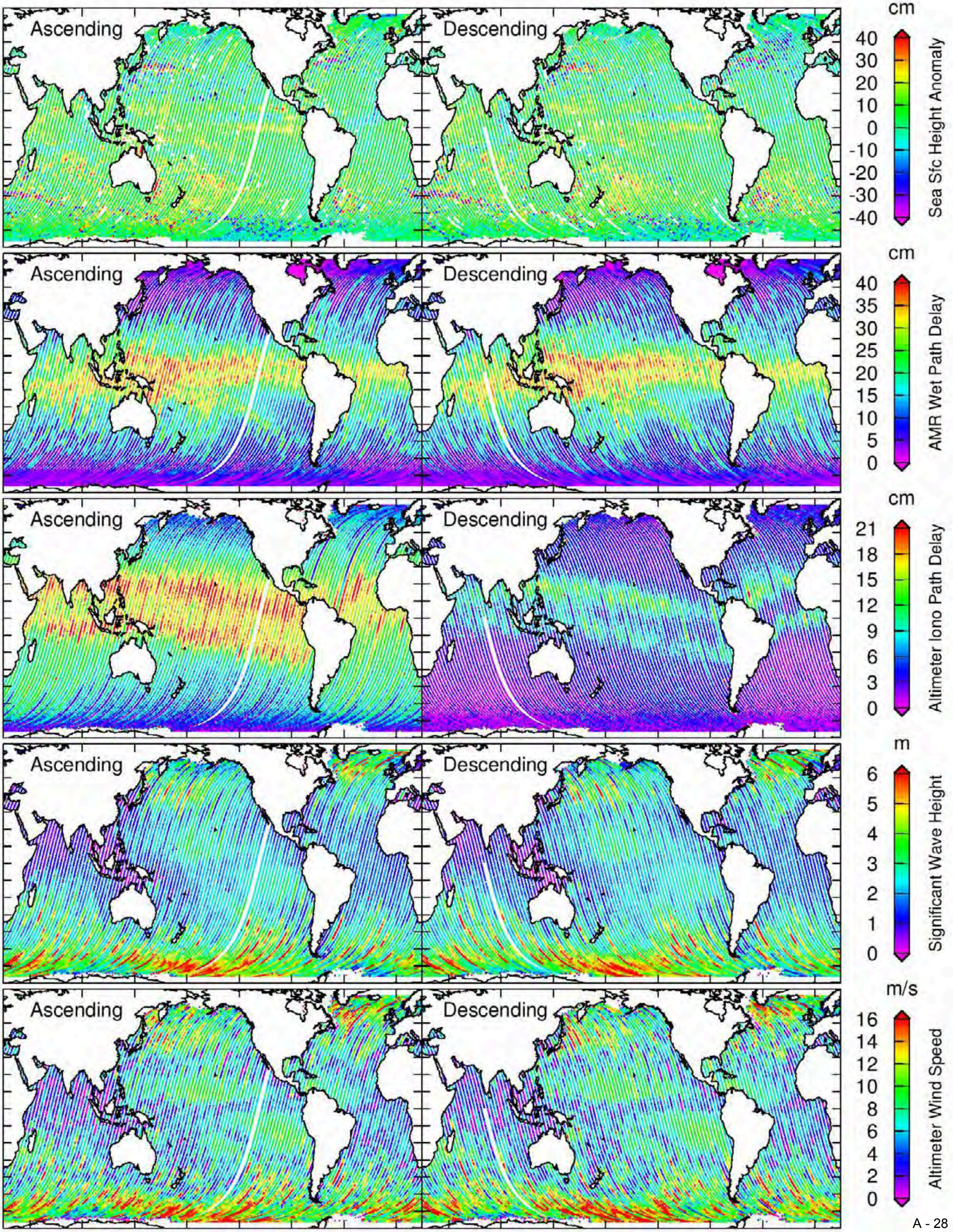


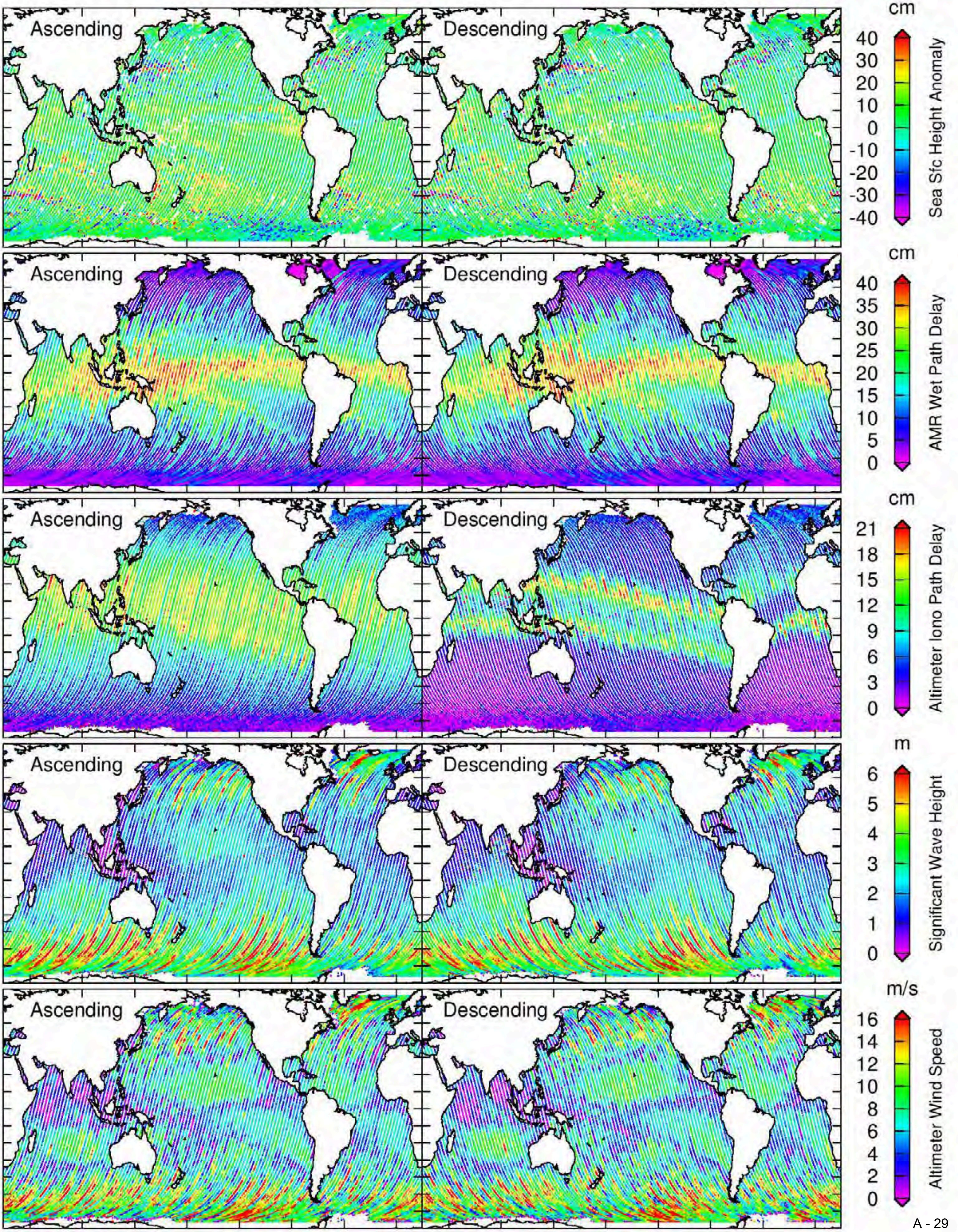
Jason-2 Cycle-211 2014-03-25 08:10:29 - 2014-04-04 06:09:01



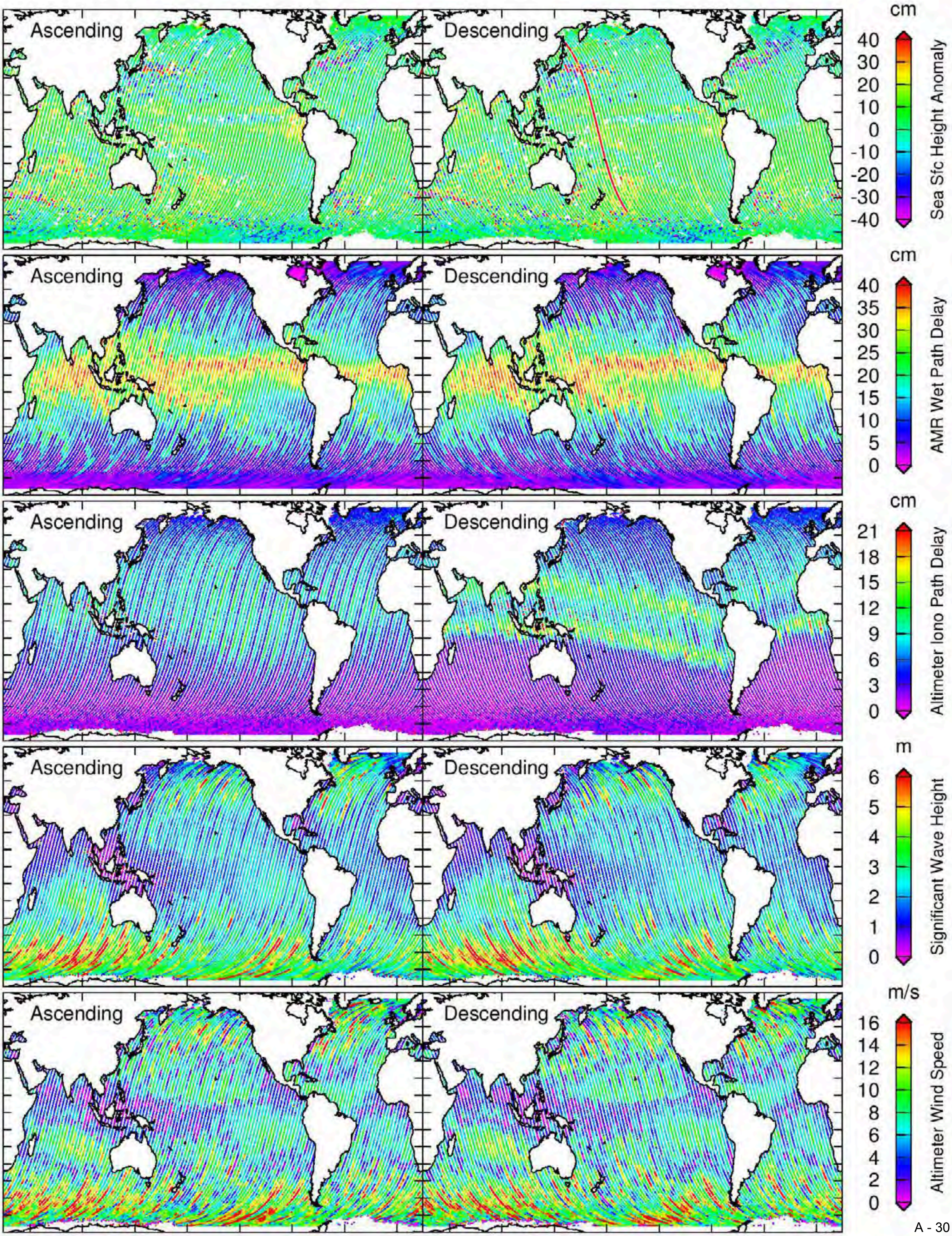
Jason-2 Cycle-212 2014-04-04 06:09:01 - 2014-04-14 04:07:33



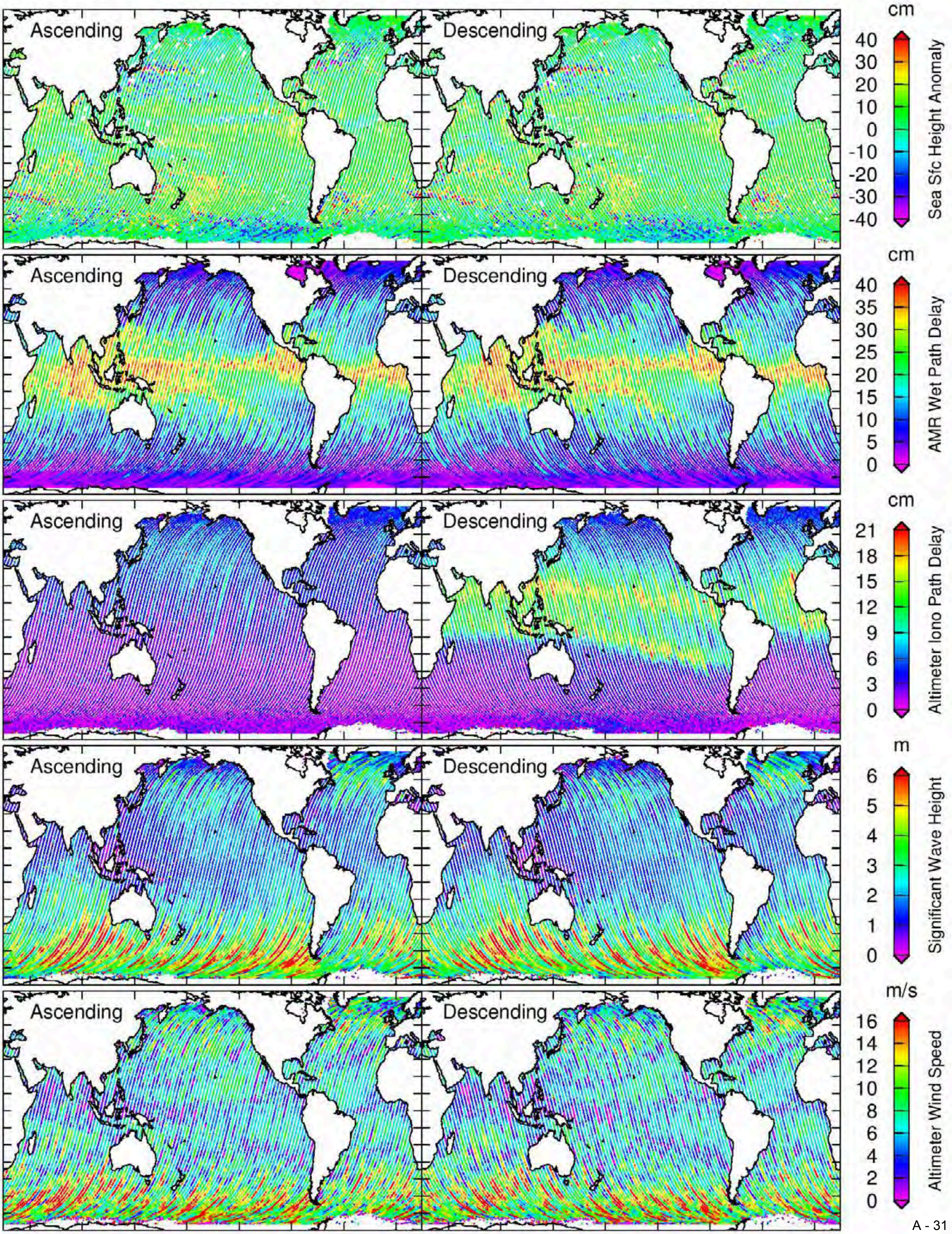
Jason-2 Cycle-213 2014-04-14 04:07:33 - 2014-04-24 02:06:04



Jason-2 Cycle-214 2014-04-24 02:06:04 - 2014-05-04 00:04:36



Jason-2 Cycle-215 2014-05-04 00:04:36 - 2014-05-13 22:03:07



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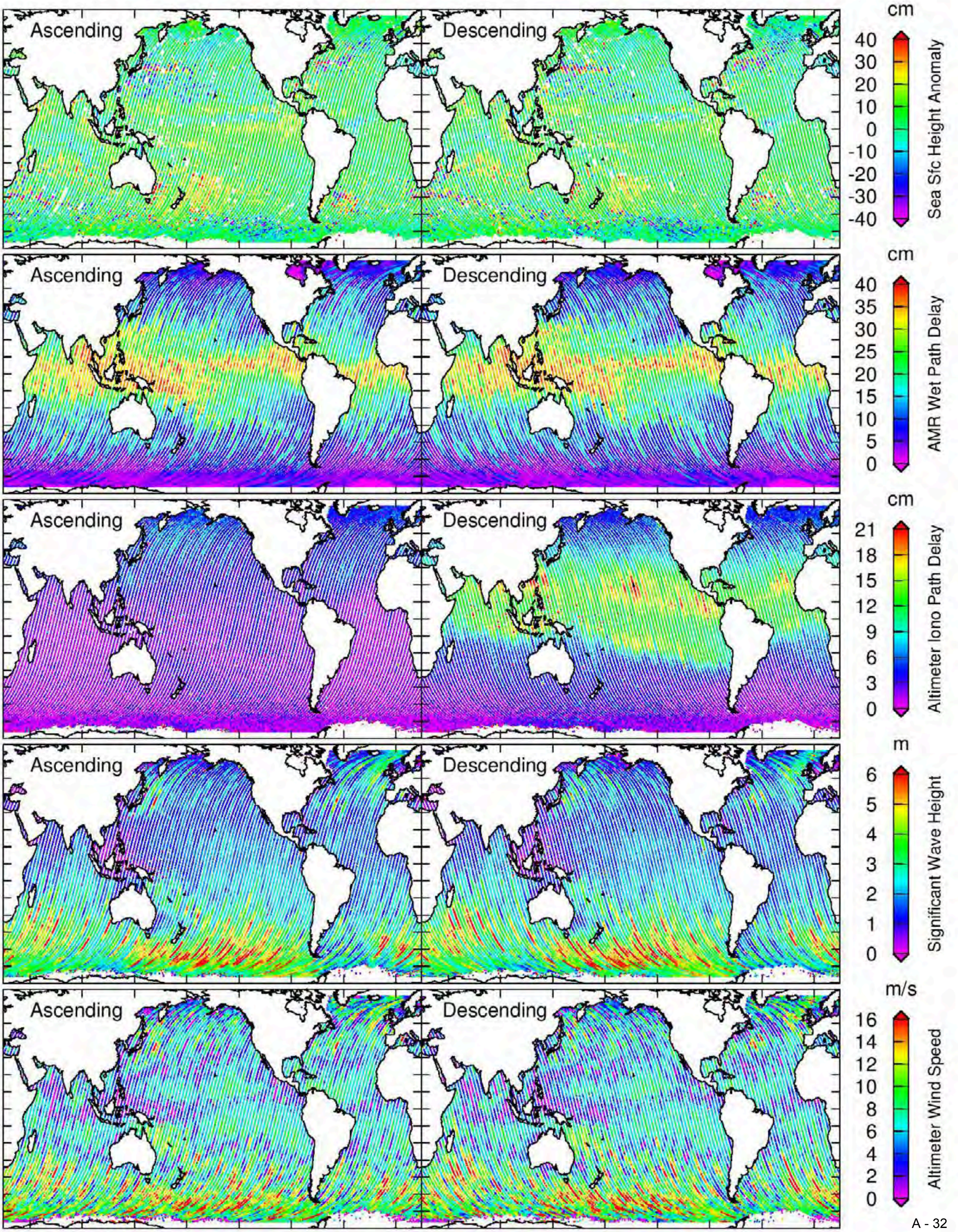
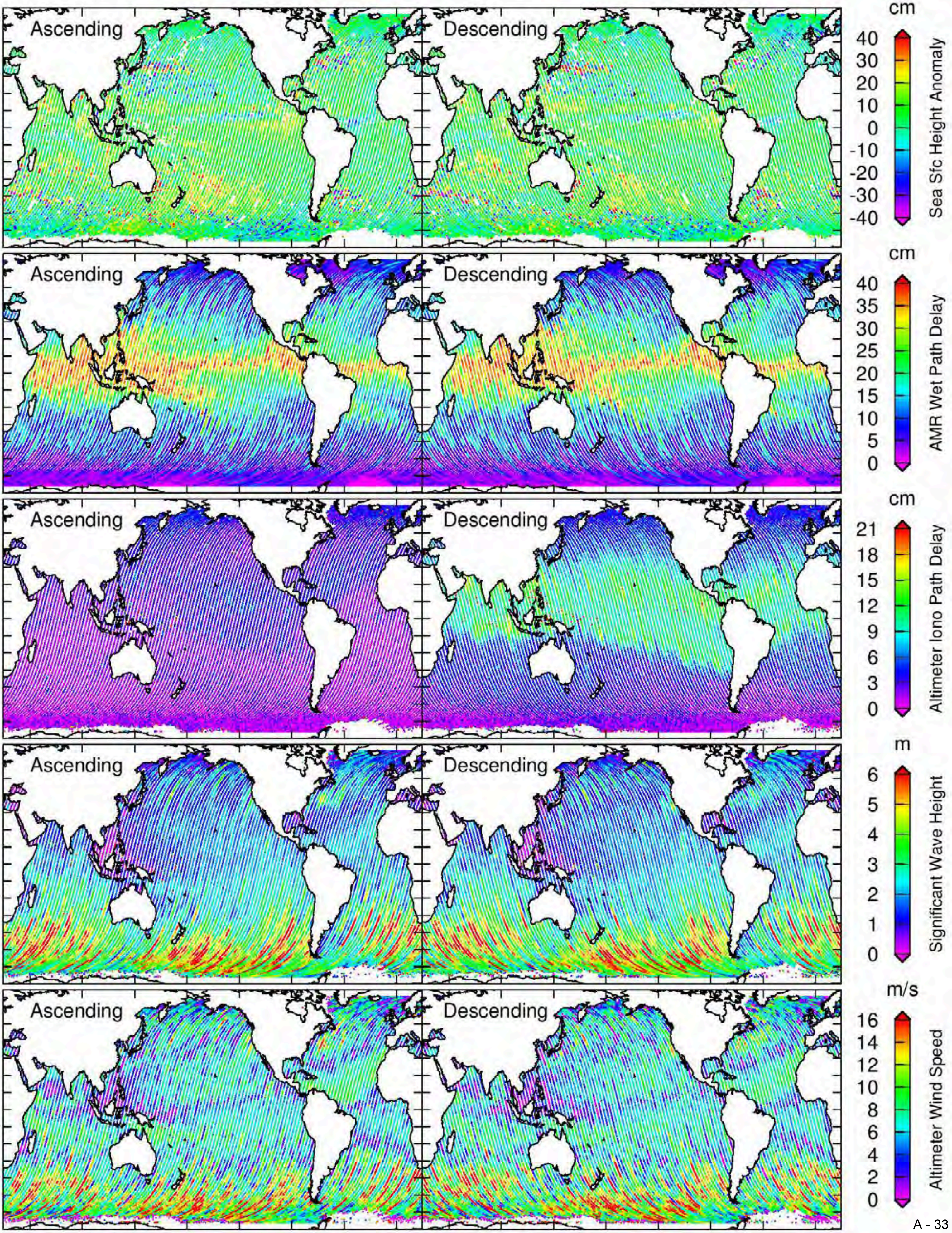
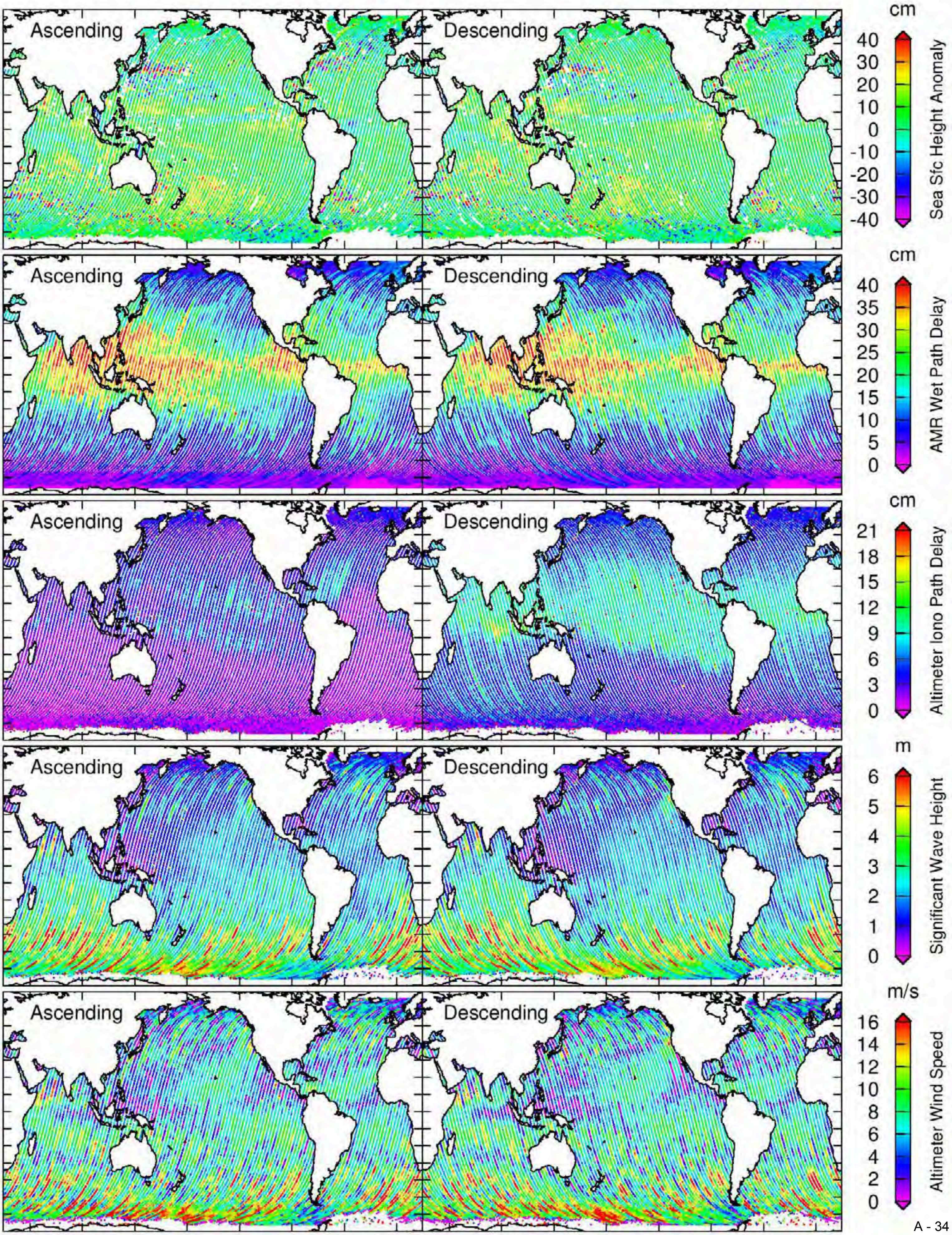


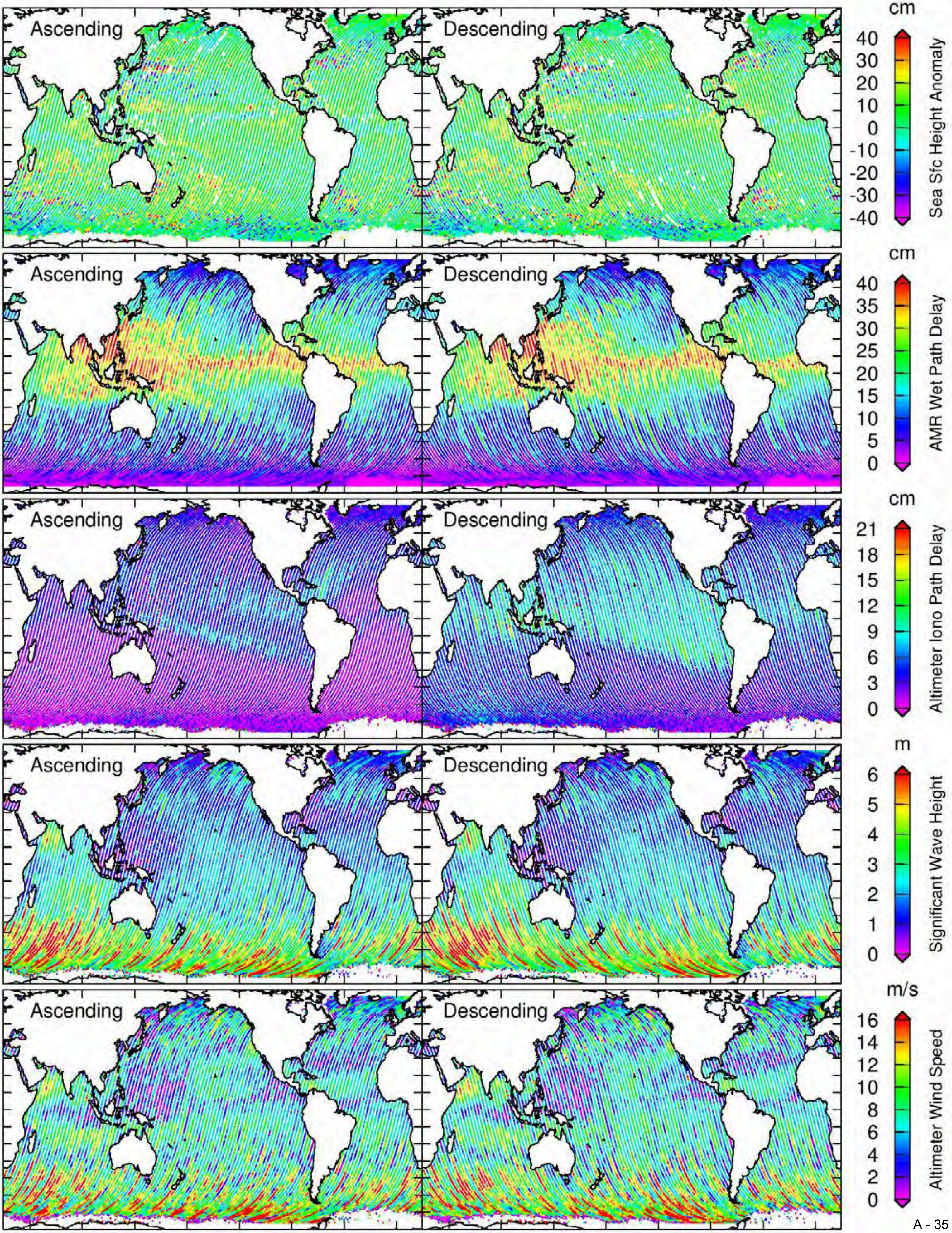
Jason-2 Cycle-217 2014-05-23 20:01:39 - 2014-06-02 18:00:11



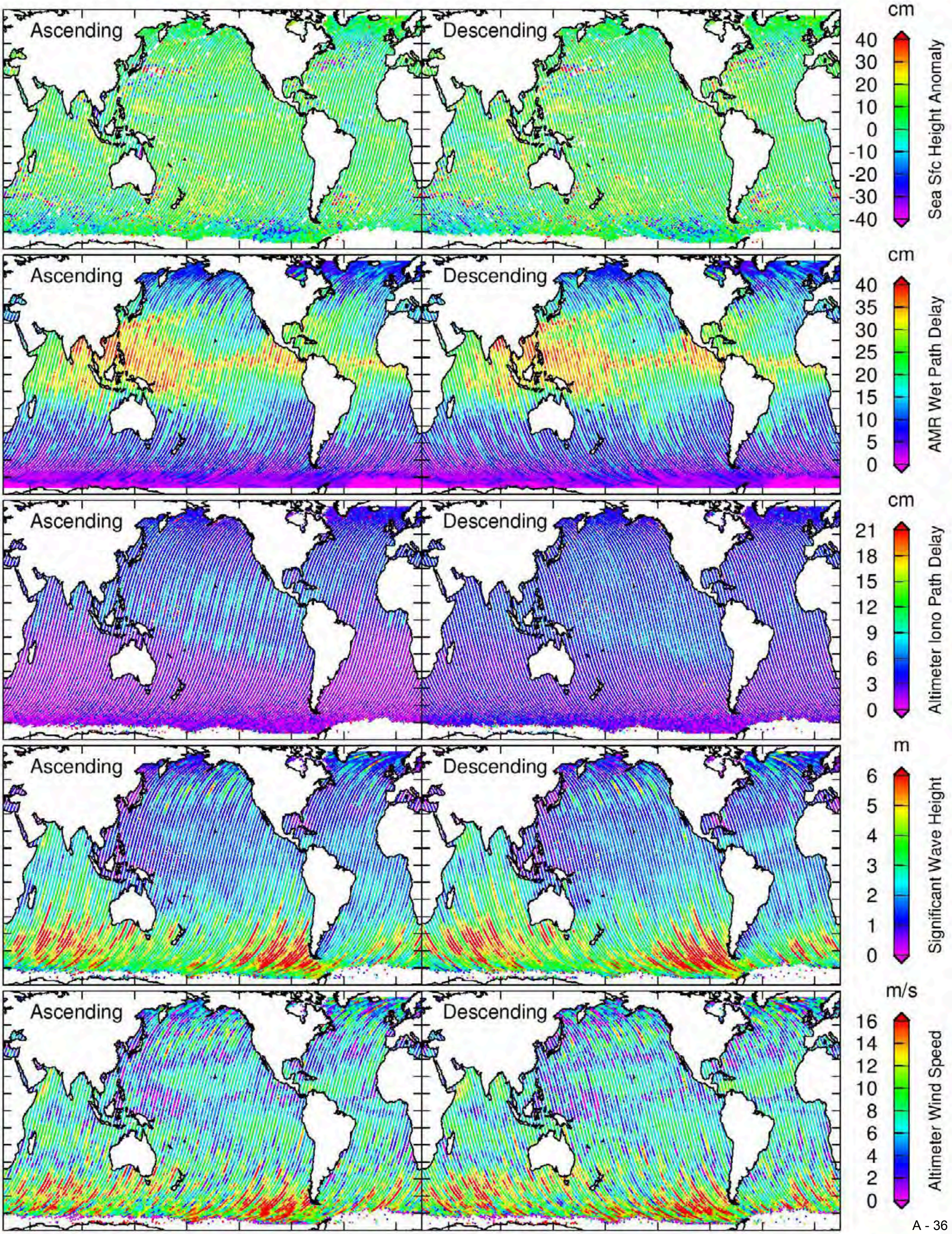
Jason-2 Cycle-218 2014-06-02 18:00:11 - 2014-06-12 15:58:42



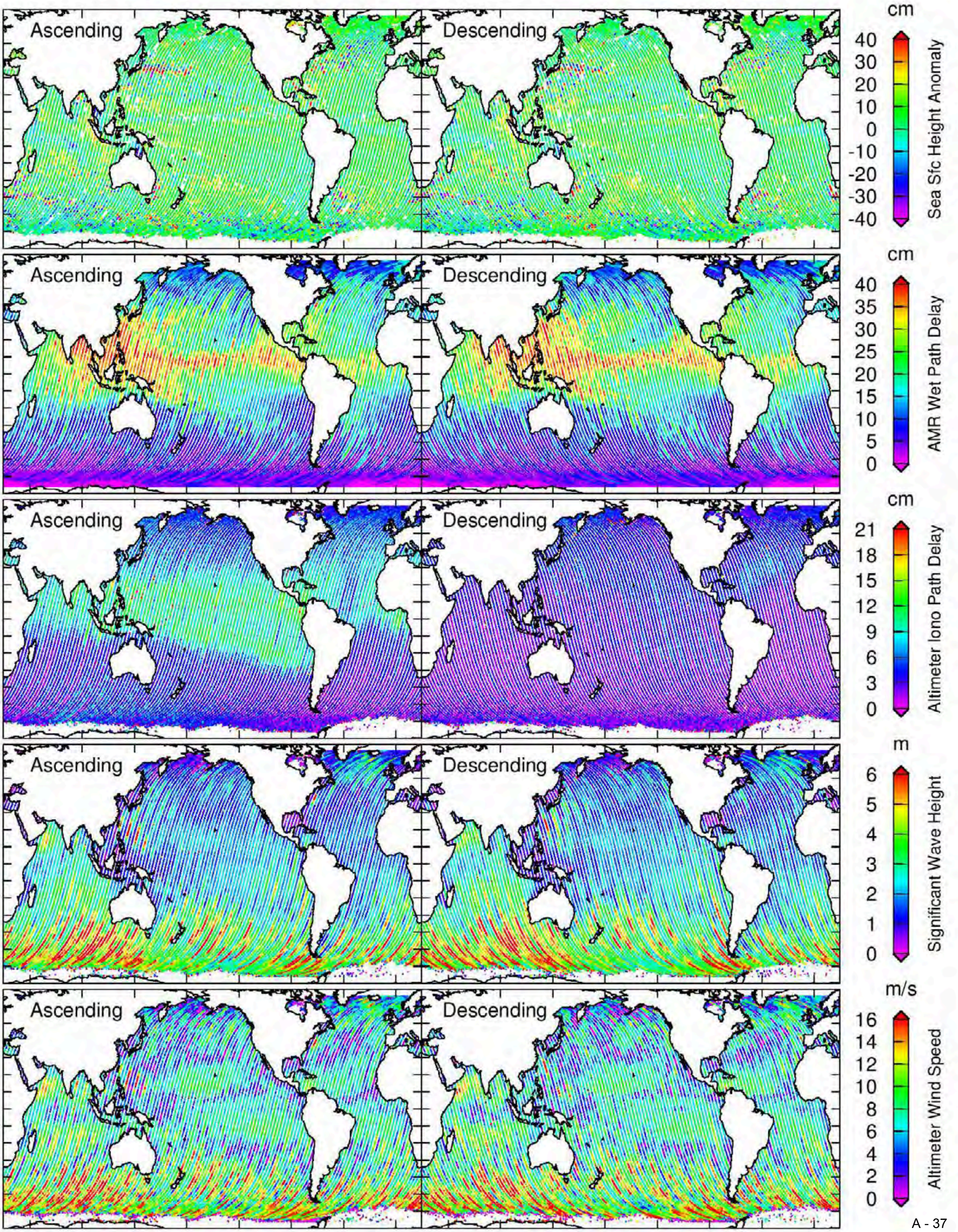
Jason-2 Cycle-219 2014-06-12 15:58:42 - 2014-06-22 13:57:14



Jason-2 Cycle-220 2014-06-22 13:57:14 - 2014-07-02 11:55:45



Jason-2 Cycle-221 2014-07-02 11:55:45 - 2014-07-12 09:54:17



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