APPENDIX 5A

DETAILS ON HYDRODYNAMIC AND WATER QUALITY MODEL DEVELOPMENT

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1.1 General Model Description

1.1.1 A computer modelling approach was adopted to assess the potential impact on marine water quality associated with the Project. The Delft3D suite of models, namely Delft3D-FLOW and Delft3D-WAQ, developed by Delft Hydraulics, was used as the platform for hydrodynamic and water quality modelling, respectively. Delft3D is a state-of-the-art computer program that simulates three-dimensional flow and water quality processes and is capable of handling the interactions between different hydrodynamic and water quality processes.

1.1.2 Delft3D-FLOW is a 3-dimensional hydrodynamic simulation module with applications for coastal, river and estuarine areas. The model calculates non-steady flow and transport phenomena that result from tidal and meteorological forcing on a curvilinear, boundary fitted grid. Delft3D-WAQ is a water quality module for numerical simulation of various physical, biological and chemical processes in three dimensions. It solves the advection diffusion-reaction equation for a predefined computational grid and for a wide range of model substances.

1.1.3 A Local Fine Grid Model, which covers the local areas of the proposed Project was set up using the Delft3D model for hydrodynamic and water quality simulations. The grid size of the Local Fine Grid Model was set to be less than 75 m near the discharge outfall to meet the modelling requirements specified in the EIA Study Brief.

1.1.4 The effects on the hydrodynamic regime were determined by examining the changes in speeds and directions of flow currents, and water levels at selected monitoring sites. Predicted water quality results were compared with those from the existing regional Update Model for a number of parameters including salinity, biochemical oxygen demand, ammonia nitrogen, nitrate, dissolved oxygen and chlorophyll-a, etc.

1.2 Model Selection and Setup

1.2.1 The existing regional model “Update Model”, which is a fully calibrated and verified model developed under Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool Study (1998) by EPD based on the Delft3D suite of models, was used to simulate the potential effects of the proposed Project on hydrodynamics and water quality of the receiving marine water. The existing grid of the Update Model in vicinity of the Cheung Chau STW Project is shown in **Figure 5A-1.** The grid size of the existing Update Model near the project site is in the order of about 300 m. It is, therefore, necessary to refine the model mesh to provide an improved resolution (less than 75m) in key areas of interest. The Local Fine Grid Model used in this EIA for the vicinity of the Project site is shown in **Figure 5A-2.**

1.2.2 The Local Fine Grid Model was linked to the regional Update Model, which is shown in **Figure 5A-3.** Open boundary conditions of the Local Fine Grid Model were transferred from the Update Model. That is, modelling was first carried out using the regional Update Model, and the output from the Update Model at the interface with the Local Fine Grid Model were used as the boundary conditions for input to the Local Fine Grid Model for both hydrodynamic and water quality simulations. The cumulative effects from the Pearl River estuaries and pollution loadings were accounted for in the Update Model.

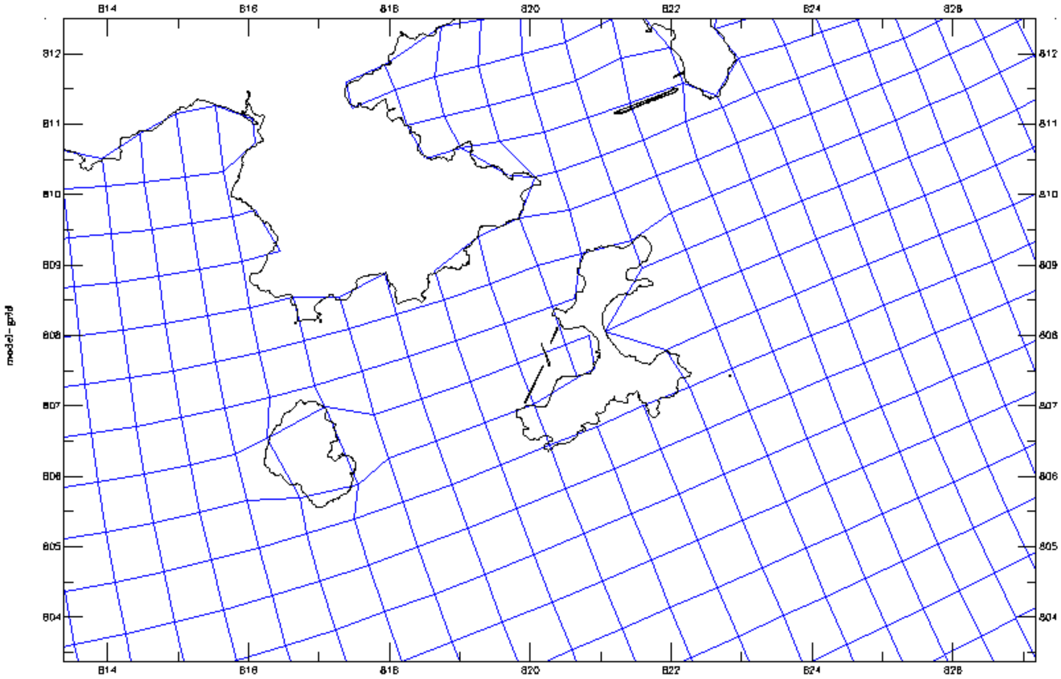


Figure 5A-1 Grid of the Update Model in Vicinity of Cheung Chau STW

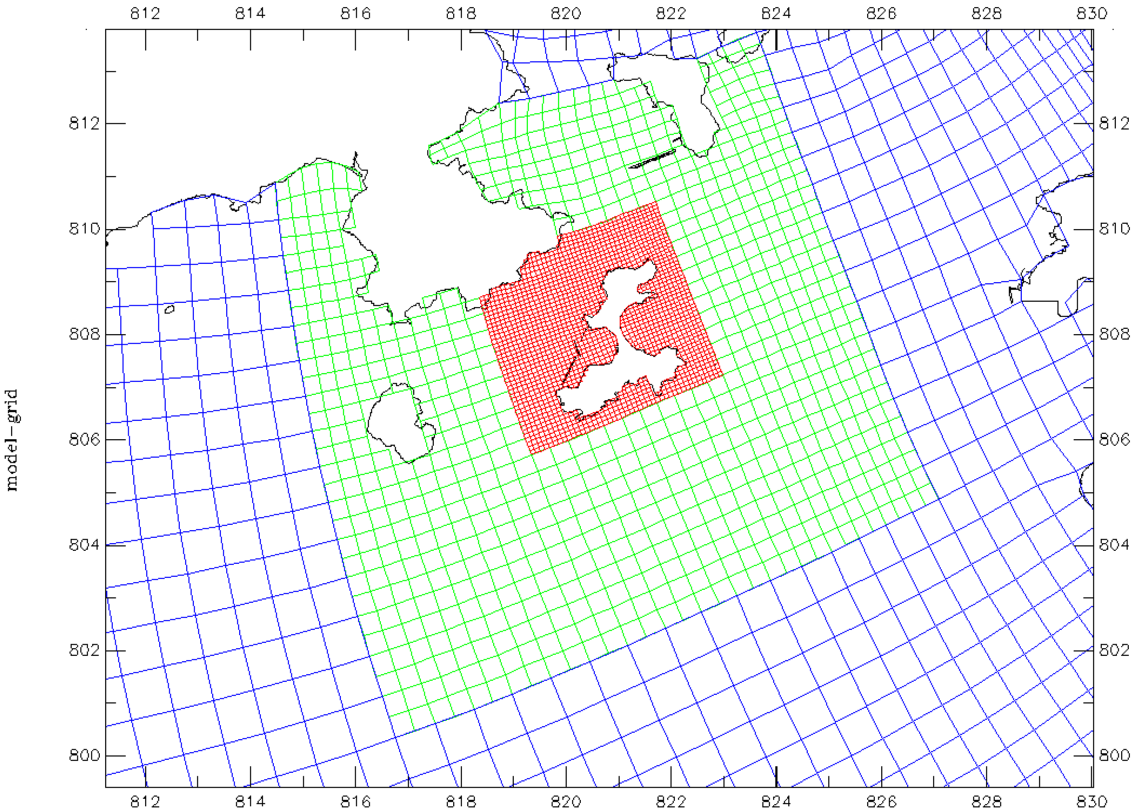


Figure 5A-2 Setup of Tiered Mesh of Local Fine Grid Model with Domain Decomposition Technique for Cheung Chau STW EIA

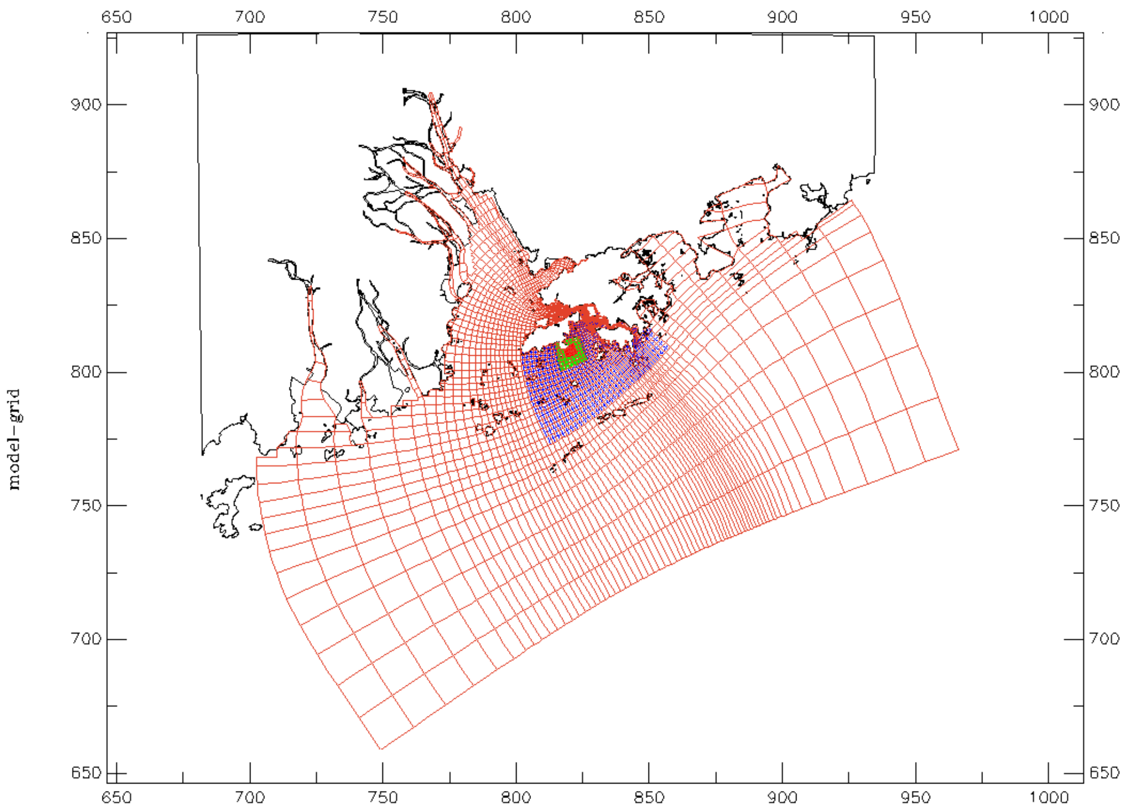


Figure 5A-3 Linkage of Update Model and Local Fine Grid Model

Domain Decomposition

1.2.3 The grid of the Update Model was refined by means of a domain decomposition technique to set up the Local Fine Grid Model.

1.2.4 Domain decomposition is a technique to subdivide a model domain into several smaller model domains, which are called sub-domains. Domain decomposition allows for local grid refinement, in both the horizontal and vertical directions. Grid refinement in the horizontal direction means that mesh sizes (fine grid) in one sub-domain are smaller than those in other subdomains (coarse grid).

1.2.5 Model computations are carried out separately on the sub-domains. The communication between the sub-domains takes place along internal open boundaries, or so-called dd-boundaries. The resulting equations are solved simultaneously for all boundaries.

1.2.6 For this Cheung Chau STW EIA study, three different sub-domains were used in the horizontal direction. The setting of the sub-domains was to allow for a smooth transition of grid dimension from the course domains to fine domains, and to achieve finer grid sizes near the project site as required in the study brief.

Meteorological forcing

1.2.7 Meteorological forcing includes solar radiation and water temperature recorded at

King's Part station by the Hong Kong Observatory. Seasonal variations of the Pearl River flow, solar radiation and wind velocity were incorporated into the simulation.

Vertical Layers of Hydrodynamic Model

1.2.8 The water column was divided into ten layers in the vertical direction for hydrodynamic simulation. The thickness of each layer was set to be 10% of the total water depth from the surface to the bottom.

Boundary Conditions

1.2.9 The Local Fine Grid Model was linked to the Regional Model "Update Model", which is a fully calibrated and verified model developed under Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool Study (1998) by EPD.

1.2.10 Open boundary conditions of the Local Fine Grid Model were defined by the Update Model. That is, modelling was first carried out using the Update Model, and the output from the regional Update Model at the interface with the Local Fine Grid Model were then used as the boundary condition for input to the Local Fine Grid Model. The cumulative effects from the Pearl River estuaries are accounted for in the Update Model, which covers the entire Hong Kong waters and the Pearl River estuaries.

Initial Conditions

1.2.11 The initial conditions for the Local Fine Grid Model were transferred from the the Update Model. This was achieved by mapping the information contained in the restart file of the Update Model to the restart file of the Local Fine Grid Model.

Flow Aggregation for Water Quality Modeling

1.2.12 Simulated flow results from the hydrodynamic simulation were used as the input for water quality simulation. To reduce the amount of computation time and data storage in water quality simulation, flow aggregation in the vertical direction of the grid were performed to reduce the total number of computation cells. The 10 layers of water depth used in the hydrodynamic simulation were aggregated into 5 layers using a thickness distribution of 10%, 20%, 20%, 30% and 20% over the total water depth from the surface to bottom.

1.2.13 In the horizontal direction, no flow aggregation was performed. This was to provide a sufficient resolution of modelled results over the aerial simulation domain to facilitate the assessment of water quality impact in local areas of the Project.

Simulation Periods and Time Step

1.2.14 For each assessment scenario, hydrodynamic model simulation was performed for a period of two 15-day full spring-neap cycles (excluding the spin-up period) for dry and wet seasons, respectively.

1.2.15 Water quality simulation also covered two 15-day full spring-neap cycles (excluding the spin-up period) for dry and wet seasons respectively. A sufficient spin-up period was provided to eliminate the initial condition effects.

1.2.16 The time steps in the hydrodynamic and water quality model were set equal to 1 minute and 0.5 hour, respectively. The predicted hydrodynamic and water quality results with the Local Fine Grid Model for the Cheung Chau STW were compared to those obtained from the Update Model to validate and calibrate the Local Fine Grid Model. Model calibration shows that the results from the Local Fine Grid Model and the Update Model matched well. The accuracy of Local Fine Grid Model is maintained. These time steps used in the hydrodynamic and water quality simulations are adequately small to ensure stable model simulations and accurate modelling results.

Wind

1.2.17 To be identical to the Update Model, a north-eastern wind with a wind speed of 5 m/s was applied for the dry season simulation. For the wet season simulation, a south western wind with a speed of 5 m/s was applied.

Hydrodynamic Forcing

1.2.18 Hydrodynamic simulations were carried out with the Local Fine Grid Model for a spring neap cycle for both the wet and dry seasons. The results were written to a "communication file" in the Delft3D model with a time interval of 1 hour, that is, the hydrodynamic modelling results were saved to a result file every one hour. Given that the time step for model simulation was 1 minute, this means that hydrodynamic modelling results were saved to a result file for later use for water quality simulation once every 60 steps of hydrodynamic model simulation

1.2.19 From the communication file, the hydrodynamic forcing data for the water quality model were derived using the coupling module in Delft3D.

Key Modeling Parameters

1.2.20 Key water quality parameters included in the model simulation are shown in **Table 5A-1.** They include salinity, water temperature, *E. coli,* oxygen, 5-day biochemical oxygen demand (BOD_5), nitrate, ammonia nitrogen, ortho-phosphate, chlorophyll-a, suspended solids, total inorganic nitrogen and unionized ammonia.

Table 5A-1 Key Water Quality Modeling Parameters

Parameter	Description
Salinity	Salinity
ModTemp	Water Temperature
E Coli	E. coli Bacteria
Oxy	Oxygen
BOD_5	5-day Biochemical Oxygen Demand
NO_3	Nitrate
NH_4	Ammonium
PO_4	Ortho-Phosphorus
AAP	Adsorbed Ortho-Phosphorus
Si	Silica
Diat	Diatoms
Green	Algae
DetC	Detritus Carbon
DetN	Detritus Nitrogen
DetP	Detritus Phosphorus
DetSi	Detritus Silica
BOD_5	5-day Biochemical Oxygen Demand
Chlfa	Chlorophyll a
SS	Suspended Solids
TotN	Total Nitrogen
TotP	Total Phosphorus
NH_3	Unionised Ammonia

Pollutant Loading

1.2.21 The pollutant loading inventory was created using the latest planning data for domestic, commercial and industrial activities. The inventory incorporated all possible pollution sources including those from landfill sites, non-point sources, surface run-off and sewage discharges.

1.2.22 The inventory also included the effluent discharges from wastewater treatment facilities including Stonecutters Island STW, San Wai STW, Siu Ho Wan STW, Sham Tseng STW, Yuen Long STW and Shek Wu Hui STW.

Coastline Configurations & Bathymetry

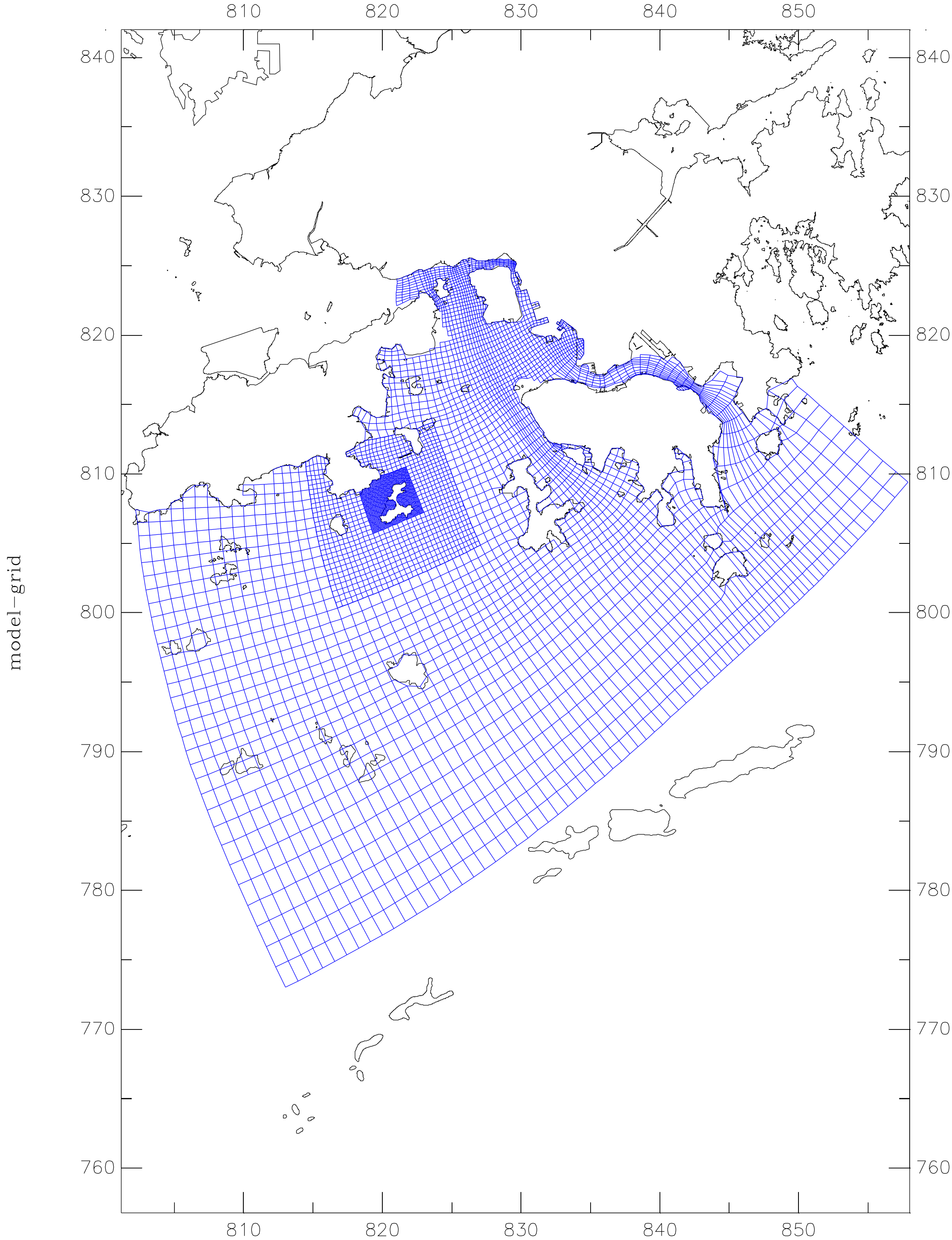
1.2.23 The latest coastline configuration for the assessment year of 2019 was adopted in model simulations of the potential impact from the Project in this EIA study. Changes in coastline configuration due to reclamation and other development activities were reflected in the model setup. The changes in coastline configuration bathymetry condition included the effects by the following development projects:

- Sunny Bay Reclamation;
- Further Development of Tseung Kwan O;
- Tuen Mun – Chek Lap Kok Link (TMCLKL);
- Hong Kong – Zhuhai – Macao Bridge Hong Kong Boundary Crossing Facilities (HKZMB - HKBCF);
- Wanchai Reclamation Phase II;
- Kwai Tsing Container Terminal Basin dredging;
- Cruise Terminal at Kai Tak;
- Hong Kong Link Road;
- Lantau Logistic Park;
- Shatin-to-Central Link; and
- Tseung Kwan O Further Development.

1.3 Model Verification and Validation

1.3.1 Modelled hydrodynamic and water quality results from the Local Fine Grid Model setup for the Cheung Chau STW EIA were compared to those from the Update Model for Year 2019 to validate and calibrate the Local Fine Grid Model. The calibration figures are shown in **Figure 5A-4 to Figure 5A-127.** The calibration shows that the results from the Local Fine Grid Model and the Update Model are in good agreement, which indicates that the accuracy of the Local Fine Grid Model is assured.

1.3.2 Having been calibrated, the Local Fine Grid Model was then applied to simulate and predict the potential impact on the receiving marine environment and the identified water sensitive receivers for each of the assessment scenarios.



Upgrading of Cheung Chau Sewage Collection, Treatment and Disposal Facilities.
Hydrodynamic and Water Quality Model Grid.

Figure 5A-4

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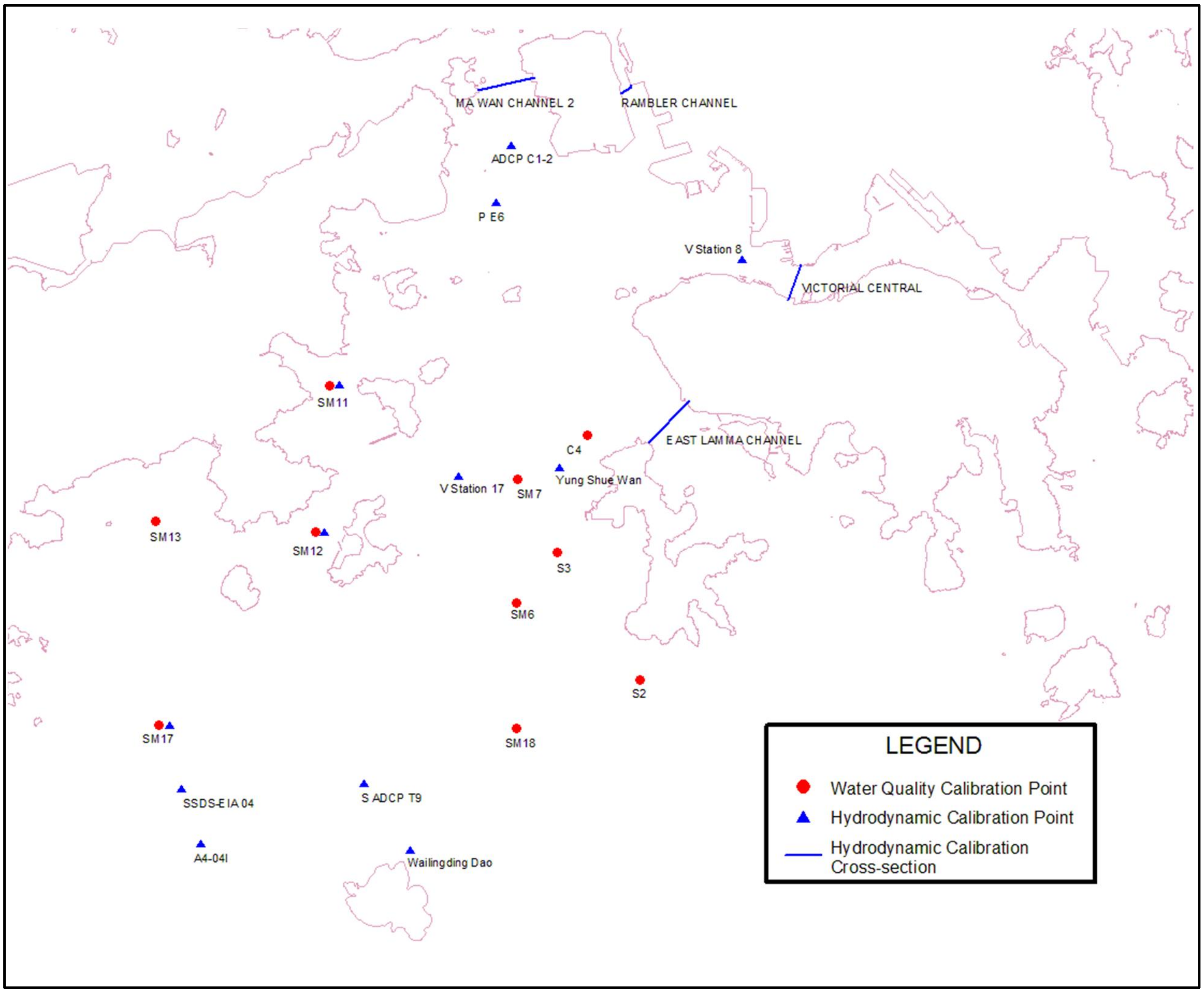

Hydrodynamic and Water Quality Calibration points for Local Fine Grid Model and Update Model.		
	Figure 5A-5	
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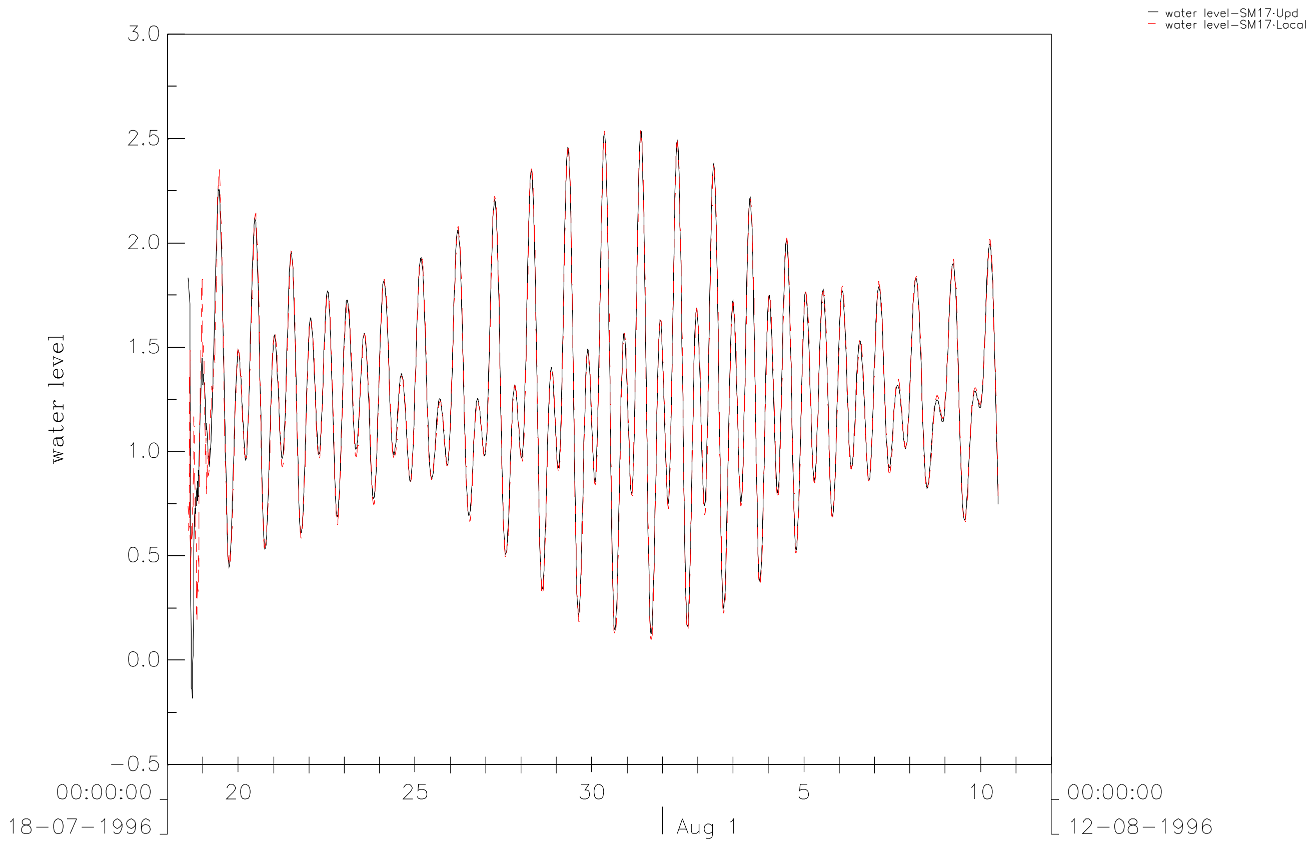
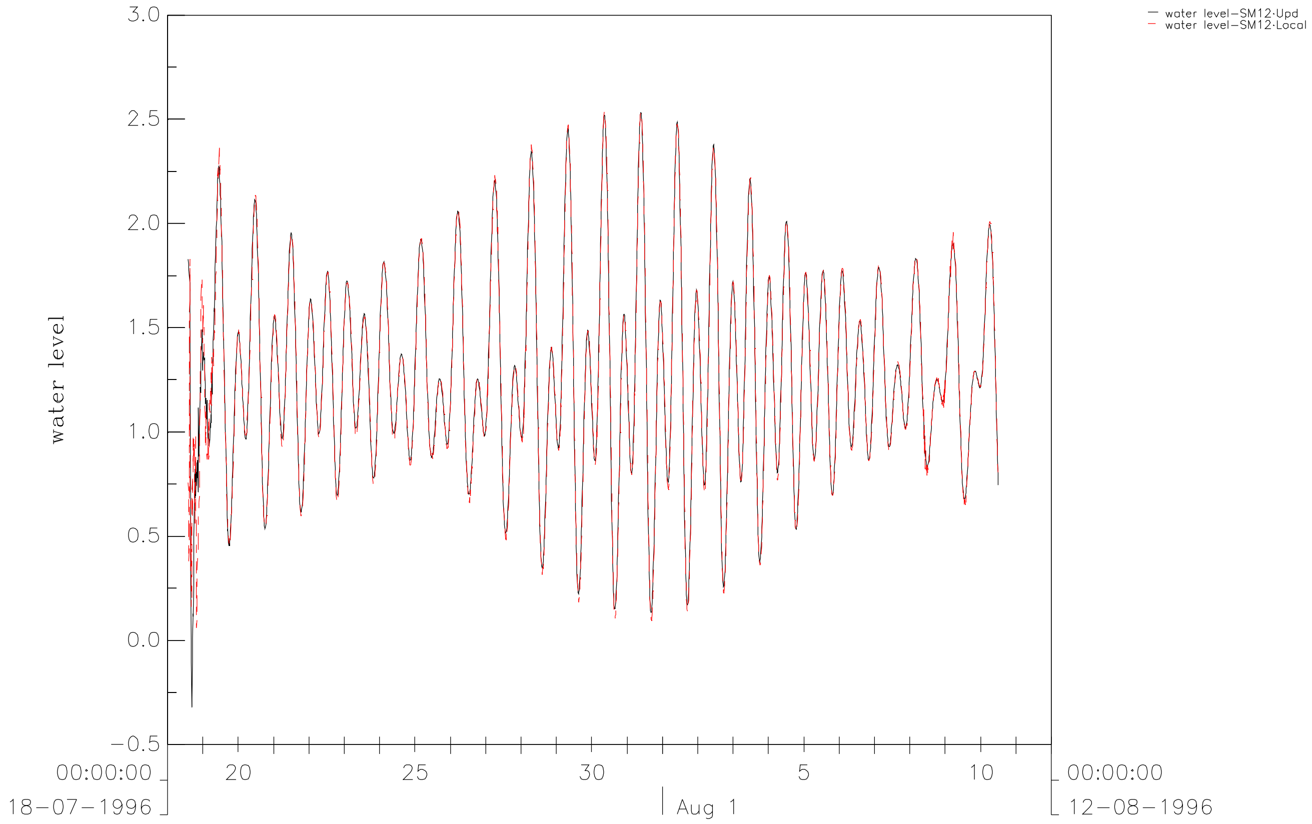


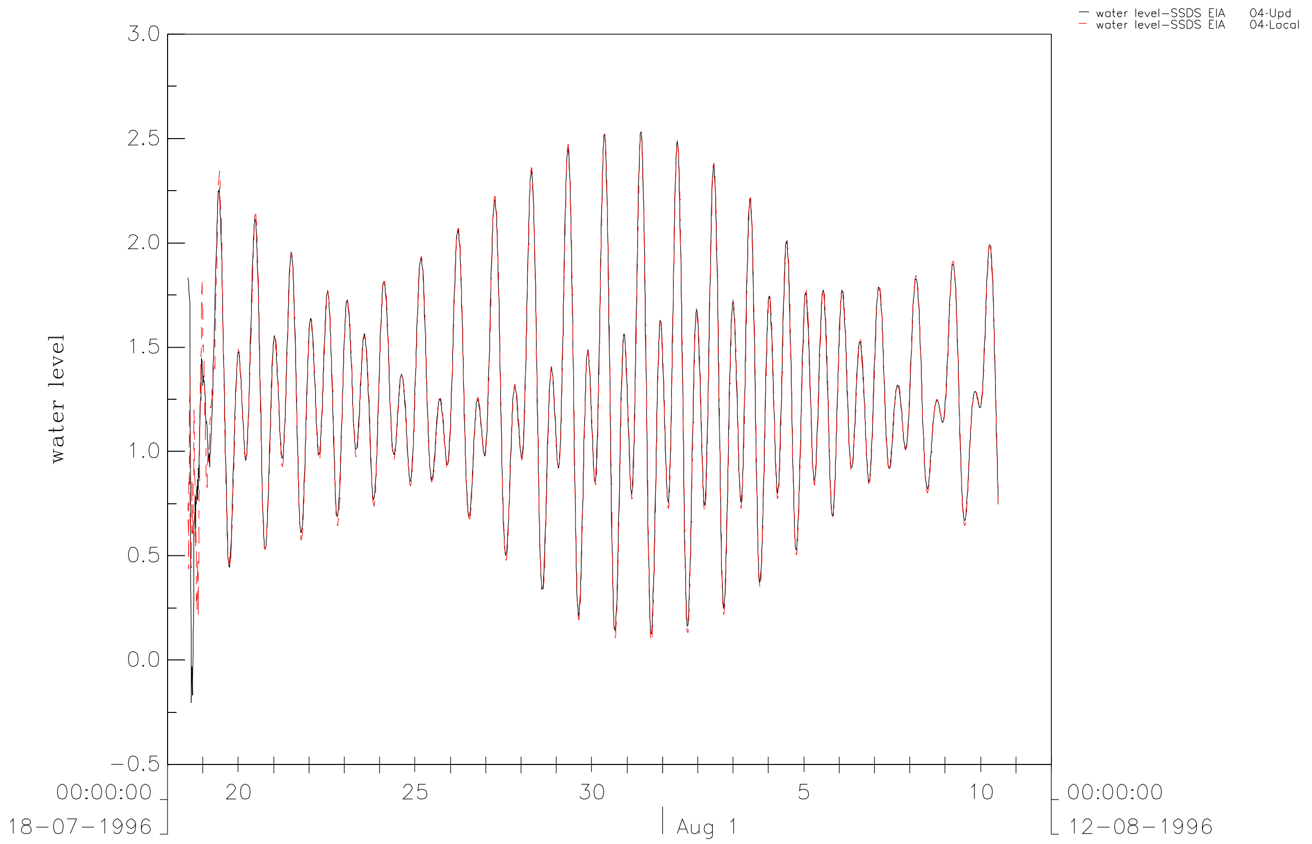


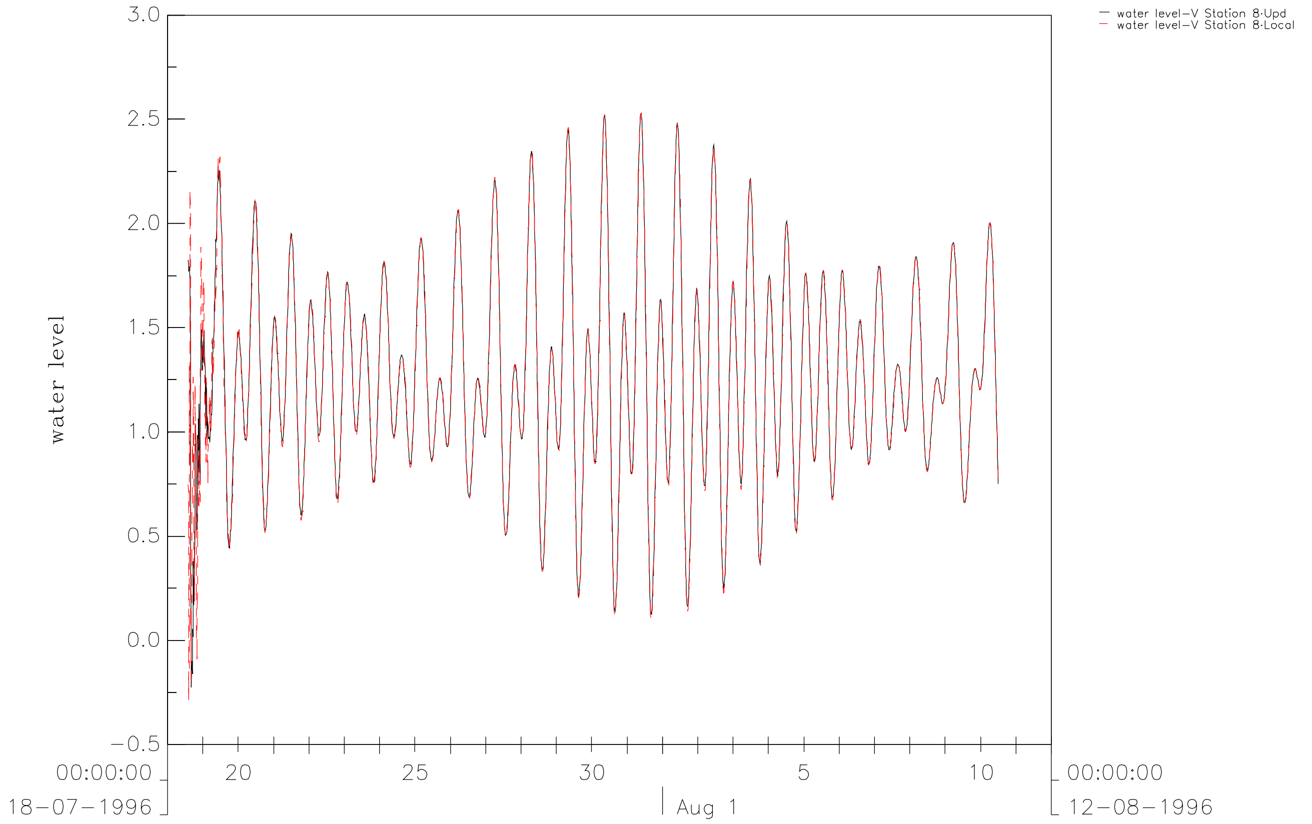
Water level comparison between Update Model and Local Refine Model at SM17 (upper) and SM12 (lower).

Dry Season

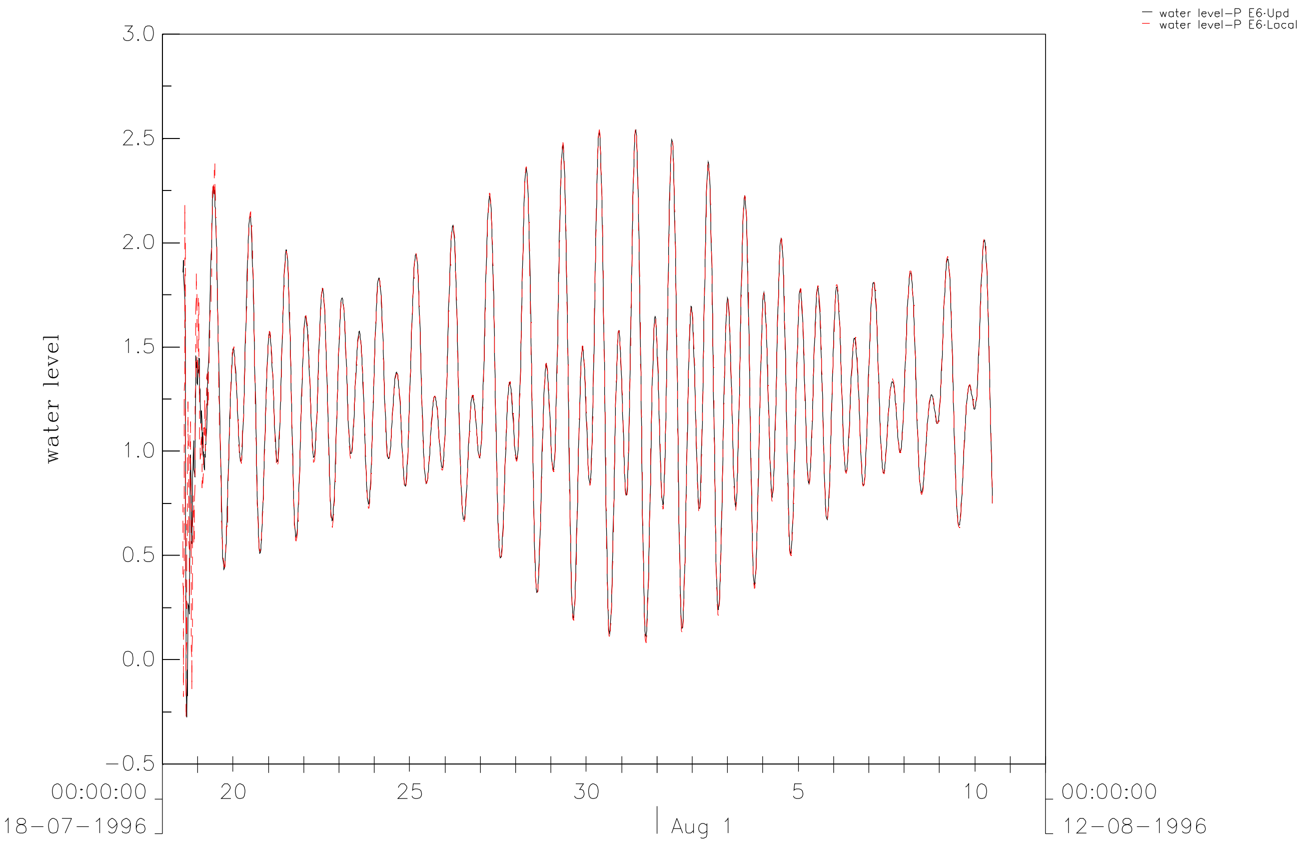
Figure 5A-6

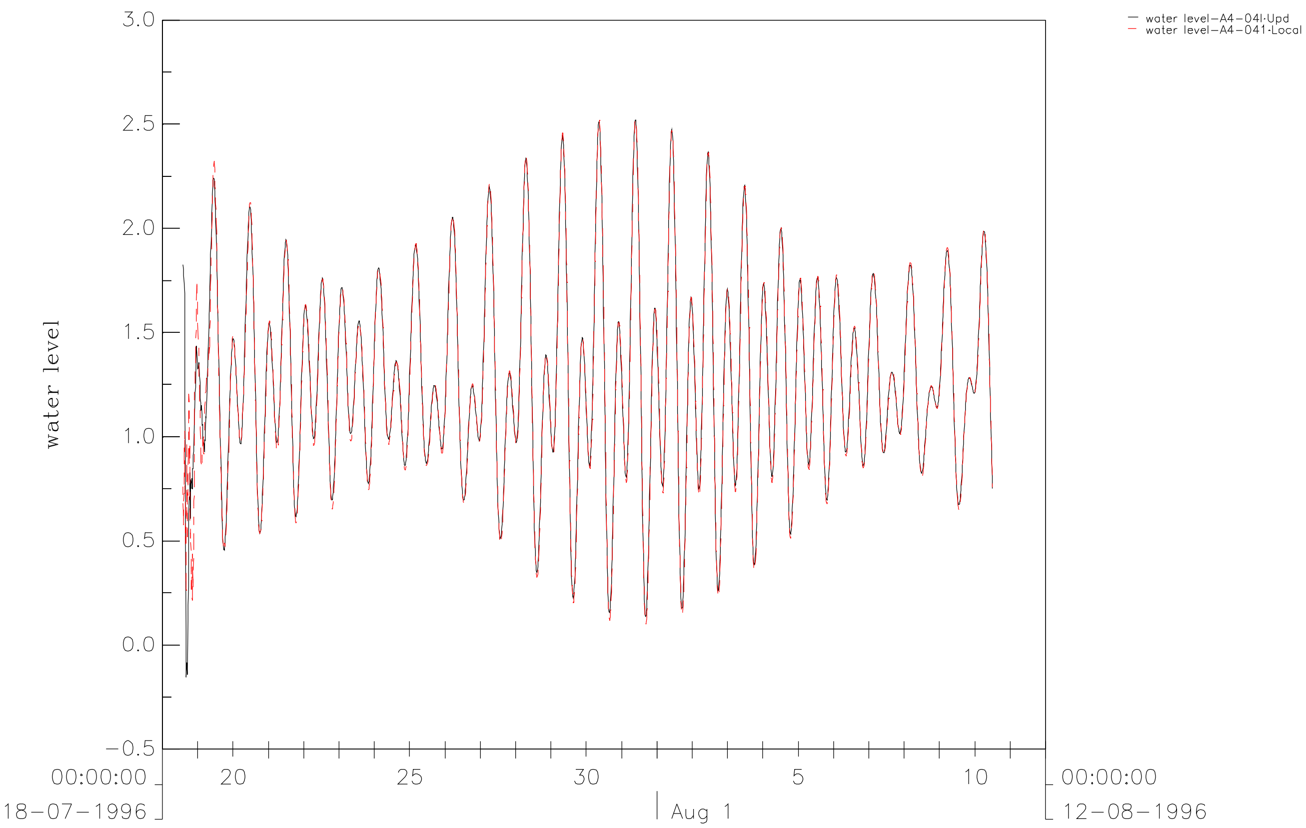
DSD & ATKINS



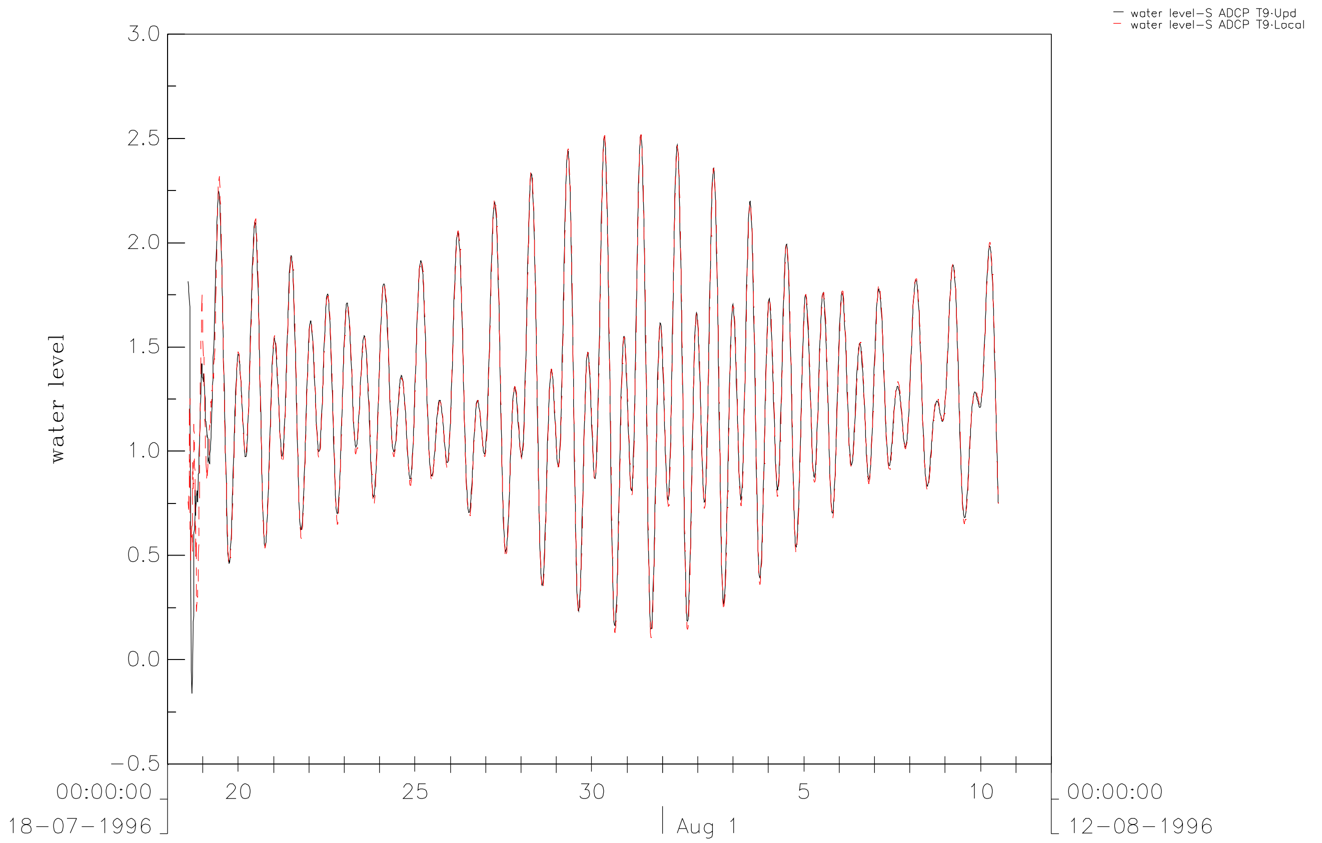


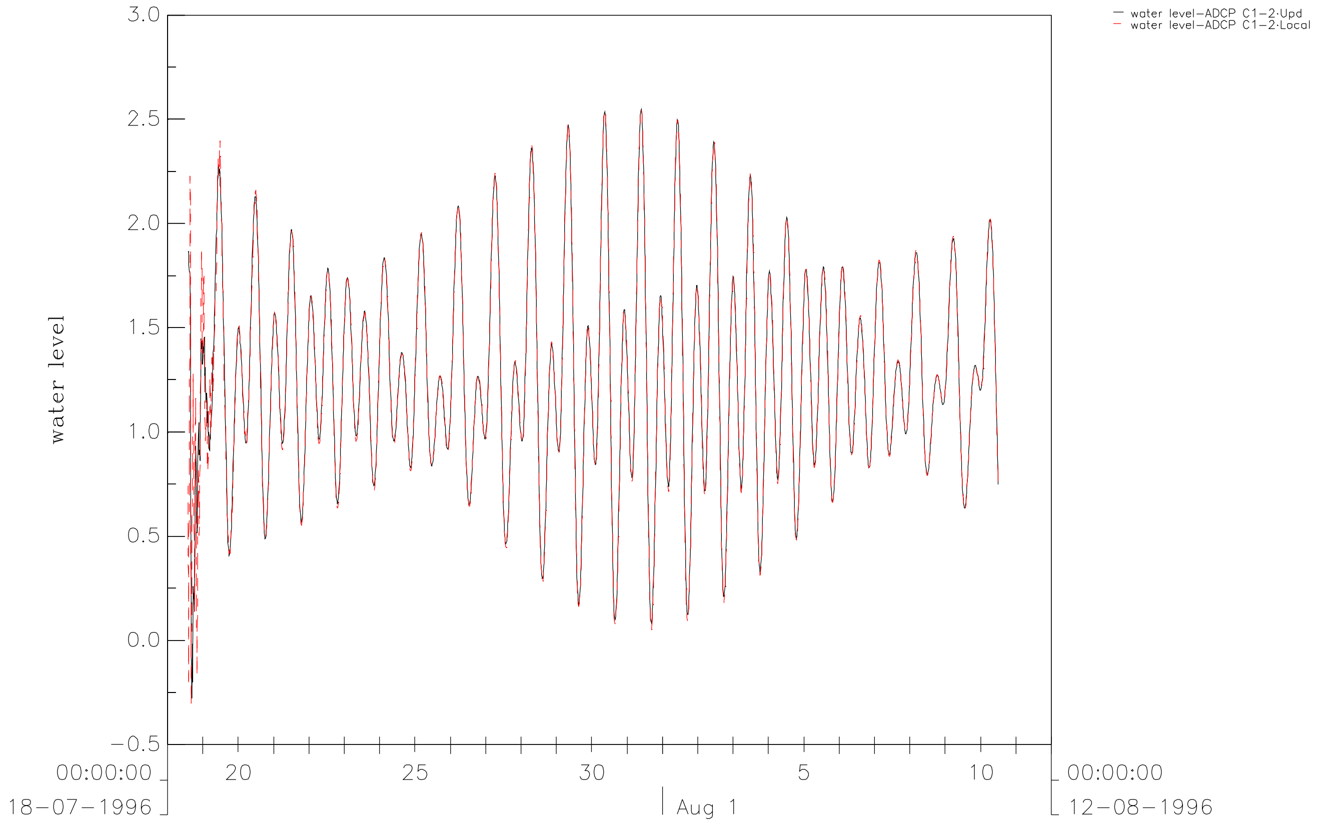
Water level comparison between Update Model and Local Refine Model at SSDS EIA 04 (upper) and V Station 8 (lower).	Dry Season
	Figure 5A-7
DSD & ATKINS	





Water level comparison between Update Model and Local Refine Model at P E6 (upper) and A4−041 (lower).	Dry Season	
	Figure 5A-8	
DSD & ATKINS		



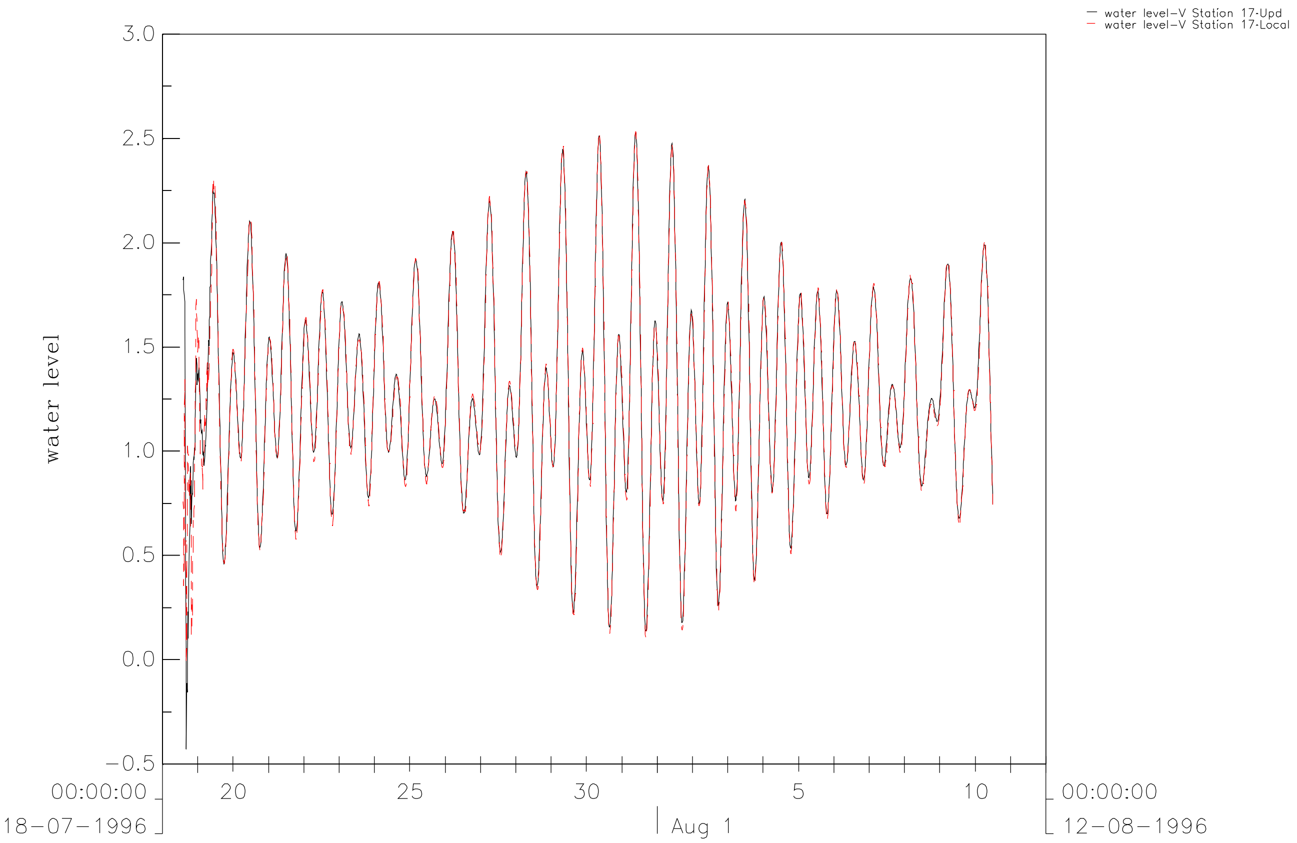


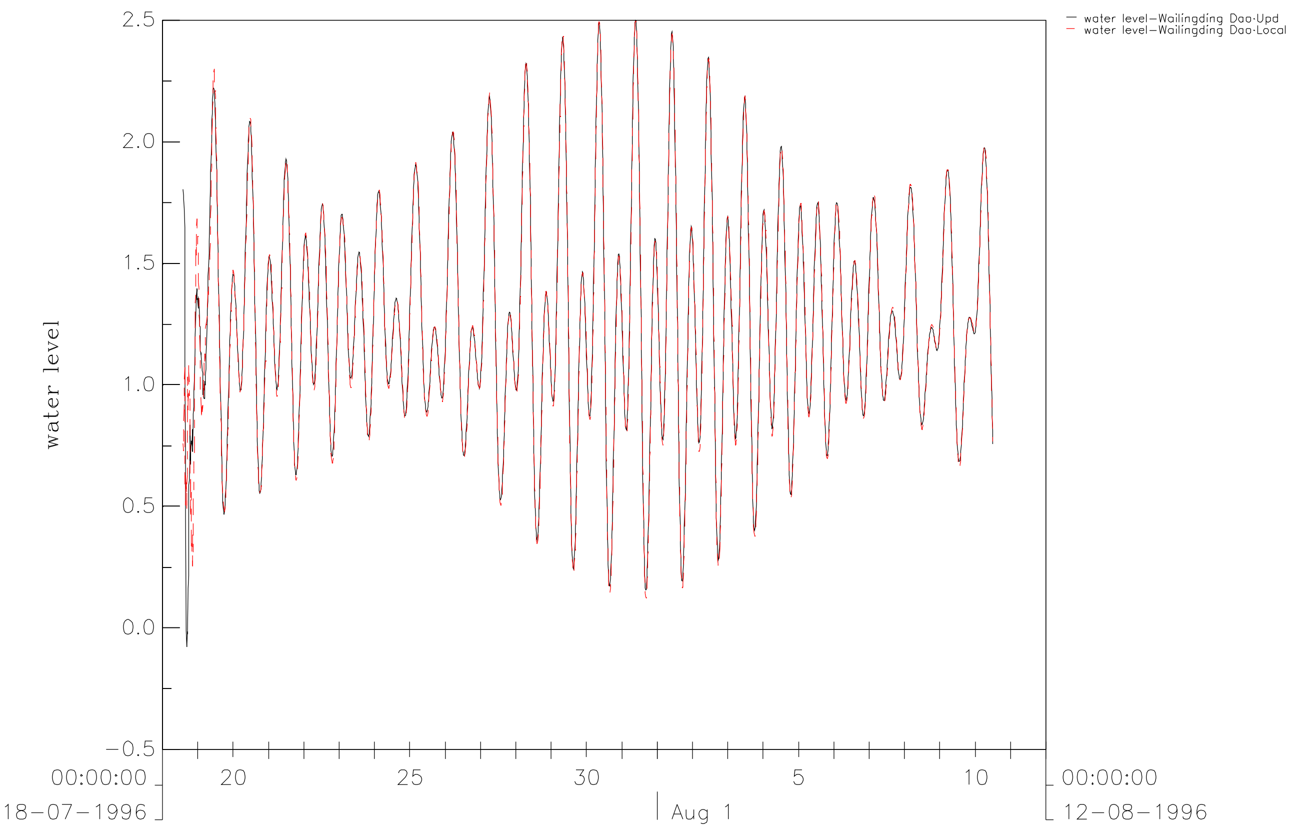
Water level comparison between Update Model and Local Refine Model at S ADCP T9 (upper) and ADCP C1-2 (lower).

Dry Season

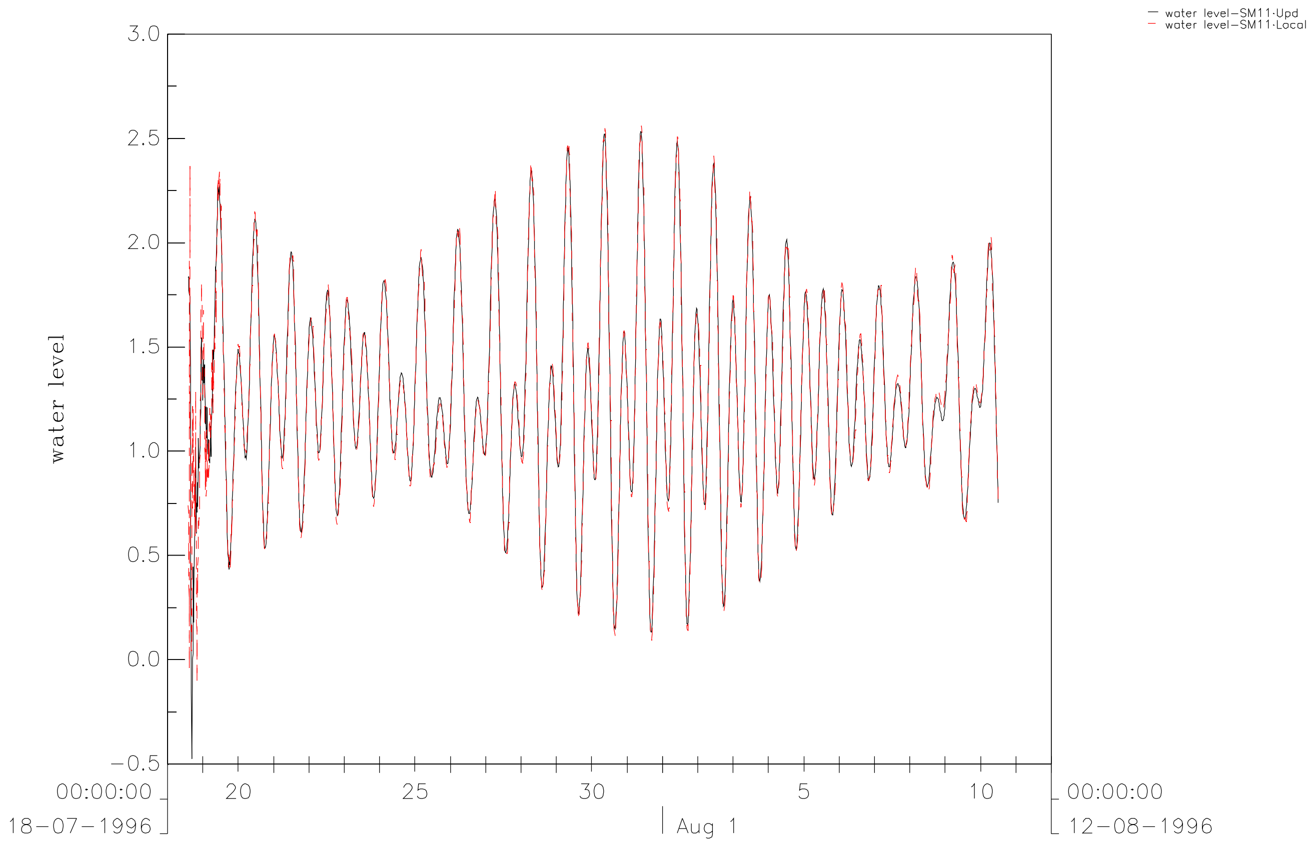
Figure 5A-9

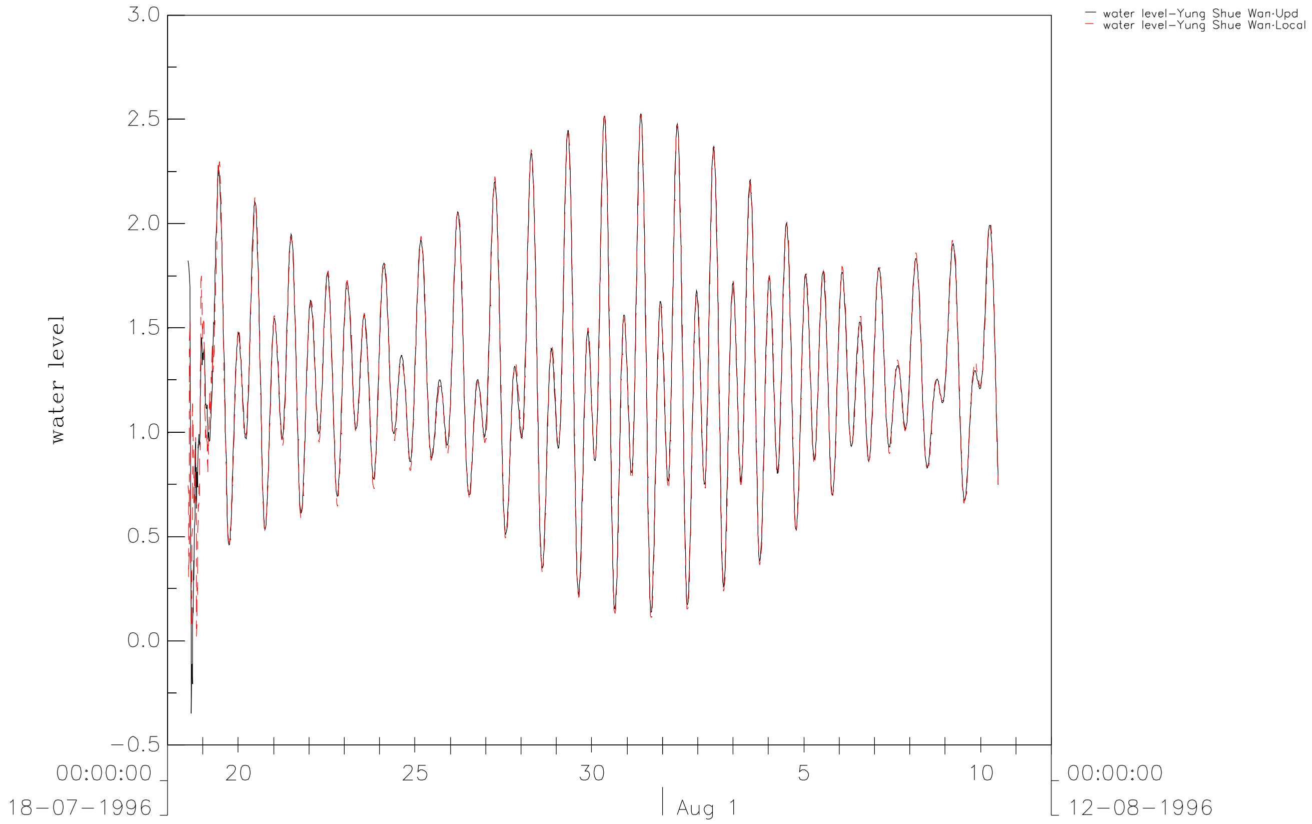
DSD & ATKINS



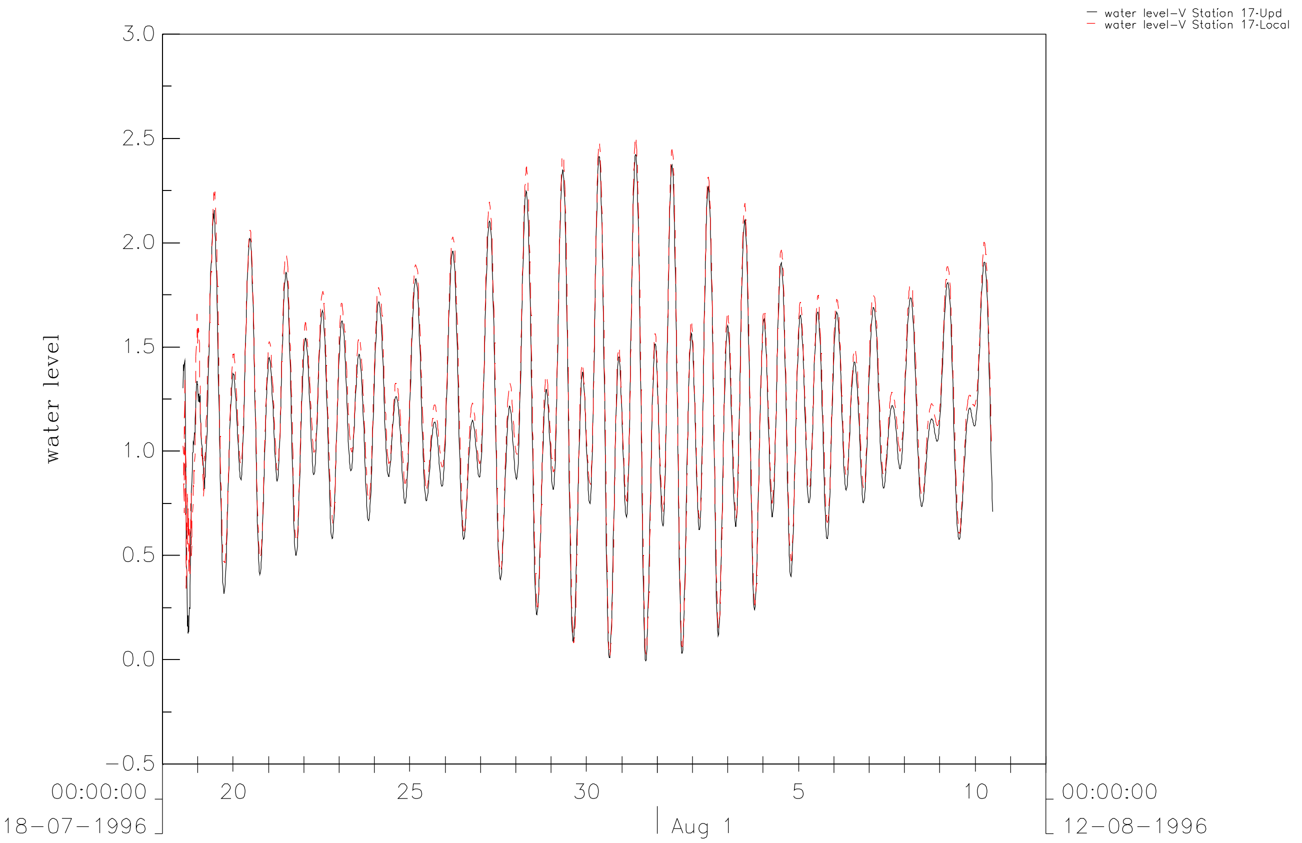


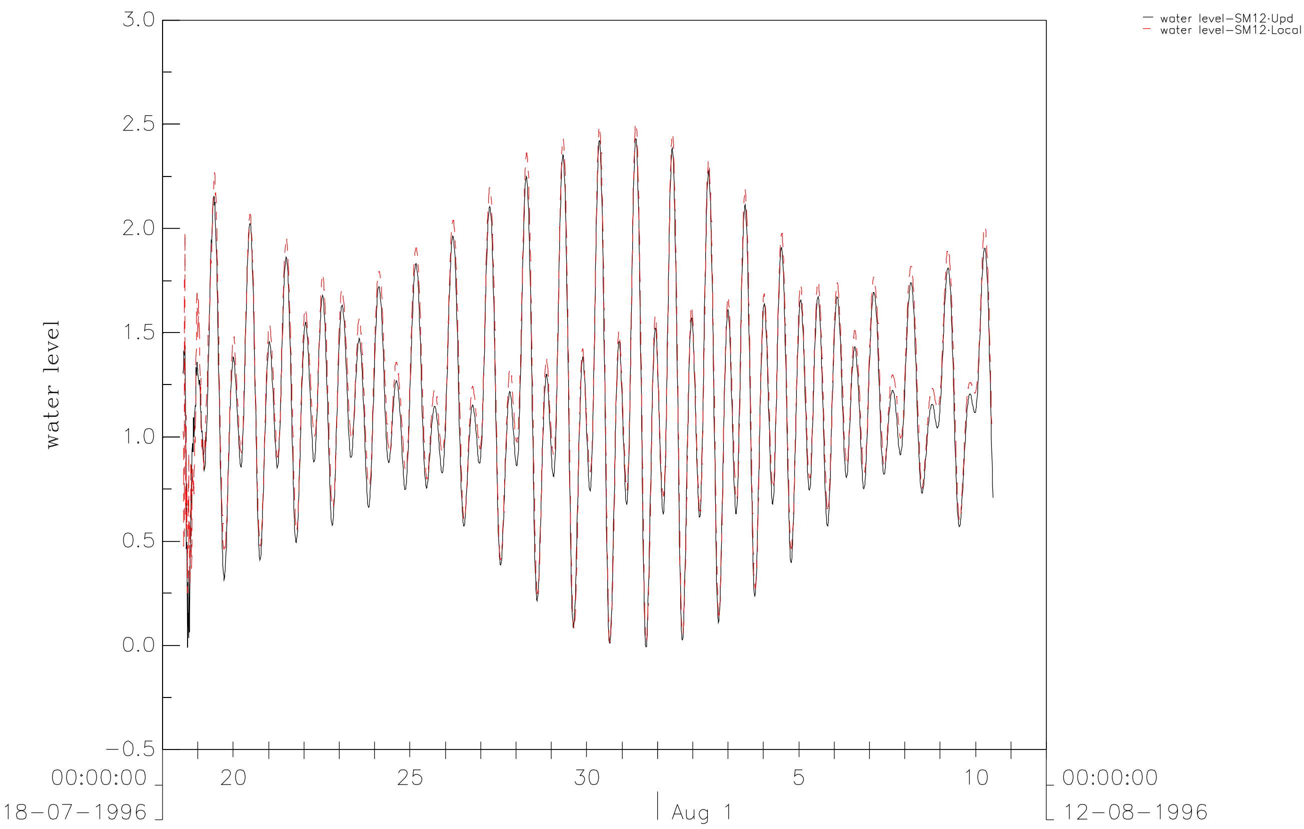
Water level comparison between Update Model and Local Refine Model at V Station 17 (upper) and Wailinding dao (lower).	Dry Season	
	Figure 5A-10	
DSD & ATKINS		



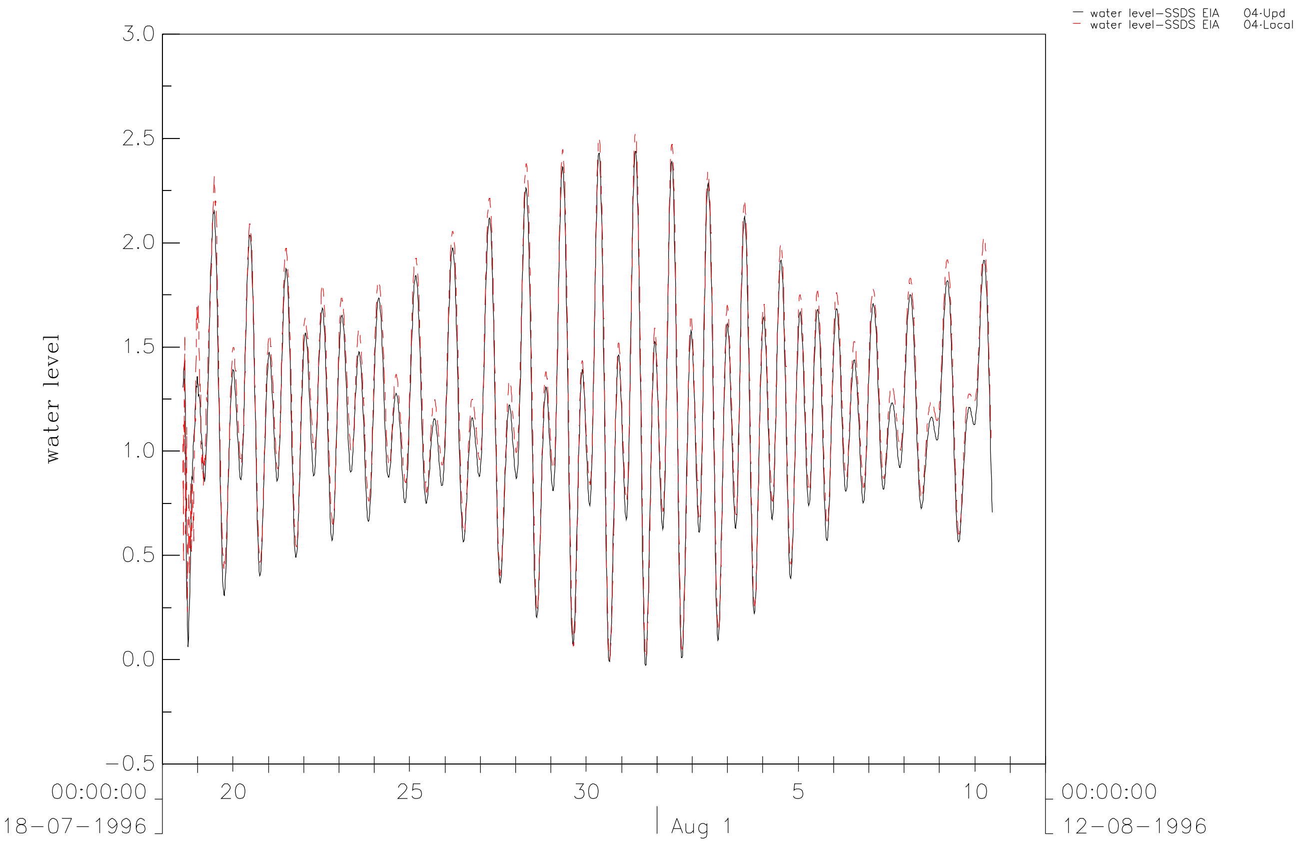


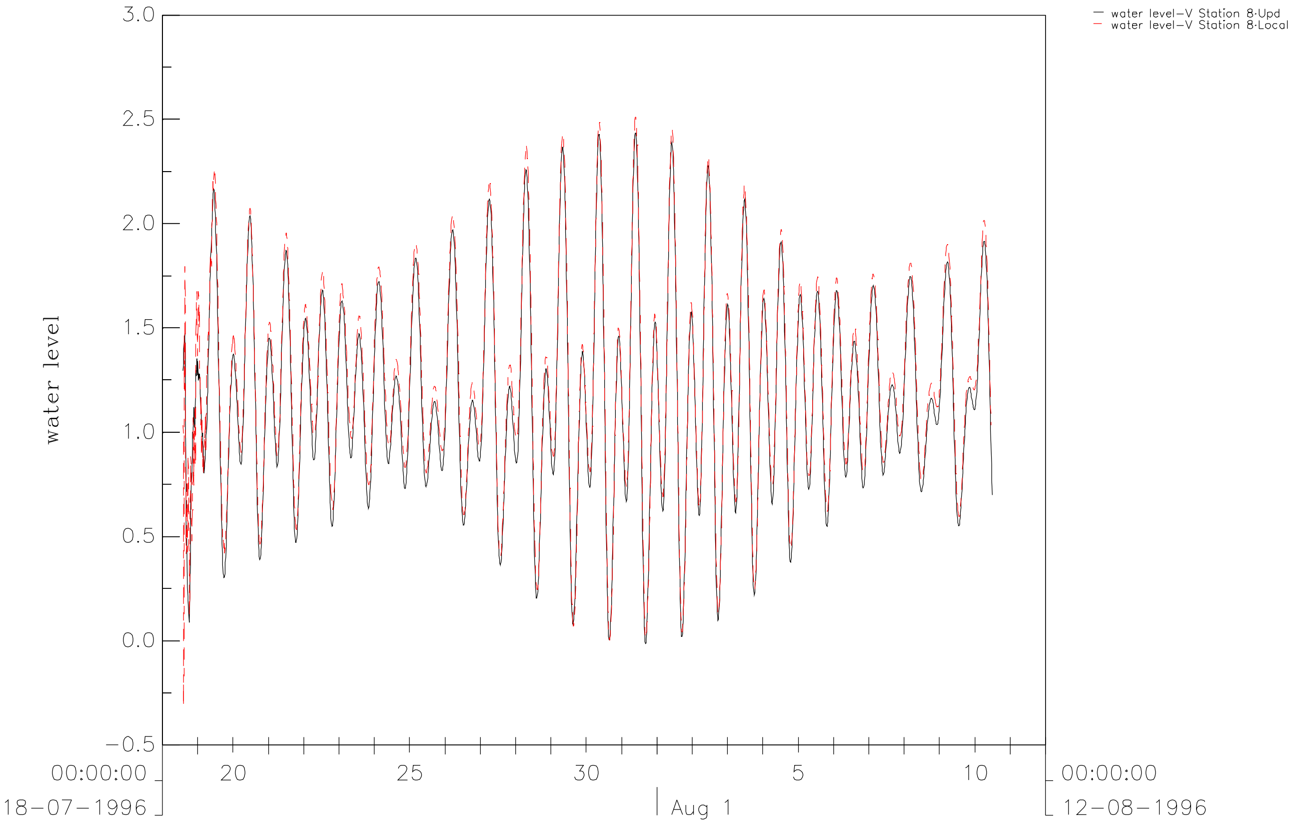
Water level comparison between Update Model and Local Refine Model at SM11(upper) and Yung Shue WAN (lower).	Dry Season
	Figure 5A-11
DSD & ATKINS	



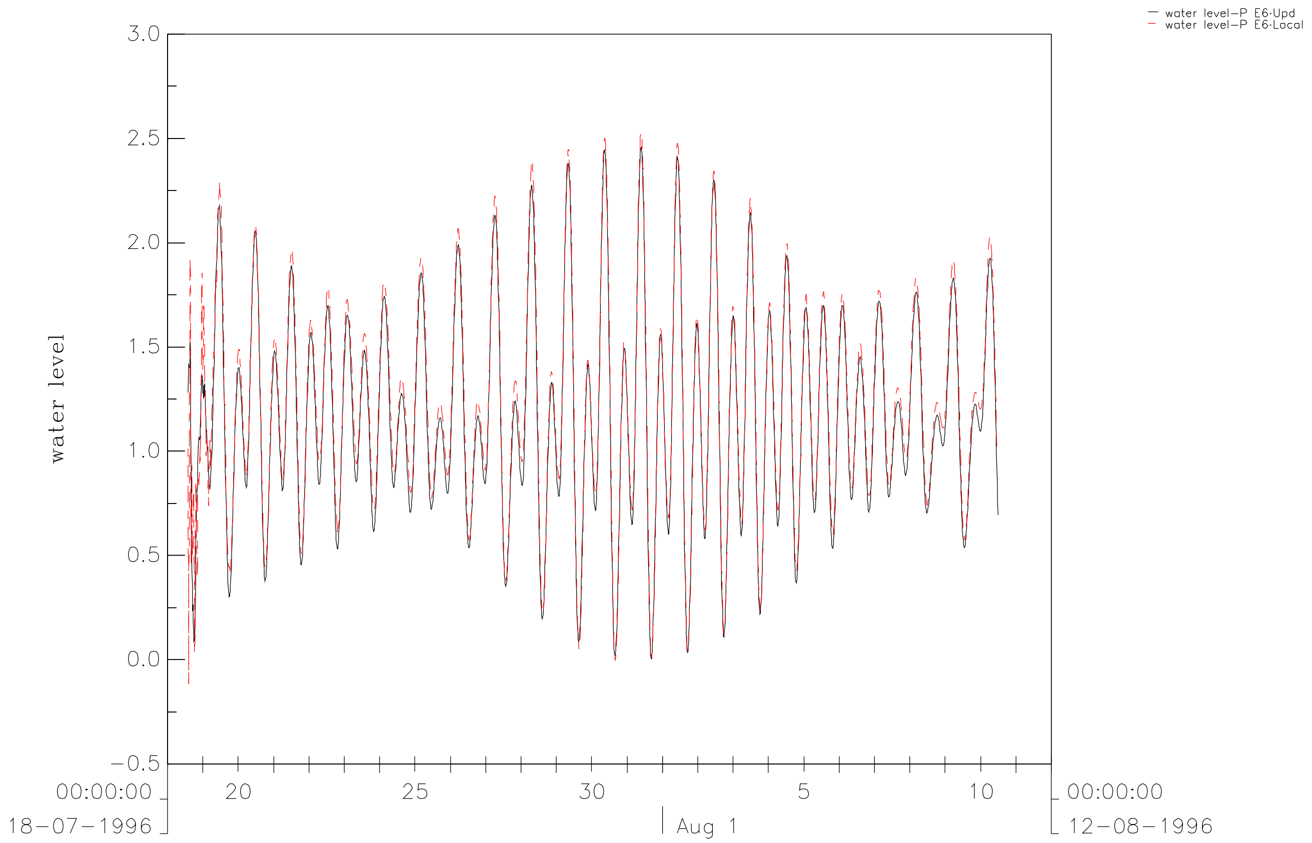


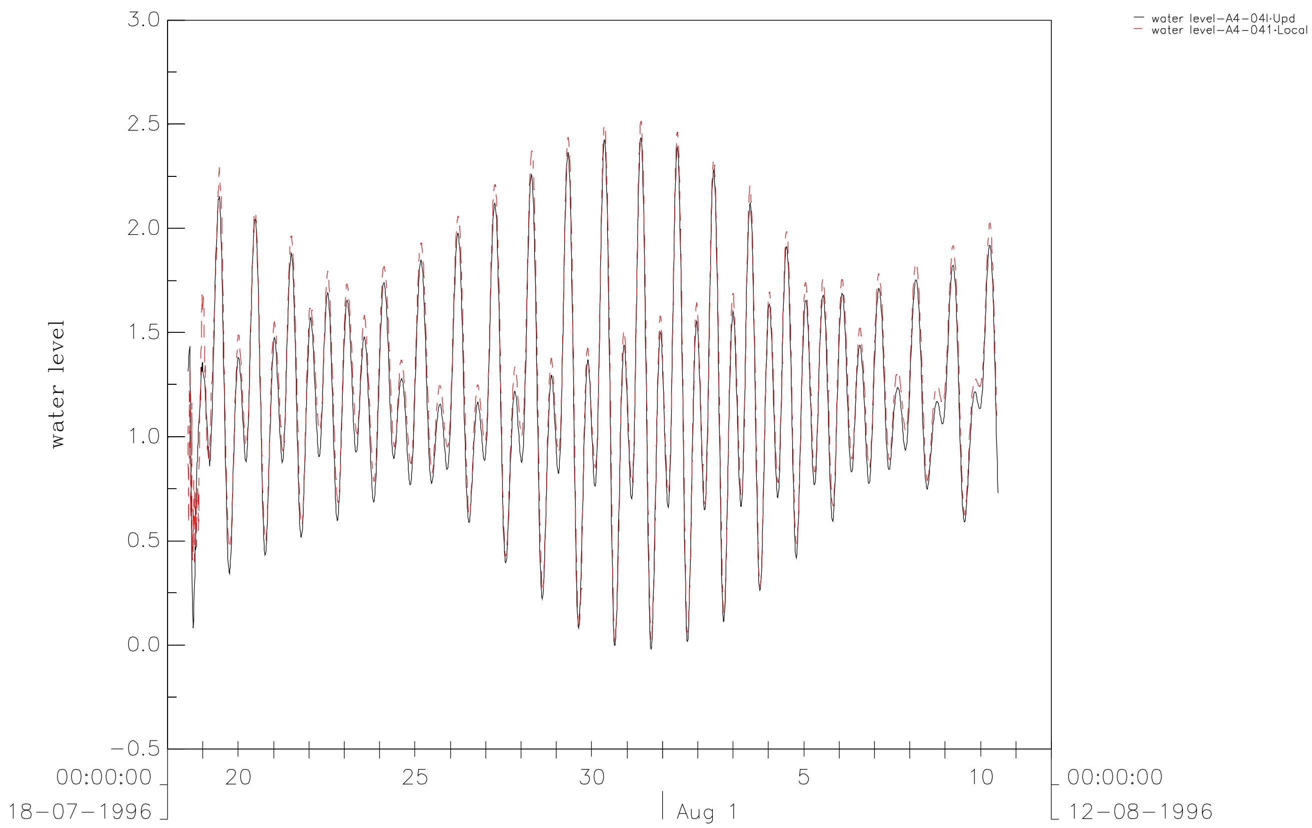
Water level comparison between Update Model and Local Refine Model at SM17 (upper) and SM12 (lower).	Wet Season	
	Figure 5A-12	
DSD & ATKINS		



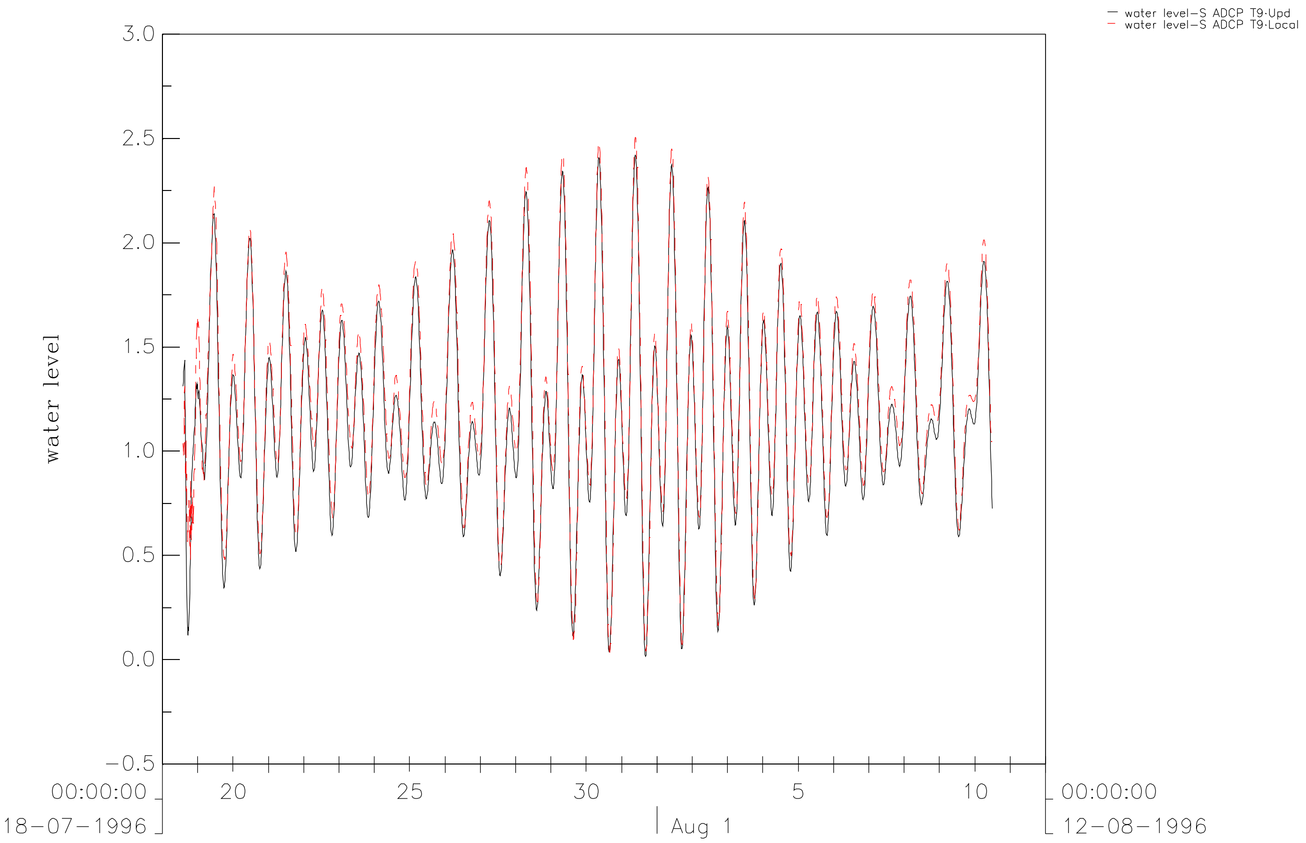


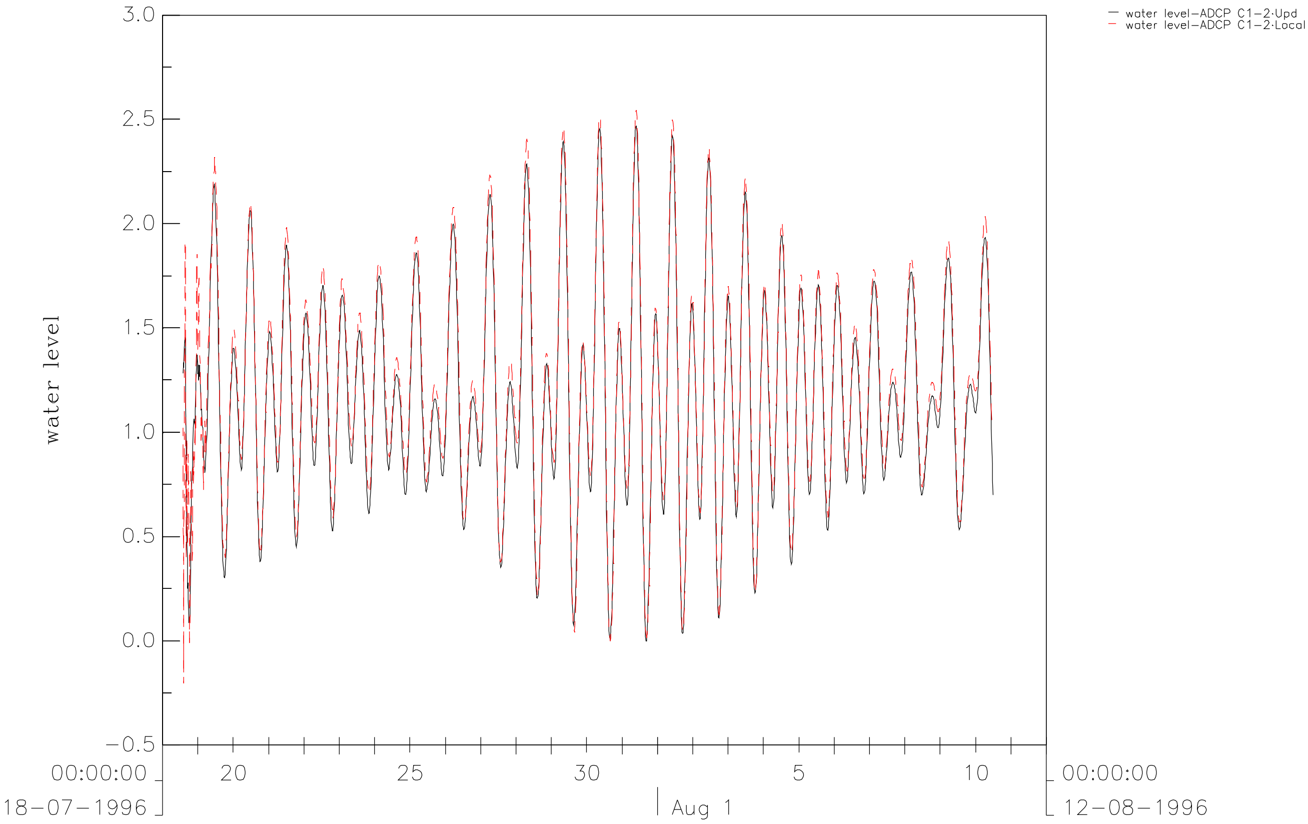
Water level comparison between Update Model and Local Refine Model at SSDS EIA 04 (upper) and V Station 8 (lower).	Wet Season
	Figure 5A-13
DSD & ATKINS	



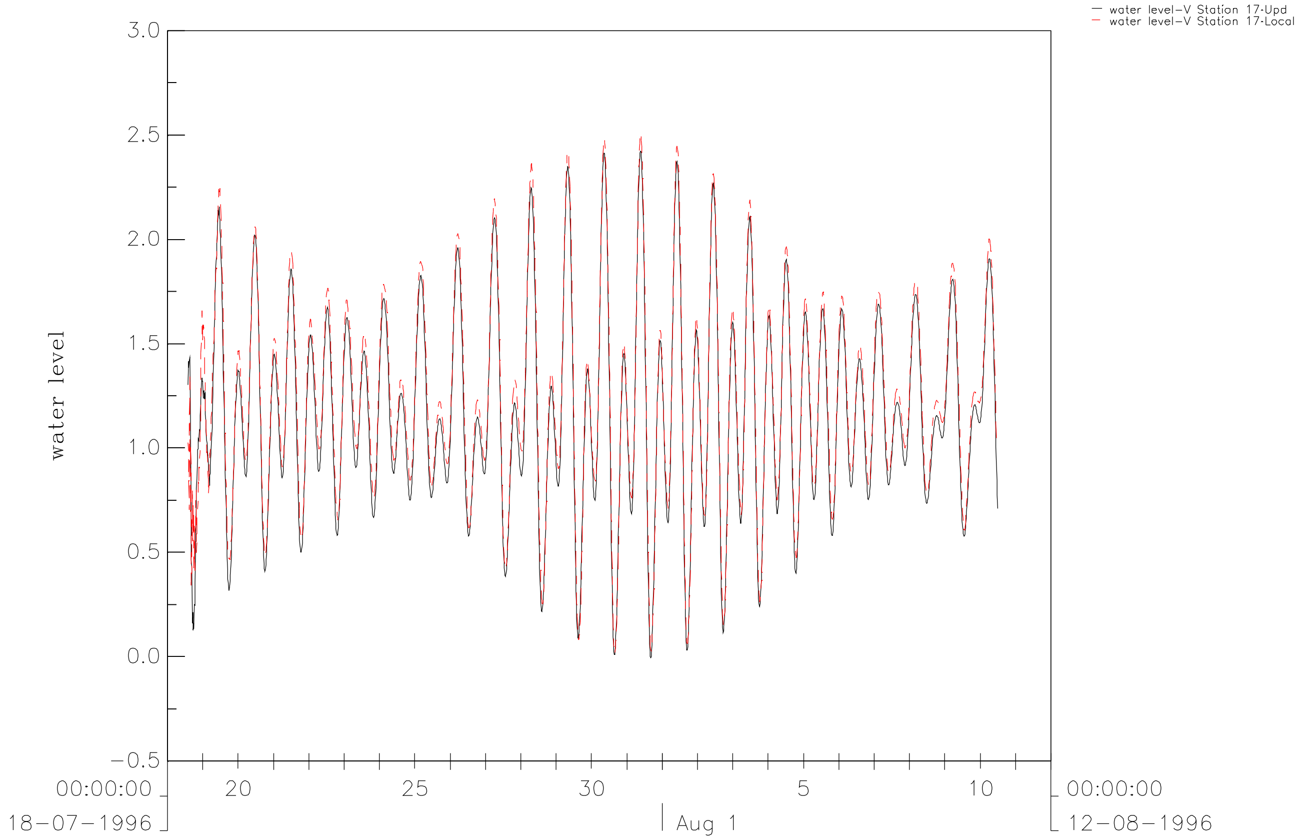


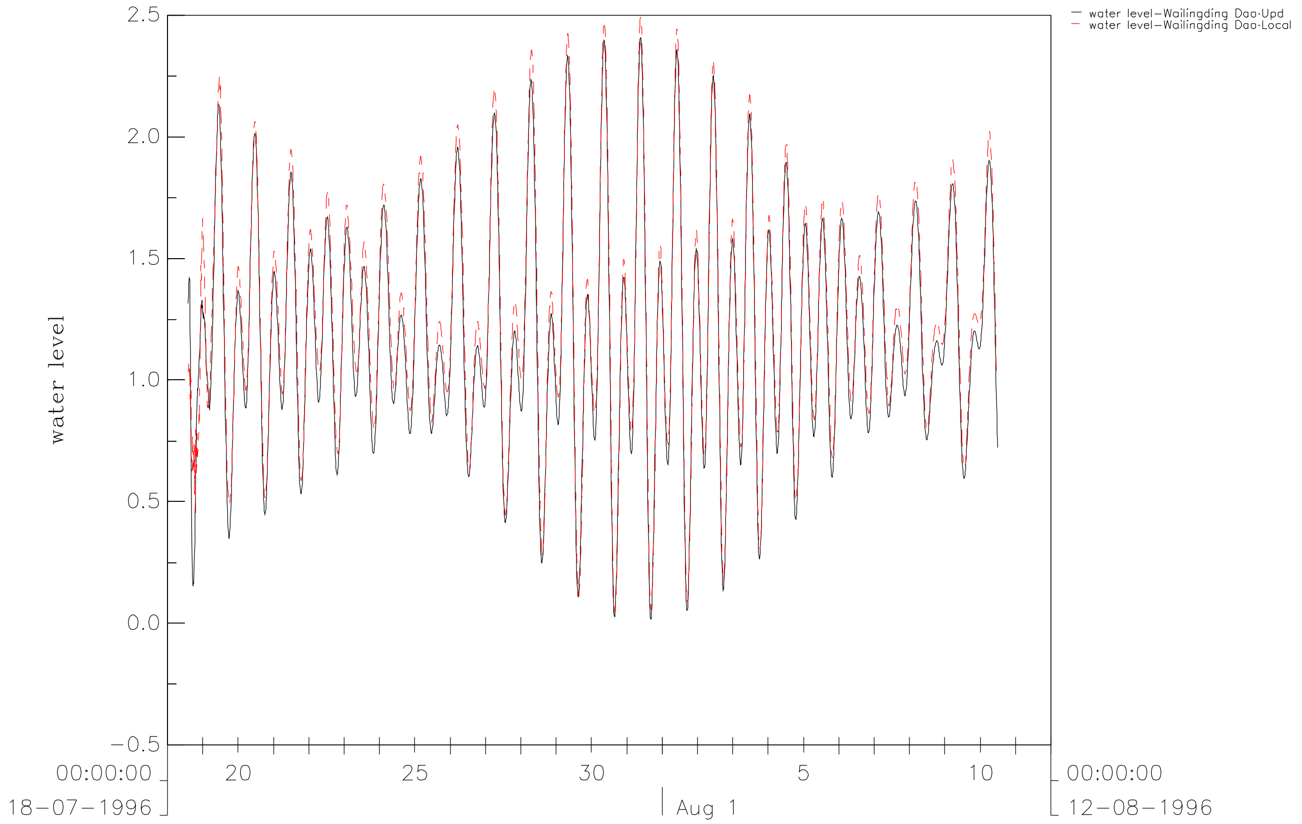
Water level comparison between Update Model and Local Refine Model at P E6 (upper) and A4–041 (lower).	Wet Season	
	Figure 5A-14	
DSD & ATKINS		



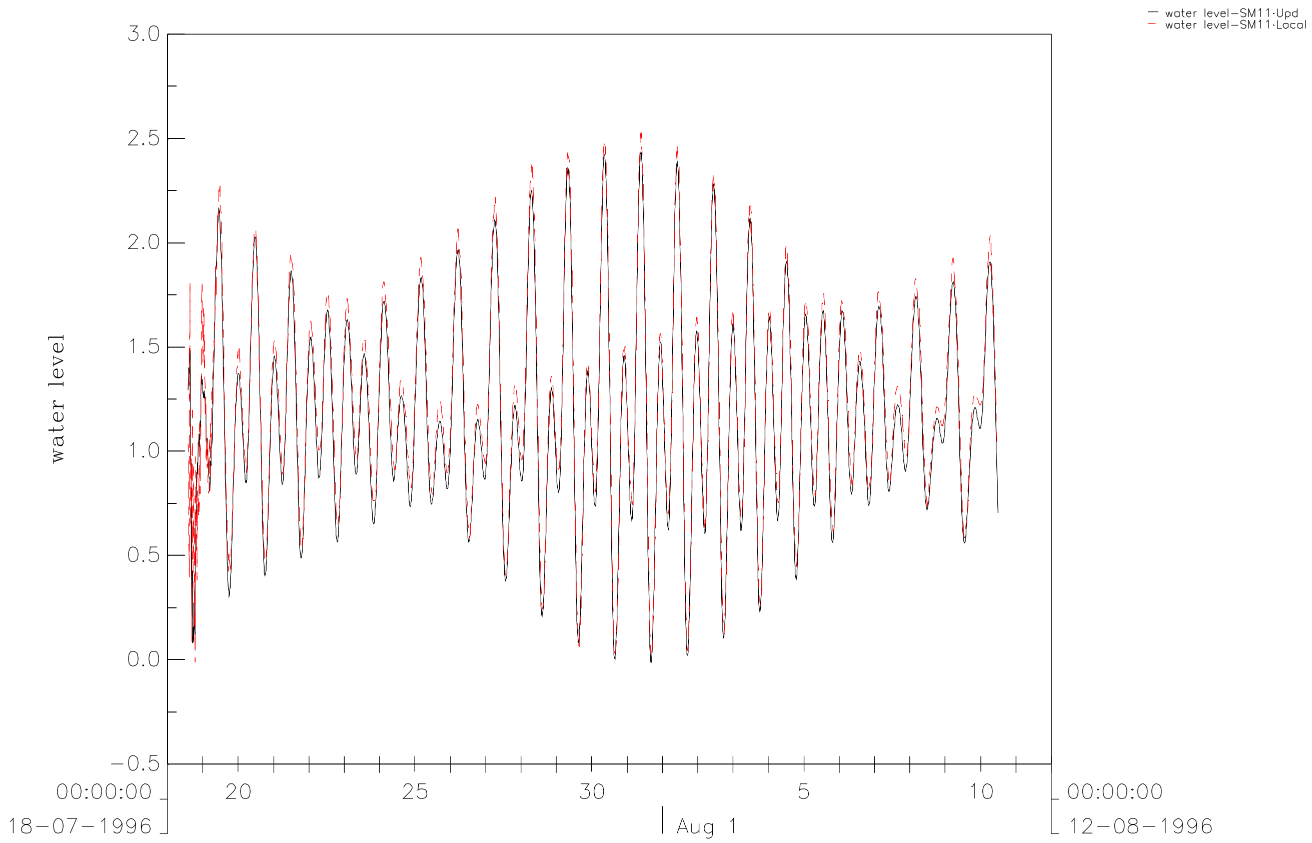


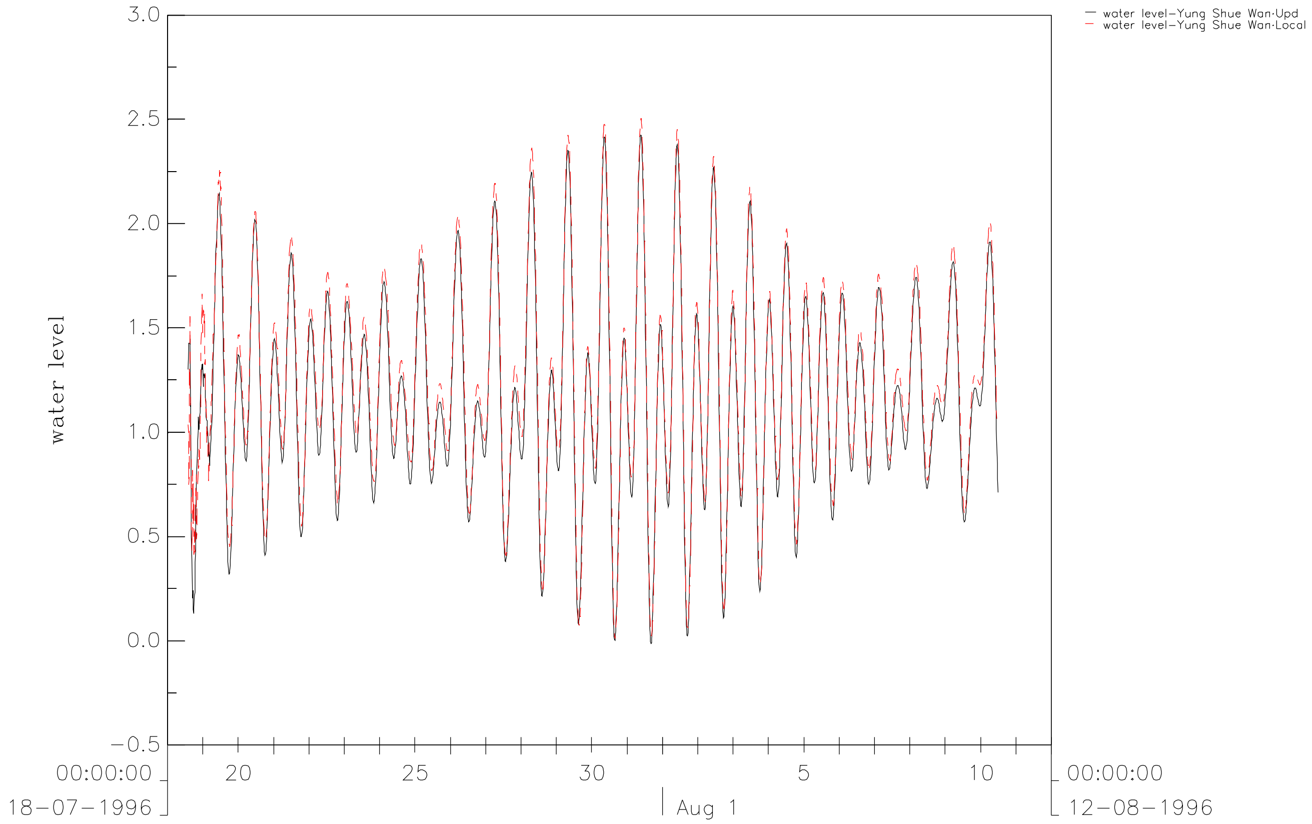
Water level comparison between Update Model and Local Refine Model at S ADCP T9 (upper) and ADCP C1–2 (lower).	Wet Season	
	Figure 5A-15	
DSD & ATKINS		



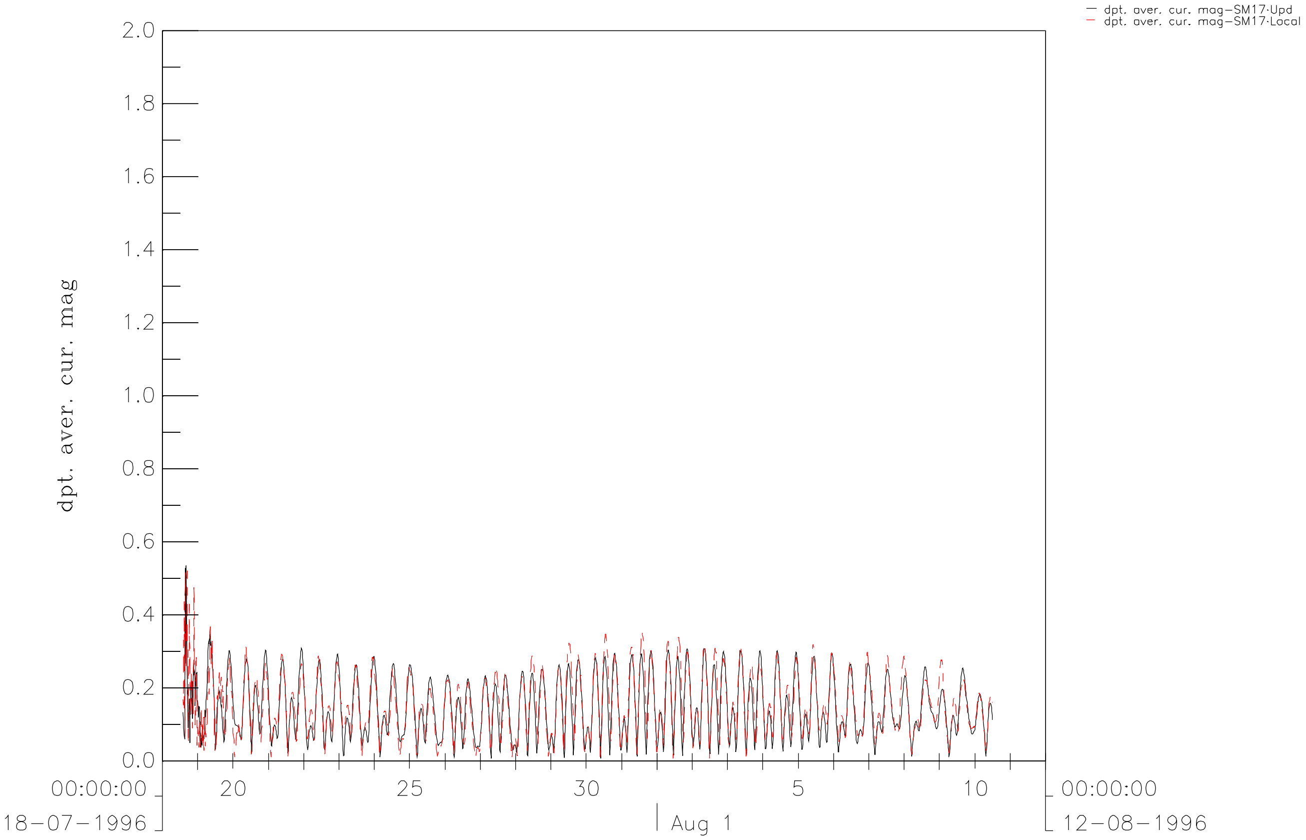


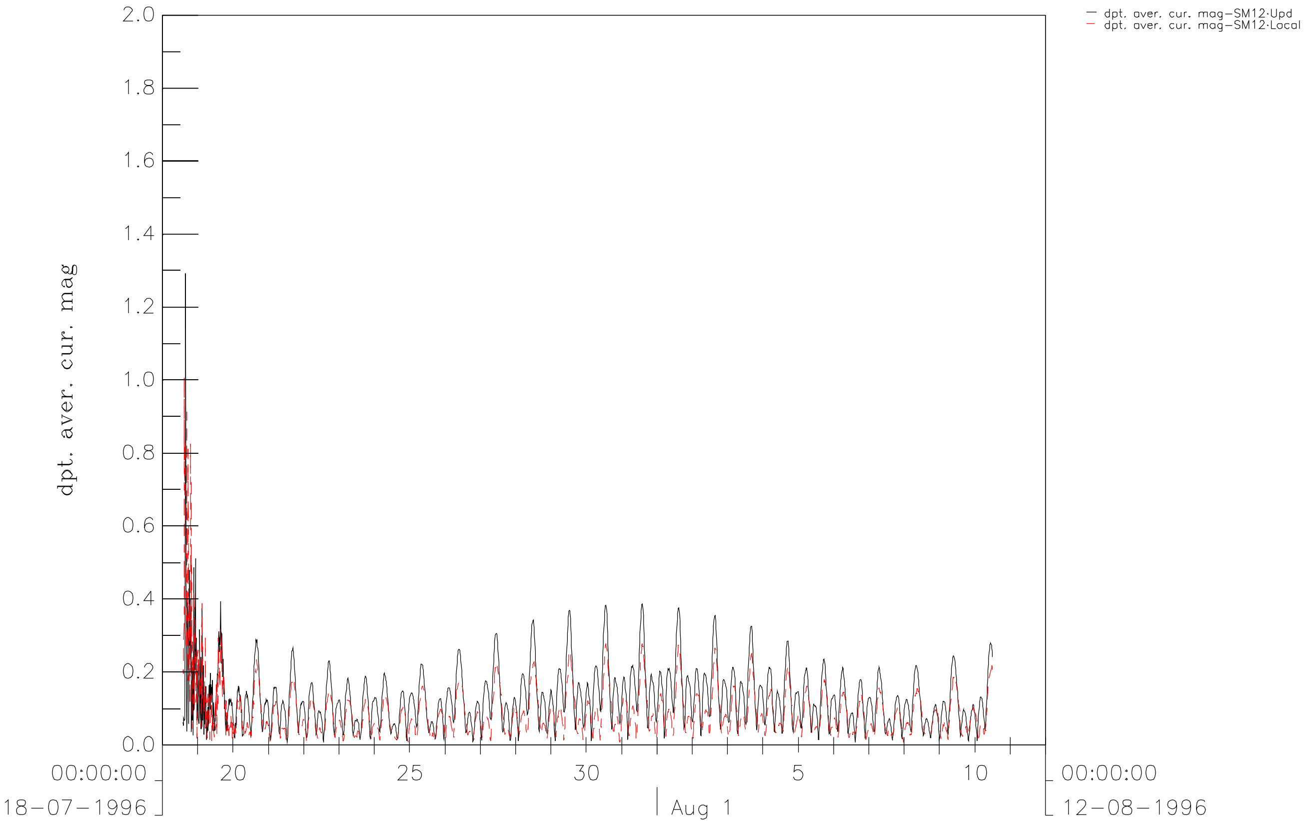
Water level comparison between Update Model and Local Refine Model at V Station 17 (upper) and Wailinding dao (lower).	Wet Season	
	Figure 5A-16	
DSD & ATKINS		





Water level comparison between Update Model and Local Refine Model at SM11(upper) and Yung Shue WAN (lower).	Wet Season	
	Figure 5A-17	
DSD & ATKINS		



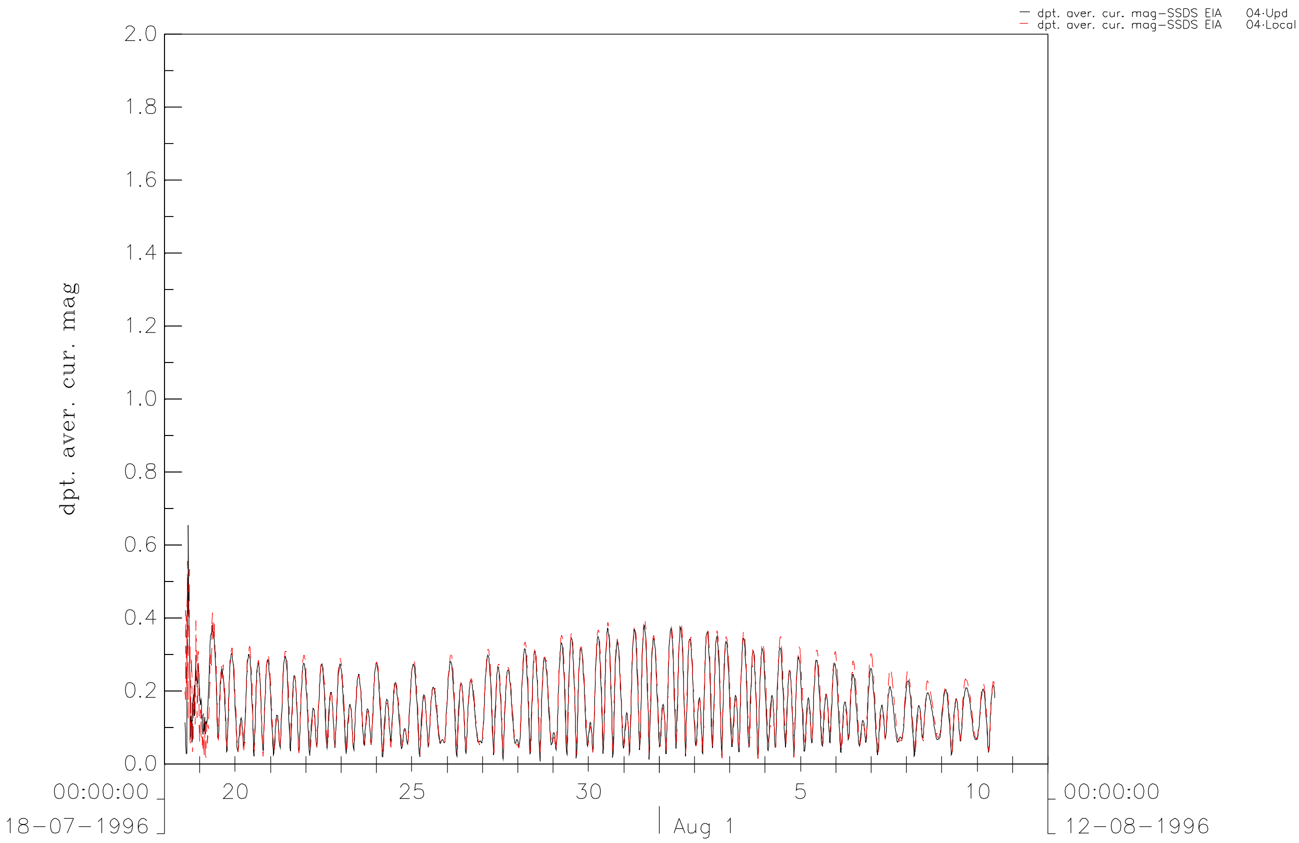


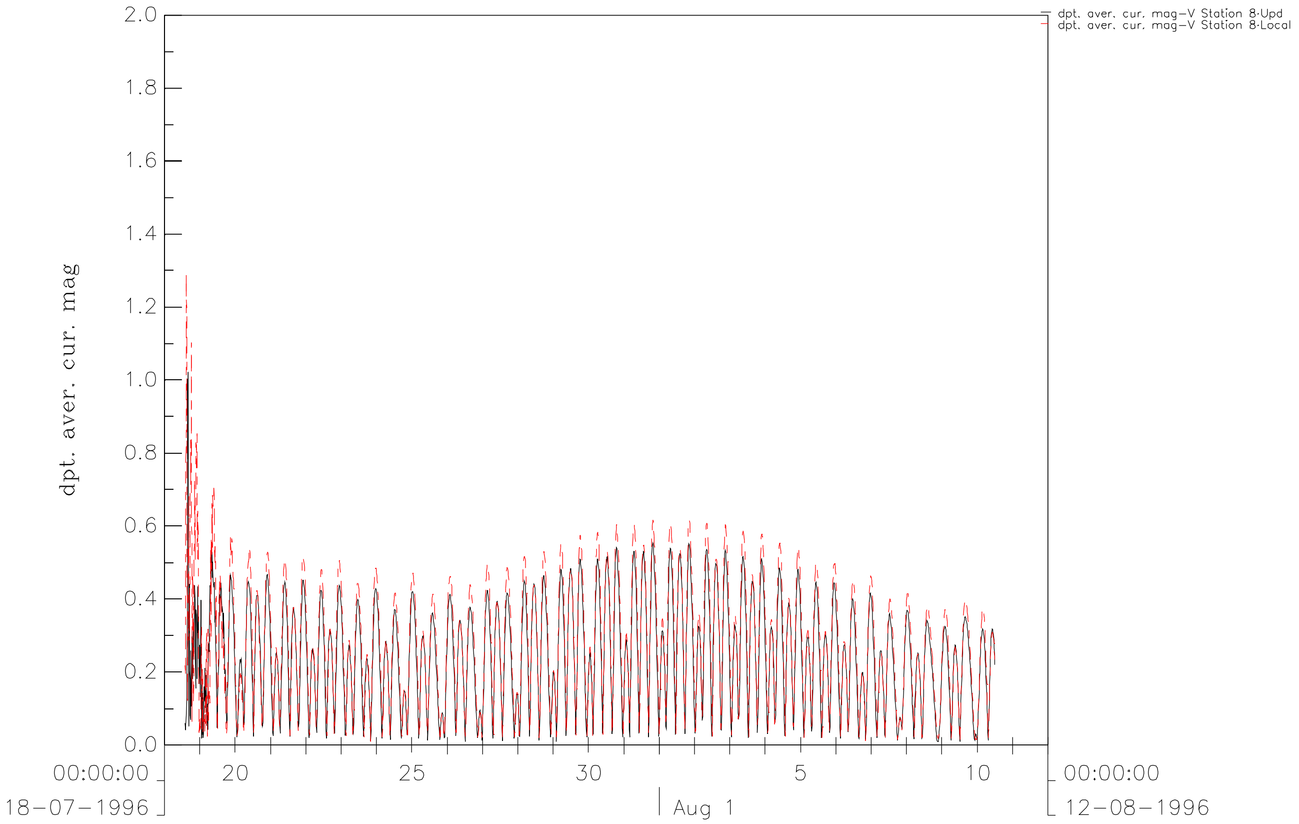
Depth averaged velocity magnitute comparison between Update Model and Local Refine Model at SM17 (upper) and SM12 (lower).

Dry Season

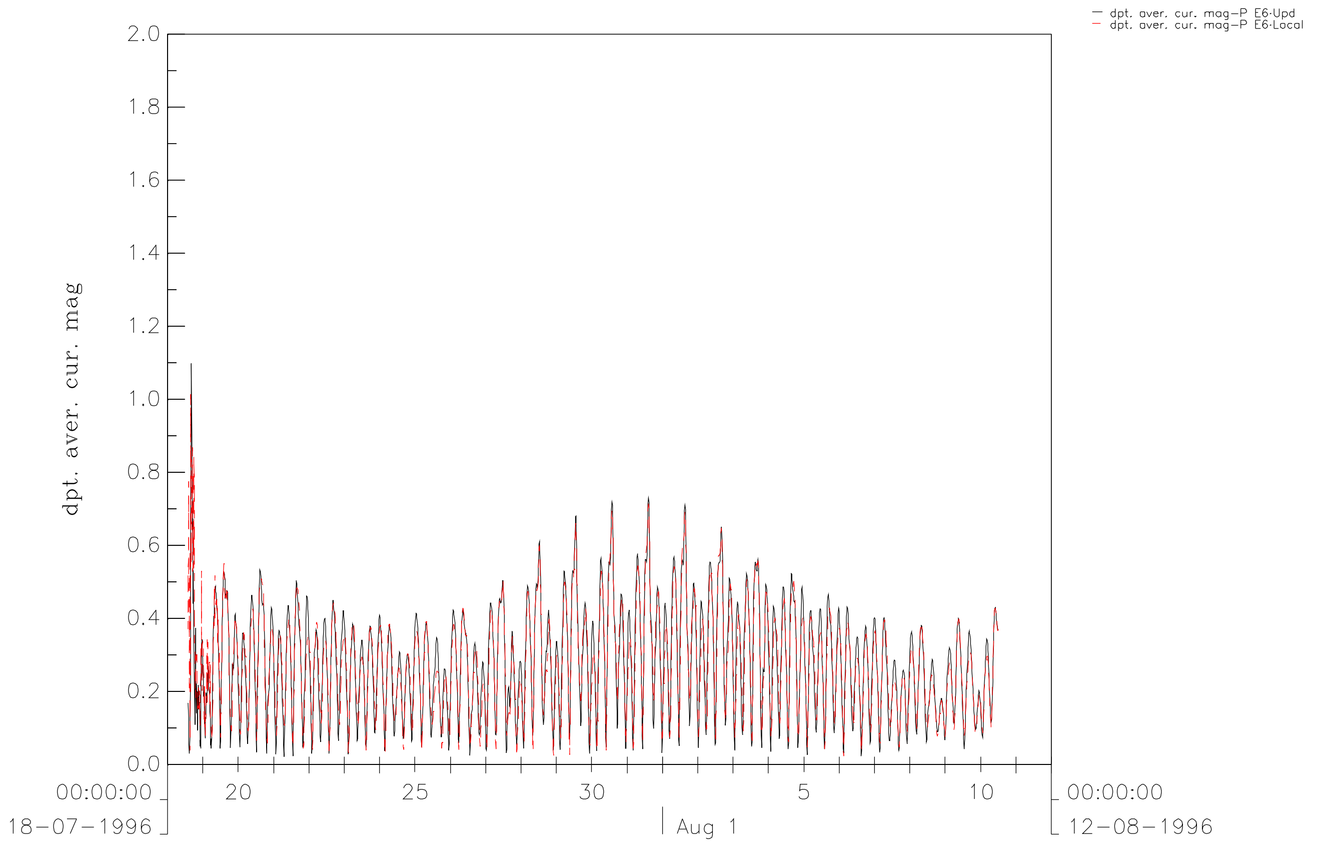
Figure 5A-18

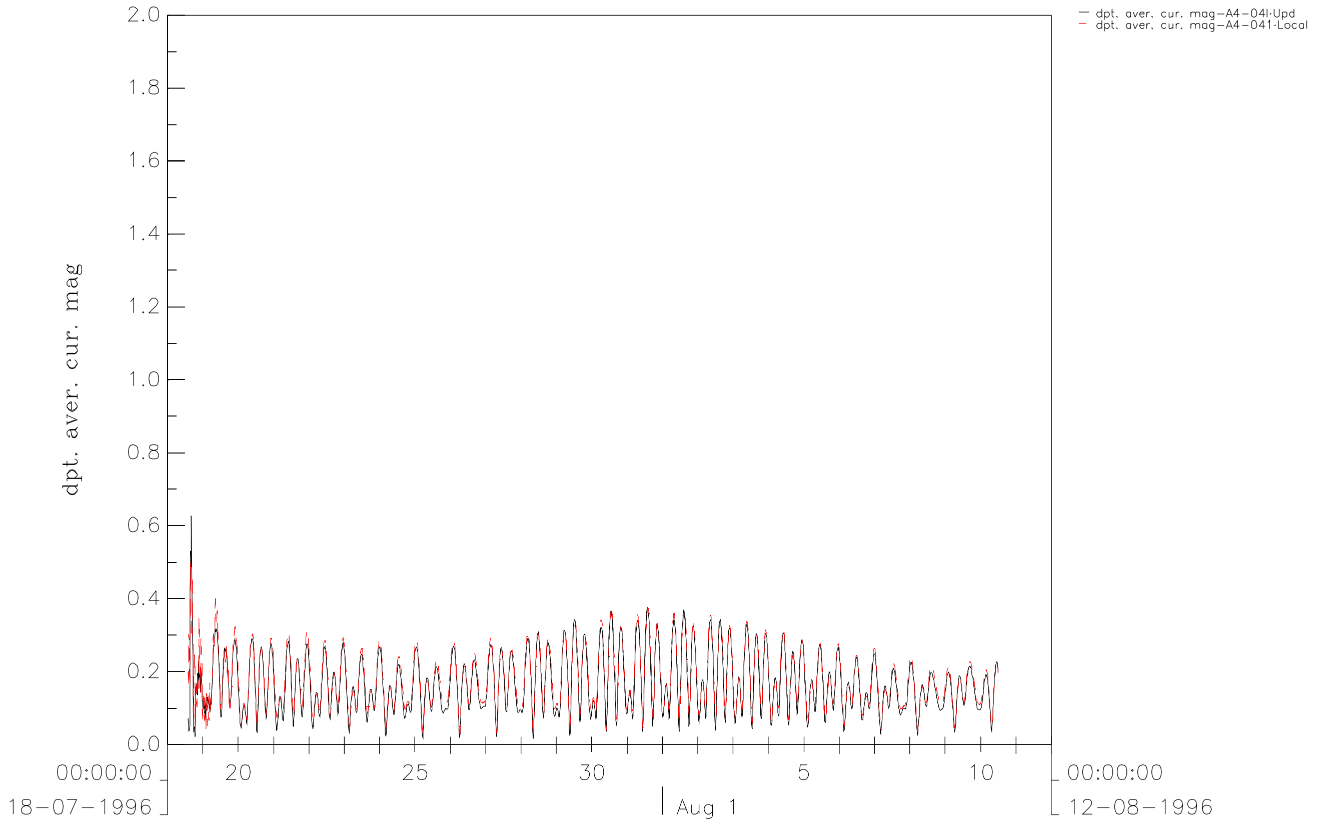
DSD & ATKINS



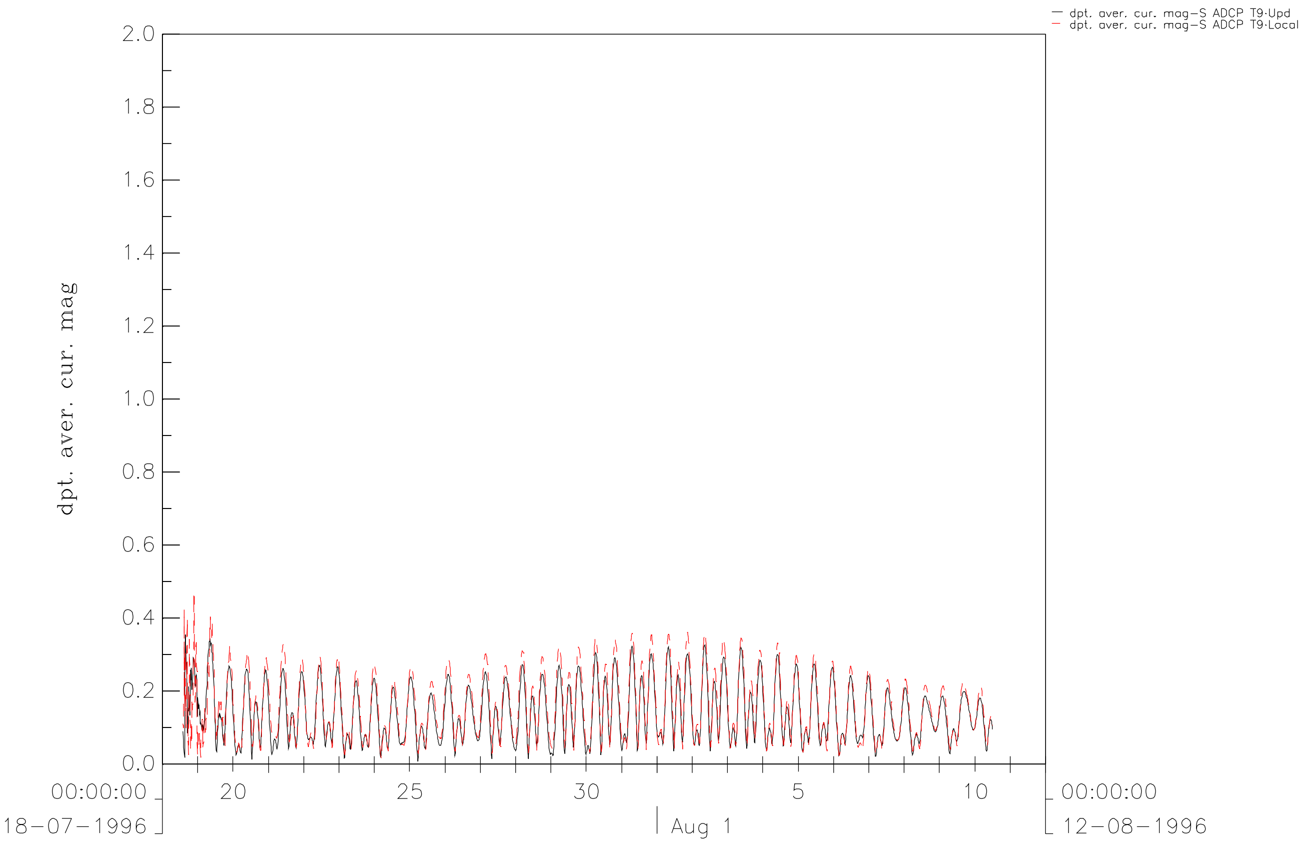


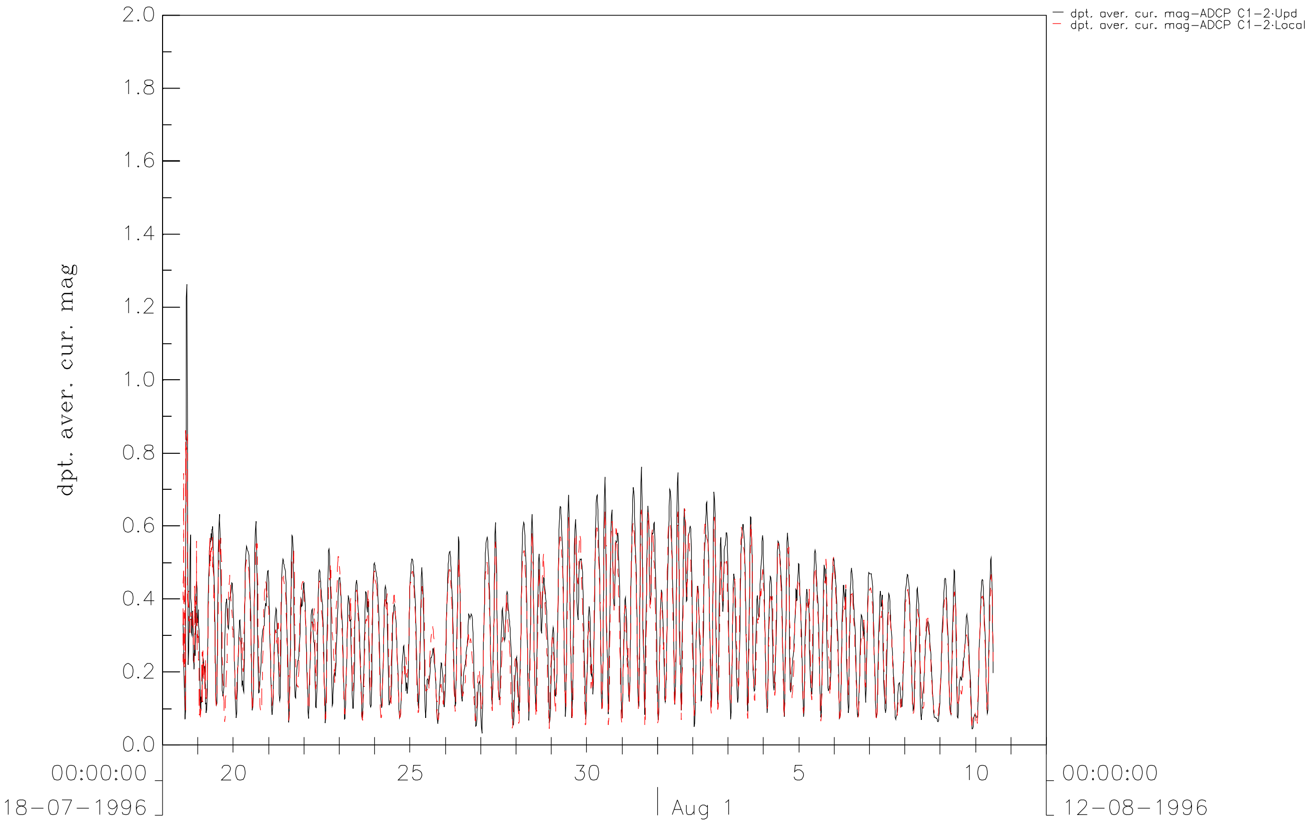
Depth averaged velocity magnitute comparison between Update Model and Local Refine Model at SSDS EIA 04 (upper) and V Station 8 (lower).	Dry Season	
	Figure 5A-19	
DSD & ATKINS		



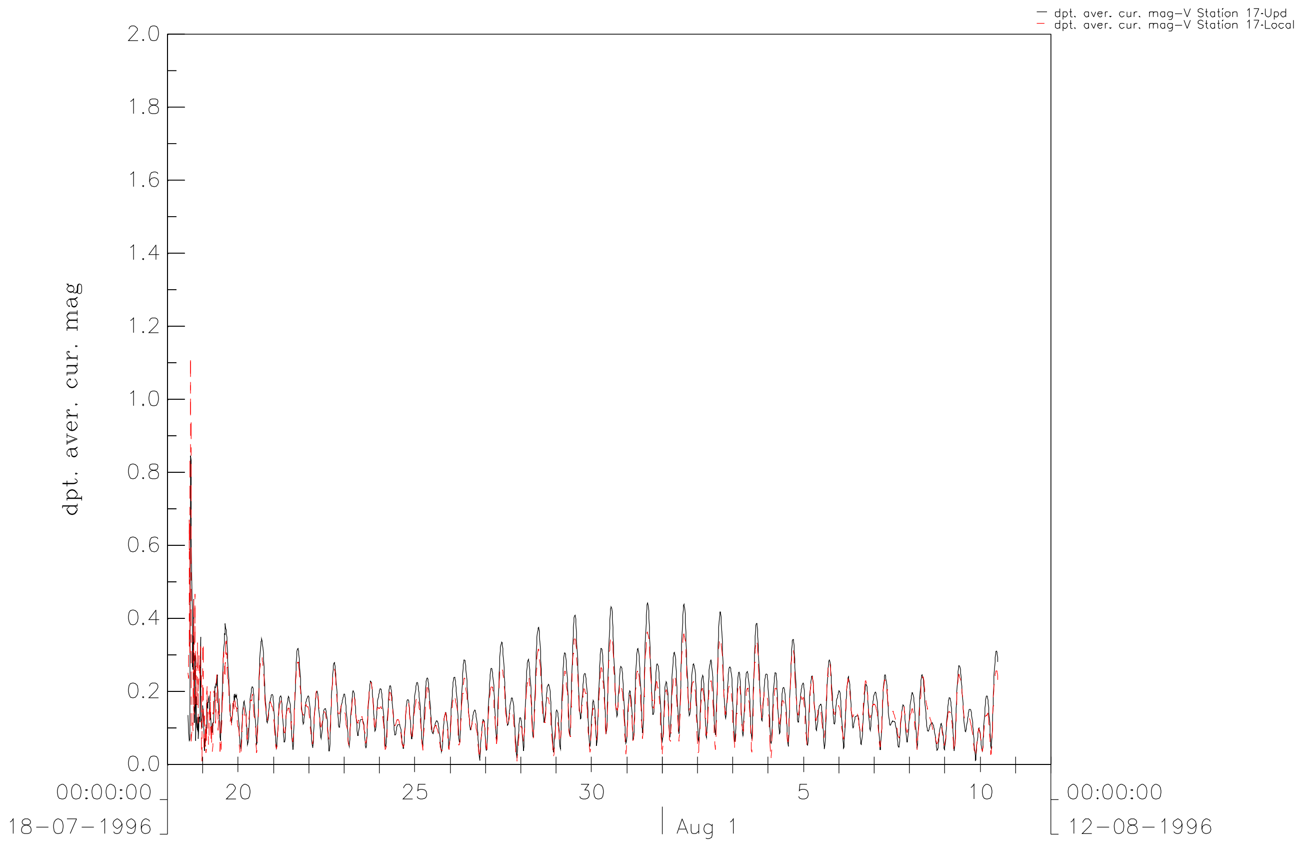


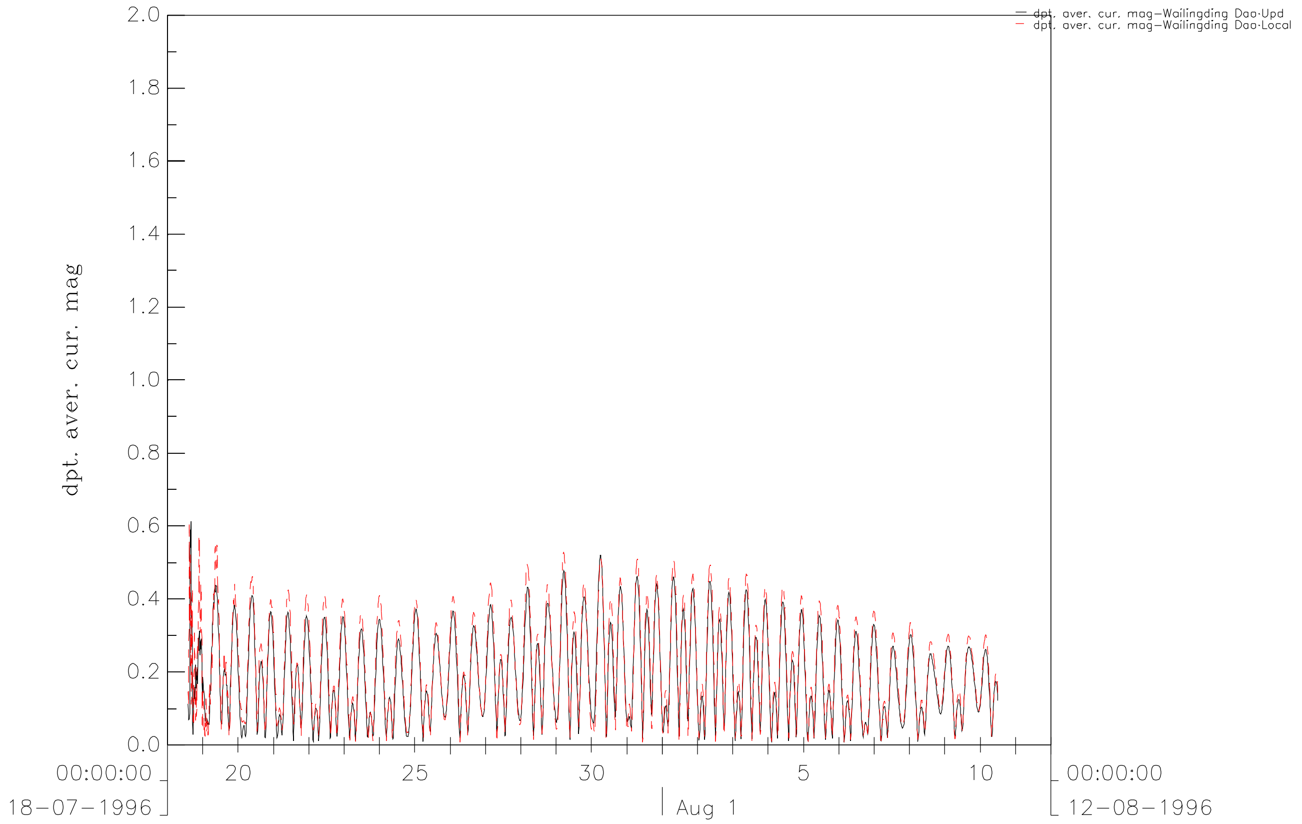
Depth averaged velocity magnitute comparison between Update Model and Local Refine Modelat P E6 (upper) and A4–041 (lower).	Dry Season	
	Figure 5A-20	
DSD & ATKINS		



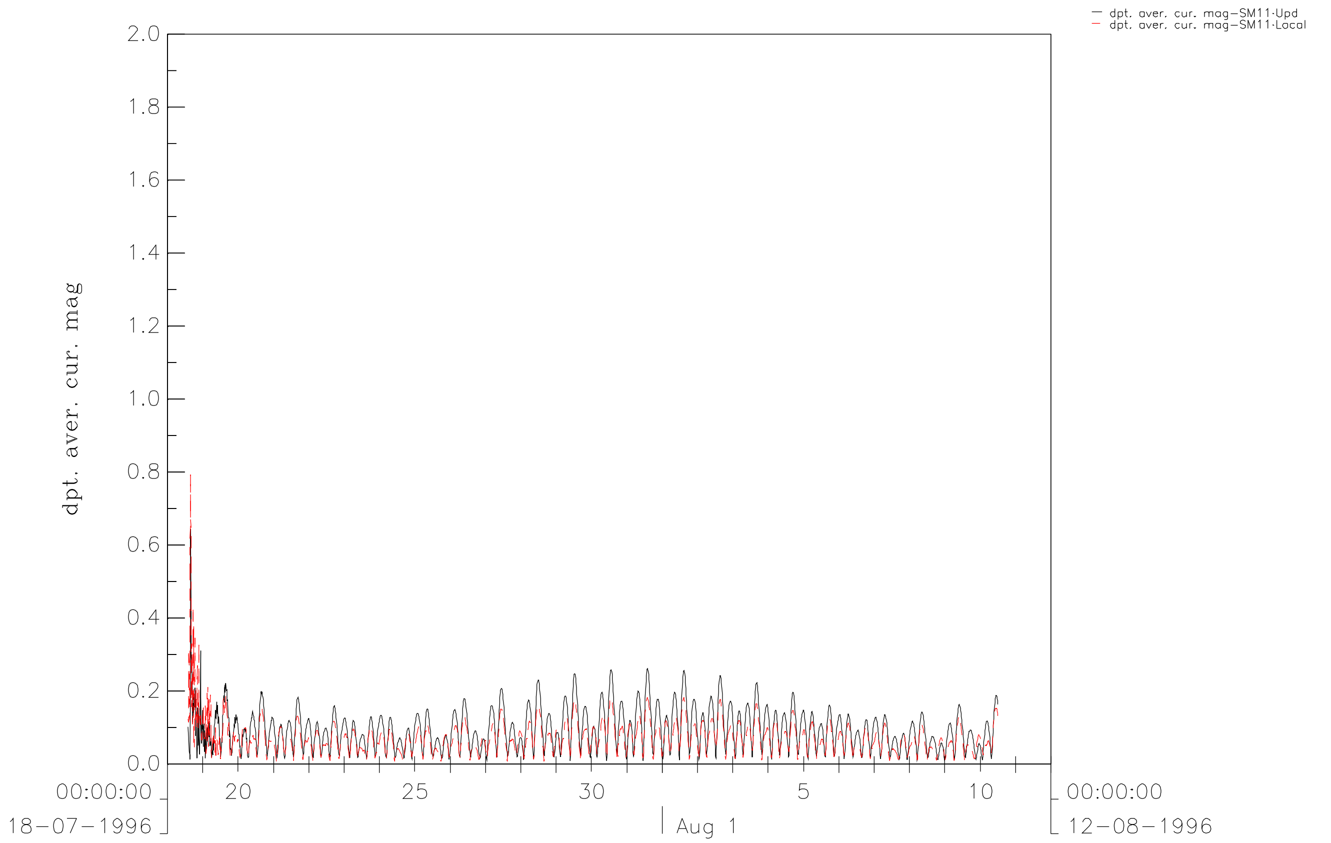


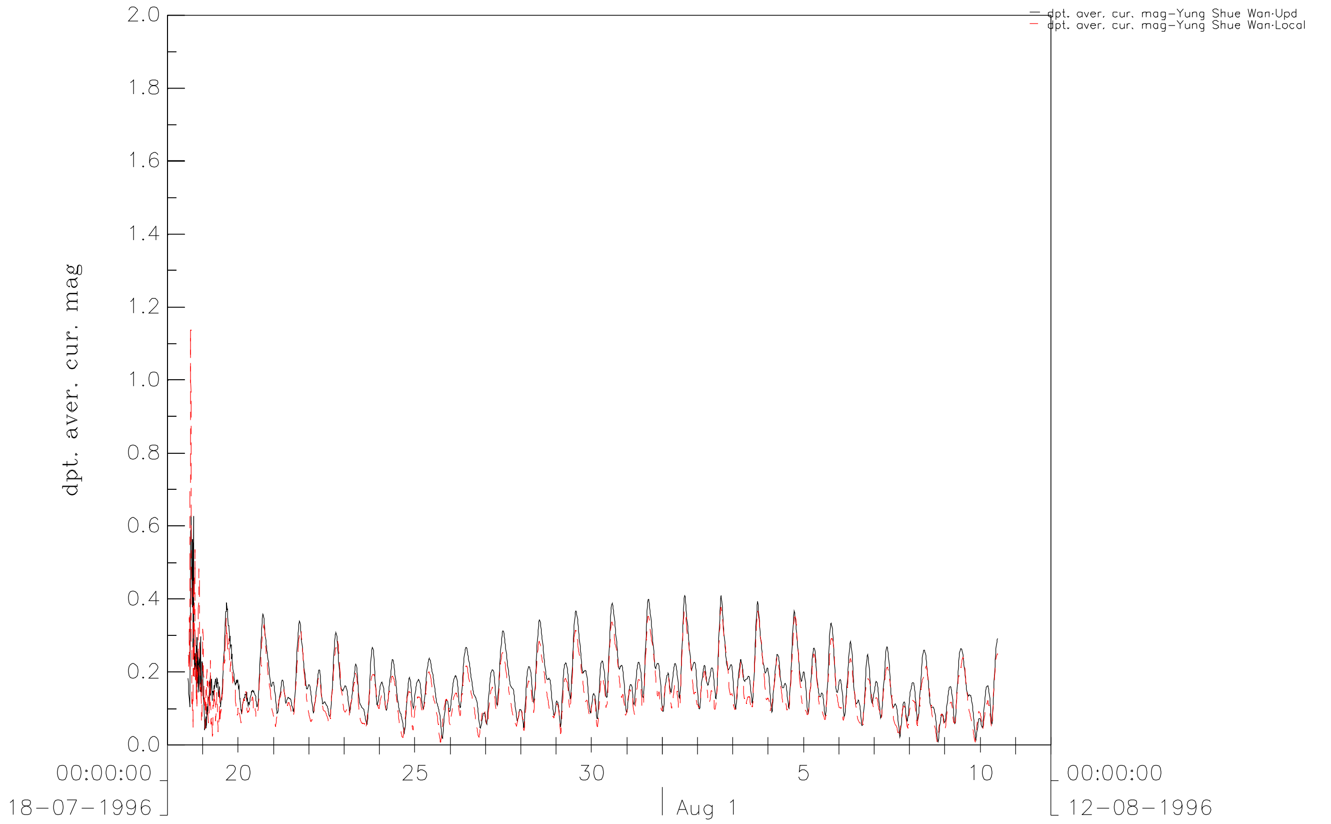
Depth averaged velocity magnitute comparison between Update Model and Local Refine Model at S ADCP T9 (upper) and ADCP C1-2 (lower).	Dry Season	
	Figure 5A-21	
DSD & ATKINS		



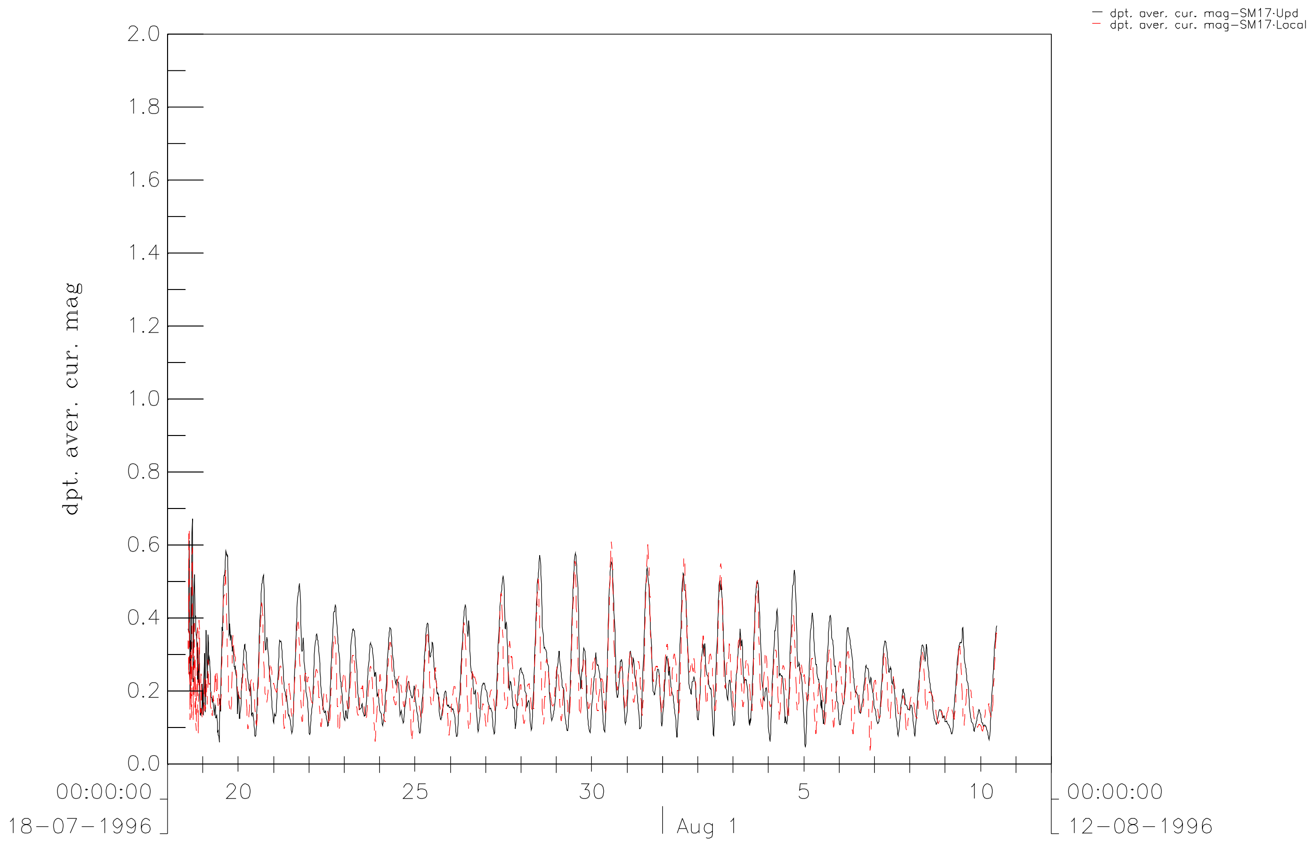


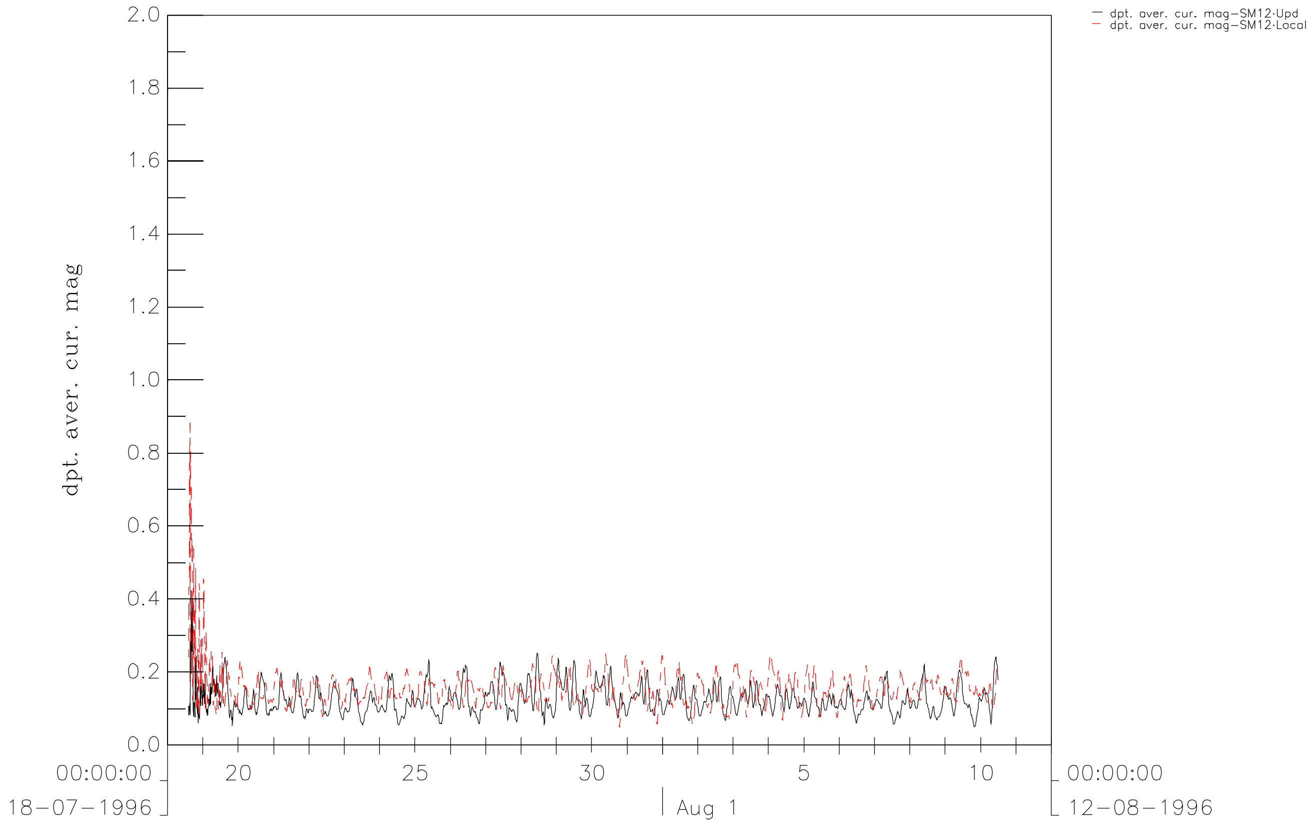
Depth averaged velocity magnitute comparison between Update Model and Local Refine Modelat at V Station 17 (upper) and Wailinding dao (lower).	Dry Season	
	Figure 5A-22	
DSD & ATKINS		



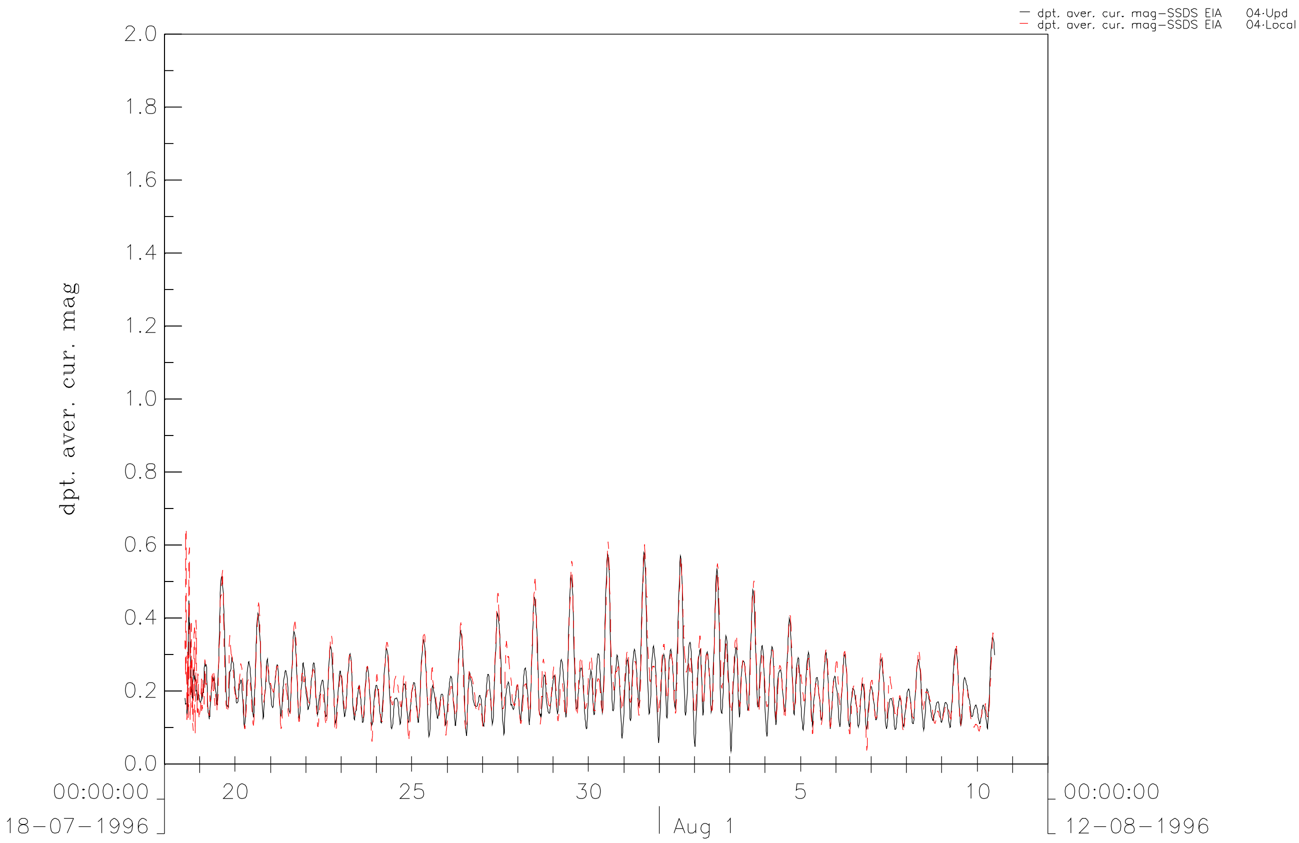


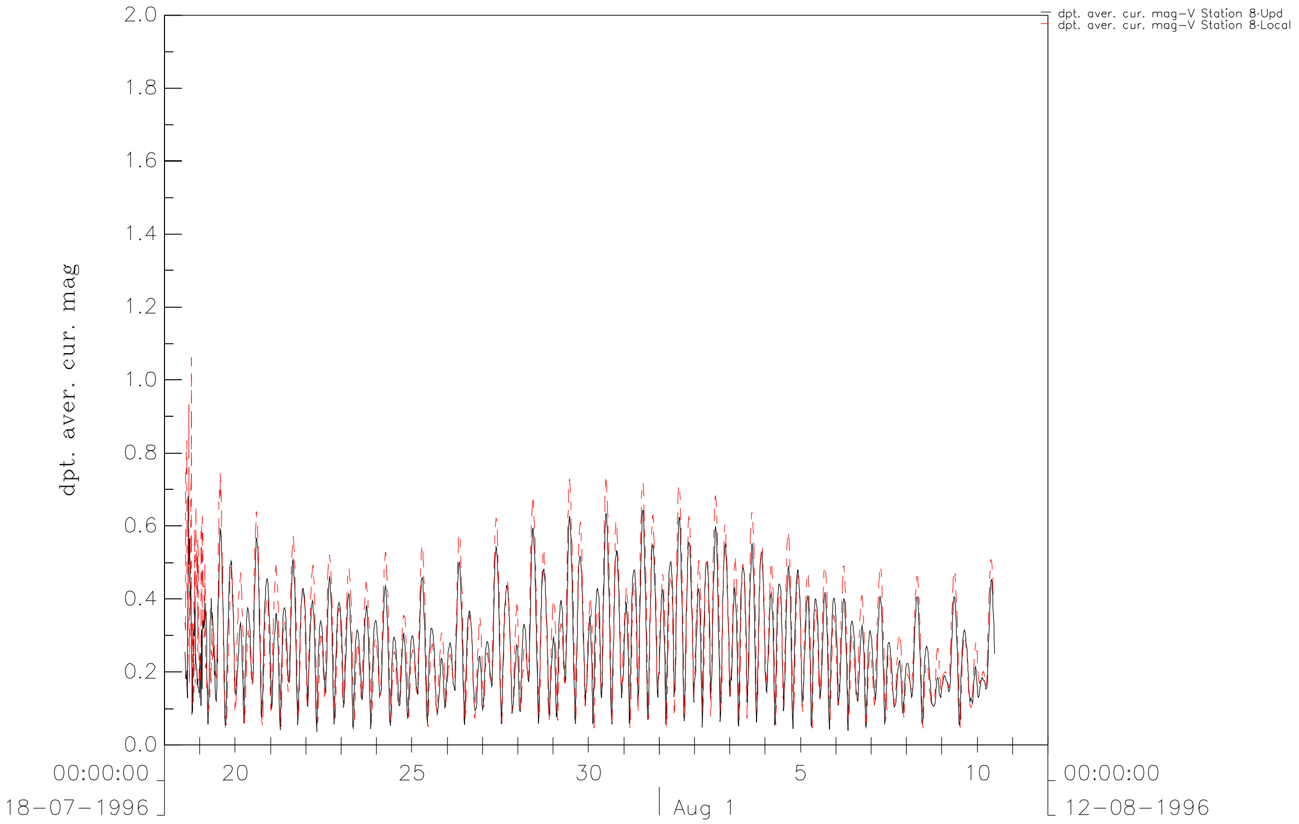
Depth averaged velocity magnitute comparison between Update Model and Local Refine Model at SM11(upper) and Yung Shue WAN (lower).	Dry Season	
	Figure 5A-23	
DSD & ATKINS		



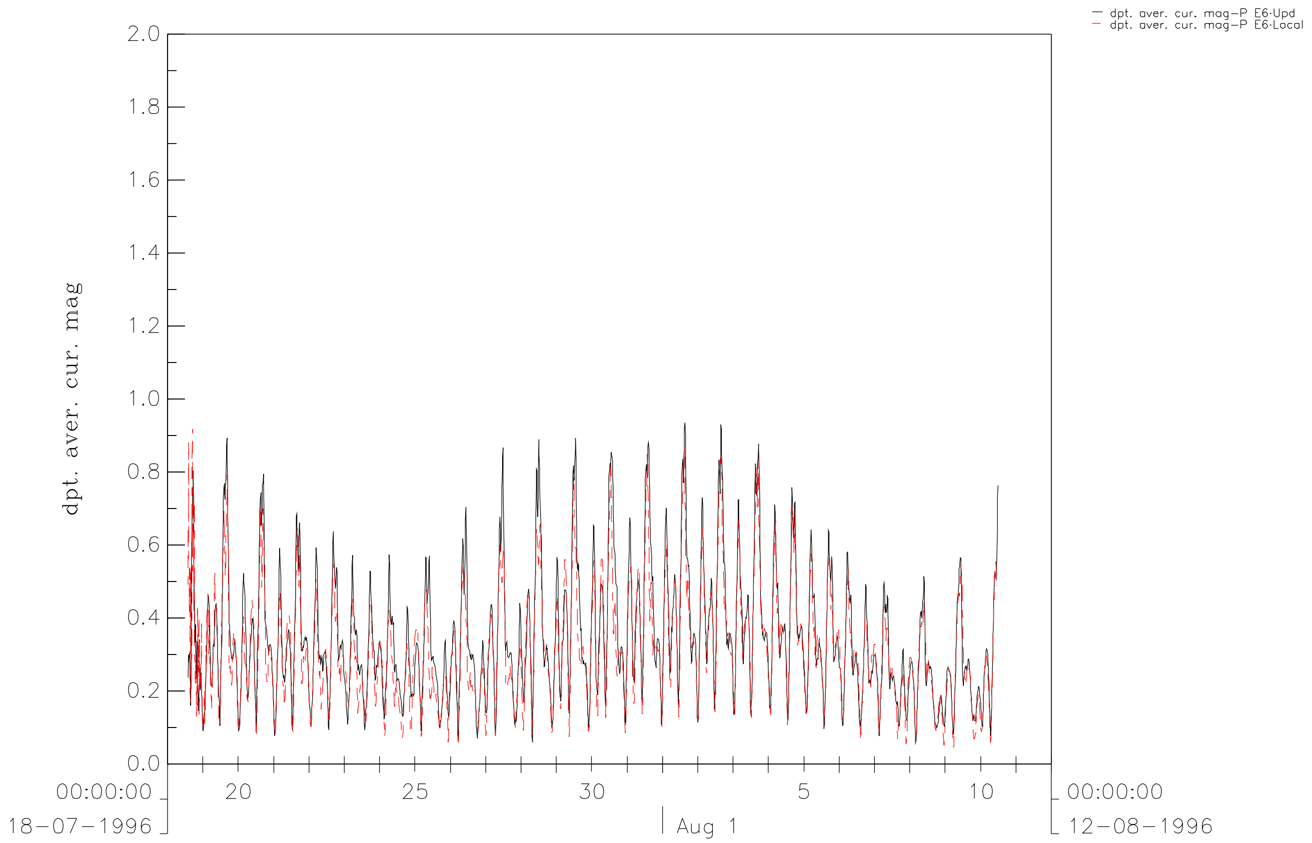


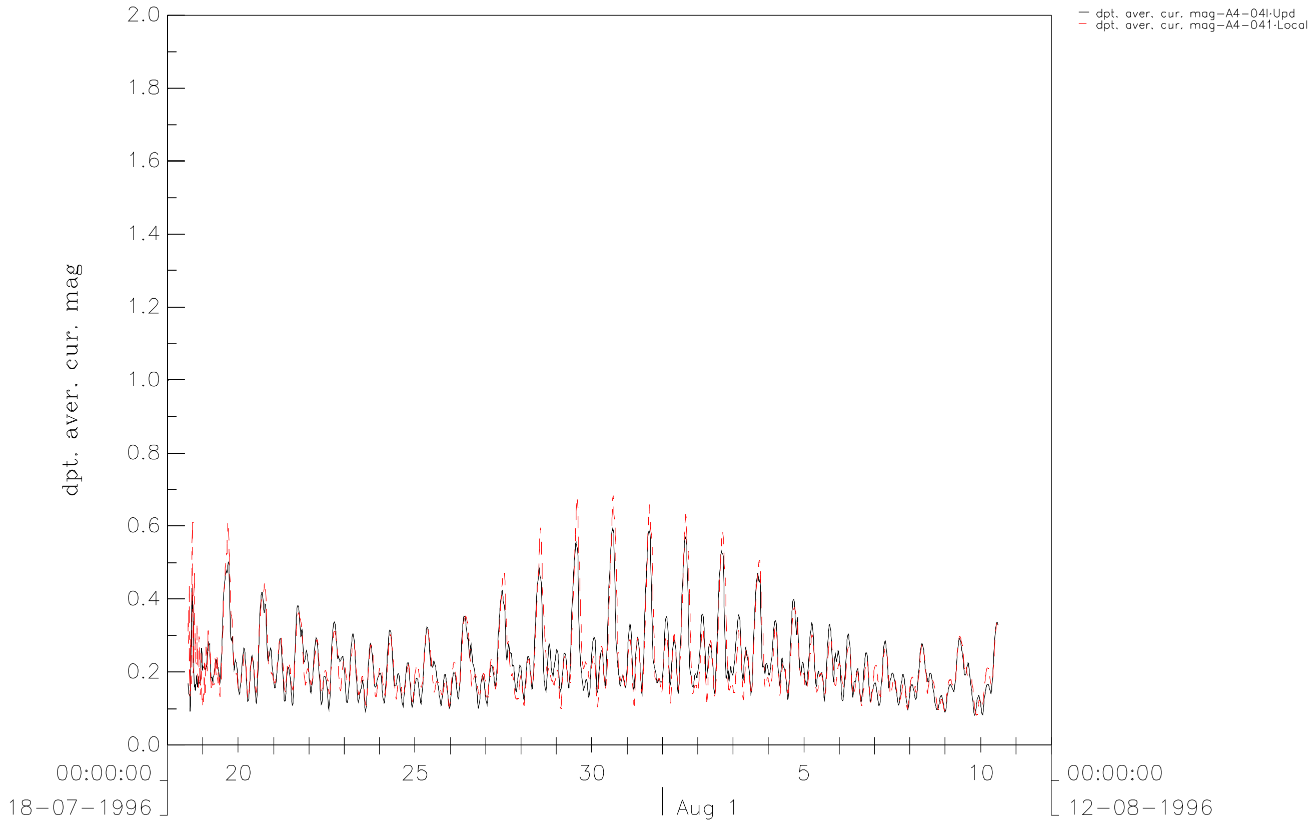
Depth averaged velocity magnitute comparison between Update Model and Local Refine Model at SM17 (upper) and SM12 (lower).	Wet Season	
	Figure 5A-24	
DSD & ATKINS		



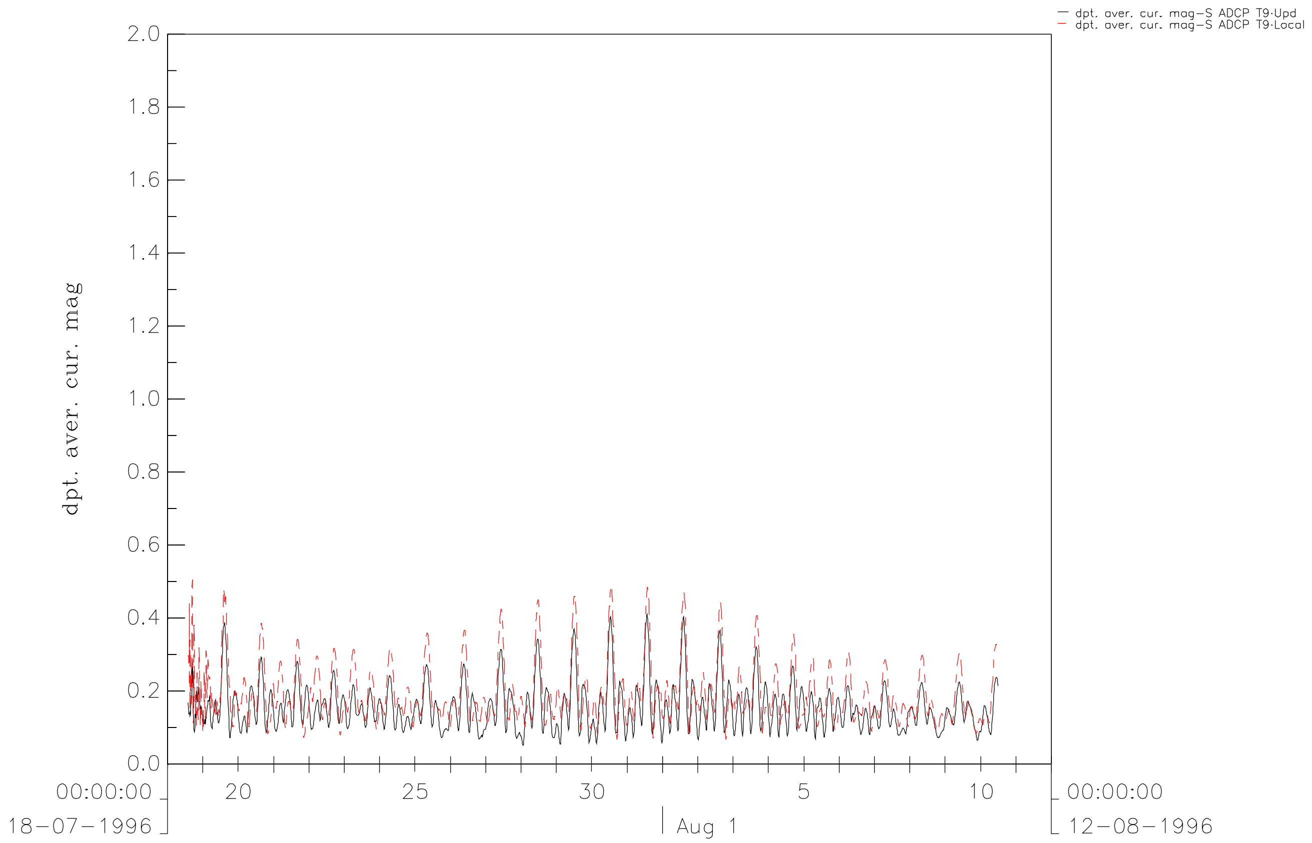


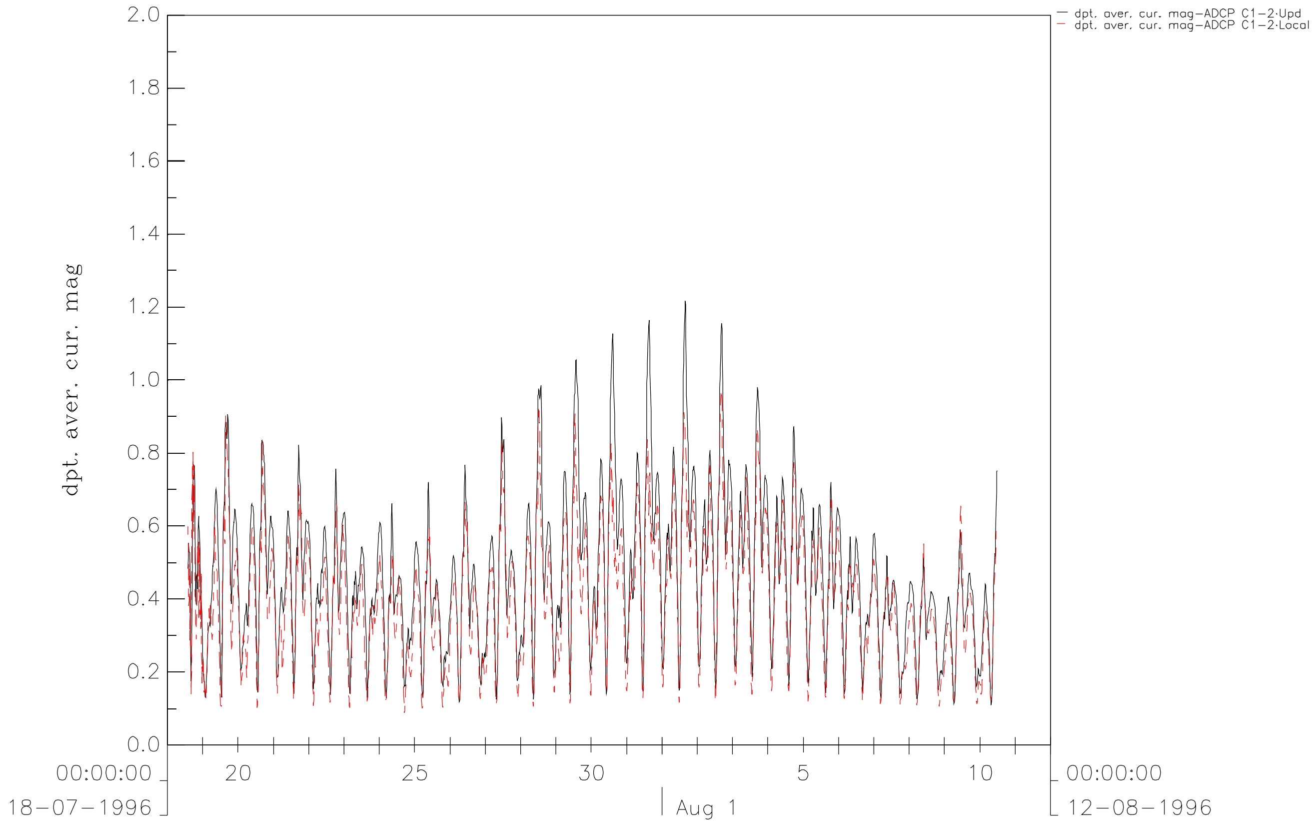
Depth averaged velocity magnitute comparison between Update Model and Local Refine Model at SSDS EIA 04 (upper) and V Station 8 (lower).	Wet Season	
	Figure 5A-25	
DSD & ATKINS		



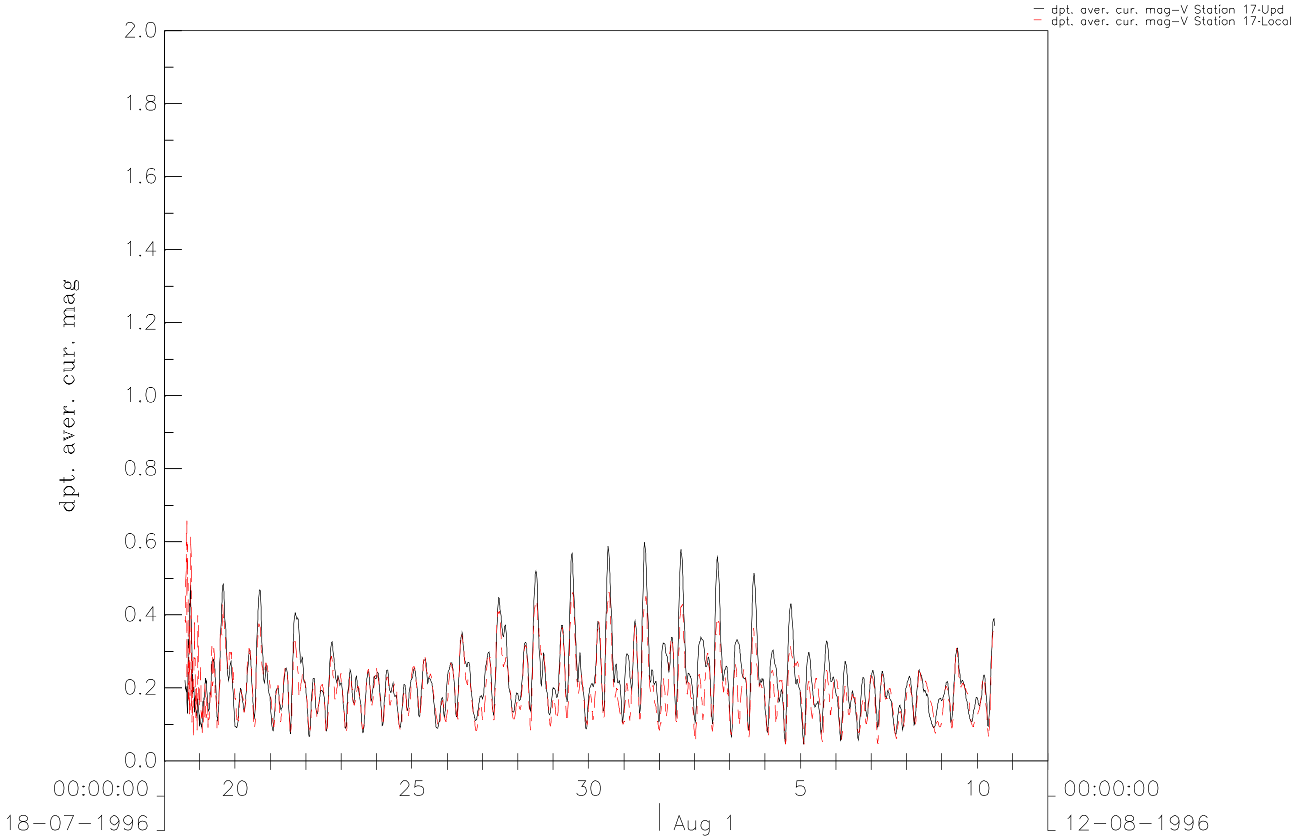


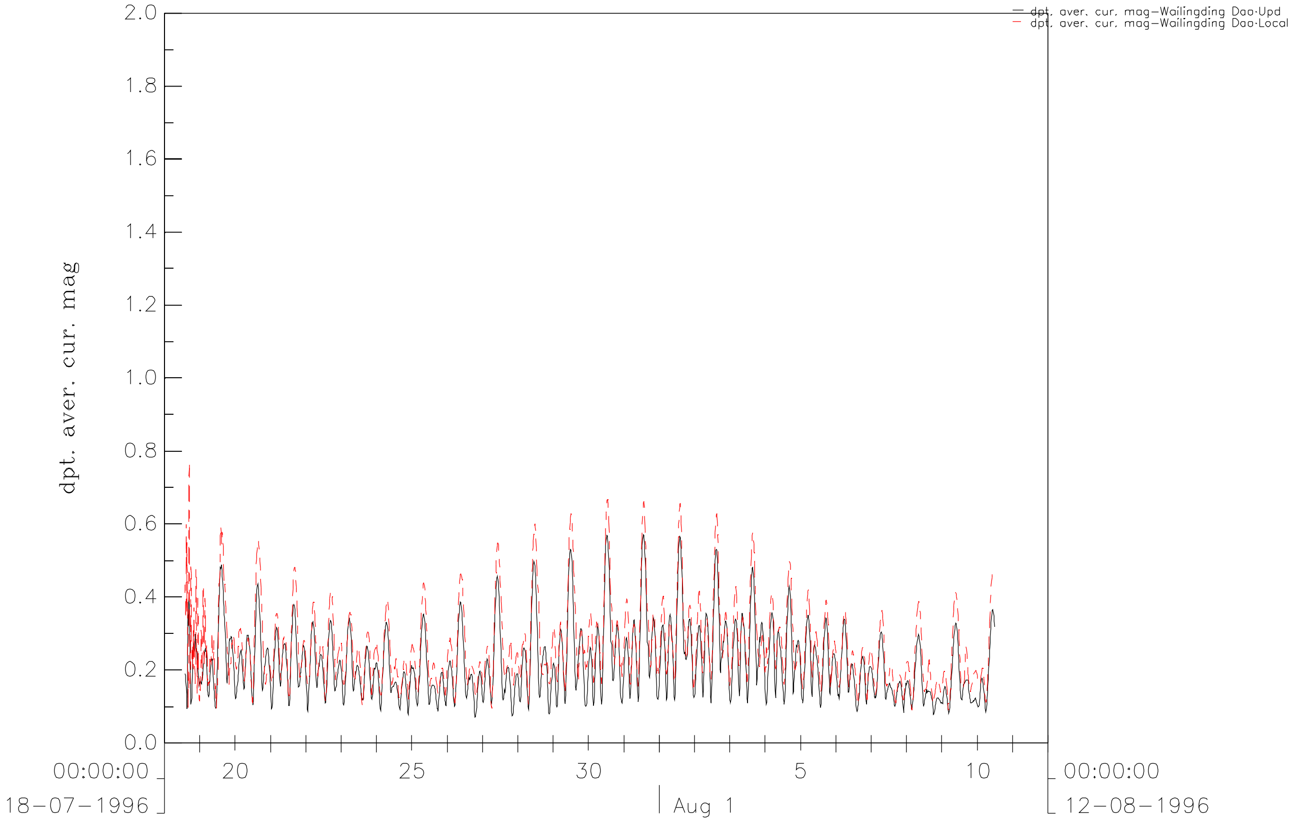
Depth averaged velocity magnitute comparison between Update Model and Local Refine Modelat P E6 (upper) and A4–041 (lower).	Wet Season	
	Figure 5A-26	
DSD & ATKINS		



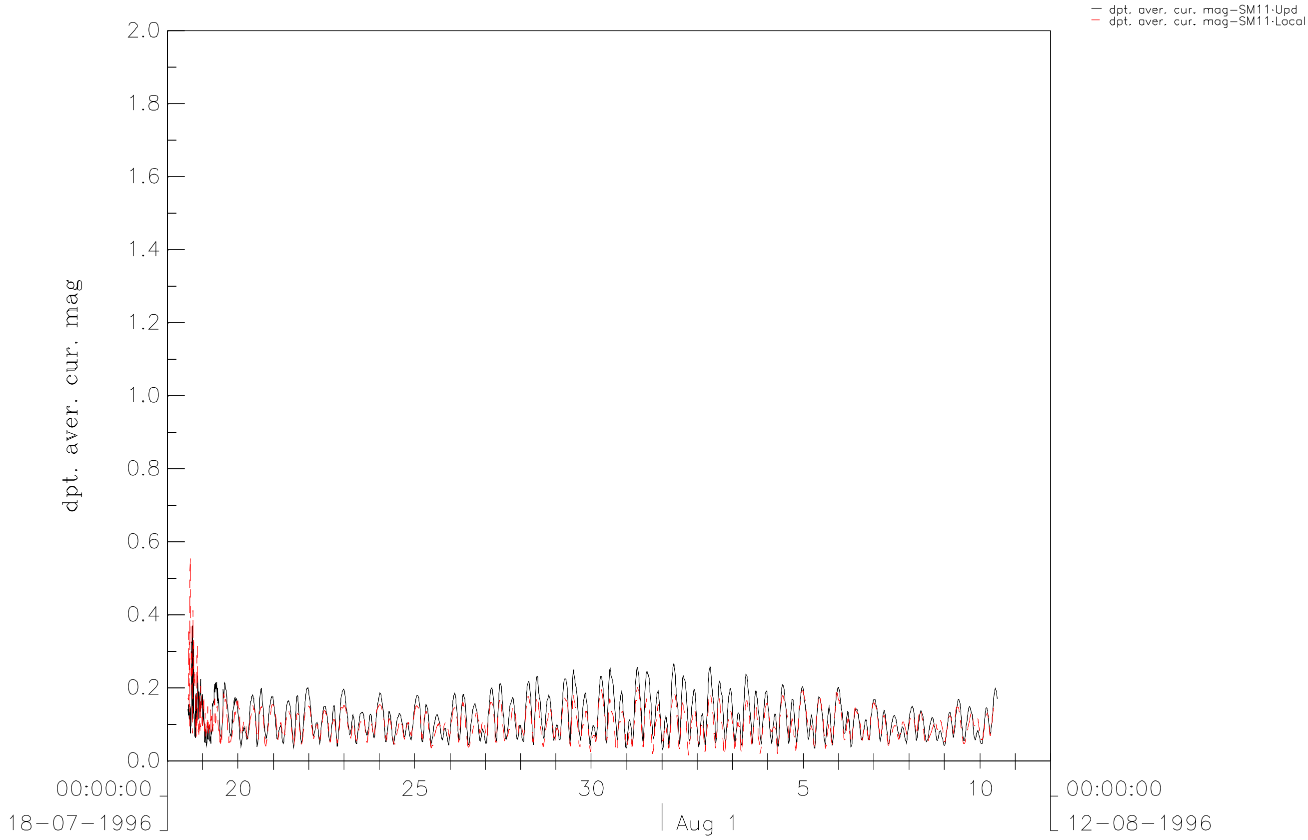


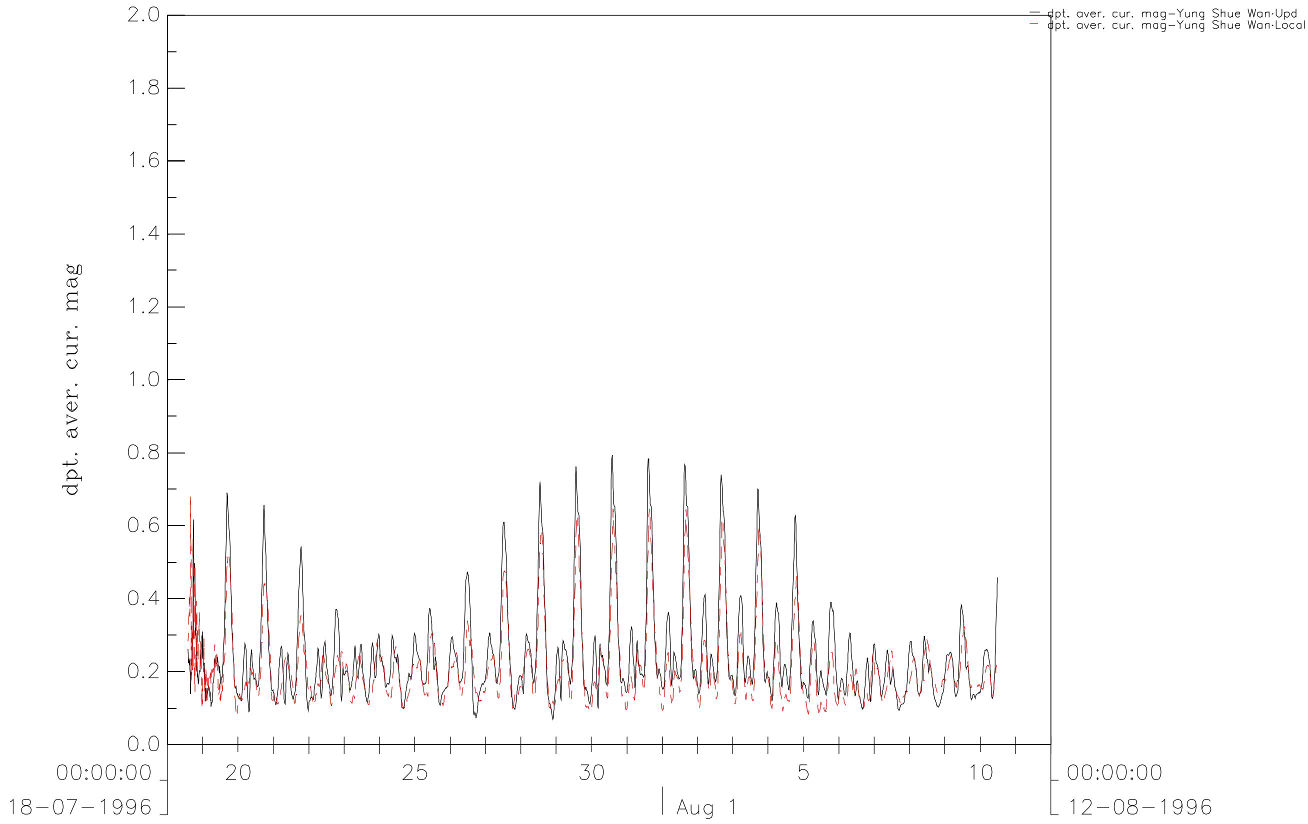
Depth averaged velocity magnitute comparison between Update Model and Local Refine Model at S ADCP T9 (upper) and ADCP C1-2 (lower).	Wet Season
	Figure 5A-27
DSD & ATKINS	



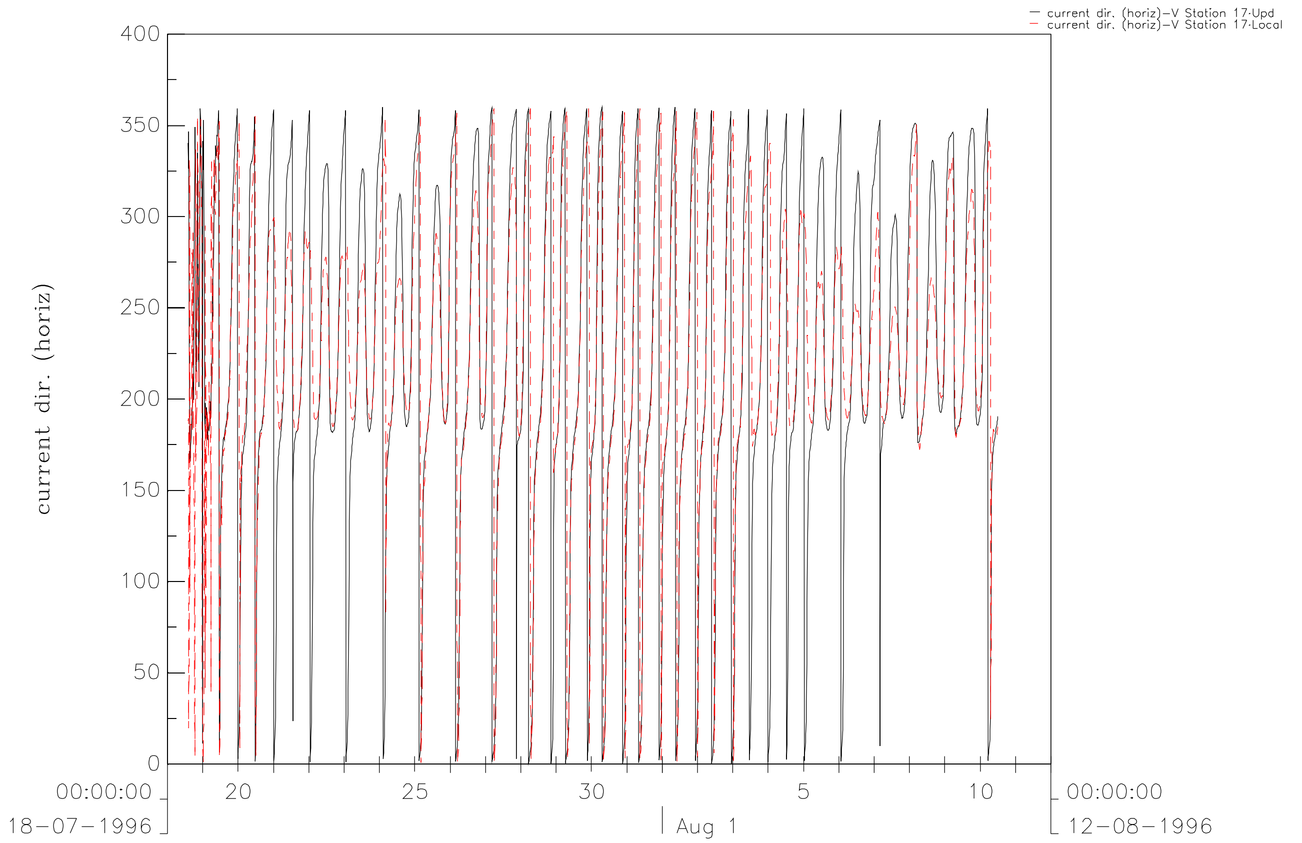


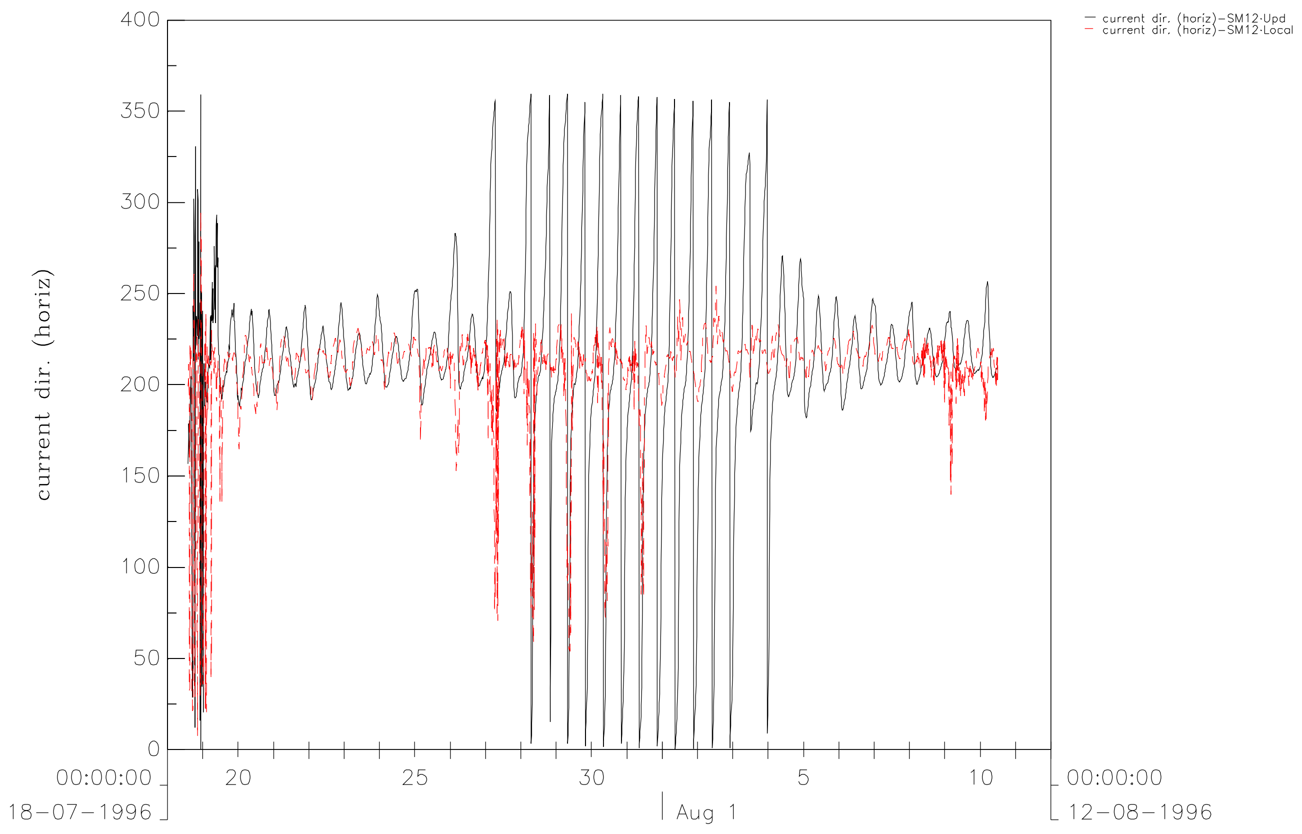
Depth averaged velocity magnitute comparison between Update Model and Local Refine Modelat at V Station 17 (upper) and Wailinding dao (lower).	Wet Season
	Figure 5A-28
DSD & ATKINS	



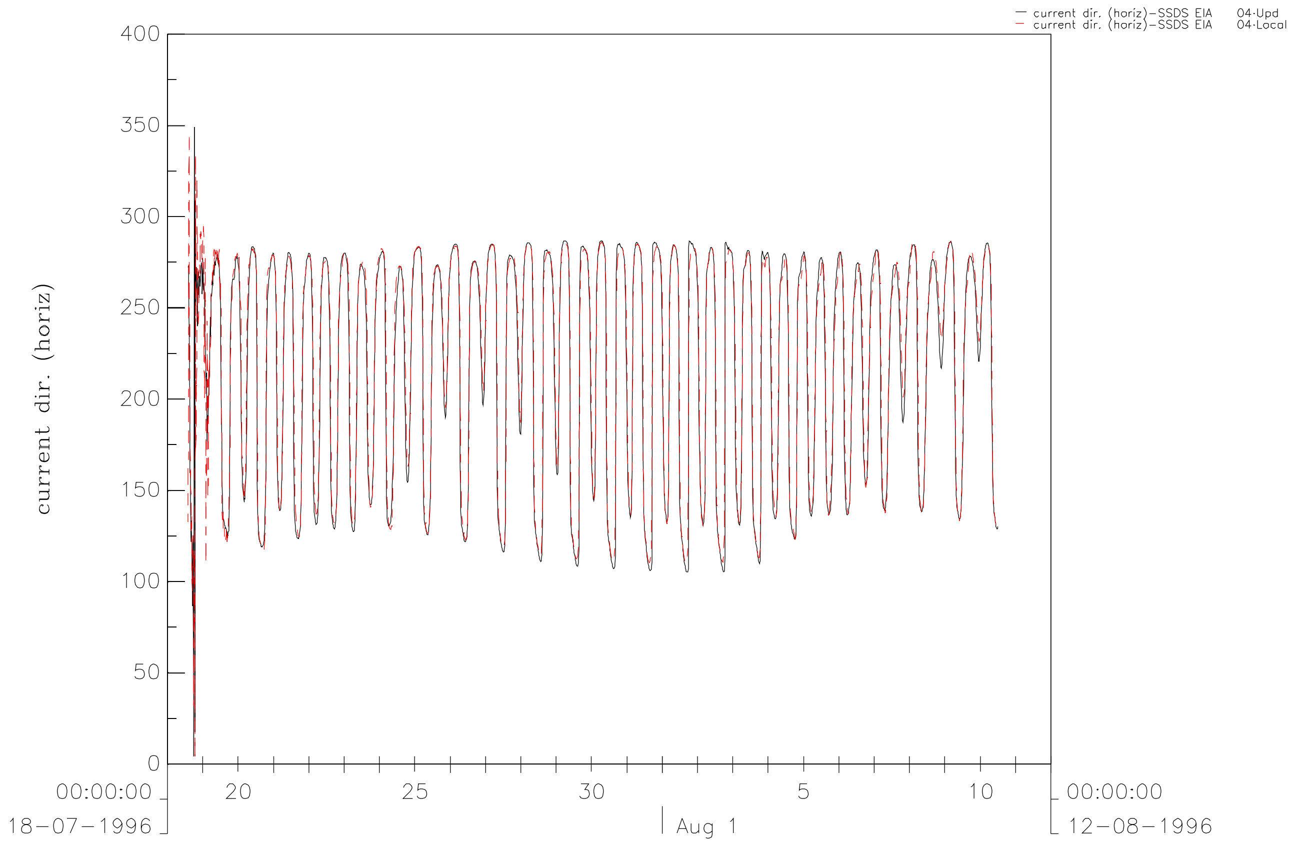


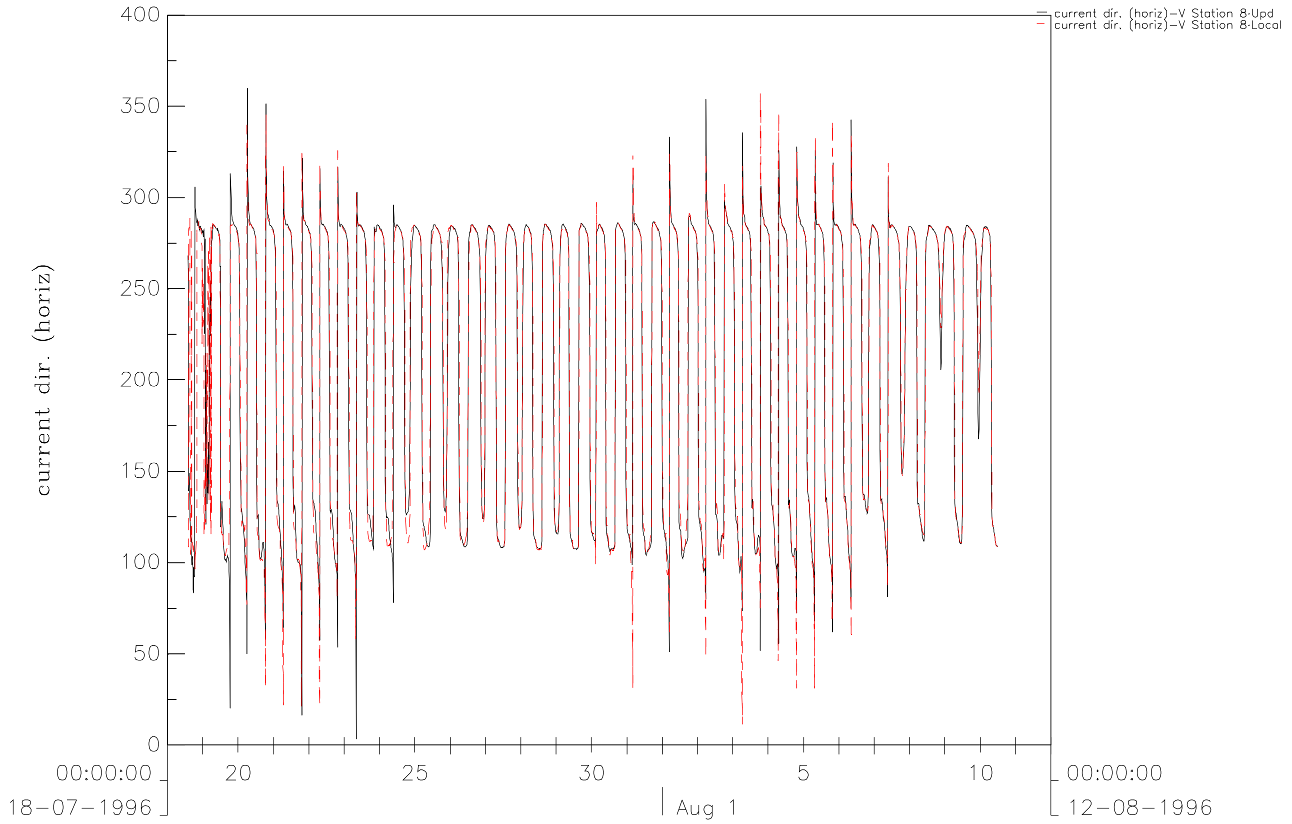
Depth averaged velocity magnitute comparison between Update Model and Local Refine Model at SM11(upper) and Yung Shue WAN (lower).	Wet Season	
	Figure 5A-29	
DSD & ATKINS		



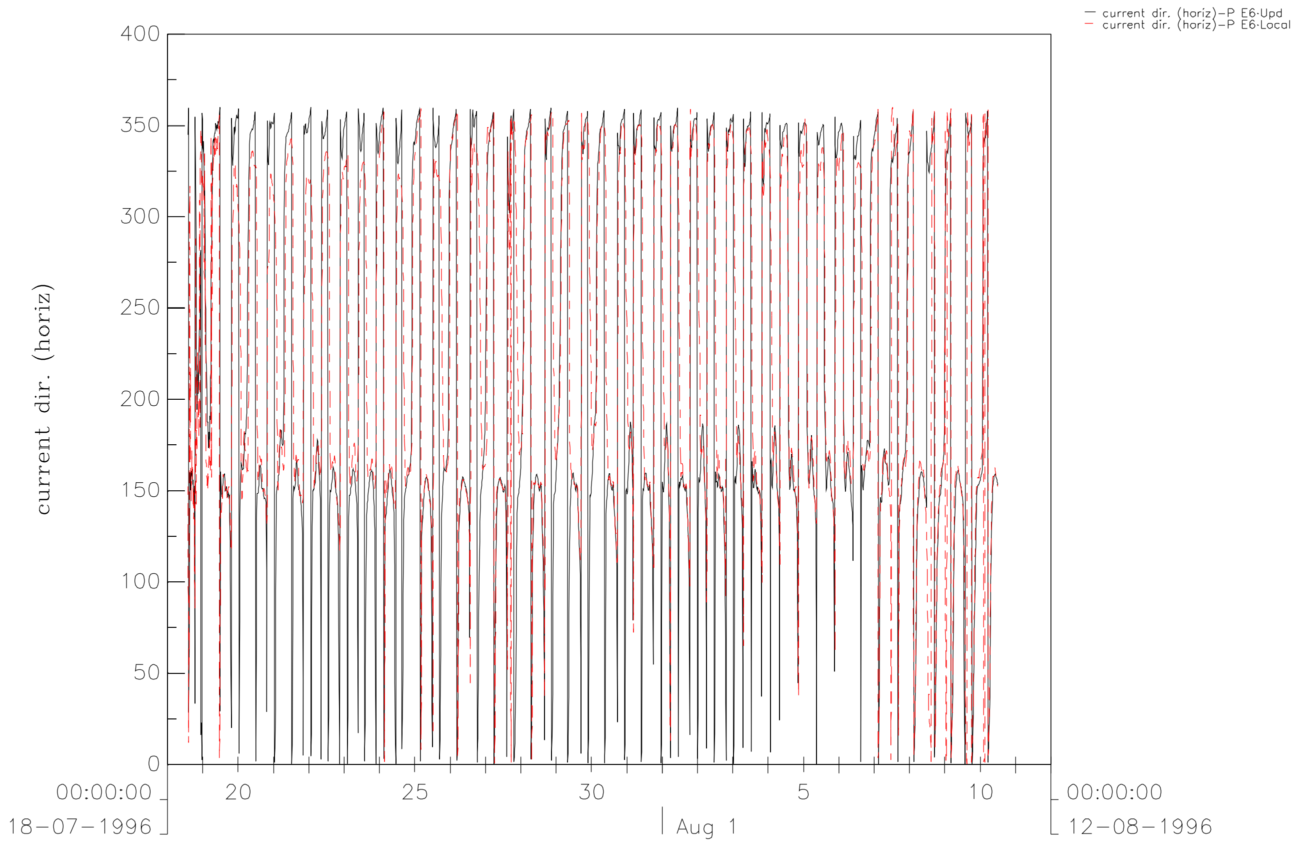


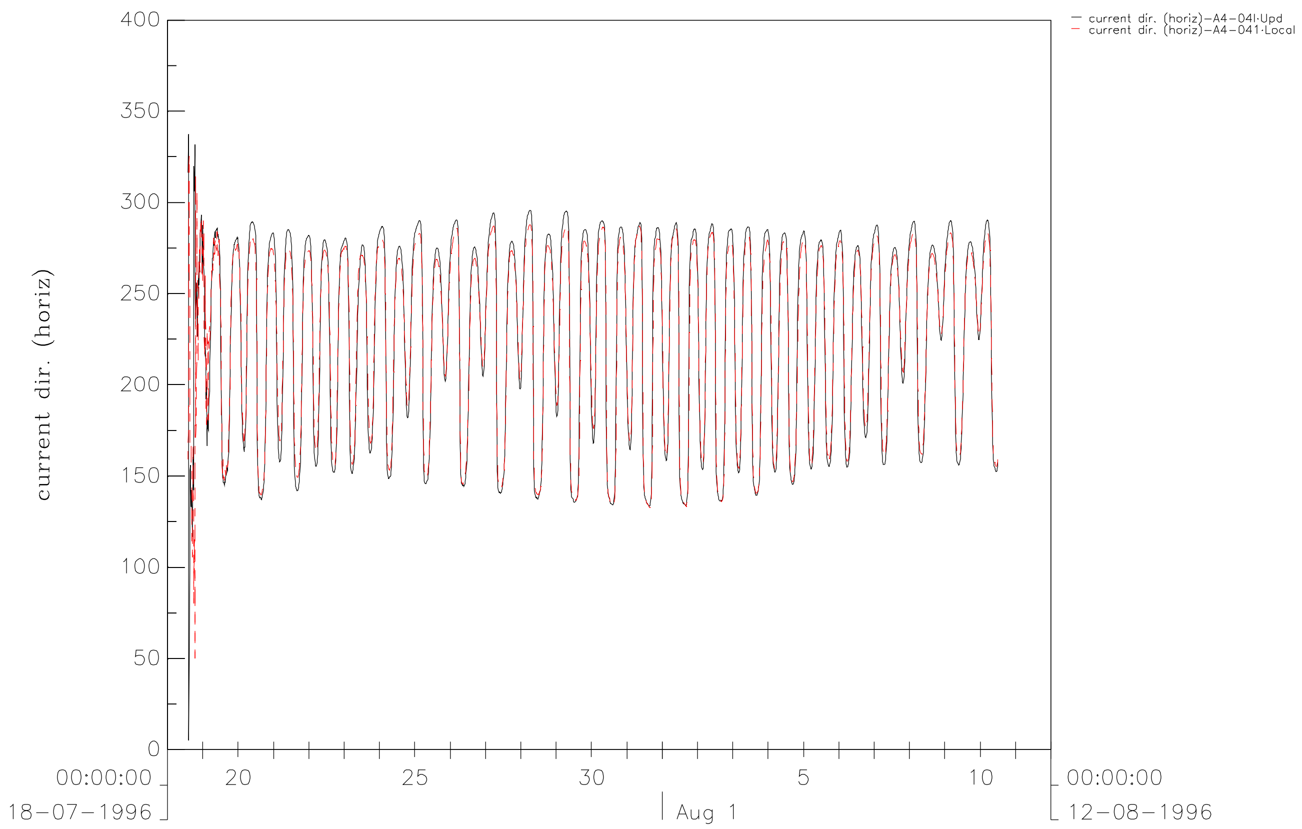
Depth averaged velocity direction comparison between Update Model and Local Refine Model at SM17 (upper) and SM12 (lower).	Dry Season
	Figure 5A-30
DSD & ATKINS	



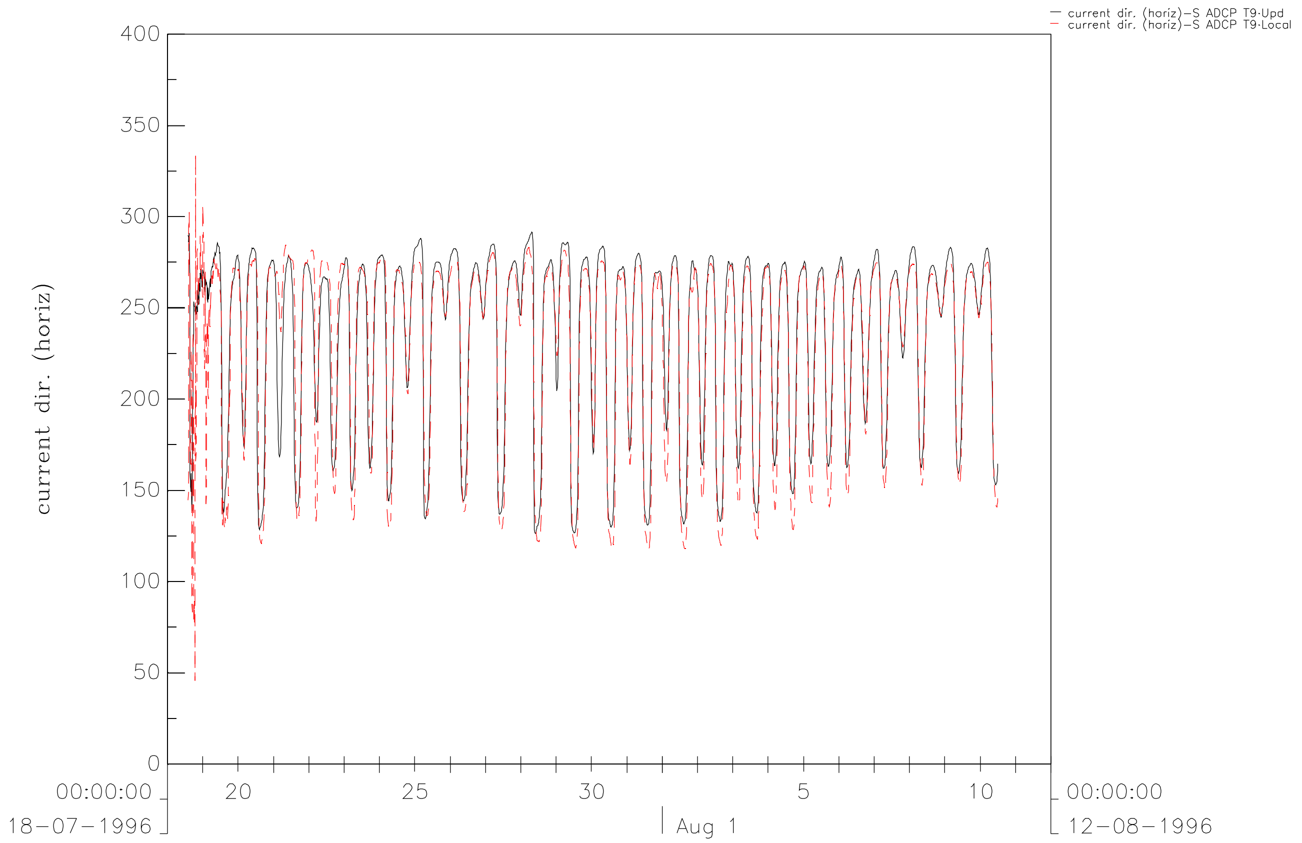


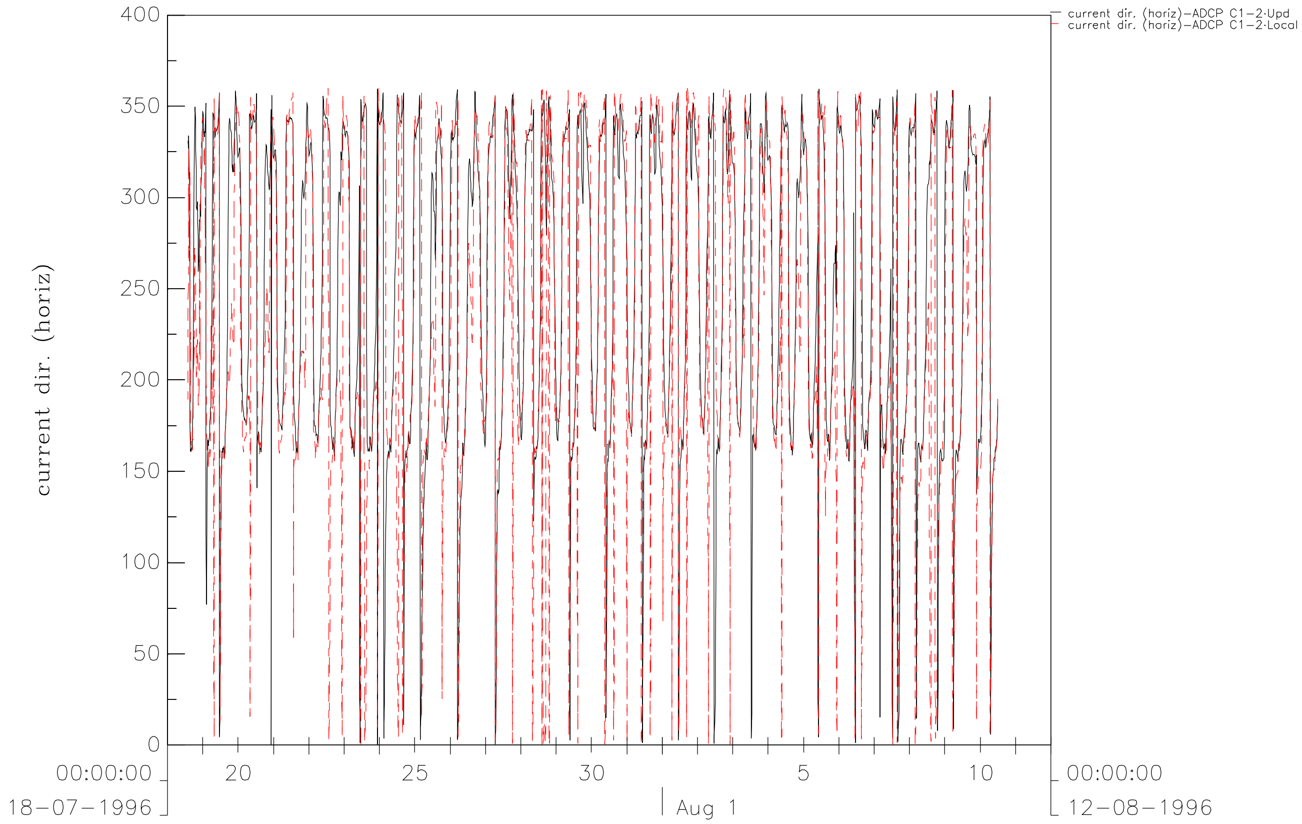
Depth averaged velocity direction comparison between Update Model and Local Refine Model at SSDS EIA 04 (upper) and V Station 8 (lower).	Dry Season	
	Figure 5A-31	
DSD & ATKINS		





Depth averaged velocity direction comparison between Update Model and Local Refine Modelat P E6 (upper) and A4-041 (lower).	Dry Season
	Figure 5A-32
DSD & ATKINS	



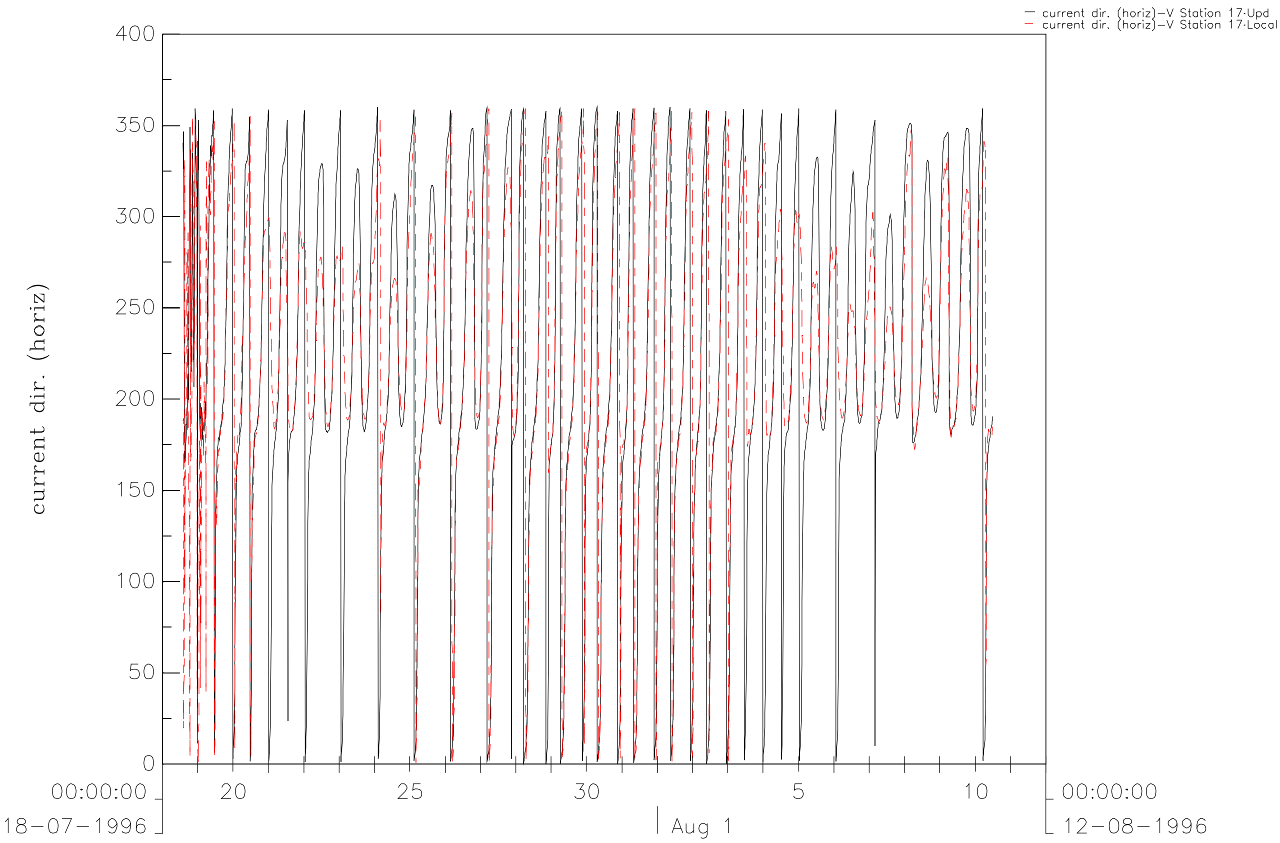


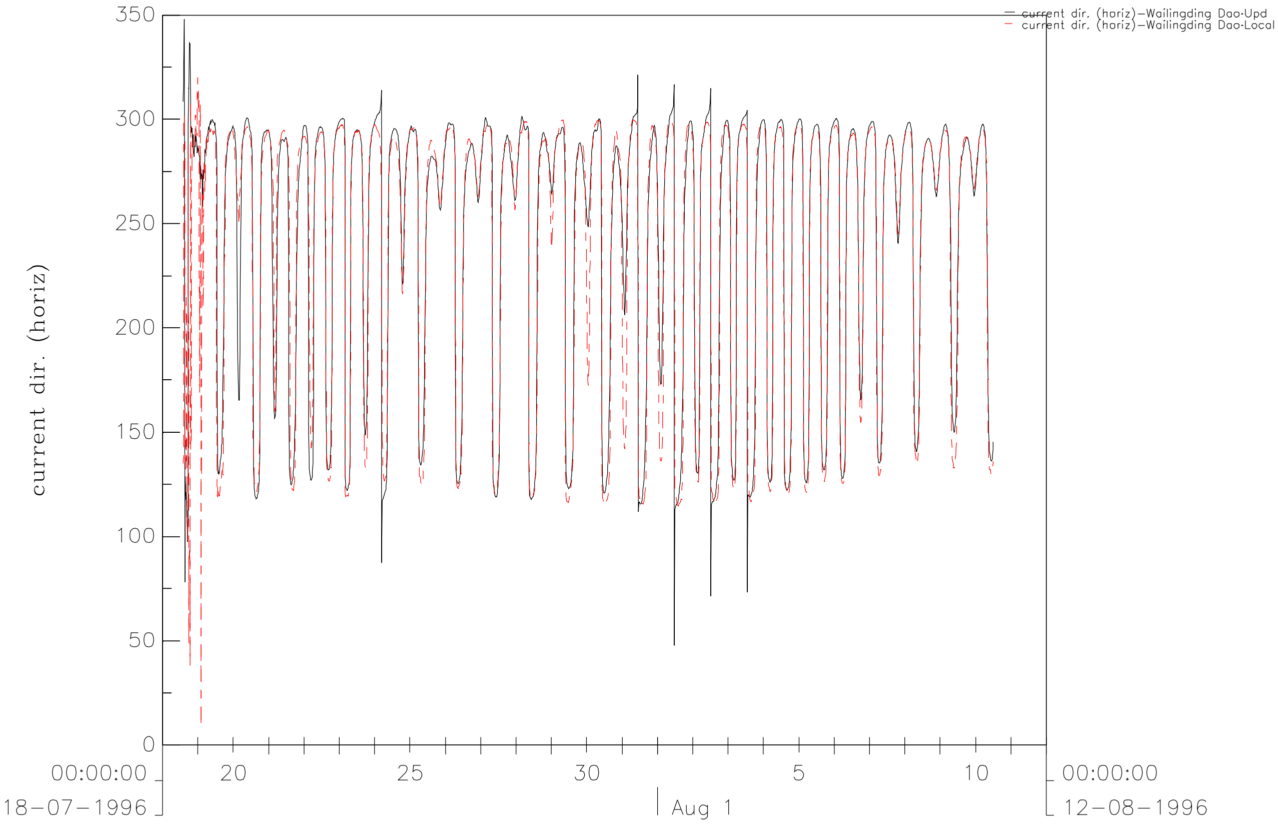
Depth averaged velocity direction comparison between Update Model and Local Refine Model at S ADCP T9 (upper) and ADCP C1–2 (lower).

Dry Season

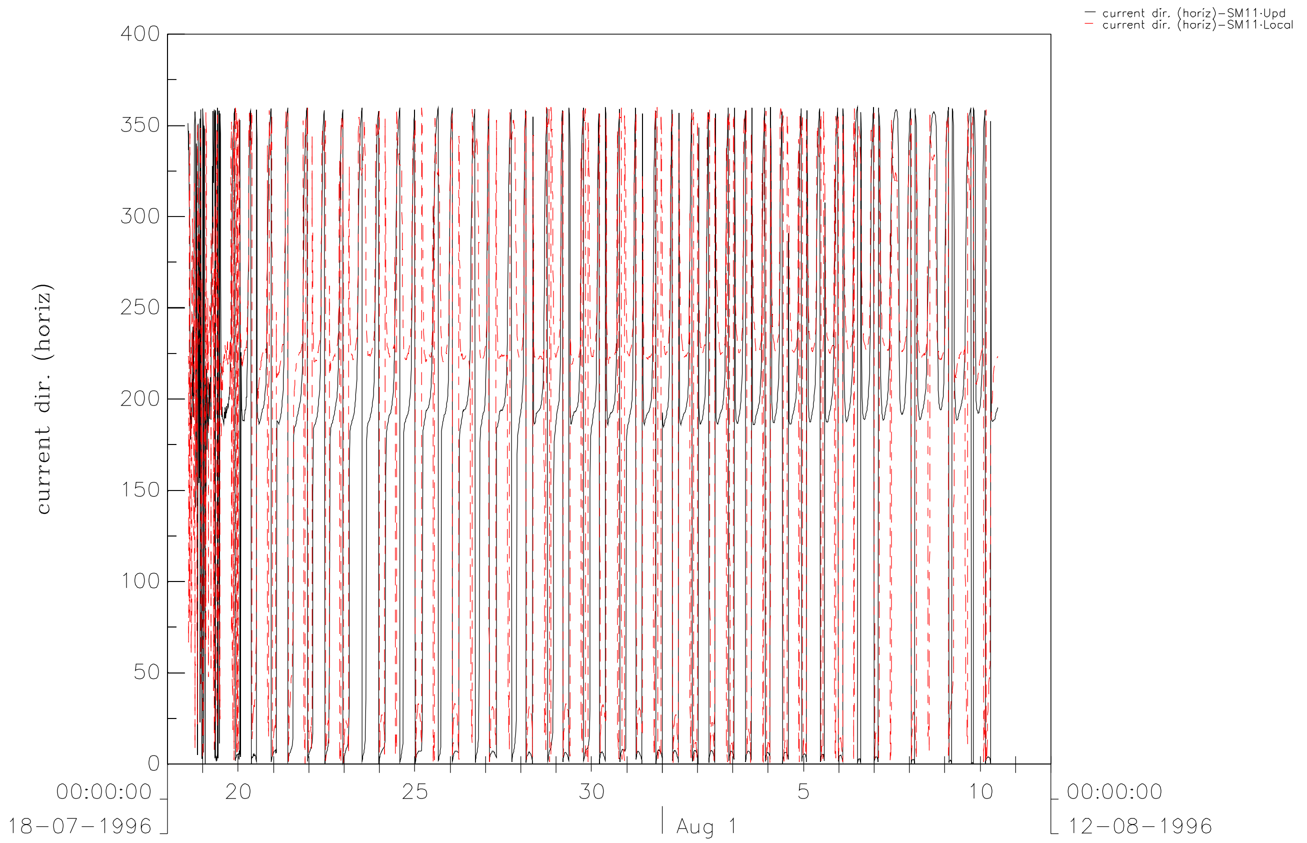
Figure 5A-33

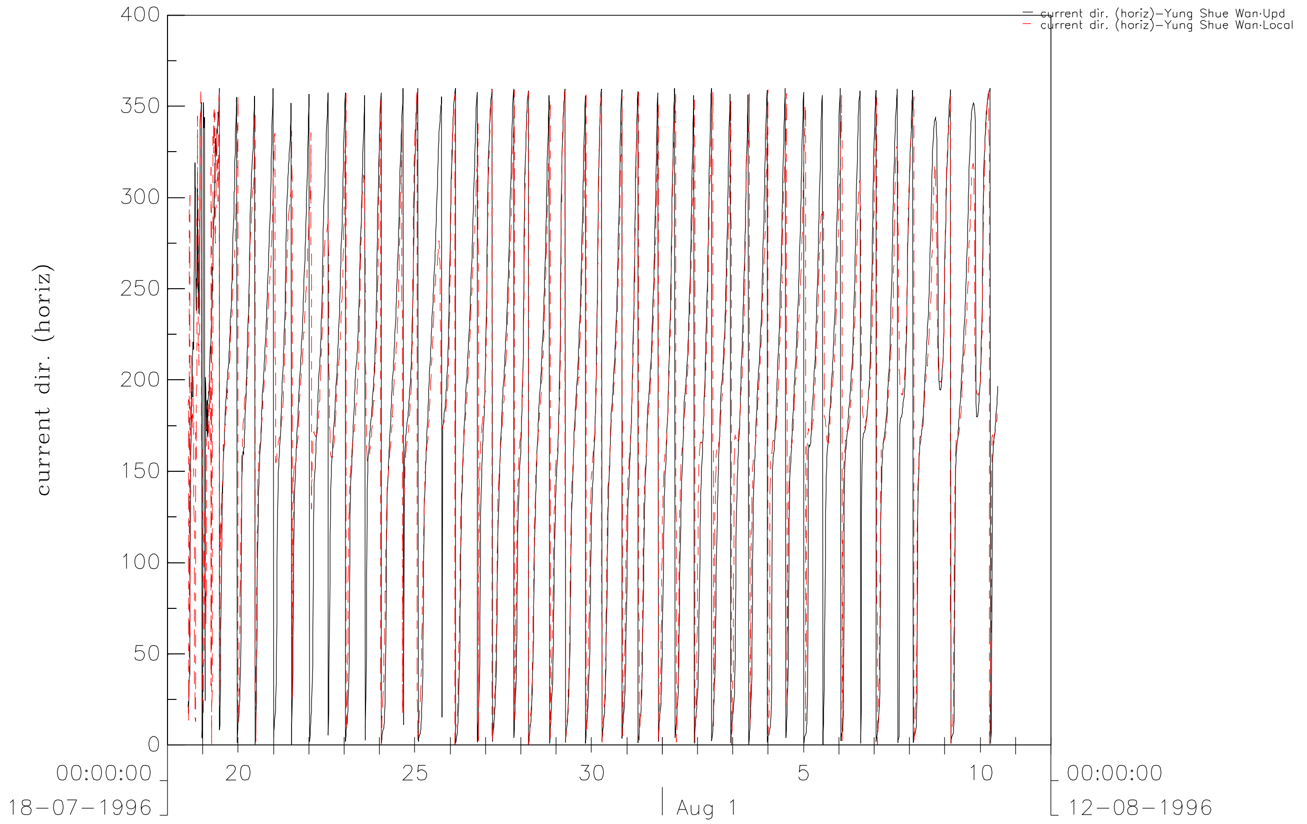
DSD & ATKINS



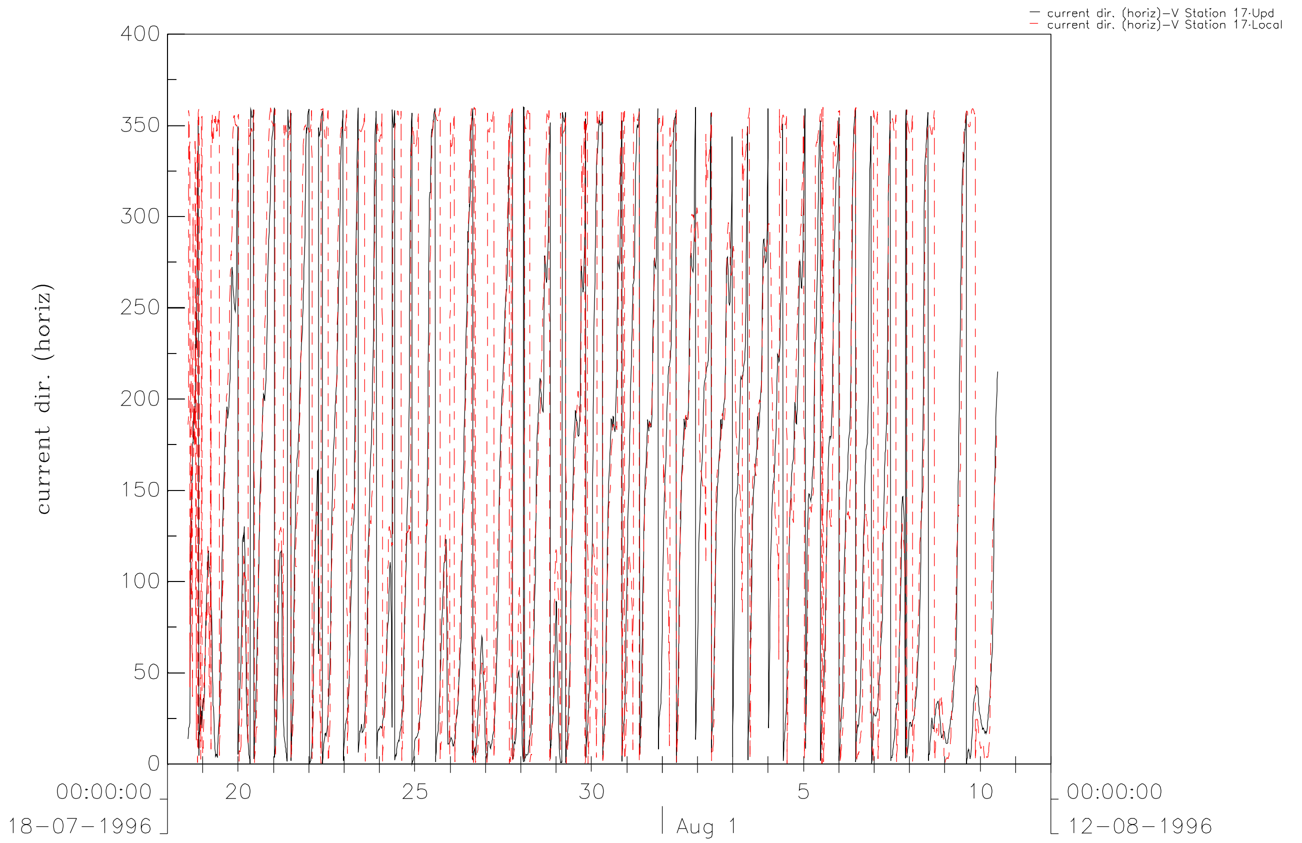


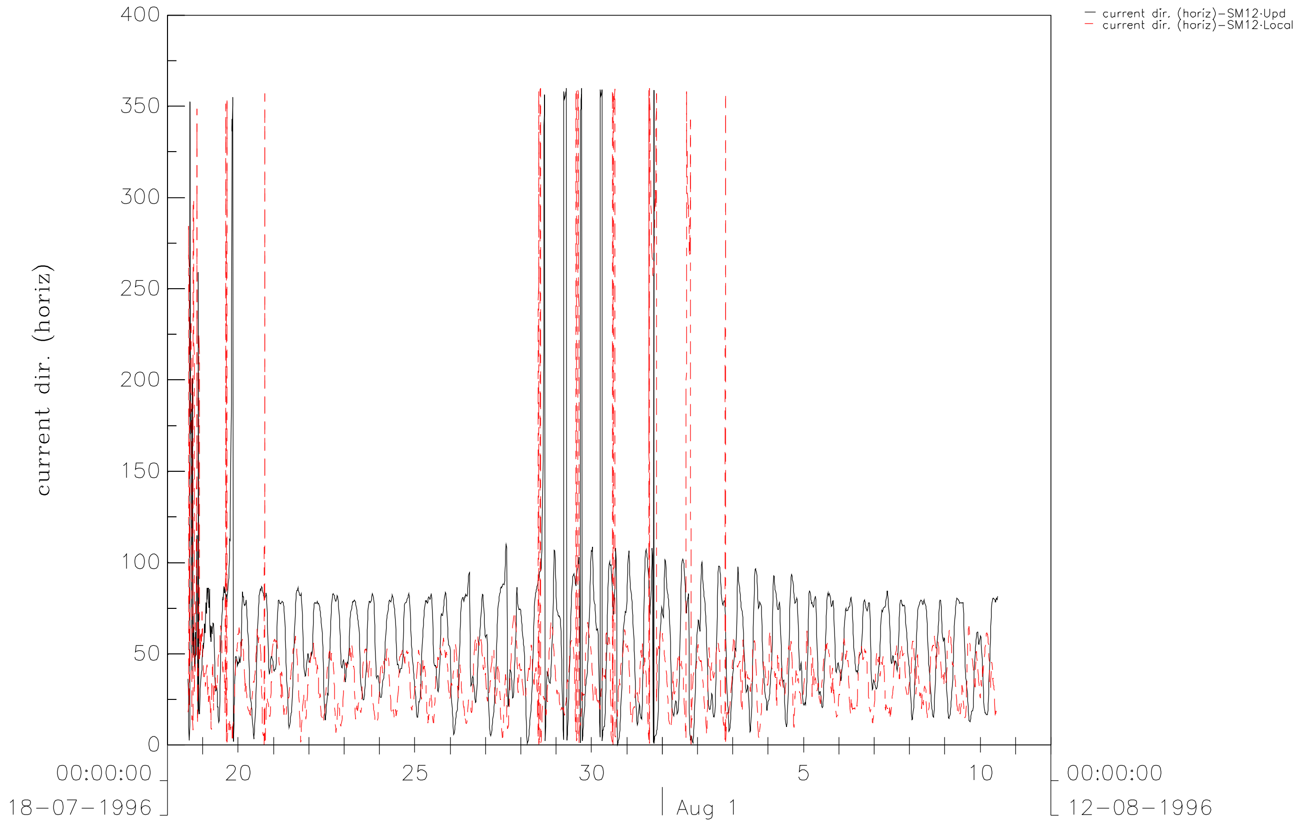
Depth averaged velocity direction comparison between Update Model and Local Refine Modelat at V Station 17 (upper) and Wailinding dao (lower).	Dry Season	
	Figure 5A-34	
DSD & ATKINS		



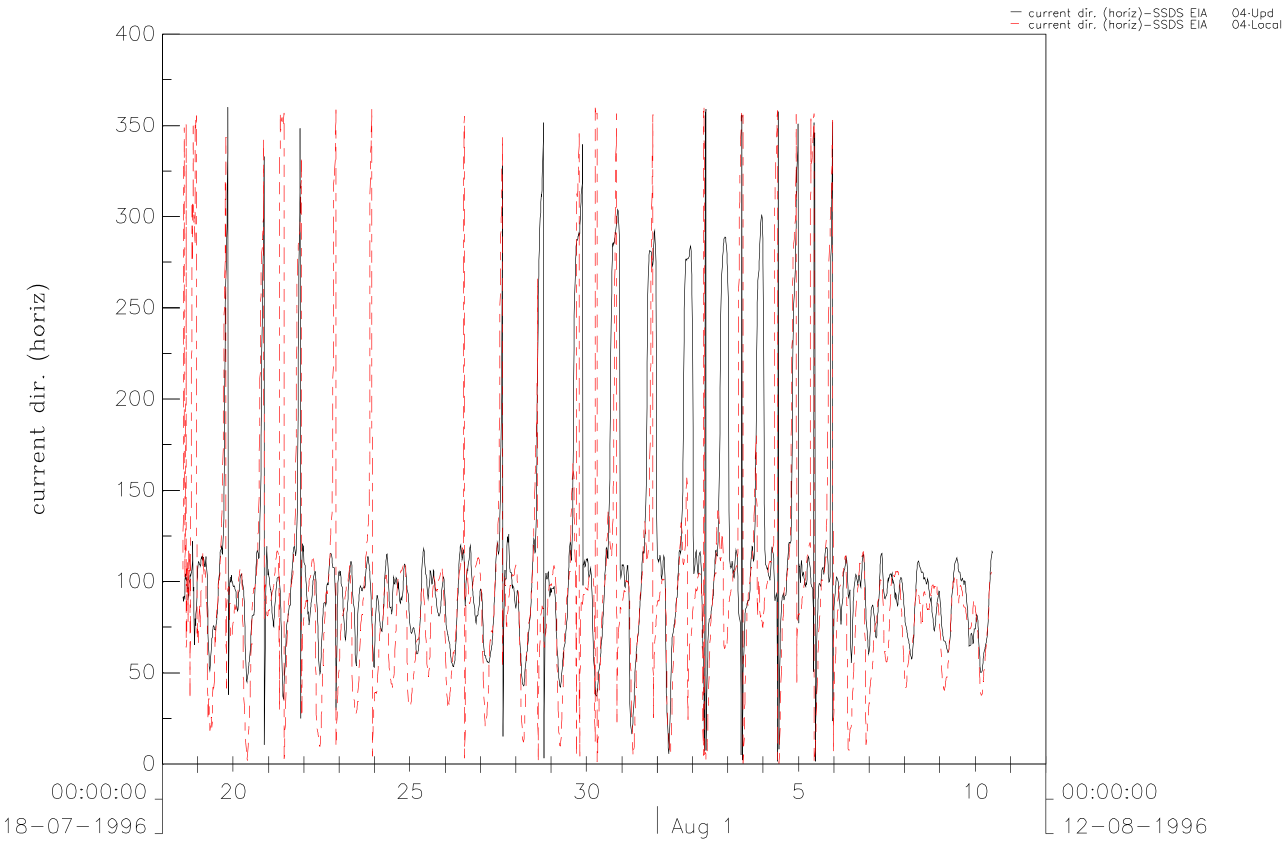


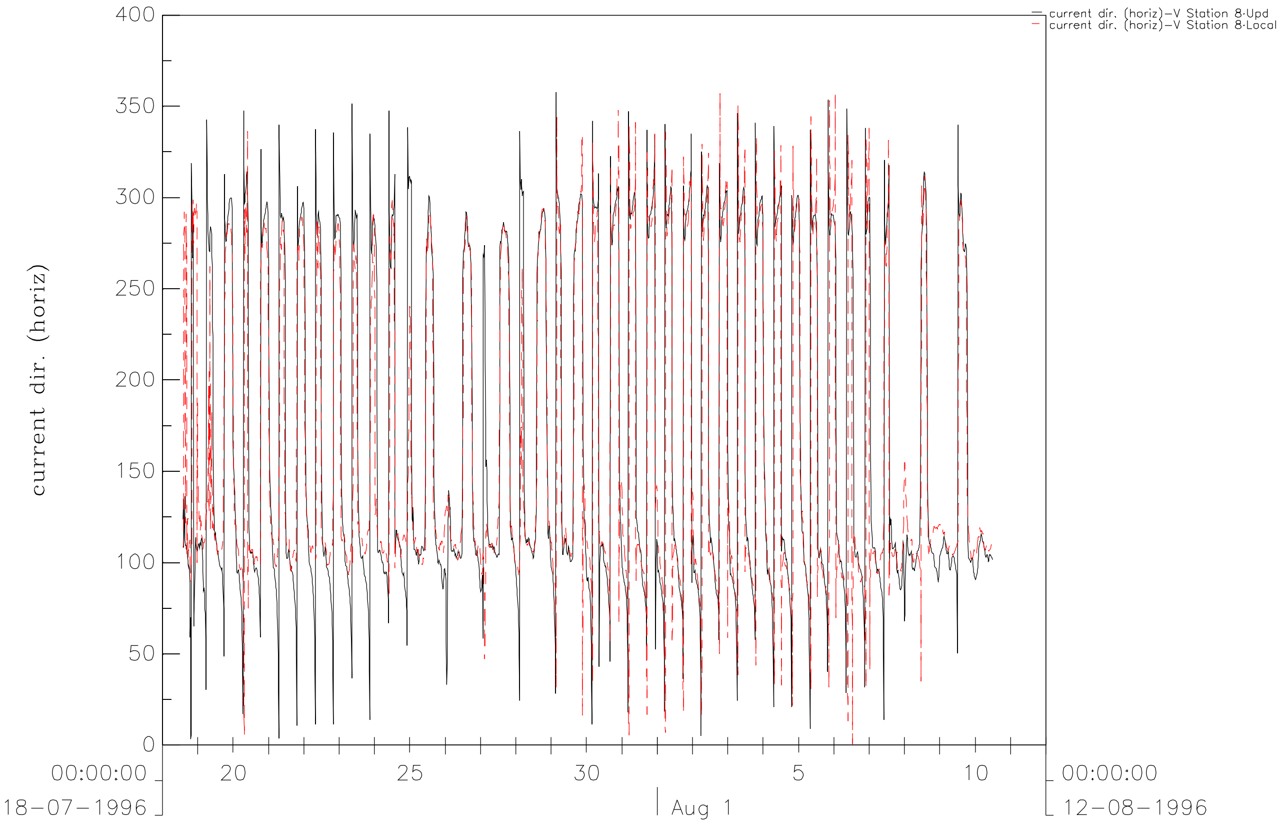
Depth averaged velocity direction comparison between Update Model and Local Refine Model at SM11(upper) and Yung Shue WAN (lower).	Dry Season
	Figure 5A-35
DSD & ATKINS	



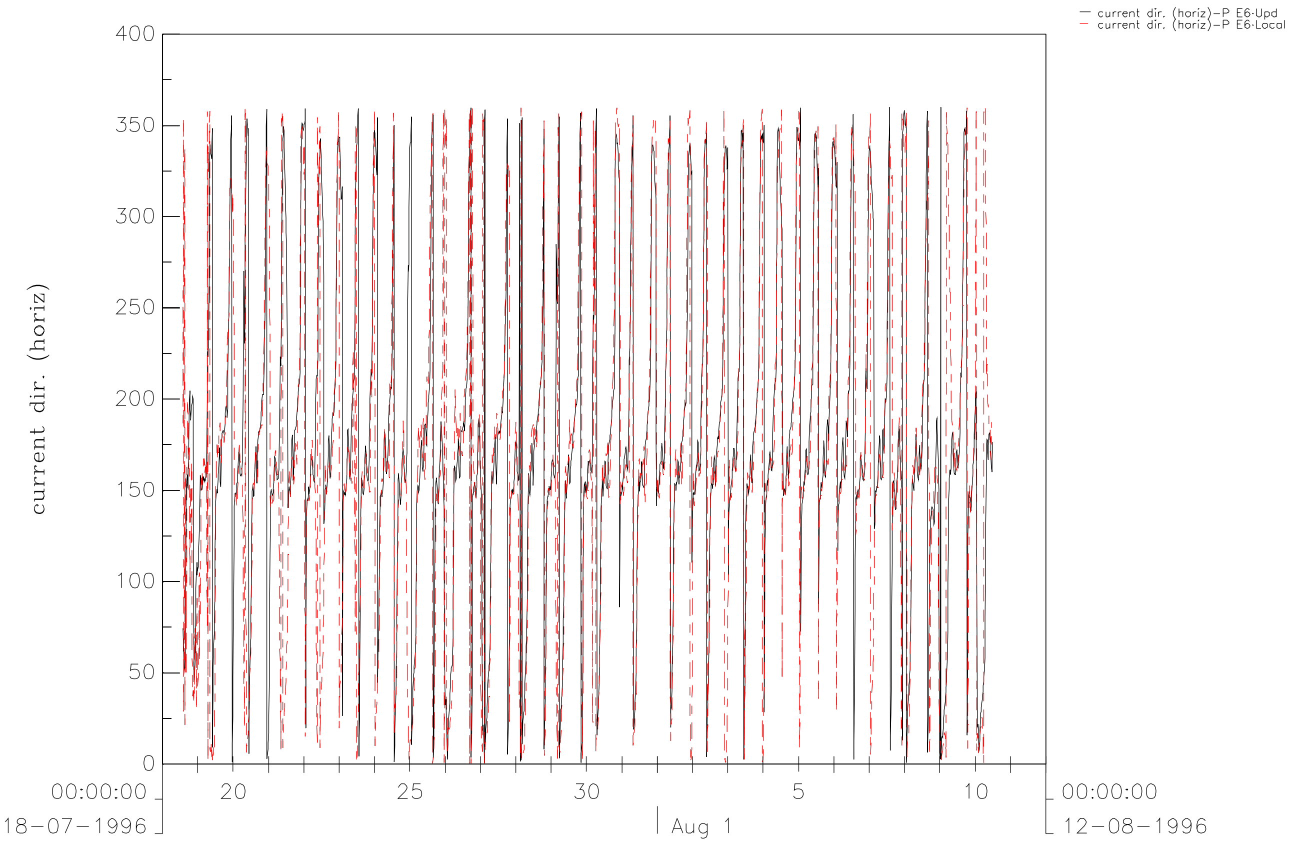


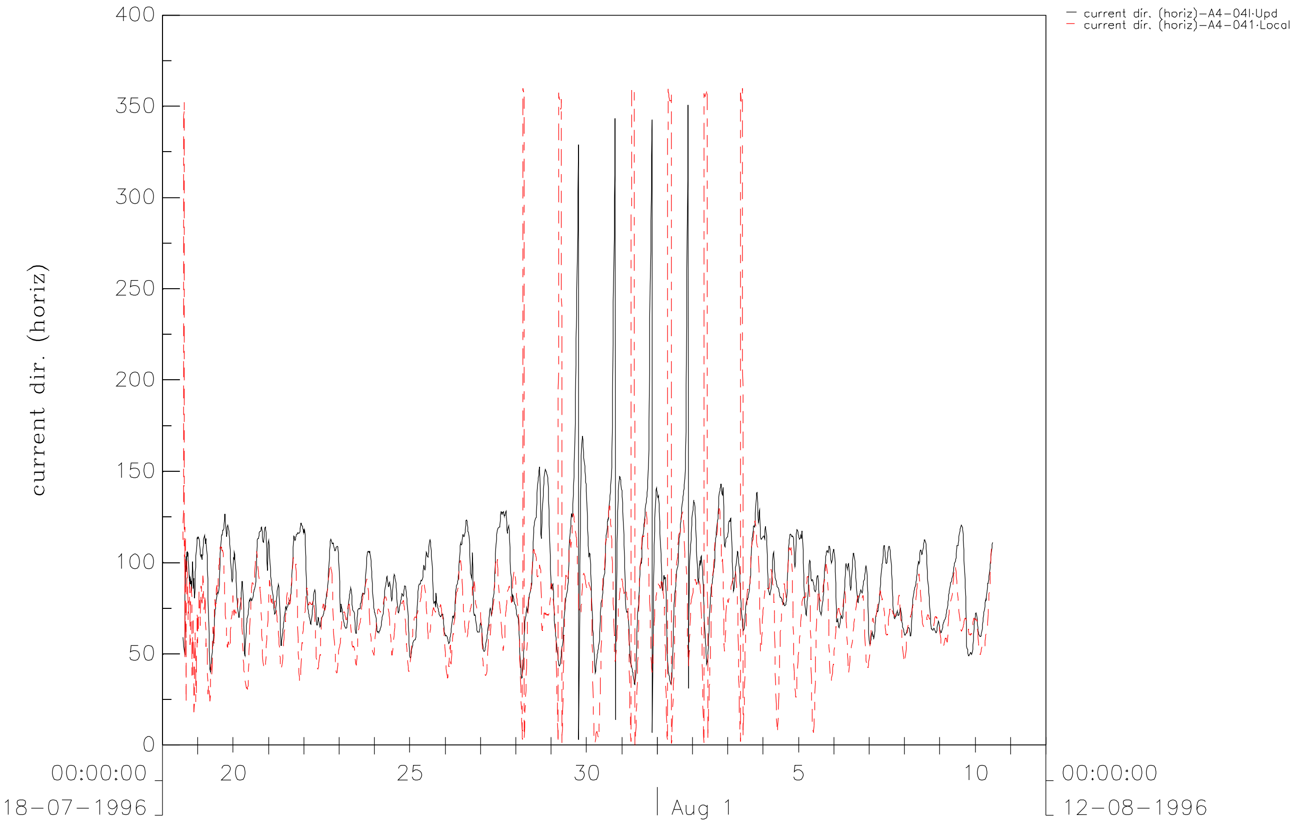
Depth averaged velocity direction comparison between Update Model and Local Refine Model at SM17 (upper) and SM12 (lower).	Wet Season
	Figure 5A-36
DSD & ATKINS	



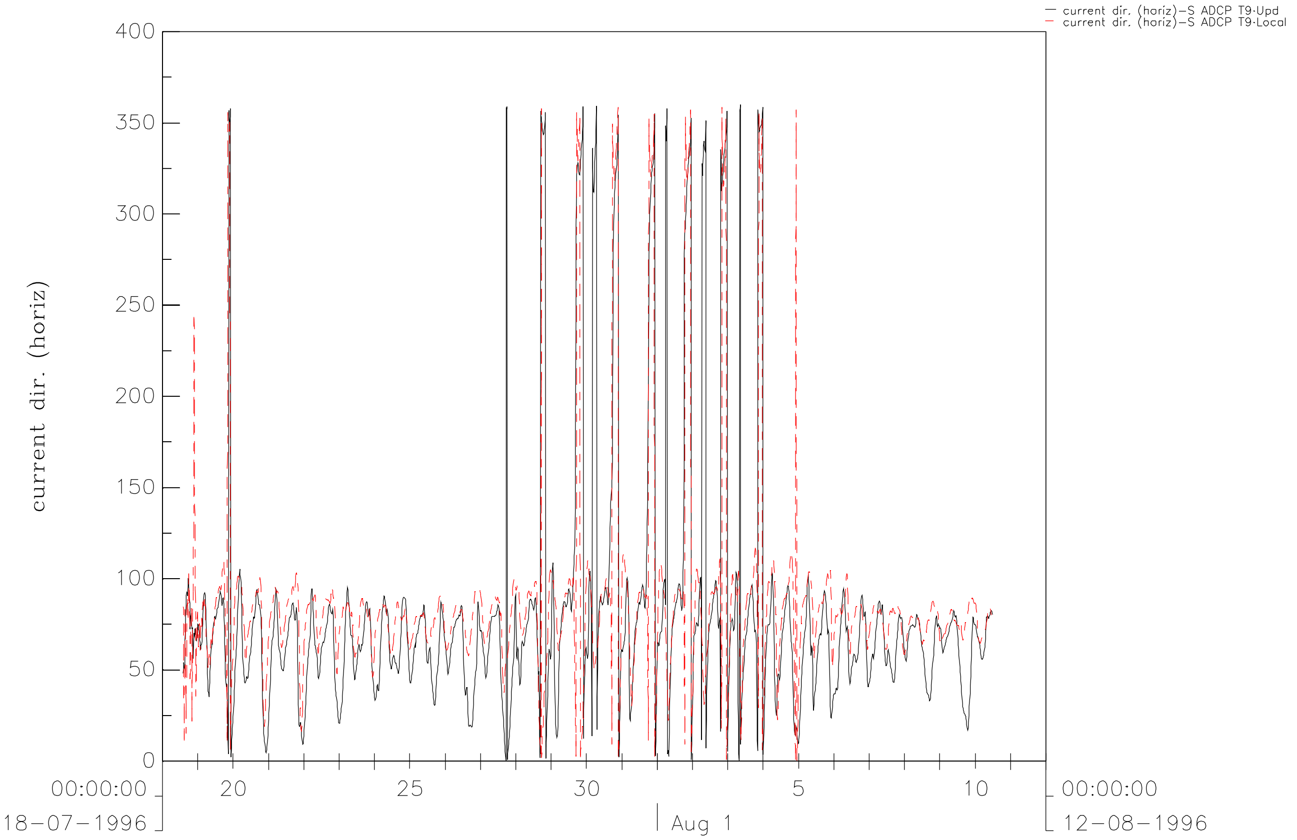


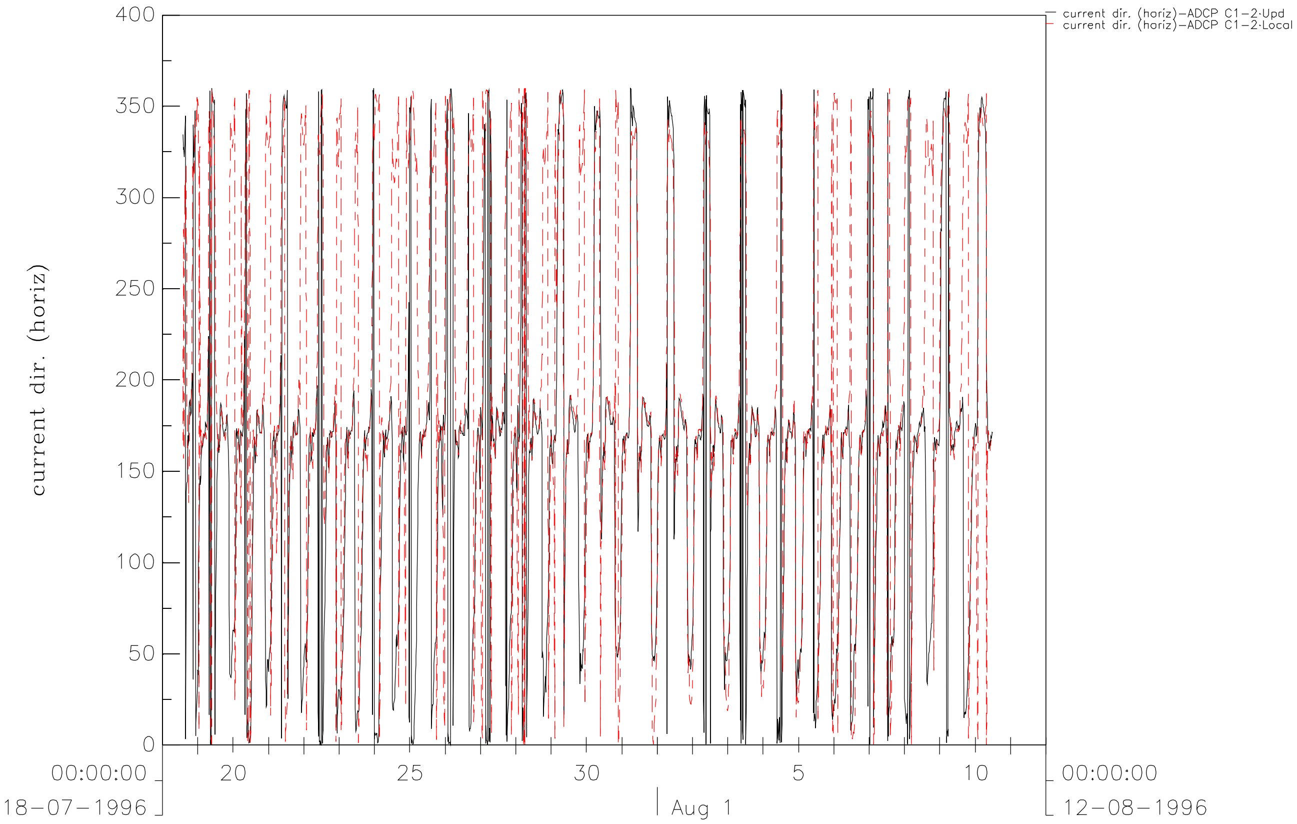
Depth averaged velocity direction comparison between Update Model and Local Refine Model at SSDS EIA 04 (upper) and V Station 8 (lower).	Wet Season	
	Figure 5A-37	
DSD & ATKINS		



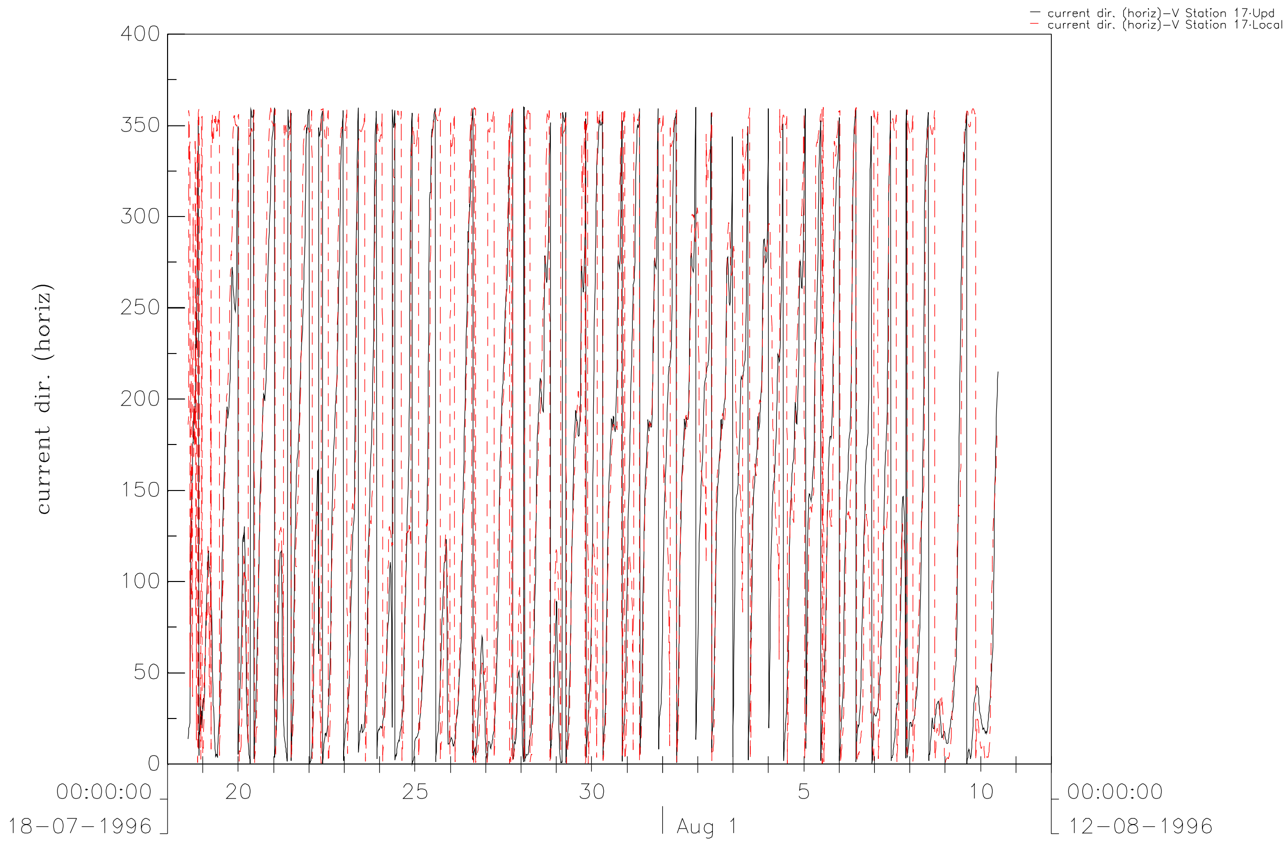


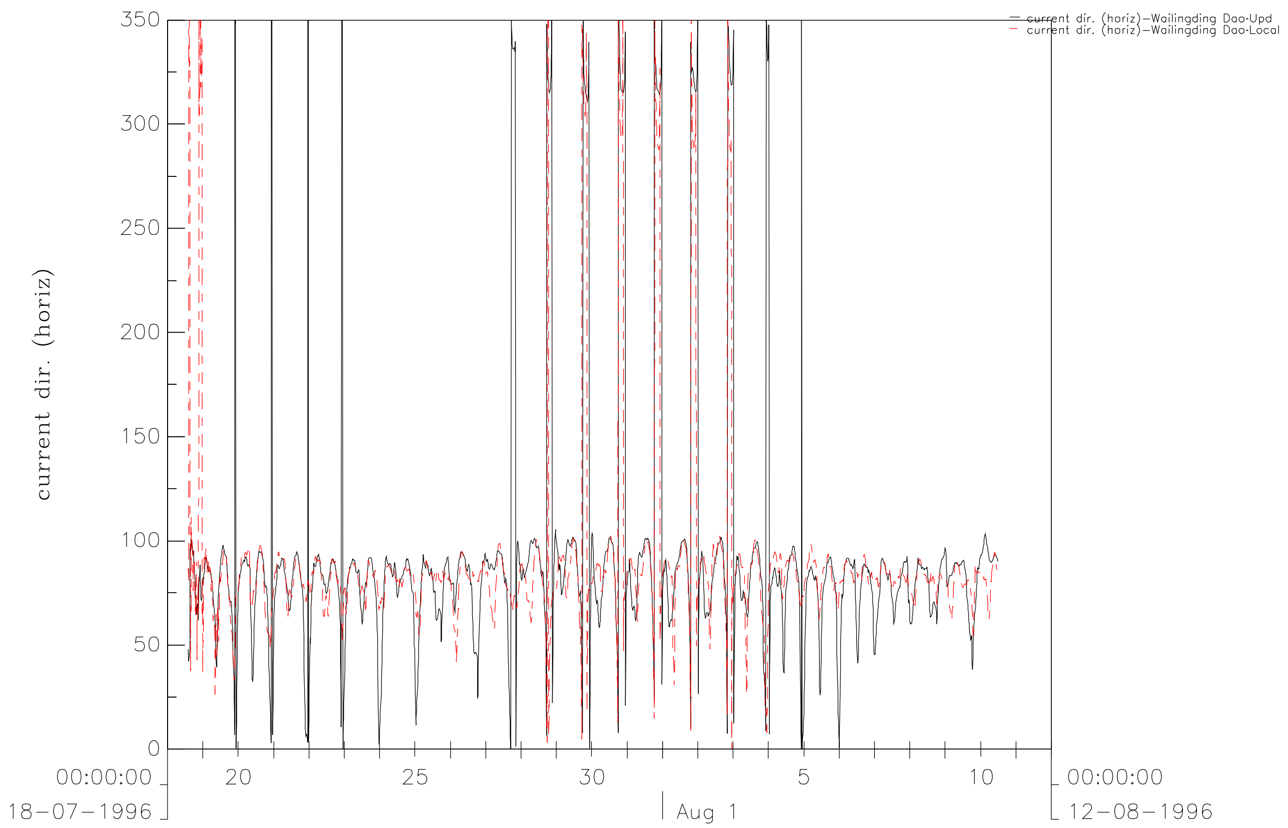
Depth averaged velocity direction comparison between Update Model and Local Refine Modelat P E6 (upper) and A4-041 (lower).	Wet Season
	Figure 5A-38
DSD & ATKINS	



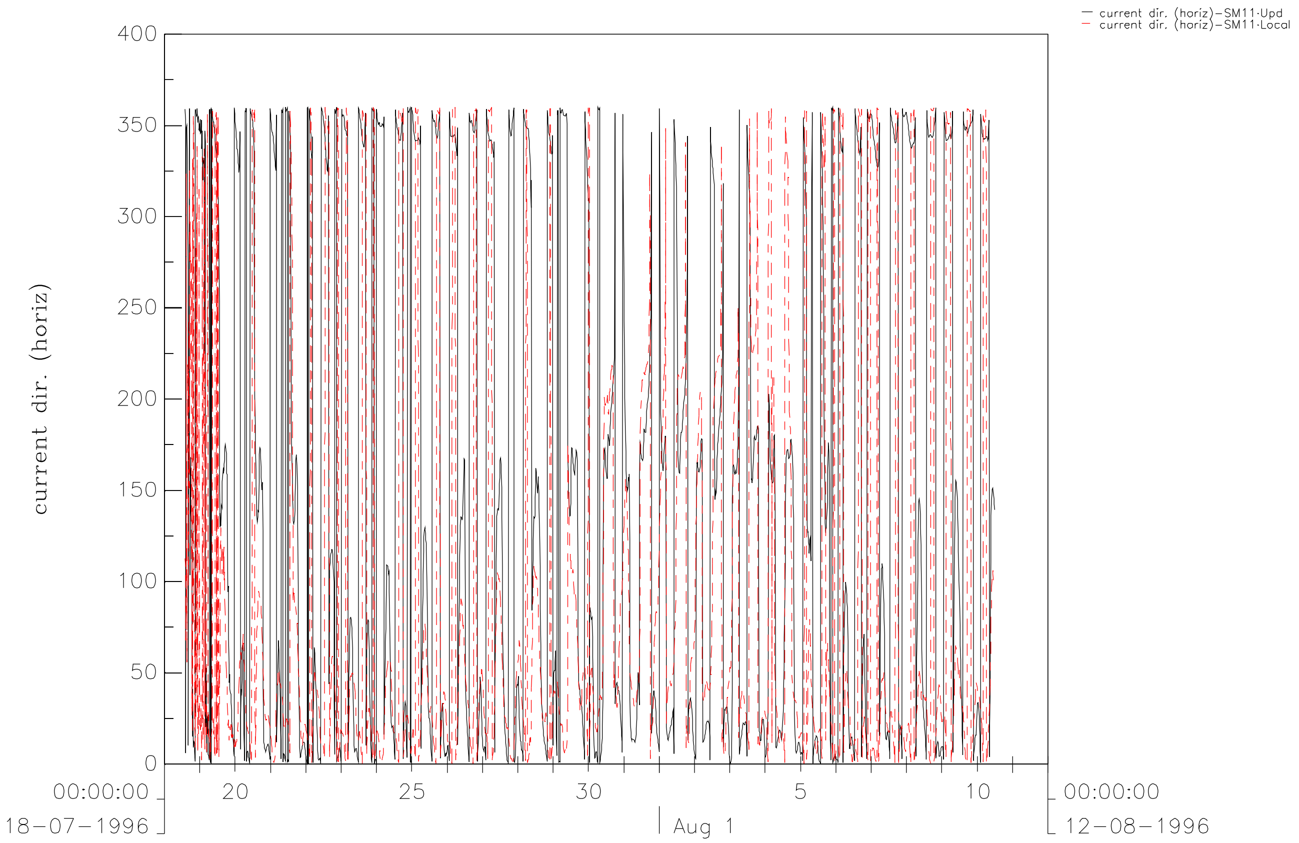


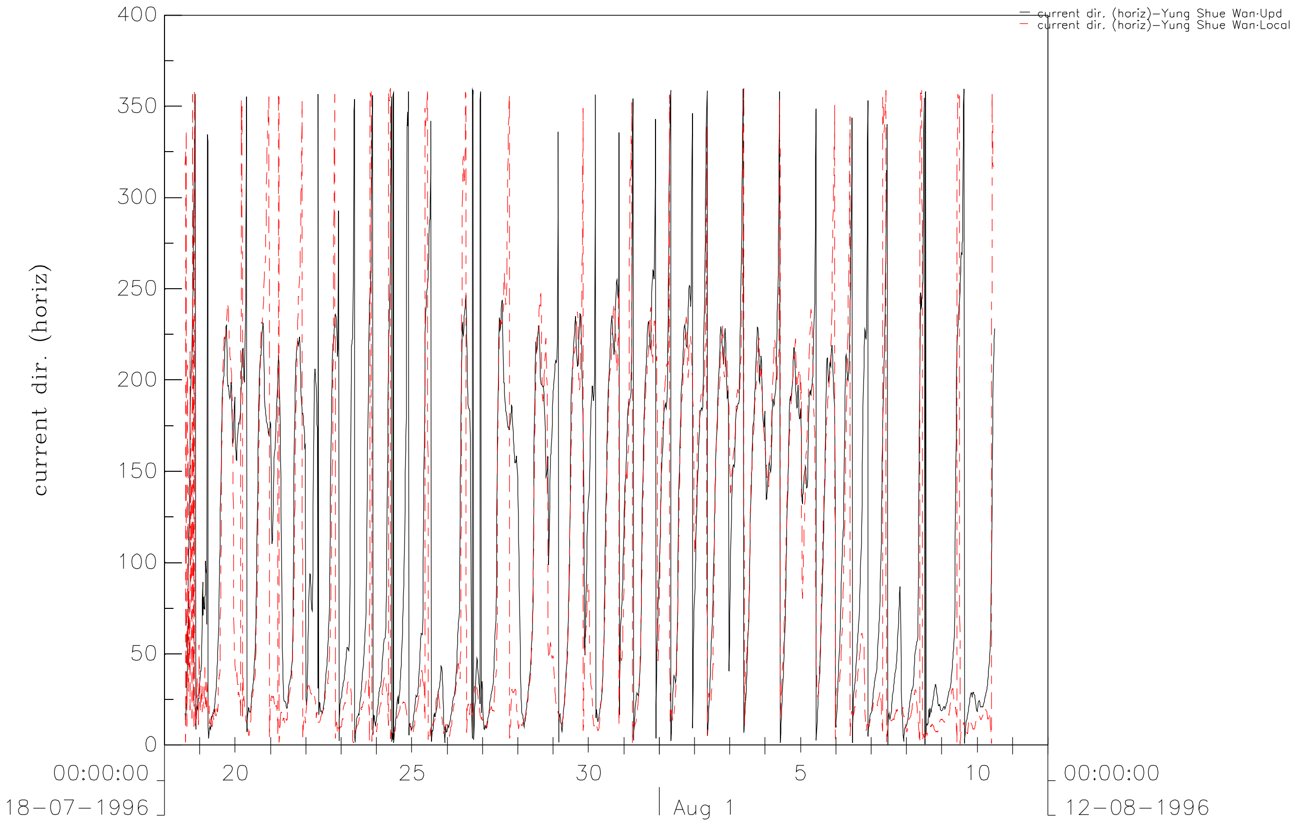
Depth averaged velocity direction comparison between Update Model and Local Refine Model at S ADCP T9 (upper) and ADCP C1–2 (lower).	Wet Season
	Figure 5A-39
DSD & ATKINS	



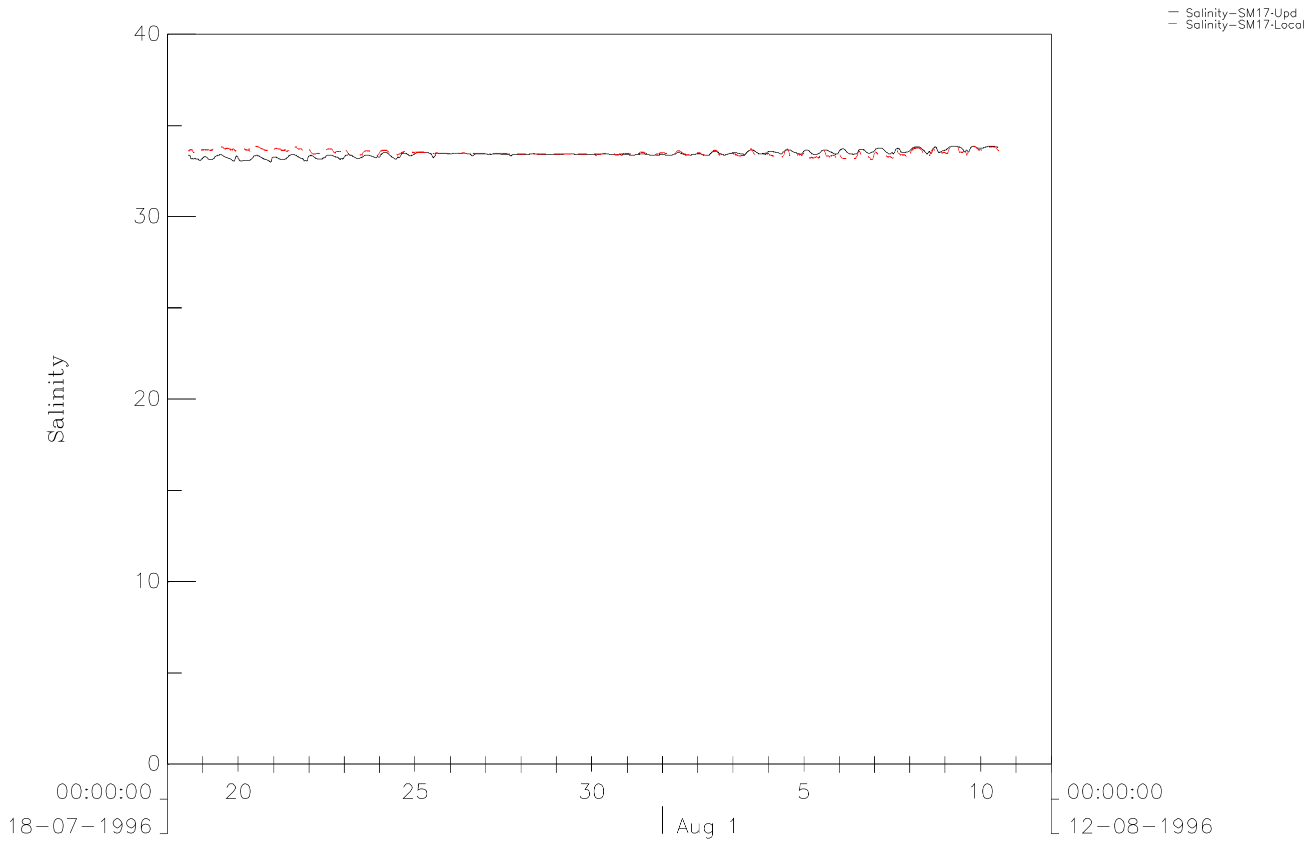


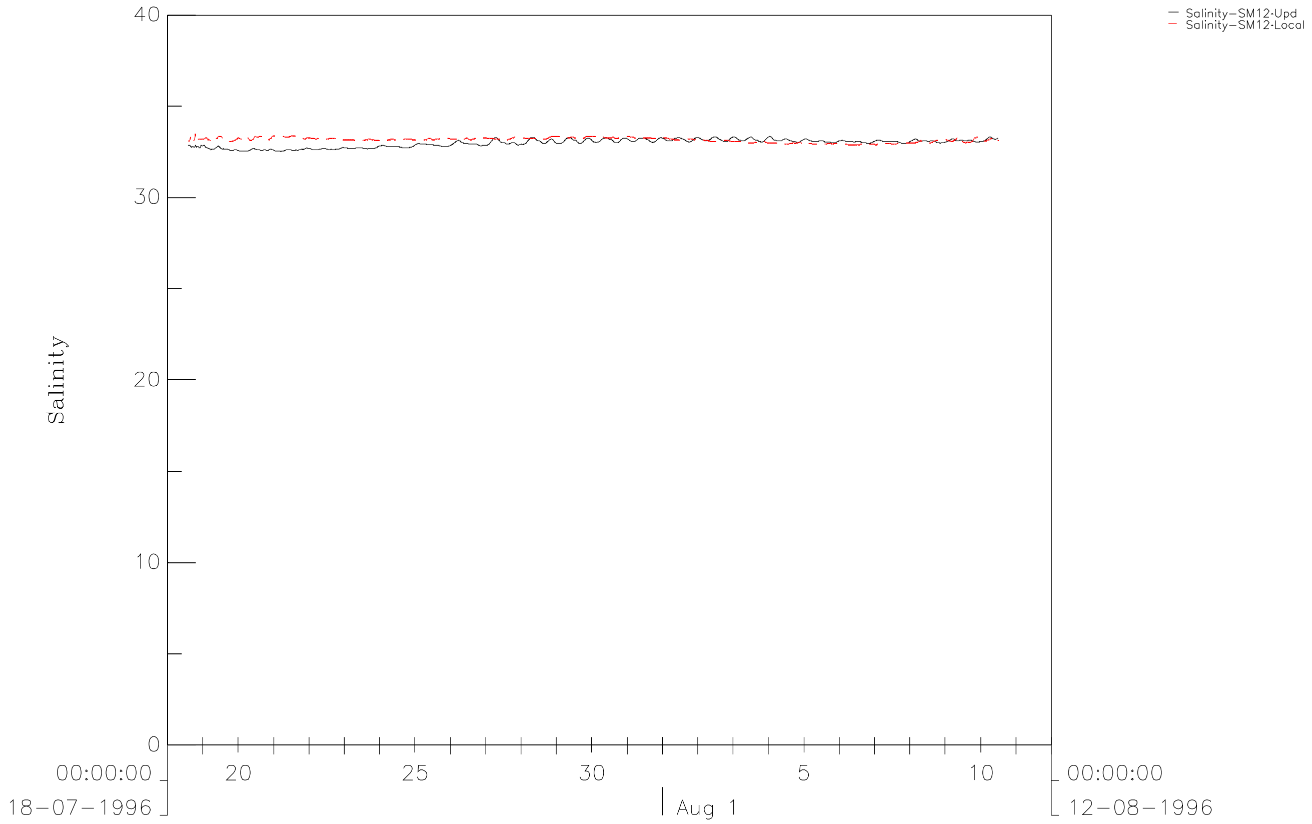
Depth averaged velocity direction comparison between Update Model and Local Refine Modelat at V Station 17 (upper) and Wailinding dao (lower).	Wet Season
	Figure 5A-40
DSD & ATKINS	



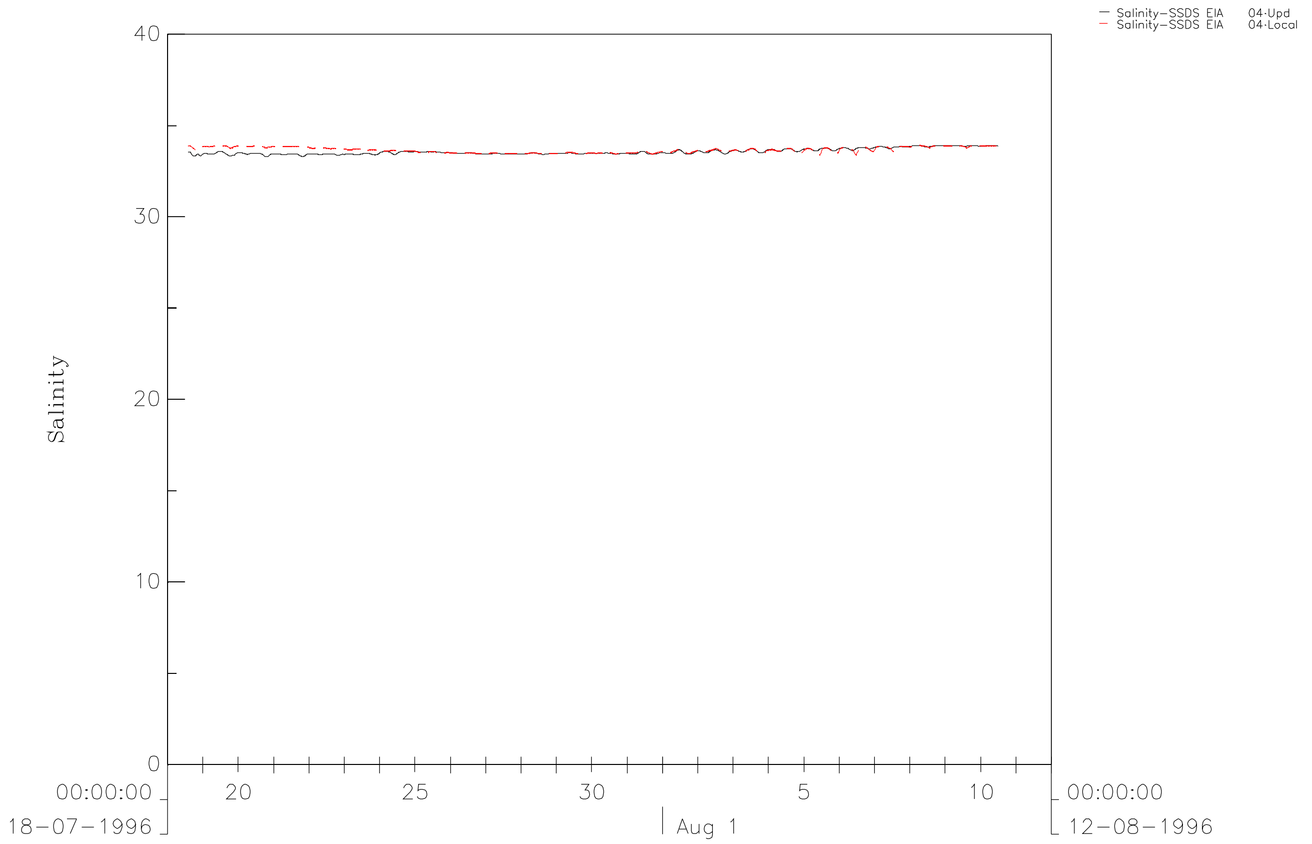


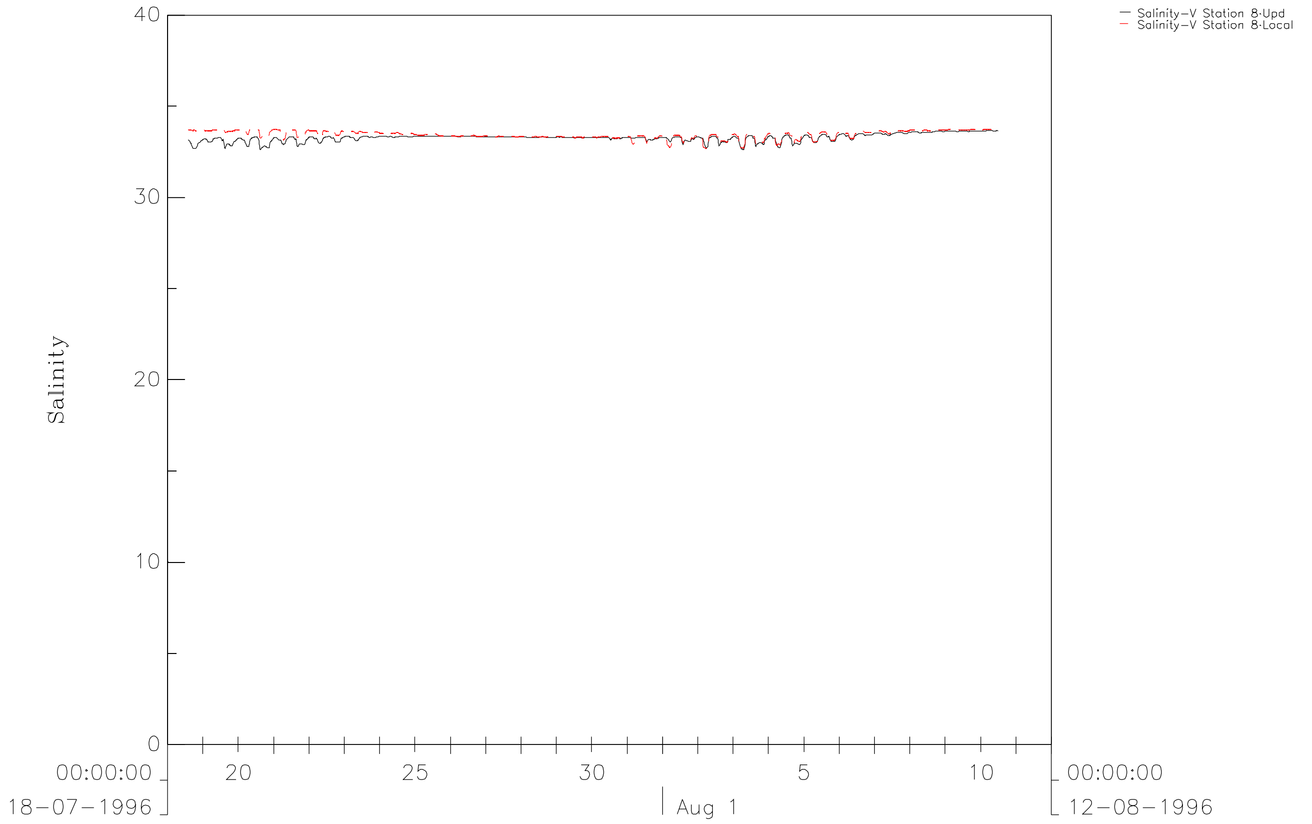
Depth averaged velocity direction comparison between Update Model and Local Refine Model at SM11(upper) and Yung Shue WAN (lower).	Wet Season	
	Figure 5A-41	
DSD & ATKINS		



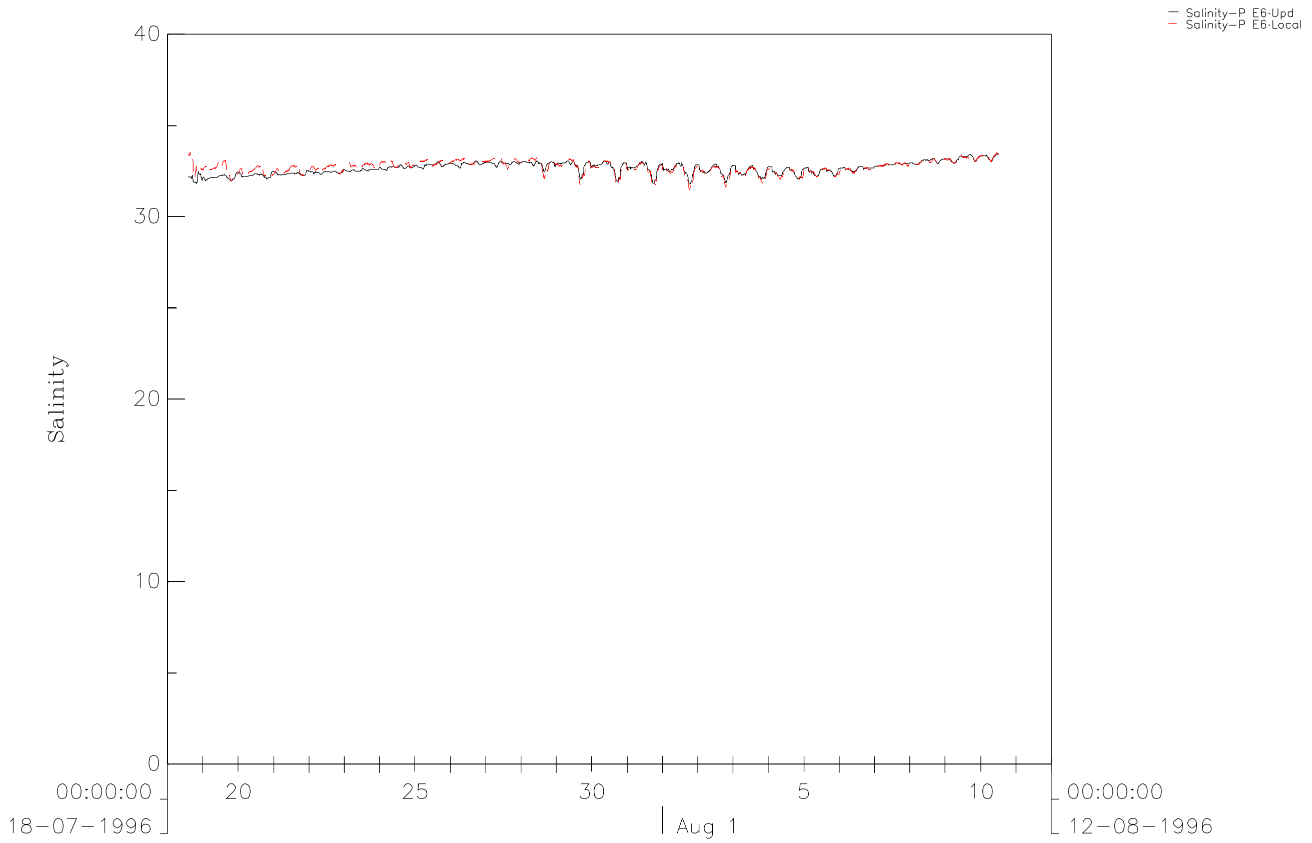


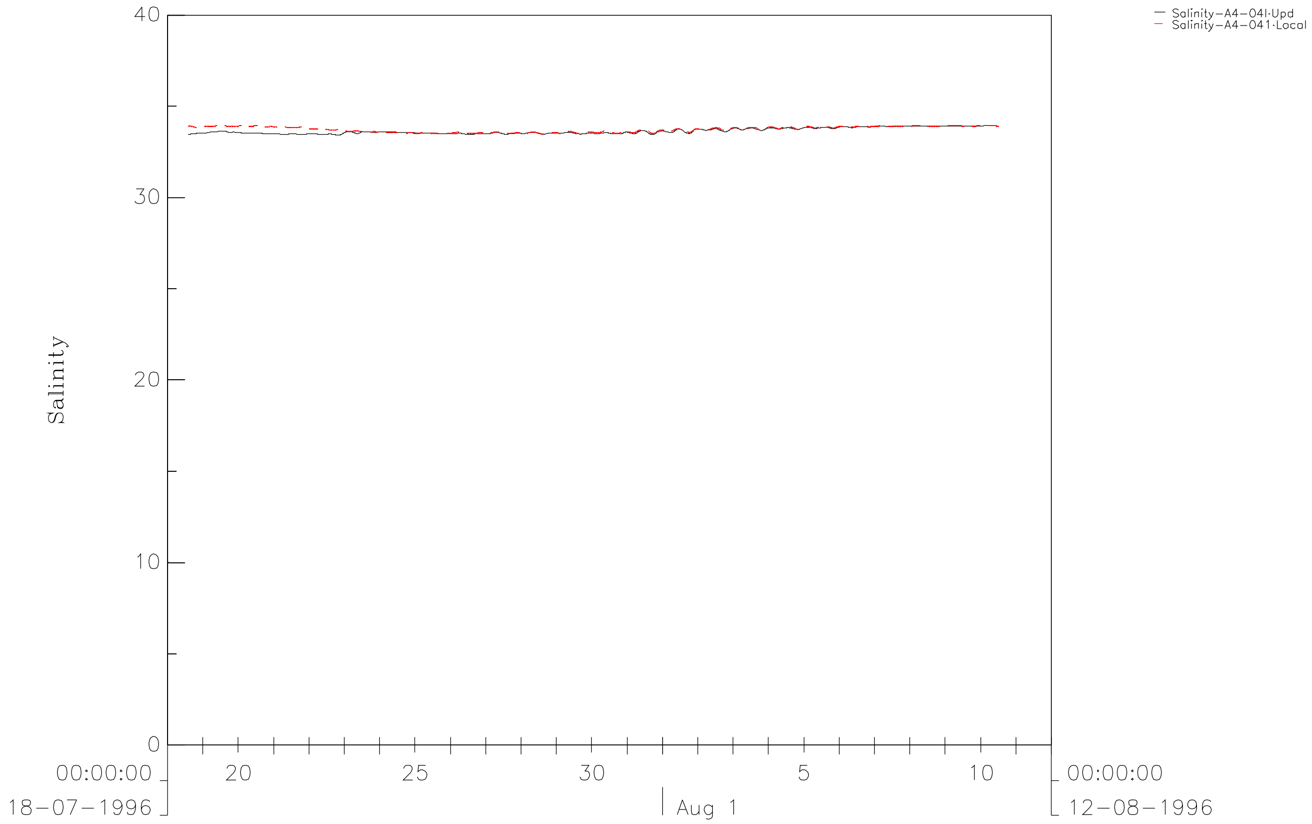
Salinity comparison between Update Model and Local Refine Model at SM17 (upper) and SM12 (lower).	Dry Season
	Figure 5A-42
DSD & ATKINS	



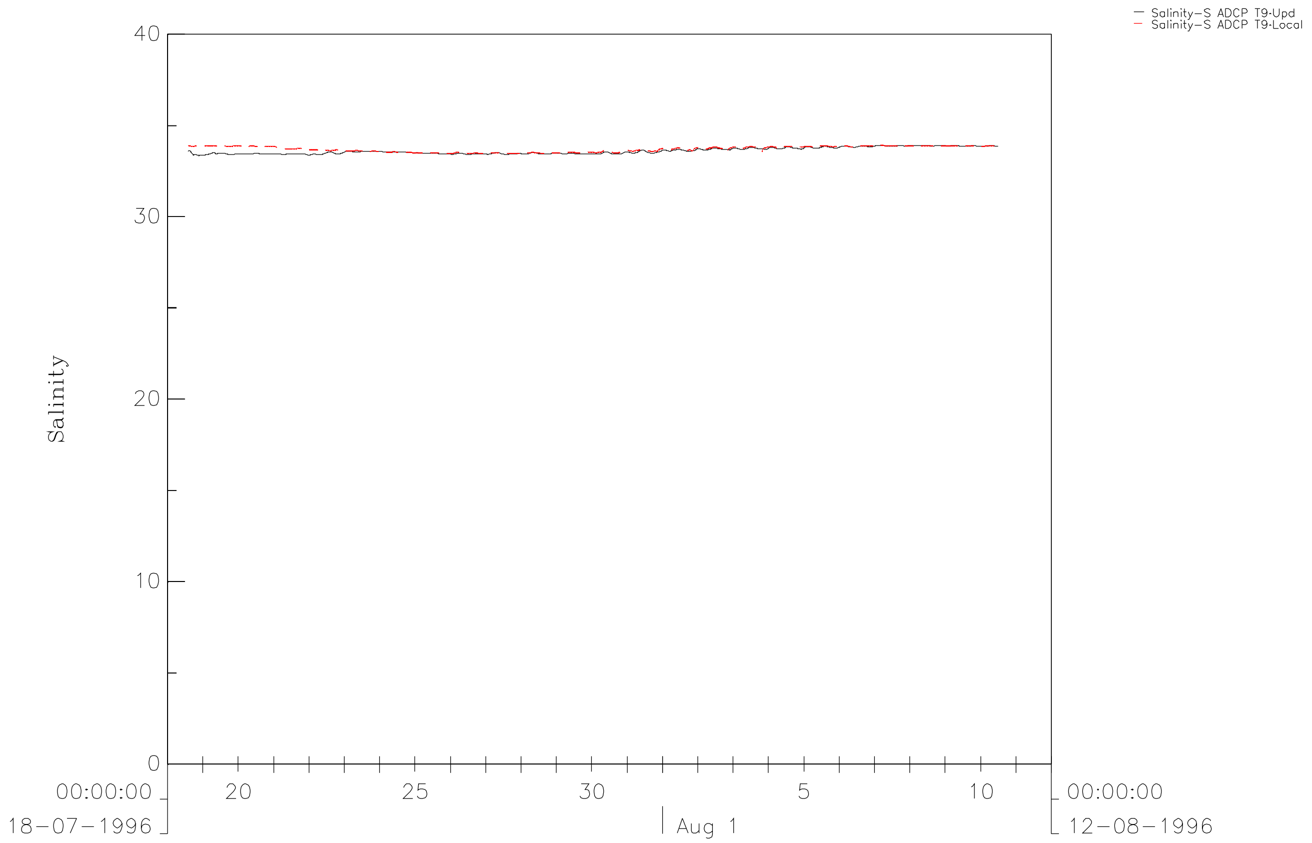


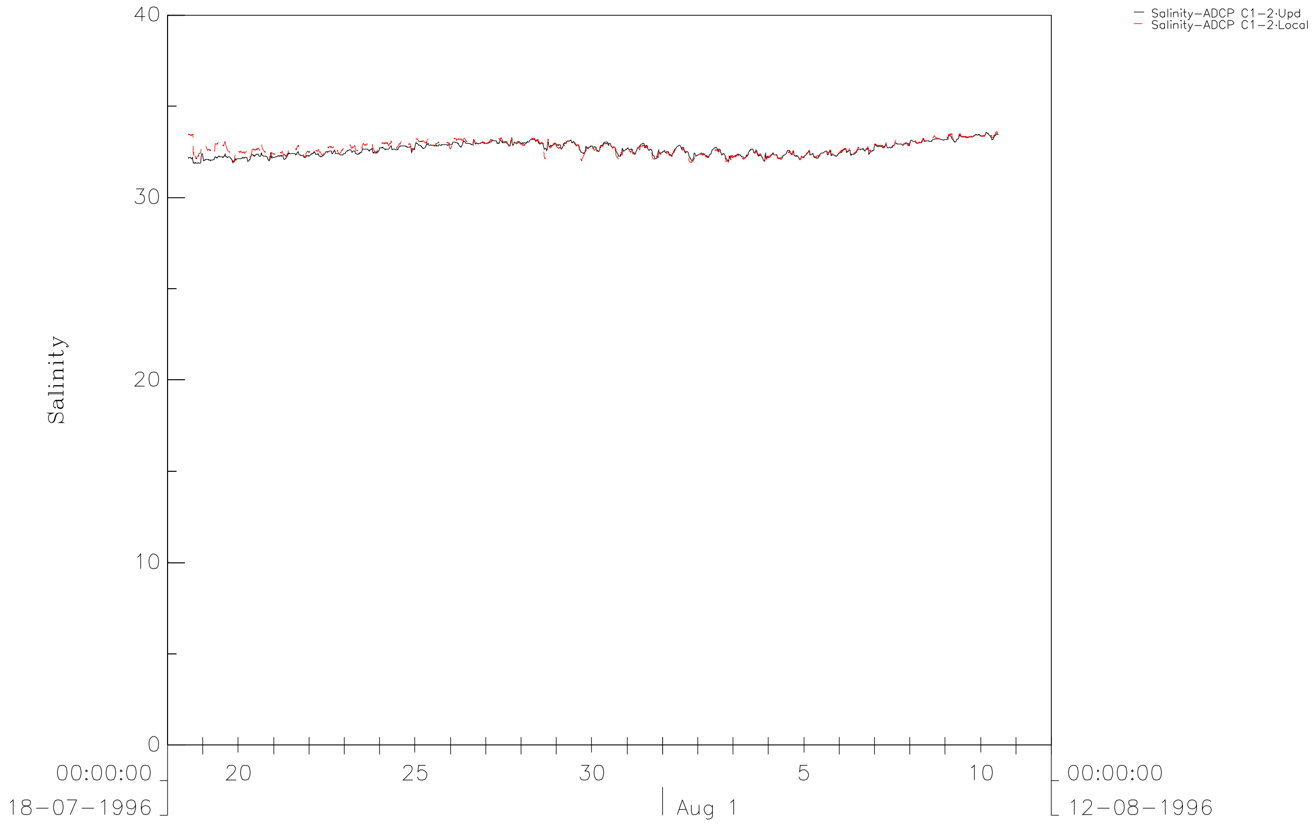
Salinity comparison between Update Model and Local Refine Model at SSDS EIA 04 (upper) and V Station 8 (lower).	Dry Season
	Figure 5A-43
DSD & ATKINS	



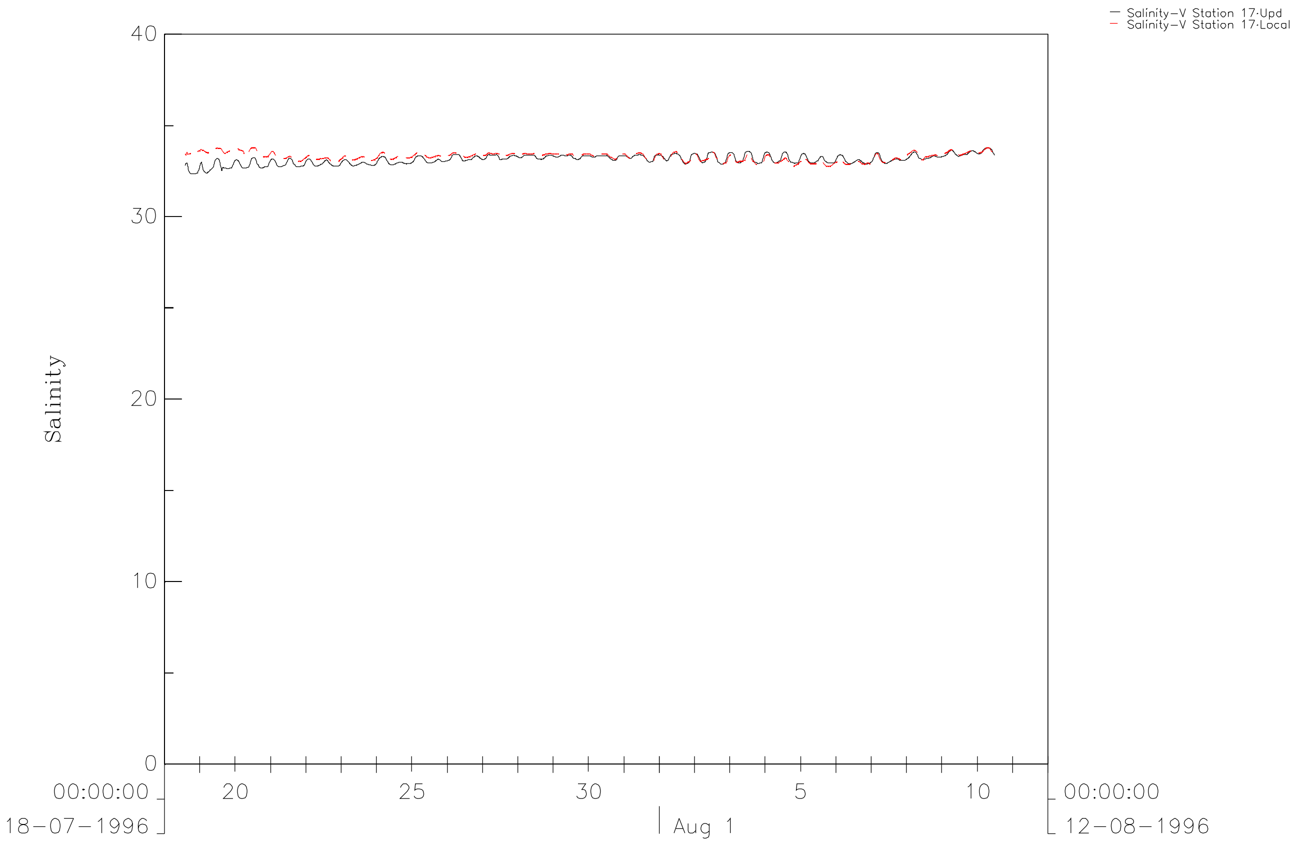


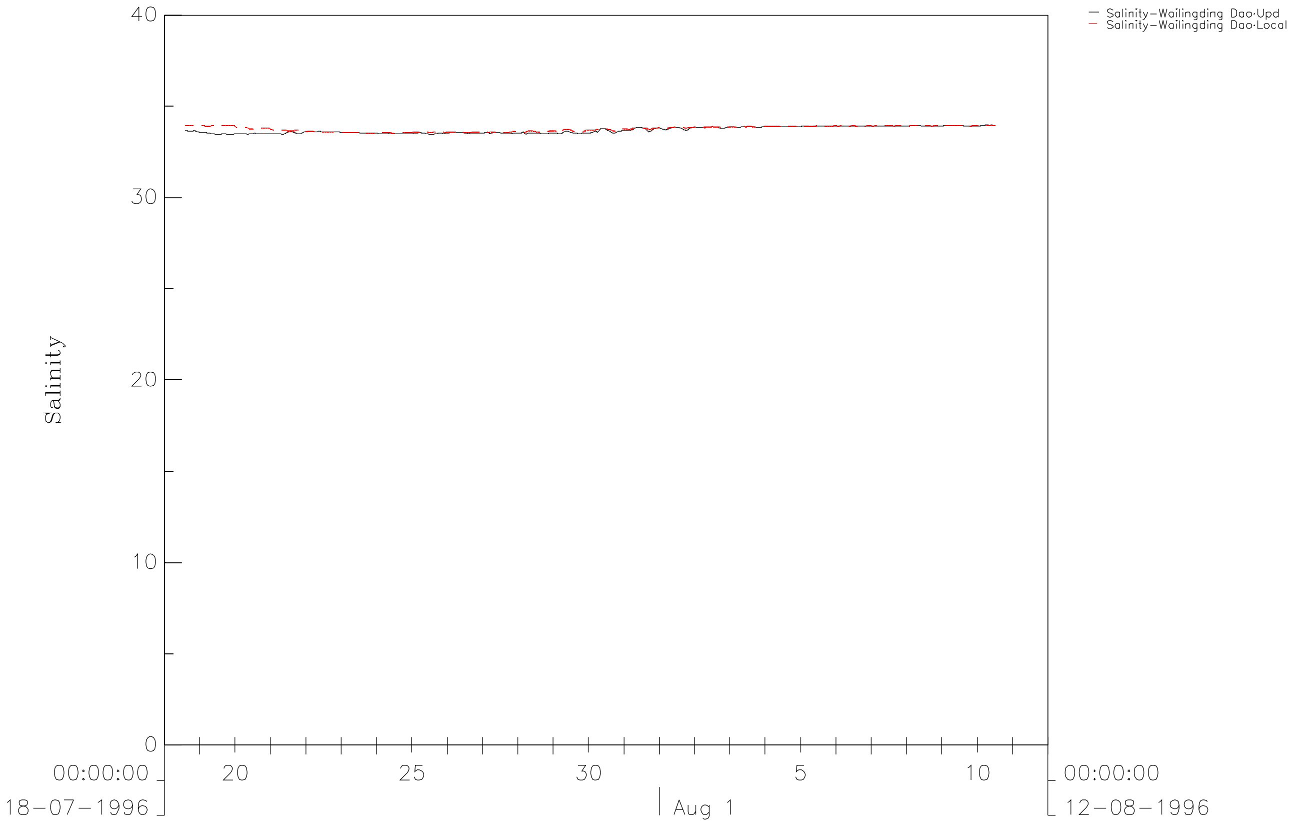
Salinity comparison between Update Model and Local Refine Model at P E6 (upper) and A4-041 (lower).	Dry Season
	Figure 5A-44
DSD & ATKINS	



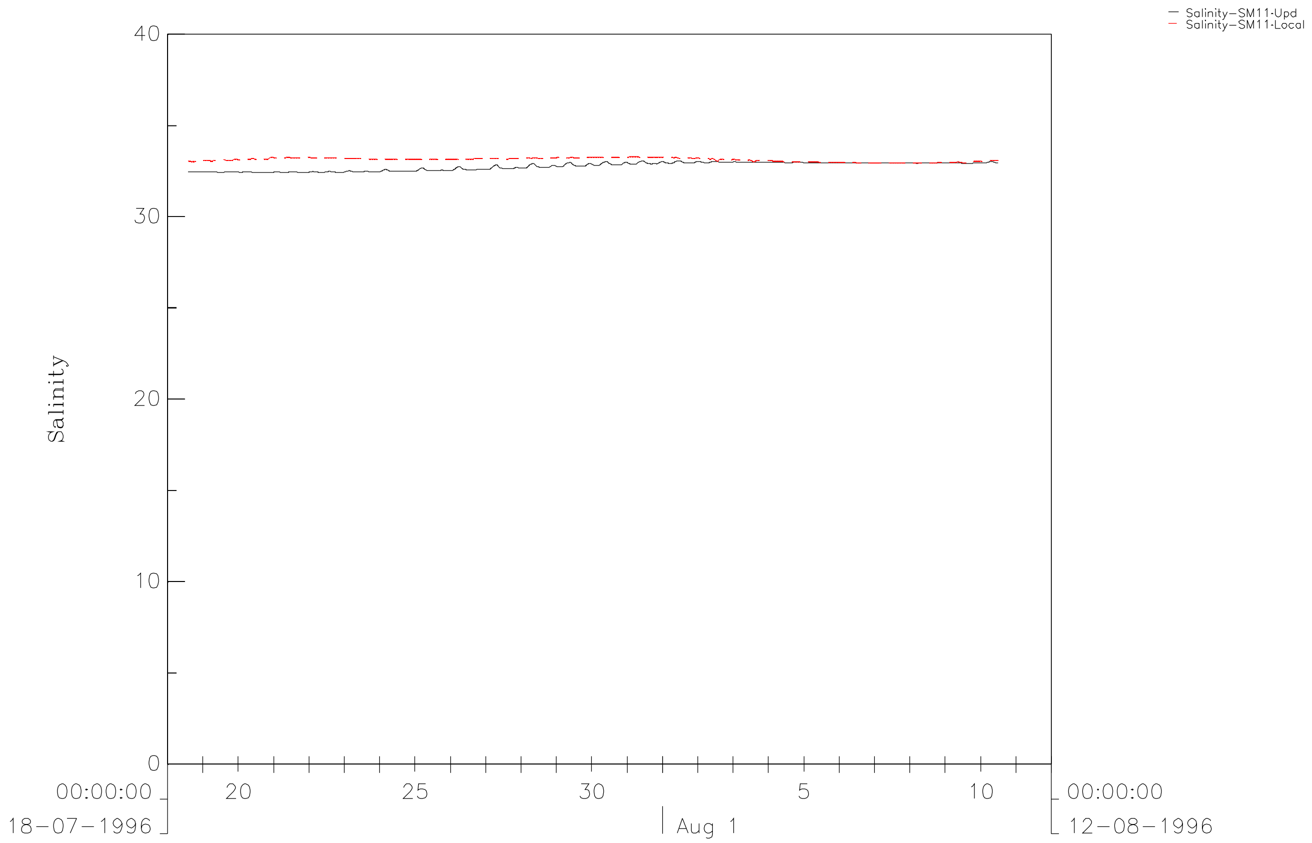


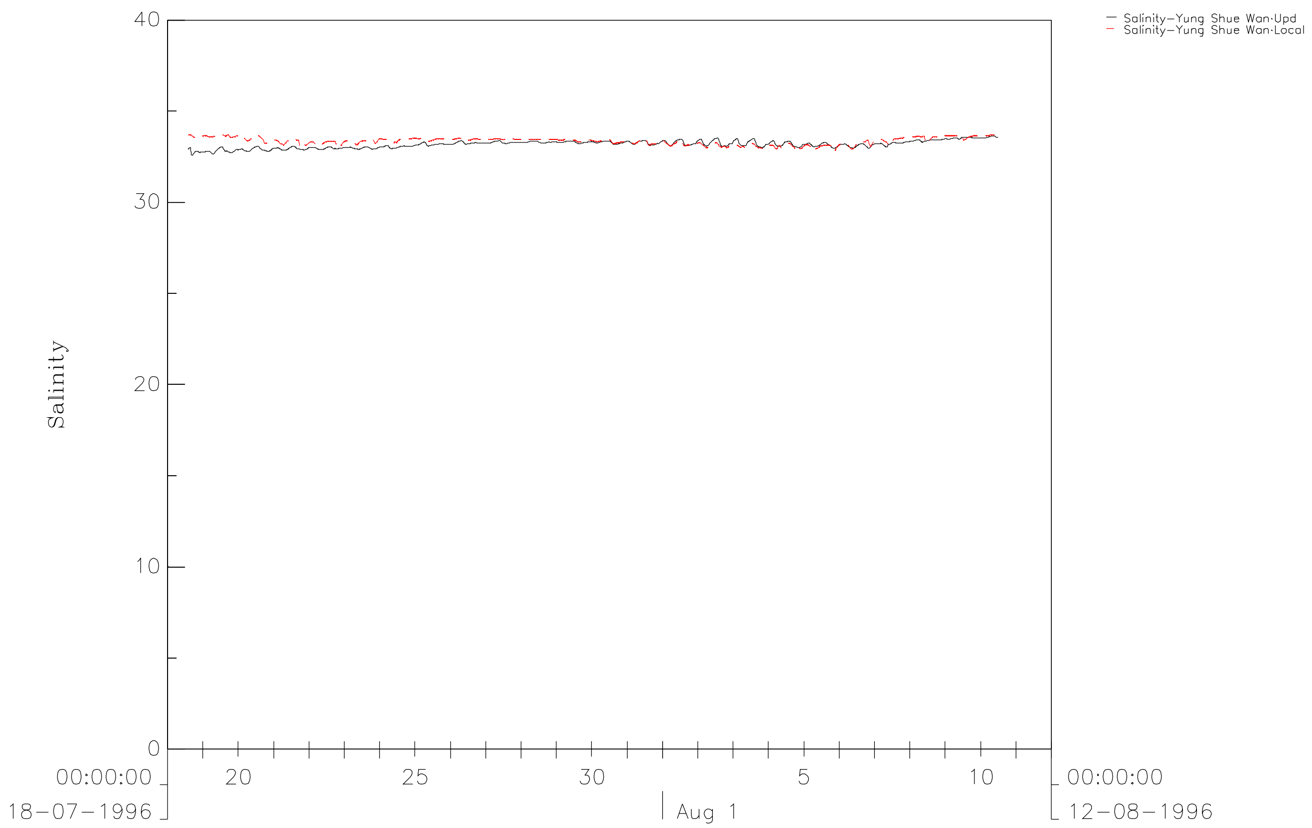
Salinity comparison between Update Model and Local Refine Model at S ADCP T9 (upper) and ADCP C1–2 (lower).	Dry Season
	Figure 5A-45
DSD & ATKINS	



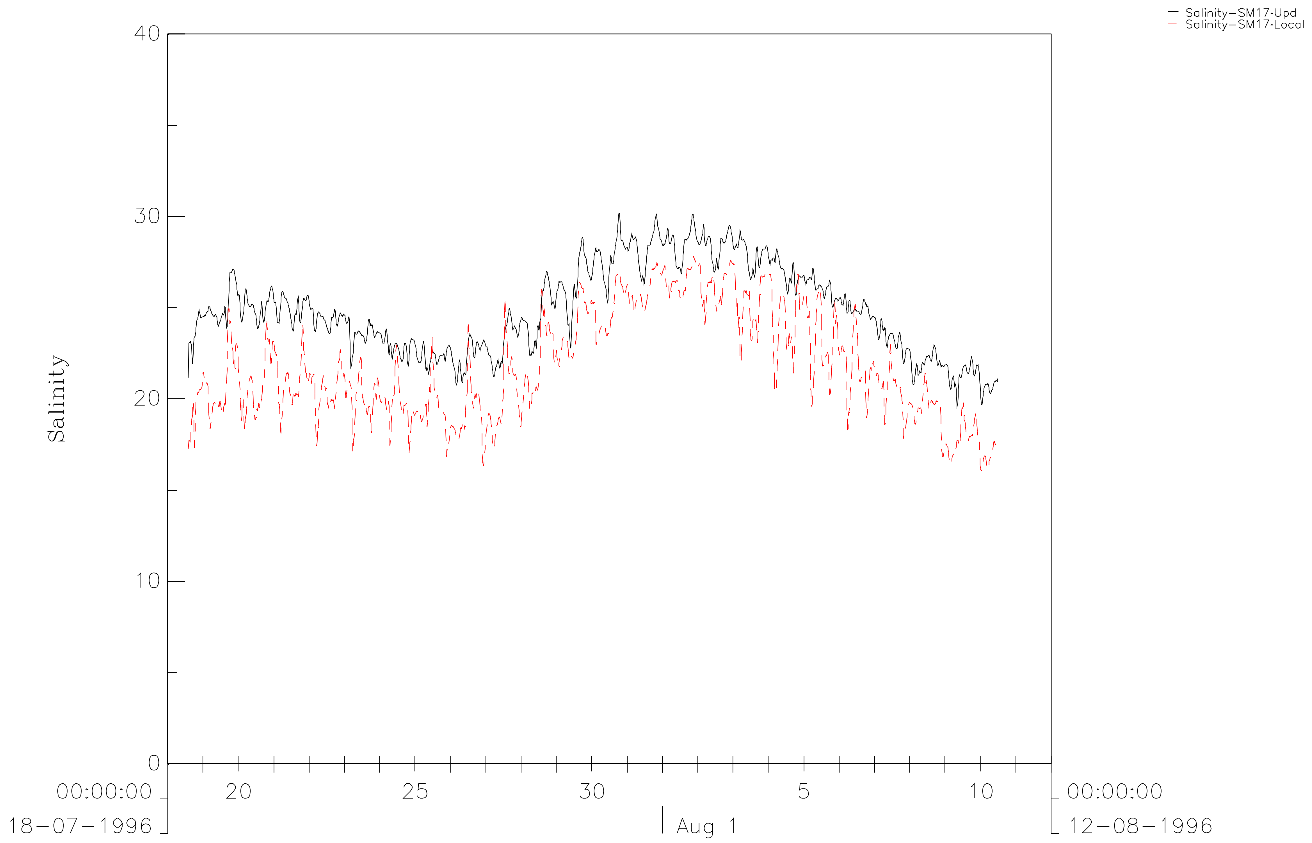


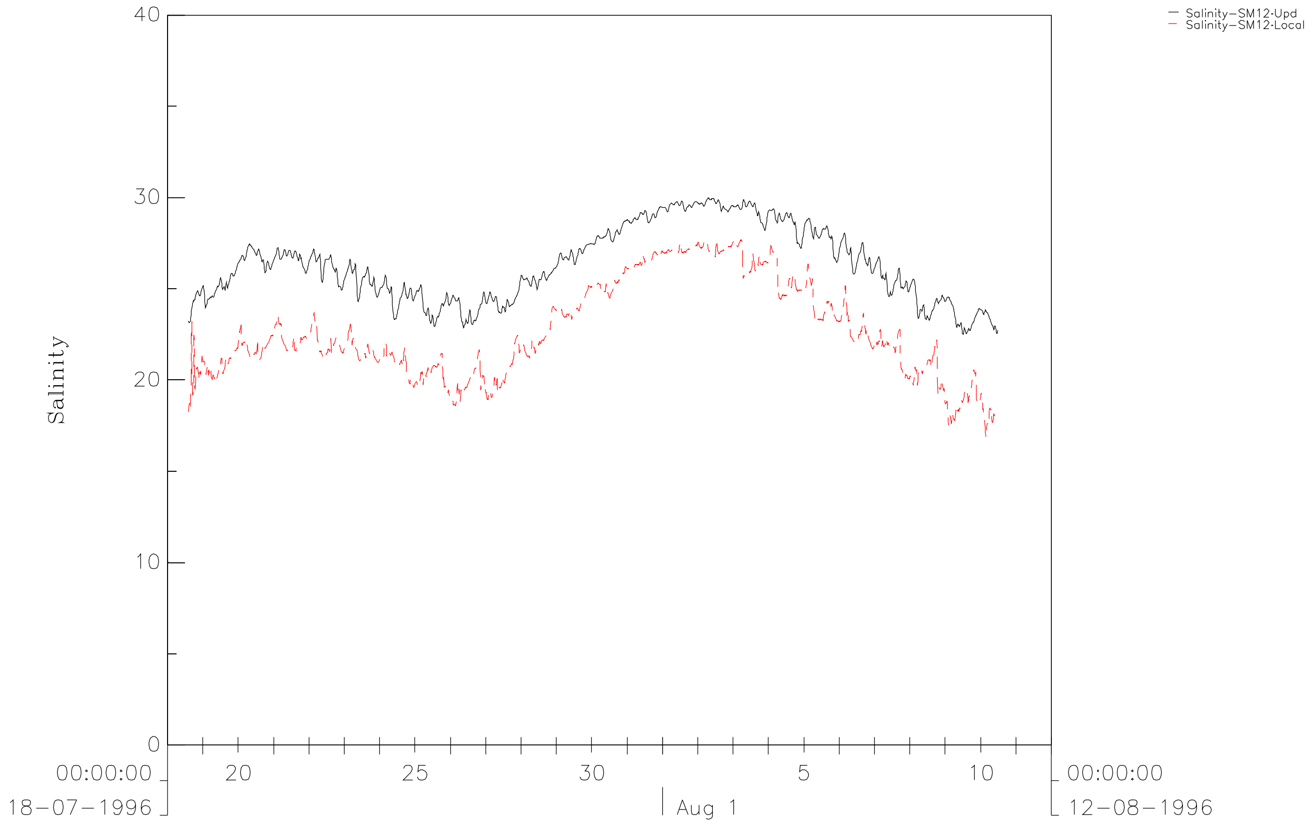
Salinity comparison between Update Model and Local Refine Model at V Station 17 (upper) and Wailinding dao (lower).	Dry Season
	Figure 5A-46
DSD & ATKINS	



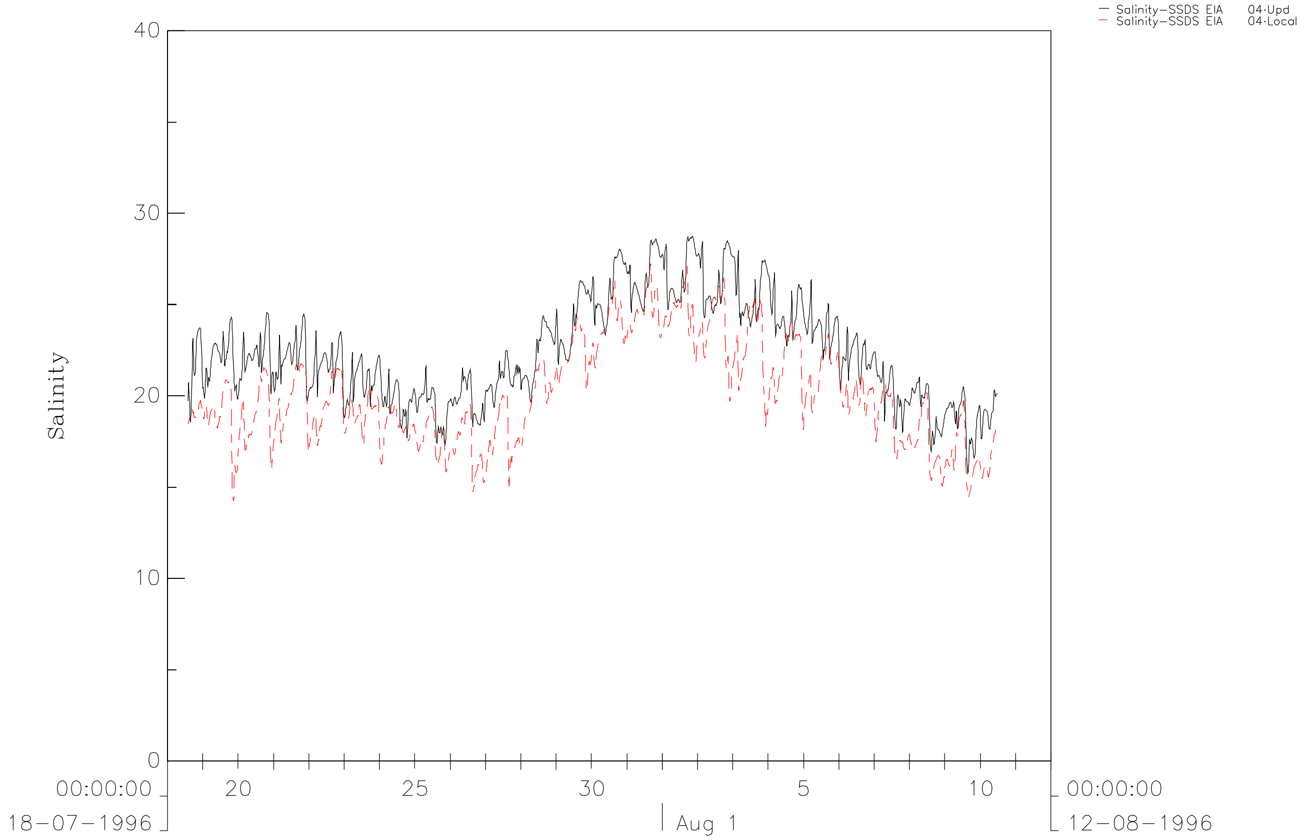


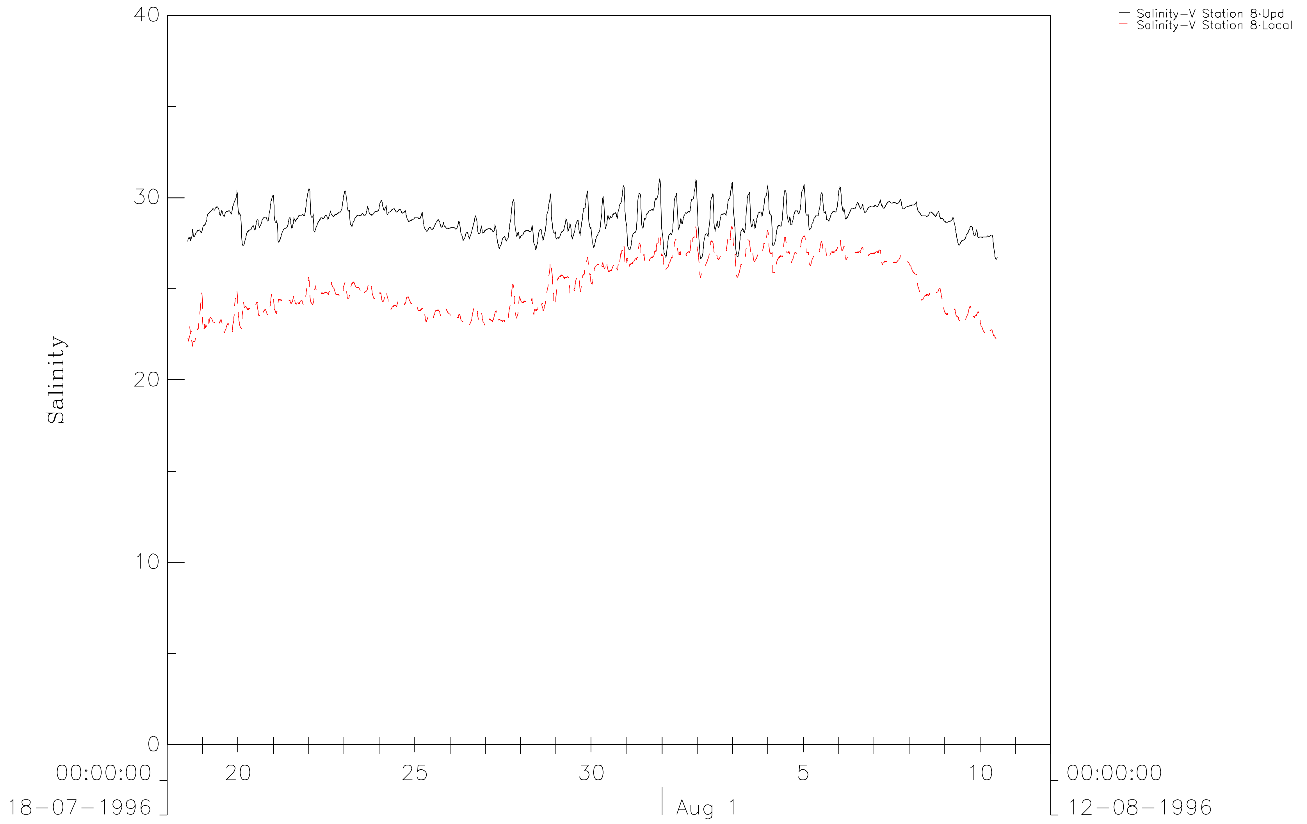
Salinity comparison between Update Model and Local Refine Model at SM11(upper) and Yung Shue WAN (lower).	Dry Season
	Figure 5A-47
DSD & ATKINS	



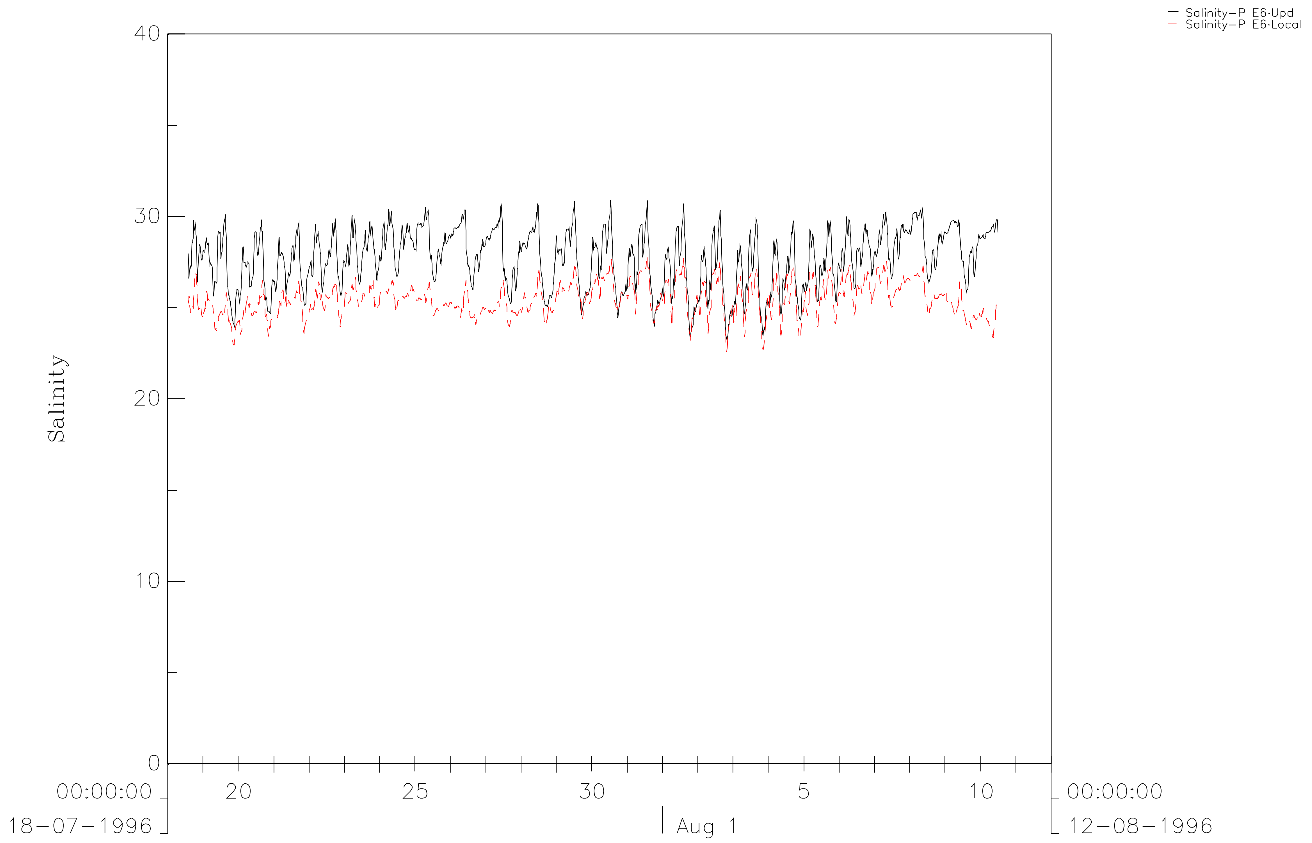


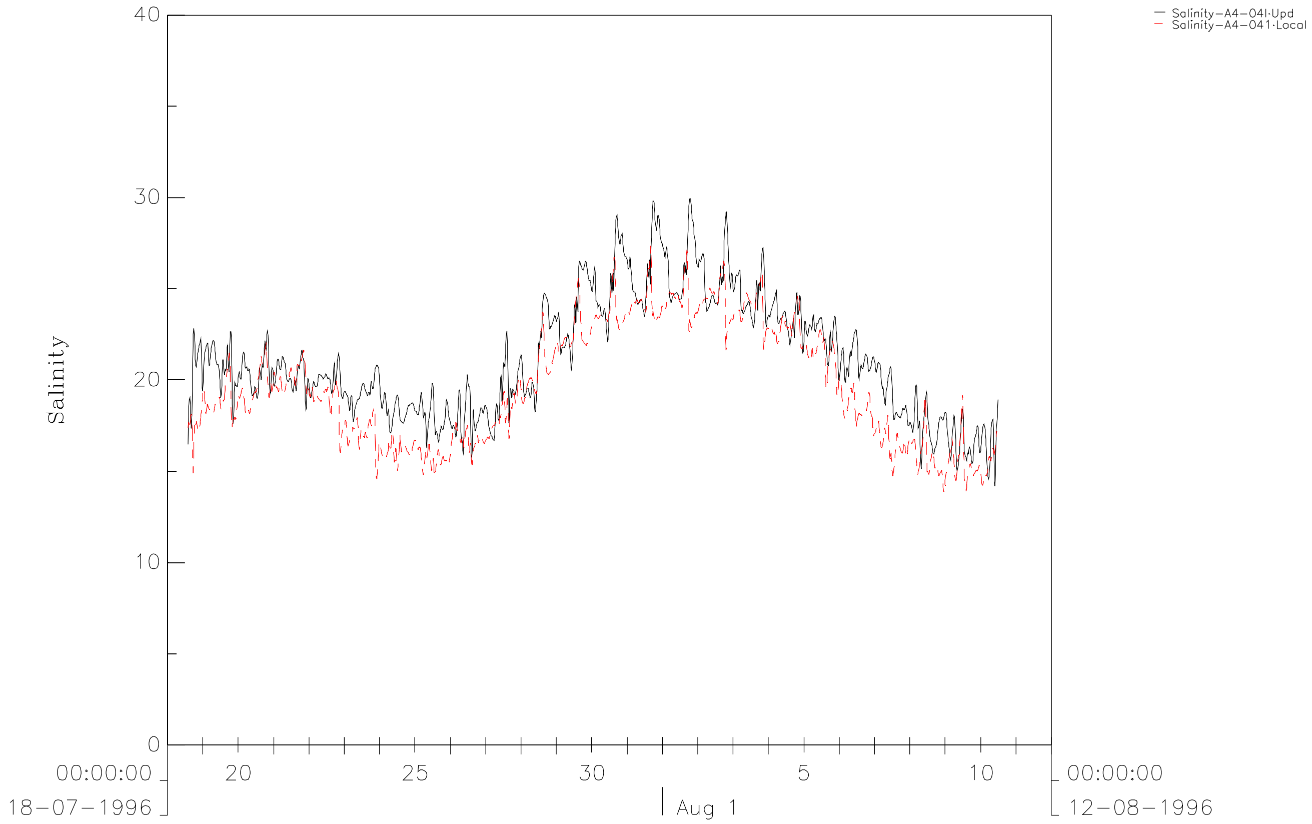
Salinity comparison between Update Model and Local Refine Model at SM17 (upper) and SM12 (lower).	Wet Season	
	Figure 5A-48	
DSD & ATKINS		



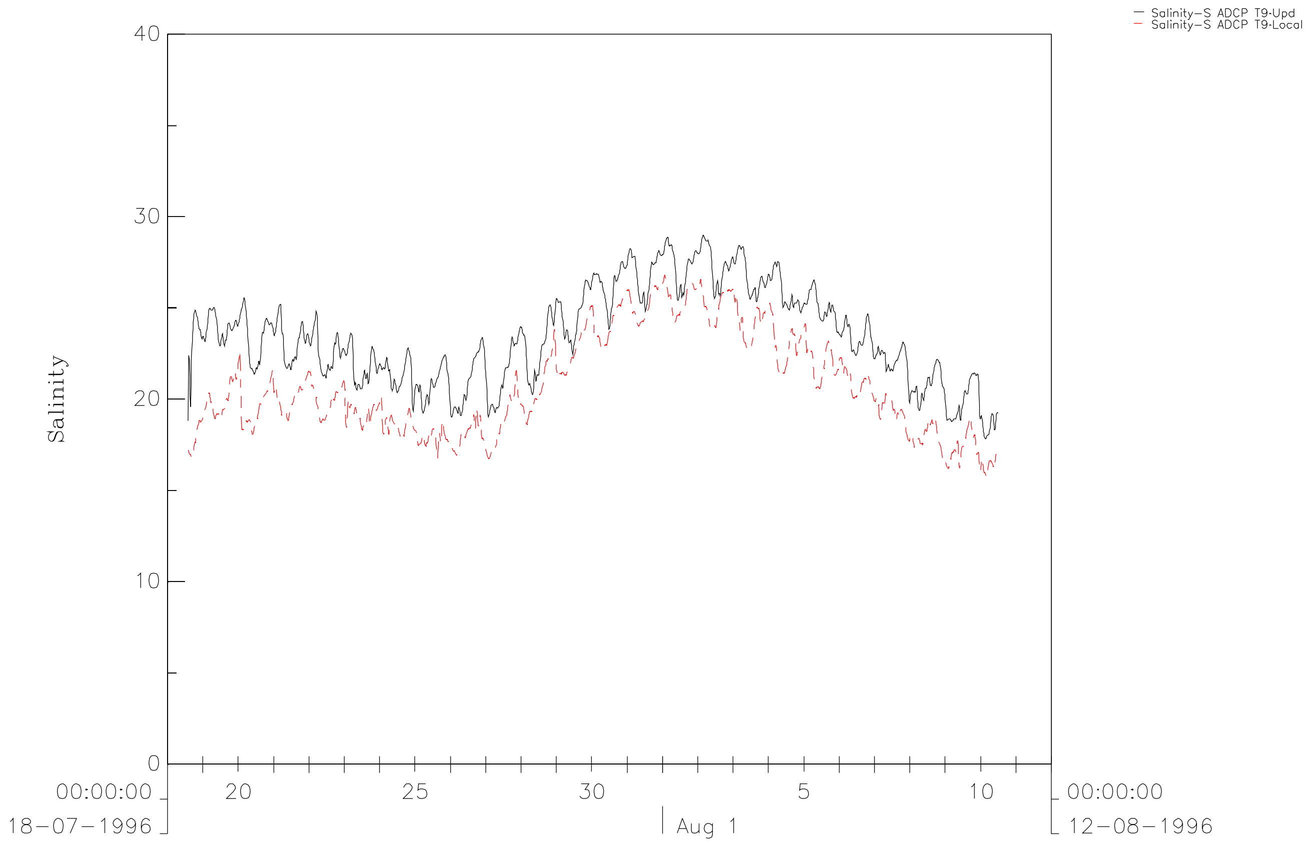


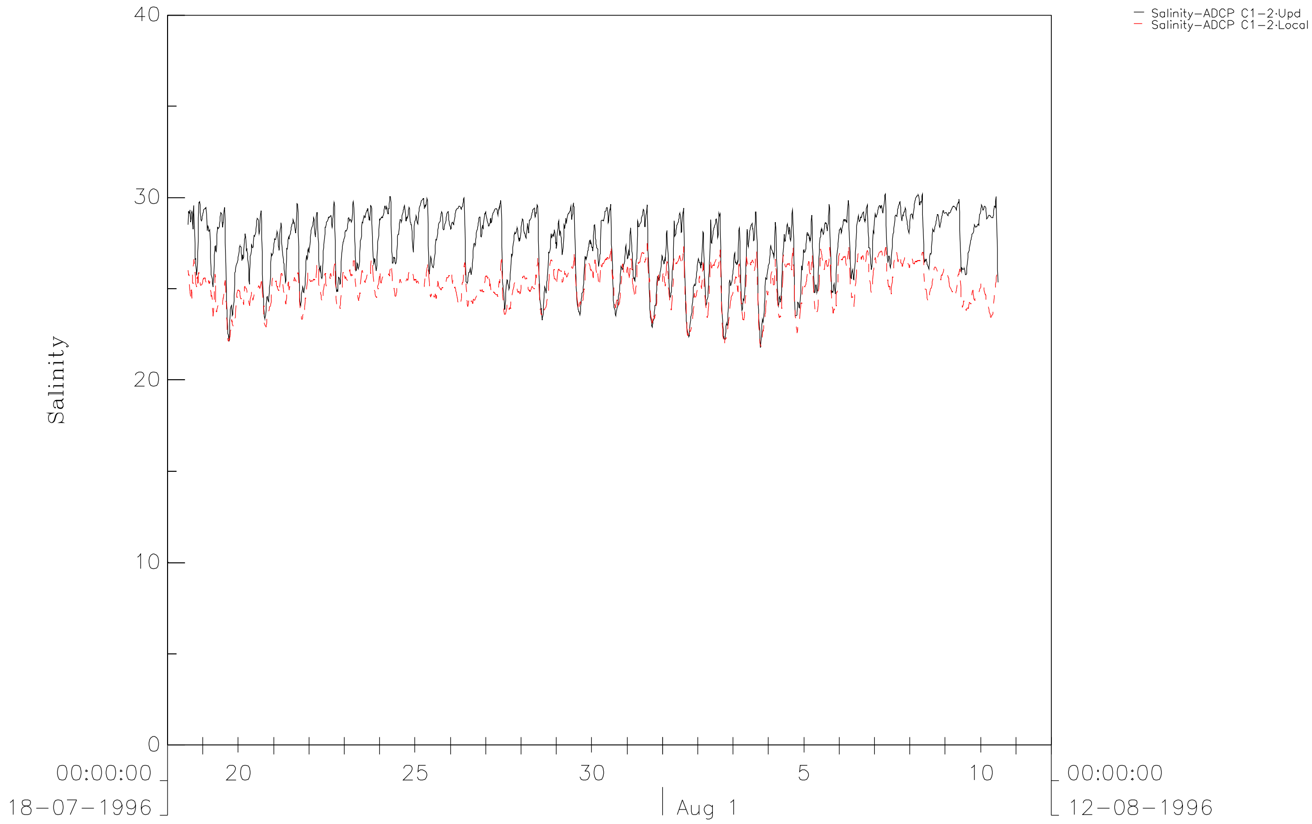
Salinity comparison between Update Model and Local Refine Model at SSDS EIA 04 (upper) and V Station 8 (lower).	Wet Season
	Figure 5A-49
DSD & ATKINS	



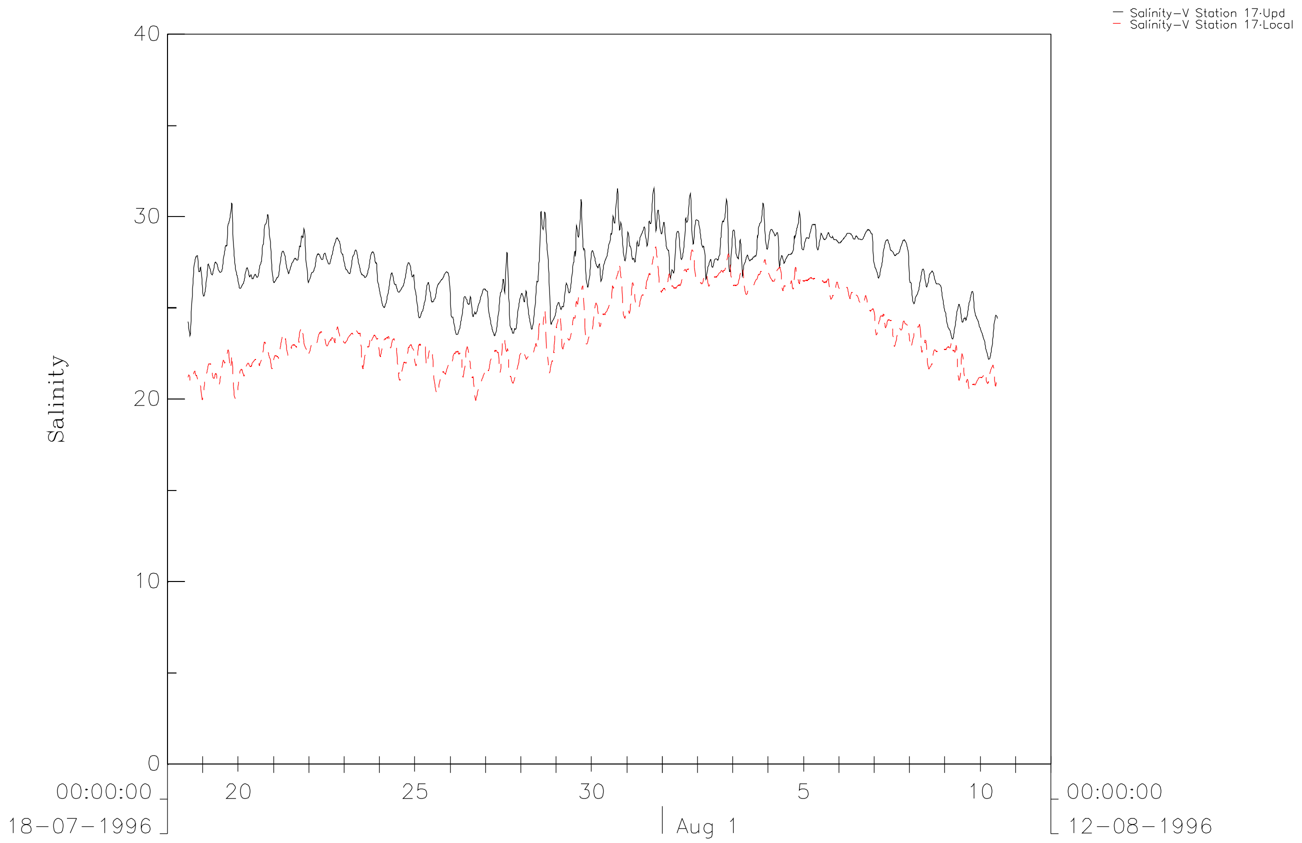


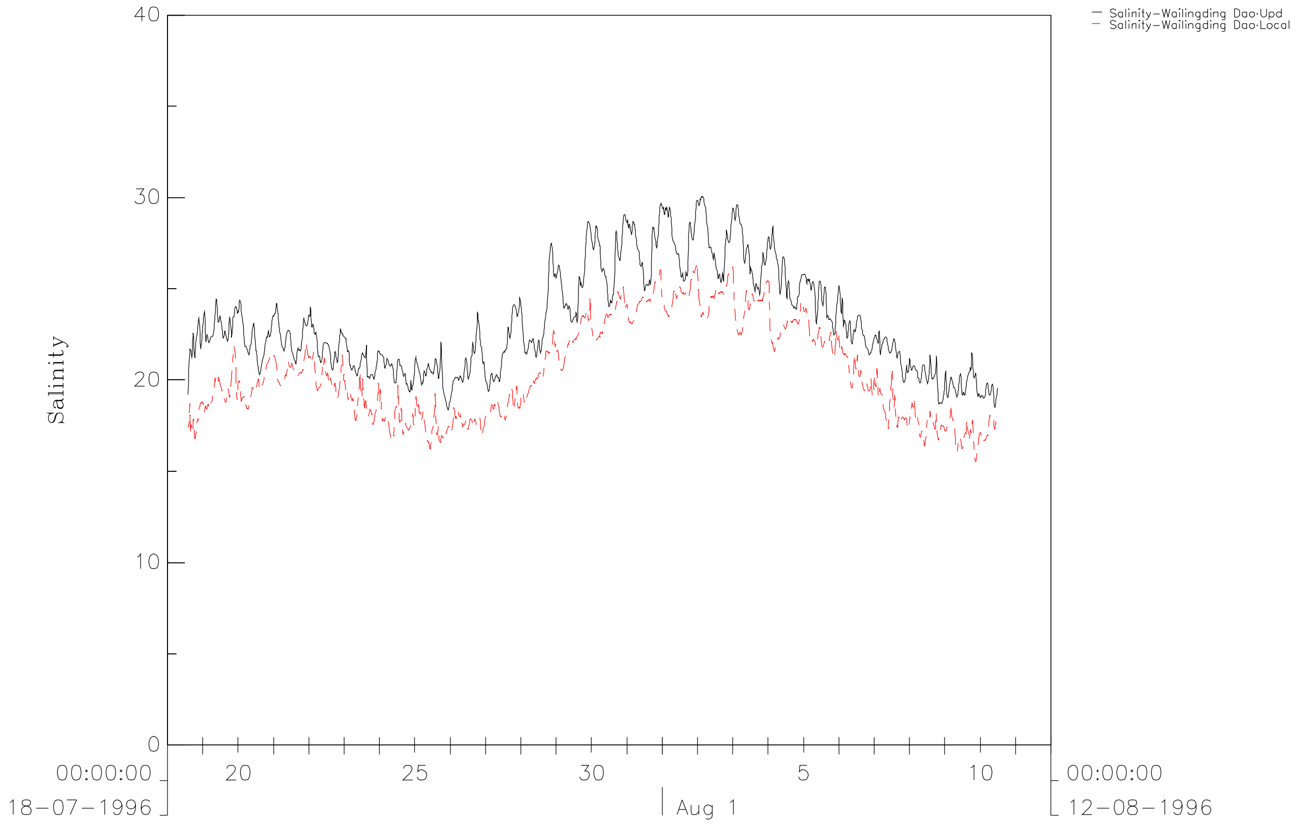
Salinity comparison between Update Model and Local Refine Model at P E6 (upper) and A4–041 (lower).	Wet Season
	Figure 5A-50
DSD & ATKINS	



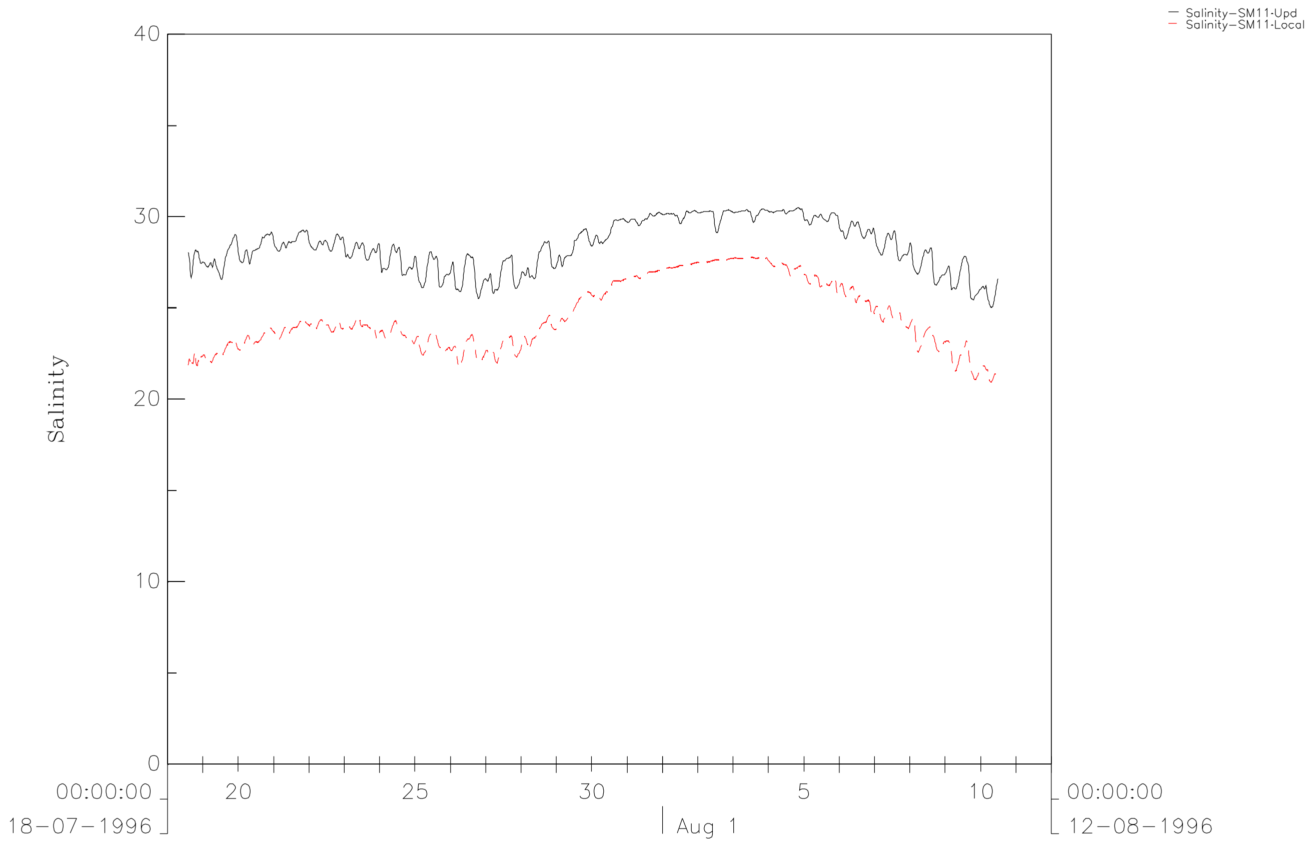


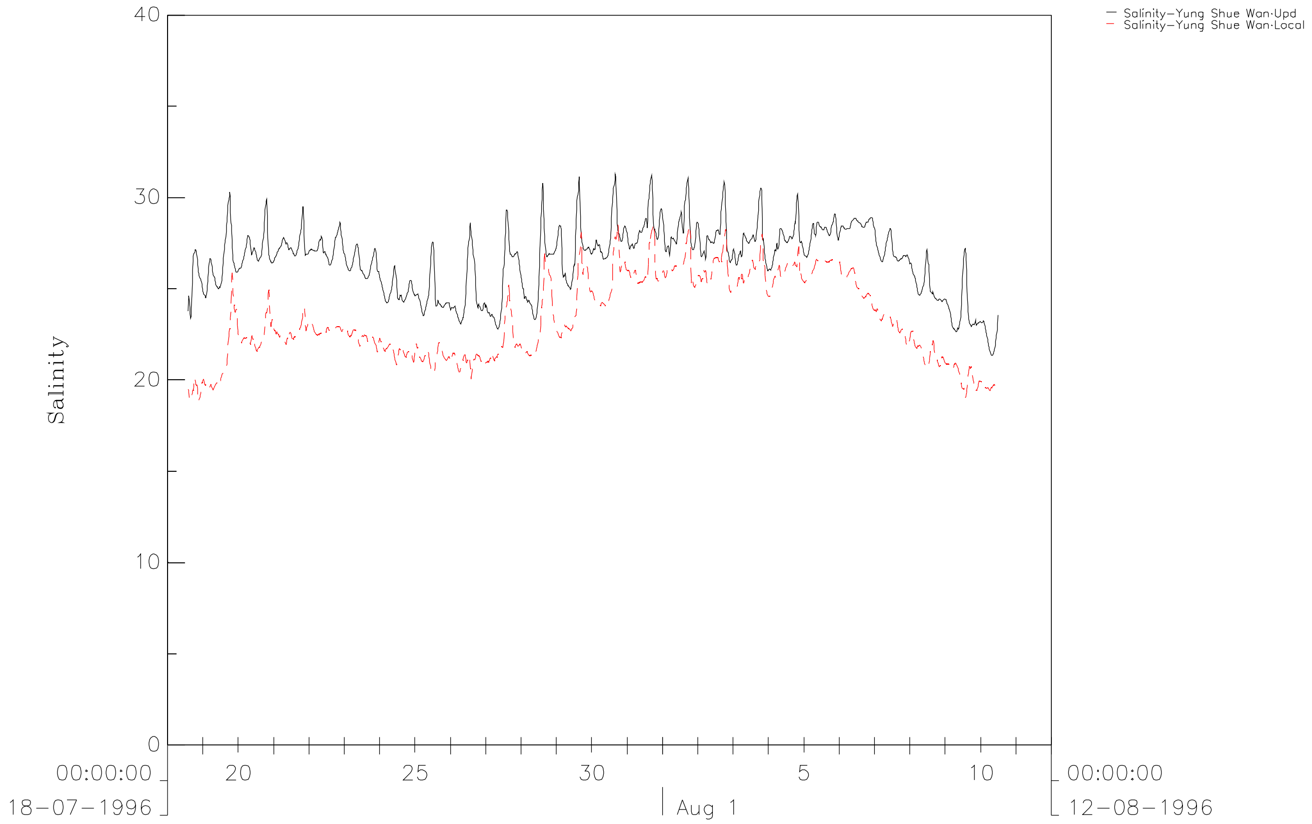
Salinity comparison between Update Model and Local Refine Model at S ADCP T9 (upper) and ADCP C1–2 (lower).	Wet Season
	Figure 5A-51
DSD & ATKINS	



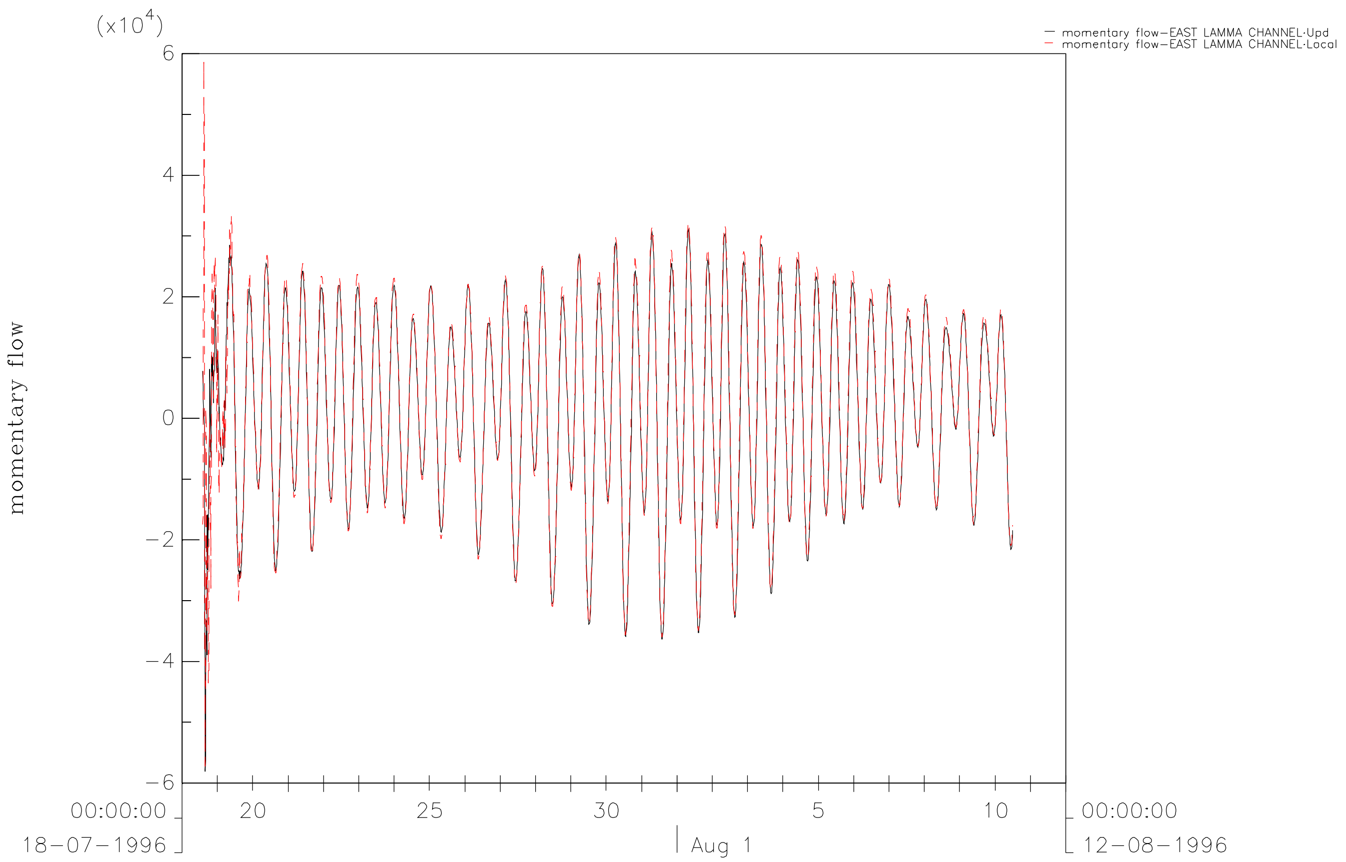


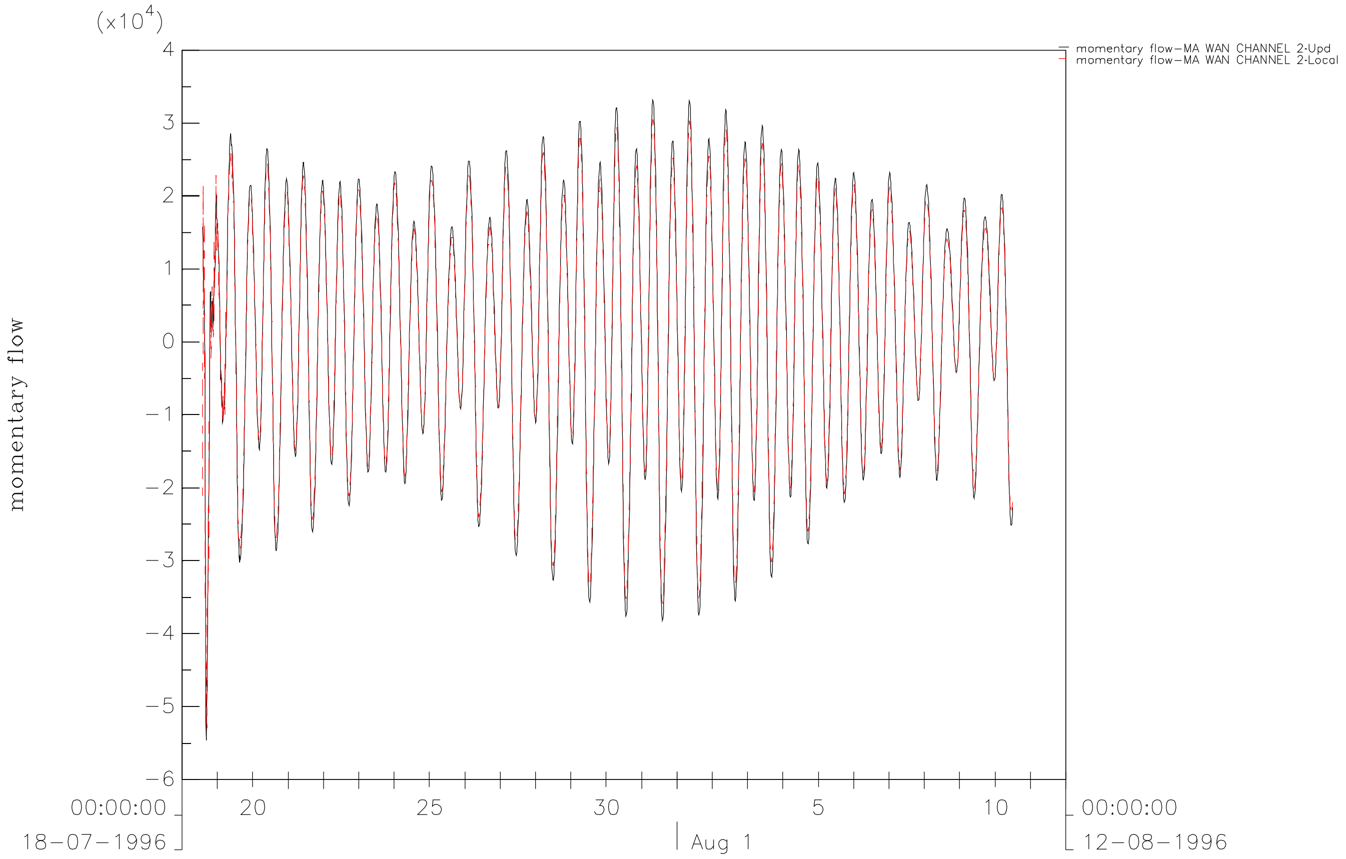
Salinity comparison between Update Model and Local Refine Model at V Station 17 (upper) and Wailinding dao (lower).	Wet Season
	Figure 5A-52
DSD & ATKINS	



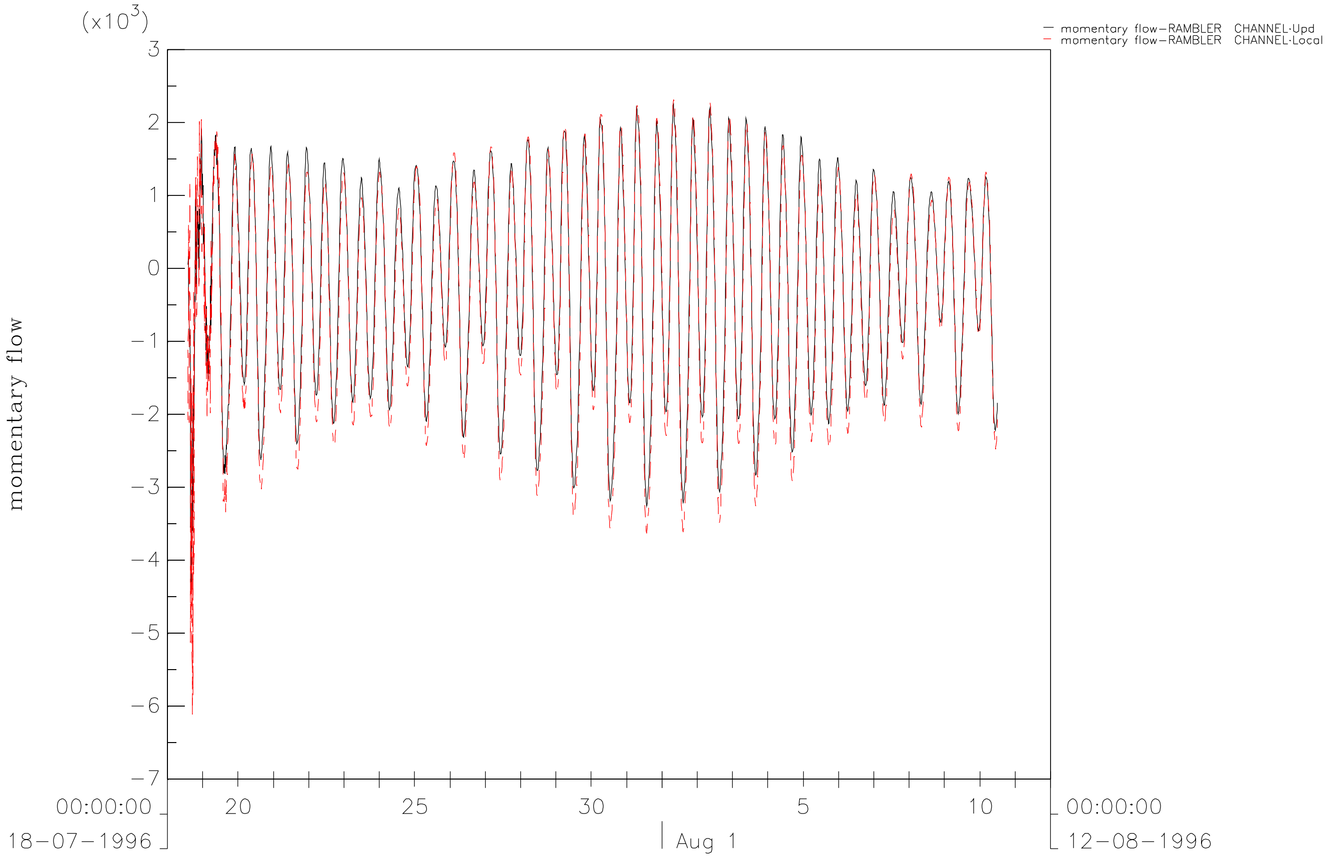


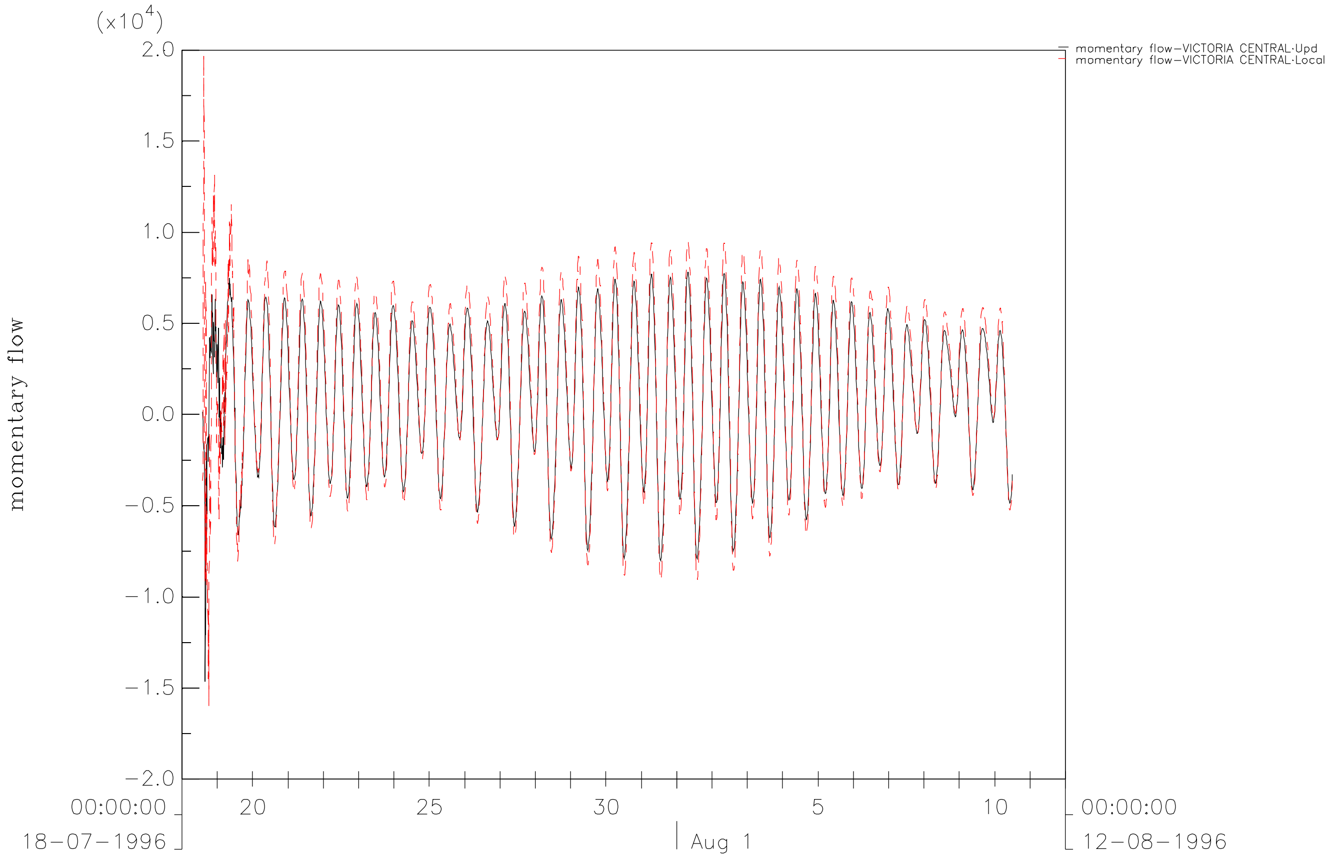
Salinity comparison between Update Model and Local Refine Model at SM11(upper) and Yung Shue WAN (lower).	Wet Season	
	Figure 5A-53	
DSD & ATKINS		





Flow comparison between Update Model and Local Refine Model at EAST LAMMA CHANNEL (upper) and MA WAN CHANNEL (lower).	Dry Season
	Figure 5A-54
DSD & ATKINS	



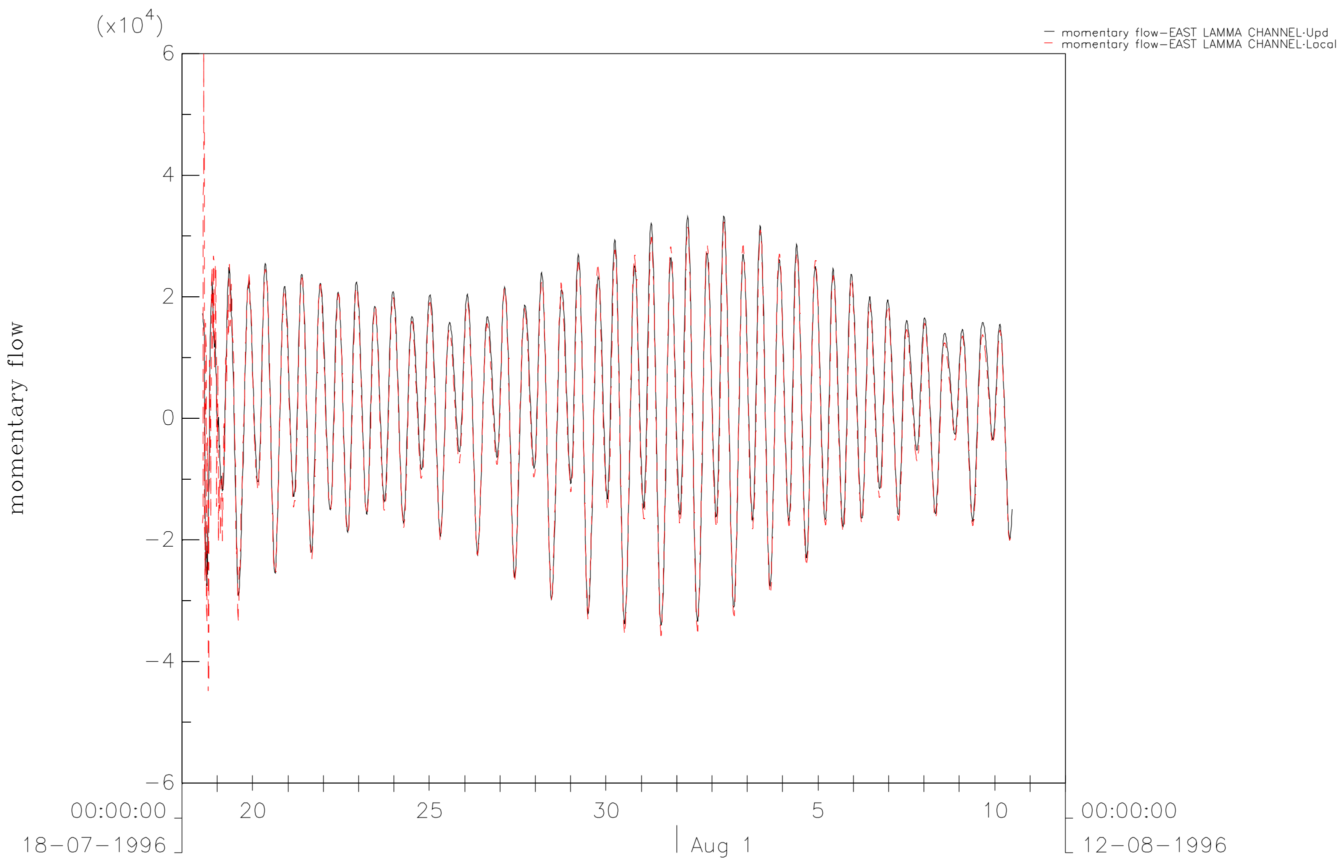


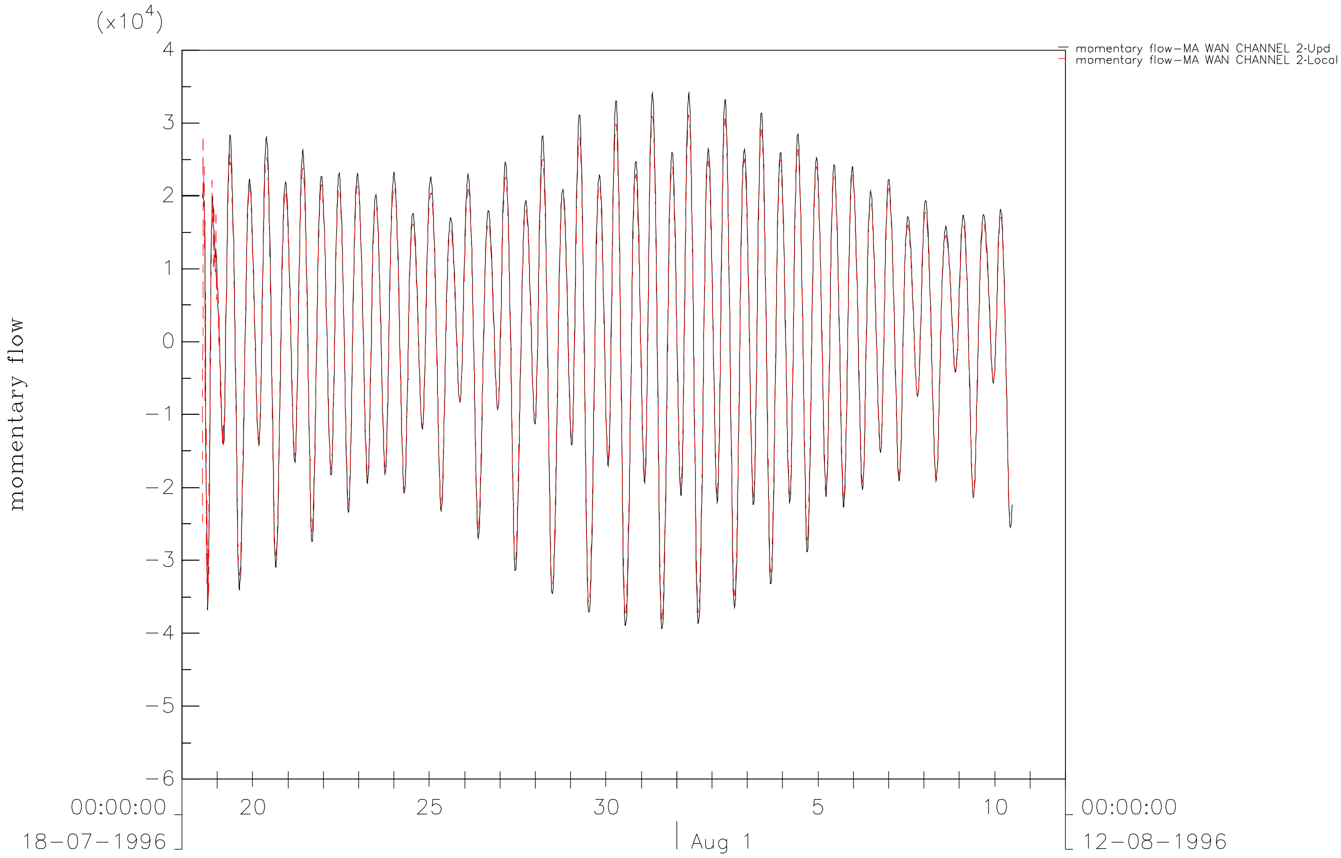
Flow comparison between Update Model and Local Refine Model at RAMBLER CHANNEL (upper) and VICTORIA CHANNEL (lower).

Dry Season

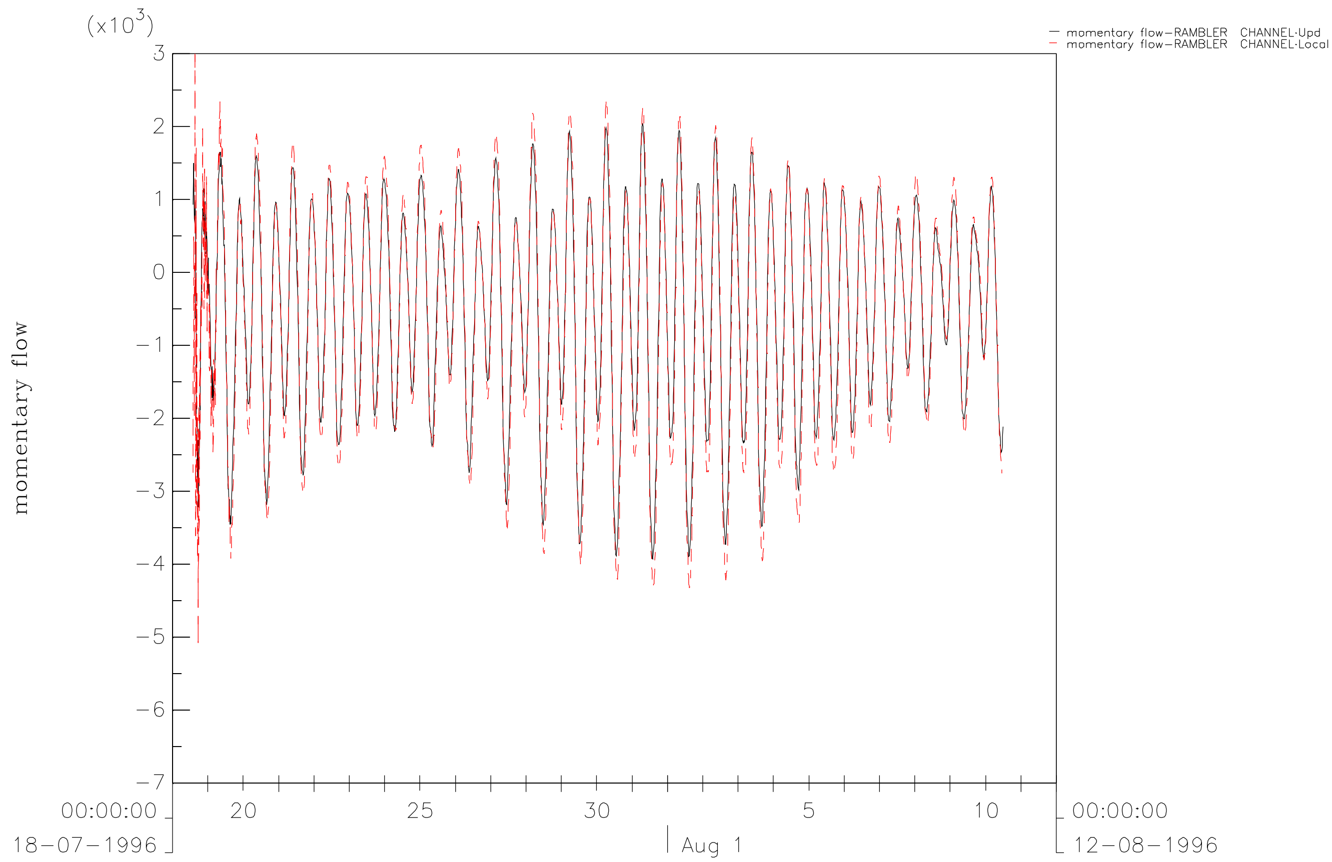
Figure 5A-55

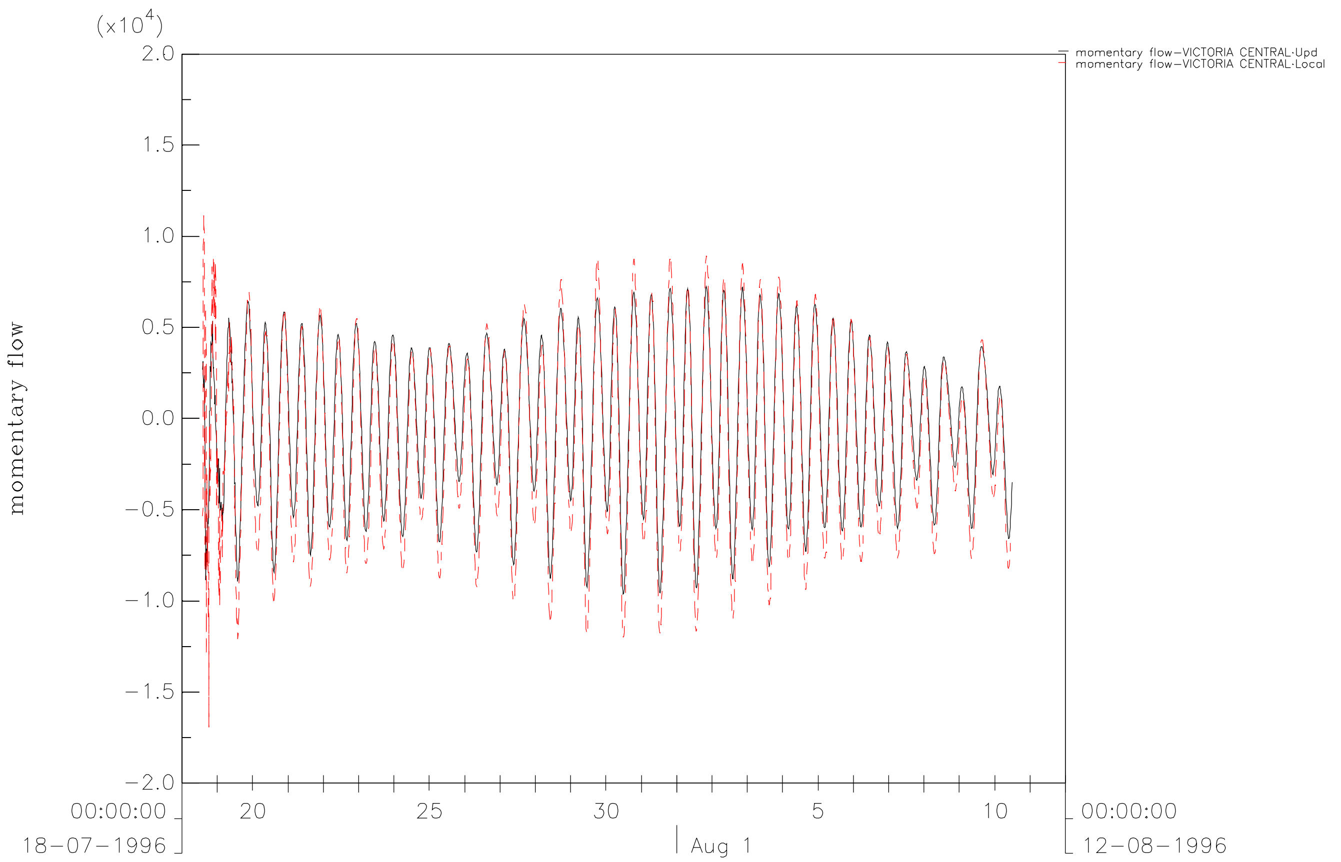
DSD & ATKINS



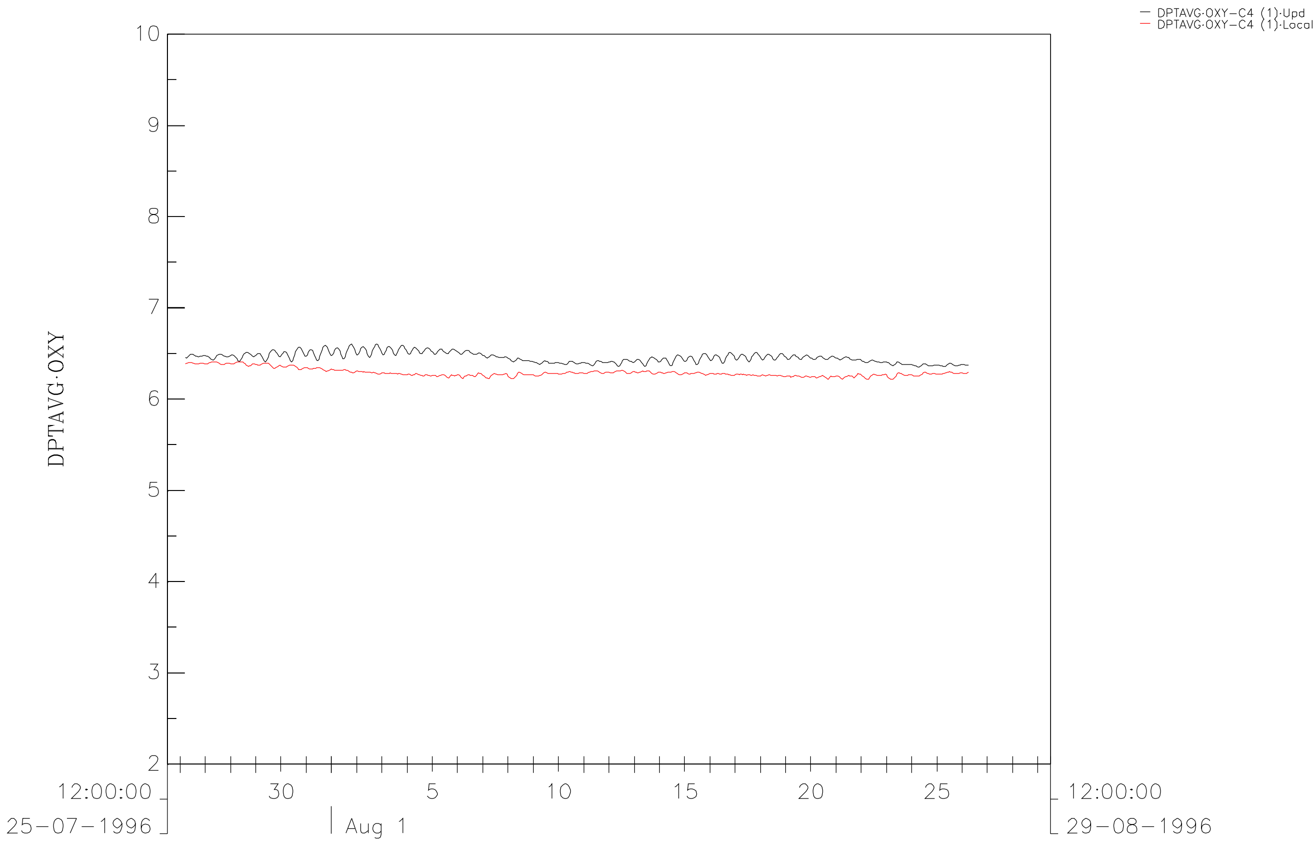


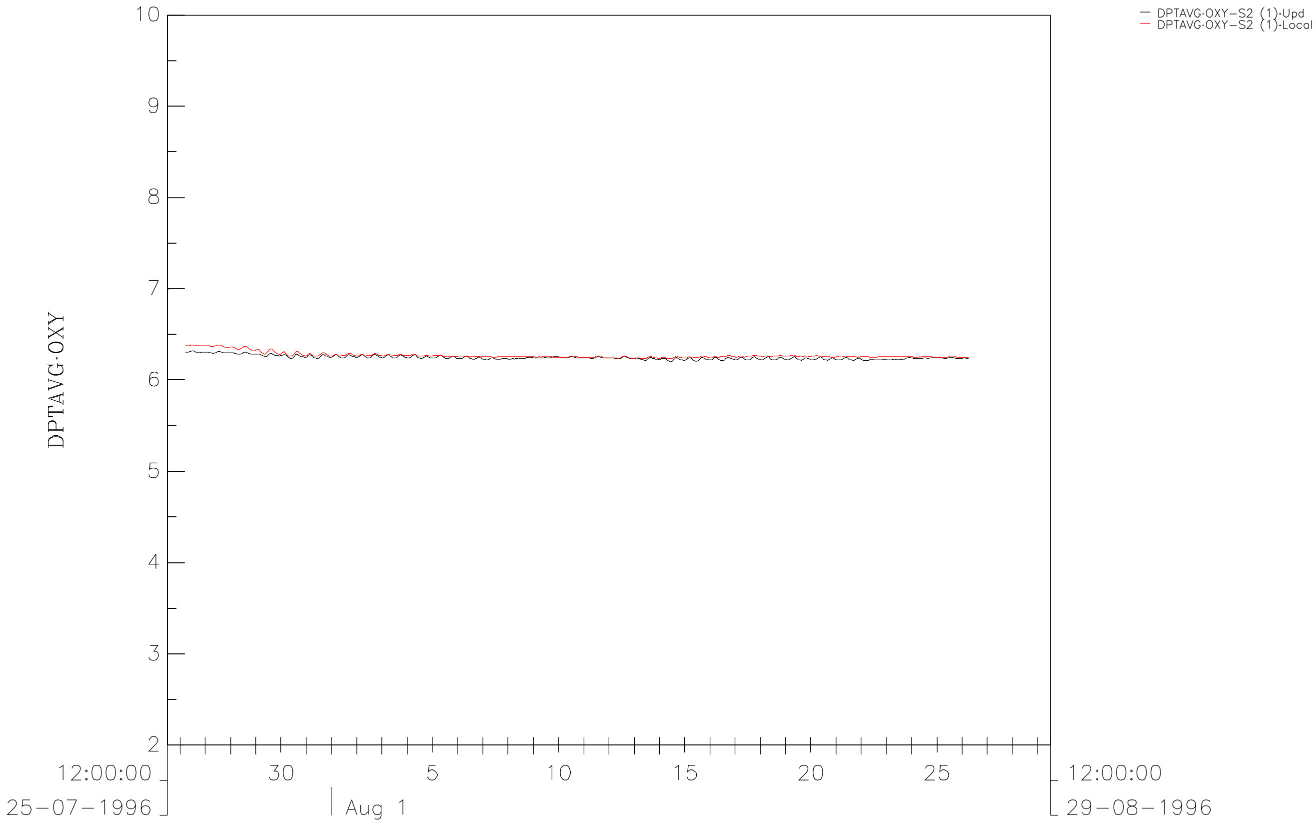
Flow comparison between Update Model and Local Refine Model at EAST LAMMA CHANNEL (upper) and MA WAN CHANNEL (lower).	Wet Season
	Figure 5A-56
DSD & ATKINS	



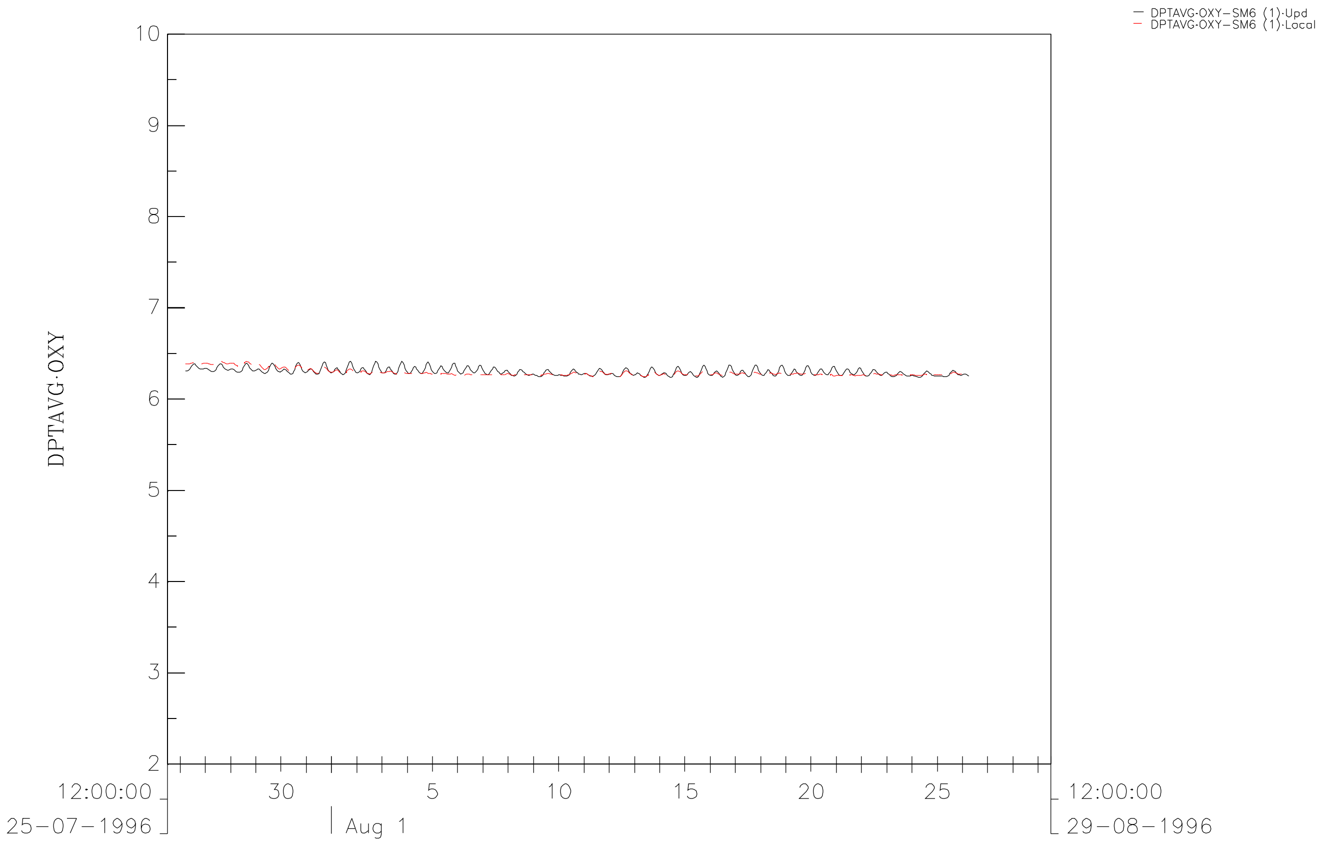


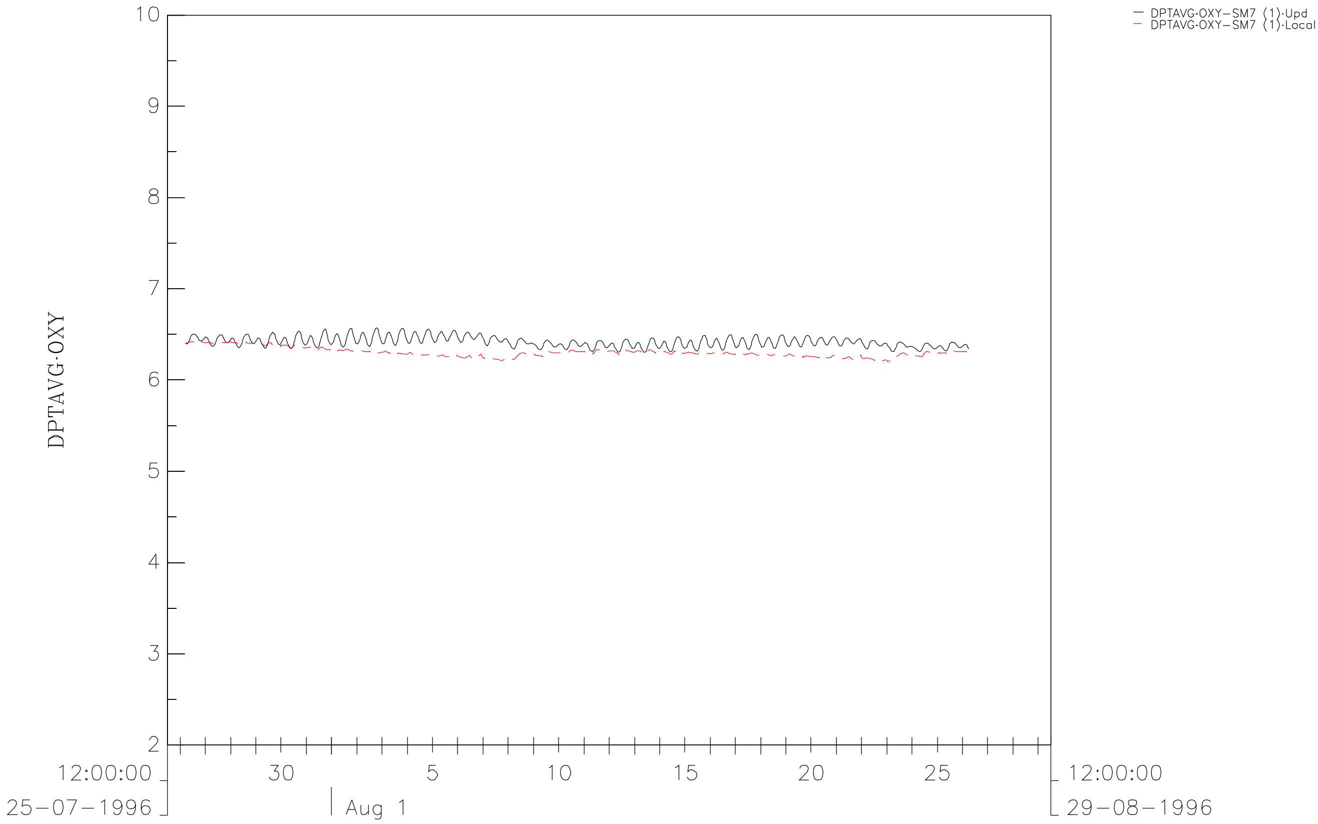
Flow comparison between Update Model and Local Refine Model at RAMBLER CHANNEL (upper) and VICTORIA CHANNEL (lower).	Wet Season	
	Figure 5A-57	
DSD & ATKINS		



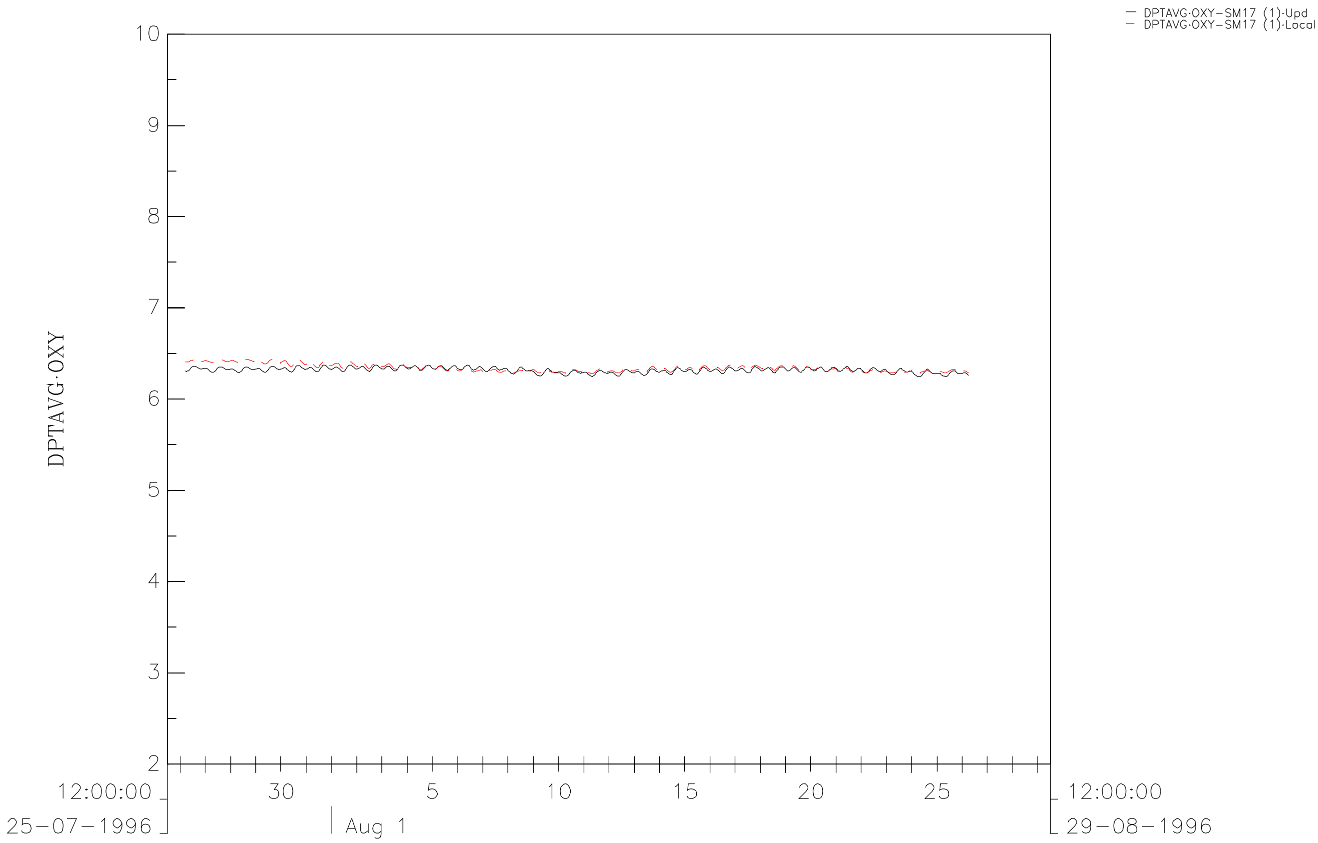


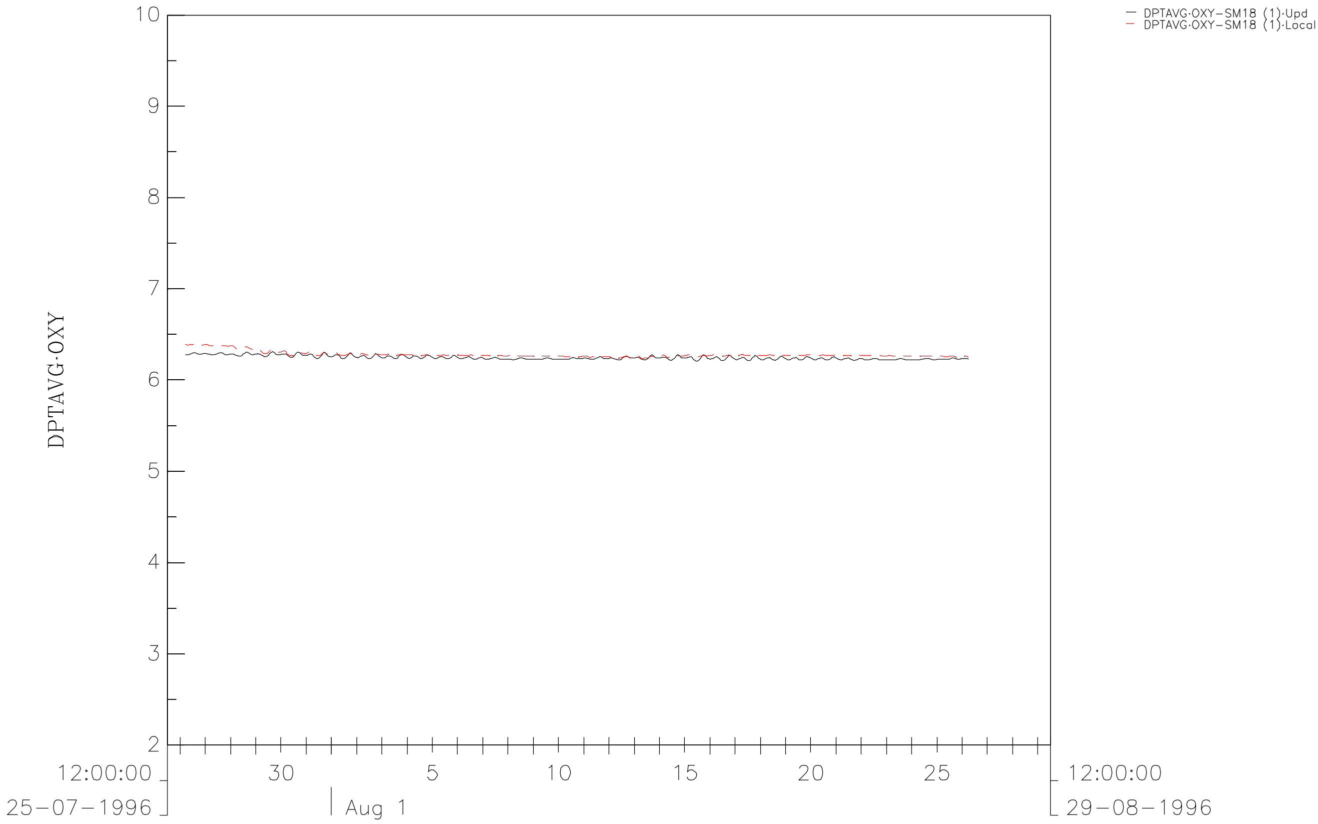
Dissolved Oxygen comparison between Update Model and Local Refine Model at C4 (upper) and S2 (lower). Baseline condition	Dry Season	
	Figure 5A-58	
DSD & ATKINS		



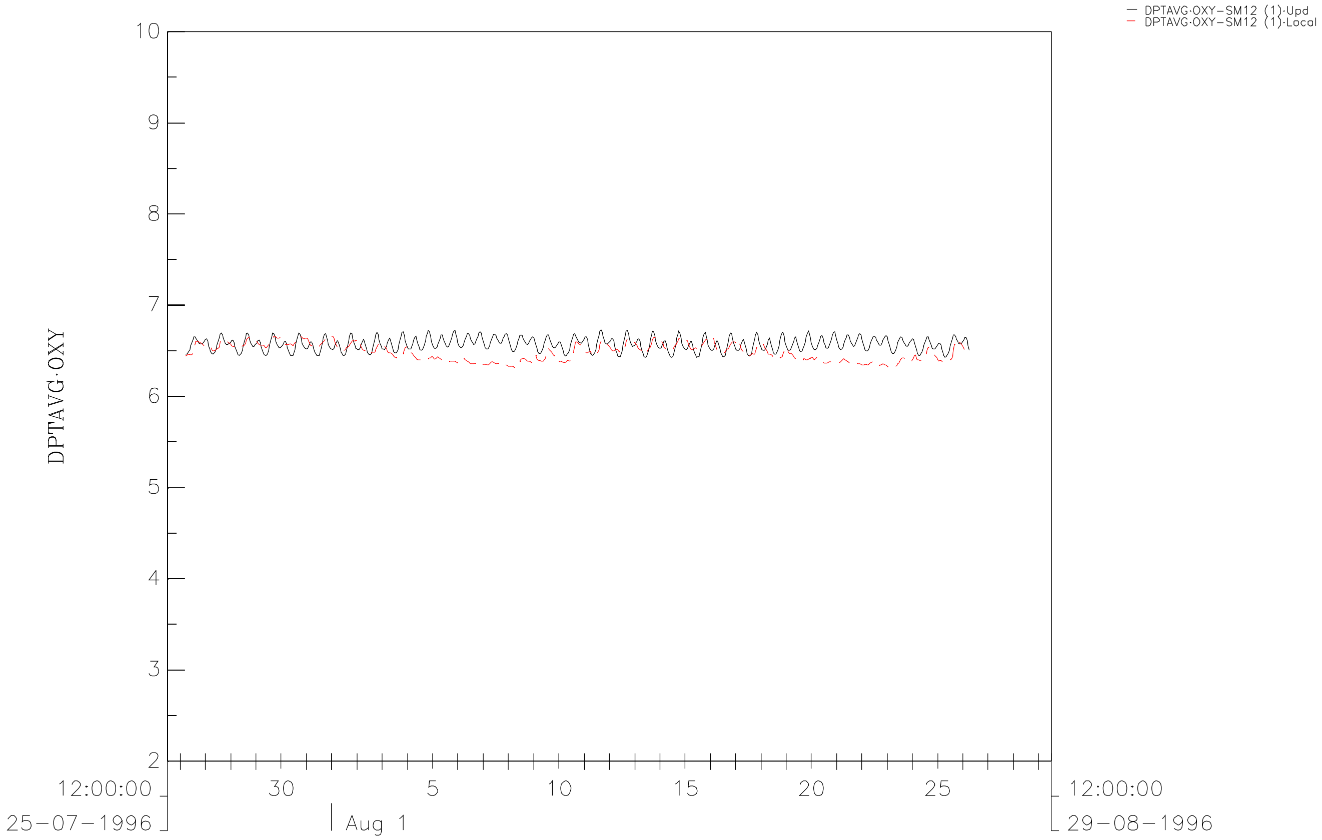


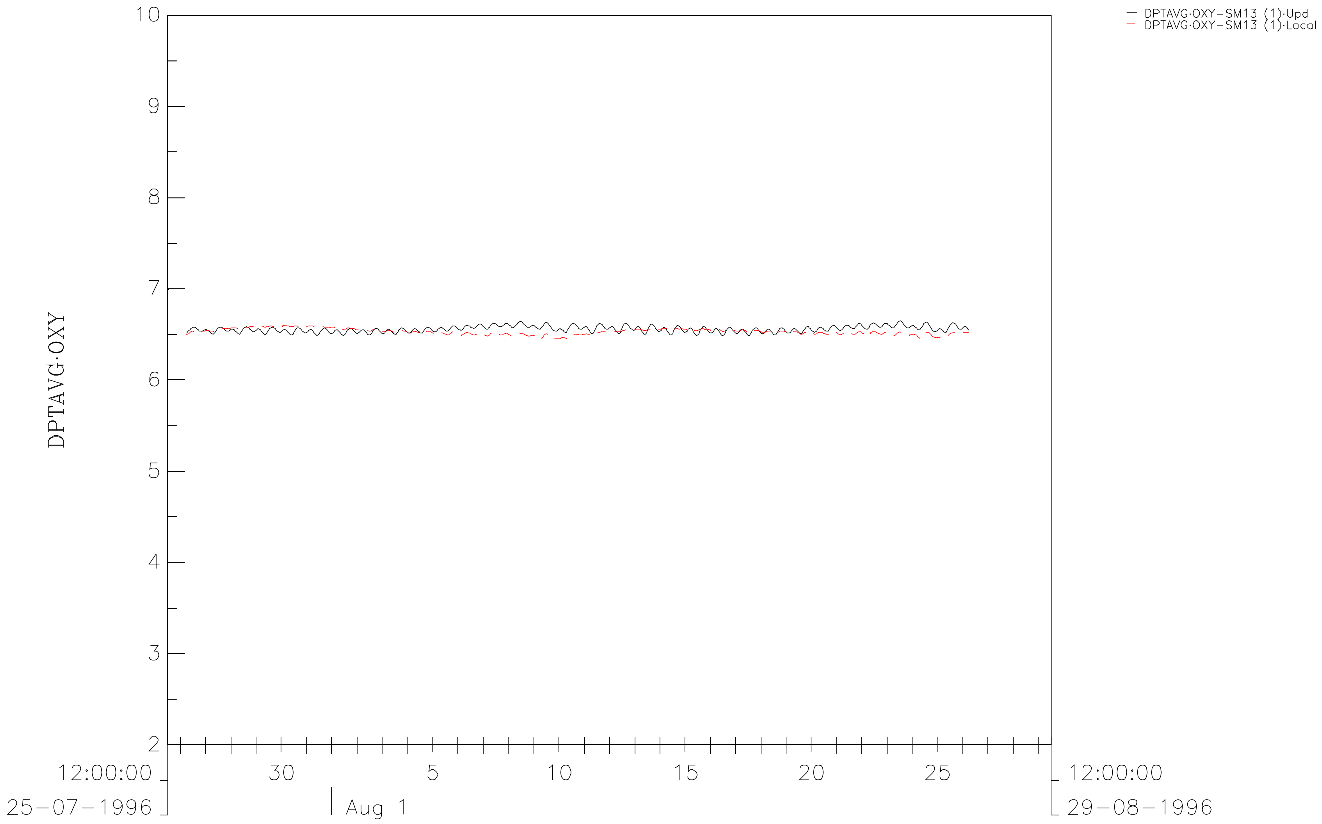
Dissolved Oxygen comparison between Update Model and Local Refine Model at SM6 (upper) and SM7 (lower). Baseline condition	Dry Season
	Figure 5A-59
DSD & ATKINS	





Dissolved Oxygen comparison between Update Model and Local Refine Model at SM17 (upper) and SM18 (lower). Baseline condition	Dry Season
	Figure 5A-60
DSD & ATKINS	



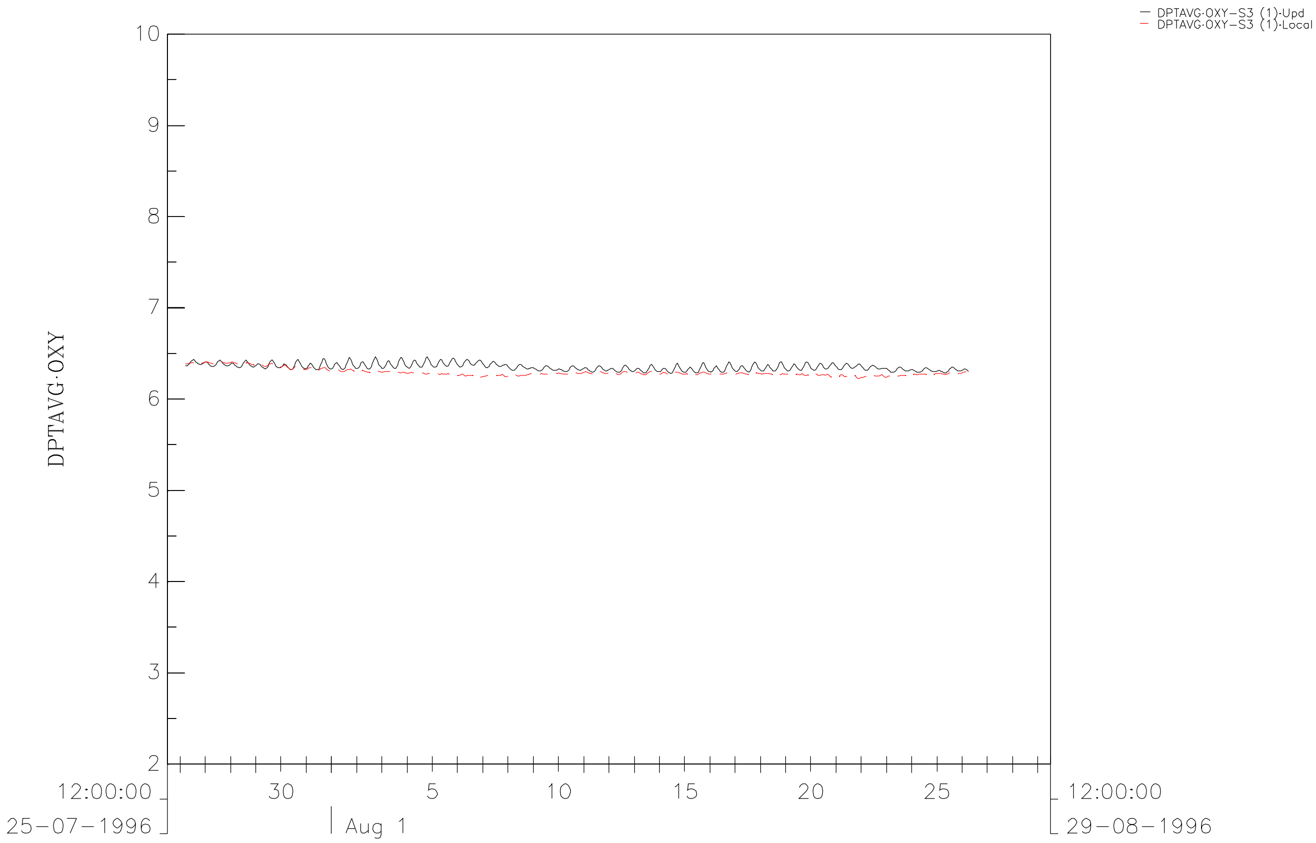


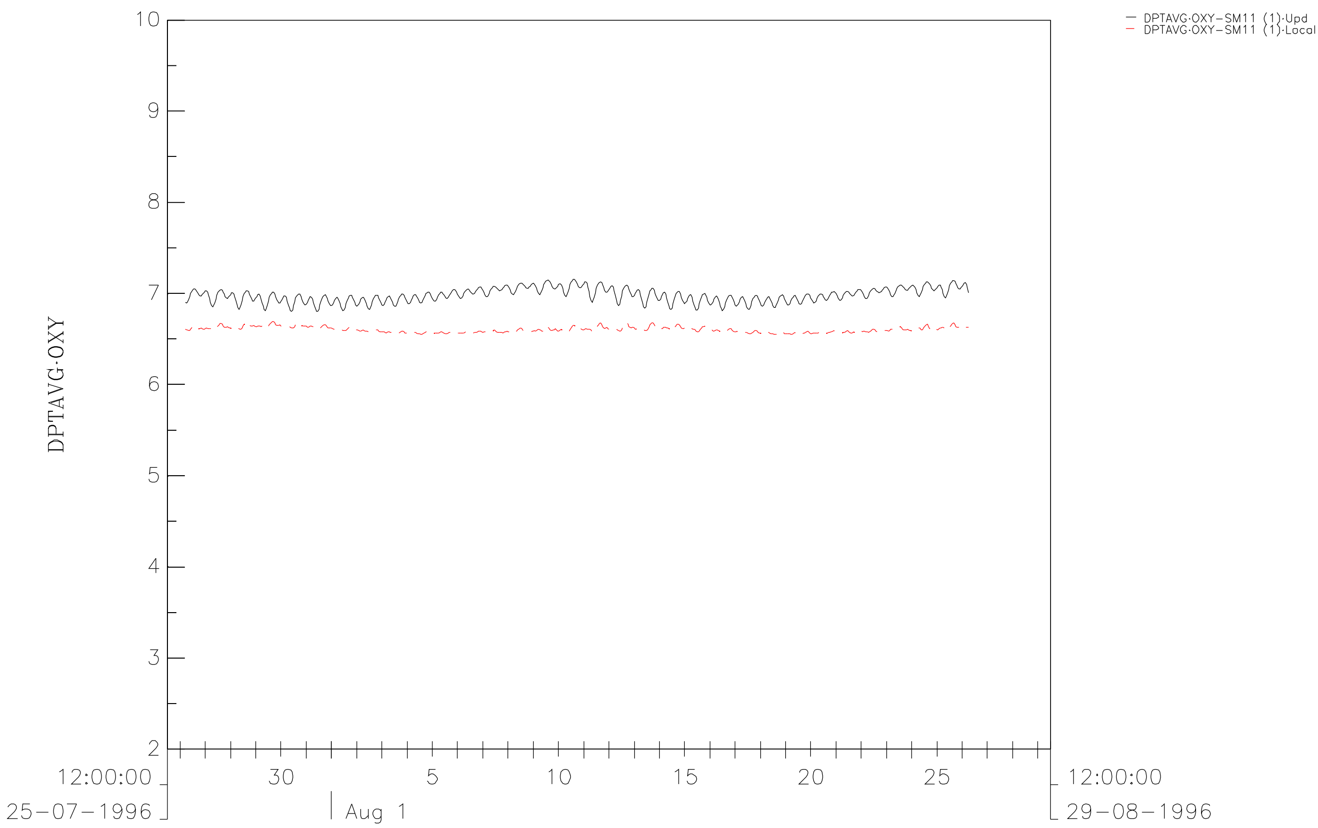
Dissolved Oxygen comparison between Update Model and Local Refine Model at SM12 (upper) and SM13 (lower). Baseline condition

Dry Season

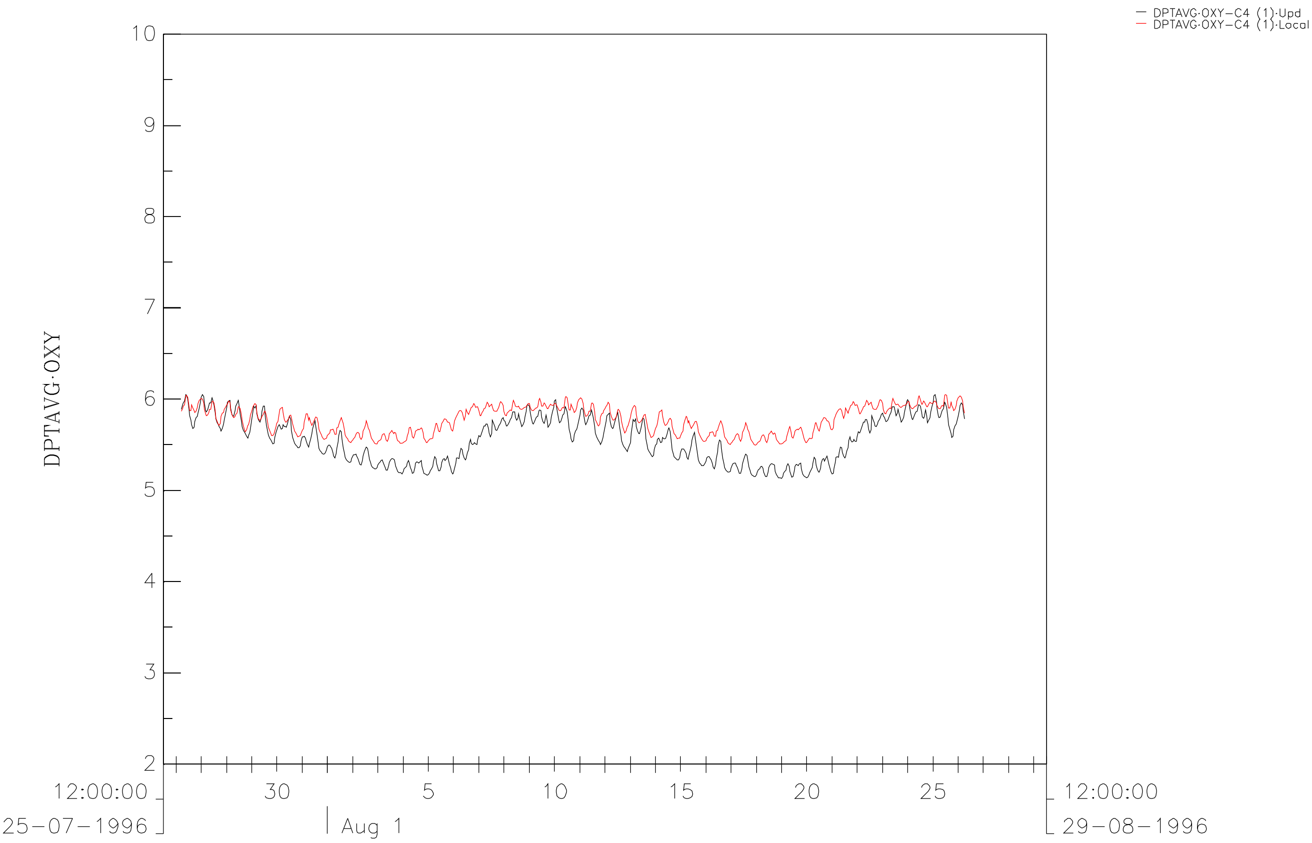
Figure 5A-61

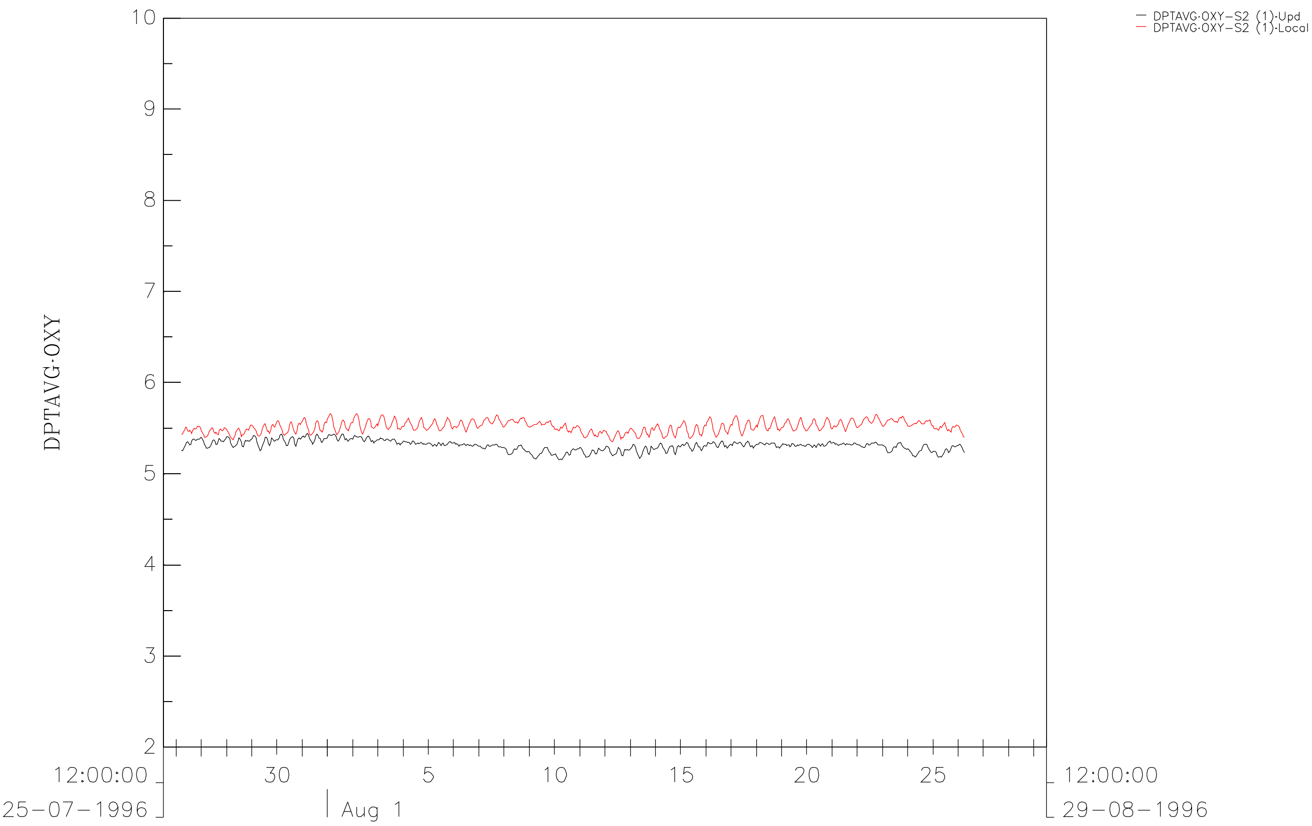
DSD & ATKINS



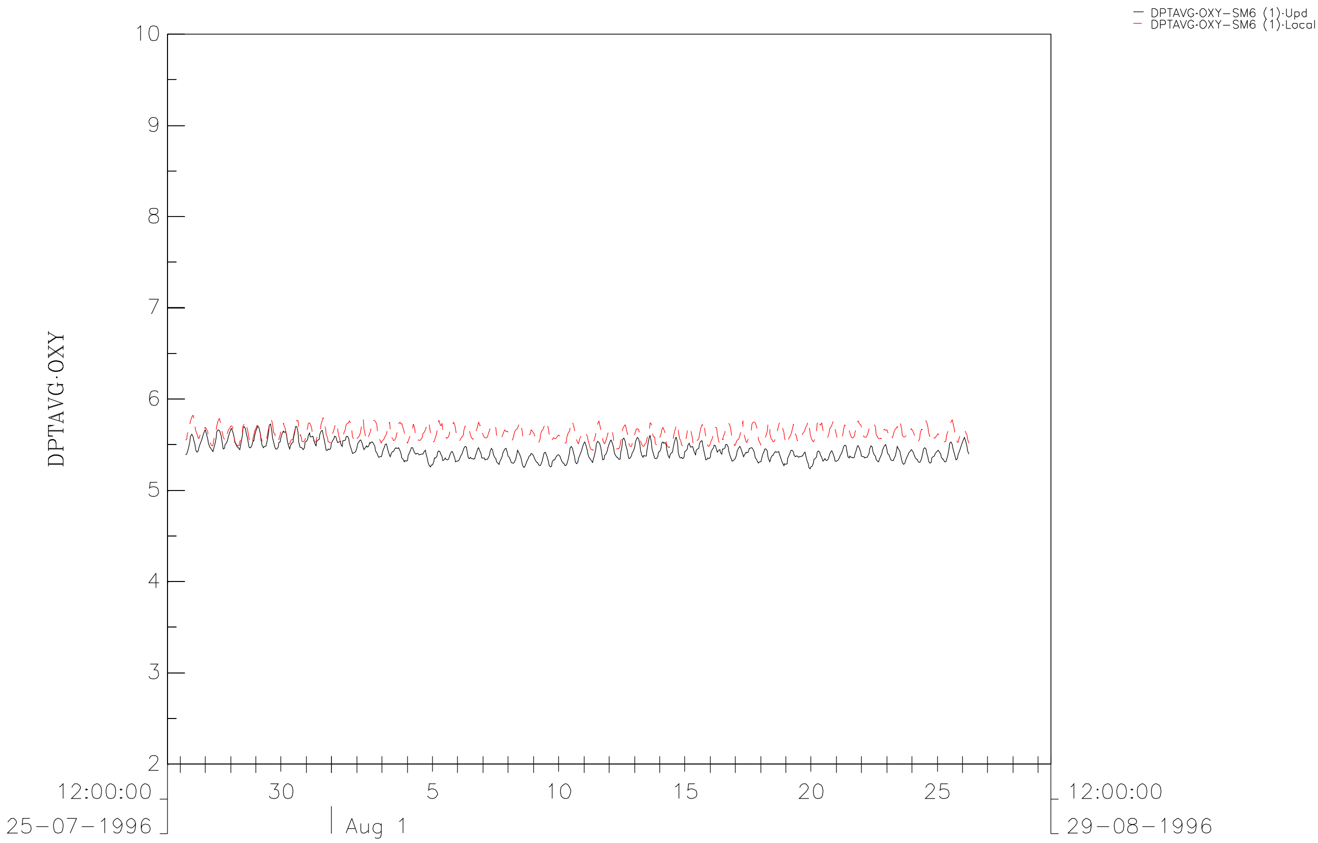


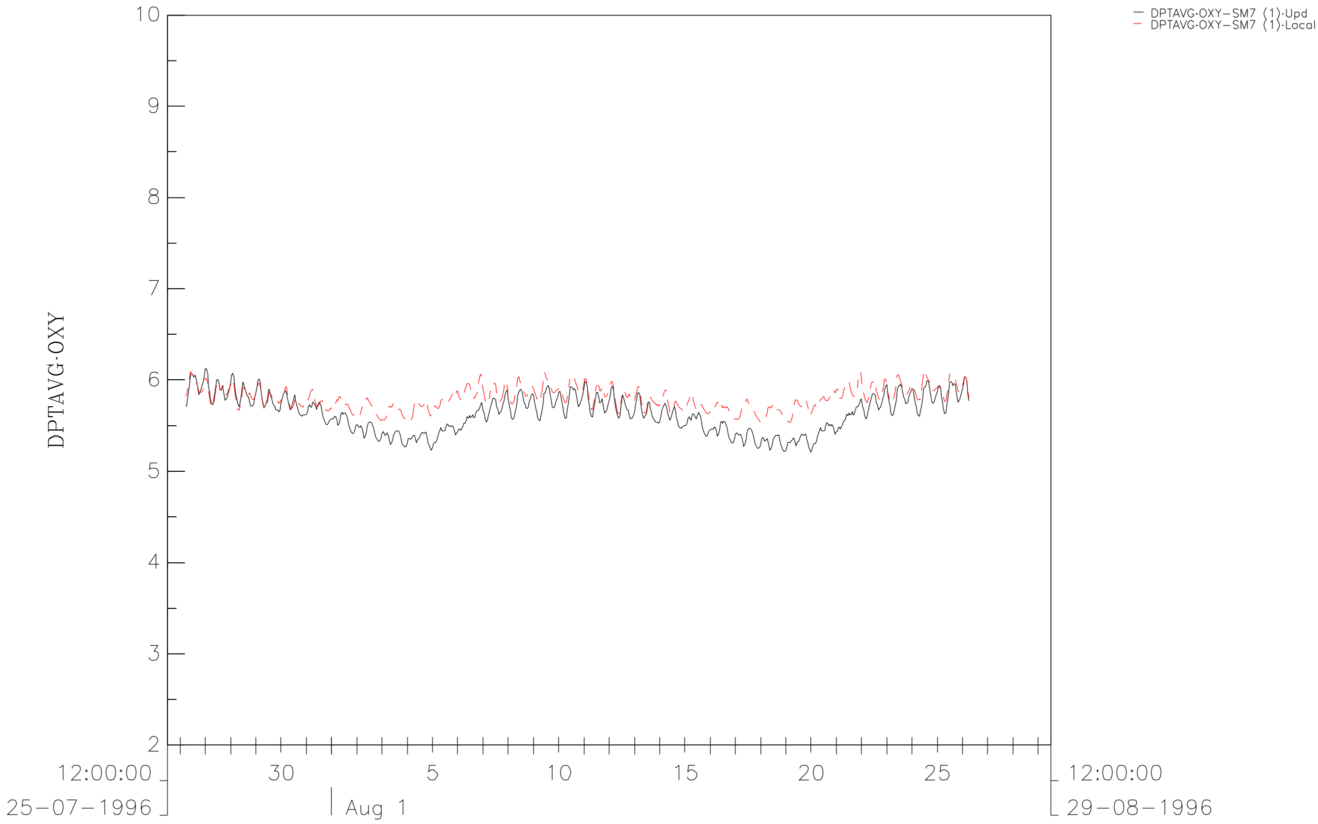
Dissolved Oxygen comparison between Update Model and Local Refine Model at S3 (upper) and SM11 (lower). Baseline condition	Dry Season **Figure 5A-62**
DSD & ATKINS	



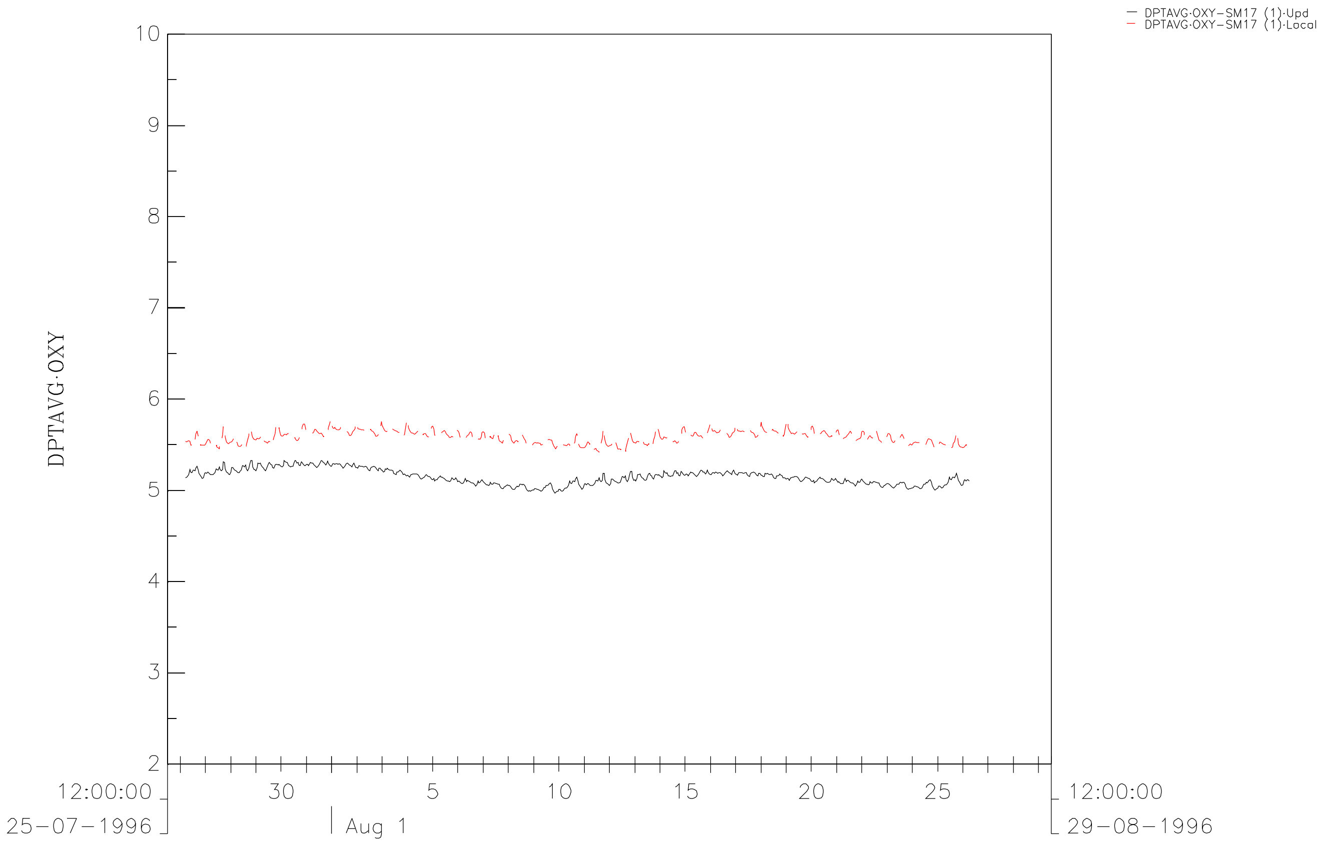


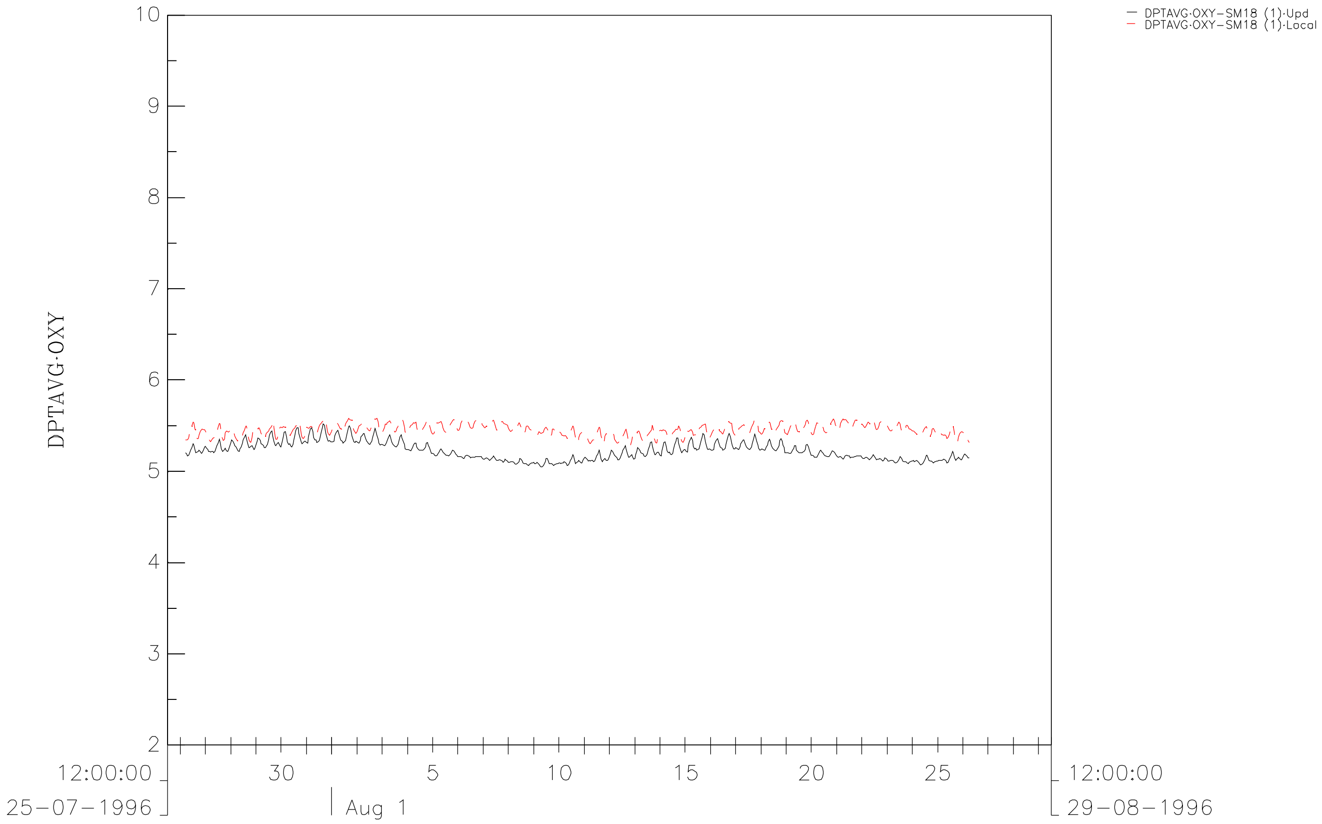
Dissolved Oxygen comparison between Update Model and Local Refine Model at C4 (upper) and S2 (lower). Baseline condition	Wet Season	
	Figure 5A-63	
DSD & ATKINS		



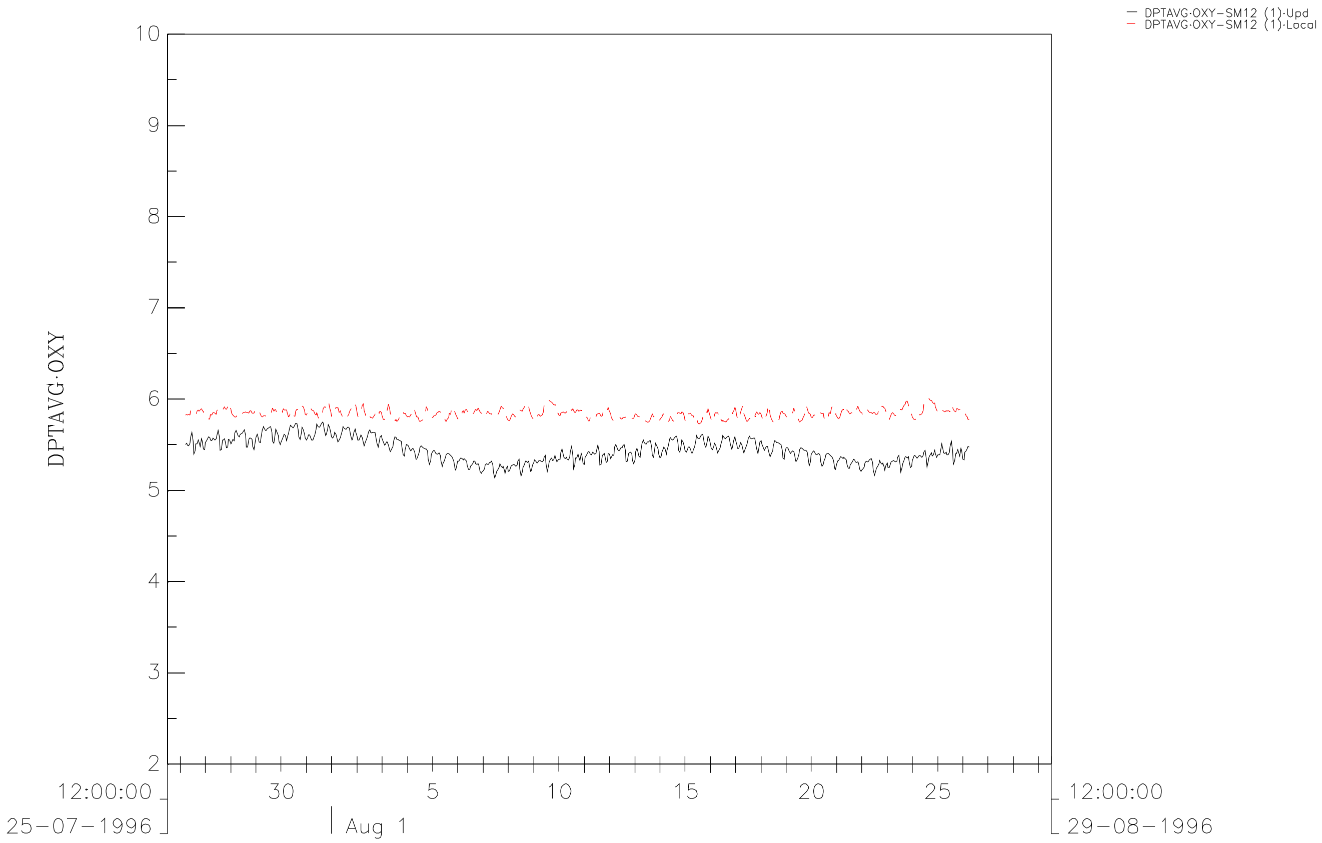


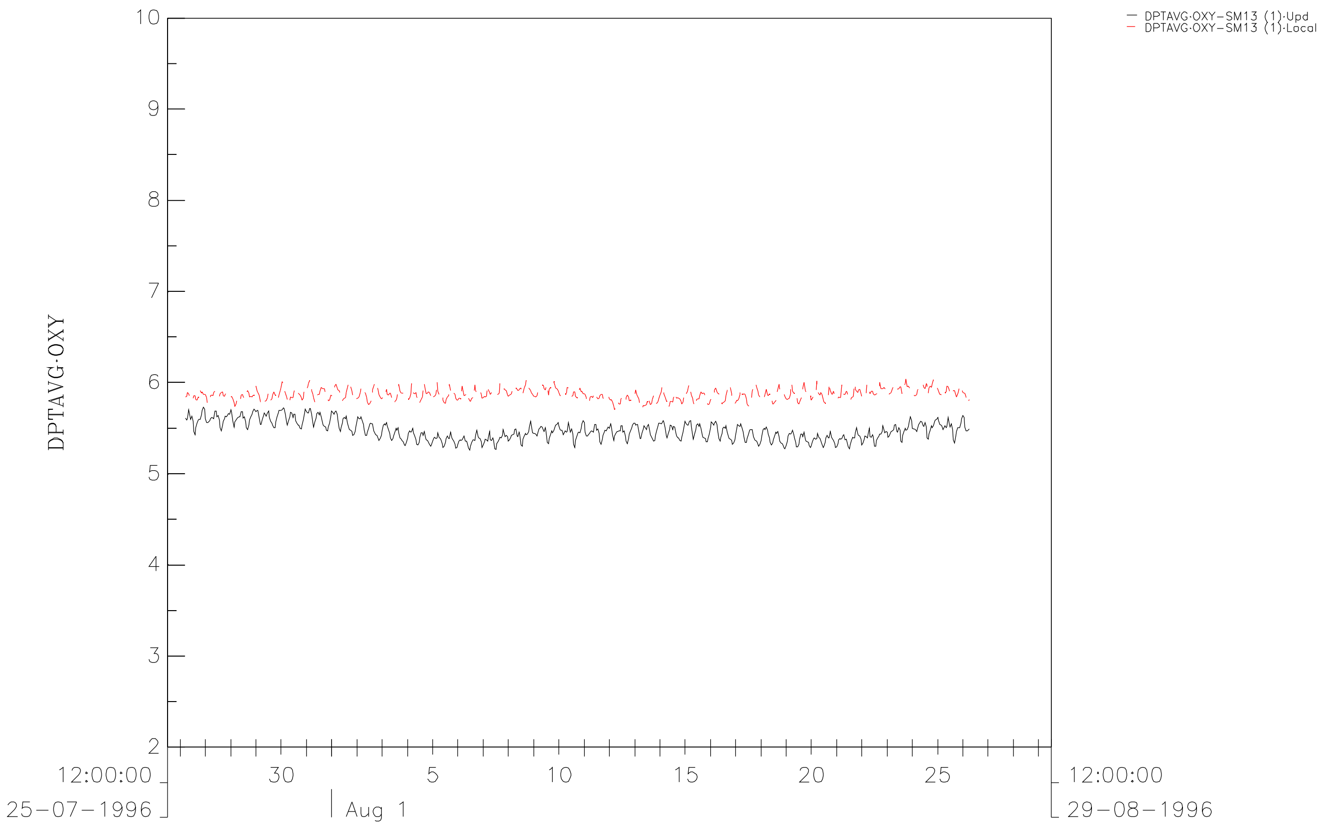
Dissolved Oxygen comparison between Update Model and Local Refine Model at SM6 (upper) and SM7 (lower). Baseline condition	Wet Season	
	Figure 5A-64	
DSD & ATKINS		



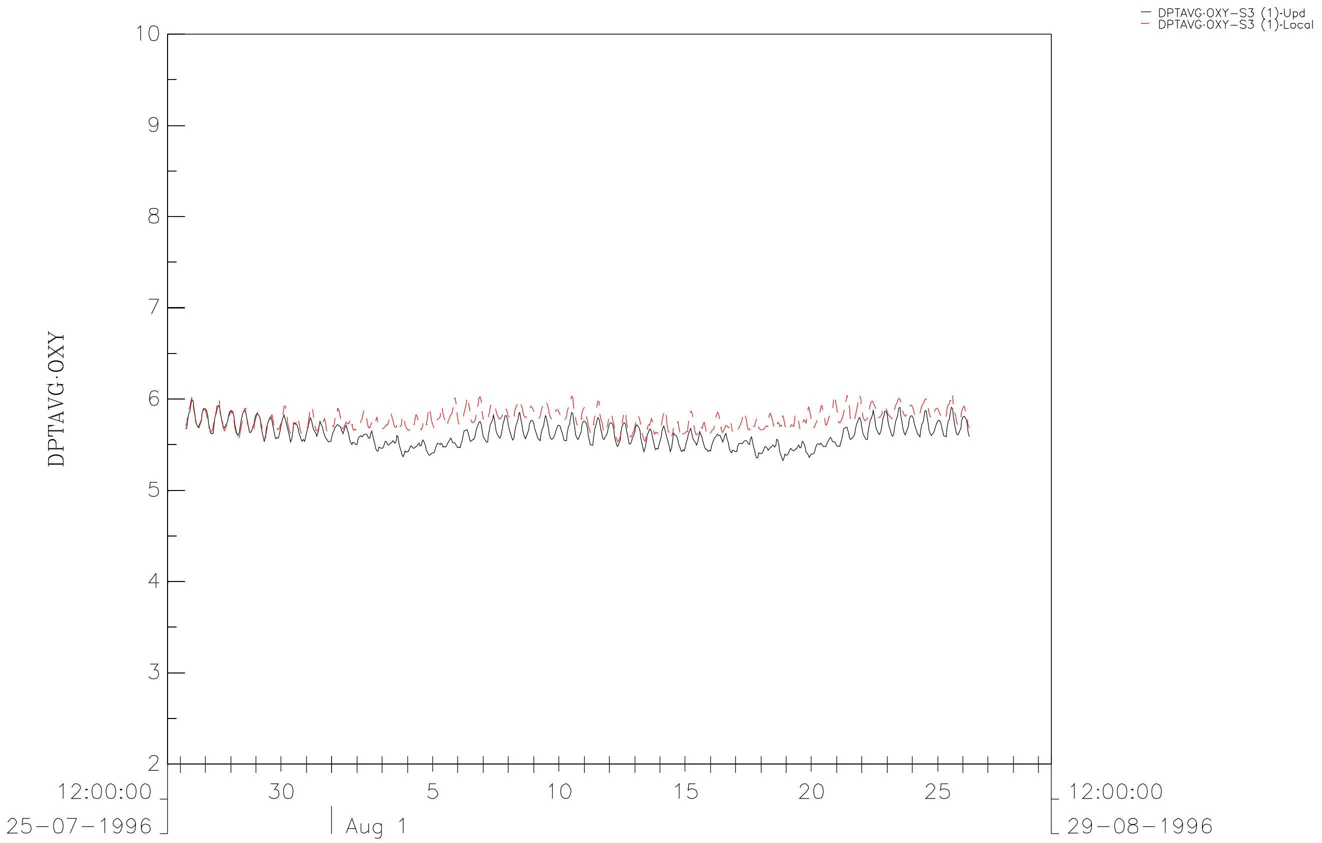


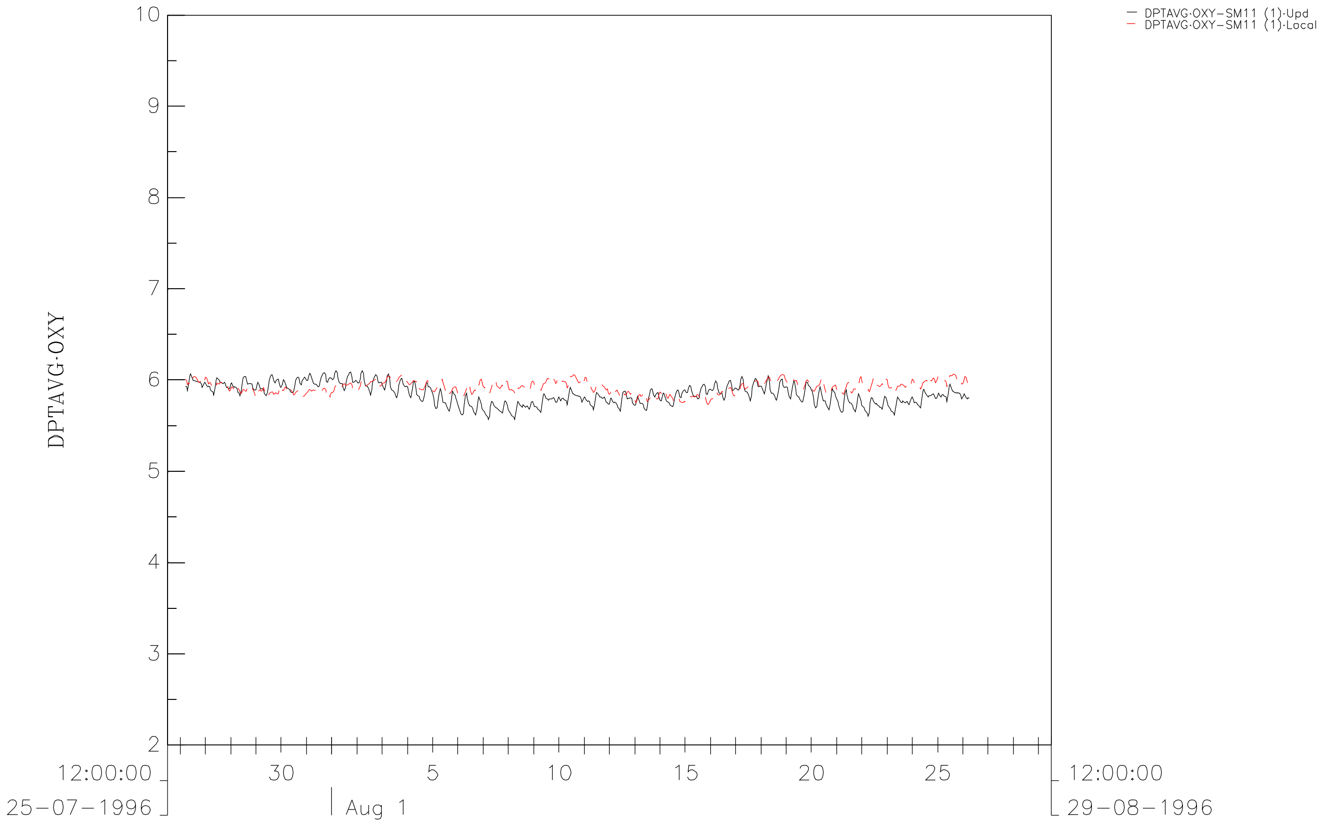
Dissolved Oxygen comparison between Update Model and Local Refine Model at SM17 (upper) and SM18 (lower). Baseline condition	Wet Season	
	Figure 5A-65	
DSD & ATKINS		



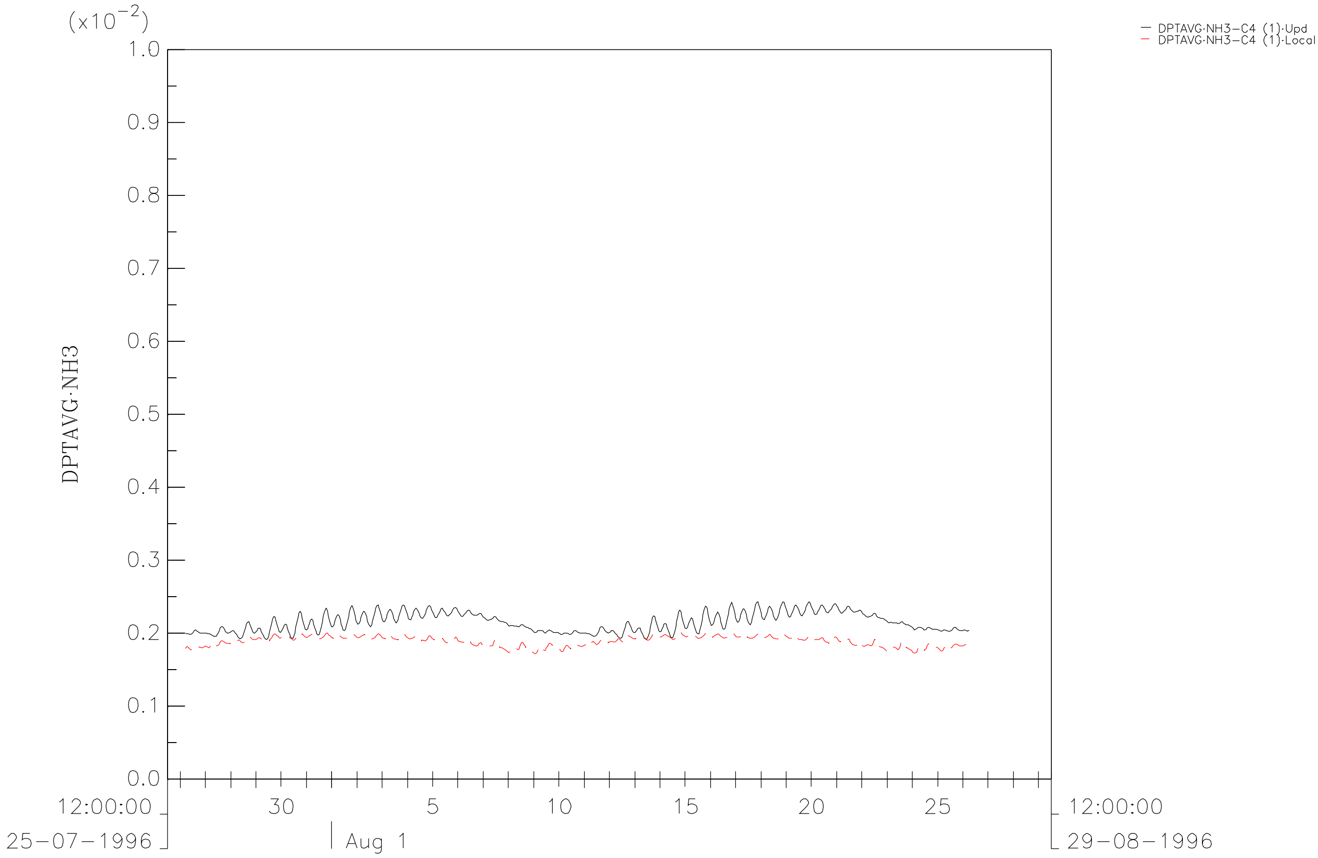


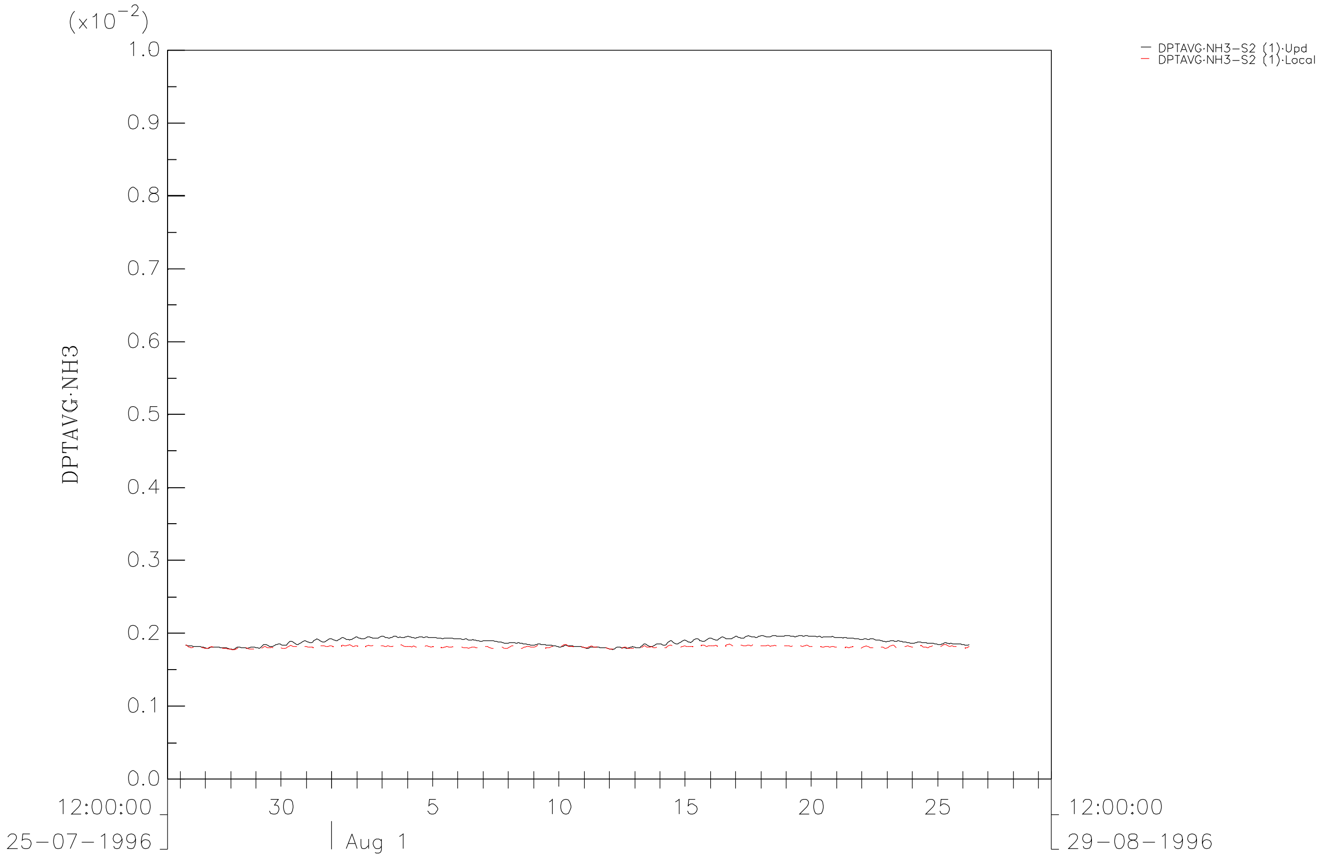
Dissolved Oxygen comparison between Update Model and Local Refine Model at SM12 (upper) and SM13 (lower). Baseline condition	Wet Season
	Figure 5A-66
DSD & ATKINS	



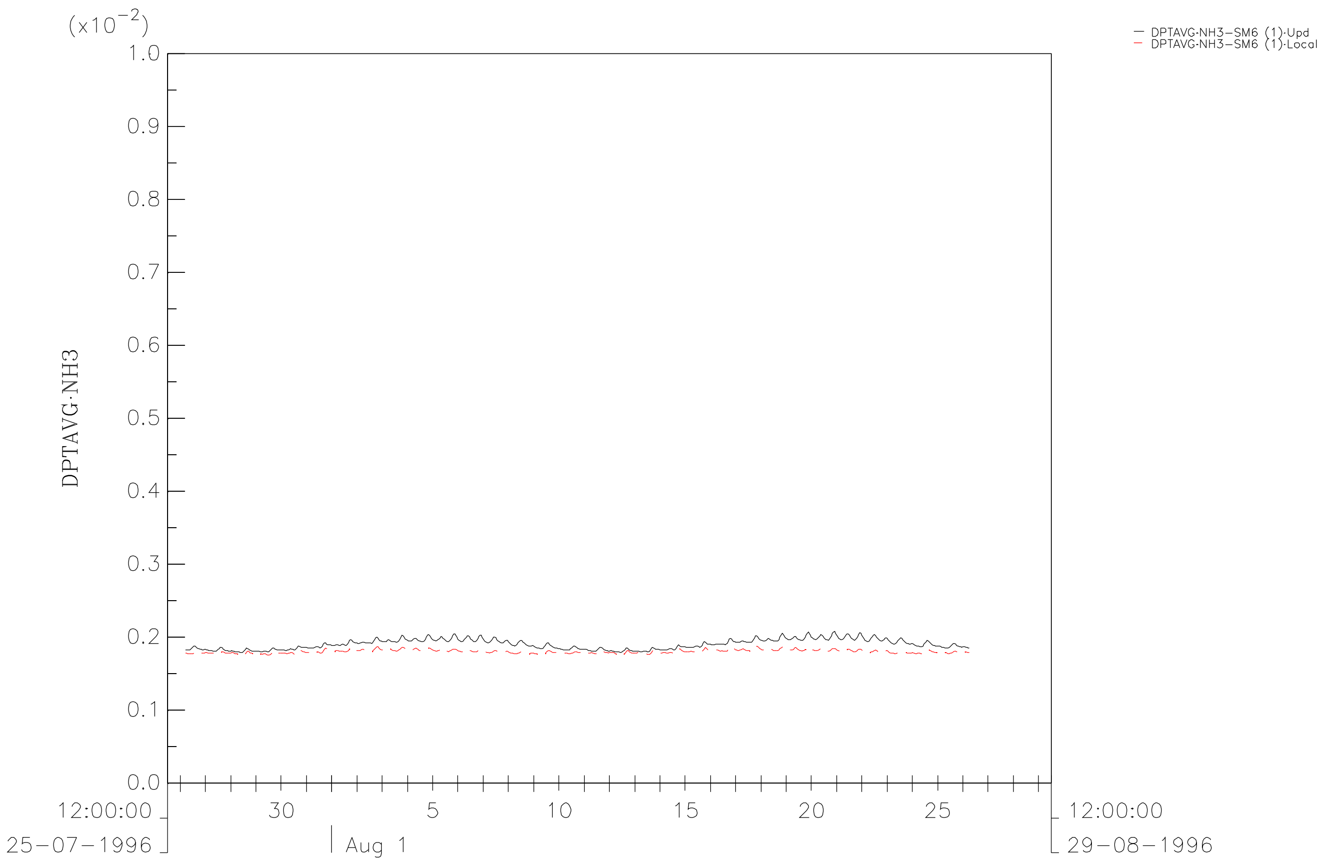


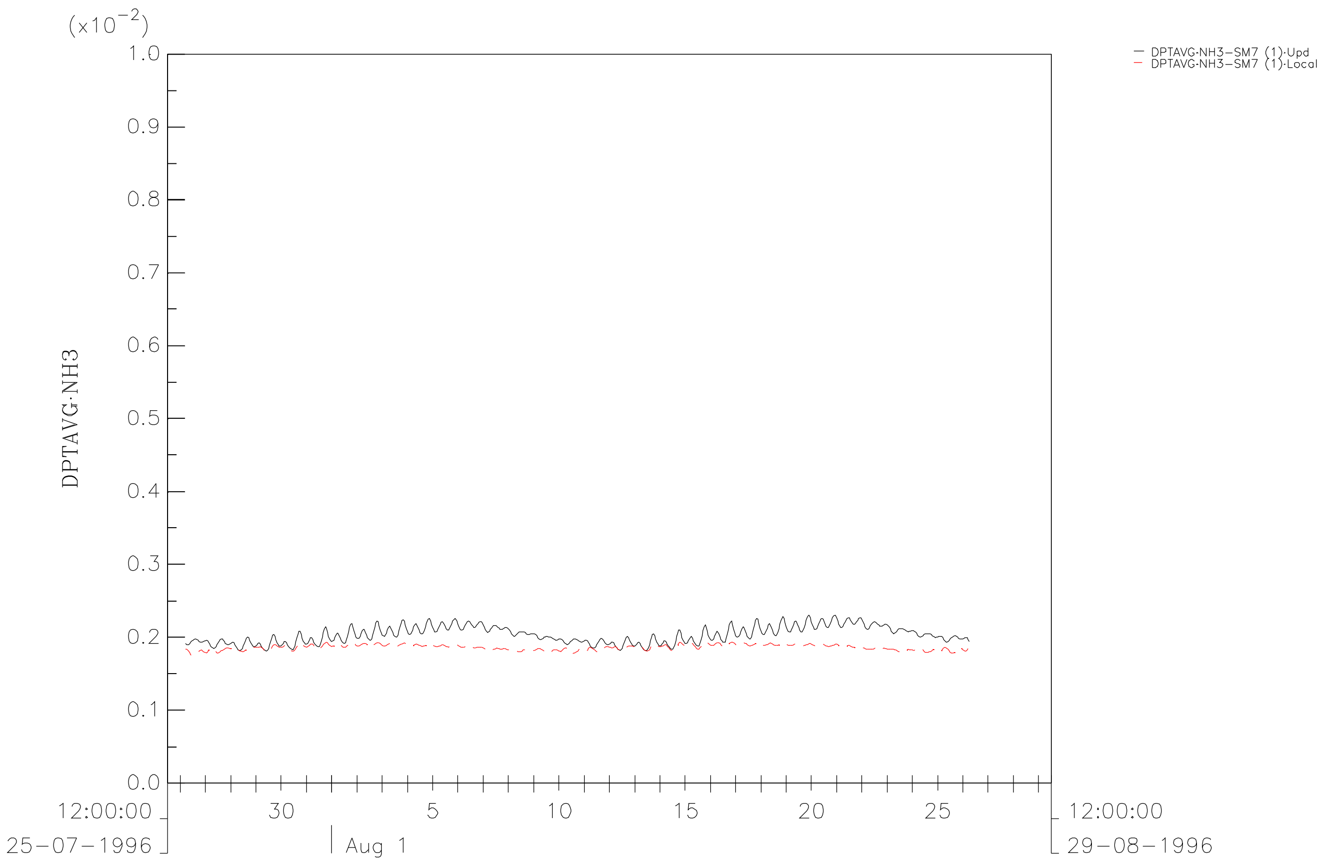
Dissolved Oxygen comparison between Update Model and Local Refine Model at S3 (upper) and SM11 (lower). Baseline condition	Wet Season
	Figure 5A-67
DSD & ATKINS	



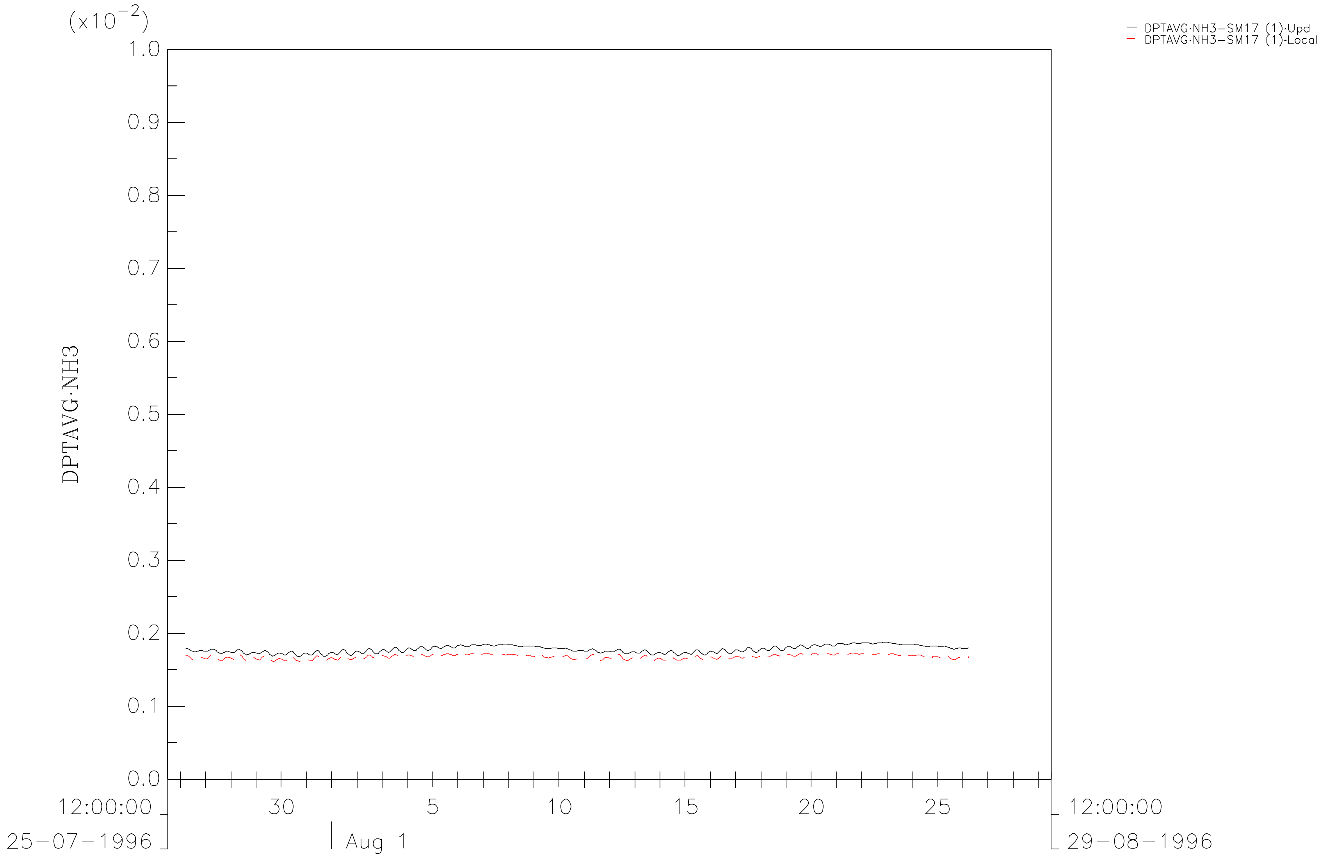


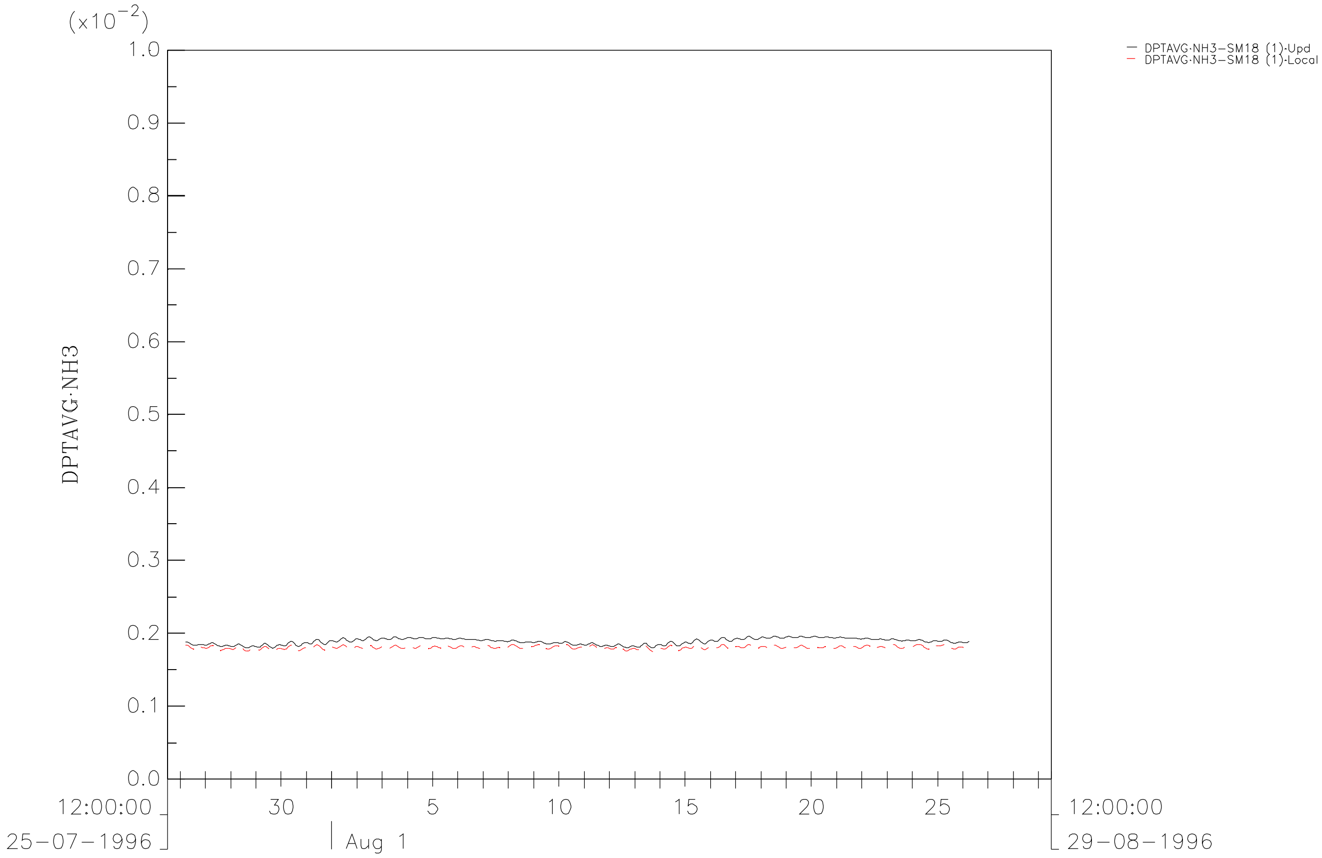
NH3 comparison between Update Model and Local Refine Model at C4 (upper) and S2 (lower). Baseline condition	Dry Season
	Figure 5A-68
DSD & ATKINS	





NH3 comparison between Update Model and Local Refine Model at SM6 (upper) and SM7 (lower). Baseline condition	Dry Season
	Figure 5A-69
DSD & ATKINS	



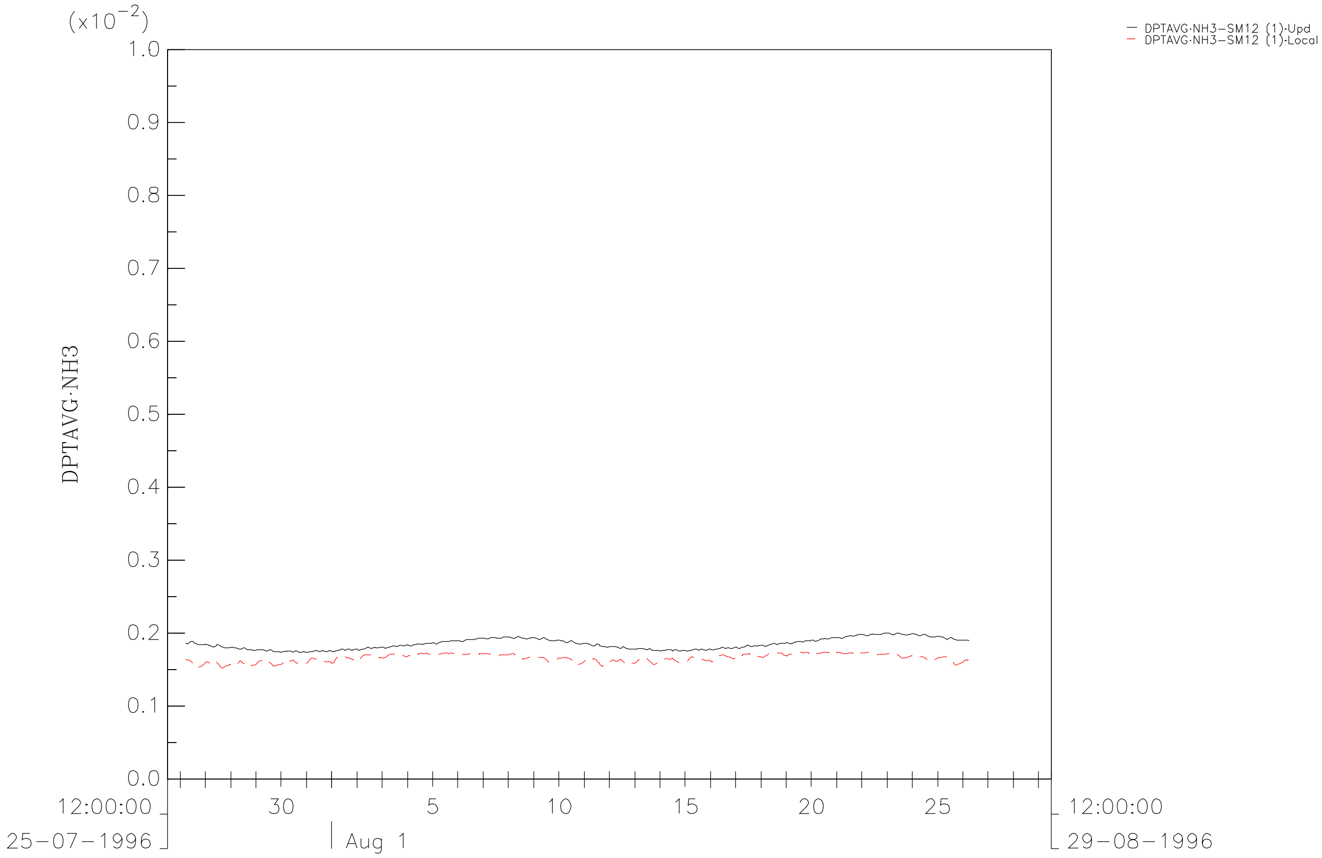


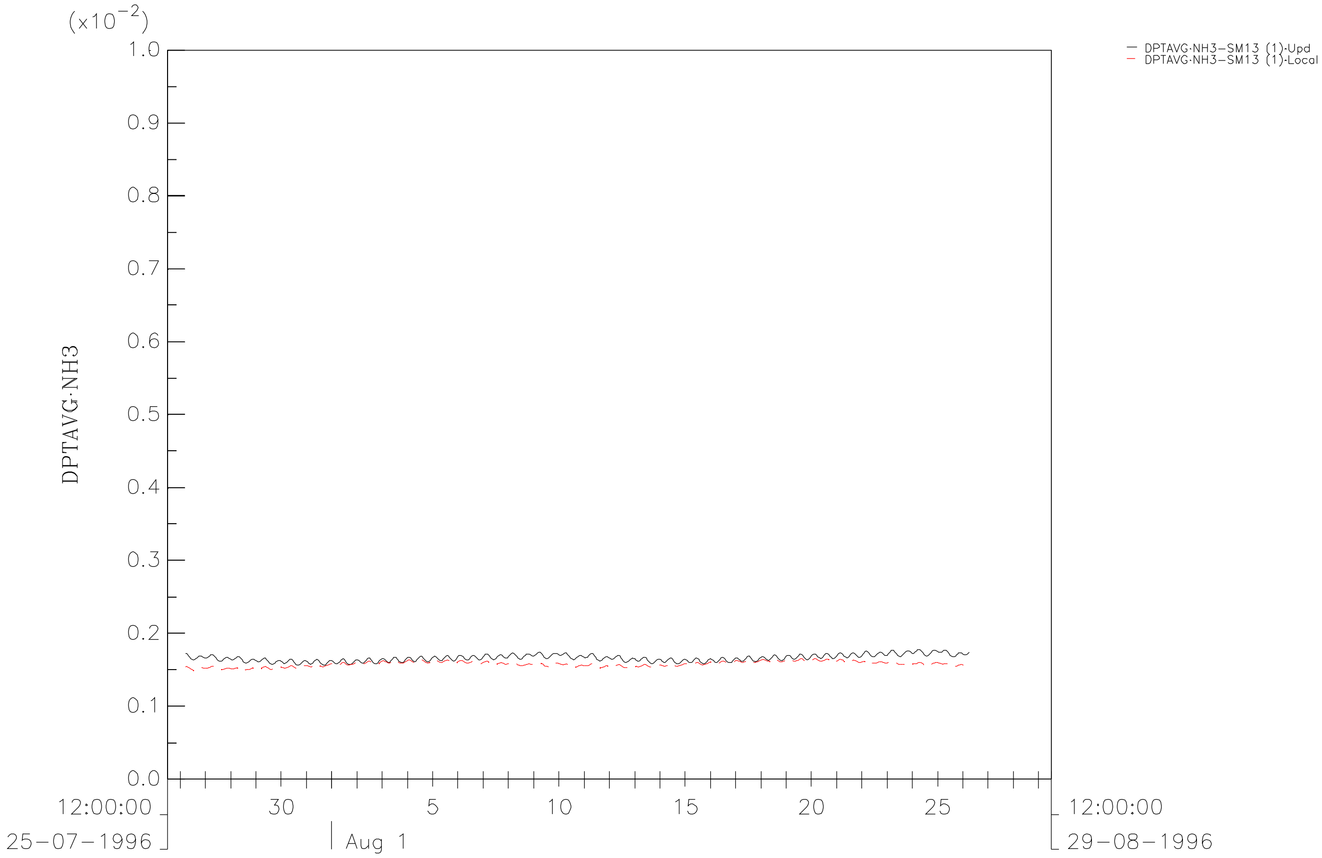
NH3 comparison between Update Model and
Local Refine Model at SM17 (upper) and SM18 (lower).
Baseline condition

Dry Season

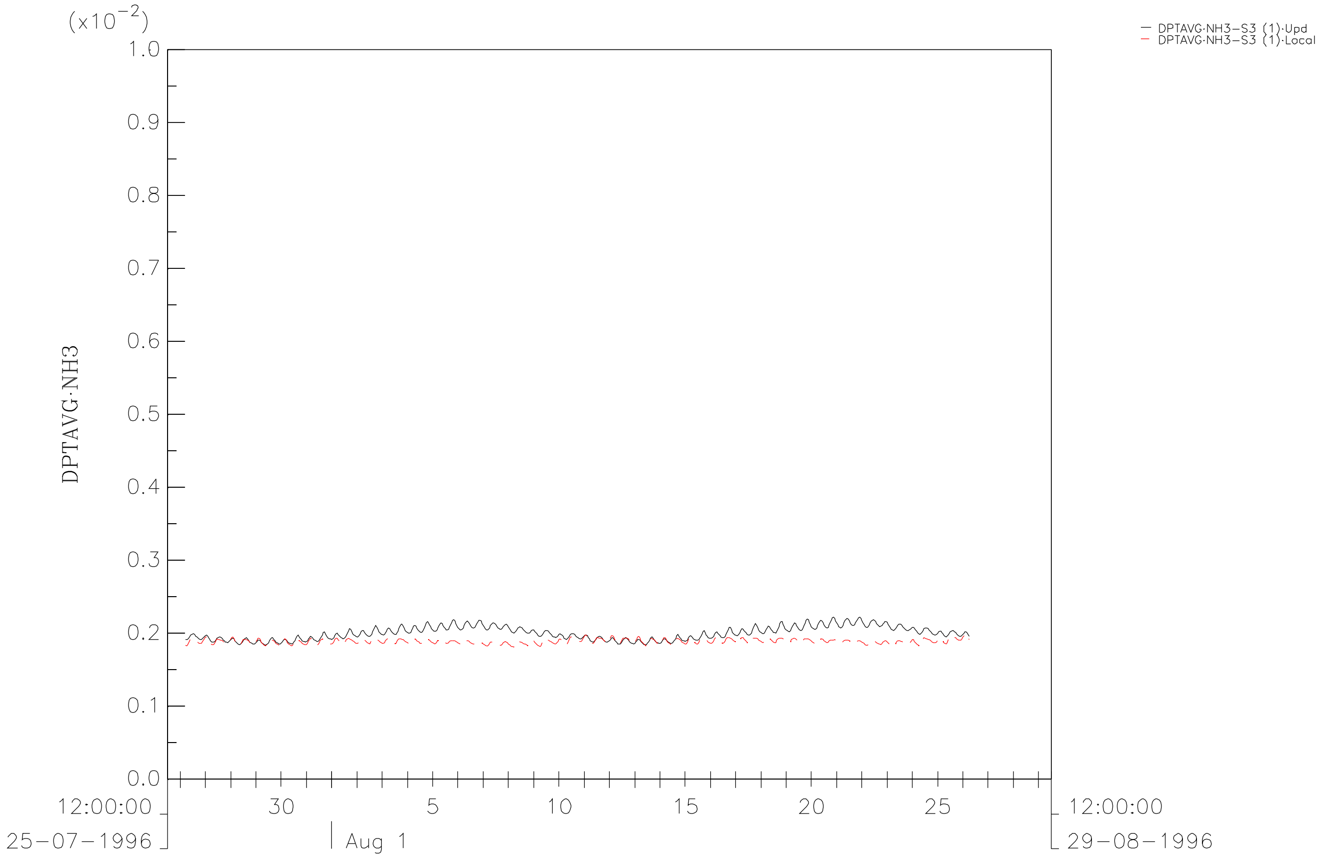
Figure 5A-70

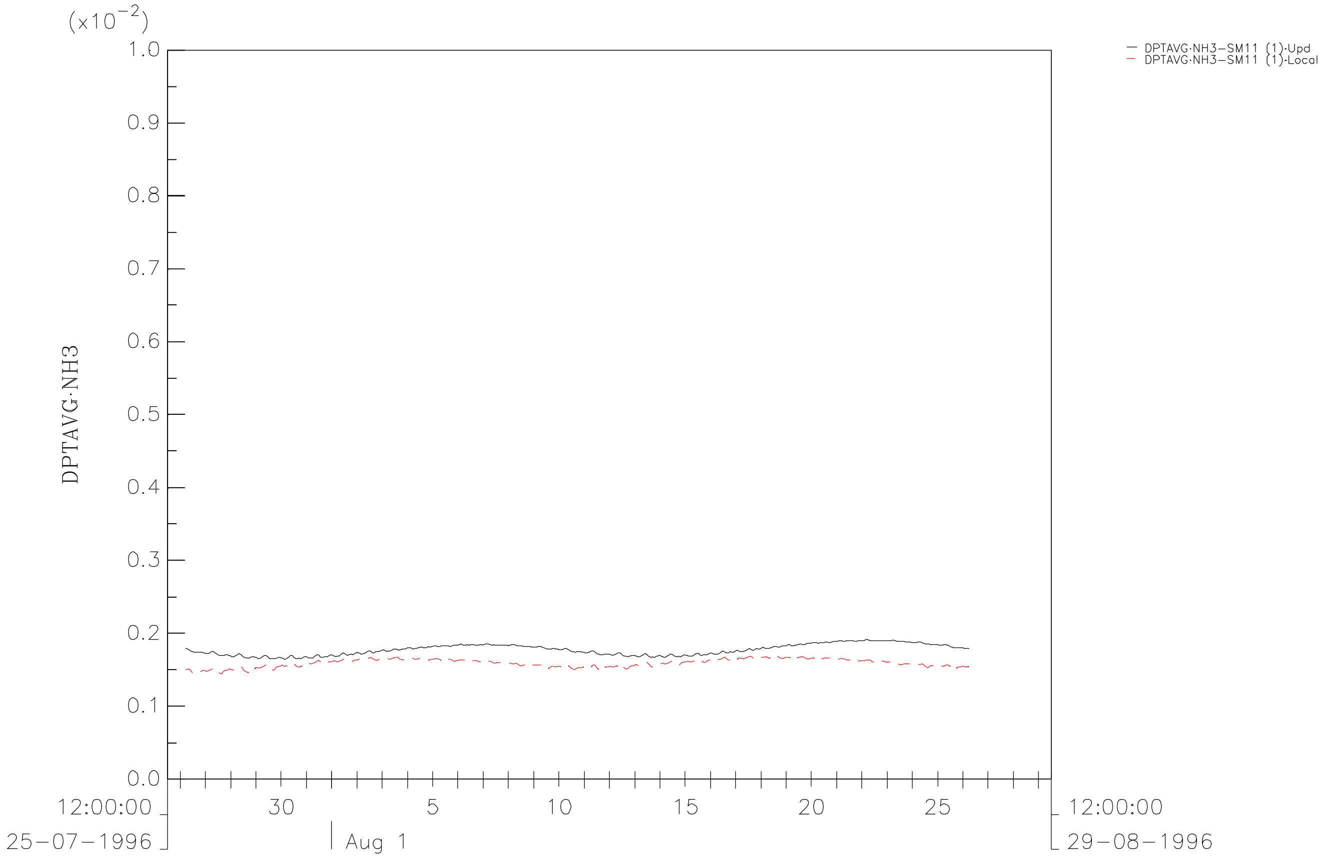
DSD & ATKINS





NH3 comparison between Update Model and Local Refine Model at SM12 (upper) and SM13 (lower). Baseline condition	Dry Season
	Figure 5A-71
DSD & ATKINS	



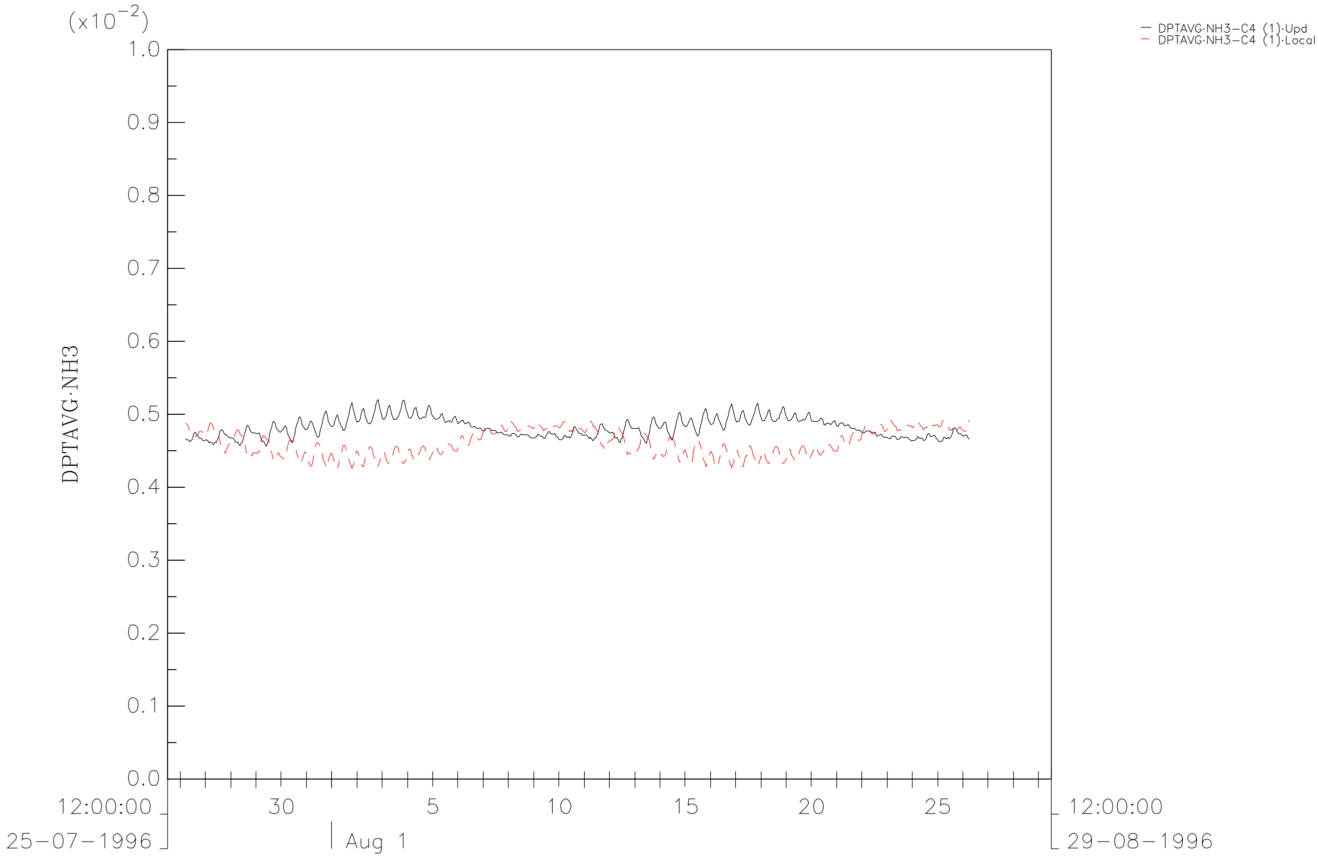


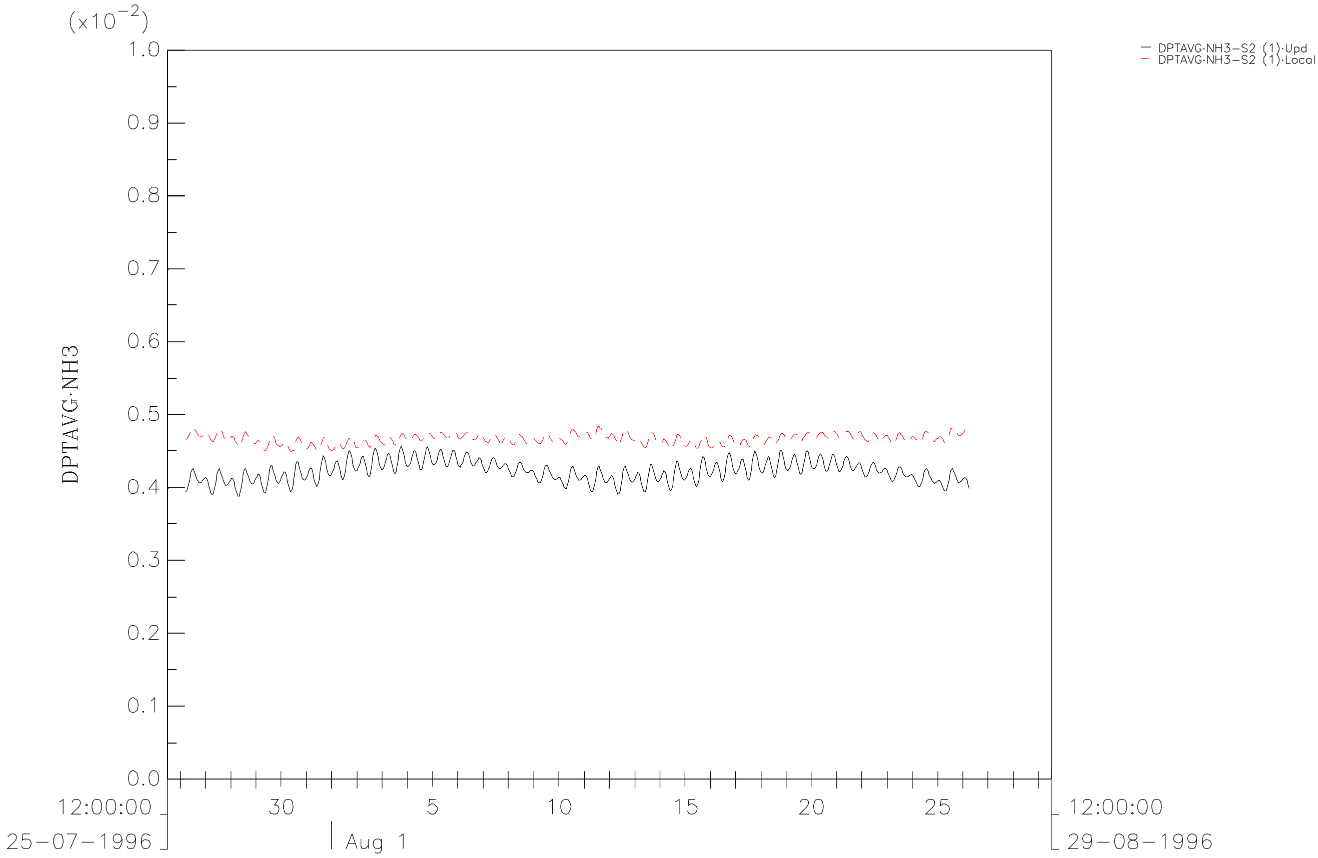
NH3 comparison between Update Model and Local Refine Model at S3 (upper) and SM11 (lower). Baseline condition

Dry Season

Figure 5A-72

DSD & ATKINS



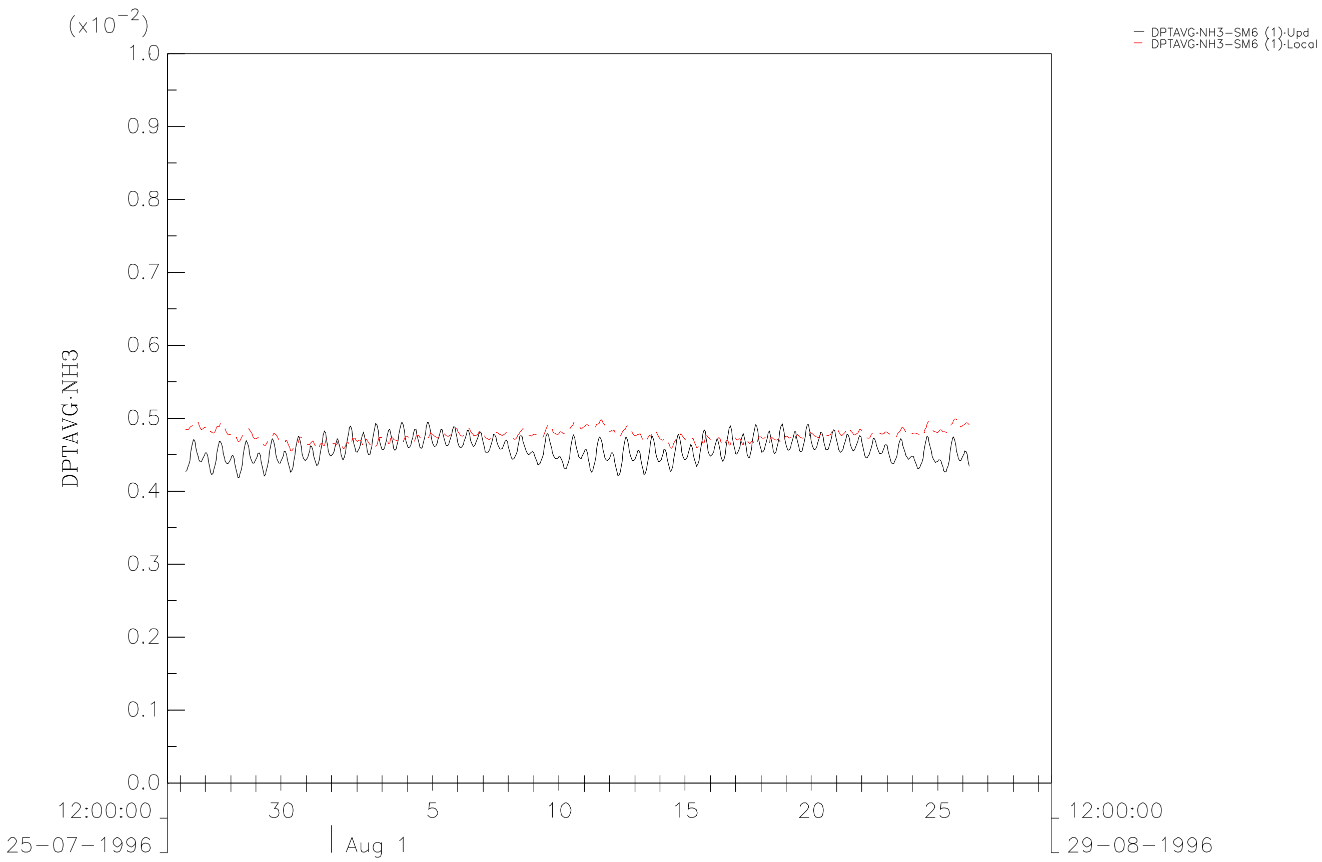


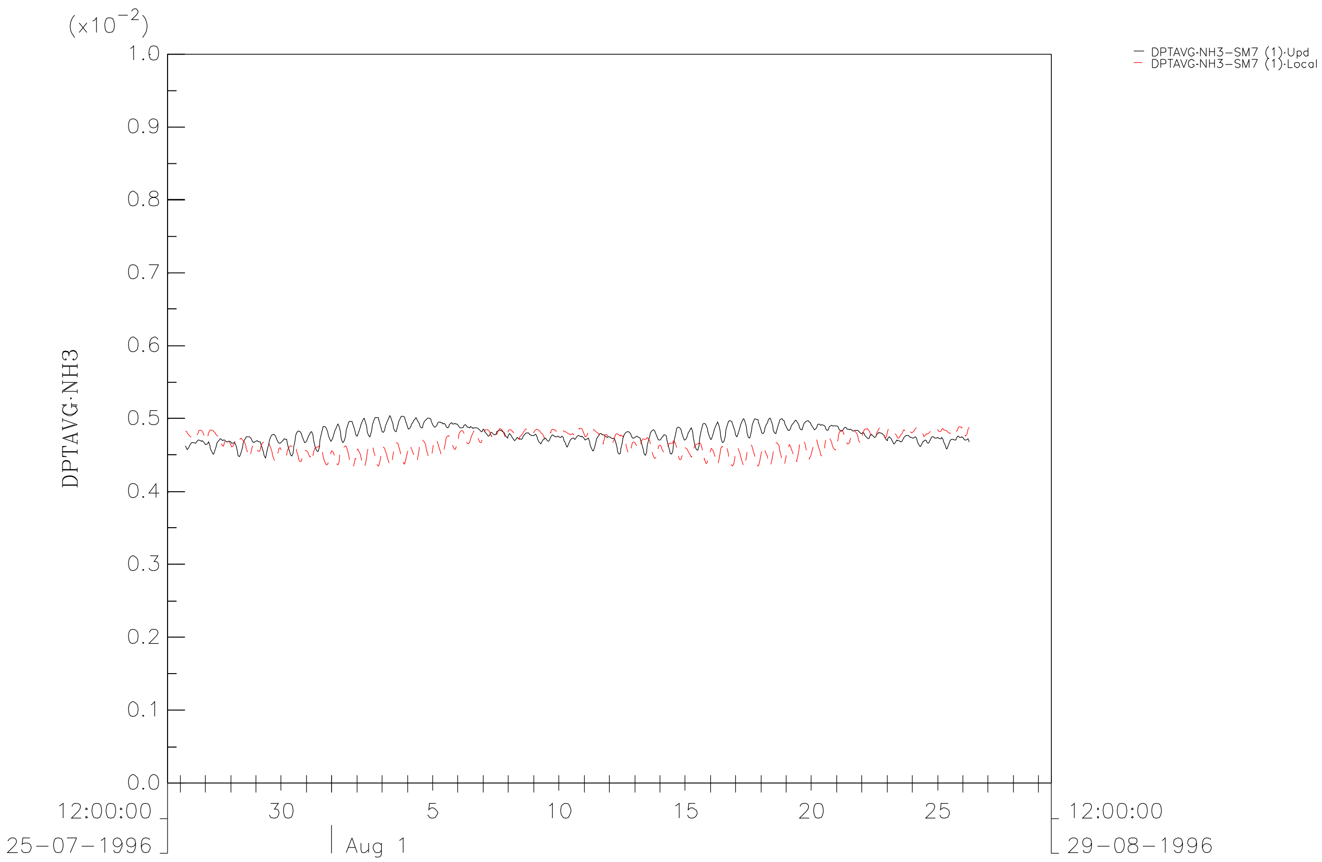
NH3 comparison between Update Model and
Local Refine Model at C4 (upper) and S2 (lower).
Baseline condition

Wet Season

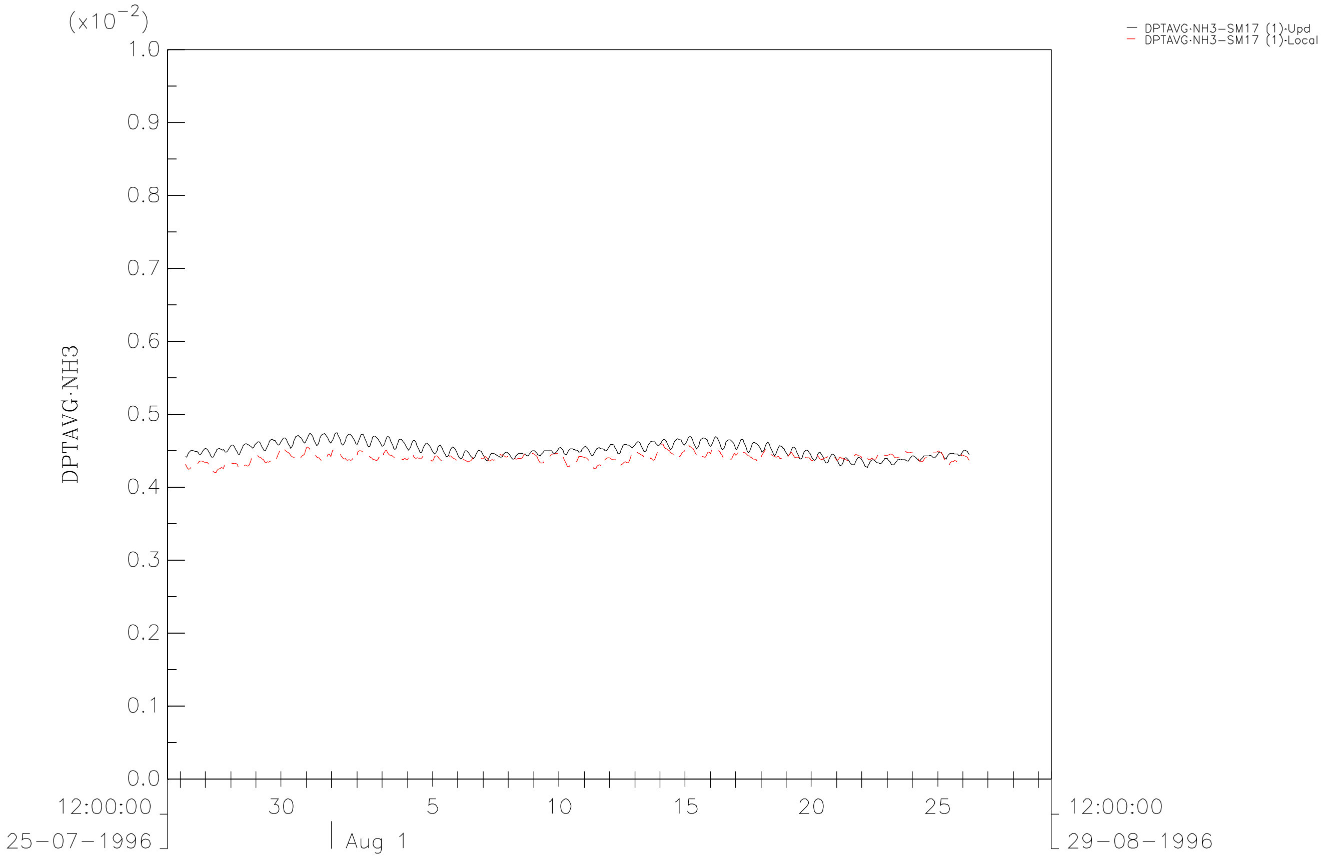
Figure 5A-73

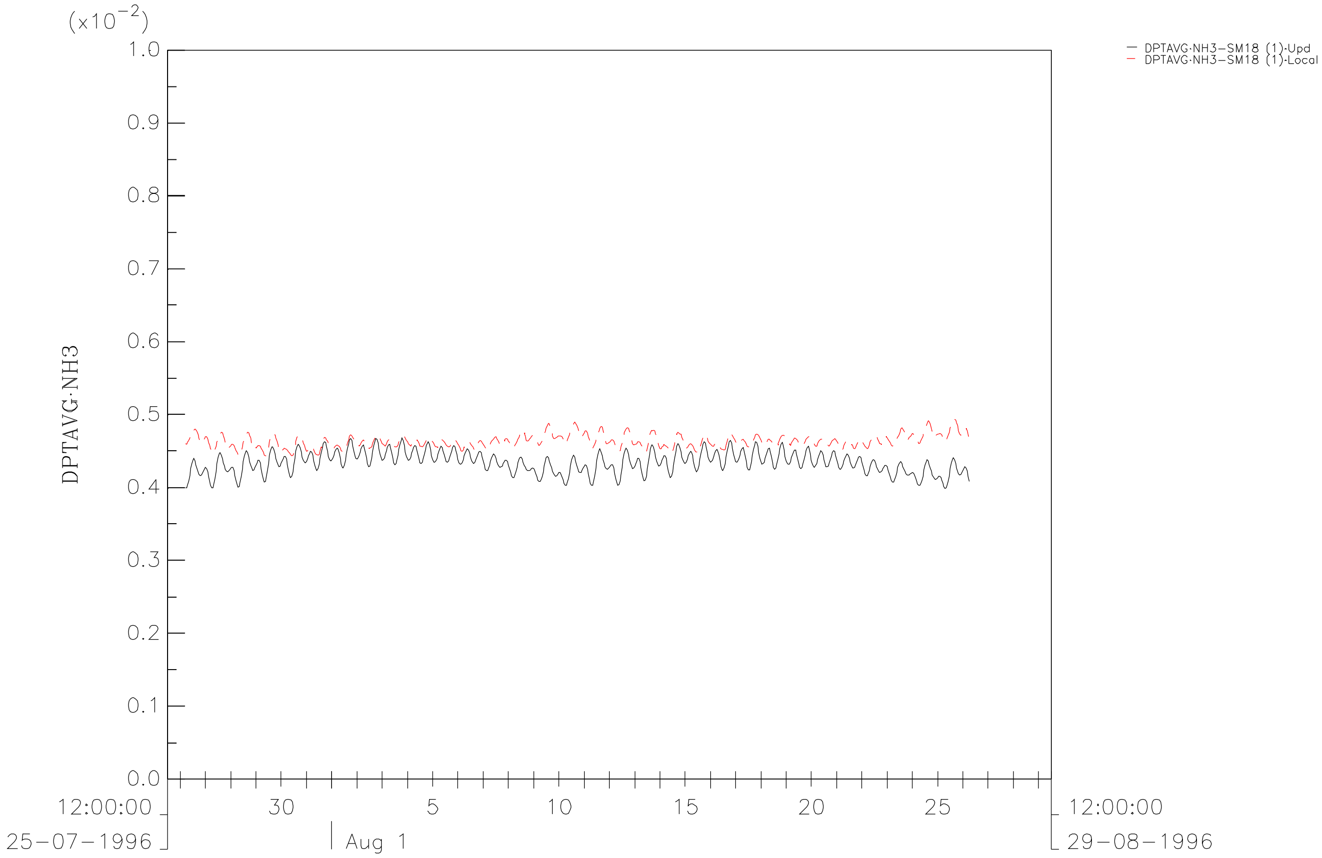
DSD & ATKINS





NH3 comparison between Update Model and Local Refine Model at SM6 (upper) and SM7 (lower). Baseline condition	Wet Season	
	Figure 5A-74	
DSD & ATKINS		



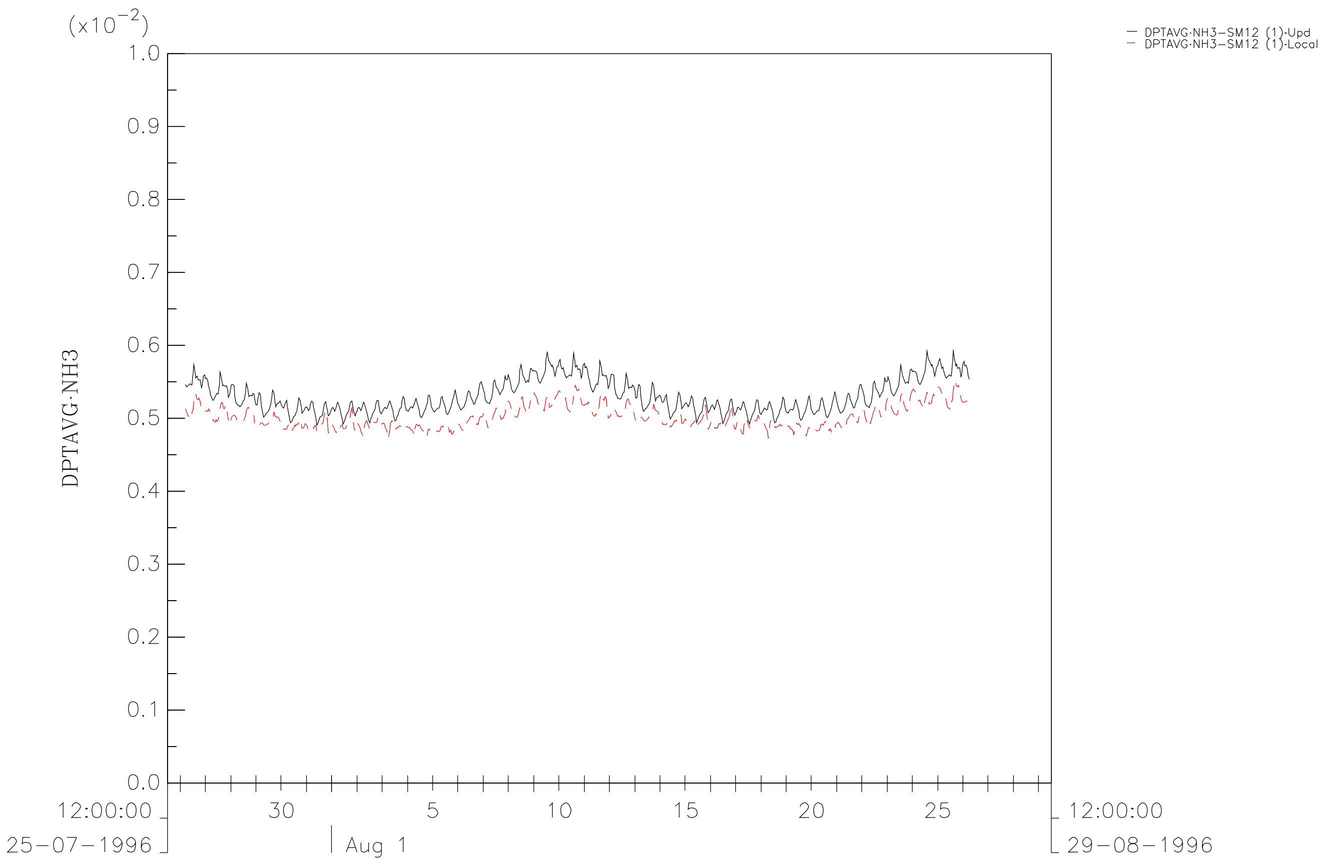


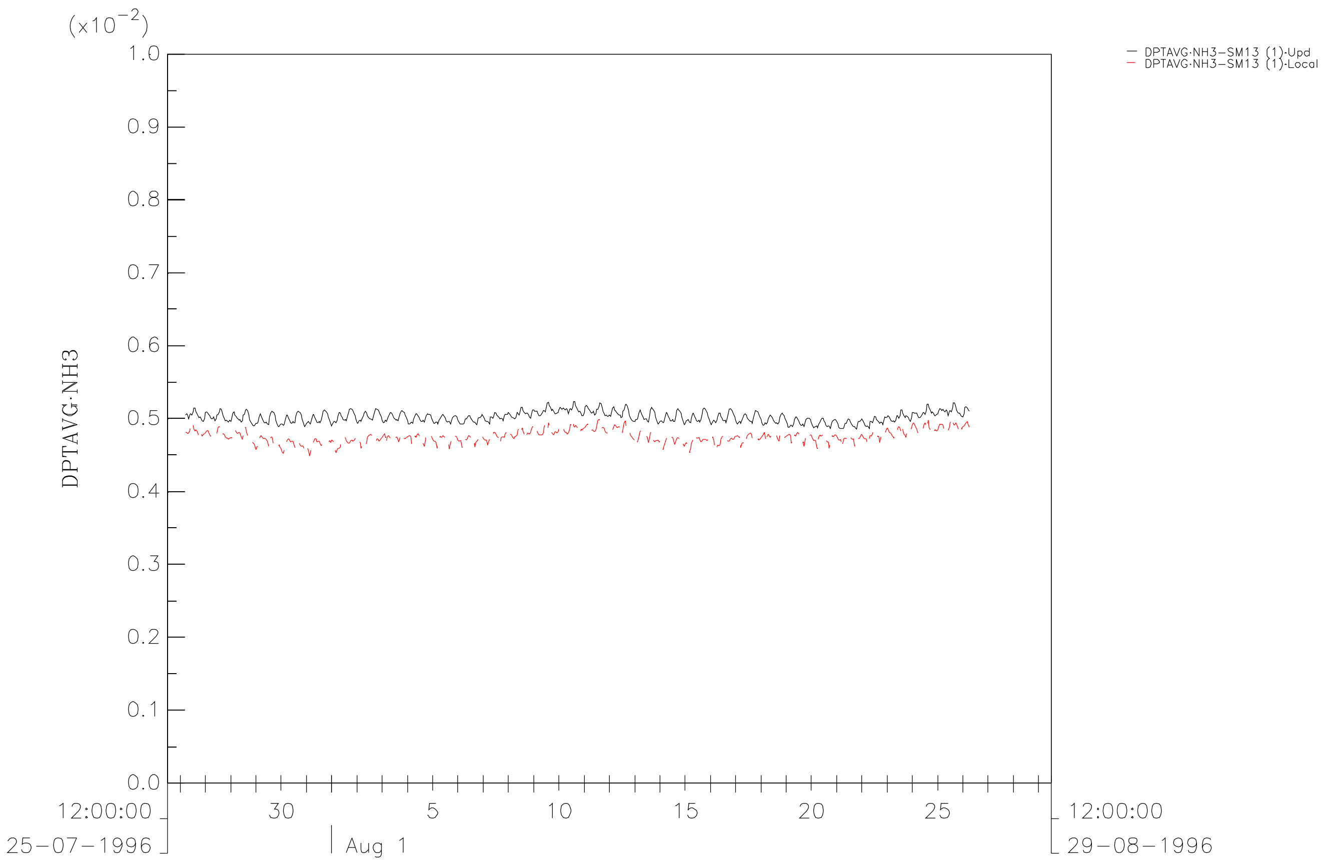
NH3 comparison between Update Model and
Local Refine Model at SM17 (upper) and SM18 (lower).
Baseline condition

Wet Season

Figure 5A-75

DSD & ATKINS



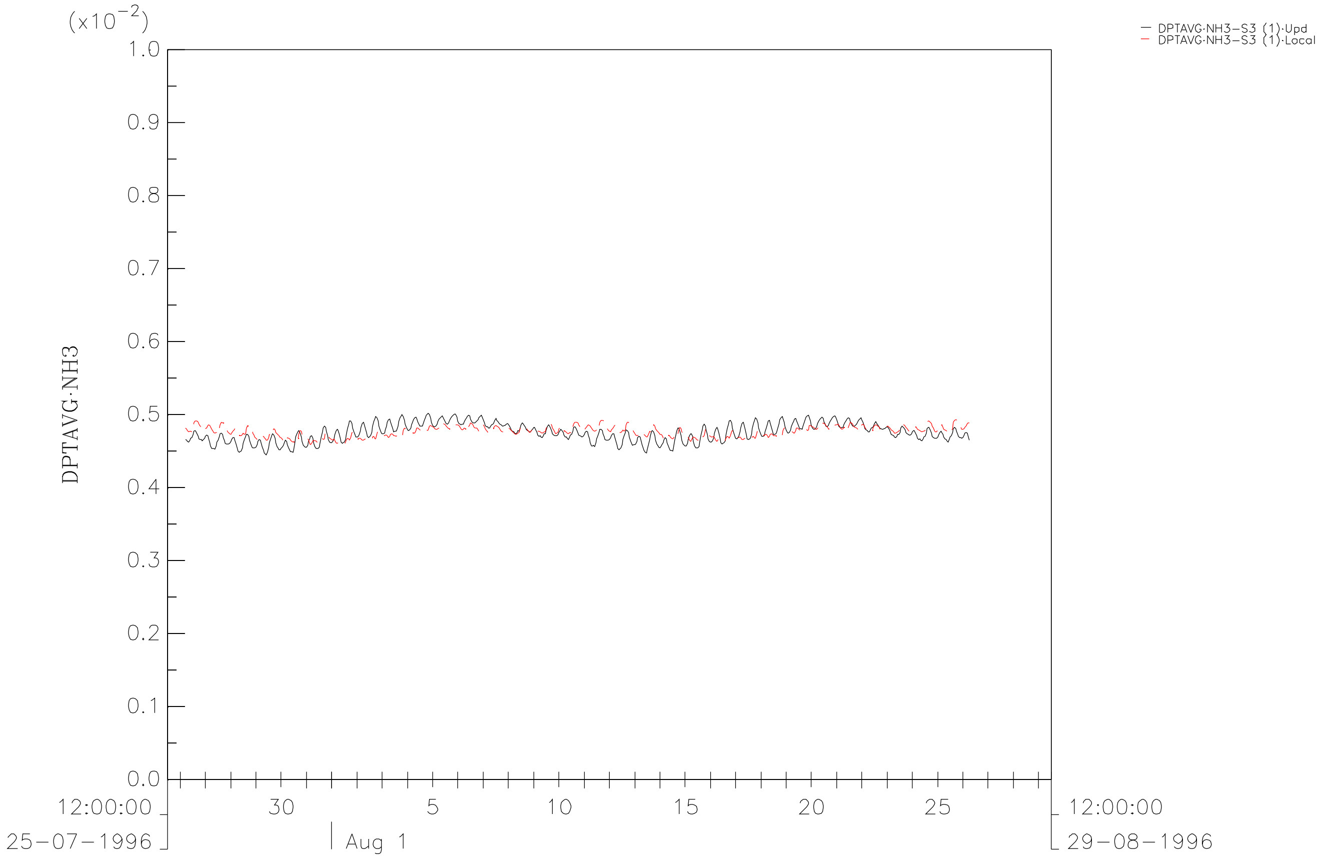


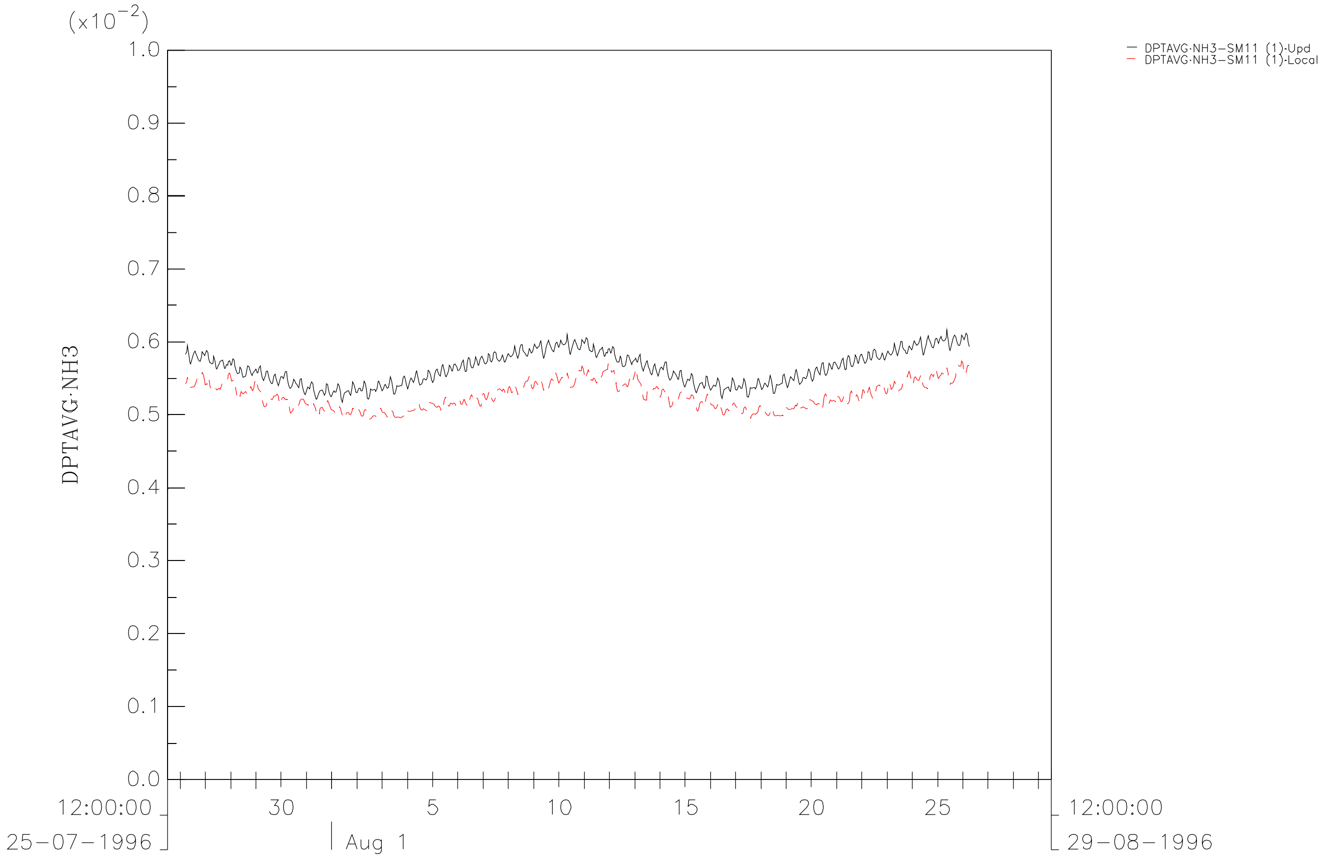
NH3 comparison between Update Model and Local Refine Model at SM12 (upper) and SM13 (lower). Baseline condition

Wet Season

Figure 5A-76

DSD & ATKINS



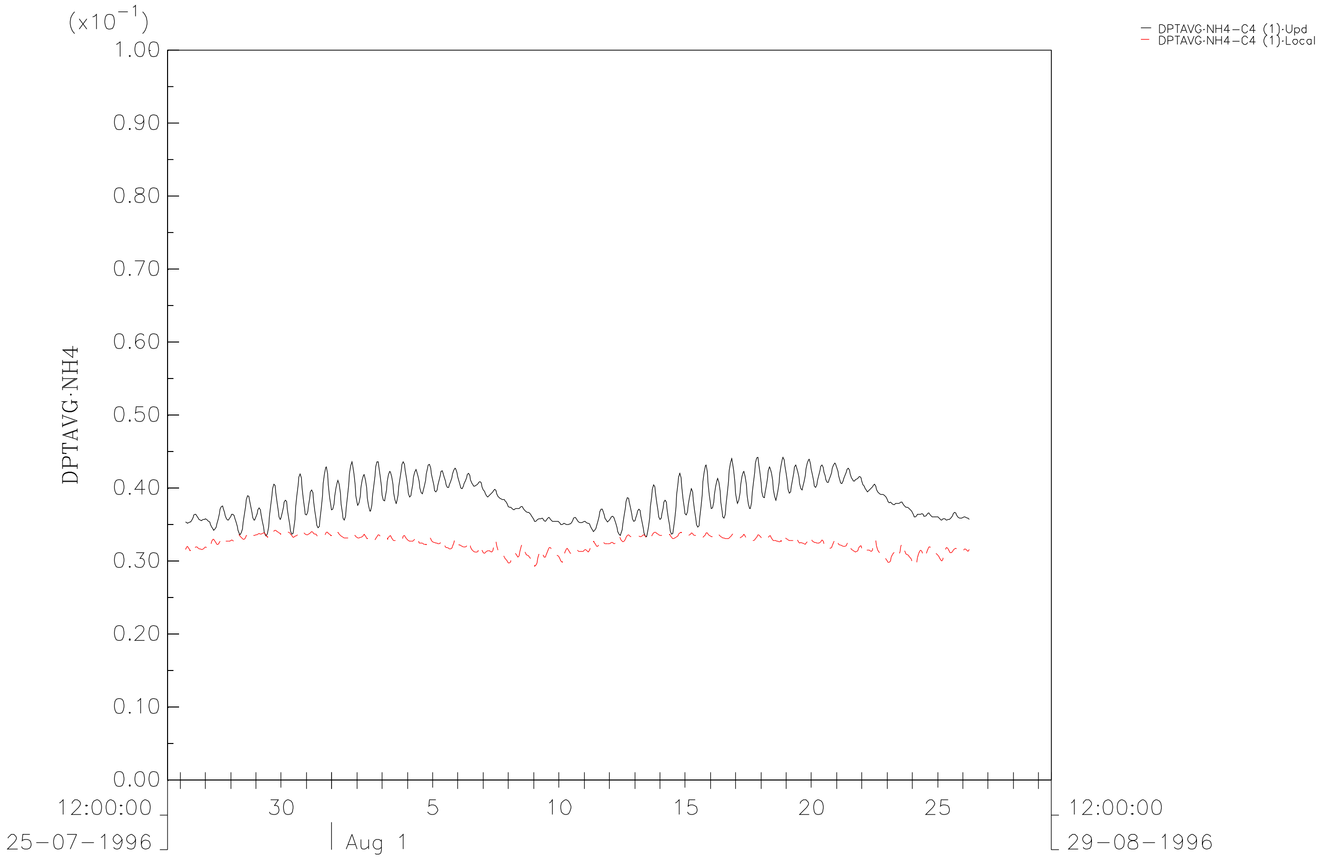


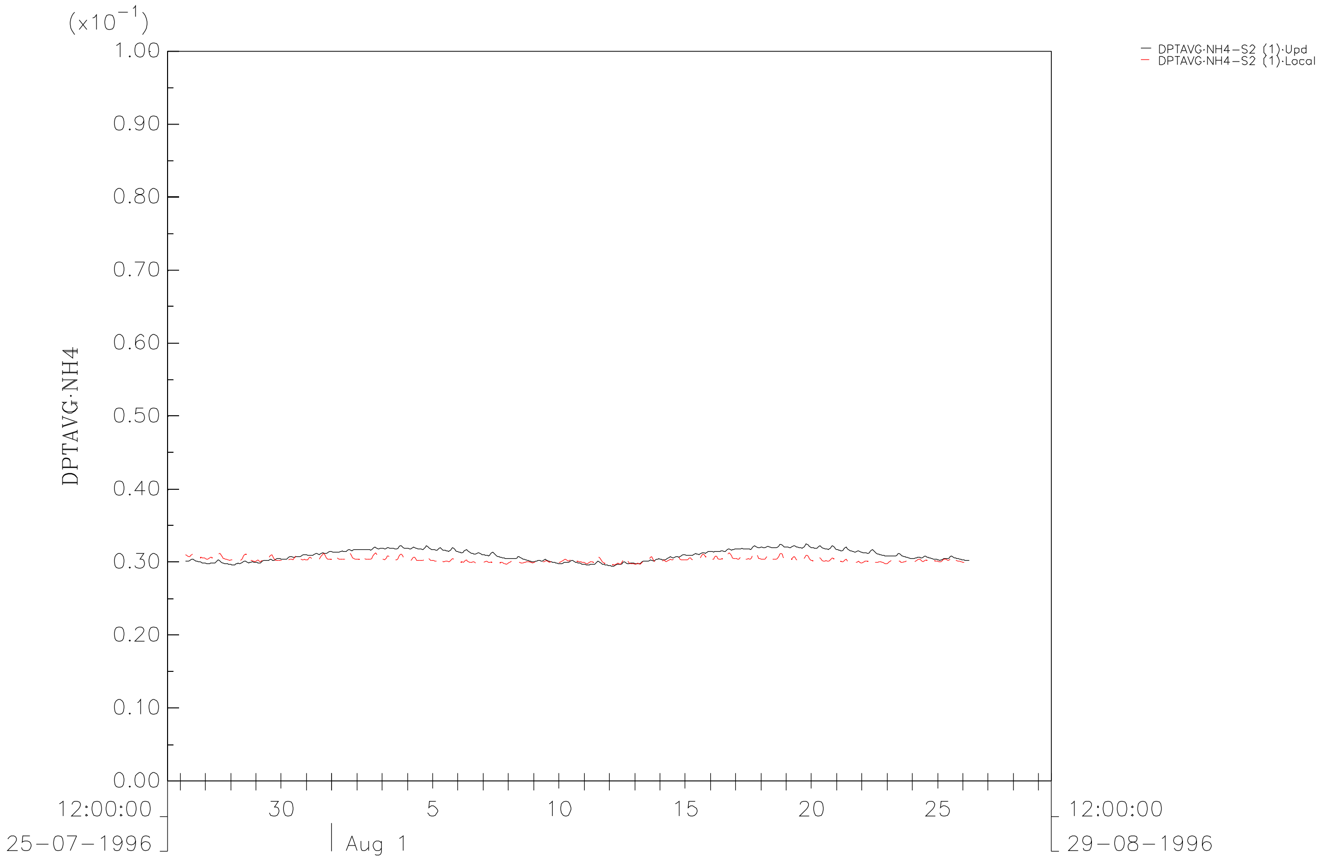
NH3 comparison between Update Model and Local Refine Model at S3 (upper) and SM11 (lower). Baseline condition

Wet Season

Figure 5A-77

DSD & ATKINS



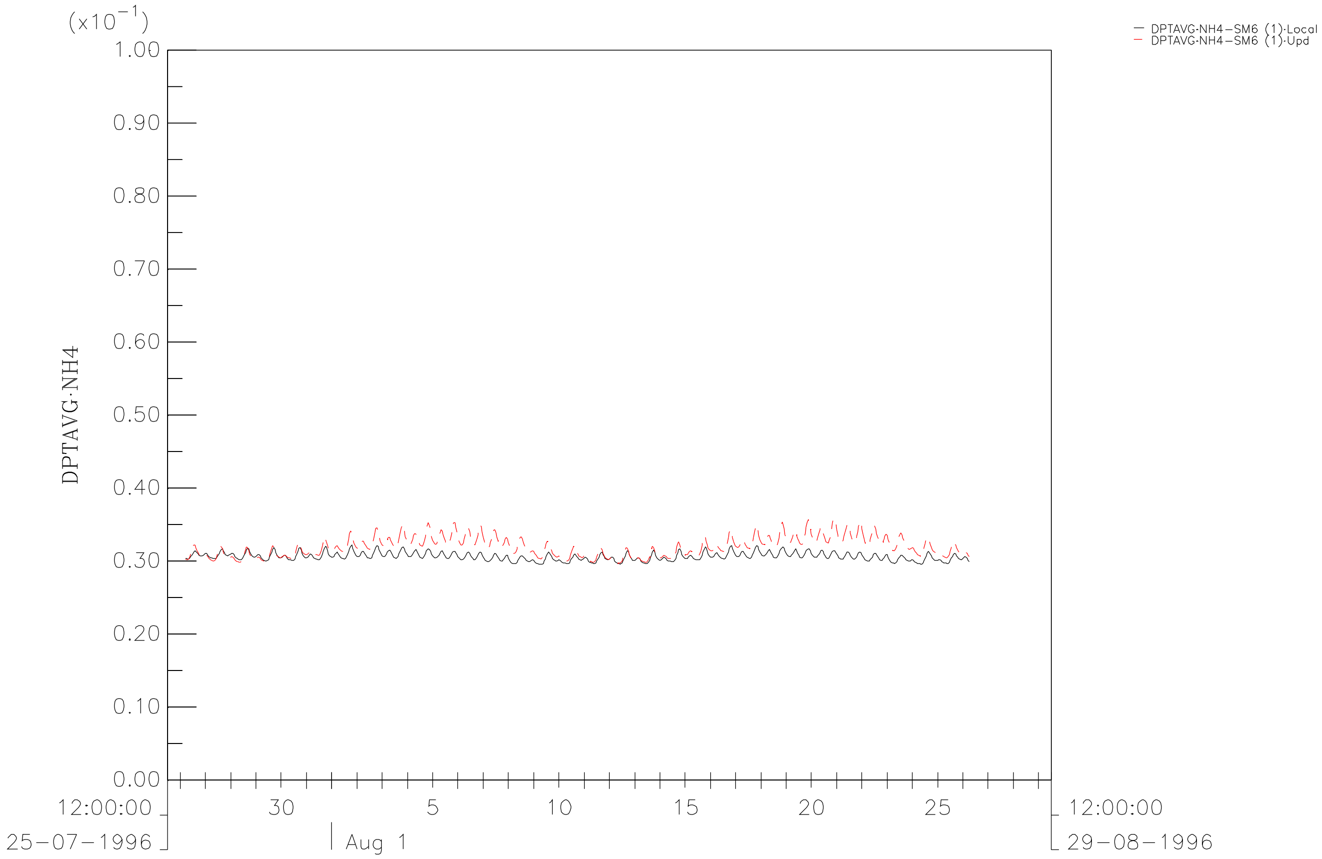


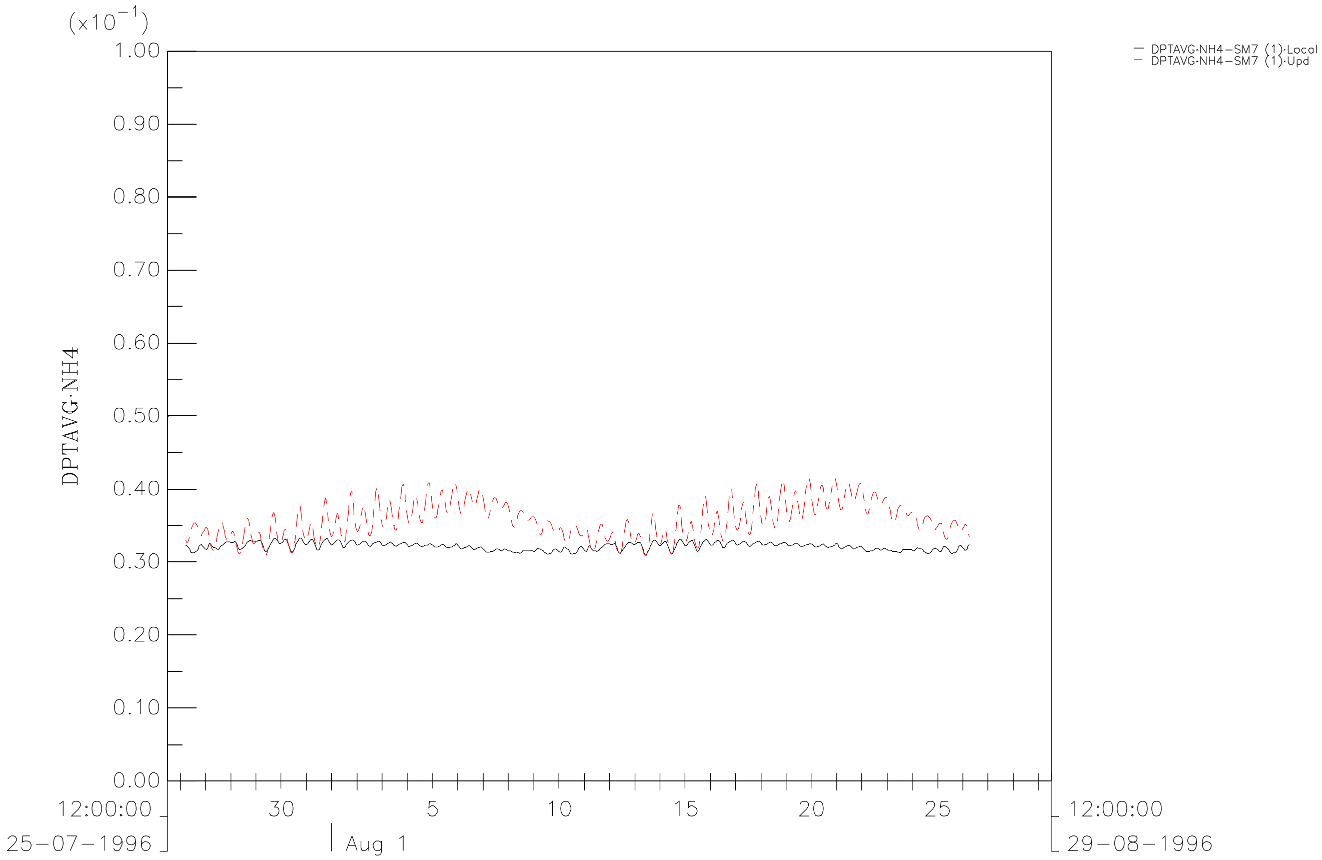
NH4 comparison between Update Model and
Local Refine Model at C4 (upper) and S2 (lower).
Baseline condition

Dry Season

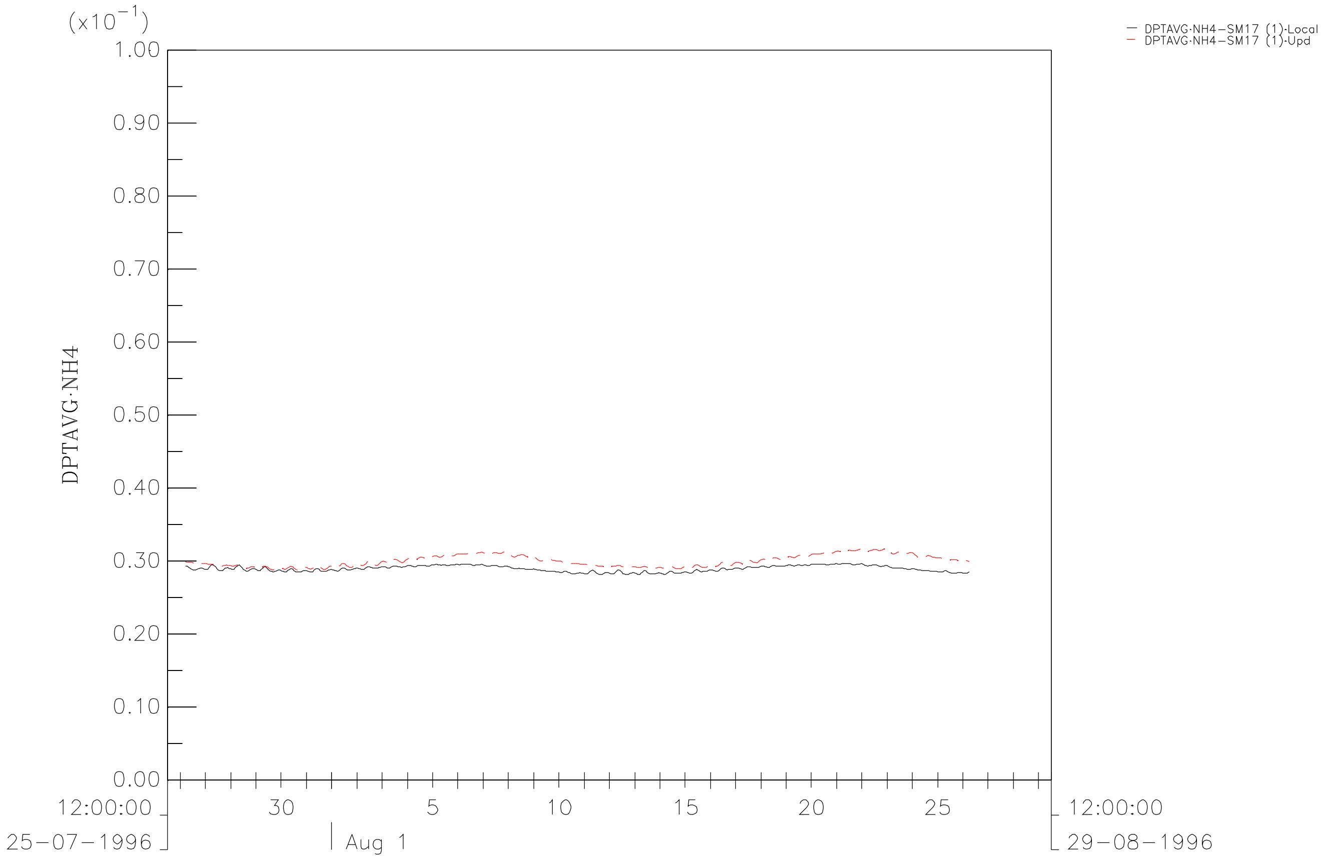
Figure 5A-78

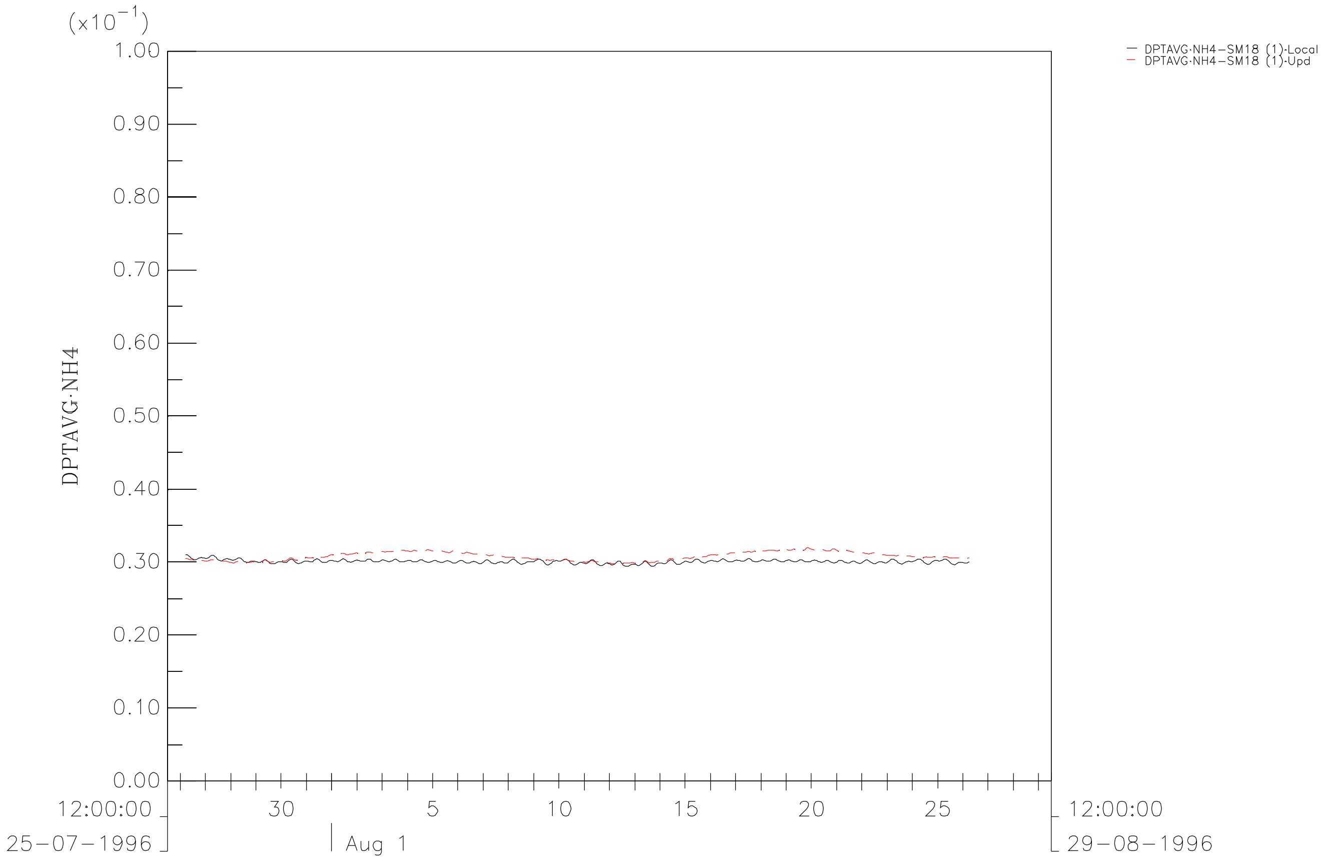
DSD & ATKINS



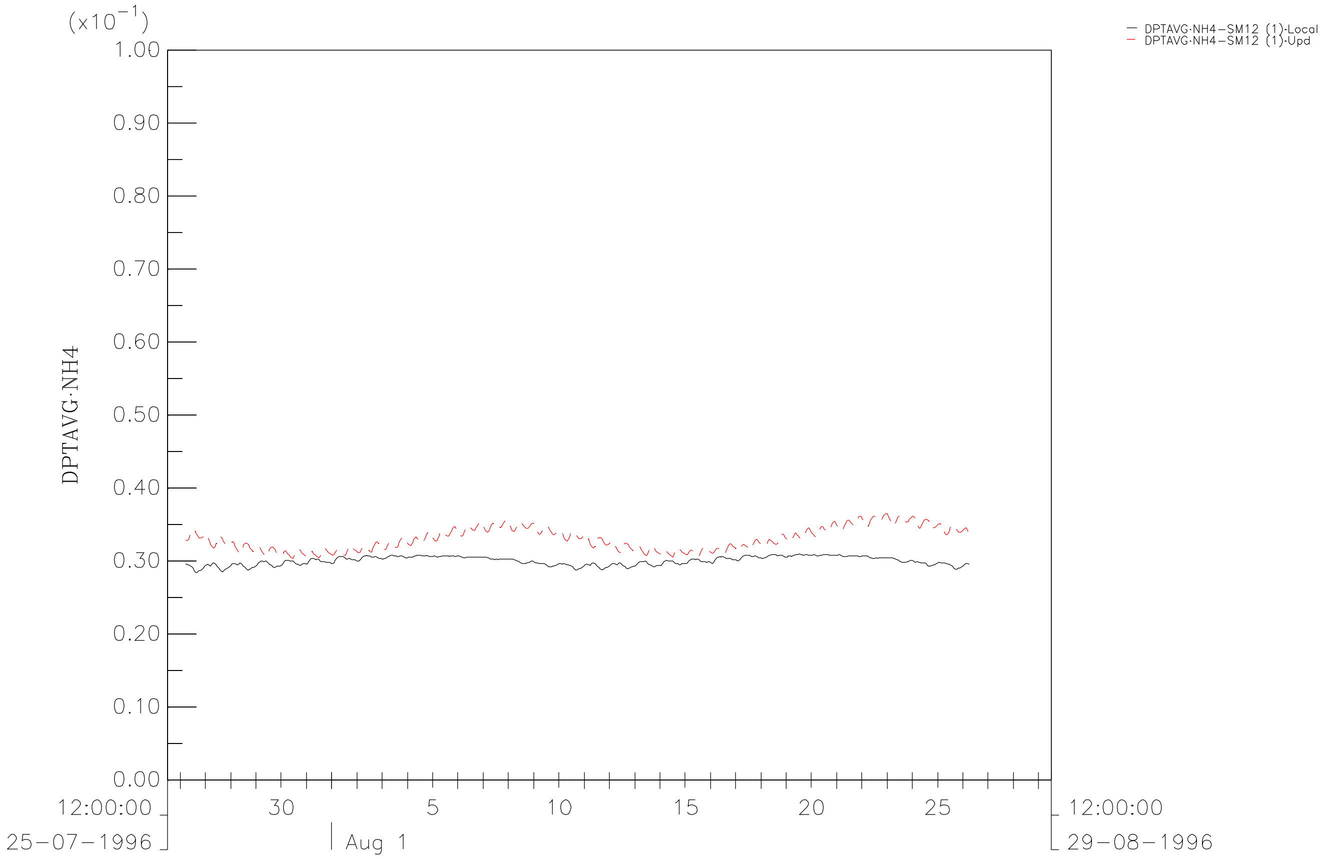


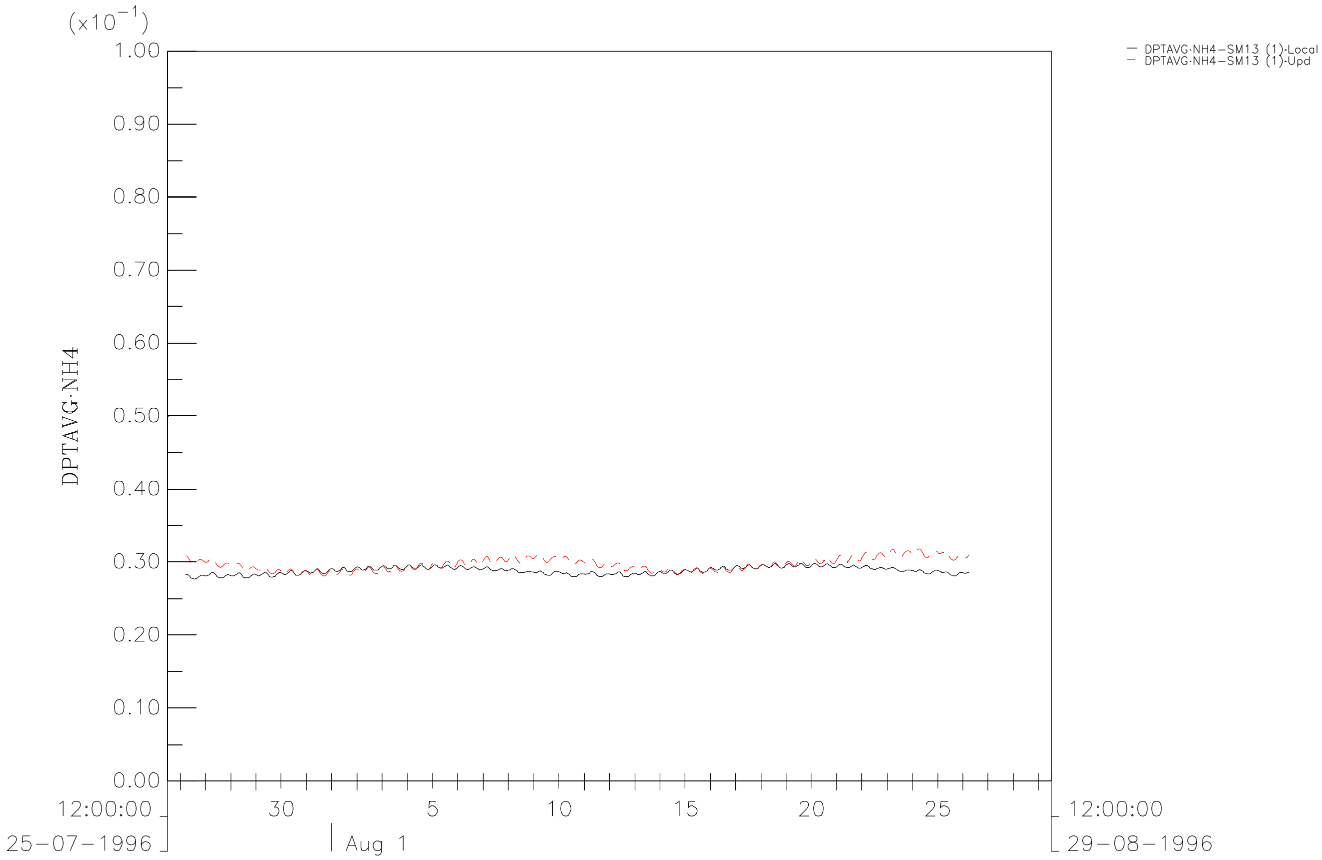
NH4 comparison between Update Model and Local Refine Model at SM6 (upper) and SM7 (lower). Baseline condition	Dry Season
	Figure 5A-79
DSD & ATKINS	





NH4 comparison between Update Model and Local Refine Model at SM17 (upper) and SM18 (lower). Baseline condition	Dry Season	
	Figure 5A-80	
DSD & ATKINS		



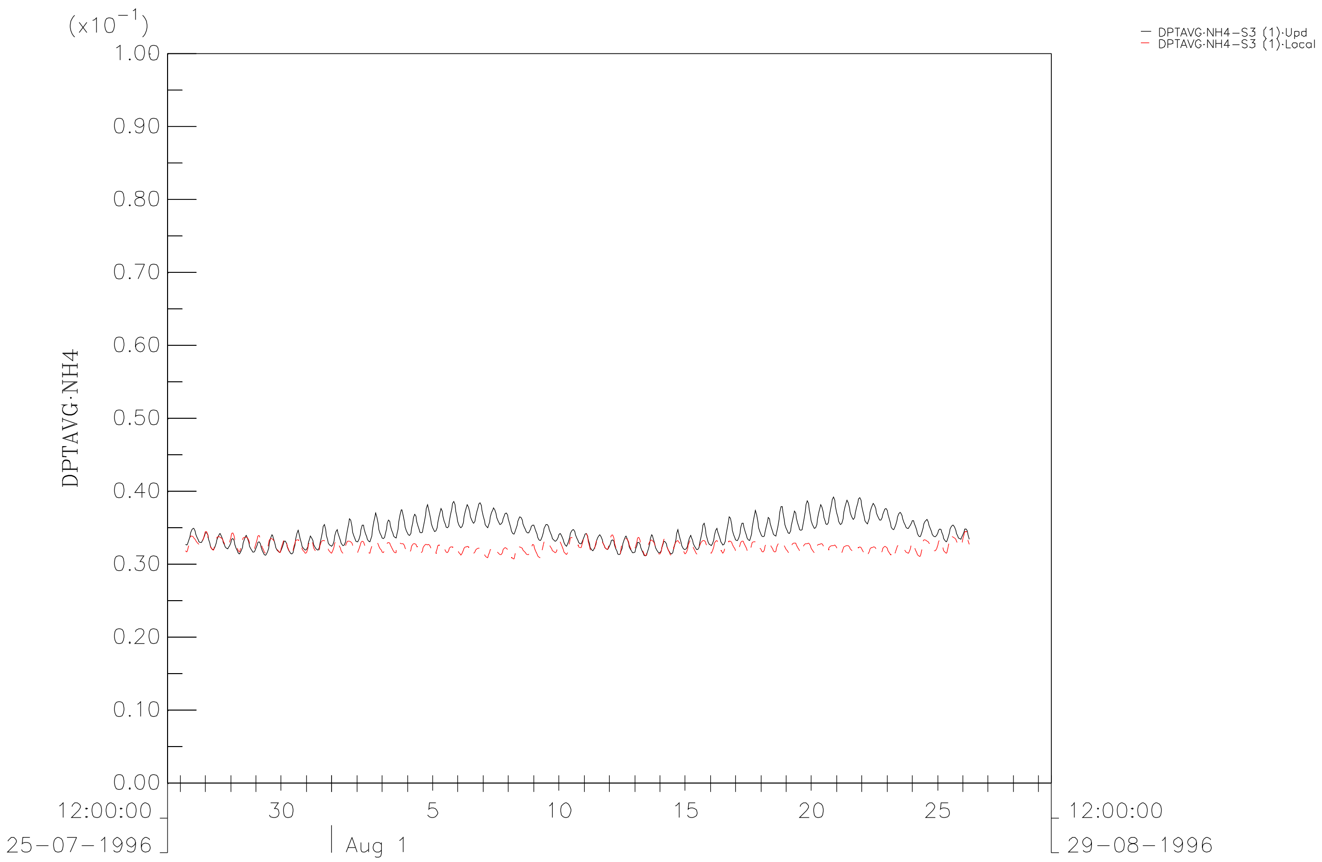


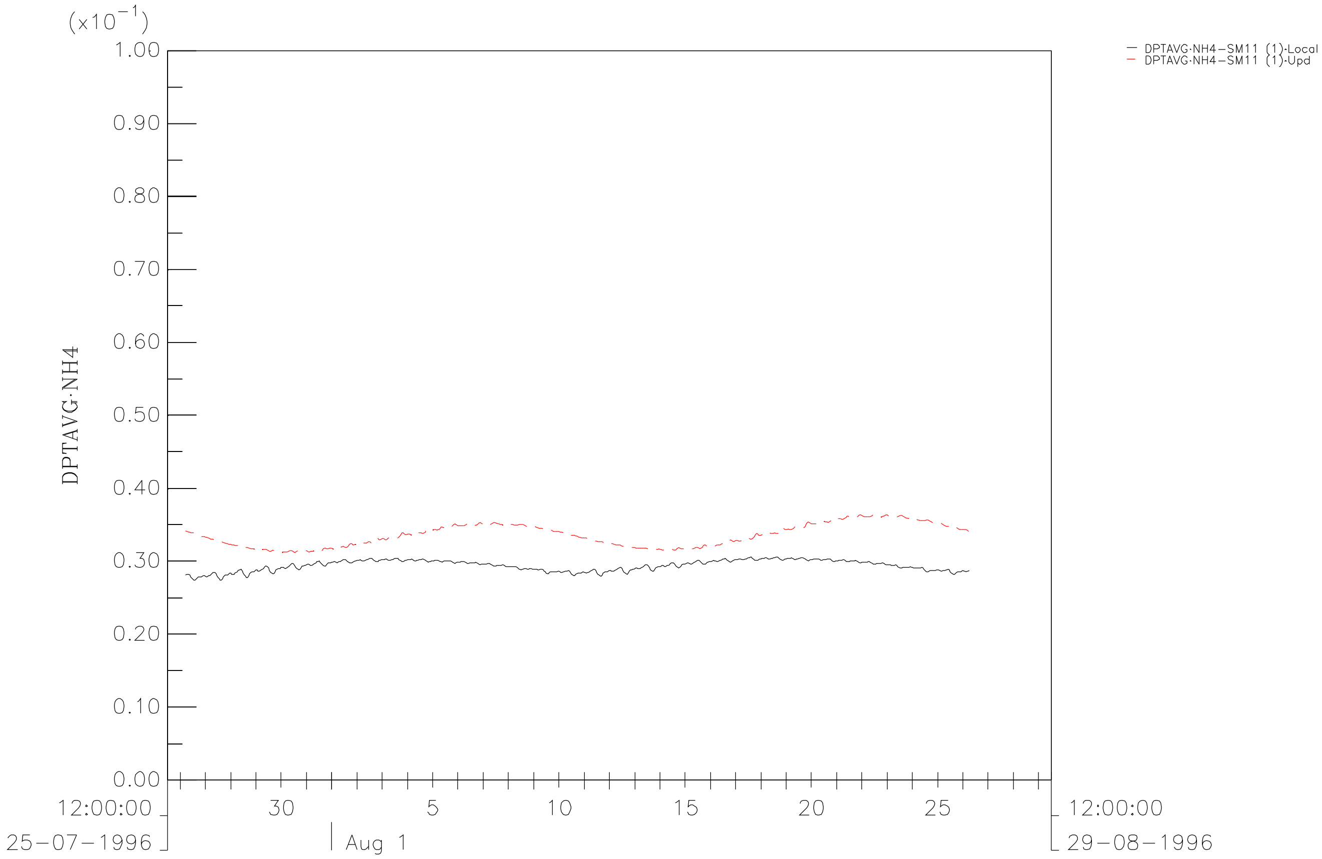
NH4 comparison between Update Model and
Local Refine Model at SM12 (upper) and SM13 (lower).
Baseline condition

Dry Season

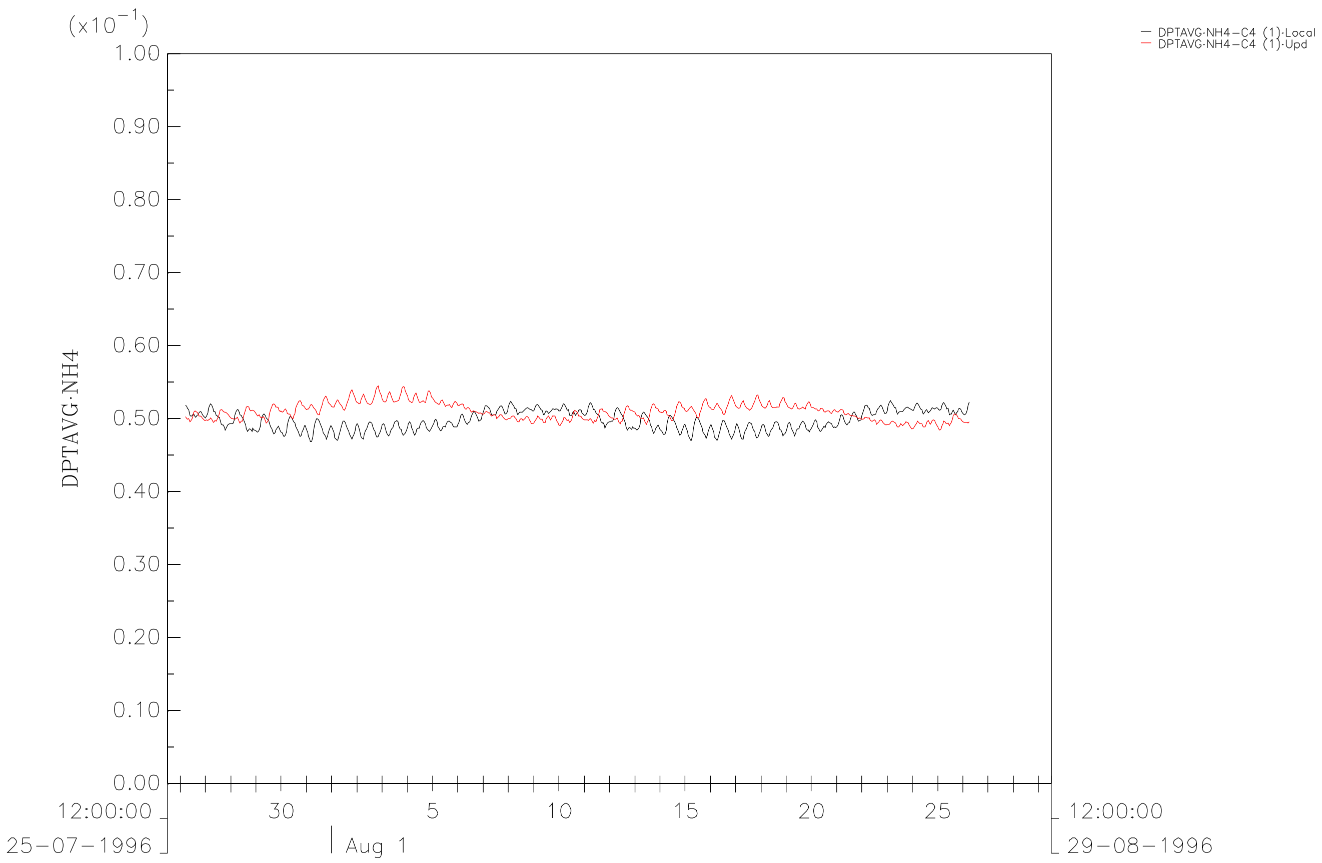
Figure 5A-81

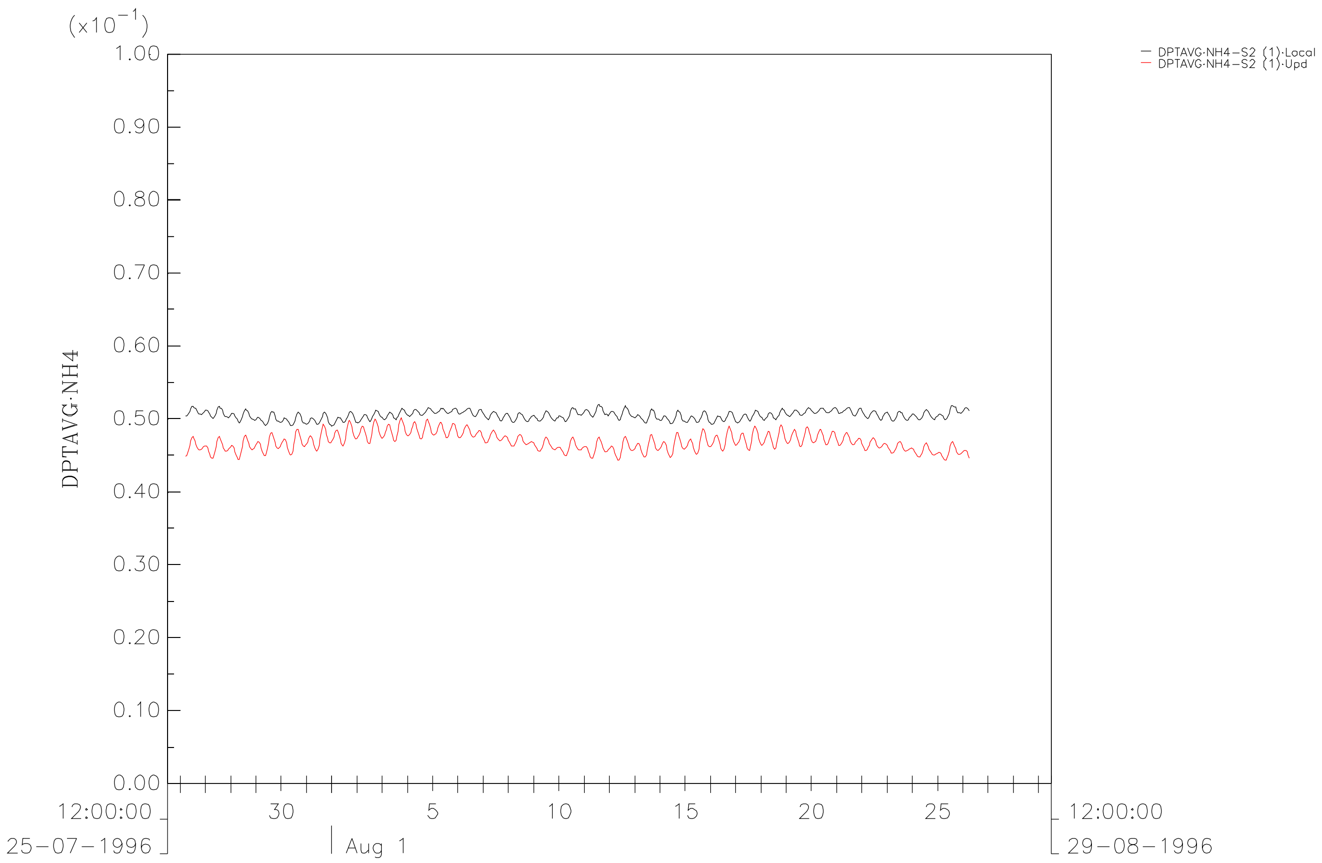
DSD & ATKINS





NH4 comparison between Update Model and Local Refine Model at S3 (upper) and SM11 (lower). Baseline condition	Dry Season
	Figure 5A-82
DSD & ATKINS	



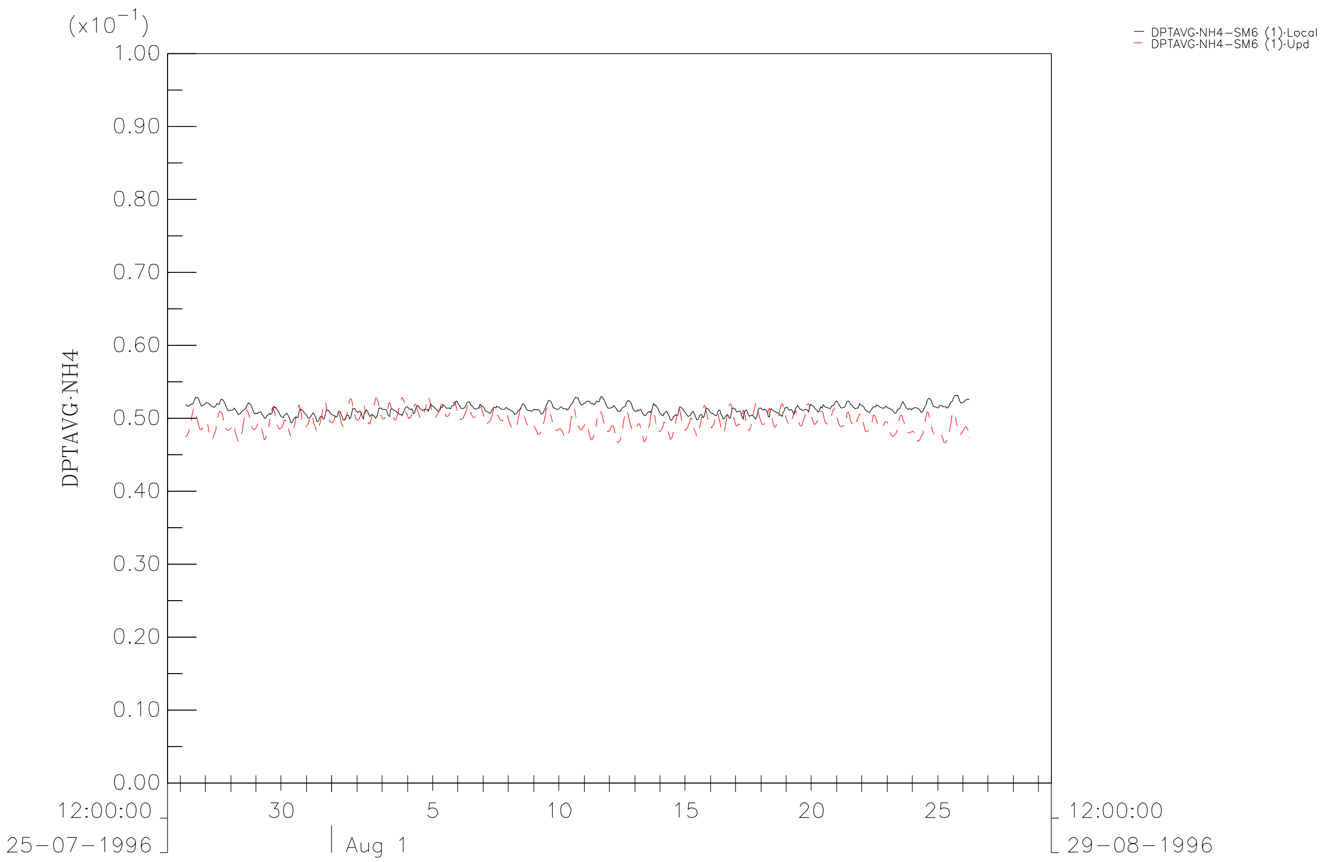


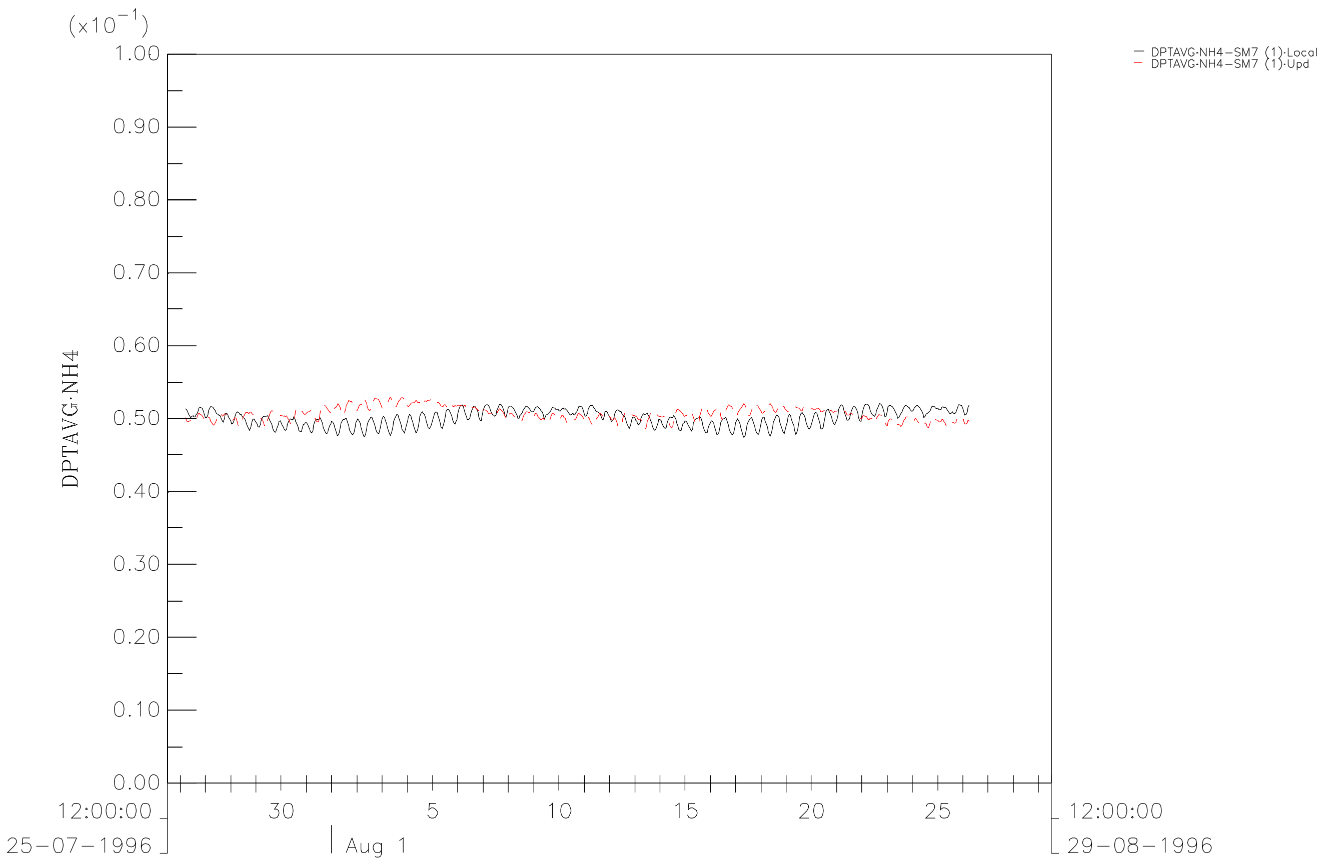
NH4 comparison between Update Model and Local Refine Model at C4 (upper) and S2 (lower). Baseline condition

Wet Season

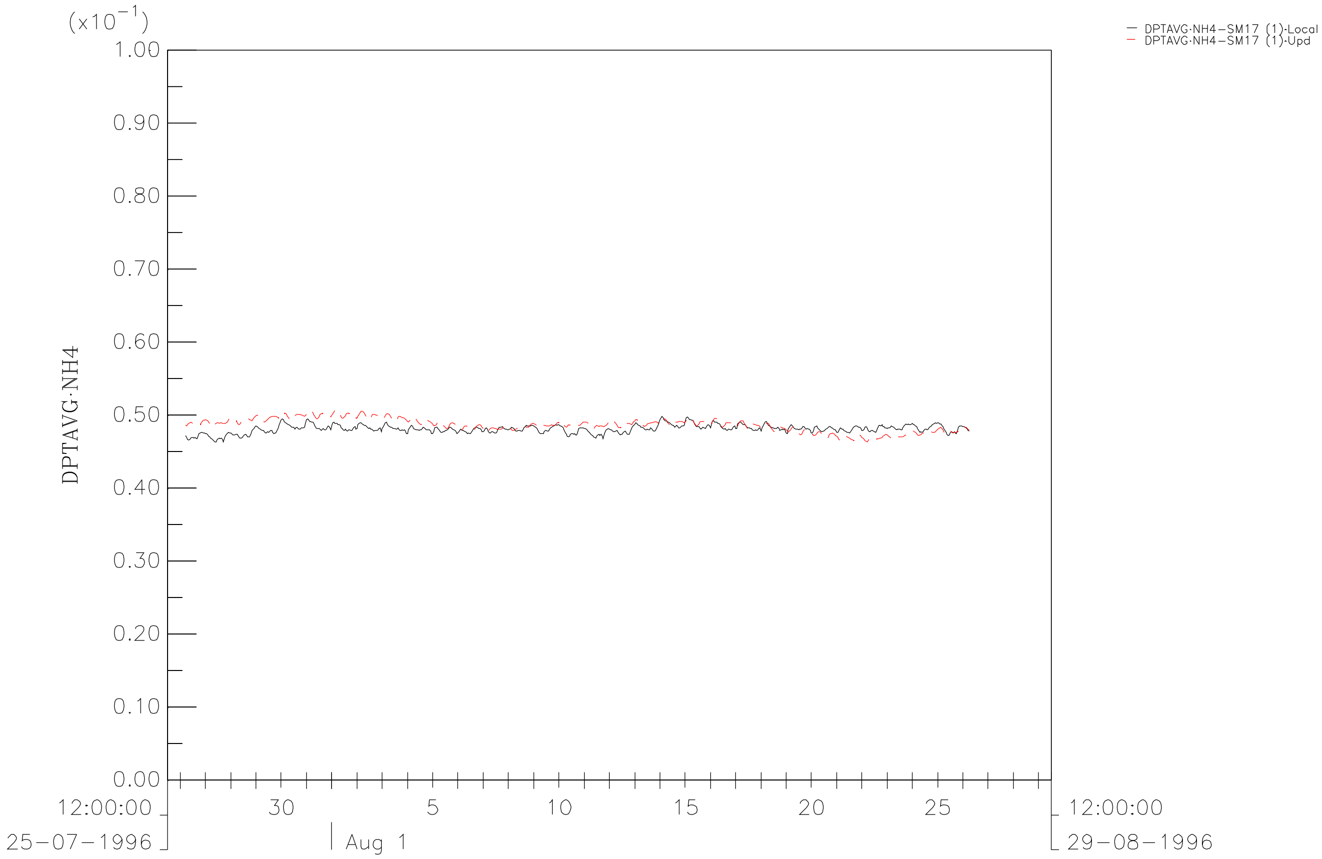
Figure 5A-83

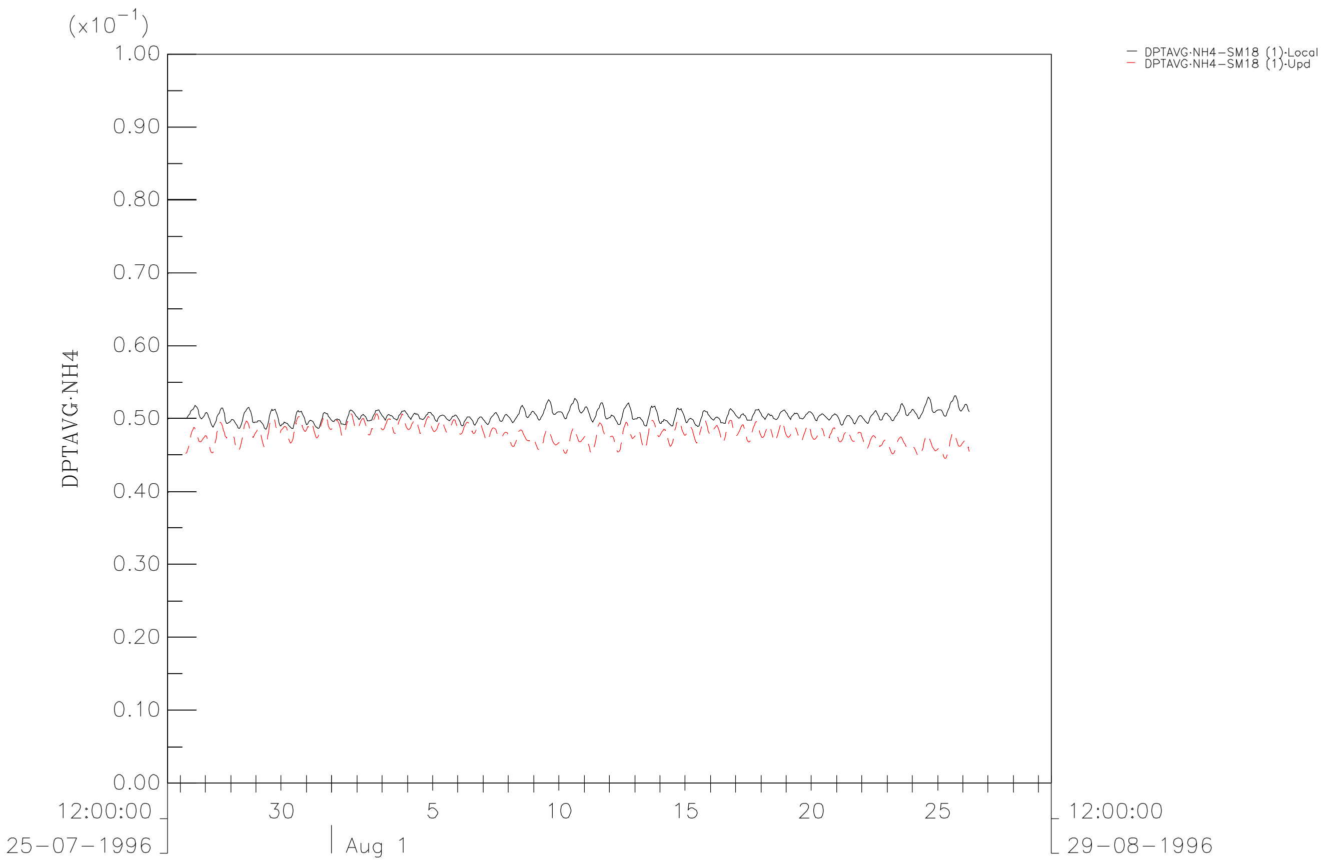
DSD & ATKINS





NH4 comparison between Update Model and Local Refine Model at SM6 (upper) and SM7 (lower). Baseline condition	Wet Season
	Figure 5A-84
DSD & ATKINS	



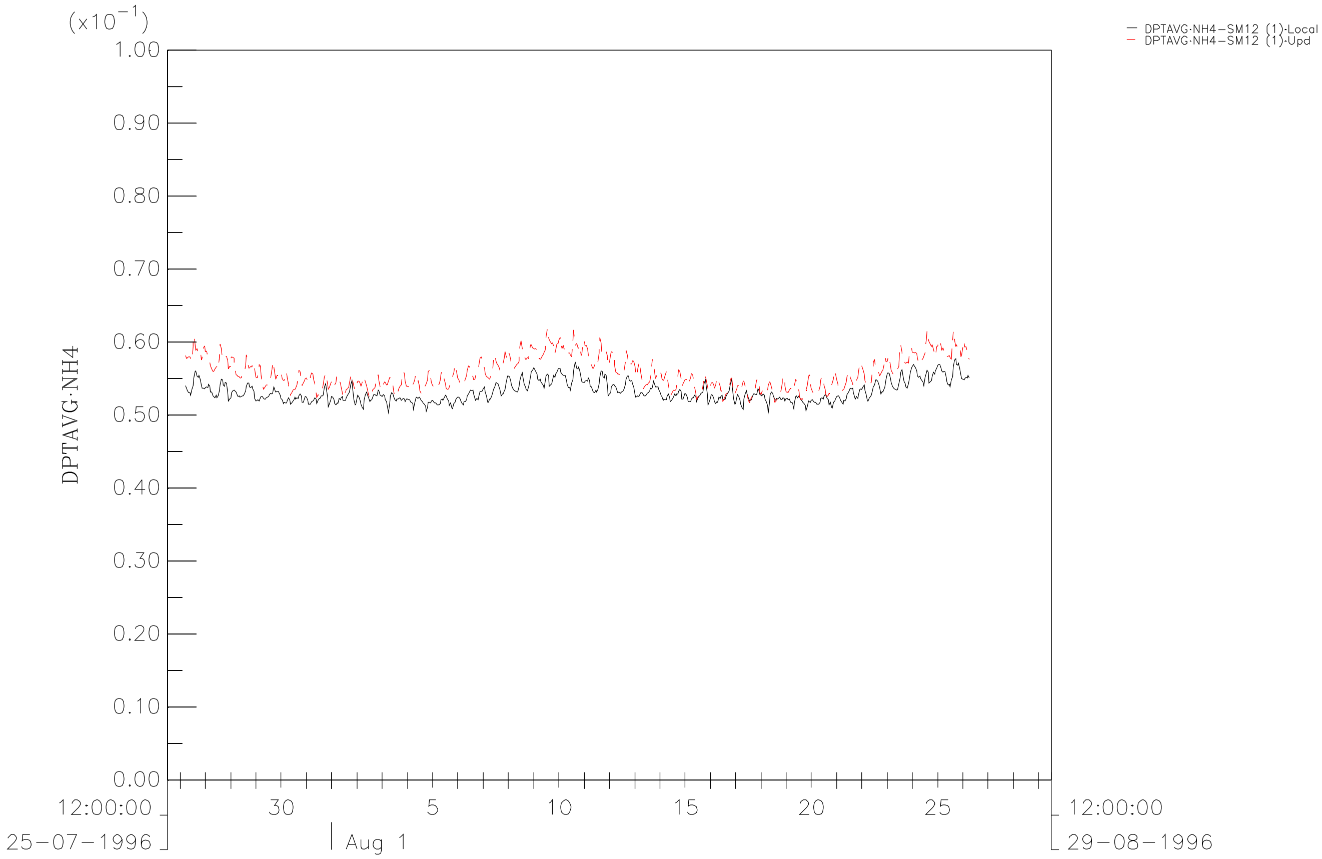


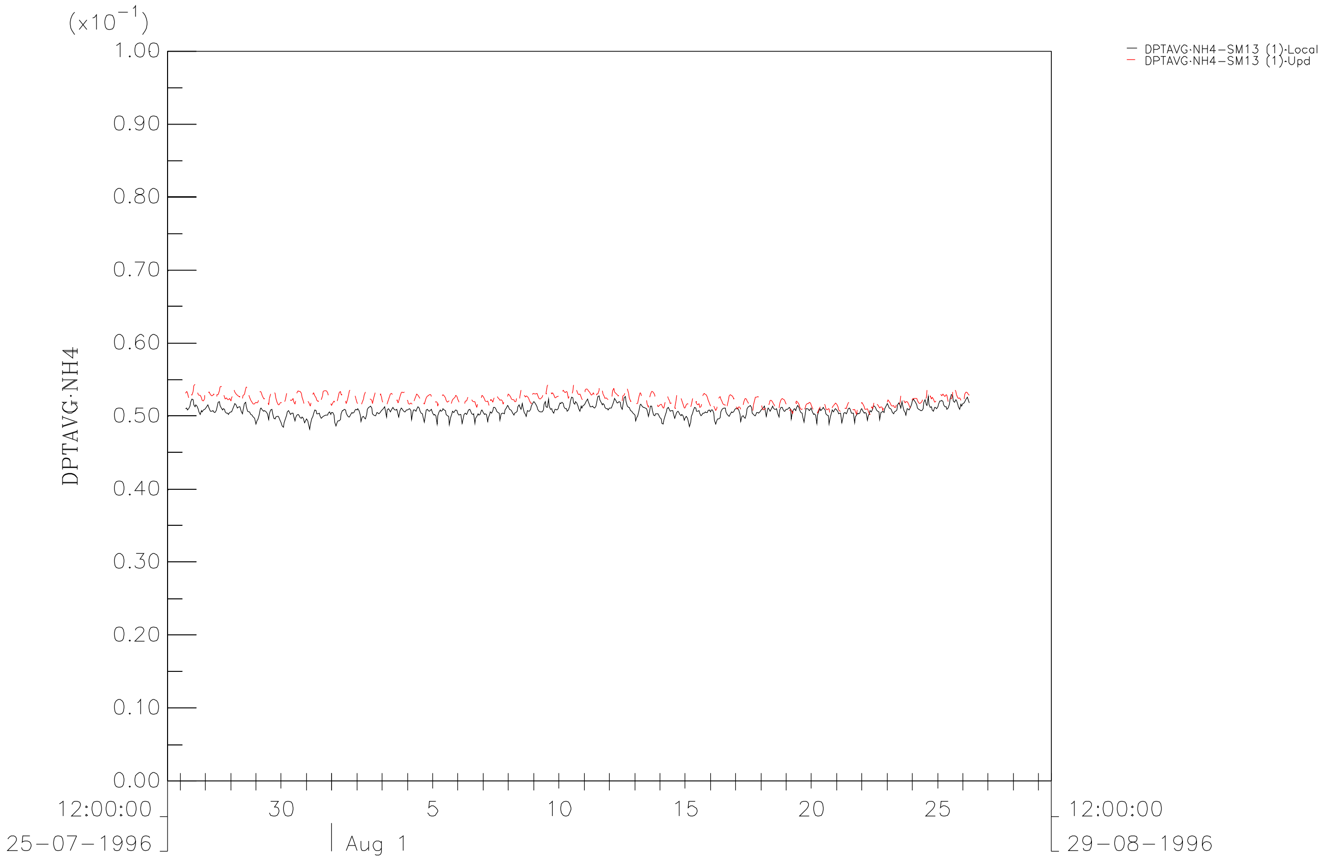
NH4 comparison between Update Model and
Local Refine Model at SM17 (upper) and SM18 (lower).
Baseline condition

Wet Season

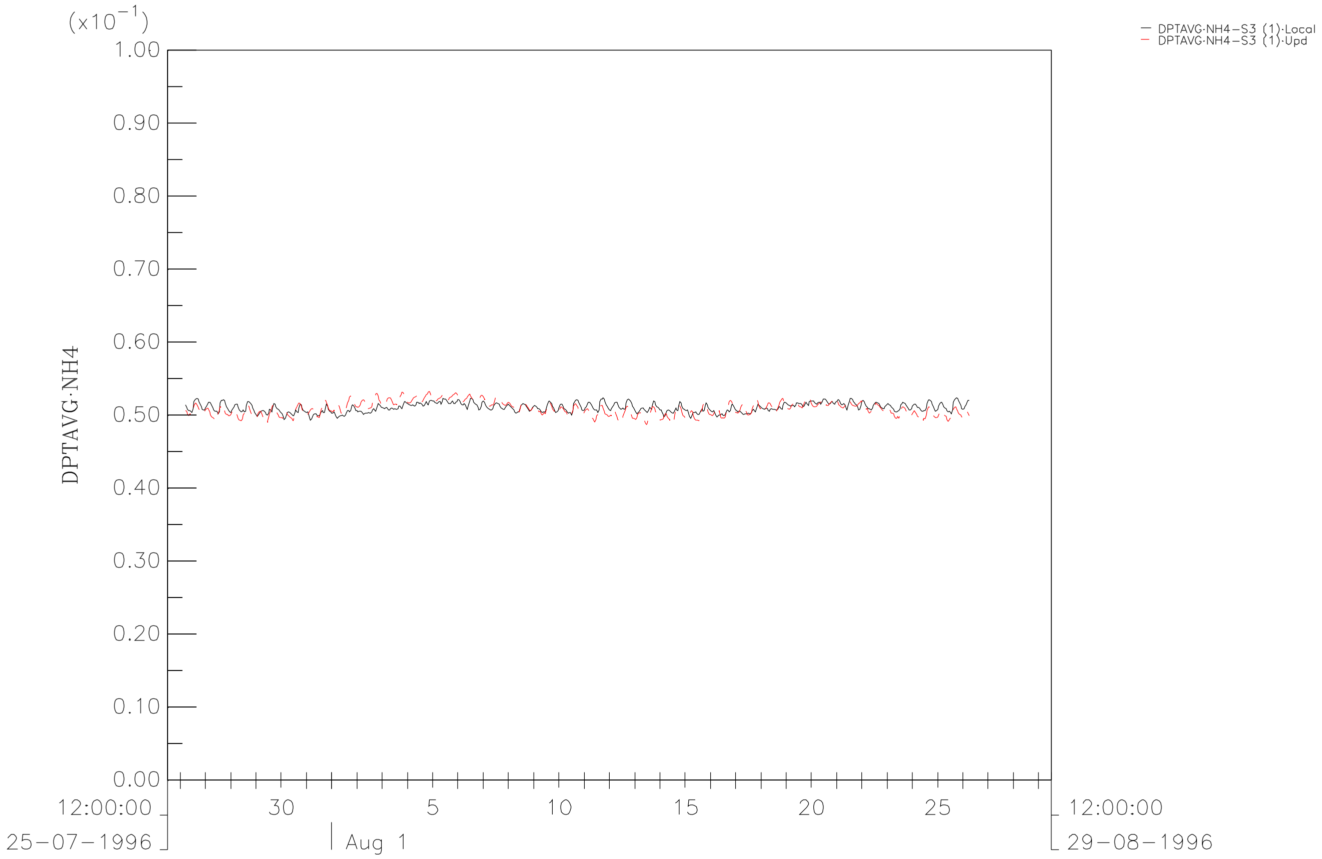
Figure 5A-85

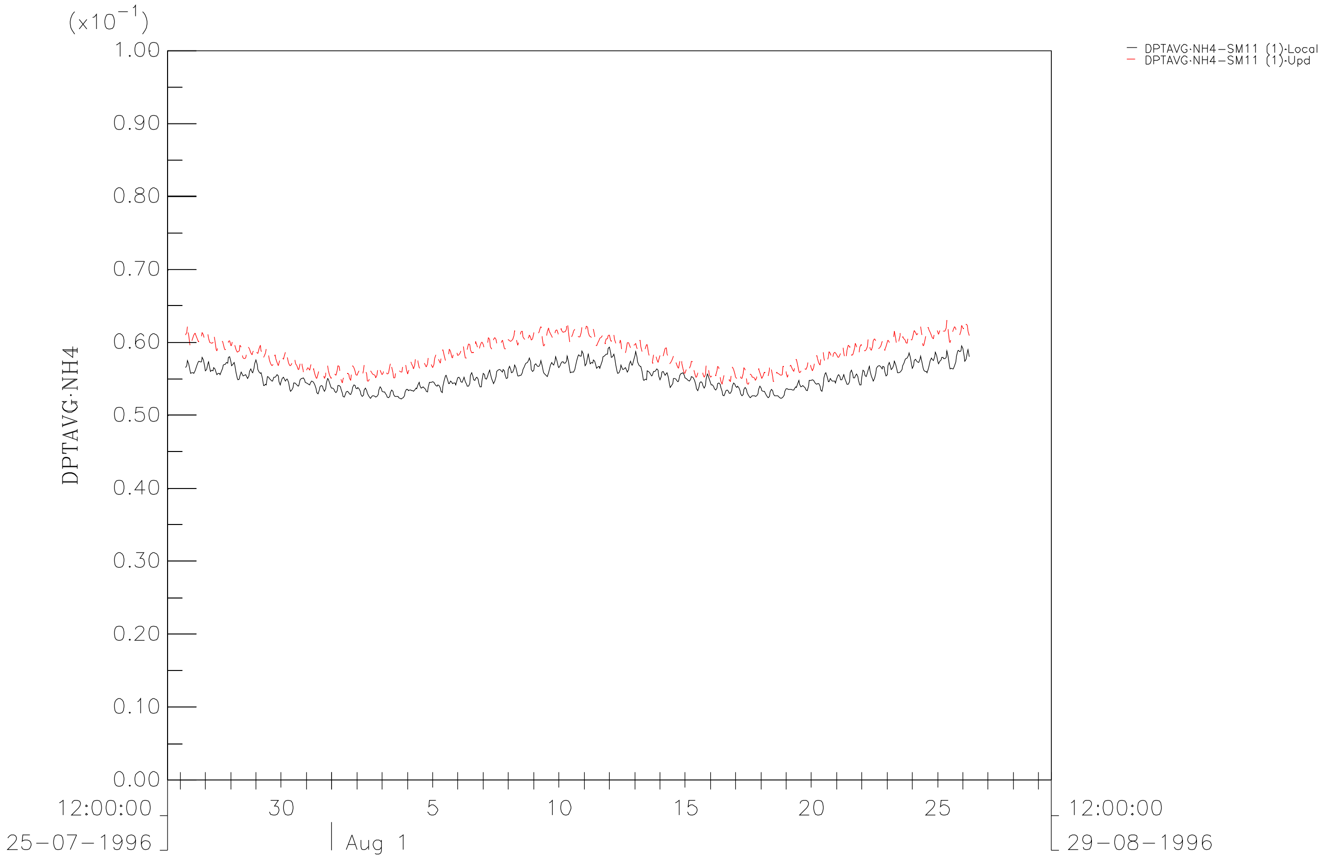
DSD & ATKINS





NH4 comparison between Update Model and Local Refine Model at SM12 (upper) and SM13 (lower). Baseline condition	Wet Season
	Figure 5A-86
DSD & ATKINS	



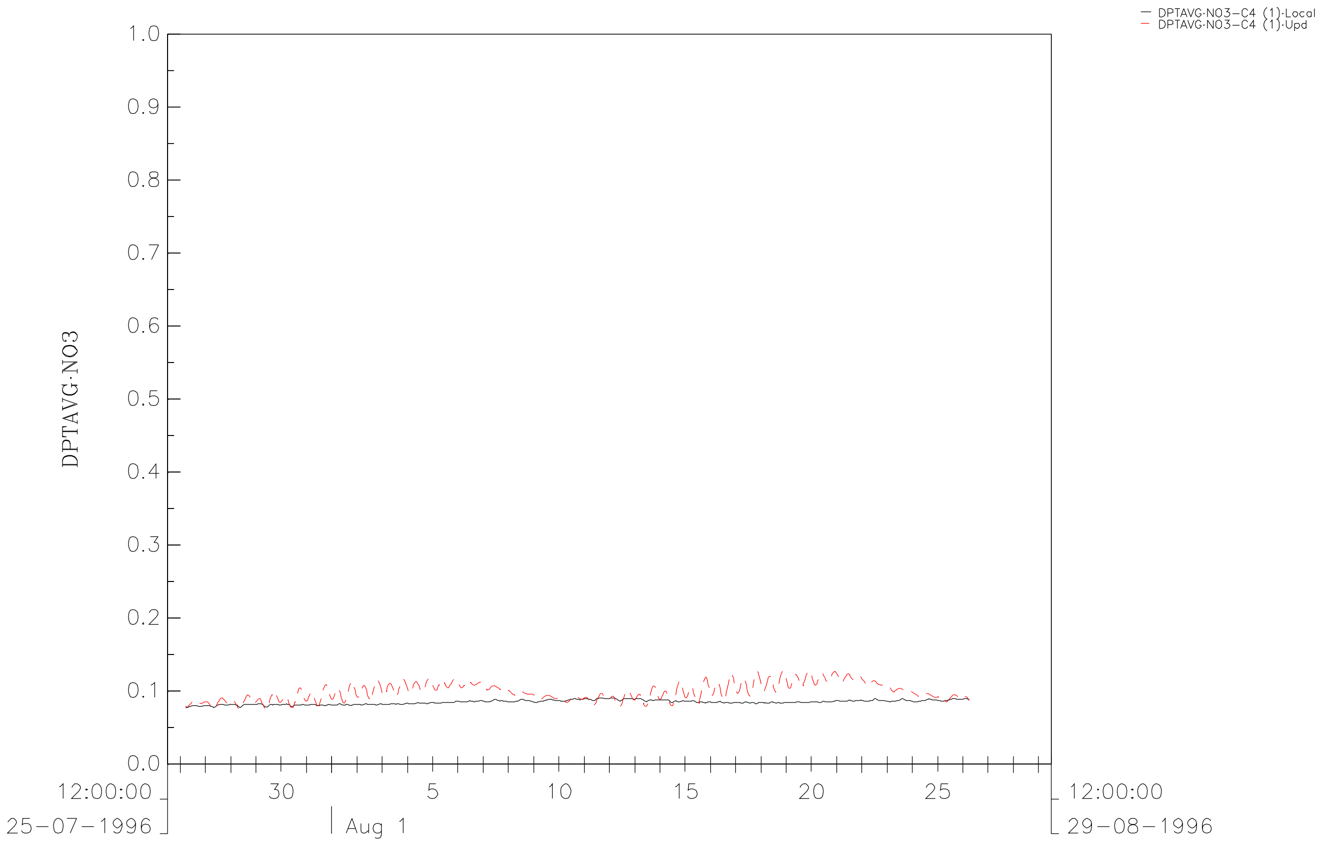


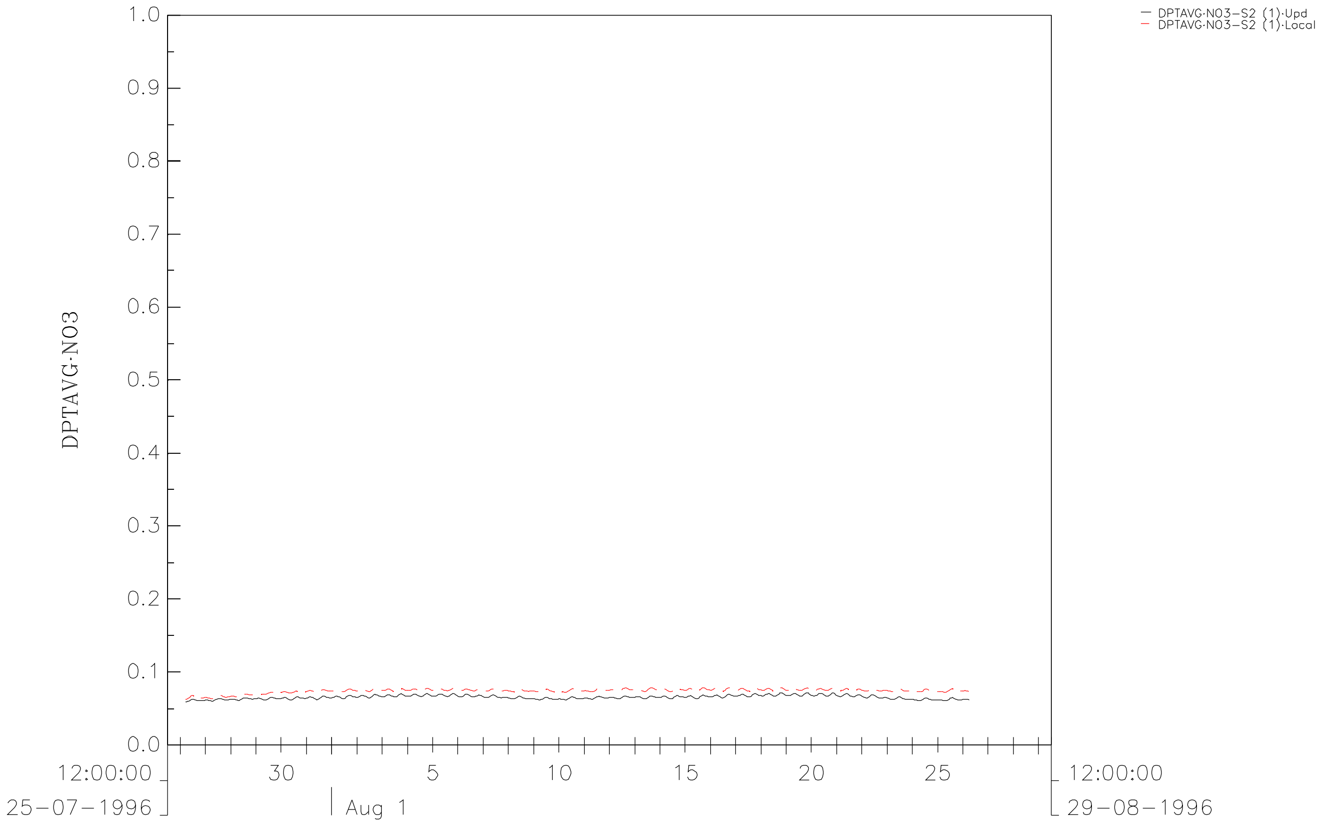
NH4 comparison between Update Model and
Local Refine Model at S3 (upper) and SM11 (lower).
Baseline condition

Wet Season

Figure 5A-87

DSD & ATKINS



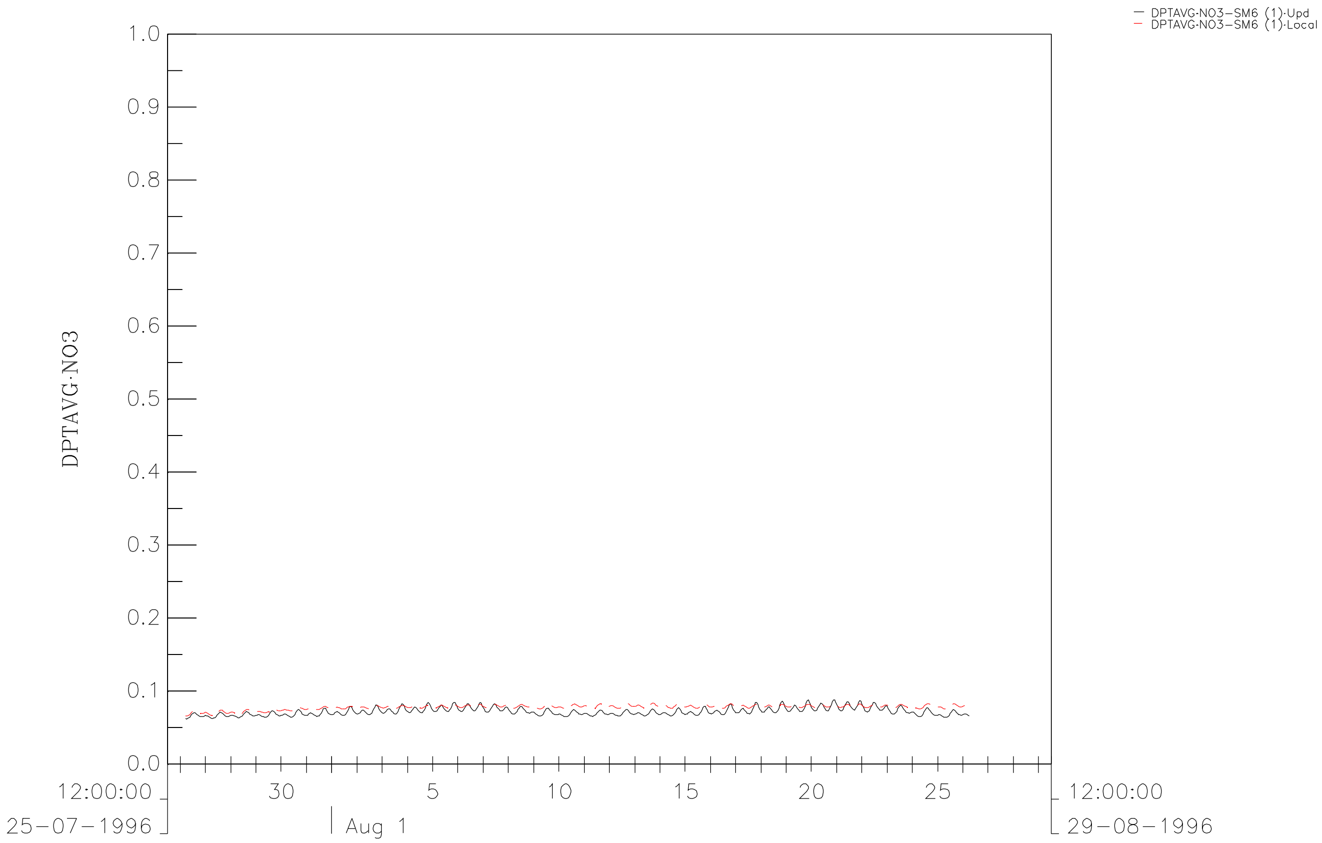


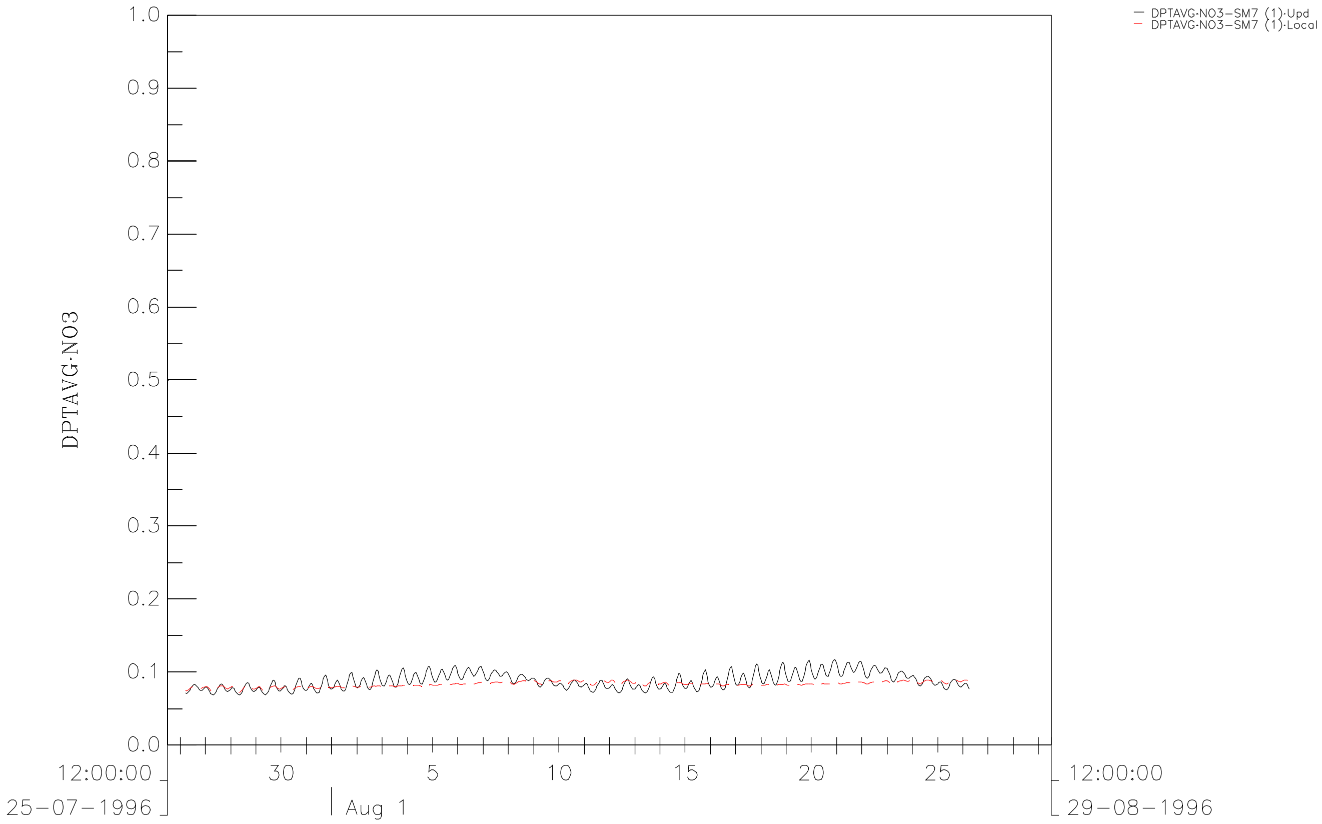
NO3 comparison between Update Model and Local Refine Model at C4 (upper) and S2 (lower). Baseline condition

Dry Season

Figure 5A-88

DSD & ATKINS



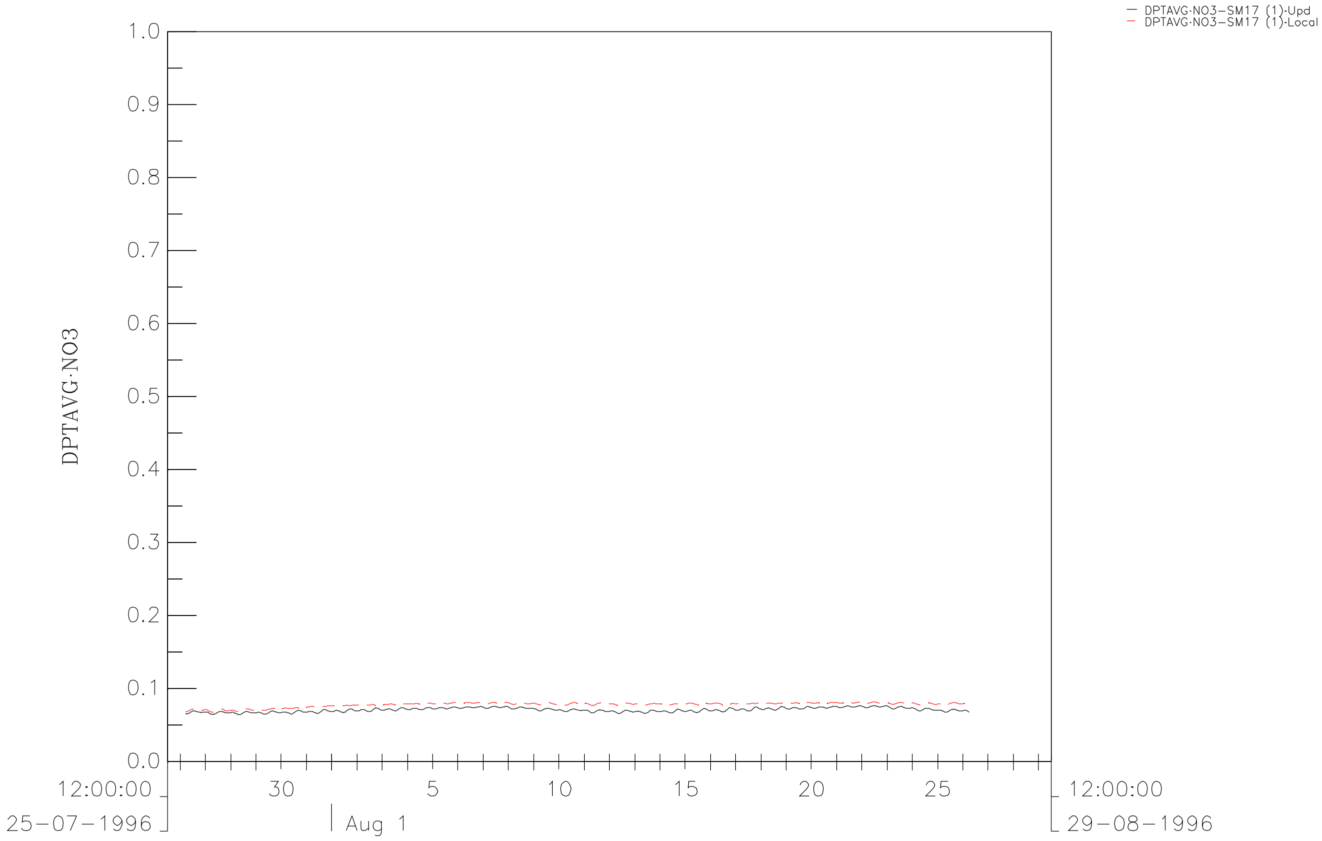


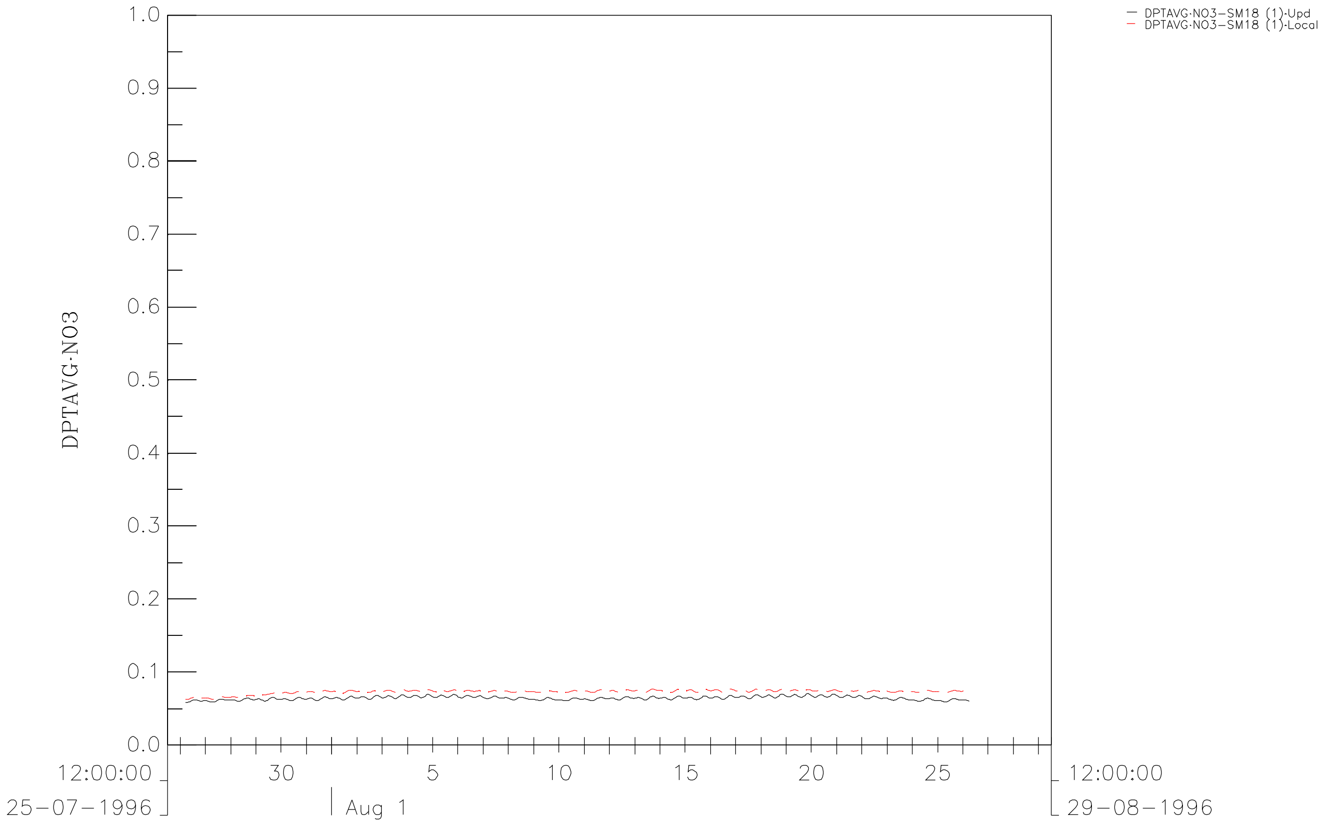
NO3 comparison between Update Model and
Local Refine Model at SM6 (upper) and SM7 (lower).
Baseline condition

Dry Season

Figure 5A-89

DSD & ATKINS



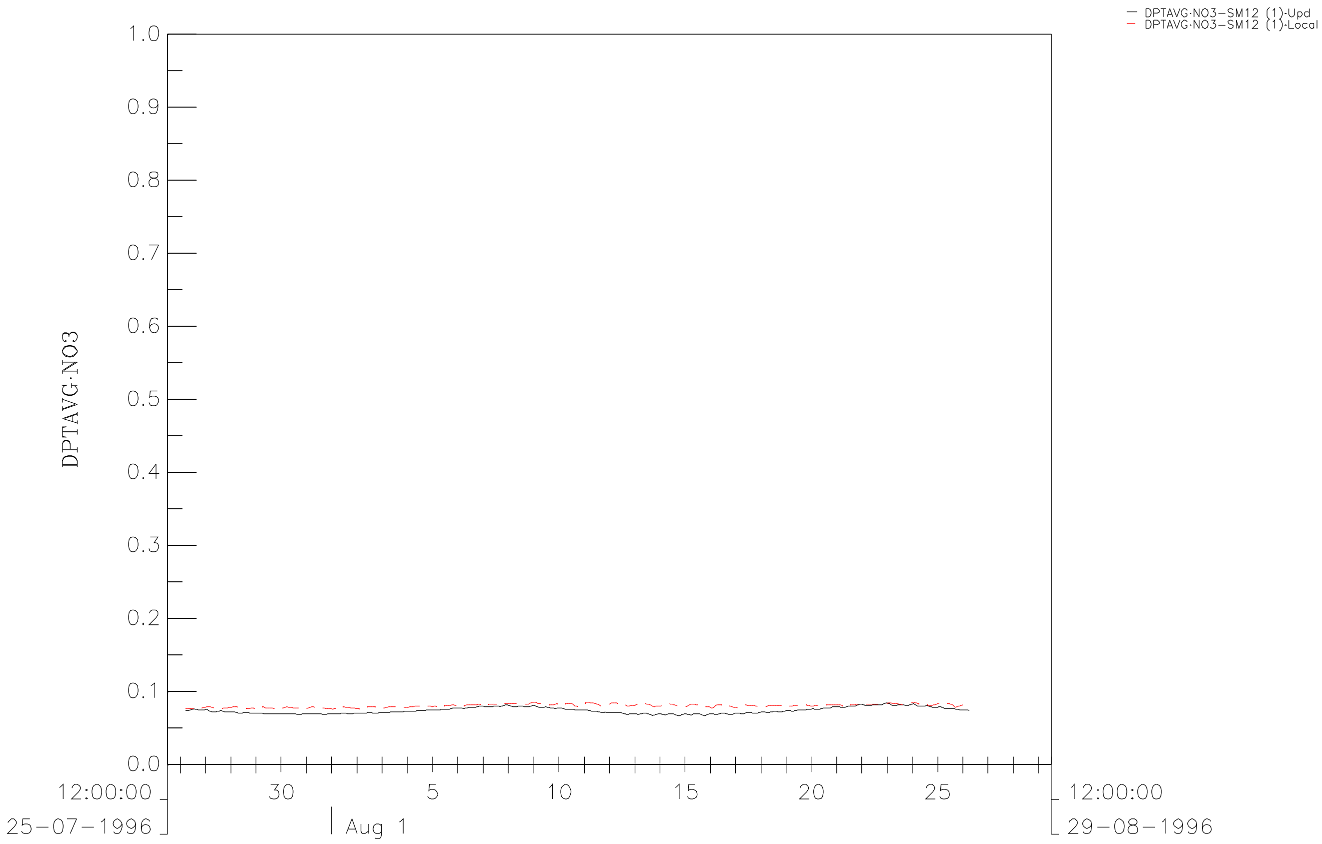


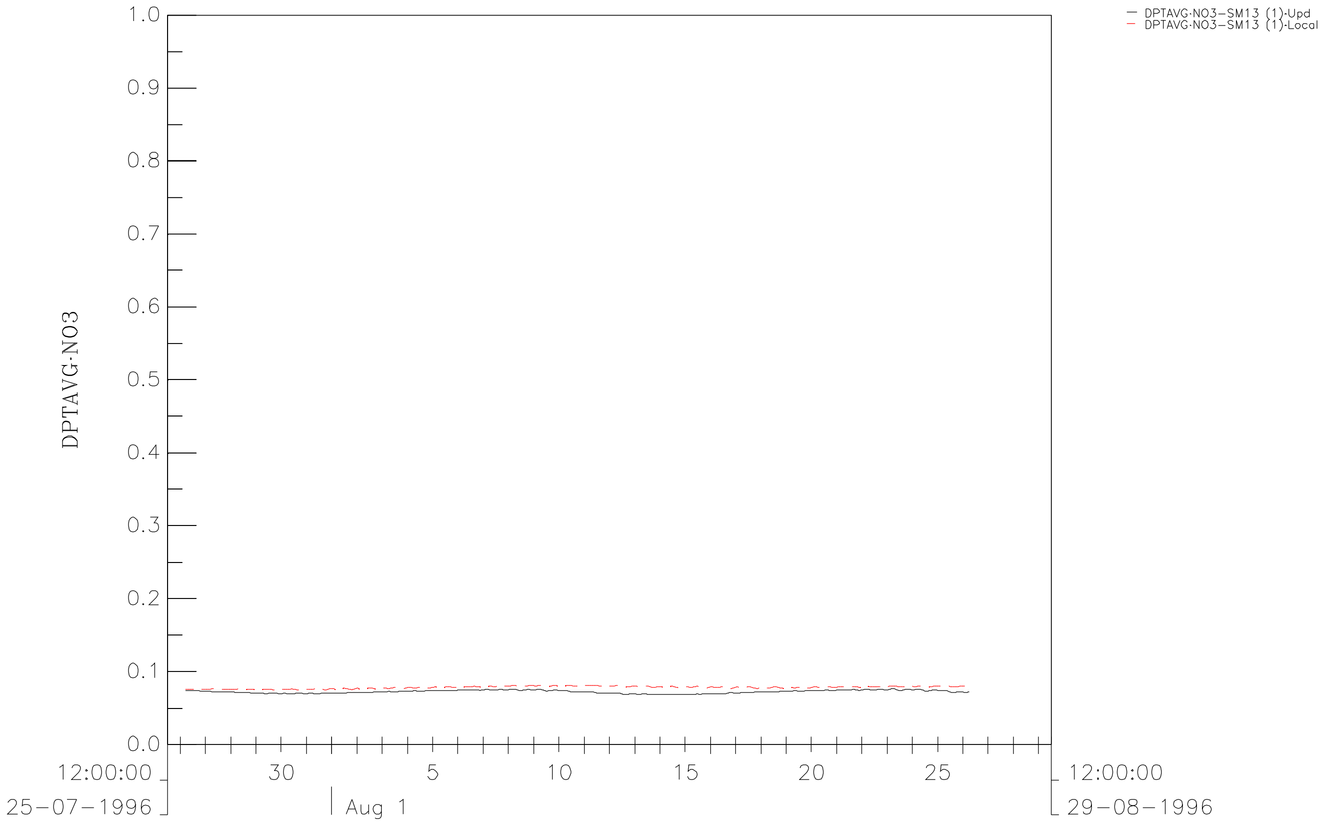
NO3 comparison between Update Model and
Local Refine Model at SM17 (upper) and SM18 (lower).
Baseline condition

Dry Season

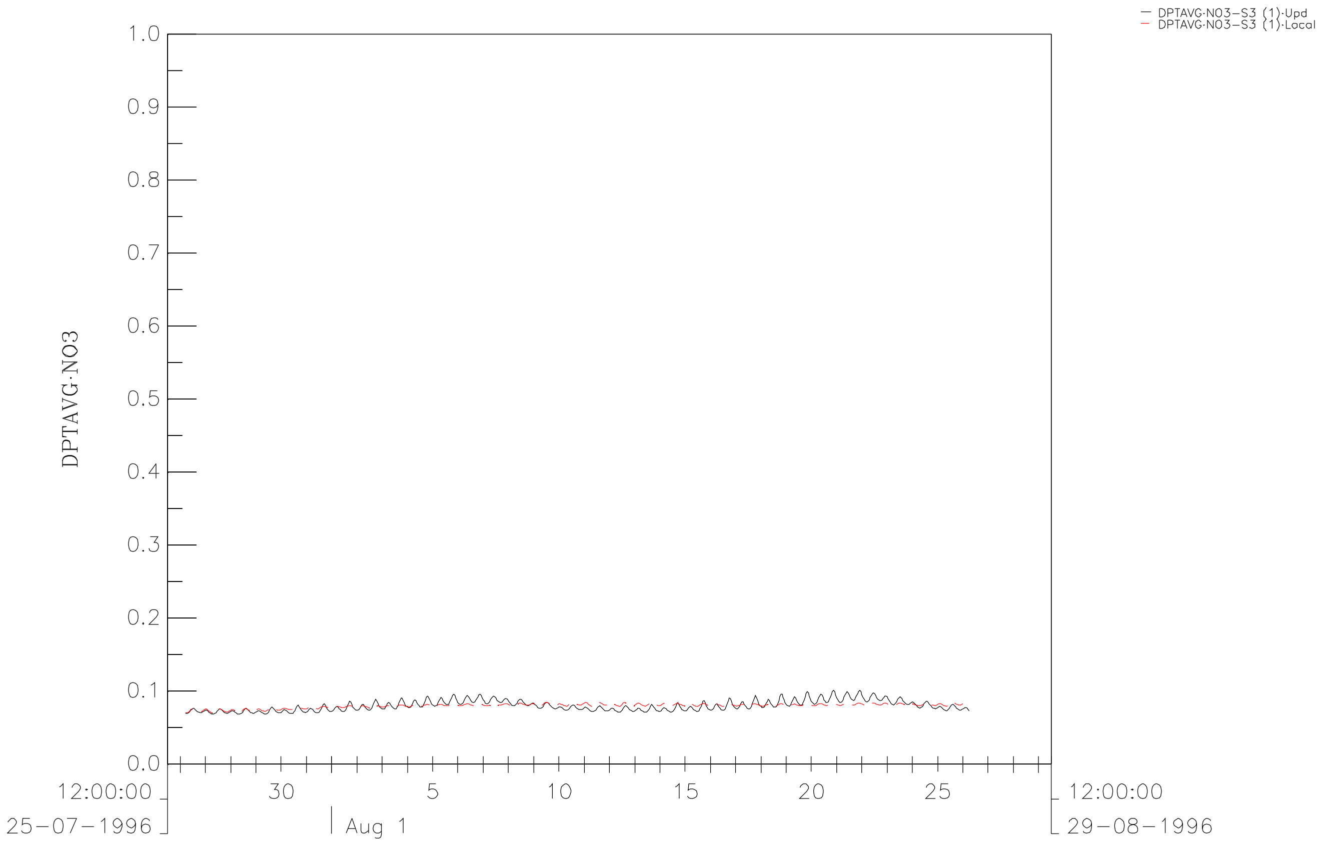
Figure 5A-90

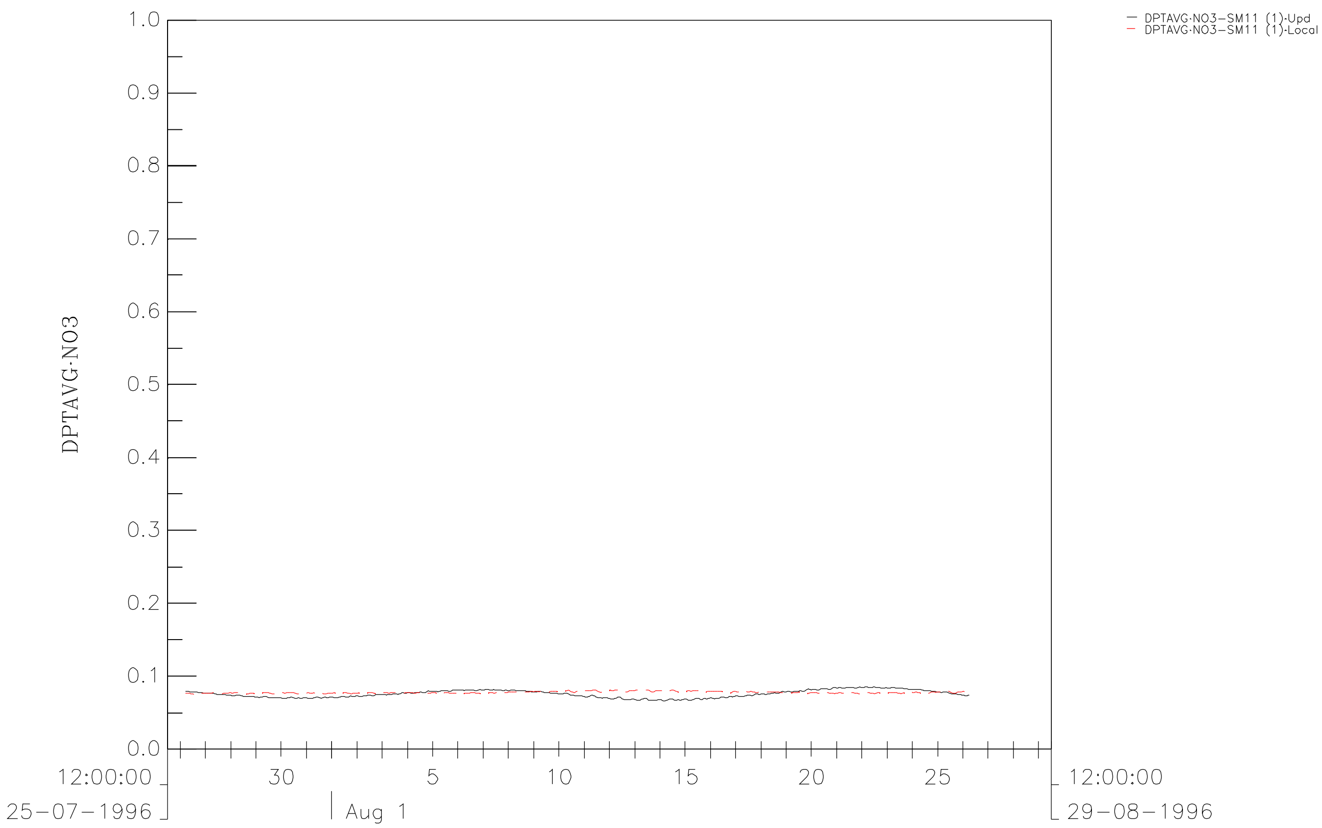
DSD & ATKINS



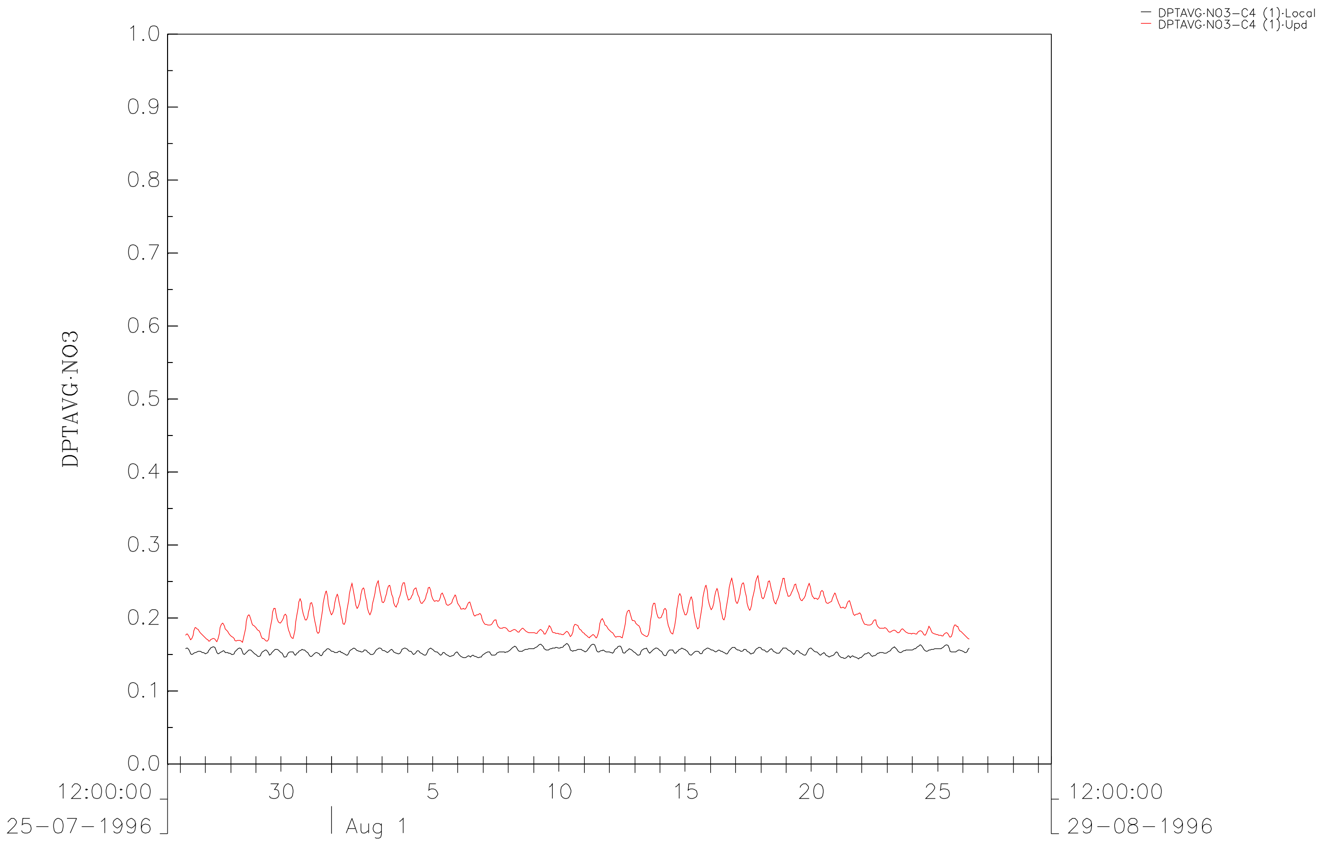


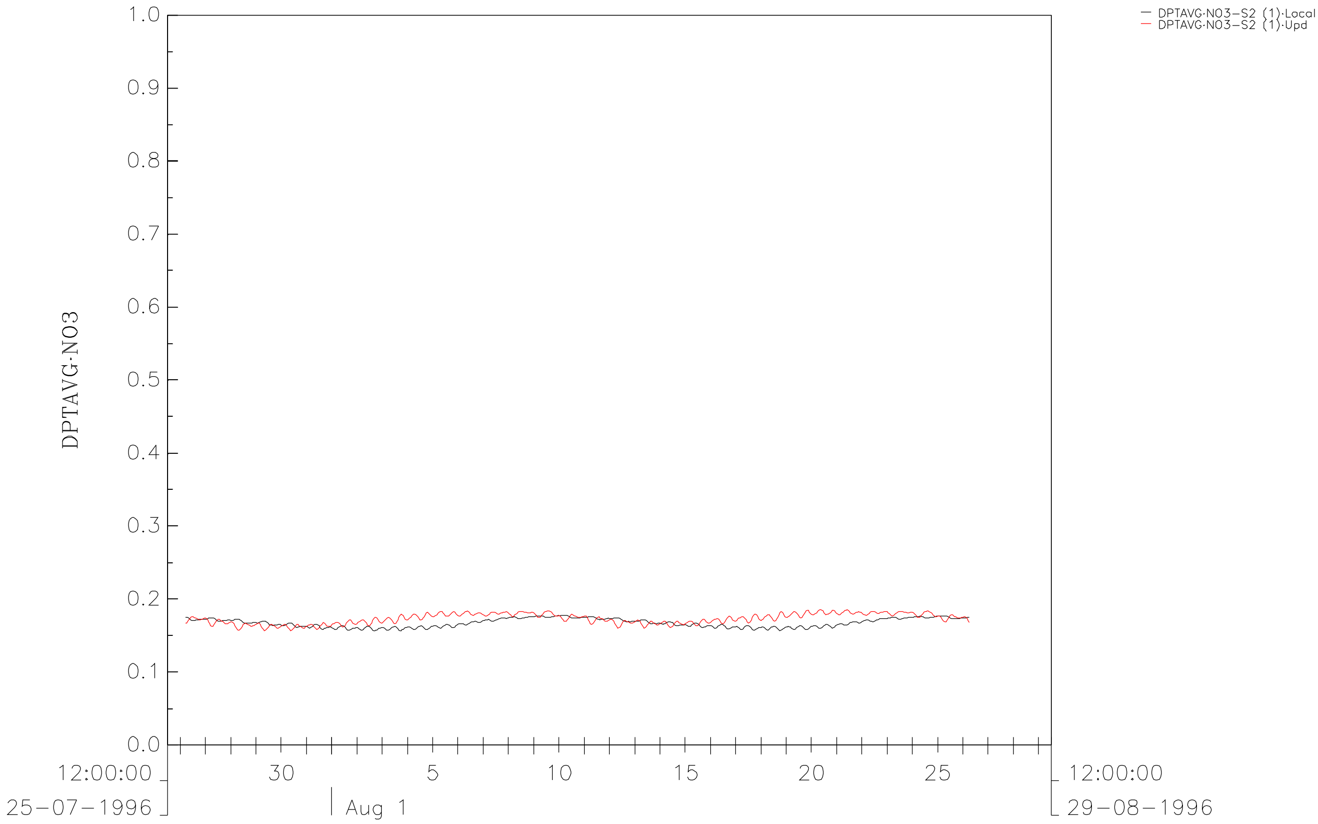
NO3 comparison between Update Model and Local Refine Model at SM12 (upper) and SM13 (lower). Baseline condition	Dry Season **Figure 5A-91**
DSD & ATKINS	



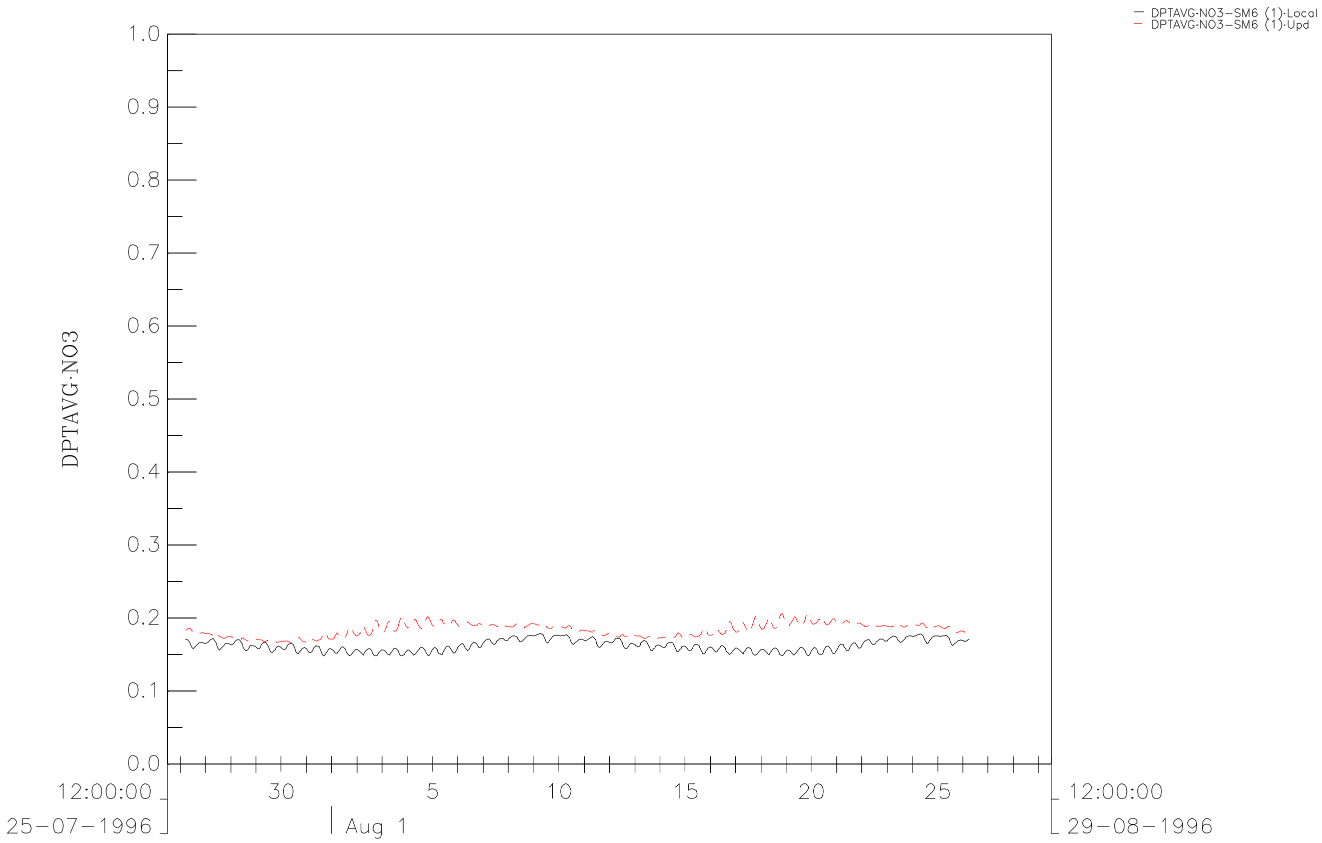


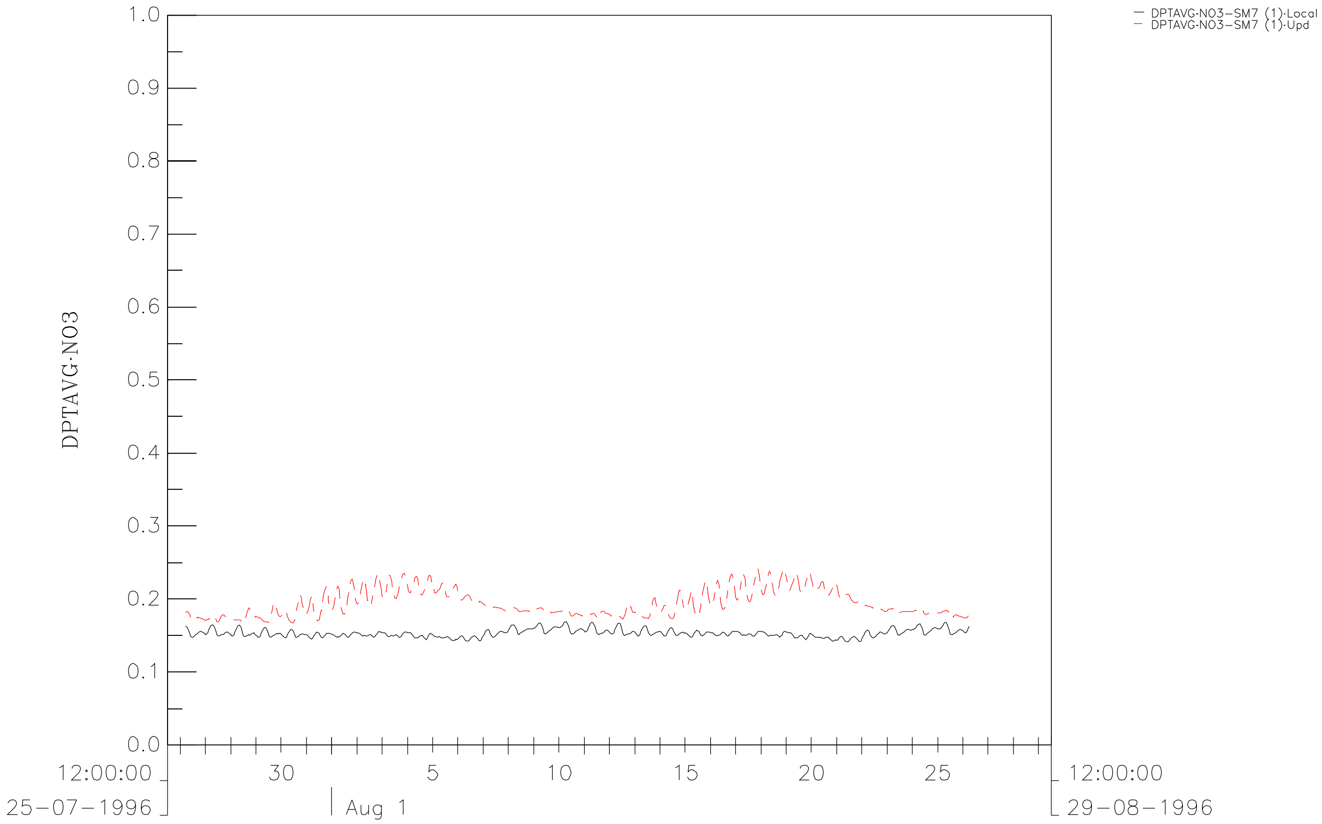
NO3 comparison between Update Model and Local Refine Model at S3 (upper) and SM11 (lower). Baseline condition	Dry Season
	Figure 5A-92
DSD & ATKINS	





NO3 comparison between Update Model and Local Refine Model at C4 (upper) and S2 (lower). Baseline condition	Wet Season	
	Figure 5A-93	
DSD & ATKINS		



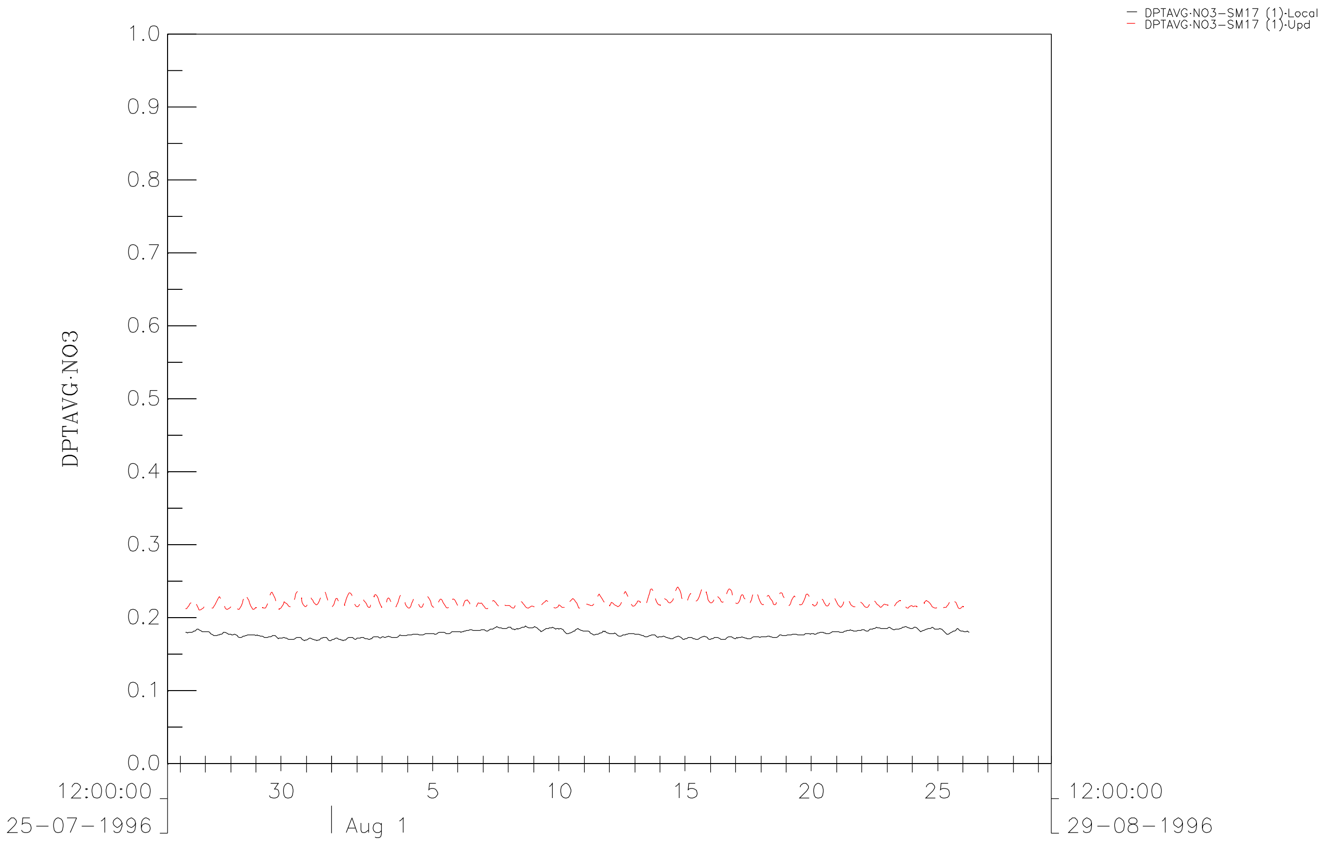


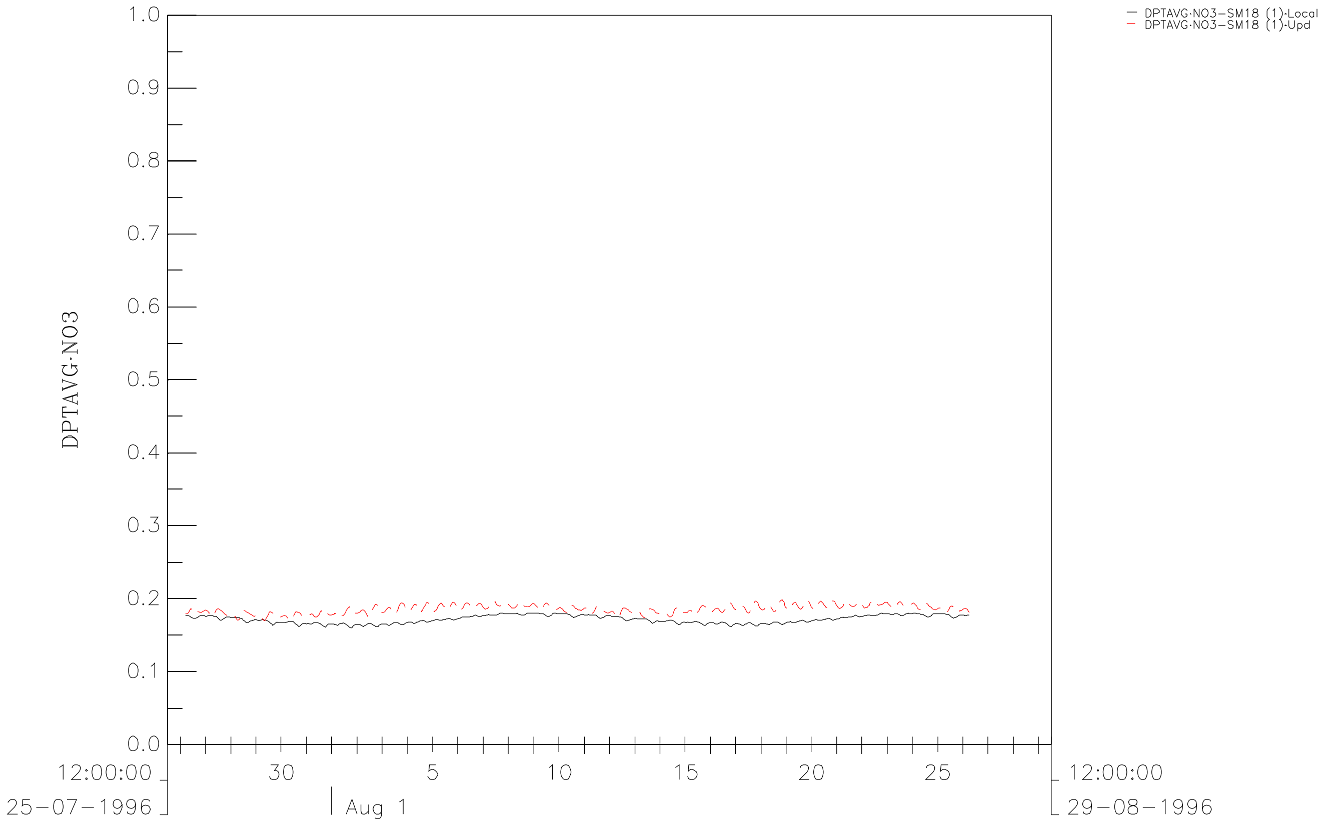
NO3 comparison between Update Model and Local Refine Model at SM6 (upper) and SM7 (lower). Baseline condition

Wet Season

Figure 5A-94

DSD & ATKINS



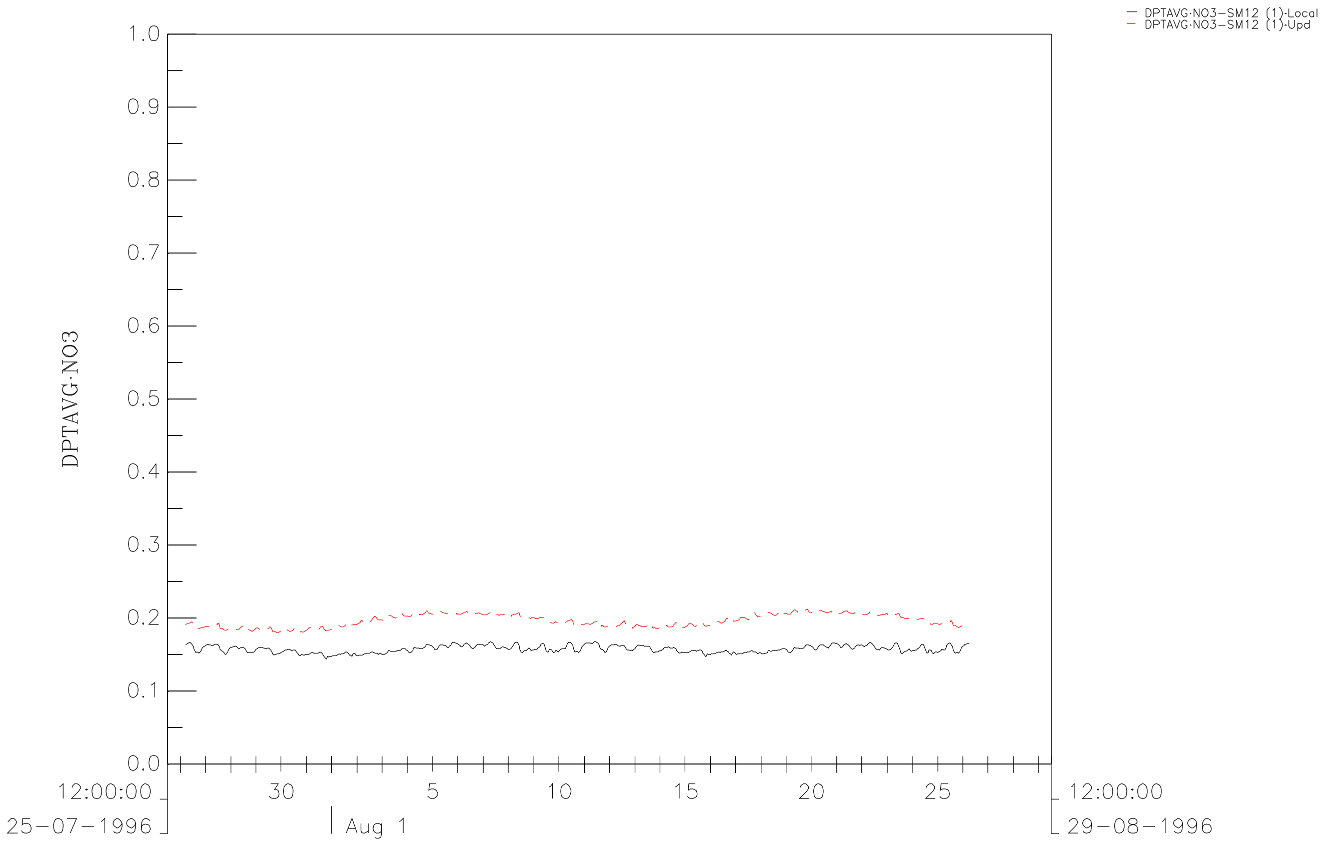


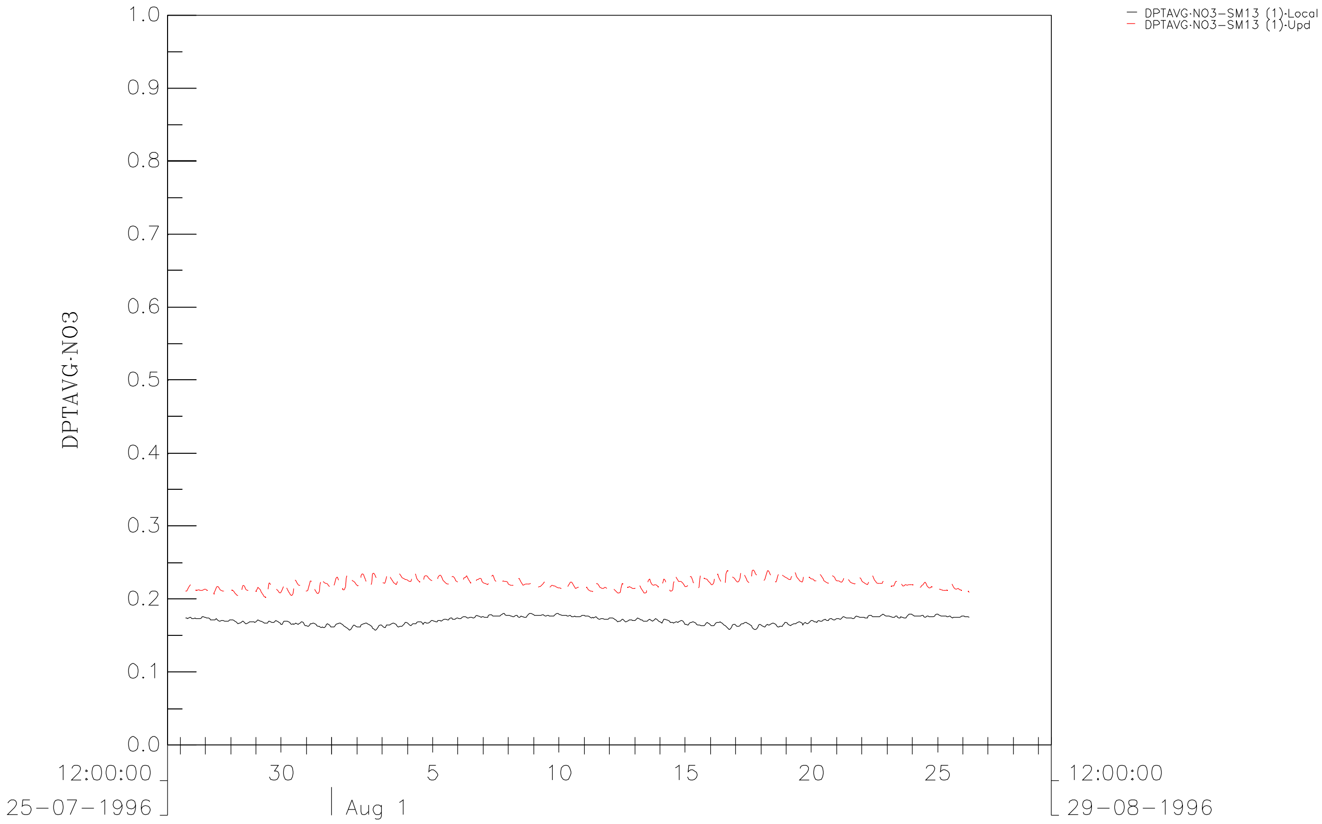
NO3 comparison between Update Model and Local Refine Model at SM17 (upper) and SM18 (lower). Baseline condition

Wet Season

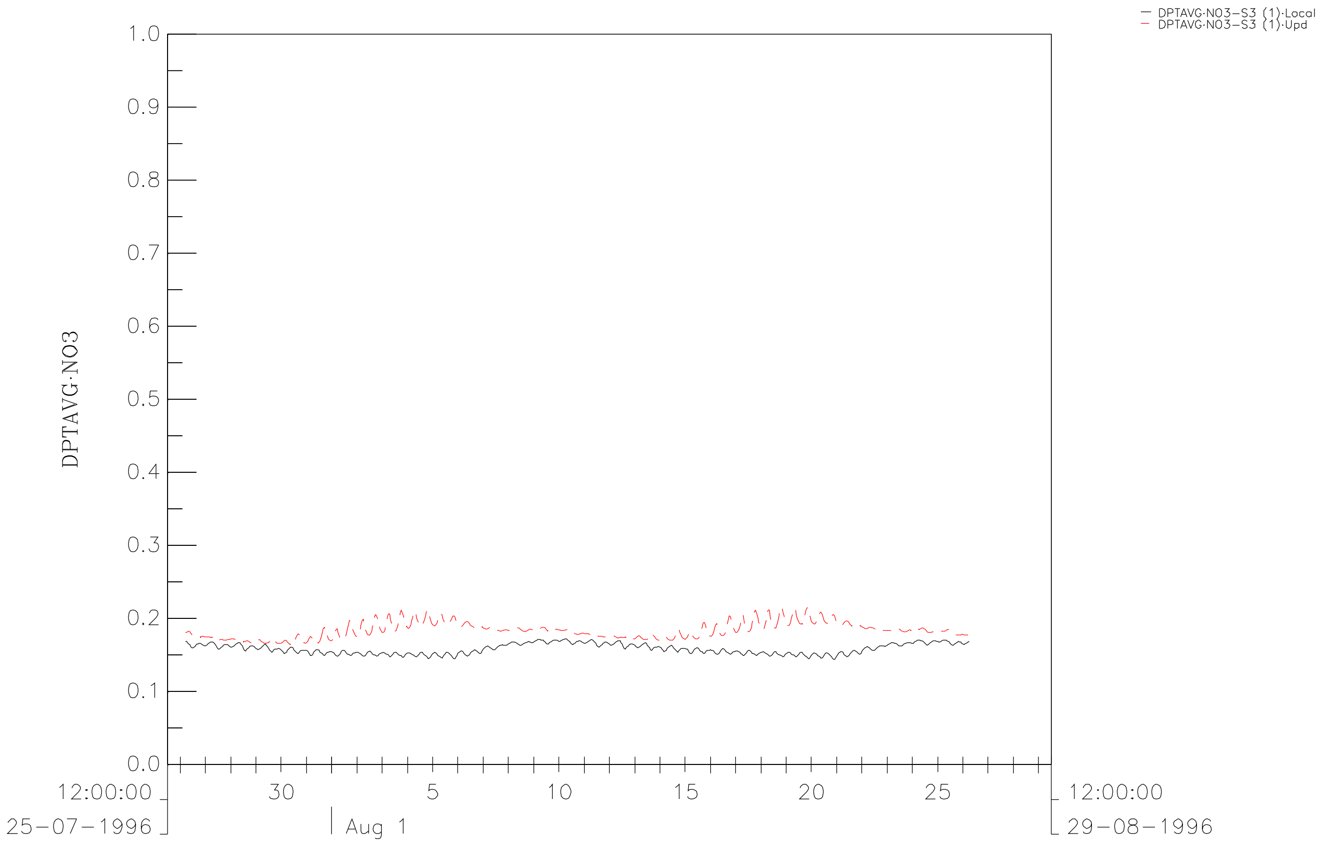
Figure 5A-95

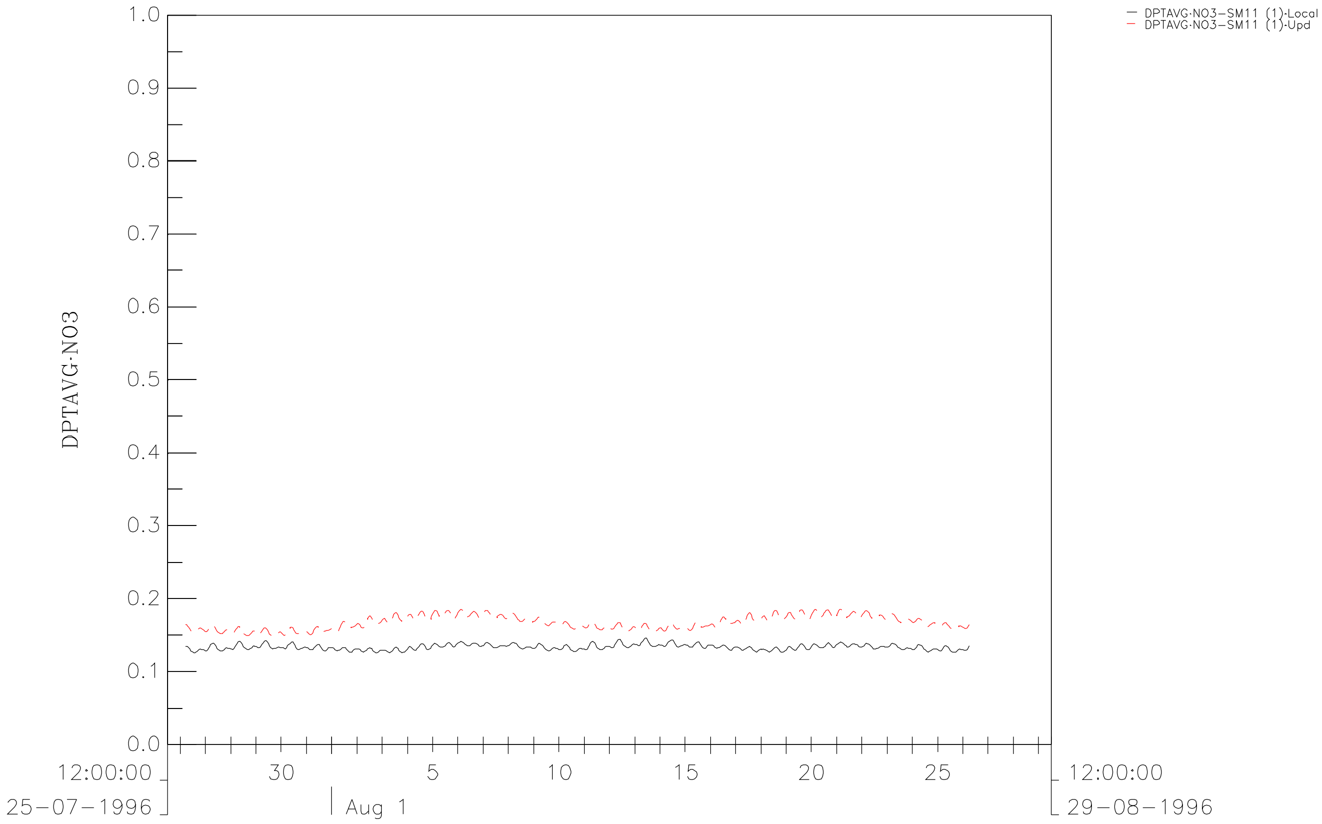
DSD & ATKINS



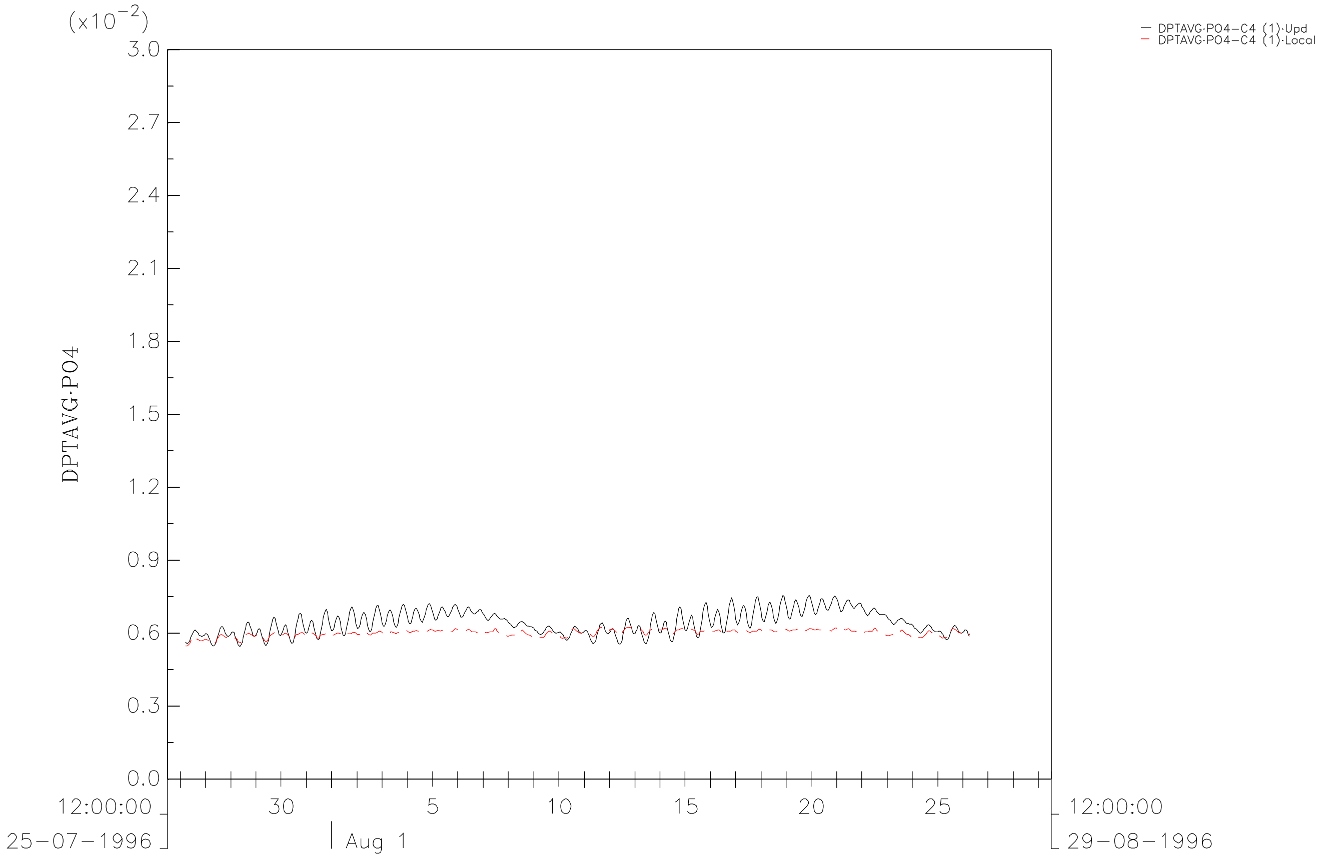


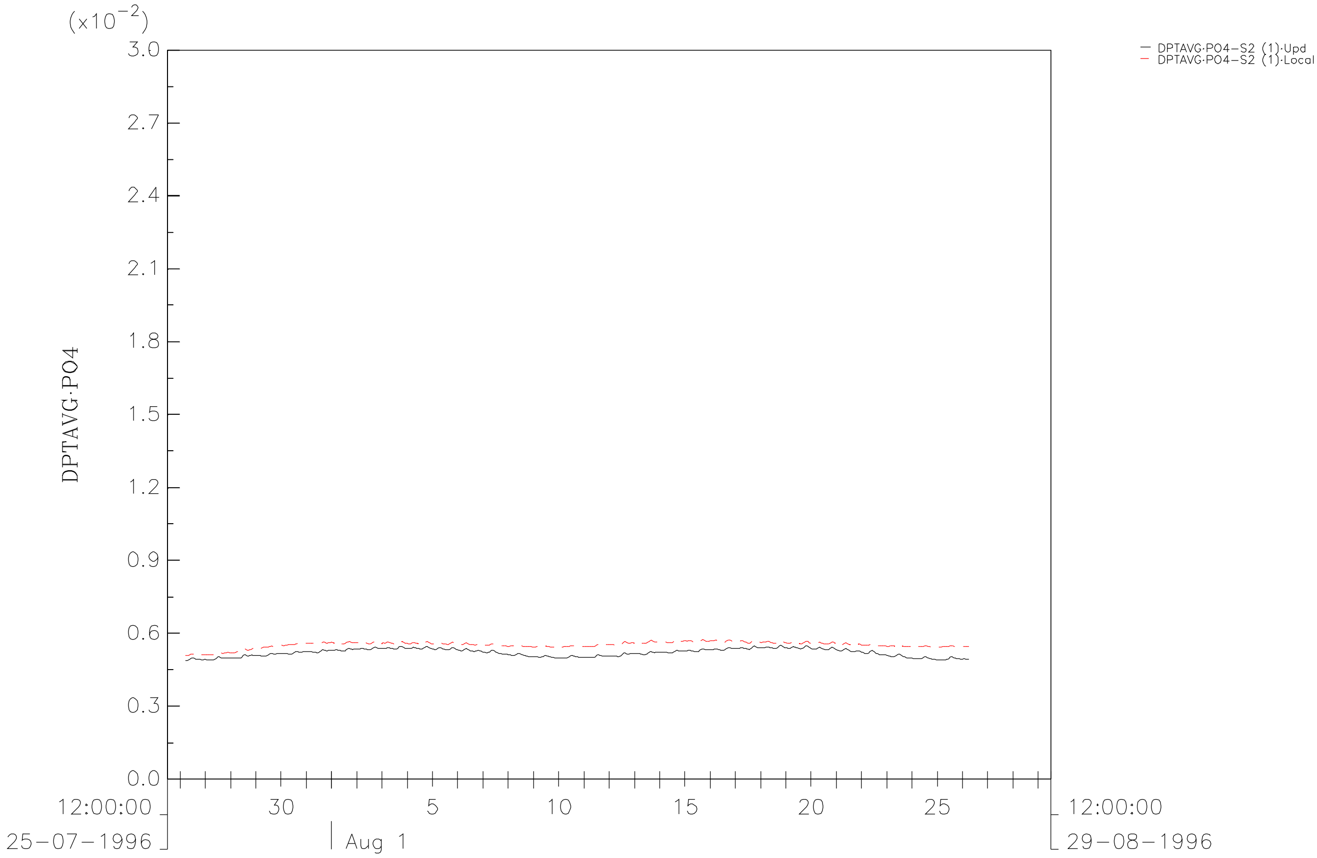
NO3 comparison between Update Model and Local Refine Model at SM12 (upper) and SM13 (lower). Baseline condition	Wet Season
	Figure 5A-96
DSD & ATKINS	



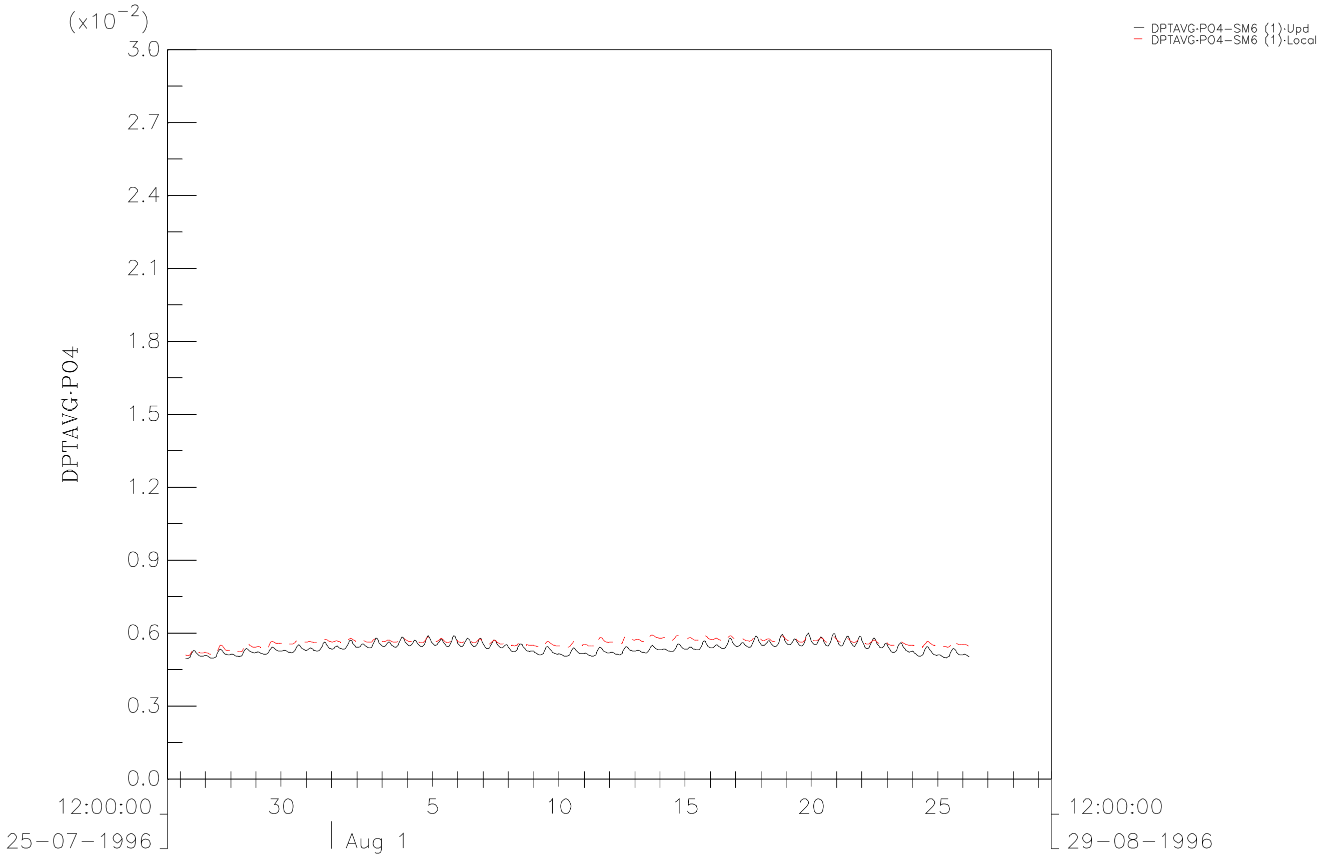


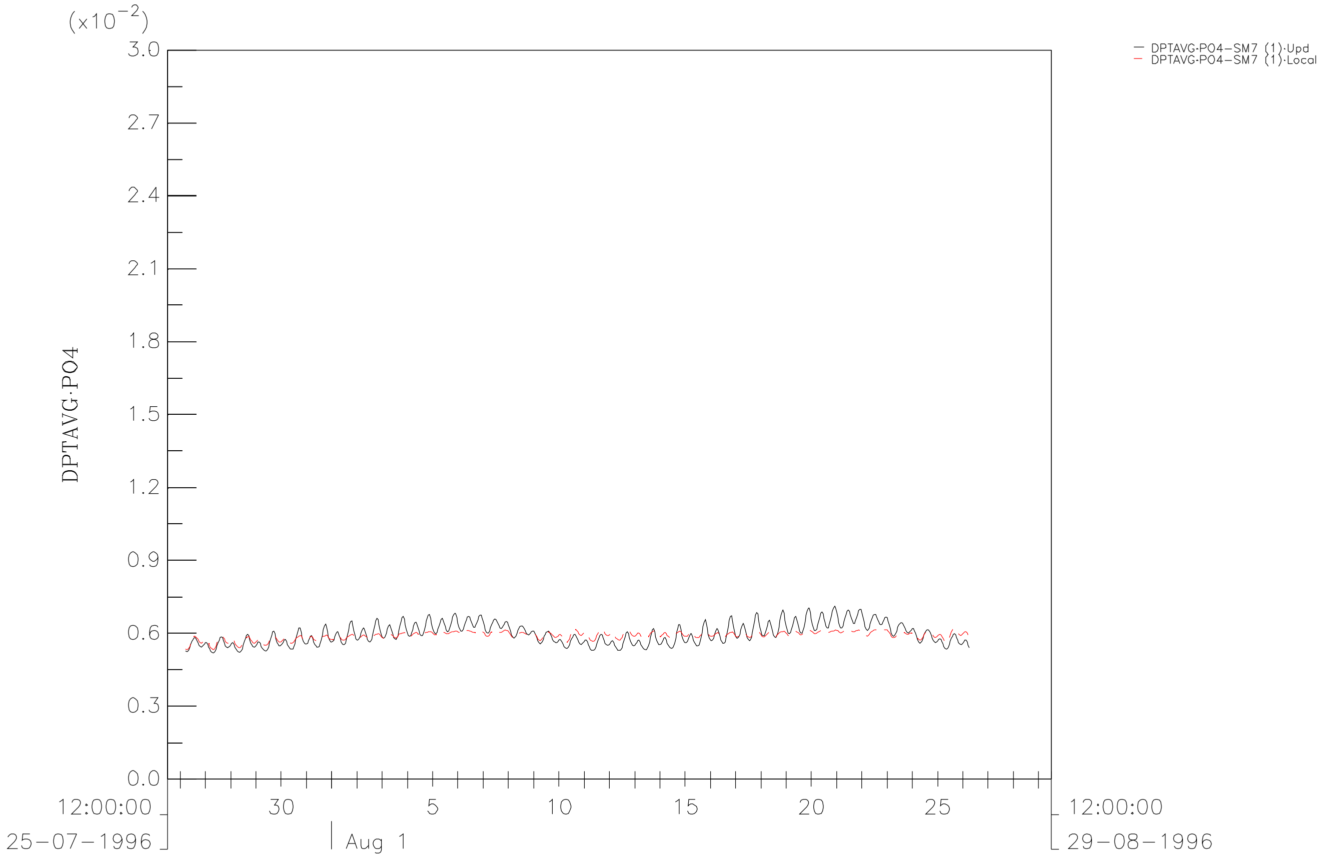
NO3 comparison between Update Model and Local Refine Model at S3 (upper) and SM11 (lower). Baseline condition	Wet Season	
	Figure 5A-97	
DSD & ATKINS		





PO4 comparison between Update Model and Local Refine Model at C4 (upper) and S2 (lower). Baseline condition	Dry Season **Figure 5A-98**
DSD & ATKINS	



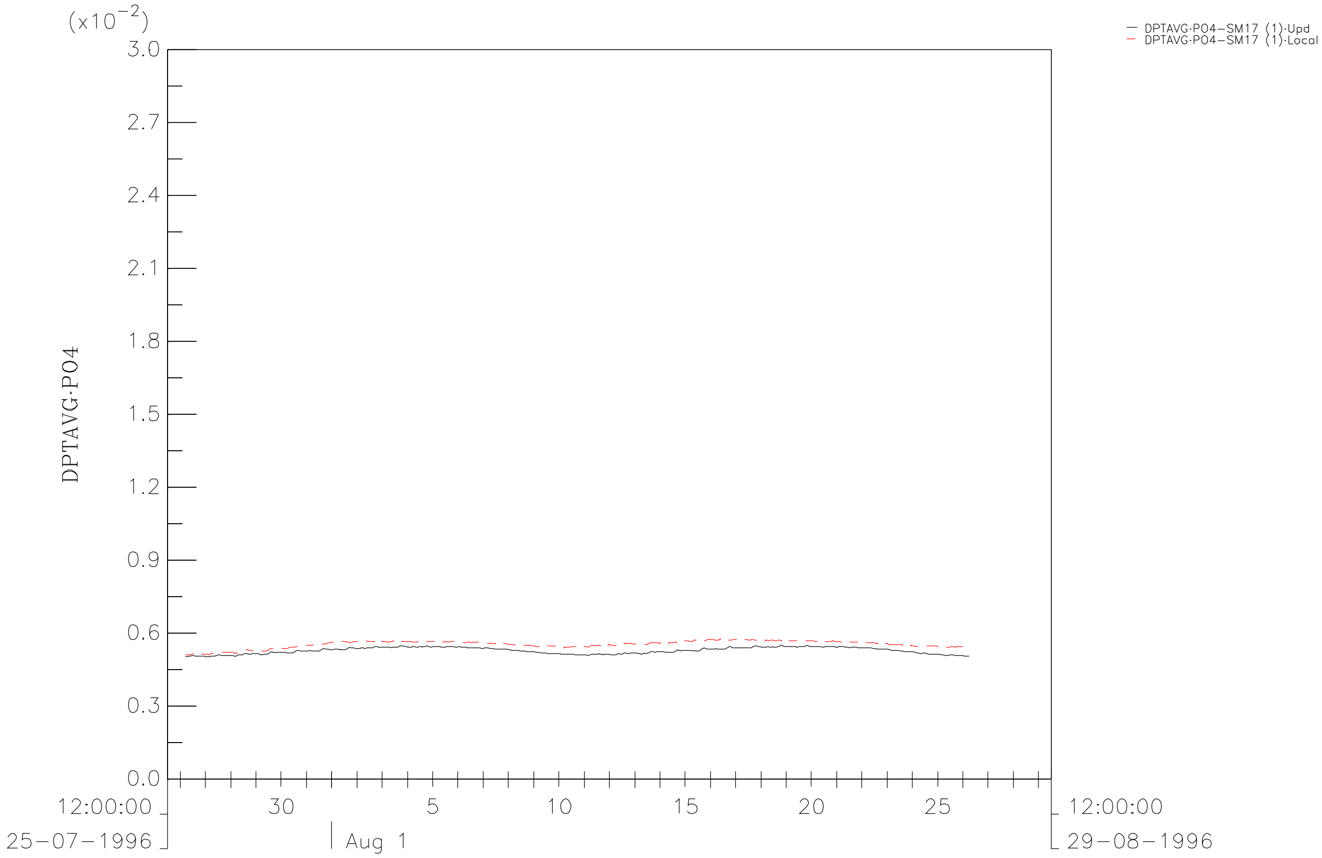


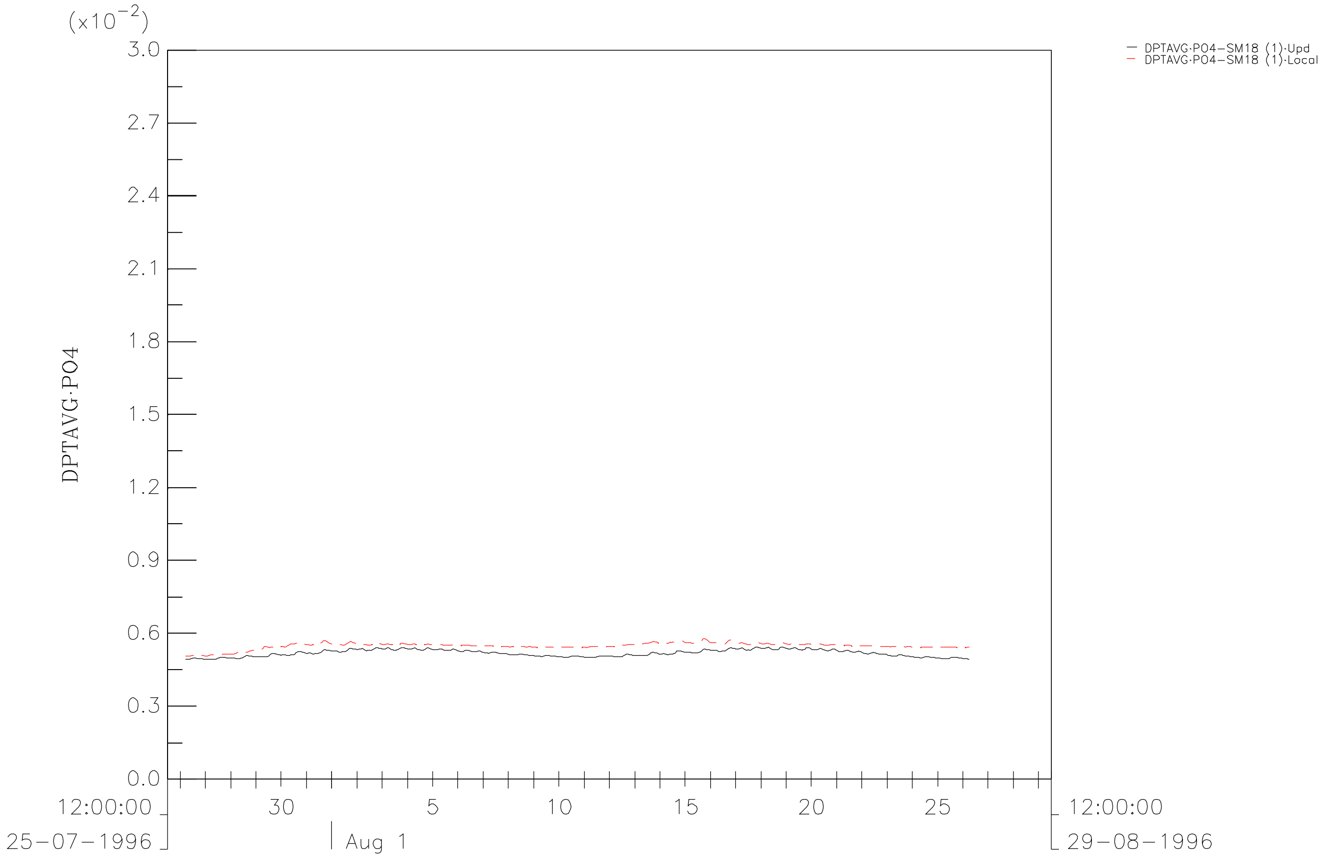
PO4 comparison between Update Model and
Local Refine Model at SM6 (upper) and SM7 (lower).
Baseline condition

Dry Season

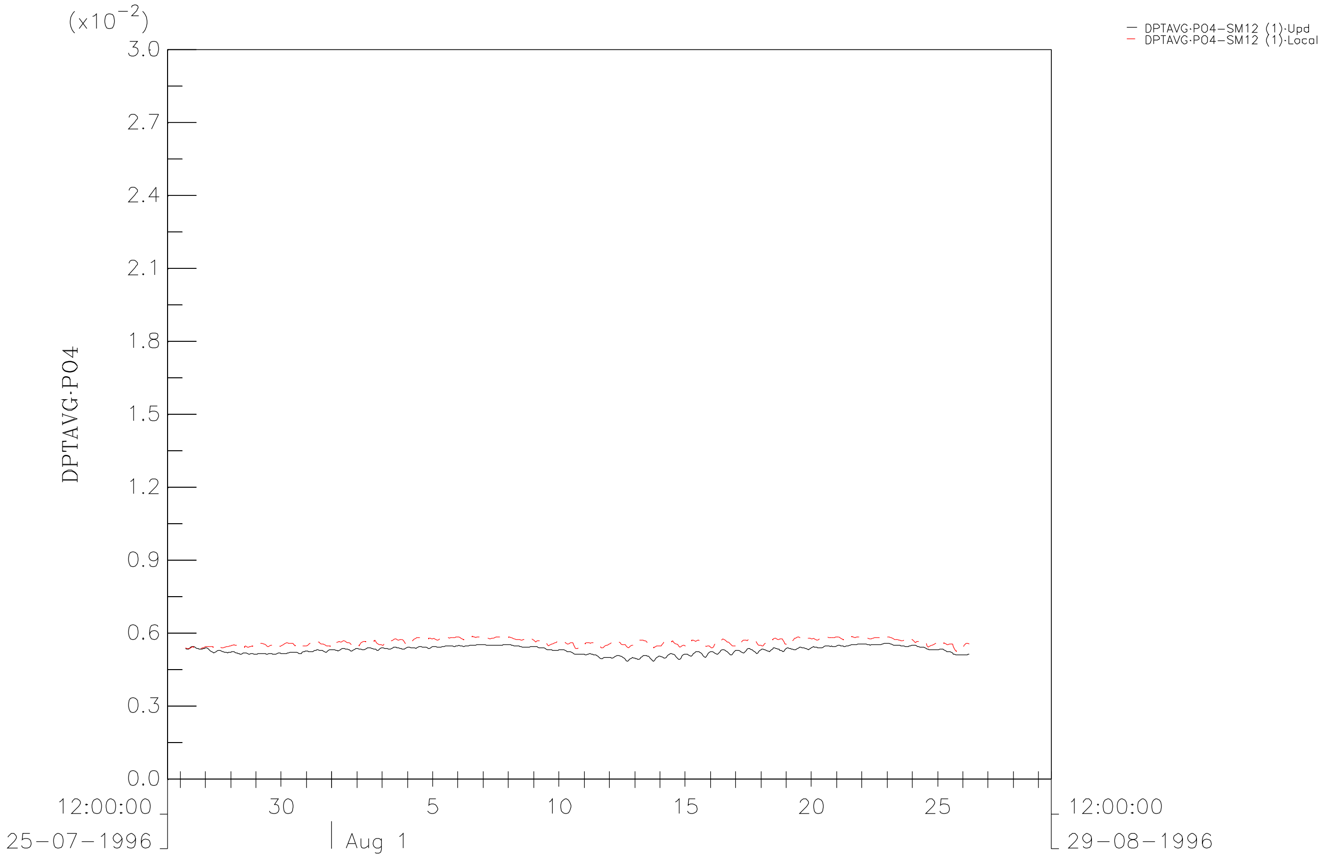
Figure 5A-99

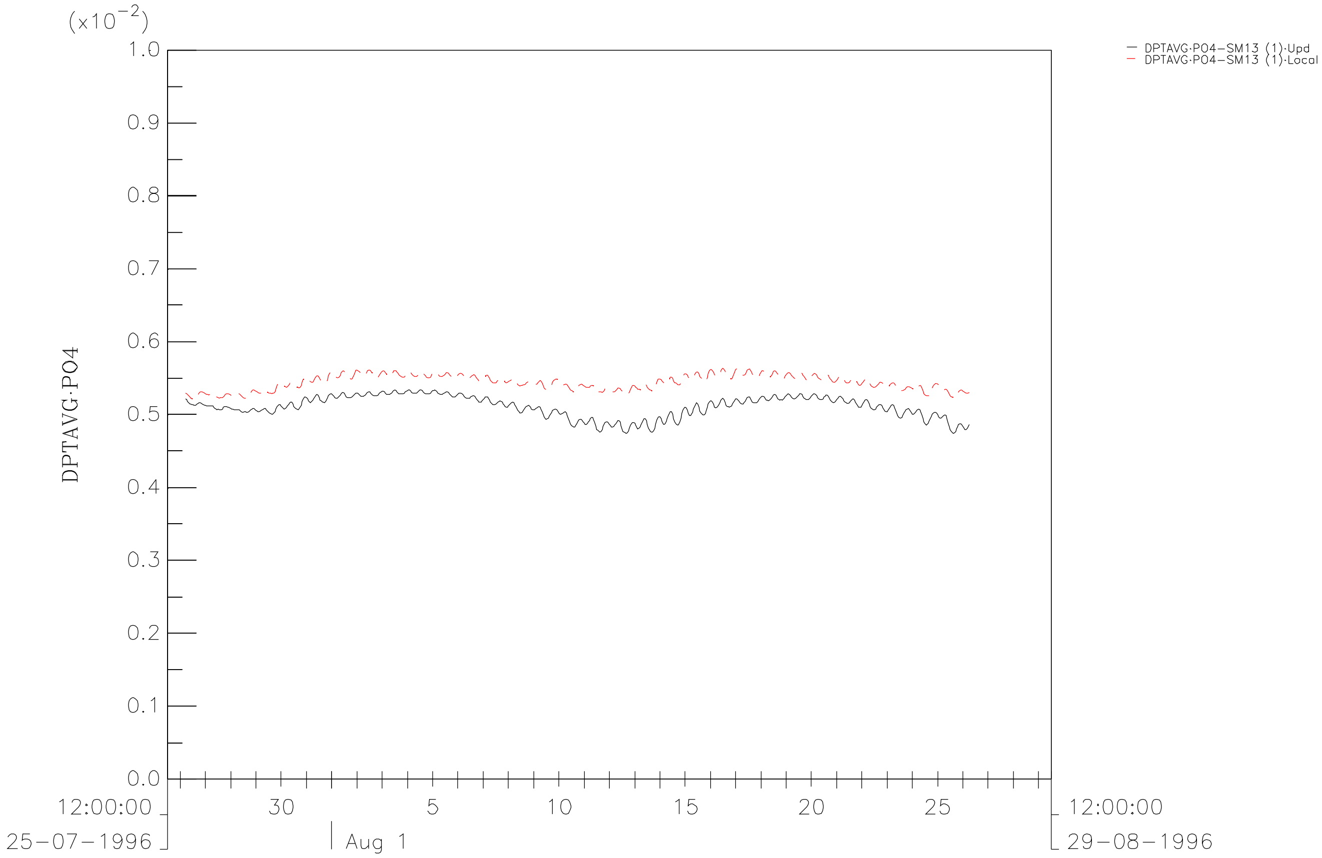
DSD & ATKINS





PO4 comparison between Update Model and Local Refine Model at SM17 (upper) and SM18 (lower). Baseline condition	Dry Season
	Figure 5A-100
DSD & ATKINS	



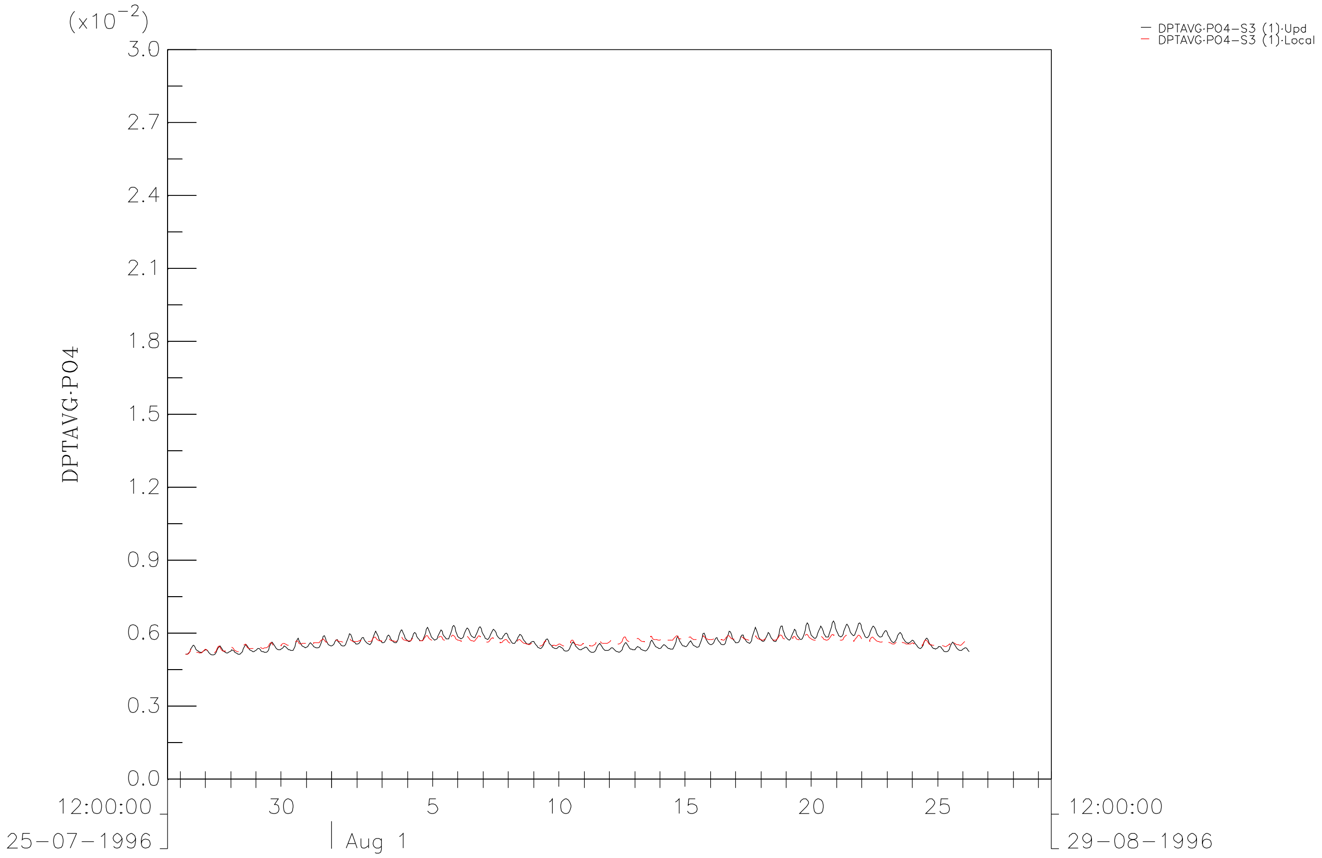


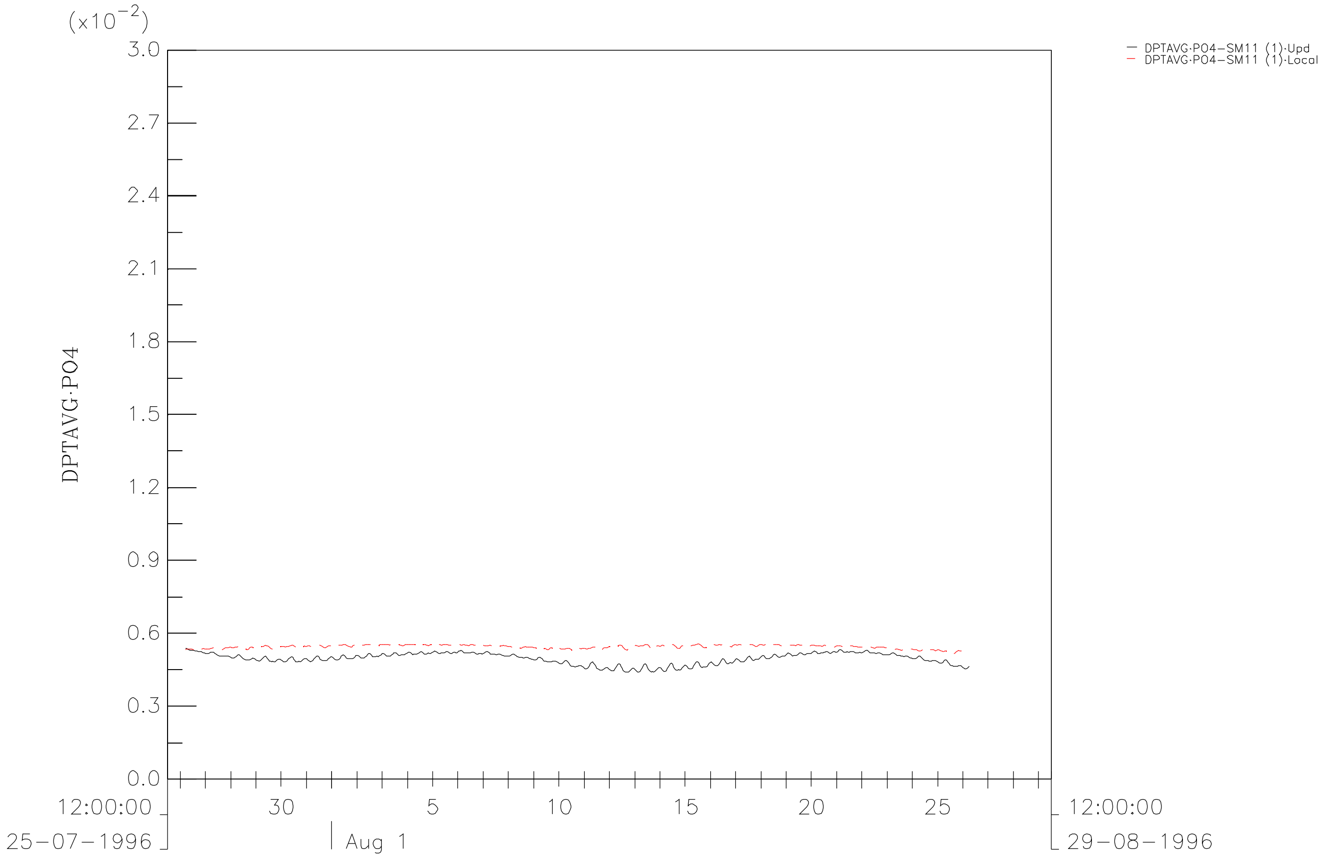
PO4 comparison between Update Model and Local Refine Model at SM12 (upper) and SM13 (lower). Baseline condition

Dry Season

Figure 5A-101

DSD & ATKINS



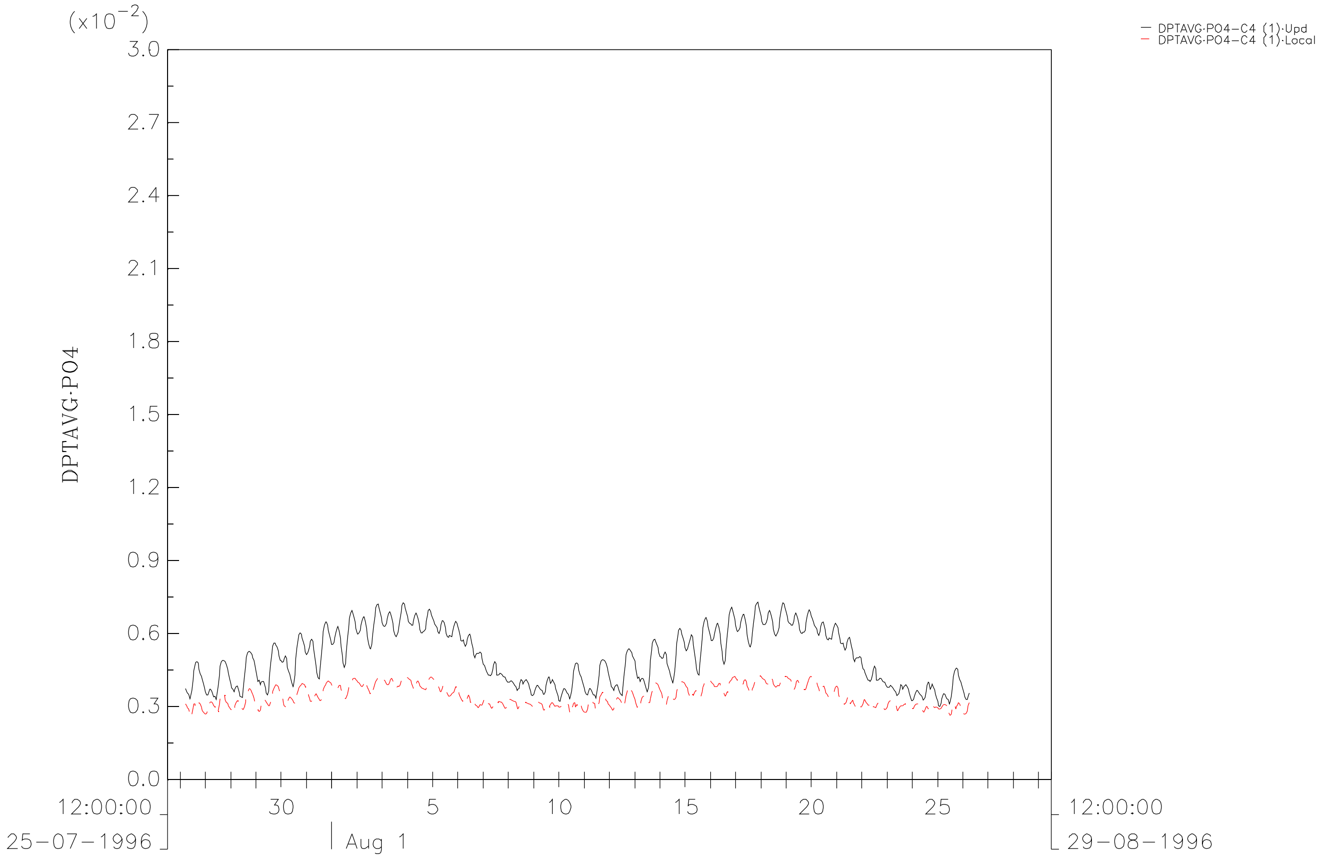


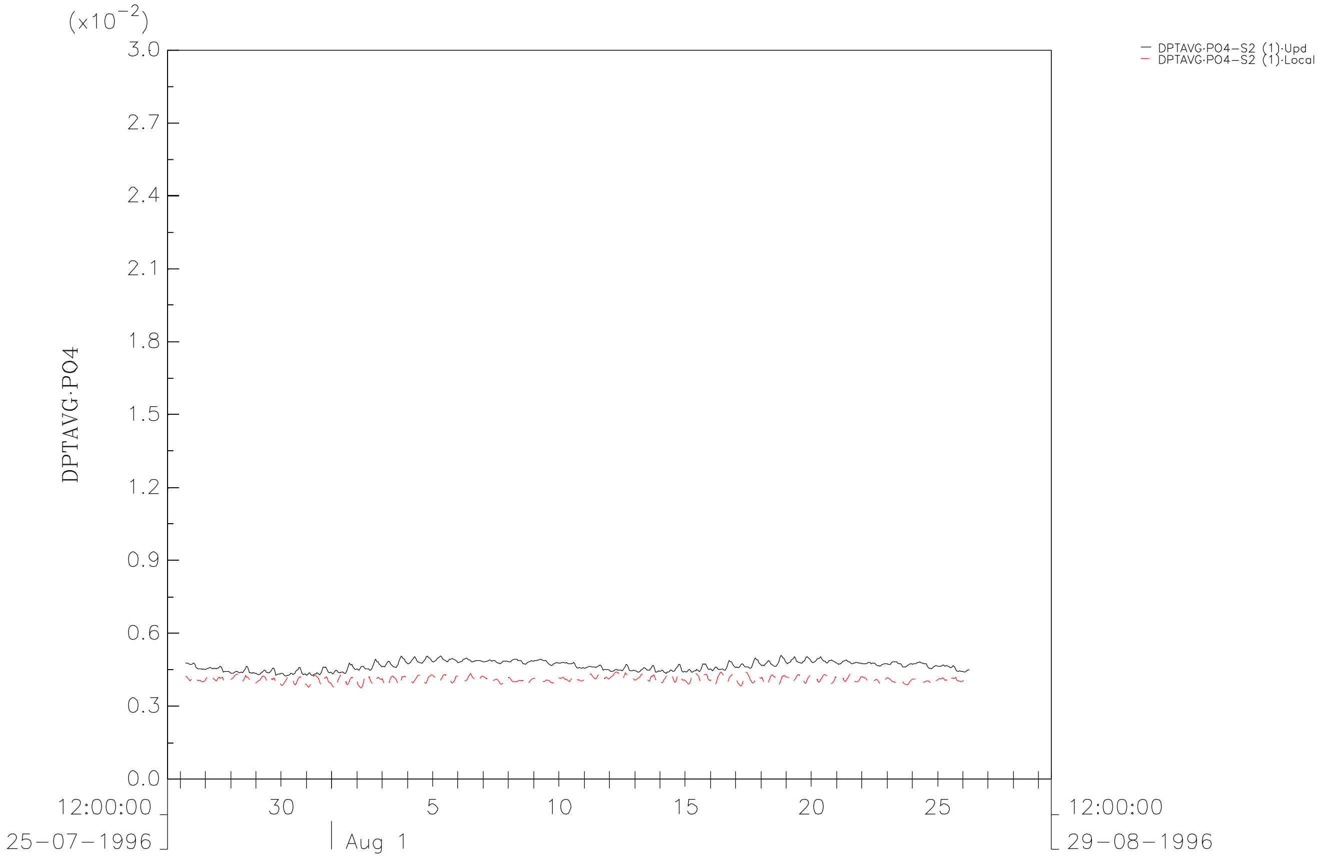
PO4 comparison between Update Model and Local Refine Model at S3 (upper) and SM11 (lower). Baseline condition

Dry Season

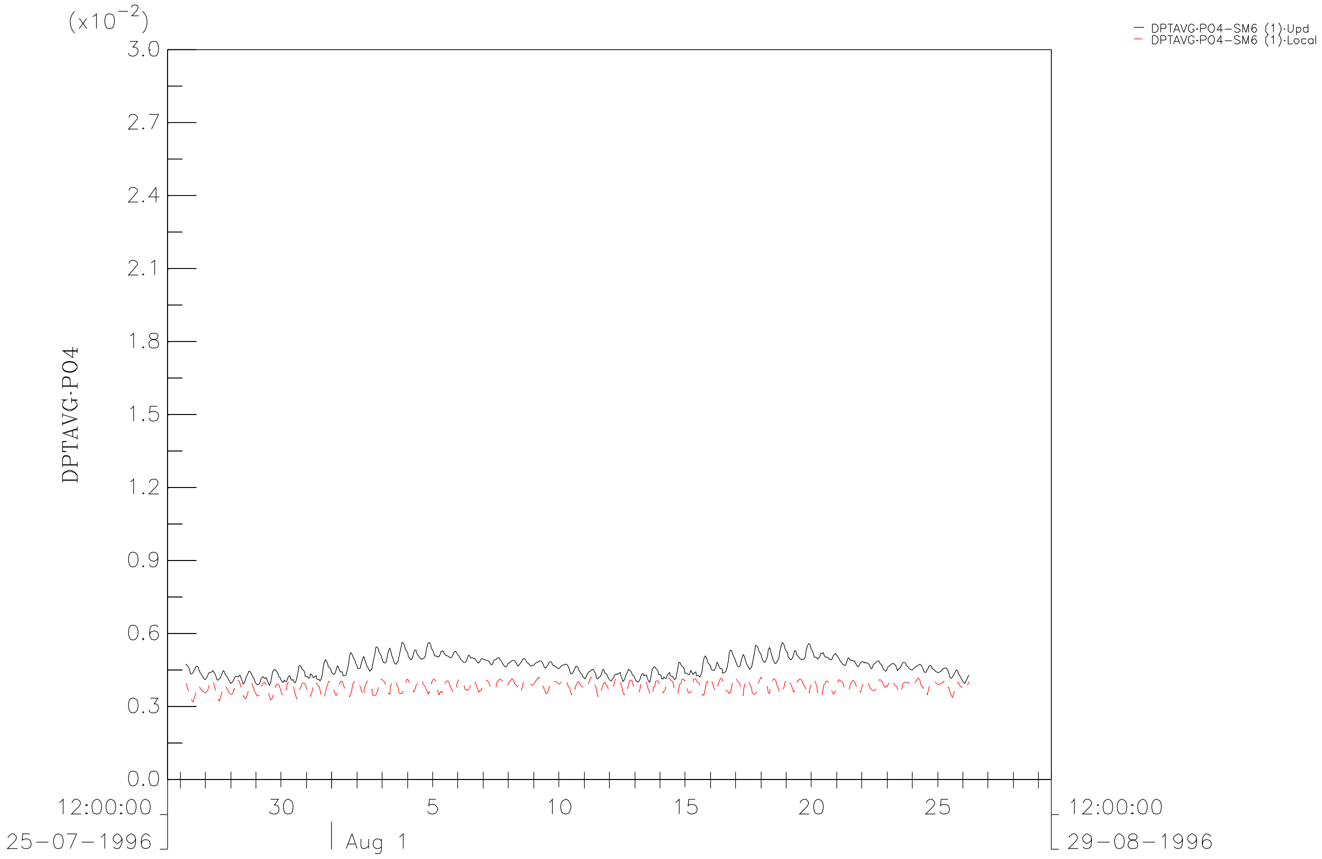
Figure 5A-102

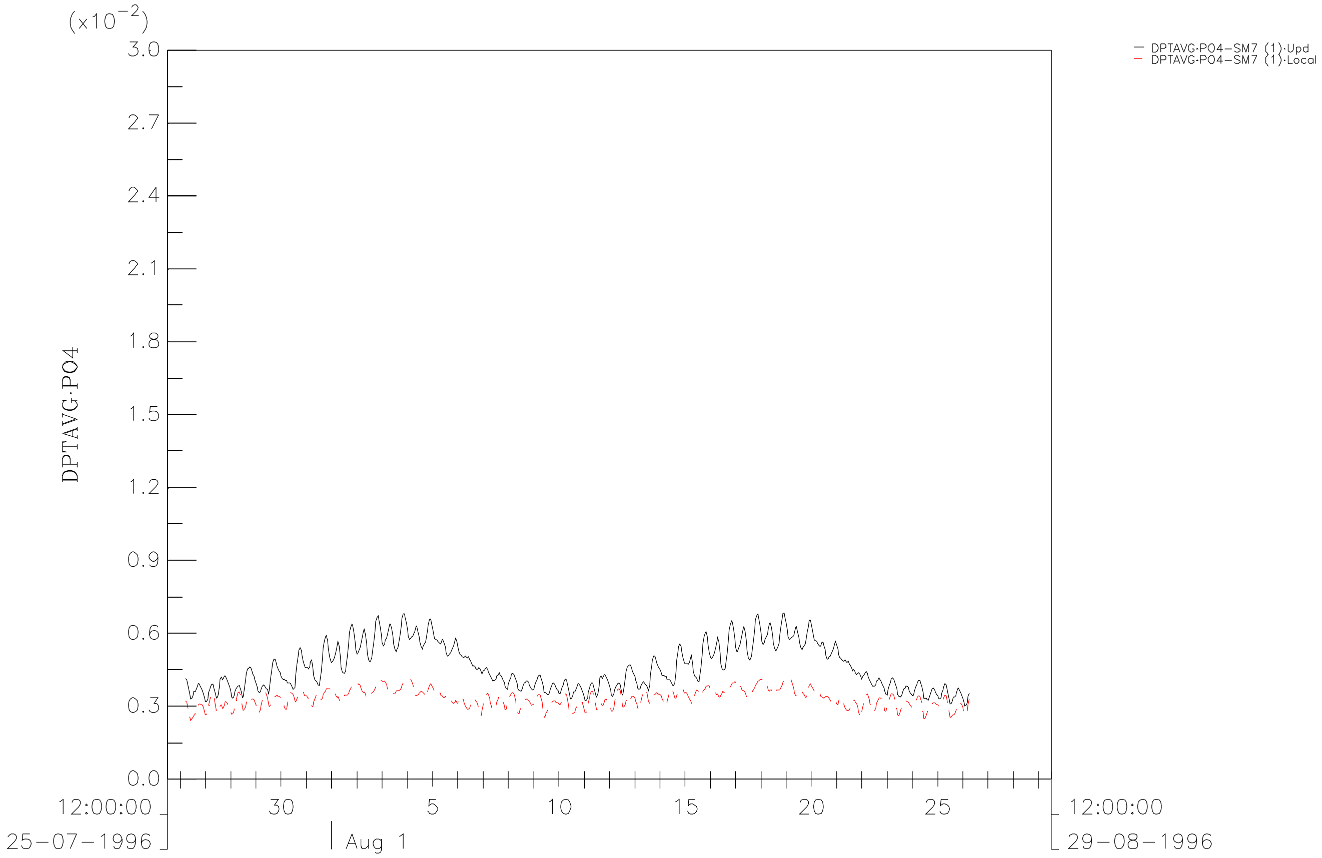
DSD & ATKINS



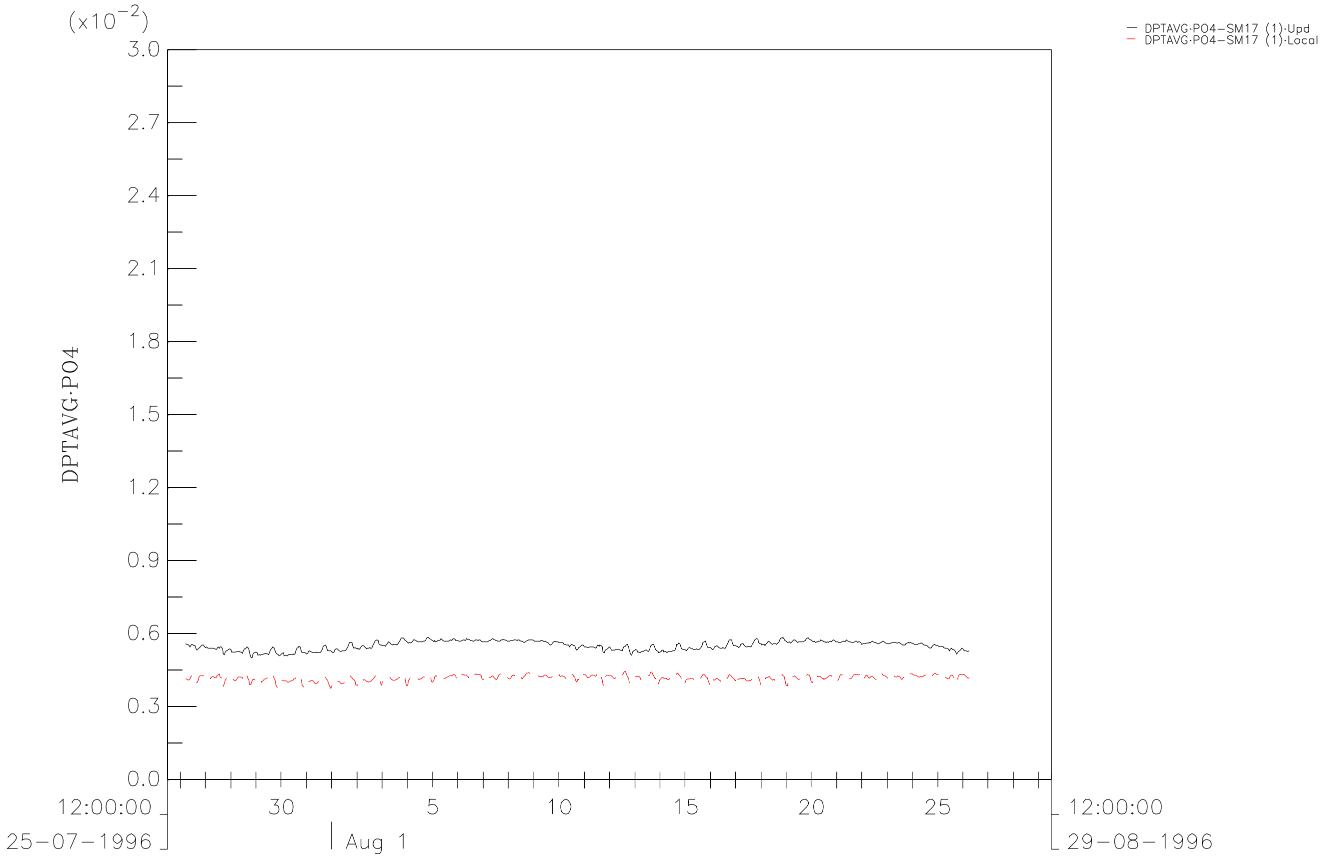


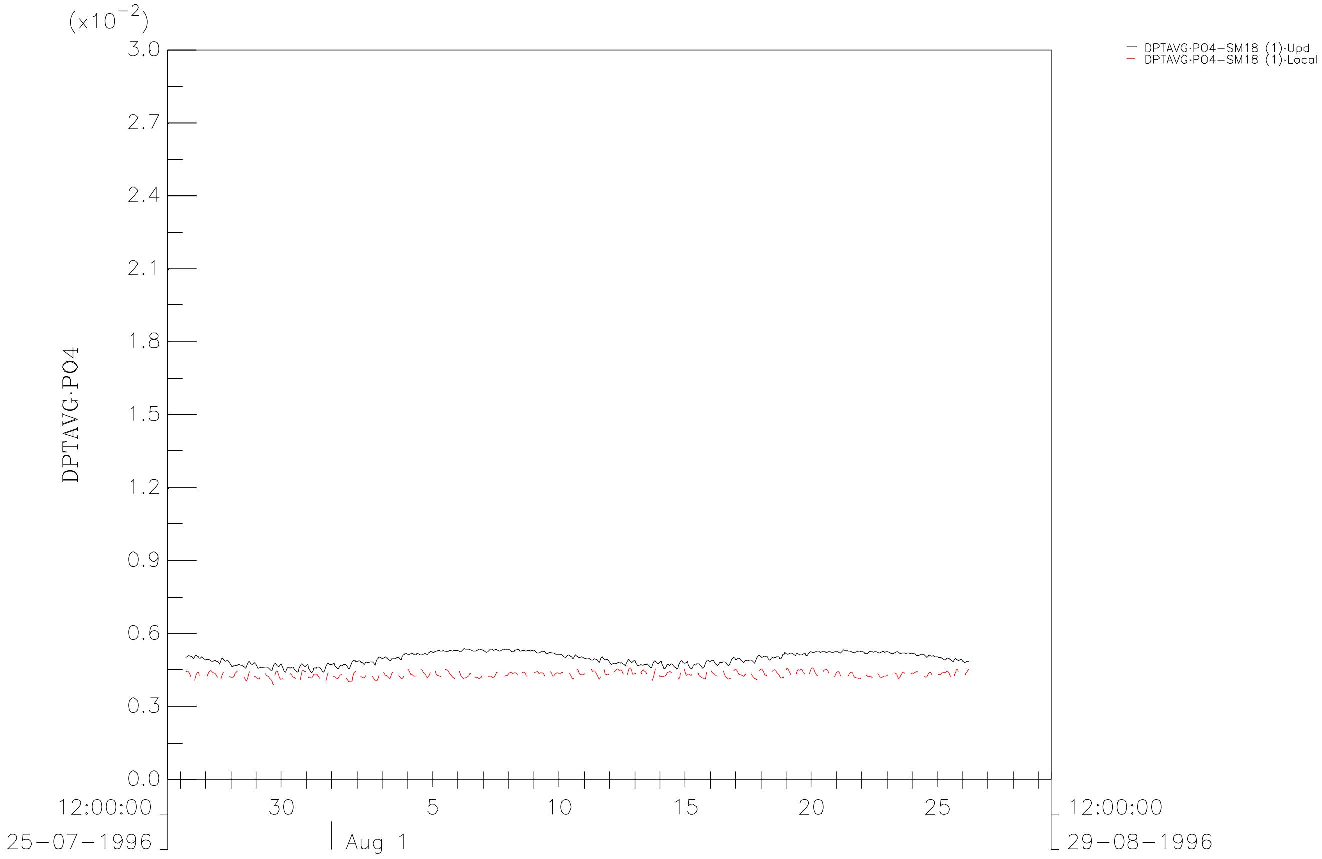
PO4 comparison between Update Model and Local Refine Model at C4 (upper) and S2 (lower). Baseline condition	Wet Season **Figure 5A-103**
DSD & ATKINS	





PO4 comparison between Update Model and Local Refine Model at SM6 (upper) and SM7 (lower). Baseline condition	Wet Season
	Figure 5A-104
DSD & ATKINS	



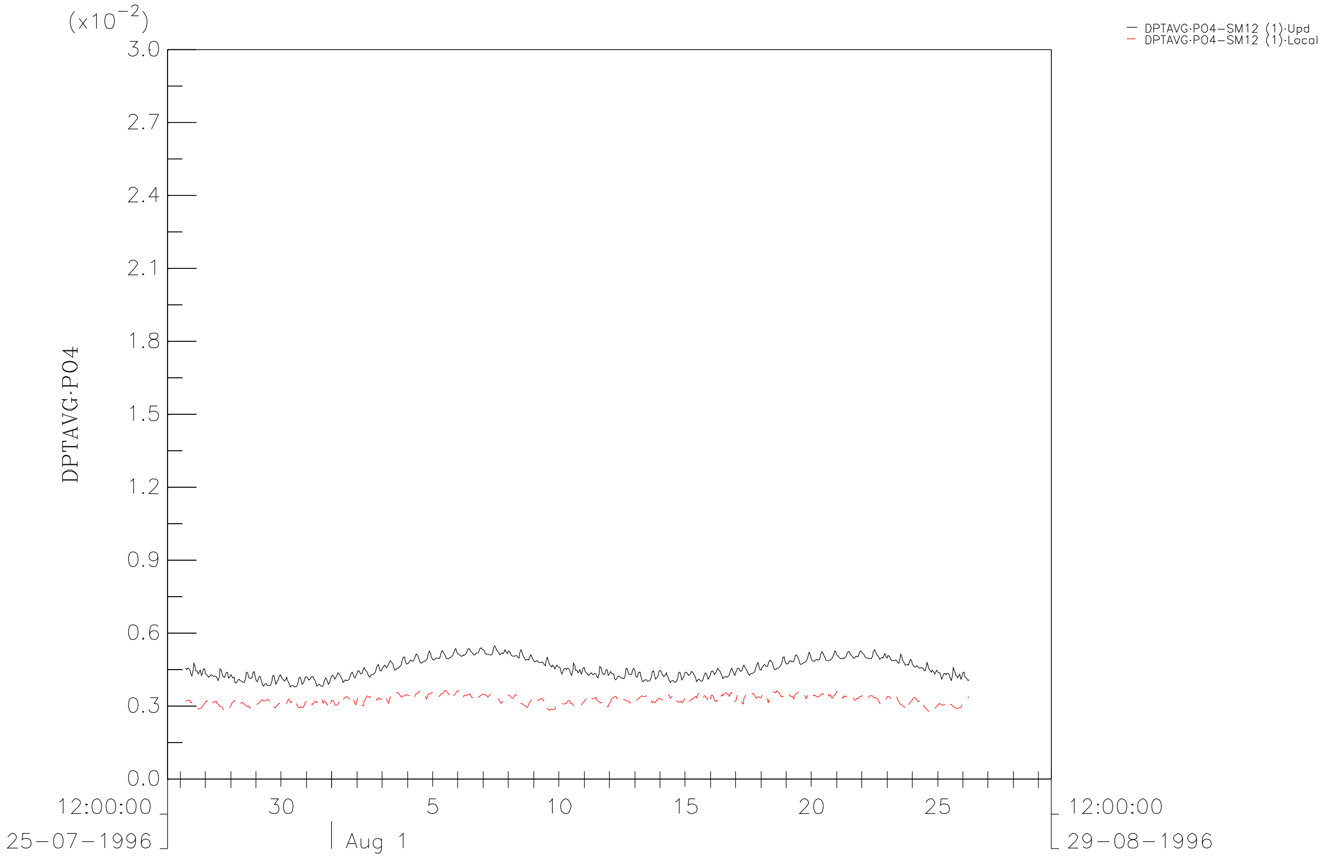


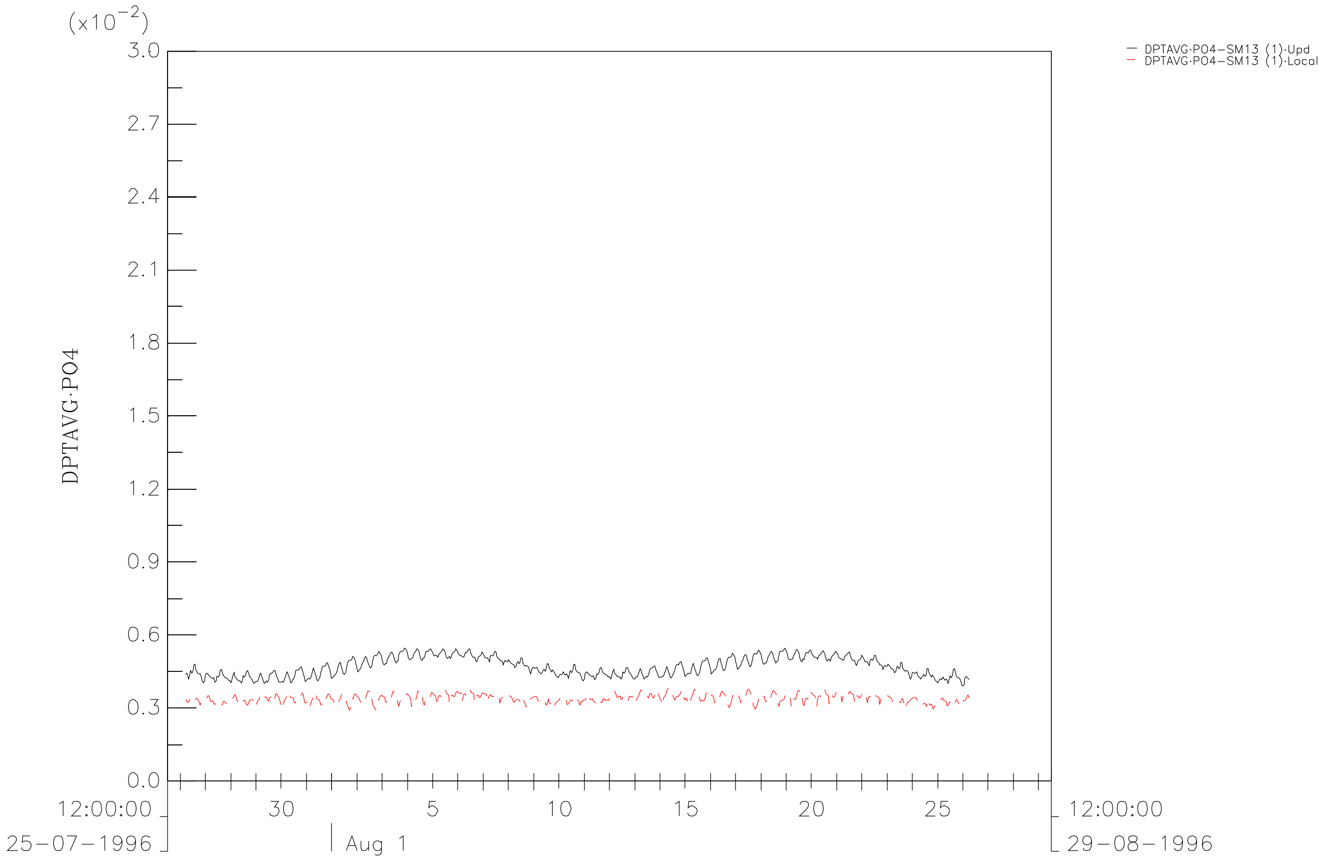
PO4 comparison between Update Model and Local Refine Model at SM17 (upper) and SM18 (lower). Baseline condition

Wet Season

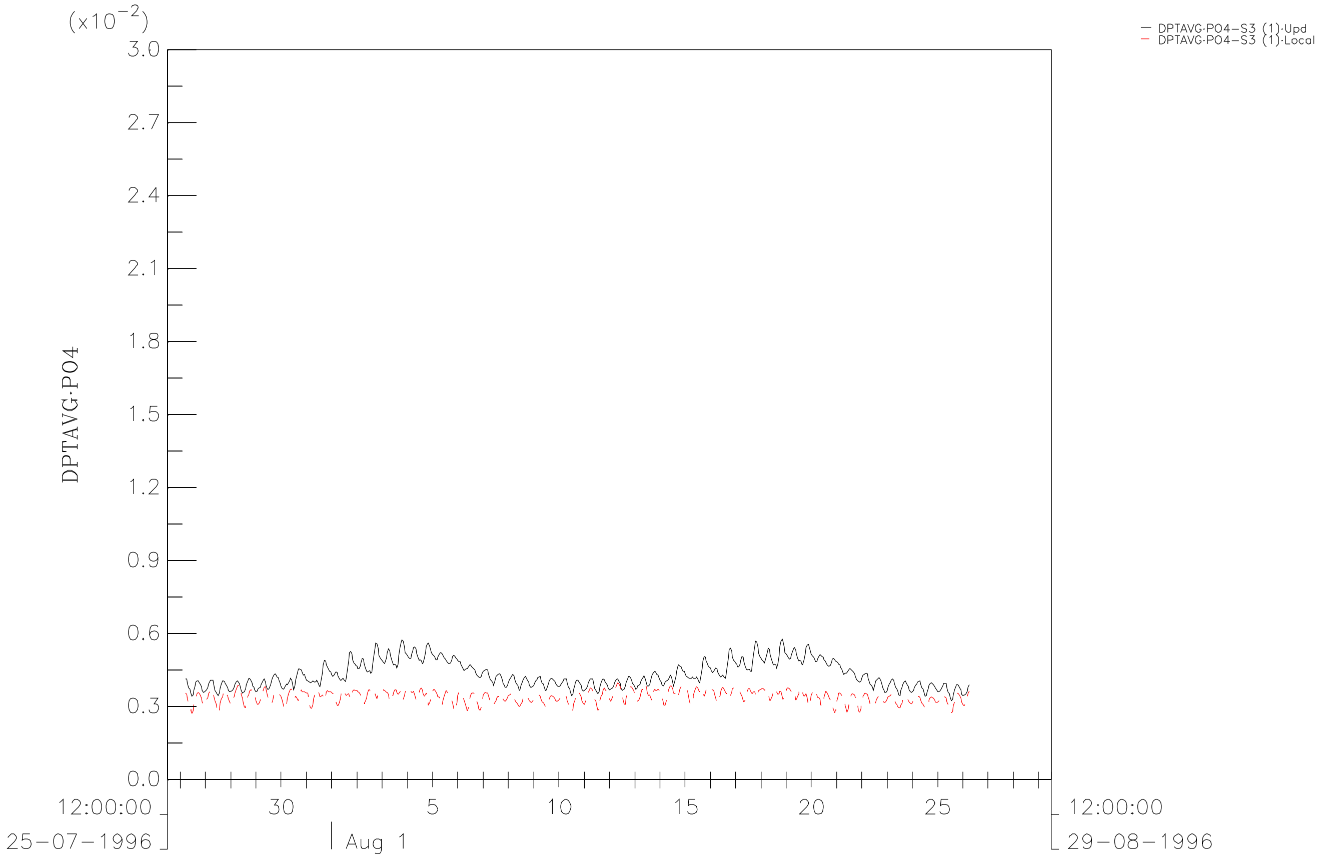
Figure 5A-105

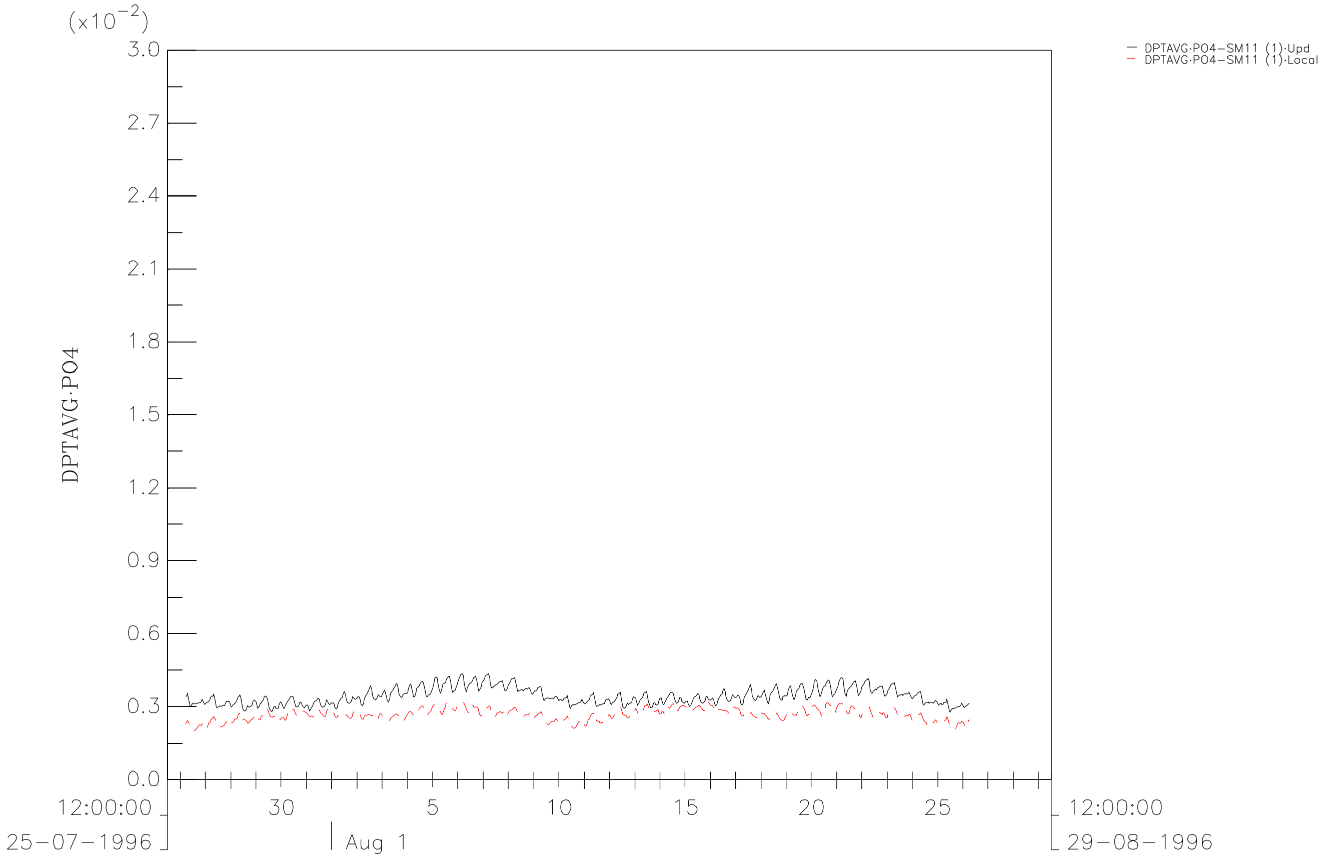
DSD & ATKINS





P04 comparison between Update Model and Local Refine Model at SM12 (upper) and SM13 (lower). Baseline condition	Wet Season
	Figure 5A-106
DSD & ATKINS	



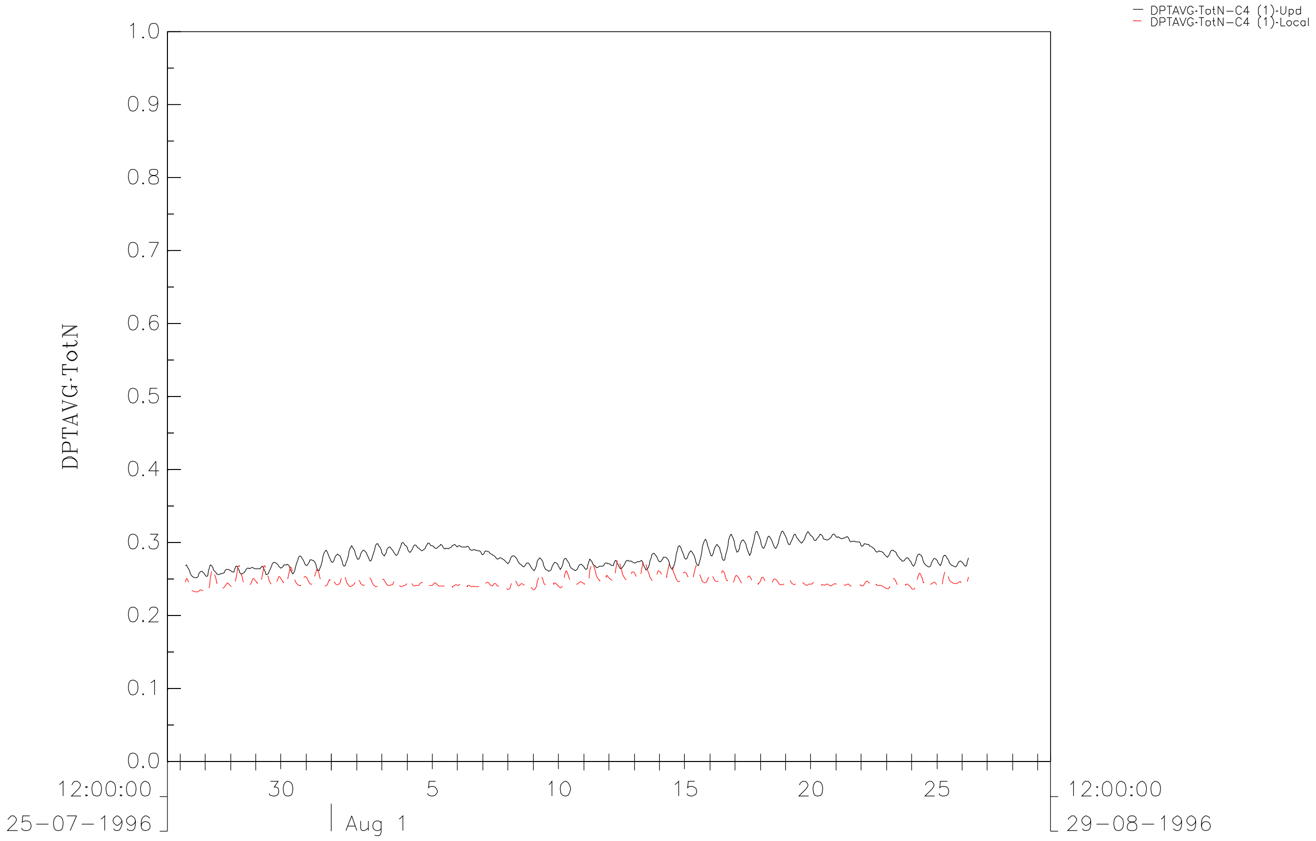


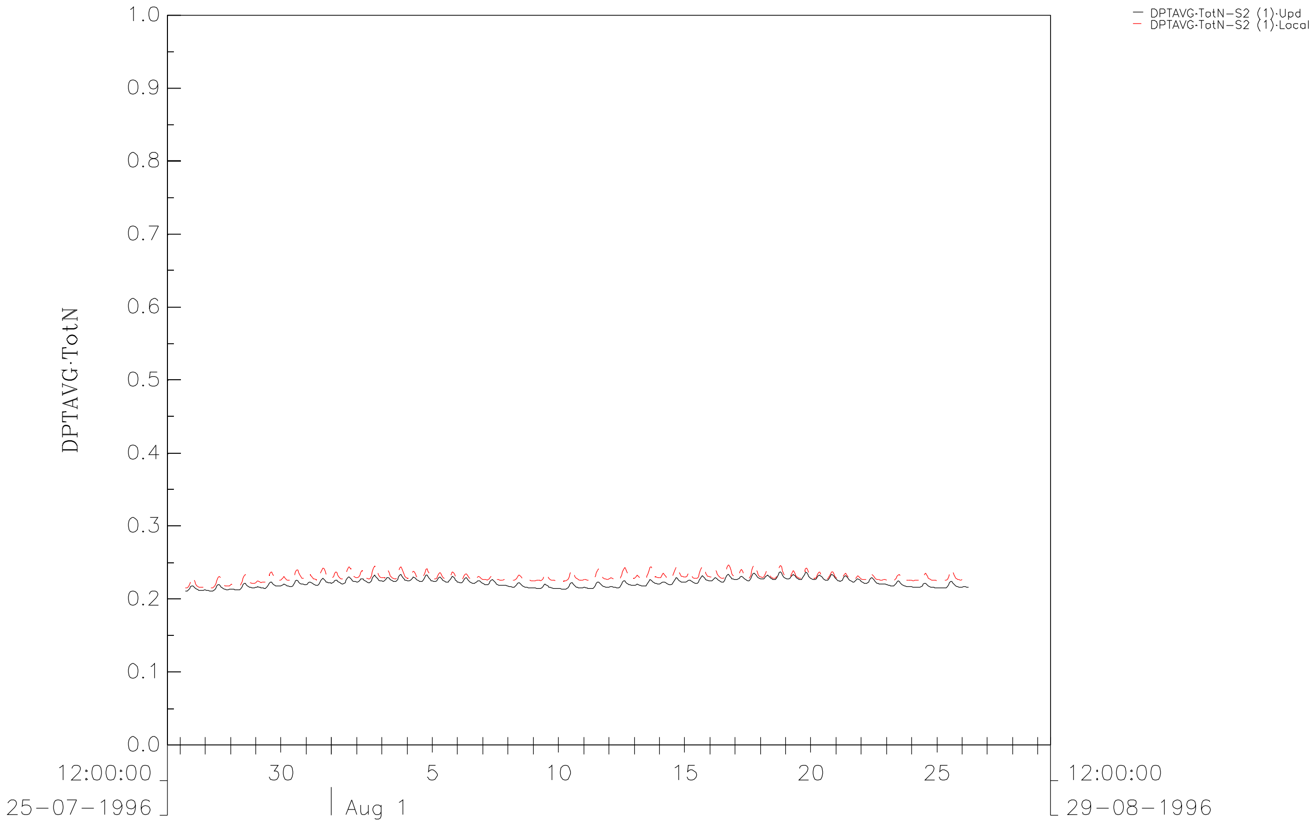
PO4 comparison between Update Model and Local Refine Model at S3 (upper) and SM11 (lower). Baseline condition

Wet Season

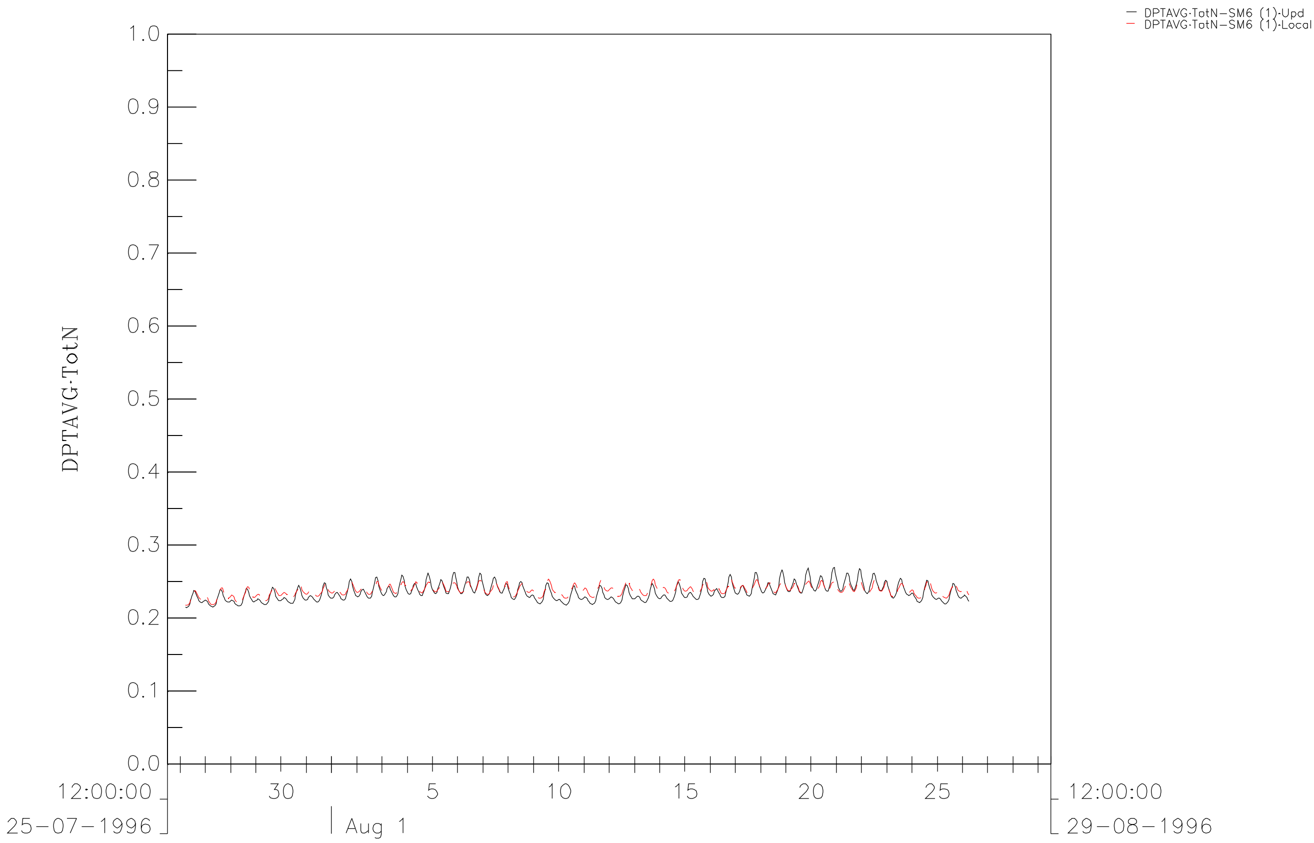
Figure 5A-107

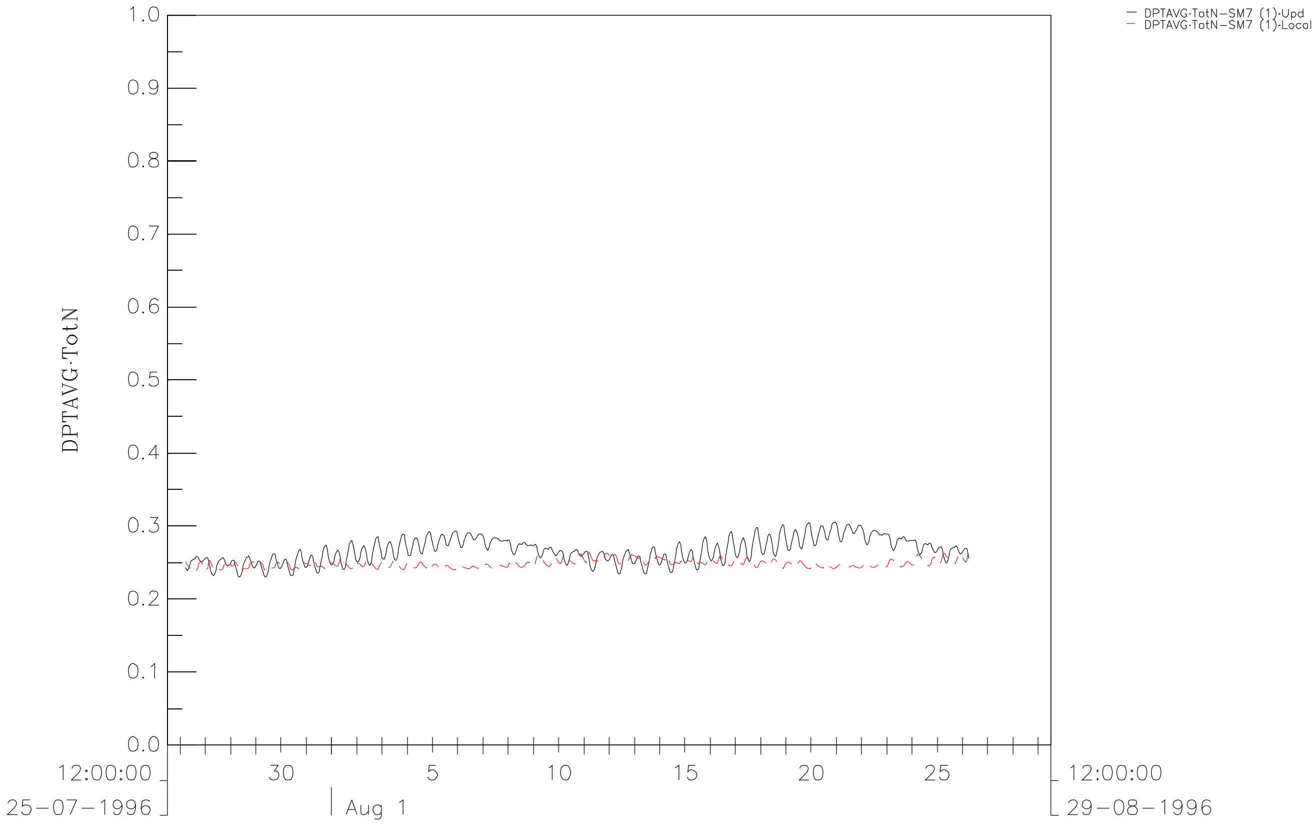
DSD & ATKINS



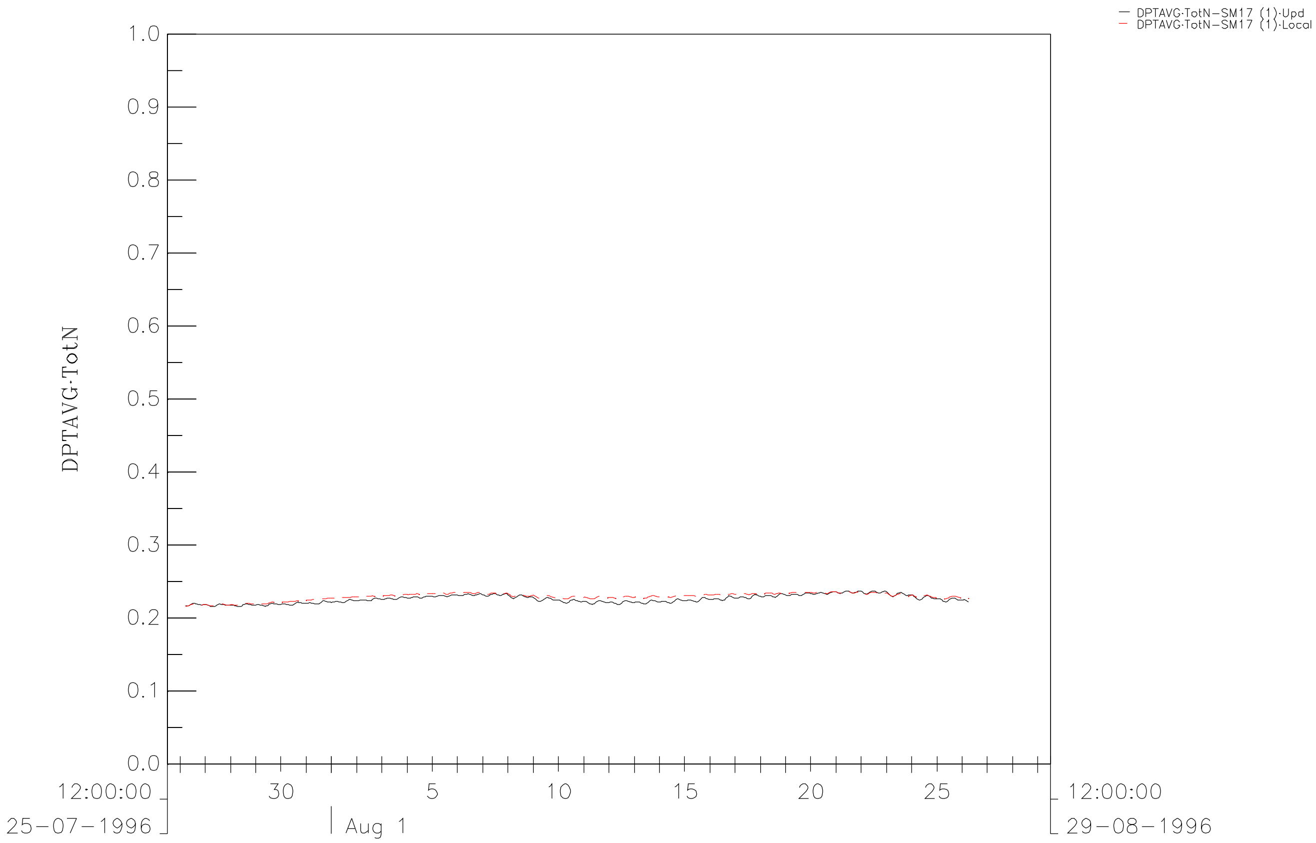


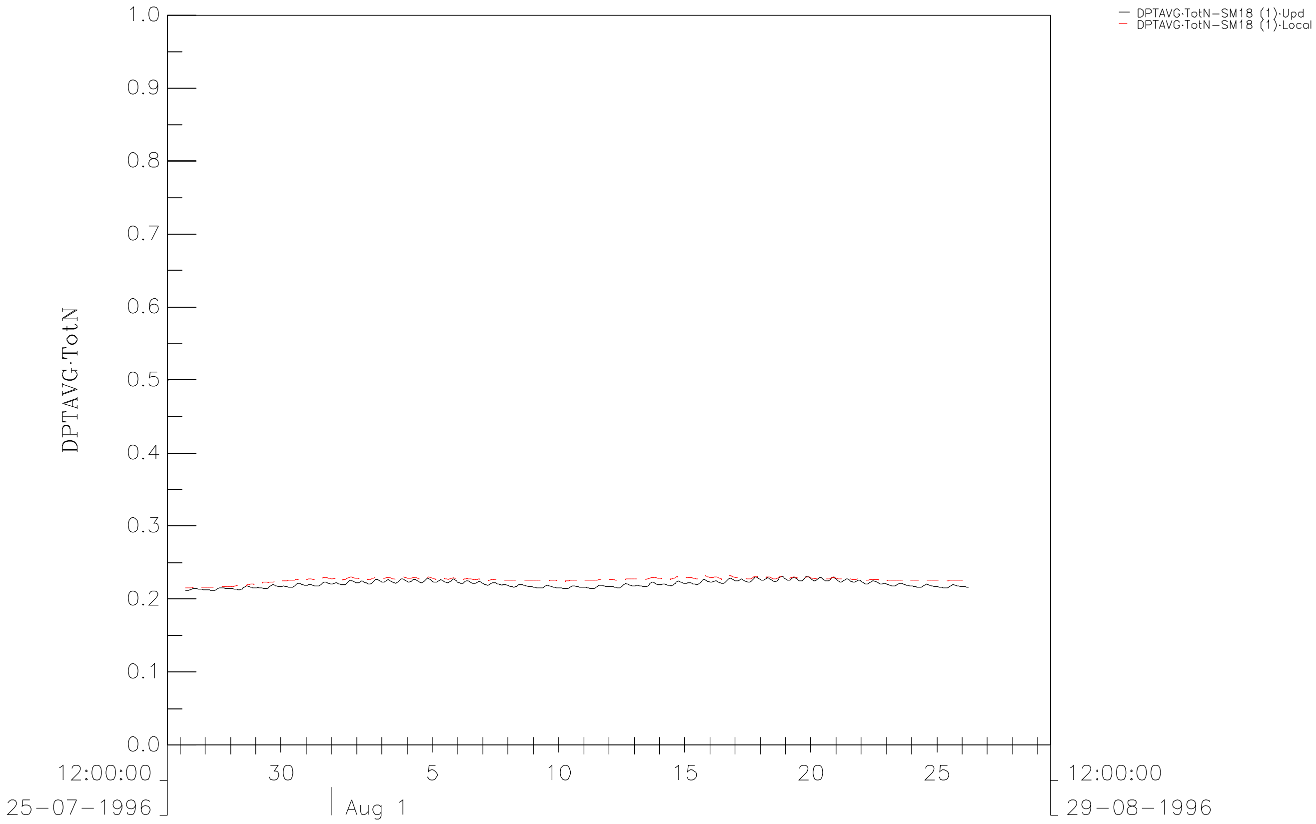
TotN comparison between Update Model and Local Refine Model at C4 (upper) and S2 (lower). Baseline condition	Dry Season
	Figure 5A-108
DSD & ATKINS	





TotN comparison between Update Model and Local Refine Model at SM6 (upper) and SM7 (lower). Baseline condition	Dry Season
	Figure 5A-109
DSD & ATKINS	



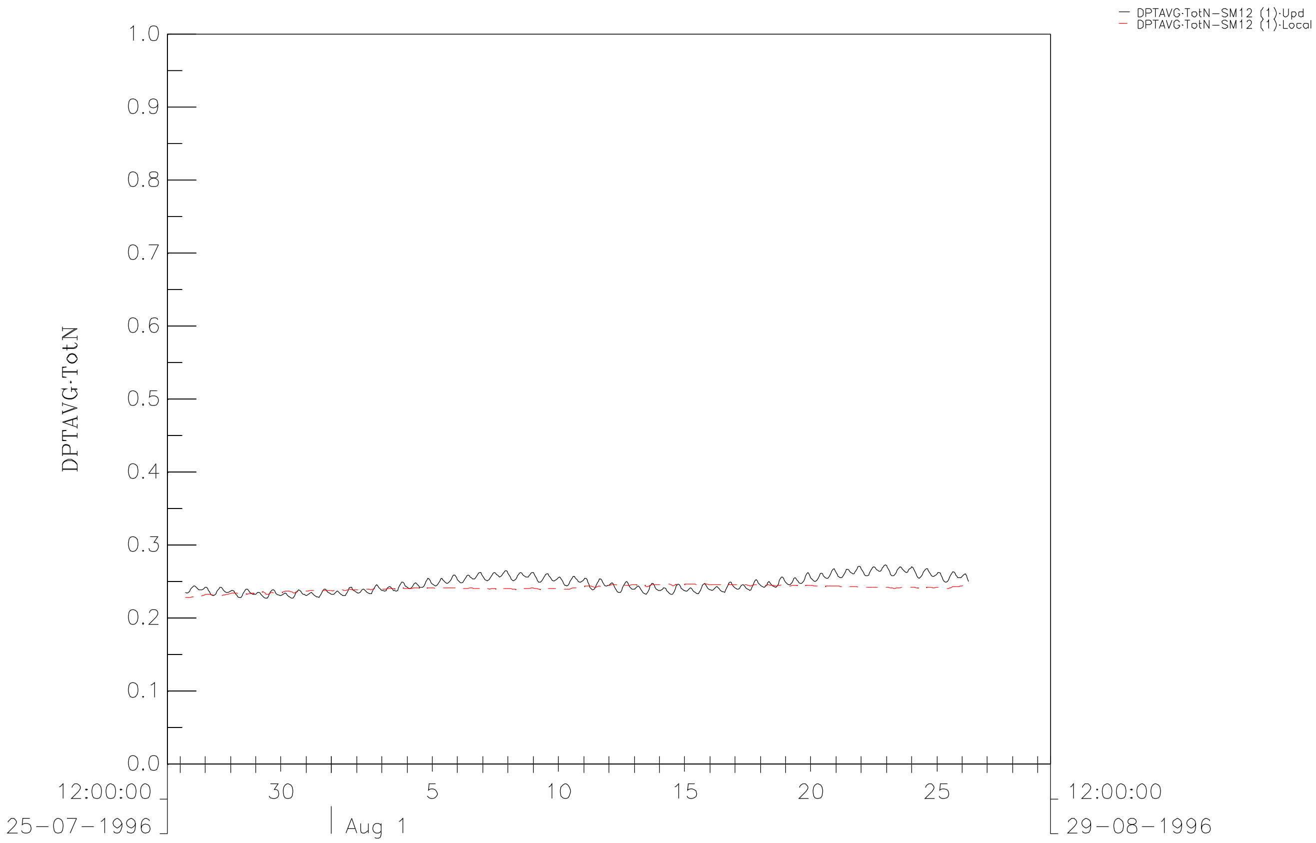


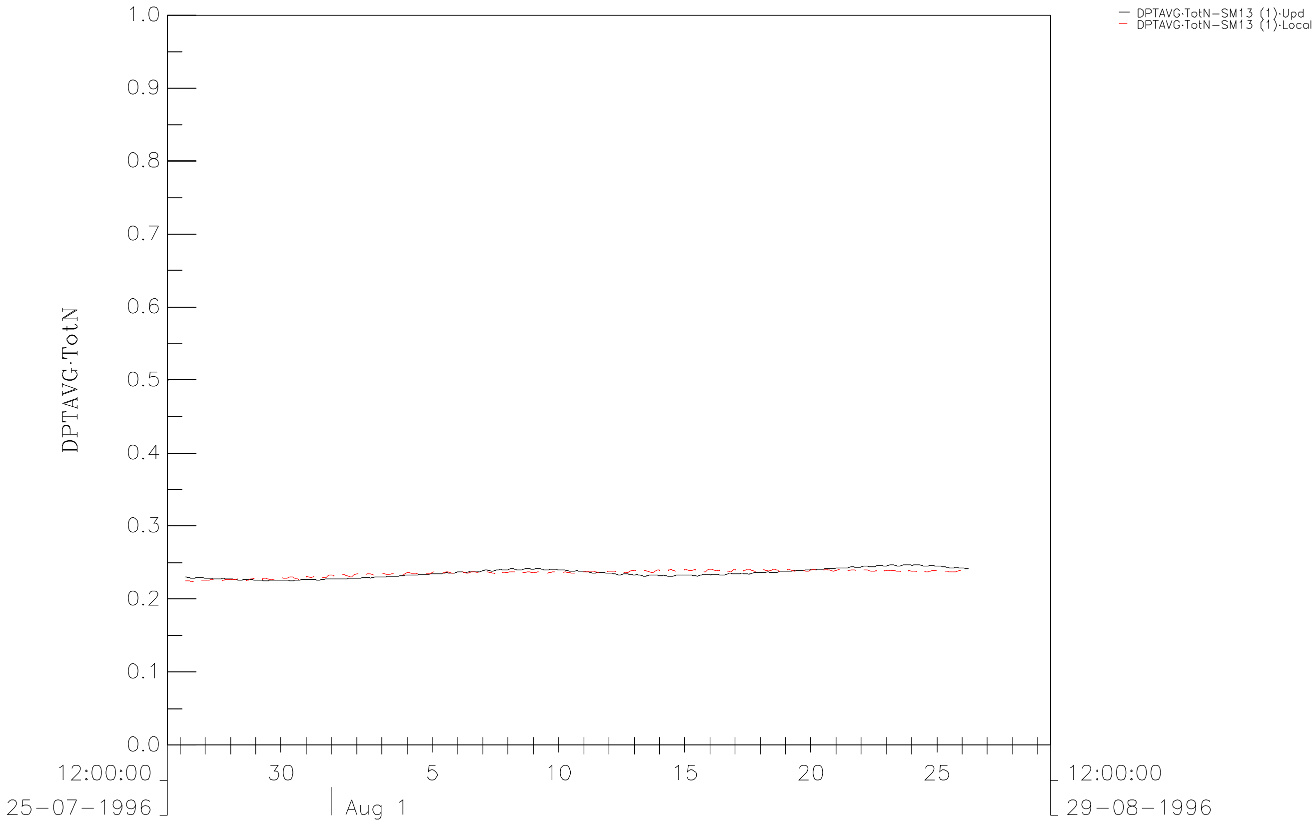
TotN comparison between Update Model and
Local Refine Model at SM17 (upper) and SM18 (lower).
Baseline condition

Dry Season

Figure 5A-110

DSD & ATKINS



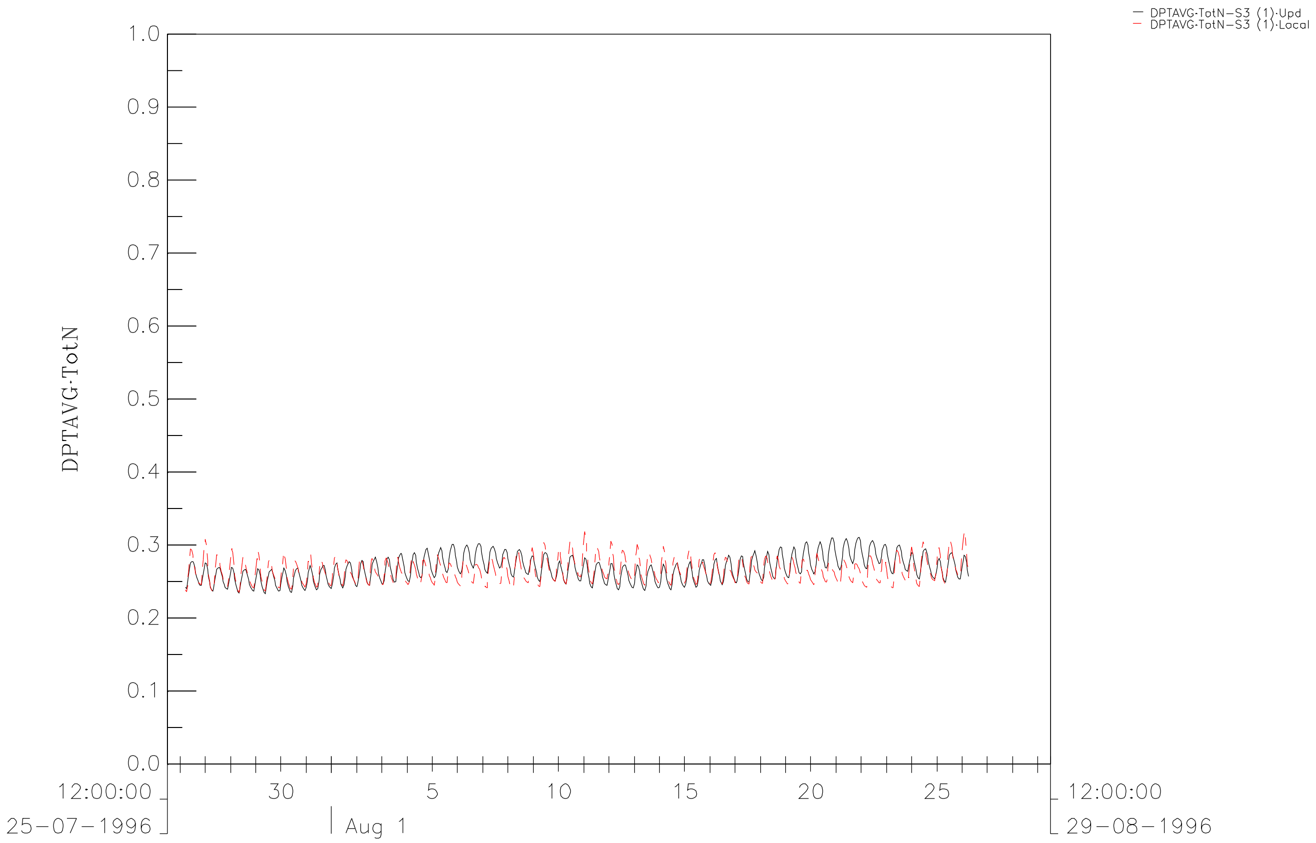


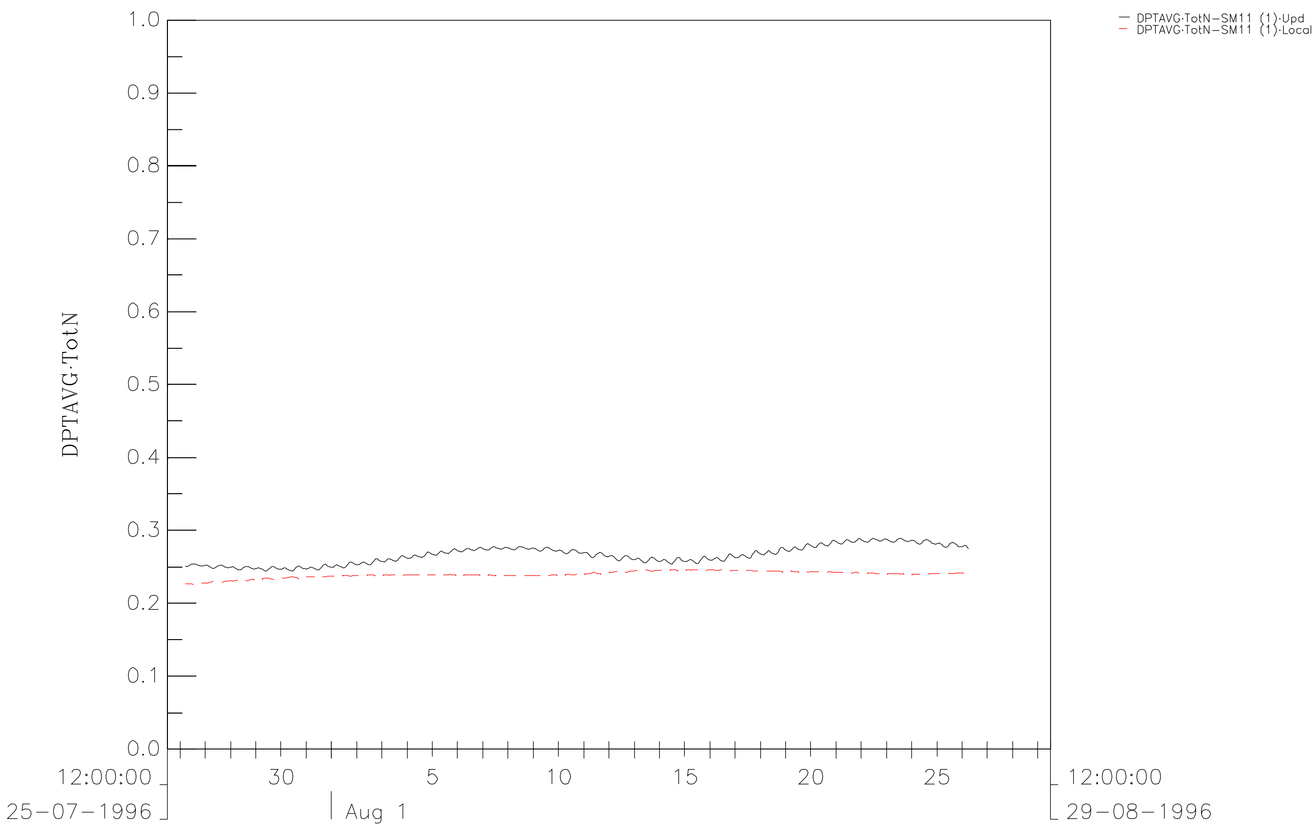
TotN comparison between Update Model and
Local Refine Model at SM12 (upper) and SM13 (lower).
Baseline condition

Dry Season

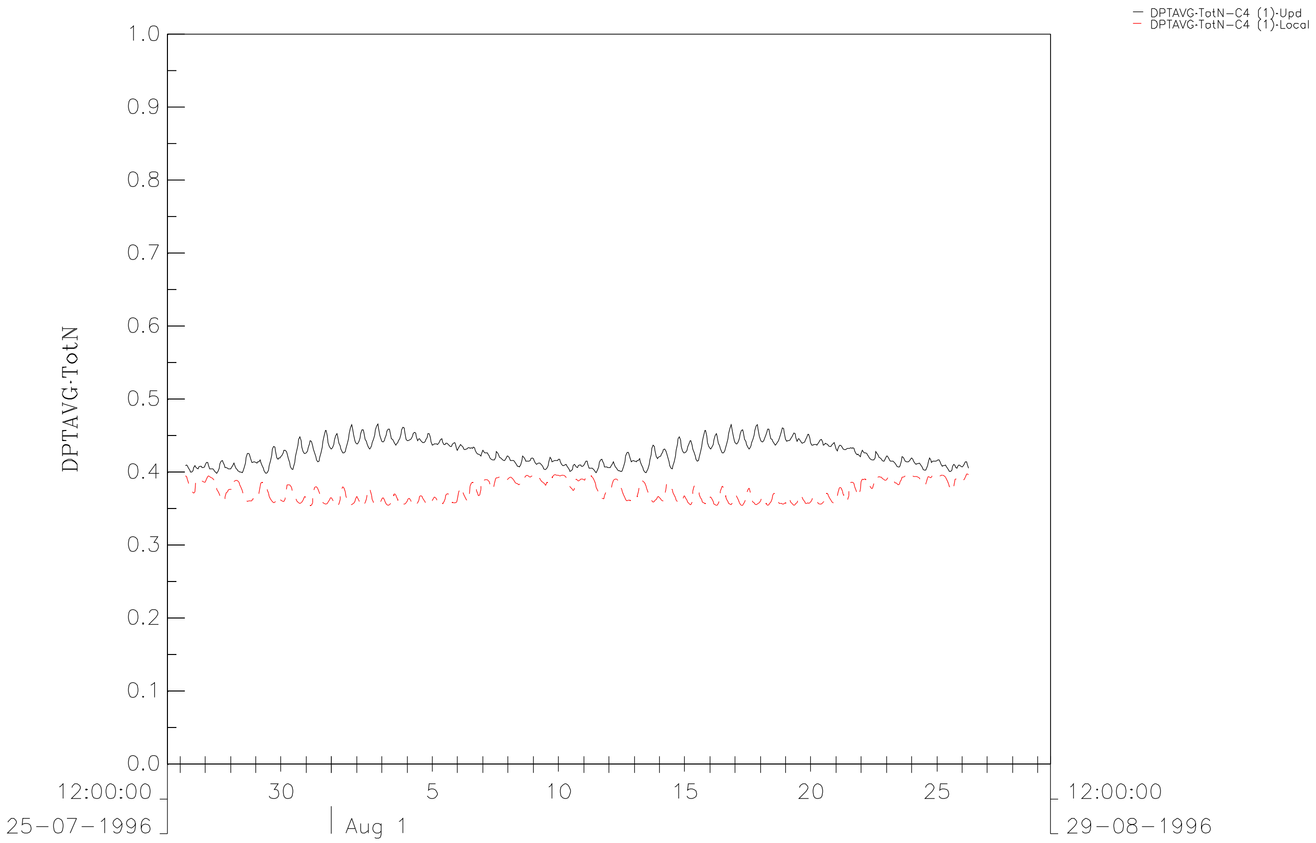
Figure 5A-111

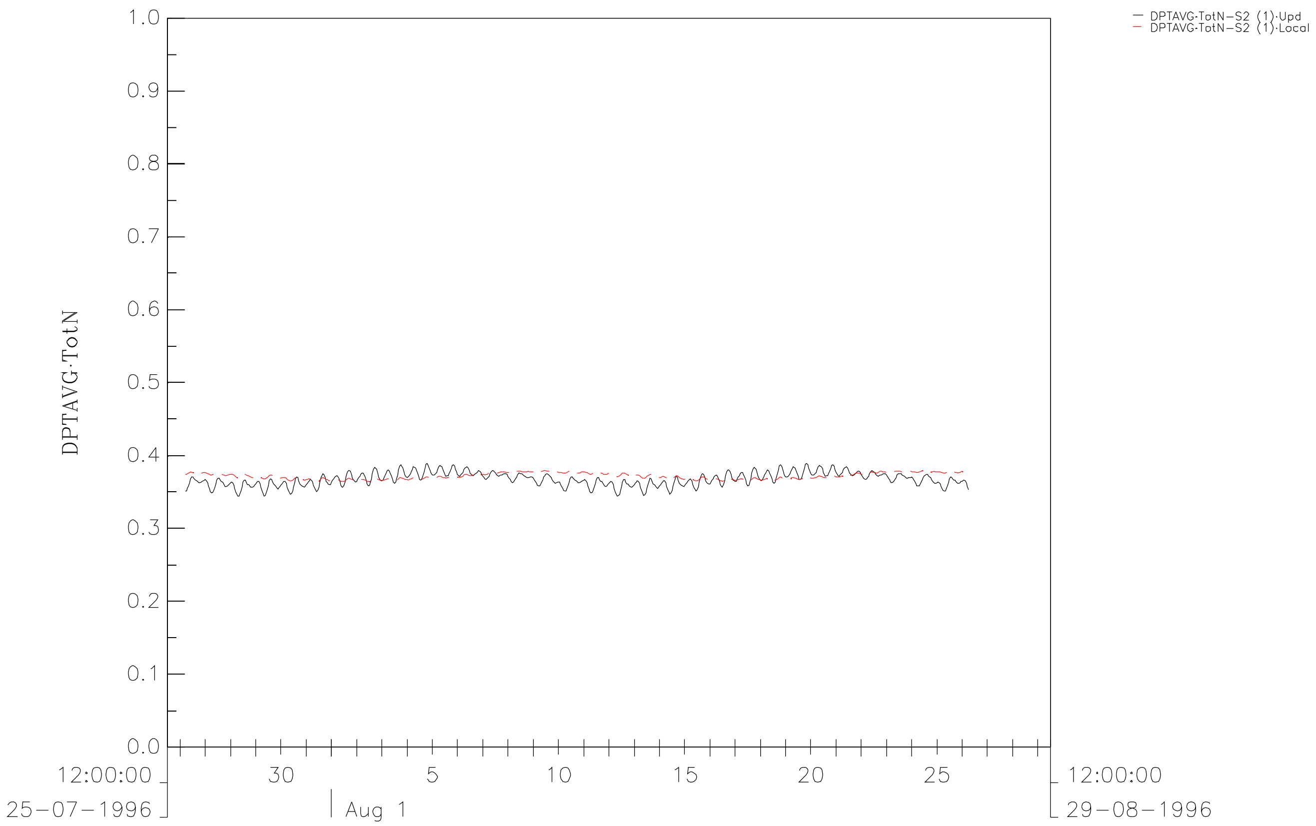
DSD & ATKINS



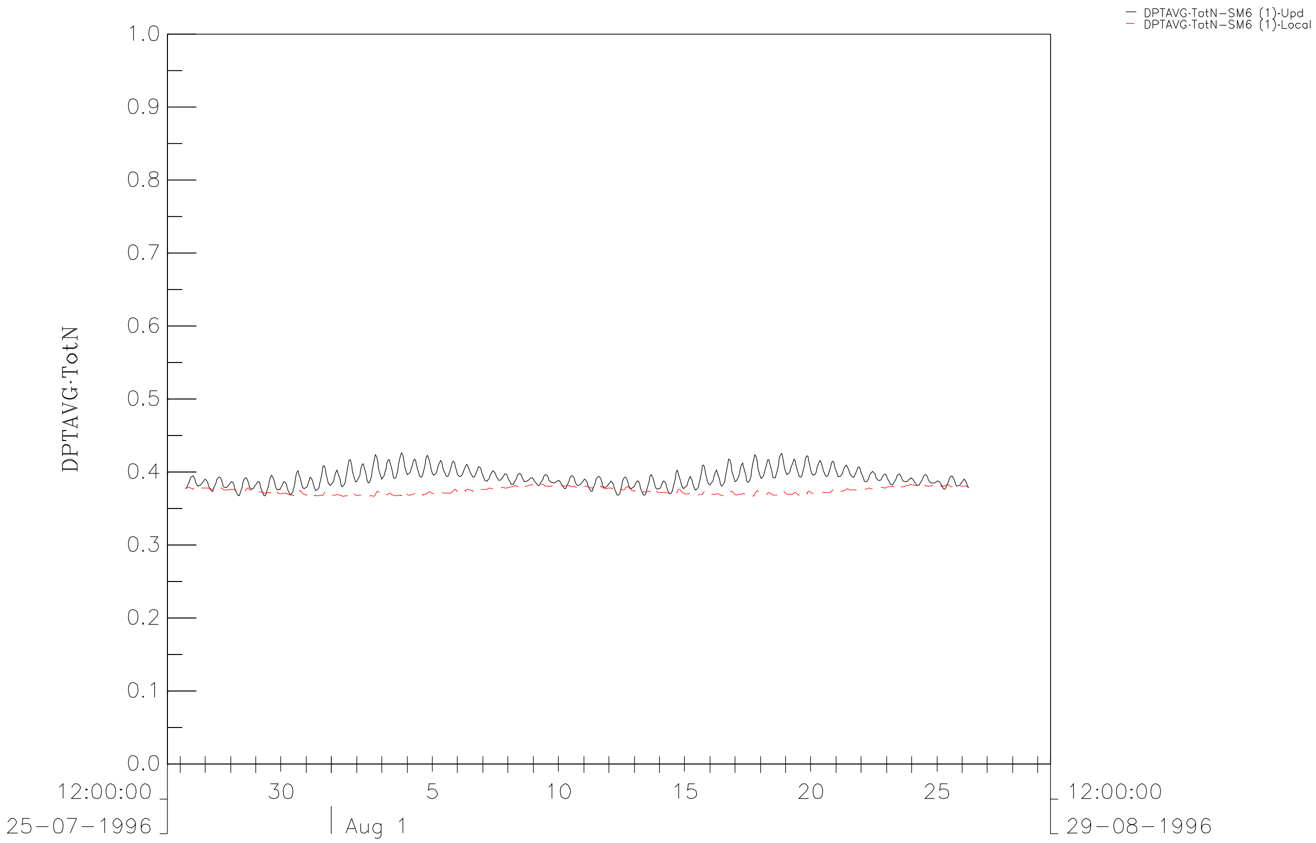


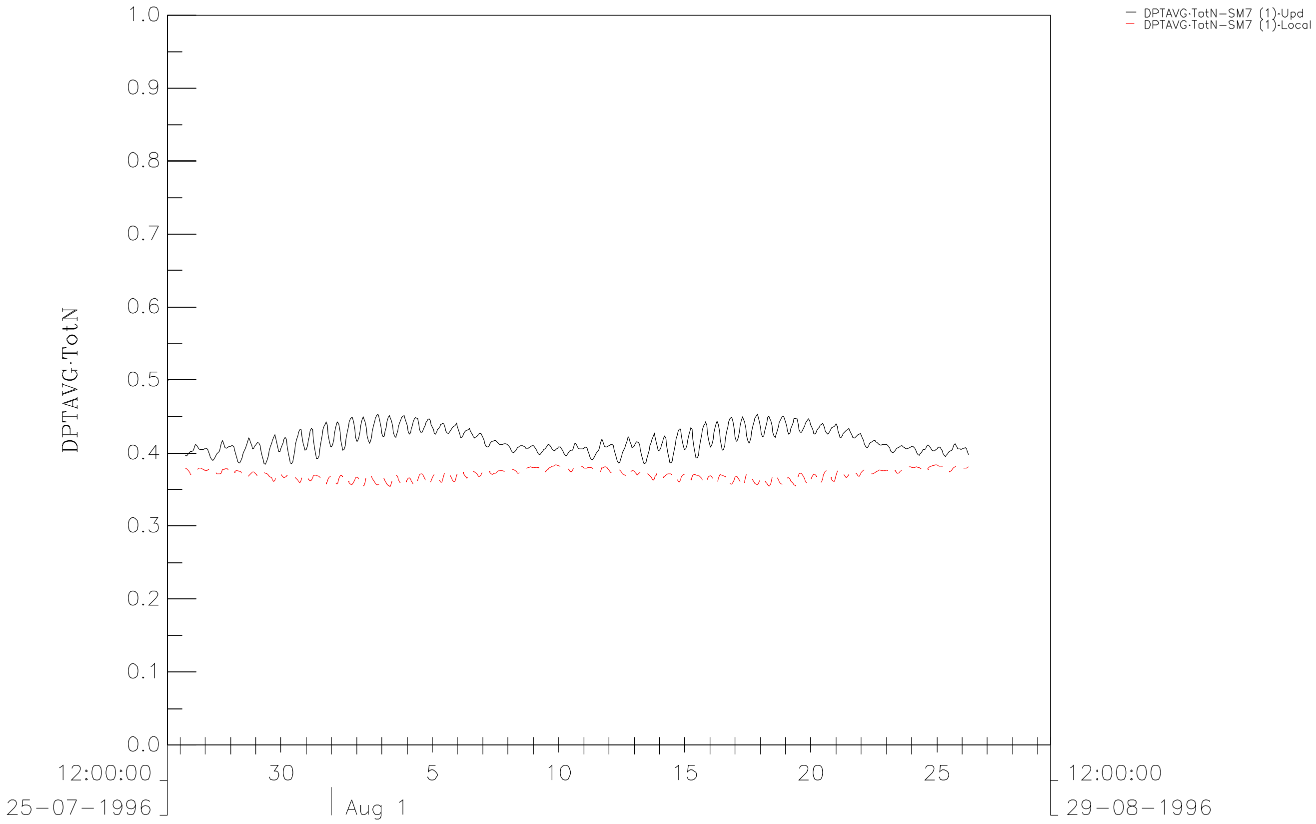
TotN comparison between Update Model and Local Refine Model at S3 (upper) and SM11 (lower). Baseline condition	Dry Season
	Figure 5A-112
DSD & ATKINS	





TotN comparison between Update Model and Local Refine Model at C4 (upper) and S2 (lower). Baseline condition	Wet Season
	Figure 5A-113
DSD & ATKINS	



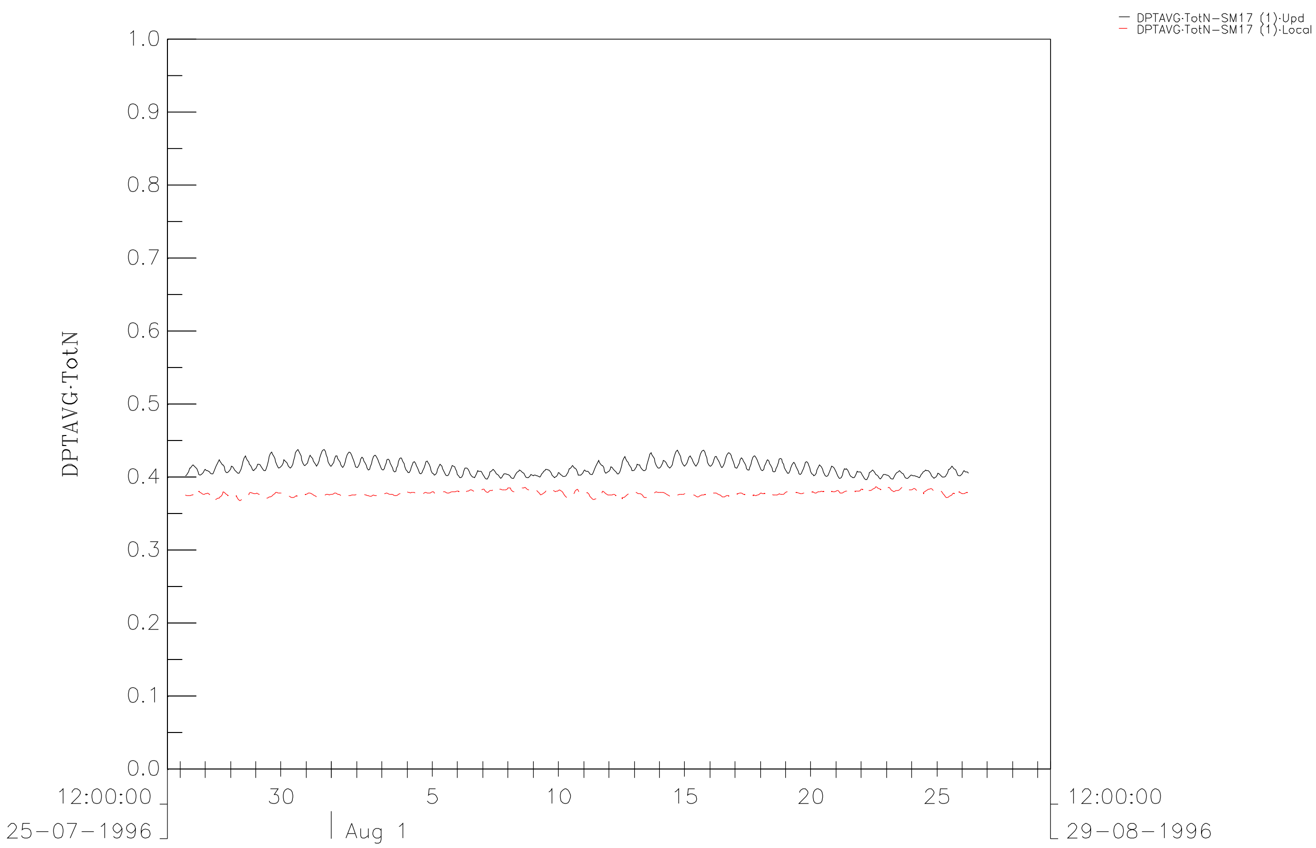


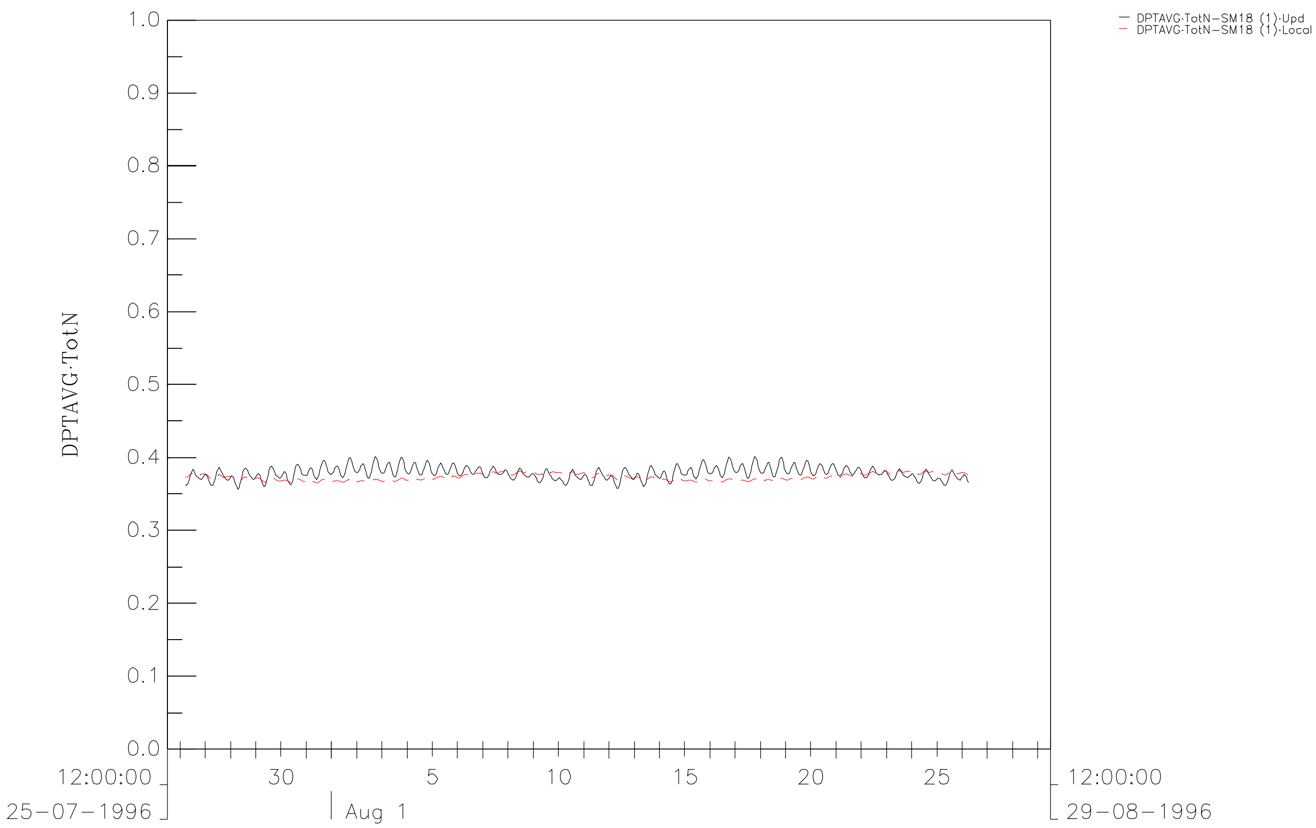
TotN comparison between Update Model and Local Refine Model at SM6 (upper) and SM7 (lower). Baseline condition

Wet Season

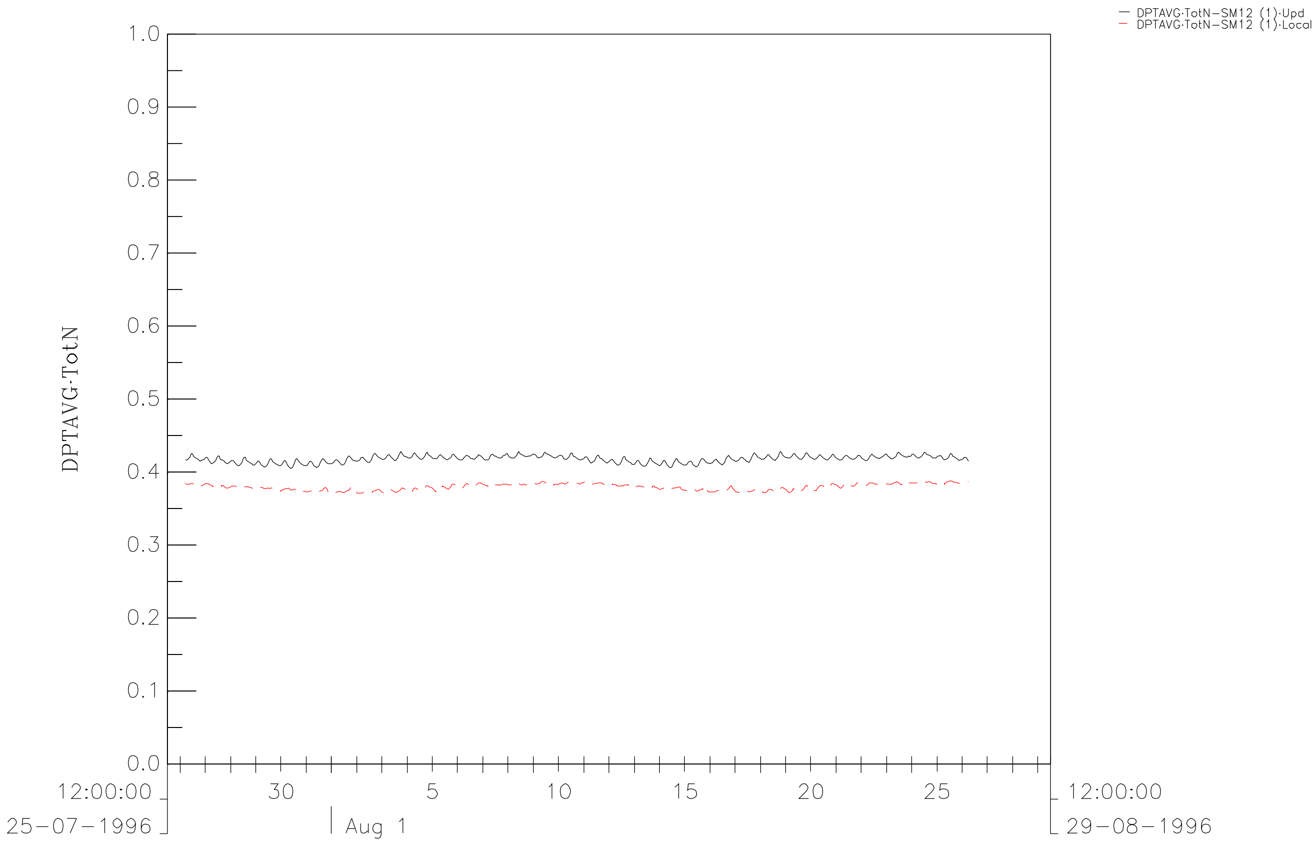
Figure 5A-114

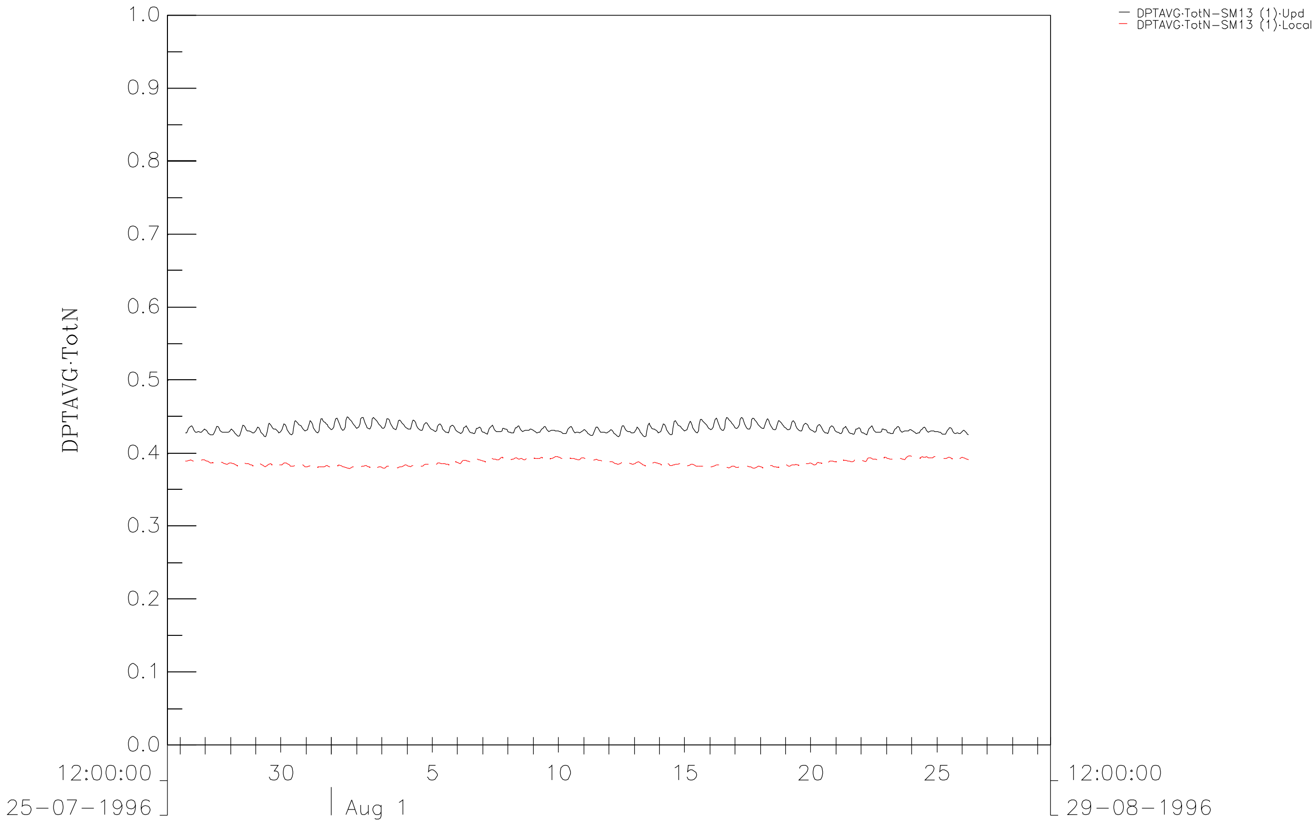
DSD & ATKINS



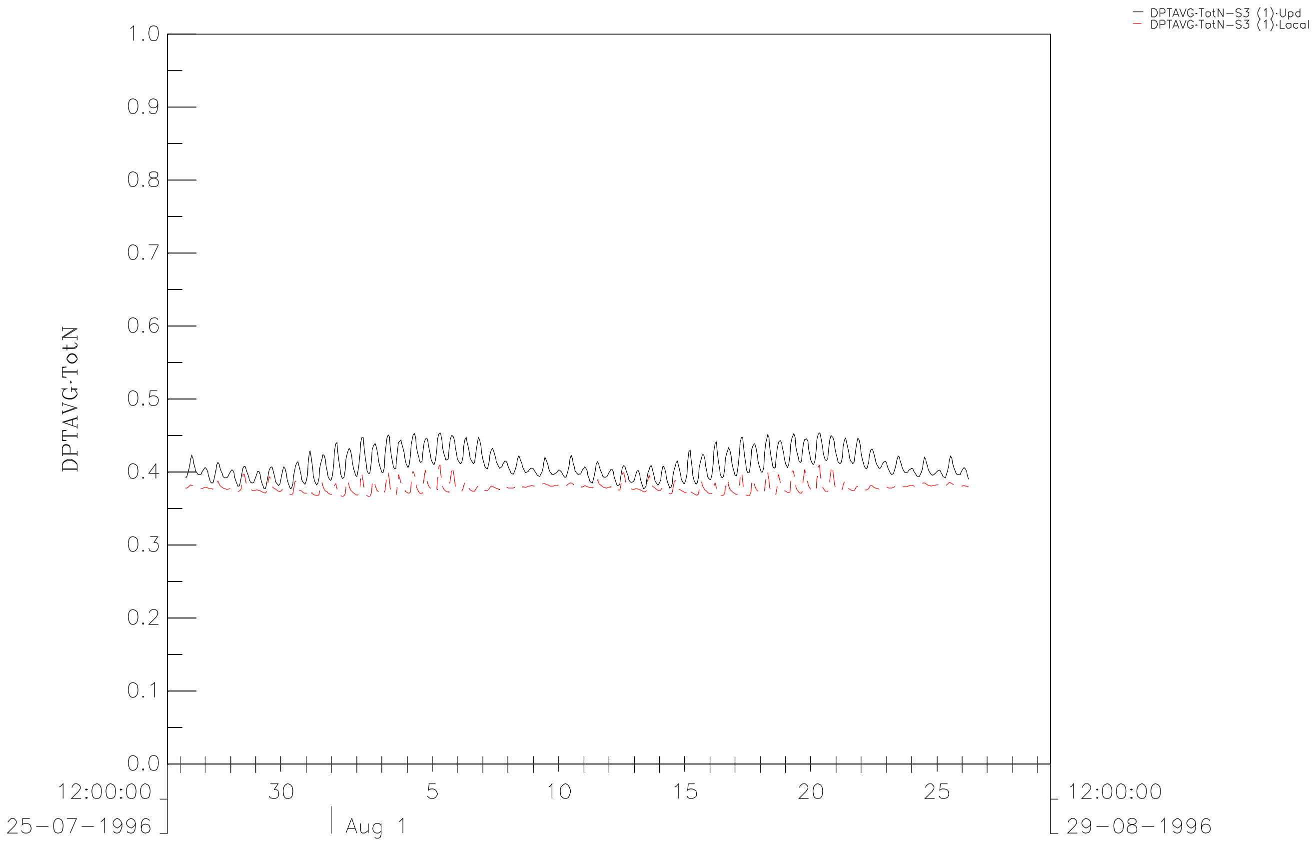


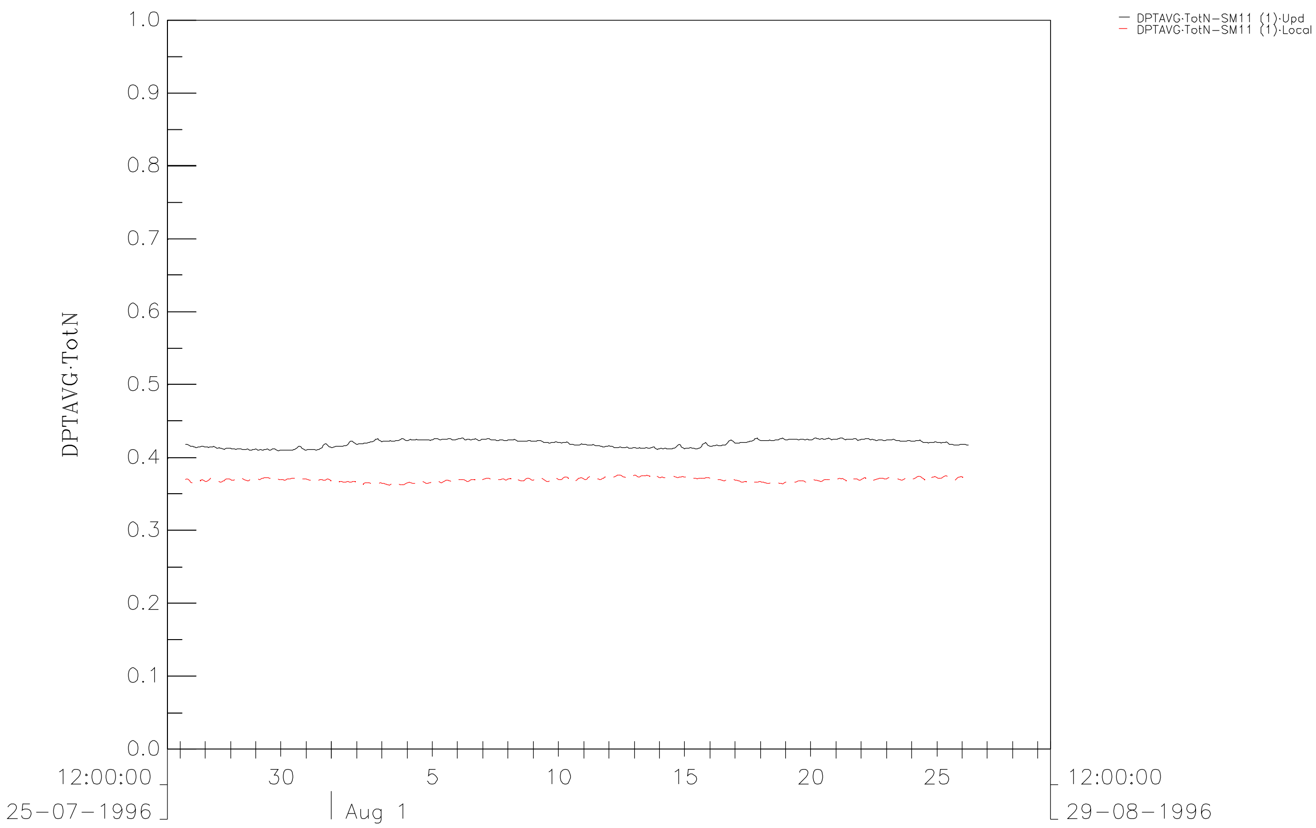
TotN comparison between Update Model and Local Refine Model at SM17 (upper) and SM18 (lower). Baseline condition	Wet Season
	Figure 5A-115
DSD & ATKINS	



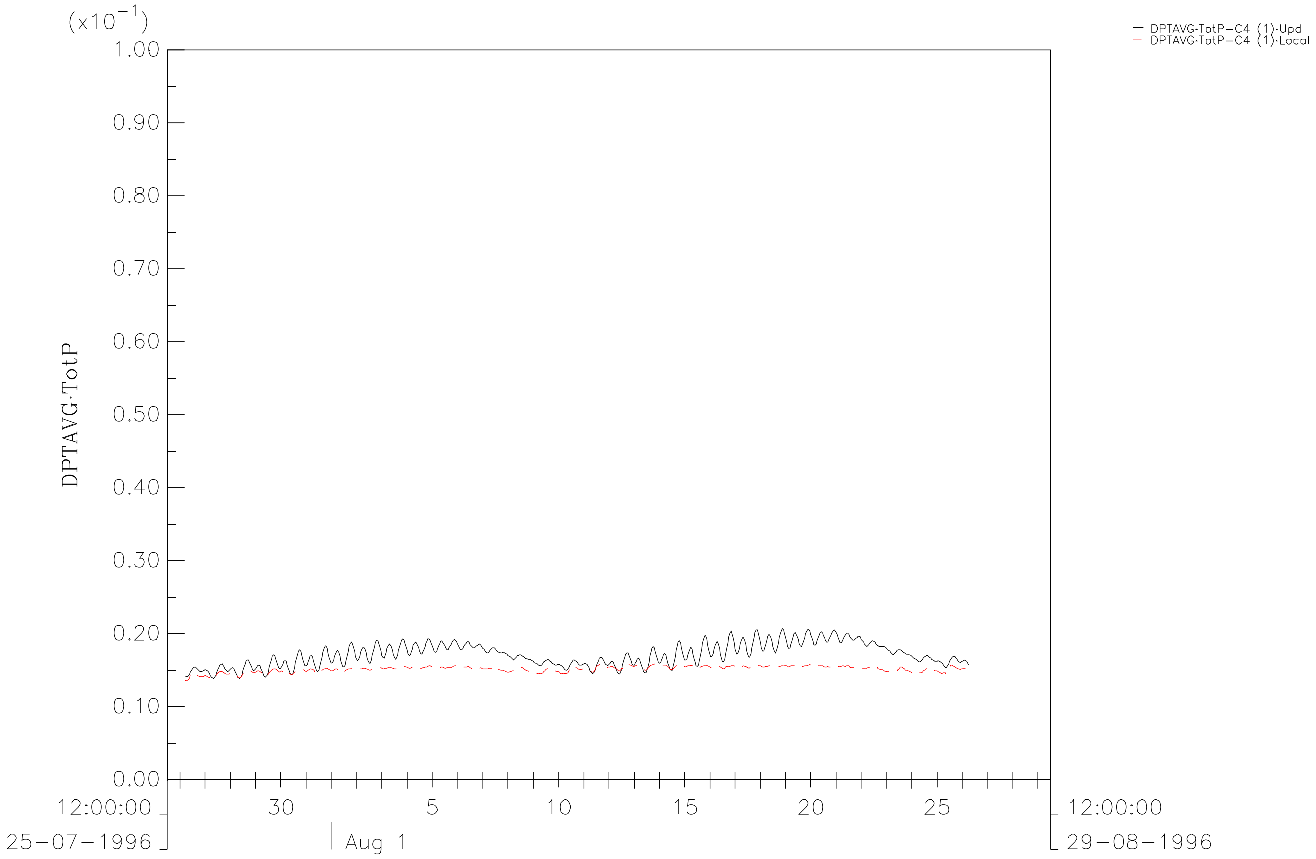


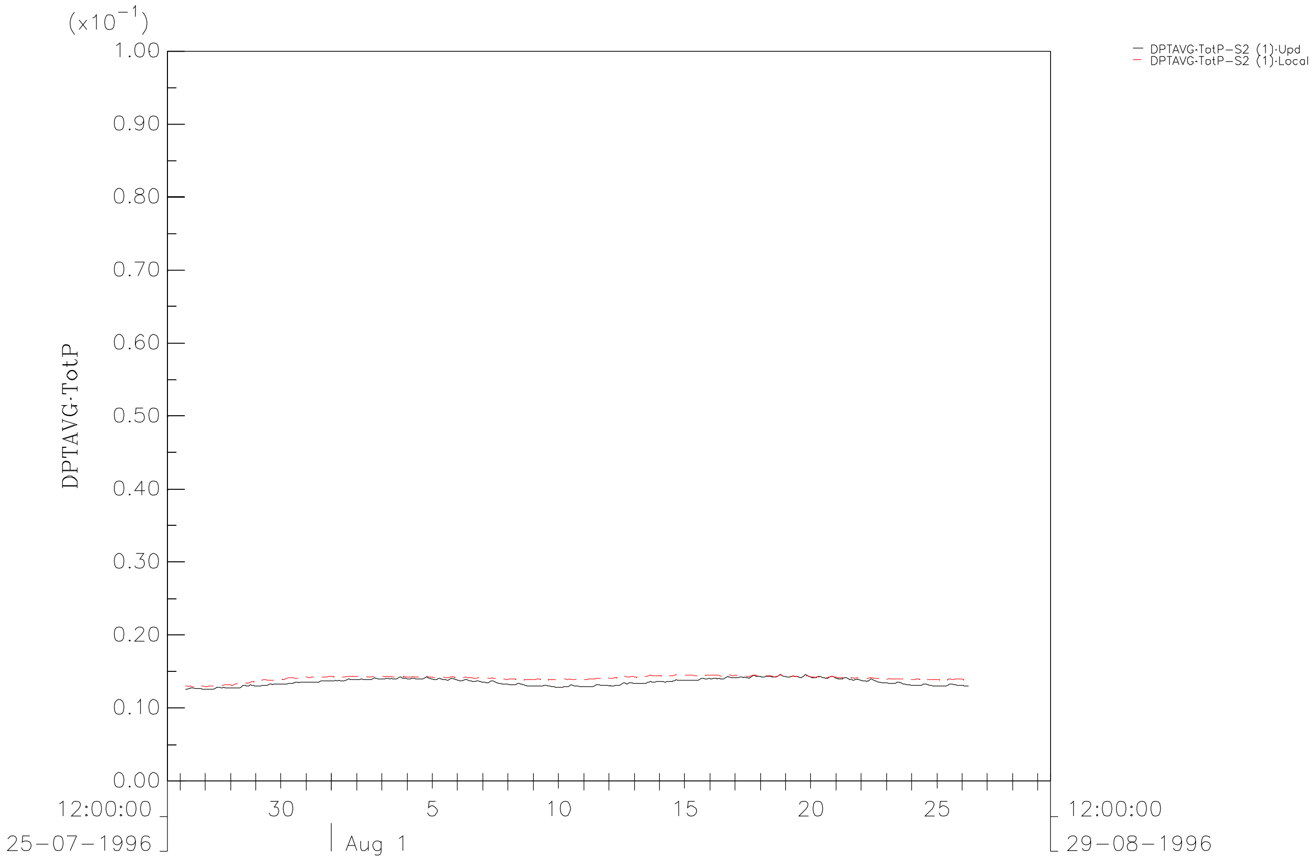
TotN comparison between Update Model and Local Refine Model at SM12 (upper) and SM13 (lower). Baseline condition	Wet Season	
	Figure 5A-116	
DSD & ATKINS		



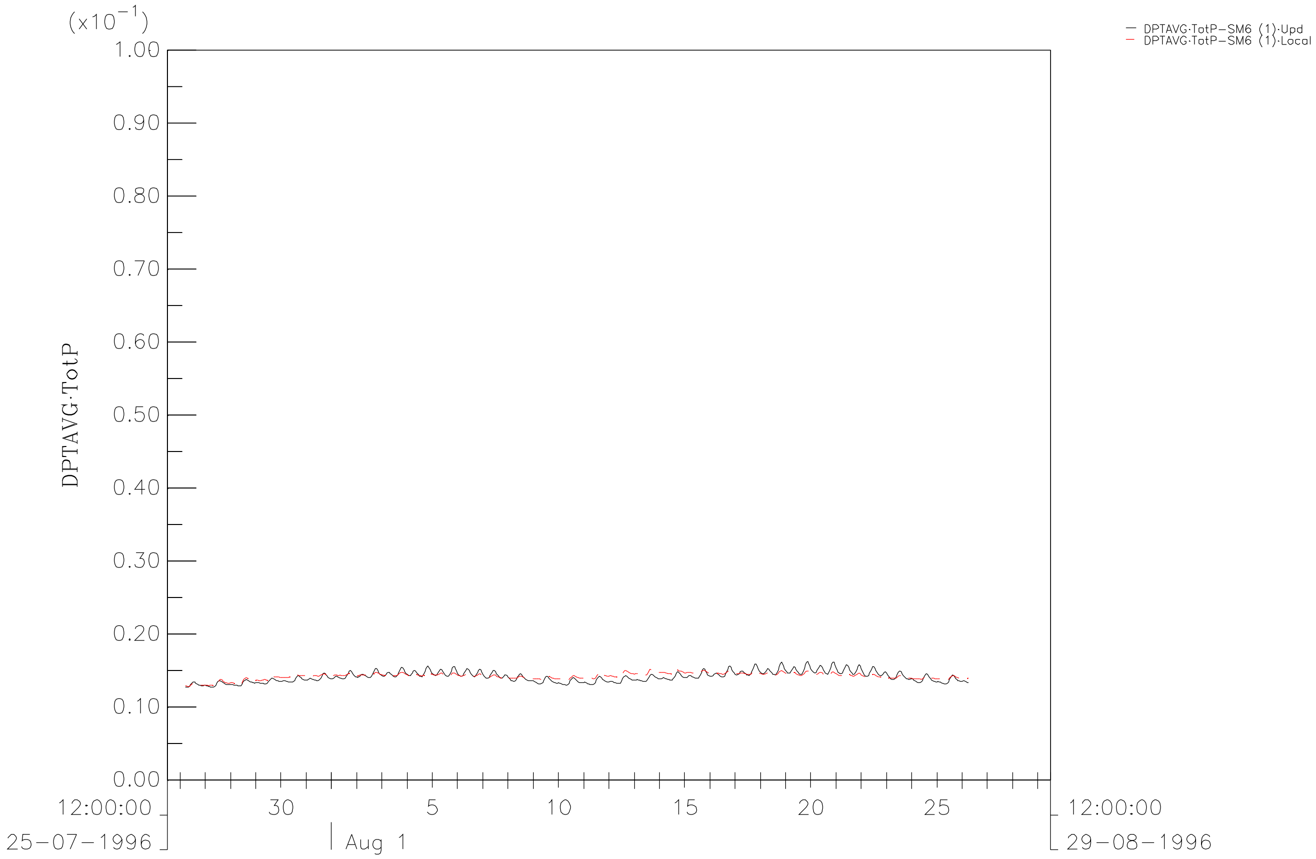


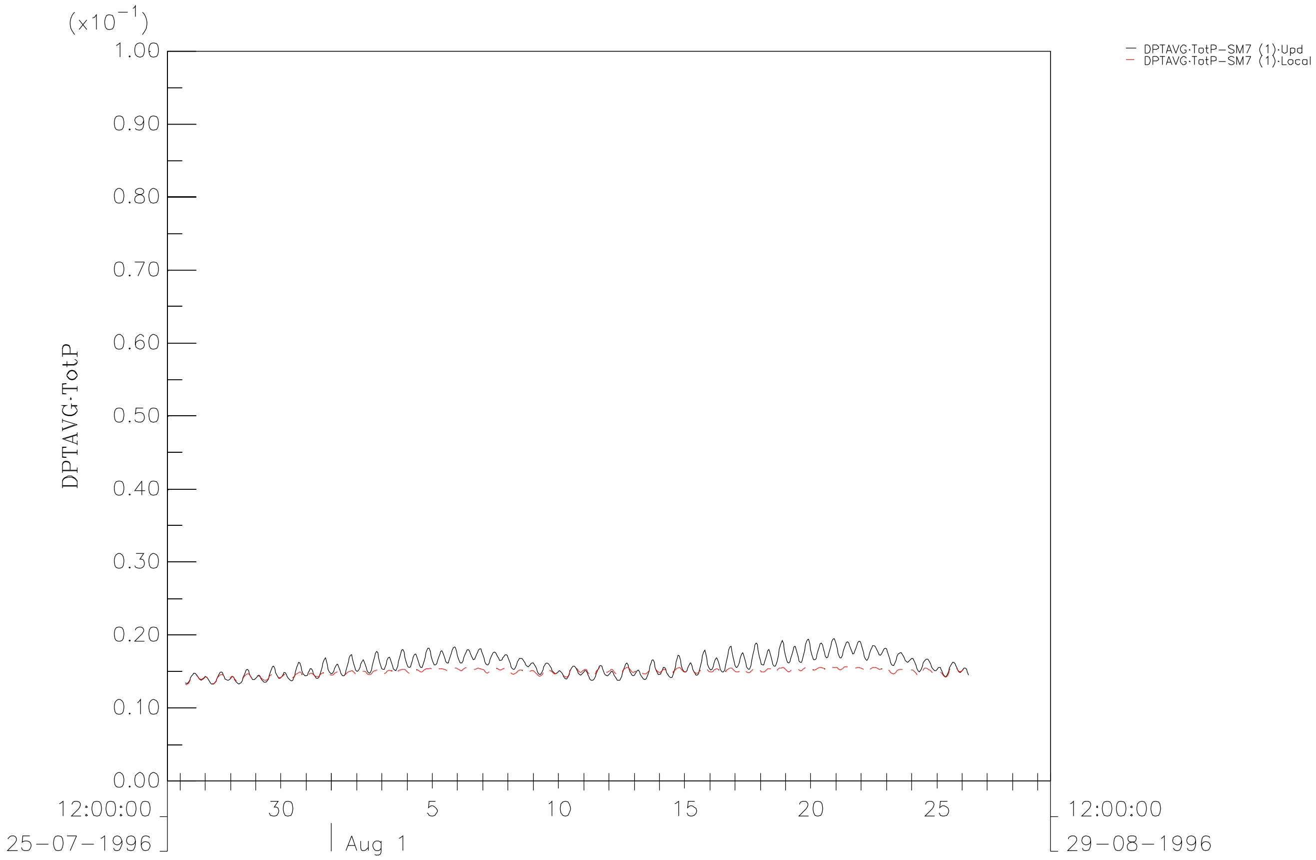
TotN comparison between Update Model and Local Refine Model at S3 (upper) and SM11 (lower). Baseline condition	Wet Season
	Figure 5A-117
DSD & ATKINS	





TotP comparison between Update Model and Local Refine Model at C4 (upper) and S2 (lower). Baseline condition	Dry Season	
	Figure 5A-118	
DSD & ATKINS		



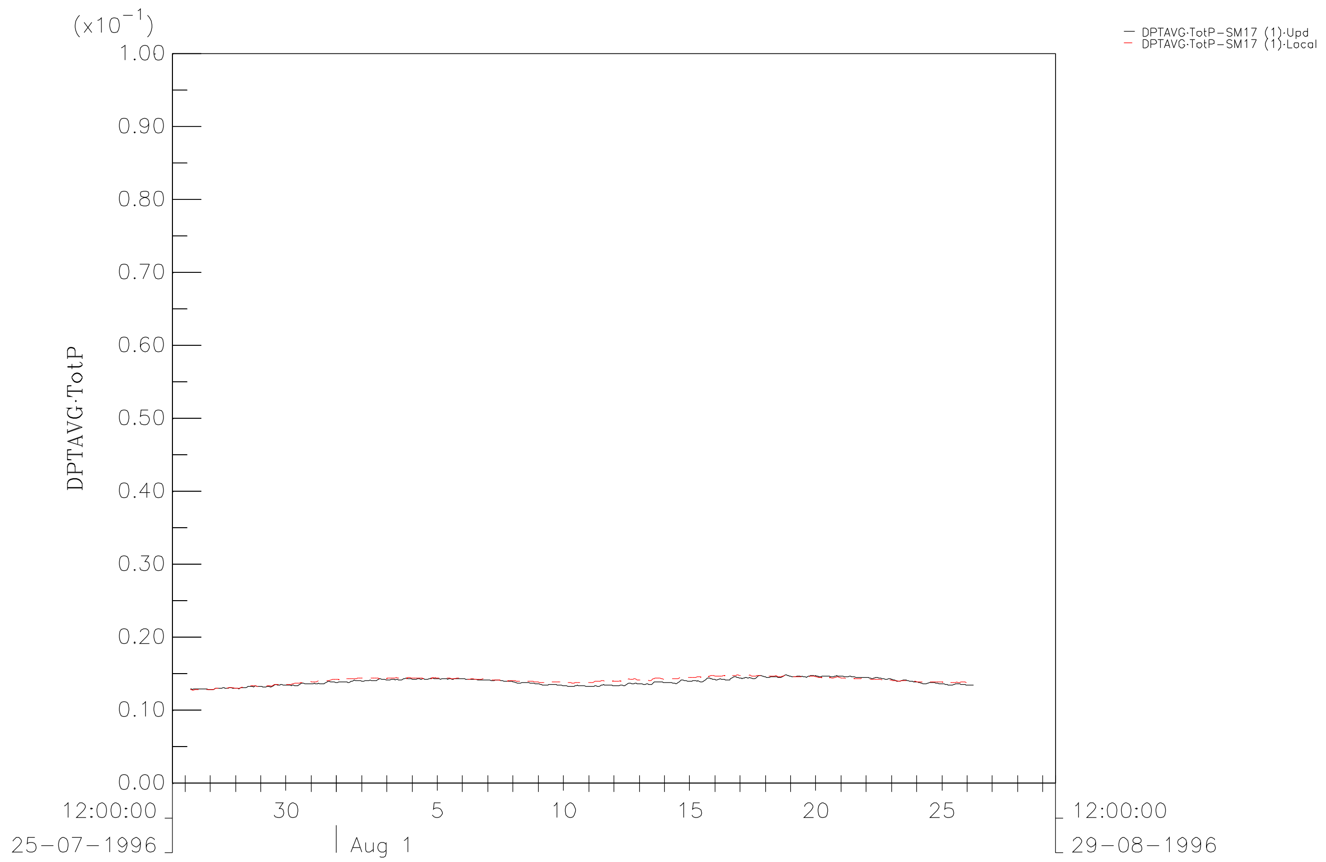


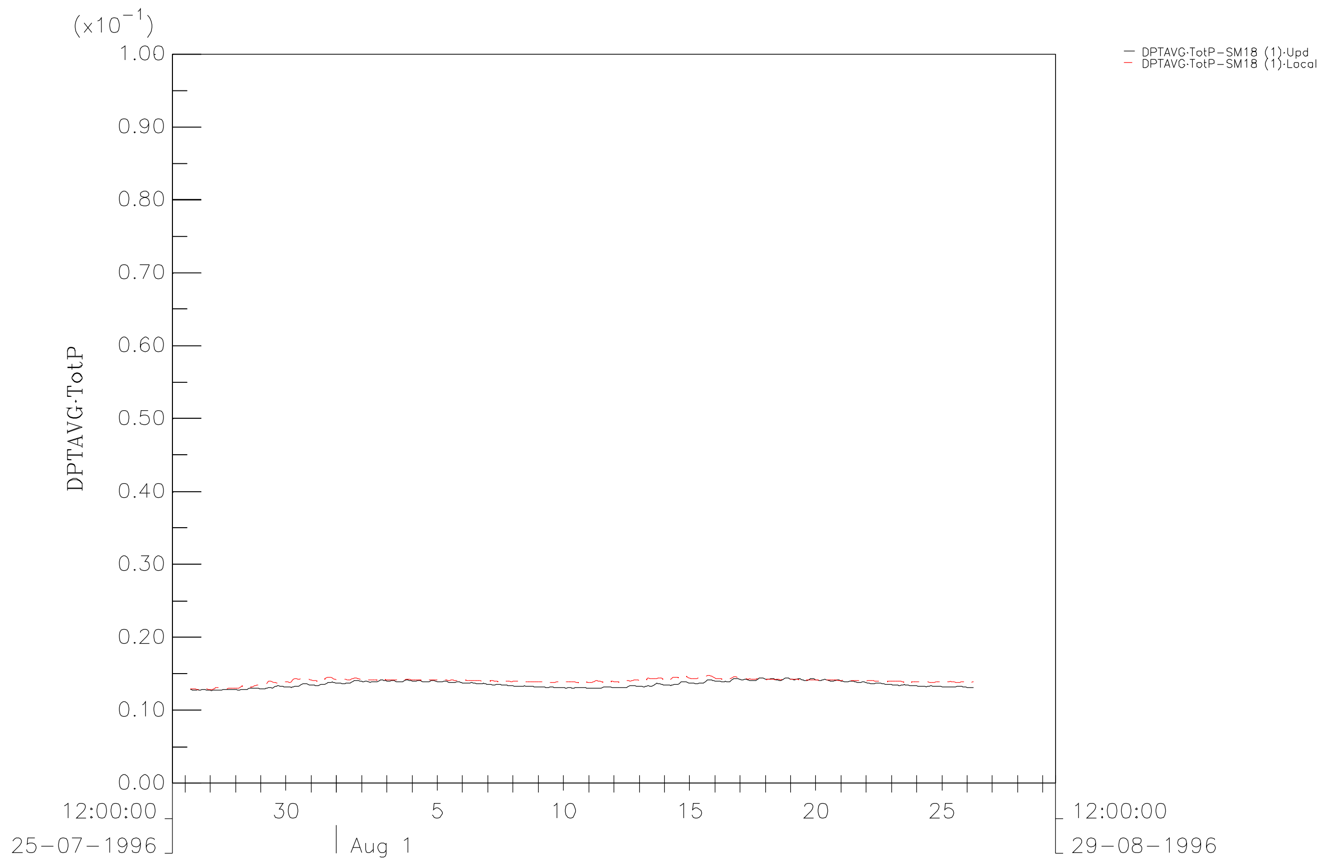
TotP comparison between Update Model and
Local Refine Model at SM6 (upper) and SM7 (lower).
Baseline condition

Dry Season

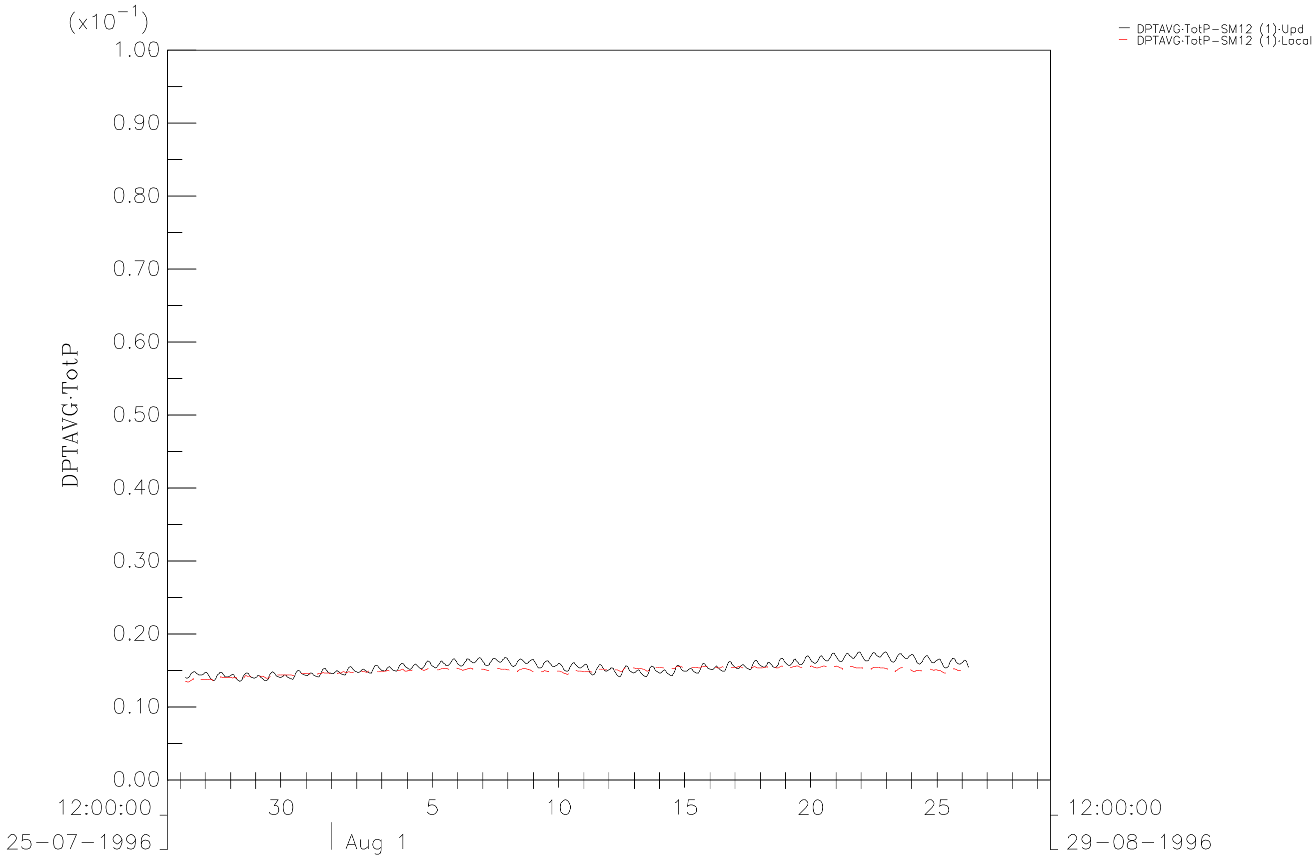
Figure 5A-119

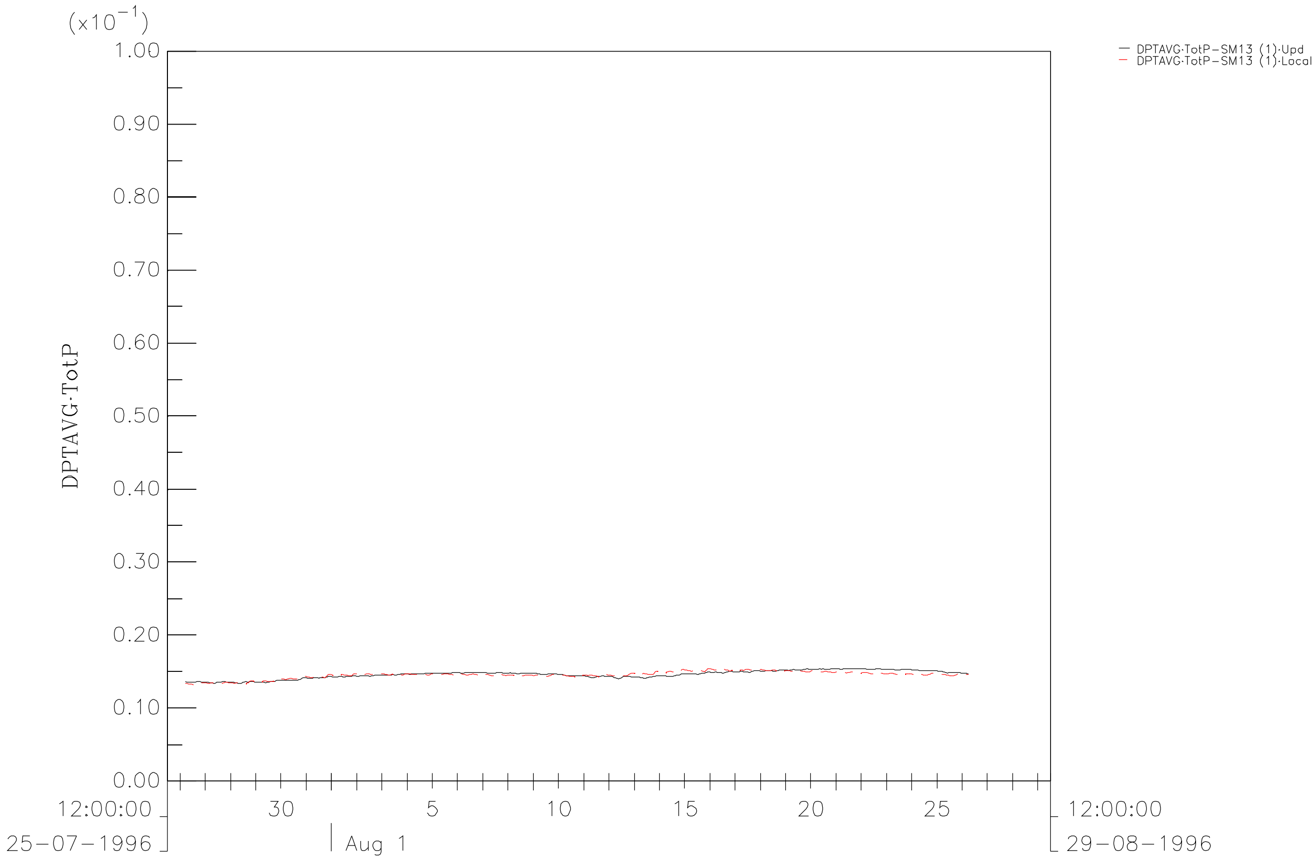
DSD & ATKINS





TotP comparison between Update Model and Local Refine Model at SM17 (upper) and SM18 (lower). Baseline condition	Dry Season	
	Figure 5A-120	
DSD & ATKINS		



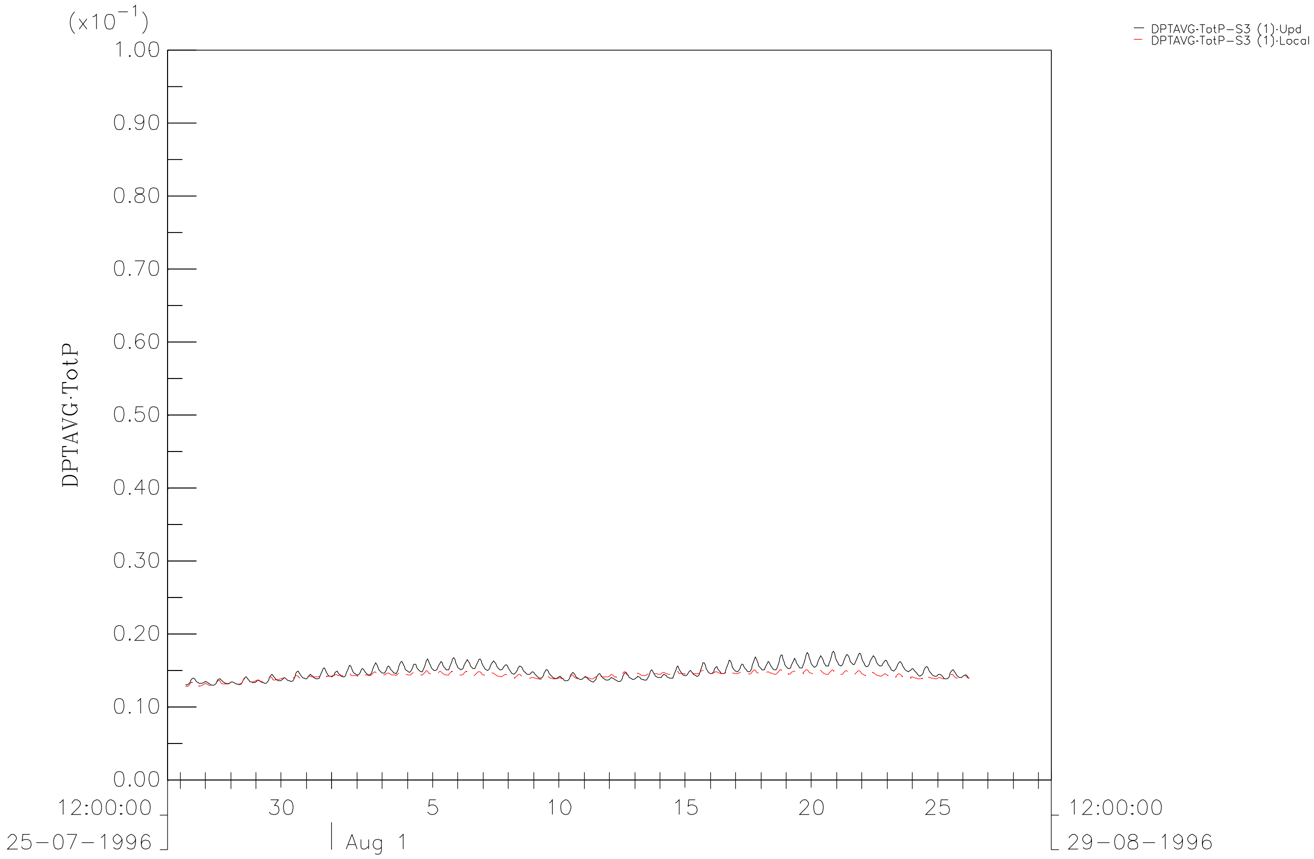


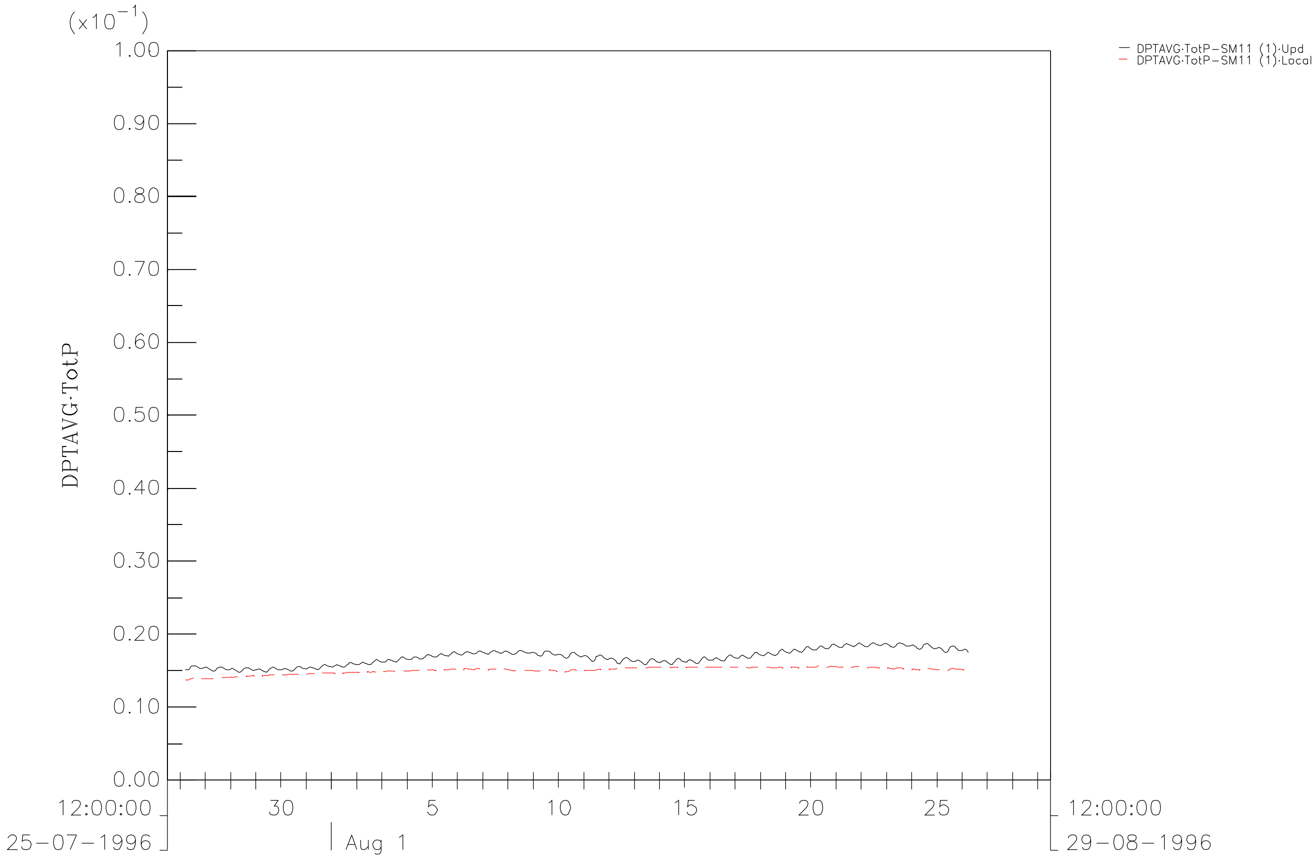
TotP comparison between Update Model and
Local Refine Model at SM12 (upper) and SM13 (lower).
Baseline condition

Dry Season

Figure 5A-121

DSD & ATKINS



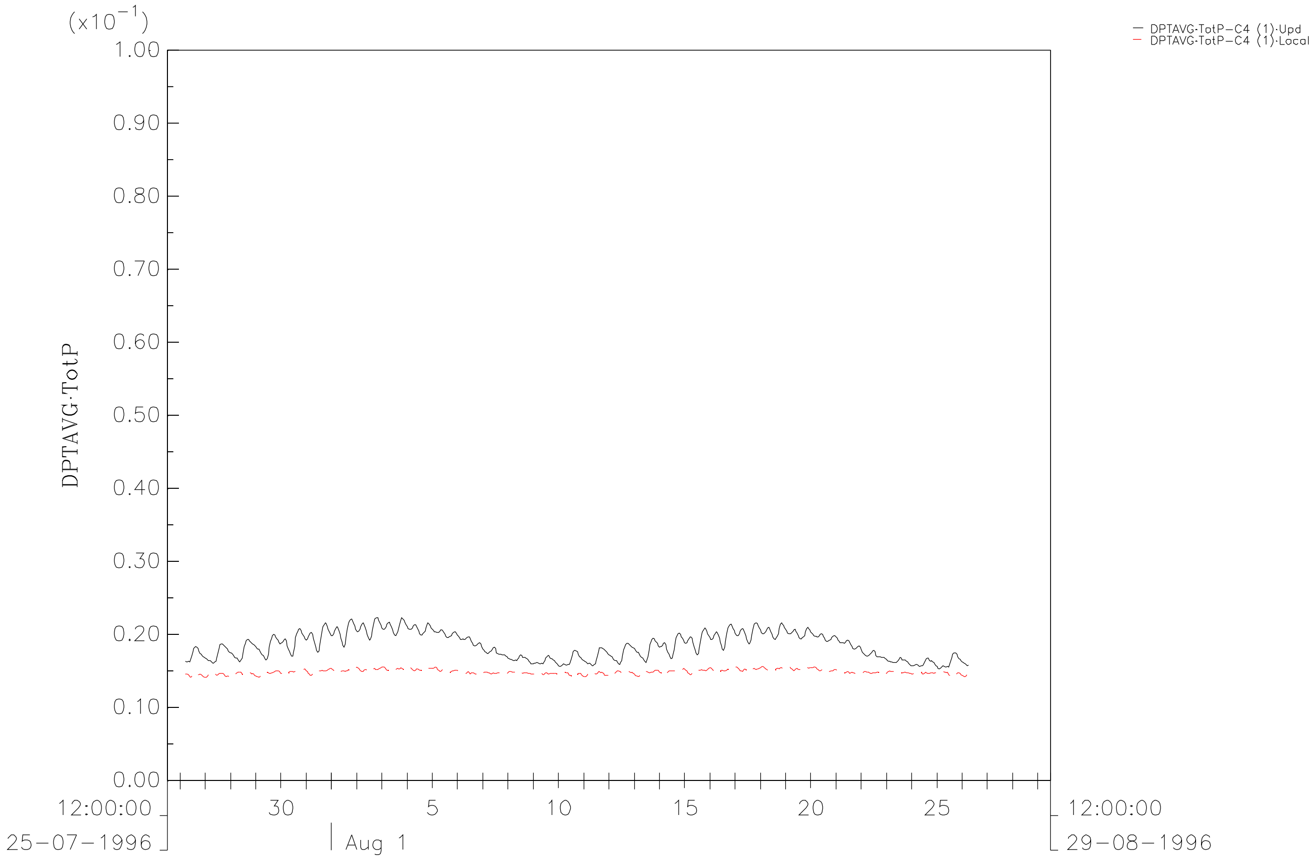


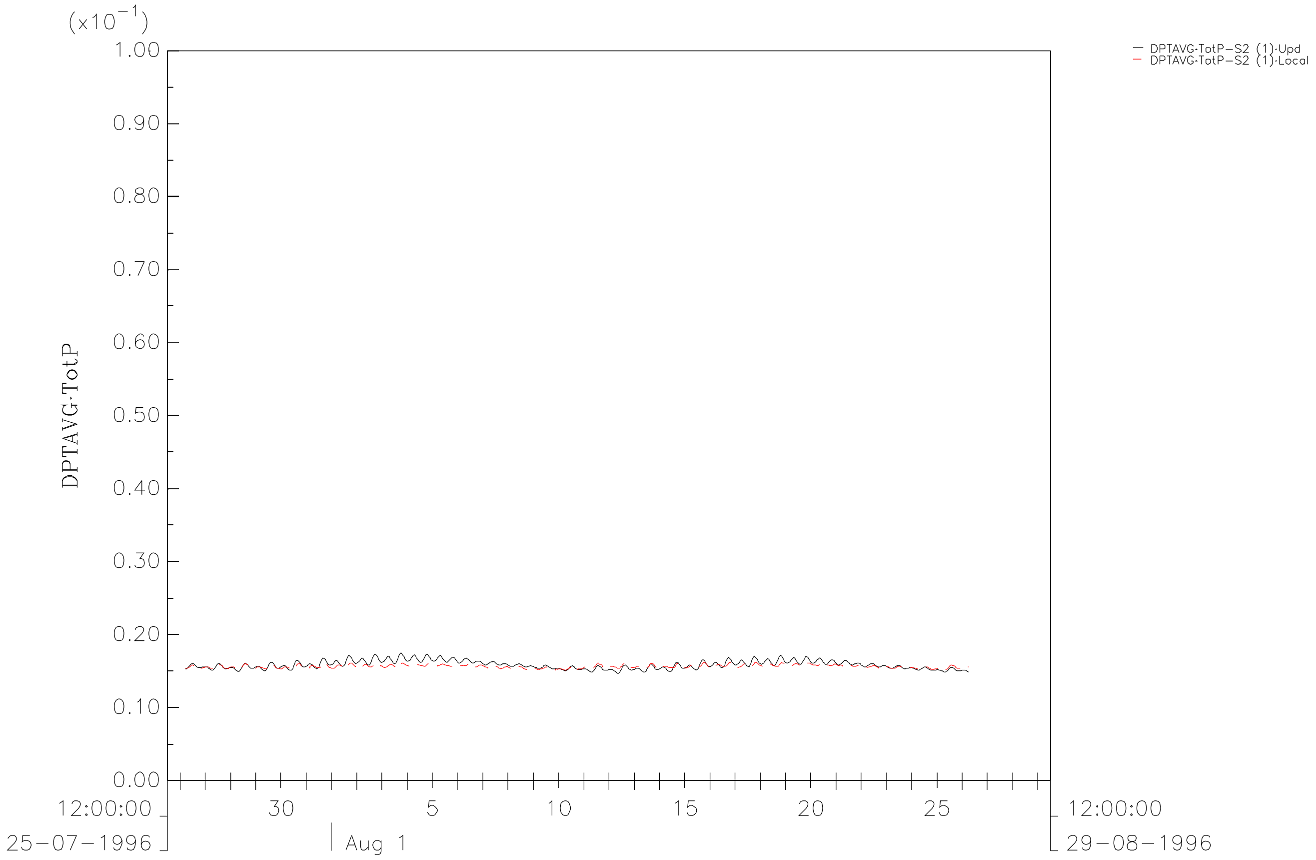
TotP comparison between Update Model and
Local Refine Model at S3 (upper) and SM11 (lower).
Baseline condition

Dry Season

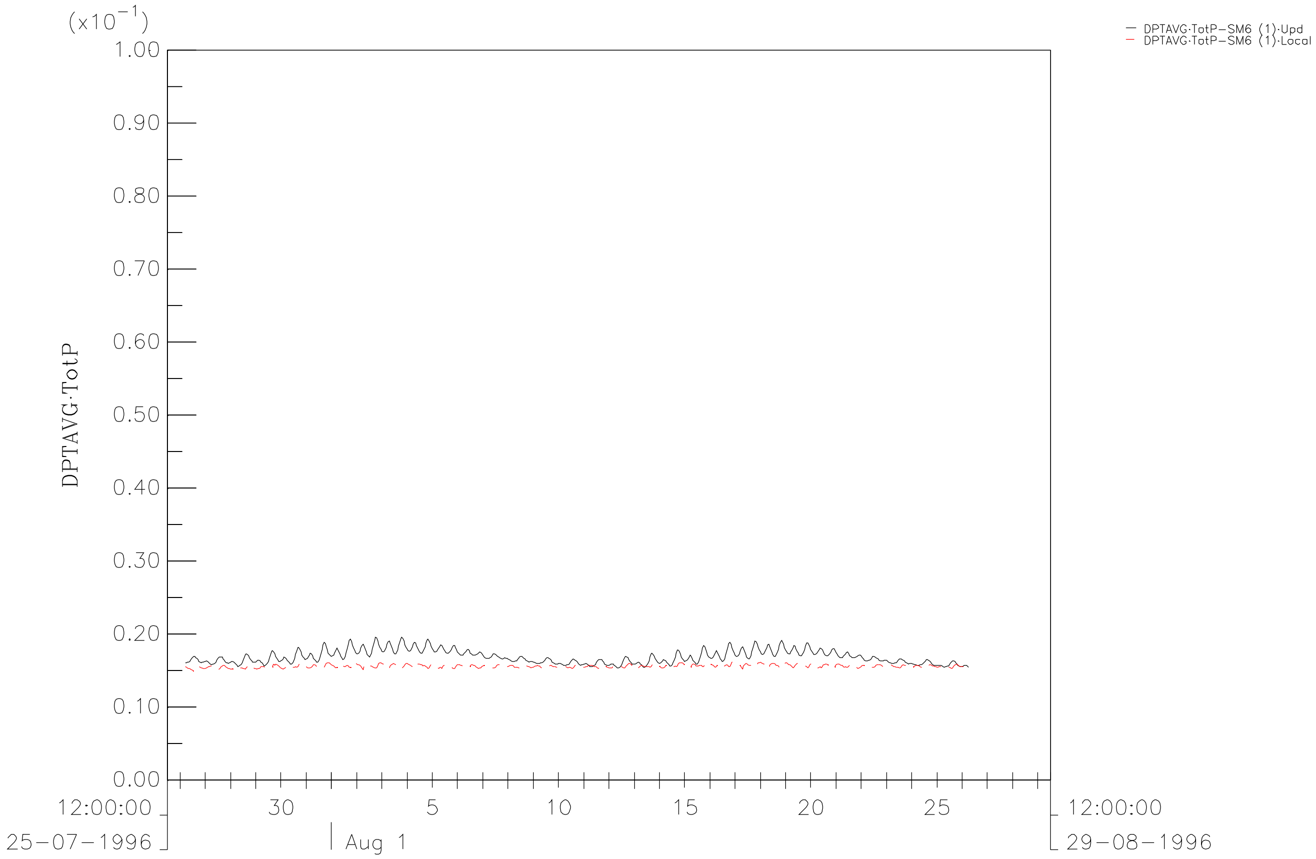
Figure 5A-122

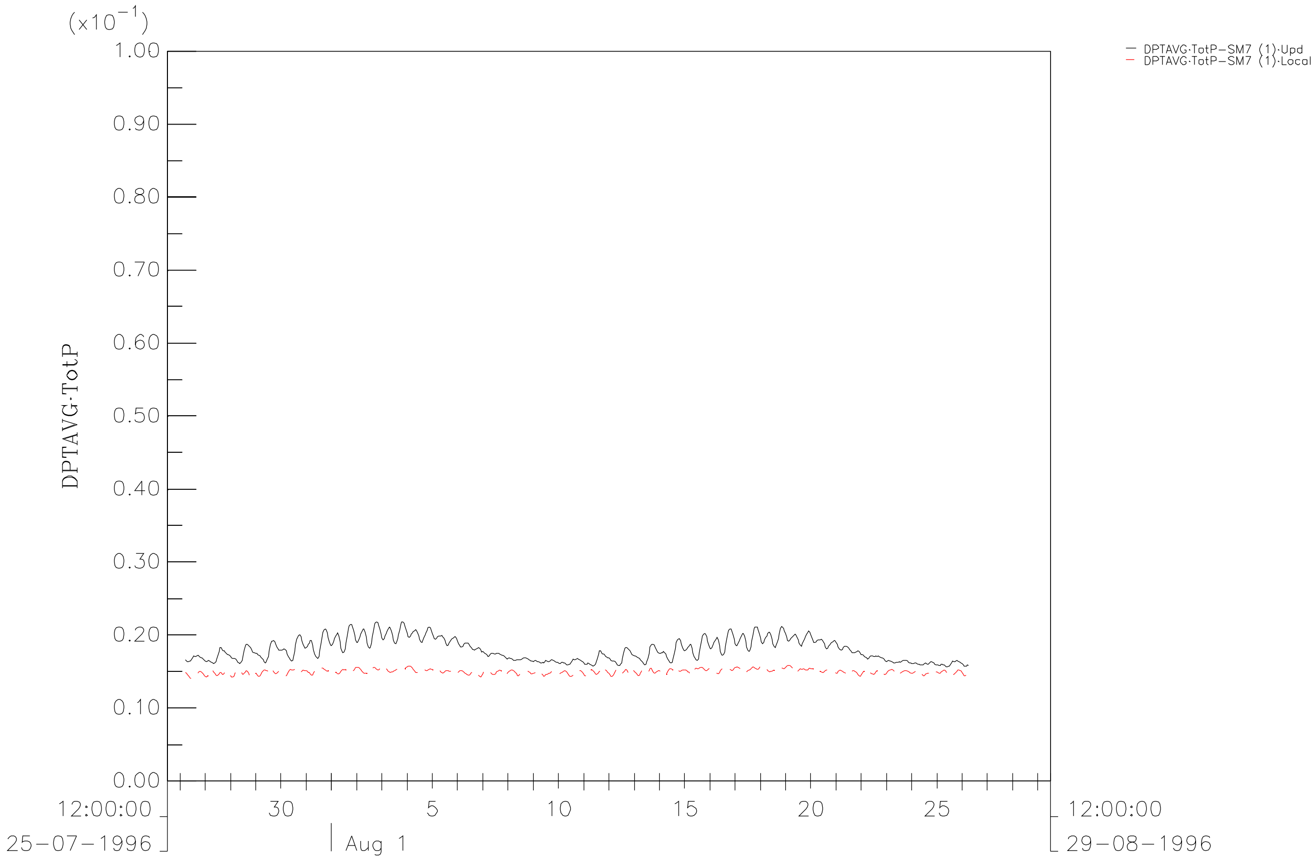
DSD & ATKINS



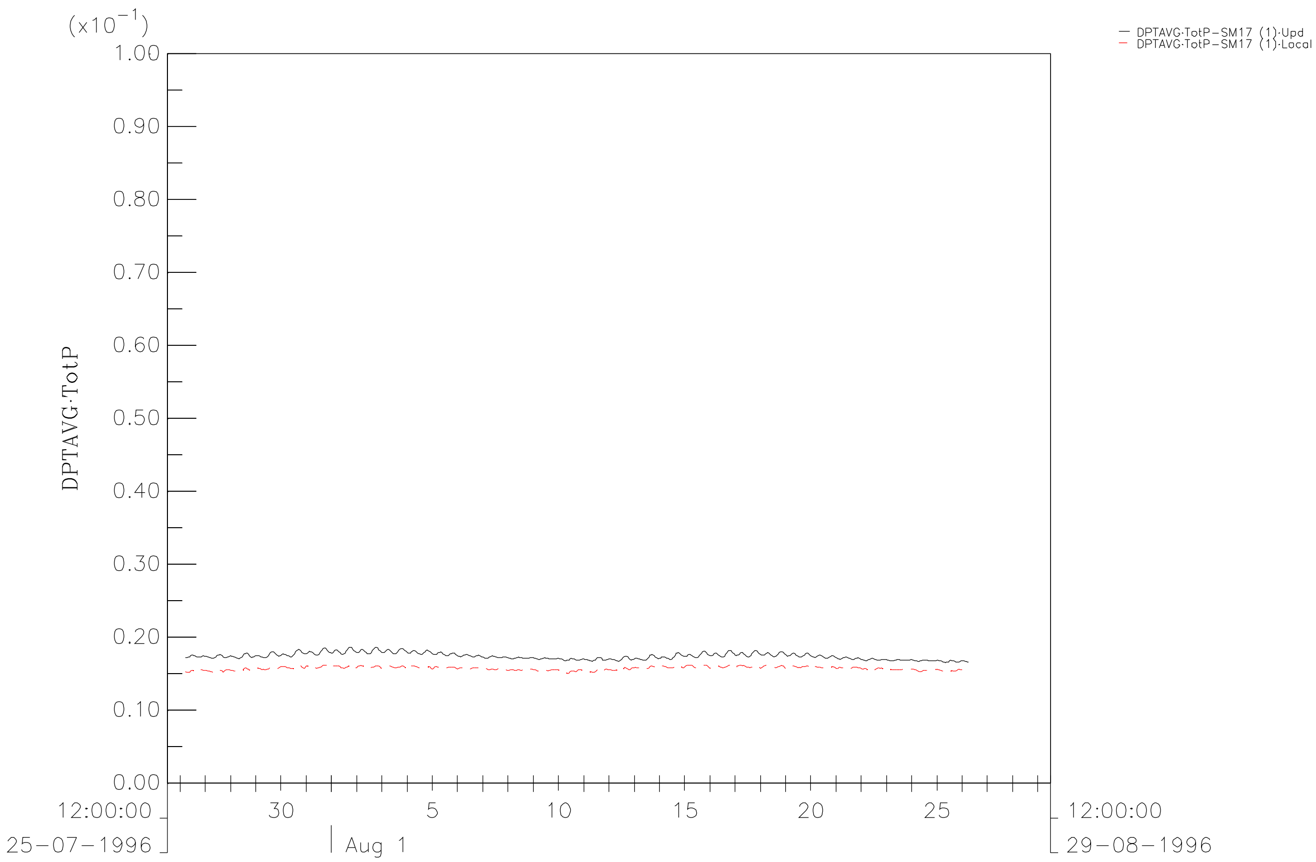


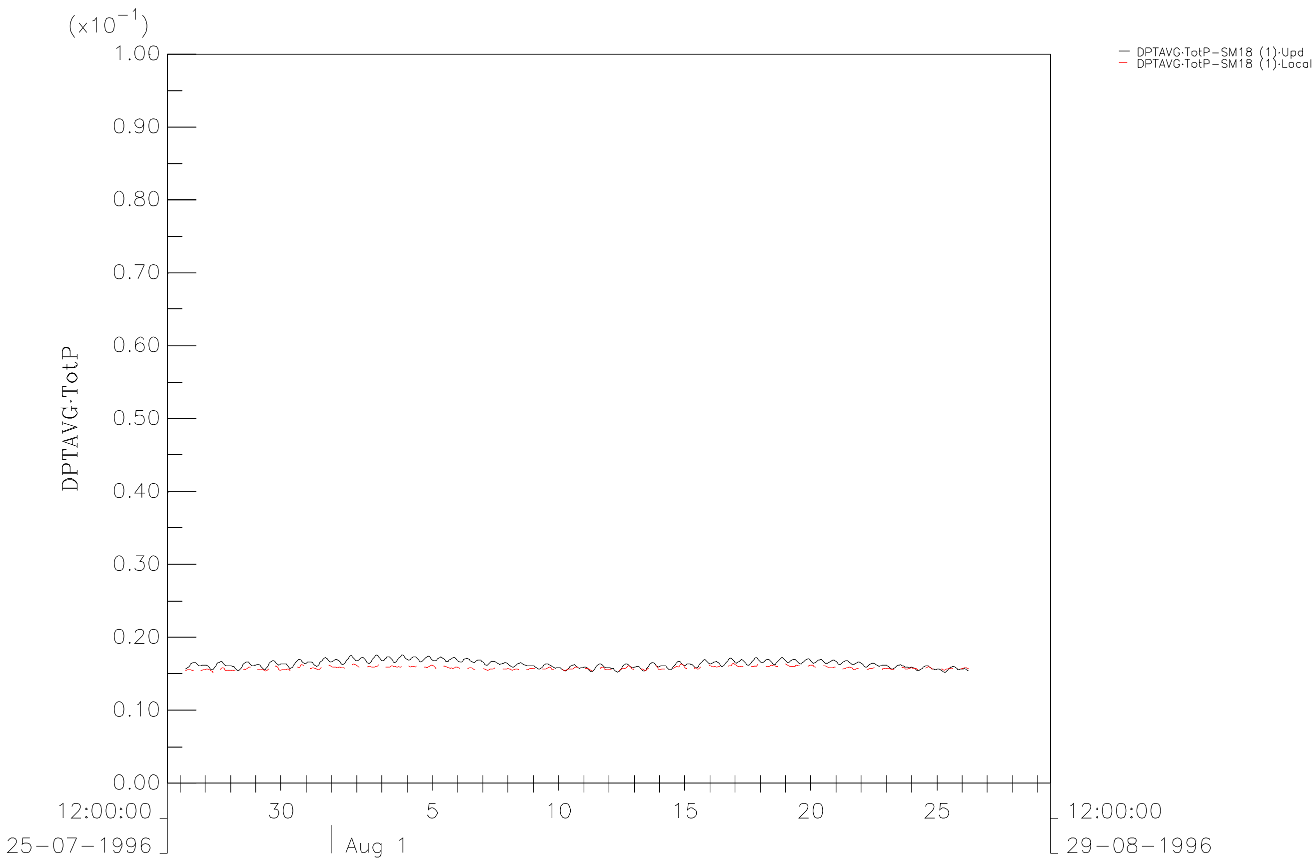
TotP comparison between Update Model and Local Refine Model at C4 (upper) and S2 (lower). Baseline condition	Wet Season
	Figure 5A-123
DSD & ATKINS	





TotP comparison between Update Model and Local Refine Model at SM6 (upper) and SM7 (lower). Baseline condition	Wet Season
	Figure 5A-124
DSD & ATKINS	



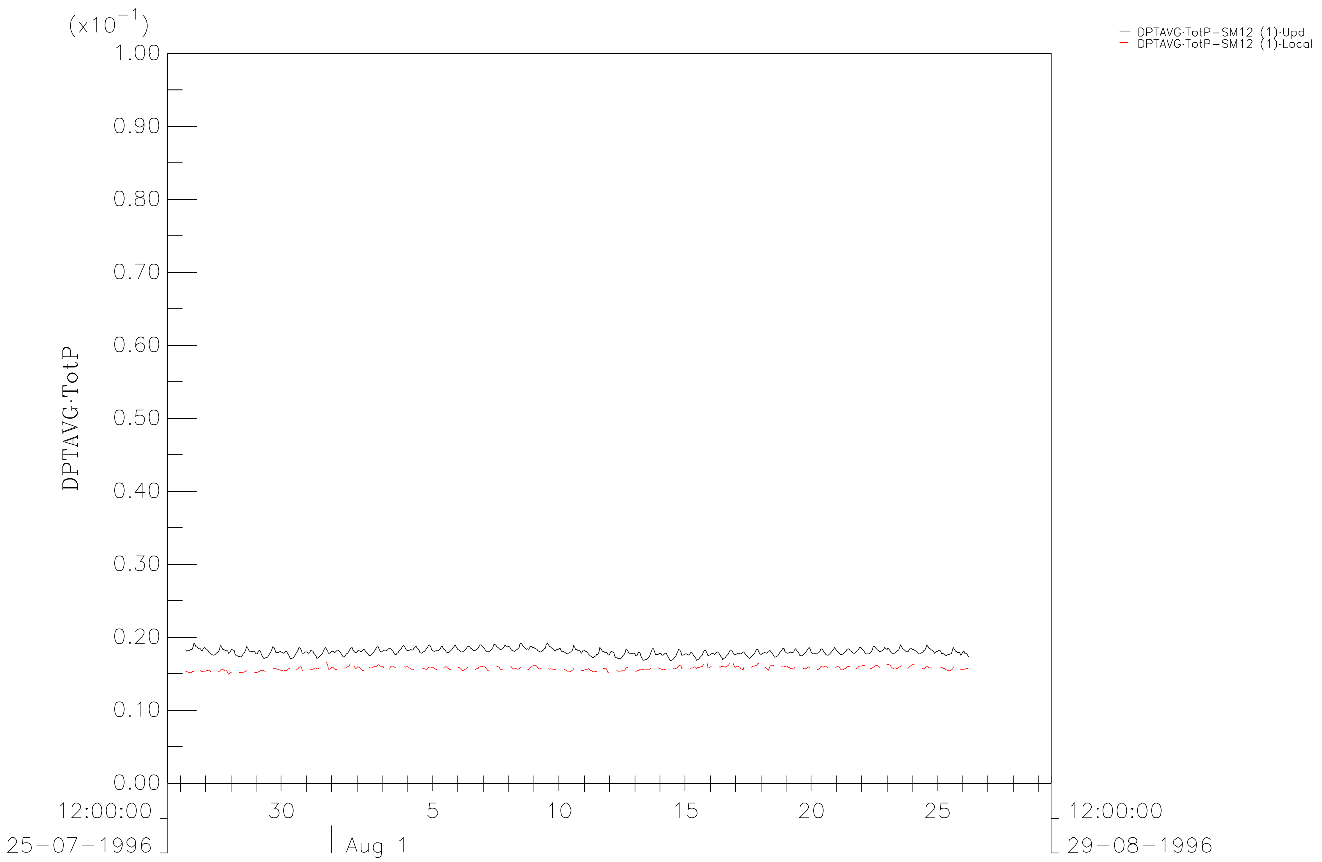


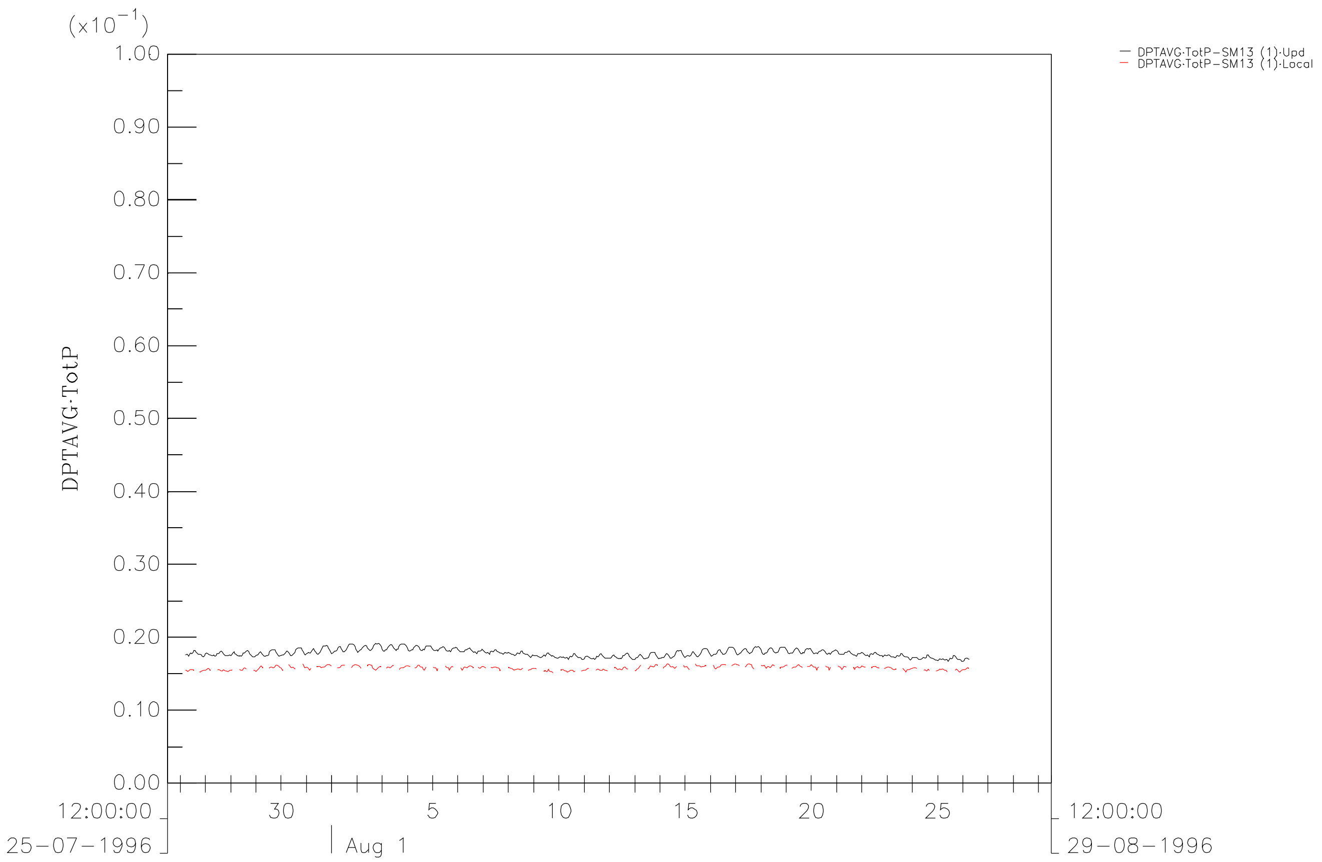
TotP comparison between Update Model and
Local Refine Model at SM17 (upper) and SM18 (lower).
Baseline condition

Wet Season

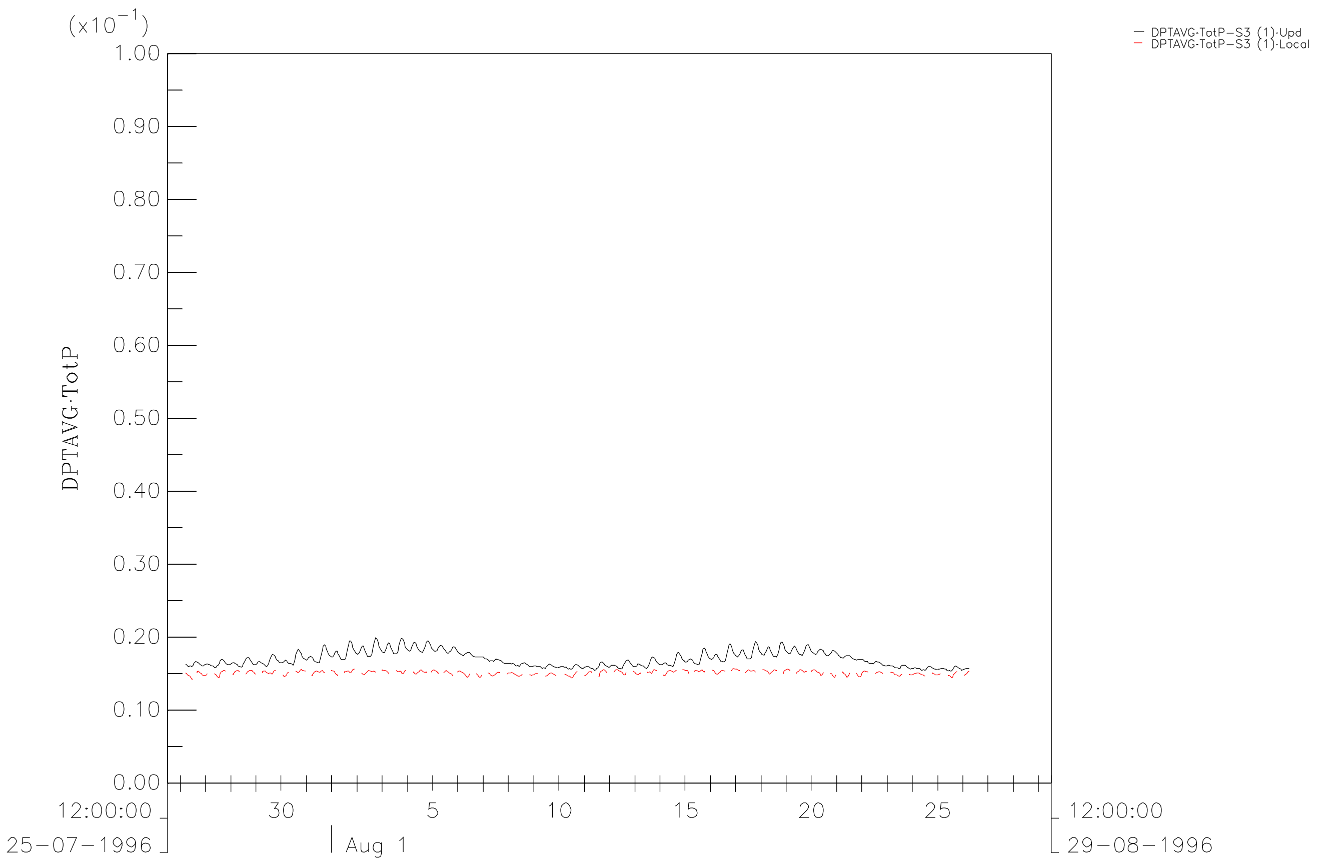
Figure 5A-125

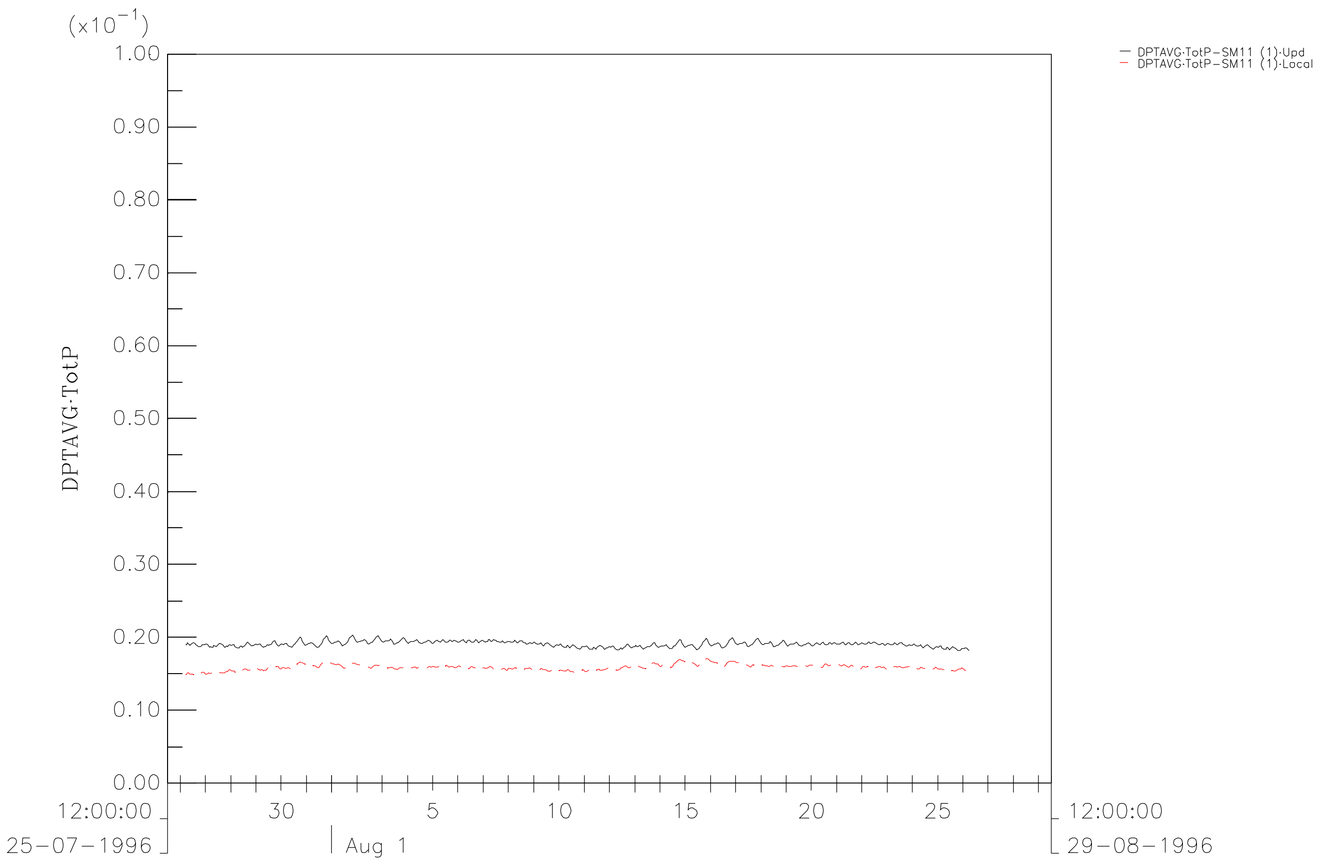
DSD & ATKINS





TotP comparison between Update Model and Local Refine Model at SM12 (upper) and SM13 (lower). Baseline condition	Wet Season
	Figure 5A-126
DSD & ATKINS	





TotP comparison between Update Model and Local Refine Model at S3 (upper) and SM11 (lower). Baseline condition	Wet Season	
	Figure 5A-127	
DSD & ATKINS		