Using short scale content of OGDR data improve the Near Real Time products of SSALTO DUACS

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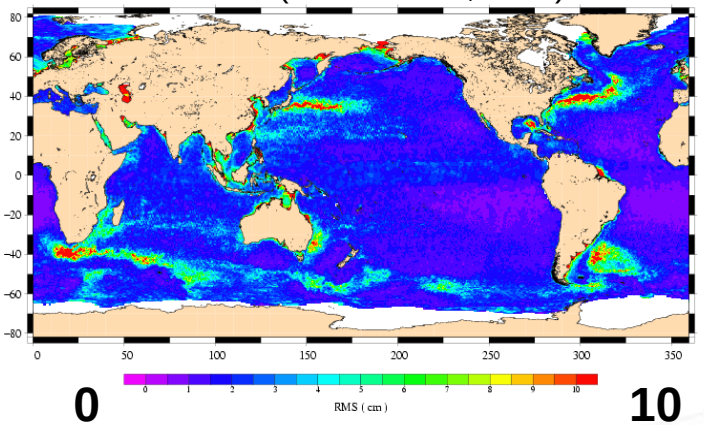
Motivation for using OGDR data

- Starting point : some DUACS processes become sub-optimal when used in Near Real Time (e.g.: OI)
- Processing time window not centered → performance loss vs offline equivalent product
- « NRT mapping error » quantified by [Pascual et al, 2008]
- In a nutshell : maps with 4 satellites in NRT feature the same performance (e.g.: comparison to in-situ) as maps with 2 satellites in traditional offline processing
- Consequent question : how does input data timeliness affect the performance of NRT maps ?

RMS of the differences between NRT and DT SLA (Pascual & al, 2008)



0 cm **10 cm**

	Delayed Time		Real Time	
	2 missions	*4 missions*	*2 missions*	*4 missions*
U	26.6	24.2	31.0	26.9
V	33.1	28.1	41.2	33.4

Differences between buoy currents (right) or tide gauges height (top) and altimetry maps. Unit : % of in-situ variance.

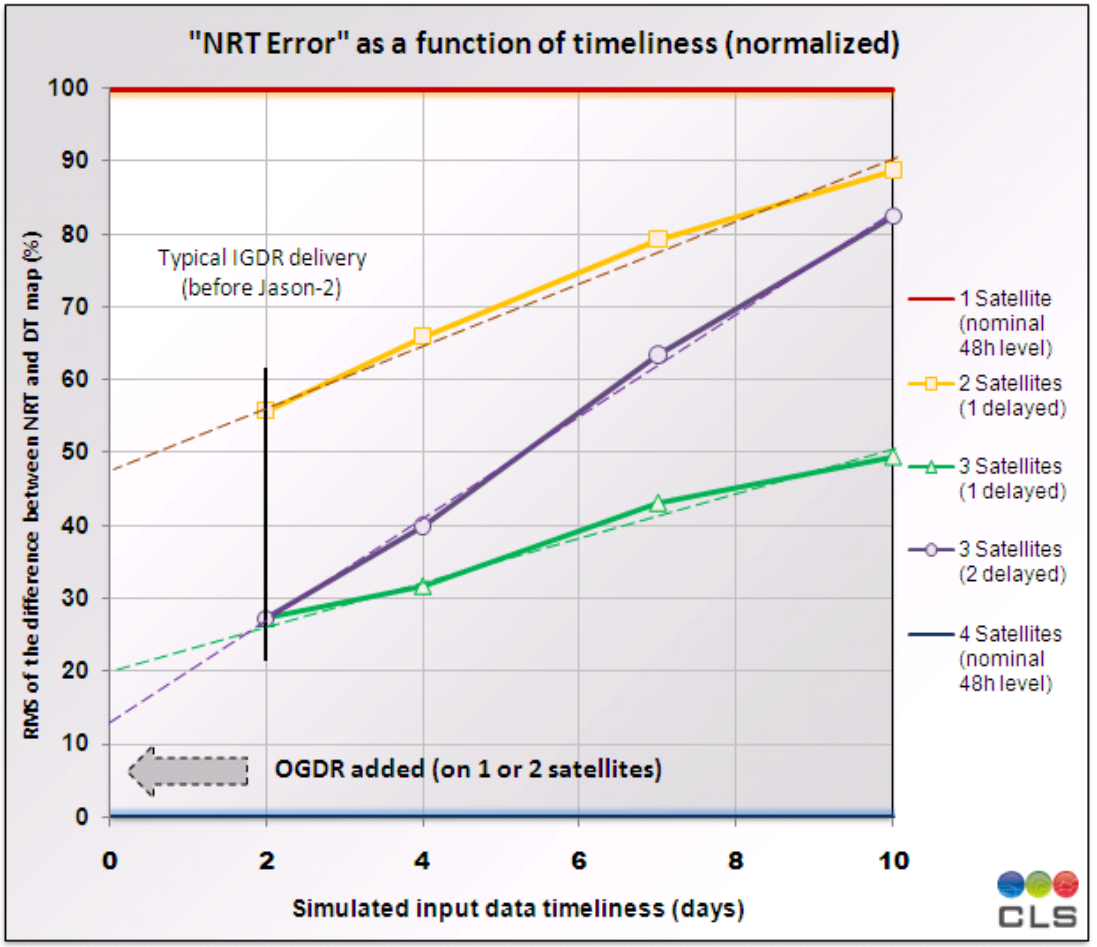
	2 missions	*4 missions*
Dealyed time Old corrections *(GOT99+IB)*	46.7	35.3
Delayed time new corrections *(GOT00+MOG2D*	36.7	29.7
Real time Orbit error No-centri	45.2	37.1

Motivation for using OGDR data

- « NRT Error » = extra error due to lack of time centering of the Optimal Interpolation

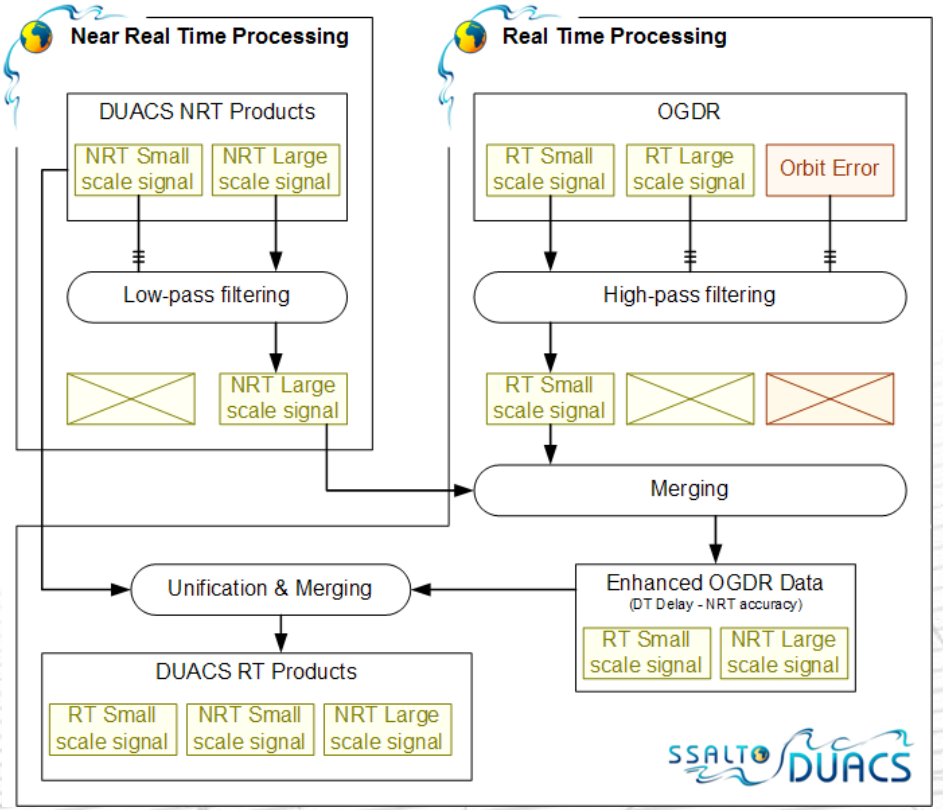
- Analysis showed that this error increased linearly with the amount of missing data (e.g. : IGDR delayed)
  - Simulation scheme : same GDR-based input, simulated timeliness before mapping
  - Same linear trend in all areas (base variance different)
  - Can be normalized by the « best » and « worst » case : 1 satellite and 4 satellites with IGDR timeliness (48h)

- Basic numbers
  - IGDR timeliness of 48h → wasted « NRT Error » (up to 6 points per satellite)
  - Using OGDR can reduce the mapping error (if the error budget can be controlled)
    → up to 40% reduction expected for the current 3 satellite constellation



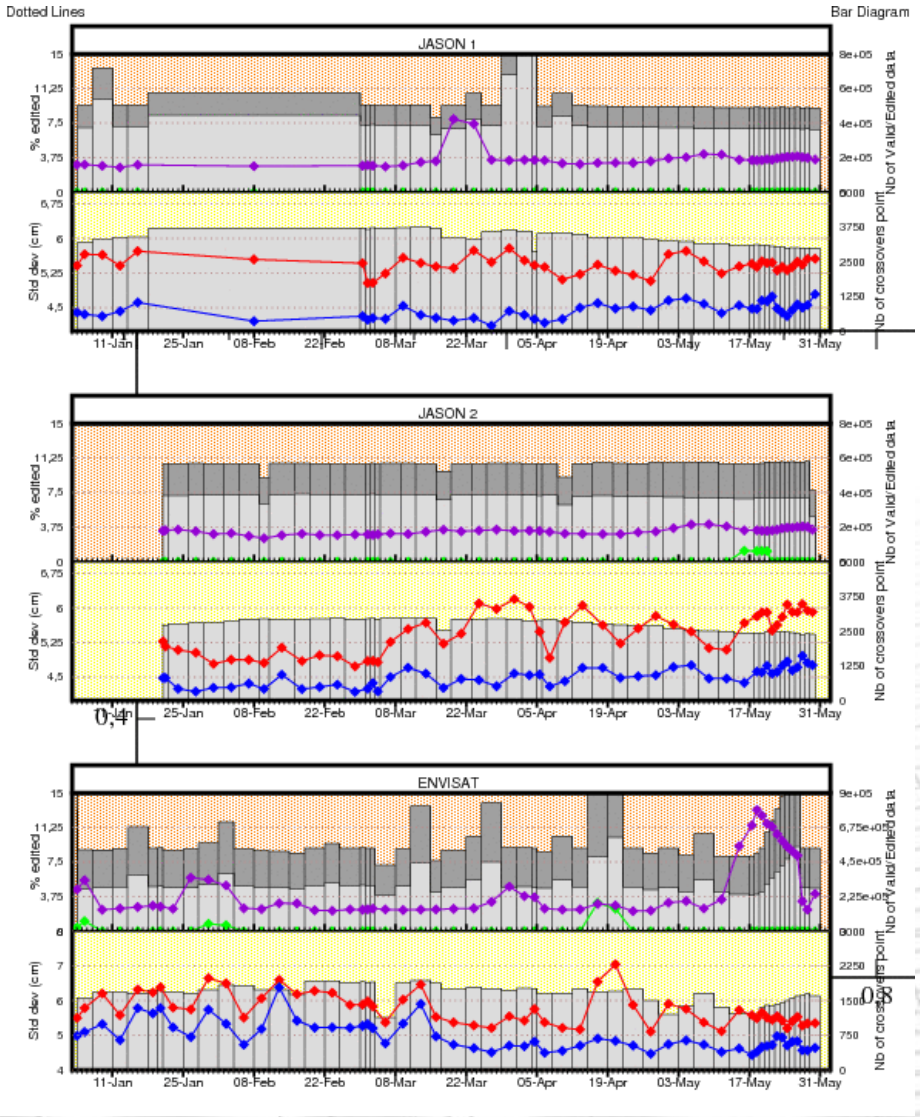
Processing overview

- OGDRs were not used in DUACS until 2007 : fast delivery error budget = deal-breaker
- The main error of OGDR is associated to orbit determination → very large scale error
- Rationale :
  - Assumption : large scale content is relatively stationary over 48h (and captured by IGDR maps)
  - Use small scale content from OGDR as an innovation to the latest multi-satellite IGDR map
  - Whenever a new IGDR flow arrives, the OGDR equivalent is removed
  - Update external corrections whenever relevant and possible (JA1 wet tropo, envisat orbit…)
  - Specific OGDR tuning of DUACS processing steps
- Two DUACS productions run every day
  - Nominal (operational): IGDR only
  - Experimental (best effort) : IGDR+ 2d of OGDR
  - Same analysis date (Production day – 6)
  - 1.5 year of daily IGDR+OGDR maps are now available



Input OGDR monitoring and QC

- With every OGDR flow :
  - Automated anomaly detection and operator warning (only on a limited amount of data fields affecting DUACS)
  - Monitoring of recent OGDR flows as a time series
- Twice a week or more : QC overview (coverage, editing, crossovers, along-track SLA…)
- Cyclic analysis : « light » Cal/Val
- User-friendly graphs soon available on AVISO website (plus CalVal-like metrics on ftp)



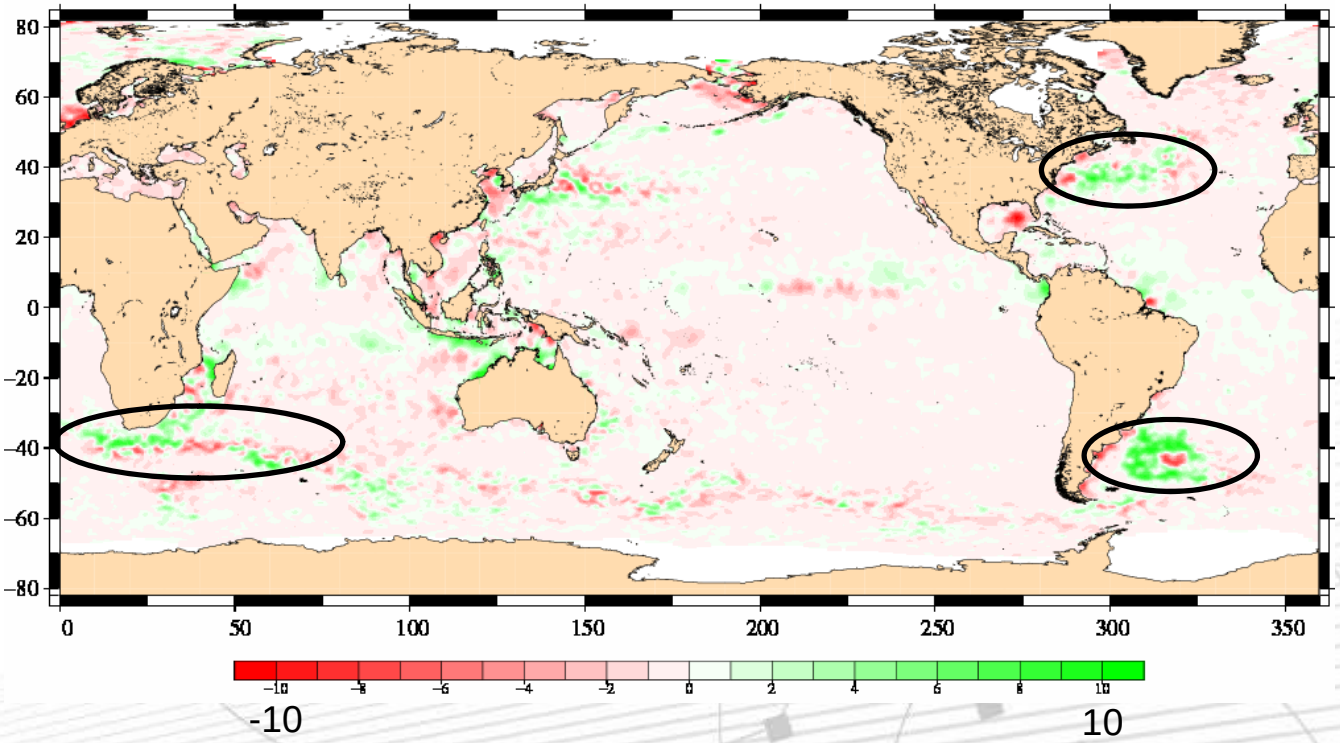
Impact on actual operational products

- Recent analysis of one year of IGDR+OGDR maps (comparison to classical NRT maps or offline data)

- Up to 150 additional ground tracks available for OI every day

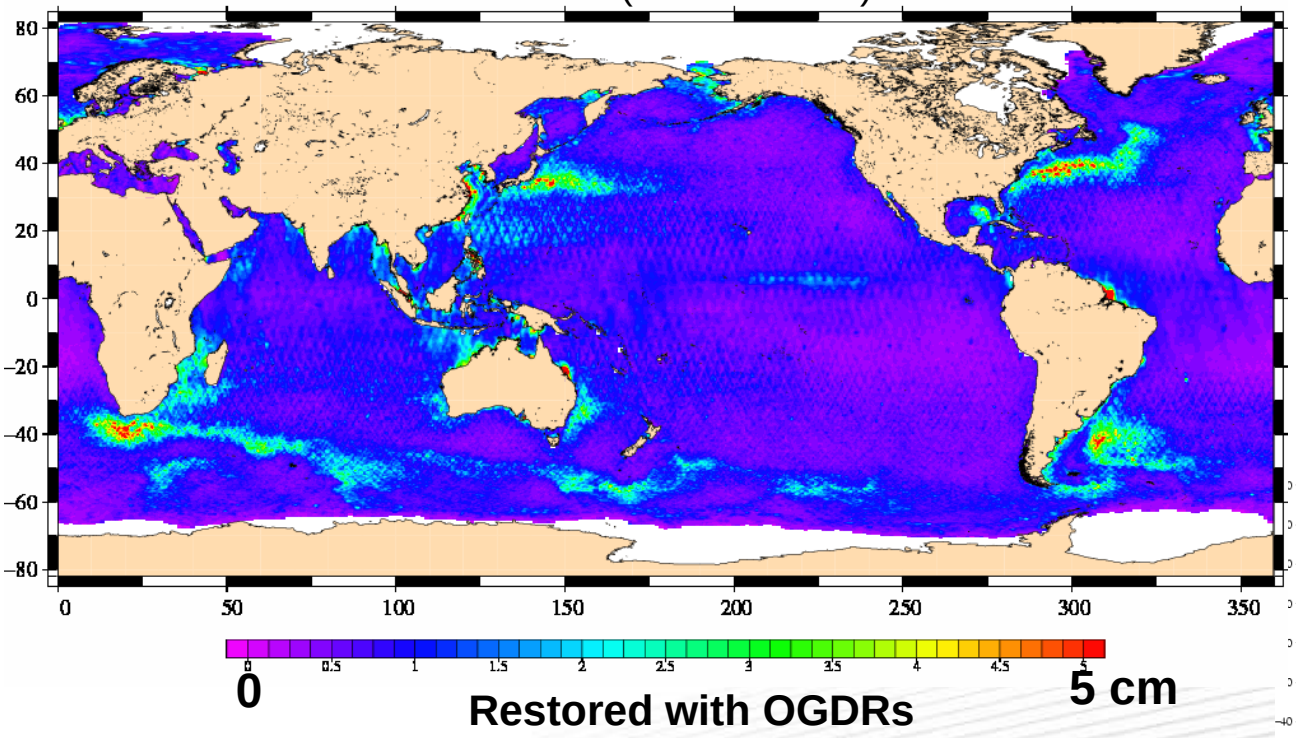
- OGDR/FDGDR data allow to observe a significant part of the variability lost by the non-centered time window in NRT

MSLA variance added when OGDR product are combined with IGDR data in NRT processing
(observed on actual operationnal data from July 2007 to July 2008)



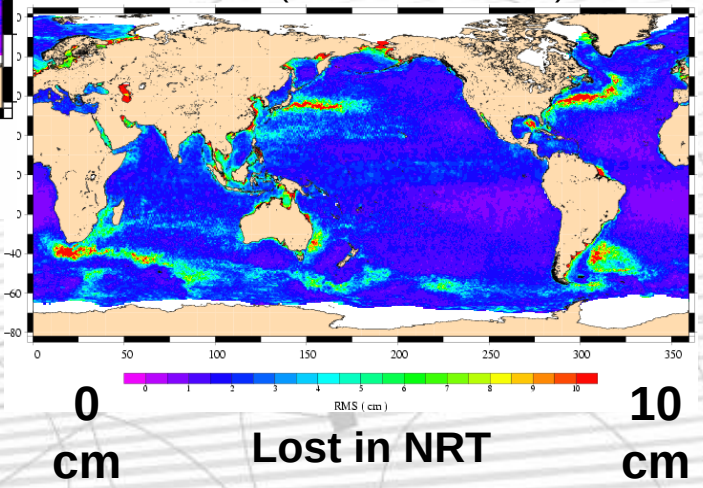
Impact on actual operational products

RMS of the differences between traditional NRT SLA (IGDR only) and combined NRT+RT SLA (IGDR+OGDR) for 2 satellites



- Variability "lost" in NRT is partially restored with OGDRs
- OGDR data have a significant impact on areas with important spatial & temporal variability

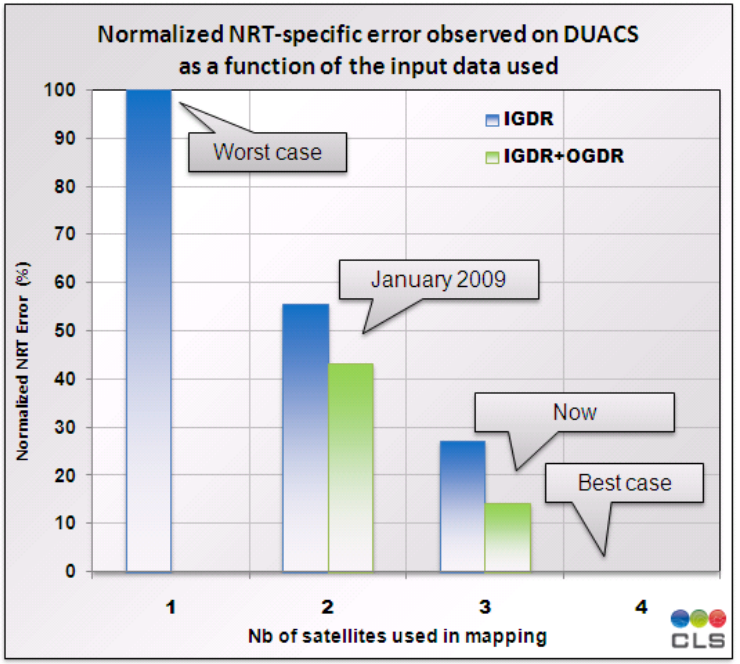
RMS of the differences between NRT and DT SLA (Pascual & al, 2008)



- RMS of the differences between classical IGDR-based and experimental IGDR+OGDR-based products is equal to ~40% of the difference between offline (DT) and NRT products

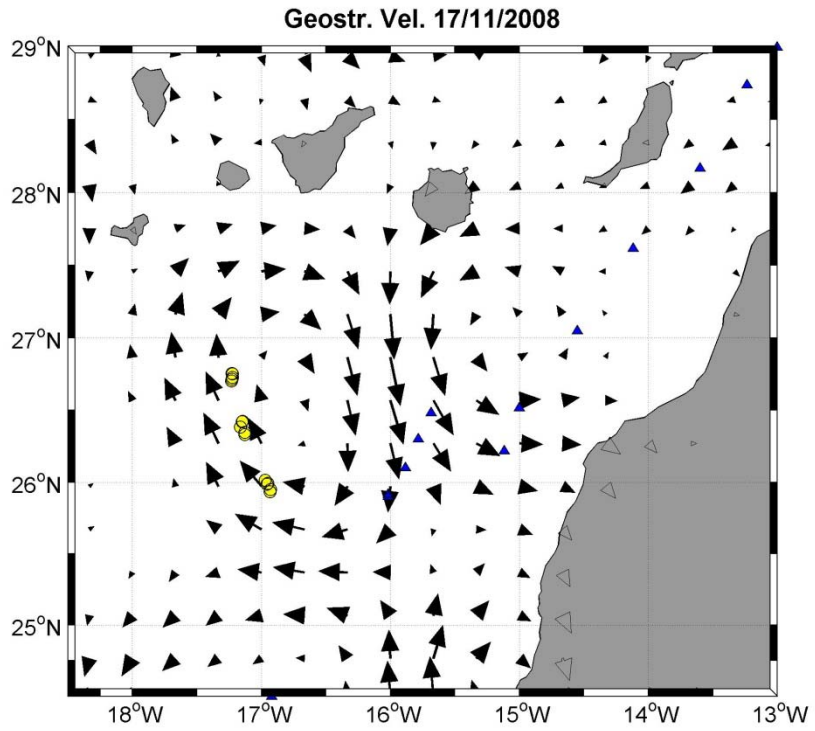
Summary and perspectives

- OGDR used in DUACS for a second daily production (tagged as experimental until MyOcean v1)
- The additional error on fast delivery SSH and corrections is minimized by using only short scale content as an innovation to IGDR NRT maps, and only until IGDRs arrive
- The improvement observed on actual data (consistency with offline maps) is consistent with predictions from simulations (OGDR error budget reasonably controlled)
- Bonus : the system is also more resilient to onboard / ground segment anomalies (nominal quality level restored faster)
- Perspectives for the future
  - On-the-fly processing of along-track SLA (edited, cross-calibrated, without large scale error) within 1 hour (upon reception of OGDR) → Perfect phasing between continuous DUACS production and daily applications
  - Improve the multi-satellite map timeliness (D-6 can be reduced to D-4 or D-2) → more recent synoptic view

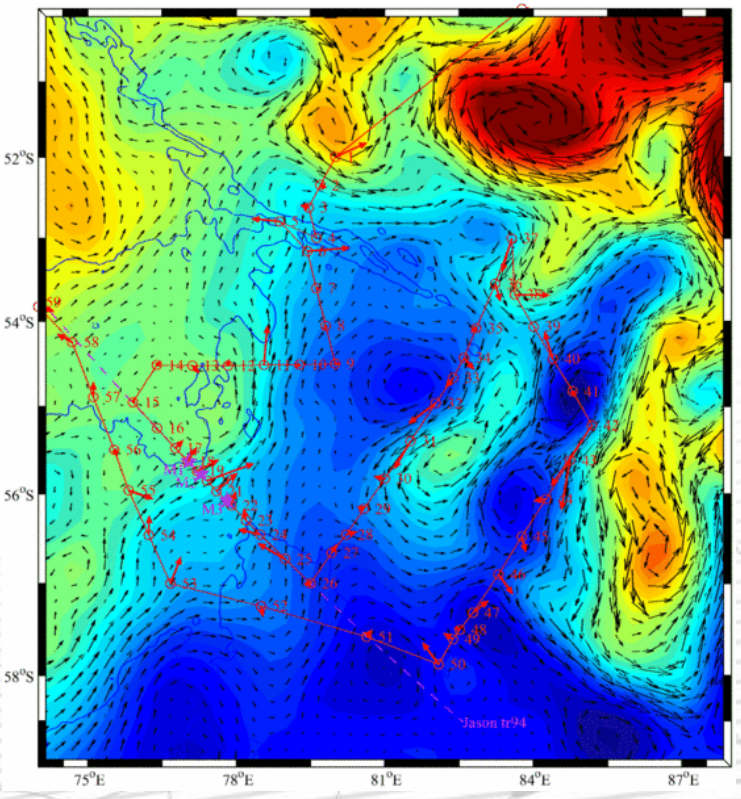


Backup material

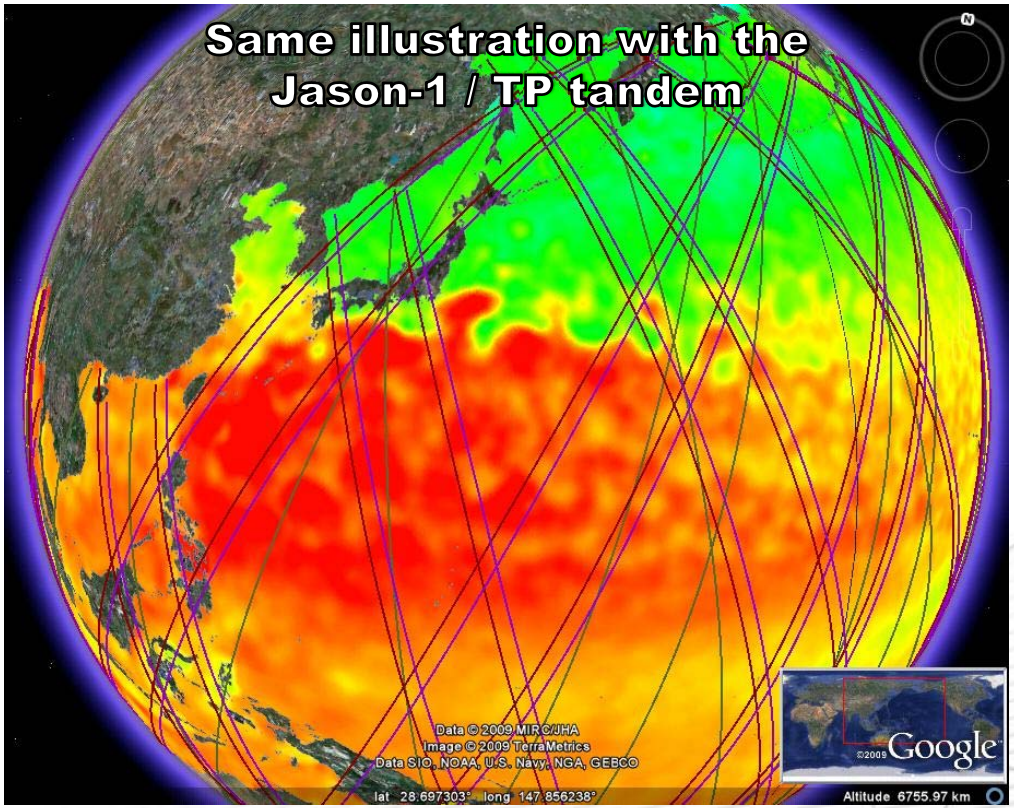
- Practical use cases of why we want to locally improve NRT maps : « the synoptic view of surface currents in real time is of great interest to confirm or refine the cruise plan and in particular to adjust float deployment position” (F.Vivier, LOCEAN - AVISO image of the month - April 2009)



Surface buoy trajectory (yellow dots) vs altimetry derived velocities - Courtesy of S.Ruiz, IMEDEA, from CANOA08 campaign (November 2008)



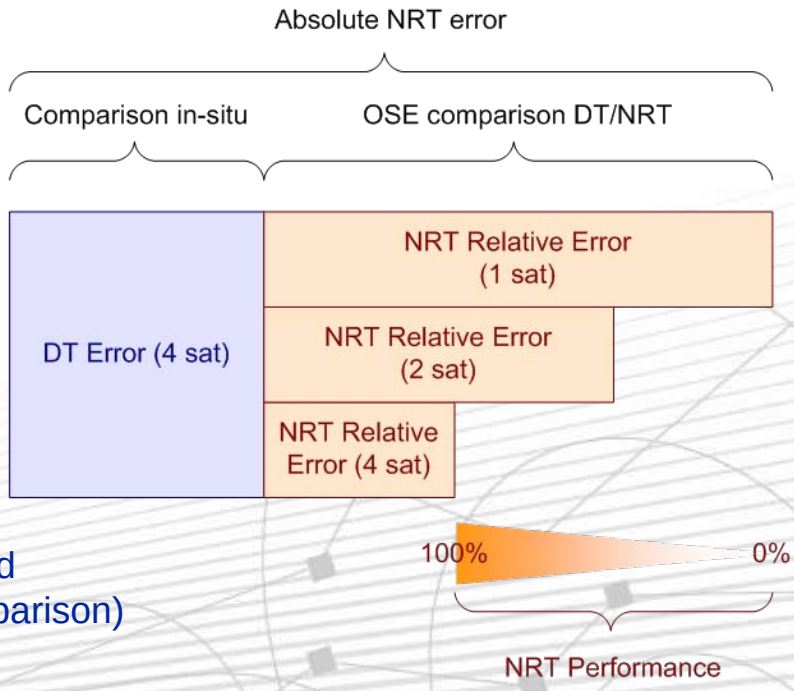
Near real time absolute dynamic topography and corresponding surface geostrophic currents during the TRACK cruise compared with L-*ADCP* measurements at the surface

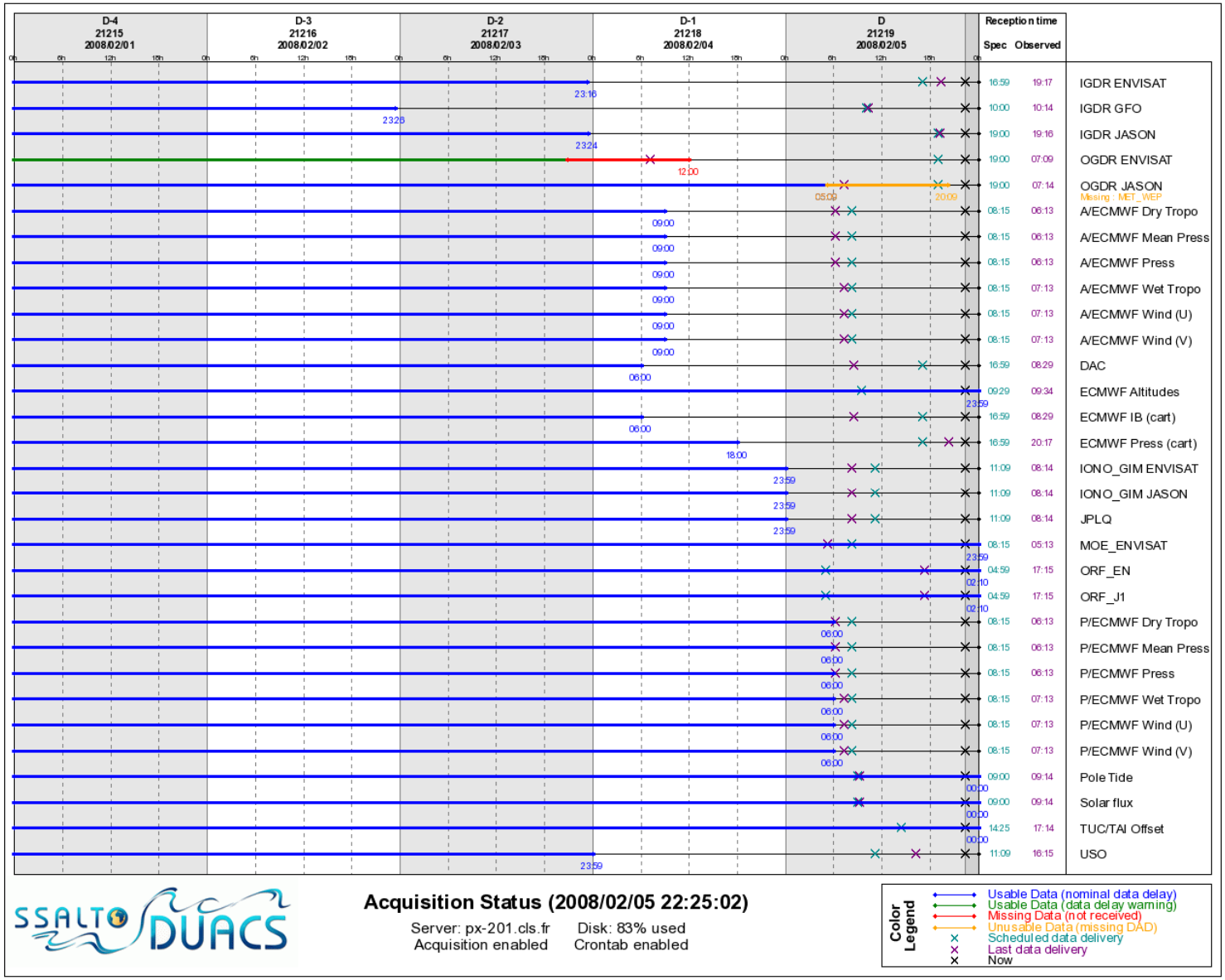

Same illustration with the
Jason-1 / TP tandem
Data © 2009 MIRC/JHA
Image © 2009 TerraMetrics
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
lat 28.697303° long 147.856238°
Altitude 6755.97 km
©2009 Google

- Other notable errors terms not mentioned
  - Jason-1 OSDR : different retracking, not radiometer wet tropo…
  - ENVISAT FDGDR : two orbits with jumps in L2 (exrapolated MOE used instead)
  - No analyzed data for ECMWF, GIM
  - No Dynamic Atmospheric Correction in OGDRs

- Normalisation process
  - Worst case is 1 satellite in NRT (less data = duacs is stopped entirely)
  - Best case is 4 satellite in NRT (2002-2005)

- The « NRT error » is only a fraction of the total error
  - Even a 4 satellite NRT map contains a lot of NRT error (Pascal et al : 4 sats NRT = 2 sats offline)
  - Even a 4 satellite offline map contains misses a lot of small scale and high-frequency features
  - The lower quality POD from MOE orbit class is neglected in this process (but observed on actual offline/NRT comparison)




D-4
21215
2008/02/01
D-3
21216
2008/02/02
D-2
21217
2008/02/03
D-1
21218
2008/02/04
D
21219
2008/02/05
Reception time
Spec Observed
IGDR ENVISAT 16:59 19:17
IGDR GFO 10:00 10:14
IGDR JASON 19:00 19:16
OGDR ENVISAT 19:00 07:09
OGDR JASON 19:00 07:14
Missing : MET_WEP
A/ECMWF Dry Tropo 08:15 06:13
A/ECMWF Mean Press 08:15 06:13
A/ECMWF Press 08:15 06:13
A/ECMWF Wet Tropo 08:15 07:13
A/ECMWF Wind (U) 08:15 07:13
A/ECMWF Wind (V) 08:15 07:13
DAC 16:59 08:29
ECMWF Altitudes 09:29 09:34
ECMWF IB (cart) 16:59 08:29
ECMWF Press (cart) 16:59 20:17
IONO_GIM ENVISAT 11:09 08:14
IONO_GIM JASON 11:09 08:14
JPLQ 11:09 08:14
MOE_ENVISAT 08:15 05:13
ORF_EN 04:59 17:15
ORF_J1 04:59 17:15
P/ECMWF Dry Tropo 08:15 06:13
P/ECMWF Mean Press 08:15 06:13
P/ECMWF Press 08:15 06:13
P/ECMWF Wet Tropo 08:15 07:13
P/ECMWF Wind (U) 08:15 07:13
P/ECMWF Wind (V) 08:15 07:13
Pole Tide 09:00 09:14
Solar flux 09:00 09:14
TUC/TAI Offset 14:25 17:14
USO 11:09 16:15
SSALTO DUACS
Acquisition Status (2008/02/05 22:25:02)
Server: px-201.cls.fr Disk: 83% used
Acquisition enabled Crontab enabled
Color Legend
Usable Data (nominal data delay)
Usable Data (data delay warning)
Missing Data (not received)
Unusable Data (missing DAD)
Scheduled data delivery
Last data delivery
Now