Uncertainty and bathymetric DEM

Developing an Open Source QGIS solution

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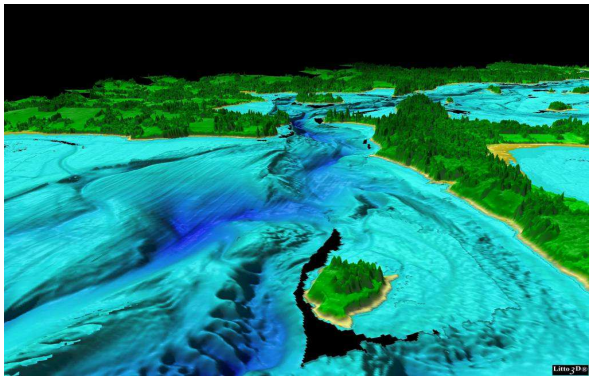
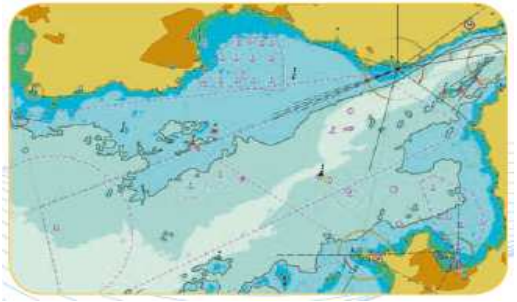
A758

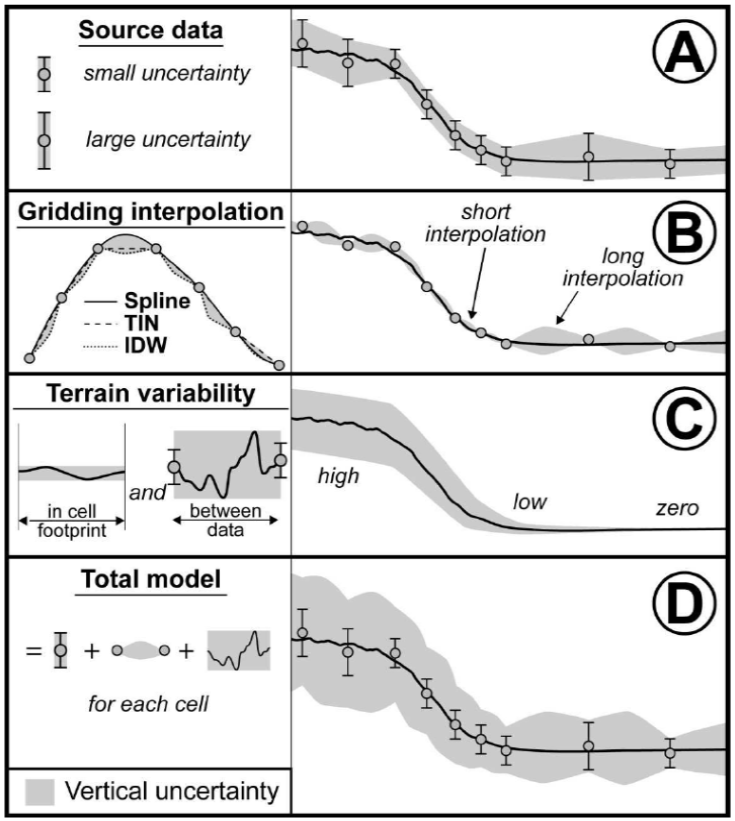



France métropolitaine
St-Pierre et Miquelon
OCÉAN PACIFIQUE NORD
OCÉAN ATLANTIQUE NORD
Clipperton
Antilles
Guyane
Wallis et Futuna
Polynésie Française
Nlle-Calédonie
Mayotte et îles éparses
Tromelin
La Réunion
OCÉAN INDIEN
St-Paul et Amsterdam
OCÉAN PACIFIQUE SUD
OCÉAN ATLANTIQUE SUD
Crozet
Kerguelen
Terre Adélie

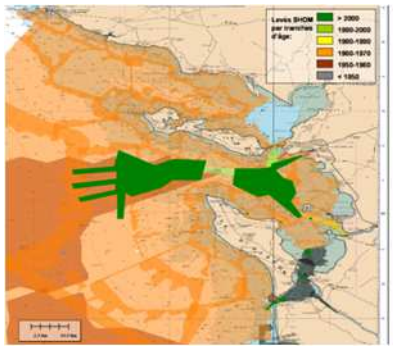


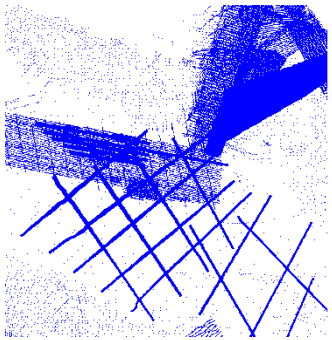
Problematic

- ✓ Generally limited information (if none) is conveyed concerning uncertainty of the DEM (global or at the cell level)
- ✓ Multiple sources of data needed to build a DEM
- ✓ Multiple acquisition and processing methods (Lead line, Single beam echosounder, multibeam, lidar, …)
- ✓ Multiple interpolation methods generate continuous surface
- ✓ Bathymetric grid used for multiple usages (hydrodynamic, geosciences, navigation)
- ✓ **Objective : Implement methods and tools to generate an estimate of the uncertainty**



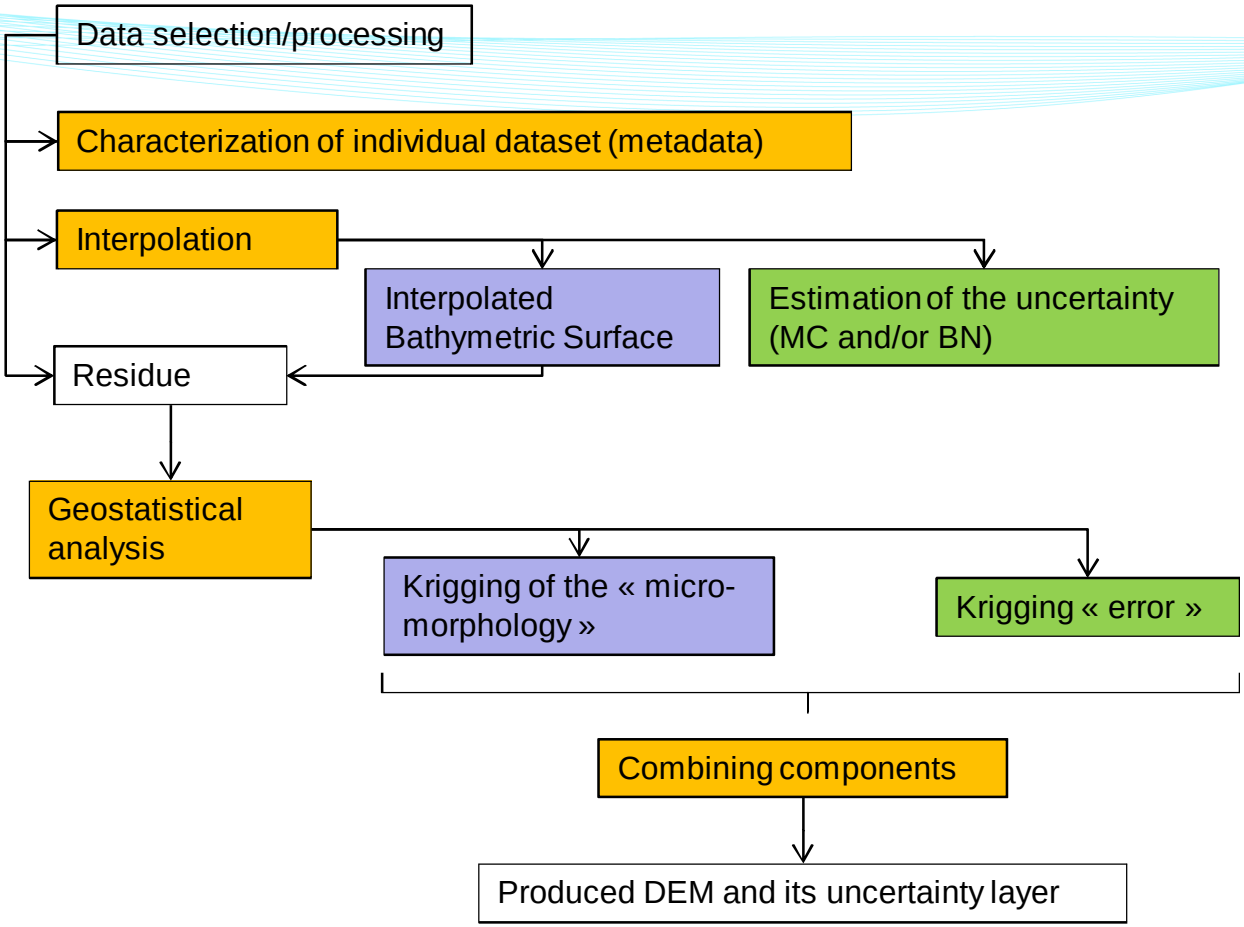
Hare et al. 2011





- ✓ **Objective : Implement methods and tools to generate an estimate of the uncertainty**

Methodology



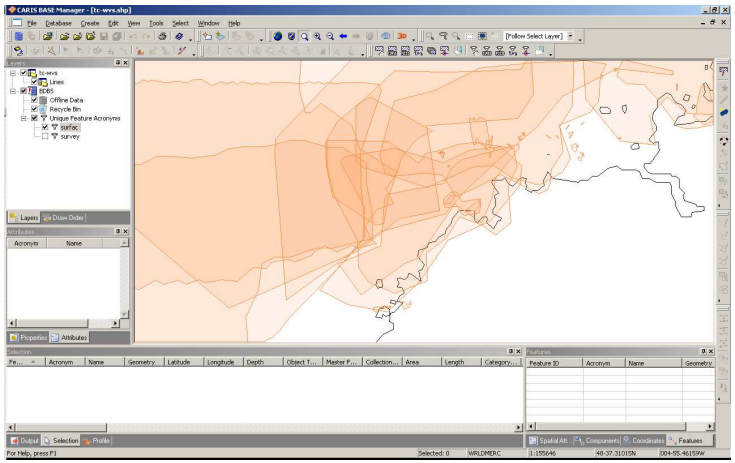
Bathymetry

Matthew Poti[1,2], Brian Kinlan[1,2,3], and Charles Menza[1]

In : A Biogeographic Assessment of Seabirds, Deep Sea Corals and Ocean Habitats of the New York Bight: Science to Support Offshore Spatial Planning, 2012

Characterization of the source data based on IHO metadata standard

- ✓ Each sounding dataset in SHOM BDB is characterized by a set of metadata
- ✓ POSACC, SOUACC, TECSOU, QUALOT (IHO defined) are used to estimate the « error budget » of each individual dataset
- ✓ Missing one of them, Estimated by the date period (assuming precision is technology driven)
- ✓ Hypothesis of a radial distribution around the sounding



Attributes

Acronym	Name	Value
captur	Capteur	Plomb de sonde
carhyd	Caractérisation hydrograph	Inconnu
CATZOC	Category of zone of confide	
cods44	Code S44 petit fond	Inconnu
codval	Code de validité	VALID Valide
corver	Correction verticale appliqu	1000000000.0 m
cretim	Creation time	20120905 125723.286
datnrv	Date de réalisation du nivea	19270101
descrp	Description	Travaux hydrographique aux
design	Désignation	leve bathymetrique
fincom	Date de fin de protection cc	20000101
geocou	Système géodésique courar	WGD WGS 1984
geoori	Système géodésique d'origir	HCROZON1 - Système Hydro
hcosys	Horizontal coordinate syste	GEOGCS["WG84",□ DATUM
idprnt	Unique identifier of parent c	1001394
infcor	Information sur la correctior	neant
infpar	Informations sur les paramè	neant
latmax	Latitude maximale du lot	48.5885667
latmin	Latitude minimale du lot	48.5278833
lonmax	Longitude maximale du lot	-4.6948833
lonmin	Longitude minimale du lot	-4.8099167
meth_p	Méthode d'estimation de la	neant
meth_z	Méthode d'estimation de la	neant
modtim	Last modified time	20120905 133720.956
nomnrv	Nom du niveau de référence	zhy Zero Hydro NON SPECIFI
nomres	Nom du DT ou du responsat	Volmat
numson	Nombre de sondes du lot	15484
objdel	Object delete state	False
OBJNAM	Object name	5192700100-22
objst8	Object State	Online
planam	Platform Name	
POSACC	Positional accuracy	10000000000.00 m
prjori	Projection d'origine	GEO - GEOGRAPHIQUE
procom	Code de protection commer	DL Diffusion libre
prodrs	Liste des organismes produ	MAB Mission des Abords de Bre
promil	Code de protection militaire	NP Non protégé
propri	Organisme propriétaire du l	SHOM Service Hydrographique
prteur	Navire porteur	ZZZ INCONNU
ps4uni	Code PS4UNI	Z Non specifie
qualot	Niveau de qualité des sonde	Z Precision non specifiee
reslot	Résolution caractéristique d	5000.00 m
SOUACC	Sounding accuracy	10000000000.0 m
srcfil	Source file name	s192700100-22.csar
srfcat	Category of bathymetric su	Standard
srfres	Gridded surface resolution	
srftyp	Storage Type	CSAR Point Cloud (.csar)
SUREND	Survey date - end	19271231
SURSTA	Survey date - start	19270101
TECSOU	Technique of sounding mea	found by lead-line
tramnt	Nom de la chaîne de traitem	neant
typlot	Modèle Numérique de Terra	0 Lot de sondes
typprof	Type de profil	0 Inconnu
uidcre	User id of the object's creat	08000048 (duigou)

Properties Attributes

The math in one slide

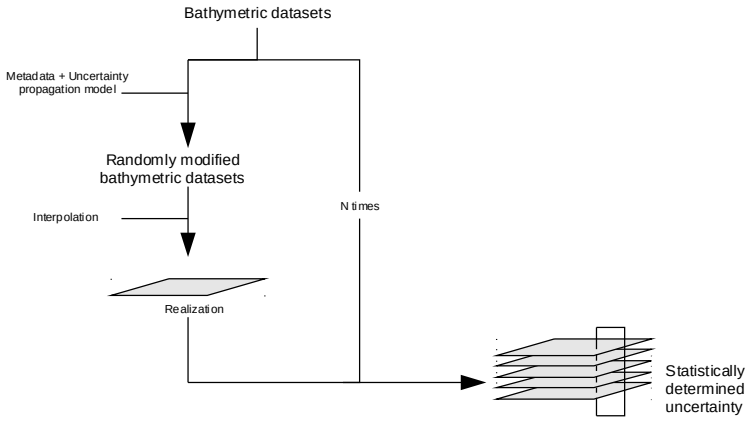
MONTE-CARLO

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 107, NO. B12, 2358, doi:10.1029/2001JB000616, 2002

On the effect of random errors in gridded bathymetric compilations

Martin Jakobsson, Brian Calder, and Larry Mayer
Center for Coastal and Ocean Mapping and Joint Hydrographic Center, University of New Hampshire, Durham, New Hampshire, USA

Received 18 October 2001; revised 8 January 2002; accepted 13 January 2002; published 20 December 2002.



BAYESIAN NETWORK

Geochemistry Geophysics Geosystems G3
Published by AGU and the Geochemical Society
Article
Volume 13, Number 9
22 September 2012
Q09011, doi:10.1029/2012GC004144
ISSN: 1525-2027

Uncertainty estimation for databased bathymetry using a Bayesian network approach

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David H. Fabre, Raymond T. Sawyer, and R. Wade Ladner
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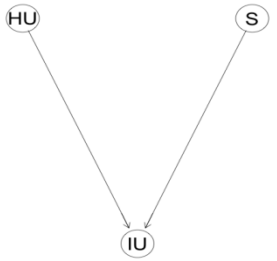


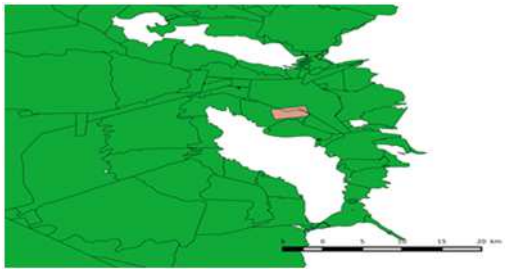
GEOSTATISTICS

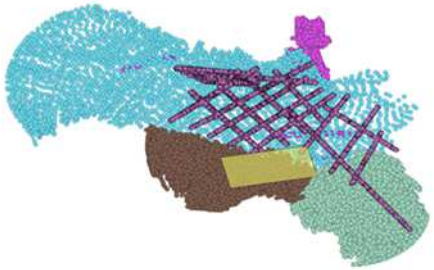
- ✓ Variogramme applied on the residue

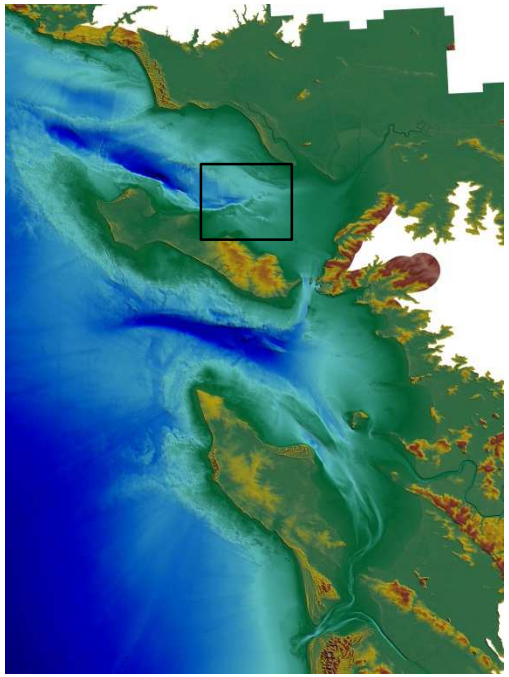
EXPRESSING THE UNCERTAINTY

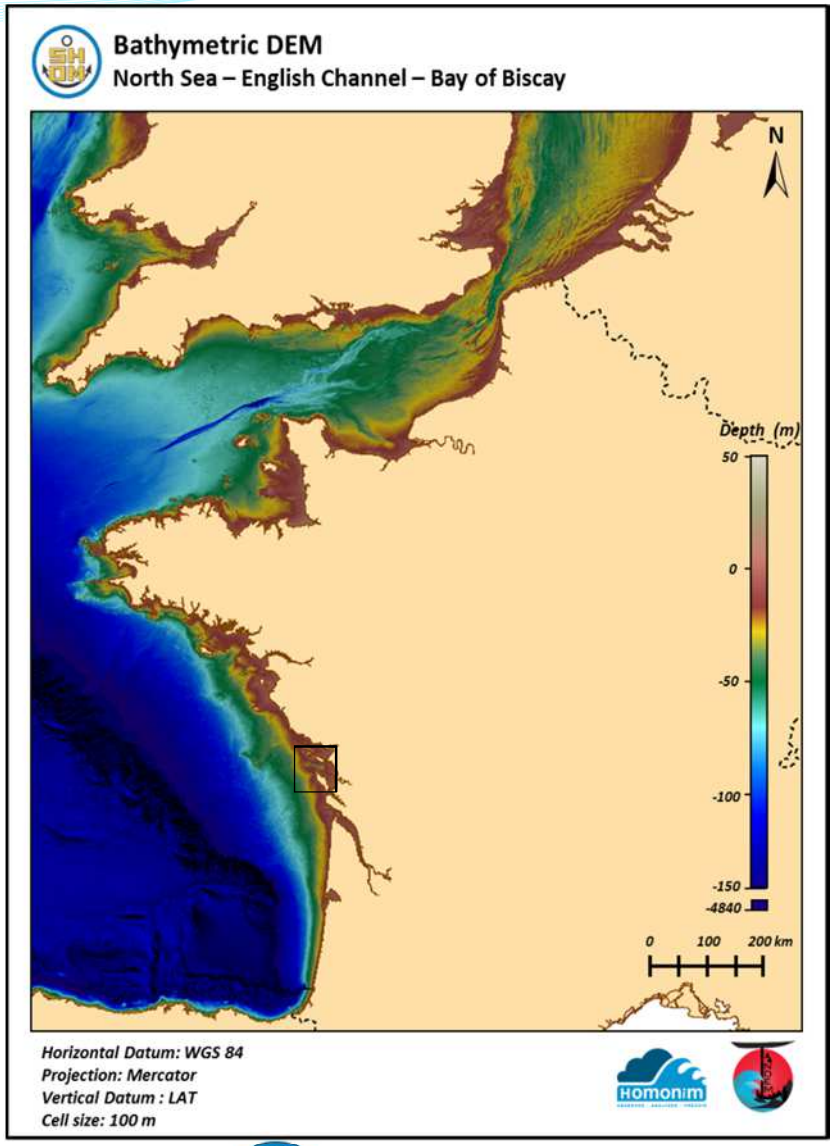
- ✓ 95 percentile – 5 percentile
- ✓ Any other expression

Results 1/3







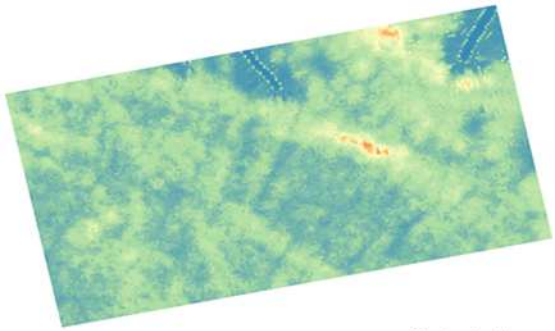

Bathymetric DEM
North Sea – English Channel – Bay of Biscay
N
Depth (m)
50
0
-50
-100
-150
-4840
0
100
200 km
Horizontal Datum: WGS 84
Projection: Mercator
Vertical Datum : LAT
Cell size: 100 m
HOMONIM

Results 2/3

Bathymétrie(m)
Interpolation 25m IDW GRASS

2
6
12
16
20

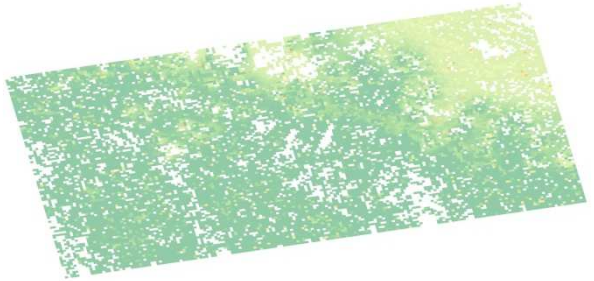
750 0 750 1500 2250 3000 m



750 0 750 1500 2250 3000 m

Monte Carlo
Interpolation 25m IDW GRASS
Incertitudes 50 membres

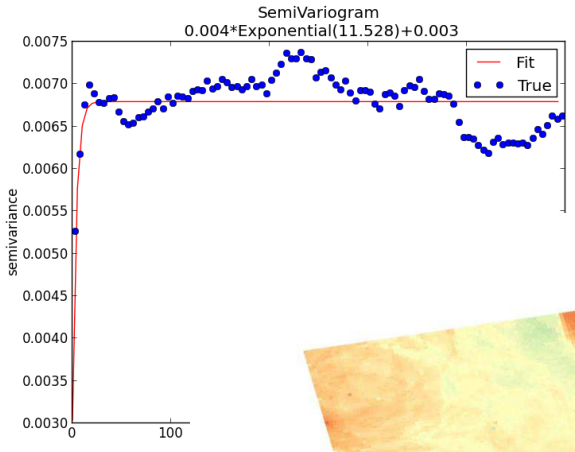
0
0.5
1.5
2
3

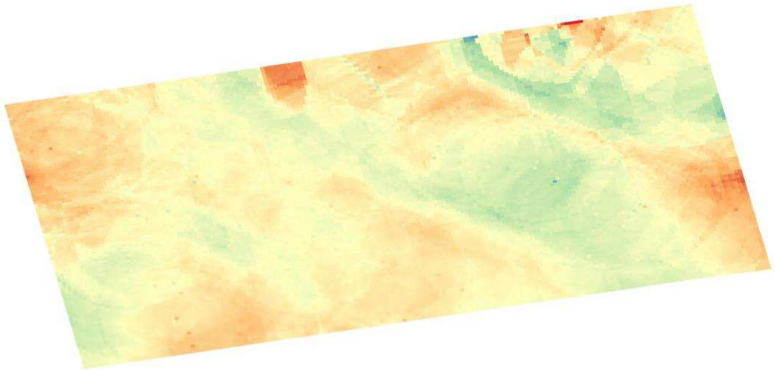


Legend
Inférence bayésienne
0.000000
0.375000
0.750000
1.125000
1.500000

500 0 500 1000 1500 2000 m

Results 3/3



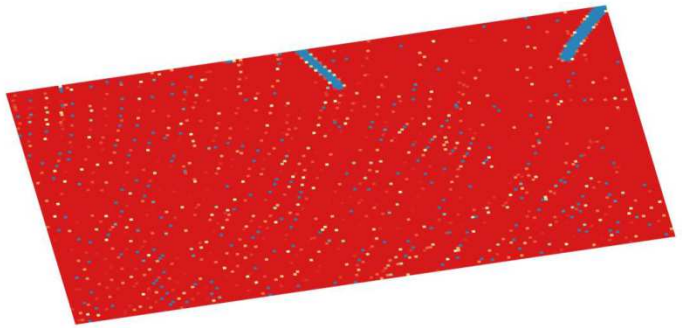


Legend

krigeage des résidus (m)

-0.250000
-0.125000
0.000000
0.125000
0.250000

500 0 500 1000 1500 2000 m



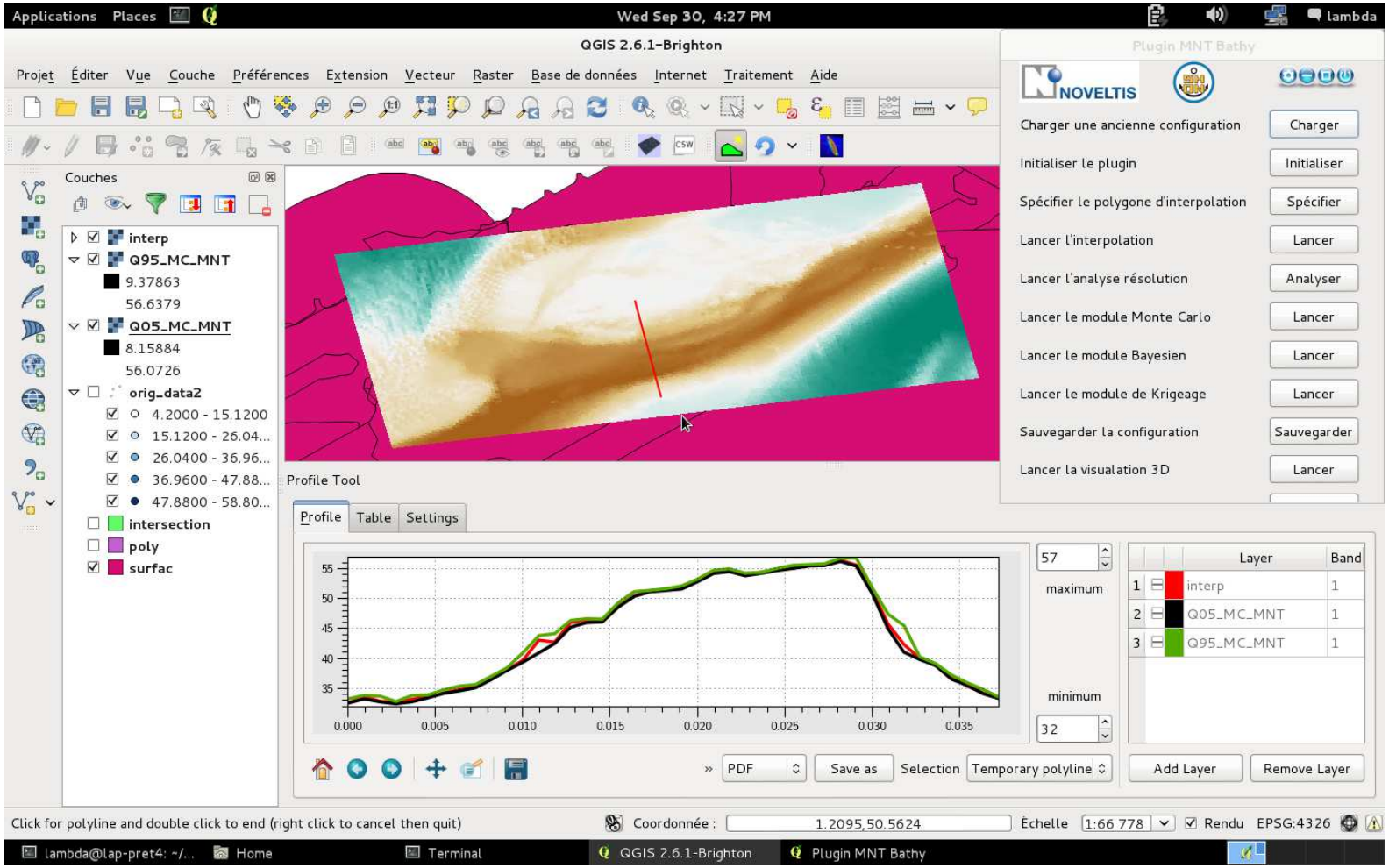
Legend

Erreur de krigeage (m)

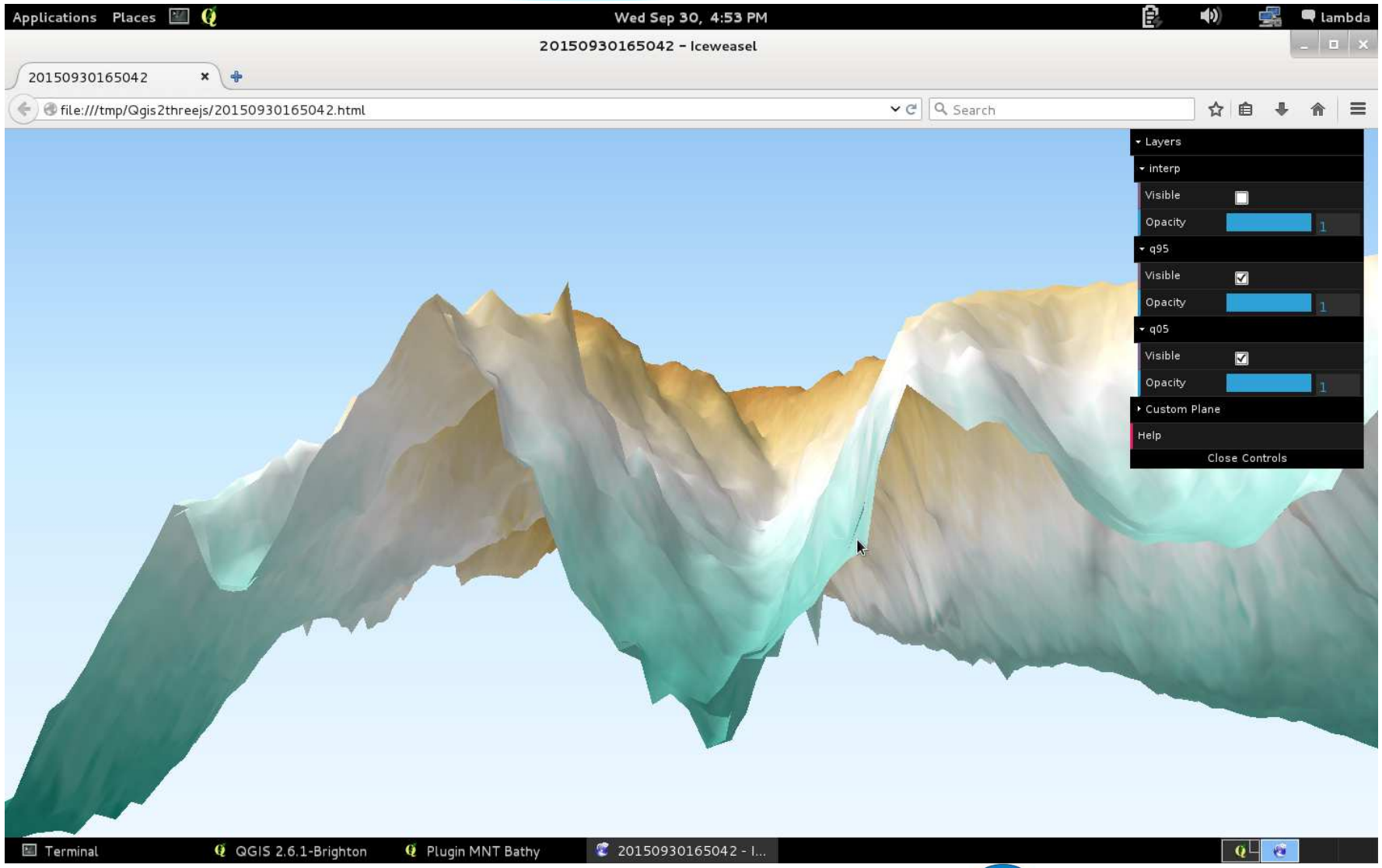
0.061201
0.061218
0.061234
0.061251
0.061268

500 0 500 1000 1500 2000 m

Exemple of GUI



Viewing / Exploiting uncertainty



CONCLUSIONS

- ✓ An attempt to provide a tool to build bathymetric DEM with its corresponding layer of uncertainty
- ✓ Methodology built on “sound” mathematical background and adapted hydrographic assumptions
- ✓ Characterization of the source data relates to international standards (IHO)
- ✓ Nearly independent of the interpolation technique
- ✓ Open source solution / flexible coding

FUTURE WORK

- ✓ Improve a-priori characterization of the source data (e.g. vertical precision as a function of depth)
- ✓ Improve Bayesian network learning and results
- ✓ Improve performances (parallelization)
- ✓ Propose better ways to present the results
- ✓ BAG implementation