

Vers les modèles d'océan de future génération

F. Lyard

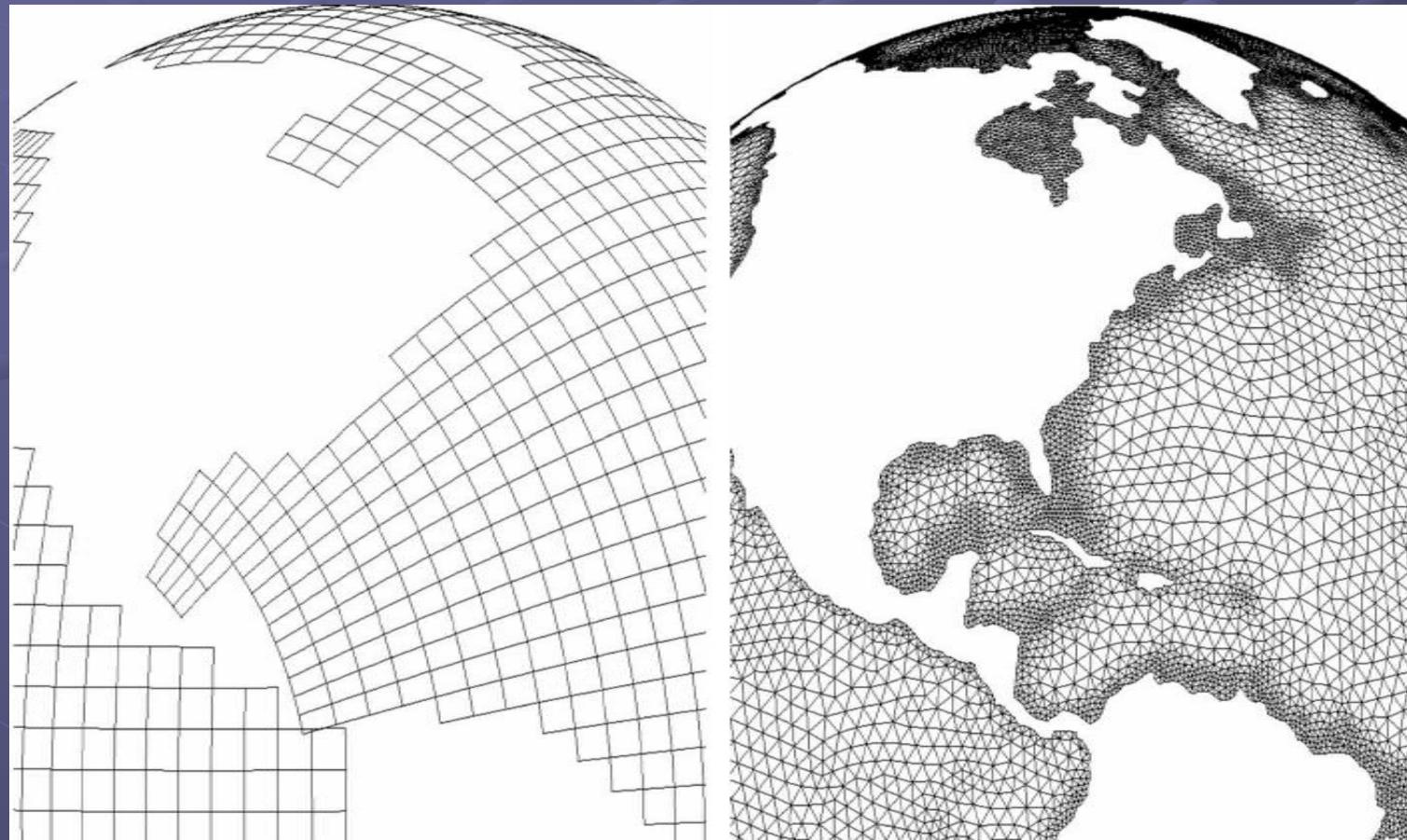
**LEGOS/CNRS
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Modèles à grilles non-structurées

Pourquoi des grilles non-structurées ?



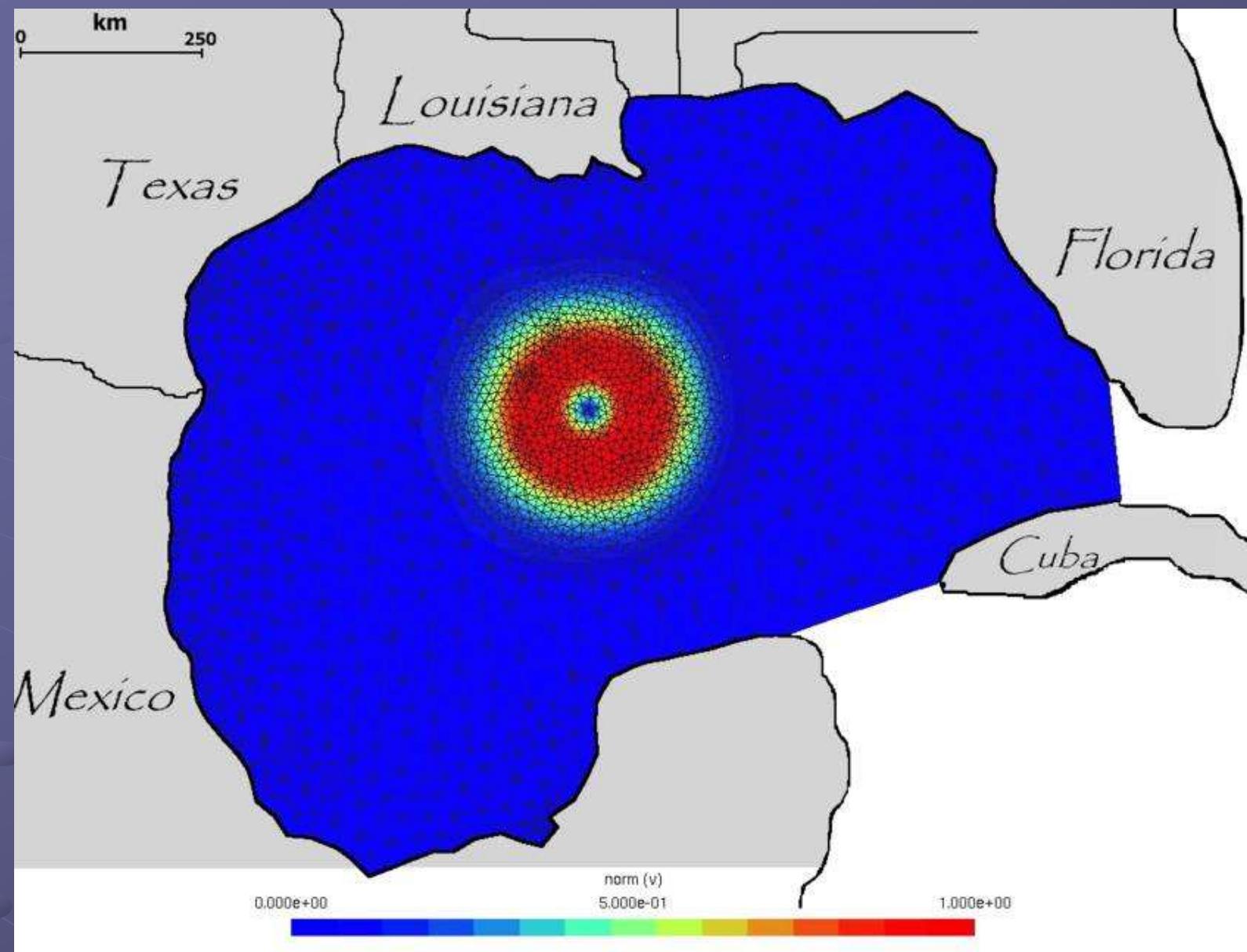
Les raisons d'un développement tardif...

Désavantages

- Méthodes numériques complexes.
- Codage complexe.
- Moins de recul en océan/atmosphère (// grilles structurées)

Avantages

- Représentation de la ligne de côte
- Résolution variable (voire adaptative).
- Pas de points singuliers (pôles).



Quelques exemples

- Marée
- Tsunami
- Surcote cyclonique
- Dispersion larvaire

Modélisation de la marée et des surcotes

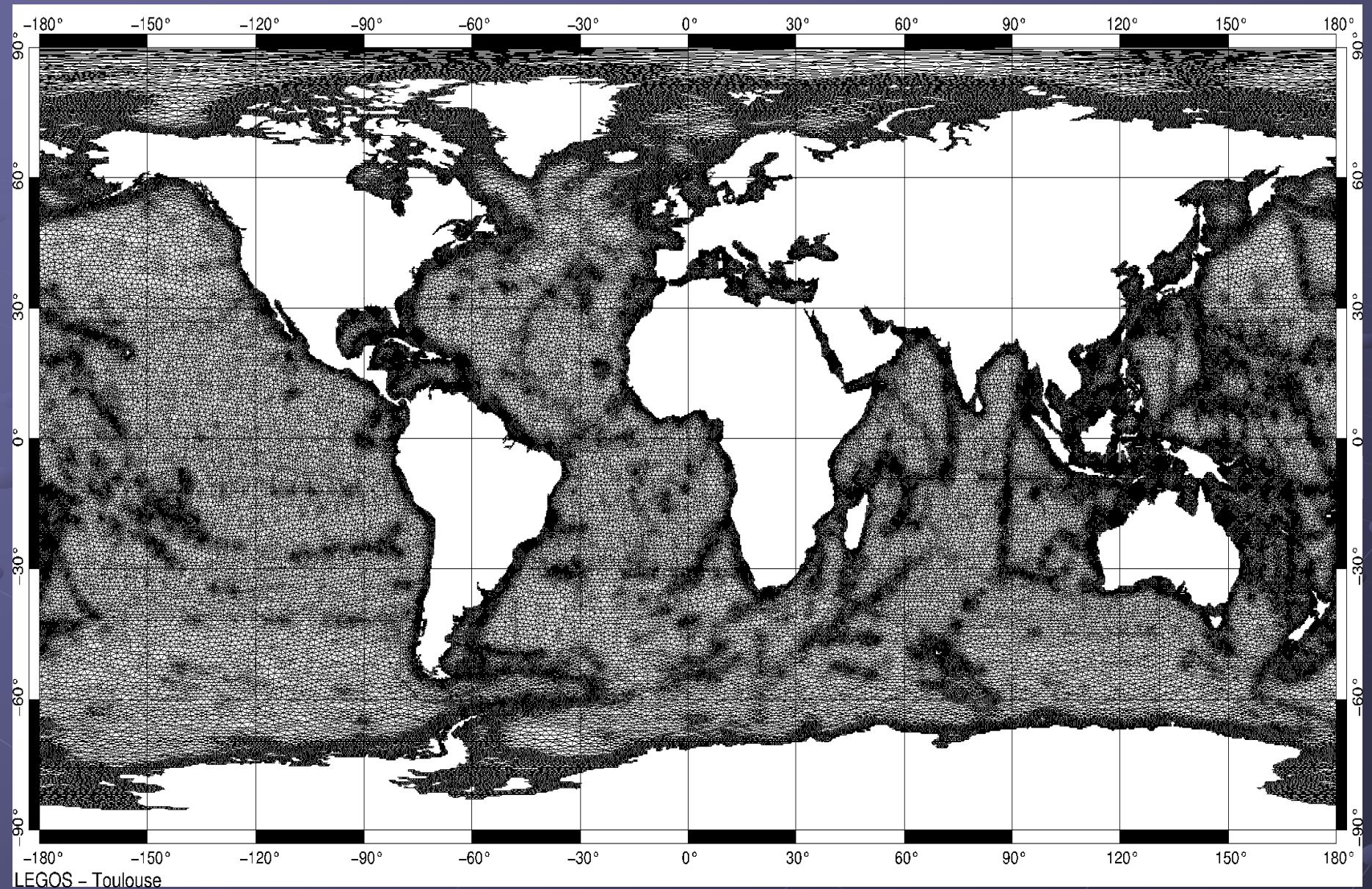
C. Le Provost

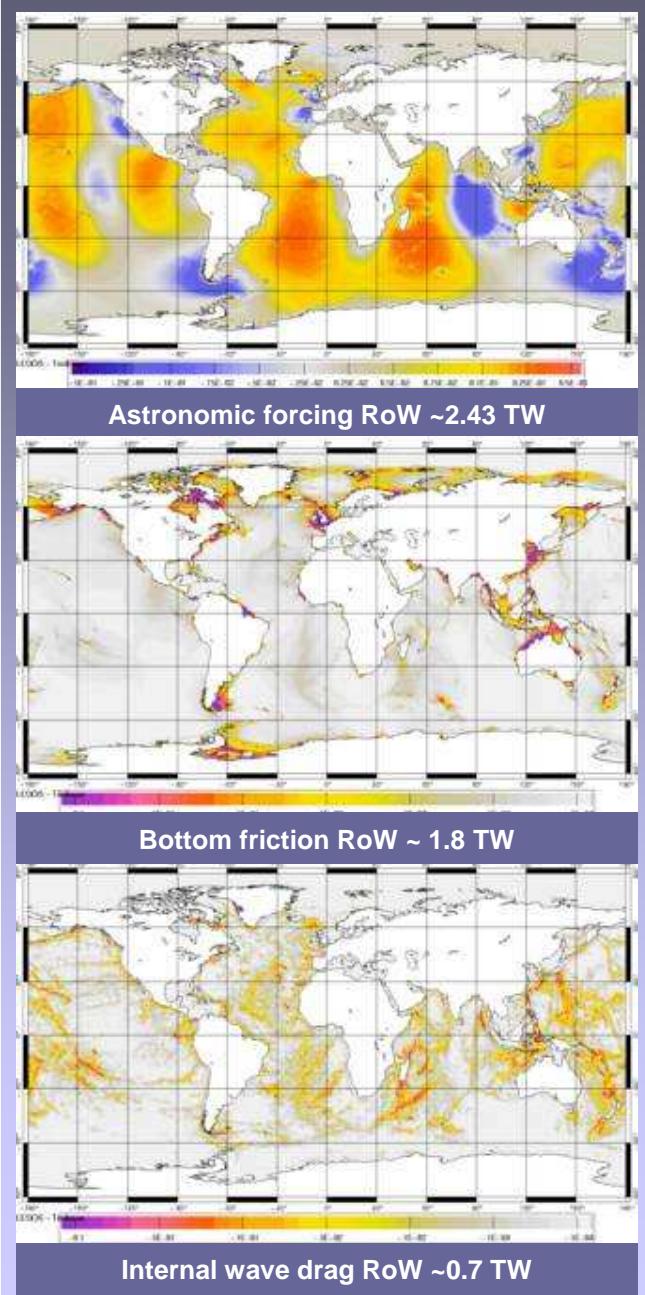
et F. Lyard, Y. Le Bars, L. Roblou

LEGOS

Observatoire Midi-Pyrénées, Toulouse

Diurnal and semi-diurnal tides: FES2004 atlas

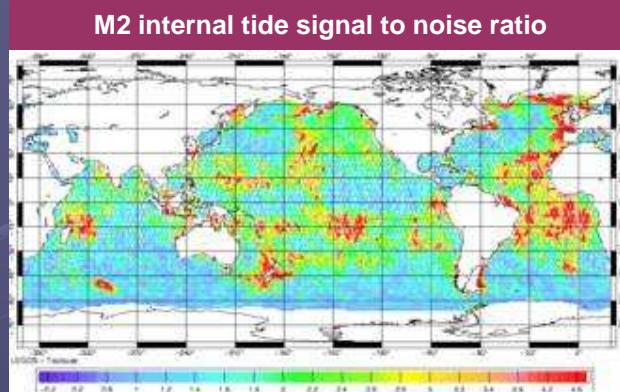




Energy transfert from barotropic to baroclinic tides

- o Unbalanced energy budgets
- o Quasi-ubiquity of the internal tides (observation T/P)

Rationales



Hypothesis

- o Significant energy transfert from barotropic to baroclinic tides
- o Transfer must be parameterized in models

Conclusion

- o A new dissipation termn (internal wave drag)
$$\vec{F}_{iwd} = -C_d \rho_o \kappa^{-1} \overline{N} \left(\vec{\nabla} H \cdot \vec{U} \right) \vec{\nabla} H$$
- o Reduced error budget in barotropic computation (by a factor of 2)
- o Balanced energy budgets
- o Quantitative assessment of internal tide energy

Approche régionale

- Objectifs :

- Investigations de la dynamique des mers de plateau et côtières
- Améliorations des données altimétriques côtières

- Approach

- Modélisation régionale de la marée avec assimilation de données
- Modélisation régionale des surcotes
- Modélisation non-structurée (T-UGOm)

- Projets COMAPI/PISTACH

(CNES/Noveltis/CLS) :

- North-East Atlantic
- Mediterranean Sea

- Pilot configuration

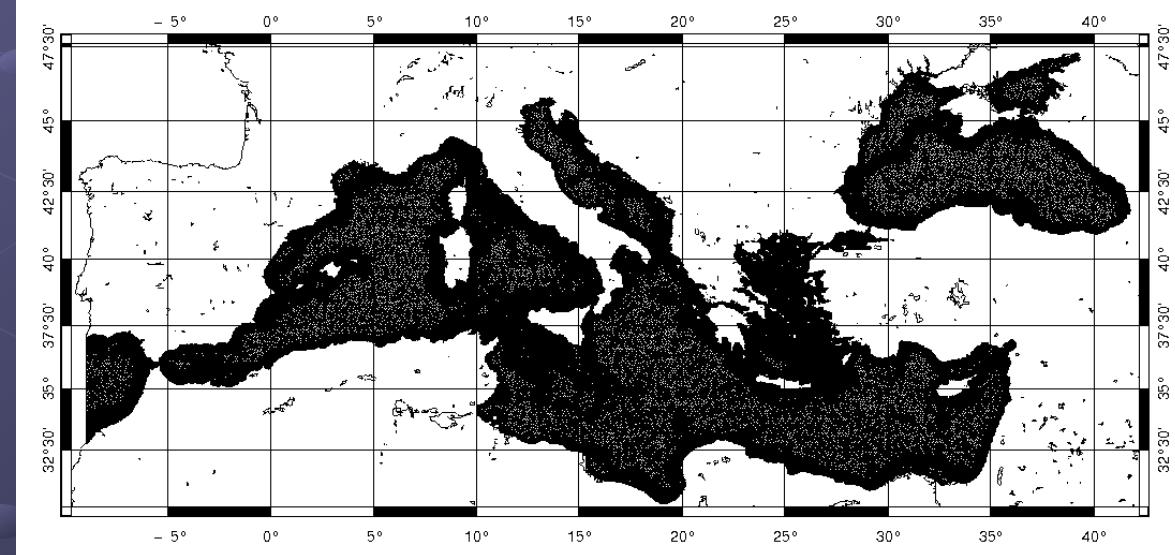
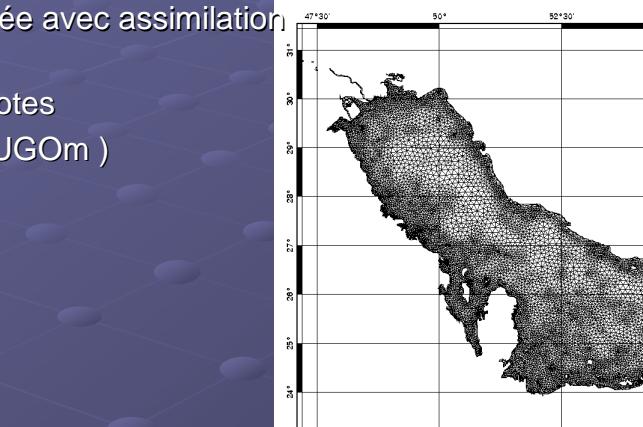
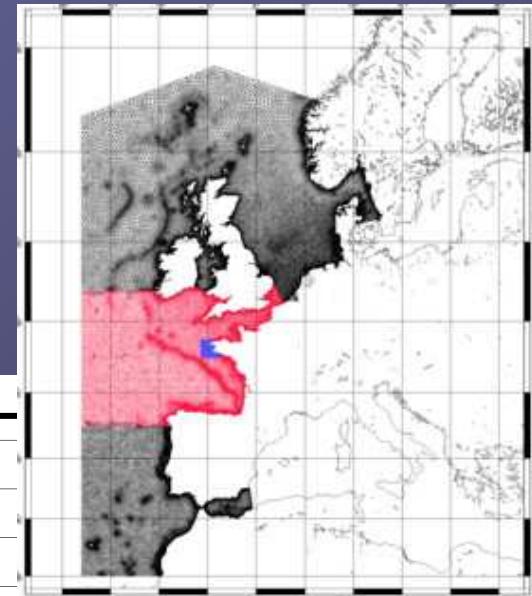
- Persian Gulf

- Chantiers scientifiques

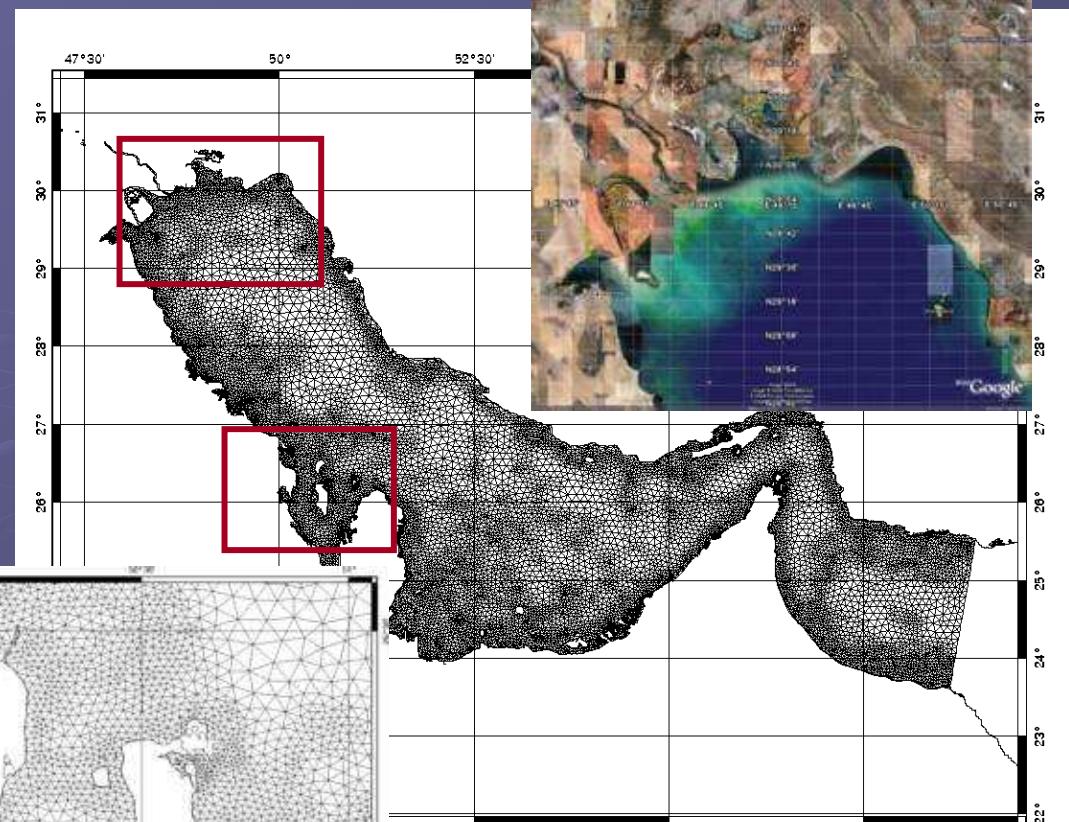
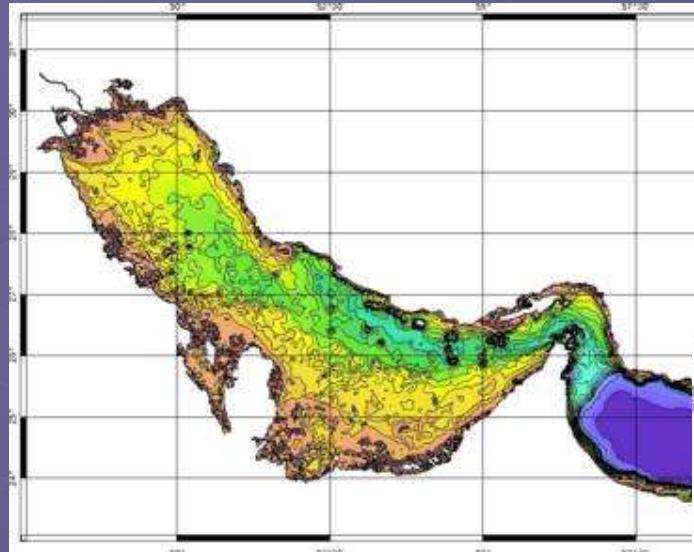
- Amazon estuary/shelf
- Caspian Sea
- Kerguelen Plateau
- Black Sea

- Etudes préliminaires

- Bering Sea
- China/indonesian Sea
- Solomon Sea
- Patagonian Shelf



Golfe Persique



Géométrie:

- Ligne de côte NOAA
- Bathymétrie SHOM
- résolution à la côte ~1km

Forçage :

- Élévations de marée FES2004
- Potentiel générateur
- Effets de charge et d'auto-attraction FES2004

Dissipation :

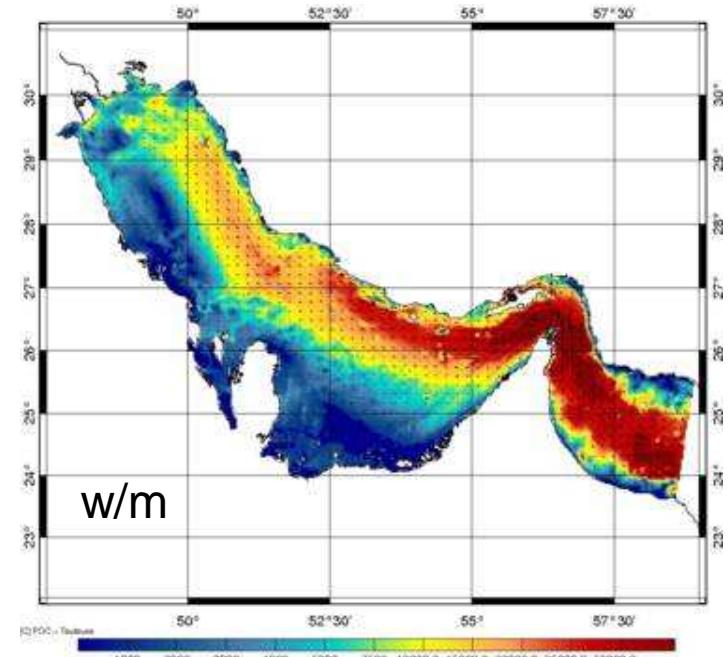
- Frottement sur le fond
- Paramétrisation des ondes internes



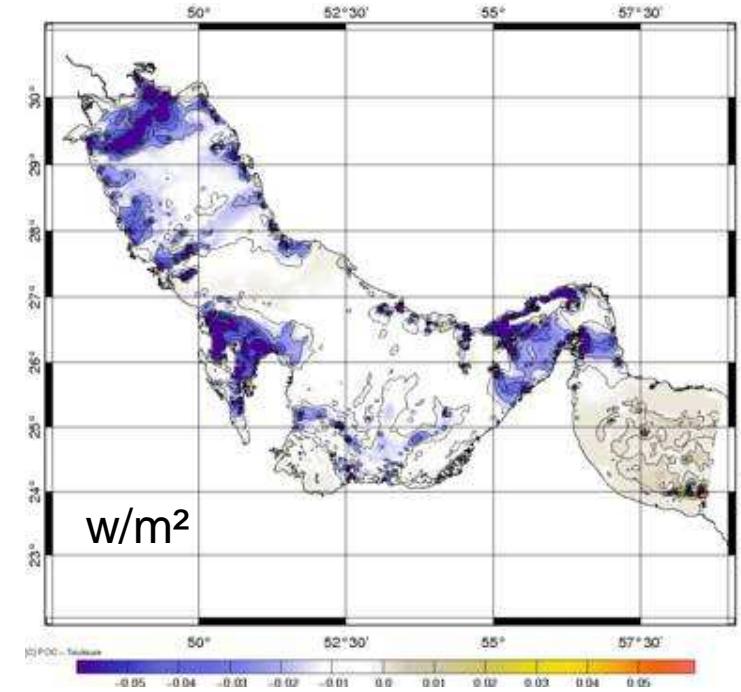
Marée (lunaire) M_2 budget d'énergie

Bien représenter les structures fines de la dynamique de marée...

- Flux d'énergie de marée ➔



- Energie dissipée par frottement sur le fond ➔



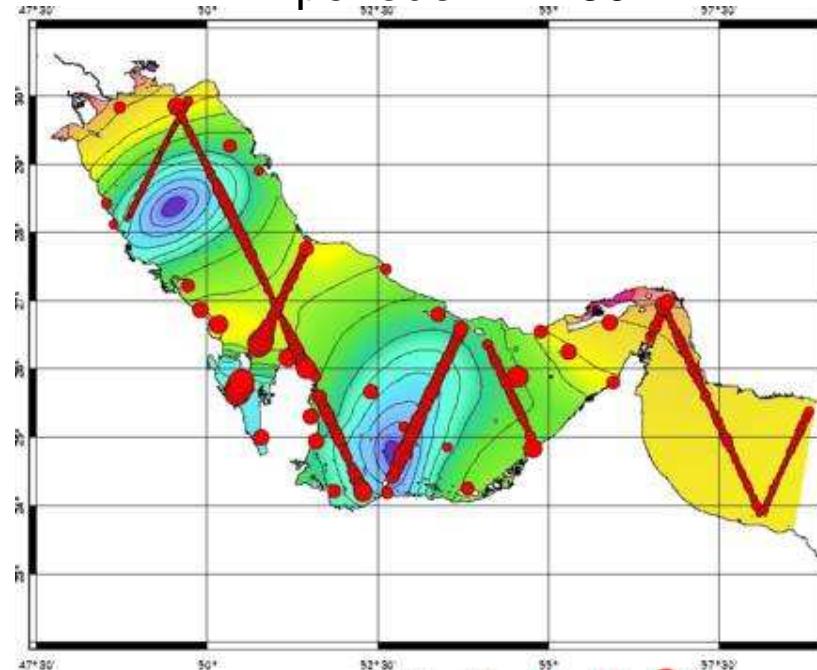
4.5 gW

Modélisation hydrodynamique plus assimilation de données

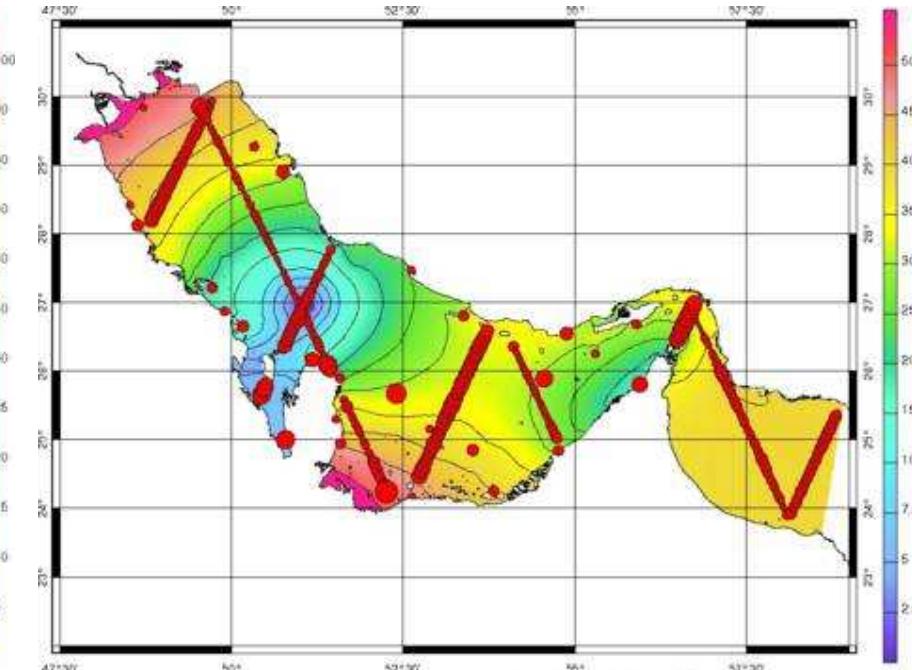
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des cartes de marée précises et détaillées

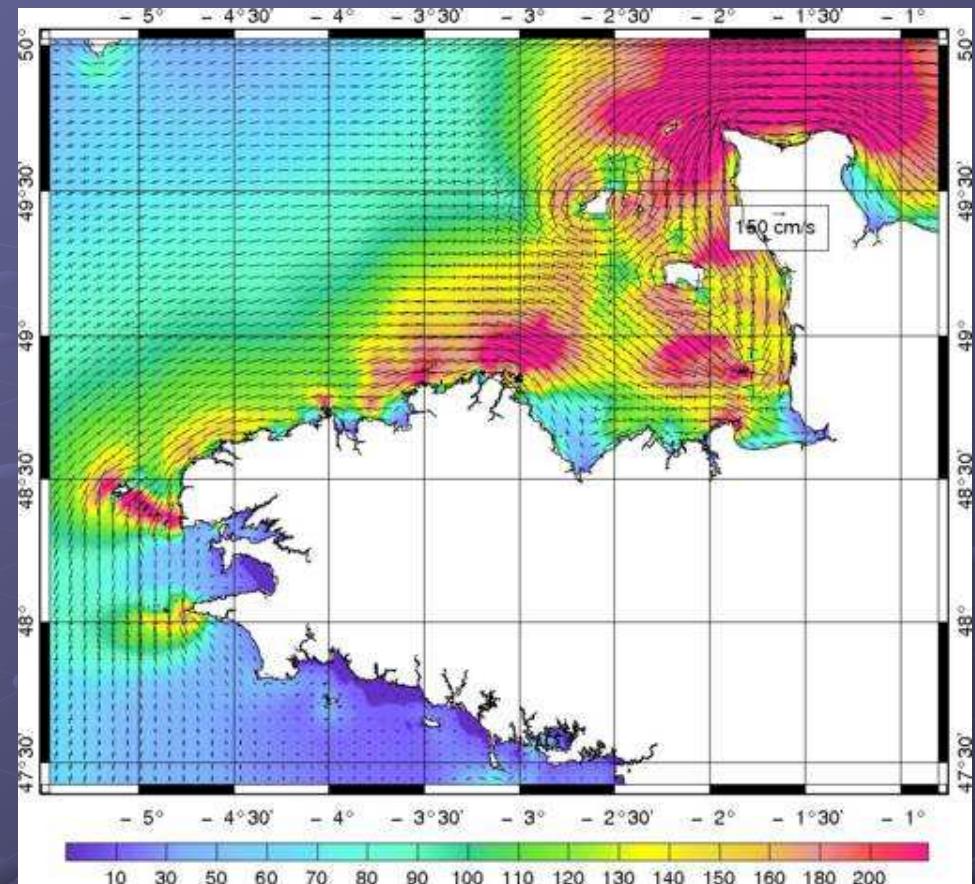
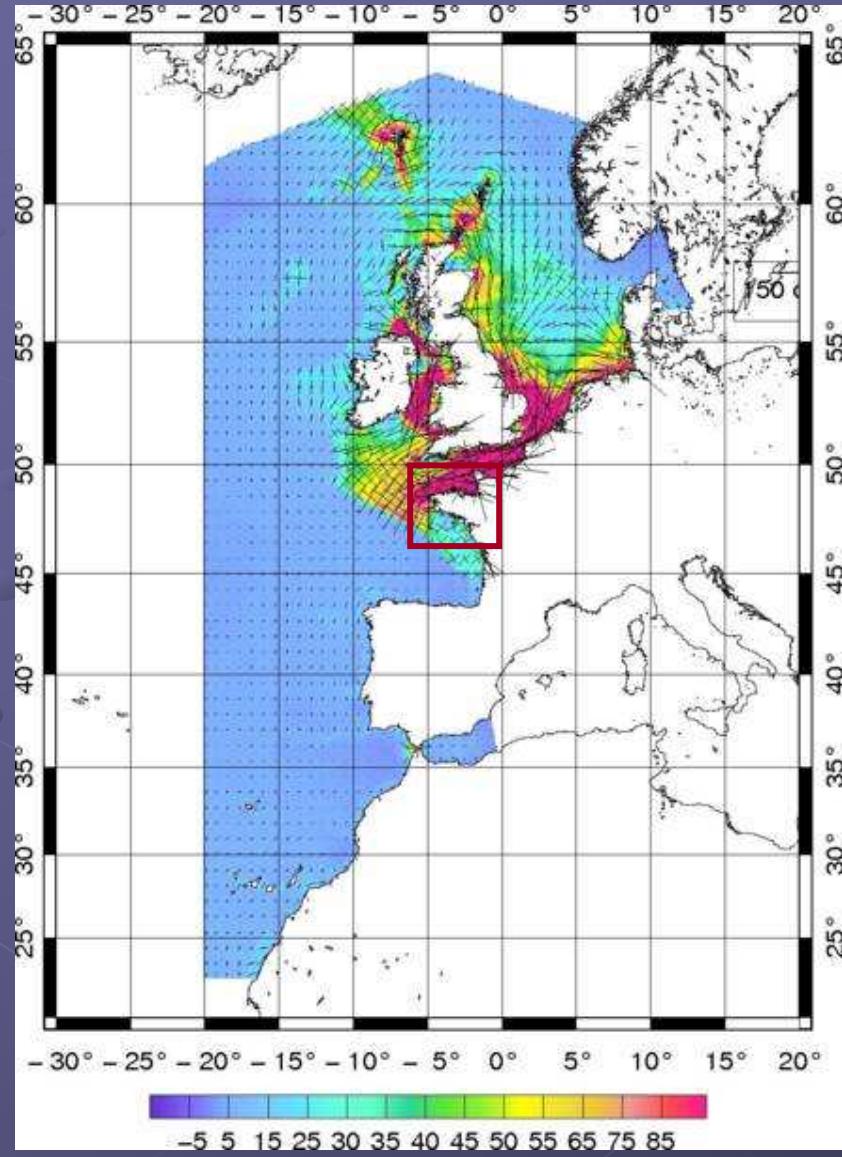
Marée M_2
période ~12h30



Marée K_1
Période ~ 24h



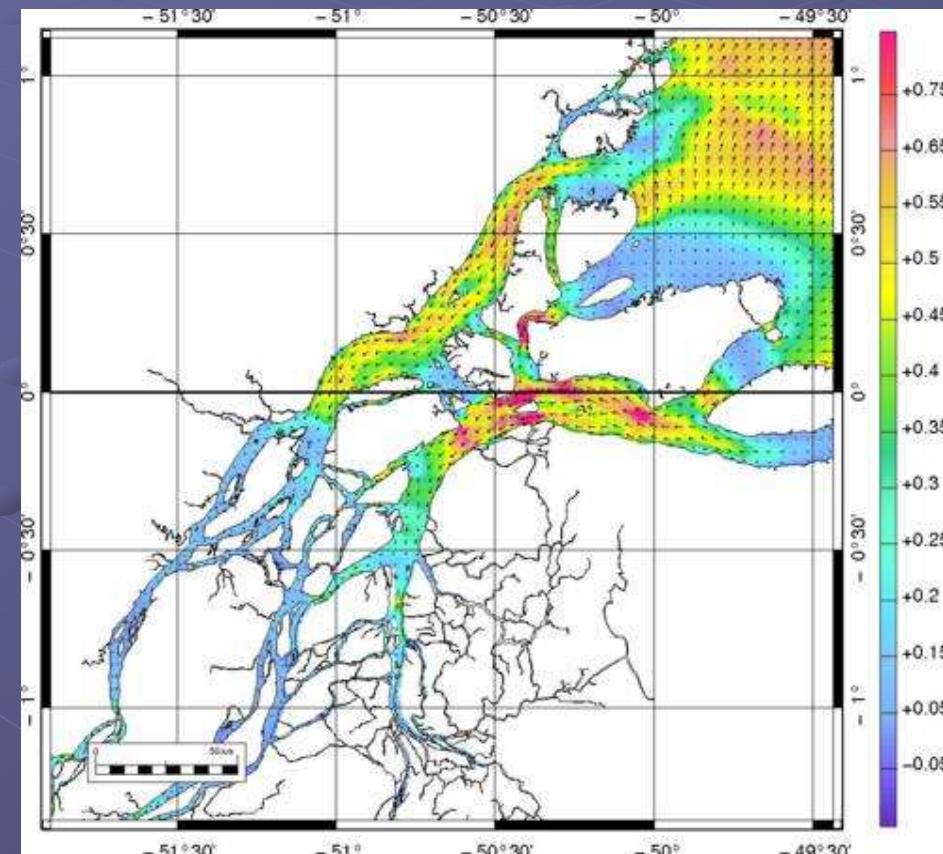
Plateau Européen



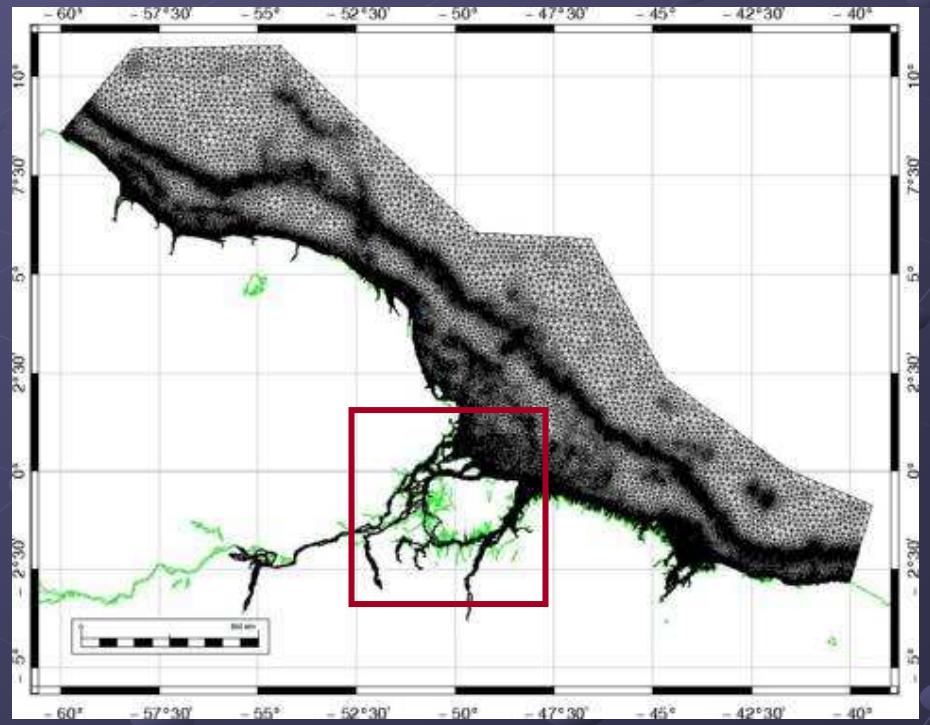
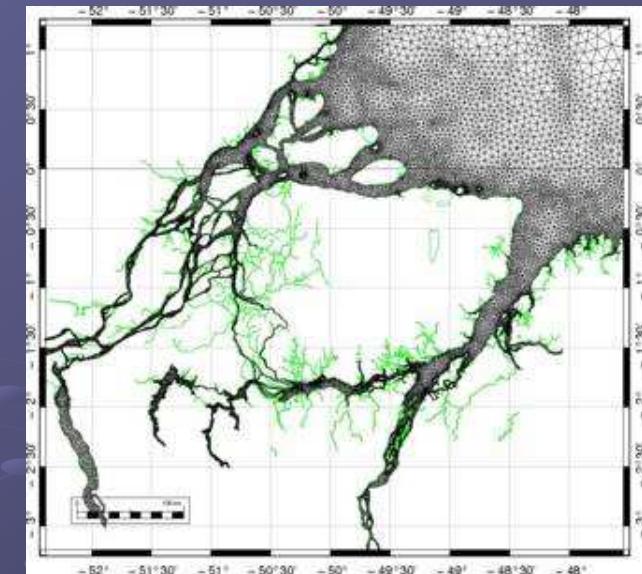
Correction régionale des mesures
altimétriques (projet COMAPI,
CNES/Noveltis)
Cartes de courants

Estuaire/Plateau de l'AMAZONE

Représentation de l'onde de marée dans le fleuve (~1000km)



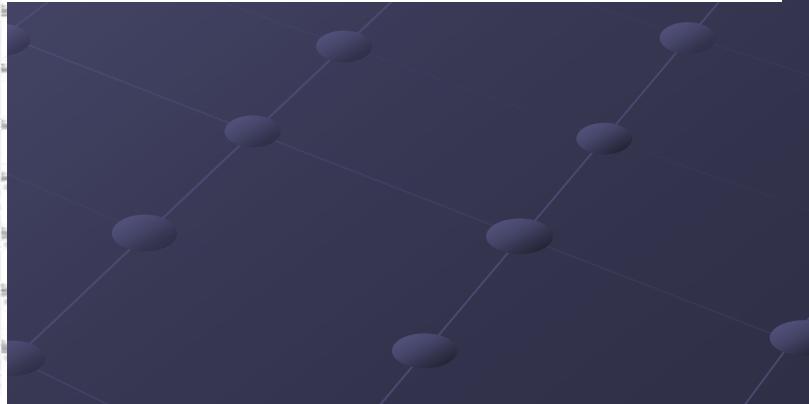
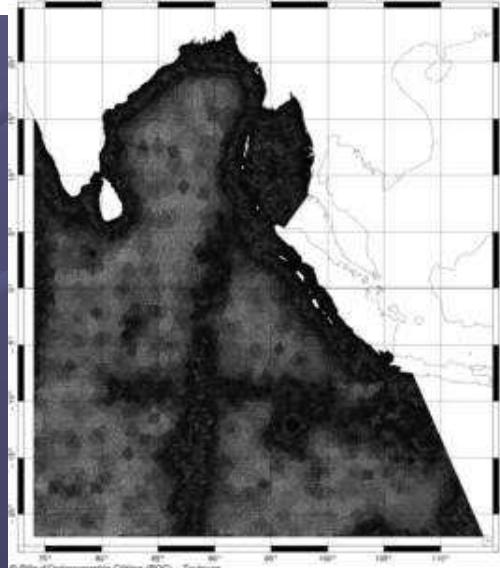
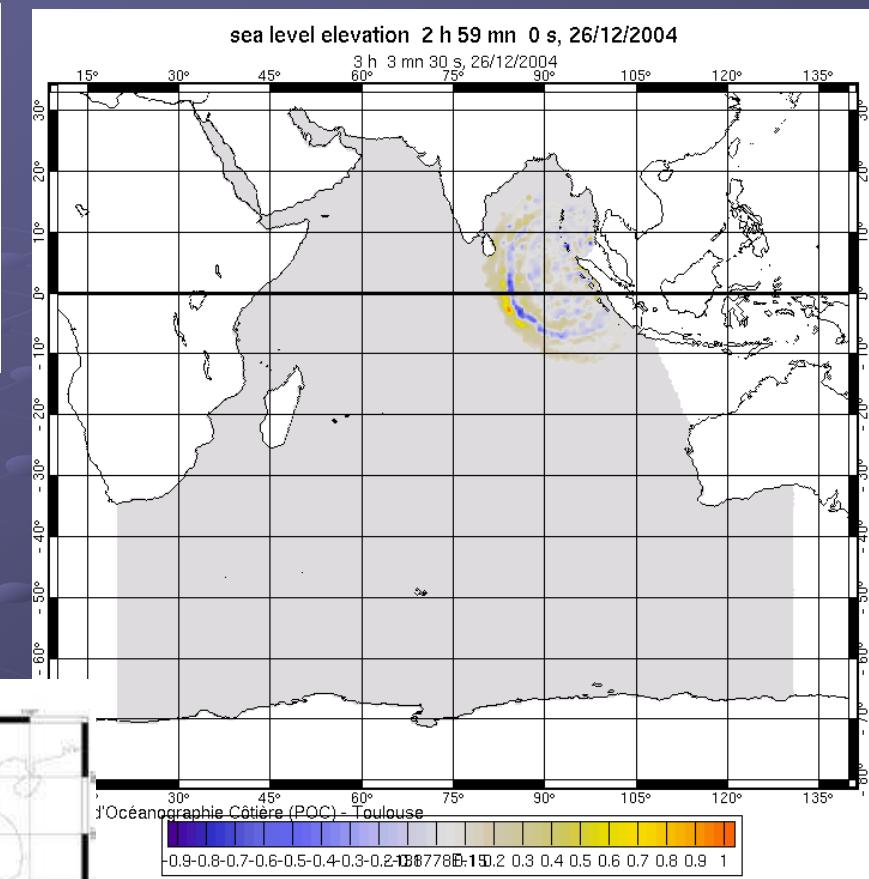
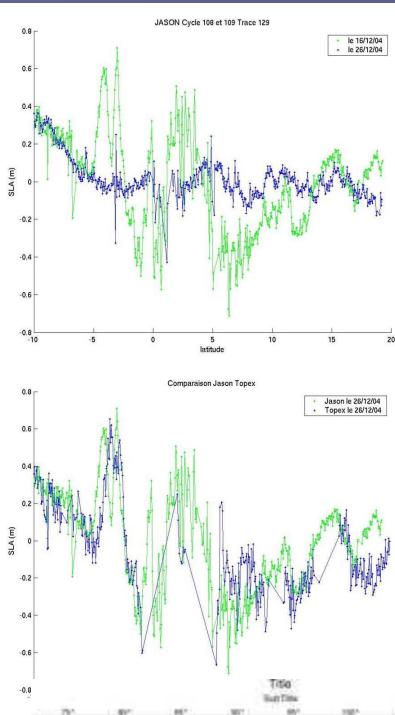
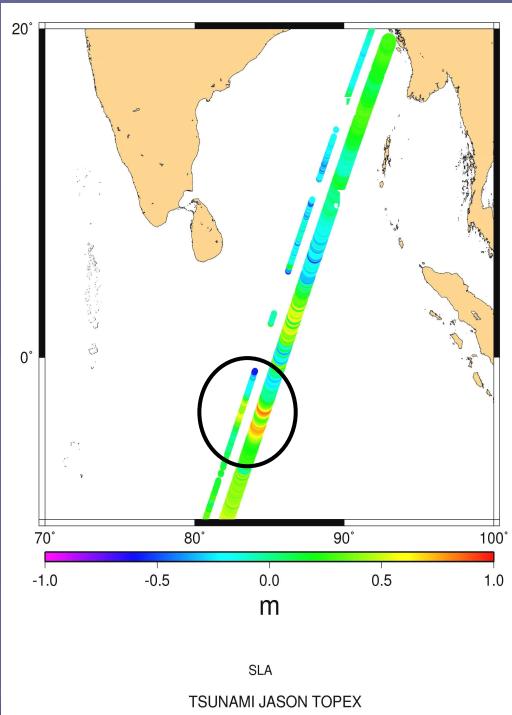
Courants de marée (fleuve)



Modélisation des ondes de tsunami

F. Lyard, O. Fachan, Y. Ménard

Modélisation du tsunami indonésien



Modélisation des surcotes cycloniques

J. Westerink, J. Dietrich, S. Tanaka; University of Notre Dame

C. Dawson, J. Proft; University of Texas at Austin

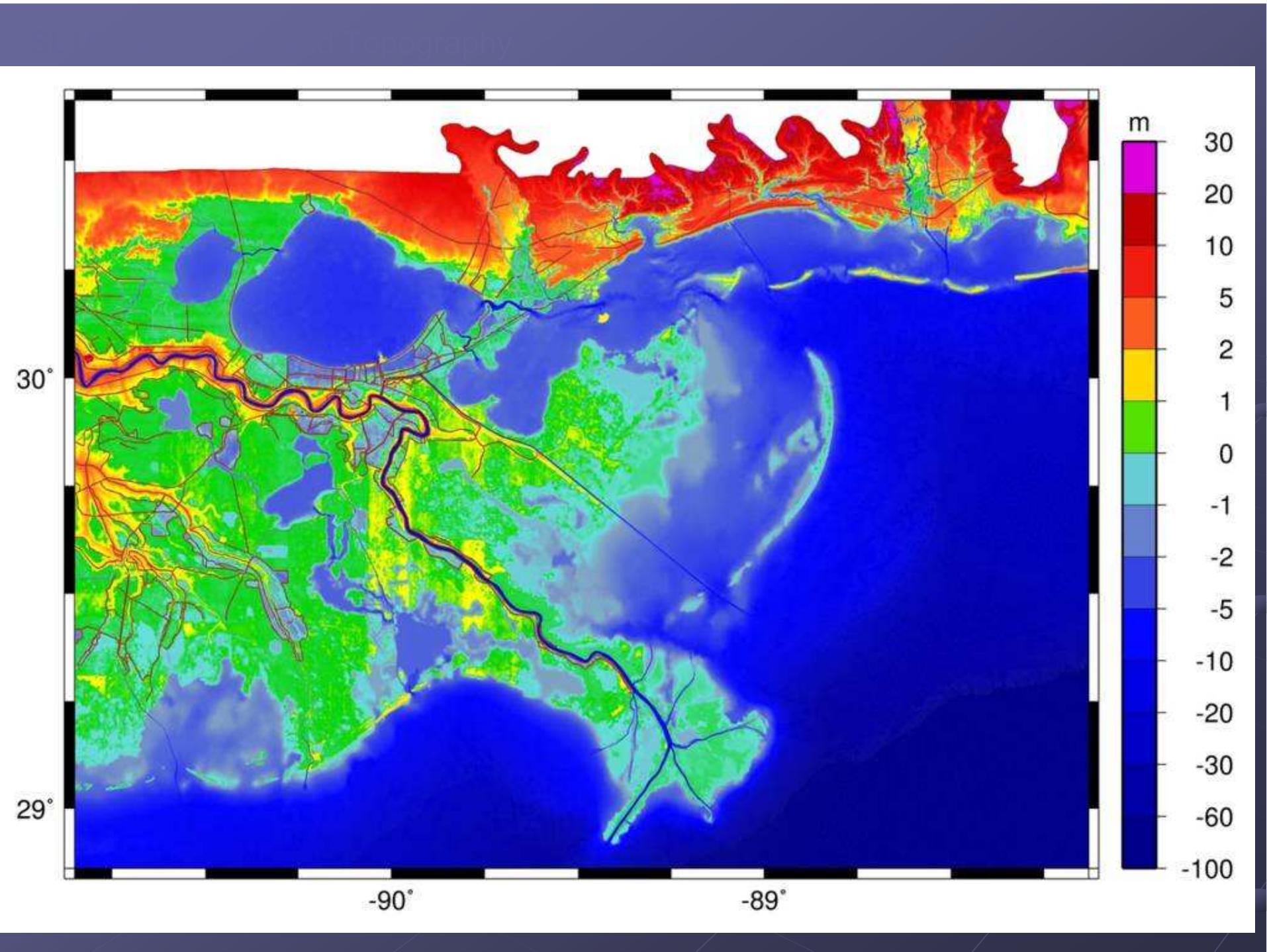
R. Luettich, J. Fleming; University of North Carolina at Chapel Hill

D. Resio, B. Ebersole, J. Smith; ERDC USACE

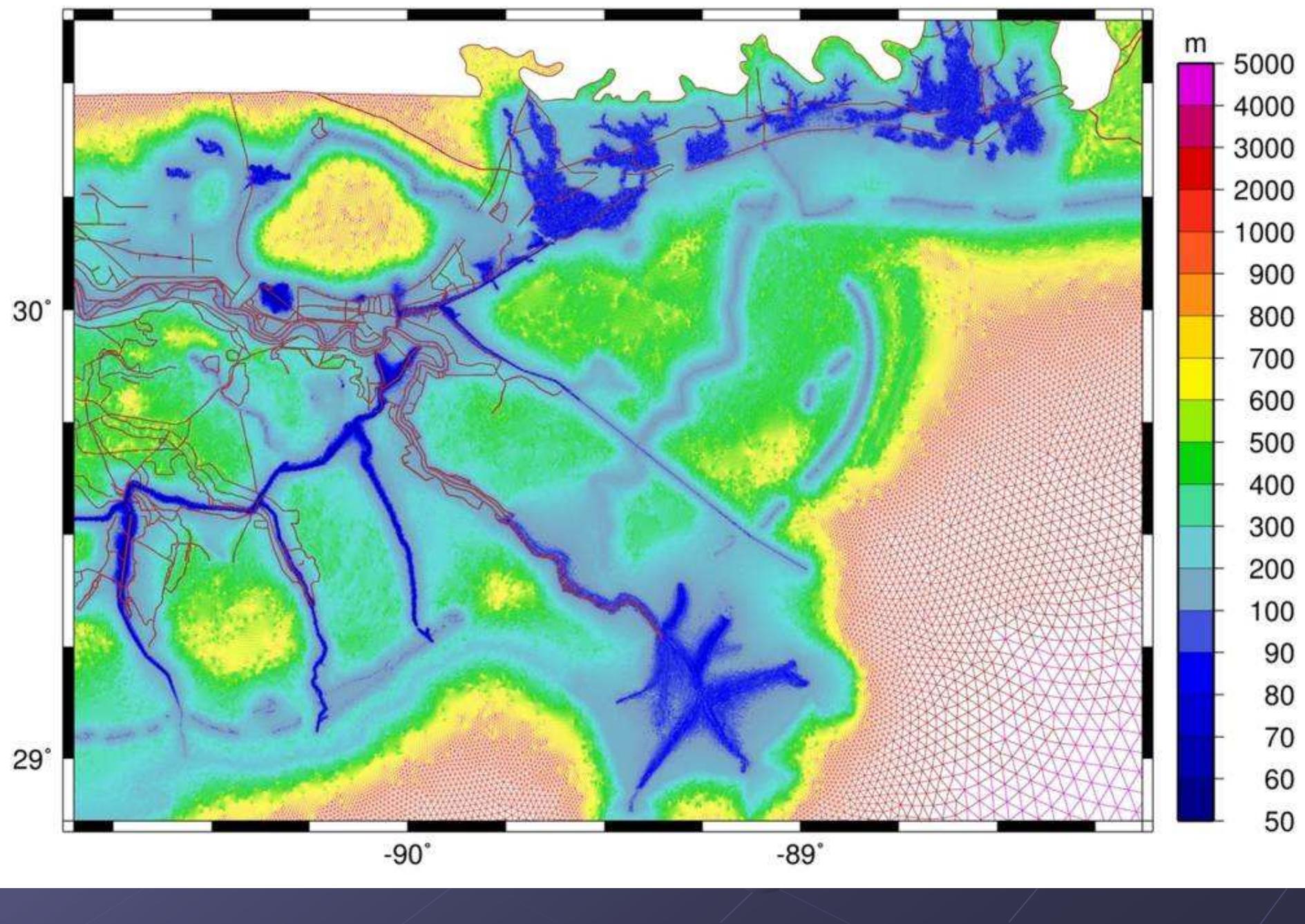
M. Zijlema, L. Holthuijsen, G. Stelling; Delft University

E. Kubatko; Ohio State University

S. Bunya; University of Tokyo

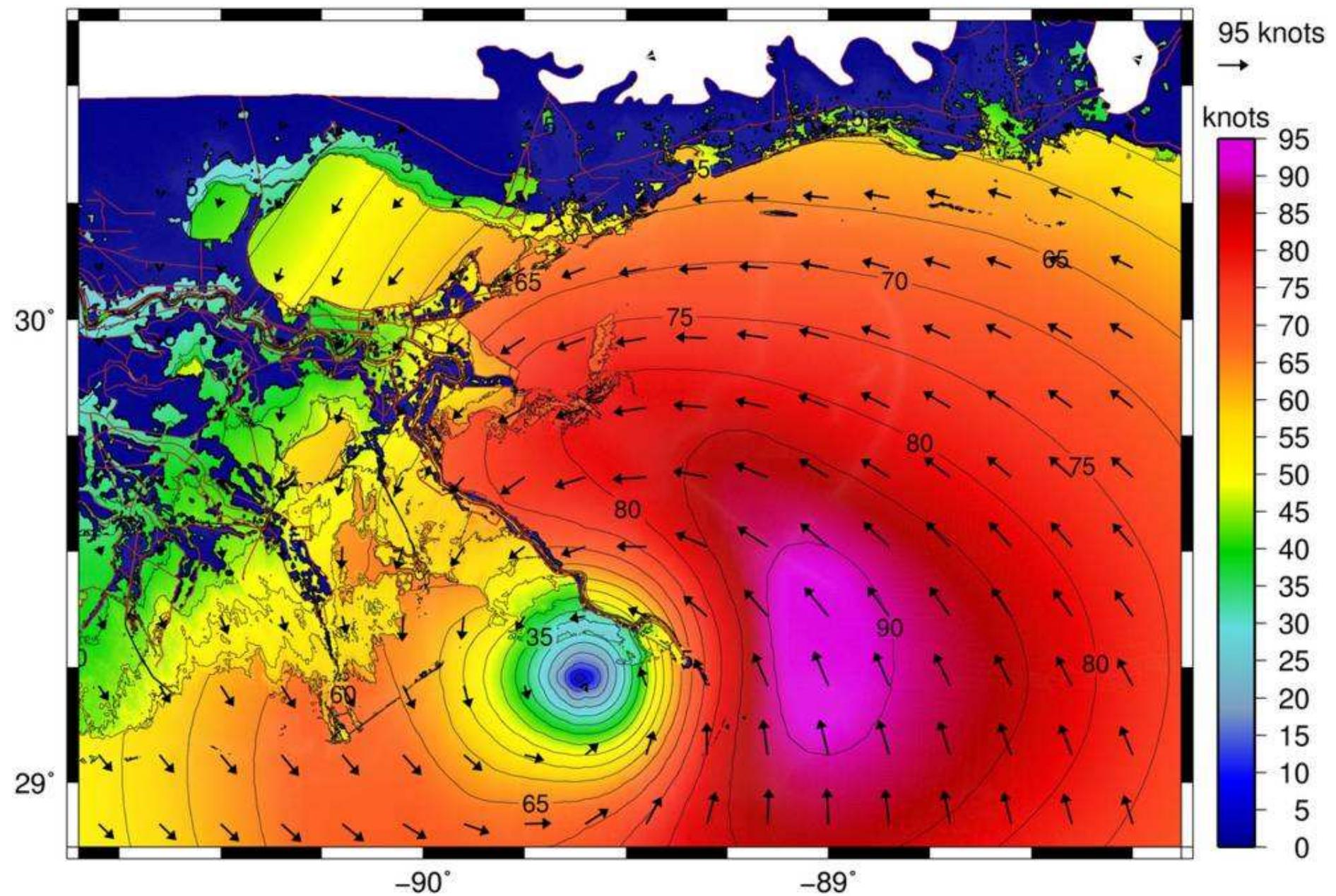


SL15 Grid Size



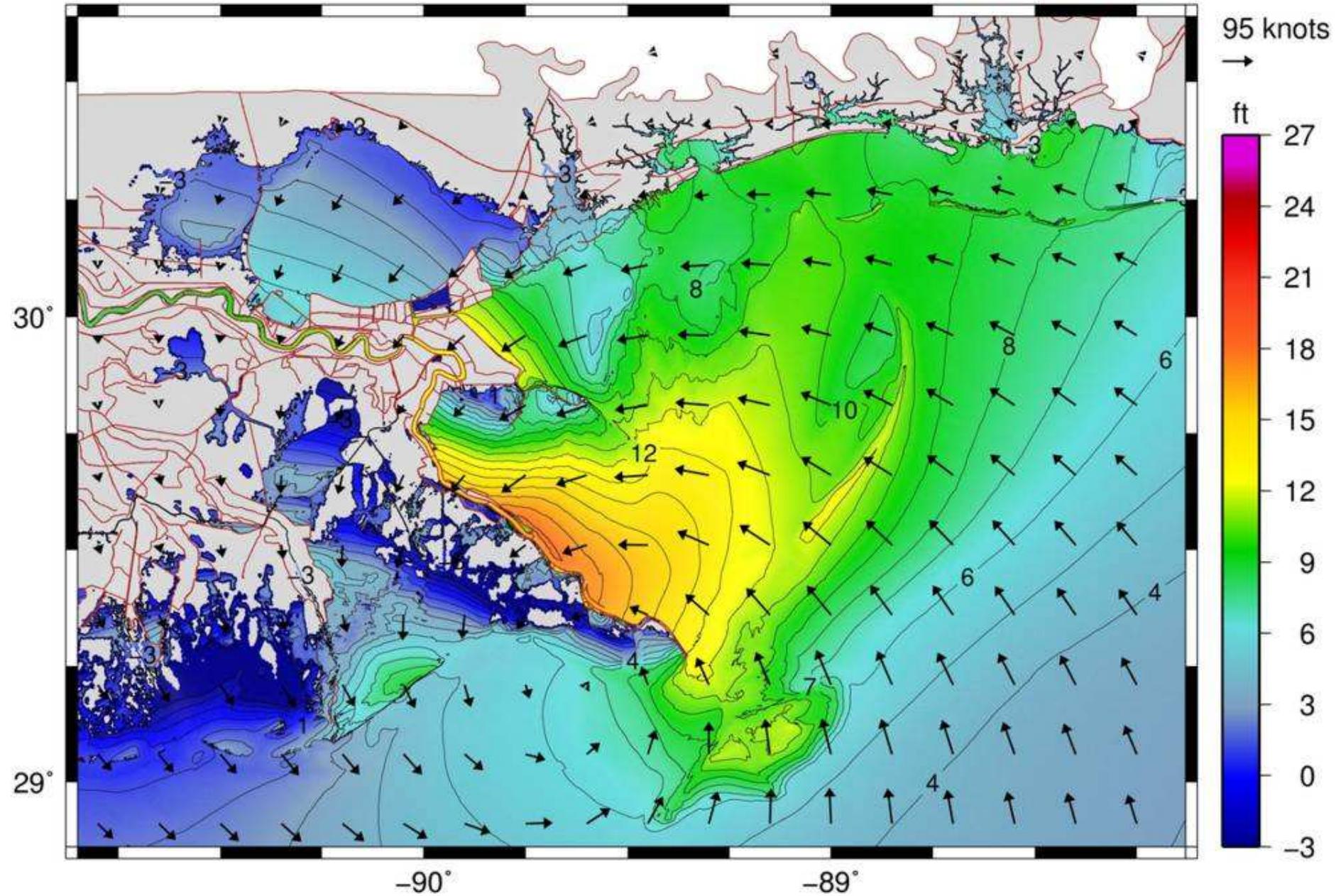
8/29 6:00 CDT

KATRINA Winds (Knots)



8/29 6:00 CDT

KATRINA Surge (ft)



Modélisation bio-hydrodynamique

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Piotr Czajko¹², Ming Guo¹, Mike Tarbotton³*

*¹ Institute of Ocean Sciences, Fisheries and Oceans Canada,
Sidney BC*

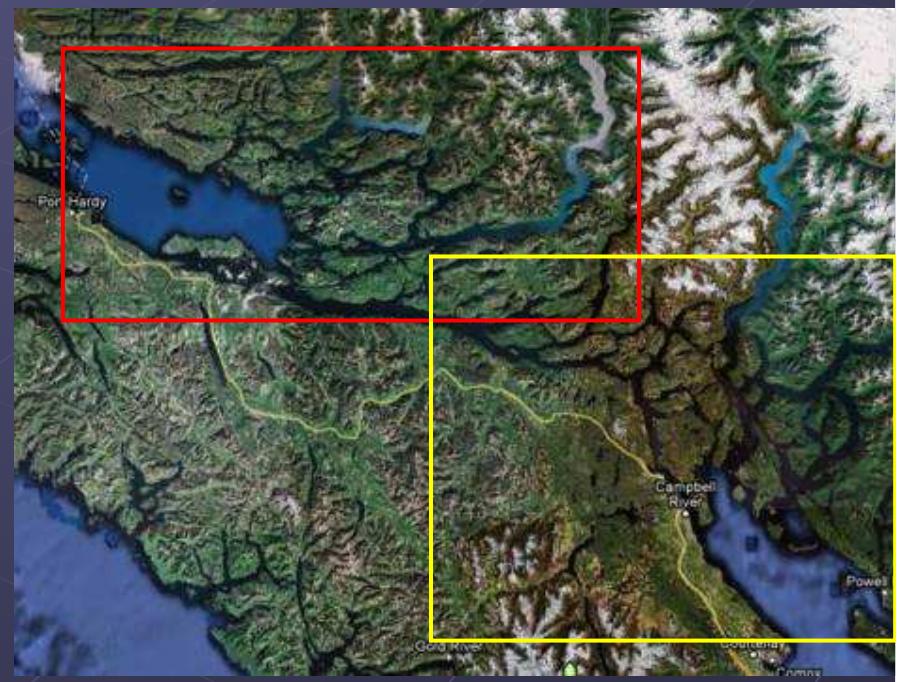
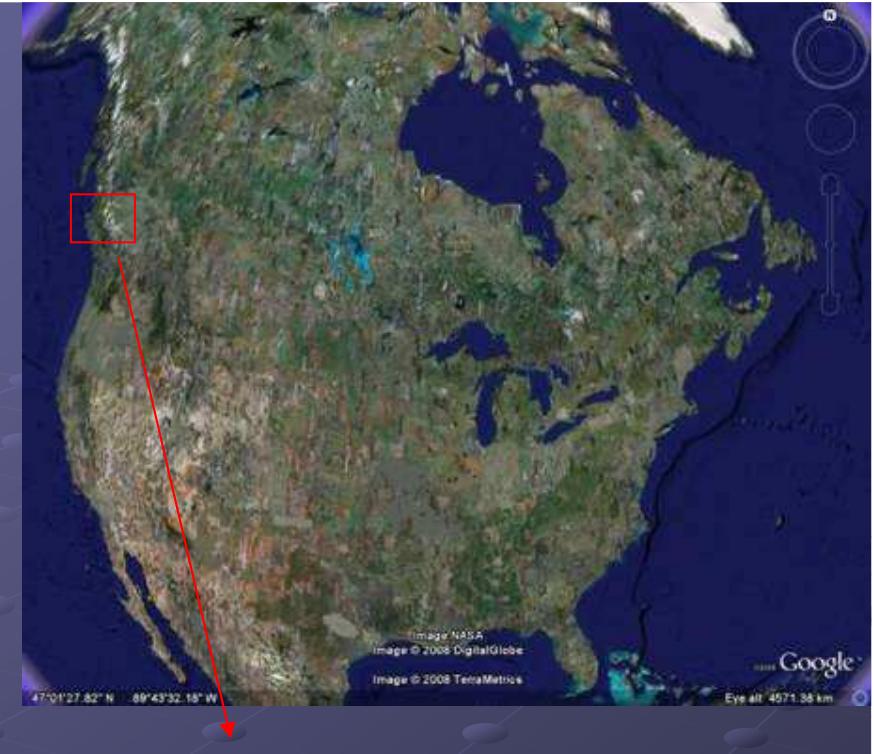
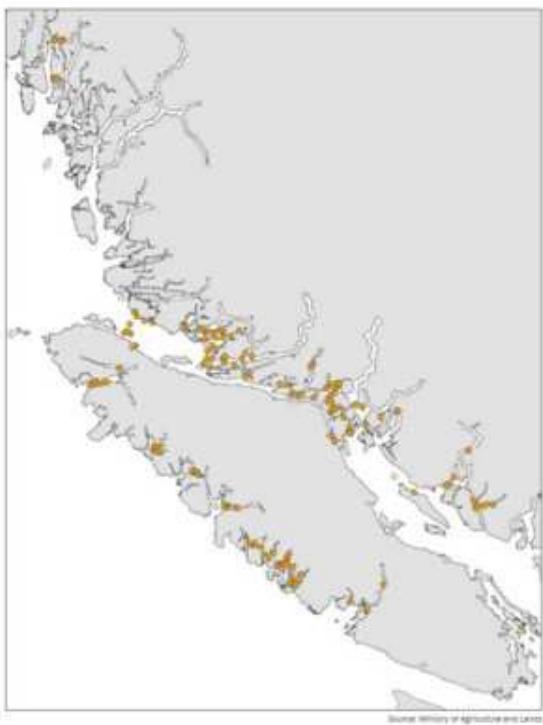
*²Department of Mechanical Engineering, University of Victoria,
Victoria BC*

³Triton Consultants, Vancouver BC

Objectifs

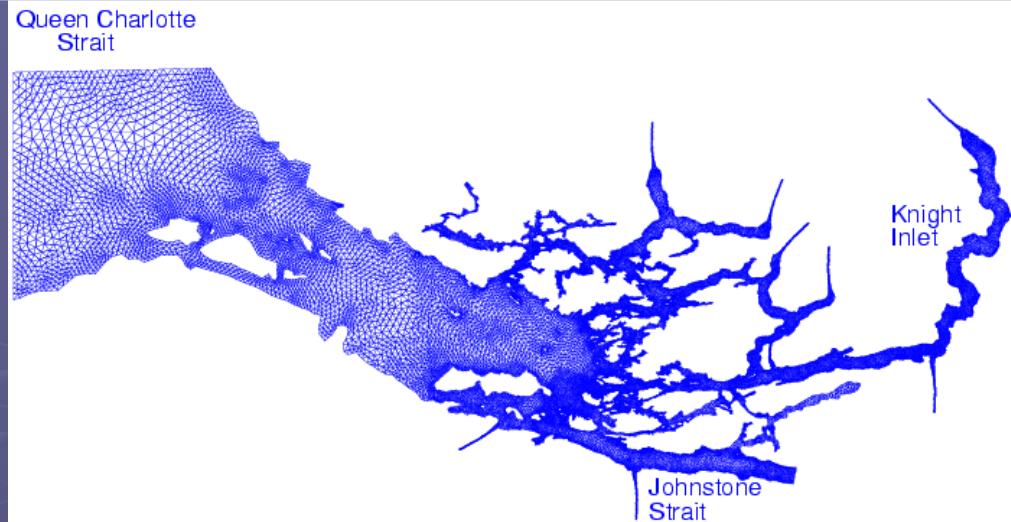
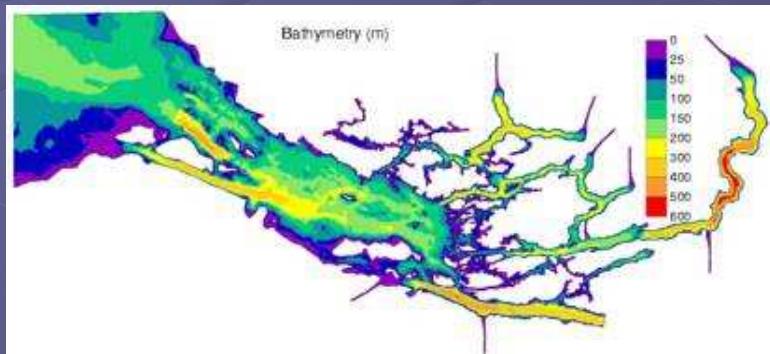
- *Simulate circulation and transport near salmon farms to help address*
 - *dispersion of sea lice to wild salmon*
 - *Viral transport from one farm to others*

Figure 6 Licensed salmon farm sites in British Columbia

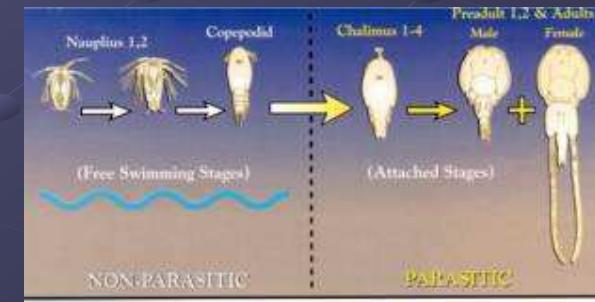


Broughton Biophysical Models

1. Physical model: *FVCOM*



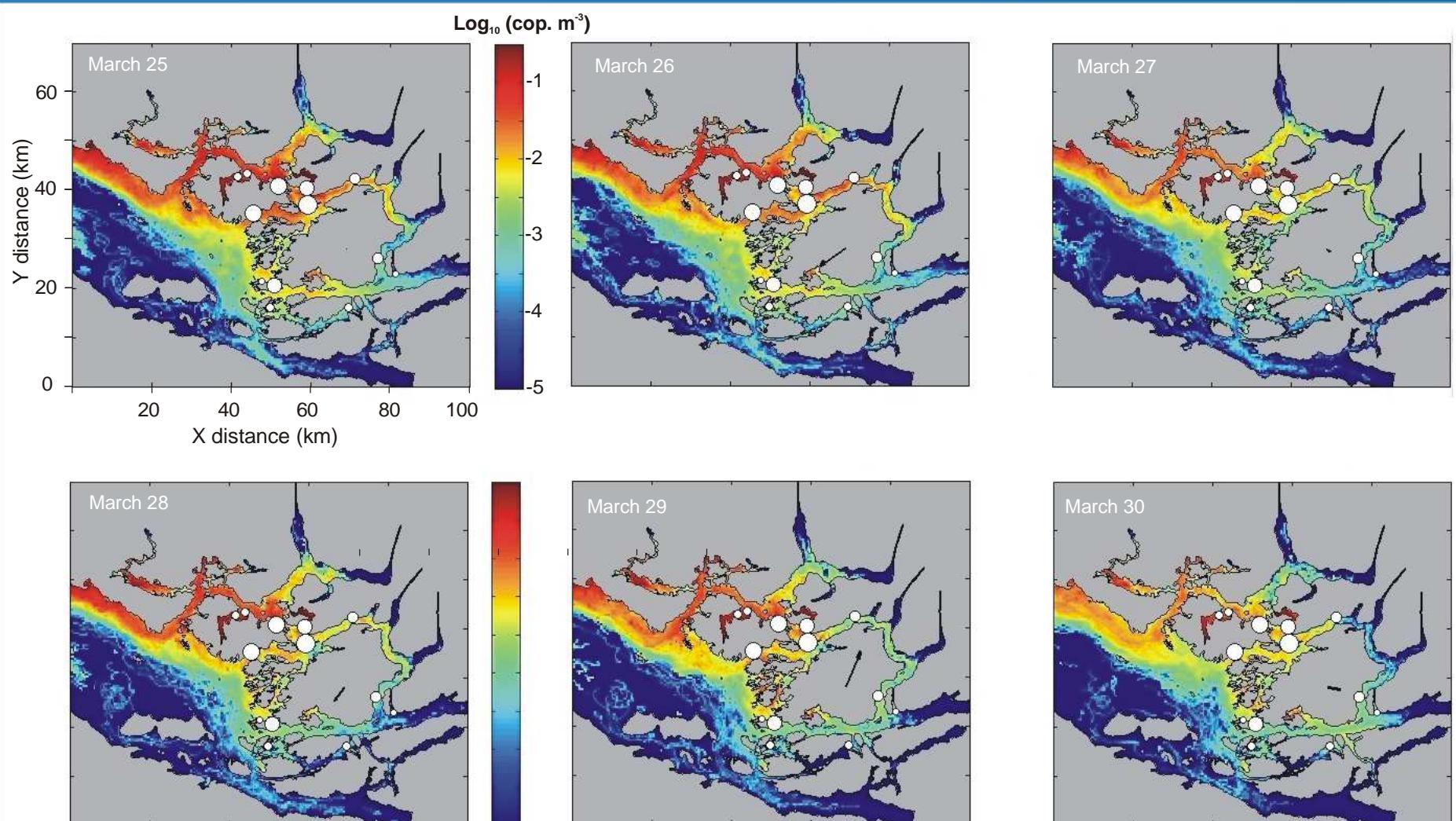
- Triangular grid
- 43K nodes, 75K Δs
- resolution: ~ 3km to 50m
- 20 sigma layers in vertical
- Depths up to 500m



2. Biological model:

- uses 4D velocity, salinity, temperature & mixing fields from FVCOM
- transports and develops lice originating on farms from egg to (infective) copepodid life stages

Copepodid concentration in surface layer



“-1” implies 1 copepodid per 10 m³, -2 implies 1 per 100 m³, ...etc

Conclusions

- Un développement important depuis 2002
- De plus en plus utilisées aux échelles littorales, côtières et régionales
- Encore un challenge à l'échelle globale
(sauf pour la marée grâce à Christian Le Provost....)