Océanographie opérationnelle au Centre de prévision météorologique et environnementale du Canada

F. Dupont, J.-F. Lemieux, G. Smith, F. Roy, C. Beaudoin, Y. Lu, S. Higginson, J. Lei, J. Xu, F. Davidson, G. Garric, R. Bourdalle-Badie et autres collaborateurs CONCEPTS

CONCEPTS
CANADIAN OPERATIONAL NETWORK OF COUPLED ENVIRONMENTAL PREDICTION SYSTEMS

Environment Canada

Fisheries and Oceans Canada

Mercator Ocean
Ocean Forecasters

CONCEPTS

National Defence

The Need for Coupled Atmosphere-Ice-Ocean Prediction

Davidson et al., SCOR, 2013

Environment Canada requires ice-ocean forecasts and information services for:

- Improved weather and wave prediction
  - Timescales from days to seasons
  - Sea ice, tropical cyclones, surface interactions
  - Initialization of seasonal forecasts
- Sea ice prediction
  - Improved automated analyses and forecasts
  - Dangerous high pressure areas
- Emergency response
  - Comprehensive trajectory modelling capacity
  - E.g. dispersion of pollutants
- Collaboration with other GoC departments
  - Fisheries and Oceans, Coast Guard
  - National Defense

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- Seventh Outline Level

CONCEPTS

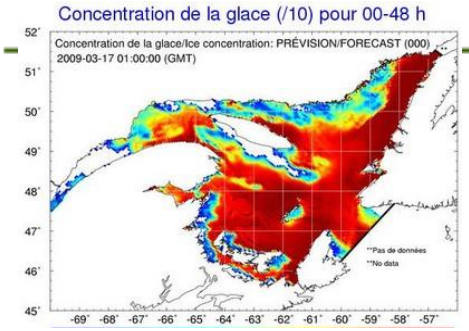
Fisheries and Oceans Canada / Pêches et Océans Canada

National Defence / Défense nationale

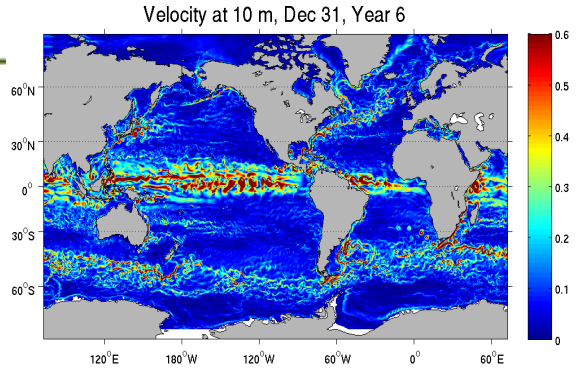
Environment Canada / Environnement Canada

Canada

Systèmes d'océanographie opérationnelle à CONCEPTS

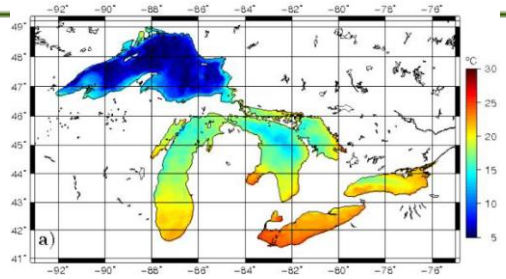


Golfe du St-Laurent (5km) couplé, opérationnelle depuis juin 2011



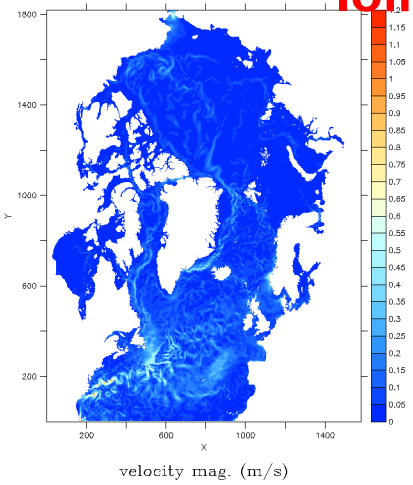
SGPOG à 12-26km op. depuis août 2015

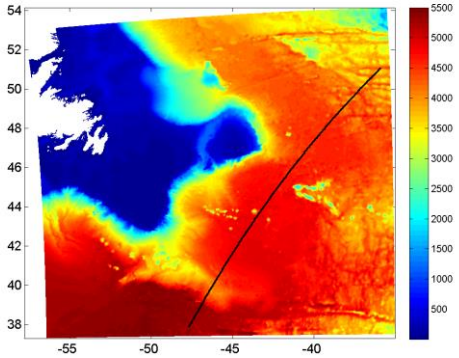
Couplé depuis été 2016, présenté plus loin



Grands Lacs 2km couplé, expérimental depuis 2016

SRPOG à 5km expérimental 2016, présenté ci-après





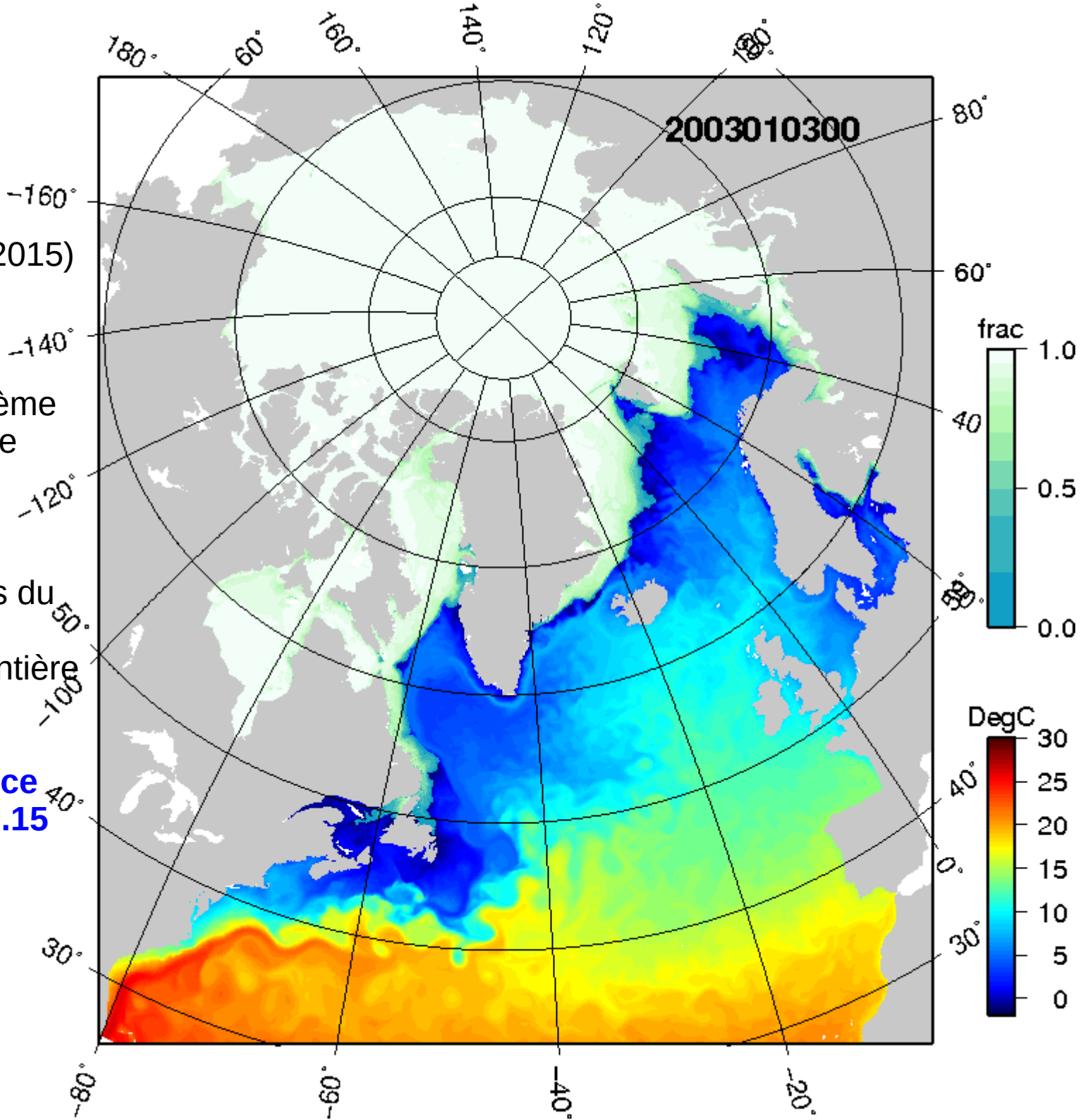
À venir: des fenêtres à 1/36°

Domaine:
1580x1817x50
512 procs
CREG12
(dupont et al. GMD 2015)

Extrait de ORCA12 (1/12ème de degrés) avec la couture nord. “CONCEPTS Regional”=CREG.

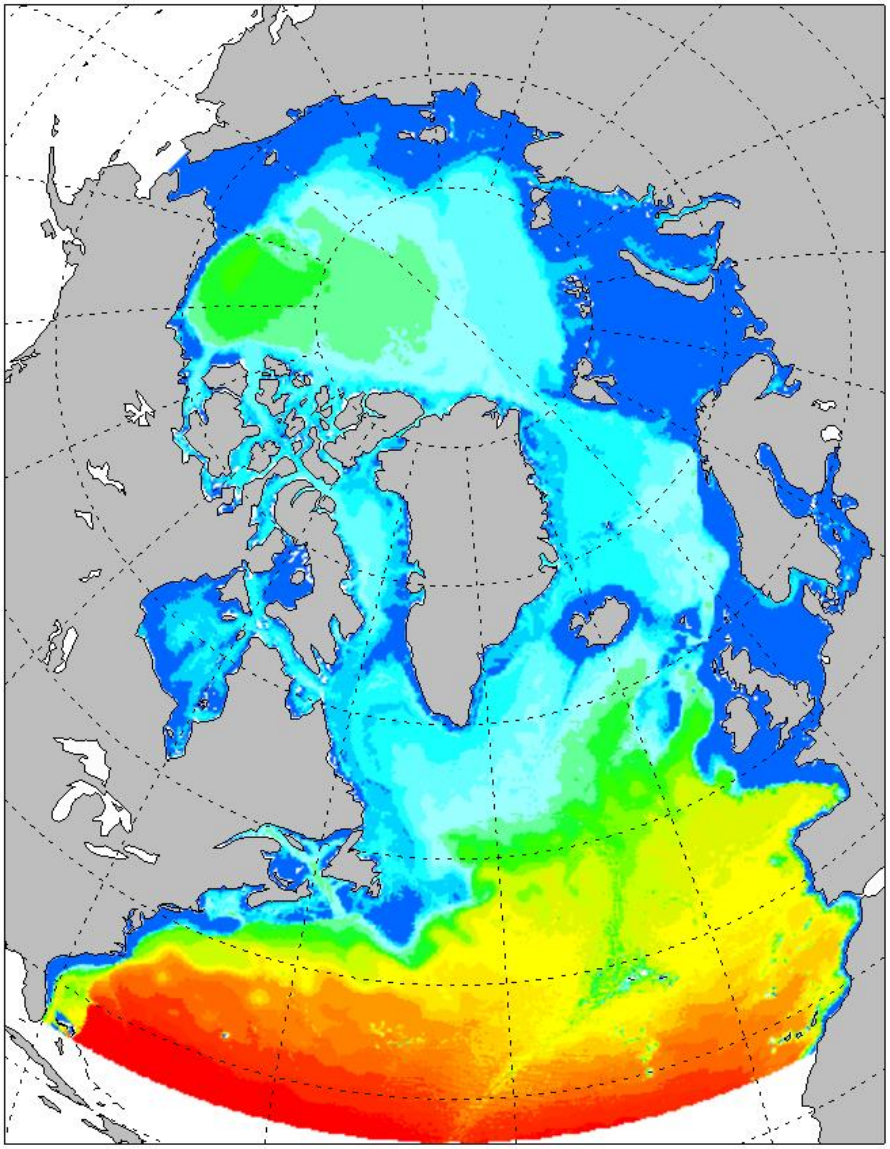
Résolution maximum près du pôle artificielle (**2 km**) et minimum le long de la frontière sud (**8 km**)

configuration CICE: 10 ice catégories (m) = [0 0.1 0.15 0.3 0.5 0.7 1.2 2 4 6+]



Rayon de Rossby de déformation

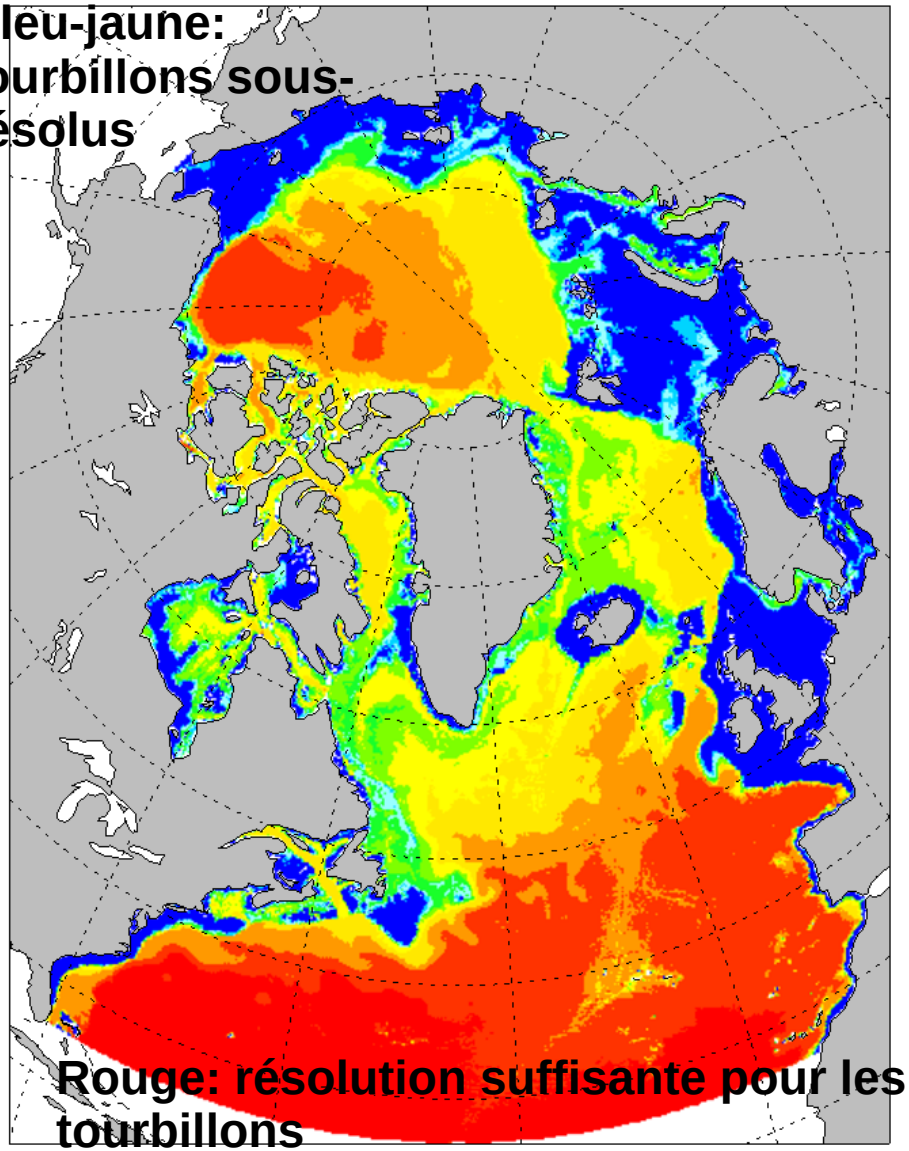
Radius (km)



0 3 6 9 12 15 18 21 24 27 30 33 36 39

Radius/DX (log2)

Bleu-jaune: tourbillons sous-résolus



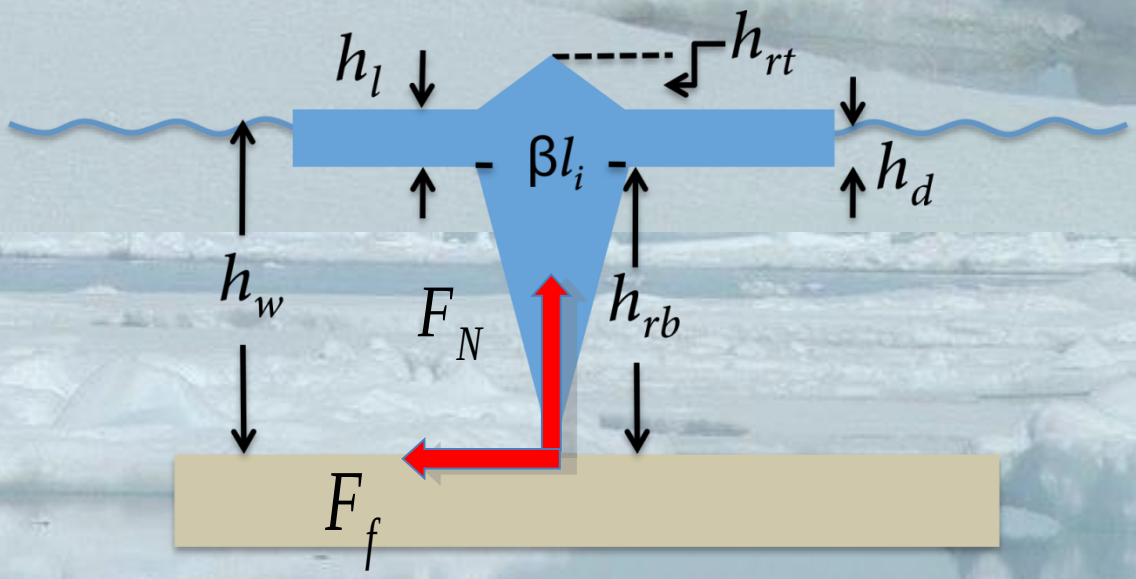
Rouge: résolution suffisante pour les tourbillons

-2 -1.5 -1 -0.5 0 0.5 1 1.5 2

Représentation de la glace de rive dans H07 et SRPOG:

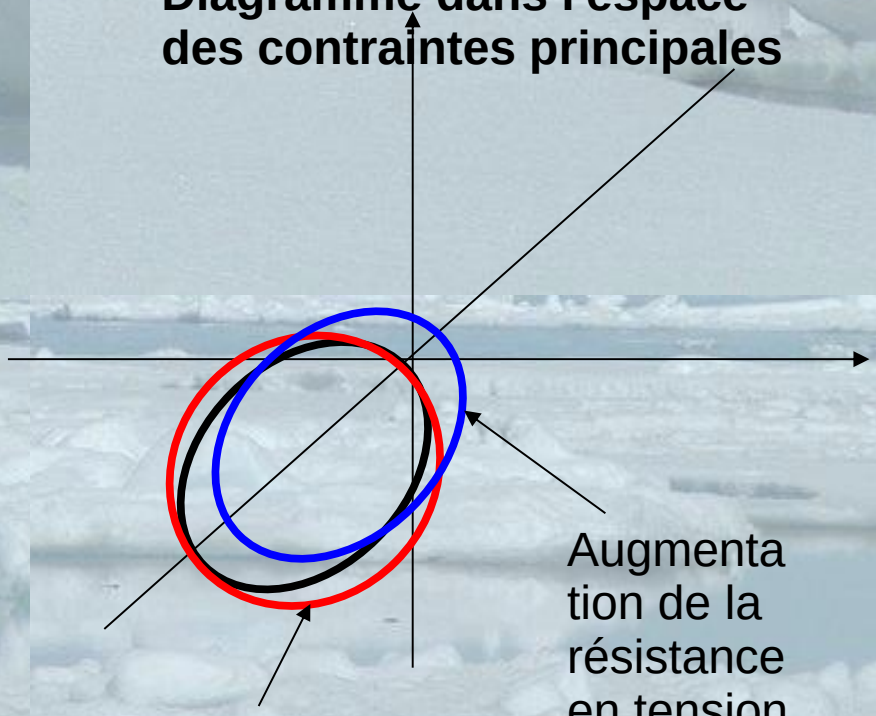
-L'ancrage au fond de la glace de rive est paramétrisée (Lemieux et al. 2015)

-Augmentation de la résistance en tension (Lemieux et al., 2016) améliore la représentation des ponts de glace mais ralentit la vitesse de glace dans le modèle.

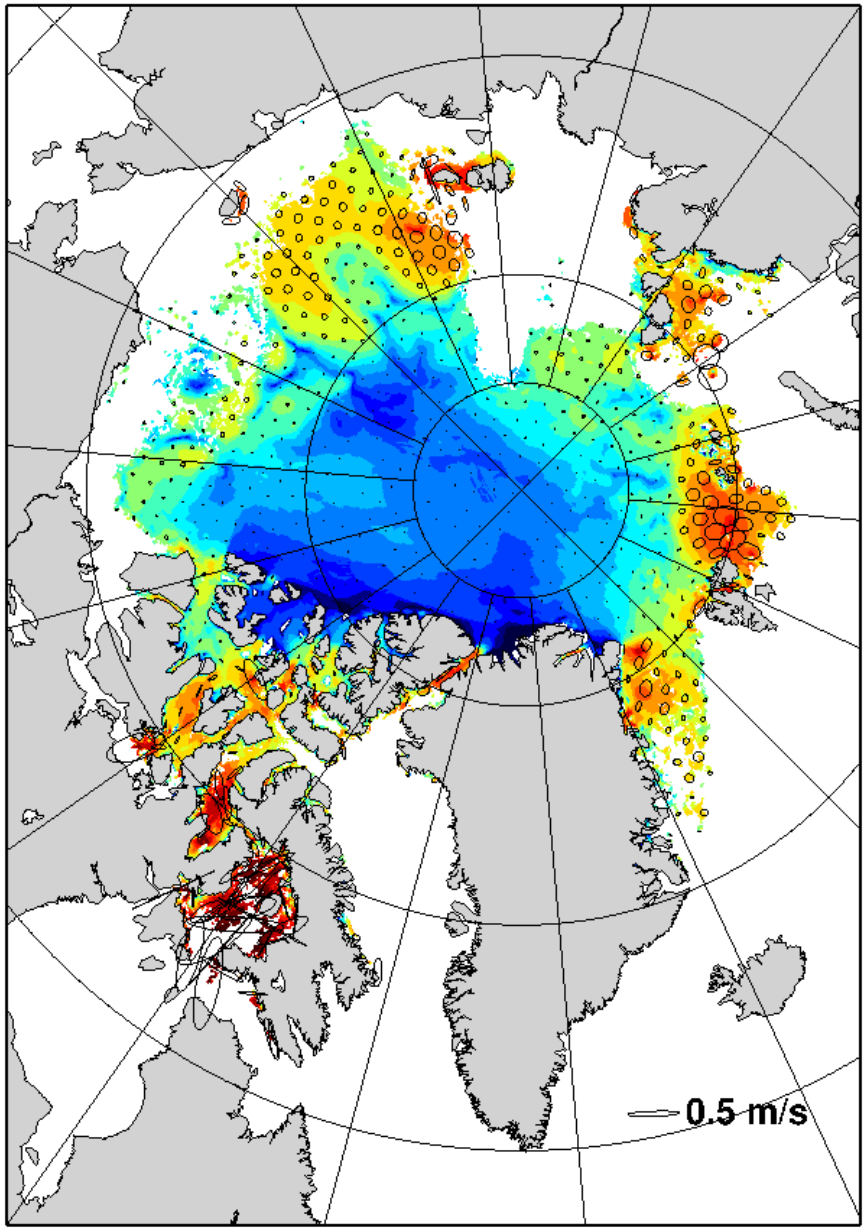


Quille de glace touchant le fond

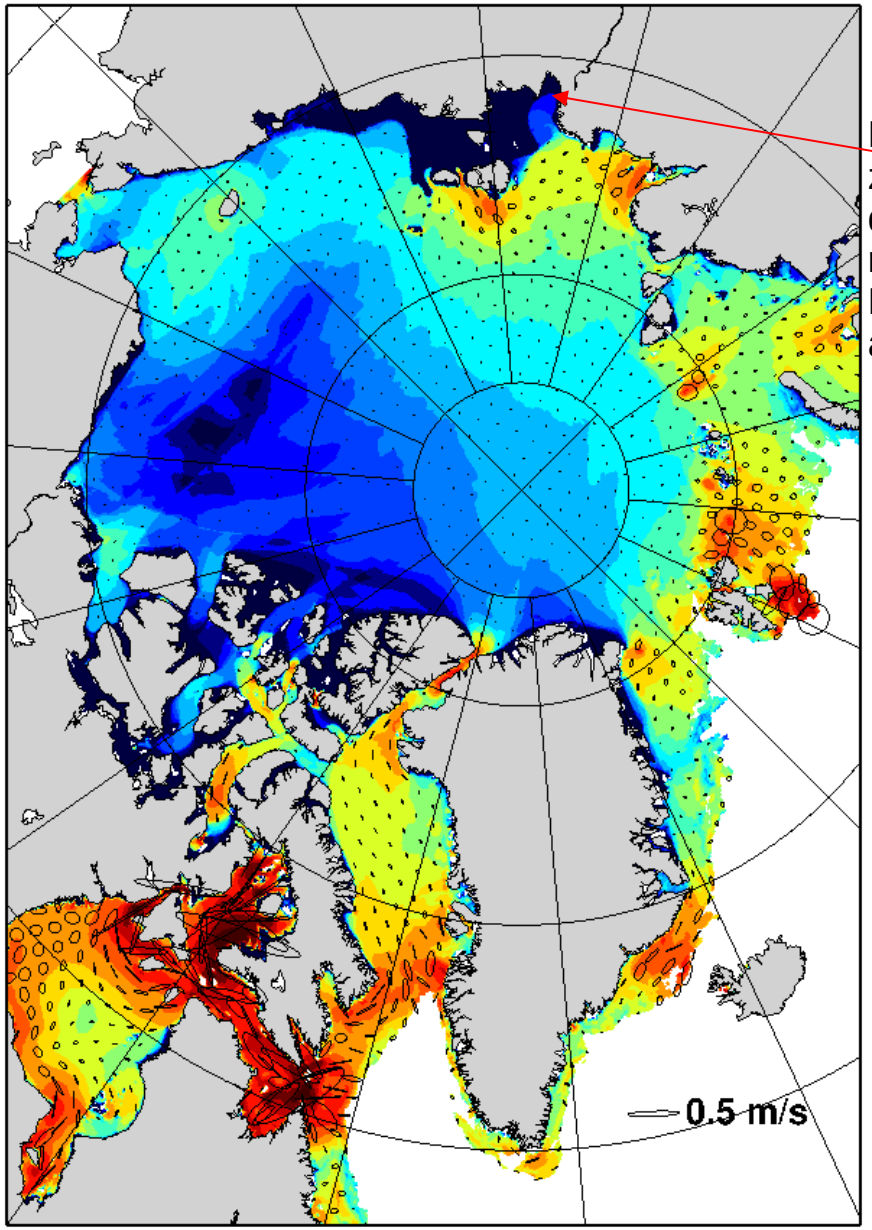
Diagramme dans l'espace des contraintes principales



Été (juillet) 2014, ellipse de marée (M2) dans la glace



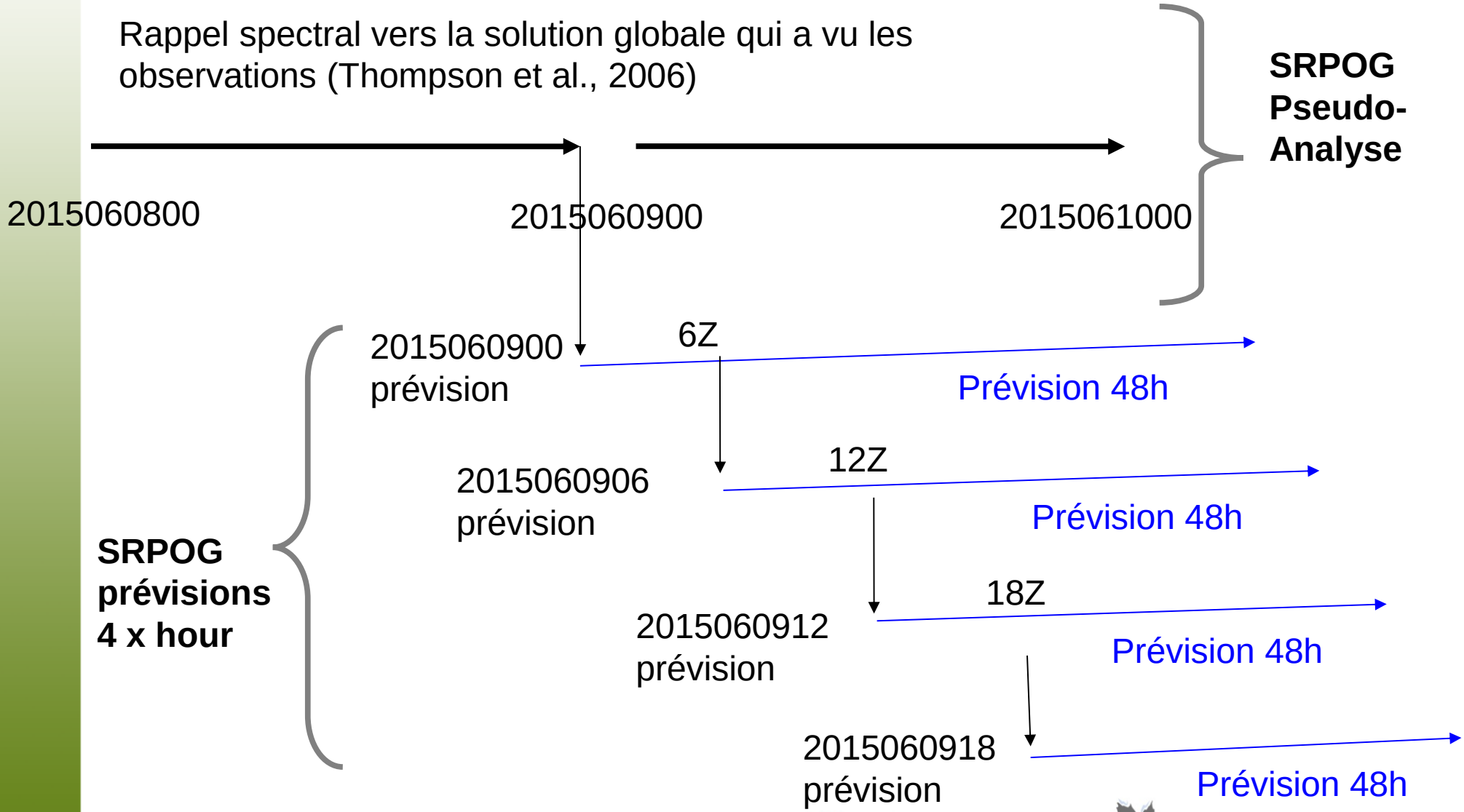
Hiver (janvier) 2015, ellipse de marée (M2) dans la glace



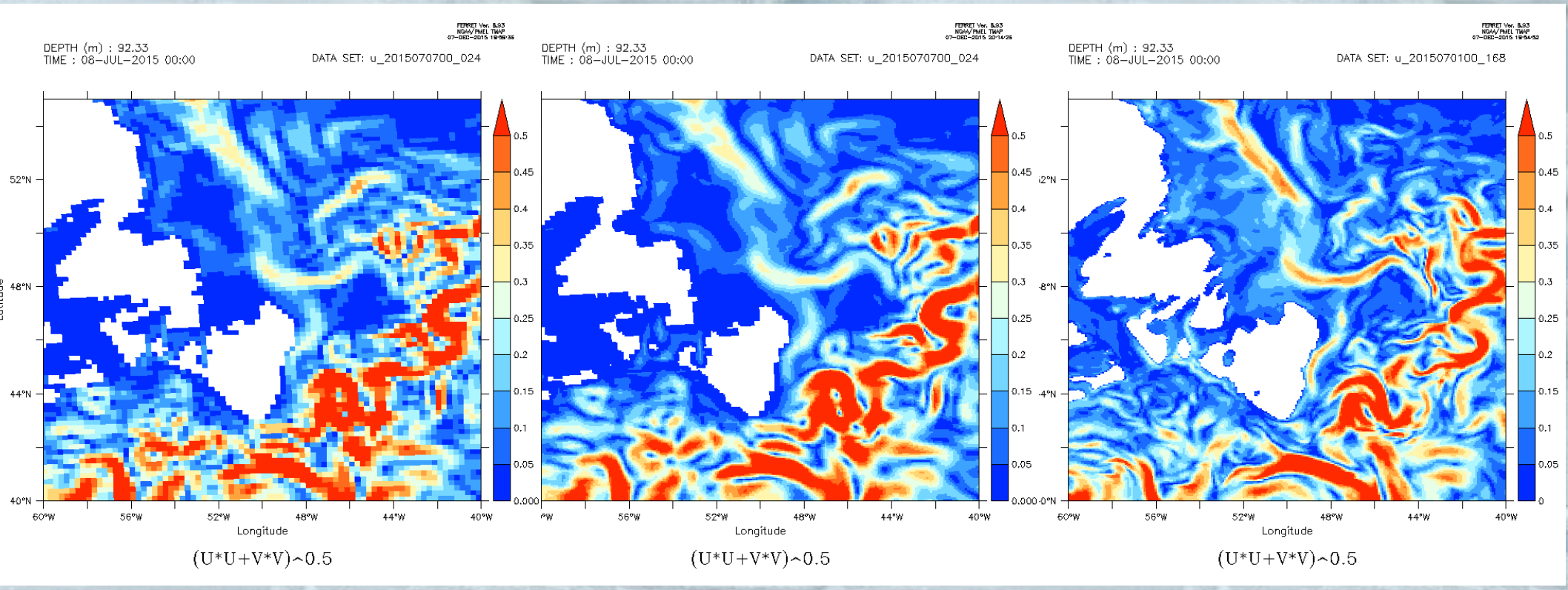
Notez la
zone mo
de glace
rive.
Lemieux
al. (2015

SRPOG:

3 Composantes: RIPS 3DVar analyse de glace, pseudo-analyse et prévision 48h



Comparaison des vitesses le 08-07-2015



global

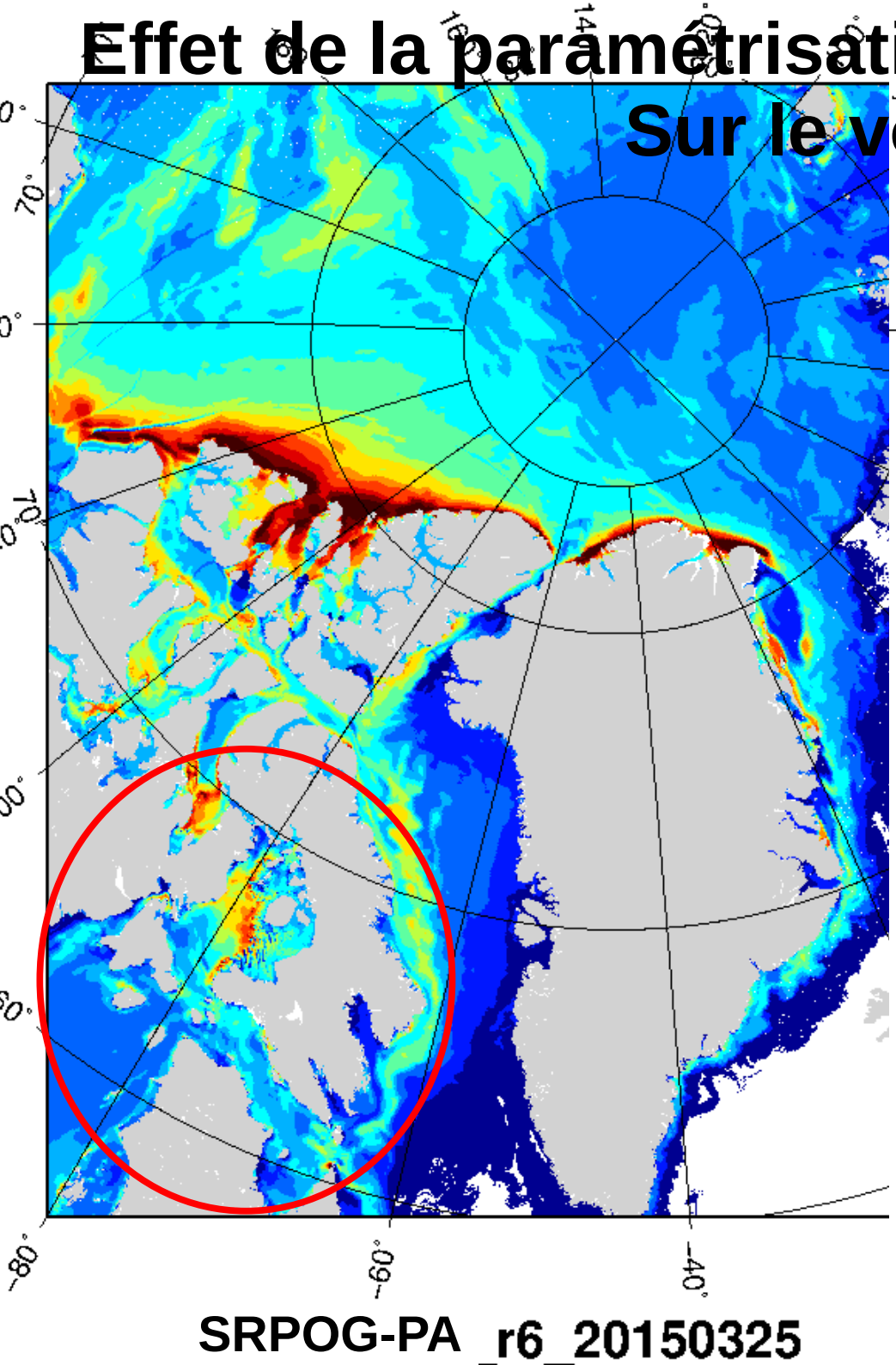
Global interpolé à 1/12ème de degrés

SRPOG

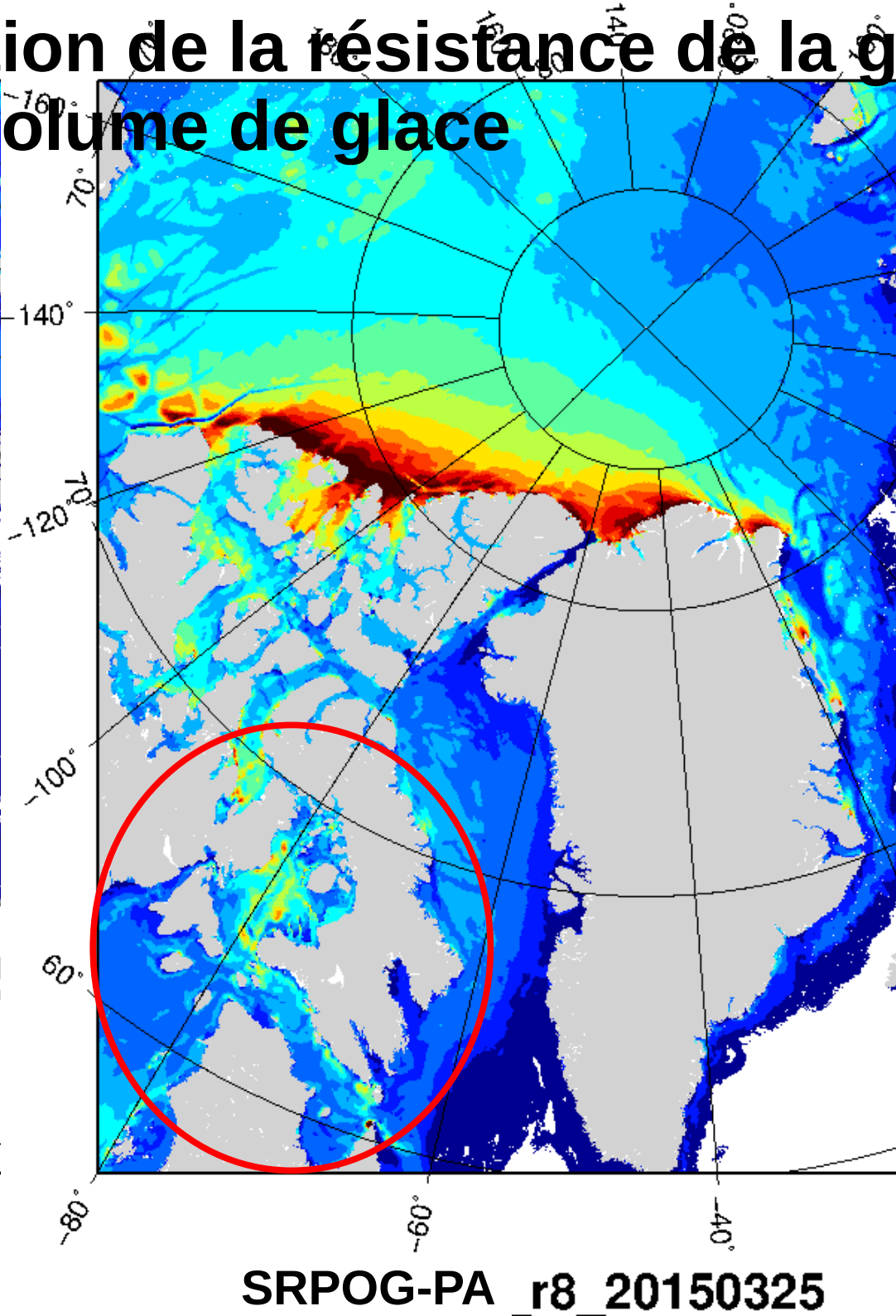
Rappel spectral (dans l'espace) aux larges échelles vers la solution globale

Effet de la paramétrisation de la résistance de la g

Sur le volume de glace

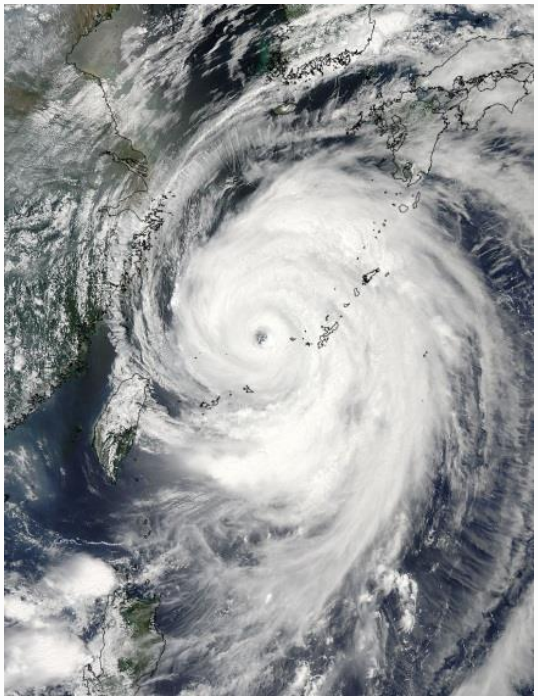


SRPOG-PA _r6_20150325



SRPOG-PA _r8_20150325

The New Coupled Global Deterministic Prediction System: Sensitivity of Operational NWP Forecasts to Coupling with an Ice-Ocean Model



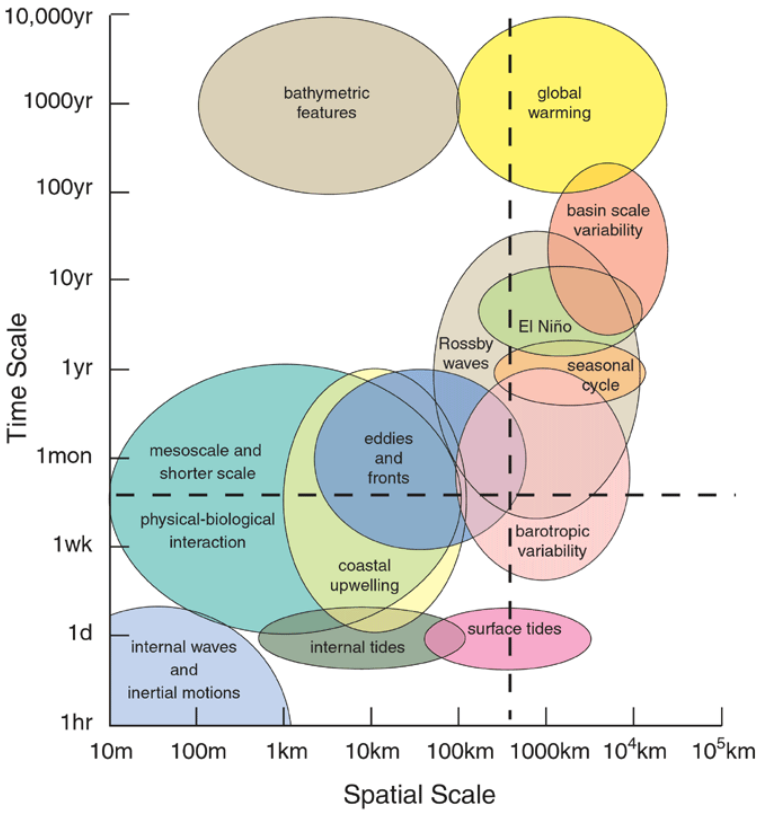
Gregory C. Smith*, Jean-Marc Bélanger, François Roy, Pierre Pellerin, Hal Ritchie, Kristjan Onu,
Environmental Numerical Prediction Research Section, ECCC

Michel Roch, Ayrton Zadra,
Numerical Weather Prediction Research Section, ECCC

Dorina Surcel Colan, Barbara Winter, Juan-Sebastian Fontecilla and Daniel Deacu
Meteorological Service of Canada, ECCC

Potential benefits of coupling for numerical weather prediction

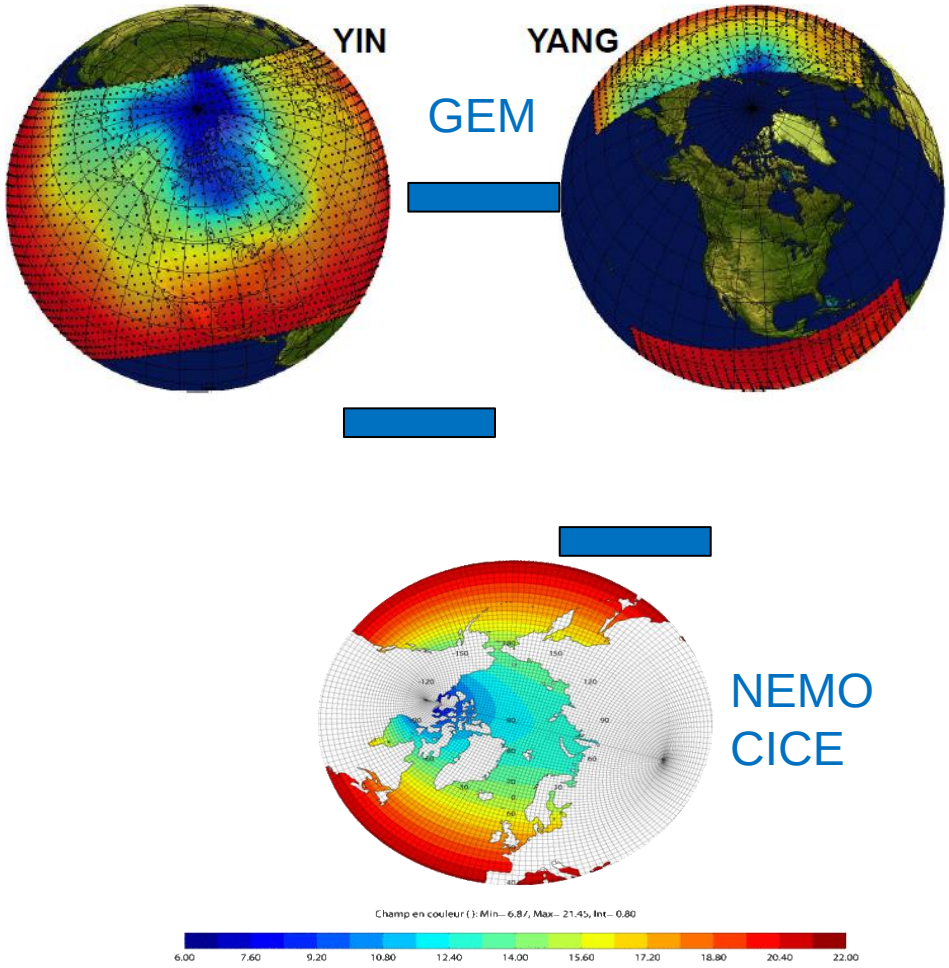
- Classic view:
  - Ocean timescales are slow compared to the atmosphere
- However, numerous short-time/space scale processes relevant for coupled NWP
  - Tropical convection,
  - Hurricanes, extra-tropical storms
  - Coastal upwelling,
  - Sea ice (polynyas, leads)
- Made possible by
  - Global Ocean Observing System (e.g. Argo)
  - Improved ice-ocean modelling and data assimilation capacity



Brassington et al., J. Op. Ocean, 2015

Global Coupled Medium-range Deterministic Forecasts

- Coupled NWP system running in operations at CCMEP since July 2016.
  - GDPS coupled to GIOPS
  - Global, fully-coupled A-I-O, 25 km(A)-1/4deg(IO),
  - 10 day forecast (2/day)
- Horizontal resolution increase of atmosphere to 15 km in 2018
- Available on RPNWMS:
  - E.g. www.meteocentre.com/plus
- MSC datamart (soon)
  - Atm: GRIB2, Ocean/Ice: Netcdf4



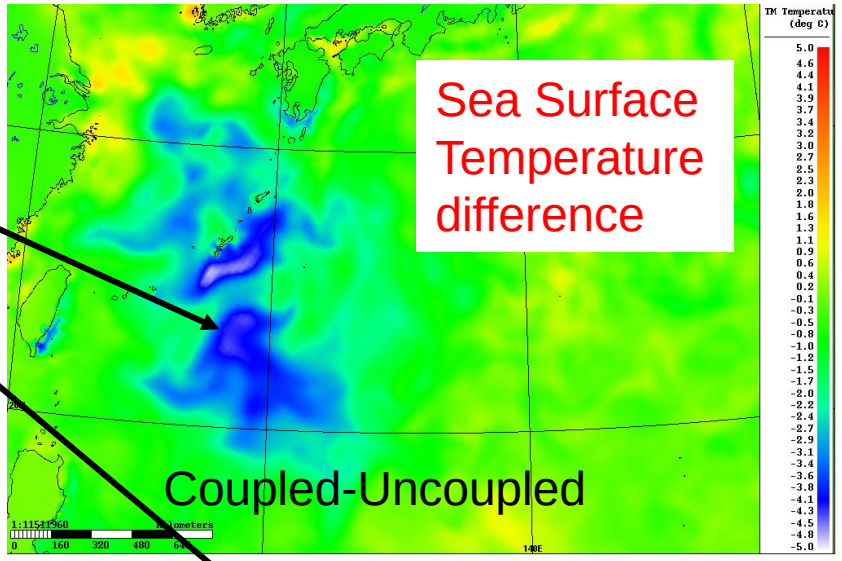
Forecast Evaluation

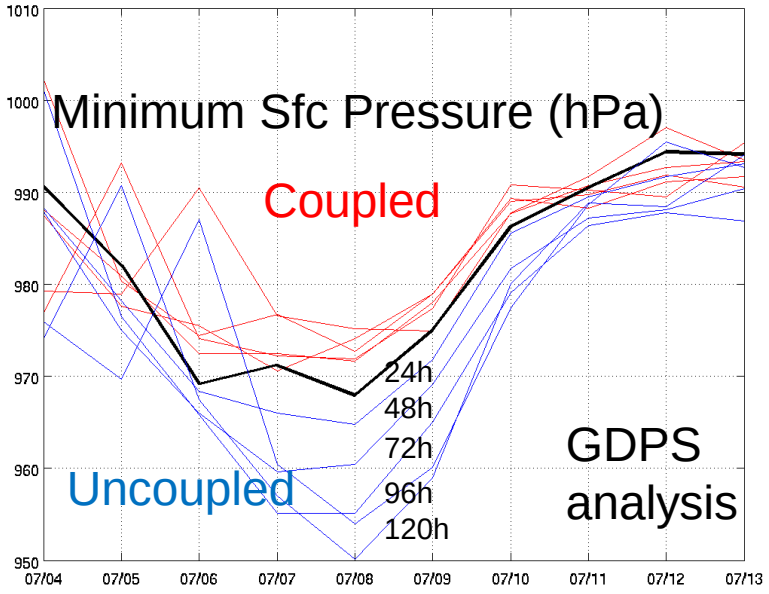
- Produce 10 day coupled forecasts every 12h
  - GEM initialized from GDPSv5.0.0 analyses
  - NEMO/CICE initialized from GIOPSv2.1.1 analyses
  - Compare Coupled forecasts to Forced (uncoupled) forecasts
- Forecast periods
  - Summer 2014 (June 15-August 31, 2014)
  - Winter 2015 (15 Dec 2014 – 01 Mar 2015)

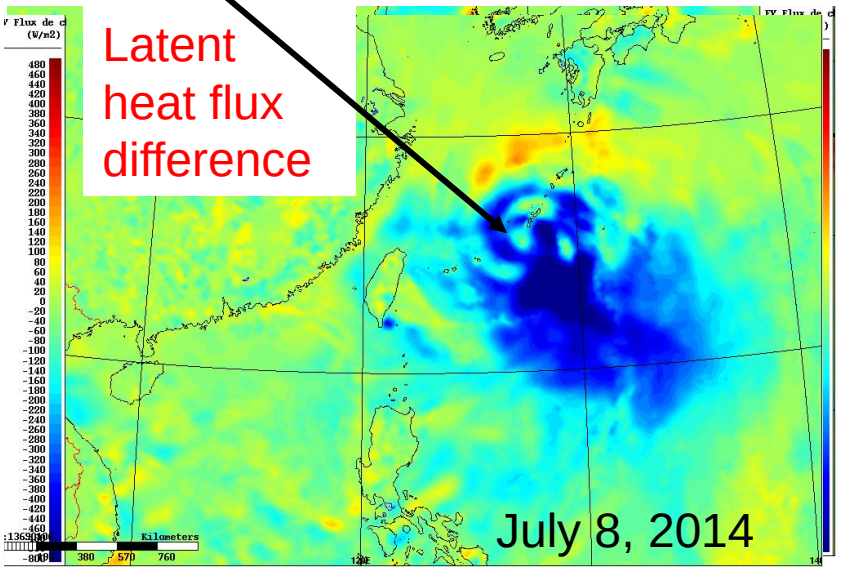
Impact of Coupling on Forecasts for TC Neoguri

96h forecasts, valid 00Z, July 10, 2014

- Coupling results in ~4°C cooling of sea surface temperature
- with associated >500 W/m2 reduction in latent heat flux
- Leads to reduced intensification at all lead times (24-120h)

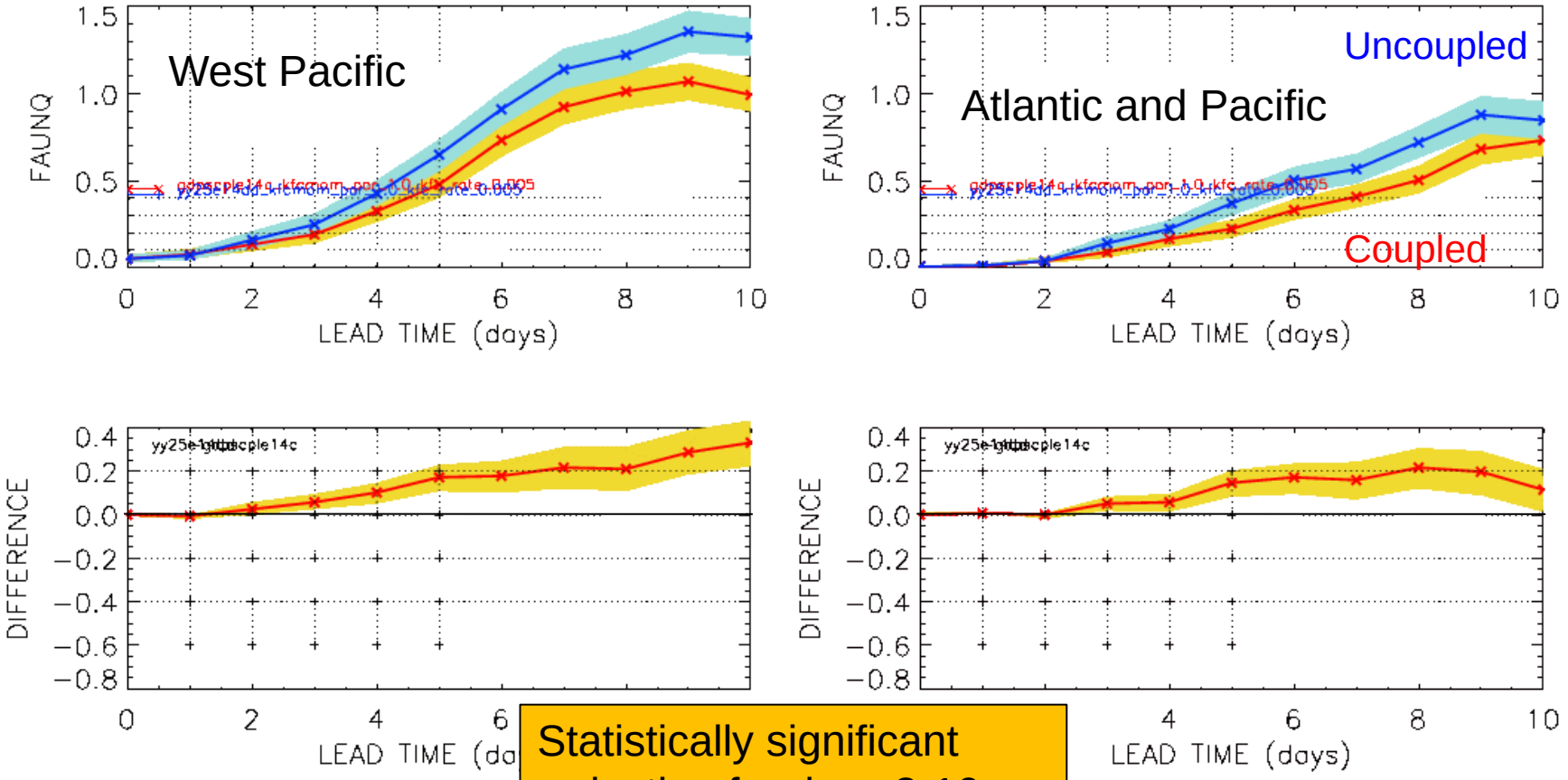






Unequivocal False Alarm Rate

Storm tracking thresholds set as in Zadra et al. (2014)



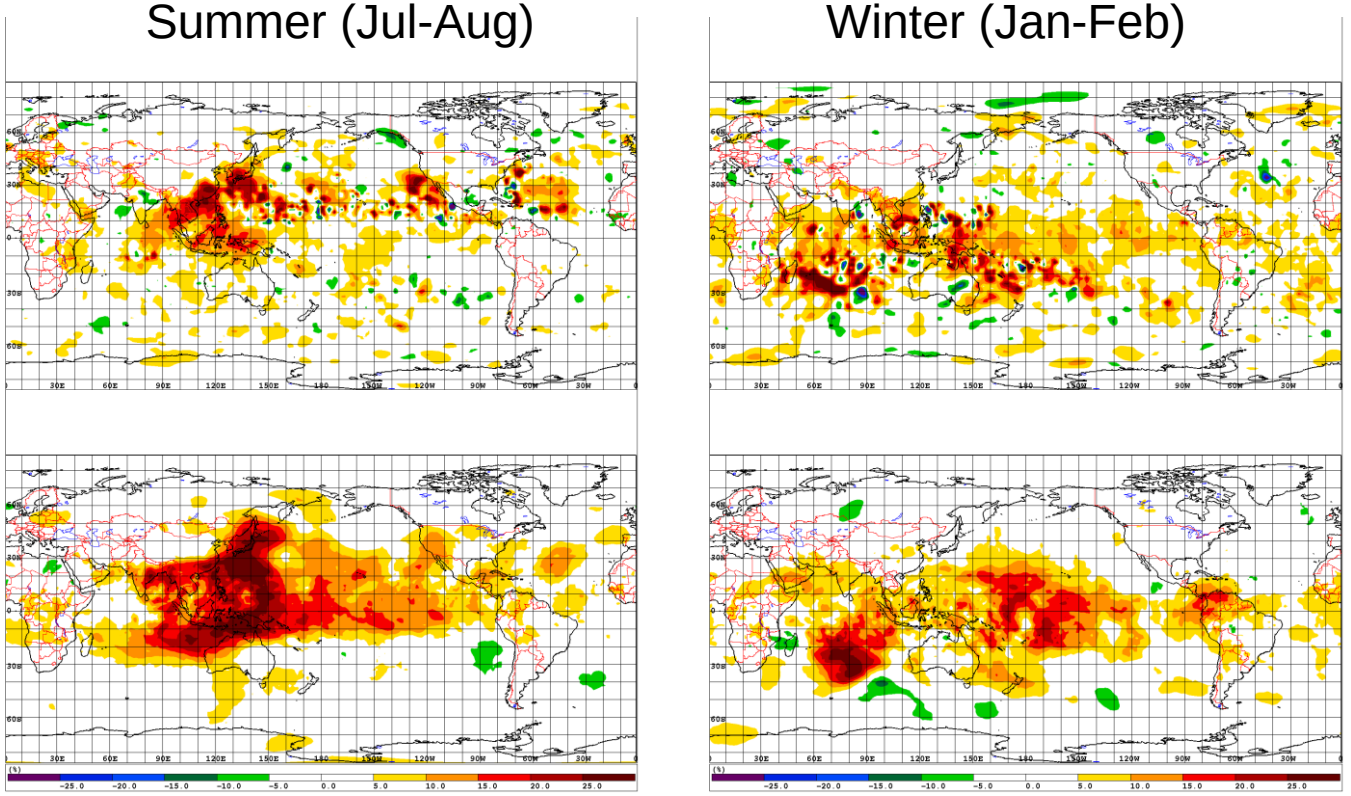
Statistically significant reduction for days 3-10

% Impact of Coupling on Geopotential Height Fields

120 hr lead time

Summer (Jul-Aug)

Winter (Jan-Feb)



850 hPa

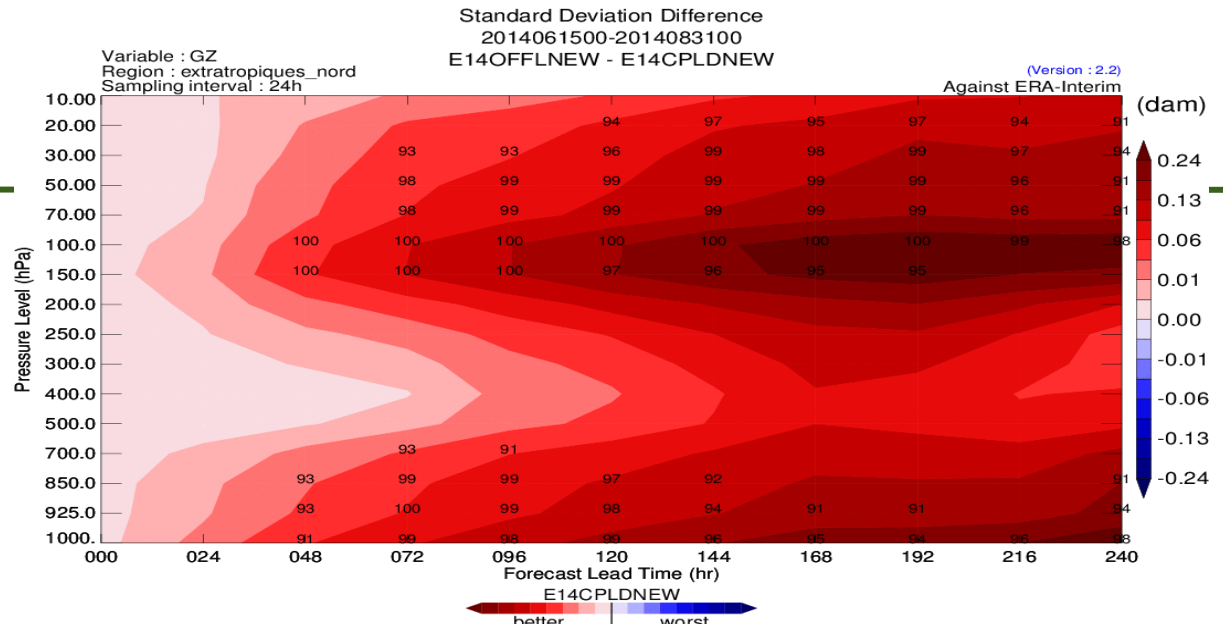
100 hPa

Worse

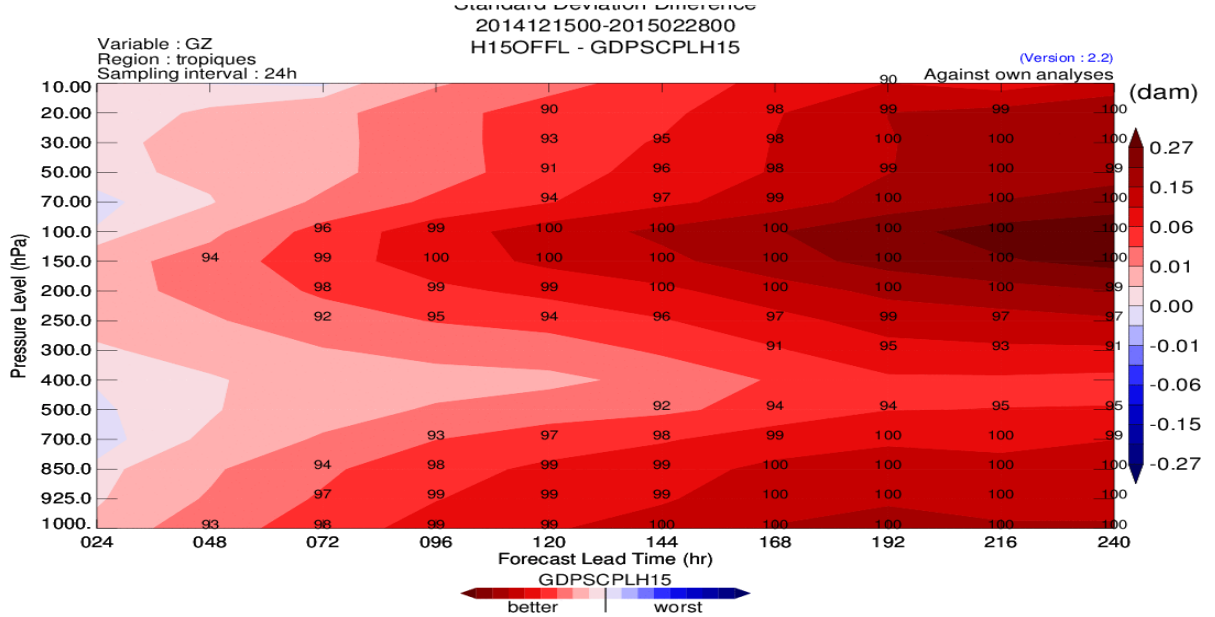
Better

Difference in StdDev error in Geopotential Height Fields

Geopotential Height for Northern Extratropics (Jul-Aug)



Geopotential Height for Tropics (Jan-Feb)



Better

Worse

Lead time (hr)

Summary

- CCMEP is currently running a suite of global and regional coupled environmental prediction systems
  - Benefit for weather prediction as well as providing an ice-ocean prediction capacity
- Global Coupled Medium-range NWP running since July 2016
  - Main impacts due to improved representation of surface fluxes for tropical cyclones
  - Significant impacts for Northern Extratropics growing with increasing lead time
  - Operational implementation planned for September 2017
- Successful implementation depends on careful treatment of surface initial conditions and sea ice physics