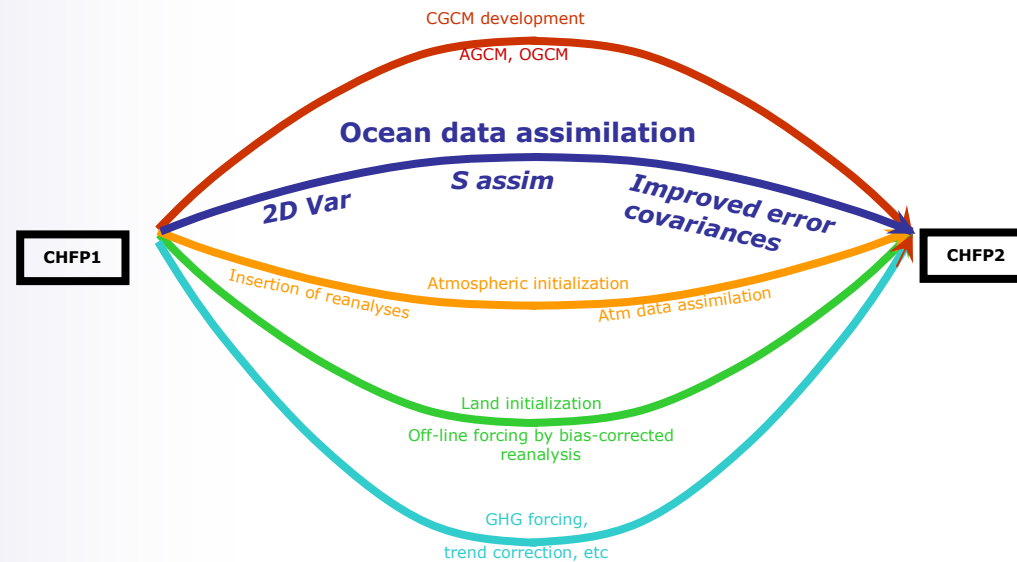


# Ocean Data Assimilation for CHFP2

Woo-Sung Lee, William J. Merryfield and Youmin Tang<sup>1</sup>  
CCCma, Univ. of Northern BC<sup>1</sup>





# Outline

## ❖ Ocean Data Assimilation

- SST nudging Initialization
- $T_{\text{obs}}$  inserting Initialization
- 2DVar Temperature Assimilation
- 2DVar Temperature Assimilation with Salinity Corrections

## ❖ Improve Error Covariance

## ❖ Future Works

# Ocean Data Assimilation

*SST nudging history run*

1970.1-  
2001.12

D  
N  
O  
S  
A  
J  
J  
M  
A  
M  
F  
J



**EXP I. SST nudging Initialization**  
(Keenlyside et al., 2005)



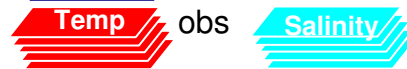
**EXP II. Tobs Inserting Initialization**  
(Kirtman and Min, 2009)



**EXP III. Temperature Data Assimilation  
using Off-line 2DVar** (Tang, 2004)



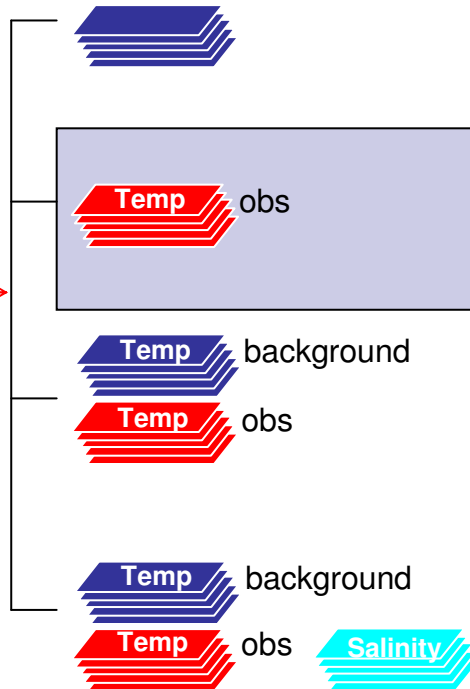
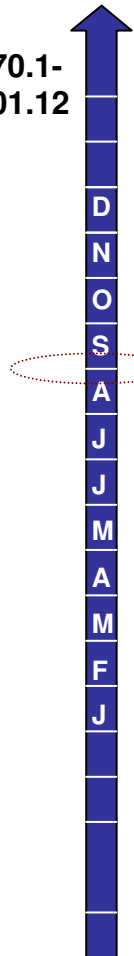
**EXP IV. Temperature Data Assimilation  
with Salinity Corrections**  
(Troccoli et al., 2002)



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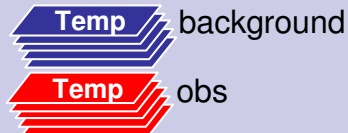
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## Off-Line 2DVar Assimilation

- Simple Variational Assimilation level-by-level (2D Var).
- Using existing reanalysis data instead of raw in situ observation.
- Background Error Covariance of Derber & Rosati (*JPO*, 1989)  
 $a \exp(-r^2/b^2)$  with  $b = 570$  km
- Variable : **3D Temperature**

# Ocean Data Assimilation

*SST nudging history run*

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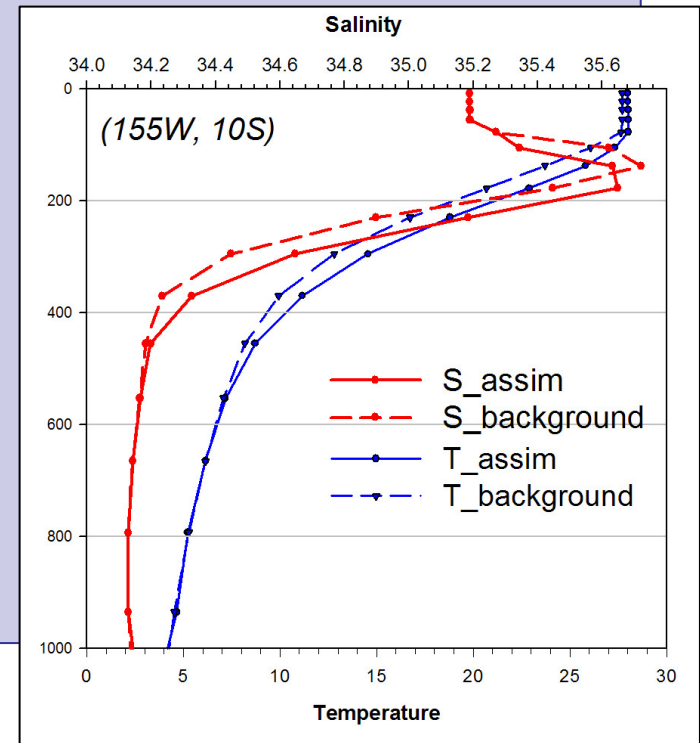


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## Salinity Correction in Presence Temp Assimilation

- Salinity field is corrected by using a method which assumes that the **temperature-salinity relationship** of the model background is preserved during the T assimilation by 2DVAR
- The effectiveness of this scheme is reflected not only in a better salinity field also in an improved temperature field.  
Then **realistic density structures** are obtained

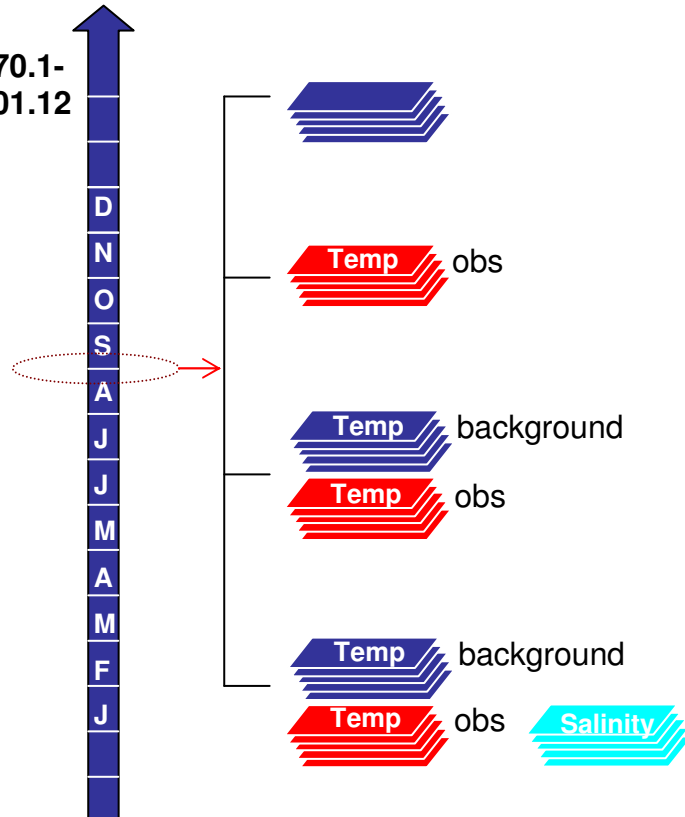




# Ocean Data Assimilation

*SST nudging history run*

1970.1-  
2001.12



## EXP I. SST nudging Initialization

(Keenlyside et al., 2005)

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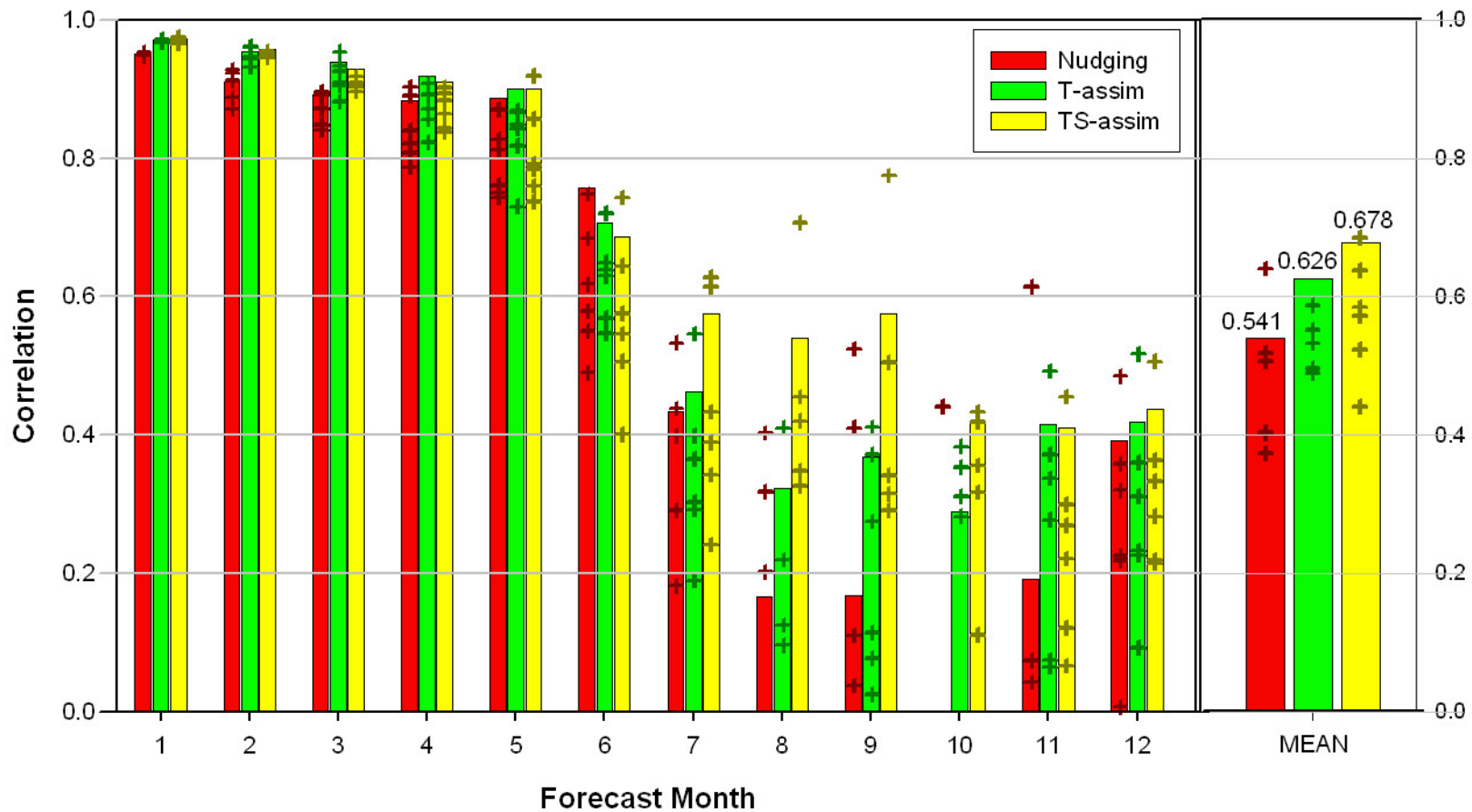
(Troccoli et al., 2002)

- ❖ Period : 1980-2001 (22-year) Aug-initialization Forecast
- ❖ Ensemble Member : 6 (with atmos perturbation)
- ❖ Model : CCCma CGCM3 (AGCM: T63L31 OGCM:1.4x0.94xL33 )
- ❖ Obs Data : GODAS reanalysis

# Ocean Data Assimilation

## Ensemble Forecasts

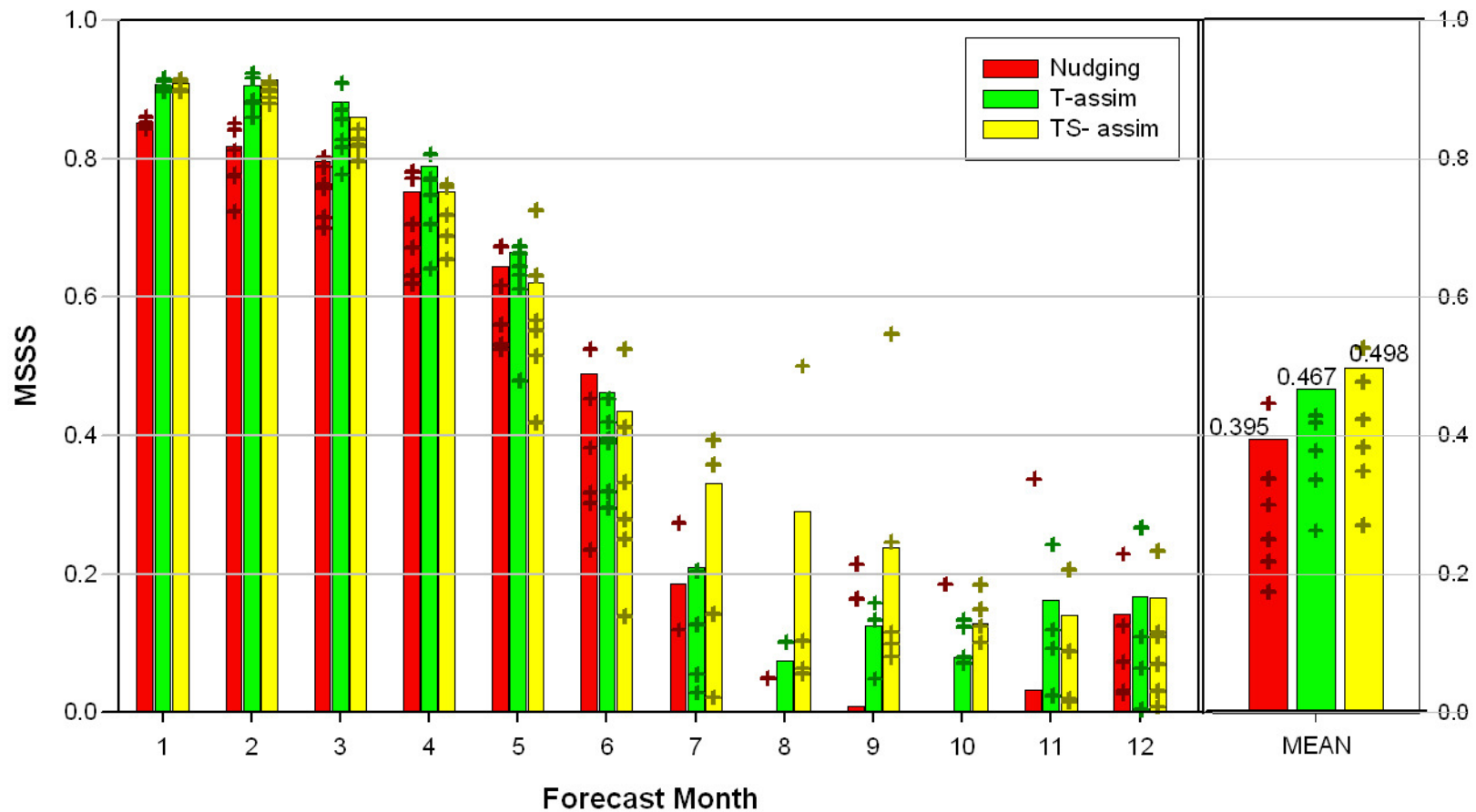
Nino3.4 CORR from 1 Sep 1980-2001(6 ensemble members)



# Ocean Data Assimilation

## Ensemble Forecasts

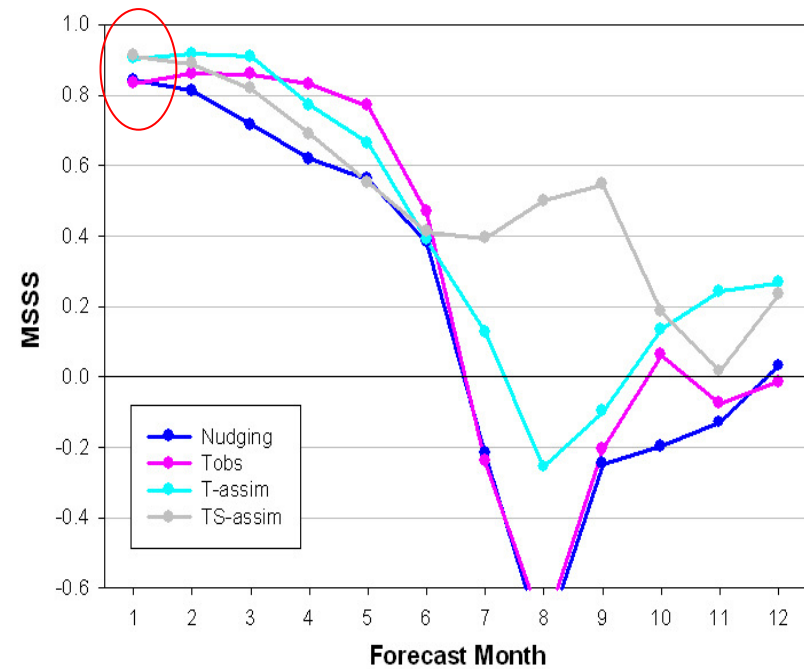
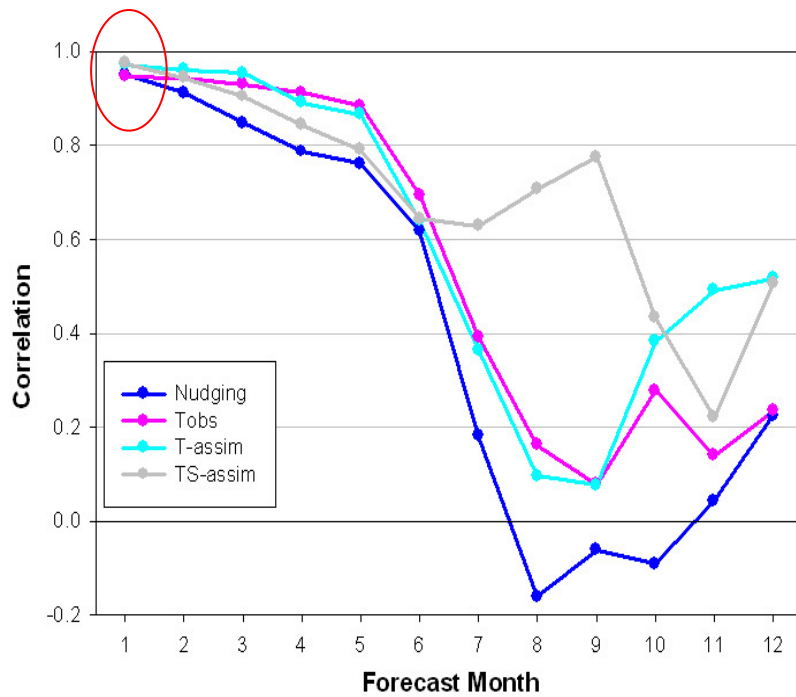
Nino3.4 MSSS from 1 Sep 1980-2001 (6 ensemble members)



# Ocean Data Assimilation

## Deterministic Forecasts

Nino3.4 CORR and MSSS from 1 Sep 1980-2001



12mon MEAN	Nudging	Tobs	T-assim	TS-assim
<b>CORR</b>	<b>0.418</b>	<b>0.550</b>	<b>0.601</b>	<b>0.698</b>
<b>MSSS</b>	<b>0.200</b>	<b>0.285</b>	<b>0.414</b>	<b>0.512</b>

# Improve Error Covariance

- Accurate background error covariances are needed to optimally propagate obs information to model state
- In ocean data assimilation the covariances have usually been parameterized very simply following Derber & Rosati (JPO 1989) as

$$a \exp(-r^2/b^2)$$

with  $b = 570$  km [e.g. Tang et al (JGR 2004), etc.]

- However ocean state anomalies are not correlated in such a simple manner
- Strategy: obtain geographically varying correlation length scales from models internal variability (assimilation run in this case)
- Smith and Murphy (JGR 2007):

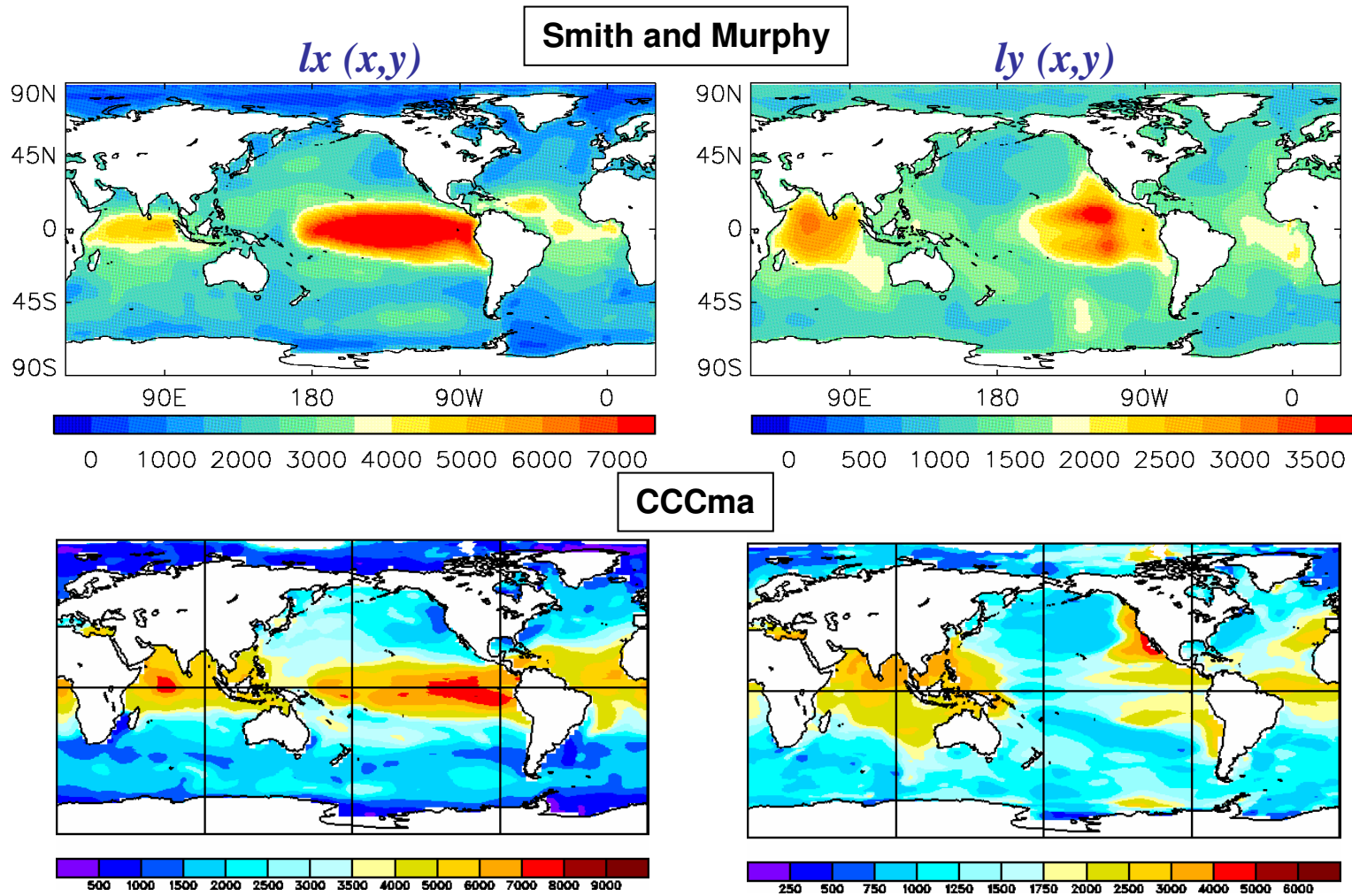
$$a \exp(- \Delta x^2/l_x^2 (x,y,z) - \Delta y^2/l_y^2(x,y,z) )$$

$l_x, l_y$  : **correlation length scale**

- Obtain zonal, meridional correlation length scales from HadCM3 run

# Improve Error Covariance

## Correlation Lengths at Sea Surface

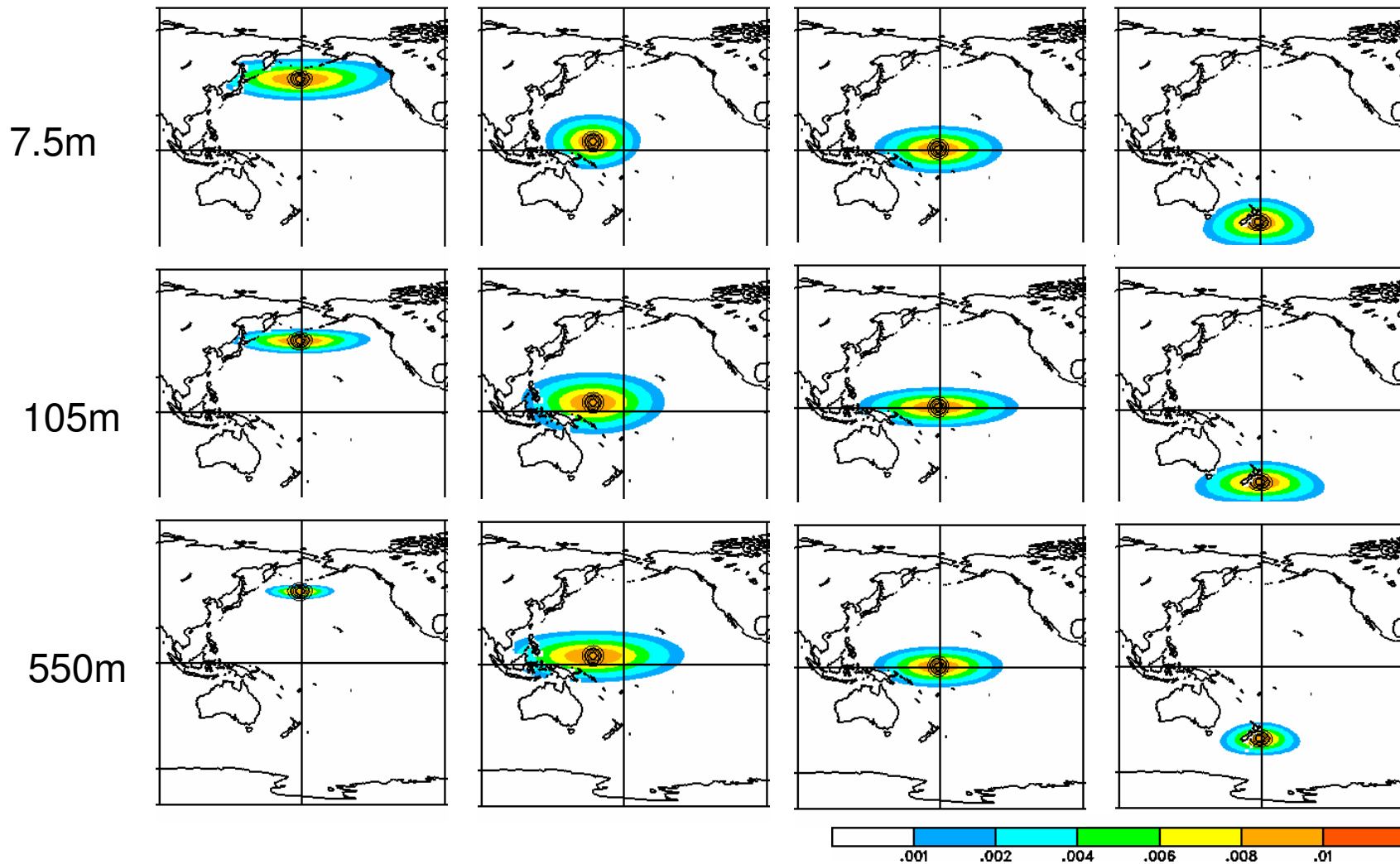


Mean over Jan, Apr, Jul and Oct

# Improve Error Covariance

## Error Covariance Structure

Smith (color) vs Derber-Rosati (line)





## Future Works

- ❖ **Apply improved error covariance to ocean initialization to compare other scheme's skill.**
- ❖ **Based on the skill differences between experimental forecasts, a set of optimal parameter and a optimal ocean initialization method for CHFP2 will be selected.**