Ocean carbon states

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Years past…

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Or, how to not do clouds and still get away with it…

- Oceans and climate
- Air-sea fluxes and climate; radiation, heat, momentum, tracers
- The ocean carbon cycle
- Only Bill knows…

Decorrelation Scales of High-Resolution Turbulent Fluxes at the Ocean Surface and a Method to Fill in Gaps in Satellite Data Products

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ABSTRACT

In the first part of the paper, a high space–time resolution (1°
turbulent fluxes at the ocean surface is used to estimate and stu
of the decorrelation scales of the latent and sensible heat flu
temporal and spatial patterns that dominate the flux fields (withi
dominant variability in the air–sea interaction. Regional com
flux-related variables such as the wind stress, the humidity di
mechanism responsible for the variability in each flux field.
In the second part of the paper, the decorrelation scales are u

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20th century changes in surface solar irradiance in simulations and observations

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Received 5 October 2006; revised 23 December 2006; accepted 5 February 2007; published 8 March 2007.

[1] The amount of solar irradiance reaching the surface is a ... in Europe and North America [*Wild et al.*, 2005; *Pinker et al.*, 2005] as a result of improving air quality in these regions.

[3] A negative shortwave anomaly at the ground does not automatically imply atmospheric cooling since the air layers above the ground can absorb the shortwave heating no longer reaching the surface, increasing the downward long-wave radiation [*Menon et al.*, 2002; *Soden et al.*, 2002]. Such radiative flux changes complicate the interpretation of the observed response of the longwave flux incident to the surface that is expected to increase due to enhanced anthropogenic greenhouse effect [*Krishnan and Ramanathan*, 2002; *Ramanathan et al.*, 2001] and the consequent warming of the air.

[4] Here we analyze the surface solar irradiance in ensemble simulations using nine state-of-the-art coupled ocean-atmosphere-land-ice general circulation models of the 20th Century prepared for the Intergovernmental Panel of Climatic Change (IPCC) Fourth Assessment Report (AR4) (details of the models can be found at http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php. The nine models used in this study are: the NOAA Geophysical Fluid Dynamics

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 112, D22101, doi:10.1029/2007JD008435, 2007

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Decadal variations of global energy and ocean heat budget and meridional energy transports inferred from recent global data sets

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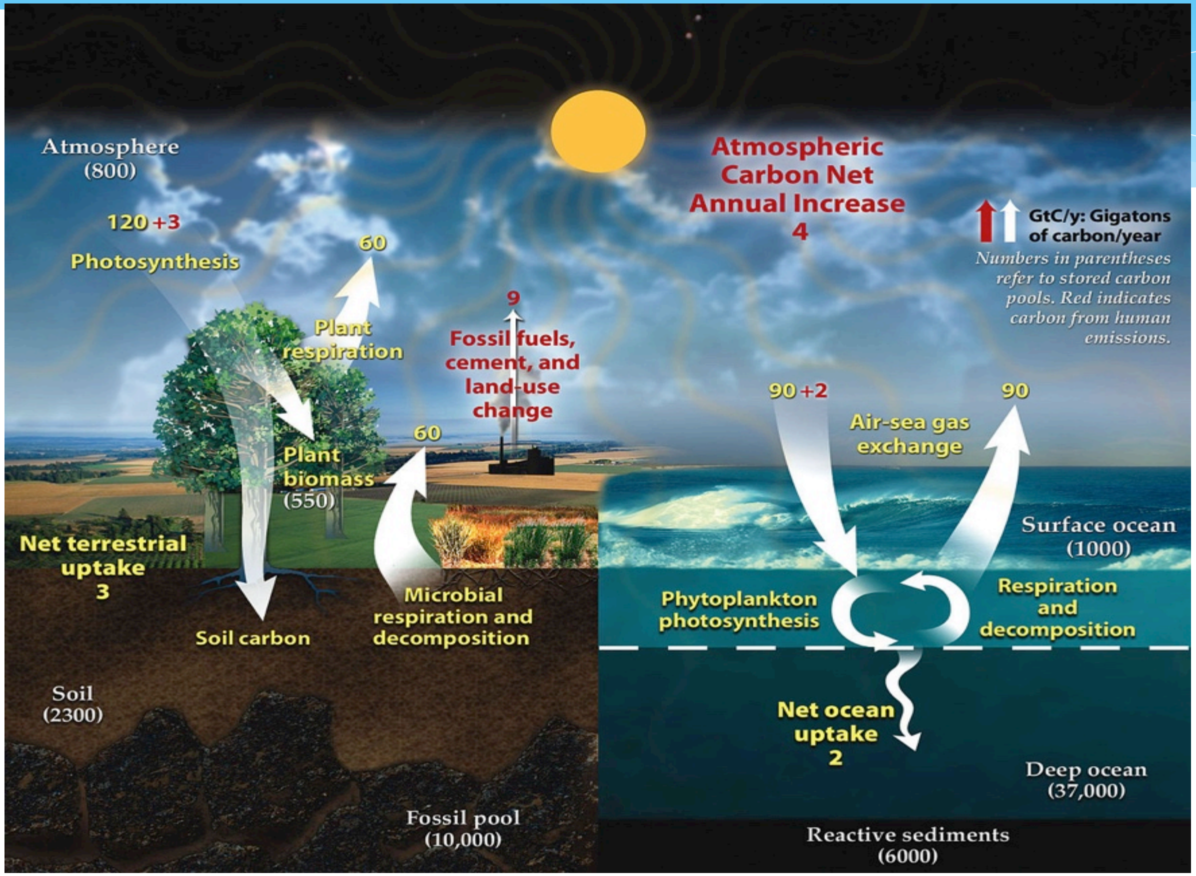
Received 18 January 2007; revised 15 May 2007; accepted 27 June 2007; published 17 November 2007.

[1] We use the most recent global, decades-long data sets, consisting of two satellite-derived top-of-atmosphere (TOA) and surface radiative flux data sets from the International Satellite Cloud Climatology Project Flux product (ISCCP-FD) and the Global Energy and Water Cycle Experiment Surface Radiation Budget project (GEWEX-SRB), three ocean surface turbulent flux data sets from Goddard Satellite-based Surface Turbulent Fluxes (GSSTF), Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite data (HOAPS) and Woods Hole Oceanographic Institution Objectively Analyzed air-sea Fluxes (WHOI) and one ocean heat content (or energy storage rate) data

, 2017. New York

Carbon sources & sinks



http://earthobservatory.nasa.gov/Features/CarbonCycle/

Air-sea gas exchange flux

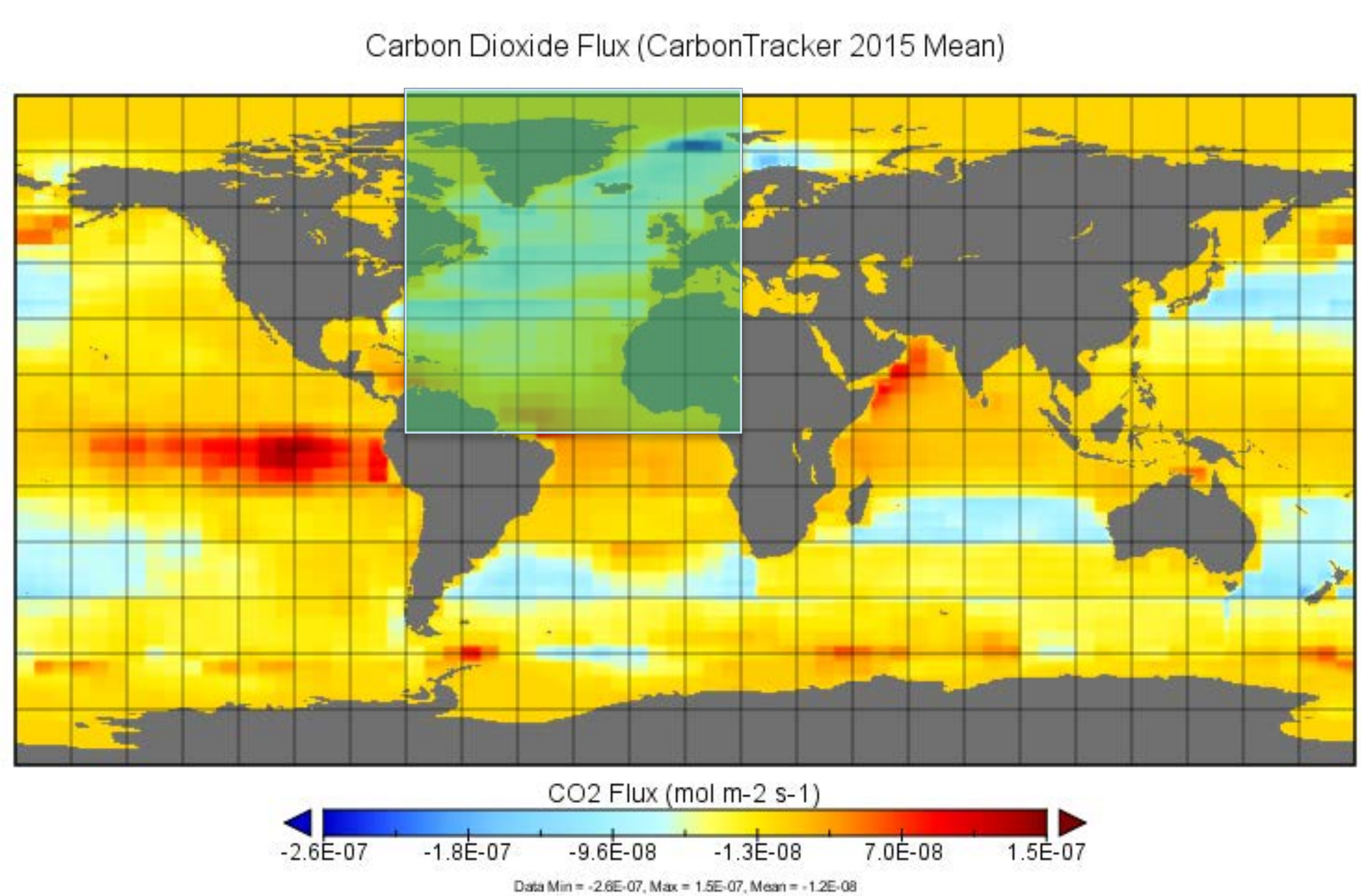
$$F = \varkappa\alpha(pCO_2^{atm} - pCO_2^{ocean})$$

↑ CO_2 Flux

↑ Solubility pump (wind speed,SST, SSS)

↑ Biological Pump

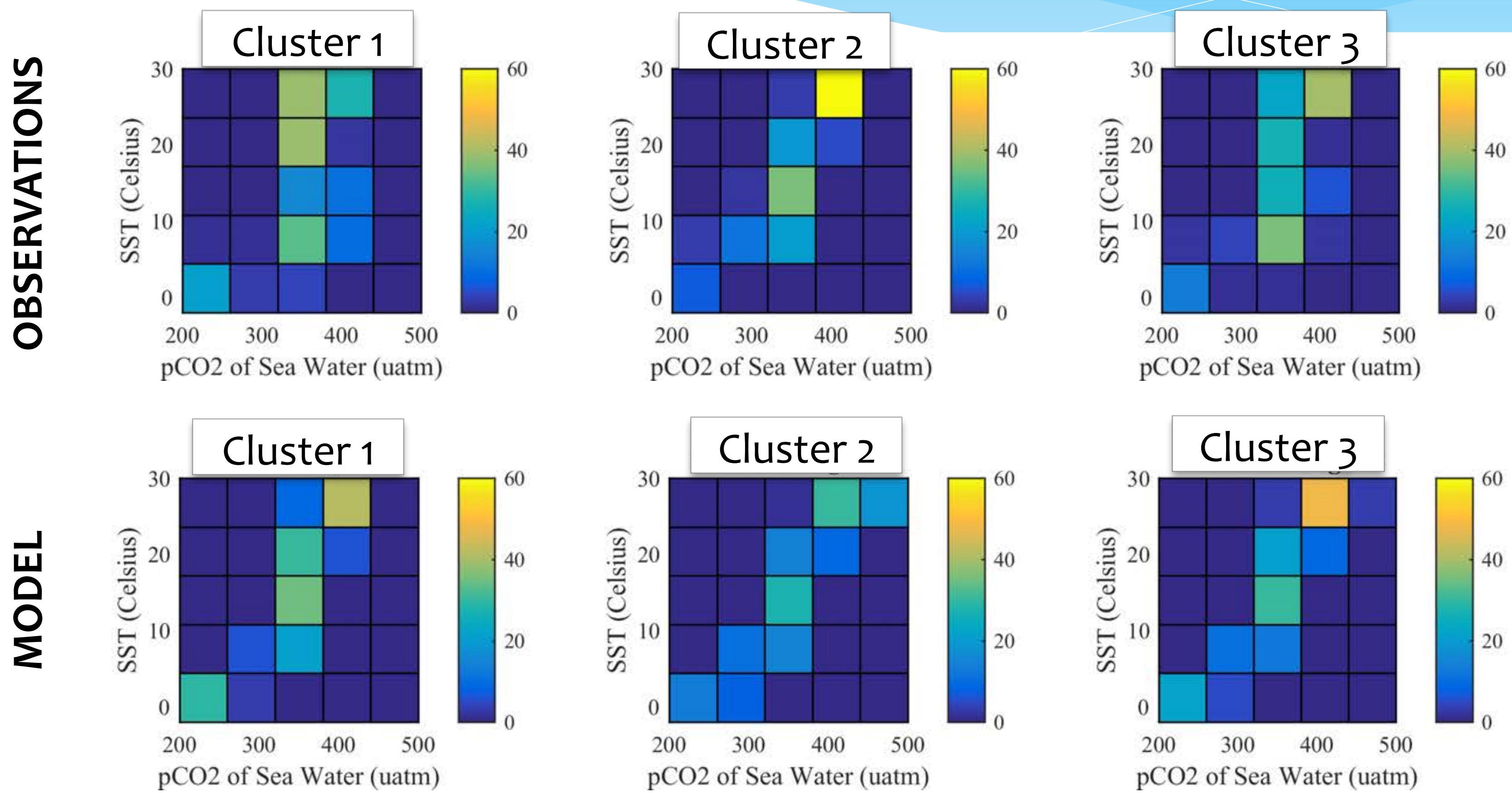
Flux of CO2 into the Ocean



Observations & Models

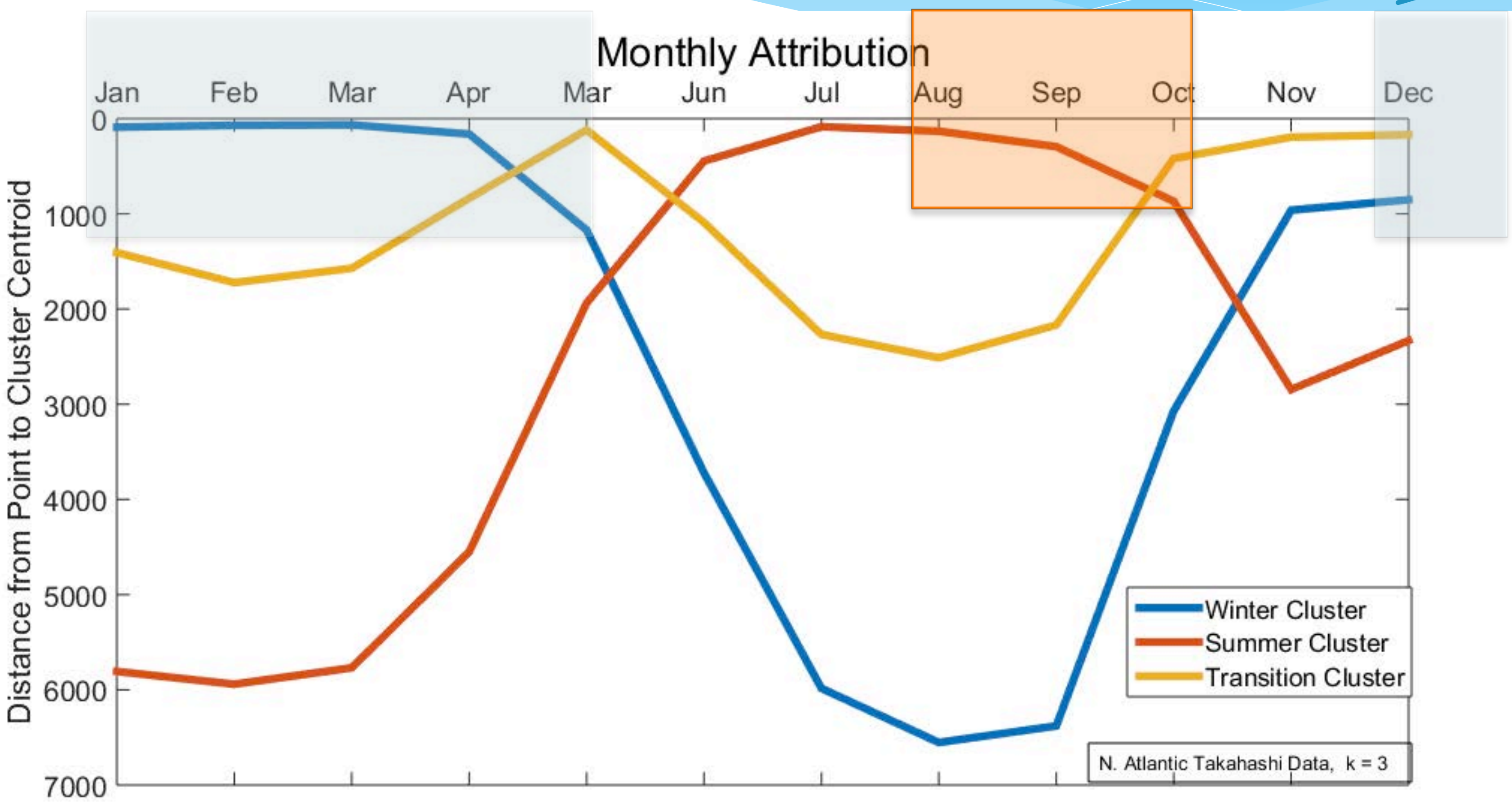
- Flux of CO_2 from the Takahashi 2012 climatology
- Surface T,S,nutrients from World Ocean Atlas 2009
- Mixed layer depth from Ifremer – DeBoyer
- Wind speeds from scatterometer
- GISS modelEv2.1 historical emissions run (20^{th} Century)

Clusters for Observations and Model



Temporal Attribution of the Regimes

Model seasons



Error attribution

$$\Delta pCO_2 = \frac{\partial pCO_2}{\partial T}\Delta T$$

Surface temperature

$$+ \frac{\partial pCO_2}{\partial S}\Delta S$$

Surface salinity

$$+ \frac{\partial pCO_2}{\partial H}\Delta H$$

Mixed layer depth

$$+ \frac{\partial pCO_2}{\partial w}\Delta w$$

Surface wind speed

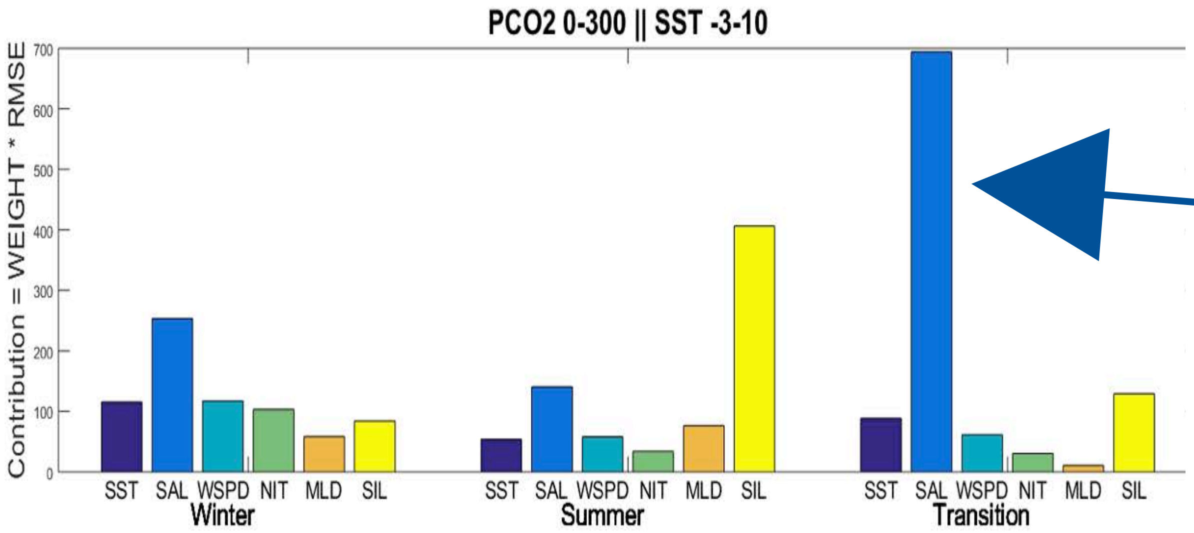
$$+ \frac{\partial pCO_2}{\partial N}\Delta N$$

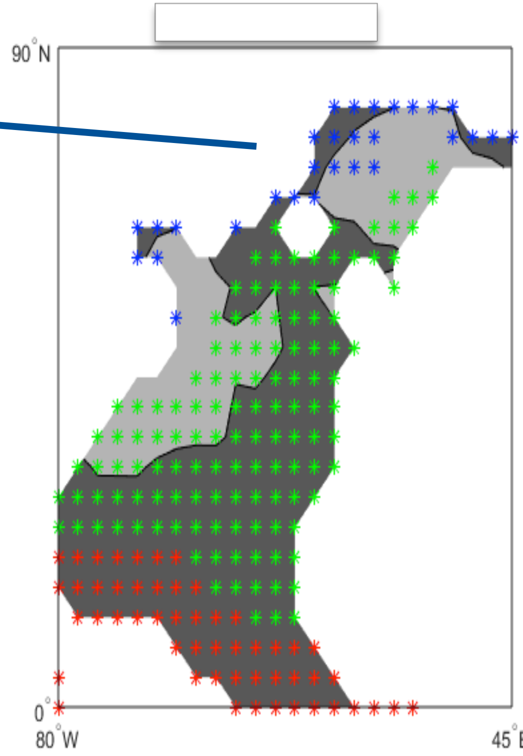
Surface nitrate

$$+ \frac{\partial pCO_2}{\partial Si}\Delta Si$$

Surface silicate

Regional error attribution: subpolar North Atlantic





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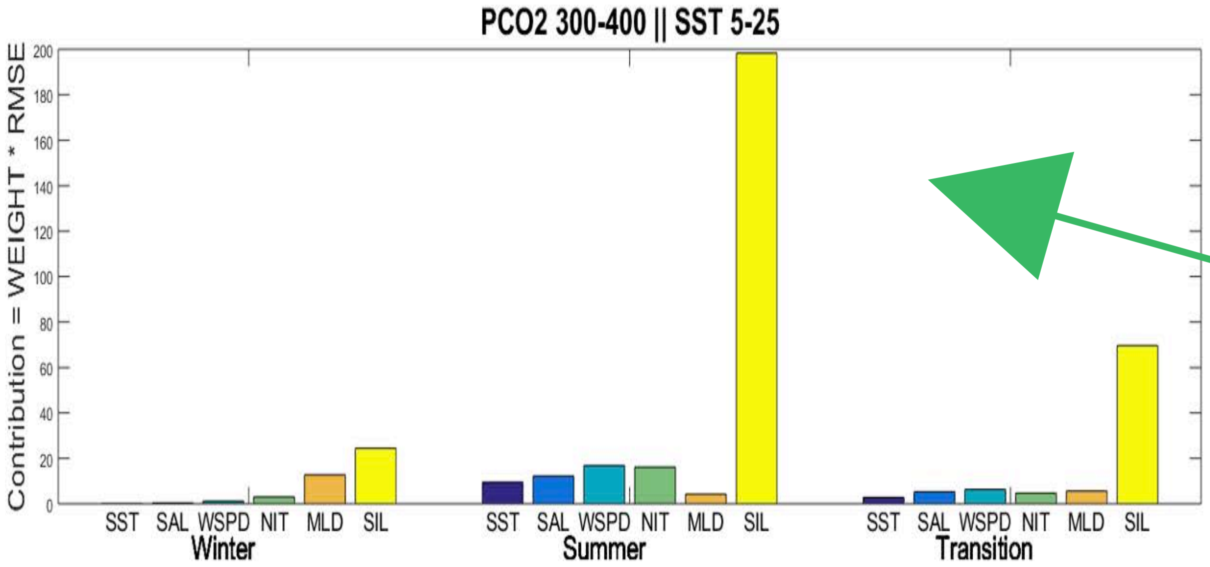
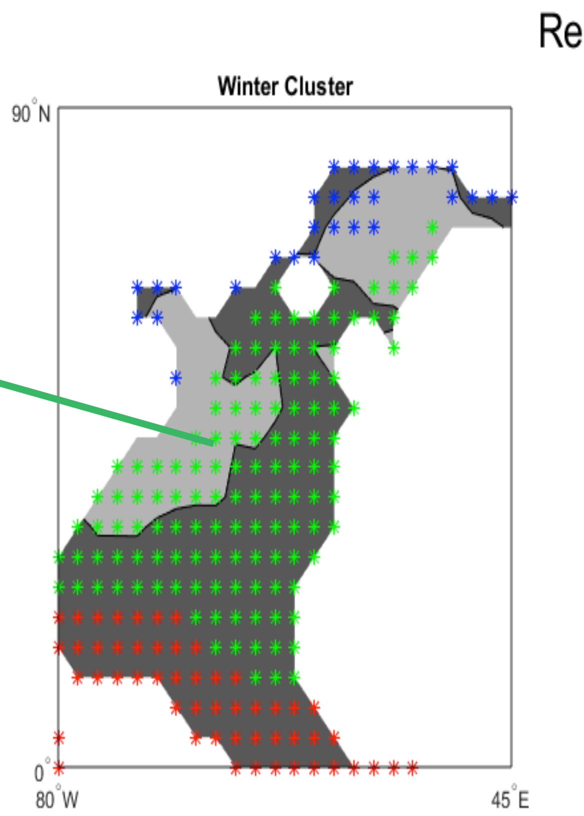
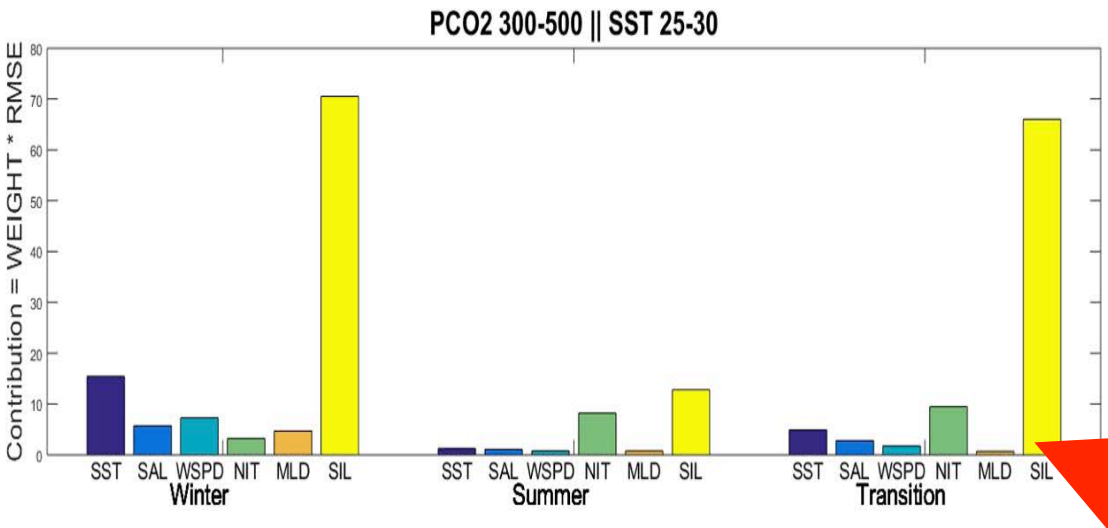
Regional error attribution: subtropical North Atlantic





Regional error attribution: the tropical North Atlantic



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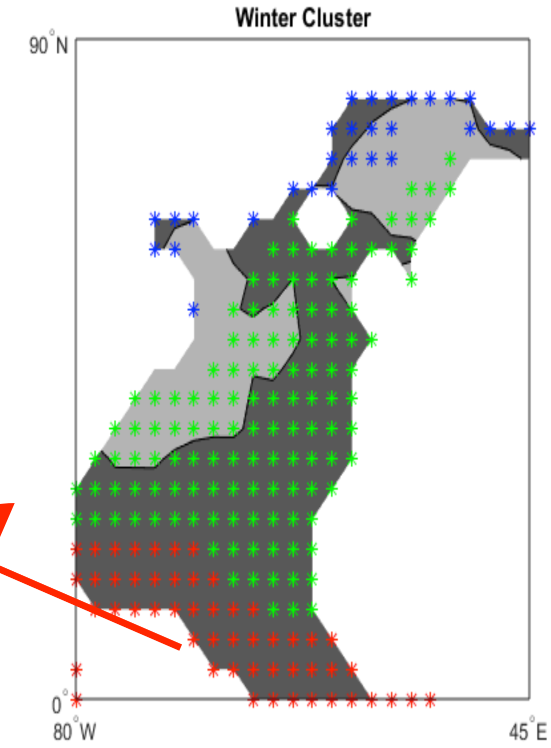

Usefulness of data mining/data reduction/big data science for climate

- Identify modes of variability; either in space or time, or both
- Use those to extract meaningful states of the ocean-climate system
- Use them to assess model skill