A GEWEX PROCESS EVALUATION STUDY (PROES) OF WATER AND ENERGY CYCLES IN MIDLATITUDE STORMS

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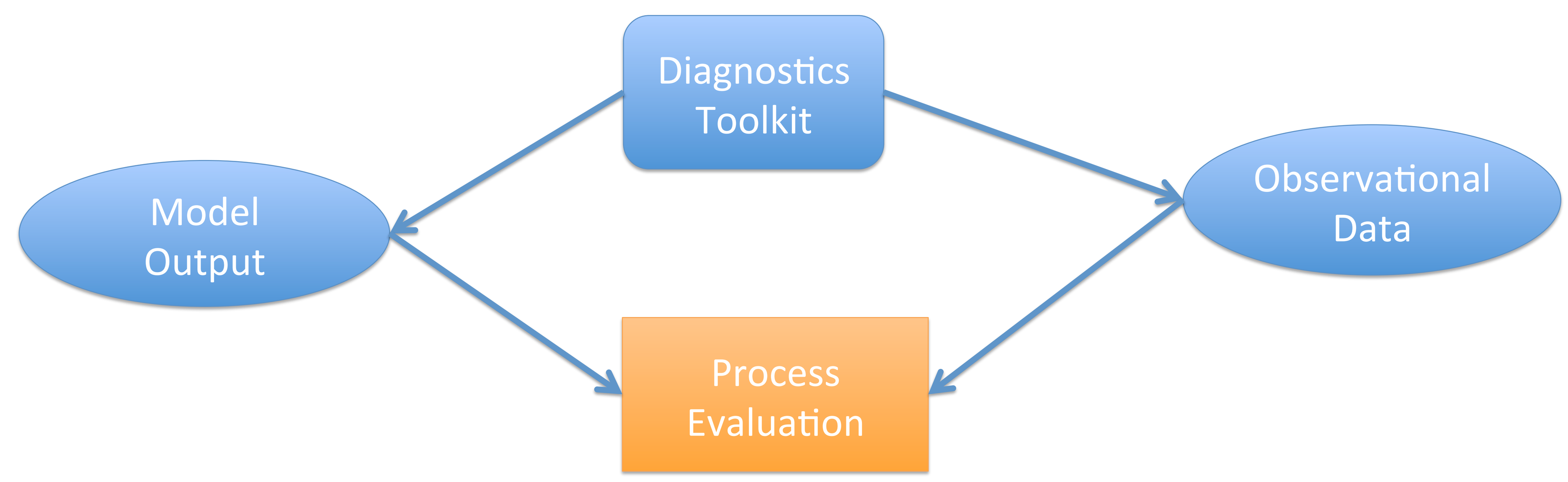
Abstract

The objective of the PROES midlatitude storms project is to create a web portal that will facilitate research on the processes involved in the interactions between clouds, precipitation, and radiation, and the midlatitude atmospheric dynamics. The portal will be structured along the lines of the PROES prototype and will include three nodes, an **observational datasets**, a **modeling output**, and a **midlatitude storm toolkit** node. The observational dataset node will provide access to reanalysis fields needed for storm analysis, such as SLP, temperature, winds, and vorticity, as well as access to GEWEX GDAP and other related datasets of clouds, precipitation, and radiation fluxes, all at daily or higher resolution. The model output node will provide access to the same or similar fields from the CFMIPII and CMIP5 model simulation archives. The baroclinic storm toolkit will provide access to software developed by storm tracking, storm area delineation, and front identification efforts that can be applied to both from studies that have already applied such tools to recent and past reanalysis data.

Here we present the use of two midlatitude storm tools to study processes involved in storm interactions with the precipitation field and to examine the skill of climate models in simulating those processes.

Formalizing PROcess Evaluation Studies: ***The GEWEX PROES program***



Objectives: Optimize the use of high resolution satellite observations with emphasis on the GEWEX datasets – Facilitate development and application of data mining and compositing techniques – Create a framework for process evaluation studies that enhance process understanding and evaluates model process performance

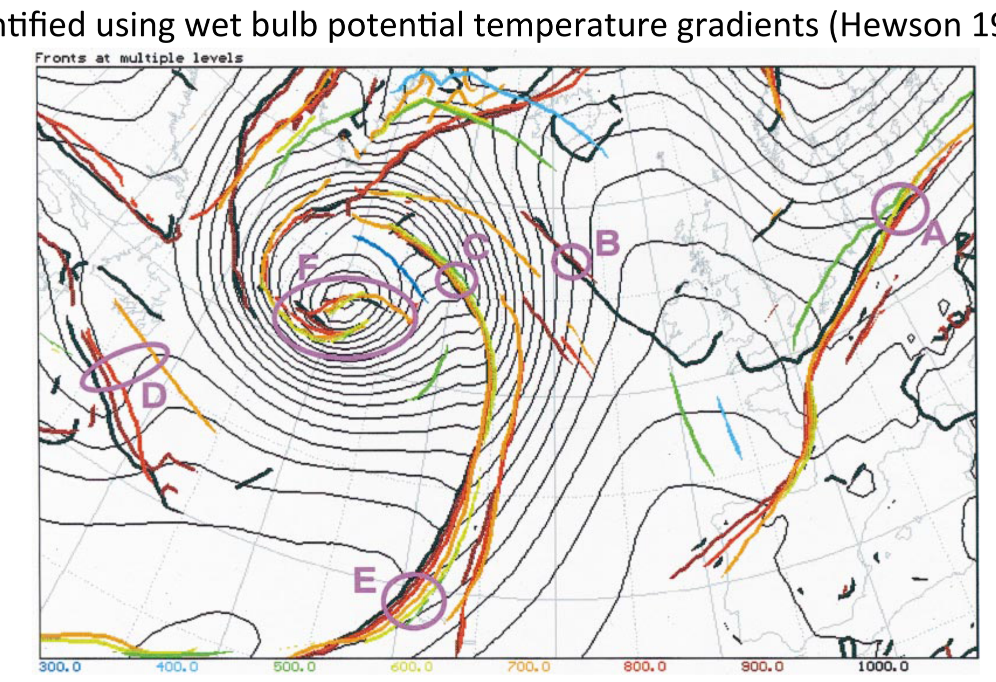
Synergies: *Obs.* - GDAP, Obs4MIPS *Diags.* – GASS, GLASS, CFMIP *Models* – CMIP, GASS, GLASS, CFMIP

Initial Steps: Pilot studies: (i) Upper Tropospheric Clouds and Convection, (ii) Radiation Kernels, (iii) Ice Sheet Surface Mass and Energy Balance, (iv) Midlatitude Storms

Midlatitude Storm Toolkit

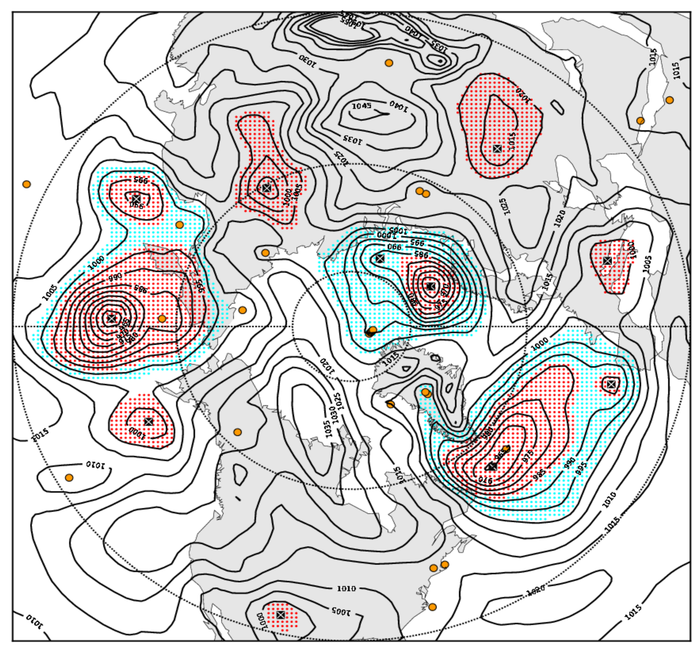
Objective Atmospheric Fronts

Identified using wet bulb potential temperature gradients (Hewson 1998)

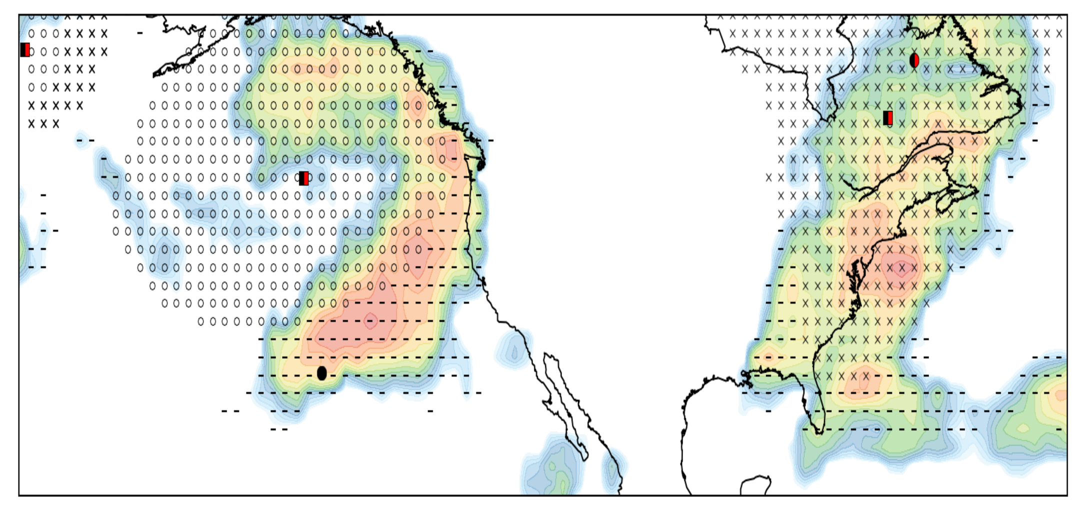


Storm Area of Influence

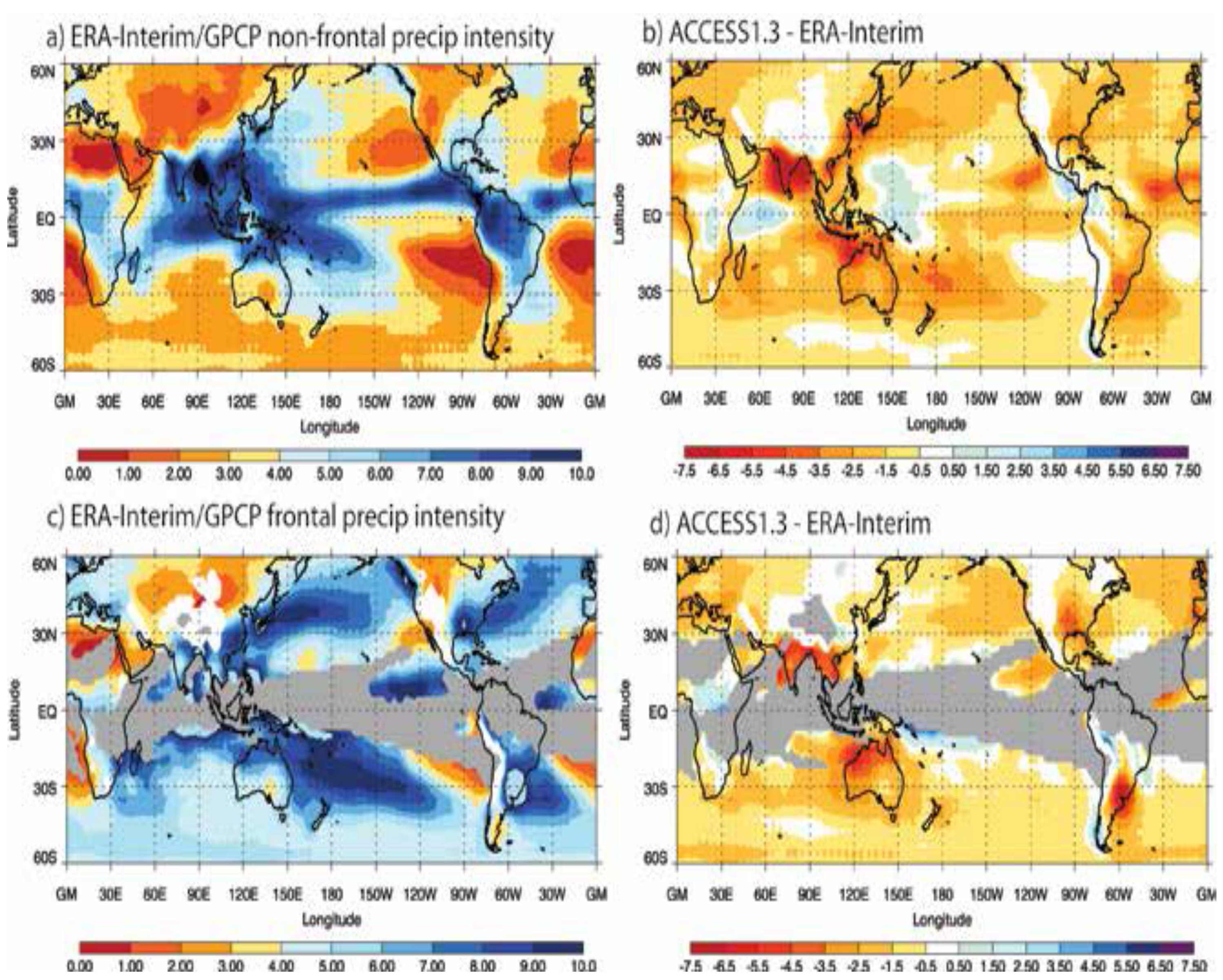
Identified using closed SLP contours (Bauer et el. 2015)



Captures well the precipitation distribution attributed to a particular storm

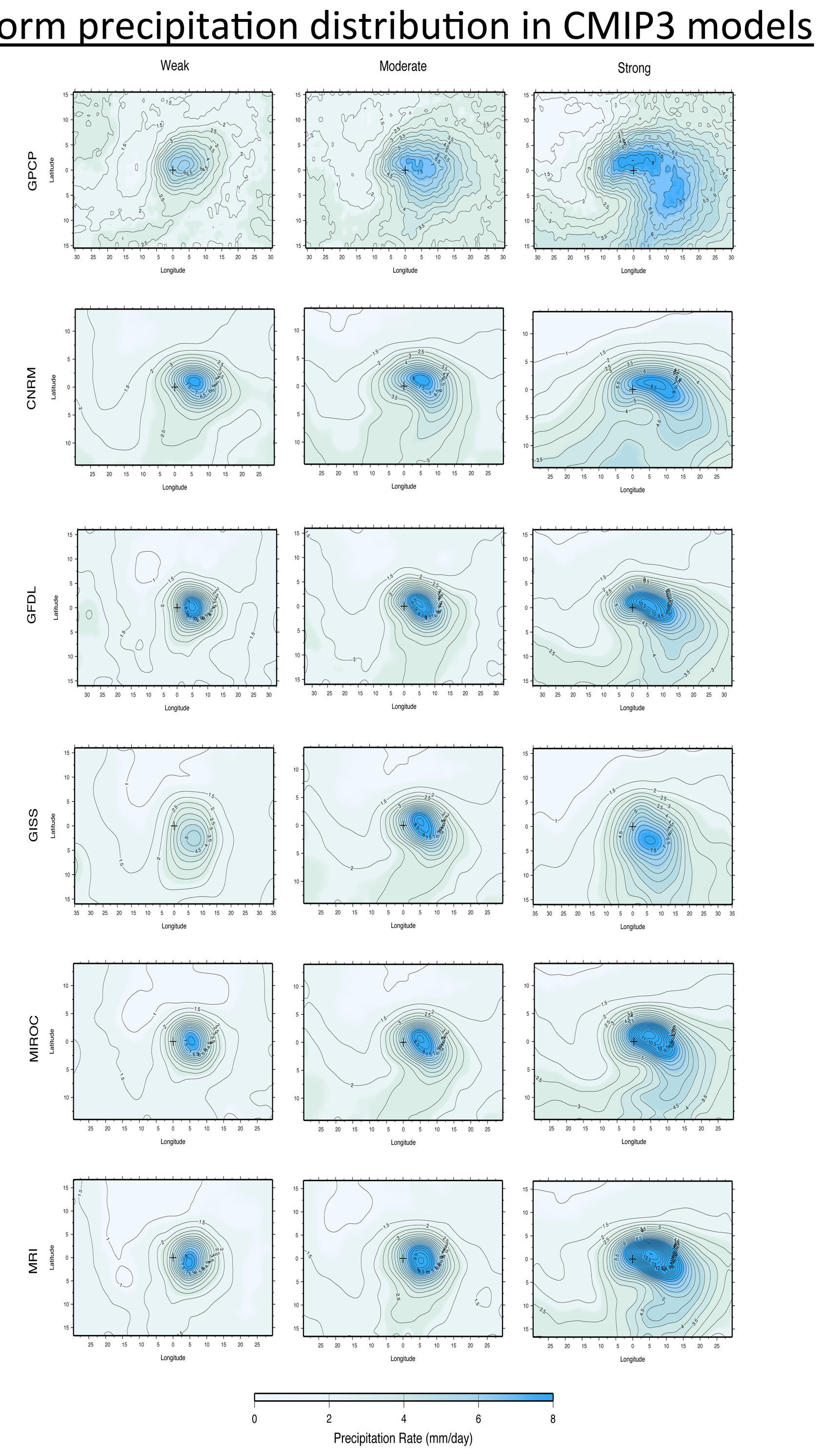


Frontal precipitation in the ACCESS model (Catto et al. 2012)



The ACCESS model shows larger precipitation deficits in the non-frontal regime than in the fronts, even in the regions of the major midlatitude storm tracks

Storm precipitation distribution in CMIP3 models



Calculation of precipitation changes with climate assuming UKMO-predicted Fewer-but-Stronger storms

	Storm Strength	Storm Frequency	Total
GPCP	+0.1 (mm/day)	-0.02 (mm/day)	+0.08 (mm/day)
CNRM	+0.08	-0.14	-0.06
GFDL	+0.08	-0.11	-0.03
GISS	+0.05	-0.10	-0.05
MIROC	+0.08	-0.11	-0.03
MRI	+0.10	-0.11	-0.01

- Models estimate correctly the increase in precipitation with storm strength but overestimate the decrease in precipitation with storm frequency.
- This is because all models produce very little midlatitude precipitation outside storm events.
- As a result, models produce a negative rather than a positive precipitation feedback when the Fewer-but-Stronger storm changes are applied together

Discussion

- Process understanding and process based model evaluation requires the simultaneous analysis of observations and model output through the application of carefully designed process diagnostic tools. This is the aim of the GEWEX PROES effort.
- An example of the PROES methodology is presented here. Two different midlatitude storm diagnostic tools are used to examine the effect of storm processes on midlatitude precipitation in observations and models.
- The process based model precipitation analysis shows that models simulate accurately changes in precipitation with storm strength, but underestimate the amount of precipitation that falls in non-frontal regimes and outside the area of influence of the storms
- A sensitivity analysis shows that in a scenario of fewer but stronger storms with climate warming, the models produce the wrong sign of precipitation feedback because their feedback process cycle is dominated by the storm strength increase rather than the storm frequency decrease