



**Evaluation of the new CNDV option of
the Community Land Model:**

**Effects of dynamic vegetation and
interactive nitrogen on
CLM4 means and variability**

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Prognostic C-N with Dynamic Vegetation

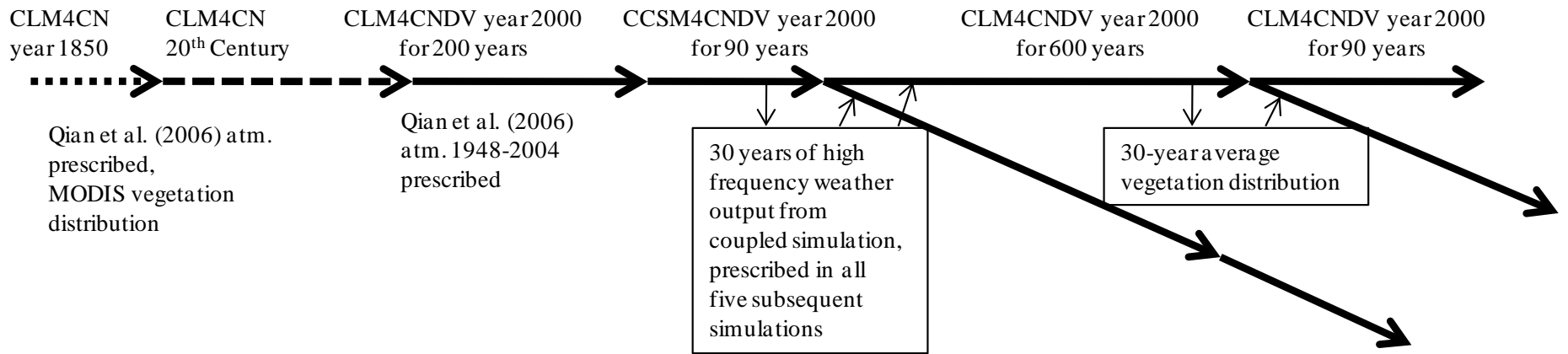
- CNDV updates the biogeography annually, but now interpolated to the ~hourly time step for consistency with CLM.
- CNDV changes the CN framework for annual processes of light competition, establishment, and survival as they pertain to the calculations of PFT cover and population density.
- CNDV incompatible with managed vegetation and transient land use option.



Evaluation

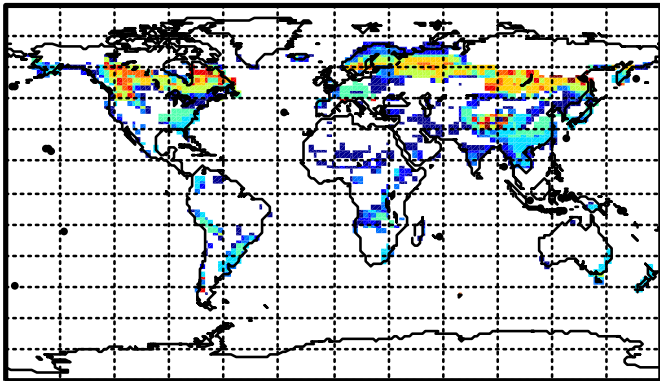
- Compare the simulated vegetation cover against the satellite observations used in CLM4SP.
- Assess the relative importance of interactive nitrogen versus interactive biogeography in present-day equilibrium simulations.
 - 3 Simulations: **CNDV vs. CDV vs. CN**
 - Compare
 - (1) annual means
 - (2) interannual variability
 - (3) seasonal variability
 - Compare against other obs/data (GCP, Globalview)



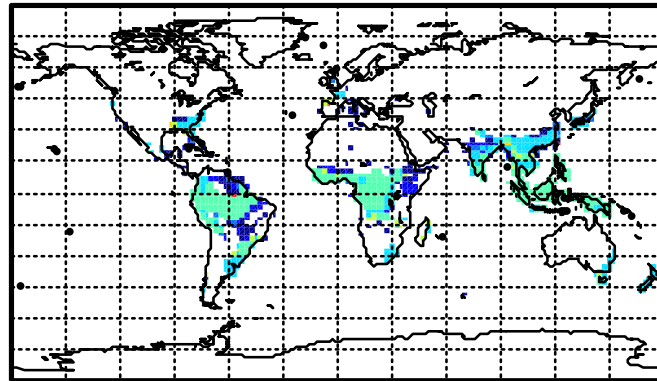


Spin-up Methodology

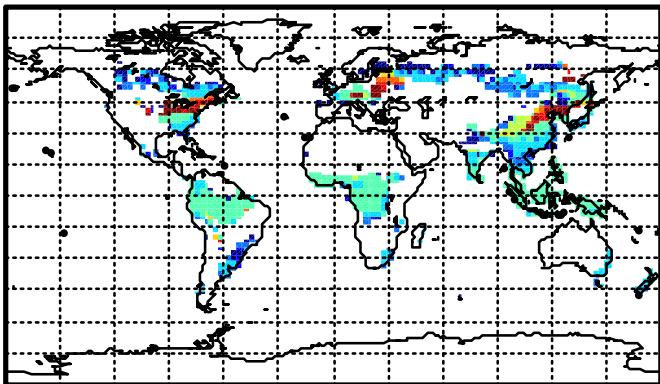
NEEDLELEAF EVERGREEN TREES



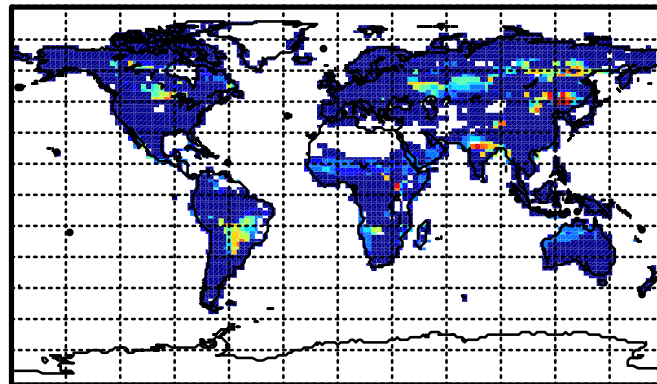
BROADLEAF EVERGREEN TREES



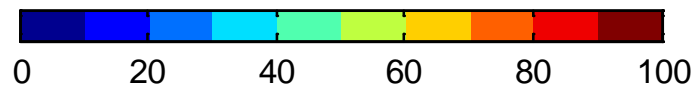
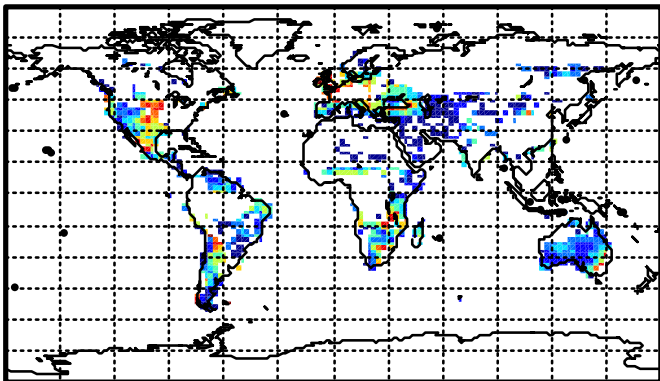
DECIDUOUS TREES



GRASSES



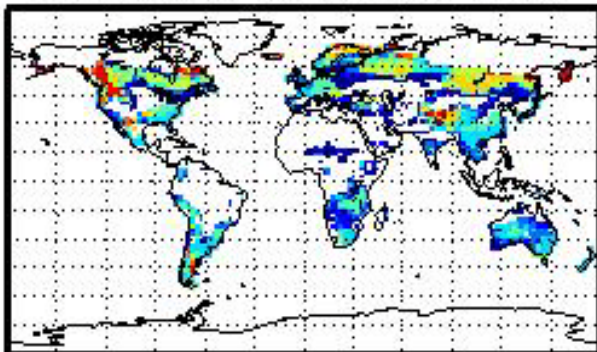
SHRUBS



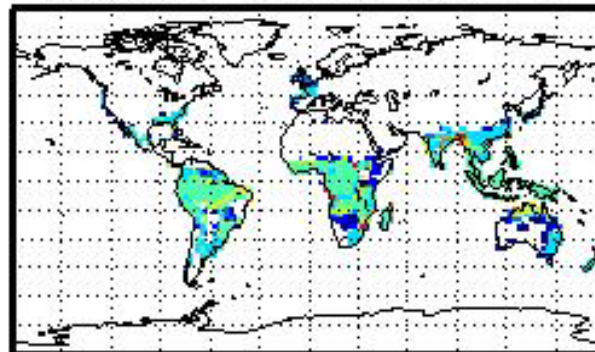
Foliar Projective Cover (%)

CNDV

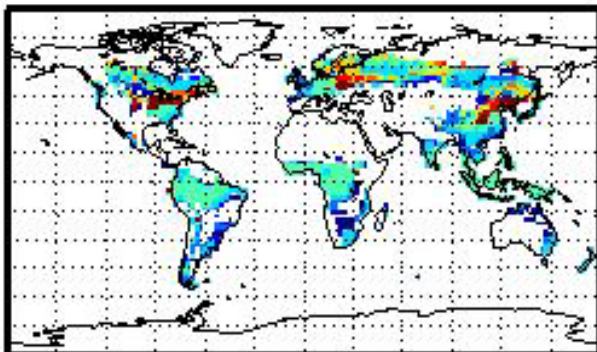
NEEDLELEAF EVERGREEN TREES



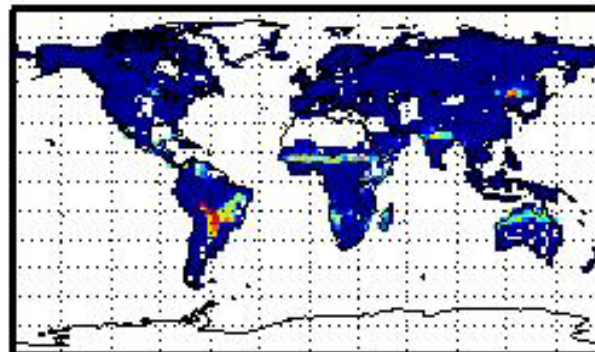
BROADLEAF EVERGREEN TREES



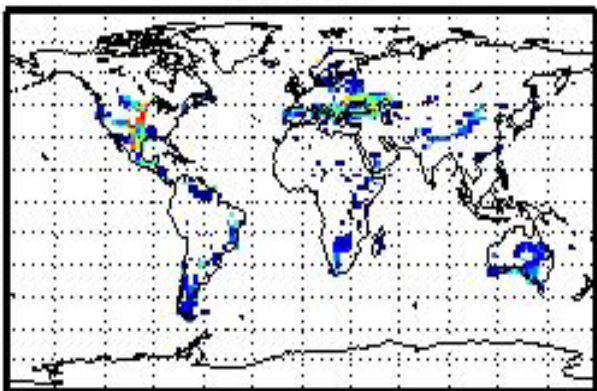
DECIDUOUS TREES



GRASSES



SHRUBS



Foliar Projective Cover (%)

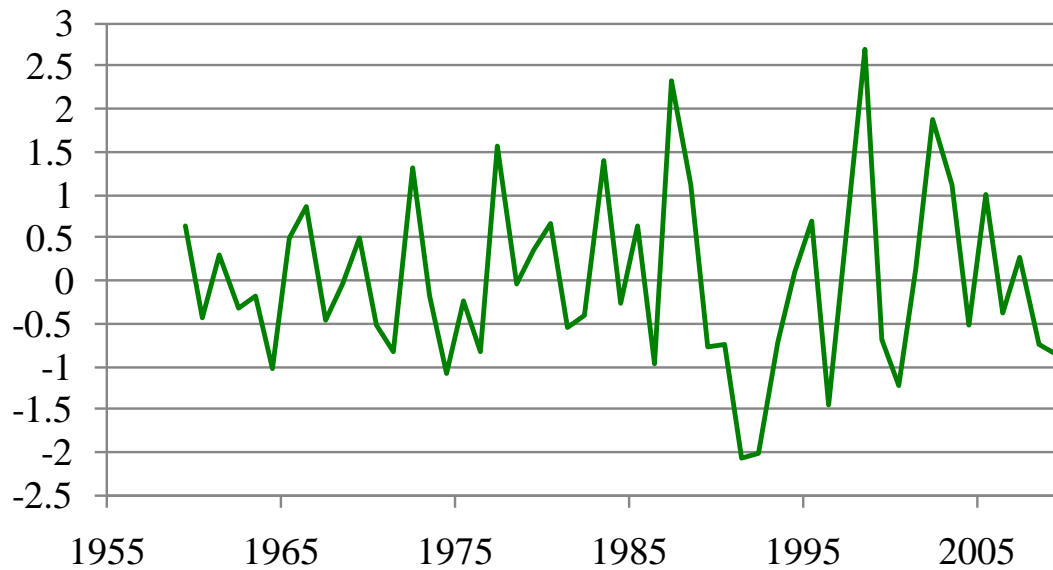
CDV

Annual Means and Interannual Variability

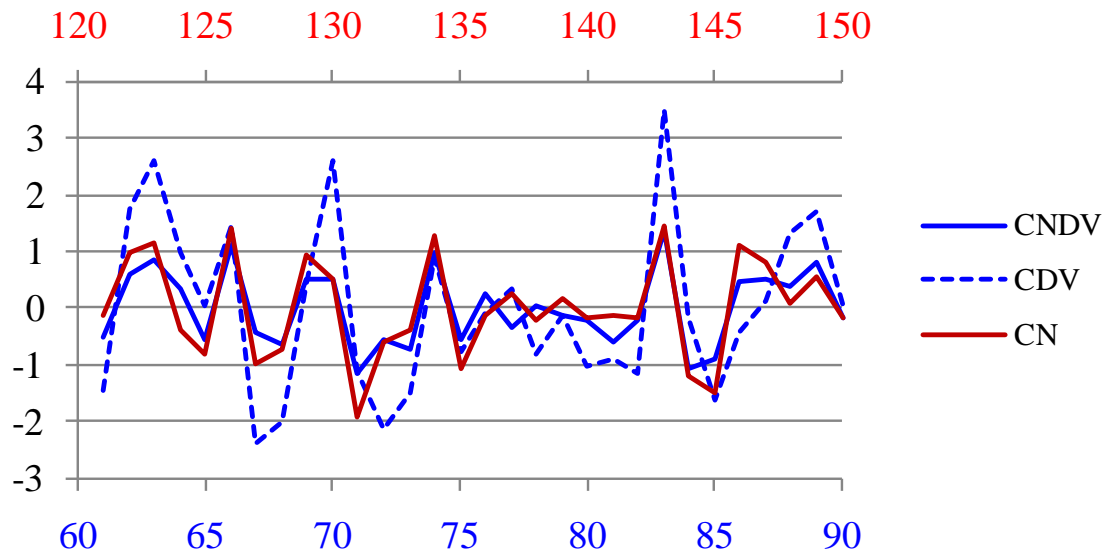
- Interactive nitrogen and the dynamic vegetation introduce degrees of freedom to the model that tend to buffer response to inter-annual environmental variability.
- N-cycle reduces both the means and standard deviations of most biogeochemical and biophysical variables more than DV.



Detrended NEE from GCPLand Sink Time Series



Detrended NEE from CLM4 Simulations



	CNDV		CDV		CN	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
NEE (- sink) (PgC/year)	-0.16	0.77	-0.14	1.58	-0.17	0.96
NBP (+ sink) (PgC/year)*	0.16	0.77	0.14	1.58	0.17	0.96
NEP (PgC/year)**	5.22	0.54	9.01	1.07	3.39	0.79
NPP (PgC/year)***	45.24	0.63	57.21	1.24	47.88	0.82
GPP (PgC/year)	127.69	1.20	162.93	2.30	135.52	1.43
Autotrophic Respiration (PgC/year)	82.45	0.69	105.73	1.41	87.64	0.85
Heterotrophic Respiration (PgC/year)	40.02	0.32	48.19	0.33	44.49	0.38
Total Ecosystem Carbon (PgC)	1877.70	2.71	2217.23	4.08	1526.26	2.66



	Impact on the Mean		Impact on St. Dev.	
	Interactive nitrogen	Dynamic vegetation	Interactive nitrogen	Dynamic vegetation
NEE (- sink) (PgC/year)	ND	ND	--	-
NBP (+ sink) (PgC/year)	ND	ND	--	-
NEP (+ sink) (PgC/year)	-	+	--	-
NPP (PgC/year)	--	-	--	-
GPP (PgC/year)	--	-	--	-
Autotrophic Respiration (PgC/year)	--	-	--	-
Heterotrophic Respiration (PgC/year)	--	-	-	--
Total Ecosystem Carbon (PgC)	-	+	-	+

CDV to
CNDV

CN to
CNDV

CDV to
CNDV

CN to
CNDV



	CNDV		CDV		CN	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
All-Sky Albedo (%)	28.33	0.15	27.76	0.14	28.32	0.14
Net Radiation (Wm^{-2})	73.39	0.23	75.11	0.30	73.67	0.24
Sensible Heat (Wm^{-2})	28.53	0.46	29.12	0.52	28.05	0.49
Latent Heat (Wm^{-2})	44.30	0.42	45.45	0.42	45.05	0.44
Canopy Transpiration (Wm^{-2})	20.80	0.15	24.14	0.26	22.14	0.17
Canopy Evaporation (Wm^{-2})	7.19	0.14	8.29	0.15	7.56	0.14
Ground Evaporation (Wm^{-2})	16.31	0.39	13.02	0.41	15.34	0.36
Total Leaf Area Index	2.10	0.03	2.36	0.04	2.33	0.04
Total Stem Area Index	0.433	0.01	0.461	0.01	0.428	0.01



	Impact on the Mean		Impact on St. Dev.	
	Interactive nitrogen	Dynamic vegetation	Interactive nitrogen	Dynamic vegetation
All-Sky Albedo (%)	+	ND	+	+
Net Radiation (Wm^{-2})	--	-	--	-
Sensible Heat (Wm^{-2})	-	+	--	-
Latent Heat (Wm^{-2})	--	-	ND	-
Canopy Transpiration (Wm^{-2})	--	-	--	-
Canopy Evaporation (Wm^{-2})	--	-	-	ND
Ground Evaporation (Wm^{-2})	++	+	-	+
Total Leaf Area Index	--	-	-	-
Total Stem Area Index	-	+	ND	ND

CDV to
CNDV

CN to
CNDV

CDV to
CNDV

CN to
CNDV

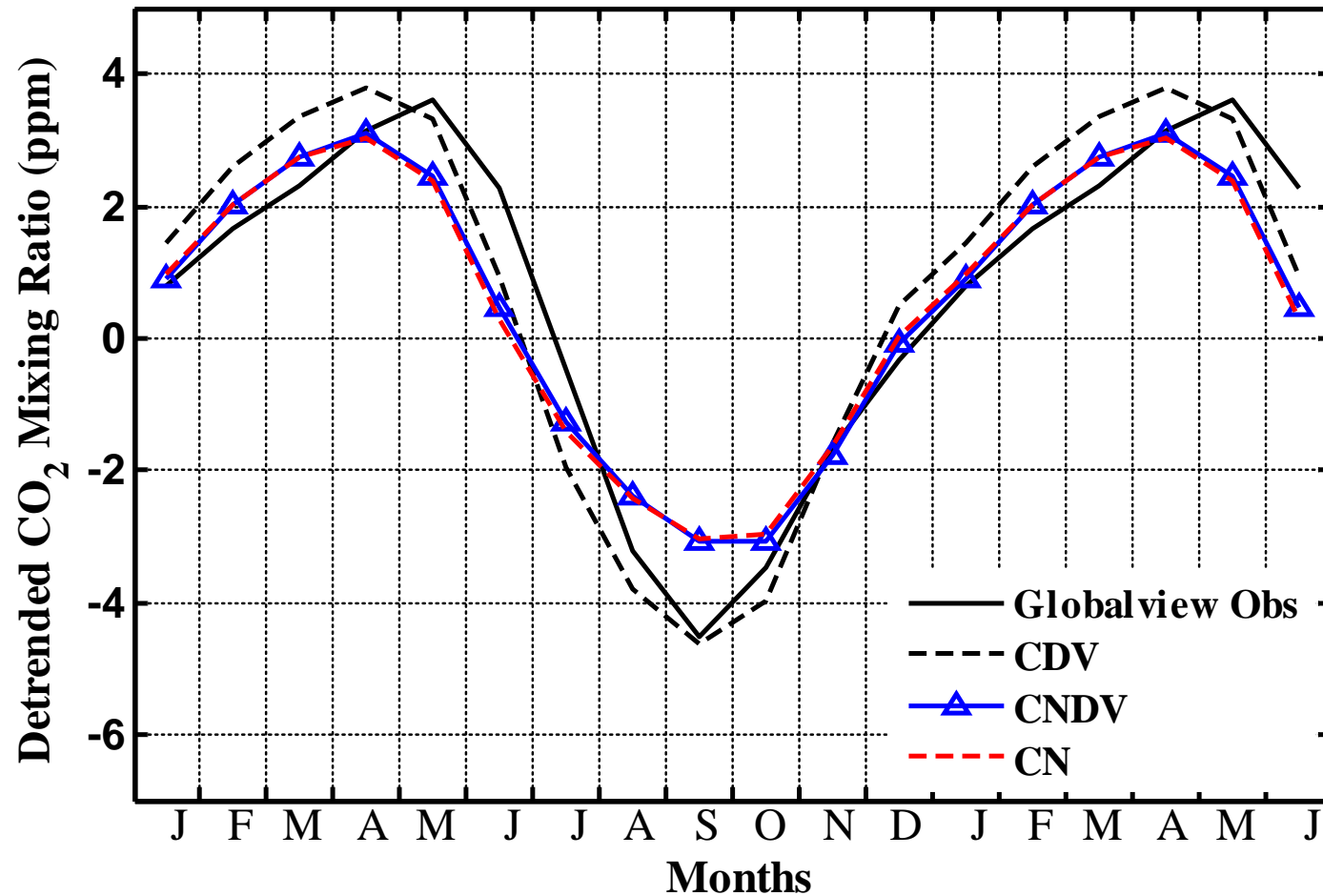


Seasonal Variability

- CDV performs better in capturing peak carbon uptake; the interactive N-cycle degrades peak CO₂ uptake during the growing season but improves CO₂ emissions during other months compared to CDV.
- The overestimated tree cover in CDV reduces overall seasonal variability of albedo and latent heat flux.
- Addition of DV reduces seasonal variability in TLAI.



Average Seasonal Cycle at Kumukahi



End of the 20th century seasonal CO₂ cycles compared to observations from GLOBALVIEW monitoring stations in Kumukahi (19.5°N, 154.8°W).

Summary

- CNDV produces reasonable vegetation distribution, and is consistent in performance whether coupled only to CLM4 in the offline mode or to the full CCSM4 suite.
- No configuration consistently performs best across the board in simulating annual or monthly means compared to other data, observations .
- The N-cycle and DV mostly reduce the annual means and inter-annual variability; but reduction from interactive N-cycle is greater.



Summary

- In equilibrium simulations, CNDV acts as a “buffer” or “regulator” of inter-annual variability compared to the CDV or CN configurations.
- The role of interactive nitrogen and dynamic vegetation may manifest differently in fully-coupled transient simulations that allow for interaction with climate.





Thank You!