GLACE-2: Overview (slides from R. Koster)

Status and Follow-up initiatives

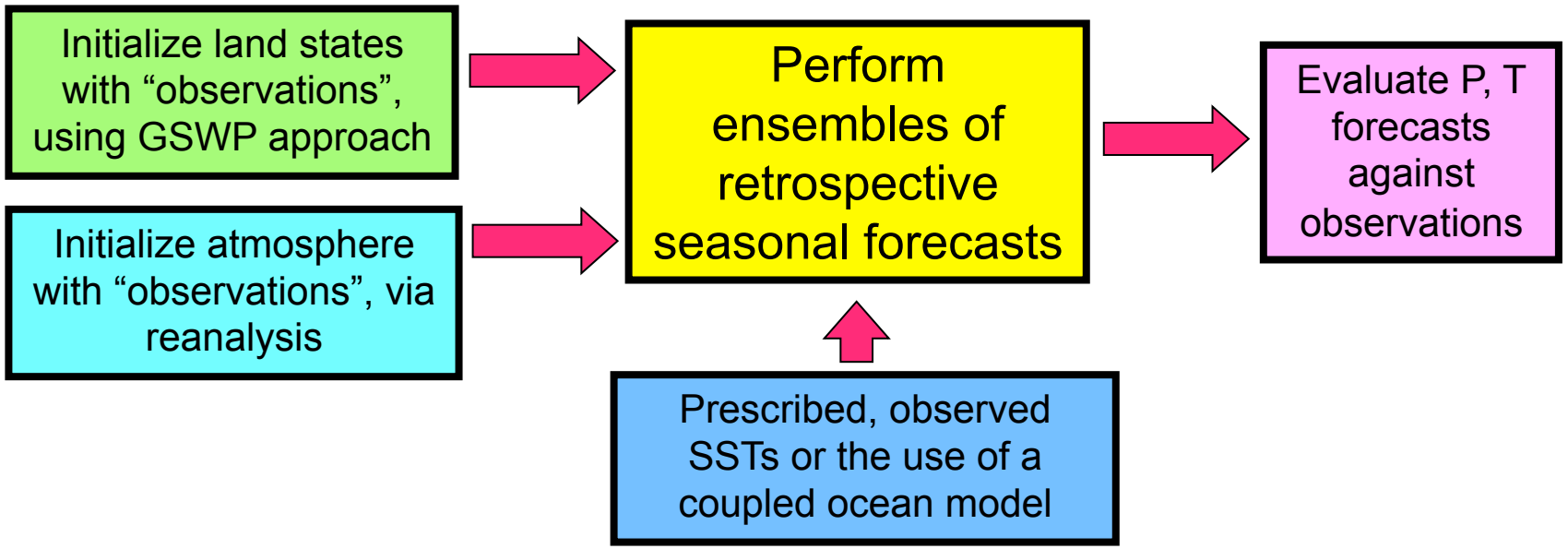
Sonia Seneviratne, ETH Zurich

GLACE-2: An international project aimed at quantifying soil moisture impacts on prediction skill.

Overall goal of GLACE-2: Determine the degree to which realistic land surface (soil moisture) initialization contributes to forecast skill (rainfall, temperature) at 1-2 month leads, using a wide array of state-of-the-art forecast systems.

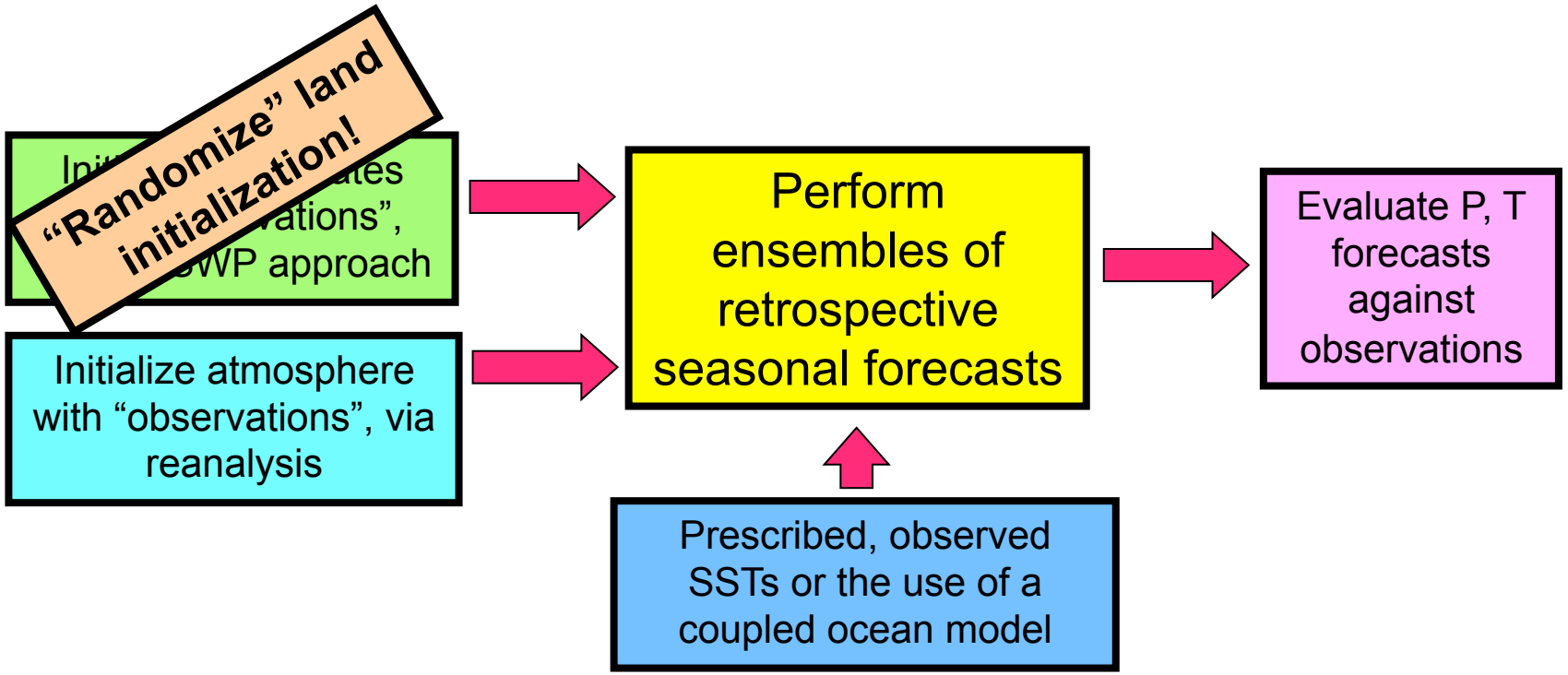
GLACE-2:
Experiment Overview

Series 1:



GLACE-2:
Experiment Overview

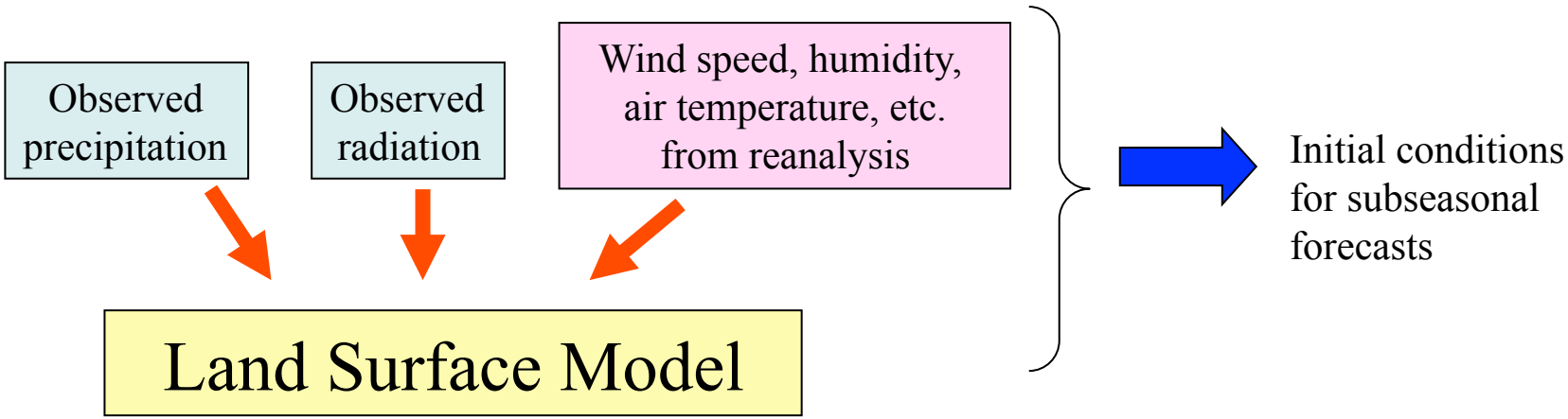
Series 2:



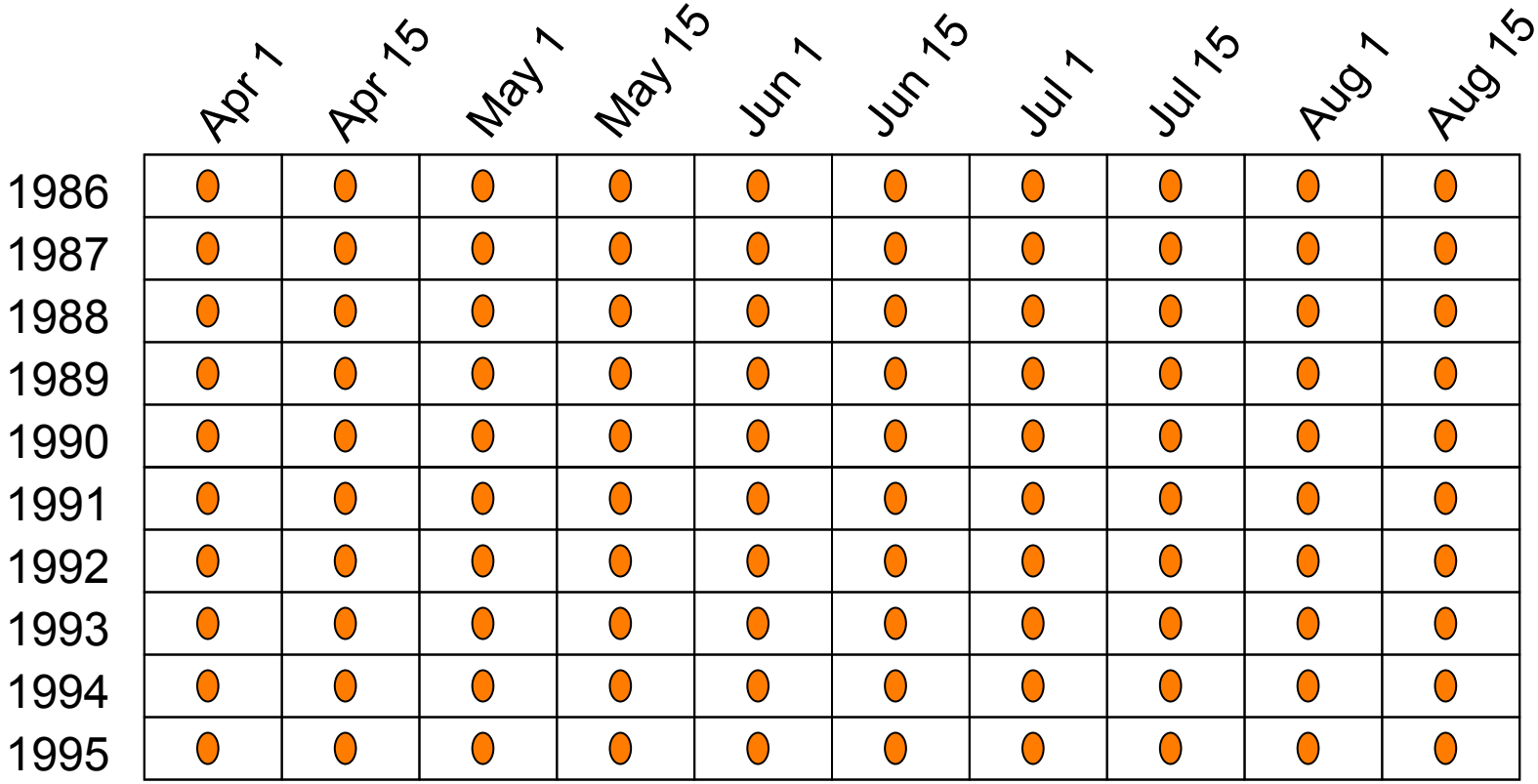
GLACE-2:
Experiment Overview

Step 3: Compare skill in two sets of forecasts; isolate contribution of realistic land initialization.

Land model initialization



Baseline: 100 Forecast Start Dates



Each ensemble consists of 10 simulations, each running for 2 months.

➡ 1000 2-month simulations.

Participant List

Group/Model	# models	Points of Contact
1. NASA/GSFC (USA): GMAO seasonal forecast system (old and new)	2	R. Koster, S. Mahanama
2. COLA (USA): COLA GCM, NCAR/CAM GCM	2	P. Dirmeyer, Z. Guo
3. Princeton (USA): NCEP GCM	1	E. Wood, L. Luo
4. ETH Zurich (Switzerland): ECHAM GCM	1	S. Seneviratne, E. Davin
5. KNMI (Netherlands): ECMWF	1	B. van den Hurk
6. ECMWF	1	G. Balsamo, F. Doblas-Reyes
7. GFDL (USA): GFDL system	1	T. Gordon
8. U. Gothenburg (Sweden): NCAR	1	J.-H. Jeong
9. CCSR/NIES/FRCGC (Japan): CCSR GCM	1	T. Yamada
10. FSU/COAPS	1	M. Boisserie
11. CCCma (?)	1	B. Merryfield
	13 models	

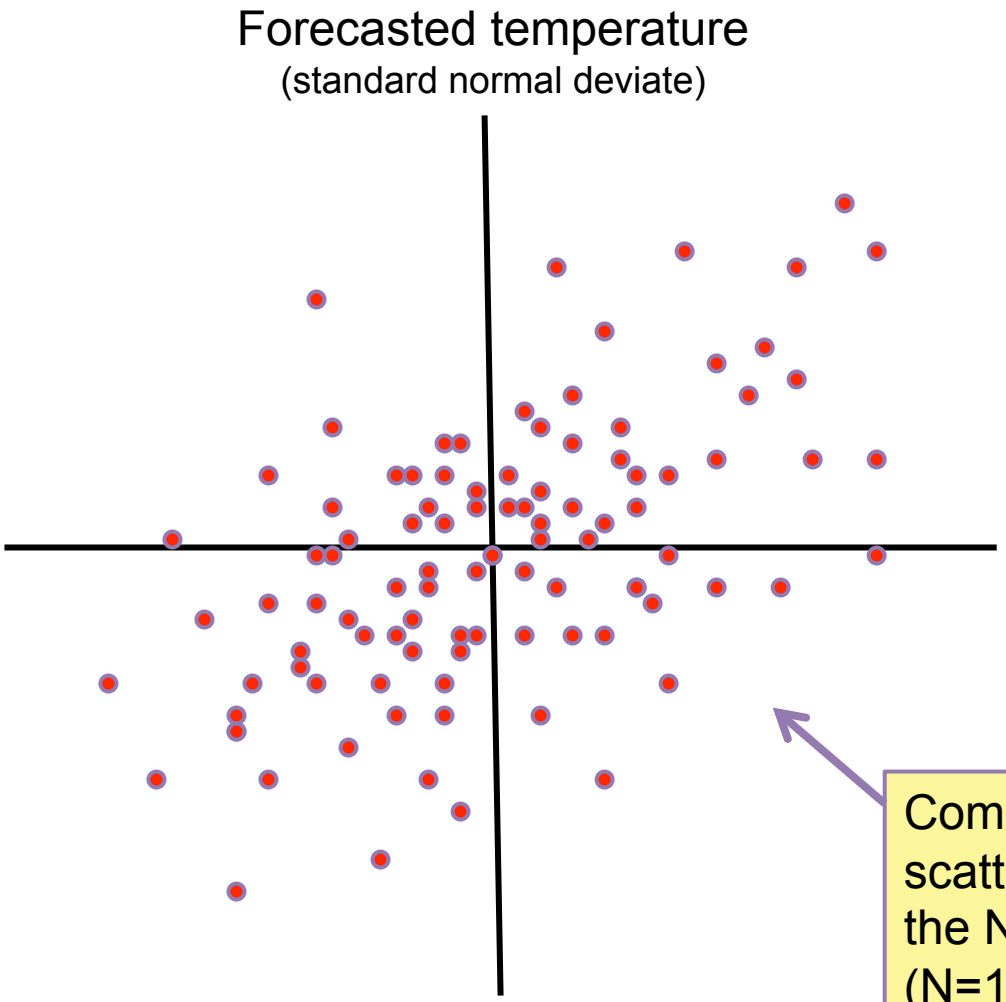
Participant List

Group/Model	# models	Points of Contact
1. NASA/GSFC (USA): GMAO seasonal forec system (old and new)		oster, S. Mahanama
2. COLA (USA): COLA GCM, NCAR/CAM GCM	2	P. Dirmeyer, Z. Guo
3. Princeton (USA): NCEP GCM	1	E. Wood, L. Luo
4. ETH Zurich (Switzerland): ECHAM GCM	1	S. Seneviratne, E. Davin
5. KNMI (Netherlands): ECMWF	1	B. van den Hurk
6. ECMWF	1	G. Balsamo, F. Doblas-Reyes
7. GFDL (USA): GFDL system		rdon
8. U. Gothenburg (Sweden): NCAR		Jeong
9. CCSR/NIES/FRCGC (Japan): CCSR GCM		mada
10. FSU/COAPS	1	M. Boisserie
11. CCCma	1	B. Merryfield
	13 models	

Green: Finished baseline forecasts

Orange: Finished half of baseline forecasts

Skill measure: r^2 when regressed against observations



Observed temperature
(standard normal deviate)

Compute r^2 from N points in scatter plot, one point for each of the N independent forecasts. (N=100 for MJJAS; N=60 for JJA)

- We focus here on multi-model “consensus” view of skill.

- We focus here on JJA, the period when N.H. evaporation is strongest.

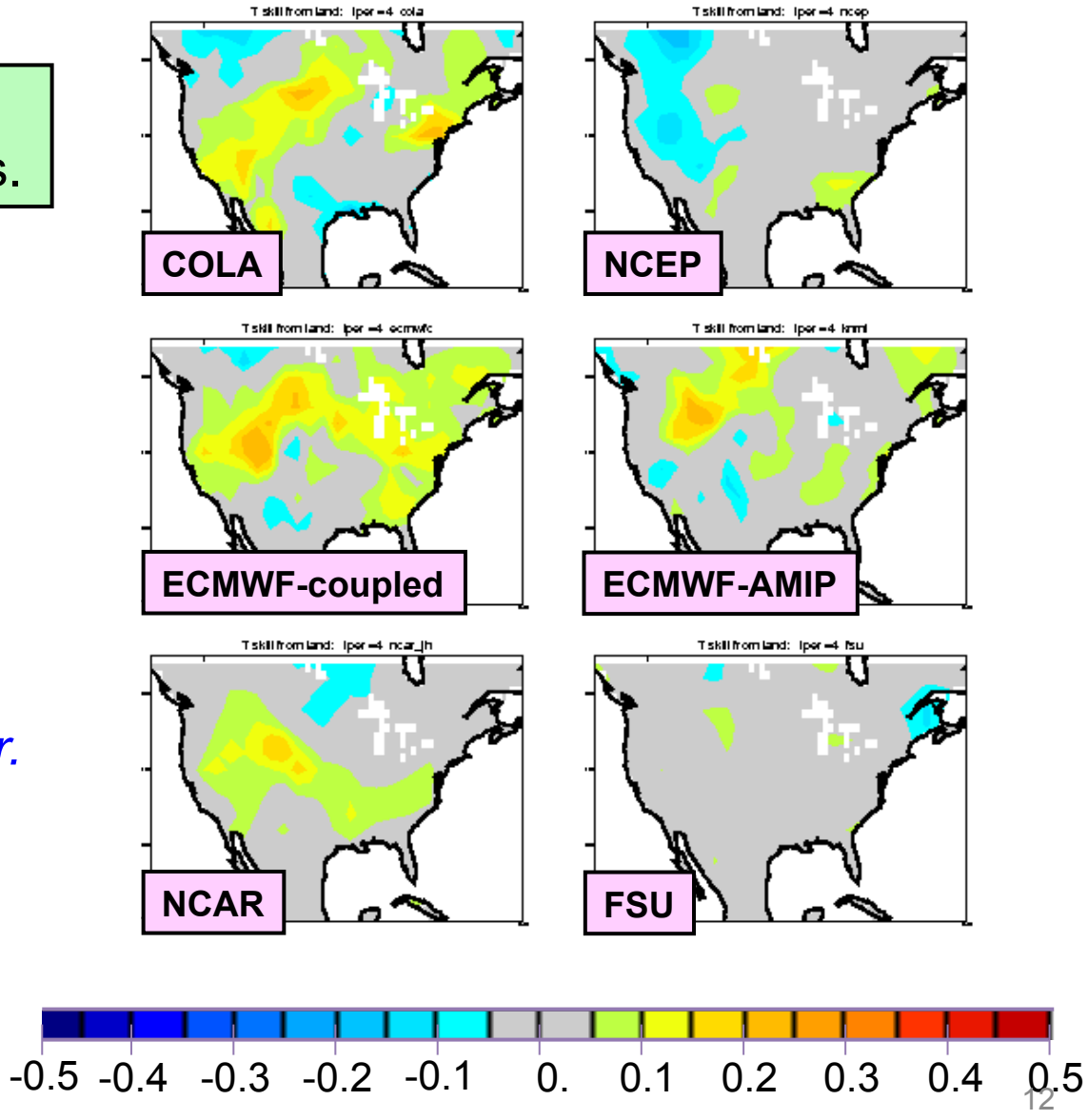
- We focus here on the U.S., for which:
  -- models show strong inherent predictability associated with land initialization (GLACE-1!)
  -- observations are reliable over the forecast period

Sample results: Isolated impact of land initialization on **r^2 skill score** for different models (r^2 *from Series 1 minus* r^2 *from Series 2*).

Predicted variable: Air temperature at 16-30 days.

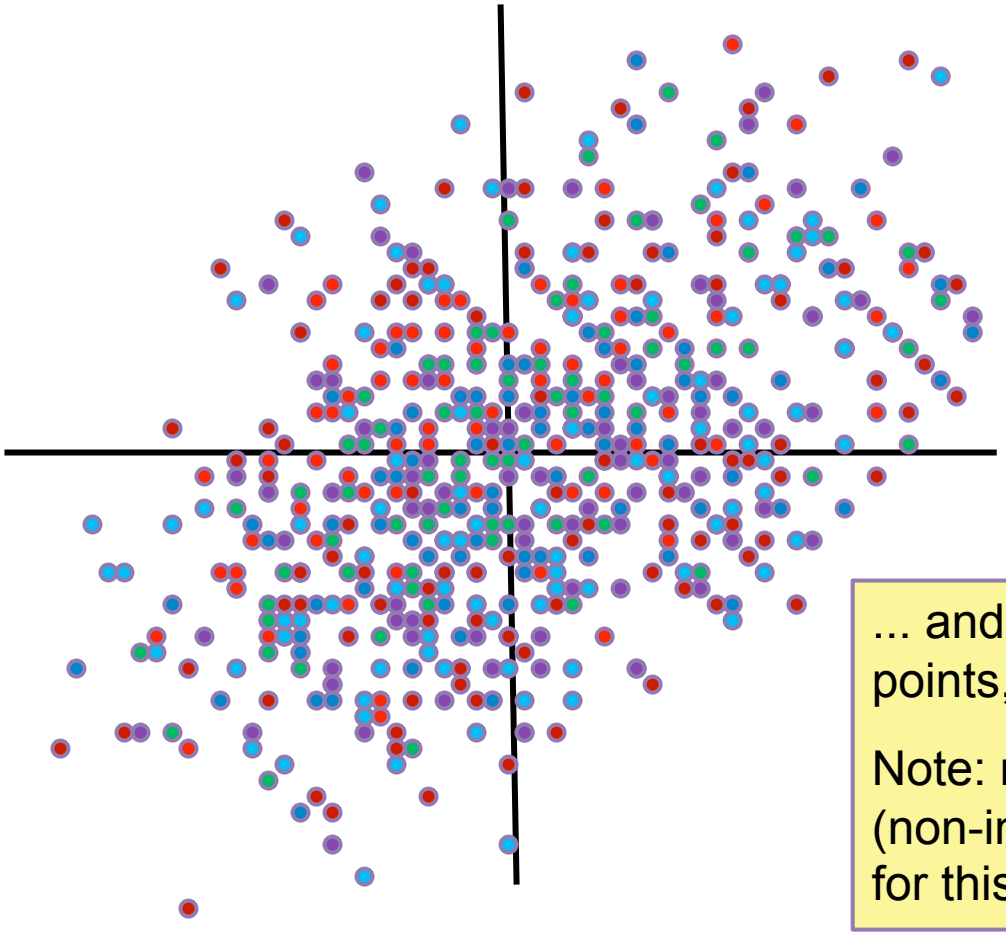
Models appear to differ in their ability to extract skill from land initialization.

Results for precipitation forecasts are much weaker.



Multi-model "consensus" measure of skill: a prerequisite to a conditional skill analysis

Forecasted temperature
(standard normal deviate)



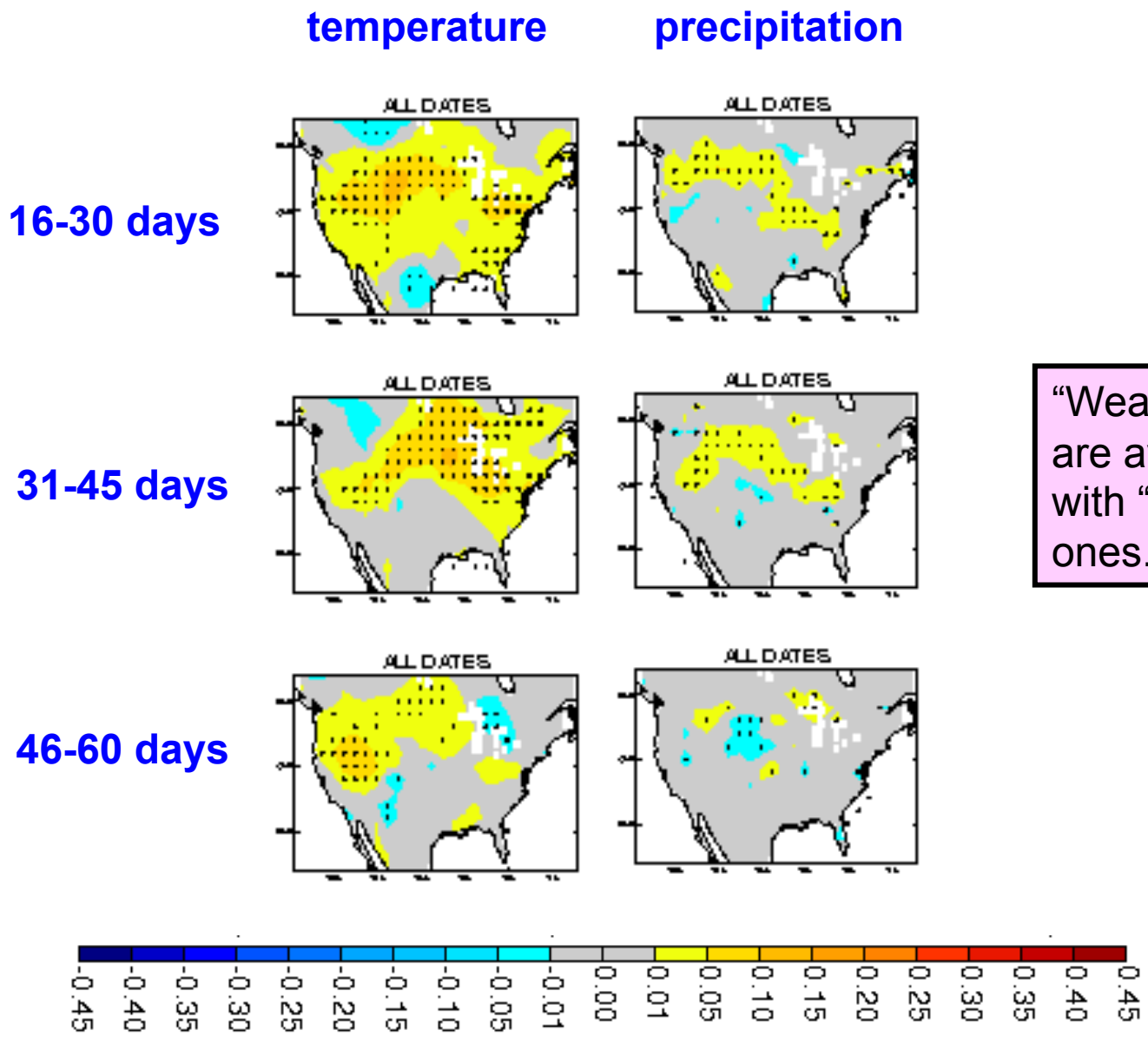
Plot results for all M models on the same scatterplot...

Observed temperature
(standard normal deviate)

... and then compute r^2 from 6MN points, N from each model.

Note: models may behave similarly (non-independently); must account for this in significance testing.

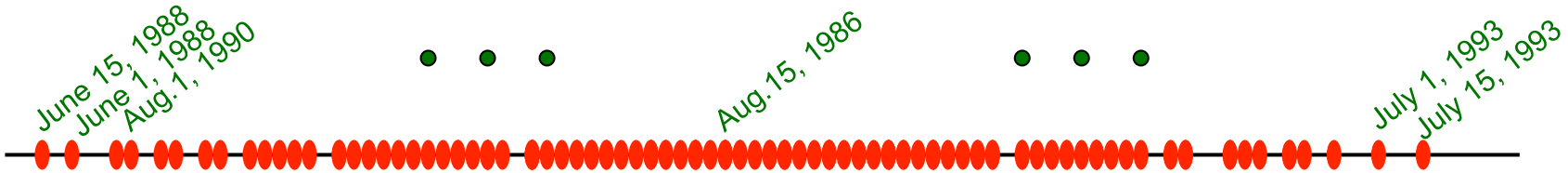
Forecasts: "Consensus" skill due to land initialization (JJA)



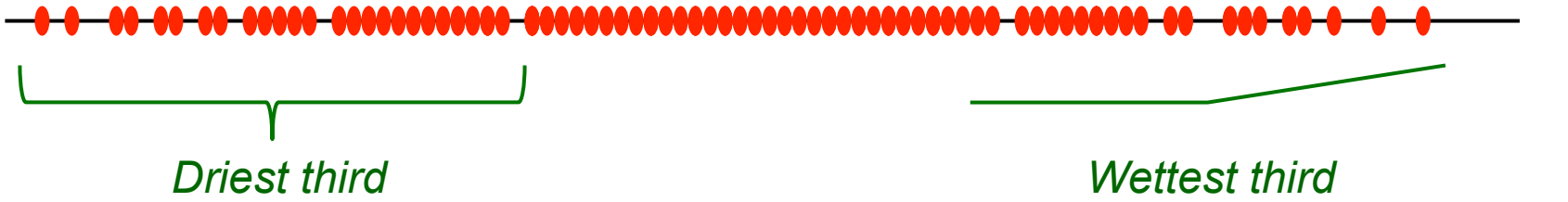
"Weaker" models are averaged in with "stronger" ones.

Conditional skill: Suppose we know at the start of a forecast that the initial soil moisture anomaly, W_i, is relatively large...

Step 1: At each grid cell, rank the forecast periods from lowest initial soil moisture to highest initial soil moisture:



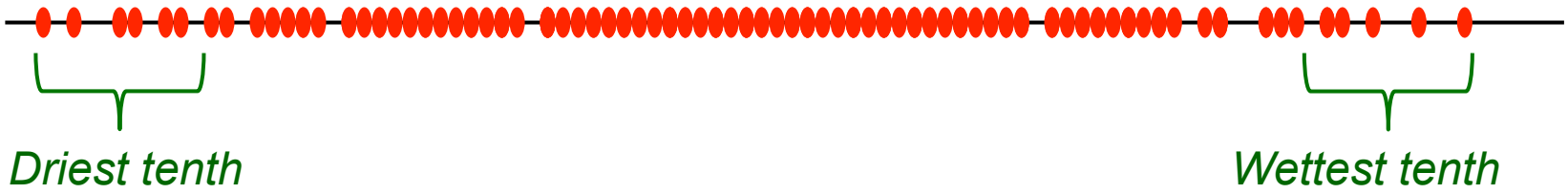
Step 2: Separate into terciles:



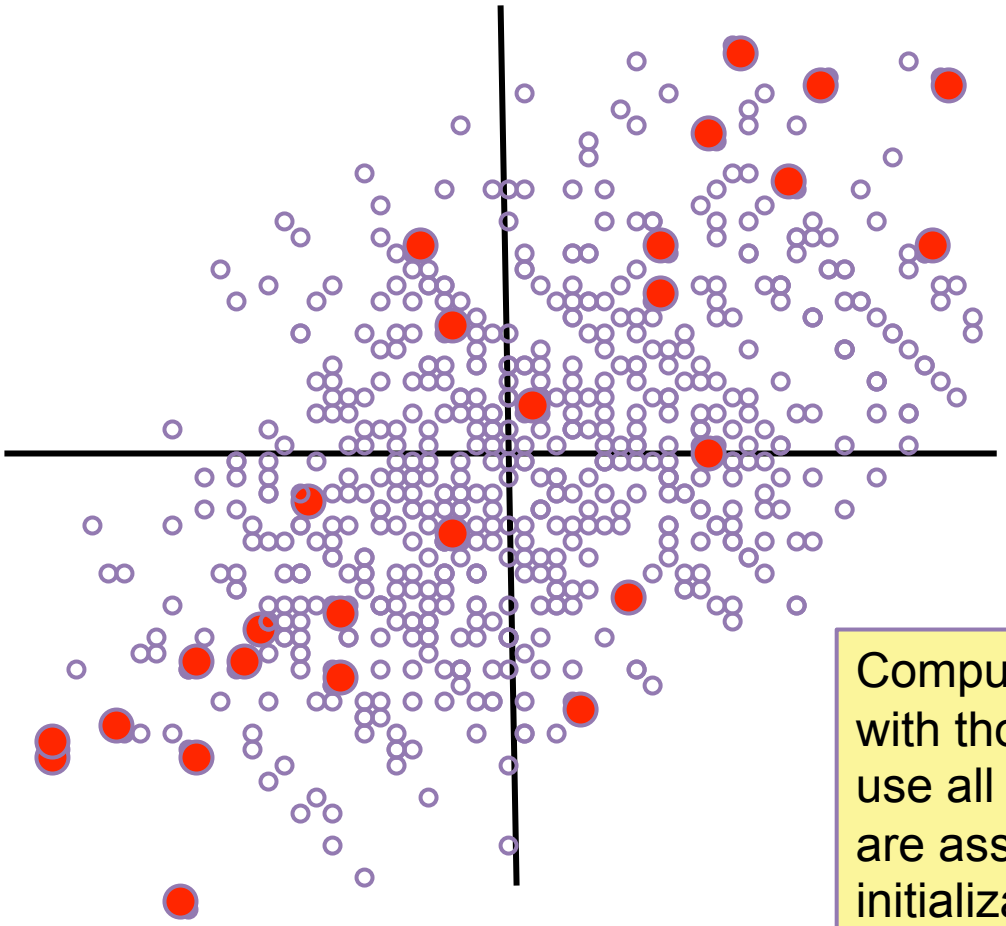
Conditional skill: Suppose we know at the start of a forecast that the initial soil moisture anomaly, W_i, is relatively large...

Step 2: Separate into quintiles:

Step 3: Separate into deciles:



Forecasted temperature
(standard normal deviate)



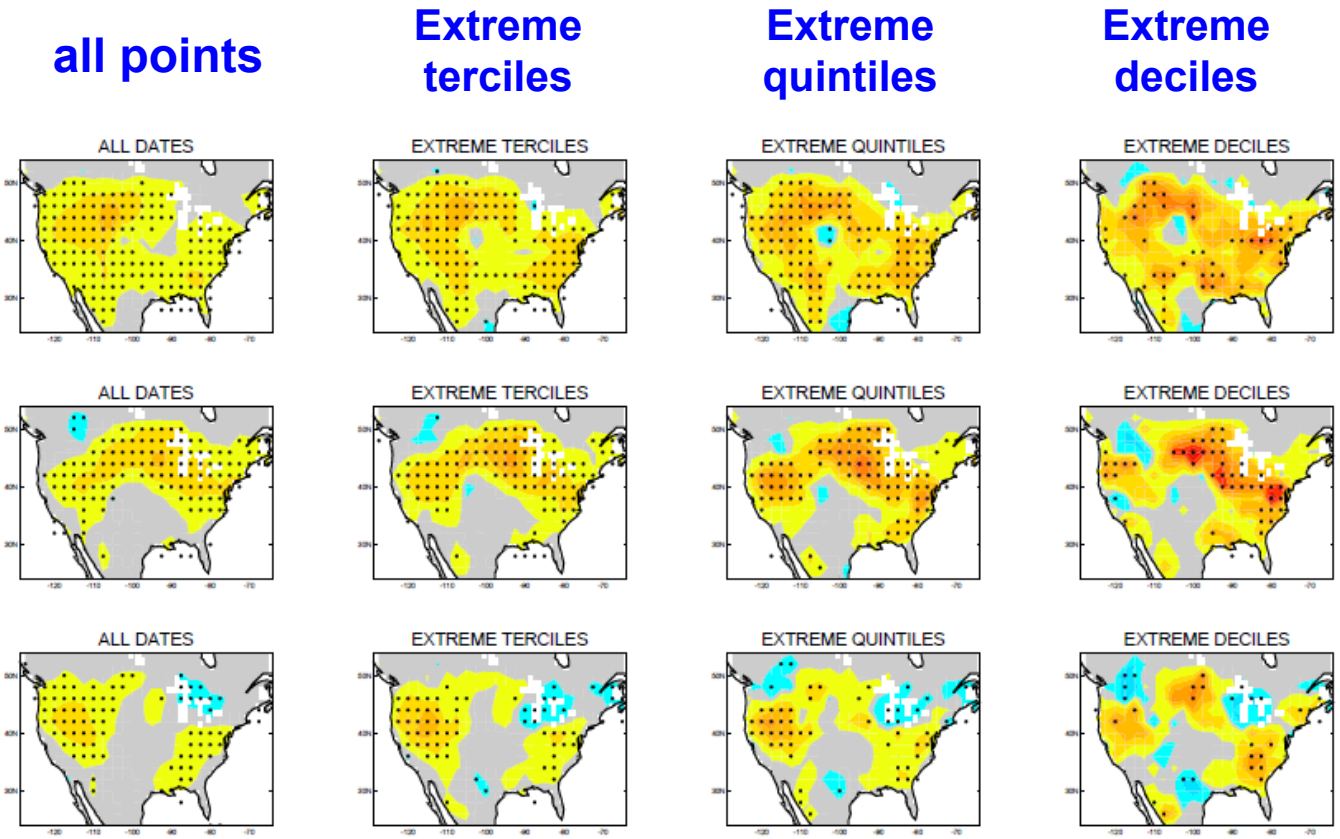
Identify start dates for which W_i is in top or bottom tercile (or quintile, or decile)

Observed temperature
(standard normal deviate)

Compute r^2 from only those points with those start dates. (As before, use all models together.) Here, we are assuming that "local impacts" of initialization are most important.

Temperature forecasts: Increase in skill due to land initialization (JJA)

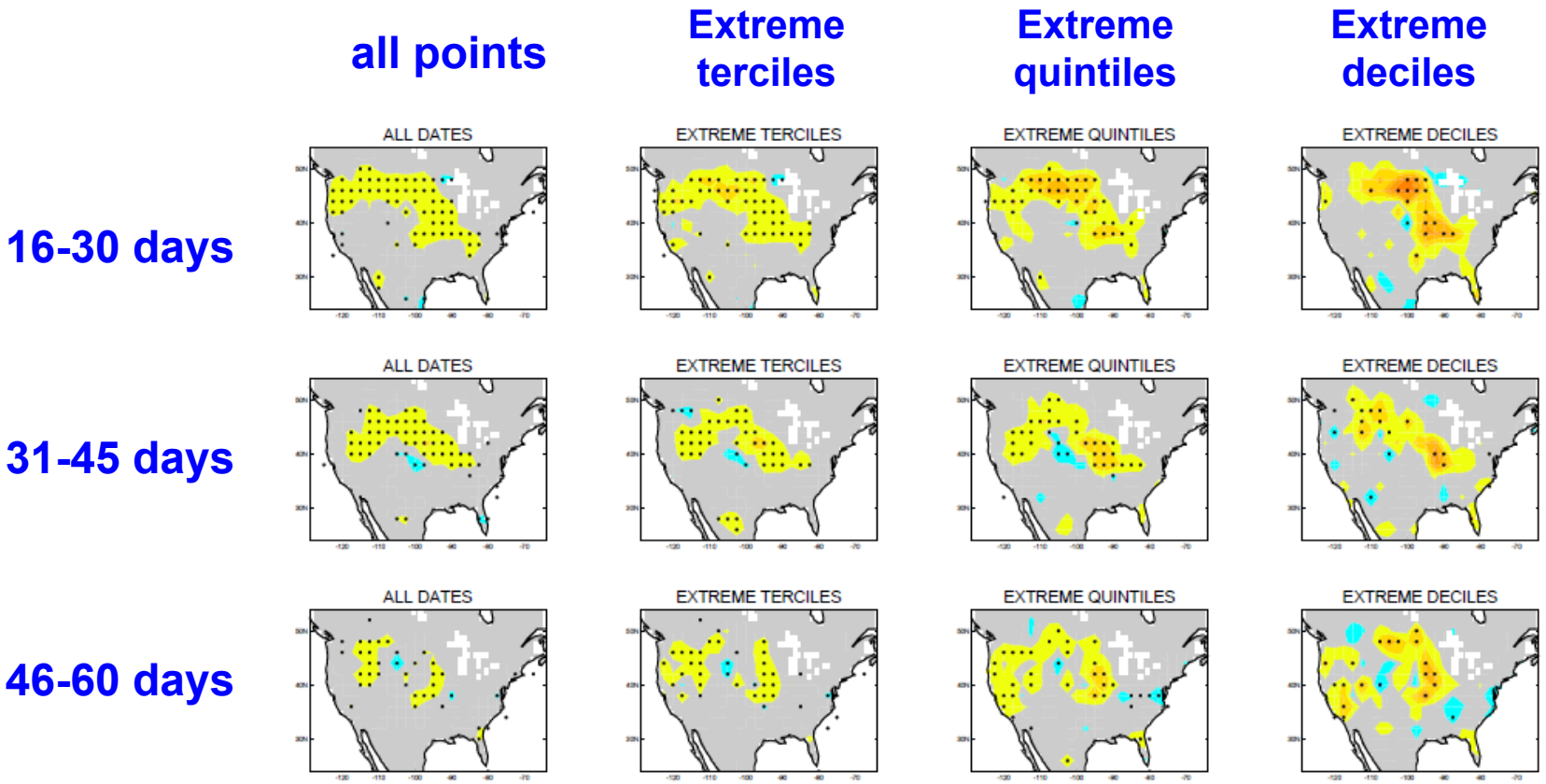
(conditioned on strength of local initial soil moisture anomaly)



(Koster et al. 2010, GRL)

Precipitation forecasts: Increase in skill due to land initialization (JJA)

(conditioned on strength of local initial soil moisture anomaly)



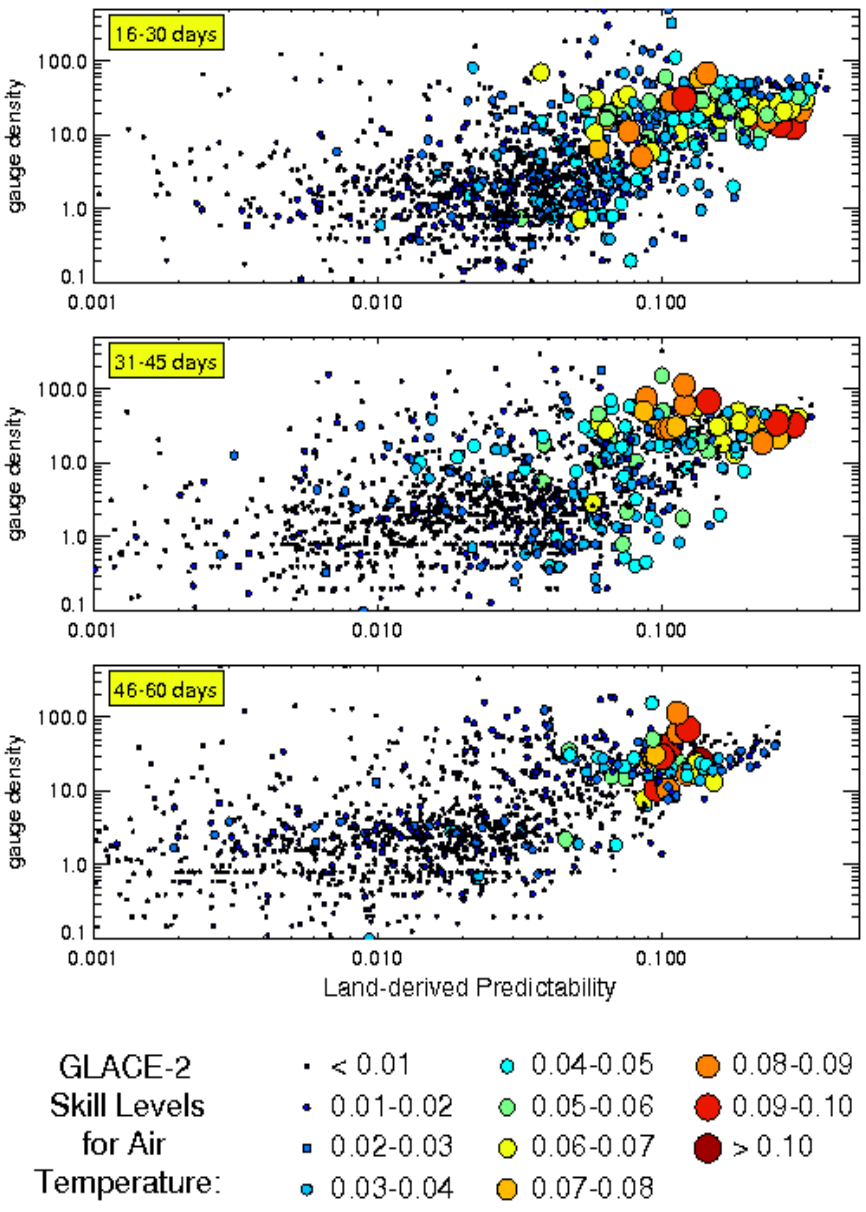
(Koster et al. 2010, GRL)

Forecast skill levels are highest in regions with both:

a) some inherent model "predictability", and

b) an adequate observational network for accurate initialization

(This is a global analysis.)



(Koster et al. 2010, in prep for JHM)

Conclusions of First GLACE-2 Analysis

1. Almost all of the expected GLACE-2 submissions are in.

2. The individual models vary in their ability to extract forecast skill from land initialization (not shown). In general,
   -- Low skill for precipitation
   -- Moderate skill (in places) for temperature, even out to two months.

3. Land initialization impacts on skill increase dramatically when conditioned on the size of the initial local soil moisture anomaly.

If you know the local soil moisture anomaly at time 0 is large, you can expect (in places) that initializing the land correctly will improve your temperature forecast significantly, and your precipitation forecast slightly, even out to 2 months.

4. The results highlight the potential usefulness of improved observational networks for prediction.

Message from Randy…

“Sonia, tell them that my life seems a little emptier since I left WGSIP. -- Randy”

Status & Follow-up

- GLACE-2 Status
  - Article published in GRL (2010) [Koster et al.]
  - Overview article in preparation for JHM [Koster et al.]
  - "European analysis" subm. to Clim. Dyn. [van den Hurk et al.]

- Follow-up (subgroups of GLACE-2):
  - Extension of simulations from 1986-1995 to 2009
  - Analysis of predictability of specific extremes (e.g. 2003 heatwave)
  - "GLACE-FUTURE" (Land-atmosphere coupling under changed climatic conditions: Changes of skill performance? Contribution to adaptation to climate change)

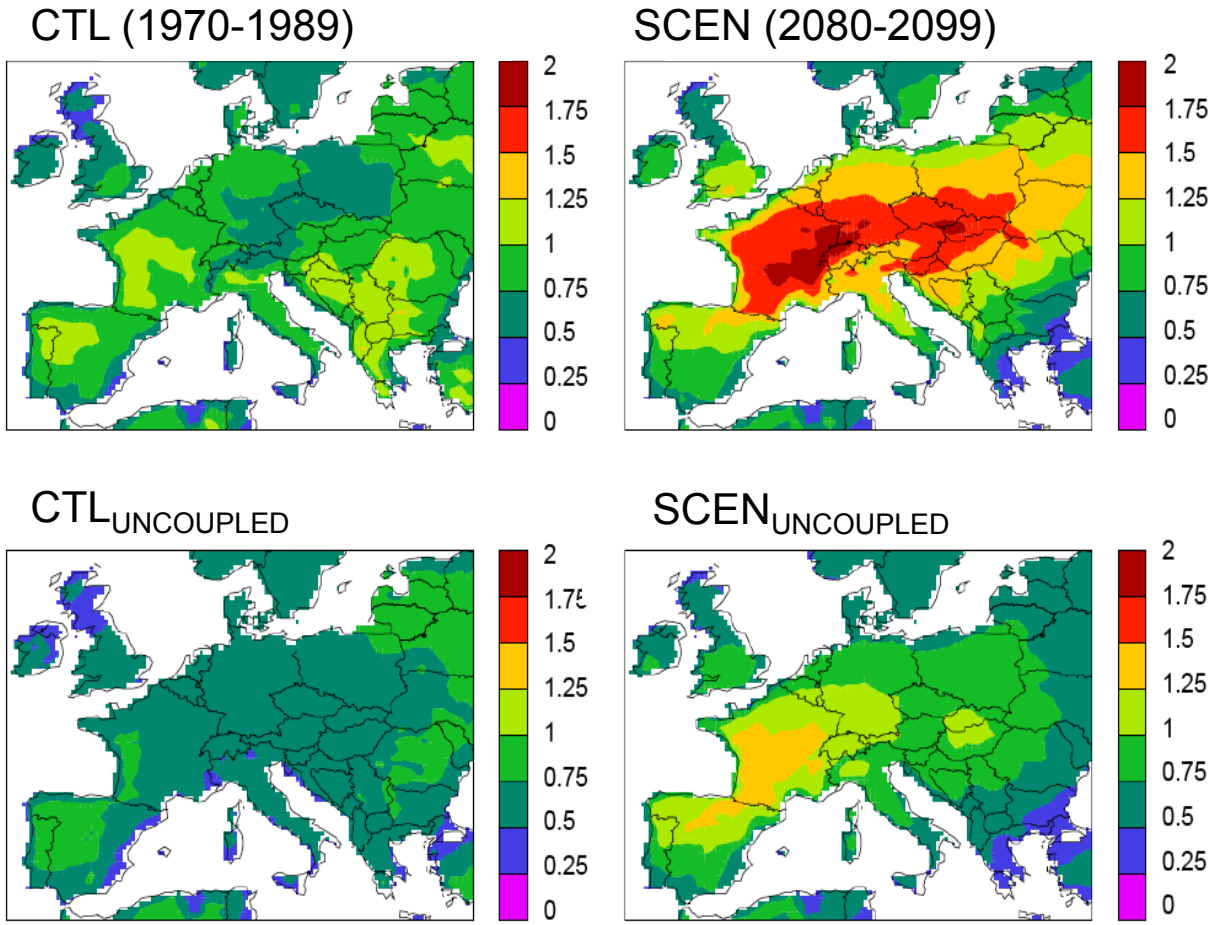
Status & Follow-up

- GLACE-2 Status
  - Article published in GRL (2010) [Koster et al.]
  - Overview article in preparation for JHM [Koster et al.]
  - "European analysis" subm. to Clim. Dyn. [van den Hurk et al.]

- Follow-up (subgroups of GLACE-2):
  - Extension of simulations from 1986-1995 to 2009
  - Analysis of predictability of specific extremes (e.g. 2003 heatwave)
  - "GLACE-FUTURE" (Land-atmosphere coupling under changed climatic conditions: Changes of skill performance? Contribution to adaptation to climate change)

Predictability and climate change

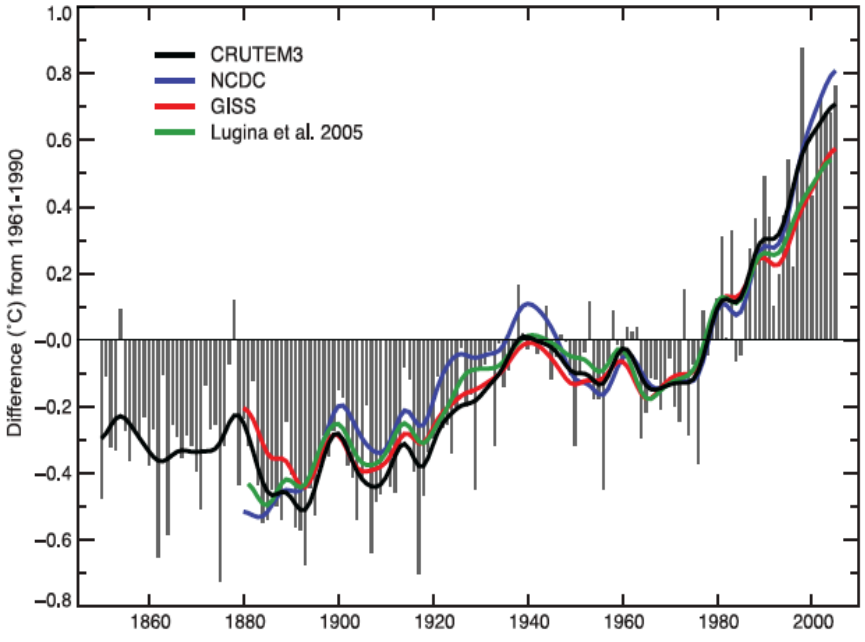
Changes in interannual variability of summer temperature
(Standard deviation of the summer (JJA) temperature)



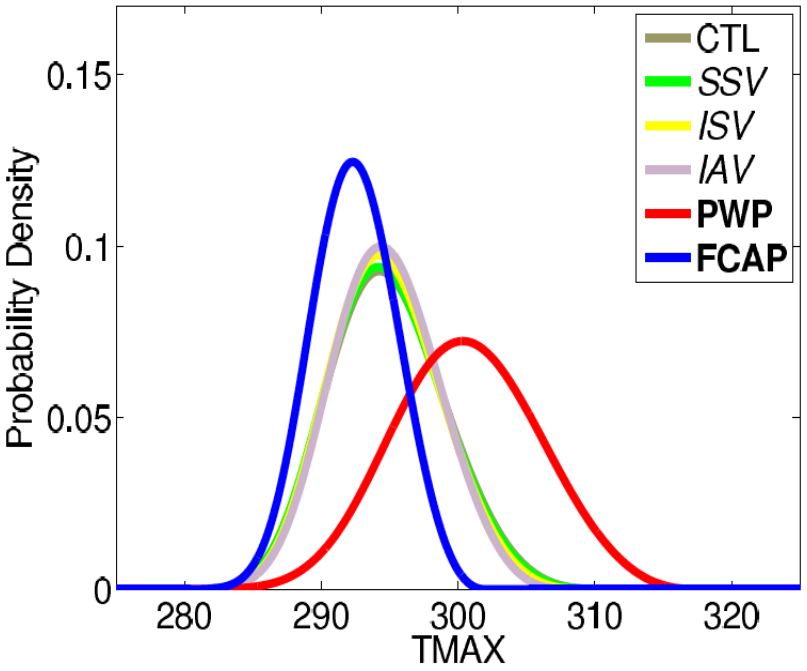
(Seneviratne et al. 2006, Nature)

Summer T^{o} variability in Central Europe in future climate is to large extent controlled by soil moisture

Predictability and climate change



(IPCC 2007)



(Jaeger and Seneviratne 2010, Climate Dynamics)

Status & Follow-up

- GLACE-2 Status
  - Article published in GRL (2010) [Koster et al.]
  - Overview article in preparation for JHM [Koster et al.]
  - "European analysis" subm. to Clim. Dyn. [van den Hurk et al.]

- Follow-up (subgroups of GLACE-2):
  - Extension of simulations from 1986-1995 to 2009
  - Analysis of predictability of specific extremes (e.g. 2003 heatwave)
  - "GLACE-FUTURE" (Land-atmosphere coupling under changed climatic conditions: Changes of skill performance? Contribution to adaptation to climate change)

DISCUSSION?