Development of a Dynamic Surface Water Component in CLM4

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Adding a Surface Water Component to CLM

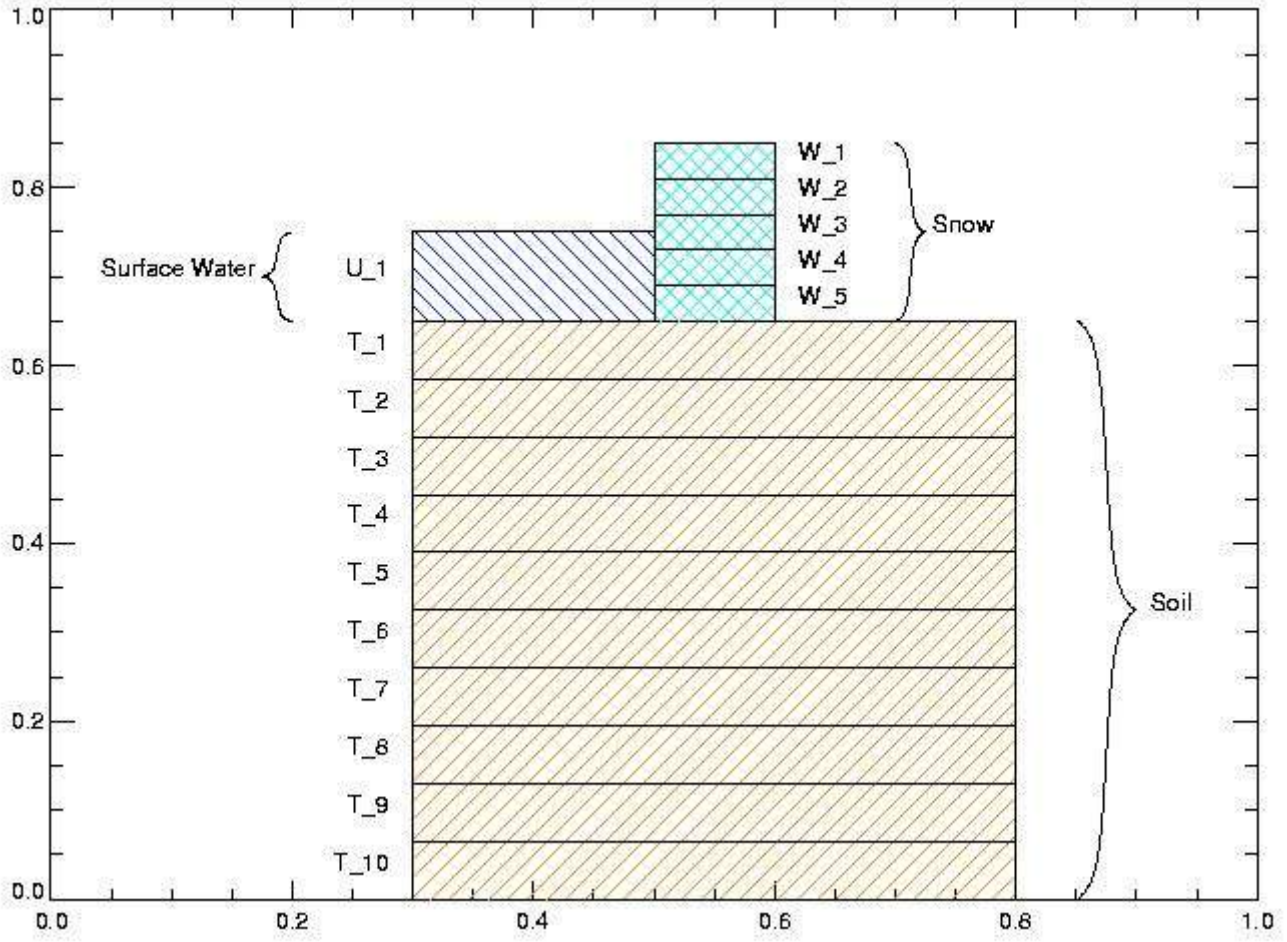
• In order to try to dynamically model wetlands, we are working on implementing a surface water storage component in CLM.

• A question arises with a single column representation of soil and snow: where does the surface water go?

• Modifying the model for fractional snow cover helps eliminate this problem.

• Now a snow column and surface water column can coexist with a single soil column, and neither needs to span the entire column.

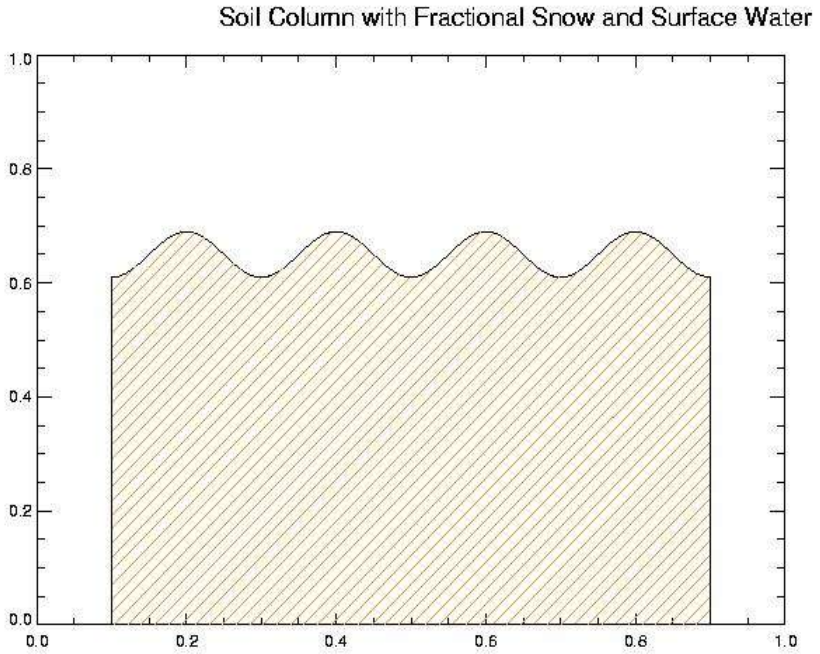
Surface Water Component Concept

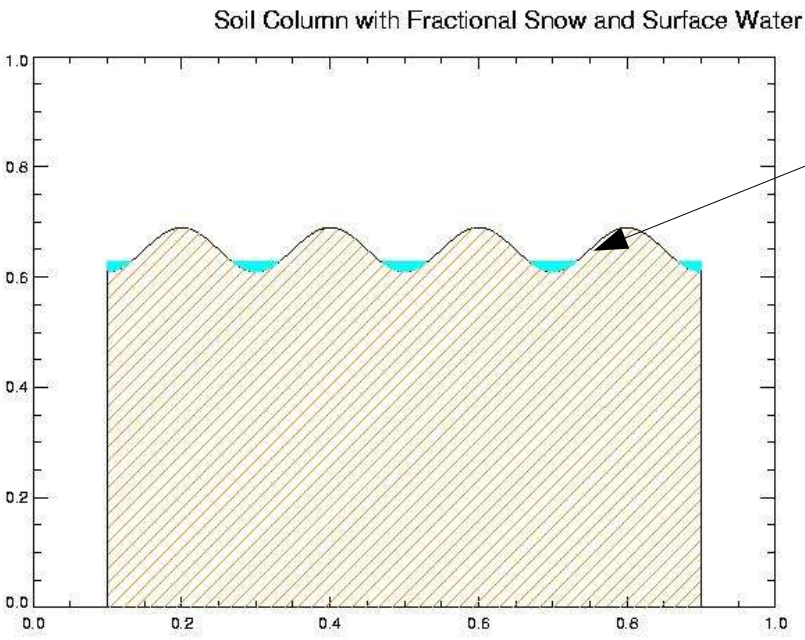


This cartoon doesn't look very physical.

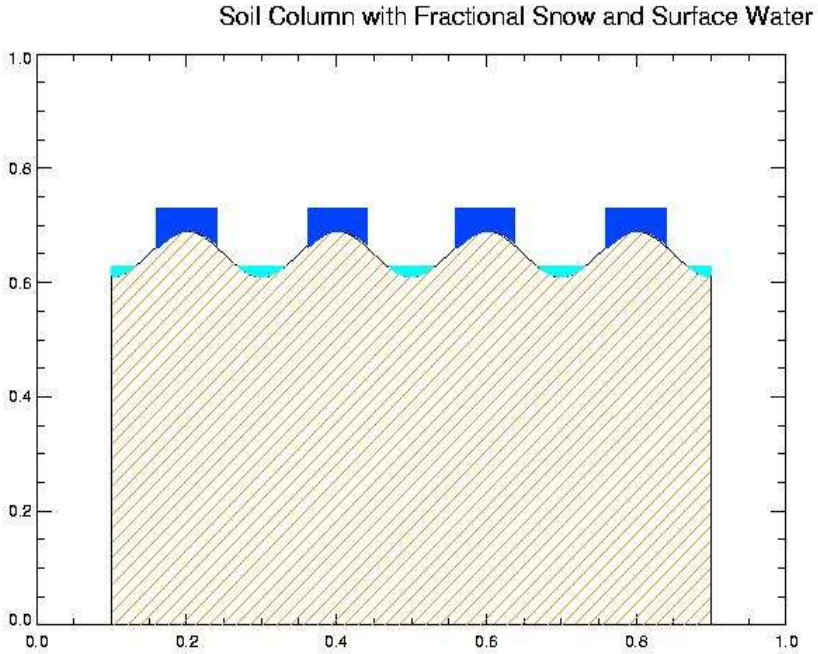
The next slide shows an equivalent, but more realistic representation.

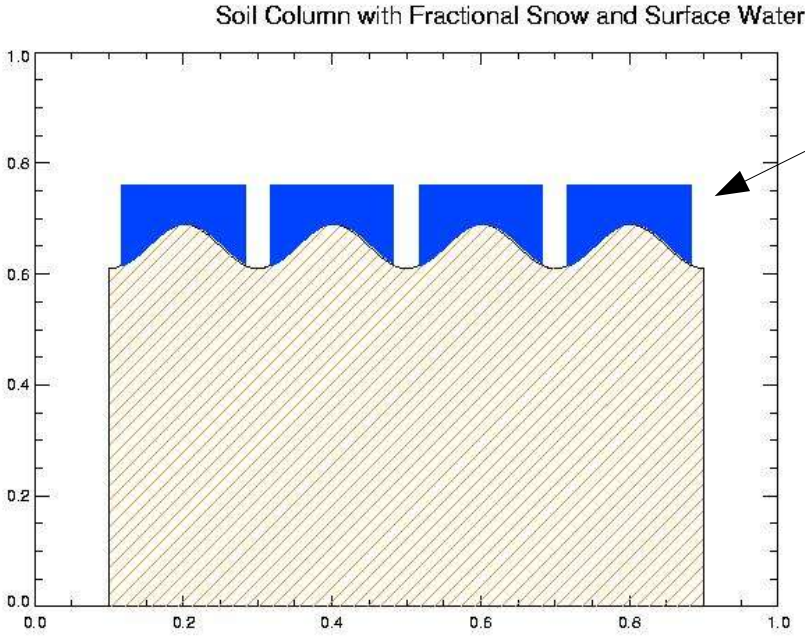
Surface Water Component Concept





Surface Water

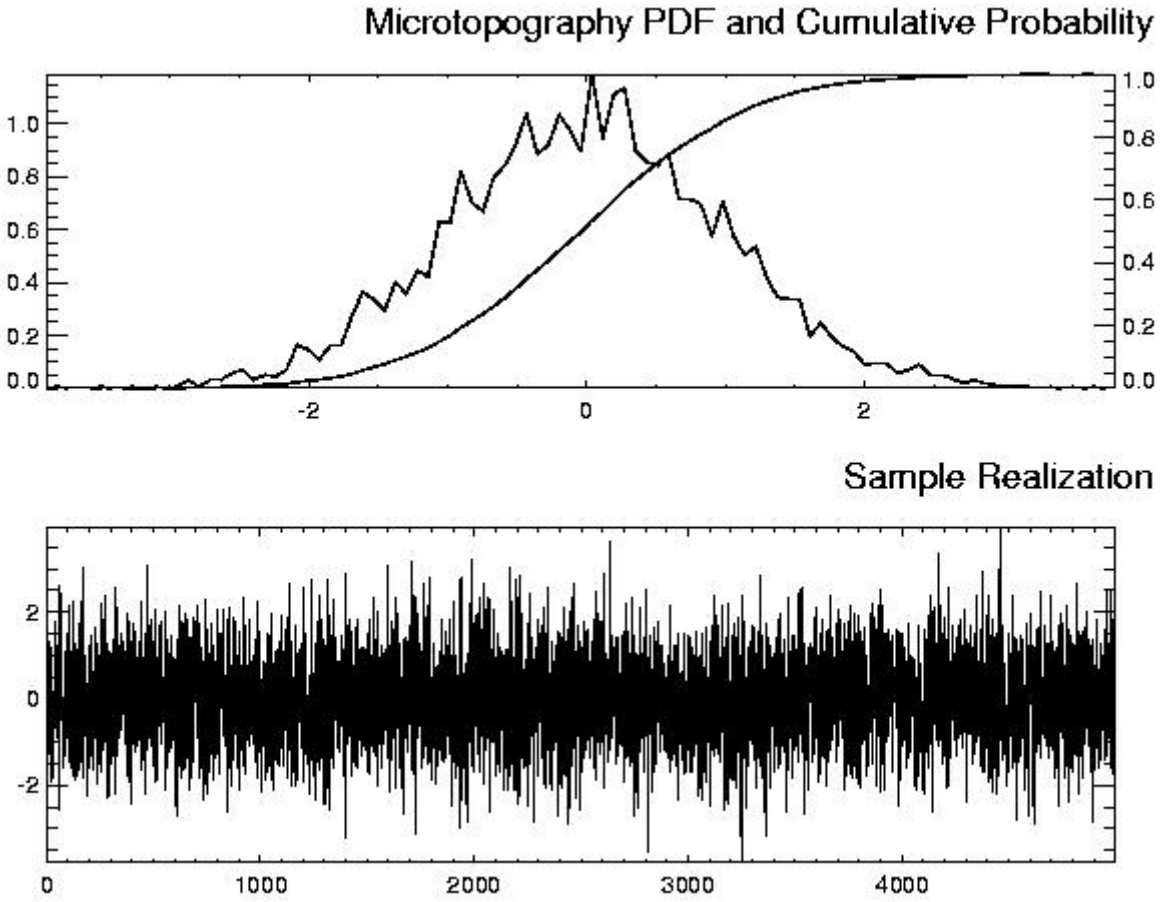




Snow

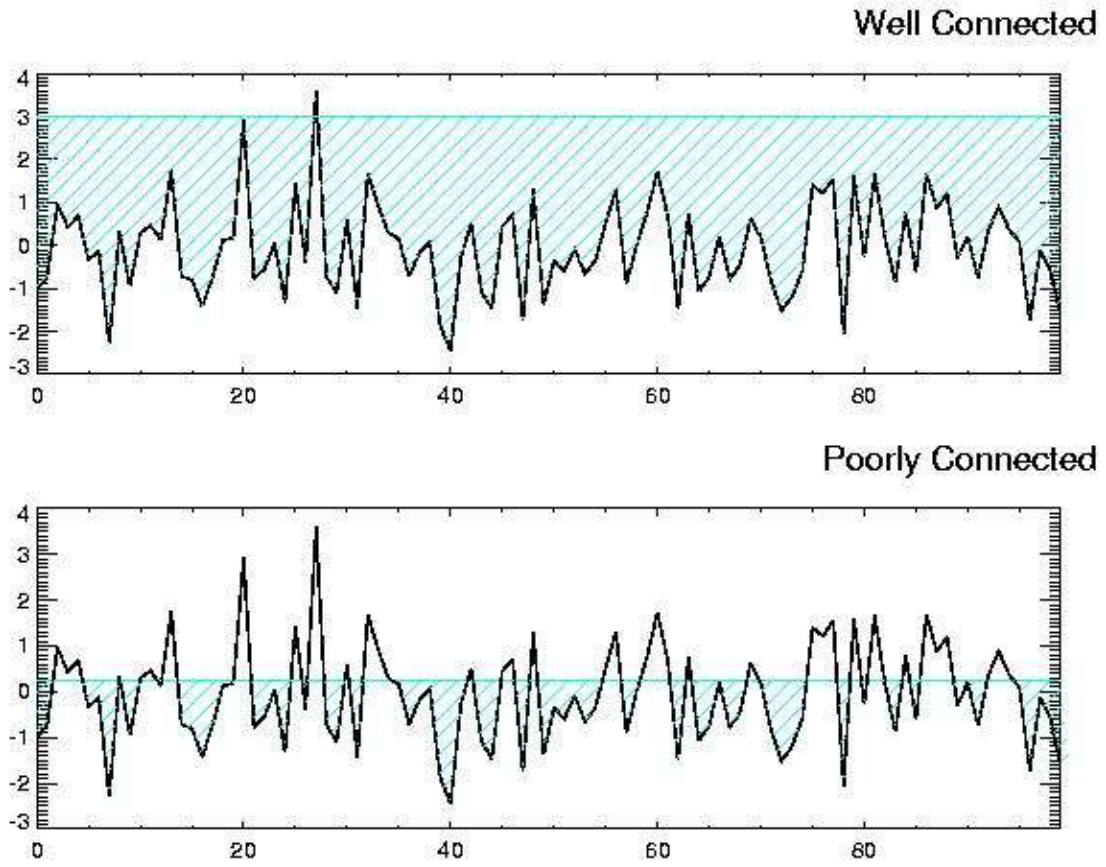
Surface Water Component Concept

• Concept is based on a parameter describing the microtopography, and some statistics regarding the sub-gridscale connectivity of different parts of the surface water store.

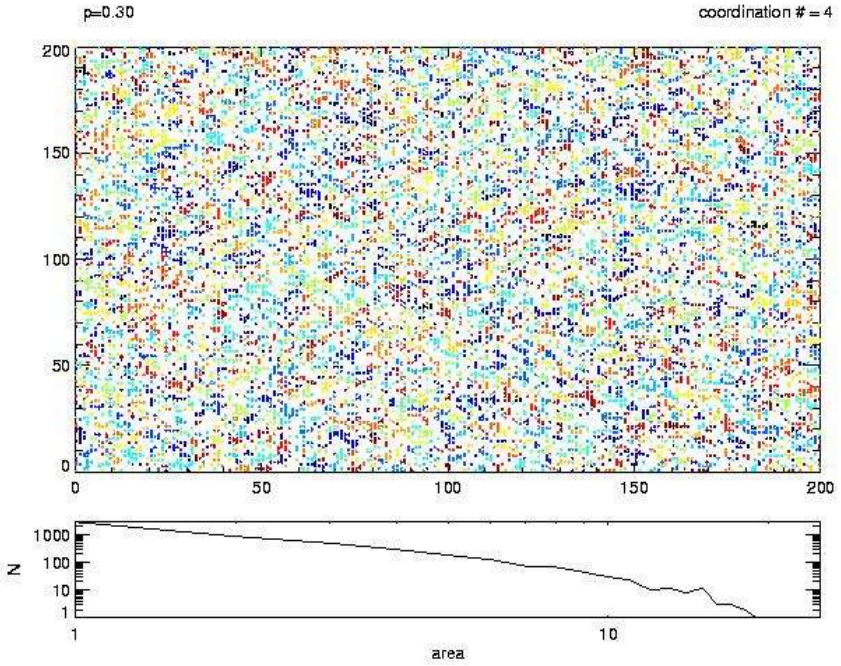


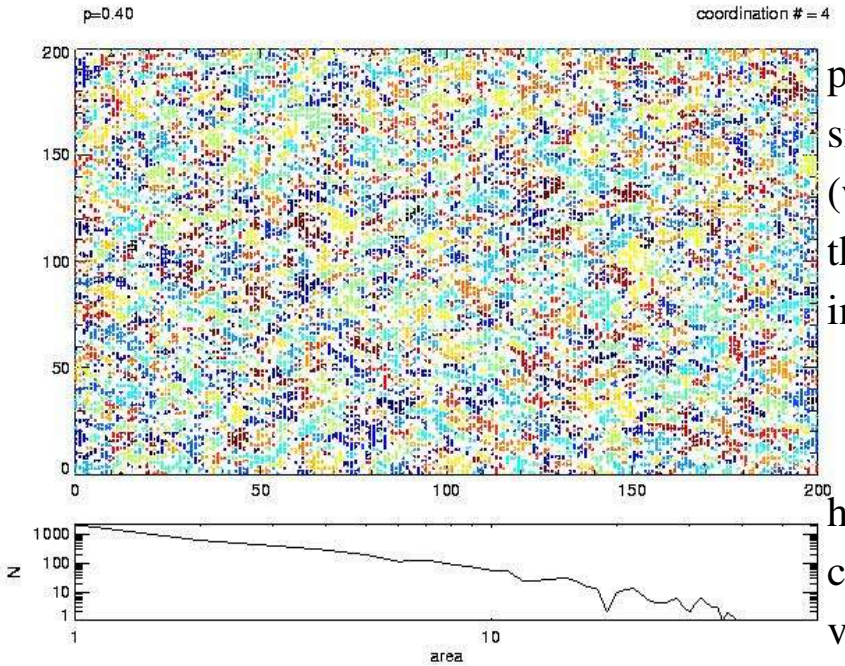
• When storage is large compared to microtopography, surface water bodies are well connected.

• When storage is small compared to microtopography, surface water bodies are generally not connected.



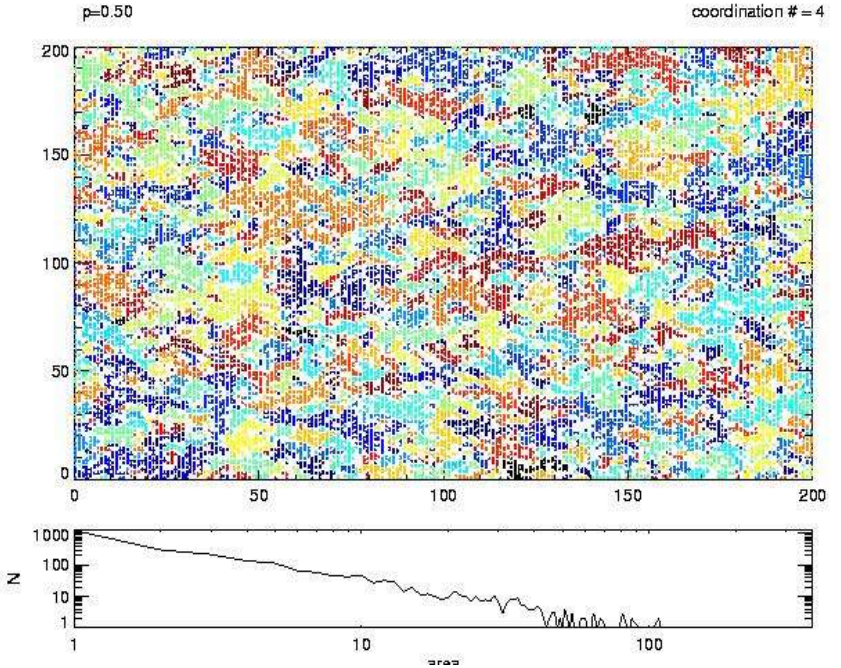
Plan View (2-D)

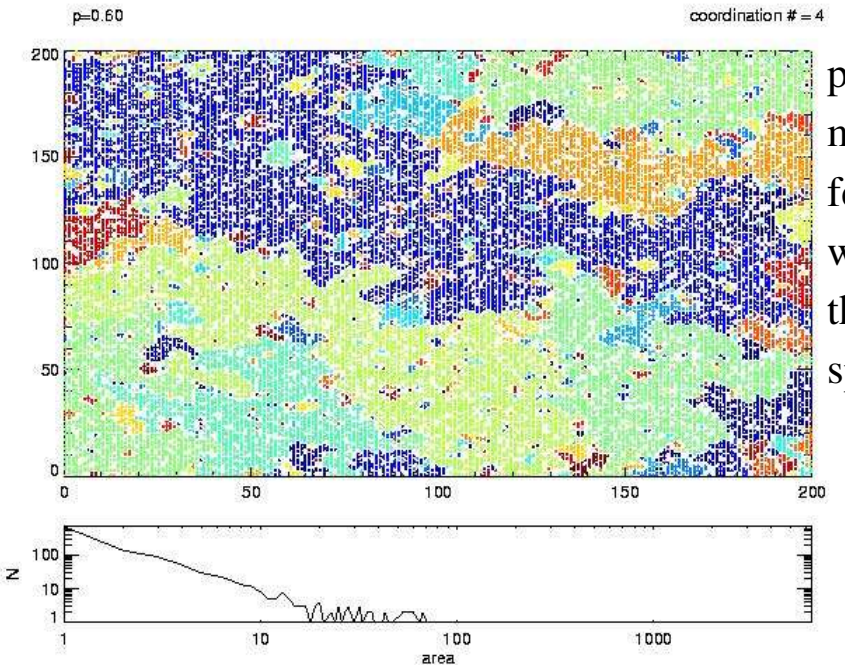




p=0.4, many small clusters (water bodies) that are independent.

histogram of cluster area versus number.

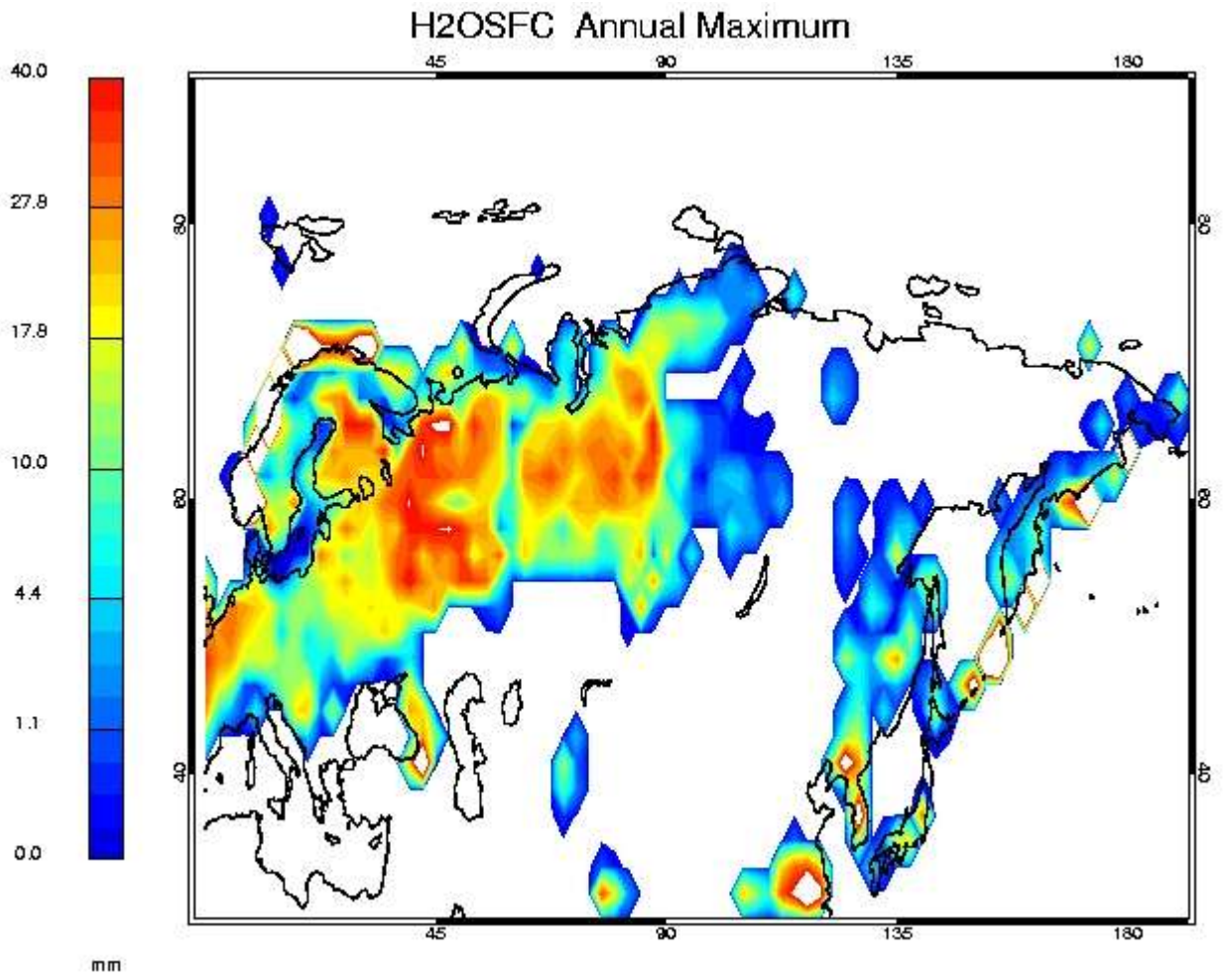




p=0.6, clusters merge, creating fewer, but larger water bodies that span the space.

Preliminary Simulations

Surface water depth



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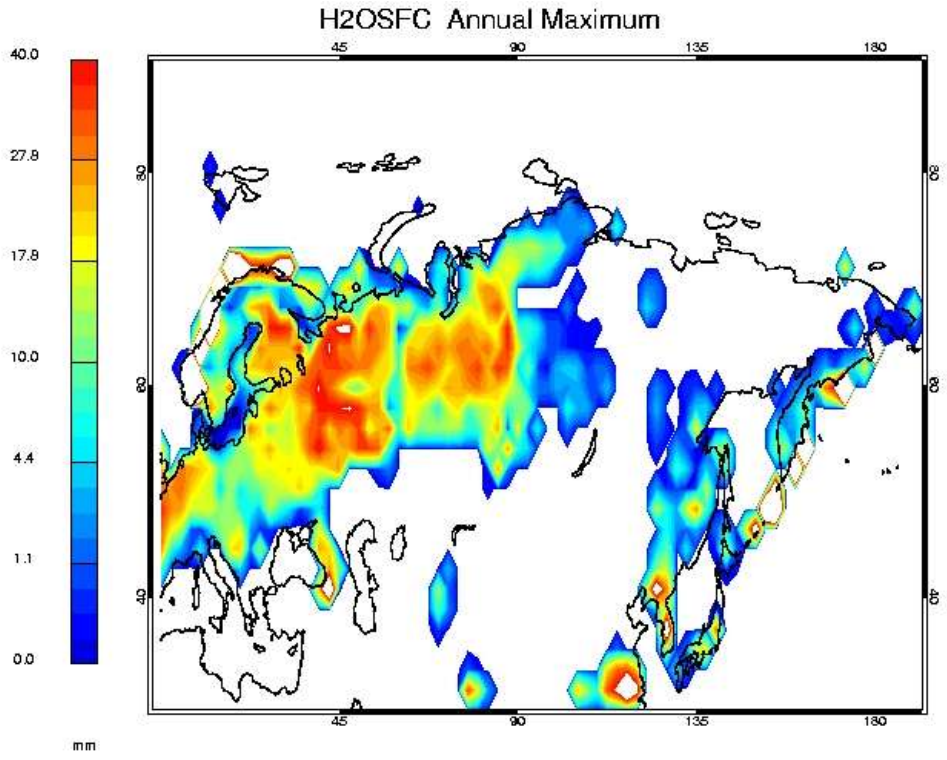
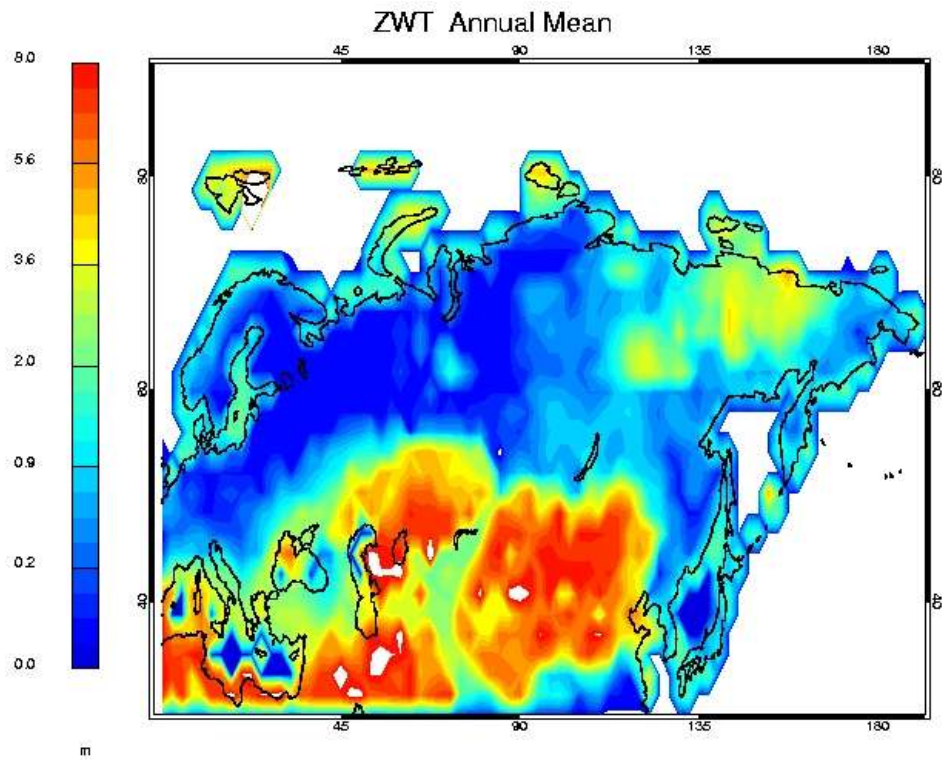


Water table depth



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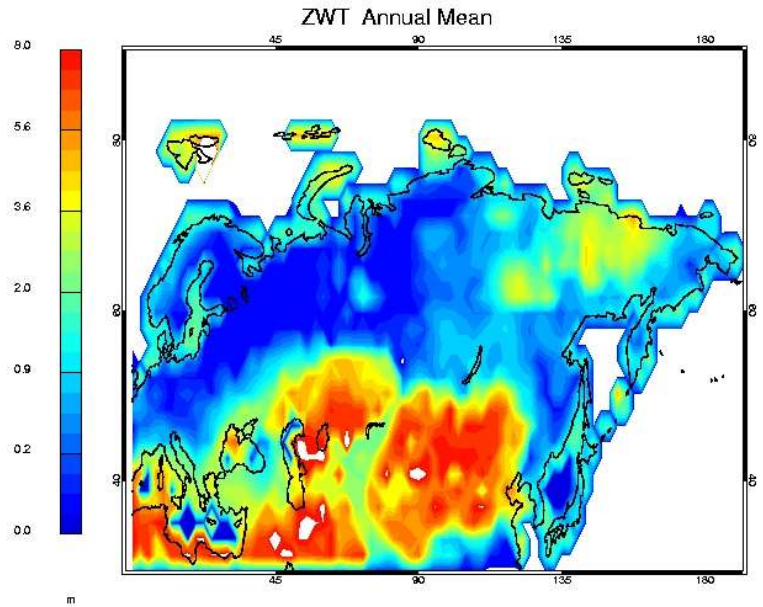
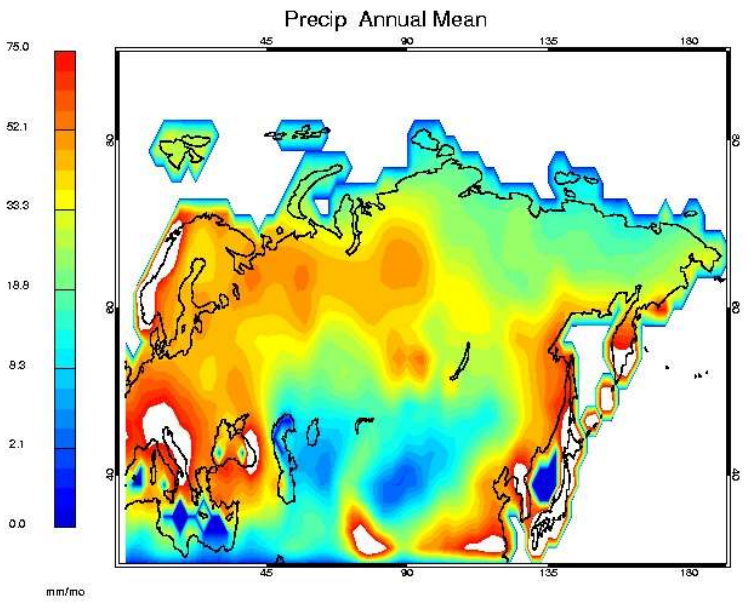


Annual mean precipitation



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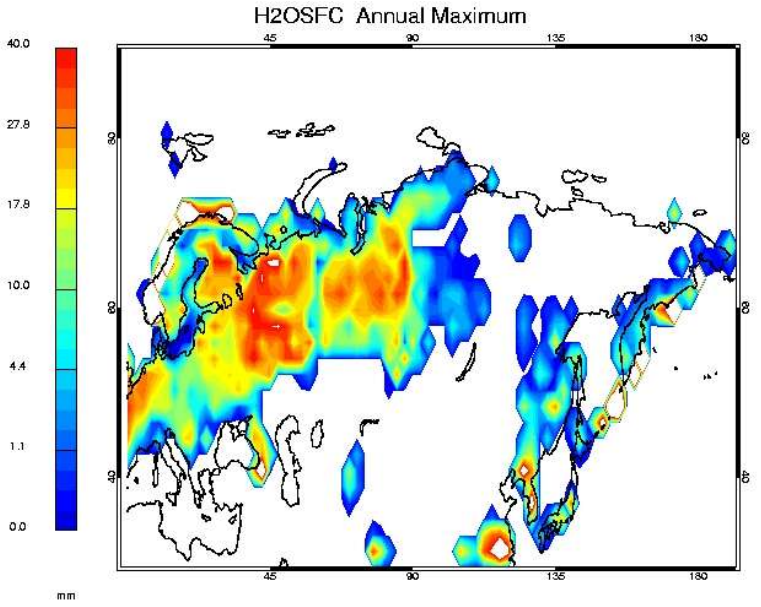

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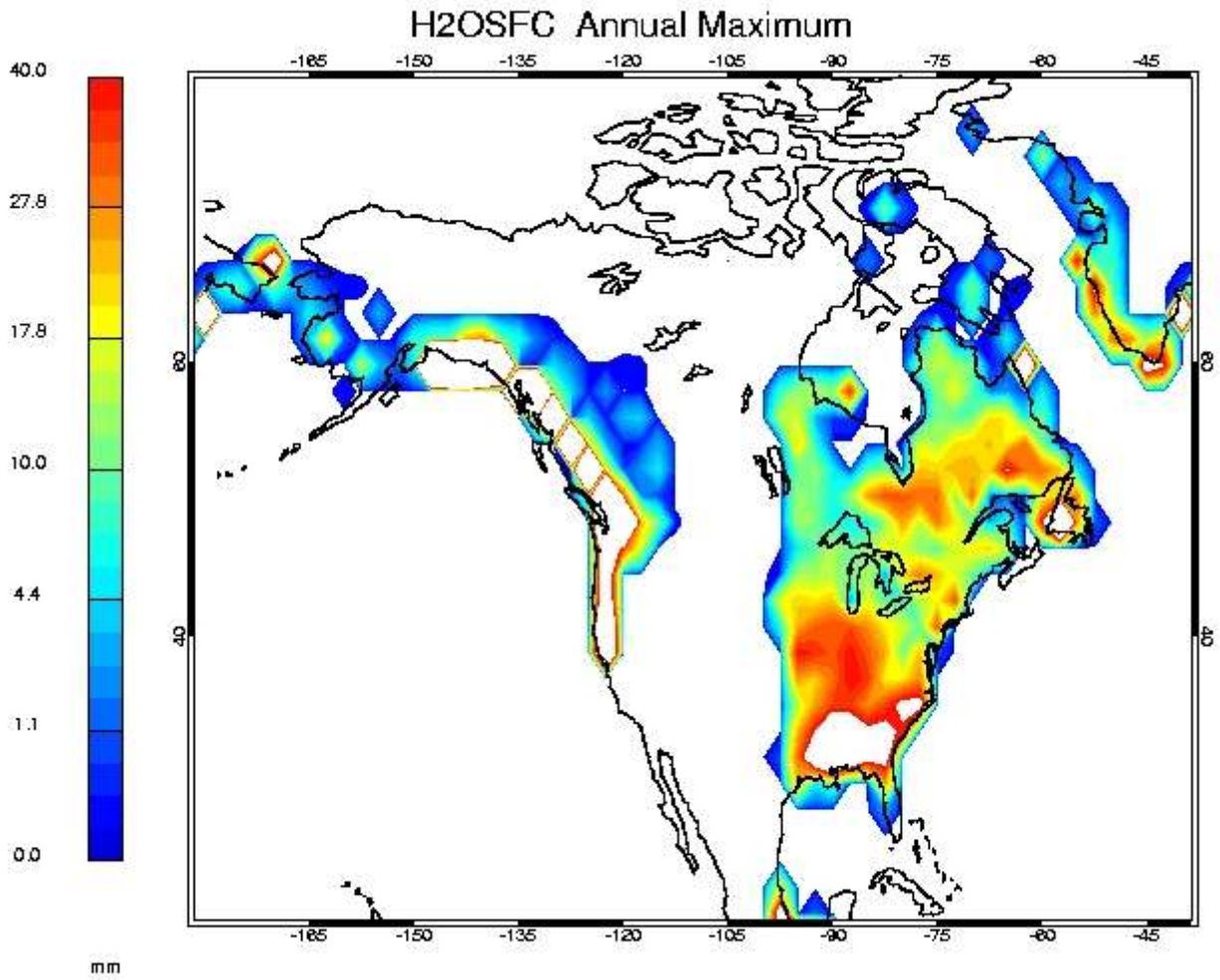

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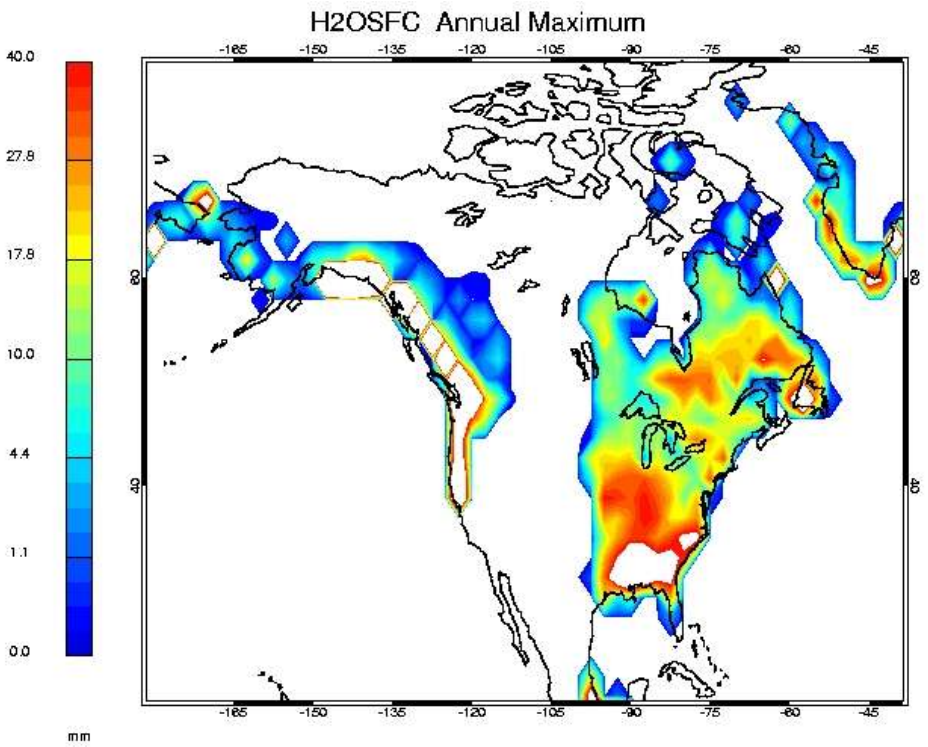
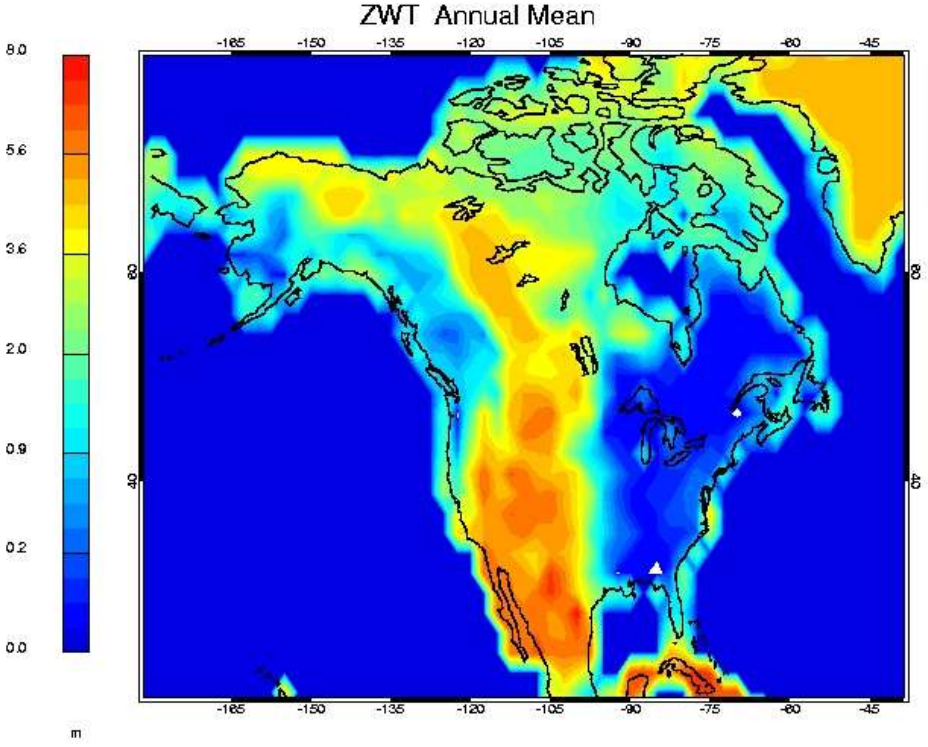


Water table depth



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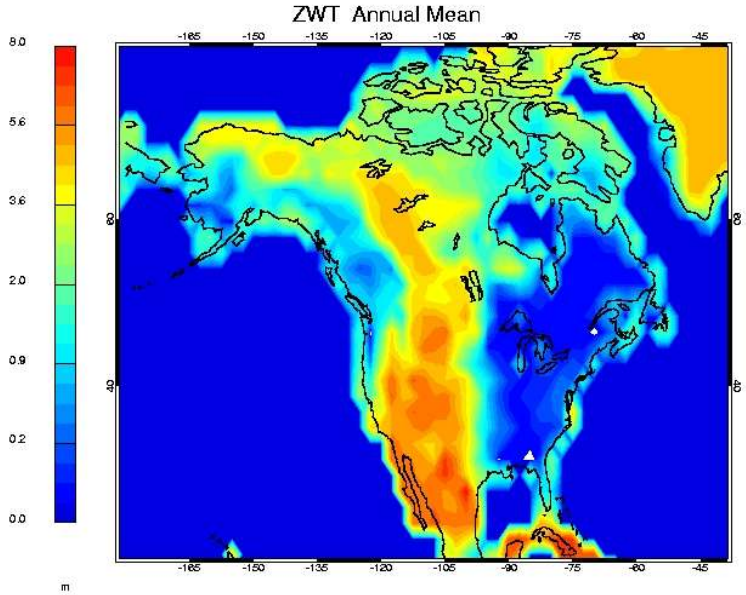

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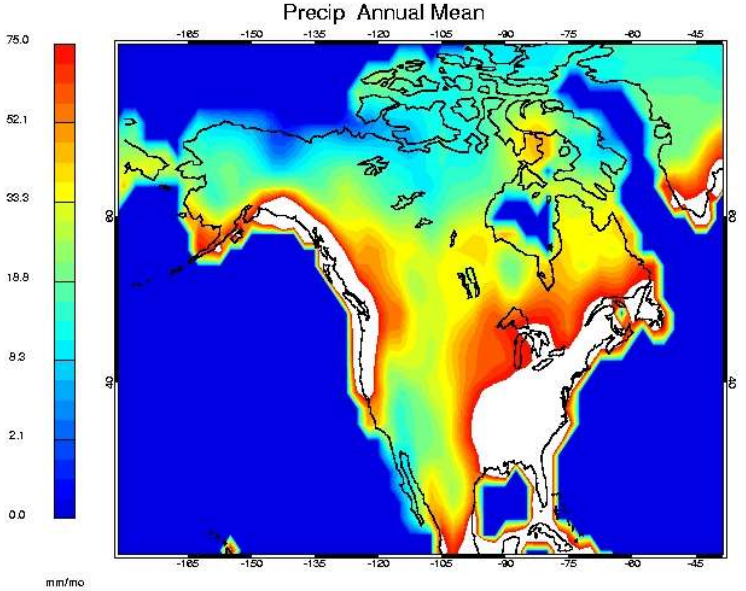

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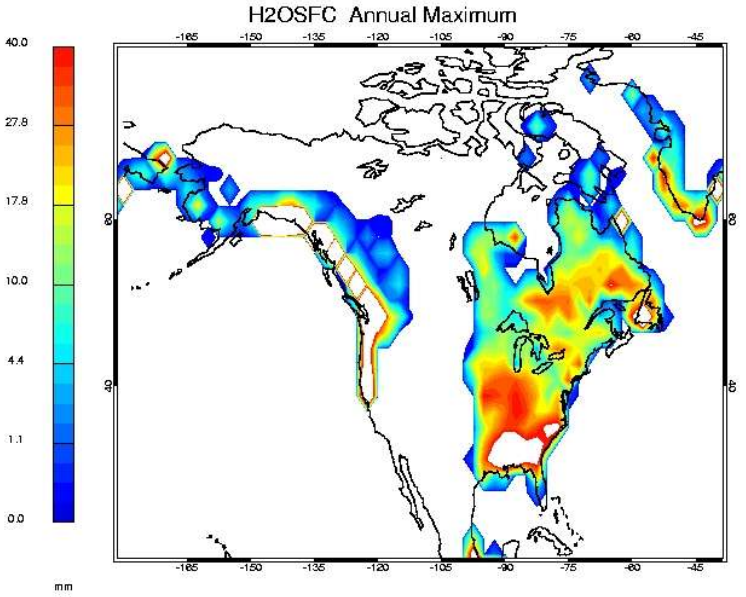

Examples: Eurasian River Basins

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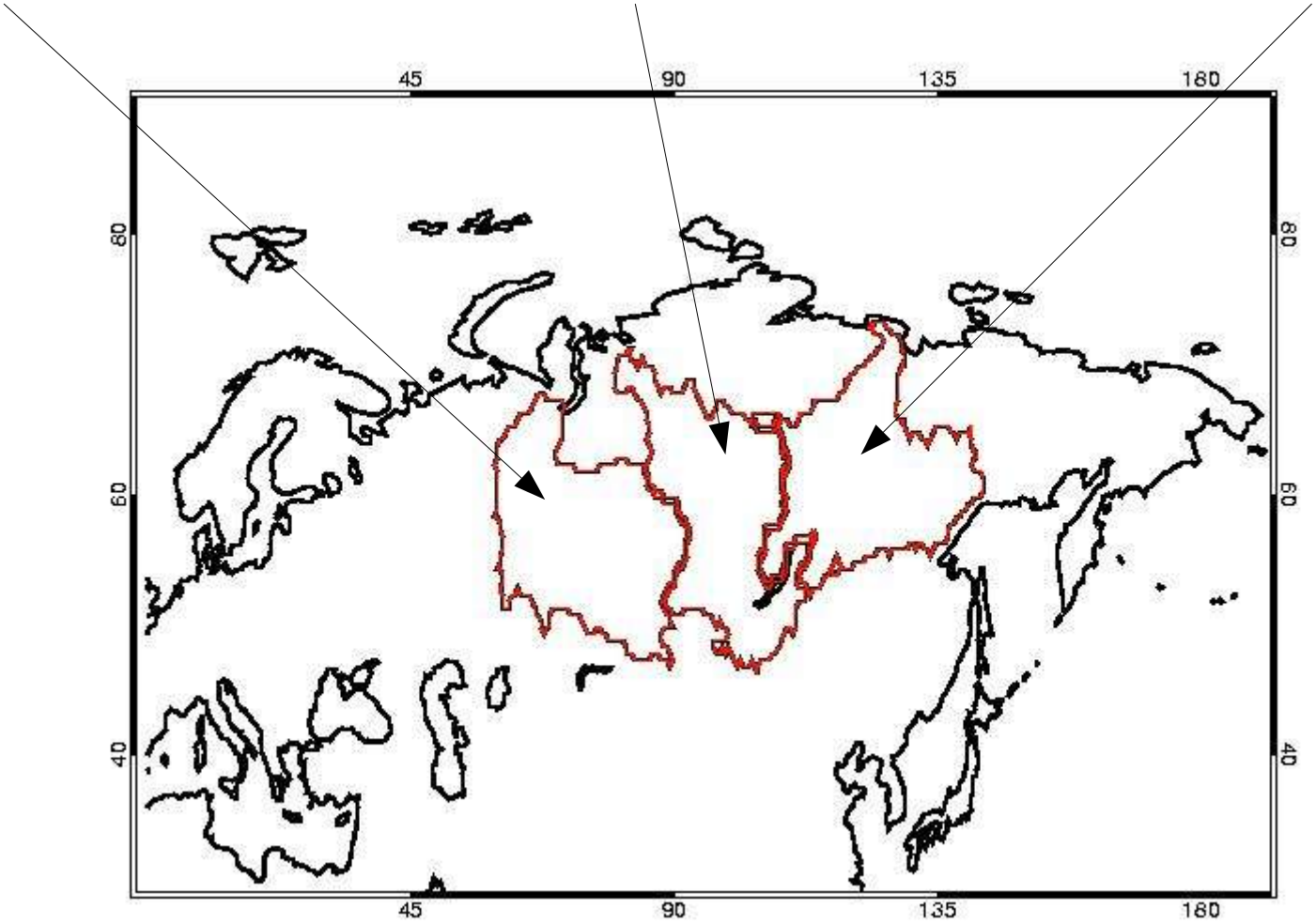

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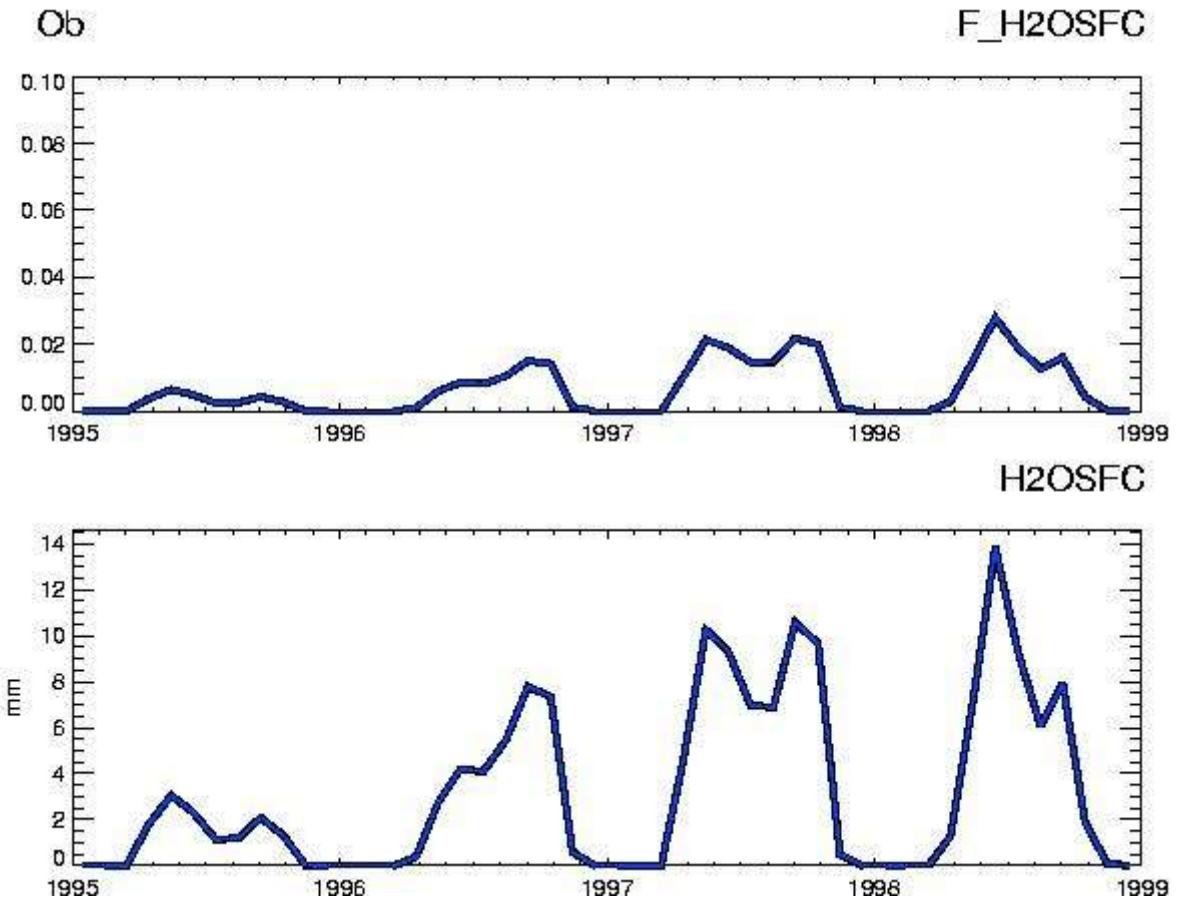

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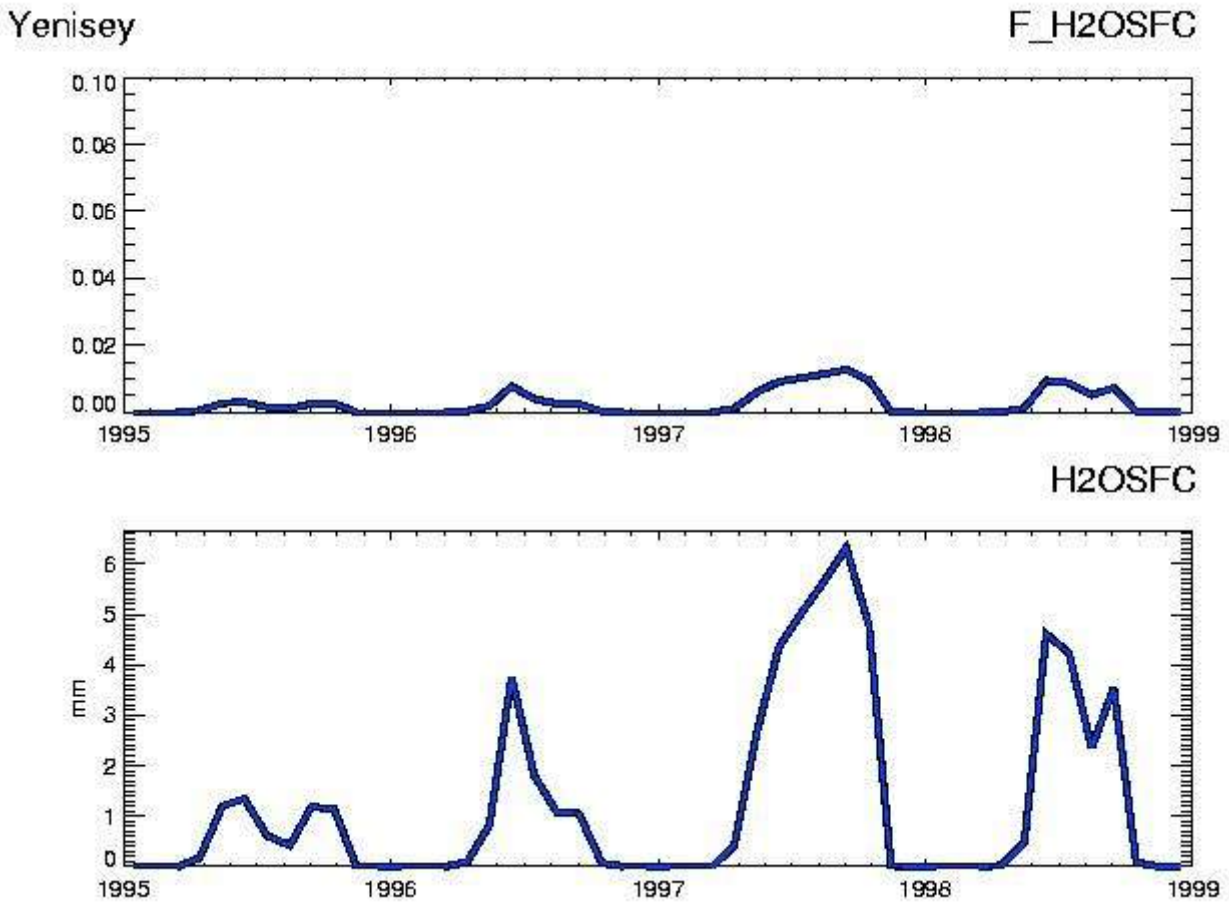

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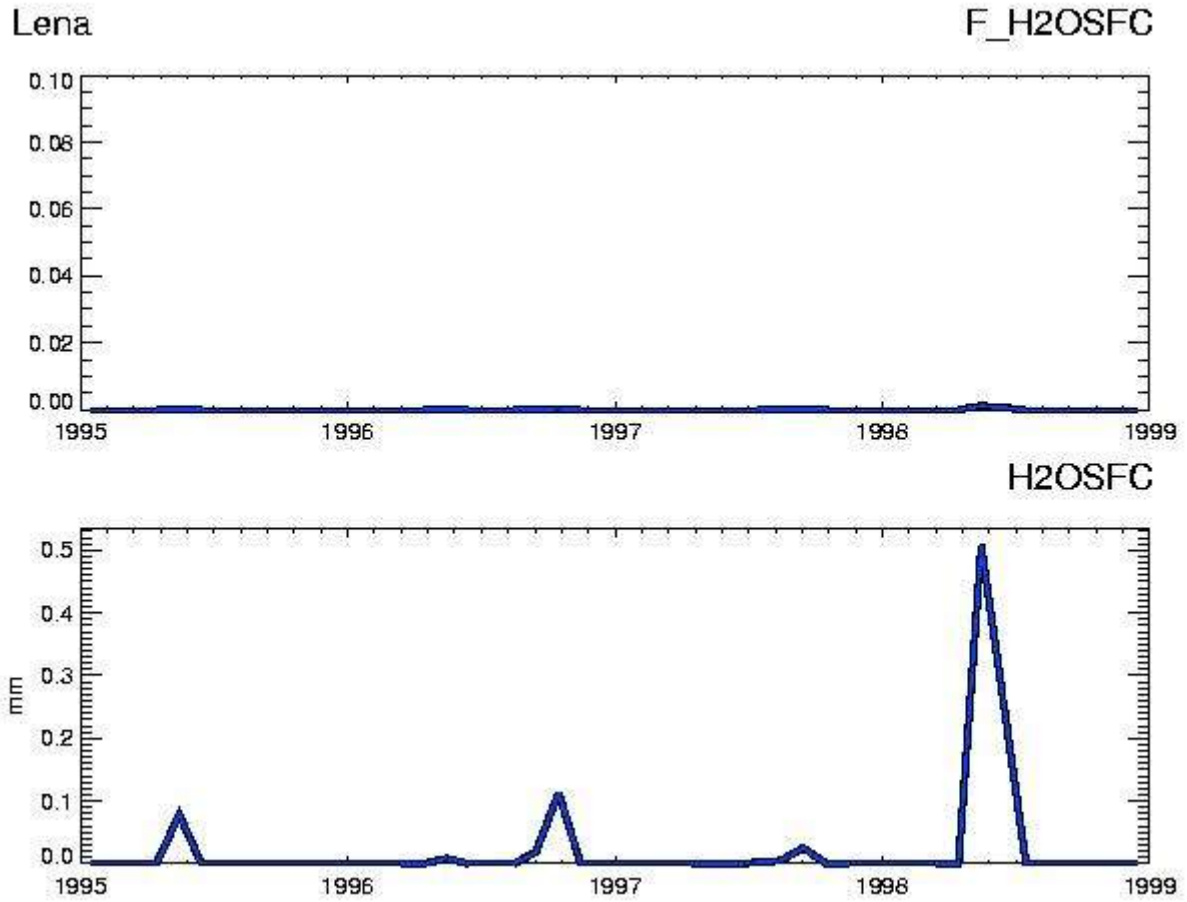
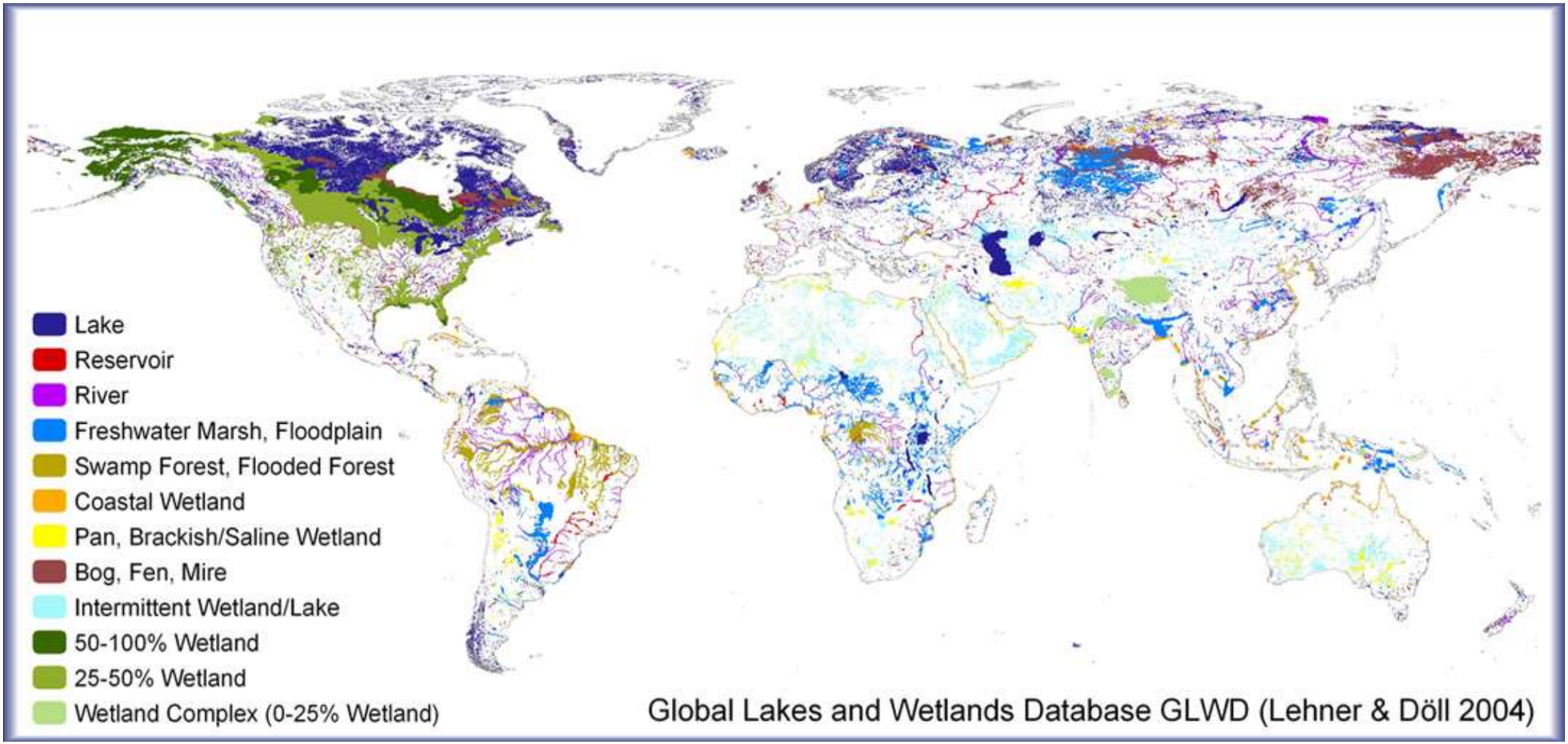
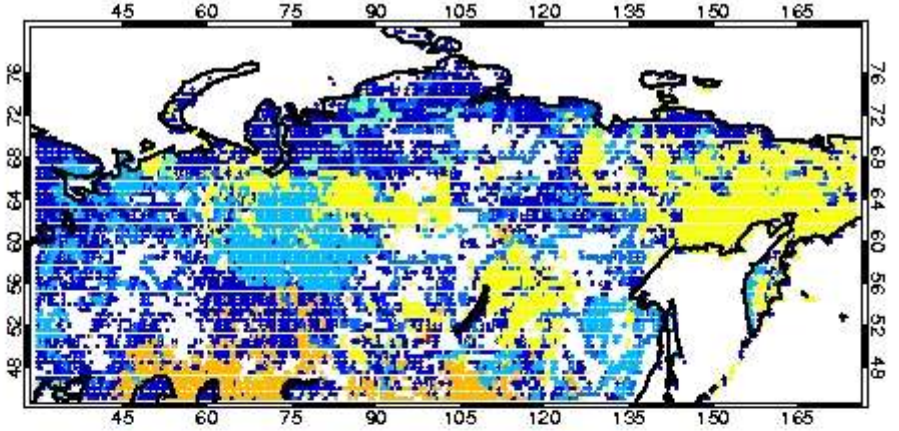


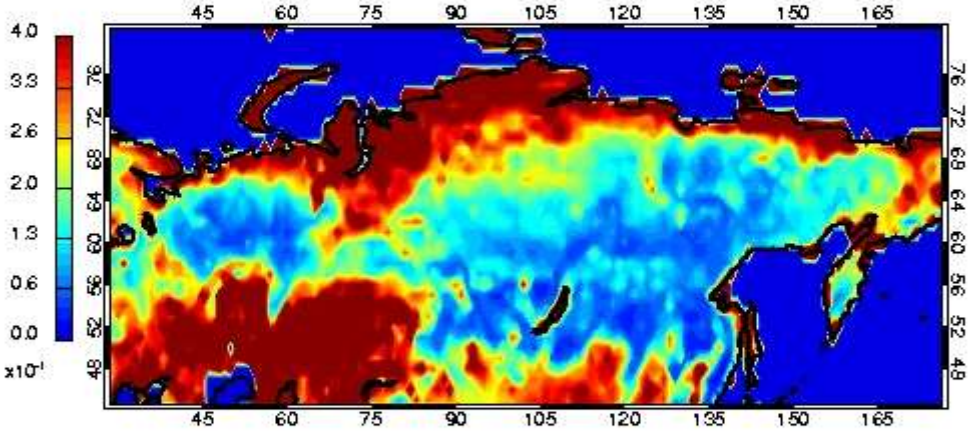
Wetland Distribution: Global Lakes and Wetlands Database



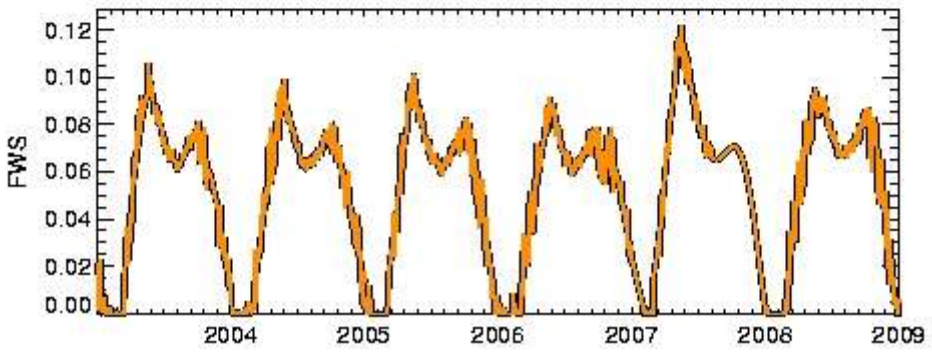
Surface Water Fraction: Passive Microwave



GLWD



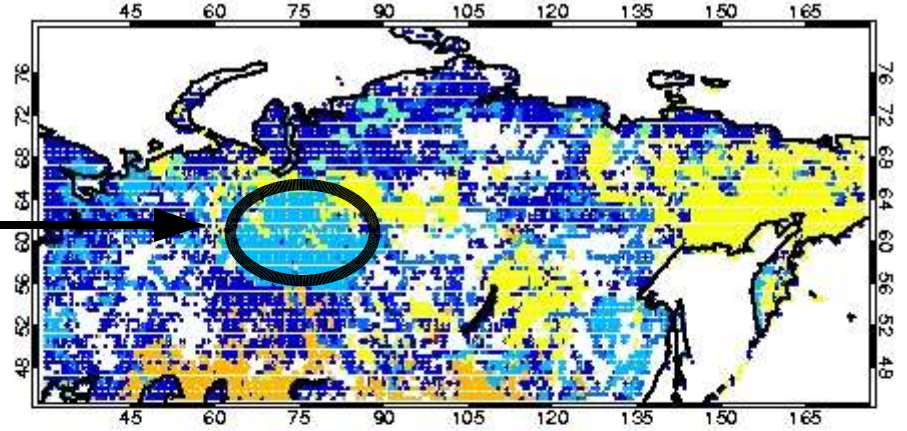
AMSR-E Surface Water Fraction



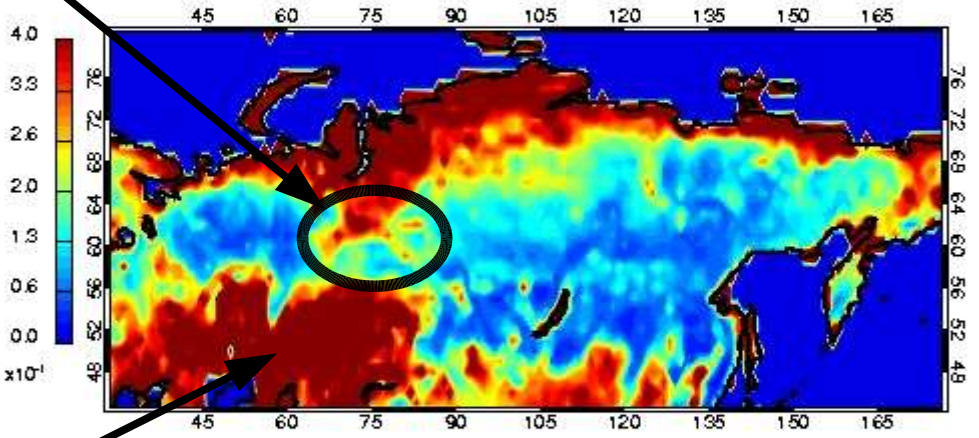
Ob River basin time series

Surface Water Fraction: Passive Microwave

Ob Basin

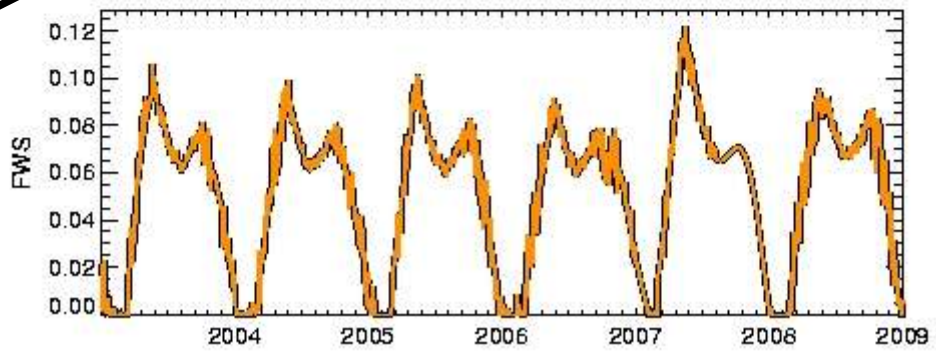


GLWD



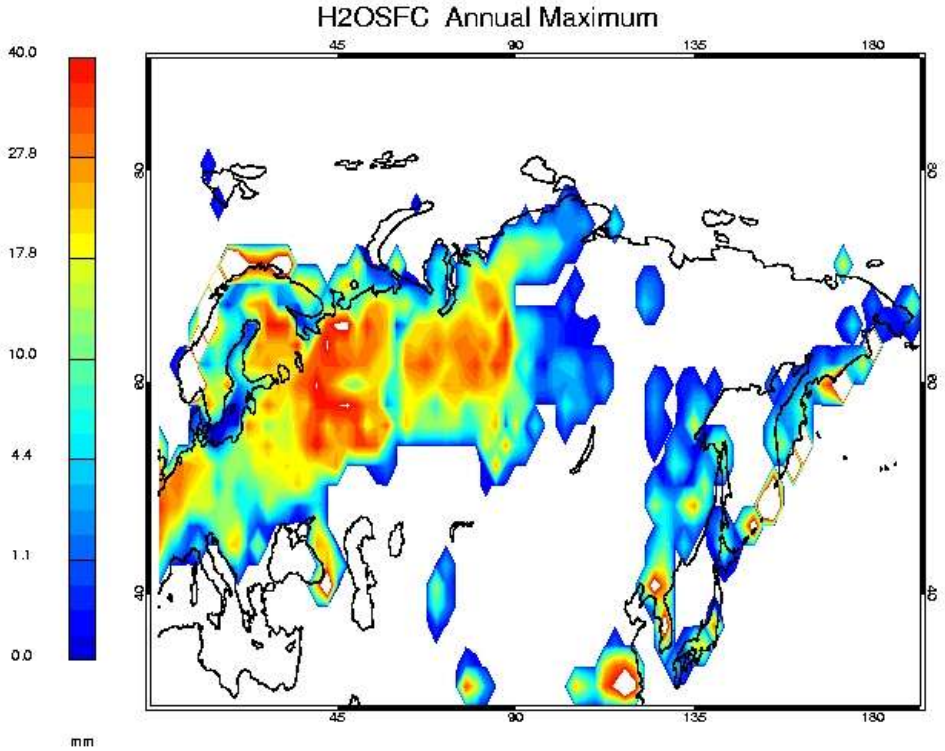
AMSR-E Surface Water Fraction

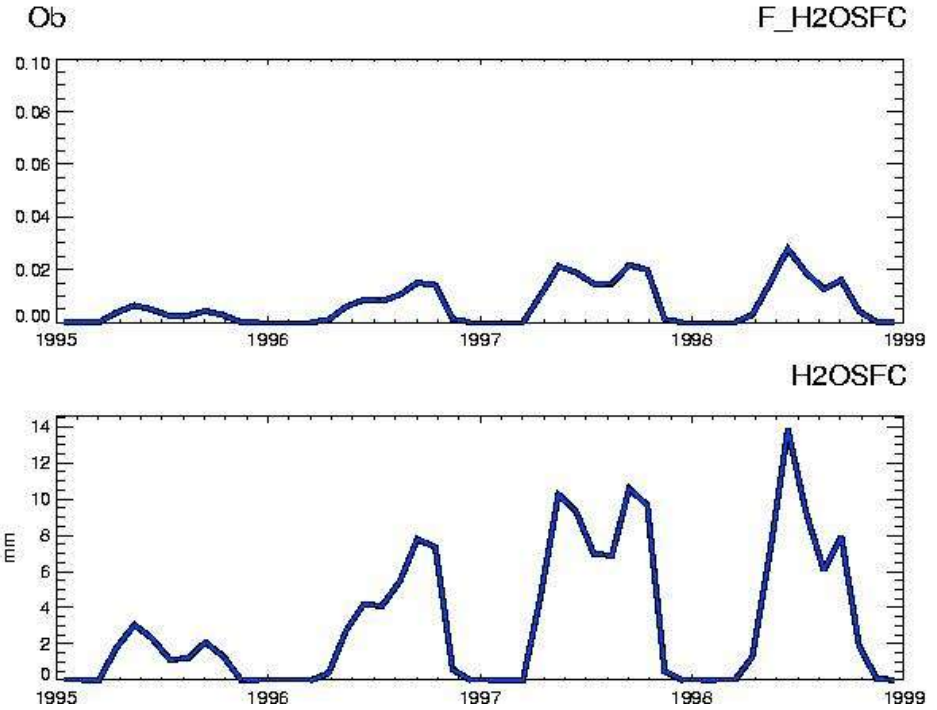
Dry areas can be misclassified as surface water



Ob River basin time series

Ob River Basin





Prospects

- A dynamic surface water store may allow studies of the evolution of wetland complexes.

- Parameterizing microtopography in terms of permafrost or soil temperatures may allow the relationship between thermokarst and wetland evolution to be studied.

- The general nature of the concept may allow it to be applied to other phenomena, e.g. flooding and inundation.

- The statistics of cluster area/perimeter and connectivity between submerged areas may be used to parameterize wetland emissions of carbon dioxide and methane and tracer transport.

Challenges

- Data for validating spatial extent and temporal variability is limited.

- Anthropogenic effects: much of the world's naturally occurring wetlands have been drained.

- There is no global, and very little regional, data regarding microtopography.