Water into Wine: Condor, PEST, and Hydrologic Modeling

Mike Fienen and Randy Hunt
Research Hydrologists
USGS Wisconsin Water Science Center
The last 10,000 years have been ideal for the development of human societies. This has been a unique time during which climate varied very little and enabled humankind to flourish.
Piping Plover—vulnerable to Sea Level Rise

Among the impacts on Plover habitat is depth to groundwater.

Small islands off the Atlantic Coast like Assateague Island, are a great early-warning system.

Have we always lived in this neighborhood?

[Images of Piping Plovers and Assateague Island in 1998 and 2006]
Sea-level rise impacts:
A multivariate problem full of uncertainties

Driving Forces
- Climate Change & Sea Level Rise

Initial Conditions
- Physical & Biological Processes
  - Groundwater Impact
  - Wetland Loss
  - Coastal Erosion
  - Inundation

Potential Impacts
- Safety
- Habitat Loss

Management Decisions

Adaptation Planning Response

USGS: Science for a Changing World

CIDA: Center for Integrated Data Analytics
Assateague Island Groundwater Model
Groundwater Model Calibration
Calibration and Uncertainty

More complex models → many parameters

Model must be run a multiple of number of parameters

Uncertainty analysis has similar computational needs

Can be run in parallel on many computers (embarrassingly)
What is PEST?

Written by John Doherty/Watermark Numerical Computing
Model-independent parameter estimation code
**Writes** ASCII model input, **reads** ASCII model output
Takes control of a model and runs it many, many times

*Pleasingly parallel*

```
input.txt
#stuff in here
par1: 1.0923
par2: 9.99E-04
...
```

```
model
#stuff in here
```

```
output.txt
#stuff in here
time  value
1.0   93.492
2.0   97.392
3.0   99.905
...
```
beoPEST is an ideal tool for model calibration

Need to launch remote slave processes
Each slave needs model files
Condor with beoPEST

**Condor Advantages:**
- Move data to each worker machine
- Automate starting of worker processes
- Provide monitoring
- Allow us to accommodate both Linux and Windows user base

Started out with about 80 Linux cores and 450 Windows cores

**Windows Issues:**
- Very expensive to access more than 32GB RAM/blade
- TCP/IP related memory trouble
- Our parent agency proposed $600/year/machine Windows license surcharge.
winsock.dll Sings the Blues—120 Workers

10% runs complete
50% runs complete
99% runs complete
100% runs complete

Jacobian calculations (continued)

Run done/slaves stopped

beoPEST finished
winsock.dll Sings the Blues—60 Workers
WINEPREFIX=$_CONDOR_SCRATCH_DIR

Thanks Ian Chesal and Rich Pieri via [condor-users]!!!
Sea Level Rise Impacts on Island Geometry—DRAFT

Back to our story…
Salinity Results of Sea Level Rise Simulations—DRAFT

Cross-section 1 | Cross-section 2 | Cross-section 3
---|---|---
SLR +0.00m | | |
SLR +0.02m | | |
SLR +0.04m | | |
SLR +0.06m | | |
SLR +0.08m | | |

Blue=fresh
Red=salty
What’s next?

Continue refining how beoPEST and Condor interact.

More hardware.

Incorporate GW results into a Bayesian Decision Network along with other processes.

Start linking the process models explicitly which will require much more computational power and more adventures with Condor.
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