Software Collaboration Tools and the Salish Sea MEOPAR Project

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University of British Columbia

salishsea.eos.ubc.ca/nemo.html

MEOPAR

MEOPAR

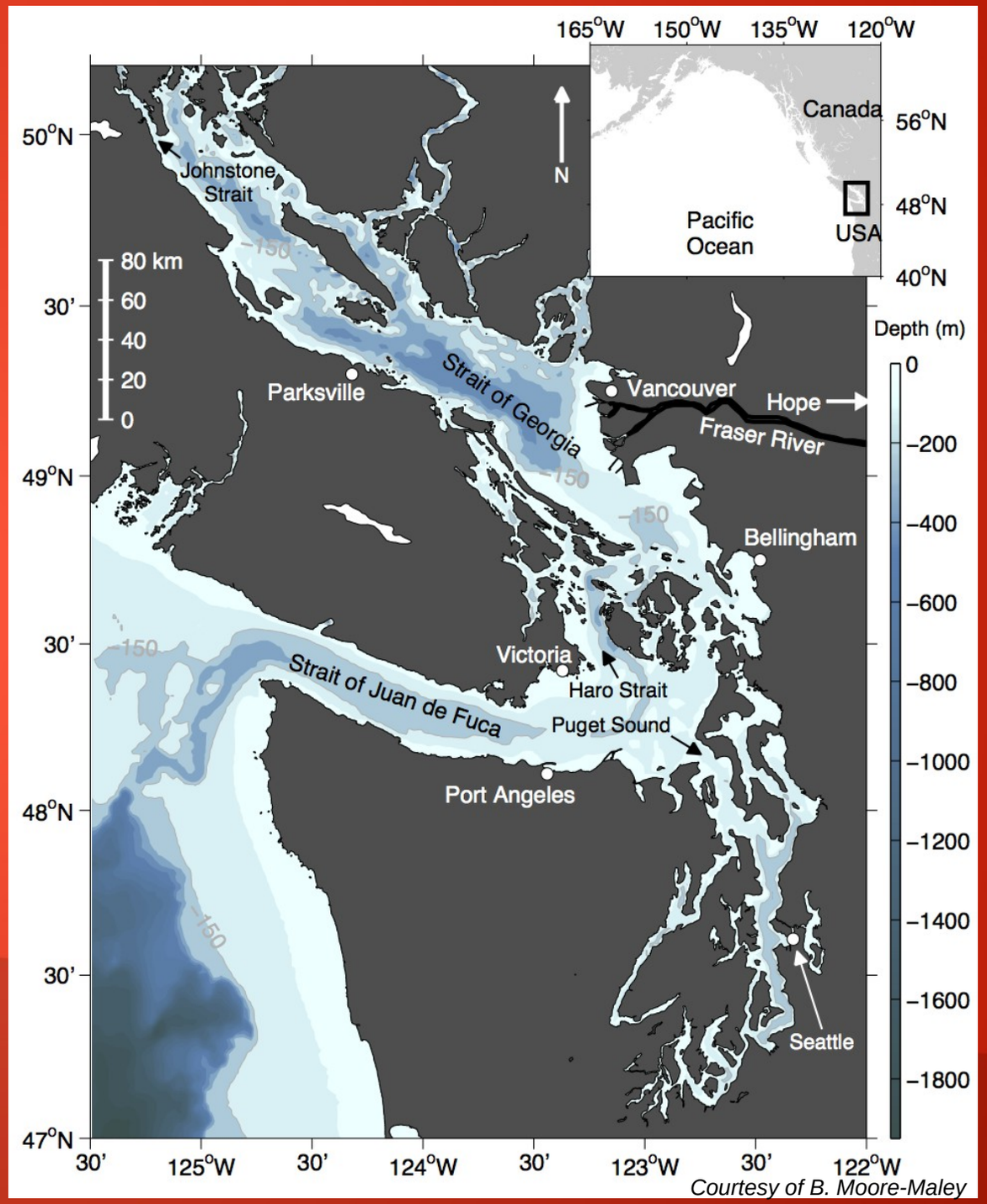
- Marine Environmental Observation Prediction and Response
- Network of Centres of Excellence
- meopar.ca

NEMO

- Nucleus for European Modelling of the Ocean
- www.nemo-ocean.eu
- Ocean model component of the DFO/EC/DND CONCEPTS program
- Regional scale configuration
- Atmospheric forcing from Environment Canada models

Salish Sea

- British Columbia mainland south coast
- Strait of Georgia
- Strait of Juan de Fuca
- Puget Sound
- Johnstone Strait



Courtesy of B. Moore-Maley

Salish Sea NEMO Model

- Resolution: ~500m horizontal; 1m to 20m depth
- Time Scale: 1-10 days
- Presently evaluating model skill via hindcast runs:
  - Tidal amplitude and phase
  - Storm surge events
  - Stratification and deep water renewal over annual cycle
- Nancy Soontiens' talk -- Thu at 12:15 in Parent room

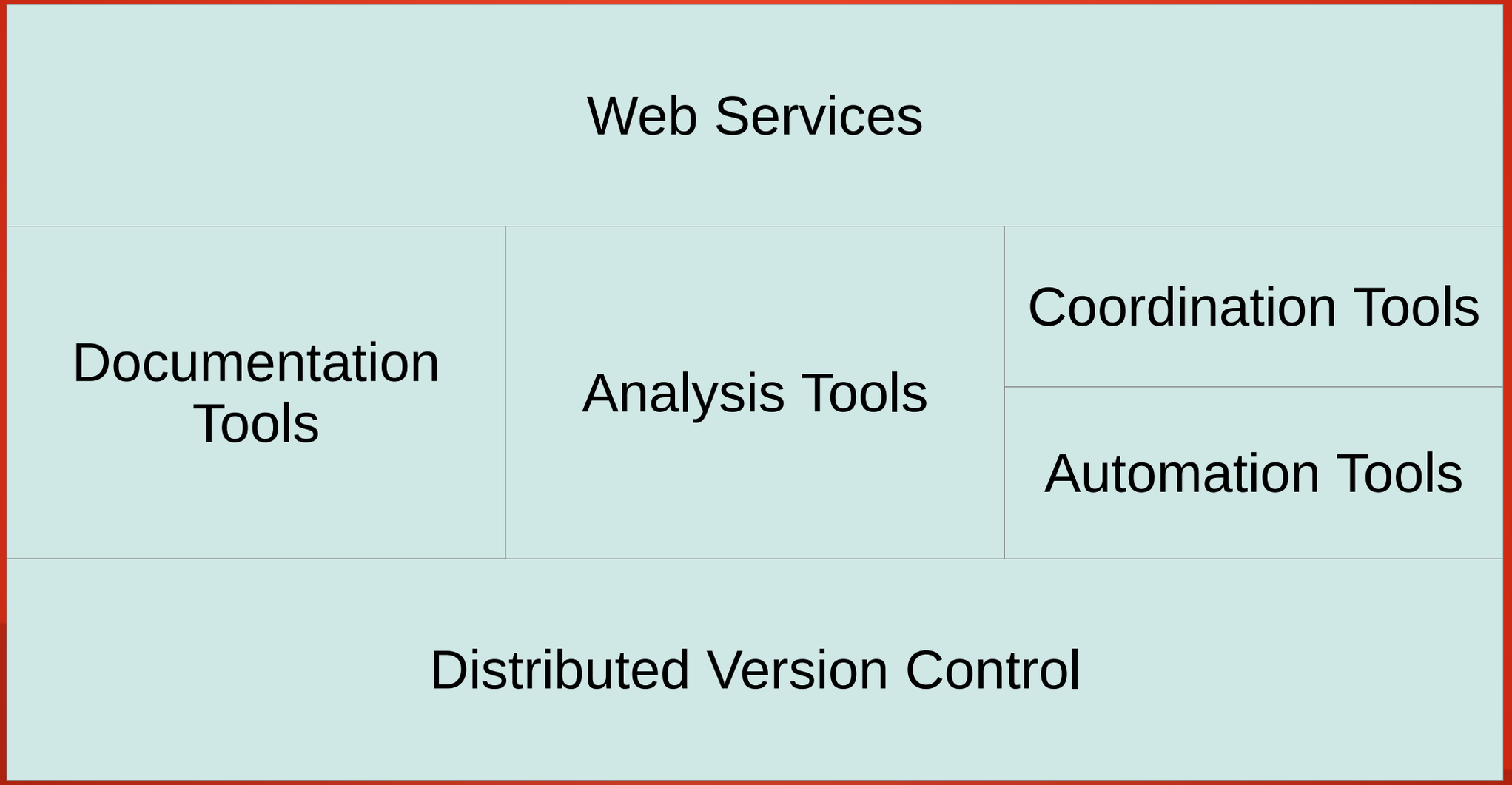
Online Collaboration

- Software Tools + Web Services
- Instantly share documentation, results, tools & code among research team
- Share results with collaborators and stakeholders
- Publish our experience with NEMO for other users

Think of the Researchers...

Think of the Researchers...

- Research productivity, not cool tools
- New things to learn, and habits to change or form
- Tools need to be:
  - Powerful
  - Low cognitive load
  - Widely applicable, reusable


Web Services
Documentation Tools
Analysis Tools
Coordination Tools
Automation Tools
Distributed Version Control

Web Services

bitbucket.org readthedocs.org nbviewer.ipython.org drive.google.com

Documentation Tools

reStructuredText
Sphinx

Analysis Tools

Python
IPython Notebook
Markdown

Coordination Tools

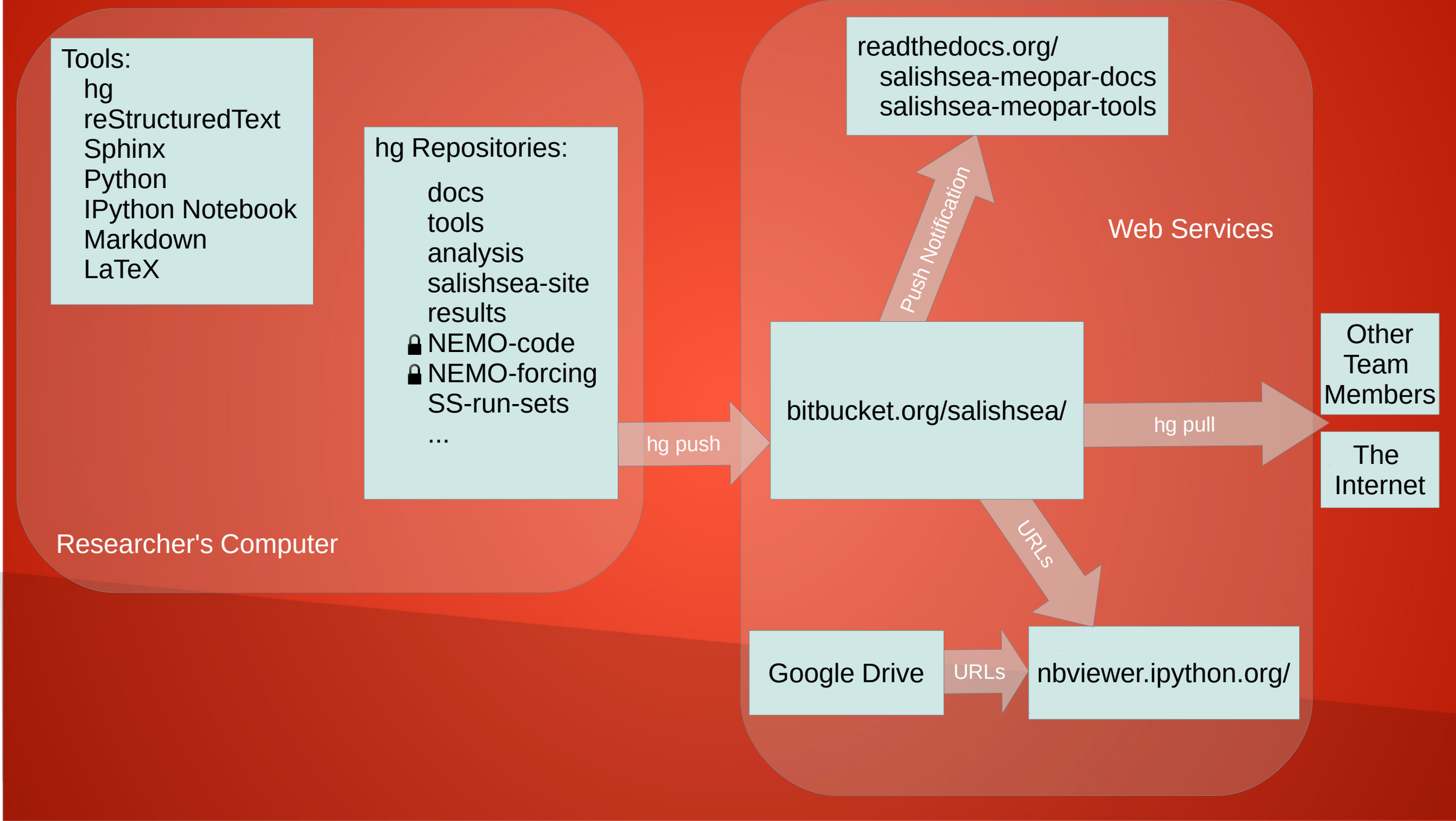
Google Drive

Automation Tools

Python

Distributed Version Control

Mercurial (hg)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Documentation

- Lots of good reasons to write documentation
- ...And usually a few more reasons why not to...
- Describe NEMO configuration experience for future users
- Describe working environment for new team members
- Be kind to our future selves

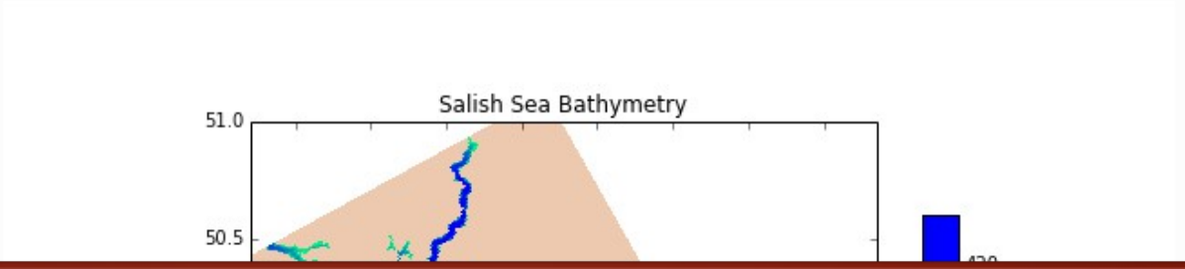
Salish Sea MEOPAR Project Documentation

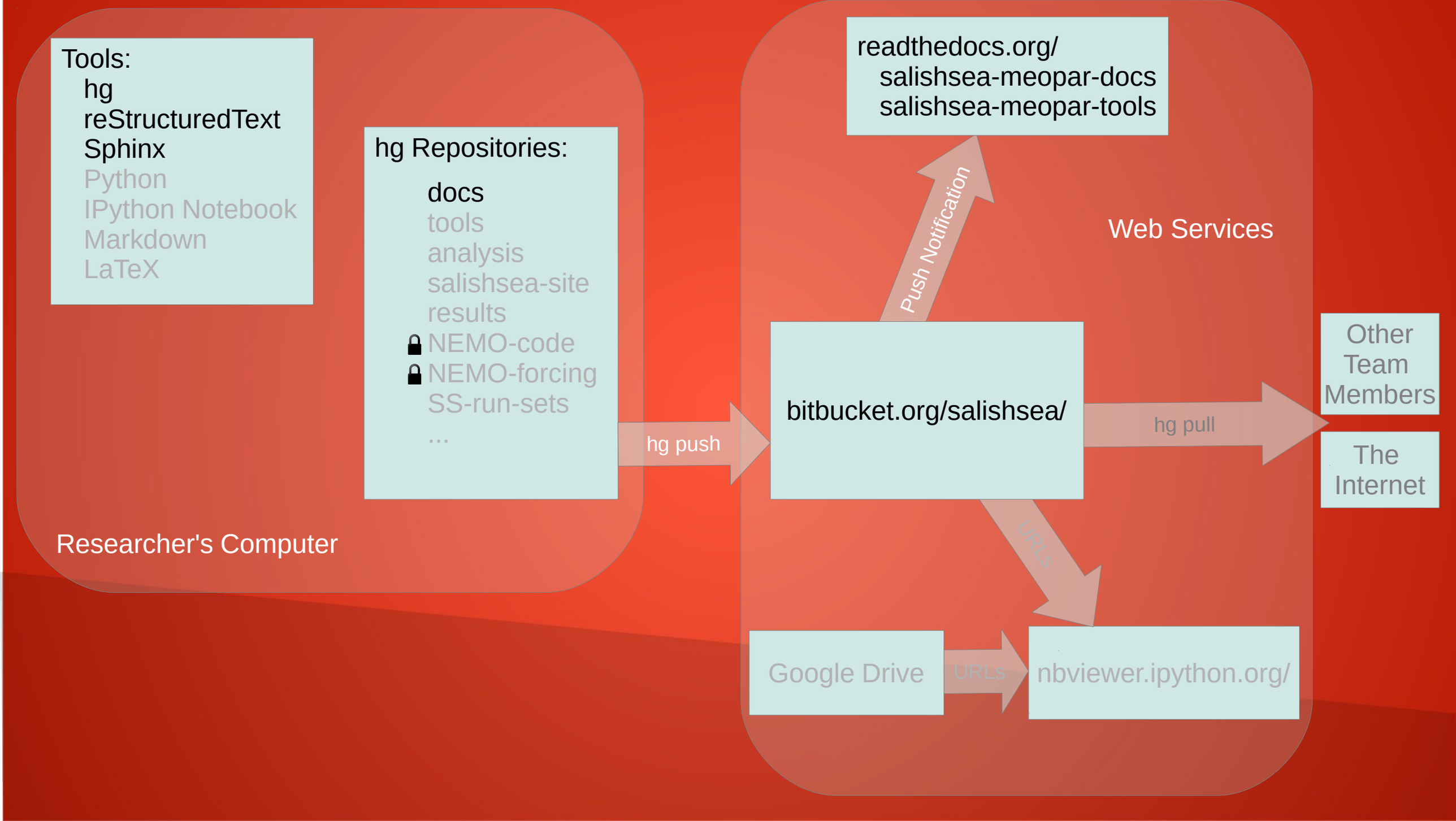
This is a collection of documentation about the Salish Sea MEOPAR project. There is a companion collection of *project tools documentation*.

About the Project

The Salish Sea is home to a large population of Canadians living in coastal communities at risk to ocean related hazards. There is an ongoing need to assess the impact of these hazards on human and marine environments through a multidisciplinary approach involving Canadian oceanographers, biologists, and social scientists. The Marine Environmental Observation Prediction and Response network (MEOPAR) provides a platform to accelerate this type of research.

The Salish Sea MEOPAR project team is developing a three-dimensional ocean model for the Strait of Georgia and Salish Sea. Using the NEMO modelling architecture the Salish Sea model will be used to evaluate storm surge risk in coastal communities. Long term goals include data assimilation from the VENUS network and a coupled biogeochemical modelling component.

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31-Oct-2002 –

Northern boundary was opened using tides (all 8 constituents) and seasonal T&S (based on Thomson and Huggett paper).

The Runs

Dates	dt s	Viscosity m^2/s	EVD m^2/s	Status	Platform	Note
Sep 23	50	50	100	blew up off Pender	Salish	
Sep 23	50	55	100	*complete*	Salish	
Sep 24	50	50	100	*complete*	Salish	
Sep 25	50	45	100	*complete*	Salish	
Sep 26	50	40	100	*complete*	Salish	
Sep 27	50	35	100	*complete*	Salish	
Sep 28	50	30	100	*complete*	Salish	
Sep 29	50	25	100	*complete*	Salish	
Sep 30	50	20	100	blew up off Stuart	Salish	
Sep 30	50	25	100	blew up off Pender	Salish	
Sep 30	50	30	100	*complete*	Salish	
Oct 1-2	50	25	100	blew up BP Mouth	Salish	
Oct 1	50	30	100	*complete*	Salish	

Simple Docs Update

```
$ cd docs
$ edit code-notes/salishsea-nemo/spinup.rst
…
```

```
31-Oct-2002 --
--------------

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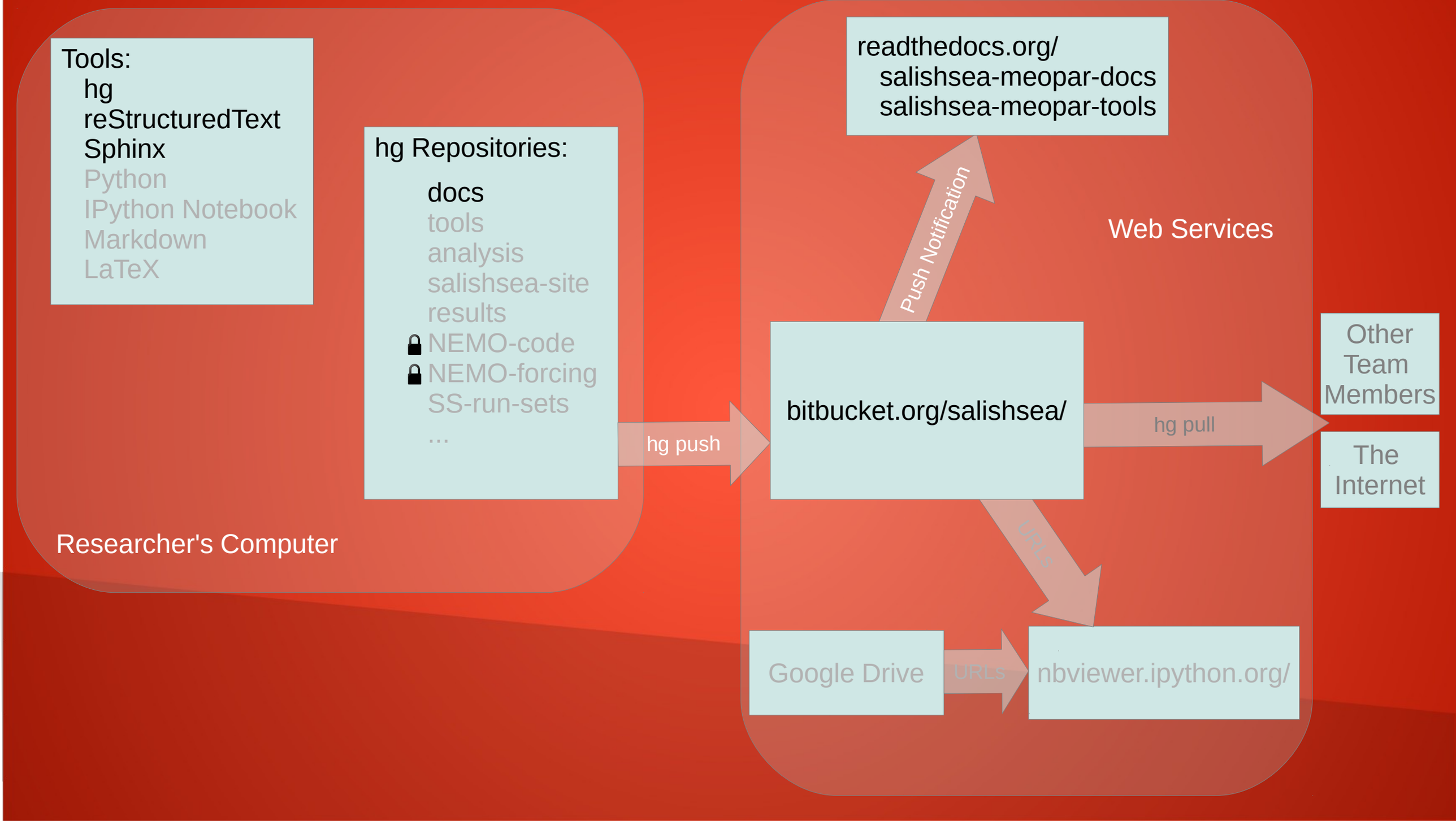
**The Runs**

========== ===== ============ ============  ================== ========== ================
 Dates      dt    Viscosity    EVD           Status             Platform   Note
            s     :math:`m^2/s` :math:`m^2/s`
========== ===== ============ ============  ================== ========== ================
Sep 23      50    50                  100    blew up off Pender    Salish
Sep 23      50    55                  100    *complete*            Salish
Sep 24      50    50                  100    *complete*            Salish
Sep 25      50    45                  100    *complete*            Salish
Sep 26      50    40                  100    *complete*            Salish
Sep 27      50    35                  100    *complete*            Salish
Sep 28      50    30                  100    *complete*            Salish
Sep 29      50    25                  100    *complete*            Salish
Sep 30      50    20                  100    blew up off Stuart    Salish
Sep 30      50    25                  100    blew up off Pender    Salish
Sep 30      50    30                  100    *complete*            Salish
Oct 1-2     50    25                  100    blew up BP Mouth      Salish
Oct 1       50    30                  100    *complete*            Salish
Oct 2-3     50    30                  100    *complete*            Salish
Oct 4-5     50    30                  100    blew up off Stuart    Salish
Oct 4-5     50    35                  100    *complete*            Salish
Oct 6-9     50    35                  100    blew up BP Mouth      Jasper
Oct 6-7     50    40                  100    *complete*            Jasper   first 2 days of 4
```

Simple Docs Update

```
$ cd docs
$ edit code-notes/salishsea-nemo/spinup.rst
…
$ hg commit -m"Add info re: recent spin-up runs."
$ hg push
```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```
31-Oct-2002 --
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**The Runs**

========== ===== ============ ============  ================== ========== ================
 Dates      dt    Viscosity    EVD           Status             Platform   Note
            s     :math:`m^2/s` :math:`m^2/s`
========== ===== ============ ============  ================== ========== ================
Sep 23      50    50                  100    blew up off Pender    Salish
Sep 23      50    55                  100    *complete*            Salish
Sep 24      50    50                  100    *complete*            Salish
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Sep 26      50    40                  100    *complete*            Salish
Sep 27      50    35                  100    *complete*            Salish
Sep 28      50    30                  100    *complete*            Salish
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Oct 6-7     50    40                  100    *complete*            Jasper   first 2 days of 4
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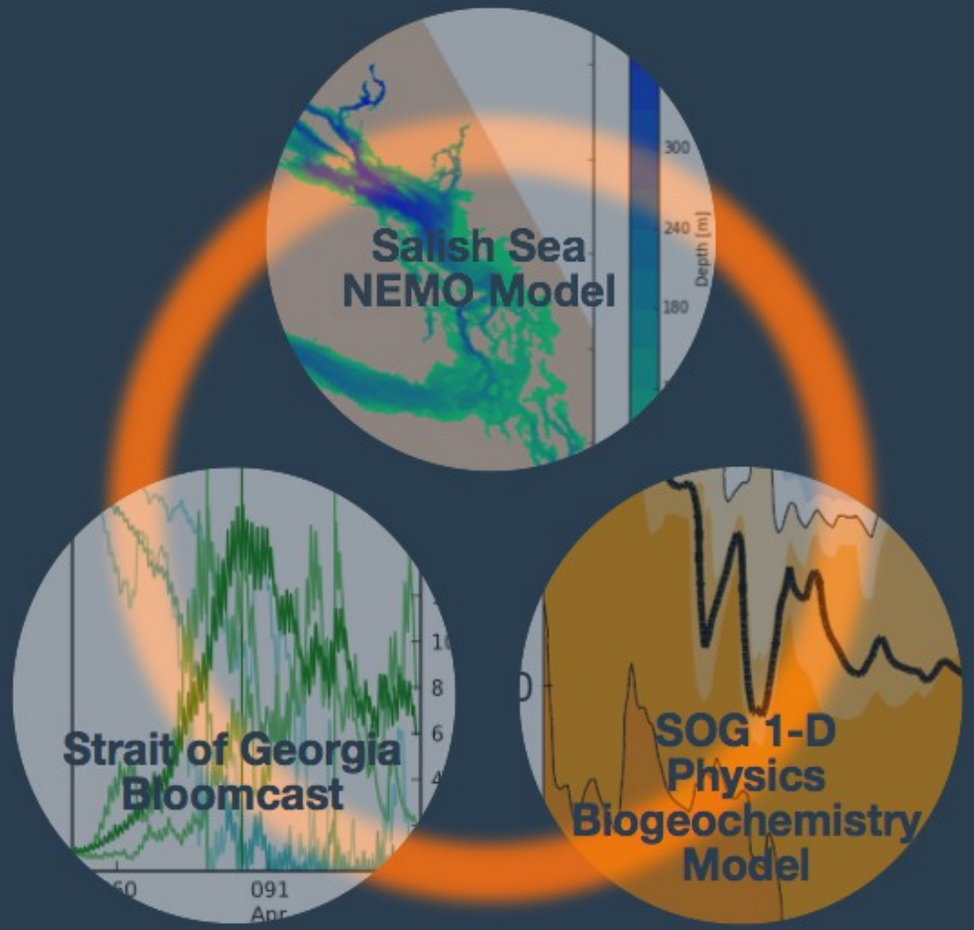
Sep 27	50	35	100	*complete*	Salish	
Sep 28	50	30	100	*complete*	Salish	
Sep 29	50	25	100	*complete*	Salish	
Sep 30	50	20	100	blew up off Stuart	Salish	
Sep 30	50	25	100	blew up off Pender	Salish	
Sep 30	50	30	100	*complete*	Salish	
Oct 1-2	50	25	100	blew up BP Mouth	Salish	
Oct 1	50	30	100	*complete*	Salish	

Docs Update with Preview

```
$ cd docs
$ edit code-notes/salishsea-nemo/quickstart.rst
...
$ make html
$ open _build/html/code-notes/salishsea-nemo/quickstart.html
    <review, edit, make, as necessary>

$ hg commit -m"Change to use new `salishsea run` command."
$ hg push
```

Widely Applicable, Reusable

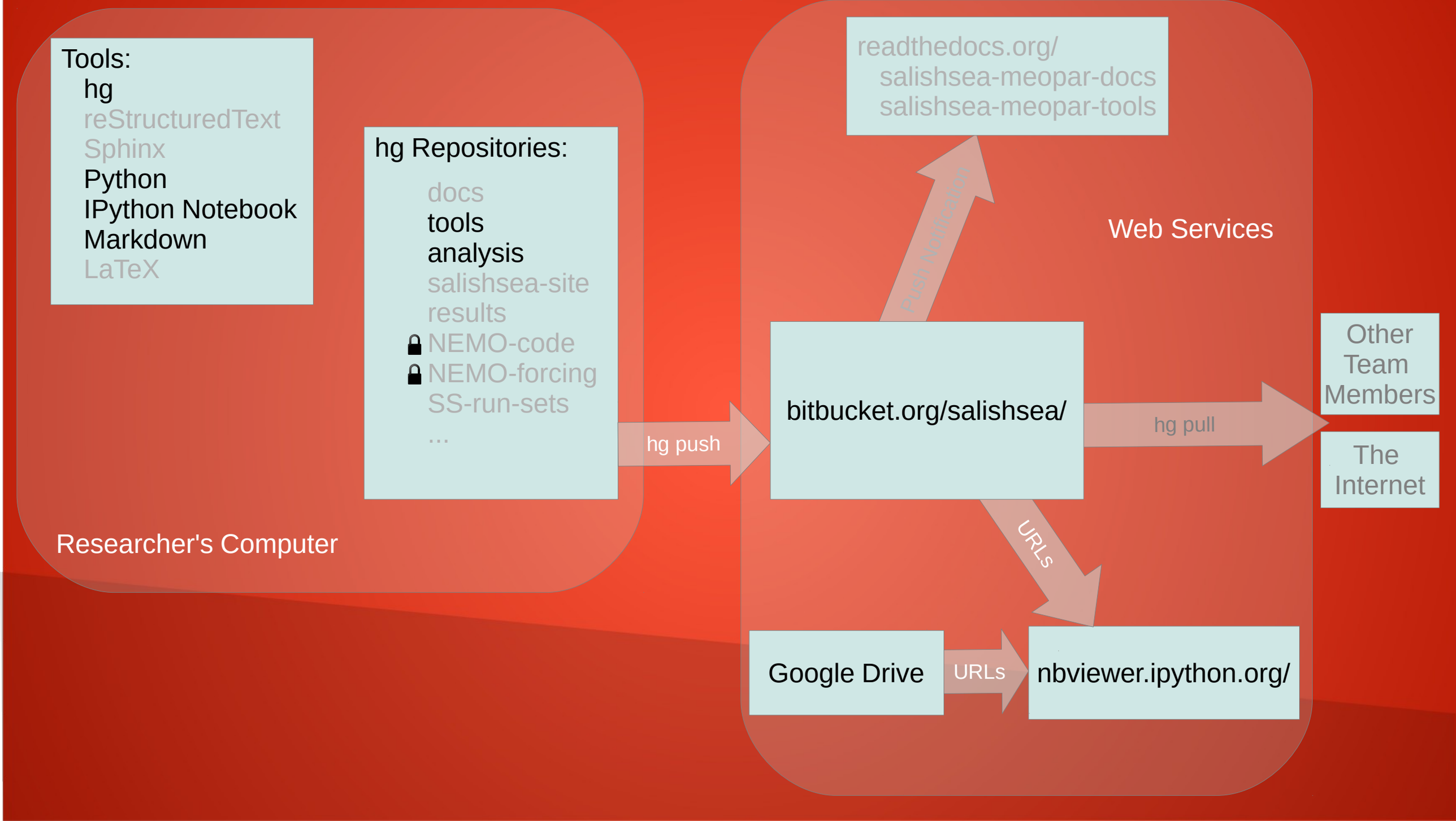


- Contributors
- License

Last updated on May 21, 2014.
Created using Sphinx 1.2.2.

Pre-processing and Analysis

- Preparation of files for boundary conditions and forcing
- Analysis of model results for verification and new insights
- Mixture of narrative, math, code, plots, animations, ...
- Scientific Python libraries provide the platform
- IPython Notebook enables us to keep narrative, math, code, plots, etc. together, and share with minimal effort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IPy Multi-tides w Fit

127.0.0.1:8888/notebooks/compare_tides/Multi-tides w Fit.ipynb#

IP[y]: Notebook Multi-tides w Fit Last Checkpoint: May 16 14:59 (autosaved)

File Edit View Insert Cell Kernel Help

In [21]:
```
ts = 240 # last half of series
for name in (name1,name2):
    for stn in range(5):
        fT1 = NC.Dataset(name+location[stn]+'.nc','r')
        time = fT1.variables["time_counter"][:]/3600.  # want hours not seconds
        ssh = fT1.variables["sossheig"][:,0,0]

        fitted, cov = curve_fit(double,time[ts:],ssh[ts:])
        if fitted[0] < 0:
            fitted[0] = -fitted[0]
            fitted[1] = fitted[1]+180.

        print location[stn]
        print "    M2 original  {0:.3f} m and {1:.0f} degrees.".format(fitted[0], fitted[1])
        print "    M2 corrected {0:.3f} m and {1:.0f} degrees.".format(fitted[0]*M2ft, fitted[1]+M2uvt)
        print "    K1 original  {0:.3f} m and {1:.0f} degrees.".format(fitted[2],fitted[3])
        print "    K1 corrected {0:.3f} m and {1:.0f} degrees.".format(fitted[2]*K1ft, fitted[3]+K1uvt)
```

```
PortRenfrew
    M2 original  0.718 m and -3 degrees.
    M2 corrected 0.709 m and 243 degrees.
    K1 original  0.462 m and -39 degrees.
    K1 corrected 0.485 m and 258 degrees.
Victoria
    M2 original  0.292 m and 69 degrees.
    M2 corrected 0.289 m and 315 degrees.
    K1 original  0.652 m and -20 degrees.
    K1 corrected 0.685 m and 276 degrees.
Sandheads
    M2 original  0.821 m and 154 degrees.
    M2 corrected 0.811 m and 400 degrees.
    K1 original  0.883 m and -2 degrees.
    K1 corrected 0.928 m and 295 degrees.
PowellRiver
    M2 original  0.927 m and 157 degrees.
```

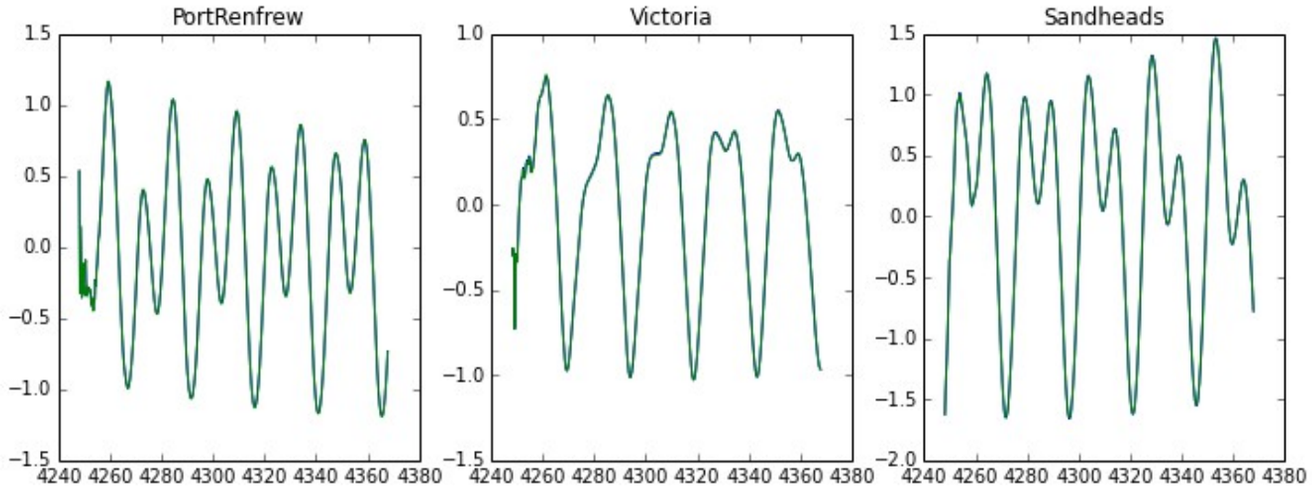
IPy Multi-tides w Fit

127.0.0.1:8888/notebooks/compare_tides/Multi-tides w Fit.ipynb#

IP[y]: Notebook Multi-tides w Fit Last Checkpoint: May 16 14:59 (autosaved)

File Edit View Insert Cell Kernel Help

In [7]:
```
plt.figure(figsize=(12,9))
for stn in range(5):
    fT1 = NC.Dataset(name1+location[stn]+'.nc','r')
    time1 = fT1.variables["time_counter"][:]/3600.  # want hours not seconds
    ssh1 = fT1.variables["sossheig"][:,0,0]
    fT2 = NC.Dataset(name2+location[stn]+'.nc','r')
    time2 = fT2.variables["time_counter"][:]/3600.  # want hours not seconds
    ssh2 = fT2.variables["sossheig"][:,0,0]
    plt.subplot(2,3,stn+1)
    plt.plot (time1, ssh1, time2, ssh2)
    plt.title(location[stn])
```



Following the approach used to rotate the Webtide tidal constituents, we can do the following:

* assume the postive along strait direction is approximately 10° measured clockwise from East
* 'up' in NEMO is rotated 29° counter-clockwise of North
* 'across' in NEMO is rotated 29° counter-clockwise of East
* the angle of rotation between along-strait direction and 'across' in NEMO is therefore $\theta = 29^\circ + 10^\circ=39^\circ$
* neglect across-strait velocity (i.e. $v_a = 0$, $\phi_v = 0$)
* u_a and ϕ_u are the depth averaged amplitude and phase at each station (calculated above)
* following the approach described in the docs [`docs/tides/tides_data_acquisition`](http://salishsea-meopar-docs.readthedocs.org/en/latest/tides/tides_data_acquisition.html):

so for u:

$$
Z1 = u_a\cos\theta\cos\phi_u
\\
Z2 = u_a\cos\theta\sin\phi_u
$$

and for v:

$$
Z1 = -u_a\sin\theta\cos\phi_u
\\
Z2 = -u_a\sin\theta\sin\phi_u
$$

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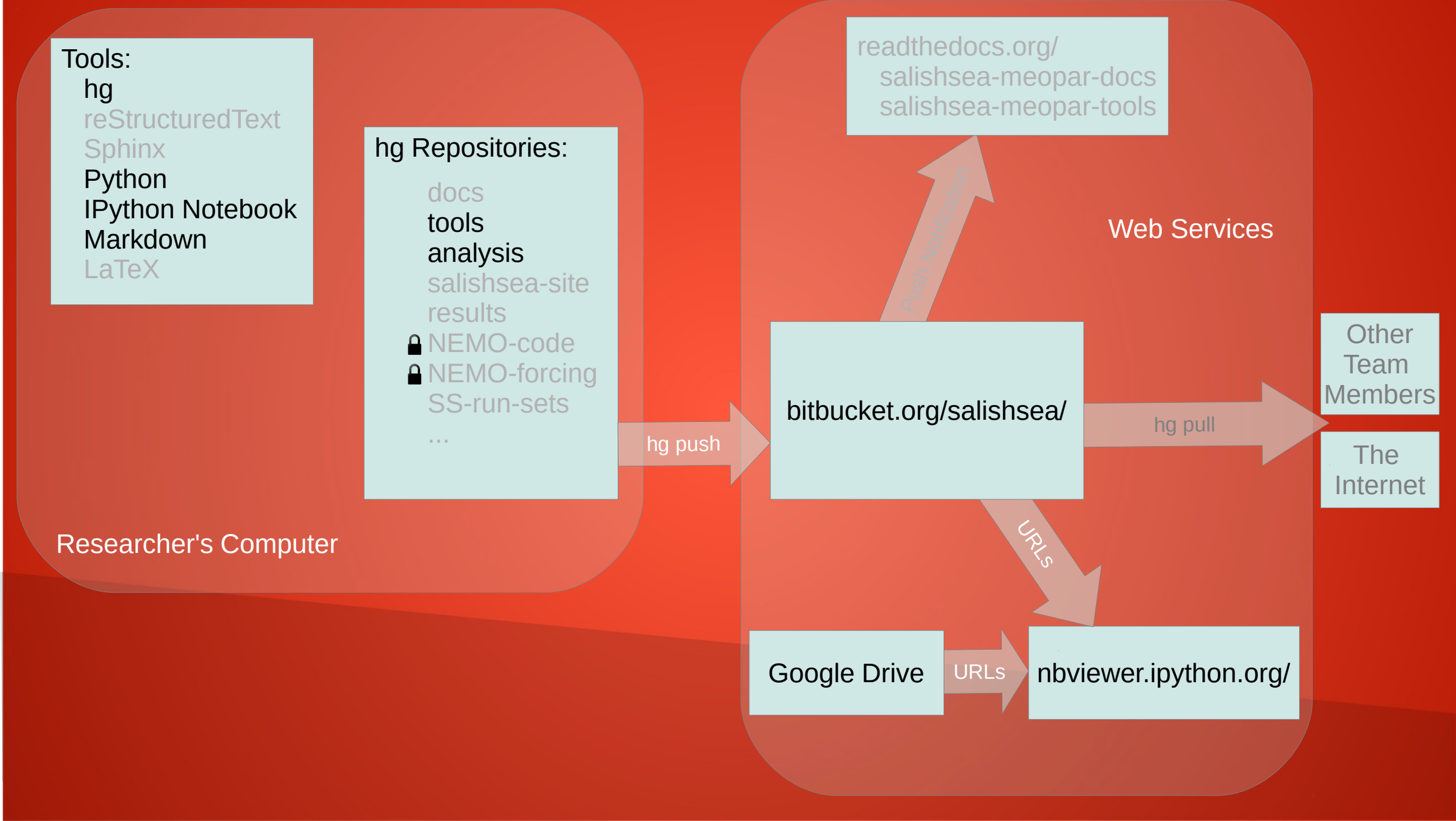
so for u:

$$Z1 = u_a \cos\theta \cos\phi_u$$
$$Z2 = u_a \cos\theta \sin\phi_u$$

and for v:

$$Z1 = -u_a \sin\theta \cos\phi_u$$
$$Z2 = -u_a \sin\theta \sin\phi_u$$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The IPython Notebooks in this directory are evaluation of the tide and storm surge results calculated by the Salish Sea NEMO model.

The links below are to static renderings of the notebooks via nbviewer.ipython.org. Descriptions below the links are from the first cell of the note (if that cell contains Markdown or raw text).

- **comp_wlev_harm.ipynb**
- **Tidal Variations.ipynb**

  This notebook looks at the effect of changing different parameters on the tides.

  Runs:
  1. tide_flux_M2K1 - M2/K1 only over 5 days. No modifications to western tides. Northern tides flux decreased.
  2. tide_flux_west - M2/K1 only with flux increased by 25% at west.
  3. tide_bottom - bottom friction reduced to 3e-3 (from 5e-3). Note: I suspect we can reduce further, perhaps to 2e-3?
  4. tide_nu15 - viscosity lowered to 15
  5. tide_bottom1e-3 - bottom friction reduced to 1e-3
  5. tide_K1phase2 - K1 phase decreased by 5 degrees.
  7. tide_K1amp - K1 amp decreased 15 %, phase decreased 5 degrees, bottom friction 1e-3

  Measured amplitude/phase from Foreman's Discovery Islands and 2004 paper are included.

  Complex differences are from the Foreman inversion method in 2004 paper.

  Uses the same curve fitting technique that Susan wrote.
- **comp_wlev_harm_compositerun.ipynb**
- **comp_wlev_harm-wNorth.ipynb**
- **Multi-tides w Fit.ipynb**

Plot model vs measured comparison results

Calculate differences and save to a csv file:

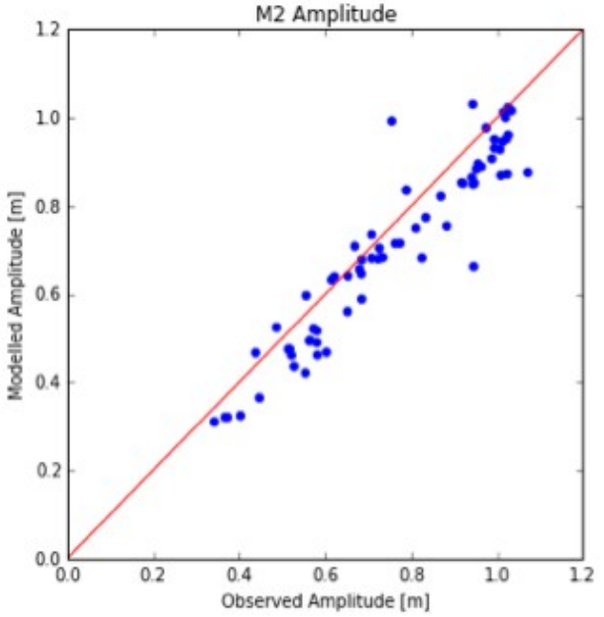
In [14]:
```
meas_wl_harm, Am_M2_all, Ao_M2_all, gm_M2_all, go_M2_all, \
D_F95_M2_all, D_M04_M2_all, Am_K1_all, Ao_K1_all, gm_K1_all, \
go_K1_all, D_F95_K1_all, D_M04_K1_all = tidetools.calc_diffs_meas_mod(runname,resultsloc,grid)
```

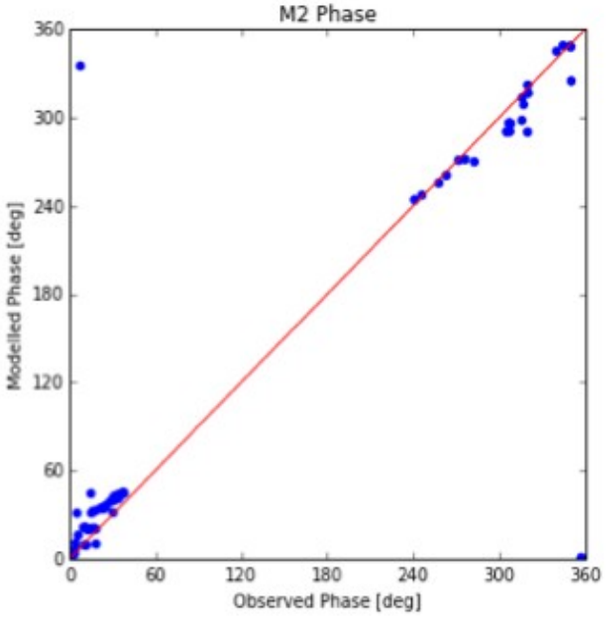
```
No point found in current domain for station 77 :(
```

Plot scatter plots for M2 and K1 constituents:

In [15]:
```
tidetools.plot_scatter_pha_amp(Am_M2_all, Ao_M2_all, gm_M2_all, go_M2_all, 'M2')
tidetools.plot_scatter_pha_amp(Am_K1_all, Ao_K1_all, gm_K1_all, go_K1_all, 'K1')
print 'Summary: K1 amplitude good, K1 phase high, M2 amplitude low, M2 phase high'
```

```
Summary: K1 amplitude good, K1 phase high, M2 amplitude low, M2 phase high
```





21-May-2014 MEOPAR

1. Storm Surge and Tides

a) Evaluate changes in K1 phase and amplitude.
-Error converting from radians to degrees. Reran
-5 degree phase change in K1 at JdF = about 5 degree phase change everywhere else (except Yorke Island). M2 not affected, K1 amps not affected. notebook
-Next step: use bf=1e-3, reduce K1 phase by 5 deg, reduce K1 amp by 15%. Apply changes to all u,v, eta. These were the errors at PA in the bf=1e-3 case.
- K1 is looking good now. I probably reduced the amplitude by a bit too much.
notebook
b) M2 amp through Islands fixed. Remaining problem is the phase. Provided changing phase and amplitude for K1 works, do the same thing to get M2 correct at Pt. Atkinson.
Next: Reduce M2 phase by 9 deg for match at PA.
M2 phase at Point Atkinson is good now. notebook nice
c) Rerun Surge cases for CMOS.
Feb 2006 reran with M2/K1 corrected and bf=1e-3. Cases: all_forcing and tidesonly.
notebook: also looks at t_tide predictions with only 8 constituents.
d) Return to trying to get tides better. Reduce EVD.
e) add more tidal constituents

8. Outreach and Sharing

a) for Jackie: SSH during Feb 5, 2006 storm surge -- spatial map. Do raw, -tides and -background. Susan to provide background.
b) tidal ellipses (along thalweg?) SEA
c) surface current plume animation

9. To watch/read

a) OSM tutorial on storm surge SEA
b) Salish Sea Models : write blurb for website

2. Spin-up and Stratification

a) thalweg movie
b) evaluate surface fronts. Request: Winds, 2003 Sep 17 & 18 on Salish - done
Fronts look pretty good: notebook
c) model is too fresh in the intermediate and deep SoG, almost certainly due to too much mixing in the Islands. Reducing EVD might help. (Hold)
d) continue spin-up
✓ 28oct6nov job finished (12:44) & xfer to ocean & jasper spin-up coll'ns
✓ 7nov16nov job finished (11:24) & xfer to ocean & jasper spin-up coll'ns
Clear evidence of a strong wind event. Mixing in SoG. Flow in JdF and out Johnstone St.
✓ 17nov26nov job finished (11:09) & xfer to ocean & jasper spin-up coll'ns
Stronger Olympic Counter-Current I've noticed yet.
stdout & stderr were not stored when run ended due to error
27nov6dec job (4739438) queued

18nov2003-1jan2004 CGRF files added to collection on jasper
16sep2003-19sep2003 CGRF files added to collection on salish
e) SEA update spin-up narrative docs

3. Orcinus

a) prod! get NEMO building here
pinged Roman on 22-May - "today or tomorrow"

4. Visualization Notebooks

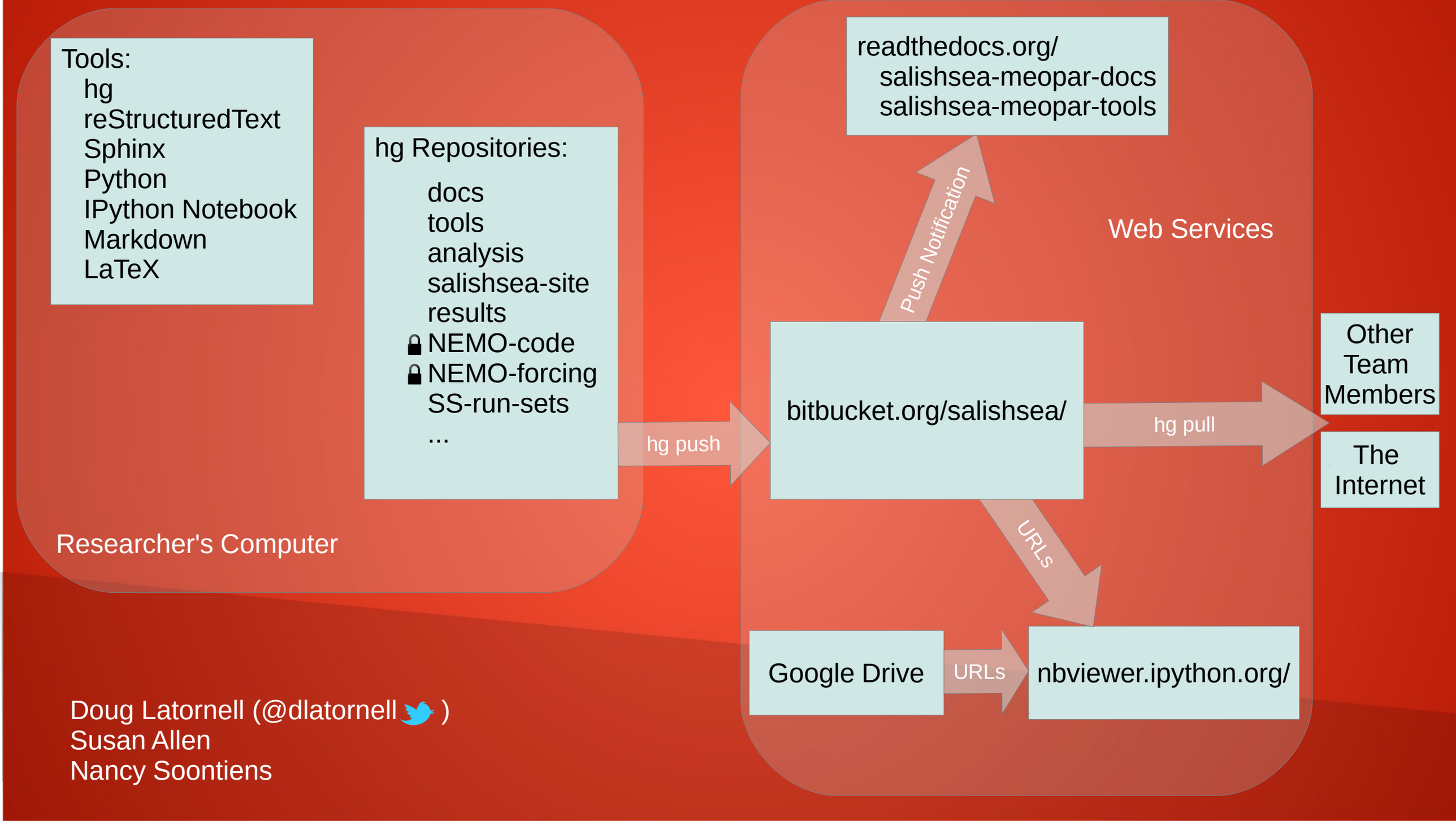
a) Doug continues

5. Nowcasts

a) prod: waiting for winds from Montreal
pinged Kao-Shen on 22-May - hope for test file next week
b) talk to Dewey about compute access

6. Migration (on hold until after CMOS)

a) 35-40 updates, all but last 4 OPA_TAM (online tracers)
b) 4th last one, integration OPA_SRC and OPA_TAM
c) last 3 in OPA_SRC, trd, surface boundary condition, diag



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