New Capabilities For Interpreting Comparison Data

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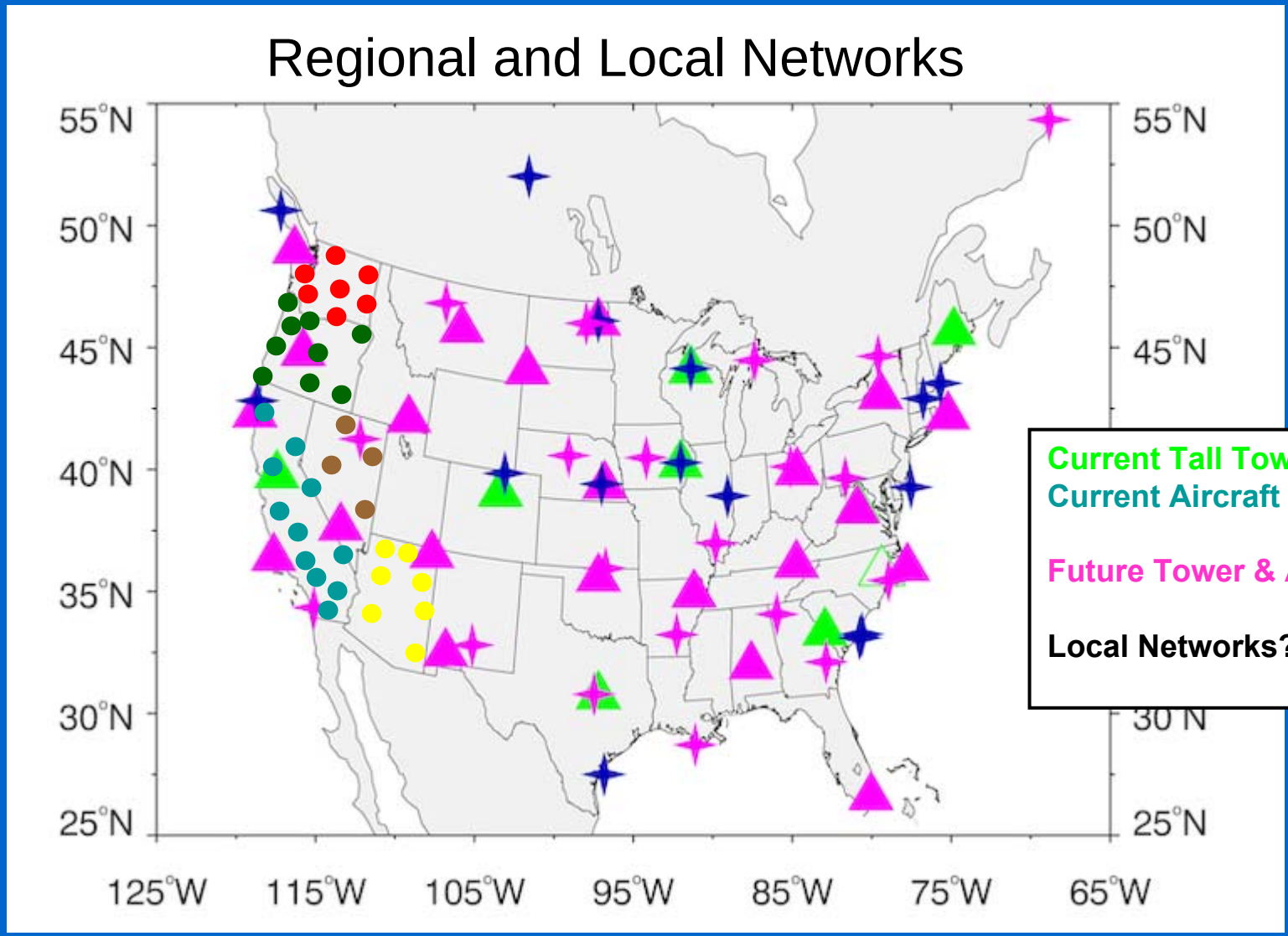
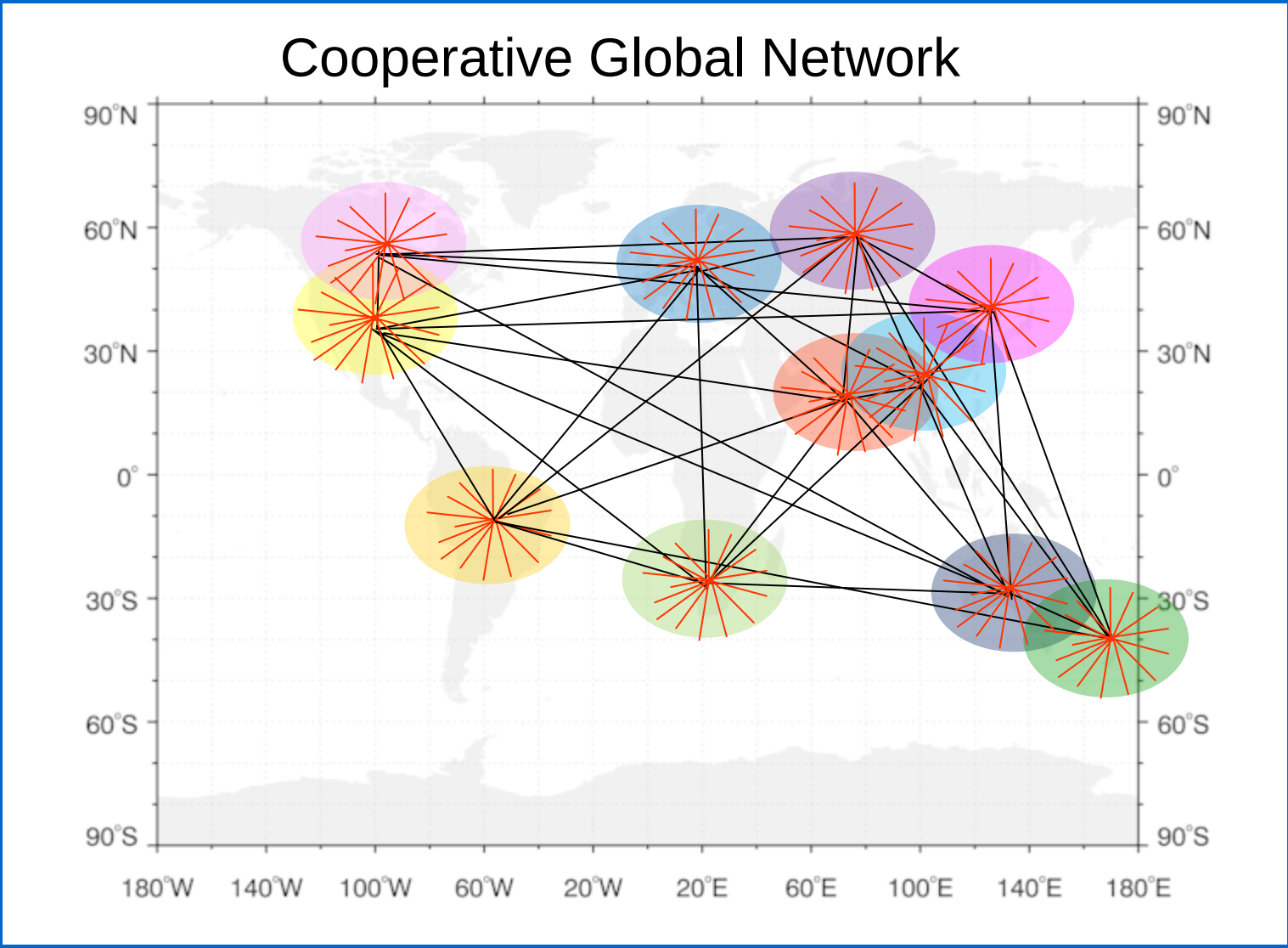
Through The Years …

- NOAA Comparison Activity: Are we closer to the required measurement accuracy? (Finland 2007)
- Making Quality Measurements without a Data Management Strategy (Canada 2003)
- A Web-based Interactive Atmospheric Data Visualization Tool: Near real-time access to data from the NOAA CMDL CCGG Observing Network (Canada 2003)
- GLOBALVIEW-CO_2: Past, Present and Future (Japan 2001)
- GLOBALVIEW-CO_2: An Update (Australia 1997)
- An Update on the Ongoing Flask-Air Intercomparison Program between NOAA and CSIRO (Australia 1997)
- Extension and Integration of Atmospheric CO_2 Data into a Globally Consistent Measurement Record (U.S. 1995)

Motivation: Cooperative Observing Systems

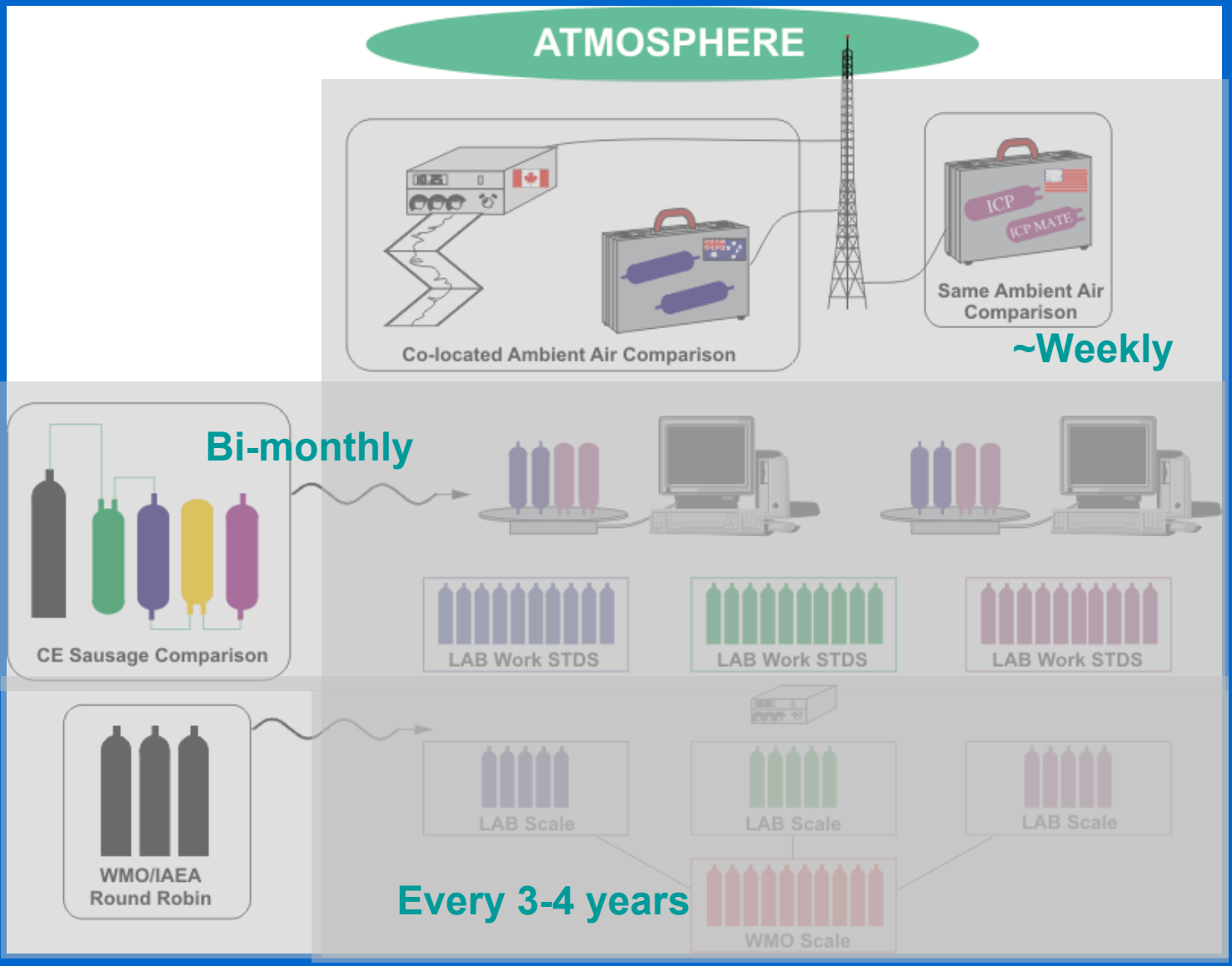


Motivation: Global Network of Regional Networks



conceptual

Motivation: Multiple Comparison Strategies



EC / NOAA

WMO RR
CE Sausage
CE Cucumber

Same Air (ALT)
Flask/In Situ (ALT)
Flask/In Situ (LLB)

ESRL Inter-Laboratory Comparison Activities

Partner	Location	Frequency	Method	Type	Parameters
CSIRO	CGO	Weekly	Flask	Same Air	CO2,CH4,CO,H2,N2O,CO2C13,CO2O18
CSIRO	ALT	Weekly	Flask/Flask	Co-located	
EC	ALT	Weekly	Flask	Same Air	CO2,CH4,CO,H2,N2O,SF6
EC	ALT, LLB	Weekly	Flask/In Situ	Co-located	CO2, CH4, CO
MPI-BGC	OXK	Weekly	Flask	Same Air	CO2,CH4,CO,H2,N2O,SF6
LSCE	MHD	Weekly	Flask	Same Air	CO2,CH4,CO,H2,N2O,SF6
LSCE	MHD	Weekly	Flask/In Situ	Co-located	CO2
IPEN	ABP	Weekly	Flask/Flask	Co-located	CO2,CH4,CO,H2,N2O,SF6
NCAR	NWR	Weekly	Flask/In Situ	Co-located	CO2
NIWA	BHD	Weekly	Flask	Same Air	CO2,CH4,CO,N2O,CO2C13,CO2O18
CE Sausage	CEI	Bi-Monthly	Flask/Flask	Same Air	CO2,CH4,CO,N2O,CO2C13,CO2O18
FMI	PAL	Weekly	Flask/In Situ	Co-located	CO2,CH4
ESRL/HATS	TST	Weekly	Flask	Same Air	N2O,SF6
AEMET	IZO	Weekly	Flask/In Situ	Co-located	CO2
ENEA	LMP	Weekly	Flask/In Situ	Co-located	CO2,CH4
LBNL	SGP	Weekly	Flask/In Situ	Co-located	CO2
CMA	WLG	Weekly	Flask/In Situ	Co-located	CO2,CH4,CO
Round Robin	RRI	3-4 Years	Cylinder	Same Air	CO2,CH4,CO,N2O,CO2C13,CO2O18

ESRL Intra-Laboratory Comparison Activities

Location	Frequency	Method	Type	Parameters
TST	Daily	Flask	Same Air	CO2,CH4,CO,H2,N2O,SF6,CO2C13,CO2O18
KUM	Weekly	Flask	Same Air	CO2,CH4,CO,H2,N2O,SF6
AAO	Monthly	Flask	Same Air	CO2,CH4,CO,H2,N2O,SF6
BRW	Weekly	Flask/In Situ	Co-located	CO2,CH4,CO
MLO	Weekly	Flask/In Situ	Co-located	CO2,CH4,CO
SMO	Weekly	Flask/In Situ	Co-located	CO2
SPO	Weekly	Flask/In Situ	Co-located	CO2
AMT	Weekly	Flask/In Situ	Co-located	CO2,CO
BAO	Weekly	Flask/In Situ	Co-located	CO2,CO
LEF	Weekly	Flask/In Situ	Co-located	CO2,CO
SCT	Weekly	Flask/In Situ	Co-located	CO2,CO
WBI	Weekly	Flask/In Situ	Co-located	CO2,CO
WGC	Weekly	Flask/In Situ	Co-located	CO2,CO
WKT	Weekly	Flask/In Situ	Co-located	CO2,CO

Looking For A More Flexible ICP Application

- View results from multiple ICPs among multiple labs
- Accommodate many same-air and co-located ICP strategies
- Scale to a 10-fold increase in ICP experiments
- Automate data transfer and archive, and DB and Web updates
- View key images and statistical summaries (Production)
- Create custom comparisons and images (Interactive)
- Web-based, Fast, Free, Robust
- Minimal Software/Hardware Requirements
- Portable

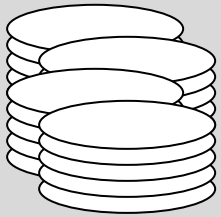
Interactive ICP Framework

1

Data Transfer (FTP or HTTP)

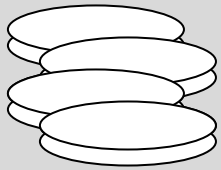
Host Lab

2



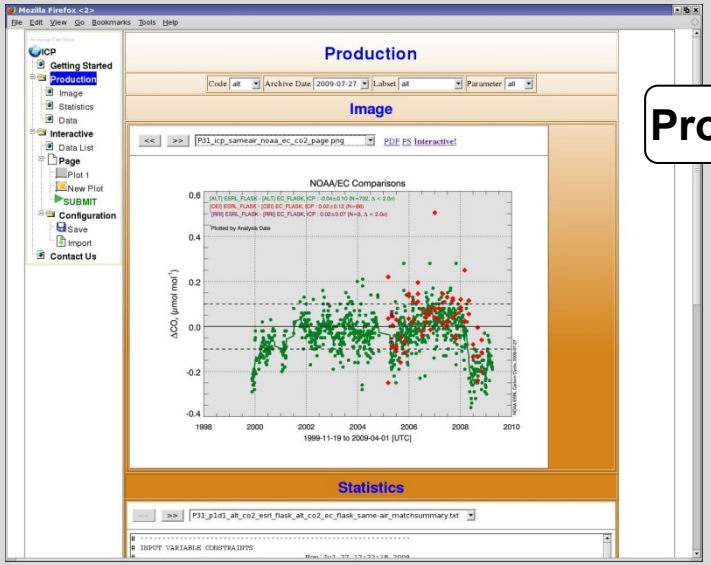
Data Archive

ICP DB



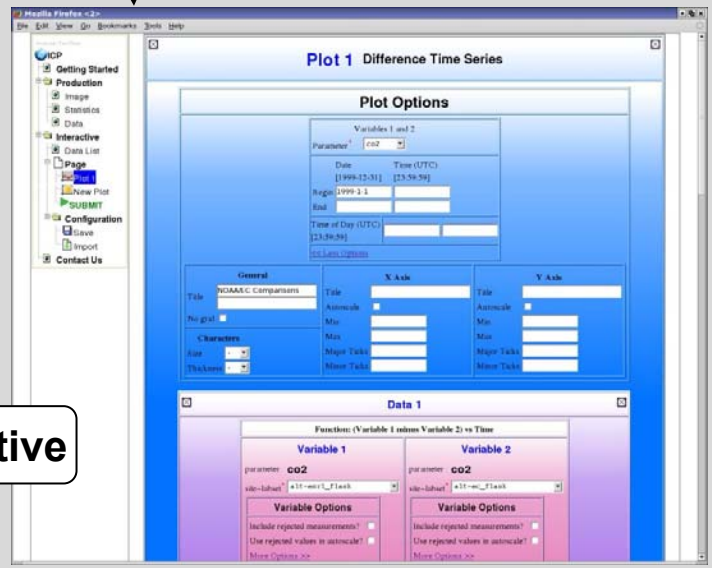
3

WEB App



Production

Interactive



Interactive ICP Framework

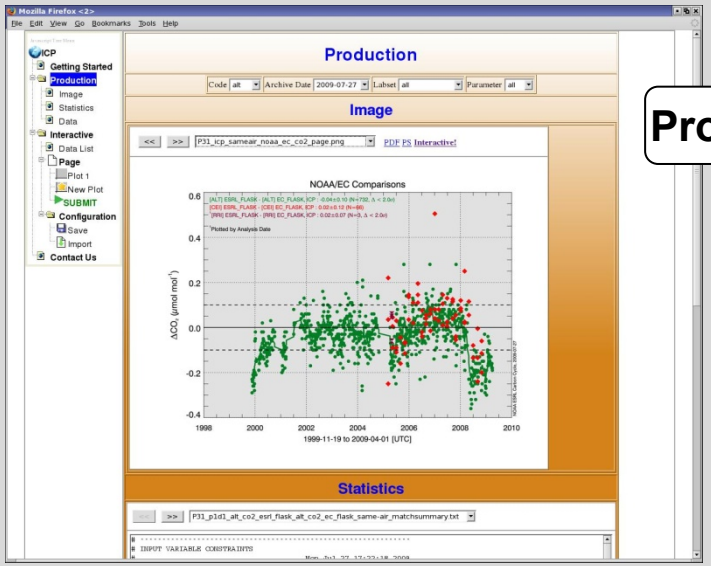
FAIL TO AUTOMATE Data Transfer

Host Lab

Data Archive

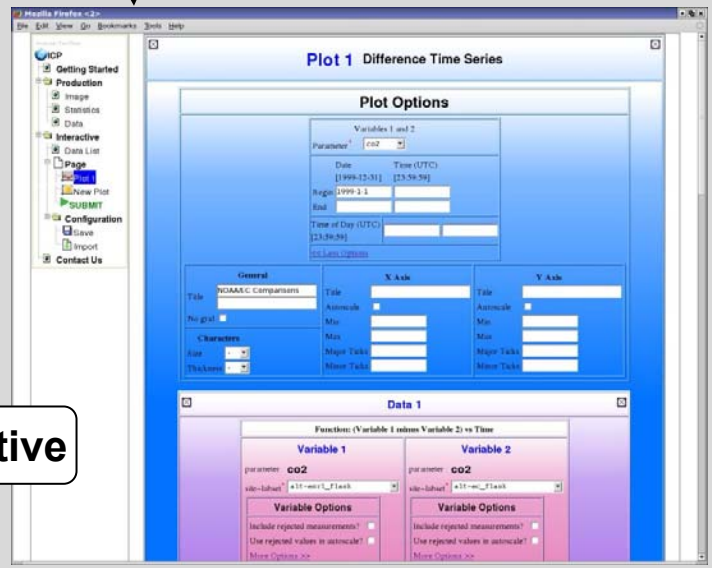
ICP DB

WEB App



Production

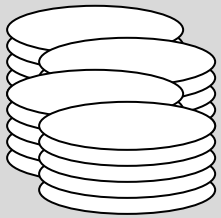
Interactive



Interactive ICP Framework

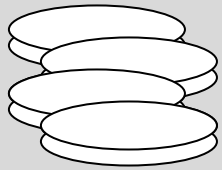
Data Transfer (FTP or HTTP)

Host Lab

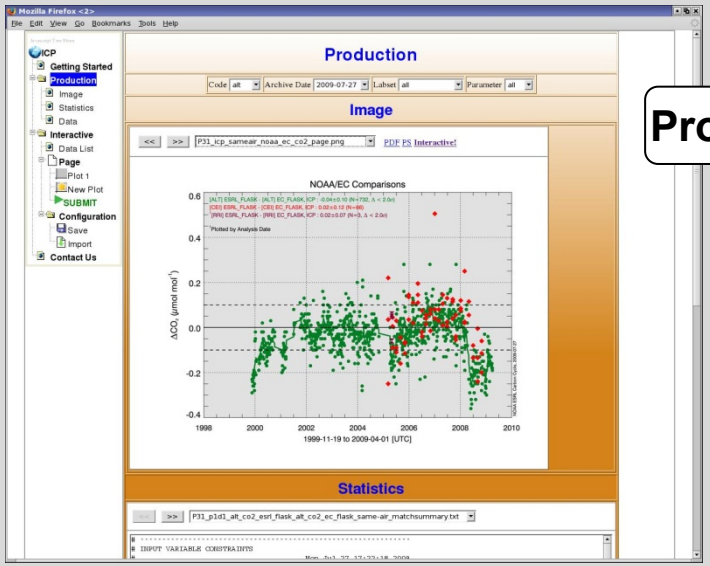


Data Archive

ICP DB

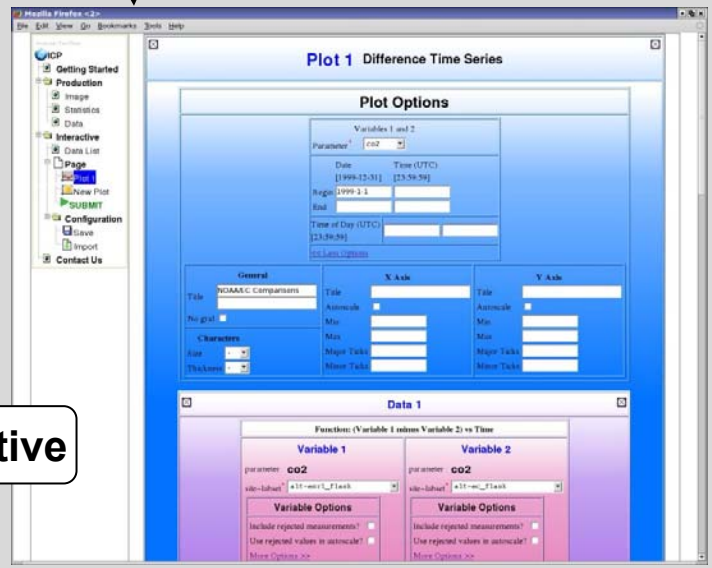


WEB App

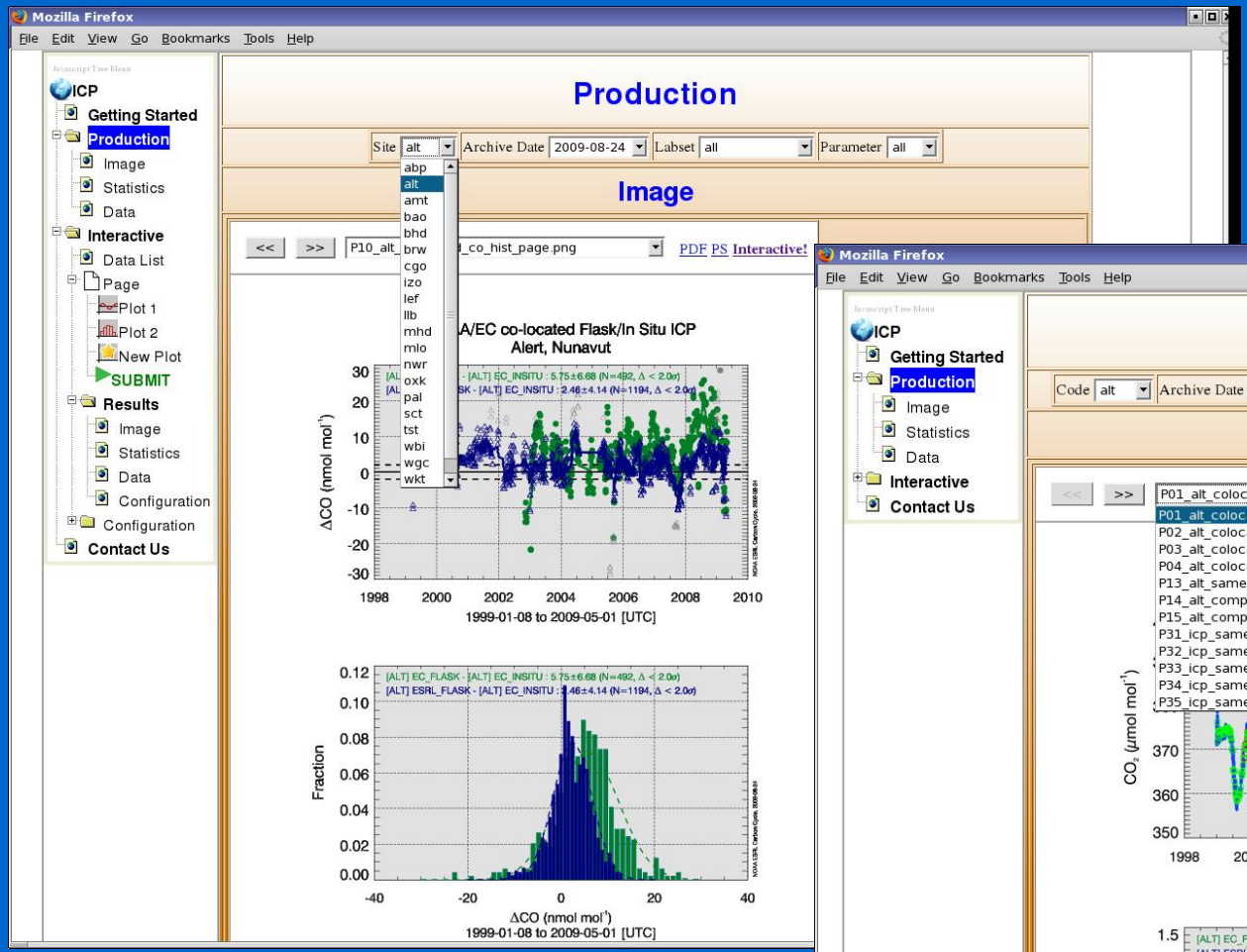


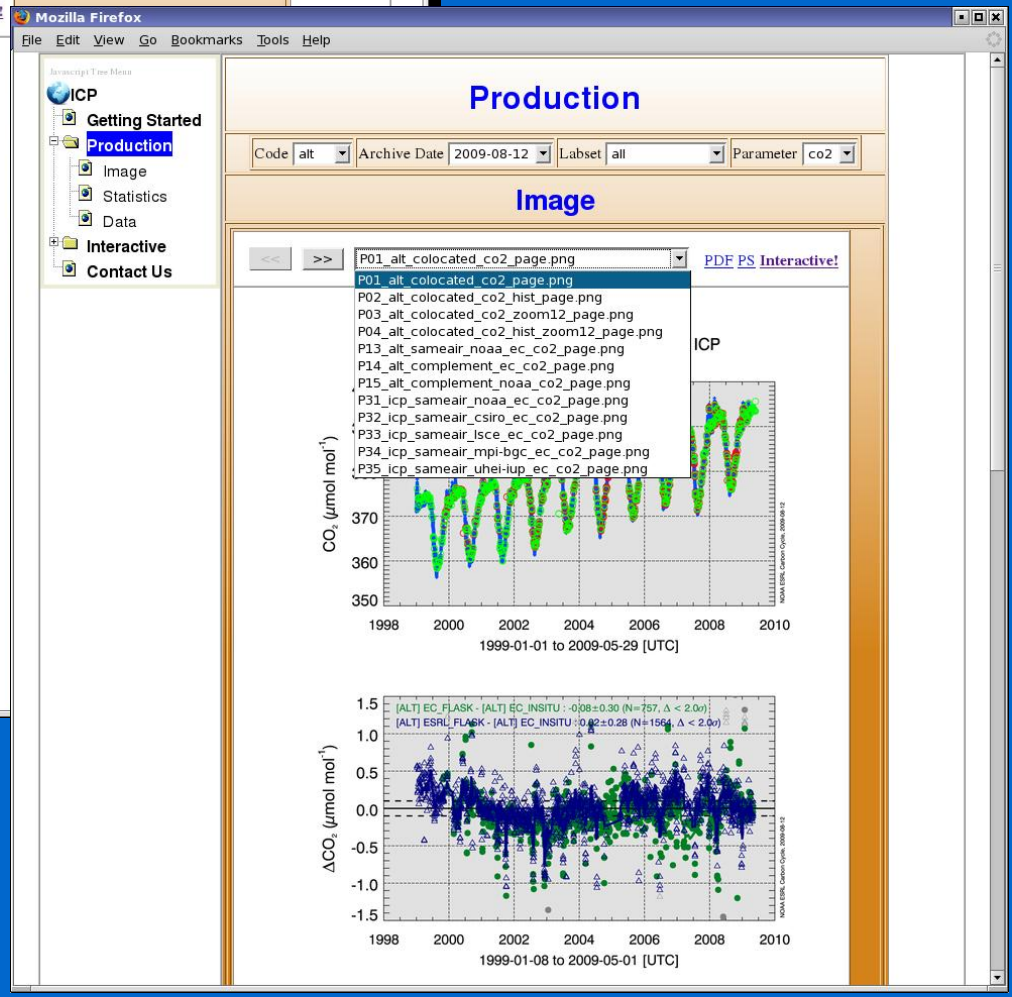
Production

Interactive



Production Images





EC data courtesy of D. Worthy

Production Statistics and Data

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Statistics

<< >> P31_p1d1_alt_co2_esrl_flask_alt_co2_ec_flask_same-air_matchsummary.txt

```
# ------------------------------------------------------------
# INPUT VARIABLE CONSTRAINTS
#                                   Mon Aug 24 15:35:30 2009
#
# VARIABLE 1:
#    Parameter:                                          CO2
#    Site:                                               ALT
#    Lab Set:                                      ESRL_FLASK
#
# VARIABLE 2:
#    Parameter:                                          CO2
#    Site:                                               ALT
#    Lab Set:                                       EC_FLASK
#
# ------------------------------------------------------------
MATCH CONDITIONS
#                                   Mon Aug 24 15:35:30 2009
#
#    Match Type:                                         ID
#    Flask Comparison:                                  ICP
#    Time Window (hr):                              49.0000
#
# ------------------------------------------------------------
# MIXING RATIO DIFFERENCES
#                                   Mon Aug 24 15:35:30 2009
#                              a =  [ALT, CO2] ESRL_FLASK ICP
#                                 b = [ALT, CO2] EC_FLASK ICP
#                                                 a minus b
#
#                                               All Available
#
#           YEAR            MEAN            STDEV               N
       1999-2009         -0.0604           0.2275             742
            1999         -0.2223           0.0580              13
            2000         -0.0908           0.0514              60
            2001         -0.0426           0.0860              46
            2002         -0.0140           0.0594              89
            2003         -0.0226           0.0750              88
            2004         -0.0333           0.0865              73
            2005         -0.0597           0.0939              76
            2006          0.0129           0.0784              97
```

Get Data

P31_p1d1_alt_co2_esrl_flask_alt_co2_ec_flask_same-air_matchdata.txt

Mozilla Firefox <2>

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```
# ------------------------------------------------------------
# INPUT VARIABLE CONSTRAINTS
#                                   Mon Aug 24 15:35:30 2009
#
# VARIABLE 1:
#    Parameter:                                          CO2
#    Site:                                               ALT
#    Lab Set:                                      ESRL_FLASK
#
# VARIABLE 2:
#    Parameter:                                          CO2
#    Site:                                               ALT
#    Lab Set:                                       EC_FLASK
#
# ------------------------------------------------------------
MATCH CONDITIONS
#                                   Mon Aug 24 15:35:30 2009
#
#    Match Type:                                         ID
#    Flask Comparison:                                  ICP
#    Time Window (hr):                              49.0000
#
# ------------------------------------------------------------------------
# MATCHED DATA
#                                                 Mon Aug 24 15:35:30 2009
#                                       v1 =  [ALT, CO2] ESRL_FLASK ICP
#                                         v2 =  [ALT, CO2] EC_FLASK ICP
#
# Vn           date/time        Id      value       unc  flg meth   magl
  v1 1999 11 19 16 41 00   4825-91    370.430   -999.990  ..I    P   10.0
  v2 1999 11 19 16 41 00   4825-91    370.720   -999.990  ..I    P   10.0
  v1 1999 11 19 16 41 00   4826-91    370.440   -999.990  ..I    P   10.0
  v2 1999 11 19 16 41 00   4826-91    370.670   -999.990  ..I    P   10.0
  v1 1999 11 25 16 26 00   4842-98    370.620   -999.990  ..I    P   10.0
  v2 1999 11 25 16 26 00   4842-98    370.860   -999.990  ..I    P   10.0
  v1 1999 12 02 20 09 00   4835-98    370.260   -999.990  ..I    P   10.0
  v2 1999 12 02 20 09 00   4835-98    370.470   -999.990  ..I    P   10.0
  v1 1999 12 02 20 09 00   4836-98    370.280   -999.990  ..I    P   10.0
  v2 1999 12 02 20 09 00   4836-98    370.540   -999.990  ..I    P   10.0
  v1 1999 12 11 17 50 00   4843-98    371.620   -999.990  ..I    P   10.0
  v2 1999 12 11 17 50 00   4843-98    371.880   -999.990  ..I    P   10.0
  v1 1999 12 11 17 50 00   4844-98    371.570   -999.990  ..I    P   10.0
  v2 1999 12 11 17 50 00   4844-98    371.790   -999.990  ..I    P   10.0
  v1 1999 12 16 15 13 00    833-91    373.660   -999.990  ..I    P   10.0
  v2 1999 12 16 15 13 00    833-91    373.850   -999.990  ..I    P   10.0
  v1 1999 12 16 15 13 00    834-91    373.370   -999.990  ..I    P   10.0
  v2 1999 12 16 15 13 00    834-91    373.570   -999.990  ..I    P   10.0
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  v2 1999 12 30 16 55 00   4845-98    373.810   -999.990  ..I    P   10.0
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```
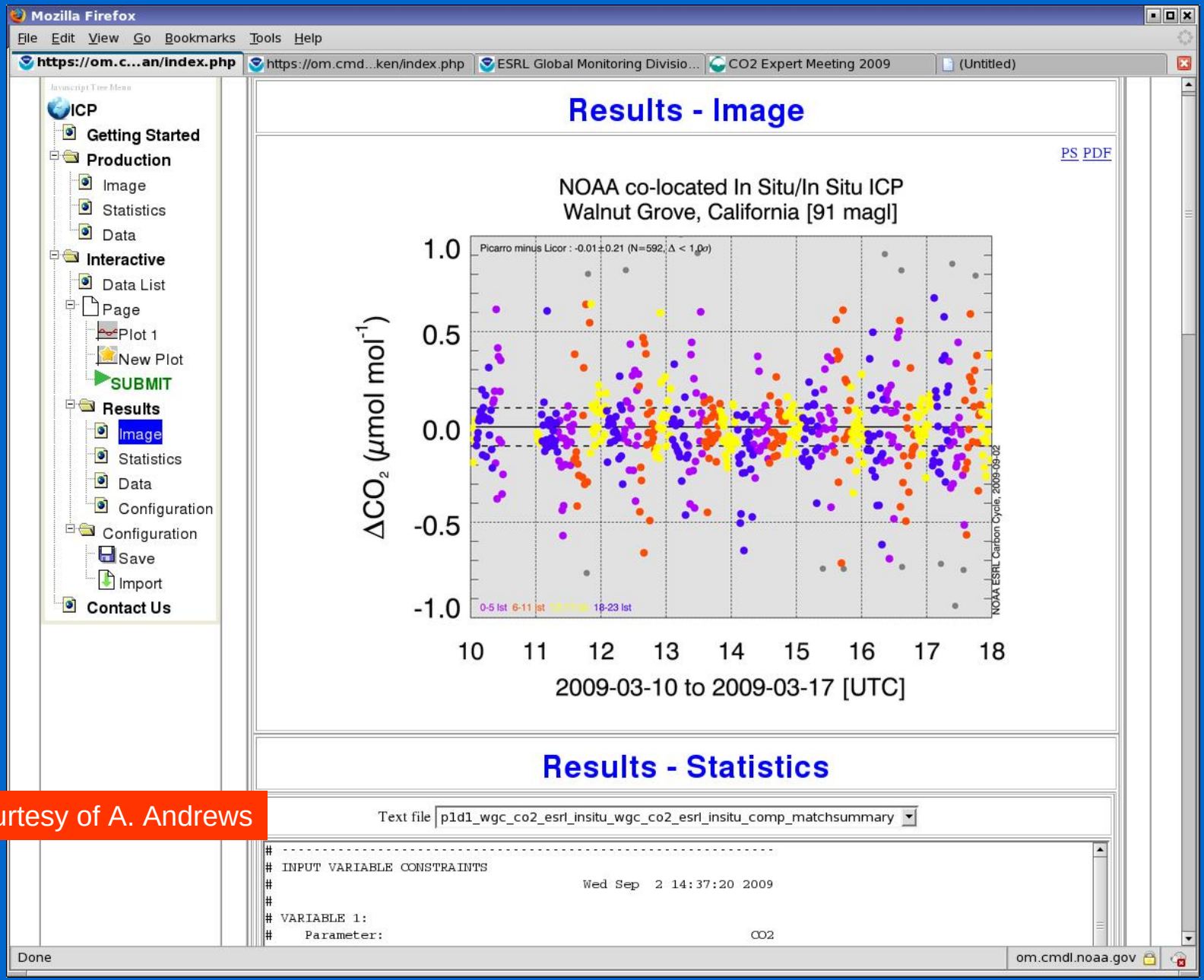

ICP Between co-located In Situ Systems



ESRL data courtesy of A. Andrews

Multiple ICPs Between 2 Labs

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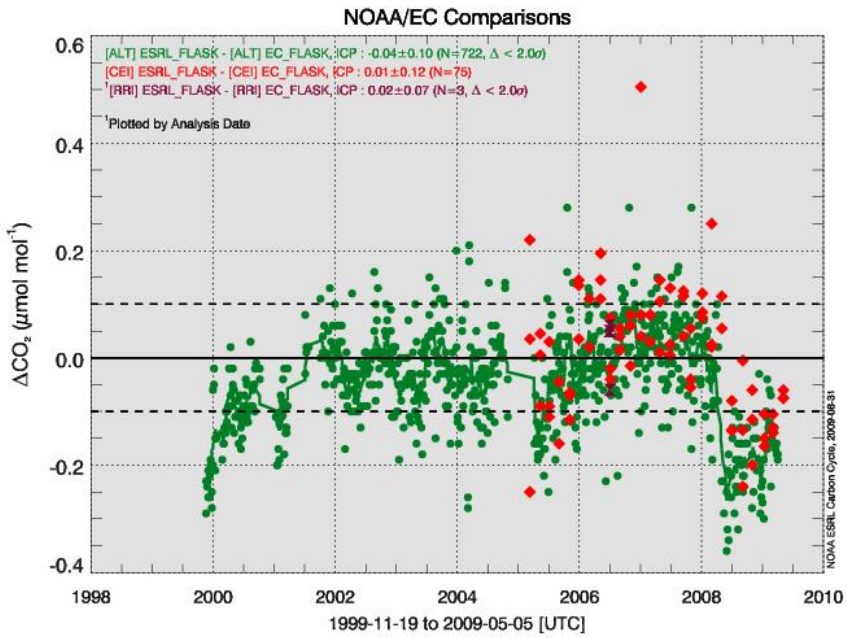
ICP
- Getting Started
- Production
  - Image
  - Statistics
  - Data
- Interactive
  - Data List
  - Page
    - Plot 1
    - Plot 2
    - New Plot
    - SUBMIT
- Results
  - Image
  - Statistics
  - Data
  - Configuration
- Configuration
  - Save
  - Import
- Contact Us

Production

Site: alt | Archive Date: 2009-08-31 | Labset: all | Parameter: all

Image

<< >> P31_icp_sameair_noaa_ec_co2_page.png PDF PS Interactive!

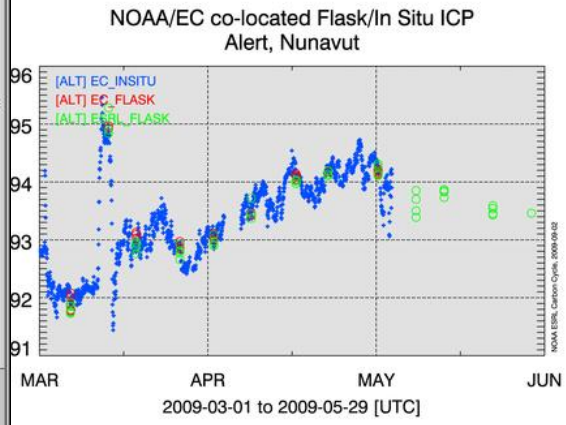


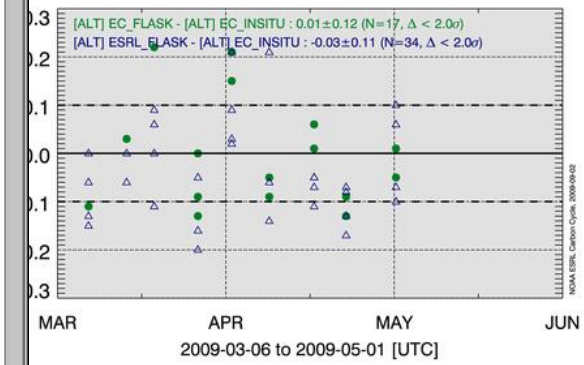
Statistics

Done

Results - Image

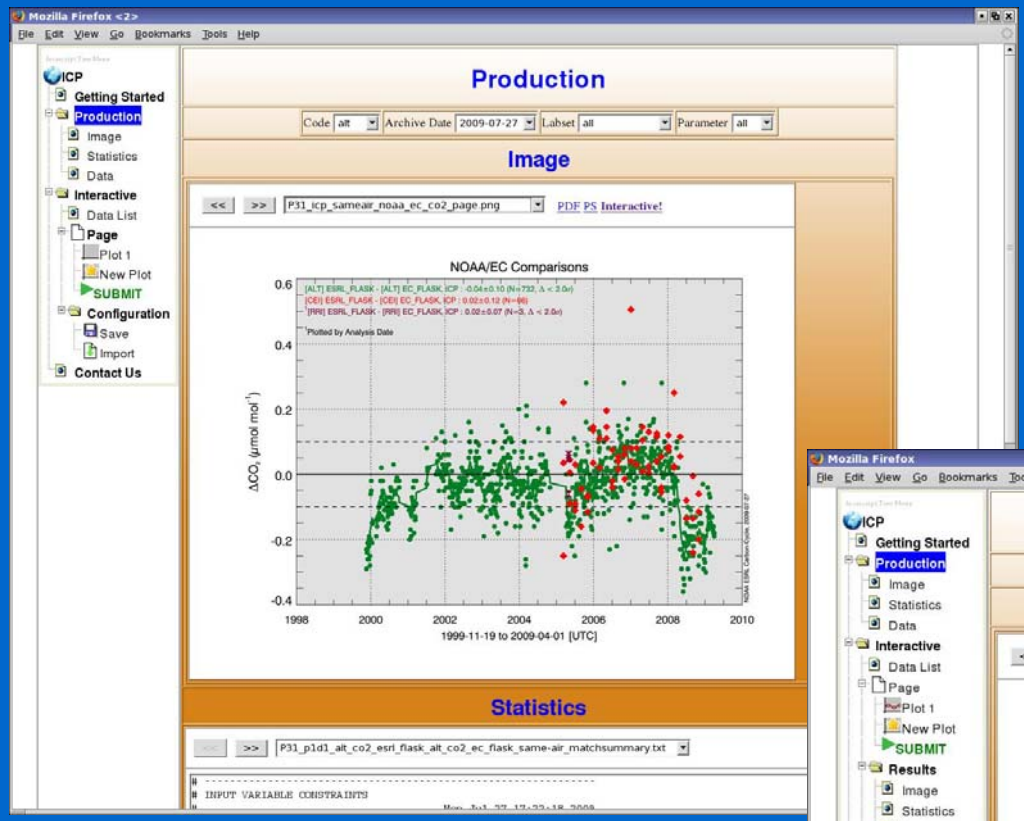
PS PDF

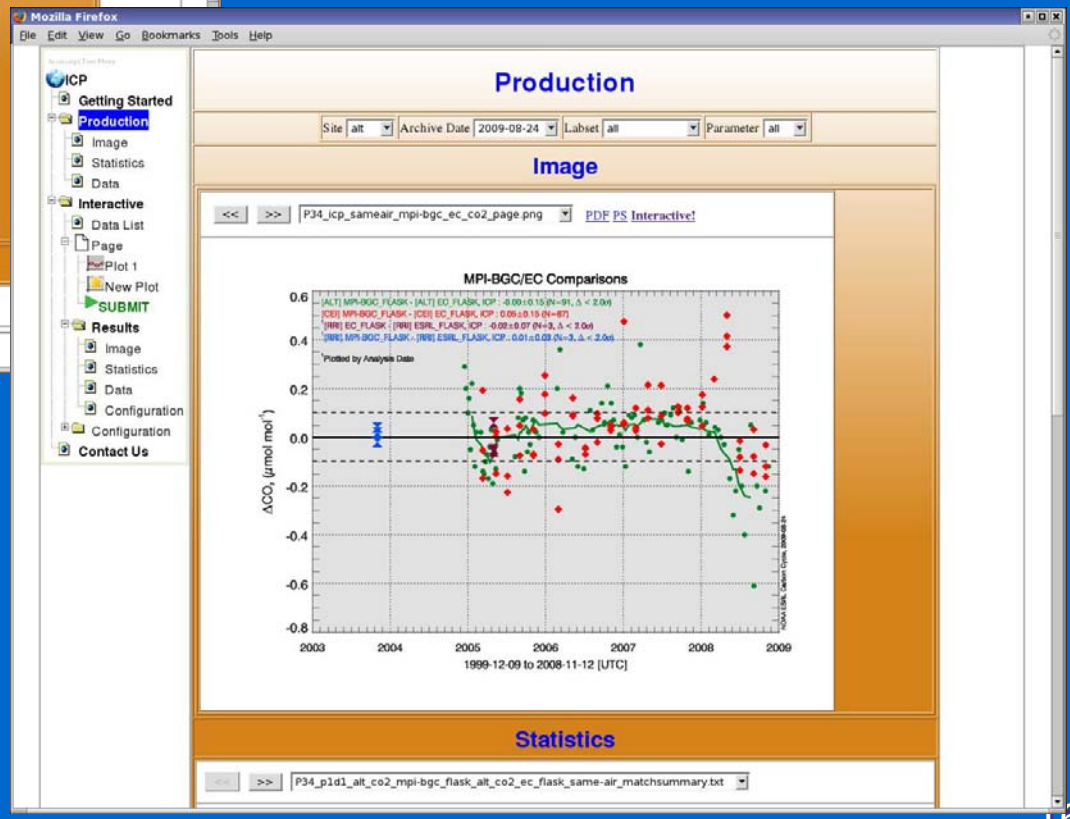




Results - Statistics

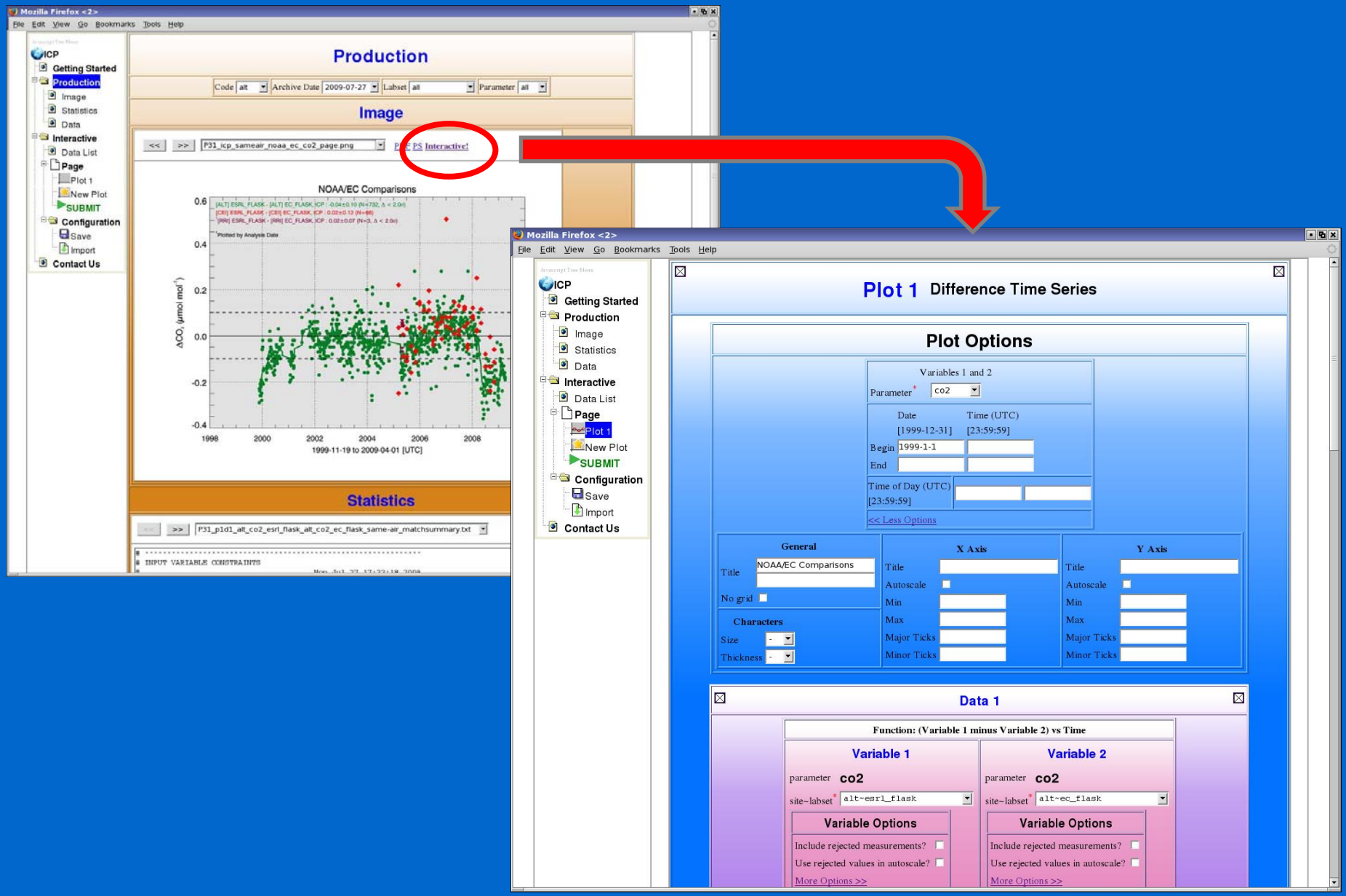
Multiple ICPs Among Multiple Labs



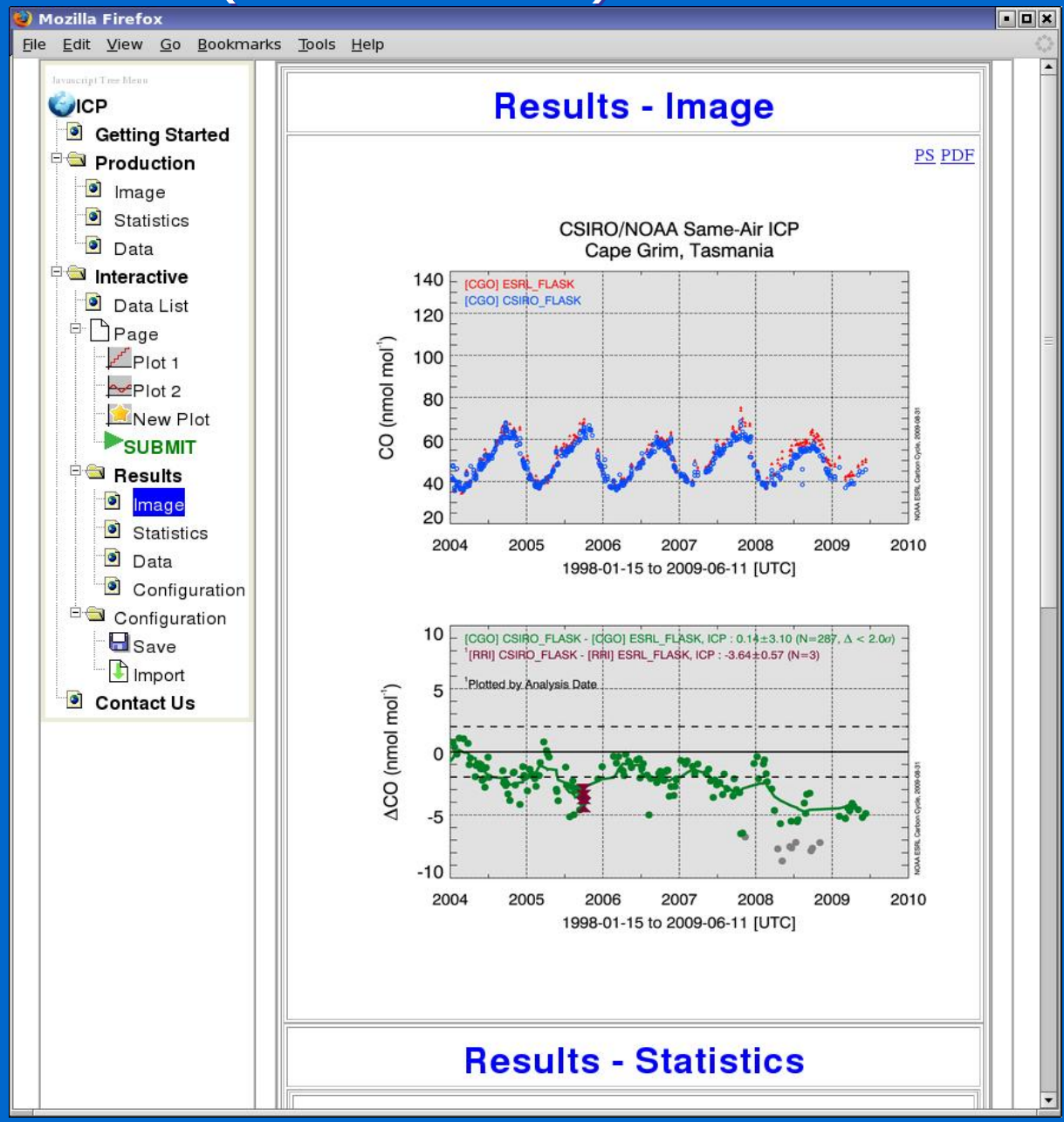


EC data courtesy of D. Worthy
MPI-BGC data courtesy of A. Jordan

“Production” to “Interactive”



Example: A First Look (Production)

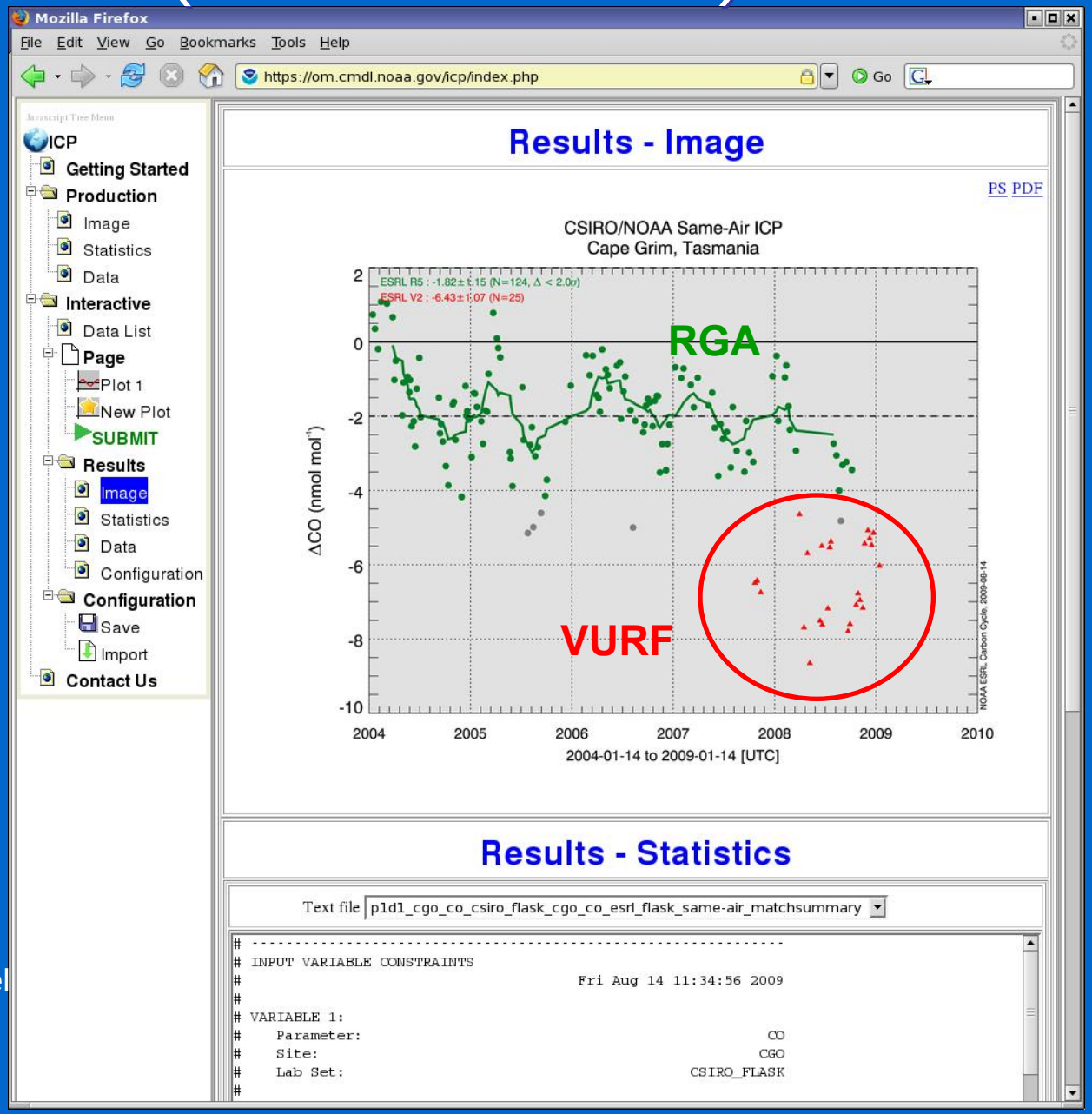


ESRL data courtesy of P. Novelli
CSIRO data courtesy of P. Krummel

A Closer Look (Interactive)

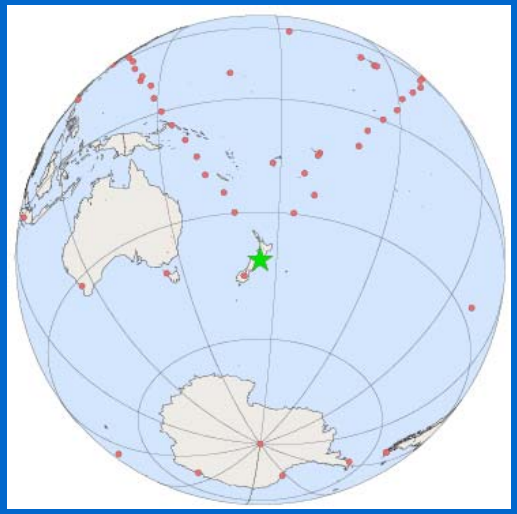
ESRL dat
CSIRO da

NOAA CO Detection (RGA and VURF)



NOAA data courtesy of P. Novelli
CSIRO data courtesy of P. Krummel

NIWA/NOAA ICP Results - CO



NOAA data courtesy of P. Novelli
NIWA data courtesy of G. Brailsford

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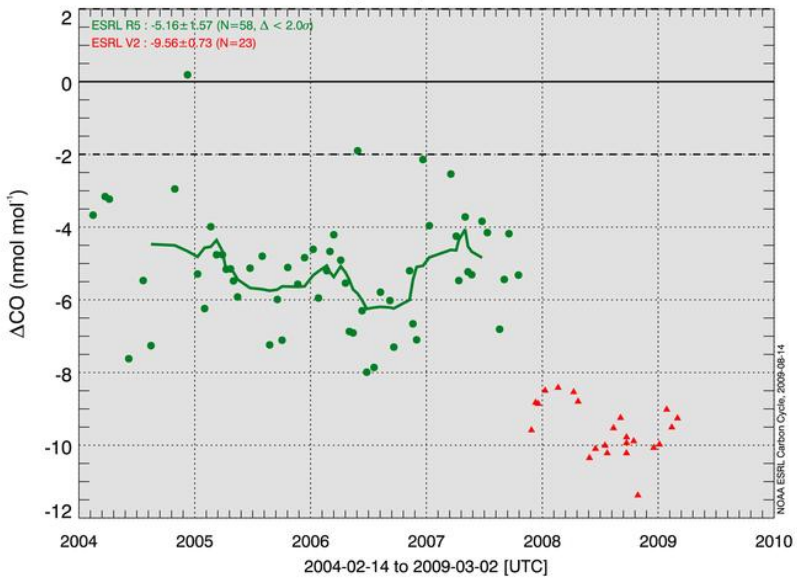
  - Getting Started
  - Production
    - Image
    - Statistics
    - Data
  - Interactive
    - Data List
    - Page
      - Plot 1
      - New Plot
      - SUBMIT
    - Results
      - Image
      - Statistics
      - Data
      - Configuration
    - Configuration
      - Save
      - Import
  - Contact Us

Results - Image

PS PDF

NIWA/NOAA Same-Air ICP
Baring Head, New Zealand



Results - Statistics

Text file p1d1_bhd_co_niwa_flask_bhd_co_esrl_flask_same-air_matchsummary

```
# ------------------------------------------------------------
# INPUT VARIABLE CONSTRAINTS
#                                        Fri Aug 14 11:53:44 2009
#
# VARIABLE 1:
#    Parameter:                                              CO
#    Site:                                                  BHD
#    Lab Set:                                          NIWA_FLASK
#
```

MPI-BGC/NOAA ICP Results

NOAA data courtesy of P. Novelli
MPI-BGC data courtesy of A. Jordan

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  - Production
    - Image
    - Statistics
    - Data
  - Interactive
    - Data List
    - Page
      - Plot 1
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    - Configuration
  - Configuration
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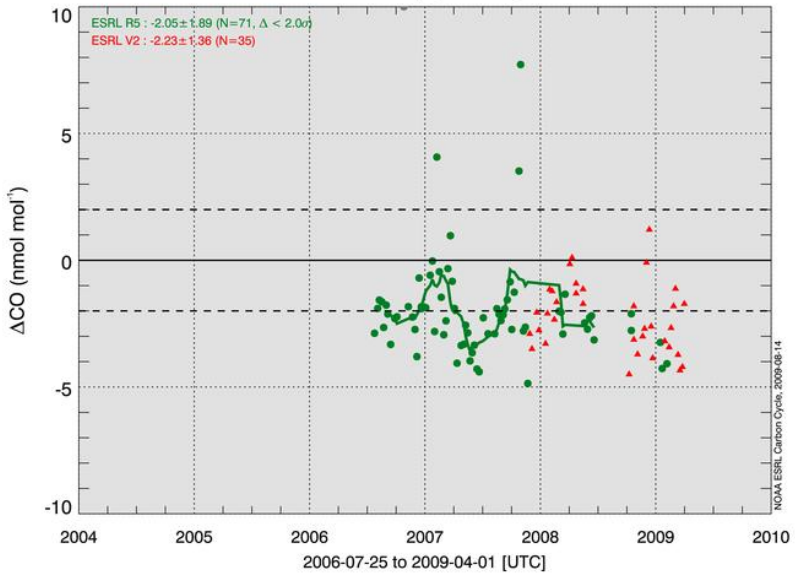
Results - Image

PS PDF

MPI-BGC/NOAA Same-Air ICP
Ochsenkopf, Germany



Results - Statistics

Text file p1d1_oxk_co_mpi-bgc_flask_oxk_co_esrl_flask_same-air_matchsummary

```
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#                                        Fri Aug 14 11:58:13 2009
#
# VARIABLE 1:
#    Parameter:                                              CO
#    Site:                                                  OXK
#    Lab Set:                                        MPI-BGC_FLASK
#
```
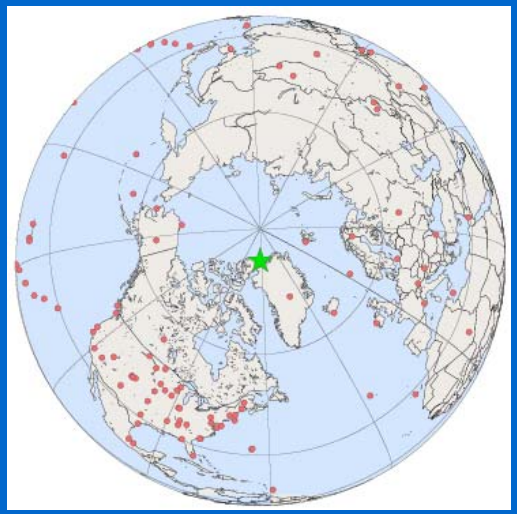

EC/NOAA ICP Results



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- Production
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  - Data
- Interactive
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  - Page
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    - New Plot
    - SUBMIT
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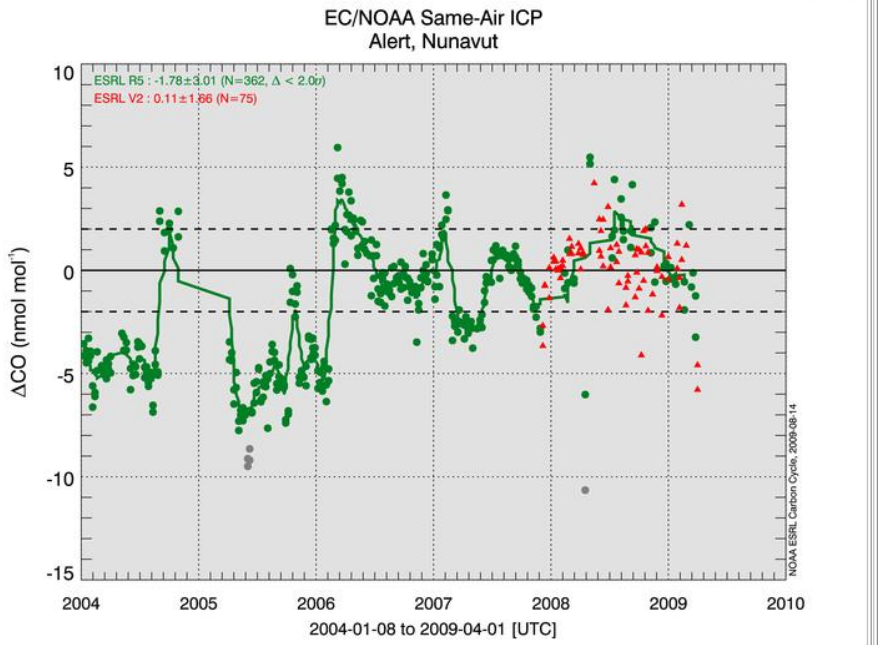
    - Image
    - Statistics
    - Data
    - Configuration
  - Configuration
    - Save
    - Import
- Contact Us

Results - Image

PS PDF



See Poster (P4) …

P.C. Novelli, P.M. Lang, K.A. Masarie, A.M. Crotwell, B.D. Hall and D. Guenther, Carbon monoxide measurements at NOAA/GMD: calibration and analysis

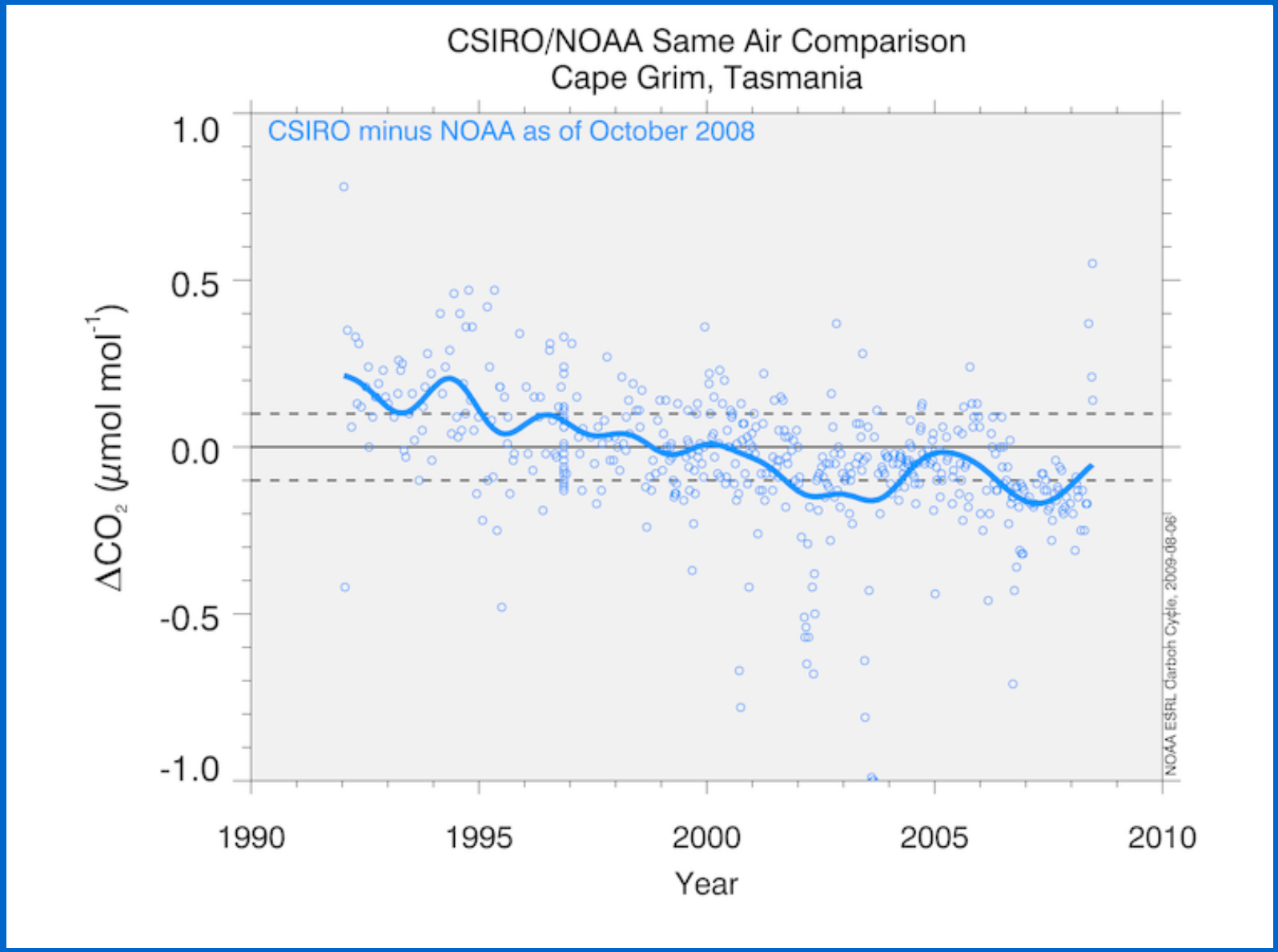
NOAA data courtesy o
EC data courtesy of D.

Direct Comparisons of Atmospheric Air

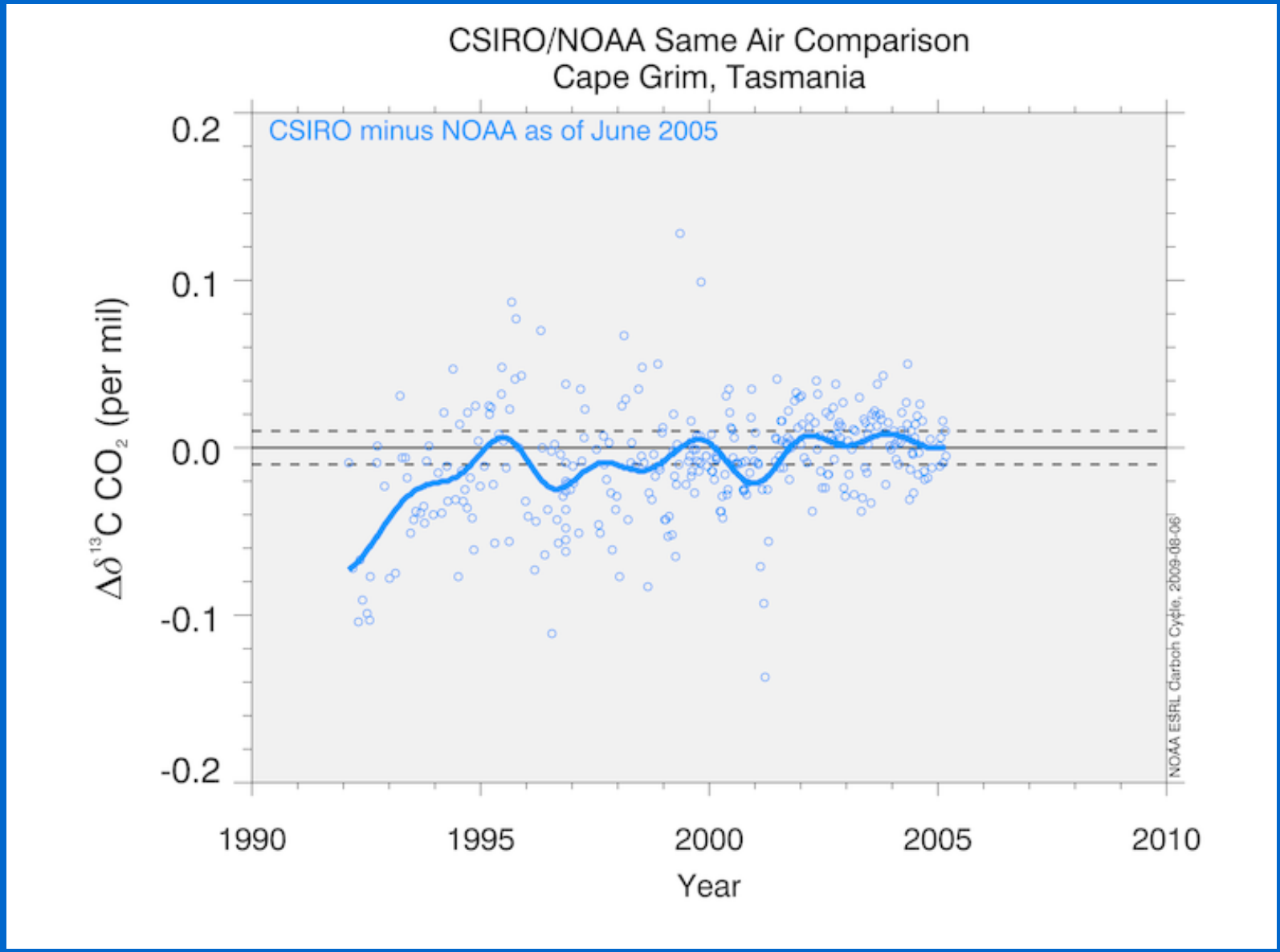
- ICP results suggest a problem
- ICP tools help identify possible causes
- Return to lab to evaluate hypotheses using fundamental methods
- Correct experimental problem if confirmed within the lab
- Edit existing data if defensible

→ improved confidence in measurements
→ may or may not improve ICP results!

ICP Results are Dynamic



ICP Results are Dynamic



Summary

- Merging independent observations into cooperative data sets must be defensible
- Ongoing and direct comparisons of atmospheric air measurements are essential
- ICPs provide independent feedback on how we are doing
- ICPs motivate to identify and solve problem
- Complementary comparisons can help narrow possible causes of observed differences
- ICP application to help us manage and visualize comparison data from many ICP strategies between many labs
- Tool that will scale to a major (10-fold) increase in the number of ICPs
- Success completely depends on data availability and readability (self-documenting files?)
- Next steps?

Thank You

Co-located Comparisons – WGC Tower

Intra-laboratory