Job Application for BIDS Computational Data Science Fellows Position

Research Experience, Background, and Interests

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Outline

- Broad overview of research interests and scientific/technical skills
- Examples of research experience and interests
  - Meteorological and CO_2 Regional Modeling
  - Square Kilometer Array (SKA) research & development
  - Dark Energy Research
- Pertinence to BIDS data science projects and research domain areas at UCB (and LBNL).
- Summary

Overview of research interests and scientific/technical skills

Interested in utilization and development of modeling, data analysis, statistical, mining, reduction, and processing algorithms, software, methods, and techniques in a wide range of possible physical science (e.g., physics, geosciences), scientific computing, and engineering disciplines. Examples:

- Monte Carlo methods and techniques
- Markov Chain Monte Carlo (MCMC) (including Bayesian analysis) and Metropolis Hastings algorithms
- Image and signal processing and analysis
- Data visualization
- Modeling and simulation

Examples of Research Experience and Interests

Meteorological & CO_2 Regional Modeling (Supv.: I. Fung,UCB)

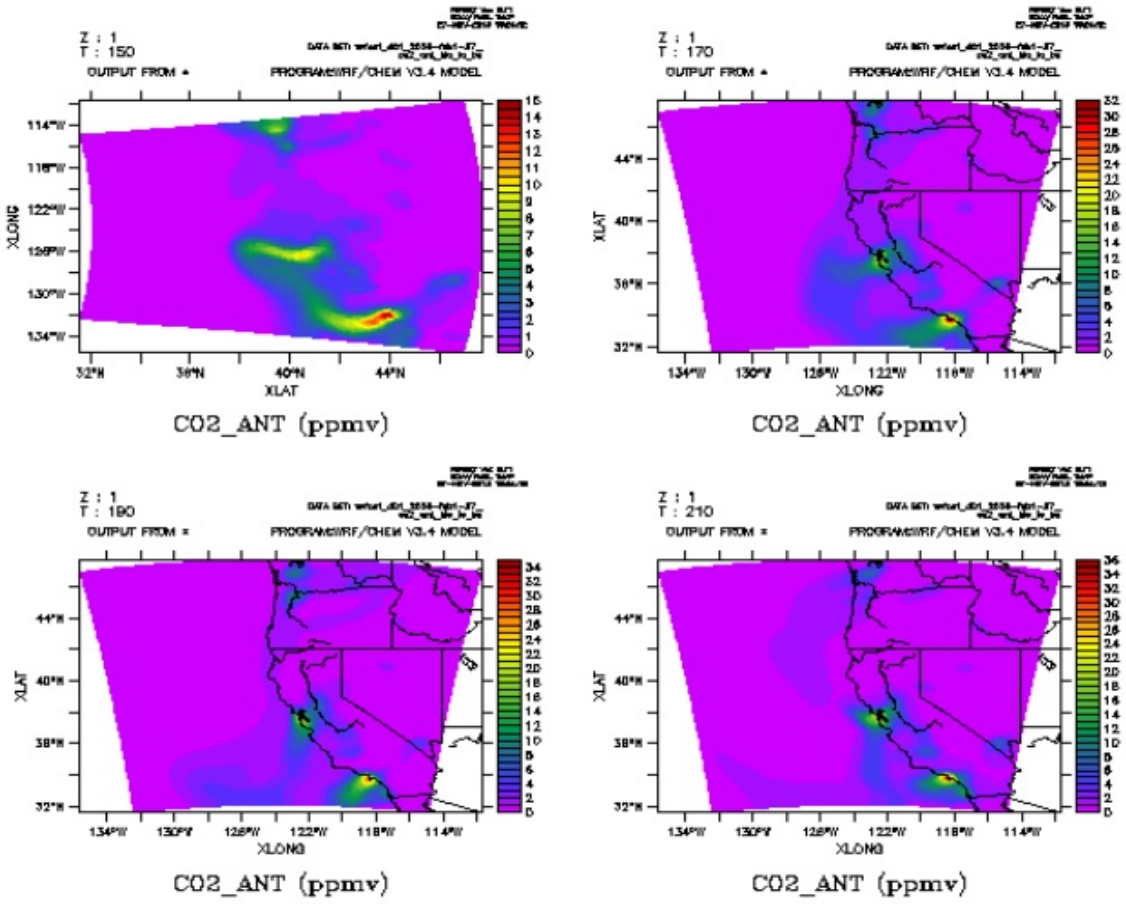
- Made extensive use of **WRF** (written mostly in **FORTRAN**), the **WRF-Chem** coupled weather-air quality model for atmospheric transport simulations, and the WRF-VPRM biospheric model to simulate CO_2 biosphere fluxes and atmospheric CO_2 concentrations. Work also involved the use of the **R statistical scripting language**, **NCAR, NCL**, **MATLAB**, **Python,** and **Ferret** for additional pre- and post-processing, modification, and visualization of **netCDF** files, and further enabling and expediting data analysis of simulation results.

Examples of Research Experience and Interests

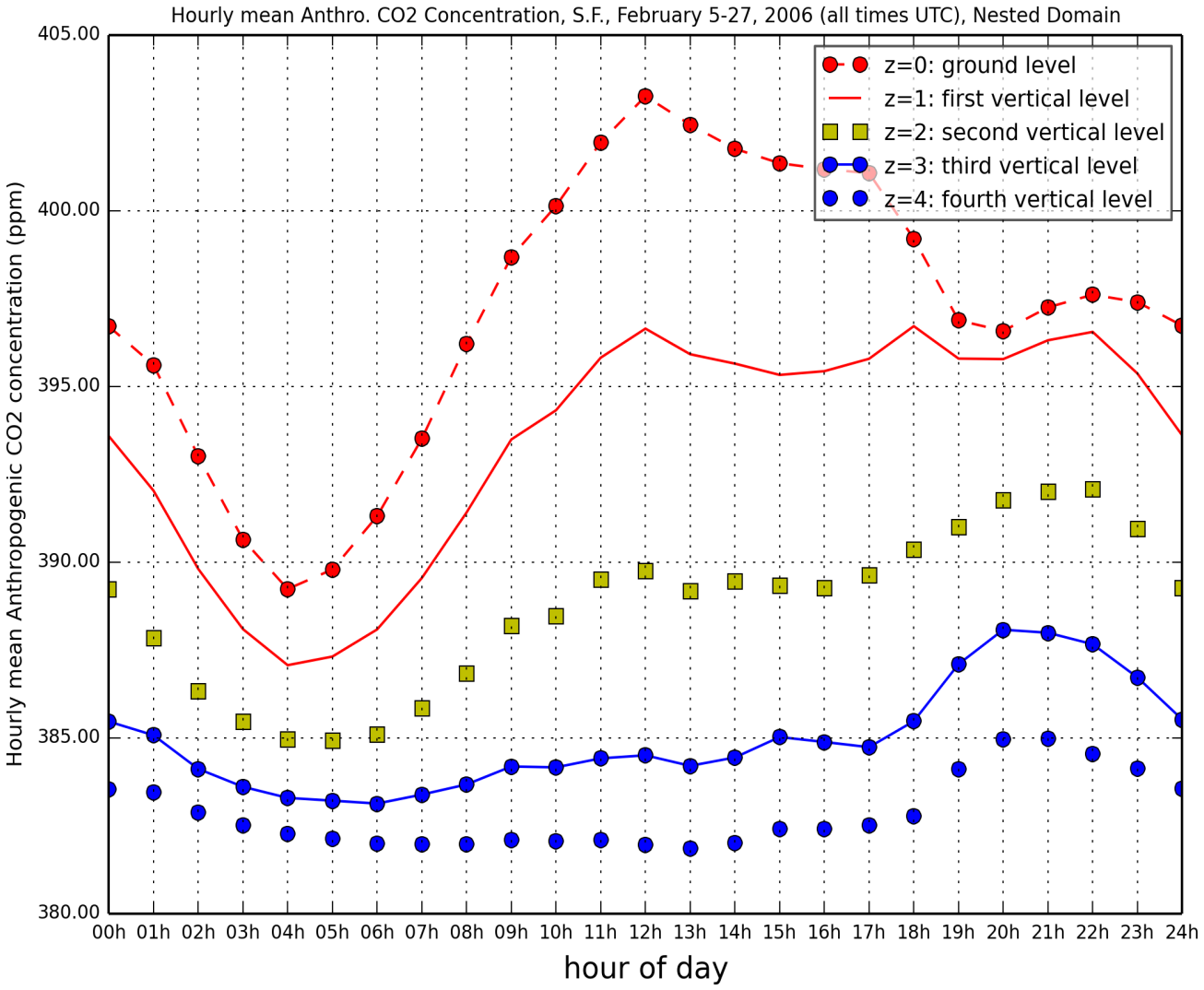
Meteorological & CO_2 Regional Modeling (Supv.: I. Fung, UCB)

- Troubleshooted and debugged **WRF**, **WRF-Chem**, and **VPRM** simulation runs and results to increase data efficiency and to decrease time to solve problems
- Installed, compiled, built and configured WRF, WRF-Chem, and VPRM on **NERSC multi-core supercomputing system** "**Hopper**" and submitted batch job scripts to this system to run the WRF model simulations
- Assisted students and post-docs in installing and configuring WRF and WRF-Chem

WRF Simulation Results: Contour Maps



WRF Simulation Results: Time Series Plots



Meteorological and CO_2 Regional Modeling

Pertinence to BIDS projects and research domain areas

- Computational Research Division (e.g., Analytics/Visualization Group) and NERSC at LBNL.
  - R&D in mathematical modeling and simulation, algorithm design, data storage, management and analysis, computer system architecture, and high-performance software implementation
- Geospatial data analysis and collection
  - **Geospatial Innovation Facility** at UCB: R&D across a broad array of integrated technologies (e.g., remote sensing, GIS, GPS, modeling, development of open source web application tools such as Cal-Adapt)
- BASC: Climate Modeling
- SDAV: scientific data management, analysis, and visualization

Examples of Research Experience and Interests

SKA Research and Development (Supv.: A. Kemball, UIUC)

- R&D in SKA calibration and processing algorithms and computing with a focus on cost and feasibility studies of radio imaging algorithms and direction-dependent calibration errors
- Evaluated the computational costs of non-deconvolved images of a number of existing radio interferometry algorithms use to deal with non-coplanar baselines in wide field radio interferometry and co-authored a corresponding internal technical report with A. Kemball

Examples of Research Experience and Interests

SKA Research and Development (Supv.: A. Kemball, UIUC)

- **M. Yashar**, A. Kemball, Computational Costs of Radio Imaging Algorithms Dealing with the Non-coplanar Baselines Effect:I, TDP Calibration and Processing Group Memo #3

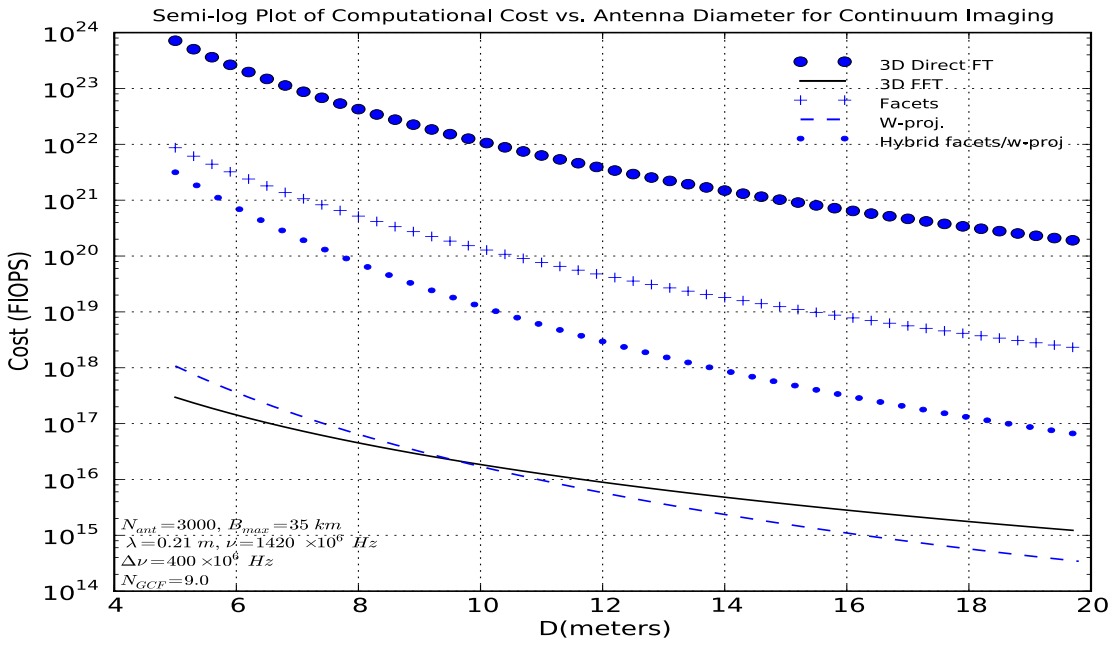


Figure 1: Semi-log y plots of computational costs (without consideration of deconvolution and parallel computing efficiency η) vs. antenna diameter D for continuum imaging for the 3-D direct FT, 3-D FFT, facets, w-projection, and hybrid facets/w-projection imaging algorithms.

Examples of Research Experience and Interests

SKA Research and Development (Supv.: A. Kemball, UIUC)

- Implemented numerical and imaging simulations (Meqtrees, CASA – **Python,C++**) and **Monte Carlo** simulations (**Python**) to address cost, feasibility, dynamic range, and image fidelity issues related to calibration and processing for SKA and dependence of these issues on key antenna and feed design parameters (e.g., sidelobe level, mount type). Co-authored corresponding technical memo: A. Kemball, T. Cornwell, **M. Yashar**, Calibration and Processing Constraints on Antenna and Feed Designs for SKA: I, TDP Calibration and Processing Group Memo #4
- Installed, built, compiled, configured C++ software development environment for CASA (gdb,ddd,Eclipse debuggers)

SKA Research and Development

Pertinence to BIDS projects and research domain areas

- Radio Astronomy Lab (RAL)
  - Radio interferometer array image modeling and analysis and imaging algorithm development
- Computational Research Division (e.g., Analytics/Visualization Group) and NERSC at LBNL.
  - R&D in mathematical modeling and simulation, algorithm design, data storage, management and analysis, computer system architecture, and high-performance software implementation
  - HPC, Big Data (for astronomy/cosmology projects).

Examples of Research Experience and Interests

Dark Energy Research (Supv.: A. Albrecht, UCD)

- MCMC analysis (involving extensive use of MATLAB code) of dark energy quintessence model (IPL or Ratra-Peebles) that included utilization of DETF data models that simulated current and future data sets from new and proposed observational programs
- Wrote and submitted batch job scripts to run MATLAB MCMC code on Linux computing cluster to expedite running of MCMC simulations and generation of MCMC output
- Troubleshooted and debugged MATLAB code, simulation runs and results

Examples of Research Experience and Interests

Dark Energy Research (Supv.: A. Albrecht, UCD)

- Lead author of paper published in Physical Review D on research results: **M. Yashar**, B. Bozek, A. Albrecht, A. Abrahamse, M. Barnard, Exploring Parameter Constraints on Quintessential Dark Energy: The Inverse Power Law Model, Physical Review D, 79, 103004, 2009.
  - From the associated likelihood contours, found that the respective increase in constraining power with higher quality data sets produced by analysis gave results that were broadly consistent with the DETF for the dark energy parameterization that they used. Also found, consistent with other findings, that for a universe containing dark energy described by the IPL potential, a cosmological constant can be excluded by high quality "Stage 4" experiments by well over 3 sigma.

Dark Energy Research

Pertinence to BIDS projects and research domain areas

- Berkeley Center for Cosmological Physics
  - Contributing to community-developed astronomical software packages in Python
  - Helping make it easier for scientists to discover, use, and contribute to open-source scientific software (DES, LSST)
  - Building tools for public to interact with peta-scale cosmology datasets
- Computational Cosmology Center
  - Developing tools, techniques, and technologies to meet analysis challenges posed by present and future cosmology data sets.

Summary

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  - Dark Energy Research
- Pertinence to BIDS data science projects, methodologies, and research domain areas at UCB.
- Please feel free to see my CV and Linkedin profile for further details, links to papers/documents, and other examples of work products

Extra Slides

Examples of Research Experience and Interests

Dark Energy Research (Supv.: A. Albrecht, UCD)

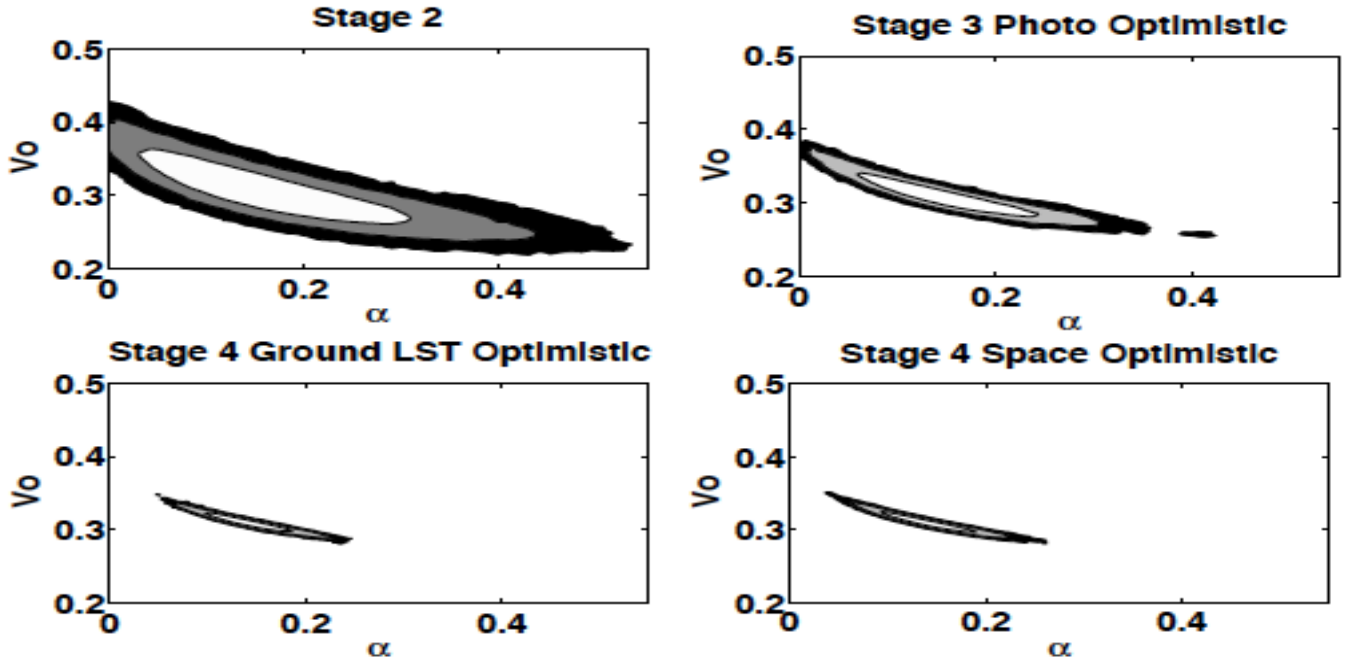

FIG. 9: $V_0 - \alpha$ 1σ (68.27%), 2σ (95.44%) and 3σ (99.73%) likelihood contours for DETF optimistic combined data sets generated from a selected IPL background cosmological model.

Computational Physics Graduate Coursework (J. Rundle, UCD)

Topics covered in course included:

- Errors, uncertainties, convergence (e.g., analyzing growth of errors, Taylor series, Gaussian integrals)
- Solving linear equations
- Numerical differentiation
- Numerical integration (quadrature)
- Ordinary differential equations
- Partial differential equations
- Fast Fourier Transforms (FFT)
- Fitting data

Data Analysis in Astrophysics Graduate Coursework (C. Fassnacht, UCD)

Topics covered in course included:

- Review of error analysis and statistics
- Fourier transforms
- Model fitting
- Forecasting errors for future experiments via Fischer Matrices
- Bayesian methods and techniques
- Error estimate via Monte Carlo techniques
- Parameter and error estimate via MCMC techniques
- Noise calculations in astrophysical measurements
- Exposure time calculations