SCIPUFF

AN OVERVIEW

Biswanath Chowdhury
Sage Management - an Xator Company

Description

- Second-order Closure Integrated Puff Model
- Gaussian puff atmospheric dispersion model
- Overlapping 3D puffs represent concentration field
- Solve ODE's for Puff moments

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History

- 1984 - Development of Hierarchy of Improved Plume Models (EPRI funded)
- 1991 - Nuclear Cloud Rise (DOD funded)
- 1995 - Hazard Prediction and Assessment Capability (HPAC) (DOD funded)
- 1998 - SCIPUFF approved as alternative model (Appendix W)
- 2000 - SCICHEM 1.0 (EPRI funded)
- 2001 - Urban Wind Field model (DOD funded)

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History (cont.)

- 2001 - Models-3/CMAQ-APT (EPRI funded)
- 2003 - Cryogenic pool model (DOD funded)
- 2004 - PRIME model in SCICHEM (EPRI funded)
- 2006 - Native coordinate support (DOD funded)
- 2009 - Source Estimation (DOD funded)
- 2011 - WRF and RAMS support (DOD funded)
- 2012-2015 - CB05 Gas Phase Chemistry, AERO5 Aerosol Chemistry (SCICHEM 3.0) (EPRI funded)

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Development Team

- **Dr. Ian Sykes** - Environmental Sciences Group Manager
  Overall model development, turbulence closure modeling of dispersion and concentration fluctuation intensity.
- **Dr. Stephen Parker** - Senior Engineer
  Graphical output, user interfaces, general code architecture.
- **Douglas Henn** - Senior Engineer
  Meteorological processing, boundary layer modeling.
- **Dr. Biswanath Chowdhury** - Senior Engineer
  Thermodynamic modeling of liquid droplets and pools, model validation, SCICHEM development and source estimation.

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Model Capabilities

Capabilities

- Transports gases, liquids and particles
- Includes primary and secondary evaporation for liquids
- Dynamics
- Variety of release types

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Release Types

- Instantaneous
- Continuous
- Moving
- Pool
- Jet
- Stack (point)
- Area
- Volume

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Unique Characteristics

- Carries variance as well as mean concentration
- Adaptive time stepping
- Adaptive grid resolution
- Efficient splitting/merging algorithm
- Laboratory scale to global scale

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Model Validation

- PGT curves for short range, surface releases
- Instantaneous dispersion data (Weil et al., Mikkelsen et al., Hogstrom)
- Laboratory dispersion and fluctuation data (Fackrell and Robins, Deardorff and Willis)
- Continental-scale ANATEX field experiment
- EPRI PMV&D tall-stack emissions experiment

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Model Validation (cont.)

- CONFLUX experiments (short range, fluctuations)
- Dugway chem/bio field tests
- Dense gas Model Data Archive (MDA)
- ATMES European tracer experiment (ETEX)
- Independent V&V studies
- Performs favorably compared to other LRT models

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Research & Development

Collaboration

- LANL – Integration with QUIC-URB model
- ENSCO - Chemical deposition
- ARIA - Plume in grid with CHIMERE model
- ENVIRON - Gas, aerosol and aqueous phase chemistry
- PSU - Ensemble modeling
- AERODYNE - Source estimation
- NCAR - Source estimation

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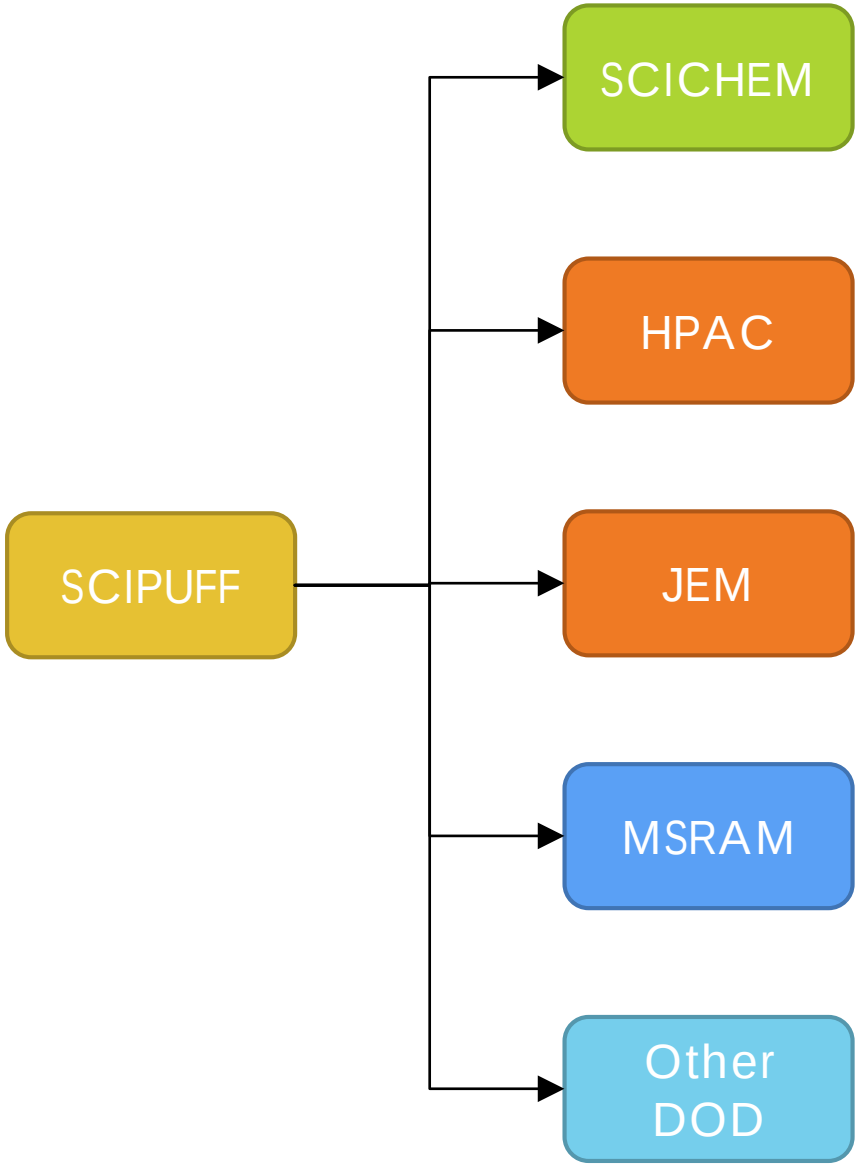
Systems using SCIPUFF

- **SCICHEM** – SCIPUFF with Chemistry
- **HPAC** - Hazard Prediction and Assessment Capability
- **JEM** - Joint Effects Model
- **MSRAM** - Maritime Security Risk Analysis Model
- Other Department of Defense systems



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Current Research & Development

- OpenMP for parallel computations
- Integration with Los Alamos National Laboratory QUIC-URB model
- SCIPUFF as inline component of WRF-ARW simulations
- Source Attribution

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R&D - Parallel SCIPUFF

- Speed increase of 1.7x - 3.4x on 4 core machines. Performance dependent on source characteristics, meteorology, sensors, etc.
- Virtually identical results between serial and parallel due to fixed list puff merging methodology.

  Maximum difference*:
  Concentration = 0% (identical)
  Deposition = 0.00004%
  Dosage = 0.000021%

* Intel Core i5, Linux OS, RAMS meteorology, continuous release, ~ 27 million data points(6,504 hours * 4,161 sensors)

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R&D - QUIC-URB Integration

- Current effort to implement QUIC-URB as a nested model
- QUIC-URB represents building flow and dispersion in near-field
  - Lagrangian particle plus “Rockle” flow field
  - Multiple buildings, complex flow
- Aggregate particles into Gaussian puffs on nest boundary
- Hand over puffs to SCIPUFF for longer ranger dispersion
- Models run concurrently with continuous transfer
  - Seamless transition across boundary

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R&D - WRF Integration

- Investigate embedding SCIPUFF inside WRF-ARW
- Run dispersion in sync with meteorology
- Direct access to full meteorological fields

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R&D - Source Attribution

- Tracking of puff source origin and time of release
- Modified puff merging scheme with release time a mass-weighted quantity within puff
- Ability to query results for new sampler sets based on time(s) of release and release ID(s)

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Conclusion

Summary

- SCIPUFF R&D ongoing and in managed environment
- Public domain source
- Sage works well with multiple contributors to advance capabilities
- Extensive model verification and validation
- Committed to regulatory air quality community

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Applications

- Air Quality Permitting – Appendix W Alternative Model:
  - Long-range transport
- Emergency Response:
  - Department Homeland Security (DHS)
  - Department of Defense (DOD)
  - Coast Guard

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