

4. Overview of WRF Program Status

WRF Executive Oversight Board

Meeting 2005-2

4th ExOB Meeting

11 August 2005

Recent Key Accomplishments of the WRF Collaboration Since April 2005

- Developed **tutorial** for 2 WRF modeling systems.
(First WRF-NMM tutorial to be held 27-29 Sept. 2005.)
- Released **WRF reference code 2.1** (August 2005) to community.
- Forecast **evaluation completed** for DTC real-time WRF winter forecast experiment conducted at Boulder DTC.
(See brief 2005-6)
- Conducted NSSL-SPC **2005 Spring Forecast Experiment** using WRF at 4 and 2 km. (Collaboration of NCAR, NCEP, NSSL, U.OK, NWS, and Pittsburgh Supercomputing Center.)
- Implemented first **operational** WRF models at **5 km**
 - Established at NCEP, 28 June 2005.
 - Both WRF cores run daily w/o convective parameterization.
- Established WRF as **primary** mesoscale modeling system supported to the **external** community.

Presentations at **2004** WRF-MM5 User's Workshop

Categorized by First-Author Affiliation

Affiliation	MM5& others	WRF*	Total
WRF Partners:			
NCAR	3	22	25
FSL		6	6
NCEP	1	7	8
AFWA	1		1
NRL		1	1
U.S. Universities	12	15	27
Other Govt. Labs	1	2	3
Private	1	2	3
Foreign	14	4	18
TOTALS (64% WRF)	33	59	92

**Includes papers comparing both WRF and MM5*

Presentations at **2005** WRF-MM5 User's Workshop

Categorized by First Author Affiliation

<u>Affiliation</u>	<u>MM5</u>	<u>WRF*</u>	<u>Total</u>
WRF Partners:			
NCAR	1	23	24
FSL		6	6
NCEP		3	3
AFWA		1	1
NRL		1	1
U.S. Universities	7	23	30
Other Govt. Labs		9	9
Private	2	3	5
Foreign	17	16	33
TOTALS	27	85	112
	(76% WRF)		

**Includes papers comparing both WRF and MM5*

WRF Three-Phase Program

- Phase 1 Status -



Phase 1 Strategy and Goals

Strategy: “Develop and **implement** WRF as the next-generation mesoscale NWP modeling system, infrastructure and process.”

Goals:

1. *Establish* common modeling **(a) software and (b) organizational infrastructures** that facilitate inter-organizational collaboration for the development and transfer of new science into a common WRF mesoscale modeling system for research and operations.
2. *Release and support* WRF as the next-generation mesoscale NWP modeling system supported to the **research community**.
3. *Implement* WRF model and infrastructure as the next-generation mesoscale NWP system used **in operations**.
4. *Create* a **sustainable repeatable process** that facilitates inter-organizational collaboration to develop and transfer new science into the common mesoscale NWP modeling infrastructure.
5. *Develop* a plan for **Phases 2 and 3**.

Quick Overview of Phase 1 Status: August '05

Goal	Threshold Activities: (Boxes indicate no. of metrics)				Objective Activities: (Boxes indicate no. metrics)			
1a	Done	<u>Done</u>	FY06	FY06	<u>FY07</u>			
1b	Done	Done	FY05	TBD	Done	Done	<u>FY06</u>	TBD
2	Done		Done	FY05	<u>Done</u>	FY05	TBD	
3	Done	Done	Done	FY06	TBD		TBD	
4	Done	Done	Done	Done	FY06	FY06	TBD	
5	Done	Done	Done	Done	<u>Done</u>	FY06	TBD	

Color key for
capability
metrics:

21 Goals achieved

11 Goals on track

7 Delayed, pending or need revision

0 Critical at-risk areas

Red outline indicates major progress since last meeting

Status of Desired Outcomes – Phase 1, Goal 1a

“A common WRF modeling infrastructure established that provides interoperability to the WRF system at level of...”

- “Software Infrastructure, allowing...
 - Input/output-field exchange *(Threshold, T)*
 - Physics exchange *(Threshold, T)*
 - Dynamic-core exchange *(Objective, O)*
- ...among WRF users.”

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
- 2 WRF cores established at NCAR, FSL, NCEP, AFWA & Univs (T)	<i>Done</i>	<i>Sept '03</i>
- 2 WRF cores <i>released</i> for community as single Reference code, with physics interoperability * (T)	<u><i>Done</i></u>	<i>June '05</i>
- <i>I/O interoperability</i> between COAMPS and WRF Reference code (T)	<i>On Track</i>	<i>FY06</i>
- <i>Physics interoperability</i> between COAMPS and WRF (T)	<i>On Track</i>	<i>FY06</i>
- <i>Core interoperability: 3 WRF-ESMF cores released to community as single Reference code (O)</i>	<u><i>On Track</i></u>	<i>FY07?</i>

Status of Desired Outcomes – Phase 1, Goal 1b

“A common WRF modeling infrastructure established that provides interoperability to the WRF system at level of...”

- “Organizational Infrastructure that...
 - Defines institutional roles of DTC and OTCs (*Threshold*)
 - Establishes common DTC (*Objective*)
 - Establish OTCs (NCEP + shared DoD).” (*Objective*)

<u>Capability Metrics</u>	<u>Status</u>	<u>Susp.Date</u>
- DoD OTC proposal submitted and approved (T)	Done	Apr '03
- DTC (Boulder) proposal approved (T)	Done	Mar '04
- DTC functional (O)	Done	Mar '04
- Distributed-DTC TOR written and signed (T)	Signing	Aug '05
- Distributed DTC functional (O)	<u>On Track</u>	Apr '06
- OTC functional at DoD (AFWA/FNMOC) (O)		
- AFWA	Done	Jul '04
- FNMOC	Done	Sep '04
- NCEP OTC proposal written and approved (T)	Written	TBD
- OTC functional at NCEP (O)	Pending	TBD

Status of Desired Outcomes – Phase 1, Goal 2

“WRF modeling system **released and supported to the research community** at a level that defines and supports...”

- “Reference code for **one core** to the research community (*Threshold*)
- Reference code for **three cores** to the research community.” (*Objective*)

<u>Capability Metrics</u>	<u>Status</u>	<u>Susp.Date</u>
- Eulerian mass core (WRFv1.0) in code repository (Reference code) and supported to community (tutorial) (T)	Done	Jun '03
- WRF-ARWv2.0 Advanced Research WRF Reference code with two-way grid nesting supported to community (T)	Done	May '04
- One core supported with grid nudging (T)	On track	Sept '05
- WRFv2.0 Reference code with two cores supported to community (O) (with documentation + tutorial)	On track	Sept '05
- WRF with grid nesting for two cores supported to community (O)	<u>Done</u>	Aug '05
- WRF-ESMF with three cores supported to community (O) (documentation + tutorial)	Under Revision	TBD

Status of Desired Outcomes – Phase 1, Goal 3

“WRF model and infrastructure **implemented** as the next-generation mesoscale NWP system used **in operations ...**”

- “... At 2 operational NWP centers *(Threshold)*
- At all three operational NWP centers.” *(Objective)*

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
- <i>End-to-end real time WRF experimental systems running daily at NCEP and AFWA (T)</i>	<i>Done</i>	<i>Oct '03</i>
- <i>DTC retrospective testing of WRF completed and statistics available (as per WRF Test Plan) (T)</i>	<i>Done</i>	<i>Jun '04</i>
- <i>WRF (two cores) implemented operationally at NCEP in Hi-Res Window domains (T)</i>	<i>Done</i>	<i>Sep '04</i>
- <i>WRF (one core) implemented operationally at AFWA in classified domains (T)</i>	<i>On track</i>	<i>Q1/FY06</i>
- <i>WRF-ESMF-based COAMPS experimental system running daily at FNMOC (O)</i>	<i>Under Revision</i>	<i>TBD</i>
- <i>WRF-ESMF-COAMPS implemented operationally at FNMOC (O)</i>	<i>Under Revis'n</i>	<i>TBD</i>

Status of Desired Outcomes – Phase 1, Goal 4

“**Sustainable repeatable process created** that facilitates inter-organizational collaboration to develop and transition new science into the common mesoscale NWP modeling infrastructure, including...”

- “WRF organization and roles defined *(Threshold)*
- WRF annual operating plan developed *(Threshold)*
- WRF 5-Year plan developed *(Threshold)*
- WRF resource plan defined.” *(Objective)*

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
- <i>DTC and NCEP-OTC organization and roles proposed (T)</i>	<i>Done</i>	<i>Dec '03</i>
- <i>WRF program Management Plan approved by ExOB (T)</i>	<i>Done</i>	<i>Dec '03</i>
- <i>WRF Management charters (roles) & appointments approved (T)</i>	<i>Done</i>	<i>Aug '04</i>
- <i>DTC FY05 annual operating plan developed & approved (T)</i>	<i>Done</i>	<i>Feb '05</i>
- <i>Preliminary WRF 5-Year Plan developed and submitted (T)</i>	<i>On Track</i>	<i>Nov '05</i>
- <i>Comprehensive WRF 5-Year Plan developed and submitted (T)</i>	<i>On Track</i>	<i>Feb '06</i>
- <i>WRF interagency resource plan defined (O)</i>	<i>Pending</i>	<i>TBD</i>

Status of Desired Outcomes – Phase 1, Goal 5

“Plan for Phases 2 and 3 developed, including...

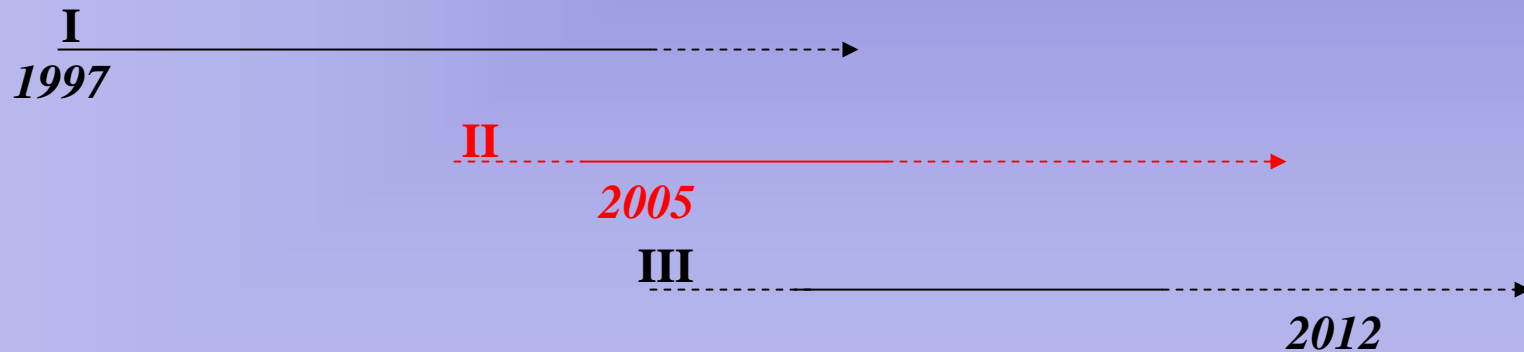
- **Significant deficiencies identified** and prioritized in Phase 1 WRF modeling system, common modeling infrastructure (CMI) and process (threshold)
- Strategy, roadmap and resource plans developed for each (threshold)
- At least one cycle of improvement executed to demonstrate repeatability
 - for one of three areas (**CMI**) (threshold)
 - for all three areas (objective)
- Funding strategy identified to entrain university community
 - strategy developed (threshold)
 - strategy implemented (objective)

Capability Metrics

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
- Critical deficiency identified in WRF infrastructure (T)	1 Done	Jul '03
- Strategy, roadmap and resource plan developed for infrastructure documentation, training and code streamlining (T)	Done	Sep '03
- Infrastructure training held for WRF signatories (T)	2 Done	Jan '04
- Infrastructure documentation draft complete (T)	3 Done	Dec '04
- Infrastructure documentation finished & released (T)	Done	Jan '05
- Infrastructure streamlining strategy developed (T)	4 On track	Oct '05
- Infrastructure streamlining completed (T)	5 Pending	TBD
- Infrastructure “understudy” position fully functional (T)	6 Done	May '05
- Funding strategy developed to entrain universities (T)	7 Done	Jul '04

WRF Three-Phase Program

- Phase 2 Status -



Phase 2: Strategy

“Use the WRF process and infrastructure to **infuse and sustain** the flow of new science and technology into the WRF mesoscale NWP modeling system to improve operations and to open new research opportunities:”

- *Identify* significant deficiencies in Phase 1 WRF:
 - modeling system
 - **common modeling infrastructure**
 - process
- *Develop* strategy, roadmap and resource plan for each
- *Execute* at least one cycle of improvement in all three areas to demonstrate repeatability

Phase 2: Critical Deficiency Identified

- “The **WRF Software Infrastructure** is complex, difficult for new users to understand, lacks in-depth documentation, and is fully known to only one person (single point of failure)”

ExOB Mtg., 1 Dec 2003

Goals for Alleviating WRF Infrastructure Deficiency

1 Dec 2003

1. **Modify existing WRF Software Infrastructure** to enhance its functionality, usability and extensibility in sync with an ESMF end state
2. **Provide second full-depth expert** for WRF infrastructure support to alleviate “single point of failure”
3. **Publish developer-level documentation** that enables experienced programmers to implement & extend WRF codes for research and operations.
4. **Upgrade user support services** through WRF infrastructure problem-logging and “help-desk”
5. **Establish infrastructure training** for new and advanced users

Quick Overview of Phase 2

Infrastructure Deficiency Status: April '05

Goal	Threshold Activities: (Boxes indicate no.of metrics)			Objective Activities: (Boxes indicate no. metrics)	
1	TBD	TBD	TBD	<u>FY06</u>	TBD
2	Done	<u>Done</u>		<u>FY07</u>	TBD
3	Done			Done	
4	Done			Done	
5	Done			TBD	

Color key for capability metrics:

7 Goals achieved

2 Goals on track

6 Delayed, pending or need revision

0 Critical at-risk areas

Red outline indicates major change since last meeting

Status of Desired Outcomes for Phase 2: Alleviating Infrastructure Deficiency – Goal 1

- “WRF **Software Infrastructure is modified** to provide different levels of complexity necessary to satisfy different functions, such that...
 - Current infrastructure is **optimized for run-time efficiency** (*Threshold*) for two cores, maintaining flexibility for research users
 - Infrastructure is **streamlined/rewritten** to enhance usability (*Threshold*) for advanced users, with efficiency & threshold functionality
 - Infrastructure is **extended** to establish compatibility with (*Objective*) ESMF standards and linkage to global capability”

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
<i>- Two WRF cores in current infrastructure optimized for run time efficiency (T)</i>	<i>On hold</i>	<i>TBD</i>
<i>- Plan developed to rewrite a streamlined WRF infrastructure that maintains efficiency & threshold functionality (T)</i>	<i>Pending</i>	<i>Jan '06</i>
<i>- Efficient, more understandable, streamlined infrastructure completed (T)</i>	<i>Pending</i>	<i>TBD</i>
<i>- Plan developed to extend WRF infrastructure to establish compatibility with ESMF standards and linkage to global capability (O)</i>	<i>On Track</i>	<i>Jan '06</i>
<i>- WRF infrastructure extended to be ESMF compliant and supporting global capability (O)</i>	<i>Pending</i>	<i>TBD</i>

Status of Desired Outcomes for Phase 2: Alleviating Infrastructure Deficiency – Goal 2

“**Second full-depth expert provided** for WRF infrastructure support to alleviate single point of failure by...

- Hiring infrastructure understudy at DTC *(Threshold)*
- Having infrastructure understudy fully trained and able to provide range of user support *(Threshold)*
- Having infrastructure understudy train others at OPCs and partner research labs to establish local full-depth infrastructure expertise” *(Objective)*

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
<i>- Infrastructure understudy hired and on site at NCAR/MMM (T)</i>	<i>Done</i>	<i>Sep. '04</i>
<i>- Infrastructure understudy fully trained and able to provide range of user support (T)</i>	<i>Done</i>	<i>May '05</i>
<i>- Full-depth infrastructure expertise established at two OPCs and two partner research labs (O)</i>	<i>On Track</i>	<i>Mar '07</i>
<i>- Full-depth infrastructure expertise established at three OPCs and all signatory research labs (O)</i>	<i>Pending</i>	<i>TBD</i>

Status of Desired Outcomes for Phase 2: Alleviating Infrastructure Deficiency – Goal 3

“**Developer-level documentation published** that enables experienced programmers to implement & extend WRF codes for research and operations, by...

- Completing draft version of WRF Infrastructure developer-level documentation *(Threshold)*
- Completing final version of WRF infrastructure developer-level documentation reviewed and published” *(Objective)*

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
<i>- Draft version of WRF infrastructure developer-level documentation completed (T)</i>	<i>Done</i>	<i>Sep. '04</i>
<i>- Final version of WRF infrastructure developer-level documentation completed, reviewed and published (O)</i>	<i>Done</i>	<i>Dec. '04</i>

Status of Desired Outcomes for Phase 2: Alleviating Infrastructure Deficiency – Goal 4

“WRF **problem-logging and ‘help-desk’** support services upgraded for users,
by...

- Establishing routine call-in support for users of the WRF infrastructure via “understudy” *(Threshold)*
- Establishing enhanced on-line web site for logging user problems & coordinating assistance on infrastructure issues” *(Objective)*

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
<i>- Routine call-in support established for users of the WRF infrastructure (T)</i>	<i>Done</i>	<i>Sep '04</i>
<i>- On-line web site enhanced for logging user problems and coordinating assistance on infrastructure issues (O)</i>	<i>Done</i>	<i>Jan '05</i>

Status of Desired Outcomes for Phase 2: Alleviating Infrastructure Deficiency – Goal 5

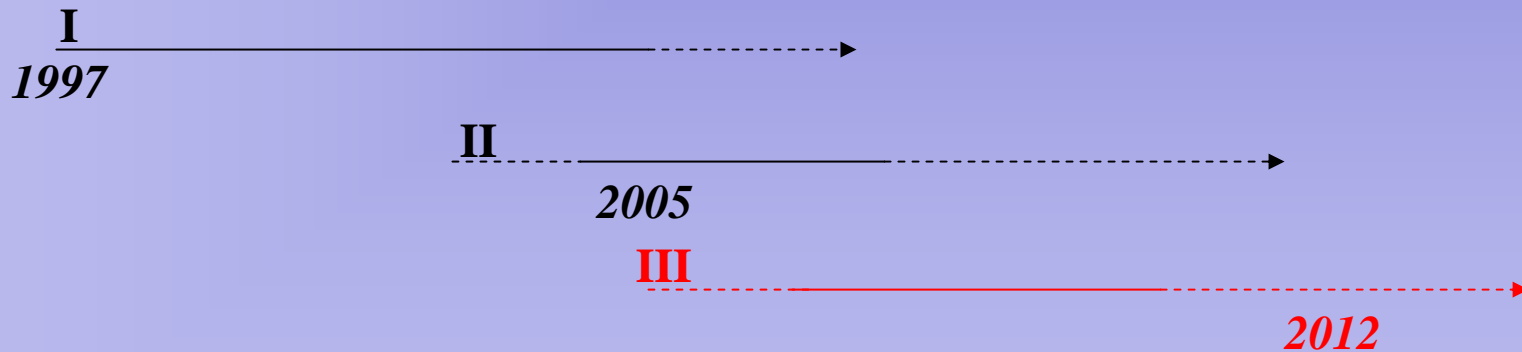
“**Infrastructure training established** for new and advanced WRF users,
by...

- Completing a special WRF infrastructure training workshop for at least one group of users *(Threshold)*
- Establishing routinely scheduled tutorial classes for training in the WRF infrastructure” *(Objective)*

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
<i>- Special training workshop on the WRF infrastructure completed for one group of users (T)</i>	<i>Done</i>	<i>Jan '04</i>
<i>- Routinely scheduled tutorial classes established for training in the WRF infrastructure (O)</i>	<i>Pending</i>	<i>TBD</i>

WRF Three-Phase Program

- Phase 3 Status -



Phase 3 Strategy and Goals

Strategy: **“Extend WRF collaboration into other modeling areas of mutual interest—e.g., Ocean modeling, Global modeling, Climate modeling, Diagnostic and Statistical post-processing”**

Goals:

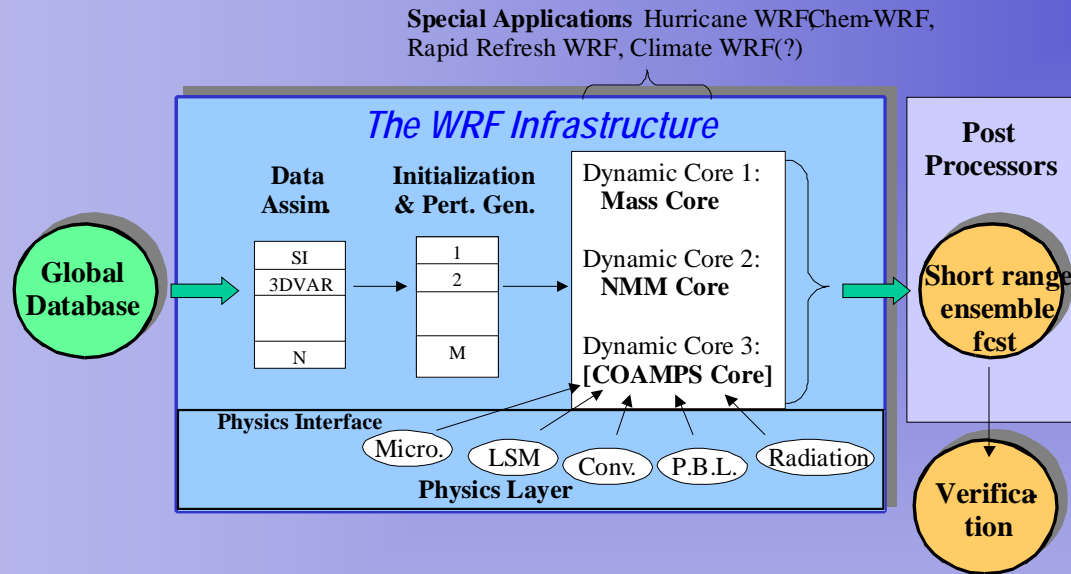
- 1. Identify additional areas of desired collaboration*
e.g. - Unified Global-Regional WRF system (proposed by COPC)
- 2. Develop strategy, roadmap and resource plan for each*

Initiation of Phase 3 requires development of Vision statement, Focused goals, Executive-level roadmap and Resource plan, as per Phase 1, Goal 5.

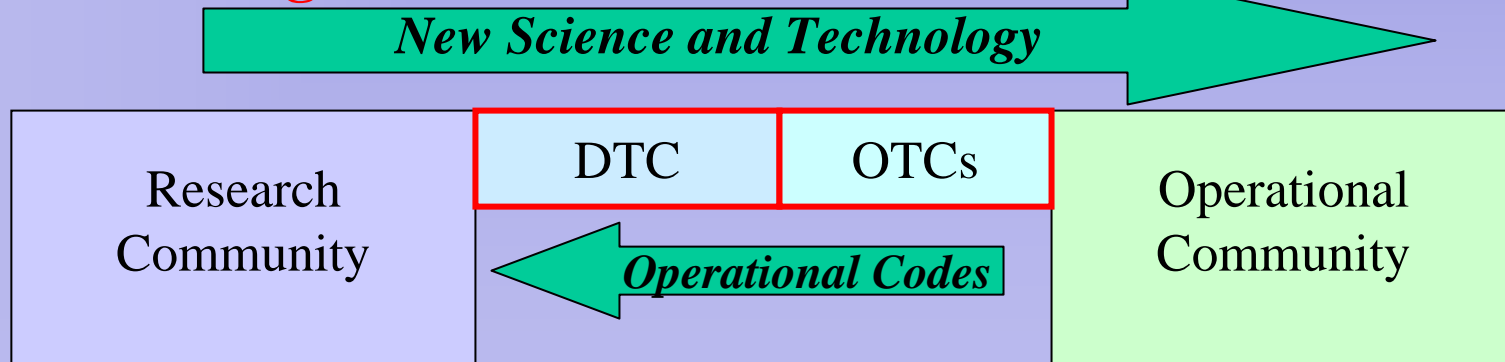
Backup Slides

The WRF Modeling Infrastructure is two-fold

1a. WRF Software Infrastructure :



1b. Organizational Infrastructure:



Previous Key Accomplishments of the WRF Collaboration - 1

- **Implemented first operational WRF models – 21 Sept 2004**
 - **NCEP running both WRF cores daily in its Hi-Res. Window domains**
- **Created distributed WRF Development Testbed Center**
- **Created DoD Operational Testbed Center**
- **Conducted real-time WRF winter forecast experiment at DTC-Boulder**
 - **5-km CONUS domain, 2 cores**
 - **Major collaborative effort by NCAR, FSL, AFWA and NCEP**
- **Developed strong WRF-DTC working relationship with NCEP**
 - **Transition projects undertaken at request of NCEP/EMC**
- **Established WRF as basis for stronger collaboration among U.S. OPCs**
 - **Concept of Operations signed (April '05)**
 - **WRF Joint Implementation Plan for North America**
 - **WRF Joint Ensemble Prediction System**

Previous Key Accomplishments of the WRF Collaboration - 2

- **Rapid expansion of WRF user community**
 - **Over 2000 registered users worldwide by June 2004**
- **Rapid expansion of WRF research and training opportunities**
 - **173 scientists attend 2004 NCAR's WRF Users Workshop**
 - **335 cumulative attendees of NCAR's WRF-ARW tutorials by 2004**
- **Extensive WRF retrospective testing at Boulder DTC**
 - **2000 runs, all seasons, multiple domains and configurations**
 - **Collaborative effort by NCAR, NCEP, FSL, AFWA and NAVO**
- **WRF real-time testing conducted at NOAA's Storm Prediction Center**
 - **Forecaster evaluations over past 3 Spring seasons**
 - **Over 80 participants from U.S., Canada and Finland ('03 & '04)**
- **Nearly two years of real-time testing with two cores at NCEP's EMC**
- **Several physics codes from international community interoperable in WRF**