

# **3. WRF Program Status and Action Items Briefing**

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WRF Executive Oversight Board

Meeting 2006-1

NCAR, Boulder, CO

5 January 2006

# Recent Key Accomplishments of the WRF Collaboration Since August 2005

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- **Conducted tutorials** for 2 WRF modeling systems. (NCAR and DTC)  
(First WRF-NMM tutorial held 27-29 September 2005)
- **Released WRF reference code 2.1.1** to community  
(November 2005, NCAR)
- **Completed WRF Joint Implementation Plan;** under review by 3 OPCs  
(Nov. 2005, COPC JAG/Operational Community Modeling)
- **Implemented first operational ensemble fcst** system with both WRF cores  
(December 2005, NCEP)
- **Conducted first full-season testing of WRF for tropical cyclones** in 2005
  - Hurricane-WRF-NMM (NCEP, 4 X daily)
  - WRF-ARW for Hurricanes (NCAR, selected storms/cases)
- **Conducted first DTC planning cycle** with guidance from broad-based Advisory Panel (see DTC status briefing for details)

# WRF Three-Phase Program

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## - Phase 1 Status -



# Phase 1 Strategy and Goals

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*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**.

# Overview of Phase 1 Status: January '06

Goal	Threshold Activities: (Boxes indicate no. of metrics)				Objective Activities: (Boxes indicate no. metrics)				
1a	Done	Done	FY06	FY06	FY10				
1b	Done	Done	TBD	TBD	Done	Done	FY06	TBD	
2	Done		Done		TBD		Done	FY06	TBD
3	Done	Done	Done	FY06	TBD		TBD		
4	Done	Done	Done	Done	FY06	FY06	TBD		
5	Done	Done	Done	Done	Done	FY06	TBD		

*No significant changes since August 2005. Two tasks now placed on "hold".*

*Color key for capability metrics:*

21 Goals achieved (no chg)

9 Goals on track (2 less)

9 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
- Physics exchange
- Dynamic-core exchange

*Note: FSL has been renamed Global Systems Division*

*(Threshold, T)*  
*(Threshold, T)*  
*(Objective, O)*

...among WRF users.”

<u>Capability Metrics</u>	<u>Status</u>	<u>Susp.Date</u>
- 2 WRF cores established at NCAR, GSD, NCEP, AFWA & Univs (T)	Done	Sept '03
- 2 WRF cores released for community as single Reference code, with physics interoperability * (T)	Done	Aug '05
- <b>I/O interoperability</b> between COAMPS and WRF Reference code (T)	On Track	FY06
- <b>Physics interoperability</b> between COAMPS and WRF (T)	On Track	FY06
- <b>Core interoperability</b> : 3 <b>WRF-ESMF cores</b> released to community as single Reference code (O)	Delayed	FY10 <i>(see WJIP, Fig.4)</i>

\* **Blue** indicates progress since WRF ExOb mtg. of 11 August '05; **Violet** indicates revision

# 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...

Note: Metric for TOR  
downgraded from  
“on track” to “on hold”

- 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 (Boulder) functional (O)	Done	Mar '04
- TOR for Distributed-DTC written (T) (no signatures)	On “hold”	TBD
- Distributed DTC functional (O)	On Track	Apr '06
- OTC functional at DoD (AFWA/FNMOC) (O)	} Done	{ Jul '04 Sep '04
- AFWA		
- FNMOC		
- NCEP OTC → Proposal for DTC-EMC node written) (T) Discussion	TBD	
- NCEP OTC functional → DTC-EMC node functional (O) Discussion	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*)

Note: Metric for nudging downgraded from “on track” to “on hold”

<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 <b>grid nudging</b> (T) (PSU seeking funds) On “hold” TBD		
- WRFv2.0 Reference code with <b>two cores supported to community</b> (O) (with documentation + tutorial)	Done	Sept '05
- WRF with <b>grid nesting</b> for two cores supported to community (O)	Delayed	June '06
- WRF-ESMF with three cores supported to research community (documentation + tutorial) (O)	Under Study	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 (T) in Hi-Res domains (04'), Hi-Res upgrade to 5 km ('05), SREF ('05), WRF-NAM (NMM) operational Mar '06</i>	<i>Done</i>	<i>Sep '04</i>
- <i>WRF (ARW) implemented operationally at AFWA in classified domains (T)</i>	<i>On track</i>	<i>Q2/FY06</i>
- <i>WRF-ESMF-based COAMPS experimental system running daily at FNMOC (O)</i>	<i>Under Study</i>	<i>TBD</i>
- <i>WRF-ESMF-COAMPS implemented operationally at FNMOC (O)</i>	<i>Under Study</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>
- DTC and OTC organization and roles proposed (T)	Done	Dec '03
- WRF program Management Plan approved by ExOB (T)	Done	Dec '03
- WRF Management charters (roles) & appointments approved (T)	Done	Aug '04
- DTC FY06 <b>annual operating plan</b> developed & approved (T)	Done	Jan '06
- <b>Preliminary WRF 5-Year Plan</b> developed and submitted (T)	Delayed	Jun '06
- <b>Comprehensive WRF 5-Year Plan</b> developed and submitted (T)	Delayed	Oct '06
- WRF interagency resource plan defined (O)	Under Study	TBD

# 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)

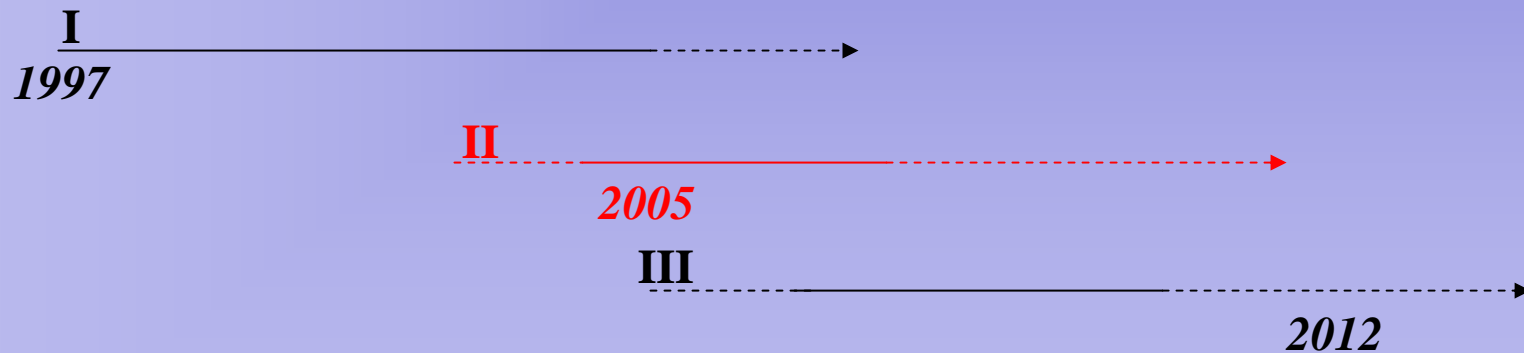
## Capability Metrics

	Status	Susp.Date
- 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
- <b>Infrastructure streamlining strategy developed (T)</b>	4 <b>Delayed</b>	<b>June '06</b>
- Infrastructure streamlining completed (O)	5 Pending	TBD
- Infrastructure “understudy” position fully functional (T)	6 Done	May '05
- Funding strategy developed to entrain universities (T)	7 Done	Jul '04 <sup>11</sup>

# WRF Three-Phase Program

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- Phase 2 Status -



# Phase 2: Strategy

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“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** (see slide 14)
  - **Process** (see slide 14)
- **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 Deficiencies Identified

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1. “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*

2. “Options are needed to establish a more firm **management plan** to sustain the WRF Program, including **resourcing for the WRF DTC**”

*ExOB Mtg., 11 Aug 2005*

*New*

# Deficiency 1:

## Goals for Alleviating WRF Infrastructure Deficiency

- 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**

# Recent Activity in support of Goal 1: Technical Workshop on Converging WRF and ESMF

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## Workshop planning:

- **Format: Technical experts on infrastructure design and/or use** Done
- **Charge to workshop participants** Done
- **Develop list of invitees** Done \*
- **Supporting materials prepared** Underway
- **Date selected (Feb. 9, 2006)** Done
- **Invitation notice distributed** Done
- **Meeting logistics: At Center Green, NCAR** Done

## Workshop follow-up:

- **Write workshop report, with options, for code convergence and streamlining**
- **Report to be reviewed by managers representing WRF research and operations organizations. (Make use of Program Office)**
- **Reconcile managers' review with technical team, as necessary**
- **Deliver final report to ExOB for approval and resourcing**
- **Implement WRF-ESMF convergence and streamlining plan**

*\* May be revised as workshop approaches*

## **Deficiency 2: Alleviating WRF Process Deficiency**

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**See Brief 7: *Transforming WRF from a “project” to a program***

# Deficiency 1: Overview of Infrastructure Deficiency Status: January '06

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



*Little change since Aug '05. See backup slides for details.*

*Color key for capability metrics:*

8 Goals achieved

3 Goals on track

4 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 &amp; threshold functionality (T)</i>	<i>Delayed</i>	<i>Jun '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>First phase done</i>	<i>Sept '05</i>
- <i>WRF infrastructure extended to be compatible with ESMF standards and supporting global capability (O)</i>	<i>Final test on hold pending ESMF development</i>	<i>FY06?</i>

# Backup Slides

# 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...

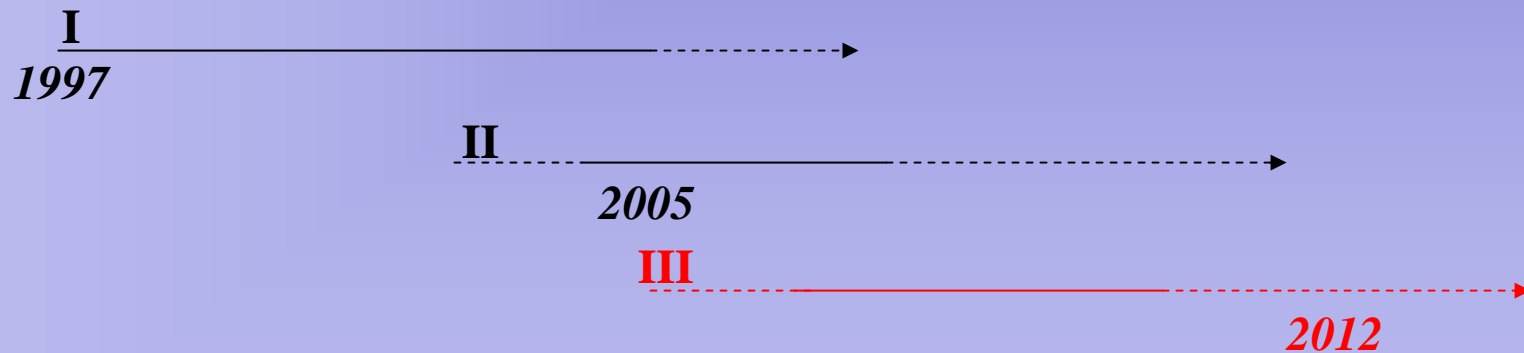
- Completing a special WRF infrastructure training workshop for at least one group of users *(Threshold)*
- Establishing routinely scheduled tutorial classes for training in the WRF infrastructure” *(Objective)*

<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

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## - Phase 3 Status -



# Phase 3 Strategy and Goals

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

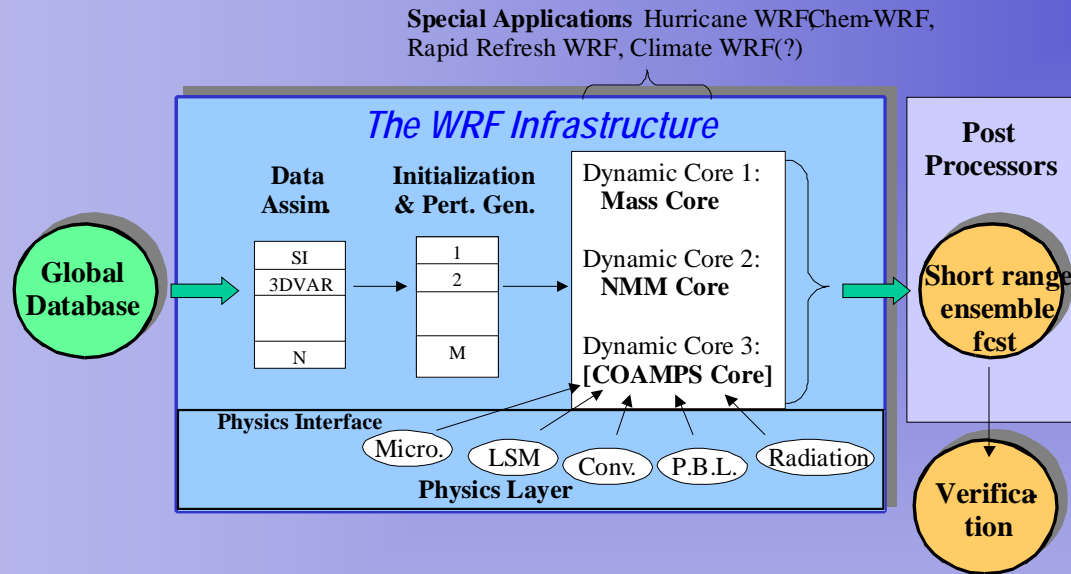
## **Goals:**

- 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**

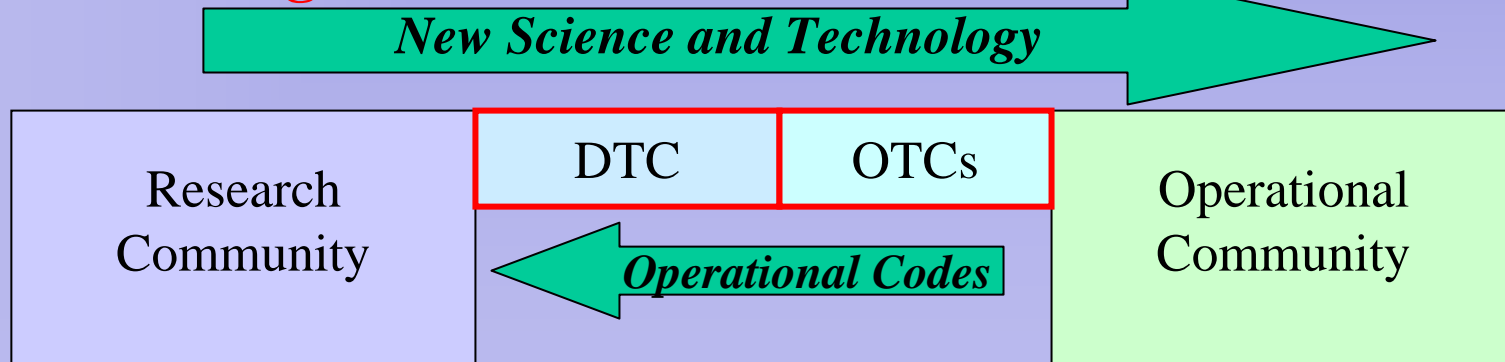
***\* Initiation of Phase 3 will require development of a vision statement, focused goals, an executive-level roadmap and a resource plan, as per Phase 1, Goal 5. These are future activities.***

# The WRF Modeling Infrastructure is two-fold

## 1a. WRF Software Infrastructure :



## 1b. Organizational Infrastructure:



# Previous Key Accomplishments of the WRF Collaboration - 1

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- **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, GSD, 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

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- **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, GSD, 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**

# Previous Key Accomplishments of the WRF Collaboration - 3

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- **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.**